Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

A LaTeX Tutorial

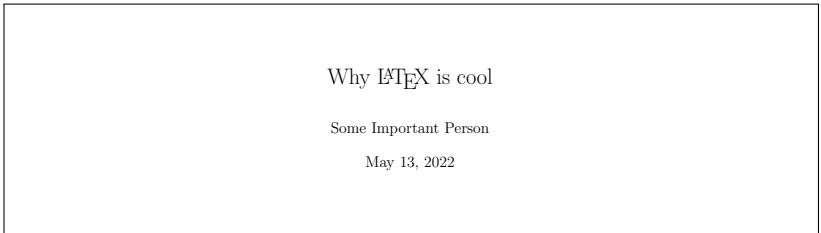
Johann von Tiesenhausen

Ingenuity Labs Research Institute
Queen's University, Kingston, Canada

June 9th, 2022

Goals of this presentation

- **Not** comprehensive
- Starting reference to show that LaTeX isn't *that* scary
- Provide some tips & tricks
- Tons of useful LaTeX tutorials by Overleaf


Why LaTeX is cool

Some Important Person

May 13, 2022

What is LaTeX?

- From Encycolpedia Britannica:

  "TeX, a page-description computer programming language developed during 1977–86 by Donald Knuth, a Stanford University professor, to improve the quality of mathematical notation in his books. Text formatting systems [...] embed plain text formatting commands in a document, which are then interpreted by the language processor to produce a formatted document for display or printing."
- LaTeXis the corresponding software package
- TeX consists of the greek letters τ, ϵ, χ, and is pronounced "lay-tech"

A LaTeX document

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

% remaining preamble goes here

\begin{document}

% content goes here

\end{document}
```

Creating a title

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

\title{Automatic Material Classification}
\author{Unal Artan \thanks{Thank you to Natalie \& Johann}}
\date{August 24, 2021}

\begin{document}

\maketitle
...
```

Adding sections

```
...
\section{Wavelet Analysis}

Researchers began studying wavelets in the 30s, because of their inherent
    cuteness in comparison to waves.

\subsection{Digression}

Would that this were a whiteboard instead \ldots

\end{document}
```

Automatic Material Classification

Unal Artan *

August 24, 2021

1 Wavelet Analysis

Researchers began studying wavelets in the 30s, because of their inherent cuteness in comparison to waves.

1.1 Digression

Would that this were a whiteboard instead ...

*Thank you to Natalie & Johann

Commonly used syntax

`\usepackage{...}`	import a LaTeX package in preamble
`\include{...}`	insert LaTeX code from another file in-place

comments	`% ...`
bold	`\textbf{...}`
italic	`\textit{...}` or `\emph{...}`
underline	`\underline{...}`
inline equations	`$...$`
block equations	`$$...$$` or `\[...\]`
“quotes”	`` `...' `` or ``` ``...'' ```
…and many more!	`\ldots`

Dimensions and layout

Dimension	Description
`pt`	point, smallest unit of measure
`in`	inch (72.27 `pt`)
`cm`	centimeter
`mm`	millimeter
`em`	relative to current point size (e.g., for 11`pt` font, 1`em` = 11`pt`)
`en`	half the width of `em`

Command	Description
`\vspace{...}`	add vertical space
`\hspace{...}`	add horizontal space

Typesetting notes

- Extra spaces between words are ignored
- An empty line starts a new **paragraph**
- Two backslashes (\\) **forces** a line break, but does not start a new paragraph (i.e., no indent)
- Periods with trailing whitespace are treated as **end of sentence**, which can be escaped by a trailing backslash (e.g., i.e.\)
- Tilde (~) inserts **non-breaking whitespace**
- Adding an asterisk (*) after some environment names will hide their numbering (e.g., section*, figure*, equation*)
- Curly braces ({…}) may be used as blocks for formatting

Lists

Packages:

enumitem	custom enumerations/nesting

Commands:

itemize	bullet points
enumerate	numbered lists
description	description lists (used here)

Itemize

```
\begin{itemize}
  \item Lima
  \item Navy
  \item Kidney
  \begin{itemize}
    \item[yes] Bean
    \item[no] Stone
  \end{itemize}
\end{itemize}
```

- Lima
- Navy
- Kidney
  - yes Bean
  - no Stone

Enumerate

```
\begin{enumerate}
  \item One
  \item Two
  \item Three
  \begin{enumerate}
    \item Three Eh
    \item Three Bee
  \end{enumerate}
\end{enumerate}
```

1. One
2. Two
3. Three
    3.a Three Eh
    3.b Three Bee

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

Tables

Packages:

array	tables with fixed-width cells
tabularx	tables with fixed page width
multirow	merge rows/columns

Commands:

tabular	table environment

Tabular

```
\begin{tabular}{ | r | l | l | }
  \hline
  Signal & Description & Range \\
  \hline
  $\theta_l$ & lift & [0, 604] mm \\
  \hline
  $\theta_d$ & dump & [0, 396] mm \\
  \hline
\end{tabular}
```

Signal	Description	Range
θ_l	lift cylinder	[0, 604] mm
θ_d	dump cylinder	[0, 396] mm

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

Math

Packages:

amsmath	core math functionality
amssymb	extended mathematical symbols set
cases	piecewise notation
algorithm2e	algorithm environment

Commands:

equation	equation environment
split	multiline equation environment
align	multiple aligned equations environment
(pbv)matrix	matrices (similar syntax to tables)

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

Common equation syntax

Description	Code	Output
subscript	`x_y`	x_y
superscript	`x^y`	x^y
grouping	`x^{y+z}`	x^{y+z}
fraction	`\frac{x}{y}`	$\frac{x}{y}$
square root	`\sqrt{x+y}`	$\sqrt{x+y}$
greek letters	`\alpha \beta \gamma`	$\alpha\ \beta\ \gamma$
spacing	`\; \: \, \!`	contextual

Equations

```
\begin{equation}
  \beta(s) = \int^\infty_{-\infty} CWT(s, \tau) \; d\tau
  \label{eq:CWTint}
\end{equation}
```

$$\beta(s) = \int_{-\infty}^{\infty} CWT(s, \tau)\, d\tau \tag{1}$$

Multiline equations

```
\begin{equation}
  \begin{split}
    a_{1, X} &= a_{1,x} \cos{\alpha} - a_{1,z} \sin{\alpha} \\
             &= 42
  \end{split}
\end{equation}
```

$$\begin{aligned} a_{1,X} &= a_{1,x} \cos \alpha - a_{1,z} \sin \alpha \\ &= 42 \end{aligned} \tag{2}$$

Matrices

```
\[
  \begin{bmatrix}
    0 & -1 & 0 & 0 \\
    1 & 0  & 0 & 0 \\
    0 & 0  & 1 & 0 \\
    0 & 0  & 0 & 1
  \end{bmatrix}
\]
```

$$\begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Matrices

```
\[
  \begin{bmatrix}
    0 & -1 & 0 & 0 \\
    1 & 0  & 0 & 0 \\
    0 & 0  & 1 & 0 \\
    0 & 0  & 0 & 1
  \end{bmatrix}
\]
```

$$\begin{bmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Exactly!

Algorithms I

```
\begin{algorithm}[H]
  \caption{Dynamic Time Warping}
  \KwIn{Time series $X[1..n]$ and $Y[1..m]$}
  \KwOut{Cost matrix $DTW[0..n][0..m]$}
  $DTW[0][0] \gets 0$ \tcp*{warping path root}
  ...

  \For{$i \gets 1$ \textbf{to} $n$}
  {
    ...
  }

  \KwRet{$DTW[1..n][1..m]$}
  \label{alg:DTW}
\end{algorithm}
```

Algorithm 1: Dynamic Time Warping

Input: Time series $X[1..n]$ and $Y[1..m]$
Output: Cost matrix $DTW[0..n][0..m]$

```
1  DTW[0][0] ← 0                                              // warping path root
2  DTW[1..n][0] ← infinity DTW[0][1..m] ← infinity for i ← 1 to n do
3      for j ← 1 to m do
4          cost ← |X[i] − Y[j]|                               // Euclidian distance
5          DTW[i][j] ← cost + min(DTW[i − 1, j],
                                  DTW[i, j − 1],
                                  DTW[i − 1, j − 1])
6      end
7  end
8  return DTW[1..n][1..m]
```

Figures and references

Ingenuity Labs

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

Packages:

- graphicx including graphics
- biblatex bibliography management
- hyperref hyperlinks

Commands:

- includegraphics include graphics ...
- addbibresource add bibliography (.bib) file
- printbibliography insert bibliography
- cite in-text citation
- href create hyperlink

Creating a figure I

```
\begin{figure}[t]
  \centering
  \includegraphics[height=0.65\textheight]{%
    figures/loader_diagram.png%
  }
  \caption{The Kubota R520s robotic 1-tonne-capacity wheel loader that was
      used for field experiments.}
  \label{fig:loader}
\end{figure}
```

Creating a figure II

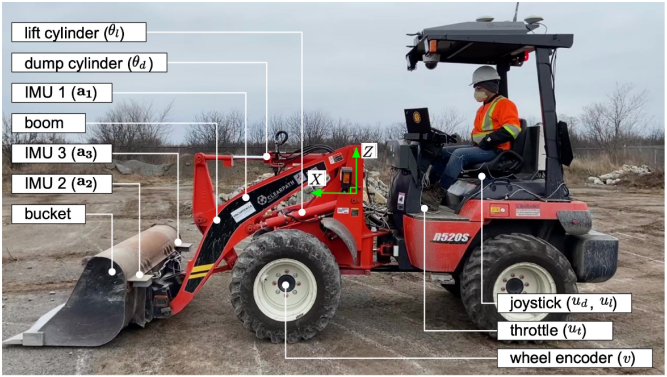


Figure 1: The Kubota R520s robotic 1-tonne-capacity wheel loader that was used for field experiments.

Label references

```
``\ldots the Kubota Loader in Figure~\ref{fig:loader}''
```

"...the Kubota Loader in Figure 1"

```
``see Equation~\ref{eq:CWTint}''
```

"see Equation 1"

Note: "fig:" and "eg:" are not necessary, but they help when writing. "ch:" and "sec:" are often used for chapters and sections.

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

Bibliography references

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands

BibTeX entry (.bib files):

```
@inproceedings{artan2021,
  author    = {Artan, Unal and Fernando, Heshan and Marshall, Joshua A.},
  booktitle = {2021 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)},
  title     = {Automatic Material Classification via Proprioceptive Sensing and Wavelet Analysis During
      Excavation},
  year      = {2021},
  pages     = {612-617},
  doi       = {10.1109/AIM46487.2021.9517696}
}
```

Corresponding in-text citation:

```
``\ldots due to breakthrough research \cite{artan2021}''
```

"...due to breakthrough research [1]"

Inserting a bibliography

Often requires you to precompile your document, run bibtex, then compile it again with resolved references ...

```
\bibliographystyle{ieeetr}
\bibliography{references.bib}
```

[1] U. Artan, H. Fernando, and J. A. Marshall, "Automatic material classification via proprioceptive sensing and wavelet analysis during excavation," in *2021 IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)*, pp. 612–617, 2021.

Hyperlinks

URL links:

```
\href{https://ieeexplore.ieee.org/document/9517696}{Paper}
```

Paper

Internal links:

```
\hypertarget{link:thisPart}{This part}
\hyperlink{link:thisPart}{That part}
```

This part

That part

Custom commands

```
\newcommand{cmd}[args][default]{def}
```

`cmd`	name of the command
`args`	number of parameters
`default`	default value for optional first parameter #1
`def`	command body

```
\newcommand{\proot}[2][]{\; ^{#1} \!\!\! \sqrt{#2}}
\[ \proot[3]{x + y} + \proot{x} \]
```

$$\sqrt[3]{x+y}+\sqrt{x}$$

Introduction

Documents

Lists

Tables

Math

Figures and references

Commands

Custom environments I

```
\newenvironment{name}[args][default]{begdef}{enddef}
```

`name`	name of the environment
`args`	number of parameters
`default`	default value for optional first parameter #1
`begdef`	`\begin` command body
`enddef`	`\end` command body

Custom environments II

```
\newenvironment{LARGEcenter}
  {\begin{center}\LARGE}
  {\end{center}}

\begin{LARGEcenter}
  Thank you for your time!
\end{LARGEcenter}
```

Any questions?

Introduction
Documents
Lists
Tables
Math
Figures and references
Commands