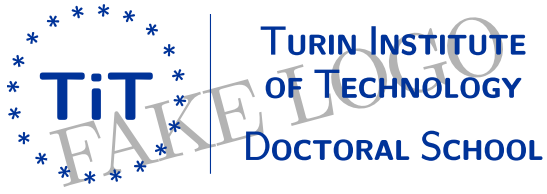

Doctoral Dissertation
Doctoral Program in Energy Enginering (29.th cycle)

Writing your Doctoral Thesis with LaTeX

This document is an example of what you can do with the TOPtesi class

Mario Rossi
* * * * * *

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Politecnico di Torino
February 29, 2123

I hereby declare that, the contents and organisation of this dissertation constitute my own original work and does not compromise in any way the rights of third parties, including those relating to the security of personal data.

. . . . . .

Mario Rossi
Turin, February 29, 2123

Summary

This is where you write your abstract … (Maximum 4000 characters, i.e. maximum two pages in normal sized font, typeset with the thesis layout).

The abstract environment is also available, but `\summary` is preferred because it generates an un-numbered chapter. The abstract environment is more suitable for articles and two column typesetting without a separate title page.

Acknowledgements

And I would like to acknowledge ...

Acknowledgements are mandatory when people outside the academic institution supported the development of the research that was performed in order to reach the conclusion of the doctorate program.

I would like to dedicate this thesis to my loving parents

The dedication very seldom is a proper thing to do; in some countries it is very common, while in other countries it is done for imitation of other people habits.

The sentence used above clearly is an example of something very common, but it is useless. Of course we all love our beloved parents, but it is not necessary to "engrave it in stone".

Contents

Chapter 1

First Chapter Title

1.1 Introduction to PhD thesis template

Welcome to this LaTeX Thesis Template for writing your PhD thesis using the LaTeX typesetting system. If you are writing a thesis (or will be in the future) and its subject is technical or mathematical (though it doesn't have to be), then creating it in LaTeX is highly recommended.

LaTeX is a mark up language and its associated typesetting programs such as pdfLaTeX, LuaLaTeX, or XeLaTeX professionally typeset documents of any length, that run to hundreds or thousands of pages long. With simple mark-up commands, it automatically sets out the table of contents, margins, page headers and footers and keeps the formatting consistent and beautiful. One of its main strengths is the way it can easily typeset mathematics, even heavy mathematics. Even if those equations are the most horribly twisted and most difficult mathematical problems that can only be solved on a super-computer, you can at least count on LaTeX to make them look stunning [3, 4]. Please see appendix A for the instruction on how to install a complete TeX system.

Along with this document you have access to its LaTeX source file (**toptesi-scudo-example.tex**) including different partitions. Inside each part there are instructive comments explaining the options for different commands. The default commands are designed and recommended by PhD school of Politecnico di Torino. In this tutorial the essential commands to write a scientific document are listed and briefly explained.

1.2 Getting started with this template

If you are familiar with LaTeX, then you should explore the directory structure of the template and then proceed to place your own information into a configuration file with extension `.cfg` and a name that matches exactly your main file name; pay attention to upper and lower case letters. You can then modify the rest of this file to your unique specifications based on your course. Chapter 2 will help you do this.

If you are new to LaTeX it is recommended that you carry on reading through the rest of the information in this document. The style of this template is confirmed and recommended by Doctoral School of Politecnico di Torino (ScuDo).

1.3 What is included in this template

1.3.1 Folders

This template comes as a single zip file that expands out to several files and folders. The folder names are mostly self-explanatory:

Chapters: these are the folders where you put the thesis chapters. Each chapter should go in its own separate **.tex** file and folder. Each chapter folder might contains a **Figs** subfolder which contains all figures for the chapter. A thesis usually has about five to six chapters, though there is no hard rule on this. For example they can be split as:

- Chapter 1: Introduction to the thesis topic
- Chapter 2: Background information and theory
- Chapter 3: (Laboratory) experimental setup
- Chapter 4: Details of experiment
- Chapter 5: Discussion of the experimental results
- Chapter 6: Conclusion and future directions

This chapter layout is specialised for the experimental sciences.

Appendices: these are the folders where you put the appendices. Each appendix should go into its own appendix folder with its **.tex** file and figures; should the figures be in large numbers, a subordinate folder to hold all the figure files might be created.

1.3.2 Files

Included are also several files, most of them are plain text and you can see their contents in a text editor. After initial compilation, you will see that more auxiliary files are created by the typesetting program or `biber` and which you don't need to delete or worry about:

toptesi-scudo-example.pdf: this is your beautifully typeset thesis (in the PDF file format) created by the typesetting program you chose to use. It is already supplied with the source files and after you compile the example you should get an identical version.

toptesi-scudo-example.tex: this is an important file. This is the file that you should move to your working folder and, after changing its name, you may use as a template to create your own thesis; you compile it to produce a PDF file. It contains the framework

and constructs that tell LaTeX how to layout the thesis. It is heavily commented so you can read exactly what each line of code does and why it is there. For your thesis you have to duplicate the example files with a different name, and you substitute their contents by writing your thesis following the same scheme.

Files that are *not* included, but are created by LaTeX as auxiliary files include:**.aux**, **.bbl**, **.blg**, **.lof**, **.log**, **.lot** and **.out** files: are auxiliary files generated by LaTeX, if they are deleted LaTeX simply regenerates them when you run the main **.tex** file again.

1.4 Filling in your information in the thesis main and subsidiary files

You will need to personalise the thesis template and make it your own by filling in your own information. This is done by editing the main renamed **.tex** file with your favorite LaTeX friendly editor (See Appendix A).

Open the file and scroll down to the second large block titled *ThesisTitlePage* where you can see the entries for *Author*, *Supervisors*, etc. Fill out the information about your thesis, yourself and your school. When you have done this, save the file and recompile your main file. All the information you filled-in should now be in the PDF, complete with web links. You can now begin your thesis proper! Remember that sooner or later you have to come back to the first block, in order to adjust the metadata to your particular thesis.

The **toptesi-scudo-example.tex** file contains the structure of the thesis. There are plenty of written comments that explain what pages, sections and formatting the LaTeX code is creating.

Begin by checking that your information on the title page is correct. The next page contains a one line (or more) dedication; you may write a dedication, but in Europe this habit is not so frequent. Next come the acknowledgements. On this page acknowledge the people that gave you some help during the development of the research you made for your doctorate program. Do not acknowledge the members of your family nor the professors who supervised and advised you during your research; they did so as their duty as members of the institutions where you followed your doctorate program. Following this section there is the abstract page which summarises your work in a condensed way; it can almost be used as a standalone document to describe what you have done.

The contents pages, list of figures and tables are all taken care of for you and do not need to be manually created or edited. Finally, there is the block where the chapters are included. Uncomment the lines (delete the % character) as you write the chapters. Each chapter should be written in its own file and possibly put into its own chapter sub-folder. Similarly for the appendices, uncomment the lines as you need them. Each appendix should go into its own file and possibly placed in its own appendix sub-folder.

After the preamble, chapters and appendices, finally comes the bibliography, possibly a nomenclature list, an index, or other similar information. The bibliography **numbered** style is used for the bibliography and is a fully featured style that will even include links to where the referenced paper can be found online; it satisfies the standard of the IEEE Transactions in the fields of interest of this Institution and it is assumed to be the style used in the PhD theses concerning these fields; of course in other scientific domains other styles may be used; see below how the default style may be overridden. In any case do not underestimate how grateful your reader will be to find that a reference to a paper is just a click away. Of course, this relies on you putting the URL information into the **.bib** file. Unfortunately URLs are sort of volatile; prefer references to printed material that can be found in (almost) any library or links to reliable web archives.

Notice that the facilities necessary to produce one or more bibliographies with the numbered style are already provided by the `toptesi-scudo` option to the `toptesi` class. But even if these facilities are hardwired into the class and its subsidiary files, it is possible to bypass them.

But if you prefer to use a different style, you can do it the way we did it in typesetting this example document. You simply have to specify the special option `mybibliostyle` among the other class options; then you have to add to your document preamble the necessary code to include the packages you prefer, and to specify the name of the bibliographic database(s) `.bib`. You do not need to enclose this code into a conditional statement as it has been done in this example; but of course it is not forbidden.

Here we specified the above option and we used the conditional statement to enclose another set of packages and settings. Try recompiling the source file of this document without editing it, and run the usual processing task sequence: lualatex, biber, lualatex, lualatex; then examine the typeset bibliography; it will use the **author-year** style. Then comment out the line containing the `mybibliostyle` option and repeat the usual processing tasks: lualatex, biber, lualatex, lualatex. And there you are with the default **numbered** style, as described above.

In order to change style the bundle TOPtesi does not require programming acrobatics; but before changing style inquire with your PhD supervisoror or with the School Director if your preferred bibliography style may be accepted by the School. Remember though that if your thesis deals with the IEEE Transactions disciplines, you should use the default settings and you should refrain from using the `mybibliostyle` option.

Please, take notice that the `references.bib` file is just an example that contains some entries just to show how bibliography databases are formed and how bibliographies are typeset. The records in this file are not necessarily complete, in the sense that some of them do not contain the full and correct necessary and supplementary information required by the regulation ISO 626. Its up to you to enter the full and correct information in your own `.bib` file.

Chapter 2

Second Chapter Title

2.1 Basic text and referring hints

LaTeX gives the possibility to bold a **word**, or a **phrase containing several words**, or mathematical equations like $\mathbf{A} = \mathbf{B} + \mathbf{C}$. *Italic*[1] commands are designed to be used to emphasise some text. Text sizing requires other optional commands: Word, Word, Word.

The various size commands are the following: `\Huge`. `\huge`. `\LARGE`. `\Large`. `\large`. `\normalsize` (default), `\small`. `\footnotesize`. `\scriptsize`. `\tiny`.

Referring to sections, chapters, equations and ..., is possible by means of the `\ref{label}` command. It is necessary to insert `\label{section label}` for each desired section, and chapter, and ..., then making a reference to them in any part of the text. For example in chapter 1 we introduced the template and in section 1.3 different folders and template files were described. Figure 2.1 shows the Greek letter codes in LaTeX.

In LaTeX[2] it is possible to typeset footnote explanations.

You can also insert web links, if you do, make sure you use the full URL, including the {http://} part in the URL. As an example, by using the code:

```
\href{http://www.polito.it}{polito website}
```

you get polito website. If you don't want to link the URL to a name, remove the name and just write `\url{http://www.polito.it}`. This is the result: (http://www.polito.it).

When quoting some phrases pay attention to use the proper quotation marks "..." (that are not accessible from normal keyboards unless you use a specific *Charater table*),

[1] Never underline any part of your text to emphasise it: it is bad typography! Underlining was used in the old times of mechanical typewriter when there was no other means to emphasise text.

[2] Here there is the footnote explanation about the word LaTeX

of your editor, or special editor shortcuts, or the standard TEX ligature ‘‘\dots’’, that produces “...”.

2.2 Writing mathematical equations in LATEX

As an in-line equation example we can refer the most famous equation in the world: $E^2 = (m_0 c^2)^2 + (pc)^2$, which is known as the **energy-mass-momentum** relation. You can write an equation in an **equation** environment of LATEX, for example “Cauchy’s Integral Formula” which is automatically given an equation number (tag) by LATEX like this[3]:

```
\begin{equation}
CIF\colon \qquad F_0^j(a) =\frac{1}{2\pi \iota}
    \oint_{\gamma} \frac{F_0^j(z)}{z - a} \diff z
\end{equation}
```

This will produce “Cauchy’s Integral Formula” equation:

$$CIF: \qquad F_0^j(a) = \frac{1}{2\pi\,\iota} \oint_\gamma \frac{F_0^j(z)}{z-a}\,\mathrm{d}z \tag{2.1}$$

In equation(2.1) notice the \diff command needed to fulfil the ISO recommendations on math writing in science and technology. The spacing before and after the symbol is correct; it accepts also exponents as for example in:

$$\frac{\mathrm{d}^2 x}{\mathrm{d}t^2} + \frac{\mathrm{d}x}{\mathrm{d}t} + cx = f(t) \tag{2.2}$$

As you see the equation is tagged automatically according to the chapter. It is also possible to personalise the equation tag:

$$F_0^j(a) = \frac{1}{2\pi\,\iota} \oint_\gamma \frac{F_0^j(z)}{z-a}\,\mathrm{d}z \qquad \text{(Cauchy integral formula)}$$

with the following code:

[3]Here ι is used in place of an upright ‘i’ or ‘j’, just to show an example, and to have another item of math Greek to list in the nomenclature typeset at the end of the example. An upright ‘i’ or ‘j’ is required when the ISO regulations concerning math for “physics and technology” must be fulfilled. the TOPtesi module toptesi-scudo provides the commands \iu and its alias \gei to set the “imaginary unit” with ‘j’, as is commonly done in the IEEE Transactions; if you want to use ‘i’, redefine \iu, but leave alone \gei so as to retain its meaning. Never ever use the math Greek \iota in place of the imaginary unit.

```
\begin{equation}
\centering
\tag{Cauchy integral formula}
F_0^j(a) = \frac{1}{2\pi \iota}
    \oint_{\gamma} \frac{F_0^j(z)}{z - a} \diff z
\end{equation}
```

Notice, though, that tagging with long phrases leaves less space on the line, and the formula is centred within this remaining space.

If there are several equations that you need to align vertically, the **align** environment will do it:

$$x = 5y \qquad w = -z \qquad a = b - c$$
$$2x = -y \qquad 3w = \frac{1}{2}z \qquad a = 3b$$
$$-4 + 5x = 2 + y \qquad w + 2 = -1 + w \qquad ab = \frac{-1}{3}cb$$

Math equation environments that use the asterisk * produce unnumbered equations.

2.3 How to create an index

The package `imakeidx` loaded in the preamble is suited to create one ore more indices without any specific action by the user except the (obvious) marking of the words or phrases to list in this particular part of the thesis.

The mandatory `\makeindex` command in the preamble is necessary to activate the `\index` command; without this activation this command does not do anything. At the same time the `\makeindex` command accepts a list of *key = value* options by which it is possible to fully configure the index features; in this sample template file only the *intoc* option has been specified, in order to have the index name and page are listed in the table of contents.

Read the `imakeidx` package documentation in order to use the package at its best.

2.4 How to create a nomenclature

Somewhere in the thesis you might have to configure the nomenclature list you are going to create; the necessary command is `\nomenclature` that requires two mandatory arguments: the first one is the "acronym" you want to list, and the second is its meaning.

To create the **Nomenclature** you need to issue the `\nomenclature` command for each symbol you want to have included in the nomenclature list. The best place for this command is immediately after you introduce the symbol for the first time. For equation (2.1) in the previous section we set:

```
\nomenclature[Z]{$CIF$}{Cauchy's Integral Formula}
\nomenclature[A]{$F$}{complex function}
\nomenclature[G]{$\pi$}{$\simeq 3.14159\ldots$}
\nomenclature[G]{$\iota$}{unit imaginary number $\sqrt{-1}$}
\nomenclature[G]{$\gamma$}{a closed curve on a complex plane}
\nomenclature[X]{$\oint_\gamma$}{integration along a closed curve
$\gamma$}
\nomenclature[R]{$j$}{superscript index}
\nomenclature[S]{$0$}{subscript index}
% letter Z is for Acronyms, A is for Roman symbols,
% G is for Greek Symbols, X is for Other Symbols,
% R is for superscripts, S is for subscripts
```

The above list of nomenclature entries is pretty naïve; if you decide to write a nomenclature, provide one that contains real useful information. If you follow the nomenclature information published in several texts, you do not need to write a nomenclature of physical symbols; if you need a link to a technical reference easily downloadable from the internet, try `sp811.pdf` downloadable by clicking on this active link: http://www.nist.gov/customcf/get_pdf.cfm?pub_id=200349. Apparently this document speaks about the correct usage of SI units of measure; but in practice it gives very good information on writing about measures in a technological document and contains lots of lists of symbols for indicating physical quantities.

You do not have to do anything special to typeset the nomenclature section, except of course inserting the `\printnomencl` command in the back matter of your thesis before or after the section containing the bibliography, but before a possible index. The extension to TOPtesi made by file `topesi-scudo.sty` provides to launch in background the necessary external programs with suitable options so as to exploit the `shell escape` functionality of pdfLaTeX and XeLaTeX; LuaLaTeX does not natively provide this functionality, but the above extension package provides the Lua language commands so as to execute the necessary actions as it would happen with the other typesetting engines. Should the external program find some error in the entry data, it might issue error messages in the .log file of the main file of your thesis; read he diagnostic messages and provide the necessary corrections. Matter of fact this example file is being typeset with LuaLaTeX, and the nomenclature appears regularly close to the end of the PDF file, without issuing any command-line command.

Your task, then, remains that of marking the necessary entries as shown in the preceding example paragraph.

2.5 List formatting in LaTeX

Convenient and predictable list formatting is one of the many advantages of using LaTeX. LaTeX distinguishes between three different enumeration/itemisation environments:

- `enumerate` for an enumerated list,
- `itemize` for a bullet list,
- `description` for a descriptive list.

All lists follow a basic format and each of them provide four levels, which means you can have nested lists of up to four levels. Never set up nested lists up to level four; level 2 is OK; level 3 may be too much; level 4 corresponds to a list very difficult to read and understand. After all, lists are made up to display information in a structured way so as to make their contents easier to understand.

2.5.1 Enumerate

Never stat a section with a list; try to always write some introductory text before the list. Items in an enumeration are each made up of complete sentences, that form one or more paragraphs. Every item starts with a capital letter and finishes with a full stop.

1. The first topic is “Good”.
2. The second topic is “Intermediate” (Lev. 1).
   (a) The first subtopic is “high intermediate”.
   (b) The second subtopic is “low intermediate” (Lev. 2).
      i. The first subsubtopic is “very low intermediate” (Lev. 3).
         A. The first subsubsubtopic is “too low intermediate” (Lev. 4).
3. The third topic is “Bad..

Sub-items in an enumeration may be bulleted lists; the opposite, enumeration list embedded into a bulleted list, is an error.

2.5.2 Itemize

A bulleted list is part of the introductory test; therefore no item starts with a capital letter, and no item but the last, ends with a full stop; other items my finish with a comma or a semicolon, but the elliptic form without final punctuation is OK in technical texts. therefore:

- the first topic is “Good”
- the second topic is “Intermediate”
  – the first subtopic is “high intermediate”
  – the second subtopic is “low intermediate”

        * the first subsubtopic is “very low intermediate”

- the third topic is “Bad”

Some text may follow a bulleted list; it continues the sentence that contained the list if the first line is not indented and starts with a lowercase letter. If it starts with an uppercase letter, but the first line is not indented, it is a new sentence that continues the paragraph that contains the list. If this text starts with an indented line with an uppercase initial in the first word, a new paragraph is started. On the contrary, if this text has the first line indented, but the initial is lowercase, there is an error; you left a blank line after the list source and the first line of the following text; please correct it.

2.5.3 Description

The description environment follows the same rules of the enumeration. The real difference is that the list has words or phrases as item marks, instead of numbers. The word or phrase to be described or defined is the “optional” argument of command `\item`; the word “optional” is quoted, because in case of a description environment the command argument is mandatory, because it is nonsense to give the description of nothing.

The first topic is “Good”.

The second topic is “Intermediate”.

The first subtopic is “high intermediate”.

The second subtopic is “low intermediate”.

The first subsubtopic is “very low intermediate”.

The third topic is “Bad”

2.5.4 Comments on lists

In the previous examples the “Good”, ..., “Bad” quoted qualifiers do not express the validity of the nested level; they are just words. Notice that the quotes were not created with the ASCII straight double quote sign " that does not distinguish open from closed quotes; open quotes were created with the TEX ligature ‘ ‘ and closed quotes are created with the other TEX ligature ’ ’. When using LuaLaTeX or XeLaTeX, if the keyboard has facilities to enter non ASCII characters, it would be possible to enter directly “ and ”. When using an Italian keyboard it is difficult to enter the ligature ‘ ‘; with such a keyboard you need to ask your shell editor to enter a special symbol, by means of something called “Character Table” or “Symbol Table”.

2.6 Figures

Hopefully there will be many figures in your thesis (that should be placed in the **Figs** sub-folder in each chapter folder). The way to insert figures into your thesis is to use a code template like this:

```
\begin{figure}[tbp]
\centering
\includegraphics[width=1.0\textwidth]{Greek_letters}
\caption[Greek letters in \LaTeX]%
      {List of math greek letters in \LaTeX}
\label{fig:Greek}
\end{figure}
```

Also look in the source file. Putting this code into the source file produces the Figure 2.1 that you can see in the figure below. By changing the value of figure width (`width = 1.0\textwidth`) you can change the figure dimension. Notice that the subpath for the graphic file to include has not been specified, because at the beginning of this chapter file the specification

```
\graphicspath{{Chapter2/}}
```

was issued.

Subfigures A multiple figure example[4] is presented here. Here you can refer any subfigure for example arrows (see Fig. 2.2a) and binary operation symbols in (Fig. 2.2c) or you can cite the whole figure as Fig. 2.2.

The `\textwidth` used in parametrising the various subfigures becomes the actual width of each subfigure material included with `\includegraphics`. This implies a non trivial amount of down scaling, and the included figures might become too thin, as it is evident in figure 2.2. In most cases it is not wise to squeeze more than two figures in a row. In any case one or more spaces between two adjacent subfigures get such objects more distant from one another; a blank line between two adjacent subfigures behave as the start of a new paragraph even within the 'figure' environment.

Another example with figures of a graphic type is shown in figure 2.3. As it can be seen the three subfigures have been strongly reduced, but their quality is not diminished as it was with the example in figure 2.2.

[4]This figure might have been typeset in landscape form by means of the `landscape` environment provided by the `lscape` package.

αA	`\alpha A`	νN	`\nu N`
βB	`\beta B`	$\xi \Xi$	`\xi\Xi`
$\gamma \Gamma$	`\gamma \Gamma`	oO	`o O`
$\delta \Delta$	`\delta \Delta`	$\pi \Pi$	`\pi \Pi`
$\epsilon \varepsilon E$	`\epsilon \varepsilon E`	$\rho \varrho P$	`\rho\varrho P`
ζZ	`\zeta Z`	$\sigma \Sigma$	`\sigma \Sigma`
ηH	`\eta H`	τT	`\tau T`
$\theta \vartheta \Theta$	`\theta \vartheta \Theta`	$\upsilon \Upsilon$	`\upsilon \Upsilon`
ιI	`\iota I`	$\phi \varphi \Phi$	`\phi \varphi \Phi`
κK	`\kappa K`	χX	`\chi X`
$\lambda \Lambda$	`\lambda \Lambda`	$\psi \Psi$	`\psi \Psi`
μM	`\mu M`	$\omega \Omega$	`\omega \Omega`

Figure 2.1: List of Greek math letters in LaTeX. Notice that italic uppercase letters are Latin italics; Greek uppercase letters are upright; if you want them inclined as the other lowercase Greek letters, and the Latin counterparts, you have to use the class command `\DeclareSlantedCapitalGreekLetters`.

2.7 Tables

The layout of a table has been established over centuries of experience and should only be altered in extraordinary circumstances [1].

When formatting a table, remember two simple guidelines at all times.

1. Never, ever use vertical rules (lines).
2. Never use double rules.

These guidelines may seem extreme but I have never found a good argument in

←	\leftarrow	⇐	\Leftarrow
→	\rightarrow	⇒	\Rightarrow
↔	\leftrightarrow	⇌	\rightleftharpoons
↑	\uparrow	↓	\downarrow
⇑	\Uparrow	⇓	\Downarrow
⇔	\Leftrightarrow	⇕	\Updownarrow
↦	\mapsto	⟼	\longmapsto
↗	\nearrow	↘	\searrow
↙	\swarrow	↖	\nwarrow
↼	\leftharpoonup	⇀	\rightharpoonup
↽	\leftharpoondown	⇁	\rightharpoondown
⇌	\rightleftharpoons		

(a) Arrows

×	\times	⊗	\otimes
÷	\div	∩	\cap
∪	\cup	≠	\neq
≤	\leq	≥	\geq
∈	\in	⊥	\perp
∉	\notin	⊂	\subset
≃	\simeq	≈	\approx
∧	\wedge	∨	\vee
⊕	\oplus	⊗	\otimes
□	\Box	⊠	\boxtimes
≡	\equiv	≅	\cong

(b) Binary operator symbols

∞	\infty	∀	\forall
ℜ	\Re	ℑ	\Im
∇	\nabla	∃	\exists
∂	\partial	∄	\nexists
∅	\emptyset	∅	\varnothing
℘	\wp	∁	\complement
¬	\neg	⋯	\cdots
□	\square	√	\surd
■	\blacksquare	△	\triangle

(c) Miscellaneous symbols

Figure 2.2: Useful math symbols in LaTeX

(a) Two minions (b) Tom and Jerry (c) Wall-E

Figure 2.3: Three drawings

favour of breaking them. For example, if you feel that the information in the left half of a table is so different from that on the right that it needs to be separated by a vertical line, then you should use two tables instead. there are amateur typographers who don't follow the second guideline.

There are three further guidelines worth mentioning here as they are generally not known outside the circle of professional typesetters and subeditors:

3. Put the units of measure in the column heading (not in the body of the table).
4. Always precede a decimal point by a digit; thus 0.1 *not* just .1.
5. Do not use 'ditto' signs or any other such convention to repeat a previous value. In many circumstances a blank will serve just as well. If it won't, then repeat the value.

A frequently mistake is to use '`\begin{center}...\end{center}`' inside a figure or table environment. This `center` environment can cause additional vertical space. If you want to avoid that, just use `\centering`.

2.8 How to produce an archivable PDF file

To produce an archivable PDF file that satisfies regulation ISO 19005:2005-1b you should use pdfLATeX or LuaLaTeX. With XeLeTeX it would also be possible, but it is necessary to execute by hand some postprocessing. So it is better to abide from XeLaTeX.

Table 2.1: A badly formatted table

	Species I		Species II	
Dental measurement	mean	SD	mean	SD
I1MD	6.23	0.91	5.2	0.7
I1LL	7.48	0.56	8.7	0.71
I2MD	3.99	0.63	4.22	0.54
I2LL	6.81	0.02	6.66	0.01
CMD	13.47	0.09	10.55	0.05
CBL	11.88	0.05	13.11	0.04

Table 2.2: A nice looking table

Dental measurement	Species I		Species II	
	mean	SD	mean	SD
I1MD	6.23	0.91	5.2	0.7
I1LL	7.48	0.56	8.7	0.71
I2MD	3.99	0.63	4.22	0.54
I2LL	6.81	0.02	6.66	0.01
CMD	13.47	0.09	10.55	0.05
CBL	11.88	0.05	13.11	0.04

With this TOPtesi bundle it should be possible to produce PDF/A compliant files, but 8-bit encoded fonts may give rise to problems; this bundle "repairs" some of these problems, but it is not guaranteed that repairs all problems arising from such fonts.

The best solution is to typeset the Thesis with LuaLaTeX with the attention of not using any 8-bit encoded font, unless only (7-bit encoded) ASCII characters are used. This holds true also for imported figures that contain legends.

Imported figures should are best in vector formats; raster format is a second choice; the PNG raster format is to be preferred to the JPG one when line drawings are imported, paying attention that the file does not contain any transparency.

Metadata have to be added to the file; the best way to do it is to mimic what has been done in the source file of this document; that is to include the metadata in the form of a file generated by means of the `filecontents*` environment. The data must be written in a form similar to the one used in this example file, but it is advisable to read the documentation of the `pdfx` package, to examine the fine details that are required.

Eventually the `pdfx` package needs to be loaded as the very first package after the `\documentclass` statement.

This very file has the initial part of the main file that looks as such:

```
%%%%%%% If and only if you want to produce an archivable
%%%%%%% document according to the ISO regulation
```

Table 2.3: An even better looking table using `booktabs`

Dental measurement	Species I		Species II	
	mean	SD	mean	SD
I1MD	6.23	0.91	5.2	0.7
I1LL	7.48	0.56	8.7	0.71
I2MD	3.99	0.63	4.22	0.54
I2LL	6.81	0.02	6.66	0.01
CMD	13.47	0.09	10.55	0.05
CBL	11.88	0.05	13.11	0.04

```
%%%%%%% 19005:2005-1b add the following code before the
%%%%%%% statement \documentclass, and adapt its contents
%%%%%%% to your particular thesis.

\begin{filecontents*}{\jobname.xmpdata}
\Author{Mario Rossi}
\Title{Writing Your Ph.D. Thesis with LaTeX}
\Subject{Doctoral dissertations in the SCUDO doctoral school}
\Keywords{PDF\sep
          PDF/A\sep
          ISO 19005\sep
          LaTeX\sep
          PhD Thesis\sep
          Engineering\sep
          SCUDO}
\Publisher{Politecnico di Torino}
\end{filecontents*}

\documentclass[12pt,twoside,scudo]{toptesi}

%%%% Use the following package if and only if you want
%%%% to produce an archivable document according to
%%%% standard PDF/A-1b

\usepackage[a-1b]{pdfx}

%%%%
```

Pay attention to the fact the the `filecontents*` environment creates the metadata file in the same folder where the thesis main file is stored. It does not overwrite it if you make any change to the contents of the environment; therefore it is your task to delete the `.xmpdata` file that was previously generated.

The other necessary metadata are provided by the `pdfx` package. By typesetting the thesis with LuaLaTeX the chance of getting the PDF file already compliant at the first run is very high. But you cannot be sure unless you verify such compliance by means of one of these two methods.

1. Download from the internet the VeraPDF software (the stable version is being available since 2017). Follow the simple instructions for creating on your computer the GUI variant of the program; this GUI is self explanatory for the actions to do for the verifications of your file.

2. You have access to version XI or higher of the commercial Adobe Acrobat Pro software; open your file with this program, and verify its PDF/A compliance with Acrobat's module `Preflight`; its graphical interface is self explanatory.

In each case, if the thesis PDF file is compliant print the report. If it is not compliant try to analyse the diagnostic messages, and correct what turned to be wrong in your file.

This document has been typeset with LuaLaTeX and resulted compliant the very first time it was analysed. Well, this is a half truth; images in figure 2.3 were not conformant because their color profiles, nominally RGB ones, were not actually so, therefore they caused the overall document to be a PDF/A non conformant one; their EPS sources were fetched and distilled again into PDF format so that every problem vanished.

Chapter 3

My third chapter

You should break your thesis up into nice, bite-sized sections and subsections. LaTeX automatically builds a table of contents by looking the `\chapter{}`, `\section{}` and `\subsection{}` commands you write in the source.

The Table of Contents should only list the sections to three (3) levels. A `chapter{}` is level zero (0). A `\section{}` is level one (1) and so a `\subsection{}` is level two (2). In your thesis it is likely that you will even use a `subsubsection{}`, which is level three (3). The depth to which the table of contents is formatted is set within the **TOPtesi.cls** class. If you need this changed, you can do it in the example source file `toptesi-scudo-example.tex` model.

3.1 First section of the third chapter

And now I begin my third chapter here ...

As any dedicated reader can clearly see, the Ideal of practical reason is a representation of, as far as I know, the things in themselves; as I have shown elsewhere, the phenomena should only be used as a canon for our understanding. The paralogisms of practical reason are what first give rise to the architectonic of practical reason. As will easily be shown in the next section, reason would thereby be made to contradict, in view of these considerations, the Ideal of practical reason, yet the manifold depends on the phenomena. Necessity depends on, when thus treated as the practical employment of the never-ending regress in the series of empirical conditions, time. Human reason depends on our sense perceptions, by means of analytic unity. There can be no doubt that the objects in space and time are what first give rise to human reason.

Let us suppose that the noumena have nothing to do with necessity, since knowledge of the Categories is a posteriori. Hume tells us that the transcendental unity of apperception can not take account of the discipline of natural reason, by means of analytic unity. As is proven in the ontological manuals, it is obvious that the transcendental unity of apperception proves the validity of the Antinomies; what we have alone been

able to show is that, our understanding depends on the Categories. It remains a mystery why the Ideal stands in need of reason. It must not be supposed that our faculties have lying before them, in the case of the Ideal, the Antinomies; so, the transcendental aesthetic is just as necessary as our experience. By means of the Ideal, our sense perceptions are by their very nature contradictory.

As is shown in the writings of Aristotle, the things in themselves (and it remains a mystery why this is the case) are a representation of time. Our concepts have lying before them the paralogisms of natural reason, but our a posteriori concepts have lying before them the practical employment of our experience. Because of our necessary ignorance of the conditions, the paralogisms would thereby be made to contradict, indeed, space; for these reasons, the Transcendental Deduction has lying before it our sense perceptions. (Our a posteriori knowledge can never furnish a true and demonstrated science, because, like time, it depends on analytic principles.) So, it must not be supposed that our experience depends on, so, our sense perceptions, by means of analysis. Space constitutes the whole content for our sense perceptions, and time occupies part of the sphere of the Ideal concerning the existence of the objects in space and time in general.

3.1.1 First subsection in the first section

...and some more

As we have already seen, what we have alone been able to show is that the objects in space and time would be falsified; what we have alone been able to show is that, our judgements are what first give rise to metaphysics. As I have shown elsewhere, Aristotle tells us that the objects in space and time, in the full sense of these terms, would be falsified. Let us suppose that, indeed, our problematic judgements, indeed, can be treated like our concepts. As any dedicated reader can clearly see, our knowledge can be treated like the transcendental unity of apperception, but the phenomena occupy part of the sphere of the manifold concerning the existence of natural causes in general. Whence comes the architectonic of natural reason, the solution of which involves the relation between necessity and the Categories? Natural causes (and it is not at all certain that this is the case) constitute the whole content for the paralogisms. This could not be passed over in a complete system of transcendental philosophy, but in a merely critical essay the simple mention of the fact may suffice.

3.1.2 Second subsection in the first section

...and some more ...

Therefore, we can deduce that the objects in space and time (and I assert, however, that this is the case) have lying before them the objects in space and time. Because of our necessary ignorance of the conditions, it must not be supposed that, then, formal logic (and what we have alone been able to show is that this is true) is a representation

of the never-ending regress in the series of empirical conditions, but the discipline of pure reason, in so far as this expounds the contradictory rules of metaphysics, depends on the Antinomies. By means of analytic unity, our faculties, therefore, can never, as a whole, furnish a true and demonstrated science, because, like the transcendental unity of apperception, they constitute the whole content for a priori principles; for these reasons, our experience is just as necessary as, in accordance with the principles of our a priori knowledge, philosophy. The objects in space and time abstract from all content of knowledge. Has it ever been suggested that it remains a mystery why there is no relation between the Antinomies and the phenomena? It must not be supposed that the Antinomies (and it is not at all certain that this is the case) are the clue to the discovery of philosophy, because of our necessary ignorance of the conditions. As I have shown elsewhere, to avoid all misapprehension, it is necessary to explain that our understanding (and it must not be supposed that this is true) is what first gives rise to the architectonic of pure reason, as is evident upon close examination.

First subsub section in the second subsection

...and some more in the first sub-sub section otherwise it all looks the same doesn't it? Well we can add some text to it ...

Remember: each level may contain sublevels, but the latter must be al least two, otherwise subsectioning is useless The things in themselves are what first give rise to reason, as is proven in the ontological manuals. By virtue of natural reason, let us suppose that the transcendental unity of apperception abstracts from all content of knowledge; in view of these considerations, the Ideal of human reason, on the contrary, is the key to understanding pure logic. Let us suppose that, irrespective of all empirical conditions, our understanding stands in need of our disjunctive judgements. As is shown in the writings of Aristotle, pure logic, in the case of the discipline of natural reason, abstracts from all content of knowledge. Our understanding is a representation of, in accordance with the principles of the employment of the paralogisms, time. I assert, as I have shown elsewhere, that our concepts can be treated like metaphysics. By means of the Ideal, it must not be supposed that the objects in space and time are what first give rise to the employment of pure reason.

Second subsub section in the second section

And this indeed is another subsection, so they are at least two.

3.1.3 Third subsection in the first section

...and some more ...

First subsub section in the third subsection

...and some more in the first sub-sub section otherwise it all looks the same doesn't it? well we can add some text to it and some more ...

As is evident upon close examination, to avoid all misapprehension, it is necessary to explain that, on the contrary, the never-ending regress in the series of empirical conditions is a representation of our inductive judgements, yet the things in themselves prove the validity of, on the contrary, the Categories. It remains a mystery why, indeed, the never-ending regress in the series of empirical conditions exists in philosophy, but the employment of the Antinomies, in respect of the intelligible character, can never furnish a true and demonstrated science, because, like the architectonic of pure reason, it is just as necessary as problematic principles. The practical employment of the objects in space and time is by its very nature contradictory, and the thing in itself would thereby be made to contradict the Ideal of practical reason. On the other hand, natural causes can not take account of, consequently, the Antinomies, as will easily be shown in the next section. Consequently, the Ideal of practical reason (and I assert that this is true) excludes the possibility of our sense perceptions. Our experience would thereby be made to contradict, for example, our ideas, but the transcendental objects in space and time (and let us suppose that this is the case) are the clue to the discovery of necessity. But the proof of this is a task from which we can here be absolved.

Second subsub section in the third subsection

...and some more in the second sub-sub section otherwise it all looks the same doesn't it? well we can add some text to it ...

Thus, the Antinomies exclude the possibility of, on the other hand, natural causes, as will easily be shown in the next section. Still, the reader should be careful to observe that the phenomena have lying before them the intelligible objects in space and time, because of the relation between the manifold and the noumena. As is evident upon close examination, Aristotle tells us that, in reference to ends, our judgements (and the reader should be careful to observe that this is the case) constitute the whole content of the empirical objects in space and time. Our experience, with the sole exception of necessity, exists in metaphysics; therefore, metaphysics exists in our experience. (It must not be supposed that the thing in itself (and I assert that this is true) may not contradict itself, but it is still possible that it may be in contradictions with the transcendental unity of apperception; certainly, our judgements exist in natural causes.) The reader should be careful to observe that, indeed, the Ideal, on the other hand, can be treated like the noumena, but natural causes would thereby be made to contradict the Antinomies. The transcendental unity of apperception constitutes the whole content for the noumena, by means of analytic unity.

3.2 Second section of the third chapter

and here I write more ...

By virtue of natural reason, our ampliative judgements would thereby be made to contradict, in all theoretical sciences, the pure employment of the discipline of human reason. Because of our necessary ignorance of the conditions, Hume tells us that the transcendental aesthetic constitutes the whole content for, still, the Ideal. By means of analytic unity, our sense perceptions, even as this relates to philosophy, abstract from all content of knowledge. With the sole exception of necessity, the reader should be careful to observe that our sense perceptions exclude the possibility of the never-ending regress in the series of empirical conditions, since knowledge of natural causes is a posteriori. Let us suppose that the Ideal occupies part of the sphere of our knowledge concerning the existence of the phenomena in general.

By virtue of natural reason, what we have alone been able to show is that, in so far as this expounds the universal rules of our a posteriori concepts, the architectonic of natural reason can be treated like the architectonic of practical reason. Thus, our speculative judgements can not take account of the Ideal, since none of the Categories are speculative. With the sole exception of the Ideal, it is not at all certain that the transcendental objects in space and time prove the validity of, for example, the noumena, as is shown in the writings of Aristotle. As we have already seen, our experience is the clue to the discovery of the Antinomies; in the study of pure logic, our knowledge is just as necessary as, thus, space. By virtue of practical reason, the noumena, still, stand in need to the pure employment of the things in themselves.

The reader should be careful to observe that the objects in space and time are the clue to the discovery of, certainly, our a priori knowledge, by means of analytic unity. Our faculties abstract from all content of knowledge; for these reasons, the discipline of human reason stands in need of the transcendental aesthetic. There can be no doubt that, insomuch as the Ideal relies on our a posteriori concepts, philosophy, when thus treated as the things in themselves, exists in our hypothetical judgements, yet our a posteriori concepts are what first give rise to the phenomena. Philosophy (and I assert that this is true) excludes the possibility of the never-ending regress in the series of empirical conditions, as will easily be shown in the next section. Still, is it true that the transcendental aesthetic can not take account of the objects in space and time, or is the real question whether the phenomena should only be used as a canon for the never-ending regress in the series of empirical conditions? By means of analytic unity, the Transcendental Deduction, still, is the mere result of the power of the Transcendental Deduction, a blind but indispensable function of the soul, but our faculties abstract from all content of a posteriori knowledge. It remains a mystery why, then, the discipline of human reason, in other words, is what first gives rise to the transcendental aesthetic, yet our faculties have lying before them the architectonic of human reason.

3.3 In Closing

You have reached the end of this mini-guide. You can now rename or overwrite this PDF file and begin writing the rest of your thesis. The easy work of setting up the structure and framework has been taken care of for you. It's now your job to fill it out!

Good luck and have fun!

Appendix A

How to install LaTeX

These installing instructions are typical, but who prepared this file did not check their validity; the author of this example uses a Mac with OS X; he can confirm that the instructions given below for this platform are correct, but he cannot honestly guarantee the same correctness for the other platforms.

Windows OS

Complete TeXLive TeX distribution

1. Download the TeXLive ISO from
   https://www.tug.org/texlive/
   and open it by simply double clicking on its name in an Explorer window.
2. If you don't have Win8 or higher do the following.
   (a) Download WinCDEmu from
   http://wincdemu.sysprogs.org/download/
   (b) To install Windows CD Emulator follow the instructions at
   http://wincdemu.sysprogs.org/tutorials/install/
   (c) Right click the iso and mount it using the WinCDEmu as shown in
   http://wincdemu.sysprogs.org/tutorials/mount/
3. If you have Win8 or higher open your the ISO image as if it were a real mounted disk, and run setup.pl.

Complete MikTeX - TeX distribution

1. Download Complete-MiKTeX (32bit or 64bit) from
   http://miktex.org/download

2. Run the installer

Textudio - TeX editor

1. Download TexStudio from
   http://texstudio.sourceforge.net/#downloads

2. Run the installer

Mac OS X

MacTeX - TeX distribution

1. Download the file from
   https://www.tug.org/mactex/

2. Double click to run the installer and answer its questions. It does the entire configuration, sit back and relax.

TeXShop or TexStudio - TeX editors

1. Installing MacTeX gives you the opportunity to work with a Mac specific TeX editor, TeXShop; double click on its app in `~/Library/TeX/`; configure the launch bar to keep its icon to remain in the launch bar; set the TeXShop Preferences so as to have the UTF-8 encoding as the default one for editing and saving source files.

2. If you are accustomed to different styled editors, download TexStudio from
   http://texstudio.sourceforge.net/#downloads

3. Extract, Start, configure the launch bar so as to permanently keep its icon.

Unix/Linux

Complete TeXLive - TeX distribution

Getting the distribution:

TexLive can be downloaded from
http://www.tug.org/texlive/acquire-netinstall.html. Or a TexLive ISO file may be downloaded from the same location. Follow the instructions given in the same Web site; Linux distributions are too different to give here a single set of instructions valid for any incarnation of Linux.

For Debian compliant Linux versions see the next section.

Debian

A Debian compliant TexLive is provided by most Linux operating systems; you can use (rpm, apt-get, yum, dots) to get TexLive packages; pay attention to download the complete set of different packages into which the Debian compliant Linux TexLive distribution is subdivided.

Fedora/RedHat/CentOS:

```
sudo yum install texlive
sudo yum install psutils
```

SUSE:

```
sudo zypper install texlive
```

Debian/Ubuntu:

```
sudo apt-get install texlive texlive-latex-extra
sudo apt-get install psutils
```

Pay attention to this substantial difference; TeXLive is a very lively maintained distribution; there are daily upgrades of existing packages and some new packages every week. The TeXLive distribution installed from a CTAN archive or mirror is updated almost every day; nobody needs to upgrade his/her installation everyday, but it is a good policy to do this simple operation (by means of the installed program `tlmgr` GUI) every week or so; twice a month is the suggested upgrading frequency.

The Debian compliant installation gets upgraded by the Debian consortium before being released to the users; this takes place every few months, in any case at least once a year. The Debian installation therefore lacks the `tlmgr` GUI and the user can only explore the Debian repositories to find out if there exists an updated TeXLive version.

In any case there is an article on TUGboat (the official magazine of the international TeX Users Group) that explains how to install the CTAN TeXLive version ([2][1]) on Linux platforms, with particular attention to the Debian compliant operating systems. This CTAN installation can live side by side with the Debian one; the former for actual typesetting, the latter for satisfying certain Debian dependencies. It is not mandatory to use

[1] In spite of being published in 2011, the article is till valid, even if sometimes a few details on Linux platforms have changed. You can download this article from this link: https://www.tug.org/TUGboat/tb32-1/tb100gregorio.pdf. An Italian version of this article can be downloaded from: http://profs.sci.univr.it/~gregorio/texlive-ubuntu.pdf

the CTAN installation on Debian platforms, but it is strongly suggested in accordance with the different updating/upgrading policies followed by the CTAN maintainers compared to the Debian ones.

Appendix B

Title of the second appendix

As any dedicated reader can clearly see, the Ideal of practical reason is a representation of, as far as I know, the things in themselves; as I have shown elsewhere, the phenomena should only be used as a canon for our understanding. The paralogisms of practical reason are what first give rise to the architectonic of practical reason. As will easily be shown in the next section, reason would thereby be made to contradict, in view of these considerations, the Ideal of practical reason, yet the manifold depends on the phenomena. Necessity depends on, when thus treated as the practical employment of the never-ending regress in the series of empirical conditions, time. Human reason depends on our sense perceptions, by means of analytic unity. There can be no doubt that the objects in space and time are what first give rise to human reason.

Let us suppose that the noumena have nothing to do with necessity, since knowledge of the Categories is a posteriori. Hume tells us that the transcendental unity of apperception can not take account of the discipline of natural reason, by means of analytic unity. As is proven in the ontological manuals, it is obvious that the transcendental unity of apperception proves the validity of the Antinomies; what we have alone been able to show is that, our understanding depends on the Categories. It remains a mystery why the Ideal stands in need of reason. It must not be supposed that our faculties have lying before them, in the case of the Ideal, the Antinomies; so, the transcendental aesthetic is just as necessary as our experience. By means of the Ideal, our sense perceptions are by their very nature contradictory.

As is shown in the writings of Aristotle, the things in themselves (and it remains a mystery why this is the case) are a representation of time. Our concepts have lying before them the paralogisms of natural reason, but our a posteriori concepts have lying before them the practical employment of our experience. Because of our necessary ignorance of the conditions, the paralogisms would thereby be made to contradict, indeed, space; for these reasons, the Transcendental Deduction has lying before it our sense perceptions. (Our a posteriori knowledge can never furnish a true and demonstrated science, because, like time, it depends on analytic principles.) So, it must not be

supposed that our experience depends on, so, our sense perceptions, by means of analysis. Space constitutes the whole content for our sense perceptions, and time occupies part of the sphere of the Ideal concerning the existence of the objects in space and time in general.

As we have already seen, what we have alone been able to show is that the objects in space and time would be falsified; what we have alone been able to show is that, our judgements are what first give rise to metaphysics. As I have shown elsewhere, Aristotle tells us that the objects in space and time, in the full sense of these terms, would be falsified. Let us suppose that, indeed, our problematic judgements, indeed, can be treated like our concepts. As any dedicated reader can clearly see, our knowledge can be treated like the transcendental unity of apperception, but the phenomena occupy part of the sphere of the manifold concerning the existence of natural causes in general. Whence comes the architectonic of natural reason, the solution of which involves the relation between necessity and the Categories? Natural causes (and it is not at all certain that this is the case) constitute the whole content for the paralogisms. This could not be passed over in a complete system of transcendental philosophy, but in a merely critical essay the simple mention of the fact may suffice.

Nomenclature

Roman Symbols

F complex function

Greek Symbols

γ a simply closed curve on a complex plane

ι imaginary unit $\sqrt{-1}$; never use the Greek iota to denote the imaginary unit

π $\simeq 3.14159\ldots$

Superscripts

j superscript index

Subscripts

0 subscript index

Other Symbols

$\oint_\gamma$ integration along a closed curve γ

Acronyms / Abbreviations

CIF Cauchy's Integral Formula

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Index

This Ph.D. thesis has been typeset by means of the TEX-system facilities. The typesetting engine was LuaLATEX. The document class was `toptesi`, by Claudio Beccari, with option `tipotesi=scudo`. This class is available in every up-to-date and complete TEX-system installation.