CSC3031 Research and Project Skills: Research Methods in Computing Projects

Simon Bowen

Updates

Aims

- Introduce different research methods used in computer science projects and considerations for using them

- Help you select research method(s) for your project

- Direct you to research methods resources

- Remember: your supervisor can advise on methods!

Recap: what is research

"Systematic investigation or inquiry aimed
at contributing to knowledge…"
Oxford English Dictionary Online

- Investigation

- Discovery

- Communication

- Integration

Investigate

Discover &
Communicate
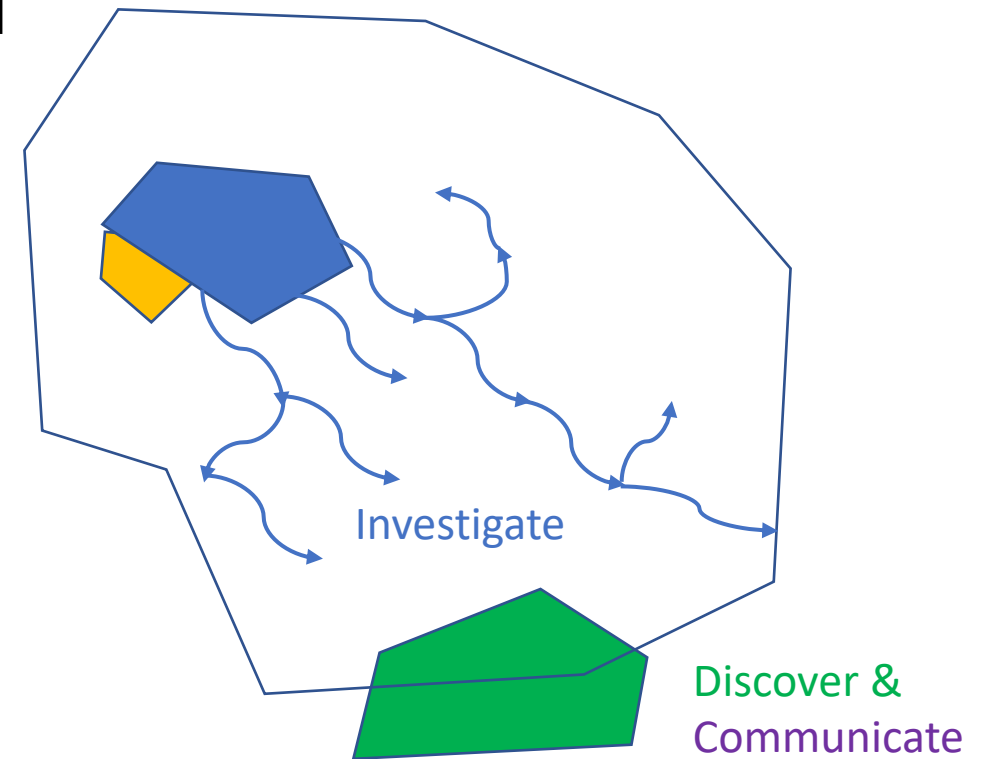
Or…

- What do you know? How do you know it?

- What is the new knowledge? How can you show this knowledge is valid? - systematically (correct, provable, trustworthy, valuable, useful…)

- > Research methodology (the science behind the methods)

Your project might involve…

- Build: new program, extension, integrations, interface, database…

- Design: create prototype or wireframe, compare designs, develop requirements…

- Apply: existing solution (algorithm, tool, dataset) new context

- Model/simulate: create abstractions to explore implementations

- Evaluate: a build, a design, a model, an application…

Where's the new knowledge?

- What works. How to implement.

- Better* designs. How to design.

- Opportunities and limitations in new contexts. How to apply.

- Utility of model/simulation. How to model.

- Is this better/worse*?

* What does better (or worse) look like?

Types of methods

Quantitative:
- From natural sciences
- Measuring
- Numerical scales
- Explaining how something works
- Hypothesis testing
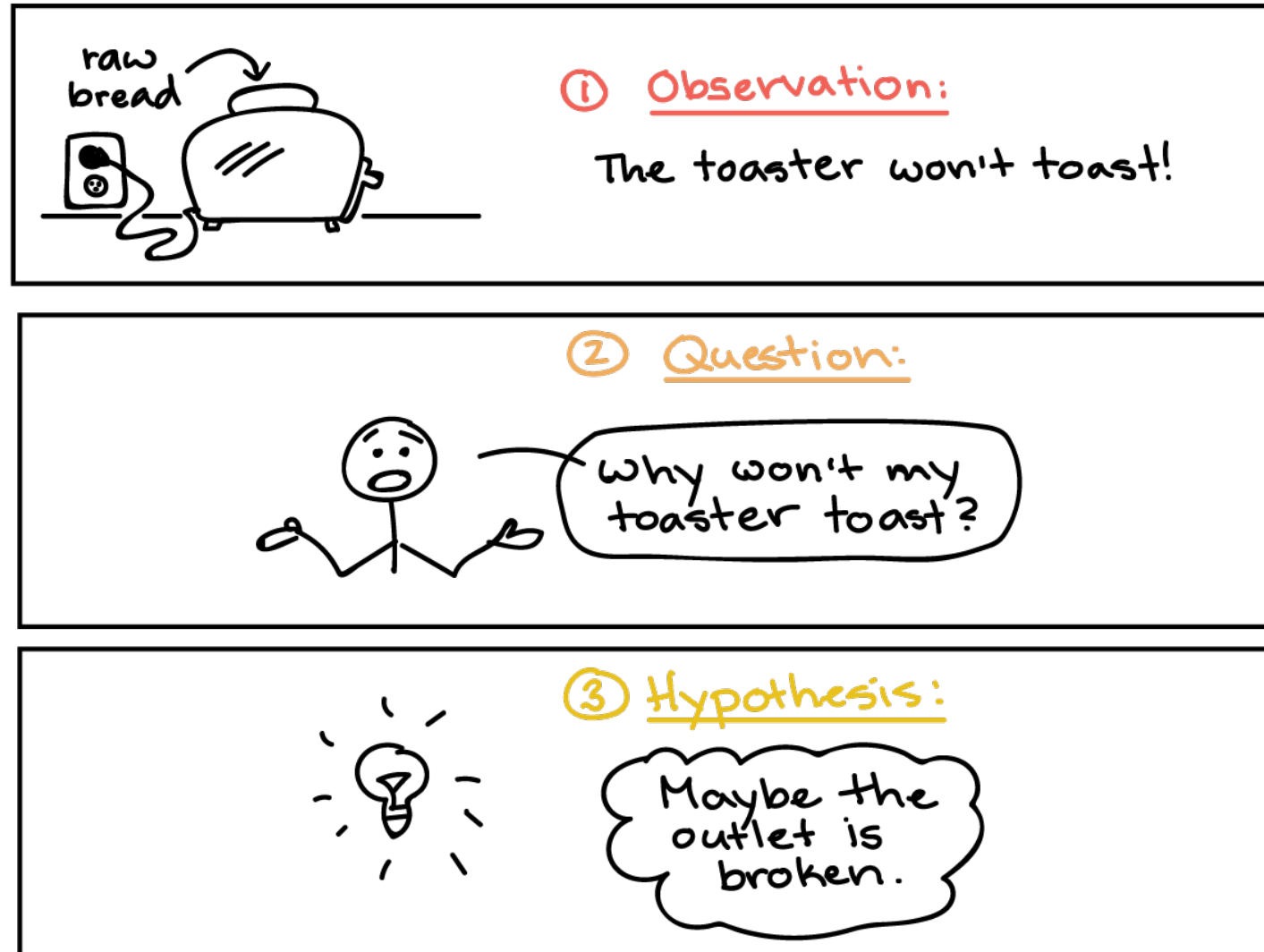- E.g experiments, (some) questionnaires

Qualitative:
- From social science
- Recording and observing
- Descriptive data (speech, text, images, sounds)
- Increasing understanding
- E.g. interviews, focus groups, observations, (some) questionnaires
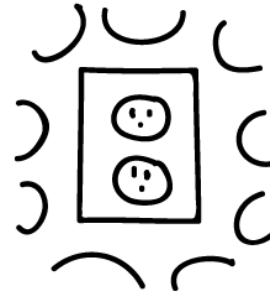
The Scientific Method

1. Make an observation

2. Ask a question

3. Propose a hypothesis

The Scientific Method
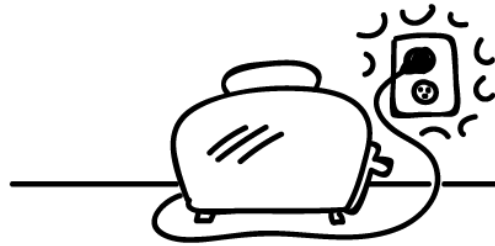
4. Make predictions (conjectures)

5. Test predictions (to prove or refute the hypothesis)

The Scientific Method

6. Iterate

Move on to next line of inquiry

New/refined hypothesis?
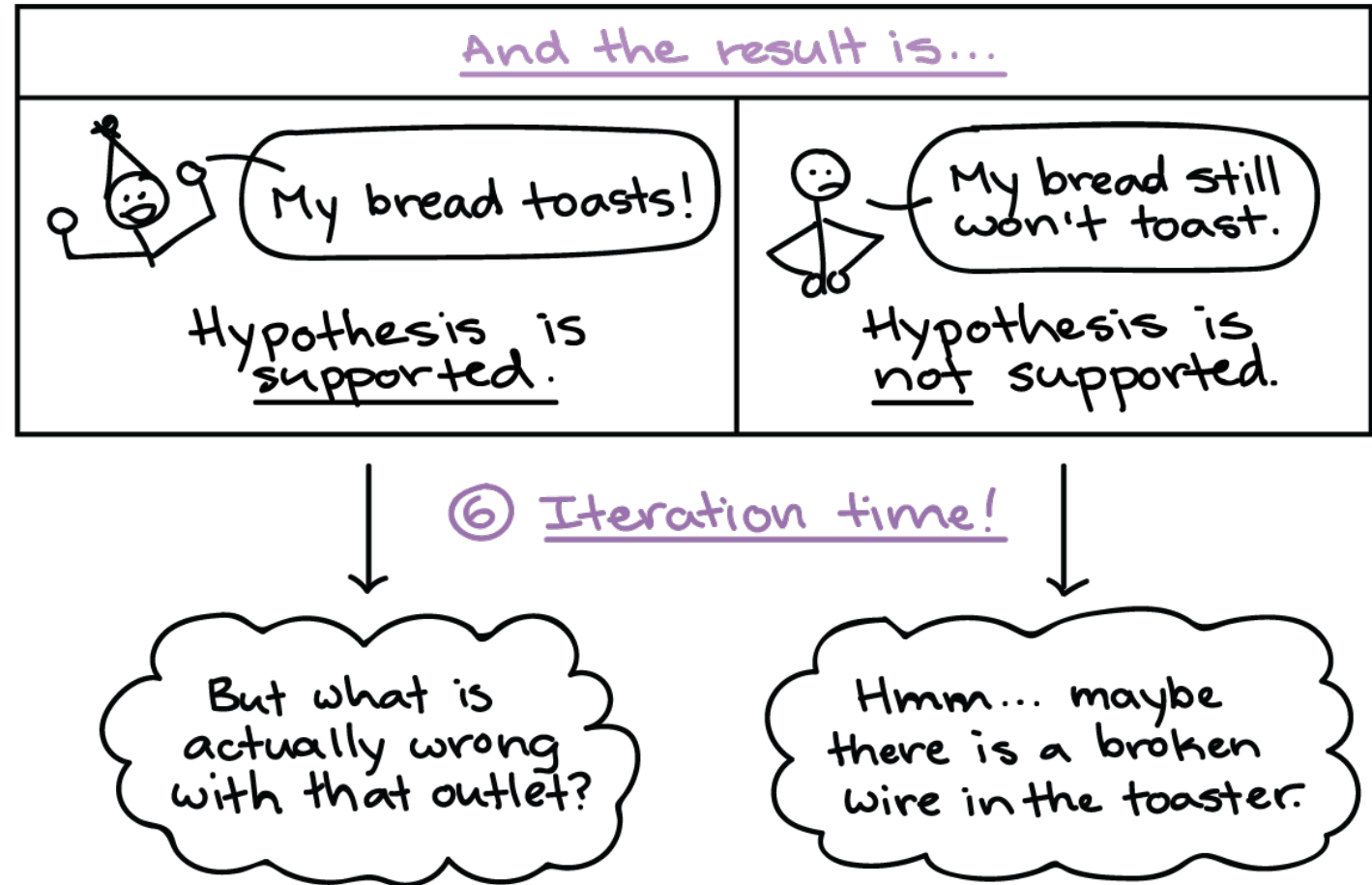
Experiments

Typically involve:

- Defining a theoretical hypothesis

- Selecting samples from a known population (in a broad sense, not necessarily people)

- Allocating samples to different experimental conditions (e.g. test and control groups)

- Introducing planned changes to one or more variables (to test effects)

- Measuring a small number of variables (to measure effects)

- Controlling all other variables (to reduce interference)

From Saunders, M. N. K., Philip Lewis, and Adrian Thornhill. Research Methods for Business Students. Seventh ed. Harlow: Pearson, 2016. Web.

Hypotheses

- An explanation for a phenomena

- Developed from theory or observations

- You aim to disprove (refute) a null hypothesis (difficult to 100% prove a hypothesis)

Example

Theory: User inputs are less precise on touch screen interfaces so larger buttons are easier to use

Hypothesis: Larger buttons improve touch screen usability

Null hypothesis: Button size has no effect on usability

Variables

Independent variables

– that you control, e.g. the user interface

Dependant variables

– that you observe, e.g. time taken to complete tasks

Controlled variables

– to reduce interference, e.g. other apps running at the same time

Also consider:

Extraneous variables

Time and location of experiment – will participants at 09:00 and 12:00 behave differently? Will windowless room affect participants?

Participants – will age, gender, health, background etc. have an effect?

Equipment – will participants use the same device (hardware, software)?

Example

2 Experimental Groups

- Group 1: small buttons on a UI
  - Monday morning Stage 3 CS students
  - On a dedicated device given to them

- Group 2: Larger buttons on a UI
  - Friday afternoon Stage 1 Business students
  - On their own devices

Improvement:

1 Experimental Group, 1 Control Group

- All participants spread across all conditions

- All conditions are carried out at the same time

- Same facilities used at each session

Understanding Users and Use

Methods to:

- Gather design or development requirements

- Understand how existing technology or software is used

- Understand how new technology or software is used

- Evaluate something

Method	In general…
Interviews	Fewer participants In depth Time consuming to conduct Time consuming to analyse
Focus groups (group interviews)	Fewer participants In depth Quick to run Time consuming to analyse
Questionnaires	More numerous participants Less depth Quick to run Can be quicker to analyse (depending on questions…)

Interviews

Structured

More formal

List of pre-set questions

Typically closed questions

Discussion is restricted

Can be time efficient

Few surprises

Easier to analyse

Unstructured

More informal

Fewer or no questions

Open questions

Discussion can extend

Can take longer

Novel insights

Harder to analyse

Semi-structured interviews – the best of both worlds?..

Interview Considerations

- Practicalities – who can you interview? how many interviewees? how long? (you are a finite resource!)

- Prepare – have an interview script, start with warm up question(s)

- Recording answers – typed or written notes, audio/video recording (you need to be able to listen and prompt too)

- Ethics! Informed consent, anonymising data etc.

Example interview script

1. Why did you come to the Glasgow Science Centre today?   **< Warm up question**

2. How did Story:Web make you think about climate change / climate action?
   - Help you make sense of it?
   - Relate to your own experiences or feel relevant to you?
   - Did it make you think differently?

   < Open questions plus prompts.

3. How did Story:Web make you think about museums and their collections, if at all?
   - Did it make you think differently?
   - About what museums are for / can do?

4. How did Story:Web help you think about what to do about climate change, if at all?
   - About the importance of climate action?
   - Will you do anything different now? Personal actions / encouraging others' action

5. Is there anything else you would like to add?   **< 'Anything else' question**

Examples of open- and closed- ended questions.

Questionnaires - Considerations

- Long or short? Few or many?

- In depth with few (qualitative) or getting statistical significance with many (quantitative)?

- Practicalities – who, how to recruit (email, social media), how to conduct (online, paper, post)

- Ethics – personal data and anonymity? Data storage (MS Forms instead of Google Forms?)

Questionnaires - Considerations

- Considerations for structured and unstructured interviews also apply to questionnaires – closed and open questions.

- Watch the length! (Long questionnaires deter completion. MS Forms estimates completion times…)

- Ask more important questions first

- Go from general to specific questions / closed to open

- Leave any questions regarding personal information to the end

- Write and rewrite your questions! Try them out with colleagues – are they clear and unambiguous?

Bias – Conscious and Unconscious

- The Hawthorne Effect - people behave differently when being observed (e.g. typing when someone is watching)

- Motivation – (excessive) financial rewards

- Familiarity – are participants your friends or family? Will they 'tell you what you want to hear'

- What **people say** and what **people do** are often not the same

Thinking about research methods for your project

1. What is your research question(s)?

   • Where is the opportunity for discovery in your topic? Your project aim could help here.

2. What is the context for your research?

   • Where are you seeking to answer the question? Which technical domain and/or real world situation? And why here (the motivation)?

3. Method

   • Which methods best suit what you want to find out (question), where you want to find out (context), and the time and resources available to you?

Analysis…

- Research methods will get you data

- BUT data (quantitative or qualitative) $\neq$ findings

- This is where analysis comes in (a future lecture)

Resources – Experiments, Interviews, Questionnaires

- [Checklist for experimental design](#)

- [A quick guide to experimental design](#)

- [Best practice for interviews](#)

- [Best practice in questionnaire design](#)

- [SurveyMonkey's Surveys 101](#)

  (aimed at market research not academic research, but still some useful tips)

Resources – SAGE Research Methods

- Largely (but not all) social science

- Aimed at post graduate (and on) research, but useful further reading

- SAGE Research Methods Videos
  Start here (e.g. "experiment", "surveys", "case studies")

- SAGE Research Methods
  Delve deeper here – little green books (qualitative) and little blue books (quantitative)
  (e.g. "Time Series Analysis", "Semi-structured interviews")
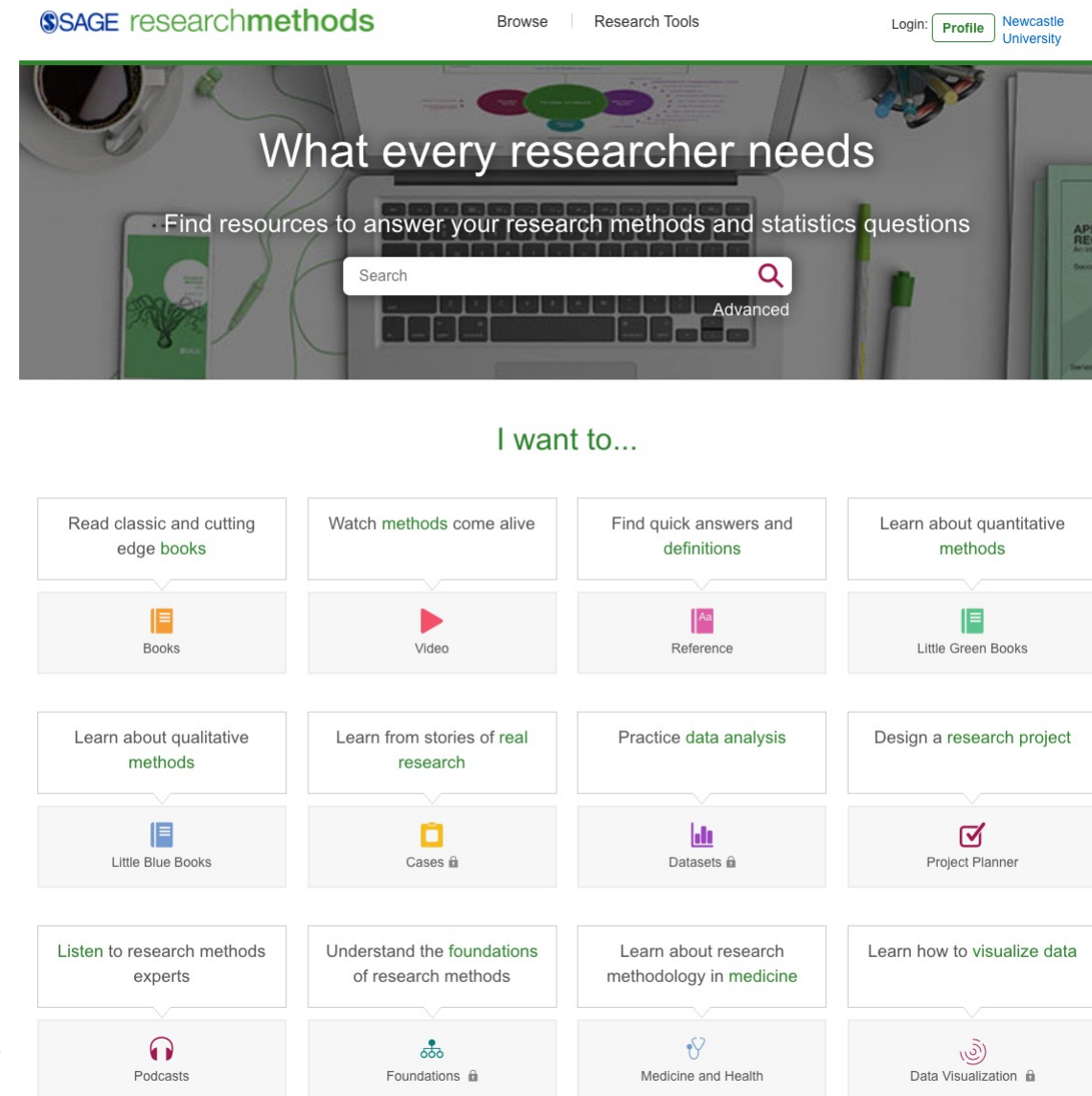
Questions?

- [Dawson, (2015) Projects in Computing and Information Systems](#) - Chapter 2, section 2.4 Research Methods pp 27-38

- Saunders, M. N. K., Philip Lewis, and Adrian Thornhill. Research Methods for Business Students. Seventh ed. Harlow: Pearson, 2016. [Web](#).