DEPARTMENT OF COMPUTER SCIENCE
SERIES OF PUBLICATIONS A
REPORT A-1999-3

Department of Computer Science Annual Report 1998

Greger Lindén and Esko Ukkonen (eds.)

UNIVERSITY OF HELSINKI
FINLAND

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Computer Science at the University of Helsinki 1998

Greger Lindén and Esko Ukkonen (eds.)
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Abstract

The Department of Computer Science at the University of Helsinki is the largest department in its field in Finland. In this report, we will present the activities at the department in 1998.

Computing Reviews (1998) Categories and Subject Descriptors:
A.1 Introductory and Survey
A.2 Reference
K.3.2 Computers and Education: Computer and Information Science Education

General Terms:

Additional Key Words and Phrases:
computer science education, research information

Contents

1 Overview

The Department of Computer Science at the University of Helsinki is part of the Faculty of Science. It is located at Teollisuuskatu 23 in Vallila, 5 km north of the centre of Helsinki.

In 1998, the teaching faculty consisted of 10 full professors, 4 senior assistants, 12 lecturers, 11 assistants and 7 full-time teachers, 44 employees altogether. In addition, the department employed 41 part-time teachers, mainly graduate and postgraduate students. The major changes in the teaching staff were the appointment of Henry Tirri to professor (Learning and Intelligent Systems) from October 1, 1998 (5 years term) and the retirement of Prof. Martti Tienari. The administrative staff consisted of 15 persons including secretaries and library staff as well as computer maintenance staff. About 40 researchers and research assistants were employed with the help of outside funding and 16 postgraduate students were funded in the graduate schools of the department. Altogether, the number of employees was 116 (31.12.1998).

The department admitted 283 new students in 1998 out of which 59 (21%) were women. Altogether, 1793 students were enrolled in the computer science programme; 370 (21%) of them were women. In addition, 64 students were enrolled as postgraduate students of which 16 (25%) were women. In 1998, 48 students completed their M.Sc. degree, 4 their Ph.Lic. degree and 2 their Ph.D. degree.

The department participated in two graduate schools, the Helsinki Graduate School in Computer Science and Engineering (HeCSE) and the Graduate School in Computational Biology, Bioinformatics, and Biometry (ComBi). ComBi started in the beginning of 1998; the school has been administered by the department and the director is Prof. Esko Ukkonen.

The main research areas at the department are algorithms, intelligent and adaptive systems, software engineering, distributed systems and data communication, and information systems. Co-operation with various industries is significant. In 1998, the department co-operated with 41 different companies within different research projects. In addition, the department works closely with several other departments at the university.

The researchers at the department published 74 refereed journal and conference articles in 1998. In addition, they published 54 other publications (technical reports, articles popularizing science, etc.), some of them in the department's library series.

The library has about 46,000 items of print, most of which have been recorded in the WWW library system. In addition, the library subscribed to 280 journals. About 2000 loans from the library were registered.

The computing facilities included about 300 Linux PCs and 30 wireless PCs. The department is connected to the university backbone network giving access to the computers of the IT Department as well as to the national FUNET wide area network and Internet.

The department participates in several student exchange programmes (NORDPLUS, Erasmus, Socrates) and 26 international undergraduate students and 4 postgraduate students are enrolled at the department as undergraduate students. Teaching in English has also been increased. The department has received 16 visiting researchers for longer or shorter periods, and 8 of the department's own researchers stayed for a longer period abroad in 1998. The researchers of the department also actively attended conferences or visited academic institutions for shorter periods.

The department receives basic funding from the university. The Ministry of Education grants additional funding for education through different strategy programmes and for the graduate schools. Research is funded by three principal organisations, the Academy of Finland, the National Technology Agency (TEKES) and the European Commission.

The degree programme in computer science has undergone a major syllabus reform between academic years 1998-99 and 1999-2000. In this report, we will present the old curriculum. The new curriculum can be found on the web pages of the department.

Prof. Martti Tienari, long-time chairman of the department, retired on the December 1, 1998. Martti Tienari took his Ph.D. degree in mathematics in 1962 and worked for the Finnish Cable Factory (now Nokia) during 1960-67 in different leading positions in the Computer Division. He was appointed as the first professor and chairman of the department in 1967 when the department was founded, and he held the position of chairman until August 1998. His research interests have focused on numerical analysis (1963–73), programming languages and compilers (1973–83) and distributed systems, data communication protocols and their formal specification (1983–). Prof. Tienari has been active in the International Federation of Information Processing (IFIP). He is a member of the Finnish Academy of Science and Letters and of the Finnish Academy of Technical Sciences.

2 Staff

Staff 31.12.1998: The following table summarises the number of employees on December 31, 1998. Basic and additional funding refers mainly to education and administration as well as graduate school funding; research funding refers to outside funding by national and international institutes and companies.

Position	Funding			Total	Vacant	Total in
	Basic	Addit.	Research			position
Professors	9.5	1.5		11	1	10
Lecturers	13.5			13.5	1	12.5
Senior Assistants	6	3		9	5	4
Assistants	14	2		16	5	11
Teachers	7			7		7
Faculty	50	6.5		56.5	12	44.5
Administrative	13	2	1	16	1	15
Researchers		2	18	20		20
Research Assts		2	19	21		21
Postgraduates		16		16		16
Researchers		20	37	57		57
TOTAL	63	26.5	38	129.5	13	116.5

In addition, the department employed 41 part-time teachers in 1998. Many of the part-time teachers are graduate or postgraduate students.

Staff summary 1994-98: The following table summarises the number of employees during the years 1994-98. Not all persons have been employed for full years (compare number of employees and person years).

	1994	1995	1996	1997	1998
Person years	71	86	100	104	110
Research active staff	34	36	33	31	29
Research support staff	18	32	42	42	47
Other staff	45	44	39	47	46
Total	97	112	114	120	122

2.1 Teachers and administrative staff

Abdulla, Mustafa, ADP Designer
Ahonen, Helena, Ph.D., Assistant, leave of absence
Alaluoma, Merja, Teacher
Alanko, Timo, Ph.D., Professor
Andberg, Sami, Teacher (part-time)
Bergius, Tanja, Teacher (part-time)
Braun, Ülle, Book Binder (part-time)
Elolampi, Pentti, M.Sc., Lecturer
Elomaa, Tapio, Ph.D., Lecturer, leave of absence in Spring 1998
Eloranta, Jaana, Ph.D., Assistant, leave of absence
Eloranta, Satu, M.Sc., Assistant
Erkiö, Hannu, Ph.D., Professor, Docent
Eskola, Jukka, Assistent
Grahne, Gösta, Ph.D., Docent, Lecturer, leave of absence
Granlund, Kaj, Teacher (part-time)
Granö, Kari, M.Sc., Assistant
Gustafsson, Juha, M.Sc., Assistant
Haajanen, Jyrki, Teacher (part-time)
Hakli, Raul, M.Sc.., Assistant
Halme, Allan, Teacher (part-time)
Heinonen, Oskari, M.Sc., Assistant, leave of absence
Helin, Heikki, Teacher (part-time)
Häkkinen, Auvo, M.Sc., Lecturer
Hämäläinen, Wilhelmiina, Teacher
Immonen, Anna, Teacher (part-time)
Jokela, Mikael, ADP Designer
Juslin, Jari, Teacher (part-time)
Kaivola, Roope, Ph.D., Docent, Senior Assistant
Karvi, Timo, Ph.Lic., Senior Assistant
Kasari, Anita, Teacher
Kaskenpalo, Petteri, Application Designer
Kauppinen, Raine, Teacher (part-time)
Kekkonen, Mika, Teacher (part-time)
Kerminen, Antti, Teacher (part-time)
Kerola, Teemu, Ph.D., Lecturer, leave of absence in Spring 1998
Kilpeläinen, Pekka, Ph.D., Professor
Kivinen, Jyrki, Ph.D., Docent, Senior Assistant
Kivioja, Teemu, Research Assistant
Klemettinen, Mika, M.Sc., Assistant, leave of absence

Kojo, Markku, M.Sc., Lecturer, leave of absence in Autumn 1998
Kraft, Janne, Teacher
Kuhlberg, Panu, Teacher (part-time)
Kuittinen, Juhani, M.Sc., Assistant
Kujala, Teija, M.Sc., Amanuensis
Kutvonen, Lea, Ph.D., Lab. Eng., leave of absence in Spring 1998
Kutvonen, Petri, M.Sc., Chief Systems Analyst
Kyrö, Jaakko, Teacher (part-time)
Kähkipuro, Pekka, M.Sc., Teacher (part-time)
Kärkkäinen, Juha, M.Sc., Assistant, leave of absence
Laakso, Karri-Pekka, M.Sc. (Tech), Teacher (part-time)
Laakso, Sari A., M.Sc., Lecturer
Laamanen, Heimo, Ph.Lic., Teacher (part-time)
Laine, Harri, Ph.Lic., Lecturer
Laine, Tei, Assistant
Latva-Koivisto, Antti, Teacher (part-time)
Lehtimäki, Jarno, Research Assistant
Lehto, Jaakko, Teacher (part-time)
Leinonen, Jani, Teacher (part-time)
Lemström, Kjell, M.Sc., Assistant, leave of absence
Liljeberg, Mika, Assistant
Lindén, Greger, Ph.D., Senior Assistant
Lokki, Heikki, Ph.Lic., Senior Assistant
Manner, Jukka, Teacher
Mannila, Heikki, Ph.D., Professor, leave of absence
Marttinen, Liisa, M.Sc., Lecturer
Mettinen, Kari, Amanuensis
Mikkonen, Jarkko, ADP Designer
Moen, Pirjo, Ph.Lic., Assistant, leave of absence
Moilanen, Jani, Teacher (part-time)
Myllymäki, Petri, Ph.D., Senior Assistant, leave of absence
Mäkelä, Matti, Techn.Dr., Professor
Nenonen, Lilli, Teacher (part-time)
Nikander, Sami, Teacher (part-time)
Niklander, Tiina, M.Sc., Amanuensis, leave of absence
Nurmi, Otto, Dr.rer.pol., Lecturer, leave of absence
Nykänen, Matti, Ph.D., Assistant, leave of absence
Orasaari, Marko, Teacher
Paakki, Jukka, Ph.D., Professor, leave of absence in Autumn 1998
Paasonen, Jussi, Teacher (part-time)

Palander, Sirkka, Secretary
Patrikka, Timo, Teacher (part-time)
Pauna, Matti, Teacher (part-time)
Pienimäki, Santeri, Teacher (part-time)
Pohjonen, Kirsti, Librarian
Pollari-Malmi, Kerttu, Techn.Lic., Lect., leave of absence from April 1998
Pulli, Harri, Teacher
Puustjärvi, Juha, Ph.Lic., Lecturer
Raatikainen, Kimmo, Ph.D., Professor
Rinta-Mönty, Janne, Teacher
Salmi, Kari, Library Secretary
Sandgren, Jenny, Teacher (part-time)
Sarkkinen, Jussi, Teacher (part-time)
Saura, Asko, Teacher (part-time)
Sievänen, Juha, System Designer
Sihvo, Satu, Teacher (part-time)
Sippu, Seppo, Ph.D., Professor
Siven, Reijo, M.Sc., Amanuensis
Soininen, Jonne, Teacher (part-time)
Sorsa, Juha-Antti, M.Sc., Teacher (part-time)
Suontaa, Kati, Secretary
Sutinen, Erkki, Ph.D., Assistant, leave of absence in Autumn 1998
Taina, Juha, Ph.Lic., Lecturer
Tienari, Martti, Ph.D., Professor (Emer. since 1.12.1998)
Tillonen, Sirkka, Porter
Tirri, Henry, Ph.D., Professor (appointed from 1.10.1998)
Toivonen, Hannu, Ph.D., Senior Assistant, leave of absence
Tuominen, Antti, Teacher (part-time)
Tuovinen, Antti-Pekka, M.Sc., Assistant, leave of absence
Turkia, Miika, ADP Designer
Ukkonen, Esko, Ph.D., Professor, Chairman of the Department
Ullgren, Marko, Teacher (part-time)
Uronen, Pekka, Teacher (part-time)
Valtakari, Kasper, Teacher (part-time)
Vasko, Kari, Teacher (part-time)
Verkamo, Inkeri, Ph.D., Docent, Lecturer, leave of absence
Vihavainen, Juha, Ph.Lic., Lecturer
Vilo, Jaak, M.Sc., Assistant
Wikla, Arto, M.Sc., Lecturer
Yli-Harja, Olli, Techn.Dr., Teacher (part-time)

Ylirisku, Satu, Teacher (part-time)

2.2 Researchers

2.2.1 Project Workers

For project acronyms, please see Section 4.8.

Campadello, Stefano, M.Sc., Res., DOLMEN, MONTAGE, MONADS
Gurtov, Andrei, Research Assistant, MOWGLI
Haataja, Juha-Pekka, Research Assistant, MONTAGE
Heikkinen, Barbara, M.Sc., Researcher, SID
Heinonen, Oskari, M.Sc., Researcher, SID
Helin, Heikki, Researcher, MONADS
Hellgren, Vesa, Ph.Lic., Research Assistant, MOCO
Huhtala, Ykä, ADP Designer, KESO
Huttunen, Markus, M.Sc., Research Assistant, IHP
Häkkinen, Auvo, M.Sc., Researcher, HPGIN
Isomarkku, Perttu, Research Assistant, SosKart
Jaakkola, Jani, Application Designer, SID
Kangasharju, Jaakko, Research Assistant, MONADS
Kilpeläinen, Pekka, Ph.D., Project Manager, SID
Kojo, Markku, M.Sc., Laboratory Engineer, MOWGLI
Kontkanen, Petri, Research Assistant, HYPE IV, PROMISE
Korpimies, Kai, M.Sc., Researcher, Komb.
Koskimies, Oskari, M.Sc., Researcher, DOLMEN, MONADS
Kuuppelomäki, Päivi, M.Sc., Research Assistant, MOCO
Kähkipuro, Pekka, Ph.Lic., Project Manager, CORBA-FORTE
Kärkkäinen, Juha, M.Sc., Researcher, FDK
Kätsyri, Jari, ADP Designer, CORBA-FORTE
Laakso, Karri-Pekka, M.Sc. (Tech), Research Assistant, FDK
Lahtinen, Jussi, Research Assistant, HYPE IV, PROMISE
Lattu, Matti, Researcher, AAPS
Leinonen, Jani, Research Assistant, MONTAGE
Lindholm, Taina, Project Secretary, PROMISE
Lindström, Jan, Researcher, RODAIN2000
Luukkainen, Matti, M.Sc., Research Assistant (part-time), MOCO
Manner, Jukka, Designer, MOWGLI
Mannila, Heikki, Ph.D., Academy Researcher, Person in charge, KESO
Misikangas, Pauli, M.Sc., Researcher, MONADS

Mononen, Tommi, Research Assistant, ÄLYJO
Mäkelä, Mikko, Research Assistant, MONADS
Niemi, Jyrki, Designer (part-time), SID
Niklander, Tiina, M.Sc., Project Manager, RODAIN2000
Nykänen, Matti, Ph.D., Academy Researcher
Paasiala, Kimmo, Designer, SID
Peltola, Juhani, Research Assistant (part-time), AAPS
Porkka, Pasi, Research Assistant, RODAIN2000
Pulli, Harri, Designer, MOWGLI
Raatikainen, Kimmo, Ph.D., Project Manager, DOLMEN
Rautama, Erkki, Research Assistant, AAPS
Sevanto, Jarkko, M.Sc., ADP Designer, DOLMEN
Sievänen, Juha, Application Designer, HPGIN
Silander, Tomi, M.Sc., Researcher, NONE
Sjöroos, Toni, Research Assistant (part-time), AAPS
Tamm, Hellis, M.Sc., Researcher, Komb.
Tamminen, Aki, Research Assistant (part-time), AAPS
Tapanainen, Jaakko, Research Assistant (part-time), KESO
Teräsvirta, Tommi, Research Assistant, AAPS
Tirri, Henry, Ph.D., Person in charge, HYPE IV, PROMISE
Toivonen, Hannu, Ph.D., Academy Researcher, HeCSE
Tykkälä, Kimmo, Research Assistant, MONADS
Valtonen, Kimmo, Research Assistant, HYPE IV, PROMISE
Vasko, Kari, Research Assistant, FDK
Vaucouleur, Sebastian, Research Assistant, CORBA-FORTE
Verkamo, A. Inkeri, Ph.D., Project Manager, KESO
Viljamaa, Antti, M.Sc., ADP Designer, FRED
Viljamaa, Jukka, M.Sc., ADP Designer, FRED

Graduate school students

Heikkinen, Barbara, M.Sc., Researcher, Kulttuurirahasto
Hegedüs, Tibor, M.Sc., Postgraduate Student, HeCSE
Heinonen, Oskari, M.Sc., Postgraduate Student, HeCSE
Klemettinen, Mika, M.Sc., Postgraduate Student, HeCSE
Kurhila, Jaakko, M.Sc., Postgraduate Student, HeCSE
Kutvonen, Lea, M.Sc., Postgraduate Student, HeCSE
Kähkipuro, Pekka, Ph.Lic., Postgraduate Student, HeCSE
Lemström, Kjell, M.Sc., Postgraduate Student, HeCSE
Moen, Pirjo, M.Sc., Postgraduate Student, HeCSE

Salmenkivi, Marko, M.Sc., Postgraduate Student, HeCSE
Taina, Juha, Ph.Lic., Postgraduate Student, HeCSE
Tuovinen, Antti-Pekka, M.Sc., Postgraduate Student, HeCSE
Vilo, Jaak, M.Sc., Postgraduate Student, HeCSE
Fredriksson, Kimmo, M.Sc., Postgraduate Student, ComBi
Lund, Tatu (University of Turku), M.Sc., Postgraduate Student, ComBi
Ollikainen, Vesa,M.Sc., Postgraduate Student, ComBi
Ravantti, Janne, M.Sc., Postgraduate Student, ComBi
Salmenkivi, Marko, M.Sc., Postgraduate Student, ComBi
Saren, Ari-Matti, M.Sc., Postgraduate Student, ComBi
Sillanpää, Mikko, M.Sc., Postgraduate Student, ComBi
Smolander, Sampo, M.Sc., Postgraduate Student, ComBi

Docents (employed outside the department)

Back, Ralph, Ph.D., Docent, Professor of Åbo Akademi
Floréen, Patrik, Ph.D., Docent, European Commission
Järvinen, Pertti, Ph.D., Docent, Professor of the University of Tampere
Koskimies, Kai, Ph.D., Docent, Professor of the University of Tampere
Linnainmaa, Seppo, Ph.D., Docent, Professor (VTT).
Orponen, Pekka, Ph.D., Docent, Professor of the University of Jyväskylä
Peltola, Eero, Ph.D., Docent, Professor of the University of Jyväskylä
Räihä, Kari-Jouko, Ph.D., Docent, Professor of University of Tampere
Soisalon-Soininen, Eljas, Ph.D., Docent, Professor of the Helsinki University of Technology
Takala, Tapio, Techn.Dr., Docent, Professor of the Helsinki University of Technology
Tarhio, Jorma, Ph.D., Docent, Professor of University of Joensuu
Valmari, Antti, Techn.Dr., Docent, Professor of the Tampere University of Technology
Veijalainen, Jari, Dr.-Ing., Docent, Professor of the University of Jyväskylä

3 Finances

Funding (thousands of marks)	1998	Total
Basic funding		11 900
Additional funding for education		
- National Information Society Strategy	1 900	
- Graduate Schools	2 000	
- Other	1 600	
Additional funding for education	5 500	5 500
Research funding		
Academy of Finland	1 700	
National Technology Agency & industry	5 100	
European Commission	1 400	
Others	300	
Research funding	8 500	8 500
TOTAL		25 900

4 Research

The research at the department has evolved over the years in step with the international research trends in computer science. Early work in numerical analysis in the 1960's made room for work in programming languages and compilers in the 1970's. Since then the research has diversified and its volume has increased.

The main sources of research funding are the Academy of Finland, the National Technology Agency (TEKES), the Ministry of Education and the European Union (EU) research programmes. All projects funded by TEKES also have partial funding by industrial partners.

The Department participates in two graduate schools that fund the research of some Ph.D. students: The Helsinki Graduate School in Computer Science and Engineering (HeCSE), a joint school with the Helsinki University of Technology); and the Graduate School in Computational Biology, Bioinformatics and Biometry (ComBi) a joint school with the Universities of Turku and Tampere. ComBi is co-ordinated by the Department and directed by Prof. Esko Ukkonen.

The department has three subprogrammes and five specialisation areas that are used in the planning of the curricula and in administration. The division is not strict, and several research projects span two sections. The sections cover roughly the following subject areas:

Computer Science

- Algorithms (Prof. Esko Ukkonen, Prof. Matti Mäkelä): algorithms and data structures, computational complexity, computational geometry, machine learning, computer graphics, numerical and symbolic computation, computational biology, geoinformatics, computationally intensive tasks.

- Intelligent Systems (Prof. Henry Tirri): Bayesian networks, intelligent and adaptive systems, artificial intelligence, computational intelligence, artificial life.

- Software Engineering (Prof. Jukka Paakki, Prof. A. Inkeri Verkamo): programming languages, compilers, software engineering, performance evaluation.

- Distributed Systems and Data Communication (Prof. Kimmo Raatikainen, Prof. Timo Alanko, Prof. Martti Tienari): mobile computing, formal specification and verification, distributed systems, computer networks, operating systems.

- Information Systems (Prof. Hannu Erkiö, Prof. Pekka Kilpeläinen, Prof. Seppo Sippu): databases, human-computer interfaces, computer supported co-operative work, information system design methodology, design of databases, text databases, object-oriented databases, logic databases, database structures and algorithms, document management, data mining and knowledge discovery, management of spatial data (GIS).

Applied Computer Science

- Applied Computer Science (Prof. Esko Ukkonen): computational biology, geoinformatics, computationally intensive tasks.

Teacher in Computer Science

- Teacher in Computer Science (Computer-supported education, Prof. Pekka Kilpeläinen): computer-aided instruction, computers in education.

In the following, the research activities of each section of the department are reviewed.

4.1 Algorithms

The main research areas in general computer science are algorithms and data structures, machine learning, probabilistic reasoning, computations by complex dynamic systems (cellular automata and genetic algorithms) and computational biology. Algorithms, Data Structures and Complexity (funded by the Academy of Finland, 1983-, Ukkonen) is the area with the longest tradition. The work on string matching algorithms (Ukkonen, Tarhio, Kärkkäinen) has been particularly successful. Theoretical work has often been conducted within the framework of systems research providing practical motivation for the problems studied. Currently, special emphasis is given to the research on algorithmic problems in computational biology and bioinformatics. A project on Algorithmic Methods of Biocomputing and Data Analysis (Academy of Finland, 1999-, Ukkonen) has just started.

The Machine Learning Group (Academy of Finland, 1994-, Mannila, Ukkonen, Elomaa, Kivinen) has studied different machine learning models and the complexity of learning tasks within these models as well as their applications, e.g. in biological sequence analysis and process industry. The aim of Neural and Computational Learning (NeuroCOLT

Working Group/EU, 1994-2000, 10 sites, Ukkonen) is to develop a fundamental understanding of learning and of when and how it can be implemented algorithmically. Machine Learning Methods in Hydrological Modelling and Optimisation (Academy of Finland, a joint project with the Finnish Environment Institute, 1994-99, Ukkonen) applies machine learning methods in hydrological modelling.

4.2 Intelligent Systems

The Complex Systems Computation Group (CoSCo, Tirri, Myllymäki) studies computational issues related to complex systems focusing on prediction and model selection issues. Current work of the CoSCo group is concentrated on theory and applications of Bayesian (belief) networks, and related probabilistic model families, such as finite mixture models. The Computationally Intelligent Hybrid-Paradigm Environments project (HYPE/TEKES, 1995-98) studied hybrid systems integrating different modules such as neural networks, probabilistic models and genetic algorithms all aiming at solving a single problem. The general objective of the Computational Intelligence Techniques for Non-linear Modelling in Social Sciences (NONE/Academy of Finland, 1998-99) project is to develop theoretically sound computational intelligence techniques for non-linear modelling of data, and methodologies for applying them in the domain of educational data. The main objective of the PROMISE project (TEKES, 1998-99) is to study methods for applying probabilistic modelling techniques (Bayesian networks, finite mixture models) and stochastic optimisation methods (simulated annealing, genetic algorithms) in constructing adaptive and intelligent systems.

4.3 Software Engineering

The research in software engineering, carried out by the Research group on Object-Oriented Software Architectures (ROOSA, Paakki, Verkamo, Tuovinen, A. Viljamaa), concentrates on software architectures from different perspectives. The group runs currently three externally funded research projects: The Framework Editor project (FRED/TEKES, 1997-1999) develops techniques and tools for designing object-oriented application frameworks based on design patterns. The Software Architecture Analysis, Recovery and Assessment project (SAARA/Academy of Finland, 1999-2001) studies methods for automatically recovering architectural knowledge from source code. The Metrics for Analysis and Improvement of Software Architectures project (MAISA/TEKES, 1999-2001) develops methods and tools for the measurement of software quality at design level. The group and its research projects have close contacts to the Nokia Research Center where Prof. Paakki is a manager in the large European EUREKA/ITEA project ESAPS on software architectures and system families.

The group has also been running a number of projects that no longer get external funding but that still partly exist in the form of graduate studies. The Channel into Object-Oriented Protocol Design project (Kannel/TEKES, Academy of Finland, 1993-1996) developed an integrated language for the design and implementation of communication protocols. The Computer-Aided Software Maintenance project (HyperSoft/TEKES, 1994-1996) developed a hypertextual tool supporting typical software maintenance and program comprehension activities.

4.4 Distributed Systems and Data Communication

Mobile Computing (MOWGLI/TEKES, 1993-99, Tienari, Raatikainen, Alanko, Kojo) studies, designs and tests new data communication architectures for GSM-based mobile data services. The Service Machine Development for an Open Long-term Mobile and Fixed Network Environment project (DOLMEN/EU, 1995-98, 12 partners, Raatikainen) demonstrates, assesses and promotes a Service Architecture (called Open Service Architecture for a Mixed fixed and mobile environment or OSAM) that meets the requirements of open provision of communication services over both fixed and mobile heterogeneous and multi-provider telecommunications networks. The Adaption Agents for Nomadic Users project (MONADS/TEKES, 1998-, Raatikainen, Koskimies) examines adaptive agents for nomadic users. Mobile Intelligent Agents in Accounting, Charging and Personal Mobility Support (MONTAGE/EU, 1998-, 5 partners, Raatikainen) aims to research, evaluate and assess the impact of agent technology to the telecommunications world. A new project, Promoting Interoperability for Multimedia services in Europe (Prime/EU, 1998-2000, 8 partners, Raatikainen) has just started.

The Modelling of Concurrency (MOCO/Academy of Finland, 1990-, Tienari, Kaivola) studies formal specification and verification of distributed systems, developing and using theories and software tools based on process algebras and temporal logic. The Open Distributed Computing Environments (ODCE, 1992-, Tienari, Raatikainen, L. Kutvonen) group concentrates on open architecture models and platforms. First, the DRYAD project (TEKES, 1992-1996, Tienari, L. Kutvonen) studied middleware support for federation of sovereign systems. Conceptual results were contributed to the Open Distributed Processing reference model standardized by ISO/ITU; experimental results included a prototype trader. A newer ODCE project, the CORBA-Based Framework for Telecommunications project (CORBA-FORTE/TEKES, 1998-1999, Tienari, Raatikainen) focuses on the performance and usability of the CORBA architecture in telecommunications systems.

The research project Database Architecture for Intelligent Networks (Darfin/TEKES, 1993-95, Raatikainen) examined database architectures that can fulfill the requirements of Intelligent Networks (IN) and Telecommunication Management Networks (TMN). The research project Real-Time Object-Based Database Architecture for Intelligent Networks (RODAIN/TEKES, 1996-99, Raatikainen) continues the work done in the Darfin project. In the project the research group has designed and specified a real-time object-oriented database architecture for Intelligent Networks and implemented a simple prototype.

The worldwide development of the LINUX operating system was initiated and co-ordinated at our department by Linus Torvalds 1991-97. The work with Linux still continues here. The objective of the department in the High Performance Gigabit I2O Networking Software project (HP-GIN/EU, 1998-2000, 3 partners, Raatikainen, Tienari) is to implement I2O extensions to the Linux standard network operating system and to add support for I2O compliant gigabit networking adapters.

4.5 Information Systems

In information systems the largest research project has concentrated on data mining (Mannila, Toivonen, Verkamo, Klemettinen), also known as knowledge discovery in databases. The research is done with the machine learning group, with statisticians, and with the appliers. The research started in the late 1980's in the context of developing tools for inferring integrity constraints from databases. Recent research results include efficient data mining methods for database re-engineering, methods for finding recurrent episodes within event sequences and development of automatic tools for the simulation of complex statistical models. The Data mining in telecommunications project (TASA/TEKES, 1994-97, Mannila, Klemettinen) has developed several new methods for extracting interesting information from large data sets. The From Data to Knowledge project (FDK/Academy of Finland, 1996-99, Mannila, Toivonen, Ukkonen, Verkamo,) is a large umbrella project developing methods for knowledge discovery from large masses of data. The project combines and develops methods in computer science and statistics, and the methods are applied to epidemiology, biotechnology, environmental research and archaeology. Knowledge Extraction for Statistical Offices (KESO/EU, 1995-98, 8 partners, Mannila, Verkamo) developed tools for knowledge discovery from large statistical data sets.

The Document Management (DocMan, Mannila, Kilpeläinen, Ahonen, Lindén) research group studies the theory and application of structured documents. Former research projects include the sgrep project (1995) which designed and implemented a search tool for structured documents. Structured and Intelligent Documents (SID/TEKES 1995-98, Kilpeläinen) was a project within the DocMan group that studied and developed methods and tools for the realisation of "intelligent documents" that would easily adapt to the needs of different users. A central goal application was document assembly, by which we mean computer-supported compilation of new documents from existing text sources. The Intelligent Management Information Systems (ÄLYJO/TEKES 1997-99, Mannila) project studies information retrieval, computer-supported co-operative work and interactive communication in management information systems.

The Transaction Management Support for Co-operative Applications (TRANSCOOP/EU, 1994-96, 3 partners, Tirri) project studied design of co-operative systems including the description and formal specification of co-operative activities.

4.6 Applied Computer Science

Applied Computer Science is pursued in several of the other research divisions, e.g. within the algorithms, machine learning, biocomputing, and data mining groups.

4.7 Teacher in Computer Science

The Animation Aided Problem Solving (AAPS/Ministry of Education 1996-98, Tarhio, Sutinen) has studied program visualisation, teaching algorithms by means of animation, and computer-supported concept mapping. The group has developed a Web-based system for fast generation of algorithm animations. The Survey of Information Technology in Human Services in Finland (SosKart/STAKES, 1998-99, Mäkelä) analyses and evaluates the state of the art and the prospects of the information technology applications currently used in human services in Finland.

4.8 Research projects in 1998 according to financing

In 1998 there were 5 projects funded by the Academy of Finland, one by the Ministry of Education, one by the National Research and Development Centre for Welfare and Health (STAKES), 9 by the National Technology Agency (TEKES) and industrial partners and 6 by the European Union. Each research project is listed below including the name of the person in charge (and project manager if different from the person in charge) as well as the time span of the project.

Academy of Finland

- Modelling of Concurrency (MOCO), Martti Tienari (Päivi Kuuppelomäki), 1.1.96-31.12.98
- Combinatorial Pattern Matching and Data Mining: Theory Algorithms and Applications (Komb.), Esko Ukkonen, 1.3.94-31.12.98
- Combining Expert Knowledge and Observed Data in Hydrological Modeling and Optimisation (IHP), Esko Ukkonen, 1.5.94-31.12.99
- From Data to Knowledge (FDK), Heikki Mannila (Hannu Toivonen) 1.10.96-30.9.99
- Computational Intelligence Techniques for Nonlinear Modeling in Social Sciences (NONE), Henry Tirri (Petri Myllymäki), 1.1.97-31.12.99

Ministry of Education

- Animation Aided Problem Solving (AAPS), Jorma Tarhio, 1.1.96-31.12.98

The National Research and Development Centre for Welfare and Health (STAKES)

- Survey of Information Technology in Human Services in Finland (SosKart), Matti Mäkelä (Jaakko Kurhila), 1.11.98-31.7.99

The National Technology Agency (TEKES) & industrial partners

- Mobile Office Workstations Using GSM Link (MOWGLI), Martti Tienari (Timo Alanko), 1.9.93-31.12.99

- Computationally Intelligent Hybrid-Paradigm Environments (HYPE), Henry Tirri (Petri Myllymäki), 1.3.95-28.2.98
- Framework Editor for Java (FRED), Jukka Paakki, 1.1.-31.12.99
- Structured and Intelligent Documents (SID), Heikki Mannila (Pekka Kilpeläinen), 1.8.95-31.7.98
- Intelligent executive information systems (ÄLYJO), Heikki Mannila (Tommi Mononen), 1.1.-31.12.99
- Real-Time Object-Based Database Architecture for Intelligent Networks (RODAIN), Kimmo Raatikainen, (Tiina Niklander), 1.1.96-31.12.99
- Performance and usability of the CORBA architecture in telecommunications technology (CORBA-FORTE), Martti Tienari, Kimmo Raatikainen (Pekka Kähkipuro), 1.1.98-31.12.99
- Adaption Agents for Nomadic Users (MONADS), Kimmo Raatikainen (Oskari Koskimies), 1.1.98-31.12.98
- Applications of Probabilistic Modeling and Search Methods (PROMISE), Henry Tirri (Petri Myllymäki), 1.3.98-31.12.99

European Union

- Neural Computational Learning II (NeuroCOLT), Esko Ukkonen, 1.1.98-31.12.00
- Knowledge Extraction for Statistical Offices (KESO), Heikki Mannila (A. Inkeri Verkamo), 1.1.96-31.3.99
- Service Machine Development for an open Long-term Mobile and Fixed Network Environment (DOLMEN), Kimmo Raatikainen, 1.9.95-31.10.98
- Mobile Intelligent Agents in Accounting, Charging and Personal Mobility Support (MONTAGE), Kimmo Raatikainen, 1.4.98-29.2.00
- High Performance Gigabit I2O Networking Software (HPGIN), Martti Tienari, Kimmo Raatikainen (Auvo Häkkinen), 1.12.98-31.5.00
- Promoting Interoperability for Multimedia services in Europe (Prime), Kimmo Raatikainen, 1.10.98-29.2.00

5 Publications

The researchers at the department published 74 refereed journal and conference articles in 1998. In addition, they published 54 other publications (technical reports, articles popularizing science, etc.), some of them in the department's library series.

Year	1995	1996	1997	1998
Monographs	1	1	3	0
Journal articles	11	19	16	10
Central conference articles	28	39	51	46
Other conference articles	13	8	19	18
Other publications	34	76	60	54
Total	87	143	149	128

5.1 Journal articles

1. Brazma, Alvis & Jonassen, Inge & Vilo, Jaak & Ukkonen, Esko: Predicting gene regulatory elements in silico on a genomic scale. *Genome Research* **8**, *11* (1998), 1202-1215.

2. Elomaa, Tapio: A review of 'How the mind works'. *AI Magazine* **19**, *3* (1998), 135-137.

3. Grahne, Gösta: Updates and counterfactuals. *Journal of Logic and Computation* **8**, *1* (1998), 87-117.

4. Granö, Kari & Paakki, Jukka & Viljamaa, Jukka & Viljamaa, Antti: Protocol engineering & Kannel. *Dr. Dobb's Journal* **23**, *4* (1998), 46-53.

5. Haussler, David & Kivinen, Jyrki & Warmuth, Manfred K.: Sequential prediction of individual sequences under general loss functions. *IEEE Transactions of Information Theory* **44**, *5* (1998), 1906-1925.

6. Kaivola, Roope: Axiomatising extended computation tree logic. *Theoretical Computer Science* **190**, *1* (1998), 41-60.

7. Kärkkäinen, Juha & Sutinen, Erkki: Lempel-Ziv index for q-grams. *Algorithmica* **21**, *1* (1998), 137-154.

8. Lahtinen, Simo-Pekka & Sutinen, Erkki & Tarhio, Jorma: Automated animation of algorithms with Eliot. *Journal of visual Languages and Computing* **9**, *3* (1998), 337-349.

9. Paakki, Jukka & Tuovinen, Antti-Pekka: Source-to-source translation of Visual Languages. *Nordic Journal of Computing* **5**, *3* (1998), 235-264.

10. Trigila, Sebastiano & Raatikainen, Kimmo & Wind, Berny & Reynolds, Paul: Mobility in long-term service architectures and distributed platforms. *IEEE Personal Communications* **5**, *4* (1998), 44-55.

5.2 Articles in the most central, refereed international conferences or collections

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2. Ahonen, Helena & Heinonen, Oskari & Klemettinen, Mika & Verkamo, A. Inkeri: Applying data mining techniques for descriptive phrase extraction in digital document collections. In *Proc. IEEE International Forum on Research and Technology Advances in Digital Libraries, ADL '98*, April 22-24, 1998, Santa Barbara, California. Los Alamitos (CA), IEEE Computer Society, 1998, pp. 2-11.

3. Ahonen, Helena & Heikkinen, Barbara & Heinonen, Oskari & Jaakkola, Jani & Kilpeläinen, Pekka & Lindén, Greger: Design and implementation of a document assembly workbench. In *Electronic publishing, artistic imaging, and digital typography. Proc. 7th International Conference on Electronic Publishing, EP '98*, held jointly with the 4th International Conference on Raster Imaging and Digital Typography, RIDT '98, St. Malo, France, March 30 - April 3, 1998. Berlin, Springer-Verlag, 1998 (Lecture notes in computer science 1375) pp. 476-486.

4. Alanko, Timo & Hippeläinen, Lassi & Kojo, Markku & Laamanen, Heimo & Liljeberg, Mika & Raatikainen, Kimmo: Mowgli: enhanced communication services for mobile computing using GSM. In *ITU Telecom Interactive 97*, Geneva 8-14 September: forum papers. Geneva, ITU, 1998, 14 p.

5. Boulicaut, Jean-Francois & Klemettinen, Mika & Mannila, Heikki: Querying inductive databases: a case study on the MINE RULE operator. In *Proc. 2nd European symposium Principles of data mining*

and knowledge discovery, PKDD '98, Nantes, France, September 23-26, 1998. Berlin, Springer-Verlag, 1998 (Lecture notes in artificial intelligence vol. 1510) pp. 194-202.

6. Brazma, Alvis & Jonassen, Inge & Vilo, Jaak & Ukkonen, Esko: Pattern discovery in biosequences. In *Proc. 4th international colloquium on Grammatical inference, ICGI-98*, Ames, Iowa, USA, July 12-14, 1998. Berlin, Springer-Verlag 1998 (Lecture notes in artificial intelligence vol. 1433) pp. 257-270.

7. Das, Gautam & Lin, King-Ip & Mannila, Heikki & Renganathan, Gopal & Smyth, Padhraic: Rule discovery from time series. In *Proc. 4th International Conference on Knowledge Discovery and Data Mining, KDD '98*, August 27-31, 1998, New York, New York. Menlo Park (CA), AAAI Press, 1998, pp. 16-22.

8. Das, Gautam & Mannila, Heikki & Ronkainen, Pirjo: Similarity of attributes by external probes. In *Proc. 4th International Conference on Knowledge Discovery and Data Mining, KDD '98*, August 27-31, 1998, New York, New York. Menlo Park (CA), AAAI Press, 1998, pp. 23-29.

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10. Dybdahl, Arne & Sutinen, Erkki & Tarhio, Jorma: On animation features of Excel. In *Changing the delivery of computer science education. 6th Annual Conference on the Teaching of Computing, 3rd Annual Conference on Integrating Technology into Computer Science Education - ITiCSE '98*, Dublin City University, Ireland, 17th-21st August 1998. New York (NY), ACM, 1998, pp. 77-80. (Publ. as SIGCSE bulletin 1998, vol. 30, no. 3).

11. Eerola, M. & Mannila, Heikki & Salmenkivi, Markku: Frailty factors and time-dependent hazards in modelling ear infections. In *Proc. Conference of the International Association for Statistical COmputing, COMPSTAT '98*, Springer-Verlag 1998, 287-292.

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16. Heinonen, Oskari: Optimal multi-paragraph text segmentation by dynamic programming. In *Proc. 36th Annual Meeting of the Association for Computational Linguistics and 17th International Conference on Computational Linguistics, COLING-ACL '98*, August 10-14, 1998, Université de Montréal, Montreal, Quebec, Canada. San Francisco (CA), Morgan Kaufmann (distr.), 1998, pp. 1484-1486.

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5.3 Articles in other refereed international conferences

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6 Education

6.1 Students

In 1998, there were 1793 undergraduate students majoring in computer science and 64 post-graduate students. In the same year, 276 new students were enlisted at the department. The department has about 800 students who take computer science as a minor subject.

6.2 Number of degrees, modules and credit units

In 1998, 48 students completed their M.Sc. degree in computer science. In addition, 4 students completed their advanced studies in computer science (minor studies). Four postgraduate students completed their Ph.Lic. degree and two their Ph.D. degree. The number of M.Sc. degrees have been fairly constant during recent years. The B.Sc. degree has been recently reintroduced, and students now tend to complete this degree before completing their M.Sc. degree.

Degree/Year	1995	1996	1997	1998
Ph.D	1	4	3	2
Ph.L.	2	3	3	4
M.Sc.	44	51	62	48
B.Sc.	7	20	15	52

Students start by completing their Approbatur studies (basic level, 15 cu). They then go on to their Cum Laude Approbatur studies (intermediate level, 55 cu) and Laudatur studies (advanced level, 95 cu). The Master's thesis is included in the Laudatur studies. In 1998, students completed studies according to the following table (minor students included).

Study Module/Year	1995	1996	1997	1998
Approbatur	166	115	141	208
Cum Laude Approbatur	133	101	117	94
Laudatur	43	62	65	42
Master's Theses	49	63	67	53
Ph.Lic. degrees	2	3	2	4
Ph.D. Degrees	1	4	3	2

The admittance of new students has been very high during recent years and the number of achieved credits have increased constantly during many years. The table below shows achieved credits during recent years (minor students included).

Year	1995	1996	1997	1998
Achieved credit units	15 037	17 178	17 494	17 863

6.3 Study Programmes

The students normally start their university studies at the age of 19. Their goal is to receive a B.Sc. (Bachelor of Science) or M.Sc. (Master of Science) degree in computer science requiring three to four or five years of study. Beyond the M.Sc. degree there are two graduate degrees: the Ph.Lic. degree (Licentiate of Philosophy) and the Ph.D. degree (Doctor of Philosophy).

The academic year has two terms: the autumn term lasts from 1 September to 20 December (classes from 11 September to 10 December) while the spring term lasts from 1 January to 31 May (classes from 16 january to 10 May, excluding one week of Easter vacation). It is also possible to study in the summer. Intensive courses of 4-5 weeks covering introductory topics are offered in June and August. Graduate courses are also organised in co-operation with other Finnish universities during the summer. These courses typically last for one week and are intended for Ph.Lic. and Ph.D. students. These courses are often given in English by foreign visitors.

In order to obtain a B.Sc. degree a student must earn 120 units of academic credit. For a M.Sc. degree 160 units of credit including a thesis is required. One credit corresponds to roughly one week (40 hours) of study. Our students typically register for 12 credits ("study weeks") in the autumn term and 15 credits in the spring term. During the summer session a student can earn an additional 8-10 credits. Most students, however, work in industrial establishments during the summer to gain practical experience in dataprocessing. Thus, a normal student should earn 27 credits a year, an exceptionally diligent full-year student 40 credits. Nevertheless, there is considerable variation in study efficiency among students.

In the following we will describe the curriculum of 1998. The reader should note that there has been a major change in the curriculum for the academic year 1999-2000. A description of the new curriculum can be found on the WWW pages of the department and in the Faculty of Science Programme Book of 1999-2000. The old curriculum is still valid for students who started their studies in 1998 or earlier.

A typical course consists of 50 to 60 lectures (a lecture lasts 45 minutes) and of 20 to 30 hours of problem solving, discussion and repetition sessions in small groups of about 10 to 20 students. Each course is examined individually with grades: 3/3 = excellent, 2/3 = good, 1/3 = satisfactory. A typical course is worth 4 or 5 credits. The computer laboratory is supervised in small groups of 6 to 12 students. Students also attend seminars with 5 to 15 students and researchers. In the seminars, students read current literature, write surveys and give oral presentations. A seminar group normally meets 2 hours per week yielding 2 credits per term.

In order to receive a M.Sc. degree in computer science, students are required to earn their credits as follows:

Computer science	$\geq$ 95 cu
Mathematics	$\geq$ 26 cu
Physics	$\geq$ 15 cu
General studies	$\geq$ 5 cu
Total	$\geq$160 cu

In mathematics, the compulsory courses are Differential and Integral Calculus I (11 cu), Algebra I (5 cu), Logic I (5 cu), and Probability Theory I (5 cu). Physics can be replaced with almost any other subject, such as economics, administration, statistics, or psychology. For a B.Sc. degree, 55 credit units of computer science is sufficient.

The computer science studies for a M.Sc. degree can be subdivided as follows:

Compulsory courses and laboratories	35 cu
Elective courses	$\geq$ 26 cu
Seminars	$\geq$ 4 cu
Project work	10 cu
M.Sc. thesis, Scientific writing	20 cu
total	$\geq$ 95 cu

The compulsory computer science courses and laboratory work cover the following areas:

Introductory programming (Java)	8 cu
Data structures	6 cu
Operating systems and hardware architecture	7 cu
Information systems and databases	10 cu
Theory of computation	4 cu
Total	35 cu

In principle, students are fairly free to choose any elective courses. They normally follow the recommendation of the department by building up a specialized background knowledge for a successful thesis in one of our research groups. Thus, a student might specialize according to his/her study goals, interests and talents, e.g. in theoretical computer science, information systems, telecommunications software, distributed systems, operating systems, artificial intelligence, or software engineering.

The postgraduate degrees are the Licentiate of Philosophy (Ph.L.) and the Doctor of Philosophy (Ph.D.). Students may apply for one of the graduate schools, but postgraduate studies can also be pursued outside the schools. Postgraduate students must have shown good academic standing in their M.Sc. studies. When they start their studies, they are assigned a personal supervisor and set up a study program. The study program outlines the field of specialisation of the studies, the topic of the thesis, and the content and the schedule of the coursework.

The requirements for the Ph.Lic. degree can be summarized as follows:

Elective courses and seminars	
in computer science	20 cu
in mathematics	20 cu
Ph.Lic. thesis	50 cu
Total	90 cu

The elective courses in mathematics can be replaced with coursework in other subjects such as physics, economy, psychology, etc., or additional courses in computer science. The Ph.Lic. thesis is normally written in English. The allocation of credits for thesis research indicates that after the required coursework it should take 1–2 years to prepare a Ph.Lic. thesis.

It is important that the student takes the courses and seminars early enough to obtain sufficient background for writing the thesis. The department recommends students to spend one or two terms at a foreign university and to participate in international courses for researchers. In this way, students may make useful contacts with researchers and research on an international level. Study abroad also helps students to improve their knowledge in English. This knowledge is essential in research work. International courses by visiting researchers are also regularly given at the department.

The Ph.D. theses are written in English. A thesis should include a scientific contribution that is significant enough to be publishable internationally. A Ph.D. thesis (as well as a Ph.Lic. thesis) can also be assembled from a number of published articles or congress papers, possibly written jointly with other authors. A dissertation of this type consists of an introductory survey written by the candidate alone, with the individual articles as appendices.

Preparing the thesis is clearly the most demanding part of the Ph.D. and Ph.Lic. studies. To succeed with the thesis it is recommendable that the student works in a research group at the department. The support and the critique give by the group is often essential for making progress in the work.

6.4 Courses given in 1998

The courses given in 1998 are listed below. Course descriptions can be found on the WWW pages of the department.

6.4.1 Basic courses (Approbatur)

Computer Systems Organisation (3 cu)
Information Systems (4 cu)
Introduction to Computing (2 cu)
Introduction to Programming (4 cu)
Programming in C (2 cu)
Programming Project (2 cu)
Unix Principles (1 cu)

6.4.2 Intermediate courses (Cum laude approbatur)

Artificial Intelligence (3 cu)
Computer Graphics
Computer Uses in Education (4 cu)
Concurrent Systems (4 cu)
CORBA architecture (3 cu)
Data Communications (4 cu)
Data Structures (4 cu)
Data Structures Project (2 cu)
Database Systems I (4 cu)
Digital Signal Processing (3 cu)
Information Systems Project (2 cu)
Network Programming (4 cu)
Scientific Writing (4 cu)
Semantics of Program (3 cu)
Software Engineering (4 cu)
Software Engineering Laboratory (6 cu)
Theory of Computing (4 cu)
Unix Platform (3 cu)

6.4.3 Advanced courses (Laudatur)

Applications of Image Processing (2 cu)
Advanced Topics in Telecommunications Systems (3 cu)
Compilers (5 cu)
Computer-Supported Co-operative Work (3 cu)
Data Compresion (4 cu)
Database Systems II (5 cu)
Design and Analysis of Algorithms (5 cu)
Distributed Operating Systems (4 cu)
Fundamentals of Image Processing (2 cu)
Knowledge Discovery in Databases (3 cu)
The LOTOS Specification Language (3 cu)
Performance Evaluation (2 cu)
Principles of Concurrent Programming II (3 cu)
Simulation Methods (2 cu)
Spatial Information Systems (3 cu)
String Processing Algorithms (4 cu)
Three Concepts: Information (4 cu)
Transaction Processing (4 cu)
User Interfaces (4 cu)
Wireless Data Communication (3 cu)

6.4.4 Seminars (each 2 cu)

Adaptive Information Systems
Artificial Life
Biodatabases
Computer Graphics
Computer Uses in Education
Data Security of Distributed Systems
Document Management
Hypertext Systems
Implementation of the LINUX Operating System
Management of a Software Engineering Project
Object Architectures
Research in User Interfaces
Research Seminar on Agent Technology
Research Seminar on Computational Biology
Research Seminar on Formal Specification of Concurrent Systems

Semi-Structured Data
Telecommunications
Telecommunications Technology
TINA
Verification of logical circuits
The Z Specification Language

6.4.5 Other studies

Tutoring (1 cu)

6.5 Accepted Theses

6.5.1 Ph.D. Theses

1. Kutvonen, Lea: Trading services in open distributed environments. (A-1998-2).

2. Sutinen, Erkki: Approximate pattern matching with the q-gram family. (A-1998-3).

6.5.2 Ph.Lic. Theses

1. Hellgren, Vesa: Parallel algorithms for labeled transition systems. (C-1998-32).

2. Kähkipuro, Pekka: Object-oriented middleware for distributed systems. (C-1998-43).

3. Laamanen, Heimo: Serveability issues in mobile distributed systems. (C-1998-44).

4. Ronkainen, Pirjo: Attribute similarity and event sequence similarity in data mining. (C-1998-42).

6.5.3 Master's Theses

The Master's Theses have been written in Finnish (despite the English title here) if not otherwise noted.

General Computer Science

1. Hjelt, Antti: Analysis of bird migration routes using bootstrap methods. (C-1998-7).

2. Isto, Pekka: Structural neural networks. (C-1998-52).

3. Konttinen, Juha: Professional ethics and ethical rules in information technology. (C-1998-33).

4. Kuokkanen, Pertti: Empirical evaluation of prediction accuracy (C-1998-56).

5. Matero, Jari: Modular lexical scanning. (C-1998-16).

6. Mäki-Uuro, Miikka: Modern computer chess: search strategies and evaluation functions. (C-1998-23).

7. Tuomimäki, Lotta: Searching heterogeneous sequence databases in computer networks. (C-1998-8).

Software

1. Britschgi, Juhana: Design of management protocols for radio resources in the UMTS system. (C-1998-21).

2. Haaja, Marko: Evolution of a class library. (C-1998-61).

3. Hakala, Ari: Authentication and key management with the X.500 directory. (C-1998-36).

4. Juppo, Juhana: Productivity in software design and implementation. (In English) (C-1998-54).

5. Karjalainen, Tommi: The maintenance and management of ATM connections. (C-1998-27).

6. Kaskinen, Jorma: Computing of preorder relations in verification software for parallel systems. (C-1998-34).

7. Lehto, Ville: Reliability of a telecommunication solution in a networked retail system. (In English) (C-1998-26).

8. Misikangas, Pauli: Automatic recognition of design patterns in object-oriented programs. (C-1998-1).

9. Muhonen, Ahti: Point-to-multipoint services in general packet radio service. (In English) (C-1998-6).

10. Rekola, Sanna: Usability of error diagnostics in some embedded systems. (C-1998-35).

11. Rönkkö, Minna: Recognising calls in a radio telephone network. (C-1998-62).

12. Schönberg, Stina E.: Improving shared knowledge creation for new product development: the use of IT-tools. (In English) (C-1998-22).

13. Sevanto, Jarkko: Control and decision making in a mobile workstation. (In English) (C-1998-20).

14. Silvennoinen, Jari: C++ and generic programming. (C-1998-14).

15. Solsona Palomar, Marc: Modifications of TCP/IP protocols in mobile-wireless environments. (In English) (C-1998-37).

16. Stenman, Jorma: Change of paradigm in developing DX200-software. (C-1998-19).

17. Tauriainen, Kati: Modelling the run time configuration of a telecommunication network element. (C-1998-15).

18. Vaaraniemi, Sami: TDE - a collaborative software design environment. (In English) (C-1998-5).

19. Väisänen, Salla: Developing a software quality system. (C-1998-17).

20. Yliharju, Sami: The USSD protocol and its use in the GSM network. (C-1998-60).

21. Åkerman, Merja-Liisa: Comparison of the COM and JavaBeans software components in Internet applications. (C-1998-18).

Information Systems

1. Aaltonen, Jyrki: A study of time series similarity using syntactic methods. (C-1998-25).

2. Arminen, Johannes: Recovery methods for main memory databases. (1998-10).

3. Elomaa, Ville: Finding interesting rules in rule collections generated by data mining methods. (C-1998-4).

4. Franssila, Mikko: Implementation of persistent objects. (In English) (C-1998-28).

5. Grönholm, Marko: Optimisation of constraint logic queries. (C-1998-57).

6. Helskyaho, Heli: Optimisation of nested queries. (C-1998-48).

7. Hietanen, Kristiina: The effects of parameter selection on finding episodes and episode rules. (In English) (C-1998-41).

8. Lemmelä, Saija-Maaria: Comparison of some data modelling techniques. (C-1998-59).

9. Litola, Jari: Visualisation of data sets. (C-1998-55).

10. Paajanen, Sirkku-Liisa: Implementation of data structures without deleting data. (C-1998-24).

11. Riihimäki, Jussi: Object exchange from heterogeneous data sources. (C-1998-46).

12. Silvonen, Mikko: Classification of Finnish newspaper articles. (C-1998-58).

13. Tuononen, Tero: Observation of abnormal behaviour and log collection in the Unix system. (C-1998-49).

14. Vanhala, Jari: Retrieving objects by means of path expressions. (C-1998-40).

15. Vierumäki, Jouni: User interface log analysis with the help of data mining techniques. (C-1998-39).

Teacher in Computer Science

1. Pirilä, Ritva: Teaching information technology and the need for it in a commercial college. (C-1998-13).

Minor Theses

1. Heinonen, Johanna: Translating object queries to relational queries in a heterogeneous database system. (C-1998-3).
2. Kanerva, Petri: Three-tier architectures for database systems. (C-1998-47).
3. Pauna, Matti: Characterisation of process equivalences with modal and temporal logics. (C-1998-53).
4. Äystö, Kirsti: Management of large objects. (C-1998-38).

7 Library

Staff

Librarian: Kirsti Pohjonen, library secretary: Kari Salmi, and part-time (20h per week) bookbinder, starting October 1 1998: Ülle Braun. In charge of the upkeep and development of the computer system: Harri Laine.

Library Committee

Chairman of the library committee: Matti Mäkelä. Other members: Satu Eloranta, Juhani Kuittinen, Päivi Kuuppelomäki, Seppo Sippu, Juha Vihavainen, Jaak Vilo. The library committee's main responsibility has been the classification of library material.

Library Collections and New Acquisitions

Monographs (books, reports etc.). There were around 800 new acquisitions in 1998 (approximately 1,100 in 1997). In particular, the amount of reports acquired through exchange has decreased considerably, because most technical reports in the field are available in electronic form, and thus the need to acquire paper copies is slight. The amount of items in print (books, reports, theses etc) in the library collections by December 31 1998 was roughly 46,000 volumes.

Periodicals. The amount of periodicals (magazines, serial publications) the library subscribed to by the end of 1998 was 280 titles, of which 215 were bought and 65 distributed free. There were 234 foreign and 46 domestic publications. Of the periodicals subject to charges, the IT Department paid for 69 magazines and the Department of Computer Science paid for 146.

The IT Department's library appropriation in 1998 was FIM 60,000.

The Library System

At the beginning of 1997, a new system was installed in the library, working from the IT Department's server kontti, with WWW-based search and browse functions (http://www.cs.helsinki.fi/kirjasto). Most of the library's collections have been recorded in the system, 39,856 out of 41,974. Most of the library's titles have also been recorded in the HELKA database, and simultaneously in the national LINDA database.

Opening Hours and Loans

During terms, the library has been kept open on Monday-Thursday 8.00.-19.00. and on Fridays 8.00.-16.00. Outside terms the library has been kept open according to general office hours. In July the library has been closed. There have been no changes in opening hours during the year 1998.

As before, there have been many loans and the library has been actively used in other ways as well. There were 2000 registered loans during 1998 (the figure does not include renewals of loans). On December 31 1998, there were approximately 2000 titles on loan. No statistics are available on self-service copying or use of the reference library, but it has been substantial.

Distanced loans and the amount of outside users is still increasing notably, apparently because the principal parts of the collection can be found in the national HELKA/LINDA databases.

Other Activities

The library's other activities include the department's publications, exchange of publications, recording the university's publication register (JULKI) and selling lecture notes to students.

A total of 129 of the department staff's publications were recorded in the university's publication register during the year 1998. For more information on publications belonging to the department's own series, see Section 7.1 (as well as Sections 5.4 and 6.5.1). Some paper copies of the Series A reports have been sent to long-term exchange partners, but a complete or partial transition to electronic exchange has been planned, in accordance with international praxis. Buying lecture notes has been possible for an hour each day, between 12.00. and 13.00. in room B435. Kari Salmi has been in charge of this service.

7.1 Publications

7.1.1 Series A

1. Lindén, Greger & Tienari, Martti (eds.): Computer Science at the University of Helsinki 1998. (A-1998-1).
2. Kutvonen Lea: Trading services in open distributed environments. Ph.D. thesis. (A-1998-2).
3. Sutinen Erkki: Approximate pattern matching with the q-gram family. Ph.D. thesis. (A-1998-3).

7.1.2 Series C

The library has published 62 reports in this series in 1998: 10 technical reports (Section 5.4), 4 Ph.Lic. Theses, and 48 Master's theses (Section 6.5.1).

7.1.3 Series D – Lecture Notes

All lecture notes are in Finnish if not otherwise noted.

1. Laine Harri: Information Systems. Part 2: Application implementation and user interfaces. Lecture notes D385, autumn 1997. 1997-1998.

2. Laine Harri: Information Systems. Part 3: System design. Lecture notes D386, autumn 1997. 1997-1998.

3. Häkkinen Auvo: 58129-5 Unix platform: Lecture notes D387, 1998.

4. Wikla Arto: 5812558-1 Introduction to programming. Part 1. Lecture notes D388, 1998.

5. Laakso Sari A: 58064-3 User Interfaces. Lecture notes D389, 1998.

6. Häkkinen Auvo: Computer System Organisation. Lecture notes D390, 1998.

7. Wikla Arto: 5812558-1 Introduction to programming. Part 2. Lecture notes D391, 1998.

8. Wikla Arto: 5812558-1 Introduction to programming: Lecture notes D392, Copies of WWW material. 1998.

9. Elolampi Pentti & Marttinen Liisa & Wikla Arto: Introduction to Computing for minor students. Lecture notes D393, 1998.

10. Laakso Sari A.: Introduction to Computing for major students: lecture notes and exercises. Lecture notes D394, 1998.

11. Lindén Greger: 580213-5 Introduction to Computing (in Swedish). Lecture notes D395, 1998.

8 Computing Facilities

Overview of Computing Facilities

The department offers a wide range of services to support the computing activities of the academic staff and students. The policy is to provide access to advanced hardware and software systems.

The computing facilities include a farm of servers (general purpose computers, file servers, and dedicated servers for mail, WWW, FTP etc.) and a network of workstations and PC microcomputers. The departmental general purpose computers include a Sun UltraSPARC Enterprise 450 server and an Alpha based Citum Power System (a repackaged Aspen server). The main file servers are Intel Pentium based systems running Linux and utilizing RAID technology. The total disk space is currently well over 200 Gbytes. The Alpha and Intel Pentium based machines use Linux, but the SPARC computers run SunOS/Solaris. Together these systems support a wide variety of services, languages and software tools including electronic mail and news, graphics and visualization tools, several typesetting systems, and relational database systems. Special attention has been paid to security and reliability.

The workstation network consists of about about 310 PCs (mostly Pentium (MMX/II/III) with high resolution monitors) running Linux. Windows 95, Windows 98 or Windows NT can be used as an alternative for Linux. About 40 of the Linux workstations are mobile laptops which can join and leave the network dynamically. Networking is based almost entirely on switched 100 Mbit/s Ethernet with an optical backbone. The mobile laptops can also utilize a departmental 2 Mbit/s radio network which currently has 9 base stations. On the UNIX side (Linux, SunOS/Solaris) NFS is used to share common resources. On the Windows side Samba (a UNIX hosted Lan Manager Server) is used. The workstations are used as tools for software development, in research and all levels of teaching.

The network of the department is connected through a firewall to the university backbone network, giving access to computers at the University IT Department as well as to the FUNET wide area network that links Finnish universities and research establishments. The computers operated by the IT Department include SPARC (Sun, Axil), Compaq Alpha and HP machines running under UNIX. Services provided by the IT Department include Oracle and Ingres database management systems, SAS statistical analysis package, NAG numerical library, and Pascal, Ada, and Prolog programming environments.

In addition, the department has access to Cray C94, Cray T3E, SGI Origin 2000, Compaq AlphaServer SG140, and other supercomputers at the Center for Scientific Computing.

The national FUNET network is further connected to the Nordic University Network, Nordunet, with a 155 Mbit/s connection. The Nordunet has a 310 Mbit/s connection capacity to the United States as well as many 155 Mbit/s connections to the European network infrastructure. This means that the department is very well connected to the Internet.

9 International Relations

The department participates in the EC Erasmus and Socrates exchange student programmes as well as the Nordic NORDplus programme. Seven foreign exchange students studied at the department, while eight students from the department studied abroad in 1998. In the same year, there were 26 foreign students majoring in computer science at the university and 57 foreign students taking classes in computer science (both majors and minors).

9.1 Instruction in English

Lectures, seminars, laboratories, exercise sessions
Spring 1998
Introduction to Computing
Programming Project
Principles of Concurrent Programming II
Seminar on Biological Databases
Seminar on Computers in Special Needs Education
Master's thesis in Computer Science
Autumn 1998
Performance Evaluation
Simulation Methods
Scientific Writing
Three concepts: Information
Research Seminar on Agent Technology
Research Seminar on Computational Biology, cont. 1999
Seminar on Telecommunications Technology

Only exercise sessions
Spring 1998
Information Systems
Concurrent Systems
Programming in C
Autumn 1998
Semantics of Programs

9.2 Instruction in Swedish

The teaching languages of the university are Finnish and Swedish. Yearly, the department, offers one course and some exercises in Swedish.

Lectures and/or exercises
Autumn 1998
Introduction to Computing
Scientific Writing

9.3 Visits abroad

Ahonen, Helena, Marie Curie Fellowship, Eberhards-Karls-Universität Tübingen, Germany, 8/97–7/99
Elomaa, Tapio, Marie Curie Fellowship, Joint Research Centre, Ispra, Italy, 2/97–8/98
Grahne, Gösta, Concordia University, Montreal, Canada, 9/97–
Kerola, Teemu, University of Texas, Austin, 8/97–7/98
Kivinen, Jyrki, University of California, Santa Cruz, USA, 11/97–1/98
Mannila, Heikki, Microsoft Research, Seattle, USA, 1–12/1998
Sutinen, Erkki, Purdue University, USA, 8/98–7/99
Tienari, Martti, University of Paderborn, Germany, 10/98–3/99; Zurich, Switzerland, 4/99-9/99; Geneva, Switzerland, 10–11/99

In addition, about 40 researchers of the department have participated in international conferences and visited foreign research institutions in 1998.

9.4 Foreign Visitors

Baum, Dieter, Prof., Universität Trier, Germany, 25.8–26.8.1998
Boulicaut, Jean-François, Dr., INSA Lyon, France, 1.11.1997–31.5.1998
Brazma, Alvis, Dr., University of Latvia, 20–28.1.1998
Campadello, Stefano, Researcher, Italy, 1.1–31.12.1998
Das, Gautam, Prof., University of Memphis, USA, 9.6–4.7.1998
Dybdahl, Arne, Research Assistant, Norway, 1.1–20.4.1998
Hegedüs, Tibor, M.Sc., Postgraduate Student, Hungary, 1.1.–31.12.1998
Jonassen, Inge, University of Bergen, Norway, 20–28.1.1998
Krumm, Heiko, Prof., University of Dortmund, Germany 14–16.9.1998
Milutinovic, Veljko, Prof., University of Belgrade, 4.9.1998
Mordechai, Ben-Ari, Weizmann Institute of Science, Israel, 12.6.1998

Morishita, Shinichi, University of Tokyo, Japan 7–8.5.1998
Tamm, Hellis, M.Sc., Postgraduate Student, Estonia, 28.8.1997–31.7.1998
Ullman, Jeffrey D., Prof., Stanford University, USA, 9–10.6.1998
Vaucouleur, Sebastian, Research Assistant, France, 15.5.–15.10.1998
Xu, Lei, Prof., University of Hong Kong, 27.3.1998

10 Administration

10.1 Department

Department Steering Committee: Spring 1998 (1.1.1998-31.7.1998, substituting members in parenthesis): Prof. Martti Tienari, chairman, (Prof. Timo Alanko), Prof. Heikki Mannila (Prof. Seppo Sippu), Prof. Esko Ukkonen (Prof. Jukka Paakki), Prof. Pekka Kilpeläinen (Senior Assistant Greger Lindén), Lecturer Harri Laine (Prof. Kimmo Raatikainen), Amanuensis Tiina Niklander (Lecturer Auvo Häkkinen), Assistant Tei Laine (Student Sami Mäkinen), Student Juha Sievänen (Tommi Björklund), Student Jarno Varjola (Student Ilkka Tuohela), Amanuensis Reijo Siven, secretary

Department Steering Committee: Autumn 1998 (1.8.1998-31.12.1998, substituting members in parenthesis): Prof. Esko Ukkonen, chairman, (Prof. Matti Mäkelä), Prof. Hannu Erkiö (Prof. Seppo Sippu), Prof. Kimmo Raatikainen (Prof. Jukka Paakki), Laboratory Engineer Lea Kutvonen (Amanuensis Tiina Niklander), Lecturer Harri Laine (Assistant Juha Gustafsson), Senior Assistant Greger Lindén (Research Assistant Mikko Mäkelä), Student Aleksi Niemelä (Student Jani Leinonen), Student Anni Rytkönen (Student Kasper Valtakari), Student Asko Saura (Student Jonne Soininen), Amanuensis Teija Kujala secretary

Department Library Committee: Assistant Satu Eloranta, Assistant Juhani Kuittinen, Research Assistant Päivi Kuuppelomäki, Prof. Matti Mäkelä (chairman), Prof. Seppo Sippu, Lecturer Juha Vihavainen, Assistant Jaak Vilo

10.2 Departmental representatives in faculty and university governing bodies

Faculty Council: Spring 1998 Prof. Timo Alanko (Prof. Hannu Erkiö), Prof. Heikki Mannila

Faculty Council: Autumn 1998 Prof. Hannu Erkiö (Lecturer Harri Laine), Prof. Matti Mäkelä (Prof. Esko Ukkonen), Student Perttu Iso-Markku (Student Jani Leinonen)

Faculty Entrance Committee: Prof. Hannu Erkiö (Senior Assistant Heikki Lokki), Prof. Seppo Sippu

Faculty Library Board: Prof. Pekka Kilpeläinen

Faculty Planning Board: Prof. Esko Ukkonen

Faculty Teaching Development Board: Prof. Henry Tirri

Board of the Rolf Nevanlinna Institute: Prof. Heikki Mannila (spring 1998), Prof. Esko Ukkonen (autumn 1998)

University Information Management Board: Prof. Esko Ukkonen

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