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?
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. If you write the 1-paragraph abstract first, 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
5. Evaluation
6. Discussion?
7. Related work
8. Future work?
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?
9. Conclusion
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

<table>
<thead>
<tr>
<th>Bad:</th>
<th>Good:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methodology</td>
<td>Methodology</td>
</tr>
<tr>
<td>- Research Question 1</td>
<td>- Results</td>
</tr>
<tr>
<td>- Research Question 2</td>
<td></td>
</tr>
<tr>
<td>Results</td>
<td>Research Question 2</td>
</tr>
<tr>
<td>- Research Question 1</td>
<td>- Methodology</td>
</tr>
<tr>
<td>- Research Question 2</td>
<td>- Results</td>
</tr>
</tbody>
</table>
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
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?
4. Technical approach
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 **change the way** people think and act

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
Writing Process

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

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

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

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

Writing Process

1. Brainstorm & Organize
2. Draft
3. Revise
4. Edit
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?
5. Is there any unnecessary information?
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