

# Scientific Research Experience

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## Section: Depth-induced Neural Tangent Kernel

This section record the scientific research experience I have learned during the work of “Depth-induced Neural Tangent Kernel”, which is given to me by my supervisor in October, 2024 carried out during October to December, and developed into an academic paper in January, 2025.

### 1.1 Technical aspect

1. A paragraph can be usually composed of three key elements in order: “truth + analysis + evaluation”. We should focus more on truth and analysis, avoiding evaluating ourselves too much.
2. To optimize space in a paper, the final sentence of a paragraph should occupy at least half of the last line.
3. The writer’s “mood” should be calm when writing a paper. Sentences with strong personal emotions should be avoided, like “However, I think that is not important.”
4. Only should we write things that are useful and related to our work.
5. What we have learned during the work may be silly and not that important in a reviewer’s aspect 😊. Do not show off our knowledge in the paper and only write indispensable ones.
6. We should write references carefully. The BibTex files found online are not always true. There are a lot of details. Say conferences, we use “@inproceedings”, and the output contain “In Proceedings of the xxx(Edition) xxx(conference)”. For NIPS, “In Advances in Neural Information Processing Systems xxx(Edition)” instead. We should use {} to ensure some words to be capitalized.

7. If our work refers to other researchers' papers, we should clearly indicate the source. Never should we use the original sentences or paragraphs in other papers. If possible, the notations should be replaced too.
8. Write clearly and formally at any time! Bad writings lead to mistakes and are both-ering when being talked about with others.
9. We should carefully read the submission guidelines and various instructions, which varies almost every year ☺.
10. We should make our paper as "smooth" as possible. Pay attention to the logic.
11. We should keep consistent throughout a paper, which includes notation, language, plotting and etc.
12. We should not ruin the requested format of a paper, and avoid using "`\quad`". However, "`\resizebox`" is acceptable.
13. When referring to others' papers, we can choose to use "`\cite`"(general citation) , "`\citet`" (textual citation) and "`\citep`"(parenthetical citation).
14. When referring to a book, it's better to indicate the chapter or theorem. The "refer-ences" should include the publisher.
15. A proof sketch should be concise and able to identifying the key idea.

## 1.2 Notation aspect

1. Only equations referenced later in the text should be numbered.
2. We should make notations differ from each other. A classical example is  $\sigma$  can usually represent the standard of a set of data or the activation function in a neural network. We should avoid using them with different meanings in the same paper.
3. Symbols should not disrupt the line spacing. If a formula is too tall in a "`$text$`" environment, then use "`\[text\]`" instead.
4. Matrices should be used in the "`\textbf`" environment, symbols in "`\boldsymbol`", and texts in "`\text`". There are also notations like "`\sin`" and "`\max`" for simplification.
5. We should use commonly used notations and avoid weird ones.

6. We should pay attention to the size of parentheses, square brackets, curly brackets, angle brackets and etc. It should be ensured that the matching ones fully enclose the content inside. For example, “ $[ (e^{x^{xx}}) + 1 ]$ ” is not proper.
7. When referring to equations, we should use “eq.\eqref{eq :xxx}”. Pay attention to the dot and the instruction.
8. When writing the “Notations” part in a paper, using declarative sentence is enough. “Let xx denote xx.” is a good example.
9. Abbreviations should not appear in a title.
10. We should remember to use “\ + space” in the end of the environment of “\[\ + space + punctuation\]” to ensure the punctuation is clear.
11. We should remember to use “ ” symbol to ensure intervals. For example, “Theorem \ref{xxx}”.

### 1.3 Language aspect

1. We should do our utmost to form our own language conventions. Such as for labels in Latex, I use “sec: xx”, “subsec: xx”, “eq: xx” and etc.
2. We should avoid writing ambiguous sentences, such as “Here, we ensure a similar amount of network parameters concerning A and B. The parameters are xxx and xxx.”(Which is for A and which is for B?)
3. Imperative Sentence should be avoided in scientific writing, which is considered as informal and subjective. For example, “Avoid using small sample sizes.” should be replaced by “Small sample sizes should be avoided.”
4. When referring to one’s unpublished work, we should use “paper” or “work”, not “article”.
5. The notations in a sentence is a clarification, and should not be considered as the main component of a sentence. Sentences like “The  $\text{NTK}_{(d)}$  is a good kernel.” is not complete. We should use “The  $\text{NTK}_{(d)}$  kernel is a good one.” instead.
6. When there are three or more items in a sentence, the very word “and” should be used before the last item.
7. The correct usage of the word “where” is: “xxx , where xxx (no comma) and xxx.”

8. The only usage of the work “respectively” is: “xxx **and** xxx represent/denote/... xxx **and** xxx, respectively.”
9. We should use past tense less in a paper. It is only needed in the “Conclusion” part.
10. The word order “Figure xxx states xxx.” is more common than “xxx is states in Figure xxx.”
11. There should be a comma behind the item “i.e.”
12. We should avoid words that are too simple, such as “do” and “use”, which will indicate that we are novice researchers ☺.
13. I’m not joking. LLMs help in modifying our language, given that we have already stated the meaning of the sentence clearly.

#### 1.4 Plotting aspect

1. The font size of the figures in the paper should be comparable to the font size of the main text, so that others can read the figures without zooming in.
2. Usually, the caption should be omitted when plotting and be added in the paper using the “Figure” environment.
3. We should choose colors with high contrast for the graphs, such as “green” and “red”.
4. Figures are not “effective” in definition, and we should not use them in the expression of a formal theorem.
5. There should be a full stop notation in a caption of a table or a figure.

#### 1.5 Experimental and Coding aspect

1. The purpose of the experiment is not always to demonstrate that our proposed method is similar to the traditional one, as this would undermine the significance of our work. Furthermore, we should not have misguided expectations about the experimental results. Instead, we should formulate hypotheses based on theoretical foundations and analyze the results accordingly.
2. We need to write well-structured code, which facilitates mostly ourselves ☺.
3. We must pay attention to any “parameter” in our code. Not only should we report them in detail in our paper, but they may influence our experimental results a lot.

4. If we can find code related to our work from the Internet, we should only use high-quality ones. The bad ones waste our time ☹.

## 1.6 Other aspects

1. A competent supervisor can make a world of difference. A responsible one will not only offer valuable insights, but also engage in in-depth discussions about our research projects. They patiently identify our issues, and meticulously teach us the ropes of conducting research and crafting a presentable academic paper. It's crucial to keep in mind that if the supervisor takes over the task of writing or revising the paper on our behalf, we'll miss out on a wealth of knowledge and skills that we should be acquiring during the process.
2. A positive mindset is helpful in all aspects of our life, including conducting research, which may be torturous from the beginning. During the last month, I made mistakes every day and my supervisor patiently identified them. Sometimes I felt a sense of disappointment. I talked with others, played games and listened to the music to keep positive.
3. Believe in ourselves. If I had known the difficulties of conducting the project my supervisor gave me from the beginning, I would no doubt reject it. However, after continuous trial-and-error and hard work, I made it.
4. Keep modifying our paper **all the time**. The current version of my paper greatly differs from the one in the beginning. Just on the night before the deadline of submitting papers, I found obvious and serious slips of the pen ☹.
5. If we conduct research in fields of machine learning and focus on the theories, "Mathematics" is vital. The mathematical knowledge needed in my paper is alien to me from the beginning. I have learned a lot all during the process, including matrix-to-matrix derivative, weak dependent sequences, Generalized Central Limit Theorem, singular value scaling and etc.
6. Focus on and love our work. View it as our own things and do not depend on others too much. If we are in the zone, we will find ourselves full of fighting spirit and forgetting about sleep and food ☺.