FINDING A RESEARCH TOPIC

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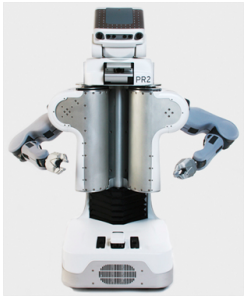
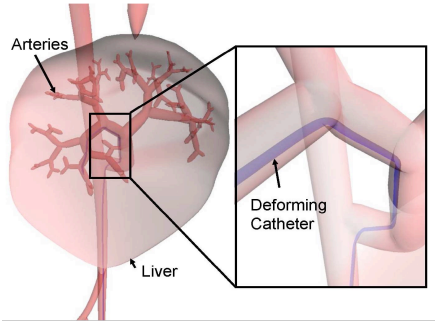
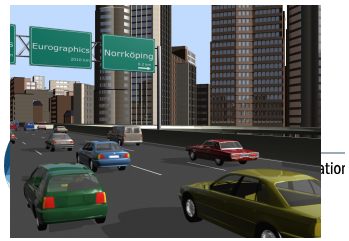
Ming C. Lin

- B.S., M.S. Ph.D. In EECS, University of California, Berkeley
- J.R. & L.S. Parker Distinguished Professor Emeritus, UNC-CH
- Elizabeth Stevinson Iribe Chair, UMD, College Park
- Research:
  - ✓ ***Virtual Reality***
  - ✓ ***Robotics***
  - ✓ ***Human-Computer Interaction***
  - ✓ ***Physically-based Modelling, Simulation & Animation***







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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

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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

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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

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Two Key Ingredients

A Good Advisor

A Good Research Question

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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

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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

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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

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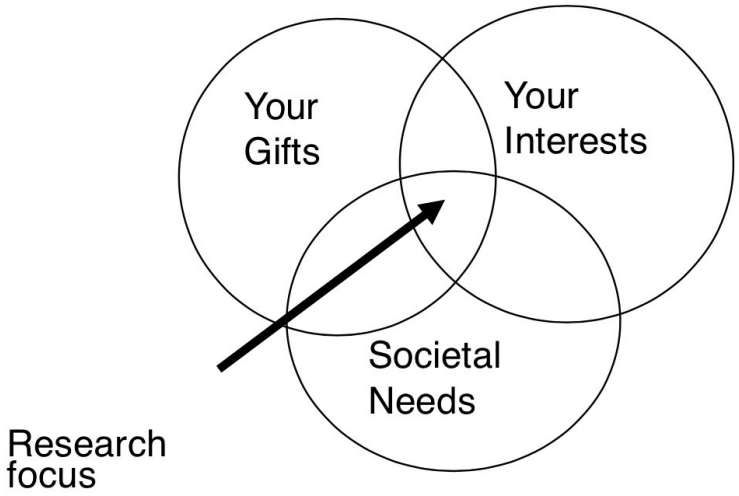
Now the harder part: Find a research topic

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



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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

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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

Flash of Brilliance

- 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!

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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

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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**

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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 ***but in fact we can***
  - No one thought of doing X but here are ***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?

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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

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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?

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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:

- http://blogs.scientificamerican.com/guest-blog/2013/07/21/the-awesomest-7-year-postdoc-or-how-i-learned-to-stop-worrying-and-love-the-tenure-track-faculty-life/
- http://dynamicecology.wordpress.com/2014/02/04/you-do-not-need-to-work-80-hours-a-week-to-succeed-in-academia/

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
- https://homes.cs.washington.edu/~mernst/advice/academic-job.html

Job Ads:

- http://cra.org/ads/

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FINDING A RESEARCH TOPIC:
OPEN DISCUSSION!!

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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?

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