On conducting research

Some scattered and not very well organized thoughts (which I may change my mind on …)

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Research sounds daunting

- How can I constantly produce new results?
- Isn't this an impossible job?
- I am having a tough time getting done with my thesis, how can I think of doing this as a career?
- Will I be able to come up with problems to solve all by myself?
- Am I in the right place?
- What job should I apply to?
- How can I succeed in an academic career? …

Lots of topics …

- Academic careers
- Theory vs. practice
- Funding problems for new faculty
- How to give presentations
- Industry job or university job? Can I switch from one to another?
- ….

Let's start with graduate school

At the beginning of your graduate studies

Get theoretical depth

- Luck favors the one who is prepared
- Take a solid set of foundational courses
- Breadth is important
- Depth is perhaps even more important
  - Math courses
    - » Analysis, Graph Theory, Combinatorics, Algebra, Probability Theory, Stochastic Processes, Topology
  - Computer Science courses
    - » ….
- There is no substitute for theoretical depth

Read classic originals

- Go to the original classics
- They are richer in ideas than subsequent "compactified" presentations in textbooks, exposes
- Examples
  - Blackwell's original papers on dynamic programming
  - Shannon's original papers on information theory
- What is an appropriate list for Computer Science?

Learn how to learn a field

- Teach yourself
- Learn how to assimilate an entire field all by yourself
- That gives you greater confidence than reading it in a textbook or from someone else
- In the future you will need to learn new areas by yourself

Towards the middle of your graduate studies

Finding the problem is 90% of the problem

- Research is not just "solving a problem"
  - Though that too can be formidable research: E.g., Solving Fermat's problem
- What is the field really about?
- What are the real bottlenecks?
- What is solvable?
- What is already known?
- What is it that is unknown?
- Why?
- ….

Later in your graduate studies

Do research only if you really like it

- You need to be very very highly motivated to do research
- There are several other professions to choose from
- Your advisor cannot motivate you to do research
- You should not be in this career because of your parents, …

Period of wilderness

- All (many, some?) graduate students go through a period of wilderness
- A period where you are not sure what you can do
- A period of searching with no light at the end of the tunnel
- Such a "period of wilderness" can be very good for you
  - In fact, I think all grad students need to go through such a period
- That is when you read a lot, you find out where exactly a particular book is on the library bookshelf, or nowadays what papers are on a particular webpage
- It is in this period that you become an "expert"
- Afterwards your students will think your knowledge is amazing

Attend conferences

- Books
  - Its all done! :(
- Conferences
  - Is this how little is known in this area? :)

The importance of making good research presentations

- You will get noticed because of your research presentations
  - In addition to your published papers
- Of course, there is simply no substitute for good results
- After you have done good work, you need to present it well
- Clarity of exposition is key
- Everything is simple
- Show everyone how simple it really is
- This takes a lot of work
- Frequently you yourself learn more about what you have been thinking when you strive to present it well

Strategic vs. Tactical research

- Think strategically (perhaps later in your career)
- Ask how to shape a field or define a field
- As opposed to how do I extend a result
  - Though that is also very important

When you are getting ready to graduate

Should you get an academic job or an industry job or a start-up …?

- There are three extremes:
  - Start ups, Universities, Industry leaders
  - Everything else is in between
- If you are thinking about an academic job
  - Aren't academic jobs nowadays difficult careers, hard to get, …?
  - How can you constantly produce new results?
  - Isn't it an impossible job?
  - I am having a tough time getting done with my thesis, how can I think of doing this as a career?
  - Will I be able to come up with problems to solve all by myself?

Aren't academic jobs nowadays difficult careers?

- You should consider an academic job only if doing research is completely unstressful to you
  - Roughly one PhD Thesis equivalent every year or so
- If it is not the right profession for you, it will be a huge strain on you, your family, etc
  - Be honest with yourself
  - Knowing others is intelligence, knowing yourself is wisdom
- You should be prepared to spend a lot of time, perhaps most of your time, on your research for the next eight (or some other number of) years
  - Will you be happy doing that?
- Research is all consuming: time, effort, attention, and life consuming
- You should make research your job only if you love it
- If you do like it, it is the best job in the world

Aren't academic jobs nowadays hard to get?

- A small not well known university may be the best choice!
- You do not need to start at a top notch university
- In fact, a small university allows you to establish yourself in an absence which is not a pressure cooker
- You will eventually equilibrate in your career at a job at as good a university as your accomplishments
- It is better to be a big fish in a small pond

After you get an academic job

Don't get swamped by teaching

- If teaching takes up all your time and swamps you, that is not good
- You need to pay attention to your research, and lots of it
- At the same time you need to teach well

How can one possibly generate research problems?

- Several approaches
- Let me illustrate a (relatively) easy route
- Start with a practical problem, and try to get to the heart of it
- The real world is very rich and admits a lot of new ideas

Attend lots of conferences

- About 2 or 3 (or more) a year …
- This is where you find out how little is known in a field
- You also get to know the people in the research community
- Also, you will get noticed through your good work and its presentation
- If you cannot get funding, pay for it yourself

What about funding?

- Getting funding for your research is not magic
- It is a question of writing proposals, talking to program managers
- You just need to talk to peers, senior faculty, etc.
- Find out all the opportunities that there are, and target all of them in a systematic way
- Its just a question of approaching it in an organized way
- In the long run do good work and everything else will follow - funding, glory, students, …

What about tenure?

- Do great research
- Teach well
- Whatever service you are assigned, execute it well
  - Be reliable with respect your service activities

Perhaps later on in your career

Quality not quantity

- You will be known by your best work
- Not by how many papers you have published
  - Later in your career!
  - In the beginning, aim to get published, and get over that threshold first
- The norm by which your accomplishments are measured is L_∞ not L_1
  - Max {Papers} rather than $\sum$ Papers

Questions and
open ended discussion