

The University of Melbourne
School of Computing and Information Systems

COMP90044

Research Methods

Semester 2, 2018

Section 1

Research Planning

Developing a research question

What type of research contribution do you hope to make ?

- Engineering
- Theory
- Practice

Aspects to consider

- What are the areas of uncertainty and opportunity ?
- How well do you know the literature in your area ?
- Is it well studied already ?
- What are the major questions ?
- Is it timely ?
- Who is the audience ?

Selecting a Research Problem

More aspects to consider:

- It's a problem you are interested in
- It's a problem your supervisor is interested in
- It's a problem you are willing to invest resources to solve
- It's a problem that can be attempted in a reasonable amount of time
- It's a problem you have the skills to tackle
- ...

Which is more important?

<http://qp.unimelb.edu.au/baileyj/>

It is best to choose a research topic about a problem that

- A** I am interested in
- B** My supervisor is interested in

Discussion examples

<http://qp.unimelb.edu.au/baileyj/>

Topic: How could the Google presentation of search results be improved ?

- A** I like it
- B** I'm not sure
- C** I don't like it

Discussion examples (cont.)

<http://qp.unimelb.edu.au/baileyj/>

Topic: Are microwave photonic filters better than ordinary microwave filters ?

A I like it

B I'm not sure

C I don't like it

Discussion examples (cont.)

<http://qp.unimelb.edu.au/baileyj/>

Topic: Applying process engineering to development of aerospace software requirements.

- A I like it
- B I'm not sure
- C I don't like it

Discussion examples (cont.)

<http://qp.unimelb.edu.au/baileyj/>

Topic: What are the advantages of storing Web documents in a compressed form ?

- A** I like it
- B** I'm not sure
- C** I don't like it

Discussion examples (cont.)

<http://qp.unimelb.edu.au/baileyj/>

Topic: Does the spatial configuration of polymer molecules follow any mathematical model ?

- A** I like it
- B** I'm not sure
- C** I don't like it

Discussion examples (cont.)

<http://qp.unimelb.edu.au/baileyj/>

Topic: To what extent can soil moisture patterns be predicted using information about vegetation, hillscape and terrain ?

- A** I like it
- B** I'm not sure
- C** I don't like it

Discussion examples (cont.)

Are these good research topics ?

- ①
 - Show $P = NP$
 - Show that smooth solutions always exist for the Navier-Stokes equations in 3D.
 - Show $P \neq NP$
 - Show that smooth solutions do not always exist for the Navier-Stokes equations in 3D.
 - Does $P = NP$?
 - Do smooth solutions always exist for the Navier-Stokes equations in 3D ?
- ② Build a computer program that can play Poker at the same standard as top professional players
- ③ Cloud computing for better carbon reduction

Where do I find a research problem ?

- Supervisor suggestion
- Reading the "Future Work" section of research papers
- Attend seminars
- Talk to other students
- Poster sessions at conferences
- Replicate/repeat existing results
- Identify findings that don't match up
- Read popular science magazines
- ...

Generating Research Ideas

There isn't recipe for doing research. Indeed the best research often makes a new recipe.

However, there are some strategies that may be useful for generating research questions and hypotheses.

- Juxtaposition
- Weakening assumptions

Brainstorming Ideas

Repeated restatement of interests, trying questions out, sleeping on them and reconsidering ... taking your time

Might try using juxtaposition. E.g.

Big data, optical communication, Peer-to-peer, hydroelectric power, finite element analysis, data mining, extrememum seeking control, sequence alignment, abstract interpretation, inverted index, binary decision diagram, elliptic curves, cloud scheduling, agents,

- ...
- ...
- ...
- The law of the hammer *"if all you have is a hammer, everything looks like a nail"*

Exercise (6 minutes)

Form groups of three people. Each group identify a topic that combines everyone's individual topics.

Automatic Idea Generation

See also

- <http://dept.cs.williams.edu/~barath/systems-topic-generator.html>
- <http://www.nadovich.com/chris/randprop/>
- <http://pdos.csail.mit.edu/scigen/>

Try Weakening Traditional Assumptions

From a talk by Jennifer Widom

(<http://i.stanford.edu/widom/principles.pdf>)

Pick a simple, but fundamental assumption underlying your topic *and then drop it*.

Topic: More accurate prediction of road traffic congestion

- Assumption: We don't know a driver's intended destination in advance
- Assumption: We can't determine identity of the driver of each car
- Assumption: Traffic lights are operating normally
- Assumption: Drivers always choose the shortest path for their journey
- ...

This can be viewed also as testing the *completeness* of an idea. Usually, we tend to just think about soundness .

Exercise

Think about your research topic. Propose two modifications of your research topic by weakening assumptions.

Research Proposals and Summaries

Lots of different kinds:

- Minor thesis (Honours or Masters Coursework)
- Research Masters
- PhD
- Research Grant
 - National competitive grant: Australian Research Council (ARC), National Health and Medical Research Council (NHRMC), overseas agencies (NSF, NIH, DoD, ...)
- Non profit organisation
 - Gates Foundation, Cancer Council Australia, Movember Australia, ...

Research Proposals/Plans: Heilmeier Questions

What are the elements of a good research proposal or research plan ?

- ❶ What are you trying to do? Articulate your objectives using absolutely no jargon.
- ❷ How is it done today, and what are the limitations of current practice ?
- ❸ What's new in your approach and why do you think it will be successful ?
- ❹ Who cares ?
- ❺ If you're successful, what difference will it make ?
- ❻ What are the risks and the payoffs ?
- ❼ How much will it cost ?
- ❽ How long will it take ?
- ❾ What are the midterm and final "exams" to check for success ?

Milestones (Coursework)

See checklist for 75pt project.

Milestones (PhD)

In Computing and Information Systems,

- 6 months: Determine topic, achieve a good initial understanding of research area and literature
- 12 months: Confirmation, have produced work equivalent to a paper which could be submitted to a refereed conference
- 24 months: Another 1-2 papers
- 36 months: Another 1-2 papers
- 42 months: Thesis, equivalent to 3-5 papers overall

Publication expectations vary across Departments in Engineering.

Assessor's perspectives on research proposal assessment

- Another one to read
- Why should I do it ?
 - It's my job
 - Want to give back to the community
 - It's on a topic I'm interested in
 - I owe someone a favour
 - I might could learn something new
 - I could become more up to date
 - ...
- May read in short bursts, on public transport, during seminars, during meetings, over breakfast, ...

For research grants, decisions on proposals may be made by people who haven't read the proposal in fine detail !

Typical Assessor Questions

- What's it about ?
- Why should I care ?
- Is hypothesis testable ?
- Will something new be done ?
- What's the evidence, why should I believe it ?
- Is the methodology appropriate ?
- Is the author up to date and aware of the relevant literature ?
- Is the author aware of possible limitations of the results ?
- Is it presented nicely ?
- Have any of the results been published somewhere ?

End