A LaTeX Tutorial

Johann von Tiesenhausen

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

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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 Encyclopedia 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, unlike WYSIWYG ("What You See Is What You Get") word processors, 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. TeX marks italic text, for example, as *this is italicized*, which is then displayed as this is italicized."

- LaTeX is 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

```
...
\tableofcontents

\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

Contents

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 . . .

Commonly used syntax

A LaTeX Tutorial

7 of 31

Introduction

Documents

Lists

Tables

Math

Figures and references

Commands

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

comments	`% ...`
bold	`\textbf{...}`
italic	`\textit{...}` or `\emph{...}`
<u>underline</u>	`\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 11pt font, 1em = 11pt)
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

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

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)

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}
```

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

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

A LATEX Tutorial

20 of 31

Introduction

Documents

Lists

Tables

Math

Figures and references

Commands

```
\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}
```

Algorithms II

A LᴬTEX Tutorial

21 of 31

Introduction

Documents

Lists

Tables

Math

Figures and references

Commands

Algorithm 1: Dynamic Time Warping

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

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

Figures and references

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}
```
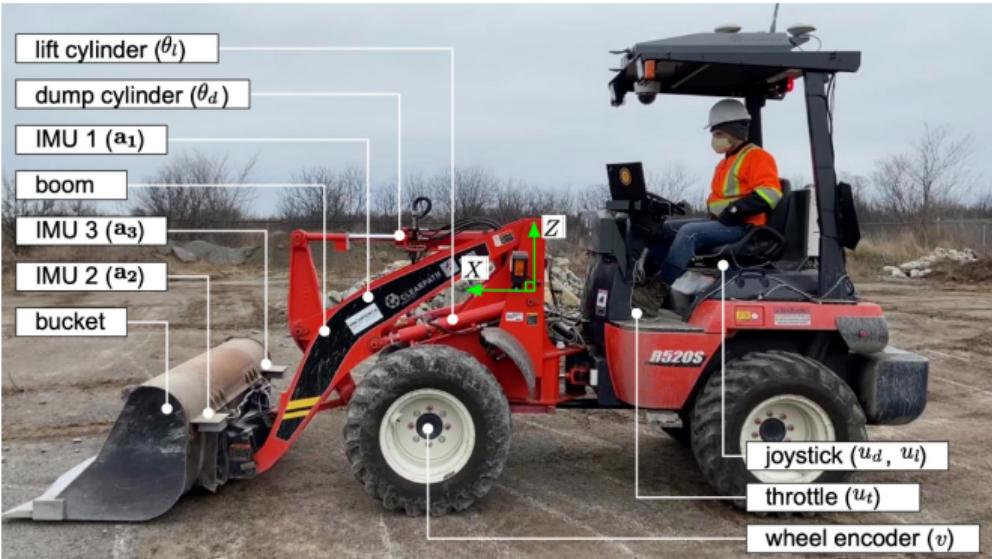
Creating a figure II

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.

Bibliography references

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

NOTE: Often requires you to compile 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

A LᴬTᴇX Tutorial

28 of 31

Introduction

Documents

Lists

Tables

Math

Figures and references

Commands

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}}
\[ \proot[3]{x + y} + \proot{x} \]
```

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

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?