

Helsinki Institute for Information Technology HIIT
Annual Report 2005

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EXECUTIVE SUMMARY

During its sixth year of operation HIIT continued its work on the scale already established. Its total budget for 2005 was 5.9 million Euro and personnel 140 researchers and staff. The publication record developed positively: the institute produced some 150 international publications. The Advanced Research Unit was located in HTC Helsinki in Ruoholahti and the Basic Research Unit on University of Helsinki Kumpula campus and Helsinki University of Technology Otaniemi campus.

The strategy work already commenced during 2004 was completed during the first half of 2005 with the decision to continue the operations of the institute with its present structure for another three years 2006-2008. In this time, the two units will align their operations so that they can be merged from 2009 onwards.

The research programme structure of the ARU was updated by merging the old programmes *Digital Economy* and *Media Convergence* with a new programme *Network Society* under the leadership of Dr Marko Turpeinen. The core activity of the new programme is the *Mobile Content Communities* project already launched in 2004. Three new projects were launched in the programme during 2005, thus getting it well off ground. In the Basic Research Unit, the main research lines remained *Data Analysis*, led by Academy Professor Heikki Mannila, *Adaptive Computing* (Docent Patrik Floréen) and *Neuroinformatics* (Docent Aapo Hyvärinen).

The institute was very successful in the calls of the European Union's 6th Framework Programme. At the beginning of 2006, six European projects were in progress. The institute also received a significant grant from the The Centenary Fund of the Technology Industries of Finland for the funding of a Principal Scientist position for five years. Dr Pekka Himanen was nominated to the post.

Highlights of the research in HIIT during 2005 include the following:

- The process migration method developed in the InfraHIP project
- The *Photos to Friends* service prototype developed in the MC2 project, based on using social networks to facilitate mobile photograph sharing
- The *Aino* search engine developed in the CoSCo research group, utilising probabilistic methods for document relevancy modelling
- The statistical method and its software implementation LiNGAM (*Linear Non-Gaussian Acyclic Model*) for analysing the causal relations of continuous variables developed in the Neuroinformatics group.

Martti Mäntylä
Professor, Research Director
Advanced Research Unit

Esko Ukkonen
Professor, Research Director
Basic Research Unit

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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 Helsinki, the University of Helsinki (UH) and Helsinki University of Technology (TKK). HIIT was founded in 1999 and has been operational since early 2000.

HIIT conducts internationally high-level strategic research in information technology and related multi-disciplinary topics, especially in areas where the Finnish information and communication technology (ICT) industry has or may reach a significant global role. HIIT works in close co-operation with Finnish universities, research institutes, and industry, aiming to improve the contents, visibility, and impact of Finnish IT research to benefit the competitiveness and progress of the Finnish information society. HIIT also aims at creating a strong network of international partnerships with leading foreign research universities and institutions.

A Board consisting of members from the universities, industry, and HIIT personnel directs HIIT. The Industrial Advisory Board manages the HIIT-industry liaison. The Scientific Advisory Board advises the Board on strategic planning of HIIT's research directions.

HIIT consists of two autonomous units. The Advanced Research Unit (ARU) mainly operates through two- to three-year long industry co-funded research projects. The present groups work on mobile computing, user experience research, complex system computation, digital economy, digital content communities, and semantic computing. Professor Martti Mäntylä is the Research Director of ARU.

The Basic Research Unit (BRU) focuses on long-term basic research issues in information technology, including challenges arising in major novel application areas in sciences and engineering. The present research groups work on data analysis, adaptive computing and neuroinformatics. Professor Esko Ukkonen is the Research Director of BRU.

ARU is mainly located in the High Tech Center Helsinki in Ruoholahti, Helsinki. In late 2005, the Complex System Computation research group of ARU moved to the premises of the Department of Computer Science of UH in Kumpula, Helsinki. BRU is mainly located at the Kumpula campus, with some activities within the Department of Computer Science and Engineering of TKK in Otaniemi, Espoo.

2 Review of Year 2005

2.1 Advanced Research Unit (Professor Martti Mäntylä)

2005 was the sixth year of operation for HIIT and its Advanced Research Unit.

The research programme structure of ARU was changed on 1.1.2005 as two of the four original programmes launched in 2000, the *Media Convergence* programme and the *Digital Economy* programme were merged in a new programme titled *Network Society*. As described in Section 4.1.3, the mission of the new programme is *human-centric development of ubiquitous information and communication technology, based on deep understanding of needs and practices of everyday life and social relations in a network society*. The Principal Scientist of the new programme is Dr Marko Turpeinen, who also became a full-time HIIT employee during 2005.

The launch of the new programme was not painless or trivial, because several major projects of the predecessor programmes had ended in 2004. Thus considerable efforts were spent on planning and preparing new project initiatives during the first half of 2005. These turned out to be quite successful, resulting in three new project launches during the second half of 2005. These included one project funded at the 100% level from the Strategic Basic Research call of TEKES. The research focus of these activities will be on various issues in social media.

The Network Society programme also participated very actively in the 4th and 5th calls of the Information Society Technologies (IST) programme of the 6th framework of the European Union, participating in six project proposals altogether. The success of these proposals turned out to be excellent: five projects were accepted for funding by the Commission and will be launched during the first half of 2006. With this, HIIT is solidly on the path towards becoming a significant participant in EU-funded research activities.

A further milestone in the launch of the new programme was the significant donation that HIIT received from The Centenary Fund of the Technology Industries of Finland for a five-year research project on *Global Network Society*, led by Pekka Himanen PhD. Himanen will work part-time also at the University of Art and Design Helsinki and as Visiting Professor at Oxford University, and hence contribute to HIIT's expanding national and international network.

2005 was far from uneventful also for the two continuing research programmes of ARU. In the Future Internet (Fuego) programme, led by Prof. Kimmo Raatikainen, both a continuation of the core project *Future Mobile Middleware* and the large ITEA/Eureka project *Services for All* (S4ALL) were launched during early 2005. S4ALL is led by Alcatel and aims to bring service-oriented architecture (SOA) to the mobile world. The Intelligent Systems programme, led by Prof. Petri Myllymäki, received funding for another TEKES' Strategic Basic Research project. In late 2005, the core research group of the programme moved to Kumpula campus.

The publication record of ARU exhibited strong growth for 2005. Apart from journal articles, conference papers, and academic theses, HIIT researchers are also increasingly publishing prototype software. An important tool for this activity was created with the founding of the Helsinki Open Source Laboratory (HOSLab) by HIIT, the Department of Computer Science and Engineering of TKK, and the Department of Computer Science of UH which hosts HOSLAB activities.

The external funding of ARU in 2005 was some 3.4 million Euros, growing slightly from 3.2 million in 2004.

HIIT was originally founded by agreement between the UH and the TKK for five years (with one-year extensions) from 1 August 1999 to 31 July 2004. As the original period ran to an end, the HIIT Board launched a strategy process aiming at defining HIIT's overall strategy for HIIT's continuation. After an extensive period of discussion and planning, the final decisions were reached in April 2005 when it was decided that the two units of the research centre would be joined from 1 January 2009. During the intervening three years 2006-2008, the research programmes, practical operations, formal position, and funding structure of the two units will be homogenized.

2.2 Basic Research Unit (Professor Esko Ukkonen)

Year 2005 was the fourth year of operation of the Basic Research Unit (BRU). Data analysis, adaptive computing, and neuroinformatics were continued as the main themes of the research activity of the unit.

The large data-analysis group, lead by Academy Professor Heikki Mannila, was proceeding with its extensive research programme on the theory and applications of data mining. The basic challenge is to develop computationally efficient methods that can be used to obtain useful information from large masses of data. The work is characterized by the interplay of theoretical study on the methods and applied research in collaboration with researchers from other sciences and from industry. On the theory side, there were several interesting developments. Spectral and Markov Chain Monte Carlo methods were developed for serialization problems arising in palaeontology. Methods were developed for mining chains of relations and for a related problem of 'authority-queries' (given a database of (author, article) pairs and (article, topic) pairs, find the authoritative author who has most articles on a given topic). The work on segmentations also continued, and new fast algorithms for the analysis of piece-wise constant time-series were obtained. Two collections of research articles were edited by the members of the group (Prof. H. Mannila, Prof. H. Toivonen) for international publishers.

In the area of adaptive computing, BRU participates in a major international project MobiLife, an EU Integrated Project with 22 partners and a total budget of about 17.3 million Euro. The HIIT component of this project is lead by Dr Patrik Floréen. A general inference module for context inference of a context-aware system was developed. The module supports different inference mechanisms, including the Bayesian inference. The Proactive Computing (PROACT) research programme of the Academy of Finland, coordinated in BRU by Prof. Mannila and Dr Greger Linden, had its last year of activity. In 2005, the ContextPhone software developed by Professor Hannu Toivonen's team continued to attract international attention. At MIT, for example, a field study lasting one year was carried out with 100 users of ContextPhone. The ContextPhone system was also expanded with a new feature called Meaning. This allows automatic context annotation of the new media items the user imports to the system (such as pictures taken by a mobile phone).

Neuroinformatics is broadly defined as the intersection of information technology and neuroscience. The neuroinformatics group, lead by Dr Aapo Hyvärinen, continued to grow in 2005. As its main achievement, the group developed a statistical method and software package called LINGAM (Linear non-gaussian acyclic model) for the analysis of causal relations between continuous data variables. The method, based

on a novel use of the independent component analysis, gives very promising results. The group will continue studying it in more detail to get full understanding of its potential.

In the funding arena, the growth of BRU still continued. The external funding of BRU in 2005 was about 1.5 million Euros, the largest funding agency being the Academy of Finland.

International recruiting continues to be one of the most important objectives of BRU. Dr Panayiotis Tsaparas and Dr Aristides Gionis continued their work in BRU. A new recruitment in 2005 was Dr Robert Gwadera (Purdue). The postdoctoral researchers from abroad contribute significantly to the research environment at BRU, and hiring from elsewhere will continue in the future.

BRU operates at the Department of Computer Science at UH and at the Laboratory of Computer and Information Science at TKK, the main site being at UH. The offices of BRU in the new Exactum building at the Kumpula campus of UH have turned out to be functional. The operation at two sites works well, and the different backgrounds of the departments provide fertile ground for innovative research.

One of the basic principles of BRU is participation in teaching. In 2005, the links to teaching were kept active at both universities.

3 Important Events

March 31

The *Scenes of a Research* event was held by HIIT's Drama project in Teatterikulma, Helsinki. The event included several dramatic presentations developed in the project that investigates the use of interactive theatre as a means of user-centric product and service concept design. Some 60 people attended the event.

May 18 – May 20

The annual HIIT Retreat event was held in Haukilammen toimintakeskus under the theme *HIIT Retreat: Roadmap Towards 2009*. The prime objective of the retreat was to discuss and plan the overall HIIT Roadmap 2009, in light of the recent decisions of the HIIT Board on HIIT's strategy. The discussion focused especially on the research themes to be addressed in 2006-2008 and how the objectives of the strategy could be reached by 2009 in practice. The desired outcome was a shared understanding of the roadmap and the next steps of its implementation.

June 1

The Finnish Parliament's Committee and HIIT co-organised a seminar on *Challenge of Creative Economy* at the University of Helsinki. Speakers at the event included the Minister of Treasury Antti Kalliomäki, Professor Manuel Castells, PhD Pekka Himanen and CEO Matti Alahuhta. The seminar was chaired by the chairman of the Committee for the Future, Member of Parliament Jyrki Katainen.

June 16 – 17

The *Context Awareness for Proactive Systems (CAPS)* conference was arranged by the Department of Computer Science, HIIT and the PROACT research programme. The programme consisted of 2 invited talks, 13 presentations and 5 posters/demonstrations. There were 33 participants from eight different countries.

August 3

Workshop on *Future Mobile Photography* was held in Ruoholahti, site of HIIT. The keynote presentation was given by Prof. Nancy Van House, SIMS, UC Berkeley, USA.

August 11

The forum theatre presentation *Satunmaa* developed by HIIT's Drama project was presented at the Tampere Theatre Festival.

August 17

Workshop on *Transparent Technologies for Spatial and Social Presence* was held in Ruoholahti site of HIIT. The keynote presentation was given by Prof. Frank Biocca from Michigan State University.

August 31

The Centenary Fund of the Technology Industries of Finland donated the Helsinki University of Technology 550,000 Euros for a five-year research project on network society. The donation was published in an event held on 31.8.2005 where the chairman of the board of the fund, Matti Alahuhta, presented the donation to the Rector of TKK Matti Pursula.

September 7

Workshop on *Social Networks and Mobile Applications* was held in Ruoholahti. The keynote presentation was given by Dr Nathan Eagle from the MIT Media Lab.

September 19 – 23

As part of the University of Helsinki's Research Assessment Exercise 2005, an international evaluation panel visited the Basic Research Unit and the Department of Computer Science. In the assessment report of the panel, BRU obtained the highest grade (7/7) for its research.

November 17

A workshop on *Socially Aware Media* was held at Yahoo! Berkeley Lab, Berkeley. Speakers included researchers from Yahoo! and HIIT.

November 21

The Finnish Information Technology Association (<http://www.tt-tori.fi/>) gave Professor Martti Mäntylä its Information Technology Distinction for 2005 in recognition of his work in information technology and computer science both in Finland and internationally, and especially in bridging university research with R&D in the information industry.

December 2

BRU organised the final seminar of the Research Programme on Proactive Computing (PROACT) in Helsinki.

December 16

Representatives of the Peer to Peer Universal Computing Consortium (PUCC) from Japan visited HIIT. A seminar was arranged.

4 Research

4.1 Advanced Research Unit Activities

The mission of ARU is to conduct strategic research in close co-operation with leading ICT companies, aiming at a significant impact on the future progress of ICT technologies and applications and the progress of the information society. To achieve this mission, the research in ARU focuses on three research programmes, each consisting of several research projects executed by the core groups of each programme and other HIIT groups. The research areas are: Future Internet (led by Professor Kimmo Raatikainen), Intelligent Systems (Professor Petri Myllymäki), and Network Society (Dr Marko Turpeinen). The Network Society programme continues the work of the Media Convergence and Digital Economy programmes ended in 2004.

The research groups and their senior researchers involved in ARU's work during 2005 were as follows: Mobile Computing (Professor Kimmo Raatikainen, Dr Ken Rimey, Dr Pekka Nikander, Dr Andrei Gurtov); User Experience Research (Dr Timo Saari, Dr Giulio Jacucci, Professor Martti Mäntylä); Complex System Computation (Professor Petri Myllymäki, Dr Wray Buntine, Dr Jorma Rissanen, Professor Henry Tirri); Digital Content Communities (Dr Marko Turpeinen, Dr Giulio Jacucci, Dr Timo Saari); Semantic Computing (Professor Eero Hyvönen); and Digital Economy (Professor Jukka Kempainen, Dr Perttu Virtanen, Dr Pekka Nikander, Dr Pekka Himanen, Professor Martti Mäntylä).

The following sections provide a more detailed account of the research activities in each research area.

4.1.1 Future Internet

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.

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?

The Future Mobile and Ubiquitous Computing (Fuego) research area at HIIT covers a selection of research topics within this general framework. Work in the research area aims to combine two major viewpoints to the Mobile Internet: the technology view and the user view (while the equally important economical and societal views are delegated to the Digital Economy research area discussed in its own section below).

The technology-oriented research line, conducted in the Mobile Computing Group led by Professor Kimmo Raatikainen, builds on expertise in areas such as Internet protocols, middleware, peer-to-peer computing, and operating systems to study enabling technologies, infrastructures, and platforms for the Mobile Internet. The user-oriented research line, conducted in the User Experience Research Group co- led by Professor Martti Mäntylä and Dr Timo Saari, builds on a combined expertise in cognitive science, psychology, media science, and computing to study end users and their needs, novel application concepts, and the resulting user experience. The two lines of work interact in creating joint prototypes, demonstrations, and field tests.

4.1.1.1 Fuego Core: Middleware for Mobile Wireless Internet

Project leader: Raatikainen, Kimmo
Research group(s): Mobile Computing
Researchers: Tarkoma, Sasu; Kangasharju, Jaakko; Lindholm, Tancred; Saaresto, Marko; Kousa, Mika; Komu, Miika; Mäkelä, Mikko; Slavov, Kristian; Thalainayar B, Ramya
Schedule: 2002-02-01 ... 2004-12-31
Cooperation units: Department of Computer Science (UH); UC Berkeley, USA
Funding: Tekes; Elisa Communications; TeliaSonera Finland; Nokia Research Center; Ericsson; Movial
Keywords: Mobile wireless Internet, middleware services, mobile computing, adaptive applications
www-page and publications: see <http://www.hiit.fi/fuego/fc/index.html>

The Fuego Core 2005 is the first year of the Fuego Core 2005/2007 project planned to run from January 1, 2005 to December 31, 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. Fuego Core 2006 Project will concentrate on four fundamental areas in future mobile middleware: XML processing and messaging, mobile distributed event system, XML synchronization and data access, and software configuration management. Our main objectives are to enhance the achievements of the previous projects and to contribute to international standardization, particularly to IETF (SIMPLE WG) and W3C (Mobile Web Initiative and Device Independence Activity).

4.1.1.2 Services for All (E!2023 ITEA S4ALL)

Project leader: Ken Rimey
Research group(s):
Researchers: Hasu, Tero; Mäntysaari, Ville; Silander, Tea; Kanerva, Pekka; Lindholm, Tancred
Schedule: 2005-01-19 ... 2007-06-30
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 new, nontraditional services exploiting local wireless networks, on prototyping of S4ALL's envisioned *Service Composer for the Mobile End User*, and on scripting language technology for rapid service development on mobile phones. We are working with the Python programming language on Series 60 phones, as well as on Nokia's Linux-based Internet Tablet.

We intend to prototype three service concepts: household device manager, contextual messaging, and digital asset management. The emphasis for all three will be on how to enable the end user to personalize and configure their devices.

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.

4.1.1.3 Context Recognition by User Situation Data Analysis (CONTEXT)

Project leader: Mäntylä, Martti
Research group(s): User Experience
Researchers: Tiitta, Sauli; Oulasvirta, Antti; Rantanen, Matti
Schedule: 2002-11-01 ... 2005-12-31
Cooperation units: BRU/HIIT
Funding: Academy of Finland
Keywords: Proactive computing, ubiquitous computing, data analysis, data mining, user-centered design, Smartphone, human-human interaction
Research programme: Academy of Finland / Proactive Computing (PROACT)
www-page and publications: see <http://www.hiit.fi/fuego/context/>

The Context project studies characterization and analysis of information about user context and its use in proactive adaptivity. In mobile and ubiquitous applications and systems, reacting to user context is a key component of proactivity: changes in the user's situation are rapid and they are strongly reflected in the user's needs and preferences.

The project focuses on the utilization of user context: how does the context reflect the user's motivations, how to make automatic inferences about the contexts, and how to characterize contexts to users and design user interaction about contexts? These questions are considered in the framework of an example application: mobile communication, a representative ubiquitous application whose usability greatly depends on how context-sensitively communication decisions are managed. The project has adopted a multidisciplinary approach where the research problems are approached by qualitative user studies, data analysis algorithm development, and empirical testing in a prototype environment. The key results are (1) methods for utilizing qualitative user situation descriptions in the development of context-sensitive applications, (2) algorithms for context analysis and characterization, and (3) models for user interaction about context. The project has produced a prototype of a context-sensitive mobile communication application.

The project started in November 2002 with qualitative user studies aimed at revealing how users interpret context descriptions and generally context structures. A humanistic research strategy has been deployed to develop a working prototype of proactive context-communication, called ContextPhone, running on a Nokia Series 60 mobile phone. At the same time, ethnomethodological studies by the research group revealed how social and temporal contexts affect interaction and how contexts could be modelled in proactive computers. The prototype has been subjected to a series of longitudinal field studies in 2004 to examine its effects on group communication behavior.

In several field studies of ContextPhone carried out during 2005, mobile awareness information was found to have its main supportive functions in coordination of group action, self-expression, and one-to-one companionship. Field experiments carried out together with Nokia Research Center operationalized and measured fragmentation of attention in human-computer interaction in mobile situations. Continuing from this, a doctoral dissertation (of Antti Oulasvirta, University of Helsinki, Department of Psychology) examined and described how human memory systems coordinate the flow of information during interrupted task processing.

Several publications summarized a humanistic, constructive approach to context that problematized the naive realistic approach prominent among engineering approaches to context-awareness. The key idea of the constructive approach is to provide sensor information for the users instead of using it as a basis for automated proactive actions.

The project ended on 31.12.2005. The work will continue in a follow-up project *Context Cues*, accepted by Academy of Finland for 1.1.2006-31.12.2009 in November 2005.

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

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| <p>Project leader: Raatikainen Kimmo Research group(s): Mobile Computing Researchers: Riva Oriana Schedule: 2004-06-01 - 2006-08-31 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</p> |
|--|

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 year 2005, the DYNAMOS platform was implemented and evaluated. The user application running on mobile phones has been implemented using Java 2 Micro-Edition (J2ME) with Connected Limited Device Configuration (CLDC) 1.0 and Mobile Information Device Profile (MIDP) 2.0 APIs. All the development was done using Nokia Series 60 phones. The developed platform enables mobile users i) to be proactively provided with a subset of relevant services available in the territory; ii) to

generate and attach to the environment several types of contextual messages to be shared with other users; and iii) to annotate official service descriptions with public or private observations, comments, and ratings.

To evaluate the feasibility and usefulness of the proposed model, a sailing scenario of recreational sailboaters was selected. The application was evaluated in a field trial organized in the August 2005. This was held in the archipelago of the Helsinki region during a sailing regatta which is organized every year by a club of sailboaters of Helsinki. 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. At the end of 2005, part of the project development has been moved towards the deployment of a flexible and reliable middleware platform for the support of context awareness on smart phones.

4.1.1.5 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: SA/ 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 of 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 Center. Taking a wide view of relevant societal issues, we decided to focus holistically in 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, these data will be carefully analysed and various methods of dramatic scenario generation explored.

4.1.1.6 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 consists of application owners, manufacturers, operators, solution providers and academia. MobiLife is part of the Wireless World Initiative, which comprises several projects for IST.

The work of the ARU focuses on Work Package 1 of the project, generally responsible for providing a sound basis for user centricity of the entire project. Specifically, ARU maintains the iterative user-centric approach and coordinates user research activities within MobiLife. It has also contributed extensively in the generation, analysis, and validation of the driving scenarios of the project.

Currently, MobiLife is conducting the fourth and final round of user research. A set of ten application probes (prototypes) are being evaluated in Finland and Italy. In addition a smaller set of integrated applications are being developed and tested in 2006. The integrated applications summarize work across technical Work Packages, in particular technology & service enabler components interacting on top on MobiLife service architecture. In addition, ARU also contributes to analyzing the legal issues related to the scenarios and the privacy/trust issues.

4.1.1.7 Infrastructure for HIP -InfraHIP

Project leader: Mäntylä, Martti
Research group(s): Mobile Computing
Researchers: Gurtov, Andrei; Beltrami, Diego; Heer, Tobias; Komu, Miika; Koponen, Teemu; Korzun, Dmitry; Abhinav, Pathak
Schedule: 2004-08-01 ... 2006-12-31
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.

Teemu Koponen and Andrei Gurtov visited ICSI at Berkeley during summer 2005 for 3 and 2 months respectively. Additionally, a collaboration visit to Tsinghua University was made by Martti Mäntylä and Andrei Gurtov. A summer intern Abhinav Pathak from IIT Kanpur/India worked in the project for 3 months. Tobias Heer has joined the group from Tübingen University to make his Master's thesis. At TML, Essi Vehmersalo and Niklass Karlsson finished their Master's theses in the project and moved to the industry; Laura Takkinen came to the project to finalize her Master's thesis and continue with post-graduate studies.

4.1.2 Intelligent Systems

Computer science is the science of studying how things can be automated. Consequently, computational studies of intelligent systems also focus on automating intelligent behaviour — a quest where modelling plays a central role as an attempt to formalize the properties of such systems: learning, inference and intervention (actions). Due to the uncertainty and incompleteness of available information in application domains of computer science and AI 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 main applied research areas include Petabyte level scalable next generation information search, future networked learning environments, location-aware personalized services and multi-disciplinary applications of modelling in social sciences, medicine and biology.

4.1.2.1 Proactive Information Retrieval by Adaptive Models of Users' Attention and Interest (PRIMA)

Project leader: Myllymäki, Petri
Research group(s): Complex System Computation (CoSCo)
Researchers: Tuulos, Ville; Miettinen, Miikka; Wettig, Hannes
Schedule: 2003-01-01 ... 2005-12-31
Cooperation units: Neural Networks Research Centre (TKK), CKIR (Helsinki School of Economics)
Funding: Academy of Finland
Keywords: Proactivity, probabilistic
Research programme: Academy of Finland / PROACT
www-page and publications: see <http://www.cis.hut.fi/projects/mi/prima>

Successful proactivity, i.e. anticipation, in varying contexts requires generalization from past experience. Generalization, on its part, requires suitable powerful (stochastic) models and a collection of data about relevant past history to learn the models. Our goal is to build probabilistic models that learn from the actions of people to model their intentions and expectations, and use the models for disambiguating the users' vague commands and to anticipate their actions. The actions and interests are monitored by measuring eye fixations and movements that exhibit both voluntary and involuntary signs of both the cognitive state of the user and his intentions. In

addition we have investigated the possibility of using real-world Web usage patterns to signal relevance.

In 2005, the final year of the project, we managed to complete most of the tasks we set out to study. Most notably, we showed that the pilot application of proactive information retrieval is feasible in restricted settings, and indirect feedback from eye movements does help. The task is far from trivial, and we did not have time to study all of the most crucial problems, most notably, proper integration of implicit feedback and textual content. We expect the already promising results to be improved notably in the future.

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

Project leader: Tirri, Henry
Research group(s): Complex System Computation (CoSCo)
Researchers: Buntine, Wray; Perttu, Sami; Löfström, Jaakko; Silander, Tomi; Tuominen Antti
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 context for our research is the development of a kernel for supporting a subject-specific node in a distributed, hierarchical system for supporting navigation and search on Internet pages. The node may have tens of millions of pages, and needs to automatically build its own hierarchies for topic, genre, and terminology - aspects of the document set that we call a concept map. The objective of the project is to provide the statistical computing techniques and their implementations needed to build a search engine kernel for the next generation Internet search services. The topics studied focus on developing statistical modelling techniques such as the multinomial Principal Component Analysis (mPCA), and addresses both the theoretical development and the applied aspects for very large (giga and terabyte) document data sets.

Development of the Multinomial PCA code base and matching theory continued in 2005, and initial pilots based on the results gave promising results. A web site for promoting the results of the project was created and is being maintained at www.componentanalysis.org.

4.1.2.3 Minimum Description Length Modelling in Computer Science and Statistics (MINOS)

Project leader: Tirri, Henry
Research group(s): Complex System Computation (CoSCo)
Researchers: Rissanen, Jorma; Myllymäki, Petri; Roos, Teemu; Kontkanen, Petri; Silander, Tomi
Schedule: 2002-01-01 ... 2005-12-31
Funding: Academy of Finland
Keywords: Minimum description length principle (MDL), stochastic complexity, universal modeling, model selection, predictive inference
www-page and publications: see <http://cosco.hiit.fi/Projects/MINOS/>

The objective of this research is to develop and study the Minimum Description Length (MDL) approach to modelling and its relationship to other probabilistic approaches used in computer science and statistics. Formally MDL modelling is approached from various directions including Fisher's Maximum Likelihood Principle and minimax formulations leading to universal coding which extends Shannon's Source Coding Theorem. In particular we will focus on the recent Normalized Maximum Likelihood formulation of MDL, as well as in the predictive form (PMDL), properties of which are not yet well understood. The emphasis on applying the theoretical work will be in computationally efficient model selection and prediction problems in computer science.

In 2005 the research continued on studying computational issues related to the Normalized Maximum Likelihood (NML) formulation of the MDL principle, and the practical applications of the results. One of the key applications studied was denoising of images with wavelet models. More information can be found at www.mdl-research.org, which is a portal for promoting MDL-related work, maintained by the CoSCo group.

4.1.2.4 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 ... 2006-12-31
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>

In the first two years of the project the work focused on basic research and experimentation with our content models and search infrastructure. Already during the early phases of the work the project produced several demonstrations that gave both us and our partners first-hand experience on the behavior of the models. The demonstrations were built using both realistic web data and data sets provided by the partners, sizes varying from 20 000 to 800 000 documents.

Based on experiences gained from the first demonstrations, we continued improving and packaging our main deliverables: MPCA content model, which is already distributed publicly, and Ydin search back-end. These form the core of Search-In-a-Box, providing the needed infrastructure for demonstrations. Together these packages sum up to some 95 000 lines of code.

Ydin and MPCA have been used to develop a demonstration of a public search engine for the freely available Wikipedia encyclopedia, an online encyclopedia undergoing rapid growth. The pilot can be found at <http://wikipedia.hiit.fi>. MPCA is also being integrated in M-Brain's content delivery system to provide relevance ranking of news content for the large editing teams working at M-Brain.

In the latter part of the project we decided to crystallize the main lessons learnt by building public prototypes of large scale, full-fledged Internet search engines. One of these prototypes, the Aino Search Engine, provides content- based search for the whole .FI domain, consisting of about 10 million documents. An effort of this scale requires strong emphasis on distribution of computational load, which was achieved by streamlining the needed components to small, independent modules. We took an opportunity to experiment with a novel content-based ranking scheme of ours, which should be especially robust in noisy environments like the Web. Together the new ranking scheme and the modular back-end form the basis for Aino. In addition this effort gave birth to an efficient web crawler, HooWWWer. Together Aino and HooWWWer power a publicly available, regularly updated, search engine for the Finnish Web. The source code of this system is also in public distribution. The Aino system was demonstrated at the annual meeting of the Fenix programme in April 2005. The system was on-line at the address <http://aino.hiit.fi> until the re-location of the Cosco team to Kumpula. A new public version of Aino will be launched later in 2006.

4.1.2.5 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; Tuominen, Antti
Administrative Manager: Kontiainen, Mikko
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 ALVIS objectives are: 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 coordinates the project, develops the central relevance component that supports ranking of documents retrieved by a query, for instance, and plays a major role in the integration and testing stages. In 2005 HIIT coordinated the efforts to produce a document-processing pipeline, integrated some core technology into the pipeline, and developed a demonstration of the relevance technology using the Wikipedia as content.

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

Project leader: Myllymäki, Petri
Research group(s):
Researchers: Tuominen, Antti
Schedule: 2005-01-01 ... 2005-12-31
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 in 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 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 being developed in the EU-project Alvis.

When visualizing complex multidimensional information, graphical representations have been proposed as more ergonomic and user friendly interface alternatives to the conventional list-based solutions used in search engines like Google. Nevertheless, the visual solutions proposed are usually built according to purely engineering principles, even though it is known that in case of complex visualizations, immediate extraction of information is often difficult, and that people have, for example, difficulties in perceiving different data dimensions at a single glance or even under longer scrutiny. What is more, the solutions are typically not properly validated. The principal goal of the suggested project is to investigate what type of mental

representations the visualizations of multidimensional information evoke and how these representations are formed, and then examine how these visualizations guide behaviour and how multidimensional representations affect problem solving and decision making.

4.1.3 Network Society

Starting in 2005, a new HIIT research programme called Network Society was launched. It strongly based on work done previously in Digital Economy and Media Convergence programmes, in addition combining new elements from data modelling and understanding of complex dynamic phenomena. The mission of Network Society programme is human-centric development of ubiquitous information and communication technology, which is based on deep understanding of 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. Anyone who has the technology to receive communication also has the technology to produce the content of communication. Digital interactions can be automatically customized to suit our needs and preferences. Places, things and situations are enriched with short-range communications, positioning and context-awareness.

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.

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 research the future everyday uses of information technology and social computing. To develop successful new technologies, and bear responsibility of design decisions, we as developers should understand and anticipate the dynamics of technology-society interaction. This requires multi-disciplinary end-to-end research from technological platforms to various viewpoints to their impact on the use environment and our human-human interactions.

4.1.3.1 Mobile Content Communities (MC2)

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities, User Experience
Researchers: Herrera, Fernando; Kuikkaniemi, Kai; Rantanen, Matti; Saari, Timo; Salovaara, Antti; Sarvas, Risto; Vuorenmaa, Janne; Hietanen, Herkko; Lehdonvirta, Vili; Järvinen, Atte; Koponen, Jarno
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 studies the social meaning and impact of new communication technology for communities that are interested in mobile gaming. The results expected of the MC2 project include evaluated and tested scenarios of mobile community gaming, template-based design tools that allow people to create their own games and game-related content, new open source tools to empower the community activity, and company-specific case studies to help the industry partners to benefit from community-created content.

Based on the interests of project participants and sponsors four concepts have been implemented related to mobile gaming content development. *Mupedev.org* is a community of developers for the open source Multi-User Publishing Environment (MUPE) platform, in collaboration with Nokia Research Center. *MAR toolkit*, is an extension to the MUPE platform for creation of mobile augmented reality multi-user applications and games. *Prediction League Engine* is a community betting system, where users set up their own prediction leagues and bet on the web and using a mobile phone. *Fansite Starter Kit* has provided design guidelines for a web-based toolkit for publishing Habbo Hotel related fansite content, in collaboration with Sulake.

We also study how the integration of a camera into a mobile phone affects people and their photographing. The work related to camera phones has focused on what kind of pictures people take and with whom they share them. We have constructed a mobile picture-sharing application *MobShare*, which was commercialized by our company partner Futurice. Another commercially available system called *Comeks* was implemented in collaboration with a new start-up Bulbon for user-created comic strips on smart phones.

4.1.3.2 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
Schedule: 2004-08-01 ... 2006-07-31
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/tte/tte41/rise/>

The project studies the possibilities in using rich semantic descriptions to combine professional-quality media content with user-created media content. 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.

HIIT concentrates in this project on building the DiMaS architecture for media distribution that bundles media content with rich semantic metadata. Especially, we study the bundling of license and digital rights management information with media content for the purpose of peer-to-peer media delivery. As a demonstration application, we implement a system for media “remixing” that allows users to easily create video material that combines video material from existing media archives with user’s own media content.

4.1.3.3 Intelligent Web Services

Project leader: Hyvönen, Eero
Research group(s): Semantic Computing
Researchers: Apiola, Mikko; Lindgren, Petri; Mäkelä, Eetu; Saarela, Samppa; Salminen, Mirva; Sidoroff, Teemu; Viljanen, Kim;
Schedule: 2003-08-01 ... 2005-07-31
Cooperation units: Department of Computer Science (UH)
Funding: Tekes; Fonecta; TeliaSonera Finland; TietoEnator; The Ministry of Finance; Stakes
Keywords: Semantic web, web services
Research programme: Tekes / FENIX
www-page and publications: see <http://www.cs.helsinki.fi/group/iwebs/>

The Intelligent Web Services (IWebS) research project studied the possibilities of the Semantic Web and Web Services technologies in both annotating services and delivering relevant services to the end-users. The project contains three major case studies. Firstly, a demonstrational intelligent yellow pages service is created, where the services can be annotated and found easily using ontology techniques. Second, we study application of semantic portal techniques using content from the eGovernment portal Suomi.fi. Thirdly, ontological representation and discovery of eHealth services are studied. The results of the IWebS project include an intelligent annotation editor for the service providers, ontologies for describing and storing the services, and an intelligent search engine for finding services for the end-users.

4.1.3.4 Wireless Woodstock Services in Finland

Project leader: Mäntylä, Martti
Research group(s): Digital Economy, User Experience, Digital Content Communities
Project Manager: Jacucci, Giulio;
Researchers: Pitkänen, Olli; Salovaara, Antti; Jacucci, Giulio; Kanerva, Pekka
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

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 is studying, prototyping and evaluating 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.

In the first two quarters of 2005 (January - June) we finished the implemented mGroup, a client-server Java application for the Nokia 6630s (a Series60 smart phones), to be used in large-scale events. The application – mGroup – is a mobile media sharing application for groups of spectators and visitors, based on the following principles:

- 1) Story-based communication spaces. Users create “media stories” inviting specific members forming different media spaces to support topical discourses.
- 2) Threaded replies and presence features. Each message is delivered instantly to its members with reply possibility. mGroup visualises member’s online/offline status and the latest contributors in the stories.
- 3) Combining spectators media and real time event content services. Spectators can access and comment dedicated stories with real-time event content (by event organisers, competitors, or performers).
- 4) Automatic album creation for post-event re-experience. Each media story is also a shared album in an up-to-date web page protected by password.

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 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 two largest trials were carried out at the Hultsfred Rockfestival June 2006, and the WRC Neste Rally August 2006. In additions TeliaSonera carried out at the World Athletic Championship trials of localised services based on near field communication.

In the fourth quarter 2005 (October - November) we have completed the analysis of the trials and completed the re-design of the application. In particular, mGroup will include a new component which will integrate the functionality of a dynamic booklet of the event. Also we are integrating presence and context aware features. TeliaSonera Finland tested rfid's possibilities (basic interest, usage and challenges) in an event environment in two B2B events. The differences between B2C and B2B events were also discussed.

The project has been accepted in the Celtic review meeting in Stockholm the 11/10/2005.

4.1.3.5 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
Schedule: 2005-10-01 ... 2007-12-31
Cooperation units: UC Berkeley, MIT Media Lab, TU Delft
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.

4.1.3.6 Network of Mobile Context-Aware Applications and Games

Project leader: Turpeinen, Marko
Research group(s): Digital Content Communities
Researchers: Vuorenmaa, Janne; Kuikkaniemi, Kai
Schedule: 2005-09-01 ... 2006-12-31
Cooperation units: Tampere University of Technology, Lappeenranta University of Technology, 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 yet exist. 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.

4.1.3.7 Role of Paper in Future Communications

Project leader: Marko Turpeinen
Research group(s): Digital Content Communities
Researchers: Vihavainen, Sami
Schedule: 2005-01-01 ... 2005-07-31
Cooperation units: University of California, Berkeley, USA
Funding: KCL
Keywords: paper, future communication needs, hybrid media

The project seeks to understand the role of paper in future communications based on expert opinions, and focus group interviews. The project especially concentrates on the requirements for the quality of paper products and hybrid media. The project will also prepare and deepen the collaboration between HIIT and KCL.

4.1.3.8 Immortalidad: Future Social Use of Photographs

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

The Immortalidad project studies future social use of personal media. Grounding the work on literature and empirical data on domestic photography capture and sharing, we design future concepts that blur the boundaries between personally, socially, and professionally created media. Also, the concepts take into account the perceptions and characteristics people assign to digital and paper as format for media. Selected concepts will be implemented with project partners. The implementation involves strong user participation and evaluation to gain a better understanding of future products, services, and business for hybrid media. The project is 18 months and 7.5 person years in total.

4.1.3.9 Managing Privacy and Trust in P2P Communication (Muppet)

Project leader: Mäntylä, Martti
Research group(s): Digital economy
Researchers: Heikkilä, Juho; Kortnesniemi, Yki; Sarkio, Katri; Stenborg, Markku; Päivärinta, Juha; Kanerva, Pekka; Reti, Tommo; Rantanen, Matti
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.

In 2006 the project will conclude in developing a demonstration on the DiMaS platform. The reputation mechanism will be extended to be aware of the involved social network. Possibilities for access control for reputation data will also be studied.

4.2 Basic Research Unit Activities

The mission of BRU is to do basic research in computer science in areas in which there are applications visible, either in other sciences or in industry. The research themes are adaptive computing (led by Dr Patrik Floréen and Professor Hannu Toivonen), data analysis (Professor Heikki Mannila, Professor Hannu Toivonen), and neuroinformatics (Dr Aapo Hyvärinen).

4.2.1 Adaptive Computing Systems

Adaptive computing 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-aware adapting 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.

4.2.1.1 Coordination of Research Programme on Proactive Computing

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: see <http://www.aka.fi/proact/>

BRU has 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).

During 2005, the coordination arranged a colloquium on proactive computing in the spring. In the colloquium, the PROACT projects presented their research for a general audience. The colloquium was held in Helsinki on Tuesday evenings and was well attended by researchers, students and other interested listeners. On 16-17 June 2005, the coordination helped in organising the 1st workshop on Context-Awareness for Proactive Systems in Helsinki. The two-day workshop was attended by about 50 researchers from 8 countries. The final seminar of the research programme was arranged on 2 December 2005. The PROACT projects themselves also organised conferences, workshops and conference in the field of proactive computing. The research programme figured extensively in the media during 2005.

The coordinator was interviewed both in journals and on TV and he also gave talks about the programme on several occasions. During 2006, the coordination helps in arranging the international evaluation of the research programme and will also publish the final scientific report of the programme.

4.2.1.2 Context Recognition by User Situation Data Analysis (CONTEXT)

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|---|
| <p>Project leader: Toivonen, Hannu Research group(s): Adaptive Computing Systems Researchers: Laasonen, Kari; Petit, Renaud; Raento, Mika; Toivonen, Hannu Schedule: 2002-11-01 ... 2005-12-31 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: see http:// www.cs.helsinki.fi/group/context/</p> |
|---|

Led by Professor Hannu Toivonen, this project looked at ways of analysing context information to enable mobile devices to recognize the situation in which they are used and to present this information to the users. This joint BRU/ARU project was part of the Research Programme on Proactive Computing of the Academy of Finland (see above), completed in December 2005.

The project developed the ContextPhone software. It is a prototyping platform for context-aware systems: it allows collection, analysis, transmission and presentation of user context on Series60 mobile phones. ContextPhone has been released as free software. ContextContacts, one of the many research applications of ContextPhone, is a service for automatic communication and representation of the context of your friends, and it is used in field research with HIIT/ARU to study how such automatic publication of one's context can be integrated into the way people manage privacy: what data can safely be communicated, or how should the service be controlled and what level of accountability should be provided.

The ContextMedia application automatically annotates and shares photos and other media captured with the phone, used in co-operation with Media Lab, University of Art and Design Helsinki, to experiment with mobile, locative and situated media practices. University of California Berkeley's Garage Cinema Research Group at the School of Information Management Science is using ContextMedia to study computer-aided annotation of mobile media. MIT Media Lab used ContextLogger to gather-for the first time in the world-actual measurements of the strength, dynamics and evolution of social networks. VTT Technical Research Center of Finland is also using ContextLogger, in order to study workgroup social patterns. The Oslo National Academy of the Arts is staging a surveillance exhibit with the aid of a custom ContextPhone application.

We have also developed methods for analyzing context data, in particularly discovery and recognition of personally important places and routes based on traces of GSM cells of a user. An immediate application is in presence services: "John left the office ten minutes ago and is heading towards home" would be an informative description of John's status. Results include new concepts and algorithms for these tasks. We have also investigated user interaction and privacy issues for context aware mobile computing.

4.2.1.3 Networking and Architecture for Proactive Systems – Algorithmics (NAPS)

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Kohonen, Jukka; Nurmi, Petteri; Suomela, Jukka; Boström, Fredrik; Hassinen, Marja; Kukkonen, Joonas; Sirén, Jouni
Schedule: 2003-01-01 ... 2005-12-31
Co-operation units: Laboratory for Theoretical Computer Science (TKK); Networking Laboratory (TKK)
Funding: Academy of Finland
Keywords: Ad hoc networking, algorithms
Research programme: Academy of Finland / Proactive Computing (PROACT)
www-page and publications: see http://www.cs.helsinki.fi/hiit_bru/projects/naps/

This HIIT/BRU project is part of the NAPS consortium (Networking and Architecture for Proactive Systems), to which belongs also the research groups of Professor Pekka Orponen (Helsinki University of Technology, Laboratory for Theoretical Computer Science) and Professor Jorma Virtamo (Helsinki University of Technology, Networking Laboratory). The consortium is part of the research programme Proactive Computing (PROACT) of the Academy of Finland. The network computing and communication models underlying proactive applications give rise to new opportunities and challenges in the fields of algorithm design and analysis.

During 2005, the project continued research on energy-efficient designs in sensor networks. We have studied balanced data gathering, where the task is to maximise the total amount of data received at the sink, while simultaneously ensuring that a minimum amount of data is forwarded from all sensors. We have presented a new approximation algorithm for finding an optimal routing in this setting. We have also studied the possibility of further improving balanced data gathering by adding a number of new relay nodes. Our earlier research on lifetime maximisation in ad-hoc networks was presented in a journal article.

4.2.1.4 Software Platform and Component Environment for yoU (Space4U)

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Przybilski, Michael; Kurppa, Teemu
Schedule: 2003-07-01 ... 2005-06-30
Co-operation units: Industrial Information Technology Laboratory (TKK); Nokia Research Center
Funding: Nokia Research Center
Keywords: Context-awareness; component frameworks; middleware; embedded systems
www - page and publications: <http://www.cs.helsinki.fi/group/space4u/>

The EUREKA ITEA project Space4U (Software Platform and Component Environment for yoU) continues the work of the ITEA project ROBOCOP. ROBOCOP resulted in a component-based architecture for middleware for embedded appliances. The aim of Space4U is to enhance this architecture with power management, fault management and remote terminal management. HIIT/BRU acts as a subcontractor to Nokia Research Center in this project. The work is focused on the parts of the Space4U project connected with terminal management and context-

dependent configuration. This part of the project develops the selection, transferral and execution of context-based software components in terminals with limited resources.

The project was divided into two phases; the first one, "Terminal Software Management System Design/Development," started in July 2003 and ended in June 2004. The second phase, "Terminal Management Demonstrator Development," started in July 2004 and ended in June 2005. The project activities in 2005 included implementation of the new version of the Robocop Runtime Environment (RRE), participation in the final specification of the extended software framework and description of extended methods and technologies, development of demonstrators and demonstration at the ITEA Symposium in October 2005.

4.2.1.5 MobiLife – Mobile Life

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik ; Nurmi, Petteri; Przybilski, Michael; Suomela, Jukka; Björkqvist, Cilla; Boström, Fredrik; Lagerspetz, Eemil
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.cs.helsinki.fi/group/mlife/](http://www.cs.helsinki.fi/group/mlife/)

The objective of the MobiLife Integrated Project is to bring advances in mobile applications and services within the reach of users in their everyday life. The MobiLife project, with 22 partners in nine countries, is coordinated by Nokia. It is part of a larger set of EU projects called Wireless World Initiative (WWI). The group at HIIT / BRU focuses on the context-awareness aspects of the project. We research context reasoning methods, as well as context-aware software architectures. HIIT/BRU is task leader of the task Context Management.

In 2005, the group worked on the design and specification of the Context Management Framework. The group's focus is on context reasoning. We have designed and implemented a generic reasoning component that allows the use of different reasoning mechanisms. To this end, we have implemented a reasoning mechanism that uses Bayesian classifiers. We have also worked on building cross-platform data gathering tools, studied the automatic recognition of socially meaningful groups from context data, and promoted the integration of the MobiLife architecture into the general WWI system architecture.

4.2.1.6 Trust4All

Project leader: Floréen, Patrik
Research group(s): Adaptive Computing Systems
Researchers: Floréen, Patrik; Przybilski, Michael
Schedule: 2005-10-30 ... 2006-09-30
Co-operation units: Nokia Research Center
Funding: Nokia Research Center
Keywords: Trust, context-awareness; component frameworks; middleware; embedded systems
www - page and publications: see <http://www.cs.helsinki.fi/group/t4all/index.html>

In the ITEA project Trust4All, we work on context-aware adaptations of trustworthy systems, in particular with regard to its dependability and security properties. The project develops a middleware software architecture for embedded systems that require a defined level of trust, due to the nature of the services they provide.

To enable this adaptation we use the frameworks and mechanisms developed in the preceding projects ROBOCOP and Space4U. The ROBOCOP project defined and implemented a middleware architecture that is especially suited for mobile devices and PDAs. The Space4U project extended this middleware with fault prevention, power management and terminal management, including secure downloading.

The project is a joint effort of several European universities and companies. The research project at HIIT/BRU is a subcontract from Nokia Research Center.

The project started with studying architecture requirements and a trust framework, as well as demonstrator use cases and requirements.

4.2.2 Data Analysis

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

4.2.2.1 Altti: Computational Methods for Gene Mapping

Project leader: Toivonen, Hannu
Research group(s): Data analysis
Researchers: Eronen, Lauri; Geerts, Floris; Goethals, Bart; Hintsanen, Petteri; Muhonen, Juho; Onkamo, Päivi; Sevon, Petteri; Toivonen, Hannu
Schedule: 2003-08-01 ... 2005-02-28
Co-operation units: GeneOS Ltd; Jurilab Ltd; Cyberell Ltd; Karolinska Institute, Sweden; Department of Medical Genetics (UH)
Funding: Tekes; companies; BRU; UH
Keywords: Gene mapping, genetics, data mining
www-page and publications: see <http://www.cs.helsinki.fi/group/genetics/>

In this completed project we developed and applied methods for gene mapping, and for analysing genotypes, haplotypes, and phenotypes and their relationships in more general. Locating genes that predispose to diseases is highly important in understanding the etiology of complex common diseases, such as heart disease, or asthma. For association analysis, the sample of patients, controls, and their relatives is genotyped and haplotyped, i.e. the two alleles at each marker locus in each individual are ordered according to their parental origin. Then, alleles and short strings of alleles of nearby (consecutive) markers correlating with the patient-control status are searched by means of association methods. The aim is to pinpoint the location of the disease susceptibility (DS) mutation as accurately as possible.

We developed computationally efficient methods for different stages of analysis of large genetic data sets. We introduced new methods for haplotyping large marker maps. These methods allow efficient and accurate haplotyping of modern high-throughput genetic data, and they have been applied with good success to some very large data sets of our partners. Significant efforts were invested into developing new population simulation technology and using it to study the effects of different gene mapping study designs, sampling methods, mapping methods, and haplotyping methods on gene mapping accuracy. The results indicate that our pipeline of computationally efficient tools is also accurate and statistically powerful in gene mapping, and it allows easier and more economical study designs.

4.2.2.2 Data Analysis for Functional Genomics

Project leader: Hollmén, Jaakko
Research group(s): Data analysis
Researchers: Ruosaari, Salla; Seppänen, Jouni; Patrikainen, Anne
Schedule: 2002-01-01... 2005-31-12
Co-operation units: Finnish Institute of Occupational Health, Department of Medical genetics (UH), National Public Health Institute (KTL)
Funding: Academy of Finland, European Commission; graduate schools
www-page and publications: see <http://www.cis.hut.fi/jhollmen/hiit/genomics.html>

The project has concentrated on developing computational methods for analyzing gene expression data in combination with other sources of data, such as CGH microarrays measuring the gene copy number changes. Such copy number number alterations play an important role in cancer research. Also, the context, such as the spatial location of the genes, has been used as an additional source of information. One of the goals of the research has been to identify a few important genes or factors behind the disease, that is, the identification of diagnostic markers. Methodologically, research towards learning of parsimonious or sparse models has been initiated. The work is mainly carried out in collaboration with domain specialists in biology and medicine.

4.2.2.3 CompGenome: New Computational Methods for Analyzing the Structural and Functional Landscapes of Mammalian Genomes

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 availability of a large mass of genomic data will make it possible to study in detail the genomic landscape in humans and other mammalian organisms and to investigate the variation both within and between species. The CompGenome project will develop and apply computational tools for describing the genomic and functional variation between individuals and between species, and study the significance of these variations for the functions of genes. This information will eventually be used to understand the potential relationships of such variations in the genome landscape and complex diseases. In particular, the project will develop (a) tools for the hierarchical description of the haplotype structure of human (and other mammalian) genomes, (b) techniques for the identification of rearrangements, duplications, and other large-scale variations in genomes; (c) methods for trait-cluster-based multiple locus testing in complex traits, and (d) tools for analyzing the relationship between transcript profiles and sharing of genome segments.

In 2005 the work has continued in several directions. Segmentation algorithms have been further developed and applied to genome data. Modeling haplotypes with a hidden Markov model led to a new technique for the haplotype reconstruction (phasing) problem. There has been also progress in developing computational methods for the identification of rearrangements from haplotype data.

4.2.2.4 Algorithmic and Probabilistic Methods in Data Mining

Project leader: Mannila, Heikki
Research group(s): Data analysis
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
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. Also issues in subspace clustering and spectral methods have been studied.

In 2005 there were several interesting developments. The methods on seriation problems in paleontological and other applications advanced very considerably, and the publications were accepted to important forums. The novel problem setting of mining chains of relations has great promises, as well as the work on condensed representations and on spatial clustering. Special emphasis was given to work on finding partial orders from data.

4.2.2.5 Spatial and Temporal Data Mining

Project leaders: Salmenkivi, Marko; Gionis, Aristides
Research group(s): Data analysis
Researchers: Leino, Antti; Hyvönen, Saara; 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.

We have developed parameter-free methods for spatial data mining based on MDL techniques. These methods have been applied to a data set of breeding information of 248 bird species in Finland. In this application the aim is to find spatially coherent regions, where the distribution of breeding bird species is similar.

Many application areas in our work are closely related to linguistic variation, and the history of settlement: firstly, the study of the distribution of place names in Finland, and secondly, the investigation of spatial distributions of Finnish dialect words. Co-operation with experts in Finno-Ugrian linguistics and folklore has been originated in the research project that analyses signs of ancient Saami inhabitation in South and Central Finland. From the computational point of view some of the main challenges are the analysis of large number of point patterns, and the uncertainty concerning the linguistic origin of individual names.

Clustering and dimension reduction techniques (e.g., ICA, PCA) have been applied to the dialect word data set, each word being associated with the set of municipalities where the word is known to be used. A goal of the research has been the exploration and evaluation of dialectically coherent regions. The problem of uneven sampling is essential in this application. The data were sampled during the whole 20th century, and the samples were not selected geographically uniformly. We model the missing data and the non-uniform sampling by Bayesian Markov random field models, and Markov chain Monte Carlo methods. The data set is large, and these procedures are heavy. We aim at reconstructing as complete data set as possible, with a clear understanding of the remaining uncertainty. Then clustering and dimension reduction techniques, for instance, can be applied to more reliable, less unbiased data.

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

4.2.2.6 Biomine: Knowledge discovery in biological databases

Project leader: Toivonen, Hannu
Research group(s): Data analysis
Researchers: Eronen, Lauri; Hintsanen, Petteri; Kulovesi, Kimmo; Muhonen, Juho; 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: see <http://www.cs.helsinki.fi/group/biomine/>

Public biological databases contain huge amounts of rich data, such as annotated sequences, proteins, domains, and orthology groups, genes and gene expressions, gene and protein interactions, scientific articles, and ontologies. The Biomine project develops methods for the analysis of such collections of data.

In the Biomine approach, all information is handled as graphs: nodes correspond to different concepts (such as gene, protein, domain, phenotype, biological process, tissue), and semantically labelled edges connect related concepts (e.g., gene BCHE codes protein CHLE, which in turn has the molecular function 'beta-amyloid binding'). One central goal is to develop methods for establishing new, previously unknown connections between nodes, in other words, creation of biological hypotheses. We develop and use data mining algorithms for this. Predicted connections could be based, for instance, on discovered analogies between two concepts or their contexts, or on finding (strong) paths between concepts.

First results include methods for extracting relevant subgraphs and models for measuring the strength of connections between given concepts. We have also integrated public biological databases to an in-house graph database of over 10 million objects. These tools are currently used in studies of, e.g., dyslexia and Huntington disease.

Discovery of patterns in graphs have numerous potential applications in biology, including the analysis of metabolic networks, regulatory relationships, protein structures, and chemical compounds, as obvious candidates. Virtually any data could be described as graphs, and the developed methods can potentially be applied in other areas, too.

4.2.3 Neuroinformatics

Leader: Hyvärinen, Aapo

Researchers: Hoyer, Patrik; Hurri, Jarmo; Hyvärinen, Aapo; Kurki, Ilmari; Köster, Urs; Perkiö, Jukka; Shimizu, Shohei

Schedule: 2003-08-01...

Co-operation units: Department of Psychology (UH); Neural Networks Research Centre (TKK); Osaka University, Naples University, Riken Brain Science Institute (Japan)

Funding: Academy of Finland; BRU basic funding, Japanese and German foundations

www-page and publications: see http://www.cs.helsinki.fi/hiit_bru/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.

A consortium was formed in collaboration with Dr Jussi Saarinen, Dept of Psychology, UH, and Dr Simo Vanni, Brain Research Unit, TKK, to conduct multidisciplinary research on the visual system in the brain. We submitted an application to the Neuroscience Program of the Academy of Finland, and obtained funding for approximately 12 person-years.

New models for statistical analysis of natural images were developed by a number of group members. In particular, we considered two-layer models, segmentation models, and multimodal integration. New methods for brain imaging data analysis were developed in collaboration with brain imaging experts in Naples University.

On the theoretical front, a new framework for estimating Bayesian networks or structural equation models for continuous-valued data was developed. This resulted in the LiNGAM software package which was made publicly available on the web. Furthermore, new optimality results were proven concerning our previously developed "score matching" method for estimation of intractable probabilistic models.

5 Research Training and Research Visits

5.1 Doctoral Degrees Earned by HIIT Personnel

Mielikäinen, Taneli: *Summarization techniques for pattern collections in data mining*. University of Helsinki, Department of Computer Science, May 2005. Professor Gautam Das was the opponent and the custos was Professor Esko Ukkonen from the University of Helsinki.

Virtanen, Perttu: *Database rights in safe European home. The path to more rigorous protection of information*. Lappeenranta University of Technology, Department of Business Administration, February 2005. Professor Mads Bryde Andersen from the University of Copenhagen, Denmark was the opponent and the custos was Professor Jukka Kempainen from Lappeenranta University of Technology and HIIT.

Välimäki, Mikko: *The Rise of Open Source Licensing. A Challenge to the Use of Intellectual Property in the Software Industry*. Helsinki University of Technology, Department of Computer Science and Engineering, May 2005. The opponent was Professor, PhD Thomas Riis from Copenhagen Business School, Denmark. Professor Juha Laine acted as the custos.

5.2 Post-graduate Courses Arranged by HIIT

Spring 2005 Courses

Advanced Topics in Databases (Foto Afrati, National Technical University of Athens)

Algorithms for segmentation problems (Heikki Mannila)

Computational Systems Biology (Esko Ukkonen)

Computer Law (Olli Pitkänen)

Information networks (Panayiotis Tsaparas)

Linear Algebra Methods for Data Mining (Saara Hyvönen)

Modeling of Perception (Aapo Hyvärinen)

Proactive Computing Colloquium: Does the computer know what you want next?
(Greger Lindén)

Research Seminar on Data Analysis for Bioinformatics (Samuel Kaski)

Seminar on New Business in Digital Economy: Computer-Mediated Communities
(Marko Turpeinen)

Spatial information management and data analysis (Marko Salmenkivi)

Three concepts: Information (Petri Myllymäki)

Summer 2005 Courses

4th Berkeley-Helsinki Workshop on Telecommunication Software Architectures
(Kimmo Raatikainen)

Autumn 2005 Courses

Advances in mobile interaction (Antti Oulasvirta)

Biological Sequence Analysis (Esko Ukkonen)

Causal analysis (Patrik Hoyer)

Computational Complexity (Aristides Gionis)

Context-Aware Computing (Patrik Floréen, Greger Lindén)

Data mining methods (Hannu Toivonen)

Graphical Models (Wray Buntine and Petri Myllymäki)

Probabilistic Logic Learning (Taneli Mielikäinen)

Research Seminar on Algorithms: Sums of Products (Mikko Koivisto)

Research Seminar on Datacommunications Software (Andrei Gurtov)

Seminar on User Interfaces and usability (Vesa Kantola)

5.3 Visits to HIIT

PhD Donato Debora, The Department of Computer and Systems Science (Dipartimento di Informatica e Sistemistica) of the University of Rome (5 Dec 2004 - 28 Jan 2005).

Head of Nokia Research Center Bob Iannucci visited Basic Research Unit, Kumpula (February 16).

Professor Dimitris Papadopoulos, Database Lab., Department of Computer Science and Engineering, University of California, Riverside USA (February 25 - March 6).

HIIT hosted four visitors from the Tsinghua University, China: Professors Lizhu Zhou, Maosong Sun, Qiang Zhou and Mr Qi Guo. The visit was related to the next generation information retrieval work done by the Cosco group in the projects SIB, Alvis and Prose (March 1 – 8).

Professor Foto Afrati, School of Electrical and Computing Engineering National Technical University of Athens (March 30 - June 15).

Mr Guo Hang from Tsinghua University, China had a 6-month visit to HIIT hosted by the SIB project of Cosco (November 2004 - April 2005).

PhD Cristiano di Flora from Federico II University of Naples, Italy. Cristiano has been collaborating with the group of Professor Kimmo Raatikainen since September 2003 (April 13 – May 11).

Research Assistant Abhinav Pathak, IIT Kanpur, India (May 1 – July 31).

Research Assistant Ramakrishna Thanniru, IIIT Bangalore, India (May 6 – July 31).

Associate Professor Gautam Das, Computer Science and Engineering Department, University of Texas at Arlington, USA (24 May - July 7).

CATR Visiting Researcher Wang Xuefei from the China Academy of Telecommunication Research of MII (CATR), the only telecom research institution of the Chinese government at the national level. At HIIT, Mr Wang partially participated in the Wireless Festival project (June 2005 - May 2006).

Professor Tatsuo Nakajima from the Distributed and Ubiquitous Computing Laboratory at Waseda University, Tokyo, Japan visited Nokia Research Center and HIIT (April 9 - October 1).

Professor Nancy Van House, SIMS, UC Berkeley, USA (August 2 – 3).

Professor Vasudeva Varma, HIIT Hyderabad, India hosted by Professor Petri Myllymäki from the CoSCO group. Professor Varma was interested in initiating discussions about potential future collaboration between the two institutes (August 9).

Researcher Simon Lacoste-Julien, Berkeley, USA (August 15 – 28).

Professor Frank Biocca, Michigan State University, USA (August 17).

Professor Andrew Barron, Yale, USA, gave two invited talks titled *Statistical Foundations and Properties of the Minimum Description Length Principle* and *Consequences of Minimum Description Length for Neural Nets and Gaussian Mixtures* (August 22 – 25).

Research Assistant David Soriano Martinez, Barcelona, Spain (September 2005 – February 2006).

PhD student Robert Gwadera, Department of Computer Sciences, Purdue University, USA (September 6 - October 9).

Dr Alexander Hinneburg, Institute for Informatics, Martin-Luther University, Germany (September 1 – 23).

Dr Ata Kaban, School of Computer Science, University of Birmingham, UK (September 11 – 24).

Research Assistant Tobias Heer, Universität Tübingen, Germany (October 2005 – May 2006).

Professors Nelson Morgan, Eran Halperin and Vern Paxson from the International Computer Science Institute (ICSI) at UC Berkeley, USA (October 12).

Dr Nathan Eagle MIT MediaLab, USA (September 9).

Shohei Shimizu, Research Fellow of the Japan Society for the Promotion of Science, Osaka University, Japan (September 16, 2003 - March 31, 2005).

Siegfried Nijssen, Institut für Informatik Freiburg, University of Freiburg, Germany (November 20 - December 3).

5.4 Visits from HIIT

Researcher Matti Rantanen: University of California at Berkeley, USA (August 18, 2004 – May 31, 2005).

Researcher Herkko Hietanen: University of California at Berkeley, USA (January 24, 2005- March 1, 2006).

Researcher Matti Kääriäinen: International Computer Science Institute, Berkeley, California Algorithms Group (April 4, 2005 - April 4, 2006).

Researcher Niina Haiminen: IBM T.J. Watson Research Center, NY, USA (May 23 - August 12).

Researcher Evimaria Terzi: Intelligent Information Systems Group, IBM Almaden Research Center, San Jose, CA, USA (May 23 - December 2).

Senior Research Scientist Andrei Gurtov: University California at Berkeley, USA (June – July 2005).

Researcher Matti Rantanen: MIT Medialab, USA (June 1 – August 31).

Researcher Teemu Koponen: International Computer Science Institute (ICSI) Berkeley, California, USA (June 1 – August 31).

Research Assistant Vladimir Poroshin: Tsinghua University in Beijing, China (September).

Senior Research Scientist Timo Saari: Michican State University, USA (September – November).

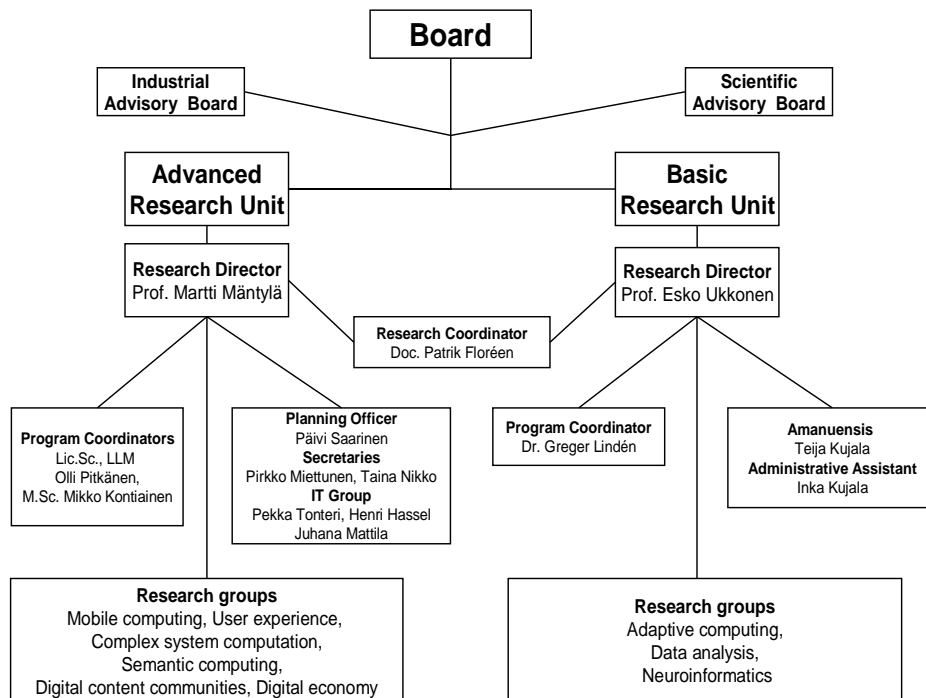
Professor Hannu Toivonen: Machine Learning Lab, Institut für Informatik, University of Freiburg, Germany (December 1, 2005 - November 31, 2006).

6 Administration

6.1 Overview

According to the management bylaws established in 2002, HIIT is the joint research institute of TKK and UH that consists of two units, the Advanced Research Unit (ARU) and the Basic Research Unit (BRU). HIIT is directed by a Board. The Scientific Advisory Board (SAB) advises the HIIT Board on strategic planning of HIIT's research activities, and the institute's industrial liaison is managed by the Industrial Advisory Board (IAB).

ARU receives its administrative services from TKK. Similarly BRU is administratively associated with UH and follows its administrative rules and procedures. In practice, BRU is hosted by the Department of Computer Science of the UH. The structure is shown in the organisation chart below that depicts the status at the end of the year 2005.



Internally, ARU consists of six research groups, facilitated by a small administration team. In addition, some thematic research areas have a Programme Coordinator who facilitates the planning and management of research activities. The Management Board of ARU, headed by the Research Director and consisting of senior researchers and administrative personnel, handles most daily management and coordination activities.

The BRU administrative structure is very light, as the unit can use the services of the departments of computer science of TKK and UH. Research Director Esko Ukkonen

is in overall charge of the unit's general management, budgeting, and planning. The administrative personnel consists of Administrative Assistant Inka Kujala, responsible for personnel, budgeting, events, and miscellaneous secretarial tasks, and Amanuensis Teija Kujala, who participates in administration with about 50 % of her total work time.

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 2005 the Board convened six times. Apart from dealing with the statutory tasks (i.e. approving the annual budgets and activity plans of the 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 2005 was the conclusion of HIIT's strategy process, ended in the second meeting on 19.4.2005. At the subsequent meetings, the Board followed the implementation of the strategy and made the necessary decisions, including filling the Research Director positions of the two units for 2006-2008 at its fifth meeting on 18.10.2005.

In 2005 the Board members (and their personal deputies) were as follows:

Members

Vice Rector, Professor Mauri Airila from 1.8.2005 Vice Rector Outi Krause, TKK,
Chairman of the Board (Vice Rector, Professor Olavi Nevanlinna)
Professor Olli Simula, TKK (Professor Markku Syrjänen)
Vice Rector, Professor Thomas Wilhelmsson, UH, Vice-Chairman of the Board
(Vice Rector, Professor Marja Makarow)
Professor Jukka Paakki (Professor Jyrki Kivinen)
Raimo Vuopionperä, LM Ericsson (Björn Melén)
Aimo Maanavilja, Elisa (Pertti Hölttä)
Juha Aaltonen (Martin Mäklin)
Jan Bosch (Harry Herlin from 18.10.2005 Henry Tirri)
Petri Myllymäki, HIIT (Greger Lindén)

Invited Members

Ari Hirvonen, TietoEnator (Olli Lötjönen)
Seppo Vanhatalo, Alma Media (Marko Turpeinen) until 13.9.2005
Eskoensio Pipatti, Sanoma-WSOY
Juha Vesaja, Yleisradio
Raimo Näätsaari from 24.11.2005 Jani Eloranta, Nordea (Juha Toivari)

The two Research Directors of HIIT are responsible for preparing and submitting propositions to the Board. In addition, the Research Coordinator and the Program Coordinators have a right to attend the meetings. In 2005 these expert members were as follows:

Expert members

Research Director Martti Mäntylä, HIIT ARU
Research Director Esko Ukkonen, HIIT BRU
Research Coordinator Patrik Floréen, HIIT ARU & BRU
Program Coordinator Olli Pitkänen, HIIT ARU
Program Coordinator Mikko Kontiainen, HIIT ARU

Board Secretary

Planning Officer Päivi Saarinen

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 2005. The next meeting is planned to take place in 2006 once HIIT has made sufficient progress along the path pointed by the SAB in its meeting in 2004.

6.4 Industrial Advisory Board

The Industrial Advisory Board (IAB) consists of representatives of companies that work closely with HIIT. The IAB had two meetings in 2005.

The main topic of the Industrial Advisory Board meeting on January 12 was to discuss HIIT's research strategy. The deans of the Computer Science Departments of the parent universities, Professor Jukka Paakki (University of Helsinki) and Professor Olli Simula (Helsinki University of Technology) gave brief position presentations on their departments' views on HIIT's mission, which was followed by a lively discussion. The directors of the two units also presented their suggestions on how the the HIIT-industry co-operation should be organised in the future.

The Industrial Advisory Board meeting 2/2005 was held on 19 October. The main topic of the meeting was to discuss HIIT's strategy and the industry's commitment to HIIT's future operations.

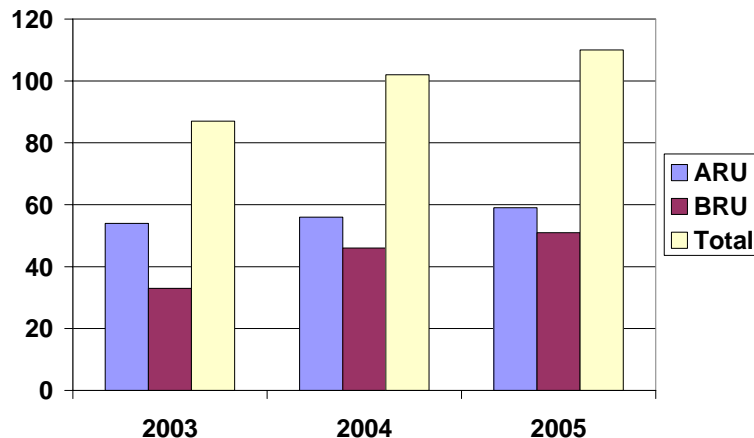
6.5 Personnel

The personnel directly employed by HIIT is formally employed by the two parent universities, i.e. the ARU personnel is employed by TKK and the BRU 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.

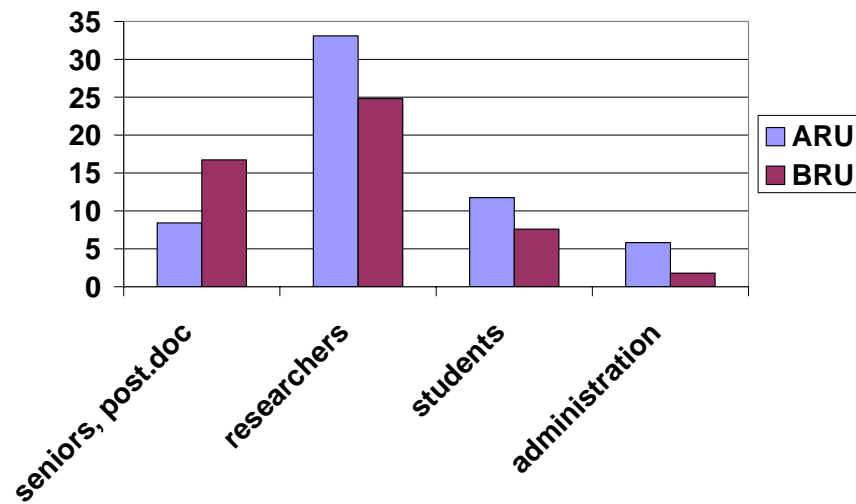
In 2005 the ARU staff completed 59 person-years, out of which approximately 90 % was with external funding and approximately 10 % with budget funding. There is a slight increase in person-years compared to 2004 (56 person-years). In 2005 BRU staff completed 51 person-years (UH 42 and TKK 9 person-years, includes about 9 person-years of graduate school students), out of which approximately 73 % was external funding and approximately 27 % was budget funding.

Person - years 2003 - 2005

| | 2003 | 2004 | 2005 |
|-------|------|------|------|
| ARU | 54 | 56 | 59 |
| BRU | 33 | 46 | 51 |
| Total | 87 | 102 | 110 |



HIIT staff 2005



The Board of HIIT nominated Professor Martti Mäntylä and Professor Esko Ukkonen as the directors of the Advanced Research Unit and the Basic Research Unit of HIIT for the term 1.1.2006-31.12.2008.

Pekka Himanen PhD was nominated as the Principal Scientist for a 5-year period starting from August 1, 2005. The Centenary Fund of the Technology Industries of Finland has given a donation to establish the position. The area of the position is to study network society and its philosophy.

7 Funding and Costs

7.1 Advanced Research Unit Finances

The finances of the Advanced Research Unit for 2005 are shown in the table below. For reference, the comparable numbers of 2003 and 2004 are also given.

| | 2003 | 2004 | 2005 |
|-------------------------------------|------------------|------------------|------------------|
| Total funding | 3 498 410 | 3 727 072 | 3 680 175 |
| TKK funding | 168 188 | 165 688 | 164 359 |
| UH funding | 168 188 | 168 200 | 168 200 |
| Academy of Finland | 379 462 | 392 087 | 586 531 |
| National Technology Agency TEKES | 2 103 451 | 2 135 821 | 1 949 083 |
| European Union | | 116 951 | 280 582 |
| Industry | 600 699 | 693 910 | 457 074 |
| Ministries and other public funding | 71 694 | 44 779 | 22 242 |
| Other domestic funding | 6 728 | 9 636 | 52 104 |
| Total expenses | 3 545 099 | 3 731 995 | 3 786 832 |
| Salaries | 2 376 864 | 2 423 516 | 2 530 688 |
| Other operational expenses | 660 739 | 761 813 | 732 690 |
| Rents | 343 216 | 380 404 | 374 023 |
| Service charge to TKK | 164 280 | 166 262 | 149 432 |

| | | | |
|---------------------------------------|------|------|------|
| University funding % of total funding | 10 % | 9 % | 9 % |
| External funding % of total funding: | 90 % | 91 % | 91 % |
| Academy funding % of total funding | 11 % | 11 % | 16 % |
| TEKES funding % of total funding | 60 % | 57 % | 53 % |
| Industry funding % of total funding | 17 % | 19 % | 12 % |
| EU funding % of total funding | 0 % | 3 % | 8 % |
| Other public funding % of total fund. | 2 % | 1 % | 2 % |

| | | | |
|------------------------------------|------|------|------|
| Salaries % of total expenses | 67 % | 65 % | 67 % |
| Other expenses % of total expenses | 23 % | 25 % | 23 % |
| Rents % of total expenses | 10 % | 10 % | 10 % |

The ramp-up of the new Network Society programme during the first half of 2005 caused some delays in launching research projects replacing projects ended in 2004. Because of this, TEKES and industry funding were both below the level of earlier years. This was offset by the rapid increase of EU-funded research and also increased expenses allocated the Academy of Finland projects ending in 2005. Nevertheless, the slow first half of the year caused the overall financial result of the year to be negative.

7.2 Basic Research Unit Finances

The finances of the Advanced Research Unit for 2005 are shown in the table below. For reference, the comparable numbers of 2003 and 2004 are also given.

| | 2003 | 2004 | 2005 |
|---|------------------|------------------|------------------|
| Total funding | 1 151 800 | 1 537 300 | 2 268 162 |
| UH funding | 631 800 | 631 800 | 731 000 |
| TKK funding | 0 | 0 | 100 000 |
| Center of Excellence funding from TKK | 75 000 | 75 000 | 78 145 |
| Academy of Finland | 285 000 | 496 000 | 879 176 |
| National Technology Agency TEKES | 115 000 | 124 000 | 107 380 |
| European Union (EU) | 0 | 80 500 | 197 597 |
| Industry | 45 000 | 130 000 | 174 864 |
| Total expenses | | | 2 018 173 |
| Salaries | | | 1 605 660 |
| Other operational expenses | | | 224 942 |
| Service charge to UH/TKK (rents included) | | | 187 571 |

| | | | |
|---------------------------------------|------|------|------|
| University funding % of total funding | 55 % | 41 % | 37 % |
| External funding % of total funding: | 45 % | 59 % | 63 % |
| CoE funding % of total funding | 7 % | 5 % | 3 % |
| Academy funding % of total funding | 25 % | 32 % | 39 % |
| TEKES funding % of total funding | 10 % | 8 % | 5 % |
| EU funding % of total funding | 0 % | 5 % | 9 % |
| Industry funding % of total funding | 4 % | 8 % | 8 % |

| | |
|------------------------------------|------|
| Salaries % of total expenses | 80 % |
| Other expenses % of total expenses | 11 % |
| Rents % of total expenses | 9 % |

The funding given by the host universities or raised from external sources continued its growth in 2005. The Technical University started direct funding of BRU. Among external funding agencies, the most notable growth was from the Academy of Finland, and the European Union. The total expenses of BRU in 2005 were about 2.36 milj. Euros. In addition to the expenses reported in the above table, in total about 340 000 euros for salaries were paid directly by the Academy of Finland (H. Mannila, A. Hyvärinen 7 months) and by graduate schools (8 PhD students).

Appendices

A Publications

| Publications 2003–2005 | 2003 | 2004 | 2005 |
|---|------|------|------|
| Articles in international scientific journals with referee practice | 21 | 19 | 29 |
| Articles in international edited works and conference proceedings with referee practice | 71 | 98 | 112 |
| Articles in Finnish scientific journals with referee practice | 2 | 1 | 1 |
| Articles in Finnish edited works and conference proceedings with referee practice | 6 | 5 | 3 |
| Scientific monographs | 5 | 4 | 8 |
| Other publications | 14 | 19 | 13 |
| Computer programs (and algorithms) | 8 | 2 | 3 |
| Patents | 0 | 0 | 0 |
| Notifications on invention | 1 | 0 | 0 |
| Degrees | | | |
| PhD or DSc thesis | 1 | 4 | 3 |
| Licentiate thesis | 0 | 1 | 1 |
| Master's thesis | 5 | 14 | 7 |

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