Research Process

- Objectives
 - What is research?
 - What is computing research?
 - What is the process of research?
- Main reference

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 A.J. Pickard, Research methods in information, Focet Publishing, 2007.

Research in General

- "The systematic study of materials and sources in order to establish facts and reach new conclusions." [Oxford Dictionary]
- Ex The mass-energy equivalence.

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Computing

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- Definition from an applied perspective.
 [Computing Curricula, 05]
- Definition from an academic perspective. [ACM,89]

Computing – Applied View

In a general way, we can define computing to mean any goal-oriented activity requiring, benefiting from, or creating computers. Thus, computing includes designing and building hardware and software systems for a wide range of purposes; processing, structuring, and managing various kinds of information; doing scientific studies using computers; making computer systems behave intelligently; creating and using communications and entertainment media; finding and gathering information relevant to any particular purpose, and so on.

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Computing – Academic View

- The discipline of computing is the systematic study of algorithmic processes that describe and transform information: their theory, analysis, design, efficiency, implementation, and application. The fundamental question underlying all computing is 'What can be (efficiently) automated?'
- Relation with the applied perspective.

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Aims of Computing Research

- Discover new ways of computing.
 - New applications and functionalities.
 - Ex <u>Collaborative design</u> in supply chains.
- Discover better ways to do computing.
 - Higher quality.
 - Ex Natural language translation.
 - More efficient.
 - Ex Planning in stochastic environments.

Aims of Computing Research (cont)

- Improve understanding of fundamentals.
 - Computability.

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- Ex <u>The halting problem</u>.
- Complexity.
- Ex Problems of the same complexity class.
- Properties of computational artifacts.
- Ex Collaborative design in supply chains.

Collaborative Design in Supply Chains

- Modern industry manufactures most products through supply chains.
- Most software applications on supply chains focus on supply chain management or information sharing.
- There is no known formal model on collaborative design in supply chains.
- A new computational <u>framework</u> is developed at IDSS Lab for optimal collaborative design in supply chains, e.g., [Xiang, Chen, and Deshmukh, 2004].

Collaborative Design of Customized Computer



The Halting Problem

- Define the self-terminating function f(p).
- The halting problem: To compute f(p) given p.
- Is there a program that solves the halting problem?
- Assume: There exists a program Q to compute f(p).
- Construct program R: Q; While f(p)=1, do;

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- End;
- R must be either self-terminating or not.

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The Halting Problem (cont)

- Start R with 1st variable initialized to its Godel number.
- It can be shown that
 - if R is self-terminating, then it will not halt; and
 - if R is not self-terminating, then it will halt.
- The assumption has lead to a contradiction.
 - No program exists that computes f(p) in general.
- There is a limit to the power of algorithmic processes.

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Research Process

- 1. Identify topic of interest.
- 2. Literature survey.
- 3. Define research question/hypotheses/objectives.
- 4. Select research method.
- 5. Formulate research proposal.
- 6. Algorithm design/analysis/implement/test.
- 7. Data collection and interpretation.
- 8. Conclude and generalize.
- 9. Dissemination.

Example of Research Process [Xiang & Hanshar, 09]

- 1. What is the relation among alternative methods for multiagent decision making?
- 2. Literature survey.
- 3. What are relative merits of LCFs and TCFs?
- 4. The research method is primarily empirical.
- 5. Formulate research proposal.
 - Use RMM and CDN as reps of LCFs and TCFs.
 - Use multiagent expedition as testbed.

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Example of Research Process (cont)

- 6. Algorithm design/analysis/implement/test.
 Environmental simulator is developed.
 Algorithm for each method is designed and coded.
- 7. Each algorithm is run at different conditions with performance collected and analyzed statistically.
- 8. The relative merits of RMM and CDN are concluded and generalized to LCFs and TCFs.
- 9. Publication at PGM-08 and IJAR.

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Revision of Research Design

- The cooperative aspect of research.
- The competitive aspect of research.
- Uncertainty of research.
- Ex Investigation of FTOPA.
- Be prepared for revision of research design.
- Constant evaluation of current design.
- Willingness to revise.

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Investigation of FTOPA

[Xiang, Beddoes and Poole, 1990]

- Motivation: To describe degree of uncertainty using a finite number of values.
- Theoretical foundation: Probabilistic logic [Aleliunas, 1988].
- Original objective: Development of a finite totally ordered probability algebra.
- The progress, the evolution, and the outcome.

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