Mastering Master Thesis

What will my Life look like in the following months? Mine: Ah shit, here we go again

"You will pee blood", this is what my master thesis advisor told me before starting the thesis. I'm not going to lie; he was right. We will cry during the thesis (He didn't, but I suspect he did it in the bathroom while I couldn't see him), trying many things that might not work, for various reasons. Are these notes an attempt to avoid peeing blood or to get the Golden Idol (your thesis) as easily as Indiana Jones? No, of course not. Ain't no Indiana. In this note, I provide "instruction" on writing a Master Thesis and organizing our time together effectively. I try. Feedback is more than welcome. One of my PhD advisor told me, "Take the best from your advisors, and improve the worst". The main focus would be the structure of your thesis, your logbook/notes that you will produce during our time together, and our meetings. Refer to this note periodically, especially before beginning the X-months research period together.

The main purpose of the thesis is to tackle a research topic over X months, dive into the literature, and address the problem from various angles to get it done. And that's it! You need to document everything. The purpose of your thesis is simple to demonstrate to everyone involved (me, you, external examiner, and even your grandmother) what you have learned thus far. You must show what you have done, what results you have achieved, and why it matters (we don't care if you know Network Theory better than Newman – because it's false). What have we done these past months? That's what your thesis is all about. Have we just played Super Mario together? I hope not... not only.

Your thesis serves as a written record that compiles your literature review, methods used to answer your research questions, and findings to address the problem behind your thesis. It's fine to fail. Your thesis is a polished version of these X months. You're going to report failures because they're just as important as new findings. Clearly, if we have one significant finding and many failures, the former will be the core of the thesis, while the latter, though important, are supplementary materials. Importantly, you need to document the reason behind the failure and critically analyze why it did not work out. It's not simply that it didn't work because my computer exploded.

How to tackle this seemingly impossible task? Take notes! Create a logbook where you document everything you do during this period. In the end, you'll use this as a starting point for your thesis. There's no way you'll remember all the discussions and methods/results we've encountered once you start writing the thesis. You keep everything, we don't throw away anything you've done. In many cultures, there is this philosophy of using the whole animal for food. It is a common practice, often rooted in the historical necessity of not wasting resources and making the most out of every available food item. That's your thesis.

Thesis Structure: So it begins

These are briefly the main chapters of your thesis with their aims

- Introduction: Why are we wasting time here? Why not go out, hang around, and have some fun? What are you going to do and why is it relevant? Why do we care? In this chapter you explain the scope and highlight the main goals of your research. Additionally, you will briefly overview the research literature to get a sense of what has been done and provide hints of how your thesis is going to fill the literature gap.
- Data: Describe your dataset because this is the starting point of your research. Provide a thorough description of the dataset's structure, including all details, and showcase some exploratory data analysis (EDA) to gain insight into the data at hand. The first part is boring, just details, while the second part is much more interesting – horrible but insightful plots.
- Methods: Here, you need to specify the statistical tools/models you've utilized. Note that you can (often) draft sections of the methods early, as you may need to wait for simulations or model training to complete. Why not use this time efficiently? You could even work on it while reviewing research literature. I am improving something... OK... but what are the key aspects of the main thing? Highlight them in a way that makes it easier to show your contribution. I call it the Matador's move (More below).
- Results: This chapter presents the findings obtained from your research. What were the findings? Let's weave a tale, linking each figure and paragraph seamlessly to craft a coherent narrative. It was not all random (I hope). For each result, try to adhere to this structure: what are we gonna look? What methods did we employ to grasp this? What did we uncover? Try to contextualize the findings within a broader perspective, trying to link to the previous chapters (Introduction and Methods). I know it's hard. Highlight which results are expected or unexpected, and always add explanation for any unexpected outcomes.
- Conclusion: Wrap up everything, emphasize the best results, elucidate the reasons behind any shortcomings, finally provide a broader context for your findings... Ultimately, what have we learned so far? Was it a waste of time?

This is a possible structure. There might be other options, depending on the thesis. If you're exploring various methods or your narrative comprises distinct sections, it's logical to mix the Methods and Results. Ideally, you outline the first method, followed by presenting the results obtained through that method. Then, in a subsequent chapter, explain the second method and its corresponding findings, while also establishing connections to the previous chapter. This approach facilitates a coherent flow, allowing readers to follow the progression of your research. Try to plan the table of contents before writing! For each chapter, you should also put an introduction and conclusion around the content, and similarly for each section. Include all other work you've done in the Supplementary Material to complete the analysis of the main part of your thesis. In every chapter of your thesis, the research questions must be repeated in direct and simple language so that the reader is always aware of the ultimate goal. At the beginning of your thesis, you should write an abstract. Write this at the end, when everything has been done. The abstract summarizes what your thesis is about, in a nutshell. It presents a problem that is definitely interesting to more than one person (that's you – not just me). We used several methodologies to tackle this incredible challenge and discovered something noteworthy. And probably these results have an impact. The first part is a perfect match of the ending part.

How to Master Thesis? Ask Grandmother!

As far as you have understood, you have to report anything you did. When explaining parts of your thesis, imagine that you're explaining them to your grandmother. She should be able to pick up your thesis, understand what you did and be able to reproduce your work based on your explanation. With the right glasses. Considering how to explain things to your grandmother is an excellent practice at every stage of your thesis report. Actually of your life. Remember that she is deaf. Repeat. Repeat. Repeat. I know it's boring. Repeat. Repeat. Repeat. You have to justify why you have made a choice. Repeat. Repeat. Repeat. Do that accurately and precisely, we have time. Sorry, we all go through that. Repeat. Repeat. Repeat.

It is highly probable that before reading these pages we already set up the research idea of your thesis. In Introduction, you need to present the research goals. Try not to write them too boldly; make them attainable. Not like a JFK speech, but it is a good starting point. Write it in a way that your grandmother will give you some money to buy ice cream, not just because you are her favorite grandson. You will need to show that you understand how your work fits into the bigger picture. The bigger picture is called research literature, and this is something you will handle at the beginning (See Literature Review below). Follow this structure. First, provide an overview of Nature – state-of-the-art. Then, narrow down on your specific case study and explain how your work will benefit humanity (what is known and what unknown). Your grandmother knows a lot of stuff, but maybe she forgets some of them. She doesn't know what you know. Give her the right context. Be specific with examples that support your work (your future chapters). There must be a reasonable number of references; otherwise, I have failed as a supervisor (see the Literature Review below). Can you do this at the beginning? No, of course not. You write first an introduction not too special and then go back to the introduction once you have finished your work. In this way, you will ensure that the scope fits with the work done. Are we cheating? No, of course not. You need to be sure that the research questions properly fit your answers and back. You are gonna waste a considerable amount of time on a cool introduction without knowing what you are gonna talk in the next chapters, it might be difficult at first to handle everything together. Back and forth, back and forth, back and forth. After reading the introduction, reader must say this.

In the Methods chapter, you need to demonstrate full control of the methods. First, you will need to explain how the tools work. Provide examples to highlight the features of your tools. As always, use examples that fit your research problem. In this way, you are explaining (in a clever way) why you chose those methods: they fit your problem! It could be that you're comparing some methods to pick the best one. Be sure that your reasoning is solid – you're not doing something just because your mom said it's the right way. You are directing the reader's attention to something (you are instructing them to observe the stars, but only a portion of the sky, your stars) and improving it. Matador. Your entire thesis will be a justification of why something happens. The methods must be clear with logical explanations, no weird combination of words to explain an algorithm. Remember the scientific method: any result must be verifiable or falsifiable. Furthermore, it's unlikely that your methods will be entertaining...so please, be kind to me, Grandma, and everyone else. After the methods, present the results. Use clear language to explain the findings, ensure the line of reasoning is accurate, and make critical statements about your findings. See how to write below. Try to write the results as if they were a detective case. This is the fun part of your thesis, so aim to shine and keep the reader on edge. In this way, you will demonstrate that you have gained a deep understanding of the topic. Remember to introduce your results clearly: explain what you're looking for, highlight the facts that are indisputable, and describe what insights you are drawing from the plot based on your hypothesis. Finally, conclusion. Conclusion should be a mirror of the introduction with a wrap up of your main findings. Try to structure them in this way. First, condense your main findings, highlighting how they align with what you put in the introduction. Next, point out some shortcomings and possible limitations of your work. It is impossible that you finished Nature in a master thesis. If you highlight the limitations, then you are doubling your results. Be honest. Finally, provide a sense of the broader picture and explain how your work will benefit mankind, i.e.

overall scientific knowledge. Remember that someone in the future will stand on your shoulders and build new knowledge upon what you have discovered. I hope. Please, don't ask how many pages your master's thesis should be. You're old enough to figure that out – there is no upper or lower limit.

ChatGPT (and similar tools) are widely used today for various tasks. I'm not asking you to avoid using them (do you think I wrote all of this by myself?). On the contrary, you should use them. Use them for coding and rephrasing parts of your work. They can efficiently speed up a large part of your work. However, try to avoid delegating all your tasks to them. Do not put yourself entirely in the hands of others, not even me. I know LLMs can be helpful and reduce your stress, but over-reliance will lead to dependency and you'll need an internet connection to function. At the end of the day, ChatGPT will have effectively done its job of predicting the next token, while you will have failed the most important part of your thesis: learning to fail. It's fine to fail, so why not embrace failure? You need to report your failures. It is okay to make mistakes, but it is not okay and unacceptable not to learn from them. Be comfortable in the unknown. Learning how to fail quickly is better than mastering prompt engineering for ChatGPT. I failed so many times and learned much more from those failures than from ChatGPT. Sometimes, I hope to fail, just because it might be more interesting.

You will need to complete some documents before, during, and after your thesis. It's called bureaucracy. I don't know how to help you directly, but I can point you to some people who might be able to assist. However, it's mostly up to you. Sorry, I am learning and trying to forget it. If you need anything from me, feel free to knock on my door. If you need help from the secretary (if there is one), you can knock on their door as well. Remember what my brother told me: "If knocking with your hands isn't enough, knock with your foot."

Logbook and Meetings: This is the Way.

Create a logbook and share it with me. The logbook should be a rough, unpolished version of your thesis, where you document everything you do during your research period. At the top of the logbook, add a bullet-point To-Do list with the tasks you plan to explore. Try to link these tasks to the sections of your logbook where you explain them in more detail. To-Do list can be something "Plot time series of users" and then in section X you can give some context of why we are plotting users. For each section, follow this structure: A figure (even if it's rough) and answer these three questions

- What do I want to understand?
- What am I computing to answer the previous question?
- Given the results in the figure, what have I understood?

The thing you're trying to understand and what you've understood can be minimal. It's perfectly fine to write, "The plot tells us nothing." We don't care about that. Just keep moving forward, progressing step by step, and climbing that mountain one inch at a time. Don't ask yourself, 'What is this thesis about?' Think. Write code. Plot. Repeat. Document everything you do so that it will be easy to trace the steps behind any failures. This way, you will be able to highlight the shortcomings or limitations of these approaches (and perhaps even improve them during your thesis). This is what will look like.

We plan to have weekly meetings lasting one hour. As we near the end of the research period, we might meet even more frequently. During our meetings, the goal is to explore the problem. Consequently, it is very likely that you will need to show me some results. There are three ways to do this. First way, it's the Logbook way: we can go through your logbook and understand your workflow. Second way, you can create a very basic presentation with the plots, and we can discuss them (this is my preferred method). Finally, we can review

your Jupyter notebook (I like this option less, but it's up to you). We'll discuss a wide range of topics, and countless ideas will come up. During our first meetings, I will be more present and perhaps even overbearing, questioning everything we do. In a sense, you might feel like I am overwhelming you. Like Mikhail Tal. It is a way to ensure that everything is properly set up. Set up for what? Do not seek a paternal figure in your thesis advisor; I'm here to assist you on your academic journey. At some point, I'll say the line, "Now you can fly."

Do I expect you to explore everything we discuss? No! Just try to note down everything we say, even if it seems trivial or silly. Later, when things are calm, consider what the best strategy might be. And go with that. I trust you. Remember: I know nothing. Sorry for that, and please question everything we say. It's called research. Do not be afraid to fail and of making decisions, you can not be paralysed with the fear of failure. At the beginning, we will outline some fallback plans. There are plans B, C, D . . . , but do not focus on them. The safety net is my responsibility; you need to operate without relying on it. Otherwise, you will not grow. Explore on your own and be curious about the problem at hand. If you think I am wrong, don't worry about it. Just prove me wrong about something. Why share your logbook with me? If I have an idea, I prefer to review what you've done and add it somewhere (keep a rough section called "Strange Ideas"). Use your logbook during our meetings to explain where we are and what we have learned so far. Let's try to have a gargantuan email thread containing everything about you, ensuring that topics are easily searchable and localized. Let's avoid scattering information around. Reduce entropy! Important: Please name it "Mail Thread (Your Name)". Why? I might not be able to reduce entropy, so it's better if you handle me properly. I'm old, sorry.

If you take notes during our first meeting, you'll already be well on your way to earning your degree. If not, do not worry. You are from the bottom and you are coming for those on top.

Language: You are not an Ancient Greek Tragedian!

Simplicity is the ultimate sophistication. Write things simple. Try to use short sentences to describe your work. If a sentence is longer than three lines, the concept is too convoluted. This can cause the reader to get lost and need to return to the beginning. And they will be pissed off. First, tell the reader what is going to happen, what you are about to explain them. Then, explain the thing to the reader. Ehi, watch out! Stick to the thing you need to explain, we do not need other information. Finally, summarize what has just been explained. I know, it's boring. The focus of a sentence is at the end, as the beginning serves to link to the previous sentence. It's easier to read a sentence that starts with something familiar (the topic we are discussing) and ends with something new (bang!). The juicy part comes at the end. Remember to use one paragraph for each point and merge paragraphs that discuss the same idea! We have already talked about ChatGPT and similar tools. Let me be more specific. These tools can be incredibly useful for improving the language and structure of your sentences. You can definitely use them. I am not a native English speaker—likely not even close to average in terms of fluency, and perhaps you're in a similar situation. I can't tell you not to use these tools, as they can be a helpful resource. However, watch out! If you rely only on these tools to generate sentences, the output might sound awkward or very weird. Some terms may be unnecessary, and I will understand that you're too lazy to refine their outputs. C'mon! "Delve into the intricate tapestry of art, creating a realm that invites us to embark on a journey of understanding the pivotal role creativity plays in shaping society". See this video. Try to write quickly from scratch, just getting your thoughts down, and then refine it as you go to improve clarity. Quick and dirty. Read it out loud. If you don't understand it yourself, how can you expect me to believe it's correct? When explaining your work, try to be direct, vigorous, and concise. "The data have been analyzed..." not only sounds clunky but also feels like it's begging for a rewrite. Honestly, if you wrote something like that, I wouldn't even know where to start roasting you. "We have analyzed these data to understand...". Definitely the way to go! "There is a relation between X and Y, that is linear" –> "X

grows linearly with Y". Ensure the reader knows who is responsible for each action. Avoid awkward, dangling sentences. This is still my greatest weakness. Furthermore, please adopt a formal tone in your writing, i.e. no jargon. During our meetings, you can think that we are at a pub. As for myself, I am drinking a Stout or White Russian. In summary, think of the reader. Explain, don't rush. Show, don't tell. Be clear and simple. Remember to make multiple passes while editing. After all this work, a typo is not something that Grandma would love to read about.

Code: It must Talk.

Ensure your code is readable and well-documented. Not for me, but for yourself. With probability $p \sim 1$, you will need to redo some of your simulations, analyses, or predictions. And this could happen at the end of the thesis. So, try to avoid that moment of frustration ... Who wrote this stuff? What was I thinking? What is this index doing?

A friend told me, "The code is the only thing that you inherit." And it is true. You will reuse parts of the code, you wrote a month ago or even earlier. Not only in your thesis, in your life. Consider using your code to explain the methods and results. It's the best starting point. Ultimately, your code embeds your research process. And while you are coding, you should always be aware of what you are actually computing. It's a feedback loop of thoughts about the problem at hand. Coding is an art form ... Try not to mess things up. You might not be Michelangelo, but you've still got your craft. Remember to share with me the GitHub repo. I won't judge you, but if you need me to review anything, it's already taken care of.

Figure: This is Cinema.

Figures are crucial as they summarize your results in a digestible way. Keep in mind that nowadays Instagram is much more popular than Facebook, there are only photos! When information can be readily grasped visually, owing to the immediacy of the medium, it is undoubtedly sensible to provide context. What am I saying? Write captions! Each caption must articulate in clear and plain language what is depicted in the figure. Emphasize to the reader where to direct their attention, what insights they can glean from the figure. Your choice of color palette is a crucial element of your plot, not merely a random selection made by matplotlib. Read this amazing guide of how to emphasize the most important information in a plot with colors. Lisa is awesome, read her other guide. Keep in mind that colors have their own grammar, and each color has a specific role. Use the same color for each object, and be consistent with style and color usage. For the main character, go for red. Noise? Grey. Certain objects inherently come with their own color associations. Bus infrastructure? Yellow. Simpson? Ensure to include labels, units of measure, and all the other details. I am 100% sure that you are using nanopixel-sized fonts. Increase the thickness of lines and fonts for improved legibility. Otherwise, I will find you... Always, think about your grandma.

Literature Review: I love scientific papers!

I apologize for that. When you begin your research period, I will send you a substantial amount of materials, typically between 5 and 10 papers. I will create a shared folder with this material. Additionally, you'll need to expand upon it. Again, sorry. While all theses are grounded in two or three central papers, the list of references can and should be even more extensive. How to expand the list? Snowball sampling! Take the papers provided and search for both cited and citing papers. The cited papers contain the work that inspired

those, so these might be useful for the motivation behind your work. Generate a graph illustrating these connections and explore it to gather as much information as possible. Use this tool. You might be tempted to cite some weird but insightful online resources. Try to always find research papers instead.

How to read a paper? Follow the Lohse method. Read the title to get a sense of what the topic is about. Read the figure. It is the correct verb. Look at the figure to understand what they are doing: what is their claim? Read the caption of each figure to infer their main findings and how they connect to the title. Figures in a paper should be linked together to create a seamless narrative while clearly conveying the paper's message. Remember the Instagram example! If the figures are poorly constructed, it reflects poorly on the paper's quality. Additionally, figures should provide insight into the methods employed. Now, read the abstract. To understand how the claim of the abstract connects to the figure, consider the narrative gap that the figure fills. By examining the figure alongside the abstract, you can dissect how the visual representation supports or illustrates the main claim or findings outlined in the abstract. The conclusion serves to summarize the main findings of the study and their relevance, similar to the abstract but with added emphasis on highlighting any shortcomings or limitations encountered during the research process. The statements in the conclusion should align closely with those in the abstract, but they may provide additional insights or reflections based on the findings obtained (some shortcomings). Remember: good papers make a point, do not list results. Read the introduction to understand the research gap the authors are trying to fill. An introduction should always follow this structure: We have understood a lot of things in research, however this is still missing and this is relevant, and we are doing it here in this way. If there is no however-ish structure, consider skipping the paper. If you require full details, such as results or methods, make sure to read the entire paper. Otherwise, move on! Ah ah, no! Remember to write down a few lines that summarize the paper. Highlight parts of the paper using colors, and choose a color scheme to understand which part is which and why you have highlighted it.

Presentation: Le grand final.

Finally, you are going away. For the final exam, you'll need to present your work to a group of people. It will include you, me, and an external examiner, maybe something else. We will try the presentation multiple times before the final exam. Why? You need to be perfect. If your presentation does not shine, with both what you are saying and the content of the slides lacking polish, then it's unlikely you'll receive a good grade. And that's disappointing after putting in all this effort. Do you think you'll be able to do it in one shot? No, you are not. We need to fine-tune it. How to do it? First, put your plots into a PowerPoint (or another tool). Then, write down on a piece of paper what you're supposed to say for each specific slide. This is something one of my ex-girlfriends taught me. Before each exam, I would write down on a blank sheet of paper everything I had learned about the specific topics the day before the exam. Okay, it wasn't a blank sheet of paper but an actual notebook. It is the same idea. This will give you confidence in what you have learned so far, where you are... but maybe don't do it the day before the final exam. The day before the final exam, just relax. Please. Try the speech (do not care of how fluent you are). If there are complex structures or key points in your speech, add this information as text boxes on the slides. Remember to include only the relevant text, not everything. Otherwise, people will read your slides instead of listening to you. If you include too many words, then people can ignore you and read. However, text will help you remember the key points of the slide. Don't commit suicide. You cannot have a slide in your presentation that is just a plot. You will fail to remember everything! If you are talking for more than 1 hour, then something is wrong. How many slides? 30? Are you crazy? Do you want to kill us? Remember that it is difficult to stay focused for so long. You have between 15 and 20 minutes to present your work, and you should aim to spend at least 1 minute per slide. The structure of the presentation should mirror that of your thesis. At the beginning, do not rush. Take your time. Emphasize why you are doing something, not how you are doing it. We do not care about the details, at least at the beginning. The first three slides are crucial; they need to catch the audience's attention.

In a perfect presentation, the figure and the text should seamlessly blend together, complementing what you are conveying verbally. What you show, you explain. Simpler is always better. As always, take your time and repeat key concepts. One minute per slide, one concept per slide. Follow this structure: What are we going to look at, and why does it matter? Introduce the slide and let us know why we should listen to you instead of looking outside the window. How will we approach it? Don't dig too much into the methods, clearly if it's not the crucial part, but let us understand how you are doing things. What's the key takeaway? Drop the mic. Practice it again. Practice with me. Take note of my suggestions and try it to implement them. Rewrite the speech. Practice it again. Take your time and remember to breathe through your nose. Here is what it will look like in your mind. Ensure that everything is spelled correctly and formatted neatly. If there is a huge white space in your slide, I will kill you. Remember that the Create backup slides where you include all additional information and content that may not fit into the main presentation but could be useful as reference material or for addressing potential questions. On the contrary, there might be a slide that you really want to show because it has important details. You can. In the backup slides. The examiner could ask something that it is not in your presentation, but you have done it. However, you cannot answer: "It is in the thesis". Intercept the opponent. Consider what the possible questions might be here or there. If you are confident they will ask those questions, direct the audience to where you want them to focus. Remember, you're in control. Bong Sao, a distinctive technique in Wing Chun, exemplifies the Chinese martial art developed by a Buddhist nun and taught to a young woman to defend herself against a local warlord. Bong Sao translates to wing hand, reflecting the shape and function of the arm in this technique, which resembles a bird's wing in its defensive posture. This technique embodies principles of economy of motion, structural integrity, and adaptability. In practical contexts, Bong Sao is used to deflect straight punches, intercept hooks, and maintain a continuous bridge for real-time responsiveness. Why am I saying this? Damn it, intercept the opponent. Guide people to where you want them to be. Float like a butterfly, sting like a bee, don't be a pig.

Research is about being comfortable in the unknown

One final thing... Research is about asking questions, and your research report is about how you've attempted to answer them. It's not just about obtaining knowledge that you can memorize comfortably, instantaneously like Neo with Kung Fu. There is no magic pill. If we already understood everything about what we were doing, there would be no need for investigation or exploration – it wouldn't qualify as research. This is what a Nobel and Ig Nobel Prize winner once told me: "If it were that easy, everyone would do it". Your thesis is about your way of solving a Rubik's Cube. I know that can be frustrating, trying many things and failing the same amount of times. Look. Most important thing, we don't have to know the answer and be comfortable with that. Questions are much more important than answers. There is nothing better than the pleasure of finding things out (when you will do that plot, that god damn plot, we will cry). Then, my master thesis advisor added something "If you puke through your nose and you like it, then we need to talk about a PhD". He was weird. Take home message? Remember that the older you get the stronger the wind gets – always in your face. Last lesson: If you need anything, please don't call me.