Research Methods and Skills

- Objectives
 - <u>Define research question</u>/hypotheses/objectives.
 - Select research method.
- Main references
 - C. Johnson, What is Research in Computing Science?, http://www.dcs.gla.ac.uk/~johnson/teaching/research_skills/re search.html.
 - C. Johnson, Basic Research Skills in Computing Science, http://www.dcs.gla.ac.uk/~johnson/teaching/research_skills/ba sics.html.
 - A.J. Pickard, Research methods in information, Focet Publishing, 2007.

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Research Question/Hypotheses/Objectives

General properties

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- The true focus of your research.
- Define the boundaries of your work in relation to others.
- Narrowly and deeply defined.
- There are operational signs of success or failure.
- View the same issue from different perspectives.

Criteria in Choosing Research Question

- Quality based
 - Originality
 - Significance
- Resource based
 - Achievable within required time frame.
 - Compatible with available resources.
- Personal trait based
 - Compatible with your interest.
 - Compatible with your experience/background.

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The Job Related Concern

- "Will I be able to find a job that uses this research?"
 - It touches on fundamental goals of graduate education.
- Objectives
 - Capable of independent investigation of challenging technical issues through literature survey, critical analysis, hypothesis formulation and verification.
 - Become leaders in R&D in academia or industry.
 HQP

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The Job Perspective of Thesis Research

- The thesis research question is narrowly and deeply defined.
- University research is often many years ahead.
- It is your general qualification as HQP that is most valuable.
- Some specific skills learned will be useful as well.
- Do not be overly concerned with the job perspective of the research question.
- Be a champion of new technology.

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Research Methods

- Most fields of computer science
 - System implementation
 - Empirical hypothesis testing
 - Mathematical proof
 - Hermeneutics (HCI relevant)
- Mostly in HCI
 - Questionnaires
 - Usability testing

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System Implementation

- Demonstrate a new idea by iteratively building better systems.
- Merit: The artifact stands as an example for a more general class of solutions.
 - Ex Multi-user operating systems vs UNIX.
- Limitations
 - If the system fails, it is unclear whether it is due to the idea or implementation.
 - It's difficult to generalize from a specific system to generic principles.
 - Ex Success of fuzzy systems.

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Ex Success of Fuzzy Control [Russell & Norvig, 03]

"Fuzzy control has been very successful in commercial products such as ... Video cameras Critics ... argue that these applications are successful because they have small rule bases, no chaining of inferences, and tunable parameters that can be adjusted to improve the system's performance. The fact that they are implemented with fuzzy operators might be incidental to their success; the key is simply to provide a concise and intuitive way to specify a smoothly interpolated real-valued function."

Empirical Hypothesis Testing

- Involve a sequence of steps.
 - Hypothesis generation: Identify the idea to be tested.
 - Ex Algorithm A is superior than algorithm B on
 Method identification: Determine the technique for establishing the hypothesis.
 - Result compilation: Gather results from following the method.
 - Conclusion: State the conclusion as either supporting or rejecting the hypothesis and its statistical significance.
- Ex Comparison of TCF and LCF in multiagent expedition.

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Empirical Hypothesis Testing (Cont)

- Limitation
 - May be difficult to control experimental conditions.
 Ex File systems, background tasks, network traffic, etc.
 - May be difficult to generalize results from restricted environment.
 - Ex Software usability at lab vs at work.
 - May be difficult to determine and conduct a sufficient number of trials.
 - Ex A nontrivial program.

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