### Math 291: Lecture 7

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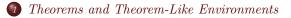
March 13, 2017

Justin A. James (MSUM)

Math 291: Lecture 7

March 13, 2017 1 / 24

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3 Defining New Environments

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## Table of Contents

#### Theorems and Theorem-Like Environments 1





Defining New Environments



Outline



2 Defining Custom Commands



Defining New Environments



Theorems and Theorem-Like Environments

## Theorem-Like Environments

- LATEX has several pre-defined *environments* that allow us to quickly typeset theorems or theorem-like structures, without having to manually set the typeface and numbering ourselves.
- Environments start with the command: \begin{environment name} and end with the command: \end{environment name}.



Theorems and Theorem-Like Environments

## Theorem-Like Environments

- One such command in LATEX is: \newtheorem{Theorem name}{theorem title}
- In this command, 'Theorem name' is the name used to call the environment.
- 'Theorem title' is the title or name that is actually printed (along with with a "counter") when the document is compiled.



## Theorem Example

- Open a new document containing your standard preamble.
- In the preamble of your document, type: \newtheorem{thm}{Theorem} into the body of your document.
- Then, type in a similar command to define the "axiom" environment: \newtheorem{ax}{Axiom}



## Theorem Example

#### An Example:

• Next, type in the following and then build:

```
\begin{thm}[The Fundamental
Theorem of Calculus]
$$\int_{a}^{b} f(x)\, dx = F(b)-F(a)$$
\end{thm}
```

• Now type in commands and build to produce the following:

#### Axiom 1.

All fishes, except sharks, are kind to children.

#### Axiom 2.

Kangaroos are not suitable for pets.

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- Notice that LATEX keeps track of the numbering for you.
- When you add or remove theorems, the numbering throughout the document is automatically updated.
- We will eventually learn a way to refer to theorem numbers.
- When used, reference labels will also be automatically updated.



- There is an optional argument that gives theorems titles of the form **Theorem 4.2** (here the 4 refers to some outside counter, like a chapter, and the 2 means that it is the second numbered theorem within that chapter.
- The syntax is:

\newtheorem{thm2}{Theorem}[enumi]
where enumi is the counter being used
(in this case, the first level of an enumerate environment).



- Define a new environment "thm2" using the syntax above.
- Then try using this new environment within an enumerated list to create the following:
  - This is the first enumerated item.
  - This is the second enumerated item.
  - This is the third enumerated item.

Theorem 3.1.

This is the first numbered theorem after item three.

#### Theorem 3.2.

This is the second numbered theorem after item three.

#### Theorem 4.1.

This is yet another theorem statement - How did it get numbered?.

#### •

• Note that we referred to a specific enumeration level in our environment definition.

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If you don't want to take the time to define environments yourself, you can use the amsthm package.

- Along with the standard environments, this package defines a newtheorem\* version, used for unnumbered theorems
- It also defines three environment styles:
  - plain (bold title, then italics in the body)
  - definition (bold title, then normal text in the body)
  - remark (italicized title, then normal text in the body)
- You can still manually define other theorem styles beyond those defined by the amsthm package.



- The "amsthm" package also defines the \swapnumbers command (in preamble before any \newtheorem commands), which puts the numbers *before* the theorem (as in: 1 Theorem).
- Finally, it defines a proof environment (\begin{proof} \end{proof}). This environment:
  - is unnumbered
  - it starts with Proof
  - it ends with:





Outline





Defining New Environments



• The syntax for defining a command is: \newcommand{\name}[#args][opt]{def}

Note:  ${\it {\rm L}\!AT}_{E\!X}$  will not allow you to redefine a command that has already been defined internally.

- Example:  $\newcommand{\di}{\displaystyle}$
- When placed in the preamble, the command is globally defined (applies to the entire document).
- When placed within an environment, it is defined only within that environment.
- When placed elsewhere in the body of a document, it can only be used from then on.

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## New Commands with Arguments

- The "#args" part of the newcommand syntax indicates the number of arguments that are required to be supplied when using the command (each argument should be put within a separate "{}").
- Each argument will be referred to separately in the definition of the command by using: #1, #2, etc.
- The command \ensuremath ensures the command will **always** be carried out in math mode (whether you call the command inside \$ signs or not).



## Examples of Commands with Arguments

• Type the following into your document:

\newcommand{\repdec}[1]
{\ensuremath{0.\overline{#1}=\frac{#1}{99}}}

• Then call your new command by entering: \$\repdec{63}\$

What happens when you build? Notice that this is a command with a single argument (input).

Try changing the input value and see what happens to the output.



## Examples of Commands with Arguments

• As another example, here is a command requiring 4 inputs:

```
\newcommand{\cfrac}[4]
{\ensuremath{\frac{\frac{#1}{#2}}
{\frac{#3}{#4}}}
```

- Add this command definition to your sample document.
- Then, test out your new \cfrac command using some different input values. What does this command do?



# Example of a command with an optional t

- The \newcommand also allows you to define commands with *optional* arguments (arguments that are available for use but not absolutely required).
- For example, try adding the following to your sample document:

\newcommand{\subvec}[3][x]
{\ensuremath{#1\_{#2}, \ldots, #1\_{#3}}}

- The first of the three arguments is optional since a default value has been supplied.
- If a new value for this optional argument is **not** supplied, the default value of x will be used. Otherwise, the new input value will be used.

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## Example of a command with an optional

 Try calling this command three times using the following inputs: \subvec[x]{1}{n} \subvec[y]{1}{n} \subvec[1}{n}

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## The Renewcommand Command

- The \renewcommand command allows us to redefine or alter an existing command.
- Here is a command that Dr. Fagerstrom uses when she runs out of alphabet on her review sheets:

```
\setcounter{enumi}{0}
\renewcommand{\labelenumi}
{(\alph{enumi}\alph{enumi})}
```

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## The Renewcommand Command

- Try using this command to create the following enumeration:
  - (a) First
  - (b) Second
  - (aa) Third
  - (bb) Fourth
- **Be careful** when using renewcommand. You can use it to accidentally overwrite standard LATEX commands!



Defining New Environments



Outline



Defining New Environments

Defining New Environments

## New Environments

- Finally, the following syntax can be used to define a new LATEX environment: \newenvironment{envname}[narg][opt] {begdef}{enddef}
- We can also define and make use of new counters using the command newcounters.
- These options are part of what makes \alpha TEX highly customizable and useful.