Week 2A: Research 101

Research Writing

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Slides adapted from Matthew Hicks' “Research 101” lectures
Reminders

Sign up for paper presentations by **Tuesday, September 6th**

Signup sheet here: [https://docs.google.com/spreadsheets/d/1dtoXZnEM36yaQLSgo--qPeEuTzl5jsNyFSkKKePDgsk/edit?usp=sharing](https://docs.google.com/spreadsheets/d/1dtoXZnEM36yaQLSgo--qPeEuTzl5jsNyFSkKKePDgsk/edit?usp=sharing).

Audience: you are not required to read the paper.

- You *are* required to participate in the class discussion of the paper.

Presenters: your job is to *teach* us the paper.

- Contextualize, pros and cons, main contributions, summarizing, identifying key assumptions.
- Prepare a short slide deck (you are free get "inspired" from existing presentations).
- Deliver a 10 – 20 minute presentation (with a 10 minute audience discussion to follow).

Course Syllabus & Schedule: [https://www.cs.utah.edu/~snagy/courses/cs5963/](https://www.cs.utah.edu/~snagy/courses/cs5963/).

Questions? Contact me at snagy@cs.utah.edu.
Questions?
Writing
Why write papers?

If you don’t publically document your work, then it does not exist (beyond you)
Why write papers?

- Document and communicate **what you did**
- Convince others that **you actually did it**
- Convince others that what you did **actually matters**
- Because you won’t get a Ph.D. without it
Writing papers is a process

1. Idea
2. Write
3. Research
4. Edit
5. Submit
The Fieldstone Writing Method

- **Start putting words on paper** as early as possible
  - Writing near a deadline is really hard
  - Finalizing “the pitch” is an iterative process

- **Write as you go along**
  - It is **easier** to talk about a problem you are currently solving
  - It is **harder** to remember all problems you solved on short notice
  - It is **easier** to revise and remove than to create from scratch
Before you start: the tagline

- **What is your paper’s tagline?**

- At most **two sentences** (15 seconds in an elevator)

- Rest of paper must gracefully support the tagline

"There can only be ONE (paper tagline)"
Highlight **what you do** and **distinguishing properties**

- Objective is not to make you look smart (e.g., big words)

**Common distinguishing adjectives:**

- Automatic
- Low-overhead
- Dynamic
- Reconfigurable
- **Find a favorite thesaurus**

**Disambiguate the core message**
The Title Rule

Paper titles should be fun or catchy, and ultimately memorable.

"You Autocomplete Me: ..."

Who’s Calling? Characterizing Robocalls...

"Users Really Do Plug in USB Drives They Find"

"Fuzzing Hardware like Software"

"Who Left Open the Cookie Jar? A Evaluation of Third-Party Cookies"
The (other) Title Rule

Your paper title and system name should be Google-able.

"ParmeSAN : Sanitizer-guided Fuzzing..."  "Fuzzing@Home : Distributed Fuzzing..."

"ExcellInt : Finding Spreadsheet Errors..."  "Favocado : Fuzzing Binding Code..."
Paper Outline

Abstract
Introduction
Background?
Technique
Implementation
Evaluation
Discussion?
Related Work
Conclusion
The “Makes Sense” Rule

A research paper should make sense just from reading its introduction, conclusion, and the captions to all figures and tables.
Write papers to be skimmed from the outside in

Abstract
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Paper Outline

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Write papers to be skimmed from the outside in

Related Work goes here
Abstract

- **Write as if it’s a standalone document**
  - Very high level and concise description

- **First paragraph**
  - High-level problem and motivation
  - Bridge sentence: *what’s the gap?*

- **Second paragraph**
  - Description of insights and approach
  - Sum up your experiment and results
  - Use **formatting** to your **advantage**
Abstract

- **Shark Tank:** study the “art” of the pitch

- **Good pitches**
  - Concise, correct, and high-level
  - Idea hasn’t been done before
  - Something that matters to society
  - Proof is in the pudding (i.e., results)

- **Bad pitches**
  - Not concise, incorrect, or too technical
  - Limited impact or already been done
  - Outcomes bad or not measurable
Choose clarity over complexity

Once, David Goodstein, a colleague of the Nobel-Prize-winning theoretical physicist Richard Feynman, said "Rich, explain to me, so that I can understand it, why spin one-half particles obey Fermi-Dirac statistics?"

Feynman looked at Goodstein and said, "I'll prepare a freshman lecture on it."

The physicist went away to compose his lesson, but a few days later came back to his colleague, "I couldn't do it," Feynman said, "I couldn't reduce it to the freshman level. That means we don't really understand it."

Papers should tell a story

Telling a story in a technical paper is not like Shakespeare or writing Dante's Inferno, but like creating a character in a movie. The goal is logical connectedness. We have all been to movies where a character did something that didn't make sense or where we said, "I'd never do that." We have all experienced plot holes in movies. When writing a technical paper, our goal is to tell a story without plot holes. We NEVER want a reviewer to say, "Why did they do it that way? This doesn't make sense. This is unclear, what are the authors hiding?" This motto applies to writing the design section just as much as the evaluation section. It even applies to the intro where our goal is to convince reviewers that our problem is important, challenging, that our approach follows given previous work, and that our approach is effective.
The “Get to the Point” Rule

Don't write a mystery novel; give the reader the important information up front.
Walk the abstraction ladder

- **High level:** the abstract concepts, layman’s terms
  - Don’t include low-level details or terms here
  - Be succinct yet correct
  - Assume audience is **clueless**

- **Low level:** technical details, specialized terms
  - Assume audience is **knowledgeable**

- Work your description from the high-level to the low-level, then back up
Introduction

- Accept/reject decisions often made here

- 4–6 paragraphs
  - Motivation
  - Problem
  - What others have done and the gap
  - What you do
  - How you implement and evaluate
  - Results
  - List of contributions

- Don’t waste space with a paper outline
Introduction

- Don't spend too much space addressing the work of others
  - It detracts from the presentation of your work

- Address works reviewers will most likely relate to your work

- A string of references signals to readers that your work is a small boat in a sea of precious work

- A good intro generally takes 1–1.5 pages

- Only append a citation once for each context you use it in
The Heilmeier Catechism

- What are you trying to do? Articulate objectives using absolutely no jargon.
- How is it done today, and what are the limits of current practice?
- What is new in your approach and why do you think it will be successful?
- Who cares? If you are successful, what difference will it make?
- What are the risks?
- How much will it cost?
- How long will it take?
- What are the mid-term and final “exams” to check for success?
The Novelty Rule

Don't claim to be first—even if you are—because that pisses reviewers off and they can always find a paper that—from 10,000 feet away—looks similar to yours.

Let others make those claims.
Corollary to the Novelty Rule

Don’t tell readers what to think (e.g., our approach is simple, clever, novel, awesome, the best ever).

Let others make those claims.
## Be concrete and explicit

<table>
<thead>
<tr>
<th>NO!</th>
<th>YES!</th>
</tr>
</thead>
<tbody>
<tr>
<td>We describe the WizWoz system. It is really cool.</td>
<td>We give the syntax and semantics of a language that supports concurrent processes (Section 3). Its innovative features are...</td>
</tr>
<tr>
<td>We study its properties</td>
<td>We prove that the type system is sound, and that type checking is decidable (Section 4)</td>
</tr>
<tr>
<td>We have used WizWoz in practice</td>
<td>We have built a GUI toolkit in WizWoz, and used it to implement a text editor (Section 5). The result is half the length of the Java version.</td>
</tr>
</tbody>
</table>
Your technique is better explained in words.

The Algorithm Rule

Algorithm 1: The UnTracer algorithm integrated in AFL.

Input: $P$: the target program
Data: $b$: a basic block
$B$: a set of basic blocks
$i$: an AFL-generated test case
$\Phi$: the set of all coverage-increasing test cases

1. AFL_SETUP()
   // Instrument oracle and tracer binaries
2. $P_O \leftarrow \text{INSTORACLE}(P)$
3. $P_T \leftarrow \text{INSTTRACER}(P)$
   // Find and modify all of oracle’s blocks
4. $B = \emptyset$
5. $B \leftarrow \text{GETBASICBLOCKS}(P)$
Related Work

- Not a place to disparage previous work
- Not a place to show your breadth of knowledge

- **Tell a story**
  - How the problem has progressed throughout history
  - How ideas relate to and build off each other

- Keep it to a few lines per paper
- End sections with **how your work fits in**
Related Work

- Delay an in-depth literature review
  - Don’t try to learn everything at once
  - Read one paper per week during system building
  - Curate, organize, and annotate a bibliography

- What papers are reviewers likely to think of when they read yours?

- Refer to papers by how they are best known (not always by author)
  - Example: “SystemName shows...” instead of “Simpson et al. shows...”

- Sentences should be complete if you were to remove citations
Conclusion

- Reverse pyramid: **tell them what you did**
  - **Start:** specific evaluation results
  - **End:** area and societal meaning

- High-level implications of your results
  - Recommendations
  - New opportunities
  - Future directions
Grammar

- Avoid past tense; use **present tense**
  - “We implement” instead of “We implemented”

- Avoid passive voice; **use active voice**
  - “We analyze functions...” instead of “Functions are analyzed...”

- Avoid **contractions**
  - “do not” instead of “don’t”

- Avoid **wiggle words**
  - Would, could, should, maybe, possibly, can

- Avoid abstract; **be concrete**
  - “A 300 pound elephant” instead of “A large elephant”

- Do not tell the reader what to do; **tell what you did**
  - “First, you need to find the six least-connected components...”
Grammar Resources

Grammar Girl
Quick and Dirty Tips
FOR BETTER WRITING

BUGS in Writing
Lyn Dupre
A Guide to Debugging Your Prose

On Writing Well
William Zinsser
More Than One Million Copies Sold

UNIVERSITY WRITING CENTER
J. WILLARD MARRIOTT LIBRARY
SECOND FLOOR, RM 2701
295 S 1500 E
SALT LAKE CITY, UT 84112
(801) 587-9122

grammarly
Graphics

Chart Suggestions—A Thought-Starter

Comparision

What would you like to show?

Distribution

Composition

Stefan Nagy
The Graphics Rule

Make graphics in vector formats, not rasters.
Graphics Resources

- **Charts and graphs**
  - Python matplotlib
  - Seaborn for enhanced charts

- **System diagrams**
  - Draw.io
  - Powerpoint
  - Inkscape (advanced)

- **Image search engines**
  - Vecteezy
  - Google image search
  - Various clipart websites
Paper Editing

- Use version tracking

- Macros for inlined comments

- PDF diffing utilities (essential for revisions)
  - \texttt{latexexpand}: combined many .tex files into a single .tex file
  - \texttt{latexdiff}: markup differences between two .tex files
  - Build a PDF diff from the resulting .tex file
Perform an adversarial review

- Identify the hurdles to **believing** your paper
  - Remove hurdles through proof or citation
  - Sometimes a citation is stronger than a self-contained proof
  - **Goal:** minimize hurdles

- Where and how will a reader **get confused**?

- What will a competitor **disagree with**?

- Are all my claims supported by **reference** or through **experimentation**?
Maintain a paper template

- **Essential sections**
  - With notes on how to write those sections

- **Default set of packages**

- **Useful commands**
  - Macros (e.g., \toolName)
  - Inlined comment macros (great for collaboration)

- **Examples of common insets**
  - Figures
  - Tables
  - Code snippets
Miscellaneous Tips

- **Introduction:** goal, intuition, reasoning, and takeaways are critical to a story

- For each paragraph:
  - At this point in the paper, **what does the reader know?**
  - What **one point** does this paragraph need to make?

- **Evaluations:** include analysis with description
  - Do not reiterate what readers can see for themselves (e.g., 50% overhead)

- **Implementations are not ideas**
  - Ideas should be **general** (e.g., implementable on other systems)
  - Implementations are **narrow embodiments** of the general idea
Maintain a lexicon of cool words

- Decompose
- Expedition, Frontier
- Side-channel, Out-of-band
- Offline, Online
- Dynamic, Static
- Continuum
- Artifact
- Transient
- Intermittent
- Taxonomy, Orthogonal, Tradeoff space
- Forward error correction, Backward error correction
- Towards (in a title especially)
- Overcoming, Suggests, Asymmetry
The Final Rule

One must always leave something for reviewers to say.
Questions?