

How to do Research (from a Theory Perspective)

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- Ranges of Research Results
- How to Find good Problems to Work on
- Research Reading
- Tips on Becoming a Good Researcher
- Final Comments

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- 4 Showing connections between problems in diverse areas (and transferring techniques between the areas).
- 5 Developing a new, interesting area of research.

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- **Learn to read!**

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 - What if you try ... ?
 - Are their open questions interesting?

Make careful and detailed notes

- write down ideas, questions, conjectures, observations, proof attempts, examples, counter-examples
- when you hit a blind alley, reread your old notes

Start small

- It's unfortunate that when you read a paper you don't see all the blind alleys, failed conjectures etc.
- Work on lots of examples, even trivial ones.
- Having seen some examples, try to extrapolate to a conjecture.
- Alternate between trying to prove/disprove the conjecture.
- Learn to appreciate counter-examples, not just for the time saving since you don't have to try a proof. Understand the structure of the problem illustrated by the counter-example.
- When you have a counter-example, adjust your conjecture - sometimes the counter-example just illustrates a special case.
- When you have a proof, try to generalize the new result.

Put emphasis on definitions

- Without the proper definitions, you can't hope to build an elegant theory.
- Gian-Carlo Rota - approx. quote. "The key to doing mathematics is getting the right definitions - proving theorems becomes a matter of hygiene."
- Try to develop a feel for when you have the right foundation of definitions.
- If things just don't feel right, there is a good chance that they're not right.

Manage your time

- Make sure you're devoting enough time for research - at least 50%.
- Prime thinking time should be spent on research.
- Most people should avoid marathon research sessions, especially when alone.
- It's very easy to avoid doing research by spending too much time on courses.
- Become a persistent researcher - be reluctant to "give up" on a problem. Discuss abandoning a problem with your supervisor.
- Meet regularly with your supervisor, especially if you're having trouble keep your nose to the grindstone.

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- **Learn to criticize your own writing:** Reading out loud often helps.

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- The lows can be very low - but, in my experience, most failed results have eventually contributed to something that has succeeded.
- As you mature as a researcher, you'll develop a set of great (international) research colleagues. The friendships can be as rewarding as the research itself.

Thank you for your attention