The empheq package
Emphasizing equations in \LaTeX 2ε

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2017/03/31

Abstract
The empheq package can best be described as a visual markup extension to amsmath. In short it offers a) a multi line equivalent of \boxed from amsmath and b) a way to produce arbitrary delimiters that span entire math displays.

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∗This file has version number v2.15, last revised 2017/03/31.
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Part I

Basic user’s guide

There can be little doubt that the de facto standard for mathematical typesetting in \LaTeX{} is the \texttt{amsmath} package. For the creation of \texttt{empheq}, a visual markup package for use in math, it made perfect sense to have \texttt{amsmath} as the backbone.

The main idea of \texttt{empheq} is to maintain the familiar syntax of the \texttt{amsmath} environments while still providing an easy way of specifying markup instructions. This manual is plastered with examples showing just how.

1 Basic use of the package

So what is it \texttt{empheq} does? Well, it allows you to produce displays like this:

\[
X = Y \Rightarrow \begin{cases}
A_1 = b_1 & c_1 = d_1 & e_1 = f_1 \\
A_2 = b_2 & c_2 = d_2 & e_2 = f_2 \\
A_3 = b_3 & c_3 = d_3 & e_3 = f_3
\end{cases}
\]

In short \texttt{empheq} enables the user to put things on every side of the display without said user having to worry about what happens to the equation numbers. For example you can now have a display containing multiple lines and still get the effect of the \texttt{boxed} command from \texttt{amsmath}.

1.1 Using the \texttt{empheq} environment

The package defines a single environment \texttt{empheq} and the usage is kind of straight forward:

\begin{verbatim}
\begin{empheq}{⟨mark-up instructions⟩}{⟨AMS env' name⟩}
⟨contents of AMS environment⟩
\end{empheq}
\end{verbatim}

A first minimal example file would then be something like

\begin{verbatim}
\documentclass{minimal}
\usepackage{empheq}
\begin{document}
\begin{empheq}[⟨align*⟩]{\tag{*}}
\begin{aligned}
a &= b \\
E &= mc^2 + \int_a^a x^2 dx
\end{aligned}
\end{empheq}
\end{document}
\end{verbatim}
1 BASIC USE OF THE PACKAGE

<table>
<thead>
<tr>
<th>Environment</th>
<th>Usage</th>
<th>Environment</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>equation</td>
<td>{equation}</td>
<td>equation*</td>
<td>{equation*}</td>
</tr>
<tr>
<td>align</td>
<td>{align}</td>
<td>align*</td>
<td>{align*}</td>
</tr>
<tr>
<td>gather</td>
<td>{gather}</td>
<td>gather*</td>
<td>{gather*}</td>
</tr>
<tr>
<td>flalign</td>
<td>{flalign}</td>
<td>flalign*</td>
<td>{flalign*}</td>
</tr>
<tr>
<td>alignat</td>
<td>{alignat=(cols)}</td>
<td>alignat*</td>
<td>{alignat*(cols)}</td>
</tr>
<tr>
<td>multiline</td>
<td>{multiline}</td>
<td>multiline*</td>
<td>{multiline*}</td>
</tr>
</tbody>
</table>

Table 1: The supported amsmath environments

This gives the following display:

\[
a = b
\]

\[
E = mc^2 + \int_a^a x \, dx
\]

Maybe not the most impressive example, but as you can see the contents of the environment is exactly the same as for the regular align* environment from amsmath. The rest of the AM\S environments are chosen the same way by typing the name as the mandatory argument of empheq with the exception of the alignat environment. For this you have to specify the number of columns as shown below.

\begin{empheq}{alignat=2}
 a &= b & c &= d \\
\text{this} &= \text{that} & \mathit{fish} &\neq fish
\end{empheq}

\[
a = b \quad c = d \quad (2)
\]

\[
\text{this} = \text{that} \quad \text{fish} \neq \text{fish} \quad (3)
\]

To choose the starred version of alignat, simply type \{alignat*=2\} instead in the above example.

The supported AM\S environments are listed in Table 1. Not supported is the standard \LaTeX eqnarray environment as it is fundamentally deficient.\footnote{See for instance http://www.tex.ac.uk/cgi-bin/texfaq2html?label=eqnarray}

1.2 Markup instructions

The optional argument of the empheq environment will take markup instructions consisting of a \langle key\rangle = \langle value\rangle list of assignments. There are currently five such keys (a sixth is added for naming consistency). They’re shown in Table 2 on the next page.
1 BASIC USE OF THE PACKAGE

### Key Usage Additional Info

<table>
<thead>
<tr>
<th>Key</th>
<th>Usage</th>
<th>Additional Info</th>
</tr>
</thead>
<tbody>
<tr>
<td>box</td>
<td>box=⟨box command⟩</td>
<td></td>
</tr>
<tr>
<td>innerbox</td>
<td>innerbox=⟨box command⟩</td>
<td></td>
</tr>
<tr>
<td>left</td>
<td>left=⟨math material⟩</td>
<td>Use \text{...} if you need text material.</td>
</tr>
<tr>
<td>right</td>
<td>right=⟨math material⟩</td>
<td>Use \text{...} if you need text material.</td>
</tr>
<tr>
<td>outerbox</td>
<td>outerbox=⟨box command⟩</td>
<td>Alias for box.</td>
</tr>
<tr>
<td>marginbox</td>
<td>marginbox=⟨box command⟩</td>
<td>Contents must be horizontally centered; can only be used in [fleqn] mode.</td>
</tr>
</tbody>
</table>

Table 2: The six keys for the optional argument of the empheq environment

**left**

The key left is for material put on the left side of the display. The material is typeset in math mode and centered vertically.

\[
\begin{empheq}[left=L \Rightarrow]{align}
    a &= b \\
    E &= mc^2 + \int_a^a x \, dx
\end{empheq}
\]

\[L \Rightarrow a = b\] \hspace{2cm} \[E = mc^2 + \int_a^a x \, dx\] (4) (5)

**right**

As there is a left key it hopefully comes as no surprise that there is a companion right key for typesetting material on the right side of the display.

\[
\begin{empheq}[right=\Leftarrow R]{align}
    a &= b \\
    E &= mc^2 + \int_a^a x \, dx
\end{empheq}
\]

\[a = b\] \hspace{2cm} \[E = mc^2 + \int_a^a x \, dx \Leftarrow R\] (6) (7)

**box**

The key box specifies the kind of box you would like to put around the display.
It can be any kind of box, as long as the contents of the box is situated on the baseline like in a \( \fbox{} \).

\begin{empheq}[box=\fbox]{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{empheq}

\begin{tabular}{|c|}
  \hline
  \( a = b \) \\
  \( E = mc^2 + \int_a^a x \, dx \) \\
  \hline
\end{tabular}

The key \texttt{outerbox} is an alias for \texttt{box} and is added for naming consistency with the key described below.

\begin{empheq}[innerbox=\fbox, left=L\Rightarrow]{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{empheq}

\begin{tabular}{|c|}
  \hline
  \( L \Rightarrow a = b \) \\
  \( E = mc^2 + \int_a^a x \, dx \) \\
  \hline
\end{tabular}

The last key is the \texttt{marginbox} key. If you typeset your math in [fleqn] mode\footnote{Sorry, but I can’t show you because this manual features centered math displays.} you may want the math display and not the outer box to align at the left margin (or rather: the indentation). If you make sure the contents of the outer box is centered horizontally inside the box, \texttt{marginbox} will align it properly. You shouldn’t set both \texttt{box} and \texttt{marginbox} at the same time, as this is surely not what you want and the package will silently use the last one in the list.

\textbf{Warning}: keyval treats commas and equal signs as separator and assignment signs which in turn means that if you want to typeset either of them, they \textit{must}—and believe me, it’s really important—be enclosed in braces. In short:

\begin{itemize}
  \item \textbf{Good} \ [\texttt{left}={(A,B)=(1,0)}] \end{itemize}
1  BASIC USE OF THE PACKAGE

Bad  \left=(A,B)=\left(1,0\right)\]

\emheqset{\left=(1,0)\]

You can also set the keys globally\footnote{Or rather: outside the scope of the \emheq environment. The settings will still obey scoping rules.} with the command \emheqset. This means that

\emheqset{marginbox=\psframebox}

will force a box=\psframebox in all occurrences of the \emheq environment, but an explicitly given box or marginbox will override this setting. You can only use the keys listed in this section as arguments to \emheqset; not the \AMS environments.

1.3 What won’t work in the \emheq environment

\intertext{\textit{text}\]
\displaybreak[\num]

Now we’ve seen some of the things that work in the \emheq environment but we also have to take note of what won’t work. As this package provides a way to box multi line math displays it can come as no surprise that using either \intertext or \displaybreak inside the \emheq environment makes no sense. Should you however happen to try them anyway, you’ll experience that \intertext issues an error message and \displaybreak issues a warning. The reason only \intertext gives an error message is that you’ll get output very different from what you expect, and that is not the case (so much at least) with \displaybreak. But of course, you’ll never see either message because you read the manual!

Very long lines

The standard \AMS environments will move the equation number if a line gets too close to it. Due to implementation, this feature is not carried correctly to the \emheq environments, so keep equation lines short then applying \emheq to them.

1.4 Special delimiters

As you’ve seen a few pages back, it’s possible to add material on both sides of the math display. When doing so you often need a delimiter that scales to fit the entire display, so it comes as no surprise that \emheq provides such delimiters.

\footnote{And thus also \shortintertext (mathtools).}
1 BASIC USE OF THE PACKAGE

\begin{center}
<table>
<thead>
<tr>
<th>Delimiter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>\lbrace</td>
</tr>
<tr>
<td>\rbrace</td>
</tr>
<tr>
<td>\lbrack</td>
</tr>
<tr>
<td>\rbrack</td>
</tr>
<tr>
<td>\langle</td>
</tr>
<tr>
<td>\rangle</td>
</tr>
<tr>
<td>\lparen</td>
</tr>
<tr>
<td>\rparen</td>
</tr>
<tr>
<td>\lvert</td>
</tr>
<tr>
<td>\rvert</td>
</tr>
<tr>
<td>\lVert</td>
</tr>
<tr>
<td>\rVert</td>
</tr>
<tr>
<td>\lfloor</td>
</tr>
<tr>
<td>\rfloor</td>
</tr>
<tr>
<td>\lceil</td>
</tr>
<tr>
<td>\rceil</td>
</tr>
</tbody>
</table>
\end{center}

Table 3: The supported auto-scaling delimiters in empheq

\begin{align}
E &= mc^2 \\
Y &= \sum_{n=1}^{\infty} \frac{1}{n^2}
\end{align}

For example one might need a large brace like the one in the cases environment:

\begin{empheq}[left=\empheqlbrace, right=\empheqrbrace]{align}
E &= mc^2 \\
Y &= \sum_{n=1}^{\infty} \frac{1}{n^2}
\end{empheq}

\begin{align}
E &= mc^2 \\
Y &= \sum_{n=1}^{\infty} \frac{1}{n^2}
\end{align}

The naming scheme is \empheq\textit{(delimiter name)} and \empheq\textit{big}\textit{(delimiter name)}. Thus \empheq\textit{rbrace} produces an auto-scaling right brace with same size as the math display while \empheq\textit{bigrbrace} produces an even bigger version that spans the inner box plus the math display inside it. For a complete list of supported delimiters see Table 3.
2 Taking things a little further

So far we have covered the basic functions of empheq: the markup instructions and the predefined auto-scaling delimiters. There is more to empheq however, and we’ll cover that in this section.

2.1 Loading the package

The package has two main requirements: One is the mathtools package which provides empheq with a lot of necessary tools for doing its thing. The other one is amsmath of course, and to make the loading procedure as easy as possible, you can simply substitute

\usepackage[leqno,fleqn,intlimits]{amsmath}

with

\usepackage[leqno,fleqn,intlimits]{empheq}

empheq makes sure that the amsmath options are passed on and loaded by amsmath. The same goes for the options provided by mathtools.

2.1.1 Compatibility with the old version

The current version (v2.15) of empheq is incompatible with versions prior to and including 0.7e. If you have documents produced with versions prior to 0.7e, then you have to load the package empheq07 instead. empheq07 now exists as a separate package package with its own documentation, but I strongly recommend switching to the new version because it is so much better.

2.2 Package options

In addition to the amsmath options, empheq itself provides a string of options listed in Table 4 on the next page.

\begin{itemize}
\item \texttt{ntheorem}
\end{itemize}

The ntheorem package is supported by means of the ntheorem option. In order for this to work properly, an amsmath bug\footnote{See the \LaTeX{} Bugs Database [http://www.latex-project.org/cgi-bin/ltxbugs2html] under \texttt{AMS\LaTeX} problem report 3624.} is fixed. For more information on this option see §3.2 on page 16.
Option | Short description
---|---
overload | Lets you use the empheq visual markup extensions transparently in an existing document.
overload2 | A wild version of overload. Use with care.
ntheorem | A support module for users of ntheorem and its thmmarks and thref options.
newmultline | With v2.10 of empheq the syntax for multline and multlined has been improved immensely.
oldmultline | Support for the somewhat strange syntax for multline and multlined in v2.00.

Table 4: Supported options in the empheq package

### 2.2.1 Using `multline`

<table>
<thead>
<tr>
<th>Option</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>newmultline</code></td>
</tr>
<tr>
<td><code>oldmultline</code></td>
</tr>
</tbody>
</table>

Those familiar with v2.00 of this package will recognize the somewhat weird syntax for using `multline` and `multlined`. The good news is that since v2.10 there is now a much improved syntax available. The option `newmultline` (default) selects this better interface, while the old interface is provided for compatibility reasons by the `oldmultline` option.

```latex
\shoveleft{\langle \text{dimen} \rangle \{\langle \text{arg} \rangle\}}
\shoveright{\langle \text{dimen} \rangle \{\langle \text{arg} \rangle\}}
```

With the new interface you also get an extended syntax for `\shoveleft` and `\shoveright` as shown in the example below.

```latex
\begin{empheq}{multline}
\framebox[.6\textwidth]{First line} \\
\framebox[.5\textwidth]{Second line} \\
\shoveleft{L+E+F+T} \\
\shoveright{R+I+G+H+T} \\
\shoveleft[1\text{cm}]{L+E+F+T} \\
\shoveright[\textwidth{R+I+G+H+T}]{R+I+G+H+T} \\
\framebox[.65\textwidth]{Last line}\end{empheq}
```
There are however a few differences in the output between the original amsmath version of multline and the one empheq provides. In amsmath a centered line in multline is centered on the page without taking into account the \multlinegap, \multlinetaggap, and the tag width. Thus amsmath can sometimes give you horrible output without giving you any warning as shown below.

\begin{multline}
\framebox[.65\columnwidth]{First line} \\
\framebox[.9\columnwidth]{Loooong line} \\
\framebox[.65\columnwidth]{Last line} \tag{wide tag}
\end{multline}

\begin{empheq}{multline}
\framebox[.65\columnwidth]{First line} \\
\framebox[.9\columnwidth]{Loooong line} \\
\framebox[.65\columnwidth]{Last line} \tag{wide tag}
\end{empheq}

In empheq these parameters are taken into account, so the same input will produce this in empheq:

\begin{empheq}{multline}
\framebox[.65\columnwidth]{First line} \\
\framebox[.9\columnwidth]{Loooong line} \\
\framebox[.65\columnwidth]{Last line} \tag{wide tag}
\end{empheq}

This results in an \texttt{Overfull \hbox (30.03783pt too wide) in paragraph ...} message in the log file, indicating a visual problem. I think this behavior is more sensible than the one the original multline environment provides.
When you choose the `oldmultline` option you may still want to use the much improved `multlined` environment defined in `mathtools` but unfortunately there will be a name clash. Instead you can access it under the name `MTmultlined`.

### 2.2.2 The `overload` option

The `overload` option redefines the original `AMS` environments so that they take an optional argument.

\[
\begin{MTmultlined}[(pos)\ [width] \ [contents]} \end{MTmultlined}
\]

For example

\[
\begin{gather} \begin{empheq} \begin{gather} a = b \end{gather} \end{empheq} \end{gather}
\]

is then actually short for

\[
\begin{empheq} \begin{gather} a = b \end{gather} \end{empheq}
\]

All the `AMS` environments are supported by this option except for the pseudo environment \[ \ldots \] (it’s not really an environment), \[ because a) you don’t really need markup instructions for a one line display, and b) would you really like a syntax like

\[
\begin{empheq} \begin{gather} a = b \end{gather} \end{empheq}
\]

where it’s difficult to see whether or not there is a typo? Choosing `overload` is meant for people who don’t want to change their entire document into `empheq` syntax. I have no problems with that; just be careful when you fiddle with \emph{empheqset} as it will affect all math displays!

There is of course a catch (well, two actually): These redefined environments don’t run as fast as the regular ones (about three times as slow), but in this day and age I seriously doubt you’ll be able to tell the difference unless you have a vast number of equations. The other catch is that you cannot use \[\texttt{\intertext}\]

\footnote{With the option `oldmultline` the `multiline` and `multline*` environments aren’t supported either because their syntax in `empheq` then differ from their syntax in `amsmath`.
and \texttt{displaybreak} as described earlier. If you find yourself wanting to use one of these features in say, an align environment, you have to use the original align environment. Luckily it is available if you call it like this:

\[
\begin{\text{AmS}\langle \text{AMS env' name}\rangle}
\langle \text{contents of AMS environment} \rangle
\end{\text{AmS}\langle \text{AMS env' name}\rangle}
\]

For example the original align environment could be selected with

\[
\begin{\text{AmSalign}}
\ldots
\end{\text{AmSalign}}
\]

These original versions with prefix \texttt{AmS} exist for all the environments.

The option \texttt{overload2} activates the overloading feature for the pseudo environment \texttt{[ ... ]}, although I doubt you’ll find it useful. Beware that this definition is fragile unless you have \texttt{e-\LaTeX} as \texttt{\LaTeX} engine. Not surprisingly \texttt{overload2} activates \texttt{overload}.

Before you get all excited about these options, you should take note of some aspects of centered math displays in amsmath. In certain circumstances truly centering the display is not always the best solution as in this example:

![Wide math display; not adjusted](example1.png)

![Wide Tag](example2.png)

Instead centering the display in the available space works pretty well:

![Wide math display; adjusted](example3.png)

![Wide Tag](example4.png)

This is what amsmath does normally, but in the gather environment it does it on a per line basis. This means that we get results like

![Wide math display; adjusted](example5.png)

![Wide math display; not adjusted](example6.png)

(i)

whether we like it or not. Inside the \texttt{empheq} environment we need to have the same adjustment for all lines else the boxing process will not work properly, so when activating the \texttt{overload} option the above two-line gather will instead look like this:

![Wide math display; adjusted](example7.png)

![Wide Tag](example8.png)

![Wide math display; adjusted](example9.png)

(i)

I leave it to you to choose whether or not this is better (I think it is better).

\[\text{\texttt{e-\LaTeX} has been the default engine for \LaTeX\ in most major distributions since 2003.}\]
2.3 A note on boxed displays

When browsing a 400+ pages textbook with at least twice the number of displayed formulae, some of them are surely more important than others. Thus the author of the book (in cooperation with the designer) should make sure that such formulae are easily found again i.e., they should be easily distinguishable from the rest of the pack. One way of doing this is putting the formula into a box which is something we’ve seen empheq being capable of. There are however a few things to keep in mind:

- Don’t overdo it. If you do it on half of them there’s no point in doing it at all. I don’t see much reason for applying this technique to more than 10% of the formulae.
- Choose the type of box carefully. You want to draw attention to it so it might as well look good.

The latter point can be illustrated by defining a macro similar to \fbox only with a little more space to the right and left of the argument.

\newcommand*\widefbox[1]{\fbox{\hspace{1em}#1\hspace{1em}}}

If we replace the \fbox from the box example before, we get this display:

\begin{empheq}{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{empheq}

\begin{center}
\begin{tabular}{|c|}
\hline
\begin{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{align}
\hline
\end{tabular}
\end{center}

Compare it with

\begin{center}
\begin{tabular}{|c|}
\hline
\begin{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{align}
\hline
\end{tabular}
\end{center}

and see which one you prefer.

Similarly one might be tempted to use colored boxes:

\definecolor{myblue}{rgb}{.8, .8, 1}
\newcommand*\mybluebox[1]{\colorbox{myblue}{\hspace{1em}#1\hspace{1em}}}

We know the drill by now.

\begin{empheq}{align}
  a &= b \\
  E &= mc^2 + \int_a^a x \, dx
\end{empheq}
\[ a = b \]  
\[ E = mc^2 + \int_a^d x \, dx \]  

(19)  
(20)

There is more on boxes later in this manual. If you’re into the fancybox package then remember to read § 3.1.

3 Support for other packages

With the multitude of packages for \LaTeX, it is not always easy to be a PWWO package (“Plays Well With Others”), but empheq tries really hard to do so. This section lists the packages where empheq has to provide workarounds and they can be divided into two categories.

Compatibility Some packages affect \LaTeX’ labelling mechanism and since empheq internally has to turn off labels and related code temporarily, hooks must be provided for these packages. Examples of such packages are hyperref and showkeys.

Enhancements Other packages provide useful features that for some reason may not work directly or optimally with empheq. In these cases the problematic commands are redefined so that they not only work with empheq, but also give the same if not better output. An example of this would be the \shadowbox command from fancybox (described below).

3.1 Support for fancybox

The fancybox package provides various boxes and you can use them with empheq as well. Here’s \ovalbox:

\begin{empheq}[box=\ovalbox]{align}
E &= mc^2 \\
Y &= \sum_{n=1}^{\infty} \frac{1}{n^2}
\end{empheq}

(21)  
(22)

The only problem with using the fancybox boxes in conjunction with the empheq environment is \shadowbox, as this macro typesets the shadow on the baseline and for the equation numbers to be placed correctly, the box command must set
its argument on the baseline. Thus the normal \shadowbox produces $\langle\text{arg}\rangle$, but we need this instead: $\langle\text{arg}\rangle$. Therefore \empheq will detect if \fancybox is loaded and in that case it’ll enhance \shadowbox in two ways:

- It defines a starred version \shadowbox* which typesets its argument on the baseline.
- The color \shadowcolor is introduced. The default color is black.

\definecolor{shadowcolor}{rgb}{0,.5,.5}
\setlength\shadowsize{2pt}

Line of text for \shadowbox*{testing of \Verb{f#&%} verbatim} and showing the shadow color.

Line of text for testing of \Verb{f#&%} verbatim and showing the shadow color.

The point is that if you want a \shadowbox around your math display then you must use the starred version:

\begin{empheq}[box=\shadowbox*]{align}
E &= mc^2 \\
Y &= \sum_{n=1}^{\infty} \frac{1}{n^2}
\end{empheq}

\(E = mc^2\) \hspace{1cm} (23)
\(Y = \sum_{n=1}^{\infty} \frac{1}{n^2}\) \hspace{1cm} (24)

See §6.2 on page 23 if you want to make a fancy box yourself.

3.2 Support for \texttt{nthm}\texttt{e}\texttt{o}\texttt{r}\texttt{m}

\textbf{Caveat:} Due to an unfortunate interaction between \empheq and \texttt{nthm}, users may want to add

\texttt{\usepackage{default}}

\texttt{after} loading \texttt{nthm} otherwise the tags may be placed wrong and any labels within the \empheq environment may be lost. In the future \texttt{nthm} should be able to test for this and add \texttt{\usepackage{default}} automatically.

Users who use \texttt{\usepackage{default}} to get another tag design, should make sure to postpone this configuration until \texttt{after} loading \texttt{nthm}.
The \texttt{ntheorem} package is supported by the means of the \texttt{ntheorem} option of \texttt{empheq}. This loads a set of extra macros which fixes various compatibility problems between \texttt{ntheorem} and \texttt{amsmath} and furthermore introduces special (internal) macros for optimum positioning of end-of-theorem markers, while retaining a user friendly interface.

When you want to use the automatic end-of-theorem marker mechanism from \texttt{ntheorem} you sometimes run into problems as you would want the marker to be placed aligned at the bottom of the math display but still keeping the tags in their proper place. In \texttt{[leqno]} mode this is not that much of a problem as the tags and the marker are set on either side of the math display like in Figure 1.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure1}
\caption{Marker placement in [leqno] mode}
\end{figure}

Unfortunately things are not this easy in \texttt{[reqno]} mode. There are two possible situations as shown in Figure 2. If possible we want the bottom of the marker to be aligned with the bottom of the math display, but at the same time we want to ensure a minimum vertical separation $\delta$ between marker and tag. In \texttt{empheq} this is controlled by the length parameter $\texttt{\mintagvsep}$ which by default is 5 pt.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2}
\caption{The two possible situations for end marks in [reqno] mode}
\end{figure}

The good news is that this is where \texttt{empheq} sets in. Basically all you need to do is to use the \texttt{empheq} environment to type set your equations inside the theorem environments:

\begin{empheq}[left=\texttt{\mintagvsep} = \delta \quad ]{align}
\end{empheq}
\begin{Theorem}
Some text at first and then a math display
\begin{empheq}{align}
a&=b\\
E&=mc^2 + \int_a^a x\, dx
\end{empheq}
\end{Theorem}

Then the tag placement and the end-of-theorem marker will be set properly (after a couple of runs as usual).
To ensure the correct outcome remember to load the packages like this:

\usepackage[ntheorem]{empheq} % this loads amsmath as well
\usepackage[thmmarks,amsmath]{ntheorem}

Remember that if you use the \texttt{overload} option you can just use the regular math environments to get the desired result with the end mark. The exception is the \texttt{[ ... \]} environment which will only work if you use the option \texttt{overload2}. 
Part II
Advanced user’s guide

The empheq package has more to offer than you have seen, but I found some of the functionality so dangerous it was best to hide it for a little while. The commands you have encountered so far in this manual all have one thing in common: They have only lower case letters in their names. Now it’s time to reveal those that have mixed-case names, thus implying that you should take great care when using them.

4 Delimiters revisited

Let’s go back to delimiters, shall we?

4.1 Creating your own delimiters

As a convenience for the user, this interface is extended in a more general way so that it is also possible to declare delimiters with the following two commands:

\DeclareLeftDelimiter\langle\text{space adjustment}\rangle\{\text{delimiter}\}
\DeclareRightDelimiter\langle\text{space adjustment}\rangle\{\text{delimiter}\}

While empheq provides auto-scaling versions of the most common delimiters, you may sometimes want some new ones. Say for instance you have loaded the stmaryrd package and you want to use the double bracket commands \llbracket and \rrbracket with empheq. Then you simply do this:

\DeclareLeftDelimiter\llbracket
\DeclareRightDelimiter\rrbracket

This defines the new delimiters \empheqllbracket, \empheqbigllbracket, \empheqrrbracket and \empheqbigrrbracket.

You can use \big... delimiters as well if you don’t like the automatic scaling. There are however ways to fine-tune if you really want it.

4.2 Fine-tuning of delimiters

\TeX provides two primitives to control the scaling of delimiters produced with \left and \right, namely the dimension \delimitershortfall (denoted by δ here) and the integer \delimiterfactor (f). The idea is that the sub-formula inside the \left-\right pair is to be vertically centered and given its height \(h_1\) and its depth \(h_2\) we want to produce a delimiter with total height \(h\), where \(h =
2 \max(h_1, h_2). TeX’ rules on this is that the minimum delimiter size \( h_{\text{min}} \) must meet the requirements

\[ h_{\text{min}} \geq h \frac{f}{1000} \quad \land \quad h_{\text{min}} \geq h - \delta \]

\TeX sets \texttt{\delimitershortfall} = 5.0\text{pt} and \texttt{\delimiterfactor} = 901, but in our case we will almost always want a delimiter that spans the entire \texttt{\left}-\texttt{\right} pair (the math display), thus a change of these settings is needed.

\begin{verbatim}
\EmphEqdelimitershortfall \EmphEqdelimiterfactor
\end{verbatim}

However it is a bad idea to just change these two settings without thinking of the effect it’ll have on the rest of the mathematics in your document. Therefore \texttt{empheq} provides the parameters \texttt{\EmphEqdelimitershortfall} (default setting is 1.0pt) and \texttt{\EmphEqdelimiterfactor} (default is 950) to cater for this.

### 4.3 Scaling material yourself

The attentive reader may have noticed that I still haven’t revealed how I managed to get the right size of that big exclamation mark in the first example of this manual, so I guess it’s about time.

\begin{verbatim}
\begin{empheq}[box=\colorbox{myblue},
right={\;\makebox[.9em]{\$
\raisebox{-.5\totalheight+\fontdimen22\textfont2}{\resizebox{!}{\EmphEqdisplayheight+\EmphEqdisplaydepth}{!}}$\;}}]
\begin{alignat=3}
A_1&=b_1 & \quad c_1&=d_1 & \quad e_1&= f_1
\end{alignat}
\end{empheq}
\end{verbatim}

The \texttt{\fontdimen22\textfont2} in the \langle length \rangle argument of \texttt{\raisebox} is the \textit{math axis} of the font. It is needed in order to get the vertical positioning of the oversized exclamation mark just right.

\footnote{The \texttt{\fontdimen22\textfont2} in the \langle length \rangle argument of \texttt{\raisebox} is the \textit{math axis} of the font. It is needed in order to get the vertical positioning of the oversized exclamation mark just right.}
5 A FEW SHORT NOTES

\begin{empheq}[left={\parbox[c]\[\EmphEqdisplayheight+\EmphEqdisplaydepth\][t]{4.5cm}\[You may find this kind of description useful.\\\enspace}]]{align}
  a &= \int_0^1 x \, dx + \frac{\text{foo} + \text{bar}}{\text{baz}} \\
  E &= mc^2
\end{empheq}

Here's another example. We want to be able to put a \parbox with some descriptive text top-aligned on the side of the display.

\begin{empheq}[left={\parbox[c]\[\EmphEqdisplayheight+\EmphEqdisplaydepth\][t]{4.5cm}\[You may find this kind of description useful.\\\enspace}]}{align}
  a &= \int_0^1 x \, dx + \frac{\text{foo} + \text{bar}}{\text{baz}} \\
  E &= mc^2
\end{empheq}

5 A few short notes

5.1 About \eqref

Internally \emph{\texttt{empheq}} separate the displayed math from the corresponding equation numbers such that we can add special delimiters or boxes. This is done by nullifying (or rather conveniently redefining) an internal command called \texttt{\maketag@@@}. Unfortunately, this component is also used by \texttt{\eqref} to typeset a reference to an equation number, so in earlier versions, \texttt{\eqref} would not work inside an \emph{empheq} environment.

In the current version this should now be working, but if you ever need to mess with \texttt{\eqref} it may be handy to know what is being done. In essence we do something similar to this:

\begin{verbatim}
\let\empheqeqrefbase\textup
... % next go inside empheq env
\renewcommand\eqref[1]{\empheqeqrefbase{\let\maketag@@@\EQsavedmaketag\tagform@{\ref{##1}}}}
\end{verbatim}

Thus if you need to alter things inside \texttt{\eqref} and need that to work within \emph{empheq} as well, you may get away with redefining \texttt{\empheqeqrefbase}.

5.2 About changes to \texttt{\baselineskip}

Users should never mess with \texttt{\baselineskip} directly, it is not the correct manner to get double spacing. Have a look at say the \texttt{setspace} package or similar, or play with \texttt{\baselinestretch} followed by \texttt{\normalsize} to initiate.
6 Creating something new

You can create your own environments and boxes to go with \empheq, but there are certain things that must be fulfilled to get it to work properly.

6.1 New \empheq-like environments

\newenvironment{⟨env name⟩}{⟨num⟩}{⟨default⟩}{⟨other commands⟩}\EmpheqMainEnv}{\endEmpheqMainEnv}

Although the real work in \empheq is done by an environment (\EmphEqMainEnv), you cannot use it like that yourself when you want to define an \empheq-like environment. Due to technical reasons (see \[4\]), you have to use a slightly different syntax:

\newenvironment{⟨env name⟩}{⟨num⟩}{⟨default⟩}{⟨other commands⟩}\EmpheqMainEnv}{\endEmpheqMainEnv}

In the above environment the \(⟨other commands⟩\) part must contain certain things before it’ll work.

Before your homemade environment will work you must set at least one key. The key family \EmphEqOpt is for all the markup instructions like left and box, while \EmphEqEnv controls the type of \textit{AMS} environment. You must set the \EmphEqEnv family before \EmphEqMainEnv else you’ll get an error message.

One example could be something like this:

\begin{important}{gather}
\setkeys{EmphEqEnv}{#2}\
\setkeys{EmphEqOpt}{box=mybluebox,#1}\
\EmpheqMainEnv\
\endEmpheqMainEnv
\end{important}{gather}
6. Creating something new

\begin{ importante}
a = b + c + d \quad \text{e} = f
\end{important}

produces

\begin{verbatim}
a = b + c + d \\
e = f
\end{verbatim} \hfill (27)  \hfill (28)

while

\begin{IMPORTANT}
\text{\left={A=B \Rightarrow \empheqlbrace} \{alignat=2}
a &= b & \quad c &= d \\
\text{this} &= \text{that} & \quad \mathit{fish} &\neq fish
\end{IMPORTANT}

produces

\begin{verbatim}
A = B \Rightarrow \begin{cases} a = b \\ c = d \\ this = that \quad fish \neq fish
\end{cases}
\end{verbatim} \hfill (29)  \hfill (30)

6.2 Creating fancy boxes

As a final example I will show you how to create complicated displays involving (vertically) asymmetrical boxes like \shadowbox*. In order to get the correct output, the contents of the box must be placed on the baseline as in \fbox. In this example we want to put a set of equations into a bright yellow box and then add another box with some explanatory text at the top of the yellow box making them overlap.

First we define the colors used and allocate the boxes. We could probably use scratch boxes, but this is safer.

\definecolor{shadecolor}{cmyk}{0,0,0.41,0}
\definecolor{light-blue}{cmyk}{0.25,0,0,0}
\newsavebox{\mysaveboxM} % M for math
\newsavebox{\mysaveboxT} % T for text

Save the display body in \mysaveboxM and the text argument in \mysaveboxT.

\newcommand{\Garybox}[2][Example]{%  
\sbox{\mysaveboxM}{#2}  
\sbox{\mysaveboxT}{\fcolorbox{black}{light-blue}{#1}}%}

Then typeset the math display in a \parbox where we control the height and save it in \mysaveboxM.

\sbox{\mysaveboxM}{%  \parbox[b]{0.5in}{\ht\mysaveboxM+.5\ht\mysaveboxT+.5\dp\mysaveboxT}[b]{%  \wd\mysaveboxM}[#2]%
}}%
We put it into the colored box with the desired width.
\sbox{mysaveboxM}{\fcolorbox{black}{shadecolor}{\makebox[\linewidth-10em]{\usebox{mysaveboxM}}}\}
Then finally we get to the real typesetting. We just insert the math display and then make a box of zero width right next to it. In that box we lift the text argument and center it at the top of the display.
\usebox{mysaveboxM}\makebox[0pt][r]{\makebox[\wd{mysaveboxM}][c]{\raisebox{\ht{mysaveboxM}-0.5\ht{mysaveboxT}+0.5\dp{mysaveboxT}-0.5\fboxrule}{\usebox{mysaveboxT}}}\}
Let’s see what it looks like.
\begin{empheq}[box={Garybox}]{align}
\sum \mathbf{F} &= \mathbf{0} \\
\sum F_x \mathbf{i} + \sum F_y \mathbf{j} + \sum F_z \mathbf{k} &= \mathbf{0} \\
\sum F_x &= 0 \\
\sum F_y &= 0 \\
\sum F_z &= 0
\end{empheq}

If we use the optional argument of \Garybox we have to enclose the entire argument of box in braces because we’re in empheq’s optional argument (as described in \cite{page 167}):
\begin{empheq}[box={\Garybox[Same old example again]}]{align}
a&=b \\
E&=mc^2 + \int_a^a x \, dx
\end{empheq}
7 Contact information

Should you have any feature request, suggestions, or bug reports then feel free to contact Lars Madsen at
daleif@math.au.dk

Please put ‘empheq’ in the subject line.

Contributors

• In November 2002 Lars Madsen [daleif@imf.au.dk] asked for some features that wasn’t readily available with amsmath or any other package. This was the start of empheq.

• Gary Gray [gray@engr.psu.edu] gave me some bug reports on the old version (v0.7) which convinced me to rewrite the package completely. The \Garybox example is inspired by a wish from Gary.

• Uwe Siart [uwe.siart@tum.de] has been a thorough beta-tester on v1.00 of the package.

• Bernard Alfonsi [alfonsi@math.u-psud.fr] reported a problem with the ntheorem option. It turned out to be a bug in the ntheorem package itself but it’s fixed in the option.

• I have received reports on weird behavior from empheq when used with the color package on some dvi-viewers, which is caused by the lack of color support in those dvi-viewers. Both Andrew B. Collier [colliera@ukzn.ac.za] and André M. de Roos [aroos@science.uva.nl] have notified me of this. The solution is to either upgrade you dvi-viewer if possible or convert the document in question to PDF or PS.

Thank you all.

References


