Research Methods in Computer Science

Lecture 6: Research methods

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14 Intellectual discovery
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- Abduction
- Induction
- Process model

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Topics

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- Overview
- Experiments
- Questionnaires

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 a set of 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 are, rather than an explanation
  - 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 the popularity or use of programming languages

- Experiment:
  - Investigation of causal relationships using test 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

Key issues for questionnaires

Consider the following questions

- What are the key issues for conducting a survey by questionnaire?
- Regarding the questionnaire itself, what types of questions do you know and what is each of them used for?

(7 minutes group discussion)

Key issues for questionnaires

- Determining the target audience
- Determining the most appropriate medium
- Achieving an acceptable response rate
- Ensuring anonymity if necessary
- Obtaining additional information about the respondents
- Questionnaire design
  - Layout and size (not too long, uncluttered)
  - Question types
    (1) Quantity or information
    How many hours ...
    (2) Classification
    Gender
    (3) List or multiple choice
    How do you keep informed?
    (4) Scale
    How easy is ...
    (5) Ranking
    Rank in order of importance
    (6) Complex grid or table
    Multiple classifications
    (7) Open-ended
    What do you think about ...