

The cases package*

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Copyright © 1993, 1994, 1995, 2000, 2002, 2020 by Donald Arseneau, asnd@triumf.ca. These macros may be freely transmitted, reproduced, or modified provided that this notice is left intact. Sub-equation numbering is based on `subeqn.sty` by Stephen Gildea; parts are based on L^AT_EX's `eqnarray` by Leslie Lamport and the L^AT_EX3 team; and some on `amsmath.sty` by the American Mathematical Society.

Description

The `cases` package provides a L^AT_EX environment `numcases` to produce multi-case equations with a separate equation number for each case. There is also `subnumcases` which numbers each case with the overall equation number plus a letter [8a, 8b, etc.]. The syntax is

```
\begin{numcases}{\langle left side \rangle }
  \langle case 1 \rangle & \langle explanation 1 \rangle \\
  \langle case 2 \rangle & \langle explanation 2 \rangle \\
  \dots
  \langle case n \rangle & \langle explanation n \rangle
\end{numcases}
```

Each $\langle case \rangle$ is a math formula, to be typeset in display-math mode, like in a regular numbered equation. Each $\langle explanation \rangle$ is a piece of lr-mode text (which may contain math mode in $\langle \dots \rangle$ or $\langle \$ \dots \$ \rangle$). The explanations are optional. Equation numbers are inserted automatically, just as for the `eqnarray` environment. In particular, the `\nonumber` command suppresses an equation number and the `\label` command allows reference to a particular case. In a `subnumcases` environment, a `\label` in the $\langle left side \rangle$ of the equation gives the overall equation number, without any letter.

To use this package, include `\usepackage{cases}` after `\documentclass`, and also after `\usepackage{amsmath}` if you are using that.

* This manual corresponds to `cases` v3.0, dated 2020/02/22.

Question: Is there a `numcases*` environment for unnumbered cases?

Answer: That would have the natural name `cases`, and it is provided by $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ (`amsmath` package), or by this package given the `[cases]` option. It can also be achieved by using an ordinary $\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ array between ‘`\left\lbrace\`’ and ‘`\right.\`’.

Speaking of `amsmath` and package options, there are differences between the style used for this package and the cases done by `amsmath` (see below), but `cases.sty` has options to increase compatibility. Here is the full list of options for this package.

[subnum] Force all `numcases` environments to be treated as `subnumcases`.

[amsstyle] For compatibility with `amsmath`’s `cases`, make `numcases` use cramped math style (`\textstyle`), and put explanations in the same math style.

[casesstyle] Change `amsmath`’s `cases` environment to work in the text/math style of `numcases`.

[cases] Define a `cases` environment for use without `amsmath`. (This is actually the same as the `[casesstyle]` option.)

[fleqn] Flush-left equation alignment, indented by `\mathindent` or `\mathmargin`. (Usually inherited from the `\documentclass` options.)

[leqno] Left-side equation numbering (usually inherited from the `\documentclass` options). This looks silly with numbered cases!

Examples

A simple example is:

```
\begin{numcases} \{|x|=\\
  x, & \text{for } x \geq 0\\
  -x, & \text{for } x < 0\\
\end{numcases}
```

Giving:

$$|x| = \begin{cases} x, & \text{for } x \geq 0 \\ -x, & \text{for } x < 0 \end{cases} \quad (1)$$

$$(2)$$

Another example, employing sub-numbering, is calculating the square root of a complex number $c + id$. First compute

$$w \equiv \begin{cases} 0 & \text{for } c = d = 0 \\ \sqrt{|c|} \sqrt{\frac{1 + \sqrt{1 + (d/c)^2}}{2}} & \text{for } |c| \geq |d| \\ \sqrt{|d|} \sqrt{\frac{|c/d| + \sqrt{1 + (c/d)^2}}{2}} & \text{for } |c| < |d| \end{cases} \quad (3a)$$

$$(3b)$$

$$(3c)$$

Then, using w from eq. (3), the square root is

$$\sqrt{c+id} = \begin{cases} 0, & w = 0 \text{ (case 3a)} & (4a) \\ w + i\frac{d}{2w}, & w \neq 0, c \geq 0 & (4b) \\ \frac{|d|}{2w} + iw, & w \neq 0, c < 0, d \geq 0 & (4c) \\ \frac{|d|}{2w} - iw, & w \neq 0, c < 0, d < 0 & (4d) \end{cases}$$

These equations, eq. (3) and (4), were produced by:

Another example, employing sub-numbering, is calculating the square root of a complex number $c+id$. First compute

```
\begin{subnumcases} {\label{weqn} w\equiv}
  0      & \text{for } c = d = 0 \text{\label{wzero}} \\
  \sqrt{|c|}, \sqrt{\frac{1 + \sqrt{1+(d/c)^2}}{2}} & \text{for } |c| \geq |d| \\
  \sqrt{|d|}, \sqrt{\frac{|c/d| + \sqrt{1+(c/d)^2}}{2}} & \text{for } |c| < |d|
\end{subnumcases}
```

Then, using w from eq.~(\ref{weqn}), the square root is

```
\begin{subnumcases}{\label{sqrteqn} \sqrt{c+id}=}
  0,, & w=0 \text{ (case \ref{wzero})} \\
  w+i\frac{d}{2w},, & w \neq 0, c \geq 0 \\
  \frac{|d|}{2w} + iw,, & w \neq 0, c < 0, d \geq 0 \\
  \frac{|d|}{2w} - iw,, & w \neq 0, c < 0, d < 0
\end{subnumcases}
```

Compatibilility with amsmath

When used in conjunction with amsmath.sty, the cases package will obey the the variant commands `\tag`, `\notag`, and `\mathmargin`, however the formatting details differ between amsmath's `cases` environment and `numcases`. For comparison, equation (3) formatted by amsmath and its `cases` environment may be entered as

```
\begin{equation}
\label{wams} w \equiv
\begin{cases}
0 & \text{for } c = d = 0 \\
\sqrt{|c|}, \sqrt{\frac{1 + \sqrt{1+(d/c)^2}}{2}} & \text{for } |c| \geq |d| \\
\sqrt{|d|}, \sqrt{\frac{|c/d| + \sqrt{1+(c/d)^2}}{2}} & \text{for } |c| < |d|
\end{cases}
\end{equation}
```

which produces

$$w \equiv \begin{cases} 0 & \text{for } c = d = 0 \\ \sqrt{|c|} \sqrt{\frac{1 + \sqrt{1 + (d/c)^2}}{2}} & \text{for } |c| \geq |d| \\ \sqrt{|d|} \sqrt{\frac{|c/d| + \sqrt{1 + (c/d)^2}}{2}} & \text{for } |c| < |d| \end{cases} \quad (5)$$

To get this more compact layout with `numcases` you can insert `\textstyle` at the beginning of each case, as needed, or use the `cases` package option `[amsstyle]`. To have the `cases` environment give the more open layout of eq. (3) you can put `\displaystyle` at the beginning of each case, or use the option `[casesstyle]` for the `cases` package. (Yes these go with the `cases` package, they are not options for `amsmath`.)

For full disclosure, even without any relevant package options, `cases.sty` will slightly adjust the `cases` environment from `amsmath`, by adding a little space after the left brace.

Sub-numbering

For control of the sub-equation-numbering style, see the $\mathcal{A}\mathcal{M}\mathcal{S}$ - $\mathcal{L}\mathcal{A}\mathcal{T}\mathcal{E}\mathcal{X}$ documentation for `subequations`, currently in section 3.11.3. If you are not using `amsmath`, that documentation still mostly applies, except the name for regular equation numbers is then ‘mainequation’ instead of ‘parentequation’. Also, the sub-numbering style can be controlled more easily by defining `\thesubequation`. An example for capitalized letters is

```
\renewcommand\thesubequation{\themaingequation.\Alph{equation}} % 13.C
```