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Tips for reading research papers

- While you're reading, ask yourself,
  - "What other problems can we solve using the tools in this paper?"
  - "What are limitations of the work that we might be able to overcome?"

Tips for leading discussions / giving presentations

- **Slides:** Whiteboard writing is good for math proofs, but if you don't want to present proofs, you should use slides or a mix of both. (i) Don't copy and paste from paper --organize the material. (ii) Contents should be logical. (iii) You should be able to explain almost every detail on the slides.
- **Rehearsal.** If possible, present the same material to someone (yourself in the mirror, your friend, officemate, professor, etc.). Remember, if you give a bad talk, you will waste 1.5 * 15 > 20 hours of other people's time! So the extra 1 hour is worthwhile.
- **Simplify things.** Decide on what topics to cover. Focusing on the most interesting parts of the paper (it's fine to mention other things in passing, but more as references). Feel free to simplify the exposition even if it means you're presenting a weaker result (papers have a tendency to do everything in full generality, which can hurt pedagogy). E.g. Instead of a result for n-dim problem, you can present 3-dim case first; instead of a convex function, you can discuss the quadratic function.
- **Proofs.** Ask yourself: if I were to derive the proof, which parts will I be stuck at? For doing proofs, the goal is to work through the key parts of the argument; if you say things follow from algebra, we'll believe you.
- **Big picture.** Make sure that everyone knows what you're talking about (review the high level problem setup and background) and why you're talking about it (convince us why we should care) before delving into the details. There will always be someone in the audience who would benefit from the basic problem setup or basic applications,
- **Outline.** Providing an outline of the remainder of the presentation (after the motivation) and referring back to this outline during the presentation can be quite valuable. If possible, put a time estimate next to each section so that you and other people have an estimate of how long things are going to take.
- **Notations.** Remembering notations is hard for the audience. To make it easier, try to give human interpretations to the mathematical symbols. One way to do this is to introduce the notation in the context of a motivating example that the audience can fall back on, e.g., "alpha_i, in the motivating example, were the individual students' latent abilities."
- **Board writing**. If you have to use the board, take full advantage of your board space, form a mental plan of how you'll use that space before starting your presentation, and avoid erasing what you wrote most recently if possible. A simple but effective strategy is to cycle through your boards, or, better yet, divide each board in half at the start of your

presentation and cycle through those board halves. If you have ample space, you can even dedicate part of a board to persistent text like useful definitions or an outline.

- **Discussion.** Understand the question before you answer it! (a common issue) When the presentation detours into a discussion, take on the role of facilitator. You can keep the audience engaged by repeating/rephrasing others' questions, providing context, and relating things back to the content of the papers. Don't stand there like watching a show.
- **Context.** When presenting a theorem, put it into an appropriate context. Evaluate its importance. Remind people why they should care. Indeed, we're reviewing these papers to learn not just what is in them but also how we can put that information to good use in the future.
- It often helps to remind the room midway through a long derivation what we're trying to accomplish and how the steps presented so far have aided us in that endeavor.
- As the discussion leader, you're in the perfect position to stimulate conversations or brainstorming sessions around how this material can applied or developed to tackle new problems.
- After the presentation solicit feedback so you can improve for next time! (Example of presentation survey)

Tips for following presentations

- It is basically impossible to follow a talk just by listening to the speaker. Your mind will inevitably wander, and unless the speaker is exceptional there will be parts that they don't explain well. The most basic correction to this is to refer to the board constantly (hopefully the important things are still up there) but this doesn't always work either: perhaps the speaker just really garbled something, or used a term without defining it, or we're in the middle of wading through a mess of algebra. In these situations you can do the following:
    a. *Ask yourself what's really going on.*
        - However complicated the current proof / algorithm / etc., it was created by a human who presumably had something in mind when they did so. In general, ask yourself: what are the different objects of interest and how do they / should they interact with each other? What difficulties was the author trying to overcome? Answering these questions will provide context that makes it much easier to follow the details.
        - For proofs, try to understand why the result should be intuitively obvious. For algorithms, try to understand why the design decisions are natural consequences of the problem statement.
    b. *Predict what is to happen next*
        - This helps you focus and is a preventative measure against getting lost in the first place; if you can stay a step ahead then you have a buffer when things get more difficult.
    c. *Keep examples in your head*

        - I know very few people (basically no one) who can understand complex abstract arguments without any context. A long-term goal in mastering a field is to generate a good repository of examples, and have a good idea of which ones to pull out to better understand a given topic. If you don't have this yet, start by thinking of at least one example (and perhaps one counterexample as well).
    d. *Refer back to the original source if available.*
        - The speaker will often say things in a different way than the original paper did. If you have access to the original paper, you can look at the explanation there, which might help.
    e. *Ask questions / tell the speaker I am confused.*
        - If neither #1 or #2 help then I'm probably pretty lost. In this case I will ask questions to try to clear up my confusion, or if I don't know what question to ask, just tell the speaker that I'm confused. For some reason a lot of people are afraid to ask questions, I guess because they think it makes them look dumb or something. Not only is this not true, but refusing to ask questions deprives you of a great opportunity to increase your understanding. Asking questions despite the fear of looking dumb is a noble human endeavor. (Of course, asking questions to show off is not noble at all and should be avoided.)
- Ideally, if you are the speaker you should already be trying to do the converse of all of these: tell the audience what is really going on, preview the talk so people know what will happen next, provide good examples, provide a good source of notes in advance, and solicit questions if people seem confused.

Tips for benefitting from talks that you can't follow entirely

Inevitably you will be in a talk that you don't understand completely. Here are ways to make the most of this situation.

- *Realize that there is something to be learned*
    - If you can't understand a talk, this is an indicator that there is a topic/idea that you do not yet know about, that someone thinks is important enough to spend 2 hours on. Try to understand what that topic is so that you have the opportunity to learn more later.
- *Understand what the tools can do*
    - As follow-up to this, if you can't get anything else out of a talk try to at least understand what the tools being presented are capable of doing. For me personally, I know **about** far more tools than I know **well**. This is very useful, because as long as I know what different tools are supposed to be able to do, I know when one is likely to be relevant to a problem I'm trying to solve, and then I can read more about it to gain the necessary expertise.
- *Write down 3 ideas/questions*

    - Try to leave every talk with at least 3 ideas/questions. This may seem like a modest goal but most people don't achieve it, and the exercise of doing so will make you more attentive.
- *Talk to people afterward*
    - You're at one of the best programs in the world. This is an excellent opportunity to learn from your peers. If you're confused by something, try to work it out with someone afterwards.