This document provides guidelines on research process and paper writing for the Deep Learning undergraduate course, School of Computer Science and Engineering, Sun Yat-sen University, 2025.

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Research process: what should you do in your project research?

- Understand the research problem, including collecting and observing relevant task data.
- Think about possible ideas by your own and discuss with team members.
- Search for related work, read and summarize, find their strengths and drawbacks/weakness, inspire more novel ideas for your project.
- Implement existing basic and state-of-the-art methods.
- With simplified experimental setup, check whether your idea works or not (in analogy to unit test).
- Observe initial results, analyze *negative* results (both quantitative and *qualitative*/visual results) and figure out all possible causes, refine your idea, go back to the previous step.
- Experiments on the project dataset, repeat result analysis and method refinement.
- Ablation study: check effect of each component in your model/method.
- Generalization study: experiments on more model architectures, on more datasets, etc.
- Hyperparameter effect: check method performance by varying hyperparameter values.
- Summarize what you have read, thought, implemented, and observed every day.
- Paper writing: (approximately in order) contribution list -> method -> experiments -> introduction -> related work -> abstract -> title.

Paper writing guideline

Note: percent numbers in brackets represent score information for your final report.

Why write a paper? To tell others that you have got something new, e.g., a new effective model or method to solve certain research problem, or a new application with a state-of-the-art method, etc.

How to write a paper? To tell others a story, in which you need to convince others that you are trying to solve an interesting problem, that you are an expert on the topic, that your method is really novel with justification/explanation, and that your method works more effectively and robustly than other methods, etc. Or like selling a product: figure out the selling point(s), then show the selling point is unique to your product, and show your product really functions better than existing ones. Hint: during paper writing, put yourself in other people's shoes, i.e., not as an author but as a reader or a reviewer.

What to write? Suppose the contribution is a novel method or model, then refer to the following guideline (but note it is just a guideline and you may have your own and better organization).

- **Title** (1%): 2-12 words; often including concise information about research problem & method.
- **Abstract** (5%): 150-300 words; miniature of the whole paper; often includes motivation and research problem (1%), method and its novelty (2%), experimental results to support your method (2%).
- **Introduction** (10%): half to one page; start from motivation to the research problem (and challenges of the problem) (2%); short summary of existing approaches and their issues (3%),

which then leads to your proposed method and its strength/advantages (3%); then very short summary of experimental results (2%); (may finally include organization of following sections).

- **Related work** (8%): half to one page; categorize related work into several types; introduce a few typical papers for each type, with one or two sentences about the idea and its uniqueness/advantages/weakness for each paper (6%); better to mention differences between each type of methods and your proposed method (particularly to emphasize the strength of your method) (2%); Related work could be merged into Introduction section when space is limited.
- **Method** (35%): very crucial section! Not only describe WHAT your model/method is, but more importantly explain WHY and/or HOW it works! There are many styles to organize this section; You may start from describing the intuitive idea behind your proposed method or model, explain intuitively how and why the idea could solve the research problem (~5%). Then describe your model or method formally, often with professional mathematical formulation and easy-to-understand figures (~5%). You may divide your model/method into several parts and introduce one by one, and you may describe the model architecture, followed by model training (elaborate loss functions here) (~15%); you have to explain/justify why your model/method would potentially works better than existing methods somewhere in the section (~10%).
- **Experiments** (35%): the purpose of this section is to experimentally support or prove your proposed method/model really works well or better. The following information is often necessary.
    - Experimental setup (~5%). This may include (1) the datasets (e.g., data number, image size, etc.) your used for evaluation, (2) preprocessing (e.g., image resize, normalization, etc.) of each data before fed to the model, (3) training protocols (optimizers, batch size, epochs, learning rate, coefficient values, etc.), (4) evaluation procedure and metrics (e.g., cross-validation, accuracy, recall, etc.), and other default settings (e.g., model backbones).
    - Effectiveness of your method (~10%): show and compare your method with a few state-of-the-art methods on one or more datasets, almost always with tables and/or figures. This subsection is to tell reviewers/readers that your method works better!
    - Generalizability of your method (~7%): show and compare your method with others on different model backbones (and even more tasks/datasets).
    - Robustness: if possible, show your method is not sensitive to hyperparameter values.
    - Ablation study: if your proposed model/method consists of a few components, then you need to show the effect of each component, e.g., by removing each component and show the decreased performance.
    - Visual demonstration and inspection (~5%): show visual results, particularly demonstrating what your method can but others cannot.
    - Not just describing each result: remember drawing a conclusion from each experiment.
- **Conclusion** (2%): it's not just a summary. You may summarize the purpose and the idea of your method, conclude that your method is better in some aspects with experimental resulting supported, and suggesting future study or applications based on your initial study.
- Supplementary material: if you have performed more experiments, but there is no enough space to include them, then you can put them in the supplementary section.

Tips for professional writing (9%):

- Paragraph organization: think about the relationship between paragraphs within each section, and the logic within each paragraph; use linking sentences between paragraphs and linking words between sentences.
- Mathematical representations: describe variables and functions professionally; x is a scalar variable (note: italic), $\mathbf{x}$ is a vector variable (note: bold, non-italic), $\mathbf{X}$ is a matrix or 3D tensor (note: capital, bold, non-italic); therefore, model parameters could be represented by $\boldsymbol{\theta}$, rather than by θ; output of a classifier can be represented by $\mathbf{y}$ but not by y because it is often a vector; also note that sometimes researchers often use $\mathbf{x}$ instead of $\mathbf{X}$ to represent images, although image is actually a 2D or 3D matrix, e.g., $D = \{\mathbf{x}_i, i = 1, \dots, N\}$ can be used to represent a set of training data, where $\mathbf{x}_i$ represents the i-th training image; you can use $\mathbf{y}_i$ and $\hat{\mathbf{y}}_i$ to respectively represent the ground-truth (i.e., expected) and the real output of a classifier, when the input is the i-th image $\mathbf{x}_i$; a loss function can be represented by $l(\boldsymbol{\theta})$ or $L(\boldsymbol{\theta}) = \cdots$, where $\boldsymbol{\theta}$ is the input variable of the function.
- Figure and table captions: put figure captions *under* figures, and table captions *above* tables; figure/table captions mainly describe the content of the figure/table. If there are multiple subfigures, you may also briefly describe what each subfigure is about in the figure caption; the caption may also contain the meaning of abbreviations in figures/tables.
- Figure content: include axes titles, and font sizes for number and words should be large enough; if multiple curves are within one figure, use different curve styles (e.g., dashed, solid,etc.) in different colors with different widths, and include figure legends somewhere in the figure.
- All equations, figures, tables should be mentioned in the main text. E.g., "Figure 1 demonstrates that ….", "As Table 1 shows , ….", "… the problem can be formulated as an optimization problem (Equation 3)" etc.
- Reference style: every conference or journal has its own style. Reference list is often ordered alphabetically based on family name of the first author. The general reference format is like: "author1_name, author2_name, …, and last_author_name. Paper title. *Conference or Journal Name*, volume number (issue number) for journal, start_page – end_page (for journal or conference proceeding; may not be included for very recent conference papers), year."
- Download tens of top conference/journal papers, check whether the above tricks have been adopted in the published papers, and summarize more tricks by yourself.

Paper writing is a two-level iterative process! In the inner loop, you write each section and need to iterate writing/rephrasing/revision at least 3 times; in the outer loop, you need to repeat whole-paper revision for at least 3 times. No revision, no submission!

Last but not least, NO plagiarism! You should NOT copy any single sentence from anywhere! Write by yourself, rephrase and reorganize them if certain information from papers is really relevant.