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How to Write a TFE Manuscript

A Manual of Composition, Orthotypography, and Typography
Version 8.2

Manresa, January 22, 2026

Capstone Project (24 ECTS) submitted by

BERENGUER DE CRUÏLLES

in partial fulfillment of the requirements for the

Bachelor's Degree in ICT Systems Engineering

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Topics: TFE manuscript; UPC Manresa

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Declaration of Responsibility

I, Berenguer de Cruïlles, author of this Capstone Project,

DECLARE

That this project and the accompanying report are original and solely the result of my work. Furthermore, all sources consulted have been included in the bibliography.

By submitting this report for evaluation, I consider this declaration signed for the purposes outlined in the agreement CG/2019/05/10, dated October 8, 2019, of the Governing Council of the Universitat Politècnica de Catalunya, which approves the procedure for plagiarism prevention.

Manresa, January 22, 2026

To those led astray
by the evil toward WYSIWYG editors.
May the odds be ever in their favor.

Acknowledgments

My heartfelt thanks to everyone who encouraged me to learn T_EX back when even printing the output was a challenge. They introduced me to the world of typography, and I have passionately enjoyed it ever since.

I am also grateful to the students who served as early adopters and reviewers of this class by using it in their own projects. Many of them provided valuable suggestions and critiques that helped improve this style. I have made an effort to ensure their names appear in the changelog for this class (appendix B).

Montse Méndez carefully reviewed version 6.4 of this documentation and contributed significantly to its improvement. I extend my deepest thanks.

Abstract

This document serves as a comprehensive guide for students preparing their Capstone Project or Master Thesis manuscript (TFE) using the `tfgitic` L^AT_EX class. It provides detailed explanations on how to structure the document into logical sections, including chapters, appendices, figures, tables, and bibliographic references, in accordance with UPC Manresa academic standards. Emphasis is placed on proper typographic practices, consistent citation methods using `biblatex`, and the importance of content clarity over visual embellishment. The document also outlines best practices for referencing figures, writing algorithms, and managing bibliographies with `BibLaTeX`, while discouraging manual formatting alterations that contradict class defaults.

Additionally, the guide introduces supporting tools such as `latexmk` for streamlined compilation and `emacs` with `AUCTeX` and `RefTeX` for efficient editing and citation management. It aims to foster a disciplined and content-oriented approach to academic writing, ensuring that students prioritize the quality and integrity of their work. By adhering to the principles and workflow proposed in this manual, students can produce well-structured, professionally formatted documents that meet institutional expectations with minimal friction.

Resum

Aquest document és una guia completa per als estudiants que preparen el seu treball final d'estudis (TFE) utilitzant la classe `tfgitic` de L^AT_EX. S'hi expliquen detalladament les instruccions per estructurar el document en seccions lògiques com ara capítols, annexos, figures, taules i referències bibliogràfiques, d'acord amb els estàndards acadèmics d'UPC Manresa. Es posa èmfasi en les bones pràctiques tipogràfiques, l'ús coherent de les citacions mitjançant `BiBLaTeX`, i la importància de la claredat del contingut per damunt de les ornamentacions visuals. També es descriuen bones pràctiques per referenciar figures, redactar algorismes i gestionar bibliografies amb `BibLaTeX`, desaconsellant les modificacions manuals que contradiguin el format establert per la classe.

A més, la guia introdueix eines de suport com `latexmk` per a una compilació més eficient, i l'editor `emacs` amb les extensions `AUCTeX` i `RefTeX` per facilitar l'edició i la gestió de citacions. L'objectiu és fomentar un enfocament disciplinat i centrat en el contingut a l'hora de redactar treballs acadèmics, assegurant que els estudiants prioritzin la qualitat i la integritat del seu treball. Seguint els principis i el flux de treball que es proposen en aquest manual, es poden generar documents ben estructurats i amb un format professional que compleixin les expectatives institucionals amb el mínim esforç.

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Part I.

Thesis Manuscript Typesetting

1. Introduction

This style has been specifically designed to facilitate the typesetting of Capstone Project or Master Thesis manuscript. In this document the acronym TFE—which derives from the Catalan form—will be used to refer to either of the two works interchangeably. Originally developed for the ICT Systems Engineering degree at UPC Manresa, the style has, especially since version 7.0, expanded to be used across any undergraduate or master’s program at UPC Manresa. It fully adheres to the current regulatory requirements [Esc23].

As this is a L^AT_EX style, it assumes the user has some knowledge of the tool. If you’ve never used L^AT_EX before, don’t be discouraged—we encourage you to try it! It is a powerful and rewarding tool that can serve you well for many years. The style also assumes that the working environment is Linux. If you are unfamiliar with L^AT_EX, we recommend checking Appendix C for a brief introduction.

The style has been designed according to the following principles:

- *High legibility.* The font and layout have been chosen to maximize readability, including high-quality mathematical typography.
- *High information density.* Without compromising legibility, the style promotes a dense layout. This is essential for improved environmental sustainability and for producing a printed document that is easier to manage.
- *Support for Catalan and English.* The style allows the document to be written in either Catalan or English. In each case, orthotypographic conventions appropriate to the chosen language are applied.

1.1. Installing the Class

The latest version of this style can always be downloaded from the following URL: <https://ocwitic.epsem.upc.edu/assignatures/tfg/format-de-la-memoria>. There, you will find a tarfile containing:

- The style documentation.
- The style file itself.
- A template for the TFE manuscript.

We recommend that you always download the most recent version from this URL, as the style is actively maintained and updated regularly.

The style (called a “class” in L^AT_EX jargon) is implemented in a single file named `tfgitic.cls`. Simply placing this file in the same directory as your manuscript source is enough to use it. The other files included in the *tarfile* are templates and documentation, which are not

required to compile the TFE, but we recommend keeping them on hand during the writing process.

In addition to standard packages, the class relies on additional packages from the `texlive` distribution, such as `tikz`, `hyperref`, `texlive-science`, `booktabs`, and some specific fonts used for the UPC logo, which must be installed beforehand. To install the required packages on a Debian-based Linux system, run the following commands:

```
$ apt-get install texlive-latex-base texlive-latex-recommended
$ apt-get install texlive-fonts-recommended texlive-pictures
$ apt-get install texlive-science texlive-latex-extra
$ apt-get install biber texlive-bibtex-extra
```

The basic steps to start typesetting the manuscript are:

1. Install the required packages as explained above.
2. Download the latest version of the class as a *tarfile* named `tgfitic.tar.gz`.
3. Extract the contents of the *tarfile*.
4. Copy the class file `tgfitic.cls` to the directory where you will develop the manuscript. We strongly recommend using a version control system to manage the source code of your report.
5. Also copy the template files: `tfe.tex` and `tfe.bib`.
6. Start writing your report using the templates!
7. Don't forget to fully read carefully this documentation before starting to write.

1.2. Class Manual

The manual for this class is the very document you are reading, which serves both as an example and as the official documentation. The source files for this document are `document-tfe-en.tex`, `document-tfe.bib`, `taula-exemple-1.png`, `taula-exemple-2.png`, `taula-exemple-3.png`, `taula-exemple-3.png`, and `halebopp3.jpg`. When compiled, they produce the `pdf` file you are currently viewing.

This documentation does not focus on topics considered standard, such as basic knowledge of `LATEX`, `emacs`, or `biblatex`. Only brief references are made to these, as extensive high-quality resources are available elsewhere for those who need them.

Regarding the formal aspects of the TFE manuscript, this document avoids elaborating on many elements that, although regulated, are automatically handled by the `tgfitic` class. These include, among others: the font and font sizes used in different contexts, page dimensions, page numbering format, line and paragraph spacing, cover design, index formatting, and many other layout details.

For the various modules—i.e., classes and packages—mentioned in this document, you can always refer to their respective user manuals using the `texdoc` command. For example, to learn more about the `siunitx` package, run the following command in the terminal:

```
$ texdoc siunitx
```

This way, you can explore the details of each package and make the most of their features.

1.3. Class Options

In the `tfgitic` class, the following options can be applied:

`creativecommons` | `nocreativecommons` This option controls whether a Creative Commons license appears on the back cover. By default, the license is included, and the chosen variant is BY-NC-SA.

The license of the report defines the legal rights granted to readers: whether they can reproduce the work, use it as a basis for derivative work, and so on. For more information, consult the FAQ on the Creative Commons website [CC22].

`catalan` | `english` This option sets the main language of the document. By default, the language is Catalan. The next chapter provides more detail on language selection.

`bachelor` | `master` This option specifies whether the document is a bachelor's thesis or a master's degree report. By default, it is treated as a capstone project.

2. The Language of the Manuscript

Every thesis manuscript is written in a main language. This style supports Catalan or English as the primary language. The appropriate option must be specified in the `tfgitic` class to indicate the main language of the document.

The main language determines several automatic elements, such as the formatting of dates. It also affects the orthotypographic conventions applied throughout the document, which differ between Catalan and English. For instance, list formatting and punctuation conventions may vary depending on the language selected.

Having English as the main language of the document does not prevent you from including sections in Catalan, or vice versa. For example, you might need to quote a passage originally written in Catalan. In such cases, it is recommended to explicitly mark the language of the excerpt. This ensures that the correct typographic conventions are applied. You can do this using a construction like the following:

```
\begin{otherlanguage}{catalan}
Quan escrivim en Català, si escrivim \verb!«aquest exemple»!,
obtenim «aquest exemple». En el cas que hi hagi cometes dins de
cometes, escrivim \verb!«Dèlia digué, «Això no funcinarà mai.»»! i
obtenim «Dèlia digué, «Això no funcinarà mai.»» tal i com demana la
tradició ortotipogràfica.
\end{otherlanguage}
```

An example of this mechanism applied to an English paragraph can be found in item 1 of Chapter 4.

3. Writing Conventions and Style Guidelines

When writing the manuscript for the TFE, some general principles should be kept in mind. Perhaps the most important is the linguistic register, which must correspond to that of a scientific and technical document.

Some fundamental points to respect are:

1. Use either the first-person plural or an impersonal style consistently throughout the document. The verb tense should be uniform. Avoid writing sentences like:

“I have found that the resulting voltage was within the margins.”

“That’s why I decided to use the most recent version.”

Instead, it is preferable to write:

“We have found that the resulting voltage was within the margins.”

“That’s why we decided to use the most recent version.”

2. Aim for a concise and precise writing style. Consider the following paragraph, extracted verbatim from a capstone manuscript:

In 2014, from ipython is born the Jupyter project, for which Jupyter Notebook is created. This is a software that, among many other things, turns ipython into a web application. Jupyter Notebook allows editing and sharing documents (notebooks) online with the main characteristic that in them one can insert live code, Tex typographies, images, equations, etc.

Here is a possible improved version:

In 2014, the Jupyter project was launched as an evolution of IPython, leading to the creation of Jupyter Notebook. This software transforms IPython into a web-based application, allowing users to edit and share notebooks online. These notebooks support live code, \LaTeX formatting, images, equations, and more.

3. Ensure correct spelling throughout the document.

Many books can help you improve your writing. A particularly recommended one is Daniel Cassany’s [Cas95]. Another useful reference is the book by Rowena Murray and Sarah Moore [MM06].

4. Fundamental Orthotypographic Criteria

Orthotypography f. Set of conventions that in each language defines the meaning and rightful usage of typographic signs, notably punctuation marks, and elements of layout such as flush margins and indentation.

(Wikipedia)

Many of the orthotypographic rules required in the TFE memory are applied automatically by the L^AT_EX class `tfgitic`. For example, page layout, page numbering, and the formatting of lists are handled by the class without any manual intervention.

However, some aspects depend on the author's input because they cannot be automated. Below is a list of essential criteria that must be applied manually.

1. *Quotation marks.* Quotation marks are used to highlight citations, terms, or expressions within the text. Handling quotation marks correctly is delicate because:

- They vary depending on the language of the document.
- They need to address complex situations, such as nested quotations.

The class `tfgitic` automatically manages these complexities. Therefore, in the source, quotations should always be written using the Latin low quotation marks « and ». When there are nested quotes, these should also use low quotes. The class will automatically convert them according to the orthotypographic rules.

For English, if you write «as in this text», the output will be “as in this text” with the proper English-style upper quotes. In nested quotes, the automatic system converts the marks correctly as well. For example, the source «she smoked a «joint» while she looked with sliced eyes» produces “she smoked a ‘joint’ while she looked with sliced eyes.” Notice how the outer quotation marks are double, and the inner ones are single, as per English typographic tradition.

Quan escrivim en Català, si escrivim «aquest exemple», obtenim «aquest exemple». En el cas que hi hagi cometes dins de cometes, escrivim «Dèlia digué, «Això no funcionarà mai.»» i obtenim «Dèlia digué, “Això no funcionarà mai.”» tal i com demana la tradició ortotipogràfica del Català.

2. *Dashes.* Different dashes have distinct uses:

- The short dash (hyphen) is used in compound words, e.g., “sought-after”.
- The medium dash (en-dash), written as -- is used in date or number ranges, e.g. “2017–2025”, typeset as «2017--2025»

- The minus sign indicates subtraction or change of sign. \LaTeX handles this automatically when in math mode. For instance, $\text{\$-3\$}$ renders as -3 , which is a correct minus sign, and $\text{\$4-2\$}$ renders as $4 - 2$. Note that $\text{\textless-3\textgreater}$ produces a hyphen dash “-3”, which is incorrect. This is a reason why numbers are always enclosed in dollar signs when typesetting \LaTeX .

It is interesting to remark that the minus sign is not the en-dash. Consider the result of typesetting $\text{\$4-2\$}$ and $\text{\textless4--2\textgreater}$, that produces $4 - 2$ and “4–2”. The first is a subtraction while the second a range.

- The long dash (em-dash), written as three dashes ---, marks interruptions or breaks in text—often used in scientific writing for parenthetical remarks.
3. *Geminated el*. The catalan “geminated el” (\l l) has a unique typographic form designed to maintain word flow without appearing as two separate letters divided by a middle dot¹. According to Fabra [Fab84], the spacing between the two els should resemble that of two normal letters without any middle dot.

In \LaTeX , the geminated el is obtained using the macro \l l.1 . For example: $\text{\texttt{Inte\l l.1igient}}$ produces *Intelligent*, and $\text{\texttt{Ape\l l.1es}}$ produces *Apelles*

Using this macro also ensures correct line breaks when a word containing a geminated el splits at the end of a line: the middle dot disappears and is replaced by a hyphen. See, for example, this excerpt written in Catalan:

Tal com ens havia dit en al·lusió a l’acuarel·la que hi havia al col·legi, mostrava un idil·li fallaç.

typeset as:

```
\begin{minipage}{0.5\linewidth}
Tal com ens havia dit en a\l l.1usió a l’acuare\l l.1a que hi havia
al co\l l.1egi, mostrava un idi\l l.1i fa\l l.1aç.
\end{minipage}
```

4. *Ellipsis*. Typographically, ellipsis are not just three ordinary dots in a row. Writing three dots consecutively breaks the typographical rhythm of the prose, as seen here...

\LaTeX provides the macro $\text{\textbackslash dots}$ to produce proper ellipsis, like this sentence...

5. *Acronyms*. Scientific texts often use acronyms to represent recurring terms. Writing acronyms in full uppercase letters visually disrupts the text flow and line rhythm. The recommended style is to use small caps, which are capital letters sized similarly to lowercase letters, preserving a balanced appearance. For example: THIS IS TEXT WRITTEN WITH SMALL CAPS.

The class $\text{\texttt{tfgitic}}$ provides the macro $\text{\textbackslashacro}$, which formats acronyms correctly. For example, $\text{\textbackslashacro\texttt{rfid}}$ outputs *RFID*—lowercase letters styled as capitals. When an acronym starts a sentence, capitalize the first letter, as in:

¹Gemination is a phonetic phenomena consisting on the articulation of a consonant for a longer period of time than that of a singleton consonant. Many languages write two times the same consonant to denote it is geminated. However, in Catalan “ \l l ” refers to pallatal el. Therefore, “ \l l ” is used to denote geminated el.

NASA is the USA spatial agency.

6. *Emphasized text.* Always mark emphasized text using the L^AT_EX macro `\emph`. Avoid using boldface except for section titles, where it is applied automatically.
7. *Foreign words.* Foreign words not adapted to the document's language are usually italicized. The class provides the macro `\est{}` for this purpose; for example, `\est{chic}` produces *chic*. Other examples include: *joie de vivre*, *blitzkrieg* or *ad infinitum*.

It is generally preferable to avoid foreignisms.

8. *Numerical values.* Numerical values are written using a comma as the decimal separator. To facilitate consistent formatting throughout the document, the package `sunitx`—already loaded by default—should be used.

Examples:

- `\num{23.036}` yields 23.04;
- `\ang{23}` yields 23°;
- `\ang{23;10;12}` yields 23°10'12";
- `\num{30.45d-4}` yields 30.45×10^{-4} ;
- `\num{3.45d-4}` yields 3.45×10^{-4} ;
- `\complexnum{2+4i}` yields $2 + 4i$.
- `\numlist{12.; 10.091; 11.54}` yields 12, 10.09 and 11.54.
- `\numproduct{5 x 100 x 2}` yields $5 \times 100 \times 2$.
- `\numrange{5}{100}` yields 5 to 100.

Note that the system automatically rounds values—in this case, to two decimal places. It is advisable to include all known decimals in the source code and allow the system to handle rounding for consistency throughout the document.

The rounding behavior and the number of decimals can be configured. By default, the style rounds to two decimal places, as required in TFE reports.

Also note how `sunitx` respects the original number of decimal digits unless more than two are used, in which case rounding applies. Compare:

- `\num{69}` yields 69
- `\num{69.2}` yields 69.2
- `\num{69.26}` yields 69.26
- `\num{69.266}` yields 69.27

9. *Units.* Units, always expressed using the International System, are also formatted via the `sunitx` package. This ensures correct spacing, line breaking, and unit notation.

Examples:

- `\qty{10.23}{\kilo\ohm}` yields 10.23 kΩ;
- `\qty{10.239}{\micro\farad}` yields 10.24 μF;
- `\qty{0.23d-3}{\metre\per\second}` yields 0.23×10^{-3} m/s;

- `\qty{100}{\degreeCelsius}` yields 100 °C;
- `\qty{12.012}{\mega\bit\per\second}` yields 12.01 Mbit/s.
- `\qtylist{12.; 10.091; 11.54}{\ohm}` yields 12 Ω, 10.09 Ω and 11.54 Ω.
- `\qtyproduct{5 x 100 x 2}{\kilo\meter}` yields 5 km × 100 km × 2 km.
- `\qtyrange{5}{100}{\degreeCelsius}` yields 5 °C to 100 °C.

Shorthand notations are available for common units, for instance:

- `\qty{3.}{\us}` yields 3 μs;
- `\qty{2.059}{\kg}` yields 2.06 kg;
- `\qty{2.3}{\kHz}` yields 2.3 kHz.

The numeric values that precede the units follow the same rules as described in the previous section. For example:

“We will use a 47 kΩ resistor in the circuit.”

“The primary coil resistance was measured at 34.12 Ω.”

10. *Formulas and chemical elements.* Chemical formulas can be typeset using the `mhchem` package, which simplifies chemical notation.

Examples:

- `\ce{H2O}` yields H₂O;
- `\ce{(NH4)2S}` yields (NH₄)₂S;
- `\ce{[AgCl2]-}` yields [AgCl₂][−];
- `\ce{1/2H2O}` yields $\frac{1}{2}$ H₂O.

It also supports chemical reactions:

- `\ce{CO2 + C -> 2CO}` yields CO₂ + C \longrightarrow 2 CO;
- `\ce{SO4^2- + Ba^2+ -> BaSO4 v}` yields SO₄^{2−} + Ba²⁺ \longrightarrow BaSO₄↓.
- `\$ \ce{x Na(NH4)HPO4 ->[\Delta] (NaPO3)_x + x NH3 ^ + x H2O} \$` yields $x \text{ Na(NH}_4\text{)HPO}_4 \xrightarrow{\Delta} (\text{NaPO}_3)_x + x \text{ NH}_3 \uparrow + x \text{ H}_2\text{O}.$

11. *URLs.* URLs should be written using the `\url` macro. This macro formats them with a monospaced font, allows line breaks at appropriate places, and makes them clickable.

Example:

- `\url{http://w3c.org}` yields <http://w3c.org>.

5. Tables and Figures

Tables and figures are considered floating elements. This means they do not appear at a fixed location within the text, but are instead positioned by the typesetting system where it deems most appropriate. To refer to them from the main text, a system of labels and cross-references is used. This allows you to cite a figure or table reliably, without needing to worry about its exact placement or numbering.

At first, working with floating elements may seem unpredictable or even confusing, particularly if you're unfamiliar with how \LaTeX handles them. Tables and figures might not appear exactly where they are placed in the source code, but rather where the system finds the most suitable location based on layout constraints.

The general recommendation is to rely on \LaTeX 's automatic placement system during the drafting phase. Only once the content is finalized should you consider manually adjusting the position of figures or tables that appear in awkward or unsuitable locations.

The `tfgitic` class prioritizes placing figures at the top of the page, and if not possible, at the bottom. It avoids placing floating elements in ways that would disrupt the flow or readability of the text.

5.1. Tags and References

The tagging and referencing system in \LaTeX is general-purpose and applies to all parts of the document—not just to figures and tables. It is also very simple to use. The system is based on the macro `\label`, which defines a tag at a given point in the text, and the macro `\ref`, which references that tag elsewhere in the document.

For example, the previous chapter begins with the following code:

```
\chapter{Introducció}
\label{chap:intro}
```

Here, the tag `chap:intro` is defined. This tag name can be chosen freely, though it is good practice to use meaningful and structured names (e.g., prefixing with `chap:` for chapters).

If we later refer to this tag using `\ref{chap:intro}`, the macro will be replaced by the appropriate chapter number: Chapter 1.

This system allows you to freely add, remove, or rearrange parts of the document without having to manually update reference numbers— \LaTeX handles that automatically, ensuring consistency throughout the text.

5.2. Tables

Floating tables are defined using the `\table` environment. Typically, a table includes a caption and a label to allow referencing. Below is a basic example:

Region	Population	Literacy Rate (%)
Northland	1 200 000	97.5
Eastvale	850 000	89.3
Southpoint	460 000	93.8

Table 5.1.: Population and literacy rate in three administrative regions.

k	<i>Speedup</i>		
	$n = 1 \times 10^6$	$n = 1 \times 10^7$	$n = 2 \times 10^7$
1	1.00	1.00	1.00
2	1.01	1.18	1.40
3	1.06	1.51	1.71
4	0.95	1.67	1.94
5	0.94	1.77	2.12
6	0.53	1.52	2.41
7	0.55	1.19	1.61
8	0.37	0.91	1.36

Table 5.2.: *Speedup* in the computation of π using `octave`.

```

\begin{table}
  \centering
  \begin{tabular}{lS[table-format=7.0]S}
    \toprule
    Region & {Population} & {Literacy Rate (\%)} \\
    \midrule
    Northland & 1200000 & 97.5 \\
    Eastvale & 850000 & 89.3 \\
    Southpoint & 460000 & 93.8 \\
    \bottomrule
  \end{tabular}
  \caption{Population and literacy rate in three administrative regions.}
  \label{tab:regions}
\end{table}

```

The result is shown in Table 5.1. Note how the numerical values are properly aligned and formatted thanks to the conventions applied by the `sunitx` package: automatic rounding, replacement of the decimal point with a comma, handling of scientific notation, and so on.

Some tables may require more complex structures. Consider, for instance, Table 5.2, which was extracted from a real project report. You can inspect the source code of this document to see how it was created.

Designing effective tables is a more technical task than it might first appear. Bringhurst, in [Bri04, p. 70], outlines several important principles to consider when typesetting tables. Appendix E briefly explains how to design good tables.



Figure 5.1.: Comet Hale-Bopp photographed in 1997 from Joshua Tree National Park, USA. © NASA.

5.3. Figures

Figures—whether graphics or photographs—are managed using a floating environment similar to that of tables. When using photographs or external images, they must be stored in separate files and inserted into the document using the `\includegraphics` macro. This macro allows:

- Including external images. When compiling with `pdflatex`, the supported formats are `jpeg`, `png`, and `pdf`.
- Scaling, cropping, and rotating images to adapt them to the layout of the document.

The following code, for example, includes a photo scaled to 80% of the page width. The result is shown in Figure 5.1.

```
\begin{figure}
  \centering
  \includegraphics[width=0.8\textwidth]{halebopp3}
  \caption{Comet Hale-Bopp photographed in 1997 from
    Joshua Tree National Park, USA. \copyright{} NASA.}
  \label{fig:hale-bopp}
\end{figure}
```

Figures can also represent diagrams or plots. In such cases, using vector formats is strongly recommended over raster images. Vector graphics result in smaller file sizes, faster printing, and better scalability. Many applications for creating diagrams and plots can export to vector formats, such as `pdf`. For instance, tools like `gnuplot` or `inkscape` support this.

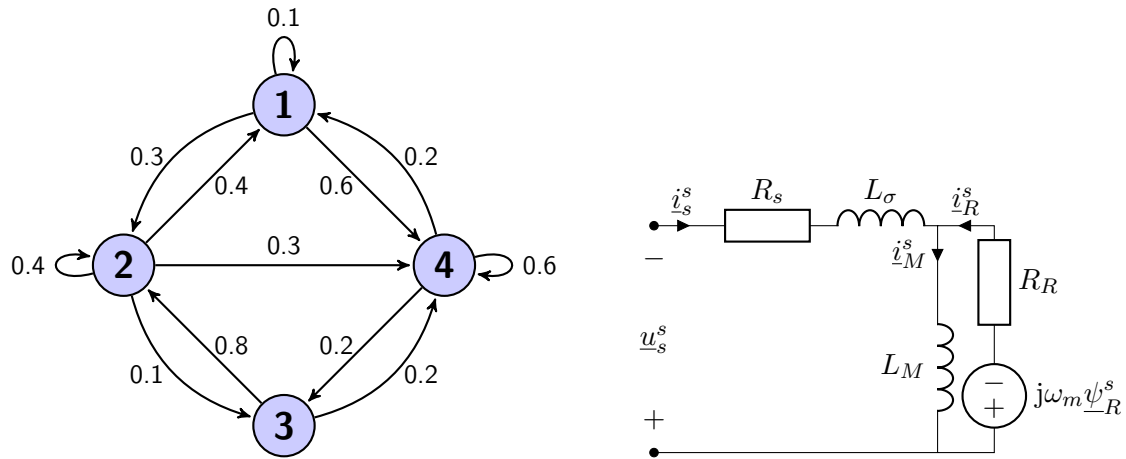
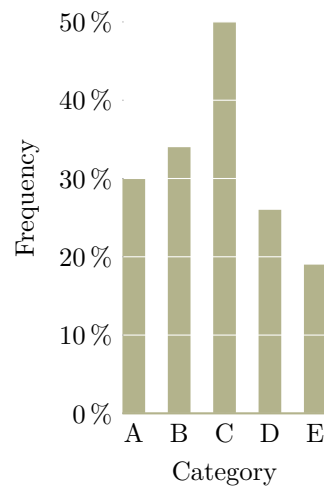


Figure 5.2.: Two sample diagrams designed using TikZ.

Figure 5.3.: A histogram created with `pgfplots`.

The method of including these vector graphics is the same as for photographs. The preferred format is typically `pdf`.

An excellent alternative for creating high-quality diagrams is the `pgf/tikz` package, along with its various extensions. This powerful tool allows you to define graphics directly within the `LATEX` source code, offering exceptional visual quality and full document integration. For many standard diagrams, this approach produces outstanding results.

There are many specialized packages built on top of `pgf/tikz` for specific types of graphics. A particularly useful one is `pgfplots`, which simplifies the creation of statistical plots and function graphs (e.g., histograms, box plots, scatter plots, etc.). Figure 5.3 shows a histogram generated using this package, styled according to the principles recommended by Tufte in [Tuf01].

5.4. Table and Figure Captions

Both tables and figures must include a short descriptive caption, also known as a *legend*. The function of the caption is similar to that of a headline: to briefly and precisely describe the table or figure. Captions should not be overly long—one or two sentences is usually sufficient. Any further explanation or commentary should appear in the main body of the text, not in the caption.

In some cases, the caption can help clarify specific elements of a figure. For example, when a single figure contains multiple subfigures, the caption can indicate the purpose of each part.

It is also common practice to cite the source of the figure or table in its caption. Some editorial styles recommend including explicit text such as “Source: ...” or “Own source” to indicate the origin of the material. However, in the style used for the TFE, such phrases are avoided, as they tend to be redundant and visually heavy.

If you are the author of the figure or table, there is no need to state it explicitly—it is understood that all original material in the document is your own. On the other hand, if the material is borrowed from another source, the caption should include a natural reference using standard citation methods (see Section 8).

Here are some examples of how to include such references in captions:

- “Phase diagram adapted from [cite].”
- “Income distribution table for central counties based on [cite].”
- “Photograph by [cite] showing the Tordell fault.”

6. Mathematical Notation

L^AT_EX was originally created with a strong focus on writing mathematical content. It provides a rich set of tools for typesetting mathematics and is extensively documented online. This chapter offers a brief and simple introduction to these capabilities.

The first thing to understand is that mathematical expressions must be written within special environments. These environments are marked clearly, and any content inside them is interpreted using mathematical typography rules.

There are two main ways to typeset mathematical expressions:

1. *Inline expressions*, written within the body of a paragraph. These are delimited by dollar signs. For example, writing `$3\sin^2x$` produces $3\sin^2 x$, and `$\int_0^5 \frac{1+\tan x}{x} dx$` renders as $\int_0^5 \frac{1+\tan x}{x} dx$.
2. *Display expressions*, which are typeset in their own line, centered on the page, but still part of the paragraph. The simplest way to write them is using the `\[... \]` environment. For example:

$$3\sin^2 x$$

$$\int_0^5 \frac{1+\tan x}{x} dx$$

Note that although these formulas are visually separated, they do not break the paragraph's structure.

Observe how the presentation differs between inline and display math. Inline math is compressed vertically to match the line spacing of the surrounding text, whereas display math uses its full height, allowing for larger symbols.

Regardless of the environment, mathematical expressions use the same syntax. Some key elements of this notation include:

- *Braces `{}`* are used to group elements, just as in programming languages. For example, `$\sqrt{a}+3$` produces $\sqrt{a} + 3$, while `$\sqrt{a+3}$` gives $\sqrt{a+3}$. To print literal braces, you must escape them with a backslash: for instance, `$A = \{x \mid x \in \mathbb{R} \wedge x \geq 10\}$` results in $A = \{x \mid x \in \mathbb{R} \wedge x \geq 10\}$.
- *Standard functions* like logarithm, sine, etc., should be written with a backslash to ensure correct spacing and font. For example, `$\log x$` renders as $\log x$ and `$\sin x$` as $\sin x$.
- *Subscripts and superscripts* are written using `_` and `^`, respectively. For example, `x^2` gives x^2 , `x^{22}` yields x^{22} , and `$x^{\sin y}_{10}$` produces $x_{10}^{\sin y}$.
- *Large operators* such as sums and integrals can also include subscripts and superscripts. For example, `$S = \sum_{i=0}^n i^2$` results in:

$$S = \sum_{i=0}^n i^2$$

-
- *Greek letters and other symbols* can be inserted by name. For example:

- $\$R_a = \pi r^2\$ \rightarrow R_a = \pi r^2$

- $\$\Lambda = \frac{\zeta \cdot \phi}{z^2 + 1}\$$ yields $\Lambda = \frac{\zeta \cdot \phi}{z^2 + 1}$

- $\$A = \overline{B \cup C}\$ \rightarrow A = \overline{B \cup C}$

You can find full symbol reference guides easily on the web.

Sometimes it is useful to number display equations so that you can refer to them later. This is done using the `equation` environment:

$$l\ddot{\theta} + g \sin \theta = 0 \tag{6.1}$$

This lets you refer to equation 6.1 from the text. It describes the motion of an ideal pendulum of length l .

The code to produce this equation is as follows:

```
\begin{equation}
\label{eq:llei-pendol}
l\ddot{\theta} + g\sin\theta = 0
\end{equation}
```

The referencing mechanism uses the same system of labels and references explained earlier in section 5.1.

7. Algorithms and Programs

The field of systems engineering naturally involves frequent interaction with topics related to algorithms, programming languages, and command-line tools. This often presents challenges in maintaining orthotypographic consistency throughout the document. This chapter highlights some fundamental guidelines to help address these issues.

7.1. Referencing Files, Commands, and Shell Interactions

In many theses, it is common to refer to specific files within the main text. File names—whether regular files, directories, or complete paths—should be typeset using a typewriter font. For this purpose, the macro `\fitx` is provided. It allows you to write entries such as `modul.c`, `/etc/cron.daily/logrotate`, `~/config/back%/_window.txt`, or `~/bashrc`. Note that this macro correctly handles special characters and breaks lines appropriately when necessary.

Sometimes it is also useful to reference commands issued in the shell. For this, we use the macro `\ord`. For example, we write `\ord|pdflatex tfe.tex|` to indicate that this document can be compiled using the command `pdflatex tfe.tex`. Note that instead of curly braces, you may enclose the argument using any delimiter—such as the vertical bar in this example.

7.2. Algorithms

Including long program listings or extensive data tables is generally discouraged within the main body of a thesis. Such material is better suited for an appendix or external digital support accessible online. However, it is often necessary to describe algorithms that play a key role in the work, either to illustrate a concept or to provide commentary.

For writing algorithms, the `algorithm2e` package proves especially useful. It is well-documented and allows you to typeset algorithms in familiar pseudo-code notation. For example, consider the following algorithm written using this syntax:

```
\begin{algorithm}
  \KwIn{$n, m$ two natural numbers}
  \KwOut{$r$ greatest common divisor of $n$ and $m$}
  \BlankLine
  \While{$n \neq m$}{
    \eIf{$n > m$}{
      $n := n - m$;
    }{
      $m := m - n$;
    }
  }
}
```

```
$r := m$\;  
\caption{Euclid algorithm}  
\label{alg:euclides}  
\end{algorithm}
```

This produces an algorithm enclosed in a floating environment, much like a figure, as shown in Algorithm 7.1. To simplify document structure, algorithms are numbered in the same sequence as figures.

Input: n, m two natural numbers
Output: r greatest common divisor of n and m

```
while  $n \neq m$  do  
  if  $n > m$  then  
    |  $n := n - m$ ;  
  else  
    |  $m := m - n$ ;  
  end  
end  
 $r := m$ ;
```

Figure 7.1.: Euclid algorithm

8. Bibliography

8.1. Citations and Bibliography in the TFE

In a scientific document such as a TFE thesis, the bibliography serves two distinct yet complementary purposes:

1. *In-text citations:* Throughout the main body of the document, references to external sources are made using citations. These citations act as pointers to works included in the bibliography and serve several essential functions:

- *Attributing information to its original source:*

“According to Stevens, [Thu01], the steam engine was invented by James Watt.”

- *Building upon existing research:*

“To calculate the performance of a steam engine, we will apply the formulas proposed by Thurston in [Thu01].”

- *Directing the reader to further reading:*

“For more information on steam engines, see the book by Thurston, [Thu01].”

Each citation refers to a corresponding entry in the bibliography using a unique identifier, ensuring clarity and traceability for the reader.

2. *Bibliography section:* At the end of the document—just before the appendices—a dedicated unnumbered chapter titled “Bibliography” lists all the sources cited throughout the text. Each entry provides the full reference information (author, title, publisher, year, etc.), formatted according to the type of publication (book, article, website, etc.) and the selected bibliographic style.

This reference list includes only works that have been cited in the text; uncited sources should not appear in the bibliography. The use of citation keys (such as `\cite{thurston01:_histor_growt_steam_engin}`) ensures a consistent link between the in-text citation and the full bibliographic record.

Together, citations and the bibliography create a clear and reliable system for referencing sources. The citations provide context and attribution within the flow of the text, while the bibliography ensures that readers can retrieve complete details about the cited works.

The method used to cite references, and the formatting of those references, varies according to the document type and follows strict and well-defined rules known as “bibliographic styles”. Some commonly used styles include APA [APA20], the Chicago Manual of Style [The17], the ISO 690 standard [ISO21], and the IEEE style [IEE18]. In the formatting of TFE documents, we use the BibTeX standard, applying the alphanumeric citation style [KWL22].

8.2. Managing the Bibliographic Database with BibLaTeX

Managing bibliographic references is not a trivial task. To assist with this, L^AT_EX provides a powerful set of tools that greatly simplify the process. Although these tools offer extensive capabilities, this section provides only a brief introduction. For more detailed information, refer to [KWL22].

The general workflow is as follows: a separate file—typically named `tfe.bib` in our case—contains descriptions of the documents cited in the text. These descriptions include metadata such as author names, publication dates, titles, and more. Each document type (e.g., book, article, manual) has a corresponding entry format with required and optional fields. The types of entries, along with the valid fields and formatting guidelines, are detailed in [KWL22, chap. 2]. This file constitutes the *bibliographic database*.

It's worth noting that `emacs` offers a specific editing mode for working with BibTeX or BibLaTeX databases. A brief guide on using this mode is available in Appendix D.

In our example, the file `tfe.bib` includes the following entries (among others used throughout the document):

```
@Book{thurston01:_histor_growt_steam_engin,
  author = {Robert Henry Thurston},
  title = {A History of the Growth of the Steam-Engine},
  publisher = {D. Appleton {and} company},
  year = 1901,
  address = {New York, USA},
  edition = {4th revised},
  langid = {english},
}

@Manual{lehman14:_biblat_packag,
  title = {The Biblatex Package},
  subtitle = {Programmable Bibliographies and Citations},
  author = {Philipp Lehman and Philip Kime and Audrey Boruvka and Joseph Wright},
  version = {2.9a},
  month = 6,
  year = 2014,
  url = {http://mirrors.ctan.org/macros/latex/contrib/biblatex/doc/biblatex.pdf}
}
```

Note that each entry begins with a unique citation key—an arbitrary identifier used to reference the document in the text via commands like `\cite{lehman14:_biblat_packag}`.

In a TFE document, you must specify which bibliographic database to use. This is done by placing the following macro near the beginning of your document:

```
\addbibresource{tfe.bib}
```

Then, to insert the bibliography table where you want it to appear, include the command:

```
\printbibliography
```

Typically, the bibliography is placed after the final chapter and before any appendices. It is not numbered, since—like the abstract or summaries—it is not considered part of the main body of the thesis. You can observe this structure by examining the source of the current example document.

8.3. Compiling a Document with Bibliographic References

When working with documents that include a bibliography, the compilation process involves additional steps compared to processing documents with only regular content. To compile this document, for example, the following sequence should be followed:

1. First, process the document using `pdflatex tfe.tex`.
2. Then, extract the bibliographic data required by the document from the bibliography database using `biber tfe`.
3. Finally, process the document again with `pdflatex tfe.tex` to integrate the extracted bibliographic references.

In general, you only need to repeat the second step (running `biber`) when the bibliography database is modified—either because new entries have been added or existing entries have been updated.

8.4. Common Questions About Bibliographic Practices

This section addresses some frequently asked questions related to the bibliography of a TFE document.

1. A common question is: How can a bibliographic reference be included in the reference list if it is not explicitly cited in the text? The short answer is—it should not be done. It is considered poor practice to include references for documents that are not cited within the body of the work. If a document is relevant to your TFE, it should certainly be cited at one or more appropriate points in the main text.
2. Not all documents are created equal in terms of scholarly value. Different sources carry different levels of *rigor*¹. For instance, an article published in a peer-reviewed scientific journal holds significantly more scholarly weight than a blog post or a website of unknown authorship.

When selecting sources for your bibliography, always prioritize those with the highest level of academic rigor available. This is especially important in the context of a TFE, where the credibility of your references directly contributes to the overall quality and trustworthiness of your work.

¹Here, rigor refers to the degree of reliability or credibility attributed to the content of a document.

9. Organizing the Thesis Structure

By “organization of the thesis” we refer to how the document is structured into chapters, sections, appendices, and other formal components.

The main objective of the document’s structure is to communicate the work carried out as clearly and effectively as possible. Consequently, the organization may vary depending on the nature of the project. However, there are general guidelines that should always be followed. The TFE regulations [Esc23] define a reference structure, which this style adheres to. The `tfgitic` class formats many of the mandatory structural elements automatically while allowing flexibility for content-dependent sections.

As mentioned in Section 1.2, the files `tfe.tex` and `tfe.bib` serve as templates for the TFE thesis document and are pre-configured to follow the organization outlined in this chapter.

9.1. General Considerations

The organization of the thesis involves numerous considerations, many of which are handled automatically by the `tfgitic` class.

The thesis is divided into two main parts: the *preliminary block* and the *central block*.

1. The preliminary block includes the cover, copyright, dedication, acknowledgments, declaration of responsibility, summaries, and the table of contents. These elements are formatted and paginated automatically.
2. The central block includes the main chapters, the bibliography, and any appendices. The structure of the central block depends on the presence of appendices. If appendices are included, the central block is split into two parts: the thesis body and the appendices. If there are no appendices, this division is omitted.

Both the thesis and the appendices are divided into chapters, sections, subsections, and—only if necessary—sub-subsections.

9.2. Main Divisions

This section lists, in order of appearance, the main components of the thesis document, indicating whether each is mandatory or optional and providing brief guidelines on their content and purpose.

Preliminary Block

1. *Cover* [Mandatory]

The thesis must begin with a compliant cover page. All metadata for the cover is defined before the `\begin{document}` command using macros provided by the style. Some macros accept an optional parameter indicating gender and number:

m Masculine singular

M Masculine plural

f Feminine singular

F Feminine plural

For example, if the thesis has a female tutor:

```
\counselor[f]{Adele Goldberg}
```

If the thesis is co-supervised by two women:

```
\advisor[F]{Margaret Hamilton and Mary Kenneth Keller}
```

The default value for omitted parameters is **m** (masculine singular). Thus, these two are equivalent:

```
\author{Berenguer de Cruïlles}  
\author[m]{Berenguer de Cruïlles}
```

The list of macros that allow you to define metadata is as follows:

title The title of the thesis. It must be the officially registered title. This is mandatory. Line breaks can be added using `\\`.

subtitle The subtitle of the thesis. This is optional.

author The student who authored the work. Written as “first name and surname” and not “surname, first name”. This is mandatory. Accepts an optional parameter with one of the following values: `[m|f]`.

advisor The supervisor or supervisors of the work. Written as “first name and surname” and not “surname, first name”. This is mandatory. Accepts an optional parameter with one of the following values: `[m|M|f|F]`.

company The company or institution where the work is carried out when officially done under an internship agreement (in “company” mode). This is required if the thesis is done in “company” mode.

counselor The academic tutor of the work. When the work is officially done under an internship agreement (“company” mode), the supervisor is a person from the company. In this case, a tutor is required—typically a faculty member with a specific role defined by the regulations [Esc23]. Written as “first name and surname” and not “surname, first name”. This is mandatory if the work is in “company” mode. Accepts an optional parameter with one of the following values: `[m|f]`.

location The city where the TFE is defended. The default is Manresa.

degree The academic degree. By default, this is the Bachelor’s Degree in ICT Systems Engineering (or its official English name if the thesis is written in English).

ects The workload in ECTS credits. By default, it is 24, which is the standard workload for the ICT Systems Engineering degree.

school The school. By default, this is the Higher Polytechnic School of Engineering of Manresa (or its official English name if the thesis is written in English).

topics The two main thematic areas covered by the thesis, in accordance with [Esc23]. The areas are selected by the supervisor (or the tutor, if applicable) from a predefined list established by the TFE procedure.

2. *Dedication and Acknowledgments* [Optional]

A short dedication may be included using the macro `\dedication`. Acknowledgments should be more extended (e.g., 1–3 paragraphs) and written in the `acknowledgements` environment. Both are automatically placed in the correct location.

3. *Summaries* [Mandatory]

Summaries allow the reader to quickly understand the purpose and conclusions of the thesis. They should not exceed half a page.

It is mandatory to include: a summary in Catalan, using the `resum` environment; a summary in English, using the `abstract` environment.

These are placed before `\begin{document}` and are automatically formatted.

4. *Table of Contents* [Mandatory]

This is generated automatically.

Central Block

Part I: Thesis Body

Remember that “Parts” are only used if the manuscript contains appendices. Otherwise, is better to avoid the “Part” subdivision.

5. *Introduction* [Mandatory]

This chapter introduces the thesis, including:

- The context, goals, and motivation of the project
- Summary of results
- Constraints (e.g., limited resources or budget)
- Specific objectives
- Outline of the document structure

It should also engage the reader’s interest and highlight the relevance of the work.

6. *Background* [Mandatory]

This chapter presents essential background knowledge:

- Prior work in the same field, including a critical and comparative review.
- Theoretical concepts, tools, languages, and methods used in the project.

This should be a concise overview, not a textbook. Relevant references should be provided.

7. *Main Content* [Mandatory]

This section consists of the main chapters describing the project. The structure depends on the specific nature of the work.

8. *Economic Study* [Optional]

If applicable, this chapter details economic considerations related to the project.

9. *Environmental and Social Impact* [Optional]

If applicable, this chapter addresses environmental and social aspects linked to the work.

10. *Conclusions* [Mandatory]

Summarizes the results, links them to the objectives, and discusses unmet goals and potential reasons.

11. *Future Work* [Optional]

Optionally, you may describe 2–4 relevant follow-up lines of work, briefly outlining how they could be approached.

12. *Bibliography* [Mandatory]

A non-numbered chapter listing all referenced works. It is automatically generated using the bibliography manager. See Chapter 8 on page 20.

Part II: Appendices13. *Appendices* [Optional]

Appendices contain supporting material that is too detailed or extensive for the main text. Examples include:

- Data tables
- Maps or plans
- Survey forms
- Hard-to-access documents cited in the text
- Transcripts of interviews
- Source code

Whenever possible, cite such material rather than including it directly. If appendices are used, the document must be split into two parts: thesis body and appendices. If not, the `\part{}` macros should be omitted.

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Part II.

Appendices

A. Best Practices for Writing a TFE Manuscript

1. Never manually force page breaks, adjust spacing arbitrarily, change fonts, or apply any other manual formatting tweaks. Let \LaTeX handle the layout, and focus your effort on the content.
2. The text and its explanatory power are the core of your TFE thesis. Your document is not a magazine, catalog, or promotional brochure.
3. Figures should serve to clarify and support what is explained in the text. Including figures simply to “fill space”, to “make it look better”, or because “there should be figures” is not acceptable. Include only those figures that are truly necessary, and design them with care. Ask yourself: if you removed a figure, would the explanation suffer? If not, the figure is probably unnecessary.
4. Use floating figures, and do not force their placement. If the number of figures is appropriate, \LaTeX 's float mechanism will place them in optimal positions.
5. Refer to all figures from the main text and explain them clearly to reinforce your intended message.
6. Choose high-quality, academically sound bibliographic references. Avoid citing web pages from unreliable sources, commercial institutions, or general-interest content.
7. Provide complete bibliographic entries. Include all available details about each source. Avoid submitting incomplete or vague references.
8. In-text citations should support your argument, broaden the context, and clarify the authorship of ideas that are not your own.

B. Version History of the *tfgitic* Class and Documentation

<i>Version</i>	<i>Modifications</i>
8.2	Some typos.
8.1	Add section numbers to pdf bookmarks. Improve some details in the manual. Solve typo contributed by Pau de las Heras. Small improvements to release script. More descriptive title for the manual. New macro <code>\classversion</code> .
8.0	Class docum now in English, <code>docum-tfe-en</code> . New appendix about table typesetting. Upgrade and localise <code>siunitx</code> use. Improve the manuscript abstract.
7.1	Updated the minimum required versions for several packages. Improved internationalization (I18N). Added gender and number parameters to macros for defining people. Enhanced word hyphenation rules for Catalan. Introduced error messages for invalid metadata combinations. Typographic information is now reflected on the inside cover. Various corrections by Aleix Llusà.
7.0	Bug fixes contributed by Eric Roy. Updated to the latest version of the <code>sunitx</code> package. Added a section on figure and table captions. Introduced the “responsible statement” as required by anti-plagiarism regulations. Differentiated the roles of tutor and supervisor. Standardized project naming according to degree or master’s level. Replaced the TFG acronym with the more general TFE. Added option to indicate whether the TFE is for a bachelor’s or a master’s program. Fixed an error in page numbering.
6.5	Improvements to the bibliography relay system.
6.4	Bug fixes. Updated the UPC logo in compliance with current regulations. Added documentation for the <code>C-c C-a</code> command in AUCTeX. Updated the CC license to version 4.0. The <code>summary</code> and <code>abstract</code> environments now apply the correct orthotypography for each language and respect paragraph structure. Added a field for location (city) on the cover. Included additional comments on bibliography formatting. Deprecated the <code>summary</code> environment in favor of <code>abstract</code> . Updated bibliography. Generalized the class to support other degrees and schools.
6.3	Bug fixes. Major improvements to publishing tools. Modified and documented full magnitude notation. Fixed an error in the implementation of the <code>abstract</code> environment, which previously did not recognize paragraph breaks.
6.2	Minor improvements to documentation.
6.1	Removed minor warnings. Added version control to the <i>tfgitic</i> class.
6.0	Documentation now includes appendices on L ^A T _E X and Emacs. Added a chapter on writing mathematical expressions. Fixed the school name in the cover template.
5.0	Added support for both English and Catalan. Improved cover formatting. Added acknowledgments section. Expanded documentation. Introduced a new section on document structure.
4.0	Added automatic hyphenation and support for English quotation marks.
3.0	Bibliography is now included in the table of contents.
2.0	Added optional macro for defining subtitles.
1.0	Introduced the class history. Added commentary on line breaks in ligatures (such as the twin “l”). Added a new reference. Rewrote the section on appendices.

C. Very Brief Introduction to L^AT_EX

L^AT_EX [Lam94] is a high-quality typesetting system. It is not a WYSIWYG editor, but rather functions as a compiler: you write your document in a “source language” and, after compilation, obtain a file—typically in pdf format. L^AT_EX itself is that source language. It is a type of markup language: you write the text and insert commands or “marks” that specify the structure—for example, titles, lists, formulas, and so on.

The key benefit is this: when writing, you can focus entirely on content, while the compiler handles formatting automatically. The final layout depends on the document class being used. Changing the class or its parameters results in a different appearance. This very document, for example, uses a class that formats a thesis according to the conventions for TFE submissions.

A golden rule—the most important one—is: *never override the formatting defined by the document class*. The appearance is the exclusive responsibility of the class.

The source code of a L^AT_EX document is written in a plain text file using a text editor. For instance, in the file `document.tex`, the contents might look like this:

```
\documentclass[a4paper,12pt]{article}
\usepackage[catalan]{babel}

\title{Un exemple}
\author{Ramon Gener}

\begin{document}
\maketitle{}

\section{Introducció}
Això és un apartat d'exemple. I això que segueix una \emph{enumeració}:
\begin{enumerate}
\item Primer punt.
\item Segon punt.
\item Tercer punt.
\end{enumerate}
\end{document}
```

To compile the document, run:

```
$ pdflatex document.tex
```

After some messages appear in the terminal, the file `document.pdf` will be generated.

Sometimes, a single compilation is not sufficient. To simplify the process, you can use the command `latexmk`, which automatically runs the compiler as many times as needed. To install it:

```
$ sudo apt install latexmk
```

This tool can also perform common tasks, such as generating a PDF or cleaning up auxiliary files. Refer to the `man` page for details. To generate a PDF:

```
$ latexmk -pdf document.tex
```

If you're using the `emacs` editor—which we recommend—see Appendix D.

To learn the basics of L^AT_EX, many resources are available. A helpful and concise introduction is found in [Oet+21].

D. Emacs Support

Emacs [Fou19; Sta81] is the recommended text editor for working with \LaTeX . Support for \LaTeX in **Emacs** is primarily provided through the extension **AUCTeX** [TAK+22], and secondarily via the **RefTeX** extension [Dom09], which works alongside AUCTeX to manage references and citations.

These tools offer powerful features, including:

- Insertion of macros and environments via key commands.
- Automatic formatting of source code.
- Syntax highlighting for improved readability.
- Integration of the compile–preview workflow.
- Auto-completion of citations and references.
- Management of bibliography databases.

D.1. Installation

If needed, install the required packages via:

```
$ sudo apt-get install emacs
$ sudo apt-get install auctex
```

Then, edit your **emacs** configuration file `~/.emacs`, adding the following lines to activate **RefTeX** when **AUCTeX** is in use:

```
;; Enable RefTeX when AUCTeX is active
(add-hook 'LaTeX-mode-hook 'turn-on-reftex)
(setq refTeX-plug-into-AUCTeX t)
```

The next time you open **emacs**, the modes will be correctly configured.

D.2. Basic Usage

When you open a file with the `.tex` extension, **emacs** automatically enters “**LaTeX mode**”. The menu bar will include:

- A “**LaTeX**” menu for inserting structures.
- A “**Command**” menu for compiling and viewing the document.

<i>Shortcut</i>	<i>Function</i>
C-c e	Insert an environment; may prompt for parameters.
C-c C-s	Insert a section, subsection, or chapter.
C-c RET	Insert a macro, such as <code>author</code> .
Tab	Insert a new item in a list environment (<code>itemize</code> , <code>enumerate</code> , <code>description</code>).
C-[Insert a citation, offering suggestions from the bibliography database.
C-c)	Same as above—alternative citation shortcut.
C-c C-c	Perform the next compilation step (e.g., compile or view, depending on context).
C-c a	Compile and view the document in one step. If necessary, runs <code>biber</code> or other tools. Most commonly used command.

Table D.1.: Frequently used Emacs commands for working with L^AT_EX. The prefix **C-** stands for the Control key.

Most commands are also available via keyboard shortcuts, which are usually faster. Table D.1 lists some of the most frequently used key bindings. Especially important is the **C-c C-c** command, which automatically determines and executes the next appropriate compilation step.

If you're editing a bibliography file with the `.bib` extension, Emacs activates BibTeX/BibLaTeX mode, allowing for efficient database management. You can insert entry templates (e.g., `@Book`), which include all fields—both mandatory and optional (prefixed with `opt`). After filling in a field, press **Tab** to jump to the next one. When done, the command **C-c C-c** removes unused fields, checks for syntax errors, and suggests a citation key. Just like that, your new reference is ready!

E. How to Typeset Tables

Poorly designed tables are a common flaw in TFE manuscripts. This appendix distills practical guidance from Bringhurst and Tufte on how to design effective tables and shows how to implement those ideas in \LaTeX .

It also presents real examples taken from theses: each original table is analysed and then redesigned and typeset.

E.1. Best Practices for Table Design

Bringhurst [Bri04, p. 70] devotes several pages to tabular typography. Püschel’s slides [Püs10] offer a concise \LaTeX -oriented summary. Designing tables is demanding; approach it deliberately. Keep the following principles in mind:

1. *Purpose and necessity*

Use a table only when structure genuinely improves comprehension. If the information reads just as well linearly, prefer prose or a list.

Every table must answer a clear question. Delete any column, row, or figure that does not contribute to that answer.

2. *Economy and simplicity*

Show the data, not the furniture. Minimise rules (lines), boxes, shading, and ornaments. Prefer white space over ruling. Spacing between columns or column groups normally replaces vertical rules entirely.

Avoid “chartjunk”: gradients, heavy fills, gratuitous bold, repeated units in cells, and spurious decimals.

3. *Hierarchy and emphasis*

Build hierarchy with position, weight, and spacing—not decoration. The eye should locate the header first, then the logical groupings.

Column headings may use a slightly different style (small caps, gentle letter-spacing, subtle weight change) but should not overpower the body.

Totals or summary rows can be separated with a thin rule above, extra white space, or a modest typographic shift—reserve shouting (all caps, heavy bold) for real emergencies.

4. *Rules (lines)*

Use as few horizontal rules as possible: often just (a) a top rule, (b) a header/body separator, (c) an optional subtotal or total rule, and (d) a bottom rule.

Avoid vertical rules; alignment and spacing should do the work.

Keep strokes hairline to light. Thick rules dominate and break the rhythm of the page.

5. *Alignment and numerals*

Align numbers by meaning:

- Integers flush right.
- Decimals aligned on the separator (use the `S` column from `siunitx` or `dcolum`).
- Put units in the header or a separate column—do not repeat a constant unit in every cell.

Use a true minus sign for negatives; reserve en-dashes for ranges. See point about dashes in Section 4.

6. *Consistency and precision*

Round consistently. Do not imply precision the data do not have.

Order rows and columns logically (chronology, magnitude, category). If the ordering principle is not obvious, state it.

7. *Spacing and proportion*

Row height: provide enough leading for legibility; avoid both “airless” stacking and gaping voids.

Column separation: keep the smallest comfortable gap; a slightly wider gap can signal a group boundary.

Keep tables within the main text measure unless a wider format is essential; very wide tables impede reading.

8. *Typography inside cells*

If the table is dense, set type slightly smaller than the running text (0.5 pt to 1 pt), but never so small that it strains the eye.

Avoid competing emphases. Reserve bold or italics for one semantic layer, not both simultaneously.

9. *Grouping and reading flow*

Group related rows with white space, not thick rules. A small extra baseline skip (an “air line”) is often enough.

Left-align text columns; centre only very short, homogeneous labels.

Avoid awkward wrapping of key identifiers. If a label is too long, abbreviate it and explain in a note.

10. *Footnotes, sources, and notes*

Annotate sparingly. Use superscript markers or symbols and collect explanations below the table in a smaller size.

Captions should be concise and specific.

11. *Accessibility and clarity*

Do not rely on colour alone; differentiation must survive grayscale printing.

Explain non-obvious abbreviations in the heading or a note.

<i>Aspect</i>	<i>Question</i>
Necessity	Does a table genuinely improve clarity over prose?
Hierarchy	Are headers / groups immediately identifiable?
Lines	Have I removed every non-essential rule?
Alignment	Are numerals and decimals properly aligned?
Units	Are units placed in headers (not repeated)?
Precision	Is decimal precision consistent and justified?
Space	Is grouping conveyed by white space, not clutter?
Caption	Is it concise, specific, and informative?
Notes	Are footnotes / sources clear yet unobtrusive?
Legibility	Is size/contrast acceptable in print?

Table E.1.: Good table checklist

Ensure scanability: a reader should grasp what each column means and where totals lie within 2 s to 3 s.

12. Avoid over-design

Resist boxing every cell. Grids imprison data; open layouts support comparison.

Use shading only if hierarchy fails without it. If you must shade, keep it very light and consistent.

Table E.1 offers a brief checklist inspired by the preceding principles. Use it to audit your tables.

E.2. L^AT_EX Implementation Hints

- Load booktabs: `\toprule`, `\midrule`, `\addlinespace`, `\bottomrule`; avoid vertical rules.
- Use `siunitx` `S` columns for numeric alignment, rounding, and decimal alignment.
- Put units in the column heading, e.g. `\multicolumn{1}{c}{Voltage (\unit{\volt})}`.
- Separate logical row groups with `\addlinespace` rather than extra `\midrules`.
- Keep captions succinct, e.g.
`\caption{Latency benchmarks for API endpoints ($n=500$).}`
- Always proof a printout; adjust spacing and rule weight after seeing physical output.

E.3. Table Examples

Example 1

In this example we analyse the table in Figure E.1, taken from a master’s thesis. Several issues contravene the best practices of Section E.1.

Table 2. Análisis de consumo por las 3 consultoras por año

Empresas	Resmas /año	Peso total (kg/año)	CO ₂ emitido (kg/año)	Árboles talados por año	Agua consumida (m ³ /año)	ClO ₂ (kg/año)	Energía kWh
Consultora 1	144	360	241	~14	82	2,9	34
Consultora 2	156	390	261	~15	88	3,1	36
Consultora 3	360	900	603	~35	206	7,2	84

Figure E.1.: Original table for example 1

<i>Papel consumido</i>			<i>Consumo de recursos inducido</i>				<i>Huella</i>
Resmas	Peso/kg		Árboles	Agua/m ³	ClO ₂ /kg	Energía/kWh	CO ₂ /kg
1	144	360	14	82	2.9	34	241
2	156	390	15	88	3.1	36	261
3	360	900	35	206	7.2	84	603

Table E.2.: Redesign of table of Figure E.1

- Decoration (colour bands, etc.) carries no information and should be removed.
- Bold is used even though it should be reserved for sectioning.
- Centre alignment is poor for numeric columns.
- Headings are verbose.
- Columns could be hierarchised to aid reading.

The redesign in Table E.2 addresses these problems:

- All superfluous decoration is removed.
- Non-essential rules¹ are dropped: no vertical rules and only the necessary horizontals. The structure becomes clear through alignment and spacing.
- Columns are aligned according to standard practice.
- Columns are rearranged to allow meaningful grouping and a hierarchical header.
- Repetitive temporal information (“año”) is moved to the caption.
- Bold is avoided. The structure alone clarifies headers; only the top-level groups are emphasised to reveal hierarchy.
- Company names were anonymised in the original; “Consultora 1” etc. adds width without meaning. Simple numbering suffices and shortens the table.

¹In typography, “rules” are horizontal or vertical lines.

Headers are upright; their role is evident thanks to the horizontal rules. Only the hierarchical layer is emphasised. In a simple, non-hierarchical table, no emphasis would be needed. The result is clearer and easier to read.

A good caption would be “Tabla 2: Consumo anual de papel de tres consultoras, consumo inducido y impacto.”

Source code for the redesigned table:

```
\begin{table}
  \centering
  \sisetup{table-number-alignment = right}
  \begin{tabular}{*}
    1
    S[table-format=3]          % Resmas
    S[table-format=3]          % Peso total
    S[table-format=2]          % CO2 emitido
    S[table-format=3]          % Árboles (aprox, con ~)
    S[table-format=1.2]        % Agua consumida
    S[table-format=2]          % ClO2 (con decimal)
    S[table-format=3]          % Energía kWh
  }
  \toprule
  &
  \multicolumn{2}{c}{\emph{Papel consumido}}&
  \multicolumn{4}{c}{\emph{Consumo de recursos inducido}}&
  \multicolumn{1}{c}{\emph{Huella}}
  \\
  \cmidrule(rl){2-3} \cmidrule(rl){4-7} \cmidrule(lr){8-8}
  &
  {Resmas} &
  {Peso/\unit{\kilogram}} &
  {Árboles} &
  {Agua/\unit{\cubic\meter}} &
  {\ce{ClO2}}/\unit{\kilogram} &
  {Energía/\unit{\kWh}} &
  {\ce{CO2}}/\unit{\kilogram} \\
  \midrule
  1 & 144 & 360 & 14 & 82 & 2.9 & 34 & 241 \\
  2 & 156 & 390 & 15 & 88 & 3.1 & 36 & 261 \\
  3 & 360 & 900 & 35 & 206 & 7.2 & 84 & 603 \\
  \bottomrule
\end{tabular}
\caption{Consumo anual de papel de tres consultoras, consumo
  inducido y impacto.}
\label{tab:redesigned-table-1}
\end{table}
```

20,41 € i 28,90 € segons la quantitat de dades consumides. Aquest cost es a la primera fila, incloent-hi 3,63 € del cost de la SIM i la seva activació. A continuació teniu una llista amb informació dels preus més detalladament:

Nº MB / mes	Cost mensual	Cost anual	Cost anual + SIM + Activació
1	2,04 €	24,54 €	28,17 €
5	2,41 €	28,90 €	32,53 €

Taula 6.1: Preus per contractar NB-IoT amb Vodafone IoT20

Figure E.2.: Original table for example 2

Velocitat (MB/s)	<i>Cost variable</i>		Cost fix (€)
	Mensual (€)	Anual (€)	
1	2.04	24.54	3.63
5	2.41	28.9	3.63

Table E.3.: Redesign of table of Figure E.2

Example 2

Figure E.2 shows another problematic table. This one compares the cost of a couple of NB-IoT network connection offers from the same company. These are the most salient issues:

- Excessive rules create a cage.
- Columns are misaligned.
- Units are repeated in every cell.
- Bold headers look heavy.
- Headings are too long, inflating column widths.
- The table is forced inline instead of floating.
- The distinction between SIM/setup costs and variable costs is unclear.

The redesign appears in Table E.3. In the redesign, the headings have been shortened and units are switen below to keep good column spacing. The hierarchical relation in the header is now explicit. A good caption would be “Taula 6.1: Preu del servei NB-IOT de Vodafone, [IoT20]. El cost fix inclou la SIM i la taxa de connexió.”

Its source is: code is:

```
\begin{tabular}{c}
S[table-format=1]          % MB
S[table-format=1.2]        % Cost mensual
S[table-format=2.2]        % Cost anual
S[table-format=2.2]        % Cost total
```

Mòdul	<i>Power off</i>	PSM	<i>eDRX</i>	NB-IoT		LTE-M	
				Average (Max / Min)	Max TX	Average (Max / Min)	Max TX
Quectel BC95-G 20c		3 μ A	0,5 mA (2,6 s)	Tx (250 mA / 70 mA) Rx (60 mA)			
SARA-R410M 24	6 μ A	8 μ A	0,9 mA (20,48 s) 0,7 mA (655,36 s)	(140 mA / 60 mA)	0,5 A	(190 mA / 100 mA)	0,5 A
SARA-R412M 24	6 μ A	8 μ A	0,9 mA (20,48 s) 0,7 mA (655,36 s)	(240 mA / 65 mA)	0,9 A	(360 mA / 100 mA)	0,9 A
SARA-R42 series 24	3 μ A	3 μ A	0,6 mA (20,48 s) 0,5 mA (655,36 s)	(230 mA / 65 mA)	0,8 A	(350 mA / 105 mA)	0,8 A

Taula 8.2: Consums dels mòduls NB-IoT i LTE-M

Figure E.3.: Original table for example 3

```

}
\toprule
&
\multicolumn{2}{c}{\emph{Cost variable}}&
\\
\cmidrule{r1}{2-3}
{Velocitat} &
{Mensual}&
{Anual} &
{Cost fix}
\\
{(\unit{\mega\byte\per\second})} &
{(\euro)}&
{(\euro)} &
{(\euro)}
\\
\midrule
1 & 2.04 & 24.54 & 3.63 \\
5 & 2.41 & 28.9 & 3.63 \\
\bottomrule
\end{tabular}

```

Example 3

Figure E.3 compares several IOT communication modules. Some support both NB-IOT and LTE-M. Formal issues echo earlier examples:

- Too many rules.
- Overly bold headers.
- Units repeated in every entry.

Mòdul	<i>Quiescent</i>		<i>eDRX</i>	
	Power off (μ A)	PSM (μ A)	Cycle (s)	I_{avg} (mA)
Quectel BC95-G		3	2.6	0.5
SARA-R410M	6	8	20.48	0.9
			655.36	0.7
SARA-R412M	6	8	20.48	0.9
			655.36	0.7
SARA-R42 series	3	3	20.48	0.6
			655.36	0.5

Table E.4.: Redesign of table in Figure E.3. Low power modes.

Mòdul	<i>NB-IoT</i>			<i>LTE-M</i>		
	I_{avg}^{min} (mA)	I_{avg}^{max} (mA)	Pic TX (A)	I_{avg}^{min} (mA)	I_{avg}^{max} (mA)	Pic TX (A)
Quectel BC95-G	60	250				
SARA-R410M	60	140	0.5	100	190	0.5
SARA-R412M	65	240	0.9	100	360	0.9
SARA-R42 series	65	230	0.8	105	350	0.8

Table E.5.: Redesign of table in Figure E.3. Tx/Rx power.

- Citations in the first column are likely repeated in the text and can be omitted.

Content-related problems are more serious:

- “dDRX” is opaque; some cells contain two values, themselves doubled.
- “Average (max/min)” is ambiguous. Is it the average of maxima/minima or the extrema of averages?
- The first row separates transmit and receive consumption; the others do not. What do their values represent?

Here the original is split into two complementary tables for clarity and to avoid an unwieldy length. Table E.4 covers consumption in low-power modes; Table E.5 focuses on transmit/receive power. The source code for both tables follows:

```
\begin{tabular}{c}
1
S[table-format=1.1]
S[table-format=1.1]
S[table-format=1.2]
S[table-format=3.2]
}
\toprule
```

```

& \multicolumn{2}{c}{\emph{Quiescent}}
& \multicolumn{2}{c}{\emph{eDRX}}
\\
\cmidrule(lr){2-3} \cmidrule(lr){4-5}
{Mödul}
& {Power off}
& {PSM}
& {Cycle}
& {I\textsubscript{avg}}
\\
& {(\unit{\micro\ampere})}
& {(\unit{\micro\ampere})}
& {(\unit{\second})}
& {(\unit{\milli\ampere})}
\\
\midrule
Quectel BC95-G & & 3 & 2.6 & 0.5 \\
SARA-R410M & 6 & 8 & 20.48 & 0.9 \\
& & & 655.36 & 0.7 \\
SARA-R412M & 6 & 8 & 20.48 & 0.9 \\
& & & 655.36 & 0.7 \\
SARA-R42 series & 3 & 3 & 20.48 & 0.6 \\
& & & 655.36 & 0.5 \\
\bottomrule
\end{tabular}

\begin{tabular}{@{}
1
S[table-format=2.0]
S[table-format=3.0]
S[table-format=1.1]
S[table-format=3.0]
S[table-format=3.0]
S[table-format=1.1]
@{}}
\toprule
&
\multicolumn{3}{c}{\emph{NB-IoT}} &
\multicolumn{3}{c}{\emph{LTE-M}}
\\
\cmidrule(r){2-4} \cmidrule(l){5-7}
{Mödul}
& {\$I_{avg}^{\min}\$}
& {\$I_{avg}^{\max}\$}
& {Pic TX}
& {\$I_{avg}^{\min}\$}
& {\$I_{avg}^{\max}\$}

```

Característica	Unity	Unreal Engine	VR Maker	Blender
Modelatge 3D	Sí	Sí	Sí	Sí
Animació	Sí	Sí	No	Sí
Blueprint Visual Scripting	Sí	Sí	No	No
Renderitzat	Bon rendiment, gràfics correctes	Excel·lent rendiment, gràfics avançats	Depèn del motor gràfic	Opcions de renderitzat potents
Compatibilitat RV	Sí	Sí	Sí	Sí (a través de plugins)
Optimització per a RV	Sí	Sí	Depèn del desenvolupador	Depèn del desenvolupador
Preu	Gratuït per a projectes bàsics	Gratuït per a projectes bàsics	Depèn del pla de subscripció	Gratuït
Comunitat i suport	Gran comunitat i suport actiu	Gran comunitat i suport actiu	Depèn del proveïdor	Comunitat més reduïda i menys recursos
Nivell d'aprenentatge	Mitjà-alta	Mitjà-alta	Mitjà-baix	Mitjà-alta
Comptabilitat amb SO	Windows, Linux i MacOS	Windows, Linux i MacOS	Windows, MacOS, iOS i Android	Windows, Linux i MacOS

Figure E.4.: Original table for example 4

```

& {Pic TX}
\\
& {(\unit{\milli\ampere})}
& {(\unit{\milli\ampere})}
& {(\unit{\ampere})}
& {(\unit{\milli\ampere})}
& {(\unit{\milli\ampere})}
& {(\unit{\ampere})}
\\
\midrule
Quectel BC95-G & 60 & 250 & { } & { } & { } & { } \\
SARA-R410M      & 60 & 140 & 0.5 & 100 & 190 & 0.5 \\
SARA-R412M      & 65 & 240 & 0.9 & 100 & 360 & 0.9 \\
SARA-R42 series& 65 & 230 & 0.8 & 105 & 350 & 0.8 \\
\bottomrule
\end{tabular}

```

Example 4

The table in Figure E.4 illustrates a non-numeric comparison (virtual-reality software). Its flaws are familiar:

Característica	Unity	Unreal Engine	VR Maker	Blender
<i>Funcionalitat bàsica</i>				
Modelatge 3D	Sí	Sí	Sí	Sí
Animació	Sí	Sí	No	Sí
Visual scripting	Sí	Sí	No	No
<i>Rendiment</i>				
Renderitzat	Bon rendiment; gràfics correctes	Excel·lent; gràfics avançats	Depèn del motor	Moltes opcions de render
Optimització RV	Sí	Sí	Depèn del dev	Depèn del dev
<i>Compatibilitat</i>				
Amb RV	Sí	Sí	Sí	Sí (plugins)
S. Operatiu	Win, Linux, macOS	Win, Linux, macOS	Win, macOS, iOS, Android	Win, Linux, macOS
<i>Cost i suport</i>				
Preu	Gratuït bàsic	Gratuït bàsic	Segons subscripció	Gratuït
Comunitat	Molt activa	Molt activa	Segons proveïdor	Més petita / menys recursos
Nivell aprenentatge	Mitjà-alt	Mitjà-alt	Mitjà-baix	Mitjà-alt

Table E.6.: Redesign of table shown in Figure E.4

- Again, an abusive use of rules—very common!
- Bold is used even though sectioning already claims it.
- Several cells are too verbose.

Table E.6 presents the redesign. Improvements include:

- Removal of unnecessary rules.
- Reduction and normalisation of emphasis.
- Shortened cell contents.
- Rows reordered for a more meaningful sequence.
- Added vertical hierarchy for easier scanning.
- Slightly reduced type size to save space.

The source code is:

```

\newcolumntype{L}{>{\raggedright\arraybackslash}X}
\renewcommand{\arraystretch}{1.05}
\newcommand{\Lone}[1]{\emph{#1}} % top level
\newcommand{\Ltwo}[1]{\hspace{1.25em}#1} % 2nd level

\begin{tabularx}{0.95\linewidth}{@{} 1 L L L L @{}}
\toprule

```

```
Característica & Unity & Unreal Engine & VR Maker & Blender \\
\midrule

\Lone{Funcionalitat bàsica} \\
\Two{Modelatge 3D}           & Sí & Sí & Sí & Sí \\
\Two{Animació}               & Sí & Sí & No & Sí \\
\Two{Visual scripting}       & Sí & Sí & No & No \\
\addlinespace[0.6ex]

\Lone{Rendiment} \\
\Two{Renderitzat}            & Bon rendiment; gràfics correctes
                             & Exce\l.lent; gràfics avançats
                             & Depèn del motor
                             & Moltes opcions de render \\
\Two{Optimització RV}        & Sí & Sí & Depèn del dev & Depèn del dev \\
\addlinespace[0.6ex]

\Lone{Compatibilitat} \\
\Two{Amb RV}                 & Sí & Sí & Sí & Sí (plugins) \\
\Two{S. Operatiu}            & Win, Linux, macOS
                             & Win, Linux, macOS
                             & Win, macOS, iOS, Android
                             & Win, Linux, macOS \\
\addlinespace[0.6ex]

\Lone{Cost i suport} \\
\Two{Preu}                   & Gratuït bàsic & Gratuït bàsic &
                             Segons subscripció & Gratuït \\
\Two{Comunitat}              & Molt activa
                             & Molt activa
                             & Segons proveïdor
                             & Més petita / menys recursos \\
\Two{Nivell aprenentatge}    & Mitjà-alt & Mitjà-alt & Mitjà-baix &
                             Mitjà-alt \\

\bottomrule
\end{tabularx}
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