

Department of Computer Science

Annual Report 2002



University of Helsinki

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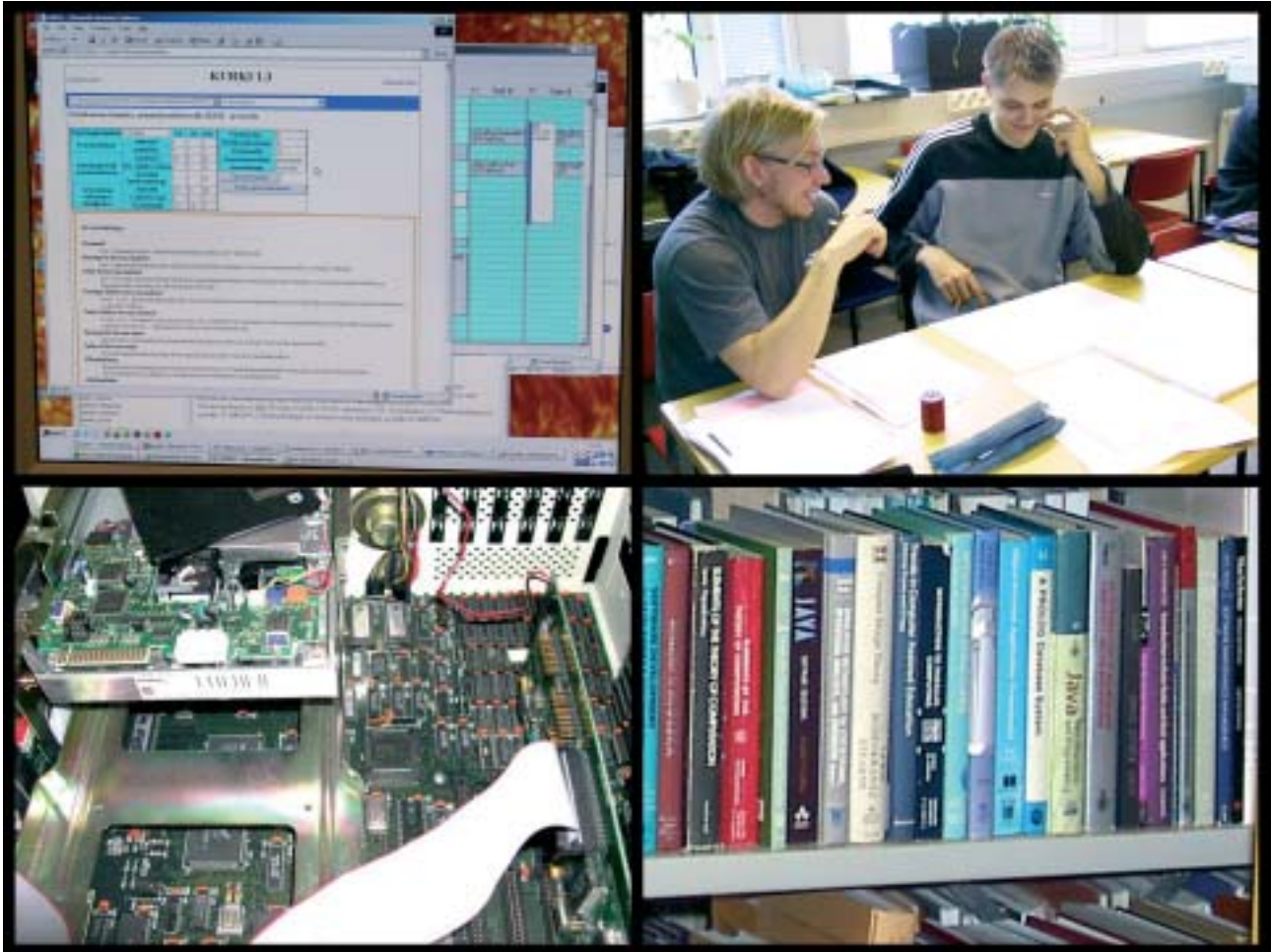
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Helsinki University Department of Computer Science Annual Report 2002

1. The Department of Computer Science in the year 2002

In 2002, the field of information technology stagnated at the level that the previous year's recession had brought about, which was evident especially in the activities of new start-up companies. However, larger, well-established endeavours were successful, to say the least. Some even thrived. One could say that the IT field, after a short period of euphoria, has reverted back to safe and reliable routines.

The development has been favourable for the department, in that the main components of academic work, basic know-how and long-term planning, have regained their status. This is evident in the results achieved at the department during the year 2002, which have been improving and even reaching record highs. As one of the most positive results we could mention that the number of graduated Masters was 72, topping the dream limit of 70 for the first time ever, and closing in on the department's official goal of 75 Masters per year. The thanks for the great increase in degrees go mainly to the teaching staff, whose dedication and excellent work bring about good results even according to official measurements.

The number of publications reached a good level (146) again after years of dwindling. The most important factors in this improvement are the national centre of excellence *FDK* (From Data to Knowledge) and the Basic Research Unit (BRU) at the HIIT research institute. These units are mainly focused on research, so they have increased the

number of publications as a snowball effect once they have started functioning properly.

During 2002, the department has been implementing its strategy that was set up for 2001-2003. The department offers a cutting-edge, varied education that emphasizes the conceptual basis of computing. The education programme has settled into a division of five different specialisation areas that concur with the main research areas of the department. In addition to the specialisation areas, some new education sectors have been established, such as language technology and software business and marketing, to deal with smaller and more topical themes in the field. The department's teaching strategy combines a traditional theoretical approach (lecture courses) with practical work (exercise sessions), and in addition, the year 2002 has seen a new branching into student-based teaching in the form of web courses and study circles.

The research at the department, for its part, strives to combine theory and practice, as well. Many of the projects have, as their baseline, a practical problem that is solved with the help of scientific methods and supported by real software tools. Research is arranged under larger research groups, attaining a larger so-called critical mass as well as a more efficient and varied research process. One positive trend worthy to note is that the research groups at the department are becoming more international with the increasing recruitment of foreign researchers.

The department funding increased during 2002 to a record-breaking 9,280,000 euros (in 2001, 7,100,000 €). Since the standing basic funding has not increased much (2,230,000 € vs. 1,930,000 € in



2001), the large increase can mainly be explained by the increase in funding from outside sources. Though the outside funding is an important factor in developing the department, it being such a large part of the department's total budget – 61% - also poses a risk. The plans to reduce or discontinue the national IT programme for education, funded by the Ministry of Education, in 2004 will shake the department's economic base in the near future.

Another factor that can lead to a disaster in the future is the continuous large increase in the student body. In the year 2002, we had 2351 registered major subject students, while in 1998, they were only 1793. Mass lectures create severe challenges on maintaining the high quality of teaching, especially since the department in its strategy has chosen to focus on teaching that centres on the students, in the form of instruction in small groups, which demands more teachers.

In spite of the threats mentioned above, the year 2002 was very successful and rewarding for the department all in all. This is mainly due to the staff, who are committed and active, often to the point of not only exceeding explicit goals but also implicit hopes.

Jukka Paakki
Head of the department

2. An overview of the year 2002

2.1 Staff and organisation

In order to develop the department's staff structure, new posts and appointments were established in 2002, in accordance with the department's staff policy. The following persons were appointed permanent posts in research and teaching: Professor in software design Inkeri Verkamo, University Lecturer in intelligent systems Eero Hyvönen, University Lecturer in basic teaching in programming Tomi Pasanen, and University Lecturer in algorithms and data structures Patrik Floréen. In addition, the following persons were appointed temporary posts: Doctoral Assistants Juha Kärkkäinen and Juho Rousu, and computer science Assistants Oskari Heinonen and Jukka Viljamaa.

The reformation of the internal administration that was started in 2001 was finalised by making the following posts permanent: Planner (of Studies) (Reijo Sivèn), Translator (Marina Kurtén) and Communications Officer (Janne Saarinen). In addition, the administration teams, headed by Office Manager Päivi Karimäki-Suvanto and Head of Studies Hannu Erkiö, employed the permanent secretaries

Sirkka Palander and Kati Suontaa and the temporary or part-time workers, Amanuensis (of Studies) Marja Huovinen, Research Secretary Tiina Väisänen and IT Designer Minna Majuri. The computer maintenance services were enforced by making IT Specialist Mikael Jokela's appointment permanent.

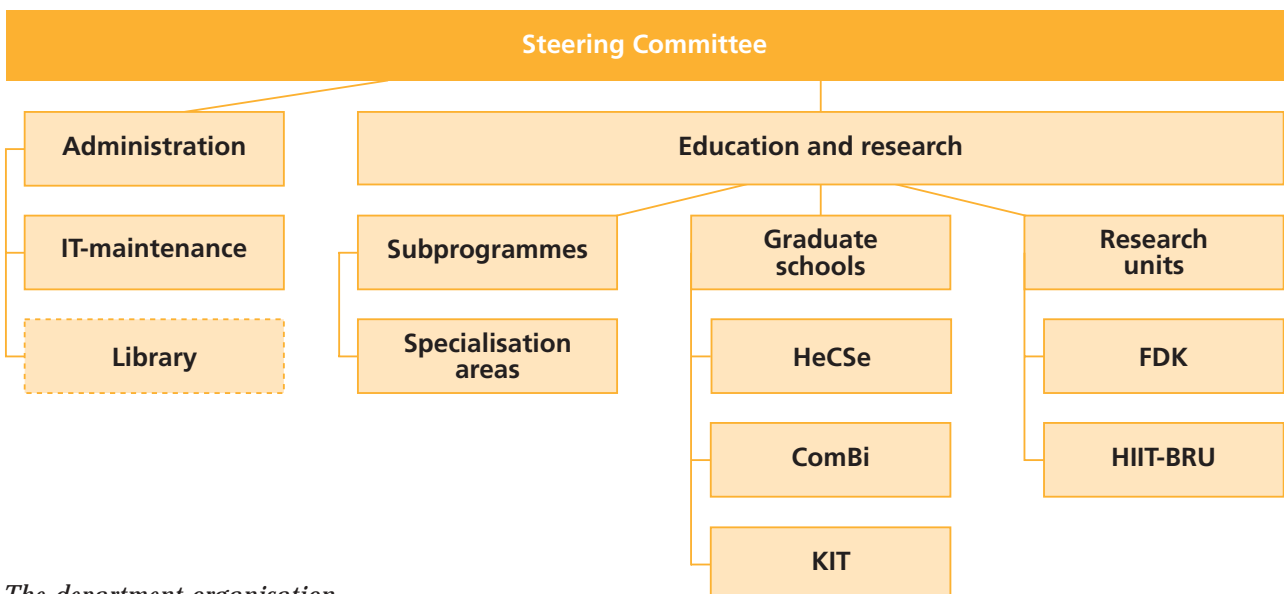
Mainly due to the rapid increase in research staff, the department staff increased to a record-breaking 152.9 measured in person-years (in 2001: 126.7 person-years). To give support to the very large and differentiated staff, the regular planning and development discussions traditionally held with teachers were extended to include researchers and even some part-time teachers. Staff administration was arranged so that a manager in charge was appointed for a larger group, and on the basis of the planning and development discussions, this manager tries to advance the careers of his or her own sector, while mapping ideas and hopes for the development of the department as a whole.

Jukka Paakki has stood as the head of the department and the chairman of the steering committee in 2002. Other persons in charge of administration are Office Manager Päivi Karimäki-Suvanto, in charge of general, staff, research and budget administration; Head of Studies (Lecturer) Hannu Erkiö, teaching administration; and IT Manager Petri Kutvonen, computer maintenance. The sub-

programmes and specialisation areas were headed by the following persons during 2002: Professors Helena Ahonen-Myka (the language technology branch in information systems), Timo Alanko (distributed systems and data communications), Tapio Elomaa (the specialisation area for algorithms and the sub-programme for teachers), Eero Hyvönen (the sub-programmes for applied computing and computer mathematician), Henry Tirri (intelligent systems), Hannu Toivonen (information systems) and Inkeri Verkamo (software design). Academy Professor Esko Ukkonen heads the FDK centre of excellence, and Research Manager Heikki Mannila the HIIT/BRU Basic Research Unit. In addition, the department is a partner in three national post-graduate schools, managing and co-ordinating two of them. Research Manager Heikki Mannila manages the ComBi postgraduate school, which is co-ordinated by Lecturer Heikki Lokki, and Professor Henry Tirri manages the HeCSE postgraduate school (starting 1 January 2003), and it is co-ordinated by University Lecturer Tiina Niklander.

The department library is large and keeps a high standard. Administratively, it is a part of the Science Faculty's Kumpula Science Library, where Professor Eero Hyvönen represents the department in the library steering committee.

To improve internal communications, the webzine me@tktl was established during the au-



The department organisation

tumn of 2002. It reports on current affairs and people at the department. One of the webzine issues reported the results of a wide investigation into contentment with the working environment at the department. The investigation was carried out during September-October, and the grade given to the working environment averaged 4.1 on a scale of 1-5. The freedom and the amiable and stress-free atmosphere at the department were deemed the best features of the working environment. On the other hand, issues that were considered to need addressing are the sense of community, the instruction of post-graduates, and the size of the pay packet.



2.2 Education

The evaluation project for Helsinki University teaching and degrees, started in 2001, was brought to the end of its second phase when an end report was written in co-operation with the departments of Mathematics, Chemistry and Physics. The feedback and the end report will be the basis for planning and implementing the further development of teaching during the following phase of the project.

Inspired by the self-evaluation report written for the evaluation project, and by the positive feedback from the international panel, the department put forth a proposition to become a quality unit. The proposition was accepted at both faculty and university levels, so the department was among the eight units that the University of Helsinki presented to the Finnish Higher Education Evaluation Council. Though the department was not chosen as one of the quality units this year, it was a definite merit to be among the finalists and an indicator that the high quality of the teaching at the department is widely recognized.

The department took active part in the development of distance and virtual education. A team led by Lecturer Teemu Kerola prepared a strategy that was accepted by the department, the strategy for e-learning for 2002-2006. Some courses were used in teaching during the spring. Important experiences of producing courses were generated espe-

cially in the TUeLIP community, a co-operation between seven European universities, which is supported by IBM by offering know-how and the services of its production lab.

Another important project in international education is the co-operation to reform the education of the Petrozavodsk State University Computer Science programme. The goal is to co-ordinate the education at Petrozavodsk and Helsinki, and thus to improve the possibilities for professional co-operation in the field of information technology. As a part of the project, some of the department's teaching material has been used in Petrozavodsk.

The development of the Pro gradu (Master's thesis) process was continued by transferring the thesis administration to a database. This new service improves the possibilities to follow the progress of theses and to create statistics over them. In addition, the guides for instructing theses and grading them were revised. The events for students approaching their thesis stage have been very popular, and it has become a tradition to arrange them four times a year.

The upgrading studies programme funded by the Ministry of Education accepted its last 71 students. The programme has been an important source of funding for the department, but the results, counted in degrees, have not reached expected limits. The reason for this is the difficulty for more mature students to combine effective studying with a fulltime job. Though no more stu-

dents will be accepted to the upgrading studies programme, the funding will continue decreasingly until the year 2004.

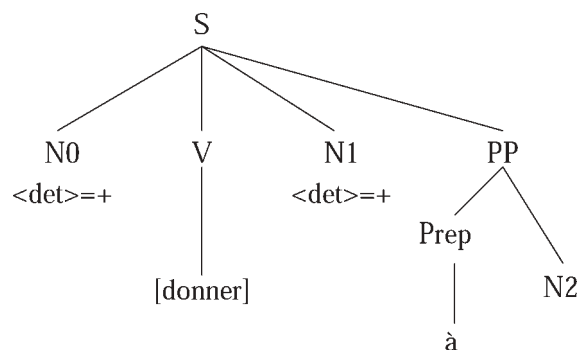
As for Master's degrees, the department reached an all-time high, 72 completed degrees. The number of PhD degrees stayed the same as in previous years, three completed degrees. It is obvious that postgraduate education needs to be made more efficient. The number of completed study weeks seems to have reached a constant, as well, and the limit of 20,000 was broken yet again (20,512 study weeks).

The department's Pro gradu grants were awarded to Pekka Aalto, Timo Nyysönen, Tiina Pelkonen, Pirkka Puustinen, Juha Markkanen, Tarja Rauste, Panu Ahjos, Jaakko Haapasalo, Mikko Hassinen, Ping Jing, Heli Koukku, Taneli Saastamoinen, Petri Savolainen, Susanna Turkki and Fei Wang in 2002.

2.3 Research

The research at the department picked up further during 2002. It was especially the activating influence of the FDK centre of excellence and the Basic Research Unit that increased the number of researchers, publications, and the funding.

The number of publications, which had been decreasing to an alarming degree lately, increased to a good 146 this year (in 2001: 97). Though the



increase can partly be explained by the large number of reports and other texts that were published in more insignificant forums, the increase in the number of journal articles from 6 to 22 is especially noteworthy.

The research funding from outside sources was a good 2,840,000 euros (in 2001: 2,080,000 €). The Finnish Academy especially increased its funding, from 57,000 euros to 1,110,000 euros. On the other hand, the other large public research sponsor, Tekes (the National Technology Agency), decreased their funding from 600,000 euros to 300,000 euros, i.e. by half from the previous year. This alarming trend can be explained, at least in part, with the fact that the funding to the HIIT Advanced Research Unit (ARU) administratively belongs to the Helsinki University of Technology, even if the research is, in fact, carried out at the department.

With this in mind, the HIIT co-operation with Helsinki University of Technology can be considered to have some negative side effects.

As an example of the high esteem in which the department is widely held, we have reason to mention the Finnish Academy research programme for proactive information technology, carried out 2002-2005, administered by HIIT/BRU (Heikki Mannila acts as manager of the programme and Greger Lindén as co-ordinator).

2.4 The Department in Numbers

Personnel (working years)	1998	1999	2000	2001	2002
Teaching	43	49	60	53.5	63.1
Professors	9	9	9.6	12.1	12.3
Senior and Doctoral assistants (University) lecturers	4	3	3.4	1.4	1.6
Assistants	10	11	12.8	14.2	19
Full-time teachers	8	9	12.9	10.4	8.3
Part-time teachers	7	7	4.4	4.2	5.3
Postgraduate students	5	10	16.9	11.2	16.6
Researchers and research staff	14	11	14.9	17.7	17
Administration	35	37	37.2	39	55.8
Total	11	13	13	16.5	17
	103	110	125.1	126.7	152.9

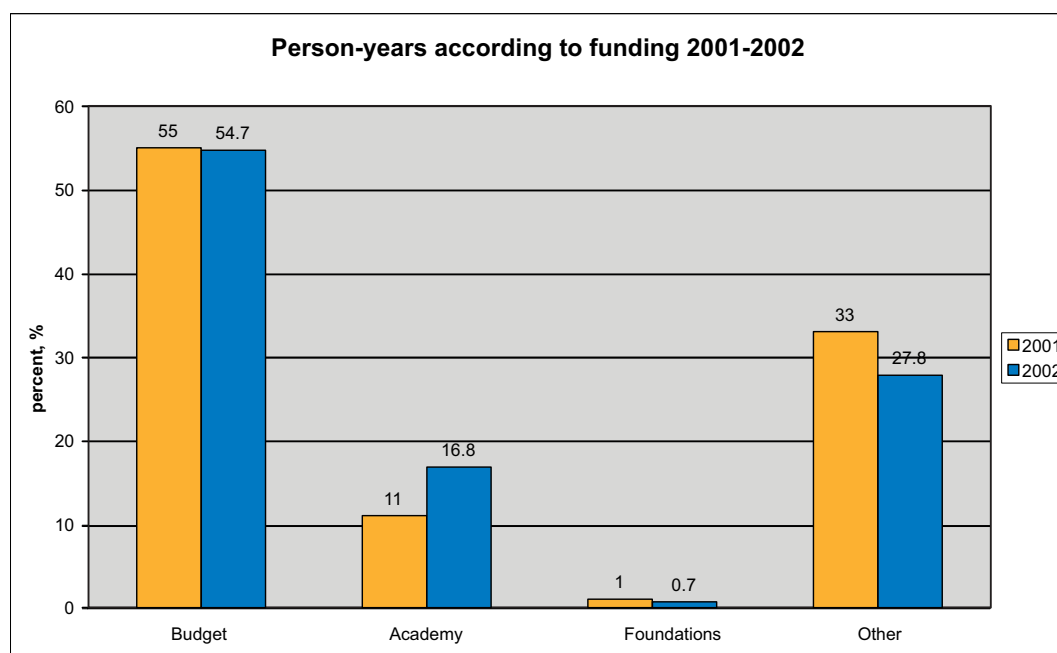
The average age of full-time personnel in 2002: 32,8 years

The gender distribution of full-time personnel in 2002: female 20,8 %, male 79,2 %

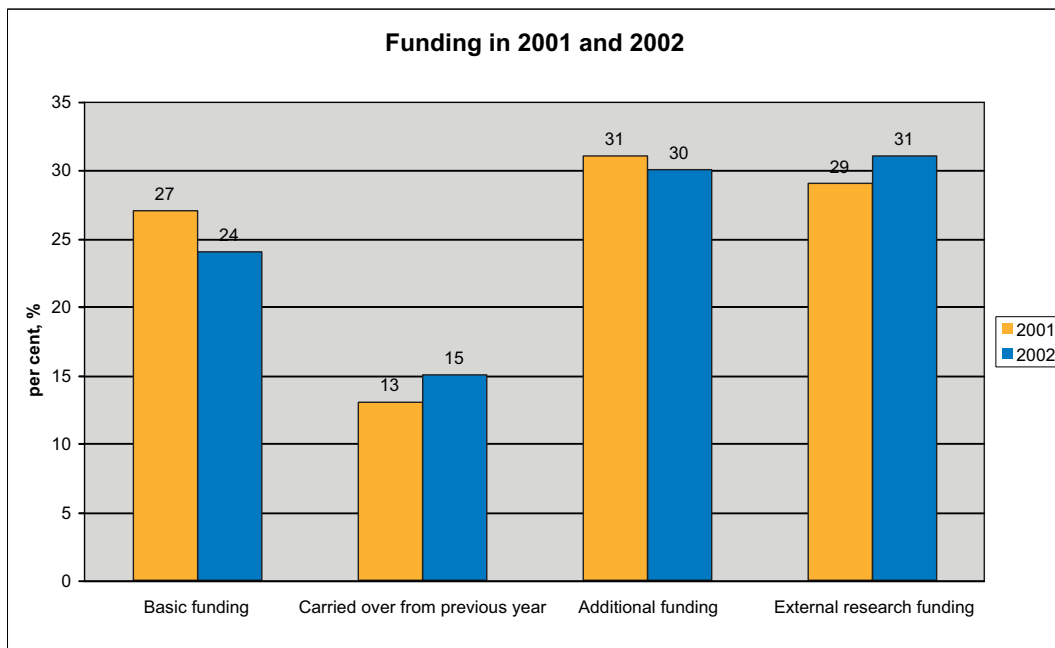
International activities and co-operation

2002

Foreign guest lecturers at the department	27
Department staff lectures in foreign countries	39

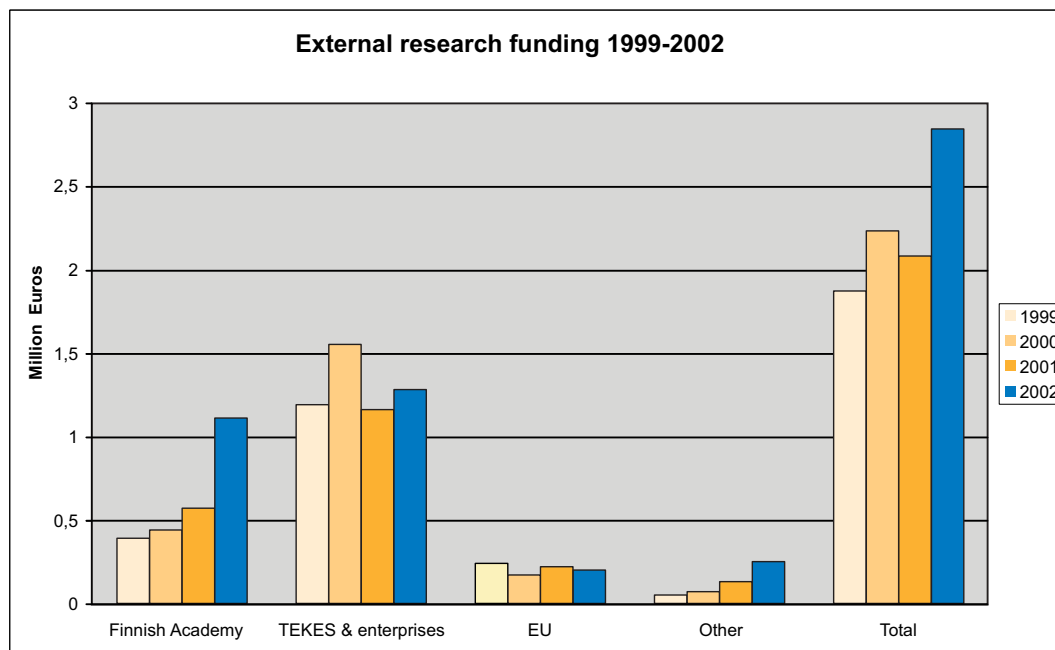


Funding (Million Euros)	1999	2000	2001	2002
Basic funding	1.92	1.92	1.93	2.23
Carried over from previous year	-	-	0.94	1.43
Additional funding	1.21	1.72	2.14	2.78
External research funding	1.86	2.22	2.08	2.84
Total	4.99	5.86	7.09	9.28
FIM	29.66	34.84	42.21	55.17

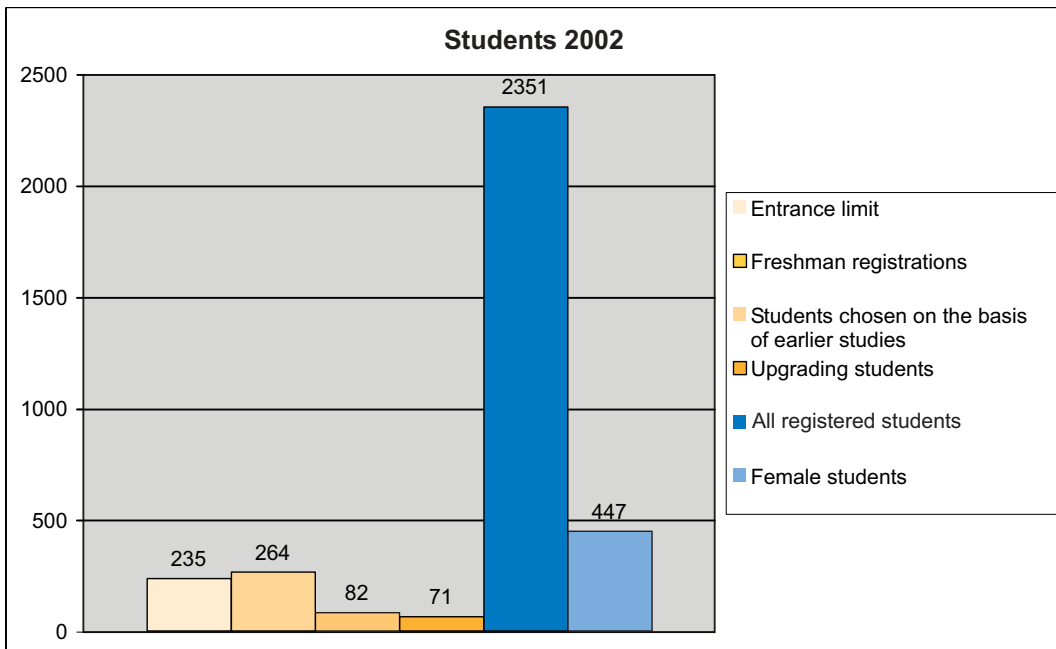
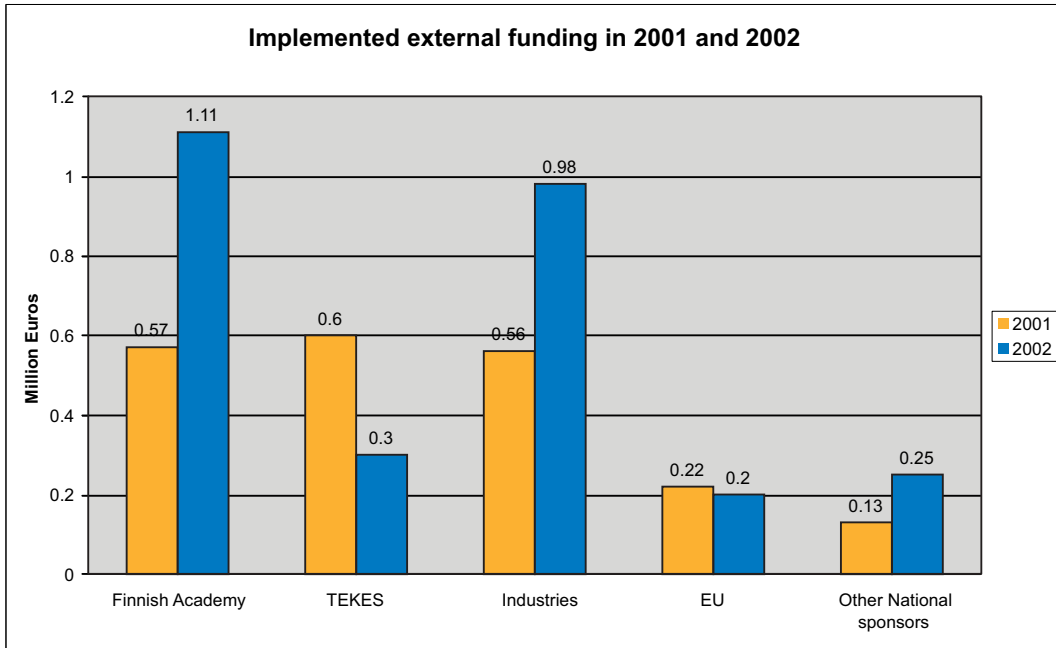


Additional funding for teaching (Million euros)

	2000	2001	2002
National IT Programme	0.66	0.66	0.92
Language Technology Programme	-	0.08	0.09
Postgraduate schools	0.35	0.47	0.49
Upgrading studies	0.47	0.82	1.15
Other	0.24	0.10	0.13
Total	1.72	2.13	2.78



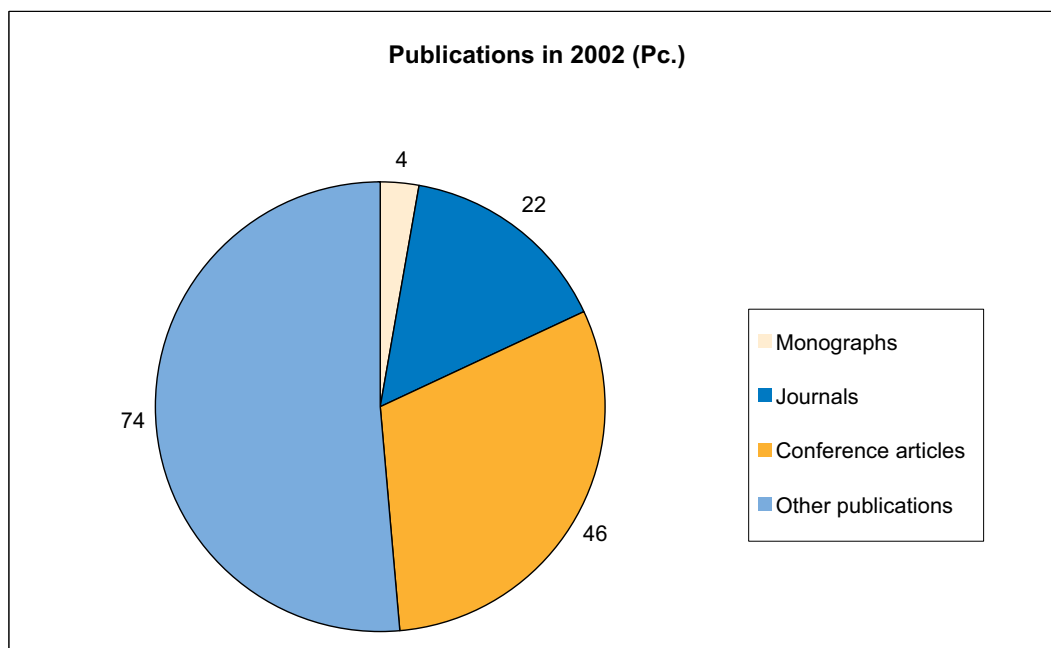
Implemented external funding (Million Euros)				2001	2002	2002 %
Finnish Academy				0.57	1.11	39 %
TEKES				0.60	0.30	11 %
Enterprises				0.56	0.98	35 %
EU				0.22	0.20	7 %
Other national sponsors				0.13	0.25	9 %
Other state funding	0.21	7 %				
Trust funds and foundations	0.04	2 %				
Total				2.08	2.84	



Students	1998	1999	2000	2001	2002
Admission quota	270	270	270	235	235
Freshman registrations	279	258	267	243	264
Students chosen on the basis of earlier studies	55	42	61	61	82
Upgrading students	-	40	81	78	71
Female students (percent)	21	22	20	20	19
All registered students	1793	1982	2110	2230	2351

Teaching	1998	1999	2000	2001	2002
Completed credits	17494	17863	21345	20554	20512
Teachers in person-years	43	49	60	54	63
Credits/person-year	415	401	343	408	326
Students/person-year	42	43	35	41	37

Study weeks are the Finnish study credit system. One study week consists of 40 hours of work, and equals 2 ECTS (European Credit Transfer System) units.



Number of publications	1998	1999	2000	2001	2002
Monographs	0	3	0	0	4
Journals, articles	10	11	8	6	22
Conference articles	64	46	49	49	46
Other publications	54	49	50	42	74
Total	128	109	107	97	146

Number of degrees

Degrees and theses (number of)	1998	1999	2000	2001	2002
Master's theses	53	63	63	75	70
Master's degrees	48	55	64	61	72

Postgraduate degrees (number of)

Licentiate degrees	4	2	5	6	4
PhD degrees	2	3	4	4	3

2.5 Nota bene 2002

Events

The annual strategy meeting was arranged in Gustavelund in Tuusula on the 9-10 January 2002. At the meeting, strategies for improving the teaching, research and administration at the department were drawn up.

The traditional department day was arranged on 5 April 2002. In addition to the presentations of teaching and research at the department, two dozen ex-workers from the department had been invited, and present long-time workers took a trip down memory lane with them, as well as envisioning a better future.

In co-operation with the State University of Petrozavodsk, the department arranged the seventh Annual Finnish Data Processing Week seminar in Petrozavodsk in May 2002.

An international summer school on *Wireless Internet*, headed by Professor Kimmo Raatikainen, was arranged at the department on 1-5 July 2002. Nine eminent lecturers from Europe and the USA spoke at the summer school.

The department arranged a double international conference, *13th European Conference on Machine Learning (ECML'02)* and *6th European Conference on Principles and Practice of Knowledge Discovery in Databases (PKDD'02)*, which gathered over 200 participants on 19-23 August 2002. Professor Tapio Elomaa and Hannu Toivonen and Research Manager Heikki Mannila acted as chairs for the programme committee, while Professor Helena Ahonen-Myka led the organizing committee.

The department had its own term opening event on 10 September 2002. In addition to the festive speech given by Academy Professor Esko Ukkonen, the department's own t-shirts were distributed to the staff, and a photo collage of the department staff, compiled by Avril Styrman, was unveiled (see page 5).

The ten years of the Linux operating system were celebrated on 11 December 2002 at a seminar that was well publicised by the press. Among the speakers were the department's IT Manager Petri

Kutvonen, Project Manager Olli-Pekka Rissanen (Ministry of Finance), R&D Manager Antti Lampinen (Kongo Group) and film director Hannu Puttonen, who showed clips from the DVD version he is making of his Linux movie.

The department received more unusual publicity when the TV series *Paholaisen tytär* ("the Devil's daughter"), which was partly filmed in the department's facilities, gathered large TV audiences in October-November 2002.

Awards, confidential posts and honours

By order of the Director of Administration, Lecturer Heikki Lokki established the current condition of computer services at the university in January-February 2002, and wrote a report on how to improve them.

Nominated by the Faculty of Science at the University of Joensuu to be the external evaluator of teaching at the Joensuu University Computer Science Department in 2002, Matti Mäkelä (Professor Emeritus) drew up a written report on the evaluation to the faculty.

Antti Martikainen, a student at the department, was awarded the Finnish SIGCHI association's thesis award of the year 2002 for his Master's thesis, *An XML-Based Framework for Developing Usable and Reusable User Interfaces for Multi-Channel Applications*, which studies the interaction between man and computer.

At the department's Christmas coffee party on 19 December 2002, the year's Good Teacher awards were given to Lecturer Harri Laine and Teacher Janne Rinta-Mänty.

To honour his active part in establishing the co-operation between the Petrozavodsk and Helsinki Computer Science departments, Lecturer (Acting Professor) Timo Alanko was appointed Doctor Honoris Causa at Petrozavodsk State University in May 2002.

Academy Professor Esko Ukkonen and his wife attended the Independence Day reception by invitation of the President of the Republic on 6 December 2002.

3. Research and education areas

3.1 COMPUTER SCIENCE

3.1.1 Algorithms

The specialisation area studies the algorithmic and theoretical aspects of formulating and solving computational problems in different application areas. The focus is on discovering efficient solutions for specific problems. The interaction between theory and practice is also of central interest. The application of well-motivated algorithms to real-world problems is within the scope of the area.

The curriculum of the specialisation area covers the core of computer science. The central obligatory courses are: Data Structures and Algorithms, Theory of Computation, and Design and Analysis of Algorithms. Advanced courses and seminars are organized on diverse modern research topics in algorithmics such as String Processing Algorithms, Machine Learning, Computational Geometry, Computational Biology and Bioinformatics, Computer Graphics, Signal Processing, Randomized Algorithms etc. Mathematics beyond the obligatory curriculum is suggested to all students of the specialisation area. Other suggested minor subjects include, e.g., Physics, Theoretical Physics and Statistics.

On the research front the current main focus areas are combinatorial pattern matching and its applications in computational biology, theory and practice of machine learning with interest in the application of the methods to data mining, data structures for biological databases, and computational geometry. An analytical approach to diverse problems is the common factor in the many different research projects within the specialisation area.

The contact persons in Algorithms are Professor Tapio Elomaa and Academy Professor Esko Ukkonen.

Education (in Finnish): <http://www.cs.helsinki.fi/algoritmit/>
<http://www.cs.helsinki.fi/research/fdk/>

Research (in English): <http://www.cs.helsinki.fi/research/fdk/>

3.1.2 Intelligent Systems

The specialisation area of Intelligent Systems studies issues related to the design and analysis of computational methods for adaptive and intelligent systems. The area covers several fields in computer science such as artificial intelligence, computational intelligence, artificial life and search methods. Future information technology will include more and more adaptive components both in hardware and software and therefore many of the methods studied are core components for future systems.

The curriculum of the Intelligent Systems area contains a wide variety of special courses, which typically require as prerequisites good programming and problem solving skills and a solid analytical background. Studies of automating intelligent behaviour are by necessity drawing ideas from many sciences, and thus the studies in many cases are multidisciplinary in nature. In addition to the methodological courses in the “Three Concepts” series, other suitable courses can be selected either from more applied topics (robotics, string matching, data mining) or from the general introductions such as artificial intelligence and machine learning. A research seminar in Intelligent Systems is intended for postgraduate level studies and multidisciplinary studies in cognitive science, neurocomputing (in cooperation with Helsinki University of Technology) and theoretical philosophy are strongly encouraged.

The research in the Intelligent Systems area is focused on issues related to deep foundational is-



Researcher Tomi Silander on Manhattan, measuring data for an intelligent positioning system.

sues in modelling and learning , and their applications to various fields from engineering to social sciences and medicine. Most of the research is associated with the Complex Systems Computation Group (CoSCo), which studies theoretical and applied topics in probabilistic and information-theoretical modelling and stochastic search methods. Current ongoing projects have applications e.g. in user profiling and personalisation, adaptive learning environments, autonomous satellite diagnosis systems, telecommunications and next generation search engines.

The contact person in Intelligent Systems is Professor Henry Tirri.

Education (in English): <http://www.cs.helsinki.fi/alykkaat/>
 Research (in English): <http://cosco.hiit.fi>

3.1.3 Software Engineering

The specialisation area of Software Engineering studies methods, techniques, and tools to systematically develop large and complex software systems of high quality. The area covers not only technical issues, but also managerial and co-operative aspects of team and project work as well as the business dimension of software products.

The curriculum of the specialisation area is rather broad, containing courses and seminars in all of the dimensions of software engineering mentioned above. There are four obligatory basic



The appointment of Inkeri Verkamo as Professor of software design was celebrated festively in December.

courses in the curriculum: Software Engineering, Software Engineering Lab, Software Architectures, and Software Processes and Quality. On top of these, special courses and seminars can be selected on topics such as programming languages, compilers, software testing, software performance, user interfaces, and software project management. The importance of the software business perspective has been taken into account by offering a minor subject on this topic, in co-operation with Helsinki University of Technology and Helsinki School of Economics and Business Administration.

The research in software engineering is focused on one of the cornerstones of software quality, the software design phase and the related technical artefact of software architectures. Currently ongoing research projects develop techniques and tools to early measurement and assurance of the quality of a software system in its design phase, before entering the implementation and testing phases. Modern object-oriented techniques, most notably design patterns, application frameworks and the UML modelling language, play an important role in the techniques and tools developed in the research projects.

The contact persons in Software Engineering are Professor Jukka Paakki and Professor Inkeri Verkamo.

Education (in Finnish): <http://www.cs.helsinki.fi/ohjelmistot/>
 Research (in English): <http://www.cs.helsinki.fi/research/roosa/>

3.1.4 Distributed Systems and Data Communication

The specialisation area of Distributed Systems and Data Communication studies how systems can be divided into independently working parallel parts, and how these parts communicate with each other. The research concentrates on examining the basic components and the protocols of such systems.

The goals of the group are twofold. On one hand, tools are developed for analysing and modelling systems based on theory. On the other hand, more powerful services are developed for the appli-

cation platform based on operating systems, data communication, distribution algorithms and effective information management solutions.

The curriculum of the specialisation area is broad, containing courses and seminars on all the research dimensions. Obligatory courses in the curriculum are Operating systems I—II, Data Communication I—II, Introduction to Specification and Verification, Computer Organization I—II, Concurrent Systems, and Distributed Systems.

The restructuring of the obligatory courses that was started in 1999 was completed in 2002. The new course structure has been found apt and functional.

Additional special courses and seminars can be selected on varying topics. Themes of current interest have been modern data-communication technology, mobile computing, security, and formal methods utilized within the specialisation area.

The needs of foreign student shas been taken into account by arranging exercise sessions in English for several of the basic courses. Some of the special courses in data communications have been taught completely in English, along with some seminars.

The research in Distributed Systems and Data Communication has four focus areas:

- The research projects of the mobile and nomadic computing group are concerned both with the protocols of wireless data communication and with applications utilizing wireless communication. Central topics have been the quality-of-service issues in heterogeneous environments.

The ECML/PKDD-2002 conference, arranged by the department in August, gathered some 200 participants in the main building of the university.



- The open distributed software systems group develops middleware services to support inter-organizational cooperation and networking. Partners in the cooperation are application components, which have been developed independently and which are under separate autonomus authorities. This means that the system must have facilities for publishing services, for automatic negotiations about agreements, and for internal management to fulfil the agreements.

- The operating system enhancements group currently focuses on real-time systems with high availability requirements. Additional subjects of experimentation have been related with real-time databases: application of optimistic strategies, memory-based storage, and replication-based fault-tolerance.

- Formal specification and verification of distributed systems is studied in the Modelling of concurrent systems group. The theoretical results of the group are based on process algebras, temporal logic, and theory of automata. The results are applied to software engineering tools.

The contact persons in Distributed Systems and Data Communication are Professor Timo Alanko and Professor Kimmo Raatikainen.

Education (in Finnish):

<http://www.cs.helsinki.fi/hajautetut/>

Research (in English): [http://](http://www.cs.Helsinki.FI/u/alanko/nodes.html)

www.cs.Helsinki.FI/u/alanko/nodes.html

3.1.5 Information Systems

The specialisation area of Information Systems studies methods, techniques, and tools needed in manipulating large volumes of data, often implemented as a database, frequently also using structured representations such as XML. The education in the specialisation area covers database management, text and document management, information retrieval, and data mining.

The core of the curriculum of Information Systems contains obligatory courses on database management and database applications: Introduction to Application Design, Introduction to Databases, Database Application Project, Database Management,

Database Modelling, and Database Structures and Algorithms. Besides these, special courses are offered on data warehousing, data mining, information extraction, spatial information systems, structured documents, information retrieval, and user interfaces. More specific subareas are covered by seminars on varying topics. In the Software Engineering Lab, design and implementation of a database system or a user interface are common topics.

The research in information systems is strongly focused on data mining and document management, including language technology. Techniques of analyzing and mining data from various sources for useful information are the key research topics. The research includes both method development and applications, for instance in gene technology, ecology, telecommunication, and publishing industry. Research in the database area is focused on recovery and concurrency control. Computer-aided teaching environments have been developed for database courses.

The contact persons in Information Systems are Professors Hannu Toivonen, Helena Ahonen-Myka, and Seppo Sippu.

Education and research:

http://www.cs.helsinki.fi/info/index_en.html

3.2 TEACHER IN COMPUTER SCIENCE

The subprogramme educates qualified computer science teachers for all levels of the educational system (lower and upper secondary schools, colleges and polytechnic institutes) and for business training. The curriculum contains a pedagogical component (35 cu), which lessens the required advanced computer science studies. The studies in pedagogy are carried out alongside the studies in the subjects to be taught. A course on Computer Uses in Education is obligatory to the students in the teacher subprogramme. The course IT for Teachers is also directed to the students of the subprogramme. Lecture courses, seminars and the subject for the Master's thesis can be chosen from



another subprogramme. Mathematics is the most popular minor subject.

The contact person in Teacher in Computer Science is Professor Tapio Elomaa.

Education (in Finnish):

<http://www.cs.helsinki.fi/opettaja/>

3.3 APPLIED COMPUTER SCIENCE

The subprogramme Applied Computer Science is meant for students who want to specialise in some application area and study that more than is possible in the other subprogrammes. Every student has an individual study programme. The research activities are pursued in several of the other research divisions, e.g. within the algorithmics, machine learning, biocomputing, computational linguistics and data mining groups.

Professor Eero Hyvönen is in charge of the subprogramme.

Education (in Finnish):

<http://www.cs.helsinki.fi/sovellettu/>

3.4 COMPUTER MATHEMATICIAN

The subprogramme Computer Mathematician is a joint programme with the Department of Mathematics. The students must include computer science and mathematics to the same amount in their degrees. Every student has an individual study programme. The mathematically oriented research problems for the students come from other research areas.

Professor Eero Hyvönen is in charge of the subprogramme.

Education (in Finnish):

<http://www.cs.helsinki.fi/matemaatikko/>

3.5 SOFTWARE BUSINESS

The Department of Computer Science, Helsinki University of Technology and the Helsinki School of Economics offer their major subject students the possibility to take software business as a minor subject. This minor subject module consists of general courses in software engineering, software production, business skills, marketing and computer legislation, as well as a project in the field. Of the students at the department, 15 were chosen for this minor subject module in 2002.

Professor Eero Hyvönen is in charge of the minor subject module.

More information (in Finnish):

<http://www.cs.helsinki.fi/ohli/>

3.6 GRADUATE SCHOOLS

3.6.1 HeCSE

The Helsinki Graduate School in Computer Science and Engineering is a postgraduate programme

Berkeley of California, the postgraduate school HeCSE and HIIT arranged their second ever summer school on the subject of software architectures for mobile data communications in Berkeley in June.



jointly offered by the Helsinki University of Technology (HUT) and the University of Helsinki (UH). It is mainly intended for students wishing to pursue their graduate studies full time, aiming for a PhD degree in four years. For these students, HeCSE offers the possibility of financial support and some other benefits such as special courses.

HeCSE incorporates the following laboratories and departments: the Laboratory of Information Processing Science (HUT), the Laboratory of Telecommunications Software and Multimedia (HUT), the Laboratory for Theoretical Computer Science (HUT), the Neural Networks Research Centre (HUT) and the Department of Computer Science (UH). The collaboration with Helsinki Institute for Information Technology (HIIT) has started recently.

Students can choose any area represented by the professors as their specialisation area. However, the main research areas in HeCSE are software systems, software engineering, telecommunication software and distributed systems, as well as learning and intelligent systems. HeCSE has granted funding for 31 students, 12 from the University of Helsinki and 19 from the Helsinki University of Technology. The other students in HeCSE are financed by projects or teaching.

More information (in English):

<http://www.cs.helsinki.fi/hecese/>

3.6.2 ComBi

The Graduate School in Computational Biology, Bioinformatics, and Biometry (ComBi) is a postgraduate program jointly offered by the University of Helsinki, the University of Turku and the University of Tampere. The Department of Computer Science at the University of Helsinki coordinates the school.

The research goal of ComBi is to develop computational, mathematical, and statistical methods for biological sciences. To that end, ComBi will educate PhDs with high-quality methodological

expertise. In their thesis work the students are expected to apply this expertise to computational, data analysis or modelling problems in biology or in some related field. The thesis projects are carried out in cooperation with one or more research groups in the application area (such as biochemistry, molecular biology, microbiology, ecology, evolution research and systematics, geography, public health).

Computational biology is a new field of research which develops methods and software implementations for computational problems in molecular biology, biotechnology, and genetics. Bioinformatics refers to the development and use of (molecular) biological databases. Biometry investigates statistical modelling problems related for example to genetic mapping, to the genetic and environmental risk factors of complex diseases, or to the spreading of infectious diseases. Further topics include population dynamics and numerical taxonomy of ecological and genetic phenomena.

More information (in English):
<http://www.cs.helsinki.fi/combi/>

3.6.3 KIT Graduate School

The KIT graduate school is a multidisciplinary, nation-wide graduate school for human language technology-related PhD studies. The graduate school is part of the emerging Nordic cooperation in the field of language technology researcher training. The school has started in 2002 and finances 5 students. A few other students financed by other funding participate in the activities of the school.

The contact person is Professor Helena Ahonen-Myka.

Education (in Finnish): <http://www.ling.helsinki.fi/kit/tutkijakoulu/>

3.7 OTHER EDUCATION

3.7.1 Upgrading Studies

A temporary programme for upgrading studies in computer science started in the autumn of 1999. It aims at teaching IT knowledge to persons with a

degree in another subject, to persons who have no degree but a certain amount of computer science studies from before, or to students who want to change their major subject into computer science. In the separate entrance exam, held for the last time in 2002, a total of 71 students were accepted into the programme.

The students are divided into tutor groups. Each group has a supervisor who guides the students to set up individual study plans. The students usually start their studies with second year courses according to the model study schedule. There is also a basic course that aims at refreshing basic knowledge in programming and software implementation in a modern environment. Additional courses and study circles are organized in the evenings and during the weekends, which provides more flexibility in scheduling the studies.

More information (in Finnish):
<http://www.cs.helsinki.fi/muuntokoulutus/>

3.7.2 The Co-operation with Upper Secondary Schools

There has been cooperation with upper secondary schools in the Helsinki region since the academic year 1999-2000. Originally, the cooperation started with a trial where six schools in Helsinki participated. At the moment, there are 12 schools participating in the programme.

Practically, the cooperation means that the pupils of the cooperating schools are allowed to participate in the first major courses in computer science after being accepted to the programme through an entrance exam. In spring 2002, 18 pupils out of 24 applicants were accepted.

The programme gives the upper secondary pupils a chance to get familiar with one of the academic fields before they start their actual academic studies. It is also a way of recruiting and motivating the students to choose computer science as field and the department as study place after the upper secondary studies.

The goal of this cooperation for both the institution and the schools is to even out the difference

between being an undergraduate and being a pupil, and to make the transition from school to university studies easier. From the point of view of the students, the main goals are to clarify study interests and career goals, to motivate upper secondary studies, and to take responsibility for their own studies. For the schools, the objective is to vary and enhance the upper secondary education, promote the profile of the schools, to make use of the expertise of scientists, and to increase the cooperation between school and university teachers.

More information (in Finnish): <http://www.cs.helsinki.fi/abinfo/lukiot.html>

3.7.3 The Language Technology Network

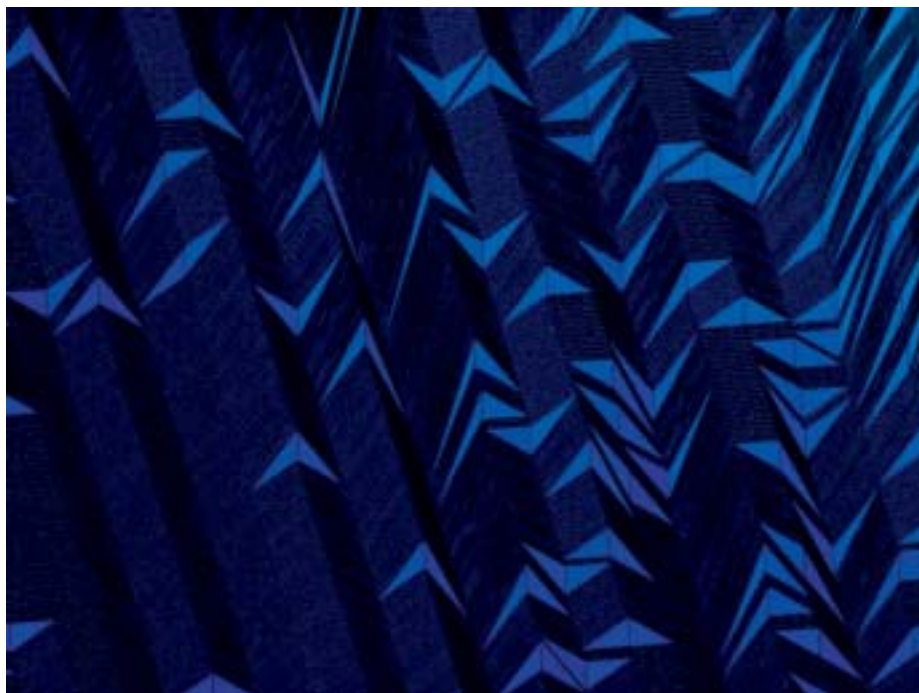
The term human language technology or natural language processing means using linguistics for information technology applications processing natural languages. Some fields of application are the use of spoken language for computer user inter-

faces, computer-aided language education, writing accessories (spell-checkers, grammar checking, etc), data mining and document management, automatic translation, speech recognition and production, interactive network applications, mobile communications technology and electronic dictionaries.

The Department of Computer Science is a member of the nation-wide language technology education network (Kieliteknologian opetus, KIT). This network enables extensive and multidisciplinary language technology studies in several universities. Students may take language technology as a large minor subject (with one other minor) in the Applied Computer Science subprogramme, or as a normal minor in the Computer Science subprogramme.

The contact person is Professor Helena Ahonen-Myka.

Education (in Finnish): <http://www.cs.helsinki.fi/u/hahonen/ktekno/>
Research: <http://www.cs.helsinki.fi/research/doremi/>



4. Research

4.1 RESEARCH UNITS

4.1.1 FDK

The From Data to Knowledge Research Unit (the FDK unit, for short; www.cs.helsinki.fi/research/fdk) develops computing methods for forming useful knowledge from large masses of data. The unit is multidisciplinary, combining in its research groups expertise in algorithmics, statistical methods and application fields such as bioinformatics and human language processing. The unit was appointed a Centre of Excellence of the Academy of Finland for a six year period starting from the beginning of 2002.

The FDK unit is a cooperation between the University of Helsinki and the Helsinki University of Technology (HUT). The main site of activities is the Department of Computer Science of the University of Helsinki. Academy Professor Esko Ukkonen is the director of the unit. In 2002 the personnel of the unit consisted of about fifty researchers and postgraduate students. At the end of 2002 the following researchers with a doctorate were members of the unit: Professor Esko Ukkonen, Professor Heikki Mannila (the Basic Research Unit of HIIT), Professor Tapio Elomaa, Professor Helena Ahonen-Myka, Professor Jaakko Hollmen (HUT), Professor Hannu Toivonen, Kimmo Fredriksson, Juha Kärkkäinen, Kjell Lemström, Greger Lindén, Vesa Ollikainen, Juho Rousu, Marko Salmenkivi.

The core competence area of the unit is algorithmics for data analysis, within which two special fields are emphasized. The first is the so-called combinatorial pattern recognition and string matching. It considers pattern recognition and matching in various discrete structures. The other main pillar is machine learning and, in particular, its application-oriented branch known as data mining. The goal is to find interesting and useful patterns, dependencies, and other hidden structures in the data. When developing data mining algorithms, one has to expand the traditional tool box of algorithmics: the concepts and methods from statis-

tics and stochastics are also needed.

The unit emphasizes in its activities the interaction between theory development and practical applications. Our goal is to find research problems, whose conceptual basis and solution algorithm have a wider application potential. We are not content with just tailoring some general-purpose approaches (as, for example, the so-called genetic algorithms) for the problem in hand. Rather, the goal is to develop and analyse original algorithms using the wide technical arsenal of algorithmics.

The unit functions as four closely connected main projects. The same persons are active in several projects. This facilitates internal communication and the utilisation of expert knowledge.

The theme of the main endeavour, Project I, is data mining and machine learning. The project develops original concepts and algorithms to strengthen a core area of the unit. We aim at results in theoretical basic research. The relevance of the results is tested in various applications. Text databases and document collections as well as event sequences in telecommunication networks are examples of the data we use. Information filtering from the Internet and other human language technology belong to the area of this project as well as using machine learning in image analysis.

Project II specialises in computational biology by studying the methods for medical genetics and for analysing data on genomics, proteomics, and metabolics. The spectrum of collaborators is wide ranging from UCLA to the European Bioinformatics Institute and to several top-class groups in Finland. We develop computational methods for example for locating the genetic basis of multifactorial diseases as well as for synthesizing gene regulatory networks from data. The intensive progress in this field is boosted by the growing number of entirely sequenced genomes and the rapid expansion of the new high-throughput measurement techniques that are able to follow the behaviour of the whole genome. The new era of 'systems biology' is about to start, with computation in a central role.

Project III deals with combinatorial pattern recognition and information retrieval. Again we combine algorithm theory and applications. Central research questions include approximate pattern

matching, efficient index structures, and the synthesis of patterns from data. Applications are several. One subproject considers the retrieval and analysis of symbolically encoded music, for example.

Project IV focuses on computational structural biology. This area is somewhat different from the DNA sequence-driven mainstream computational biology. The main task is to construct three-dimensional computer models for biological macromolecular complexes, from electron micrographs, for example.

In addition to the basic research and doctoral education, the FDK unit also wants to serve as an algorithm ‘atelier’ which develops computational solutions to new problems in different fields. The unit is searching for new partners who could pose computational problems in the forefront of the research.

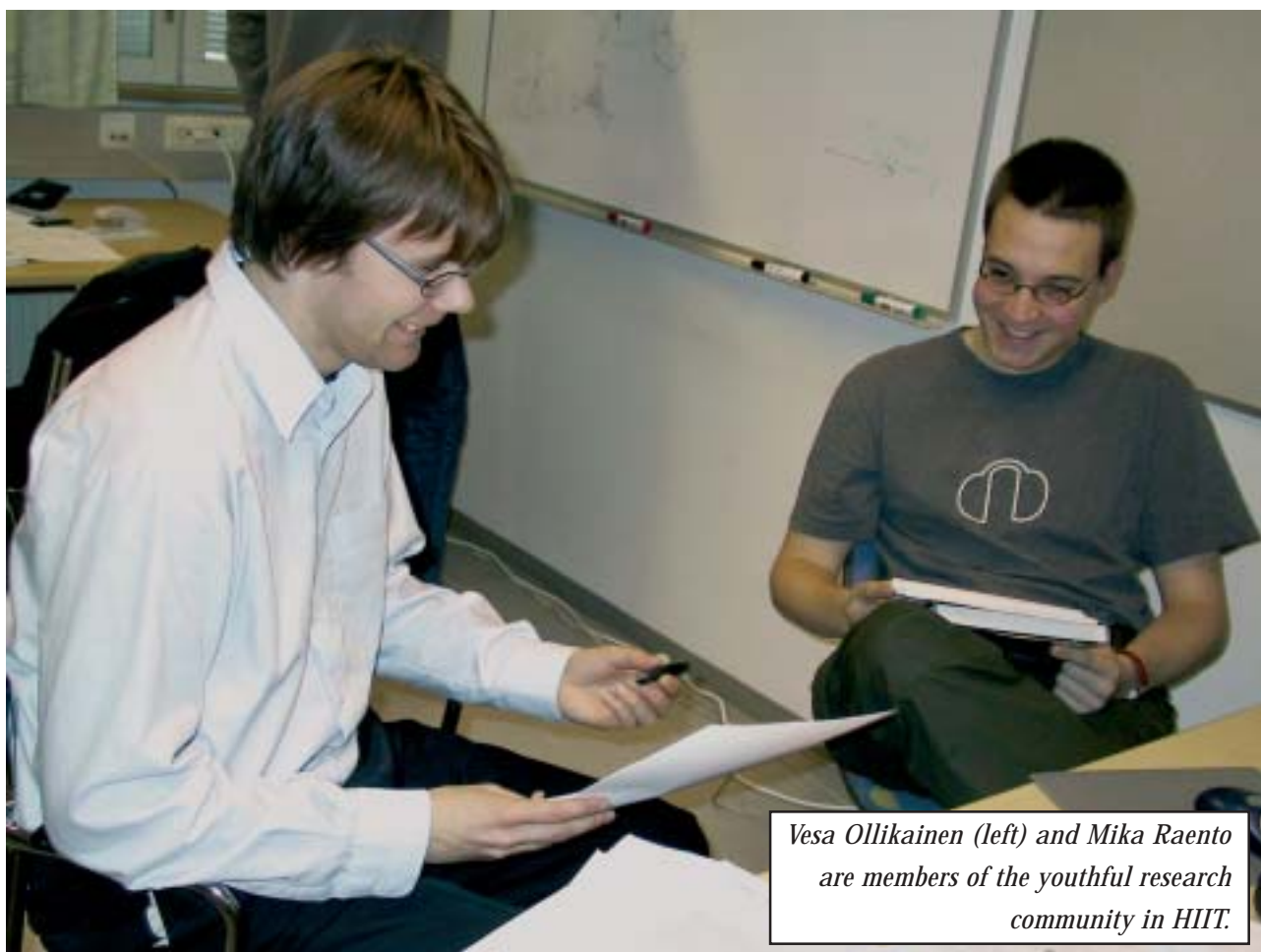
Research unit homepage:

<http://www.cs.helsinki.fi/research/fdk/>

4.1.2 The Basic Research Unit at HIIT

The Helsinki Institute for Information Technology (HIIT) is a joint research unit of the University of Helsinki and Helsinki University of Technology. The unit aims at significantly enhancing the strategic research in the field of computer science, while improving the co-operation between the University of Helsinki and the Helsinki University of Technology. HIIT consists of two units: the Advanced Research Unit (headed by Martti Mäntylä), which works in co-operation with the industries and functions primarily at the University of Technology, and the new Basic Research Unit (headed by Heikki Mannila) that started operations at the beginning of the year 2002. The Basic Research Unit functions primarily at the Computer Science Department in Vallila.

The Basic Research Unit (BRU) carries out first-rate basic research in the field of computer science, in close co-operation with end-users in other disciplines and in the industries. BRU con-



Vesa Ollikainen (left) and Mika Raento are members of the youthful research community in HIIT.

sists of research groups with national and international senior researchers, researchers and post-graduates. Their basic funding is part of the long-term funding of BRU, but the groups are active in procuring outside funding, as well. The activities of BRU are arranged around certain blanket themes. At first, the research will be focused on two main themes: proactive computing (ubiquitous computing, calm/invisible computing) as well as the basic problems and applications of data analysis and data mining.

In the field of proactive computing, the activities at BRU will focus on a few areas, as follows.

1. The basic problems with linking computation and mobile communications. In this field, we will examine the rules of distributed computing. The purpose is to examine computing that is energy-aware, models of adiabatic computing, etc.

2. Adaptive user interfaces. All (successful) human communication must be set in context, i.e. what is communicated and how it depends on the situation. Data processing software is typically free of context, and cannot adapt to the user's situation at the moment of use, or to user history, for example. Research is carried out on methods that can enhance the usability of the software.

BRU is involved in developing the theories and applications of data analysis and data mining in close co-operation with different end-users. During its first year, the unit focuses on the following research themes, among others.

1. Gene expressions, problems concerning the regulation and inheritance of expressions. The researchers will develop methods for analysing gene expression data, which can be linked with other biological material.
2. The theoretical analysis of DNA sequences. The exact function of the non-coding areas in the human genome are unknown so far. This research develops methods with which divergently structured areas can be quantitatively identified in a DNA string.
3. Methods of analysis for large discrete data arrays. Many applications allow the user to gather multidimensional data arrays, where each observa-

tion value is typically a small integer. This kind of material may be approximated efficiently by using the method of frequent sets.

In its entirety, the unit will focus on 4-6 large themes that will overlap each other and on the research carried out at institutions for other disciplines. The Basic Research Unit works in co-operation with research groups at the department, especially with the group From Data to Knowledge, a Centre of Excellence led by Academy Professor Esko Ukkonen. The staff of BRU act as teachers at both the Department of Computer Science and Engineering at the Helsinki University of Technology and at the Department of Computer Science at the University of Helsinki. In addition, intensive courses are arranged in co-operation with the graduate schools in the field.

Queries may be sent to
heikki.mannila@cs.helsinki.fi.

Research unit homepage:
http://www.cs.helsinki.fi/hiit_bru/ and
<http://www.hiit.fi> for more information.

4.2 RESEARCH GROUPS

4.2.1 CoSCo

The CoSCo research group investigates computational issues related to complex systems, focusing on prediction and model selection tasks. The research areas addressed include stochastic modelling and data analysis - especially with Bayesian networks and related probabilistic model families, such as finite mixture models and Bayesian multinets - information theoretical approaches to inference (MDL/MML), theoretical and empirical validation of on-line prediction algorithms, case-based reasoning (CBR), and stochastic optimisation algorithms, such as simulated annealing and genetic algorithms. The work has both a strong basic research component, being at the intersection of computer science, information theory and mathematical statistics, and an applied component where the results are applied in multiple disci-

plines from social sciences, criminology, ecology and medicine to industrial engineering. Recent focus areas in the applied research include personalisation for the Internet, diagnostics for space satellites, next generation search engine techniques and modelling for location-aware services.

In general the CoSCo team benefits from a rare combination of theoretical competence with top-level programming skills. As a concrete demonstration of this, CoSCo has recently opened the unique B-Course service (<http://b-course.cs.Helsinki.fi>), a sophisticated tool for state-of-the-art data analysis on the web. For performing the extensive empirical tests required for evaluating the theoretical methods developed, the group has developed software that allows the researchers to use several dozens of Linux-workstations as a single “virtual supercomputer”, which has made it possible to study empirically many interesting exponential-time problems.

In two recent (1997,1999) evaluations in National Technology Agency (TEKES) research programmes, the group got excellent remarks both for theoretical and more applied work. Two more recent acknowledgements of the high level of the scientific work done in the group were 2nd place in CoIL Challenge 2000, a large international prediction competition with 147 contestants consisting of academic and commercial research groups all over the world, and an honorable mention at the Knowledge Discovery and Databases prediction competition (KDD Cup'01) for being 2nd out of 114 participating international groups in the pharmaceutical prediction task concerning molecular bioactivity. The CoSCo group has also established excellent research contacts to all major probabilistic modelling research groups in the world, with frequent visiting scientists.

CoSCo is affiliated with Helsinki Institute for Information Technology's (HIIT) Advanced Research Unit (<http://www.hiit.fi>).

Contact person: Professor Henry Tirri

Research group homepage:
<http://cosco.hiit.fi>

Selected publications:

P.Myllymäki, T.Silander, H.Tirri, P.Uronen, B-Course: A Web-Based Tool for Bayesian and Causal Data Analysis. *International Journal on Artificial Intelligence Tools*, Vol. 11 (2002), No. 3, 369-387.

W.Buntine, Variational Extensions to EM and Multinomial PCA. Pp. 23-34 in *Proceedings of the 13th European Conference on Machine Learning*, edited by T. Elomaa, H. Mannila and H. Toivonen. Vol. 2430 in *Lecture Notes in Artificial Intelligence*, Springer-Verlag 2002.

J.Kurhila, M.Miettinen, P.Nokelainen, H.Tirri, EDUCO - A Collaborative Learning Environment Based on Social Navigation. Pp. 242-252 in *Proceedings of the 2nd International Conference on Adaptive Hypermedia and Adaptive Web Based Systems (Malaga, Spain, May 2002)*.

T.Roos, P.Myllymäki, H.Tirri, A Statistical Modeling Approach to Location Estimation. *IEEE Transactions on Mobile Computing*, Vol. 1, No. 1, January-March 2002, 59-69.



4.2.2 Networking in Open Distributed Environments - NODES

The NODES group has been formed to stimulate and coordinate research on distributed and networked systems and applications. The group's scope of interests includes concurrency, data communication software, and distributed systems.

The current focus is on the design and development of infrastructure for mobile computing, on performance evaluation of distributed and networked systems, and on open distributed software architectures and services.

In 2002, there were four main research groups active.

- The Wireless Internet group works with wireless data communication systems and applications. The work started in the mid-90s, and the original goal was to create convenient access from a portable computer through the wireless wide-area networks (e.g., GSM) to the Internet. Subsequent research has diverted from this platform in various directions. Two projects examine data communication protocols in heterogeneous networks (IIP Wireless and MIND). The TranSat project developed improvements to TCP over satellite links. The special focus area of IP Quality-of-Services was addressed by two projects (MIND and Robocop). One project aims at developments in tourism applications for nomadic users (CRUMPET). The Fuego Core project (at HIIT) investigates middleware infrastructure for mobile Internet. In addition, the group has participated in European academic co-operation (EVC-WIN and ANWIRE) and in the Asia-IT programme by EC (VAAWIT).

- The open distributed software systems group develops middleware services to support inter-organizational cooperation and networking. Partners in the cooperation are application components, which have been developed independently and which are under separate autonomous authorities. This means that the system must have facilities for publishing services, for automatic negotiations about agreements, and for internal management to fulfil the agreements. Middleware services must conceptually be capable to work in parallel on several application platforms; in the experimental part of the work the project tried two component-based platforms (CORBA CCM, EJB). The project PILARCOS II implemented prototypes of main middleware services; the performance of the middleware was evaluated using empirical measurements (PILARCOS).

- In the operating system enhancements group there were two active projects. One project was developing a fault-tolerant real-time database system; special attention was given to concurrency control and transaction scheduling (RTD-pilot). The sec-

ond project investigates the capabilities of Linux in environments where high availability and timeliness are required (nsrtLinux).

- Formal specification and verification of distributed systems is studied in the Modelling of concurrent systems group. The theoretical results of the group are based on process algebras, temporal logic, and theory of automata. The results are applied to software engineering tools.

Contact person for the NODES group: Professor Kimmo Raatikainen

Research group homepage:

<http://www.cs.helsinki.fi/u/alanko/nodes.html>

Project list:

Improving Internet protocols for wireless links (IIP Wireless)

Mobile IP based network developments (MIND)

Transport Protocol and Resource Management for Mobile Satellite Networks (TranSat)

Robust Open Component Based Software Architecture or Configurable Devices Project (Robocop)

Tourism-related value-added services for nomadic users (CRUMPET)

Middleware for Mobile Wireless Internet (Fuego Core; HIIT-projeksti)

European Virtual Center of Excellence on Wireless Internet (EVC-WIN)

Academic Network for Wireless Internet Research in Europe (ANWIRE)

Wireless Internet Applications for Agriculture (VAAWIT)

Production and integration of large component systems (PILARCOS)

Fault-tolerant real-time database systems (RTD-pilot)

Non-stop real-time Linux (nsrtLinux)

Modelling of concurrency (MOCO)

Selected publications:

Selected publications:

- K. Raatikainen: Middleware for Mobile Applications Beyond 3G. In Smart Networks. Proceedings of SmartNet 2002, April 9-10, 2002, Saariselkä, Lapland, Finland. Kluwer, pp. 3-17.
- P. Sarolahti, A. Kuznetsov: Congestion Control in Linux TCP, In Proc. of Usenix 2002/Freenix track, pp. 49-62, Monterey, CA, USA, June 2002.
- J. Manner, L. Burness, E. Hepworth, A. López, E. Mitjana: Provision of QoS in Heterogeneous Wireless IP Access Networks 13th IEEE International Symposium on Personal Indoor and Mobile Radio Communications (PIMRC), September 15-18, 2002, Lisbon, Portugal.
- P. Eardley, J. Eisl, R. Hancock, D. Higgins, J. Manner, P. Ruiz: Evolving beyond UMTS - The MIND network. IEE Third International Conference on 3G Mobile Communication Technologies, May 8 - 10, 2002, London, UK.
- J. Manner, A. López, A. Mihailovic, H. Velayos, E. Hepworth and Y. Khouaja: Evaluation of Mobility and QoS Interaction. Computer Networks, Volume 38, Issue 2, 5 February 2002, pages 137-163. (Elsevier Science Publisher).
- J. Kempf (editor): Problem Description: Reasons for Doing Context Transfers Between Nodes in an IP Access Network. Internet Engineering Task Force, Request for Comments (RFC) 3374, September 2002.
- L. Kutvonen: Automated Management of Inter-organisational Applications. In: Proc Enterprise Distributed Object Computing (EDOC 2002). Lausanne, 2002.
- M. Luukkainen: Verification of Dense Time Properties using Theories of Untimed Process Algebra. In: Proc. 20th Conference on Formal Description Techniques for Networked Systems (FORTE'01), 2001.

4.2.3 Research Group on Object-Oriented Software Architectures (ROOSA)

The ROOSA research group at the Department of Computer Science studies software architectures, and especially their object-oriented paradigms. The research focuses on conceptual issues as well as on constructive methods. The methods and tools developed provide support for systematically forward-engineering software in an architecture-centric way, for reverse-engineering software into its architectural views, and for assuring the quality of a software system in terms of its architecture.

In 2002, the following research projects and groups were active:

Framework Editor for Java (Fred & James).

The projects aim at increasing the knowledge of application frameworks and design patterns in software construction. The main result of the projects is a software tool which supports a design pattern-based method of building reusable application frameworks in Java, and guides the systematic construction of final applications from the frameworks. By including a substantial part of the functional behaviour of a family of software systems in the same domain, application frameworks are currently considered to be the main approach to large-scale systematic software reuse. The practical benefits of the developed method and tool will be shown by a number of industrial case studies.

Metrics for Analysis and Improvement of Software Architectures (Maisa)

& Techniques for UML-Based Software Development (UML++).

The projects develop methods for the measurement of software quality at the design level. The metrics are computed from the system's architectural description (given in UML), predicting the quality attributes of the system derived from it. Most notably, size and performance metrics are addressed. A novel technique that has been developed is design analysis and quality prediction by automated search of design patterns and anti-patterns from the architecture. Typically, a large number of design pattern occurrences is a sign of good quality,

whereas finding occurrences of anti-patterns probably is an indication of poor quality. The method is implemented in a software tool that computes the metrics, visualises the pattern occurrences that are found and, based on this information, predicts the quality of the software system to be built from the architecture. Another topic in the UML++ project is (semi-)automatic reverse engineering of architectural views over a software family by extracting patterns from its source code. Technically, the patterns conform to the notion of “specialisation pattern” developed in the Fred/James project, so the method makes it possible to bring an application framework under the management of the Fred environment.

Framework Integration and Testing Application (Rita).

Testing object-oriented frameworks is difficult because a framework, when considered as code, is an incomplete program whose behavior cannot be studied until actual applications have been derived from it. The Rita project develops methods and tools for the testing of framework-based software systems and for verifying the quality of testing with new forms of code coverage criteria. The project is part of the large European Eureka/ITEA project CAFÉ (From Concept to Application in System-Family Engineering) that develops methods and processes for systematically building system families.

Contact persons: Professor Jukka Paakki, Pro-

fessor Inkeri Verkamo

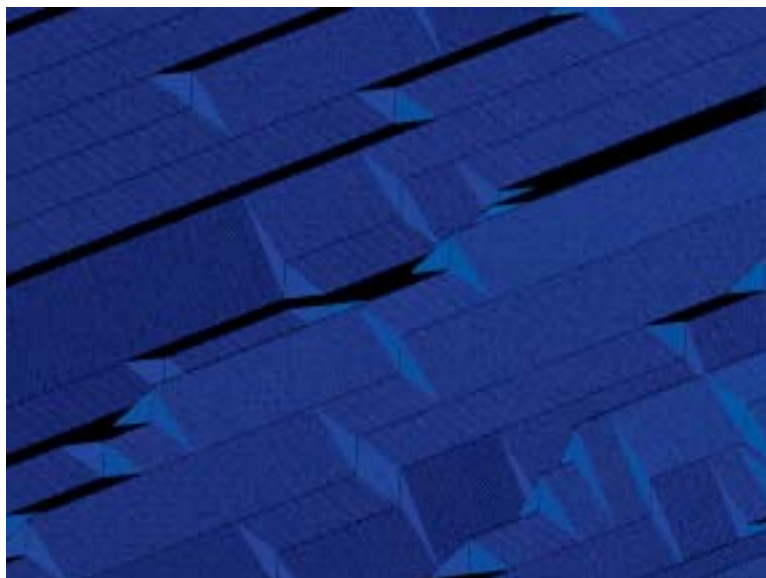
Research group homepage:

<http://www.cs.helsinki.fi/research/roosa/>
www.cs.helsinki.fi/research/roosa/

Selected publications:

Selected publications:

- Ferenc R., Gustafsson J., Müller L., Paakki J.: Recognizing Design Patterns in C++ Programs with the Integration of Columbus and Maisa. *Acta Cybernetica* 15, 4, 2002, 669-682.
- Gustafsson J., Paakki J., Nenonen L., and Verkamo A.I.: Architecture-Centric Software Evolution by Software Metrics and Design Patterns. In: *Proceedings of the 6th European Conference on Software Maintenance and Reengineering (CSMR2002)*, Budapest, Hungary, March 2002, 108-115.
- Taina J., Paakki J., Kauppinen R.: RITA - a Framework Integration and Testing Application. To appear in *Proceedings of the Finnish Data Processing Week (FDPW'02)*, Petroskoi, Russia.
- Viljamaa A., Viljamaa J.: Creating Framework Specialization Instructions for Tool Environments. In: *Proceedings of the Nordic Workshop on Software Development Tools and Techniques (K. Osterbye, ed.)*, NWPER'2002, IT University of Copenhagen, 2002.



4.2.4 Document Management, Information Retrieval and Data Mining (Doremi)

The Doremi research group is active in the areas of document management, information retrieval, data mining and human language technology. The fields of study include document assembly, event detection and tracking, text mining, and question-answering systems. The research is both theoretical and applied.

The research in document assembly concentrates on constructing tailored documents from existing documents and document fragments. The assembly process uses different methods in finding, clustering, reorganising, and modifying relevant fragments to be included in the new document. Typical applications include product manuals where a manual may be tailored to correspond to a certain customer-specific product configuration. In our approach a graphical assembly interface for an end user is dynamically generated based on a simple description of the possible target manuals. In the area of event detection and tracking the group studies the problems of first story detection and topic tracking. The first story detection task is about spotting new, previously unreported real-life events from online news-feed, while the topic tracking attaches a document to a previously detected event. We have addressed these problems by extracting locations, proper names, temporal expressions and normal terms from documents, and assigning weights for these semantic classes based on empirical analysis. We have also proposed new similarity measures based on semantic classes. In our experiments on a Finnish online news-stream corpus, we have found that the use of semantic classes improves the performance significantly. We have developed a working environment for a journalist that consists of a news story editor (an XML editor) and a retrieval interface to a collection of news stories. The environment includes an integrated event detection and tracking module.

In text mining, the group develops data mining techniques for finding regularities in texts. The research has resulted in methods for finding all maximal word sequences with at least a given frequency

in a document collection. The set of frequent sequences that occur in a document can then be used as a condensed content descriptor for the document in further processing, e.g. information retrieval. We have participated in the international “Initiative for the Evaluation of XML retrieval” project, the aim of which is to create a large testbed and scoring methods for XML retrieval.

We have developed a question-answering system for a company helpdesk. The incoming natural language questions are analyzed and the best answer candidates are retrieved from the old question-answer pairs. Varying parts, e.g. product prices, can be recognized and replaced with up-to-date values from a database.

Contact persons: Professor Helena Ahonen-Myka, Greger Lindén, Marko Salmenkivi

Research group homepage: <http://www.cs.helsinki.fi/research/doremi/>

Project list:

Knowledge Worker's Workstation (TYTTI)
Question-Answering for Processing of Natural Language Queries (APPA)
Doremi Text Mining

Selected publications:

Ahonen-Myka, H.: Discovery of frequent word sequences in text. The ESF Exploratory Workshop on Pattern Detection and Discovery in Data Mining, Imperial College, London, 16-19 September, 2002. Lecture Notes in Artificial Intelligence 2447, Springer, 2002.

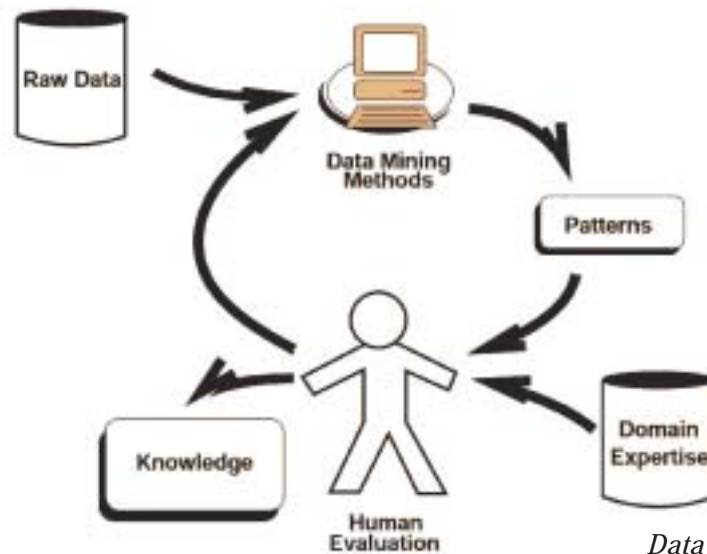
Aunimo, L., Heinonen, O., Kuuskoski, R., Makkonen, J., Petit, R., and Virtanen, O. Question Answering System for Incomplete and Noisy Data - Methods and measures for its evaluation. To appear in the proceedings of the 25th European Conference on Information Retrieval Research, Pisa, Italy, April 14-16, 2003.

Doucet, A. Améliorer les descripteurs de documents semi-structurés en utilisant les informations contextuelles. INFORSID 2002, Nantes, France, June 4-7, 2002, p. 401-402. ISBN: 2-906855-18-9

Fluch, M., Lindén, G., and Popescu, A. A journalist's tool for writing and retrieving news stories. In the Proceedings of XML Finland 2002, October 21-22, 2002, Helsinki, HIIT Publications 2002-03, p. 96-108.

Lehtonen, M., Petit, R., Heinonen, O., and Lindén, G. A Dynamic User Interface for Document Assembly. In the proceedings of the ACM Document Engineering (DocEng) '02, November 8-9, 2002, McLean, Virginia, USA, p.134-141.

Makkonen, J., Ahonen-Myka, H., and Salmenkivi, M. Applying Semantic Classes in Event Detection and Tracking. The International Conference on Natural Language Processing (ICON-2002), December 18-21, 2002, Mumbai, India.



Data mining is one of the main research areas at the department.

4.3 PROJECTS

Algorithms

Project: Networking and Architecture for Proactive Systems (NAPS) - Algorithms and Protocols
Researchers: Floréen, Patrik; Orponen, Pekka (HUT); Kohonen, Jukka; Ukkonen, Johannes; Kaski, Petteri (HUT); Autere, Antti (HUT); Falck, Emil (HUT).

Funding: Academy of Finland (Proact programme)

Summary:

This is a joint project with the Laboratory for Theoretical Computer Science of Helsinki University of Technology (HUT) and part of a consortium, which also includes the Networking Laboratory of HUT.

The network computing and communication models underlying proactive applications give rise to new opportunities and challenges in the fields of algorithm design and analysis. The project approaches, among others, multiobjective optimization problems in topology control and hierarchical routing of ad hoc networks by the well-established methods of systematic design and analysis of algorithms, specifically approximative and randomized techniques applied in the context of distributed online computational problems.

Project: Algorithmic Machine Learning
Researchers: Elomaa, Tapio; Rousu, Juho; Kääriäinen, Matti; Lindgren, J.T.; Malinen, Tuomo
Funding: Department of Computer Science

Summary:

Machine learning is concerned with the construction of computer programs that automatically improve with experience. We aim at mathematically rigorous analysis and development of learning programs and understanding of the underlying theory of the learning process(es). The group has studied extensively the properties of evaluation functions that are used to partition numerical attribute domains in machine learning algorithms. We have also analyzed decision tree pruning, progressive sampling and on-line learning.

Project: Robotics and Active Machine Vision
Researchers: Elomaa, Tapio; Autio, Ilkka; Koskenniemi, Ilkka
Funding: University of Helsinki

Summary:

Robotics presents a challenging application area for computer science. We have a Nomad Super Scout II research robot with Vision. The project studies the control software architecture of an autonomous office robot. In particular, we are interested in uses of active machine vision and applications of machine learning methods therein.

Project: A Global Molecular Approach in the Study of Microbial Stress
Researchers: Ukkonen, Esko; Rantanen, Ari; Pesonen, Antti (VTT)
Funding: Academy of Finland (Life2000 Programme)

Summary:

This is a subproject of a larger consortium co-ordinated by Professor Hans Söderlund (VTT). The goal is to develop computer software and related theoretical concepts and algorithms for the data analysis, visualization and modelling of the transcriptional and translational data produced by the biology partners of the consortium. The following computational problems will be considered: clustering of transcriptional and translational profiles; correlating such profiles against each other and against patterns in DNA sequences; synthesis of gene regulatory networks from data; computational support of a novel transcriptional profiling technique; analysis and alignment of 2D proteomics gels; development of data management infrastructure.

Project: Integrated Computational Methods for Genomic, Proteomic and Metabolic Modelling

Researchers: Ukkonen, Esko; Rousu, Juho; Mäkinen, Veli

Funding: Academy of Finland (MaDaMe Programme)

Summary:

The goal of this project is to develop computational methods and computer software for integrated analysis and mathematical modelling of genomic, proteomic, and metabolic data. The tools will aid to uncover and visualize the regulatory patterns and networks hidden in the data. Various computational approaches - such as pattern matching, machine learning, data mining, knowledge representation and sequence analysis - will be used.

Project: Logic-Based Query Languages for Molecular Biology Databases

Researchers: Ukkonen, Esko; Nykänen, Matti; Hakli, Raul; Tamm, Hellis

Funding: Academy of Finland, Department of Computer Science

Summary:

New application domains for database management systems demand that systems adapt to domain-specific data needs and not vice versa. In particular, databases of molecular biology data such as DNA strands encoded as strings must offer flexible tools for their manipulation. Thus we have extended the well-known relational database model to encompass strings as an independent data type, which permits user-defined string manipulation predicates within the query language. The extension draws its motivation from the concept of multiple sequence alignment employed in molecular biology, while its mathematical and computational aspects stem from temporal logic and automata theory, respectively.

Project: Neural and Computational Learning (NeuroCOLT)

Researchers: Ukkonen, Esko; Tirri, Henry; Elomaa, Tapio; Kivinen, Jyrki; Myllymäki, Petri

Funding: European Commission

Summary:

A European working group of more than ten partners on the theory and applications of machine learning.

Project: Pattern Matching and Machine Learning - Algorithms and Biocomputing Applications

Researchers: Ukkonen, Esko; Lemström, Kjell; Tamm, Hellis; Fredriksson, Kimmo; Suhonen, Heikki; Palin, Kimmo; Pienimäki Anna

Funding: Academy of Finland

Summary:

The project researches new algorithms for machine learning, pattern matching, and string matching, and applies them in various data analysis and information management problems. Special emphasis will be given to algorithmic problems in molecular biology and bioinformatics. Another application area is information retrieval in computer networks, for example, and in image and music databases.

Project: Structure, Assembly and Dynamics of Biological Macromolecule Complexes

Researchers: Ukkonen, Esko; Kivioja, Teemu; Ravantti, Janne; Verkhovsky, Anatoly; Mielikäinen, Taneli; Lamberg, Peter

Funding: Academy of Finland (RAKBIO Programme)

Summary:

The project develops original algorithms and software for the tomographic reconstruction of 3D models for biological macromolecule complexes such as viruses. The computational problems in the modeling of the assembly processes as well as the dynamic behaviour of such complexes will also be considered. A joint project with Professor Dennis Bamford (Division of Genetics).

Intelligent Systems

Project: Computationally Efficient Probabilistic Learning and Reasoning

Researchers: Myllymäki, Petri; Kontkanen, Petri

Funding: Academy of Finland

Summary:

The main motivation for this work is the need to develop methods for constructing computationally intelligent models from sample data and expert domain knowledge. The constructed models will be used for solving predictive (regression, classification) and explorative (data mining, visualization) modelling tasks. Although the advantages of probabilistic models have been largely recognized, the approach has often been neglected as a theoretically correct, but computationally infeasible methodology. The purpose of this research is to develop computationally efficient methods for probabilistic modelling.

Project: Advanced FDIR

Researchers: Tirri, Henry; Myllymäki, Petri; Valtonen, Kimmo; Silander, Tomi

Funding: Space Systems Finland

Summary:

The motivation for this work is the need to increase the autonomy and reliability of spacecraft. This is necessary partly to reduce operational costs, partly to enable missions where ground contact is intermittent (e.g. low earth orbit) or not real-time (e.g. planetary missions). Traditionally, failures detected on-board a spacecraft trigger a transition to a “safe mode”, in which the spacecraft tries to ensure its survival, while waiting for ground control to analyse the failure and issue commands to isolate it and recover from it. In the Advanced FDIR project, the goal is to avoid the “safe mode” approach and instead develop on-board recovery procedures that can be used without interrupting mission operations, even if recovery leads to degraded spacecraft performance.

Project: Computationally Efficient Methods for Deep Computing (DeepC)

Researchers: Tirri, Henry; Myllymäki, Petri; Silander, Tomi; Lahtinen, Jussi; Perttu, Sami

Funding: Academy of Finland

Summary:

Deep Computing is a term for methods solving complex and large-scale modelling and analysis problems with emerging computer systems that combine ultrafast processing with sophisticated analytical software. Deep Computing can be seen to consist of three intertwined research areas: Deep modelling (prediction and data mining with very large data sets), Deep optimization (computationally efficient optimization of complex multivariate cost functions) and Deep view (interfaces for understanding high-dimensional data). The methodological research objective of the project is to develop the theory and methods required for obtaining very large-scale computational, data and communications capabilities that can be used to solve “grand challenge”-level Deep Computing problems in business and science. The applied research objective is to demonstrate solutions to previously intractable business and scientific problems by exploiting the advances in Deep Computing research in areas such as data modelling and analysis, high-end computing, search and optimization algorithms, and high-dimensional visualisation.

Project: Personalized Adaptive Interfaces (PAI)

Researchers: Tirri, Henry; Myllymäki, Petri; Nokelainen, Petri; Silander, Tomi; Ojanpää, Sami; Misikangas, Pauli; Miettinen, Miikka; Lepola, Tuomas; Wettig, Hannes

Funding: TEKES, Alma Media, Ekahau, BayesIT

Summary:

The main objective of the PAI project is to develop methods for applying probabilistic modelling techniques, such as Bayesian network models, in building and using personalised, adaptive user interfaces. Specific research problems include user data segmentation, user profiling and user identification, and location-aware computing. The associated pilot projects focus on problems related to intelligent educational technologies, adaptive WWW services and adaptive mobile services.

Project: MINOS: Minimum Description Length Modeling in Computer Science and Statistics

Researchers: Tirri, Henry; Rissanen, Jorma; Roos, Teemu; Kontkanen, Petri

Funding: Academy of Finland

Summary:

The general objective of MINOS is to study and develop the Minimum Description Length (MDL) approach to modeling and its relationship to other probabilistic approaches used in computer science and statistics. The emphasis on applying the theoretical work will be in computationally efficient model selection and prediction problems in computer science, but the results are widely applicable in statistical modeling in general including regression, cluster analysis and curve estimation.

Software Engineering

Project: Tool Support for Industrial Java Frameworks (James)

Researchers: Paakki, Jukka; Viljamaa, Antti

Funding: Tampere University of Technology (as a joint Tekes project)

Summary:

The project develops a software tool that supports a design pattern-based method of building reusable application frameworks in Java and guides the systematic construction of final applications from the frameworks. The practical benefits of the method and tool are assessed in a number of industrial case studies.

Project: Metrics for Analysis and Improvement of Software Architectures (Maisa)

Researchers: Paakki, Jukka; Verkamo, A. Inkeri; Gustafsson, Juha; Nurminen, Ahti

Funding: Tekes, Kone, Nokia Mobile Phones, Nokia Research Center, Space Systems Finland

Summary:

The project develops methods for the measurement of software quality at the design level. The metrics are computed from the system's architectural description (given in UML), predicting the quality attributes of the system derived from the description. A novel technique under development is design analysis and quality prediction by automated search of design patterns and anti-patterns from the architecture. The method is implemented in a software tool that computes the metrics, visualizes the pattern occurrences that are found and, based on this information, predicts the quality of the software system to be built from the architecture.

Project: Techniques for UML-Based Software Development (UML++)

Researchers: Paakki, Jukka; Gustafsson, Juha; Viljamaa, Jukka

Funding: Academy of Finland

Summary:

The project continues the research started in the Maisa project in a consortium with the University of Tampere and Tampere University of Technology as the other partners. The goal is to develop a comprehensive software development environment with UML as the central technology. One service of the environment will be architectural quality assurance, studied at the Department. Another research topic is (semi-)automatic reverse engineering of architectural views over a software family by extracting instances of patterns from its

source code. Technically, the patterns conform to the notion of “specialisation pattern” developed in the James project, so the method is integrated with the framework tool developed in James.

Project: Framework Integration and Testing Application (Rita)
Researchers: Paakki, Jukka; Kauppinen, Raine; Taina, Juha **Funding:** Nokia Research Center (as a joint Tekes project)

Summary:

The project develops methods and tools for the testing of framework-based software systems and for verifying the quality of testing with new forms of code coverage criteria. The project is part of the large European Eureka/ITEA project CAFÉ (From Concept to Application in System-Family Engineering) that develops methods and processes for systematically building system families.

Distributed Systems and Data Communication

Project: Improving Internet Protocols for Wireless Links (IIP-Wireless)
Researchers: Raatikainen, Kimmo; Kojo, Markku; Kulve, Tuomas; Leggio, Simone; Riva, Oriana; Sarolahti, Pasi; Saarto, Jarno
Funding: TEKES, Nokia Research Center, Nokia Hungary, Sonera

Summary:

The objective of the IIP-Wireless project is to measure the TCP performance implications of those link characteristics that are typical for wireless wide-area links as well as to design and implement new experimental TCP performance enhancements and analyse the impact of the enhancements. The results are contributed to the Internet Engineering Task Force (IETF). In addition, a real-time software emulator called Seawind is developed further in the project. Seawind enables measurements of real protocol implementations in modelled networking environments. Seawind provides a rich set of ways to define transfer characteristics typical for wireless links, including delays and errors. The software also has the means to conduct large sets of experiments in an automatic fashion. Tools of analysing measurement data have been integrated into the Seawind software. The software has been licensed by nine universities and research institutes.

Project: Mobile IP Based Network Developments (MIND)
Researchers: Raatikainen, Kimmo; Kojo, Markku; Manner, Jukka; Peri, Indrek
Funding: (European Commission) Nokia Research Center

Summary:

Driven by the increasing demand for mobile and cordless broadband services in hot spot areas like airports, campus, and conference centres, the MIND project will provide a true broadband multimedia IP-based radio technology. Starting from the results of its predecessor project (BRAIN), the MIND project will offer the integration of end-to-end services over IP and evolve IP towards mobility. Furthermore, it will enable the interworking of private, corporate, and public networks. It will also support a wide range of services (point-to-point, point-to-multi-point, symmetric, and asymmetric) and allow roaming as well as inter- and -intra-system handover with GSM/GPRS and UMTS networks. MIND will also include new network topologies like ad hoc, self-organising and meshed networks, enhanced QoS in IP-based mobile networks and self-organisation at all layers of HIPER-LAN/2.

Project: TranSat
Researchers: Raatikainen, Kimmo; Kojo, Markku; Astuti, Davide; Daniel, Laila
Funding: (ESA) Alcatel Space Industry

Summary:

The Transat project was launched at the end of 2001. The aim of the project is to develop the operation and performance of Internet transport protocols in a satellite environment. The project focuses on two main fields. The first is the enhancement of TCP protocols by improving the TCP sender and receiver algorithms, and to improve the support offered to the transport level at link level. The second is the enhancement of resource management for the satellite link, and on the IP level, the coupling of differentiated package treatment (IP QoS) to the differentiated services offered by a satellite link. A prototype implementation will be made based on the suggested solutions, and finally, experiments will be made to test it.

Project: ROBOCOP QoS System Design

Researchers: Raatikainen, Kimmo; Kyrö, Jaakko

Funding: Nokia Research Center

Summary:

The Robocop project is in the process of specifying the middleware component architecture of embedded systems. Embedded systems vary from mobile phones and PDAs to digital TVs and network interface facilities. The core of the Robocop architecture consists of a component model framework and examples of software components on various abstraction levels. This approach allows the use of software components from any producer as part of the embedded software environments. It is also possible to exchange hardware components without changes to the application program.

Project: CRUMPET

Researchers: Raatikainen, Kimmo; Tarkoma, Sasu; Leinonen, Jani

Funding: European Commission

Summary:

The overall aim of CRUMPET is to implement, validate, and trial tourism-related value-added services for nomadic users (across mobile and fixed networks). In particular the use of agent technology will be evaluated (in terms of user-acceptability, performance and best-practice) as a suitable approach for fast creation of robust, scalable, seamlessly accessible nomadic services. The implementation will be based on a standards-compliant open source agent framework, extended to support nomadic applications, devices, and networks.

Project: Middleware for Mobile Wireless Internet (Fuego Core; project at HIIT)

Researcher: Raatikainen, Kimmo; Tarkoma, Sasu; Kangasharju, Jaakko; Lindholm, Tancred (HUT); Rantanen, Matti (HUT); Rimey, Ken (HIIT); Saaresto, Marko

Funding: Tekes, Nokia, Elisa Communications, Sonera, More Magic Solutions

Summary:

The current trend in developing forthcoming telecommunication networks is to utilize Internet protocols. However, to meet the requirements for the next generations of telecommunication networks we need new protocol solutions, both above the IP protocol and below it. Issues under study in the Internet community and in various standardization bodies, forums and consortia of telecommunications include mobility, Quality-of-Service, security, management of networks and services, ad-hoc networking and dynamic configuration, service discovery, geospatial locating, etc.

Project: EVC-WIN: European Virtual Centre of Excellence in Wireless Internet

Contact person: Raatikainen, Kimmo

Funding: Aachen University of Technology, King's College London, Universidad Politecnica de Madrid, University of Athens, University of Catania, University of Helsinki, Pierre and Marie Curie University (Paris 6 University) and the Technical University of Lisbon

Summary:

The European Virtual Centre of Excellence in Wireless Internet is a loosely coupled co-operation network of eight European universities. Its objectives include providing revolutionary solutions of the technical problems for the effective deployment of the Wireless Internet, networking leading European research groups for sharing knowledge and achievements in the Wireless Internet, and leveraging the interest for the Wireless Internet within the European Union. While the significant advances in current technologies are gradually transforming the vision into a reality, the greatest challenges are still ahead of us. Enabling the Wireless Internet is a challenging task because of the unique characteristics of wireless environment, including user mobility, dynamic topologies, unreliability of wireless links, and scarcity of resources.

Project: Academic Network for Wireless Internet Research in Europe (ANWIRE)

Researchers: Raatikainen, Kimmo; Niklander, Tiina; Kojo, Markku; Manner, Jukka; Tarkoma, Sasu; Kangasharju, Jaakko

Funding: European Commission

Summary:

ANWIRE is a thematic network established mainly by academic institutions from various EU countries acting in two main overlapping research tracks: Wireless Internet and Reconfigurability.

In both areas ANWIRE aims at

- i) organising and coordinating parallel actions in key research areas, in order to encompass research activities towards the design of a fully integrated system; and
- ii) promoting and disseminating solutions, in order to make them available to the research and industrial community.

Project: Wireless Internet Applications for Agriculture (VAAWIT)

Researcher: Raatikainen; Kimmo

Funding: European Commission

Summary:

The project focuses on the Asia IT&C programme component “Liaise with European IT&C Initiatives & Programmes” selecting “Agriculture” as the Area of Activity with a focus on dairy farming. It will integrate EU initiatives and expertise with SE Asian experts and partners to explore application of the rapidly emerging communications technology for value-added solutions in agriculture. The target application groups include smallholder farms, commercial farms and research farms that have implications for agriculture at policy level.

Project: Production and Integration of Large Component Systems (PILARCOS)

Researchers: Kutvonen, Lea; Alanko, Timo; Vähäaho, Markku; Haataja Juha; Silfver, Egil; Suoranta, Timo; Metso, Janne

Funding: Tekes, Nokia Research Center, SysOpen, Tellabs

Summary:

The Pilarcos project develops middleware solutions for the automatic management of interorganizational applications. The application behaviour is governed by contracts between sovereign components; these contracts define the forms and rules of cooperation. The federated application architecture under development presents an application as an architecture model, the roles in which are populated by traded service components. The services can be selected either at the development, startup or run-time of the application. The service component providers are independent of each other in the selection of implementation technology, for example. The federated architecture requires advanced middleware services for contract negotiation, for distributed startup of services, and for establishment of heterogeneous communication channels.

The PILARCOS project develops prototypes of these services. The project results are applicable to mobile computing, electronic commerce applications or networking support between enterprises, for example.

Project: RTD-Pilot

Researchers: Raatikainen Kimmo; Niklander, Tiina; Lindström, Jan; Raatikka, Vilho; Lyytinen, Ilpo

Funding: TEKES, Solid Information Technology, Nokia Networks

Summary:

RTD-Pilot continues the series of RODAIN projects in the study and prototype development of a real-time database system for the needs of telecommunication. The database solutions under study are distributed, fault tolerant and optimistic .

Project: Non-Stop Real-Time Linux

Researchers: Raatikainen, Kimmo; Häkkinen, Auvo; Karlstedt, Mika; Strandell, Toni; Vähäkangas, Taneli

Funding: Nokia Research Center

Summary:

nsrtLinux (Non-Stop Real-Time Linux) studied timeliness and high-availability improvements to Linux. With the help of testing and benchmarking programmes implemented in replicate server environments, the group examined delays that arise in the kernel and applications. Special focus was laid on the changes to time-slice management and to alternation, and on the effect of open source code CORBA platforms on delays. In addition, the group studied the real-time performance of open source databases. The proposals to improve timeliness characteristics were contributed to the Carrier Grade Linux working group in the Open Source Development Laboratory (ODSL).

Project: Modelling of Concurrency (MOCO)

Researchers: Tienari, Martti; Karvi, Timo; Luukkainen, Matti

Funding: Department of Computer Science Summary:

Formal specification and verification of distributed systems is studied in the Modelling of concurrent systems group. The theoretical results of the group are based on process algebras, temporal logic, and theory of automata. The results are applied to software engineering tools.

Information systems

Project: The Knowledge Worker's Work Station (TYTTI)

Researchers: Ahonen-Myka, Helena; Heinonen Oskari; Makkonen, Juha; Piitulainen, Jussi; Lindén, Greger; Lehtonen, Miro; Fluch, Martin; Popescu, Andrei; Petit, Renaud

Funding: TEKES, Alma Media, Nokia Networks, Vaisala, Lingsoft

Summary:

The project aims at building tools for a professional knowledge worker (e.g. a journalist), including tools for creating, accessing, and assembling structured (XML) documents, and tools for detecting and tracking events in newsfeed.

Project: Question-Answering for Processing of Natural Language Queries (APPA)

Researchers: Ahonen-Myka, Helena; Heinonen, Oskari; Aunimo, Lili; Kuuskoski, Reeta; Makkonen, Juha; Petit, Renaud; Viljanen, Kim; Virtanen, Otso

Funding: Companies

Summary:

A question-answering (Q/A) system provides answers to a user's written natural language questions from a da-

tabase. If no answer can be found, a human expert writes a new answer, which is also stored in the database. The techniques used are based both on statistical and linguistic methods.

Project: Doremi Text Mining

Researchers: Ahonen-Myka, Helena; Doucet, Antoine; Kostianen, Hanna-Kaisa; Hendry, Kai

Funding: Academy of Finland

Summary:

We attempt to extract from text a small set of word sequences that describe the contents of a document. Moreover, the methods should be able to handle hierarchically structured documents, e.g. XML. This means studying how to attach structural information to textual phrases. We also consider extracting generalised phrases from annotated texts, e.g. from texts annotated with morphological features (part-of-speech, case, number). Generalisation means replacing infrequent words with more general features, such as the part-of-speech.

Project: Graphical Interface Solutions and Techniques (GIST)

Researchers: Laakso, Sari A.; Laakso, Karri-Pekka

Funding: Department of Computer Science, Interacta Design Oy

Summary:

To design a successful user interface, we need use cases based on the realistic goals of users. We have developed a tentative design process that shows how the features and the user interface of an application are derived from goal-based use cases. To help create high-quality design, we have defined a collection of user interface design patterns.

Project: Context Recognition by User Situation Data Analysis

Researchers: Toivonen, Hannu; Laasonen, Kari; Raento, Mika

Funding: Academy of Finland

Summary:
In mobile and ubiquitous applications and systems, reacting to the user context is a key component of proactivity: changes in the user's situation are rapid and they are strongly reflected to the user's needs and preferences. The project studies characterization and analysis of information about user context and its use in proactive adaptivity: what is the user's understanding of her current context, how to make automatic inferences about the contexts, and how to characterize the context to users and design user interaction about contexts. The research problems are approached by qualitative end user studies, data analysis algorithm development, and empirical testing in a prototype environment. The project is carried out jointly with the Basic Research Unit of HIIT.

Project: Data mining for gene mapping

Researchers: Toivonen, Hannu; Mannila, Heikki; Geerts, Floris; Hintsanen, Petteri; Hyvönen, Saara; Koivisto, Mikko; Ollikainen, Vesa; Onkamo, Päivi; Sevon, Petteri; Terzi, Evimaria

Funding: University of Helsinki, National Public Health Institute

Summary:

Locating genes that predispose to certain diseases is highly important in understanding the etiology of complex common diseases, such as heart disease or asthma. Current techniques for gene mapping do not work well on complex traits, nor are they very well suited for the analysis of data stemming from modern laboratory techniques. The project develops methods for gene mapping and genetic data analysis in more general, based on data mining techniques and on the use of the Markov chain Monte Carlo analysis. The project is carried out jointly with the Basic Research Unit of HIIT.

Applied Computer Science

Project: Semantic Web: intelligent directory services
Researchers: Hyvönen Eero; Kettula Suvi; Raatikka Vilho; Saarela Samppa; Styrman Arvil; Viljanen Kim
Funding: Tekes, Nokia, TietoEnator, Espoo City Museum, National Board of Antiquities, Foundation of Helsinki University Museum

Summary:

Development and application of Semantic Web technologies to making heterogenous databases semantically interoperable. Ontology-based information retrieval. Case applications include semantic image repositories and Finnish museum databases.

Project: Urban Biodiversity: a Multitaxon Model in Multiple Scales for Urban Planning
Researchers: Lokki, Heikki; Mäkelä, Matti; Nyqvist, Tommy
Funding: Academy of Finland

Summary:

As a part of an interdisciplinary team headed by Professor Juhani Lokki (Finnish Museum of Natural History, University of Helsinki) a valuation model is to be constructed as part of a general model of urban biodiversity.

5. Supporting activities

5.1 ADMINISTRATION

THE DEPARTMENT STEERING COMMITTEE IN 2002

There were no changes in the line-up of the steering committee during 2002.

Members of the Steering Committee

Professor Jukka Paakki, chairman

Professor Seppo Sippu

Professor Henry Tirri

Lecturer Auvo Häkkinen

Lecturer Harri Laine

University Lecturer Tiina Niklander

Student Sampo Lehtinen

Student Antti Mattila

Student Marko Saaresto

University Lecturer Pirjo Moen, Secretary (1 Jan – 28 Feb 2002),

Office Manager Päivi Karimäki-Suvanto, Secretary (1 Mar 2002 -)

deputies

Professor Kimmo Raatikainen

Professor Timo Alanko

Professor Tapio Elomaa

Lecturer Teemu Kerola

Assistant Jan Lindström

Lecturer Markku Kojo

Student Seija Törmälehto

Student Nuutti Rintala

Student Joonas Muhonen

Administration services at the department in 2002

The department administration offers the staff and students services in staff, teaching, budgeting, research and general administration. Furthermore, the administrative team assists the department's steering committee and chair in the preparation and enforcement of matters that belong to their jurisdiction.

The teaching administration is in charge of organising the teaching as well as student counselling.

The department staff administration takes care of employment and work satisfaction issues. The budget administration handles the department's economy as well as assists the department management in budgeting and accounting.

The research administration assists research projects that are funded from outside sources with budgeting and accounting services as well as with funding applications.

The general administration services include assistance to the management of the department with various studies and reports, proofreading and

translation services for the staff, and secretarial services to students, as well as internal and external information services.

A total of 10 persons (8.5 person-years) were employed in the administration team during 2002.

5.2 LIBRARY



The Department has a library which is administratively part of the Kumpula Science Library founded in 2001 by the University's Faculty of Science. Still located in the same premises as the

Department, it will move to Kumpula in 2004 and integrate its activities with the other Faculty of Science departmental libraries. The library now holds about 49,000 volumes of literature, making it the

largest computer science library in Finland. The annual cumulation is about 350 monographic titles and 200 journal subscriptions. In 2002 the library used about 61,000 EUR for acquisition of new material.

The library is a departmental library mostly serving its own clientele (i.e. academic university personnel and more advanced students of the Department). For outside visitors the collections are freely available for reading and browsing on the premises, but home loans are subject to restrictions.

The collections of the library are catalogued in the national library system (HELKA/LINDA) and in the library's own database. The material in these databases is classified according to the ACM Computing Classification System (CCS).

When the library moves to Kumpula and becomes a fully integrated part of the Kumpula Science Library, there will be a number of changes in the long-standing departmental library practices (collections are reorganised, outside visitors are granted full access to material, the separate database will be discarded etc.). Planning for these changes was started in 2002 and will continue with full force in 2003.

The library is also responsible for the distribution and sale of departmental reports, including PhD theses. Paper copies of reports are available from the library, and electronic versions are accessible through the Department's FTP server.

The library has two full-time employees, one librarian and one secretary.

5.3 OVERVIEW OF COMPUTING FACILITIES

The department is dedicated to providing a wide range of advanced high-quality computing facilities for use by computer science faculty and students. The number of users of these facilities is about 4,200. The facilities are operated by a technical staff who are not only responsible for the installation and maintenance of the systems, but who also assist faculty and students in the use and development of software systems for research projects.

Our workstation network consists of more than

500 PCs (mostly Pentium 4, most of them with flat TFT monitors) running Linux. Windows 2000 can be used as an alternative to Linux. More than 100 of the workstations are mobile laptops that can join and leave the network dynamically.

The general computing facilities include a farm of servers:

general-purpose computers, a computing cluster, file servers and other functionally dedicated servers (mail, WWW, FTP etc.), and servers for different user groups. Linux is used almost entirely as the operating system for the servers. The centralised file servers utilise RAID technology and currently offer over 1.5 Tbytes storage space. Together, these systems support a wide variety of services, languages and software tools including electronic mail and news, graphics and visualisation tools, several typesetting systems, and relational database systems. Special attention has been paid to security and reliability.

Networking is based on switched 100 Mbit/s Ethernet with an optical backbone. The mobile laptops can also utilise a departmental IEEE 802.11b type radio network which currently has 15 base stations. In the Linux (and UNIX) environment NFS is used to share common resources. On the Windows side Samba (a Linux-hosted Lan Manager Server) is utilized. The workstations are used as tools for software development, in research and on all levels of teaching.

The network of the department is connected through a firewall to the university backbone network, giving access to general-purpose UNIX computers at the University IT Department as well as to the FUNET wide area network that links Finnish universities and research establishments. The IT Department also offers a large modem and ISDN pool for remote access.

In addition, the department has access to a number of supercomputing facilities at the Finnish IT Center for Science (CSC).

The national FUNET network is further connected to the Nordic University Network, Nordunet, with a 5 Gbit/s connection. The Nordunet has a 2.5 Gbit/s connection capacity to the United States as well as many high-capacity connections to the European network infrastructure.

Appendices

PUBLICATIONS

ALGORITHMS

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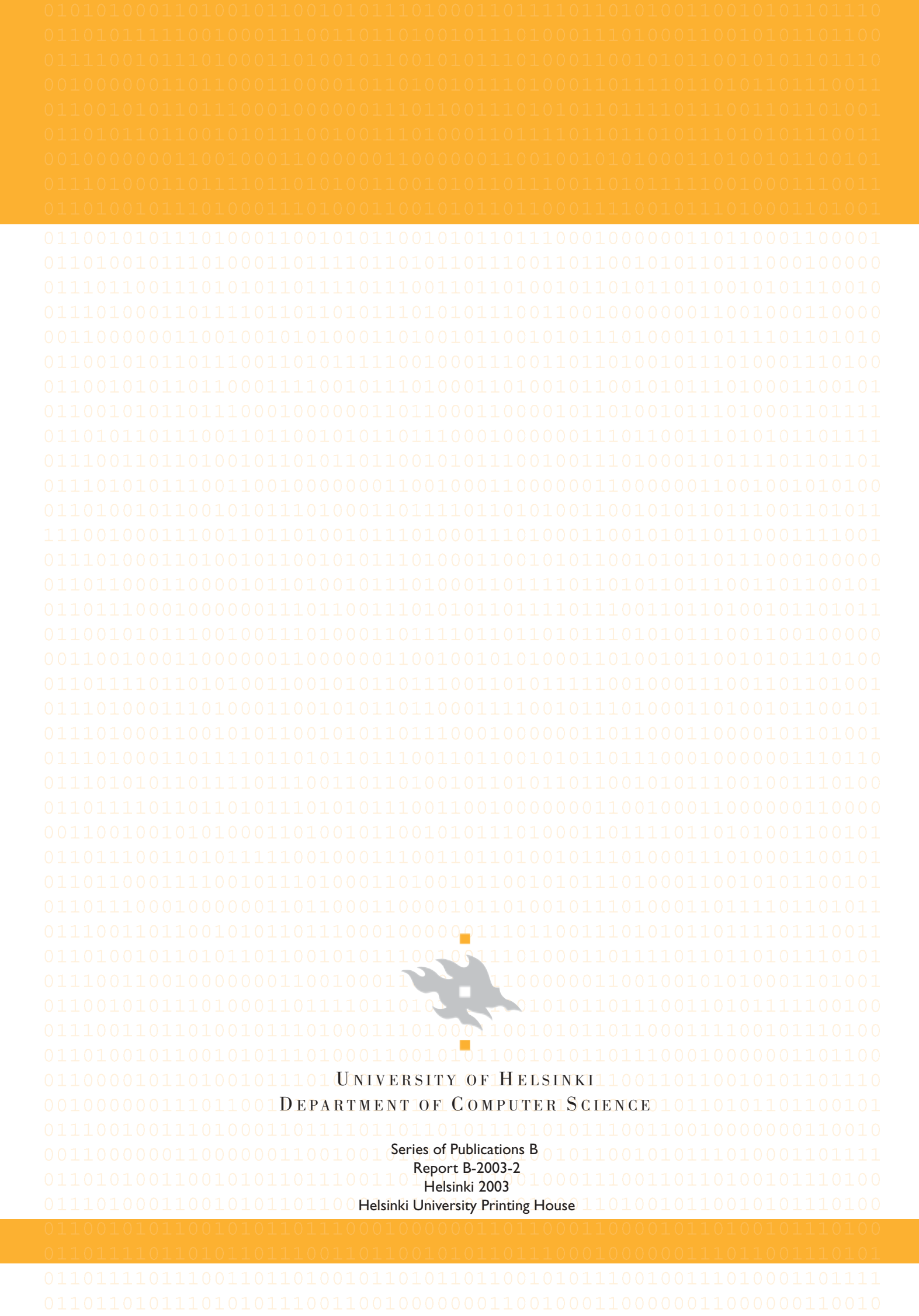
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		Ågren, Lassi

Part-time Teachers 2002

Nimi
 Aarnio, Lauri
 Airamaa, Kimmo Kalevi
 Alanko, Lauri Emil
 Aulaskari, Ismo Matti Ilmari
 Aunimo, Lili Annika

This list of persons contains the names of part-time teachers who have not held any other positions at the department during the year 2002.



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