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Some Research Paper Writing Recommendations

7-8 minutes

Last week, I received an email from Alex Orso and Sebastian Uchitel, who had been asked to give a talk on "How to get my papers accepted at top SE conferences" at the Latin American School on Software Engineering. Here's their question:

> We hope you can spare a few minutes to share with us the key recommendations you would give to PhD students that have not yet had successful submissions to top software engineering conferences, such as ICSE.

An interesting request, and ~~I certainly look forward to receive some of the advice my fellow researchers will be providing~~ you can see the advice of my fellow researchers in a presentation by Alex Orso.

When working with my students on papers, I must admit I sometimes repeat myself. Below are some of the things I hear myself say most often.

Explain the Innovation

The first thing to keep in mind is that *a research paper should explain the innovation*. This makes it quite different from a text book chapter, or from a hands-on tutorial. The purpose is not to explain a technique so that others can use it. Instead, the purpose of a research paper is *to explain what is new* about the proposed technique.

Identify the Contributions

Explaining novelty is driven by *contributions*. A contribution is anything the world did not know before this paper, but which we now do know thanks to this paper.

I tend to insist on an explicit *list of contributions*, which I usually put at the end of the paper.

> "The contributions of this paper are …"

Each contribution is an *outcome*, not the process of doing something.

Contributions are things, not effort. Thus, “we spent 6 months manually analyzing 500,000 commit messages” is *not* a contribution. This effort, though, hopefully has resulted in a useful contribution, which may be that “for projects claiming to do test-driven development, to our surprise we found that 75% of the code commits are not accompanied by a commit in the test code.”

Usually, when thinking about the structure of a paper, quite a bit of actual research has been done already. It is then important to reassess everything that has been done, in order to see what the real contributions of the research are. Contributions can include a new experimental design, a novel technique, a shared data set or open source tool, as well as new empirical evidence contradicting, confirming, or enriching existing theories.

Structure the Paper

With the contributions laid out, the structure of the paper appears naturally: *Each contribution corresponds to a section*.

This does not hold for the introductory and concluding sections, but it does hold for each of the core sections.

Furthermore, it is essential to *separate background material from own contributions*. Clearly, most papers will rely on existing theories or techniques. These must be explained. Since the goal of the paper is to explain the innovation, *all material that is not new should be clearly isolated*. In this way, it easiest for the reader (and the reviewer) to see what is new, and what is not new, about this paper.

As an example, take a typical structure of a research paper:

1. Introduction
2. Background: Cool existing work that you build upon.
3. Problem statement: The deficiency you spotted
4. Conceptual solution: A new way to deal with that problem!
5. Open source implementation: Available for everyone!
6. Experimental design for evaluation: Trickier than we thought!
7. Evaluation results: It wasn’t easy to demonstrate, but yes, we’ve good evidence that this may work!
8. Discussion: What can we do with these results? Promising ideas for future research or applications? And: a critical analysis of the threats to the validity of our results.
9. Related work
10. Concluding remarks.

In such a setup, sections 4-7 can each correspond to a contribution (and sometimes to more than one). The discussion section (8) is much more speculative, and usually does not contribute solid new knowledge.

Communicate the Contributions

Contributions not just help in structuring a paper.

They are also the key aspect program committees look at when deciding about acceptence of a paper.

When reviewers evaluate a paper, they try to identify, and interpret the contributions. Are these contributions really new? Are they important? Are they trivial? Did the authors provide sufficient evaluations for their claims? *The paper should help the reviewer, by being very explicit about the contributions and the claims to fame of these contributions*.

When program committee members discuss a paper, they do so in terms of contributions. Thus, contributions should not just be strong, they should also be *communicable*.

For smaller conferences, it is safe to assume that all reviewers are epxerts. For large conferences, such as ICSE, the program committee is broad. Some of reviewers will be genuine experts on the topic of the paper, and these reviewers should be truly excited about the results. Other reviewers, however, will be experts in completely different fields, and may have little understanding of the paper's topic. *When submitting to prestigious yet broad conferences, it is essential to make sure that any reviewer can understand and appreciate the contributions.*

The ultimate non-expert is the program chair. The chair has to make a decision on *every* paper. If the program chair cannot understand a paper's contributions, it is highly unlikely that the paper will get accepted.

Share Contributions Early

Getting a research paper, including its contributions, right, is hard. Especially since contributions have to be understandable by non-experts.

Therefore, it is crucial to offer help to others, volunteering to read preliminary drafts of papers, assessing the strength of theircontributions. In return, you'll have other people, possibly non-experts, assess the drafts you are producing, in this way helping each other to publish a paper at this prestigious conference.

But wait. Isn't helping others a bad idea for highly competitive conferences? Doesn't it reduce one's own chances?

No. Software engineering conferences, including ICSE and FSE, accept any paper that is good. Such conferences do *not* work with accpetance rates that are fixed in advance. Thus, helping each other may *increase the acceptance rate*, but will not negatively affect any author.

Does This Help?

I hope some of these guidelines will be useful to "PhD students that have not yet had successful submissions to top software engineering conferences, such as ICSE."

A lot more advice is available on the Internet on how to write a research paper. I do not have a list of useful resources available at the time of writing, but perhaps in the near future I will extend this post with useful additional pointers.

Luckily, this post is not a research paper. None of the ideas presented here is new. But they have worked for me, and I hope they'll work for you too.

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