Introduction to LaTeX and Beamer

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Proseminar Ausgewählte Themen der Künstlichen Intelligenz

1 - Introduction to LaTeX

2 - Beamer document class for presentations

1 - Introduction to LaTeX

Introduction

LaTeX{} is a document preparation system for high-quality typesetting. It is most often used for medium-to-large technical or scientific documents but it can be used for almost any form of publishing.

- Typesetting journal articles, technical reports, books, and slide presentations.
- Control over large documents containing sectioning, cross-references, tables and figures.
- Typesetting of complex mathematical formulas.
- Advanced typesetting of mathematics with AMS-LaTeX.
- Automatic generation of bibliographies and indexes.
- Multi-lingual typesetting.
- Inclusion of artwork, and process or spot colour.
- Using PostScript or Metafont fonts.

Installation

- On **Linux**, the easiest way is to install the `texlive` package (often `texlive-full` to obtain all dependencies).
- On **MacOS**, you can also install `texlive` if you have `brew` installed, or use `MacTeX` http://www.tug.org/mactex.
- On **Windows**, the `MikTex` distribution https://miktex.org is the best way to go.

After installation, all you need is a text editor to create `.tex` files and compile them with `pdflatex`:

```
pdflatex article.tex
```

However, a good IDE may save you a lot of time:

- LyX, Kyle, TeXStudio, TeXMaker, etc.

You can also use web-services, such as https://overleaf.com.

Resources

LaTeX{} exists since the early 80's, so the internet is full of information.

- https://www.latex-project.org : the official page.
- https://en.wikibooks.org/wiki/LaTeX : a complete free book.
- https://tex.stackexchange.com/: stackoverflow-like for LaTeX, every possible question has already been asked.
- Cheat sheet: https://wch.github.io/latexsheet

First document `minimal-report.tex`

```latex
% Preamble starts with document type
\documentclass[a4paper,10pt]{report}

% Information
\title{Title of the report}
\author{Author Name}
\date{\today}

% Start the document
\begin{document}

% Title is automatically generated
\maketitle

% Content of the document

% Finish the document
\end{document}
```

Structure of the document

A TeX document always starts with the `documentclass`:

```
\documentclass[a4paper,10pt]{report}
```

The possible documents types include:

- `letter`: for single-page documents.
- `article`: compact, multipages documents (scientific papers).
- `report`: extended multipages documents, organized in chapters (reports, Bachelor/Master/PhD thesis).
- `book`: for real books.
- `memoir`: based on the book class, but you can create any kind of document with it.
- `beamer`: for slides.

More specialized templates can be provided in a `.cls` file.

Arguments between square brackets define the paper size, font size, number of columns, etc.

→ Modify `minimal-report.tex` to see what each document type does.

Document class options

- `10pt, 11pt, 12pt`: Sets the size of the main font in the document. If no option is specified, 10pt is assumed.
- `a4paper, letterpaper`: Defines the paper size.
- `titlepage, notitlepage`: Specifies whether a new page should be started after the document title or not.
- `twocolumn`: Instructs LaTeX to typeset the document in two columns instead of one.
- `twoside, oneside`: Specifies whether double or single sided output should be generated.
- `landscape`: Changes the layout of the document to print in landscape mode.

Preamble

Between the document class and `\begin{document}` is the **preamble**.

You can import **packages** there where you can tune the appearance of your document.

For example, if you use non-ASCII characters (ß, ü…), you need to tell LaTeX{} to use the UTF-8 encoding:

```
\usepackage[T1]{fontenc}
\usepackage[utf8]{inputenc}
```

You can also change the font if you do not like the default `Computer Modern`:

```
\renewcommand*\rmdefault{ppl} % Palatino
```

or:

```
\usepackage{times} % Times New Roman
```

Basic formatting

- You can use **bold**, *emphasized* (or *italic*) and `typewriter` font faces:

```
You can use \textbf{bold}, \emph{emphasized} (or \textit{italic})
and \texttt{typewriter} font faces.
```

- Paragraphs are separated by a blank line. `\\` represents a line break.

```
This is the first paragraph where I describe blabla.

This is the second paragraph, with a lot of additional blabla,
separated with a big vertical space.\\
This is another paragraph, closer to the second.
```

Font size

- You can locally change the size of the font with the following commands (increasing sizes):

```
\tiny \scriptsize \footnotesize \small \normalsize
\large \Large \LARGE \huge \Huge
```

- For example, this {\Huge word} will be huge.

```
For example, this {\Huge word} will be huge.
```

- The commands can apply to whole sections of the text, delimited by curly braces.

Line spacing

- The default line spacing is single, which looks too “compressed” for reports.
- A better value is the one-and-a-half line spacing. It simply has to be declared in the preamble:

```
\usepackage{setspace}
%\singlespacing
\onehalfspacing
%\doublespacing
%\setstretch{1.1}
```

Margins

- The default margins of a LaTeX{} document are too wide. You can import the `geometry` package to reduce them:

```
\usepackage{geometry}
```

- You can also provide a value (here one inch) to control them:

```
\usepackage[margin=1in]{geometry}
```

- or even control the top/left/right/bottom margins individually:

```
\usepackage[top=0.5in,left=1in,right=1in,bottom=0.5in]{geometry}
```

Text alignment

- By default, paragraphs are justified (which is good), with automatic hyphenation of long words.
- If you need to center or left-align some text, you can use environments (but no hyphenation):

```
\begin{center}
    This text will be centered horizontally on the page.
\end{center}

\begin{flushleft}
    This text will be aligned to the left.
\end{flushleft}

\begin{flushright}
    This text will be aligned to the right.
\end{flushright}
```

Structuring a document

- A LaTeX{} document can of course be structured into chapters, sections and subsections (or even deeper).
- It depends on the document class: letters have nothing, articles and beamer slides do not have chapters, reports, books and memoirs do.

```
\chapter{Introduction}
\chapter{Related Work}
    \section{Classical approach}
    \section{Deep learning approach}
        \subsection{Convolutional networks}
        \subsection{Recurrent networks}
\chapter{Methods}
    \section{Neural networks}
        \subsection{Architecture}
        \subsection{Training procedure}
    \section{Evaluation}
\chapter{Results}
\chapter{Discussion}
```

Structuring a document

- Each part will automatically get a number according to its position in the hierarchy.

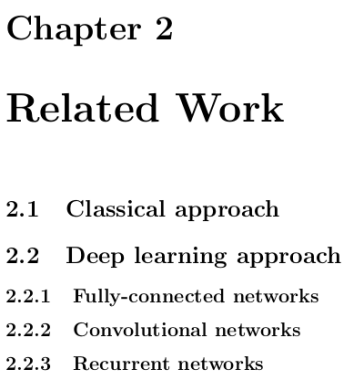


Figure 1: How Chapter 2 will look like.

Structuring a document

- If you do not want to give a number to the section, add a $*$:

```
\chapter{Introduction}
\chapter{Related Work}
    \section{Classical approach}
    \section{Deep learning approach}
        \subsection*{Fully-connected networks}
        \subsection*{Convolutional networks}
        \subsection*{Recurrent networks}
\chapter{Methods}
    \section{Neural networks}
        \subsection{Architecture}
        \subsection{Training procedure}
    \section{Evaluation}
\chapter{Results}
\chapter{Discussion}
```

Table of contents

- You can automatically obtain the table of contents by specifying right after the title page:

```
\tableofcontents
```

Contents

Labels and references

- You can reference a section in the text by using `\ref` and `\label`:

```
\chapter{Introduction}
As we will see in section \ref{sec:training}, we...
...
\chapter{Methods}
    \section{Neural networks}
        \subsection{Architecture}
        \subsection{Training procedure}
            \label{sec:training}
    \section{Evaluation}
...
```

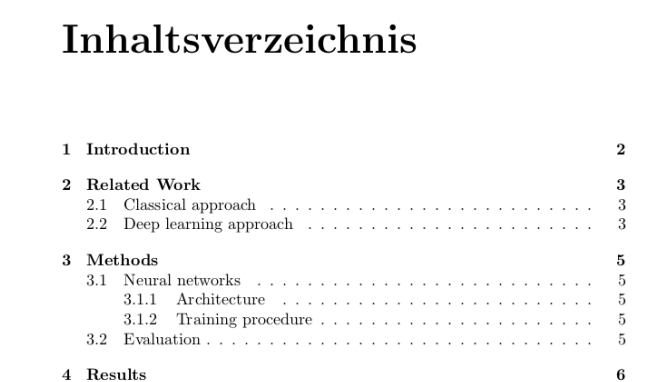
As we will see in section 3.1.2, we...

- Labels have to unique. They correspond to the current level in the hierarchy.
- Note: You will have to compile the source twice to get the right references.

Language

- You will have noticed that words such as “Chapter”, “Contents” and so on, are written in English.
- If you write in German, make sure you import the `babel` package and configure it to German:

```
\usepackage[german]{babel}
```



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Figures and images

- Images (png, pdf, jpg) can be included in figures:

```
\usepackage{graphicx}
...
\begin{figure}
    \centering
    \includegraphics[width=0.6\textwidth]{img/alexnet.png}
    \caption{AlexNet.\label{fig:alexnet}}
\end{figure}
```

- You can specify its width (relative to the page width or absolute in mm/in), its height, its orientation and so on.
- The caption will be automatically numbered.
- If you add a label to the caption, you can cite the figure with `\ref`:

```
As depicted on Fig. \ref{fig:alexnet}
```

Lists and enumerations

- Lists are possible with the `itemize` environment.
- Enumerations with the `enumerate` environment. Numbers are generated automatically.
- They can be nested.

```
\begin{enumerate}
    \item The first things to consider are:
        \begin{itemize}
            \item this;
            \item that;
            \item that also.
        \end{itemize}
    \item Then one should take:
        \begin{itemize}
            \item this;
            \item that.
        \end{itemize}
        into account.
\end{enumerate}
```

Mathematical equations

- The main strength of LaTeX{} w.r.t Office is the possibility to produce nice equations:

$$\nabla_\theta \mathcal{J}(\theta) = \mathbf{E}_{\pi_\theta}[\nabla_\theta \log \pi_\theta(s,a) Q^{\pi_\theta}(s,a)] \tag{1}$$

```
\usepackage{amssymb,amsmath}
...
\begin{equation} \label{eq:continuouspolicyloss}
\nabla_\theta \mathcal{J}(\theta) = \mathbf{E}_{\pi_\theta}
            [\nabla_\theta \log \pi_\theta(s, a) Q^{\pi_\theta}(s, a)]
\end{equation}
```

- Math symbols $\nabla_\theta \mathcal{J}(\theta)$ can also be used inline:

```
Math symbols $\nabla_\theta \mathcal{J}(\theta)$ can also be used...
```

Mathematical equations

- Equations can be numbered, aligned, etc...

$$\begin{aligned} \nabla_\theta J(\theta) &\approx \mathbf{E}_{\pi_\theta}[\nabla_\theta Q(s,a|\theta)|_{s=s_t,a=\mu_\theta(s_t)}] \\ &= \mathbf{E}_{\pi_\theta}[\nabla_a Q^{\pi_\theta}(s,a)|_{s=s_t,a=\mu_\theta(s_t)} \times \nabla_\theta \mu_\theta(s)|_{s=s_t}] \end{aligned} \tag{2}$$

```
\begin{align} \label{eq:deterministicgradient}
    \nabla_{\theta} J(\theta)
        & \approx \mathbf{E}_{\pi_\theta}
            [\nabla_{\theta} Q(s,a|\theta)|_{s=s_t,a=\mu_\theta (s_t)}]
            \nonumber\\
        & = \mathbf{E}_{\pi_\theta}[\nabla_{a}
            Q^{\pi_\theta}(s, a)|_{s=s_t,a=\mu_\theta(s_t)}
            \times \nabla_{\theta}\mu_\theta(s)|_{s=s_t}]
\end{align}
```

Mathematical equations

- Complete guide to amsmath:

http://www.tug.org/teTeX/tetex-texmfdist/doc/latex/amsmath/amsldoc.pdf

- Short math guide:

ftp://ftp.ams.org/ams/doc/amsmath/short-math-guide.pdf

- Symbols cheat sheet:

http://reu.dimacs.rutgers.edu/Symbols.pdf

References

- The other main advantage of LaTeX{} is the ability to cleanly manage references (Vitay and Hamker, 2014).
- Vitay and Hamker (2014) showed that blabla...

```
The other main advantage of \LaTeX{} is the ability to
cleanly manage references \citep{Vitay2014}.

\cite{Vitay2014} showed that blabla...
```

- There are two tools for that: `bibtex` and `biblatex`. Here we focus on `bibtex` with the `natbib` package:

```
\usepackage{natbib}
\bibliographystyle{plain}
```

- `natbib` allows you to use `\cite` for inline citations Author (year), and `\citep` for citation in parentheses (Author, year).

References

- The first thing is to create a `.bib` file (e.g. `biblio.bib`) for bib entries, such as:

```
@article{Vitay2014,
  title   = {Timing and expectation of reward: a neuro-computational
             model of the afferents to the ventral tegmental area.},
  author  = {Vitay, Julien and Hamker, Fred H.},
  journal = {Frontiers in Neurorobotics},
  year    = {2014},
  volume  = {8},
  number  = {4},
  pages   = {1--14},
}
```

- The first argument to `@article` is the **key**, which is what you will use inside `\cite` or `\citep` to refer to the journal article.
- There are different entry types: `article`, `book`, `inproceedings`, `inbook`, `phdthesis`, etc., with different required fields.

http://bib-it.sourceforge.net/help/fieldsAndEntryTypes.php

References: article entry

(Vitay and Hamker, 2014)

```
@article{Vitay2014,
  title   = {Timing and expectation of reward: a neuro-computational
             model of the afferents to the ventral tegmental area.},
  author  = {Vitay, Julien and Hamker, Fred H.},
  journal = {Frontiers in Neurorobotics},
  year    = {2014},
  volume  = {8},
  number  = {4},
  pages   = {1--14},
}
```

References: book entry

(Sutton and Barto, 1998)

```
@book{Sutton1998,
    author = {Sutton, Richard S. and Barto, Andrew G.},
    title = {Introduction to Reinforcement Learning},
    year = {1998},
    isbn = {0262193981},
    edition = {1st},
    publisher = {MIT Press},
    address = {Cambridge, MA, USA},
}
```

References: conference proceedings

(Silver et al., 2014)

```
@inproceedings{Silver2014,
    author = {Silver, D. and Lever, G. and Heess, N. and
              Degris, T. and Wierstra, D. and Riedmiller, M.},
    title = {{Deterministic Policy Gradient Algorithms}},
    booktitle = {Proceedings of Machine Learning Research},
    year = {2014},
    editor = {Xing, Eric P and Jebara, Tony},
    pages = {387--395},
    publisher = {PMLR},
    volume = {32},
    address = {Beijing, China},
}
```

References: compiling

- Once your bib file is created, you need to add at the end of your document:

```
\bibliography{biblio}
```

by omitting the `.bib` extension of your `biblio.bib` file.

- You should now call `bibtex` on the generated `.aux` file and recompile two times:

```
pdflatex main.tex # Compiles a first time to gather the \cite commands
bibtex main.aux # Generates a .bbl file with the correct entries
pdflatex main.tex # Add the entries to the References section
pdflatex main.tex # Make sur the citations are correct
```

References: selecting a style

Different journals/disciplines have different requirement for the citation style:

- Chicago-style : (Weinstein 2009)

Weinstein, Joshua I. 2009. “The Market in Plato’s Republic.”" Classical Philology 104:439–58.

- Harvard-style: (Maynard, 1999)

Maynard, W 1999 ‘Thoreau’s House at Walden’, Art Bulletin, 81, 2, pp. 303

- Numbered / Nature [13]

13. Herron, B. J. et al. Efficient generation and mapping of recessive developmental mutations using ENU mutagenesis. Nat. Genet. 30, 185–189 (2002).

References: selecting a style

- LaTeX{} hat tons of predefined styles which you can directly use:

  plain, abbrv, unsrt, alpha…

http://www.cs.stir.ac.uk/~kjt/software/latex/showbst.html

- You just need to call `\bibliographystyle` in the preamble:

```
\bibliographystyle{alpha}
```

- The style we recommend for the report is `apalike` (American Psychological Association-like)

```
\usepackage{apalike}
\bibliographystyle{apalike}
```

- You can also download any of the `.csl` files on this website and put them in the same directory:

https://github.com/citation-style-language/styles

References: managing entries

- Typing entries by hand can be very exhausting.
- There are many **reference managers** available to help you:
  - Jabref http://www.jabref.org/
  - Colwiz https://www.colwiz.com/
  - KBibTex http://home.gna.org/kbibtex
  - Mendeley http://www.mendeley.com/
  - Zotero http://www.zotero.org/
  - Readcube https://www.readcube.com/
- Some are desktop applications, others are cloud-based services.
- Most of them allow you to search the web for a reference and automatically import them in your `.bib` file with all the correct fields.
- Some (Mendeley/Zotero) even have a browser plugin to save references from a web page in one click.

LaTeX{} can do so much more

- And much more: tables, algorithms, music sheets, posters, flyers...
- A lot of non-standard packages can be downloaded from CTAN (Comprehensive TEX Archive Network):

https://www.ctan.org

2 - Beamer document class for presentations

The beamer document class

```
\documentclass[9pt]{beamer}

\title{Title of the presentation}
\author{Author Name}
\institute{TU Chemnitz}
\date{\today}

% Start the document
\begin{document}

% Title slide is automatically generated
\frame{\titlepage}

% Slides are frame environments
\begin{frame}{Introduction}

My first slide.

\end{frame}
```

Making slides with beamer

- The only difference with a normal LaTeX{} document is the `beamer` document class, and the use of `frame` environments for each slide.
- For the slide content, just use normal LaTeX{}:

```
\begin{frame}{Title of the slide}

\begin{itemize}
    \item I will first talk about this.
    \item But also talk about this.
\end{itemize}

\begin{center}
    \includegraphics[width=0.6\textwidth]{img/image1.png}
\end{center}

\end{frame}
```

Two columns

- It is often useful to have two columns on a slide (e.g. an image on the left and some bullet points on the right).
- Beamer provides the `columns` environment for that:

```
\begin{columns}
    \begin{column}{0.5\textwidth} % Left column is 50% of the slide
        \begin{center}
            \includegraphics[width=0.9\columnwidth]{image1.jpg}
        \end{center}
    \end{column}
    \begin{column}{0.5\textwidth} % Right column
        \begin{itemize}
            \item First point.
            \item Second point.
        \end{itemize}
    \end{column}
\end{columns}
```

Overlay: Incremental revealing

```
Some people like suspense in their slides:
\pause
\begin{itemize}
\item First I will talk about this.
\pause
\item Then explain that.
\pause
\item Finally conclude on this.
\end{itemize}
```

Some people like suspense in their slides:

Overlay: Incremental revealing

```
Some people like suspense in their slides:
\pause
\begin{itemize}
\item First I will talk about this.
\pause
\item Then explain that.
\pause
\item Finally conclude on this.
\end{itemize}
```

Some people like suspense in their slides:

- First I will talk about this.

Overlay: Incremental revealing

```
Some people like suspense in their slides:
\pause
\begin{itemize}
\item First I will talk about this.
\pause
\item Then explain that.
\pause
\item Finally conclude on this.
\end{itemize}
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Some people like suspense in their slides:

- First I will talk about this.
- Then explain that.

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```
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\begin{itemize}
\item First I will talk about this.
\pause
\item Then explain that.
\pause
\item Finally conclude on this.
\end{itemize}
```

Some people like suspense in their slides:

- First I will talk about this.
- Then explain that.
- Finally conclude on this.

Overlay: specifying the slide number

```
Some people like suspense in their slides:
\begin{enumerate}[A]
\item<2-5> \color<5>[rgb]{0,0,0.6} First I will talk about this.
\item<3-4> Then explain that.
\item<4-4> Finally conclude on this.
\end{enumerate}
```

Some people like suspense in their slides:

Overlay: specifying the slide number

```
Some people like suspense in their slides:
\begin{enumerate}[A]
\item<2-5> \color<5>[rgb]{0,0,0.6} First I will talk about this.
\item<3-4> Then explain that.
\item<4-4> Finally conclude on this.
\end{enumerate}
```

Some people like suspense in their slides:

A First I will talk about this.

Overlay: specifying the slide number

```
Some people like suspense in their slides:
\begin{enumerate}[A]
\item<2-5> \color<5>[rgb]{0,0,0.6} First I will talk about this.
\item<3-4> Then explain that.
\item<4-4> Finally conclude on this.
\end{enumerate}
```

Some people like suspense in their slides:

A First I will talk about this.

B Then explain that.

Overlay: specifying the slide number

```
Some people like suspense in their slides:
\begin{enumerate}[A]
\item<2-5> \color<5>[rgb]{0,0,0.6} First I will talk about this.
\item<3-4> Then explain that.
\item<4-4> Finally conclude on this.
\end{enumerate}
```

Some people like suspense in their slides:

A. First I will talk about this.

B. Then explain that.

C. Finally conclude on this.

Overlay: specifying the slide number

```
Some people like suspense in their slides:
\begin{enumerate}[A]
\item<2-5> \color<5>[rgb]{0,0,0.6} First I will talk about this.
\item<3-4> Then explain that.
\item<4-4> Finally conclude on this.
\end{enumerate}
```

Some people like suspense in their slides:

A First I will talk about this.

Overlay: elements which can be controlled

- `\textbf<>{}` controls when to bold text.
- `\only<>{}` controls when to reveal text, occupies NO space otherwise.
- `\textit<>{}` controls when to italicize text.
- `\uncover<>{}` controls when to reveal text, DOES occupy space otherwise.
- `\color<>[]{}` controls when to change color of text.
- `\alt<>{}{}` reveals first argument when specification is true, otherwise reveals second argument.
- `\alert<>{}` controls when to highlight text (default red).
- `\item<>` controls when an item is shown.

Beamer styles

- Beamer comes with plenty of styles (AnnHarbor, Madrid, etc.) and color themes which can be used directly:

https://hartwork.org/beamer-theme-matrix

```
\usetheme{Antibes}
\usecolortheme{dolphin}
\beamertemplatenavigationsymbolsempty
```

- The advantage of themes is that you can structure your slides into `\section`, `\subsection`, etc., and the current section will be displayed in the header.
- The TU Chemnitz also has a corporate beamer style:

https://www.tu-chemnitz.de/uk/corporate_design/vorlagen/dokumente/latex/latex-beamer.zip

Structuring

```
\section{Intro to Beamer}
    \subsection{About Beamer}
    \subsection[Basic Structure]{Basic Structure}
    \subsection{How to Compile}
\section{Overlaying Concepts}
    \subsection{Specifications}
    \subsection[Examples]{Examples: Lists, Graphics, Tables}
\section[Sparkle]{Adding that Sparkle}
    \subsection{Sections}
    \subsection{Themes}
\section*{References}
```

You can force the table of contents to displayed at the beginning of each section with:

```
\AtBeginSection[]
{
    \begin{frame}{Table of Contents}
    \tableofcontents[currentsection]
    \end{frame}
}
```

References

Silver, D., Lever, G., Heess, N., Degris, T., Wierstra, D., and Riedmiller, M. (2014). Deterministic Policy Gradient Algorithms. In E. P. Xing and T. Jebara (Eds.), *Proceedings of ICML* (Vol. 32, pp. 387–395). Beijing, China: PMLR.

Sutton, R. S., and Barto, A. G. (1998). *Reinforcement learning: An introduction* (Vol. 28). MIT press.

Vitay, J., and Hamker, F. H. (2014). Timing and expectation of reward: A neuro-computational model of the afferents to the ventral tegmental area. *Frontiers in Neurorobotics*, *8*(4), 1–14.