Intro to Research and Grad School

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The Point

- **Successful transition from UG to PhD or thesis MS student requires a fundamental attitude adjustment**
  - **In contrast: Course-based MS can largely be viewed as an extension of UG education**

The Point Continued

- Undergrad degree is about learning known material
- Grad degree is about…
  - Learning how to create and communicate new knowledge
    - Dirty secret: We cannot directly teach either of these
  - Becoming an expert in your area
    - By halfway through you should be teaching your advisor new things

What is Research?

- Like pornography: Hard to define, but you know it when you see it
- Like a patented invention: Should be new, useful, non-obvious
- Characteristics of a research problem
  - Answer will advance the state of the art
  - Chance of failure
  - More than implementation

How to Fail in Grad School

- Focus only on course work
  - It worked as an undergrad, right?
- Totally blow off course work
- Use your brilliance as a crutch
  - The smarter you are, the later you learn how to work hard
  - Nobody gets a PhD without working hard

How to Fail in Grad School

- Don’t ask for help…
  - Assume people know what you’re doing
  - Assume you are expected to know everything already
- Don’t listen when people give you advice
- Do all your work from home

Succeeding in Grad School

- **Attack problems like a two year old**
  - **Play with things fearlessly and relentlessly**
  - **Don’t worry about breaking them**
  - **Just do it – do not give up**
- **Find an advisor who’s right for you**
- **Learn basic science**
  - **Statistics and experiment design**
- **Pick up the necessary math and CS theory on the way**

Succeeding in Grad School

- **Balanced time management**
  - **Research, classes, TAing, etc…**
- **Be present and engaged**
  - **Be part of the grad student culture**
- **Be proactive and persistent**
  - **1% inspiration, 99% perspiration**
  - **“You only need a good idea about every two years”**

Succeeding in Grad School

- **Read a lot**
  - **But not too much**
- **Write a lot**
  - **Write earlier rather than later**
    - **Writing kills bad ideas**
    - **Writing helps good ideas develop**
  - **Impossible to write too much**
  - **Sooner or later you'll need to become a good technical writer**

Finding an Advisor

- One of the most important decisions you'll make here
- Questions
  - Are you interested in the research?
  - Are your styles compatible?
  - Do you want a new professor or an established one?
  - Do you want a big research group or a small one?

Finding an Advisor

- **How to answer the questions?**
  1. **Surf the web, read papers**
  2. **Talk to students and professors**
  3. **Go to prospective advisors' research meetings**
  - **Start now**
- **Should find an advisor this year**
  - **Preferably this Fall**
- **What if it doesn't work out?**

Changing Advisors

- **Don’t be too stressed, it happens**
- **However:**
  - **Make honest effort to explore all options before switching**
  - **Communicate clearly with everyone involved**
  - **Avoid burning bridges**
  - **Should rarely happen more than once**

The Implicit Contract

- **Unwritten two-sided agreement that is the basis for all good student-advisor relationships**

- **Breach of contract – on either side – may be grounds for terminating the relationship**

Your Advisor Must…

- Advise you
- Teach you how to do research in your area
- Teach you how to write papers
- Protect you from funding concerns (within reason)
- Help you find an interesting and relevant thesis topic

Your Advisor Must…

- **Be your advocate to the department**
- **Eventually**
  - **Let you give conference talks**
  - **Introduce you to your research community**
  - **Write letters of recommendation for you**

You Must…

- **Be a good investment in terms of time and money**
  - **Be present, visible, and willing to learn**
  - **Learn and work independently**
  - **Get stuff done**
  - **Learn to publish results**
  - **Support the group's research**
- **Jump through some hoops**

What is a Thesis?

- A statement that can be proved or disproved
- A document that does this

- You are here to produce these

What is NOT a Thesis?

- A question
- An algorithm
- A non-falsifiable statement
- A collection of experiments
- A program
- A piece of hardware

Finding a Thesis Topic

- Probably the hardest part of grad school
- Needs to be
  - A new idea (Ph.D.)
  - A good idea
  - Right level of difficulty
    - Doable by you
    - In the next 18 months (Ph.D.)
- Remember: It’s not your life’s work

Finding a Thesis Topic

- **Should be a reasonably hot topic**
  - **You don't want to give job talk based on stuff nobody is interested in, or thinks is important**
  - **Perfect topic: Area will be hotter in 5 years than it is now**
- **You better be excited about it when you start**
  - **You'll be sick of it by the time you're finished**

Finding a Topic: Hamming's Razor

- What are you working on?
- What's the most important open problem in your area?
- Why aren't they the same? (Ouch!)

What is a Dissertation?

- Existence proof that you can do research
- 2 ± 0.5 years of hard work
  - Necessary but not sufficient
- Whatever you can get five professors to sign
- Like getting a driver's license:
  - If you pass the exam nobody cares what your score was

Time Management

- **Research – this is what you're primarily here for**
- **Classes – can't screw these up**
- **TA duties – can't screw these up**
- **Service to your group**
  - **Think of it as a tax**
- **Service to the department**
  - **Somewhat optional**

Coding in Grad School

- Code only to support a research goal
  - Except for classes or for fun
- Don’t tune for performance unless it really matters
- Don’t act like a professional programmer – you’re not being paid enough

Coding in Grad School

- **Do learn a language that supports rapid prototyping**
  - **Perl, Python, Scheme, or whatever**
- **Do learn professional paranoia**
  - **Code producing numbers for publication better not be wrong**
    - **Understand the algorithms**
    - **Test code creatively: Use code reviews, unit tests, test harnesses, randomized testing, etc.**

Reading List

- ***The Dream Machine* – Waldrop**

- ***The Mythical Man Month* – Brooks**
- ***Hackers* – Levy**
- ***Elements of Style – Strunk and White***
- ***The Visual Display of Quantitative Information* – Tufte**

Conclusion

- **You arrive as a student, leave as a colleague**
- **Many people enjoy grad school**
  - **Try to be one of them**
  - **SLC has unparalleled access to outdoor recreation**