

CSC 595 - Research Skills

Communication #1: How to Write a Paper

Nishant Mehta

- **1. General Principles**
- 2. The Introduction
- 3. Related Work
- 4. Presenting Theoretical Results
- 5. Presenting Experimental Results
- 6. Conclusion (easiest thing to write!)
- 7. Structure of Papers in Different Areas

Motivation (FOR YOU TO WRITE!)

- Find the beautiful idea... what is it?
 - The idea that makes you passionate about this work
 - The reason you will love your paper
- Write passionately, fueled by this idea. Let your passion dance off the page
- Be energized to write from this passion
- Be the one who *wants* to write the paper (and not anyone else), because you want to tell the story in your own way

Your Motivation is *Not* Just for You

- The love you have for your paper will be evident to the reader
- That passion dancing off the page will be an invitation to the reader to join you
- If you have fun when you write, that fun will be picked up by the reader
 - Really helpful in review process: a happy reviewer is much more likely to give a high score

Keep the Reader Happy

- A happy reader will remember your work, may tell others about it
- A happy *reviewer* is more likely to argue for your work to be accepted!
- **A frustrated reviewer is likely to turn into an adversarial reviewer**

Tell a Story

- What is the story of the paper?
 - Huh? Story? Think: If you had 2 minutes to talk to a researcher friend, how would you explain your work in a way that excites them
- Example:
 - It is known how to get algorithms that satisfy frequently interacting users
 - But we noticed that *which* users frequently interact can depend on the algorithm
 - We discovered something bad: for popular algorithms, frequently interacting users belong to a narrow demographic
 - So, we wondered, what if the algorithm also optimized for having a diverse base of frequently interacting users?

Tell a Story

- What is the story of the paper?
- Huh? Story? Think: If you had 2 minutes to talk to a researcher friend, how would you explain your work in a way that excites them
- Example:
 - Few children are able to immerse themselves into coding
 - We observed that most children like playing with Legos
 - So, we thought, what if coding could be more like Legos?
 - What if a child could connect physical blocks in different ways to make code?
 - We designed a visual “code block” programming language, and many kids like it!

Tell a Story

- Use the story to help frame your Introduction
- What makes a good story?
 - Minimal background to get the reader started (Context)

This guy Bob is on his way home to New York (via London).
He sat next to a US police officer on his flight to London.

Large language models (LLMs) are now widely used.

- Introduce a conflict/struggle/challenge (Motivation)

Bob said the wrong thing to the officer.
The officer now knows Bob committed a crime.

Unfortunately, LLM training consumes massive amounts of energy. Resource struggle will lead to nuclear war.

- Introduce a solution (Contribution)

Bob decides to skip his last leg and stay in London.

In this work, we show how to massively reduce training time via a new compression approach.

- Happily ever after (Why Contribution is Amazing)

Bob now lives a happy life in London.

The new approach works as well as standard LLMs and also saves the Earth from total destruction.

Tell a Story

- How about telling the story of your paper as it happened? That is, the true chronology
- Not a good idea! Why?
 - Page limit
 - True story is messy. People (and especially over-worked reviewers) need simplicity
 - With the benefit of hindsight, you can find a simpler story
- But I want to tell the true story :-(
 - Do it at the bar : -). In-person chats. Try doing it in a talk!

Captivate the Audience

- Introduce intrigue, a mystery (audience listens on to see how it may be resolved)
 - Works well literature. But in a paper? It can work, but be careful. Paper $\neq$ mystery novel!
- Question approach:
 - Put several questions in the Introduction.
 - A little after each question (still within Introduction), give answer to the question.
 - Bonus: entire paper can be framed as answering questions
(3 major questions could translate to 3 major contribution sections)
- Puzzle approach (recall: normal science as puzzle solving):
 - Discuss a recent phenomenon
 - A little later, mention that you shed light on what is going on

Captivate the Audience

- Whenever possible, use **active voice** over **passive voice**. Compare:
 - “the road was run on by Alice” vs “Alice ran down the road”
- Form connections: how do your results/findings connection to other problems or phenomena in the literature?
- Mention open questions. Why?
 - Indicates that this work becomes part of a *line* of work. It’s alive. It’s non-terminal.
 - Implicitly invites the reader to join the party. They feel a bit more connected to the work

Captivate the Audience

- Write in a way that excites the reader
- Bad example: “We show that information compression is equivalent to learning.” 🤔
- Good example: “We show — for the first time — that information compression is equivalent to learning, resolving a longstanding conjecture due to Famous Person (1975).”

Flow

- What is good flow?
- Structural aspect of flow:
 - each sentence flows into the next to form paragraphs
 - each paragraph ends with a sentence that links to the start of the next paragraph
 - each section ends with a thought that sets up the opening for the next section
 - “It is natural to wonder whether our results are optimal. In the next section, we answer this question in the affirmative by showing matching lower bounds.”

Flow

- What is good flow?
- Story aspect of flow:
 - The writing sticks to the story. It doesn't interrupt itself, even with seemingly smooth interruptions. Compare:

“Alice woke up late that morning. She was wearing blue pajamas with three circular buttons. A single thread barely grasped the bottom button. The carpet had a rich golden hue. She raced over the carpet, out of the room, to catch the school bus.”

VS

“Alice woke up late that morning. She raced out of the room to catch the school bus.”

Flow

- Why does flow matter?
- Good flow allows the reader to immerse themselves in your paper
- Reading becomes a pleasant, seamless process
 - Better to have a happy reviewer than frustrated one!

Flow Disruptors

- Even with great flow in terms of structure and story, flow can easily be disrupted
- How can flow be disrupted? Things that cause the reader to context-switch.
- Key villains:
 - Spelling mistakes
 - Grammar mistakes (very bad! reader has to re-read sentence to figure out intended meaning)
 - Using citations as nouns: Compare “A major result of [17] is that...” versus “A major result of Kano et al. (2010) is that...”

Flow Disruptors

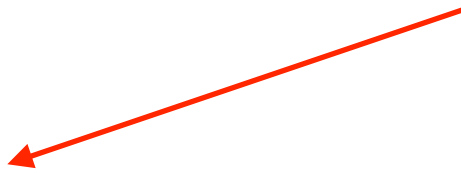
- Even with great flow in terms of structure and story, flow can easily be disrupted
- How can flow be disrupted? Things that cause the reader to context-switch.
- Key villains:
 - Long proofs in the main text
 - Give proof sketches instead
 - Mathematical equations that aren't part of any sentence
 - *All* equations (unless appearing in a table) should be part of a sentence, with proper grammar.

It holds that

$$E = mc^2,$$

where c is the speed of light.

Note the use of a comma for grammatical correctness



Flow Disruptors

- Even with great flow in terms of structure and story, flow can easily be disrupted
- How can flow be disrupted? Things that cause the reader to context-switch.
- Key villains:
 - Inconsistent style of writing.
 - Often happens in Frankenstein's monster papers - each section (or worse, each paragraph) written by a different author. Avoid this!!

Flow Disruptors

- Even with great flow in terms of structure and story, flow can easily be disrupted
- How can flow be disrupted? Things that cause the reader to context-switch.
- Key villains:
 - Using undefined terminology or variable names
 - Reader wonders: “Did I miss something? Am I supposed to know what this means?”
 - You know what all the key terms and variables mean, but the reader is not inside your head!
 - Avoiding this issue requires developing an important skill: simulating the mind of the reader. Think: “at this point of the paper, what does the *reader* know?”

Flow Disruptors - Example

- Bad example: “We show that it is possible for a scheduling algorithm to be both fair and efficient.”
- Issues: has fairness been formalized? has a notion of efficiency been put forth? If not, both terms are vague
- Good example: “In this work, we consider an algorithm to be fair if it satisfies the maximin criterion from Rawls (1971). Our notion of efficiency is the number of samples used. Contrary to popular belief, we demonstrate that it is possible for a scheduling algorithm to be both fair and efficient.”

Design a Skeleton (Outline)

- Decide on (rough) section titles
- Have a plan for their order (can change later)
- For Introduction, decide on main purpose for each paragraph
 - For first three paragraphs, you might even decide a main purpose for each sentence.
That's how important each sentence of the early part of the Intro is!
- For later sections, decide on main subsections
 - When writing a section, decide on main purpose of each paragraph

Signposting (Tell the Reader Where You Are Going)

- At the end of the Intro, tell the reader what the other sections are
 - When you start out, it's better to rigidly stick with this
 - As you grow, you can start deviating (e.g., integrating this roadmap with your list of contributions)
- At the start of each section, tell the reader what you are going to do (the point of the section)
- Use descriptive subsection headers and paragraph headers to help the reader

- 1. General Advice
- **2. The Introduction**
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First Three Paragraph of the Introduction

- Goal: If possible, tell reader what paper is about (what you do) on first page
 - If you can't, then at least do this within first three paragraphs
- What blocks you from telling reader what you do on first page?
 - Might need to give **minimal** context - could cost a paragraph
 - Need to **quickly** mention problem + motivation (if new), or problem + why past work wasn't good enough
- Be creative: might write 10 versions of first three paragraphs.
 - Plan to throw many versions of it
- First three paragraphs should be a work of art

Structure of the Introduction (Longer Version)

Context paragraph (make it exciting)

Challenge paragraph (make it exciting)

“Your solution” paragraph (make it exciting)

2–3 paragraphs on ideas about any of:

- Your solution (techniques/methods)

- More detail about problem/challenges

- More context (can connect more to prior work)

Contributions paragraph (can be itemized list)

Outline of paper

Structure of the Introduction (Shorter Version)

Context paragraph (make it exciting)

Challenge paragraph (make it exciting)

“Your solution” paragraph (make it exciting)

Just one more paragraph covering any of:

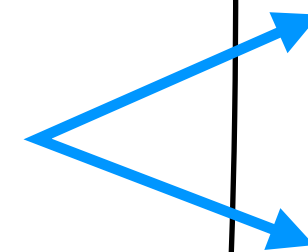
Ideas about your solution (techniques/methods)

Problem variations you consider

Contributions paragraph (can be itemized list)

Outline of paper

can be merged



Signposting - Introduction and Beyond

- At end of Introduction, tell reader what the other sections are
 - When inexperienced, better to rigidly stick to this
 - As you grow, try deviating (e.g., integrate roadmap with list of contributions)
- At the start of each section, tell the reader what you are going to do (the point of the section)
- Use descriptive subsection headers and paragraph headers to help the reader

Tables in Introduction

- Tables can efficiently organize much past work + your contributions
 - For theoretical results, opportunity to signpost
- Also useful to include past results in the table
- A common style: checkboxes for different attributes

Figures in Introduction

- Beautiful, well-thought-out figure can efficiently convey new ideas
- Can make reading process more pleasant

When to Write Introduction?

- **Early Strategy:** First thing you write in the paper. Why is it good?
 - Clarify your thinking - “Muddled writing reflects muddled thinking”
 - Make clear to yourself what key contributions are
 - Figure out the story
 - Know if you have enough to submit!
- **Late Strategy:** Last thing you write in the paper. Why is it good?
 - Story and all results are clear to you know, so easier to write
- Which strategy to use?
 - Suggestion: Do both. Make the story clear early on, and improve the Introduction (possibly a full rewrite) at the end.

Presenting Results in Introduction

- Proudly state your results so the reader cares about achievements
- BUT don't overstate results - reader will lose trust in you
 - Be as specific as what is expected: don't hide stuff in big-O unless you explicitly tell the reader you are doing so (can lead to overstating of results)
- Accurately state *other people's results*!
 - Easy way to get bad reputation: claim past results are worse than they really are

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Related Work

- Just like the rest of your paper, Related Work should follow the story of your paper
 - What does that mean? Discuss related works, while *contrasting* with your own work
 - Ironically, discuss “related” works in a way that makes them seem *unrelated* (not too similar) to your own work

Related Work - Where to Place?

- Common choices:
 - **Section 2 (right after Introduction):** Allows to build background sooner, but delays the reader in seeing your contributions
 - **Section N-1 (penultimate section):** Reader sees your core content sooner, but has less context. Adversarial reviewer might be thinking of “highly related work” (which, as you explain *much* later, is not that related) while reading your core content. This is bad.
- So, where to place Related Work section? Try both placements. Also, no need to rigidly have a Related Work section. For some papers (especially when there is less related work to discuss), it can be integrated into the Introduction.

Related Work - Caution

- Take care when discussing others' works
- If you must say something negative about a prior work, use guarded language. Why?
 - To be nice
 - To protect yourself (you don't know who is reviewing your paper)
- Even if you must say something negative, try to also say something positive (but don't force it)

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Presenting Theoretical Results

- Give the reader the high level idea of where you are going before launching into details
- If a theorem is very complicated:
 - Consider putting informal version of theorem in Introduction (makes it easier to discuss result in Introduction)

Presenting Theoretical Results

- Clearly state all assumptions
- For any theorem/lemma/etc., ensure that setting/assumptions for the result are clear
- Different styles of introducing notation: Introduce most notation in “Preliminaries” subsection
OR Introduce notation on demand
 - What style to use? Usually some of both

Mathematical Pitfalls

- Presenting highly technical results without interpretation. Help the reader! Even hardcore math people really appreciate simplicity.
- Using very advanced techniques (not known to most people in your sub-area) without much introduction.
- Help the reader. Reviewers really appreciate learning. Happy reviewers are more likely to argue for your paper to be accepted

Mathematical Pitfalls

- Presenting nontrivial mathematical results without providing proofs
(at a minimum, put proofs in the appendix)
- Skipping nontrivial steps in proofs
 - Only noticed by avid readers who excitedly look at proof
 - This reader is your friend, until they get annoyed and become your enemy!

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Experiments

- As important as experiments are, reader is often tired by this point of the paper
- So, expect reader to skim. Make writing convenient for skimming. How?
 - Give quick descriptions of experimental protocols
 - Use subsection (or subsubsection) headers to separate out different types of experiments/experimental questions
 - Make subsection headers the same as the message that comes out from your experiments (caution: this requires a lot of confidence in the message)

Experiments

- Each experiment should be designed to address a question (part of the story of the paper)
 - So, a plot resulting from an experiment should have one key message
 - This message can be summarized in the caption
 - Example:
 - “We hypothesized that increasing the fuzziness of the koala stuffed animal would decrease the stress level of the user. To test this, we created a sequence of koala stuffed animals of increasing fuzziness and recorded user stress levels. The results, shown in Figure X, indicate that stress level decreases up until fuzziness 0.7 and then essentially flatlines thereafter. Interestingly, one user spontaneously combusted when interacting with fuzziness 1.0. Fortunately, the koala was unharmed.”

Experiments Section Pitfalls

- Literal description of experimental results, without interpretation
- Experimental protocol not discussed anywhere. At a minimum, give high-level in main text, and have full details (enough to allow for reproducibility) in the appendix.
- Experimental protocol presented, but unclear what questions experiments are meant to address.

Experiments Section Pitfalls

- A really, really, really bad pitfall (bad scientists do it intentionally):
 - Vital details (related to scientific integrity) missing
 - “We selected the parameter configuration that gave the best results for our method. We then compared our method’s performance to prior work”
 - How were parameters configured for those methods? Was it the same way? If so, is that a fair comparison? If not, what did you do differently?

Figure Pitfalls - Semantics

- Orphans: Figures that are never referenced in the main text (give every orphan a home!)
 - Note: these figures could occur in *any* section (not just Experiments section)
- Vital details given in captions but left out of main text
- Missing legend
- Missing error bars
- Axes not labeled

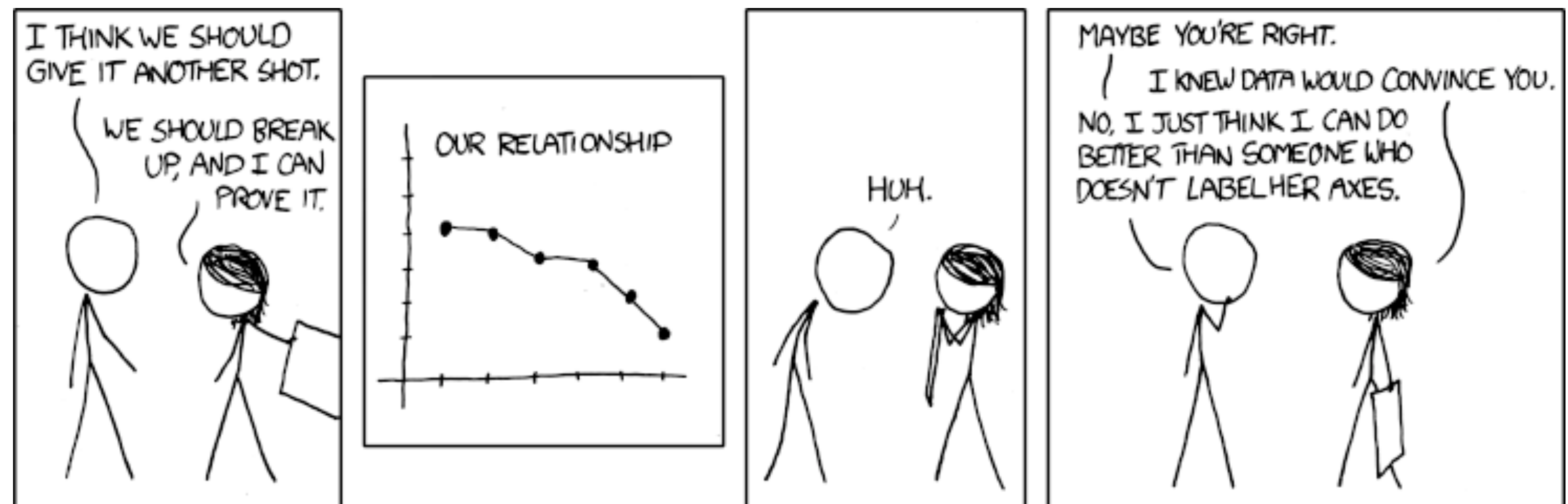


Figure Pitfalls - Style

- Use of bar plot when scatter plot makes more sense, and vice versa
- Labels are too small (paper unreadable if printed out!)
- JPEG or PNG instead of vector graphics
 - Gets uglier the more the reader zooms in
 - Also, limited reuse if someone wants to use your figure in a talk
- Ugly color scheme or user-unfriendly color scheme
 - red-green color blindness occurs in over 5% of males and about 0.5% of females

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General Structure of Different Kinds of Papers

- General structure of a CHI paper:
 - Introduction
 - Background/Related Work
 - Expert Interviews or Survey (User study) to identify main challenges (Optional; if no intense study is needed, this can happen even in the Introduction)
 - System Design
 - Technical (or custom artistic) evaluation
 - Evaluation via user study
 - Discussion/Limitations and Future Work

General Structure of Different Kinds of Papers

- General structure of a Machine Learning:
 - Introduction
 - Background/Related Work
 - Problem Setup
 - New Technical Idea
 - Algorithm
 - Technical Results
 - Experiments (sometimes optional)
 - Discussion

General Structure of Different Kinds of Papers

- General structure of a Graphics paper:

- Introduction
- Related work
- Method
- Experimental results
- Conclusion

(see [guide](#))

Detailed Writing Tips

- Next up:
 - Simplicity
 - How to be economical with space
 - Phrases to avoid
 - Common word choice mistakes
 - Frequent grammar mistakes

Keep It Simple

1. Never use a metaphor, simile, or other figure of speech which you are used to seeing in print.
2. Never use a long word where a short one will do.
3. If it is possible to cut a word out, always cut it out.
4. Never use the passive where you can use the active.
5. Never use a foreign phrase, a scientific word, or a jargon word if you can think of an everyday English equivalent.
6. Break any of these rules sooner than saying anything outright barbarous.

From George Orwell's Politics and the English Language

[original](#)

[quick read](#)

Be Economical With Space

- In order to → To
- whether or not → whether
- the question as to whether → whether
- all of our ideas → all our ideas
- This is an algorithm that → This algorithm
- It appears to be the case that → It appears that
- It is indeed the case that → Indeed,
- We now give a description of → We now describe
- Basically, →
- It is important to note that →

Frequent Grammar Mistakes

- Beginning a sentence with “However, ”
 - Not grammatically correct. Easy fix: change preceding period to semi-colon as in “Dogs bark. However, not all are loud.” → “Dogs bark; however, not all are loud.”
- Beginning a sentence with “But”
 - Not grammatically correct
- Beginning a sentence with “Where”
 - Only correct if the sentence is a question. Otherwise, grammatically incorrect

Which vs That

- “Which” clauses are optional:
 - “Our algorithm, which is the first of its kind, solves the problem.”
(which clause can be removed without affecting grammar)
- “That” clauses are necessary
 - “Our algorithm that addresses the Byzantine agreement problem is efficient.”
 - If multiple algorithms are discussed in a paper, the “that” clause is essential to identify a specific algorithm

Things To Avoid

- Using “this” as a noun
 - Problem: often unclear what “this” refers to
 - Solution: only use “this” as a modifier

“The use of LEDs in our piano interface decreased user fatigue while also increasing flashiness. This led to quicker learning of musical pieces.” (unclear what “this” refers to)

→

“The use of LEDs in our piano interface decreased user fatigue while also increasing flashiness. This increase led to quicker learning of musical pieces.”
- Using “it” when the referent is not clear
 - Example: “Algorithm A then calls Algorithm B. It runs efficiently.”
 - Problem: What is “It”? Algorithm A or Algorithm B?

Things To Avoid

- Lack of clarity due to passive voice
 - Example: “In this game, first, an action is played.”
 - Problem: Which agent played the action? Unclear!
 - Fix: “In this game, first, the Adversary plays its action.”

Phrases to Avoid

- Avoid buzzwords and trite (= overused) expressions:
 - big data
 - synergy
 - Nowadays
 - In a nutshell
 - Utilize (write “Use” instead)

Common word choice mistakes

- Farther vs Further
 - Use “Farther” for distance and “Further” for everything else
- Loose vs Lose ([empirical evidence of misuse](#))
- Affect vs Effect
- So-called
 - Be careful. One common definition of this word has a negative connotation: “used to show that you think a word that is used to describe someone or something is not suitable or not correct:”
 - I prefer to avoid using this word. There usually is a different word choice that works just as well. Basic trick: “we use the so-called Bellman equation” → “we use the *Bellman equation*”

Closing

- Some heuristics:
 - Look at the structure (and writing!) of recent papers in your field that got best paper awards
 - Write an Introduction section early, and have your advisor look at it
 - Always be prepared to rewrite. The Intro was written by a previous version of yourself (not you). Detach from your ego

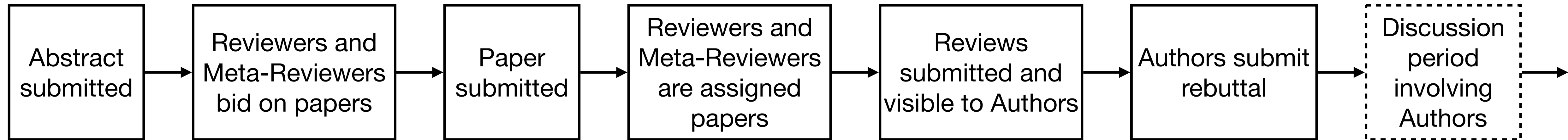
What Happens After You Submit a Paper

- You decompress by hiking with friends
- No... what happens to that paper you submitted?

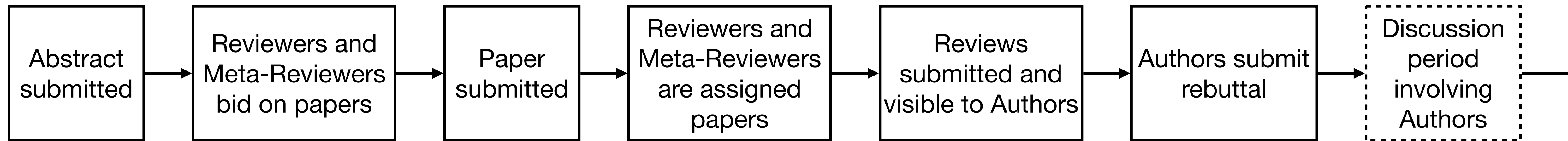
First Things First: Program Committee Structure

- CHI
 - Subcommittee Chair, Area Chair, Paper Chair, Reviewer
- ICSE
 - Area Chair, PC member (Reviewer)
- SIGGRAPH
 - Area Chair, Reviewer
- NeurIPS/ICML/ICLR
 - Senior Area Chair, Area Chair, Reviewer

Example of a Review Process



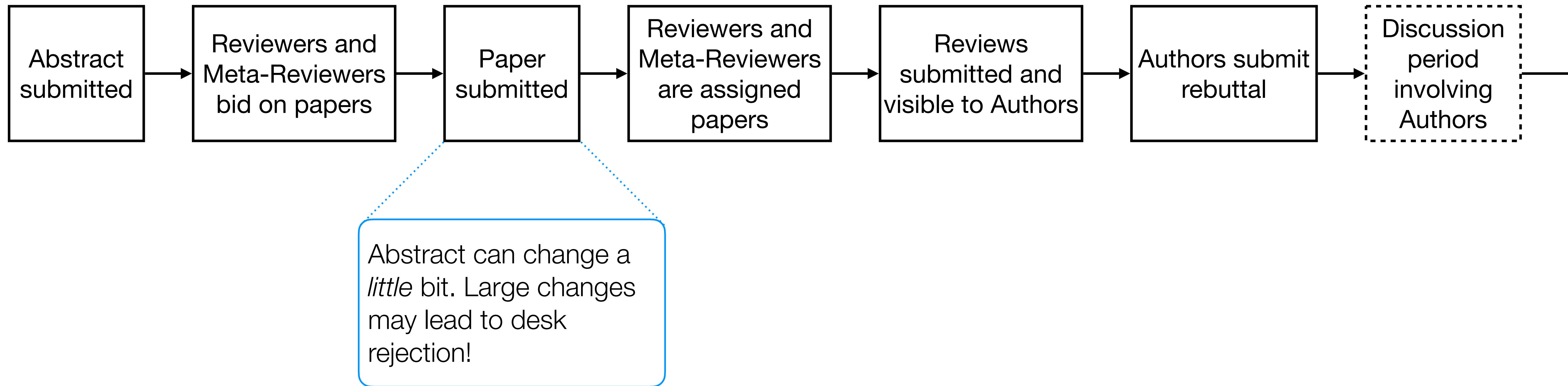
Example of a Review Process



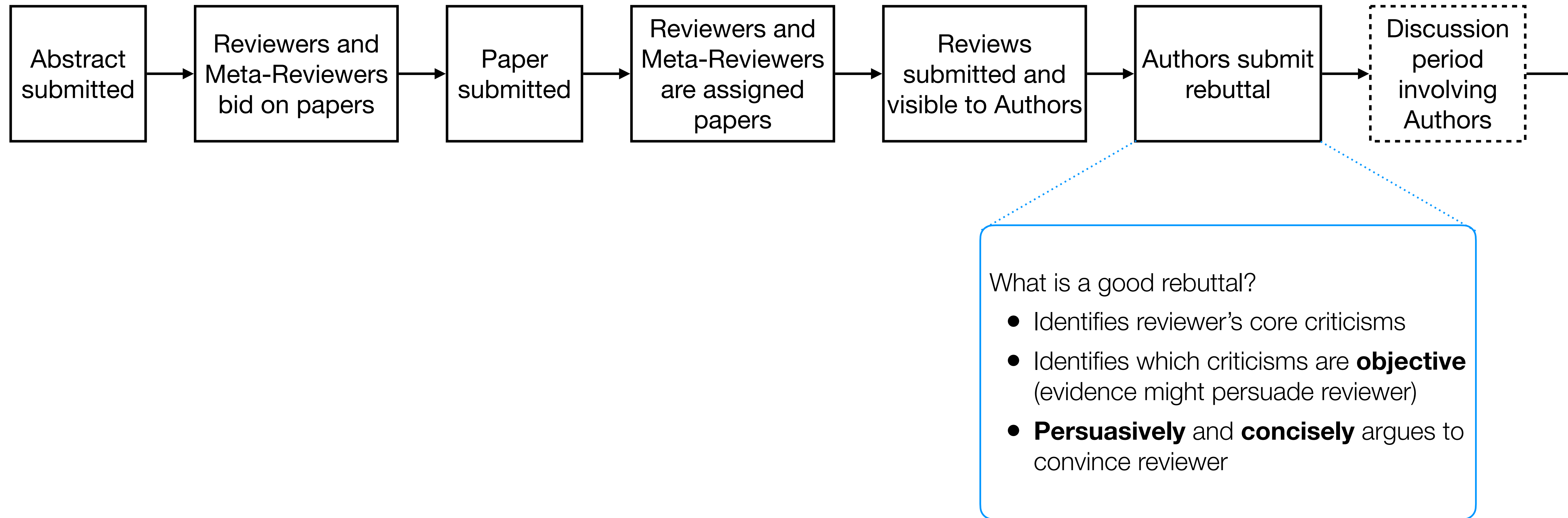
Reviewers + Meta-Reviewers
can see Title and Abstract.

So, make sure people would
be interested in your paper
can easily identify it from Title
and Abstract!!

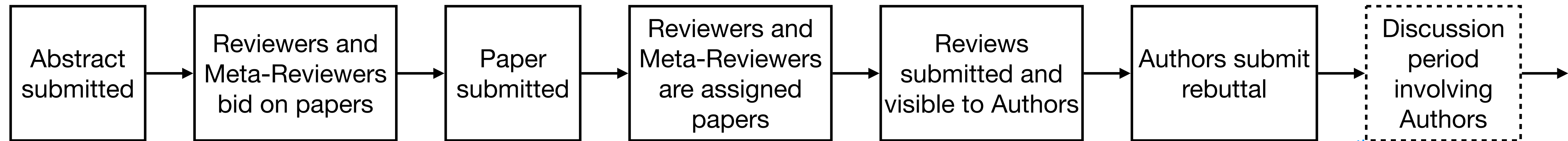
Example of a Review Process



Example of a Review Process



Example of a Review Process



Think of this as a sequence of rebuttals

Use great responsibility in using ability to send more responses to Reviewers. Why?

- Reviewers have limited time for reviewing. Most Reviewers will skim (or not read) if you send too much text (long responses, or too many responses)

Example of a Review Process

