

## Preface

Reading research papers in mathematical disciplines takes training. A student's natural tendency is to read a paper from beginning to end in a depth-first manner. Every time they get stuck at a concept, they branch down another path, and then another, to the point where even getting through an abstract for a paper can take days and is exhausting.

Needless to say, this is not the best way to read technical material of any kind, mathematical or otherwise.

I have spent many hours explaining to my students how they should be reading papers, and if you're reading this and you have students of your own, you've probably done the same. While I don't claim to have the perfect method for reading any given paper, I've learnt over the years how to quickly skim a paper, flying over it and scanning the terrain as it were. I've learnt when to make a deep dive all the way to ground level, and when to resurface. And above all, I've learnt to distinguish the different reasons for reading technical material in the first place, and that each mode requires a different treatment.

I've looked all over the web for good material to give to students to learn how to read papers in (theoretical) computer science. I've found a few short articles here and there: S. Keshav's note on reading systems papers, Michael Mitzenmacher's helpful document, a page by Jason Eisner, and the many blog posts by Terry Tao, to name a few. There are also a number of good short articles on reading mathematics that I've drawn some inspiration from.

But none of these capture the essence of what I try to achieve in my reading and what I want my students to be able to do. It's a kind of Thurstonian ideal of understanding: where the proof falls away and what you're left with is a deep conceptual appreciation of how the parts of a proof (or a theorem, or a set of definitions) fit together, and what they really *mean*.

Moreover, if one is to *teach* the art of reading, it is important not just to describe the goal, but to find a way to get there: with exercises, little practices, and muscle-strengthening activities. This is after all the difference between teaching and showing.

That is my motivation for this collection of notes. It is my attempt to demystify and systematize a set of tools for reading papers. It will not be complete, and it will likely not resemble how you read papers. But hopefully it provides one way of getting to the promised land.

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### *Narrowing the scope*

There is no one-size-fits-all strategy for learning how to read technical material. Indeed, even within computer science, one would read a paper in operating systems very differently to one in algorithms, or one in machine learning or even one in programming languages.

I make no claim to generality in these notes. I will limit myself to what I know: papers in algorithms (and theoretical computer science in general), with some side excursions to areas like data mining and machine learning that combine mathematical treatment with some empirical validation. I cover these other areas mainly because many of my students work on the border between theory and practice, as do I, and there's often a "intimidation by mathematics" effect that I hope can be mitigated by being better able to understand the mathematical elements of such papers.

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### *On Reading "with purpose"*

But what is "reading with purpose" anyway ? We read for many reasons. We might read a paper to learn about a problem, or review it for a conference or journal. We might be looking for a particular lemma, or a proof technique. We might be using it as a reference for related work. And we don't just read papers. We read lecture notes, surveys, monographs, textbooks, short abstracts, and proposals. Each of these different media, and purposes, require a slightly different reading strategy. And I've found that even this realization is both surprising and important for students.

And thus the title. The idea in this seminar is to be aware of the different reasons ("telos") a paper is written and read, and adjust one's interpretation of the work and strategies accordingly.

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### *On Reading And Writing*

If you're reading these notes in an attempt to learn how to read papers better, be warned that as a side effect you might start *writing* better as well! Indeed, reading and writing are really two sides of the same communication coin. One of the most basic precepts in writing is: "know your audience". Once you have a good understanding of how to read a paper, and thus understand the reader (the "audience") well, your writing will inevitably improve as you seek to provide that which the reader wants.