Writing Skills for Mathematical Contest in Modeling

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Abstract

This paper presents some writing skills for the paper of Mathematical Contest in Modeling (MCM) and Interdisciplinary Contest in Modeling (ICM). It is not necessary to name the sections as what are presented in this paper, but the corresponding contents should be included in the submitted paper.

Index Terms

Mathematical Contest in Modeling, Interdisciplinary Contest in Modeling, Academic Writing Skill

I. Introduction

The Mathematical Contest in Modeling (MCM) is a contest where teams of undergraduates use mathematical modeling to present their solutions to real world problems. ICM, the Interdisciplinary Contest in Modeling, is a part of MCM. Since undergraduates who have never written academic papers usually have no idea about the difference between academic papers and literary compositions, we would like to give a brief introduction here to show the special points in writing MCM papers.

II. Anatomy of a Paper

An academic paper consists of "Title, Affiliation, Abstract, Introduction, Main Body, (Discussions,) Conclusions and Future Work,(Acknowledgements,) References". While usually a paper for MCM should include the following parts.

- Title
- Abstract and Key Words
- Introduction
- Notations and Assumptions
- The Model
- The Solutions
- Discussions
- Conclusions & Future Work
- References

A. Title

The title should be meaningful and brief, trying to hit the main point of your paper.

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B. Abstract

Despite the fact that an abstract is quite brief, it must do almost as much work as the multi-page paper that follows it. In an academic paper, this means that it should in most cases include the following sections. Each section is typically a single sentence, although there is room for creativity. In particular, the parts may be merged or spread among a set of sentences. Use the following as a checklist for your abstract:

- Motivation: Why do we care about the problem and the results? If the problem isn't obviously "interesting" it might be better to put motivation first; but if your work is incremental progress on a problem that is widely recognized as important, then it is probably better to put the problem statement first to indicate which piece of the larger problem you are breaking off to work on. This section should include the importance of your work, the difficulty of the area, and the impact it might have if successful.
- Problem statement: What problem are you trying to solve? What is the scope of your work (a generalized approach, or for a specific situation)? Be careful not to use too much jargon. In some cases it is appropriate to put the problem statement before the motivation, but usually this only works if most readers already understand why the problem is important.
- Approach: How did you go about solving or making progress on the problem? Did you use simulation, analytic models, prototype construction, or analysis of field data for an actual product? What was the extent of your work (did you look at one application program or a hundred programs in twenty different programming languages?) What important variables did you control, ignore, or measure?
- Results: What's the answer? Specifically, most good computer architecture papers conclude that something is so many percent faster, cheaper, smaller, or otherwise better than something else. Put the result there, in numbers. Avoid vague, hand-waving results such as "very", "small", or "significant." If you must be vague, you are only given license to do so when you can talk about orders-of-magnitude improvement. There is a tension here in that you should not provide numbers that can be easily misinterpreted, but on the other hand you don't have room for all the caveats.
- Conclusions: What are the implications of your answer? Is it going to change the world (unlikely), be a significant "win", be a nice hack, or simply serve as a road sign indicating that this path is a waste of time (all of the previous results are useful). Are your results general, potentially generalizable, or specific to a particular case?

C. Introduction

Usually an introduction of an academic paper should include the following contents:

- What is the problem and why is it interesting?
- Who are the main contributors?
- What did they do?
- With respect to the existing work, what novel thing will you reveal?
- The organization of the rest part of the paper.

Since you have only four days for the MCM, the following contents are essential.

- Describe the problem by your own words. Usually the problem is not familiar to you, so you must consult some materials on the Internet. You need to clearly explain how you interpreted the problem, and what you decided to work on. It's also a place to give a little more background on the problem.
- You should cite some existing work. Then, based on the existing work's deficiencies, present your destination and strongpoint of your models and results by several sentences.

- Present the hardness of the problem(or ideal mathematical model), and introduce your solving methods for the models briefly.
- Present the organization of the rest part of the paper.
- Note that anything you cited should be referred as a reference.

D. Notations and Assumptions

In this section, you should present the notations used in the following, and the assumptions you made in the models and solving methods. The assumptions should be as reasonable as possible.

E. The Model

Modeling is the first step to solve the problem. The modeling process can be as follows.

- Analyze the problem, and refine the mathematical essence of the problem.
- Present the mathematical models.
- Show the strongpoint of your models (by comparing with some existing models) if you can. The comparisons should based on the mathematical analysis, because here you have not solve the models yet.
- **Don't gloss over this section, even if the model is very simple. Actually, a simple model that leads to good results is especially nice!**
- This part should be present naturally, that is, your model should be "deduced", and not be "proposed".
- You can also present several models. But, if some of the models cannot be solved during the limited 4 days, they should not be presented here. They should be presented in the discussion section.

F. The Solutions

Here, we describe our methods of dealing with the data generated by the section of modeling. This is the section that actually describes how we solve the problem.

- Usually your model is solved approximately, which means that maybe your solution is not the precise solution of the proposed model. Try to identify the reason why you use the approximation algorithm.
- You would better employ more than one algorithm solving the model. Generally speaking, more precise an algorithm is, more computing time it cost. This should be identified in the discussion section.

G. Analysis and Discussions

- Show the data that you have obtained by tables and graphics. Analyze the data curve, and then you should draw some conclusions on the influences of different parameters in the models. Pay attention that your results must be reasonable!
- There could be some approximations in the modeling process and the solving procedure. Try to identify these points and discuss these shortcomings. Of course your approximate methods are also reasonable, and the reasonability should be indicated by the solvability of your models, the low complexity of your algorithm, and the precision of your solutions, etc.
- Compare the results with some existing results, and it will be excellent if your results are better than some published research results. This could be the most important strongpoint of your methods.
- **Note that you must come to some conclusions, and the strongpoint and weakpoint of your method must be indicated. These could be presented in an exclusive section to show them to the judges strikingly.**

H. Conclusions & Future Work

Try to draw some conclusions on what you have done. Maybe you have come to the conclusions in the "discussion" part, but don't hesitate to repeat them again. Here you must summarize all the conclusions briefly. Moreover, if you can find something to be done in the future, present it as the future work.

III. Summary

The summary is presented in the summary sheet. Each summary sheet should include:

- **Restatement and clarification of the problem**: State in your own words what you are going to do.
- **Assumptions and rationale/justification**: Emphasize the assumptions that bear on the problem. Clearly list all variables used in your model.
- **Your model design and justification** for type model used or developed.
- **Model testing and sensitivity analysis**, including error analysis, etc.
- **Strengths and weaknesses** of your model or approach.

Important notices:

- This is without a doubt the **most important part** of the paper. The difference between an honorable mention and a successful participant is that the judges never read more than the summary of an SP paper. The summary should be written **last**. Let me say that again: You should not write the summary until the rest of the paper is done. **In an ideal timetable, all of Monday should be set aside for writing the summary**.
- The summary must **briefly hit all the main points and ideas of your paper**. If you did anything creative, it must be here. Further you must put numerical results in the summary, such as "Our final algorithm performed 67.5% better than a simple greedy algorithm, and 123.3% better than a random choice".
- You must include all your main ideas in the summary, but **brevity is very important**. You would try to make the summary around half a page, definitely not more than 2/3.
- The summary (and ideally the whole paper) should be written **collaboratively**. One way to do this is to have each person individually sit down and spend an hour (at least) writing the best summary that they can. Then, come back together and read the summaries out loud to each other. After discussing them, set them aside and as a team write a new summary together up on a blackboard.

IV. Skills for Academic Papers

- Try your best to use standard symbols and notations, such as G for gravity, a for acceleration, etc.
- Use acronyms after their definitions. The following is an example.
  When you mention "finite element method" for the first time, you should state as "finite element method (FEM)". Then, you can use FEM instead of finite element method in the rest part of the paper.
- Try your best to change the sentence structure.

V. Conclusion

Writing academic paper is one of the most important parts of scientific researches, and the quality of your paper is based on daily accumulations. Practice time and time again, and you could be a good writer for academic papers.