Research Methods in Automated Software Engineering

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Outline

- Research methods in general

- How do others do it?

- What area of ASE are you working in?

- What sort of contribution do you want to make?

- What is your research question?

- What is your experimental approach?

- How will you evaluate your results?

- How will you disseminate your results?

- Summary

Research Methods

- **Engineering vs Science vs Social Sciences**

  ☐ Science – hypothesis, experiment, results, conclusions

  ☐ Social sciences – as above OR cases, generalisation, theory

  ☐ Engineering – often a mix! E.g.

    ☐ Collect lots of data & try and generalise to frameworks, theories

    ☐ Develop theory/hypothesis and try and prove by experiments (including software development & trialing!)

- **Qualitative vs Quantitative**

  ☐ Qualatative – "can we build it?", trials on exemplar problems, feature comparisons, expert opinion, heuristics

  ☐ Quantitative – data collection, surveys, instrumentation, data analysis, statistical analysis

How do others do it???

- I think a great approach to deciding your research methods is look carefully @ how others in your area do it in their work

- What area of ASE working in?

- What contributions do they claim?

- What did they do and how did they do it?

- How did they PROVE its new/better/interesting?

- If you want to be better than them… can you use same/similar approach???

What area of ASE are you working in?

- Theoretical foundations

- Formal methods, models

- Architecture

- Technology - UI, database, testing, SOA, …

- Tools

- Empirical

Lets go around the room and see…!

What contribution do you want to make?

- New theoretical foundations

- Solve problem with existing vs new theory, model, approach, tool, combination of these

- Apply theory, model, approach, tool to a new problem, new domain

- Improve theory, model, approach, tool – features, scalability, performance, security, …

- Discover new insights e.g. from large datasets, widely used method/ tool, …

- Capture new datasets, metrics others might further analyse, use

What is the AUTOMATED software engineering contribution???

Lets go around the room and see…!

What is your research question?

- Think about:

  - ☐ Problem you are trying to solve

  - ☐ Current state of the art

  - ☐ Your approach to solving

  - ☐ Frame as one (or more) "questions"

  - ☐ PICOC (*Population*, *Intervention*, *Comparison*, *Outcomes*, and *Context*)

- "Can a visual notation be effectively used to specify and generate code generators?"

- "What evidence is there of PP studies conducted in higher education settings that investigated PP's effectiveness and/or pair compatibility for CS/SE education?"

  - ☐ "How was PP's effectiveness measured in PP studies and how effective has PP been when used within higher education settings?"

Lets go around the room…

What is your experimental approach?

- Prove theories, validate model via analysis

- Build something (show it can be done)

- Apply theory/model/approach/tool to one or more problems successfully (or unsuccessfully! ☺)

- Generate/gather data and analyse

- Ask opinions, apply heuristics, generalise from examples

Lets go around the room…

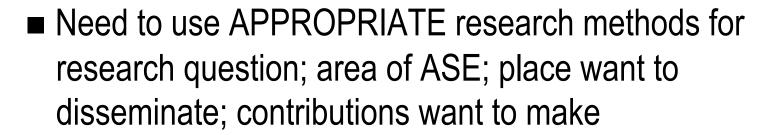# How will you evaluate your results?

- Theorem prove

- Model check

- Identify what can/can't do – model, process, analyse, test, trial

- Pass (or fail) tests

- Statistical analysis, incl. power analysis

- Qualitative vs quantitative e.g. % users liks vs dislike

- Grounded theory etc

Lets go around the room…

How will you disseminate your results?

- ASE conference ☺

- ASE journal ☺ ☺

- ICSE, FSE, ISTA, MODELS, ESEM, PROMISE, …

- TSE, TOSEM, SP&E, JSS, JVLC, SoSym, IST, …

- Nature?? ☺

- Open source

- PROMISE repository

- Center of Excellence for Software Traceability (CoEST)

Lets go around the room…

Summary

- Need to use APPROPRIATE research methods for research question; area of ASE; place want to disseminate; contributions want to make

- Consider (in my order):
  - What area of ASE working in
  - Contributions you would like to make
  - What research questions trying to answer
  - Expectations of the venues you will disseminate your research in
  - Suitable experimental methods
  - Suitable evaluation approaches, analysis

Recommended Readings

- ASE Panel – Characteristics of an ASE paper - http://www.ase-conferences.org/panel/index.html

- Martin Höst, Per Runeson, Checklists for Software Engineering Case Study Research, ESEM 2007

- Ross Jeffery, Theory, methods and models in software engineering research

- Mary Shaw, What Makes Good Research in Software Engineering?, International Journal of Software Tools for Technology Transfer, 2002, vol. 4, no. 1, pp. 1-7.

- Steve Easterbrook, Janice Singer, Margaret-Anne Storey, Daniela Damian, Selecting Empirical Methods for Software Engineering Research, http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.81.9285

- Mary Shaw, Writing Good Software Engineering Research Papers, Proceedings of the 25th International Conference on Software Engineering, IEEE Computer Society, 2003, pp. 726-736.

- Carsten Sorenson, This is not an article: just some thoughts on how to write one, http://mobility.lse.ac.uk/download/Sorensen2005b.pdf