Environments

Math Environment

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This Presentation

- Basic math symbols

- `displaymath` and `equation` environment.

- Referencing equations.

- General math equations.

Basic Math Symbols

- In word processors, inserting math symbols/greek letters usually involves a few menus.

- LaTeX uses command to make advanced symbols.

- We can use normal operators: $+, -, =, x$.

- For more complex operators, such as fractions, we use commands:

$$\text{\\frac\{numerator\}\{denominator\}}$$

$$\frac{numerator}{denominator}$$

- The next slide contains a table of basic math operators.

Basic Math Symbols Table

Command	Output	Command	Output
\cdot	·	\times	×
\div	÷	\equiv	≡
\sqrt	√	< >	< >
\leq	≤	\geq	≥
\sum	∑	\int	∫

Math Example

$$\texttt{\textbackslash frac}\{a\}\{b\} \; \texttt{\textbackslash cdot} \; \texttt{\textbackslash frac}\{c\}\{d\}$$

$$\frac{a}{b} \cdot \frac{c}{d}$$

- Refer to the supplemental documentation for more lists of operators and symbols.

Greek Characters

- Greek letters can also be made by using simple commands.

- For instance, the letter Alpha (α) can be made with `\alpha`.

- LaTeX recognizes the difference of upper case and lower case in the input code.

- For example, `\xi` and `\Xi` produces ξ and Ξ, respectively.

- The supplemental documents contain the list of Greek characters.

Super and Subscripts

- To make a superscript we use the following command: $\backslash a\char`\^\{x\}$ will produce a^x.

- To make a subscript we use the following command: $\backslash\beta\_\{1\}$ will produce β_1

Displaymath Environment

- One of the many math environments is the `displaymath` environment.

- This environment will give an equation some vertical spacing between lines.

- This environment is especially helpful if we're trying to point out an equation in a document.

Displaymath Environment Example

Here we have some very basic text that would
appear in a document.   Then we want to
introduce an equation, like the one below:
\begin{displaymath}
E=MC^{2}
\end{displaymath}
Now we return to normal text.   We can see
how the equation is easy to read.

Displaymath Environment Example (con't)

Here we have some very basic text that would appear in a document. Then we want to introduce an equation, like the one below:

$$E = MC^2$$

Now we return to normal text. We can see how the equation is easy to read.

Displaymath Alternative

- We can use an alternative to the `displaymath` environment that has the same output, but without having to type the cumbersome environment commands.

- Placing `\[` and `\]` around an equation will make it display the exact same way as using the `displaymath` environment.

- This takes a lot less time with no difference to the reader.

- If you prefer to keep a very organized input source file, then using environments will be a much cleaner look.

Displaymath Alternative Example

Let's return to a similar example to the one above. Here we will use the shorter command. Remember, this command is meant to make an equation appear with a lot of space around it, such as the one below:
\[E=MC^{2}\]
Now we return to normal text. We can see how the equation is easy to read. Also, we dropped two lines from the code.

Displaymath Alternative Example (con't)

Let's return to a similar example to the one above. Here we will use the shorter command. Remember, this command is meant to make an equation appear with a lot of space around it, such as the one below:

$$E = MC^2$$

Now we return to normal text. We can see how the equation is easy to read. Also, we dropped two lines from the code.

Equation Environment

- In academic journals mathematical equations are often numberd either to the left or right of the equation.

- This allows authors to reference by number.

- This involves a little bit of formatting in word processors, and even when it's done, it does not automatically renumber the equations.

- To create a numbered equation, we can use the `equation` environment.

- The equation will appear the same way they do in `displaymath`, except it is numbered.

Equation Environment Example

In an academic journal, we may want to
introduce an important equation and have it
numbered for easy reference. So we will
induce the equation using the equation
environment:
\begin{equation}
y=\alpha+\beta_{n}x
\end{equation}
Now we return to normal text and continue
the article. We can also reference the
above equation by number.

Equation Environment Example (con't)

In an academic journal, we may want to introduce an important equation and have it numbered for easy reference. So we will induce the equation using the equation environment:

$$y = \alpha + \beta_n x \tag{1}$$

Now we return to normal text and continue the article. We can also reference the above equation by number.

More on Equation Environment

- If we insert an equation prior to the first equation, then LaTeX will automatically renumber all of the equations.

- Also, LaTeX has an easy way to reference equations.

- Putting the actual equation number in the text isn't efficient, if the equation number changed, then we would manually need to change it.

- So, we can label equations and then refer to that equation by name. When the equation numbers change, our corresponding references would also change.

- Next to `\begin{environment}`, we place `\label{eq:`*name*`}`

- We then refer to that in our text with either with `(\ref{eq:`*name*`})` or `\eqref{eq:`*name*`}`.

More on Equation Environment Example

Let's return to the equation example. Now
we want to have our equation numbered and
labeled so we can refer to it.
\begin{equation} \label{eq:*line*}
y=\alpha+\beta_{n}x
\end{equation}
Now we return to normal text and continue
the article. As you can see, the above
equation is labeled (\ref{eq:*line*}).

Let's return to the equation example. Now we want to have our equation numbered and labeled so we can refer to it.

$$(2) \qquad\qquad y = \alpha + \beta_n x$$

Now we return to normal text and continue the article. As you can see, the above equation is labeled (2).

General Equations

- `displaymath` and `equation` environments inserts space between the equation and the body text.

- Sometimes it's appropriate to include the equations within a sentence without extra spacing.

- Within the body of the text, we can use `$` to start and end an equation.

- This is especially helpful when we're just showing an equation after some algebraic manipulation.

General Equation Example

Below we present the Pythagorean theorem in it's common form: \begin{displaymath}
a^{2}+b^{2}=c^{2}
\end{displaymath}
But there are several forms, we can also look at it as $\sqrt{a^{2}+b^{2}}=c$. We can also reference the above equation by number.

General Equation Example (con't)

Below we present the Pythagorean theorem in it's common form:

$$a^2 + b^2 = c^2$$

But there are several forms, we can also look at it as $\sqrt{a^2 + b^2} = c$.

Matrices

- When we're using the `displaymath` and `equation` environment we can make nice looking matrices.

- Within our environment we need to include another command called `\begin{array}` to begin the actual matrix

- Next to the beginning of the array, we include the justification of our matrix, for matrices we always use `{ccc}` to center the numbers in the columns.

- Look closely at the following example to see how matrices work.

Matrix Example

```
\begin{displaymath}
\left( \begin{array}{ccc} \\
x_{11} & x_{12} & x_{1i} \\
x_{21} & x_{22} & x_{2i} \\
x_{j1} & x_{j2} & x_{ji}
\end{array} \right)
\end{displaymath}
```

Matrix Example (con't)

$$
\begin{pmatrix}
x_{11} & x_{12} & x_{1i} \\
x_{21} & x_{22} & x_{2i} \\
x_{j1} & x_{j2} & x_{ji}
\end{pmatrix}
$$

Math Environment Review

- The `displaymath` environment inserts an equation with lots of space around it.

- The `equation` environment is the same as the `displaymath`, but numbers each equation.

- To make equations within the text, begin and end the formula with $.

- Within a math environment, we can make a matrix using `\begin{array}`.

- Take a look at the supplemental documents for lists of commands and extensive math formatting.

- NEXT: Tables