

LATEX workshop

From novice to expert, to appreciator.

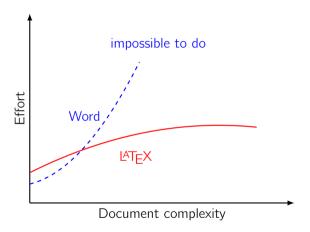
Dr. Gilles Callebaut
KU Leuven Ghent – Dramco

https://github.com/GillesC/LaTeX-Workshop

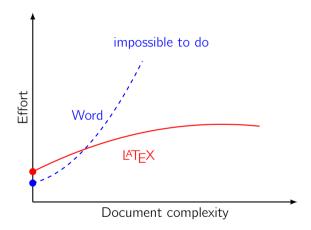
1. Why LATEX?

- Getting up and running
 - The basics
- Up your L^AT_EX game with TikZ
 - Master Thesis Template

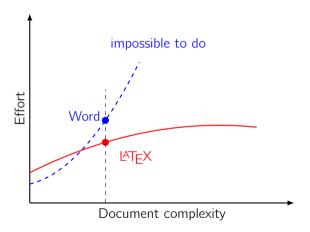
1.0 Why LaTeX?



1.0 Why LaTeX?



1.0 Why LaTeX?



1.0 My goals for this workshop

- See the beauty and possibilities of LATEX
- Give an overview of the basics and elaborate on common pitfalls and must-have knowledge
- ▶ Provide a basis to fall back on (not everything will be covered in detail)

- You can put text in comments and later retrieve old parts
- You can rearrange text easily by just switching some lines
- You can make unbelievably nice looking professional figures
- Using commands to replace words |
- ► Abbreviations (and re-using them) student
- Reusing the same colors in text, graphs to depict the same things
- Math in MS Word is awful.
- Referencing/citing becomes a worry of the past.

- ▶ You can put text in comments and later retrieve old parts
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- ► Using commands to replace words *research*
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- 1. Why LATEX?
- 2. Getting up and running
 - 3. The basics
- 4. Up your LATEX game with Ti*k*Z
 - 5. Master Thesis Template

2.0 Install LaTeX

Distribution:

- ► Tex Live for Windows (or MikTeX)
- ► TeX Live for Linux
- MacTeX for macOS

Editors:

VS Code, overleaf.com, TeXworks, TeXstudio, Texmaker, etc.

2.0 Using Overleaf

Key features:

- Setup-free LATEX
- Visual Editor and Code Editor
- Project sharing
- **.** . . .

Offline editors when:

- Project is large (long compile time)
- ► More extensive features (e.g., with VS Code)
- Working offline

- 1. Why LATEX?
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3.1 Starting a document

Document class

```
\documentclass{article}
\begin{document}
    Hello world!
\end{document}
```

\documentclass tells LATEX how to lay out your document

Standard classes are article, report, book, letter, beamer for presentations

Each major publisher typically has its own class (e.g., IEEEtran)

3.1 Starting a document

Preamble

```
\documentclass{article}

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

In the preamble, you define which packages to use

- \usepackage[english]{babel}
- \usepackage{graphicx}

```
\usepackage[option1,
option2]{graphicx}
```

3.1 Starting a document

Document itself

```
\documentclass{article}
\begin{document}
   Hello world!
\end{document}
```

\begin{...} and \end{...} define the beginning and the ending of an environment

\begin{document} and \end{document}
identify where your document
starts and stops

3.1 Including a Title and an Author

```
\documentclass{article}
\title{\ldots...} and \author{\ldots...}
\title{\mathrm{My First Document}} are self-explanatory
\author{E. Peschiera}
\date{\} \date{\} is useful to suppress the
\begin{document} showing of the current date
\maketitle
Hello world! \maketitle is fundamental! Without it,
\end{document}
```

Note: templates can define their own title/author commands.

3.1 Including a Title and an Author

Result

```
\documentclass{article}
\title{My First Document}
\author{G. Callebaut}
\date{}
\begin{document}
   \maketitle
   Hello world!
\end{document}
```

My First Document

E. Peschiera

Hello world!

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3.1 Including Structuring Elements

Numbered elements

```
► \chapter{...}
```

```
▶ \section{...}
```

- ▶ \subsection{...}
- ► \subsubsection{...}

Unnumbered elements, same commands but with *

► \chapter*{...}

Depending on the template, certain elements might not be present

- \chapter{} only in books and reports
- No structuring elements supported in letters

3.1 Including Structuring Elements

```
1 \documentclass{article}
 3 \title{My First Document}
 4 \author{E. Peschiera}
 5 \date{}
7 \begin{document}
 9 \maketitle
11 Hello world!
13 \section{See the number}
14 text in first section
16 \section*{No number}
17 text in second section
19 \end{document}
```

My First Document

E. Peschiera

Hello world!

1 See the number

text in first section

No number

text in second section

3.2 Including a Figure

```
Need graphicx package
  \usepackage{graphicx}
Define a figure environment
    \begin{figure} [placing
   specifier]
      \centering
      \includegraphics[options]{
   pathToFigure}
      \caption{text explaining
   the figure
    \end{figure}
```

[placing specifier]

- \blacktriangleright h = here
- ▶ t = top of the page
- b = bottom of the page
- p = on a special page for figures, tables, etc.
- ! = override LaTeX parameters that normally decide good positioning

3.2 Including a Figure

```
Need graphicx package
  \usepackage{graphicx}
Define a figure environment
    \begin{figure} [placing
   specifier]
      \centering
      \includegraphics[options]{
   pathToFigure}
      \caption{text explaining
   the figure
    \end{figure}
```

\centering makes sure the included figure is centered in the environment

similar placing as in figures, but now with respect to the other subfigures.

3.2 Using Subfigures

```
\usepackage{caption}
  \usepackage{subcaption}
Define a figure environment
    \begin{figure}[placing
   specifier]
      \begin{subfigure} [placing
   specifier]
        \includegrpahics
    \end{subfigure}
    \hfill
      \begin{subfigure} [placing
   specifier]
```

\subfigure allows to place different subfigures in one figure environment.

\includegraphics finds and inserts the actual figure file

- optional typically refers to the width or height of the figure
- most often related to \textwidth, e.g.
 [width=0.5\textwidth]

Needs

```
\begin{table}[placing options]
   \caption{text explaining the
   Table }
   \centering
   \begin{tabular}{columnFormat}
     colTitle & <repeat for all
   columns>\\
     \hline
     data & data & <repeat>\\
     \hline
   \end{tabular}
\end{table}
```

table environment makes sure that the table can be correctly placed

tabular environment
= actual table

```
\begin{table}[placing options]
   \caption{text explaining the
   Table
   \centering
   \begin{tabular}{columnFormat}
     colTitle & <repeat for all
   columns>\\
     \hline
     data & data & <repeat>\\
     \hline
   \end{tabular}
\end{table}
```

{columnFormat} defines

- How many columns in the table
- ► The layout of the columns
 - c: centered text
 - I: left-aligned text
 - r: right-aligned text
 - fixed-width columns p{2cm}
 - m: middle
 - p: top
 - b: bottom

```
\begin{table}[placing options]
   \caption{text explaining the
   Table
   \centering
   \begin{tabular}{columnFormat}
     colTitle & <repeat for all
   columns>\\
     \hline
     data & data & <repeat>\\
     \hline
   \end{tabular}
\end{table}
```

```
& is a column separator. Used to show in which column the next item goes
```

\hline inserts a horizontal line

```
\\ is the standard LaTeX command for a line break In a table: next row
```

```
\documentclass{article}
   \usepackage{graphicx}
 5 \title{My First Document}
 6 \author(E. Peschiera)
 7 \date()
 9 \begin{document}
 11 \maketitle
13 \section{Included Table}
 14 This is a short Table
    \begin{table}{h}
        \caption{Look at my awesome result numbers.}
        \centering
        \begin{tabular}{||c|r}
              Exp. name & time [s] & Comment \\
              walking & 180.15 & really fun \\
              running & 59,23 & difficult \\
              swimming & 00.0 & impossible on land \\
              Abline
27 \end{table}
28 \end{table}
        \end{tabular}
30 some other text here
31
32 \end{document}
```

My First Document

E. Peschiera

1 Included Table

This is a short Table

 Exp. name
 time
 s
 Comment

 walking
 180.15
 really fun

 running
 59.23
 difficult

 swimming
 00.0
 impossible on land

some other text here

3.2 Note on Figures and Tables

In case your document is multicolumn, e.g., IEEE paper, but your figure needs to span more than 1 column: use * when defining the environment

```
\begin{figure*} ... \end{figure*}
\begin{table*} ... \end{table*}
```

3.2 Making beautiful tables

Highly recommended document:

https://people.inf.ethz.ch/markusp/teaching/guides/guide-tables.pdf.

Guidelines

- avoid vertical lines
- Avoid "boxing up" cells, usually 3 horizontal lines are enough: above, below, and after heading (see examples in this guide)
- avoid double horizontal lines
- enough space between rows
- if in doubt, align left
- right-align numbers (using same notation/unit)
- use \usepackage{booktabs}

3.2 Making beautiful tables

Rank	Lead Arranger	Number of Deals	Dollar Amount	Market Share	Equator Principles Adoption
1	State Bank of India	52	\$21,631.6	10.1%	NA
2	Mitsubishi UFJ Financial	88	9,486.1	4.4	Dec 2005
3	Sumitomo Mitsui	71	8,188.1	3.8	Jan 2006
4	Credit Agrocole	60	6,506.4	3.1	Jun 2005
5	Mizuho Financial	55	5,797.5	2.7	Oct 2003
6	Société Generale	55	5,760.5	2.7	Sep 2007
7	BNP Paribas	55	5,390.8	2.5	Oct 2008
8	Axis Bank	18	5,216.9	2.4	NA
9	IDBI Bank	10	5,162.3	2.4	NA
10	ING	49	4,916.1	2.3	Jun 2003
	Others	102	135,430.4	63.6	
	Total Market	615	\$213,486.7	100%	

3.3 Inserting an Equation

Free-standing equation

Need amsmath package \usepackage{amsmath}

Use equation environment
\begin{equation}
 <type equation here>
\end{equation}

To type your equation, you need to know the correct commands

A nice overview: https://en.wikibooks.org/wiki/ LaTeX/Mathematics

3.3 Inserting an Equation

```
1 \documentclass{article}
2 \quad \text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\text{\t
```

My First Document

E. Peschiera

1 Included Equation

some other text here

This is a very difficult and rarely seen equation

$$x_{1,2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \tag{1}$$

LATEX workshop

3.3 Inserting an Equation

In-line equation

An equation can also be in-line = inside the text

This is enabled by using the math environment \$...\$ e.g., Variable \$D\$ is calculated as \$D = S \oplus d_i\$ using the XOR operation.

Variable *D* is calculated as $D = S \oplus d_i$ using the XOR operation.

Of course, not possible to refer to these equations as they do not have a number

3.4 Inserting an Algorithm

```
Many packages exist to typeset an algorithm 
\usepackage{algorithmic} 
\usepackage{algorithm2e} 
\usepackage{algpseudocode}
```

Suggested: algpseudocode

Algorithm typically embedded in an algorithm environment

```
\usepackage{algorithm}
\begin{algorithm}
...
\end{algorithm}
```

3.4 Inserting an Algorithm

```
\documentclass{article}
 3 \usepackage{graphicx}
 4 \usepackage{algorithm}
 5 \usepackage{algpseudocode}
 7 \begin{document}
 9 \section{Included Algorithm}
11 This is a very simple algorithm in pseudocode.
13 \begin{algorithm}[h]
   \caption{Example algorithm.}
       \begin{algorithmic}[1]
             \If {$i\geg \mathsf{maxval}$}
\State $i\gets 0$
               \If {$i+k\leg \mathsf{maxval}$}
                  \State $i\gets i+k$
               \EndIf
             \EndIf
       \end{algorithmic}
```

1 Included Algorithm

This is a very simple algorithm in pseudocode.

```
Algorithm 1 Example algorithm.

1: if i \geq \max then

2: i \leftarrow 0

3: else

4: if i + k \leq \max then

5: i \leftarrow i + k

6: end if
```

3.5 Inserting a Listing

Instead of pseudocode, you can also typeset actual code. This is called a *listing*

```
\usepackage{listings}
\begin{lstlisting}
  <code here>
\end{lstlisting}
```

Or input code file directly, using \lstinputlisting[language= programmingLanguage]{PathToSourcefile} The listings package supports many programming languages, but still enables you to customize everything you want

Full explanation:

```
https://en.wikibooks.org/wiki/
LaTeX/Source Code Listings
```

3.5 Inserting a Listing

Actual listing and result

Better package for Python: minted, https://ctan.org/pkg/minted

3.5 Code highlighting with minted



The minted package supports many programming languages, but requires installing Pygments. (supported out-of-the-box in Overleaf)

More information: https://www.overleaf.com/learn/latex/Code_Highlighting_with_minted

3.6 Labels and Referencing

A figure, table, equation, algorithm, listing has no place in a document, unless it is referenced!

```
\label{<label>} inside the
environment to be referenced, and
\ref{<label>} in the text.
e.g.,
\caption{Some fig.
caption}\label{fig:cool-fig}.
Fig.~\ref{fig:cool-fig} becomes
Fig. 1.
```

```
Use \usepackage{cleveref} and use
correct naming conventions:
         ch: chapter
        sec: (sub)section
         fig: figure
        tab: table
         lst: code listing
         alg: algorithm
        app: appendix (sub)section
    \cref{fig:cool-fig} becomes
    Fig. 1.
```

3.6 Labels and Referencing

```
1 \documentclass{article}
 3 \usepackage{graphicx}
 5 \begin{document}
 7 \section{Included labeled Figure}
 9 Fig.~\ref{fig:a_fig} shows bla bla bla
11 \begin{figure}[h]
        \centering
        \includegraphics[width=0.3\textwidth]{fig.png}
        \caption{A fig in a figure.}
        \label{fig:a_fig}
16 \end{figure}
17
18 \end{document}
```

1 Included labeled Figure

 ${\rm Fig.}~1$ shows bla bla bla



Figure 1: A fig in a figure.

Best practice

Resource you want to cite, must be provided to LaTeX in BibTex format

Although you could store your BibTex directly in your .tex document, much better to store it in a separate .bib file, and point LaTeX to this file.

```
In the preamble:
```

```
\usepackage[style=ieee]{biblatex}
\addbibresource{bib.bib}
\AtBeginBibliography{\footnotesize}

The last command is optional.

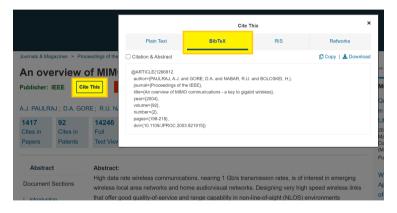
Just before the end of the document:
\printbibliography
```

KU LEUVEN

3.7 BibTeX

```
@ARTICLE{10460235,
  author={Callebaut, Gilles and Liu, Liang and
  Eriksson, Thomas and Van der Perre, Liesbet and
  Edfors, Ove and Fager, Christian},
  journal={IEEE Microwave Magazine},
  title={6G Radio Testbeds: Requirements, Trends, and Approaches},
  vear={2024}.
  volume=\{25\}.
  number={4}.
  pages=\{14-31\}.
  doi={10.1109/MMM.2024.3351970}
```

On IEEEXplore



Citing a reference

Optional, but to prettify citations \usepackage{cite} (← only if you are not using biblatex)

```
In text:
"...using a
reference~\cite{citekey}"
```

 \sim is a fixed space. This prevents a line-break on this space.

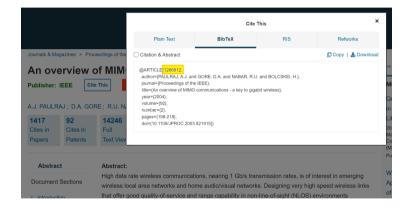
Always insert \sim before \cite{}.

1 Included Reference

A famous paper from the early 2000s pointed out how the use of multiple antennas at the transmitter and at the receiver was the key to achieving data rates in the order of 1 Gb/s [1].

References

 A. Paulraj, D. A. Gore, R. U. Nabar, and H. Boleskei, "An overview of MIMO communications - A key to gigabit wireless," *Proceedings of the IEEE*, vol. 92, no. 2, pp. 198–218, 2004.



3.7 Cleaning BibTeX file



https://flamingtempura.github.io/bibtex-tidy

3.7 Want to know more about Ref. Managers and BibTeX?

Or more general information about information retrieval?

Contact colleague Eef Soete (eef.soete@kuleuven.be)



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Why creating figures in LATEX?

- + Adjustability/Flexibility Rebuilding your document automatically updates the figure: making changes is as easy as modifying LATEX code

4.0 Why creating figures in LATEX?

- + Adjustability/Flexibility
 Rebuilding your document automatically updates the figure: making changes is as easy as modifying LATEX code
- + Consistency: Fonts, colors, text sizes, etc., are consistent.
- + Vector graphics
- + Easy to port your text to a slide deck
- The learning curve. .
- Compiling can become slow

Inspired by the Tikz workshop by Pieter Belmans (https://github.com/pbelmans/tikz-workshop).

4.0 Why creating figures in LATEX?

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Why creating figures in LATEX?

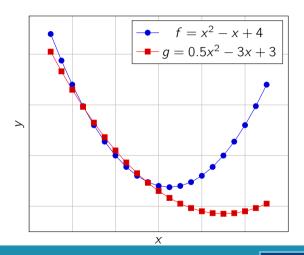
- + Adjustability/Flexibility Rebuilding your document automatically updates the figure: making changes is as easy as modifying LATEX code
- + Consistency: Fonts, colors, text sizes, etc., are consistent.
- + Vector graphics
- + Easy to port your text to a slide deck
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4.0 Resources

- ► TeXample.net
- ► PGFPlots.net
- ► PGFPlots Gallery

4.0 Plotting CSV files

```
-5.0
    34.0
           30.5
-4.5
    28.75
           26.625
-4.0
    24.0
           23.0
-3.5
    19.75
           19.625
-3.0
    16.0 16.5
-2.5
    12.75 13.625
-2.0
    10.0 11.0
-1.5 7.75 8.625
-1.0
    6.0 6.5
```



4.0 Integration with External Tools

matlab2tikz https://github.com/nschloe/matlab2tikz Export Matlab figures directly to TikZ.

4.0 Tikz Externalize (in Overleaf)

- ► TikZ is recompiled every run
- externalize to save as PDF
- \tikzexternalize{prefix=tikz/} command must be given in the project's main
 .tex file
- ▶ Ensure in Overleaf that tikz/ is created and contains a dummy file
- Set a filename for each TikZ picture \tikzsetnextfilename{file name}
- ▶ More information on the Overleaf Documentation.

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5.0 Now it's your turn

- Download and compile the master's thesis template at https://iiw.kuleuven.be/studeren/masterproef/sjablonen
- ► Clean-up the .bib file
- Plot a graph using Tikz with your own generated data
- Include two pictures and place them side-by-side
- Add another reference and cite it in the document.
- Add another abbreviation to the abbreviations.tex document and use it in your text (in plural).

5.1 Best Practices

- use \usepackage{subcaption}, not subfigure package
- use \usepackage{biblatex}, not package cite and natbib
- use cleveref
- use siunitx
- use booktabs and tabularx if required
- name your tikz figures (see next section)
- Open issues in the GitHub repo for feature requests or errors.
- structure your text using \input{} commands.
- Comment out parts of the thesis to compile quicker (chapter per chapter), also handy when debugging

5.1 Common issues

- Copying and pasting resulted in an error. Often Unicode problem.
- ► Read the log outputs, i.e., errors, when compiling failed.
- Use of reserved characters: \ { } \$ & # ^ _ % ~ (in .bib or in text). You need to escape them using \or other means.



5.1 Acknowledgments & References

- ► This slide deck started from previous work from Dr. Ing. Jens Vankeirsbilck and Ing. Emanuele Peschiera.
- ► Thanks to Benjamin J. B. Deutschmann and Thomas Wilding for the beautiful Tikz examples.
- ► Thesis specific: https://dramcoedu.github.io/ThesisTips-and-Tricks
- Writing documents in LATEX: https://github.com/DRAMCO/writing-scientific-papers-in-latex-tips-and-tricks
- ► LATEX specific : https://github.com/dramco-edu/LaTex
- ► LATEX Workshop: https://github.com/GillesC/LaTeX-Workshop



LATEX workshop

From novice to expert, to appreciator.

Dr. Gilles Callebaut
KU Leuven Ghent – Dramco

https://github.com/GillesC/LaTeX-Workshop