CS3101

Lecture 3: Latex environments and packages

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Latex Environments

- General blueprints of LaTeX markup is an **environment**.
- A LaTeX environment has the following basic structure:

```
\begin{<environment>}      % Explicit start
    %
    % Content
    %
\end{<environment>}        % Explicit end
```

- We have already seen examples with `document`:

```
\begin{document}
    %
    % Body
    %
\end{document}
```

Now for many many examples

The `center` Environment

- If you want to center justify your text, then you are in luck!

```
\begin{center}
    This text is centered.
\end{center}
```

This text is centered.

- This one is super simple.

The `equation` Environment

- Displayed lines of math can be viewed as an environment.

The following

```
\begin{equation}
    \sum_{n=1}^\infty \frac{1}{n^s}
        = \prod_{p \text{ prime}} \frac{1}{1 - p^{-s}}
\end{equation}
```

produces

$$\sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{p \text{ prime}} \frac{1}{1 - p^{-s}} \tag{1}$$

Now for a slight distraction

Cross-referencing (detour)

$$\sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{p \text{ prime}} \frac{1}{1 - p^{-s}} \tag{2}$$

- Notice the number at the right side (It ChAnGeD!)
- Created with the `equation` environment.
- Like with citations and references, we can use that number to reference that equation elsewhere.

Labels and Refs (down the rabbit hole)

- We need to add a tag to our `equation` environment.
- Look for `\label{<tag>}`

Updated code:

```
\begin{equation}\label{Euler}
    \sum_{n=1}^\infty \frac{1}{n^s}
        = \prod_{p \text{ prime}} \frac{1}{1 - p^{-s}}
\end{equation}
Equation \eqref{Euler} is the Euler decomposition.
```

$$\sum_{n=1}^{\infty} \frac{1}{n^s} = \prod_{p \text{ prime}} \frac{1}{1 - p^{-s}} \tag{3}$$

Equation (3) is the Euler decomposition.

Refs and Eqrefs (almost out)

- We used `\eqref{<tag>}` which is special for equations.

```
This is an eqref \eqref{Euler}.
This is a ref \ref{Euler}.
```

This is an eqref (3). This is a ref 3.

- With the exception of equation-llike environments, use `\ref{<tag>}`.
- We will see more examples!

The `align` environment

This uses the `amsmath` package we haven't discussed yet.

```
\begin{align}
    \sum_{n=1}^{\infty} \frac{1}{n^2}
    &= 1 + \frac{1}{4} + \frac{1}{9} + \cdots \\
    &= \frac{\pi^2}{6} .
\end{align}
```

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = 1 + \frac{1}{4} + \frac{1}{9} + \cdots \tag{4}$$

$$= \frac{\pi^2}{6}. \tag{5}$$

- Lots to discuss. First, each line has a number.

```
\begin{align}
    \sum_{n=1}^{\infty} \frac{1}{n^2}
    &= 1 + \frac{1}{4} + \frac{1}{9} + \cdots \\
    &= \frac{\pi^2}{6} .
\end{align}
```

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = 1 + \frac{1}{4} + \frac{1}{9} + \cdots \tag{6}$$

$$= \frac{\pi^2}{6}. \tag{7}$$

- Latex **aligns** based on the & symbol.
- New lines are created using \\
- To reference a specific line, put `\label{<tag>}` on that line.

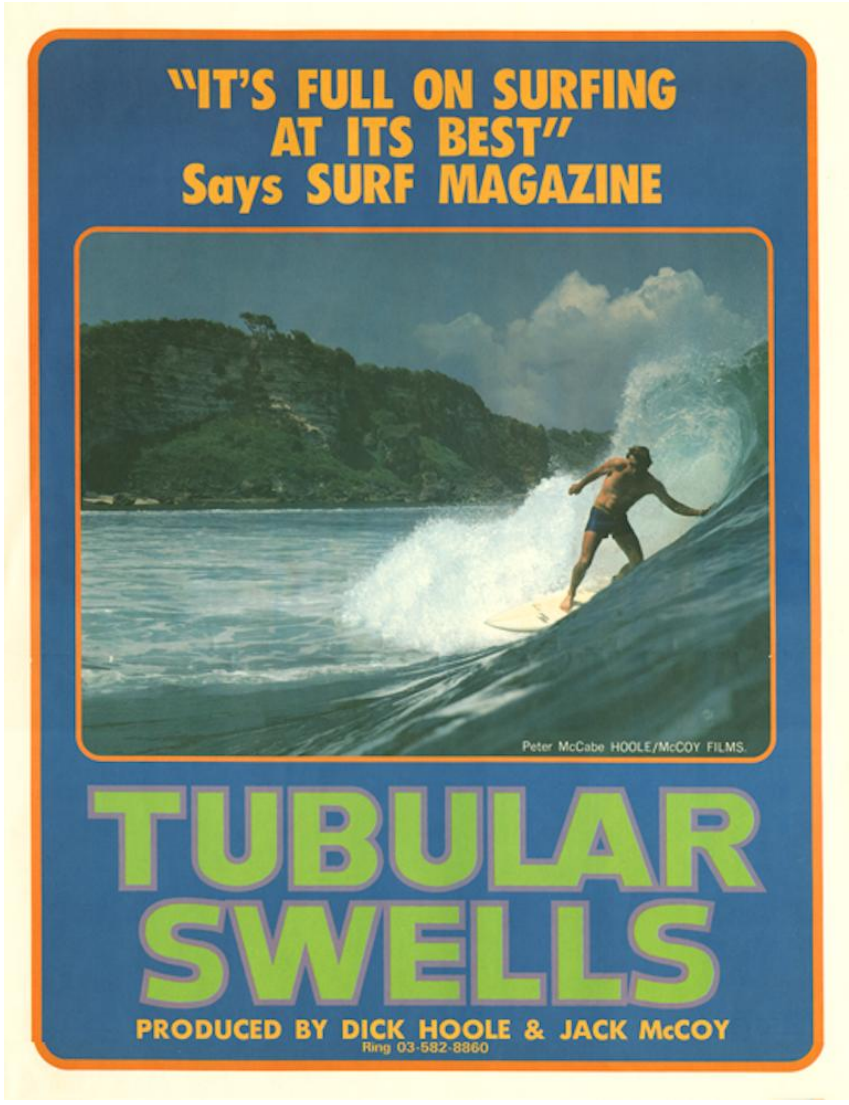
- We can remove the numbers from the `equation` and `align` environments.
- Use environments `equation*` and `align*`.
- Often `*` is used to remove numbering.

```
\begin{align*}
    \sum_{n=1}^{\infty} \frac{1}{n^2}
    &= 1 + \frac{1}{4} + \frac{1}{9} + \cdots \\
    &= \frac{\pi^2}{6} .
\end{align*}
```

$$\begin{aligned}\sum_{n=1}^{\infty} \frac{1}{n^2} &= 1 + \frac{1}{4} + \frac{1}{9} + \cdots \\ &= \frac{\pi^2}{6}.\end{aligned}$$

The `tabular` Environment

I can't **not** think of **tubular**



The `tabular` Environment (seriously now)

- `tabular` is used for creating tables in LaTeX.
- One can specify the alignment, formatting, and content of each cell within the table.
- The `tabular` environment requires an argument:

```
\begin{tabular}{|l|c|r|}
    % Content
\end{tabular}
```

- The `{|l|c|r|}` explains how to format:
  - `|` put vertical lines
  - `l` left-justifies the text in the column
  - `c` center-justifies the text in the column
  - `r` right-justifies the text in the column
- Thus, we have 3 columns separated by vertical lines.

- We will nest two enviornments: `center` and `tabular` for a centered table.

```
\begin{center}
\begin{tabular}{|l|c|r|}
    \hline
    \textbf{My} & \textbf{Favorite} & \textbf{Table} \\
    \hline
    Look, & it has entries. & Neat. \\
    \hline
\end{tabular}
\end{center}
```

My	**Favorite**	**Table**
Look, it	has entries in it.	Whoa cool.

- `\hline` adds a horiztonal line.

The `enumerate` and `itemize` Environments

- `enumerate` is used to construct numbered lists.
- It enables one to specify items within the list, automatically numbering them in the desired format.
- It's magical moment when you do not have to renumber items in your list.

```
\begin{enumerate}
    \item First item,
    \item Second item,
    \item Another item,
    \item I am losing count.
\end{enumerate}
```

1. First item,
2. Second item,
3. Another item,
4. I am losing count.

```
\begin{itemize}
    \item First item,
    \item Second item,
    \item Another item,
    \item I am losing count.
\end{itemize}
```

- First item,
- Second item,
- Another item,
- I am losing count.

In a pdf the default symbol is •.

- One can skip or simply change the numbering using `\setcounter`.
- You can nest `enumerate` and `itemize`, individually or together.

```
\begin{enumerate}
    \item Look at me.
    \item \begin{enumerate}
        \item I can make
        \item nested enumerates.
    \end{enumerate}
    \item So cool.
\end{enumerate}
```

1. Look at me.
2. 2.1 I can make

   2.2 nested enumerates.
3. So cool.

Moving onto LaTeX packages.

LaTeX Packages

- LaTeX packages are essential tools that enhance the functionality of LaTeX.
- Packages are sets of additional commands and features that extend the capabilities of the basic LaTeX system, often for specialized tasks.
- To include a package, one first needs it to be installed in the local machine—or one can use Overleaf (#StillNotSponspored) and avoid thinking about this.
- To use a LaTeX package, you need to include it in the preamble of your document.

```
\usepackage[<options>]{<package name>}
```

Example Packages

- The first few lines of the lecture notes look like

```
\documentclass[a4paper, 12pt]{article}
\usepackage{amsmath}
\usepackage{amsthm}
\usepackage{amssymb}
\usepackage{enumerate}
\usepackage{hyperref}
```

- Will mention a few packages that might be particularly relevant.

The amsmath package

- One of the most useful packages for mathematical output.
- It provides numerous environments and commands for formatting equations, aligning mathematical expressions, and handling mathematical symbols.
- `align` environment. Also matrix environments like `matrix`, `pmatrix`, and `bmatrix`.

```
\[
    \begin{pmatrix}
        1 & 2 \\
        3 & 4 \\
    \end{pmatrix}
\]
```

$$\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$$

The amsthm Package

- Specifically designed to facilitate the typesetting of theorems, lemmas, definitions, and similar structures in a document.
- Key features include:

1. **Theorem-like Environments:** Allows you to define new theorem-like structures (like Theorem, Lemma, Corollary, Proposition, Definition, Example, Remark).
2. **Customization:** Provides options to customize the style of theorem-like environments, such as italicized or normal text, numbering, and shared or independent counters.
3. **Proof Environment:** Offers a dedicated proof environment for typesetting proofs, automatically adding a QED symbol at the end.

More into amsthm

- One needs to first define the theorem-like environment in the preamble.
- There are two main commands for doing this:

```
\newtheorem{<name>}{<printed output>}[<numbered within>]
\newtheorem{<name>}[<numbered like>]{<printed output>}
```

- As an example, we use the following in the lecture notes:

```
\newtheorem{theorem}{Theorem}[section]
```

- The enviornment name is `theorem`. It prints out 'Theorem', and it is numbered within the sections.

amsthm Example

```
\begin{theorem}
    The equation $x^n + y^n = z^n$ has no solution in
    the positive integers for $n \geq 3$.
\end{theorem}
```

Theorem

The equation $x^n + y^n = z^n$ has no solution in the positive integers for $n \geqslant 3$.

- These slides don't do this example justice.

The graphicx package

- A powerful tool for including and manipulating graphics (or images) within documents.
- Extends the basic capabilities by providing commands for inserting images, scaling, rotating, and controlling their placement.

```
\begin{figure}
    \centering
    \includegraphics[scale=0.2]{imgs/Sherlock.jpg}
    \caption{My dog.}
\end{figure}
```

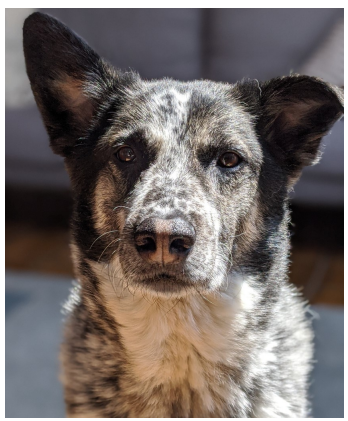


Figure 1: My dog.

Beyond...

- There are over 4000 packages for LaTeX.
- A few honorable mentions:

1. `hyperref` : Enables references and citations to produce hyperlinks within the `pdf` file. (This file uses it.)
2. `listings` & `minted` : Displays code and pseudo-code in a structure block.
3. `siunitx` : For those working often with SI units, this can help manage it all.
4. `tikz` : Very powerful image producing package. The possibilities are stunning.