Workshop LaTEX

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Introduction

LaTeX is a document-generation software that behaves similarly to a programming language.

Importance

Advantages:
Free of charge.
Better text formatting and organization.
Powerful mathematical formula system.
Easy reference management.
Cross-platform (works on various operating systems).
Extensive online documentation about its functionality.

How to create LaTeX Files

As any other programming language LATEX needs two important things:

(1) TEX compiler (such as MiKTeX, MacTex, etc. . .)
MiKTeX: https://miktex.org/ ← OFFLINE

(2) Text editor (such as TeXstudio,Texmaker, etc. . .)
TeXstudio: https://www.texstudio.org/

Overleaf : TEX compiler and editor ← ONLINE

No installation, real-time collaboration, version control, hundreds of LaTeX templates, and more.

https://www.overleaf.com/

First Steps: Learn how to...

01

Start a LaTeX File

02

Write Text

03

Write Mathematic Symbols

04

Input Equations

05

Insert Figures

06

Create Empty Pages

01

LaTeX File

Document classes

When processing an input file, LaTeX needs to know which layout standard to use.

Therefore, in the beginning of the file you insert the line:

\documentclass[options]{class}

Where options and class can be, for example: **\documentclass[11pt,twoside,a4paper]{article}**

{class} ⟶ Article, IEEEtran, minimal, report, book, slides, letter, beamer, etc…

[options] ⟶ Letter font, paper size, landscape, multicolumn, etc…

Learn more in: https://en.wikibooks.org/wiki/LaTeX/Document_Structure

Packages

While writing your document, you will probably find that there are some areas where basic LaTeX cannot solve your problem.

If you want to include graphics, colored text or source code from a file into your document, you need to have packages.

Some packages come with the LaTeX base distribution. Others are provided separately.
For that, you need to use the command:

\usepackage[options]{package}

For example: **\usepackage{color}; \usepackage{amsmath}; \usepackage{amssymb}**

As you may noticed by now, the structure of a LaTeX command is
\command[optional parameter]{parameter}

Sectioning Commands

The commands for inserting sections are fairly intuitive:

\chapter{Introduction}
This chapter's content...

\section{Structure}
This section's content...

\subsection{Top Matter}
This subsection's content...

\subsubsection{Article Information}
This subsubsection's content...

Notice that you do not need to specify section numbers; LaTeX will sort that out for you.

To get an unnumbered section heading which does not go into the Table of Contents, follow the command name with an asterisk before the opening curly brace:

\subsection*{Introduction}

But before adding the document sections we need to start the document itself. For that we code the lines:

\begin{document}
...

\end{document}

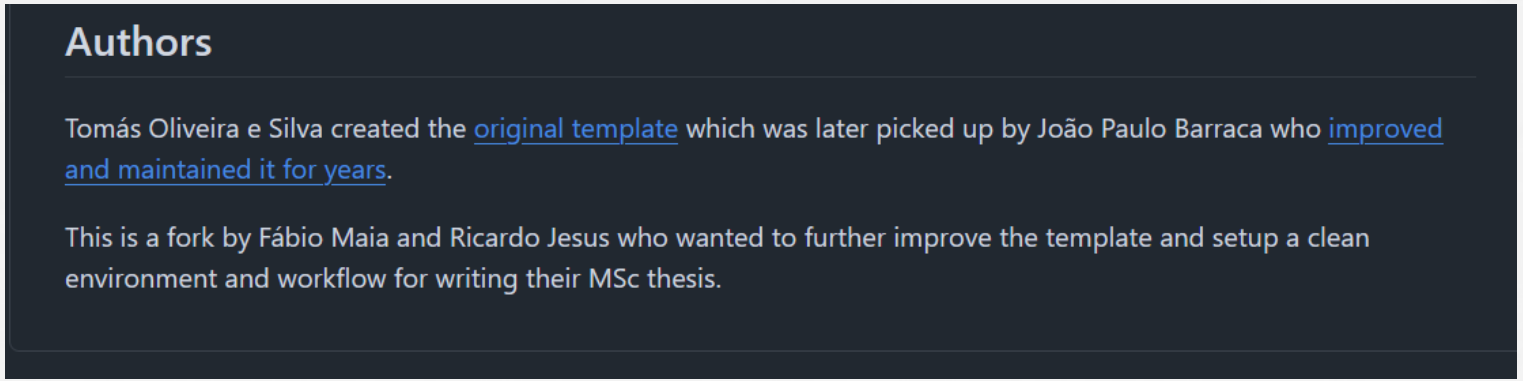
Let's use the Thesis Model

How to find it...

https://github.com/detiuaveiro/ua-thesis-template

They updated the template, but I still prefer to work on the original!

Scroll down until you find the authors section and click on the original template.
Let's work on that one!



Very Important Details for Thesis Document

You need to:

- Adjust the letter size;
- Adjust the document dimensions;
- Adjust the color of the headbar;
- Add chapters format;
- Add thesis year in the header;
- Add university logo.

```
\documentclass[11pt,twoside,a4paper]{report}
\usepackage[DM,newLogo,final]{uaThesis}
\def\ThesisYear{2023}

% optional packages
\usepackage{booktabs}
\usepackage[english]{babel}
\usepackage[utf8]{inputenc}
\usepackage[top=3cm,bottom=3cm,left=3cm,right=2.5cm,asymmetric]{geometry}
```

Let’s open the TeXstudio

02

Write Text

Like any other document, you can write simple text normally on the .tex file

However,…

If you add an **%** before the text, you will have a comment
% This is a comment;

If you add the command **\textbf{}** you will have some text in bold
This text \textbf{is in bold}; (you can select a text and do CTRL+B)

and if you add **\textit{}** you will have the text in italics
\textit{text is in italics}. (you can select a text and do CTRL+I)

Latex does not deal very well with accents and special characters. For that use the package:

\usepackage[portuguese]{babel}

Or you can have more like:
\usepackage[english,portuguese]{babel}

But be careful: this means that the corrector will accept both portuguese and english words.

Additionally… If you don’t want to write everything in the same .tex file you can opt to have several .tex documents and then one principal .tex file where you call all the others like:

Chapter1.tex
Chapter2.tex
Chapter3.tex
Chapter4.tex

} .tex files to be added in the main document

Manuscript.tex → Main .tex file

In the Manuscript.tex you will add:

\input{Chapter1.tex}
\input{Chapter2.tex}
\input{Chapter3.tex}
\input{Chapter4.tex}

03

Mathematical symbols

How to input symbols in the Text

Several times, when writing equations in Latex I go to:
https://oeis.org/wiki/List_of_LaTeX_mathematical_symbols

If you want to insert a specific symbol between the texto you need to add $$ between the symbol command: $\this_is_a_symbol$

For example: Aveiro's temperature is 26°C or 26°C . This will compile as: 26°C

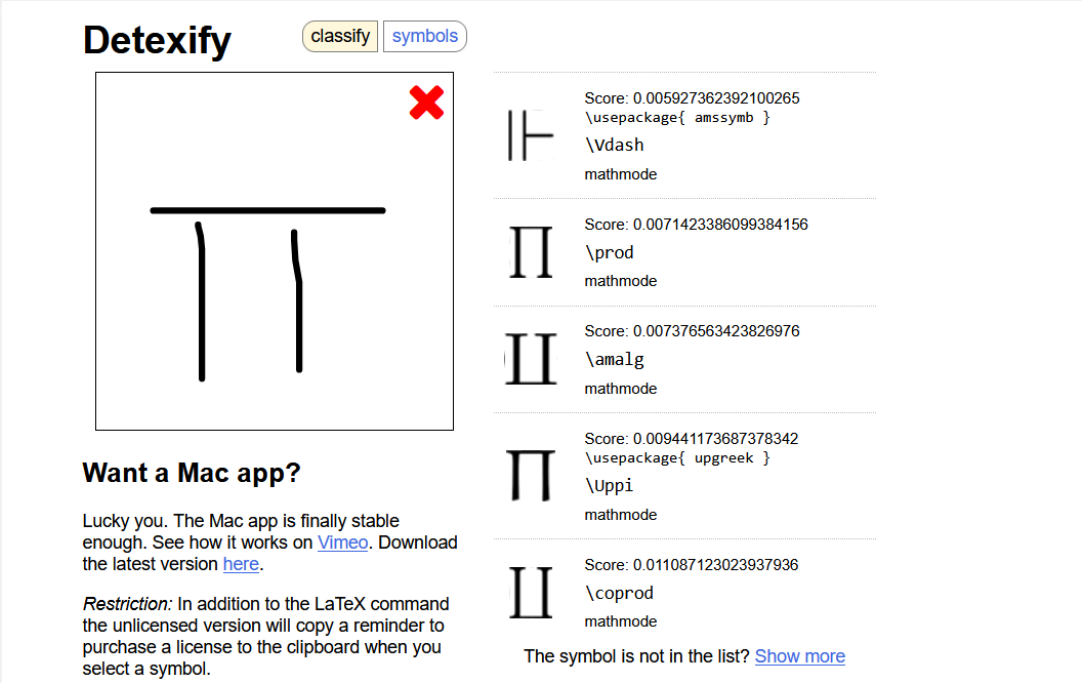
Another example: Δ_{x} will compile as: Δ_x

$: encloses a mathematical text
^: for superscript text
_: for underwritten

What if I don’t know the name of the symbol?!

You can draw the symbol!

Go to:
https://detexify.kirelabs.org/classify.html

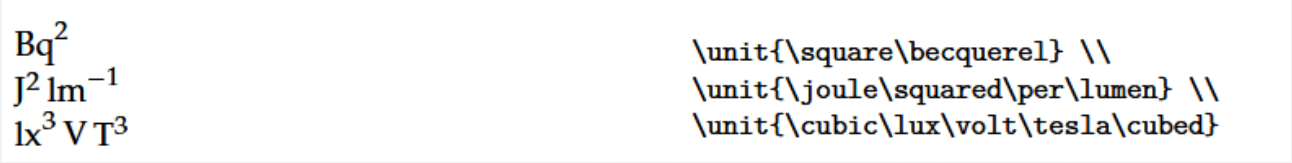


I have different units in my document

You might want to use the package siunitx:

\usepackage{siunitx} % express measurements with units

https://tex.stackexchange.com/questions/2248/what-package-should-i-use-to-typeset-units



Bq^2
$\mathrm{J}^2\,\mathrm{lm}^{-1}$
$\mathrm{lx}^3\,\mathrm{V}\,\mathrm{T}^3$

```
\unit{\square\becquerel} \\
\unit{\joule\squared\per\lumen} \\
\unit{\cubic\lux\volt\tesla\cubed}
```

Go to the package manual:
https://ctan.fisiquimicamente.com/macros/latex/contrib/siunitx/siunitx.pdf

04

Equations

Equations Within the text:

You will be needing the environment: \begin{math} …. \end{math}

```
\item compute entropy, \begin{math} e_{l}, \end{math} as \begin{math} e_{l} = -e_{0}
\sum_{j=1}^{n} \overline{E}_{j,l} \ln\overline{E}_{j,l} \end{math}, where \begin{math}
e_{0} \end{math} is the Shannon entropy constant, usually considered as \begin{math}
e_{0} = (\ln n)^{-1} \end{math};
```

What you write
Vs
What you will see

2. compute entropy, e_l, as $e_l = -e_0 \sum_{j=1}^{n} \overline{E}_{j,l} \ln \overline{E}_{j,l}$, where e_0 is the Shannon entropy constant, usually considered as $e_0 = (\ln n)^{-1}$;

Equations Outside the text:

There is 2 options:

Big difference?
One will appear in the List of equations, and the other will not.

(1) With the \begin{math} …. \end{math}

```
\begin{center}
        \begin{math} W_{l} = \frac{ d_{l}}{\sum_{l=1}^{k} d_{l}} \end{math}.
\end{center}
```

4. compute the degree of importance of the normalization methods, M_l, with

$$W_l = \frac{d_l}{\sum_{l=1}^{k} d_l}.$$

(2) With the \begin{equation} …. \end{equation}

```
\begin{equation}
        \beta_{j} = \sum_{l=1}^{k} W_{l} ~ E_{j,l}.
\end{equation}
```

$$\beta_j = \sum_{l=1}^{k} W_l \; E_{j,l}. \qquad (2.2)$$

05

Insert Figures

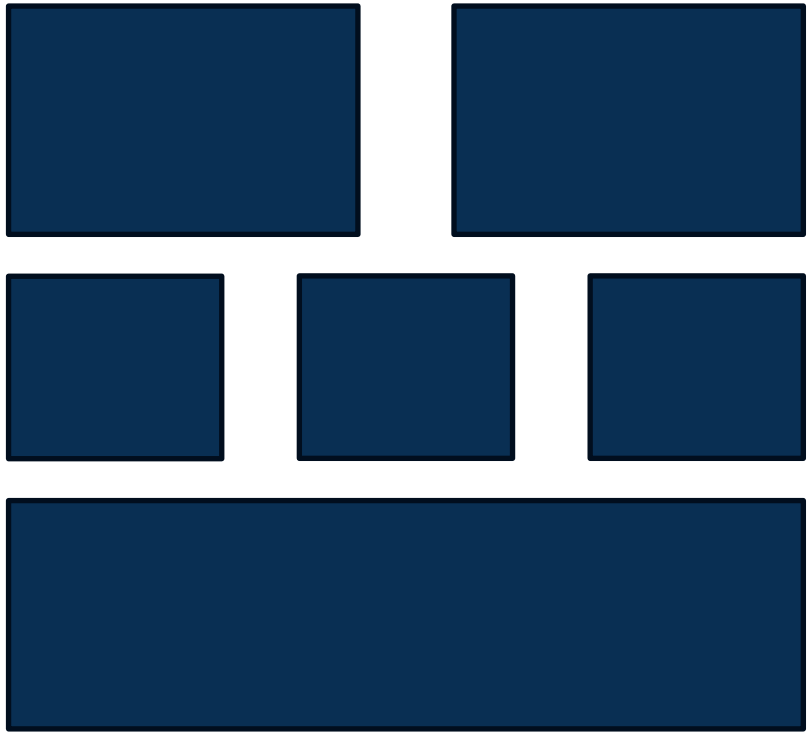
How to select where the Figure goes?

Let’s use the float package:
\usepackage{float}

```
\begin{figure}[h]
		\centering
		\includegraphics[width=1]{Figure3}
		\caption{Volcano plots retrieved from the GeneSEA Explorer, 'Differential Gene Expression Analysis: Volcano plots'. Results from the demo dataset.}
		\label{Figure3}
\end{figure}
```

[h] indicates that the float is allowed to be placed inline
[t] indicates that the float is allowed to go into a top area
[b] indicates that the float is allowed to go into a bottom area
[p] indicates the the float is allowed to go on a float page or column area

Learn more in: https://tex.stackexchange.com/questions/39017/how-to-influence-the-position-of-float-environments-like-figure-and-table-in-lat



Try and do this Figure

CHALLENGE

06

Insert Empty Pages

How to get Empty Pages

You will need…

```
\usepackage{emptypage}      % make empty pages really empty (no page numbers)
```

And to code:

\clearpage
or
\cleardoublepage

What's the difference?

\cleardoublepage ensures that the next page is an odd-numbered (right-hand) page!

More advanced Steps: Learn how to...

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Create a Bibliography

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Create Tables

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Use Hiperlinks

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Create Lists for Acronyms, Figures, etc...

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Other

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Recommendations

07

Bibliography

There are a lot of ways to do bibliography…

This one I think is one of the most practical ones.

Code in the bottom of the main document:

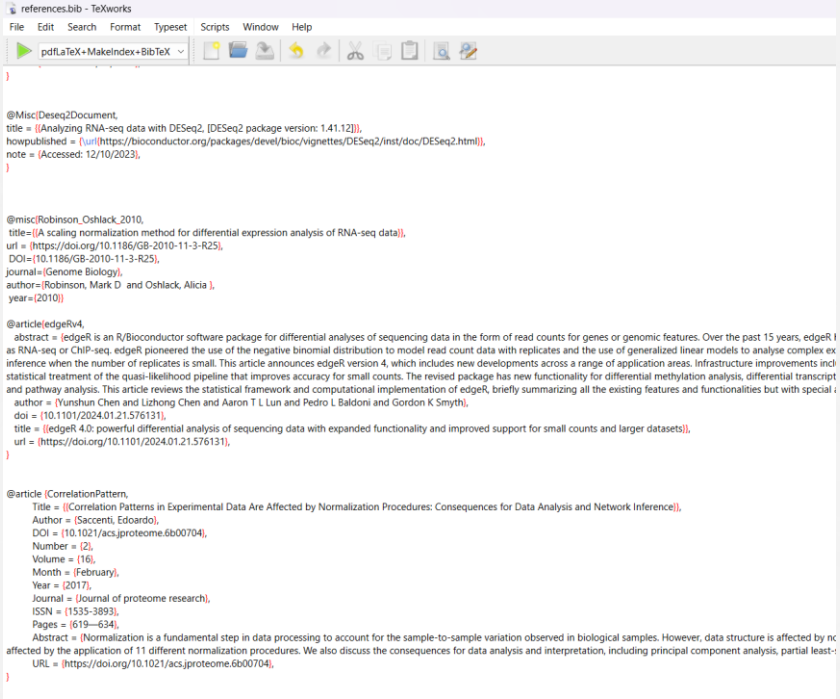
For the page of the ‘chapter’ References to appear in the Index

```
\cleardoublepage
\phantomsection
\addcontentsline{toc}{chapter}{References}
\renewcommand{\bibname}{References}

{\small\bibliography{references}}
\bibliographystyle{IEEEtran}
```

To gather all the references in a ‘chapter’

Code in the References.bib document:



What to do when I have an article with so many authors… et al.

```
%%%%% Change for et al.

\makeatletter
\def\bstctlcite{\@ifnextchar[{\@bstctlcite}{\@bstctlcite[@auxout]}}
\def\@bstctlcite[#1]#2{\@bsphack
                \@for\@citeb:=#2\do{%
                        \edef\@citeb{\expandafter\@firstofone\@citeb}%
                        \if@filesw\immediate\write\csname
#1\endcsname{\string\citation{\@citeb}}\fi}%
                \@esphack}
\makeatother
```

In the packages section

```
\bstctlcite{IEEEexample:BSTcontrol}
```

Right after the \begin{document}

```
@IEEEtranBSTCTL{IEEEexample:BSTcontrol,
CTLuse_forced_etal = "yes",
CTLmax_names_forced_etal = "3",
CTLnames_show_etal = "2" }
```

In the References.bib

08

Create Tables

Tables

We can start with a simple example:

```
\begin{table}[h]
 \centering
  \caption{Parâmetros para a modulação 3D da FPG.}
  \begin{tabular}{|c|c|c|c|}
\hline
  Nome & Expressão & Valor & Definição \\
  \hline
  n1  & 1,4457 & 1,4457 & índice de refração do núcleo   \\
    \hline
     n2  & 1,4378 & 1,4378 &  índice de refração do bainha  \\
      \hline
   n3  & 1,446  &  1,446 & índice de refração do passo do índice de grating   \\
    \hline
  \end{tabular}
 \label{tab: resultados}
\end{table}
```

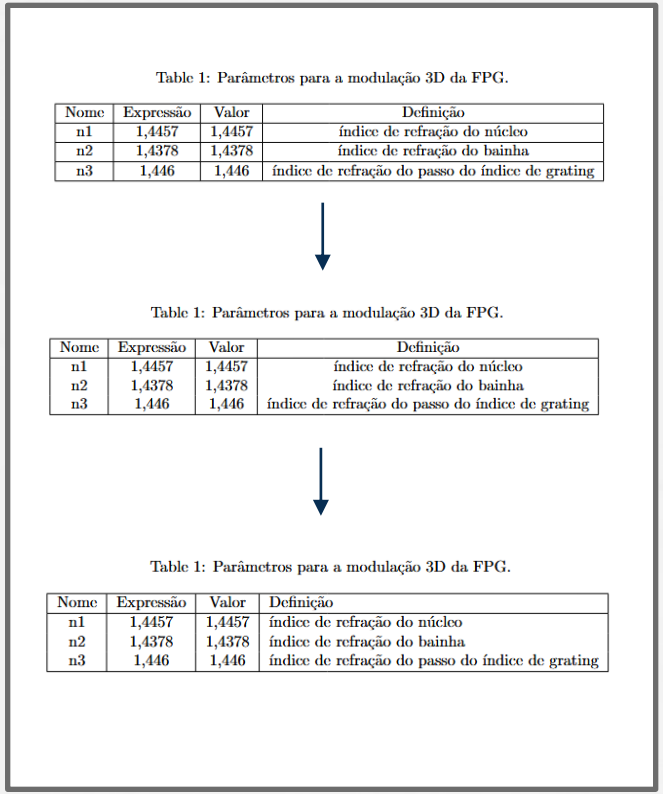


Table 1: Parâmetros para a modulação 3D da FPG.

Nome	Expressão	Valor	Definição
n1	1,4457	1,4457	índice de refração do núcleo
n2	1,4378	1,4378	índice de refração do bainha
n3	1,446	1,446	índice de refração do passo do índice de grating

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Table 1: Parâmetros para a modulação 3D da FPG.

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n3	1,446	1,446	índice de refração do passo do índice de grating

Important Code lines for tables

\centering → To make the Table centered.

\begin{tabular} → To start to define the structure of the Table.

\begin{tabular}{|c|c|c|c|} → To define the number of columns and if we want the texto to be on the left, center or rigth. Also, we can decide if we want the columns to be separated by a rule or not.

\hline → Horizontal Line

\caption{} → Table's caption. **Important:** Insert the captions always before the \begin{tabular}!

\label{tab: resultados} → Table's label. The "tab: resultados" will be the name of the table that you will need to call to ref the table in the text. So, select very well the labels you give.

\begin{table}[h] → We can select how to position the table the same way we do with the figures.

What can I do if the Table is too big and I need to adjust it for the page?

First Solution:

(1) Adjust table to page size:

```
\usepackage{siunitx}
\usepackage{booktabs}
\usepackage{adjustbox}
\usepackage{wrapfig}
```

1 Section

	Method	Abbreviation	Field
1	Quantile	Quantile	Transcriptomics
2	Robust Quantile	robust quantile	Proteomics
3	Locally weighted linear regression	loess	Transcriptomics
4	Reads Per Million	RPM	Transcriptomics
5	Median	—	Transcriptomics and Proteomics
6	Variance stabilizing normalization	VSN or Vsn	Transcriptomics and Proteomics

vs

1 Section

	Method	Abbreviation	Field
1	Quantile	Quantile	Transcriptomics
2	Robust Quantile	robust quantile	Proteomics
3	Locally weighted linear regression	loess	Transcriptomics
4	Reads Per Million	RPM	Transcriptomics
5	Median	—	Transcriptomics and Proteomics
6	Variance stabilizing normalization	VSN or Vsn	Transcriptomics and Proteomics

The Code will be:

```
\begin{adjustbox}{width =0.85\textwidth}
		\begin{tabular}{cccccc}
			\toprule
			& Method & Abbreviation & Field \\ \midrule
			1 &  Quantile  &  Quantile & Transcriptomics\\
			2 & Robust Quantile & robust quantile & Proteomics \\
			3 & Locally weighted linear regression & loess & Transcriptomics \\
			4 & Reads Per Million & RPM & Transcriptomics \\
			5 & Median & --- & Transcriptomics and Proteomics \\
			6 & Variance stabilizing normalization & VSN or Vsn & Transcriptomics and Proteomics\\
			\bottomrule
		\end{tabular}
\end{adjustbox}
```

Second Solution:

(2) Rotate table and page:

To change the page footer position!
Not needed!
Just a code to have!

```
\usepackage{pdflscape}
\usepackage{fancyhdr}
\usepackage{wrapfig}

\fancypagestyle{mylandscape}{
    \fancyhf{}  %Clears the header/footer
    \fancyfoot{% Footer
        \makebox[\textwidth][r]{% Right
            \rlap{\hspace{0cm}% Push out of margin by \footskip
                \smash{% Remove vertical height
                    \raisebox{4.87in}{% Raise vertically
                        \rotatebox{90}{\thepage}}}}}% Rotate counter-clockwise
    \renewcommand{\headrulewidth}{0pt}% No header rule
    \renewcommand{\footrulewidth}{0pt}% No footer rule
}
```

You will need to ‘play’ a little bit with this values in ‘navy blue’ until you get the table in the position and orientation that you want.

The Code will be:

```
\begin{landscape}
        \thispagestyle{mylandscape}

\begin{wraptable}{l}{26cm}
        \vspace{1cm}
        \centering
        \caption{List of normalization methods investigated in the present study.}
        \label{table: normalization methods}
        \begin{adjustbox}{width =1.85\textwidth}
                \begin{tabular}{cccccc}
                        \toprule
                        & Method & Abbreviation & Field \\ \midrule
                        1 &  Quantile  &  Quantile & Transcriptomics\\
                        2 & Robust Quantile & robust quantile & Proteomics \\
                        3 & Locally weighted linear regression & loess & Transcriptomics \\
                        4 & Reads Per Million & RPM & Transcriptomics \\
                        5 & Median & --- & Transcriptomics and Proteomics \\
                        6 & Variance stabilizing normalization & VSN or Vsn & Transcriptomics and Proteomics\\
                        \bottomrule
                \end{tabular}
        \end{adjustbox}
\end{wraptable}
\end{landscape}
```

To decide how much of the page you want to use for the table. And decide if you want the table on the left, center or right.

Similar function to the wraptable. You can select the size of the table in reference to the text width.

Challenge

Create a Landscape page with a Figure

Solution:

```
\begin{landscape}
        \thispagestyle{mylandscape}

\begin{figure}[H]
        \centering
        \includegraphics[width=1.1\linewidth]{images/Frequency_plot}
        \caption{Frequency plot.}
        \label{fig: Frequency plot}
\end{figure}

\end{landscape}
```

09

Use Hiperlinks

Packages that you will need!

```
\usepackage{blindtext, graphicx}
\usepackage{hyperref}
\hypersetup{
            colorlinks   = true, %Colours links instead of ugly boxes
            urlcolor     = blue, %Colour for external hyperlinks
            linkcolor    = black, %Colour of internal links
            citecolor   = red %Colour of citations
}
```

Very important so you don't have those 'ugly' boxes around the citation

```
\usepackage{url}
\def\UrlBreaks{\do\/\do-}
```

You will need also
`\renewcommand\_{\textunderscore\allowbreak} %% to allow word break while using underscore`

Use:
\ref{} for Figures, Tables and Equations (what will be inside the {…} will be the text inside of the Label of the Figure, table or equation)
\cite{} for the References

Packages that you will need!

14 Recommended Tutorials

Differential Expression Analysis with DESeq2: Tutorial which explains the DESeq2 workflow.

R and RNA-Seq (Fall 2020 Bootcamp): It has videos with the basis of R, and some analysis with DESeq2. (Recommend lessons 6 to 12)

How to analyze RNA Seq Gene Expression data using DESeq2: It is a good video to follow the coding process.
Second Part of How to analyze RNA Seq Gene Expression data using DESeq2: Second part of the previous link. It has another example to follow.

Multifactor Designs in DESeq2: Good tutorial that explains how to do and interpret the multifactor designs.

DESeq2 - multifactorial example: Simple case example. Well explained.

Mutant vs Wild Type: Simple case example. Well explained.

Visualizing the results: DESeq2 advanced tutorial for DE genes visualization.

Sanbomics — Differential expression analysis with Deseq2: Good tutorial, well explained. It helps to understand how to select specific levels when a variable has more than two levels, to perform several comparison tests.
Sanbomics — RNAseq analysis — Gene ontology (GO) in R: DESeq2 advanced tutorial for DE genes visualization.
Sanbomics — Simple gene ontology and pathway enrichment from a gene list: With David Gene Ontology. Simple and easy to follow and understand.
Sanbomics — RNAseq volcano plot of differentially expressed genes: DESeq2 volcano plots.

\usepackage{hyperref}

You can get this type of text through the \href{}{} code.

The link

How you want the link to show

\href{**https://support.bioconductor.org/p/9135384/**}{**DESeq2 - multifactorial example**}: Simple case example. Well explained.

10

Create Lists

Add Page with List of contents

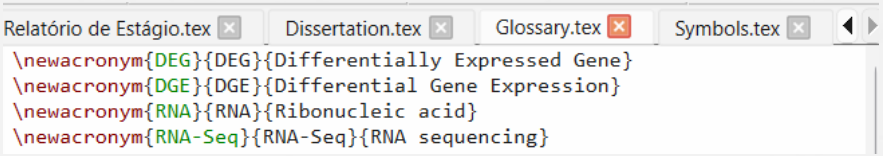
```
%
% Tables of contents, of figures, ...
%
\pagenumbering{roman}

\tableofcontents

%List of figures
\cleardoublepage
\phantomsection
\addcontentsline{toc}{chapter}{List of Figures}

\renewcommand{\listfigurename}{List of Figures}
{\small\listoffigures}

%List of tables
\cleardoublepage
\phantomsection
\addcontentsline{toc}{chapter}{List of Tables}
\renewcommand{\listtablename}{List of Tables}
{\small\listoftables}

\cleardoublepage

\phantomsection
\addcontentsline{toc}{chapter}{List of Acronyms}
\printacronyms[title={List of Acronyms}]

\cleardoublepage

%\phantomsection
%\addcontentsline{toc}{chapter}{List of symbols}
%\printglossary[title={List of symbols}]

\cleardoublepage
```

Very important! You need to change the page numbering the moment you start writing your document:

```
\chapter{Introduction}
\pagenumbering{arabic}
```

How to construct your Glossary page

First, create a file called **Glossary.tex**



This is the definition that will appear in the glossary + in brackets the first time you call the acronym in the text.

\newacronym {**h2o**}[H2O]{**Water**}
\newacronym {**adsl**}[ADSL]{**Asymmetric Digital Subscriber Line**}

To use this command, you will be needing:
\usepackage[acronym]{glossaries}

This is what will be shown in the Glosssary page and in the compiled file.

Furthermore, to call the Glossary.tex you will need:
\loadglsentries{Glossary.tex}
\makeglossaries

This is how you write in the text

You can do the same for a symbol.tex

11

Other

Align Text Inside of Equations

This

$$\text{(normalization)} \quad \overline{E}_{j,l} := \frac{E_{j,l}}{\sum_{j=1}^{n} E_{j,l}} \tag{3}$$

$$\text{(entropy)} \quad e_l := -\frac{1}{\ln n} \sum_{j=1}^{n} \overline{E}_{j,l} \ln \overline{E}_{j,l} \tag{4}$$

$$\text{(diversification)} \quad d_l := 1 - e_l \tag{5}$$

$$\text{(importance)} \quad w_l := \frac{d_l}{\sum_{l=1}^{k} d_l} \tag{6}$$

The equations are centered

That

$$\text{(normalization)} \quad \overline{E}_{j,l} := \frac{E_{j,l}}{\sum_{j=1}^{n} E_{j,l}} \tag{3}$$

$$\text{(entropy)} \quad e_l := -\frac{1}{\ln n} \sum_{j=1}^{n} \overline{E}_{j,l} \ln \overline{E}_{j,l} \tag{4}$$

$$\text{(diversification)} \quad d_l := 1 - e_l \tag{5}$$

$$\text{(importance)} \quad w_l := \frac{d_l}{\sum_{l=1}^{k} d_l} \tag{6}$$

The end of the text is aligned

Align Text Inside of Equations

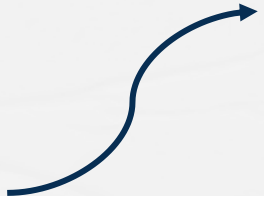
```
\begin{equation}\label{3}
                \text{(normalization)} \; \; \;      \overline{E}_{j,l} := \frac{E_{j,l}}{\sum_{j=1}^{n} E_{j,l}}
\end{equation}


\begin{equation} \label{4}
                \phantom{xxxxxxxxxxxx}
                \text{(entropy)} \; \; \;              e_{l} := -\frac{1}{\ln n}  \sum_{j=1}^{n} \overline{E}_{j,l} \ln\overline{E}_{j,l}
\end{equation}


\begin{equation} \label{5}
                \text{(diversification)} \; \; \;  d_l := 1 - e_l \phantom{xxxx}
\end{equation}


\begin{equation} \label{6}
                \text{(importance)} \; \; \; w_{l} := \frac{ d_{l}}{\sum_{l=1}^{k} d_{l}} \phantom{l}
\end{equation}
```

Not so ‘correct’

Show your code in the document!

Use Verbatim!

```
\begin{center}
    \begin{verbatim}
        Ejl <- reactive({ apply(TakeTheDeletedToNA(), 2,
                function(col) col / sum(col, na.rm = T)) })
    \end{verbatim}
\end{center}
```



You will have ZER0 problems with symbols!

```
Ejl <- reactive({ apply(TakeTheDeletedToNA(), 2,
function(col) col / sum(col, na.rm = T)) })
```

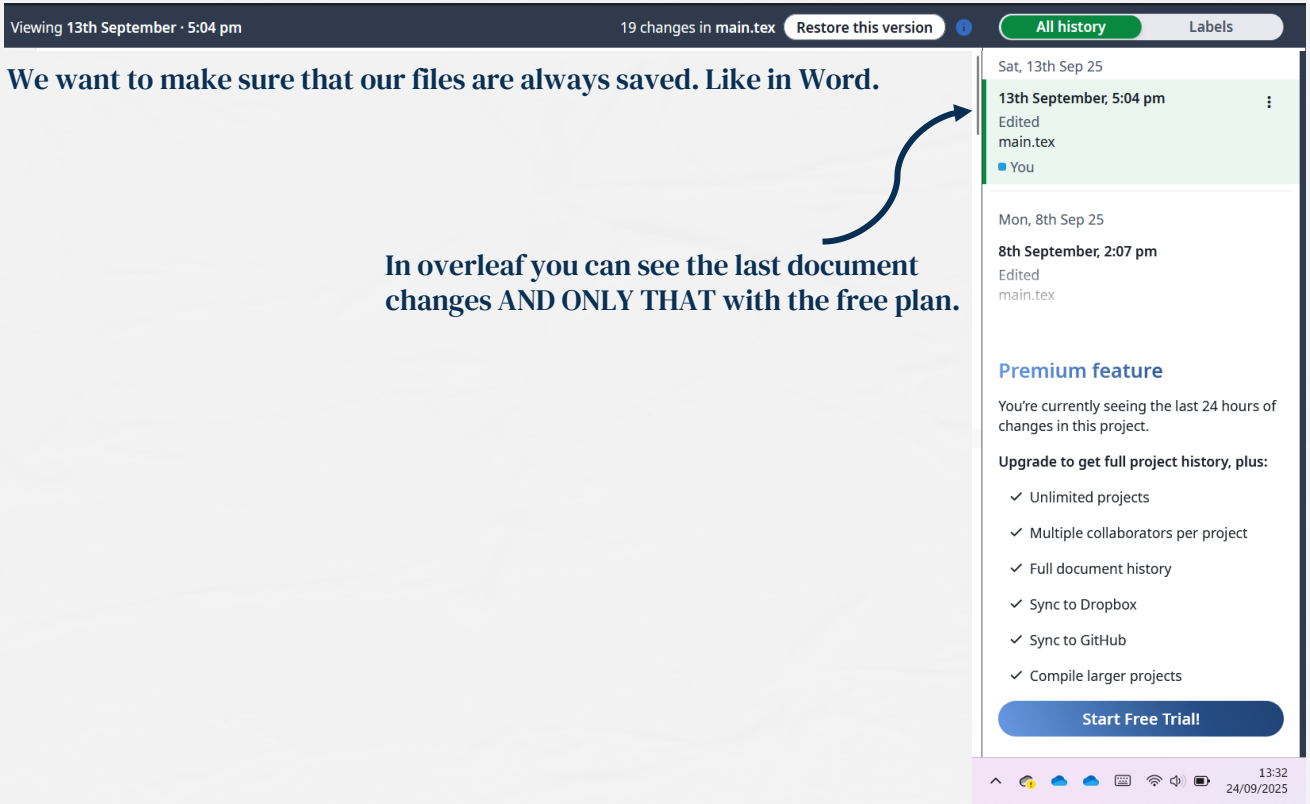
```
\begin{center}
    \begin{boxedverbatim}
        Ejl <- reactive({ apply(TakeTheDeletedToNA(), 2,
                function(col) col / sum(col, na.rm = T)) })
    \end{boxedverbatim}
\end{center}
```

```
Ejl <- reactive({ apply(TakeTheDeletedToNA(), 2,
 function(col) col / sum(col, na.rm = T)) })
```

Can we see old versions of the document?

We want to make sure that our files are always saved. Like in Word.

In overleaf you can see the last document changes AND ONLY THAT with the free plan.



How to Change the Chapter Title Size and the Header space

```
%%% correction to the chapter and title size

\usepackage{sectsty}
\chapternumberfont{\LARGE}
\chaptertitlefont{\huge}

%%% Change the space before Chapter head.
\usepackage{etoolbox}
\makeatletter
\patchcmd{\@makechapterhead}{50\p@}{0pt}{}{}
\patchcmd{\@makeschapterhead}{50\p@}{0pt}{}{}
\makeatother
%%%%%%%%%%
```

By changing the font

Normally the font is ‘Huge’

‘Play’ with the value

Time for questions ☺