An Interactive Introduction to LaTeX

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An Interactive Introduction to LaTeX

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https://github.com/jdleesmiller/latex-course

Outline

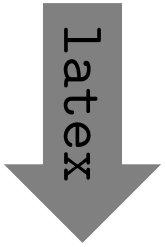
Why LaTeX?

- It makes beautiful documents
  - Especially mathematics
- It was created by scientists, for scientists
  - A large and active community
- It is powerful — you can extend it
  - Packages for papers, presentations, spreadsheets, ...
- You may be required to use it
  - Some journals, conferences, publishers expect it

How does it work?

- You write your document in `plain text` with `commands` that describe its structure and meaning.
- The `latex` program processes your text and commands to produce a beautifully formatted document.

```
The rain in Spain falls \emph{mainly} on the plain.
```



The rain in Spain falls *mainly* on the plain.

More examples of commands and their output. . .

```
\begin{itemize}
\item Tea
\item Milk
\item Biscuits
\end{itemize}
```

- Tea
- Milk
- Biscuits

```
\begin{figure}
\includegraphics{gerbil}
\end{figure}
```

```
\begin{equation}
\alpha + \beta + 1
\end{equation}
```

$$\alpha + \beta + 1 \qquad (1)$$

Attitude adjustment

- Use commands to describe ‘what it is’, not ‘how it looks’.
- Focus on your content.
- Let LaTeX do its job.

For the tech-savvy:

- LaTeX is like programming: you write source code.
- LaTeX can be seen as a markup language.
  (compare: HTML, Markdown)

Getting started

- A minimal LaTeX document:

```
\documentclass{article}
\begin{document}
Hello World! % your content goes here...
\end{document}
```

- Commands start with a *backslash* \ .
- Every document starts with a `\documentclass` command.
- The *argument* in curly braces { } tells LaTeX what kind of document we are creating: an `article`.
- A percent sign % starts a *comment* — LaTeX will ignore the rest of the line.

Getting started with **Overleaf**

- Overleaf is a website for writing documents in LaTeX.
- It 'compiles' your LaTeX automatically to show you the results.

Click here to open the example document in **Overleaf**

For best results, please use Google Chrome or a recent Mozilla Firefox.

- As we go through the following slides, try out the examples by typing them into the example document on Overleaf.
- **No really, you should try them out as we go!**

Typesetting Text

- Type your text between `\begin{document}` and `\end{document}`.
- For the most part, you can just type your text normally.

```
Words are separated by one or more
spaces.

Paragraphs are separated by one
or more blank lines.
```

Words are separated by one or more spaces.

Paragraphs are separated by one or more blank lines.

- Space in the source file is collapsed in the output.

```
The   rain       in Spain
falls mainly on the plain.
```

The rain in Spain falls mainly on the plain.

- You can typeset en- and em-dashes:

```
The proof is quite easy ---
  as noted on pages 10--13.
```

The proof is quite easy — as noted on pages 10–13.

Typesetting Text: Caveats

- Quotation marks are a bit tricky:
  use a backtick ` on the left and an apostrophe ´ on the right.

`Single quotes: ‘text’.`	Single quotes: ‘text’.
`Double quotes: ‘‘text’’.`	Double quotes: “text”.

- Some common characters have special meanings in LaTeX:

  % percent sign
  # hash (pound / sharp) sign
  & ampersand
  $ dollar sign

- If you just type these, you'll get an error. If you want one to appear in the output, you have to *escape* it by preceding it with a backslash.

`\$\%\&\#!`	$%&#!

Handling Errors

- LaTeX can get confused when it is trying to compile your document. If it does, it stops with an error, which you must fix before it will produce any output.
- For example, if you misspell `\emph` as `\meph`, LaTeX will stop with an "undefined control sequence" error, because "meph" is not one of the commands it knows.

Advice on Errors

1. Don't panic! Errors happen.
2. Fix them as soon as they arise — if what you just typed caused an error, you can start your debugging there.
3. If there are multiple errors, start with the first one — the cause may even be above it.

Typesetting Exercise 1

Typeset this in LaTeX: [1]

In March 2006, Congress raised that ceiling an additional $0.79 trillion to $8.97 trillion, which is approximately 68% of GDP. As of October 4, 2008, the "Emergency Economic Stabilization Act of 2008" raised the current debt ceiling to $11.3 trillion.

Click to open this exercise in **Overleaf**

- Hint: watch out for characters with special meanings!
- Once you've tried, click here to see my solution.

[1] http://en.wikipedia.org/wiki/Economy_of_the_United_States

Typesetting Mathematics: Dollar Signs

- Why are dollar signs $ special? We use them to mark mathematics in text.

```
% not so good:
Let a and b be distinct positive
integers, and let c = a - b + 1.

% much better:
Let $a$ and $b$ be distinct positive
integers, and let $c = a - b + 1$.
```

Let a and b be distinct positive integers, and let c = a - b + 1.

Let a and b be distinct positive integers, and let $c = a - b + 1$.

- Always use dollar signs in pairs — one to begin the mathematics, and one to end it.
- LaTeX handles spacing automatically; it ignores your spaces.

```
Let $y=mx+b$ be \ldots

Let $y = m x + b$ be \ldots
```

Let $y = mx + b$ be ...

Let $y = mx + b$ be ...

Typesetting Mathematics: Notation

- Use caret ^ for superscripts and underscore _ for subscripts.

```
$y = c_2 x^2 + c_1 x + c_0$
```

$y = c_2 x^2 + c_1 x + c_0$

- Use curly braces { } to group superscripts and subscripts.

```
$F_n = F_n-1 + F_n-2$      % oops!

$F_n = F_{n-1} + F_{n-2}$ % ok!
```

$F_n = F_n - 1 + F_n - 2$

$F_n = F_{n-1} + F_{n-2}$

- There are commands for Greek letters and common notation.

```
$\mu = A e^{Q/RT}$

$\Omega = \sum_{k=1}^{n} \omega_k$
```

$\mu = A e^{Q/RT}$

$\Omega = \sum_{k=1}^{n} \omega_k$

Typesetting Mathematics: Displayed Equations

- If it's big and scary, *display* it on its own line using `\begin{equation}` and `\end{equation}`.

```
The roots of a quadratic equation
are given by
\begin{equation}
x = \frac{-b \pm \sqrt{b^2 - 4ac}}
         {2a}
\end{equation}
where $a$, $b$ and $c$ are \ldots
```

The roots of a quadratic equation are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad (2)$$

where a, b and c are . . .

Caution: LaTeX mostly ignores your spaces in mathematics, but it can't handle blank lines in equations — don't put blank lines in your mathematics.

Interlude: Environments

- `equation` is an *environment* — a context.
- A command can produce different output in different contexts.

```
We can write
$ \Omega = \sum_{k=1}^{n} \omega_k $
in text, or we can write
\begin{equation}
  \Omega = \sum_{k=1}^{n} \omega_k
\end{equation}
to display it.
```

We can write $\Omega = \sum_{k=1}^{n} \omega_k$ in text, or we can write

$$\Omega = \sum_{k=1}^{n} \omega_k \tag{3}$$

to display it.

- Note how the Σ is bigger in the `equation` environment, and how the subscripts and superscripts change position, even though we used the same commands.

In fact, we could have written `$...$` as `\begin{math}...\end{math}`.

Interlude: Environments

- The `\begin` and `\end` commands are used to create many different environments.
- The `itemize` and `enumerate` environments generate lists.

```
\begin{itemize} % for bullet points
\item Biscuits
\item Tea
\end{itemize}

\begin{enumerate} % for numbers
\item Biscuits
\item Tea
\end{enumerate}
```

- Biscuits
- Tea

1. Biscuits
2. Tea

Interlude: Packages

- All of the commands and environments we've used so far are built into LaTeX.
- *Packages* are libraries of extra commands and environments. There are thousands of freely available packages.
- We have to load each of the packages we want to use with a `\usepackage` command in the *preamble*.
- Example: `amsmath` from the American Mathematical Society.

```
\documentclass{article}
\usepackage{amsmath} % preamble
\begin{document}
% now we can use commands from amsmath here...
\end{document}
```

Typesetting Mathematics: Examples with amsmath

- Use `equation*` ("equation-star") for unnumbered equations.

```
\begin{equation*}
  \Omega = \sum_{k=1}^{n} \omega_k
\end{equation*}
```

$$\Omega = \sum_{k=1}^{n} \omega_k$$

- LaTeX treats adjacent letters as variables multiplied together, which is not always what you want. amsmath defines commands for many common mathematical operators.

```
\begin{equation*} % bad!
 min_{x,y} (1-x)^2 + 100(y-x^2)^2
\end{equation*}
\begin{equation*} % good!
\min_{x,y}{(1-x)^2 + 100(y-x^2)^2}
\end{equation*}
```

$$min_{x,y}(1-x)^2+100(y-x^2)^2$$

$$\min_{x,y}(1-x)^2+100(y-x^2)^2$$

- You can use `\operatorname` for others.

```
\begin{equation*}
\beta_i =
\frac{\operatorname{Cov}(R_i, R_m)}
     {\operatorname{Var}(R_m)}
\end{equation*}
```

$$\beta_i = \frac{\operatorname{Cov}(R_i, R_m)}{\operatorname{Var}(R_m)}$$

Typesetting Mathematics: Examples with amsmath

- Align a sequence of equations at the equals sign

$$\begin{aligned}(x+1)^3 &= (x+1)(x+1)(x+1)\\ &= (x+1)(x^2+2x+1)\\ &= x^3+3x^2+3x+1\end{aligned}$$

with the `align*` environment.

```
\begin{align*}
(x+1)^3 &= (x+1)(x+1)(x+1) \\
        &= (x+1)(x^2 + 2x + 1) \\
        &= x^3 + 3x^2 + 3x + 1
\end{align*}
```

- An ampersand `&` separates the left column (before the $=$) from the right column (after the $=$).
- A double backslash `\\` starts a new line.

Typesetting Exercise 2

Typeset this in LaTeX:

Let $X_1, X_2, \ldots, X_n$ be a sequence of independent and identically distributed random variables with $\mathrm{E}[X_i] = \mu$ and $\mathrm{Var}[X_i] = \sigma^2 < \infty$, and let

$$S_n = \frac{1}{n} \sum_{i}^{n} X_i$$

denote their mean. Then as n approaches infinity, the random variables $\sqrt{n}(S_n - \mu)$ converge in distribution to a normal $N(0, \sigma^2)$.

Click to open this exercise in **Overleaf**

- Hint: the command for ∞ is `\infty`.
- Once you've tried, click here to see my solution.

The Basics

- Congrats! You've already learned how to ...
  - Typeset text in LaTeX.
  - Use lots of different commands.
  - Handle errors when they arise.
  - Typeset some beautiful mathematics.
  - Use several different environments.
  - Load packages.
- That's amazing!
- Next, we'll see how to use LaTeX to write structured documents with sections, cross references, figures, tables and bibliographies.

Outline

Structured Documents

- So far, we learned about commands and environments for typesetting text and mathematics.
- Now, we'll learn about commands and environments for structuring documents.
- You can try out the new commands in Overleaf:

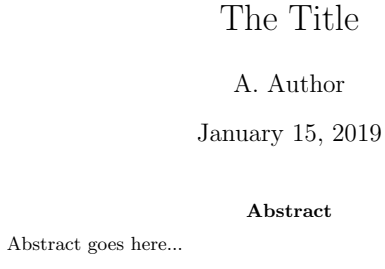
Click here to open the example document in **Overleaf**

- Let's get started!

Title and Abstract

- Tell LaTeX the `\title` and `\author` names in the preamble.
- Then use `\maketitle` in the document to actually create the title.
- Use the `abstract` environment to make an abstract.

```
\documentclass{article}

\title{The Title}

\author{A. Author}

\date{\today}

\begin{document}
\maketitle

\begin{abstract}
Abstract goes here...
\end{abstract}

\end{document}
```



Sections

- Just use `\section` and `\subsection`.
- Can you guess what `\section*` and `\subsection*` do?

```
\documentclass{article}
\begin{document}

\section{Introduction}

The problem of \ldots

\section{Method}

We investigate \ldots

\subsection{Sample Preparation}

\subsection{Data Collection}

\section{Results}

\section{Conclusion}

\end{document}
```

1 Introduction

The problem of . . .

2 Method

We investigate . . .

2.1 Sample Preparation

2.2 Data Collection

3 Results

4 Conclusion

Labels and Cross-References

- Use `\label` and `\ref` for automatic numbering.
- The amsmath package provides `\eqref` for referencing equations.

```
\section{Introduction}
\label{sec:intro}

In Section \ref{sec:method}, we \ldots

\section{Method}
\label{sec:method}

\begin{equation}
\label{eq:euler}
e^{i\pi} + 1 = 0
\end{equation}

By \eqref{eq:euler} on page
\pageref{eq:euler}, we have \ldots
```

1 Introduction

In Section 2, we ...

2 Method

$$e^{i\pi} + 1 = 0 \quad (1)$$

By (1) on page 1, we have ...

References: Caveats

- To be able to calculate references, LaTeX sometimes needs to be run several times.
- Overleaf manages that for you, but if you're using LaTeX locally you should be aware of that.
- There is a script `latexmk` that manages that for you, it's normally included with LaTeX.

Structured Documents Exercise

Typeset this short paper in LaTeX: [2]

Click to open the paper

Make your paper look like this one. Use `\ref` and `\eqref` to avoid explicitly writing section and equation numbers into the text.

Click to open this exercise in **Overleaf**

- Once you've tried, click here to see my solution.

[2] From `http://pdos.csail.mit.edu/scigen/`, a random paper generator.

Outline

Graphics

- Requires the `graphicx` package, which provides the `\includegraphics` command.
- Supported graphics formats include JPEG, PNG and PDF (usually).

```
\includegraphics[
  width=0.5\textwidth]{gerbil}

\includegraphics[
  width=0.3\textwidth,
  angle=270]{gerbil}
```

Interlude: Optional Arguments

- We use square brackets [ ] for optional arguments, instead of braces { }.
- `\includegraphics` accepts optional arguments that allow you to transform the image when it is included. For example, `width=0.3\textwidth` makes the image take up 30% of the width of the surrounding text (`\textwidth`).
- `\documentclass` accepts optional arguments, too. Example:

  ```
  \documentclass[12pt,twocolumn]{article}
  ```

  makes the text bigger (12pt) and puts it into two columns.
- Where do you find out about these? See the slides at the end of this presentation for links to more information.

Floats

- Allow LaTeX to decide where the figure will go (it can "float").
- You can also give the figure a caption, which can be referenced with `\ref`.

```
\documentclass{article}
\usepackage{graphicx}
\begin{document}

Figure \ref{fig:gerbil} shows \ldots

\begin{figure}
\centering
\includegraphics[%
  width=0.5\textwidth]{gerbil}
\caption{\label{fig:gerbil}Aww\ldots.}
\end{figure}

\end{document}
```

Figure 1: Aww....

Figure 1 shows ...

Tables

- Tables in LaTeX take some getting used to.
- Use the `tabular` environment from the `tabularx` package.
- The argument specifies column alignment — **l**eft, **r**ight, **r**ight.

```
\begin{tabular}{lrr}
Item   & Qty & Unit \$ \\
Widget & 1   & 199.99  \\
Gadget & 2   & 399.99  \\
Cable  & 3   & 19.99   \\
\end{tabular}
```

Item	Qty	Unit $
Widget	1	199.99
Gadget	2	399.99
Cable	3	19.99

- It also specifies vertical lines; use `\hline` for horizontal lines.

```
\begin{tabular}{|l|r|r|} \hline
Item   & Qty & Unit \$ \\\hline
Widget & 1   & 199.99  \\
Gadget & 2   & 399.99  \\
Cable  & 3   & 19.99   \\\hline
\end{tabular}
```

Item	Qty	Unit $
Widget	1	199.99
Gadget	2	399.99
Cable	3	19.99

- Use an ampersand [&] to separate columns and a double backslash [\] [\] to start a new row (like in the `align*` environment that we saw in part 1).

Outline

bibTeX 1

- Put your references in a `.bib` file in 'bibtex' database format:

```
@Article{Jacobson1999Towards,
  author = {Van Jacobson},
  title = {Towards the Analysis of Massive Multiplayer Online
           Role-Playing Games},
  journal = {Journal of Ubiquitous Information},
  Month = jun,
  Year = 1999,
  Volume = 6,
  Pages = {75--83}}

@InProceedings{Brooks1997Methodology,
  author = {Fredrick P. Brooks and John Kubiatowicz and
            Christos Papadimitriou},
  title = {A Methodology for the Study of the
           Location-Identity Split},
  booktitle = {Proceedings of OOPSLA},
  Month = jun,
  Year = 1997}
```

- Most reference managers can export to bibtex format.

bibTEX 2

- Each entry in the `.bib` file has a *key* that you can use to reference it in the document. For example, `Jacobson1999Towards` is the key for this article:

```
@Article{Jacobson1999Towards,
  author = {Van Jacobson},
  ...
}
```

- It's a good idea to use a key based on the name, year and title.
- LATEX can automatically format your in-text citations and generate a list of references; it knows most standard styles, and you can design your own.

bibTEX 3

- Use the `natbib` package[3] with `\citet` and `\citep`.
- Reference `\bibliography` at the end, and specify a `\bibliographystyle`.

```
\documentclass{article}
\usepackage{natbib}
\begin{document}

\citet{Brooks1997Methodology}
show that \ldots. Clearly,
all odd numbers are prime
\citep{Jacobson1999Towards}.

\bibliography{bib-example}
% if 'bib-example' is the name of
% your bib file

\bibliographystyle{plainnat}
% try changing to abbrvnat

\end{document}
```

Brooks et al. [1997] show that .... Clearly, all odd numbers are pri
[Jacobson, 1999].

References

Fredrick P. Brooks, John Kubiatowicz, and Christos Papadimitriou. A meth
ology for the study of the location-identity split. In *Proceedings of OOPSI*
June 1997.

Van Jacobson. Towards the analysis of massive multiplayer online role-playi
games. *Journal of Ubiquitous Information*, 6:75–83, June 1999.

[3] There is a new package with more features named `biblatex` but most of the articles templates still use `natbib`.

Exercise: Putting it All Together

Add an image and a bibliography to the paper from the previous exercise.

1. You have the following example files on your computer:
   Image file: gerbil.jpg
   Bib file: bib-exercise.bib
2. Upload them to Overleaf (use the project menu).

Bibliographies: Exercise

1. Here is the text for a short article:[4]

   Click to open this exercise in **Overleaf**

2. Add LaTeX commands to the text to make it look like this one:

   Click to open the model document

Hints

- Use the `enumerate` and `itemize` environments for lists.
- To typeset a % percent sign, *escape* it with a backslash (`\%`).
- To typeset the equation, use `\frac` for the fraction and the `\left(` and `\right)` commands for the parentheses.

[4] Based on http://www.cgd.ucar.edu/cms/agu/scientific_talk.html

Outline

Presentations with beamer

- Beamer is a package for creating presentations (such as this one!) in LaTeX.
- It provides the beamer document class.
- Use the frame environment to create slides.

```
\documentclass{beamer}

\title{Welcome to Beamer}
\author{You}
\institute{Where You're From}
\date{Date of Presentation}

\begin{document}

\begin{frame}
\titlepage % beamer's \maketitle
\end{frame}

\end{document}
```

Presentations with beamer: Following Along

- As we go through the following slides, try out the examples by typing them into the example document on **Overleaf**.

Click to open the example document in **Overleaf**

Presentations with beamer: Frames

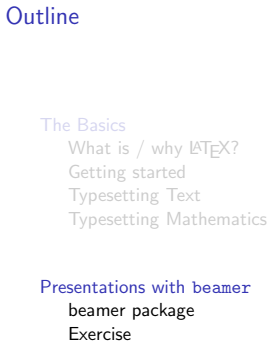
- Use \frametitle to give the frame a title.
- Then add content to the frame.
- The source for this frame looks like:

```
\begin{frame}
  \frametitle{Presentations with beamer: Frames}
  \begin{itemize}
    \item Use \texttt{frametitle} to give the frame a title.
    \item Then add content to the frame.
    \item The source for this frame looks like ...
  \end{itemize}
\end{frame}
```

Presentations with beamer: Sections

- You can use \sections to group your frames, and beamer will use them to create an automatic outline.
- To generate an outline, use the \tableofcontents command. Here's an abridged one for this presentation. The currentsection option highlights the current section.

```
\begin{frame}{Outline}
\tableofcontents[currentsection]
\end{frame}
```



Presentations with beamer: Multiple Columns

- Use the columns and column environments to break the slide into columns.
- The argument for each column determines its width.
- See also the multicol package, which automatically breaks your content into columns.

```
\begin{columns}
  \begin{column}{0.4\textwidth}
    \begin{itemize}
    \item Use the columns ...
    \item The argument ...
    \item See also the ...
    \end{itemize}
  \end{column}
  \begin{column}{0.6\textwidth}
    % second column
  \end{column}
\end{columns}
```

Presentations with beamer: Highlights

- Use \emph or \alert to highlight:

`I should \emph{emphasise} that this is an \alert{important} point.`	I should *emphasise* that this is an important point.

- Or specify bold face or italics:

`Text in \textbf{bold face}. Text in \textit{italics}.`	Text in **bold face**. Text in *italics*.

- Or specify a color (American spelling):

`It \textcolor{red}{stops} and \textcolor{green}{starts}.`	It stops and starts.

- See https://en.wikibooks.org/wiki/LaTeX/Colors for more colors & custom colors.

Presentations with beamer: Figures

- Use \includegraphics from the graphicx package.
- The figure environment centers by default, in beamer.

```
\begin{figure}
\includegraphics[
  width=0.5\textwidth]{gerbil}
\end{figure}
```

Presentations with beamer: Blocks

- A block environment makes a titled box.

```
\begin{block}{Interesting Fact}
This is important.
\end{block}

\begin{alertblock}{Cautionary Tale}
This is really important!
\end{alertblock}
```

Interesting Fact

This is important.

Cautionary Tale

This is really important!

- How exactly they look depends on the theme. . .

Presentations with beamer: Themes

- Customise the look of your presentation using themes.
- See http://deic.uab.es/~iblanes/beamer_gallery/index_by_theme.html for a large collection of themes.

Click to open the file with themes in **Overleaf**

```
\documentclass{beamer}

% or Warsaw, Bergen, Madrid, ...
\usetheme{Darmstadt}

% or albatross, beaver, crane, ...
\usecolortheme{beetle}

\title{Theme Demo}
\author{John}
\begin{document}
\begin{frame}
\titlepage
\end{frame}
\end{document}
```

Presentations with beamer: Animation

- A frame can generate multiple slides.
- Use the \pause command to show only part of a slide.

```
\begin{itemize}
\item Can you feel the
\pause \item anticipation?
\end{itemize}
```

- Can you feel the

Presentations with beamer: Animation

- A frame can generate multiple slides.
- Use the \pause command to show only part of a slide.

```
\begin{itemize}
\item Can you feel the
\pause \item anticipation?
\end{itemize}
```

- Can you feel the
- anticipation?

- There are many more clever ways of making animations in beamer; see also the \only, \alt, and \uncover commands.

More info on beamer:

- LaTeX/Presentations on Wikibooks
- Beamer package manual

Presentations with beamer: Exercise

Recreate Peter Norvig's excellent "Gettysburg Powerpoint Presentation" in beamer.[5]

1. Open this exercise in **Overleaf**:

   Click to open this exercise in **Overleaf**

2. Upload the following image to **Overleaf** via the files menu.

   gettysburg_graph.png

3. Add LaTeX commands to the text to make it look like this one:

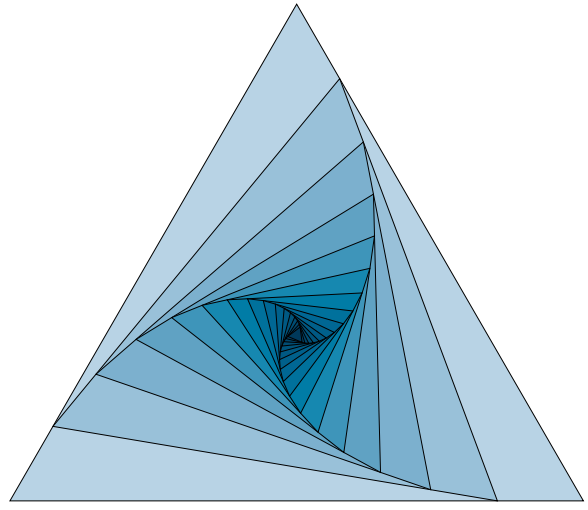
   Click to open the model document

[5] http://norvig.com/Gettysburg

Outline

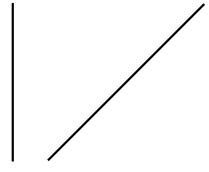
Drawings with Ti*k*Z

- Ti*k*Z is a package for drawing figures in LaTeX.
- It defines a powerful drawing language inside LaTeX. Short programs can draw surprisingly complicated things.



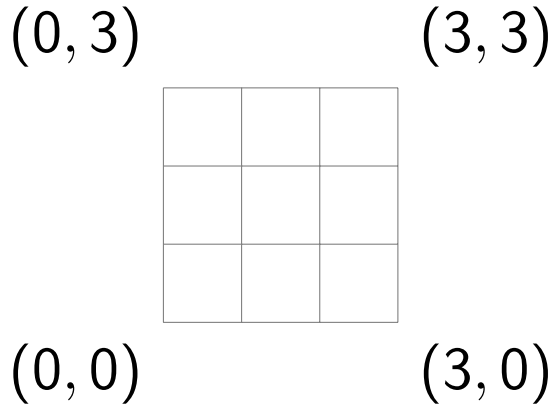
- We'll start with simple things. To draw a line in Ti*k*Z:

```
\begin{tikzpicture}
\draw (0,0) -- (1,1); % a line
\end{tikzpicture}
```



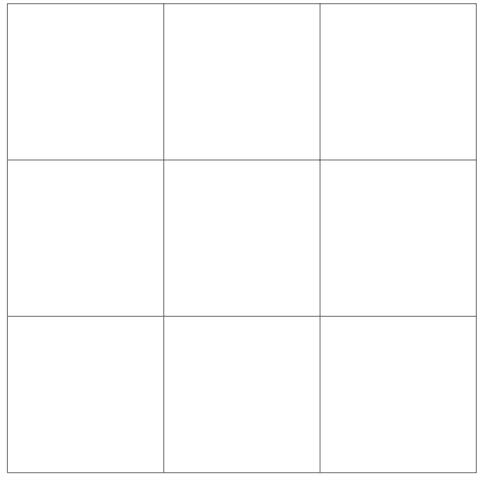
Drawings with Ti*k*Z: Coordinates

- The default coordinates are centimeters, with the usual sense:



- It helps to draw a grid when you are working with Ti*k*Z:

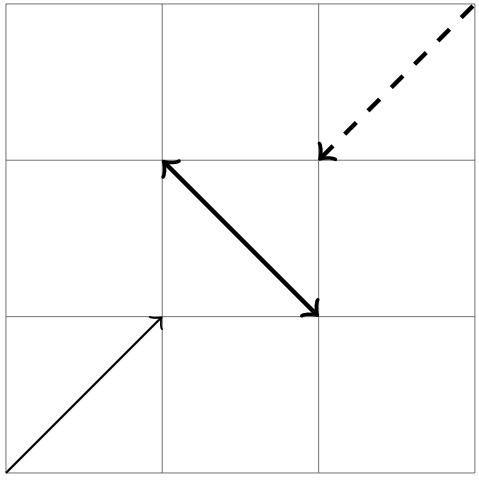
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
\end{tikzpicture}
```



Drawings with TikZ: Lines

- Arrow heads and line styles are specified as options to the `\draw` command.
- End each draw command with a ; semicolon.

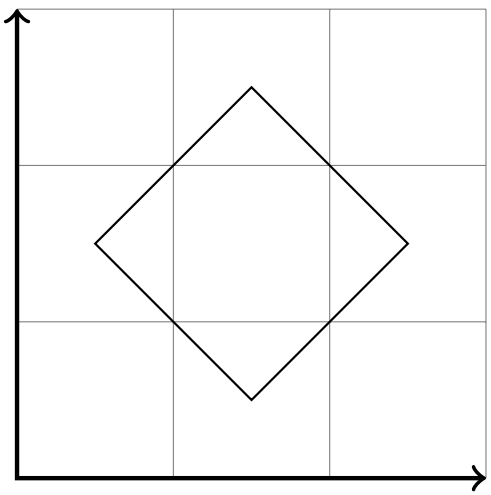
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
\draw[->] (0,0) -- (1,1);
\draw[<->, thick] (2,1) -- (1,2);
\draw[<-, thick, dashed] (2,2)--(3,3);
\end{tikzpicture}
```



Drawings with TikZ: Paths

- You can specify multiple points to form a path.
- Arrows will appear only at the ends of the path.

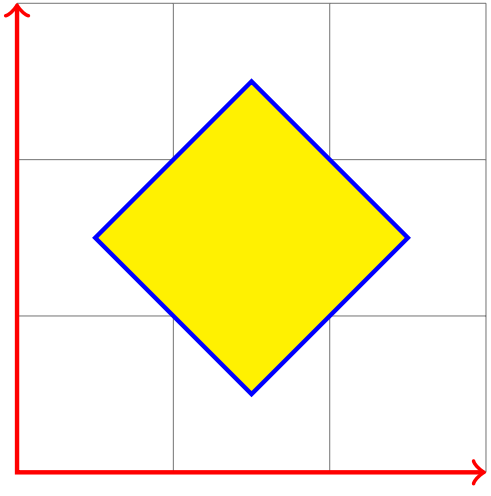
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
% axes:
\draw[<->, thick] (0,3)--(0,0)--(3,0);
% diamond:
\draw (1.5,0.5) -- (2.5,1.5) --
      (1.5,2.5) -- (0.5,1.5) --
      cycle; % close the path
\end{tikzpicture}
```



Drawings with TikZ: Colours

- Colours are also specified as options to `\draw`.

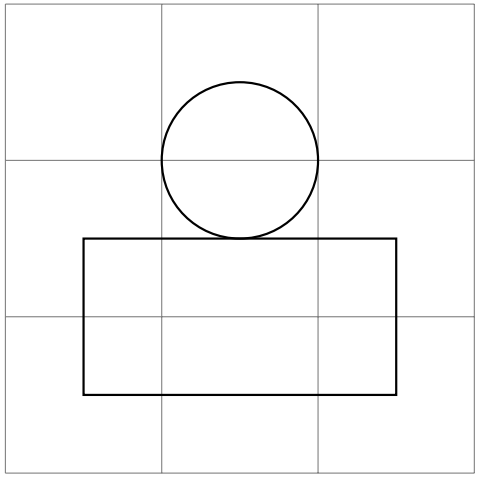
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
% axes
\draw[<->, thick, red]
  (0,3)--(0,0)--(3,0);
% diamond
\draw[thick, blue, fill=yellow]
  (1.5,0.5) -- (2.5,1.5) --
  (1.5,2.5) -- (0.5,1.5) --
  cycle;
\end{tikzpicture}
```



Drawings with TikZ: Shapes

- TikZ has built-in commands for simple shapes.

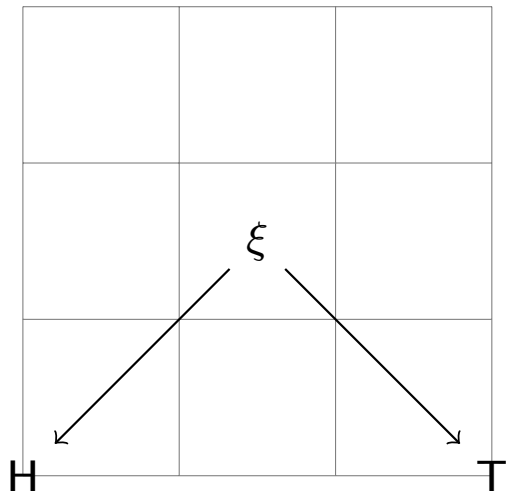
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
\draw (1.5,2.0) circle (0.5);
\draw (0.5,0.5) rectangle (2.5,1.5);
\end{tikzpicture}
```



Drawings with Ti*k*Z: Nodes & Labels

- Use nodes to place text (and math) in Ti*k*Z drawings.
- You can also use nodes as coordinates — useful for diagrams.

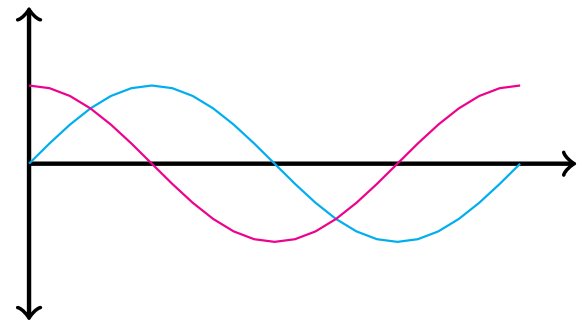
```
\begin{tikzpicture}
\draw[help lines] (0,0) grid (3,3);
\node (h) at (0,0) {H};
\node (x) at (1.5,1.5) {$\xi$};
\node (t) at (3,0) {T};
\draw[->] (x) -- (h);
\draw[->] (x) -- (t);
\end{tikzpicture}
```



Drawings with TikZ: Functions

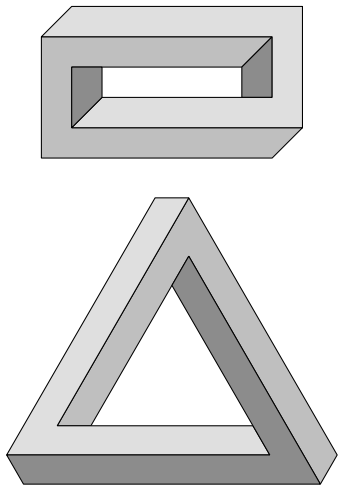
- You can even plot some simple functions.

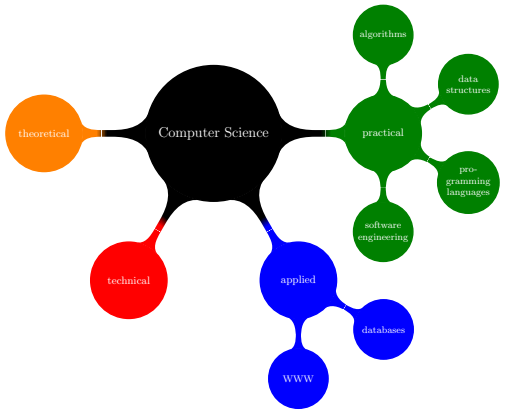
```
\begin{tikzpicture}[scale=0.5]
% y axis
\draw[<->, thick] (0,2) -- (0,-2);
% x axis
\draw[ ->, thick] (0,0) -- (7, 0);
% curves
\draw[cyan,domain=0:2*pi]
  plot (\x, {sin(\x r)});
\draw[magenta,domain=0:2*pi]
  plot (\x, {cos(\x r)});
\end{tikzpicture}
```



Drawings with Ti*k*Z: Examples

- Check out TEXample.net for many Ti*k*Z examples:





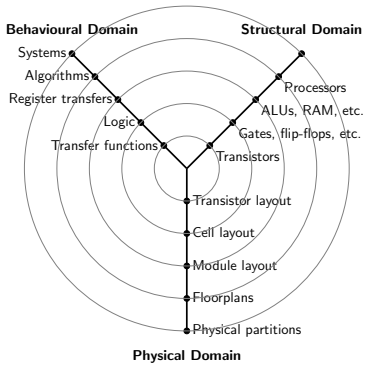
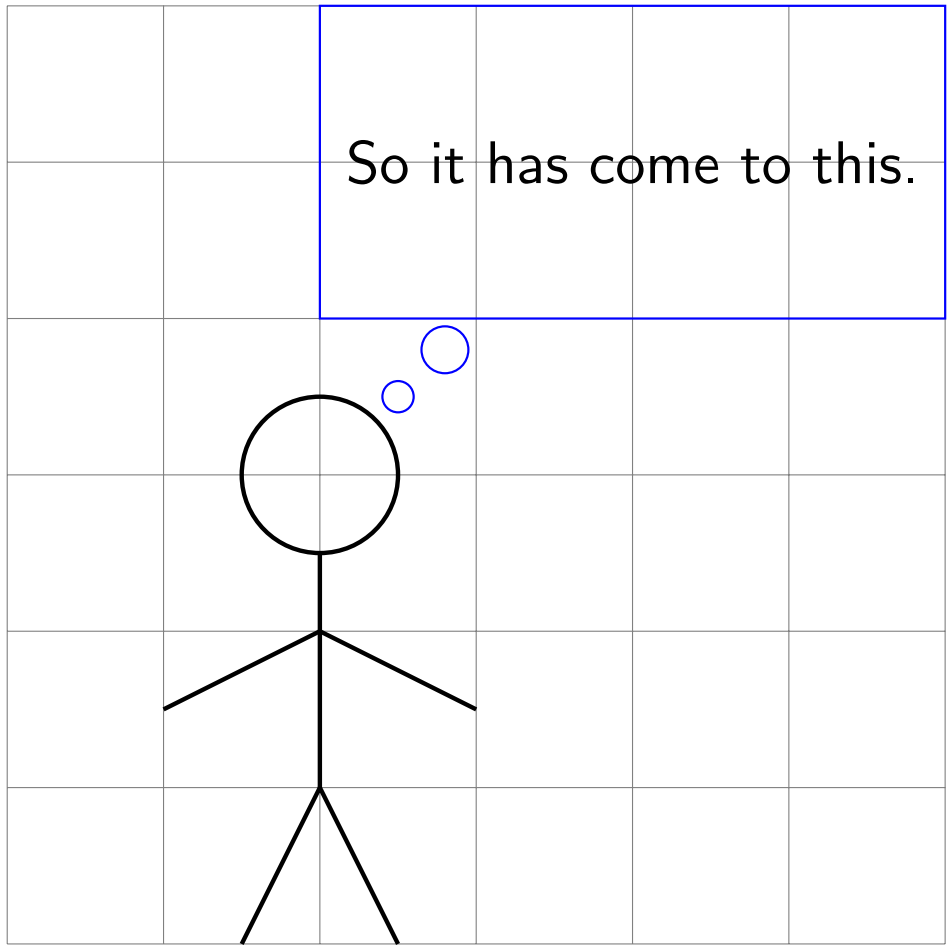


Figure 1: Gajski-Kuhn Y-chart

Drawings with Ti*k*Z: Exercise

Draw this in Ti*k*Z:[6]



[6] Based on https://xkcd.com/1022

Outline

Outline

More Neat Things

- The `\tableofcontents` command also works outside `beamer` to generate a table of contents from the `\section` commands.
- You can define your own commands as shortcuts:

```
\newcommand{\rperf}{%
  \rho_{\text{perf}}}
\begin{equation*}
\rperf = {\bf c}'{\bf X} + \varepsilon
\end{equation*}

\newcommand{\textblue}[1]{%
  \textcolor{blue}{#1}}
This is \textblue{blue} now.
```

$$\rho_{\text{perf}} = \mathbf{c}'\mathbf{X} + \varepsilon$$

This is blue now.

% at the end of a line suppresses a line break where LaTeX is sensitive to whitespace.

More Neat Packages

- `todonotes`: comments and TODO management
- `pgfplots`: create graphs in LaTeX
- `listings`: source code printer for LaTeX
- `chemfig`, `mhchem`: chemical formulae and graphics
- `gchords`, `guitar`: guitar chords and tabulature
- `cwpuzzle`: crossword puzzles
- `exam`: problem sheets' generator (creating pdf with or without the solutions)
- `geometry`: can be helpful to set up the page layout

See https://www.overleaf.com/latex/examples and http://texample.net for examples of (most of) these packages.

Installing LaTeX

- To run LaTeX on your own computer, you'll want to use a LaTeX *distribution*. A distribution includes a `latex` program and (typically) several thousand packages.
  - On Windows: MikTeX or TeXLive
  - On Linux: TeXLive
  - On Mac: MacTeX
- You'll also want a text editor with LaTeX support. See Comparison of TeX editors for a list of (many) options.
- You'll also have to know more about how `latex` and its related tools work — see the resources on the next slide.

Online Resources

- The LaTeX Wikibook — excellent tutorials and reference material.
- TeX Stack Exchange — ask questions and get excellent answers incredibly quickly
- LaTeX Community — a large online forum
- Comprehensive TeX Archive Network (CTAN) — over four thousand packages plus documentation
- Google will usually get you to one of the above.

Thanks, and happy TEXing!