Research Methods in computer science

Spring 2025

Lecture 3

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Agenda

Research Topic Formulation

Recap…

- What do you need to know/learn?
- What do you already know/learn?
- What do you want to work on?

- Practice, observe, adapt, seek feedback, iterate

Finding a Topic

Different from working on a topic

Didn’t get a chance to practice this much until now

How to Find a Topic?

An Observation About Ideas…

Rarely do we see an idea with no relation to the existing body of knowledge.

How to Find a Topic?

Read, read, read, discuss, go to talks

Discuss research/tech when eating lunch!

Listen to your advisor: sometimes you may not have a choice, but you can still bring small ideas

How to Find a Topic? - 2

“it's really stressful just knowing that you have to come up with a new idea/question that thousands and thousands of genius researchers before have never thought of or solved. How did you come up with your idea in your particular field?

Also, what qualifies for a research topic? If I use previous knowledge and bring them together in new ways, does it count? Feels even more impossible to come up with an entirely new theory in say, math that just happens to have been overlooked by euler or gauss. Or discover a new property of an element or some random cell in the human body.”

https://www.reddit.com/r/PhD/comments/vt8c7j/how_do_you_come_up_with_a_topic_for_research/

Idea Generator Heuristics

- Combination / Hybrid techniques
  - From the same discipline
    - (e.g., ….)
  - From a different discipline
    - (e.g., ….)
- Address Gap/limitation (Incremental?)
  - Handle some cases that were not handled
  - Improve some (partial) aspects of dimension
- Apply different datasets / settings / contexts

We will revisit this topic later in the semester!

Lets say you are convinced you found a topic. You are excited.

How to know if we should pursue the topic?

Why do (PhD) research?

Do not work on ideas before evaluating them. Learn how to evaluate them.

Finding a research topic - 1

A hard problem

– but some heuristics may help:

Subject candidate topics to four basic questions [Herb Simon]:

1. Will anybody care about the answer?
Is there any utility in answer? Sometimes we care about the answer even without utility (e.g., DNA structure, structure of the Universe).

2. Solvable within the given amount of time?
Is this the right time to start with it? Can I finish it in 2-4 years?

3. Will I be the first to answer this question?
Need to look at past and ongoing work around the world. Are other people working on it now?

4. Do I have good tools to address this question?

Adapted from slides by Marek J. Druzdzel

Finding a research topic - 2

Why will I be successful in my research?

"Because I'm smarter than others"

bad answer ...

There are scores of smart people around.

"Because I'm a hard worker"

better ...

But everybody who wants to succeed works hard.

"Because I have a secret weapon"

Much better!

Adapted from slides by Marek J. Druzdzel

Finding a research topic - 3

What is a secret weapon?

A comparative advantage over your competitors to glory:

A good problem that nobody has thought about before.

- First to think about this problem because of personal or professional experiences?
  - Should we look for research ideas in journal articles?
- Resources I can access – people, computation resources, software, tools
- My background beyond technical: hobbies, music, interests in other fields, or life situations e.g., diseases common in my family, business links

Adapted from slides by Marek J. Druzdzel

We will see how there are parallels between finding good research topic vs finding good topics for startups.

We will discuss other ways of evaluating ideas next time. E.g., Heilmeier's ideas.

Do not work on ideas before evaluating them. Learn how to evaluate them.

researchdiaries.org

Rodrigo Fonseca

HW2 - Research Formulation

What are you trying to do? Articulate your objectives using absolutely no jargon.

How is it done today, and what are the limits of current practice?

What's new in your approach and why do you think it will be successful?

Who cares?

Heilmeier

HW2 - Research Formulation

If you're successful, what difference will it make?

What are the risks and the payoffs?

How much will it cost?

How long will it take?

What are the midterm and final "exams" to check for success?

Heilmeier