UNIVERSITY OF MANNHEIM
School of Business Informatics and Mathematics

# Latex

## Seminar in Green Software Engineering

Based on slides by Dr. Pasquale Salza

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# What is LaTeX?

- Pronounced *LAY-tek* or *LAH-tek*
- A tool used to create professional looking documents
- *What You See Is What You Mean* (no *What You See What You Get*)
- Separation of the contents from the style

# Why learn LaTeX?

- Used all over the world for scientific documents and books
- Quickly tackle the typesetting for mathematics, table of contents and referencing
- Plenty of community open source packages

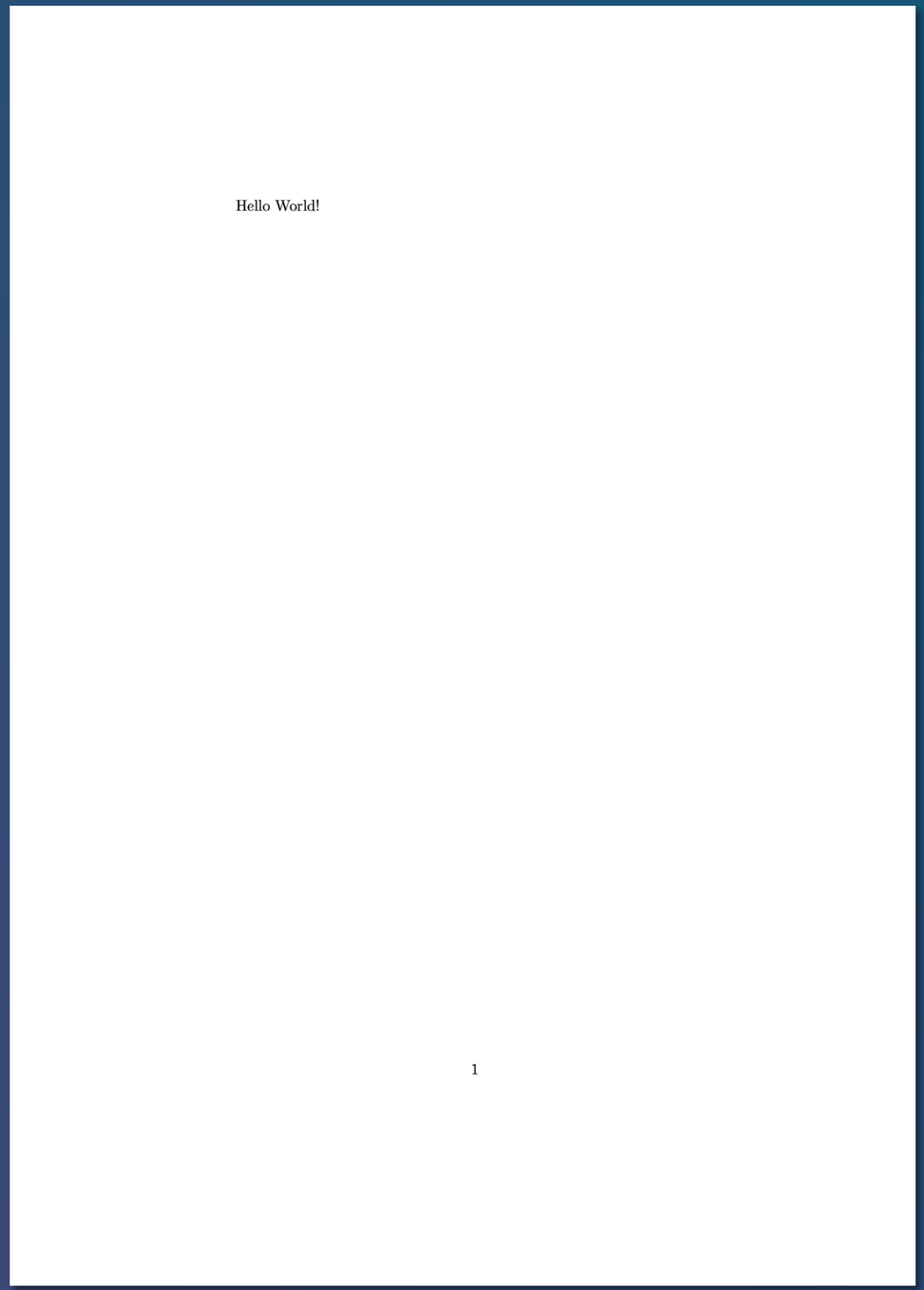
# Overleaf

- Cloud-Based LaTeX editor
- Real Time Collaboration
- Intuitive Interface
- Extensive Templates
- Check if Premium account with Uni Email

# 👋 Hello World!

```latex
\documentclass{article}

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

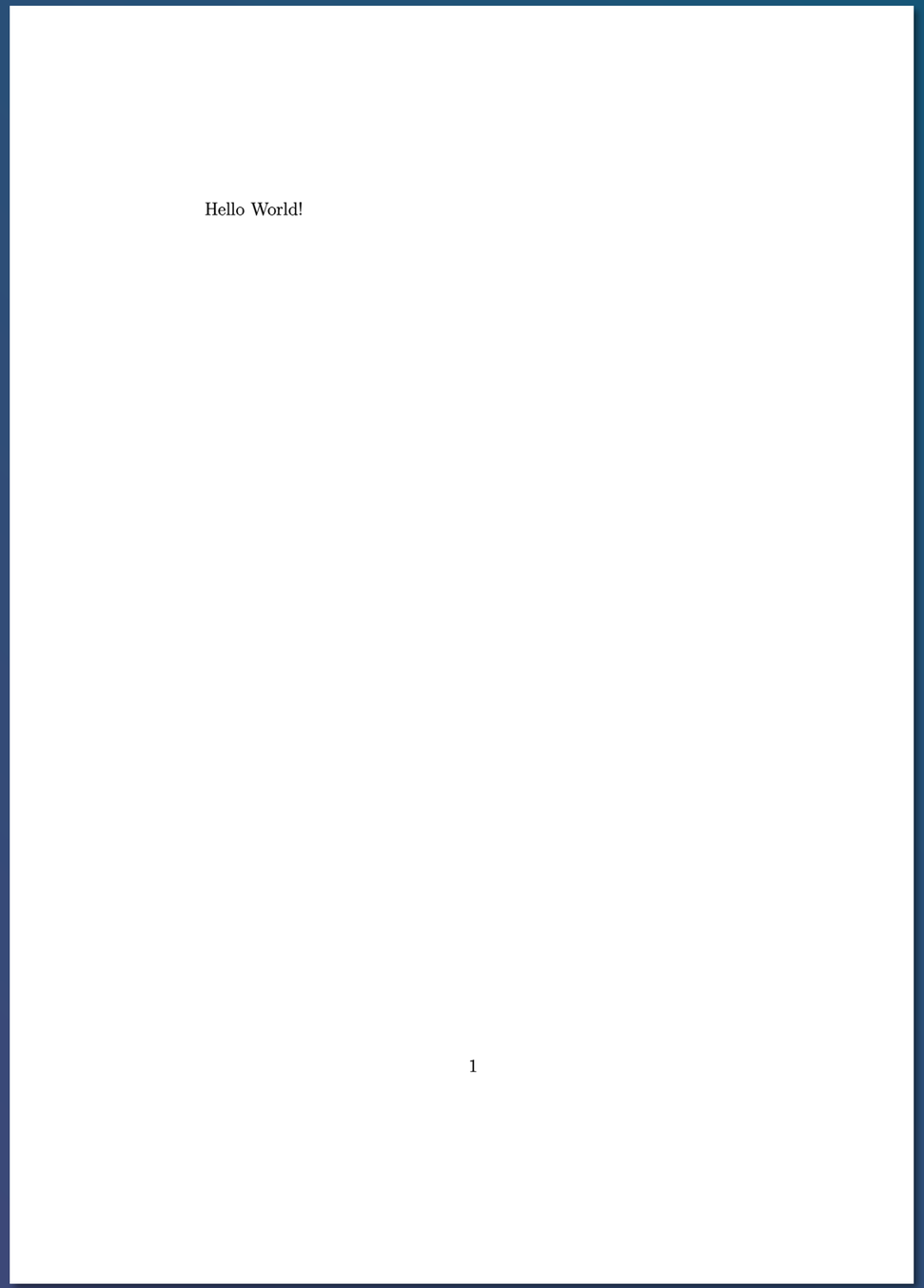
- `\documentclass` defines the type/class of document
- `article` is the simplest and most common in LaTeX
- Other options are `book`, `report`, or any template, e.g., *IEEE*
- The content of the document is enclosed inside the `\begin{document}` and `\end{document}` tags



# UP! The preamble

```latex
\documentclass[12pt, letterpaper]{article}

\usepackage[utf8]{inputenc}

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

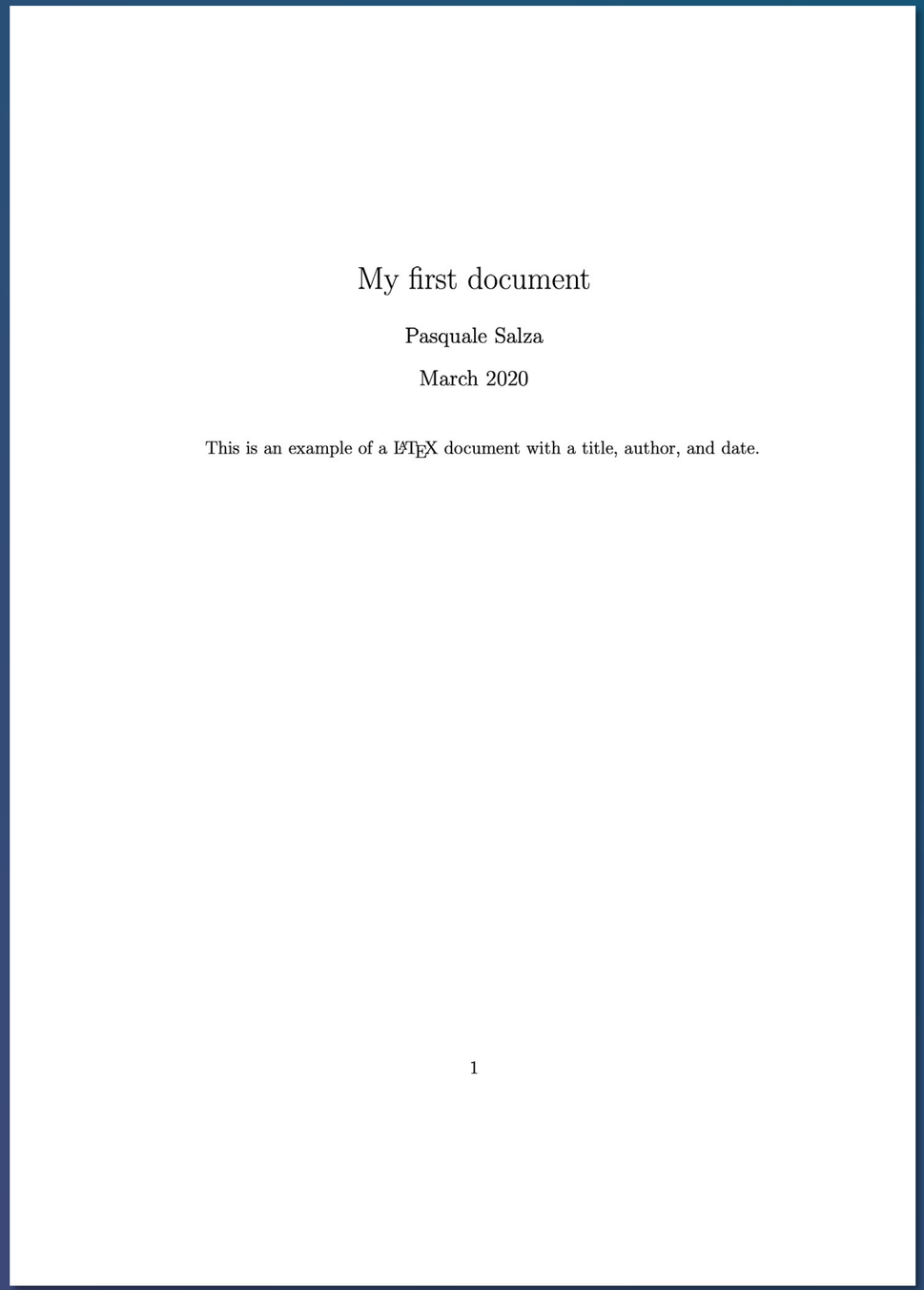
- Everything before `\begin{document}` is called *preamble*
- The preamble contains all the packages and settings for the document
- `\documentclass[12pt, letterpaper]{article}` defines some options for the command
- `\usepackage[utf8]{inputenc}` defines the encoding, i.e., how the character are interpreted from bytes



# UP! Title, author, and date

```latex
\documentclass[12pt, letterpaper]{article}
\usepackage[utf8]{inputenc}

\title{My first document}
\author{Pasquale Salza}
\date{March 2020}

\begin{document}
\maketitle
This is an example of a \LaTeX{} document with a title, author, and date.
\end{document}
```

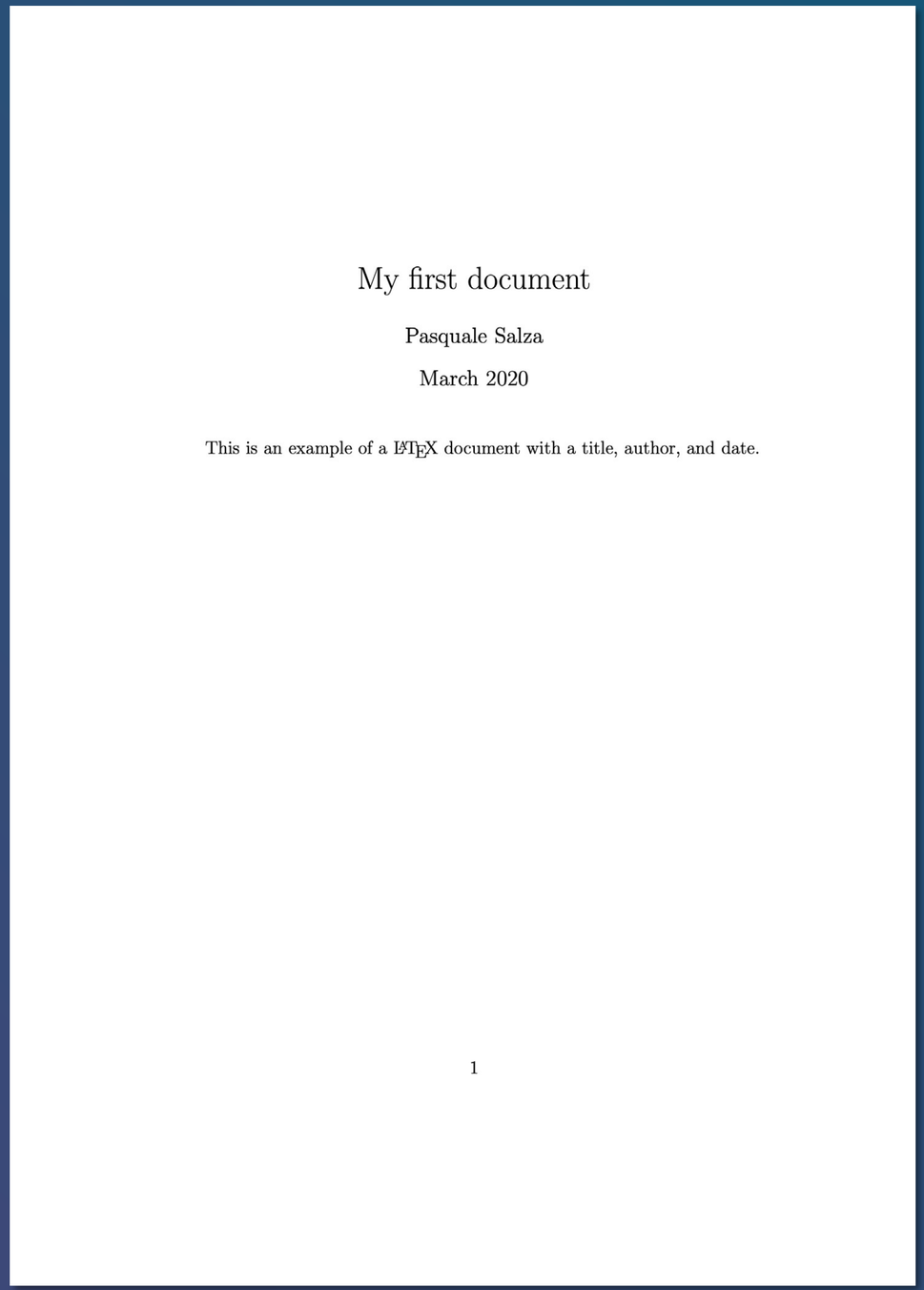
- `\title{}`, `\author{}`, and `\date{}` have to be added to the preamble
- `\today` can be used to have an automatic date
- `\maketitle` prints this information on the document



# 💬 Comments

```latex
\documentclass[12pt, letterpaper]{article}
\usepackage[utf8]{inputenc}

\title{My first document}
\author{Pasquale Salza}
\date{March 2020}

\begin{document}
\maketitle
This is an example of a \LaTeX{} document with a title, author, and date.
% This is a comment.
\end{document}
```

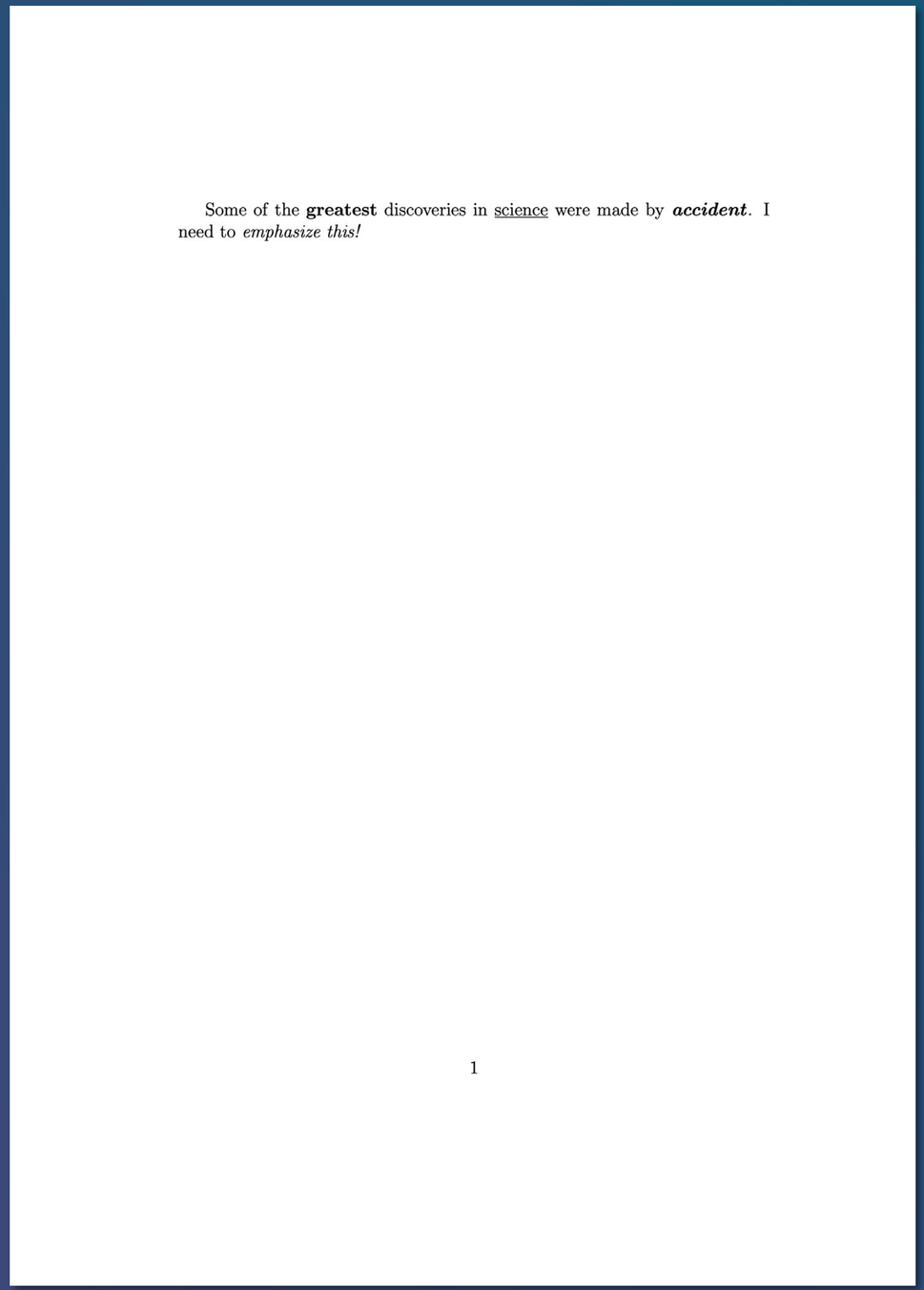
- Line comments are possible by using the % symbol
- The % symbol can be escaped by using \%
- Multiline comments can be obtained by using the verbatim package and comment environment



# 🖍️ Bold, italics, and underlining

```
1 \begin{document}
2 Some of the \textbf{greatest}
3 discoveries in \underline{science}
4 were made by \textbf{\textit{accident}}.
5 I need to \emph{emphasize this!}
6 \end{document}
```

- Bold text is written with `\textbf{}`
- Italicised text with `\textit{}`
- `\underline{}` prints underlined text
- `\emph{}` can be used to emphasize text, but it depends on the template

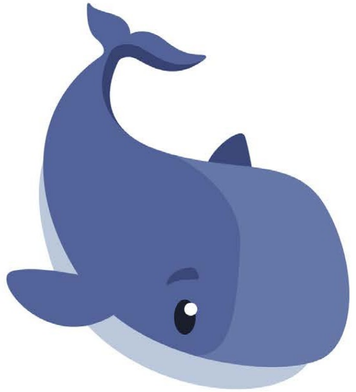


# Figures

```latex
\usepackage{graphicx}

\begin{document}
Whales are a widely distributed and diverse group of
fully aquatic placental marine mammals.

\includegraphics{whale.pdf}

They are an informal grouping within the infraorder Cetacea,
usually excluding dolphins and porpoises.
\end{document}
```

- We can import images by using the `graphicx` package
- `\includegraphics{}` prints the image, which is supposed to be in the same folder of the LaTeX file
- Use vector instead of raster graphics to preserve the best quality

Whales are a widely distributed and diverse group of fully aquatic placental marine mammals.



They are an informal grouping within the infraorder Cetacea, usually excluding dolphins and porpoises.

# 🖼️ Captions, labels, and references

```latex
Whales are a widely distributed and diverse group of
fully aquatic placental marine mammals.

\begin{figure}[h]
    \centering
    \includegraphics[width=0.5\textwidth]{whale.pdf}
    \caption{A nice whale}
    \label{fig:whale}
\end{figure}

As you can see in the Figure \ref{fig:whale},
the whale is a beautiful animal.
The figure is on page \pageref{fig:whale}.
```

- The figure environment can be used to caption, label, and reference an image
- `\caption{}` controls the text for the caption
- `\label{}` defines the label to be used for referencing the figure
- `\ref{}` and `\pageref{}` dynamically replace the command with corresponding figure and page numbers, respectively

Whales are a widely distributed and diverse group of fully aquatic placental marine mammals.

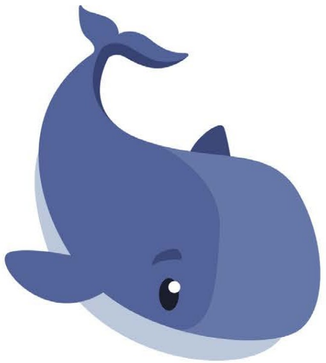


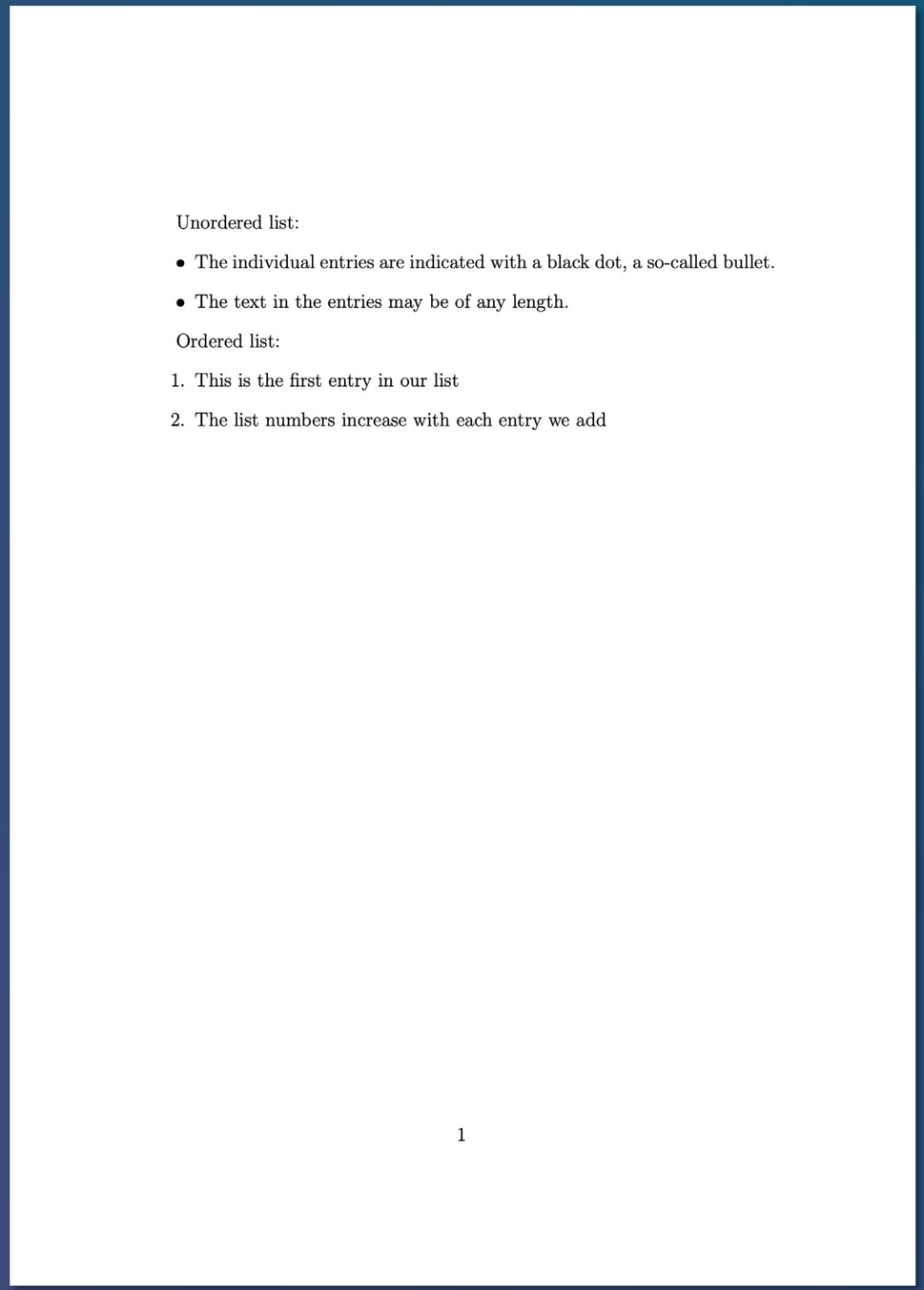
Figure 1: A nice whale

As you can see in the Figure 1, the whale is a beautiful animal. The figure is on page 1.

# ☑ Unordered and ordered lists

```
1 Unordered list:
2 \begin{itemize}
3     \item The individual entries are indicated with a black dot,
4     a so-called bullet
5     \item The text in the entries may be of any length
6 \end{itemize}
7
8 Ordered list:
9 \begin{enumerate}
10    \item This is the first entry in our list
11    \item The list numbers increase with each entry we add
12 \end{enumerate}
```

- The lists can be obtained by using specific environments
- `itemize` is used for unordered lists
- `enumerate` environment is for ordered lists
- Every list entry must be preceded by `\item`



Unordered list:

- The individual entries are indicated with a black dot, a so-called bullet.
- The text in the entries may be of any length.

Ordered list:

1. This is the first entry in our list
2. The list numbers increase with each entry we add

1

# 1234 Inline math

```
1 In physics, the mass-energy equivalence is stated
2 by the equation $E=mc^2$, discovered in 1905 by Albert Einstein.
```

- Inline mode for math allows to write formulas as part of the text
- The allowed delimiters to enable this mode are: `\(` … `\)`, `$` … `$`, or `\begin{math}` … `\end{math}`
- Formulas are automatically formatted

In physics, the mass-energy equivalence is stated by the equation $E = mc^2$, discovered in 1905 by Albert Einstein.

# 🔢 Display math

```
1 The mass-energy equivalence is described by the famous equation
2
3 \[ E=mc^2 \]
4
5 discovered in 1905 by Albert Einstein.
6 In natural units ($c = 1$), the formula expresses the identity
7
8 \begin{equation}
9 E=m
10 \end{equation}
```

- Display mode shows formulas separately from the text lines
- `\[ … \]` and `\begin{displaymath} … \end{displaymath}` show the unnumbered formula
- `\begin{equation} … \end{equation}` is used for the numbered version

The mass-energy equivalence is described by the famous equation

$$E = mc^2$$

discovered in 1905 by Albert Einstein. In natural units ($c = 1$), the formula expresses the identity

$$E = m \tag{1}$$

# 🔢 Math examples

```
Subscripts in math mode are written as $a_b$ and
superscripts are written as $a^b$.
These can be combined an nested to write expressions such as

\[ T^{i_1 i_2 \dots i_p}_{j_1 j_2 \dots j_q} =
T(x^{i_1},\dots,x^{i_p},e_{j_1},\dots,e_{j_q}) \]

We write integrals using $\int$ and fractions using $\frac{a}{b}$.
Limits are placed on integrals using superscripts and subscripts:

\[ \int_0^1 \frac{1}{e^x} =  \frac{e-1}{e} \]

Lower case Greek letters are written as $\omega$ $\delta$ etc.
while upper case Greek letters are written as $\Omega$ $\Delta$.

Mathematical operators are prefixed with a backslash as
$\sin(\beta)$, $\cos(\alpha)$, $\log(x)$ etc.
```

Subscripts in math mode are written as $a_b$ and superscripts are written as $a^b$. These can be combined an nested to write expressions such as

$$T^{i_1 i_2 \dots i_p}_{j_1 j_2 \dots j_q} = T(x^{i_1},\dots,x^{i_p},e_{j_1},\dots,e_{j_q})$$

We write integrals using $\int$ and fractions using $\frac{a}{b}$. Limits are placed on integrals using superscripts and subscripts:

$$\int_0^1 \frac{1}{e^x} = \frac{e-1}{e}$$

Lower case Greek letters are written as $\omega$ $\delta$ etc. while upper case Greek letters are written as $\Omega$ $\Delta$.

Mathematical operators are prefixed with a backslash as $\sin(\beta)$, $\cos(\alpha)$, $\log(x)$ etc.

# Abstract

```latex
\begin{document}

\maketitle

\begin{abstract}
    This is a simple paragraph at the beginning of the
    document. A brief introduction about the main subject.
\end{abstract}

\end{document}
```

- The `abstract` environment allows to print a formatted abstract
- The majority of templates support it
- The abstract is usually written as a single paragraph, without newlines

My first document

Pasquale Salza

March 2020

**Abstract**

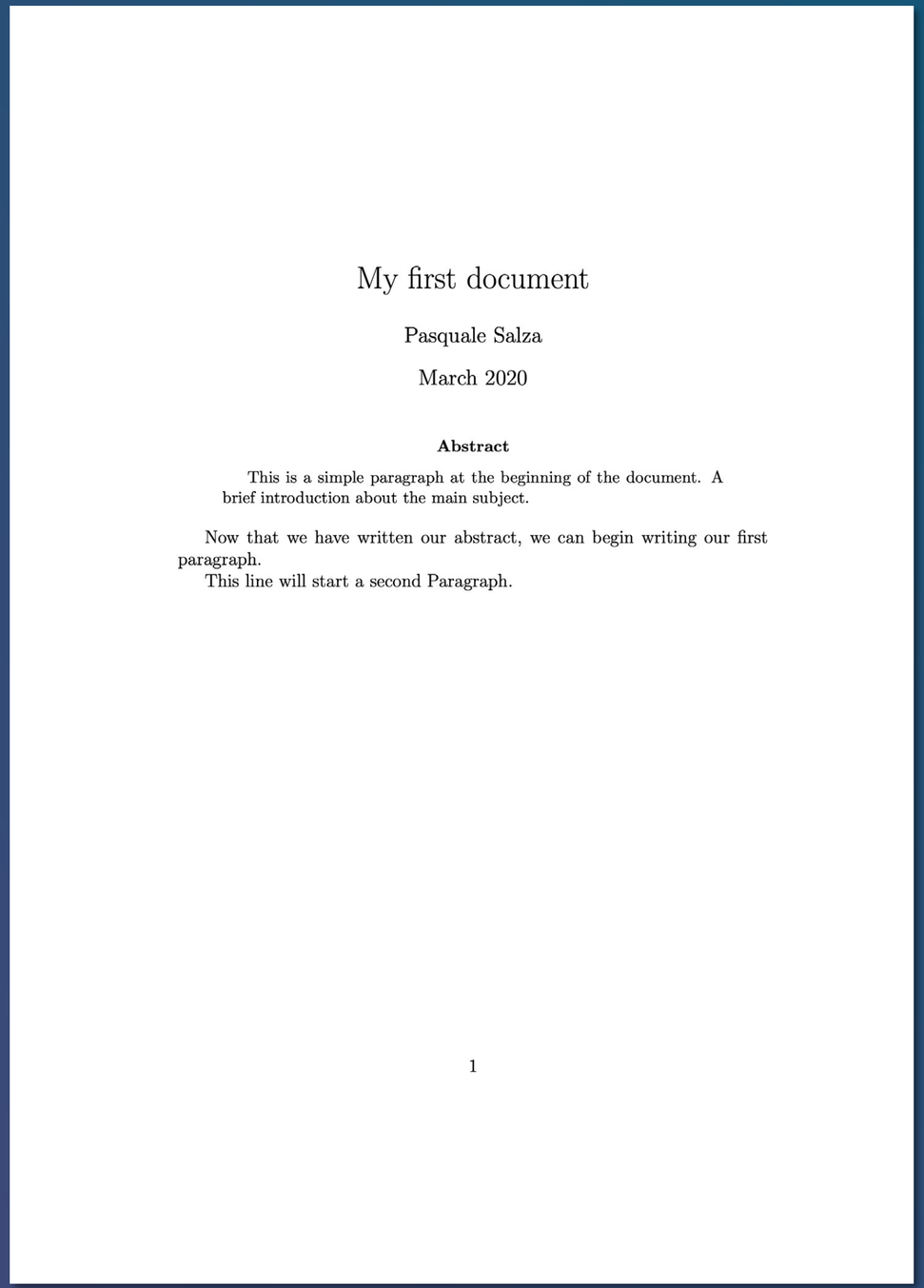
This is a simple paragraph at the beginning of the document. A brief introduction about the main subject.

1

# 🆕 Paragraphs and newlines

```latex
\begin{abstract}
    This is a simple paragraph at the beginning of the
    document. A brief introduction about the main subject.
\end{abstract}

Now that we have written our abstract,
we can begin writing our first paragraph.

This line will start a second Paragraph.
```

- To start a new paragraph is necessary to insert a double blank line
- The template decides whether indent automatically new paragraphs
- A single newline does’t have any impact on the print, but it has on the version control, e.g., git
- To start a new line without actually stating a new paragraph is possible by using `\\` or `\newline`, but it should be avoided to not interfere with LaTeX typesetting



My first document

Pasquale Salza

March 2020

**Abstract**

This is a simple paragraph at the beginning of the document. A brief introduction about the main subject.

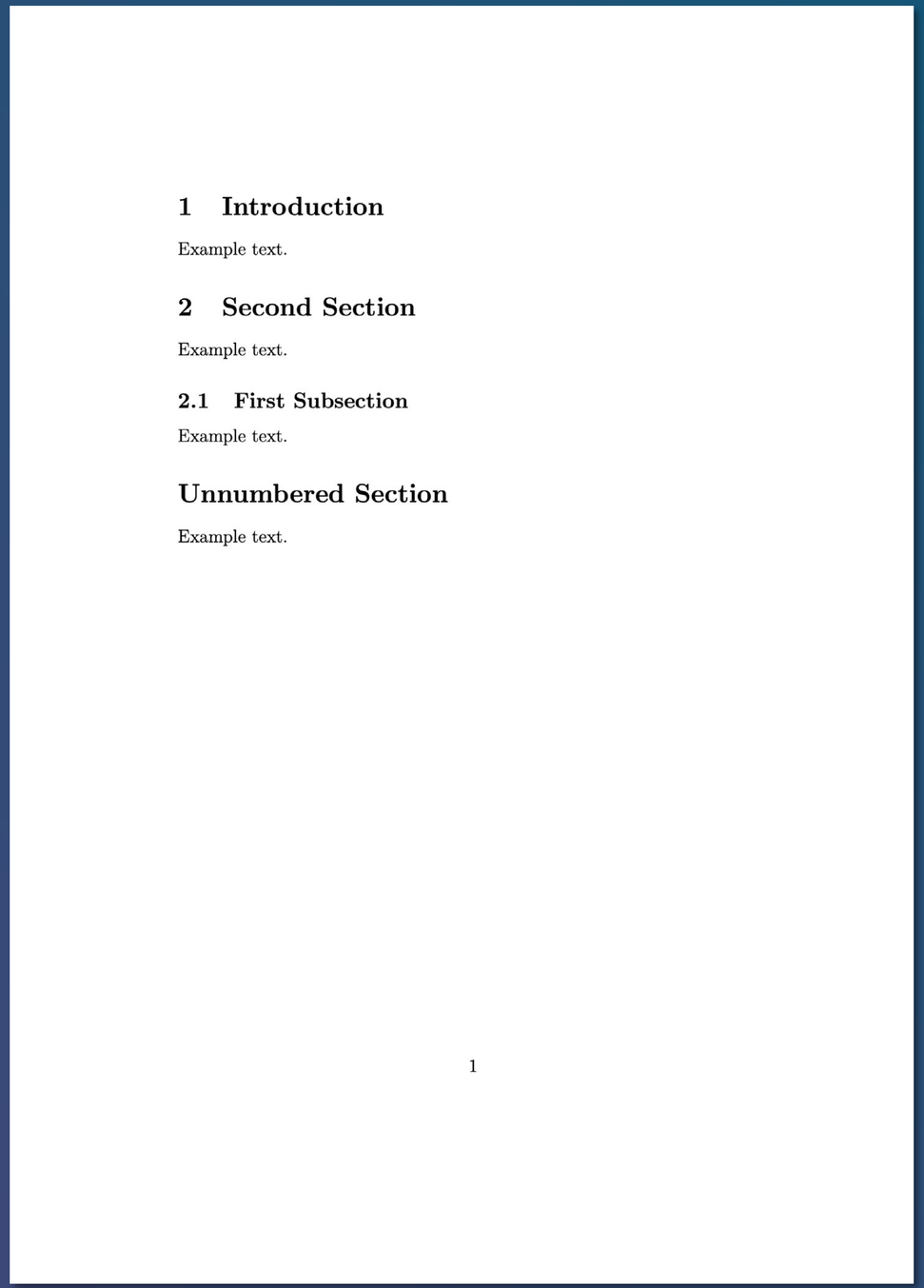
Now that we have written our abstract, we can begin writing our first paragraph.
This line will start a second Paragraph.

1

# Sections

```latex
\section{Introduction}
Example text.

\section{Second Section}
Example text.

\subsection{First Subsection}
Example text.

\section*{Unnumbered Section}
Example text.
```

- Section commands allow to give a structure to a document
- `\section{}` marks the beginning of a new section, specifying a title for this
- Section numbering can be disabled by using the star version of `\section{}`, i.e., `\section*{}`



## 1 Introduction

Example text.

## 2 Second Section

Example text.

### 2.1 First Subsection

Example text.

## Unnumbered Section

Example text.

# Section levels

| Level | Command |
|---|---|
| -1 | \part{part} |
| 0 | \chapter{chapter} |
| 1 | \section{section} |
| 2 | \subsection{subsection} |
| 3 | \subsubsection{subsubsection} |
| 4 | \paragraph{paragraph} |
| 5 | \subparagraph{subparagraph} |

Version of \section{

Chapter 1

chapter

1.1 section

1.1.1 subsection

subsubsection

paragraph

subparagraph

# Tables

```latex
\begin{table}[h]
    \centering
    \begin{tabular}{c c c}
        \toprule
        Col1 & Col2 & Col3 \\
        \midrule
        cell1 & cell2 & cell3 \\
        cell4 & cell5 & cell6 \\
        cell7 & cell8 & cell9 \\
        \bottomrule
    \end{tabular}
    \caption{This is an example of table}
    \label{tab:example}
\end{table}

Table \ref{tab:example} is an example of
referenced \LaTeX{} elements.
```

| Col1 | Col2 | Col3 |
|---|---|---|
| cell1 | cell2 | cell3 |
| cell4 | cell5 | cell6 |
| cell7 | cell8 | cell9 |

Table 1: This is an example of table

Table 1 is an example of referenced LaTeX elements.

- The `tabular` environment is the default method to create tables
- `{c c c}` specifies to use three columns with centered alignment, `l` for left, and `r` for right
- The `&` symbol specify the breaks for the cells
- New rows are specified by `\\`

# Bibliography ffile

- The bibliography files must have the standard bibtex syntax
- The first line of a record entry, e.g., `@article`, tells BibTeX the type of information enclosed between parentheses
- The label of the entry is indicated as first argument and has to be a unique identifier, e.g., `einstein`
- Every other field has the syntax `key = value` and is comma-separated

```
@article{einstein,
    author = "Albert Einstein",
    title = "{Zur Elektrodynamik bewegter K{\"o}rper}. ({German})
    [{On} the electrodynamics of moving bodies]",
    journal = "Annalen der Physik",
    volume = "322",
    number = "10",
    pages = "891--921",
    year = "1905",
    DOI = "http://dx.doi.org/10.1002/andp.19053221004",
    keywords = "physics"
}

@book{dirac,
    title = {The Principles of Quantum Mechanics},
    author = {Paul Adrien Maurice Dirac},
    isbn = {9780198520115},
    series = {International series of monographs on physics},
    year = {1981},
    publisher = {Clarendon Press},
    keywords = {physics}
}

@online{knuthwebsite,
    author = "Donald Knuth",
    title = "Knuth: Computers and Typesetting",
    url  = "http://www-cs-faculty.stanford.edu/~uno/abcde.html",
    addendum = "(accessed: 01.09.2016)",
    keywords = "latex,knuth"
}
```

# 📚 Bibliography management

```latex
\usepackage{biblatex}
\addbibresource{sample.bib}

\begin{document}
Let's cite! The Einstein's journal paper \cite{einstein} and the Dirac's
book \cite{dirac} are physics related items.

\printbibliography
\end{document}
```

- `\usepackage{biblatex}` imports the bibliography manager
- `\addbibresource{sample.bib}` imports the data file, i.e., `sample.bib`, which includes the information about each reference
- `\cite{einstein}` inserts a reference within the document, `[2]` in this case, corresponding to an entry in bibliography having `einstein` as a keyword
- `\printbibliography` prints the list of cited references

Let's cite! The Einstein's journal paper [2] and the Dirac's book [1] are physics related items.

## References


[1] Paul Adrien Maurice Dirac. *The Principles of Quantum Mechanics*. International series of monographs on physics. Clarendon Press, 1981. ISBN: 9780198520115.

[2] Albert Einstein. "Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]". In: *Annalen der Physik* 322.10 (1905), pp. 891–921. DOI: http://dx.doi.org/10.1002/andp.19053221004.

# biber backend

```
\usepackage[
backend=biber,
style=alphabetic,
sorting=ynt
]{biblatex}
\addbibresource{sample.bib}

\begin{document}
\textit{The \LaTeX\ Companion} book \cite{latexcompanion}, the Donald
Knuth's website \cite{knuthwebsite}, \textit{The Comprehensive Tex Archive
Network} (CTAN) \cite{ctan} are \LaTeX\ related items; but the others Donald
Knuth's items \cite{knuth-fa,knuth-acp} are dedicated to programming.
\printbibliography
\end{document}
```

- `biber` is a highly customizable backend to `bibtex`
- `style=alphabetic` specifies the bibliography style
- `sorting=ynt` determines the criteria to sort the bibliographic sources, i.e., year, name, and title
- `\cite{}` can also specify multiple citations

*The LaTeX Companion* book [GMS93], the Donald Knuth's website [Knu], *The Comprehensive Tex Archive Network* (CTAN) [Gre93] are LaTeX related items; but the others Donald Knuth's items [Knu73; Knu68] are dedicated to programming.

## References


[Knu68] Donald E. Knuth. *The Art of Computer Programming*. Four volumes. Seven volumes planned. Addison-Wesley, 1968.

[Knu73] Donald E. Knuth. "Fundamental Algorithms". In: Addison-Wesley, 1973. Chap. 1.2.

[GMS93] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Reading, Massachusetts: Addison-Wesley, 1993.

[Gre93] George D. Greenwade. "The Comprehensive Tex Archive Network (CTAN)". In: *TUGBoat* 14.3 (1993), pp. 342–351.

[Knu] Donald Knuth. *Knuth: Computers and Typesetting*. URL: `http://www-cs-faculty.stanford.edu/~uno/abcde.html`.