COMP 516
Research Methods in Computer Science

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Lecture 10: Research Methods

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Classifying Research (1)

Research can be classified from three different perspectives:

1. Field
   Position of the research within a hierarchy of topics

   Example:
   Artificial Intelligence → Automated Reasoning →
   First-Order Reasoning → Decidability
2. Approach
   Research methods that are employed as part of the research process

   Examples:
   Case study, Experiment, Survey, Proof
3. Nature
   - Pure theoretical development
   - Review of pure theory and evaluation of its applicability
   - Applied research

Classifying Research (2)

- Pure theory:
  Developing theories and working on their consequences, with regard to experimentation or application
- Descriptive studies:
  Reviewing and evaluating existing theories, including describing the state of the art, comparing predictions with experimental data
- Exploratory studies:
  Investigating an 'entirely' new area of research, exploring a situation or a problem
  See `http://www2.uiah.fi/projects/metodi/177.htm`
- Explanatory studies:
  Explaining or clarifying some phenomena or identifying the relationship between things

Classifying Research (2)

- Causal studies:
  Assessing the causal relationship between things
- Normative studies:
  Producing a theory of design (or of other development) like recommendations, rules, standards, algorithms, advices or other tools for improving the object of study
- Problem-solving studies:
  Resolving a problem with a novel solution and/or improving something in one way or another
- Development and Application studies:
  Developing or constructing something novel

Quantitative and Qualitative Research Methods

- Quantitative research methods
  - Methods associated with measurements (on numeric scales)
  - Stemming from natural sciences
  - Used to test hypotheses or create observations for inductive reasoning
  - Accuracy and repeatability of vital importance
- Qualitative research methods
  - Methods involving case studies and surveys
  - Stemming from social sciences
  - Concerned with increasing understanding of an area
  - Repeatability usually a problem

Research Methods (1)

- Action research:
  - Pursues action (or change) and understanding at the same time
  - Continuously alternates between action and critical reflection, while refining methods, data and interpretation in the light of the understanding developed in the earlier cycles

  Example: Reflective teaching
- Case study:
  - In-depth exploration of a single situation
  - Usually generates a large amount of (subjective) data
  - Should not merely report the data obtained or behaviour observed but attempt to generalise from the specific details of the situation observed

  Example: Case study of open source software development

Research Methods (2)

- Survey:
  - Usually undertaken using questionnaires or interviews
  - Questionnaire and interview design important!
    (See Dawson 2005 for details)
  - Determination of sample size and sample elements important!
    (See specialist literature for details)

  Example: Survey on popularity or use of programming languages
- Experiment:
  - Investigation of causal relationships using tests controlled by the researcher
  - Usually performed in development, evaluation and problem solving projects

  Example: Evaluation of processor performance

Key Elements of an Experiment

- A precise hypothesis that the experiment will confirm or refute
- A completely specified experimental system, which will be modified in some systematic way to elicit the effects predicted by the hypothesis
- Quantitative measurement of the results of modifying the experimental system
- Use of controls to ensure that the experiment really tests the hypothesis
- Analysis of the measured data to determine whether they are consistent with the hypothesis
- Report of procedures and results so that others can replicate the experiment