How to Write a Research Paper

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Why is communication important in research?

Facilitates knowledge sharing

Research papers
Presentations
Blogs

Documents steps along the way

Replicability
Project transfer
Onboarding

Challenges in Successful Communication

- Writing clearly
  - Does your writing effectively convey what you intended to communicate?
- Writing sensibly
  - Are you communicating information that it makes sense to share?
- Writing cleanly
  - Is your writing free of distractions?

Strategies for Getting Started

Approach #1: Summarize research

- Do all of your research first, and then write about it
- Pro:
  - Allows you to guide your narrative by your experimental findings
- Con:
  - Can result in slower research (e.g., experiments that turn out to be unnecessary!)
  - You might forget some details along the way

Approach #2: Write and research simultaneously

- Draft your outline before starting your experiments, and fill in details as you go
- Pro:
  - Provides you with a clear roadmap for your research
- Con:
  - Can result in more stressful research (e.g., experiments don't turn out as planned!)
  - You might not have a good idea of which experiments are needed until you start your research

Which strategy works best?

- Whichever works best for you!
- Might change depending on your project

Getting Down to the Details

- A “typical” CS research paper has several components
  - Introduction
  - Related work
  - Methods
  - Evaluation
  - Discussion
  - Conclusion
- These components may vary depending on your project
  - Separate “Data” section
  - Separate “Results” section
  - Discussion merged with conclusion

Introduction

- Sets the tone
- Provides the motivation for the research
- Typically contains the following:
  - Problem statement: Broadly speaking, what problem is this research solving?
  - Summary: Briefly, what is this paper about?
  - Rationale: Why is this necessary or useful?
  - Contributions: What are the key takeaway points that set this work apart from others?

Related Work

- Situates your work in the broader research context
- Explains what has been done so far, and what the limitations are
  - What makes your research unique?
- Organizational tips:
  - Group relevant work based on underlying commonalities
  - For each paper (or group of related papers), provide a high-level summary and explain how your own work differs
- Make sure to cite all relevant papers!
  - Other researchers working on your topic are likely to be your reviewers

Methods

- Describes what you did and how you did it
- Try to include any details necessary for replicating your work:
  - What your data looks like and how it was collected (if not including a separate “Data” section)
  - How you implemented your approach(es)
    - External libraries
    - Model parameters
  - Why you made your design decisions
- Depending on your methods, it may help to supplement your writing with figures, algorithms, equations, or proofs

Evaluation

- Explains how you assessed the quality of your work
- Describes any:
  - Baseline or alternative models or conditions
  - Training settings, if relevant
    - Training/validation/test splits
    - Hyperparameter tuning
  - Evaluation metrics
- Usually includes results
  - Objectively describe the results
  - Use measures that make it easy to interpret the findings (e.g., X outperforms Y by Z%)
  - Supplement written results with visual aids (e.g., charts or tables)

Discussion

- Analyzes your findings from a more qualitative perspective
- Answers one or more of the following questions:
  - What were some key themes across your findings?
  - What did your method get right?
  - What are some lingering areas for improvement?
  - Based on your findings, what recommendations would you make?
- Might include a more formal error analysis
  - What are some common error categories?
  - What percentage of instances belong to error category X?
  - What might have caused this category of errors?
  - How might it be addressed in the future?

Conclusions

- Summarizes your findings and key takeaway points
  - What do you want people to remember when they finish reading your paper?
- Reiterates contributions
- Provides links to your data or code, if available
- Optionally suggests some high-level future directions

Don’t neglect your references!

- Important to make sure your references are properly cited
  - Make sure all authors’ names are included
  - Make sure venue/journal names are accurate
  - Visually scan your reference section to make sure nothing looks “off”
- Check with your target venue to see how references should be formatted

How long should each section be?

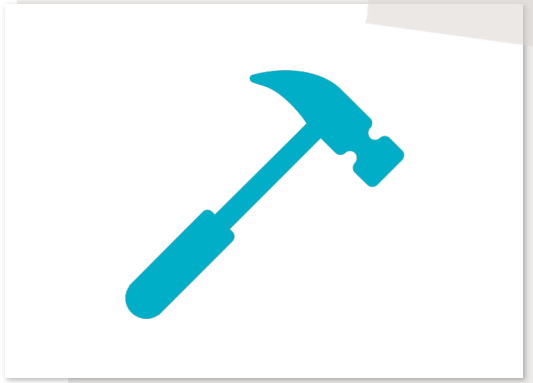
- Depends on your paper contents and any length constraints set by your target venue
- As a general rule:
  - Introduction: 10%
  - Related Work: 15%
  - Methods: 35%
  - Evaluation: 25%
  - Discussion: 10%
  - Conclusion: 5%

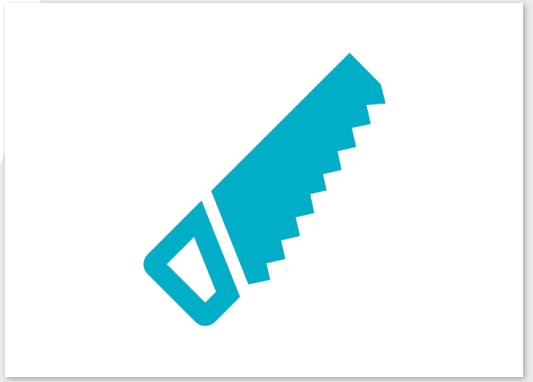
Activity

- Work with your partner to create an outline for your research paper, using the following shared document for guidance:
  - Group 1: Removed after workshop!
  - Group 2: Removed after workshop!
  - Group 3: Removed after workshop!
  - Template: https://docs.google.com/document/d/1IWe_6aLJvboxIqSypPtrijaCj5SQQYDEcYH4KthoZ9E/edit?usp=sharing
- We'll reconvene to discuss any questions or obstacles you came across!
- You can use your outline as a guide when writing your research paper

Tools of the Trade

- Common text processors:
  - Microsoft Word
  - LaTeX
- LaTeX is the norm in most CS research fields
  - Probably what your advisor will ask you to use in grad school!
- Check with your advisor to see what their preferred workflow is for writing/editing:
  - Full draft at once?
  - Smaller sections along the way?
  - In-text notes?
  - Tracked changes?
  - Comments?





LaTeX Basics

- Markup language that is compiled into a PDF
- Pros:
  - Produces professional-looking papers with minimal formatting intervention
  - Offers good support for typesetting equations
  - No need to worry about reference formatting!
- Cons:
  - Learning curve
  - Requires compiling to see what the final product looks like
- Popular platform for collaborative LaTeX editing: www.overleaf.com
- Check for venue-specific style files
  - ACM: https://www.acm.org/publications/proceedings-template
  - IEEE: https://www.ieee.org/conferences/publishing/templates.html
  - ACL: https://acl-org.github.io/ACLPUB/formatting.html
- Useful LaTeX documentation: https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes

Tips for Collaborative Writing

- Create a plan to distribute work among co-authors
  - Popular option: Assign co-authors to sections based on which aspects of the research they worked on
- Decide on authorship order
  - Convention varies depending on CS discipline
  - Common in AI:
    - First author: Project lead (often the student who “drove” the project)
    - Last author: Project supervisor (often the research advisor for the project lead)
    - Middle authors: Ordered from largest to smallest contribution
  - For papers with joint first authors, indicate so with a footnote

Tips for Collaborative Writing

- Discuss a timeline
  - How far in advance do you want to finish your first draft?
  - How much time will each author need for editing?
  - If your advisor will be part of the editing process, make sure that your timeline works for them!
- Decide on norms for writing/editing:
  - Will one author write or edit at a time before passing updates along to others?
  - Will all authors write or edit at the same time? (If so, how will potential conflicts be managed?)

How to Edit a Research Paper

- Start with easy edits:
  - Run a spelling or grammar checker
  - Classic writing resource: Elements of Style
- "Tighten" your writing:
  - Are there places where you're repeating yourself?
  - Are there simpler ways to describe things?
- Scan for writing "flow":
  - Are there any unnatural or abrupt transitions?
  - Does the order of information make sense?
- Don't be afraid to delete large sections or rewrite heavily!
  - A first draft is *not* a final draft (and usually is unrecognizable by the time you're finished editing!)

What about the title?

- Never underestimate the power of a good title!
- Catchy titles may encourage people to skim through your paper or attend your conference presentation
- Make sure your title isn’t misleading or misrepresentative of the paper’s contents
- Try to keep your title concise while still remaining descriptive

Practice makes perfect!

- Writing good research papers is an acquired skill---don't worry if you're not an expert yet!
- Editing your peers' papers can help you learn what to focus on and what to avoid
- Volunteering to review for conferences and workshops in your research area can help you learn what reviewers are looking for from the "other side"
  - If your research area usually only recruits reviewers with advanced degrees, ask your advisor if you can serve as a secondary or "shadow" reviewer on one or two of their upcoming review assignments