Math 291: Lecture 3

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Outline

Comments from Lab 2

- An environment is something that starts with
  \begin{*name of environment*}
  and ends with
  \end{*name of environment*}
- The enumerate environment was used in the lab.
- Note that you can nest one enumerate environment within another. When you do so it is customary to indent the 'inner' one by a tab
  - it makes it easier to remember the correct number (and location) of end-statements
  - it makes your code easier to read
- I will expect you to use the enumerate environment on all future labs. We will cover it in detail in Week 4, but this week we're going to focus on Math.

Outline

Display versus In-line Math

Compare the following. The first in each pair is in-line math, and the second in each pair is displayed math.

- The fraction $\frac{3}{4}$.
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$$\frac{3}{4}.$$
- The convergence of the infinite sum $\sum_{i=1}^{\infty} \frac{1}{n^p}$ is determined by the value of the parameter p.
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Display versus In-line Math

- Notice that in each pair, there are differences in the size of the expression and in the sub- and superscript locations in the typeset formulas.
- LaTeX uses \$ $\cdots$ \$ to typeset "in-line" equations.
- For displayed equations, there are a few options:
  - \$\$ $\cdots$ \$\$ [this is the default for un-numbered equations]
  - \begin{displaymath} *blah blah* \end{displaymath}
  - \begin{equation} *blah blah* \end{equation}
    [this is the default for equations with an equation number]
  - \begin{equation*} *blah blah* \end{equation*}
    (the * tells the compiler **not** to assign an equation number)
  - Antiquated Method: \[*blah blah* \]
    [Note: If you actually use this, I won't give you full credit. It's included here only so that you can read and understand files from other people.]
- Hybrid
  - \$\displaystyle *blahhh...* \$
    [Size and sub- and superscript locations are as in displayed equations, but it is typeset in-line. See next slide.]

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- Changes to the size and sub- and superscript behavior occur in all "large symbols" such as: $\sum, \int, \bigcap, \bigcup, \bigvee$, etc.
- Changes to only subscript behavior occur in the commands: $\lim, \liminf, \min, \max$, etc.
  - For example consider: $\min_P L(P, f)$ and $\min_P L(P, f)$

Practice Exercises:

- Type $\lim_{n\to\infty} \frac{n^2}{3n^2-2n+1} = \frac{1}{3}$ in four ways:
  - As an in-line equation (using \$ $\cdots$ \$)
  - As a displayed equation (using \$\$ $\cdots$ \$\$)
  - As a displayed equation with line numbers (using \begin{equation},\end{equation})
  - As an in-line equation using the \displaystyle command.

Outline

Sizing Grouping Symbols

- Compare the form of the statements: $(\frac{1}{2}+\frac{1}{5})$ and $\left(\frac{1}{2}+\frac{1}{5}\right)$.
- Automatically-sizing grouping symbols are added using the commands: \left(and \right)
- Possible other pairs for these commands include: ( ) [] || $\lfloor\,\rfloor$, etc.
- The compiler requires a \right for each \left, but does not require the left and right sides to have the same shape.
- If you want to have just a left or just a right, you can use the "empty" grouping symbol of \right. or \left. for the missing side (note the period as part of the command name).

Sizing of Grouping Symbols

- Practice:
  - Typeset: $\left(\frac{1}{3}, 6\right]$
  - Typeset: $\right)\frac{1}{3}, 6\left[$
  - Typeset the formula: $\left(1+\frac{1}{n}\right)^{n} \longrightarrow e$
  - Typeset the formula: $\left[\frac{1}{x}+3x\right|_{1}^{5} = -\frac{4}{5}+12 = \frac{56}{5}$

Sizing of Grouping Symbols

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  - Typeset the formula: $\left[\frac{1}{x}+3x\right|_1^5=-\frac{4}{5}+12=\frac{56}{5}$
- Actual Code:
  - `$$\left(\frac{1}{3},6\right]$$`
  - `$$\left)\frac{1}{3},6\right[$$`
  - `$$\left(1+\frac{1}{n}\right)^n \longrightarrow e$$`
  - `$$\left[\frac{1}{x}+3x\right|_1^5=-\frac{4}{5}+12=\frac{56}{5}$$`

Outline

Accents

- Here are some of the most frequently used accent characters:
  - $\hat{a}$, $\tilde{w}$, $\vec{x}$
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  - A few other common ones are: `\bar{}`, `\dot{}`, `\acute{}`,
  - Some special cases: we use $\vec{\imath}$ and $\vec{\jmath}$ instead of $\vec{i}$ and $\vec{j}$
  - Use the special commands`\imath` and `\jmath` to get the un-dotted versions. (e.g. `\vec{\imath}`)

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  - Use the special commands`\imath` and `\jmath` to get the un-dotted versions. (e.g. `\vec{\imath}`)
- Two more related symbols are `\widehat{}` and `\widetilde{}`.
- For example, we used these instead of regular hats and tildes in these expressions: $\widehat{xyz}$ and $\widetilde{3xy}$.

More Accents

- Three more common commands are:
  `\overline{}, \underline{}, \underbrace{}.`
- For example, consider: $\overline{\overline{a}^2 + \underline{xy} + \overline{\overline{z}}}$
- or: $(a+b)^2 = a^2 + \underbrace{ab + ab}+b^2 = a^2 + 2ab + b^2$

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- If we include the package `amsmath`, we can also make use of additional commands like: `\overleftarrow{}, \underleftrightarrow{}, \xrightarrow[this below]{that above}`, etc.
  - Recall: In LaTeX commands, [] indicates an optional argument, while { } indicates a required argument (empty is usually allowed).
- It is best to use a built-in command when possible, as vertical spacing issues have usually been addressed. But if all else fails...

Stacking Commands

There are several commands that allow us to place objects on top of one another.

- `\stackrel{upper}{lower}`
- `{upper \choose lower}`
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- Practice: Typeset $\underbrace{\overrightarrow{AB} + \overrightarrow{BC}} + \overrightarrow{CD} \xrightarrow[\text{addition}]{\text{vector}} \overrightarrow{AC} + \overrightarrow{CD} \stackrel{\text{simp}}{=} \overrightarrow{AD}$

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- Here is the code to do this:

```
$$\underbrace{\overrightarrow{AB}+\overrightarrow{BC}}
+\overrightarrow{CD}
\xrightarrow[\mbox{addition}]{\mbox{vector}}
\overrightarrow{AC}+\overrightarrow{CD}
\stackrel{\mbox{\tiny simp}}{=} \overrightarrow{AD}$$
```

Outline

Multiple Equations and Multi-Line Equations

- The commands: eqnarray, eqnarray*, align, align* are all environments for typesetting multiple equations. They work as follows:
  - Each command creates a math mode.
  - Each line gets its own equation number in the un-starred versions.
  - They are most often used for long derivations.
  - They make use of the special alignment character &.

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  - They are most often used for long derivations.
  - They make use of the special alignment character &.
- "multline" and "split" are two special environments for a single long equation
- The "multline" command:
  - Creates a math mode.
  - Allows line breaks to be added manually.
  - Equation numbers are placed either to the left of the first line or to the right of the last line.
  - Lines are justified as: left, center, . . . , center, right
- The "split" command:
  - Is used within another math mode (so you can use it inside another math environment such as equation, equation*, etc.).
  - Line breaks are still done manually.
  - Equation numbers are vertically centered (at least by default).
  - It makes use of the special alignment character &.

Multiple Equations and Multi-Line Equations

- Practice: Type (with align or align*, and note the difference)

```
\begin{align}
\sin t  \left( \csc t - \sin t \right)
&= \sin t \left( \frac{1}{\sin t} - \sin t \right) \\
&= 1 - \sin^2 t \\
&= \cos^2 t
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- Your output should look like (using align):

$$\sin t \left(\csc t - \sin t\right) = \sin t \left(\frac{1}{\sin t} - \sin t\right) \tag{1}$$
$$= 1 - \sin^2 t \tag{2}$$
$$= \cos^2 t \tag{3}$$

- & indicates the location in each line that should act as the alignment reference, \\ says when to end a line.

Multiple Equations and Multi-Line Equations

- Next, try:

```
\begin{multline}
382x^{13}+32x^{12}+x^{11}+x^{10}+x^9+x^8+x^7+321x^6\\
+x^5+19x^4+x^3+38x^2+x+1
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- Try this again using the commands `\begin{equation}`, `\begin{split}`, etc.