Traversing LATEX

Hera Brown

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Traversing LATEX The Harried Undergraduate's Guide

Hera Brown

The Oxford University Computer Science and Technology Society

February 22, 2025

What is LATEX?

A (very brief) History of LATEX Why Should I Care?

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 LATEX is a tool used to typeset technical documents.

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- LATEX is a tool used to typeset technical documents
- It's different from other document preparation systems you've probably used before (e.g. Word); instead of the output looking just like the input, in LATEX you type both the text, and macros (like commands or functions) that control how the text looks.

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- LATEX documents look quite different before and after they've been processed!

\section{What is \LaTeX?}

\begin{frame}
\frametitle{What is \LaTeX?}
\begin{columns}
\begin{column}{0.5\textwidth}
\begin{itemize}[]
\item \LaTeX{} is a tool

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Fig. 1. A sample of the code used to typeset this slide

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- LATEX documents look quite different before and after they've been processed!
- It might look a little scary at first, but once you get over the learning curve LATEX becomes a very powerful tool.

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A (very brief) History of LATEX1

• LaTEX's genealogy can be traced back to TEX, a typesetting tool created by Donald Knuth in 1978. TEX is a more basic set of commands and macros than LATEX, and still forms the basis of LATEX — a lot of what we'll learn today is technically TEX, not LATEX!

¹Thanks, Wikipedia, for all this information!

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 To give you an idea of how stable TeX is as a tool, it's been stable since 1990. Only minor updates have been released since then (indeed, its version number is asymptotically approaching π).
- Lack TeX was developed by Leslie Lamport in the early 1980s, as a package of macros on top of TeX. The current standard, LaTeX $2_{\mathcal{E}}$, was released in 1994.

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LATEX has been designed with the intention of separating presentation from content; the intention is that you just need to type up your document semantically, and LATEX will handle the difficult formatting bits. We'll see a lot of ways in which LATEX makes things easier for us in this way in the talk.

¹Thanks, Wikipedia, for all this information!

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Why Should I Care?

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What's in it for you? Well:

• It's the way to write papers and texts to the academic standard.

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- It's the way to write papers and texts to the academic standard.
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 Impress them with your LATEX skills.

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- It's the way to write papers and texts to the academic standard.
- Sometimes you'll get tutors who refuse to mark handwritten notes.
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- If you're doing a third- or fourth-year project, you'll need to write a report. That report will probably need to be written in LATEX.

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- It's the way to write papers and texts to the academic standard.
- Sometimes you'll get tutors who refuse to mark handwritten notes.
 Impress them with your LaTeX skills.
- If you're doing a third- or fourth-year project, you'll need to write a report. That report will probably need to be written in LATEX.
- It's just fun to use LATEX! It's very rewarding to make beautiful documents.

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Some examples of what I've done

Want some examples? Well, here's what I've made so far this year:

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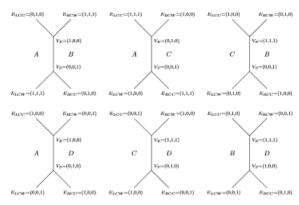
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Want some examples? Well, here's what I've made so far this year:

If using B-rep, then, the winged-edge structure starts off looking like:



The final convex hull has an identical structure, but with every instance of (1, 1, 1) replaced with (3, 3, 3), with new corresponding faces. Said replacements are the intermediate edges added during the algorithm's running.

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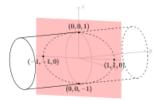
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Want some examples? Well, here's what I've made so far this year:

Q5. (a) We get a cylinder lying on its side, cut diagonally, as below::



Note that the ends of the cylinders are only included above to make the diagram look like a cylinder; the cylinder really should be infinitely long. Why Should I Care?

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Want some examples? Well, here's what I've made so far this year:

1. We may encode the transition relation on the above LTS as such:

Transition	x_1	x_1'	x_2	x_2'
(0,0)	0	0	0	0
(0,1)	0	0	0	1
(0, 2)	0	1	0	0
(0, 3)	0	1	0	1
(1,0)	0	0	1	0
(1, 1)	0	0	1	1
(1, 2)	0	1	1	0
(1, 3)	0	1	1	1
(2, 2)	1	1	0	0
(2, 3)	1	1	0	1
(3, 2)	1	1	1	0
(3, 3)	1	1	1	1

From this and by inspection, we can write out an equivalent Boolean formula which captures the relation as:

$$\neg x_1 \lor x_1'$$

Which seems quite simplified.

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Some examples of what I've done

Want some examples? Well, here's what I've made so far this year:

- (e) Again, we'll follow Sider in LfP 9.7:
 - (1) $\forall \alpha \Box \phi \rightarrow \Box \phi$
 - (2) $\Box(\forall \alpha \Box \phi \rightarrow \Box \phi)$
 - (3) $\Diamond \forall \alpha \Box \phi \rightarrow \Diamond \Box \phi$
 - (4) $\Diamond \Box \phi \rightarrow \phi$
 - $(5) \quad \Diamond \forall \alpha \Box \phi \rightarrow \phi$
 - $(6) \quad \forall \alpha (\Diamond \forall \alpha \Box \phi \to \phi)$
 - $(7) \quad \Diamond \forall \alpha \Box \phi \rightarrow \forall \alpha \phi$
 - $(8) \quad \Box(\Diamond \forall \alpha \Box \phi \to \forall \alpha \phi)$
 - $(9) \quad \Box \Diamond \forall \alpha \Box \phi \rightarrow \Box \forall \alpha \phi$
 - $(10) \forall \alpha \Box \phi \rightarrow \Box \Diamond \forall \alpha \Box \phi$
 - (11) $\forall \alpha \Box \phi \rightarrow \Box \forall \alpha \phi$

and so it follows that $\vdash_{SQML} \Box \forall \alpha \phi \rightarrow \forall \alpha \Box \phi$.

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Some examples of what I've done

Want some examples? Well, here's what I've made so far this year:

All these were put together in a week or so, for problem sheets. Once you get the hang of it, it's pretty easy to make pretty documents pretty fast.

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We'll be making an answer sheet to the MT22 Discrete Maths sheet 1.
 Hopefully you should know all the symbols we're using!

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- We'll be making an answer sheet to the MT22 Discrete Maths sheet 1.
 Hopefully you should know all the symbols we're using!
- If at any point you have any questions, do stop me and ask them!

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 To get started with LaTeX, you'll need something to type in, and something to turn your LaTeX code into a document (usually a pdf).
 There are a ton of ways to do this — it can be a little confusing trying to find the right tools for you!

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- For a proper editor that's free and open source, I'd recommend getting TEXworks (which is what I'm using to edit these slides in!). It's quick and easy to set up, and comes with a bunch of useful features (compiles many distributions of LATEX, manages references, lets you split up your project into many files) and is easily extensible with your own features.

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- If you just want to play around and follow these slides for a bit, though, there are online editors as well — I've heard that Overleaf is good for this.

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\usepackage{amsmath}
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\usepackage{enumitem}

\begin{document}
 Hello, world!
\end{document}

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- To do this, we just add \begin{document} and \end{document}, and type the content of the document in-between.
- And you should now have your first LaTEX document!

\documentclass{article}
\usepackage{amsmath}
\usepackage{amssymb}
\usepackage{enumitem}

\begin{document}
 Hello, world!
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Discrete Maths 1

Hera Brown February 21, 2025

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- This typesets to...
- That doesn't look quite right.
 Some of the symbols have gone missing, or look different to how they should do. The text also hasn't been formatted very well; it's all one big block.
- Let's fix the latter issue first.
 How do we lay things out more nicely?

Discrete Maths 1

Hera Brown February 21, 2025

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Hera Brown February 21, 2025

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\end{enumerate}

\section{Question 2}

Traversing LATEX

Hera Brown

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- We'd also the subparts of the document to be spaced out nicely. For this, we'll use the \begin{enumerate} and \end{enumerate} macros.
- Between these, we add items to the list by using the \item macro, as such:
- And this looks like:

Discrete Maths 1

Lists and More Lists

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Question 1

- Here there are no elements of the set n — n in Z and n2 < 0, and so the following set would be 0.
- Here we want the solutions of the equation n4 - 3n2 + 2n, and the set formed by these would be -2.0.1.
- 3. Here we want all the numbers of the form n2 n where n<5. So the set would be 0, 2, 6, 12.
- Here it turns out that the set contains exactly the prime numbers. So the set would be 2.3.5.7....

Question 2

- This set has at least min(—A—,—B—) elements, and at most —A—+—B— elements.
- 2. This set has at least 0 elements, and at most min(—A—,—B—) elements.

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Discrete Maths 1

Hera Brown February 21, 2025

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- Updating the code, we get:

Discrete Maths 1

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Question 1

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Discrete Maths 1

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Question 1

- (i) Here there are no elements of the set n — n in Z and n2 < 0, and so the following set would be 0.
- (ii) Here we want the solutions of the equation n4 - 3n2 + 2n, and the set formed by these would be -2.0.1.
- (iii) Here we want all the numbers of the form n2 - n where n < 5. So the set would be 0, 2, 6, 12.
- (iv) Here it turns out that the set contains exactly the prime numbers. So the set would be 2.3.5.7.....

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- (ii) This set has at least 0 elements, and at most min(—A—,—B—) elements.

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 We've now got the high-level structure of the document down. But each individual paragraph doesn't look so good. The notation's off entirely! What do we do about it?

Question 1

(i) Here there are no elements of the set n — n in Z and n2 < 0, and so the following set would be 0.

² "Math" if you're American.

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Question 1

(i) Here there are no elements of the set n - n in Z and n2 < 0, and so the following set would be 0.

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 The answer lies in maths mode Maths mode is where the hard word of typesetting mathematical symbols happens in LATEX.

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Typesetting Maths

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- The answer lies in maths mode Maths mode is where the hard word of typesetting mathematical symbols happens in LATEX.
- Typically, maths mode is entered with a \$ symbol, and escaped with another \$ symbol.

Question 1

(i) Here there are no elements of the set n - n in Z and n2 < 0, and so the following set would be 0.

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- The answer lies in maths mode. Maths mode is where the hard word of typesetting mathematical symbols happens in LaTeX.
- Typically, maths mode is entered with a \$ symbol, and escaped with another \$ symbol.
 So, for instance, \$\pi + \sqrt{e^3}\$ would be typeset as π + √e³.

Question 1

(i) Here there are no elements of the set n — n in Z and n2 < 0, and so the following set would be 0.

² "Math" if you're American.

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 With this in mind, let's try and typeset our document a bit more nicely.

\section{Question 1}
\begin{enumerate}
\item Here there are no
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- With this in mind, let's try and typeset our document a bit more nicely.
- First, let's add the dollar signs:

\section{Question 1}
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First, let's add the dollar signs:

\section{Question 1} \begin{enumerate}

\item Here there are no elements of the set \$\{n | n in Z and n2 < 0\}\\$, and so the following set would be \$0\\$.

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- With this in mind, let's try and typeset our document a bit more nicely.
- First, let's add the dollar signs:
- Then macros to type the mathematical symbols:

\section{Question 1} \begin{enumerate} \item Here there are no elements of the set

 $f(n \mid n \text{ in } Z \text{ and } n2 < 0)$ and so the following set would be \$0\$.

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- Let's see what that looks like...

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 and so the following set
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Question 1

1. Here there are no elements of the set $\{n|n\in\mathbb{Z}\wedge n^2<0\}$, and so the following set would be \emptyset .

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- And finally, we need to make the curly brackets into macros, so that LATEX can read them properly:
- Let's see what that looks like
- Brilliant! Let's get the rest of the document done...

Question 1

1. Here there are no elements of the set $\{n|n\in\mathbb{Z}\wedge n^2<0\}$, and so the following set would be 0.

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The Maths Environment

Discrete Maths 1

Hera Brown February 21, 2025

Question 1

- (i) Here there are no elements of the set {n|n ∈ Z ∧ n² < 0}, and so the following set would be ∅.
- (ii) Here we want the solutions of the equation $n^4 3n^2 + 2n$, and the set formed by these would be $\{-2, 0, 1\}$.
- (iii) Here we want all the numbers of the form $n^2 n$ where n < 5. So the set would be $\{0, 2, 6, 12\}$.
- (iv) Here it turns out that the set contains exactly the prime numbers. So the set would be {2,3,5,7,...}.

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 Most of the LATEX macros used to typeset mathematics are pretty obvious. Probably the most obvious are the Greek letters, where you just type a backslash followed by the name of a letter.

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 If you want the lowercase letter, write the name in lowercase.
 Otherwise, make the first letter of the macro a capital.
- For instance, α , β typesets to α , \$\beta\$ typesets to β , and \$\gamma\$ typesets to γ .

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 - The logical symbols ¬, ∧, ∨, →, ∀ and ∃ are typeset by \neg, \wedge, \vee, \rightarrow, \forall and \exists respectively.

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 Some of the most obvious ones are typeset as follows:
 - The logical symbols ¬, ∧, ∨, →, ∀ and ∃ are typeset by \neg, \wedge, \respectively.
 - The set-theoretic symbols $\{,\},\cup,\cap,\subseteq,\in,\mathcal{P},\mathbb{N},\mathbb{Z}$ and \mathbb{Q} can be typeset by $\{, \}, \, \text{cup}, \, \text{subseteq}, \, \text{in}, \, \text{mathcal}\{P\}, \, \text{mathbb}\{N\}, \, \text{mathbb}\{Z\} \, \text{and} \, \text{mathbb}\{Q\} \, \text{respectively.}$

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 - Superscripts such as x² and e^π, and subscripts such as p₀ and τ_i, can be typeset using ^ and _ respectively: so we could write x^2, e^\pi, p_0 and \tau_i.

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 - Equalities and inequalities such as \leq , \geq , \neq , \sim , \approx , \prec and \preceq are typeset by leq, leq, leq, leq, leq, leq, leq.

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 - The set-theoretic symbols {, }, ∪, ∩, ⊆, ∈, P, N, Z and Q can be typeset by \{, \}, \cup, \cap, \subseteq, \in, \mathcal{P}, \mathbb{N}, \mathbb{Z} and \mathbb{Q} respectively.
 - Superscripts such as x^2 and e^{π} , and subscripts such as p_0 and τ_i , can be typeset using $\hat{}$ and $\underline{}$ respectively: so we could write x^2 , e^{π_0} and tau_i .
 - Equalities and inequalities such as \leq , \geq , \neq , \sim , \approx , \prec and \preceq are typeset by \leq, \geq, \neq, \sim, \approx, \prec and \preceq respectively.
- If you ever see a symbol out in the wild, and can't recognise it, do visit
 https://detexify.kirelabs.org. It lets you draw in the symbol by
 hand, and gives you a list of what macros might typeset that symbol
 it's very comprehensive!

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 All these macros are great. But what if we need more? What if we want to define our own?

Defining Your Own Macros

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- It turns out you can! Let's suppose that you want to typeset $[g]_{f^u_\mu}^{lpha}$ over and over in a document. To typeset that, every time, you'd need to type $[g]^\alpha_{f^u_\mathbb{S}}.$

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 </sub>
- But LATEX comes to the rescue. You can define a new macro yourself by typing \newcommand{\name}{...}.

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- It turns out you can! Let's suppose that you want to typeset [g]^α<sub>f^u_β over and over in a document. To typeset that, every time, you'd need to type \$[g]^\alpha_{f^u_\beta}\$. That's an awful lot of effort.
 </sub>
- But LATEX comes to the rescue. You can define a new macro yourself by typing \newcommand{\name}{...}.
 So, in this case, we'd write:

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All these macros are great. But what if we need more? What if we want to define our own?

- It turns out you can! Let's suppose that you want to typeset [g]^α_{fβ} over and over in a document. To typeset that, every time, you'd need to type \$[g]^\alpha_{f}^u_\beta}\$. That's an awful lot of effort.
- But LATEX comes to the rescue. You can define a new macro yourself by typing \newcommand{\name}{...}.
 So, in this case, we'd write:

and then wherever we wanted to typeset $[g]_{f_{\beta}}^{\alpha}$, we'd just type g instead. Neat!

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• You can even parametrise your macros. Suppose that you've constructed some complex formula that looks like $[A|\longleftrightarrow|\emptyset]$. The code to typeset that is $[A]\setminus \{A\} \in \mathbb{R}^n$. It's a bit of a pain to typeset.

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 Instead of defining a family of macros, each with a different variable in place of A, you can parametrise your macro as follows:

and then all you need to do is type, say, $\ensuremath{\mbox{Neq}{\sigma}}\$, which then typesets as $[\Sigma|\longleftrightarrow|\emptyset]$.

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 Instead of defining a family of macros, each with a different variable in place of A, you can parametrise your macro as follows:

- and then all you need to do is type, say, $\ensuremath{\mbox{Neeq}\space}$, which then typesets as $[\Sigma]\longleftrightarrow |\emptyset]$.
- This generalises; if you replace the "1" in the above with "2" or "3", for instance, you can then define a macro with two or three parameters!

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• There's even more you can do with the maths mode.

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• There's even more you can do with the maths mode.

 Sometimes you have some big long formula that's too long to write inline, with the rest of the text. Say that you want to talk about a Taylor series:

$$f(a) + \frac{f'(a)}{1!}(x-a) + \frac{f''(a)}{2!}(x-a)^2 + \frac{f'''(a)}{3!}(x-a)^3 + \dots$$
 (1)

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 It's not really feasible to fit that in one line. Thankfully, you can use the equation environment to typeset large equations on their own lines.

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 \end{align}

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- And then add the maths we want. We use the & character to tell LATEX what character we're aligning about, and \\ to start a new line.

\begin{align}
 x &= \pi^2 - 3 \\
 y &= 6x
\end{align}

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$$x = \pi^2 - 3 \tag{1}$$

$$y = 6x \tag{2}$$

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- Again, to get rid of the reference numbers, just write align* instead:

$$x = \pi^2 - 3 \tag{1}$$

$$y = 6x \tag{2}$$

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 In the computer science degree, you'll want to be writing down code a lot of the time in your problem sheets. It's definitely possible (you've been seeing it in this presentation!), but from what we've seen so far, LATEX doesn't get the indentation right, and has trouble with the symbols.

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 The answer is the tabbing environment. The tabbing environment lets you control the indentation of your code when it's being typeset. First we'd set up the environment: ant in IATEY

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- And now we set the tab-stops.
 Tab-stops tell LATEX how large you want your indentations to be. Here we'll set them to be one em, which is about the width of "M" on the page.

\begin{tabbing}
\end{tabbing}

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 Tab-stops tell LATEX how large you want your indentations to be. Here we'll set them to be one em, which is about the width of "M" on the page.

\begin{tabbing}
 \hspace{1em}\=\hspace{1em}\=\kill
\end{tabbing}

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 Now we'll want to add some code. Here you can just type in whatever you want typeset, so long as it's valid LaTeX. \begin{tabbing}
\hspace{1em}\=\hspace{1em}\=\kill

\end{tabbing}

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 For indentation, you'll want to add \> to the start of each line

for multiple indents.
You'll also want to add \\ to end
your lines, as with the align
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you want an indent; add multiple

\end{tabbing}

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 For indentation, you'll want to add \> to the start of each line you want an indent; add multiple

You'll also want to add \\ to end your lines, as with the align environment.

for multiple indents.

```
\begin{tabbing}
  \hspace{1em}\=\hspace{1em}\=\kill
  int x = 1; \\
  while(x $<$ len)\{\\
   \> xs = x:xs\\
  \}
  \end{tabbing}
```

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You'll also want to add \\ to end your lines, as with the align environment

This ends up looking like:

```
\begin{tabbing}
  \hspace{1em}\=\hspace{1em}\=\kill
  int x = 1; \\
  while(x $<$ len)\{\\
    \> xs = x:xs\\
  \}
  \end{tabbing}
```

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This ends up looking like:

environment

```
\begin{aligned} & \text{int } \mathbf{x} = \mathbf{1}; \\ & \text{while } (\mathbf{x} < \text{len}) \; \{ \\ & \text{xs} = \mathbf{x} \text{:xs} \\ & \} \end{aligned}
```

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This ends up looking like:

environment

 If you want the typewriter look, add \tt at the start of each line (but after any \>'s); this gets

```
\begin{aligned} & \text{int } \mathsf{x} = 1; \\ & \text{while } \left( \mathsf{x} < \mathsf{len} \right) \left\{ \\ & \mathsf{xs} = \mathsf{x} : \mathsf{xs} \\ \right\} \end{aligned}
```

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 You'll also want to add \\ to end your lines, as with the align environment

- This ends up looking like:
- If you want the typewriter look, add \tt at the start of each line (but after any \>'s); this gets

```
int x = 1;
while (x < len) {
   xs = x:xs
}</pre>
```

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Which is just how the code examples in these slides were made.

```
int x = 1;
while (x < len) {
   xs = x:xs
}</pre>
```

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Goodbye!

What have we covered today? Well, we've looked at:

How to set up a document that'll typeset successfully,

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Thanks for listening!

Any questions?