Methodology of Research in Computer and Information Science

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5 + 3 ECTS credit points

Examination: Active participation and written examination on Philosophy of Science (Chalmers' book)

Methodology of Research in Computer Science
Course objectives

- Familiarity with the philosophy of science
- Understanding Computer Science as a discipline
- Master the craftmanship of scientific work
- Introduction to postgraduate studies and academia
- Early preparation for the PhD dissertation

Course schedule (prel.)

8/10	Introduction to the science of computing. *Sture Hägglund*
15/10	Introduction to the philosophy of science. *Ingemar Nordin*.
22/10	Methods of Computer Science. Writing a thesis proposal. *Sture Hägglund*.
29/10	Scientific and electronic publishing. *Peter Berkesand*
	The PhD student experience. Social and practical issues in research education and graduate studies. *Lillemor Wallgren*.
5/11	Science and Technology. *Ingemar Nordin*.
	Time for advising for study groups. *Sture Hägglund*
12/11	The world of Science. Ethics and quality control in scientific work. *Sture Hägglund*.
19/11	Discussion of methodological issues in computer science research and reports from study groups. *Sture Hägglund*
t b a	Information for new doctoral students. *Lillemor Wallgren*. Library resources. *Ingegerd Baurén*
?/?	Examination 13 - 16. (Date to be decided.)

Literature:

A.F. Chalmers: What is this thing called Science?, Latest ed., Open University Press, (Previous edition can be used if the course leader is informed before the examination.).

Timothy Colburn: Methodology of Computer Science. In Philosophy of Computing and Information, pp 318 - 326, Blackwell, 2004.

P.J. Denning, et al.: Computing as a Discipline, Communications of the ACM, vol 12, no 1, Jan 1989.

B. Gustafsson, G. Hermerén, B. Pettersson: Vad är god forskningssed? Vetenskapsrådets rapportserie, 2005:1. www.vr.se

Ned Kock. A Case of Academic Plagiarism. Comm of the ACM, vol 42, no 7, July 1999.

Erik Sandewall: The Methodology of Design Iteration for Systems-oriented Research in Computer Science. http://www.ida.liu.se/ext/caisor/pm-archive/morador/001/index.html

A.J. Smith: The task of the Referee, IEEE Computer, vol 23, no 4, April 1990ACM Self Assessment Procedure XXII: Ethics, CACM, vol 33, no 11, November 1990.

S. Hägglund (ed.): Selected term papers on Methodology of Research in Computer Science, Vol II, Lecture Notes, IDA, LiTH, 1997

Study group assignments:

1. form a group of 3-4 persons, preferrably with common research interests
2. select a topic for the group's work
3. assign a chairman/coordinator for the group
4. get approval for the assignment and advise on literature, form of work, etc.
5. carry out a number of discussion meetings
6. document your activities
7. submit the report to the course leader

The primary task of the study groups is to provide a forum for discussion of the matters treated in the course!

Study group assignments, example topics:

- Research methods in xxx, where xxx may be a subarea of computer and information science, for instance human-computer interaction, software engineering, artificial intelligence, etc.
- The nature of Computer Science.
- Assessing the quality of research and researchers in Computer Science.
- Science vs. technology, Computer Science as an engineering discipline.
- The philosophy of AI.
- Concept and theory formation in Computer Science.
- Qualitative methods in Computer Science research.
- Scientific discovery in Computer Science.
- Computer Science Thesis Work: Science, Engineering, or Art?

Philosophy of science

Science aims for
- insights, understanding
- power to predict

Scientific results should be
- possible to communicate
- repeatable/verifiable
- cumulative

Philosophy of science

The search for "true" knowledge:
- Concepts, categories, definitions
- Hypotheses
- Theories
- Models

Deduction	-	Induction
Verification	-	Falsification
Rationalism	-	Empiricism
Normal science	-	Scientific revolutions

Conducting scientific work

Virtues
- Critical attitude and thinking
- Relying on established methods
- Relating to previous work
- Openness with publication and data
- Credit to peers

and sins
- Vague concepts and definitions
- Weak arguments, missing justification
- Undue claims, lack of criticism
- Re-invention of existing knowledge
- Publication for its own sake

Computer Science as a Discipline

" Computer science and engineering is the systematic study of algorithmic processes - their theory, analysis, design, efficiency, implementation and application – that describe and transform information."

ACM Task Force on the core of Computer Science "Computing as a discipline."

" Computer science is the study of the phenomena surrounding computers."

Newell and Simon, ACM Turing Lecture 1976: "Computer Science as Empirical Inquiry: Symbols and Search."

Computer Science as a Discipline

Major paradigms or cultural styles (Denning & al. 1989)
- Theory
- Abstraction (modeling)
- Design

Scientific search for knowledge vs. Engineering design

Paradigms of Computer Science

Theory
- characterize objects (definition)
- hypothesize relationships (theorems)
- determine truth (proof)
- interpret results

Abstraction (modeling)
- form hypothesis
- construct model and predict
- design experiment, collect data
- analyze results

Design
- state requirements
- state specifications
- design and implement the system
- test the system

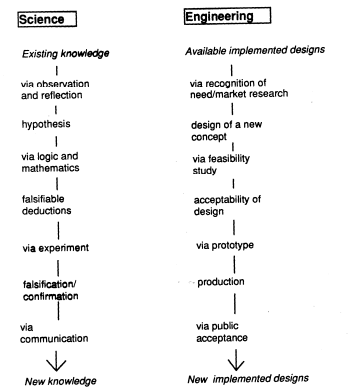

Figure 5. Development in science vs. engineering (modified from [Rogers 83]).

Methodology of Computer Science

Timothy Colburn

”Computer programs are mathematical expressions…” *Tony Hoare*

”Programs are tools or working environments for people…” C*hristiane Floyd”*

Modeling and abstraction central activities

Computer and Information Science

Computer Engineering
Computer Science
Software Engineering
Information Systems

Cognitive Systems, Information science, …

Datavetenskap och informatik

Datalogi/Datavetenskap/Datateknik
Informatik/Data- och systemvetenskap
Programvaruteknik
Kognitionsvetenskap
Informationsvetenskap
Medie- och kommunikationsvetenskap

Performing research in computer science

- explaining phenomena
- theories of formal systems
- algorithm design and analysis
- system design and analysis
- empirical investigations
- feasibility demonstration
- . . .

Results: theories, methods, artifacts, empirical data ...?

Issues:

- how to apply the (a?) scientific method?
- what is a result?
- why write programs?
- the role of negative results