Organizing an Experimental Paper

Organizing Papers

- In addition to adhering to obvious writing platitudes (be clear, be precise, be concise, use proper grammar, etc.) a good scientific paper always contains certain important pieces of information, properly organized.
- Conventions about what topics are included and how they are organized vary from area to area, but many are standard across subdisciplines.
- My expertise is writing experimental papers in artificial intelligence.
- I have found that providing an outline template to graduate students writing class project reports in my AI "depth" classes has been quite useful.

Outline

1) Introduction

2) Background

2) Problem Definition and Algorithm
   2.1) Task Definition
   2.2) Algorithm Definition

3) Experimental Evaluation
   3.1) Hypothesis and Experimental Method
   3.2) Results
   3.3) Discussion

4) Related Work

5) Future Work

6) Conclusions

Introduction

- Describe and motivate the problem you are addressing. What is the problem? Why is it important?

- Briefly describe your approach to the problem and how it compares to previous approaches. What is the primary advantage of your approach?

- Summarize the basic hypothesis and results of the paper. Algorithm A was found to run n% faster and produce results that were m% better than Algorithm B, the previous best approach to the problem.

Background
(optional)

- If your work builds on previous research or definitions unfamiliar to your audience, briefly review each relevant piece of background research and provide references.

- This allows the body of the paper to assume knowledge of this relevant background material.

- This section may also elaborate on the limitations of previous approaches and thereby set the stage for your own work.

Problem Definition & Algorithm

- **Task Definition**: Precisely define the problem to be addressed, clearly specifying the inputs and outputs of the task.
  - Provide a concrete example of an instance of the problem. A realistic example is preferable to an abstract one with meaningless tokens.
  - Elaborate on the significance of this problem and the current best results.

- **Algorithm Description:** Precisely describe the algorithm proposed for addressing the problem.
  - Describe the basic approach and how it is different from previous approaches to the problem.
  - Give the details of the procedure, providing pseudocode.
  - Trace through the algorithm solving a concrete example. The simplest, realistic problem that illustrates all of the important steps is best.

Experimental Evaluation

- **Method:** Describe the experimental hypothesis and method.
  - What criteria are used to evaluate the method?, e.g. quality or accuracy of the result, run time, etc.
  - What is the experimental hypothesis?, e.g. algorithm A is better than algorithm B.
  - How is performance data collected to evaluate this hypothesis?
  - What is the input data used and why is it realistic or representative?
  - What competing methods are also evaluated?
  - Average over a sufficient number of problems.

- **Results**: Describe the quantitative results of the experiment.
  - Graphical presentations such as graphs and histograms are preferable to tables of numbers.
  - Clearly explain the presentation of all data.
  - Summarize the primary differences illustrated by the data. Are these differences statistically significant?

Experimental Evaluation (cont)

- **Discussion:** Discuss and explain the results.
  - Does the data support your hypothesis?
  - What other conclusions does the data support about the strengths and weaknesses of your approach compared to competing ones.
  - Don't oversell, be realistic and let the data speak for itself.
  - How can the results be explained in terms of underlying properties of the algorithms or data used in the experiment?
  - Goal is to increase understanding of the problem, not just to win a contest.

Related Work

- For each piece of previous work that addresses the same or closely related problem, clearly answer the following questions:
  - What was their problem and method?
  - How does your problem and/or method differ?
  - Why is your problem and/or method better, and how do your experimental results support this conclusion?

- Don't be *overly* critical of prior work, acknowledge their contribution but be clear about how your approach overcomes some important shortcomings. Don't make unsubstantiated claims. Remember, these people will likely be reviewing your paper!

- Make sure you reference any potentially related work of any member of the program committee or editorial board and watch what you say about their work!

Future Work

- What are the major remaining limitations of your approach?
- Make some some suggestions about potential algorithm changes to address these limitations.
- Suggest additional experiments that would further illuminate issues revealed by your results.

Conclusions

- Briefly summarize the main results of the paper.
- What is the impact and significance of these results in relation to the motivation for studying the problem given in the introduction.
- How will your results affect future research and applications in the area?

Final Comments

- Currently, computer scientists are not well trained in experimental methodology. Observing reserachers in other experimental sciences can be useful.
- Of course, formally proving properties of algorithms is preferable *if possible*. Experimentation is for hypotheses which are intractable to prove or rely on conjectured properties of real-world data.
- Read influential papers in the area looking for commonalities in their content, organization, and presentation in order to determine a style that is appropriate for the particular research community.
- Have your paper proof-read by a knowledgable member of the particular research community who can predict the stylistic and methodological concerns of potential reviewers.
- Adapt to the audience, try to predict and address their particular background and concerns.
- Don't be overly discouraged by rejection, learn from the process and you may yet live to publish rather than perish.