



# Mastering Mathematics with $\text{\LaTeX}$

A Workshop to Unlock Your Writing Potential!

Lorenzo Zambelli    Levi Moes





FMF - Fysisch-Mathematische Faculteitsvereniging  
University of Groningen

$\text{\LaTeX}$  Workshop, 8 May 2023

# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

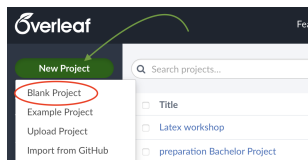
# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

- **Step 1:** Go to `www.overleaf.com`, and sign up.

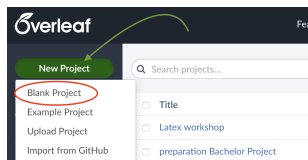
# Set up Overleaf

- **Step 1:** Go to `www.overleaf.com`, and sign up.
- **Step 2:** Open a new *Blank* project



# Set up Overleaf

- **Step 1:** Go to `www.overleaf.com`, and sign up.
- **Step 2:** Open a new *Blank* project



- **Step 3:** Give a look at *main.tex*, while waiting for your classmates 😊

There are two main components to the `main.tex` file

There are two main components to the `main.tex` file

- **Preamble:** everything **before** the initialisation of the document class
  - **Packages:** add additional functionality to  $\text{\LaTeX}$ , called using



There are two main components to the `main.tex` file

- **Preamble:** everything **before** the initialisation of the document class
  - **Packages:** add additional functionality to  $\text{\LaTeX}$ , called using
- **Main document environment:** everything between `\begin{document}` and `\end{document}`
  - **Environments:** used to divide the text into neat blocks of content
  - called using `and`

**For clarity:** outline the rest of your document as follows

**For clarity:** outline the rest of your document as follows

- Load your preamble **separately**: create a new file called `preamble.sty`, and call it using

**For clarity:** outline the rest of your document as follows

- Load your preamble **separately**: create a new file called `preamble.sty`, and call it using
- For each item discussed today:
  - create a new `name.tex` file for each
  - call it using
  - separate each using `or`

Outline the remainder of your document by creating a subfile for each of the following topics (add )

- Writing text
- Inserting images
- Tables
- Math environments
- Referencing

References are essential for academic papers. How to properly use citations and references in your project?

References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`

References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`
- **Step 2:** Include in the `.bib` file all your references.



References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`
- **Step 2:** Include in the `.bib` file all your references.
- **Step 3:** In in your main document/or in `.sty` file include the package *biblatex*

References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`
- **Step 2:** Include in the `.bib` file all your references.
- **Step 3:** In in your main document/or in `.sty` file include the package *biblatex*
- **Step 4:** Add the command in the preamble of the main file

References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`
- **Step 2:** Include in the `.bib` file all your references.
- **Step 3:** In in your main document/or in `.sty` file include the package *biblatex*
- **Step 4:** Add the command in the preamble of the main file
- **Step 5:** Add the command at the bottom of the main file

References are essential for academic papers. How to properly use citations and references in your project?

- **Step 1:** Create a file with extension `.bib`
- **Step 2:** Include in the `.bib` file all your references.
- **Step 3:** In in your main document/or in `.sty` file include the package `biblatex`
- **Step 4:** Add the command in the preamble of the main file
- **Step 5:** Add the command at the bottom of the main file
- **Step 6:** You can start citing using the command

```
\documentclass{article}

\usepackage{biblatex}
\addbibresource{example.bib}

\begin{document}
\ldots{} Recently I was learning to use Bib\LaTeX{}
from-\cite{lshort}. It seems very useful. \ldots

\ldots{} which was already shown by Mrs.-Curie
in-\cite{curie}. \ldots

\ldots{} this can be easily explained by
the fact that Einstein was a time
traveller-\cite{dream}. \ldots

\printbibliography
\end{document}
```

... Recently I was learning to use Bib $\LaTeX$  from [3]. It seems very useful. ...  
... which was already shown by Mrs. Curie in [1]. ...  
... this can be easily explained by the fact that Einstein was a time traveller [2]. ...

## References

- [1] Marie Curie. “Les nouvelles substances radioactives”. In: *Revue scientifique*. 4th ser. 14.3 (1900).
- [2] Jane Diviner. *Yesterday’s dream*. The vision came to me while I was sleeping. It was very vivid. July 19, 3012.
- [3] Tobias Oetiker et al. *The Not So Short Introduction to  $\LaTeX 2_{\epsilon}$* . Mar. 9, 2021. URL: <https://www.ctan.org/pkg/lshort-english>.

# How to write reference in the .bib file?

The bibliographic database has its own syntax,

```
@<entry type>{<marker>,  
  <field1> = {<value1>},  
  <field2> = {<value2>},  
  <field3> = {<value3>},  
  :  
}
```

In the basic style of Bib $\LaTeX$  we have the following types:

- `article` for articles from journals or other periodicals.
- `book` for single-volume book.
- `online` for accessed online resources.
- `misc` for entries that do not fit any of the predefined categories.

Examples of fields are `author`, `title`, `journaltitle`, `date`, `url`, `doi`, `note`, etc...



# Example

```
@article{Bloembergen2018,  
  author = {Daan Bloembergen and  
           Davide Grossi and  
           Martin Lackner},  
  title = {On Rational Delegations in Liquid Democracy},  
  journal = {CoRR},  
  volume = {abs/1802.08020},  
  year = {2018},  
  url = {http://arxiv.org/abs/1802.08020},  
  eprinttype = {arXiv},  
  eprint = {1802.08020},  
  timestamp = {Mon, 13 Aug 2018 16:48:13 +0200},  
  biburl = {https://dblp.org/rec/journals/corr/abs-1802-08020.bib},  
  bibsource = {dblp computer science bibliography, https://dblp.org}  
}  
  
@book{Jackson2010,  
  title = {Social and Economic Networks},  
  author = {Jackson, M. O.} ,  
  isbn = {9781400833993},  
  year = {2010},  
  publisher = {Princeton University Press},  
  keywords = {Economics},  
}
```



# Journals and search-engine help you!

All journals and search-engine have the function cite!

For example, Google Scholar has something like this

The image shows a screenshot of the Google Scholar interface. The search query is "Unveiling the Truth in Liquid Democracy with Misinformed Voters". The search results list the paper by Becker, Ruben, et al. (2021) from Springer. A red arrow points to the "Cite" button in the article's metadata. Another red arrow points to the "Cite" dialog box that appears, showing various citation styles (MLA, APA, Chicago, Harvard, Vancouver) and a "Bibtex" button circled in red. The Bibtex button is highlighted with a red circle and a red arrow pointing to it from the dialog box.



# Try yourself!

Search the article *Liquid Democracy: Potentials, Problems, and Perspectives* by Christian Blum and cite it in your article.

You have **5** minutes. Good luck!



# Where can you find research papers?

Many available databases:

- Mathscinet;
- Web of science;
- Scopus;
- Google scholar.

Not all are publicly available, but many are accessible on campus via [uwp.rug.nl](http://uwp.rug.nl)

RUG library: **SmartCat**, **LibGuides**.





Most of the more recent papers are also available in preprint form on ArXiv at <https://arxiv.org/archive/math>



# What is a c1s file?



# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

- Common formatting styles
  - Bold: (for emphasis)
  - Italics: (for referencing authors or titles of other works)
  - Underline: (for emphasis)
    - (via `\u`) allows for further customisability
  - Typewriter: (for referencing program files or external documentation)

- Common formatting styles
  - Bold: (for emphasis)
  - Italics: (for referencing authors or titles of other works)
  - Underline: (for emphasis)
    - (via `\u`) allows for further customisability
  - Typewriter: (for referencing program files or external documentation)
- **Quotations:** open with “ (double accent grave) and close with ” (double quotation marks)

- Normal text does **not** require its own environment. It can be written directly into the source code of your  $\text{\LaTeX}$  document
  - **Spacing:** a new line can be forced using `'//'` or `'`
  - `:` entering a line of whitespace in your source code adds a new line automatically

- Normal text does **not** require its own environment. It can be written directly into the source code of your  $\text{\LaTeX}$  document
  - **Spacing:** a new line can be forced using `'//'` or `'`
  - `:` entering a line of whitespace in your source code adds a new line automatically
- **Sectioning:** add headings to different parts of your document. This can be done using
  - 
  - 
  -



- Normal text does **not** require its own environment. It can be written directly into the source code of your  $\text{\LaTeX}$  document
  - **Spacing:** a new line can be forced using `'//'` or `'`
  - `:` entering a line of whitespace in your source code adds a new line automatically
- **Sectioning:** add headings to different parts of your document. This can be done using
  - 
  - 
  -

- Normal text does **not** require its own environment. It can be written directly into the source code of your  $\text{\LaTeX}$  document
  - **Spacing:** a new line can be forced using `'//'` or `'`
  - `:` entering a line of whitespace in your source code adds a new line automatically
- **Sectioning:** add headings to different parts of your document. This can be done using
  - 
  - 
  -
- Each will be nested accordingly in your table of contents





## For the following text: reformat as follows

But I am not afraid to consider the final question as to whether, ultimately – in the great future – we can arrange the atoms the way we want; the very atoms, all the way down! What would happen if we could arrange the atoms one by one the way we want them (within reason, of course; you can't put them so that they are chemically unstable, for example). Up to now, we have been content to dig in the ground to find minerals. We heat them and we do things on a large scale with them, and we hope to get a pure substance with just so much impurity, and so on. But we must always accept some atomic arrangement that nature gives us. We haven't got anything, say, with a "checkerboard" arrangement, with the impurity atoms precisely arranged 1,000 angstroms apart, or in some other particular pattern.

- Bold: every word including 'atom'
- Underline: every instance of 'we'
- Italicise: every word beginning with the letter 'i'
- Typewriter: every word beginning with the letter 'p'

- Add a table of contents (using `\tableofcontents`) **before** `\begin{document}`
  - Add sections, subsections, and subsubsections to your “Writing text” file and see how this affects your table of contents

# Table of Contents

- 1 Crafting the Perfect Article Template *100*
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

- **Known as a “floating” environment:** automatic placement on your page unless specified otherwise by the following modifiers
  - `h` - place the float approximately here
  - `t` - place the float at the top of the page
  - `b` - place the float at the bottom of the page
  - `p` - place the float on a separate page specifically for floats only
  - `!` - overrides default  $\LaTeX$  placement
  - `H` - place the float **precisely** at this location
    - requires

- **Known as a “floating” environment:** automatic placement on your page unless specified otherwise by the following modifiers
  - `h` - place the float approximately here
  - `t` - place the float at the top of the page
  - `b` - place the float at the bottom of the page
  - `p` - place the float on a separate page specifically for floats only
  - `!` - overrides default  $\LaTeX$  placement
  - `H` - place the float **precisely** at this location
    - requires
- **Multiple modifiers:** prioritized in order from **left to right**

## The figure environment

```
\begin{figure}[htp!]  
  \centering  
  \includegraphics[width=0.5\textwidth]{<pathway_to_image>}  
  \caption{Caption}  
  \label{fig: my_label}  
\end{figure}
```

- In-line reference of the image using



- **Floats and text side-by-side:** minipage environment

```
%%% PICTURE AND TEXT SIDE-BY-SIDE + TOP ALIGNMENT
\begin{minipage}[t]{0.45\linewidth}
\vspace{0pt}
\raggedright
  \centering
  \includegraphics[width=\textwidth]{pathway_to_image}
\end{minipage}
\quad
\begin{minipage}[t]{0.45\linewidth}
\vspace{0pt}
\raggedright
  INSERT TEXT
\end{minipage}
```

# Try for yourself

Use the minipage environment for the following

- Find a picture of your favorite animal.
- Write a short description the animal, and reference the image in your description
- Place the image and description side-by-side

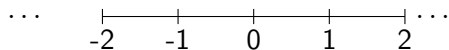
- Initialised by the following
  - `table` (float environment): specifies table placement
  - `tabular`: specifies table contents
  - Use in a `minipage`: table not necessary

```
\begin{table}[htp!]  
  \centering  
  \begin{tabular}{l|c|r}  
    cell 11 & cell 12 & cell 13 \\ \hline  
    cell 21 & cell 22 & cell 33  
  \end{tabular}  
  \caption{Caption}  
  \label{tab: my_label}  
\end{table}
```

The Tikz package allows one to make simple illustrations in LaTeX.

The Tikz package allows one to make simple illustrations in LaTeX.  
Let's draw the integers on the number line:

The Tikz package allows one to make simple illustrations in LaTeX.  
Let's draw the integers on the number line:







The code used for this was:

```

\begin{figure}[H]
\begin{tikzpicture}
    \draw (-2, 0) -- (2, 0);           %draw the line number line
    \foreach \n in {-2, -1, 0, 1, 2}{ % for loop from -2 to 2
        \draw (\n, -0.1) -- (\n, 0.1); % draw dashes
        \node at (\n,-0.2) {\n};       % draw labels
    }
    \node at (2.5, 0) {$\dots$};      % dots at the end
    \node at (-3, 0) {$\dots$};
\end{tikzpicture}

```

# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading



There exists different mathematics package, but the most useful are:

- `amsmath` adds a lot of symbols and functionality for inside a maths environment;
- `amssymb` adds many mathematical symbols to be used;
- `physics` adds a lot of shorthand-notation for often used mathematical expressions in physics

There are multiple ways to initiate a mathematics environment:

- The command `\math` is for inline mathematics

Let

$$\text{Let } e^{i\pi} + 1 = 0$$

There are multiple ways to initiate a mathematics environment:

- The command `math` is for inline mathematics

Let

$$e^{i\pi} + 1 = 0$$

- The environment `equation`, allows the equation to have it own line,

```
\begin{equation}
  a^2 + b^2 = c^2
\end{equation}
```

The equation block is for centered equations:

$$a^2 + b^2 = c^2 \quad (1)$$

There are multiple ways to initiate a mathematics environment:

- The command `math` is for inline mathematics

Let

$$\text{Let } e^{i\pi} + 1 = 0$$

- The environment `equation`, allows the equation to have it own line,

```
\begin{equation}
  a^2 + b^2 = c^2
\end{equation}
```

The equation block is for centered equations:

$$a^2 + b^2 = c^2 \quad (1)$$

- The environment `align`, allows to aligned multiple equations,

```
\begin{align}
  y &=& x \cdot \sqrt{x^2} \\
  &=& x^2
\end{align}
```

Multiple lines of maths aligned.

$$y = x \cdot \sqrt{x^2} \quad (1)$$

$$= x^2 \quad (2)$$

# Math environments

To unnumbered equations we used the command `*`,

```
\begin{align*}
  y &= x \cdot \sqrt{x^2} \\
  &= x^2
\end{align*}
```

Multiple lines of maths aligned.

$$y = x \cdot \sqrt{x^2}$$
$$= x^2$$

Note that `align*` will unnumber all the equations inside that environment. If you want to number one or more equations, then you need used the command

```
\begin{align}
  y &= x \cdot \sqrt{x^2} \\
  &= x^2 \nonumber
\end{align}
```

Multiple lines of maths aligned.

$$y = x \cdot \sqrt{x^2} \quad (1)$$
$$= x^2$$

# The physics package

Here follows some useful commands,

Command	Result	Command	Result
<code>\abs{x}</code>	$ x $	<code>\comm{A}{B}</code>	$[A, B]$
<code>A \cross B</code>	$A \times B$	<code>\grad{A}</code>	$\nabla A$
<code>\div{A}</code>	$\nabla \cdot A$	<code>\curl{A}</code>	$\nabla \times A$
<code>\sin[2]{x}</code>	$\sin^2(x)$	<code>\Re{z} + \Im{z}</code>	$\operatorname{Re}\{z\} + \operatorname{Im}\{z\}$
<code>\dd{x}</code>	$dx$	<code>\dd[3]{x}</code>	$d^3x$
<code>\dv{x}</code>	$\frac{d}{dx}$	<code>\dv{f}{x}</code>	$\frac{df}{dx}$
<code>\dv[2]{f}{x}</code>	$\frac{d^2 f}{dx^2}$	<code>\pdv{x}</code>	$\frac{\partial}{\partial x}$
<code>\pdv{f}{x}</code>	$\frac{\partial f}{\partial x}$	<code>\pdv[2]{f}{x}</code>	$\frac{\partial^2 f}{\partial x^2}$
<code>\pdv{f}{x}{y}</code>	$\frac{\partial^2 f}{\partial x \partial y}$	<code>\pdv*{f}{x}</code>	$\partial f / \partial x$
<code>\bra{a}</code>	$\langle a $	<code>\ket{b}</code>	$ b\rangle$

There are some environments available for matrices, the most used are

Environment	Brackets
<code>pmatrix</code>	Normal: $( )$
<code>bmatrix</code>	Square: $[ ]$
<code>Bmatrix</code>	Curly: $\{ \}$
<code>vmatrix</code>	Lines: $   $
<code>Vmatrix</code>	Double lines: $     $

Example:

```
X =
\begin{pmatrix}
1 & 2 & 3 & \cdots & 104 \\
3 & 4 & 5 & \cdots & 106 \\
\vdots & \vdots & \vdots & \ddots & \\
\vdots & \vdots & \vdots & \ddots & \\
43 & 44 & 45 & \cdots & 146
\end{pmatrix}
```

$$X = \begin{pmatrix} 1 & 2 & 3 & \cdots & 104 \\ 3 & 4 & 5 & \cdots & 106 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 43 & 44 & 45 & \cdots & 146 \end{pmatrix}$$

# Declare you own math operator

Sometimes you need to define your own operator, you can do it by using the command `\operatorname` in the preamble,

$$\operatorname{Corr}(X, Y) = 0$$

Other times, you to use a sequence of commands multiple times, in that case you should define a new command by using the command `\newcommand`.



# Theorems and Proofs

When writing mathematical documents, you probably need a way to typeset “lemmas”, “definitions”, “axioms”, and similar structures. These are known as theorems in  $\text{\LaTeX}$ , and can be created using the

command in the preamble. The “name” is the name of the environment (“lemmas”, “definitions”, “axioms”, etc ...). You can use the following environment within the document,

```
\begin{<name>}[<title>]  
  This is my interesting theorem  
\end{<name>}
```



# Try yourself!

Write the following theorem and proposition.

## Proposition (Minkowski's Inequality)

For  $x \in \mathbb{K}^n$  and let  $1 \leq p < \infty$ , we have

$$\left( \sum_{i=1}^n |x_i + y_i|^p \right)^{1/p} \leq \left( \sum_{i=1}^n |x_i|^p \right)^{1/p} + \left( \sum_{i=1}^n |y_i|^p \right)^{1/p}$$

## Theorem (Stokes' Theorem)

$$\int_S (\nabla \times \mathbf{F}) \cdot \mathbf{n} \, dS = \int_C \mathbf{F} \cdot d\mathbf{x}$$

where  $C$  is the closed curve enclosing the open surface  $S$ .

You have **5** minutes. Good luck!



# Try yourself!

Do the following:





- Declare your own mathematical operator;  
*Example: the operator of the correlation*
- Declare a new command with at least one input;
- Open one of your books at random, and copy one equation;
- Write the matrix multiplication of an  $n \times n$  matrix  $A$  with a vector  $x$ ,

$$\begin{bmatrix} a_{1,1} & a_{1,2} & a_{1,3} & \cdots & a_{1,n} \\ a_{2,1} & a_{2,2} & a_{2,3} & \cdots & a_{2,n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ a_{n,1} & a_{n,2} & a_{n,3} & \cdots & a_{n,n} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{bmatrix} = \mathbf{b}$$

You have **10** minutes. Good luck!



# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

# Beamer document class

L<sup>A</sup>T<sub>E</sub>X can also be used to make presentations via the Beamer. To make use of it change the first line of your article to

```
\documentclass{beamer}
```

Now every slide corresponds to a "frame", to add a frame write

```
\begin{frame}{Frame Title}  
  \LaTeX  
\end{frame}
```





# Try yourself!

Make a nice presentation of the matrix you just made.

You can do  $\LaTeX$  as when we were writing a paper, except now we can view each frame as its own document.



# Table of Contents

- 1 Crafting the Perfect Article Template 100
- 2 Mastering the Art of Writing 
- 3 Bringing Your Content to Life 
- 4 Falling in Love with Mathematics 
- 5 Presenting with Confidence 
- 6 Further reading

- LaTeX reference file by Floris Westerman
- Symbols
- The not so short introduction to Latex
- Keith Conrad's advice on Mathematical writing
- Poonen's practical suggestions for mathematical writing
- Advanced Figures with Inkscape



Thank You ❤️

Your opinion matters! Help us improve by sharing your valuable feedback.



*FMF*