Research Methods for Computer Science

Today's goals

- Case studies
- Look at fantasy abstracts
- Methods needed
- Construction via narrative

Case studies

- Loved in computer science
- Limited options
  - Software engineering
  - Big systems
- Goals?

What's a good CS case?

- Detailed
- Unique
- Generalizable? (N=1)
- Exemplify
  - as opposed to critical or extreme

Methods?

- Almost any!
  - Observations, counting, interviews, focus groups
- Analysis
  - Qual and quant
  - Theory seeking and theory testing

Action Research

- Organisational change
- Organisation participation
- Joint setting of research goals
- Joint evaluation of outcomes
- Honest about process

Pros and Cons

- Not much choice in CS
- Open to multiple methods
- Can’t generalise
- Can go astray

Why write fantasy abstracts?

- Writing is key to research
  - Dissemination
  - Communication
  - Self-dialogue
  - Narrative of the research

Myths of Science

- Scientists are rational
- Science progress is orderly
- Analysis leads to theory
- Experiments refute theory

Science narratives

- Marshall evidence
- Interpret
- Force concreteness
- Open to criticism

Self-critiquing

- What's your research question?
- What is my point?
- Will "this" prove my point?
- Who cares?

Problems

- I am not sure I have the right method
- I don’t understand the method
- My supervisor won’t let me

CS Research

- Inherently multidisciplinary
- Other fields are not multidisciplinary
- Planned
- Specific Purpose
- Clear start and finish dates
- Finite resources (time, people, and money)

Key Players

- The researcher
- The supervisor
- The evaluator

Regardless of the type of research, it is critical that it be reliable

Research Methods

- Procedures for collecting data, formulating a hypothesis, testing a hypothesis, interpreting results, and drawing conclusions

Quantitative Research

- Develop models, theories, and hypotheses describing a phenomenon
- Quantitative methods involve measuring something that will help develop the model/theory/hypothesis
- Large samples needed
- Experiments are repeatable

Qualitative Research

- Discover underlying meanings and patterns of relationships without using or developing mathematical models.
- Qualitative methods involve fieldwork which could include interviews or personal observations
- Usually small sample sizes
- Experiments not necessarily repeatable

Qualitative research is frequently a precursor to quantitative research.

The Research Team

- Researcher
- Supervisor(s)
- Evaluator(s)

The Researcher

- Discuss with your supervisor what supervision and work schedule is good for you and them.
- Discuss the topic and timetable with the supervisor
- Stick with the schedule and don’t disappear from the supervisor’s radar
- Keep systematic records of work
- Submit written material with enough time for the supervisor to read it.

The Researcher

- Discuss the final submission details with the supervisor
- Don’t ignore criticisms or guidance from the supervisor
- Make sure you don’t do anything illegal
- Remember you are the driver
- Let the supervisor know of any problems
- Do your best.

The Supervisor

- Know the rules and standards of the organization regarding research
- Make sure the supervisees know the rules and standards
- Discuss dates and work schedules
- Give needed guidance
- Continuously update skill set
- Schedule regular meetings

The Quality Evaluator Examiner

- Evaluates the completed project.
- Evaluates based on the contribution, complexity of the problem, the usefulness of the solution, and the presentation style.
- Very objective … well, it's supposed to be :-)

The Quality Assuror Examiner

- Reviews and gives feedback at various checkpoints in the research.
- Can eliminate big problems from occurring at the end of the project
- Can be too subjective, but not nearly as subjective as the supervisor.

It is usually easier to be either a Quality Assuror or a Quality Evaluator, but not both. So choose one of each if you can.

If you get the chance to be an evaluator it can improve your own research

Typical Evaluation Criteria

- Does the title correspond well to the contents?
- Does the abstract give a complete and correct picture of the contents?
- Can the abstract be understood without reading the paper?
- Does the introduction explain clearly what the investigated problem is?
- Does the introduction give a complete and brief overview of the whole project?

Evaluation Criteria Continued

- Does the author explain all terminology in a clear and precise way?
- Are terms used in a consistent way?
- Does the author make use of relevant scientific conventions in the choice of terminology and definitions?

Evaluation Criteria Continued

- Is the description of each method sufficiently clear and detailed to allow replication?
- Are there any technical flaws where a method is applied in an incorrect way?

Evaluation Criteria Continued

- Are the presented results relevant?
- Is the analysis done correctly?
- Are the analysis techniques relevant?
- Are tables and figures used in a correct and relevant way?
- Are all results presented objectively?
- Does the text match the tables/figures?

Evaluation Criteria Continued

- Are the conclusions reasonable?
- Are the arguments scientifically valid or are the too speculative?
- Is the summary well written?

Evaluation Criteria Continued

- Are the references syntactically correct?
- Are there sources cited which are not referenced?
- Are there sources referenced but not cited?
- Are citations syntactically correct?
- Are citations placed in the text in a reasonable way?
- Has the relevant literature been covered?

WHAT IS RESEARCH

research?

- what is it?
- should you be doing it?
- how do you do it?

definitions of research

"Systematic investigation towards increasing the sum of knowledge"

(Chambers 20th Century Dictionary)

"an endeavour to discover new or collate old facts etc. by the scientific study of a subject or by a course of critical investigation."

(The Concise Oxford Dictionary)

*The good researcher is not 'one who knows the right answers' but 'one who is struggling to find out what the right questions might be'. (*Phillips and Pugh (2005: 48))

What is research?

- **research.** 1.a. the systematic investigation into and study of materials, sources, etc, in order to establish facts and reach new conclusions. b. an endeavour to discover new or collate old facts etc by the scientific study of a subject or by a course of critical investigation. [Oxford Concise Dictionary]

What is research?

- Research is what we do when we have a question or a problem we want to resolve
- We may already think we know the answer to our question already
- We may think the answer is obvious, common sense even
- But until we have subjected our problem to rigorous scientific scrutiny, our 'knowledge' remains little more than guesswork or at best, intuition.

What is research?

- First priority is to formulate your question
- Then figure out how you are going to answer it
  - How have others answered it?
  - How does your proposal fit in with what others have done?
  - How will you know when you have answered it?
- Then you can present your answer

definitions of research

- Research is defined by the Higher Education Funding Council for England (HECFE) as '*original investigation undertaken in order to gain knowledge and understanding' (RAE, 2008).*
- *Three key terms in this definition have been italicized* for emphasis; *original, gain and knowledge and understanding.*

Originality

- There is no point in repeating the work of others and discovering or producing what is already known
- *originality is doing something that has not been done be*fore. While this remains a relatively simplistic definition, it is important to discuss how originality relates to projects.

Originality

- What can **you do that is original?**
- **What type of things** can **you produce that are original?**

Originality

You can be original in two ways.

1. You can be original in the way you do things – for example, doing something someone has done before but using a different technique or approach.
2. You can be original by producing or developing something that has not been produced before.

Originality

Number of areas in which your project can be original:

1. You can be original in the way you do things – for example, doing something someone has done before but using a different techniqueor approach.
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Originality

- Identifies a number of areas in which your project can be original:
  - **Tools, techniques, procedures and methods. You may apply new tools and techniques**. to existing problems or try new procedures and methods in contexts where they have not been applied before.
  - **Exploring the unknown.** Although rare, you may investigate a field that no one has thought to investigate before.

Originality

- Identifies a number of areas in which your project can be original:
- **Exploring the unanticipated.** Although you may investigate a field of research that has been looked at many times before, you may come across unexpected results or exciting new directions as yet unexplored.
- **The use of data.** You can interpret data in different ways, use them in new ways or apply them in alternative areas that have not yet been investigated.

Contribution to knowledge

- Body of knowledge represents world understanding
  - Theories
  - concepts
  - models,
  - the sciences,
  - the arts and so forth.
- Knowledge is stored in:
  - books,journal articles,
  - conference proceedings,
  - documents,
  - reports, the Internet, art, peoples, minds and more.

Hierarchy of Knowledge

- *data,*
- *information,*
- *knowledge and*
- *wisdom.*

Hierarchy of Knowledge

- **Data** are the factual elements that describe objects or events. They represent the raw numbers and raw text you gather from your investigations.
  - *rainfall data from various sites around the country.*
- **Information**, represents data that have been processed in order to provide you with some insight into their meaning. Information provides you with an idea of the ‘what’ (i.e., what is happening in the
  - *Converting your rainfall data into information may lead to graphs summarizing monthly totals, charts presenting seasonal fluctuations and text or tables summarizing average daily rainfall at different sites.*

Hierarchy of Knowledge

- ***Knowledge*** is your higher-level understanding of things. Knowledge represents your understanding of the ‘why’. Knowledge is your personal interpretation of what you gain from information as rules, patterns, decisions, models, ideas and so on.
  - knowledge represents your understanding of why rainfall might have changed during this period
- *Wsdom.*

Hierarchy of Knowledge

- *Wisdom.* Wisdom represents your ability to put your knowledge into practice. It represents your ability to apply your skills and experiences to create new knowledge and adapt to different situations.
  - Wisdom would represent your ability to predict likely changes to rainfall and climate in the future or enable you to understand why rain falls at particular levels in entirely different parts of the world

Research Process

- Realize there is a problem
- Look to see if anyone has solved it
- Develop a plan to solve it
- Solve it
- Evaluate your solution
- Disseminate your solution