

The best method for presentation of research results in theses and papers

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This text describes how to write research papers or research Ms. or Ph.D. theses. Most of the instructions are also applicable for preparing transparencies (because of some differences, transparency preparation is explained in a separate document, written by Veljko Milutinovic, copied also on my web page in parallel to this document). If this method is not suitable for your article, chances are that you are not doing research but rather development, implementation or other type of work.

The main key to the successful presentation is to repeat your 'story' four times: in the title, abstract, introduction (or chapter 1) and in the text. That is, make readable and as complete as possible versions of your work using the order of 10, 100, 1000 and 10.000 words. Why? Because you have four different types of readers. Among those who will ever notice your work, I estimate that 80% will see only title, 15% will read the abstract, 4% will read also introduction, and the surviving 1% will read the whole paper. This is assuming you did your job properly, otherwise you will have 0% in the last group. If you do not believe this, just make your own statistics on things you read, and time you have (or time you want to spend) for reading other people's work.

Title

Choose a title that enables the expert to figure out the essence of the basic idea(s) and the main contribution(s).

Wrong title may bring you wrong referees or examiners, and may not attract busy colleagues to your work when seeing it on your web page or on a search engine that may not even catch your work (which decreases your visibility). If you are solving problem X using method Y, you have probably searched Internet for both X and Y. Others do the same, so let your work be observed easily.

Abstract

State clearly what problem has been studied and/or what is the goal of the thesis/paper. Give a brief statement on existing solutions and their drawbacks. List major contributions of the thesis. State briefly assumptions and limitations. The abstract should also include major idea(s), the type (e.g. performance, complexity) and result of analysis done.

The abstract is written for researchers that are familiar with the research area, and can grasp your contribution easily. Most of them have worked on the same or related problem. Clear abstract is the key to having your work properly credited in other people's work, since again colleagues may be too busy to figure it themselves, and are more likely to ignore it than to spend time doing the work you were supposed to do. Examiners will also have a friendly start with your text. Misleading abstracts are unfortunately quite common practice in the

research literature. Avoid excessive explanations that should be part of introduction. First answer above questions, then see whether you have space to say anything else.

This structure is also suitable for performance evaluation type of articles. In a performance evaluation article, the problem is to determine the best protocol under various conditions. Existing performance evaluations are existing solutions etc. Survey type of articles have different presentation style. A survey should describe all relevant solutions, classify them according to assumptions made and some properties (that is, present a taxonomy), and draw some conclusions.

Chapter 1 (Introduction)

The introduction of the paper, or Chapter 1 of the thesis, should give the summary of the article. It should contain separate sections on the following items:

- i) Introduction (basic facts needed to tune the reader to the thesis or paper);
- ii) Problem statement (precise definition and importance); avoid very technical definitions and statements (present them in later text) and instead give good intuition for your involved definitions or facts.
- iii) Existing solutions and their criticism (limit only to those directly relevant to the contribution of the thesis; give a motivation for doing research on the topic);
- iv) Contributions (proposed solutions; why they are expected to be better; essence of the idea(s) used in proposed solutions);
- v) Conditions, assumptions and limitations of the research done;
- vi) Analysis (theoretical, experimental, simulations, implementations,...) done in thesis; under what conditions and scenarios is your solution best?

In case iii, iv, vi, give only the highlights, with pointers to later sections and chapters that provide details. The introduction should attempt therefore to present full version of your article in readable and intuitively clear form. Many of your reviewers, and, with significant probability even examiners, will stop reading your article unless you fully convinced them in introduction (or Chapter 1) about your contribution. Life is demanding, and they have other tasks to do. Readers and especially followers of your research direction will appreciate such style and will prefer mentioning your work rather than the work of someone else who remained unclear in introduction and the article was never read due to the lack of time.

Literature review

Chapter or section 2 should give a full literature review. It should collect all known results relevant to the problem stated, whether or not they are used in proposed contributions. No additional literature review shall be added in later chapters. In later chapters, you may only refer to well known results (e.g. those covered in undergraduate computer science program such as Dijkstra's shortest path algorithm, sorting algorithms etc.). Discuss advantages and drawbacks of known solutions that are relevant to your problem, and also discuss the relevance of each reviewed item to your topic and your solutions.

It is very easy for a reviewer or even examiner to save his time by observing a missing important reference, and claiming that that reference may solve your problem in a better way. That may or may not be true, but you can lose even if your solution is better, since decisions made are in most cases final, and your publication or even defense can be prolonged with or without good reasons.

For every discussed reference, it is very important to relate them to your problem and contribution in one of several ways: it does not exactly solve the same problem, it solves the same problem but makes different assumptions about the system, it has some limitations that you do not have, it makes the same assumptions but does not work well under certain conditions and scenarios for which you have better solutions, or, if none of these is true, you are considering it as valid competitor, and will try to defeat it in your analytical or experimental comparisons. If you are not able to defeat it (under some assumptions and/or scenarios), I would advise you not to go public with your research and earn undesirable reputation.

The remaining chapters (sections)

The remaining chapters should present your contributions (including conditions, assumptions, and limitations, where appropriate), and their analysis. That is, very same items listed above shall be presented in full, preferably in the same order.

Many problems have complex formulation or are based on terms that a reader is supposed to be already familiar with. You need to make sure that the audience is as wide as possible, given the space you have to express yourself. If the problem formulation is somewhat complex, make sure you give an illustration about the problem. Draw a figure if appropriate, clearly state what is the input in that figure, what is the expected output in that case. If you use some terms specific to an area, try to enlarge audience by defining them. Few extra sentences might be needed by a reader (examiner) generally working in the area, but not particularly doing research on similar problems. Make sure your article is readable with ordinary efforts; otherwise it may not be read at all.

Your proposed solution may also need to be nicely illustrated. First give (or repeat, if already done in introductory parts) the intuitive solution. Then go into details of your solution, step by step. A figure is worth a thousands words. Is your solution always working? Can you prove it? How does it work? Is your analysis about worst case or average case? What kind of theoretical and analytical support can you give for your proposed scheme/solution?

One of the most frequent mistakes made by authors is to ignore the limitations, assumptions made (compared to assumptions made in other relevant papers), and scenarios for which their solution is clear winner. You shall not be overly optimistic about your solution(s) and make unfounded claims. Smaller but justified claim is better than large unfounded claim. Your referees may turn easily down your paper because of unsupported large claim, but can also easily accept your even minor contribution if it is well documented and proven. Include all the possible criticism of your own contribution directly in your article. It is much better that you criticize yourself than to leave such 'pleasure' to examiners and referees. Show that you are in full control of the problem and solutions.

The performance of your solution can be compared with existing solutions, if any exists under same or similar assumptions, analytically and/or by doing a simulation. In case of a simulation/experiments, make sure you give sufficient information to the reader so that

anyone wishing to repeat the experiments will be able to do so and obtain similar experimental results. Make sure you selected the best independent variables and measured the performance by key indicators. Select key diagrams or tables to present. Too many diagrams may show that you are lost yourself in your simulation rather than showing really important information. Many less important tables/diagrams can be replaced by few sentences giving the key derived information from the experiments. Give some explanation for the obtained results. The reader needs some assurance that your program did not have bugs. The best way is to explain why such kind of data are obtained.

Conclusion

What did you achieve with this research? What are the drawbacks of your solution(s)? What kind of future work can be done? Do you have some ideas that you intend to study further? The ownership of some other possible solutions, not fully explored, or subject of your forthcoming different article, can be protected by outlining them briefly in the conclusion section, sometimes with reference to upcoming article.

To conclude this advise, try to follow a +-+ pattern in introduction and main text. That is, start with positive enthusiastic comments about your work and contribution, then become realistic and list all the drawbacks and limitations, but then finish on a positive note, with a clear winner statement about the value of your contribution. It is important that the reader stops reading your article with positive impression. He might be writing his report afterwards.

Finally, it is very important to use proper English grammar and sentence structure. Ask for help if your English is not up to the required standard. You must be very careful with misprints. Do read your article carefully one more time, after some time delay, and check for possible misprints. The referees and examiners expect you to be very professional. They are not robots, they are human, and their opinion is partially subjective. Try to make positive value for the subjective part in overall evaluation by showing that you take care of your writing.

Any comments, criticism, and additions to this advice on writing articles are most welcome. Please send them to ivan@site.uottawa.ca.