LaTeX Workshop

Joshua Pribe

13 February, 2020

For these slides and some practice material, go to https://github.com/jpribe/latex-course

Make an Overleaf account with your Purdue email at www.overleaf.com/edu/purdue to do the exercises

NSAC
NANOTECHNOLOGY STUDENT ADVISORY COUNCIL
PURDUE UNIVERSITY

ELECTRICAL & COMPUTER ENGINEERING * GRADUATE STUDENT ASSOCIATION *

Outline

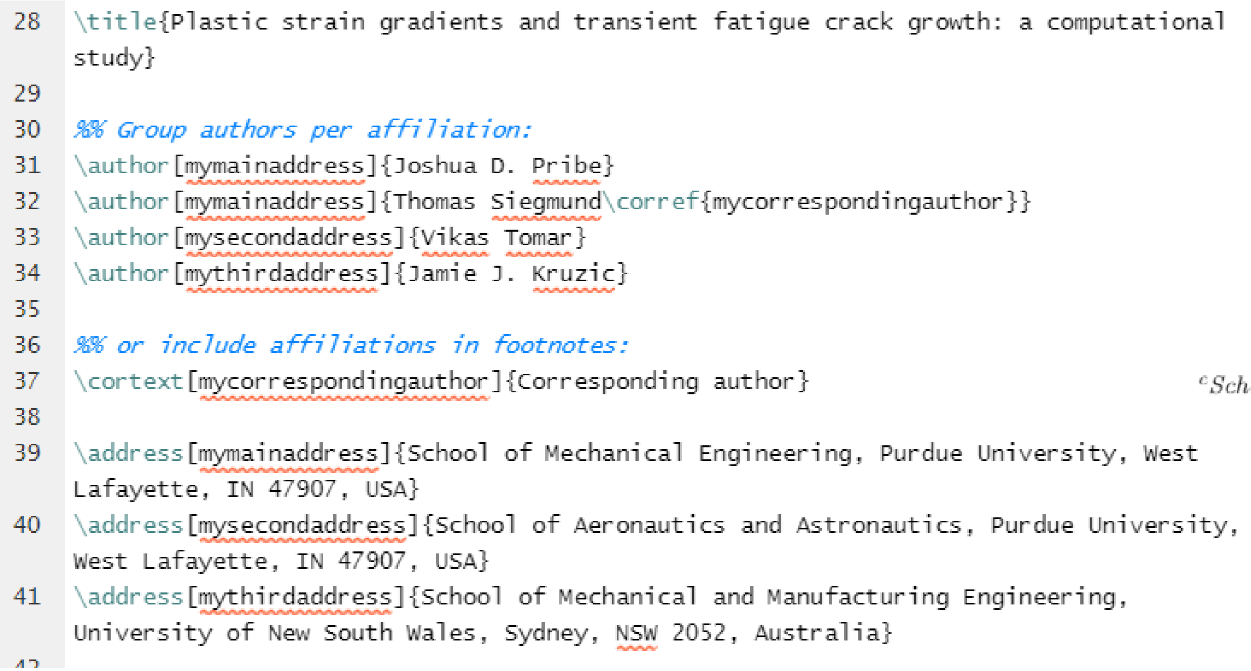
- What is LaTeX?
  - LaTeX vs. Word (and other “WYSIWYG” word processors)
  - Situations where LaTeX is more/less efficient

- Basics of LaTeX coding
  - Outline of a document

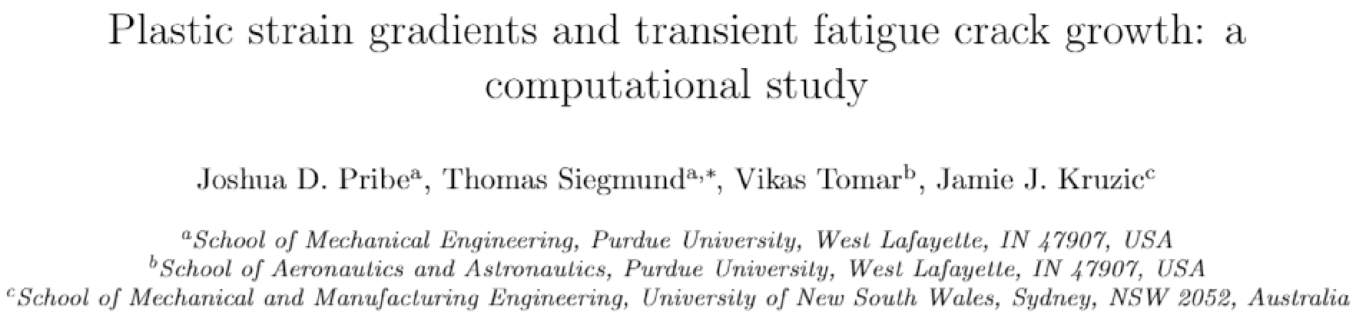
- LaTeX for academic papers
  - Equations
  - Figures
  - Bibliography/citations

LaTeX background

- Essentially a programming language
- You write code, and a compiler turns it into a pretty-looking document



```latex
\title{Plastic strain gradients and transient fatigue crack growth: a computational study}

%% Group authors per affiliation:
\author[mymainaddress]{Joshua D. Pribe}
\author[mymainaddress]{Thomas Siegmund\corref{mycorrespondingauthor}}
\author[mysecondaddress]{Vikas Tomar}
\author[mythirdaddress]{Jamie J. Kruzic}

%% or include affiliations in footnotes:
\cortext[mycorrespondingauthor]{Corresponding author}

\address[mymainaddress]{School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907, USA}
\address[mysecondaddress]{School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907, USA}
\address[mythirdaddress]{School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, NSW 2052, Australia}
```



Plastic strain gradients and transient fatigue crack growth: a computational study

Joshua D. Pribe[a], Thomas Siegmund[a,*], Vikas Tomar[b], Jamie J. Kruzic[c]

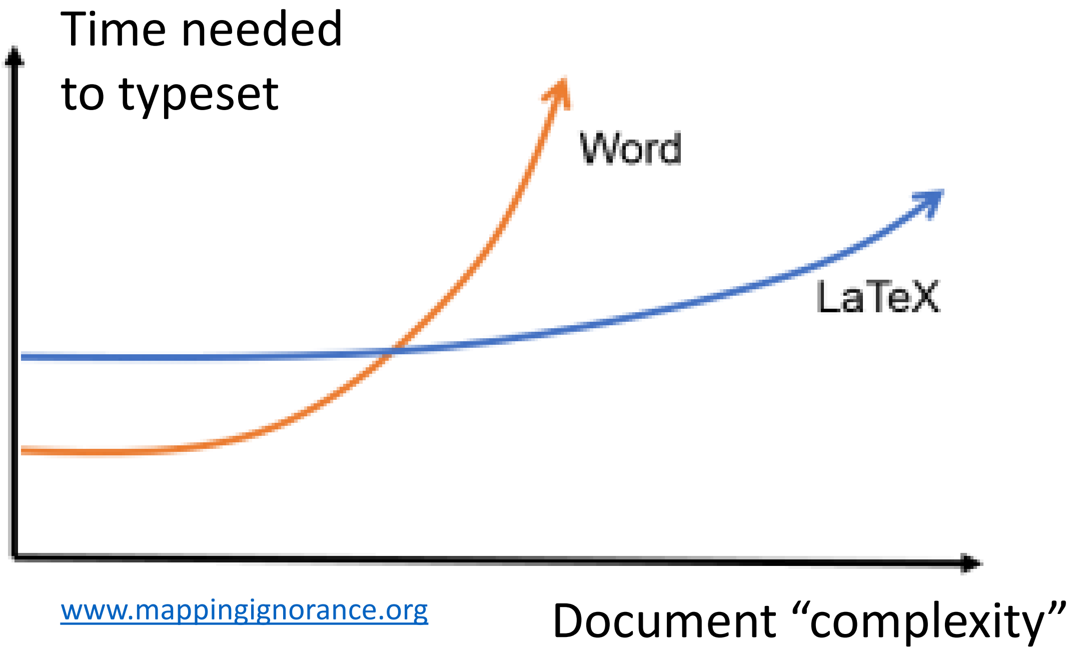
[a]*School of Mechanical Engineering, Purdue University, West Lafayette, IN 47907, USA*
[b]*School of Aeronautics and Astronautics, Purdue University, West Lafayette, IN 47907, USA*
[c]*School of Mechanical and Manufacturing Engineering, University of New South Wales, Sydney, NSW 2052, Australia*

LaTeX advantages

- Focus on content instead of appearance
  - Style files take care of appearance when you compile your code
- Write complex equations and reference them in the text
- Easily insert and reference figures
- Copy and paste code snippets
  - Once you learn something once, you never have to do it again!

LaTeX vs. Word

- LaTeX is more efficient as you add more “stuff” to a document
  - Equations
  - Figures
  - References/special characters in the text
- Word processors work better for large blocks of text

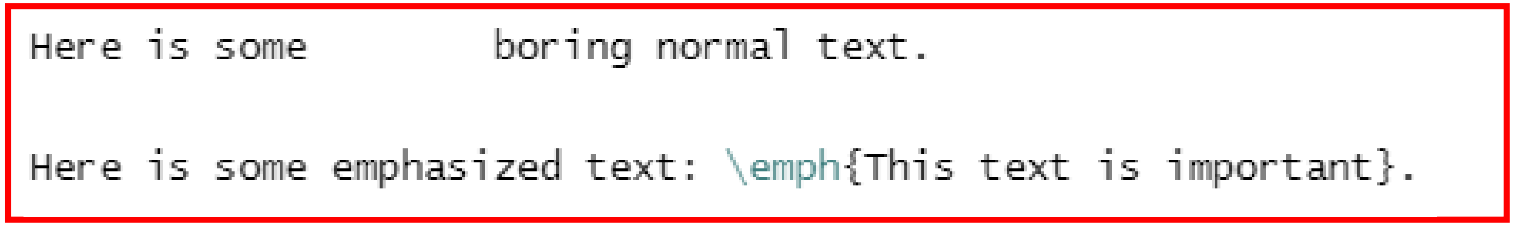


www.mappingignorance.org

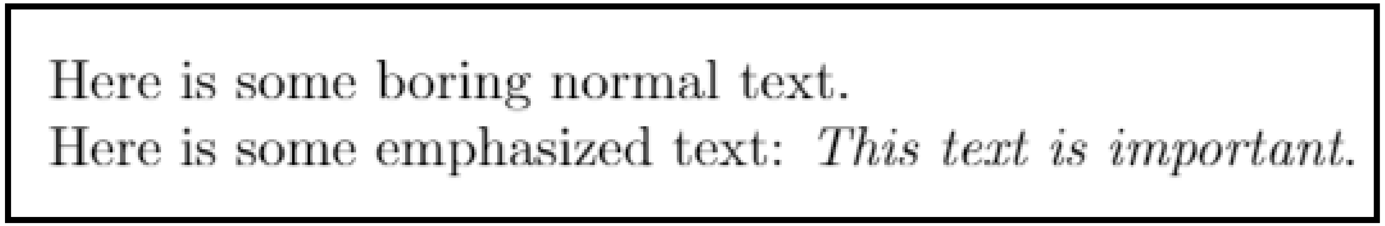
- Steep, but relatively short learning curve
- Google is your friend!

LaTeX Basics

- Write in plain text
- Commands and environments specify the structure
  - Commands start with a backslash \ and typically include an argument in braces { }



```
Here is some        boring normal text.

Here is some emphasized text: \emph{This text is important}.
```

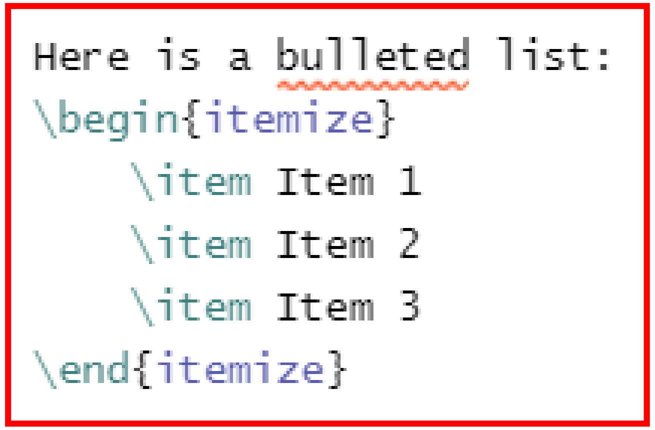


Here is some boring normal text.
Here is some emphasized text: *This text is important.*

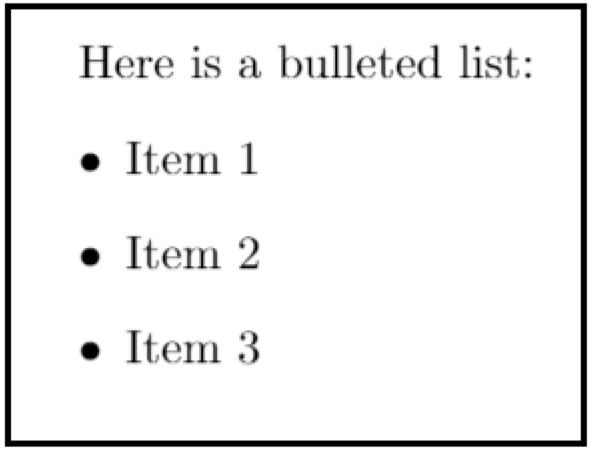
- Words are separated by one or more spaces
- Paragraphs are separated by one or more blank lines
- LaTeX automatically handles spacing, indentation, etc. based on a style file

LaTeX Basics

- Write in plain text
- Commands and environments specify the structure
  - Commands start with a backslash \ and typically include an argument in braces { }
  - Environments tell the interpreter how to interpret a block of code



```
Here is a bulleted list:
\begin{itemize}
    \item Item 1
    \item Item 2
    \item Item 3
\end{itemize}
```



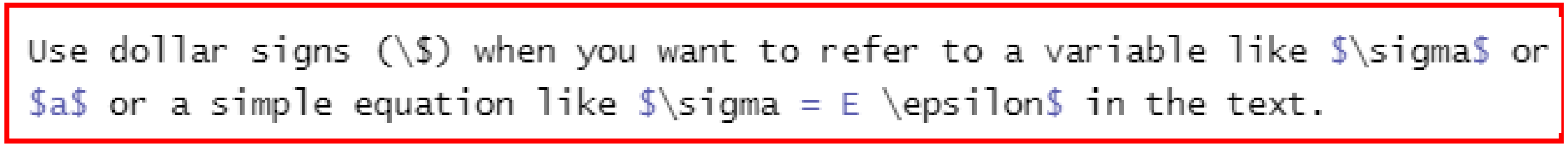
Here is a bulleted list:

- Item 1
- Item 2
- Item 3

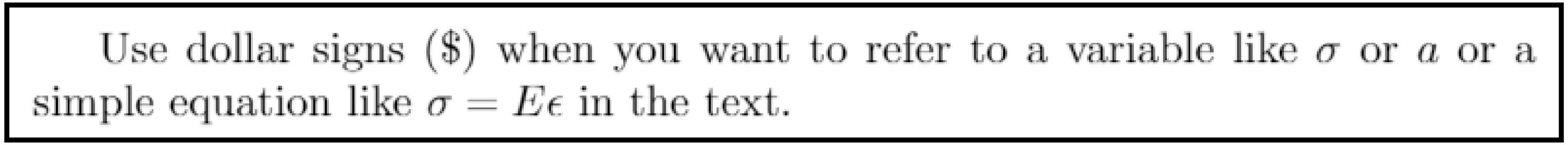
- The `\begin{}` and `\end{}` commands mark the start and end of an environment
- The `itemize` environment makes a bulleted list
- The `enumerate` environment makes a numbered list

LaTeX Basics

You can also include math in line (this is where LaTeX really shines!)



```
Use dollar signs (\$) when you want to refer to a variable like $\sigma$ or
$a$ or a simple equation like $\sigma = E \epsilon$ in the text.
```



Use dollar signs ($) when you want to refer to a variable like σ or a or a simple equation like $\sigma = E\epsilon$ in the text.

- Text in between the `$` signs is interpreted in “math mode”
- Need to “escape” the $ by writing `\$` in the code
  - Do this for $&%# signs
- More on equations later…

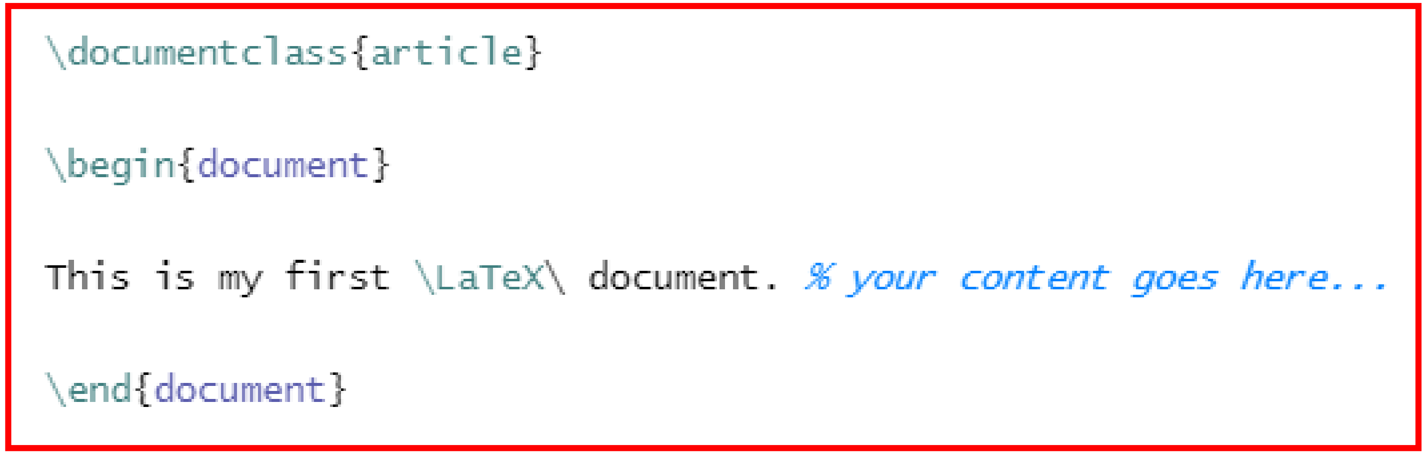
Document structure

- Always start with the `\documentclass` command
  - Many journals and publishers have their own `documentclass` (e.g. `elsarticle` for Elsevier journals)

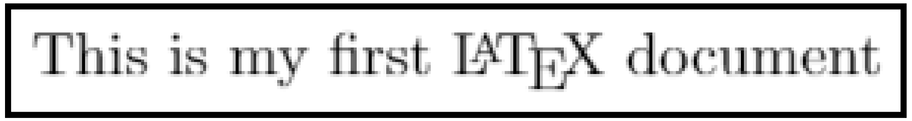
- `%` sign indicates a comment

- All document text goes between `\begin{document}` and `\end{document}`

- Let’s add some organization to our document…



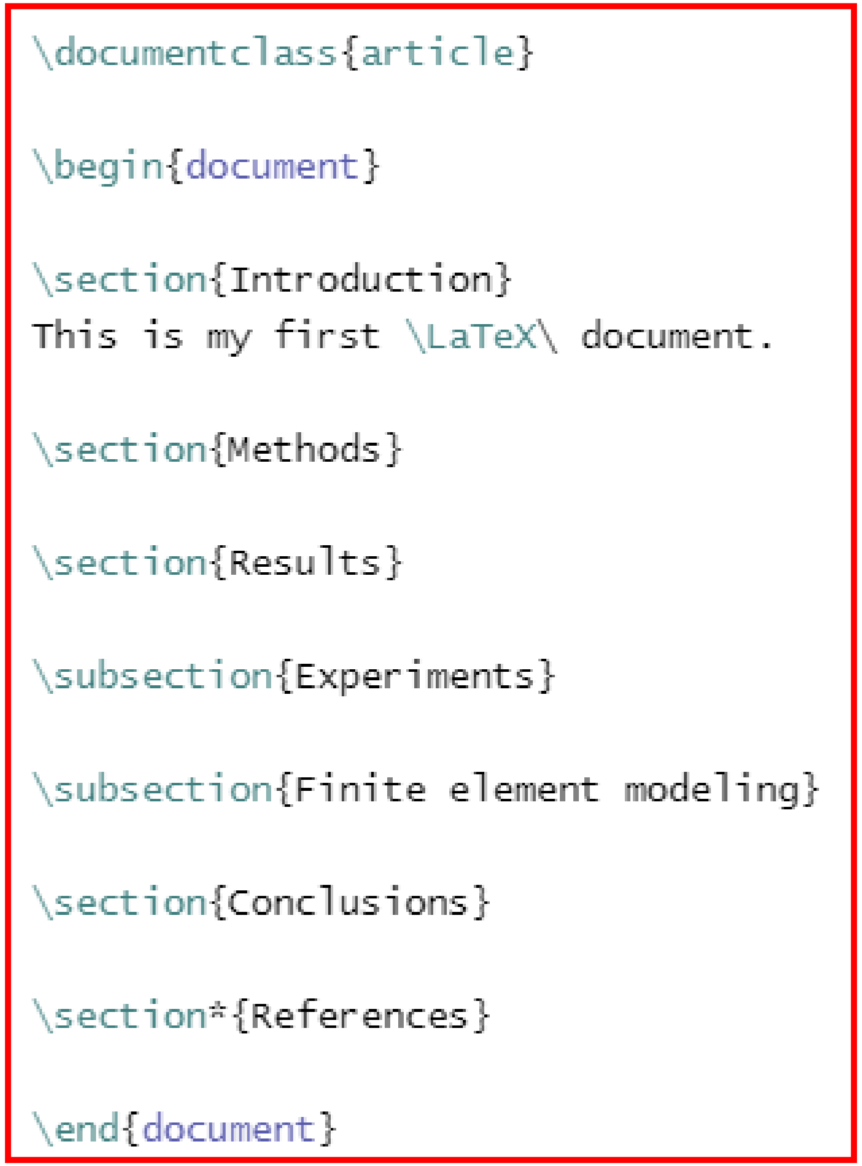
```latex
\documentclass{article}

\begin{document}

This is my first \LaTeX\ document. % your content goes here...

\end{document}
```



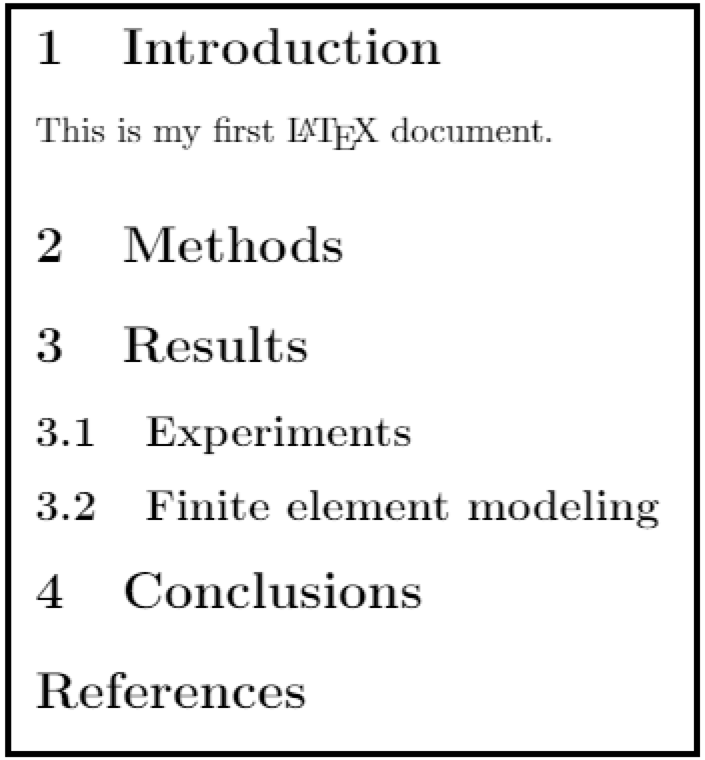
This is my first LaTeX document

Document structure

- `\section{}` and `\subsection{}` create numbered sections and subsections
- Adding a `*` removes the number (e.g. `\section*{}`)



```
\documentclass{article}

\begin{document}

\section{Introduction}
This is my first \LaTeX\ document.

\section{Methods}

\section{Results}

\subsection{Experiments}

\subsection{Finite element modeling}

\section{Conclusions}

\section*{References}

\end{document}
```



1 Introduction

This is my first LaTeX document.

2 Methods

3 Results

3.1 Experiments

3.2 Finite element modeling

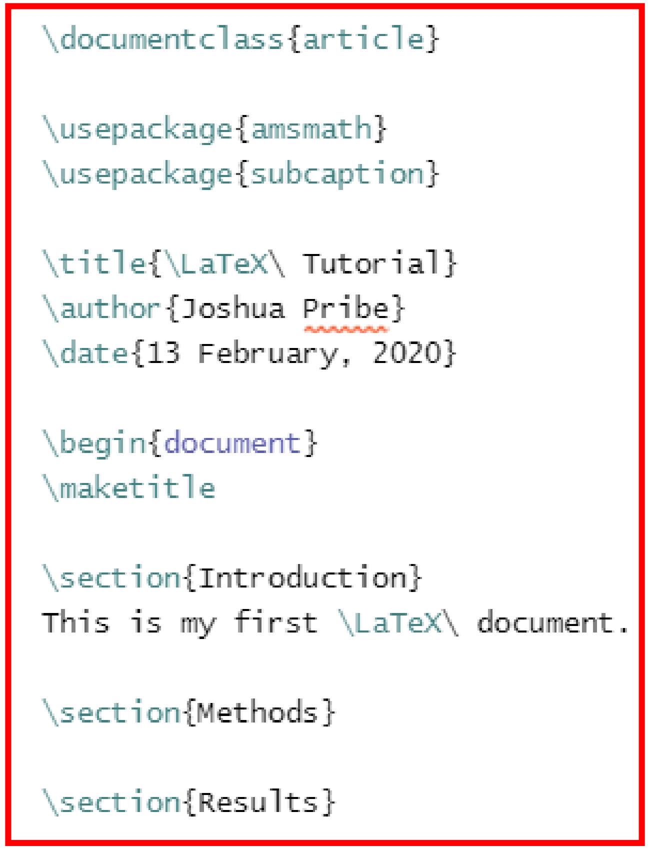
4 Conclusions

References

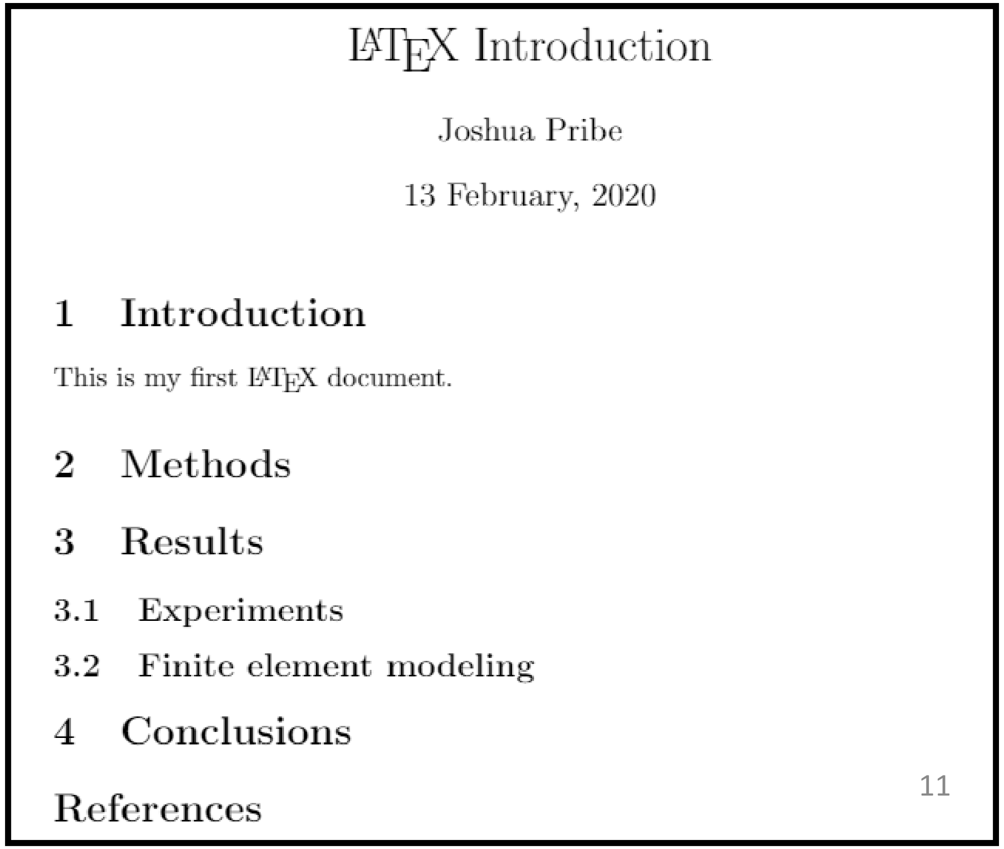
Document structure

- The “preamble”: space between `\documentclass` and `\begin{document}`
- In the preamble you can:
  - Include packages: get access to more commands and environments
  - Define metadata (authors, title, date, …)

- `amsmath` is useful for equations
- graphicx needed for making figures
- `subcaption` lets you make multi-part figures



```
\documentclass{article}

\usepackage{amsmath}
\usepackage{subcaption}

\title{\LaTeX\ Tutorial}
\author{Joshua Pribe}
\date{13 February, 2020}

\begin{document}
\maketitle

\section{Introduction}
This is my first \LaTeX\ document.

\section{Methods}

\section{Results}
```



LaTeX Introduction

Joshua Pribe

13 February, 2020

1 Introduction

This is my first LaTeX document.

2 Methods

3 Results

3.1 Experiments

3.2 Finite element modeling

4 Conclusions

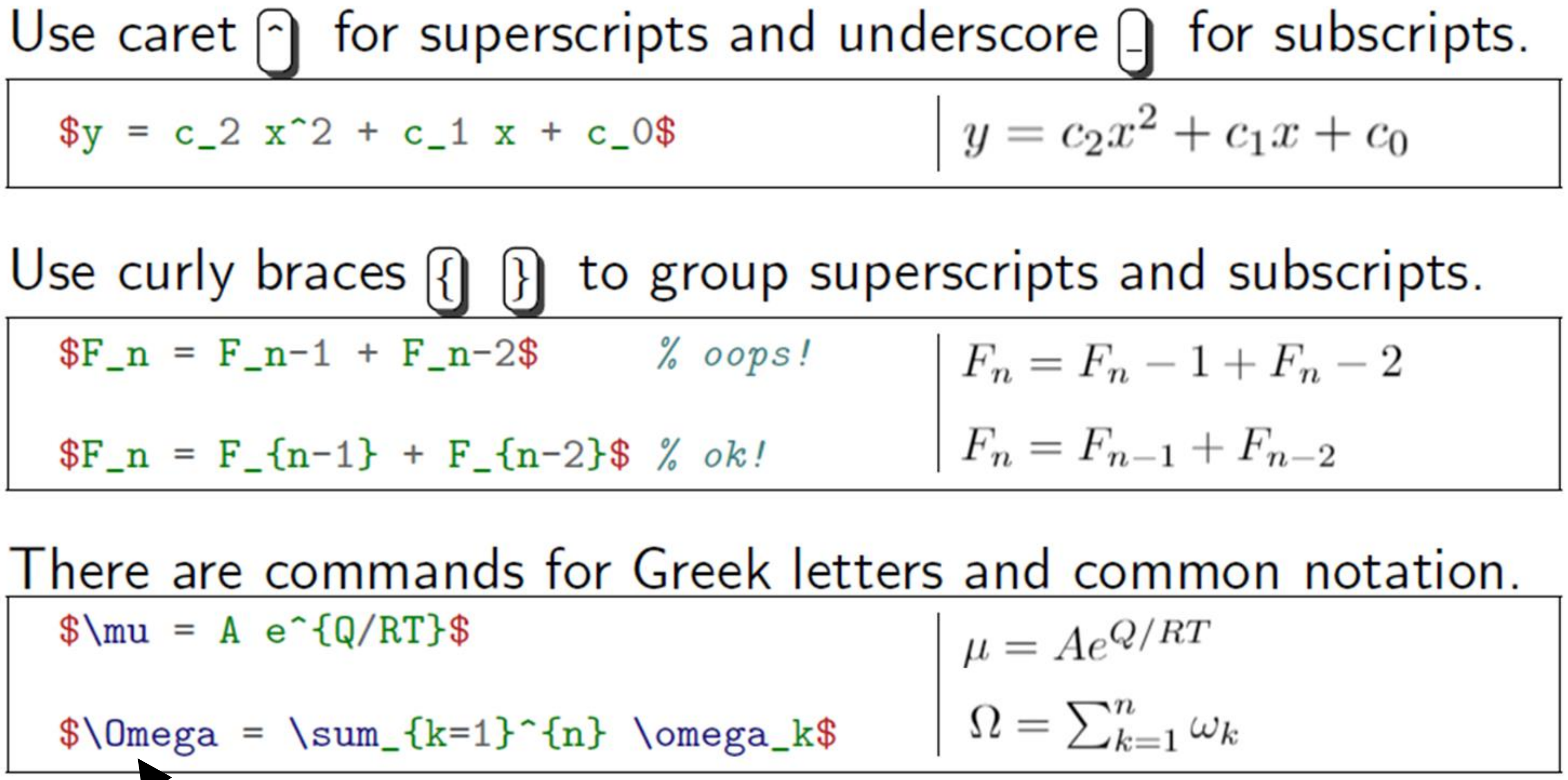
References

Equations

Equations: Math mode basics

- Within the text, use $ signs to signify math mode

- LaTeX ignores spaces in math mode
  - Use spaces freely to make your code look nice



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.

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

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

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

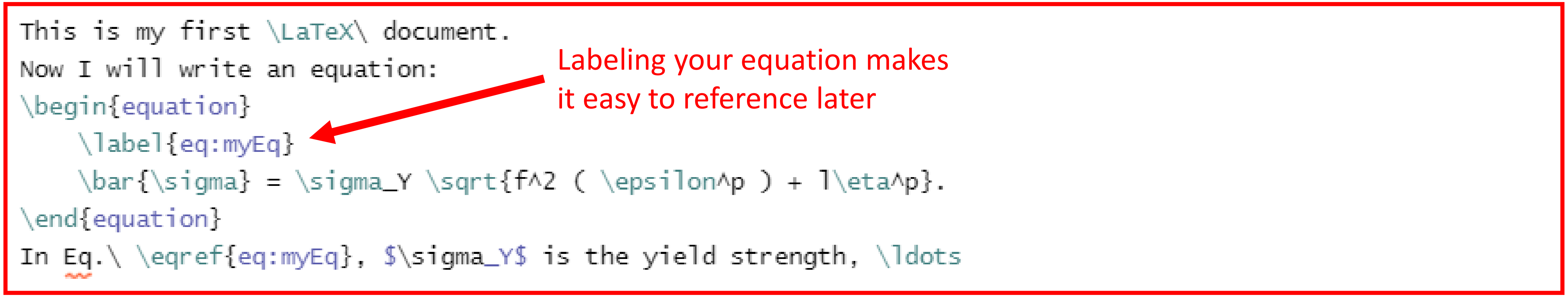
$\Omega = \sum_{k=1}^{n} \omega_k$

Capital first letter in the code → capital Greek letter

Examples from J.D. Lees-Miller, *An Interactive Introduction to LaTeX*

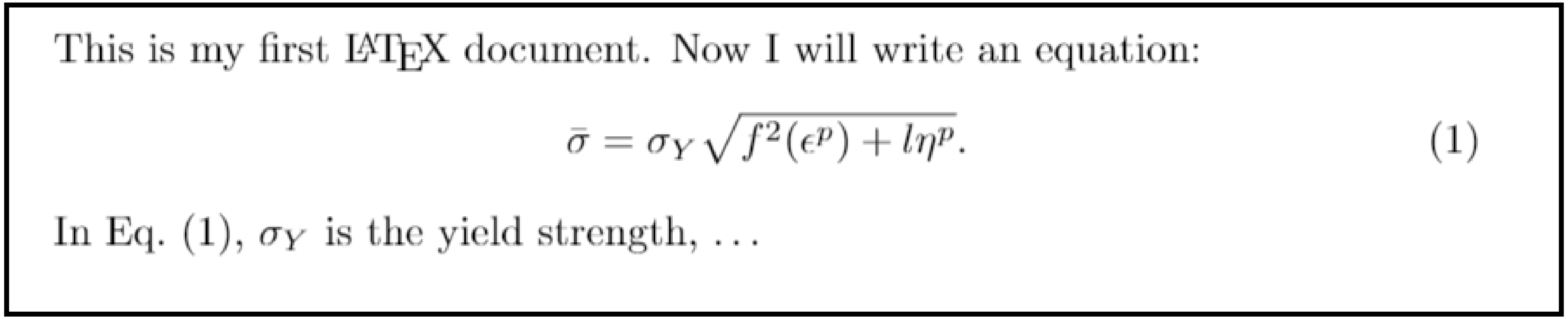
Equations: The `equation` environment

For numbered equations, use the `equation` environment



```
This is my first \LaTeX\ document.
Now I will write an equation:
\begin{equation}
    \label{eq:myEq}
    \bar{\sigma} = \sigma_Y \sqrt{f^2 ( \epsilon^p ) + l\eta^p}.
\end{equation}
In Eq.\ \eqref{eq:myEq}, $\sigma_Y$ is the yield strength, \ldots
```

Labeling your equation makes it easy to reference later



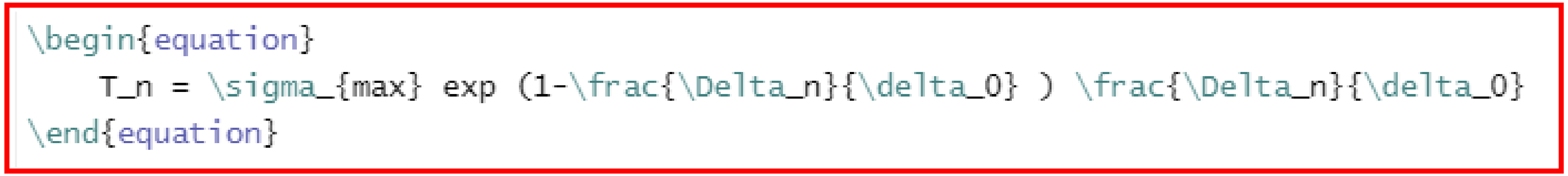
This is my first LaTeX document. Now I will write an equation:

$$\bar{\sigma} = \sigma_Y \sqrt{f^2(\epsilon^p) + l\eta^p}. \tag{1}$$

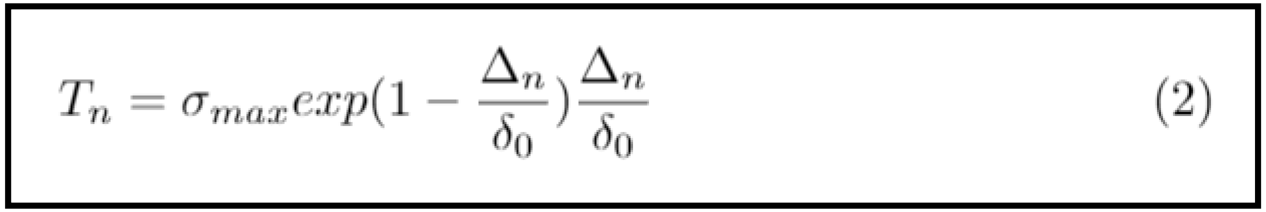
In Eq. (1), σ_Y is the yield strength, …

Equations: Other considerations

Sometimes equations look ugly without some additional commands…



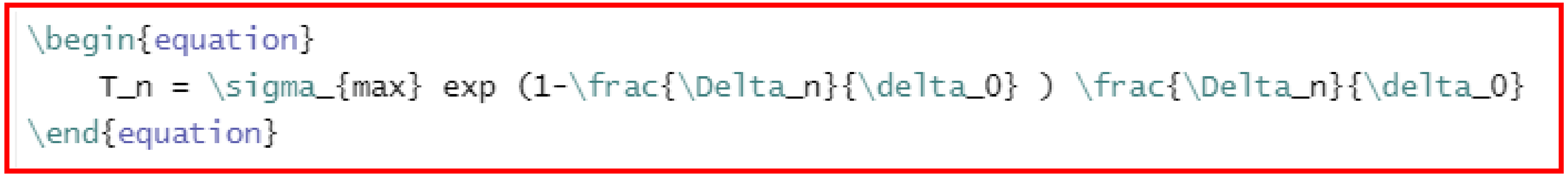
```
\begin{equation}
    T_n = \sigma_{max} exp (1-\frac{\Delta_n}{\delta_0} ) \frac{\Delta_n}{\delta_0}
\end{equation}
```



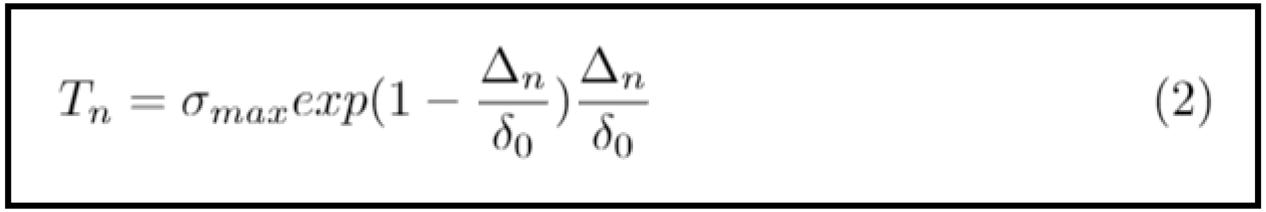
$$T_n = \sigma_{max} exp(1 - \frac{\Delta_n}{\delta_0})\frac{\Delta_n}{\delta_0} \tag{2}$$

Equations: Other considerations

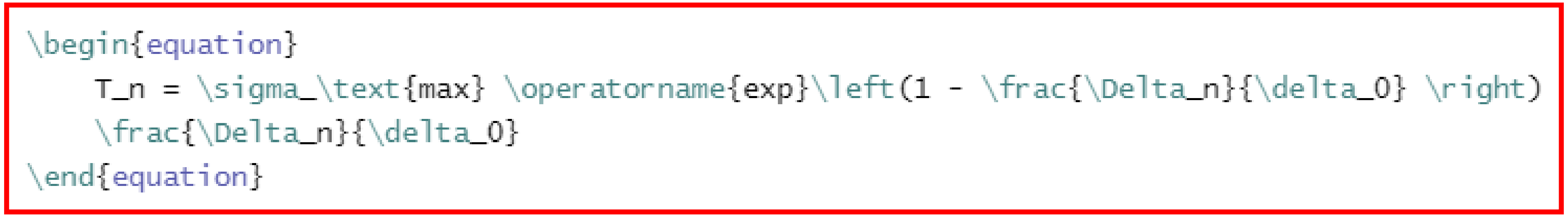
Sometimes equations look ugly without some additional commands…



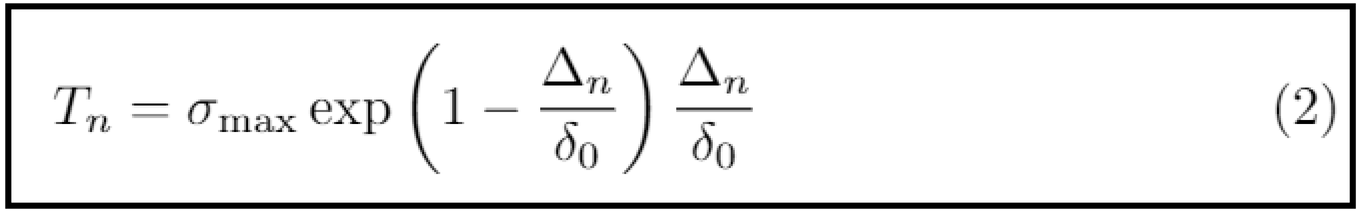
```
\begin{equation}
    T_n = \sigma_{max} exp (1-\frac{\Delta_n}{\delta_0} ) \frac{\Delta_n}{\delta_0}
\end{equation}
```



$$T_n = \sigma_{max} exp(1 - \frac{\Delta_n}{\delta_0})\frac{\Delta_n}{\delta_0} \qquad (2)$$



```
\begin{equation}
    T_n = \sigma_\text{max} \operatorname{exp}\left(1 - \frac{\Delta_n}{\delta_0} \right)
    \frac{\Delta_n}{\delta_0}
\end{equation}
```

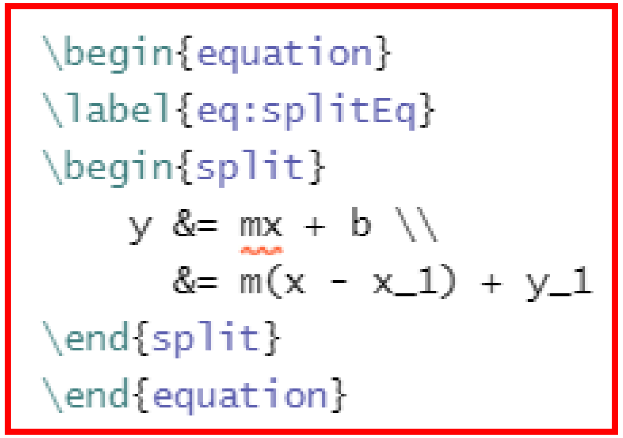


$$T_n = \sigma_\text{max} \operatorname{exp}\left(1 - \frac{\Delta_n}{\delta_0}\right)\frac{\Delta_n}{\delta_0} \qquad (2)$$

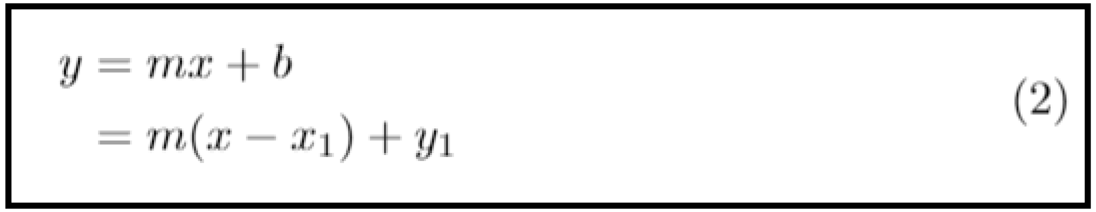
- Use `\text{}` if you want plaintext in an equation
- Use `\operatorname{}` for functions like `exp`
- `\left(` and `\right)` make sure the `()` look nice

Equations: Multiple lines

- Use the `split` environment to handle equations that span multiple lines
  - Nested within an equation
  - & indicates where the equations should align
  - \\ starts a new line
  - Equation number is always centered vertically
  - If you want a label, define it before the `split` environment



```
\begin{equation}
\label{eq:splitEq}
\begin{split}
    y &= mx + b \\
      &= m(x - x_1) + y_1
\end{split}
\end{equation}
```

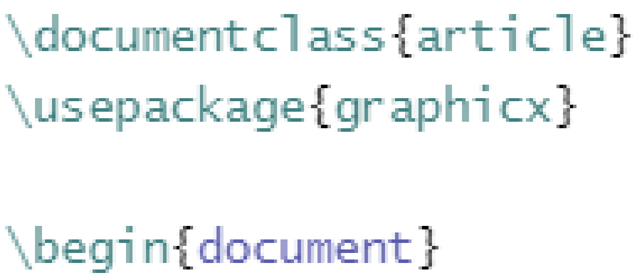


$$\begin{split} y &= mx + b \\ &= m(x - x_1) + y_1 \end{split} \tag{2}$$

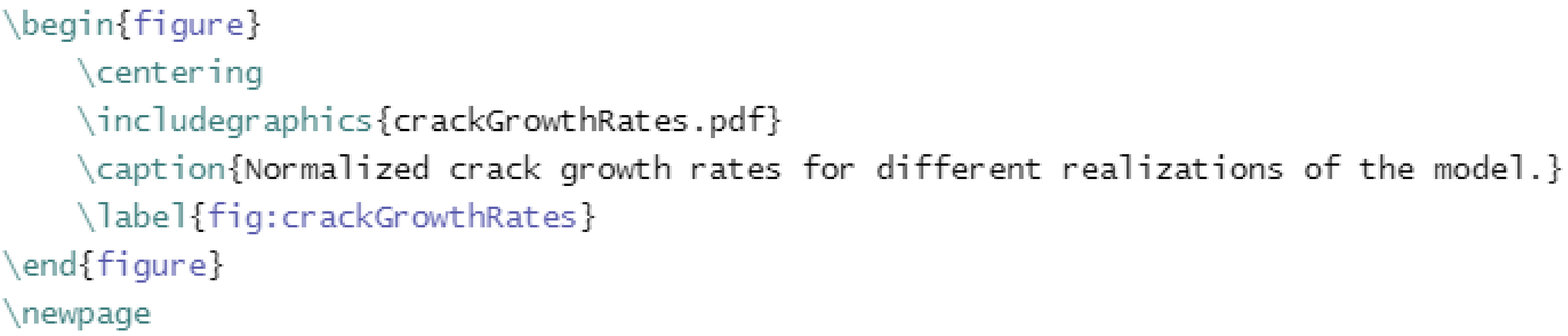
Figures

Figure environment

- Include the `graphicx` package
- Upload a JPEG, PNG, or PDF file to your Overleaf project
- Within the `figure` environment, use the `includegraphics` command

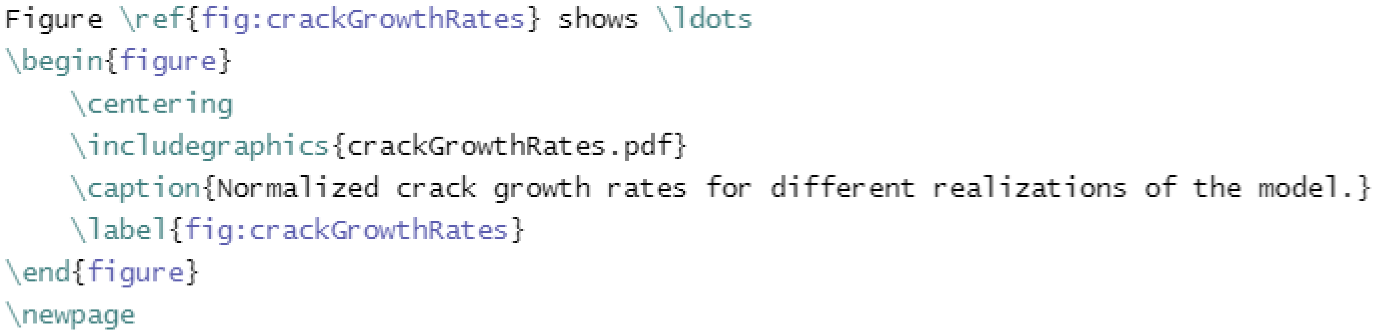


```
\documentclass{article}
\usepackage{graphicx}

\begin{document}
```



```
\begin{figure}
    \centering
    \includegraphics{crackGrowthRates.pdf}
    \caption{Normalized crack growth rates for different realizations of the model.}
    \label{fig:crackGrowthRates}
\end{figure}
\newpage
```

Figure environment



```
Figure \ref{fig:crackGrowthRates} shows \ldots
\begin{figure}
    \centering
    \includegraphics{crackGrowthRates.pdf}
    \caption{Normalized crack growth rates for different realizations of the model.}
    \label{fig:crackGrowthRates}
\end{figure}
\newpage
```

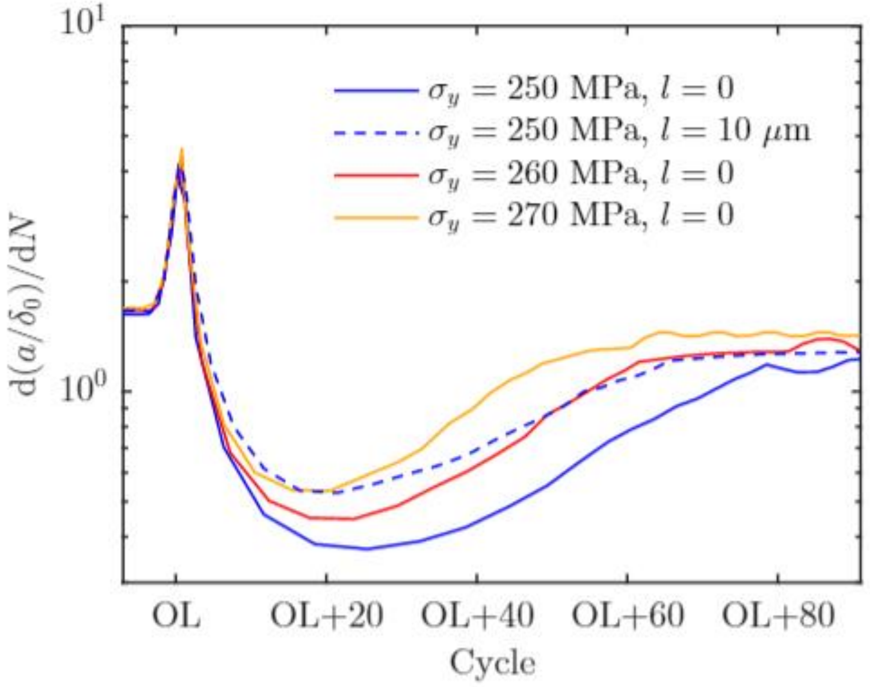


Figure 1: Normalized crack growth rates for different realizations of the model.

Figure 1 shows . . .

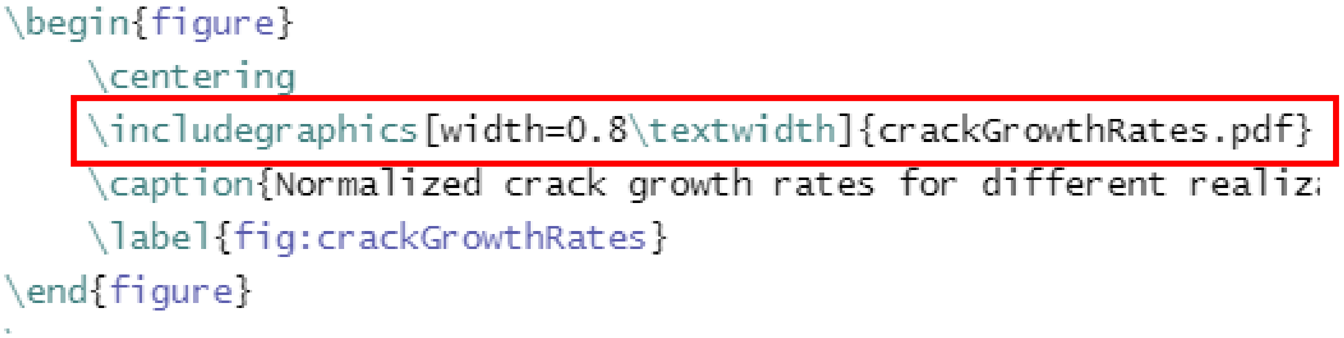
LaTeX automatically sets the caption font size and the spacing before/after the figure based on the style file.
There are commands to change this if you'd like

Aside: floats

- A figure is a float: LaTeX automatically places it in the “best” location
- You can suggest a location by adding an optional argument as input to the figure environment
  - `\begin{figure}[b]` → place the figure at the bottom of the page
  - `\begin{figure}[t]` → …at the top
  - `\begin{figure}[h]` → place the figure here
- Add an `!` before the letter to *force* LaTeX to do what you want, even if it thinks it’s a bad idea (e.g. `[!b]`)

Figure environment: Size

- Optional argument to the `includegraphics` command
- Usually specify size as a fraction of `\textwidth`



```
\begin{figure}
    \centering
    \includegraphics[width=0.8\textwidth]{crackGrowthRates.pdf}
    \caption{Normalized crack growth rates for different realiz
    \label{fig:crackGrowthRates}
\end{figure}
```

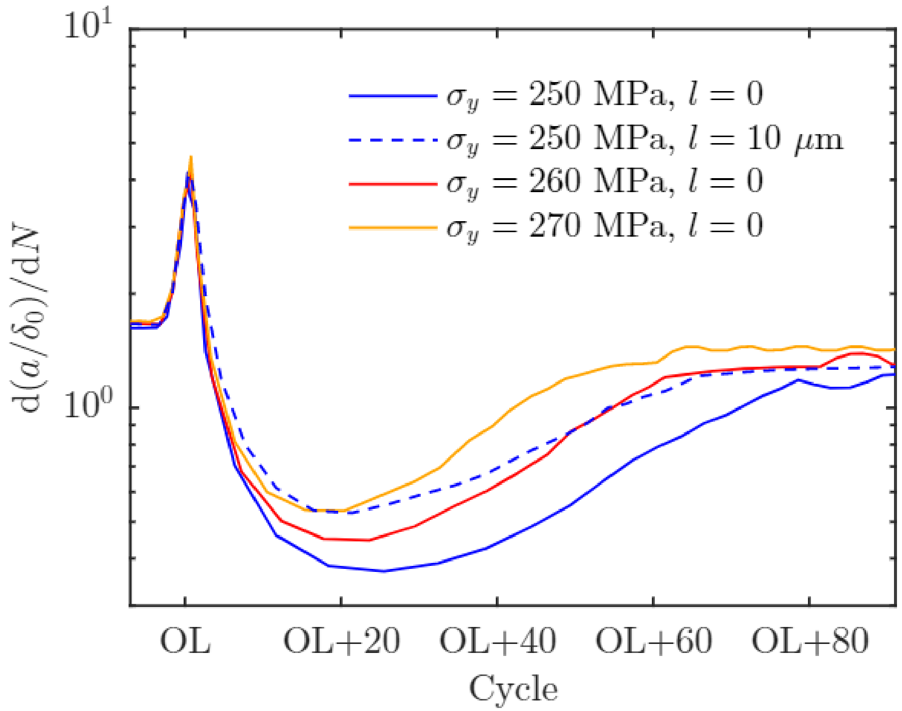
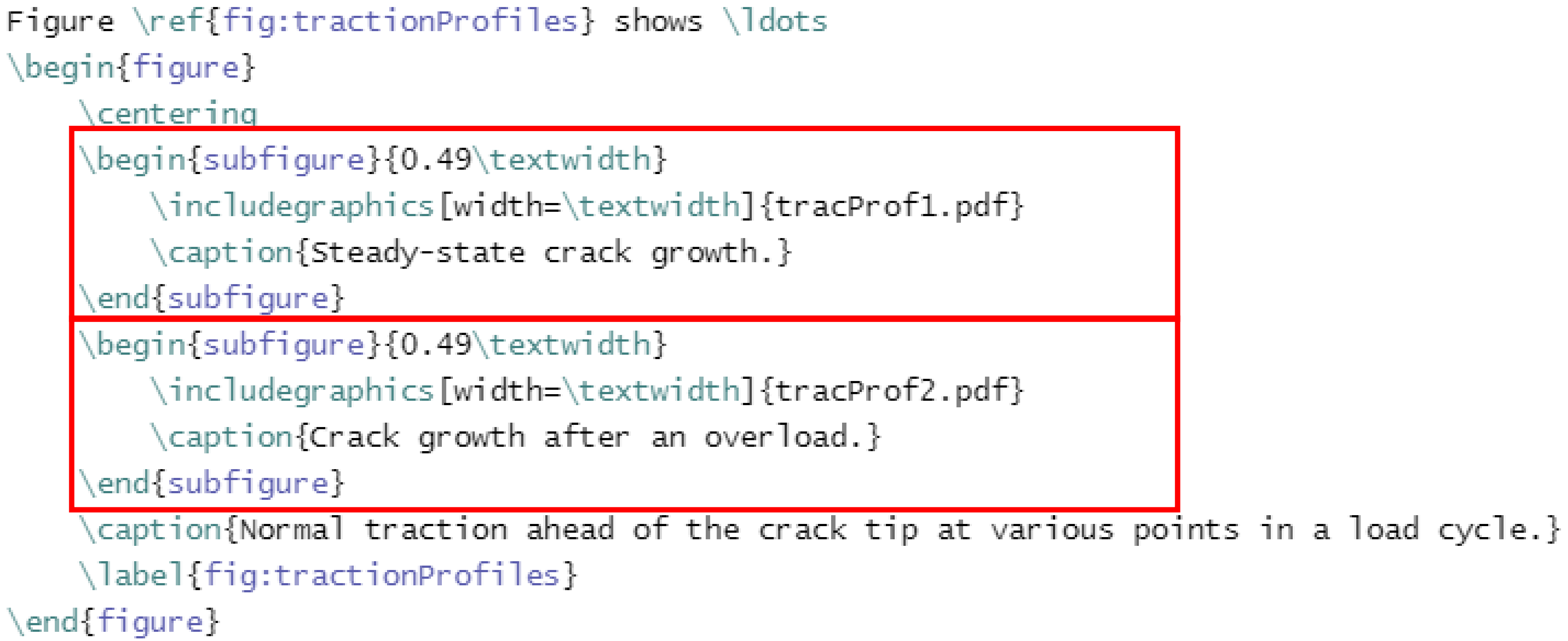


Figure 1: Normalized crack growth rates for different realizations of the model.

Figure 1 shows ...

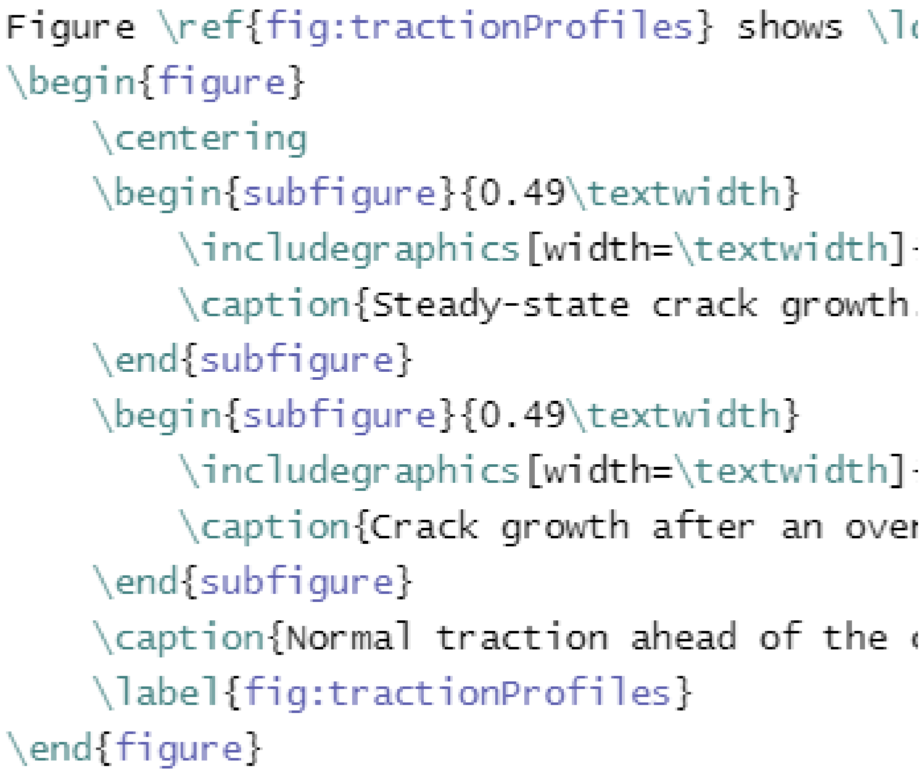
Subfigure environment: Multi-part figures

- Include the `subcaption` package in the preamble
- Use the `subfigure` environment within the `figure` environment
  - The width of the subfigure is a *required* argument—put it in `{ }`
  - This basically creates a box on the page with the width you specify; LaTeX puts your graphics into this box

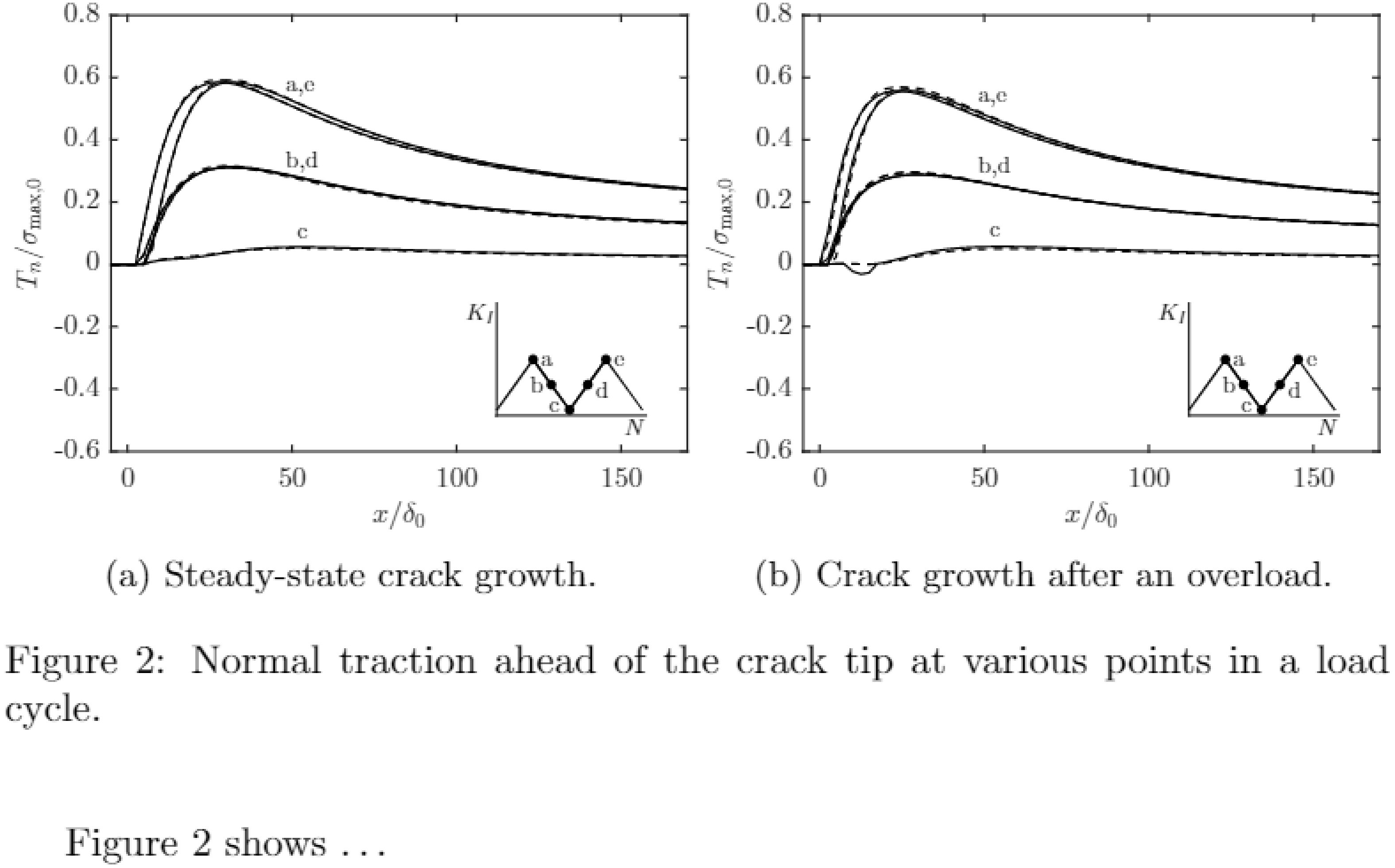


```
Figure \ref{fig:tractionProfiles} shows \ldots
\begin{figure}
    \centering
    \begin{subfigure}{0.49\textwidth}
        \includegraphics[width=\textwidth]{tracProf1.pdf}
        \caption{Steady-state crack growth.}
    \end{subfigure}
    \begin{subfigure}{0.49\textwidth}
        \includegraphics[width=\textwidth]{tracProf2.pdf}
        \caption{Crack growth after an overload.}
    \end{subfigure}
    \caption{Normal traction ahead of the crack tip at various points in a load cycle.}
    \label{fig:tractionProfiles}
\end{figure}
```

Subfigure environment: Multi-part figures



```
Figure \ref{fig:tractionProfiles} shows \l
\begin{figure}
    \centering
    \begin{subfigure}{0.49\textwidth}
        \includegraphics[width=\textwidth]
        \caption{Steady-state crack growth.
    \end{subfigure}
    \begin{subfigure}{0.49\textwidth}
        \includegraphics[width=\textwidth]
        \caption{Crack growth after an over
    \end{subfigure}
    \caption{Normal traction ahead of the
    \label{fig:tractionProfiles}
\end{figure}
```



(a) Steady-state crack growth.

(b) Crack growth after an overload.

Figure 2: Normal traction ahead of the crack tip at various points in a load cycle.

Figure 2 shows . . .

Bibliography

- Most citation management software can output a BibTeX file
- See resources on the next page for how to incorporate a bibliography
  - Typically use the `natbib` package
- See resources on the last slide for details

Other stuff

- Tables
  - Admittedly a bit painful to code by yourself
  - Use a resource like www.tablesgenerator.com/ or Excel2LaTeX to convert WYSIWYG table to LaTeX, and include the packages `tabularx` and `booktabs` to make publication-quality tables
- `Beamer`: documentclass for making presentations with LaTeX
  - Can also use MathType to write LaTeX-style equations into a PowerPoint file
- `TikZ`: make beautiful graphics

Other stuff

- Good resources:
  - Overleaf learn (LaTeX and Overleaf-specific tutorials)
    - Slides from the 3-part Free Online Introduction to LaTeX
  - LaTeX wikibook (surprisingly useful!)
  - TeX StackExchange (probably the first hit if you Google a LaTeX question)
- Overleaf has several autocomplete capabilities that can help speed things up (e.g. it adds the commands within the figure environment after you type `\begin{figure}`)
- Download a LaTeX distribution if you want to work locally on your computer
  - Windows: MikTeX or TeXLive
  - Mac: MacTeX