Math and LaTeX

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Adapter from Mini Course on LaTeX by David Diez

Outline

- Mathematics in LaTeX

Guide to LaTeX

The book *Guide to LaTeX* offers a very nice introduction, and we will closely follow some of the examples in these chapters in this class:

Math in LaTeX

We will cover several aspects of the mathematics environments offered in LaTeX.

- Basic mathematics in text
- Different equation environments
- Mathematical symbols
- Mathematical expressions
- Accenting and modifying text
- Automatic sizing of bracket symbols
- Text in mathematical equations
- Arrays and matrices

Inserting math into text

LaTeX makes it easy to add Greek letters like α, ζ, μ, etc. into text. In the same way, equations can be added easily as well: $y = x^3$, $\sum z^j$, $x_1 + \cdots + x_n$.

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easily as well: $y=x^3$, $\sum z^j$, $x_1+\cdots+x_n$.
```

The $ signs tell LaTeX when to switch into or out of math model. For instance, to create α above, type α.

How can we create β?

Equation array

Some equations are long and should be on their on lines. In such a case, use the `eqnarray` or `eqnarray*` environment:

```
\begin{eqnarray*}
\sum_{k=0}^{\infty}0.5^k = \frac{1}{1-0.5} = 2
\end{eqnarray*}
```

The result in LaTeX for `eqnarray*`:

$$\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1-0.5} = 2$$

Equation referencing

Just like tables and figures, equations can be referenced. Use `eqnarray` (no asterisk) to add an equation number:

$$\sum_{k=0}^{\infty} 0.5^k = \frac{1}{1-0.5} = 2 \tag{1}$$

`\label{powerSeries}` can be put inside the equation array and then be referenced via `\ref{powerSeries}`.

```
\begin{eqnarray}
\sum_{k=0}^{\infty}0.5^k = \frac{1}{1-0.5} = 2
\label{powerSeries}
\end{eqnarray}
```

Aligned equations

Another environment, `align` (and `align*`) are handy for aligning multiline equations.

```
\begin{align}
(a+b)^3 &= (a+b) (a^2 + 2ab + b^2) \notag \\
        &= a^3 + 3a^2b + 3ab^2 + b^3
\end{align}
```

Result:

$$\begin{aligned}(a+b)^3 &= (a+b)(a^2+2ab+b^2) \\ &= a^3 + 3a^2b + 3ab^2 + b^3 \end{aligned} \tag{2}$$

The `\\` command creates a line break. The command `\notag` was used to suppress the equation number of the first line, which requires the `amsmath` package. (Q: We have an equation number. What should I have included in the code?)

Multiple alignments

The `align` environment permits several alignments:

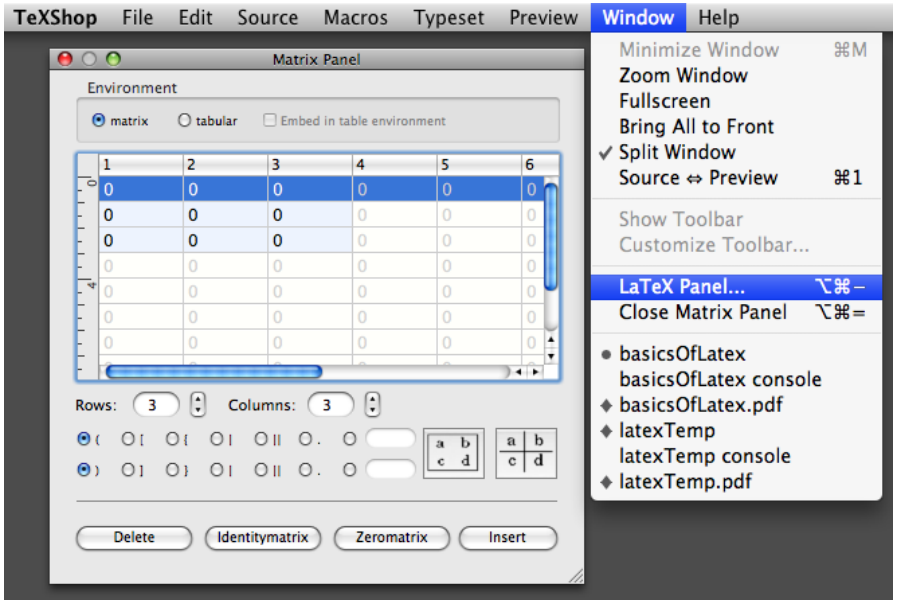
```
\begin{align*}
(a+b)^0 &=1                          & (a+b)^1 &= a+b \\
(a+b)^2 &=a^2 + 2ab + b^2    & (a+b)^3 &= a^3 + 3a^2b + 3ab^2 + b^3
\end{align*}
```

outputs

$$(a+b)^0 = 1 \qquad (a+b)^1 = a+b$$
$$(a+b)^2 = a^2 + 2ab + b^2 \qquad (a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$$

Mathematics and symbols

It is a little difficult to learn all the math syntax and a good help source is the LaTeX and Matrix Panels:



The Matrix Panel is especially useful since matrices can require a lot of writing. The LaTeX panel is handy as a quick reference.

Some symbols

Here is a very small subset of the symbols available in LaTeX.

$\leftarrow$	$\leftarrow$	$\Leftarrow$	$\Leftarrow$	$\leftrightarrow$	$\leftrightarrow$
$\geq$	$\geq$	$\neq$	$\neq$	$\notin$	$\notin$
∂	∂	$\oint$	$\oint$	∇	∇
$\bigcap$	$\bigcap$	$\bigcup$	$\bigcup$	$\cap$	$\cap$
$\subset$	$\subset$	$\supseteq$	$\supseteq$	$\not\supseteq$	$\not\supseteq$
$\bigodot$	$\bigodot$	$\bigotimes$	$\bigotimes$	$\oplus$	$\oplus$
$\clubsuit$	$\clubsuit$	$\perp$	$\perp$	$\vdash$	$\vdash$

For a searchable PDF with thousands of symbols, see

www.ctan.org/tex-archive/info/symbols/comprehensive/symbols-a4.pdf

Also see the LaTeX Panel (under the menu item Window).

Character modifications

Text and symbols in math mode can also be modified.

Regular		Modified		Accents	
R	R	$\mathbb{R}$	$\mathbb{R}$	$\tilde{R}$	$\tilde{R}$
A	A	$\mathcal{A}$	$\mathcal{A}$	$\widetilde{A}$	$\widetilde{A}$
x	x	$\mathbf{x}$	$\mathbf{x}$	$\bar{x}$	$\bar{x}$
p	p	p	p	$\hat{p}$	$\hat{p}$
X	X	X	X	$\widehat{X}$	$\widehat{X}$

Two other accents: $\dot{x}$ and $\ddot{x}$ via $\dot{x}$ and $\ddot{x}$.

Subscripts and exponents

We can create subscripts (e.g. x_1) and superscripts (e.g. 3^2):

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```

When the subscript is a single character, then it is acceptable to omit the curly braces. That is, the following is equally acceptable for the text above:

```
We can create subscripts (e.g. $x_1$) and
superscripts (e.g. $3^2$):
```

If more than one character is in the sub/superscript, braces are necessary to avoid problems: `$2_10$` outputs 2_10. Sub and superscripts can be used simultaneously: x_{ij}^2.

Fractions and roots

We can easily create fractions such as $\frac{2+3}{4+5} = \frac{5}{9}$ or roots such as $\sqrt{81} = 9$ and $\sqrt[4]{81} = 3$.

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or roots such as $\sqrt{81}=9$ and $\sqrt[4]{81} = 3$.
```

And we can combine them as well: $\frac{\sqrt{4}+3}{\sqrt{16}+5} = \frac{5}{9}$.

```
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$\frac{\sqrt{4} + 3}{\sqrt{16} + 5} = \frac{5}{9}$.
```

Sums and integrals

We can also create sums and integrals:

```
\begin{align*}
\sum_{i=0}^{\infty} p^i &= \frac{1}{1-p}   &  \int_{1}^{2}3x^2dx        &= 7 \\
\sum\nolimits_{i=0}^{\infty} 0.5^i &= 2    &  \int\limits_{1}^{1}3x^2dx &= 0 \\
\end{align*}
```

which results in

$$\sum_{i=0}^{\infty} p^i = \frac{1}{1-p} \qquad \int_{1}^{2} 3x^2 dx = 7$$

$$\sum\nolimits_{i=0}^{\infty} 0.5^i = 2 \qquad \int\limits_{1}^{1} 3x^2 dx = 0$$

The commands `\nolimits` and `\limits` can be used to override the default displays of limits in LaTeX.

Practice

Produce the following result using the `eqnarray*` environment:

$$\sum_{i=0}^{n} p^i = \frac{1 - p^{n-1}}{1 - p}$$

Some examples may be utilized in `latexTemp.tex`.

Sizing of Brackets

A small problem with bracket sizes is shown in the left equation, and this problem is fixed on the right.

$$(\frac{2+3}{4+5}) \qquad \left(\frac{2+3}{4+5}\right)$$

The coding for the expressions above

```
\begin{align*}
  (\frac{2+3}{4+5}) &&& \left(\frac{2+3}{4+5}\right)
\end{align*}
```

Generally we can use \left(, \left[, \left|, and \left\{ and their corresponding right brackets to create automatically sized brackets. These commands *must* be inside one of the equations environments and the left and right brackets must always be balanced.

Matrices

Matrices also can be made in LaTeX:

$$\left(\begin{array}{ccc} 4 & 1 & 19 \\ 3 & 8 & 8 \end{array}\right)$$

The code:

```
\begin{eqnarray*}
\left(\begin{array}{ccc} 4 & 1 & 19 \\
  3 & 8 & 8 \end{array}\right)
\end{eqnarray*}
```

The syntax for an `array` is the same as for `tabular` (a table).

Space and stacking

Space can be added in equations using \quad, and expressions can be stacked via \stackrel:

```
\begin{eqnarray*}
  E(X+Y) \stackrel{indep.}{=} E(X) + E(Y)
    \quad\quad
    Var(X+Y) \stackrel{indep.}{=} Var(X) + Var(Y)
\end{eqnarray*}
```

produces

$$E(X+Y) \stackrel{indep.}{=} E(X) + E(Y) \qquad Var(X+Y) \stackrel{indep.}{=} Var(X) + Var(Y$$

Summary

After this class, you should have a general idea of

- using the math modes in LaTeX

Any questions?