All About Research: Getting Started

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Background: Jeanne Ferrante
- Ph.D. Math., MIT, 1974
- Assistant Professor, Math., Tufts 1974-78
- IBM T. J. Watson Research Center, 1978-94
  - Transition from theory to compilers
  - Projects
  - Experimental Compiler System
  - PTRAN: parallelism
  - Program Dependence Graph, Static Single Assignment
- Professor, CSE, UCSD, 1994-present
  - Memory Hierarchy
  - Runtime and compiler optimizations for performance
  - Scheduling large-scale distributed systems
- Associate Dean, Engineering, 2001-present

What is research, and why do it?
To investigate a problem in scientific manner
Goal: solution that advances state of knowledge
- theory to experiment, algorithms to prototypes
- Why?
  - Be on leading edge of discovery
  - Transfer discoveries for societal benefit
  - It’s playful, creative, fun and rewarding!
  - Interesting careers in academia and industry

Surely You’re Joking, Mr. Feynman!
- “Now that I am burned out and I’ll never accomplish anything...I’m going to play with physics, whenever I want to, without worrying about any importance whatsoever.”
- “Within a week I was in the cafeteria and some guy, fooling around, threw a plate in the air. I saw it wobble, and I noticed the red medallion of Cornell on the plate going around....the medallion went around faster than the wobbling. I had nothing to do, so I start to figure out the motion of the wobbling plate.”
- “There was no importance to what I was doing, but ultimately there was. The diagrams and the whole business that I got the Nobel prize for came from that piddling around with the wobbling plate.”
**How to get started in research?**

- Choosing a research area
- Identifying a research advisor
- Choosing a Ph.D. committee
- Identifying a thesis topic
- Working in a research team
- Getting financial support and what’s expected
- Planning for academia vs. industry

**Choosing a Research Area**

- Area exciting and interesting to you
- Important problems in area
- Activities in the area should suit you
  - Systems vs. theory
  - Take courses, attend seminars
  - Talk to professors, visitors, other students
  - Read widely
  - Learn about yourself!

**Identifying a research advisor**

- Talk to other advisees of potential advisors
- Talk to potential advisors and ask:
  - What are their upcoming projects?
  - Do they have research assistantships?
  - How much time they expect to spend with new students?
  - How much time they spend with current students?
  - Do they have group meetings?
  - What’s are their expected milestones for a Ph.D. student?
- Try out a few advisors
  - Reading course, small project

**Choosing a Ph.D. Committee**

- Advisor will make suggestions
- Talk to each potential member about your research area and thesis topic
- A member outside your area can give valuable insights, but you need to explain in their terms
- A member inside your area can function as a co-advisor
- The hardest part of getting a Ph.D. is scheduling your thesis committee!
Identifying a Thesis Problem

- Question assumptions
- Hot topics: advantages and disadvantages
- Take time to understand the problem thoroughly
- Break the problem into manageable pieces
- Develop methods that work for you:
  - When to work deeply or broadly, when to put aside
  - Have a variety of activities that can vary your day
  - Set aside blocks of time when you focus on each activity
  - Keep a work diary
- Research is not knowing the answer or how to get it!

Bertrand Russell, Autobiography

“Every morning I would sit down before a blank sheet of paper. Throughout the day, with a brief interval for lunch, I would stare at the blank sheet. Often when evening came it was still empty. ... It seemed quite likely that the whole of the rest of my life might be consumed in looking at that blank sheet of paper ...”
Went on to publish (with Whitehead) the 3-volume *Principia Mathematica*

Working in a Research Team

- Research often a collaborative, social process
- Work on communicating your ideas
- Be generous with giving credit to others, but
- Carve out your problem in the group and
- Stand up for your accomplishments
- Your role in the team may change as you progress
- Team is a good place to try out ideas, practice talks, get feedback on papers, advise other students
- Any problems should be brought to team leader sooner rather than later

Getting financial support and what’s expected

- Research assistantships vs. fellowships
- Try a teaching assistantship at least 1 term
  - Builds communication skills, learn the area in a new way
- For RA’s, expect to work on grant area initially
- Prepare for your research meetings
  - Its fine to question assumptions
  - Develop your own opinions and present them well
  - Consider keeping a research diary
- Make sure you will be getting publishable results
- Try your hand at grant writing, supervising students
- Your aim is to become an independent researcher
### Planning for Academia vs. Industry

- **Industrial research lab**
  - Colleagues, few students, no grants, company concerns

- **University**
  - More multitasking: teaching, service, advising graduate students, grants

- **Need to plan in advance for academic careers**
  - Publications and where to send them, teaching, leadership