The package nicematrix*

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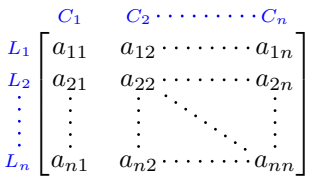
Abstract

The LaTeX package nicematrix provides new environments similar to the classical environments `{tabular}`, `{array}` and `{matrix}` of array and amsmath but with extended features.



Product	dimensions (cm)			Price
	L	l	h	
small	3	5.5	1	30
standard	5.5	8	1.5	50.5
premium	8.5	10.5	2	80
extra	8.5	10	1.5	85.5
special	12	12	0.5	70

The package nicematrix is entirely contained in the file `nicematrix.sty`. This file may be put in the current directory or in a `texmf` tree. However, the best is to install nicematrix with a TeX distribution as MiKTeX, TeXlive or MacTeX.

Remark: If you use LaTeX via Internet with, for example, Overleaf, you can upload the file `nicematrix.sty` in the repertory of your project in order to take full advantage of the latest version de nicematrix.[1]

This package can be used with `xelatex`, `lualatex`, `pdflatex` but also by the classical workflow `latex-dvips-ps2pdf` (or Adobe Distiller). *However, the file nicematrix.dtx of the present documentation should be compiled with XeLaTeX.*

This package requires and **loads** the packages l3keys2e, array, amsmath, pgfcore and the module shapes of PGF (tikz, which is a layer over PGF is *not* loaded). The final user only has to load the package with `\usepackage{nicematrix}`.

The idea of nicematrix is to create PGF nodes under the cells and the positions of the rules of the tabular created by array and to use these nodes to develop new features. As usual with PGF, the coordinates of these nodes are written in the `.aux` to be used on the next compilation and that's why nicematrix may need **several compilations**.[2]

Most features of nicematrix may be used without explicit use of PGF or Tikz (which, in fact, is not loaded by default).

A command `\NiceMatrixOptions` is provided to fix the options (the scope of the options fixed by this command is the current TeX group: they are semi-global).

*This document corresponds to the version 5.18 of nicematrix, at the date of 2021/07/15.

[1] The latest version of the file `nicematrix.sty` may be downloaded from the SVN server of TeXLive:
https://www.tug.org/svn/texlive/trunk/Master/texmf-dist/tex/latex/nicematrix/nicematrix.sty

[2] If you use Overleaf, Overleaf will do automatically the right number of compilations.

1 The environments of this package

The package nicematrix defines the following new environments.

{NiceTabular}	{NiceArray}	{NiceMatrix}
{NiceTabular*}	{pNiceArray}	{pNiceMatrix}
	{bNiceArray}	{bNiceMatrix}
	{BNiceArray}	{BNiceMatrix}
	{vNiceArray}	{vNiceMatrix}
	{VNiceArray}	{VNiceMatrix}

The environments {NiceArray}, {NiceTabular} and {NiceTabular*} are similar to the environments {array}, {tabular} and {tabular*} of the package array (which is loaded by nicematrix).

The environments {pNiceArray}, {bNiceArray}, etc. have no equivalent in array.

The environments {NiceMatrix}, {pNiceMatrix}, etc. are similar to the corresponding environments of amsmath (which is loaded by nicematrix): {matrix}, {pmatrix}, etc.

It's recommended to use primarily the classical environments and to use the environments of nicematrix only when some feature provided by these environments is used (this will save memory).

All the environments of the package nicematrix accept, between square brackets, an optional list of *key=value* pairs. **There must be no space before the opening bracket ([) of this list of options.**

Important
Before the version 5.0, it was mandatory to use, for technical reasons, the letters L, C et R instead of l, c et r in the preambles of the environments of nicematrix. If we want to be able to go on using these letters, nicematrix must be loaded with the option define-L-C-R.

```
\usepackage[define-L-C-R]{nicematrix}
```

This key will probably be deleted in a future version of nicematrix.

2 The vertical space between the rows

It's well known that some rows of the arrays created by default with LaTeX are, by default, too close to each other. Here is a classical example.

```
$\begin{pmatrix}
\frac12 & -\frac12 \\
\frac13 & \frac14 \\
\end{pmatrix}$
```

$$\begin{pmatrix} \frac{1}{2} & -\frac{1}{2} \\ \frac{1}{3} & \frac{1}{4} \end{pmatrix}$$

Inspired by the package cellspace which deals with that problem, the package nicematrix provides two keys cell-space-top-limit and cell-space-bottom-limit similar to the parameters \cellspacetoplimit and \cellspacebottomlimit of cellspace.
There is also a key cell-space-limits to set both parameters at once.
The initial value of these parameters is 0 pt in order to have for the environments of nicematrix the same behaviour as those of array and amsmath. However, a value of 1 pt would probably be a good choice and we suggest to set them with \NiceMatrixOptions.[3]

```
\NiceMatrixOptions{cell-space-limits = 1pt}
```

[3] One should remark that these parameters apply also to the columns of type S of siunitx whereas the package cellspace is not able to act on such columns of type S.

```
$\begin{pNiceMatrix}
\frac12 & -\frac12 \\
\frac13 & \frac14 \\
\end{pNiceMatrix}$
```

$$\begin{pmatrix} \frac{1}{2} & -\frac{1}{2} \\ \frac{1}{3} & \frac{1}{4} \end{pmatrix}$$

3 The vertical position of the arrays

The package nicematrix provides a option `baseline` for the vertical position of the arrays. This option takes in as value an integer which is the number of the row on which the array will be aligned.

```
$A = \begin{pNiceMatrix}[baseline=2]
\frac{1}{\sqrt{1+p^2}} & p & 1-p \\
1 & 1 & 1 \\
1 & p & 1+p
\end{pNiceMatrix}$
```

$$A = \begin{pmatrix} \frac{1}{\sqrt{1+p^2}} & p & 1-p \\ 1 & 1 & 1 \\ 1 & p & 1+p \end{pmatrix}$$

It's also possible to use the option `baseline` with one of the special values `t`, `c` or `b`. These letters may also be used absolutely like the option of the environments `{tabular}` and `{array}` of array. The initial value of `baseline` is `c`.

In the following example, we use the option `t` (equivalent to `baseline=t`) immediately after an `\item` of list. One should remark that the presence of a `\hline` at the beginning of the array doesn't prevent the alignment of the baseline with the baseline of the first row (with `{tabular}` or `{array}` of array, one must use `\firsthline`).

```
\begin{enumerate}
\item an item
\smallskip
\item \renewcommand{\arraystretch}{1.2}
$\begin{NiceArray}[t]{lcccccc}
\hline
n   & 0 & 1 & 2 & 3 & 4  & 5 \\
u_n & 1 & 2 & 4 & 8 & 16 & 32
\hline
\end{NiceArray}$
\end{enumerate}
```

1. an item
2. | n | 0 | 1 | 2 | 3 | 4 | 5 |
   |---|---|---|---|---|---|---|
   | u_n | 1 | 2 | 4 | 8 | 16 | 32 |

However, it's also possible to use the tools of booktabs[4]: `\toprule`, `\bottomrule`, `\midrule`, etc.

```
\begin{enumerate}
\item an item
\smallskip
\item
$\begin{NiceArray}[t]{lcccccc}
\toprule
n   & 0 & 1 & 2 & 3 & 4  & 5 \\
\midrule
u_n & 1 & 2 & 4 & 8 & 16 & 32
\bottomrule
\end{NiceArray}$
\end{enumerate}
```

1. an item
2. | n | 0 | 1 | 2 | 3 | 4 | 5 |
   |---|---|---|---|---|---|---|
   | u_n | 1 | 2 | 4 | 8 | 16 | 32 |

It's also possible to use the key `baseline` to align a matrix on an horizontal rule (drawn by `\hline`). In this aim, one should give the value `line-`*i* where *i* is the number of the row following the horizontal rule.

```
\NiceMatrixOptions{cell-space-limits=1pt}
```

[4] The extension booktabs is *not* loaded by nicematrix.

```
$A=\begin{pNiceArray}{cc|cc}[baseline=line-3]
\dfrac1A & \dfrac1B & 0 & 0 \\
\dfrac1C & \dfrac1D & 0 & 0 \\
\hline
0 & 0 & A & B \\
0 & 0 & D & D \\
\end{pNiceArray}$
```

$$A = \left(\begin{array}{cc|cc} \frac{1}{A} & \frac{1}{B} & 0 & 0 \\ \frac{1}{C} & \frac{1}{D} & 0 & 0 \\ \hline 0 & 0 & A & B \\ 0 & 0 & D & D \end{array}\right)$$

4 The blocks

4.1 General case

In the environments of nicematrix, it's possible to use the command `\Block` in order to place an element in the center of a rectangle of merged cells of the array.[5]
The command `\Block` must be used in the upper leftmost cell of the array with two arguments.

- The first argument is the size of the block with the syntax *i*`-`*j* where *i* is the number of rows of the block and *j* its number of columns.

  If this argument is empty, its default value is `1-1`. If the number of rows is not specified, or equal to `*`, the block extends until the last row (idem for the columns).

- The second argument is the content of the block. It's possible to use `\\` in that content to have a content on several lines. In `{NiceTabular}` the content of the block is composed in text mode whereas, in the other environments, it is composed in math mode.

Here is an example of utilisation of the command `\Block` in mathematical matrices.

```
$\begin{bNiceArray}{ccc|c}[margin]
\Block{3-3}{A} & & & 0 \\
& \hspace*{1cm} & & \Vdots \\
& & & 0 \\
\hline
0 & \Cdots& 0 & 0
\end{bNiceArray}$
```

$$\left[\begin{array}{ccc|c} \multicolumn{3}{c|}{\multirow{3}{*}{A}} & 0 \\ & & & \vdots \\ & & & 0 \\ \hline 0 & \cdots & 0 & 0 \end{array}\right]$$

One may wish to raise the size of the "A" placed in the block of the previous example. Since this element is composed in math mode, it's not possible to use directly a command like `\large`, `\Large` and `\LARGE`. That's why the command `\Block` provides an option between angle brackets to specify some TeX code which will be inserted before the beginning of the math mode.[6]

```
$\begin{bNiceArray}{ccc|c}[margin]
\Block{3-3}<\Large>{A} & & & 0 \\
& \hspace*{1cm} & & \Vdots \\
& & & 0 \\
\hline
0 & \Cdots& 0 & 0
\end{bNiceArray}$
```

$$\left[\begin{array}{ccc|c} \multicolumn{3}{c|}{\multirow{3}{*}{A}} & 0 \\ & & & \vdots \\ & & & 0 \\ \hline 0 & \cdots & 0 & 0 \end{array}\right]$$

It's possible to set the horizontal position of the block with one of the keys `l`, `c` and `r`.

[5] The spaces after a command `\Block` are deleted.

[6] This argument between angular brackets may also be used to insert a command of font such as `\bfseries` when the command `\\` is used in the content of the block.

```
$\begin{bNiceArray}{ccc|c}[margin]
\Block[r]{3-3}<\LARGE>{A} & & & 0 \\
& \hspace*{1cm} & & \Vdots \\
& & & 0 \\
\hline
0 & \Cdots& 0 & 0
\end{bNiceArray}$
```

$$\left[\begin{array}{ccc|c} & & & 0 \\ & A & & \vdots \\ & & & 0 \\ \hline 0 & \cdots & 0 & 0 \end{array}\right]$$

In fact, the command `\Block` accepts as first optional argument (between square brackets) a list of couples key-value. The available keys are as follows:

- the keys `l`, `c` and `r` are used to fix the horizontal position of the content of the block, as explained previously;
- the key `fill` takes in as value a color and fills the block with that color;
- the key `draw` takes in as value a color and strokes the frame of the block with that color (the default value of that key is the current color of the rules of the array);
- the key `color` takes in as value a color and apply that color the content of the block but draws also the frame of the block with that color;
- the key `line-width` is the width (thickness) of the frame (this key should be used only when the key `draw` or the key `hvlines` is in force);
- the key `rounded-corners` requires rounded corners (for the frame drawn by `draw` and the shape drawn by `fill`) with a radius equal to the value of that key (the default value is 4 pt[7]);
- the key `borders` provides the ability to draw only some borders of the blocks; the value of that key is a (comma-separated) list of elements covered by `left`, `right`, `top` and `bottom`;
- the keys `t` and `b` fix the base line that will be given to the block when it has a multi-line content (the lines are separated by `\\`);
- the keys `hvlines` draws all the vertical and horizontal rules in the block.

One must remark that, by default, the commands `\Blocks` don't create space. There is exception only for the blocks mono-row and the blocks mono-column as explained just below.

In the following example, we have had to enlarge by hand the columns 2 and 3 (with the construction `wc{...}` of array).

```
\begin{NiceTabular}{cwc{2cm}wc{3cm}c}
rose      & tulipe & marguerite & dahlia \\
violette
& \Block[draw=red,fill=[RGB]{204,204,255},rounded-corners]{2-2}
                    {\LARGE De très jolies fleurs}
   & & souci \\
pervenche & & & lys \\
arum      & iris & jacinthe & muguet
\end{NiceTabular}
```

rose	tulipe	marguerite	dahlia
violette	De très jolies fleurs		souci
pervenche			lys
arum	iris	jacinthe	muguet

[7] This value is the initial value of the *rounded corners* of Tikz.

4.2 The mono-column blocks

The mono-column blocks have a special behaviour.

- The natural width of the contents of these blocks is taken into account for the width of the current column.
- The specification of the horizontal position provided by the type of column (`c`, `r` or `l`) is taken into account for the blocks.
- The specifications of font specified for the column by a construction `>{...}` in the preamble of the array are taken into account for the mono-column blocks of that column (this behaviour is probably expected).

```
\begin{NiceTabular}{@{}>{\bfseries}lr@{}} \hline
\Block{2-1}{John}    & 12 \\
                     & 13 \\ \hline
Steph                &  8 \\ \hline
\Block{3-1}{Sarah}   & 18 \\
                     & 17 \\
                     & 15 \\ \hline
Ashley               & 20 \\ \hline
Henry                & 14 \\ \hline
\Block{2-1}{Madison} & 15 \\
                     & 19 \\ \hline
\end{NiceTabular}
```

John	12
	13
Steph	8
Sarah	18
	17
	15
Ashley	20
Henry	14
Madison	15
	19

4.3 The mono-row blocks

For the mono-row blocks, the natural height and depth are taken into account for the height and depth of the current row (as does a standard `\multicolumn` of LaTeX).

4.4 The mono-cell blocks

A mono-cell block inherits all the properties of the mono-row blocks and mono-column blocks.

At first sight, one may think that there is no point using a mono-cell block. However, there are some good reasons to use such a block.

- It's possible to use the command `\\` in a (mono-cell) block.
- It's possible to use the option of horizontal alignment of the block in derogation of the type of column given in the preamble of the array.
- It's possible do draw a frame around the cell with the key `draw` of the command `\Block` and to fill the background with rounded corners with the keys `fill` and `rounded-corners`.[8]
- It's possible to draw one or several borders of the cell with the key `borders`.

```
\begin{NiceTabular}{cc}
\toprule
Writer & \Block[l]{}{year\\ of birth} \\
\midrule
Hugo & 1802 \\
Balzac & 1799 \\
\bottomrule
\end{NiceTabular}
```

Writer	year of birth
Hugo	1802
Balzac	1799

We recall that if the first mandatory argument of `\Block` is left blank, the block is mono-cell.[9]

[8] If one simply wishes to color the background of a unique celle, there is no point using the command `\Block`: it's possible to use the command `\cellcolor` (when the key `colortbl-like` is used).

[9] One may consider that the default value of the first mandatory argument of `\Block` is `1-1`.

4.5 Horizontal position of the content of the block

By default, the horizontal position of the content of a block is computed by using the positions of the *contents* of the columns implied in that block. That's why, in the following example, the header "First group" is correctly centered despite the instruction `!{\qquad}` in the preamble which has been used to increase the space between the columns (this is not the behaviour of `\multicolumn`).

```
\begin{NiceTabular}{@{}c!{\qquad}ccc!{\qquad}ccc@{}}
\toprule
Rank & \Block{1-3}{First group} & & & \Block{1-3}{Second group} \\
     & 1A & 1B & 1C & 2A & 2B & 2C \\
\midrule
 1 & 0.657 & 0.913 & 0.733 & 0.830 & 0.387 & 0.893\\
 2 & 0.343 & 0.537 & 0.655 & 0.690 & 0.471 & 0.333\\
 3 & 0.783 & 0.885 & 0.015 & 0.306 & 0.643 & 0.263\\
 4 & 0.161 & 0.708 & 0.386 & 0.257 & 0.074 & 0.336\\
\bottomrule
\end{NiceTabular}
```

Rank	First group			Second group		
	1A	1B	1C	2A	2B	2C
1	0.657	0.913	0.733	0.830	0.387	0.893
2	0.343	0.537	0.655	0.690	0.471	0.333
3	0.783	0.885	0.015	0.306	0.643	0.263
4	0.161	0.708	0.386	0.257	0.074	0.336

New 5.17 In order to have an horizontal positionning of the content of the block computed with the limits of the columns of the LaTeX array (and not with the contents of those columns), one may use the key `L`, `R` and `C` of the command `\Block`.

5 The rules

The usual techniques for the rules may be used in the environments of nicematrix (excepted `\vline`). However, there is some small differences with the classical environments.

5.1 Some differences with the classical environments

5.1.1 The vertical rules

In the environments of nicematrix, the vertical rules specified by `|` in the preambles of the environments are never broken, even by an incomplete row or by a double horizontal rule specified by `\hline\hline` (there is no need to use hhline).

```
\begin{NiceTabular}{|c|c|} \hline
First & Second \\ \hline\hline
Peter \\ \hline
Mary & George\\ \hline
\end{NiceTabular}
```

First	Second
Peter	
Mary	George

However, the vertical rules are not drawn in the blocks (created by `\Block`: cf. p. 4) nor in the corners (created by the key `corner`: cf. p. 10).

If you use booktabs (which provides `\toprule`, `\midrule`, `\bottomrule`, etc.) and if you really want to add vertical rules (which is not in the spirit of booktabs), you should notice that the vertical rules drawn by nicematrix are compatible with booktabs.

```
$\begin{NiceArray}{|cccc|} \toprule
a & b & c & d \\ \midrule
1 & 2 & 3 & 4 \\
1 & 2 & 3 & 4 \\ \bottomrule
\end{NiceArray}$
```

a	b	c	d
1	2	3	4
1	2	3	4

However, it's still possible to define a specifier (named, for instance, `I`) to draw vertical rules with the standard behaviour of array.

```
\newcolumntype{I}{!{\vrule}}
```

However, in this case, it is probably more clever to add a command `\OnlyMainNiceMatrix` (cf. p. 38):

```
\newcolumntype{I}{!{\OnlyMainNiceMatrix{\vrule}}}
```

5.1.2 The command \cline

The horizontal and vertical rules drawn by `\hline` and the specifier "`|`" make the array larger or wider by a quantity equal to the width of the rule (with array and also with nicematrix).

For historical reasons, this is not the case with the command `\cline`, as shown by the following example.

```
\setlength{\arrayrulewidth}{2pt}
\begin{tabular}{cccc} \hline
A&B&C&D \\ \cline{2-2}
A&B&C&D \\ \hline
\end{tabular}
```

A	B	C	D
A	B	C	D

In the environments of nicematrix, this situation is corrected (it's still possible to go to the standard behaviour of `\cline` with the key `standard-cline`).

```
\setlength{\arrayrulewidth}{2pt}
\begin{NiceTabular}{cccc} \hline
A&B&C&D \\ \cline{2-2}
A&B&C&D \\ \hline
\end{NiceTabular}
```

A	B	C	D
A	B	C	D

5.2 The thickness and the color of the rules

The environments of nicematrix provide a key `rules/width` to set the width (in fact the thickness) of the rules in the current environment. In fact, this key merely sets the value of the length `\arrayrulewidth`.

It's well known that colortbl provides the command `\arrayrulecolor` in order to specify the color of the rules.

With nicematrix, it's possible to specify the color of the rules even when colortbl is not loaded. For sake of compatibility, the command is also named `\arrayrulecolor`. The environments of nicematrix also provide a key `rules/color` to fix the color of the rules in the current environment. This key sets the value locally (whereas `\arrayrulecolor` acts globally).

```
\begin{NiceTabular}{|ccc|}[rules/color=[gray]{0.9},rules/width=1pt]
\hline
rose & tulipe & lys \\
arum & iris & violette \\
muguet & dahlia & souci \\
\hline
\end{NiceTabular}
```

rose	tulipe	lys
arum	iris	violette
muguet	dahlia	souci

If one wishes to define new specifiers for columns in order to draw vertical rules (for example with a specific color or thicker than the standard rules), he should consider the command `\OnlyMainNiceMatrix` described on page 38.

5.3 The tools of nicematrix for the rules

Here are the tools provided by nicematrix for the rules.

- the keys `hlines`, `vlines` and `hvlines`;
- the specifier "`|`" in the preamble (for the environments with preamble);
- the command `\Hline`.

All these tools don't draw the rules in the blocks nor in the empty corners (when the key `corners` is used).

- These blocks are:
  - the blocks created by the command `\Block`[10] presented p. 4;
  - the blocks implicitely delimited by the continuous dotted lines created by `\Cdots`, `Vdots`, etc. (cf. p. 19).
- The corners are created by the key `corners` explained below (see p. 10).

In particular, this remark explains the difference between the standard command `\hline` and the command `\Hline` provided by nicematrix.

5.3.1 The keys hlines and vlines

The keys `hlines` and `vlines` (which draw, of course, horizontal and vertical rules) take in as value a list of numbers which are the numbers of the rules to draw.
In fact, for the environments with delimiters (such as `{pNiceMatrix}` or `{bNiceArray}`), the key `vlines` don't draw the exterior rules (this is certainly the expected behaviour).

```
$\begin{pNiceMatrix}[vlines,rules/width=0.2pt]
1 & 2 & 3 & 4 & 5 & 6 \\
1 & 2 & 3 & 4 & 5 & 6 \\
1 & 2 & 3 & 4 & 5 & 6
\end{pNiceMatrix}$
```

$$\left(\begin{array}{c|c|c|c|c|c} 1 & 2 & 3 & 4 & 5 & 6 \\ 1 & 2 & 3 & 4 & 5 & 6 \\ 1 & 2 & 3 & 4 & 5 & 6 \end{array}\right)$$

5.3.2 The key hvlines

The key `hvlines` (no value) is the conjonction of the keys `hlines` and `vlines`.

```
\setlength{\arrayrulewidth}{1pt}
\begin{NiceTabular}{cccc}[hvlines,rules/color=blue]
rose      & tulipe & marguerite & dahlia \\
violette  & \Block[draw=red]{2-2}{\LARGE fleurs}  & & souci \\
pervenche & & & lys \\
arum      & iris & jacinthe & muguet
\end{NiceTabular}
```

rose	tulipe	marguerite	dahlia
violette	fleurs		souci
pervenche			lys
arum	iris	jacinthe	muguet

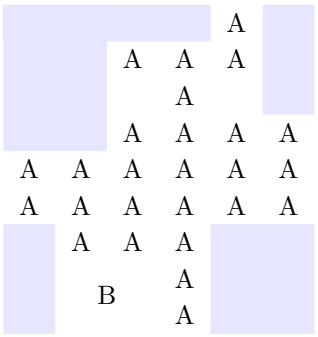
New 5.17 The key `hvlines-except-corners` is similar to the key `hvlines` but does not draw the rules on the horizontal and vertical borders of the array.

[10] And also the command `\multicolumn` also it's recommended to use instead `\Block` in the environments of nicematrix.

5.3.3 The (empty) corners

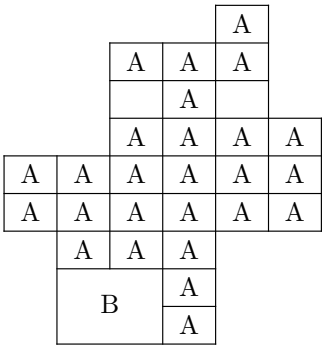
The four `corners` of an array will be designed by `NW`, `SW`, `NE` and `SE` (*north west*, *south west*, *north east* and *south east*).
For each of these corners, we will call *empty corner* (or simply *corner*) the reunion of all the empty rectangles starting from the cell actually in the corner of the array.[11]
However, it's possible, for a cell without content, to require nicemarix to consider that cell as not empty with the key `\NotEmpty`.

In the example on the right (where B is in the center of a block of size 2×2), we have colored in blue the four (empty) corners of the array.



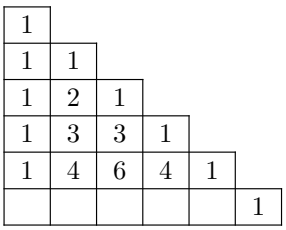
When the key `corners` is used, nicematrix computes the (empty) corners and these corners will be taken into account by the tools for drawing the rules (the rules won't be drawn in the corners). *Remark*: In the previous versions of nicematrix, there was only a key `hvlines-except-corners` (now considered as obsolete).

```
\NiceMatrixOptions{cell-space-top-limit=3pt}
\begin{NiceTabular}{*{6}{c}}[corners,hvlines]
  &   &   &   & A \\
  &   & A & A & A \\
  &   &   & A \\
  &   & A & A & A & A \\
A & A & A & A & A & A \\
A & A & A & A & A & A \\
  & A & A & A \\
  & \Block{2-2}{B} & & A \\
  &   &   & A \\
\end{NiceTabular}
```



It's also possible to provide to the key `corners` a (comma-separated) list of corners (designed by `NW`, `SW`, `NE` and `SE`).

```
\NiceMatrixOptions{cell-space-top-limit=3pt}
\begin{NiceTabular}{*{6}{c}}[corners=NE,hvlines]
1\\
1&1\\
1&2&1\\
1&3&3&1\\
1&4&6&4&1\\
 & & & & &1
\end{NiceTabular}
```



▷ The corners are also taken into account by the tools provided by nicematrix to color cells, rows and columns. These tools don't color the cells which are in the corners (cf. p. 12).

[11] For sake of completeness, we should also say that a cell contained in a block (even an empty cell) is not taken into account for the determination of the corners. That behaviour is natural.

5.4 The command \diagbox

The command `\diagbox` (inspired by the package diagbox), allows, when it is used in a cell, to slash that cell diagonally downwards.[12].

```
$\begin{NiceArray}{*{5}{c}}[hvlines]
\diagbox{x}{y}  & e & a & b & c \\
e & e & a & b & c \\
a & a & e & c & b \\
b & b & c & e & a \\
c & c & b & a & e
\end{NiceArray}$
```

x \ y	e	a	b	c
e	e	a	b	c
a	a	e	c	b
b	b	c	e	a
c	c	b	a	e

It's possible to use the command `\diagbox` in a `\Block`.

5.5 Dotted rules

In the environments of the package nicematrix, it's possible to use the command `\hdottedline` (provided by nicematrix) which is a counterpart of the classical commands `\hline` and `\hdashline` (the latter is a command of arydshln).

```
\begin{pNiceMatrix}
1 & 2 & 3 & 4 & 5 \\
\hdottedline
6 & 7 & 8 & 9 & 10 \\
11 & 12 & 13 & 14 & 15
\end{pNiceMatrix}
```

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ \hdashline 6 & 7 & 8 & 9 & 10 \\ 11 & 12 & 13 & 14 & 15 \end{pmatrix}$$

In the environments with an explicit preamble (like `{NiceTabular}`, `{NiceArray}`, etc.), it's possible to draw a vertical dotted line with the specifier "`:`".

```
\left(\begin{NiceArray}{cccc:c}
1 & 2 & 3 & 4 & 5 \\
6 & 7 & 8 & 9 & 10 \\
11 & 12 & 13 & 14 & 15
\end{NiceArray}\right)
```

$$\left(\begin{array}{cccc:c} 1 & 2 & 3 & 4 & 5 \\ 6 & 7 & 8 & 9 & 10 \\ 11 & 12 & 13 & 14 & 15 \end{array}\right)$$

It's possible to change in nicematrix the letter used to specify a vertical dotted line with the option `letter-for-dotted-lines` available in `\NiceMatrixOptions`. Thus released, the letter "`:`" can be used otherwise (for example by the package arydshln[13]).

Remark: In the package array (on which the package nicematrix relies), horizontal and vertical rules make the array larger or wider by a quantity equal to the width of the rule[14]. In nicematrix, the dotted lines drawn by `\hdottedline` and "`:`" do likewise.

6 The color of the rows and columns

6.1 Use of colortbl

We recall that the package colortbl can be loaded directly with `\usepackage{colortbl}` or by loading xcolor with the key `table`: `\usepackage[table]{xcolor}`.

Since the package nicematrix is based on array, it's possible to use colortbl with nicematrix.

However, there is two drawbacks:

[12] The author of this document considers that type of construction as graphically poor.
[13] However, one should remark that the package arydshln is not fully compatible with nicematrix.
[14] In fact, with array, this is true only for `\hline` and "`|`" but not for `\cline`: cf p. 8

- The package colortbl patches array, leading to some incompatibilities (for instance with the command `\hdotsfor`).
- The package colortbl constructs the array row by row, alterning colored rectangles, rules and contents of the cells. The resulting PDF is difficult to interpret by some PDF viewers and may lead to artefacts on the screen.
  - Some rules seem to disappear. This is because many PDF viewers give priority to graphical element drawn posteriorly (which is in the spirit of the "painting model" of PostScript and PDF). Concerning this problem, MuPDF (which is used, for instance, by SumatraPDF) gives better results than Adobe Reader).
  - A thin white line may appear between two cells of the same color. This phenomenon occurs when each cell is colored with its own instruction `fill` (the PostScript operator `fill` noted `f` in PDF). This is the case with colortbl: each cell is colored on its own, even when `\columncolor` or `\rowcolor` is used.

    As for this phenomenon, Adobe Reader gives better results than MuPDF.

  The package nicematrix provides tools to avoid those problems.

6.2 The tools of nicematrix in the \CodeBefore

The package nicematrix provides some tools (independent of colortbl) to draw the colored panels first, and, then, the content of the cells and the rules. This strategy is more conform to the "painting model" of the formats PostScript and PDF and is more suitable for the PDF viewers. However, it requires several compilations.[15]

The extension nicematrix provides a key `code-before` for some code that will be executed before the drawing of the tabular.

An alternative syntax is provided: it's possible to put the content of that `code-before` between the keywords `\CodeBefore` and `\Body` at the beginning of the environment.

```
\begin{pNiceArray}{preamble}
\CodeBefore
instructions of the code-before
\Body
contents of the environnement
\end{pNiceArray}
```

New commands are available in that `\CodeBefore`: `\cellcolor`, `\rectanglecolor`, `\rowcolor`, `\columncolor`, `\rowcolors`, `\chessboardcolors` and `arraycolor`.[16]

All these commands accept an optional argument (between square brackets and in first position) which is the color model for the specification of the colors.

These commands don't color the cells which are in the "corners" if the key `corners` is used. This key has been described p. 10.

- The command `\cellcolor` takes its name from the command `\cellcolor` of colortbl.

  This command takes in as mandatory arguments a color and a list of cells, each of which with the format i-j where i is the number of the row and j the number of the columnn of the cell.

[15] If you use Overleaf, Overleaf will do automatically the right number of compilations.

[16] Remark that, in the `\CodeBefore`, PGF/Tikz nodes of the form "`(i-|j)`" are also available to indicate the position to the potential rules: cf. p. 36.

```
\begin{NiceTabular}{|c|c|c|}
\CodeBefore
  \cellcolor[HTML]{FFFF88}{3-1,2-2,1-3}
\Body
\hline
a & b & c \\ \hline
e & f & g \\ \hline
h & i & j \\ \hline
\end{NiceTabular}
```

a	b	c
e	f	g
h	i	j

- The command **\rectanglecolor** takes three mandatory arguments. The first is the color. The second is the upper-left cell of the rectangle and the third is the lower-right cell of the rectangle.

```
\begin{NiceTabular}{|c|c|c|}
\CodeBefore
  \rectanglecolor{blue!15}{2-2}{3-3}
\Body
\hline
a & b & c \\ \hline
e & f & g \\ \hline
h & i & j \\ \hline
\end{NiceTabular}
```

a	b	c
e	f	g
h	i	j

- The command **\arraycolor** takes in as mandatory argument a color and color the whole tabular with that color (excepted the potential exterior rows and columns: cf. p. 17). It's only a particular case of **\rectanglecolor**.

- The command **\chessboardcolors** takes in as mandatory arguments two colors and it colors the cells of the tabular in quincunx with these colors.

```
$\begin{pNiceMatrix}[r,margin]
\CodeBefore
  \chessboardcolors{red!15}{blue!15}
\Body
1 & -1 & 1 \\
-1 & 1 & -1 \\
1 & -1 & 1
\end{pNiceMatrix}$
```

$$\begin{pmatrix} 1 & -1 & 1 \\ -1 & 1 & -1 \\ 1 & -1 & 1 \end{pmatrix}$$

We have used the key **r** which aligns all the columns rightwards (cf. p. 31).

- The command **\rowcolor** takes its name from the command **\rowcolor** of colortbl. Its first mandatory argument is the color and the second is a comma-separated list of rows or interval of rows with the form *a*-*b* (an interval of the form *a*- represent all the rows from the row *a* until the end).

```
$\begin{NiceArray}{lll}[hvlines]
\CodeBefore
  code-before = \rowcolor{red!15}{1,3-5,8-}
\Body
a_1 & b_1 & c_1 \\
a_2 & b_2 & c_2 \\
a_3 & b_3 & c_3 \\
a_4 & b_4 & c_4 \\
a_5 & b_5 & c_5 \\
a_6 & b_6 & c_6 \\
a_7 & b_7 & c_7 \\
a_8 & b_8 & c_8 \\
a_9 & b_9 & c_9 \\
a_{10} & b_{10} & c_{10} \\
\end{NiceArray}$
```

a_1	b_1	c_1
a_2	b_2	c_2
a_3	b_3	c_3
a_4	b_4	c_4
a_5	b_5	c_5
a_6	b_6	c_6
a_7	b_7	c_7
a_8	b_8	c_8
a_9	b_9	c_9
a_{10}	b_{10}	c_{10}

- The command `\columncolor` takes its name from the command `\columncolor` of colortbl. Its syntax is similar to the syntax of `\rowcolor`.

- The command `\rowcolors` (with a *s*) takes its name from the command `\rowcolors` of xcolor[17]. The *s* emphasizes the fact that there is *two* colors. This command colors alternately the rows of the tabular with the tow colors (provided in second and third argument), beginning with the row whose number is given in first (mandatory) argument.

  In fact, the first (mandatory) argument is, more generally, a comma separated list of intervals describing the rows involved in the action of `\rowcolors` (an interval of the form *i*- describes in fact the interval of all the rows of the tabular, beginning with the row *i*).

  The last argument of `\rowcolors` is an optional list of pairs key-value (the optional argument in the first position corresponds to the colorimetric space). The available keys are `cols`, `restart` and `respect-blocks`.

  - The key `cols` describes a set of columns. The command `\rowcolors` will color only the cells of these columns. The value is a comma-separated list of intervals of the form *i*-*j* (where *i* or *j* may be replaced by `*`).
  - With the key `restart`, each interval of rows (specified by the first mandatory argument) begins with the same color.[18]
  - With the key `respect-blocks` the "rows" alternately colored may extend over several rows if they have to incorporate blocks (created with the command `\Block`: cf. p. 4).

```
\begin{NiceTabular}{clr}[hvlines]
\CodeBefore
  \rowcolors[gray]{2}{0.8}{}[cols=2-3,restart]
\Body
\Block{1-*}{Results} \\
John & 12 \\
Stephen & 8 \\
Sarah & 18 \\
Ashley & 20 \\
Henry & 14 \\
Madison & 15
\end{NiceTabular}
```

Results		
A	John	12
	Stephen	8
B	Sarah	18
	Ashley	20
	Henry	14
	Madison	15

```
\begin{NiceTabular}{lr}[hvlines]
\CodeBefore
  \rowcolors{1}{blue!10}{}[respect-blocks]
\Body
\Block{2-1}{John}    & 12 \\
                     & 13 \\
Steph                &  8 \\
\Block{3-1}{Sarah}   & 18 \\
                     & 17 \\
                     & 15 \\
Ashley               & 20 \\
Henry                & 14 \\
\Block{2-1}{Madison} & 15 \\
                     & 19
\end{NiceTabular}
```

John	12
	13
Steph	8
Sarah	18
	17
	15
Ashley	20
Henry	14
Madison	15
	19

[17] The command `\rowcolors` of xcolor is available when xcolor is loaded with the option `table`. That option also loads the package colortbl.

[18] Otherwise, the color of a given row relies only upon the parity of its absolute number.

We recall that all the color commands we have described don't color the cells which are in the "corners". In the following example, we use the key `corners` to require the determination of the corner *north east* (NE).

```
\begin{NiceTabular}{cccccc}[corners=NE,margin,hvlines,first-row,first-col]
\CodeBefore
  \rowcolors{1}{blue!15}{}
\Body
  & 0 & 1 & 2 & 3 & 4 & 5 & 6 \\
0 & 1 \\
1 & 1 & 1 \\
2 & 1 & 2 & 1 \\
3 & 1 & 3 & 3 & 1 \\
4 & 1 & 4 & 6 & 4 & 1 \\
5 & 1 & 5 & 10 & 10 & 5 & 1 \\
6 & 1 & 6 & 15 & 20 & 15 & 6 & 1 \\
\end{NiceTabular}
```

	0	1	2	3	4	5	6
0	1						
1	1	1					
2	1	2	1				
3	1	3	3	1			
4	1	4	6	4	1		
5	1	5	10	10	5	1	
6	1	6	15	20	15	6	1

One should remark that all the previous commands are compatible with the commands of booktabs (`\toprule`, `\midrule`, `\bottomrule`, etc). However, booktabs is not loaded by nicematrix.

```
\begin{NiceTabular}[c]{lSSSS}
\CodeBefore
  \rowcolor{red!15}{1-2}
  \rowcolors{3}{blue!15}{}
\Body
\toprule
\Block{2-1}{Product} &
\Block{1-3}{dimensions (cm)} & & &
\Block{2-1}{\rotate Price} \\
\cmidrule(rl){2-4}
 & L & l & h \\
\midrule
small    & 3   & 5.5  & 1   & 30    \\
standard & 5.5 & 8    & 1.5 & 50.5  \\
premium  & 8.5 & 10.5 & 2   & 80    \\
extra    & 8.5 & 10   & 1.5 & 85.5  \\
special  & 12  & 12   & 0.5 & 70    \\
\bottomrule
\end{NiceTabular}
```

Product	dimensions (cm)			Price
	L	l	h	
small	3	5.5	1	30
standard	5.5	8	1.5	50.5
premium	8.5	10.5	2	80
extra	8.5	10	1.5	85.5
special	12	12	0.5	70

We have used the type of column `S` of siunitx.

6.3 Color tools with the syntax of colortbl

It's possible to access the preceding tools with a syntax close to the syntax of colortbl. For that, one must use the key `colortbl-like` in the current environment.[19]
There are three commands available (they are inspired by colortbl but are *independent* of colortbl):

- `\cellcolor` which colorizes a cell;
- `\rowcolor` which must be used in a cell and which colorizes the end of the row;
- `\columncolor` which must be used in the preamble of the environment with the same syntax as the corresponding command of colortbl (however, unlike the command `\columncolor` of colortbl, this command `\columncolor` can appear within another command, itself used in the preamble of the array).

[19] Up to now, this key is *not* available in `\NiceMatrixOptions`.

```
\NewDocumentCommand { \Blue } { } { \columncolor{blue!15} }
\begin{NiceTabular}[colortbl-like]{>{\Blue}c>{\Blue}cc}
\toprule
\rowcolor{red!15}
Last name & First name & Birth day \\
\midrule
Achard & Jacques & 5 juin 1962 \\
Lefebvre & Mathilde & 23 mai 1988 \\
Vanesse & Stephany & 30 octobre 1994 \\
Dupont & Chantal & 15 janvier 1998 \\
\bottomrule
\end{NiceTabular}
```

Last name	First name	Birth day
Achard	Jacques	5 juin 1962
Lefebvre	Mathilde	23 mai 1988
Vanesse	Stephany	30 octobre 1994
Dupont	Chantal	15 janvier 1998

7 The command \RowStyle

New 5.18 The command `\RowStyle` takes in as argument some formatting intructions that will be applied to each cell on the rest of the current row.

That command also takes in as optional argument (between square brackets) a list of key-value pairs. The available keys are `cell-space-top-limit`, `cell-space-bottom-limit` and `cell-space-limits` with the same meaning that the corresponding global keys (cf. p. 2).

```
\begin{NiceTabular}{cccc}[hlines,colortbl-like]
\RowStyle[cell-space-limits=3pt]{\rotate}
first & second & third & fourth \\
\rowcolor{blue!50}\RowStyle{\color{white}\sffamily}
1 & 2 & 3 & 4 \\
\end{NiceTabular}
```

first	second	third	fourth
1	2	3	4

The command `\rotate` is described p. 31.

8 The width of the columns

In the environments with an explicit preamble (like `{NiceTabular}`, `{NiceArray}`, etc.), it's possible to fix the width of a given column with the standard letters `w` and `W` of the package array.

```
\begin{NiceTabular}{Wc{2cm}cc}[hvlines]
Paris  & New York & Madrid \\
Berlin & London   & Roma   \\
Rio    & Tokyo    & Oslo
\end{NiceTabular}
```

Paris	New York	Madrid
Berlin	London	Roma
Rio	Tokyo	Oslo

In the environments of nicematrix, it's also possible to fix the *minimal* width of all the columns of an array directly with the key `columns-width`.

```
$\begin{pNiceMatrix}[columns-width = 1cm]
1  & 12 & -123 \\
12 & 0  & 0    \\
4  & 1  & 2
\end{pNiceMatrix}$
```

$$\begin{pmatrix} 1 & 12 & -123 \\ 12 & 0 & 0 \\ 4 & 1 & 2 \end{pmatrix}$$

Note that the space inserted between two columns (equal to 2 `\tabcolsep` in `{NiceTabular}` and to 2 `\arraycolsep` in the other environments) is not suppressed (of course, it's possible to suppress this space by setting `\tabcolsep` or `\arraycolsep` equal to 0 pt before the environment).

It's possible to give the special value `auto` to the option `columns-width`: all the columns of the array will have a width equal to the widest cell of the array.[20]

```
$\begin{pNiceMatrix}[columns-width = auto]
1  & 12 & -123 \\
12 & 0  & 0    \\
4  & 1  & 2
\end{pNiceMatrix}$
```

$$\begin{pmatrix} 1 & 12 & -123 \\ 12 & 0 & 0 \\ 4 & 1 & 2 \end{pmatrix}$$

Without surprise, it's possible to fix the minimal width of the columns of all the matrices of a current scope with the command `\NiceMatrixOptions`.

```
\NiceMatrixOptions{columns-width=10mm}
$\begin{pNiceMatrix}
a & b \\ c & d
\end{pNiceMatrix}
=
\begin{pNiceMatrix}
1   & 1245 \\ 345 & 2
\end{pNiceMatrix}$
```

$$\begin{pmatrix} a & b \\ c & d \end{pmatrix} = \begin{pmatrix} 1 & 1245 \\ 345 & 2 \end{pmatrix}$$

But it's also possible to fix a zone where all the matrices will have their columns of the same width, equal to the widest cell of all the matrices. This construction uses the environment `{NiceMatrixBlock}` with the option `auto-columns-width`[21]. The environment `{NiceMatrixBlock}` has no direct link with the command `\Block` presented previously in this document (cf. p. 4).

```
\begin{NiceMatrixBlock}[auto-columns-width]
$\begin{array}{c}
\begin{bNiceMatrix}
 9 & 17 \\ -2 & 5
 \end{bNiceMatrix} \\ \\
\begin{bNiceMatrix}
 1   & 1245345 \\  345 & 2
\end{bNiceMatrix}
\end{array}$
\end{NiceMatrixBlock}
```

$$\begin{bmatrix} 9 & 17 \\ -2 & 5 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1245345 \\ 345 & 2 \end{bmatrix}$$

9 The exterior rows and columns

The options `first-row`, `last-row`, `first-col` and `last-col` allow the composition of exterior rows and columns in the environments of nicematrix.
A potential "first row" (exterior) has the number 0 (and not 1). Idem for the potential "first column".

```
$\begin{pNiceMatrix}[first-row,last-row,first-col,last-col,nullify-dots]
       & C_1    & \Cdots &        & C_4    &        \\
L_1    & a_{11} & a_{12} & a_{13} & a_{14} & L_1    \\
\Vdots & a_{21} & a_{22} & a_{23} & a_{24} & \Vdots \\
       & a_{31} & a_{32} & a_{33} & a_{34} &        \\
L_4    & a_{41} & a_{42} & a_{43} & a_{44} & L_4    \\
```

[20] The result is achieved with only one compilation (but PGF/Tikz will have written informations in the `.aux` file and a message requiring a second compilation will appear).

[21] At this time, this is the only usage of the environment `{NiceMatrixBlock}` but it may have other usages in the future.

```
       & C_1    & \Cdots &        & C_4    &
\end{pNiceMatrix}$
```

$$\begin{array}{c} \\ L_1 \\ \vdots \\ L_4 \\ \\ \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & \cdots & \cdots & C_4 \end{array} \\ \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix} \\ \begin{array}{cccc} C_1 & \cdots & \cdots & C_4 \end{array} \end{array} \begin{array}{c} \\ L_1 \\ \vdots \\ L_4 \\ \\ \end{array}$$

The dotted lines have been drawn with the tools presented p. 19.

We have several remarks to do.

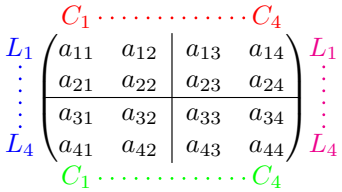
- For the environments with an explicit preamble (i.e. `{NiceTabular}`, `{NiceArray}` and its variants), no letter must be given in that preamble for the potential first column and the potential last column: they will automatically (and necessarily) be of type `r` for the first column and `l` for the last one.[22]
- One may wonder how nicematrix determines the number of rows and columns which are needed for the composition of the "last row" and "last column".
  - For the environments with explicit preamble, like `{NiceTabular}` and `{pNiceArray}`, the number of columns can obviously be computed from the preamble.
  - When the option `light-syntax` (cf. p. 33) is used, nicematrix has, in any case, to load the whole body of the environment (and that's why it's not possible to put verbatim material in the array with the option `light-syntax`). The analysis of this whole body gives the number of rows (but not the number of columns).
  - In the other cases, nicematrix compute the number of rows and columns during the first compilation and write the result in the `aux` file for the next run.

    However, it's possible to provide the number of the last row and the number of the last column as values of the options `last-row` and `last-col`, tending to an acceleration of the whole compilation of the document. That's what we will do throughout the rest of the document.

It's possible to control the appearance of these rows and columns with options `code-for-first-row`, `code-for-last-row`, `code-for-first-col` and `code-for-last-col`. These options specify tokens that will be inserted before each cell of the corresponding row or column.

```
\NiceMatrixOptions{code-for-first-row = \color{red},
                   code-for-first-col = \color{blue},
                   code-for-last-row = \color{green},
                   code-for-last-col = \color{magenta}}
$\begin{pNiceArray}{cc|cc}[first-row,last-row=5,first-col,last-col,nullify-dots]
       & C_1    & \Cdots &        & C_4    &        \\
L_1    & a_{11} & a_{12} & a_{13} & a_{14} & L_1    \\
\Vdots & a_{21} & a_{22} & a_{23} & a_{24} & \Vdots \\
\hline
       & a_{31} & a_{32} & a_{33} & a_{34} &        \\
L_4    & a_{41} & a_{42} & a_{43} & a_{44} & L_4    \\
       & C_1    & \Cdots &        & C_4    &
\end{pNiceArray}$
```

[22] The users wishing exteriors columns with another type of alignment should consider the command `\SubMatrix` available in the `\CodeAfter` (cf. p. 25).



Remarks

- As shown in the previous example, the horizontal and vertical rules doesn't extend in the exterior rows and columns.

  However, if one wishes to define new specifiers for columns in order to draw vertical rules (for example thicker than the standard rules), he should consider the command `\OnlyMainNiceMatrix` described on page 38.

- A specification of color present in `code-for-first-row` also applies to a dotted line draw in this exterior "first row" (excepted if a value has been given to `xdots/color`). Idem for the other exterior rows and columns.

- Logically, the potential option `columns-width` (described p. 16) doesn't apply to the "first column" and "last column".

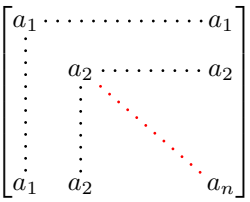
- For technical reasons, it's not possible to use the option of the command `\\` after the "first row" or before the "last row". The placement of the delimiters would be wrong. If you are looking for a workaround, consider the command `\SubMatrix` in the `\CodeAfter` described p. 25.

10 The continuous dotted lines

Inside the environments of the package nicematrix, new commands are defined: `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, and `\Iddots`. These commands are intended to be used in place of `\dots`, `\cdots`, `\vdots`, `\ddots` and `\iddots`.[23]

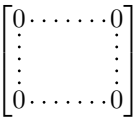
Each of them must be used alone in the cell of the array and it draws a dotted line between the first non-empty cells[24] on both sides of the current cell. Of course, for `\Ldots` and `\Cdots`, it's an horizontal line; for `\Vdots`, it's a vertical line and for `\Ddots` and `\Iddots` diagonal ones. It's possible to change the color of these lines with the option `color`.[25]

```
\begin{bNiceMatrix}
a_1      & \Cdots &        & & a_1    \\
\Vdots   & a_2    & \Cdots & & a_2    \\
         & \Vdots & \Ddots[color=red] \\
\\
a_1      & a_2    &        & & a_n
\end{bNiceMatrix}
```



In order to represent the null matrix, one can use the following codage:

```
\begin{bNiceMatrix}
0      & \Cdots & 0      \\
\Vdots &        & \Vdots \\
0      & \Cdots & 0
\end{bNiceMatrix}
```



[23] The command `\iddots`, defined in nicematrix, is a variant of `\ddots` with dots going forward. If `mathdots` is loaded, the version of `mathdots` is used. It corresponds to the command `\adots` of unicode-math.

[24] The precise definition of a "non-empty cell" is given below (cf. p. 39).

[25] It's also possible to change the color of all theses dotted lines with the option `xdots/color` (*xdots* to remind that it works for `\Cdots`, `\Ldots`, `\Vdots`, etc.): cf. p. 23.

However, one may want a larger matrix. Usually, in such a case, the users of LaTeX add a new row and a new column. It's possible to use the same method with nicematrix:

```
\begin{bNiceMatrix}
0      & \Cdots & \Cdots & 0      \\
\Vdots &        &        & \Vdots \\
\Vdots &        &        & \Vdots \\
0      & \Cdots & \Cdots & 0
\end{bNiceMatrix}
```

$$\begin{bmatrix} 0 & \cdots & \cdots & 0 \\ \vdots & & & \vdots \\ \vdots & & & \vdots \\ 0 & \cdots & \cdots & 0 \end{bmatrix}$$

In the first column of this exemple, there are two instructions `\Vdots` but, of course, only one dotted line is drawn.

In fact, in this example, it would be possible to draw the same matrix more easily with the following code:

```
\begin{bNiceMatrix}
0       & \Cdots &        & 0      \\
\Vdots  &        &        &        \\
        &        &        & \Vdots \\
0       &        & \Cdots & 0
\end{bNiceMatrix}
```

$$\begin{bmatrix} 0 & \cdots & \cdots & 0 \\ \vdots & & & \vdots \\ \vdots & & & \vdots \\ 0 & \cdots & \cdots & 0 \end{bmatrix}$$

There are also other means to change the size of the matrix. Someone might want to use the optional argument of the command `\\` for the vertical dimension and a command `\hspace*` in a cell for the horizontal dimension.[26]
However, a command `\hspace*` might interfer with the construction of the dotted lines. That's why the package nicematrix provides a command `\Hspace` which is a variant of `\hspace` transparent for the dotted lines of nicematrix.

```
\begin{bNiceMatrix}
0      & \Cdots & \Hspace*{1cm} & 0      \\
\Vdots &        &               & \Vdots \\[1cm]
0      & \Cdots &               & 0
\end{bNiceMatrix}
```

$$\begin{bmatrix} 0 & \cdots & \cdots & 0 \\ \vdots & & & \vdots \\ \vdots & & & \vdots \\ 0 & \cdots & \cdots & 0 \end{bmatrix}$$

10.1 The option nullify-dots

Consider the following matrix composed classicaly with the environment `{pmatrix}` of amsmath.

```
$A = \begin{pmatrix}
h & i & j & k & l & m \\
x &   &   &   &   & x
\end{pmatrix}$
```

$$A = \begin{pmatrix} h & i & j & k & l & m \\ x & & & & & x \end{pmatrix}$$

If we add `\ldots` instructions in the second row, the geometry of the matrix is modified.

```
$B = \begin{pmatrix}
h & i & j & k & l & m \\
x & \ldots & \ldots  & \ldots & \ldots & x
\end{pmatrix}$
```

$$B = \begin{pmatrix} h & i & j & k & l & m \\ x & \ldots & \ldots & \ldots & \ldots & x \end{pmatrix}$$

By default, with nicematrix, if we replace `{pmatrix}` by `{pNiceMatrix}` and `\ldots` by `\Ldots`, the geometry of the matrix is not changed.

```
$C = \begin{pNiceMatrix}
h & i & j & k & l & m \\
x & \Ldots & \Ldots & \Ldots & \Ldots & x
\end{pNiceMatrix}$
```

$$C = \begin{pmatrix} h & i & j & k & l & m \\ x & \ldots & \ldots & \ldots & \ldots & x \end{pmatrix}$$

[26] In nicematrix, one should use `\hspace*` and not `\hspace` for such an usage because nicematrix loads array. One may also remark that it's possible to fix the width of a column by using the environment `{NiceArray}` (or one of its variants) with a column of type `w` or `W`: see p. 16

However, one may prefer the geometry of the first matrix A and would like to have such a geometry with a dotted line in the second row. It's possible by using the option `nullify-dots` (and only one instruction `\Ldots` is necessary).

```
$D = \begin{pNiceMatrix}[nullify-dots]
h & i & j & k & l & m \\
x & \Ldots & & & & x
\end{pNiceMatrix}$
```

$$D = \begin{pmatrix} h & i & j & k & l & m \\ x & \cdots & & & & x \end{pmatrix}$$

The option `nullify-dots` smashes the instructions `\Ldots` (and the variants) horizontally but also vertically.

10.2 The commands \Hdotsfor and \Vdotsfor

Some people commonly use the command `\hdotsfor` of amsmath in order to draw horizontal dotted lines in a matrix. In the environments of nicematrix, one should use instead `\Hdotsfor` in order to draw dotted lines similar to the other dotted lines drawn by the package nicematrix.
As with the other commands of nicematrix (like `\Cdots`, `\Ldots`, `\Vdots`, etc.), the dotted line drawn with `\Hdotsfor` extends until the contents of the cells on both sides.

```
$\begin{pNiceMatrix}
1 & 2 & 3 & 4 & 5 \\
1 & \Hdotsfor{3} & 5 \\
1 & 2 & 3 & 4 & 5 \\
1 & 2 & 3 & 4 & 5
\end{pNiceMatrix}$
```

$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ 1 & \cdots & & & 5 \\ 1 & 2 & 3 & 4 & 5 \\ 1 & 2 & 3 & 4 & 5 \end{pmatrix}$$

However, if these cells are empty, the dotted line extends only in the cells specified by the argument of `\Hdotsfor` (by design).

```
$\begin{pNiceMatrix}
1 & 2 & 3 & 4 & 5 \\
  & \Hdotsfor{3} \\
1 & 2 & 3 & 4 & 5 \\
1 & 2 & 3 & 4 & 5
\end{pNiceMatrix}$
```

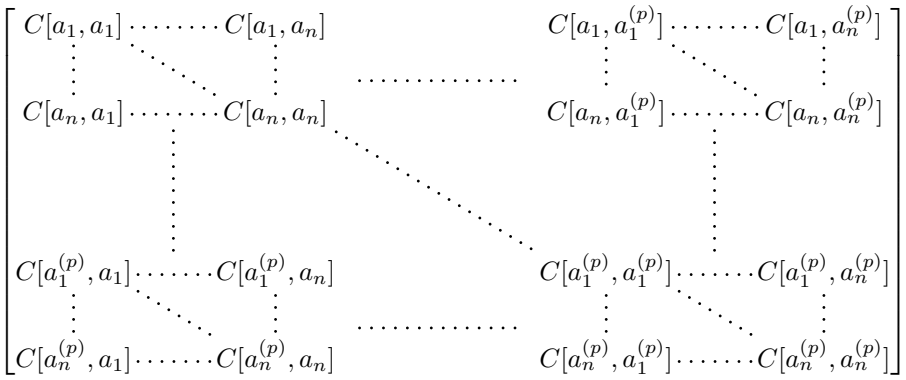
$$\begin{pmatrix} 1 & 2 & 3 & 4 & 5 \\ & \cdots & & & \\ 1 & 2 & 3 & 4 & 5 \\ 1 & 2 & 3 & 4 & 5 \end{pmatrix}$$

Remark: Unlike the command `\hdotsfor` of amsmath, the command `\Hdotsfor` may be used even when the package colortbl[27] is loaded (but you might have problem if you use `\rowcolor` on the same row as `\Hdotsfor`).

The package nicematrix also provides a command `\Vdotsfor` similar to `\Hdotsfor` but for the vertical dotted lines. The following example uses both `\Hdotsfor` and `\Vdotsfor`:

```
\begin{bNiceMatrix}
C[a_1,a_1] & \Cdots & C[a_1,a_n]
  & \hspace*{20mm} & C[a_1,a_1^{(p)}] & \Cdots & C[a_1,a_n^{(p)}] \\
\Vdots & \Ddots & \Vdots
  & \Hdotsfor{1} & \Vdots & \Ddots & \Vdots \\
C[a_n,a_1] & \Cdots & C[a_n,a_n]
  & & C[a_n,a_1^{(p)}] & \Cdots & C[a_n,a_n^{(p)}] \\
\rule{0pt}{15mm}\NotEmpty & \Vdotsfor{1} & & \Ddots & & \Vdotsfor{1} \\
C[a_1^{(p)},a_1] & \Cdots & C[a_1^{(p)},a_n]
  & & C[a_1^{(p)},a_1^{(p)}] & \Cdots & C[a_1^{(p)},a_n^{(p)}] \\
\Vdots & \Ddots & \Vdots
  & \Hdotsfor{1} & \Vdots & \Ddots & \Vdots \\
C[a_n^{(p)},a_1] & \Cdots & C[a_n^{(p)},a_n]
  & & C[a_n^{(p)},a_1^{(p)}] & \Cdots & C[a_n^{(p)},a_n^{(p)}]
\end{bNiceMatrix}
```

[27] We recall that when xcolor is loaded with the option `table`, the package colortbl is loaded.



10.3 How to generate the continuous dotted lines transparently

Imagine you have a document with a great number of mathematical matrices with ellipsis. You may wish to use the dotted lines of nicematrix without having to modify the code of each matrix. It's possible with the keys. `renew-dots` and `renew-matrix`.[28]

- The option `renew-dots`

  With this option, the commands `\ldots`, `\cdots`, `\vdots`, `\ddots`, `\iddots`[23] and `\hdotsfor` are redefined within the environments provided by nicematrix and behave like `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, `\Iddots` and `\Hdotsfor`; the command `\dots` ("automatic dots" of `amsmath`) is also redefined to behave like `\Ldots`.

- The option `renew-matrix`

  With this option, the environment `{matrix}` is redefined and behave like `{NiceMatrix}`, and so on for the five variants.

Therefore, with the keys `renew-dots` and `renew-matrix`, a classical code gives directly the ouput of nicematrix.

```
\NiceMatrixOptions{renew-dots,renew-matrix}
\begin{pmatrix}
1      & \cdots & \cdots & 1      \\
0      & \ddots &        & \vdots \\
\vdots & \ddots & \ddots & \vdots \\
0      & \cdots & 0      & 1
\end{pmatrix}
```

$$\begin{pmatrix} 1 & \cdots & \cdots & 1 \\ 0 & \ddots & & \vdots \\ \vdots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 1 \end{pmatrix}$$

10.4 The labels of the dotted lines

The commands `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, `\Iddots` and `\Hdotsfor` (and the command `\line` in the `\CodeAfter` which is described p. 24) accept two optional arguments specified by the tokens `_` and `^` for labels positionned below and above the line. The arguments are composed in math mode with `\scriptstyle`.

```
$\begin{bNiceMatrix}
1 & \hspace*{1cm}                & 0 \\[8mm]
  & \Ddots^{n \text{ times}} &   \\
0 &                              & 1
\end{bNiceMatrix}$
```

$$\begin{bmatrix} 1 & & 0 \\ & \overset{n \text{ times}}{\iddots} & \\ 0 & & 1 \end{bmatrix}$$

[28] The options `renew-dots`, `renew-matrix` can be fixed with the command `\NiceMatrixOptions` like the other options. However, they can also be fixed as options of the command `\usepackage`. There is also a key `transparent` which is an alias for the conjonction of `renew-dots` and `renew-matrix` but it must be considered as obsolete.

10.5 Customisation of the dotted lines

The dotted lines drawn by `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, `\Iddots` and `\Hdotsfor` (and by the command `\line` in the `\CodeAfter` which is described p. 24) may be customized by three options (specified between square brackets after the command):

- `color`;
- `shorten`;
- `line-style`.

These options may also be fixed with `\NiceMatrixOptions`, as options of `\CodeAfter` or at the level of a given environment but, in those cases, they must be prefixed by `xdots`, and, thus have for names:

- `xdots/color`;
- `xdots/shorten`;
- `xdots/line-style`.

For the clarity of the explanations, we will use those names.

The option xdots/color

The option `xdots/color` fixes the color or the dotted line. However, one should remark that the dotted lines drawn in the exterior rows and columns have a special treatment: cf. p. 17.

The option xdots/shorten

The option `xdots/shorten` fixes the margin of both extremities of the line. The name is derived from the options "`shorten >`" and "`shorten <`" of Tikz but one should notice that nicematrix only provides `xdots/shorten`. The initial value of this parameter is 0.3 em (it is recommanded to use a unit of length dependent of the current font).

The option xdots/line-style

It should be pointed that, by default, the lines drawn by Tikz with the parameter `dotted` are composed of square dots (and not rounded ones).[29]

```
\tikz \draw [dotted] (0,0) -- (5,0) ;
```

In order to provide lines with rounded dots in the style of those provided by `\ldots` (at least with the *Computer Modern* fonts), the package nicematrix embeds its own system to draw a dotted line (and this system uses PGF and not Tikz). This style is called `standard` and that's the initial value of the parameter `xdots/line-style`.
However (when Tikz is loaded) it's possible to use for `xdots/line-style` any style provided by Tikz, that is to say any sequence of options provided by Tikz for the Tizk pathes (with the exception of "`color`", "`shorten >`" and "`shorten <`").

Here is for example a tridiagonal matrix with the style `loosely dotted`:

```
$\begin{pNiceMatrix}[nullify-dots,xdots/line-style=loosely dotted]
a      & b      & 0      &        & \Cdots & 0      \\
b      & a      & b      & \Ddots &        & \Vdots \\
0      & b      & a      & \Ddots &        &        \\
       & \Ddots & \Ddots & \Ddots &        & 0      \\
\Vdots &        &        &        &        & b      \\
0      & \Cdots &        & 0      & b      & a
\end{pNiceMatrix}$
```

$$\begin{pmatrix} a & b & 0 & \cdots & 0 \\ b & a & b & \ddots & \vdots \\ 0 & b & a & \ddots & 0 \\ \vdots & \ddots & \ddots & \ddots & b \\ 0 & \cdots & 0 & b & a \end{pmatrix}$$

[29] The first reason of this behaviour is that the PDF format includes a description for dashed lines. The lines specified with this descriptor are displayed very efficiently by the PDF readers. It's easy, starting from these dashed lines, to create a line composed by square dots whereas a line of rounded dots needs a specification of each dot in the PDF file.

10.6 The dotted lines and the rules

The dotted lines determine virtual blocks which have the same behaviour regarding the rules (the rules specified by the specifier `|` in the preamble, by the command `\Hline` and by the keys `hlines`, `vlines` and `hvlines` are not drawn within the blocks).[30]

```
$\begin{bNiceMatrix}[margin,hvlines]
\Block{3-3}<\LARGE>{A} & & & 0 \\
& \hspace*{1cm} & & \Vdots \\
& & & 0 \\
0 & \Cdots& 0 & 0
\end{bNiceMatrix}$
```

$$\left[\begin{array}{ccc|c} \multicolumn{3}{c|}{\multirow{3}{*}{\Large A}} & 0 \\ & & & \vdots \\ & & & 0 \\ \hline 0 & \cdots & 0 & 0 \end{array}\right]$$

11 The \CodeAfter

The option `code-after` may be used to give some code that will be executed *after* the construction of the matrix.[31]

For the legibility of the code, an alternative syntax is provided: it's possible to give the instructions of the `code-after` at the end of the environment, after the keyword `\CodeAfter`. Although `\CodeAfter` is a keyword, it takes in an optional argument (between square brackets). The keys accepted form a subset of the keys of the command `\WithArrowsOptions`.

The experienced users may, for instance, use the PGF/Tikz nodes created by nicematrix in the `\CodeAfter`. These nodes are described further beginning on p. 34.

Moreover, two special commands are available in the `\CodeAfter`: `line` and `\SubMatrix`.

11.1 The command \line in the \CodeAfter

The command `\line` draws directly dotted lines between nodes. It takes in two arguments for the two cells to link, both of the form i-j where is the number of the row and j is the number of the column. The options available for the customisation of the dotted lines created by `\Cdots`, `\Vdots`, etc. are also available for this command (cf. p. 23).

This command may be used, for example, to draw a dotted line between two adjacent cells.

```
\NiceMatrixOptions{xdots/shorten = 0.6 em}
\begin{pNiceMatrix}
I       & 0      & \Cdots  &0     \\
0       & I      & \Ddots  &\Vdots\\
\Vdots  &\Ddots  & I       &0     \\
0       &\Cdots  & 0       &I
\CodeAfter \line{2-2}{3-3}
\end{pNiceMatrix}
```

$$\begin{pmatrix} I & 0 & \cdots & 0 \\ 0 & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & I \end{pmatrix}$$

It can also be used to draw a diagonal line not parallel to the other diagonal lines (by default, the dotted lines drawn by `\Ddots` are "parallelized": cf. p. 39).

[30] On the other side, the command `\line` in the `\CodeAfter` (cf. p. 24) does *not* create block.
[31] There is also a key `code-before` described p. 12.

```
\begin{bNiceMatrix}
1      & \Cdots &   & 1      & 2      & \Cdots          & 2      & \\
0      & \Ddots &   & \Vdots & \Vdots & \hspace*{2.5cm} & \Vdots & \\
\Vdots & \Ddots &   &        &        &                 &        & \\
0      & \Cdots & 0 & 1      & 2      & \Cdots          & 2
\CodeAfter \line[shorten=6pt]{1-5}{4-7}
\end{bNiceMatrix}
```

$$\begin{bmatrix} 1 & \cdots & 1 & 2 & \cdots & 2 \\ & \ddots & \vdots & \vdots & \iddots & \\ 0 & & & & & \\ \vdots & \iddots & & & & \\ 0 & \cdots & 0 & 1 & 2 & \cdots & 2 \end{bmatrix}$$

11.2 The command \SubMatrix in the \CodeAfter

The command **\SubMatrix** provides a way to put delimiters on a portion of the array considered as a submatrix. The command **\SubMatrix** takes in five arguments:

- the first argument is the left delimiter, which may be any extensible delimiter provided by LaTeX : `(`, `[`, `\{`, **\langle**, **\lgroup**, **\lfloor**, etc. but also the null delimiter `.`;
- the second argument is the upper-left corner of the submatrix with the syntax i-j where i the number of row and j the number of column;
- the third argument is the lower-right corner with the same syntax;
- the fourth argument is the right delimiter;
- the last argument, which is optional, is a list of key-value pairs.[32]

One should remark that the command **\SubMatrix** draws the delimiters after the construction of the array: no space is inserted by the command **\SubMatrix** itself. That's why, in the following example, we have used the key **margin** and you have added by hand some space between the third and fourth column with **@{\hspace{1.5em}}** in the preamble of the array.

```
\[\begin{NiceArray}{ccc@{\hspace{1.5em}}c}[cell-space-limits=2pt,margin]
 1           & 1           & 1           & x \\
\dfrac{1}{4} & \dfrac{1}{2} & \dfrac{1}{4} & y \\
 1           & 2           & 3           & z
\CodeAfter
  \SubMatrix({1-1}{3-3})
  \SubMatrix({1-4}{3-4})
\end{NiceArray}\]
```

$$\begin{pmatrix} 1 & 1 & 1 \\ \frac{1}{4} & \frac{1}{2} & \frac{1}{4} \\ 1 & 2 & 3 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \end{pmatrix}$$

New 5.18 In fact, the command **\SubMatrix** also takes in two optional arguments specified by the traditionnal symbols `^` and `_` for material in superscript and subscript.

```
$\begin{bNiceMatrix}[right-margin=1em]
1 & 1 & 1 \\
1 & a & b \\
1 & c & d
\CodeAfter
  \SubMatrix[{2-2}{3-3}]^{T}
\end{bNiceMatrix}$
```

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & \begin{bmatrix} a & b \\ c & d \end{bmatrix}^T \\ 1 & \end{bmatrix}$$

The options of the command **\SubMatrix** are as follows:

[32] There is no optional argument between square brackets in first position because a square bracket just after **\SubMatrix** must be interpreted as the first (mandatory) argument of the command **\SubMatrix**: that bracket is the left delimiter of the sub-matrix to construct (eg.: **\SubMatrix[{2-2}{4-7}]**).

- `left-xshift` and `right-shift` shift horizontally the delimiters (there exists also the key `xshift` which fixes both parameters);
- `extra-height` adds a quantity to the total height of the delimiters (height `\ht` + depth `\dp`);
- `delimiters/color` fixes the color of the delimiters (also available in `\NiceMatrixOptions`, in the environments with delimiters and as option of the keyword `\CodeAfter`);
- `slim` is a boolean key: when that key is in force, the horizontal position of the delimiters is computed by using only the contents of the cells of the submatrix whereas, in the general case, the position is computed by taking into account the cells of the whole columns implied in the submatrix (see example below). ;
- `vlines` contents a list of numbers of vertical rules that will be drawn in the sub-matrix (if this key is used without value, all the vertical rules of the sub-matrix are drawn);
- `hlines` is similar to `vlines` but for the horizontal rules;
- `hvlines`, which must be used without value, draws all the vertical and horizontal rules.

One should remark that these keys add their rules after the construction of the main matrix: no space is added between the rows and the columns of the array for theses rules.

All these keys are also available in `\NiceMatrixOptions`, at the level of the environments of nicematrix or as option of the command `\CodeAfter` with the prefix `sub-matrix` which means that their names are therefore `sub-matrix/left-xshift`, `sub-matrix/right-xshift`, `sub-matrix/xshift`, etc.

```
$\begin{NiceArray}{cc@{\hspace{5mm}}l}[cell-space-limits=2pt]
  &   & \frac12 \\
  &   & \frac14 \\[1mm]
a & b & \frac12a+\frac14b \\
c & d & \frac12c+\frac14d \\
\CodeAfter
  \SubMatrix({1-3}{2-3})
  \SubMatrix({3-1}{4-2})
  \SubMatrix({3-3}{4-3})
\end{NiceArray}$
```

$$\begin{pmatrix} \frac12 \\ \frac14 \end{pmatrix} \\ \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} \frac12 a + \frac14 b \\ \frac12 c + \frac14 d \end{pmatrix}$$

Here is the same example with the key `slim` used for one of the submatrices.

```
$\begin{NiceArray}{cc@{\hspace{5mm}}l}[cell-space-limits=2pt]
  &   & \frac12 \\
  &   & \frac14 \\[1mm]
a & b & \frac12a+\frac14b \\
c & d & \frac12c+\frac14d \\
\CodeAfter
  \SubMatrix({1-3}{2-3})[slim]
  \SubMatrix({3-1}{4-2})
  \SubMatrix({3-3}{4-3})
\end{NiceArray}$
```

$$\begin{pmatrix} \frac12 \\ \frac14 \end{pmatrix} \\ \begin{pmatrix} a & b \\ c & d \end{pmatrix} \begin{pmatrix} \frac12 a + \frac14 b \\ \frac12 c + \frac14 d \end{pmatrix}$$

There is also a key `name` which gives a name to the submatrix created by `\SubMatrix`. That name is used to create PGF/Tikz nodes: cf p. 37.

It's also possible to specify some delimiters[33] by placing them in the preamble of the environment (for the environments with a preamble: `{NiceArray}`, `{pNiceArray}`, etc.). This syntax is inspired by the extension blkarray.
When there are two successive delimiters (necessarily a closing one following by an opening one for another submatrix), a space equal to `\enskip` is automatically inserted.

[33] Those delimiters are `(`, `[`, `\{` and the closing ones. Of course, it's also possible to put `|` and `||` in the preamble of the environement.

```
$\begin{pNiceArray}{(c)(c)(c)}
a_{11} & a_{12}                                          & a_{13} \\
a_{21} & \displaystyle \int_0^1\dfrac{1}{x^2+1}\,dx & a_{23} \\
a_{31} & a_{32}                                          & a_{33}
\end{pNiceArray}$
```

$$\left(\begin{pmatrix} a_{11} \\ a_{21} \\ a_{31} \end{pmatrix} \begin{pmatrix} a_{12} \\ \displaystyle\int_0^1 \dfrac{1}{x^2+1}\,dx \\ a_{32} \end{pmatrix} \begin{pmatrix} a_{13} \\ a_{23} \\ a_{33} \end{pmatrix}\right)$$

12 The notes in the tabulars

12.1 The footnotes

The package nicematrix allows, by using footnote or footnotehyper, the extraction of the notes inserted by `\footnote` in the environments of nicematrix and their composition in the footpage with the other notes of the document.

If nicematrix is loaded with the option `footnote` (with `\usepackage[footnote]{nicematrix}` or with `\PassOptionsToPackage`), the package footnote is loaded (if it is not yet loaded) and it is used to extract the footnotes.

If nicematrix is loaded with the option `footnotehyper`, the package footnotehyper is loaded (if it is not yet loaded) ant it is used to extract footnotes.

Caution: The packages footnote and footnotehyper are incompatible. The package footnotehyper is the successor of the package footnote and should be used preferently. The package footnote has some drawbacks, in particular: it must be loaded after the package xcolor and it is not perfectly compatible with hyperref.

12.2 The notes of tabular

The package nicematrix also provides a command `\tabularnote` which gives the ability to specify notes that will be composed at the end of the array with a width of line equal to the width of the array (excepted the potential exterior columns). With no surprise, that command is available only in the environments without delimiters, that is to say `{NiceTabular}`, `{NiceArray}` and `{NiceMatrix}`. In fact, this command is available only if the extension enumitem has been loaded (before or after nicematrix). Indeed, the notes are composed at the end of the array with a type of list provided by the package enumitem.

```
\begin{NiceTabular}{@{}llr@{}}[first-row,code-for-first-row = \bfseries]
\toprule
Last name & First name & Birth day \\
\midrule
Achard\tabularnote{Achard is an old family of the Poitou.}
& Jacques & 5 juin 1962 \\
Lefebvre\tabularnote{The name Lefebvre is an alteration of the name Lefebure.}
& Mathilde & 23 mai 1988 \\
Vanesse & Stephany & 30 octobre 1994 \\
Dupont & Chantal & 15 janvier 1998 \\
\bottomrule
\end{NiceTabular}
```

Last name	First name	Birth day
Achard[a]	Jacques	June 5, 2005
Lefebvre[b]	Mathilde	January 23, 1975
Vanesse	Stephany	October 30, 1994
Dupont	Chantal	January 15, 1998

[a] Achard is an old family of the Poitou.
[b] The name Lefebvre is an alteration of the name Lefebure.

- If you have several successive commands `\tabularnote{...}` *with no space at all between them*, the labels of the corresponding notes are composed together, separated by commas (this is similar to the option `multiple` of footmisc for the footnotes).
- If a command `\tabularnote{...}` is exactly at the end of a cell (with no space at all after), the label of the note is composed in an overlapping position (towards the right). This structure may provide a better alignment of the cells of a given column.
- If the key `notes/para` is used, the notes are composed at the end of the array in a single paragraph (as with the key `para` of threeparttable).
- There is a key `tabularnote` which provides a way to insert some text in the zone of the notes before the numbered tabular notes.
- If the package booktabs has been loaded (before or after nicematrix), the key `notes/bottomrule` draws a `\bottomrule` of booktabs *after* the notes.
- The command `\tabularnote` may be used *before* the environment of nicematrix. Thus, it's possible to use it on the title inserted by `\caption` in an environment `{table}` of LaTeX.
- It's possible to create a reference to a tabular note created by `\tabularnote` (with the usual command `\label` used after the `\tabularnote`).

For an illustration of some of those remarks, see table 1, p. 29. This table has been composed with the following code.

```
\begin{table}
\setlength{\belowcaptionskip}{1ex}
\centering
\caption{Use of \texttt{\textbackslash tabularnote}\tabularnote{It's possible
    to put a note in the caption.}}
\label{t:tabularnote}
\begin{NiceTabular}{@{}llc@{}
[notes/bottomrule, tabularnote = Some text before the notes.]
\toprule
Last name & First name & Length of life \\
\midrule
Churchill & Wiston &  91\\
Nightingale\tabularnote{Considered as the first nurse of
history.}\tabularnote{Nicknamed ``the Lady with the Lamp''.}
& Florence & 90 \\
Schoelcher & Victor & 89\tabularnote{The label of the note is overlapping.}\\
Touchet & Marie & 89 \\
Wallis & John & 87 \\
\bottomrule
\end{NiceTabular}
\end{table}
```

12.3 Customisation of the tabular notes

The tabular notes can be customized with a set of keys available in `\NiceMatrixOptions`. The name of these keys is prefixed by `notes`.

- `notes/para`
- `notes/bottomrule`
- `notes/style`
- `notes/label-in-tabular`
- `notes/label-in-list`
- `notes/enumitem-keys`
- `notes/enumitem-keys-para`
- `notes/code-before`

For sake of commodity, it is also possible to set these keys in `\NiceMatrixOptions` via a key `notes` which takes in as value a list of pairs *key=value* where the name of the keys need no longer be prefixed by `notes`:

```
\NiceMatrixOptions
  {
    notes =
     {
       bottomrule ,
       style = ... ,
       label-in-tabular = ... ,
       enumitem-keys =
        {
          labelsep = ... ,
          align = ... ,
          ...
        }
     }
  }
```

We detail these keys.

- The key `notes/para` requires the composition of the notes (at the end of the tabular) in a single paragraph.

  Initial value: `false`

  That key is also available within a given environment.

Table 1: Use of `\tabularnote`[a]

Last name	First name	Length of life
Churchill	Wiston	91
Nightingale[b,c]	Florence	90
Schoelcher	Victor	89[d]
Touchet	Marie	89
Wallis	John	87

Some text before the notes.

[a] It's possible to put a note in the caption.
[b] Considered as the first nurse of history.
[c] Nicknamed "the Lady with the Lamp".
[d] The label of the note is overlapping.

- The key `notes/bottomrule` adds a `\bottomrule` of booktabs *after* the notes. Of course, that rule is drawn only if there is really notes in the tabular. The package booktabs must have been loaded (before or after the package nicematrix). If it is not, an error is raised.

  Initial value: `false`

  That key is also available within a given environment.

- The key `notes/style` is a command whose argument is specified by `#1` and which gives the style of numerotation of the notes. That style will be used by `\ref` when referencing a tabular note marked with a command `\label`. The labels formatted by that style are used, separated by commas, when the user puts several consecutive commands `\tabularnote`. The marker `#1` is meant to be the name of a LaTeX counter.

  Initial value: `\textit{\alph{#1}}`

  Another possible value should be a mere `\arabic{#1}`

- The key `notes/label-in-tabular` is a command whose argument is specified by `#1` which is used when formatting the label of a note in the tabular. Internally, this number of note has already been formatted by `notes/style` before sent to that command.

  Initial value: `\textsuperscript{#1}`

  In French, it's a tradition of putting a small space before the label of note. That tuning could be acheived by the following code:

  ```
  \NiceMatrixOptions{notes/label-in-tabular = \,\textsuperscript{#1}}
  ```

- The key `notes/label-in-list` is a command whose argument is specified by `#1` which is used when formatting the label in the list of notes at the end of the tabular. Internally, this number of note has already been formatted by `notes/style` before sent to that command.

  Initial value: `\textsuperscript{#1}`

  In French, the labels of notes are not composed in upper position when composing the notes. Such behaviour could be acheived by:

  ```
  \NiceMatrixOptions{notes/label-in-list = #1.\nobreak\hspace{0.25em}}
  ```

  The command `\nobreak` is for the event that the option `para` is used.

- The notes are composed at the end of the tabular by using internally a style of list of enumitem.

  The key `notes/enumitem-keys` specifies a list of pairs *key=value* (following the specifications of enumitem) to customize that type of list.

  Initial value: `noitemsep , leftmargin = * , align = left , labelsep = 0pt`

  This initial value contains the specification `align = left` which requires a composition of the label leftwards in the box affected to that label. With that tuning, the notes are composed flush left, which is pleasant when composing tabulars in the spirit of booktabs (see for example the table 1, p. 29).

- The key `notes/enumitem-keys-para` is similar to the previous one but corresponds to the type of list used when the option `para` is in force. Of course, when the option `para` is used, a list of type `inline` (as called by enumitem) is used and the pairs *key=value* should correspond to such a list of type `inline`.

  Initial value: `afterlabel = \nobreak, itemjoin = \quad`

- The key `notes/code-before` is a token list inserted by nicematrix just before the composition of the notes at the end of the tabular.

  Initial value: *empty*

  For example, if one wishes to compose all the notes in gray and `\footnotesize`, he should use that key:

  ```
  \NiceMatrixOptions{notes/code-before = \footnotesize \color{gray}}
  ```

It's also possible to add `\raggedright` or `\RaggedRight` in that key (`\RaggedRight` is a command of ragged2e).

For an example of customisation of the tabular notes, see p. 41.

12.4 Use of {NiceTabular} with threeparttable

If you wish to use the environment `{NiceTabular}` or `{NiceTabular*}` in an environment `{threeparttable}` of the eponymous package, you have to patch the environment `{threeparttable}` with the following code (with a version of LaTeX at least 2020/10/01).

```
\makeatletter
\AddToHook{env/threeparttable/begin}
  {\TPT@hookin{NiceTabular}\TPT@hookin{NiceTabular*}}
\makeatother
```

13 Other features

13.1 Use of the column type S of siunitx

If the package siunitx is loaded (before or after nicematrix), it's possible to use the `S` column type of siunitx in the environments of nicematrix. The implementation doesn't use explicitly any private macro of siunitx.

```
$\begin{pNiceArray}{ScWc{1cm}c}[nullify-dots,first-row]
{C_1} & \Cdots &  & C_n \\
2.3  & 0 & \Cdots & 0 \\
12.4 & \Vdots & & \Vdots \\
1.45 \\
7.2  & 0 & \Cdots & 0
\end{pNiceArray}$
```

$$\begin{pNiceArray}{ScWc{1cm}c}[nullify-dots,first-row]
C_1 & \Cdots & & C_n \\
2.3 & 0 & \Cdots & 0 \\
12.4 & \Vdots & & \Vdots \\
1.45 \\
7.2 & 0 & \Cdots & 0
\end{pNiceArray}$$

On the other hand, the `d` columns of the package dcolumn are not supported by nicematrix.

13.2 Alignment option in {NiceMatrix}

The environments without preamble (`{NiceMatrix}`, `{pNiceMatrix}`, `{bNiceMatrix}`, etc.) provide two options `l` and `r` which generate all the columns aligned leftwards (or rightwards).

```
$\begin{bNiceMatrix}[r]
\cos x & - \sin x \\
\sin x & \cos x
\end{bNiceMatrix}$
```

$$\begin{bNiceMatrix}[r]
\cos x & - \sin x \\
\sin x & \cos x
\end{bNiceMatrix}$$

13.3 The command \rotate

The package nicematrix provides a command `\rotate`. When used in the beginning of a cell, this command composes the contents of the cell after a rotation of 90° in the direct sens.
In the following command, we use that command in the `code-for-first-row`.[34]

[34] It can also be used in `RowStyle` (cf. p. 16).

```
\NiceMatrixOptions%
 {code-for-first-row = \scriptstyle \rotate \text{image of },
  code-for-last-col = \scriptstyle }
$A = \begin{pNiceMatrix}[first-row,last-col=4]
e_1 & e_2 & e_3       \\
1   & 2   & 3   & e_1 \\
4   & 5   & 6   & e_2 \\
7   & 8   & 9   & e_3
\end{pNiceMatrix}$
```

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \begin{matrix} e_1 \\ e_2 \\ e_3 \end{matrix} \quad \begin{matrix} \text{image of } e_1 & \text{image of } e_2 & \text{image of } e_3 \end{matrix}$$

If the command `\rotate` is used in the "last row" (exterior to the matrix), the corresponding elements are aligned upwards as shown below.

```
\NiceMatrixOptions%
 {code-for-last-row = \scriptstyle \rotate ,
  code-for-last-col = \scriptstyle }
$A = \begin{pNiceMatrix}[last-row=4,last-col=4]
1   & 2   & 3   & e_1 \\
4   & 5   & 6   & e_2 \\
7   & 8   & 9   & e_3 \\
\text{image of } e_1 & e_2 & e_3
\end{pNiceMatrix}$
```

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \begin{matrix} e_1 \\ e_2 \\ e_3 \end{matrix} \quad \begin{matrix} \text{image of } e_1 & e_2 & e_3 \end{matrix}$$

13.4 The option small

With the option `small`, the environments of the package nicematrix are composed in a way similar to the environment `{smallmatrix}` of the package amsmath (and the environments `{psmallmatrix}`, `{bsmallmatrix}`, etc. of the package mathtools).

```
$\begin{bNiceArray}{cccc|c}[small,
                            last-col,
                            code-for-last-col = \scriptscriptstyle,
                            columns-width = 3mm ]
1 & -2 & 3 & 4 & 5 \\
0 & 3  & 2 & 1 & 2 & L_2 \gets 2 L_1 - L_2 \\
0 & 1  & 1 & 2 & 3 & L_3 \gets L_1 + L_3
\end{bNiceArray}$
```

$$\left[\begin{array}{cccc|c} 1 & -2 & 3 & 4 & 5 \\ 0 & 3 & 2 & 1 & 2 \\ 0 & 1 & 1 & 2 & 3 \end{array}\right] \begin{matrix} \\ L_2 \leftarrow 2L_1 - L_2 \\ L_3 \leftarrow L_1 + L_3 \end{matrix}$$

One should note that the environment `{NiceMatrix}` with the option `small` is not composed *exactly* as the environment `{smallmatrix}`. Indeed, all the environments of nicematrix are constructed upon `{array}` (of the package array) whereas the environment `{smallmatrix}` is constructed directly with an `\halign` of TeX.

In fact, the option `small` corresponds to the following tuning:

- the cells of the array are composed with `\scriptstyle`;
- `\arraystretch` is set to 0.47;
- `\arraycolsep` is set to 1.45 pt;
- the characteristics of the dotted lines are also modified.

13.5 The counters iRow and jCol

In the cells of the array, it's possible to use the LaTeX counters `iRow` and `jCol` which represent the number of the current row and the number of the current column[35]. Of course, the user must not change the value of these counters which are used internally by nicematrix.
In the `\CodeBefore` (cf. p. 12) and in the `\CodeAfter` (cf. p. 24), `iRow` represents the total number of rows (excepted the potential exterior rows) and `jCol` represents the total number of columns (excepted the potential exterior columns).

```
$\begin{pNiceMatrix}% don't forget the %
    [first-row,
     first-col,
     code-for-first-row = \mathbf{\alph{jCol}} ,
     code-for-first-col = \mathbf{\arabic{iRow}} ]
&   &    &    &   \\
& 1 & 2  & 3  & 4 \\
& 5 & 6  & 7  & 8 \\
& 9 & 10 & 11 & 12
\end{pNiceMatrix}$
```

$$\begin{array}{c} \\ \mathbf{1} \\ \mathbf{2} \\ \mathbf{3} \end{array} \begin{array}{c} \begin{array}{cccc} \mathbf{a} & \mathbf{b} & \mathbf{c} & \mathbf{d} \end{array} \\ \begin{pmatrix} 1 & 2 & 3 & 4 \\ 5 & 6 & 7 & 8 \\ 9 & 10 & 11 & 12 \end{pmatrix} \end{array}$$

If LaTeX counters called `iRow` and `jCol` are defined in the document by packages other than nicematrix (or by the final user), they are shadowed in the environments of nicematrix.

The package nicematrix also provides commands in order to compose automatically matrices from a general pattern. These commands are `\AutoNiceMatrix`, `\pAutoNiceMatrix`, `\bAutoNiceMatrix`, `\vAutoNiceMatrix`, `\VAutoNiceMatrix` and `\BAutoNiceMatrix`.
These commands take in two mandatory arguments. The first is the format of the matrix, with the syntax *n*-*p* where *n* is the number of rows and *p* the number of columns. The second argument is the pattern (it's a list of tokens which are inserted in each cell of the constructed matrix, excepted in the cells of the potential exterior rows and columns).

```
$C = \pAutoNiceMatrix{3-3}{C_{\arabic{iRow},\arabic{jCol}}}$
```

$$C = \begin{pmatrix} C_{1,1} & C_{1,2} & C_{1,3} \\ C_{2,1} & C_{2,2} & C_{2,3} \\ C_{3,1} & C_{3,2} & C_{3,3} \end{pmatrix}$$

13.6 The option light-syntax

The option `light-syntax` (inpired by the package spalign) allows the user to compose the arrays with a lighter syntax, which gives a better legibility of the TeX source.
When this option is used, one should use the semicolon for the end of a row and spaces or tabulations to separate the columns. However, as usual in the TeX world, the spaces after a control sequence are discarded and the elements between curly braces are considered as a whole.

```
$\begin{bNiceMatrix}[light-syntax,first-row,first-col]
{} a              b                  ;
a  2\cos a        {\cos a + \cos b}  ;
b \cos a+\cos b   { 2 \cos b }
\end{bNiceMatrix}$
```

$$\begin{array}{c} \\ a \\ b \end{array} \begin{array}{c} \begin{array}{cc} a & b \end{array} \\ \begin{bmatrix} 2\cos a & \cos a + \cos b \\ \cos a + \cos b & 2\cos b \end{bmatrix} \end{array}$$

It's possible to change the character used to mark the end of rows with the option `end-of-row`. As said before, the initial value is a semicolon.

When the option `light-syntax` is used, it is not possible to put verbatim material (for example with the command `\verb`) in the cells of the array.[36]

[35] We recall that the exterior "first row" (if it exists) has the number 0 and that the exterior "first column" (if it exists) has also the number 0.

[36] The reason is that, when the option `light-syntax` is used, the whole content of the environment is loaded as a TeX argument to be analyzed. The environment doesn't behave in that case as a standard environment of LaTeX which only put TeX commands before and after the content.

13.7 Color of the delimiters

For the environements with delimiters (`{pNiceArray}`, `{pNiceMatrix}`, etc.), it's possible to change the color of the delimiters with the key `delimiters/color`.

```
$\begin{bNiceMatrix}[delimiters/color=red]
1 & 2 \\
3 & 4
\end{bNiceMatrix}$
```

$$\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$$

This colour alos applies to the delimiters drawn by the command `\SubMatrix` (cf. p. 25).

13.8 The environment {NiceArrayWithDelims}

In fact, the environment `{pNiceArray}` and its variants are based upon a more general environment, called `{NiceArrayWithDelims}`. The first two mandatory arguments of this environment are the left and right delimiters used in the construction of the matrix. It's possible to use `{NiceArrayWithDelims}` if we want to use atypical or asymetrical delimiters.

```
$\begin{NiceArrayWithDelims}
   {\downarrow}{\uparrow}{ccc}[margin]
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9
\end{NiceArrayWithDelims}$
```

$$\left\downarrow \begin{array}{ccc} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{array} \right\uparrow$$

14 Use of Tikz with nicematrix

14.1 The nodes corresponding to the contents of the cells

The package nicematrix creates a PGF/Tikz node for each (non-empty) cell of the considered array. These nodes are used to draw the dotted lines between the cells of the matrix (inter alia).

Caution : By default, no node is created in a empty cell.

However, it's possible to impose the creation of a node with the command `\NotEmpty`. [37]

The nodes of a document must have distinct names. That's why the names of the nodes created by nicematrix contains the number of the current environment. Indeed, the environments of nicematrix are numbered by a internal global counter.

In the environment with the number n, the node of the row i and column j has for name `nm-`n`-`i`-`j.

The command `\NiceMatrixLastEnv` provides the number of the last environment of nicematrix (for LaTeX, it's a "fully expandable" command and not a counter).

However, it's advisable to use instead the key `name`. This key gives a name to the current environment. When the environment has a name, the nodes are accessible with the name "*name-i-j*" where *name* is the name given to the array and i and j the numbers of row and column. It's possible to use these nodes with PGF but the final user will probably prefer to use Tikz (which is a convenient layer upon PGF). However, one should remind that nicematrix doesn't load Tikz by default. In the following examples, we assume that Tikz has been loaded.

```
$\begin{pNiceMatrix}[name=mymatrix]
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9
\end{pNiceMatrix}$
\tikz[remember picture,overlay]
     \draw (mymatrix-2-2) circle (2mm) ;
```

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & \textcircled{5} & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

[37] One should note that, with that command, the cell is considered as non-empty, which has consequencies for the continuous dotted lines (cf. p. 19) and the computation of the "corners" (cf. p. 10).

Don't forget the options `remember picture` and `overlay`.

In the `\CodeAfter`, the things are easier : one must refer to the nodes with the form *i*-*j* (we don't have to indicate the environment which is of course the current environment).

```
$\begin{pNiceMatrix}
1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9
\CodeAfter
  \tikz \draw (2-2) circle (2mm) ;
\end{pNiceMatrix}$
```

$$\begin{pmatrix} 1 & 2 & 3 \\ 4 & \textcircled{5} & 6 \\ 7 & 8 & 9 \end{pmatrix}$$

In the following example, we have underlined all the nodes of the matrix (we explain below the technic used : cf. p. 46).

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix}$$

14.2 The "medium nodes" and the "large nodes"

In fact, the package nicematrix can create "extra nodes": the "medium nodes" and the "large nodes". The first ones are created with the option `create-medium-nodes` and the second ones with the option `create-large-nodes`.[38]

These nodes are not used by nicematrix by default, and that's why they are not created by default.

The names of the "medium nodes" are constructed by adding the suffix "`-medium`" to the names of the "normal nodes". In the following example, we have underlined the "medium nodes". We consider that this example is self-explanatory.

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix}$$

The names of the "large nodes" are constructed by adding the suffix "`-large`" to the names of the "normal nodes". In the following example, we have underlined the "large nodes". We consider that this example is self-explanatory.[39]

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix}$$

The "large nodes" of the first column and last column may appear too small for some usage. That's why it's possible to use the options `left-margin` and `right-margin` to add space on both sides of the array and also space in the "large nodes" of the first column and last column. In the following example, we have used the options `left-margin` and `right-margin`.[40]

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix}$$

[38] There is also an option `create-extra-nodes` which is an alias for the conjonction of `create-medium-nodes` and `create-large-nodes`.

[39] There is no "large nodes" created in the exterior rows and columns (for these rows and columns, cf. p. 17).

[40] The options `left-margin` and `right-margin` take dimensions as values but, if no value is given, the default value is used, which is `\arraycolsep` (by default: 5 pt). There is also an option `margin` to fix both `left-margin` and `right-margin` to the same value.

It's also possible to add more space on both side of the array with the options `extra-left-margin` and `extra-right-margin`. These margins are not incorporated in the "large nodes". It's possible to fix both values with the option `extra-margin` and, in the following example, we use `extra-margin` with the value 3 pt.

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix}$$

Be careful : These nodes are reconstructed from the contents of the contents cells of the array. Usually, they do not correspond to the cells delimited by the rules (if we consider that these rules are drawn).

Here is an array composed with the following code:

```
\large
\begin{NiceTabular}{wl{2cm}ll}[hvlines]
fraise & amande & abricot \\
prune & pêche & poire  \\[1ex]
noix & noisette & brugnon
\end{NiceTabular}
```

fraise	amande	abricot
prune	pêche	poire
noix	noisette	brugnon

Here, we have colored all the cells of the array with `\chessboardcolors`.

fraise	amande	abricot
prune	pêche	poire
noix	noisette	brugnon

Here are the "large nodes" of this array (without use of `margin` nor `extra-margin`).

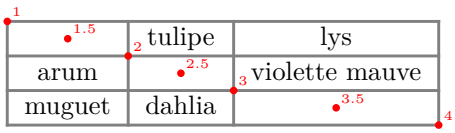
fraise	amande	abricot
prune	pêche	poire
noix	noisette	brugnon

The nodes we have described are not available by default in the `\CodeBefore` (described p. 12).

New 5.16 It's possible to have these nodes available in the `\CodeBefore` by using the key `create-cell-nodes` of the keyword `\CodeBefore` (in that case, the nodes are created first before the construction of the array by using informations written on the `aux` file and created a second time during the contruction of the array itself).

14.3 The nodes which indicate the position of the rules

The package nicematrix creates a PGF/Tikz node merely called i (with the classical prefix) at the intersection of the horizontal rule of number i and the vertical rule of number i (more specifically the potential position of those rules because maybe there are not actually drawn). The last node has also an alias called `last`. There is also a node called i`.5` midway between the node i and the node $i+1$. These nodes are available in the `\CodeBefore` and the `\CodeAfter`.



If we use Tikz (we remind that nicematrix does not load Tikz by default, by only PGF, which is a sub-layer of Tikz), we can access, in the `\CodeAfter` but also in the `\CodeBefore`, to the intersection of the (potential) horizontal rule i and the (potential) vertical rule j with the syntax `(`i`-|`j`)`.

```
\begin{NiceMatrix}
\CodeBefore
  \tikz \draw [fill=red!15] (7-|4) |- (8-|5) |- (9-|6) |- cycle ;
\Body
1 \\
1 & 1 \\
1 & 2 &  1 \\
1 & 3 &  3 &  1 \\
1 & 4 &  6 &  4 &  1 \\
1 & 5 & 10 & 10 &  5 &  1 \\
1 & 6 & 15 & 20 & 15 &  6 &  1 \\
1 & 7 & 21 & 35 & 35 & 21 &  7 & 1 \\
1 & 8 & 28 & 56 & 70 & 56 & 28 & 8 & 1
\end{NiceMatrix}
```

$$\begin{matrix}
1 & & & & & & & & \\
1 & 1 & & & & & & & \\
1 & 2 & 1 & & & & & & \\
1 & 3 & 3 & 1 & & & & & \\
1 & 4 & 6 & 4 & 1 & & & & \\
1 & 5 & 10 & 10 & 5 & 1 & & & \\
1 & 6 & 15 & 20 & 15 & 6 & 1 & & \\
1 & 7 & 21 & 35 & 35 & 21 & 7 & 1 & \\
1 & 8 & 28 & 56 & 70 & 56 & 28 & 8 & 1
\end{matrix}$$

The nodes of the form i`.5` may be used, for example to cross a row of a matrix (if Tikz is loaded).

```
$\begin{pNiceArray}{ccc|c}
2 & 1 & 3 & 0 \\
3 & 3 & 1 & 0 \\
3 & 3 & 1 & 0
\CodeAfter
  \tikz \draw [red] (3.5-|1) -- (3.5-|last) ;
\end{pNiceArray}$
```

$$\left(\begin{array}{ccc|c}
2 & 1 & 3 & 0 \\
3 & 3 & 1 & 0 \\
3 & 3 & 1 & 0
\end{array}\right)$$

14.4 The nodes corresponding to the command \SubMatrix

The command `\SubMatrix` available in the `\CodeAfter` has been described p. 25.

If a command `\SubMatrix` has been used with the key `name` with an expression such as `name=`*`MyName`* three PGF/Tikz nodes are created with the names *`MyName`*`-left`, *`MyName`* and *`MyName`*`-right`.

The nodes *`MyName`*`-left` and *`MyName`*`-right` correspond to the delimiters left and right and the node *`MyName`* correspond to the submatrix itself.

In the following example, we have highlighted these nodes (the submatrix itself has been created with `\SubMatrix\{{2-2}{3-3}\}`).

$$\begin{pmatrix}
121 & 23 & 345 & 345 \\
45 & \left\{\begin{matrix} 346 & 863 \\ 38458 & 34 \end{matrix}\right\} & & 444 \\
3462 & & & 294 \\
34 & 7 & 78 & 309
\end{pmatrix}$$

15 API for the developpers

The package nicematrix provides two variables which are internal but public[41]:

- `\g_nicematrix_code_before_tl` ;
- `\g_nicematrix_code_after_tl`.

These variables contain the code of what we have called the "`code-before`" and the "`code-after`". The developper can use them to add code from a cell of the array (the affectation must be global, allowing to exit the cell, which is a TeX group).

One should remark that the use of `\g_nicematrix_code_before_tl` needs one compilation more (because the instructions are written on the `aux` file to be used during the next run).

Example : We want to write a command `\hatchcell` to hatch the current cell (with an optional argument between brackets for the color). It's possible to program such command `\hatchcell` as follows, explicitely using the public variable `\g_nicematrix_code_before_tl` (this code requires the Tikz library patterns: `\usetikzlibrary{patterns}`).

```
ExplSyntaxOn
\cs_new_protected:Nn \__pantigny_hatch:nnn
  {
    \tikz \fill [ pattern = north~west~lines , pattern~color = #3 ]
       ( #1 -| #2) rectangle ( \int_eval:n { #1 + 1 } -| \int_eval:n { #2 + 1 } ) ;
  }

\NewDocumentCommand \hatchcell { ! O { black } }
  {
    \tl_gput_right:Nx \g_nicematrix_code_before_tl
      { \__pantigny_hatch:nnn { \arabic { iRow } } { \arabic { jCol } } { #1 } }
  }
\ExplSyntaxOff
```

Here is an example of use:

```
\begin{NiceTabular}{ccc}[hvlines]
Tokyo & Paris & London \\
Lima & \hatchcell[blue!30]Oslo & Miami \\
Los Angeles & Madrid & Roma
\end{NiceTabular}
```

Tokyo	Paris	London
Lima	Oslo	Miami
Los Angeles	Madrid	Roma

16 Technical remarks

16.1 Definition of new column types

The package nicematrix provides the command `\OnlyMainNiceMatrix` which is meant to be used in definitions of new column types. Its argument is evaluated if and only if we are in the main part of the array, that is to say not in a potential exterior row.
For example, one may wish to define a new column type `?` in order to draw a (black) heavy rule of width 1 pt. The following definition will do the job[42]:

```
\newcolumntype{?}{!{\OnlyMainNiceMatrix{\vrule width 1 pt}}}
```

[41] According to the LaTeX3 conventions, each variable with name beginning with `\g_nicematrix` ou `\l_nicematrix` is public and each variable with name beginning with `\g__nicematrix` or `\l__nicematrix` is private.
[42] The command `\vrule` is a TeX (and not LaTeX) command.

The heavy vertical rule won't extend in the exterior rows.[43]

```
$\begin{pNiceArray}{cc?cc}[first-row,last-row=3]
C_1 & C_2 & C_3 & C_4 \\
a & b & c & d \\
e & f & g & h \\
C_1 & C_2 & C_3 & C_4
\end{pNiceArray}$
```

$$\begin{array}{cccc} C_1 & C_2 & C_3 & C_4 \\ \left(\begin{array}{cc:cc} a & b & c & d \\ e & f & g & h \end{array}\right. & & & \\ C_1 & C_2 & C_3 & C_4 \end{array}$$

This specifier `?` may be used in the standard environments `{tabular}` and `{array}` (of the package array) and, in this case, the command `\OnlyMainNiceMatrix` is no-op.

16.2 Diagonal lines

By default, all the diagonal lines[44] of a same array are "parallelized". That means that the first diagonal line is drawn and, then, the other lines are drawn parallel to the first one (by rotation around the left-most extremity of the line). That's why the position of the instructions `\Ddots` in the array can have a marked effect on the final result.

In the following examples, the first `\Ddots` instruction is written in color:

Example with parallelization (default):

```
$A = \begin{pNiceMatrix}
1      & \Cdots &        & 1      \\
a+b    & \Ddots &        & \Vdots \\
\Vdots & \Ddots &        &        \\
a+b    & \Cdots & a+b    & 1
\end{pNiceMatrix}$
```

$$A = \begin{pmatrix} 1 & \cdots & & 1 \\ a+b & \ddots & & \vdots \\ \vdots & \ddots & & \\ a+b & \cdots & a+b & 1 \end{pmatrix}$$

```
$A = \begin{pNiceMatrix}
1      & \Cdots &        & 1      \\
a+b    &        &        & \Vdots \\
\Vdots & \Ddots & \Ddots &        \\
a+b    & \Cdots & a+b    & 1
\end{pNiceMatrix}$
```

$$A = \begin{pmatrix} 1 & \cdots & & 1 \\ a+b & \ddots & & \vdots \\ \vdots & \ddots & & \\ a+b & \cdots & a+b & 1 \end{pmatrix}$$

It's possible to turn off the parallelization with the option `parallelize-diags` set to `false`:

The same example without parallelization:

$$A = \begin{pmatrix} 1 & \cdots & & 1 \\ a+b & \ddots & & \vdots \\ \vdots & \ddots & & \\ a+b & \cdots & a+b & 1 \end{pmatrix}$$

It's possible to specify the instruction `\Ddots` which will be drawn first (and which will be used to draw the other diagonal dotted lines when the parallelization is in force) with the key `draw-first`: `\Ddots[draw-first]`.

16.3 The "empty" cells

An instruction like `\Ldots`, `\Cdots`, etc. tries to determine the first non-empty cell on both sides. However, an "empty cell" is not necessarily a cell with no TeX content (that is to say a cell with no token between the two ampersands `&`). The precise rules are as follow.

- An implicit cell is empty. For example, in the following matrix:

[43] Of course, such rule is defined by the classical technics of nicematrix and, for this reason, won't cross the double rules of `\hline\hline`.

[44] We speak of the lines created by `\Ddots` and not the lines created by a command `\line` in `code-after`.

```
\begin{pmatrix}
a & b \\
c \\
\end{pmatrix}
```

the last cell (second row and second column) is empty.

- Each cell whose TeX ouput has a width equal to zero is empty.
- A cell containing the command `\NotEmpty` is not empty (and a PGF/Tikz node) is created in that cell.
- A cell with a command `\Hspace` (or `\Hspace*`) is empty. This command `\Hspace` is a command defined by the package nicematrix with the same meaning as `\hspace` except that the cell where it is used is considered as empty. This command can be used to fix the width of some columns of the matrix without interfering with nicematrix.
- A cell of a column of type `p`, `m` or `t` is always considered as not emtpy. *Caution* : One should not rely upon that point because it may change if a future version of nicematrix.

16.4 The option exterior-arraycolsep

The environment `{array}` inserts an horizontal space equal to `\arraycolsep` before and after each column. In particular, there is a space equal to `\arraycolsep` before and after the array. This feature of the environment `{array}` was probably not a good idea[45]. The environment `{matrix}` of amsmath and its variants (`{pmatrix}`, `{vmatrix}`, etc.) of amsmath prefer to delete these spaces with explicit instructions `\hskip -\arraycolsep`[46]. The package nicematrix does the same in all its environments, `{NiceArray}` included. However, if the user wants the environment `{NiceArray}` behaving by default like the environment `{array}` of array (for example, when adapting an existing document) it's possible to control this behaviour with the option `exterior-arraycolsep`, set by the command `\NiceMatrixOptions`. With this option, exterior spaces of length `\arraycolsep` will be inserted in the environments `{NiceArray}` (the other environments of nicematrix are not affected).

16.5 Incompatibilities

The package nicematrix is not fully compatible with the package arydshln (because this package redefines many internal of array).
Anyway, in order to use arydshln, one must first free the letter "`:`" by giving a new letter for the vertical dotted rules of nicematrix:

```
\NiceMatrixOptions{letter-for-dotted-lines=;}
```

Up to now, the package nicematrix is not compatible with aastex63. If you want to use nicematrix with aastex63, send me an email and I will try to solve the incompatibilies.

the package nicematrix is not compatible with the class ieeeaccess (because that class is not compatible with PGF/Tikz).

[45] In the documentation of `{amsmath}`, we can read: *The extra space of `\arraycolsep` that array adds on each side is a waste so we remove it [in `{matrix}`] (perhaps we should instead remove it from array in general, but that's a harder task).*

[46] And not by inserting `@{}` on both sides of the preamble of the array. As a consequence, the length of the `\hline` is not modified and may appear too long, in particular when using square brackets.

17 Examples

17.1 Notes in the tabulars

The tools provided by nicematrix for the composition of the tabular notes have been presented in the section 12 p. 27.

Let's consider that we wish to number the notes of a tabular with stars.[47]

First, we write a command `\stars` similar the well-known commands `\arabic`, `\alph`, `\Alph`, etc. which produces a number of stars equal to its argument [48]

```
\ExplSyntaxOn
\NewDocumentCommand \stars { m }
  { \prg_replicate:nn { \value { #1 } } { $ \star $ } }
\ExplSyntaxOff
```

Of course, we change the style of the labels with the key `notes/style`. However, it would be interesting to change also some parameters in the type of list used to compose the notes at the end of the tabular. First, we required a composition flush right for the labels with the setting `align=right`. Moreover, we want the labels to be composed on a width equal to the width of the widest label. The widest label is, of course, the label with the greatest number of stars. We know that number: it is equal to `\value{tabularnote}` (because `tabularnote` is the LaTeX counter used by `\tabularnote` and, therefore, at the end of the tabular, its value is equal to the total number of tabular notes). We use the key `widest*` of enumitem in order to require a width equal to that value: `widest*=\value{tabularnote}`.

```
\NiceMatrixOptions
  {
    notes =
     {
       style = \stars{#1} ,
       enumitem-keys =
        {
          widest* = \value{tabularnote} ,
          align = right
        }
     }
  }


\begin{NiceTabular}{{}llr{}}[first-row,code-for-first-row = \bfseries]
\toprule
Last name & First name & Birth day \\
\midrule
Achard\tabularnote{Achard is an old family of the Poitou.}
& Jacques & 5 juin 1962 \\
Lefebvre\tabularnote{The name Lefebvre is an alteration of the name Lefebure.}
& Mathilde & 23 mai 1988 \\
Vanesse & Stephany & 30 octobre 1994 \\
Dupont & Chantal & 15 janvier 1998 \\
\bottomrule
\end{NiceTabular}
```

[47] Of course, it's realistic only when there is very few notes in the tabular.
[48] In fact: the value of its argument.

Last name	First name	Birth day
Achard⋆	Jacques	June 5, 2005
Lefebvre⋆⋆	Mathilde	January 23, 1975
Vanesse	Stephany	October 30, 1994
Dupont	Chantal	January 15, 1998

⋆Achard is an old family of the Poitou.

⋆⋆The name Lefebvre is an alteration of the name Lefebure.

17.2 Dotted lines

An example with the resultant of two polynoms:

```
\setlength{\extrarowheight}{1mm}
\[\begin{vNiceArray}{cccc:ccc}[columns-width=6mm]
a_0   &      &&       &b_0    &      &      \\
a_1   &\Ddots&&       &b_1    &\Ddots&      \\
\Vdots&\Ddots&&       &\Vdots &\Ddots&b_0   \\
a_p   &      &&a_0    &       &      &b_1   \\
      &\Ddots&&a_1    &b_q    &      &\Vdots\\
      &      &&\Vdots &       &\Ddots&      \\
      &      &&a_p    &       &      &b_q
\end{vNiceArray}\]
```

$$\left|\begin{array}{cccc:ccc}
a_0 & & & & b_0 & & \\
a_1 & \Ddots & & & b_1 & \Ddots & \\
\Vdots & \Ddots & & & \Vdots & \Ddots & b_0 \\
a_p & & & a_0 & & & b_1 \\
 & \Ddots & & a_1 & b_q & & \Vdots \\
 & & & \Vdots & & \Ddots & \\
 & & & a_p & & & b_q
\end{array}\right|$$

An example for a linear system:

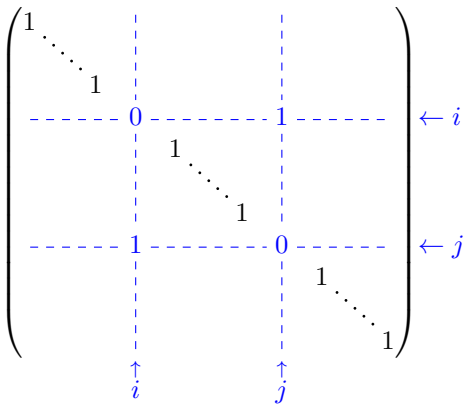
```
$\begin{pNiceArray}{*6c|c}[nullify-dots,last-col,code-for-last-col=\scriptstyle]
1      & 1 & 1 &\Cdots &   & 1      & 0      & \\
0      & 1 & 0 &\Cdots &   & 0      &        & L_2 \gets L_2-L_1 \\
0      & 0 & 1 &\Ddots &   & \Vdots &        & L_3 \gets L_3-L_1 \\
       &   &   &\Ddots &   &        & \Vdots & \Vdots \\
\Vdots &   &   &\Ddots &   & 0      & \\
0      &   &   &\Cdots & 0 & 1      & 0      & L_n \gets L_n-L_1
\end{pNiceArray}$
```

$$\left(\begin{array}{cccccc|c}
1 & 1 & 1 & \cdots & \cdots & 1 & 0 \\
0 & 1 & 0 & \cdots & \cdots & 0 & \vdots \\
0 & 0 & 1 & \ddots & & \vdots & \vdots \\
\vdots & & \ddots & \ddots & & 0 & \vdots \\
\vdots & & & \ddots & 0 & 1 & \vdots \\
0 & \cdots & \cdots & 0 & 1 & & 0
\end{array}\right)
\begin{array}{l}
\\
L_2 \leftarrow L_2 - L_1 \\
L_3 \leftarrow L_3 - L_1 \\
\\
\\
L_n \leftarrow L_n - L_1
\end{array}$$

17.3 Dotted lines which are no longer dotted

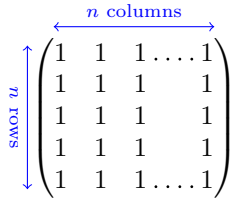
The option `line-style` controls the style of the lines drawn by `\Ldots`, `\Cdots`, etc. Thus, it's possible with these commands to draw lines which are not longer dotted.

```
\NiceMatrixOptions{code-for-first-row = \scriptstyle,code-for-first-col = \scriptstyle }
\setcounter{MaxMatrixCols}{12}
\newcommand{\blue}{\color{blue}}
\[\begin{pNiceMatrix}[last-row,last-col,nullify-dots,xdots/line-style={dashed,blue}]
1& & & \Vdots & & & & \Vdots \\
& \Ddots[line-style=standard] \\
& & 1 \\
\Cdots[color=blue,line-style=dashed]&   &  & \blue 0 &
\Cdots & & & \blue 1 & & & \Cdots & \blue \leftarrow i \\
& & & & 1 \\
& & &\Vdots & & \Ddots[line-style=standard] & & \Vdots \\
& & & & & & 1 \\
\Cdots & & & \blue 1 & \Cdots & & \Cdots & \blue 0 & & & \Cdots & \blue \leftarrow j \\
& & & & & & & & 1 \\
& & & & & & & & & \Ddots[line-style=standard] \\
& & & \Vdots & & & & \Vdots & & & 1 \\
& & & \blue \overset{\uparrow}{i} & & & & \blue \overset{\uparrow}{j} \\
\end{pNiceMatrix}\]
```



In fact, it's even possible to draw solid lines with the commands `\Cdots`, `\Vdots`, etc.

```
\NiceMatrixOptions
  {nullify-dots,code-for-first-col = \color{blue},code-for-first-col=\color{blue}}
$\begin{pNiceMatrix}[first-row,first-col]
       &   & \Ldots[line-style={solid,<->},shorten=0pt]^{n \text{ columns}} \\
       & 1 & 1 & 1 & \Ldots & 1 \\
       & 1 & 1 & 1 &  & 1 \\
\Vdots[line-style={solid,<->}]_{n \text{ rows}} & 1 & 1 & 1 &  & 1 \\
       & 1 & 1 & 1 &  & 1 \\
       & 1 & 1 & 1 & \Ldots & 1
\end{pNiceMatrix}$
```



17.4 Stacks of matrices

We often need to compose mathematical matrices on top on each other (for example for the resolution of linear systems).

In order to have the columns aligned one above the other, it's possible to fix a width for all the columns. That's what is done in the following example with the environment `{NiceMatrixBlock}` and its option `auto-columns-width`.

```
\begin{NiceMatrixBlock}[auto-columns-width]
\NiceMatrixOptions
  {
    light-syntax,
    last-col, code-for-last-col = \color{blue} \scriptstyle,
  }
\setlength{\extrarowheight}{1mm}

$\begin{pNiceArray}{rrrr|r}
12  -8  7  5   3 {} ;
 3 -18 12  1   4    ;
-3 -46 29 -2 -15    ;
 9  10 -5  4   7
\end{pNiceArray}$

\smallskip
$\begin{pNiceArray}{rrrr|r}
12  -8   7  5   3                          ;
0   64 -41  1  19  { L_2 \gets L_1-4L_2  } ;
0 -192 123 -3 -57  { L_3 \gets L_1+4L_3  } ;
0 -64   41 -1 -19  { L_4 \gets 3L_1-4L_4 } ;
\end{pNiceArray}$

\smallskip
$\begin{pNiceArray}{rrrr|r}
12 -8   7 5  3 ;
0  64 -41 1 19 ;
0   0   0 0  0 { L_3 \gets 3 L_2 + L_3 }
\end{pNiceArray}$

\smallskip
$\begin{pNiceArray}{rrrr|r}
12 -8   7 5  3 {} ;
0  64 -41 1 19    ;
\end{pNiceArray}$

\end{NiceMatrixBlock}
```

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 3 & -18 & 12 & 1 & 4 \\ -3 & -46 & 29 & -2 & -15 \\ 9 & 10 & -5 & 4 & 7 \end{array}\right)$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & -192 & 123 & -3 & -57 \\ 0 & -64 & 41 & -1 & -19 \end{array}\right) \begin{array}{l} \\ L_2 \leftarrow L_1 - 4L_2 \\ L_3 \leftarrow L_1 + 4L_3 \\ L_4 \leftarrow 3L_1 - 4L_4 \end{array}$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right) L_3 \leftarrow 3L_2 + L_3$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \end{array}\right)$$

However, one can see that the last matrix is not perfectly aligned with others. That's why, in LaTeX, the parenthesis have not exactly the same width (smaller parenthesis are a bit slimer).

In order the solve that problem, it's possible to require the delimiters to be composed with the maximal width, thanks to the boolean key `delimiters/max-width`.

```
\begin{NiceMatrixBlock}[auto-columns-width]
\NiceMatrixOptions
  {
    delimiters/max-width,
    light-syntax,
    last-col, code-for-last-col = \color{blue}\scriptstyle,
  }
\setlength{\extrarowheight}{1mm}

$\begin{pNiceArray}{rrrr|r}
12  -8  7  5   3 {} ;
 3 -18 12  1   4    ;
-3 -46 29 -2 -15    ;
 9  10 -5  4   7
\end{pNiceArray}$

...
\end{NiceMatrixBlock}
```

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 3 & -18 & 12 & 1 & 4 \\ -3 & -46 & 29 & -2 & -15 \\ 9 & 10 & -5 & 4 & 7 \end{array}\right)$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & -192 & 123 & -3 & -57 \\ 0 & -64 & 41 & -1 & -19 \end{array}\right) \begin{array}{l} L_2 \leftarrow L_1 - 4L_2 \\ L_3 \leftarrow L_1 + 4L_3 \\ L_4 \leftarrow 3L_1 - 4L_4 \end{array}$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right) L_3 \leftarrow 3L_2 + L_3$$

$$\left(\begin{array}{rrrr|r} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \end{array}\right)$$

If you wish an alignment of the different matrices without the same width for all the columns, you can construct a unique array and place the parenthesis with commands `\SubMatrix` in the `\CodeAfter`. Of course, that array can't be broken by a page break.

```
\setlength{\extrarowheight}{1mm}
\[\begin{NiceMatrix}[ r, last-col=6, code-for-last-col = \scriptstyle \color{blue} ]
12 &  -8  &  7 & 5 &  3 \\
 3 & -18  & 12 & 1 &  4 \\
-3 & -46  & 29 &-2 &-15 \\
```

```
 9 & 10   &-5  &4  & 7 \\[1mm]
12 & -8   & 7  &5  & 3 \\
0  & 64   &-41 & 1 & 19 & L_2 \gets L_1-4L_2  \\
0  & -192 &123 &-3 &-57 & L_3 \gets L_1+4L_3  \\
0  & -64  & 41 &-1 &-19 & L_4 \gets 3L_1-4L_4 \\[1mm]
12 & -8   &7   &5  & 3 \\
0  & 64   &-41 &1  &19 \\
0  &  0   &0   &0  & 0  & L_3 \gets 3L_2+L_3 \\[1mm]
12 & -8   &7   &5  & 3 \\
0  & 64   &-41 & 1 & 19 \\
\CodeAfter [sub-matrix/vlines=4]
   \SubMatrix({1-1}{4-5})
   \SubMatrix({5-1}{8-5})
   \SubMatrix({9-1}{11-5})
   \SubMatrix({12-1}{13-5})
\end{NiceMatrix}\]
```

$$\left(\begin{array}{cccc|c} 12 & -8 & 7 & 5 & 3 \\ 3 & -18 & 12 & 1 & 4 \\ -3 & -46 & 29 & -2 & -15 \\ 9 & 10 & -5 & 4 & 7 \end{array}\right)$$

$$\left(\begin{array}{cccc|c} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & -192 & 123 & -3 & -57 \\ 0 & -64 & 41 & -1 & -19 \end{array}\right) \begin{array}{l} \\ L_2 \leftarrow L_1 - 4L_2 \\ L_3 \leftarrow L_1 + 4L_3 \\ L_4 \leftarrow 3L_1 - 4L_4 \end{array}$$

$$\left(\begin{array}{cccc|c} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \\ 0 & 0 & 0 & 0 & 0 \end{array}\right) L_3 \leftarrow 3L_2 + L_3$$

$$\left(\begin{array}{cccc|c} 12 & -8 & 7 & 5 & 3 \\ 0 & 64 & -41 & 1 & 19 \end{array}\right)$$

17.5 How to highlight cells of a matrix

In order to highlight a cell of a matrix, it's possible to "draw" that cell with the key `draw` of the command `\Block` (this is one of the uses of a mono-cell block[49]).

```
$\begin{pNiceArray}{>{\strut}cccc}[margin,rules/color=blue]
\Block[draw]{}{a_{11}} & a_{12} & a_{13} & a_{14} \\
a_{21} & \Block[draw]{}{a_{22}} & a_{23} & a_{24} \\
a_{31} & a_{32} & \Block[draw]{}{a_{33}} & a_{34} \\
a_{41} & a_{42} & a_{43} & \Block[draw]{}{a_{44}} \\
\end{pNiceArray}$
```

$$\begin{pNiceArray}{>{\strut}cccc}[margin,rules/color=blue] \Block[draw]{}{a_{11}} & a_{12} & a_{13} & a_{14} \\ a_{21} & \Block[draw]{}{a_{22}} & a_{23} & a_{24} \\ a_{31} & a_{32} & \Block[draw]{}{a_{33}} & a_{34} \\ a_{41} & a_{42} & a_{43} & \Block[draw]{}{a_{44}} \\ \end{pNiceArray}$$

We should remark that the rules we have drawn are drawn *after* the construction of the array and thus, they don't spread the cells of the array. We recall that, on the other side, the commands `\hline` and `\Hline`, the specifier "`|`" and the options `hlines`, `vlines` and `hvlines` spread the cells.[50]

[49] We recall that, if the first mandatory argument of the command `\Block` is left empty, that means that the block is a mono-cell block

[50] For the command `\cline`, see the remark p. 8.

It's possible to color a row with `\rowcolor` in the `code-before` (or with `\rowcolor` in the first cell of the row if the key `colortbl-like` is used—even when colortbl is not loaded).

```
\begin{pNiceArray}{>{\strut}cccc}[margin, extra-margin=2pt,colortbl-like]
  \rowcolor{red!15}A_{11} & A_{12} & A_{13} & A_{14} \\
  A_{21} & \rowcolor{red!15}A_{22} & A_{23} & A_{24} \\
  A_{31} & A_{32} & \rowcolor{red!15}A_{33} & A_{34} \\
  A_{41} & A_{42} & A_{43} & \rowcolor{red!15}A_{44}
\end{pNiceArray}
```

$$\begin{pmatrix} A_{11} & A_{12} & A_{13} & A_{14} \\ A_{21} & A_{22} & A_{23} & A_{24} \\ A_{31} & A_{32} & A_{33} & A_{34} \\ A_{41} & A_{42} & A_{43} & A_{44} \end{pmatrix}$$

However, it's not possible to do a fine tuning. That's why we describe now a method to highlight a row of the matrix. We create a rectangular Tikz node which encompasses the nodes of the second row with the Tikz library fit. This Tikz node is filled after the construction of the matrix. In order to see the text *under* this node, we have to use transparency with the `blend mode` equal to `multiply`.

Caution : Some PDF readers are not able to show transparency.[51]

That example and the following ones require Tikz (by default, nicematrix only loads PGF, which is a sub-layer of Tikz) and the Tikz library `fit`. The following lines in the preamble of your document do the job:

```
\usepackage{tikz}
\usetikzlibrary{fit}
```

We create a rectangular Tikz node which encompasses the nodes of the second row by using the tools of the Tikz library fit. Those nodes are not available by default in the `\CodeBefore` (for efficiency). We have to require their creation with the key `create-cell-nodes` of the keyword `\CodeBefore`.

```
\tikzset{highlight/.style={rectangle,
                           fill=red!15,
                           rounded corners = 0.5 mm,
                           inner sep=1pt,
                           fit=#1}}

$\begin{bNiceMatrix}
\CodeBefore [create-cell-nodes]
  \tikz \node [highlight = (2-1) (2-3)] {} ;
 \Body
0 & \Cdots & 0 \\
1 & \Cdots & 1 \\
0 & \Cdots & 0 \\
\end{bNiceMatrix}$
```

$$\begin{bmatrix} 0 & \cdots & 0 \\ 1 & \cdots & 1 \\ 0 & \cdots & 0 \end{bmatrix}$$

We consider now the following matrix. If we want to highlight each row of this matrix, we can use the previous technique three times.

[51] In Overleaf, the "built-in" PDF viewer does not show transparency. You can switch to the "native" viewer in that case.

```
\[\begin{pNiceArray}{ccc}[last-col]
\CodeBefore [create-cell-nodes]
  \begin{tikzpicture}
  \node [highlight = (1-1) (1-3)] {} ;
  \node [highlight = (2-1) (2-3)] {} ;
  \node [highlight = (3-1) (3-3)] {} ;
  \end{tikzpicture}
\Body
a & a + b & a + b + c & L_1 \\
a & a     & a + b     & L_2 \\
a & a     & a         & L_3
\end{pNiceArray}\]
```

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix} \begin{matrix} L_1 \\ L_2 \\ L_3 \end{matrix}$$

The result may seem disappointing. We can improve it by using the "medium nodes" instead of the "normal nodes".

```
\[\begin{pNiceArray}{ccc}[last-col,create-medium-nodes]
\CodeBefore [create-cell-nodes]
  \begin{tikzpicture} [name suffix = -medium]
  \node [highlight = (1-1) (1-3)] {} ;
  \node [highlight = (2-1) (2-3)] {} ;
  \node [highlight = (3-1) (3-3)] {} ;
  \end{tikzpicture}
\Body
a & a + b & a + b + c & L_1 \\
a & a     & a + b     & L_2 \\
a & a     & a         & L_3
\end{pNiceArray}\]
```

$$\begin{pmatrix} a & a+b & a+b+c \\ a & a & a+b \\ a & a & a \end{pmatrix} \begin{matrix} L_1 \\ L_2 \\ L_3 \end{matrix}$$

17.6 Utilisation of \SubMatrix in the \CodeBefore

In the following example, we illustrate the mathematical product of two matrices.
The whole figure is an environment `{NiceArray}` and the three pairs of parenthesis have been added with `\SubMatrix` in the `\CodeBefore`.

$$\begin{matrix} & & & & C_j & & \\ & & & \begin{pmatrix} b_{11} & \cdots & b_{1j} & \cdots & b_{1n} \\ \vdots & & \vdots & & \vdots \\ & & b_{kj} & & \\ \vdots & & \vdots & & \vdots \\ b_{n1} & \cdots & b_{nj} & \cdots & b_{nn} \end{pmatrix} & & \\ L_i & \begin{pmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & & \vdots \\ a_{i1} & \cdots & a_{ik} & \cdots & a_{in} \\ \vdots & & \vdots \\ a_{n1} & \cdots & a_{nn} \end{pmatrix} & \begin{pmatrix} & \vdots & \\ \cdots & c_{ij} & \cdots \\ & & \end{pmatrix} & & \end{matrix}$$

```
\tikzset{highlight/.style={rectangle,
                           fill=red!15,
                           rounded corners = 0.5 mm,
                           inner sep=1pt,
                           fit=#1}}


\[\begin{NiceArray}{*{6}{c}@{\hspace{6mm}}*{5}{c}}[nullify-dots]
\CodeBefore [create-cell-nodes]
  \SubMatrix({2-7}{6-11})
  \SubMatrix({7-2}{11-6})
  \SubMatrix({7-7}{11-11})
  \begin{tikzpicture}
    \node [highlight = (9-2) (9-6)] { } ;
    \node [highlight = (2-9) (6-9)] { } ;
  \end{tikzpicture}
\Body
    &        &        &        &        &        &        & \color{blue}\scriptstyle C_j \\
    &        &        &        &        & b_{11} & \Cdots & b_{1j} & \Cdots & b_{1n} \\
    &        &        &        &        & \Vdots &        & \Vdots &        & \Vdots \\
    &        &        &        &        &        &        & b_{kj} \\
    &        &        &        &        &        &        & \Vdots \\
    &        &        &        &        & b_{n1} & \Cdots & b_{nj} & \Cdots & b_{nn} \\[3mm]
    & a_{11} & \Cdots &        &        & a_{1n} \\
    & \Vdots &        &        &        & \Vdots &        &        & \Vdots \\
\color{blue}\scriptstyle L_i
    & a_{i1} & \Cdots & a_{ik} & \Cdots & a_{in} & \Cdots &        & c_{ij} \\
    & \Vdots &        &        &        & \Vdots \\
    & a_{n1} & \Cdots &        &        & a_{nn}  \\
\CodeAfter
\tikz \draw [gray,shorten > = 1mm, shorten < = 1mm] (9-4.north) to [bend left] (4-9.west) ;
\end{NiceArray}\]
```

18 Implementation

By default, the package nicematrix doesn't patch any existing code.

However, when the option `renew-dots` is used, the commands `\cdots`, `\ldots`, `\dots`, `\vdots`, `\ddots` and `\iddots` are redefined in the environments provided by nicematrix as explained previously. In the same way, if the option `renew-matrix` is used, the environment `{matrix}` of amsmath is redefined.

On the other hand, the environment `{array}` is never redefined.

Of course, the package nicematrix uses the features of the package array. It tries to be independent of its implementation. Unfortunately, it was not possible to be strictly independent. For example, the package nicematrix relies upon the fact that the package `{array}` uses `\ialign` to begin the `\halign`.

Declaration of the package and packages loaded

The prefix `nicematrix` has been registred for this package.
See: `http://mirrors.ctan.org/macros/latex/contrib/l3kernel/l3prefixes.pdf`
<@@=nicematrix>

First, we load pgfcore and the module shapes. We do so because it's not possible to use `\usepgfmodule` in `\ExplSyntaxOn`.

```
\RequirePackage{pgfcore}
\usepgfmodule{shapes}
```

We give the traditional declaration of a package written with `expl3`:

```
\RequirePackage{l3keys2e}
\ProvidesExplPackage
  {nicematrix}
  {\myfiledate}
  {\myfileversion}
  {Enhanced arrays with the help of PGF/TikZ}
```

The command for the treatment of the options of `\usepackage` is at the end of this package for technical reasons.

We load some packages. The package xparse is still loaded for use on Overleaf.

```
\RequirePackage { xparse }
\RequirePackage { array }
\RequirePackage { amsmath }


\cs_new_protected:Npn \@@_error:n { \msg_error:nn { nicematrix } }
\cs_new_protected:Npn \@@_error:nn { \msg_error:nnn { nicematrix } }
\cs_new_protected:Npn \@@_error:nnn { \msg_error:nnnn { nicematrix } }
\cs_new_protected:Npn \@@_fatal:n { \msg_fatal:nn { nicematrix } }
\cs_new_protected:Npn \@@_fatal:nn { \msg_fatal:nnn { nicematrix } }
\cs_new_protected:Npn \@@_msg_new:nn { \msg_new:nnn { nicematrix } }
\cs_new_protected:Npn \@@_msg_new:nnn { \msg_new:nnnn { nicematrix } }
\cs_new_protected:Npn \@@_msg_redirect_name:nn
  { \msg_redirect_name:nnn { nicematrix } }
```

Technical definitions

```
\bool_new:N \c_@@_in_preamble_bool
\bool_set_true:N \c_@@_in_preamble_bool
\AtBeginDocument { \bool_set_false:N \c_@@_in_preamble_bool }
\bool_new:N \c_@@_arydshln_loaded_bool
\bool_new:N \c_@@_booktabs_loaded_bool
\bool_new:N \c_@@_enumitem_loaded_bool
\bool_new:N \c_@@_tikz_loaded_bool
\AtBeginDocument
  {
    \@ifpackageloaded { arydshln }
      { \bool_set_true:N \c_@@_arydshln_loaded_bool }
      { }
    \@ifpackageloaded { booktabs }
      { \bool_set_true:N \c_@@_booktabs_loaded_bool }
      { }
    \@ifpackageloaded { enumitem }
      { \bool_set_true:N \c_@@_enumitem_loaded_bool }
      { }
    \@ifpackageloaded { tikz }
      {
```

In some constructions, we will have to use a `{pgfpicture}` which *must* be replaced by a `{tikzpicture}` if Tikz is loaded. However, this switch between `{pgfpicture}` and `{tikzpicture}` can't be done dynamically with a conditional because, when the Tikz library `external` is loaded by the user, the pair `\tikzpicture`-`\endtikpicture` (or `\begin{tikzpicture}`-`\end{tikzpicture}`) must be statically "visible" (even when externalization is not activated).
That's why we create `\c_@@_pgfortikzpicture_tl` and `\c_@@_endpgfortikzpicture_tl` which will be used to construct in a `\AtBeginDocument` the correct version of some commands.

```
        \bool_set_true:N \c_@@_tikz_loaded_bool
        \tl_const:Nn \c_@@_pgfortikzpicture_tl { \exp_not:N \tikzpicture }
```

```
        \tl_const:Nn \c_@@_endpgfortikzpicture_tl { \exp_not:N \endtikzpicture }
      }
      {
        \tl_const:Nn \c_@@_pgfortikzpicture_tl { \exp_not:N \pgfpicture }
        \tl_const:Nn \c_@@_endpgfortikzpicture_tl { \exp_not:N \endpgfpicture }
      }
  }
```

We test whether the current class is revtex4-1 (deprecated) or revtex4-2 because these classes redefines `\array` (of array) in a way incompatible with our programmation. At the date January 2021, the current version revtex4-2 is 4.2e (compatible with booktabs).

```
\bool_new:N \c_@@_revtex_bool
\@ifclassloaded { revtex4-1 }
  { \bool_set_true:N \c_@@_revtex_bool }
  { }
\@ifclassloaded { revtex4-2 }
  { \bool_set_true:N \c_@@_revtex_bool }
  { }
```

Maybe one of the previous classes will be loaded inside another class... We try to detect that situation.

```
\cs_if_exist:NT \rvtx@ifformat@geq { \bool_set_true:N \c_@@_revtex_bool }

\cs_generate_variant:Nn \tl_if_single_token_p:n { V }
```

The following regex will be used to modify the preamble of the array when the key `colortbl-like` is used.

```
\regex_const:Nn \c_@@_columncolor_regex { \c { columncolor } }
```

If the final user uses nicematrix, PGF/Tikz will write instruction `\pgfsyspdfmark` in the aux file. If he changes its mind and no longer loads nicematrix, an error may occur at the next compilation because of remanent instructions `\pgfsyspdfmark` in the aux file. With the following code, we try to avoid that situation.

```
\cs_new_protected:Npn \@@_provide_pgfsyspdfmark:
  {
    \iow_now:Nn \@mainaux
      {
        \ExplSyntaxOn
        \cs_if_free:NT \pgfsyspdfmark
          { \cs_set_eq:NN \pgfsyspdfmark \@gobblethree }
        \ExplSyntaxOff
      }
    \cs_gset_eq:NN \@@_provide_pgfsyspdfmark: \prg_do_nothing:
  }
```

We define a command `\iddots` similar to `\ddots` ($\ddots$) but with dots going forward ($\iddots$). We use `\ProvideDocumentCommand` and so, if the command `\iddots` has already been defined (for example by the package mathdots), we don't define it again.

```
\ProvideDocumentCommand \iddots { }
  {
    \mathinner
      {
        \tex_mkern:D 1 mu
        \box_move_up:nn { 1 pt } { \hbox:n { . } }
        \tex_mkern:D 2 mu
        \box_move_up:nn { 4 pt } { \hbox:n { . } }
        \tex_mkern:D 2 mu
        \box_move_up:nn { 7 pt }
          { \vbox:n { \kern 7 pt \hbox:n { . } } }
        \tex_mkern:D 1 mu
      }
  }
```

This definition is a variant of the standard definition of `\ddots`.

In the aux file, we will have the references of the PGF/Tikz nodes created by nicematrix. However, when booktabs is used, some nodes (more precisely, some row nodes) will be defined twice because their position will be modified. In order to avoid an error message in this case, we will redefine \pgfutil@check@rerun in the aux file.

```
\AtBeginDocument
  {
    \@ifpackageloaded { booktabs }
      { \iow_now:Nn \@mainaux \nicematrix@redefine@check@rerun }
      { }
  }
\cs_set_protected:Npn \nicematrix@redefine@check@rerun
  {
    \cs_set_eq:NN \@@_old_pgfutil@check@rerun \pgfutil@check@rerun
```

The new version of \pgfutil@check@rerun will not check the PGF nodes whose names start with nm- (which is the prefix for the nodes created by nicematrix).

```
    \cs_set_protected:Npn \pgfutil@check@rerun ##1 ##2
      {
        \str_if_eq:eeF { nm- } { \tl_range:nnn { ##1 } 1 3 }
          { \@@_old_pgfutil@check@rerun { ##1 } { ##2 } }
      }
  }
```

We have to know whether colortbl is loaded in particular for the redefinition of \everycr.

```
\bool_new:N \c_@@_colortbl_loaded_bool
\AtBeginDocument
  {
    \@ifpackageloaded { colortbl }
      {
        \bool_set_true:N \c_@@_colortbl_loaded_bool
      }
      {
```

The command \CT@arc@ is a command of colortbl which sets the color of the rules in the array. We will use it to store the instruction of color for the rules even if colortbl is not loaded.

```
        \cs_set_protected:Npn \CT@arc@ { }
        \cs_set:Npn \arrayrulecolor #1 # { \CT@arc { #1 } }
        \cs_set:Npn \CT@arc #1 #2
          {
            \dim_compare:nNnT \baselineskip = \c_zero_dim \noalign
            { \cs_gset:Npn \CT@arc@ { \color #1 { #2 } } }
          }
```

Idem for \CT@drs@.

```
        \cs_set:Npn \doublerulesepcolor #1 # { \CT@drs { #1 } }
        \cs_set:Npn\CT@drs #1 #2
          {
            \dim_compare:nNnT \baselineskip = \c_zero_dim \noalign
            { \cs_gset:Npn \CT@drsc@ { \color #1 { #2 } } }
          }
        \cs_set:Npn \hline
          {
            \noalign { \ifnum 0 = `} \fi
            \cs_set_eq:NN \hskip \vskip
            \cs_set_eq:NN \vrule \hrule
            \cs_set_eq:NN \@width \@height
            { \CT@arc@ \vline }
            \futurelet \reserved@a
            \@xhline
          }
      }
  }
```

We need that line for the case where you use || with colortbl loaded.

```
\cs_set_protected:Npn \CT@drsc@ { }
```

We have to redefine `\cline` for several reasons. The command `\@@_cline` will be linked to `\cline` in the beginning of `{NiceArrayWithDelims}`. The following commands must *not* be protected.

```
\cs_set:Npn \@@_standard_cline #1 { \@@_standard_cline:w #1 \q_stop }
\cs_set:Npn \@@_standard_cline:w #1-#2 \q_stop
  {
    \int_compare:nNnT \l_@@_first_col_int = 0 { \omit & }
    \int_compare:nNnT { #1 } > 1 { \multispan { \@@_pred:n { #1 } } & }
    \multispan { \int_eval:n { #2 - #1 + 1 } }
    {
      \CT@arc@
      \leaders \hrule \@height \arrayrulewidth \hfill
```

The following `\skip_horizontal:N \c_zero_dim` is to prevent a potential `\unskip` to delete the `\leaders`[52]

```
      \skip_horizontal:N \c_zero_dim
    }
```

Our `\everycr` has been modified. In particular, the creation of the `row` node is in the `\everycr` (maybe we should put it with the incrementation of `\c@iRow`). Since the following `\cr` correspond to a "false row", we have to nullify `\everycr`.

```
    \everycr { }
    \cr
    \noalign { \skip_vertical:N -\arrayrulewidth }
  }
```

The following version of `\cline` spreads the array of a quantity equal to `\arrayrulewidth` as does `\hline`. It will be loaded excepted if the key `standard-cline` has been used.

```
\cs_set:Npn \@@_cline
```

We have to act in a fully expandable way since there may be `\noalign` (in the `\multispan`) to detect. That's why we use `\@@_cline_i:en`.

```
  { \@@_cline_i:en \l_@@_first_col_int }
```

The command `\cline_i:nn` has two arguments. The first is the number of the current column (it *must* be used in that column). The second is a standard argument of `\cline` of the form *i-j*.

```
\cs_set:Npn \@@_cline_i:nn #1 #2 { \@@_cline_i:w #1-#2 \q_stop }
\cs_set:Npn \@@_cline_i:w #1-#2-#3 \q_stop
  {
```

Now, `#1` is the number of the current column and we have to draw a line from the column `#2` to the column `#3` (both included).

```
    \int_compare:nNnT { #1 } < { #2 }
      { \multispan { \int_eval:n { #2 - #1 } } & }
    \multispan { \int_eval:n { #3 - #2 + 1 } }
      {
        \CT@arc@
        \leaders \hrule \@height \arrayrulewidth \hfill
        \skip_horizontal:N \c_zero_dim
      }
```

You look whether there is another `\cline` to draw (the final user may put several `\cline`).

```
    \peek_meaning_remove_ignore_spaces:NTF \cline
      { & \@@_cline_i:en { \@@_succ:n { #3 } } }
      { \everycr { } \cr }
  }
\cs_generate_variant:Nn \@@_cline_i:nn { e n }
```

The following commands are only for efficiency. They must *not* be protected because it will be used (for instance) in names of PGF nodes.

```
\cs_new:Npn \@@_succ:n #1 { \the \numexpr #1 + 1 \relax }
\cs_new:Npn \@@_pred:n #1 { \the \numexpr #1 - 1 \relax }
```

The following command is a small shortcut.

[52] See question 99041 on TeX StackExchange.

```
\cs_new:Npn \@@_math_toggle_token:
  { \bool_if:NF \l_@@_NiceTabular_bool \c_math_toggle_token }

\cs_new_protected:Npn \@@_set_CT@arc@:
  { \peek_meaning:NTF [ \@@_set_CT@arc@_i: \@@_set_CT@arc@_ii: }
\cs_new_protected:Npn \@@_set_CT@arc@_i: [ #1 ] #2 \q_stop
  { \cs_set:Npn \CT@arc@ { \color [ #1 ] { #2 } } }
\cs_new_protected:Npn \@@_set_CT@arc@_ii: #1 \q_stop
  { \cs_set:Npn \CT@arc@ { \color { #1 } } }

\cs_set_eq:NN \@@_old_pgfpointanchor \pgfpointanchor
```

The column S of siunitx

We want to know whether the package siunitx is loaded and, if it is loaded, we redefine the `S` columns of siunitx.

```
\bool_new:N \c_@@_siunitx_loaded_bool
\AtBeginDocument
  {
    \@ifpackageloaded { siunitx }
      { \bool_set_true:N \c_@@_siunitx_loaded_bool }
      { }
  }
```

The command `\@@_renew_NC@rewrite@S:` will be used in each environment of nicematrix in order to "rewrite" the `S` column in each environment.

```
\AtBeginDocument
  {
    \bool_if:nTF { ! \c_@@_siunitx_loaded_bool }
      { \cs_set_eq:NN \@@_renew_NC@rewrite@S: \prg_do_nothing: }
      {
```

For version of siunitx at least equal to 3.0, the adaptation is different from previous ones. We test the version of siunitx by the existence of the control sequence `\siunitx_cell_begin:w`.

```
        \cs_if_exist:NTF \siunitx_cell_begin:w
          {
            \cs_new_protected:Npn \@@_renew_NC@rewrite@S:
              {
                \renewcommand*{\NC@rewrite@S}[1][]
                  {
                    \@temptokena \exp_after:wN
                      {
                        \tex_the:D \@temptokena
                        > {
                            \@@_Cell:
                            \keys_set:nn { siunitx } { ##1 }
                            \siunitx_cell_begin:w
                          }
```

`\@@_true_c:` will be replaced statically by `c` at the end of the construction of the preamble.

```
                        \@@_true_c:
                        < { \siunitx_cell_end: \@@_end_Cell: }
                      }
                    \NC@find
                  }
              }
          }
          {
            \cs_new_protected:Npn \@@_renew_NC@rewrite@S:
              {
                \renewcommand*{\NC@rewrite@S}[1][]
                  {
                    \@temptokena \exp_after:wN
```

```
                    {
                      \tex_the:D \@temptokena
                      > { \@@_Cell: \c_@@_table_collect_begin_tl S {##1} }
                      \@@_true_c:
                      < { \c_@@_table_print_tl \@@_end_Cell: }
                    }
                  \NC@find
                }
            }
        }
    }
}
```

The following code is used to define `\c_@@_table_collect_begin_tl` and `\c_@@_table_print_tl` when the version of siunitx is prior to 3.0. The command `\@@_adapt_S_column` is used in the environment `{NiceArrayWithDelims}`.

```
\AtBeginDocument
  {
    \cs_set_eq:NN \@@_adapt_S_column: \prg_do_nothing:
    \bool_lazy_and:nnT
      { \c_@@_siunitx_loaded_bool }
      { ! \cs_if_exist_p:N \siunitx_cell_begin:w }
      {
        \cs_set_protected:Npn \@@_adapt_S_column:
          {
            \group_begin:
            \@temptokena = { }
            \cs_set_eq:NN \NC@find \prg_do_nothing:
            \NC@rewrite@S { }
            \tl_gset:NV \g_tmpa_tl \@temptokena
            \group_end:
            \tl_new:N \c_@@_table_collect_begin_tl
            \tl_set:Nx \l_tmpa_tl { \tl_item:Nn \g_tmpa_tl 2 }
            \tl_gset:Nx \c_@@_table_collect_begin_tl { \tl_item:Nn \l_tmpa_tl 1 }
            \tl_new:N \c_@@_table_print_tl
            \tl_gset:Nx \c_@@_table_print_tl { \tl_item:Nn \g_tmpa_tl { -1 } }
            \cs_gset_eq:NN \@@_adapt_S_column: \prg_do_nothing:
          }
      }
  }
```

Parameters

For compatibility with versions prior to 5.0, we provide a load-time option `define_L_C_R`. With this option, it's possible to use the letters `L`, `C` and `R` instead of `l`, `c` and `r` in the preamble of the environments of nicematrix as it was mandatory before version 5.0.

```
\bool_new:N \c_@@_define_L_C_R_bool
\cs_new_protected:Npn \@@_define_L_C_R:
  {
    \newcolumntype L l
    \newcolumntype C c
    \newcolumntype R r
  }
```

The following counter will count the environments `{NiceArray}`. The value of this counter will be used to prefix the names of the Tikz nodes created in the array.

```
\int_new:N \g_@@_env_int
```

The following command is only a syntaxic shortcut. It must *not* be protected (it will be used in names of PGF nodes).

```
\cs_new:Npn \@@_env: { nm - \int_use:N \g_@@_env_int }
```

The command \NiceMatrixLastEnv is not used by the package nicematrix. It's only a facility given to the final user. It gives the number of the last environment (in fact the number of the current environment but it's meant to be used after the environment in order to refer to that environment — and its nodes — without having to give it a name). This command *must* be expandable since it will be used in pgf nodes.

```
\NewExpandableDocumentCommand \NiceMatrixLastEnv { }
  { \int_use:N \g_@@_env_int }
```

The following command is only a syntaxic shortcut. The q in qpoint means *quick*.

```
\cs_new_protected:Npn \@@_qpoint:n #1
  { \pgfpointanchor { \@@_env: - #1 } { center } }
```

The following counter will count the environments {NiceMatrixBlock}.

```
\int_new:N \g_@@_NiceMatrixBlock_int
```

The dimension \l_@@_columns_width_dim will be used when the options specify that all the columns must have the same width (but, if the key columns-width is used with the special value auto, the boolean \l_@@_auto_columns_width_bool also will be raised).

```
\dim_new:N \l_@@_columns_width_dim
```

The following counters will be used to count the numbers of rows and columns of the array.

```
\int_new:N \g_@@_row_total_int
\int_new:N \g_@@_col_total_int
```

The following token list will contain the type of the current cell (l, c or r). It will be used by the blocks.

```
\tl_new:N \l_@@_cell_type_tl
\tl_set:Nn \l_@@_cell_type_tl { c }
```

When there is a mono-column block (created by the command \Block), we want to take into account the width of that block for the width of the column. That's why we compute the width of that block in the \g_@@_blocks_wd_dim and, after the construction of the box \l_@@_cell_box, we change the width of that box to take into account the length \g_@@_blocks_wd_dim.

```
\dim_new:N \g_@@_blocks_wd_dim
```

Idem pour the mono-row blocks.

```
\dim_new:N \g_@@_blocks_ht_dim
\dim_new:N \g_@@_blocks_dp_dim
```

The sequence \g_@@_names_seq will be the list of all the names of environments used (via the option name) in the document: two environments must not have the same name. However, it's possible to use the option allow-duplicate-names.

```
\seq_new:N \g_@@_names_seq
```

We want to know whether we are in an environment of nicematrix because we will raise an error if the user tries to use nested environments.

```
\bool_new:N \l_@@_in_env_bool
```

If the user uses {NiceArray} or {NiceTabular} the flag \l_@@_NiceArray_bool will be raised.

```
\bool_new:N \l_@@_NiceArray_bool
```

In fact, if there is delimiters in the preamble of {NiceArray} (eg: [cccc]), this boolean will be set to false.

If the user uses {NiceTabular} or {NiceTabular*}, we will raise the following flag.

```
\bool_new:N \l_@@_NiceTabular_bool
```

If the user uses {NiceTabular*}, the width of the tabular (in the first argument of the environment {NiceTabular*}) will be stored in the following dimension.

```
\dim_new:N \l_@@_tabular_width_dim
```

If the user uses an environment without preamble, we will raise the following flag.

```
\bool_new:N \l_@@_Matrix_bool
```

The following boolean will be raised when the command \rotate is used.

```
\bool_new:N \g_@@_rotate_bool
```

We will write in \g_@@_aux_tl all the instructions that we have to write on the aux file for the current environment. The contain of that token list will be written on the aux file at the end of the environment (in an instruction \tl_gset:cn { c_@@_ \int_use:N \g_@@_env_int _ tl }).

```
\tl_new:N \g_@@_aux_tl
```

```
\cs_new_protected:Npn \@@_test_if_math_mode:
  {
    \if_mode_math: \else:
      \@@_fatal:n { Outside~math~mode }
    \fi:
  }
```

The letter used for the vlines which will be drawn only in the sub-matrices. vlism stands for *vertical lines in sub-matrices*.

```
\tl_new:N \l_@@_letter_vlism_tl
```

The list of the columns where vertical lines in sub-matrices (vlism) must be drawn. Of course, the actual value of this sequence will be known after the analyse of the preamble of the array.

```
\seq_new:N \g_@@_cols_vlism_seq
```

The following colors will be used to memorize the color of the potential "first col" and the potential "first row".

```
\colorlet { nicematrix-last-col } { . }
\colorlet { nicematrix-last-row } { . }
```

The following string is the name of the current environment or the current command of nicematrix (despite its name which contains *env*).

```
\str_new:N \g_@@_name_env_str
```

The following string will contain the word *command* or *environment* whether we are in a command of nicematrix or in an environment of nicematrix. The default value is *environment*.

```
\tl_set:Nn \g_@@_com_or_env_str { environment }
```

The following command will be able to reconstruct the full name of the current command or environment (despite its name which contains *env*). This command must *not* be protected since it will be used in error messages and we have to use \str_if_eq:VnTF and not \tl_if_eq:NnTF because we need to be fully expandable).

```
\cs_new:Npn \@@_full_name_env:
  {
    \str_if_eq:VnTF \g_@@_com_or_env_str { command }
      { command \space \c_backslash_str \g_@@_name_env_str }
      { environment \space \{ \g_@@_name_env_str \} }
  }
```

The following token list corresponds to the option code-after (it's also possible to set the value of that parameter with the keyword \CodeAfter).

```
\tl_new:N \g_nicematrix_code_after_tl
```

For the key `code` of the command `\SubMatrix` (itself in the main `\CodeAfter`), we will use the following token list.

```
\tl_new:N \l_@@_code_tl
```

The following token list has a function similar to `\g_nicematrix_code_after_tl` but it is used internally by nicematrix. In fact, we have to distinguish between `\g_nicematrix_code_after_tl` and `\g_@@_internal_code_after_tl` because we must take care of the order in which instructions stored in that parameters are executed.

```
\tl_new:N \g_@@_internal_code_after_tl
```

The counters `\l_@@_old_iRow_int` and `\l_@@_old_jCol_int` will be used to save the values of the potential LaTeX counters `iRow` and `jCol`. These LaTeX counters will be restored at the end of the environment.

```
\int_new:N \l_@@_old_iRow_int
\int_new:N \l_@@_old_jCol_int
```

The TeX counters `\c@iRow` and `\c@jCol` will be created in the beginning of `{NiceArrayWithDelims}` (if they don't exist previously).

The following token list corresponds to the key `rules/color` available in the environments.

```
\tl_new:N \l_@@_rules_color_tl
```

This boolean will be used only to detect in an expandable way whether we are at the beginning of the (potential) column zero, in order to raise an error if `\Hdotsfor` is used in that column.

```
\bool_new:N \g_@@_after_col_zero_bool
```

A kind of false row will be inserted at the end of the array for the construction of the `col` nodes (and also to fix the width of the columns when `columns-width` is used). When this special row will be created, we will raise the flag `\g_@@_row_of_col_done_bool` in order to avoid some actions set in the redefinition of `\everycr` when the last `\cr` of the `\halign` will occur (after that row of `col` nodes).

```
\bool_new:N \g_@@_row_of_col_done_bool
```

It's possible to use the command `\NotEmpty` to specify explicitely that a cell must be considered as non empty by nicematrix (the Tikz nodes are constructed only in the non empty cells).

```
\bool_new:N \g_@@_not_empty_cell_bool
```

`\l_@@_code_before_tl` may contain two types of informations:

- A `code-before` written in the `aux` file by a previous run. When the `aux` file is read, this `code-before` is stored in `\g_@@_code_before_`*i*`_tl` (where *i* is the number of the environment) and, at the beginning of the environment, it will be put in `\l_@@_code_before_tl`.
- The final user can explicitly add material in `\l_@@_code_before_tl` by using the key `code-before` or the keyword `\CodeBefore` (with the keyword `\Body`).

```
\tl_new:N \l_@@_code_before_tl
\bool_new:N \l_@@_code_before_bool
```

The following token list will contain ce code inserted in each cell of the current row (this token list will be cleared at the beginning of each row).

```
\tl_new:N \g_@@_row_style_tl
```

The following dimensions will be used when drawing the dotted lines.

```
\dim_new:N \l_@@_x_initial_dim
\dim_new:N \l_@@_y_initial_dim
\dim_new:N \l_@@_x_final_dim
\dim_new:N \l_@@_y_final_dim
```

expl3 provides scratch dimensions `\l_tmpa_dim` and `\l_tmpb_dim`. We creates two more in the same spirit (if they don't exist yet: that's why we use `\dim_zero_new:N`).

```
\dim_zero_new:N \l_tmpc_dim
\dim_zero_new:N \l_tmpd_dim
```

Some cells will be declared as "empty" (for example a cell with an instruction `\Cdots`).

```
\bool_new:N \g_@@_empty_cell_bool
```

The following dimensions will be used internally to compute the width of the potential "first column" and "last column".

```
\dim_new:N \g_@@_width_last_col_dim
\dim_new:N \g_@@_width_first_col_dim
```

The following sequence will contain the characteristics of the blocks of the array, specified by the command `\Block`. Each block is represented by 6 components surrounded by curly braces: {*imin*}{*jmin*}{*imax*}{*jmax*}{*options*}{*contents*}.
The variable is global because it will be modified in the cells of the array.

```
\seq_new:N \g_@@_blocks_seq
```

We also manage a sequence of the *positions* of the blocks. Of course, it's redundant with the previous sequence, but it's for efficiency. In that sequence, each block is represented by only the four first components: {*imin*}{*jmin*}{*imax*}{*jmax*}.

```
\seq_new:N \g_@@_pos_of_blocks_seq
```

In fact, this sequence will also contain the positions of the cells with a `\diagbox`. The sequence `\g_@@_pos_of_blocks_seq` will be used when we will draw the rules (which respect the blocks).

We will also manage a sequence for the positions of the dotted lines. These dotted lines are created in the array by `\Cdots`, `\Vdots`, `\Ddots`, etc. However, their positions, that is to say, their extremities, will be determined only after the construction of the array. In this sequence, each item contains four components: {*imin*}{*jmin*}{*imax*}{*jmax*}.

```
\seq_new:N \g_@@_pos_of_xdots_seq
```

The sequence `\g_@@_pos_of_xdots_seq` will be used when we will draw the rules required by the key `hvlines` (these rules won't be drawn within the virtual blocks corresponding to the dotted lines).

The final user may decide to "stroke" a block (using, for example, the key `draw=red!15` when using the command `\Block`). In that case, the rules specified, for instance, by `hvlines` must not be drawn around the block. That's why we keep the information of all that stroken blocks in the following sequence.

```
\seq_new:N \g_@@_pos_of_stroken_blocks_seq
```

If the user has used the key `corners` (or the key `hvlines-except-corners`), all the cells which are in an (empty) corner will be stored in the following sequence.

```
\seq_new:N \l_@@_corners_cells_seq
```

The list of the names of the potential `\SubMatrix` in the `\CodeAfter` of an environment. Unfortunately, that list has to be global (we have to use it inside the group for the options of a given `\SubMatrix`).

```
\seq_new:N \g_@@_submatrix_names_seq
```

The sequence `\g_@@_multicolumn_cells_seq` will contain the list of the cells of the array where a command `\multicolumn{`n`}{...}{...}` with $n > 1$ is issued. In `\g_@@_multicolumn_sizes_seq`, the "sizes" (that is to say the values of n) correspondant will be stored. These lists will be used for the creation of the "medium nodes" (if they are created).

```
\seq_new:N \g_@@_multicolumn_cells_seq
\seq_new:N \g_@@_multicolumn_sizes_seq
```

The following counters will be used when searching the extremities of a dotted line (we need these counters because of the potential "open" lines in the `\SubMatrix`—the `\SubMatrix` in the `code-before`).

```
\int_new:N \l_@@_row_min_int
\int_new:N \l_@@_row_max_int
\int_new:N \l_@@_col_min_int
\int_new:N \l_@@_col_max_int
```

The following sequence will be used when the command `\SubMatrix` is used in the `code-before` (and not in the `\CodeAfter`). It will contain the position of all the sub-matrices specified in the `code-before`. Each sub-matrix is represented by an "object" of the forme `{`i`}{`j`}{`k`}{`l`}` where i and j are the number of row and column of the upper-left cell and k and l the number of row and column of the lower-right cell.

```
\seq_new:N \g_@@_submatrix_seq
```

We are able to determine the number of columns specified in the preamble (for the environments with explicit preamble of course and without the potential exterior columns).

```
\int_new:N \g_@@_static_num_of_col_int
```

The following parameters correspond to the keys `fill`, `draw`, `borders` and `rounded-corners` of the command `\Block`.

```
\tl_new:N \l_@@_fill_tl
\tl_new:N \l_@@_draw_tl
\clist_new:N \l_@@_borders_clist
\dim_new:N \l_@@_rounded_corners_dim
```

The last parameter has no direct link with the [empty] corners of the array (which are computed and taken into account by nicematrix when the key `corners` is used).

The following token list correspond to the key `color` of the command `\Block`.

```
\tl_new:N \l_@@_color_tl
```

Here is the dimension for the width of the rule when a block (created by `\Block`) is stroked.

```
\dim_new:N \l_@@_line_width_dim
```

The parameters of the horizontal position of the label of a block. If the user uses the key `c` or `C`, the value is `c`. If the user uses the key `l` or `L`, the value is `l`. If the user uses the key `r` or `R`, the value is `r`. If the user has used a capital letter, the boolean `\l_@@_hpos_of_block_cap_bool` will be raised (in the second pass of the analyze of the keys of the command `\Block`).

```
\tl_new:N \l_@@_hpos_of_block_tl
\tl_set:Nn \l_@@_hpos_of_block_tl { c }
\bool_new:N \l_@@_hpos_of_block_cap_bool
```

For the vertical position, the possible values are `c`, `t` and `b`. Of course, it would be interesting to program a key `T` and a key `B`.

```
\tl_new:N \l_@@_vpos_of_block_tl
\tl_set:Nn \l_@@_vpos_of_block_tl { c }
```

Used when the key `draw-first` is used for `\Ddots` or `\Iddots`.

```
\bool_new:N \l_@@_draw_first_bool
```

The following flag corresponds to the key `hvlines` of the command `\Block`.

```
\bool_new:N \l_@@_hvlines_block_bool
```

The blocks which use the key `-` will store their content in a box. These boxes are numbered with the following counter.

```
\int_new:N \g_@@_block_box_int
```

```
\dim_new:N \l_@@_submatrix_extra_height_dim
\dim_new:N \l_@@_submatrix_left_xshift_dim
\dim_new:N \l_@@_submatrix_right_xshift_dim
\clist_new:N \l_@@_hlines_clist
\clist_new:N \l_@@_vlines_clist
\clist_new:N \l_@@_submatrix_hlines_clist
\clist_new:N \l_@@_submatrix_vlines_clist
```

Variables for the exterior rows and columns

The keys for the exterior rows and columns are `first-row`, `first-col`, `last-row` and `last-col`. However, internally, these keys are not coded in a similar way.

- **First row**

  The integer `\l_@@_first_row_int` is the number of the first row of the array. The default value is 1, but, if the option `first-row` is used, the value will be 0.

```
    \int_new:N \l_@@_first_row_int
    \int_set:Nn \l_@@_first_row_int 1
```

- **First column**

  The integer `\l_@@_first_col_int` is the number of the first column of the array. The default value is 1, but, if the option `first-col` is used, the value will be 0.

```
    \int_new:N \l_@@_first_col_int
    \int_set:Nn \l_@@_first_col_int 1
```

- **Last row**

  The counter `\l_@@_last_row_int` is the number of the potential "last row", as specified by the key `last-row`. A value of -2 means that there is no "last row". A value of -1 means that there is a "last row" but we don't know the number of that row (the key `last-row` has been used without value and the actual value has not still been read in the `aux` file).

```
    \int_new:N \l_@@_last_row_int
    \int_set:Nn \l_@@_last_row_int { -2 }
```

  If, in an environment like `{pNiceArray}`, the option `last-row` is used without value, we will globally raise the following flag. It will be used to know if we have, after the construction of the array, to write in the `aux` file the number of the "last row".[53]

```
    \bool_new:N \l_@@_last_row_without_value_bool
```

  Idem for `\l_@@_last_col_without_value_bool`

```
    \bool_new:N \l_@@_last_col_without_value_bool
```

- **Last column**

  For the potential "last column", we use an integer. A value of -2 means that there is no last column. A value of -1 means that we are in an environment without preamble (e.g. `{bNiceMatrix}`) and there is a last column but we don't know its value because the user has used the option `last-col` without value. A value of 0 means that the option `last-col` has been used in an environment with preamble (like `{pNiceArray}`): in this case, the key was necessary without argument.

```
    \int_new:N \l_@@_last_col_int
    \int_set:Nn \l_@@_last_col_int { -2 }
```

[53] We can't use `\l_@@_last_row_int` for this usage because, if nicematrix has read its value from the `aux` file, the value of the counter won't be -1 any longer.

However, we have also a boolean. Consider the following code:

```
\begin{pNiceArray}{cc}[last-col]
1 & 2 \\
3 & 4
\end{pNiceArray}
```

In such a code, the "last column" specified by the key `last-col` is not used. We want to be able to detect such a situation and we create a boolean for that job.

```
\bool_new:N \g_@@_last_col_found_bool
```

This boolean is set to `false` at the end of `\@@_pre_array_ii:`.

The command \tabularnote

The LaTeX counter `tabularnote` will be used to count the tabular notes during the construction of the array (this counter won't be used during the composition of the notes at the end of the array). You use a LaTeX counter because we will use `\refstepcounter` in order to have the tabular notes referenceable.

```
\newcounter { tabularnote }
```

We will store in the following sequence the tabular notes of a given array.

```
\seq_new:N \g_@@_tabularnotes_seq
```

However, before the actual tabular notes, it's possible to put a text specified by the key `tabularnote` of the environment. The token list `\l_@@_tabularnote_tl` corresponds to the value of that key.

```
\tl_new:N \l_@@_tabularnote_tl
```

The following counter will be used to count the number of successive tabular notes such as in `\tabularnote{Note 1}\tabularnote{Note 2}\tabularnote{Note 3}`. In the tabular, the labels of those nodes are composed as a comma separated list (e.g. ^{a,b,c}).

```
\int_new:N \l_@@_number_of_notes_int
```

The following function can be redefined by using the key `notes/style`.

```
\cs_new:Npn \@@_notes_style:n #1 { \textit { \alph { #1 } } }
```

The following fonction can be redefined by using the key `notes/label-in-tabular`.

```
\cs_new:Npn \@@_notes_label_in_tabular:n #1 { \textsuperscript { #1 } }
```

The following function can be redefined by using the key `notes/label-in-list`.

```
\cs_new:Npn \@@_notes_label_in_list:n #1 { \textsuperscript { #1 } }
```

We define `\thetabularnote` because it will be used by LaTeX if the user want to reference a footnote which has been marked by a `\label`. The TeX group is for the case where the user has put an instruction such as `\color{red}` in `\@@_notes_style:n`.

```
\cs_set:Npn \thetabularnote { { \@@_notes_style:n { tabularnote } } }
```

The tabular notes will be available for the final user only when enumitem is loaded. Indeed, the tabular notes will be composed at the end of the array with a list customized by enumitem (a list tabularnotes in the general case and a list tabularnotes* if the key para is in force). However, we can test whether enumitem has been loaded only at the beginning of the document (we want to allow the user to load enumitem after nicematrix).

```
\AtBeginDocument
  {
    \bool_if:nTF { ! \c_@@_enumitem_loaded_bool }
      {
        \NewDocumentCommand \tabularnote { m }
          { \@@_error:n { enumitem~not~loaded } }
      }
      {
```

The type of list tabularnotes will be used to format the tabular notes at the end of the array in the general case and tabularnotes* will be used if the key para is in force.

```
        \newlist { tabularnotes } { enumerate } { 1 }
        \setlist [ tabularnotes ]
          {
            topsep = 0pt ,
            noitemsep ,
            leftmargin = * ,
            align = left ,
            labelsep = 0pt ,
            label =
              \@@_notes_label_in_list:n { \@@_notes_style:n { tabularnotesi } } ,
          }
        \newlist { tabularnotes* } { enumerate* } { 1 }
        \setlist [ tabularnotes* ]
          {
            afterlabel = \nobreak ,
            itemjoin = \quad ,
            label =
              \@@_notes_label_in_list:n { \@@_notes_style:n { tabularnotes*i } }
          }
```

The command \tabularnote is available in the whole document (and not only in the environments of nicematrix) because we want it to be available in the caption of a {table} (before the following {NiceTabular} or {NiceArray}). That's also the reason why the variables \c@tabularnote and \g_@@_tabularnotes_seq will be cleared at the end of the environment of nicematrix (and not at the beginning).
Unfortunately, if the package caption is loaded, the command \caption evaluates its argument twice and since it is not aware (of course) of \tabularnote, the command \tabularnote is, in fact, not usable in \caption when caption is loaded.[54]

```
        \NewDocumentCommand \tabularnote { m }
          {
            \bool_if:nTF { ! \l_@@_NiceArray_bool && \l_@@_in_env_bool }
              { \@@_error:n { tabularnote~forbidden } }
              {
```

\l_@@_number_of_notes_int is used to count the number of successive tabular notes such as in \tabularnote{Note 1}\tabularnote{Note 2}\tabularnote{Note 3}. We will have to compose the labels of theses notes as a comma separated list (e.g. ^{a,b,c}).

```
                \int_incr:N \l_@@_number_of_notes_int
```

We expand the content of the note at the point of use of \tabularnote as does \footnote.

```
                \seq_gput_right:Nn \g_@@_tabularnotes_seq { #1 }
                \peek_meaning:NF \tabularnote
                  {
```

[54] We should try to find a solution to that problem.

If the following token is *not* a `\tabularnote`, we have finished the sequence of successive commands `\tabularnote` and we have to format the labels of these tabular notes (in the array). We compose those labels in a box `\l_tmpa_box` because we will do a special construction in order to have this box in a overlapping position if we are at the end of a cell.

```
                    \hbox_set:Nn \l_tmpa_box
                      {
```

We remind that it is the command `\@@_notes_label_in_tabular:n` that will (most of the time) put the labels in a `\textsuperscript`.

```
                        \@@_notes_label_in_tabular:n
                          {
                            \stepcounter { tabularnote }
                            \@@_notes_style:n { tabularnote }
                            \prg_replicate:nn { \l_@@_number_of_notes_int - 1 }
                              {
                                ,
                                \stepcounter { tabularnote }
                                \@@_notes_style:n { tabularnote }
                              }
                          }
                      }
```

We use `\refstepcounter` in order to have the (last) tabular note referenceable (with the standard command `\label`) and that's why we have to go back with a decrementation of the counter `tabularnote` first.

```
                    \addtocounter { tabularnote } { -1 }
                    \refstepcounter { tabularnote }
                    \int_zero:N \l_@@_number_of_notes_int
                    \hbox_overlap_right:n { \box_use:N \l_tmpa_box }
```

If the command `\tabularnote` is used exactly at the end of the cell, the `\unskip` (inserted by array?) will delete the skip we insert now and the label of the footnote will be composed in an overlapping position (by design).

```
                    \skip_horizontal:n { \box_wd:N \l_tmpa_box }
                  }
              }
          }
      }
  }
```

Command for creation of rectangle nodes

The following command should be used in a `{pgfpicture}`. It creates a rectangle (empty but with a name).
`#1` is the name of the node which will be created; `#2` and `#3` are the coordinates of one of the corner of the rectangle; `#4` and `#5` are the coordinates of the opposite corner.

```
\cs_new_protected:Npn \@@_pgf_rect_node:nnnnn #1 #2 #3 #4 #5
  {
    \begin { pgfscope }
    \pgfset
      {
        outer~sep = \c_zero_dim ,
        inner~sep = \c_zero_dim ,
        minimum~size = \c_zero_dim
      }
    \pgftransformshift { \pgfpoint { 0.5 * ( #2 + #4 ) } { 0.5 * ( #3 + #5 ) } }
    \pgfnode
      { rectangle }
      { center }
      {
        \vbox_to_ht:nn
          { \dim_abs:n { #5 - #3 } }
```

```
          {
            \vfill
            \hbox_to_wd:nn { \dim_abs:n { #4 - #2 } } { }
          }
      }
      { #1 }
      { }
    \end { pgfscope }
  }
```

The command `\@@_pgf_rect_node:nnn` is a variant of `\@@_pgf_rect_node:nnnn`: it takes two PGF points as arguments instead of the four dimensions which are the coordinates.

```
\cs_new_protected:Npn \@@_pgf_rect_node:nnn #1 #2 #3
  {
    \begin { pgfscope }
    \pgfset
      {
        outer~sep = \c_zero_dim ,
        inner~sep = \c_zero_dim ,
        minimum~size = \c_zero_dim
      }
    \pgftransformshift { \pgfpointscale { 0.5 } { \pgfpointadd { #2 } { #3 } } }
    \pgfpointdiff { #3 } { #2 }
    \pgfgetlastxy \l_tmpa_dim \l_tmpb_dim
    \pgfnode
      { rectangle }
      { center }
      {
        \vbox_to_ht:nn
          { \dim_abs:n \l_tmpb_dim }
          { \vfill \hbox_to_wd:nn { \dim_abs:n \l_tmpa_dim } { } }
      }
      { #1 }
      { }
    \end { pgfscope }
  }
```

The options

By default, the commands `\cellcolor` and `\rowcolor` are available for the user in the cells of the tabular (the user may use the commands provided by `\colortbl`). However, if the key `colortbl-like` is used, these commands are available.

```
\bool_new:N \l_@@_colortbl_like_bool
```

By default, the behaviour of `\cline` is changed in the environments of nicematrix: a `\cline` spreads the array by an amount equal to `\arrayrulewidht`. It's possible to disable this feature with the key `\l_@@_standard_line_bool`.

```
\bool_new:N \l_@@_standard_cline_bool
```

The following dimensions correspond to the options `cell-space-top-limit` and co (these parameters are inspired by the package cellspace).

```
\dim_new:N \l_@@_cell_space_top_limit_dim
\dim_new:N \l_@@_cell_space_bottom_limit_dim
```

The following dimension is the distance between two dots for the dotted lines (when `line-style` is equal to `standard`, which is the initial value). The initial value is 0.45 em but it will be changed if the option `small` is used.

```
\dim_new:N \l_@@_inter_dots_dim
\AtBeginDocument { \dim_set:Nn \l_@@_inter_dots_dim { 0.45 em } }
```

The \AtBeginDocument is only a security in case revtex4-1 is used (even though it is obsolete).

The following dimension is the minimal distance between a node (in fact an anchor of that node) and a dotted line (we say "minimal" because, by definition, a dotted line is not a continuous line and, therefore, this distance may vary a little).

```
\dim_new:N \l_@@_xdots_shorten_dim
\AtBeginDocument { \dim_set:Nn \l_@@_xdots_shorten_dim { 0.3 em } }
```

The \AtBeginDocument is only a security in case revtex4-1 is used (even though it is obsolete).

The following dimension is the radius of the dots for the dotted lines (when line-style is equal to standard, which is the initial value). The initial value is 0.53 pt but it will be changed if the option small is used.

```
\dim_new:N \l_@@_radius_dim
\AtBeginDocument { \dim_set:Nn \l_@@_radius_dim { 0.53 pt } }
```

The \AtBeginDocument is only a security in case revtex4-1 is used (even if it is obsolete).

The token list \l_@@_xdots_line_style_tl corresponds to the option tikz of the commands \Cdots, \Ldots, etc. and of the options line-style for the environments and \NiceMatrixOptions. The constant \c_@@_standard_tl will be used in some tests.

```
\tl_new:N \l_@@_xdots_line_style_tl
\tl_const:Nn \c_@@_standard_tl { standard }
\tl_set_eq:NN \l_@@_xdots_line_style_tl \c_@@_standard_tl
```

The boolean \l_@@_light_syntax_bool corresponds to the option light-syntax.

```
\bool_new:N \l_@@_light_syntax_bool
```

The string \l_@@_baseline_tl may contain one of the three values t, c or b as in the option of the environment {array}. However, it may also contain an integer (which represents the number of the row to which align the array).

```
\tl_new:N \l_@@_baseline_tl
\tl_set:Nn \l_@@_baseline_tl c
```

The flag \l_@@_exterior_arraycolsep_bool corresponds to the option exterior-arraycolsep. If this option is set, a space equal to \arraycolsep will be put on both sides of an environment {NiceArray} (as it is done in {array} of array).

```
\bool_new:N \l_@@_exterior_arraycolsep_bool
```

The flag \l_@@_parallelize_diags_bool controls whether the diagonals are parallelized. The initial value is true.

```
\bool_new:N \l_@@_parallelize_diags_bool
\bool_set_true:N \l_@@_parallelize_diags_bool
```

The following parameter correspond to the key corners. The elements of that clist must be in NW, SW, NE and SE.

```
\clist_new:N \l_@@_corners_clist
```

```
\dim_new:N \l_@@_notes_above_space_dim
\AtBeginDocument { \dim_set:Nn \l_@@_notes_above_space_dim { 1 mm } }
```

The \AtBeginDocument is only a security in case revtex4-1 is used (even if it is obsolete).

The flag \l_@@_nullify_dots_bool corresponds to the option nullify-dots. When the flag is down, the instructions like \vdots are inserted within a \hphantom (and so the constructed matrix has exactly the same size as a matrix constructed with the classical {matrix} and \ldots, \vdots, etc.).

```
\bool_new:N \l_@@_nullify_dots_bool
```

The following flag will be used when the current options specify that all the columns of the array must have the same width equal to the largest width of a cell of the array (except the cells of the potential exterior columns).

```
\bool_new:N \l_@@_auto_columns_width_bool
```

The following boolean corresponds to the key `create-cell-nodes` of the keyword `\CodeBefore`.

```
\bool_new:N \g_@@_recreate_cell_nodes_bool
```

The string `\l_@@_name_str` will contain the optional name of the environment: this name can be used to access to the Tikz nodes created in the array from outside the environment.

```
\str_new:N \l_@@_name_str
```

The boolean `\l_@@_medium_nodes_bool` will be used to indicate whether the "medium nodes" are created in the array. Idem for the "large nodes".

```
\bool_new:N \l_@@_medium_nodes_bool
\bool_new:N \l_@@_large_nodes_bool
```

The boolean `\l_@@_except_borders_bool` will be raised when the key `hvlines-except-borders` will be used (but that key has also other effects).

```
\bool_new:N \l_@@_except_borders_bool
```

The dimension `\l_@@_left_margin_dim` correspond to the option `left-margin`. Idem for the right margin. These parameters are involved in the creation of the "medium nodes" but also in the placement of the delimiters and the drawing of the horizontal dotted lines (`\hdottedline`).

```
\dim_new:N \l_@@_left_margin_dim
\dim_new:N \l_@@_right_margin_dim
```

The dimensions `\l_@@_extra_left_margin_dim` and `\l_@@_extra_right_margin_dim` correspond to the options `extra-left-margin` and `extra-right-margin`.

```
\dim_new:N \l_@@_extra_left_margin_dim
\dim_new:N \l_@@_extra_right_margin_dim
```

The token list `\l_@@_end_of_row_tl` corresponds to the option `end-of-row`. It specifies the symbol used to mark the ends of rows when the light syntax is used.

```
\tl_new:N \l_@@_end_of_row_tl
\tl_set:Nn \l_@@_end_of_row_tl { ; }
```

The following parameter is for the color the dotted lines drawn by `\Cdots`, `\Ldots`, `\Vdots`, `\Ddots`, `\Iddots` and `\Hdotsfor` but *not* the dotted lines drawn by `\hdottedline` and ":".

```
\tl_new:N \l_@@_xdots_color_tl
```

The following token list corresponds to the key `delimiters/color`.

```
\tl_new:N \l_@@_delimiters_color_tl
```

Sometimes, we want to have several arrays vertically juxtaposed in order to have an alignment of the columns of these arrays. To acheive this goal, one may wish to use the same width for all the columns (for example with the option `columns-width` or the option `auto-columns-width` of the environment `{NiceMatrixBlock}`). However, even if we use the same type of delimiters, the width of the delimiters may be different from an array to another because the width of the delimiter is fonction of its size. That's why we create an option called `delimiters/max-width` which will give to the delimiters the width of a delimiter (of the same type) of big size. The following boolean corresponds to this option.

```
\bool_new:N \l_@@_delimiters_max_width_bool
```

```
\keys_define:nn { NiceMatrix / xdots }
  {
    line-style .code:n =
      {
        \bool_lazy_or:nnTF
```

We can't use `\c_@@_tikz_loaded_bool` to test whether tikz is loaded because `\NiceMatrixOptions` may be used in the preamble of the document.

```
          { \cs_if_exist_p:N \tikzpicture }
          { \str_if_eq_p:nn { #1 } { standard } }
          { \tl_set:Nn \l_@@_xdots_line_style_tl { #1 } }
          { \@@_error:n { bad~option~for~line-style } }
      } ,
    line-style .value_required:n = true ,
    color .tl_set:N = \l_@@_xdots_color_tl ,
    color .value_required:n = true ,
    shorten .dim_set:N = \l_@@_xdots_shorten_dim ,
    shorten .value_required:n = true ,
```

The options `down` and `up` are not documented for the final user because he should use the syntax with `^` and `_`.

```
    down .tl_set:N = \l_@@_xdots_down_tl ,
    up .tl_set:N = \l_@@_xdots_up_tl ,
```

The key `draw-first`, which is meant to be used only with `\Ddots` and `\Iddots`, which be catched when `\Ddots` or `\Iddots` is used (during the construction of the array and not when we draw the dotted lines).

```
    draw-first .code:n = \prg_do_nothing: ,
    unknown .code:n = \@@_error:n { Unknown~key~for~xdots }
  }


\keys_define:nn { NiceMatrix / rules }
  {
    color .tl_set:N = \l_@@_rules_color_tl ,
    color .value_required:n = true ,
    width .dim_set:N = \arrayrulewidth ,
    width .value_required:n = true
  }
```

First, we define a set of keys "`NiceMatrix / Global`" which will be used (with the mechanism of `.inherit:n`) by other sets of keys.

```
\keys_define:nn { NiceMatrix / Global }
  {
    delimiters .code:n =
      \keys_set:nn { NiceMatrix / delimiters } { #1 } ,
    delimiters .value_required:n = true ,
    rules .code:n = \keys_set:nn { NiceMatrix / rules } { #1 } ,
    rules .value_required:n = true ,
    standard-cline .bool_set:N = \l_@@_standard_cline_bool ,
    standard-cline .default:n = true ,
    cell-space-top-limit .dim_set:N = \l_@@_cell_space_top_limit_dim ,
    cell-space-top-limit .value_required:n = true ,
    cell-space-bottom-limit .dim_set:N = \l_@@_cell_space_bottom_limit_dim ,
    cell-space-bottom-limit .value_required:n = true ,
    cell-space-limits .meta:n =
      {
        cell-space-top-limit = #1 ,
        cell-space-bottom-limit = #1 ,
      } ,
    cell-space-limits .value_required:n = true ,
    xdots .code:n = \keys_set:nn { NiceMatrix / xdots } { #1 } ,
    light-syntax .bool_set:N = \l_@@_light_syntax_bool ,
```

```
    light-syntax .default:n = true ,
    end-of-row .tl_set:N = \l_@@_end_of_row_tl ,
    end-of-row .value_required:n = true ,
    first-col .code:n = \int_zero:N \l_@@_first_col_int ,
    first-row .code:n = \int_zero:N \l_@@_first_row_int ,
    last-row .int_set:N = \l_@@_last_row_int ,
    last-row .default:n = -1 ,
    code-for-first-col .tl_set:N = \l_@@_code_for_first_col_tl ,
    code-for-first-col .value_required:n = true ,
    code-for-last-col .tl_set:N = \l_@@_code_for_last_col_tl ,
    code-for-last-col .value_required:n = true ,
    code-for-first-row .tl_set:N = \l_@@_code_for_first_row_tl ,
    code-for-first-row .value_required:n = true ,
    code-for-last-row .tl_set:N = \l_@@_code_for_last_row_tl ,
    code-for-last-row .value_required:n = true ,
    hlines .clist_set:N = \l_@@_hlines_clist ,
    vlines .clist_set:N = \l_@@_vlines_clist ,
    hlines .default:n = all ,
    vlines .default:n = all ,
    vlines-in-sub-matrix .code:n =
      {
        \tl_if_single_token:nTF { #1 }
          { \tl_set:Nn \l_@@_letter_vlism_tl { #1 } }
          { \@@_error:n { One~letter~allowed } }
      } ,
    vlines-in-sub-matrix .value_required:n = true ,
    hvlines .code:n =
      {
        \clist_set:Nn \l_@@_vlines_clist { all }
        \clist_set:Nn \l_@@_hlines_clist { all }
      } ,
    hvlines-except-borders .code:n =
      {
        \clist_set:Nn \l_@@_vlines_clist { all }
        \clist_set:Nn \l_@@_hlines_clist { all }
        \bool_set_true:N \l_@@_except_borders_bool
      } ,
    parallelize-diags .bool_set:N = \l_@@_parallelize_diags_bool ,
```

With the option `renew-dots`, the command `\cdots`, `\ldots`, `\vdots`, `\ddots`, etc. are redefined and behave like the commands `\Cdots`, `\Ldots`, `\Vdots`, `\Ddots`, etc.

```
    renew-dots .bool_set:N = \l_@@_renew_dots_bool ,
    renew-dots .value_forbidden:n = true ,
    nullify-dots .bool_set:N = \l_@@_nullify_dots_bool ,
    create-medium-nodes .bool_set:N = \l_@@_medium_nodes_bool ,
    create-large-nodes .bool_set:N = \l_@@_large_nodes_bool ,
    create-extra-nodes .meta:n =
      { create-medium-nodes , create-large-nodes } ,
    left-margin .dim_set:N = \l_@@_left_margin_dim ,
    left-margin .default:n = \arraycolsep ,
    right-margin .dim_set:N = \l_@@_right_margin_dim ,
    right-margin .default:n = \arraycolsep ,
    margin .meta:n = { left-margin = #1 , right-margin = #1 } ,
    margin .default:n = \arraycolsep ,
    extra-left-margin .dim_set:N = \l_@@_extra_left_margin_dim ,
    extra-right-margin .dim_set:N = \l_@@_extra_right_margin_dim ,
    extra-margin .meta:n =
      { extra-left-margin = #1 , extra-right-margin = #1 } ,
    extra-margin .value_required:n = true ,
  }
```

We define a set of keys used by the environments of nicematrix (but not by the command `\NiceMatrixOptions`).

```
\keys_define:nn { NiceMatrix / Env }
  {
```

The key `hvlines-except-corners` is now deprecated.

```
    hvlines-except-corners .code:n =
      {
        \clist_set:Nn \l_@@_corners_clist { #1 }
        \clist_set:Nn \l_@@_vlines_clist { all }
        \clist_set:Nn \l_@@_hlines_clist { all }
      } ,
    hvlines-except-corners .default:n = { NW , SW , NE , SE } ,
    corners .clist_set:N = \l_@@_corners_clist ,
    corners .default:n = { NW , SW , NE , SE } ,
    code-before .code:n =
     {
       \tl_if_empty:nF { #1 }
         {
           \tl_put_right:Nn \l_@@_code_before_tl { #1 }
           \bool_set_true:N \l_@@_code_before_bool
         }
     } ,
```

The options `c`, `t` and `b` of the environment `{NiceArray}` have the same meaning as the option of the classical environment `{array}`.

```
    c .code:n = \tl_set:Nn \l_@@_baseline_tl c ,
    t .code:n = \tl_set:Nn \l_@@_baseline_tl t ,
    b .code:n = \tl_set:Nn \l_@@_baseline_tl b ,
    baseline .tl_set:N = \l_@@_baseline_tl ,
    baseline .value_required:n = true ,
    columns-width .code:n =
      \tl_if_eq:nnTF { #1 } { auto }
        { \bool_set_true:N \l_@@_auto_columns_width_bool }
        { \dim_set:Nn \l_@@_columns_width_dim { #1 } } ,
    columns-width .value_required:n = true ,
    name .code:n =
```

We test whether we are in the measuring phase of an environment of amsmath (always loaded by nicematrix) because we want to avoid a fallacious message of duplicate name in this case.

```
      \legacy_if:nF { measuring@ }
        {
          \str_set:Nn \l_tmpa_str { #1 }
          \seq_if_in:NVTF \g_@@_names_seq \l_tmpa_str
            { \@@_error:nn { Duplicate~name } { #1 } }
            { \seq_gput_left:NV \g_@@_names_seq \l_tmpa_str }
          \str_set_eq:NN \l_@@_name_str \l_tmpa_str
        } ,
    name .value_required:n = true ,
    code-after .tl_gset:N = \g_nicematrix_code_after_tl ,
    code-after .value_required:n = true ,
    colortbl-like .code:n =
      \bool_set_true:N \l_@@_colortbl_like_bool
      \bool_set_true:N \l_@@_code_before_bool ,
    colortbl-like .value_forbidden:n = true
  }
\keys_define:nn { NiceMatrix / notes }
  {
    para .bool_set:N = \l_@@_notes_para_bool ,
    para .default:n = true ,
    code-before .tl_set:N = \l_@@_notes_code_before_tl ,
    code-before .value_required:n = true ,
    code-after .tl_set:N = \l_@@_notes_code_after_tl ,
    code-after .value_required:n = true ,
```

```
    bottomrule .bool_set:N = \l_@@_notes_bottomrule_bool ,
    bottomrule .default:n = true ,
    style .code:n = \cs_set:Nn \@@_notes_style:n { #1 } ,
    style .value_required:n = true ,
    label-in-tabular .code:n =
      \cs_set:Nn \@@_notes_label_in_tabular:n { #1 } ,
    label-in-tabular .value_required:n = true ,
    label-in-list .code:n =
      \cs_set:Nn \@@_notes_label_in_list:n { #1 } ,
    label-in-list .value_required:n = true ,
    enumitem-keys .code:n =
      {
        \bool_if:NTF \c_@@_in_preamble_bool
          {
            \AtBeginDocument
              {
                \bool_if:NT \c_@@_enumitem_loaded_bool
                  { \setlist* [ tabularnotes ] { #1 } }
              }
          }
          {
             \bool_if:NT \c_@@_enumitem_loaded_bool
               { \setlist* [ tabularnotes ] { #1 } }
          }
      } ,
    enumitem-keys .value_required:n = true ,
    enumitem-keys-para .code:n =
      {
        \bool_if:NTF \c_@@_in_preamble_bool
          {
            \AtBeginDocument
              {
                \bool_if:NT \c_@@_enumitem_loaded_bool
                  { \setlist* [ tabularnotes* ] { #1 } }
              }
          }
          {
            \bool_if:NT \c_@@_enumitem_loaded_bool
              { \setlist* [ tabularnotes* ] { #1 } }
          }
      } ,
    enumitem-keys-para .value_required:n = true ,
    unknown .code:n  = \@@_error:n { Unknown~key~for~notes }
  }
\keys_define:nn { NiceMatrix / delimiters }
  {
    max-width .bool_set:N = \l_@@_delimiters_max_width_bool ,
    max-width .default:n = true ,
    color .tl_set:N = \l_@@_delimiters_color_tl ,
    color .value_required:n = true ,
  }
```

We begin the construction of the major sets of keys (used by the different user commands and environments).

```
\keys_define:nn { NiceMatrix }
  {
    NiceMatrixOptions .inherit:n =
      { NiceMatrix / Global } ,
    NiceMatrixOptions / xdots .inherit:n = NiceMatrix / xdots ,
    NiceMatrixOptions / rules .inherit:n = NiceMatrix / rules ,
    NiceMatrixOptions / notes .inherit:n = NiceMatrix / notes ,
    NiceMatrixOptions / delimiters .inherit:n = NiceMatrix / delimiters ,
```

```
    NiceMatrixOptions / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
    SubMatrix / rules .inherit:n = NiceMatrix / rules ,
    CodeAfter / xdots .inherit:n = NiceMatrix / xdots ,
    NiceMatrix .inherit:n =
      {
        NiceMatrix / Global ,
        NiceMatrix / Env ,
      } ,
    NiceMatrix / xdots .inherit:n = NiceMatrix / xdots ,
    NiceMatrix / rules .inherit:n = NiceMatrix / rules ,
    NiceMatrix / delimiters .inherit:n = NiceMatrix / delimiters ,
    NiceTabular .inherit:n =
      {
        NiceMatrix / Global ,
        NiceMatrix / Env
      } ,
    NiceTabular / xdots .inherit:n = NiceMatrix / xdots ,
    NiceTabular / rules .inherit:n = NiceMatrix / rules ,
    NiceTabular / delimiters .inherit:n = NiceMatrix / delimiters ,
    NiceArray .inherit:n =
      {
        NiceMatrix / Global ,
        NiceMatrix / Env ,
      } ,
    NiceArray / xdots .inherit:n = NiceMatrix / xdots ,
    NiceArray / rules .inherit:n = NiceMatrix / rules ,
    NiceArray / delimiters .inherit:n = NiceMatrix / delimiters ,
    pNiceArray .inherit:n =
      {
        NiceMatrix / Global ,
        NiceMatrix / Env ,
      } ,
    pNiceArray / xdots .inherit:n = NiceMatrix / xdots ,
    pNiceArray / rules .inherit:n = NiceMatrix / rules ,
    pNiceArray / delimiters .inherit:n = NiceMatrix / delimiters ,
  }
```

We finalise the definition of the set of keys "`NiceMatrix / NiceMatrixOptions`" with the options specific to `\NiceMatrixOptions`.

```
\keys_define:nn { NiceMatrix / NiceMatrixOptions }
  {
    last-col .code:n = \tl_if_empty:nF { #1 }
                         { \@@_error:n { last-col~non~empty~for~NiceMatrixOptions } }
                       \int_zero:N \l_@@_last_col_int ,
    small .bool_set:N = \l_@@_small_bool ,
    small .value_forbidden:n = true ,
```

With the option `renew-matrix`, the environment `{matrix}` of amsmath and its variants are redefined to behave like the environment `{NiceMatrix}` and its variants.

```
    renew-matrix .code:n = \@@_renew_matrix: ,
    renew-matrix .value_forbidden:n = true ,
```

The key `transparent` is now considered as obsolete (because its name is ambiguous).

```
    transparent .code:n =
      {
        \@@_renew_matrix:
        \bool_set_true:N \l_@@_renew_dots_bool
        \@@_error:n { Key~transparent }
      } ,
    transparent .value_forbidden:n = true,
```

The option `exterior-arraycolsep` will have effect only in `{NiceArray}` for those who want to have for `{NiceArray}` the same behaviour as `{array}`.

```
    exterior-arraycolsep .bool_set:N = \l_@@_exterior_arraycolsep_bool ,
```

If the option `columns-width` is used, all the columns will have the same width.
In `\NiceMatrixOptions`, the special value `auto` is not available.

```
    columns-width .code:n =
      \tl_if_eq:nnTF { #1 } { auto }
        { \@@_error:n { Option~auto~for~columns-width } }
        { \dim_set:Nn \l_@@_columns_width_dim { #1 } } ,
```

Usually, an error is raised when the user tries to give the same name to two distincts environments of nicematrix (theses names are global and not local to the current TeX scope). However, the option `allow-duplicate-names` disables this feature.

```
    allow-duplicate-names .code:n =
      \@@_msg_redirect_name:nn { Duplicate~name } { none } ,
    allow-duplicate-names .value_forbidden:n = true ,
```

By default, the specifier used in the preamble of the array (for example in `{pNiceArray}`) to draw a vertical dotted line between two columns is the colon ":". However, it's possible to change this letter with `letter-for-dotted-lines` and, by the way, the letter ":" will remain free for other packages (for example arydshln).

```
    letter-for-dotted-lines .code:n =
      {
        \tl_if_single_token:nTF { #1 }
          { \str_set:Nx \l_@@_letter_for_dotted_lines_str { #1 } }
          { \@@_error:n { One~letter~allowed } }
      } ,
    letter-for-dotted-lines .value_required:n = true ,
    notes .code:n = \keys_set:nn { NiceMatrix / notes } { #1 } ,
    notes .value_required:n = true ,
    sub-matrix .code:n =
     \keys_set:nn { NiceMatrix / sub-matrix } { #1 } ,
    sub-matrix .value_required:n = true ,
    unknown .code:n  = \@@_error:n { Unknown~key~for~NiceMatrixOptions }
  }
\str_new:N \l_@@_letter_for_dotted_lines_str
\str_set_eq:NN \l_@@_letter_for_dotted_lines_str \c_colon_str
```

`\NiceMatrixOptions` is the command of the nicematrix package to fix options at the document level. The scope of these specifications is the current TeX group.

```
\NewDocumentCommand \NiceMatrixOptions { m }
  { \keys_set:nn { NiceMatrix / NiceMatrixOptions } { #1 } }
```

We finalise the definition of the set of keys "`NiceMatrix / NiceMatrix`" with the options specific to `{NiceMatrix}`.

```
\keys_define:nn { NiceMatrix / NiceMatrix }
  {
    last-col .code:n = \tl_if_empty:nTF {#1}
                         {
                           \bool_set_true:N \l_@@_last_col_without_value_bool
                           \int_set:Nn \l_@@_last_col_int { -1 }
                         }
                         { \int_set:Nn \l_@@_last_col_int { #1 } } ,
    l .code:n = \tl_set:Nn \l_@@_type_of_col_tl l ,
    r .code:n = \tl_set:Nn \l_@@_type_of_col_tl r ,
    small .bool_set:N = \l_@@_small_bool ,
    small .value_forbidden:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~NiceMatrix }
  }
```

We finalise the definition of the set of keys "NiceMatrix / NiceArray" with the options specific to {NiceArray}.

```
\keys_define:nn { NiceMatrix / NiceArray }
  {
```

In the environments {NiceArray} and its variants, the option last-col must be used without value because the number of columns of the array is read from the preamble of the array.

```
    small .bool_set:N = \l_@@_small_bool ,
    small .value_forbidden:n = true ,
    last-col .code:n = \tl_if_empty:nF { #1 }
                         { \@@_error:n { last-col~non~empty~for~NiceArray } }
                       \int_zero:N \l_@@_last_col_int ,
    notes / para .bool_set:N = \l_@@_notes_para_bool ,
    notes / para .default:n = true ,
    notes / bottomrule .bool_set:N = \l_@@_notes_bottomrule_bool ,
    notes / bottomrule .default:n = true ,
    tabularnote .tl_set:N = \l_@@_tabularnote_tl ,
    tabularnote .value_required:n = true ,
    r .code:n = \@@_error:n { r~or~l~with~preamble } ,
    l .code:n = \@@_error:n { r~or~l~with~preamble } ,
    unknown .code:n = \@@_error:n { Unknown~key~for~NiceArray }
  }
\keys_define:nn { NiceMatrix / pNiceArray }
  {
    first-col .code:n = \int_zero:N \l_@@_first_col_int ,
    last-col .code:n = \tl_if_empty:nF {#1}
                         { \@@_error:n { last-col~non~empty~for~NiceArray } }
                       \int_zero:N \l_@@_last_col_int ,
    first-row .code:n = \int_zero:N \l_@@_first_row_int ,
    small .bool_set:N = \l_@@_small_bool ,
    small .value_forbidden:n = true ,
    r .code:n = \@@_error:n { r~or~l~with~preamble } ,
    l .code:n = \@@_error:n { r~or~l~with~preamble } ,
    unknown .code:n = \@@_error:n { Unknown~key~for~NiceMatrix }
  }
```

We finalise the definition of the set of keys "NiceMatrix / NiceTabular" with the options specific to {NiceTabular}.

```
\keys_define:nn { NiceMatrix / NiceTabular }
  {
    notes / para .bool_set:N = \l_@@_notes_para_bool ,
    notes / para .default:n = true ,
    notes / bottomrule .bool_set:N = \l_@@_notes_bottomrule_bool ,
    notes / bottomrule .default:n = true ,
    tabularnote .tl_set:N = \l_@@_tabularnote_tl ,
    tabularnote .value_required:n = true ,
    last-col .code:n = \tl_if_empty:nF {#1}
                         { \@@_error:n { last-col~non~empty~for~NiceArray } }
                       \int_zero:N \l_@@_last_col_int ,
    r .code:n = \@@_error:n { r~or~l~with~preamble } ,
    l .code:n = \@@_error:n { r~or~l~with~preamble } ,
    unknown .code:n = \@@_error:n { Unknown~key~for~NiceTabular }
  }
```

Important code used by {NiceArrayWithDelims}

The pseudo-environment \@@_Cell:–\@@_end_Cell: will be used to format the cells of the array. In the code, the affectations are global because this pseudo-environment will be used in the cells of a \halign (via an environment {array}).

```
\cs_new_protected:Npn \@@_Cell:
  {
    \tl_gclear:N \g_@@_exit_cell_tl
```

At the beginning of the cell, we link `\CodeAfter` to a command which do *not* begin with `\omit` (whereas the standard version of `\CodeAfter` begins with `\omit`).

```
    \cs_set_eq:NN \CodeAfter \@@_CodeAfter_i:n
```

We increment `\c@jCol`, which is the counter of the columns.

```
    \int_gincr:N \c@jCol
```

Now, we increment the counter of the rows. We don't do this incrementation in the `\everycr` because some packages, like arydshln, create special rows in the `\halign` that we don't want to take into account.

```
    \int_compare:nNnT \c@jCol = 1
      { \int_compare:nNnT \l_@@_first_col_int = 1 \@@_begin_of_row: }
```

The content of the cell is composed in the box `\l_@@_cell_box` because we want to compute some dimensions of the box. The `\hbox_set_end:` corresponding to this `\hbox_set:Nw` will be in the `\@@_end_Cell:` (and the potential `\c_math_toggle_token` also).

```
    \hbox_set:Nw \l_@@_cell_box
    \bool_if:NF \l_@@_NiceTabular_bool
      {
        \c_math_toggle_token
        \bool_if:NT \l_@@_small_bool \scriptstyle
      }
```

We will call *corners* of the matrix the cases which are at the intersection of the exterior rows and exterior columns (of course, the four corners doesn't always exist simultaneously).
The codes `\l_@@_code_for_first_row_tl` and *al* don't apply in the corners of the matrix.

```
    \g_@@_row_style_tl
    \int_compare:nNnTF \c@iRow = 0
      {
        \int_compare:nNnT \c@jCol > 0
          {
            \l_@@_code_for_first_row_tl
            \xglobal \colorlet { nicematrix-first-row } { . }
          }
      }
      {
        \int_compare:nNnT \c@iRow = \l_@@_last_row_int
          {
            \l_@@_code_for_last_row_tl
            \xglobal \colorlet { nicematrix-last-row } { . }
          }
      }
  }
```

The following macro `\@@_begin_of_row` is usually used in the cell number 1 of the row. However, when the key `first-col` is used, `\@@_begin_of_row` is executed in the cell number 0 of the row.

```
\cs_new_protected:Npn \@@_begin_of_row:
  {
    \tl_gclear:N \g_@@_row_style_tl
    \int_gincr:N \c@iRow
    \dim_gset_eq:NN \g_@@_dp_ante_last_row_dim \g_@@_dp_last_row_dim
    \dim_gset:Nn \g_@@_dp_last_row_dim { \box_dp:N \@arstrutbox }
    \dim_gset:Nn \g_@@_ht_last_row_dim { \box_ht:N \@arstrutbox }
    \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \pgfcoordinate
      { \@@_env: - row - \int_use:N \c@iRow - base }
      { \pgfpoint \c_zero_dim { 0.5 \arrayrulewidth } }
    \str_if_empty:NF \l_@@_name_str
```

```
      {
        \pgfnodealias
          { \l_@@_name_str - row - \int_use:N \c@iRow - base }
          { \@@_env: - row - \int_use:N \c@iRow - base }
      }
    \endpgfpicture
  }
```

Remark: If the key `recreate-cell-nodes` of the `\CodeBefore` is used, then we will add some lines to that command.

The following code is used in each cell of the array. It actualises quantities that, at the end of the array, will give informations about the vertical dimension of the two first rows and the two last rows. If the user uses the `last-row`, some lines of code will be dynamically added to this command.

```
\cs_new_protected:Npn \@@_update_for_first_and_last_row:
  {
    \int_compare:nNnTF \c@iRow = 0
      {
        \dim_gset:Nn \g_@@_dp_row_zero_dim
          { \dim_max:nn \g_@@_dp_row_zero_dim { \box_dp:N \l_@@_cell_box } }
        \dim_gset:Nn \g_@@_ht_row_zero_dim
          { \dim_max:nn \g_@@_ht_row_zero_dim { \box_ht:N \l_@@_cell_box } }
      }
      {
        \int_compare:nNnT \c@iRow = 1
          {
            \dim_gset:Nn \g_@@_ht_row_one_dim
              { \dim_max:nn \g_@@_ht_row_one_dim { \box_ht:N \l_@@_cell_box } }
          }
      }
  }
\cs_new_protected:Npn \@@_rotate_cell_box:
  {
    \box_rotate:Nn \l_@@_cell_box { 90 }
    \int_compare:nNnT \c@iRow = \l_@@_last_row_int
      {
        \vbox_set_top:Nn \l_@@_cell_box
          {
            \vbox_to_zero:n { }
            \skip_vertical:n { - \box_ht:N \@arstrutbox + 0.8 ex }
            \box_use:N \l_@@_cell_box
          }
      }
    \bool_gset_false:N \g_@@_rotate_bool
  }
\cs_new_protected:Npn \@@_adjust_size_box:
  {
    \dim_compare:nNnT \g_@@_blocks_wd_dim > \c_zero_dim
      {
        \box_set_wd:Nn \l_@@_cell_box
          { \dim_max:nn { \box_wd:N \l_@@_cell_box } \g_@@_blocks_wd_dim }
        \dim_gzero:N \g_@@_blocks_wd_dim
      }
    \dim_compare:nNnT \g_@@_blocks_dp_dim > \c_zero_dim
      {
        \box_set_dp:Nn \l_@@_cell_box
          { \dim_max:nn { \box_dp:N \l_@@_cell_box } \g_@@_blocks_dp_dim }
        \dim_gzero:N \g_@@_blocks_dp_dim
      }
    \dim_compare:nNnT \g_@@_blocks_ht_dim > \c_zero_dim
      {
        \box_set_ht:Nn \l_@@_cell_box
```

```
          { \dim_max:nn { \box_ht:N \l_@@_cell_box } \g_@@_blocks_ht_dim }
        \dim_gzero:N \g_@@_blocks_ht_dim
      }
  }
\cs_new_protected:Npn \@@_end_Cell:
  {
    \@@_math_toggle_token:
    \hbox_set_end:
    \g_@@_exit_cell_tl
    \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
    \@@_adjust_size_box:
    \box_set_ht:Nn \l_@@_cell_box
      { \box_ht:N \l_@@_cell_box + \l_@@_cell_space_top_limit_dim }
    \box_set_dp:Nn \l_@@_cell_box
      { \box_dp:N \l_@@_cell_box + \l_@@_cell_space_bottom_limit_dim }
```

We want to compute in `\g_@@_max_cell_width_dim` the width of the widest cell of the array (except the cells of the "first column" and the "last column").

```
    \dim_gset:Nn \g_@@_max_cell_width_dim
      { \dim_max:nn \g_@@_max_cell_width_dim { \box_wd:N \l_@@_cell_box } }
```

The following computations are for the "first row" and the "last row".

```
    \@@_update_for_first_and_last_row:
```

If the cell is empty, or may be considered as if, we must not create the PGF node, for two reasons:

- it's a waste of time since such a node would be rather pointless;
- we test the existence of these nodes in order to determine whether a cell is empty when we search the extremities of a dotted line.

However, it's very difficult to determine whether a cell is empty. Up to now we use the following technic:

- if the width of the box `\l_@@_cell_box` (created with the content of the cell) is equal to zero, we consider the cell as empty (however, this is not perfect since the user may have used a `\rlap`, a `\llap` or a `\mathclap` of mathtools.
- the cells with a command `\Ldots` or `\Cdots`, `\Vdots`, etc., should also be considered as empty; if `nullify-dots` is in force, there would be nothing to do (in this case the previous commands only write an instruction in a kind of `\CodeAfter`); however, if `nullify-dots` is not in force, a phantom of `\ldots`, `\cdots`, `\vdots` is inserted and its width is not equal to zero; that's why these commands raise a boolean `\g_@@_empty_cell_bool` and we begin by testing this boolean.

```
    \bool_if:NTF \g_@@_empty_cell_bool
      { \box_use_drop:N \l_@@_cell_box }
      {
        \bool_lazy_or:nnTF
          \g_@@_not_empty_cell_bool
          { \dim_compare_p:nNn { \box_wd:N \l_@@_cell_box } > \c_zero_dim }
          \@@_node_for_cell:
          { \box_use_drop:N \l_@@_cell_box }
      }
    \int_gset:Nn \g_@@_col_total_int { \int_max:nn \g_@@_col_total_int \c@jCol }
    \bool_gset_false:N \g_@@_empty_cell_bool
    \bool_gset_false:N \g_@@_not_empty_cell_bool
  }
```

The following command creates the PGF name of the node with, of course, `\l_@@_cell_box` as the content.

```
\cs_new_protected:Npn \@@_node_for_cell:
  {
    \pgfpicture
    \pgfsetbaseline \c_zero_dim
```

```
    \pgfrememberpicturepositiononpagetrue
    \pgfset
      {
        inner~sep = \c_zero_dim ,
        minimum~width = \c_zero_dim
      }
    \pgfnode
      { rectangle }
      { base }
      { \box_use_drop:N \l_@@_cell_box }
      { \@@_env: - \int_use:N \c@iRow - \int_use:N \c@jCol }
      { }
    \str_if_empty:NF \l_@@_name_str
      {
        \pgfnodealias
          { \l_@@_name_str - \int_use:N \c@iRow - \int_use:N \c@jCol }
          { \@@_env: - \int_use:N \c@iRow - \int_use:N \c@jCol }
      }
    \endpgfpicture
  }
```

As its name says, the following command is a patch for the command `\@@_node_for_cell:`. This patch will be appended on the left of `\@@_node_for_the_cell:` when the construction of the cell nodes (of the form `(i-j)`) in the `\CodeBefore` is required.

```
\cs_new_protected:Npn \@@_patch_node_for_cell:n #1
  {
    \cs_new_protected:Npn \@@_patch_node_for_cell:
      {
        \hbox_set:Nn \l_@@_cell_box
          {
            \box_move_up:nn { \box_ht:N \l_@@_cell_box}
              \hbox_overlap_left:n
                {
                  \pgfsys@markposition
                    { \@@_env: - \int_use:N \c@iRow - \int_use:N \c@jCol - NW }
```

I don't know why the following adjustement is needed when the compilation is done with XeLaTeX or with the classical way `latex`, `divps`, `ps2pdf` (or Adobe Distiller). However, it seems to work.

```
                  #1
                }
            \box_use:N \l_@@_cell_box
            \box_move_down:nn { \box_dp:N \l_@@_cell_box }
              \hbox_overlap_left:n
                {
                  \pgfsys@markposition
                    { \@@_env: - \int_use:N \c@iRow - \int_use:N \c@jCol - SE }
                  #1
                }
          }
      }
  }
```

We have no explanation for the different behaviour between the TeX engines...

```
\bool_lazy_or:nnTF \sys_if_engine_xetex_p: \sys_if_output_dvi_p:
  {
    \@@_patch_node_for_cell:n
      { \skip_horizontal:n { 0.5 \box_wd:N \l_@@_cell_box } }
  }
  { \@@_patch_node_for_cell:n { } }
```

The second argument of the following command `\@@_instruction_of_type:nnn` defined below is the type of the instruction (`Cdots`, `Vdots`, `Ddots`, etc.). The third argument is the list of options.

This command writes in the corresponding `\g_@@_type_lines_tl` the instruction which will actually draw the line after the construction of the matrix.

For example, for the following matrix,

```
\begin{pNiceMatrix}
1 & 2 & 3 & 4 \\
5 & \Cdots & & 6 \\
7 & \Cdots[color=red]
\end{pNiceMatrix}
```

$$\begin{pmatrix} 1 & 2 & 3 & 4 \\ 5 & \cdots & & 6 \\ 7 & \cdots & & \end{pmatrix}$$

the content of `\g_@@_Cdots_lines_tl` will be:

```
\@@_draw_Cdots:nnn {2}{2}{}
\@@_draw_Cdots:nnn {3}{2}{color=red}
```

The first argument is a boolean which indicates whether you must put the instruction on the left or on the right on the list of instructions.

```
\cs_new_protected:Npn \@@_instruction_of_type:nnn #1 #2 #3
  {
    \bool_if:nTF { #1 } \tl_gput_left:cx \tl_gput_right:cx
      { g_@@_ #2 _ lines _ tl }
      {
        \use:c { @@ _ draw _ #2 : nnn }
          { \int_use:N \c@iRow }
          { \int_use:N \c@jCol }
          { \exp_not:n { #3 } }
      }
  }
```

We want to use `\array` of array. However, if the class used is revtex4-1 or revtex4-2, we have to do some tuning and use the command `\@array@array` instead of `\array` because these classes do a redefinition of `\array` incompatible with our use of `\array`.

```
\cs_new_protected:Npn \@@_revtex_array:
  {
    \cs_set_eq:NN \@acoll \@arrayacol
    \cs_set_eq:NN \@acolr \@arrayacol
    \cs_set_eq:NN \@acol \@arrayacol
    \cs_set_nopar:Npn \@halignto { }
    \@array@array
  }
\cs_new_protected:Npn \@@_array:
  {
    \bool_if:NTF \c_@@_revtex_bool
      \@@_revtex_array:
      {
        \bool_if:NTF \l_@@_NiceTabular_bool
          { \dim_set_eq:NN \col@sep \tabcolsep }
          { \dim_set_eq:NN \col@sep \arraycolsep }
        \dim_compare:nNnTF \l_@@_tabular_width_dim = \c_zero_dim
          { \cs_set_nopar:Npn \@halignto { } }
          { \cs_set_nopar:Npx \@halignto { to \dim_use:N \l_@@_tabular_width_dim } }
```

It colortbl is loaded, `\@tabarray` has been redefined to incorporate `\CT@start`.

```
        \@tabarray
      }
```

`\l_@@_baseline_tl` may have the value `t`, `c` or `b`. However, if the value is `b`, we compose the `\array` (of array) with the option `t` and the right translation will be done further. Remark that `\str_if_eq:VnTF` is fully expandable and you need something fully expandable here.

```
    [ \str_if_eq:VnTF \l_@@_baseline_tl c c t ]
  }
```

We keep in memory the standard version of `\ialign` because we will redefine `\ialign` in the environment `{NiceArrayWithDelims}` but restore the standard version for use in the cells of the array.

```
\cs_set_eq:NN \@@_old_ialign: \ialign
```

The following command creates a `row` node (and not a row of nodes!).

```
\cs_new_protected:Npn \@@_create_row_node:
  {
```

The `\hbox:n` (or `\hbox`) is mandatory.

```
    \hbox
      {
        \bool_if:NT \l_@@_code_before_bool
          {
            \vtop
              {
                \skip_vertical:N 0.5\arrayrulewidth
                \pgfsys@markposition { \@@_env: - row - \@@_succ:n \c@iRow }
                \skip_vertical:N -0.5\arrayrulewidth
              }
          }
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgfcoordinate { \@@_env: - row - \@@_succ:n \c@iRow }
          { \pgfpoint \c_zero_dim { - 0.5 \arrayrulewidth } }
        \str_if_empty:NF \l_@@_name_str
          {
            \pgfnodealias
              { \l_@@_name_str - row - \@@_succ:n \c@iRow }
              { \@@_env: - row - \@@_succ:n \c@iRow }
          }
        \endpgfpicture
      }
  }
```

The following must *not* be protected because it begins with `\noalign`.

```
\cs_new:Npn \@@_everycr: { \noalign { \@@_everycr_i: } }
\cs_new_protected:Npn \@@_everycr_i:
  {
    \int_gzero:N \c@jCol
    \bool_gset_false:N \g_@@_after_col_zero_bool
    \bool_if:NF \g_@@_row_of_col_done_bool
      {
        \@@_create_row_node:
```

We don't draw the rules of the key `hlines` (or `hvlines`) but we reserve the vertical space for theses rules.

```
        \tl_if_empty:NF \l_@@_hlines_clist
          {
            \tl_if_eq:NnF \l_@@_hlines_clist { all }
              {
                \exp_args:NNx
                  \clist_if_in:NnT
                  \l_@@_hlines_clist
                  { \@@_succ:n \c@iRow }
              }
              {
```

The counter `\c@iRow` has the value -1 only if there is a "first row" and that we are before that "first row", i.e. just before the beginning of the array.

```
                \int_compare:nNnT \c@iRow > { -1 }
                  {
                    \int_compare:nNnF \c@iRow = \l_@@_last_row_int
```

The command \CT@arc@ is a command of colortbl which sets the color of the rules in the array. The package nicematrix uses it even if colortbl is not loaded. We use a TeX group in order to limit the scope of \CT@arc@.

```
                        { \hrule height \arrayrulewidth width \c_zero_dim }
                    }
                }
            }
        }
    }
```

The command \@@_newcolumntype is the command \newcolumntype of array without the warnings for redefinitions of columns types (we will use it to redefine the columns types w and W).

```
\cs_set_protected:Npn \@@_newcolumntype #1
  {
    \cs_set:cpn { NC @ find @ #1 } ##1 #1 { \NC@ { ##1 } }
    \peek_meaning:NTF [
      { \newcol@ #1 }
      { \newcol@ #1 [ 0 ] }
  }
```

When the key renew-dots is used, the following code will be executed.

```
\cs_set_protected:Npn \@@_renew_dots:
  {
    \cs_set_eq:NN \ldots \@@_Ldots
    \cs_set_eq:NN \cdots \@@_Cdots
    \cs_set_eq:NN \vdots \@@_Vdots
    \cs_set_eq:NN \ddots \@@_Ddots
    \cs_set_eq:NN \iddots \@@_Iddots
    \cs_set_eq:NN \dots \@@_Ldots
    \cs_set_eq:NN \hdotsfor \@@_Hdotsfor:
  }
```

When the key colortbl-like is used, the following code will be executed.

```
\cs_new_protected:Npn \@@_colortbl_like:
  {
    \cs_set_eq:NN \cellcolor \@@_cellcolor_tabular
    \cs_set_eq:NN \rowcolor \@@_rowcolor_tabular
    \cs_set_eq:NN \columncolor \@@_columncolor_preamble
  }
```

The following code \@@_pre_array_ii: is used in {NiceArrayWithDelims}. It exists as a standalone macro only for legibility.

```
\cs_new_protected:Npn \@@_pre_array_ii:
  {
```

If booktabs is loaded, we have to patch the macro \@BTnormal which is a macro of booktabs. The macro \@BTnormal draws an horizontal rule but it occurs after a vertical skip done by a low level TeX command. When this macro \@BTnormal occurs, the row node has yet been inserted by nicematrix *before* the vertical skip (and thus, at a wrong place). That why we decide to create a new row node (for the same row). We patch the macro \@BTnormal to create this row node. This new row node will overwrite the previous definition of that row node and we have managed to avoid the error messages of that redefinition [55].

```
    \bool_if:NT \c_@@_booktabs_loaded_bool
      { \tl_put_left:Nn \@BTnormal \@@_create_row_node: }
    \box_clear_new:N \l_@@_cell_box
    \normalbaselines
```

[55] cf. \nicematrix@redefine@check@rerun

If the option `small` is used, we have to do some tuning. In particular, we change the value of `\arraystretch` (this parameter is used in the construction of `\@arstrutbox` in the beginning of `{array}`).

```
\bool_if:NT \l_@@_small_bool
  {
    \cs_set_nopar:Npn \arraystretch { 0.47 }
    \dim_set:Nn \arraycolsep { 1.45 pt }
  }


\bool_if:NT \g_@@_recreate_cell_nodes_bool
  {
    \tl_put_right:Nn \@@_begin_of_row:
      {
        \pgfsys@markposition
          { \@@_env: - row - \int_use:N \c@iRow - base }
      }
  }
```

The environment `{array}` uses internally the command `\ialign`. We change the definition of `\ialign` for several reasons. In particular, `\ialign` sets `\everycr` to `{ }` and we *need* to have to change the value of `\everycr`.

```
\cs_set_nopar:Npn \ialign
  {
    \bool_if:NTF \c_@@_colortbl_loaded_bool
      {
        \CT@everycr
          {
            \noalign { \cs_gset_eq:NN \CT@row@color \prg_do_nothing: }
            \@@_everycr:
          }
      }
      { \everycr { \@@_everycr: } }
    \tabskip = \c_zero_skip
```

The box `\@arstrutbox` is a box constructed in the beginning of the environment `{array}`. The construction of that box takes into account the current value of `\arraystretch`[56] and `\extrarowheight` (of array). That box is inserted (via `\@arstrut`) in the beginning of each row of the array. That's why we use the dimensions of that box to initialize the variables which will be the dimensions of the potential first and last row of the environment. This initialization must be done after the creation of `\@arstrutbox` and that's why we do it in the `\ialign`.

```
    \dim_gzero_new:N \g_@@_dp_row_zero_dim
    \dim_gset:Nn \g_@@_dp_row_zero_dim { \box_dp:N \@arstrutbox }
    \dim_gzero_new:N \g_@@_ht_row_zero_dim
    \dim_gset:Nn \g_@@_ht_row_zero_dim { \box_ht:N \@arstrutbox }
    \dim_gzero_new:N \g_@@_ht_row_one_dim
    \dim_gset:Nn \g_@@_ht_row_one_dim { \box_ht:N \@arstrutbox }
    \dim_gzero_new:N \g_@@_dp_ante_last_row_dim
    \dim_gzero_new:N \g_@@_ht_last_row_dim
    \dim_gset:Nn \g_@@_ht_last_row_dim { \box_ht:N \@arstrutbox }
    \dim_gzero_new:N \g_@@_dp_last_row_dim
    \dim_gset:Nn \g_@@_dp_last_row_dim { \box_dp:N \@arstrutbox }
```

After its first use, the definition of `\ialign` will revert automatically to its default definition. With this programmation, we will have, in the cells of the array, a clean version of `\ialign`.

```
    \cs_set_eq:NN \ialign \@@_old_ialign:
    \halign
  }
```

[56] The option `small` of nicematrix changes (among other) the value of `\arraystretch`. This is done, of course, before the call of `{array}`.

We keep in memory the old versions or \ldots, \cdots, etc. only because we use them inside \phantom commands in order that the new commands \Ldots, \Cdots, etc. give the same spacing (except when the option nullify-dots is used).

```
\cs_set_eq:NN \@@_old_ldots \ldots
\cs_set_eq:NN \@@_old_cdots \cdots
\cs_set_eq:NN \@@_old_vdots \vdots
\cs_set_eq:NN \@@_old_ddots \ddots
\cs_set_eq:NN \@@_old_iddots \iddots
\bool_if:NTF \l_@@_standard_cline_bool
  { \cs_set_eq:NN \cline \@@_standard_cline }
  { \cs_set_eq:NN \cline \@@_cline }
\cs_set_eq:NN \Ldots \@@_Ldots
\cs_set_eq:NN \Cdots \@@_Cdots
\cs_set_eq:NN \Vdots \@@_Vdots
\cs_set_eq:NN \Ddots \@@_Ddots
\cs_set_eq:NN \Iddots \@@_Iddots
\cs_set_eq:NN \hdottedline \@@_hdottedline:
\cs_set_eq:NN \Hline \@@_Hline:
\cs_set_eq:NN \Hspace \@@_Hspace:
\cs_set_eq:NN \Hdotsfor \@@_Hdotsfor:
\cs_set_eq:NN \Vdotsfor \@@_Vdotsfor:
\cs_set_eq:NN \multicolumn \@@_multicolumn:nnn
\cs_set_eq:NN \Block \@@_Block:
\cs_set_eq:NN \rotate \@@_rotate:
\cs_set_eq:NN \OnlyMainNiceMatrix \@@_OnlyMainNiceMatrix:n
\cs_set_eq:NN \dotfill \@@_old_dotfill:
\cs_set_eq:NN \CodeAfter \@@_CodeAfter:
\cs_set_eq:NN \diagbox \@@_diagbox:nn
\cs_set_eq:NN \NotEmpty \@@_NotEmpty:
\cs_set_eq:NN \RowStyle \@@_RowStyle:n
\bool_if:NT \l_@@_colortbl_like_bool \@@_colortbl_like:
\bool_if:NT \l_@@_renew_dots_bool \@@_renew_dots:
```

The sequence \g_@@_multicolumn_cells_seq will contain the list of the cells of the array where a command \multicolumn{n}{...}{...} with $n > 1$ is issued. In \g_@@_multicolumn_sizes_seq, the "sizes" (that is to say the values of n) correspondant will be stored. These lists will be used for the creation of the "medium nodes" (if they are created).

```
\seq_gclear:N \g_@@_multicolumn_cells_seq
\seq_gclear:N \g_@@_multicolumn_sizes_seq
```

The counter \c@iRow will be used to count the rows of the array (its incrementation will be in the first cell of the row).

```
\int_gset:Nn \c@iRow { \l_@@_first_row_int - 1 }
```

At the end of the environment {array}, \c@iRow will be the total number de rows.
\g_@@_row_total_int will be the number or rows excepted the last row (if \l_@@_last_row_bool has been raised with the option last-row).

```
\int_gzero_new:N \g_@@_row_total_int
```

The counter \c@jCol will be used to count the columns of the array. Since we want to know the total number of columns of the matrix, we also create a counter \g_@@_col_total_int. These counters are updated in the command \@@_Cell: executed at the beginning of each cell.

```
\int_gzero_new:N \g_@@_col_total_int
\cs_set_eq:NN \@ifnextchar \new@ifnextchar
\@@_renew_NC@rewrite@S:
\bool_gset_false:N \g_@@_last_col_found_bool
```

During the construction of the array, the instructions \Cdots, \Ldots, etc. will be written in token lists \g_@@_Cdots_lines_tl, etc. which will be executed after the construction of the array.

```
\tl_gclear_new:N \g_@@_Cdots_lines_tl
\tl_gclear_new:N \g_@@_Ldots_lines_tl
\tl_gclear_new:N \g_@@_Vdots_lines_tl
```

```
    \tl_gclear_new:N \g_@@_Ddots_lines_tl
    \tl_gclear_new:N \g_@@_Iddots_lines_tl
    \tl_gclear_new:N \g_@@_HVdotsfor_lines_tl

    \tl_gclear_new:N \g_nicematrix_code_before_tl
  }
```

This is the end of `\@@_pre_array_ii:`.

The command `\@@_pre_array:` will be executed after analyse of the keys of the environment.

```
\cs_new_protected:Npn \@@_pre_array:
  {
    \cs_if_exist:NT \theiRow { \int_set_eq:NN \l_@@_old_iRow_int \c@iRow }
    \int_gzero_new:N \c@iRow
    \cs_if_exist:NT \thejCol { \int_set_eq:NN \l_@@_old_jCol_int \c@jCol }
    \int_gzero_new:N \c@jCol
```

We recall that `\l_@@_last_row_int` and `\l_@@_last_column_int` are *not* the numbers of the last row and last column of the array. There are only the values of the keys `last-row` and `last-column` (maybe the user has provided erroneous values). The meaning of that counters does not change during the environment of nicematrix. There is only a slight adjustment: if the user have used one of those keys without value, we provide now the right value as read on the `aux` file (of course, it's possible only after the first compilation).

```
    \int_compare:nNnT \l_@@_last_row_int = { -1 }
      {
        \bool_set_true:N \l_@@_last_row_without_value_bool
        \bool_if:NT \g_@@_aux_found_bool
          { \int_set:Nn \l_@@_last_row_int { \seq_item:Nn \c_@@_size_seq 3 } }
      }
    \int_compare:nNnT \l_@@_last_col_int = { -1 }
      {
        \bool_if:NT \g_@@_aux_found_bool
          { \int_set:Nn \l_@@_last_col_int { \seq_item:Nn \c_@@_size_seq 6 } }
      }
```

If there is a exterior row, we patch a command used in `\@@_Cell:` in order to keep track of some dimensions needed to the construction of that "last row".

```
    \int_compare:nNnT \l_@@_last_row_int > { -2 }
      {
        \tl_put_right:Nn \@@_update_for_first_and_last_row:
          {
            \dim_gset:Nn \g_@@_ht_last_row_dim
              { \dim_max:nn \g_@@_ht_last_row_dim { \box_ht:N \l_@@_cell_box } }
            \dim_gset:Nn \g_@@_dp_last_row_dim
              { \dim_max:nn \g_@@_dp_last_row_dim { \box_dp:N \l_@@_cell_box } }
          }
      }

    \seq_gclear:N \g_@@_submatrix_seq
```

Now the `\CodeBefore`.

```
    \bool_if:NT \l_@@_code_before_bool \@@_exec_code_before:
```

The value of `\g_@@_pos_of_blocks_seq` has been written on the `aux` file and loaded before the (potential) execution of the `\CodeBefore`. Now, we clear that variable because it will be reconstructed during the creation of the array.

```
    \seq_gclear:N \g_@@_pos_of_blocks_seq
```

Idem for other sequences written on the aux file.

```
    \seq_gclear_new:N \g_@@_multicolumn_cells_seq
    \seq_gclear_new:N \g_@@_multicolumn_sizes_seq
```

The code in `\@@_pre_array_ii:` is used only here.

```
    \@@_pre_array_ii:
```

The array will be composed in a box (named `\l_@@_the_array_box`) because we have to do manipulations concerning the potential exterior rows.

```
    \box_clear_new:N \l_@@_the_array_box
```

If the user has loaded `nicematrix` with the option `define-L-C-R`, he will be able to use `L`, `C` and `R` instead of `l`, `c` and `r` in the preambles of the environments of nicematrix (it's a compatibility mode since `L`, `C` and `R` were mandatory before version 5.0).

```
    \bool_if:NT \c_@@_define_L_C_R_bool \@@_define_L_C_R:
```

The preamble will be constructed in `\g_@@_preamble_tl`.

```
    \@@_construct_preamble:
```

Now, the preamble is constructed in `\g_@@_preamble_tl`

We compute the width of both delimiters. We remember that, when the environment `{NiceArray}` is used, it's possible to specify the delimiters in the preamble (eg `[ccc]`).

```
    \dim_zero_new:N \l_@@_left_delim_dim
    \dim_zero_new:N \l_@@_right_delim_dim
    \bool_if:NTF \l_@@_NiceArray_bool
      {
        \dim_gset:Nn \l_@@_left_delim_dim { 2 \arraycolsep }
        \dim_gset:Nn \l_@@_right_delim_dim { 2 \arraycolsep }
      }
      {
```

The command `\bBigg@` is a command of amsmath.

```
        \hbox_set:Nn \l_tmpa_box { $ \bBigg@ 5 \g_@@_left_delim_tl $ }
        \dim_set:Nn \l_@@_left_delim_dim { \box_wd:N \l_tmpa_box }
        \hbox_set:Nn \l_tmpa_box { $ \bBigg@ 5 \g_@@_right_delim_tl $ }
        \dim_set:Nn \l_@@_right_delim_dim { \box_wd:N \l_tmpa_box }
      }
```

Here is the beginning of the box which will contain the array. The `\hbox_set_end:` corresponding to this `\hbox_set:Nw` will be in the second part of the environment (and the closing `\c_math_toggle_token` also).

```
    \hbox_set:Nw \l_@@_the_array_box
    \skip_horizontal:N \l_@@_left_margin_dim
    \skip_horizontal:N \l_@@_extra_left_margin_dim
    \c_math_toggle_token
    \bool_if:NTF \l_@@_light_syntax_bool
      { \use:c { @@-light-syntax } }
      { \use:c { @@-normal-syntax } }
  }
```

The following command `\@@_pre_array_i:w` will be used when the keyword `\CodeBefore` is present at the beginning of the environment.

```
\cs_new_protected:Npn \@@_pre_array_i:w #1 \Body
  {
    \tl_put_right:Nn \l_@@_code_before_tl { #1 }
    \bool_set_true:N \l_@@_code_before_bool
```

We go on with `\@@_pre_array:` which will (among other) execute the `\CodeBefore` (specified in the key `code-before` or after the keyword `\CodeBefore`). By definition, the `\CodeBefore` must be executed before the body of the array...

```
    \@@_pre_array:
  }


\keys_define:nn { NiceMatrix / RowStyle }
  {
    cell-space-top-limit .code:n =
      {
        \tl_gput_right:Nn \g_@@_row_style_tl
          {
            \tl_gput_right:Nn \g_@@_exit_cell_tl
              { \dim_set:Nn \l_@@_cell_space_top_limit_dim { #1 } }
          }
      } ,
    cell-space-top-limit .value_required:n = true ,
    cell-space-bottom-limit .code:n =
      {
        \tl_gput_right:Nn \g_@@_row_style_tl
          {
            \tl_gput_right:Nn \g_@@_exit_cell_tl
              { \dim_set:Nn \l_@@_cell_space_bottom_limit_dim { #1 } }
          }
      } ,
    cell-space-bottom-limit .value_required:n = true ,
    cell-space-limits .meta:n =
      {
        cell-space-top-limit = #1 ,
        cell-space-bottom-limit = #1 ,
      } ,
    unknown .code:n = \@@_error:n { Unknown~key~for~RowStyle }
  }


\NewDocumentCommand \@@_RowStyle:n { O { } m }
  {
    \tl_gset:Nn \g_@@_row_style_tl { #2 }
    \keys_set:nn { NiceMatrix / RowStyle } { #1 }
    #2
    \ignorespaces
  }
```

The \CodeBefore

The following command will be executed if the `\CodeBefore` has to be actually executed.

```
\cs_new_protected:Npn \@@_pre_code_before:
  {
```

First, we give values to the LaTeX counters `iRow` and `jCol`. We remind that, in the `code-before` (and in the `\CodeAfter`) they represent the numbers of rows and columns of the array (without the potential last row and last column). The value of `\g_@@_row_total_int` is the number of the last row (with potentially a last exterior row) and `\g_@@_col_total_int` is the number of the last column (with potentially a last exterior column).

```
    \int_set:Nn \c@iRow { \seq_item:Nn \c_@@_size_seq 2 }
    \int_set:Nn \c@jCol { \seq_item:Nn \c_@@_size_seq 5 }
    \int_set_eq:NN \g_@@_row_total_int { \seq_item:Nn \c_@@_size_seq 3 }
    \int_set_eq:NN \g_@@_col_total_int { \seq_item:Nn \c_@@_size_seq 6 }
```

Now, we will create all the `col` nodes and `row` nodes with the informations written in the `aux` file. You use the technique described in the page 1229 of `pgfmanual.pdf`, version 3.1.4b.

```
    \pgfsys@markposition { \@@_env: - position }
    \pgfsys@getposition { \@@_env: - position } \@@_picture_position:
    \pgfpicture
    \pgf@relevantforpicturesizefalse
```

First, the recreation of the `row` nodes.

```
    \int_step_inline:nnn \l_@@_first_row_int { \g_@@_row_total_int + 1 }
      {
        \pgfsys@getposition { \@@_env: - row - ##1 } \@@_node_position:
        \pgfcoordinate { \@@_env: - row - ##1 }
          { \pgfpointdiff \@@_picture_position: \@@_node_position: }
      }
```

Now, the recreation of the `col` nodes.

```
    \int_step_inline:nnn \l_@@_first_col_int { \g_@@_col_total_int + 1 }
      {
        \pgfsys@getposition { \@@_env: - col - ##1 } \@@_node_position:
        \pgfcoordinate { \@@_env: - col - ##1 }
          { \pgfpointdiff \@@_picture_position: \@@_node_position: }
      }
```

Now, you recreate the diagonal nodes by using the `row` nodes and the `col` nodes.

```
    \@@_create_diag_nodes:
```

Now, the creation of the cell nodes `(i-j)`, and, maybe also the "medium nodes" and the "large nodes".

```
    \bool_if:NT \g_@@_recreate_cell_nodes_bool \@@_recreate_cell_nodes:
    \endpgfpicture
    \bool_if:NT \c_@@_tikz_loaded_bool
      {
        \tikzset
          {
            every~picture / .style =
              { overlay , name~prefix = \@@_env: - }
          }
      }
    \cs_set_eq:NN \cellcolor \@@_cellcolor
    \cs_set_eq:NN \rectanglecolor \@@_rectanglecolor
    \cs_set_eq:NN \roundedrectanglecolor \@@_roundedrectanglecolor
    \cs_set_eq:NN \rowcolor \@@_rowcolor
    \cs_set_eq:NN \rowcolors \@@_rowcolors
    \cs_set_eq:NN \arraycolor \@@_arraycolor
    \cs_set_eq:NN \columncolor \@@_columncolor
    \cs_set_eq:NN \chessboardcolors \@@_chessboardcolors
    \cs_set_eq:NN \SubMatrix \@@_SubMatrix_in_code_before
  }


\cs_new_protected:Npn \@@_exec_code_before:
  {
    \seq_gclear_new:N \g_@@_colors_seq
    \bool_gset_false:N \g_@@_recreate_cell_nodes_bool
    \group_begin:
```

We compose the `code-before` in math mode in order to nullify the spaces put by the user between instructions in the `code-before`.

```
    \bool_if:NT \l_@@_NiceTabular_bool \c_math_toggle_token
```

Here is the `\CodeBefore`. The construction is a bit complicated because `\l_@@_code_before_tl` may begin with keys between square brackets. Moreover, after the analyze of those keys, we sometimes have to decide to do *not* execute the rest of `\l_@@_code_before_tl` (when it is asked for the creation

of cell nodes in the \CodeBefore). That's why we begin with a \q_stop: it will be used to discard the rest of \l_@@_code_before_tl.

```
    \exp_last_unbraced:NV \@@_CodeBefore_keys: \l_@@_code_before_tl \q_stop
```

Now, all the cells which are specified to be colored by instructions in the \CodeBefore will actually be colored. It's a two-stages mechanism because we want to draw all the cells with the same color at the same time to absolutely avoid thin white lines in some PDF viewers.

```
    \@@_actually_color:
    \bool_if:NT \l_@@_NiceTabular_bool \c_math_toggle_token
    \group_end:
    \bool_if:NT \g_@@_recreate_cell_nodes_bool
      { \tl_put_left:Nn \@@_node_for_cell: \@@_patch_node_for_cell: }
  }


\keys_define:nn { NiceMatrix / CodeBefore }
  {
    create-cell-nodes .bool_gset:N = \g_@@_recreate_cell_nodes_bool ,
    create-cell-nodes .default:n = true ,
    sub-matrix .code:n = \keys_set:nn { NiceMatrix / sub-matrix } { #1 } ,
    sub-matrix .value_required:n = true ,
    delimiters / color .tl_set:N = \l_@@_delimiters_color_tl ,
    delimiters / color .value_required:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~CodeAfter }
  }
\NewDocumentCommand \@@_CodeBefore_keys: { O { } }
  {
    \keys_set:nn { NiceMatrix / CodeBefore } { #1 }
    \@@_CodeBefore:w
  }
```

We have extracted the options of the keyword \CodeBefore in order to see whether the key create-cell-nodes has been used. Now, you can execute the rest of the \CodeAfter, excepted, of course, if we are in the first compilation.

```
\cs_new_protected:Npn \@@_CodeBefore:w #1 \q_stop
  {
    \bool_if:NT \g_@@_aux_found_bool
      {
        \@@_pre_code_before:
        #1
      }
  }
```

By default, if the user uses the \CodeBefore, only the col nodes, row nodes and diag nodes are available in that \CodeBefore. With the key create-cell-nodes, the cell nodes, that is to say the nodes of the form (i-j) (but not the extra nodes) are also available because those nodes also are recreated and that recreation is done by the following command.

```
\cs_new_protected:Npn \@@_recreate_cell_nodes:
  {
    \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
      {
        \pgfsys@getposition { \@@_env: - ##1 - base } \@@_node_position:
        \pgfcoordinate { \@@_env: - row - ##1 - base }
          { \pgfpointdiff \@@_picture_position: \@@_node_position: }
        \int_step_inline:nnn \l_@@_first_col_int \g_@@_col_total_int
          {
            \cs_if_exist:cT
              { pgf @ sys @ pdf @ mark @ pos @ \@@_env: - ##1 - ####1 - NW }
              {
                \pgfsys@getposition
                  { \@@_env: - ##1 - ####1 - NW }
```

```
                \@@_node_position:
              \pgfsys@getposition
                { \@@_env: - ##1 - ####1 - SE }
                \@@_node_position_i:
              \@@_pgf_rect_node:nnn
                { \@@_env: - ##1 - ####1 }
                { \pgfpointdiff \@@_picture_position: \@@_node_position: }
                { \pgfpointdiff \@@_picture_position: \@@_node_position_i: }
            }
        }
    }
  \@@_create_extra_nodes:
}
```

The environment {NiceArrayWithDelims}

```
\NewDocumentEnvironment { NiceArrayWithDelims }
  { m m O { } m ! O { } t \CodeBefore }
  {
    \@@_provide_pgfsyspdfmark:
    \bool_if:NT \c_@@_footnote_bool \savenotes
```

The aim of the following `\bgroup` (the corresponding `\egroup` is, of course, at the end of the environment) is to be able to put an exposant to a matrix in a mathematical formula.

```
    \bgroup

    \tl_gset:Nn \g_@@_left_delim_tl { #1 }
    \tl_gset:Nn \g_@@_right_delim_tl { #2 }
    \tl_gset:Nn \g_@@_preamble_tl { #4 }

    \int_gzero:N \g_@@_block_box_int
    \dim_zero:N \g_@@_width_last_col_dim
    \dim_zero:N \g_@@_width_first_col_dim
    \bool_gset_false:N \g_@@_row_of_col_done_bool
    \str_if_empty:NT \g_@@_name_env_str
      { \str_gset:Nn \g_@@_name_env_str { NiceArrayWithDelims } }
```

The following line will be deleted when we will consider that only versions of siunitx after v3.0 are compatible with nicematrix.

```
    \@@_adapt_S_column:
    \bool_if:NTF \l_@@_NiceTabular_bool
      \mode_leave_vertical:
      \@@_test_if_math_mode:
    \bool_if:NT \l_@@_in_env_bool { \@@_fatal:n { Yet~in~env } }
    \bool_set_true:N \l_@@_in_env_bool
```

The command `\CT@arc@` contains the instruction of color for the rules of the array[57]. This command is used by `\CT@arc@` but we use it also for compatibility with colortbl. But we want also to be able to use color for the rules of the array when colortbl is *not* loaded. That's why we do the following instruction which is in the patch of the beginning of arrays done by colortbl. Of course, we restore the value of `\CT@arc@` at the end of our environment.

```
      \cs_gset_eq:NN \@@_old_CT@arc@ \CT@arc@
```

We deactivate Tikz externalization because we will use PGF pictures with the options `overlay` and `remember picture` (or equivalent forms). We deactivate with `\tikzexternaldisable` and not with `\tikzset{external/export=false}` which is *not* equivalent.

```
    \cs_if_exist:NT \tikz@library@external@loaded
      {
        \tikzexternaldisable
```

[57] e.g. `\color[rgb]{0.5,0.5,0}`

```
        \cs_if_exist:NT \ifstandalone
          { \tikzset { external / optimize = false } }
      }
```

We increment the counter `\g_@@_env_int` which counts the environments of the package.

```
    \int_gincr:N \g_@@_env_int
    \bool_if:NF \l_@@_block_auto_columns_width_bool
      { \dim_gzero_new:N \g_@@_max_cell_width_dim }
```

The sequence `\g_@@_blocks_seq` will contain the carateristics of the blocks (specified by `\Block`) of the array. The sequence `\g_@@_pos_of_blocks_seq` will contain only the position of the blocks. Of course, this is redundant but it's for efficiency.

```
    \seq_gclear:N \g_@@_blocks_seq
    \seq_gclear:N \g_@@_pos_of_blocks_seq
```

In fact, the sequence `\g_@@_pos_of_blocks_seq` will also contain the positions of the cells with a `\diagbox`.

```
    \seq_gclear:N \g_@@_pos_of_stroken_blocks_seq
    \seq_gclear:N \g_@@_pos_of_xdots_seq
    \tl_gclear_new:N \g_@@_code_before_tl
    \tl_gclear:N \g_@@_row_style_tl
```

We load all the informations written in the `aux` file during previous compilations corresponding to the current environment.

```
    \bool_gset_false:N \g_@@_aux_found_bool
    \tl_if_exist:cT { c_@@ _ \int_use:N \g_@@_env_int _ tl }
      {
        \bool_gset_true:N \g_@@_aux_found_bool
        \use:c { c_@@ _ \int_use:N \g_@@_env_int _ tl }
      }
```

Now, we prepare the token list for the instructions that we will have to write on the `aux` file at the end of the environment.

```
     \tl_gclear:N \g_@@_aux_tl
    \tl_if_empty:NF \g_@@_code_before_tl
      {
        \bool_set_true:N \l_@@_code_before_bool
        \tl_put_right:NV \l_@@_code_before_tl \g_@@_code_before_tl
      }
```

The set of keys is not exactly the same for `{NiceArray}` and for the variants of `{NiceArray}` (`{pNiceArray}`, `{bNiceArray}`, etc.) because, for `{NiceArray}`, we have the options `t`, `c`, `b` and `baseline`.

```
    \bool_if:NTF \l_@@_NiceArray_bool
      { \keys_set:nn { NiceMatrix / NiceArray } }
      { \keys_set:nn { NiceMatrix / pNiceArray } }
    { #3 , #5 }

    \tl_if_empty:NF \l_@@_rules_color_tl
      { \exp_after:wN \@@_set_CT@arc@: \l_@@_rules_color_tl \q_stop }
% \bigskip
```

The argument `#6` is the last argument of `{NiceArrayWithDelims}`. With that argument of type "`t \CodeBefore`", we test whether there is the keyword `\CodeBefore` at the beginning of the environment. If that keyword is present, we have now to extract all the content between that keyword `\CodeBefore` and the (other) keyword `\Body`. It's the job that will do the command `\@@_pre_array_i:w`. After that job, the command `\@@_pre_array_i:w` will go on with `\@@_pre_array:`.

```
    \IfBooleanTF { #6 } \@@_pre_array_i:w \@@_pre_array:
  }
  {
    \bool_if:NTF \l_@@_light_syntax_bool
      { \use:c { end @@-light-syntax } }
      { \use:c { end @@-normal-syntax } }
    \c_math_toggle_token
```

```
    \skip_horizontal:N \l_@@_right_margin_dim
    \skip_horizontal:N \l_@@_extra_right_margin_dim
    \hbox_set_end:
```

End of the construction of the array (in the box `\l_@@_the_array_box`).

It the user has used the key `last-row` with a value, we control that the given value is correct (since we have just constructed the array, we know the real number of rows of the array).

```
    \int_compare:nNnT \l_@@_last_row_int > { -2 }
      {
        \bool_if:NF \l_@@_last_row_without_value_bool
          {
            \int_compare:nNnF \l_@@_last_row_int = \c@iRow
              {
                \@@_error:n { Wrong~last~row }
                \int_gset_eq:NN \l_@@_last_row_int \c@iRow
              }
          }
      }
```

Now, the definition of `\c@jCol` and `\g_@@_col_total_int` change: `\c@jCol` will be the number of columns without the "last column"; `\g_@@_col_total_int` will be the number of columns with this "last column".[58]

```
    \int_gset_eq:NN \c@jCol \g_@@_col_total_int
    \bool_if:nTF \g_@@_last_col_found_bool
      { \int_gdecr:N \c@jCol }
      {
        \int_compare:nNnT \l_@@_last_col_int > { -1 }
          { \@@_error:n { last~col~not~used } }
      }
```

We fix also the value of `\c@iRow` and `\g_@@_row_total_int` with the same principle.

```
    \int_gset_eq:NN \g_@@_row_total_int \c@iRow
    \int_compare:nNnT \l_@@_last_row_int > { -1 } { \int_gdecr:N \c@iRow }
```

Now, we begin the real construction in the output flow of TeX. First, we take into account a potential "first column" (we remind that this "first column" has been constructed in an overlapping position and that we have computed its width in `\g_@@_width_first_col_dim`: see p. 113).

```
    \int_compare:nNnT \l_@@_first_col_int = 0
      {
        \skip_horizontal:N \col@sep
        \skip_horizontal:N \g_@@_width_first_col_dim
      }
```

The construction of the real box is different when `\l_@@_NiceArray_bool` is true (`{NiceArray}` or `{NiceTabular}`) and in the other environments because, in `{NiceArray}` or `{NiceTabular}`, we have no delimiter to put (but we have tabular notes to put). We begin with this case.

```
    \bool_if:NTF \l_@@_NiceArray_bool
      {
        \str_case:VnF \l_@@_baseline_tl
          {
            b \@@_use_arraybox_with_notes_b:
            c \@@_use_arraybox_with_notes_c:
          }
          \@@_use_arraybox_with_notes:
      }
```

Now, in the case of an environment `{pNiceArray}`, `{bNiceArray}`, etc. We compute `\l_tmpa_dim` which is the total height of the "first row" above the array (when the key `first-row` is used).

```
      {
        \int_compare:nNnTF \l_@@_first_row_int = 0
          {
```

[58] We remind that the potential "first column" (exterior) has the number 0.

```
            \dim_set_eq:NN \l_tmpa_dim \g_@@_dp_row_zero_dim
            \dim_add:Nn \l_tmpa_dim \g_@@_ht_row_zero_dim
          }
          { \dim_zero:N \l_tmpa_dim }
```

We compute `\l_tmpb_dim` which is the total height of the "last row" below the array (when the key `last-row` is used). A value of -2 for `\l_@@_last_row_int` means that there is no "last row".[59]

```
        \int_compare:nNnTF \l_@@_last_row_int > { -2 }
          {
            \dim_set_eq:NN \l_tmpb_dim \g_@@_ht_last_row_dim
            \dim_add:Nn \l_tmpb_dim \g_@@_dp_last_row_dim
          }
          { \dim_zero:N \l_tmpb_dim }
        \hbox_set:Nn \l_tmpa_box
          {
            \c_math_toggle_token
            \tl_if_empty:NF \l_@@_delimiters_color_tl
              { \color { \l_@@_delimiters_color_tl } }
            \exp_after:wN \left \g_@@_left_delim_tl
            \vcenter
              {
```

We take into account the "first row" (we have previously computed its total height in `\l_tmpa_dim`). The `\hbox:n` (or `\hbox`) is necessary here.

```
                \skip_vertical:N -\l_tmpa_dim
                \hbox
                  {
                    \bool_if:NTF \l_@@_NiceTabular_bool
                      { \skip_horizontal:N -\tabcolsep }
                      { \skip_horizontal:N -\arraycolsep }
                    \@@_use_arraybox_with_notes_c:
                    \bool_if:NTF \l_@@_NiceTabular_bool
                      { \skip_horizontal:N -\tabcolsep }
                      { \skip_horizontal:N -\arraycolsep }
                  }
```

We take into account the "last row" (we have previously computed its total height in `\l_tmpb_dim`).

```
                \skip_vertical:N -\l_tmpb_dim
              }
```

Curiously, we have to put again the following specification of color. Otherwise, with XeLaTeX (and not with the other engines), the closing delimiter is not colored.

```
            \tl_if_empty:NF \l_@@_delimiters_color_tl
              { \color { \l_@@_delimiters_color_tl } }
            \exp_after:wN \right \g_@@_right_delim_tl
            \c_math_toggle_token
          }
```

Now, the box `\l_tmpa_box` is created with the correct delimiters.

We will put the box in the TeX flow. However, we have a small work to do when the option `delimiters/max-width` is used.

```
        \bool_if:NTF \l_@@_delimiters_max_width_bool
          {
            \@@_put_box_in_flow_bis:nn
              \g_@@_left_delim_tl \g_@@_right_delim_tl
          }
          \@@_put_box_in_flow:
      }
```

We take into account a potential "last column" (this "last column" has been constructed in an overlapping position and we have computed its width in `\g_@@_width_last_col_dim`: see p. 114).

```
    \bool_if:NT \g_@@_last_col_found_bool
```

[59] A value of -1 for `\l_@@_last_row_int` means that there is a "last row" but the the user have not set the value with the option `last row` (and we are in the first compilation).

```
      {
        \skip_horizontal:N \g_@@_width_last_col_dim
        \skip_horizontal:N \col@sep
      }
    \bool_if:NF \l_@@_Matrix_bool
      {
        \int_compare:nNnT \c@jCol < \g_@@_static_num_of_col_int
          { \@@_error:n { columns~not~used } }
      }
    \group_begin:
    \globaldefs = 1
    \@@_msg_redirect_name:nn { columns~not~used } { error }
    \group_end:
    \@@_after_array:
```

The aim of the following `\egroup` (the corresponding `\bgroup` is, of course, at the beginning of the environment) is to be able to put an exposant to a matrix in a mathematical formula.

```
    \egroup
```

We want to write on the aux file all the informations corresponding to the current environment.

```
    \iow_now:Nn \@mainaux { \ExplSyntaxOn }
    \iow_now:Nx \@mainaux
      {
        \tl_gset:cn { c_@@_ \int_use:N \g_@@_env_int _ tl }
          \iow_newline: { \iow_newline: \exp_not:V \g_@@_aux_tl }
      }
    \iow_now:Nn \@mainaux { \ExplSyntaxOff }

    \bool_if:NT \c_@@_footnote_bool \endsavenotes
  }
```

This is the end of the environment `{NiceArrayWithDelims}`.

We construct the preamble of the array

The transformation of the preamble is an operation in several steps.

The preamble given by the final user is in `\g_@@_preamble_tl` and the modified version will be stored in `\g_@@_preamble_tl` also.

```
\cs_new_protected:Npn \@@_construct_preamble:
  {
```

First, we will do an "expansion" of the preamble with the tools of the package array itself. This "expansion" will expand all the constructions with `*` and with all column types (defined by the user or by various packages using `\newcolumntype`).
Since we use the tools of array to do this expansion, we will have a programmation which is not in the style of expl3.

We redefine the column types `w` and `W`. We use `\@@_newcolumntype` instead of `\newcolumtype` because we don't want warnings for column types already defined. These redefinitions are in fact *protections* of the letters `w` and `W`. We don't want these columns type expanded because we will do the patch ourselves after. We want to be able the standard column types `w` and `W` in potential `{tabular}` of array in some cells of our array. That's why we do those redefinitions in a TeX group.

```
    \group_begin:
```

If we are in an environment without explicit preamble, we have nothing to do (excepted the treatment on both sides of the preamble which will be done at the end).

```
    \bool_if:NF \l_@@_Matrix_bool
     {
       \@@_newcolumntype w [ 2 ] { \@@_w: { ##1 } { ##2 } }
       \@@_newcolumntype W [ 2 ] { \@@_W: { ##1 } { ##2 } }
```

First, we have to store our preamble in the token register `\@temptokena` (those "token registers" are *not* supported by expl3).

```
\exp_args:NV \@temptokena \g_@@_preamble_tl
```

Initialisation of a flag used by array to detect the end of the expansion.

```
\@tempswatrue
```

The following line actually does the expansion (it's has been copied from `array.sty`). The expanded version is still in `\@temptokena`.

```
\@whilesw \if@tempswa \fi { \@tempswafalse \the \NC@list }
```

Now, we have to "patch" that preamble by transforming some columns. We will insert in the TeX flow the preamble in its actual form (that is to say after the "expansion") following by a marker `\q_stop` and we will consume these tokens constructing the (new form of the) preamble in `\g_@@_preamble_tl`. This is done recursively with the command `\@@_patch_preamble:n`. In the same time, we will count the columns with the counter `\c@jCol`.

```
\int_gzero:N \c@jCol
\tl_gclear:N \g_@@_preamble_tl
```

`\g_tmpb_bool` will be raised if you have a `|` at the end of the preamble.

```
\bool_gset_false:N \g_tmpb_bool
\tl_if_eq:NnTF \l_@@_vlines_clist { all }
  {
    \tl_gset:Nn \g_@@_preamble_tl
      { ! { \skip_horizontal:N \arrayrulewidth } }
  }
  {
    \clist_if_in:NnT \l_@@_vlines_clist 1
      {
        \tl_gset:Nn \g_@@_preamble_tl
          { ! { \skip_horizontal:N \arrayrulewidth } }
      }
  }
```

The sequence `\g_@@_cols_vlsim_seq` will contain the numbers of the columns where you will to have to draw vertical lines in the potential sub-matrices (hence the name `vlism`).

```
\seq_clear:N \g_@@_cols_vlism_seq
```

The counter `\l_tmpa_int` will count the number of consecutive occurrences of the symbol `|`.

```
\int_zero:N \l_tmpa_int
```

Now, we actually patch the preamble (and it is constructed in `\g_@@_preamble_tl`).

```
\exp_after:wN \@@_patch_preamble:n \the \@temptokena \q_stop
\int_gset_eq:NN \g_@@_static_num_of_col_int \c@jCol
}
```

Now, we replace `\columncolor` by `\@@_columncolor_preamble`.

```
\bool_if:NT \l_@@_colortbl_like_bool
  {
    \regex_replace_all:NnN
      \c_@@_columncolor_regex
      { \c { @@_columncolor_preamble } }
      \g_@@_preamble_tl
  }
```

Now, we can close the TeX group which was opened for the redefinition of the columns of type `w` and `W`.

```
\group_end:
```

If there was delimiters at the beginning or at the end of the preamble, the environment `{NiceArray}` is transformed into an environment `{xNiceMatrix}`.

```
\bool_lazy_or:nnT
  { ! \str_if_eq_p:Vn \g_@@_left_delim_tl { . } }
  { ! \str_if_eq_p:Vn \g_@@_right_delim_tl { . } }
  { \bool_set_false:N \l_@@_NiceArray_bool }
```

We want to remind whether there is a specifier | at the end of the preamble.

```
    \bool_if:NT \g_tmpb_bool { \bool_set_true:N \l_@@_bar_at_end_of_pream_bool }
```

We complete the preamble with the potential "exterior columns".

```
    \int_compare:nNnTF \l_@@_first_col_int = 0
      { \tl_gput_left:NV \g_@@_preamble_tl \c_@@_preamble_first_col_tl }
      {
        \bool_lazy_all:nT
          {
            \l_@@_NiceArray_bool
            { \bool_not_p:n \l_@@_NiceTabular_bool }
            { \tl_if_empty_p:N \l_@@_vlines_clist }
            { \bool_not_p:n \l_@@_exterior_arraycolsep_bool }
          }
          { \tl_gput_left:Nn \g_@@_preamble_tl { @ { } } }
      }
    \int_compare:nNnTF \l_@@_last_col_int > { -1 }
      { \tl_gput_right:NV \g_@@_preamble_tl \c_@@_preamble_last_col_tl }
      {
        \bool_lazy_all:nT
          {
            \l_@@_NiceArray_bool
            { \bool_not_p:n \l_@@_NiceTabular_bool }
            { \tl_if_empty_p:N \l_@@_vlines_clist }
            { \bool_not_p:n \l_@@_exterior_arraycolsep_bool }
          }
          { \tl_gput_right:Nn \g_@@_preamble_tl { @ { } } }
      }
```

We add a last column to raise a good error message when the user put more columns than allowed by its preamble. However, for technical reasons, it's not possible to do that in `{NiceTabular*}` (`\l_@@_tabular_width_dim`=0pt).

```
    \dim_compare:nNnT \l_@@_tabular_width_dim = \c_zero_dim
      {
        \tl_gput_right:Nn \g_@@_preamble_tl
          { > { \@@_error_too_much_cols: } l }
      }
  }


\cs_new_protected:Npn \@@_patch_preamble:n #1
  {
    \str_case:nnF { #1 }
      {
        c { \@@_patch_preamble_i:n #1 }
        l { \@@_patch_preamble_i:n #1 }
        r { \@@_patch_preamble_i:n #1 }
        > { \@@_patch_preamble_ii:nn #1 }
        ! { \@@_patch_preamble_ii:nn #1 }
        @ { \@@_patch_preamble_ii:nn #1 }
        | { \@@_patch_preamble_iii:n #1 }
        p { \@@_patch_preamble_iv:nnn t #1 }
        m { \@@_patch_preamble_iv:nnn c #1 }
        b { \@@_patch_preamble_iv:nnn b #1 }
        \@@_w: { \@@_patch_preamble_v:nnnn { }                          #1 }
        \@@_W: { \@@_patch_preamble_v:nnnn { \cs_set_eq:NN \hss \hfil } #1 }
        \@@_true_c: { \@@_patch_preamble_vi:n #1 }
        (  { \@@_patch_preamble_vii:nn #1 }
        [  { \@@_patch_preamble_vii:nn #1 }
        \{ { \@@_patch_preamble_vii:nn #1 }
        )  { \@@_patch_preamble_viii:nn #1 }
        ]  { \@@_patch_preamble_viii:nn #1 }
        \} { \@@_patch_preamble_viii:nn #1 }
```

```
        C { \@@_error:nn { old~column~type } #1 }
        L { \@@_error:nn { old~column~type } #1 }
        R { \@@_error:nn { old~column~type } #1 }
        \q_stop { }
      }
      {
        \str_if_eq:VnTF \l_@@_letter_for_dotted_lines_str { #1 }
          { \@@_patch_preamble_xi:n #1 }
          {
            \str_if_eq:VnTF \l_@@_letter_vlism_tl { #1 }
              {
                \seq_gput_right:Nx \g_@@_cols_vlism_seq
                  { \int_eval:n { \c@jCol + 1 } }
                \tl_gput_right:Nx \g_@@_preamble_tl
                  { \exp_not:N ! { \skip_horizontal:N \arrayrulewidth } }
                \@@_patch_preamble:n
              }
              {
                \bool_lazy_and:nnTF
                  { \str_if_eq_p:nn { : } { #1 } }
                  \c_@@_arydshln_loaded_bool
                  {
                    \tl_gput_right:Nn \g_@@_preamble_tl { : }
                    \@@_patch_preamble:n
                  }
                  { \@@_fatal:nn { unknown~column~type } { #1 } }
              }
          }
      }
  }
```

For `c`, `l` and `r`

```
\cs_new_protected:Npn \@@_patch_preamble_i:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > { \@@_Cell: \tl_set:Nn \l_@@_cell_type_tl { #1 } }
        #1
        < \@@_end_Cell:
      }
```

We increment the counter of columns and then we test for the presence of a `<`.

```
    \int_gincr:N \c@jCol
    \@@_patch_preamble_x:n
  }
```

For `>`, `!` and `@`

```
\cs_new_protected:Npn \@@_patch_preamble_ii:nn #1 #2
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { #1 { #2 } }
    \@@_patch_preamble:n
  }
```

For `|`

```
\cs_new_protected:Npn \@@_patch_preamble_iii:n #1
  {
```

`\l_tmpa_int` is the number of successive occurrences of `|`

```
    \int_incr:N \l_tmpa_int
    \@@_patch_preamble_iii_i:n
  }
```

```
\cs_new_protected:Npn \@@_patch_preamble_iii_i:n #1
  {
    \str_if_eq:nnTF { #1 } |
      { \@@_patch_preamble_iii:n | }
      {
        \tl_gput_right:Nx \g_@@_preamble_tl
          {
            \exp_not:N !
              {
                \skip_horizontal:n
                  {
                    \dim_eval:n
                      {
                        \arrayrulewidth * \l_tmpa_int
                        + \doublerulesep * ( \l_tmpa_int - 1)
                      }
                  }
              }
          }
        \tl_gput_right:Nx \g_@@_internal_code_after_tl
          { \@@_vline:nn { \@@_succ:n \c@jCol } { \int_use:N \l_tmpa_int } }
        \int_zero:N \l_tmpa_int
        \str_if_eq:nnT { #1 } { \q_stop }
          { \bool_gset_true:N \g_tmpb_bool }
        \@@_patch_preamble:n #1
      }
  }
\bool_new:N \l_@@_bar_at_end_of_pream_bool
```

For `p`, `m` and `b`

```
\cs_new_protected:Npn \@@_patch_preamble_iv:nnn #1 #2 #3
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > {
            \@@_Cell:
            \begin { minipage } [ #1 ] { \dim_eval:n { #3 } }
            \mode_leave_vertical:
            \arraybackslash
            \vrule height \box_ht:N \@arstrutbox depth 0 pt width 0 pt
          }
        c
        < {
            \vrule height 0 pt depth \box_dp:N \@arstrutbox width 0 pt
            \end { minipage }
            \@@_end_Cell:
          }
      }
```

We increment the counter of columns, and then we test for the presence of a `<`.

```
    \int_gincr:N \c@jCol
    \@@_patch_preamble_x:n
  }
```

For `w` and `W`

```
\cs_new_protected:Npn \@@_patch_preamble_v:nnnn #1 #2 #3 #4
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > {
            \hbox_set:Nw \l_@@_cell_box
            \@@_Cell:
            \tl_set:Nn \l_@@_cell_type_tl { #3 }
```

```
          }
        c
        < {
            \@@_end_Cell:
            #1
            \hbox_set_end:
            \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
            \@@_adjust_size_box:
            \makebox [ #4 ] [ #3 ] { \box_use_drop:N \l_@@_cell_box }
          }
      }
```

We increment the counter of columns and then we test for the presence of a `<`.

```
    \int_gincr:N \c@jCol
    \@@_patch_preamble_x:n
  }
```

For `\@@_true_c:` which will appear in our redefinition of the columns of type `S` (of siunitx).

```
\cs_new_protected:Npn \@@_patch_preamble_vi:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { c }
```

We increment the counter of columns and then we test for the presence of a `<`.

```
    \int_gincr:N \c@jCol
    \@@_patch_preamble_x:n
  }
```

For `(`, `[` and `\{`.

```
\cs_new_protected:Npn \@@_patch_preamble_vii:nn #1 #2
  {
    \bool_if:NT \l_@@_small_bool { \@@_fatal:n { Delimiter~with~small } }
```

If we are before the column 1 and not in `{NiceArray}`, we reserve space for the left delimiter.

```
    \int_compare:nNnTF \c@jCol = \c_zero_int
      {
        \str_if_eq:VnTF \g_@@_left_delim_tl { . }
          {
```

In that case, in fact, the first letter of the preamble must be considered as the left delimiter of the array.

```
            \tl_gset:Nn \g_@@_left_delim_tl { #1 }
            \tl_gset:Nn \g_@@_right_delim_tl { . }
            \@@_patch_preamble:n #2
          }
          {
            \tl_gput_right:Nn \g_@@_preamble_tl { ! { \enskip } }
            \@@_patch_preamble_vii_i:nn { #1 } { #2 }
          }
      }
      { \@@_patch_preamble_vii_i:nn { #1 } { #2 } }
  }
\cs_new_protected:Npn \@@_patch_preamble_vii_i:nn #1 #2
  {
    \tl_gput_right:Nx \g_@@_internal_code_after_tl
      { \@@_delimiter:nnn #1 { \@@_succ:n \c@jCol } \c_true_bool }
    \tl_if_in:nnTF { ( [ \{ ) ] \} } { #2 }
      {
        \@@_error:nn { delimiter~after~opening } { #2 }
        \@@_patch_preamble:n
      }
      { \@@_patch_preamble:n #2 }
  }
```

For `)`, `]` and `\}`. We have two arguments for the following command because we directly read the following letter in the preamble (we have to see whether we have a opening delimiter following and we also have to see whether we are at the end of the preamble because, in that case, our letter must be considered as the right delimiter of the environment if the environment is `{NiceArray}`).

```
\cs_new_protected:Npn \@@_patch_preamble_viii:nn #1 #2
  {
    \bool_if:NT \l_@@_small_bool { \@@_fatal:n { Delimiter~with~small } }
    \tl_if_in:nnTF { ) ] \} } { #2 }
      { \@@_patch_preamble_viii_i:nnn #1 #2 }
      {
        \tl_if_eq:nnTF { \q_stop } { #2 }
          {
            \str_if_eq:VnTF \g_@@_right_delim_tl { . }
              { \tl_gset:Nn \g_@@_right_delim_tl { #1 } }
              {
                \tl_gput_right:Nn \g_@@_preamble_tl { ! { \enskip } }
                \tl_gput_right:Nx \g_@@_internal_code_after_tl
                  { \@@_delimiter:nnn #1 { \int_use:N \c@jCol } \c_false_bool }
                \@@_patch_preamble:n #2
              }
          }
          {
            \tl_if_in:nnT { ( [ \{ } { #2 }
              { \tl_gput_right:Nn \g_@@_preamble_tl { ! { \enskip } } }
            \tl_gput_right:Nx \g_@@_internal_code_after_tl
              { \@@_delimiter:nnn #1 { \int_use:N \c@jCol } \c_false_bool }
            \@@_patch_preamble:n #2
          }
      }
  }
\cs_new_protected:Npn \@@_patch_preamble_viii_i:nnn #1 #2 #3
  {
    \tl_if_eq:nnTF { \q_stop } { #3 }
      {
        \str_if_eq:VnTF \g_@@_right_delim_tl { . }
          {
            \tl_gput_right:Nn \g_@@_preamble_tl { ! { \enskip } }
            \tl_gput_right:Nx \g_@@_internal_code_after_tl
              { \@@_delimiter:nnn #1 { \int_use:N \c@jCol } \c_false_bool }
            \tl_gset:Nn \g_@@_right_delim_tl { #2 }
          }
          {
            \tl_gput_right:Nn \g_@@_preamble_tl { ! { \enskip } }
            \tl_gput_right:Nx \g_@@_internal_code_after_tl
              { \@@_delimiter:nnn #1 { \int_use:N \c@jCol } \c_false_bool }
            \@@_error:nn { double~closing~delimiter } { #2 }
          }
      }
      {
        \tl_gput_right:Nx \g_@@_internal_code_after_tl
          { \@@_delimiter:nnn #1 { \int_use:N \c@jCol } \c_false_bool }
        \@@_error:nn { double~closing~delimiter } { #2 }
        \@@_patch_preamble:n #3
      }
  }
\cs_new_protected:Npn \@@_patch_preamble_xi:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      { ! { \skip_horizontal:N 2\l_@@_radius_dim } }
```

The command `\@@_vdottedline:n` is protected, and, therefore, won't be expanded before writing on `\g_@@_internal_code_after_tl`.

```
    \tl_gput_right:Nx \g_@@_internal_code_after_tl
      { \@@_vdottedline:n { \int_use:N \c@jCol } }
    \@@_patch_preamble:n
  }
```

After a specifier of column, we have to test whether there is one or several `<{..}` because, after those potential `<{...}`, we have to insert `!{\skip_horizontal:N ...}` when the key `vlines` is used.

```
\cs_new_protected:Npn \@@_patch_preamble_x:n #1
  {
    \str_if_eq:nnTF { #1 } { < }
      \@@_patch_preamble_ix:n
      {
        \tl_if_eq:NnTF \l_@@_vlines_clist { all }
          {
            \tl_gput_right:Nn \g_@@_preamble_tl
              { ! { \skip_horizontal:N \arrayrulewidth } }
          }
          {
            \exp_args:NNx
            \clist_if_in:NnT \l_@@_vlines_clist { \@@_succ:n \c@jCol }
              {
                \tl_gput_right:Nn \g_@@_preamble_tl
                  { ! { \skip_horizontal:N \arrayrulewidth } }
              }
          }
        \@@_patch_preamble:n { #1 }
      }
  }
\cs_new_protected:Npn \@@_patch_preamble_ix:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { < { #1 } }
    \@@_patch_preamble_x:n
  }
```

The redefinition of \multicolumn

The following command must *not* be protected since it begins with `\multispan` (a TeX primitive).

```
\cs_new:Npn \@@_multicolumn:nnn #1 #2 #3
  {
```

The following lines are from the definition of `\multicolumn` in array (and *not* in standard LaTeX). The first line aims to raise an error if the user has put more that one column specifier in the preamble of `\multicolumn`.

```
    \multispan { #1 }
    \begingroup
    \cs_set:Npn \@addamp { \if@firstamp \@firstampfalse \else \@preamerr 5 \fi }
```

You do the expansion of the (small) preamble with the tools of array.

```
    \@temptokena = { #2 }
    \@tempswatrue
    \@whilesw \if@tempswa \fi { \@tempswafalse \the \NC@list }
```

Now, we patch the (small) preamble as we have done with the main preamble of the array.

```
    \tl_gclear:N \g_@@_preamble_tl
    \exp_after:wN \@@_patch_m_preamble:n \the \@temptokena \q_stop
```

The following lines are an adaptation of the definition of `\multicolumn` in array.

```
    \exp_args:NV \@mkpream \g_@@_preamble_tl
    \@addtopreamble \@empty
    \endgroup
```

Now, you do a treatment specific to nicematrix which has no equivalent in the original definition of \multicolumn.

```
    \int_compare:nNnT { #1 } > 1
      {
        \seq_gput_left:Nx \g_@@_multicolumn_cells_seq
          { \int_use:N \c@iRow - \@@_succ:n \c@jCol }
        \seq_gput_left:Nn \g_@@_multicolumn_sizes_seq { #1 }
        \seq_gput_right:Nx \g_@@_pos_of_blocks_seq
          {
            { \int_use:N \c@iRow }
            { \int_eval:n { \c@jCol + 1 } }
            { \int_use:N \c@iRow }
            { \int_eval:n { \c@jCol + #1 } }
          }
      }
```

The following lines were in the original definition of \multicolumn.

```
    \cs_set:Npn \@sharp { #3 }
    \@arstrut
    \@preamble
    \null
```

We add some lines.

```
    \int_gadd:Nn \c@jCol { #1 - 1 }
    \int_compare:nNnT \c@jCol > \g_@@_col_total_int
      { \int_gset_eq:NN \g_@@_col_total_int \c@jCol }
    \ignorespaces
  }
```

The following commands will patch the (small) preamble of the \multicolumn. All those commands have a m in their name to recall that they deal with the redefinition of \multicolumn.

```
\cs_new_protected:Npn \@@_patch_m_preamble:n #1
  {
    \str_case:nnF { #1 }
      {
        c { \@@_patch_m_preamble_i:n #1 }
        l { \@@_patch_m_preamble_i:n #1 }
        r { \@@_patch_m_preamble_i:n #1 }
        > { \@@_patch_m_preamble_ii:nn #1 }
        ! { \@@_patch_m_preamble_ii:nn #1 }
        @ { \@@_patch_m_preamble_ii:nn #1 }
        | { \@@_patch_m_preamble_iii:n #1 }
        p { \@@_patch_m_preamble_iv:nnn t #1 }
        m { \@@_patch_m_preamble_iv:nnn c #1 }
        b { \@@_patch_m_preamble_iv:nnn b #1 }
        \@@_w: { \@@_patch_m_preamble_v:nnnn { }                          #1 }
        \@@_W: { \@@_patch_m_preamble_v:nnnn { \cs_set_eq:NN \hss \hfil } #1 }
        \@@_true_c: { \@@_patch_m_preamble_vi:n #1 }
        C { \@@_error:nn { old~column~type } #1 }
        L { \@@_error:nn { old~column~type } #1 }
        R { \@@_error:nn { old~column~type } #1 }
        \q_stop { }
      }
      { \@@_fatal:nn { unknown~column~type } { #1 } }
  }
```

For c, l and r

```
\cs_new_protected:Npn \@@_patch_m_preamble_i:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > { \@@_Cell: \tl_set:Nn \l_@@_cell_type_tl { #1 } }
```

```
        #1
        < \@@_end_Cell:
      }
```
We test for the presence of a `<`.
```
    \@@_patch_m_preamble_x:n
  }
```
For `>`, `!` and `@`
```
\cs_new_protected:Npn \@@_patch_m_preamble_ii:nn #1 #2
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { #1 { #2 } }
    \@@_patch_m_preamble:n
  }
```
For `|`
```
\cs_new_protected:Npn \@@_patch_m_preamble_iii:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { #1 }
    \@@_patch_m_preamble:n
  }
```
For `p`, `m` and `b`
```
\cs_new_protected:Npn \@@_patch_m_preamble_iv:nnn #1 #2 #3
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > {
            \@@_Cell:
            \begin { minipage } [ #1 ] { \dim_eval:n { #3 } }
            \mode_leave_vertical:
            \arraybackslash
            \vrule height \box_ht:N \@arstrutbox depth 0 pt width 0 pt
          }
        c
        < {
            \vrule height 0 pt depth \box_dp:N \@arstrutbox width 0 pt
            \end { minipage }
            \@@_end_Cell:
          }
      }
```
We test for the presence of a `<`.
```
    \@@_patch_m_preamble_x:n
  }
```
For `w` and `W`
```
\cs_new_protected:Npn \@@_patch_m_preamble_v:nnnn #1 #2 #3 #4
  {
    \tl_gput_right:Nn \g_@@_preamble_tl
      {
        > {
            \hbox_set:Nw \l_@@_cell_box
            \@@_Cell:
            \tl_set:Nn \l_@@_cell_type_tl { #3 }
          }
        c
        < {
            \@@_end_Cell:
            #1
            \hbox_set_end:
            \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
            \@@_adjust_size_box:
            \makebox [ #4 ] [ #3 ] { \box_use_drop:N \l_@@_cell_box }
```

```
          }
      }
```

We test for the presence of a `<`.

```
    \@@_patch_m_preamble_x:n
  }
```

For `\@@_true_c:` which will appear in our redefinition of the columns of type `S` (of siunitx).

```
\cs_new_protected:Npn \@@_patch_m_preamble_vi:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { c }
```

We test for the presence of a `<`.

```
    \@@_patch_m_preamble_x:n
  }
```

After a specifier of column, we have to test whether there is one or several `<{..}` because, after those potential `<{...}`, we have to insert `!{\skip_horizontal:N ...}` when the key `vlines` is used.

```
\cs_new_protected:Npn \@@_patch_m_preamble_x:n #1
  {
    \str_if_eq:nnTF { #1 } { < }
      \@@_patch_m_preamble_ix:n
      {
        \tl_if_eq:NnTF \l_@@_vlines_clist { all }
          {
            \tl_gput_right:Nn \g_@@_preamble_tl
              { ! { \skip_horizontal:N \arrayrulewidth } }
          }
          {
            \exp_args:NNx
            \clist_if_in:NnT \l_@@_vlines_clist { \@@_succ:n \c@jCol }
              {
                \tl_gput_right:Nn \g_@@_preamble_tl
                  { ! { \skip_horizontal:N \arrayrulewidth } }
              }
          }
        \@@_patch_m_preamble:n { #1 }
      }
  }
\cs_new_protected:Npn \@@_patch_m_preamble_ix:n #1
  {
    \tl_gput_right:Nn \g_@@_preamble_tl { < { #1 } }
    \@@_patch_m_preamble_x:n
  }
```

The command `\@@_put_box_in_flow:` puts the box `\l_tmpa_box` (which contains the array) in the flow. It is used for the environments with delimiters. First, we have to modify the height and the depth to take back into account the potential exterior rows (the total height of the first row has been computed in `\l_tmpa_dim` and the total height of the potential last row in `\l_tmpb_dim`).

```
\cs_new_protected:Npn \@@_put_box_in_flow:
  {
    \box_set_ht:Nn \l_tmpa_box { \box_ht:N \l_tmpa_box + \l_tmpa_dim }
    \box_set_dp:Nn \l_tmpa_box { \box_dp:N \l_tmpa_box + \l_tmpb_dim }
    \tl_if_eq:NnTF \l_@@_baseline_tl { c }
      { \box_use_drop:N \l_tmpa_box }
      \@@_put_box_in_flow_i:
  }
```

The command `\@@_put_box_in_flow_i:` is used when the value of `\l_@@_baseline_tl` is different of `c` (which is the initial value and the most used).

```
\cs_new_protected:Npn \@@_put_box_in_flow_i:
  {
    \pgfpicture
```

```
      \@@_qpoint:n { row - 1 }
      \dim_gset_eq:NN \g_tmpa_dim \pgf@y
      \@@_qpoint:n { row - \@@_succ:n \c@iRow }
      \dim_gadd:Nn \g_tmpa_dim \pgf@y
      \dim_gset:Nn \g_tmpa_dim { 0.5 \g_tmpa_dim }
```

Now, `\g_tmpa_dim` contains the y-value of the center of the array (the delimiters are centered in relation with this value).

```
      \str_if_in:NnTF \l_@@_baseline_tl { line- }
        {
          \int_set:Nn \l_tmpa_int
            {
              \str_range:Nnn
                \l_@@_baseline_tl
                6
                { \tl_count:V \l_@@_baseline_tl }
            }
          \@@_qpoint:n { row - \int_use:N \l_tmpa_int }
        }
        {
          \str_case:VnF \l_@@_baseline_tl
            {
              { t } { \int_set:Nn \l_tmpa_int 1 }
              { b } { \int_set_eq:NN \l_tmpa_int \c@iRow }
            }
            { \int_set:Nn \l_tmpa_int \l_@@_baseline_tl }
          \bool_lazy_or:nnT
            { \int_compare_p:nNn \l_tmpa_int < \l_@@_first_row_int }
            { \int_compare_p:nNn \l_tmpa_int > \g_@@_row_total_int }
            {
              \@@_error:n { bad~value~for~baseline }
              \int_set:Nn \l_tmpa_int 1
            }
          \@@_qpoint:n { row - \int_use:N \l_tmpa_int - base }
```

We take into account the position of the mathematical axis.

```
          \dim_gsub:Nn \g_tmpa_dim { \fontdimen22 \textfont2 }
        }
      \dim_gsub:Nn \g_tmpa_dim \pgf@y
```

Now, `\g_tmpa_dim` contains the value of the y translation we have to to.

```
    \endpgfpicture
    \box_move_up:nn \g_tmpa_dim { \box_use_drop:N \l_tmpa_box }
    \box_use_drop:N \l_tmpa_box
  }
```

The following command is *always* used by `{NiceArrayWithDelims}` (even if, in fact, there is no tabular notes: in fact, it's not possible to know whether there is tabular notes or not before the composition of the blocks).

```
\cs_new_protected:Npn \@@_use_arraybox_with_notes_c:
  {
```

With an environment `{Matrix}`, you want to remove the exterior `\arraycolsep` but we don't know the number of columns (since there is no preamble) and that's why we can't put `@{}` at the end of the preamble. That's why we remove a `\arraycolsep` now.

```
    \bool_lazy_and:nnT \l_@@_Matrix_bool \l_@@_NiceArray_bool
      {
        \box_set_wd:Nn \l_@@_the_array_box
          { \box_wd:N \l_@@_the_array_box - \arraycolsep }
      }
```

We need a `{minipage}` because we will insert a LaTeX list for the tabular notes (that means that a `\vtop{\hsize=...}` is not enough).

```
    \begin { minipage } [ t ] { \box_wd:N \l_@@_the_array_box }
    \box_use_drop:N \l_@@_the_array_box
```

We have to draw the blocks right now because there may be tabular notes in some blocks (which are not mono-column: the blocks which are mono-column have been composed in boxes yet)... and we have to create (potentially) the extra nodes before creating the blocks since there are `medium` nodes to create for the blocks.

```
    \@@_create_extra_nodes:
    \seq_if_empty:NF \g_@@_blocks_seq \@@_draw_blocks:
    \bool_lazy_or:nnT
      { \int_compare_p:nNn \c@tabularnote > 0 }
      { ! \tl_if_empty_p:V \l_@@_tabularnote_tl }
      \@@_insert_tabularnotes:
    \end { minipage }
  }
\cs_new_protected:Npn \@@_insert_tabularnotes:
  {
    \skip_vertical:N 0.65ex
```

The TeX group is for potential specifications in the `\l_@@_notes_code_before_tl`.

```
    \group_begin:
    \l_@@_notes_code_before_tl
    \tl_if_empty:NF \l_@@_tabularnote_tl { \l_@@_tabularnote_tl \par }
```

We compose the tabular notes with a list of enumitem. The `\strut` and the `\unskip` are designed to give the ability to put a `\bottomrule` at the end of the notes with a good vertical space.

```
    \int_compare:nNnT \c@tabularnote > 0
      {
        \bool_if:NTF \l_@@_notes_para_bool
          {
            \begin { tabularnotes* }
              \seq_map_inline:Nn \g_@@_tabularnotes_seq { \item ##1 } \strut
            \end { tabularnotes* }
```

The following `\par` is mandatory for the event that the user has put `\footnotesize` (for example) in the `notes/code-before`.

```
            \par
          }
          {
            \tabularnotes
              \seq_map_inline:Nn \g_@@_tabularnotes_seq { \item ##1 } \strut
            \endtabularnotes
          }
      }
    \unskip
    \group_end:
    \bool_if:NT \l_@@_notes_bottomrule_bool
      {
        \bool_if:NTF \c_@@_booktabs_loaded_bool
          {
```

The two dimensions `\aboverulesep` et `\heavyrulewidth` are parameters defined by booktabs.

```
            \skip_vertical:N \aboverulesep
```

`\CT@arc@` is the specification of color defined by colortbl but you use it even if colortbl is not loaded.

```
            { \CT@arc@ \hrule height \heavyrulewidth }
          }
          { \@@_error:n { bottomrule~without~booktabs } }
      }
    \l_@@_notes_code_after_tl
    \seq_gclear:N \g_@@_tabularnotes_seq
    \int_gzero:N \c@tabularnote
  }
```

The case of `baseline` equal to `b`. Remember that, when the key `b` is used, the `{array}` (of array) is constructed with the option `t` (and not `b`). Now, we do the translation to take into account the option `b`.

```
\cs_new_protected:Npn \@@_use_arraybox_with_notes_b:
  {
    \pgfpicture
      \@@_qpoint:n { row - 1 }
      \dim_gset_eq:NN \g_tmpa_dim \pgf@y
      \@@_qpoint:n { row - \int_use:N \c@iRow - base }
      \dim_gsub:Nn \g_tmpa_dim \pgf@y
    \endpgfpicture
    \dim_gadd:Nn \g_tmpa_dim \arrayrulewidth
    \int_compare:nNnT \l_@@_first_row_int = 0
      {
        \dim_gadd:Nn \g_tmpa_dim \g_@@_ht_row_zero_dim
        \dim_gadd:Nn \g_tmpa_dim \g_@@_dp_row_zero_dim
      }
    \box_move_up:nn \g_tmpa_dim { \hbox { \@@_use_arraybox_with_notes_c: } }
  }
```

Now, the general case.

```
\cs_new_protected:Npn \@@_use_arraybox_with_notes:
  {
```

We convert a value of `t` to a value of `1`.

```
    \tl_if_eq:NnT \l_@@_baseline_tl { t }
      { \tl_set:Nn \l_@@_baseline_tl { 1 } }
```

Now, we convert the value of `\l_@@_baseline_tl` (which should represent an integer) to an integer stored in `\l_tmpa_int`.

```
    \pgfpicture
    \@@_qpoint:n { row - 1 }
    \dim_gset_eq:NN \g_tmpa_dim \pgf@y
    \str_if_in:NnTF \l_@@_baseline_tl { line- }
      {
        \int_set:Nn \l_tmpa_int
          {
            \str_range:Nnn
              \l_@@_baseline_tl
              6
              { \tl_count:V \l_@@_baseline_tl }
          }
        \@@_qpoint:n { row - \int_use:N \l_tmpa_int }
      }
      {
        \int_set:Nn \l_tmpa_int \l_@@_baseline_tl
        \bool_lazy_or:nnT
          { \int_compare_p:nNn \l_tmpa_int < \l_@@_first_row_int }
          { \int_compare_p:nNn \l_tmpa_int > \g_@@_row_total_int }
          {
            \@@_error:n { bad~value~for~baseline }
            \int_set:Nn \l_tmpa_int 1
          }
        \@@_qpoint:n { row - \int_use:N \l_tmpa_int - base }
      }
    \dim_gsub:Nn \g_tmpa_dim \pgf@y
    \endpgfpicture
    \dim_gadd:Nn \g_tmpa_dim \arrayrulewidth
    \int_compare:nNnT \l_@@_first_row_int = 0
      {
        \dim_gadd:Nn \g_tmpa_dim \g_@@_ht_row_zero_dim
        \dim_gadd:Nn \g_tmpa_dim \g_@@_dp_row_zero_dim
      }
    \box_move_up:nn \g_tmpa_dim { \hbox { \@@_use_arraybox_with_notes_c: } }
  }
```

The command `\@@_put_box_in_flow_bis:` is used when the option `delimiters/max-width` is used because, in this case, we have to adjust the widths of the delimiters. The arguments `#1` and `#2` are the delimiters specified by the user.

```
\cs_new_protected:Npn \@@_put_box_in_flow_bis:nn #1 #2
  {
```

We will compute the real width of both delimiters used.

```
    \dim_zero_new:N \l_@@_real_left_delim_dim
    \dim_zero_new:N \l_@@_real_right_delim_dim
    \hbox_set:Nn \l_tmpb_box
      {
        \c_math_toggle_token
        \left #1
        \vcenter
          {
            \vbox_to_ht:nn
              { \box_ht:N \l_tmpa_box + \box_dp:N \l_tmpa_box }
              { }
          }
        \right .
        \c_math_toggle_token
      }
    \dim_set:Nn \l_@@_real_left_delim_dim
      { \box_wd:N \l_tmpb_box - \nulldelimiterspace }
    \hbox_set:Nn \l_tmpb_box
      {
        \c_math_toggle_token
        \left .
        \vbox_to_ht:nn
          { \box_ht:N \l_tmpa_box + \box_dp:N \l_tmpa_box }
          { }
        \right #2
        \c_math_toggle_token
      }
    \dim_set:Nn \l_@@_real_right_delim_dim
      { \box_wd:N \l_tmpb_box - \nulldelimiterspace }
```

Now, we can put the box in the TeX flow with the horizontal adjustments on both sides.

```
    \skip_horizontal:N  \l_@@_left_delim_dim
    \skip_horizontal:N -\l_@@_real_left_delim_dim
    \@@_put_box_in_flow:
    \skip_horizontal:N \l_@@_right_delim_dim
    \skip_horizontal:N -\l_@@_real_right_delim_dim
  }
```

The construction of the array in the environment `{NiceArrayWithDelims}` is, in fact, done by the environment `{@@-light-syntax}` or by the environment `{@@-normal-syntax}` (whether the option `light-syntax` is in force or not). When the key `light-syntax` is not used, the construction is a standard environment (and, thus, it's possible to use verbatim in the array).

```
\NewDocumentEnvironment { @@-normal-syntax } { }
```

First, we test whether the environment is empty. If it is empty, we raise a fatal error (it's only a security). In order to detect whether it is empty, we test whether the next token is `\end` and, if it's the case, we test if this is the end of the environment (if it is not, an standard error will be raised by LaTeX for incorrect nested environments).

```
  {
    \peek_meaning_ignore_spaces:NTF \end \@@_analyze_end:Nn
```

Here is the call to `\array` (we have a dedicated macro `\@@_array:` because of compatibility with the classes revtex4-1 and revtex4-2).

```
      { \exp_args:NV \@@_array: \g_@@_preamble_tl }
  }
  {
```

```
    \@@_create_col_nodes:
    \endarray
  }
```

When the key `light-syntax` is in force, we use an environment which takes its whole body as an argument (with the specifier `b` of xparse).

```
\NewDocumentEnvironment { @@-light-syntax } { b }
  {
```

First, we test whether the environment is empty. It's only a security. Of course, this test is more easy than the similar test for the "normal syntax" because we have the whole body of the environment in `#1`.

```
    \tl_if_empty:nT { #1 } { \@@_fatal:n { empty~environment } }
    \tl_map_inline:nn { #1 }
      {
        \str_if_eq:nnT { ##1 } { & }
          { \@@_fatal:n { ampersand~in~light-syntax } }
        \str_if_eq:nnT { ##1 } { \\ }
          { \@@_fatal:n { double-backslash~in~light-syntax } }
      }
```

Now, you extract the `\CodeAfter` of the body of the environment. Maybe, there is no command `\CodeAfter` in the body. That's why you put a marker `\CodeAfter` after `#1`. If there is yet a `\CodeAfter` in `#1`, this second (or third...) `\CodeAfter` will be catched in the value of `\g_nicematrix_code_after_tl`. That doesn't matter because `\CodeAfter` will be set to *no-op* before the execution of `\g_nicematrix_code_after_tl`.

```
    \@@_light_syntax_i #1 \CodeAfter \q_stop
  }
```

Now, the second part of the environment. It is empty. That's not surprising because we have caught the whole body of the environment with the specifier `b` provided by xparse.

```
  { }
\cs_new_protected:Npn \@@_light_syntax_i #1\CodeAfter #2\q_stop
  {
    \tl_gput_right:Nn \g_nicematrix_code_after_tl { #2 }
```

The body of the array, which is stored in the argument `#1`, is now splitted into items (and *not* tokens).

```
    \seq_gclear_new:N \g_@@_rows_seq
    \tl_set_rescan:Nno \l_@@_end_of_row_tl { } \l_@@_end_of_row_tl
    \exp_args:NNV \seq_gset_split:Nnn \g_@@_rows_seq \l_@@_end_of_row_tl { #1 }
```

If the environment uses the option `last-row` without value (i.e. without saying the number of the rows), we have now the opportunity to know that value. We do it, and so, if the token list `\l_@@_code_for_last_row_tl` is not empty, we will use directly where it should be.

```
    \int_compare:nNnT \l_@@_last_row_int = { -1 }
      { \int_set:Nn \l_@@_last_row_int { \seq_count:N \g_@@_rows_seq } }
```

Here is the call to `\array` (we have a dedicated macro `\@@_array:` because of compatibility with the classes revtex4-1 and revtex4-2).

```
    \exp_args:NV \@@_array: \g_@@_preamble_tl
```

We need a global affectation because, when executing `\l_tmpa_tl`, we will exit the first cell of the array.

```
    \seq_gpop_left:NN \g_@@_rows_seq \l_tmpa_tl
    \exp_args:NV \@@_line_with_light_syntax_i:n \l_tmpa_tl
    \seq_map_function:NN \g_@@_rows_seq \@@_line_with_light_syntax:n
    \@@_create_col_nodes:
    \endarray
  }
\cs_new_protected:Npn \@@_line_with_light_syntax:n #1
  { \tl_if_empty:nF { #1 } { \\ \@@_line_with_light_syntax_i:n { #1 } } }
```

```
\cs_new_protected:Npn \@@_line_with_light_syntax_i:n #1
  {
    \seq_gclear_new:N \g_@@_cells_seq
    \seq_gset_split:Nnn \g_@@_cells_seq { ~ } { #1 }
    \seq_gpop_left:NN \g_@@_cells_seq \l_tmpa_tl
    \l_tmpa_tl
    \seq_map_inline:Nn \g_@@_cells_seq { & ##1 }
  }
```

The following command is used by the code which detects whether the environment is empty (we raise a fatal error in this case: it's only a security).

```
\cs_new_protected:Npn \@@_analyze_end:Nn #1 #2
  {
    \str_if_eq:VnT \g_@@_name_env_str { #2 }
      { \@@_fatal:n { empty~environment } }
```

We reput in the stream the `\end{...}` we have extracted and the user will have an error for incorrect nested environments.

```
    \end { #2 }
  }
```

The command `\@@_create_col_nodes:` will construct a special last row. That last row is a false row used to create the `col` nodes and to fix the width of the columns (when the array is constructed with an option which specifies the width of the columns).

```
\cs_new:Npn \@@_create_col_nodes:
  {
    \crcr
    \int_compare:nNnT \l_@@_first_col_int = 0
      {
        \omit
        \hbox_overlap_left:n
          {
            \bool_if:NT \l_@@_code_before_bool
              { \pgfsys@markposition { \@@_env: - col - 0 } }
            \pgfpicture
            \pgfrememberpicturepositiononpagetrue
            \pgfcoordinate { \@@_env: - col - 0 } \pgfpointorigin
            \str_if_empty:NF \l_@@_name_str
              { \pgfnodealias { \l_@@_name_str - col - 0 } { \@@_env: - col - 0 } }
            \endpgfpicture
            \skip_horizontal:N 2\col@sep
            \skip_horizontal:N \g_@@_width_first_col_dim
          }
        &
      }
    \omit
```

The following instruction must be put after the instruction `\omit`.

```
    \bool_gset_true:N \g_@@_row_of_col_done_bool
```

First, we put a `col` node on the left of the first column (of course, we have to do that *after* the `\omit`).

```
    \int_compare:nNnTF \l_@@_first_col_int = 0
      {
        \bool_if:NT \l_@@_code_before_bool
          {
            \hbox
              {
                \skip_horizontal:N -0.5\arrayrulewidth
                \pgfsys@markposition { \@@_env: - col - 1 }
                \skip_horizontal:N 0.5\arrayrulewidth
              }
          }
```

```
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgfcoordinate { \@@_env: - col - 1 }
          { \pgfpoint { - 0.5 \arrayrulewidth } \c_zero_dim }
        \str_if_empty:NF \l_@@_name_str
          { \pgfnodealias { \l_@@_name_str - col - 1 } { \@@_env: - col - 1 } }
        \endpgfpicture
      }
      {
        \bool_if:NT \l_@@_code_before_bool
          {
            \hbox
              {
                \skip_horizontal:N 0.5\arrayrulewidth
                \pgfsys@markposition { \@@_env: - col - 1 }
                \skip_horizontal:N -0.5\arrayrulewidth
              }
          }
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgfcoordinate { \@@_env: - col - 1 }
          { \pgfpoint { 0.5 \arrayrulewidth } \c_zero_dim }
        \str_if_empty:NF \l_@@_name_str
          { \pgfnodealias { \l_@@_name_str - col - 1 } { \@@_env: - col - 1 } }
        \endpgfpicture
      }
```

We compute in `\g_tmpa_skip` the common width of the columns (it's a skip and not a dimension). We use a global variable because we are in a cell of an `\halign` and because we have to use this variable in other cells (of the same row). The affectation of `\g_tmpa_skip`, like all the affectations, must be done after the `\omit` of the cell.

We give a default value for `\g_tmpa_skip` (`0 pt plus 1 fill`) but it will just after be erased by a fixed value in the concerned cases.

```
    \skip_gset:Nn \g_tmpa_skip { 0 pt~plus 1 fill }
    \bool_if:NF \l_@@_auto_columns_width_bool
      { \dim_compare:nNnT \l_@@_columns_width_dim > \c_zero_dim }
      {
        \bool_lazy_and:nnTF
          \l_@@_auto_columns_width_bool
          { \bool_not_p:n \l_@@_block_auto_columns_width_bool }
          { \skip_gset_eq:NN \g_tmpa_skip \g_@@_max_cell_width_dim }
          { \skip_gset_eq:NN \g_tmpa_skip \l_@@_columns_width_dim }
        \skip_gadd:Nn \g_tmpa_skip { 2 \col@sep }
      }
    \skip_horizontal:N \g_tmpa_skip
    \hbox
      {
        \bool_if:NT \l_@@_code_before_bool
          {
            \hbox
              {
                \skip_horizontal:N -0.5\arrayrulewidth
                \pgfsys@markposition { \@@_env: - col - 2 }
                \skip_horizontal:N 0.5\arrayrulewidth
              }
          }
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgfcoordinate { \@@_env: - col - 2 }
          { \pgfpoint { - 0.5 \arrayrulewidth } \c_zero_dim }
        \str_if_empty:NF \l_@@_name_str
          { \pgfnodealias { \l_@@_name_str - col - 2 } { \@@_env: - col - 2 } }
        \endpgfpicture
```

```
    }
```

We begin a loop over the columns. The integer `\g_tmpa_int` will be the number of the current column. This integer is used for the Tikz nodes.

```
    \int_gset:Nn \g_tmpa_int 1
    \bool_if:NTF \g_@@_last_col_found_bool
      { \prg_replicate:nn { \g_@@_col_total_int - 3 } }
      { \prg_replicate:nn { \g_@@_col_total_int - 2 } }
      {
        &
        \omit
        \int_gincr:N \g_tmpa_int
```

The incrementation of the counter `\g_tmpa_int` must be done after the `\omit` of the cell.

```
        \skip_horizontal:N \g_tmpa_skip
        \bool_if:NT \l_@@_code_before_bool
          {
            \hbox
              {
                \skip_horizontal:N -0.5\arrayrulewidth
                \pgfsys@markposition { \@@_env: - col - \@@_succ:n \g_tmpa_int }
                \skip_horizontal:N 0.5\arrayrulewidth
              }
          }
```

We create the `col` node on the right of the current column.

```
        \pgfpicture
          \pgfrememberpicturepositiononpagetrue
          \pgfcoordinate { \@@_env: - col - \@@_succ:n \g_tmpa_int }
            { \pgfpoint { - 0.5 \arrayrulewidth } \c_zero_dim }
          \str_if_empty:NF \l_@@_name_str
            {
              \pgfnodealias
                { \l_@@_name_str - col - \@@_succ:n \g_tmpa_int }
                { \@@_env: - col - \@@_succ:n \g_tmpa_int }
            }
        \endpgfpicture
    }
```

```
        &
        \omit
        \int_gincr:N \g_tmpa_int
        \skip_horizontal:N \g_tmpa_skip
        \bool_lazy_all:nT
          {
            \l_@@_NiceArray_bool
            { \bool_not_p:n \l_@@_NiceTabular_bool }
            { \clist_if_empty_p:N \l_@@_vlines_clist }
            { \bool_not_p:n \l_@@_exterior_arraycolsep_bool }
            { ! \l_@@_bar_at_end_of_pream_bool }
          }
          { \skip_horizontal:N -\col@sep }
        \bool_if:NT \l_@@_code_before_bool
          {
            \hbox
              {
                \skip_horizontal:N -0.5\arrayrulewidth
```

With an environment `{Matrix}`, you want to remove the exterior `\arraycolsep` but we don't know the number of columns (since there is no preamble) and that's why we can't put `@{}` at the end of the preamble. That's why we remove a `\arraycolsep` now.

```
                \bool_lazy_and:nnT \l_@@_Matrix_bool \l_@@_NiceArray_bool
                  { \skip_horizontal:N -\arraycolsep }
                \pgfsys@markposition { \@@_env: - col - \@@_succ:n \g_tmpa_int }
```

```
                \skip_horizontal:N 0.5\arrayrulewidth
                \bool_lazy_and:nnT \l_@@_Matrix_bool \l_@@_NiceArray_bool
                  { \skip_horizontal:N \arraycolsep }
              }
          }
        \pgfpicture
          \pgfrememberpicturepositiononpagetrue
          \pgfcoordinate { \@@_env: - col - \@@_succ:n \g_tmpa_int }
            {
              \bool_lazy_and:nnTF \l_@@_Matrix_bool \l_@@_NiceArray_bool
                 {
                   \pgfpoint
                     { - 0.5 \arrayrulewidth - \arraycolsep }
                     \c_zero_dim
                 }
                 { \pgfpoint { - 0.5 \arrayrulewidth } \c_zero_dim }
            }
          \str_if_empty:NF \l_@@_name_str
            {
              \pgfnodealias
                { \l_@@_name_str - col - \@@_succ:n \g_tmpa_int }
                { \@@_env: - col - \@@_succ:n \g_tmpa_int }
            }
        \endpgfpicture


    \bool_if:NT \g_@@_last_col_found_bool
      {
        \hbox_overlap_right:n
          {
            \skip_horizontal:N \g_@@_width_last_col_dim
            \bool_if:NT \l_@@_code_before_bool
              {
                \pgfsys@markposition
                  { \@@_env: - col - \@@_succ:n \g_@@_col_total_int }
              }
            \pgfpicture
            \pgfrememberpicturepositiononpagetrue
            \pgfcoordinate { \@@_env: - col - \@@_succ:n \g_@@_col_total_int }
              \pgfpointorigin
            \str_if_empty:NF \l_@@_name_str
              {
                \pgfnodealias
                  { \l_@@_name_str - col - \@@_succ:n \g_@@_col_total_int }
                  { \@@_env: - col - \@@_succ:n \g_@@_col_total_int }
              }
            \endpgfpicture
          }
      }
    \cr
  }
```

Here is the preamble for the "first column" (if the user uses the key `first-col`)

```
\tl_const:Nn \c_@@_preamble_first_col_tl
  {
    >
      {
```

At the beginning of the cell, we link `\CodeAfter` to a command which do *not* begin with `\omit` (whereas the standard version of `\CodeAfter` begins with `\omit`).

```
        \cs_set_eq:NN \CodeAfter \@@_CodeAfter_i:n
        \bool_gset_true:N \g_@@_after_col_zero_bool
        \@@_begin_of_row:
```

The contents of the cell is constructed in the box `\l_@@_cell_box` because we have to compute some dimensions of this box.

```
        \hbox_set:Nw \l_@@_cell_box
        \@@_math_toggle_token:
        \bool_if:NT \l_@@_small_bool \scriptstyle
```

We insert `\l_@@_code_for_first_col_tl`... but we don't insert it in the potential "first row" and in the potential "last row".

```
        \bool_lazy_and:nnT
          { \int_compare_p:nNn \c@iRow > 0 }
          {
            \bool_lazy_or_p:nn
              { \int_compare_p:nNn \l_@@_last_row_int < 0 }
              { \int_compare_p:nNn \c@iRow < \l_@@_last_row_int }
          }
          {
            \l_@@_code_for_first_col_tl
            \xglobal \colorlet { nicematrix-first-col } { . }
          }
      }
```

Be careful: despite this letter `l` the cells of the "first column" are composed in a `R` manner since they are composed in a `\hbox_overlap_left:n`.

```
    l
    <
      {
        \@@_math_toggle_token:
        \hbox_set_end:
        \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
        \@@_adjust_size_box:
        \@@_update_for_first_and_last_row:
```

We actualise the width of the "first column" because we will use this width after the construction of the array.

```
        \dim_gset:Nn \g_@@_width_first_col_dim
          { \dim_max:nn \g_@@_width_first_col_dim { \box_wd:N \l_@@_cell_box } }
```

The content of the cell is inserted in an overlapping position.

```
        \hbox_overlap_left:n
          {
            \dim_compare:nNnTF { \box_wd:N \l_@@_cell_box } > \c_zero_dim
              \@@_node_for_cell:
              { \box_use_drop:N \l_@@_cell_box }
            \skip_horizontal:N \l_@@_left_delim_dim
            \skip_horizontal:N \l_@@_left_margin_dim
            \skip_horizontal:N \l_@@_extra_left_margin_dim
          }
        \bool_gset_false:N \g_@@_empty_cell_bool
        \skip_horizontal:N -2\col@sep
      }
  }
```

Here is the preamble for the "last column" (if the user uses the key `last-col`).

```
\tl_const:Nn \c_@@_preamble_last_col_tl
  {
    >
      {
```

At the beginning of the cell, we link `\CodeAfter` to a command which do *not* begin with `\omit` (whereas the standard version of `\CodeAfter` begins with `\omit`).

```
    \cs_set_eq:NN \CodeAfter \@@_CodeAfter_i:n
```

With the flag `\g_@@_last_col_found_bool`, we will know that the "last column" is really used.

```
        \bool_gset_true:N \g_@@_last_col_found_bool
        \int_gincr:N \c@jCol
        \int_gset_eq:NN \g_@@_col_total_int \c@jCol
```

The contents of the cell is constructed in the box `\l_tmpa_box` because we have to compute some dimensions of this box.

```
        \hbox_set:Nw \l_@@_cell_box
          \@@_math_toggle_token:
          \bool_if:NT \l_@@_small_bool \scriptstyle
```

We insert `\l_@@_code_for_last_col_tl`... but we don't insert it in the potential "first row" and in the potential "last row".

```
        \int_compare:nNnT \c@iRow > 0
          {
            \bool_lazy_or:nnT
              { \int_compare_p:nNn \l_@@_last_row_int < 0 }
              { \int_compare_p:nNn \c@iRow < \l_@@_last_row_int }
              {
                \l_@@_code_for_last_col_tl
                \xglobal \colorlet { nicematrix-last-col } { . }
              }
          }
      }
    l
    <
      {
        \@@_math_toggle_token:
        \hbox_set_end:
        \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
        \@@_adjust_size_box:
        \@@_update_for_first_and_last_row:
```

We actualise the width of the "last column" because we will use this width after the construction of the array.

```
        \dim_gset:Nn \g_@@_width_last_col_dim
          { \dim_max:nn \g_@@_width_last_col_dim { \box_wd:N \l_@@_cell_box } }
        \skip_horizontal:N -2\col@sep
```

The content of the cell is inserted in an overlapping position.

```
        \hbox_overlap_right:n
          {
            \dim_compare:nNnT { \box_wd:N \l_@@_cell_box } > \c_zero_dim
              {
                \skip_horizontal:N \l_@@_right_delim_dim
                \skip_horizontal:N \l_@@_right_margin_dim
                \skip_horizontal:N \l_@@_extra_right_margin_dim
                \@@_node_for_cell:
              }
          }
        \bool_gset_false:N \g_@@_empty_cell_bool
      }
  }
```

The environment `{NiceArray}` is constructed upon the environment `{NiceArrayWithDelims}` but, in fact, there is a flag `\l_@@_NiceArray_bool`. In `{NiceArrayWithDelims}`, some special code will be executed if this flag is raised.

```
\NewDocumentEnvironment { NiceArray } { }
  {
    \bool_set_true:N \l_@@_NiceArray_bool
    \str_if_empty:NT \g_@@_name_env_str
      { \str_gset:Nn \g_@@_name_env_str { NiceArray } }
```

We put . and . for the delimiters but, in fact, that doesn't matter because these arguments won't be used in `{NiceArrayWithDelims}` (because the flag `\l_@@_NiceArray_bool` is raised).

```
    \NiceArrayWithDelims . .
  }
  { \endNiceArrayWithDelims }
```

We create the variants of the environment {NiceArrayWithDelims}.

```
\cs_new_protected:Npn \@@_def_env:nnn #1 #2 #3
  {
    \NewDocumentEnvironment { #1 NiceArray } { }
      {
        \str_if_empty:NT \g_@@_name_env_str
          { \str_gset:Nn \g_@@_name_env_str { #1 NiceArray } }
        \@@_test_if_math_mode:
        \NiceArrayWithDelims #2 #3
      }
      { \endNiceArrayWithDelims }
  }
\@@_def_env:nnn p ( )
\@@_def_env:nnn b [ ]
\@@_def_env:nnn B \{ \}
\@@_def_env:nnn v | |
\@@_def_env:nnn V \| \|
```

The environment {NiceMatrix} and its variants

```
\cs_new_protected:Npn \@@_begin_of_NiceMatrix:nn #1 #2
  {
    \bool_set_true:N \l_@@_Matrix_bool
    \use:c { #1 NiceArray }
      {
        *
          {
            \int_compare:nNnTF \l_@@_last_col_int < 0
              \c@MaxMatrixCols
              { \@@_pred:n \l_@@_last_col_int }
          }
          { > \@@_Cell: #2 < \@@_end_Cell: }
      }
  }
\clist_map_inline:nn { { } , p , b , B , v , V }
  {
    \NewDocumentEnvironment { #1 NiceMatrix } { ! O { } }
      {
        \str_gset:Nn \g_@@_name_env_str { #1 NiceMatrix }
        \tl_set:Nn \l_@@_type_of_col_tl c
        \keys_set:nn { NiceMatrix / NiceMatrix } { ##1 }
        \exp_args:Nne \@@_begin_of_NiceMatrix:nn { #1 } \l_@@_type_of_col_tl
      }
      { \use:c { end #1 NiceArray } }
  }
```

The following command will be linked to \NotEmpty in the environments of nicematrix.

```
\cs_new_protected:Npn \@@_NotEmpty:
  { \bool_gset_true:N \g_@@_not_empty_cell_bool }
```

The environments {NiceTabular} and {NiceTabular*}

```
\NewDocumentEnvironment { NiceTabular } { O { } m ! O { } }
  {
    \str_gset:Nn \g_@@_name_env_str { NiceTabular }
    \keys_set:nn { NiceMatrix / NiceTabular } { #1 , #3 }
    \bool_set_true:N \l_@@_NiceTabular_bool
    \NiceArray { #2 }
  }
```

```
  { \endNiceArray }

\NewDocumentEnvironment { NiceTabular* } { m O { } m ! O { } }
  {
    \str_gset:Nn \g_@@_name_env_str { NiceTabular* }
    \dim_set:Nn \l_@@_tabular_width_dim { #1 }
    \keys_set:nn { NiceMatrix / NiceTabular } { #2 , #4 }
    \bool_set_true:N \l_@@_NiceTabular_bool
    \NiceArray { #3 }
  }
  { \endNiceArray }
```

After the construction of the array

```
\cs_new_protected:Npn \@@_after_array:
  {
    \group_begin:
```

When the option `last-col` is used in the environments with explicit preambles (like `{NiceArray}`, `{pNiceArray}`, etc.) a special type of column is used at the end of the preamble in order to compose the cells in an overlapping position (with `\hbox_overlap_right:n`) but (if `last-col` has been used), we don't have the number of that last column. However, we have to know that number for the color of the potential `\Vdots` drawn in that last column. That's why we fix the correct value of `\l_@@_last_col_int` in that case.

```
    \bool_if:NT \g_@@_last_col_found_bool
      { \int_set_eq:NN \l_@@_last_col_int \g_@@_col_total_int }
```

If we are in an environment without preamble (like `{NiceMatrix}` or `{pNiceMatrix}`) and if the option `last-col` has been used without value we also fix the real value of `\l_@@_last_col_int`.

```
    \bool_if:NT \l_@@_last_col_without_value_bool
      { \int_set_eq:NN \l_@@_last_col_int \g_@@_col_total_int }
```

It's also time to give to `\l_@@_last_row_int` its real value.

```
    \bool_if:NT \l_@@_last_row_without_value_bool
      { \int_set_eq:NN \l_@@_last_row_int \g_@@_row_total_int }

    \tl_gput_right:Nx \g_@@_aux_tl
      {
        \seq_gset_from_clist:Nn \exp_not:N \c_@@_size_seq
          {
            \int_use:N \l_@@_first_row_int ,
            \int_use:N \c@iRow ,
            \int_use:N \g_@@_row_total_int ,
            \int_use:N \l_@@_first_col_int ,
            \int_use:N \c@jCol ,
            \int_use:N \g_@@_col_total_int
          }
        \iow_newline:
      }
```

We write also the potential content of `\g_@@_pos_of_blocks_seq` (it will be useful if the command `\rowcolors` is used with the key `respect-blocks`).

```
    \seq_if_empty:NF \g_@@_pos_of_blocks_seq
      {
        \tl_gput_right:Nx \g_@@_aux_tl
          {
            \seq_gset_from_clist:Nn \exp_not:N \g_@@_pos_of_blocks_seq
              { \seq_use:Nnnn \g_@@_pos_of_blocks_seq , , , }
            \iow_newline:
          }
      }
    \seq_if_empty:NF \g_@@_multicolumn_cells_seq
      {
```

```
        \tl_gput_right:Nx \g_@@_aux_tl
          {
            \seq_gset_from_clist:Nn \exp_not:N \g_@@_multicolumn_cells_seq
              { \seq_use:Nnnn \g_@@_multicolumn_cells_seq , , , }
            \iow_newline:
            \seq_gset_from_clist:Nn \exp_not:N \g_@@_multicolumn_sizes_seq
              { \seq_use:Nnnn \g_@@_multicolumn_sizes_seq , , , }
            \iow_newline:
          }
      }
```

Now, you create the diagonal nodes by using the `row` nodes and the `col` nodes.

```
    \@@_create_diag_nodes:
```

By default, the diagonal lines will be parallelized[60]. There are two types of diagonals lines: the `\Ddots` diagonals and the `\Iddots` diagonals. We have to count both types in order to know whether a diagonal is the first of its type in the current `{NiceArray}` environment.

```
    \bool_if:NT \l_@@_parallelize_diags_bool
      {
        \int_gzero_new:N \g_@@_ddots_int
        \int_gzero_new:N \g_@@_iddots_int
```

The dimensions `\g_@@_delta_x_one_dim` and `\g_@@_delta_y_one_dim` will contain the Δ_x and Δ_y of the first `\Ddots` diagonal. We have to store these values in order to draw the others `\Ddots` diagonals parallel to the first one. Similarly `\g_@@_delta_x_two_dim` and `\g_@@_delta_y_two_dim` are the Δ_x and Δ_y of the first `\Iddots` diagonal.

```
        \dim_gzero_new:N \g_@@_delta_x_one_dim
        \dim_gzero_new:N \g_@@_delta_y_one_dim
        \dim_gzero_new:N \g_@@_delta_x_two_dim
        \dim_gzero_new:N \g_@@_delta_y_two_dim
      }
    \int_zero_new:N \l_@@_initial_i_int
    \int_zero_new:N \l_@@_initial_j_int
    \int_zero_new:N \l_@@_final_i_int
    \int_zero_new:N \l_@@_final_j_int
    \bool_set_false:N \l_@@_initial_open_bool
    \bool_set_false:N \l_@@_final_open_bool
```

If the option `small` is used, the values `\l_@@_radius_dim` and `\l_@@_inter_dots_dim` (used to draw the dotted lines created by `\hdottedline` and `\vdotteline` and also for all the other dotted lines when `line-style` is equal to `standard`, which is the initial value) are changed.

```
    \bool_if:NT \l_@@_small_bool
      {
        \dim_set:Nn \l_@@_radius_dim { 0.37 pt }
        \dim_set:Nn \l_@@_inter_dots_dim { 0.25 em }
```

The dimension `\l_@@_xdots_shorten_dim` corresponds to the option `xdots/shorten` available to the user. That's why we give a new value according to the current value, and not an absolute value.

```
        \dim_set:Nn \l_@@_xdots_shorten_dim { 0.6 \l_@@_xdots_shorten_dim }
      }
```

Now, we actually draw the dotted lines (specified by `\Cdots`, `\Vdots`, etc.).

```
    \@@_draw_dotted_lines:
```

The following computes the "corners" (made up of empty cells) but if there is no corner to compute, it won't do anything. The corners are computed in `\l_@@_corners_cells_seq` which will contain all the cells which are empty (and not in a block) considered in the corners of the array.

```
    \@@_compute_corners:
```

The sequence `\g_@@_pos_of_blocks_seq` must be "adjusted" (for the case where the user have written something like `\Block{1-*}`).

[60] It's possible to use the option `parallelize-diags` to disable this parallelization.

```
\@@_adjust_pos_of_blocks_seq:
```

The following code is only for efficiency. We determine whether the potential horizontal and vertical rules are "complete", that is to say drawn in the whole array. We are sure that all the rules will be complete when there is no block, no virtual block (determined by a command such as `\Cdots`, `\Vdots`, etc.) and no corners. In that case, we switch to a shortcut version of `\@@_vline_i:nn` and `\@@_hline:nn`.

```
\bool_lazy_all:nT
  {
    { \seq_if_empty_p:N \g_@@_pos_of_blocks_seq }
    { \seq_if_empty_p:N \g_@@_pos_of_xdots_seq }
    { \seq_if_empty_p:N \l_@@_corners_cells_seq }
  }
  {
    \cs_set_eq:NN \@@_vline_i:nn \@@_vline_i_complete:nn
    \cs_set_eq:NN \@@_hline_i:nn \@@_hline_i_complete:nn
  }
\tl_if_empty:NF \l_@@_hlines_clist \@@_draw_hlines:
\tl_if_empty:NF \l_@@_vlines_clist \@@_draw_vlines:
\cs_set_eq:NN \SubMatrix \@@_SubMatrix
```

Now, the internal `code-after` and then, the `\CodeAfter`.

```
\bool_if:NT \c_@@_tikz_loaded_bool
  {
    \tikzset
      {
        every~picture / .style =
          {
            overlay ,
            remember~picture ,
            name~prefix = \@@_env: -
          }
      }
  }
\cs_set_eq:NN \line \@@_line
\g_@@_internal_code_after_tl
\tl_gclear:N \g_@@_internal_code_after_tl
```

When `light-syntax` is used, we insert systematically a `\CodeAfter` in the flow. Thus, it's possible to have two instructions `\CodeAfter` and the second may be in `\g_nicematrix_code_after_tl`. That's why we set `\Code-after` to be *no-op* now.

```
\cs_set_eq:NN \CodeAfter \prg_do_nothing:
```

We clear the list of the names of the potential `\SubMatrix` that will appear in the `\CodeAfter` (unfortunately, that list has to be global).

```
\seq_gclear:N \g_@@_submatrix_names_seq
```

We compose the `code-after` in math mode in order to nullify the spaces put by the user between instructions in the `code-after`.

```
% \bool_if:NT \l_@@_NiceTabular_bool \c_math_toggle_token
```

And here's the `\CodeAfter`. Since the `\CodeAfter` may begin with an "argument" between square brackets of the options, we extract and treat that potential "argument" with the command `\@@_CodeAfter_keys:`.

```
\exp_last_unbraced:NV \@@_CodeAfter_keys: \g_nicematrix_code_after_tl
\scan_stop:
% \bool_if:NT \l_@@_NiceTabular_bool \c_math_toggle_token
\tl_gclear:N \g_nicematrix_code_after_tl
\group_end:
```

`\g_nicematrix_code_before_tl` is for instructions in the cells of the array such as `\rowcolor` and `\cellcolor` (when the key `colortbl-like` is in force). These instructions will be written on the `aux` file to be added to the `code-before` in the next run.

```
    \tl_if_empty:NF \g_nicematrix_code_before_tl
      {
```

The command \rowcolor in tabular will in fact use \rectanglecolor in order to follow the behaviour of \rowcolor of colortbl. That's why there may be a command \rectanglecolor in \g_nicematrix_code_before_tl. In order to avoid an error during the expansion, we define a protected version of \rectanglecolor.

```
        \cs_set_protected:Npn \rectanglecolor { }
        \cs_set_protected:Npn \columncolor { }
        \tl_gput_right:Nx \g_@@_aux_tl
          {
            \tl_gset:Nn \exp_not:N \g_@@_code_before_tl
              { \exp_not:V \g_nicematrix_code_before_tl }
            \iow_newline:
          }
        \bool_set_true:N \l_@@_code_before_bool
      }
    % \bool_if:NT \l_@@_code_before_bool \@@_write_aux_for_cell_nodes:

    \str_gclear:N \g_@@_name_env_str
    \@@_restore_iRow_jCol:
```

The command \CT@arc@ contains the instruction of color for the rules of the array[61]. This command is used by \CT@arc@ but we use it also for compatibility with colortbl. But we want also to be able to use color for the rules of the array when colortbl is *not* loaded. That's why we do the following instruction which is in the patch of the end of arrays done by colortbl.

```
    \cs_gset_eq:NN \CT@arc@ \@@_old_CT@arc@
  }
```

The following command will extract the potential options (between square brackets) at the beginning of the \CodeAfter (that is to say, when \CodeAfter is used, the options of that "command" \CodeAfter). Idem for the \CodeBefore.

```
\NewDocumentCommand \@@_CodeAfter_keys: { O { } }
  { \keys_set:nn { NiceMatrix / CodeAfter } { #1 } }
```

We remind that the first mandatory argument of the command \Block is the size of the block with the special format i-j. However, the user is allowed to omit i or j (or both). This will be interpreted as: the last row (resp. column) of the block will be the last row (resp. column) of the block (without the potential exterior row—resp. column—of the array). By convention, this is stored in \g_@@_pos_of_blocks_seq (and \g_@@_blocks_seq) as a number of rows (resp. columns) for the block equal to 100. It's possible, after the construction of the array, to replace these values by the correct ones (since we know the number of rows and columns of the array).

```
\cs_new_protected:Npn \@@_adjust_pos_of_blocks_seq:
  {
    \seq_gset_map_x:NNn \g_@@_pos_of_blocks_seq \g_@@_pos_of_blocks_seq
      { \@@_adjust_pos_of_blocks_seq_i:nnnn ##1 }
  }
```

The following command must *not* be protected.

```
\cs_new:Npn \@@_adjust_pos_of_blocks_seq_i:nnnn #1 #2 #3 #4
  {
    { #1 }
    { #2 }
    {
      \int_compare:nNnTF { #3 } > { 99 }
        { \int_use:N \c@iRow }
        { #3 }
    }
    {
      \int_compare:nNnTF { #4 } > { 99 }
```

[61] e.g. \color[rgb]{0.5,0.5,0}

```
        { \int_use:N \c@jCol }
        { #4 }
    }
  }
```

We recall that, when externalization is used, `\tikzpicture` and `\endtikzpicture` (or `\pgfpicture` and `\endpgfpicture`) must be directly "visible". That's why we have to define the adequate version of `\@@_draw_dotted_lines:` whether Tikz is loaded or not (in that case, only PGF is loaded).

```
\AtBeginDocument
  {
    \cs_new_protected:Npx \@@_draw_dotted_lines:
      {
        \c_@@_pgfortikzpicture_tl
        \@@_draw_dotted_lines_i:
        \c_@@_endpgfortikzpicture_tl
      }
  }
```

The following command *must* be protected because it will appear in the construction of the command `\@@_draw_dotted_lines:`.

```
\cs_new_protected:Npn \@@_draw_dotted_lines_i:
  {
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \g_@@_HVdotsfor_lines_tl
    \g_@@_Vdots_lines_tl
    \g_@@_Ddots_lines_tl
    \g_@@_Iddots_lines_tl
    \g_@@_Cdots_lines_tl
    \g_@@_Ldots_lines_tl
  }

\cs_new_protected:Npn \@@_restore_iRow_jCol:
  {
    \cs_if_exist:NT \theiRow { \int_gset_eq:NN \c@iRow \l_@@_old_iRow_int }
    \cs_if_exist:NT \thejCol { \int_gset_eq:NN \c@jCol \l_@@_old_jCol_int }
  }
```

We define a new PGF shape for the diag nodes because we want to provide a anchor called `.5` for those nodes.

```
\pgfdeclareshape { @@_diag_node }
  {
    \savedanchor { \five }
      {
        \dim_gset_eq:NN \pgf@x \l_tmpa_dim
        \dim_gset_eq:NN \pgf@y \l_tmpb_dim
      }
    \anchor { 5 } { \five }
    \anchor { center } { \pgfpointorigin }
  }

\cs_new_protected:Npn \@@_write_aux_for_cell_nodes:
  {
    \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
      {
        \int_step_inline:nnn \l_@@_first_col_int \g_@@_col_total_int
          {
            \cs_if_exist:cT { pgf @ sh @ ns @ \@@_env: - ##1 - ####1 }
              {
```

```
                \pgfscope
                \pgftransformshift
                  { \pgfpointanchor { \@@_env: - ##1 - ####1 } { north~west } }
                \pgfnode
                  { rectangle }
                  { center }
                  {
                    \hbox
                      { \pgfsys@markposition { \@@_env: - ##1 - ####1 - NW } }
                  }
                  { }
                  { }
                \endpgfscope
                \pgfscope
                \pgftransformshift
                  { \pgfpointanchor { \@@_env: - ##1 - ####1 } { south~east } }
                \pgfnode
                  { rectangle }
                  { center }
                  {
                    \hbox
                      { \pgfsys@markposition { \@@_env: - ##1 - ####1 - SE } }
                  }
                  { }
                  { }
                \endpgfscope
              }
          }
      }
    \endpgfpicture
    \@@_create_extra_nodes:
  }
%   \end{macrocode}
%
% \bigskip
% The following command creates the diagonal nodes (in fact, if the matrix is
% not a square matrix, not all the nodes are on the diagonal).
%    \begin{macrocode}
\cs_new_protected:Npn \@@_create_diag_nodes:
  {
    \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \int_step_inline:nn { \int_max:nn \c@iRow \c@jCol }
      {
        \@@_qpoint:n { col - \int_min:nn { ##1 } { \c@jCol + 1 } }
        \dim_set_eq:NN \l_tmpa_dim \pgf@x
        \@@_qpoint:n { row - \int_min:nn { ##1 } { \c@iRow + 1 } }
        \dim_set_eq:NN \l_tmpb_dim \pgf@y
        \@@_qpoint:n { col - \int_min:nn { ##1 + 1 } { \c@jCol + 1 } }
        \dim_set_eq:NN \l_tmpc_dim \pgf@x
        \@@_qpoint:n { row - \int_min:nn { ##1 + 1 } { \c@iRow + 1 } }
        \dim_set_eq:NN \l_tmpd_dim \pgf@y
        \pgftransformshift { \pgfpoint \l_tmpa_dim \l_tmpb_dim }
```

Now, `\l_tmpa_dim` and `\l_tmpb_dim` become the width and the height of the node (of shape `@à_diag_node`) that we will construct.

```
        \dim_set:Nn \l_tmpa_dim { ( \l_tmpc_dim - \l_tmpa_dim ) / 2 }
        \dim_set:Nn \l_tmpb_dim { ( \l_tmpd_dim - \l_tmpb_dim ) / 2 }
        \pgfnode { @@_diag_node } { center } { } { \@@_env: - ##1 } { }
        \str_if_empty:NF \l_@@_name_str
          { \pgfnodealias { \l_@@_name_str - ##1 } { \@@_env: - ##1 } }
      }
```

Now, the last node. Of course, that is only a `coordinate` because there is not `.5` anchor for that node.

```
    \int_set:Nn \l_tmpa_int { \int_max:nn \c@iRow \c@jCol + 1 }
    \@@_qpoint:n { row - \int_min:nn { \l_tmpa_int } { \c@iRow + 1 } }
    \dim_set_eq:NN \l_tmpa_dim \pgf@y
    \@@_qpoint:n { col - \int_min:nn { \l_tmpa_int } { \c@jCol + 1 } }
    \pgfcoordinate
      { \@@_env: - \int_use:N \l_tmpa_int } { \pgfpoint \pgf@x \l_tmpa_dim }
    \pgfnodealias
      { \@@_env: - last }
      { \@@_env: - \int_eval:n { \int_max:nn \c@iRow \c@jCol + 1 } }
    \str_if_empty:NF \l_@@_name_str
      {
        \pgfnodealias
          { \l_@@_name_str - \int_use:N \l_tmpa_int }
          { \@@_env: - \int_use:N \l_tmpa_int }
        \pgfnodealias
          { \l_@@_name_str - last }
          { \@@_env: - last }
      }
    \endpgfpicture
  }
```

We draw the dotted lines

A dotted line will be said *open* in one of its extremities when it stops on the edge of the matrix and *closed* otherwise. In the following matrix, the dotted line is closed on its left extremity and open on its right.

$$\begin{pmatrix} a+b+c & a+b & a \\ a & \cdots\cdots\cdots\cdots\cdots & \\ a & a+b & a+b+c \end{pmatrix}$$

The command `\@@_find_extremities_of_line:nnnn` takes four arguments:

- the first argument is the row of the cell where the command was issued;
- the second argument is the column of the cell where the command was issued;
- the third argument is the x-value of the orientation vector of the line;
- the fourth argument is the y-value of the orientation vector of the line.

This command computes:

- `\l_@@_initial_i_int` and `\l_@@_initial_j_int` which are the coordinates of one extremity of the line;
- `\l_@@_final_i_int` and `\l_@@_final_j_int` which are the coordinates of the other extremity of the line;
- `\l_@@_initial_open_bool` and `\l_@@_final_open_bool` to indicate whether the extremities are open or not.

```
\cs_new_protected:Npn \@@_find_extremities_of_line:nnnn #1 #2 #3 #4
  {
```

First, we declare the current cell as "dotted" because we forbide intersections of dotted lines.

```
    \cs_set:cpn { @@ _ dotted _ #1 - #2 } { }
```

Initialization of variables.

```
    \int_set:Nn \l_@@_initial_i_int { #1 }
    \int_set:Nn \l_@@_initial_j_int { #2 }
    \int_set:Nn \l_@@_final_i_int { #1 }
    \int_set:Nn \l_@@_final_j_int { #2 }
```

We will do two loops: one when determinating the initial cell and the other when determinating the final cell. The boolean `\l_@@_stop_loop_bool` will be used to control these loops. In the first loop, we search the "final" extremity of the line.

```
\bool_set_false:N \l_@@_stop_loop_bool
\bool_do_until:Nn \l_@@_stop_loop_bool
  {
    \int_add:Nn \l_@@_final_i_int { #3 }
    \int_add:Nn \l_@@_final_j_int { #4 }
```

We test if we are still in the matrix.

```
    \bool_set_false:N \l_@@_final_open_bool
    \int_compare:nNnTF \l_@@_final_i_int > \l_@@_row_max_int
      {
        \int_compare:nNnTF { #3 } = 1
          { \bool_set_true:N \l_@@_final_open_bool }
          {
            \int_compare:nNnT \l_@@_final_j_int > \l_@@_col_max_int
              { \bool_set_true:N \l_@@_final_open_bool }
          }
      }
      {
        \int_compare:nNnTF \l_@@_final_j_int < \l_@@_col_min_int
          {
            \int_compare:nNnT { #4 } = { -1 }
              { \bool_set_true:N \l_@@_final_open_bool }
          }
          {
            \int_compare:nNnT \l_@@_final_j_int > \l_@@_col_max_int
              {
                \int_compare:nNnT { #4 } = 1
                  { \bool_set_true:N \l_@@_final_open_bool }
              }
          }
      }
    \bool_if:NTF \l_@@_final_open_bool
```

If we are outside the matrix, we have found the extremity of the dotted line and it's an *open* extremity.

```
      {
```

We do a step backwards.

```
        \int_sub:Nn \l_@@_final_i_int { #3 }
        \int_sub:Nn \l_@@_final_j_int { #4 }
        \bool_set_true:N \l_@@_stop_loop_bool
      }
```

If we are in the matrix, we test whether the cell is empty. If it's not the case, we stop the loop because we have found the correct values for `\l_@@_final_i_int` and `\l_@@_final_j_int`.

```
      {
        \cs_if_exist:cTF
          {
            @@ _ dotted _
            \int_use:N \l_@@_final_i_int -
            \int_use:N \l_@@_final_j_int
          }
          {
            \int_sub:Nn \l_@@_final_i_int { #3 }
            \int_sub:Nn \l_@@_final_j_int { #4 }
            \bool_set_true:N \l_@@_final_open_bool
            \bool_set_true:N \l_@@_stop_loop_bool
          }
          {
            \cs_if_exist:cTF
              {
                pgf @ sh @ ns @ \@@_env:
                - \int_use:N \l_@@_final_i_int
```

```
                - \int_use:N \l_@@_final_j_int
              }
              { \bool_set_true:N \l_@@_stop_loop_bool }
```

If the case is empty, we declare that the cell as non-empty. Indeed, we will draw a dotted line and the cell will be on that dotted line. All the cells of a dotted line have to be marked as "dotted" because we don't want intersections between dotted lines. We recall that the research of the extremities of the lines are all done in the same TeX group (the group of the environment), even though, when the extremities are found, each line is drawn in a TeX group that we will open for the options of the line.

```
              {
                \cs_set:cpn
                  {
                    @@ _ dotted _
                    \int_use:N \l_@@_final_i_int -
                    \int_use:N \l_@@_final_j_int
                  }
                  { }
              }
          }
      }
  }
```

For `\l_@@_initial_i_int` and `\l_@@_initial_j_int` the programmation is similar to the previous one.

```
\bool_set_false:N \l_@@_stop_loop_bool
\bool_do_until:Nn \l_@@_stop_loop_bool
  {
    \int_sub:Nn \l_@@_initial_i_int { #3 }
    \int_sub:Nn \l_@@_initial_j_int { #4 }
    \bool_set_false:N \l_@@_initial_open_bool
    \int_compare:nNnTF \l_@@_initial_i_int < \l_@@_row_min_int
      {
        \int_compare:nNnTF { #3 } = 1
          { \bool_set_true:N \l_@@_initial_open_bool }
          {
            \int_compare:nNnT \l_@@_initial_j_int = { \l_@@_col_min_int -1 }
              { \bool_set_true:N \l_@@_initial_open_bool }
          }
      }
      {
        \int_compare:nNnTF \l_@@_initial_j_int < \l_@@_col_min_int
          {
            \int_compare:nNnT { #4 } = 1
              { \bool_set_true:N \l_@@_initial_open_bool }
          }
          {
            \int_compare:nNnT \l_@@_initial_j_int > \l_@@_col_max_int
              {
                \int_compare:nNnT { #4 } = { -1 }
                  { \bool_set_true:N \l_@@_initial_open_bool }
              }
          }
      }
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \int_add:Nn \l_@@_initial_i_int { #3 }
        \int_add:Nn \l_@@_initial_j_int { #4 }
        \bool_set_true:N \l_@@_stop_loop_bool
      }
      {
        \cs_if_exist:cTF
          {
```

```
                @@ _ dotted _
                \int_use:N \l_@@_initial_i_int -
                \int_use:N \l_@@_initial_j_int
              }
              {
                \int_add:Nn \l_@@_initial_i_int { #3 }
                \int_add:Nn \l_@@_initial_j_int { #4 }
                \bool_set_true:N \l_@@_initial_open_bool
                \bool_set_true:N \l_@@_stop_loop_bool
              }
              {
                \cs_if_exist:cTF
                  {
                    pgf @ sh @ ns @ \@@_env:
                    - \int_use:N \l_@@_initial_i_int
                    - \int_use:N \l_@@_initial_j_int
                  }
                  { \bool_set_true:N \l_@@_stop_loop_bool }
                  {
                    \cs_set:cpn
                      {
                        @@ _ dotted _
                        \int_use:N \l_@@_initial_i_int -
                        \int_use:N \l_@@_initial_j_int
                      }
                      { }
                  }
              }
          }
      }
```

We remind the rectangle described by all the dotted lines in order to respect the corresponding virtual "block" when drawing the horizontal and vertical rules.

```
    \seq_gput_right:Nx \g_@@_pos_of_xdots_seq
      {
        { \int_use:N \l_@@_initial_i_int }
        { \int_use:N \l_@@_initial_j_int }
        { \int_use:N \l_@@_final_i_int }
        { \int_use:N \l_@@_final_j_int }
      }
  }
```

The following commmand (*when it will be written*) will set the four counters `\l_@@_row_min_int`, `\l_@@_row_max_int`, `\l_@@_col_min_int` and `\l_@@_col_max_int` to the intersections of the submatrices which contains the cell of row `#1` and column `#2`. As of now, it's only the whole array (excepted exterior rows and columns).

```
\cs_new_protected:Npn \@@_adjust_to_submatrix:nn #1 #2
  {
    \int_set:Nn \l_@@_row_min_int 1
    \int_set:Nn \l_@@_col_min_int 1
    \int_set_eq:NN \l_@@_row_max_int \c@iRow
    \int_set_eq:NN \l_@@_col_max_int \c@jCol
```

We do a loop over all the submatrices specified in the `code-before`. We have stored the position of all those submatrices in `\g_@@_submatrix_seq`.

```
    \seq_map_inline:Nn \g_@@_submatrix_seq
      { \@@_adjust_to_submatrix:nnnnnn { #1 } { #2 } ##1 }
  }
```

`#1` and `#2` are the numbers of row and columns of the cell where the command of dotted line (ex.: `\Vdots`) has been issued. `#3`, `#4`, `#5` and `#6` are the specification (in i and j) of the submatrix where are analysing.

```
\cs_set_protected:Npn \@@_adjust_to_submatrix:nnnnnn #1 #2 #3 #4 #5 #6
```

```
  {
    \bool_if:nT
      {
           \int_compare_p:n { #3 <= #1 }
        && \int_compare_p:n { #1 <= #5 }
        && \int_compare_p:n { #4 <= #2 }
        && \int_compare_p:n { #2 <= #6 }
      }
      {
        \int_set:Nn \l_@@_row_min_int { \int_max:nn \l_@@_row_min_int { #3 } }
        \int_set:Nn \l_@@_col_min_int { \int_max:nn \l_@@_col_min_int { #4 } }
        \int_set:Nn \l_@@_row_max_int { \int_min:nn \l_@@_row_max_int { #5 } }
        \int_set:Nn \l_@@_col_max_int { \int_min:nn \l_@@_col_max_int { #6 } }
      }
  }

\cs_new_protected:Npn \@@_set_initial_coords:
  {
    \dim_set_eq:NN \l_@@_x_initial_dim \pgf@x
    \dim_set_eq:NN \l_@@_y_initial_dim \pgf@y
  }
\cs_new_protected:Npn \@@_set_final_coords:
  {
    \dim_set_eq:NN \l_@@_x_final_dim \pgf@x
    \dim_set_eq:NN \l_@@_y_final_dim \pgf@y
  }
\cs_new_protected:Npn \@@_set_initial_coords_from_anchor:n #1
  {
    \pgfpointanchor
      {
        \@@_env:
        - \int_use:N \l_@@_initial_i_int
        - \int_use:N \l_@@_initial_j_int
      }
      { #1 }
    \@@_set_initial_coords:
  }
\cs_new_protected:Npn \@@_set_final_coords_from_anchor:n #1
  {
    \pgfpointanchor
      {
        \@@_env:
        - \int_use:N \l_@@_final_i_int
        - \int_use:N \l_@@_final_j_int
      }
      { #1 }
    \@@_set_final_coords:
  }
\cs_new_protected:Npn \@@_open_x_initial_dim:
  {
    \dim_set_eq:NN \l_@@_x_initial_dim \c_max_dim
    \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - ##1 - \int_use:N \l_@@_initial_j_int }
          {
            \pgfpointanchor
              { \@@_env: - ##1 - \int_use:N \l_@@_initial_j_int }
              { west }
            \dim_set:Nn \l_@@_x_initial_dim
              { \dim_min:nn \l_@@_x_initial_dim \pgf@x }
          }
      }
```

If, in fact, all the cells of the columns are empty (no PGF/Tikz nodes in those cells).

```
    \dim_compare:nNnT \l_@@_x_initial_dim = \c_max_dim
      {
        \@@_qpoint:n { col - \int_use:N \l_@@_initial_j_int }
        \dim_set_eq:NN \l_@@_x_initial_dim \pgf@x
        \dim_add:Nn \l_@@_x_initial_dim \col@sep
      }
  }
\cs_new_protected:Npn \@@_open_x_final_dim:
  {
    \dim_set:Nn \l_@@_x_final_dim { - \c_max_dim }
    \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - ##1 - \int_use:N \l_@@_final_j_int }
          {
            \pgfpointanchor
              { \@@_env: - ##1 - \int_use:N \l_@@_final_j_int }
              { east }
            \dim_set:Nn \l_@@_x_final_dim
              { \dim_max:nn \l_@@_x_final_dim \pgf@x }
          }
      }
```

If, in fact, all the cells of the columns are empty (no PGF/Tikz nodes in those cells).

```
    \dim_compare:nNnT \l_@@_x_final_dim = { - \c_max_dim }
      {
        \@@_qpoint:n { col - \@@_succ:n \l_@@_final_j_int }
        \dim_set_eq:NN \l_@@_x_final_dim \pgf@x
        \dim_sub:Nn \l_@@_x_final_dim \col@sep
      }
  }
```

The first and the second arguments are the coordinates of the cell where the command has been issued. The third argument is the list of the options.

```
\cs_new_protected:Npn \@@_draw_Ldots:nnn #1 #2 #3
  {
    \@@_adjust_to_submatrix:nn { #1 } { #2 }
    \cs_if_free:cT { @@ _ dotted _ #1 - #2 }
      {
        \@@_find_extremities_of_line:nnnn { #1 } { #2 } 0 1
```

The previous command may have changed the current environment by marking some cells as “dotted”, but, fortunately, it is outside the group for the options of the line.

```
        \group_begin:
          \int_compare:nNnTF { #1 } = 0
            { \color { nicematrix-first-row } }
            {
```

We remind that, when there is a “last row” `\l_@@_last_row_int` will always be (after the construction of the array) the number of that “last row” even if the option `last-row` has been used without value.

```
              \int_compare:nNnT { #1 } = \l_@@_last_row_int
                { \color { nicematrix-last-row } }
            }
          \keys_set:nn { NiceMatrix / xdots } { #3 }
          \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
          \@@_actually_draw_Ldots:
        \group_end:
      }
  }
```

The command `\@@_actually_draw_Ldots:` has the following implicit arguments:

- \l_@@_initial_i_int
- \l_@@_initial_j_int
- \l_@@_initial_open_bool
- \l_@@_final_i_int
- \l_@@_final_j_int
- \l_@@_final_open_bool.

The following function is also used by \Hdotsfor.

```
\cs_new_protected:Npn \@@_actually_draw_Ldots:
  {
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \@@_open_x_initial_dim:
        \@@_qpoint:n { row - \int_use:N \l_@@_initial_i_int - base }
        \dim_set_eq:NN \l_@@_y_initial_dim \pgf@y
      }
      { \@@_set_initial_coords_from_anchor:n { base~east } }
    \bool_if:NTF \l_@@_final_open_bool
      {
        \@@_open_x_final_dim:
        \@@_qpoint:n { row - \int_use:N \l_@@_final_i_int - base }
        \dim_set_eq:NN \l_@@_y_final_dim \pgf@y
      }
      { \@@_set_final_coords_from_anchor:n { base~west } }
```

We raise the line of a quantity equal to the radius of the dots because we want the dots really "on" the line of texte. Of course, maybe we should not do that when the option line-style is used (?).

```
    \dim_add:Nn \l_@@_y_initial_dim \l_@@_radius_dim
    \dim_add:Nn \l_@@_y_final_dim \l_@@_radius_dim
    \@@_draw_line:
  }
```

The first and the second arguments are the coordinates of the cell where the command has been issued. The third argument is the list of the options.

```
\cs_new_protected:Npn \@@_draw_Cdots:nnn #1 #2 #3
  {
    \@@_adjust_to_submatrix:nn { #1 } { #2 }
    \cs_if_free:cT { @@ _ dotted _ #1 - #2 }
      {
        \@@_find_extremities_of_line:nnnn { #1 } { #2 } 0 1
```

The previous command may have changed the current environment by marking some cells as "dotted", but, fortunately, it is outside the group for the options of the line.

```
        \group_begin:
          \int_compare:nNnTF { #1 } = 0
            { \color { nicematrix-first-row } }
            {
```

We remind that, when there is a "last row" \l_@@_last_row_int will always be (after the construction of the array) the number of that "last row" even if the option last-row has been used without value.

```
              \int_compare:nNnT { #1 } = \l_@@_last_row_int
                { \color { nicematrix-last-row } }
            }
          \keys_set:nn { NiceMatrix / xdots } { #3 }
          \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
          \@@_actually_draw_Cdots:
        \group_end:
      }
  }
```

The command `\@@_actually_draw_Cdots:` has the following implicit arguments:

- `\l_@@_initial_i_int`
- `\l_@@_initial_j_int`
- `\l_@@_initial_open_bool`
- `\l_@@_final_i_int`
- `\l_@@_final_j_int`
- `\l_@@_final_open_bool`.

```
\cs_new_protected:Npn \@@_actually_draw_Cdots:
  {
    \bool_if:NTF \l_@@_initial_open_bool
      { \@@_open_x_initial_dim: }
      { \@@_set_initial_coords_from_anchor:n { mid~east } }
    \bool_if:NTF \l_@@_final_open_bool
      { \@@_open_x_final_dim: }
      { \@@_set_final_coords_from_anchor:n { mid~west } }
    \bool_lazy_and:nnTF
      \l_@@_initial_open_bool
      \l_@@_final_open_bool
      {
        \@@_qpoint:n { row - \int_use:N \l_@@_initial_i_int }
        \dim_set_eq:NN \l_tmpa_dim \pgf@y
        \@@_qpoint:n { row - \@@_succ:n \l_@@_initial_i_int }
        \dim_set:Nn \l_@@_y_initial_dim { ( \l_tmpa_dim + \pgf@y ) / 2 }
        \dim_set_eq:NN \l_@@_y_final_dim \l_@@_y_initial_dim
      }
      {
        \bool_if:NT \l_@@_initial_open_bool
          { \dim_set_eq:NN \l_@@_y_initial_dim \l_@@_y_final_dim }
        \bool_if:NT \l_@@_final_open_bool
          { \dim_set_eq:NN \l_@@_y_final_dim \l_@@_y_initial_dim }
      }
    \@@_draw_line:
  }
\cs_new_protected:Npn \@@_open_y_initial_dim:
  {
    \@@_qpoint:n { row - \int_use:N \l_@@_initial_i_int - base }
    \dim_set:Nn \l_@@_y_initial_dim
      { \pgf@y + ( \box_ht:N \strutbox + \extrarowheight ) * \arraystretch }
    \int_step_inline:nnn \l_@@_first_col_int \g_@@_col_total_int
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - \int_use:N \l_@@_initial_i_int - ##1 }
          {
            \pgfpointanchor
              { \@@_env: - \int_use:N \l_@@_initial_i_int - ##1 }
              { north }
            \dim_set:Nn \l_@@_y_initial_dim
              { \dim_max:nn \l_@@_y_initial_dim \pgf@y }
          }
      }
  }
\cs_new_protected:Npn \@@_open_y_final_dim:
  {
    \@@_qpoint:n { row - \int_use:N \l_@@_final_i_int - base }
    \dim_set:Nn \l_@@_y_final_dim
      { \pgf@y - ( \box_dp:N \strutbox ) * \arraystretch }
    \int_step_inline:nnn \l_@@_first_col_int \g_@@_col_total_int
```

```
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - \int_use:N \l_@@_final_i_int - ##1 }
          {
            \pgfpointanchor
              { \@@_env: - \int_use:N \l_@@_final_i_int - ##1 }
              { south }
            \dim_set:Nn \l_@@_y_final_dim
              { \dim_min:nn \l_@@_y_final_dim \pgf@y }
          }
      }
  }
```

The first and the second arguments are the coordinates of the cell where the command has been issued. The third argument is the list of the options.

```
\cs_new_protected:Npn \@@_draw_Vdots:nnn #1 #2 #3
  {
    \@@_adjust_to_submatrix:nn { #1 } { #2 }
    \cs_if_free:cT { @@ _ dotted _ #1 - #2 }
      {
        \@@_find_extremities_of_line:nnnn { #1 } { #2 } 1 0
```

The previous command may have changed the current environment by marking some cells as "dotted", but, fortunately, it is outside the group for the options of the line.

```
        \group_begin:
          \int_compare:nNnTF { #2 } = 0
            { \color { nicematrix-first-col } }
            {
              \int_compare:nNnT { #2 } = \l_@@_last_col_int
                { \color { nicematrix-last-col } }
            }
          \keys_set:nn { NiceMatrix / xdots } { #3 }
          \tl_if_empty:VF \l_@@_xdots_color_tl
            { \color { \l_@@_xdots_color_tl } }
          \@@_actually_draw_Vdots:
        \group_end:
      }
  }
```

The command `\@@_actually_draw_Vdots:` has the following implicit arguments:

- `\l_@@_initial_i_int`
- `\l_@@_initial_j_int`
- `\l_@@_initial_open_bool`
- `\l_@@_final_i_int`
- `\l_@@_final_j_int`
- `\l_@@_final_open_bool`.

The following function is also used by `\Vdotsfor`.

```
\cs_new_protected:Npn \@@_actually_draw_Vdots:
  {
```

The boolean `\l_tmpa_bool` indicates whether the column is of type `l` or may be considered as if.

```
    \bool_set_false:N \l_tmpa_bool
```

First the case when the line is closed on both ends.

```
    \bool_lazy_or:nnF \l_@@_initial_open_bool \l_@@_final_open_bool
      {
        \@@_set_initial_coords_from_anchor:n { south~west }
        \@@_set_final_coords_from_anchor:n { north~west }
        \bool_set:Nn \l_tmpa_bool
          { \dim_compare_p:nNn \l_@@_x_initial_dim = \l_@@_x_final_dim }
      }
```

Now, we try to determine whether the column is of type `c` or may be considered as if.

```
    \bool_if:NTF \l_@@_initial_open_bool
      \@@_open_y_initial_dim:
      { \@@_set_initial_coords_from_anchor:n { south } }
    \bool_if:NTF \l_@@_final_open_bool
      \@@_open_y_final_dim:
      { \@@_set_final_coords_from_anchor:n { north } }
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \bool_if:NTF \l_@@_final_open_bool
          {
            \@@_qpoint:n { col - \int_use:N \l_@@_initial_j_int }
            \dim_set_eq:NN \l_tmpa_dim \pgf@x
            \@@_qpoint:n { col - \@@_succ:n \l_@@_initial_j_int }
            \dim_set:Nn \l_@@_x_initial_dim { ( \pgf@x + \l_tmpa_dim ) / 2 }
            \dim_set_eq:NN \l_@@_x_final_dim \l_@@_x_initial_dim
```

We may think that the final user won't use a "last column" which contains only a command `\Vdots`. However, if the `\Vdots` is in fact used to draw, not a dotted line, but an arrow (to indicate the number of rows of the matrix), it may be really encountered.

```
            \int_compare:nNnT \l_@@_last_col_int > { -2 }
              {
                \int_compare:nNnT \l_@@_initial_j_int = \g_@@_col_total_int
                  {
                    \dim_set_eq:NN \l_tmpa_dim \l_@@_right_margin_dim
                    \dim_add:Nn \l_tmpa_dim \l_@@_extra_right_margin_dim
                    \dim_add:Nn \l_@@_x_initial_dim \l_tmpa_dim
                    \dim_add:Nn \l_@@_x_final_dim \l_tmpa_dim
                  }
              }
          }
          { \dim_set_eq:NN \l_@@_x_initial_dim \l_@@_x_final_dim }
      }
      {
        \bool_if:NTF \l_@@_final_open_bool
          { \dim_set_eq:NN \l_@@_x_final_dim \l_@@_x_initial_dim }
          {
```

Now the case where both extremities are closed. The first conditional tests whether the column is of type `c` or may be considered as if.

```
            \dim_compare:nNnF \l_@@_x_initial_dim = \l_@@_x_final_dim
              {
                \dim_set:Nn \l_@@_x_initial_dim
                  {
                    \bool_if:NTF \l_tmpa_bool \dim_min:nn \dim_max:nn
                      \l_@@_x_initial_dim \l_@@_x_final_dim
                  }
                \dim_set_eq:NN \l_@@_x_final_dim \l_@@_x_initial_dim
              }
          }
      }
    \@@_draw_line:
  }
```

For the diagonal lines, the situation is a bit more complicated because, by default, we parallelize the diagonals lines. The first diagonal line is drawn and then, all the other diagonal lines are drawn parallel to the first one.
The first and the second arguments are the coordinates of the cell where the command has been issued. The third argument is the list of the options.

```
\cs_new_protected:Npn \@@_draw_Ddots:nnn #1 #2 #3
  {
    \@@_adjust_to_submatrix:nn { #1 } { #2 }
```

```
    \cs_if_free:cT { @@ _ dotted _ #1 - #2 }
      {
        \@@_find_extremities_of_line:nnnn { #1 } { #2 } 1 1
```

The previous command may have changed the current environment by marking some cells as "dotted", but, fortunately, it is outside the group for the options of the line.

```
        \group_begin:
          \keys_set:nn { NiceMatrix / xdots } { #3 }
          \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
          \@@_actually_draw_Ddots:
        \group_end:
      }
  }
```

The command `\@@_actually_draw_Ddots:` has the following implicit arguments:

- `\l_@@_initial_i_int`
- `\l_@@_initial_j_int`
- `\l_@@_initial_open_bool`
- `\l_@@_final_i_int`
- `\l_@@_final_j_int`
- `\l_@@_final_open_bool`.

```
\cs_new_protected:Npn \@@_actually_draw_Ddots:
  {
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \@@_open_y_initial_dim:
        % \@@_qpoint:n { col - \int_use:N \l_@@_initial_j_int }
        % \dim_set_eq:NN \l_@@_x_initial_dim \pgf@x
        \@@_open_x_initial_dim:
      }
      { \@@_set_initial_coords_from_anchor:n { south~east } }
    \bool_if:NTF \l_@@_final_open_bool
      {
        % \@@_open_y_final_dim:
        % \@@_qpoint:n { col - \@@_succ:n \l_@@_final_j_int }
        \@@_open_x_final_dim:
        \dim_set_eq:NN \l_@@_x_final_dim \pgf@x
      }
      { \@@_set_final_coords_from_anchor:n { north~west } }
```

We have retrieved the coordinates in the usual way (they are stored in `\l_@@_x_initial_dim`, etc.). If the parallelization of the diagonals is set, we will have (maybe) to adjust the fourth coordinate.

```
    \bool_if:NT \l_@@_parallelize_diags_bool
      {
        \int_gincr:N \g_@@_ddots_int
```

We test if the diagonal line is the first one (the counter `\g_@@_ddots_int` is created for this usage).

```
        \int_compare:nNnTF \g_@@_ddots_int = 1
```

If the diagonal line is the first one, we have no adjustment of the line to do but we store the Δ_x and the Δ_y of the line because these values will be used to draw the others diagonal lines parallels to the first one.

```
          {
            \dim_gset:Nn \g_@@_delta_x_one_dim
              { \l_@@_x_final_dim - \l_@@_x_initial_dim }
            \dim_gset:Nn \g_@@_delta_y_one_dim
              { \l_@@_y_final_dim - \l_@@_y_initial_dim }
          }
```

If the diagonal line is not the first one, we have to adjust the second extremity of the line by modifying the coordinate \l_@@_x_initial_dim.

```
          {
            \dim_set:Nn \l_@@_y_final_dim
              {
                \l_@@_y_initial_dim +
                ( \l_@@_x_final_dim - \l_@@_x_initial_dim ) *
                \dim_ratio:nn \g_@@_delta_y_one_dim \g_@@_delta_x_one_dim
              }
          }
      }
    \@@_draw_line:
  }
```

We draw the \Iddots diagonals in the same way.
The first and the second arguments are the coordinates of the cell where the command has been issued. The third argument is the list of the options.

```
\cs_new_protected:Npn \@@_draw_Iddots:nnn #1 #2 #3
  {
    \@@_adjust_to_submatrix:nn { #1 } { #2 }
    \cs_if_free:cT { @@ _ dotted _ #1 - #2 }
      {
        \@@_find_extremities_of_line:nnnn { #1 } { #2 } 1 { -1 }
```

The previous command may have changed the current environment by marking some cells as "dotted", but, fortunately, it is outside the group for the options of the line.

```
        \group_begin:
          \keys_set:nn { NiceMatrix / xdots } { #3 }
          \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
          \@@_actually_draw_Iddots:
        \group_end:
      }
  }
```

The command \@@_actually_draw_Iddots: has the following implicit arguments:

- \l_@@_initial_i_int
- \l_@@_initial_j_int
- \l_@@_initial_open_bool
- \l_@@_final_i_int
- \l_@@_final_j_int
- \l_@@_final_open_bool.

```
\cs_new_protected:Npn \@@_actually_draw_Iddots:
  {
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \@@_open_y_initial_dim:
        \@@_open_x_initial_dim:
      }
      { \@@_set_initial_coords_from_anchor:n { south~west } }
    \bool_if:NTF \l_@@_final_open_bool
      {
        \@@_open_y_final_dim:
        \@@_open_x_final_dim:
      }
      { \@@_set_final_coords_from_anchor:n { north~east } }
    \bool_if:NT \l_@@_parallelize_diags_bool
      {
```

```
        \int_gincr:N \g_@@_iddots_int
        \int_compare:nNnTF \g_@@_iddots_int = 1
          {
            \dim_gset:Nn \g_@@_delta_x_two_dim
              { \l_@@_x_final_dim - \l_@@_x_initial_dim }
            \dim_gset:Nn \g_@@_delta_y_two_dim
              { \l_@@_y_final_dim - \l_@@_y_initial_dim }
          }
          {
            \dim_set:Nn \l_@@_y_final_dim
              {
                \l_@@_y_initial_dim +
                ( \l_@@_x_final_dim - \l_@@_x_initial_dim ) *
                \dim_ratio:nn \g_@@_delta_y_two_dim \g_@@_delta_x_two_dim
              }
          }
      }
    \@@_draw_line:
  }
```

The actual instructions for drawing the dotted line with Tikz

The command `\@@_draw_line:` should be used in a `{pgfpicture}`. It has six implicit arguments:

- `\l_@@_x_initial_dim`
- `\l_@@_y_initial_dim`
- `\l_@@_x_final_dim`
- `\l_@@_y_final_dim`
- `\l_@@_initial_open_bool`
- `\l_@@_final_open_bool`

```
\cs_new_protected:Npn \@@_draw_line:
  {
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \tl_if_eq:NNTF \l_@@_xdots_line_style_tl \c_@@_standard_tl
      \@@_draw_standard_dotted_line:
      \@@_draw_non_standard_dotted_line:
  }
```

We have to do a special construction with `\exp_args:NV` to be able to put in the list of options in the correct place in the Tikz instruction.

```
\cs_new_protected:Npn \@@_draw_non_standard_dotted_line:
  {
    \begin { scope }
    \exp_args:No \@@_draw_non_standard_dotted_line:n
      { \l_@@_xdots_line_style_tl , \l_@@_xdots_color_tl }
  }
```

We have used the fact that, in PGF, un color name can be put directly in a list of options (that's why we have put diredtly `\l_@@_xdots_color_tl`).

The argument of `\@@_draw_non_standard_dotted_line:n` is, in fact, the list of options.

```
\cs_new_protected:Npn \@@_draw_non_standard_dotted_line:n #1
  {
    \@@_draw_non_standard_dotted_line:nVV
      { #1 }
      \l_@@_xdots_up_tl
      \l_@@_xdots_down_tl
  }
```

```
\cs_new_protected:Npn \@@_draw_non_standard_dotted_line:nnn #1 #2 #3
  {
    \draw
      [
        #1 ,
        shorten~> = \l_@@_xdots_shorten_dim ,
        shorten~< = \l_@@_xdots_shorten_dim ,
      ]
          ( \l_@@_x_initial_dim , \l_@@_y_initial_dim )
```

Be careful: We can't put `\c_math_toggle_token` instead of `$` in the following lines because we are in the contents of Tikz nodes (and they will be *rescanned* if the Tikz library babel is loaded).

```
       -- node [ sloped , above ] { $ \scriptstyle #2 $ }
          node [ sloped , below ] { $ \scriptstyle #3 $ }
          ( \l_@@_x_final_dim , \l_@@_y_final_dim ) ;
    \end { scope }
  }
\cs_generate_variant:Nn \@@_draw_non_standard_dotted_line:nnn { n V V }
```

The command `\@@_draw_standard_dotted_line:` draws the line with our system of dots (which gives a dotted line with real round dots).

```
\cs_new_protected:Npn \@@_draw_standard_dotted_line:
  {
    \bool_lazy_and:nnF
      { \tl_if_empty_p:N \l_@@_xdots_up_tl }
      { \tl_if_empty_p:N \l_@@_xdots_down_tl }
      {
        \pgfscope
        \pgftransformshift
          {
            \pgfpointlineattime { 0.5 }
              { \pgfpoint \l_@@_x_initial_dim \l_@@_y_initial_dim }
              { \pgfpoint \l_@@_x_final_dim \l_@@_y_final_dim }
          }
        \pgftransformrotate
          {
            \fp_eval:n
              {
                atand
                 (
                   \l_@@_y_final_dim - \l_@@_y_initial_dim ,
                   \l_@@_x_final_dim - \l_@@_x_initial_dim
                 )
              }
          }
        \pgfnode
          { rectangle }
          { south }
          {
            \c_math_toggle_token
            \scriptstyle \l_@@_xdots_up_tl
            \c_math_toggle_token
          }
          { }
          { \pgfusepath { } }
        \pgfnode
          { rectangle }
          { north }
          {
            \c_math_toggle_token
            \scriptstyle \l_@@_xdots_down_tl
            \c_math_toggle_token
          }
```

```
        { }
        { \pgfusepath { } }
      \endpgfscope
    }
  \group_begin:
```

The dimension `\l_@@_l_dim` is the length ℓ of the line to draw. We use the floating point reals of expl3 to compute this length.

```
    \dim_zero_new:N \l_@@_l_dim
    \dim_set:Nn \l_@@_l_dim
      {
        \fp_to_dim:n
          {
            sqrt
             (
               ( \l_@@_x_final_dim - \l_@@_x_initial_dim ) ^ 2
                 +
               ( \l_@@_y_final_dim - \l_@@_y_initial_dim ) ^ 2
             )
          }
      }
```

It seems that, during the first compilations, the value of `\l_@@_l_dim` may be erroneous (equal to zero or very large). We must detect these cases because they would cause errors during the drawing of the dotted line. Maybe we should also write something in the aux file to say that one more compilation should be done.

```
    \bool_lazy_or:nnF
      { \dim_compare_p:nNn { \dim_abs:n \l_@@_l_dim } > \c_@@_max_l_dim }
      { \dim_compare_p:nNn \l_@@_l_dim = \c_zero_dim }
      \@@_draw_standard_dotted_line_i:
  \group_end:
}
\dim_const:Nn \c_@@_max_l_dim { 50 cm }
\cs_new_protected:Npn \@@_draw_standard_dotted_line_i:
  {
```

The number of dots will be `\l_tmpa_int + 1`.

```
    \bool_if:NTF \l_@@_initial_open_bool
      {
        \bool_if:NTF \l_@@_final_open_bool
          {
            \int_set:Nn \l_tmpa_int
              { \dim_ratio:nn \l_@@_l_dim \l_@@_inter_dots_dim }
          }
          {
            \int_set:Nn \l_tmpa_int
              {
                \dim_ratio:nn
                  { \l_@@_l_dim - \l_@@_xdots_shorten_dim }
                  \l_@@_inter_dots_dim
              }
          }
      }
      {
        \bool_if:NTF \l_@@_final_open_bool
          {
            \int_set:Nn \l_tmpa_int
              {
                \dim_ratio:nn
                  { \l_@@_l_dim - \l_@@_xdots_shorten_dim }
                  \l_@@_inter_dots_dim
              }
          }
```

```
        {
          \int_set:Nn \l_tmpa_int
            {
              \dim_ratio:nn
                { \l_@@_l_dim - 2 \l_@@_xdots_shorten_dim  }
                \l_@@_inter_dots_dim
            }
        }
    }
```

The dimensions `\l_tmpa_dim` and `\l_tmpb_dim` are the coordinates of the vector between two dots in the dotted line.

```
  \dim_set:Nn \l_tmpa_dim
    {
      ( \l_@@_x_final_dim - \l_@@_x_initial_dim ) *
      \dim_ratio:nn \l_@@_inter_dots_dim \l_@@_l_dim
    }
  \dim_set:Nn \l_tmpb_dim
    {
      ( \l_@@_y_final_dim - \l_@@_y_initial_dim ) *
      \dim_ratio:nn \l_@@_inter_dots_dim \l_@@_l_dim
    }
```

The length ℓ is the length of the dotted line. We note Δ the length between two dots and n the number of intervals between dots. We note $\delta = \frac{1}{2}(\ell - n\Delta)$. The distance between the initial extremity of the line and the first dot will be equal to $k \cdot \delta$ where $k = 0$, 1 or 2. We first compute this number k in `\l_tmpb_int`.

```
  \int_set:Nn \l_tmpb_int
    {
      \bool_if:NTF \l_@@_initial_open_bool
        { \bool_if:NTF \l_@@_final_open_bool 1 0 }
        { \bool_if:NTF \l_@@_final_open_bool 2 1 }
    }
```

In the loop over the dots, the dimensions `\l_@@_x_initial_dim` and `\l_@@_y_initial_dim` will be used for the coordinates of the dots. But, before the loop, we must move until the first dot.

```
  \dim_gadd:Nn \l_@@_x_initial_dim
    {
      ( \l_@@_x_final_dim - \l_@@_x_initial_dim ) *
      \dim_ratio:nn
        { \l_@@_l_dim - \l_@@_inter_dots_dim * \l_tmpa_int }
        { 2 \l_@@_l_dim }
      * \l_tmpb_int
    }
  \dim_gadd:Nn \l_@@_y_initial_dim
    {
      ( \l_@@_y_final_dim - \l_@@_y_initial_dim ) *
      \dim_ratio:nn
        { \l_@@_l_dim - \l_@@_inter_dots_dim * \l_tmpa_int }
        { 2 \l_@@_l_dim }
      * \l_tmpb_int
    }
  \pgf@relevantforpicturesizefalse
  \int_step_inline:nnn 0 \l_tmpa_int
    {
      \pgfpathcircle
        { \pgfpoint \l_@@_x_initial_dim \l_@@_y_initial_dim }
        { \l_@@_radius_dim }
      \dim_add:Nn \l_@@_x_initial_dim \l_tmpa_dim
      \dim_add:Nn \l_@@_y_initial_dim \l_tmpb_dim
    }
  \pgfusepathqfill
}
```

User commands available in the new environments

The commands \@@_Ldots, \@@_Cdots, \@@_Vdots, \@@_Ddots and \@@_Iddots will be linked to \Ldots, \Cdots, \Vdots, \Ddots and \Iddots in the environments {NiceArray} (the other environments of nicematrix rely upon {NiceArray}).

The syntax of these commands uses the character _ as embellishment and thats' why we have to insert a character _ in the *arg spec* of these commands. However, we don't know the future catcode of _ in the main document (maybe the user will use underscore, and, in that case, the catcode is 13 because underscore activates _). That's why these commands will be defined in a \AtBeginDocument and the *arg spec* will be rescanned.

```
\AtBeginDocument
  {
    \tl_set:Nn \l_@@_argspec_tl { O { } E { _ ^ } { { } { } } }
    \tl_set_rescan:Nno  \l_@@_argspec_tl { } \l_@@_argspec_tl
    \exp_args:NNV \NewDocumentCommand \@@_Ldots \l_@@_argspec_tl
      {
        \int_compare:nNnTF \c@jCol = 0
          { \@@_error:nn { in~first~col } \Ldots }
          {
            \int_compare:nNnTF \c@jCol = \l_@@_last_col_int
              { \@@_error:nn { in~last~col } \Ldots }
              {
                 \@@_instruction_of_type:nnn \c_false_bool { Ldots }
                   { #1 , down = #2 , up = #3 }
              }
          }
        \bool_if:NF \l_@@_nullify_dots_bool
          { \phantom { \ensuremath { \@@_old_ldots } } }
        \bool_gset_true:N \g_@@_empty_cell_bool
      }


    \exp_args:NNV \NewDocumentCommand \@@_Cdots \l_@@_argspec_tl
      {
        \int_compare:nNnTF \c@jCol = 0
          { \@@_error:nn { in~first~col } \Cdots }
          {
            \int_compare:nNnTF \c@jCol = \l_@@_last_col_int
              { \@@_error:nn { in~last~col } \Cdots }
              {
                 \@@_instruction_of_type:nnn \c_false_bool { Cdots }
                   { #1 , down = #2 , up = #3 }
              }
          }
        \bool_if:NF \l_@@_nullify_dots_bool
          { \phantom { \ensuremath { \@@_old_cdots } } }
        \bool_gset_true:N \g_@@_empty_cell_bool
      }


    \exp_args:NNV \NewDocumentCommand \@@_Vdots \l_@@_argspec_tl
      {
        \int_compare:nNnTF \c@iRow = 0
          { \@@_error:nn { in~first~row } \Vdots }
          {
            \int_compare:nNnTF \c@iRow = \l_@@_last_row_int
              { \@@_error:nn { in~last~row } \Vdots }
              {
                 \@@_instruction_of_type:nnn \c_false_bool { Vdots }
                   { #1 , down = #2 , up = #3 }
              }
```

```
        }
      \bool_if:NF \l_@@_nullify_dots_bool
        { \phantom { \ensuremath { \@@_old_vdots } } }
      \bool_gset_true:N \g_@@_empty_cell_bool
    }


  \exp_args:NNV \NewDocumentCommand \@@_Ddots \l_@@_argspec_tl
    {
      \int_case:nnF \c@iRow
        {
          0                  { \@@_error:nn { in~first~row } \Ddots }
          \l_@@_last_row_int { \@@_error:nn { in~last~row } \Ddots }
        }
        {
          \int_case:nnF \c@jCol
            {
              0                  { \@@_error:nn { in~first~col } \Ddots }
              \l_@@_last_col_int { \@@_error:nn { in~last~col } \Ddots }
            }
            {
              \keys_set_known:nn { NiceMatrix / Ddots } { #1 }
              \@@_instruction_of_type:nnn \l_@@_draw_first_bool { Ddots }
                { #1 , down = #2 , up = #3 }
            }

        }
      \bool_if:NF \l_@@_nullify_dots_bool
        { \phantom { \ensuremath { \@@_old_ddots } } }
      \bool_gset_true:N \g_@@_empty_cell_bool
    }


  \exp_args:NNV \NewDocumentCommand \@@_Iddots \l_@@_argspec_tl
    {
      \int_case:nnF \c@iRow
        {
          0                  { \@@_error:nn { in~first~row } \Iddots }
          \l_@@_last_row_int { \@@_error:nn { in~last~row } \Iddots }
        }
        {
          \int_case:nnF \c@jCol
            {
              0                  { \@@_error:nn { in~first~col } \Iddots }
              \l_@@_last_col_int { \@@_error:nn { in~last~col } \Iddots }
            }
            {
              \keys_set_known:nn { NiceMatrix / Ddots } { #1 }
              \@@_instruction_of_type:nnn \l_@@_draw_first_bool { Iddots }
                { #1 , down = #2 , up = #3 }
            }
        }
      \bool_if:NF \l_@@_nullify_dots_bool
        { \phantom { \ensuremath { \@@_old_iddots } } }
      \bool_gset_true:N \g_@@_empty_cell_bool
    }
}
```

End of the `\AtBeginDocument`.

Despite its name, the following set of keys will be used for `\Ddots` but also for `\Iddots`.

```
\keys_define:nn { NiceMatrix / Ddots }
  {
    draw-first .bool_set:N = \l_@@_draw_first_bool ,
```

```
    draw-first .default:n = true ,
    draw-first .value_forbidden:n = true
  }
```

The command `\@@_Hspace:` will be linked to `\hspace` in `{NiceArray}`.

```
\cs_new_protected:Npn \@@_Hspace:
  {
   \bool_gset_true:N \g_@@_empty_cell_bool
   \hspace
  }
\cs_set_eq:NN \@@_old_multicolumn \multicolumn
```

The command `\@@_Hdotsfor` will be linked to `\Hdotsfor` in `{NiceArrayWithDelims}`. Tikz nodes are created also in the implicit cells of the `\Hdotsfor` (maybe we should modify that point).

This command must *not* be protected since it begins with `\multicolumn`.

```
\cs_new:Npn \@@_Hdotsfor:
  {
    \bool_lazy_and:nnTF
      { \int_compare_p:nNn \c@jCol = 0 }
      { \int_compare_p:nNn \l_@@_first_col_int = 0 }
      {
        \bool_if:NTF \g_@@_after_col_zero_bool
          {
            \multicolumn { 1 } { c } { }
            \@@_Hdotsfor_i
          }
          { \@@_fatal:n { Hdotsfor~in~col~0 } }
      }
      {
        \multicolumn { 1 } { c } { }
        \@@_Hdotsfor_i
      }
  }
```

The command `\@@_Hdotsfor_i` is defined with `\NewDocumentCommand` because it has an optional argument. Note that such a command defined by `\NewDocumentCommand` is protected and that's why we have put the `\multicolumn` before (in the definition of `\@@_Hdotsfor:`).

```
\AtBeginDocument
  {
    \tl_set:Nn \l_@@_argspec_tl { O { } m O { } E { _ ^ } { { } { } } }
    \tl_set_rescan:Nno \l_@@_argspec_tl { } \l_@@_argspec_tl
```

We don't put `!` before the last optionnal argument for homogeneity with `\Cdots`, etc. which have only one optional argument.

```
    \exp_args:NNV \NewDocumentCommand \@@_Hdotsfor_i \l_@@_argspec_tl
      {
        \tl_gput_right:Nx \g_@@_HVdotsfor_lines_tl
          {
            \@@_Hdotsfor:nnnn
              { \int_use:N \c@iRow }
              { \int_use:N \c@jCol }
              { #2 }
              {
                #1 , #3 ,
                down = \exp_not:n { #4 } ,
                up = \exp_not:n { #5 }
              }
          }
        \prg_replicate:nn { #2 - 1 } { & \multicolumn { 1 } { c } { } { } }
      }
  }
```

Enf of `\AtBeginDocument`.

```
\cs_new_protected:Npn \@@_Hdotsfor:nnnn #1 #2 #3 #4
  {
    \bool_set_false:N \l_@@_initial_open_bool
    \bool_set_false:N \l_@@_final_open_bool
```

For the row, it's easy.

```
    \int_set:Nn \l_@@_initial_i_int { #1 }
    \int_set_eq:NN \l_@@_final_i_int \l_@@_initial_i_int
```

For the column, it's a bit more complicated.

```
    \int_compare:nNnTF { #2 } = 1
      {
        \int_set:Nn \l_@@_initial_j_int 1
        \bool_set_true:N \l_@@_initial_open_bool
      }
      {
        \cs_if_exist:cTF
          {
            pgf @ sh @ ns @ \@@_env:
            - \int_use:N \l_@@_initial_i_int
            - \int_eval:n { #2 - 1 }
          }
          { \int_set:Nn \l_@@_initial_j_int { #2 - 1 } }
          {
            \int_set:Nn \l_@@_initial_j_int { #2 }
            \bool_set_true:N \l_@@_initial_open_bool
          }
      }
    \int_compare:nNnTF { #2 + #3 -1 } = \c@jCol
      {
        \int_set:Nn \l_@@_final_j_int { #2 + #3 - 1 }
        \bool_set_true:N \l_@@_final_open_bool
      }
      {
        \cs_if_exist:cTF
          {
            pgf @ sh @ ns @ \@@_env:
            - \int_use:N \l_@@_final_i_int
            - \int_eval:n { #2 + #3 }
          }
          { \int_set:Nn \l_@@_final_j_int { #2 + #3 } }
          {
            \int_set:Nn \l_@@_final_j_int { #2 + #3 - 1 }
            \bool_set_true:N \l_@@_final_open_bool
          }
      }
    \group_begin:
    \int_compare:nNnTF { #1 } = 0
      { \color { nicematrix-first-row } }
      {
        \int_compare:nNnT { #1 } = \g_@@_row_total_int
          { \color { nicematrix-last-row } }
      }
    \keys_set:nn { NiceMatrix / xdots } { #4 }
    \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
    \@@_actually_draw_Ldots:
    \group_end:
```

We declare all the cells concerned by the `\Hdotsfor` as "dotted" (for the dotted lines created by `\Cdots`, `\Ldots`, etc., this job is done by `\@@_find_extremities_of_line:nnnn`). This declaration is done by defining a special control sequence (to nil).

```
    \int_step_inline:nnn { #2 } { #2 + #3 - 1 }
      { \cs_set:cpn { @@ _ dotted _ #1 - ##1 } { } }
  }


\AtBeginDocument
  {
    \tl_set:Nn \l_@@_argspec_tl { O { } m O { } E { _ ^ } { { } { } } }
    \tl_set_rescan:Nno  \l_@@_argspec_tl { } \l_@@_argspec_tl
    \exp_args:NNV \NewDocumentCommand \@@_Vdotsfor: \l_@@_argspec_tl
      {
        \tl_gput_right:Nx \g_@@_HVdotsfor_lines_tl
          {
            \@@_Vdotsfor:nnnn
              { \int_use:N \c@iRow }
              { \int_use:N \c@jCol }
              { #2 }
              {
                #1 , #3 ,
                down = \exp_not:n { #4 } , up = \exp_not:n { #5 }
              }
          }
      }
  }
```

Enf of `\AtBeginDocument`.

```
\cs_new_protected:Npn \@@_Vdotsfor:nnnn #1 #2 #3 #4
  {
    \bool_set_false:N \l_@@_initial_open_bool
    \bool_set_false:N \l_@@_final_open_bool
```

For the column, it's easy.

```
    \int_set:Nn \l_@@_initial_j_int { #2 }
    \int_set_eq:NN \l_@@_final_j_int \l_@@_initial_j_int
```

For the row, it's a bit more complicated.

```
    \int_compare:nNnTF #1 = 1
      {
        \int_set:Nn \l_@@_initial_i_int 1
        \bool_set_true:N \l_@@_initial_open_bool
      }
      {
        \cs_if_exist:cTF
          {
            pgf @ sh @ ns @ \@@_env:
            - \int_eval:n { #1 - 1 }
            - \int_use:N \l_@@_initial_j_int
          }
          { \int_set:Nn \l_@@_initial_i_int { #1 - 1 } }
          {
            \int_set:Nn \l_@@_initial_i_int { #1 }
            \bool_set_true:N \l_@@_initial_open_bool
          }
      }
    \int_compare:nNnTF { #1 + #3 -1 } = \c@iRow
      {
        \int_set:Nn \l_@@_final_i_int { #1 + #3 - 1 }
        \bool_set_true:N \l_@@_final_open_bool
      }
      {
        \cs_if_exist:cTF
          {
            pgf @ sh @ ns @ \@@_env:
            - \int_eval:n { #1 + #3 }
            - \int_use:N \l_@@_final_j_int
```

```
          }
          { \int_set:Nn \l_@@_final_i_int { #1 + #3 } }
          {
            \int_set:Nn \l_@@_final_i_int { #1 + #3 - 1 }
            \bool_set_true:N \l_@@_final_open_bool
          }
      }
    \group_begin:
    \int_compare:nNnTF { #2 } = 0
      { \color { nicematrix-first-col } }
      {
        \int_compare:nNnT { #2 } = \g_@@_col_total_int
          { \color { nicematrix-last-col } }
      }
    \keys_set:nn { NiceMatrix / xdots } { #4 }
    \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
    \@@_actually_draw_Vdots:
    \group_end:
```

We declare all the cells concerned by the `\Vdotsfor` as "dotted" (for the dotted lines created by `\Cdots`, `\Ldots`, etc., this job is done by `\@@_find_extremities_of_line:nnnn`). This declaration is done by defining a special control sequence (to nil).

```
    \int_step_inline:nnn { #1 } { #1 + #3 - 1 }
      { \cs_set:cpn { @@ _ dotted _ ##1 - #2 } { } }
  }
```

The command `\@@_rotate:` will be linked to `\rotate` in `{NiceArrayWithDelims}`.

```
\cs_new_protected:Npn \@@_rotate: { \bool_gset_true:N \g_@@_rotate_bool }
```

The command \line accessible in code-after

In the `\CodeAfter`, the command `\@@_line:nn` will be linked to `\line`. This command takes two arguments which are the specifications of two cells in the array (in the format i-j) and draws a dotted line between these cells.

First, we write a command with an argument of the format i-j and applies the command `\int_eval:n` to i and j ; this must *not* be protected (and is, of course fully expandable).[62]

```
\cs_new:Npn \@@_double_int_eval:n #1-#2 \q_stop
  { \int_eval:n { #1 } - \int_eval:n { #2 } }
```

With the following construction, the command `\@@_double_int_eval:n` is applied to both arguments before the application of `\@@_line_i:nn` (the construction uses the fact the `\@@_line_i:nn` is protected and that `\@@_double_int_eval:n` is fully expandable).

```
\AtBeginDocument
  {
    \tl_set:Nn \l_@@_argspec_tl { O { } m m ! O { } E { _ ^ } { { } { } } }
    \tl_set_rescan:Nno  \l_@@_argspec_tl { } \l_@@_argspec_tl
    \exp_args:NNV \NewDocumentCommand \@@_line \l_@@_argspec_tl
      {
        \group_begin:
        \keys_set:nn { NiceMatrix / xdots } { #1 , #4 , down = #5 , up = #6 }
        \tl_if_empty:VF \l_@@_xdots_color_tl { \color { \l_@@_xdots_color_tl } }
          \use:e
            {
```

[62] Indeed, we want that the user may use the command `\line` in `\CodeAfter` with LaTeX counters in the arguments — with the command `\value`.

```
              \@@_line_i:nn
                { \@@_double_int_eval:n #2 \q_stop }
                { \@@_double_int_eval:n #3 \q_stop }
            }
        \group_end:
      }
  }
\cs_new_protected:Npn \@@_line_i:nn #1 #2
  {
    \bool_set_false:N \l_@@_initial_open_bool
    \bool_set_false:N \l_@@_final_open_bool
    \bool_if:nTF
      {
        \cs_if_free_p:c { pgf @ sh @ ns @ \@@_env: - #1 }
          ||
        \cs_if_free_p:c { pgf @ sh @ ns @ \@@_env: - #2 }
      }
      {
        \@@_error:nnn { unknown~cell~for~line~in~CodeAfter } { #1 } { #2 }
      }
      { \@@_draw_line_ii:nn { #1 } { #2 } }
  }
\AtBeginDocument
  {
    \cs_new_protected:Npx \@@_draw_line_ii:nn #1 #2
      {
```

We recall that, when externalization is used, `\tikzpicture` and `\endtikzpicture` (or `\pgfpicture` and `\endpgfpicture`) must be directly "visible" and that why we do this static construction of the command `\@@_draw_line_ii:`.

```
        \c_@@_pgfortikzpicture_tl
        \@@_draw_line_iii:nn { #1 } { #2 }
        \c_@@_endpgfortikzpicture_tl
      }
  }
```

The following command *must* be protected (it's used in the construction of `\@@_draw_line_ii:nn`).

```
\cs_new_protected:Npn \@@_draw_line_iii:nn #1 #2
  {
    \pgfrememberpicturepositiononpagetrue
    \pgfpointshapeborder { \@@_env: - #1 } { \@@_qpoint:n { #2 } }
    \dim_set_eq:NN \l_@@_x_initial_dim \pgf@x
    \dim_set_eq:NN \l_@@_y_initial_dim \pgf@y
    \pgfpointshapeborder { \@@_env: - #2 } { \@@_qpoint:n { #1 } }
    \dim_set_eq:NN \l_@@_x_final_dim \pgf@x
    \dim_set_eq:NN \l_@@_y_final_dim \pgf@y
    \@@_draw_line:
  }
```

The commands `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, and `\Iddots` don't use this command because they have to do other settings (for example, the diagonal lines must be parallelized).

Colors of cells, rows and columns

We want to avoid the thin white lines that are shown in some PDF viewers (eg: with the engine MuPDF used by SumatraPDF). That's why we try to draw rectangles of the same color in the same instruction `\pgfusepath { fill }` (and they will be in the same instruction `fill`—coded `f`— in the resulting PDF).
The commands `\@@_rowcolor`, `\@@_columncolor` and `\@@_rectanglecolor` (which are linked to `\rowcolor`, `\columncolor` and `\rectanglecolor` before the execution of the `code-before`) don't directly draw the corresponding rectangles. Instead, they store their instructions color by color:

- A sequence `\g_@@_colors_seq` will be built containing all the colors used by at least one of these instructions. Each *color* may be prefixed by it color model (eg: `[gray]{0.5}`).
- For the color whose index in `\g_@@_colors_seq` is equal to i, a list of instructions which use that color will be constructed in the token list `\g_@@_color_`i`_tl`. In that token list, the instructions will be written using `\@@_rowcolor:n`, `\@@_columncolor:n` and `\@@_rectanglecolor:nn` (corresponding of `\@@_rowcolor`, `\@@_columncolor` and `\@@_rectanglecolor`).

bigskip `#1` is the color and `#2` is an instruction using that color. Despite its name, the command `\@@_add_to_color_seq` doesn't only add a color to `\g_@@_colors_seq`: it also updates the corresponding token list `\g_@@_color_`i`_tl`. We add in a global way because the final user may use the instructions such as `\cellcolor` in a loop of pgffor in the `\CodeBefore` (and we recall that a loop of pgffor is encapsulated in a group).

```
\cs_new_protected:Npn \@@_add_to_colors_seq:nn #1 #2
  {
```

Firt, we look for the number of the color and, if it's found, we store it in `\l_tmpa_int`. If the color is not present in `\l_@@_colors_seq`, `\l_tmpa_int` will remain equal to 0.

```
    \int_zero:N \l_tmpa_int
    \seq_map_indexed_inline:Nn \g_@@_colors_seq
      { \tl_if_eq:nnT { #1 } { ##2 } { \int_set:Nn \l_tmpa_int { ##1 } } }
    \int_compare:nNnTF \l_tmpa_int = \c_zero_int
```

First, the case where the color is a *new* color (not in the sequence).

```
      {
        \seq_gput_right:Nn \g_@@_colors_seq { #1 }
        \tl_gset:cx { g_@@_color _ \seq_count:N \g_@@_colors_seq _ tl } { #2 }
      }
```

Now, the case where the color is *not* a new color (the color is in the sequence at the position `\l_tmpa_int`).

```
     { \tl_gput_right:cx { g_@@_color _ \int_use:N \l_tmpa_int _tl } { #2 } }
  }
\cs_generate_variant:Nn \@@_add_to_colors_seq:nn { x n }
```

The macro `\@@_actually_color:` will actually fill all the rectangles, color by color (using the sequence `\l_@@_colors_seq` and all the token lists of the form `\l_@@_color_`i`_tl`).

```
\cs_new_protected:Npn \@@_actually_color:
  {
    \pgfpicture
    \pgf@relevantforpicturesizefalse
    \seq_map_indexed_inline:Nn \g_@@_colors_seq
      {
        \color ##2
        \use:c { g_@@_color _ ##1 _tl }
        \tl_gclear:c { g_@@_color _ ##1 _tl }
        \pgfusepath { fill }
      }
    \endpgfpicture
  }
\cs_set_protected:Npn \@@_cut_on_hyphen:w #1-#2\q_stop
  {
    \tl_set:Nn \l_tmpa_tl { #1 }
    \tl_set:Nn \l_tmpb_tl { #2 }
  }
```

Here is an example : `\@@_rowcolor {red!15} {1,3,5-7,10-}`

```
\NewDocumentCommand \@@_rowcolor { O { } m m }
  {
    \tl_if_blank:nF { #2 }
      {
```

```
        \@@_add_to_colors_seq:xn
          { \tl_if_blank:nF { #1 } { [ #1 ] } { #2 } }
          { \@@_rowcolor:n { #3 } }
      }
  }
\cs_new_protected:Npn \@@_rowcolor:n #1
  {
    \tl_set:Nn \l_@@_rows_tl { #1 }
    \tl_set:Nn \l_@@_cols_tl { - }
```

The command `\@@_cartesian_path:` takes in two implicit arguments: `\l_@@_cols_tl` and `\l_@@_rows_tl`.

```
    \@@_cartesian_path:
  }
```

Here an example : `\@@_columncolor:nn {red!15} {1,3,5-7,10-}`

```
\NewDocumentCommand \@@_columncolor { O { } m m }
  {
    \tl_if_blank:nF { #2 }
      {
        \@@_add_to_colors_seq:xn
          { \tl_if_blank:nF { #1 } { [ #1 ] } { #2 } }
          { \@@_columncolor:n { #3 } }
      }
  }
\cs_new_protected:Npn \@@_columncolor:n #1
  {
    \tl_set:Nn \l_@@_rows_tl { - }
    \tl_set:Nn \l_@@_cols_tl { #1 }
```

The command `\@@_cartesian_path:` takes in two implicit arguments: `\l_@@_cols_tl` and `\l_@@_rows_tl`.

```
    \@@_cartesian_path:
  }
```

Here is an example : `\@@_rectanglecolor{red!15}{2-3}{5-6}`

```
\NewDocumentCommand \@@_rectanglecolor { O { } m m m }
  {
    \tl_if_blank:nF { #2 }
      {
        \@@_add_to_colors_seq:xn
          { \tl_if_blank:nF { #1 } { [ #1 ] } { #2 } }
          { \@@_rectanglecolor:nnn { #3 } { #4 } { 0 pt } }
      }
  }
```

The last argument is the radius of the corners of the rectangle.

```
\NewDocumentCommand \@@_roundedrectanglecolor { O { } m m m m }
  {
    \tl_if_blank:nF { #2 }
      {
        \@@_add_to_colors_seq:xn
          { \tl_if_blank:nF { #1 } { [ #1 ] } { #2 } }
          { \@@_rectanglecolor:nnn { #3 } { #4 } { #5 } }
      }
  }
```

The last argument is the radius of the corners of the rectangle.

```
\cs_new_protected:Npn \@@_rectanglecolor:nnn #1 #2 #3
  {
```

```
    \@@_cut_on_hyphen:w #1 \q_stop
    \tl_clear_new:N \l_tmpc_tl
    \tl_clear_new:N \l_tmpd_tl
    \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl
    \tl_set_eq:NN \l_tmpd_tl \l_tmpb_tl
    \@@_cut_on_hyphen:w #2 \q_stop
    \tl_set:Nx \l_@@_rows_tl { \l_tmpc_tl - \l_tmpa_tl }
    \tl_set:Nx \l_@@_cols_tl { \l_tmpd_tl - \l_tmpb_tl }
```

The command `\@@_cartesian_path:n` takes in two implicit arguments: `\l_@@_cols_tl` and `\l_@@_rows_tl`.

```
    \@@_cartesian_path:n { #3 }
  }
```

Here is an example : `\@@_cellcolor[rgb]{0.5,0.5,0}{2-3,3-4,4-5,5-6}`

```
\NewDocumentCommand \@@_cellcolor { O { } m m }
  {
    \clist_map_inline:nn { #3 }
      { \@@_rectanglecolor [ #1 ] { #2 } { ##1 } { ##1 } }
  }


\NewDocumentCommand \@@_chessboardcolors { O { } m m  }
  {
    \int_step_inline:nn { \int_use:N \c@iRow }
      {
        \int_step_inline:nn { \int_use:N \c@jCol }
          {
            \int_if_even:nTF { ####1 + ##1 }
              { \@@_cellcolor [ #1 ] { #2 } }
              { \@@_cellcolor [ #1 ] { #3 } }
            { ##1 - ####1 }
          }
      }
  }


\keys_define:nn { NiceMatrix / arraycolor }
  { except-corners .code:n = \@@_error:n { key except-corners } }
```

The command `\@@_arraycolor` (linked to `\arraycolor` at the beginning of the `\CodeBefore`) will color the whole tabular (excepted the potential exterior rows and columns). The third argument is a optional argument which a list of pairs key-value.

```
\NewDocumentCommand \@@_arraycolor { O { } m O { } }
  {
    \keys_set:nn { NiceMatrix / arraycolor } { #3 }
    \@@_rectanglecolor [ #1 ] { #2 }
      { 1 - 1 }
      { \int_use:N \c@iRow - \int_use:N \c@jCol }
  }


\keys_define:nn { NiceMatrix / rowcolors }
  {
    respect-blocks .bool_set:N = \l_@@_respect_blocks_bool ,
    respect-blocks .default:n = true ,
    cols .tl_set:N = \l_@@_cols_tl ,
    restart .bool_set:N = \l_@@_rowcolors_restart_bool ,
    restart .default:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~rowcolors }
  }
```

The command \rowcolors (accessible in the code-before) is inspired by the command \rowcolors of the package xcolor (with the option table). However, the command \rowcolors of nicematrix has *not* the optional argument of the command \rowcolors of xcolor. Here is an example: \rowcolors{1}{blue!10}{}[respect-blocks].
#1 (optional) is the color space ; #2 is a list of intervals of rows ; #3 is the first color ; #4 is the second color ; #5 is for the optional list of pairs key-value.

```
\NewDocumentCommand \@@_rowcolors { O { } m m m O { } }
  {
```

The group is for the options.

```
    \group_begin:
    \tl_clear_new:N \l_@@_cols_tl
    \tl_set:Nn \l_@@_cols_tl { - }
    \keys_set:nn { NiceMatrix / rowcolors } { #5 }
```

The boolean \l_tmpa_bool will indicate whereas we are in a row of the first color or of the second color.

```
    \bool_set_true:N \l_tmpa_bool
    \bool_if:NT \l_@@_respect_blocks_bool
      {
```

We don't want to take into account a block which is completely in the "first column" of (number 0) or in the "last column" and that's why we filter the sequence of the blocks (in a the sequence \l_tmpa_seq).

```
        \seq_set_eq:NN \l_tmpb_seq \g_@@_pos_of_blocks_seq
        \seq_set_filter:NNn \l_tmpa_seq \l_tmpb_seq
          { \@@_not_in_exterior_p:nnnn ##1 }
      }
    \pgfpicture
    \pgf@relevantforpicturesizefalse
    \clist_map_inline:nn { #2 }
      {
        \tl_set:Nn \l_tmpa_tl { ##1 }
        \tl_if_in:NnTF \l_tmpa_tl { - }
          { \@@_cut_on_hyphen:w ##1 \q_stop }
          { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@iRow } }
```

The counter \l_tmpa_int will be the index of the loop.

```
        \int_set:Nn \l_tmpa_int \l_tmpa_tl
        \bool_if:NTF \l_@@_rowcolors_restart_bool
          { \bool_set_true:N \l_tmpa_bool }
          { \bool_set:Nn \l_tmpa_bool { \int_if_odd_p:n { \l_tmpa_tl } } }
        \int_zero_new:N \l_tmpc_int
        \int_set:Nn \l_tmpc_int \l_tmpb_tl
        \int_do_until:nNnn \l_tmpa_int > \l_tmpc_int
          {
```

We will compute in \l_tmpb_int the last row of the "block".

```
            \int_set_eq:NN \l_tmpb_int \l_tmpa_int
```

If the key respect-blocks is in force, we have to adjust that value (of course).

```
            \bool_if:NT \l_@@_respect_blocks_bool
              {
                \seq_set_filter:NNn \l_tmpb_seq \l_tmpa_seq
                  { \@@_intersect_our_row_p:nnnn ####1 }
                \seq_map_inline:Nn \l_tmpb_seq { \@@_rowcolors_i:nnnn ####1 }
```

Now, the last row of the block is computed in \l_tmpb_int.

```
              }
            \tl_set:Nx \l_@@_rows_tl
              { \int_use:N \l_tmpa_int - \int_use:N \l_tmpb_int }
            \bool_if:NTF \l_tmpa_bool
              {
                \tl_if_blank:nF { #3 }
                  {
```

```
                    \tl_if_empty:nTF { #1 }
                      \color
                      { \color [ #1 ] }
                      { #3 }
```

The command `\@@_cartesian_path:` takes in two implicit arguments: `\l_@@_cols_tl` and `\l_@@_rows_tl`.

```
                    \@@_cartesian_path:
                    \pgfusepath { fill }
                  }
                \bool_set_false:N \l_tmpa_bool
              }
              {
                \tl_if_blank:nF { #4 }
                  {
                    \tl_if_empty:nTF { #1 }
                      \color
                      { \color [ #1 ] }
                      { #4 }
```

The command `\@@_cartesian_path:` takes in two implicit arguments: `\l_@@_cols_tl` and `\l_@@_row_tl`.

```
                    \@@_cartesian_path:
                    \pgfusepath { fill }
                  }
                \bool_set_true:N \l_tmpa_bool
              }
            \int_set:Nn \l_tmpa_int { \l_tmpb_int + 1 }
          }
      }
    \endpgfpicture
    \group_end:
  }


\cs_new_protected:Npn \@@_rowcolors_i:nnnn #1 #2 #3 #4
  {
    \int_compare:nNnT { #3 } > \l_tmpb_int
      { \int_set:Nn \l_tmpb_int { #3 } }
  }


\prg_new_conditional:Nnn \@@_not_in_exterior:nnnn p
  {
    \bool_lazy_or:nnTF
      { \int_compare_p:nNn { #4 } = \c_zero_int }
      { \int_compare_p:nNn { #2 } = { \@@_succ:n { \c@jCol } } }
      \prg_return_false:
      \prg_return_true:
  }
```

The following command return `true` when the block intersects the row `\l_tmpa_int`.

```
\prg_new_conditional:Nnn \@@_intersect_our_row:nnnn p
  {
    \bool_if:nTF
      {
        \int_compare_p:n { #1 <= \l_tmpa_int }
        &&
        \int_compare_p:n { \l_tmpa_int <= #3 }
      }
      \prg_return_true:
      \prg_return_false:
  }
```

The following command uses two implicit arguments: `\l_@@_rows_tl` and `\l_@@_cols_tl` which are specifications for a set of rows and a set of columns. It creates a path but does *not* fill it. It must be filled by another command after. The argument is the radius of the corners. We define below a command `\@@_cartesian_path:` which corresponds to a value 0 pt for the radius of the corners. This command is in particular used in `\@@_rectanglecolor:nnn` (used in `\@@_rectanglecolor`, itself used in `\@@_cellcolor`).

```
\cs_new_protected:Npn \@@_cartesian_path:n #1
  {
    \bool_lazy_and:nnT
      { ! \seq_if_empty_p:N \l_@@_corners_cells_seq }
      { \dim_compare_p:nNn { #1 } = \c_zero_dim }
      {
        \@@_expand_clist:NN \l_@@_cols_tl \c@jCol
        \@@_expand_clist:NN \l_@@_rows_tl \c@iRow
      }
```

We begin the loop over the columns.

```
    \clist_map_inline:Nn \l_@@_cols_tl
      {
        \tl_set:Nn \l_tmpa_tl { ##1 }
        \tl_if_in:NnTF \l_tmpa_tl { - }
          { \@@_cut_on_hyphen:w ##1 \q_stop }
          { \@@_cut_on_hyphen:w ##1 - ##1 \q_stop }
        \bool_lazy_or:nnT
          { \tl_if_blank_p:V \l_tmpa_tl }
          { \str_if_eq_p:Vn \l_tmpa_tl { * } }
          { \tl_set:Nn \l_tmpa_tl { 1 } }
        \bool_lazy_or:nnT
          { \tl_if_blank_p:V \l_tmpb_tl }
          { \str_if_eq_p:Vn \l_tmpb_tl { * } }
          { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@jCol } }
        \int_compare:nNnT \l_tmpb_tl > \c@jCol
          { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@jCol } }
```

`\l_tmpc_tl` will contain the number of column.

```
        \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl
```

If we decide to provide the commands `\cellcolor`, `\rectanglecolor`, `\rowcolor`, `\columncolor`, `\rowcolors` and `\chessboardcolors` in the `code-before` of a `\SubMatrix`, we will have to modify the following line, by adding a kind of offset. We will have also some other lines to modify.

```
        \@@_qpoint:n { col - \l_tmpa_tl }
        \int_compare:nNnTF \l_@@_first_col_int = \l_tmpa_tl
          { \dim_set:Nn \l_tmpc_dim { \pgf@x - 0.5 \arrayrulewidth } }
          { \dim_set:Nn \l_tmpc_dim { \pgf@x + 0.5 \arrayrulewidth } }
        \@@_qpoint:n { col - \@@_succ:n \l_tmpb_tl }
        \dim_set:Nn \l_tmpa_dim { \pgf@x + 0.5 \arrayrulewidth }
```

We begin the loop over the rows.

```
        \clist_map_inline:Nn \l_@@_rows_tl
          {
            \tl_set:Nn \l_tmpa_tl { ####1 }
            \tl_if_in:NnTF \l_tmpa_tl { - }
              { \@@_cut_on_hyphen:w ####1 \q_stop }
              { \@@_cut_on_hyphen:w ####1 - ####1 \q_stop }
            \tl_if_empty:NT \l_tmpa_tl { \tl_set:Nn \l_tmpa_tl { 1 } }
            \tl_if_empty:NT \l_tmpb_tl
              { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@iRow } }
            \int_compare:nNnT \l_tmpb_tl > \c@iRow
              { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@iRow } }
```

Now, the numbers of both rows are in `\l_tmpa_tl` and `\l_tmpb_tl`.

```
            \seq_if_in:NxF \l_@@_corners_cells_seq
              { \l_tmpa_tl - \l_tmpc_tl }
              {
                \@@_qpoint:n { row - \@@_succ:n \l_tmpb_tl }
```

```
                \dim_set:Nn \l_tmpb_dim { \pgf@y + 0.5 \arrayrulewidth }
                \@@_qpoint:n { row - \l_tmpa_tl }
                \dim_set:Nn \l_tmpd_dim { \pgf@y + 0.5 \arrayrulewidth }
                \pgfsetcornersarced { \pgfpoint { #1 } { #1 } }
                \pgfpathrectanglecorners
                  { \pgfpoint \l_tmpc_dim \l_tmpd_dim }
                  { \pgfpoint \l_tmpa_dim \l_tmpb_dim }
              }
          }
      }
  }
```

The following command corresponds to a radius of the corners equal to 0 pt. This command is used by the commands `\@@_rowcolors`, `\@@_columncolor` and `\@@_rowcolor:n` (used in `\@@_rowcolor`).

```
\cs_new_protected:Npn \@@_cartesian_path: { \@@_cartesian_path:n { 0 pt } }
```

The following command will be used only with `\l_@@_cols_tl` and `\c@jCol` (first case) or with `\l_@@_rows_tl` and `\c@iRow` (second case). For instance, with `\l_@@_cols_tl` equal to `2,4-6,8-*` and `\c@jCol` equal to `10`, the clist `\l_@@_cols_tl` will be replaced by `2,4,5,6,8,9,10`.

```
\cs_new_protected:Npn \@@_expand_clist:NN #1 #2
  {
    \clist_set_eq:NN \l_tmpa_clist #1
    \clist_clear:N #1
    \clist_map_inline:Nn \l_tmpa_clist
      {
        \tl_set:Nn \l_tmpa_tl { ##1 }
        \tl_if_in:NnTF \l_tmpa_tl { - }
          { \@@_cut_on_hyphen:w ##1 \q_stop }
          { \@@_cut_on_hyphen:w ##1 - ##1 \q_stop }
        \bool_lazy_or:nnT
          { \tl_if_blank_p:V \l_tmpa_tl }
          { \str_if_eq_p:Vn \l_tmpa_tl { * } }
          { \tl_set:Nn \l_tmpa_tl { 1 } }
        \bool_lazy_or:nnT
          { \tl_if_blank_p:V \l_tmpb_tl }
          { \str_if_eq_p:Vn \l_tmpb_tl { * } }
          { \tl_set:Nx \l_tmpb_tl { \int_use:N #2 } }
        \int_compare:nNnT \l_tmpb_tl > #2
          { \tl_set:Nx \l_tmpb_tl { \int_use:N #2 } }
        \int_step_inline:nnn \l_tmpa_tl \l_tmpb_tl
          { \clist_put_right:Nn #1 { ####1 } }
      }
  }
```

When the user uses the key `colortbl-like`, the following command will be linked to `\cellcolor` in the tabular.

```
\NewDocumentCommand \@@_cellcolor_tabular { O { } m }
  {
    \peek_remove_spaces:n
      {
        \tl_gput_right:Nx \g_nicematrix_code_before_tl
          {
```

We must not expand the color (`#2`) because the color may contain the token `!` which may be activated by some packages (ex.: `babel` with the option `french` on latex and pdflatex).

```
            \cellcolor [ #1 ] { \exp_not:n { #2 } }
              { \int_use:N \c@iRow - \int_use:N \c@jCol }
          }
      }
  }
```

When the user uses the key `colortbl-like`, the following command will be linked to `\rowcolor` in the tabular.

```
\NewDocumentCommand \@@_rowcolor_tabular { O { } m }
  {
    \peek_remove_spaces:n
      {
        \tl_gput_right:Nx \g_nicematrix_code_before_tl
          {
            \exp_not:N \rectanglecolor [ #1 ] { \exp_not:n { #2 } }
              { \int_use:N \c@iRow - \int_use:N \c@jCol }
              { \int_use:N \c@iRow - \exp_not:n { \int_use:N \c@jCol } }
          }
      }
  }

\NewDocumentCommand \@@_columncolor_preamble { O { } m }
  {
```

With the following line, we test whether the cell is the first one we encounter in its column (don't forget that some rows may be incomplete).

```
    \int_compare:nNnT \c@jCol > \g_@@_col_total_int
      {
```

You use `gput_left` because we want the specification of colors for the columns drawn before the specifications of color for the rows (and the cells). Be careful: maybe this is not effective since we have an analyze of the instructions in the `\CodeBefore` in order to fill color by color (to avoid the thin white lines).

```
        \tl_gput_left:Nx \g_nicematrix_code_before_tl
          {
            \exp_not:N \columncolor [ #1 ]
              { \exp_not:n { #2 } } { \int_use:N \c@jCol }
          }
      }
  }
```

The vertical rules

We give to the user the possibility to define new types of columns (with `\newcolumntype` of array) for special vertical rules (*e.g.* rules thicker than the standard ones) which will not extend in the potential exterior rows of the array.
We provide the command `\OnlyMainNiceMatrix` in that goal. However, that command must be no-op outside the environments of nicematrix (and so the user will be allowed to use the same new type of column in the environments of nicematrix and in the standard environments of array).
That's why we provide first a global definition of `\OnlyMainNiceMatrix`.

```
\cs_set_eq:NN \OnlyMainNiceMatrix \use:n
```

Another definition of `\OnlyMainNiceMatrix` will be linked to the command in the environments of nicematrix. Here is that definition, called `\@@_OnlyMainNiceMatrix:n`.

```
\cs_new_protected:Npn \@@_OnlyMainNiceMatrix:n #1
  {
    \int_compare:nNnTF \l_@@_first_col_int = 0
      { \@@_OnlyMainNiceMatrix_i:n { #1 } }
      {
        \int_compare:nNnTF \c@jCol = 0
          {
            \int_compare:nNnF \c@iRow = { -1 }
              { \int_compare:nNnF \c@iRow = { \l_@@_last_row_int - 1 } { #1 } }
          }
          { \@@_OnlyMainNiceMatrix_i:n { #1 } }
      }
  }
```

This definition may seem complicated by we must remind that the number of row `\c@iRow` is incremented in the first cell of the row, *after* a potential vertical rule on the left side of the first cell.

The command `\@@_OnlyMainNiceMatrix_i:n` is only a short-cut which is used twice in the above command. This command must *not* be protected.

```
\cs_new_protected:Npn \@@_OnlyMainNiceMatrix_i:n #1
  {
    \int_compare:nNnF \c@iRow = 0
      { \int_compare:nNnF \c@iRow = \l_@@_last_row_int { #1 } }
  }
```

Remember that `\c@iRow` is not always inferior to `\l_@@_last_row_int` because `\l_@@_last_row_int` may be equal to -2 or -1 (we can't write `\int_compare:nNnT \c@iRow < \l_@@_last_row_int`).

The following command will be executed in the `internal-code-after`. The rule will be drawn *before* the column `#1` (that is to say on the left side). `#2` is the number of consecutive occurrences of `|`.

```
\cs_new_protected:Npn \@@_vline:nn #1 #2
  {
```

The following test is for the case where the user don't use all the columns specified in the preamble of the environment (for instance, a preamble of `|c|c|c|` but only two columns used).

```
    \int_compare:nNnT { #1 } < { \c@jCol + 2 }
      {
        \pgfpicture
        \@@_vline_i:nn { #1 } { #2 }
        \endpgfpicture
      }
  }
\cs_new_protected:Npn \@@_vline_i:nn #1 #2
  {
```

`\l_tmpa_tl` is the number of row and `\l_tmpb_tl` the number of column. When we have found a row corresponding to a rule to draw, we note its number in `\l_tmpc_tl`.

```
    \tl_set:Nx \l_tmpb_tl { #1 }
    \tl_clear_new:N \l_tmpc_tl
    \int_step_variable:nNn \c@iRow \l_tmpa_tl
      {
```

The boolean `\g_tmpa_bool` indicates whether the small vertical rule will be drawn. If we find that it is in a block (a real block, created by `\Block` or a virtual block corresponding to a dotted line, created by `\Cdots`, `\Vdots`, etc.), we will set `\g_tmpa_bool` to `false` and the small vertical rule won't be drawn.

```
        \bool_gset_true:N \g_tmpa_bool
        \seq_map_inline:Nn \g_@@_pos_of_blocks_seq
          { \@@_test_vline_in_block:nnnn ##1 }
        \seq_map_inline:Nn \g_@@_pos_of_xdots_seq
          { \@@_test_vline_in_block:nnnn ##1 }
        \seq_map_inline:Nn \g_@@_pos_of_stroken_blocks_seq
          { \@@_test_vline_in_stroken_block:nnnn ##1 }
        \clist_if_empty:NF \l_@@_corners_clist
          \@@_test_in_corner_v:
        \bool_if:NTF \g_tmpa_bool
          {
            \tl_if_empty:NT \l_tmpc_tl
```

We keep in memory that we have a rule to draw.

```
              { \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl }
          }
          {
            \tl_if_empty:NF \l_tmpc_tl
              {
                \@@_vline_ii:nnnn
                  { #1 }
                  { #2 }
```

```
                  \l_tmpc_tl
                  { \int_eval:n { \l_tmpa_tl - 1 } }
                \tl_clear:N \l_tmpc_tl
              }
          }
      }
    \tl_if_empty:NF \l_tmpc_tl
      {
        \@@_vline_ii:nnnn
          { #1 }
          { #2 }
          \l_tmpc_tl
          { \int_use:N \c@iRow }
        \tl_clear:N \l_tmpc_tl
      }
  }


\cs_new_protected:Npn \@@_test_in_corner_v:
   {
     \int_compare:nNnTF \l_tmpb_tl = { \@@_succ:n \c@jCol }
       {
         \seq_if_in:NxT
           \l_@@_corners_cells_seq
           { \l_tmpa_tl - \@@_pred:n \l_tmpb_tl }
           { \bool_set_false:N \g_tmpa_bool }
       }
       {
         \seq_if_in:NxT
           \l_@@_corners_cells_seq
           { \l_tmpa_tl - \l_tmpb_tl }
           {
             \int_compare:nNnTF \l_tmpb_tl = 1
               { \bool_set_false:N \g_tmpa_bool }
               {
                 \seq_if_in:NxT
                   \l_@@_corners_cells_seq
                   { \l_tmpa_tl - \@@_pred:n \l_tmpb_tl }
                   { \bool_set_false:N \g_tmpa_bool }
               }
           }
       }
   }
```

`#1` is the number of the column; `#2` is the number of vertical rules to draw (with potentially a color between); `#3` and `#4` are the numbers of the rows between which the rule has to be drawn.

```
\cs_new_protected:Npn \@@_vline_ii:nnnn #1 #2 #3 #4
  {
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \@@_qpoint:n { row - #3 }
    \dim_set_eq:NN \l_tmpa_dim \pgf@y
    \@@_qpoint:n { col - #1 }
    \dim_set_eq:NN \l_tmpb_dim \pgf@x
    \@@_qpoint:n { row - \@@_succ:n { #4 } }
    \dim_set_eq:NN \l_tmpc_dim \pgf@y
    \bool_lazy_and:nnT
      { \int_compare_p:nNn { #2 } > 1 }
      { ! \tl_if_blank_p:V \CT@drsc@ }
      {
        \group_begin:
        \CT@drsc@
        \dim_add:Nn \l_tmpa_dim { 0.5 \arrayrulewidth }
```

```
        \dim_sub:Nn \l_tmpc_dim { 0.5 \arrayrulewidth }
        \dim_set:Nn \l_tmpd_dim
          { \l_tmpb_dim - ( \doublerulesep + \arrayrulewidth ) * ( #2 - 1 ) }
        \pgfpathrectanglecorners
          { \pgfpoint \l_tmpb_dim \l_tmpa_dim }
          { \pgfpoint \l_tmpd_dim \l_tmpc_dim }
        \pgfusepath { fill }
        \group_end:
      }
    \pgfpathmoveto { \pgfpoint \l_tmpb_dim \l_tmpa_dim }
    \pgfpathlineto { \pgfpoint \l_tmpb_dim \l_tmpc_dim }
    \prg_replicate:nn { #2 - 1 }
      {
        \dim_sub:Nn \l_tmpb_dim \arrayrulewidth
        \dim_sub:Nn \l_tmpb_dim \doublerulesep
        \pgfpathmoveto { \pgfpoint \l_tmpb_dim \l_tmpa_dim }
        \pgfpathlineto { \pgfpoint \l_tmpb_dim \l_tmpc_dim }
      }
    \CT@arc@
    \pgfsetlinewidth { 1.1 \arrayrulewidth }
    \pgfsetrectcap
    \pgfusepathqstroke
  }
```

The following command draws a complete vertical rule in the column `#1` (`#2` is the number of consecutive rules specified by the number of `|` in the preamble). This command will be used if there is no block in the array (and the key `corners` is not used).

```
\cs_new_protected:Npn \@@_vline_i_complete:nn #1 #2
  { \@@_vline_ii:nnnn { #1 } { #2 } 1 { \int_use:N \c@iRow } }
```

The command `\@@_draw_vlines:` draws all the vertical rules excepted in the blocks, in the virtual blocks (determined by a command such as `\Cdots`) and in the corners (if the key `corners` is used).

```
\cs_new_protected:Npn \@@_draw_vlines:
  {
    \int_step_inline:nnn
      {
        \bool_if:nTF { \l_@@_NiceArray_bool && ! \l_@@_except_borders_bool }
          1 2
      }
      {
        \bool_if:nTF { \l_@@_NiceArray_bool && ! \l_@@_except_borders_bool }
          { \@@_succ:n \c@jCol }
          \c@jCol
      }
      {
        \tl_if_eq:NnF \l_@@_vlines_clist { all }
          { \clist_if_in:NnT \l_@@_vlines_clist { ##1 } }
          { \@@_vline:nn { ##1 } 1 }
      }
  }
```

The horizontal rules

The following command will be executed in the `internal-code-after`. The rule will be drawn *before* the row `#1`. `#2` is the number of consecutive occurrences of `\Hline`.

```
\cs_new_protected:Npn \@@_hline:nn #1 #2
  {
    \pgfpicture
    \@@_hline_i:nn { #1 } { #2 }
    \endpgfpicture
  }
```

```
\cs_new_protected:Npn \@@_hline_i:nn #1 #2
  {
```

`\l_tmpa_tl` is the number of row and `\l_tmpb_tl` the number of column. When we have found a column corresponding to a rule to draw, we note its number in `\l_tmpc_tl`.

```
    \tl_set:Nn \l_tmpa_tl { #1 }
    \tl_clear_new:N \l_tmpc_tl
    \int_step_variable:nNn \c@jCol \l_tmpb_tl
      {
```

The boolean `\g_tmpa_bool` indicates whether the small horizontal rule will be drawn. If we find that it is in a block (a real block, created by `\Block` or a virtual block corresponding to a dotted line, created by `\Cdots`, `\Vdots`, etc.), we will set `\g_tmpa_bool` to `false` and the small horizontal rule won't be drawn.

```
        \bool_gset_true:N \g_tmpa_bool
        \seq_map_inline:Nn \g_@@_pos_of_blocks_seq
          { \@@_test_hline_in_block:nnnn ##1 }
        \seq_map_inline:Nn \g_@@_pos_of_xdots_seq
          { \@@_test_hline_in_block:nnnn ##1 }
        \seq_map_inline:Nn \g_@@_pos_of_stroken_blocks_seq
          { \@@_test_hline_in_stroken_block:nnnn ##1 }
        \clist_if_empty:NF \l_@@_corners_clist \@@_test_in_corner_h:
        \bool_if:NTF \g_tmpa_bool
          {
            \tl_if_empty:NT \l_tmpc_tl
```

We keep in memory that we have a rule to draw.

```
              { \tl_set_eq:NN \l_tmpc_tl \l_tmpb_tl }
          }
          {
            \tl_if_empty:NF \l_tmpc_tl
              {
                \@@_hline_ii:nnnn
                  { #1 }
                  { #2 }
                  \l_tmpc_tl
                  { \int_eval:n { \l_tmpb_tl - 1 } }
                \tl_clear:N \l_tmpc_tl
              }
          }
      }
    \tl_if_empty:NF \l_tmpc_tl
      {
        \@@_hline_ii:nnnn
          { #1 }
          { #2 }
          \l_tmpc_tl
          { \int_use:N \c@jCol }
        \tl_clear:N \l_tmpc_tl
      }
  }


\cs_new_protected:Npn \@@_test_in_corner_h:
   {
     \int_compare:nNnTF \l_tmpa_tl = { \@@_succ:n \c@iRow }
       {
         \seq_if_in:NxT
           \l_@@_corners_cells_seq
           { \@@_pred:n \l_tmpa_tl - \l_tmpb_tl }
           { \bool_set_false:N \g_tmpa_bool }
       }
       {
         \seq_if_in:NxT
           \l_@@_corners_cells_seq
```

```
            { \l_tmpa_tl - \l_tmpb_tl }
            {
              \int_compare:nNnTF \l_tmpa_tl = 1
                { \bool_set_false:N \g_tmpa_bool }
                {
                  \seq_if_in:NxT
                    \l_@@_corners_cells_seq
                    { \@@_pred:n \l_tmpa_tl - \l_tmpb_tl }
                    { \bool_set_false:N \g_tmpa_bool }
                }
            }
        }
    }
```

`#1` is the number of the row; `#2` is the number of horizontal rules to draw (with potentially a color between); `#3` and `#4` are the number of the columns between which the rule has to be drawn.

```
\cs_new_protected:Npn \@@_hline_ii:nnnn #1 #2 #3 #4
  {
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \@@_qpoint:n { col - #3 }
    \dim_set_eq:NN \l_tmpa_dim \pgf@x
    \@@_qpoint:n { row - #1 }
    \dim_set_eq:NN \l_tmpb_dim \pgf@y
    \@@_qpoint:n { col - \@@_succ:n { #4 } }
    \dim_set_eq:NN \l_tmpc_dim \pgf@x
    \bool_lazy_and:nnT
      { \int_compare_p:nNn { #2 } > 1 }
      { ! \tl_if_blank_p:V \CT@drsc@ }
      {
        \group_begin:
        \CT@drsc@
        \dim_set:Nn \l_tmpd_dim
          { \l_tmpb_dim - ( \doublerulesep + \arrayrulewidth ) * ( #2 - 1 ) }
        \pgfpathrectanglecorners
          { \pgfpoint \l_tmpa_dim \l_tmpb_dim }
          { \pgfpoint \l_tmpc_dim \l_tmpd_dim }
        \pgfusepathqfill
        \group_end:
      }
    \pgfpathmoveto { \pgfpoint \l_tmpa_dim \l_tmpb_dim }
    \pgfpathlineto { \pgfpoint \l_tmpc_dim \l_tmpb_dim }
    \prg_replicate:nn { #2 - 1 }
      {
        \dim_sub:Nn \l_tmpb_dim \arrayrulewidth
        \dim_sub:Nn \l_tmpb_dim \doublerulesep
        \pgfpathmoveto { \pgfpoint \l_tmpa_dim \l_tmpb_dim }
        \pgfpathlineto { \pgfpoint \l_tmpc_dim \l_tmpb_dim }
      }
    \CT@arc@
    \pgfsetlinewidth { 1.1 \arrayrulewidth }
    \pgfsetrectcap
    \pgfusepathqstroke
  }
```

```
\cs_new_protected:Npn \@@_hline_i_complete:nn #1 #2
  { \@@_hline_ii:nnnn { #1 } { #2 } 1 { \int_use:N \c@jCol } }
```

The command `\@@_draw_hlines:` draws all the horizontal rules excepted in the blocks (even the virtual drawn determined by commands such as `\Cdots` and in the corners (if the key `corners` is used).

```
\cs_new_protected:Npn \@@_draw_hlines:
  {
    \int_step_inline:nnn
      {
        \bool_if:nTF { \l_@@_NiceArray_bool && ! \l_@@_except_borders_bool }
          1 2
      }
      {
        \bool_if:nTF { \l_@@_NiceArray_bool && ! \l_@@_except_borders_bool }
          { \@@_succ:n \c@iRow }
          \c@iRow
      }
      {
        \tl_if_eq:NnF \l_@@_hlines_clist { all }
          { \clist_if_in:NnT \l_@@_hlines_clist { ##1 } }
          { \@@_hline:nn { ##1 } 1 }
      }
  }
```

The command `\@@_Hline:` will be linked to `\Hline` in the environments of nicematrix.

```
\cs_set:Npn \@@_Hline: { \noalign { \ifnum 0 = `} \fi \@@_Hline_i:n { 1 } }
```

The argument of the command `\@@_Hline_i:n` is the number of successive `\Hline` found.

```
\cs_set:Npn \@@_Hline_i:n #1
  {
    \peek_meaning_ignore_spaces:NTF \Hline
      { \@@_Hline_ii:nn { #1 + 1 } }
      { \@@_Hline_iii:n { #1 } }
  }
\cs_set:Npn \@@_Hline_ii:nn #1 #2 { \@@_Hline_i:n { #1 } }
\cs_set:Npn \@@_Hline_iii:n #1
  {
    \skip_vertical:n
      {
        \arrayrulewidth * ( #1 )
        + \doublerulesep * ( \int_max:nn 0 { #1 - 1 } )
      }
    \tl_gput_right:Nx \g_@@_internal_code_after_tl
      { \@@_hline:nn { \@@_succ:n { \c@iRow } } { #1 } }
    \ifnum 0 = `{ \fi }
  }
```

The key hvlines

The following command tests whether the current position in the array (given by `\l_tmpa_tl` for the row and `\l_tmpb_tl` for the column) would provide an horizontal rule towards the right in the block delimited by the four arguments `#1`, `#2`, `#3` and `#4`. If this rule would be in the block (it must not be drawn), the boolean `\l_tmpa_bool` is set to `false`.

```
\cs_new_protected:Npn \@@_test_hline_in_block:nnnn #1 #2 #3 #4
  {
    \bool_lazy_all:nT
      {
        { \int_compare_p:nNn \l_tmpa_tl > { #1 } }
        { \int_compare_p:nNn \l_tmpa_tl < { #3 + 1 } }
        { \int_compare_p:nNn \l_tmpb_tl > { #2 - 1 } }
        { \int_compare_p:nNn \l_tmpb_tl < { #4 + 1 } }
      }
      { \bool_gset_false:N \g_tmpa_bool }
  }
```

The same for vertical rules.

```
\cs_new_protected:Npn \@@_test_vline_in_block:nnnn #1 #2 #3 #4
  {
    \bool_lazy_all:nT
      {
        { \int_compare_p:nNn \l_tmpa_tl > { #1 - 1 } }
        { \int_compare_p:nNn \l_tmpa_tl < { #3 + 1 } }
        { \int_compare_p:nNn \l_tmpb_tl > { #2 } }
        { \int_compare_p:nNn \l_tmpb_tl < { #4 + 1 } }
      }
      { \bool_gset_false:N \g_tmpa_bool }
  }
\cs_new_protected:Npn \@@_test_hline_in_stroken_block:nnnn #1 #2 #3 #4
  {
    \bool_lazy_all:nT
      {
        { \int_compare_p:nNn \l_tmpa_tl > { #1 - 1 } }
        { \int_compare_p:nNn \l_tmpa_tl < { #3 + 2 } }
        { \int_compare_p:nNn \l_tmpb_tl > { #2 - 1 } }
        { \int_compare_p:nNn \l_tmpb_tl < { #4 + 1 } }
      }
      { \bool_gset_false:N \g_tmpa_bool }
  }
\cs_new_protected:Npn \@@_test_vline_in_stroken_block:nnnn #1 #2 #3 #4
  {
    \bool_lazy_all:nT
      {
        { \int_compare_p:nNn \l_tmpa_tl > { #1 - 1 } }
        { \int_compare_p:nNn \l_tmpa_tl < { #3 + 1 } }
        { \int_compare_p:nNn \l_tmpb_tl > { #2 - 1 } }
        { \int_compare_p:nNn \l_tmpb_tl < { #4 + 2 } }
      }
      { \bool_gset_false:N \g_tmpa_bool }
  }
```

The key corners

When the key `corners` is raised, the rules are not drawn in the corners. Of course, we have to compute the corners before we begin to draw the rules.

```
\cs_new_protected:Npn \@@_compute_corners:
  {
```

The sequence `\l_@@_corners_cells_seq` will be the sequence of all the empty cells (and not in a block) considered in the corners of the array.

```
    \seq_clear_new:N \l_@@_corners_cells_seq
    \clist_map_inline:Nn \l_@@_corners_clist
      {
        \str_case:nnF { ##1 }
          {
            { NW }
            { \@@_compute_a_corner:nnnnnn 1 1 1 1 \c@iRow \c@jCol }
            { NE }
            { \@@_compute_a_corner:nnnnnn 1 \c@jCol 1 { -1 } \c@iRow 1 }
            { SW }
            { \@@_compute_a_corner:nnnnnn \c@iRow 1 { -1 } 1 1 \c@jCol }
            { SE }
            { \@@_compute_a_corner:nnnnnn \c@iRow \c@jCol { -1 } { -1 } 1 1 }
          }
          { \@@_error:nn { bad~corner } { ##1 } }
      }
```

Even if the user has used the key `corners` (or the key `hvlines-except-corners`), the list of cells in the corners may be empty.

```
    \seq_if_empty:NF \l_@@_corners_cells_seq
      {
```

You write on the `aux` file the list of the cells which are in the (empty) corners because you need that information in the `\CodeBefore` since the commands which color the `rows`, `columns` and `cells` must not color the cells in the corners.

```
        \tl_gput_right:Nx \g_@@_aux_tl
          {
            \seq_set_from_clist:Nn \exp_not:N \l_@@_corners_cells_seq
              { \seq_use:Nnnn \l_@@_corners_cells_seq , , , }
            \iow_newline:
          }
      }
  }
```

"Computing a corner" is determining all the empty cells (which are not in a block) that belong to that corner. These cells will be added to the sequence `\l_@@_corners_cells_seq`.

The six arguments of `\@@_compute_a_corner:nnnnnn` are as follow:

- `#1` and `#2` are the number of row and column of the cell which is actually in the corner;
- `#3` and `#4` are the steps in rows and the step in columns when moving from the corner;
- `#5` is the number of the final row when scanning the rows from the corner;
- `#6` is the number of the final column when scanning the columns from the corner.

```
\cs_new_protected:Npn \@@_compute_a_corner:nnnnnn #1 #2 #3 #4 #5 #6
  {
```

For the explanations and the name of the variables, we consider that we are computing the left-upper corner.
First, we try to determine which is the last empty cell (and not in a block: we won't add that precision any longer) in the column of number 1. The flag `\l_tmpa_bool` will be raised when a non-empty cell is found.

```
    \bool_set_false:N \l_tmpa_bool
    \int_zero_new:N \l_@@_last_empty_row_int
    \int_set:Nn \l_@@_last_empty_row_int { #1 }
    \int_step_inline:nnnn { #1 } { #3 } { #5 }
      {
        \@@_test_if_cell_in_a_block:nn { ##1 } { \int_eval:n { #2 } }
        \bool_lazy_or:nnTF
          {
             \cs_if_exist_p:c
               { pgf @ sh @ ns @ \@@_env: - ##1 - \int_eval:n { #2 } }
          }
          \l_tmpb_bool
          { \bool_set_true:N \l_tmpa_bool }
          {
            \bool_if:NF \l_tmpa_bool
              { \int_set:Nn \l_@@_last_empty_row_int { ##1 } }
          }
      }
```

Now, you determine the last empty cell in the row of number 1.

```
    \bool_set_false:N \l_tmpa_bool
    \int_zero_new:N \l_@@_last_empty_column_int
    \int_set:Nn \l_@@_last_empty_column_int { #2 }
    \int_step_inline:nnnn { #2 } { #4 } { #6 }
      {
        \@@_test_if_cell_in_a_block:nn { \int_eval:n { #1 } } { ##1 }
        \bool_lazy_or:nnTF
```

```
          \l_tmpb_bool
          {
            \cs_if_exist_p:c
              { pgf @ sh @ ns @ \@@_env: - \int_eval:n { #1 } - ##1 }
          }
          { \bool_set_true:N \l_tmpa_bool }
          {
            \bool_if:NF \l_tmpa_bool
              { \int_set:Nn \l_@@_last_empty_column_int { ##1 } }
          }
      }
```

Now, we loop over the rows.

```
    \int_step_inline:nnnn { #1 } { #3 } \l_@@_last_empty_row_int
      {
```

We treat the row number ##1 with another loop.

```
        \bool_set_false:N \l_tmpa_bool
        \int_step_inline:nnnn { #2 } { #4 } \l_@@_last_empty_column_int
          {
            \@@_test_if_cell_in_a_block:nn { ##1 } { ####1 }
            \bool_lazy_or:nnTF
              \l_tmpb_bool
              {
                \cs_if_exist_p:c
                  { pgf @ sh @ ns @ \@@_env: - ##1 - ####1 }
              }
              { \bool_set_true:N \l_tmpa_bool }
              {
                \bool_if:NF \l_tmpa_bool
                  {
                    \int_set:Nn \l_@@_last_empty_column_int { ####1 }
                    \seq_put_right:Nn
                      \l_@@_corners_cells_seq
                      { ##1 - ####1 }
                  }
              }
          }
      }
  }
```

The following macro tests whether a cell is in (at least) one of the blocks of the array (or in a cell with a \diagbox).
The flag \l_tmpb_bool will be raised if the cell #1-#2 is in a block (or in a cell with a \diagbox).

```
\cs_new_protected:Npn \@@_test_if_cell_in_a_block:nn #1 #2
  {
    \int_set:Nn \l_tmpa_int { #1 }
    \int_set:Nn \l_tmpb_int { #2 }
    \bool_set_false:N \l_tmpb_bool
    \seq_map_inline:Nn \g_@@_pos_of_blocks_seq
      { \@@_test_if_cell_in_block:nnnnnnn \l_tmpa_int \l_tmpb_int ##1 }
  }
\cs_new_protected:Npn \@@_test_if_cell_in_block:nnnnnnn #1 #2 #3 #4 #5 #6
  {
    \int_compare:nNnT { #3 } < { \@@_succ:n { #1 } }
      {
        \int_compare:nNnT { #1 } < { \@@_succ:n { #5 } }
          {
            \int_compare:nNnT { #4 } < { \@@_succ:n { #2 } }
              {
                \int_compare:nNnT { #2 } < { \@@_succ:n { #6 } }
                  { \bool_set_true:N \l_tmpb_bool }
              }
```

```
        }
    }
}
```

The commands to draw dotted lines to separate columns and rows

These commands don't use the normal nodes, the medium nor the large nodes. They only use the `col` nodes and the `row` nodes.

Horizontal dotted lines

The following command must *not* be protected because it's meant to be expanded in a `\noalign`.

```
\cs_new:Npn \@@_hdottedline:
  {
    \noalign { \skip_vertical:N 2\l_@@_radius_dim }
    \@@_hdottedline_i:
  }
```

On the other side, the following command should be protected.

```
\cs_new_protected:Npn \@@_hdottedline_i:
  {
```

We write in the code-after the instruction that will actually draw the dotted line. It's not possible to draw this dotted line now because we don't know the length of the line (we don't even know the number of columns).

```
    \tl_gput_right:Nx \g_@@_internal_code_after_tl
      { \@@_hdottedline:n { \int_use:N \c@iRow } }
  }
```

The command `\@@_hdottedline:n` is the command written in the `\CodeAfter` that will actually draw the dotted line. Its argument is the number of the row *before* which we will draw the row.

```
\AtBeginDocument
  {
```

We recall that, when externalization is used, `\tikzpicture` and `\endtikzpicture` (or `\pgfpicture` and `\endpgfpicture`) must be directly "visible". That's why we construct now a version of `\@@_hdottedline:n` with the right environment (`\begin{pgfpicture}\end{pgfpicture}` or `\begin{tikzpiture}...\end{tikzpicture}`).

```
    \cs_new_protected:Npx \@@_hdottedline:n #1
      {
        \bool_set_true:N \exp_not:N \l_@@_initial_open_bool
        \bool_set_true:N \exp_not:N \l_@@_final_open_bool
        \c_@@_pgfortikzpicture_tl
        \@@_hdottedline_i:n { #1 }
        \c_@@_endpgfortikzpicture_tl
      }
  }
```

The following command *must* be protected since it is used in the construction of `\@@_hdottedline:n`.

```
\cs_new_protected:Npn \@@_hdottedline_i:n #1
  {
    \pgfrememberpicturepositiononpagetrue
    \@@_qpoint:n { row - #1 }
```

We do a translation par `-\l_@@_radius_dim` because we want the dotted line to have exactly the same position as a vertical rule drawn by "`|`" (considering the rule having a width equal to the diameter of the dots).

```
    \dim_set_eq:NN \l_@@_y_initial_dim \pgf@y
    \dim_sub:Nn \l_@@_y_initial_dim \l_@@_radius_dim
    \dim_set_eq:NN \l_@@_y_final_dim \l_@@_y_initial_dim
```

The dotted line will be extended if the user uses `margin` (or `left-margin` and `right-margin`).

The aim is that, by standard the dotted line fits between square brackets (`\hline` doesn't).

```
\begin{bNiceMatrix}
1 & 2 & 3 & 4 \\
\hline
1 & 2 & 3 & 4 \\
\hdottedline
1 & 2 & 3 & 4
\end{bNiceMatrix}
```

$$\begin{bmatrix} 1 & 2 & 3 & 4 \\ \hline 1 & 2 & 3 & 4 \\ \hdottedline 1 & 2 & 3 & 4 \end{bmatrix}$$

But, if the user uses `margin`, the dotted line extends to have the same width as a `\hline`.

```
\begin{bNiceMatrix}[margin]
1 & 2 & 3 & 4 \\
\hline
1 & 2 & 3 & 4 \\
\hdottedline
1 & 2 & 3 & 4
\end{bNiceMatrix}
```

$$\begin{bmatrix} 1 & 2 & 3 & 4 \\ \hline 1 & 2 & 3 & 4 \\ \hdottedline 1 & 2 & 3 & 4 \end{bmatrix}$$

```
    \@@_qpoint:n { col - 1 }
    \dim_set:Nn \l_@@_x_initial_dim
      {
        \pgf@x +
```

We do a reduction by `\arraycolsep` for the environments with delimiters (and not for the other).

```
        \bool_if:NTF \l_@@_NiceArray_bool \c_zero_dim \arraycolsep
        - \l_@@_left_margin_dim
      }
    \@@_qpoint:n { col - \@@_succ:n \c@jCol }
    \dim_set:Nn \l_@@_x_final_dim
      {
        \pgf@x -
        \bool_if:NTF \l_@@_NiceArray_bool \c_zero_dim \arraycolsep
        + \l_@@_right_margin_dim
      }
```

For reasons purely aesthetic, we do an adjustment in the case of a rounded bracket. The correction by `0.5 \l_@@_inter_dots_dim` is *ad hoc* for a better result.

```
    \tl_if_eq:NnF \g_@@_left_delim_tl (
      { \dim_gadd:Nn \l_@@_x_initial_dim  { 0.5 \l_@@_inter_dots_dim } }
    \tl_if_eq:NnF \g_@@_right_delim_tl )
      { \dim_gsub:Nn \l_@@_x_final_dim { 0.5 \l_@@_inter_dots_dim } }
```

Up to now, we have no option to control the style of the lines drawn by `\hdottedline` and the specifier ":" in the preamble. That's why we impose the style `standard`.

```
    \tl_set_eq:NN \l_@@_xdots_line_style_tl \c_@@_standard_tl
    \@@_draw_line:
  }
```

Vertical dotted lines

```
\cs_new_protected:Npn \@@_vdottedline:n #1
  {
    \bool_set_true:N \l_@@_initial_open_bool
    \bool_set_true:N \l_@@_final_open_bool
```

We recall that, when externalization is used, `\tikzpicture` and `\endtikzpicture` (or `\pgfpicture` and `\endpgfpicture`) must be directly "visible".

```
    \bool_if:NTF \c_@@_tikz_loaded_bool
      {
        \tikzpicture
        \@@_vdottedline_i:n { #1 }
        \endtikzpicture
```

```
      }
      {
        \pgfpicture
        \@@_vdottedline_i:n { #1 }
        \endpgfpicture
      }
  }

\cs_new_protected:Npn \@@_vdottedline_i:n #1
  {
```

The command `\CT@arc@` is a command of colortbl which sets the color of the rules in the array. The package nicematrix uses it even if colortbl is not loaded.

```
    \CT@arc@
    \pgfrememberpicturepositiononpagetrue
    \@@_qpoint:n { col - \int_eval:n { #1 + 1 } }
```

We do a translation par `-\l_@@_radius_dim` because we want the dotted line to have exactly the same position as a vertical rule drawn by "`|`" (considering the rule having a width equal to the diameter of the dots).

```
    \dim_set:Nn \l_@@_x_initial_dim { \pgf@x - \l_@@_radius_dim }
    \dim_set:Nn \l_@@_x_final_dim { \pgf@x - \l_@@_radius_dim }
    \@@_qpoint:n { row - 1 }
```

We arbitrary decrease the height of the dotted line by a quantity equal to `\l_@@_inter_dots_dim` in order to improve the visual impact.

```
    \dim_set:Nn \l_@@_y_initial_dim { \pgf@y - 0.5 \l_@@_inter_dots_dim }
    \@@_qpoint:n { row - \@@_succ:n \c@iRow }
    \dim_set:Nn \l_@@_y_final_dim { \pgf@y + 0.5 \l_@@_inter_dots_dim }
```

Up to now, we have no option to control the style of the lines drawn by `\hdottedline` and the specifier "`:`" in the preamble. That's why we impose the style `standard`.

```
    \tl_set_eq:NN \l_@@_xdots_line_style_tl \c_@@_standard_tl
    \@@_draw_line:
  }
```

The environment {NiceMatrixBlock}

The following flag will be raised when all the columns of the environments of the block must have the same width in "auto" mode.

```
\bool_new:N \l_@@_block_auto_columns_width_bool
```

Up to now, there is only one option available for the environment `{NiceMatrixBlock}`.

```
\keys_define:nn { NiceMatrix / NiceMatrixBlock }
  {
    auto-columns-width .code:n =
      {
        \bool_set_true:N \l_@@_block_auto_columns_width_bool
        \dim_gzero_new:N \g_@@_max_cell_width_dim
        \bool_set_true:N \l_@@_auto_columns_width_bool
      }
  }

\NewDocumentEnvironment { NiceMatrixBlock } { ! O { } }
  {
    \int_gincr:N \g_@@_NiceMatrixBlock_int
    \dim_zero:N \l_@@_columns_width_dim
    \keys_set:nn { NiceMatrix / NiceMatrixBlock } { #1 }
    \bool_if:NT \l_@@_block_auto_columns_width_bool
      {
```

```
        \cs_if_exist:cT { @@_max_cell_width_ \int_use:N \g_@@_NiceMatrixBlock_int }
          {
            \exp_args:NNc \dim_set:Nn \l_@@_columns_width_dim
              { @@_max_cell_width_ \int_use:N \g_@@_NiceMatrixBlock_int }
          }
      }
  }
```

At the end of the environment `{NiceMatrixBlock}`, we write in the main `.aux` file instructions for the column width of all the environments of the block (that's why we have stored the number of the first environment of the block in the counter `\l_@@_first_env_block_int`).

```
  {
    \bool_if:NT \l_@@_block_auto_columns_width_bool
      {
        \iow_shipout:Nn \@mainaux \ExplSyntaxOn
        \iow_shipout:Nx \@mainaux
          {
            \cs_gset:cpn
              { @@ _ max _ cell _ width _ \int_use:N \g_@@_NiceMatrixBlock_int }
```

For technical reasons, we have to include the width of a potential rule on the right side of the cells.

```
              { \dim_eval:n { \g_@@_max_cell_width_dim + \arrayrulewidth } }
          }
        \iow_shipout:Nn \@mainaux \ExplSyntaxOff
      }
  }
```

The extra nodes

First, two variants of the functions `\dim_min:nn` and `\dim_max:nn`.

```
\cs_generate_variant:Nn \dim_min:nn { v n }
\cs_generate_variant:Nn \dim_max:nn { v n }
```

The following command is called in `\@@_use_arraybox_with_notes_c:` just before the construction of the blocks (if the creation of medium nodes is required, medium nodes are also created for the blocks and that construction uses the standard medium nodes).

```
\cs_new_protected:Npn \@@_create_extra_nodes:
  {
    \bool_if:nTF \l_@@_medium_nodes_bool
      {
        \bool_if:NTF \l_@@_large_nodes_bool
          \@@_create_medium_and_large_nodes:
          \@@_create_medium_nodes:
      }
      { \bool_if:NT \l_@@_large_nodes_bool \@@_create_large_nodes: }
  }
```

We have three macros of creation of nodes: `\@@_create_medium_nodes:`, `\@@_create_large_nodes:` and `\@@_create_medium_and_large_nodes:`.

We have to compute the mathematical coordinates of the "medium nodes". These mathematical coordinates are also used to compute the mathematical coordinates of the "large nodes". That's why we write a command `\@@_computations_for_medium_nodes:` to do these computations.

The command `\@@_computations_for_medium_nodes:` must be used in a `{pgfpicture}`.

For each row i, we compute two dimensions `l_@@_row_`i`_min_dim` and `l_@@_row_`i`_max_dim`. The dimension `l_@@_row_`i`_min_dim` is the minimal y-value of all the cells of the row i. The dimension `l_@@_row_`i`_max_dim` is the maximal y-value of all the cells of the row i.
Similarly, for each column j, we compute two dimensions `l_@@_column_`j`_min_dim` and `l_@@_column_`j`_max_dim`. The dimension `l_@@_column_`j`_min_dim` is the minimal x-value of all the cells

of the column j. The dimension `l_@@_column_j_max_dim` is the maximal x-value of all the cells of the column j.
Since these dimensions will be computed as maximum or minimum, we initialize them to `\c_max_dim` or `-\c_max_dim`.

```
\cs_new_protected:Npn \@@_computations_for_medium_nodes:
  {
    \int_step_variable:nnNn \l_@@_first_row_int \g_@@_row_total_int \@@_i:
      {
        \dim_zero_new:c { l_@@_row_\@@_i: _min_dim }
        \dim_set_eq:cN { l_@@_row_\@@_i: _min_dim } \c_max_dim
        \dim_zero_new:c { l_@@_row_\@@_i: _max_dim }
        \dim_set:cn { l_@@_row_\@@_i: _max_dim } { - \c_max_dim }
      }
    \int_step_variable:nnNn \l_@@_first_col_int \g_@@_col_total_int \@@_j:
      {
        \dim_zero_new:c { l_@@_column_\@@_j: _min_dim }
        \dim_set_eq:cN { l_@@_column_\@@_j: _min_dim } \c_max_dim
        \dim_zero_new:c { l_@@_column_\@@_j: _max_dim }
        \dim_set:cn { l_@@_column_\@@_j: _max_dim } { - \c_max_dim }
      }
```

We begin the two nested loops over the rows and the columns of the array.

```
    \int_step_variable:nnNn \l_@@_first_row_int \g_@@_row_total_int \@@_i:
      {
        \int_step_variable:nnNn
          \l_@@_first_col_int \g_@@_col_total_int \@@_j:
```

If the cell (i-j) is empty or an implicit cell (that is to say a cell after implicit ampersands `&`) we don't update the dimensions we want to compute.

```
          {
            \cs_if_exist:cT
              { pgf @ sh @ ns @ \@@_env: - \@@_i: - \@@_j: }
```

We retrieve the coordinates of the anchor `south west` of the (normal) node of the cell (i-j). They will be stored in `\pgf@x` and `\pgf@y`.

```
              {
                \pgfpointanchor { \@@_env: - \@@_i: - \@@_j: } { south~west }
                \dim_set:cn { l_@@_row_\@@_i: _min_dim}
                  { \dim_min:vn { l_@@_row _ \@@_i: _min_dim } \pgf@y }
                \seq_if_in:NxF \g_@@_multicolumn_cells_seq { \@@_i: - \@@_j: }
                  {
                    \dim_set:cn { l_@@_column _ \@@_j: _min_dim}
                      { \dim_min:vn { l_@@_column _ \@@_j: _min_dim } \pgf@x }
                  }
```

We retrieve the coordinates of the anchor `north east` of the (normal) node of the cell (i-j). They will be stored in `\pgf@x` and `\pgf@y`.

```
                \pgfpointanchor { \@@_env: - \@@_i: - \@@_j: } { north~east }
                \dim_set:cn { l_@@_row _ \@@_i: _ max_dim }
                  { \dim_max:vn { l_@@_row _ \@@_i: _ max_dim } \pgf@y }
                \seq_if_in:NxF \g_@@_multicolumn_cells_seq { \@@_i: - \@@_j: }
                  {
                    \dim_set:cn { l_@@_column _ \@@_j: _ max_dim }
                      { \dim_max:vn { l_@@_column _ \@@_j: _max_dim } \pgf@x }
                  }
              }
          }
      }
```

Now, we have to deal with empty rows or empty columns since we don't have created nodes in such rows and columns.

```
    \int_step_variable:nnNn \l_@@_first_row_int \g_@@_row_total_int \@@_i:
      {
        \dim_compare:nNnT
          { \dim_use:c { l_@@_row _ \@@_i: _ min _ dim } } = \c_max_dim
```

```
          {
            \@@_qpoint:n { row - \@@_i: - base }
            \dim_set:cn { l_@@_row _ \@@_i: _ max _ dim } \pgf@y
            \dim_set:cn { l_@@_row _ \@@_i: _ min _ dim } \pgf@y
          }
      }
    \int_step_variable:nnNn \l_@@_first_col_int \g_@@_col_total_int \@@_j:
      {
        \dim_compare:nNnT
          { \dim_use:c { l_@@_column _ \@@_j: _ min _ dim } } = \c_max_dim
          {
            \@@_qpoint:n { col - \@@_j: }
            \dim_set:cn { l_@@_column _ \@@_j: _ max _ dim } \pgf@y
            \dim_set:cn { l_@@_column _ \@@_j: _ min _ dim } \pgf@y
          }
      }
  }
```

Here is the command `\@@_create_medium_nodes:`. When this command is used, the "medium nodes" are created.

```
\cs_new_protected:Npn \@@_create_medium_nodes:
  {
    \pgfpicture
      \pgfrememberpicturepositiononpagetrue
      \pgf@relevantforpicturesizefalse
      \@@_computations_for_medium_nodes:
```

Now, we can create the "medium nodes". We use a command `\@@_create_nodes:` because this command will also be used for the creation of the "large nodes".

```
      \tl_set:Nn \l_@@_suffix_tl { -medium }
      \@@_create_nodes:
      \endpgfpicture
  }
```

The command `\@@_create_large_nodes:` must be used when we want to create only the "large nodes" and not the medium ones[63]. However, the computation of the mathematical coordinates of the "large nodes" needs the computation of the mathematical coordinates of the "medium nodes". Hence, we use first `\@@_computations_for_medium_nodes:` and then the command `\@@_computations_for_large_nodes:`.

```
\cs_new_protected:Npn \@@_create_large_nodes:
  {
    \pgfpicture
      \pgfrememberpicturepositiononpagetrue
      \pgf@relevantforpicturesizefalse
      \@@_computations_for_medium_nodes:
      \@@_computations_for_large_nodes:
      \tl_set:Nn \l_@@_suffix_tl { - large }
      \@@_create_nodes:
    \endpgfpicture
  }
\cs_new_protected:Npn \@@_create_medium_and_large_nodes:
  {
    \pgfpicture
      \pgfrememberpicturepositiononpagetrue
      \pgf@relevantforpicturesizefalse
      \@@_computations_for_medium_nodes:
```

Now, we can create the "medium nodes". We use a command `\@@_create_nodes:` because this command will also be used for the creation of the "large nodes".

[63] If we want to create both, we have to use `\@@_create_medium_and_large_nodes:`

```
      \tl_set:Nn \l_@@_suffix_tl { - medium }
      \@@_create_nodes:
      \@@_computations_for_large_nodes:
      \tl_set:Nn \l_@@_suffix_tl { - large }
      \@@_create_nodes:
    \endpgfpicture
  }
```

For "large nodes", the exterior rows and columns don't interfer. That's why the loop over the columns will start at 1 and stop at `\c@jCol` (and not `\g_@@_col_total_int`). Idem for the rows.

```
\cs_new_protected:Npn \@@_computations_for_large_nodes:
  {
    \int_set:Nn \l_@@_first_row_int 1
    \int_set:Nn \l_@@_first_col_int 1
```

We have to change the values of all the dimensions `l_@@_row_`*i*`_min_dim`, `l_@@_row_`*i*`_max_dim`, `l_@@_column_`*j*`_min_dim` and `l_@@_column_`*j*`_max_dim`.

```
    \int_step_variable:nNn { \c@iRow - 1 } \@@_i:
      {
        \dim_set:cn { l_@@_row _ \@@_i: _ min _ dim }
          {
            (
              \dim_use:c { l_@@_row _ \@@_i: _ min _ dim } +
              \dim_use:c { l_@@_row _ \@@_succ:n \@@_i: _ max _ dim }
            )
            / 2
          }
        \dim_set_eq:cc { l_@@_row _ \@@_succ:n \@@_i: _ max _ dim }
          { l_@@_row_\@@_i: _min_dim }
      }
    \int_step_variable:nNn { \c@jCol - 1 } \@@_j:
      {
        \dim_set:cn { l_@@_column _ \@@_j: _ max _ dim }
          {
            (
              \dim_use:c { l_@@_column _ \@@_j: _ max _ dim } +
              \dim_use:c
                { l_@@_column _ \@@_succ:n \@@_j: _ min _ dim }
            )
            / 2
          }
        \dim_set_eq:cc { l_@@_column _ \@@_succ:n \@@_j: _ min _ dim }
          { l_@@_column _ \@@_j: _ max _ dim }
      }
```

Here, we have to use `\dim_sub:cn` because of the number 1 in the name.

```
    \dim_sub:cn
      { l_@@_column _ 1 _ min _ dim }
      \l_@@_left_margin_dim
    \dim_add:cn
      { l_@@_column _ \int_use:N \c@jCol _ max _ dim }
      \l_@@_right_margin_dim
  }
```

The command `\@@_create_nodes:` is used twice: for the construction of the "medium nodes" and for the construction of the "large nodes". The nodes are constructed with the value of all the dimensions `l_@@_row_`*i*`_min_dim`, `l_@@_row_`*i*`_max_dim`, `l_@@_column_`*j*`_min_dim` and `l_@@_column_`*j*`_max_dim`. Between the construction of the "medium nodes" and the "large nodes", the values of these dimensions are changed.
The function also uses `\l_@@_suffix_tl` (`-medium` or `-large`).

```
\cs_new_protected:Npn \@@_create_nodes:
  {
```

```
    \int_step_variable:nnNn \l_@@_first_row_int \g_@@_row_total_int \@@_i:
      {
        \int_step_variable:nnNn \l_@@_first_col_int \g_@@_col_total_int \@@_j:
          {
```

We draw the rectangular node for the cell (`\@@_i-\@@_j`).

```
            \@@_pgf_rect_node:nnnnn
              { \@@_env: - \@@_i: - \@@_j: \l_@@_suffix_tl }
              { \dim_use:c { l_@@_column_ \@@_j: _min_dim } }
              { \dim_use:c { l_@@_row_ \@@_i: _min_dim } }
              { \dim_use:c { l_@@_column_ \@@_j: _max_dim } }
              { \dim_use:c { l_@@_row_ \@@_i: _max_dim } }
            \str_if_empty:NF \l_@@_name_str
              {
                \pgfnodealias
                  { \l_@@_name_str - \@@_i: - \@@_j: \l_@@_suffix_tl }
                  { \@@_env: - \@@_i: - \@@_j: \l_@@_suffix_tl }
              }
          }
      }
```

Now, we create the nodes for the cells of the `\multicolumn`. We recall that we have stored in `\g_@@_multicolumn_cells_seq` the list of the cells where a `\multicolumn{`n`}{...}{...}` with n>1 was issued and in `\g_@@_multicolumn_sizes_seq` the correspondant values of n.

```
    \seq_mapthread_function:NNN
      \g_@@_multicolumn_cells_seq
      \g_@@_multicolumn_sizes_seq
      \@@_node_for_multicolumn:nn
  }


\cs_new_protected:Npn \@@_extract_coords_values: #1 - #2 \q_stop
  {
    \cs_set_nopar:Npn \@@_i: { #1 }
    \cs_set_nopar:Npn \@@_j: { #2 }
  }
```

The command `\@@_node_for_multicolumn:nn` takes two arguments. The first is the position of the cell where the command `\multicolumn{`n`}{...}{...}` was issued in the format i-j and the second is the value of n (the length of the "multi-cell").

```
\cs_new_protected:Npn \@@_node_for_multicolumn:nn #1 #2
  {
    \@@_extract_coords_values: #1 \q_stop
    \@@_pgf_rect_node:nnnnn
      { \@@_env: - \@@_i: - \@@_j: \l_@@_suffix_tl }
      { \dim_use:c { l_@@_column _ \@@_j: _ min _ dim } }
      { \dim_use:c { l_@@_row _ \@@_i: _ min _ dim } }
      { \dim_use:c { l_@@_column _ \int_eval:n { \@@_j: +#2-1 } _ max _ dim } }
      { \dim_use:c { l_@@_row _ \@@_i: _ max _ dim } }
    \str_if_empty:NF \l_@@_name_str
      {
        \pgfnodealias
          { \l_@@_name_str - \@@_i: - \@@_j: \l_@@_suffix_tl }
          { \int_use:N \g_@@_env_int - \@@_i: - \@@_j: \l_@@_suffix_tl}
      }
  }
```

The blocks

The code deals with the command `\Block`. This command has no direct link with the environment `{NiceMatrixBlock}`.

The options of the command \Block will be analyzed first in the cell of the array (and once again when the block will be put in the array). Here is the set of keys for the first pass.

```
\keys_define:nn { NiceMatrix / Block / FirstPass }
  {
    l .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl l ,
    l .value_forbidden:n = true ,
    r .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl r ,
    r .value_forbidden:n = true ,
    c .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl c ,
    c .value_forbidden:n = true ,
    L .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl l ,
    L .value_forbidden:n = true ,
    R .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl r ,
    R .value_forbidden:n = true ,
    C .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl c ,
    C .value_forbidden:n = true ,
    t .code:n = \tl_set:Nn \l_@@_vpos_of_block_tl t ,
    t .value_forbidden:n = true ,
    b .code:n = \tl_set:Nn \l_@@_vpos_of_block_tl b ,
    b .value_forbidden:n = true ,
    color .tl_set:N = \l_@@_color_tl ,
    color .value_required:n = true ,
  }
```

The following command \@@_Block: will be linked to \Block in the environments of nicematrix. We define it with \NewExpandableDocumentCommand because it has an optional argument between < and > (for TeX instructions put before the math mode of the label and before the beginning of the small array of the block). It's mandatory to use an expandable command.

```
\NewExpandableDocumentCommand \@@_Block: { O { } m D < > { } m }
  {
```

If the first mandatory argument of the command (which is the size of the block with the syntax i-j) has not be provided by the user, you use 1-1 (that is to say a block of only one cell).

```
    \peek_remove_spaces:n
      {
        \tl_if_blank:nTF { #2 }
          { \@@_Block_i 1-1 \q_stop }
          { \@@_Block_i #2 \q_stop }
        { #1 } { #3 } { #4 }
      }
  }
```

With the following construction, we extract the values of i and j in the first mandatory argument of the command.

```
\cs_new:Npn \@@_Block_i #1-#2 \q_stop { \@@_Block_ii:nnnnn { #1 } { #2 } }
```

Now, the arguments have been extracted: #1 is i (the number of rows of the block), #2 is j (the number of columns of the block), #3 is the list of key-values, #4 are the tokens to put before the math mode and the beginning of the small array of the block and #5 is the label of the block.

```
\cs_new_protected:Npn \@@_Block_ii:nnnnn #1 #2 #3 #4 #5
  {
```

We recall that #1 and #2 have been extracted from the first mandatory argument of \Block (which is of the syntax i-j). However, the user is allowed to omit i or j (or both). We detect that situation by replacing a missing value by 100 (it's a convention: when the block will actually be drawn these values will be detected and interpreted as *maximal possible value* according to the actual size of the array).

```
    \bool_lazy_or:nnTF
      { \tl_if_blank_p:n { #1 } }
      { \str_if_eq_p:nn { #1 } { * } }
      { \int_set:Nn \l_tmpa_int { 100 } }
      { \int_set:Nn \l_tmpa_int { #1 } }
```

```
    \bool_lazy_or:nnTF
      { \tl_if_blank_p:n { #2 } }
      { \str_if_eq_p:nn { #2 } { * } }
      { \int_set:Nn \l_tmpb_int { 100 } }
      { \int_set:Nn \l_tmpb_int { #2 } }
```

If the block is mono-column.

```
    \int_compare:nNnTF \l_tmpb_int = 1
      {
        \tl_if_empty:NTF \l_@@_cell_type_tl
          { \tl_set:Nn \l_@@_hpos_of_block_tl c }
          { \tl_set_eq:NN \l_@@_hpos_of_block_tl \l_@@_cell_type_tl }
      }
      { \tl_set:Nn \l_@@_hpos_of_block_tl c }
```

The value of `\l_@@_hpos_of_block_tl` may be modified by the keys of the command `\Block` that we will analyze now.

```
    \keys_set_known:nn { NiceMatrix / Block / FirstPass } { #3 }
    \tl_set:Nx \l_tmpa_tl
      {
        { \int_use:N \c@iRow }
        { \int_use:N \c@jCol }
        { \int_eval:n { \c@iRow + \l_tmpa_int - 1 } }
        { \int_eval:n { \c@jCol + \l_tmpb_int - 1 } }
      }
```

Now, `\l_tmpa_tl` contains an "object" corresponding to the position of the block with four components, each of them surrounded by curly brackets:
{*imin*}{*jmin*}{*imax*}{*jmax*}.

If the block is mono-column or mono-row, we have a special treatment. That's why we have two macros: `\@@_Block_iv:nnnnn` and `\@@_Block_v:nnnnn` (the five arguments of those macros are provided by curryfication).

```
    \bool_lazy_or:nnTF
      { \int_compare_p:nNn { \l_tmpa_int } = 1 }
      { \int_compare_p:nNn { \l_tmpb_int } = 1 }
      { \exp_args:Nxx \@@_Block_iv:nnnnn }
      { \exp_args:Nxx \@@_Block_v:nnnnn }
    { \l_tmpa_int } { \l_tmpb_int } { #3 } { #4 } { #5 }
  }
```

The following macro is for the case of a `\Block` which is mono-row or mono-column (or both). In that case, the content of the block is composed right now in a box (because we have to take into account the dimensions of that box for the width of the current column or the height and the depth of the current row). However, that box will be put in the array *after the construction of the array* (by using PGF).

```
\cs_new_protected:Npn \@@_Block_iv:nnnnn #1 #2 #3 #4 #5
  {
    \int_gincr:N \g_@@_block_box_int
    \cs_set_protected_nopar:Npn \diagbox ##1 ##2
      {
        \tl_gput_right:Nx \g_@@_internal_code_after_tl
          {
            \@@_actually_diagbox:nnnnnn
              { \int_use:N \c@iRow }
              { \int_use:N \c@jCol }
              { \int_eval:n { \c@iRow + #1 - 1 } }
              { \int_eval:n { \c@jCol + #2 - 1 } }
              { \exp_not:n { ##1 } } { \exp_not:n { ##2 } }
          }
      }
    \box_gclear_new:c
```

```
      { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
    \hbox_gset:cn
      { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
      {
```

For a mono-column block, if the user has specified a color for the column in the preamble of the array, we want to fix that color in the box we construct. We do that with `\set@color` and not `\color_ensure_current:` because that command seems to be bugged: it doesn't work in XeLaTeX when fontspec is loaded.

```
        \tl_if_empty:NTF \l_@@_color_tl
          { \int_compare:nNnT { #2 } = 1 \set@color }
          { \color { \l_@@_color_tl } }
```

If the block is mono-row, we use `\g_@@_row_style_tl` even it has yet been used in the beginning of the cell where the command `\Block` has been issued because we want to be able to take into account a potential instruction of color of the font in `\g_@@_row_style_tl`.

```
        \int_compare:nNnT { #1 } = 1 \g_@@_row_style_tl
        \group_begin:
        \cs_set:Npn \arraystretch { 1 }
        \dim_set_eq:NN \extrarowheight \c_zero_dim
        #4
```

If the box is rotated (the key `\rotate` may be in the previous `#4`), the tabular used for the content of the cell will be constructed with a format `c`. In the other cases, the tabular will be constructed with a format equal to the key of position of the box. In other words: the alignement internal to the tabular is the same as the external alignment of the tabular (that is to say the position of the block in its zone of merged cells).

```
        \bool_if:NT \g_@@_rotate_bool { \tl_set:Nn \l_@@_hpos_of_block_tl c }
        \bool_if:NTF \l_@@_NiceTabular_bool
          {
            \use:x
              {
                \exp_not:N \begin { tabular } [ \l_@@_vpos_of_block_tl ]
                  { @ { } \l_@@_hpos_of_block_tl @ { } }
              }
              #5
            \end { tabular }
          }
          {
            \c_math_toggle_token
            \use:x
              {
                \exp_not:N \begin { array } [ \l_@@_vpos_of_block_tl ]
                { @ { } \l_@@_hpos_of_block_tl @ { } }
              }
              #5
            \end { array }
            \c_math_toggle_token
          }
        \group_end:
      }
    \bool_if:NT \g_@@_rotate_bool
      {
        \box_grotate:cn
          { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
          { 90 }
        \bool_gset_false:N \g_@@_rotate_bool
      }
```

If we are in a mono-column block, we take into account the width of that block for the width of the column.

```
    \int_compare:nNnT { #2 } = 1
      {
        \dim_gset:Nn \g_@@_blocks_wd_dim
```

```
        {
          \dim_max:nn
            \g_@@_blocks_wd_dim
            {
              \box_wd:c
                { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
            }
        }
    }
```

If we are in a mono-row block, we take into account the height and the depth of that block for the height and the depth of the row.

```
    \int_compare:nNnT { #1 } = 1
      {
        \dim_gset:Nn \g_@@_blocks_ht_dim
          {
            \dim_max:nn
              \g_@@_blocks_ht_dim
              {
                \box_ht:c
                  { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
              }
          }
        \dim_gset:Nn \g_@@_blocks_dp_dim
          {
            \dim_max:nn
              \g_@@_blocks_dp_dim
              {
                \box_dp:c
                  { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
              }
          }
      }
    \seq_gput_right:Nx \g_@@_blocks_seq
      {
        \l_tmpa_tl
```

In the list of options `#3`, maybe there is a key for the horizontal alignment (`l`, `r` or `c`). In that case, that key has been read and stored in `\l_@@_hpos_of_block_tl`. However, maybe there were no key of the horizontal alignement and that's why we put a key corresponding to the value of `\l_@@_hpos_of_block_tl`, which is fixed by the type of current column.

```
        { \exp_not:n { #3 } , \l_@@_hpos_of_block_tl }
        {
          \box_use_drop:c
            { g_@@_ block _ box _ \int_use:N \g_@@_block_box_int _ box }
        }
      }
  }
```

The following macro is for the standard case, where the block is not mono-row and not mono-column. In that case, the content of the block is *not* composed right now in a box. The composition in a box will be done further, just after the construction of the array.

```
\cs_new_protected:Npn \@@_Block_v:nnnnn #1 #2 #3 #4 #5
  {
    \seq_gput_right:Nx \g_@@_blocks_seq
      {
        \l_tmpa_tl
        { \exp_not:n { #3 } }
        \exp_not:n
          {
            {
              \bool_if:NTF \l_@@_NiceTabular_bool
                {
```

```
                \group_begin:
                \cs_set:Npn \arraystretch { 1 }
                \dim_set_eq:NN \extrarowheight \c_zero_dim
                #4
```

If the box is rotated (the key `\rotate` may be in the previous `#4`), the tabular used for the content of the cell will be constructed with a format `c`. In the other cases, the tabular will be constructed with a format equal to the key of position of the box. In other words: the alignement internal to the tabular is the same as the external alignment of the tabular (that is to say the position of the block in its zone of merged cells).

```
                \bool_if:NT \g_@@_rotate_bool
                  { \tl_set:Nn \l_@@_hpos_of_block_tl c }
                \use:x
                  {
                    \exp_not:N \begin { tabular } [ \l_@@_vpos_of_block_tl ]
                    { @ { } \l_@@_hpos_of_block_tl @ { } }
                  }
                  #5
                \end { tabular }
                \group_end:
              }
              {
                \group_begin:
                \cs_set:Npn \arraystretch { 1 }
                \dim_set_eq:NN \extrarowheight \c_zero_dim
                #4
                \bool_if:NT \g_@@_rotate_bool
                  { \tl_set:Nn \l_@@_hpos_of_block_tl c }
                \c_math_toggle_token
                \use:x
                  {
                    \exp_not:N \begin { array } [ \l_@@_vpos_of_block_tl ]
                    { @ { } \l_@@_hpos_of_block_tl @ { } }
                  }
                  #5
                \end { array }
                \c_math_toggle_token
                \group_end:
              }
          }
        }
    }
}
```

We recall that the options of the command `\Block` are analyzed twice: first in the cell of the array and once again when the block will be put in the array *after the construction of the array* (by using PGF).

```
\keys_define:nn { NiceMatrix / Block / SecondPass }
  {
    fill .tl_set:N = \l_@@_fill_tl ,
    fill .value_required:n = true ,
    draw .tl_set:N = \l_@@_draw_tl ,
    draw .default:n = default ,
    rounded-corners .dim_set:N = \l_@@_rounded_corners_dim ,
    rounded-corners .default:n = 4 pt ,
    color .code:n = \color { #1 } \tl_set:Nn \l_@@_draw_tl { #1 } ,
    color .value_required:n = true ,
    borders .clist_set:N = \l_@@_borders_clist ,
    borders .value_required:n = true ,
    hvlines .bool_set:N = \l_@@_hvlines_block_bool ,
    hvlines .default:n = true ,
    line-width .dim_set:N = \l_@@_line_width_dim ,
```

```
    line-width .value_required:n = true ,
    l .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl l ,
    l .value_forbidden:n = true ,
    r .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl r ,
    r .value_forbidden:n = true ,
    c .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl c ,
    c .value_forbidden:n = true ,
    L .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl l
                \bool_set_true:N \l_@@_hpos_of_block_cap_bool ,
    L .value_forbidden:n = true ,
    R .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl r
                \bool_set_true:N \l_@@_hpos_of_block_cap_bool ,
    R .value_forbidden:n = true ,
    C .code:n = \tl_set:Nn \l_@@_hpos_of_block_tl c
                \bool_set_true:N \l_@@_hpos_of_block_cap_bool ,
    C .value_forbidden:n = true ,
    t .code:n = \tl_set:Nn \l_@@_vpos_of_block_tl t ,
    t .value_forbidden:n = true ,
    b .code:n = \tl_set:Nn \l_@@_vpos_of_block_tl b ,
    b .value_forbidden:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~Block }
  }
```

The command `\@@_draw_blocks:` will draw all the blocks. This command is used after the construction of the array. We have to revert to a clean version of `\ialign` because there may be tabulars in the `\Block` instructions that will be composed now.

```
\cs_new_protected:Npn \@@_draw_blocks:
  {
    \cs_set_eq:NN \ialign \@@_old_ialign:
    \seq_map_inline:Nn \g_@@_blocks_seq { \@@_Block_iv:nnnnnn ##1 }
  }
\cs_new_protected:Npn \@@_Block_iv:nnnnnn #1 #2 #3 #4 #5 #6
  {
```

The integer `\l_@@_last_row_int` will be the last row of the block and `\l_@@_last_col_int` its last column.

```
    \int_zero_new:N \l_@@_last_row_int
    \int_zero_new:N \l_@@_last_col_int
```

We remind that the first mandatory argument of the command `\Block` is the size of the block with the special format i-j. However, the user is allowed to omit i or j (or both). This will be interpreted as: the last row (resp. column) of the block will be the last row (resp. column) of the block (without the potential exterior row—resp. column—of the array). By convention, this is stored in `\g_@@_blocks_seq` as a number of rows (resp. columns) for the block equal to 100. That's what we detect now.

```
    \int_compare:nNnTF { #3 } > { 99 }
      { \int_set_eq:NN \l_@@_last_row_int \c@iRow }
      { \int_set:Nn \l_@@_last_row_int { #3 } }
    \int_compare:nNnTF { #4 } > { 99 }
      { \int_set_eq:NN \l_@@_last_col_int \c@jCol }
      { \int_set:Nn \l_@@_last_col_int { #4 } }
    \int_compare:nNnTF \l_@@_last_col_int > \g_@@_col_total_int
      {
        \int_compare:nTF
          { \l_@@_last_col_int <= \g_@@_static_num_of_col_int }
          {
            \msg_error:nnnn { nicematrix } { Block~too~large~2 } { #1 } { #2 }
            \@@_msg_redirect_name:nn { Block~too~large~2 } { none }
            \group_begin:
            \globaldefs = 1
            \@@_msg_redirect_name:nn { columns~not~used } { none }
            \group_end:
```

```
          }
          { \msg_error:nnnn { nicematrix } { Block~too~large~1 } { #1 } { #2 } }
      }
      {
        \int_compare:nNnTF \l_@@_last_row_int > \g_@@_row_total_int
          { \msg_error:nnnn { nicematrix } { Block~too~large~1 } { #1 } { #2 } }
          { \@@_Block_v:nnnnnn { #1 } { #2 } { #3 } { #4 } { #5 } { #6 } }
      }
  }
\cs_new_protected:Npn \@@_Block_v:nnnnnn #1 #2 #3 #4 #5 #6
  {
```

The sequence of the positions of the blocks will be used when drawing the rules (in fact, there is also the `\multicolumn` and the `\diagbox` in that sequence).

```
    \seq_gput_left:Nn \g_@@_pos_of_blocks_seq { { #1 } { #2 } { #3 } { #4 } }
```

The group is for the keys.

```
    \group_begin:
    \keys_set:nn { NiceMatrix / Block / SecondPass } { #5 }
    \bool_if:NT \l_@@_hvlines_block_bool
      {
        \tl_gput_right:Nx \g_nicematrix_code_after_tl
          {
            \@@_hvlines_block:nnn
              { \exp_not:n { #5 } }
              { #1 - #2 }
              { \int_use:N \l_@@_last_row_int - \int_use:N \l_@@_last_col_int }
          }
      }
    \tl_if_empty:NF \l_@@_draw_tl
      {
        \tl_gput_right:Nx \g_nicematrix_code_after_tl
          {
            \@@_stroke_block:nnn
              { \exp_not:n { #5 } }
              { #1 - #2 }
              { \int_use:N \l_@@_last_row_int - \int_use:N \l_@@_last_col_int }
          }
        \seq_gput_right:Nn \g_@@_pos_of_stroken_blocks_seq
           { { #1 } { #2 } { #3 } { #4 } }
      }
    \clist_if_empty:NF \l_@@_borders_clist
      {
        \tl_gput_right:Nx \g_nicematrix_code_after_tl
          {
            \@@_stroke_borders_block:nnn
              { \exp_not:n { #5 } }
              { #1 - #2 }
              { \int_use:N \l_@@_last_row_int - \int_use:N \l_@@_last_col_int }
          }
      }
    \tl_if_empty:NF \l_@@_fill_tl
      {
```

The command `\@@_extract_brackets` will extract the potential specification of color space at the beginning of `\l_@@_fill_tl` and store it in `\l_tmpa_tl` and store the color itself in `\l_tmpb_tl`.

```
        \exp_last_unbraced:NV \@@_extract_brackets \l_@@_fill_tl \q_stop
        \tl_gput_right:Nx \g_nicematrix_code_before_tl
          {
            \exp_not:N \roundedrectanglecolor
              [ \l_tmpa_tl ]
              { \exp_not:V \l_tmpb_tl }
```

```
            { #1 - #2 }
            { \int_use:N \l_@@_last_row_int - \int_use:N \l_@@_last_col_int }
            { \dim_use:N \l_@@_rounded_corners_dim }
        }
    }

  \cs_set_protected_nopar:Npn \diagbox ##1 ##2
    {
      \tl_gput_right:Nx \g_@@_internal_code_after_tl
        {
          \@@_actually_diagbox:nnnnnn
            { #1 }
            { #2 }
            { \int_use:N \l_@@_last_row_int }
            { \int_use:N \l_@@_last_col_int }
            { \exp_not:n { ##1 } } { \exp_not:n { ##2 } }
        }
    }

  \hbox_set:Nn \l_@@_cell_box { \set@color #6 }
  \bool_if:NT \g_@@_rotate_bool \@@_rotate_cell_box:
```

Let's consider the following `{NiceTabular}`. Because of the instruction `!{\hspace{1cm}}` in the preamble which increases the space between the columns (by adding, in fact, that space to the previous column, that is to say the second column of the tabular), we will create *two* nodes relative to the block: the node `1-1-block` and the node `1-1-block-short`.

```
\begin{NiceTabular}{cc!{\hspace{1cm}}c}
\Block{2-2}{our block} &      & one    \\
                       &      & two    \\
three                  & four & five   \\
six                    & seven & eight \\
\end{NiceTabular}
```

We highlight the node `1-1-block`

our block		one
		two
three	four	five
six	seven	eight

We highlight the node `1-1-block-short`

our block		one
		two
three	four	five
six	seven	eight

The construction of the node corresponding to the merged cells.

```
  \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \@@_qpoint:n { row - #1 }
    \dim_set_eq:NN \l_tmpa_dim \pgf@y
    \@@_qpoint:n { col - #2 }
    \dim_set_eq:NN \l_tmpb_dim \pgf@x
    \@@_qpoint:n { row - \@@_succ:n { \l_@@_last_row_int } }
    \dim_set_eq:NN \l_tmpc_dim \pgf@y
    \@@_qpoint:n { col - \@@_succ:n { \l_@@_last_col_int } }
    \dim_set_eq:NN \l_tmpd_dim \pgf@x
```

We construct the node for the block with the name `(#1-#2-block)`.
The function `\@@_pgf_rect_node:nnnnn` takes in as arguments the name of the node and the four coordinates of two opposite corner points of the rectangle.

```
    \begin { pgfscope }
    \@@_pgf_rect_node:nnnnn
      { \@@_env: - #1 - #2 - block }
      \l_tmpb_dim \l_tmpa_dim \l_tmpd_dim \l_tmpc_dim
    \end { pgfscope }
```

Now, we create the "short node" which, in general, will be used to put the label (that is to say the content of the node). However, if one the keys `L`, `C` or `R` is used (that information is provided by the boolean `\l_@@_hpos_of_block_cap_bool`), we don't need to create that node since the normal node is used to put the label.

```
    \bool_if:NF \l_@@_hpos_of_block_cap_bool
      {
        \dim_set_eq:NN \l_tmpb_dim \c_max_dim
```

The short node is constructed by taking into account the *contents* of the columns involved in at least one cell of the block. That's why we have to do a loop over the rows of the array.

```
        \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
          {
```

We recall that, when a cell is empty, no (normal) node is created in that cell. That's why we test the existence of the node before using it.

```
            \cs_if_exist:cT
              { pgf @ sh @ ns @ \@@_env: - ##1 - #2 }
              {
                \seq_if_in:NnF \g_@@_multicolumn_cells_seq { ##1 - #2 }
                  {
                    \pgfpointanchor { \@@_env: - ##1 - #2 } { west }
                    \dim_set:Nn \l_tmpb_dim { \dim_min:nn \l_tmpb_dim \pgf@x }
                  }
              }
          }
```

If all the cells of the column were empty, `\l_tmpb_dim` has still the same value `\c_max_dim`. In that case, you use for `\l_tmpb_dim` the value of the position of the vertical rule.

```
        \dim_compare:nNnT \l_tmpb_dim = \c_max_dim
          {
            \@@_qpoint:n { col - #2 }
            \dim_set_eq:NN \l_tmpb_dim \pgf@x
          }
        \dim_set:Nn \l_tmpd_dim { - \c_max_dim }
        \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
          {
            \cs_if_exist:cT
              { pgf @ sh @ ns @ \@@_env: - ##1 - \int_use:N \l_@@_last_col_int }
              {
                \seq_if_in:NnF \g_@@_multicolumn_cells_seq { ##1 - #2 }
                  {
                    \pgfpointanchor
                      { \@@_env: - ##1 - \int_use:N \l_@@_last_col_int }
                      { east }
                    \dim_set:Nn \l_tmpd_dim { \dim_max:nn \l_tmpd_dim \pgf@x }
                  }
              }
          }
        \dim_compare:nNnT \l_tmpd_dim = { - \c_max_dim }
          {
            \@@_qpoint:n { col - \@@_succ:n { \l_@@_last_col_int } }
            \dim_set_eq:NN \l_tmpd_dim \pgf@x
          }
        \@@_pgf_rect_node:nnnnn
          { \@@_env: - #1 - #2 - block - short }
          \l_tmpb_dim \l_tmpa_dim \l_tmpd_dim \l_tmpc_dim
      }
```

If the creation of the "medium nodes" is required, we create a "medium node" for the block. The function `\@@_pgf_rect_node:nnn` takes in as arguments the name of the node and two PGF points.

```
    \bool_if:NT \l_@@_medium_nodes_bool
      {
        \@@_pgf_rect_node:nnn
```

```
        { \@@_env: - #1 - #2 - block - medium }
        { \pgfpointanchor { \@@_env: - #1 - #2 - medium } { north~west } }
        {
          \pgfpointanchor
            { \@@_env:
              - \int_use:N \l_@@_last_row_int
              - \int_use:N \l_@@_last_col_int - medium
            }
            { south~east }
        }
    }
```

Now, we will put the label of the block beginning with the case of a `\Block` of one row.

```
  \int_compare:nNnTF { #1 } = { #3 }
    {
```

We take into account the case of a block of one row in the "first row" or the "last row".

```
      \int_compare:nNnTF { #1 } = 0
        { \l_@@_code_for_first_row_tl }
        {
          \int_compare:nNnT { #1 } = \l_@@_last_row_int
            \l_@@_code_for_last_row_tl
        }
```

If the block has only one row, we want the label of the block perfectly aligned on the baseline of the row. That's why we have constructed a `\pgfcoordinate` on the baseline of the row, in the first column of the array. Now, we retrieve the y-value of that node and we store it in `\l_tmpa_dim`.

```
          \pgfextracty \l_tmpa_dim { \@@_qpoint:n { row - #1 - base } }
```

We retrieve (in `\pgf@x`) the x-value of the center of the block.

```
      \pgfpointanchor
        {
          \@@_env: - #1 - #2 - block
          \bool_if:NF \l_@@_hpos_of_block_cap_bool { - short }
        }
        {
          \str_case:Vn \l_@@_hpos_of_block_tl
            {
              c { center }
              l { west }
              r { east }
            }
        }
```

We put the label of the block which has been composed in `\l_@@_cell_box`.

```
      \pgftransformshift { \pgfpoint \pgf@x \l_tmpa_dim }
      \pgfset { inner~sep = \c_zero_dim }
      \pgfnode
        { rectangle }
        {
           \str_case:Vn \l_@@_hpos_of_block_tl
            {
              c { base }
              l { base~west }
              r { base~east }
            }
        }
        { \box_use_drop:N \l_@@_cell_box } { } { }
    }
```

If the number of rows is different of 1, we will put the label of the block by using the short node (the label of the block has been composed in `\l_@@_cell_box`).

```
    {
```

If we are in the first column, we must put the block as if it was with the key `r`.

```
        \int_compare:nNnT { #2 } = 0
          { \tl_set:Nn \l_@@_hpos_of_block_tl r }
        \bool_if:nT \g_@@_last_col_found_bool
          {
            \int_compare:nNnT { #2 } = \g_@@_col_total_int
              { \tl_set:Nn \l_@@_hpos_of_block_tl l }
          }
        \pgftransformshift
          {
            \pgfpointanchor
              {
                \@@_env: - #1 - #2 - block
                \bool_if:NF \l_@@_hpos_of_block_cap_bool { - short }
              }
              {
                \str_case:Vn \l_@@_hpos_of_block_tl
                  {
                    c { center }
                    l { west }
                    r { east }
                  }
              }
          }
        \pgfset { inner~sep = \c_zero_dim }
        \pgfnode
          { rectangle }
          {
             \str_case:Vn \l_@@_hpos_of_block_tl
              {
                c { center }
                l { west }
                r { east }
              }
          }
          { \box_use_drop:N \l_@@_cell_box } { } { }
      }
    \endpgfpicture
    \group_end:
  }


\NewDocumentCommand \@@_extract_brackets { O { } }
  {
    \tl_set:Nn \l_tmpa_tl { #1 }
    \@@_store_in_tmpb_tl
  }
\cs_new_protected:Npn \@@_store_in_tmpb_tl #1 \q_stop
  { \tl_set:Nn \l_tmpb_tl { #1 } }
```

The first argument of `\@@_stroke_block:nnn` is a list of options for the rectangle that you will stroke. The second argument is the upper-left cell of the block (with, as usual, the syntax i-j) and the third is the last cell of the block (with the same syntax).

```
\cs_new_protected:Npn \@@_stroke_block:nnn #1 #2 #3
  {
    \group_begin:
    \tl_clear:N \l_@@_draw_tl
    \dim_set_eq:NN \l_@@_line_width_dim \arrayrulewidth
    \keys_set_known:nn { NiceMatrix / BlockStroke } { #1 }
    \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \tl_if_empty:NF \l_@@_draw_tl
```

```
      {
```

If the user has used the key `color` of the command `\Block` without value, the color fixed by `\arrayrulecolor` is used.

```
        \str_if_eq:VnTF \l_@@_draw_tl { default }
          { \CT@arc@ }
          { \exp_args:NV \pgfsetstrokecolor \l_@@_draw_tl }
      }
    \pgfsetcornersarced
      {
        \pgfpoint
          { \dim_use:N \l_@@_rounded_corners_dim }
          { \dim_use:N \l_@@_rounded_corners_dim }
      }
    \@@_cut_on_hyphen:w #2 \q_stop
    \bool_lazy_and:nnT
      { \int_compare_p:n { \l_tmpa_tl <= \c@iRow } }
      { \int_compare_p:n { \l_tmpb_tl <= \c@jCol } }
      {
        \@@_qpoint:n { row - \l_tmpa_tl }
        \dim_set:Nn \l_tmpb_dim { \pgf@y }
        \@@_qpoint:n { col - \l_tmpb_tl }
        \dim_set:Nn \l_tmpc_dim { \pgf@x }
        \@@_cut_on_hyphen:w #3 \q_stop
        \int_compare:nNnT \l_tmpa_tl > \c@iRow
          { \tl_set:Nx \l_tmpa_tl { \int_use:N \c@iRow } }
        \int_compare:nNnT \l_tmpb_tl > \c@jCol
          { \tl_set:Nx \l_tmpb_tl { \int_use:N \c@jCol } }
        \@@_qpoint:n { row - \@@_succ:n \l_tmpa_tl }
        \dim_set:Nn \l_tmpa_dim { \pgf@y }
        \@@_qpoint:n { col - \@@_succ:n \l_tmpb_tl }
        \dim_set:Nn \l_tmpd_dim { \pgf@x }
        \pgfpathrectanglecorners
          { \pgfpoint \l_tmpc_dim \l_tmpb_dim }
          { \pgfpoint \l_tmpd_dim \l_tmpa_dim }
        \pgfsetlinewidth { 1.1 \l_@@_line_width_dim }
```

We can't use `\pgfusepathqstroke` because of the key `rounded-corners`.

```
        \pgfusepath { stroke }
      }
    \endpgfpicture
    \group_end:
  }
```

Here is the set of keys for the command `\@@_stroke_block:nnn`.

```
\keys_define:nn { NiceMatrix / BlockStroke }
  {
    color .tl_set:N = \l_@@_draw_tl ,
    draw .tl_set:N = \l_@@_draw_tl ,
    draw .default:n = default ,
    line-width .dim_set:N = \l_@@_line_width_dim ,
    rounded-corners .dim_set:N = \l_@@_rounded_corners_dim ,
    rounded-corners .default:n = 4 pt
  }
```

The first argument of `\@@_hvlines_block:nnn` is a list of options for the rules that we will draw. The second argument is the upper-left cell of the block (with, as usual, the syntax i-j) and the third is the last cell of the block (with the same syntax).

```
\cs_new_protected:Npn \@@_hvlines_block:nnn #1 #2 #3
  {
    \dim_set_eq:NN \l_@@_line_width_dim \arrayrulewidth
    \keys_set_known:nn { NiceMatrix / BlockBorders } { #1 }
    \@@_cut_on_hyphen:w #2 \q_stop
    \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl
```

```
    \tl_set_eq:NN \l_tmpd_tl \l_tmpb_tl
    \@@_cut_on_hyphen:w #3 \q_stop
    \tl_set:Nx \l_tmpa_tl { \int_eval:n { \l_tmpa_tl + 1 } }
    \tl_set:Nx \l_tmpb_tl { \int_eval:n { \l_tmpb_tl + 1 } }
    \pgfpicture
    \pgfrememberpicturepositiononpagetrue
    \pgf@relevantforpicturesizefalse
    \CT@arc@
    \pgfsetlinewidth { 1.1 \l_@@_line_width_dim }
```

First, the vertical rules.

```
    \@@_qpoint:n { row - \l_tmpa_tl }
    \dim_set_eq:NN \l_tmpa_dim \pgf@y
    \@@_qpoint:n { row - \l_tmpc_tl }
    \dim_set_eq:NN \l_tmpb_dim \pgf@y
    \int_step_inline:nnn \l_tmpd_tl \l_tmpb_tl
      {
        \@@_qpoint:n { col - ##1 }
        \pgfpathmoveto { \pgfpoint \pgf@x \l_tmpa_dim }
        \pgfpathlineto { \pgfpoint \pgf@x \l_tmpb_dim }
        \pgfusepathqstroke
      }
```

Now, the horizontal rules.

```
    \@@_qpoint:n { col - \l_tmpb_tl }
    \dim_set:Nn \l_tmpa_dim { \pgf@x + 0.5 \arrayrulewidth }
    \@@_qpoint:n { col - \l_tmpd_tl }
    \dim_set:Nn \l_tmpb_dim { \pgf@x - 0.5 \arrayrulewidth }
    \int_step_inline:nnn \l_tmpc_tl \l_tmpa_tl
      {
        \@@_qpoint:n { row - ##1 }
        \pgfpathmoveto { \pgfpoint \l_tmpa_dim \pgf@y }
        \pgfpathlineto { \pgfpoint \l_tmpb_dim \pgf@y }
        \pgfusepathqstroke
      }
    \endpgfpicture
  }
```

The first argument of `\@@_stroke_borders_block:nnn` is a list of options for the borders that you will stroke. The second argument is the upper-left cell of the block (with, as usual, the syntax i-j) and the third is the last cell of the block (with the same syntax).

```
\cs_new_protected:Npn \@@_stroke_borders_block:nnn #1 #2 #3
  {
    \dim_set_eq:NN \l_@@_line_width_dim \arrayrulewidth
    \keys_set_known:nn { NiceMatrix / BlockBorders } { #1 }
    \dim_compare:nNnTF \l_@@_rounded_corners_dim > \c_zero_dim
      { \@@_error:n { borders~forbidden } }
      {
        \clist_map_inline:Nn \l_@@_borders_clist
          {
            \clist_if_in:nnF { top , bottom , left , right } { ##1 }
              { \@@_error:nn { bad~border } { ##1 } }
          }
        \@@_cut_on_hyphen:w #2 \q_stop
        \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl
        \tl_set_eq:NN \l_tmpd_tl \l_tmpb_tl
        \@@_cut_on_hyphen:w #3 \q_stop
        \tl_set:Nx \l_tmpa_tl { \int_eval:n { \l_tmpa_tl + 1 } }
        \tl_set:Nx \l_tmpb_tl { \int_eval:n { \l_tmpb_tl + 1 } }
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgf@relevantforpicturesizefalse
        \CT@arc@
        \pgfsetlinewidth { 1.1 \l_@@_line_width_dim }
```

```
        \clist_if_in:NnT \l_@@_borders_clist { right }
          { \@@_stroke_vertical:n \l_tmpb_tl }
        \clist_if_in:NnT \l_@@_borders_clist { left }
          { \@@_stroke_vertical:n \l_tmpd_tl }
        \clist_if_in:NnT \l_@@_borders_clist { bottom }
          { \@@_stroke_horizontal:n \l_tmpa_tl }
        \clist_if_in:NnT \l_@@_borders_clist { top }
          { \@@_stroke_horizontal:n \l_tmpc_tl }
        \endpgfpicture
    }
  }
```

The following command is used to stroke the left border and the right border. The argument `#1` is the number of column (in the sense of the `col` node).

```
\cs_new_protected:Npn \@@_stroke_vertical:n #1
  {
    \@@_qpoint:n \l_tmpc_tl
    \dim_set:Nn \l_tmpb_dim { \pgf@y + 0.5 \l_@@_line_width_dim }
    \@@_qpoint:n \l_tmpa_tl
    \dim_set:Nn \l_tmpc_dim { \pgf@y + 0.5 \l_@@_line_width_dim }
    \@@_qpoint:n { #1 }
    \pgfpathmoveto { \pgfpoint \pgf@x \l_tmpb_dim }
    \pgfpathlineto { \pgfpoint \pgf@x \l_tmpc_dim }
    \pgfusepathqstroke
  }
```

The following command is used to stroke the top border and the bottom border. The argument `#1` is the number of row (in the sense of the `row` node).

```
\cs_new_protected:Npn \@@_stroke_horizontal:n #1
  {
    \@@_qpoint:n \l_tmpd_tl
    \clist_if_in:NnTF \l_@@_borders_clist { left }
      { \dim_set:Nn \l_tmpa_dim { \pgf@x - 0.5 \l_@@_line_width_dim } }
      { \dim_set:Nn \l_tmpa_dim { \pgf@x + 0.5 \l_@@_line_width_dim } }
    \@@_qpoint:n \l_tmpb_tl
    \dim_set:Nn \l_tmpb_dim { \pgf@x + 0.5 \l_@@_line_width_dim }
    \@@_qpoint:n { #1 }
    \pgfpathmoveto { \pgfpoint \l_tmpa_dim \pgf@y }
    \pgfpathlineto { \pgfpoint \l_tmpb_dim \pgf@y }
    \pgfusepathqstroke
  }
```

Here is the set of keys for the command `\@@_stroke_borders_block:nnn`.

```
\keys_define:nn { NiceMatrix / BlockBorders }
  {
    borders .clist_set:N = \l_@@_borders_clist ,
    rounded-corners .dim_set:N = \l_@@_rounded_corners_dim ,
    rounded-corners .default:n = 4 pt ,
    line-width .dim_set:N = \l_@@_line_width_dim
  }
```

How to draw the dotted lines transparently

```
\cs_set_protected:Npn \@@_renew_matrix:
  {
    \RenewDocumentEnvironment { pmatrix } { }
      { \pNiceMatrix }
      { \endpNiceMatrix }
    \RenewDocumentEnvironment { vmatrix } { }
      { \vNiceMatrix }
      { \endvNiceMatrix }
    \RenewDocumentEnvironment { Vmatrix } { }
```

```
      { \VNiceMatrix }
      { \endVNiceMatrix }
    \RenewDocumentEnvironment { bmatrix } { }
      { \bNiceMatrix }
      { \endbNiceMatrix }
    \RenewDocumentEnvironment { Bmatrix } { }
      { \BNiceMatrix }
      { \endBNiceMatrix }
  }
```

Automatic arrays

```
\cs_new_protected:Npn \@@_set_size:n #1-#2 \q_stop
  {
    \int_set:Nn \l_@@_nb_rows_int { #1 }
    \int_set:Nn \l_@@_nb_cols_int { #2 }
  }
```

We will extract the potential keys `l`, `r` and `c` and pass the other keys to the environment `{NiceArrayWithDelims}`.

```
\keys_define:nn { NiceMatrix / Auto }
  {
    l .code:n = \tl_set:Nn \l_@@_type_of_col_tl l ,
    r .code:n = \tl_set:Nn \l_@@_type_of_col_tl r ,
    c .code:n = \tl_set:Nn \l_@@_type_of_col_tl c
  }
\NewDocumentCommand \AutoNiceMatrixWithDelims { m m O { } m O { } m ! O { } }
  {
    \int_zero_new:N \l_@@_nb_rows_int
    \int_zero_new:N \l_@@_nb_cols_int
    \@@_set_size:n #4 \q_stop
```

The group is for the protection of `\l_@@_type_of_col_tl`.

```
    \group_begin:
    \tl_set:Nn \l_@@_type_of_col_tl c
    \keys_set_known:nnN { NiceMatrix / Auto } { #3, #5, #7 } \l_tmpa_tl
    \use:x
      {
        \exp_not:N \begin { NiceArrayWithDelims } { #1 } { #2 }
          { * { \int_use:N \l_@@_nb_cols_int } { \l_@@_type_of_col_tl } }
          [ \exp_not:V \l_tmpa_tl ]
      }
    \int_compare:nNnT \l_@@_first_row_int = 0
      {
        \int_compare:nNnT \l_@@_first_col_int = 0 { & }
        \prg_replicate:nn { \l_@@_nb_cols_int - 1 } { & }
        \int_compare:nNnT \l_@@_last_col_int > { -1 } { & } \\
      }
    \prg_replicate:nn \l_@@_nb_rows_int
      {
        \int_compare:nNnT \l_@@_first_col_int = 0 { & }
```

We put `{ }` before `#6` to avoid a hasty expansion of a potential `\arabic{iRow}` at the beginning of the row which would result in an incorrect value of that `iRow` (since `iRow` is incremented in the first cell of the row of the `\halign`).

```
        \prg_replicate:nn { \l_@@_nb_cols_int - 1 } { { } #6 & } #6
        \int_compare:nNnT \l_@@_last_col_int > { -1 } { & } \\
      }
    \int_compare:nNnT \l_@@_last_row_int > { -2 }
      {
        \int_compare:nNnT \l_@@_first_col_int = 0 { & }
        \prg_replicate:nn { \l_@@_nb_cols_int - 1 } { & }
        \int_compare:nNnT \l_@@_last_col_int > { -1 } { & } \\
```

```
      }
    \end { NiceArrayWithDelims }
    \group_end:
  }
\cs_set_protected:Npn \@@_define_com:nnn #1 #2 #3
  {
    \cs_set_protected:cpn { #1 AutoNiceMatrix }
      {
        \str_gset:Nx \g_@@_name_env_str { #1 AutoNiceMatrix }
        \AutoNiceMatrixWithDelims { #2 } { #3 }
      }
  }
\@@_define_com:nnn p ( )
\@@_define_com:nnn b [ ]
\@@_define_com:nnn v | |
\@@_define_com:nnn V \| \|
\@@_define_com:nnn B \{ \}
```

We define also a command `\AutoNiceMatrix` similar to the environment `{NiceMatrix}`.

```
\NewDocumentCommand \AutoNiceMatrix { O { } m O { } m ! O { } }
  {
    \group_begin:
    \bool_set_true:N \l_@@_NiceArray_bool
    \AutoNiceMatrixWithDelims . . { #2 } { #4 } [ #1 , #3 , #5 ]
    \group_end:
  }
```

The redefinition of the command \dotfill

```
\cs_set_eq:NN \@@_old_dotfill \dotfill
\cs_new_protected:Npn \@@_dotfill:
  {
```

First, we insert `\@@_dotfill` (which is the saved version of `\dotfill`) in case of use of `\dotfill` "internally" in the cell (e.g. `\hbox to 1cm {\dotfill}`).

```
    \@@_old_dotfill
    \bool_if:NT \l_@@_NiceTabular_bool
      { \group_insert_after:N \@@_dotfill_ii: }
      { \group_insert_after:N \@@_dotfill_i: }
  }
\cs_new_protected:Npn \@@_dotfill_i: { \group_insert_after:N \@@_dotfill_ii: }
\cs_new_protected:Npn \@@_dotfill_ii: { \group_insert_after:N \@@_dotfill_iii: }
```

Now, if the box if not empty (unfornately, we can't actually test whether the box is empty and that's why we only consider it's width), we insert `\@@_dotfill` (which is the saved version of `\dotfill`) in the cell of the array, and it will extend, since it is no longer in `\l_@@_cell_box`.

```
\cs_new_protected:Npn \@@_dotfill_iii:
  { \dim_compare:nNnT { \box_wd:N \l_@@_cell_box } = \c_zero_dim  \@@_old_dotfill }
```

The command \diagbox

The command `\diagbox` will be linked to `\diagbox:nn` in the environments of nicematrix.

```
\cs_new_protected:Npn \@@_diagbox:nn #1 #2
  {
    \tl_gput_right:Nx \g_@@_internal_code_after_tl
      {
        \@@_actually_diagbox:nnnnnn
          { \int_use:N \c@iRow }
          { \int_use:N \c@jCol }
          { \int_use:N \c@iRow }
          { \int_use:N \c@jCol }
          { \exp_not:n { #1 } }
```

```
          { \exp_not:n { #2 } }
      }
```

We put the cell with `\diagbox` in the sequence `\g_@@_pos_of_blocks_seq` because a cell with `\diagbox` must be considered as non empty by the key `corners`.

```
    \seq_gput_right:Nx \g_@@_pos_of_blocks_seq
      {
        { \int_use:N \c@iRow }
        { \int_use:N \c@jCol }
        { \int_use:N \c@iRow }
        { \int_use:N \c@jCol }
      }
  }
```

The command `\diagbox` is also redefined locally when we draw a block.

The first four arguments of `\@@_actually_diagbox:nnnnnn` correspond to the rectangle (=block) to slash (we recall that it's possible to use `\diagbox` in a `\Block`). The two other are the elements to draw below and above the diagonal line.

```
\cs_new_protected:Npn \@@_actually_diagbox:nnnnnn #1 #2 #3 #4 #5 #6
  {
    \pgfpicture
    \pgf@relevantforpicturesizefalse
    \pgfrememberpicturepositiononpagetrue
    \@@_qpoint:n { row - #1 }
    \dim_set_eq:NN \l_tmpa_dim \pgf@y
    \@@_qpoint:n { col - #2 }
    \dim_set_eq:NN \l_tmpb_dim \pgf@x
    \pgfpathmoveto { \pgfpoint \l_tmpb_dim \l_tmpa_dim }
    \@@_qpoint:n { row - \@@_succ:n { #3 } }
    \dim_set_eq:NN \l_tmpc_dim \pgf@y
    \@@_qpoint:n { col - \@@_succ:n { #4 } }
    \dim_set_eq:NN \l_tmpd_dim \pgf@x
    \pgfpathlineto { \pgfpoint \l_tmpd_dim \l_tmpc_dim }
    {
```

The command `\CT@arc@` is a command of colortbl which sets the color of the rules in the array. The package nicematrix uses it even if colortbl is not loaded.

```
        \CT@arc@
        \pgfsetroundcap
        \pgfusepathqstroke
    }
    \pgfset { inner~sep = 1 pt }
    \pgfscope
    \pgftransformshift { \pgfpoint \l_tmpb_dim \l_tmpc_dim }
    \pgfnode { rectangle } { south~west }
      { \@@_math_toggle_token: #5 \@@_math_toggle_token: } { } { }
    \endpgfscope
    \pgftransformshift { \pgfpoint \l_tmpd_dim \l_tmpa_dim }
    \pgfnode { rectangle } { north~east }
      { \@@_math_toggle_token: #6 \@@_math_toggle_token: } { } { }
    \endpgfpicture
  }
```

The keyword \CodeAfter

The `\CodeAfter` (inserted with the key `code-after` or after the keyword `\CodeAfter`) may always begin with a list of pairs *key-value* between square brackets. Here is the corresponding set of keys.

```
\keys_define:nn { NiceMatrix }
  {
    CodeAfter / rules .inherit:n = NiceMatrix / rules ,
```

```
    CodeAfter / sub-matrix .inherit:n = NiceMatrix / sub-matrix
  }
\keys_define:nn { NiceMatrix / CodeAfter }
  {
    sub-matrix .code:n = \keys_set:nn { NiceMatrix / sub-matrix } { #1 } ,
    sub-matrix .value_required:n = true ,
    delimiters / color .tl_set:N = \l_@@_delimiters_color_tl ,
    delimiters / color .value_required:n = true ,
    rules .code:n = \keys_set:nn { NiceMatrix / rules } { #1 } ,
    rules .value_required:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~CodeAfter }
  }
```

In fact, in this subsection, we define the user command `\CodeAfter` for the case of the "normal syntax". For the case of "light-syntax", see the definition of the environment `{@@-light-syntax}` on p. 108.

In the environments of nicematrix, `\CodeAfter` will be linked to `\@@_CodeAfter:`. That macro must *not* be protected since it begins with `\omit`.

```
\cs_new:Npn \@@_CodeAfter: { \omit \@@_CodeAfter_i:n }
```

However, in each cell of the environment, the command `\CodeAfter` will be linked to the following command `\@@_CodeAfter_i:n` which do *not* begin with `\omit` (and thus, the user will be able to use `\CodeAfter` without error and without the need to prefix by `\omit`.

We have to catch everything until the end of the current environment (of nicematrix). First, we go until the next command `\end`.

```
\cs_new_protected:Npn \@@_CodeAfter_i:n #1 \end
  {
    \tl_gput_right:Nn \g_nicematrix_code_after_tl { #1 }
    \@@_CodeAfter_ii:n
  }
```

We catch the argument of the command `\end` (in `#1`).

```
\cs_new_protected:Npn \@@_CodeAfter_ii:n #1
  {
```

If this is really the end of the current environment (of nicematrix), we put back the command `\end` and its argument in the TeX flow.

```
    \str_if_eq:eeTF \@currenvir { #1 } { \end { #1 } }
```

If this is not the `\end` we are looking for, we put those tokens in `\g_nicematrix_code_after_tl` and we go on searching for the next command `\end` with a recursive call to the command `\@@_CodeAfter:n`.

```
      {
        \tl_gput_right:Nn \g_nicematrix_code_after_tl { \end { #1 } }
        \@@_CodeAfter_i:n
      }
  }
```

The delimiters in the preamble

The command `\@@_delimiter:nnn` will be used to draw delimiters inside the matrix when delimiters are specified in the preamble of the array. It does *not* concern the exterior delimiters added by `{NiceArrayWithDelims}` (and `{pNiceArray}`, `{pNiceMatrix}`, etc.).
A delimiter in the preamble of the array will write an instruction `\@@_delimiter:nnn` in the `\g_@@_internal_code_after_tl` (and also potentially add instructions in the preamble provided to `\array` in order to add space between columns).

The first argument is the type of delimiter (`(`, `[`, `\{`, `)`, `]` or `\}`). The second argument is the number of columnn. The third argument is a boolean equal to `\c_true_bool` (resp. `\c_false_true`) when the delimiter must be put on the left (resp. right) side.

```
\cs_new_protected:Npn \@@_delimiter:nnn #1 #2 #3
```

```
{
  \pgfpicture
  \pgfrememberpicturepositiononpagetrue
  \pgf@relevantforpicturesizefalse
```

`\l_@@_y_initial_dim` and `\l_@@_y_final_dim` will be the y-values of the extremities of the delimiter we will have to construct.

```
    \@@_qpoint:n { row - 1 }
    \dim_set_eq:NN \l_@@_y_initial_dim \pgf@y
    \@@_qpoint:n { row - \@@_succ:n \c@iRow }
    \dim_set_eq:NN \l_@@_y_final_dim \pgf@y
```

We will compute in `\l_tmpa_dim` the x-value where we will have to put our delimiter (on the left side or on the right side).

```
    \bool_if:nTF { #3 }
      { \dim_set_eq:NN \l_tmpa_dim \c_max_dim }
      { \dim_set:Nn \l_tmpa_dim { - \c_max_dim } }
    \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - ##1 - #2 }
          {
            \pgfpointanchor
              { \@@_env: - ##1 - #2 }
              { \bool_if:nTF { #3 } { west } { east } }
            \dim_set:Nn \l_tmpa_dim
              { \bool_if:nTF { #3 } \dim_min:nn \dim_max:nn \l_tmpa_dim \pgf@x }
          }
      }
```

Now we can put the delimiter with a node of PGF.

```
    \pgfset { inner~sep = \c_zero_dim }
    \dim_zero:N \nulldelimiterspace
    \pgftransformshift
      {
        \pgfpoint
          { \l_tmpa_dim }
          { ( \l_@@_y_initial_dim + \l_@@_y_final_dim + \arrayrulewidth ) / 2 }
      }
    \pgfnode
      { rectangle }
      { \bool_if:nTF { #3 } { east } { west } }
      {
```

Here is the content of the PGF node, that is to say the delimiter, constructed with its right size.

```
        \nullfont
        \c_math_toggle_token
        \tl_if_empty:NF \l_@@_delimiters_color_tl
          { \color { \l_@@_delimiters_color_tl } }
        \bool_if:nTF { #3 } { \left #1 } { \left . }
        \vcenter
          {
            \nullfont
            \hrule \@height
                   \dim_eval:n { \l_@@_y_initial_dim - \l_@@_y_final_dim }
                   \@depth \c_zero_dim
                   \@width \c_zero_dim
          }
        \bool_if:nTF { #3 } { \right . } { \right #1 }
        \c_math_toggle_token
      }
      { }
      { }
    \endpgfpicture
}
```

The command \SubMatrix

```
\keys_define:nn { NiceMatrix / sub-matrix }
  {
    extra-height .dim_set:N = \l_@@_submatrix_extra_height_dim ,
    extra-height .value_required:n = true ,
    left-xshift .dim_set:N = \l_@@_submatrix_left_xshift_dim ,
    left-xshift .value_required:n = true ,
    right-xshift .dim_set:N = \l_@@_submatrix_right_xshift_dim ,
    right-xshift .value_required:n = true ,
    xshift .meta:n = { left-xshift = #1, right-xshift = #1 } ,
    xshift .value_required:n = true ,
    delimiters / color .tl_set:N = \l_@@_delimiters_color_tl ,
    delimiters / color .value_required:n = true ,
    slim .bool_set:N = \l_@@_submatrix_slim_bool ,
    slim .default:n = true ,
    hlines .clist_set:N = \l_@@_submatrix_hlines_clist ,
    hlines .default:n = all ,
    vlines .clist_set:N = \l_@@_submatrix_vlines_clist ,
    vlines .default:n = all ,
    hvlines .meta:n = { hlines, vlines } ,
    hvlines .value_forbidden:n = true ,
  }
\keys_define:nn { NiceMatrix }
  {
    SubMatrix .inherit:n = NiceMatrix / sub-matrix ,
    CodeAfter / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
    NiceMatrix / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
    NiceArray / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
    pNiceArray / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
    NiceMatrixOptions / sub-matrix .inherit:n = NiceMatrix / sub-matrix ,
  }
```

The following keys set is for the command `\SubMatrix` itself (not the tuning of `\SubMatrix` that can be done elsewhere).

```
\keys_define:nn { NiceMatrix / SubMatrix }
  {
    hlines .clist_set:N = \l_@@_submatrix_hlines_clist ,
    hlines .default:n = all ,
    vlines .clist_set:N = \l_@@_submatrix_vlines_clist ,
    vlines .default:n = all ,
    hvlines .meta:n = { hlines, vlines } ,
    hvlines .value_forbidden:n = true ,
    name .code:n =
      \tl_if_empty:nTF { #1 }
        { \@@_error:n { Invalid~name~format } }
        {
          \regex_match:nnTF { \A[A-Za-z][A-Za-z0-9]*\Z } { #1 }
            {
              \seq_if_in:NnTF \g_@@_submatrix_names_seq { #1 }
                { \@@_error:nn { Duplicate~name~for~SubMatrix } { #1 } }
                {
                  \str_set:Nn \l_@@_submatrix_name_str { #1 }
                  \seq_gput_right:Nn \g_@@_submatrix_names_seq { #1 }
                }
            }
            { \@@_error:n { Invalid~name~format } }
        } ,
    rules .code:n = \keys_set:nn { NiceMatrix / rules } { #1 } ,
    rules .value_required:n = true ,
    code .tl_set:N = \l_@@_code_tl ,
    code .value_required:n = true ,
    name .value_required:n = true ,
    unknown .code:n = \@@_error:n { Unknown~key~for~SubMatrix }
```

```
  }

\NewDocumentCommand \@@_SubMatrix_in_code_before { m m m m ! O { } }
  {
    \peek_remove_spaces:n
      {
        \@@_cut_on_hyphen:w #3 \q_stop
        \tl_clear_new:N \l_tmpc_tl
        \tl_clear_new:N \l_tmpd_tl
        \tl_set_eq:NN \l_tmpc_tl \l_tmpa_tl
        \tl_set_eq:NN \l_tmpd_tl \l_tmpb_tl
        \@@_cut_on_hyphen:w #2 \q_stop
        \seq_gput_right:Nx \g_@@_submatrix_seq
          { { \l_tmpa_tl } { \l_tmpb_tl } { \l_tmpc_tl } { \l_tmpd_tl } }
        \tl_gput_right:Nn \g_@@_internal_code_after_tl
          { \SubMatrix { #1 } { #2 } { #3 } { #4 } [ #5 ] }
      }
  }
```

In the internal `code-after` and in the `\CodeAfter` the following command `\@@_SubMatrix` will be linked to `\SubMatrix`.

- `#1` is the left delimiter;
- `#2` is the upper-left cell of the matrix with the format *i*-*j*;
- `#3` is the lower-right cell of the matrix with the format *i*-*j*;
- `#4` is the right delimiter;
- `#5` is the list of options of the command;
- `#6` is the potential subscript;
- `#7` is the potential superscript.

For explanations about the construction with rescanning of the preamble, see the documentation for the user command `\Cdots`.

```
\AtBeginDocument
  {
    \tl_set:Nn \l_@@_argspec_tl { m m m m O { } E { _ ^ } { { } { } } }
    \tl_set_rescan:Nno  \l_@@_argspec_tl { } \l_@@_argspec_tl
    \exp_args:NNV \NewDocumentCommand \@@_SubMatrix \l_@@_argspec_tl
      {
        \peek_remove_spaces:n
          { \@@_sub_matrix:nnnnnnn
              { #1 } { #2 } { #3 } { #4 }  { #5 } { #6 } { #7 } }
      }
  }
\cs_new_protected:Npn \@@_sub_matrix:nnnnnnn #1 #2 #3 #4 #5 #6 #7
  {
    \group_begin:
```

The four following token lists correspond to the position of the `\SubMatrix`.

```
    \tl_clear_new:N \l_@@_first_i_tl
    \tl_clear_new:N \l_@@_first_j_tl
    \tl_clear_new:N \l_@@_last_i_tl
    \tl_clear_new:N \l_@@_last_j_tl
```

The command `\@@_cut_on_hyphen:w` cuts on the hyphen an argument of the form *i*-*j*. The value of *i* is stored in `\l_tmpa_tl` and the value of *j* is stored in `\l_tmpb_tl`.

```
    \@@_cut_on_hyphen:w #2 \q_stop
    \tl_set_eq:NN \l_@@_first_i_tl \l_tmpa_tl
    \tl_set_eq:NN \l_@@_first_j_tl \l_tmpb_tl
    \@@_cut_on_hyphen:w #3 \q_stop
```

```
    \tl_set_eq:NN \l_@@_last_i_tl \l_tmpa_tl
    \tl_set_eq:NN \l_@@_last_j_tl \l_tmpb_tl
    \bool_lazy_or:nnTF
      { \int_compare_p:nNn \l_@@_last_i_tl > \g_@@_row_total_int }
      { \int_compare_p:nNn \l_@@_last_j_tl > \g_@@_col_total_int }
      { \@@_error:n { SubMatrix~too~large } }
      {
        \str_clear_new:N \l_@@_submatrix_name_str
        \keys_set:nn { NiceMatrix / SubMatrix } { #5 }
        \pgfpicture
        \pgfrememberpicturepositiononpagetrue
        \pgf@relevantforpicturesizefalse
        \pgfset { inner~sep = \c_zero_dim }
        \dim_set_eq:NN \l_@@_x_initial_dim \c_max_dim
        \dim_set:Nn \l_@@_x_final_dim { - \c_max_dim }
```

The last value of `\int_step_inline:nnn` is provided by currifycation.

```
        \bool_if:NTF \l_@@_submatrix_slim_bool
          { \int_step_inline:nnn \l_@@_first_i_tl \l_@@_last_i_tl }
          { \int_step_inline:nnn \l_@@_first_row_int \g_@@_row_total_int }
          {
            \cs_if_exist:cT
              { pgf @ sh @ ns @ \@@_env: - ##1 - \l_@@_first_j_tl }
              {
                \pgfpointanchor { \@@_env: - ##1 - \l_@@_first_j_tl } { west }
                \dim_set:Nn \l_@@_x_initial_dim
                  { \dim_min:nn \l_@@_x_initial_dim \pgf@x }
              }
            \cs_if_exist:cT
              { pgf @ sh @ ns @ \@@_env: - ##1 - \l_@@_last_j_tl }
              {
                \pgfpointanchor { \@@_env: - ##1 - \l_@@_last_j_tl } { east }
                \dim_set:Nn \l_@@_x_final_dim
                  { \dim_max:nn \l_@@_x_final_dim \pgf@x }
              }
          }
        \dim_compare:nNnTF \l_@@_x_initial_dim = \c_max_dim
          { \@@_error:nn { impossible~delimiter } { left } }
          {
            \dim_compare:nNnTF \l_@@_x_final_dim = { - \c_max_dim }
              { \@@_error:nn { impossible~delimiter } { right } }
              { \@@_sub_matrix_i:nnnn { #1 } { #4 } { #6 } { #7 } }
          }
        \endpgfpicture
      }
    \group_end:
  }
```

`#1` is the left delimiter, `#2` is the right one, `#3` is the subscript and `#4` is the superscript.

```
\cs_new_protected:Npn \@@_sub_matrix_i:nnnn #1 #2 #3 #4
  {
    \@@_qpoint:n { row - \l_@@_first_i_tl - base }
    \dim_set:Nn \l_@@_y_initial_dim
      { \pgf@y + ( \box_ht:N \strutbox + \extrarowheight ) * \arraystretch }
    \@@_qpoint:n { row - \l_@@_last_i_tl - base }
    \dim_set:Nn \l_@@_y_final_dim
      { \pgf@y - ( \box_dp:N \strutbox ) * \arraystretch }
    \int_step_inline:nnn \l_@@_first_col_int \g_@@_col_total_int
      {
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - \l_@@_first_i_tl - ##1 }
          {
            \pgfpointanchor { \@@_env: - \l_@@_first_i_tl - ##1 } { north }
```

```
            \dim_set:Nn \l_@@_y_initial_dim
              { \dim_max:nn \l_@@_y_initial_dim \pgf@y }
          }
        \cs_if_exist:cT
          { pgf @ sh @ ns @ \@@_env: - \l_@@_last_i_tl - ##1 }
          {
            \pgfpointanchor { \@@_env: - \l_@@_last_i_tl - ##1 } { south }
            \dim_set:Nn \l_@@_y_final_dim
              { \dim_min:nn \l_@@_y_final_dim \pgf@y }
          }
      }
    \dim_set:Nn \l_tmpa_dim
      {
        \l_@@_y_initial_dim - \l_@@_y_final_dim +
        \l_@@_submatrix_extra_height_dim - \arrayrulewidth
      }
    \dim_set_eq:NN \nulldelimiterspace \c_zero_dim
```

We will draw the rules in the `\SubMatrix`.

```
    \group_begin:
    \pgfsetlinewidth { 1.1 \arrayrulewidth }
    \tl_if_empty:NF \l_@@_rules_color_tl
      { \exp_after:wN \@@_set_CT@arc@: \l_@@_rules_color_tl \q_stop }
    \CT@arc@
```

Now, we draw the potential vertical rules specified in the preamble of the environments with the letter fixed with the key `vlines-in-sub-matrix`. The list of the columns where there is such rule to draw is in `\g_@@_cols_vlism_seq`.

```
    \seq_map_inline:Nn \g_@@_cols_vlism_seq
      {
        \int_compare:nNnT \l_@@_first_j_tl < { ##1 }
          {
            \int_compare:nNnT
              { ##1 } < { \int_eval:n { \l_@@_last_j_tl + 1 } }
              {
```

First, we extract the value of the abscissa of the rule we have to draw.

```
                \@@_qpoint:n { col - ##1 }
                \pgfpathmoveto { \pgfpoint \pgf@x \l_@@_y_initial_dim }
                \pgfpathlineto { \pgfpoint \pgf@x \l_@@_y_final_dim }
                \pgfusepathqstroke
              }
          }
      }
```

Now, we draw the vertical rules specified in the key `vlines` of `\SubMatrix`. The last argument of `\int_step_inline:nn` or `\clist_map_inline:Nn` is given by curryfication.

```
    \tl_if_eq:NnTF \l_@@_submatrix_vlines_clist { all }
      { \int_step_inline:nn { \l_@@_last_j_tl - \l_@@_first_j_tl } }
      { \clist_map_inline:Nn \l_@@_submatrix_vlines_clist }
      {
        \bool_lazy_and:nnTF
          { \int_compare_p:nNn { ##1 } > 0 }
          {
             \int_compare_p:nNn
               { ##1 } < { \l_@@_last_j_tl - \l_@@_first_j_tl + 1 } }
          {
            \@@_qpoint:n { col - \int_eval:n { ##1 + \l_@@_first_j_tl } }
            \pgfpathmoveto { \pgfpoint \pgf@x \l_@@_y_initial_dim }
            \pgfpathlineto { \pgfpoint \pgf@x \l_@@_y_final_dim }
            \pgfusepathqstroke
          }
          { \@@_error:nnn { Wrong~line~in~SubMatrix } { vertical } { ##1 } }
      }
```

Now, we draw the horizontal rules specified in the key `hlines` of `\SubMatrix`. The last argument of `\int_step_inline:nn` or `\clist_map_inline:Nn` is given by curryfication.

```
    \tl_if_eq:NnTF \l_@@_submatrix_hlines_clist { all }
      { \int_step_inline:nn { \l_@@_last_i_tl - \l_@@_first_i_tl } }
      { \clist_map_inline:Nn \l_@@_submatrix_hlines_clist }
      {
        \bool_lazy_and:nnTF
          { \int_compare_p:nNn { ##1 } > 0 }
          {
            \int_compare_p:nNn
              { ##1 } < { \l_@@_last_i_tl - \l_@@_first_i_tl + 1 } }
          {
            \@@_qpoint:n { row - \int_eval:n { ##1 + \l_@@_first_i_tl } }
```

We use a group to protect `\l_tmpa_dim` and `\l_tmpb_dim`.

```
            \group_begin:
```

We compute in `\l_tmpa_dim` the x-value of the left end of the rule.

```
            \dim_set:Nn \l_tmpa_dim
              { \l_@@_x_initial_dim - \l_@@_submatrix_left_xshift_dim }
            \str_case:nn { #1 }
              {
                (  { \dim_sub:Nn \l_tmpa_dim { 0.9 mm } }
                [  { \dim_sub:Nn \l_tmpa_dim { 0.2 mm } }
                \{ { \dim_sub:Nn \l_tmpa_dim { 0.9 mm } }
              }
            \pgfpathmoveto { \pgfpoint \l_tmpa_dim \pgf@y }
```

We compute in `\l_tmpb_dim` the x-value of the right end of the rule.

```
            \dim_set:Nn \l_tmpb_dim
              { \l_@@_x_final_dim + \l_@@_submatrix_right_xshift_dim }
            \str_case:nn { #2 }
              {
                )  { \dim_add:Nn \l_tmpb_dim { 0.9 mm } }
                ]  { \dim_add:Nn \l_tmpb_dim { 0.2 mm } }
                \} { \dim_add:Nn \l_tmpb_dim { 0.9 mm } }
              }
            \pgfpathlineto { \pgfpoint \l_tmpb_dim \pgf@y }
            \pgfusepathqstroke
            \group_end:
          }
          { \@@_error:nnn { Wrong~line~in~SubMatrix } { horizontal } { ##1 } }
      }
```

If the key `name` has been used for the command `\SubMatrix`, we create a PGF node with that name for the submatrix (this node does not encompass the delimiters that we will put after).

```
    \str_if_empty:NF \l_@@_submatrix_name_str
      {
        \@@_pgf_rect_node:nnnnn \l_@@_submatrix_name_str
          \l_@@_x_initial_dim \l_@@_y_initial_dim
          \l_@@_x_final_dim \l_@@_y_final_dim
      }
    \group_end:
```

The group was for `\CT@arc@` (the color of the rules).

Now, we deal with the left delimiter. Of course, the environment `{pgfscope}` is for the `\pgftransformshift`.

```
    \begin { pgfscope }
    \pgftransformshift
      {
        \pgfpoint
          { \l_@@_x_initial_dim - \l_@@_submatrix_left_xshift_dim }
          { ( \l_@@_y_initial_dim + \l_@@_y_final_dim ) / 2 }
      }
```

```
    \str_if_empty:NTF \l_@@_submatrix_name_str
      { \@@_node_left:nn #1 { } }
      { \@@_node_left:nn #1 { \@@_env: - \l_@@_submatrix_name_str - left } }
    \end { pgfscope }
```

Now, we deal with the right delimiter.

```
    \pgftransformshift
      {
        \pgfpoint
          { \l_@@_x_final_dim + \l_@@_submatrix_right_xshift_dim }
          { ( \l_@@_y_initial_dim + \l_@@_y_final_dim ) / 2 }
      }
    \str_if_empty:NTF \l_@@_submatrix_name_str
      { \@@_node_right:nnnn #2 { } { #3 } { #4 } }
      {
        \@@_node_right:nnnn #2
          { \@@_env: - \l_@@_submatrix_name_str - right } { #3 } { #4 }
      }
    \cs_set_eq:NN \pgfpointanchor \@@_pgfpointanchor:n
    \flag_clear_new:n { nicematrix }
    \l_@@_code_tl
  }
```

In the key `code` of the command `\SubMatrix` there may be Tikz instructions. We want that, in these instructions, the i and j in specifications of nodes of the forms i-j, `row-`i, `col-`j and i-`|`j refer to the number of row and columm *relative* of the current `\SubMatrix`. That's why we will patch (locally in the `\SubMatrix`) the command `\pgfpointanchor`.

```
\cs_set_eq:NN \@@_old_pgfpointanchor \pgfpointanchor
```

The following command will be linked to `\pgfpointanchor` just before the execution of the option `code` of the command `\SubMatrix`. In this command, we catch the argument `#1` of `\pgfpointanchor` and we apply to it the command `\@@_pgfpointanchor_i:nn` before passing it to the original `\pgfpointanchor`. We have to act in an expandable way because the command `\pgfpointanchor` is used in names of Tikz nodes which are computed in an expandable way.

```
\cs_new_protected:Npn \@@_pgfpointanchor:n #1
  {
    \use:e
      { \exp_not:N \@@_old_pgfpointanchor { \@@_pgfpointanchor_i:nn #1 } }
  }
```

In fact, the argument of `\pgfpointanchor` is always of the form `\a_command { name_of_node }` where "`name_of_node`" is the name of the Tikz node without the potential prefix and suffix. That's why we catch two arguments and work only on the second by trying (first) to extract an hyphen `-`.

```
\cs_new:Npn \@@_pgfpointanchor_i:nn #1 #2
  { #1 { \@@_pgfpointanchor_ii:w #2 - \q_stop } }
```

Since `\seq_if_in:NnTF` and `\clist_if_in:NnTF` are not expandable, we will use the following token list and `\str_case:nVTF` to test whether we have an integer or not.

```
\tl_const:Nn \c_@@_integers_alist_tl
  {
    { 1 } { } { 2 } { } { 3 } { } { 4 } { } { 5 } { }
    { 6 } { } { 7 } { } { 8 } { } { 9 } { } { 10 } { }
    { 11 } { } { 12 } { } { 13 } { } { 14 } { } { 15 } { }
    { 16 } { } { 17 } { } { 18 } { } { 19 } { } { 20 } { }
  }


\cs_new:Npn \@@_pgfpointanchor_ii:w #1-#2\q_stop
  {
```

If there is no hyphen, that means that the node is of the form of a single number (ex.: `5` or `11`). In that case, we are in an analysis which result from a specification of node of the form i-|j. In that case, the i of the number of row arrives first (and alone) in a `\pgfpointanchor` and, the, the j arrives (alone) in the following `\pgfpointanchor`. In order to know whether we have a number of row of a number of column, we keep track of the number of such treatments by the expandable flag called `nicematrix`.

```
    \tl_if_empty:nTF { #2 }
      {
        \str_case:nVTF { #1 } \c_@@_integers_alist_tl
          {
            \flag_raise:n { nicematrix }
            \int_if_even:nTF { \flag_height:n { nicematrix } }
              { \int_eval:n { #1 + \l_@@_first_i_tl - 1 } }
              { \int_eval:n { #1 + \l_@@_first_j_tl - 1 } }
         }
         { #1 }
      }
```

If there is an hyphen, we have to see whether we have a node of the form i-j, `row-`i or `col-`j.

```
      { \@@_pgfpointanchor_iii:w { #1 } #2 }
  }
```

There was an hyphen in the name of the node and that's why we have to retrieve the extra hyphen we have put (cf. `\@@_pgfpointanchor_i:nn`).

```
\cs_new:Npn \@@_pgfpointanchor_iii:w #1 #2 -
  {
    \str_case:nnF { #1 }
      {
        { row } { row - \int_eval:n { #2 + \l_@@_first_i_tl - 1 } }
        { col } { col - \int_eval:n { #2 + \l_@@_first_j_tl - 1 } }
      }
```

Now the case of a node of the form i-j.

```
      {
        \int_eval:n { #1 + \l_@@_first_i_tl - 1 }
        - \int_eval:n { #2 + \l_@@_first_j_tl - 1 }
      }
  }
```

The command `\@@_node_left:nn` puts the left delimiter with the correct size. The argument `#1` is the delimiter to put. The argument `#2` is the name we will give to this PGF node (if the key `name` has been used in `\SubMatrix`).

```
\cs_new_protected:Npn \@@_node_left:nn #1 #2
  {
    \pgfnode
      { rectangle }
      { east }
      {
        \nullfont
        \c_math_toggle_token
        \tl_if_empty:NF \l_@@_delimiters_color_tl
          { \color { \l_@@_delimiters_color_tl } }
        \left #1
        \vcenter
          {
            \nullfont
            \hrule \@height \l_tmpa_dim
                   \@depth \c_zero_dim
                   \@width \c_zero_dim
          }
        \right .
        \c_math_toggle_token
      }
```

```
      { #2 }
      { }
  }
```

The command `\@@_node_right:nn` puts the right delimiter with the correct size. The argument `#1` is the delimiter to put. The argument `#2` is the name we will give to this PGF node (if the key `name` has been used in `\SubMatrix`). The argument `#3` is the subscript and `#4` is the superscript.

```
\cs_new_protected:Npn \@@_node_right:nnnn #1 #2 #3 #4
  {
    \pgfnode
      { rectangle }
      { west }
      {
        \nullfont
        \c_math_toggle_token
        \tl_if_empty:NF \l_@@_delimiters_color_tl
          { \color { \l_@@_delimiters_color_tl } }
        \left .
        \vcenter
          {
            \nullfont
            \hrule \@height \l_tmpa_dim
                   \@depth \c_zero_dim
                   \@width \c_zero_dim
          }
        \right #1
        \tl_if_empty:nF { #3 } { _ { \smash { #3 } } }
        ^ { \smash { #4 } }
        \c_math_toggle_token
      }
      { #2 }
      { }
  }
```

We process the options at package loading

We process the options when the package is loaded (with `\usepackage`) but we recommend to use `\NiceMatrixOptions` instead.
We must process these options after the definition of the environment `{NiceMatrix}` because the option `renew-matrix` executes the code `\cs_set_eq:NN \env@matrix \NiceMatrix`.
Of course, the command `\NiceMatrix` must be defined before such an instruction is executed.

The boolean `\g_@@_footnotehyper_bool` will indicate if the option `footnotehyper` is used.

```
\bool_new:N \c_@@_footnotehyper_bool
```

The boolean `\c_@@_footnote_bool` will indicate if the option `footnote` is used, but quicky, it will also be set to `true` if the option `footnotehyper` is used.

```
\bool_new:N \c_@@_footnote_bool
\@@_msg_new:nnn { Unknown~key~for~package }
  {
    The~key~'\l_keys_key_str'~is~unknown. \\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~available~keys,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    define-L-C-R,~
    footnote,~
    footnotehyper,~
    renew-dots,~and
```

```
    renew-matrix.
  }
```

Maybe we will completely delete the key 'transparent' in a future version.

```
\@@_msg_new:nn { Key~transparent }
  {
    The~key~'transparent'~is~now~obsolete~(because~it's~name~
    is~not~clear).~You~should~use~the~conjonction~of~'renew-dots'~
    and~'renew-matrix'.~However,~you~can~go~on.
  }
\@@_msg_new:nn { define-L-C-R }
  {
    You~have~used~the~key~'define-L-C-R'.~Please~note~that~this~key~
    will~probably~be~deleted~in~a~future~version~of~'nicematrix'.\\
    However,~you~can~go~on.
  }
\keys_define:nn { NiceMatrix / Package }
  {
    define-L-C-R .code:n =
      \@@_error:n { define-L-C-R }
      \bool_set_true:N \c_@@_define_L_C_R_bool ,
    renew-dots .bool_set:N = \l_@@_renew_dots_bool ,
    renew-dots .value_forbidden:n = true ,
    renew-matrix .code:n = \@@_renew_matrix: ,
    renew-matrix .value_forbidden:n = true ,
    transparent .code:n =
      {
        \@@_renew_matrix:
        \bool_set_true:N \l_@@_renew_dots_bool
        \@@_error:n { Key~transparent }
      } ,
    transparent .value_forbidden:n = true,
    footnote .bool_set:N = \c_@@_footnote_bool ,
    footnotehyper .bool_set:N = \c_@@_footnotehyper_bool ,
    unknown .code:n = \@@_error:n { Unknown~key~for~package }
  }
\ProcessKeysOptions { NiceMatrix / Package }


\@@_msg_new:nn { footnote~with~footnotehyper~package }
  {
    You~can't~use~the~option~'footnote'~because~the~package~
    footnotehyper~has~already~been~loaded.~
    If~you~want,~you~can~use~the~option~'footnotehyper'~and~the~footnotes~
    within~the~environments~of~nicematrix~will~be~extracted~with~the~tools~
    of~the~package~footnotehyper.\\
    If~you~go~on,~the~package~footnote~won't~be~loaded.
  }
\@@_msg_new:nn { footnotehyper~with~footnote~package }
  {
    You~can't~use~the~option~'footnotehyper'~because~the~package~
    footnote~has~already~been~loaded.~
    If~you~want,~you~can~use~the~option~'footnote'~and~the~footnotes~
    within~the~environments~of~nicematrix~will~be~extracted~with~the~tools~
    of~the~package~footnote.\\
    If~you~go~on,~the~package~footnotehyper~won't~be~loaded.
  }


\bool_if:NT \c_@@_footnote_bool
  {
```

The class beamer has its own system to extract footnotes and that's why we have nothing to do if beamer is used.

```
    \@ifclassloaded { beamer }
      { \bool_set_false:N \c_@@_footnote_bool }
      {
        \@ifpackageloaded { footnotehyper }
          { \@@_error:n { footnote~with~footnotehyper~package } }
          { \usepackage { footnote } }
      }
  }
\bool_if:NT \c_@@_footnotehyper_bool
  {
```

The class beamer has its own system to extract footnotes and that's why we have nothing to do if beamer is used.

```
    \@ifclassloaded { beamer }
      { \bool_set_false:N \c_@@_footnote_bool }
      {
        \@ifpackageloaded { footnote }
          { \@@_error:n { footnotehyper~with~footnote~package } }
          { \usepackage { footnotehyper } }
      }
    \bool_set_true:N \c_@@_footnote_bool
  }
```

The flag `\c_@@_footnote_bool` is raised and so, we will only have to test `\c_@@_footnote_bool` in order to know if we have to insert an environment `{savenotes}`.

Error messages of the package

The following message will be deleted when we will delete the key `except-corners` for the command `\arraycolor`.

```
\@@_msg_new:nn { key except-corners }
  {
    The~key~'except-corners'~has~been~deleted~for~the~command~\token_to_str:N
    \arraycolor\ in~the~\token_to_str:N \CodeBefore.~You~should~instead~use~
    the~key~'corners'~in~your~\@@_full_name_env:.\\
    If~you~go~on,~this~key~will~be~ignored.
  }
\seq_new:N \c_@@_types_of_matrix_seq
\seq_set_from_clist:Nn \c_@@_types_of_matrix_seq
  {
    NiceMatrix ,
    pNiceMatrix , bNiceMatrix , vNiceMatrix, BNiceMatrix, VNiceMatrix
  }
\seq_set_map_x:NNn \c_@@_types_of_matrix_seq \c_@@_types_of_matrix_seq
  { \tl_to_str:n { #1 } }
```

If the user uses too much columns, the command `\@@_error_too_much_cols:` is executed. This command raises an error but try to give the best information to the user in the error message. The command `\seq_if_in:NVTF` is not expandable and that's why we can't put it in the error message itself. We have to do the test before the `\@@_fatal:n`.

```
\cs_new_protected:Npn \@@_error_too_much_cols:
  {
    \seq_if_in:NVTF \c_@@_types_of_matrix_seq \g_@@_name_env_str
      {
        \int_compare:nNnTF \l_@@_last_col_int = { -2 }
        { \@@_fatal:n { too~much~cols~for~matrix } }
        {
          \bool_if:NF \l_@@_last_col_without_value_bool
```

```
            { \@@_fatal:n { too~much~cols~for~matrix~with~last~col } }
        }
      }
      { \@@_fatal:n { too~much~cols~for~array } }
  }
```

The following command must *not* be protected since it's used in an error message.

```
\cs_new:Npn \@@_message_hdotsfor:
  {
    \tl_if_empty:VF \g_@@_HVdotsfor_lines_tl
      { ~Maybe~your~use~of~\token_to_str:N \Hdotsfor\ is~incorrect.}
  }
\@@_msg_new:nn { too~much~cols~for~matrix~with~last~col }
  {
    You~try~to~use~more~columns~than~allowed~by~your~
    \@@_full_name_env:.\@@_message_hdotsfor:\ The~maximal~number~of~
    columns~is~\int_eval:n { \l_@@_last_col_int - 1 }~(plus~the~
    exterior~columns).~This~error~is~fatal.
  }
\@@_msg_new:nn { too~much~cols~for~matrix }
  {
    You~try~to~use~more~columns~than~allowed~by~your~
    \@@_full_name_env:.\@@_message_hdotsfor:\ Recall~that~the~maximal~
    number~of~columns~for~a~matrix~is~fixed~by~the~LaTeX~counter~
    'MaxMatrixCols'.~Its~actual~value~is~\int_use:N \c@MaxMatrixCols.~
    This~error~is~fatal.
  }
```

For the following message, remind that the test is not done after the construction of the array but in each row. That's why we have to put `\c@jCol-1` and not `\c@jCol`.

```
\@@_msg_new:nn { too~much~cols~for~array }
  {
    You~try~to~use~more~columns~than~allowed~by~your~
    \@@_full_name_env:.\@@_message_hdotsfor:\ The~maximal~number~of~columns~is~
    \int_use:N \g_@@_static_num_of_col_int\
    ~(plus~the~potential~exterior~ones).~
    This~error~is~fatal.
  }
\@@_msg_new:nn { last~col~not~used }
  {
    The~key~'last-col'~is~in~force~but~you~have~not~used~that~last~column~
    in~your~\@@_full_name_env:.~However,~you~can~go~on.
  }
\@@_msg_new:nn { columns~not~used }
  {
    The~preamble~of~your~\@@_full_name_env:\ announces~\int_use:N
    \g_@@_static_num_of_col_int\ columns~but~you~use~only~\int_use:N \c@jCol.\\
    You~can~go~on~but~the~columns~you~did~not~used~won't~be~created.
  }
\@@_msg_new:nn { in~first~col }
  {
    You~can't~use~the~command~#1 in~the~first~column~(number~0)~of~the~array.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { in~last~col }
  {
    You~can't~use~the~command~#1 in~the~last~column~(exterior)~of~the~array.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
```

```
\@@_msg_new:nn { in~first~row }
  {
    You~can't~use~the~command~#1 in~the~first~row~(number~0)~of~the~array.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { in~last~row }
  {
    You~can't~use~the~command~#1 in~the~last~row~(exterior)~of~the~array.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { double~closing~delimiter }
  {
    You~can't~put~a~second~closing~delimiter~"#1"~just~after~a~first~closing~
    delimiter.~This~delimiter~will~be~ignored.
  }
\@@_msg_new:nn { delimiter~after~opening }
  {
    You~can't~put~a~second~delimiter~"#1"~just~after~a~first~opening~
    delimiter.~This~delimiter~will~be~ignored.
  }
\@@_msg_new:nn { bad~option~for~line-style }
  {
    Since~you~haven't~loaded~Tikz,~the~only~value~you~can~give~to~'line-style'~
    is~'standard'.~If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { Unknown~key~for~xdots }
  {
    As~for~now,~there~is~only~three~keys~available~here:~'color',~'line-style'~
    and~'shorten'~(and~you~try~to~use~'\l_keys_key_str').~If~you~go~on,~
    this~key~will~be~ignored.
  }
\@@_msg_new:nn { Unknown~key~for~RowStyle }
  {
    As~for~now,~there~is~only~three~keys~available~here:~'cell-space-top-limit',~
    'cell-space-bottom-limit~and~'cell-space-limits'~(and~you~try~to~use~
    '\l_keys_key_str').~If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { Unknown~key~for~rowcolors }
  {
    As~for~now,~there~is~only~two~keys~available~here:~'cols'~and~'respect-blocks'~
    (and~you~try~to~use~'\l_keys_key_str').~If~you~go~on,~
    this~key~will~be~ignored.
  }
\@@_msg_new:nn { ampersand~in~light-syntax }
  {
    You~can't~use~an~ampersand~(\token_to_str:N &)~to~separate~columns~because~
    ~you~have~used~the~key~'light-syntax'.~This~error~is~fatal.
  }
\@@_msg_new:nn { SubMatrix~too~large }
  {
    Your~command~\token_to_str:N \SubMatrix\
    can't~be~drawn~because~your~matrix~is~too~small.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { double-backslash~in~light-syntax }
  {
    You~can't~use~\token_to_str:N \\~to~separate~rows~because~you~have~used~
    the~key~'light-syntax'.~You~must~use~the~character~'\l_@@_end_of_row_tl'~
    (set~by~the~key~'end-of-row').~This~error~is~fatal.
  }
```

```
\@@_msg_new:nn { standard-cline~in~document }
  {
    The~key~'standard-cline'~is~available~only~in~the~preamble.\\
    If~you~go~on~this~command~will~be~ignored.
  }
\@@_msg_new:nn { old~column~type }
  {
    The~column~type~'#1'~is~no~longer~defined~in~'nicematrix'.~
    Since~version~5.0,~you~have~to~use~'l',~'c'~and~'r'~instead~of~'L',~
    'C'~and~'R'.~You~can~also~use~the~key~'define-L-C-R'.\\
    This~error~is~fatal.
  }
\@@_msg_new:nn { bad~value~for~baseline }
  {
    The~value~given~to~'baseline'~(\int_use:N \l_tmpa_int)~is~not~
    valid.~The~value~must~be~between~\int_use:N \l_@@_first_row_int\ and~
    \int_use:N \g_@@_row_total_int\ or~equal~to~'t',~'c'~or~'b'.\\
    If~you~go~on,~a~value~of~1~will~be~used.
  }
\@@_msg_new:nn { Invalid~name~format }
  {
    You~can't~give~the~name~'\l_keys_value_tl'~to~a~\token_to_str:N
    \SubMatrix.\\
    A~name~must~be~accepted~by~the~regular~expression~[A-Za-z][A-Za-z0-9]*.\\
    If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { Wrong~line~in~SubMatrix }
  {
    You~try~to~draw~a~#1~line~of~number~'#2'~in~a~
    \token_to_str:N \SubMatrix\ of~your~\@@_full_name_env:\ but~that~
    number~is~not~valid.~If~you~go~on,~it~will~be~ignored.
  }
\@@_msg_new:nn { impossible~delimiter }
  {
    It's~impossible~to~draw~the~#1~delimiter~of~your~
    \token_to_str:N \SubMatrix\ because~all~the~cells~are~empty~
    in~that~column.
    \bool_if:NT \l_@@_submatrix_slim_bool
      { ~Maybe~you~should~try~without~the~key~'slim'. } \\
    If~you~go~on,~this~\token_to_str:N \SubMatrix\ will~be~ignored.
  }
\@@_msg_new:nn { empty~environment }
  { Your~\@@_full_name_env:\ is~empty.~This~error~is~fatal. }
\@@_msg_new:nn { Delimiter~with~small }
  {
    You~can't~put~a~delimiter~in~the~preamble~of~your~\@@_full_name_env:\
    because~the~key~'small'~is~in~force.\\
    This~error~is~fatal.
  }
\@@_msg_new:nn { unknown~cell~for~line~in~CodeAfter }
  {
    Your~command~\token_to_str:N\line\{#1\}\{#2\}~in~the~'code-after'~
    can't~be~executed~because~a~cell~doesn't~exist.\\
    If~you~go~on~this~command~will~be~ignored.
  }
\@@_msg_new:nnn { Duplicate~name~for~SubMatrix }
  {
    The~name~'#1'~is~already~used~for~a~\token_to_str:N \SubMatrix\
    in~this~\@@_full_name_env:.\\
    If~you~go~on,~this~key~will~be~ignored.\\
```

```
    For~a~list~of~the~names~already~used,~type~H~<return>.
  }
  {
    The~names~already~defined~in~this~\@@_full_name_env:\ are:~
    \seq_use:Nnnn \g_@@_submatrix_names_seq { ~and~ } { ,~ } { ~and~ }.
  }
\@@_msg_new:nn { r~or~l~with~preamble }
  {
    You~can't~use~the~key~'\l_keys_key_str'~in~your~\@@_full_name_env:.~
    You~must~specify~the~alignment~of~your~columns~with~the~preamble~of~
    your~\@@_full_name_env:.\\
    If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { Hdotsfor~in~col~0 }
  {
    You~can't~use~\token_to_str:N \Hdotsfor\ in~an~exterior~column~of~
    the~array.~This~error~is~fatal.
  }
\@@_msg_new:nn { bad~corner }
  {
    #1~is~an~incorrect~specification~for~a~corner~(in~the~keys~
    'corners'~and~'except-corners').~The~available~
    values~are:~NW,~SW,~NE~and~SE.\\
    If~you~go~on,~this~specification~of~corner~will~be~ignored.
  }
\@@_msg_new:nn { bad~border }
  {
    #1~is~an~incorrect~specification~for~a~border~(in~the~key~
    'borders'~of~the~command~\token_to_str:N \Block).~The~available~
    values~are:~left,~right,~top~and~bottom.\\
    If~you~go~on,~this~specification~of~border~will~be~ignored.
  }
\@@_msg_new:nn { last-col~non~empty~for~NiceArray }
  {
    In~the~\@@_full_name_env:,~you~must~use~the~key~
    'last-col'~without~value.\\
    However,~you~can~go~on~for~this~time~
    (the~value~'\l_keys_value_tl'~will~be~ignored).
  }
\@@_msg_new:nn { last-col~non~empty~for~NiceMatrixOptions }
  {
    In~\NiceMatrixoptions,~you~must~use~the~key~
    'last-col'~without~value.\\
    However,~you~can~go~on~for~this~time~
    (the~value~'\l_keys_value_tl'~will~be~ignored).
  }
\@@_msg_new:nn { Block~too~large~1 }
  {
    You~try~to~draw~a~block~in~the~cell~#1-#2~of~your~matrix~but~the~matrix~is~
    too~small~for~that~block. \\
  }
\@@_msg_new:nn { Block~too~large~2 }
  {
    The~preamble~of~your~\@@_full_name_env:\ announces~\int_use:N
    \g_@@_static_num_of_col_int\
    columns~but~you~use~only~\int_use:N \c@jCol\ and~that's~why~a~block~
    specified~in~the~cell~#1-#2~can't~be~drawn.~You~should~add~some~ampersands~
    (&)~at~the~end~of~the~first~row~of~your~
    \@@_full_name_env:.\\
    If~you~go~on,this~block~and~maybe~others~will~be~ignored.
  }
```

```
\@@_msg_new:nn { unknown~column~type }
  {
    The~column~type~'#1'~in~your~\@@_full_name_env:\
    is~unknown. \\
    This~error~is~fatal.
  }
\@@_msg_new:nn { tabularnote~forbidden }
  {
    You~can't~use~the~command~\token_to_str:N\tabularnote\
    ~in~a~\@@_full_name_env:.~This~command~is~available~only~in~
    \{NiceTabular\},~\{NiceArray\}~and~\{NiceMatrix\}. \\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { borders~forbidden }
  {
    You~can't~use~the~key~'borders'~of~the~command~\token_to_str:N \Block\
    because~the~option~'rounded-corners'~
    is~in~force~with~a~non-zero~value.\\
    If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { bottomrule~without~booktabs }
  {
    You~can't~use~the~key~'tabular/bottomrule'~because~you~haven't~
    loaded~'booktabs'.\\
    If~you~go~on,~this~key~will~be~ignored.
  }
\@@_msg_new:nn { enumitem~not~loaded }
  {
    You~can't~use~the~command~\token_to_str:N\tabularnote\
    ~because~you~haven't~loaded~'enumitem'.\\
    If~you~go~on,~this~command~will~be~ignored.
  }
\@@_msg_new:nn { Wrong~last~row }
  {
    You~have~used~'last-row=\int_use:N \l_@@_last_row_int'~but~your~
    \@@_full_name_env:\ seems~to~have~\int_use:N \c@iRow \ rows.~
    If~you~go~on,~the~value~of~\int_use:N \c@iRow \ will~be~used~for~
    last~row.~You~can~avoid~this~problem~by~using~'last-row'~
    without~value~(more~compilations~might~be~necessary).
  }
\@@_msg_new:nn { Yet~in~env }
  { Environments~of~nicematrix~can't~be~nested.\\ This~error~is~fatal. }
\@@_msg_new:nn { Outside~math~mode }
  {
    The~\@@_full_name_env:\ can~be~used~only~in~math~mode~
    (and~not~in~\token_to_str:N \vcenter).\\
    This~error~is~fatal.
  }
\@@_msg_new:nn { One~letter~allowed }
  {
    The~value~of~key~'\l_keys_key_str'~must~be~of~length~1.\\
    If~you~go~on,~it~will~be~ignored.
  }
\@@_msg_new:nnn { Unknown~key~for~Block }
  {
    The~key~'\l_keys_key_str'~is~unknown~for~the~command~\token_to_str:N
    \Block.\\ If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~available~keys,~type~H~<return>.
  }
  {
```

```
    The~available~keys~are~(in~alphabetic~order):~b,~borders,~c,~draw,~fill,~
    hvlines,~l,~line-width,~rounded-corners,~r~and~t.
  }
\@@_msg_new:nnn { Unknown~key~for~CodeAfter }
  {
    The~key~'\l_keys_key_str'~is~unknown.\\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~available~keys~in~\token_to_str:N
    \CodeAfter,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    delimiters/color,~
    rules~(with~the~subkeys~'color'~and~'width'),~
    sub-matrix~(several~subkeys)~
    and~xdots~(several~subkeys).~
    The~latter~is~for~the~command~\token_to_str:N \line.
  }
\@@_msg_new:nnn { Unknown~key~for~SubMatrix }
  {
    The~key~'\l_keys_key_str'~is~unknown.\\
    If~you~go~on,~this~key~will~be~ignored. \\
    For~a~list~of~the~available~keys~in~\token_to_str:N
    \SubMatrix,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    'delimiters/color',~
    'extra-height',~
    'hlines',~
    'hvlines',~
    'left-xshift',~
    'name',~
    'right-xshift',~
    'rules'~(with~the~subkeys~'color'~and~'width'),~
    'slim',~
    'vlines'~and~'xshift'~(which~sets~both~'left-xshift'~
    and~'right-xshift').\\
  }
\@@_msg_new:nnn { Unknown~key~for~notes }
  {
    The~key~'\l_keys_key_str'~is~unknown.\\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~available~keys~about~notes,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    bottomrule,~
    code-after,~
    code-before,~
    enumitem-keys,~
    enumitem-keys-para,~
    para,~
    label-in-list,~
    label-in-tabular~and~
    style.
  }
\@@_msg_new:nnn { Unknown~key~for~NiceMatrixOptions }
  {
    The~key~'\l_keys_key_str'~is~unknown~for~the~command~
    \token_to_str:N \NiceMatrixOptions. \\
    If~you~go~on,~it~will~be~ignored. \\
```

```
    For~a~list~of~the~*principal*~available~keys,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    allow-duplicate-names,~
    cell-space-bottom-limit,~
    cell-space-limits,~
    cell-space-top-limit,~
    code-for-first-col,~
    code-for-first-row,~
    code-for-last-col,~
    code-for-last-row,~
    corners,~
    create-extra-nodes,~
    create-medium-nodes,~
    create-large-nodes,~
    delimiters~(several~subkeys),~
    end-of-row,~
    first-col,~
    first-row,~
    hlines,~
    hvlines,~
    last-col,~
    last-row,~
    left-margin,~
    letter-for-dotted-lines,~
    light-syntax,~
    notes~(several~subkeys),~
    nullify-dots,~
    renew-dots,~
    renew-matrix,~
    right-margin,~
    rules~(with~the~subkeys~'color'~and~'width'),~
    small,~
    sub-matrix~(several~subkeys),
    vlines,~
    xdots~(several~subkeys).
  }
\@@_msg_new:nnn { Unknown~key~for~NiceArray }
  {
    The~key~'\l_keys_key_str'~is~unknown~for~the~environment~
    \{NiceArray\}. \\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~*principal*~available~keys,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    b,~
    baseline,~
    c,~
    cell-space-bottom-limit,~
    cell-space-limits,~
    cell-space-top-limit,~
    code-after,~
    code-for-first-col,~
    code-for-first-row,~
    code-for-last-col,~
    code-for-last-row,~
    colortbl-like,~
    columns-width,~
    corners,~
    create-extra-nodes,~
    create-medium-nodes,~
```

```
    create-large-nodes,~
    delimiters/color,~
    extra-left-margin,~
    extra-right-margin,~
    first-col,~
    first-row,~
    hlines,~
    hvlines,~
    last-col,~
    last-row,~
    left-margin,~
    light-syntax,~
    name,~
    notes/bottomrule,~
    notes/para,~
    nullify-dots,~
    renew-dots,~
    right-margin,~
    rules~(with~the~subkeys~'color'~and~'width'),~
    small,~
    t,~
    tabularnote,~
    vlines,~
    xdots/color,~
    xdots/shorten~and~
    xdots/line-style.
  }
```

This error message is used for the set of keys `NiceMatrix/NiceMatrix` and `NiceMatrix/pNiceArray` (but not by `NiceMatrix/NiceArray` because, for this set of keys, there is also the keys `t`, `c` and `b`).

```
\@@_msg_new:nnn { Unknown~key~for~NiceMatrix }
  {
    The~key~'\l_keys_key_str'~is~unknown~for~the~
    \@@_full_name_env:. \\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~*principal*~available~keys,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    b,~
    baseline,~
    c,~
    cell-space-bottom-limit,~
    cell-space-limits,~
    cell-space-top-limit,~
    code-after,~
    code-for-first-col,~
    code-for-first-row,~
    code-for-last-col,~
    code-for-last-row,~
    colortbl-like,~
    columns-width,~
    corners,~
    create-extra-nodes,~
    create-medium-nodes,~
    create-large-nodes,~
    delimiters~(several~subkeys),~
    extra-left-margin,~
    extra-right-margin,~
    first-col,~
    first-row,~
    hlines,~
    hvlines,~
```

```
    l,~
    last-col,~
    last-row,~
    left-margin,~
    light-syntax,~
    name,~
    nullify-dots,~
    r,~
    renew-dots,~
    right-margin,~
    rules~(with~the~subkeys~'color'~and~'width'),~
    small,~
    t,~
    vlines,~
    xdots/color,~
    xdots/shorten~and~
    xdots/line-style.
  }
\@@_msg_new:nnn { Unknown~key~for~NiceTabular }
  {
    The~key~'\l_keys_key_str'~is~unknown~for~the~environment~
    \{NiceTabular\}. \\
    If~you~go~on,~it~will~be~ignored. \\
    For~a~list~of~the~*principal*~available~keys,~type~H~<return>.
  }
  {
    The~available~keys~are~(in~alphabetic~order):~
    b,~
    baseline,~
    c,~
    cell-space-bottom-limit,~
    cell-space-limits,~
    cell-space-top-limit,~
    code-after,~
    code-for-first-col,~
    code-for-first-row,~
    code-for-last-col,~
    code-for-last-row,~
    colortbl-like,~
    columns-width,~
    corners,~
    create-extra-nodes,~
    create-medium-nodes,~
    create-large-nodes,~
    extra-left-margin,~
    extra-right-margin,~
    first-col,~
    first-row,~
    hlines,~
    hvlines,~
    last-col,~
    last-row,~
    left-margin,~
    light-syntax,~
    name,~
    notes/bottomrule,~
    notes/para,~
    nullify-dots,~
    renew-dots,~
    right-margin,~
    rules~(with~the~subkeys~'color'~and~'width'),~
    t,~
    tabularnote,~
```

```
    vlines,~
    xdots/color,~
    xdots/shorten~and~
    xdots/line-style.
  }
\@@_msg_new:nnn { Duplicate~name }
  {
    The~name~'\l_keys_value_tl'~is~already~used~and~you~shouldn't~use~
    the~same~environment~name~twice.~You~can~go~on,~but,~
    maybe,~you~will~have~incorrect~results~especially~
    if~you~use~'columns-width=auto'.~If~you~don't~want~to~see~this~
    message~again,~use~the~key~'allow-duplicate-names'~in~
    '\token_to_str:N \NiceMatrixOptions'.\\
    For~a~list~of~the~names~already~used,~type~H~<return>. \\
  }
  {
    The~names~already~defined~in~this~document~are:~
    \seq_use:Nnnn \g_@@_names_seq { ~and~ } { ,~ } { ~and~ }.
  }
\@@_msg_new:nn { Option~auto~for~columns-width }
  {
    You~can't~give~the~value~'auto'~to~the~key~'columns-width'~here.~
    If~you~go~on,~the~key~will~be~ignored.
  }
```

19 History

The successive versions of the file `nicematrix.sty` provided by TeXLive are available on the SVN server of TeXLive:

`https:www.tug.org/svn/texlive/trunk/Master/texmf-dist/tex/latex/nicematrix/nicematrix.sty`

Changes between versions 1.0 and 1.1

The dotted lines are no longer drawn with Tikz nodes but with Tikz circles (for efficiency).
Modification of the code which is now twice faster.

Changes between versions 1.1 and 1.2

New environment `{NiceArray}` with column types `L`, `C` and `R`.

Changes between version 1.2 and 1.3

New environment `{pNiceArrayC}` and its variants.
Correction of a bug in the definition of `{BNiceMatrix}`, `{vNiceMatrix}` and `{VNiceMatrix}` (in fact, it was a typo).
Options are now available locally in `{pNiceMatrix}` and its variants.
The names of the options are changed. The old names were names in "camel style".

Changes between version 1.3 and 1.4

The column types `w` and `W` can now be used in the environments `{NiceArray}`, `{pNiceArrayC}` and its variants with the same meaning as in the package array.
New option `columns-width` to fix the same width for all the columns of the array.

Changes between version 1.4 and 2.0

The versions 1.0 to 1.4 of nicematrix were focused on the continuous dotted lines whereas the version 2.0 of nicematrix provides different features to improve the typesetting of mathematical matrices.

Changes between version 2.0 and 2.1

New implementation of the environment `{pNiceArrayRC}`. With this new implementation, there is no restriction on the width of the columns.
The package nicematrix no longer loads mathtools but only amsmath.
Creation of "medium nodes" and "large nodes".

Changes between version 2.1 and 2.1.1

Small corrections: for example, the option `code-for-first-row` is now available in the command `\NiceMatrixOptions`.
Following a discussion on TeX StackExchange[64], Tikz externalization is now deactivated in the environments of the package nicematrix.[65]

Changes between version 2.1.2 and 2.1.3

When searching the end of a dotted line from a command like `\Cdots` issued in the "main matrix" (not in the exterior column), the cells in the exterior column are considered as outside the matrix. That means that it's possible to do the following matrix with only a `\Cdots` command (and a single `\Vdots`).

$$\begin{array}{c} \\ \begin{pmatrix} 0 & \vdots & 0 \\ & a\cdots\cdots & \\ 0 & & 0 \end{pmatrix} \end{array} \begin{array}{c} C_j \\ \\ L_i \end{array}$$

Changes between version 2.1.3 and 2.1.4

Replacement of some options `O { }` in commands and environments defined with xparse by `! O { }` (because a recent version of xparse introduced the specifier `!` and modified the default behaviour of the last optional arguments).
See `www.texdev.net/2018/04/21/xparse-optional-arguments-at-the-end`

Changes between version 2.1.4 and 2.1.5

Compatibility with the classes revtex4-1 and revtex4-2.
Option `allow-duplicate-names`.

Changes between version 2.1.5 and 2.2

Possibility to draw horizontal dotted lines to separate rows with the command `\hdottedline` (similar to the classical command `\hline` and the command `\hdashline` of arydshln).
Possibility to draw vertical dotted lines to separate columns with the specifier "`:`" in the preamble (similar to the classical specifier "`|`" and the specifier "`:`" of arydshln).

[64] cf. `tex.stackexchange.com/questions/450841/tikz-externalize-and-nicematrix-package`
[65] Before this version, there was an error when using nicematrix with Tikz externalization. In any case, it's not possible to externalize the Tikz elements constructed by nicematrix because they use the options `overlay` and `remember picture`.

Changes between version 2.2 and 2.2.1

Improvment of the vertical dotted lines drawn by the specifier ":" in the preamble.
Modification of the position of the dotted lines drawn by `\hdottedline`.

Changes between version 2.2.1 and 2.3

Compatibility with the column type `S` of siunitx.
Option `hlines`.

Changes between version 2.3 and 3.0

Modification of `\Hdotsfor`. Now `\Hdotsfor` erases the `\vlines` (of "`|`") as `\hdotsfor` does.
Composition of exterior rows and columns on the four sides of the matrix (and not only on two sides) with the options `first-row`, `last-row`, `first-col` and `last-col`.

Changes between version 3.0 and 3.1

Command `\Block` to draw block matrices.
Error message when the user gives an incorrect value for `last-row`.
A dotted line can no longer cross another dotted line (excepted the dotted lines drawn by `\cdottedline`, the symbol "`:`" (in the preamble of the array) and `\line` in `code-after`).
The starred versions of `\Cdots`, `\Ldots`, etc. are now deprecated because, with the new implementation, they become pointless. These starred versions are no longer documented.
The vertical rules in the matrices (drawn by "`|`") are now compatible with the color fixed by colortbl.
Correction of a bug: it was not possible to use the colon "`:`" in the preamble of an array when `pdflatex` was used with french-babel (because french-babel activates the colon in the beginning of the document).

Changes between version 3.1 and 3.2 (and 3.2a)

Option `small`.

Changes between version 3.2 and 3.3

The options `first-row`, `last-row`, `first-col` and `last-col` are now available in the environments `{NiceMatrix}`, `{pNiceMatrix}`, `{bNiceMatrix}`, etc.
The option `columns-width=auto` doesn't need any more a second compilation.
The options `renew-dots`, `renew-matrix` and `transparent` are now available as package options (as said in the documentation).
The previous version of nicematrix was incompatible with a recent version of expl3 (released 2019/09/30). This version is compatible.

Changes between version 3.3 and 3.4

Following a discussion on TeX StackExchange[66], optimization of Tikz externalization is disabled in the environments of nicematrix when the class standalone or the package standalone is used.

Changes between version 3.4 and 3.5

Correction on a bug on the two previous versions where the `code-after` was not executed.

[66] cf. `tex.stackexchange.com/questions/510841/nicematrix-and-tikz-external-optimize`

Changes between version 3.5 and 3.6

LaTeX counters `iRow` and `jCol` available in the cells of the array.
Addition of `\normalbaselines` before the construction of the array: in environments like `{align}` of amsmath the value of `\baselineskip` is changed and if the options `first-row` and `last-row` were used in an environment of nicematrix, the position of the delimiters was wrong.
A warning is written in the `.log` file if an obsolete environment is used.
There is no longer artificial errors `Duplicate~name` in the environments of amsmath.

Changes between version 3.6 and 3.7

The four "corners" of the matrix are correctly protected against the four codes: `code-for-first-col`, `code-for-last-col`, `code-for-first-row` and `code-for-last-row`.
New command `\pAutoNiceMatrix` and its variants (suggestion of Christophe Bal).

Changes between version 3.7 and 3.8

New programmation for the command `\Block` when the block has only one row. With this programmation, the vertical rules drawn by the specifier "`|`" at the end of the block is actually drawn. In previous versions, they were not because the block of one row was constructed with `\multicolumn`.
An error is raised when an obsolete environment is used.

Changes between version 3.8 and 3.9

New commands `\NiceMatrixLastEnv` and `\OnlyMainNiceMatrix`.
New options `create-medium-nodes` and `create-large-nodes`.

Changes between version 3.9 and 3.10

New option `light-syntax` (and `end-of-row`).
New option `dotted-lines-margin` for fine tuning of the dotted lines.

Changes between versions 3.10 and 3.11

Correction of a bug linked to `first-row` and `last-row`.

Changes between versions 3.11 and 3.12

Command `\rotate` in the cells of the array.
Options `vlines`, `hlines` and `hvlines`.
Option `baseline` pour `{NiceArray}` (not for the other environments).
The name of the Tikz nodes created by the command `\Block` has changed: when the command has been issued in the cell i-j, the name is i-j`-block` and, if the creation of the "medium nodes" is required, a node i-j`-block-medium` is created.
If the user tries to use more columns than allowed by its environment, an error is raised by nicematrix (instead of a low-level error).
The package must be loaded with the option `obsolete-environments` if we want to use the deprecated environments.

Changes between versions 3.12 and 3.13

The behaviour of the command `\rotate` is improved when used in the "last row".
The option `dotted-lines-margin` has been renamed in `xdots/shorten` and the options `xdots/color` and `xdots/line-style` have been added for a complete customisation of the dotted lines.
In the environments without preamble (`{NiceMatrix}`, `{pNiceMatrix}`, etc.), it's possible to use the options `l` (=`L`) or `r` (=`R`) to specify the type of the columns.
The starred versions of the commands `\Cdots`, `\Ldots`, `\Vdots`, `\Ddots` and `\Iddots` are deprecated since the version 3.1 of nicematrix. Now, one should load nicematrix with the option `starred-commands` to avoid an error at the compilation.
The code of nicematrix no longer uses Tikz but only PGF. By default, Tikz is *not* loaded by nicematrix.

Changes between versions 3.13 and 3.14

Correction of a bug (question 60761504 on `stackoverflow`).
Better error messages when the user uses `&` or `\\` when `light-syntax` is in force.

Changes between versions 3.14 and 3.15

It's possible to put labels on the dotted lines drawn by `\Ldots`, `\Cdots`, `\Vdots`, `\Ddots`, `\Iddots`, `\Hdotsfor` and the command `\line` in the `code-after` with the tokens `_` and `^`.
The option `baseline` is now available in all the environments of nicematrix. Before, it was available only in `{NiceArray}`.
New keyword `\CodeAfter` (in the environments of nicematrix).

Changes between versions 3.15 and 4.0

New environment `{NiceTabular}`
Commands to color cells, rows and columns with a perfect result in the PDF.

Changes between versions 4.0 and 4.1

New keys `cell-space-top-limit` and `cell-space-bottom-limit`
New command `\diagbox`
The key `hvline` don't draw rules in the blocks (commands `\Block`) and in the virtual blocks corresponding to the dotted lines.

Changes between versions 4.1 and 4.2

It's now possible to write `\begin{pNiceMatrix}a&b\\c&d\end{pNiceMatrix}^2` with the expected result.

Changes between versions 4.2 and 4.3

The horizontal centering of the content of a `\Block` is correct even when an instruction such as `!{\qquad}` is used in the preamble of the array.
It's now possible to use the command `\Block` in the "last row".

Changes between versions 4.3 and 4.4

New key `hvlines-except-corners`.

Changes between versions 4.4 and 5.0

Use of the standard column types `l`, `c` and `r` instead of `L`, `C` and `R`.
It's now possible to use the command `\diagbox` in a `\Block`.
Command `\tabularnote`

Changes between versions 5.0 and 5.1

The vertical rules specified by `|` in the preamble are not broken by `\hline\hline` (and other).
Environment `{NiceTabular*}`
Command `\Vdotsfor` similar to `\Hdotsfor`
The variable `\g_nicematrix_code_after_tl` is now public.

Changes between versions 5.1 and 5.2

The vertical rules specified by `|` or `||` in the preamble respect the blocks.
Key `respect-blocks` for `\rowcolors` (with a *s*) in the `code-before`.
The variable `\g_nicematrix_code_before_tl` is now public.
The key `baseline` may take in as value an expression of the form *line-i* to align the `\hline` in the row *i*.
The key `hvlines-except-corners` may take in as value a list of corners (eg: NW,SE).

Changes between versions 5.2 and 5.3

Keys `c`, `r` and `l` for the command `\Block`.
It's possible to use the key `draw-first` with `\Ddots` and `\Iddots` to specify which dotted line will be drawn first (the other lines will be drawn parallel to that one if parallelization is activated).

Changes between versions 5.3 and 5.4

Key `tabularnote`.
Different behaviour for the mono-column blocks.

Changes between versions 5.4 and 5.5

The user must never put `\omit` before `\CodeAfter`.
Correction of a bug: the tabular notes `\tabularnotes` were not composed when present in a block (except a mono-column block).

Changes between versions 5.5 and 5.6

Different behaviour for the mono-row blocks.
New command `\NotEmpty`.

Changes between versions 5.6 and 5.7

New key `delimiters-color`
Keys `fill`, `draw` and `line-width` for the command `\Block`.

Changes between versions 5.7 and 5.8

Keys `cols` and `restart` of the command `\rowcolors` in the `code-before`.
Modification of the behaviour of `\\` in the columns of type `p`, `m` or `b` (for a behaviour similar to the environments of array).
Better error messages for the command `\Block`.

Changes between versions 5.8 and 5.9

Correction of a bug: in the previous versions, it was not possible to use the key `line-style` for the continuous dotted lines when the Tikz library `babel` was loaded.
New key `cell-space-limits`.

Changes between versions 5.9 and 5.10

New command `\SubMatrix` available in the `\CodeAfter`.
It's possible to provide options (between brackets) to the keyword `\CodeAfter`.
A (non fatal) error is raised when the key `transparent`, which is deprecated, is used.

Changes between versions 5.10 and 5.11

It's now possible, in the `code-before` and in the `\CodeAfter`, to use the syntax `|(i-|j)` for the Tikz node at the intersection of the (potential) horizontal rule number i and the (potential) vertical rule number j.

Changes between versions 5.11 and 5.12

Keywords `\CodeBefore` and `\Body` (alternative syntax to the key `code-before`).
New key `delimiters/max-width`.
New keys `hlines`, `vlines` and `hvlines` for the command `\SubMatrix` in the `\CodeAfter`.
New key `rounded-corners` for the command `\Block`.

Changes between versions 5.12 and 5.13

New command `\arraycolor` in the `\CodeBefore` (with its key `except-corners`).
New key `borders` for the command `\Block`.
New command `\Hline` (for horizontal rules not drawn in the blocks).
The keys `vlines` and `hlines` takes in as value a (comma-separated) list of numbers (for the rules to draw).

Changes between versions 5.13 and 5.14

Nodes of the form `(1.5)`, `(2.5)`, `(3.5)`, etc.
Keys `t` and `b` for the command `\Block`.
Key `corners`.

Changes between versions 5.14 and 5.15

Key `hvlines` for the command `\Block`.
The commands provided by nicematrix to color cells, rows and columns don't color the cells which are in the "corners" (when the key `corner` is used).
It's now possible to specify delimiters for submatrices in the preamble of an environment.
The version 5.15b is compatible with the version 3.0+ of siunitx (previous versions were not).

Changes between versions 5.15 and 5.16

It's now possible to use the cells corresponding to the contents of the nodes (of the form `i-j`) in the `\CodeBefore` when the key `create-cell-nodes` of that `\CodeBefore` is used. The medium and the large nodes are also available if the corresponding keys are used.

Changes between versions 5.16 and 5.17

The key `define-L-C-R` (only available at load-time) now raises a (non fatal) error (that key will probably be deleted in a future version of nicematrix).
Keys `L`, `C` and `R` for the command `\Block`.
Key `hvlines-except-borders`.
It's now possible to use a key `l`, `r` or `c` with the command `\pAutoNiceMatrix` (and the similar ones).

Changes between versions 5.17 and 5.18

New command `\RowStyle`

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