LATEX – Tables, Arrays and Alignment

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4 Tables, Arrays and Alignment

4.1 Tables

4.1.1 Simple Tables

Tables are created with the \texttt{tabular} environment.

Example:

\begin{center}
\begin{tabular}{lcl}
Name & Date & Formula \\
Newton & 1687 & $F = m a$ \\
Einstein & 1905 & $E = mc^2$
\end{tabular}
\end{center}

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newton</td>
<td>1687</td>
<td>$F = ma$</td>
</tr>
<tr>
<td>Einstein</td>
<td>1905</td>
<td>$E = mc^2$</td>
</tr>
</tbody>
</table>

Notes:

1. Tables are usually placed in the centre of the page, hence the \texttt{center} environment.

2. Directly after the \begin{tabular} command, the number and alignment of the columns in the table is specified. The alignments are \texttt{l} – left, \texttt{c} – center, and \texttt{r} – right. In our example \{lcl\} specifies three columns with the indicated alignments.

3. Within each line of the table columns are separated by an ampersand, \texttt{&}, and the line terminated by \texttt{\\}.

4.1.2 Adding Lines

1. Vertical lines are indicated by a | between alignment specifiers.

2. Horizontal lines are indicated by the command \texttt{\hline} at the appropriate position.

3. The \texttt{\cline} command can be used to add partial horizontal lines. \texttt{\cline{i-j}} draws a line in columns \texttt{i} to \texttt{j}.
Example:
\begin{center}
\begin{tabular}{|l||cl|}
\hline
Name & Date & Formula \\ 
\hline
Newton & 1687 & $F = m a$ \\ 
\cline{2-3}
Einstein & 1905 & $E = m c^2$ \\ 
\hline
\end{tabular}
\end{center}

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newton</td>
<td>1687</td>
<td>$F = ma$</td>
</tr>
<tr>
<td>Einstein</td>
<td>1905</td>
<td>$E = mc^2$</td>
</tr>
</tbody>
</table>

4.1.3 Vertical Spacing

Vertical spacing of tables can be altered by using changing \texttt{\textbackslash arraystretch}. In the example below this is altered within the \texttt{center} environment; if it were done outside the environment the change would affect the \textit{whole} document.

Example
\begin{center}
\renewcommand{\arraystretch}{1.25}
\begin{tabular}{|l||cl|}
\hline
Name & Date & Formula \\ 
\hline
Newton & 1687 & $F = m a$ \\ 
Einstein & 1905 & $E = m c^2$ \\ 
\hline
\end{tabular}
\end{center}

<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newton</td>
<td>1687</td>
<td>$F = ma$</td>
</tr>
<tr>
<td>Einstein</td>
<td>1905</td>
<td>$E = mc^2$</td>
</tr>
</tbody>
</table>

4.1.4 \texttt{\textbackslash multicolumn}

The \texttt{\textbackslash multicolumn} command is used to spread items across columns of a table.
Example:

\begin{center}
\renewcommand{\arraystretch}{1.25}
\begin{tabular}{|l||c|c|}
\hline
\multicolumn{3}{|c|}{Physics Formulas} \\
\hline
Name & Date & Formula \\
\hline
Newton & 1687 & $F = ma$ \\
Einstein & 1905 & $E = mc^2$ \\
\hline
\end{tabular}
\end{center}

<table>
<thead>
<tr>
<th>Physics Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Newton</td>
</tr>
<tr>
<td>Einstein</td>
</tr>
</tbody>
</table>

In this example
\multicolumn{3}{|c|}{Physics Formulas} \\
indicates that the entry should span 3 columns. A \multicolumn line has its own vertical lines.

Example:

\begin{center}
\renewcommand{\arraystretch}{1.25}
\begin{tabular}{|l||c|c|}
\hline
\multicolumn{3}{|c|}{Physics Formulas} \\
\hline
Name & Date & Formula \\
\hline
Newton & 1687 & $F = ma$ \\
Einstein & 1905 & $E = mc^2$ \\
\hline
\end{tabular}
\end{center}

<table>
<thead>
<tr>
<th>Physics Formulas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Newton</td>
</tr>
<tr>
<td>Einstein</td>
</tr>
</tbody>
</table>
4.2 Mathematical Arrays

4.2.1 Arrays

The array environment is used to align mathematical formulas and works in much the same way as the tabular environment.

Example:

\[
\mathbf{A} = \left[ \begin{array}{cccc}
a_{11} & a_{12} & \ldots & a_{1n} \\
a_{21} & a_{22} & \ldots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & \ldots & a_{mn}
\end{array} \right]
\]

\[
y = \left\{ \begin{array}{rcc}
-1 & \text{for} & x < 0 \\
0 & \text{for} & x = 0 \\
1 & \text{for} & x > 0
\end{array} \right.
\]

\LaTeX{} will usually complain if brackets don’t come in pairs, thus the use of \texttt{\right} as an invisible right bracket.

4.2.2 Matrices

The amsmath package provides a convenient way of formatting matrices. There are a number of different environments which enclose matrices in different types of braces:
<table>
<thead>
<tr>
<th>Environment</th>
<th>Braces</th>
</tr>
</thead>
<tbody>
<tr>
<td>matrix</td>
<td>None</td>
</tr>
<tr>
<td>pmatrix</td>
<td>( )</td>
</tr>
<tr>
<td>bmatrix</td>
<td>[ ]</td>
</tr>
<tr>
<td>Bmatrix</td>
<td>{ }</td>
</tr>
<tr>
<td>vmatrix</td>
<td></td>
</tr>
<tr>
<td>Vmatrix</td>
<td></td>
</tr>
</tbody>
</table>

As for tables and arrays, the matrix elements are separated by & and the line terminated by \\.
Unlike tables and arrays, matrices do not need alignment specifiers.

Example:

\[
\mathbf{A} = \begin{pmatrix} 1 & 2 & 3 \\
4 & 5 & 6 \\
7 & 8 & 9 \end{pmatrix}
\]

\[
\begin{bmatrix}
a_{11} & a_{12} & \ldots & a_{1n} \\
a_{21} & a_{22} & \ldots & a_{2n} \\
\vdots & \vdots & \ddots & \vdots \\
a_{m1} & a_{m2} & \ldots & a_{mn} \\
\end{bmatrix}
\]

Note the different spacing in this example and the same matrix constructed earlier using brackets and the \texttt{array} environment.

### 4.3 Aligning Equations

Standard \LaTeX{} has a \texttt{eqnarray} environment for aligning equations, (see NSSI §3.5), but the \texttt{align} environment from \texttt{amsmath} is more convenient. The \texttt{align} environment produces numbered equations, the examples below use \texttt{align*} which leaves equations unnumbered.
Example:

Our first example aligns the = symbols:

\begin{align*}
    x &= r \cos \theta \\
    y &= r \sin \theta
\end{align*}

\[ x = r \cos \theta \]
\[ y = r \sin \theta \]

Example:

The following structure is common:

\begin{align*}
    I &= \int_{0}^{\pi} \sin t \, dt \\
    &= \left[ - \cos t \right]_{0}^{\pi} \\
    &= - \cos \pi + \cos 0 \\
    &= 2
\end{align*}

\[ I = \int_{0}^{\pi} \sin t \, dt \]
\[ = [- \cos t]_{0}^{\pi} \]
\[ = - \cos \pi + \cos 0 \]
\[ = 2 \]

Example:

The \texttt{intertext} command allows text to interspersed with equations while maintaining the alignment.

\begin{align*}
    I &= \int_{0}^{\pi} \sin t \, dt \\
    \text{intertext{which is easily integrated}} \\
    &= \left[ - \cos t \right]_{0}^{\pi} \\
    &= - \cos \pi + \cos 0 \\
    &= 2
\end{align*}
\[ I = \int_0^\pi \sin t \, dt \]

which is easily integrated

\[ = [\cos t]_0^\pi \]
\[ = -\cos \pi + \cos 0 \]
\[ = 2 \]

**Example:**

The \texttt{align} environment can also create multiple aligned columns where the ampersand doubles as an \textit{alignment point} and as a \textit{column separator}. In this example the first and third ampersands on each line are alignment points while the second ampersand on each line is a column separator.

\begin{align*}
\frac{d}{dx} \sin x &= \cos x \\
& \frac{d}{dx} e^x &= e^x \\
\frac{d}{dx} \cos x &= -\sin x \\
& \frac{d}{dx} \log x &= \frac{1}{x}
\end{align*}

Notes:

1. The \texttt{align} environment itself starts mathematics mode, and therefore it is not enclosed in $$ signs.

2. Blank lines are not allowed within the \texttt{align} environment.

3. While the \texttt{align} and \texttt{eqnarray} environments are similar and used for similar purposes, alignment marks, i.e. & , are used differently and spacing is slightly different in the two. 