Art of Reading a Scientific Paper

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Katherine Sytwu
What are some challenges you’ve faced while reading scientific papers?
Before reading, identify your goal

• **Overview Level:** I want to understand a topic
  – E.g. What is the current state of research for graphene plasmonics?

• **Main ideas Level:** I want to understand the results of a paper
  – E.g. How does the propagation length of a graphene plasmon depend on carrier density?

• **Details Level:** I want to understand their methods or derivation
  – E.g. How did they measure the propagation length and verify their results?
Find the appropriate paper type

• **Literature Reviews**

These papers summarize a topic, and can be in tutorial/textbook form, a summary of recent papers, or just an organized list of citations and references.

These are great starting points whenever learning about a new topic.
Find the appropriate paper type

- Literature Reviews
- Articles/Reports/Letters

These are your typical scientific papers. They will usually spend most of the paper on methods and results.

Letters are usually constrained in length (4-6 pages), so detailed information (methods, derivations, additional measurements, etc.) will be in supplementary information (SI).
Find the appropriate paper type

- Literature Reviews
- Articles/Reports/Letters
- News & Views

These are summaries of a research paper by an expert in the field, meant to put the research in context for a broad scientific audience.

Not all papers have these, but they are good to read if available.
Reading Review Articles

Review articles are written for all different levels, from those starting out in the field, to experts who want an overarching view.

1. Find a review at an appropriate level for you
   • Is the scope too large? Too narrow?
   • Is there too much jargon right away? Find one that is more introductory

2. Identify the relevant sections
   • Reviews can be quite long – figure out which sections are worth reading

3. Browse through figures and captions first
   • Get a general idea of what the review will cover and the research it considers most relevant

4. Read through the review like a textbook
Workshop Activity: Find a Review Paper

1. **Open Google Scholar and find a review article of your research topic**
   - Is the abstract understandable? If not, find another one that is appropriate for your level of knowledge
   - Some reviews are just an organized compilation of recently published papers – avoid those for now, and look for ones that are meant to be more pedagogical
   - Can’t find a review paper on your topic? You may have to broaden the scope – it’s possible that your topic is a subsection of a review paper

2. **Pair off and summarize to your partner the topic and scope of the review paper**
   - What topics will this review cover? How is the review organized?
   - Why is this topic interesting?
Finding Research Papers – Searching Smart

• Start with a review paper, and find the relevant papers they cite
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- Start with a review paper, and find the relevant papers they cite
- Start with a relevant paper, and find papers that cite it
- Start with a relevant paper, and look up papers also published by the first author or the last author
  - First author will be the lead researcher, last author will be the lead principal investigator (PI)
Reading a Scientific Paper: Summarize the Main Ideas and Results

1. Identify your goal
2. This is not a novel: know the ending before you start reading
   – Abstract should outline motivation and results of the paper
   – If main idea is still unclear after the abstract and introduction, read the conclusions
   – Look over the figures before reading the details
3. You don’t have to read in order (or the entire paper)
   – Sometimes skipping from the abstract to the conclusions and going back and forth in the paper will help
4. At this level, you are trusting the authors and their conclusions
Don’t fall into the rabbit hole!

Scientific papers can contain a lot of jargon, and one can easily fall in the rabbit hole of old papers and trying to understand everything.

- You don’t need to fully understand every paper you find
  - Some parts of a paper will be more important than others
- Identify which terms are worth figuring out
  - Sometimes extra concepts are thrown in as semi-related examples, or to appease a reviewer

There are more papers than physically possible to read – a key skill is being able to quickly skim a paper and determine which ones are worth close reading.
Workshop Activity: Quickly Read a Scientific Paper

1. **Find a paper related to your current research project** (but not from your group)

2. **Read the abstract and introduction**
   - Keep track of unfamiliar terms
     - Are these necessary to understand, or just an example the authors threw in?
   - What’s the goal of this paper? What is its main result?

3. **Look at the figures and captions**
   - If the figures make sense, skim the results, and make sure your interpretation agrees with the authors’
   - If they don’t, read through the results section to find the part that references the figure, and try to get a main idea from each figure.

4. **Read the conclusions.** Does this align with your takeaway points?

5. **Write a 1-3 sentence summary of the paper**
   - You can import the paper into Mendeley and type the notes in there
   - Alternatively, can keep track in Word/Powerpoint, or on paper
Everyone has their own way of close reading a paper. Some advice specific to scientific papers:

- **Start with the same principles of summarizing a paper**
  - Figure out the main conclusions before reading the whole paper
- **Don’t get sidetracked by jargon**
  - Google or ask your mentor for definitions. Don’t feel like you need to fully understand every cited work
  - Finish one paper before starting the next
- **Highlight/underline acronyms for easy reference later**
  - Some are common acronyms, while others can be specific to a paper
- **Summarize sections of papers as you read**
Help! This paper still doesn’t make sense!

Prepare to reread a paper 2, 3, or 4 times before fully understanding it. Still, things may be confusing when

- You do not have enough background
- Things are too complicated
- They don’t make sense. Just because something is published doesn’t mean you have to take it as gospel

When having trouble,

- Look up the references, a textbook, or relevant reviews. Older papers will generally have more detailed derivations and explanations, though be careful – they may be out of date
- Come back to it later. It may not make sense during the first or second read, but it might make more sense after reading other papers in the field.
- Propose a journal club. It can be helpful to get perspectives and analysis from multiple people.
Critically reading a paper

Critically analyzing a paper is probably the most difficult part of reading a paper. This gets easier, though, with more background of the field, and practice.

Some questions to consider:

- What assumptions did the authors make?
- Why did they choose certain methods over others?
- Are the results plausible? Are there alternative explanations that would be consistent with the results?
- Are the conclusions consistent with the experiment and results?
- Given these results, what other experiments can we try? What would be the next logical follow-up experiment?
- What other systems can we apply these methods to?
Workshop Activity: Getting Started for Close Reading

1. Find a recent paper on your topic from your group

2. Do summary level reading again
   - Read the abstract and introduction to get the main idea of the paper
   - Keep track of words/concepts unfamiliar to you. Do any of these overlap with those from before?
   - Look at the figures and captions. Are these similar or different than the ones you saw before?
   - Read the conclusion and summarize

3. Read through the methods and results
   - Keep track of unfamiliar words/concepts. Which ones are important to understand?

4. Imagine you needed to replicate these results
   - What would you need? What details are missing from the paper? Can you find it in the SI?
I’ve read the paper – now what?

• **Summarize the paper in your own words**
  – This is useful so you don’t have to reread the paper in the future
  – Keep track of your summaries, either on the paper itself, in Mendeley, Word, Powerpoint, or a notebook

• **Organize/save the paper somewhere**
  – Make it easy to find again if you need to reference it
  – Physical organization (folders, piles, etc.) vs. digital (folders, Mendeley, Papers, etc.)
Overview of Mendeley
Keep track of notes and annotations
Automatically import files

Tick the folders you want Mendeley to watch. Any new PDFs in these folders will be imported into Mendeley automatically.
Automatically organize your files
Automatically organize your files
Terman Library has workshops in the fall for Mendeley and other citation managers as well as advanced searching techniques. Workshop material is also available online.

https://library.stanford.edu/englib/workshops
Recap: When reading a paper...

1. Identify your goal or purpose
2. Figure out the main idea and results before diving in
3. Practice critically analyzing papers and coming up with follow-up experiments
4. Summarize, summarize, summarize
5. Find an organization strategy that works for you

What other strategies do you use?