Reading Research for Undergrads

Presented by FemPhys

Schedule

waiting for peeps	3:30 - 3:35	**05 minutes**
introductions	3:35 - 3:50	**15 minutes**
publishing world & discussion	3:50 - 4:10	**20 minutes**
skills: finding papers	4:10 - 4:25	**15 minutes**
break + search practice	4:25 - 4:40	**15 minutes**
skills: reading strategies	4:40 - 4:55	**15 minutes**
surface vs deep understanding	4:55 - 5:05	**10 minutes**
skills: maintaining library	5:05 - 5:15	**05 minutes**

Academic Publishing: What is it & why do we care?

- Why do we care about journal articles (AKA papers AKA the literature) and publishing?
    - Publishing science in journals accomplishes (kind of) two goals.
        - Peer review: Vetting results in as unbiased a manner as possible.
        - Communication and recording: Providing a formal forum for discussion, lasting records of results, spreading ideas, and making connections between works through citing.
    - As an individual researcher, accessing journal articles informs you. Contributing journal articles is the primary recognized method of contributing to science.
        - Is this contribution thing really true? Not really. There are many ways to contribute to the professional science community, and to contribute to science more broadly, including participating in conferences, having interpersonal discussions, educating people outside the field, etc.
        - This being the primary *recognized* method, though, leads to the infamous “publish or perish” mentality of many academic institutions.
    - Knowing the literature is roughly equivalent to knowing the landscape of who is researching what, where, and knowing what questions people have answered and care about. Being able to reference relevant work in an introduction shows that you know the field and makes connections between your work and the work of other researchers. It’s particularly important to know that other researchers have not already answered the question you are trying to answer.
    - This said, not everything that’s published is good or right. Definitely not all of it is well written.

Academic Publishing: How does it work?

- A group of researchers are educated and interested in a field. They pursue a question or problem that they haven't seen covered in the literature before.
- They write up their results with context and their method (in varying degrees of detail).
- Once the article feels mostly ready, they post it on the arXiv as a preprint (as in, before being published in a peer reviewed journal) and submit it to a journal. Submitting to many journals costs money. (Sometimes up to $2000/article, charged only when the article is published.)
- The journal's editors send the paper to referees. Referees are often picked based on their familiarity with the field. Referees read the paper and submit comments anonymously to the article authors, along with a judgement like, "publish subject to small tweaks," "major issues, hold off on publishing," or "reject." The authors and referees often communicate in this way for several months before the article is published.
- Article gets published. Scientists hear about the work through it being cited by other researchers, through talks at conferences, reviewing the articles published in journals they like, twitter, their network.

Academic Publishing: Who's who

- Journals are organizations, with mandates and goals and stuff. Journals have specific topics that they publish on and rules about quality, readability, etc.
- For instance, this is the guiding policy of *Physical Review*:
    - "It is the policy of the American Physical Society that the Physical Review accept for publication those manuscripts that significantly advance physics and have been found to be scientifically sound, important to the field, and in satisfactory form. The Society will implement this policy as fairly and efficiently as possible and without regard to national boundaries."
- *Physical Review A*, for example, publishes research on atomic, molecular, and optical physics and quantum information.
- Accordingly, different journals have different reputations.
    - *Phys. Rev. A, B,..* have solid reputations for publishing reliable research, and lots of it. They are organized by the American Physical Society and don't have publishing costs.
    - *Physical Review Letters (PRL)* accepts papers that are deemed to be "significant" from all fields of physics. It has a somewhat prestigious reputation, has a publishing cost, and is more difficult to be published in than the other *Phys. Reviews*.
    - *The New Journal of Physics* is open-access, run by the Institute of Physics (UK), and has a significant publishing cost.

    - *Nature* and related journals like *Nature Communications* and *Science* have very prestigious reputations, but are criticized for being overly sensational at the expense of validity and rigour.
- The arXiv is an open access online archive of manuscripts in fields from quantum physics to mathematics to quantitative biology.
    - Papers are generally sent to the arXiv well before they are published in a recognized journal.
    - Submissions are not peer-reviewed, but are accepted by a group of moderators specific to each category of the arXiv. This tool means that a great deal of physics and math research is functionally open access.
    - Peer-reviewed papers are also hosted on the arXiv---look for a journal reference on the abstract page of a paper to see if it's been peer-reviewed.

Skills: Finding things to read

Note on having access to journals: campus internet usually gives automatic access to journals. If you're off campus, go to https://uwaterloo.ca/library/services/get-access-anywhere

- Scrolling for academics:
    - plenty of good twitter accounts. see who @femphys is following for examples like @blackphysicists
    - arXiv publishes lists of accepted articles every day.
    - SciRate adds rating and commenting to arXiv articles
- I don't know what I'm interested in!
    - Popular science magazines are good ways to get a quick overview of seminal or very interesting recent work.
        - e.g. *New Scientist, Physics Today* and *Discover* for less technical articles
        - *Scientific American* for very readable, less sensationalized, and more detailed articles
        - *Science* and *Nature* for a wide variety of research written for non-experts (i.e. researchers in fields other than the author's' own).
    - Follow these outlets on twitter; they tweet their articles and they can guide you to some very twitter-present science people.
    - Ask profs or the TAs about their research. Ask PHYS 10 lecturers about introductory or exciting reading material. If you don't feel comfortable speaking with them, look up their list of publications.
    - Don't worry if you're not into finding your own field right now. Try to do a research term with a prof or a research project, and they'll help you find or give you a problem to dig into.
- I know the field that I'm interested in!
    - Make a list of keywords or concepts describing what you're into and related things.
    - Search these keywords and combinations of them with "review" to find review papers--huge compendiums of literature in specific fields.

    - Pick an author that you know or one that keeps coming up in searches and scroll through their publications on their website or on the search engine you're using.
    - Keep up to date with what other people in the field find interesting using scirate.com.
- I have a specific research question!
    - Write it out. Identify your key concepts. Write down synonyms, closely related concepts, and umbrella concepts.
    - Do a fancy search on Google Scholar, arXiv, Web of Science, and/or Scopus.

Skills: Fancy academic searching

- search engines
    - Google Scholar, arXiv: broad, includes non-peer-reviewed work
    - Web of Science, Scopus: only peer-reviewed work, includes # citations
    - MathSciNet: same plus classification system of math, short summaries
- Search tools:
    - AND combines concepts
    - OR combines search terms
    - () separates concepts and holds search terms together
    - "search phrases"
    - find multiple endings of a word with * e.g. quant* finds quantum, quantized, etc
- Identify your research concept:
    - "use differential geometry to describe gravity in highly symmetric scenarios"
    - list separate concepts: differential geometry, gravity, symmetry
    - find related concepts for each, e.g. for differential geometry:
        - geometry, Pythagorean theorem, ...
    - ("differential geometry" OR "geometry" OR "Pythagorean theorem") AND ("gravity" OR grav*) AND (symmetr* OR spherical)

Skills: Knowing what's important

- It's tough to know what's significant when you don't have the big picture of a research field. Developing that picture takes a lot of time, so don't worry too much about knowing right away.
- If you find it interesting, consider it important.
- You can use search engines to find how many citations a paper has. This is a *loose indicator* of the impact or importance of the paper in a field. Keep in mind that :
    - citations go up with time
    - citations differ between databases as their sets of papers differ
    - citations are not endorsements (could easily be critiques)
    - many citations are from the same authors or from the authors' research group
    - women statistically receive 10% less citations than men.

    - see e.g. *Nature News.* “Men cite themselves more than women do.” & “Machine learning algorithm quantifies gender bias in astronomy.” (2016).
- You’ll probably change your mind about what’s important and interesting. Sometimes that’s because you’re wrong about an idea. That’s chill. That’s science.

Skills: Knowing the structure of a paper

Know where in the paper you should be looking for what.

- formal structure of a paper
    - abstract - supposed to be the paper in paragraph form.
    - intro - literature review, context and motivation for the work, outline of the paper
    - theoretical background
    - body - experiment or numerics or calculations or whatever. the details.
    - results - often stated within the body.
    - conclusion - restating the motivation and the results, with their impact on the field.
- content
    - context and motivation - why is this area interesting? how did this question arise? where does the problem fit into the landscape of research?
    - problem - what is the actual problem/experiment/setup being considered?
    - assumptions - what is assumed to be true? are there simplifying assumptions made?
    - method - the process whereby the results were acquired.
    - results - the answer (or sometimes non answer) to the posed problem.
    - conclusions - where does the result fit into the landscape of research? are there consequences? are there further questions that should be addressed?

Skills: General reading strategies

The general goal of reading a paper is to understand the content. how do you approach that?

- know how you like to read & gather your tools.
    - reading a paper on mendeley means you can read it on any device and make notes.
    - reading a physical copy of a paper is easier for a lot of people. keep your pens and some sticky notes on hand.
- read a paper through two or three times.
- underline/highlight terms that you don’t understand. make a note when you think the concept is crucial for understanding the content of the paper.
- check:
    - do I feel like I grasp the main concepts of the paper?
    - can I easily address anything that I don’t understand?
    - are my issues with the background/content preventing me from understanding the results, specifically? are these issues preventing my from trusting the results?

    - the third one is a grey area. keep those reservations in mind.
- identify and write down, as succinctly as possible:
    - the main problem/question
    - the assumptions made
        - e.g. we can do any operation on the system, we have a bath at temperature T, we have infinite time
    - the results
    - important conclusions
    - issues that you have
    - questions or resources for you to pursue further.

Skills: Avoiding rabbit holes

Rabbit holes: when you find something you don't understand and become engulfed in trying to understand it, or find an interesting reference and become engulfed in it, drawing your focus away from the goal of understanding the paper.

- first time reading the paper: underline what you don't get. be specific.
- second time: make a note about what the concept is used for. is it mentioned in an aside? in a proof? what is it about the concept that is being used? (this one can be hard to answer unless you understand the concept).
- look up the concept. look at wiki/wolfram entries before research papers.
- identify what the concept is (e.g. lin alg defn, theoretical setup in cosmo, property of a hamiltonian). is that enough to move on with your understanding of the paper?
    - if yes, get back to the content you came here for.
    - if no, continue to explore the concept until you can move on with the paper OR until your knowledge acquiry goal changes.
- write your thoughts down as you read. be honest and be critical. it's fantastic if all your notes are "wtf is this," as long as you're being as specific as possible about what it is you don't understand.
- use tiny sticky notes. much easier to remove when you've resolved the thought.
    - e.g. "this is like the method i read in that *Nature* paper last week."
    - "i don't follow this calculation. is it explained in an appendix or reference?"
    - "suspicious of this assumption. seems to be unphysical, maybe contradicts my previous knowledge from a specific source?"

Skills: Reading with a goal

What are you actually reading the paper *for*? Identifying what you want from the paper can change how you read it. Note that your circumstances will probably change as you grow as a researcher. Think about developing towards that more experienced situation, especially with respect to asking questions.

- I'm new to this field. I don't really know what's interesting. I just want to learn!

    - read review papers. these give a picture of the research landscape of a field. they introduce many key concepts, identify where those concepts came from, and collect many results from the field without delving into the specifics. reviews are stellar for surface understanding and context building.
    - make specific notes about references that you think might be interesting. write the references down and save the papers, but don't go down a rabbit hole.
    - intro and conclusion are the most important parts here. intro gives lots of info about the field. conclusion tells you why this paper is important. the stuff in between can be difficult and less vital to understanding the field than you think
    - make lists of keywords and identify relevant textbooks.
- I'm new to this field. I don't have much background, but my goal is to really understand the main result this paper.
    - this happens a lot when you start a research project with a prof. they give you a couple of papers to read, often with an implied goal of you becoming familiar with the specific results.
    - ask for a specific outcome of reading these papers.
        - "are we going to use a similar experimental method?"
        - "will this paper explain all of the theory I need to know?"
        - "why do you want me to read this?"
    - if your prof gave you these papers, ask them questions. ask whether you correctly identified the assumptions and results of the paper. ask for direction once you feel you understand the paper---where are you supposed to go from here?
- I'm not so new to this field, but I don't have a specific question. I want to see where this paper takes me. I'm starting to construct knowledge of the research landscape. I want to practice asking good questions and hopefully come up with some questions that haven't been addressed in the literature yet.
    - make notes about how different papers connect to one another.
    - look at the assumptions made. why were they picked? convenience? physicality? do the assumptions exclude a set of phenomena? make a list of possible questions/extensions of the research stemming from changing the assumptions made.
    - it feels intimidating to hear about people coming up with their own research questions and areas and shit. follow your gut--pursue topics which get you a little excited. if there aren't "original" questions coming, don't worry. keep learning. use question strategies. it'll come.
    - question strategies:
        - change the assumptions up.
        - does this result impact x? e.g. other papers, your own understanding.
- I have a specific research question that I think this paper might help me out with.
    - write the question out.
    - identify what area you think the paper will help with.
    - write out how the paper does or does not help.

Skills: Surface & deep learning

- surface learning is superficial, often involves taking statements for granted. deep learning incorporates knowledge into your personal worldview/web of knowledge.
- deep learning is the goal in academic pursuits
- surface learning can be used strategically to get there. if the goal is to understand the results of a paper, it's not always effective to require deep understanding of every concept leading to the paper's results. this is partially due to the generically nonlinear organization of very new information and partially due to being new in a field--you gotta start somewhere, and it's not practical to go in a chronological order with a field that is decades old.

Skills: Maintaining a library

Keeping track of what you've read is an important and difficult skill. Citation tools can make this way easier. There are a few, but we'll focus on Mendeley for simplicity. This citation manager is free and has a browser extension, a web library, and a desktop version.

- use the browser extension to save a reference and available pdfs to the web library
- organize pdfs & references by folders and keywords.
- highlight and make notes directly on pdfs in the document viewer.
- make meta notes, viewable in the web and desktop libraries.
- grade A citation hygiene:
    - write short meta notes about why you saved a paper. the abstract of a paper tells you the content, but it won't necessarily remind you why you thought it was interesting in the first place.
        - "i liked another paper by this author and am collecting their work."
        - "the result in section two could be applicable for a particular extension of my research."
    - write down how you found the paper. this helps to construct awareness of the structure of the field, what searching methods work, and who is helpful to speak to.
        - "cited by this other paper."
        - "from a scopus search for ("superconducting qubits" AND "quantum field theory)"
    - save papers in folders describing their topics.
        - e.g. you have lots of papers related to superconductivity: save them in a superconductivity folder, plus a folder telling you whether they're experimental, theoretical, about applications of superconductivty, etc