

An Interactive Introduction to \LaTeX

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An Interactive Introduction to \LaTeX

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

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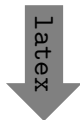
Why L^AT_EX?

- ▶ 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}
```

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

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: <code>'text'</code> .	Single quotes: <code>'text'</code> .
Double quotes: <code>“text”</code> .	Double quotes: <code>“text”</code> .

- ▶ Some common characters have special meanings in \LaTeX :

<code>%</code>	percent sign
<code>#</code>	hash (pound / sharp) sign
<code>&</code>	ampersand
<code>\$</code>	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.

<code>\\$ \% \& \# !</code>	<code>\$ \% \& \# !</code>
---------------------------------	--------------------------------

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 L^AT_EX: 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](#).

¹http://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 $y = mx + b$ be \ldots

Let $y = mx + b$ be \ldots

Let $y = mx + b$ be \ldots

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!
```

$$F_n = F_n - 1 + F_n - 2$$

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

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

- There are commands for Greek letters and common notation.

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

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

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

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

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

$$\Omega = \sum_{k=1}^n \omega_k \quad (3)$$

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}
```

- ▶ Biscuits
- ▶ Tea

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

1. Biscuits
2. Tea

Interlude: Packages

- ▶ All of the commands and environments we've used so far are built into L^AT_EX.
- ▶ *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 L^AT_EX:

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

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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}
```

The Title

A. Author

January 15, 2019

Abstract

Abstract goes here...

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

$$e^{i\pi} + 1 = 0 \tag{1}$$

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](#).

²From <http://pdos.csail.mit.edu/scigen/>, a random paper generator.

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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, **c**enter.

```
\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).

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- 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 Kubiawicz 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.

bibT_EX 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.
- ▶ L^AT_EX can automatically format your in-text citations and generate a list of references; it knows most standard styles, and you can design your own.

bibT_EX 3

- ▶ Use the natbib package³ 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 abbrnat

\end{document}
```

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

References

Fredrick P. Brooks, John Kubiawicz, and Christos Papadimitriou. A methodology for the study of the location-identity split. In *Proceedings of OOPSL* June 1997.

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

³There 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.

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

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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}
```

Welcome to Beamer

You

Where You're From

Date of Presentation

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.

Outline

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

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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 <code>\emph{emphasise}</code> that this is an <code>\alert{important}</code> point.	I should <i>emphasise</i> that this is an important point.
---	--

- ▶ Or specify bold face or italics:

Text in <code>\textbf{bold face}</code> . Text in <code>\textit{italics}</code> .	Text in bold face . Text in <i>italics</i> .
--	--

- ▶ Or specify a color (American spelling):

It <code>\textcolor{red}{stops}</code> and <code>\textcolor{green}{starts}</code> .	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}
```

Interesting Fact

This is important.

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

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

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\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>

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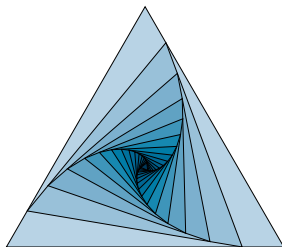
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Drawings with TikZ

- ▶ TikZ is a package for drawing figures in \LaTeX .
- ▶ It defines a powerful drawing language inside \LaTeX . Short programs can draw surprisingly complicated things.



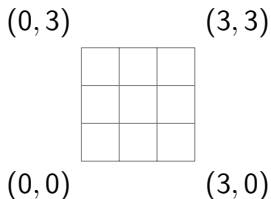
- ▶ We'll start with simple things. To draw a line in TikZ:

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



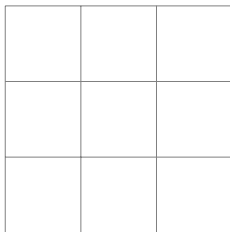
Drawings with TikZ: Coordinates

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



- It helps to draw a grid when you are working with TikZ:

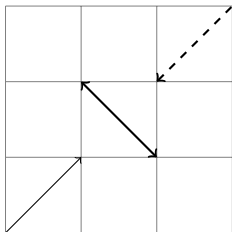
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
\end{tikzpicture}
```



Drawings with TikZ: Lines

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

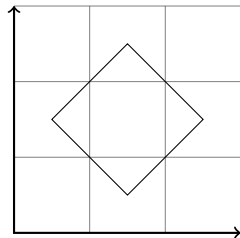
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
  \draw[->] (0,0) -- (1,1);  
  \draw[<->, thick] (2,1) -- (1,2);  
  \draw[<-, thick, dashed] (2,2)--(3,3);  
\end{tikzpicture}
```



Drawings with TikZ: Paths

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

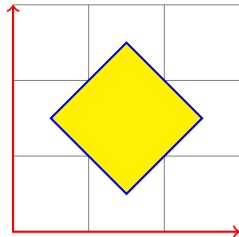
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
  % axes:  
  \draw[<->, thick] (0,3)--(0,0)--(3,0);  
  % diamond:  
  \draw (1.5,0.5) -- (2.5,1.5) --  
        (1.5,2.5) -- (0.5,1.5) --  
        cycle; % close the path  
\end{tikzpicture}
```



Drawings with TikZ: Colours

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

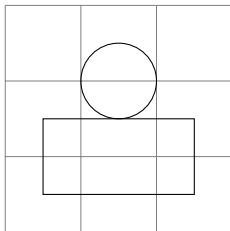
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
  % axes  
  \draw[<-->, thick, red]  
    (0,3)--(0,0)--(3,0);  
  % diamond  
  \draw[thick, blue, fill=yellow]  
    (1.5,0.5) -- (2.5,1.5) --  
    (1.5,2.5) -- (0.5,1.5) --  
    cycle;  
\end{tikzpicture}
```



Drawings with TikZ: Shapes

- TikZ has built-in commands for simple shapes.

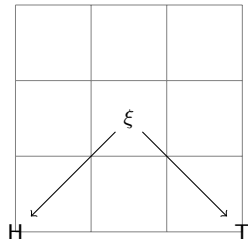
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
  \draw (1.5,2.0) circle (0.5);  
  \draw (0.5,0.5) rectangle (2.5,1.5);  
\end{tikzpicture}
```



Drawings with TikZ: Nodes & Labels

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

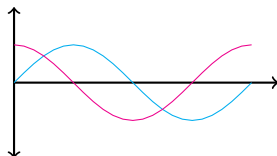
```
\begin{tikzpicture}  
  \draw[help lines] (0,0) grid (3,3);  
  \node (h) at (0,0) {H};  
  \node (x) at (1.5,1.5) {$\xi$};  
  \node (t) at (3,0) {T};  
  \draw[->] (x) -- (h);  
  \draw[->] (x) -- (t);  
\end{tikzpicture}
```



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 TikZ: Examples

- Check out [TeXample.net](https://www.texample.net) for many TikZ examples:

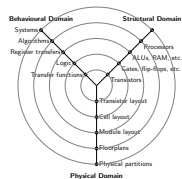
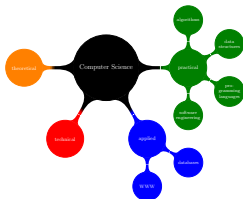
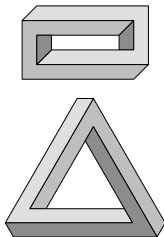
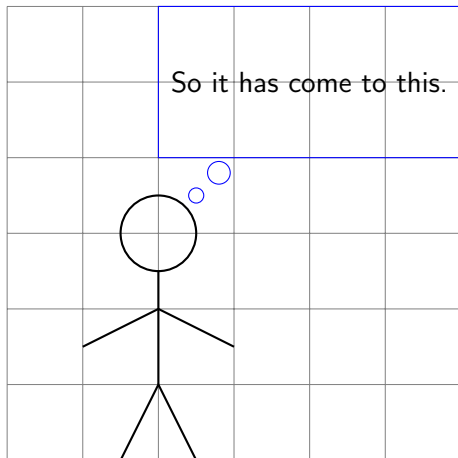


Figure 1: Gajski-Kuhn Y-chart

Drawings with TikZ: Exercise

Draw this in TikZ:⁶



⁶Based on <https://xkcd.com/1022>

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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 L^AT_EX

- ▶ To run L^AT_EX on your own computer, you'll want to use a L^AT_EX *distribution*. A distribution includes a latex program and (typically) several thousand packages.
 - ▶ On Windows: [MikT_EX](#) or [T_EXLive](#)
 - ▶ On Linux: [T_EXLive](#)
 - ▶ On Mac: [MacT_EX](#)
- ▶ You'll also want a text editor with L^AT_EX 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 L^AT_EX Wikibook](#) — excellent tutorials and reference material.
- ▶ [T_EX Stack Exchange](#) — ask questions and get excellent answers incredibly quickly
- ▶ [L^AT_EX Community](#) — a large online forum
- ▶ [Comprehensive T_EX Archive Network \(CTAN\)](#) — over four thousand packages plus documentation
- ▶ Google will usually get you to one of the above.

Thanks, and happy T_EXing!