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How to write a thesis at the AIRLab

According to: Matteo Matteucci, Andrea Bonarini, ...

Last Update: 15/01/2021

The following is a collection of useful information for the drafting of a thesis manuscript. It does not claim to be the definitive guide, consider it to be **a list of the things we continue to correct in all the theses and we are tired of**. TLDR: a “better prevent rather than cure” guide.

In the following you won't find a guide to the rules for the Laurea exams which you should know by heart at this point. If not, you should read them carefully:

- School of Industrial and Information Engineering: <https://www.ingindinf.polimi.it/it/esami-di-laurea>
- Computer Science and Engineering: <https://ccs-informatica.elet.polimi.it/master.html>, https://www.ingindinf.polimi.it/fileadmin/user_upload/scuola/esami_laurea/ING_INFORMATICA.pdf

Preamble

It may perhaps seem obvious, but let's clarify the rules of the game from the very beginning so they can drive you through the writing of **every single page of your manuscript**:

- Be clear, explicit, practical and focused! For each sentence, at any time, it should be clear why you are writing what you are writing to the reader, which, in principle, could be not specifically aware of the topic you are presenting. If not, you need to rephrase or reorganize the text.
- Do not put in the report everything you know, but only what is strictly related to the subject (focused!) and functional to the discussion of your work (practical!).

- Organize concepts in a rational framework, don't take for granted important concepts (be clear and explicit!), do not repeat concepts over and over unless explicitly required for the clarity of presentation (be practical and focused!)
- Read over and over again what you write, possibly **on paper, not on screen**. Have other people who are not aware of the subject read the writing too.
- **Use a spell checker!!!!**

The length of a thesis manuscript as well as the duration of a thesis, is not predetermined, but it is clear when a thesis and its writing can be said to be complete. A thesis can be said to be complete when there are results to be accounted for in the manuscript (which involve a certain amount of scientific or even technological innovation). Similarly, a thesis manuscript is complete when:

- It has been written and proofread.
- The documentation of any accompanying tool is in the appendix.
- When the **airlab package** is delivered to the advisor

The most frequent question which usually follows at this point is “how many pages should a thesis be long?”. In our experience 100 pages are the mean for thesis with controrelatore and 60 pages for thesis without controrelatore with one standard deviation being 10 pages (but notice that the controrelatore usually prefers you to stay on the lower tail of the distribution than on the upper tail) so aim for 90-100 in that case. By no means, the length of a thesis manuscript should exceed 150 pages (excluding appendix).

Advisor (relatore), co-advisor (correlatore), and discussant (controrelatore)

The advisor (**relatore**) and the possibly involved co-advisor (**correlatore**) are the persons responsible for your thesis work as a graduate student. Their task is to guide you in carrying out the work and ensure that the final result is worthy of being read both from the point of view of the form and from the point of view of the content. It is not the role of the advisor and co-advisor to write your thesis as it is not their role to do the work, thus, use their time in the most effective way, for instance, give them content that is ready to be read and spell checked, they do not have to fix your writing but give feedbacks on content and presentation form.

The **controrelatore** (you could translate it as discussant, reviewer or opponent) is an independent professor which will be selected once you have already uploaded the thesis by an independent graduation committee to review your thesis. His/her opinion on the manuscript will affect your graduation mark, so keep in mind that the content of your thesis manuscript should be understandable for this independent reviewer which you will not know until you have already submitted the manuscript for his/here revision, and which may be not specifically acquainted to the topic of your thesis.

Advisor and (co-)advisors, when involved, must follow you in carrying out the thesis by giving you indications and suggestions every time you get stuck at some point, but it goes without saying that the thesis should not be done by them. We suggest you to interact frequently with your advisor and/or co-advisor and not to disappear for a long time without communicating with them (3 weeks is a very long time!). Communication can be done in various ways; we suggest asking for a meeting at most every two weeks and an email a week describing the activities

recently done. If nothing new has been done, an email saying that is fine, just to know that you are continuing to work on your thesis and that you have no particular issue.

Here are some good rules for interacting with your (co-)advisor at the time of thesis writing:

- (co-)advisors must review the thesis, they will evaluate it. Therefore they must start reading it at least one month before the deadline for delivery. Obviously, it will be a draft and not the final version, but it should already have the structure and contents of the final one. While you are writing, you should send chapters to be read one at a time.
- Never give a manuscript that has never been proofread and spell checked to the (co-)advisors; they must be able to focus on the contents and on the outline, not on grammar.
- **Use a spellchecker!**

At the end of the thesis you will not necessarily have to deliver a physical copy of the thesis to the supervisor. Some advisors want only the digital version of it, just ask! What is mandatory is the **airlab package**.

Writing tools

The quality of a thesis is independent of the tool used for its writing; nevertheless, from our past experience and from colleagues who have preceded you, we suggest using LaTeX and for this purpose we provide a "package" with a style that should already respect all the formatting indications that will follow and relative instructions on how to use it.

- You can download it from the following link, in case you improve on it please let us know so we can update it: <https://gitlab.com/airlab-404/thesis-latex-template>

LaTeX is an editing system that allows you to write documents in pure text format and then compile them into a pdf document with hyperlinks too. It is usually installed on Linux systems or it can be easily installed for Windows and Mac systems. On the web you can find several LaTeX guides and packages: just google for them.

As LaTeX is a TAG-based formatting language, a good editor that supports the writing of the thesis is essential. Under linux, Kile, Texmaker, Emacs, vim or gedit are possible choices, but you can also use online collaborative tools as well:

- At the time of writing the most user friendly tool is Overleaf, which is free for the kind of use you will do during your thesis: <https://www.overleaf.com/>

We strongly discourage any tool which does not use pure, standard, latex format such as some WYSWYG tools which use proprietary languages of macros (e.g., LyX). Learning LaTeX, for the kind of use you will do takes less than a week and it is full of support websites!

In case it was not clear, **use a spell checker!** Many editors already have a built-in one, but it is not sufficient. To make your writing smooth and clear, especially if you are not proficient in English, we warmly suggest you to try Grammarly <https://www.grammarly.com/>, the free plan will already make a great difference in the result, consider investing in a limited pro plan for the months you will be writing your thesis, you will see the difference and your (co-)advisors too! A plug-in for overleaf which uses grammarly exists, might be interesting trying to use it <https://chrome.google.com/webstore/detail/overleaf-textarea/iejmieihafhnmjopblelhbpdgchbckil> .

In scientific and education contexts, plagiarism is something to care particularly. Because of this, you should make all the effort of not to use other people's content, including images, without providing a proper acknowledgement of use. Images should all have the source reference in the caption and sentences taken verbatim should be put in quotes. You can check the level of plagiarism of your thesis by using some anti plagiarism tools. Grammarly pro plan <https://www.grammarly.com/plagiarism-checker> already provides one otherwise you can use Turn it in <https://www.turnitin.com/>, or iThenticate <https://www.ithenticate.com/>.

Structure and content

To structure the writing of your thesis just keep in mind some simple rules to facilitate the reviewer reading with a smooth flow of information. Therefore:

- There must be reasons for some piece of knowledge to be in the state of the art, i.e., it has to be functional to the content of the thesis.
- Already from the thesis table of content (and therefore from the titles of chapters and sections) you should be able to understand the line of reasoning and the overall content
- The overall length of the thesis should be 100 pages + appendices with 10 pages of standard deviation. Sometimes less is more, so 90-100 is a good range!
- The average length of a sentence is about 2-3 lines. Never exceed 6 :-)
- Paragraphs are conceptual blocks, do not start a new one every sentence and do not make paragraphs one page long. The reader rests between paragraphs, too many breaks are annoying, too few are tiring.
- Insert examples to make the discussion clearer.

There is no standard outline of a thesis, but most of them have the following content, but we suggest you discuss a preliminary outline with your (co-)advisors prior to start writing:

- Introduction of the thesis context, the objectives of the thesis, what you have done, why you have done it that way, which are the results/outcome of the thesis + the thesis outline.
- State of the art and background useful to understand the problem you have faced, the tools you have used to face it, the way other people use to face it so far.
- The problem statement formulated in a clear way, with open issues and thesis goals. Then you introduce the way you faced the problem with the motivation for your approach. The latter part could go in another chapter.
- A quantitative evaluation of what you have done, with a clear description of the tools you have used to obtain your evaluation and the details required to replicate the outcome. Results need to be discussed and you should provide a clear interpretation of them as well.
- A discussion/conclusion of the thesis in which you highlight the most relevant findings and the open issues remaining for future development/research

In the English version you should also put an **Italian summary of the thesis. This is the Italian translation of the Introduction**, not the translation of the abstract.

Before starting to write the thesis is suggested to define a detailed table of content, including few lines for every chapter and section, and an estimation of the length of the section. This helps to define a reasonable framework for the thesis and to estimate what you need to write. Discuss with your (co-)advisor this detailed table of contents before starting to write the thesis.

Elements of style

Writing style is a personal thing; nevertheless you are writing a formal document with the precise goal of making the reader understand. Therefore, any style element should be chosen to make him/her understand. In short: be clear, explicit, practical and focused!

- Use the first person, either singular or plural, in a consistent way from the beginning to the end and do not change.
- Use **always direct form**, indeed passive forms are more complex to understand and they do not add any piece of information to your writing.
- Make always explicit the subject of a verb in your paragraphs. Do not make too many implicit references, repeat the subject everytime it might be useful to understand your point. The title of a chapter or section is not the subject for the following text.
- Be consistent in the names, avoid synonyms, indeed if you use a different word to state the same thing it means you want to convey a different meaning in the two statements; if this is not the case, you are just creating inconsistencies.
- Use the present or the past tense; be consistent, if you use the present use it always and do not mix. Do not use the future unless you are talking about future works. The future is the tense of the **things you have not done**.

The previous are related to the form, the following more to the presentation

- Write positively and not negatively
 - Wrong: ... our system does not represent a solution for problem A ...
 - Correct: ... our system represents a solution for problem B ...
- Don't write as you speak, do not use contractions
 - Wrong: ... this didn't result in ...
 - Correct: ... this did not result in ...
- Be as specific as possible
 - Wrong: ... techniques we describe can be used for ...
 - Correct: ... techniques we describe in this thesis can be used for ...
 - Correct: ... techniques we describe in Chapter 4 can be used for ...

Formatting elements

Many of the formatting tips in the following, and many more are already supported by Grammarly and the provided Latex style so you do not have to check them by your own, otherwise keep always in mind:

- Do not insert spaces before the comma, semicolon, colon, point, exclamation point, question mark. Do not put spaces after the opening parenthesis and before the closing parenthesis. If you are writing in Italian, do not put spaces between an article and the apostrophe, and between the apostrophe and the following word.
- Do not use quotes unless absolutely necessary.
 - Wrong: ... I focused on some "design choices" ...
 - Correct: ... I focused on some design choices ...
- Use capital letters only for proper personal names and not for technical terms unless they are used in the literature as names or before making acronyms, e.g., Artificial Intelligence (AI) or Reinforcement Learning (RL), etc.

- Use capital letters when referring to figures, chapters or sections in the text if they are followed by the number. Do not use capital letters when referring to figures, chapters or sections without indicating them by their number.
 - Wrong: ... in figure 2.1 ...
 - Correct: ... in Figure 2.1 ...
 - Wrong: ... as illustrated in chapter 3 ...
 - Correct: ... as shown in Chapter 3 ...
 - Wrong: ... the algorithm described in the previous Section ...
 - Correct: ... the algorithm described in the previous section ...
 - Wrong: In this Chapter we introduce the concept ...
 - Correct: In this chapter we introduce the concept ...
- To abbreviate "for example" you can use "e.g.," to abbreviate "that is" you can use "i.e.,". Notice the presence of the coma after the point!
- Use italics, `\emph{}` in LaTeX, only the first time you introduce a term or when defining it.

Other formatting tips should be taken into account

- Begin a new chapter (or paragraph or section) with a capital letter. The first paragraph of a section should not be indented, the following ones should be indented. End each sentence with a period.
- Each sentence of an itemized or enumerated list must start with a capital letter and end with a comma, a semicolon or a period (make a choice and respect it consistently throughout the manuscript). The last sentence of the list must be closed with a period.
- Mathematical formulas and math environments need punctuation as normal text. Do not start a new paragraph after a formula if you do not have a period at the end of the formula i.e., do not leave a black line in LaTeX or start that line with %.
- All figures and tables must be referenced in the text. The reference style should be consistent in the whole thesis: for example, choose whether to use "Fig. X.Y" ("Tab. X.Y") or "Figure X.Y" ("Table X.Y") and always keep the same format.
- The format of the captions of figures and tables must be uniform. Either they all start with a capital letter (the typical case) or they all start with a lowercase letter; they all end with a period (the typical case,) or they all end without a period, and so on.
- The ellipsis must always be three dots: "...".
- Maintain uniformity in writing names. If you have denoted an object as "LonMark", then always write it like this and not, for example, "Lonmark".
- Index, chapters, bibliography, etc., always start on the right page.

In the case of the LaTeX style provided, the format and layout are already correct. Here there are some additional LaTeX tips:

- Images go top, yes top, in the page where you reference them or after, never before. If you cannot fit them top, you can use bottom, but never in the middle of the text.
- Spaces before the `\ref{}` and `\cite{}` should be made non separable using `~` instead of plain space
 - Wrong: ... as stated in `\cite{xyz}` the result of ...
 - Correct: ... as stated in `~\cite{xyz}` the result of ...
- To start a new paragraph on a new line do not use `\\` just leave an empty line between the two paragraphs

Figures and Bibliography

Images and tables go top, **yes top**, in the page where you reference them or after, never before. If you cannot fit them top, you can use bottom, but never in the middle of the text. Figures should be readable so make them as big as possible. (We know this is repeated, it means it is as important as using a spell checker!!!).

Among the possible ways for plotting data numbers in 2D and 3D graphs we suggest gnuplot (<http://www.gnuplot.info>); it exists for both Linux and Windows and you can find excellent tutorials on the net on how to use it. Nevertheless many other environments, including python can be used for plots. Keep plots and all vectorial figures in vector format, i.e., do not convert them into png or jpg, but use formats such as eps, pdf, svg, etc. (check the one supported by your LaTeX install). Consider the reduction scale that may occur when you put the figure in the text: numbers and any character associated to the plots should be readable in the final format.

All the axes in the plot must be associated with an indication of what they contain and the measurement unit. Plotting tools often "auto-scale" the chart, making two charts not directly comparable visually as they have axes with different ranges. Make all the charts which have to be compared having comparable ranges! Add legend and describe the content of each picture in the caption with enough details not to have to read the referring text to understand its content. Consider that thesis are often printed in black and white so you should be able to read the plots in this case too.

Each bibliography item must contain the authors, the title, the reference (journal, thesis, internal report, collection of articles), year of publication, the publisher and possibly the page numbers with volume and issue.

The AIRLab package

Before the final presentation ("Discussione di tesi"), each MSc student has to upload important material to the OneDrive directory which will be provided by the (co-)advisors. Ask about it!

When to upload

This upload has to be successfully done 1 week before the date of the final presentation, in order to give sufficient time to the (co-)advisor to check the completeness and the correctness of the uploaded material.

What to upload

Each student will find a folder on the server with his/her name (e.g. 2019_Doe_John), that has to be filled according to the template that can be found in the folder Year_Surname_Name. You should copy it in your folder and leave the template empty ;-)

- A README.txt file with the description of the content of your package and all the information which is required to check its integrity. Your (co-)advisor will start from this file to be sure everything is there and it is "working".

- Code: This folder contains all the codes developed during the project and a readme file explaining how to make them run.
- Data: This folder contains all the experimental data, simulation data, etc. generated during the MSc thesis. The data has to be ordered, with meaningful file names.
- Final Presentation: this folder contains the final presentation file (Powerpoint .pptx).
- Final Thesis: This folder contains the files of the final manuscript (PDF and sources, – .docx or LaTeX sources, including figures).
- Media: This folder contains the final video of the thesis (see below) and all the figures used in the thesis manuscript or in the presentation. If needed, you can create compressed archives (.zip or .rar).
- Figures should be saved in an editable vectorial format when possible (.fig MATLAB figure, .eps Vectorial figures, .png Bitmap figures (resolution ≥ 600 DPI)).

Each student has to provide a final video 2-3min long, provided with an english audio description, clearly explaining the background, the aims of the thesis, the methods developed, and the results obtained. The video should be saved as .mp4 video with a resolution $\geq 720p$ encoded with h264. The video will be eventually published on the Youtube channel of AIRLab, and you can link it in your CV, if you like.

How to upload

Ask your (co-)advisors to provide you the link to the OneDrive directory where to upload the material.

Thesis discussion and presentation template

Once you have done with thesis writing and finally took a 24h long sleep it is time to work on your thesis presentation which is worth part of your thesis final grade and it will pose you in front of a totally new experience if you did not make presentations before!

To help you in preparing it we have prepared a slide template with important rules to follow:

- AIRLab slide template:
https://polimi365-my.sharepoint.com/:p:/g/personal/10104160_polimi_it/ETne18XoAvtNr_zj3yTbEVroBQP1yytOw-wdh1c9O3WbMiA?e=o8EPHI

Most important things to remember when making a presentation:

- Tell a story, i.e., structure it so to be sure you also give the big picture!
- Make people understand, i.e., be clear, use examples, use images
- Keep people with you, i.e., eye contact and tell a story!
- Stay within your timing