IEEE Signal Processing Society

POLITÉCNICO DE LEIRIA | ESCOLA SUPERIOR DE TECNOLOGIA E GESTÃO

IEEE

LaTeX Workshop

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LaTeX: How and Why?

- **Origins:**
  - Developed by **Leslie Lamport** in 1984
  - Built on top of Donald Knuth's **TeX** typesetting system (1978)
- **Purpose:**
  - Simplify the creation of complex documents
  - Provide superior control over document layout and formatting
- **Why:**
  - Many packages to do what you probably want to do
  - No need to worry about formatting: someone does the template, you just write

LaTeX: How and Why? What about Word?

- **Superior Typesetting Quality:**
  - Professional and consistent formatting
  - Optimal handling of mathematical equations and symbols
- **Automated Document Management:**
  - Automatic numbering of sections, figures, tables, and references
  - Easy generation of tables of contents, bibliographies, and indexes
- **Version Control Compatibility:**
  - Plain text files integrate seamlessly with version control systems (e.g., Git)
- **Stability and Consistency:**
  - Consistent output across different platforms and devices
  - Minimal formatting issues when sharing documents
- **Focus on Content:**
  - Encourages separation of content and styling
  - Reduces distractions from formatting during the writing process

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The Overleaf Minimum

```latex
\documentclass{article}
\usepackage{graphicx} % Required for inserting images

\title{Latex workshop}
\author{José Filipe}
\date{December 2024}

\begin{document}

\maketitle

\section{Introduction}

\end{document}
```

The Bare Bones

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

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

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Paragraphs and linebreaks

- One “enter” does nothing
- Blank line to create new paragraph
- `\\` or `\linebreak` for break a line

Paragraphs and linebreaks

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

\begin{document}
    Lorem ipsum odor amet, consectetuer adipiscing elit.
    Donec proin hac nostra suspendisse nunc facilisis quisque.

    Faucibus metus justo varius \linebreak pretium
    erat viverra auctor.
    Habitasse quis purus iaculis \\ condimentum at
    inceptos magnis.
\end{document}
```

Bold, italics, and underlines

- `\textbf{...}` bold text
- `\textit{...}` italic text
- `\underline{...}` underline text

Bold, italics, and underlines

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

\begin{document}
    Lorem \textbf{ipsum odor} amet,
    consectetuer \textit{adipiscing} elit.

    Donec proin hac \underline{nostra} suspendisse
    nunc \textbf{\textit{\underline{facilisis quisque}}}.
\end{document}
```

Generalising Commands

- As you probably noticed by now...
  - There is an escape character: `\`
  - Commands start with `\`
    - **Almost every direct interface with LaTeX starts with the `\`**
    - To write the escape character: `\textbackslash`
  - Followed by the command name
  - Optional arguments are enclosed in square brackets `[...]`
  - Arguments are enclosed in curly braces `{...}`
  - Multiple arguments are provided sequentially

Generalising Commands

```
\comandName[opt. 1, opt. 2, ...]{arg. 1}{arg. 2}...
```

Another LaTeX interface: Environments

- Define blocks of content with specific formatting or behaviour
- Start with `\begin{environment}` and end with `\end{environment}`
- The environment name must match in both `\begin{...}` and `\end{...}`
- Some environments accept optional arguments in square brackets `[...]`
- Common environments: `itemize`, `enumerate`, `figure`, `table`, `equation`, etc.

Lists

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

\begin{document}

    \begin{itemize}
        \item Lorem ipsum odor amet
        \item Justo sed duis purus
        \begin{itemize}
            \item Consectetuer adipiscing elit
            \item Donec proin hac nostra suspendisse
        \end{itemize}
        \item Nunc facilisis quisque
    \end{itemize}
\end{document}
```

Lists

- Lorem ipsum odor amet
- Justo sed duis purus
  - Consectetuer adipiscing elit
  - Donec proin hac nostra suspendisse
- Nunc facilisis quisque

Numbered Lists

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

\begin{document}

    \begin{enumerate}
        \item Lorem ipsum odor amet
        \item Justo sed duis purus
        \begin{enumerate}
            \item Consectetuer adipiscing elit
            \item Donec proin hac nostra suspendisse
        \end{enumerate}
        \item Nunc facilisis quisque
    \end{enumerate}
\end{document}
```

Numbered Lists

1. Lorem ipsum odor amet
2. Justo sed duis purus
   2.1 Consectetuer adipiscing elit
   2.2 Donec proin hac nostra suspendisse
3. Nunc facilisis quisque

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Figures

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

\begin{document}
    \begin{figure}
        \centering
        \includegraphics[width=0.5\columnwidth]{Figures/sps_logo}
        \caption{Logo IEEE SPS.}
    \end{figure}
\end{document}
```

Figures

- Use a `figure` environment
- `\centering`:
  - Centers the content within the `figure` environment
  - Ensures the image is horizontally aligned in the middle of the page or column
- `\includegraphics`:
  - Inserts an image into the document
  - Commonly used options:
    - `width`: Specifies the width of the image (e.g., `width=0.5\columnwidth`)
    - `height`: Specifies the height of the image
    - `scale`: Scales the image by a factor
  - Takes path to image as argument (inside `{...}`)
- `\caption`:
  - Adds a caption below the image

Figures

Figure 1: Logo IEEE SPS.

Figure Placement

- LaTeX handles figure placement automatically for optimal layout
- Common placement specifiers:
  - `h` – here
  - `t` – top
  - `b` – bottom
  - `!` – override internal parameters
- Messing with Figure placement can disrupt the document flow!
- Letting LaTeX decide ensures the professional appearance
- Just accept that LaTeX knows better, this is not MS Word and that is a bonus!

References

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

\begin{document}
    \begin{figure}
        \centering
        \includegraphics[width=0.5\columnwidth]{Figures/sps_logo}
        \caption{Logo IEEE SPS.}
        \label{fig:sps}
    \end{figure}

    Figure~\ref{fig:sps} is the SPS logo!
\end{document}
```

References

- `\label{...}` assigns a label to an element (e.g., figures, tables, sections)
  - We can call a figure by a name
  - No matter the order, it will always be the right figure!
  - It is a breeze to create lists of figure
  - Labels for figure usually start with `fig:`
- `\ref{...}` references the labelled element
- Using ~ ensures that ”Figure” and its number stay on the same line

References

Figure 2: Logo IEEE SPS.

Figure 2 is the SPS logo!

Packages and Clever References

```latex
\documentclass[12pt]{article}
\usepackage{graphicx}
\usepackage{cleveref}

\begin{document}
    \begin{figure}
        \centering
        \includegraphics[width=0.5\columnwidth]{Figures/sps_logo}
        \caption{Logo IEEE SPS.}
        \label{fig:sps}
    \end{figure}

    \cref{fig:sps} is the SPS logo!
\end{document}
```

Packages and Clever References

Figure 3: It is yet another IEEE SPS logo.

Both Figure 2 and fig. 3 are the SPS logo!

Packages and Clever References

- `\usepackage{..}` loads extra functionalities, packages made by the communities (basically, libraries)
- We are importing the `cleveref` package
  - `\cref{...}` automatically includes the type of the referenced object (e.g., ”Figure”, ”Table”) without manual text
  - Using `\cref{fig:sps}` produces ”Figure 1” automatically, maintaining proper spacing and formatting

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The Equation Environment

- Use the `equation` environment to display numbered equations.
- Automatically centres the equation and assigns a number for referencing.
- Syntax:

```
\begin{equation}
    % Your equation here
\end{equation}
```

The Equation Environment

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

\begin{document}
    Here is a simple equation:

    \begin{equation}
        E = mc^2
    \end{equation}
\end{document}
```

Mathematical Notation Basics

- Greek Letters: `\alpha` (α), `\beta` (β),`\delta` (δ), `\Delta` (Δ), etc.
- Operations: + ($+$), - ($-$), `\times` ($\times$), `\cdot` ($\cdot$)
- Fractions: `\frac{a}{b}` $\left(\frac{a}{b}\right)$
- Subscript: `a_{i}` (a_i)
- Superscript: `x^{2}` $\left(x^2\right)$
- Summations: `\sum_{i=1}^{n} x_i` $\left(\sum_{i=1}^{n} x_i\right)$
- Integrals: `\int_{a}^{b} f(x) \, dx` $\left(\int_a^b f(x)\,dx\right)$

Mathematical Notation Basics – Challenge

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}} \tag{1}$$

Referencing Equations

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

\begin{document}
    The \cref{eq:std} shows the standard deviation:

    \begin{equation}
        \sigma = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N}}
        \label{eq:std}
    \end{equation}

\end{document}
```

Referencing Equations

The eq. (2) shows the standard deviation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(x_i - \mu)^2}{N}} \tag{2}$$

Inline Equations

- Embed mathematical expressions within text using `$...$`
- For inline equations and symbols
- Supports standard LaTeX math syntax

Inline Equations

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

\begin{document}
    According to Newton's second law, the force applied
    to an object is given by $F = ma$, where:
    \begin{itemize}
        \item $F$ is the force in Newtons ($N$)
        \item $m$ is the mass in kilograms ($kg$)
        \item $a$ is the acceleration in meters per
              second squared ($m \cdot s^{-2}$)
    \end{itemize}
    This equation is fundamental in physics.
\end{document}
```

Inline Equations

According to Newton's second law, the force applied to an object is given by $F = ma$, where:

- F is the force in Newtons (N)
- m is the mass in kilograms (kg)
- a is the acceleration in meters per second squared ($m \cdot s^{-2}$)

This equation is fundamental in physics.

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Comparing Tables: booktabs vs. Regular Tables

Which table looks better?

Table 1: Regular style table.

Parameter	Value	Unit
Length	10	m
Width	5	m
Height	3	m

Table 2: Booktabs style table.

Parameter	Value	Unit
Length	10	m
Width	5	m
Height	3	m

Why booktabs?

- Developed to improve the quality of tables in LaTeX documents
- Aimed at enhancing readability and visual appeal of tables.
- **Best Practices:**
  - Avoid using vertical lines; rely on spacing and horizontal rules
  - Maintain consistency in table design throughout the document

Basic Tables

```
\documentclass[12pt]{article}
\usepackage{cleveref}
\usepackage{booktabs}

\begin{document}
    \begin{table}
        \centering
        \caption{Basic table.}
        \label{tab:basic}
        \begin{tabular}{l|cr}
            \toprule
            \textbf{Parameter} & \textbf{Value} & \textbf{Unit} \\
            \midrule
            Length             & 10             & m             \\
            Width              &  5             & m             \\
            \bottomrule
        \end{tabular}
    \end{table}
    \Cref{tab:basic} is a basic table.
\begin{end}
```

Basic Tables

- `\begin{table}` ... `\end{table}`
  - Environment that holds the caption, label, and the actual table
- `\begin{tabular}` ... `\end{tabular}`
  - Defines the table's structure
  - Column alignment specified within curly braces:
    - `l`: Left-aligned
    - `c`: Center-aligned
    - `r`: Right-aligned
    - `|`: Vertical lines (use sparingly with `booktabs`)
- `&` separates columns
- `\\` ends rows

Basic Tables

- `\toprule`: Thick line at the top
- `\midrule`: Thin line between header and data
- `\bottomrule`: Thick line at the bottom

Basic Tables

Table 3: Basic table.

Parameter	Value	Unit
Length	10	m
Width	5	m

Table 3 is a basic table.

Basic Tables – Challenge

Law	Differential form	Integral form
Gauss	$\nabla \cdot \vec{\mathbf{E}} = \frac{\rho}{\epsilon_0}$	$\int_S \vec{\mathbf{E}} \cdot \hat{n}\, \mathrm{dS} = \frac{\mathbf{Q}}{\epsilon_0}$
Gauss for Magnetism	$\nabla \cdot \vec{\mathbf{B}} = 0$	$\int_S \vec{\mathbf{B}} \cdot \hat{n}\, \mathrm{dS} = 0$
Faraday	$\nabla \times \vec{\mathbf{E}} = -\frac{\partial \vec{\mathbf{B}}}{\partial t}$	$\oint \vec{\mathbf{E}} \cdot \mathrm{d}\vec{r} = -\frac{d}{dt} \int_S \vec{\mathbf{B}} \cdot \hat{n}\, \mathrm{dS}$
Ampère	$\nabla \times \vec{\mathbf{B}} = \mu_0 \vec{\mathbf{J}} + \mu_0 \epsilon_0 \frac{\partial \vec{\mathbf{E}}}{\partial t}$	$\oint \vec{\mathbf{B}} \cdot \mathrm{d}\vec{r} = \mu_0 \mathbf{I} + \mu_0 \epsilon_0 \int_S \vec{\mathbf{E}} \cdot \hat{n}\, \mathrm{dS}$

Advanced Tables

- As you probably can conclude, tables are not LaTeX strong suit
- `https://www.tablesgenerator.com`

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Text Structure

- **Chapter** (`\chapter{Chapter Name}`) - *(Only in certain document classes)*
- **Section** (`\section{Section Name}`)
- **Subsection** (`\subsection{Subsection Name}`)
- **Subsubsection** (`\subsubsection{Subsubsection Name}`)
- It is possible to associate a label to each of these, for referencing

Text Structure

```
\documentclass{article}
\usepackage{cleveref}

\begin{document}
    \section{Introduction}
    \label{sec:intro}
    This is the introduction section.

    \section{Methodology}
    \label{sec:method}
    Refer to \cref{sec:intro} for the introduction.

    \subsection{Data Collection}
    \label{sec:data}
    Details about data collection for \cref{sec:method}.

    \subsubsection{Survey Design}
    \label{sec:survey}
    Information on survey design.
\end{document}
```

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IEEE Conference Template

- https://www.overleaf.com/latex/templates/ieee-conference-template/grfzhhncsfqn
- Open as Template

Organising a Project

- Erase all pdfs
- Change `conference_101719.tex` to `main.tex`
- Erase everything between `\end{IEEEkeywords}` and `\end{document}`

Organising a Project

- Create a new file called `body.tex`
- Paste the code in slide 53 inside the `document` environment into it
- Write `\input{body.tex}` bellow `\end{IEEEkeywords}`
  - ´´Pastes" the content of a tex file inside another
  - We can easily write the content in `body.tex` and change template, by using `\input{body}`

Citations and Bibtex

- Create a new file called `citations.bib`
- Add the following two lines, below the `\input{body}` line

```
% This is the citations style
\bibliographystyle{IEEEtran}
% This is the file where the citations are stored
\bibliography{citations}
```

Citations and Bibtex

- Paste bibtex references inside `citations.bib`

```
@INPROCEEDINGS{Filipe2021,
  author={Filipe, Jose N. and Carreira, J. and Tavora, Luis M. N.
          and de Faria, Sergio M. M. and Navarro, Antonio and Assuncao, Pedro A. A.},
  booktitle={2021 Telecoms Conference (ConfTELE)},
  title={Tree-Based Ensemble Methods for Complexity Reduction of VVC Intra Coding},
  year={2021},
  volume={},
  number={},
  pages={1-6},
  doi={10.1109/ConfTELE50222.2021.9435476}
}
```

- `Filipe2021` is the key we are going to use to cite this workshop
- It can be changed to whatever we want

Citations and Bibtex

- Use `\cite{...}` to cite a work
- For instance, add the following to `body.tex`

```
This work~\cite{Filipe2021} is not about \LaTeX.
```

Citations and Bibtex

- Order in `bib` file does not matter
- References are order according with the rules in the bibliography style (order of appearance, alphabetically, etc)
- Numbers are dynamically assigned by LaTeX no need to worry about them at all!!!

IPL Template

- https://www.overleaf.com/latex/templates/polytechnic-university-of-leiria-thesis-template/tqgbrncfhwgt
- Open as Template

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What is Beamer?

- **Beamer** is a LaTeX class for creating presentations
- It allows you to create slides with consistent styling and structure
- Utilizes frames to organize content into individual slides

Basic Presentation

```
\documentclass{beamer}

\begin{document}

    \begin{frame}{Slide Title}
        Your content goes here.
    %\end{frame}

\end{document}
```

Slightly Less Basic Presentation

```
\documentclass{beamer}
\usetheme{Madrid}

\title{Introduction to LaTeX Beamer}
\author{Jane Doe}
\institute{Engineering Department, XYZ University}
\date{\today}

\begin{document}

    \begin{frame}
        \titlepage
    % \end{frame}

    \begin{frame}{Slide Title}
        Your content goes here.
    % \end{frame}

\end{document}
```

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Thank You