

Helsinki Institute for Information Technology HIIT Annual Report 2006

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EXECUTIVE SUMMARY

During its seventh year of operation HIIT continued its growth both organically and by accepting new research groups to join the institute. Its total budget for 2006 was 6.7 million Euro and personnel 140 researchers and staff. The publication record developed positively: the institute produced some 170 international publications. During 2006, it operated in three locations: Ruoholahti (High Tech Center Helsinki), Otaniemi (TKK campus) and Kumpula (UH campus). At present (May 2007), the Ruoholahti unit has been relocated in Spektri Business Park next to TKK campus in Otaniemi. Administratively, HIIT consists of the Advanced Research Unit (ARU) in TKK and the Basic Research Unit (BRU) in UH.

Year 2006 was the first one in the transition period of 2006-2008 for implementing the new strategy and structure of HIIT. The main goal in 2006 was to establish the new research programme structure and renew accordingly the administration and working procedures.

A new working model was adopted that is based on research programmes. The institute has currently four long-term research programmes, each led by a professor-level senior researcher with a programme manager. The programmes have an internal management board and an advisory board consisting of external members from industry and universities. The administration of the institute was developed such that its budgetary planning now follows the research programme structure. The external image of the institution was also reformed.

HIIT's research continued to enjoy success during the year. In the international evaluation of the research of the University of Helsinki, HIIT was awarded the best grade 7/7. According to the evaluation, "The unit can without hesitation be declared leading in its chosen area of research. It has a strong international colour." TEKES decided to award strategic research funding to the *Trustworthy Internet* project that will form the core activity of this research line for the next several years. In the 6th Framework Programme of the European Union, four new projects were launched during the year.

Highlights of the research in HIIT during 2006 include the following:

- *The Ubiquitous Interaction* group developed a messaging service that combines ideas from social media with wireless communication in a novel fashion
- *The Mobile Computing* group developed a new software platform to support wireless communication, in particular for the support of distributed event-oriented systems
- In the *Algorithmic Data Analysis* programme, new algorithms for the seriation of partially ordered data was developed, with excellent performance on biological data

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1 HIIT in Brief

Helsinki Institute for Information Technology HIIT is a joint research institute of the two leading research universities in Finland, the Helsinki University of Technology (TKK) and the University of Helsinki (UH). It was founded in 1999. At present HIIT has some 140 researchers and staff. During 2006, it operated in three locations: Ruoholahti (High Tech Center Helsinki), Otaniemi (TKK campus) and Kumpula (UH campus). At present (May 2007), the Ruoholahti unit has been relocated in Spektri Business Park next to TKK campus in Otaniemi.

HIIT conducts internationally high-level strategic research in information technology and related multi-disciplinary topics, especially in areas where the Finnish IT industry has a significant role. It works in close co-operation with Finnish universities, research institutes, and industry, aiming at significant scientific impact that also benefits the industry and the progress of the Finnish information society. HIIT also has a strong network of international partnerships with leading foreign research universities and institutions.

HIIT's work is organised in long-term research programmes, each consisting of several co-operating groups with a total of 25-40 researchers. Each programme has an Advisory Board consisting of representatives from industry and academia.

The present programmes are as follows:

Algorithmic Data Analysis (ADA) Director: Academy Professor Heikki Mannila

The development in measurement and data collection technologies have made it possible to gather and store large amount of information in many areas of science and industry. The ability to analyze these masses of raw data has increased at a much slower speed, however. The research programme on data analysis develops data mining and computational statistics methods for various application tasks.

Future Internet (FI) Director: Professor Kimmo Raatikainen

Enhancing Internet infrastructure to enable efficient, secure and trusted always-on connectivity and services.

Network Society (NS) Director: Professor Marko Turpeinen

Human-centric multidisciplinary anticipation and development of ubiquitous information and communication technology, which is based on deep understanding of needs and practices of everyday life and social relations in a network society.

Probabilistic Adaptive Systems (PAS) Director: Professor Petri Myllymäki

Exploration and further development of the theory of sophisticated probabilistic models and their applications for solving problems appearing in complex real-world stochastic systems.

A Board consisting of members from the universities, industry, and HIIT personnel directs HIIT. The Scientific Advisory Board advises the Board on strategic planning of HIIT's research directions. Administratively, HIIT consists of the Advanced Research Unit (ARU) at TKK and the Basic Research Unit (BRU) at UH. Professors Martti Mäntylä (ARU) and Esko Ukkonen (BRU) direct the two units.

2 Review of Year 2006

2006 was HIIT's seventh year of operation.

As decided by the HIIT Board in 2005, this year was also the first of the transition period 2006-2008 preparing the way for the merging of the two units of HIIT, the Advanced Research Unit (ARU) and the Basic Research Unit (BRU).

During this year, considerable progress along this path was made. In particular, the HIIT Board formally agreed on HIIT's research programmes in June 2006. On this basis, the operation, administration and reporting of the institute was reorganised according to the research programmes, and new institute-wide internal administrative bodies were launched. As a result, various administrative processes of the previous two units were aligned and homogenized.

This also facilitated the inclusion of several new research groups to the institute: the *Combinatorial Pattern Matching* group led by Professor Esko Ukkonen from University of Helsinki, the *Statistical Machine Learning and Bioinformatics* group led by Professor Samuel Kaski and the *Distributed Networking and Security* research group led by Professor Antti Ylä-Jääski, both from Helsinki University of Technology, all joined HIIT during the year.

With the new groups, HIIT can now better be described as an integrated institute operating in three sites (Otaniemi, Kumpula, and Ruoholahti) than an institute consisting of two distinct units. The decision to move the Ruoholahti unit to TKK campus, made at the end of 2006 (already implemented at the time of writing this review), reinforces this development.

HIIT's research continued to enjoy success during the year. In the international evaluation of the research of the University of Helsinki, the activities of HIIT on UH's Kumpula campus were awarded the best grade 7/7. According to the evaluation, "The unit can without hesitation be declared leading in its chosen area of research. It has a strong international colour."

In concert with this, the *Finnish Centre of Excellence for Algorithmic Data Analysis Research* (Algodan) was one of the 18 research groups selected by the Academy of Finland to the national centre-of-excellence programme for 2008 - 2013. HIIT's Kumpula site will be the main center of activity of the CoE. Professor Esko Ukkonen is the director and Academy Professor Heikki Mannila the vice-director of Algodan. The work in Algodan will contribute primarily to HIIT's *Algorithmic Data Analysis* programme.

Significant progress was also achieved in the networking research line of HIIT's *Future Internet* programme. In particular, TEKES' new GIGA technology programme decided to award strategic research funding (3+2 years) to the *Trustworthy Internet* project that will form the core activity of the research line for the next several years. The long-term funding has enabled us to set quite bold objectives for the research, with the aim of contributing significantly to the so-called "clean slate" approach to Internet architecture in close co-operation especially with the International Computer Science Institute at UC Berkeley. Supplementary funding received for co-operation with Universität Aachen and the Swedish Institute for Computer Science (SICS) has increased the international character of this research line even further. The funding

also facilitated the invitation of several summer trainees from IIT Kanpur, India, to HIIT during Summer 2006.

In the area of context-awareness and smart phones, the success of the prototyping platform ContextPhone for context-aware applications continued. The platform has been published as freely downloadable software. Applications built on top of ContextPhone have been used in several research institutions including the MIT Media Lab, and has been the basis for data analysis method development at HIIT. ContextMedia, a contextual mobile media gathering tool, has been used together with the University of Art and Design Helsinki in several artist-led workshops around the world as well as by the Garage Cinema Research Group at UC Berkeley.

HIIT also continued to compete successfully for funding from the 6th Framework Programme of the European Union, with the result that no less than four new EU projects (IPCity, FUGA, CALLAS, and P2P Fusion) were launched during the year. HIIT also participated in two European-scale projects included in the ITEA cluster of the Eureka programme.

During this year, HIIT participated actively in the preparation of the 7th Framework Programme, formally launched at the end of 2006. In particular, HIIT joined in the activities of several Technology Platforms and contributed to their Strategic Research Agendas. HIIT also participated with two stands in the IST 2006 conference held on 21-23 November 2006 in Helsinki at the Helsinki Fair Centre.

HIIT continued its strong presence in education, especially at doctoral level. HIIT co-organised the *Rutgers-Helsinki Ph.D. Student Workshop on Spontaneous Networking* run in Rutgers University in May 2006. The workshop was the first of a series planned to take place every year; the 2nd workshop is scheduled for May 2007.

Seven HIIT researchers received their doctoral degrees during the year – the highest number ever. The Finnish Society for Computer Science nominated one of them, Risto Sarvas, as the recipient of the best CS doctoral thesis award for 2006.

In 2006, the total number of original publications of HIIT was 171 (147 in 2005). The total funding was MEUR 6.67 and the total number of person-years was about 119, both being about 13 percent higher than in 2005.

3 Important Events

16.1.2006

HIIT was accepted as the member of the DIMES ry consortium in its board meeting on 16.1.2006.

1.3.2006

The Basic Research Unit was awarded the best grade 7/7 in the international evaluation of the research at the University of Helsinki. The evaluation report is available at <http://www.helsinki.fi/research2005/english/results.html>.

1.3.2006

Seminar on *New Everyday Information Society*. HIIT held a seminar on New Everyday Information Society (Uusi arjen tietoyhteiskunta) related to a study on the influence of new information and communications technology on society awarded to a HIIT-led consortium by the Ministry of Communications and Transportation.

21.4.2006

Professor Jukka Kempainen received an honorary award from TeliaSonera Finland Foundation.

22–23.5.2006:

The annual HIIT Retreat was held in Haukilampi. The prime topic discussed was the new research programme structure of HIIT, its content and implications.

5.6.2006

HIIT's Global Network Society project and the Policy Network co-arranged the seminar *Future of European Social Models: Is it a tragedy play or a success story?* Speakers of the event included Professor Anthony Giddens, Foreign Minister Erkki Tuomioja and Professor Pekka Himanen.

14–16.6.2006

The Evaluation of the Research Programme on Proactive Computing (PROACT) was held in Helsinki. An international panel evaluated the programme and its projects. HIIT coordinated the programme and three out of fourteen projects were managed by HIIT.

6–8.7.2006

The *IIIA - 2006: International Workshop on Intelligent Information Access* was held in the Marina Congress Center, Helsinki. HIIT was one of the co-sponsors of the event.

28.8.2006

Two new research groups were accepted into HIIT: *the Computational Biology* group led by Professor Esko Ukkonen from the University of Helsinki and *the Statistical Machine Learning and Bioinformatics* group led by Professor Samuel Kaski from Helsinki University of Technology.

13.10.2006

The HIIT Steering Board decided to accept *the Distributed Networking and Security research* group led by Professor Antti Ylä-Jääski from Helsinki University of Technology to HIIT. The work of the group will focus on the Future Internet programme of HIIT.

29.10.–2.11.2006

HIIT co-arranged the seminar *Naming and Addressing for Next-Generation Internetworks* in Schloss Dagstuhl, Germany. Dr. Andrei Gurtov co-chaired the event.

1.11.2006

Dr. Marko Turpeinen, the Programme Director of the Network Society research programme at HIIT, was nominated as the Professor of Media Technology at the Royal Institute of Technology (KTH), Sweden, from 1.11.2006 onwards. Professor Turpeinen will continue his work at HIIT, and plans to divide his time between KTH and HIIT.

21–23.11.2006

The IST 2006 conference was held in Helsinki at the Helsinki Fair Centre. HIIT had two stands in the conference exhibition, presenting the results of the ALVIS project and the Merkitys-Meaning system developed in the Context project.

14.12.2006

Finnish Centre of Excellence for Algorithmic Data Analysis Research (Algodan) is one of the 18 research groups selected by the Academy of Finland to the national centre-of-excellence programme for 2008-2013. The unit mainly works at the Department of Computer Science, and Helsinki University of Technology also participates. Algodan develops new concepts, principles and algorithms for computational data analysis, and applies them in practice. Both basic computer science research and widely applied collaboration are carried out in the unit. Professor Esko Ukkonen is the director and Academy Professor Heikki Mannila the vice-director of Algodan.

4 Research

From 2006 onwards, HIIT adopted an organisation based on research programmes that cover all sites. Accordingly, from 2006, HIIT's research will also be documented by programme rather than by unit as in previous annual reports.

4.1 Algorithmic Data Analysis (ADA)

The mission of the data analysis research programme in HIIT is to develop useful algorithmic data analysis methods for other sciences and for industry. The work involves both basic research in computer science and applied work on problems arising from applications.

The programme is lead by Academy Professor Heikki Mannila and it consists of six research groups that have a strong cohesion and frequent interactions with each other. The groups and their senior members are as follows.

- Combinatorial Pattern Matching (Esko Ukkonen, Kjell Lemström, Juha Kärkkäinen, Juho Rousu)
- Data Mining (Heikki Mannila, Aristides Gionis)
- Discovery Group (Hannu Toivonen)
- Parsimonious Modelling (Jaakko Hollmén)
- Adaptive Computing (Patrik Floréen)
- Statistical Machine Learning and Bioinformatics (Sami Kaski)

Professor Ukkonen's and Professor Kaski's groups joined in late 2006 and their work for 2006 is not further presented in this report.

4.1.1 Algorithmic and Probabilistic Methods in Data Mining

Project leader: Mannila, Heikki
Research group(s): Data Mining, Discovery Group, Parsimonious Modelling
Researchers: Toivonen, Hannu; Hollmén, Jaakko; Gionis, Aristides; Terzi, Evimaria; Leino, Antti; Mielikäinen, Taneli; Seppänen, Jouni; Tatti, Nikolaj; Bingham, Ella; Gwadera, Robert; Puolamäki, Kai; Heikinheimo, Hannes; Ukkonen, Antti; Haiminen, Niina
Schedule: 2002-01-01...
Funding: Academy of Finland; graduate schools; European Commission funding from TKK; BRU basic funding
www-page and publications: see <http://www.cs.helsinki.fi/research/fdk/datamining/>

The project develops methods for the exploratory data analysis of large and high-dimensional data sets. One of the themes has been finding frequent patterns in large collections of data. The pattern classes include ordered and unordered patterns. Currently areas of interest include condensed representations and the combination of combinatorial and probabilistic techniques for approximating distributions. For sequential data, interests are in algorithms for sequence segmentation under various restrictions and in discovery of order from unordered data sets. Further, issues in subspace clustering and spectral methods have also been studied.

In 2006 there were several interesting developments. The methods on ordering seriation problems in paleontological and other applications advanced very

considerably, and the publications were accepted to important forums. The work on finding partial orders from data also advanced. The novel problem setting of mining chains of relations has great promises, as well as the work on condensed representations and on spatial clustering.

4.1.2 Application of Probabilistic Inductive Logic Programming II (April II)

<p>Project leader: Mannila, Heikki Research group(s): Data Mining Researchers: Mannila, Heikki; Mielikäinen Taneli Schedule: 2004-01-01... 2006-12-31 Co-operation units: Albert-Ludwigs-Universität Freiburg, Imperial College of Science, Technology and Medicine, INRIA, Rocquencourt, University of Florence, Florence Funding: EU www-page and publications: http://www.aprill.org</p>
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Probabilistic inductive logic programming combines probabilistic modelling and inductive logic programming to provide a general framework for learning probabilistic logical models from structured data.

The goal of the APRIL II project is to study the theoretical basis of probabilistic inductive logic programming, develop efficient computational models for the estimation of the structures and parameters of probabilistic logical models, and to apply these models to practical modelling problems, especially in the field of bioinformatics. Researchers from the Albert-Ludwig in Freiburg, Imperial College of Science, Technology and Medicine, INRIA Rocquencourt, Helsinki Institute for Information Technology and the University of Florence participate in the project. In Helsinki, the research is focused on algorithmics for probabilistic inductive logic programming, especially algorithmics for segmentation problems. Year 2006 was the final year of the project, and the emphasis stayed on segmentation problems.

4.1.3 Combining Multiple Data Sources in Functional Genomics for Improving Genome-wide Interferences

<p>Project leader: Hollmén, Jaakko Research group(s): Parsimonious Modelling Researchers: Ruosaari, Salla; Toivola, Janne; Rasinen, Antti Schedule: 2004-01-01... 2007-31-12 Co-operation units: Funding: Academy of Finland www-page and publications: see http://www.cis.hut.fi/jhollmen/hiit/genomics.html</p>
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We address a fundamental data-analytic limitation of genome-wide microarray measurements. The number of genes that can be measured at a time is already huge but the number of samples (microarrays) is small and limited by the measurement cost and sample availability. Hence, the relative number of representative samples per gene is always very small, and the problem will persist; in new experimental settings there never exists representative data a priori. This makes accurate data analysis difficult and increases the chances of false discoveries when targeting a holistic view of the cell, based on the noisy high-dimensional data

Our bioinformatics research problem is how to take advantage of existing, partially representative data sets of different types to support inferences in biological and medical questions. If this problem can be solved, data analysis methods could use the accumulating body of data, part of which may be publicly available, in supporting genome-wide inferences in new settings and research questions.

The developed methods will be applied in a representative set of research problems in two biomedical areas: cancer research and neuroscience.

4.1.4 Computational Methods for the Analysis of Palaeontological Data

<p>Project leader: Mannila, Heikki Research group(s): Data Mining Researchers: Mannila, Heikki; Heikinheimo, Hannes; Puolamäki, Kai; Ella Bingham Schedule: 2005-01-01... 2008-12-31 Funding: Academy of Finland</p>

The project develops computational methods for the analysis of palaeontological and other ecological data. The project has developed new dating methods based on spectral ordering and MCMC methods. A method using MCMC and the so-called Bernoulli model were used to discover errors in the data.

The hierarchical structure of modern mammal data was studied with the help of distance measurements based on distribution, and the automatic learning of the hierarchy was analysed. The project is a cooperation with the Department of Geology at the University of Helsinki.

The work led to several important publications in 2006. The paper on seriation methods based on spectral techniques was published in *Paleobiology*, and a paper on MCMC tools for estimating the ordering of sites appeared in *PLoS Computational Biology*. The work was extended to the study of ecological datasets, where work on clustering methods showed interesting spatial coherence on mammalian species distributions.

4.1.5 Context Recognition by User Situation Data Analysis (CONTEXT)

<p>Project leader: Toivonen, Hannu Research group(s): Discovery Group Researchers: Laasonen, Kari; Raento, Mika; Toivonen, Hannu Schedule: 2002-11-01 ... 2007-07-31 Co-operation units: ARU/HiIT Funding: Academy of Finland, graduate schools Keywords: Context recognition, mobile devices, data mining Research programme: Academy of Finland / Proactive Computing (PROACT) www-page and publications: http://www.hiit.fi/fi/context</p>
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This project studies the characterisation and analysis of user contexts, and the utilisation of context data in pro-active computing. Special focus is laid on the problems of privacy, algorithms for analysing context data, and software technology for context-aware applications. The project is a co-operation with the User Experience group at the Applied Research Unit at HIIT. The project developed the ContextPhone software, which collects, saves and relays context information in normal S60 mobile phones. It can also automatically annotate the pictures taken with

camera phones with context information and move them e.g. to a website. With the help of this software, the project has studied the effect of relaying context information on communication and developed methods for refining cell-based location data into a more useful, logical form. ContextPhone has been used in research at UCLA Berkeley, MIT, and the University of Art and Design Helsinki, among others.

4.1.6 Genetic Analysis of Schizophrenia Phenotype

Project leader: Mannila, Heikki
Research group(s): Data Mining
Researchers: Mannila, Heikki; Parviainen, Pekka; Koivisto, Mikko; Wessman, Jaana
Schedule: 2006-05-01... 2007-09-30
Funding: Orion

The project develops computational tools for the analysis of large phenotypic databases related to schizophrenia.

4.1.7 Inductive Queries for Mining Patterns and models (IQ)

Project leader: Mannila, Heikki
Research group(s): Data Mining
Researchers: Mannila, Heikki
Schedule: 2006-08-31... 2007-08-31
Co-operation units: Universiteit Antwerpen, the Netherlands, Institut National des Sciences Appliquées de Lyon, France, Institute Josef Stefan, Slovenia
Funding: EU
www-page and publications: <http://iq.ijs.si>

One of the main challenges of data mining is developing a common theoretical framework. Inductive databases, i.e. databases for data mining with a declarative approach to data analysis, offer a promising approach to this problem.

The IQ project studies the theoretical basis of inductive databases and develops inductive databases for various data analysis problems. They are being applied to biological problems.

4.1.8 Knowledge discovery in biological databases (Biomine)

Project leader: Toivonen, Hannu
Research group(s): Discovery Group
Researchers: Eronen, Lauri; Hintsanen, Petteri; Kulovesi, Kimmo; Sevon, Petteri; Toivonen, Hannu
Schedule: 2005-03-01 ... 2007-12-31
Co-operation units: Jurilab Ltd; Biocomputing Platforms Ltd; GeneOS Ltd; Department of Medical Genetics, University of Helsinki; Karolinska Institutet, Stockholm; CSC; VTT Biotechnology
Funding: Tekes; companies; BRU; UH
Keywords: Bioinformatics, data mining, link analysis and discovery
www-page and publications: <http://www.hiit.fi/ada/biomine/>

The project develops methods and tools for the analysis of public bio-databases (sequences, proteins, interactions, articles etc). With their help, bio-scientists can

enhance their own data, discover previously unknown connections and analogies to public databases, and aim resources at the most promising objects of further study. The main application focus is on further analysis of candidate genes found in gene mapping. The project has studied the presentation of biological information as a graph, where the nodes represent different concepts (e.g. genes, proteins, tissue, phenotypes, cellular component) and the edges represent the relations between them (e.g. the connection between gene and biological process reported in a gene database). The project has developed methods for the analysis of such graphs and the automatic searching and visualisation of such relations between the concepts.

4.1.9 Mobile Life (MobiLife)

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Nurmi, Petteri; Suomela, Jukka; Boström, Fredrik; Hassinen, Marja; Kukkonen, Joonas; Lagerspetz, Eemil; Karlstedt, Mika
Schedule: 2004-09-01 ... 2006-12-31
Cooperation units: Nokia Corporation; Alcatel-CIT; Ericsson AB; Oy LM Ericsson Ab; Hewlett-Packard Italiana srl; Motorola Ltd.; Motorola SAS; NEC Europe Ltd.; Siemes Mobile Communications SpA; DoCoMo Communications Laboratories Europe GmbH; Elisa Corporation; Fraunhofer Gesellschaft zur Foerderung der angewandten Forschung e.V.; University of Helsinki; Universität Kassel, Fachgebiet Kommunikationstechnik; The University of Surrey; NEOS Engineering SRL; Stichting Telematica Instituut; UNIS, spol s.r.o.; Suunto Oy; BellStream SP.z.o.o.; Telecom Italia
Funding: European Union
Research programme: Information Society Technologies (EU FP6), FP6-2003-IST-2 (IST-511607 MobiLife)
www - page and publications: <http://www.hiit.fi/fi/mobilife/>

The objective of the MobiLife project was to bring user-centred advances in mobile applications and services within the reach of users in their everyday life. The MobiLife project, with 22 partners in nine countries, was coordinated by Nokia. It was part of a larger group of EU projects called Wireless World Initiative (WWI). The group at HIIT / BRU focused on context awareness. It studied new context-reasoning methods, as well as developed context-aware applications. HIIT/BRU headed the task that studied context management. MobiLife concluded at the end of year 2006.

During 2006, the open-source software BeTelGeuse (see <http://www.cs.helsinki.fi/group/acs/betelgeuse/>) for data collection was developed, and the work on a general reasoning component for producing recommendations [1] continued. The group also participated in developing the Context Watcher application (see <http://portals.telin.nl/contextwatcher/>). In addition, clustering algorithms for spatial data and a simulator for presenting context data were developed.

The work of the Mobilife project in the Future Internet programme is described in section 4.2.10 below.

[1] Petteri Nurmi, Alfons Salden, Sian Lun Lau, Jukka Suomela, Michael Sutterer, Jean Millerat, Miquel Martin, Eemil Lagerspetz, and Remco Poortinga. A system for context-dependent user modeling. Proc. OTM Federated Workshops (Montpellier, France, October-November 2006), Lecture Notes in Computer Science 4278. Springer-Verlag, Berlin, Germany, 2006, 1894-1903.

4.1.10 Molecular Markers for Asbestos-exposure related lung cancer

Project leader: Hollmén, Jaakko
Research group(s): Parsimonious Modelling
Researchers: Korpela, Mikko
Schedule: 2005-05-01 ... 2008-04-30
Co-operation units: Finnish Institute of Occupational Health; HUSLAB
Funding: Tekes
www-page and publications: see <http://www.cis.hut.fi/jhollmen/hiit/genomics.html>

The broader goal is to discover molecular markers for asbestos-exposure-related lung cancer. To help in this endeavour, the aim of our research is to develop novel data-analysis methods, models and algorithms for the analysis of high-throughput measurements. Specifically, the interest lies in the analysis of microarray-based gene expression and gene copy number change measurements. These measurements can be combined or additionally augmented by data sets from publically available databases. The search for the diagnostic variables can be considered as a problem of parsimonious modelling, in which a few informative variables are sought amongst a large number of available measurements. These informative variables can then be used in diagnostics of asbestos-exposure-related lung cancer.

4.1.11 New Computational Methods for Analyzing the Structural and Functional Landscapes of Mammalian Genomes (CompGenome)

Project leader: Mannila, Heikki
Research group(s): Data analysis
Researchers: Gionis, Aristides; Haiminen, Niina; Koivisto, Mikko; Kollin, Jussi; Wessman, Jaana
Schedule: 2003-11-01 ... 2007-12-31
Co-operation units: National Public Health Institute (KTL); Finnish Genome Center; Karolinska Institute, Sweden; Department of Medical Genetics Research (UH)
Funding: Academy of Finland
Research programme: Academy of Finland / Systems Biology and Bioinformatics
www-page and publications: see <http://www.cs.helsinki.fi/group/genetics/>

The project studies species-specific and inter-species genetic and functional varieties. The goal is to understand multifactorial diseases, among others. The biological themes include haplotype structures, large-scale genetic variations, phenotype clustering, and gene expression. The main computational themes are probabilistic modelling and MCMC methods, data mining and pattern discovery, and combinatorial algorithms. The project, a collaboration with the Finnish Genome Centre, the National Public Health Institute and Karolinska Institutet in Stockholm, belongs to the Academy of Finland's SYSBIO programme.

During the year, 2006 the project continued segmenting genomes and modelling multidimensional phenotypes, as well as creating a new population-based computational method for haplotyping. The group reached interesting results in these research fields, especially from a computational point of view.

4.1.12 Semantic Interpreter Widened Experience (Stepwise)

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Nurmi, Petteri
Schedule: 2006-09-01 ... 2007-08-31
Cooperation units: Nokia Research Center
Funding: Nokia Research Center, subcontracting
www - page and publications: <http://www.hiit.fi/ada/stepwise>

A subcontract project for Nokia Research Center, Stepwise is aimed at improving users' experiences of context-aware services with the help of statistical inference and simulation. The project started in September 2006.

4.1.13 Spatial and Temporal Data Mining

Project leaders: Salmenkivi, Marko; Gionis, Aristides
Research group(s): Data analysis
Researchers: Leino, Antti; Hyvönen, Saara; Junttila, Esa; Mannila, Heikki
Co-operation units: Research Institute for the Languages of Finland; Division of Atmospheric Sciences (UH); Finnish Museum of Natural History (UH); Department of Geology (UH); Institute of Biotechnology (UH); Department of Finno-Ugrian Studies (UH); Department of Comparative Religion (UH)
Funding: Graduate schools, BRU basic funding
www-page and publications: see <http://www.cs.helsinki.fi/research/fdk/datamining/>

Study of place names, dialects, biodiversity, and climate, for example, results in data sets that have strong spatial and (possibly) temporal components. The research project looks at data mining methods that can be used to find spatial and temporal relationships in high-dimensional data. The project works in very close collaboration with the "Algorithmic and probabilistic methods in data mining" project.

Many application areas in our work are closely related to linguistic variation. We have developed methods for finding spatial co-location rules that are statistically significant (spatial correlation rules) and applied them to a large set of Finnish place name elements to get insight into the history of settlement in Finland. Clustering and dimension reduction techniques (e.g., ICA, PCA) have been applied to a Finnish dialect word data set. Sampling rates in different regions are very uneven, and thus, treating the problem of missing data is essential in the data analysis task. Due to their computational cost, Bayesian methods have traditionally been utilized mainly in confirmatory data analysis. We have employed Bayesian Markov random field models, and Markov chain Monte Carlo methods in preprocessing the data, that is, modelling the missing data. Our experiments show that the methods are efficient enough to be applied to the large dialect word data, and the preprocessing clearly improves the quality of the results of the subsequent data mining approaches.

In close collaboration with the Division of Atmospheric Sciences we have analysed meteorological and micro-meteorological data sets to detect factors influencing the formation of atmospheric aerosol particles. Clustering and classification methods have been used. The applicability of kernel methods to this task has also been under study.

4.1.14 Coordination of the Research Programme on Proactive Computing

<p>Programme leader: Mannila, Heikki Programme coordinator: Lindén, Greger Schedule: 2002-01-01 ... 2006-12-31 Funding: Academy of Finland Research programme: Academy of Finland / Proactive Computing (PROACT) www-page and publications: http://www.aka.fi/proact/</p>

BRU coordinated the Research Programme on Proactive Computing (PROACT) during 2002-2005. The programme was jointly funded by the Academy of Finland, Tekes and the French Ministry of Research and New Technologies. The objective of the coordination was to guarantee that the projects formed a coherent programme by co-operating and benefiting from each other's work. In addition to the coordination, HIIT participated in three PROACT projects, namely Context Recognition by User Situation Data Analysis (CONTEXT), Networking and Architecture for Proactive Systems (NAPS) and Proactive Information Retrieval by Adaptive Models of User's Attention and Interests (PRIMA).

In 2006, the coordinators planned and realised the evaluation of the programme. An international panel consisting of 4 experts on proactive information technology reviewed the whole programme and the projects one by one, interviewed representatives for the researchers in all 14 projects and representatives for the programme steering committee and the coordinators, and wrote an evaluation report. The report was published on 28 February 2007 and is available on the programme's web site.

4.2 Future Internet (FI)

The 1990s were marked by two simultaneous significant trends that changed the role of information and communications technology in the everyday lives of most people living in the developed part of the world: the Internet and mobile telephone. In the coming years these two explosive technologies are expected to merge in the Mobile Internet, fulfilling the vision of ubiquitous computing and communications providing access to digital services any time and anywhere. With this, computing seems to be destined to invade and inhabit, for better or worse, every nook and cranny of our environment and everyday life: home, office, car, school, library, sports facility, shopping mall, etc.

The mission of the Future Internet programme is to enhance Internet infrastructure to enable efficient, secure and trusted always-on connectivity and services. Our vision is that future applications and platforms will be context-aware, adaptive and personalized. In addition, they need to be executable in a reasonable manner, on a variety of execution environments: anywhere, anyhow, anytime, and by anyone. This vision poses immense challenges to computing research. What will the end users use their Mobile Internet devices for? Which new services can be created on the basis of technologies such as positioning, context sensitivity, and adaptive multimodal interaction? What kinds of technical infrastructures and platforms are needed?

In the vast research space in mobile computing and communications, the Future Internet programme focuses on three research themes, outlined below: Security-Trust-Privacy, Mobile Always-on Connectivity, and Scalable Open Service Architectures. Solutions for research challenges in these three themes are sought in distributed algorithms and structures, middleware, and protocols.

The Adaptive Computing Group, led by Adjunct Professor Patrik Floréen and Professor Hannu Toivonen, focuses on the methodology and implementation of systems that adjust to different situations. An adaptive system may change its own behaviour to the goals, tasks, interests, and other features of individual users. It may be context- or situation-aware adaptation to changes in location, time and user activity. Adaptive computing plays an important role in ubiquitous and pervasive computing as well as in intelligent and user-friendly applications. In 2006 the group ran the Trust for All project in the Future Internet programme.

The Distributed Applications group, led by Dr. Kenneth Rimey, studies middleware, network services, and other enabling software infrastructures for new Internet applications, taking the point of view that obtaining meaningful observations of and experience with underlying technologies requires building at least engineering prototypes of applications based on them. Current projects include Services for All and P2P-Fusion, the latter in collaboration with the Digital Content Communities group.

The Mobile Computing Group, led by Professor Kimmo Raatikainen and Adjunct Professor Sasu Tarkoma, investigates different aspects of wireless and mobile communications. The group has a strong focus on mobile middleware and service platforms. In 2006 the group ran Fuego Core and FuegoSphere projects.

The Networking Research Group, led by Adjunct Professor Andrei Gurtov, investigates issues related to the architecture of the future Internet, especially

locator/identifier split and new approaches to establishing trust by overlay networks. In 2006 the group ran projects Location Privacy and Authentication in Massively Distributed Systems Infrastructure for HIP, Multiaccess Experimentations in Real Converging Networks, and Trustworthy Internet.

4.2.1 Fuego Core: Middleware for Mobile Wireless Internet

<p>Project leader: Raatikainen, Kimmo Research group(s): Mobile Computing Researchers: Kangasharju, Jaakko; Sri Kalyanaraman Ramya; Lindholm, Tancred; Lagerspetz, Emil Schedule: 2005-01-01 ... 2007-12-31 Cooperation units: Department of Computer Science (UH); UC Berkeley, USA Funding: Tekes; TeliaSonera Finland; Nokia Research Center Keywords: middleware, mobile internet, data communications www-page and publications: see http://www.hiit.fi/mobic</p>

The Fuego Core 2006 is the second year of the Fuego Core 2005/2007 Project planned to run from 1 January, 2005 to 31 December, 2007. It is the core project of the Fuego Research Program in the Helsinki Institute for Information Technology (HIIT). It continues the work on future mobility middleware started in 2002. The Fuego Core 2007 Project will concentrate on five fundamental areas in future mobile middleware: XML processing and messaging, mobile distributed event system, XML synchronization and data access, software configuration management, and desktop search. Our main objectives are to enhance the achievements of the previous projects and to contribute to international standardization, particularly to W3C (Efficient XML Interchange, Mobile Web Initiative and Device Independence Activity).

4.2.2 FuegoSphere

<p>Project leader: Tarkoma, Sasu Research group(s): Mobile Computing Researchers: Kangasharju, Jaakko; Lindholm, Tancred Schedule: 2006-09-01 ... 2007-03-31 Funding: Nokia Keywords: middleware, XML, Web services</p>

The Fuego Core project at HIIT has investigated mobile middleware and developed XML-based services, namely an event system which efficiently filters events, a binary XML serializer and parser, and XML synchronization software. This project investigates the extension, integration, and reuse of these components.

4.2.3 Services for All (E!2023 ITEA S4ALL)

Project leader: Ken Rimey
Research group(s): Distributed Applications
Researchers: Mäntysaari, Ville; Silander, Tea; Kanerva, Pekka; Piispanen, Tuomas; Hasu, Tero
Schedule: 2005-01-19 ... 2007-09-30
Cooperation units: Alcatel CIT, France; BULL, France; Capricode, Finland; Fraunhofer FOKUS, Germany; INRIA, France; Institut National des Télécommunications, France; mCentric, Spain; Nokia, Finland; Schneider Electric, France; Thales, France; Université Joseph Fourier (LSR - IMAG), France; Universidad Politécnica de Madrid, Spain; University of Kassel, Germany; Vodafone, Germany; Odonata, France
Funding: Tekes
Keywords: Web services, Service-oriented architecture, Middleware, Orchestration, Service creation

The ITEA Services for All (S4ALL) project aims to make possible a world of user-centric services that are easy to create, share and use. HIIT's contribution focuses on prototyping of S4ALL's envisioned *Service Composer for the Mobile End User*, on scripting language technology for rapid service development on mobile phones, and on applications to device management. We are working with the Python programming language on Series 60 phones, as well as on Nokia's Linux-based Internet Tablet.

S4ALL envisions providing end users with an interactive application enabling them to compose useful applications by combining component web services, flexibly identified by semantic type. HIIT is creating a first prototype of this Service Composer for the mobile phone.

We are also developing certain enhancements to the scripting tool set, namely a wrapper generator to facilitate access from scripts to the phone's various native application database APIs, as well as a compatibility library enabling running of many scripts on the desktop for testing purposes.

4.2.4 Dynamic Composition and Sharing of Context-aware Mobile Services - DYNAMOS

Project leader: Raatikainen Kimmo
Research group(s): Mobile Computing
Researchers: Riva Oriana
Schedule: 2004-06-01 - 2006-09-30
Cooperation units: VTT Technical Research Centre of Finland
Funding: Tekes; ICT Turku; Suunto; TeliaSonera Finland; VTT
Keywords: mobile computing, context-awareness, mobile devices
Research programme: Tekes/ Fenix

The main objective of the DYNAMOS project is to develop and evaluate a framework for providing mobile users with relevant services available in their daily surroundings, where relevance has a user-specific definition (e.g., cost, location, accessibility, etc.). In addition, the project investigates issues related to context-awareness, service-profile matching, and trust.

During the years 2004-2005, the DYNAMOS platform was implemented and evaluated in a field trial organized in August 2005. This was held in the archipelago of the Helsinki region during a sailing regatta. 9 sailboaters used the DYNAMOS application and reported their interest in this kind of application. In particular, this experience in the real field of action helped discover technical problems regarding context sensing and context management.

In the year 2006, the HIIT project development has focused on the design and development of Contory, a middleware for the provisioning of context information on smart phones. To make context provisioning flexible and reliable, Contory integrates multiple context provisioning strategies, namely internal sensors-based, external infrastructure-based, and distributed provisioning in ad hoc networks. Applications can request context information provided by Contory using a declarative query language which features on-demand, periodic, and event-based context queries. Contory has been implemented in J2ME CLDC and CDC and tested on Nokia Series 60 and Series 80 phones. Experimental results obtained in a testbed of smart phones demonstrate the feasibility of this approach and quantify the cost of supporting context provisioning in terms of energy consumption.

4.2.5 Infrastructure for HIP – InfraHIP

Project leader: Mäntylä, Martti
Research group(s): Networking
Researchers: Gurtov, Andrei; Komu, Miika; Takkinen, Laura; Korzun, Dmitry; Beltrami, Diego; Abhinav, Pathak; Partanen, Antti; Bagri Abhijit
Schedule: 2004-08-01 ... 2007-03-31
Cooperation units: Laboratory of Telecommunications Software and Multimedia (TKK)
Funding: Tekes, Ericsson, Nokia, Finnish Defence Forces, Elisa
Keywords: Internet, architecture, security, mobility, communication protocols
www-page and publications: see <http://infrahip.hiit.fi/>

The Host Identity Protocol (HIP) and the related architecture form a proposal to change the TCP/IP stack to better support mobility and multi-homing. Additionally, they provide for enhanced security and privacy and advanced network concepts, such as moving networks and mobile ad hoc networks. The InfraHIP project studies application-related aspects of HIP, including APIs, rendezvous service, operating system security, multiple end-points within a single host, process migration, and issues related to enterprise-level solutions. Through this, the project maintains HIIT (and thereby Finland) as one of the leading research centres doing HIP -related work. "Infra" in the project name stands for Infrastructure. As the basic HIP protocol is almost ready, the project focuses on developing the missing infrastructure pieces such as DNS, NAT, and firewall support to enable a widespread deployment of HIP.

4.2.6 Trustworthy Internet: Overlay Infrastructure for Trusted Computing and Communications

Project leader: Mäntylä, Martti
Research group(s): Networking
Researchers: Gurtov, Andrei; Karila, Arto; Koponen, Teemu; Ponomarev, Oleg; Lindqvist, Janne; Varjonen, Samu; Karvonen, Kristiina
Schedule: 2006-01-01 ... 2008-12-31
Cooperation units: Laboratory of Telecommunications Software and Multimedia (TKK)
Funding: Tekes
Keywords: DoS, SPAM, PGP, trust chain, overlay
www-page and publications: see <http://trustinet.hiit.fi>

Trust is the fundamental enabler for information ecosystems where services are consumed and produced. In today's information economy, trust is the necessary foundation for secure interoperability, and central to the successful realization of what is possible on the Web. Unfortunately, the present Internet falls short of this objective in several respects as evidenced by viruses and worms, denial-of-service (DoS) attacks, and junk mail that plague end users. Another set of threats is created by the increasing data collection practices, compromising users' privacy. These problems appear to become even more acute if functionalities such as terminal mobility are introduced in the existing Internet infrastructure.

The Trustworthy Internet (TrustInet) research project will study how the trustworthiness of the Internet can be heightened by adding a slim overlay infrastructure on top of the existing IP networks. The light overlay infrastructure builds a new kind of network layer platform for the services above. Thus, in our vision, our research will enable trustworthy Internet service platforms that connect the service consumers and providers with each other to enable services and service delivery mechanisms. To achieve the vision, the project will carry out original research in cooperation with an extensive international partner network; create prototype technologies, platforms, and solutions; perform experiments; influence the standardization of the field; and contribute to researcher education.

4.2.7 Multiaccess Experimentations in Real Converging Networks – MERCoNe

Project leader: Gurtov, Andrei
Research group(s): Networking
Researchers: Khurri, Andrey; Vorobyeva, Ekaterina
Schedule: 2006-01-01 ... 2007-12-31
Cooperation units: The Laboratory of Computer and Information Science (TKK)
Funding: Tekes, L M Ericsson Oyj, Nethawk Oyj, Nokia Oyj, Secgo Oy, TeliaSonera Finland Oyj, VTT
Keywords: IPv6, measurement, HIP, N770, mobile router
www-page and publications: see <http://www2.cs.hut.fi/~pmrg/index.cgi?id=256>

MERCoNe (Multiaccess Experimentations in Real Converging Networks) solves new issues related to multiaccess in this heterogeneous multi-operator environment: seamless multi-operator and multi-domain mobility. It aims to integrate the capabilities of different networks to an end-to-end, seamless, efficient and secure solution for the user. Multi-domain implies that there are multiple providers of access and network connectivity. Multiple access technologies may be used, where mobility takes place across multiple trust domains. Multiple IP addressing realms may be used across various domains, e.g. IPv6 as well as public and private IPv4 addressing spaces. MERCoNe will also develop support for network mobility that can be multi-homed either with a single mobile router that has multiple attachments to the Internet, or by using multiple mobile routers that attach the mobile network to the fixed network. MERCoNe creates a cross-layer and cross-domain handover triggering architecture that is used for optimizing multiaccess and multi-operator environment management. The architecture provides means to gather cross-layer information, to process the information and to provide it, e.g., for mobility mechanisms, inter-operator roaming, end-to-end signaling, TCP/IP stack protocol optimization, media adaptation and other purposes defined by the project.

4.2.8 NordicHIP

Project leader: Gurtov, Andrei
Research group(s): Networking
Researchers: Yaqub, Kamran
Schedule: 2006-06-01 ... 2010-06-31
Cooperation units: Laboratory of Telecommunications Software and Multimedia (TKK), Computer and Network Architectures Lab, Swedish Institute of Computer Science (SICS)
Funding: Nordunet3
Keywords: Name resolution, IPv6, privacy
www-page and publications: see <http://www.nordforsk.org/meny.cfm?m=182>

The NordicHIP project involves issues in areas of Security and Internet communication services. The public identities provided by HIP are essential to support trust and authentication between hosts. Furthermore, HIP allows for scalable security architectures as the requirement to the support infrastructure are modest; most communication occurs directly between HIP peers. Secure host and network mobility are the main assets built into the basic HIP protocol. On the communication side, HIP offers good possibilities for co-existence of IPv4 and IPv6 networks by supporting handovers between different IP versions. In this project, we will further investigate discovery of v4/v6 gateways and performance issues of cross-version IP mobility. We believe HIP can be a base for future Mobile Internet by addressing security and performance shortcoming found in the earlier proposals for mobility protocols.

4.2.9 Location Privacy and Authentication in Massively Distributed Systems – LPAMDS

Project leader: Gurtov, Andrei
Research group(s): Networking
Researchers: Komu, Miika; Korzun, Dmitry
Schedule: 2006-01-16 ... 2007-12-31
Cooperation units: RWTH Aachen
Funding: Academy of Finland
Keywords: HIP, Internet indirection infrastructure, onion routing
www-page and publications: see <http://ds.informatik.rwth-aachen.de/>

The Internet has rapidly evolved during the last decade. Today, more and more mobile devices are capable of mobile communication and use the internet on the road. Most protocols that are used today have been developed in the 1970s. Therefore, they do not support host mobility, anonymity, host authentication, multicast, anycast and quality of service. There are many reasons why these services are still not available. The most important reason is that many of the Internet core components must be modified or replaced in order to enable these services.

The InfraHIP project team in Finland works on solutions to overcome the limitations of existing Internet Protocol IP. The Host Identity Protocol (HIP) uses public key cryptography to authenticate communication partners and to secure the connection between them. Although HIP does not require core components to be altered, some additional infrastructure is still required. The project InfraHIP uses the i3 technology to create a scalable and reliable infrastructure for HIP.

The research group in RWTH Aachen has already developed a proxy application which enables SAMBA support over i3. Cooperation between both has synergistic effects on both projects. Although HIP enables anonymity on the HIP layer, the data traffic on the network layer can still be monitored and traced back to certain IP addresses. The Project SARA, which was developed in Aachen, enables anonymity on the network layer.

A combination of both techniques offers a vast variety of possible uses. The idea of combining HIP authentication and SARAs anonymity offers the possibility to use anonymous identities. With these identities, it is possible to provide a trusted service without being exposed to third parties like military regimes.

Besides the main project, we lay one of our emphases on the promotion of young scientists. The exchange between Germany and Finland intends to help young scientists to gain experience in working in an international environment. Several PhD students from Finland and two PhD students from Germany will work on this project. Diploma students working on the project could be supervised directly while working abroad.

4.2.10 MobiLife – Mobile Life

Project leader: Mäntylä, Martti
Research group(s): User Experience, Digital Economy
Researchers: Kurvinen, Esko; Salovaara, Antti; Mäntylä, Teemu; Pitkänen, Olli; Ylitalo, Katri; Kontiainen, Mikko;
Schedule: 2004-09-01 ... 2006-12-31
Cooperation units: Nokia Corporation; Alcatel-CIT; Ericsson AB; Oy LM Ericsson Ab; Hewlett-Packard Italiana srl; Motorola Ltd.; Motorola SAS; NEC Europe Ltd.; Siemes Mobile Communications SpA; DoCoMo Communications Laboratories Europe GmbH; Elisa Corporation; Fraunhofer Gesellschaft zur Foerderung der angewandten Forschung e.V.; University of Helsinki; Universität Kassel, Fachgebiet Kommunikationstechnik; The University of Surrey; NEOS Engineering SRL; Stichting Telematica Instituut; UNIS, spol s.r.o.; Suunto Oy; BellStream SP.z.o.o.; Telecom Italia
Funding: European Union
Keywords: application, service, mobile, wireless, user-centricity
Research programme: Information Society Technologies (EU FP6), FP6-2003-IST-2 (IST-511607 MobiLife)
www-page and publications: see <https://www.ist-mobilife.org/>

People are used to being able to contact anyone, anywhere, at any time. However, the challenge of enabling mass-market-scale ubiquitous services and applications remains. The strategic goal of MobiLife is to bring advances in mobile applications and services within the reach of users in their everyday life by innovating and deploying new applications and services based on the evolving capabilities of 3G systems and beyond.

Future environments affected by the ICT convergence give new possibilities, but also new challenges due to increasing heterogeneity, user needs and expectations. The research challenge of MobiLife is to address problematics related to different end-user devices, available networks, interaction modes, applications and services.

MobiLife will have both technological and societal global impact by addressing the technical viability and user-acceptance of solutions that belong to three main Focus Areas:

- Self-awareness provides support for automatic configuration arrangement of devices, services, and local connectivity in the user's local environment. It also enables automatic and multi-modal interfaces that enhance the user experience and minimize the active user effort needed in managing the local environment.
- Group-awareness comprises context and presence support enabling individuals to relate to, share, and interact with each other and common artefacts. Also novel privacy and trust models are addressed, which are mandatory for users to be able to rely on and use these new services and applications.
- World-awareness offers automatic support for seamless access to and delivery of services across different domains that enable individuals to retain the accustomed use of their services, as they move between different environments and infrastructures.

The MobiLife consortium consisted of application owners, manufacturers, operators, solution providers and academia. MobiLife was part of the Wireless World Initiative, which comprises several projects for IST.

ARU was responsible for providing a sound basis for user centricity of the entire project. ARU coordinates user research activities within MobiLife. It has also contributed extensively in the generation, analysis, and validation of the driving scenarios of the project.

During the last months of MobiLife, the project activities focused on organization and reporting of the fourth and final round of user research. The results of the project will be published in a book by Wiley ("The MobiLife Book: Enabling Technologies for Mobile Services", edited by Mika Klemettinen, forthcoming 2007), ARU being the first editor of a chapter presenting evaluation findings, and a key contributor in the introduction section that describes the user -centric research approach adopted by the project. In addition, Olli Pitkänen (ARU) was the editor responsible for Chapter 10, "Legal and Regulatory Framework."

The work of the Mobilife project in the Algorithmic Data Analysis programme is described in section 4.1.9 above.

4.2.11 Trust4All

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Przybiski, Michael; Musto, Topi
Schedule: 2005-10-30 ... 2006-12-31
Co-operation units: Nokia Research Center
Funding: Nokia Research Center
Keywords: Trust, context-awareness; component frameworks; middleware; embedded systems
www - page and publications: <http://www.hiit.fi/fi/trust4all/>

The EUREKA/ITEA project Trust4All studies the concept of trust in software architectures. The focus is on context-aware systems, and especially the trust and safety features of such systems. The research is based on the middleware for embedded systems that was developed in the Robocop project and enhanced in the Space4U project.

In 2006, a model for the secure access requirements of (software) components was developed. This access control mechanism has been implemented and tested and the new approach will be integrated into the Trust4All middleware in 2007. To show the functionality of the new method, a prototype that will be utilising the new middleware has been developed. Trust4All is a EUREKA/ITEA collaboration between several European universities and companies. The research carried out at HIIT/BRU is subcontracted from Nokia Research Center.

4.3 Network Society (NS)

The mission of Network Society programme is human-centric multidisciplinary anticipation and development of ubiquitous information and communication technology, which is based on deep understanding of the needs and practices of our everyday life and our social relations in a network society.

In the next phase of information and communication technology development, information technology is mobile and ubiquitous. It augments human capacities to communicate, both globally and locally. We develop novel tools, platforms and services for these mobile and ubiquitous services. Special focus areas are mobile cognition, emotional adaptation of media, and group activity. Field trials in real settings enable us to investigate thoroughly the implications and value of technological interventions.

Information technology is also fundamentally social technology. In a network society, it can reinforce existing physical communities and help build entirely new connections. People and their social networks strongly influence the services and the information mediated by new technologies. New technologies will also shape and alter our means and habits of social interaction. Based on collected datasets on computer-mediated social activities, we, in collaboration with other HIIT research programmes, develop tools and methods to model such dynamic social networks. We seek to combine these with novel methods for community- and group-centric product and service design.

The network society is open for user innovations. As information technology penetrates all realms of society – business, government, communities, and individuals – it is reconstructed by people to fit with their needs and priorities. We build technical platforms and tools that support open media creation, management and distribution, foster new types of computer-mediated collaboration and learning, and help the development of related business activities.

To develop successful new technologies, and bear the responsibility for design decisions, we as developers should understand and anticipate the dynamics of technology-society interaction. What are the sustainable development models for a network society, how is socio-economic behaviour changing due to new forms of computer-mediated interaction, and what are the open legal issues related to these development paths? This requires multi-disciplinary end-to-end research from technological solutions to their impact on our physical environment and human-human interactions.

4.3.1 Mobile Content Communities (MC2)

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities, User Experience
Researchers: Hietanen, Herkko; Herrera, Fernando; Kuikkaniemi, Kai; Rantanen, Matti; Saari, Timo; Salovaara, Antti; Sarvas, Risto; Vuorenmaa, Janne; Lehdonvirta, Vili; Koponen, Jarno; Järvinen, Atte
Schedule: 2003-06-01 ... 2006-05-31
Cooperation units: TKK / Software Business and Engineering Institute; Helsinki School of Economics / CKIR; University of Tampere / HyperMediaLab; UC Berkeley, USA
Funding: Tekes; Alma Media; TeliaSonera Finland; Veikkaus; Nokia; Starcut; Sulake; Accenture; Futurice; Digital Chocolate
Keywords: Mobility, community, digital media content, social user experience
Research programme: Tekes / FENIX
www-page and publications: see <http://pong.hiit.fi/>

The Mobile Content Communities (MC2) project has studied the role of mobile social media, especially in the domains of gaming and photography. During the project's timeframe (2003-06) the core themes of MC2 increased significantly in academic and commercial relevance and overall societal visibility.

We conducted practice-oriented, multi-disciplinary, and international research with both operational and contextual dimensions. The contextual components consisted of gaining deep understanding of digital communities through modelling and reflecting on the social gaming and photo -sharing community activity, as well as understanding the individual and social experience related to playing games, and creating and using mobile media. The operational components were building and nurturing communities interested in making content for and with mobile devices, and developing products, tools and processes that support people in their collaborative activities regarding mobile media. These communities were studied from the points of view of the users (community members), as well as reflecting the interests of different commercial actors (device manufacturers, media companies, operators, enabling software houses, and game developers).

The results of the project include evaluated and tested scenarios of mobile community gaming, new tools and services for mobile social media, new open source tools to empower the community activity, company-specific case studies to help the industry partners to benefit from community-created content, and academia/industry networks for future collaboration. The project result highlights include:

- 50 academic papers published
- four product concepts implemented (Mobshare, Comic Story Creator, Mupeland Yard, Prediction League)
- two start-up companies (Bulbon, Pixelgene)
- two commercial products: Mobshare became PhotosToFriends or Kuvaboxi by Futurice, and Comic Story Creator was commercialized as Comeks by Bulbon
- MC2 game experience findings were ranked as one of the most relevant game research result of recent years at the Game Developer Conference 2006 in San Jose
- international network of virtual economy researchers (VERN, *virtual-economy.org*) started and hosted by HIIT

- international and domestic visibility in game -industry-related events, such as Game Developer Conference talk and panel in 2005
- advancement of the use of Creative Commons licenses, especially in the context of games and photos
- five continuation projects at HIIT directly related to MC2 themes (COMSOA, MoMUPE, DChoc, Immortalidad, FUGA)

4.3.2 Community Media and Service-Oriented Architecture (COMSOA)

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities, User Experience
Researchers: Rantanen, Matti; Reti, Tommo; Lehdonvirta, Vili; Herrera, Fernando; Hietanen, Herkko; Johnson, Mikael; Kurvinen, Esko; Huotari, Kai; Savolainen, Petri; Järvinen, Miika
Schedule: 2005-10-01 ... 2007-12-31
Cooperation units: UC Berkeley, MIT Media Lab, Waseda University
Funding: Tekes
Keywords: Social networks, community-centric design, service-oriented computing
www-page and publications: See <http://pong.hiit.fi/>

In COMSOA we focus on basic phenomena of community media, i.e., systems that enable and support social creativity, participatory media, and distributed problem solving. This work is grounded on a properly instrumented platform that facilitates the rapid creation of community services and experimentation with them. This basis is offered by service-oriented computing (SOC), a new emerging cross-disciplinary paradigm that has risen to offer solutions to various challenges in large-scale distributed computing. The service-oriented system architecture (SOA) changes the way software applications are designed, delivered, and consumed. Services are autonomous, platform-independent computational elements that can be described, published, and discovered using standard protocols and service metadata. They can be used to build networks of collaborating applications distributed within and across organizational boundaries, or closer to consumers. SOA offers high availability and bandwidth through many users' wideband connections, and good scalability with no central servers as bottlenecks and one point of failure.

The COMSOA project studies the paradigm shift of service-oriented computing from a community-centric viewpoint. This is in contrast with the main body of research on service-oriented architectures, which mostly concentrates on potential benefits that can be achieved in technical adaptivity and replicability, business service flexibility, service life cycle management, and service discovery. This viewpoint typically pays little attention to the social behaviour of individuals and informal ad-hoc communities that are offering, subscribing and using the services on these new platforms. The term "peer-to-peer" has come to be applied to networks that expect end users to contribute their own files, computing time, or other resources to some shared project. Even more interesting than the systems' technical underpinnings are their socially disruptive potential: how in various ways they return content, choice, and control to other users.

We argue that dynamic social network analysis (SNA) and probabilistic community modelling coupled with systematic design methods, such as user-centric product concept design (UCPCD), are necessary building blocks of novel community-centric methodologies to design the architecture of future community services. This requires multi-disciplinary end-to-end research from technological platforms to various viewpoints on their implications in actual use in real world users and communities.

COMSOA research will consist of (1) in-depth case studies of selected community media services, (2) development of new methods and tools for dynamic community analysis and modeling, (3) demonstration of the benefits of service-oriented computing by building extensions to service platforms being developed at HIIT, most notably to Digital Content Distribution Management System DiMaS, and (4) development of novel community-centric methodology for product and service concept design.

4.3.3 Rich Semantic Media for Personal and Professional Users (RISE)

Project leader: Turpeinen Marko
Research group(s): Digital Content Communities
Researchers: Reti, Tommo; Sarvas, Risto; Hietanen, Herkko; Seppälä, Lassi
Schedule: 2004-08-01 ... 2006-08-01
Cooperation units: Technical Research Centre of Finland (VTT), Information Technology
Funding: Tekes; Alma Media; SanomaWSOY; VTT; YLE
Keywords: semantic metadata, media content template, licensing
Research programme: Tekes / FENIX
www-page and publications: see <http://www.vtt.fi/proj/rise/>, <http://pong.hiit.fi/>

The project studies the possibilities in using rich semantic descriptions to combine professional-quality media content with user-created media content. The project also developed tools and process models to support private and professional content creators as well as publishers in producing and utilising rich semantic content through the whole content lifecycle. The results of the project help the professional actors to position themselves and their products in the semantic content markets of the future.

In particular, the project studies media captured with mobile devices, semi-automatic template-based methods to compose media content and in creating new metadata for media, as well as different technical options for implementation. The project also studies the legal issues related to combining personal and professional media content.

In the RISE project, we have extended the Distribution Management System (DiMaS) architecture for media distribution that bundles media content with rich semantic metadata. Especially, we studied the bundling of license and digital rights management information with media content for the purpose of peer-to-peer media delivery.

Lastly, as a demonstration application, we implemented a web-based system called *Remix Engine* that allows users to easily create video material that combines video material from existing media archives with users' own media content.

4.3.4 Network of Mobile Context-Aware Applications and Games (MoMUPE)

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities
Researchers: Vuorenmaa, Janne; Kuikkaniemi, Kai; Seppälä, Lassi
Schedule: 2005-09-01 ... 2007-12-31
Cooperation units: Nokia Research Centre, Tampere University of Technology, Lappeenranta University of Technology, Technical Research Centre of Finland (VTT)
Funding: Nokia
Keywords: mobile media, multi-user applications, context-aware systems
Research programme: Tekes / Fenix
www-page and publications: see <http://www.mupe.net/>

Mobile phones are advanced communication devices and they can be used to create context-aware applications. Although context-awareness has been a hot research topic for a long time, no widely used applications exist yet. This project aims to create context-aware multi-user applications that can be run on any mobile phone. The applications are developed with the Multi-User Publishing Environment (MUPE), which is an open source application platform developed in NRC. It has been used successfully in many NRC and university projects - including the Mobile Content Communities project at HIIT - and this project continues this work. The platform enables rapid development of mobile multi-user context-aware applications and games, and it allows the new technologies in mobile phones to be easily used. MUPE already has an active developer community, and this project aims to research new and emerging technologies.

4.3.5 Technology platform for community driven mobile games and operator collaboration (DChoc)

Project leader: Turpeinen Marko
Research group(s): Digital Content Communities
Researchers: Kuikkaniemi, Kai; Rantanen, Matti; Lehdonvirta, Vili
Schedule: 2006-11-01 ... 2007-12-31
Funding: Digital Chocolate
Keywords: Mobile, Communities, Mobile operators, Mobile games

Digital Chocolate is a developer of games and applications for mobile phones located in San Mateo, CA, USA and Helsinki. The project develops a commercial mobile community platform for multi-player games and other social services. The role of HIIT is to aid in the development and evaluation of the platform, and in community modeling based on usage data.

4.3.6 P2P-Fusion

Project leader: Rimey, Kenneth
Research group(s): Digital Content Communities, Distributed Applications
Researchers: Reti, Tommo; Hietanen, Herkko; Huotari, Kai; Järvinen, Miika; Savolainen, Petri; Ruottu, Toni
Schedule: 2006-06-01 ... 2009-05-31
Cooperation units: University of Art and Design Helsinki, Finland; Delft University of Technology, Netherlands; Budapest University of Technology and Economics, Hungary; KnowledgeLand, Netherlands; Netherlands Institute for Sound and Vision, Netherlands; National Audiovisual Archive, Hungary
Funding: European Union
Keywords: Peer-to-peer systems, audiovisual media, reuse, licensing, social networking
Research program: FP6 IST
Web page: <http://www.p2p-fusion.org/>

The P2P-FUSION project is developing a new software system, Fusion, to make it easy for people to create, reuse, and share audio and video productions over the Internet legally and without costly servers or complex system management.

Fusion binds together a peer-to-peer network, a distributed metadata store, social enrichment features, audiovisual production and editing software, support for embedded licenses, and a social media application toolkit into an integrated, easy-to-use solution.

4.3.7 Immortalidad: Future Social Use of Photographs

Project leader: Sarvas, Risto
Research group(s): Digital Content Communities (DCC)
Researchers: Näsänen, Jaana; Vihavainen, Sami; Turpeinen, Marko, Lehmuskallio, Asko
Schedule: 2005-08-15 ... 2007-02-15
Cooperation units: Futurice Oy; Yliopistopaino Oy; University of California, Berkeley, USA
Funding: Keskuslaboratorio KCL
Keywords: photography, digital media, communities, social software
www-page and publications: see <http://pong.hiit.fi/dcc/>

The Immortalidad project studied future social uses of personal media. Grounding the work on literature and empirical data on domestic photography capture and sharing, the project designed future concepts that blurred the boundaries between personally, socially, and professionally created media. Also, the concepts took into account the perceptions and characteristics people assign to digital and paper as format for media. A photo book concept was implemented with project partners. The project took 18 months and 7.5 person years in total.

4.3.8 Creating meanings and user experiences with user-created metadata – Täky

Project leader: Sarvas, Risto
Research group(s): Digital Content Communities (DCC)
Researchers: Vihavainen, Sami; Seppälä, Lassi; Tiitta, Sauli; Kurvinen, Esko; Turpeinen, Marko
Schedule: 2006-11-01 ... 2008-03-31
Cooperation units: VTT, Nokia, SanomaWSOY, Aina Group, Profium, Yahoo! Research Berkeley, USA
Funding: Tekes
Keywords: tagging, tags, mobile applications

User-created free keywords, tags, have become an important tool in communicating, organizing, and searching user-generated content in the Internet. The new phenomenon in tagging with free keywords is that it is actively done as part of social networking and also outside any professional or organizational context. One major question in designing systems that leverage tags is the users' motivation to do the tagging. Why would the user tag the content? The tagging must have a benefit for the user, and often the benefit has to be immediate. To solve the issue of motivating the user the tagging interaction has to be designed to bring clear and understandable benefits to the user relatively quickly. A consequence of this is that the mechanisms for motivating the user affect the tags themselves. In this project we will test this hypothesis by testing three tag-related applications with three user groups.

4.3.9 Pamphlet – Hybrid media products and services for communities

Project leader: Sarvas, Risto
Research group(s): Digital Content Communities (DCC)
Researchers: Johnson, Mikael; Lehmuskallio, Asko
Schedule: 2006-04-01 ... 2007-04-30
Cooperation units: Myllykosken Pallo, Dynamoid Oy, Kuluttajatutkimuskeskus
Funding: Keskuslaboratoria KCL, Futurice Oy, Tekniska Föreningen i Finland (TFiF)
Keywords: hybrid media, video photography, communities, community media, paper media

Pamphlet studies digital media communities and designs hybrid media product concepts for those communities. One of the objectives of the designed concepts is that the community members themselves can customize or otherwise affect the product. The project gains more understanding on the role of paper-based products in digital media communities and in methodologies for designing paper/digital hybrid services. The project started in April 2006 and ends in October 2007. It is a co-operation project with KCL, Dynamoid, Futurice, TFIF, Myllykosken Pallo, TKK, and the National Consumer Research Center.

4.3.10 Managing Privacy and Trust in P2P Communication (Muppet)

Project leader: Mäntylä, Martti
Research group(s): Digital economy
Researchers: Kortnesniemi, Yki; Heikkilä, Juho; Ylitalo, Katri; Stenborg, Markku; Päivärinta, Juha; Kanerva, Pekka; Reti, Tommo; Rantanen, Matti; Sääksvuori, Lauri
Schedule: 2004-01-01 ... 2006-12-31
Cooperation units: Laboratory for Theoretical Computer Science (TKK); University of California at Berkeley, USA
Funding: Tekes; Ericsson; Nokia; Yleisradio
Keywords: trust, privacy, P2P, mobile
www-page and publications: see <http://www.hiit.fi/muppet/>

Peer-to-Peer technologies can offer radically new possibilities for communication, be it broadcast, group or person-to-person communication. At the same time, the distributed nature of this technology presents us with many trust and privacy challenges especially in the mobile environment.

In 2004 we looked at game-theory-based incentives of trustworthy behaviour, collected an extensive state-of-the-art report on existing reputation mechanisms, synthesized an initial reputation management engine that can work in a peer-to-peer fashion, and built a simple demonstration for Nokia Series 60 phones based on the findings. The demonstration focused on a simple e-market application.

In 2005 the work continued by extending the research into the mechanism of multiple contexts and beginning to work with real P2P technology. To accomplish this, the project started cooperation with DiMaS as well as Dr Johan Pouwelse from TUDelft. It published papers of the reputation mechanism and privacy evaluations of distributed reputation.

During 2006 the project built a demonstration system of a reputation engine integrated with the CoMedia messaging platform running on Nokia Series 60 mobile phones. In the demonstration, all media activities of CoMedia were interpreted as reputation-building events and used as input to a reputation engine implemented on the mobile platform. Visualisation of the reputation information was integrated into the CoMedia display. In addition, the project also studied empirically the impact of reputation information to user behaviour in auctions using methods of experimental economy.

The project was ended on 31.12.2006.

4.3.11 Wireless Woodstock Services in Finland

<p>Project leader: Martti Mäntylä Research group(s): Ubiquitous Interaction, Digital Economy, Digital Content Communities Project Manager: Jacucci, Giulio; Researchers: Jacucci, Giulio; Pitkänen, Olli; Salovaara, Antti; Kanerva, Pekka; Evans, John Schedule: 2004-05-01 ... 2006-11-30 Cooperation units: TeliaSonera Finland and international Celtic consortium including Ericsson AB (Sweden), Blekinge Inst. of Technology (Sweden), Musiclink AB (Sweden), Migoli (Sweden), Stockholm School of Economics (Sweden), TeliaSonera Sweden (Sweden), WIT-Software (Portugal), University of Coimbra (Portugal) and Light Minds (UK). Funding: Tekes Keywords: mobile solutions, large-scale events, user experience, pricing models, legal issues Research programme: Eureka/CELTIC</p>
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Wireless Woodstock Services in Finland is the Finnish part of the multinational CELTIC project Wireless Festival. It is managed, carried out and funded separately in Finland, but is implemented in close co-operation with participants in Sweden. The two-and-a-half year project studies, prototypes and evaluates mobile solutions for large-scale events, such as music festivals and sports events.

Based on the findings of a study at the Hultsfred Rock festival (S) and at the Neste Rally (Fin), we developed two prototype services: the Dynamic Booklet a mobile digital program of the event, and mGroup a mobile group media application for chatting and creating shared media albums. The application – mGroup – is a mobile media-sharing application for groups of spectators and visitors. Currently, the generally available solutions enable sharing of media and dialogue between two users by using SMS and MMS messages. These messages have to be sent individually to each member of the group, and chatting with the whole group is not possible. Possibilities to add instant media and near-field communications are being studied.

In the third quarter (July – September 2005) the project focussed on trials, the prototype applications has been the object of trials in events in Sweden, Germany and Finland with the cooperation of TeliaSonera. The project has been accepted in the Celtic review meeting in Stockholm the 11/10/2005.

During 2006, HIIT contributed to the project on two efforts: user research and business research. The tasks planned for 2006 were to finalise the design and implementation, and integrate trials and analysis results to final conclusions. Another task was to find out business possibilities in an event environment. HIIT contributed to these tasks successfully. HIIT developed a new group messaging prototype – CoMedia – and evaluated it in two large-scale events: Neste Oil Rally in Finland and c/o Pop electronic music festival in Germany. CoMedia provides advanced features to mobile users, such as real-time information about the other users situations. To integrate the findings with project-wide activities, CoMedia also included a component called Dynamic Booklet – an event programme that was accessible from the mobile phone and which could be used together with the group communication

feature. A similar component was developed by Swedish partners, and this enabled integration of findings.

4.3.12 IPCity Integrated Project on Interaction and Presence in Urban Environments

Project leader: Jacucci, Giulio
Research group(s): Ubiquitous Interaction
Researchers: Jacucci, Giulio; Evans, John; Ilmonen, Tommi; Oulasvista, Antti
Schedule: 2006-01-01 ... 2009-12-31
Cooperation units: Fraunhofer FIT, Sony Netservices SNS, Aalborg University, Vienna University of Technology, Graz University of Technology, University of Oulu, University of Applied Arts Vienna, Université Marne la Vallée, Helsinki University of Technology
Funding: European Union
Keywords: Presence and interaction in mixed reality environments
Research programme: EU 6th Framework Research Programme IST
www-page and publications: See <http://www.ipcity.eu/>

The research aim of the IPCity project is to investigate analytical and technological approaches to presence in real life settings. Analytically, this includes extending the approaches to presence accounting for the participative and social constitution of presence, the multiplicity and distribution of events in time and space. Technologically, this translates into developing portable environments for on-site configuration, mobile and light-weight mixed reality interfaces with the ambition to weave them into "the fabric of everyday life". Methodologically, this calls for moving "out of the lab" with field trials in real settings, applying a triangulation of disciplines and methods for evaluation. These range from interpretative-ethnographic to quasi-experimental approaches and include cognitive science, social-psychological, and cultural-anthropological disciplines.

The vision of the IPCity project is to provide citizens, visitors, as well as professionals involved in city development or the organisation of events with a set of technologies that enable them to collaboratively envision, debate emerging developments, experience past and future views or happenings of their local urban environment, discovering new aspects of their city. This includes:

- Extending analytical frameworks for presence, including the participative constitution of presence, the role of (shared) memory and mutual understanding, temporal fluctuations and interruptions (design for non-disruptiveness).
- Developing an environment for MR interaction prototyping and a platform and toolkit for cross-reality content authoring.
- A range of building blocks and components ranging from mobile and lightweight mixed reality for situated participation to semi-stationary outdoor mixed reality environments that exploit the features of the surrounding physical environment. The showcases include urban renewal projects, large-scale events, and explorative edutainment and storytelling applications.

4.3.13 CALLAS– Conveying Affectiveness in Leading–edge Living Adaptive Systems

Project leader: Giulio Jacucci
Research group(s): Ubiquitous Interaction
Researchers: Jacucci, Giulio; Evans, John; Ilmonen, Tommi; Kurvinen, Esko; Salovaara, Antti
Schedule: 2006-11-01 ... 2010-04-30
Cooperation units: VTT Electronics, BBC, Metaware, Studio Azzurro, XIM, Digital Video, Humanware, Nexture, University of Augsburg, ICCS/NTUA, University of Mons, University of Teeside, Helsinki University of Technology, Paris 8, Scuola Normale, Superiore di Pisa, University of Reading, Fondazione Teatro Massimo, HITLaboratory New Zealand
Funding: European Union
Keywords: multimodality, emotions, affective interfaces, art and entertainment, interactive drama
Research programme: EU 6th Framework Research Programme IST
www-page and publications: See <http://www.callas-newmedia.eu/>

Multimodal Interfaces aim at achieving the highest level of naturalness in Human-Computer Interaction. A major trend for Multimodal Interfaces research activities in recent years has been the investigation and the development of affective interfaces, which are able to analyse and render emotions as part of interactive systems. These have been developed as an extension of Multimodal interfaces, in particular agent-based interfaces in which the user engages in "social" communication with characters. As a consequence, early affective interfaces have mostly involved those simple emotional models which are able solely to detect and/or to animate the six basic emotion categories (cf. Ekman's categories).

With the development of New Media, in particular in the area of Art and Entertainment, there is a need and opportunity to go beyond these basic emotion models, developing affective interfaces which are able to handle a larger variety of emotions, to include individual variation in emotion recognition and generation, as well as to manage in a coherent way the time and the situation (i.e. the context). Digital Art and Entertainment systems aim at generating affective responses: this is why their development will greatly benefit from technology that could make this process more explicit, as well as based on appropriate formalisms and technologies embedding them.

CALLAS will investigate key aspects of Multimodal Affective Interfaces in the specific area of Art and Entertainment applications. As an integrated project CALLAS will address the following high-level objectives:

- 1) To advance the state-of-the-art in Multimodal Affective Interfaces by i) developing new emotional models that will be able to take into account a comprehensive user experience in Digital Arts and Entertainment applications and ii) new modality-processing techniques to capture (and elicit) these new emotional categories
- 2) To research, develop, and integrate advanced software components, tailored to the processing of individual modalities supporting the semantic recognition of emotions, making them available through a "living" repository, called the CALLAS "shelf"
- 3) To develop a software methodology for the development and the engineering of Multimodal Interfaces that will make their development accessible to a larger

community, i.e. the assembly of a Multimodal interface from individual components will no more require a deep understanding of theories of Multimodality.

The effectiveness of the CALLAS approach in pursuing the aforementioned objectives will be validated by developing significant research prototypes (or Showcases) in three major fields of Digital Arts and Entertainment:

- Augmented Reality for Art, Entertainment, and Digital Theatre
- Interactive Installations for Public Spaces
- Next-Generation Interactive Television

CALLAS also aims to ensure the sustainability and the replicability of the technology results. This will be addressed mainly by supporting Technology Transfer, in particular towards SMEs operating in the new media sector, whether these SMEs are involved in Digital Arts and Entertainment or are innovative technology spin-offs.

4.3.14 The Fun of Gaming: Measuring the Human Experience of Media Enjoyment

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities
Researchers: Huotari, Kai; Kontiainen, Mikko; Kosunen, Ilkka; Kuikkaniemi, Kai; Saari, Timo
Schedule: 2006-05-01 ... 2009-04-30
Cooperation units: Helsingin kauppakorkeakoulu, Högskolan på Gotland, Ruotsi, Hanover University of Music and Drama, Saksa, University of Technology (RWTH) Aachen for the Faculty of Medicine represented by University Hospital Aachen, Saksa
Funding: European Union
Keywords: Digital games, User experience, Measurements
Research programme: FP6 NEST
www-page and publications: see <http://www.hse.fi/fuga>

The main objective of FUGA is to create novel methods and improve existing measures in order to examine how the different dimensions of Computer Game Experience can be assessed comprehensively with high temporal resolution. FUGA will employ a broad variety of innovative techniques based on (a) laboratory and mobile psychophysiological recordings (i.e., facial EMG, EEG, ECG, EDA, and respiration), (b) functional magnetic resonance imaging (fMRI), (c) eye movement recordings, (d) the so-called (online) implicit association test, and (e) tracking of behavioural indicators of emotion and motivation. An important objective of FUGA is to establish the construct validity, reliability, and predictive validity of the different Game Experience measures. A further objective is to develop a prototype of an emotionally adaptive game. The innovative measurement approach provided by FUGA can be applied when designing new digital games for different purposes (e.g., entertainment, education, therapy). In addition to its scientific impact, FUGA would be expected to contribute to the rise of the European computer games industry.

4.3.15 Context Cues: Context data derived situation cues to support meaningful interactions

Project leader: Oulasvirta, Antti
Research group(s): User Experience
Researchers: Oulasvirta, Antti; Salovaara, Antti; Yanev, Kliment; Tiitta, Sauli
Schedule: 2006-01-01 ... 2009-12-31
Cooperation units: Department of Computer Science, University of Helsinki, Massachusetts Institute of Technology (MIT), USA, Nokia Research Center
Funding: Academy of Finland
Keywords: Awareness information, human-computer interaction, user psychology, social cognition, field research
www-page and publications: <http://www.hiit.fi/u/oulasvir>

Awareness applications communicate, automatically or in a usercontrolled manner, cues of other people's or users' state or situation. A wide variety of novel awareness applications will soon be enabled by modern ubiquitous sensor technologies, the envisioned domains ranging from communications to e-health and sports. Their key conceptual elements, situation cues, are automatically inferred attributes that describe users' state or situation to a remote user, e.g., one's location, work mode, activity, or interruptability.

The project makes a new trans-disciplinary crossover, namely, we introduce the social psychological approach to the computer inference and design of situation cues in ubiquitous computing environments.

First, from the social psychological perspective, we ask which situation cues and how can they be used to make meaningful inferences of others, and what are the conditions for these inferences to provide a basis for socially meaningful, transparent and accountable action that preserves privacy? A model of the processes in situation cue inference proposed here provides a theoretical framework to build on in the empirical part of the project. The usefulness of results to many application areas will be ensured by combining theoretically grounded, application-independent social psychological laboratory experiments with exploratory, application-specific experiments on the field.

Second, from the point of view of data mining, we ask what cues can be reliably inferred from real sensor data? This will be tackled by constructing data mining models of situation data and combining them with and evaluating against laboratory experiments on human inferences of those cues. The results will have impact on the design of future awareness applications, particularly because they answer such questions as what situation cues are needed and how to infer, model, select, and represent them, as well as how to support user-control over them.

4.3.16 PASION: Psychologically Augmented Social Interaction Over Networks

Project leader: Antti Oulasvirta
Research group(s): User Experience
Researchers: Oulasvirta, Antti; Nyysönen, Tuomo; Saari, Timo; Tiitta, Sauli
Schedule: 2006-01-01 ... 2009-12-31
Cooperation units: Helsinki School of Economics
Funding: European Union
Keywords: Emotions, knowledge work, information networks, social interaction, mobile devices, awareness systems
Research programme: FP6-2004-IST-4

Ever more frequently, social and particularly group interactions involve mediated communication. Yet we know very little about the factors determining the effectiveness of the interaction. How do participants in mediated communication substitute the implicit and non-verbal signals, which play such an important role in traditional, face-to-face communication? What are the equivalent signals in a mediated environment? The mechanisms involved in traditional communication are well-known. By contrast, very little is known about the forms of mediated communication. For instance, we do not know the role of implicit and non-verbal communication when the communication takes place in a mediated environment. PASION's working hypothesis is that in mediated environments these messages will take completely new forms and that these forms are due to group interactions in technology-mediated environments.

As current communication technologies are ineffective in conveying the social, non-verbal and contextual information required for effective communication, PASION will deliver an innovative shared virtual environment where a pioneering mediated social communication will take place. During trials PASION will be used by a "large community of mobile users" providing strategic support to the activity of the group (adapted to the needs of specific applications in collaborative work and social gaming) by implementing "specific feedback strategies" based on the interpretation of the state and dynamics of social communication within the group.

In the four years of the project, PASION will investigate the basic scientific and technological issues which need to be resolved to achieve this goal. Basic research will investigate the socio-psychological foundations of mediated social interaction. Wizard-of-Oz prototypes will be used to elicit user input on basic concepts. Ergonomic studies will investigate critical issues of usability and user acceptability. Using this input, the project will design and develop new techniques to capture information relevant to social communication, and new ways of representing this information to users within the SVE. Two trials (one for each specific application collaborative work, and social gaming) will investigate the effectiveness the concepts and technologies incorporated in the environment. A special effort will be dedicated to the investigation of the complicated ethical issues raised by this work, and to plans for business development

4.3.17 DRAMA – Scenario Methods for User Centered Product Concept Design

Project leader: Mäntylä, Martti
Research group(s): User Experience
Researchers: Tiitta, Sauli; Kankainen, Tomi; Kantola, Vesa; Mehto, Kati; Sädekallio, Outi; Pennanen, Merja
Schedule: 2004-01-01 ... 2007-12-31
Cooperation units: Helsinki Polytechnic Stadia; University of Art and Design Helsinki
Funding: Academy of Finland
Keywords: User-centric product concept design, Devised theatre, Forum theatre, Narrative theatre, Scenario-based design
Research programme: Academy of Finland/Industrial Design Programme
www-page and publications: see <http://www.hiit.fi/fuego/drama/>

DRAMA - Scenario Methods for User-Centered Product Concept Design (UCPCD) is a multidisciplinary research project, in which UCPCD's scenario-based working methodology and process are reinforced with methods of devised theatre. The ultimate goal is to make the human voice loud and clear in the new product development to create humane products. This is achieved by improving current working methods, tools, and processes.

In DRAMA we study possibilities to use devised theatre methods with UCPCD to create a new, rich and more profound approach to user centricity and to create dramatic scenarios, a new form of scenarios. In DRAMA this is done by comparing several devised theatre and UCPCD methods and defining the relevant application areas for each one.

The following methodological areas of UCPCD will be studied. 1. User research: user research methods, collecting user narratives and other dramatic compositions, and notation of user narratives. 2. Analysis of user data: methods for analyzing user narratives and interpreting user needs. 3. Product or service concept design: techniques for utilizing user narratives as a basis for design, writing the manuscript for a scenario on the basis of user narratives, the form and output of scenarios. 4. Concept evaluation: evaluation of concepts with users using devised theatre and dramatic scenarios.

The project was launched on January 1, 2004. As the first step, we defined the research contexts and user groups together with the National Consumer Research Centre. Taking a wide view of relevant societal issues, we decided to focus holistically on professional people of the age 55±5 years, a period of life where people often begin to be concerned with the nearing retirement age.

During the rest of 2004 the project performed two rounds of experimental drama production (narrative theatre and forum theatre) aimed at specific user groups (nurses' teachers; church workers; policemen) and also studied the same groups with traditional methods of user research. Through this, we have collected an extensive set of qualitative user data that allows us to compare qualitatively the data obtainable by these two parallel methods. During 2005 and 2006, these data have been carefully analysed and various methods of dramatic scenario generation explored.

4.3.18 Open innovation

Project leader: Martikainen, Petri
Research group(s):
Researchers:
Schedule: 2006-11-10 ... 2007-02-28
Cooperation units: Forum Virium Helsinki
Funding: Helsingin kaupunki, talous- ja suunnittelukeskus, Elinkeinopalvelu
Keywords: open innovation

The project prepared a study examining current Finnish situation concerning open innovation and making suggestions for future development. A report in Finnish was the main deliverable of the work.

4.3.19 Towards Ubiquitous Network Society

Project leader: Mäntylä, Martti
Research group(s):
Researchers: Martikainen, Petri; Kemppinen, Jukka; Pitkänen, Olli; Salovaara, Antti; Sarkio, Katri; Sarvas, Risto; Virtanen, Perttu; Oulasvirta, Antti; Kurvinen, Esko; Kontiainen, Mikko; Karila, Arto
Schedule: 2006-06-01 ... 2006-09-15
Cooperation units:
Funding: Ministry of Transport and Communications Finland
Keywords: Ubiquitous, Ubicom, ubitechnology, ubimedia

The Ubiquitous Network Society is an umbrella term for the next generation of information and communications technology, in which formerly separate developments will meet and join forces. The effects will be wide-reaching. Information technology will intrude into every location and situation; all kinds of content will be created, distributed, and consumed digitally; and all kinds of objects, goods, and even places will be integrated into the network with the help of ubiquitous electronic sensors.

By virtue of its unique features, the ubiquitous network society and its technology, ubitechnology, will open up enormous opportunities in all areas of life. Ubitechnology is *local*: spaces, objects, and situations will be enriched by ubiquitous short-range wireless networking, by location information, and by context awareness. It is *social*: the actions and context of the user and his social network will shape the available services and the information they deliver. It is *open*: it leaves room for the innovations and insights of each user.

These opportunities will not come to fruition by themselves. The report created in the project describes the most significant challenges the ubiworld sets for users, for developers of products and services, and for the regulatory authorities and government. The response to these challenges must be driven by people and their needs, not technology: a future may be technically feasible but nevertheless incompatible with everyday life, its customs, or its social structures.

4.3.20 Global network society (GNS)

<p>Project leader: Himanen, Pekka Research group(s): Digital Economy Researchers: Schedule: 2005-08-01 ... 2010-07-31 Cooperation units: Oxford University Funding: The Centenary Fund of the Technology Industries of Finland Keywords: Network society index Research programme: Network Society</p>
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The aim of this research line is to analyse at macroscopic societal level the logic and global challenges of the network society. The baseline of the work is given by the studies of Professor Pekka Himanen with Professor Manuel Castells, who have previously analyzed comparatively the Finnish/European, the Silicon Valley/USA, and Singapore/Chinese network society models. An interim goal of the work is to develop an integrated set of indicators, the *Global Future Index*, for describing the relations of network society development to innovation systems and social context. Outcomes of the work include a draft version of the index that has been presented to the World Economic Forum. Other planned outcomes include a monograph to be published in 2007.

4.4 Probabilistic Adaptive Systems (PAS)

Computer science is the science of studying how things can be automated. When automating intelligent behaviour, modelling plays a central role as an attempt to formalize the properties of processes characterizing learning, inference and intervention (actions). Due to the uncertainty and incompleteness of available information in application domains of computer science - the artificial intelligence and machine learning domains in particular - such models are commonly based on probabilities.

The aim of our research is fundamental understanding and development of computationally efficient probabilistic and information-theoretic modelling techniques, and their multi-disciplinary applications from engineering to sciences.

The work has a strong basic research component, being at the intersection of computer science, information theory and mathematical statistics. The results of this methodological work are applied both in science and industrial applications resulting in advanced prototypes and fully fielded applications. The recent applied research areas include industrial collaboration related to user modelling, next generation information search and signal denoising, as well as multi-disciplinary applications of probabilistic modelling techniques in social sciences, medicine, historical studies, biology and neuroinformatics.

4.4.1 Scalable Probabilistic Methods for Next Generation Internet Search Engines (PROSE)

Project leader: Myllymäki, Petri
Research group(s): Complex System Computation (CoSCo)
Researchers: Buntine, Wray; Lahtinen, Jussi; Löfström, Jaakko; Perkiö, Jukka; Poroshin, Vladimir; Tuominen Antti; Tuulos, Ville; Valtonen, Kimmo
Schedule: 2003-01-01... 2006-12-31
Funding: Academy of Finland
Keywords: Internet search, concept maps, probabilistic modeling, genre, multinomial Principal Components Analysis
www-page and publications: see <http://cosco.hiit.fi/search/prose.html>

It is evident that with hundreds of millions of pages of information on the Internet, search has become a fundamental service. The abundance of available information sets new challenges for even the best current search engines, and what is needed is qualitatively better ways to answer user queries. The aim of the PROSE project was to study modern computational statistical methods necessary for developing next-generation internet search engines, as well as scalable efficient implementations of them. The work focused on developing statistical modelling techniques such as multinomial principal component analysis (mPCA).

In addition to theoretical and analytical research and development of methods, the project studied how well suited the methods are for very large document collections (in the giga- and tera-byte class). Such methods are necessary for implementing the more advanced features of search engines, such as multi-class grouping, forming topic hierarchies in document bodies automatically, and intelligent query distribution to search engine clusters that specialize in different topic areas. In addition to the basic methodological research, the project developed software libraries based on open-source libraries of scientific computation. The software libraries developed in the project can be utilised for the efficient implementation of various functions in the nodes of a distributed search engine. A web site for promoting the results of the project was created and is being maintained at www.componentanalysis.org.

4.4.2 Search-In-a-Box (SIB)

Project leader: Myllymäki, Petri
Research group(s): Complex System Computation (CoSCo)
Researchers: Buntine, Wray; Tuominen, Antti; Tuulos, Ville; Löfström, Jaakko; Perkiö, Jukka; Poroshin, Vladimir
Schedule: 2003-03-01 ... 2007-06-30
Cooperation units: Department of Computer Sciences (University of Tampere), Department of Health Policy and Management (University of Kuopio)
Funding: Tekes; Nokia; Alma Media; M-Brain, Wisane, National Board of Patents and Registration of Finland
Keywords: Open source, search engines, modeling
Research programme: Tekes / FENIX
www-page and publication see <http://cosco.hiit.fi/search/sib.html>

The SIB project develops mutually supportive, next-generation methods for semantic information retrieval and personification based on automatic analysis of tera- and peta-scale information sources. These methods have been integrated to a set of

prototypes that are tested in different pilot environments, such as corporate information-management systems, topic-based search engines, analysis of news articles, and public intelligent search engines. Since information retrieval will be a mainstay of future information networks, the potential applications for the technology developed are obvious.

The methods developed in the SIB project comprise the basic technology in future web-based information-management systems, both in the internal information networks of companies and in open systems providing Internet information (such as Internet search engines). A public demonstrator of the possibilities of the technology, the Aino Search Engine at aino.hiit.fi, provides a content-based search for the whole .FI domain, consisting currently of about 10 million documents.

4.4.3 ALVIS – Superpeer Semantic Search Engine

Project leader: Myllymäki, Petri
Research group(s): Complex System Computation (CoSCo)
Researchers: Buntine, Wray; Valtonen, Kimmo; Silander, Tomi; Poroshin, Vladimir; Tuulos, Ville; Löfström, Jaakko; Lahtinen, Jussi; Tuominen, Antti
Administrative Manager: Kontiainen, Mikko; Valtonen, Kimmo
Schedule: 2004-01-01 ... 2006-12-31
Cooperation units: Unite Mathematique, Informatique et Genome, Institut National de la; Recherche Agronomique (INRA-CRJJ); Ecole Polytechnique Federale de Lausanne, Distributed Information Systems Lab (EPFL); Lund University, Department of Information Technology (ULUND); Technical University of Denmark, Center of Knowledge Technology (DTU); Index Data Aps (Index Data); Exalead SA (Exalead); Universite Paris-Nord, Laboratoire d'Informatique (Paris 13); ALMA Bioinformatica, S.L. (AB); Jozef Stefan Institute (JSI), Department of Intelligent Systems and Department of Knowledge Technologies; Tsinghua University (TU), Department of Computer Science and Technology
Funding: European Union
Keywords: semantic based search, machine learning, peer-to-peer, probabilistic models
Research programme: EU FP6-IST-1
www-page and publications: see <http://cosco.hiit.fi/search/alvis.html>

The main objective of the ALVIS project was to provide a powerful, free, stand-alone semantic-based search system so that application-domain experts can readily build topic-specific search sites without needing to become information retrieval experts or computer systems gurus, and further to develop complementary distributed components, together with bridges to existing topic-specific search sites, so that the individual sites can be linked up to form a search network. The semantic-based search engine is intended to automatically build and maintain its own semantic structure with named entities, topics and so forth, and to input primitive ontologies. It is not a Semantic Web engine, and does not rely on the existence of Semantic Web ontologies or build its own ontologies. The semantic structure is created semi-automatically using statistical and machine learning methods for the purpose of returning better search results. The distributed system is intended to be able to operate with heterogeneous search servers, using query topics as a routing mechanism, and using distributed methods for ranking and semantic-based processing.

HIIT coordinated the project, developed the central relevance component that supports ranking of documents retrieved by a query, for instance, and played a major

role in the integration and testing stages. Furthermore, in 2006 HIIT established and organised a scientific meeting "International Workshop on Intelligent Information Access" (IIIA-2006), which brought a great number of experts in the field to Helsinki in July 2006 (<http://cosco.hiit.fi/search/IIIA2006/>).

4.4.4 Cognitively Inspired Visual Interfaces for Representing Multidimensional Information (CIVI)

Project leader: Myllymäki, Petri
Research group(s):
Researchers: Uronen, Pekka, Lahtinen, Jussi; Kontkanen, Petri
Schedule: 2005-01-01 ... 2008-12-31
Cooperation units: Center for Knowledge and Innovation Research (CKIR), Helsinki School of Economics
Funding: Academy of Finland
Keywords: graphical interfaces, visualization, multidimensional scaling, information retrieval, human cognition, mental representations
www-page and publications: <http://cosco.hiit.fi/projects.html>

With the hundreds of millions of documents on the Internet and intranets, lack of information is rarely a problem, but how to access the information we need. In this information retrieval setting we can distinguish between two separate tasks: filtering out the relevant information from the vast data masses available, and representing the resulting multi-dimensional information in a useful format. In this project we focus on the second task and assume that the first task can be solved by using publicly available tools such as the open-source search software package developed in the Alvis and SIB projects. On one hand, the question is studied as a mathematical dimension reduction problem, on the other, as a challenge in perceptual psychology; a view studied in collaboration with Ilpo Kojo's group at CKIR.

4.4.5 MDL-Based Methods for Image Denoising (KUKOT)

Leader: Myllymäki, Petri
Researchers: Rissanen, Jorma; Roos, Teemu; Kontkanen, Petri; Mononen, Tommi; Wettig, Hannes
Schedule: 2006-01-01...2007-12-31
Co-operation units: Laboratory for Computational Engineering, Helsinki University of Technology;
Funding: TEKES
www-page and publications: <http://www.mdl-research.org>

We can consider digital bit streams processed in the ICT sector as consisting of two overlapping parts, where one part is useful information and the other is useless noise. There is noise in all digital media; it is generated by the faults in original information sources (such as bad image resolution) and errors in signal transmission (such as disruptions in wireless communications or faults in hard drives). Noise can be filtered if the features of the source are known (in some degree at least), but it is very difficult to build general methods for denoising since they have to be able to construct adaptive models of random noise sources. The main problem with such adaptive modelling is the regularization of models; too complex (over-adaptive) models will interpret noise as part of the information and thus be rendered useless.

MDL (Minimum Description Length) is an information-theoretical framework developed by the father of arithmetic encoding, Jorma Rissanen. It provides an elegant solution for this problem. Unfortunately, the methods based on the MDL theory are often very challenging computationally. Based on the latest results of the MDL theory, the project has collaborated with Jorma Rissanen and developed new, computationally efficient general denoising methods.

4.4.6 Probabilistic Methods for Microarray Data Analysis (PMMA)

Leader: Myllymäki, Petri
Researchers: Rissanen, Jorma; Roos, Teemu; Kontkanen, Petri; Wettig, Hannes; Lahtinen, Jussi; Silander, Tomi
Schedule: 2004-01-01...2007-12-31
Co-operation units: Laboratory for Computational Engineering, Helsinki University of Technology; Institute of Biomedicine, University of Helsinki
Funding: TEKES
www-page and publications: <http://cosco.hiit.fi/projects.html>

The main objective of the research is to develop advanced methods for microarray data analysis. In particular the project focuses on the following research issues: denoising of microarray images, comprestimation (multiterminal estimation), gene clustering and classification, and estimation of the reliability of the results.

In 2006, the project developed an algorithm for finding the globally optimal Bayes network for cases with 30 or less variables. The empirical testing of the algorithm is still going on. In addition, the project studied methods for parallelizing Bayes network learning algorithms, and developed a novel, theoretically elaborate method for constructing variable-width bin histogram density estimators.

4.4.7 Neuroinformatics

Leader: Hyvärinen, Aapo
Researchers: Hoyer, Patrik; Hurri, Jarmo; Hyvärinen, Aapo; Kurki, Ilmari; Köster, Urs; Perkiö, Jukka; Shimizu, Shohei; Kerminen, Antti
Schedule: 2003-08-01...
Co-operation units: Department of Psychology (UH); Adaptive Informatics Research Centre (TKK); Osaka University, Naples University, Low temperature laboratory (TKK), Maastricht University, Institute for Statistical Mathematics (Tokyo)
Funding: Academy of Finland; BRU basic funding, Japanese and German foundations
www-page and publications: see <http://www.hiit.fi/neuroinf/>

Neuroinformatics is broadly defined as the intersection of Information technology and neuroscience. Our research goals are 1) to build mathematical models of brain function. In computational visual neuroscience, our approach is to consider how the brain performs a sophisticated statistical and probabilistic analysis of the environment. To this end we also need 2) to develop new multivariate statistical models. A fundamental mathematical method that we use is independent component analysis (ICA) and some of its extensions. As a collaborative effort, we also 3) apply advanced statistical methods on neuroscientific data.

We developed a two-layer probabilistic model of complex continuous-valued data. When the model is estimated from natural images, we obtain a processing system

which is quite similar to what is found in the primary visual cortex. This is the first time both layers of such a model have been successfully estimated from natural images. The model is also promising for other kinds of data; in fact, it is a generalization of independent component analysis which has already been applied on many different fields.

The statistical structure of natural images was further investigated using different nonlinear methods where the idea is to first take a nonlinear transformation of the data, and then apply linear methods, usually independent component analysis. This provides a technically simple, if more restricted, alternative to multilayer models such as the one described above.

The subproject on causal discovery continued successfully, and its main result, the LiNGAM framework, was published in the Journal of Machine Learning Research, the most respected journal in the field.

A new research direction is to investigate unsupervised learning of features which are useful for action. In contrast to most other action-related representation learning schemes, the idea here is to learn a representation without any kind of reinforcement, so that the representation simply learns the regularities of the consequences of actions.

5 Research Training and Research Visits

5.1 Doctoral Degrees Earned by HIIT Personnel

Ilmonen, Tommi: *Tools and Experiments in Multimodal Interaction*. Helsinki University of Technology, Department of Computer Science and Engineering, December 2006. The opponent was Professor Michael Cohen, Computer Arts Lab, University of Aizu, Japan and the custos Professor Tapio Takala.

Oulasvirta, Antti: *Studies of Working Memory in Interrupted Human–Computer Interaction*. University of Helsinki, Department of Psychology, November 2006. The opponent was Professor Deborah Boehm-Davis from George Mason University and the custos Professor Christina Krause. The supervisor of the thesis was Professor Pertti Saariluoma from University of Jyväskylä.

Pitkänen, Olli: *Legal Challenges to Future Information Businesses*. Helsinki University of Technology, Department of Computer Science and Engineering, March 2006. The opponents were Professors Olli Martikainen and Jukka Mähönen and the custos Professor Martti Mäntylä.

Sarvas, Risto: *Designing User-Centric Metadata for Digital Snapshot Photography*. Helsinki University of Technology, Department of Computer Science and Engineering, December 2006. The opponent was Professor Walter Bender from MIT Media Lab, USA and the custos Professor Reijo Sulonen.

Seppänen, Jouni: *Using and Extending Itemsets in Data Mining: Query Approximation, Dense Itemsets, and Tiles*. Helsinki University of Technology, Department of Computer Science and Engineering, May 2006. Custos: Professor Heikki Mannila.

Tarkoma, Sasu: *Efficient Content-based Routing, Mobility-aware Topologies, and Temporal Subspace Matching*. University of Helsinki, Department of Computer Science, April 2006. The opponent was Professor Luís Rodrigues, Universidade de Lisboa and the custos Professor Kimmo Raatikainen.

Terzi, Evimaria: *Problems and Algorithms for Sequence Segmentations*. University of Helsinki, Department of Computer Science, December 2006. The opponent was Professor Dimitris Achlioptas, UC Santa Cruz, and custos was Professor Esko Ukkonen.

5.2 Post-graduate Courses Arranged by HIIT

Spring 2006 Courses

Component-Based Development (Michael Przybiski)

Image Processing (Jarmo Hurri)

Information Retrieval Methods (Greger Lindén)

Internet Technologies for Mobile Computing (Kimmo Raatikainen)

Three Concepts: Probability (Petri Myllymäki)

Network Application Frameworks and XML (Sasu Tarkoma)
 Mobilijärjestelmien ohjelmointi (Tero Hasu)
 Modeling of Vision (Aapo Hyvärinen)
 Models and Algorithms for Complex Networks (Panayiotis Tsaparas)
 Universal Artificial Intelligence: Mathematical and Philosophical Foundations (Teemu Roos)
 Seminar on Biological Sequence Analysis and Comparative Genomics (Esko Ukkonen)
 Seminar on Clustering Techniques (Saara Hyvönen)
 Seminar on Temporal and Spatial Data Analysis (Marko Salmenkivi)
 Spatial Data Mining (Antti Leino)

Autumn 2006 Courses

Causal Analysis (Patrik Hoyer)
 Computational Neuroscience (Jarmo Hurri)
 Graph Theory (Petteri Kaski)
 Information Retrieval Research Seminar (Greger Lindén)
 Mobile and Ubiquitous Computing (Oriana Riva and Kimmo Raatikainen)
 Practical Course in Biodatabases (Petteri Sevon)
 Three Concepts: Information (Petri Myllymäki)
 Research Seminar on Markov Decision Processes (Huizhen Yu)
 Research seminar on Network Security (Andrei Gurtov)
 Adaptive Computing Research Seminar (Patrik Floréen)
 Seminar on Data mining from graph data (Petteri Sevon)

5.3 Visits to HIIT

Abhijit, Bagri	IIT Kanpur, India	3 mo
Abhinav, Pathak	IIT Kanpur, India	6 mo
Achlioptas, Dimitris	UC Santa Cruz, USA	1 wk
Bender, Walter	MIT & One Laptop Per Child (OLPC), USA	3 days
Bertsekas, Dimitri	MIT, USA	3 wk
Blankinship, Erik	MIT, USA	1 mo
Bonchi, Francesco	Knowledge Discovery and Delivery Laboratory (KDD), Pisa, Italy	3 wk
Cutting, Doug	Yahoo! Berkeley, USA	1 mo
Gao, Cong	University of Edinburgh, England	1 mo
Garriga, Gemma	Dept. Llenguatges i Sistemes Informàtics	1 wk

	Barcelona, Spain	
Gunopulos, Dimitrios	University of California, Riverside	1 mo
Heer, Tobias	Universität Tübingen, Germany	6 mo
Jaakkola, Tommi	MIT, USA	1 mo
Kallio, Aleksi	Finnish IT Center for Science (CSC)	2 wk
Leino, Yrjö	Finnish IT Center for Science (CSC)	2 mo
Lu, Jiaheng	National University of Singapore, Singapore	2 wk
Madden, Michael	National University of Ireland	3 mo
Mayrhofer, Rene	University of Lancaster, UK	1 wk
Na, Joong Chae	Seoul National University, South Korea	1 yr
Nakajima, Tatsuo	Waseda University; Japan	2 mo
Nicolas, François	Laboratoire d'Informatique, de Robotique et de Microélectronique de Montpellier (LIRMM), France	3 mo
Pierstorff, Nora	Institute of Genetics of the University of Cologne, Germany	1 wk
Pouwelse, Johan	Delft University of Technology, Netherlands	1 day
Schönauer, Stefan	IBM Almaden Research Center, USA	1 wk
Shen, Hao	The Australian National University	2 wk
Shohei, Shimizu	Research Fellow of the Japan Society for the Promotion of Science The Institute of Statistical Mathematics, Japan	6 mo
Simon, Hans Ulrich	Fakultät für Mathematik, Lehrstuhl Mathematik & Informatik, Deutschland	2 wk
Szedmak Sandor	University of Southampton, UK	8 mo
Tassa, Tamir	Department of Mathematics and Computer Science, The Open University, Israel	2 wk
Van House, Nancy	School of Information, UC Berkeley, USA	2 days
Vicente, Asun	University of Valencia, Spain	4 mo
Vorobyeva, Ekaterina	University of Petroskoi; Russia	4 mo
Whang, Leo Sang-Min	Yonsei University, South Korea	3 days
Yu, Huizhen	MIT, USA	9 mo

5.4 Visits from HIIT

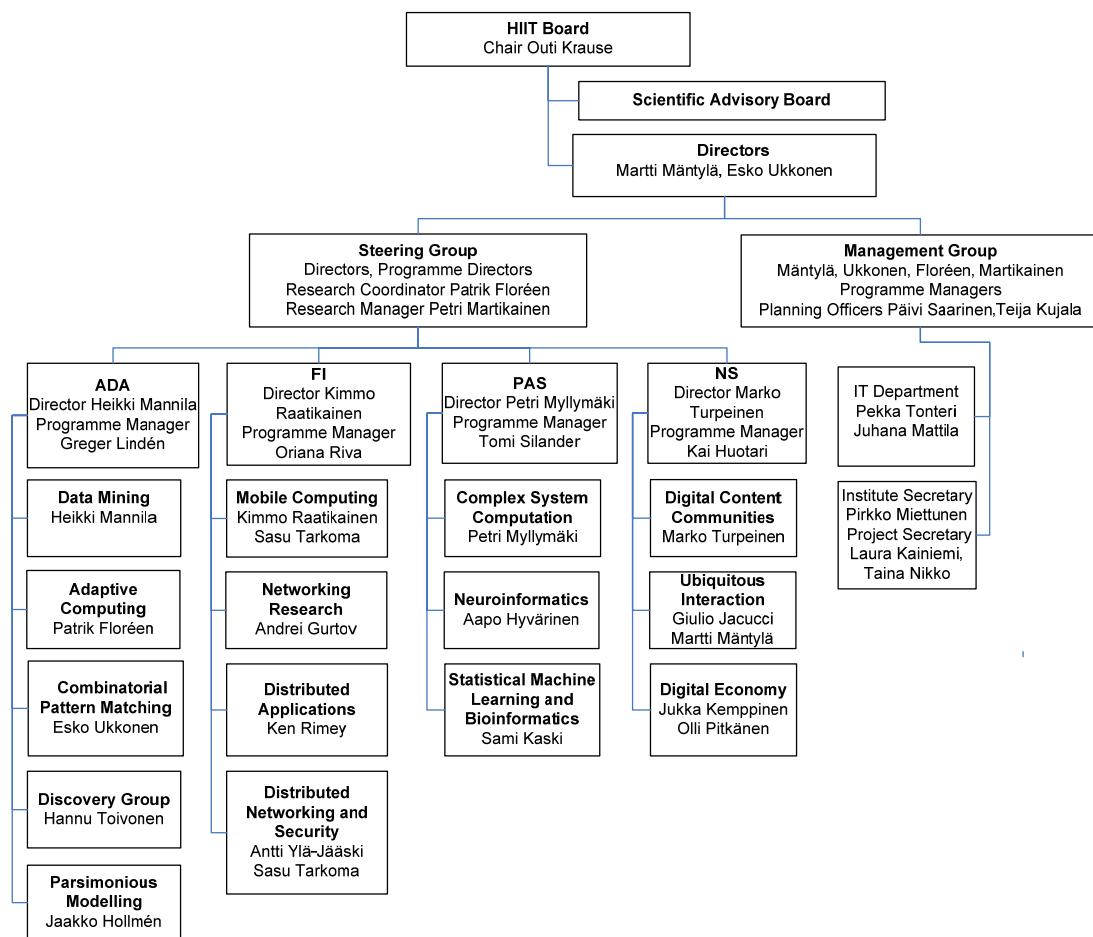
Haiminen, Niina	IBM Almaden Research Center, USA	3 mo
Hyvärinen, Aapo	Institute for Statistical Mathematics, Japan	1 mo
Koponen, Teemu	ICSI, Berkeley, USA	6 mo
Kääriäinen, Matti	ICSI, Berkeley, USA	9 mo
Lehdonvirta, Vili	Waseda University, Japan	4 mo
Oulasvirta, Antti	Deutsche Telekom Laboratories; Germany	3 mo
Raento, Mika	University of Nottingham, United Kingdom	2 mo
Reti, Tommo	University of Berkeley, USA	5 mo
Saari, Timo	Stanford University, USA	2 mo
Terzi, Evimaria	Microsoft Search Labs, Mountain View, USA	4 mo
Toivonen, Hannu	University of Freiburg, Germany	11 mo
Turpeinen, Marko	KTH, Sweden	2 mo

6 Administration

6.1 Overview

HIIT is a joint research centre of TKK and UH. The HIIT Board, nominated by the universities, decides on its overall research strategy and research programmes. The Scientific Advisory Board, nominated by the Board, provides scientific guidance and criticism for the Board. At present HIIT consists of two administrative units. The Advanced Research Unit (ARU) is associated with TKK, and the Basic Research Unit (BRU) is associated with UH. Each unit has a Director nominated by the Board.

The present structure of HIIT is depicted in the following organigram:



Research programmes are led by the Programme Directors. Together with the Directors, they constitute the Steering Group responsible for inter-programme coordination and planning. It also accepts new research groups to HIIT. The Management Group is responsible for the coordination of the administrative processes such as planning, budgeting, and reporting; communications; and preparation of joint events.

Research programmes each have a Programme Management Group, consisting of the senior researchers of the research groups contributing to the work. The Research Programme Manager facilitates the operation of the programme management group and coordinates the joint activities of the programme. A Programme Advisory Board, consisting of invited members from industry and academia, provides feedback on programme results and advises on their vision, mission, and key research lines. The programme-specific PABs replace the earlier Industrial Advisory Board that was disbanded in 2006.

HIIT's administration team provides administrative services. The IT department is responsible for the IT infrastructure and key services of the institute.

6.2 Board

The highest decision-making body of HIIT is the Board. The Board consists of nine full members of whom eight are appointed by the parent universities and represent the academic community and the main industrial partners of HIIT. One member of the board represents and is elected by HIIT personnel. In addition, the Board invites members from industrial companies with whom HIIT co-operates to participate in the work of the Board. The decision-making power is invested in the full members, whereas the invited members have the right to attend and to speak at the meetings.

In 2006 the Board convened four times. Apart from dealing with the statutory tasks (i.e. approving the annual budgets and activity plans of both units, approving the HIIT annual report, following up the work of the units through the regular activity updates given by the two Research Directors of HIIT, etc.), the major theme for the Board's work in 2006 was to follow and guide the implementation of the strategy work on the basis of the decisions made in 2005 on the future of the institute. Accordingly, the Board formally accepted the new research programme structure of HIIT in May 2006. In September 2006 the Board accepted the performance negotiation materials of HIIT that for the first time were structured according to the new programmes. Another theme closely followed by the Board was HIIT's participation in the planning of the so-called Strategic Centers of Excellence, a new initiative proposed by the Science and Technology Council in June 2006.

In 2006 the Board members (and their personal deputies) were as follows:

Members

Vice Rector Outi Krause	TKK, Chairman of the Board
(Vice Rector Olavi Nevanlinna)	TKK
Professor Olli Simula,	TKK
(Professor Markku Syrjänen)	TKK
Vice Rector, Thomas Wilhelmsson	UH, Vice-Chairman of the Board
(Vice Rector, Professor Marja Makarow)	UH
Professor Jukka Paakki	UH
(Professor Jyrki Kivinen)	UH
Raimo Vuopionperä,	LM Ericsson
(Björn Melén)	LM Ericsson
Aimo Maanavilja	Elisa
(Pertti Hölttä)	Elisa
Juha Aaltonen	TeliaSonera Finland
(Martin Mäklin)	TeliaSonera Finland
Petri Myllymäki	HIIT
(Greger Lindén)	HIIT

Nokia terminated its representation in HIIT Board by December 31, 2005. The position was left vacant for 2006.

Invited Members

Ari Hirvonen	TietoEnator
(Olli Lötjönen)	TietoEnator
Eskoensio Pipatti	Sanoma-WSOY
Juha Vesaoja	Yleisradio
Jani Eloranta,	
from 19.9.2006 Pekka Järvinen	Nordea
(Juha Toivari)	Nordea

The two Research Directors of HIIT are responsible for preparing and submitting propositions to the Board. In addition, the Research Manager, Research Coordinator and the Program Coordinators have the right to attend meetings. In 2006 these expert members were as follows:

Expert members

Research Director Martti Mäntylä, HIIT ARU
Research Director Esko Ukkonen, HIIT BRU
Research Manager Petri Martikainen, HIIT ARU
Research Coordinator Patrik Floréen, HIIT ARU & BRU
Program Coordinator Olli Pitkänen, HIIT ARU
Program Coordinator Mikko Kontiainen until 31.7.2006, HIIT ARU

Board Secretary

Planning Officer Päivi Saarinen

The effective term of HIIT Board 2004-2006 ended. The new Board will be appointed early 2007 for the term 2007-2008.

6.3 Scientific Advisory Board

The Scientific Advisory Board (SAB) of HIIT consists of internationally prominent scholars who are invited by the HIIT Board. The objective of the SAB is to provide critical guidance about HIIT's research activities and to advise the HIIT Board on strategic planning of the future research directions of HIIT. The following scholars are members of the SAB:

Dr Ross Anderson	University of Cambridge
Professor Alberto Apostolico	Purdue University
Professor Richard Buxbaum	University of California at Berkeley
Professor Christos Faloutsos	Carnegie Mellon University
Professor Randy Katz	University of California at Berkeley
Professor Bengt Jonsson	Uppsala University
Professor Martin Kersten	University of Amsterdam and CWI1
Professor Kari-Jouko Räihä	University of Tampere
Professor Mart Saarma	University of Helsinki
Professor John Shawe-Taylor	University of Southampton
Dr Martin Vingron, Director	Max Planck Institute for Molecular Genetics

¹⁾ National Research Institute for Mathematics and Computer Science in the Netherlands

The SAB did not meet during 2006. A next meeting is planned for late 2007 or 2008 to monitor the progress of HIIT's strategy.

6.4 Personnel

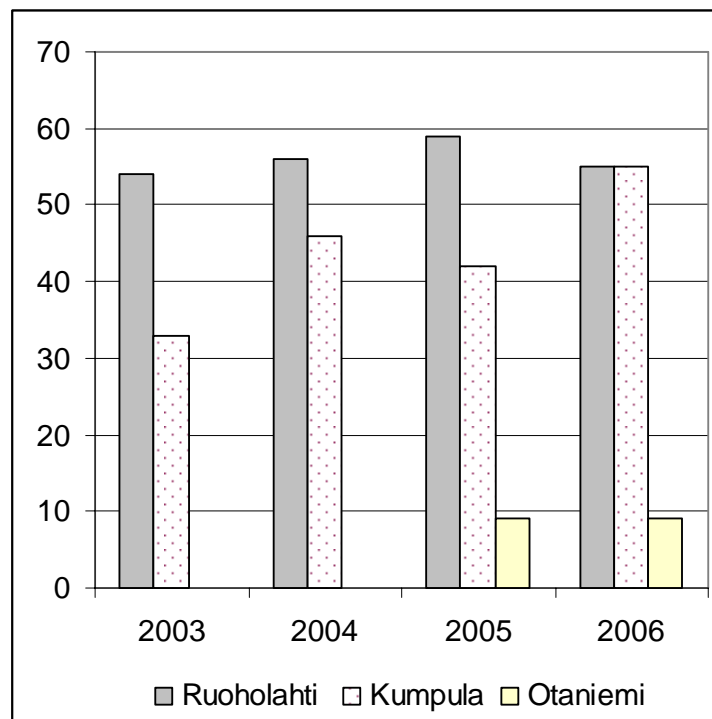
The personnel directly employed by HIIT is formally employed by the two parent universities, i.e. the Ruoholahti and Otaniemi personnel is employed by TKK and the Kumpula personnel by UH. In addition, there is a number of persons working in HIIT with some other form of funding, such as postgraduate students with funding from Helsinki Graduate School of Computer Science and Engineering (HeCSE) and researchers with academic positions. Many of HIIT's personnel have double or even triple affiliations. Most common is the affiliation to one or both of the parent universities, but there are also some who share their time between HIIT and some other organisation. The diversity of affiliations is characteristic to HIIT personnel.

Number of person-years and distribution by sites in 2003-2006

Staff (person-years)	2003	2004	2005	2006
Ruoholahti	54	56	59	55
Kumpula	33	46	42	55
Otaniemi	¹⁾	¹⁾	9	9
Total	87	102	110	119

¹⁾ Otaniemi personnel was included in Kumpula staff in 2003 and 2004

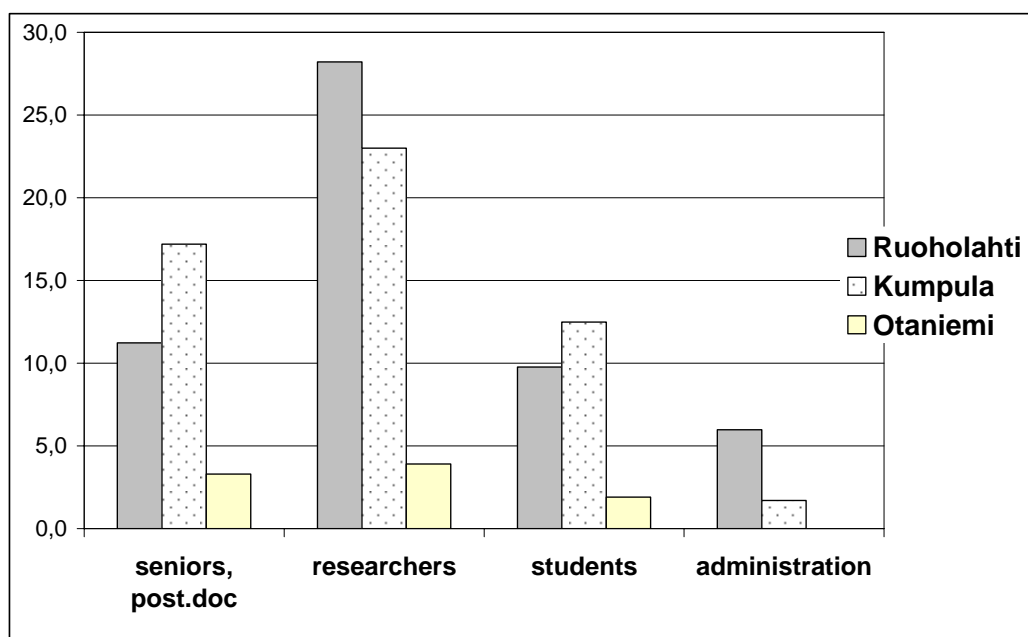
One research group (CoSCo) moved from Ruoholahti to Kumpula at the start of 2006. Thus the actual growth of personnel was roughly equal in both sites.



In 2006 the total number of employees was 173 and HIIT staff completed 119 person-years, i.e., nine more than the previous year. About 17 % of the personnel were foreigners coming e.g. from China, England, Germany, Greece, India, Italy, Pakistan, Russia, Spain, USA.

Number of person-years and distribution by personnel groups in 2006

Staff (person-years)	Ruoholahti	Kumpula	Otaniemi	Total	Change from previous year
Seniors, post-doc	11	17	3	31	+ 6
Researchers	28	23	4	55	- 3
Students	10	13	2	25	+ 6
Administration	6	2		8	
Total person-years	55	55	9	119	+ 9



The number of person-years of researchers is the highest, 47 %. Nevertheless, during 2006 the share of senior researchers, post-docs and students nevertheless increased. This development was in line with HIIT policy, which favours research groups with a good balance of personnel at different levels of advancement.

7 Funding and Costs

Ruoholahti Unit Finances

The finances of the Ruoholahti Unit for 2006 are shown in the table below.

RUOHOLAHTI	2004	2005	2006
Total funding	3 727 072	3 680 175	3 958 172
TKK funding	165 688	164 359	263 272
UH funding	168 200	168 200	168 200
Academy of Finland	392 087	586 531	140 698
National Technology Agency TEKES	2 135 821	1 949 083	1 953 297
European Union	116 951	280 582	658 028
Industry	693 910	457 074	559 943
Ministries and other public funding	44 779	22 242	99 727
Other domestic funding	9 636	52 104	115 007
Total expenses	3 731 995	3 786 832	3 809 977
Salaries	2 423 516	2 530 688	2 511 946
Other operational expenses	761 813	732 690	725 940
Rents ¹⁾	380 404	374 023	407 331
Service charge to TKK ¹⁾	166 262	149 432	164 760

University funding % of total funding	9 %	9 %	11 %
External funding % of total funding:	91 %	91 %	89 %
Academy funding % of total funding	11 %	16 %	4 %
TEKES funding % of total funding	57 %	53 %	49 %
Industry funding % of total funding	19 %	12 %	14 %
EU funding % of total funding	3 %	8 %	17 %
Other public funding % of total fund.	1 %	2 %	5 %

Salaries % of total expenses	65 %	67 %	66 %
Other expenses % of total expenses	25 %	23 %	23 %
Rents % of total expenses	10 %	10 %	11 %

During 2006, four new research projects funded by the European Union were launched in the Ruoholahti unit, more than doubling the funding from this source. The decline of Academy of Finland funding is largely explained by the move of the Complex System Computation group from Ruoholahti to Kumpula, and also by the ending of the PROACT programme where the unit had a strong presence.

¹⁾ Rents and service charges shown are based on formal bookkeeping. The rents charged are based on TKK's internal rates. The actual rents were some 240 000 euros higher; thus the Ruoholahti unit received indirect funding from TKK. Service charges are also charged at 50% of the usual TKK rate. With these included, the actual TKK funding to the Ruoholahti unit was some 400 000 euros higher than shown.

Kumpula Unit Finances

The finances of the Kumpula Unit for 2006 are shown in the table below. For reference, the comparable numbers of 2005 are also given.

KUMPULA	2005	2006
Total funding	1 861 421	2 179 499
UH funding	731 000	891 744
Academy of Finland	650 580	490 570
National Technology Agency TEKES	107 380	418 612
European Union (EU)	197 597	274 818
Industry	174 864	103 756
Total expenses	1 635 915	1 965 993
Salaries	1 270 587	1 483 555
Other operational expenses	222 111	242 647
Service charge to UH (rents included)	143 217	239 790

University funding % of total funding	39 %	41 %
External funding % of total funding:	61 %	59 %
Academy funding % of total funding	35 %	22.5 %
TEKES funding % of total funding	6 %	19 %
EU funding % of total funding	11 %	12.5 %
Industry funding % of total funding	9 %	5 %

Salaries % of total expenses	78 %	75 %
Other expenses % of total expenses	14 %	12 %
Service charge % of total expenses	9 %	12 %

The notable growth of the TEKES funding is mostly due to the move of the Complex System Computation Group (CoSCo) to Kumpula. The service charge to UH has also clearly increased as a service charge is now also taken from the basic UH funding. In addition to the expenses reported in the above table, in total about 160 000 euros for salaries were paid directly by graduate schools (9 PhD students).

Otaniemi Unit Finances

The finances of the Otaniemi Unit for 2006 are shown in the table below. For reference, the comparable numbers of 2005 are also given.

OTANIEMI	2005	2006
Total funding	406 741	436 790
TKK funding	100 000	106 386
Center of Excellence funding from TKK	78 145	71 280
Academy of Finland	228 596	218 226
National Technology Agency TEKES	0	40 898
European Union (EU)	0	0
Industry	0	0
Total expenses	382 258	395 107
Salaries	335 073	344 875
Other operational expenses	2 831	21 064
Service charge to UH/TKK (rents included)	44 354	29 168

University funding % of total funding	25 %	24 %
External funding % of total funding:	75 %	76 %
CoE funding % of total funding	19 %	16 %
Academy funding % of total funding	56 %	50 %
TEKES funding % of total funding	0 %	9 %
EU funding % of total funding	0 %	0 %
Industry funding % of total funding	0 %	0 %

Salaries % of total expenses	88 %	87 %
Other expenses % of total expenses	1 %	5 %
Rents % of total expenses	12 %	7 %

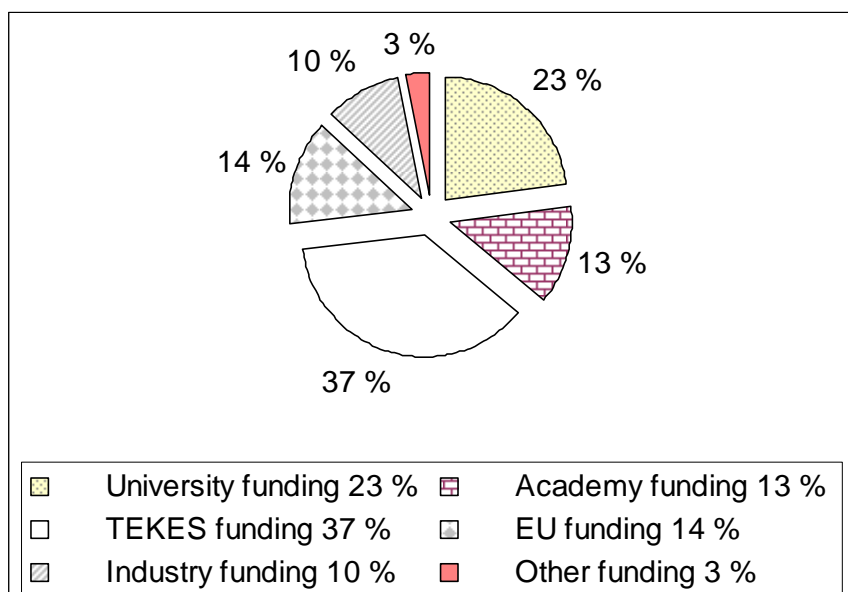
The above table gives a financial report of the Otaniemi site of HIIT. In addition to the expenses reported in the table, in total about 135 000 euros for salaries were paid directly by the Academy of Finland (H. Mannila) and by graduate schools (2 PhD students).

HIIT Finances Summary

HIIT	2005	2006
Total funding	5 948 337	6 574 462
Universities	1 241 704	1 500 882
Academy of Finland	1 465 707	849 494
National Technology Agency TEKES	2 056 463	2 412 807
European Union (EU)	478 179	932 846
Industry	631 938	663 699
Ministries and other public funding	22 242	99 727
Other funding	52 104	115 007
Total expenses	5 805 006	6 171 076
Salaries	4 136 348	4 340 376
Other operational expenses	957 632	989 651
Service charge to UH/TKK	337 003	433 718
Rents	374 023	407 331

University funding % of total funding	21 %	23 %
External funding % of total funding:	79 %	77 %
Academy funding % of total funding	25 %	13 %
TEKES funding % of total funding	35 %	37 %
EU funding % of total funding	8 %	14 %
Industry funding % of total funding	11 %	10 %
Other funding % of total funding	1 %	3 %

Salaries % of total expenses	71 %	70 %
Other expenses % of total expenses	22 %	23 %
Rents % of total expenses	7 %	7 %



Appendices

A Publications

Publications 2004–2006	2004	2005	2006
Articles in international scientific journals with referee practice	19	29	38
Articles in international edited works and conference proceedings with referee practice	98	112	101
Articles in Finnish scientific journals with referee practice	1	1	3
Articles in Finnish edited works and conference proceedings with referee practice	5	3	2
Scientific monographs	4	8	2
Other publications	19	13	18
Computer programs (and algorithms)	2	3	1
Degrees			
PhD or DSc thesis	4	3	7
Licentiate thesis	1	1	2
Master's thesis	14	7	10

Articles in international scientific journals with referee practice (38)

Bas, P. & **Hurri, J.**: Vulnerability of DM watermarking of non-iid host signals to attacks utilising the statistics of independent components. IEE proceedings information security: IEE. 153 (2006) : 3, p. 127-139.

Buntine, W.; Bloehdorn, S.: Special issue on "Learning in Web Search". Informatica - an International Journal of Computing and Informatics, 2006. Vol. 30, No. 2, Electronic publication.

Greig, M. & Haanpää, H. & **Kaski, P.**: On the coexistence of conference matrices and near $2-(2k + 1, k, k - 1)$ designs. Journal of combinatorial theory. New York (NY) :113 (2006) : 4, p. 703-711.

Eronen, L. & Geerts, F. & Toivonen, H.: HaploRec : efficient and accurate large-scale reconstruction of haplotypes. BMC bioinformatics. London : BioMed Central. 7 (2006) : 542, 38 p.

Evans, J. & Hemment, D. & Humphries, T. & **Raento, M.**: LOCA : location oriented critical arts. Loca: Location Oriented Critical Arts. Leonardo electronic almanac. - Ipswich, MA : Ebsco Information Services. 14 (2006) : 3.

Fortelius, M. & **Gionis, A.** & Jernvall, J. & **Mannila, H.**: Spectral ordering and biochronology of European fossil mammals. Paleobiology. Chicago, IL. 32 (2006): 2, s. 206-214.

Haanpää, H. & Jarvisalo, M. & **Kaski, P.**: Hard satisfiable clause sets for benchmarking equivalence reasoning techniques. *Journal on Satisfiability, Boolean Modeling and Computation*. 2 (2006), p. 27-46.

Hintsanen, P. & Sevon, P. & Onkamo, P. & **Eronen, L. & Toivonen, H.**: An empirical comparison of case-control and trio based study designs in high throughput association. *Journal of medical genetics*. London : British Medical Association. 43 (2006), p. 617-624.

Hyvärinen, A.: Consistency of pseudolikelihood estimation of fully visible Boltzmann machines. *Neural computation*. Cambridge (MA) : MIT. (2006) : 18, p. 2283-2292.

Jaeger, M. & Nielsen, J.D. & **Silander, T.**: Learning probabilistic decision graphs. *International journal of approximate reasoning*. - New York, NY : North-Holland. 42 (2006), p. 84-100.

Jacucci, G.; Oulasvirta, A.; Salovaara, A.: Active construction of experience through multimedia: a field study with implications for recording and sharing. *Personal and Ubiquitous Computing*, 2006. Electronic publication

Kaski, P. & Östergård, Patric R. J. & Pottonen, O.: The Steiner quadruple systems of order 16. *Journal of combinatorial theory*. New York (NY). 113 (2006) : 8, p. 1764-1770.

Koivisto, M.: Optimal 2-constraint satisfaction via sum-product algorithms. *Information processing letters*. - Amsterdam : Elsevier. 98 (2006) : 1, p. 24-28.

Korzun, D.; Gurtov, A.: On Applying Linear Diophantine Equations to Route Modeling in Self-Organizing Networks. *Electrosvyaz*, 2006. No. 6, pp.34-38.

Korzun, D.; Gurtov, A.: On Scalability Properties of the Hi3 Control Plane. *Elsevier Computer Communications*, 2006. Vol. 29, No. 17, pp. 3591-3601.

Kurki, I. & Hyvärinen, A. & Laurinen, P.L.: Collinear context (and learning) change the profile of the perceptual filter. *Vision Research*, 46(13):2009-2014, 2006. Elsevier: Amsterdam.

Macaulay, C.; **Jacucci, G.**; O'Neill, S.; **Kankainen, T.**; Simpson, Morna: The emerging roles of performance within HCI and interaction design. *Interacting with computers*, 2006. Vol. 6, 942-955.

Mehto, K.; Kantola, V.; Tiitta, S.; Kankainen, T.: Interacting with user data - Theory and examples of drama and dramaturgy as methods of exploration and evaluation in user-centered design. *Interacting with computers*, 2006. Vol. 18, No. 5, 977-995.

Mielikäinen, T.: Frequency-based views to pattern collections. *Discrete applied mathematics*. Amsterdam : Elsevier. 154 (2006), p. 1113-1139.

Mielikäinen, T. & Ukkonen, E.: The complexity of maximum matroid-greedoid intersection and weighted greedoid maximization. *Discrete applied mathematics*. - Amsterdam : Elsevier. -154 (2006), p. 684-691.

M. Miettinen, J. Kurhila, P. Nokelainen and **H. Tirri**, Supporting Open-Ended Discourse with Transparent Groupware. *International Journal of Web Based Communities*, Vol. 2, No. 1, pp. 17-30.

S. Myllykangas, J. Himberg, T. Böhling, B. Nagy, **J. Hollmén** & S. Knuutila. DNA copy number amplification profiling of human neoplasms. *Oncogene*, 25(55):7324-7332, 2006. Nature Publishing Group.

Nokelainen, P. & **Silander, T.** & Ruohotie P. & Tirri, H.: Investigating the number of non-linear and multi-modal relationships between observed variables measuring growth-oriented atmosphere. *Quality & quantity* : 40 (2006), 22 p..

Nymark P., Wikman H., **Ruosaari S., Hollmén J.**, Vanhala E., Karjalainen A., Anttila S. & Knuutila S.: Identification of specific gene copy number changes in asbestos-related lung cancer. *Cancer Research*, 66(11):5737-5743, 2006.

Onkamo, P. & **Toivonen, H.**: A survey of data mining methods for linkage disequilibrium mapping. *Human Genomics*. 2 (2006) : 5, p. 336-340.

Oulasvirta, A.; Saariluoma, P. : Surviving task interruptions: Investigating the implications of long-term working memory theory . *International Journal of Human-Computer Studies*, 2006. Vol. 64, No. 10 , 941-961.

Puolamäki, K. & Fortelius, M. & **Mannila, H.**: Seriation in paleontological data using Markov Chain Monte Carlo methods. *PLoS computational biology*. San Francisco, CA : Public Library of Science . 2 (2006) : 2 , s. 1-9.

Raento, M.: The data subject's right of access and to be informed in Finland: an experimental study. *International journal of law and information technology*. 14 (2006) : 3, p. 390-409.

Rantanen, A. & **Mielikäinen, T. & Rousu, J.** & Maaheimo, H. & **Ukkonen, E.**: Planning optimal measurements of isotopomer distributions for estimation of metabolic fluxes. *Oxford University Press*. 22 (2006) : 10, p. 1198-1206.

Ravaja, N.; **Saari, T.: Turpeinen, M.**; Laarni, J.; Salminen, M.; Kivikangas: Spatial Presence and Emotions during Video Game Playing: Does it Matter with Whom You Play?. *Presence*, 2006. Vol. 15, No. 4, 381-392.

Salmela E., Taskinen O., **Seppänen J. K.**, Sistonen P., Daly M. J., Lahermo P., Savontaus M-L. & Kere J.: Subpopulation difference scanning: a strategy for exclusion mapping of susceptibility genes. *Journal of Medical Genetics*, Vol. 43, pp. 590-597, 2006. Published Online First: 27 January 2006. doi:10.1136/jmg.2005.038414

Sevon, P. & Toivonen, H. & Ollikainen, V.: TreeDT : tree pattern mining for gene mapping. *IEEE/ACM transactions on computational biology and bioinformatics*. New York (NY) : IEEE. 3 (2006) : 2, p. 174-185.

Shimizu, S. & Hoyer, P.O. & Hyvärinen, A. & Kerminen, A.: A linear non-gaussian acyclic model for causal discovery. *Journal of machine learning research*. - Cambridge (MA) : MIT Press. 7 (2006), p. 2003-2030.

Shimizu, S. & Hyvärinen, A. & Hoyer, P.O. & Kano, Y.: Finding a causal ordering via independent component analysis. *Computational statistics & data analysis*. - Amsterdam. 50 (2006), p.

Sulkava M., Tikka J. & **Hollmén J.**: Sparse regression for analyzing the development of foliar nutrient concentrations in coniferous trees. *Ecological Modeling*, 191(1):118-130, 2006.

Tarkoma, S.; Kangasharju, J.: Optimizing Content-based Routers: Posets and Forests. *Distributed Computing*, 2006. Vol. 19, No. 1, pp. 62-77.

Venna, J. & Kaski, S.: Local multidimensional scaling. *Neural Networks*, 19, pp 889-899, 2006.

Yee, W. G. & Beigbeder, M. & **Buntine, W.**: SIGIR06 workshop report on open source information retrieval systems (OSIR06). *ACM Sigir forum*. New York (NY). 40 (2006) : 2, p. 61-65.

Articles in Finnish scientific journals with referee practice (3)

Leino, A. & Hyvönen, S. & Salmenkivi, M.: Mitä murteita suomessa onkaan: murreosanaston levikin kvantitatiivista analyysiä. *Virittäjä*. - Helsinki : Kotikielen seura. 110 (2006): 1, p. 26-45.

Ryynänen, O.-P. & Puhakka, M. & **Myllymäki, P.** & Palomäki, P. & Anttonen, V. & Jukola, R. & Takala, J.: Sairaalaan lähettämisen arviointi Bayesin verkkomallilla. *Suomen lääkärilehti*. Helsinki : Suomen lääkäriiliitto. 61 (2006) : 51, p. 5353-5358.

Salmenkivi, M. & Pulkkinen, R. & Tuominen, H.: Leksikaalisten ja syntaktisten nimenosien yleisyydestä ja levinneisyydestä peruskartan paikannimisessä. *Virittäjä* 110 (2006) : 2, p. 190-228.

Articles in international edited works and conference proceedings with referee practice (101)

Agrawal, R. & Rantau, R. & **Terzi, E.**: Context-sensitive ranking. *ACM-Sigmod International Conference on Management of Data: SIGMOD 2006*. - New York, N.Y : Association for Computing Machinery cop. 2006. 12 p..

Agrawal, R. & **Terzi, E.**: On honesty in sovereign information sharing. *International Conference on Extending Database Technology: Advances in database technology, EDBT 2006*. - Berlin

Bingham, E. & Gionis, A. & Haiminen, N. & Hiisilä, H. & **Mannila, H. & Terzi, E.**: Segmentation and dimensionality reduction. *Proceedings of the Sixth SIAM International Conference on Data Mining*. - Philadelphia : Society for Industrial and Applied Mathematics cop. 2006. p. 372-383.

Buntine, W.; Jakulin, A. : Discrete Components Analysis. In: Saunders, Craig, J; Grobelnik, Marko; Gunn, Steve, R; Shawe-Taylor, John, S, *Subspace, Latent Structure and Feature Selection Techniques*. Berlin ; Heidelberg, Germany 2006, Springer-Verlag, 1-33.

Buntine, W. & Taylor, M.P. & Lagunas, F.: Standards for Open Source Information Retrieval. *Workshop on Open Source Information Retrieval: OSIR 2006*. p. 68-72.

Buntine, W.; Valtonen, K.: Topic Models in ALVIS. The International Workshop on Intelligent Information Access (IIIA-2006), July 6-8, 2006, Helsinki. Helsinki 2006, 11.

Floréen, P. & Kukkonen, J. & Lagerspetz, E. & Nurmi, P. & Suomela, J. : BeTelGeuse : tool for context data gathering via Bluetooth. Proceedings of the Second Workshop on Context Awareness for Proactive Systems. Kassel : Kassel University Press 2006. p. 137-139.

Fokker, J.; **Buntine, W.;** Pouwelse, J.: Tagging in Peer-to-Peer Wikipedia - A Method to Induce Cooperation. Conference on Research & Development on Information Retrieval, Seattle, WA, USA, August 6-11, 2006. 39-45.

Fokker, J.; Pouwelse, J.; **Buntine, W.:** Tag-Based Navigation for Peer-to-Peer Wikipedia. Collaborative Web Tagging Workshop, 15th International World Wide Web Conference (WWW2006), Edinburgh, Scotland, UK, 22.5.2006. 2006, ACM.

Fokker, J. & **Buntine, W.** & Pouwelse, J.: Tagging in Peer-to-Peer Wikipedia : a method to induce cooperation. Workshop on Open Source Information Retrieval: OSIR 2006 : 7 p.

Gionis, A. & Mannila, H. & Mielikäinen, T. & Tsaparas, P.: Assessing data mining results via swap randomization. International Conference on Knowledge Discovery and Data Mining: KDD-2006. - New York, NY : ACM Press 2006. p. 167-176.

Gionis, A. & Mannila, H. & Puolamäki, K. & Ukkonen, A.: Algorithms for discovering bucket orders from data. International Conference on Knowledge Discovery and Data Mining: KDD-2006. - New York, NY : ACM Press 2006. p. 561-566.

Hasu, T.: Programmatic Building of Models Just for Pretty Printing. 6th OOPSLA Workshop on Domain-Specific Modeling, Portland, Oregon, USA, 2006. 2006, University of Jyväskylä, Department of Computer Science and Information Systems, pp. 79-86.

Heikinheimo H., Mannila H. & Seppänen J. K.: Finding trees from unordered 0-1 data. PKDD 2006.

Heinonen, M. & Rantanen, A. & **Mielikäinen, T.** & Pitkänen, E. & Kokkonen, J. & **Rousu, J. :** Ab initio prediction of molecular fragments from tandem mass spectrometry data. German Conference on Bioinformatics, GCB 2006, Tübingen, Germany 2006. - Bonn : Gesellschaft für Informatik 2006. p. 40-53.

M. Hermersdorf, H. Nyholm, J. Salminen, **H. Tirri, J. Perkiö and V. Tuulos,** Sensing in Rich Bluetooth Environments, In Workshop on World-Sensor-Web (WSW'2006).

Hietanen, H.; Melanie Dulong de Rosnay: Legal Metadata for Semantic Web Applications: Case Creative Commons. Proceedings of Symposium on Digital Semantic Content across Cultures Pariisi, Louvre, kesäkuu 2006. 2006, Suomalais-ranskalainen teknillistieteellinen seura.

Hoyer, P.O. & Shimizu, S. & Hyvärinen, A. & Kerminen, A. & Kano, Y.: New permutation algorithms for causal discovery using ICA. International Conference, ICA: ICA 2006. p. 115-122.

Hoyer, P. O. & Shimizu, S. & Kerminen, A.: Estimation of linear, non-gaussian causal models in the presence of confounding latent variables. Probabilistic Graphical Models: Proceedings of the third European workshop on Probabilistic Graphical Models. Prague: Action M Agency 2006. p. 155-162.

Hurri, J.: Learning cue-invariant visual responses. Conference on Neural Information Processing Systems: Advances in neural information processing systems 18. - Cambridge, Mass: MIT Press cop. 2006. p. 539-546.

Hyvärinen, A. & Köster, U.: FastISA: A fast fixed-point algorithm for independent subspace analysis. In Proc. European Symposium on Artificial Neural Networks, Bruges, Belgium, 2006.

Hyvärinen, A. & Perkiö, J.: Learning to segment any random vector. In Proc. IEEE Int. Joint Conf. on Neural Networks, pages 4167-4172, Vancouver, Canada, 2006.

Hyvärinen, A. & Shimizu, S.: A quasi-stochastic gradient algorithm for variance-dependent component analysis. In Proc. Int. Conf. on Artificial Neural Networks, p. 211-220, Athens, Greece, 2006.

Hyvönen, S. & Junninen, H. & Laakso, L. & Dal Maso, M. & Grönholm, T. & Bonn, B. & Keronen, P. & Aalto, P.P. & Hiltunen, V. & Pohja, T. & Launiainen, S. & Tunved, P. & Hansson, H. C. & Hari, P. & Mannila, H. & Kulmala, M.: Data mining approaches to explaining aerosol formation. Proceedings of the iEMSs Third Biennial Meeting: "Summit on Environmental Modelling and Software". International Environmental Modelling and Software Society. 7 p..

Immonen, O.; Galli, L.; Haaker, T.; Killström, U.; **Pitkänen, O.**; de Reuver, Marc: Can advertising based earnings logic become a basis for future mobile business models?. The 3rd International CICT Conference, Mobile and Wireless Content, Services and Networks, Copenhagen, Denmark, 30 November - 1 December 2006.. Denmark 2006, Technical University of Denmark.

Kabán, A. & **Bingham, E.:** ICA-based binary feature construction. Independent Component Analysis and Blind Signal Separation: 6th International Conference, ICA 2006, Charleston, SC, USA, March 5-8, 2006. Proceedings. Editors: Justinian Rosca, Deniz Erdogmus, Jose C. Principe, Simon Haykin. p. 140 - 148.

Kangasharju, J.; Kangasharju, J.: An Optimal Basis for Efficient Peer-to-Peer Content Distribution Algorithms. International Conference on Computer Communications and Networks, Arlington, USA, 2006. 2006, IEEE, pp. 481-486.

Kangasharju, J.; **Lindholm, T.;** **Tarkoma, S.:** On Encrypting and Signing Binary XML Messages in the Wireless Environment. International Conference on Web Services, Chicago, USA, 2006. 2006, IEEE, pp. 637-644.

Killström, U.; Mrohs, B.; Immonen, O.; **Pitkänen, O.**; Galli, L.; de Reuver, M.; Haaker, T.: A new mobile service architecture addresses future mobile business environments. Wireless World Research Forum Meeting WWRF17; November 2006.

Klami, A. & Kaski, S.: Generative models that discover dependencies between data sets. In S. McLoone, T. Adali, J. Larsen, M. Van Hulle, A. Rogers, S.C. Douglas, editors, Machine Learning for Signal Processing XVI, pages 123-128. IEEE, 2006.

Kohonen, J. & Suomela, J.: Lessons learned in the challenge: making predictions and scoring them. PASCAL Machine Learning Challenges Workshop. Berlin : Springer cop. 2006. p. 95-116.

Koivisto, M.: An $O^*(2n)$ algorithm for graph coloring and other partitioning problems via inclusion-exclusion. 47th Annual IEEE Symposium on Foundations of Computer Science. Los Alamitos, CA : IEEE Computer Society cop. 2006. p. 583-590.

Koivisto, M.: Parent assignment is hard for the MDL, AIC, and NML costs. Conference on Learning Theory. Berlin : Springer cop. 2006. p. 289-303.

Koivisto, M.: Advances in exact Bayesian structure discovery in Bayesian networks. Conference on Uncertainty in Artificial Intelligence. Corvallis, OR: AUAI Press cop. 2006. p. 241-248.

Kollin, J. & Koivisto, M.: Bayesian learning with mixtures of trees. European Conference on Machine Learning. Berlin : Springer cop. 2006. p. 294-305.

Komu, M.: Native SHIM APIs. Internet Engineering Task Force 66, Montreal, Quebec, July 9-14 2006.

Koolwaaij, J. & Tarlano, A. & Luther, M. & **Nurmi, P.** & Mrohs, B. & Battestini, A. & Vaidya, R.: Context watcher : sharing context information in everyday life. Web Technologies, Applications, and Services: WTAS 2006 : Acta Press 2006. 10 p.

Koponen, T.; Eronen, P.; Särelä, M. :Resilient Connections for SSH and TLS. 2006 USENIX Annual Technical Conference, Boston, MA, USA, 30/5/06-3/6/06. Boston, MA 2006, USENIX, s. 329-340.

Korpela M. & Hollmén J.: Extending an algorithm for clustering gene expression time series. In J. Rousu, S. Kaski, and E. Ukkonen, editors, Proceedings of the Workshop on Probabilistic Modeling and Machine Learning in Structural and Systems Biology, University of Helsinki, Department of Computer Science, Series of Publications B, Report B-2006-4, pages 120-124, June 2006.

Kuikkaniemi, K.; Turpeinen, M.; Salovaara, A.; Saari, T.; Vuorenmaa, J.: Toolkit for user-created augmented reality games. MUM 2006 - The 5th International Conference on Mobile and Ubiquitous Multimedia; Stanford University, CA, USA; December 4th-6th 2006. 2006, Nokia in association with ACM.

Kulovesi, K. & **Muhonen, J. & Lappalainen, I.** & Riikonen, P. T. & Vihinen, M. & **Toivonen, H.** & Pasanen, T.: Visualisation of associations between nucleotides in SNP neighbourhoods. Intelligent data analysis in biomedicine and pharmacology. Verona : University of Verona 2006. p. 61-62.

Kurvinen, E.; Aftelak, Andy; Häyrynen, Annakaisa: User-Centered Design in the Context of Large and Distributed Projects. CHI2006, April 22-27, 2006, Montreal, Canada. 995-1000.

Kurvinen, E., Lehmuskallio, H., Häyrynen Annakaisa: Mashing Up Mobile: Lessons from the Field. WWRF#17, Heidelberg, Germany, 15-17.11.2006. 2006, The Wireless World Research Forum, n/a.

Kääriäinen, M.: Active learning in the non-realizable case. ALT 2006: Algorithmic learning theory. Berlin : Springer 2006. p. 63-77.

Kääriäinen, M.: Semi-supervised model selection based on cross-validation. International Joint Conference on Neural Networks. Vancouver, BC, Canada. Piscataway, N.J : IEEE Xplore cop. 2006. p. 1894-1899.

Lahtinen, J. & **Myllymäki, P.** & Ryyänen, O.-P.: P-Course : medical applications of Bayesian classification with informative priors. Workshop on AI Techniques in Healthcare: ECAI'2006 Università di Trento 2006. p. 38-40.

Landwehr, N. & **Mielikäinen, T. & Eronen, L. & Toivonen, H. & Mannila, H.:** Constrained Hidden Markov Models for population-based haplotyping. Probabilistic modeling and machine learning in structural an systems biology. - Helsinki : Helsinki University Printing House 2006. p. 38-43.

Laur, S. & Lipmaa, H. & **Mielikäinen, T.:** Cryptographically private support vector machines. International Conference on Knowledge Discovery and Data Mining: KDD-2006. - New York, NY : ACM Press 2006. p. 618-624. Lemström, K. & Pienimäki, A.: Approaches for content-based retrieval of symbolically encoded polyphonic music. 9th International Conference on Music Perception and Cognition. Bologna : Bononia University Press 2006. 8 p..

Lindholm, T.; Kangasharju, J.; Tarkoma, S.: Fast and Simple XML Tree Differencing by Sequence Alignment. In: Brailsford, David F., Proc. of the 2006 ACM Symposium on Document Engineering. New York, USA 2006, 75-84.

Martin, M. & **Nurmi, P.:** A generic large scale simulator for ubiquitous computing. International Conference on Mobile and Ubiquitous Systems, Networks and Services: Mobiculous 2006: IEEE Computer Science Press 2006. 3 p.

Mielikäinen, T.: Transaction databases, frequent itemsets, and their condensed representations. KDID 2005: Knowledge discovery in inductive databases. Berlin : Springer cop. 2006. p. 139-164.

Mielikäinen, T. & Panov, P. & Džeroski, S.: Itemset support queries using frequent itemsets and their condensed representations. International Conference on Discovery Science: Discovery science. - Berlin : Springer cop. 2006. p. 161-172.

Mielikäinen, T. & Terzi, E. & Tsaparas, P.: Aggregating time partitions. International Conference on Knowledge Discovery and Data Mining: KDD-2006. - New York, NY : ACM Press 2006. p. 347-356.

Miettinen, P. & Mielikäinen, T. & Gionis, A. & Das, G. & Mannila, H.: The discrete basis problem. European Conference on Principles and Practice of Knowledge Discovery in Databases: Knowledge discovery in databases. - Berlin : Springer 2006. p. 335-346.

Muhonen, J. & Toivonen, H.: Closed non-derivable itemsets PKDD 2006: European Conference on Principles and Practice of Knowledge Discovery in Databases: Knowledge discovery in databases. - Berlin: Springer 2006. p. 601-608.

Nikkilä, J. & Honkela, A. & Kaski, S.: Exploring the independence of gene regulatory modules. In Juho Rousu, Samuel Kaski, and Esko Ukkonen, editors, Probabilistic Modeling and Machine Learning in Structural and Systems Biology (PMSB 2006), workshop proceedings, pages 131-136, Helsinki University Printing House, 2006.

Nurmi, P.: A Bayesian framework for online reputation systems. Advanced International Conference on Telecommunications: Telecommunications, 2006. IEEE cop. 6 p.

Nurmi, P.: Modeling energy constrained routing in selfish ad hoc networks. Proceedings of the 2006 workshop on Game Theory for Communications and Networks. New York : ACM Press 2006, 10 p.

Nurmi, P. & Koolwaaij, J.: Identifying meaningful locations. International Conference on Mobile and Ubiquitous Systems, Networks and Services: Ubiquitous 2006. IEEE Computer Science Press 2006. 8 p.

Nurmi, P. & Salden, A. & Lau, S.L. & Suomela, J. & Sutterer, M. & Millerat, J. & Martin, M. & Lagerspetz, E. & Poortinga, R.: A system for context-dependent user modelling. Proceedings of OTM Federated Workshops, 2006, Montpellier, France : 2006. p. 1894-1903.

Oja, M. & Peltonen, J. & Kaski, S.: Estimation of human endogenous retrovirus activities from expressed sequence databases. Probabilistic modeling and machine learning in structural and systems biology. - Helsinki : Helsinki University Printing House 2006. p. 50-54.

Peltonen, J. & Goldberger, J. & Kaski, S.: Fast discriminative component analysis for comparing examples. Workshop on Learning to Compare Examples: Proceedings of the NIPS 2006 Workshop on Learning to Compare Examples. [Canada] : 2006. - hy157274, 5 p..

Perkiö, J. & Tuulos, V. & Hermersdorf, M. & Nyholm, H. & Salminen, J. & Tirri, H.: Utilizing rich Bluetooth environments for identity prediction and exploring social networks as techniques for ubiquitous computing. IEEE/WIC/ACM International Conference on Web Intelligence: 2006 IEEE/WIC/ACM. - Los Alamitos, CA : IEEE Computer Society 2006. p. 137-141.

Pitkänen, O.: Legal Research Topics within Services Sciences. CASCON 2006, Toronto, Canada, October 16-19, 2006. Canada 2006, IBM Press.

Pitkänen, O.: Scenario Method to Find Legal Challenges to Future Information Businesses. The 6th International Conference on Managing Information in Digital Economy, Bonn, Germany, June 19-21, 2006. Germany 2006, International Business Information Management Association.

Pitkänen, O.: Technology-Based Research Agenda on the Data Protection Law. International Conference on Law and Technology (LawTech 2006), Cambridge, MA, USA, October 9-11, 2006.. 2006, The International Association of Science and Technology for Development.

Przybilski, M.: Requirements elicitation in international research projects. Proc. 12th Americas Conference on Information Systems (Acapulco, Mexico, August 2006).

Raverdy, P.G.; **Riva, O.;** de La Capelle, A.; Chibout, R.; Issarny, V.: Efficient Context-aware Service Discovery in Multi-Protocol Pervasive Environments. 7th International Conference on Mobile Data Management (MDM'06), Nara (Japan), 10-12 May 2006. 2006, IEEE.

Riva, O. : Contory: A Middleware for the Provisioning of Context Information on Smart Phones. ACM/IFIP/USENIX 7th International Middleware Conference (Middleware'06), Melbourne (Australia), Nov 27 - Dec 1, 2006. 2006, ACM.

Riva, O.; di Flora, C. : Contory: A Smart Phone Middleware Supporting Multiple Context Provisioning Strategies. 2nd International Workshop on Services and Infrastructure for the Ubiquitous and Mobile Internet (SIUMI'06), at the 26th International Conference on Distributed Computing Systems (ICDCS'06), Lisbon (Portugal), 4-7 July 2006. 2006, IEEE.

Riva, O.; di Flora, C.; Russo, S.; **Raatikainen, K.:** Unearthing Design Patterns to Support Context-Awareness. 3rd Workshop on Middleware Support for Pervasive Computing (PerWare'06), at the 4th IEEE International Conference on Pervasive Computing and Communications (PerCom'06), Pisa (Italy), 13-17 March 2006. 2006 IEEE.

Riva, O.; Toivanen, S. : A Hybrid Model of Context-aware Service Provisioning Implemented on Smart Phones. 3rd IEEE International Conference on Pervasive Services (ICPS'06), Lyon (France), 26-29 June 2006. 2006 , IEEE, 47-56.

Roos, T. & Heikkilä, T. & Myllymäki, P.: A compression-based method for stemmatic analysis. ECAI 2006. - Amsterdam : IOS Press cop. 2006. p. 805-806.

Roos, T. & Myllymäki, P. & Grünwald, P. & Tirri, H.: Generalization to unseen cases. Conference on Neural Information Processing Systems 18. Cambridge, Mass. : MIT Press cop. 2006. p. 1129-1136.

Salmenkivi, M.: Efficient mining of correlation patterns in spatial point data. European Conference on Principles and Practice of Knowledge Discovery in Databases: Knowledge discovery in databases. Berlin ; New York : Springer 2006. p. 359-370.

Salmenkivi, M.: Finding representative sets of dialect words for geographical regions. Language resources and evaluation: Proceedings. - [Italy] : 2006. s . 1980-1985.

Salovaara, A.; Jacucci, G.; Oulasvirta, A.; Saari, T.; Kanerva, P.; Kurvinen, E.; Tiitta, S.: Collective creation and sense-making of mobile media. SIGCHI conference on human factors in computing systems (CHI'06), Montreal, Canada, 24.-27.4.2006. New York, NY, USA 2006, Association for Computing Machinery (ACM), 1211-1220.

Schmeltz Pedersen, G.; Ardö, A.; Cromme, M.; Taylor, M.; **Buntine, W.:** ALVIS - Superpeer Semantic Search Engine - ECDL 2006 Demo Submission. 10th European Conference, ECDL 2006, Alicante, Spain, September 17-22, 2006. Berliini, Saksa 2006, Springer Verlag, 461-462.

Schmitt, V.; **Pathak, A.; Komu, M.;** Eggert, L.: HIP Extensions for the Traversal of Network Address Translators. Internet Engineering Task Force 66, Montreal, Quebec, July 9-14 2006.

Seiffert, U. & Hammer, B. & **Kaski, S. & Villmann, T.:** Neural networks and machine learning in bioinformatics - theory and applications. In Proceedings of ESANN'06, 14th European Symposium on Artificial Neural Networks, pages 521--532. d-side, Evere, Belgium, 2006.

Sevon, P. & Eronen, L. & Hintsanen, P. & Kulovesi, K. & Toivonen, H.: Link discovery in graphs derived from biological databases. DILS 2006: Data integration in the life sciences. - Berlin: Springer 2006. p. 35-49.

Shimizu, S. & Hyvärinen, A. & Hoyer, P.O. & Kerminen, A. & Kano, Y.: Testing significance of mixing and demixing coefficients in ICA. International Conference, ICA: ICA 2006. p. 901-908.

Silander, T. & Myllymäki, P.: A simple approach for finding the globally optimal Bayesian network structure. Conference on Uncertainty in Artificial Intelligence: Uncertainty in artificial intelligence. - Corvallis, Or: AUAI Press cop. 2006. p. 445-452.

Sugimoto, S.; **Komu, M.**; Marcelo, B.; Slavov, K.: Socket API for Multihoming SHIM. Internet Engineering Task Force 66, Montreal, Quebec, July 9-14 2006.

Rasinen A, **Hollmén J. & Mannila H.:** Analysis of Linux evolution using aligned source code segments. In N. Lavrac, L. Todorovski, and K.P. Jantke, editors, Proceedings of the Ninth International Conference on Discovery Science, volume 4265 of Lecture Notes in Artificial Intelligence, pages 209-218. Springer-Verlag, 2006.

E. Soini, J. Martikainen, **J. Lahtinen, P. Myllymäki, P. Kontkanen, K. Valtonen** and O.-P. Ryyänen, Efficient Data Mining And Probabilistic Inference With P-Course: A Bayesian Method With Multilevel Priors For Medical Applications. The ISPOR 9th Annual European Congress Presentations in Value in Health: The Journal of the International Society for Pharmacoeconomics and Outcomes Research, Vol.9 (2006), No. 6 (November/December), A270.

Suomela, J.: Locality helps sleep scheduling. In Workshop on World-Sensor-Web (WSW'2006). p. 41-44.

Suomela, J.: Approximating relay placement in sensor networks. Proc. 3rd ACM International Workshop on Performance Evaluation of Wireless Ad Hoc, Sensor, and Ubiquitous Networks (PE-WASUN, Torremolinos, Spain). New York, NY: ACM Press 2006. p. 145-148.

Suomela, J.: Computational complexity of relay placement in sensor networks. Proc. 32nd Conference on Current Trends in Theory and Practice of Computer Science (SOFSEM 2006, Czech Republic, Jan 2006), Lecture Notes in Computer Science 3831. Berlin: Springer-Verlag 2006. p. 521-529.

Tarkoma, S.: Preventing Spam in Publish/Subscribe. 26th IEEE International Conference on Distributed Computing Systems Workshops (ICDCSW'06), 5th International Workshop on Distributed Event-Based Systems (DEBS 2006), July 2006, Lisbon. 2006, IEEE.

Tarkoma, S.: TSR: Temporal Subspace Routing for Peer-to-Peer Data Sharing. Globecom 2006, 27.11 - 1.12., San Francisco, USA. 2006, IEEE.

Tarkoma, S.; Kangasharju, J.; Lindholm, T.; Raatikainen, K.: Fuego: Experiences with Mobile Data Communication and Synchronization. 17th Annual IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC), September 2006, Helsinki. 2006, IEEE.

Tatti, N. & Mielikäinen, T. & Gionis, A. & Mannila, H.: What is the dimension of your binary data? Sixth IEEE International Conference on Data Mining, ICDM 2006, 18-22 December 2006, Hong Kong, China. - Los Alamitos (CA) : IEEE Computer Society 2006. 10 p..

Tikka J. & **Hollmén J.:** Long-term prediction of time series using a parsimonious set of inputs and LS-SVM. In Amaury Lendasse, editor, Proceedings of the First Symposium on Time Series Prediction (ESTSP'07), pages 87-96, February 2007.

Tikka J., Lendasse A. & **Hollmén J.:** Analysis of fast input selection: Application in time series prediction. In Stefanos Kollias, Andreas Stafylopatis, Wlodzislaw Duch, and Erkki Oja, editors, Proceedings of the 16th International Conference on Artificial Neural Networks (ICANN'06), volume 4132 of Lecture Notes in Computer Science, pages 161-170. Springer-Verlag, 2006.

Terzi, E. & Tsaparas, P.: Efficient algorithms for sequence segmentation. SIAM International Conference on Data Mining: Proceedings of the Sixth SIAM International Conference on Data Mining. - Philadelphia : Society for Industrial and Applied Mathematics cop. 2006. 12 p.

Tuominen, A.; Tuulos, V.: BulkFS: a Distributed Fault-Tolerant File System for Massive Data Applications. International Workshop on Intelligent Information Access, Helsinki, 6.-8. 7. 2006. Helsinki 2006, 59-61.

Tuulos, V.; Tuominen, A.: Some Key Challenges in Web Crawlers and Content-Based Search Engines. The International Workshop on Intelligent Information Access (IIIA-2006), Helsinki, Finland, July 6-8, 2006. Helsinki 2006, 63.

Venna, J. & Kaski, S.: Visualizing Gene Interaction Graphs with Local Multidimensional Scaling. In Michel Verleysen, editor, Proceedings of the 14th European Symposium on Artificial Neural Networks (ESANN'2006), pages 557--562, Bruges, 2006.

Zhou, L. & **Buntine, W.:** Preface to the "web search technology - from search to semantic search" workshop (SWET'06). First Asian Semantic Web Conference: Proceedings of The Semantic Web ASWC 2006 Workshops: Jilin University Press 2006. p. 221-222.

Zhou, L.; **Buntine, W.;** : Web Search Technology - from Search to Semantic Search. In Proceedings of the 1st Asian Semantic Web Conference (ASWC 2006), edited by Li, G; Liang, Y; Ronchetti, M, 3.-7.9.2006, Beijing, China. 2006, Jilin University Press.

Articles in Finnish edited works and conference proceedings with referee practice (2)

Pulkkinen, R. & **Salmenkivi, M.:** Mitä paikannimet kertovat Suomen karhusta? Karhun kannoilla - in the footsteps of the bear. Proceedings of the multidisciplinary symposium "In the Footsteps of the Bear", 147-156. Pori, Finland, 2006.

Mielikäinen, T.: Tietämyksen yhteenvetoja. Tietojenkäsittelytieteen päivät 2006. - Helsinki : University of Helsinki 2006. p. 12-17.

Scientific monographs published abroad (1)

Kaski, P. & Östergård, P.R.J. :Classification algorithms for codes and designs. Berlin: Springer, 2006, 412 p. Series: Algorithms and computation in mathematics.

Scientific monographs published in Finland (1)

Kemppinen, J.: Digitaaliongelman - Kirjoitus oikeudesta ja ympäristöstä. Lappeenranta 2006, Lappeenranta University of Technology. 502 pp.

Other scientific publications (17)

Beigbeder, M. & **Buntine, W.** & Yee, W.G. (eds.): Proceedings of the Second Workshop on Open Source Information Retrieval (OSIR06), Seattle, WA.

Buntine, W.; **Tirri, H.;** **Myllymäki, P. (eds.);** Proceedings of the International Workshop on Intelligent Information Access (IIIA-2006). Helsinki, Finland 2006. 75 p.

Bäck, A.; Vainikainen, S.; Näkki, P.; **Reti, T.;** **Sarvas, R.;** Seppälä, L.; **Turpeinen, M.;** **Hietanen, H.:** Semantically supported media services with user participation. Report on the RISE-project.. Espoo: VTT, 2006. 99 pp. (VTT Publications 612).

Killström, U.; Galli, L.; Haaker, T.; Immonen, O.; Kijl, B.; **Pitkänen, O.;** Saarinen, P.; Virola, H.: Initial Marketplace Dynamics (incl. Business Models) analysis. Eurooppa: 2006. 145 (MobiLife Deliverable (IST-2004-511607) D07b (D1.2b)) .

Killström, U.; Häyrynen, A.; Galli, L.; Immonen, O.; **Pitkänen, O.;** Haaker, T.; de Reuver, M.; Mercer, K.: Marketplace Dynamics and Socio-economic Implications. Eurooppa: 2006. 113 (MobiLife Deliverable (IST-2004-511607) D1.8).

Kontkanen, P. & Myllymäki, P.: Information-theoretically optimal histogram density estimation. HIIT technical reports. Helsinki Institute for Information Technology. (2006): 2, 8 p.

Kurvinen, E.; Häyrynen, Annakaisa; Klemettinen, Mika: MobiLife UCD Process. IST-MobiLife Public Deliverable D1.4c. 2006.

Pitkänen, O.: Legal Challenges to Future Information Businesses. Helsinki: Tietotekniikan tutkimuslaitos HIIT, 2006. 229 (HIIT Publications 2006-1).

Pitkänen, O.: Legal and Regulation Framework Specification: Competence within Mobile Families and Ad-hoc Communities. Eurooppa: 2006. 128 (MobiLife Deliverable (IST-2004-511607) D11 (D1.6)).

Martikainen, P. (editor); **Karila, A.;** **Kemppinen, J.;** **Konttinen, M.;** **Kurvinen, E.;** **Mäntylä, M.;** **Oulasvirta, A.;** **Pitkänen, O.;** **Raento, M.;** **Salovaara, A.;** **Sarkio, Katri;** **Sarvas, Risto;** **Turpeinen, Marko;** **Virtanen, Perttu:** Towards Ubiquitous Network Society. Helsinki: Tietotekniikan tutkimuslaitos HIIT, 2006. 96 pp. (HIIT Report Series 2006-3).

Puolamäki, K. & Kaski, S.: Proceedings of the NIPS 2005 Workshop on Machine Learning for Implicit Feedback and User Modeling. Helsinki University of Technology, Espoo, Finland, 2006.

Rousu, J. & Kaski, S. & Ukkonen, E.: Probabilistic modeling and machine learning in structural and systems biology : workshop proceedings. Helsinki University Printing House, 2006. Series of Publications B / University of Helsinki.

Sarkio, K.; Mäntylä, M.: Is Your Neighbor a Traitor? Distributed Reputation Management in Member-Initiated Virtual Communities. Helsinki: Helsinki Institute for Information Technology, 2006. 15 (HIIT Technical Report 2006-1).

Sarvas, R.: Designing User-Centric Metadata for Digital Snapshot Photography. Helsinki: Tietotekniikan tutkimuslaitos HIIT, 2006. 181 pp. (HIIT Publications 2006-4).

Yu, H. & Bertsekas, D.P.: Convergence results for some temporal difference methods based on least squares. [USA] : [Massachusetts Institute of Technology], 2006. 27 p.

Yu, H. & Bertsekas, D.P.: A least squares Q-learning algorithm for optimal stopping problems. [USA] : [Massachusetts Institute of Technology], 2006 20 p.

Yu, H. & Bertsekas, D.P.: On near-optimality of the set of finite-state controllers for average cost POMDP. [USA]: [Massachusetts Institute of Technology], 2006. 15 p.

Posters (1)

Tarkoma, S; Sri Kalyanaraman, R; Lindholm, T; Kangasharju, J; Raatikainen, K: Fuego Mobility Middleware. 4th International Conference on Mobile Systems, Applications, and Services (Mobisys 2006). 2006, ACM.

Computer programs (and algorithms) (1)

Tarkoma, Sasu; Kangasharju, Jaakko; Komu, Miika; Kousa, Mika; Lindholm, Tancred; Saareto, Marko; Slavov, Kristian; Thalainayar Balasubramanian, Ramya: Fuego middleware. (Versio: 2.0). Computer software. 2006.

Degrees

PhD or Dsc thesis

Ilmonen, Tommi: Tools and Experiments in Multimodal Interaction. Doctoral Dissertation, Helsinki University of Technology, Department of Computer Science and Engineering, December 2006.

Oulasvirta, Antti: Studies of Working Memory in Interrupted Human-Computer Interaction. Doctoral Dissertation, University of Helsinki, Department of Psychology, Cognitive Science, November 2006.

Pitkänen, Olli: Legal Challenges to Future Information Businesses. Doctoral Dissertation, Helsinki University of Technology, Department of Computer Science and Engineering, March 2006.

Sarvas, Risto: Designing User-Centric Metadata for Digital Snapshot Photography. Doctoral Dissertation, Helsinki University of Technology, Department of Computer Science and Engineering, December 2006.

Seppänen, Jouni K.: Using and extending itemsets in data mining: query approximation, dense itemsets, and tiles. Doctoral dissertation, Department of Computer Science and Engineering, Helsinki University of Technology, 2006.

Tarkoma, Sasu: Efficient Content-based Routing, Mobility-aware Topologies, and Temporal Subspace Matching. Doctoral Dissertation, University of Helsinki, Department of Computer Science, April 2006.

Terzi, E.: Problems and Algorithms for Sequence segmentations. Helsinki : University of Helsinki, 2006 x, 141 p. Series of publications A / Department of Computer Science, Helsinki.

Licentiate thesis

Sarkio, Katri: Distributed Reputation Management in P2P Based Virtual Communities: Tailored Trustworthiness Estimations. Licentiate Thesis, Helsinki University of Technology, Department of Computer Science and Engineering, May 2006.

Kangasharju, Jaakko: An XML Messaging Service for Mobile Device. Licentiate Thesis, University of Helsinki, Department of Computer Science, April 2006.

Masters thesis

Heer, T.: Lightweight Authentication for the Host Identity Protocol (HIP). Diploma Thesis, University of Tübingen, 2006

Kerminen, Antti: Empirical evaluation of the stability of causal discovery using ICA. Helsinki University of Technology, Department of Computer Science and Engineering. (C-2006-52)

Korpela, Mikko: Analysis of changes in gene expression time series data. Master's thesis, Helsinki University of Technology, Department of Computer Science and Engineering, February 2006.

Kousa, Mika: Supporting Multiple IPsec Security Associations in Host Identity Protocol Mobility and Multihoming. Master's thesis, Helsinki University of Technology, Department of Computer Science and Engineering, October 2006.

Kuikkaniemi, Kai: Financing and Coordinating Digital Media Research in Helsinki. Master Thesis, Helsinki University of Technology, Department of Industrial Engineering and Management, June 2006.

Miettinen, Pauli: The Discrete Basis Problem. Helsinki University of Technology, Department of Computer Science and Engineering. (C-2006-10)

Nurmi, Petteri: Theoretic modeling of routing in selfish ad hoc networks. Helsinki University of Technology, Department of Computer Science and Engineering. (C-2006-21)

Sumari, Lauri: Interacting with multiple devices in mobile work. Master's thesis, Department of Computer Science and Engineering, Helsinki University of Technology, October 2006.

Takkinen, Elina: Host Identity Protocol Privacy Management. Master's Thesis, Helsinki University of Technology, Department of Computer Science and Engineering, March 2006.

Varjonen, Samu: Security in 3G Networks. Master thesis, University of Helsinki, October 2006.

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Päivärinta, Juha	Research Assistant	Ruoholahti
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Raento, Mika	Researcher / Combi	Kumpula
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Rasinen, Antti	Researcher	Otaniemi
Reti, Tommo	Researcher	Ruoholahti
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Riva, Oriana	Researcher	Ruoholahti
Roos, Teemu	Researcher / Hecse	Kumpula
Ruosaari, Salla	Researcher / Combi	Otaniemi
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Sarkio, Katri	Researcher	Ruoholahti
Sarvas, Risto	Research Scientist	Ruoholahti
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Savolainen, Petri	Researcher	Ruoholahti
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Seppänen, Jouni	Postdoctoral Researcher	Otaniemi
Sevon, Petteri	Postdoctoral Researcher	Kumpula
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Silander, Tomi	Researcher	Kumpula
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Sri Kalyanaraman, Ramya	Researcher	Ruoholahti
Sulander, Anu	Research Assistant	Kumpula
Suomela, Jukka	Researcher	Kumpula
Szedmak, Sandor	Visiting Researcher	Kumpula
Sääksvuori, Lauri	Research Assistant	Ruoholahti
Tarkoma, Sasu	Research Scientist	Ruoholahti
Tatti, Nikolaj	Researcher / Combi	Otaniemi
Terzi, Evimaria	Researcher / Combi	Kumpula
Tiitta, Sauli	Researcher	Ruoholahti
Tikka, Heidi	Researcher	Ruoholahti
Toivola, Janne	Research Assistant	Otaniemi
Toivonen, Hannu	Professor	Kumpula
Tonteri, Pekka	IT Specialist	Ruoholahti
Tsapas, Panayiotis	Postdoctoral Researcher	Kumpula
Tuominen, Antti	Researcher	Ruoholahti
Turpeinen, Marko	Principal Scientist	Ruoholahti
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Tuulos, Ville	Research Assistant	Kumpula
Ukkonen, Antti	Researcher	Otaniemi
Ukkonen, Esko	Research Director	Kumpula
Uronen, Pekka	Researcher	Kumpula

Valtonen, Kimmo	Researcher	Ruoholahti
Valtonen, Kimmo	Researcher	Kumpula
Varjonen, Samu	Researcher	Ruoholahti
Wessman, Jaana	Researcher / Hecse	Kumpula
Wettig, Johannes	Researcher	Kumpula
Vihavainen, Sami	Researcher	Ruoholahti
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Vuorinen, Matti	Research Assistant	Kumpula
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Yanev, Kliment	Research Assistant	Kumpula
Yu, Huizhen	Researcher	Kumpula
Ånäs, Susanna	Researcher	Ruoholahti