FINDING A RESEARCH TOPIC

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• Research:
  ✓ Virtual Reality
  ✓ Robotics
  ✓ Human-Computer Interaction
  ✓ Physically-based Modelling, Simulation & Animation
Research and Core Interests History

• CS, Asian Studies, Understanding Languages (BA Williams College)
• Diagrammatic Logic for Hardware (MS, PhD Indiana University)
• Hardware Verification (Postdoc Rice University)
• Software Verification, Software Security (WPI)
• Computing Education Research with emphasis on role of Programming Methods and Languages (Brown University)
• Effective integration of Math+CS in K-12 for teachers and students (Bootstrap: a national-scale K-12 outreach program on computing and data science)
WHERE ARE YOU IN YOUR SELECTION OF A RESEARCH TOPIC?
Which Best Describes You?

Show of Hands ...
• Do you already have a settled advisor?

Regarding the stage of your research:
• I have a concrete thesis topic
• I have an area/direction, but not yet a concrete topic
• I don’t have either an area/direction or a topic yet
• Other
FINDING A RESEARCH TOPIC:
SOME BASICS
What to Know...

• The path to find a research topic will be a zigzag road
  • Don’t expect to find it in just one shot

• Often your research topic changes along your career
  • So no need to feel that you will be stuck with your Ph.D. topic for the rest of your life

• Ok to span two fields
  • Many breakthroughs are made this way
Selecting a Topic

Moving from coursework to picking a topic is often a low point, even for the most successful students.

Why?

— Going from what you know (coursework with answers) to something new (research) in which no one knows the answer and there can be many answers.
Two Key Ingredients

A Good Advisor

A Good Research Question
Selecting an Advisor

What should you consider when selecting an advisor? Working style and what they can prepare you for.

Compatible working style is important

- Prefer scheduled or as-needed meetings?
- Hands-on in training on paper writing, etc?
- Degree and topics of mentoring?
- Get to know your working style; be honest with yourself
- An advisor can (should) be for life
Selecting an Advisor

What should you consider when selecting an advisor? Working style and what they can prepare you for.

Preparing you for your goals

- Do they publish at the level you hope to?
- Are they connected in their community as you’d want to be?
- Do they write successful proposals (if you’ll need to)?
- You have to work hard to place better than your advisor
Advisors and Funding

Graduate students are generally funded by one of a research position (RA), teaching position (TA), or personal funding (rare for PhD)

If your advisor funds you from grants

- taking on a PhD student requires them to raise ~60K per year
  - Federal grants, corporate awards or gifts, scholarships
- your work may need to align with their funding
- they will gauge your fit for their group before agreeing
- you may be asked to help write a proposal for your work
Now the harder part: Find a research topic

*The path to success consists of three simple elements. Find what interests you that you can do well, and is needed by the people.*
Find your own strength

Understand others is intelligence.
Understand yourself is wisdom.
--- Lao Tze

• What is easier for you?
  – Writing and modifying a complex software and debugging it?
  – Prove theorem?
  – Analyzing data?

• How to find it if you don’t know?
  – Try various projects/classes
7 WAYS TO IDENTIFY A GOOD RESEARCH PROBLEM
A Talk Inspires You

- You hear a talk in your area and think “I could do that better!” or “Why didn’t they think of X?”
- You start a discussion with the speaker...

Warnings:
- Your idea may have already been done
- Your idea may not work
Data Need Answers

- You participate in a data collection/analysis effort with another student or in industry
- You become fascinated with the potential to answer questions no one is asking
- Warning:
  - If industry, make sure you can access the data and publish
  - There may be a question of who gets to answer those questions
The Apprentice

- Your advisor has a list of topics/funded projects that need to be worked on
- A fairly common, easy method

**Warnings:**

- Several people may be working on the project: you have to find your own angle
- Don’t work long on something that isn’t really exciting
The Extended Course Project

➢ You do a project in a course that turns out to be great – you want to do much more
➢ Another pretty good method
➢ Warnings:
  ➢ Check with your advisor
  ➢ The project may not be extensible to a PhD thesis
The Fixer

- You get annoyed by something and wonder why things (don’t) work that way

- Warning:
  - Can end up picking something too big or too vague: it’s okay to make solid progress on a vexing problem, without getting all the way to a solution
You wake up in the middle of the night with a wonderful idea or a new approach to solve an open problem

Warnings:
- It may not seem so wonderful in the morning
- Even if it does, you may not be able to convince others
- Note that it doesn’t usually work this way!
The Interdisciplinarian

- You learn about a problem in another field that you think you can help with (e.g. history and computer science)

- Warning:
  - You will need real collaboration with someone in the other field
  - You’ll need to make the case that this really is a contribution to both fields (especially to your own)
THINGS TO THINK ABOUT
Love Your Topic ... Enough

You’ll be living with it for several years

– Sets the course for your next 2-3 years
– Determines, in part, opportunities offered to you upon graduation
– May work in same/related area for years
– You’ll have periods of doubt, disliking your topic, thinking you aren’t getting anywhere.

All normal!
Topic Scale and Scope

Scale
Should be big enough to have more than one open problem, or solving one should lead to another

Scope
– Too narrow, e.g., just analysis no experiment, not leave enough room
– Too broad, open ended e.g., data mining, for what? why?

Beware Hot Topics Unless Truly Interested
Interdisciplinary Research Topic

These days, many top faculty candidates have interdisciplinary thesis topics

- Examples: AI + Systems, HCI + Software engineering, AI + Biology/Medicine, HCI + Psychology, database + architecture, HCI+ education.

Benefits

- May leverage your interest/strength in the other areas
- You can find jobs in other areas/departments
- You can easily find coadvisers and collaborators
- It might be easier to bring “fresh air” to an old area or problem
- There is so much to learn, so you won’t get bored
Think “Out of the Box”

- Great things are not incremental advances
- Examples:
  - Our field thought $X$ but in fact $Y$ is true
  - No one thought we could do $X$ \textit{but in fact we can}
  - No one thought of doing $X$ but here are \textit{reasons why it is crucial}
FINAL TAKEAWAYS
Useful Things to Consider

- Is your topic doable?
  - Do you have the tools? the data? the skills?
  - If not, can you get them?
- Do you have a story to tell?
  - Why my topic is new
  - Why my topic is scientifically exciting
  - Why solving my topic will help the world
Once You Find a Topic

- When you tell your story
  - Does your advisor like it?
  - Do your friends think it’s cool?
- What if no one likes it?
  - Maybe you’re wrong: Consider it
  - If you still think you are right, try to convince your advisor
- Personal story: Advisors can be wrong but you need to gain their support or find another
Now for the practical side

- Is it doable in the amount of time (5-7 years total for the PhD) you have?
- Is it fundable?
- Is it something you can get a job you like with?
Tips and Suggestions

• Topic + advisor are both important

• Follow your interests and passion
  – Key driver for success and impact
    • Are you eager to get to work, continue working?

• If not really interested, adapt
  – Tedium or actual lack of interest and motivation?
When you’re stuck at the start

Read/present papers regularly to find open research issues
• Practice summarizing, synthesizing & comparing sets of papers
• Write your own slides for presentations
• Don’t 100% believe what a paper says

Work with a senior PhD student on their research

Get feedback and ideas from others: conferences, research internships, advisor’s idea

Sometimes you need to take a leap of faith!
• Be open to trial – and - error
When you’re **still** stuck…

**Do internships in industry**
- They have many problems but have no time to solve them

**Attend PhD oral exams, thesis defenses, faculty candidate talks**
- Understand how to formulate problems
- Understand what constitutes a problem solution

**Assess your progress, with your advisor**
- Set goals per semester
- Have you ruled out an area? converged on an area?
- Chosen a topic for an exploratory research project?
When you’re really really stuck

• Change research topics?
  – May move you out of your advisor’s comfort zone of expertise
  – Starting from “scratch” (e.g., need to learn the related work in a new area)

• Change research advisor?
  – May go through ‘shakedown’ period again
  – May or may not be better off

• Sometimes taking a few months break can relax you and freshen up your mind!
A Great Article for Every Grad Student (and Advisor)

“How to Succeed in Graduate School: A Guide for Students and Advisors,” ACM Digital Library
Resources

CRA-W Career Mentoring Workshops:
– http://www.cra-w.org/ArticleDetails/tabid/77/ArticleID/50/Career-Mentoring-Workshop-CMW.aspx

On Academic Life:

On Post-Docs:
– http://cra.org/resources/bp-view/best_practices_memo_computer_science_postdocs_best_practices/

Tips on doing an academic job search:
– http://matt.might.net/articles/advice-for-academic-job-hunt/
– http://people.mills.edu/spertus/job-search/job.html

Job Ads:
– http://cra.org/ads/
FINDING A RESEARCH TOPIC:
OPEN DISCUSSION!!
Q & A

➤ How many of you have topics you’re happy with?
  ➤ How did you find them?

➤ How many have topics you are not so happy with?
  ➤ How did you find them?
  ➤ What are you going to do about it?