Writing scientific papers

Michael Ernst, PhD
Catherine Howell, PhD

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Your background

Have you read a research paper?

10?

Have you written a technical paper?

What language was it in?

Was it peer-reviewed?

Was it published?

Did you read "Writing a technical paper"? (https://homes.cs.washington.edu/~mernst/advice/write-technical-paper.html)

The only way to get better is to practice!

Why do we write?

- For other people
- For ourselves

How should you balance research time and writing time?

This is a false distinction.

The goal of research is to increase understanding.

Writing increases your understanding.

Writing increases others' understanding.

Outline

Introduction

Structure of a scientific paper

Writing process

Critiquing your own writing

Activity: improve an abstract

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
4. Technical approach
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
9. Conclusion

Writing = expressing your argument

What is the purpose of each part?

Structure of a scientific paper

1. **Abstract**
2. Introduction
3. Example, motivation, background?
4. Technical approach
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
9. Conclusion

1. Abstract

Briefly describes the key idea and contributions

- How would you describe your work in 1 minute?

Resist the temptation to make it long

- If it's too long, people won't read it or will get lost
- Helps you clarify the purpose of the paper

A reader should be intrigued:

- Convinced it's an interesting problem
- Know the general solution approach and results
- Curious about the details

Write the abstract first

If you write the 10-page paper first,
the 1-paragraph abstract becomes easier to write.

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the 10-page paper becomes easier to write.

The abstract forces you to think about the point of your paper and its main claims.

Structure of a scientific paper

1. Abstract
2. **Introduction**
3. Example, motivation, background?
4. Technical approach
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6. Discussion?
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9. Conclusion

2. Introduction

Briefly describes the key idea and contributions

- ○ Just like the abstract does!
- ○ More details, especially motivation
  - ■ Tie the problem to real-world issues
- ○ You need to be able to describe the paper at multiple levels of detail

Include a concrete example

- ○ A running example is best

Include a figure (plus more throughout the paper)

Structure of a scientific paper

1. Abstract
2. Introduction
3. **Example, motivation, background?**
4. Technical approach
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
9. Conclusion

3. Example, motivation, background

Rarely needed.

The introduction usually subsumes these.

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
4. **Technical approach**
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
9. Conclusion

4. Technical details

Depends on your scientific area.

Should enable a Master's student to reproduce all your results without making any design choices.

Also make your artifacts publicly available.

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
4. Technical approach
5. **Evaluation**
6. Discussion?
7. Related work
8. Future work?
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5. Evaluation (e.g., experiments)

Explicitly state Research Questions

● Can feel a bit pedantic, but is invaluable in organizing your work

Write the methodology before you do any experiments

Intersperse methodology with results

Bad:
Methodology
● Research Question 1
● Research Question 2
Results
● Research Question 1
● Research Question 2

Good:
Research Question 1
● Methodology
● Results
Research Question 2
● Methodology
● Results

Structure of a scientific paper

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2. Introduction
3. Example, motivation, background?
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5. Evaluation
6. **Discussion?**
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9. Conclusion

6. Discussion

Generalizations

Limitations

Threats to validity

(Usually these go elsewhere.
The "Discussion" section is a last resort.)

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
4. Technical approach
5. Evaluation
6. Discussion?
7. **Related work**
8. Future work?
9. Conclusion

7. Related work

Write this before you do your evaluation

You might write it before or after you write your idea in detail

Relate the previous research to one another and to your work

● Avoid unconnected blurbs about each paper

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
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5. Evaluation
6. Discussion?
7. Related work
8. **Future work?**
9. Conclusion

8. Future work

Don't be boring or obvious

Only include this section if you can share insight

Structure of a scientific paper

1. Abstract
2. Introduction
3. Example, motivation, background?
4. Technical approach
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
9. **Conclusion**

9. Conclusion or *Contributions*

Don't omit it. Readers need closure

- Safe approach: mirror the abstract
- Another approach: say more (explain *why*) because the reader has more background

Contributions: The big picture

The purpose of a paper is to <u>change the way people think and act</u>

Relentlessly ask, "Why do I care?"

Your context is limited, and in 5 years no one will be using your tool

Enduring value comes from lessons that others can apply in their own context

Generalize your contributions

BAD:

- We built a system that does X
- We improved the performance of system Y by 50%
- We proved theorem Z

GOOD:

- We developed the new A methodology
- We discovered that the B methodology applies to domain C
- We developed a new optimization approach or proof technique that is applicable in situation D

Engineering (proof, system, experiment) is critical, but in support of the real contributions; don't frame engineering as the contribution.

Writing Process

1. Brainstorm & Organize
2. Draft
3. Revise
4. Edit
5. Publish

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Brainstorm and Organize

Purpose: state your contribution and argument

Interplay of writing and research

Brainstorming Strategies

Write a bullet-point outline

Use a graphic organizer

Use the structure of the paper

Write the abstract first

Brainstorming Tips

Write a lot -- you can re-organize later

Use hardcopy versions to write or read your writing

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Writing a Draft

Purpose: Write in paragraphs to flesh out the contribution and argument

Drafting Strategies

Just starting writing -- pick part of your outline and go

- one good choice: the easiest part to write -- get it done and move on, don't use it to delay real work
- another good choice: the part that is hardest to write because you are most confused about it

First drafts are not yet for public consumption

Drafting Tips

Focus on the clarity of your argument

If overwhelmed, focus on one section

If you're stuck, make a note and move on

Don't get hung up on grammar

- be clear, but you can fix small grammar points later

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Revising

Purpose: to check for clarity of your writing

Re-read to check the validity of your argument

You should revise & edit first, then get feedback from others

Revising Strategies

Outline what you've written

Place a size limit and cut down your writing

For each sentence/paragraph/section: is it contributing to your argument?

Is anything left out?

Use a rubric to evaluate your writing

General Rubric to Guide Revision

1. Is the purpose clear?
2. Is the argument clearly organized and presented?
3. Are the text and/or figures appropriate for the audience?
4. Are there English errors that detract from understanding?

Sample Rubric for an Abstract

1. Is there a clear statement of the problem?
2. Is there a clear statement of the research contribution?
3. Is there a clear statement of why the solution is interesting or useful?
4. Is the reader curious for more details?
5. Is there any unnecessary information?

Revising Tips

Let your writing sit before you re-read

Get feedback sequentially -- first you revise on your own, then ask others for comments

Respect your reviewers' comments and time

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Editing

Purpose: fix any problems with language

Focus specifically on:
- English fluency (transitions & argument)
- Grammar

Editing Strategies

Read it aloud and listen for what sounds wrong

Check for transition words and the language used to make your argument clear

Check for verb tense consistency

Make sure figures are consistent and helpful

Editing Tips

Let the paper sit for a day

See the tips in Strunk and White and on Mike's webpage

https://homes.cs.washington.edu/~mernst/advice/write-technical-paper.html

Writing Process

1. Brainstorm & Organize
2. Draft
3. Revise
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5. Publish

Publishing Tips

Follow the guidelines for submission

Don't submit a paper until it's ready

How to evaluate your own writing

We all have a blind spot with respect to our own writing

(We think that) we know what we mean already

We skim over poor explanations

Feedback from others

The best way to get a fresh, honest opinion

- costs time, uses up a resource, not always available
- be a good colleague:
  - don't always lean on others
  - the same skills let you give them good feedback

Goal:
correct, comprehensible, compelling

Use a rubric:

● Do you use jargon? in non-standard ways?
● Is the outline present in the paper?
● Are there any missing steps?
● For every claim, is it justified?

The outline should be present in the paper

The outline helped you understand the research and your argument

- No grammar/details to distract while writing
- No grammar/details to distract while reading

It can help the reader too

- Use (sub)sections, boldface, etc.
- Write a mini-outline at the beginning of (sub) sections

Getting a fresh perspective

Ask a friend

Change the context
Wait a day, print in hardcopy, move to a different location, take a break

Activity: Improving an Abstract

Small-group task:

1. Use the rubric to evaluate an abstract
2. Rewrite the abstract to improve it

Sample Rubric for an Abstract

1. Is there a clear statement of the problem?
2. Is there a clear statement of the research contribution?
3. Is there a clear statement of why the solution is interesting or useful?
4. Is the reader curious for more details?
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Homework for next class

Prepare (part of) a technical paper

● At least the abstract and introduction -- 1-2 pages

Email it to michael.ernst@imdea.org with subject line "Writing Scientific Papers", *before* the next class

Bring 5 hardcopies to class

We will discuss them in class