CS 2001: Research Topics

Reading & Reviewing Papers, Generating Ideas

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September 2, 2025

Plan for this lecture

- Structure of a paper
- Reading papers for breadth/depth
- Reviewing papers
  - How conference reviews work
  - Structure of a paper review
  - Example reviews
- What makes a good idea?
  - Criteria
  - How to come up with ideas?
  - Getting started on testing ideas

Structure of a Paper

Structure of an 8-page, 2-col Paper

- Abstract
- Introduction
- Related Work
- Approach/Method
- Validation/Results/Experiments
- Conclusion
- Acknowledgements
- References

Abstract (1 paragraph)

- Purpose
  - Why is this paper interesting?
  - Why should I spend my time reading this?
  - What do you claim to do?
- Summarize problem being tackled, key innovations, main results
- One strategy: write it after rest of paper written
  - Caveat: some conferences might want an abstract earlier than the submission deadline

Some text from Adam Lee's slides

Introduction (1-1.5 page)

- Purpose: motivate work, inform reader what is to come
- First paragraph: describe problem and state current gap in science, including current methods' deficiencies
  - Also briefly describe motivation: why addressing this particular gap is important, has applications
- Second paragraph: state the very high-level idea of your solution to address this gap
- Third paragraph: briefly introduce your method
- Fourth paragraph: briefly summarize experiments
- Fifth paragraph: summarize contributions
- Concept figure (Fig. 1): illustrate key idea of the work
- Important: sets initial expectations

Some text from Adam Lee's slides

Related Work (0.5-1 page)

- Note: This may also come before Conclusions—tradeoffs?
- Purpose: inform reader you are aware of prior results, and demonstrate the novelty of the work
- Summarize 15-50 most relevant papers
- Organize by rough topic or approach (use paragraph headings but no separate subsections, for space)
- Within each paragraph, can describe papers at a course level, e.g. “Some works approach the task by… [ref1, ref2, ref3].”
- End each paragraph or group of papers with how proposed method is different

Some text from Adam Lee’s slides

Approach (2.5-3.5 pages)

- Purpose: describe novel approach, contribution
- Have an introductory paragraph describing an overview of the approach
- Make it clear which part of the approach is standard/from prior work, and which part is new/novel/innovative
- Common to have 2-5 subsections
- Should be detailed enough for others to replicate the work—in ML, common to include a separate "implementation details" section (could also go in appendix/supplementary)

Some text from Adam Lee's slides

Experiments (2.5-3.5 pages)

- Purpose: prove stated contributions are meaningful
- Forms: performance measurements, simulation results, analysis of user study data, formal proofs…
- Include experimental setup (e.g. data and metrics used, methods tested with names, perhaps in special font setting)
- Include one or more results subsections (the outcomes from running the experiments); may want to title each paragraph with the high-level takeaway
- Show results in tables and/or figures, and describe/analyze these tables/figures in the text
- Explicitly make all the conclusions you want the reviewers to draw from them
- May or may not show statistical significance but be prepared to answer questions about it

Some text from Adam Lee's slides

Conclusion (1 paragraph)

- Summarize contributions and findings of the paper, briefly
- Acknowledge limitations and briefly suggest future work– no more than 1-2 sentences (may vary by research community)
- Some conferences require a standalone Limitations section

Discussion (takes different forms)

- May be part of experiments, potentially conclusion
- Purpose: papers do not often “close” a topic—this is where you reflect on what has been done, and what is still open
- May include: interpretation of results or evaluation, discussion of open problems, description of limitations, etc.

Text from Adam Lee’s slides

Acknowledgements (1 paragraph)

- Omit for review due to anonymity
- Ask your advisor which funding sources to acknowledge, any particular phrasing to use
- Can also thank the anonymous reviewers and area chairs

References

- Standard formats for this
- Can get bibtex citations for a paper from Google Scholar or DBLP, but may have to fix
- If a paper appeared in a conference/journal, **don't cite the arxiv version**
- Use consistent formatting, e.g. the same conference should use the exact same string including abbreviation for the conference name

How to Read Papers

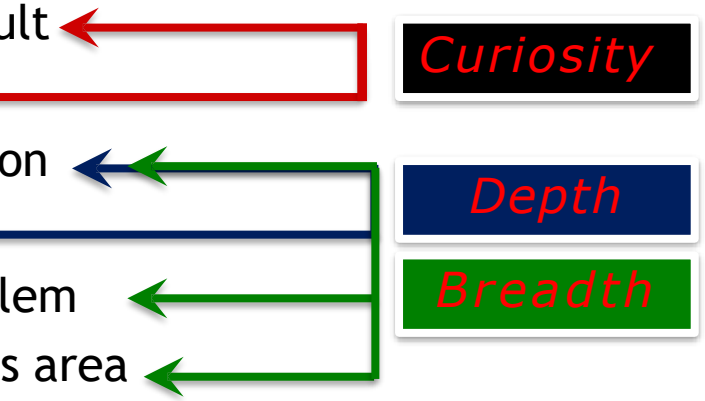
Why do we read papers?

- To know what others in our field are doing
- To get ideas for research projects
  - in terms of problems/tasks, as well as gaps and deficiencies in prior methods
- To know the relevant techniques
- To avoid reinventing the wheel
- To avoid having our papers rejected because we didn't compare to relevant baselines

Why do we read papers?

There are many legitimate reasons for reading a paper

- I heard someone talking about this result
- The conference talk interested me
- It's related to a problem I am working on
- My advisor told me to
- This provides context for another problem
- I think that I might want to explore this area
- …



Take-away point: Why you plan to read a paper will—to some degree—dictate how you should go about reading it

Slide credit: Adam Lee

Too many papers!

- CVPR, the top conference in my field, has over 1000+ papers each year– and there are 5+ such conferences each year in my field
- Sometimes papers are organized by topic, or by significance (e.g. oral/spotlight/poster)
- One approach: go through all titles, read the abstract and skim intro and figures for ¼ of papers, read 30 papers in detail
- Take notes (ask senior grad students for advice)
- Faculty often skim papers, and you will skim some, but have to read some in detail

Reading groups

- Start or join a reading group
- Divide and conquer approach – members of the group educate each other on topics they've become experts on
- Share the burden of finding good learning materials, e.g. slides
- Discuss ideas for follow-up work together

Reading for breadth vs depth

- Breadth
  - Get a sense of the “pulse” of the field, what are open problems
  - Identify potential research directions
  - Get exposed to techniques—you never know when a seemingly unrelated technique may come in handy
- Depth
  - If your advisor sends you a paper, spend at least 30 min reading it
  - You need to know some papers in great detail
  - But if you do 5 hours of reading a week, you should spend 20 hours doing active work, i.e. developing your method and conducting your experiments

Multi-pass Approach

Keshav* has a nice paper on a three-pass reading approach

Pass 1: Basic comprehension

- What is the main topic of the paper?
- What are the authors' claimed contributions?
- What do they cite?

Pass 2: First look at real details

- Focus on details: evaluation, figures, methods
- Ignore proofs

Pass 3: Depth!

- Fully understand all details

* S. Keshav, "How to Read a Paper," ACM SIGCOMM Computer Communication Review 37(3) : 83-84, July 2007.

Slide credit: Adam Lee

First Pass: Decide How Much Time to Invest

Focus your attention on:

- Title and Abstract
- Full details of the Introduction
- Section and Sub-Section headings in the body
- Full details in the Conclusion
- Skim references, note what you've read

After this, you should know about the "5 Cs"

- Category: Experimental paper? Theory? Measurement?
- Context: What does this paper cite?
- Correctness: Do any assumptions seem reasonable?
- Contributions: What do the authors (claim) to contribute?
- Clarity: Can you follow the paper?

You can probably accomplish this for most papers in ~10 minutes

Slide credit: Adam Lee

Second Pass: Breadth of Knowledge

General idea: Read the whole paper, but skip super-intricate details like proofs, some equations (if many).

Focus on:

- Understanding methodology, evaluation, figures, etc.
- Mark relevant references for later reading (more breadth!)
- Being able to explain the main ideas of the paper to someone else

This process can take up to an hour for a 10-page paper

Why so long?

- Perhaps you're new to the subject area
- Authors use methodologies or techniques that are unfamiliar
- Paper is just badly written…

Slide adapted from: Adam Lee

Second Pass: Breadth of Knowledge

Important questions include:

- What are the motivations for this work?
- What is the proposed solution? Is it novel?
- How is this solution evaluated?
- What do you think about the problem, solution, and evaluation?
- What are the contributions of this work?
- Des this paper close an area of research? Open a new one? Lead to interesting future work?
- What questions do you still have?

Griswold has a nice template for answering these questions—linked on the course page.

Slide credit: Adam Lee

Third Pass: Develop Intricate Understanding

Main focus: Everything you've glossed over so far

- Thorough scrutiny of assumptions
- What alternative solutions might have been possible?
- Does the evaluation cover enough meaningful cases?
- Detailed examination of proofs and proof techniques

After a thorough pass, you should (ideally) be able to replicate the results presented in the paper

This is a time-intensive process

- 4-5 hours for beginners
- Around an hour for more experienced readers

Slide credit: Adam Lee

Note-Taking

Note-taking can help build your understanding of a paper and manage the *many* papers that you'll eventually read

Note taking while you read helps capture the context of your reading session for later reference

Use a highlighter to mark major points, definitions, and theorems for quick reference later

Make notes in the margin

- Write down questions as they pop into your head
- Answer previous questions as you find answers
- Summarize tables, graphs, etc.
- Add details to incomplete/unclear examples

Slide credit: Adam Lee

Note-Taking

Note taking after you read can also help

- Ensure complete understanding of relevant papers
- Manage large collections of papers as your progress in your studies

Consider making a document per research area

For each paper, write up:

- A technical summary of the work
- A brief description of the paper's relation to other works
- Relationships to your ongoing/planned research
- Resources you can use in your work (e.g. data)
- Any cool ideas for future work that come to mind

Slide adapted from: Adam Lee

Filling in the Gaps

Initially, you will have an incomplete knowledge of a research area. How can you fix this problem?

Step 1: Read up on prior work!

Step 2: Understand how this paper fits into more recent research

There are research tools to help aid these processes

- ACM portal: http://portal.acm.org
- IEEEXplore: http://ieeexplore.ieee.org/Xplore
- Google scholar: http://scholar.google.com
- Citeseer: http://citeseerx.ist.psu.edu/
- DBLP: https://dblp.uni-trier.de/
- Perplexity Deep Research https://www.perplexity.ai/

Slide adapted from: Adam Lee

Reference management software

- Mendeley
- EndNote
- Zotero
- PaperPile
- ReadCube Papers

Conference Review Process

Conferences and You

- Ratio of conference to journal pubs typically higher in CS than other areas
- Conferences at different tiers; top-tier may have acceptance rates of 15-30%
- Example goal for your PhD:
  - 2-3 top-tier conference pubs,
  - 2-3 second-tier conference pubs,
  - 1-2 journal pubs

Conference Review Process

- Papers are submitted by a fixed deadline
  - The more prestigious the conference, the less likely deadline will be extended
- Program Chairs assign papers to Area Chairs (semi-automatically) for handling
- Area Chairs select reviewers from available pool (and help recruit reviewers)
- A paper may be reviewed by 3-5 reviewers

Conference Review Process (cont'd)

- In many conferences, reviews are released before final decision, and authors get a chance to respond to comments (rebuttal), to correct misunderstandings and provide further details
- Next, reviewers discuss (moderated by AC), update their reviews, and AC makes decision recommendation based on final reviews
- How much time does a reviewer spend with a paper? How much time does the area chair spend with it? Which papers does the area chair spend more/less time with? What does this imply for how papers, reviews, and rebuttals should be written?

Conference Review Process (cont'd)

- If decision is accept, authors have a few weeks to submit final ("camera-ready") version
- If decision is reject, authors may submit to a workshop associated with the conference, or submit to another conference
- Dual submissions usually not ok (can't have same paper under review for two conferences at the same time)
  - Exception: some 4-page extended abstract submissions, considered work in progress
  - Those are good to do, can add to CV, but they are non-archival and not considered real publications, so don't invest too much time

Author/Reviewer Anonymity

- Double-blind review: authors don't know who reviewers are, vice versa. Why?
- Single-blind: authors don't know reviewer identities
- There may be policies about "tech report" submissions (e.g. on arxiv.org) during paper anonymity/review time – allowed/not
- You may accidentally find out a paper's author identities when you review, but you shouldn't actively try to find it out
- Reviewer identity is hidden from authors, but not hidden from program and area chairs
- Thus, apart from honor and karma, you should do a good job at reviewing because these chairs should have a good opinion of you for later job opportunities

Scores in Reviews

- Comments that reviewers write are important; also important are scores
- CVPR reviewing scale:
  - Strong Accept, Weak Accept, Borderline, Weak Reject, Strong Reject
- NeurIPS reviewing scale:
  - 10: Top 5% of accepted NeurIPS papers. Truly groundbreaking work.
  - 9: Top 15% of accepted NeurIPS papers. An excellent submission; a strong accept.
  - 8: Top 50% of accepted NeurIPS papers. A very good submission; a clear accept.
  - 7: A good submission; accept. I vote for accepting this submission, although I would not be upset if it were rejected.
  - 6: Marginally above the acceptance threshold. I tend to vote for accepting this submission, but rejecting it would not be that bad.
  - 5: Marginally below the acceptance threshold. I tend to vote for rejecting this submission, but accepting it would not be that bad.
  - 4: An okay submission, but not good enough; a reject. I vote for rejecting this submission, although I would not be upset if it were accepted.
  - 3: A clear reject: I vote and argue for rejecting this submission.
  - 2: I'm surprised this work was submitted to NeurIPS; a strong reject.
  - 1: Trivial or wrong or already known.

Reviews Followed by Rebuttals

- A rebuttal is a short document (1-page) where authors address concerns by reviewers; typically short deadline for conferences
- Typically in question-answer format
- The goal is to rebut factual errors on the reviewers' part, and alleviate concerns for on-the-fence reviewers
- Especially important for borderline papers (WA, B, WR) or (WA/WR, B, B) or (B, B, B)

Review Score Scenarios

- Which papers (with what scores) get accepted?
  - What happens to a paper with (WA, WA, WA)?
  - What happens to a paper with (WA, B, WR)?
  - What happens to a paper with (WA, WA, SR)?
  - What happens to a paper with (B, B, B)?
- Scores and decisions for one conference:
  - https://github.com/evanzd/ICLR2021-OpenReviewData
  - https://docs.google.com/spreadsheets/d/1MLlgV82_4K1FJGSjUKm2R8cw5msn4xmrhtnS9FLAS6k/edit#gid=189496698

Role of a Reviewer

- A reviewer is a judge—they safeguard the quality of a publication venue
- A reviewer also gives feedback and helps steer a particular work (if suggestions that reviewer gives are sensible)
- Both of these imply reviewing should be taken very seriously!
- Important: Keep papers you review *confidential*, to protect the authors' work!
- Important: Do *not* try to find out who the authors are
- One reviewer responsible for 1/30-th of someone's PhD career
  - Say a student will publish 5 papers (1 per year) to be granted their PhD, 2 attempts to publish one paper, each attempt is reviewed by 3 reviews

A Reviewer Should:

- Read the paper carefully (1-2 hours)
- Take notes about strengths, weaknesses, points that seem unclear, problematic, even typos (if time)
- Use notes to fill out a review template (~15-30 min)
- Be responsive to area chair requests for discussion
- Read rebuttal, others' reviews, and complete final scores (if there is a rebuttal/discussion phase)

Reviewer Guideline Examples

- NeurIPS: https://nips.cc/Conferences/2020/PaperInformation/ReviewerGuidelines
- CVPR: http://cvpr2020.thecvf.com/submission/main-conference/reviewer-guidelines
- CHI: https://chi2021.acm.org/for-authors/presenting/papers/guide-to-reviewing-papers
- ISCA: https://www.iscaconf.org/isca2020/submit/reviewers.php

How to Review Papers

Why Review Papers?

Reason 1: Testing your own comprehension

- Noting contributions, significance, strengths, and weaknesses
- Identifying promising areas for future work

Reason 2: Group meetings / reading groups

- Similar to above, but to promote discussion within group

Reason 3: Related work in your papers

- Can be thought of as *very* concise paper reviews
- Summarize main technical points, compare/contrast with your work

Reason 4: Conference and journal reviews

- Peer review is used to judge the merit of scientific papers
- Reviews influence accept/reject decision and author revisions

Slide credit: Adam Lee

Purpose of a Conference Review

A conference paper review serves many purposes:

- Synthesizes the reviewer's understanding of the paper
- Communicates the reviewer's thoughts about the paper to other PC members and the PC chair
- Partially documents the PC's decision to accept/reject the paper
- Provides guidance to the authors regarding possible (or mandatory!) improvements to their work

As a result, the review is important at all stages of the process

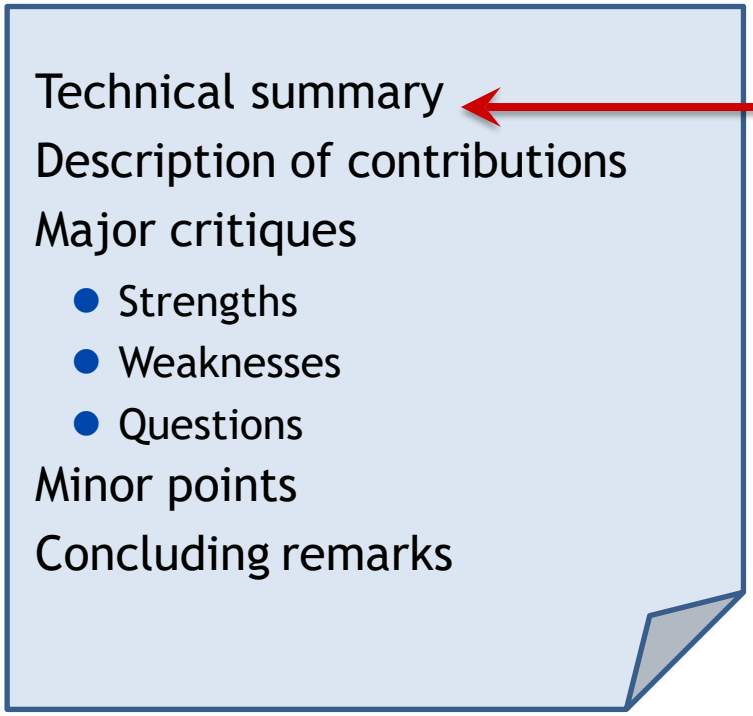
Bottom line: A paper review should *not* be a book report!

Slide credit: Adam Lee

Example Review Questions (ICCV'21)

1. [Summary] In 3-5 sentences, describe the key ideas, experiments, and their significance.
2. [Strengths] What are the strengths of the paper? Clearly explain why these aspects of the paper are valuable.
3. [Weaknesses] What are the weaknesses of the paper? Clearly explain why these aspects of the paper are weak. Please make the comments very concrete based on facts (e.g. list relevant citations if you feel the ideas are not novel). If applicable, please indicate key issues and questions which, if well addressed during the 1-page rebuttal, might influence you to change your rating.
4. [Overall rating] Paper rating (pre-rebuttal)
   - Strong Accept / Weak Accept / Borderline / Weak Reject / Strong Reject
5. [Detailed comments] Additional comments regarding the paper (e.g. typos, any suggestions to make the submission stronger).
6. [Reproducibility] Is the method described in this paper reproducible?
7. [Confidence] Reviewer's confidence in his/her recommendation
8. Please provide an "Overall Rating", following the rebuttal and reviewers discussions.
   - Strong Accept / Accept / Leaning to Accept / Learning to Reject / Reject / Strong Reject
9. Justification of final rating. Describe the rationale for your final rating, including notes based on the rebuttal, discussion, and other reviews.

Structure of a Paper Review



Content:

- Very short (1-2 paragraphs)
- Overview of the paper

Purpose:

- It provides the **reviewer** with context for the review
- It allows the **PC chair** to get a quick synopsis of the paper
- It convinces the **author** that the reviewer read and understands the paper

Slide credit: Adam Lee

Structure of a Paper Review

Technical summary

Description of contributions

Major critiques

- Strengths
- Weaknesses
- Questions

Minor points

Concluding remarks

Content:

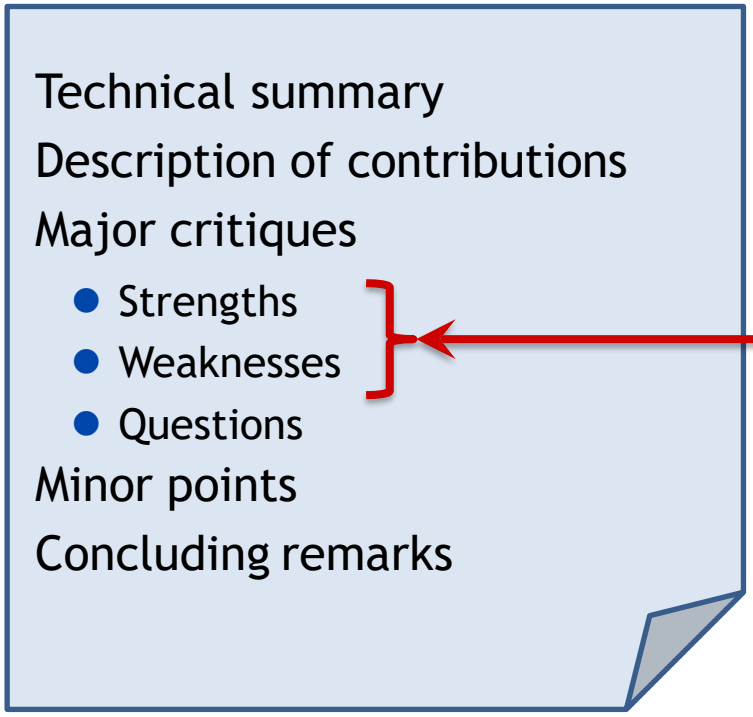
- Very short (1-2 paragraphs)
- Quick summary of the **novel aspects** of the paper

Purpose:

- Novelty is **paramount**! This provides evidence for the final accept/reject decision
- Again, it convinces the author that the reviewer understands the novelty of their contribution
- It sets the stage for detailed critiques

Slide credit: Adam Lee

Structure of a Paper Review



Content:

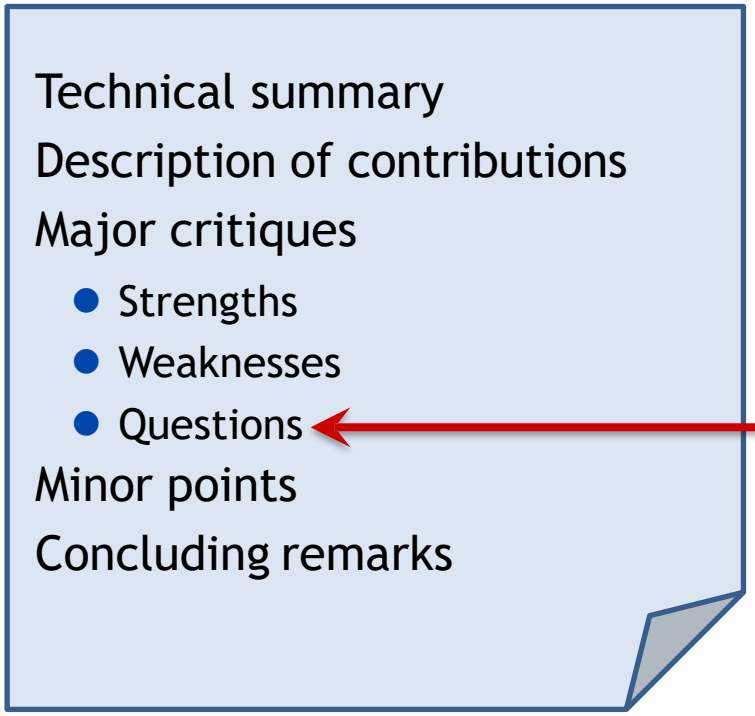
- **Technical** and/or **methodological** strengths and weaknesses
- *Examples*:
  - How interesting is the problem?
  - Novel proof techniques or solutions
  - Missing related work
  - Assessment of the (in)completeness of the evaluation
  - …

Purpose:

- Primary assessment of the paper
  - Do the authors bring something of intellectual value to the table?
  - Is the paper somewhat **incremental**, but well executed?
  - Does the paper have **fatal flaws**?
- Typically, this provides **fodder for discussion** at the PC meeting

Slide credit: Adam Lee

Structure of a Paper Review



Content:

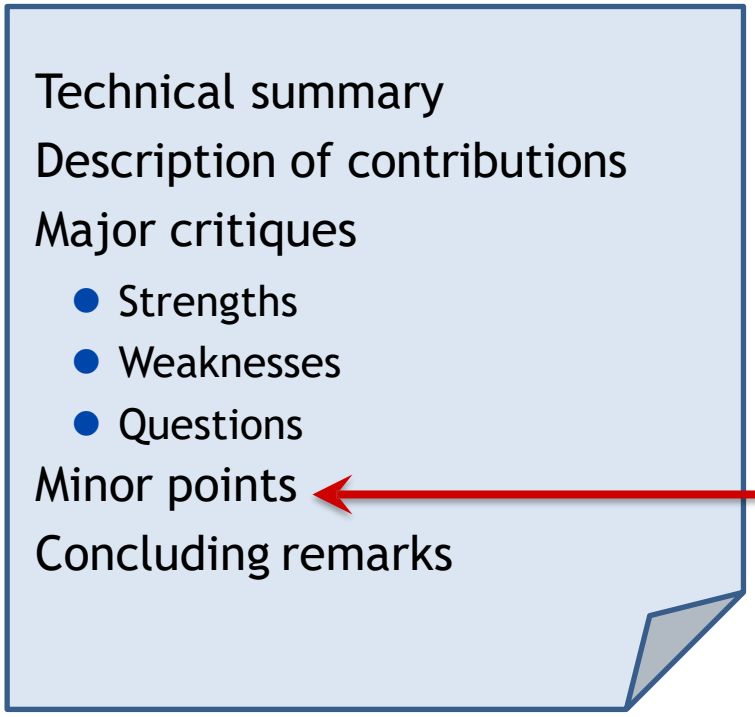
- Remarks on any thing that was unclear in the paper

Purpose:

- To stimulate discussion with **other reviewers**
- To inform the **author** of questions that remain unanswered after reading the paper
- May be addressed by authors in rebuttal

Slide adapted from: Adam Lee

Structure of a Paper Review



Content:

- Aspects of the paper that don't influence the novelty of the contribution, but do impact the quality of the paper overall
- *Examples:*
  - Typos and grammar errors
  - Suggestions for better examples
  - Corrections to minor logical flaws
  - …

Purpose:

- Helpful for planning revisions

Slide credit: Adam Lee

Structure of a Paper Review

Technical summary

Description of contributions

Major critiques

- Strengths
- Weaknesses
- Questions

Minor points

Concluding remarks

Content:

- Very short (1-2 paragraphs)
- Final assessment of paper, with justification

Purpose:

- Provide final suggestions
- Communicate your views on the paper to others
  - You might love the paper, yet make many negative critiques
  - You might hate the paper, yet say some positive things about it
  - This is where you clarify

Slide credit: Adam Lee

Avoiding Pitfalls

	Pitfall	Recommendation
1	Seek to find all flaws in the paper, in part to show your expertise as a reviewer.	Look for reasons to accept a paper. Despite its flaws, does it point in new directions or expose promising insights? The community can benefit from imperfect, insightful papers.
2	Since the review process is anonymous, it is appropriate to criticize the paper as if the authors did not have feelings.	Your tone should be the same as if you are giving comments to a colleague face-to-face. It is always possible to be constructive, focus on the work, and do not attack the researchers behind it. The purpose of a review is not only for selecting papers, but to improve the quality of all the work in our area.
3	Reject papers that build on recently-published new directions but accept those that build on the established norm.	While truly new papers are best (and rare), consider accepting papers that follow-up on recently-published promising directions. These papers allow the community to explore ideas that can not be fully-developed in one paper.
4	Advocate rejecting a paper with little comment, because it is obvious that all with agree with you. Ditto for accept.	Explain why you advocate a rejection or acceptance, because people will often disagree with you. Your explanations will make you a more effective advocate or detractor for the paper.
5	Advocate rejecting (almost) all papers to show how tough you are.	Your job is to decide what is best which is not usually accomplished by rejecting every submission.
6	Advocate rejecting a paper because you seem to remember it being the same as (or similar to) unidentified prior work.	In this situation, the professional should reference important prior work after refreshing one's memory regarding what it contains. One missing reference is usually not a reason to reject a paper.

Text from Hill and McKinley

* http://www.cs.utexas.edu/users/mckinley/notes/reviewing.html

Common Reviewing Pitfalls

- Saying something has been done before, but not citing papers
- Citing your own work—don't want to reveal your identity, and chances are, other work is relevant and can be mentioned too, if you think the authors made major omissions in citing relevant work
- Being unreasonably picky about writing, method and experiments—you should be picky, but pay attention to contributions too, and be willing to forgive small mistakes
- Not being critical enough, or being too critical

Common Paper Weaknesses

- Not novel (this or very similar techniques have been proposed before)
- Missed relevant baselines (competitor methods)
- Hard to tell where improvement over baselines comes from—need ablation experiments
- Doesn't improve over baselines by a lot, very small gain over the most similar methods
- "Only quantitative results; weak baselines; weak evaluation (automatic/instrinsic vs. human/extrinsic)"
- "Weak ablation study; weak experiments (dataset, competitors, baselines)"
- Not well written, method not clear, motivation not clear

Discussion of a Paper

- AC may call for a discussion (on reviewing platform)
- Reviewers bring up especially important points
- Other reviewers agree/disagree with whether an issue raised is truly problematic, whether it is a critical problem, etc
- Sometimes/often a review will change their mind, based on rebuttal, or based on other reviewer's comments
- It's ok to change your mind, if you have a good reason– don't be afraid to
- Also don't be afraid to be the only person being very positive about a paper—and provide arguments

Generating Ideas &
Getting Started on Testing Them

What makes a good idea for a PhD student?

- Is it worth doing?
  - Will it improve how we do work in the field?
  - Will it be useful for the world?
- Is it interesting enough?
  - Has it been done before?
  - Will the community learn something from it?
- Can it be done?
  - Is it too ambitious?
  - Do you and your team have the skills to do it?
  - (Are you uniquely qualified to do it?)
- Will it fit well in a good PhD thesis?
- Is your advisor interested in this?
- Does your advisor have funding, or might they be able to acquire it, for this type of idea?

The Heilmeier Catechism

- “DARPA operates on the principle that generating big rewards requires taking big risks. But how does the Agency determine what risks are worth taking?
- George H. Heilmeier, a former DARPA director (1975-1977), crafted a set of questions known as the "Heilmeier Catechism" to help Agency officials think through and evaluate proposed research programs.
- What are you trying to do? Articulate your 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?”

https://www.darpa.mil/work-with-us/heilmeier-catechism

National Science Foundation Merit Review Criteria

- “Intellectual Merit: The Intellectual Merit criterion encompasses the potential to advance knowledge; and
- Broader Impacts: The Broader Impacts criterion encompasses the potential to benefit society and contribute to the achievement of specific, desired societal outcomes.”

- How might these be formulated for some of our iconic papers?

https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_3.jsp

National Science Foundation Merit Review Criteria

"The following elements should be considered in the review for both criteria:

1. What is the potential for the proposed activity to:
   a. Advance knowledge and understanding within its own field or across different fields (Intellectual Merit); and
   b. Benefit society or advance desired societal outcomes (Broader Impacts)?
2. To what extent do the proposed activities suggest and explore creative, original, or potentially transformative concepts?
3. Is the plan for carrying out the proposed activities well-reasoned, well-organized, and based on a sound rationale? Does the plan incorporate a mechanism to assess success?
4. How well qualified is the individual, team, or organization to conduct the proposed activities?
5. Are there adequate resources available to the PI (either at the home organization or through collaborations) to carry out the proposed activities?"

https://www.nsf.gov/pubs/policydocs/pappg18_1/pappg_3.jsp

Are these good or bad ideas?

- Develop a dataset for a new problem
- Replace the neural architecture in one system with another architecture
- Develop a more efficient way to accomplish the same task
- Make AI think like a human
- Compare how two methods work
- Make the outputs of a method more interpretable

How to come up with ideas?

- Come up with a new problem – when good/bad?
- Twist on an existing problem, with somewhat new approach
- Existing problem, propose dramatically new and improved method, or an incremental, but well-performant twist
- Solution for an existing problem but under new resource constraints–e.g. limited supervision, computational resources
- Blend problems/solutions—apply techniques from one area to another area
- Compare methods in a way that hasn't been compared

Environments for new ideas

- Places/settings in which I've come up with new ideas that ended up being published:
  - While observing my child
  - While watching ads during NFL games
  - While riding in a cab
  - While going for walks
  - While reading papers

Setting Up

- Set up code for a baseline method—whether written from scratch, or code other researchers shared—get your "hands dirty"
- Set up evaluation—make sure it is correct, fair
  - Machine learning: Train/validation/test split (val to pick hyperparameters, use test set once)
  - Relevant metrics used—if proposing new metrics, explain why they are needed
  - Make sure your method isn't using unfair advantage—anything that isn't part of your contribution
  - Are the results what you expected? In both cases (yes/no), double-check your work

Developing Your Method

- Start with existing method (baseline), use existing code or implement from scratch (sometimes simpler, published code not always easy to use)
- Think about which parts of your full framework are your actual contribution that you will highlight in the paper, and which parts are standard

Experiments

- You need to show impact of your key contribution
  - Scientific method—change one variable at a time, to show its impact
  - Bad: 3 new method components (2 of which not very interesting), new metric, new dataset–and only compared against 1 baseline
- Gives rise to “ablation” experiments—compare a backbone to the backbone with each of your key ideas added, one at a time, then together
- Also need to compare to methods from the very recent literature—the more the merrier (if done properly)

Bookkeeping

- When developing your method and conducting validation (e.g. running experiments)– it's crucial that you document your work!
- You should be able to reproduce the exact settings and results that you obtained—apart from factors due to randomness (but can set random seed)
- You should know the complete setting of results you include in papers, and all results you show your advisor
- You should include as much information as possible to enable others to reproduce your results, even share code if possible—helps with getting your work cited

What if Results Don’t Look Good?

- Your baseline and evaluation is set up well, but your proposed method doesn’t outperform the baseline?
- This is likely to happen, often—try to understand what isn’t working well and why, then iterate on method
- Try simple changes first, e.g. tuning algorithm “knobs”
- Come up with simple environments where your new idea should work–e.g. a simpler test set, no-noise environment, attentive users, etc.
- It’s ok to iterate on metrics too—perhaps one metric is too coarse to show impact of your method
- Keep reading papers to get more ideas on method

Sometimes, You Give Up

- Sometimes, you iterate but nothing works
- When to give up on this overall idea, topic?
- “Give up” = publish in a workshop
- Really hard to say, but important to know there may be a time you need to stop—1 year?
- Consider whether it is worth investing *even more time* in this particular project
- It doesn’t reflect on your ability as a researcher!
- It’s not wasted time—use the skills you acquired to tackle a related problem!

Getting Help

- Lots of learning resources on the web
  - Check out tutorials from relevant conferences
- Peers, senior students
  - Formulate your request clearly, make it efficient for them to help
  - Don’t hesitate to ask for help—you’re just starting, they’re an expert!
- Your advisor
  - Often, it makes sense to try to figure things out on your own, unless it’s something that advisor can easily and quickly resolve
  - Send email rather than waiting, or show up at their door—if you’ve discussed with your advisor that’s ok; potentially use Slack group
- Reading group
  - Volunteer to present your work
  - Will get help with brainstorming
  - Sometimes just talking about your work helps!