How to Write an Independent Work Paper

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slides and ideas thanks to Dave Walker, Zak Kincaid, David Dobkin, Kyle Jamieson, Robert Fish, Xiaoyan Li, …

Opening question…

What is the difference between your talk and your paper?

- Due dates: (Dec 8 vs Jan 8)
- Different goals
  - 9-minute talk
    - Generate interest
    - Leave the listener with **one cool idea**
      - One cool idea is more likely to be remembered than many
    - Make them want to hear more
  - 25-page paper
    - Comprehensive explanation
    - Fill in the details
    - But still engaging – the intro should make the reader want to check out the rest of the paper
- Different skills
  - Distilling the essence (the talk)
  - Filling in the details (the paper)
  - Enough background to appreciate (the talk)
  - Clear, complete, well-organized explanations and related work (the paper)
  - More visual skills (the talk)
  - More writing skills (the paper)

Before we dig into details…

- When to start writing?
  - NOW!
- How to view the writing-research process?
  - Iterative
  - Writing the motivation can generate ideas about evaluation (need to back up the motivation)
  - Describing intermediate results yields ideas about further data to collect
  - Advisor feedback can iteratively improve both the report and the research itself.

First piece of advice

- **Remember your reader.**
  - What is the value of this word / sentence / paragraph / section *for my reader?*
- Your reader: COS classmates.
- Put yourself in the place of the reader
  - What does my reader know so far?
  - Am I saying something my reader can't understand given what they know so far?
  - What do they need to know next?
  - Define jargon before use

Second Piece of Advice

- The first piece of advice (remember your reader/audience!) applies universally
- Some of the other pieces of advice in this talk apply less universally

Outline

- Abstract
- Introduction: Motivation and Goals
- Background and Related Work
- Approach
- Implementation
- Evaluation
- Conclusions and Future Work
- Bibliography
- Appendices

Abstract

- Key idea
- Succinct! (About 3-5 sentences)
  - Problem
  - Method
  - Implications/Major Findings/Achievements
- Not
  - Notation
  - Background

Abstract Example

"This paper details the design, development, and evaluation of a Kinect-powered application to facilitate the instruction of ballroom dance. The application uses the Kinect camera's skeletal tracking capabilities to teach and evaluate users through various ballroom dance positions and concepts, taking the form of a number of training modules that end with a game-like assessment portion. This application aims to fill a hole in ballroom dance instruction, providing the ease of access of self-study materials alongside the quality of instruction of live coaching."

"Using Kinect To Learn How To Ballroom Dance"
Michael Li, Fall 2015

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Introduction

- CGI model (via Derek Dreyer)

- **Context:**
  - Motivate the work – why do we care?
    - Concrete examples of real-world problems
    - Statistics on prevalence of problem helps

- **Gap:**
  - What is your problem? Define it clearly!
  - Why hasn't it been solved already?

- **Innovation**:
  - What have you done that is new?
  - How does it fill the gap?

Get to the Point!

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Background and Related Work

- Context for your work
  - What is known?
  - What is similar?
  - What is different about your project?
- May list several works at once
  - "Several others have proposed approximations [a,b,c]."
- Summarize closest, most important to your work

- You have space (pages)!

Related Work: *Before or After?*

- Pros of discussing related work at beginning
  - Give fuller context for your work
  - Answer the questions of knowledgeable readers

- Pros of discussing related work at end
  - Readers now know your work and can more easily understand the differences with existing work

You Can Do a Bit of Both:
(Set the stage at the beginning; Analyze in technical depth later)

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Approach

- Big picture driving details to follow
- What is big idea of your solution?
  - Design?
  - Experimental approach?
  - Theoretical approach?
  - New domain?
- What makes it different from previous?

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Implementation

- Can someone reproduce your work from your description of it?
  - Link to your code/dataset in GitHub
- Give details important to
  - achieving your goals
  - proving your claims
- Why as well as how

Implementation - *Advice*

- This is not a diary!
  - stream-of-consciousness writing does not highlight key ideas
- However, sometimes failed or discarded attempts worth mentioning
  - Do so when provides insight for the "why"
  - Example: "I chose clustering algorithm A among several tested because algorithm B turned out to be too slow, algorithm C didn't work in this case, …"

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Evaluation

- How successful is your project?
- What are the criteria for success?
  - Should state these earlier at a high level of abstraction
    - Can be part of Intro (ie: CGI – what is the *Gap*?)
    - Can be part of Approach (ie: what you are aiming for)
  - Can be more precise here
- Experiments to show success?
  - Performance evaluation
  - Quantified user studies
  - Comparison to other approaches
  - Measure significance of optimizations

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Conclusions and Future Work

- Can be one or two sections
- Summary of important contributions
- Discuss how you would go forward
- Discuss how others can go forward

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Bibliography

- All papers, software tools, videos, … that you mention in the text
- Other references you may have used but not cited in the text
  - e.g., background reading
- Relevant private communications
  - e.g., researcher sends you unpublished performance numbers that you use in text

    "Joe Smith, private communication, 2016"

Bibliographic Form

- Many acceptable forms
  - Different publishers, different forms
- Authors, paper title, publication title, publisher, date, pages. (online pointer)

[8] Jon Kleinberg. “Authoritative Sources in a Hyperlinked Environment.” In Proc. 9th ACM-SIAM Symposium on Discrete Algorithms, pp. 668—677. New York: ACM Press, 1998.

Citations in text

- Use number in brackets to refer to biblio. entry:

  "The HITS algorithm [8] also computes a link-based …"

- Using a bibliographic tool makes things easier

  – e.g. bibtex for latex

- Footnotes for asides – <u>sparingly</u>

  "… traverse index in reverse chronological order[2]…"

"[2]Although this is not an absolute requirement …"

Citations in Text - *Style*

- Do not use citations as a noun.
  - You will see lots of published authors do this. It is **bad style**.
- You have used a citation correctly when it can be removed from the sentence and it is still a sentence:
  - good: "The HITS algorithm [8] computes ..."
  - bad: "[8] defines the HITS algorithm to compute ..."

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Appendices

- Optional
- Do not expect reader to even skim them
- Uses
  - Data tables summarized in paper
  - Details of long proof
  - Details of algorithm/code
  - Details interesting to only those very involved
- A luxury of a thesis or “mini thesis”

Writing Advice – *High Level*

- Write for a general technical audience
  - e.g., all your COS classmates
  - Not for your advisor!
- Don't blur your contributions with those of others.
  - "We know that …" Your result? Someone else's?
- Get feedback on drafts
  - Classmates, advisor, …

Writing Advice - *Details*

- Eliminate redundancy
  - "What is the information content of this word or sentence?"
- Ask yourself: Did I say what I really meant or did I just use a cliché or "robotic" phrase that was easy to throw down on the page?
- Avoid unnecessary complexity and jargon
  - From George Orwell's essay on *Politics and the English language*
    - Never use a long word where a short one will do.
    - If it is possible to cut a word out, always cut it out.
    - Never use the passive where you can use the active.
- Define technical terms, jargon and notation clearly
  - Before using!
  - write out domain-specific abbreviations first time used, e.g., "The Domain Name System (DNS) is …."
- Proofread! Spell-check!

Writing Advice - *LaTeX*

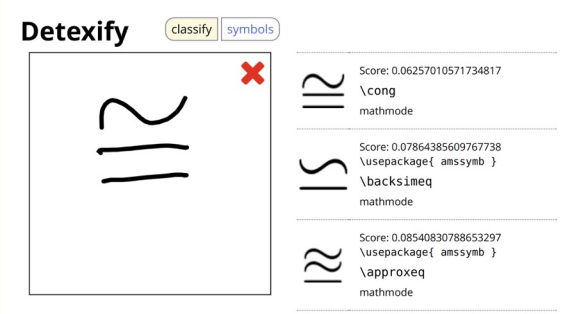
- Don't need to use it, but…

> Inspired by Sean Carroll's closely-related Alternative-Science Respectability Checklist, without further ado I now offer the *Ten Signs a Claimed Mathematical Breakthrough is Wrong*.
>
> **1. The authors don't use TeX.** This simple test (suggested by Dave Bacon) already catches at least 60% of wrong mathematical breakthroughs. David Deutsch and Lov Grover are among the only known false positives.

Scott Aaronson

Writing Advice - *LaTeX*

- Written by programmers for technical writing
  - Easy to include figures, equations, make citations, cross references...
- Tools to simplify writing in LaTeX:
  - overleaf.com (no need to install LaTeX)
  - detexify (hand-writing → LaTeX symbols)



- Try it, you'll like it!

Writing Advice - *Form*

- 12pt Times-Roman font
- 1-inch margins
- double-spaced
- Use the provided LaTeX template files
  - Single-semester:
    https://www.cs.princeton.edu/courses/archive/www-coursefiles/iw/IWreport.zip
  - Thesis:
    https://static.us.edusercontent.com/files/MR65koh4cnT1RK4PMbf3Ihj9
  - Example at https://www.overleaf.com/read/vwbpbhswvntr

FAQ: How many pages?

Averages for a small sample of A-level papers

Section	1 sem. proj.	thesis
Introduction	avg. 1.5	2-8, avg. 3.5
Related Work	avg. 4.5	avg. 7.5
Approach	1 – 8, avg. 3	1-8, avg. 3.5
Implementation	avg. 10	avg. 13.5
Evaluation	avg. 5.5	avg. 11.5
Conclusions	avg. 1.25	1-7, avg. 3.5

Writing Advice – *Graphics*

- Use figures to help clarity
  - Data interpretation
  - Design block diagram / architectures
  - interfaces
- Do not overuse figures
  - What does reader gain by seeing this figure?
- Figure sizes
  - Large enough to easily read
  - Don’t pad paper with unnecessarily large figures

Writing advice - *Procedure*

- Start with extended outline
- Don't try to write it all at once
- Write something, even a few lines, every day
  - The first sentence/paragraph/draft is the hardest so churn it out and then go back and revise
- Use headers and sub-headers
  - helps illuminate logical flow of paper
- "Don't fall in love with your prose. Writing and rewriting is what every author does to create papers that are both convincing and clear"

[Dr. Rob Fish]

Look at some examples

- IW papers:
  - https://drive.google.com/drive/folders/1ht-67QRUUNZzSRo6KPBL1ff1kEOh4VNN
- Senior theses:
  - https://dataspace.princeton.edu/handle/88435/dsp01mp48sc83w/simple-search?query=2022

Summary

- Follow outline but don’t be shackled by it
- Remember your reader
- Don’t lose the big picture for the details
- Allow time to develop the paper day by day
- See posted examples