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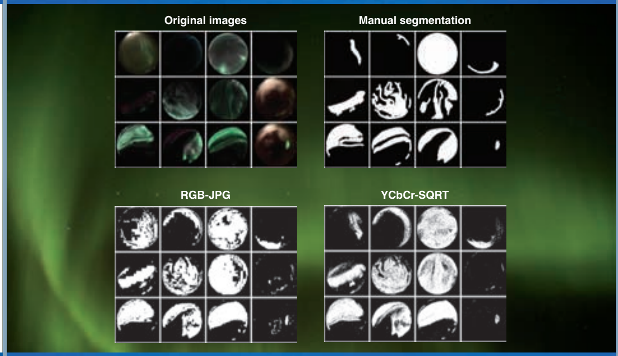
Computer Science Research in Finland 2000–2006



International Evaluation

Academy of Finland
Research funding and expertise

Publications of the Academy of Finland 8/07

Computer Science Research in Finland 2000–2006

International Evaluation

Members of Evaluation Panel

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Description

Publisher	Academy of Finland	Date 11 October 2007
Author(s)	Editor: Dr Mikko Syrjäsuo	
Title	Computer Science Research in Finland 2000–2006: International Evaluation	
Abstract	The Academy of Finland invited an international panel of experts to evaluate the scientific quality of computer science research in Finland in 2000–2006. The panel members were Prof. Hans Gellersen (Chair), Prof. Lars Birkedal, Prof. Letizia Jaccheri, Prof. Fionn Murtagh, Prof. Tatsuo Nakajima, Prof. Enrico Nardelli, Prof. Naftali Tishby, and Prof. Herb Yang. Standardised self-assessment questionnaires were sent to 35 research units within the scope of the evaluation, and the panel visited and interviewed 28 of these units during the week of 25 to 29 June 2007. This evaluation report describes the panel's observations on the quality of computer science research, its different sub-fields, and each evaluated and interviewed unit. These observations are accompanied by recommendations on improvement both on general and unit level. Additionally, statistics on research personnel, funding, publications, and educational output are provided in the Appendix. The general view of the panel is that Finnish computer science research is healthy with impressive publication activity and international visibility. Nevertheless, the panel recommends that research units adopt publication strategies that are more effective in achieving impact. The panel also suggests that the computer science community actively lobby for bibliometric impact assessments that are more inclusive of computer science than the ones in current use to ensure that its impact is recognised. While the graduate schools have a positive effect on completion rates and times of doctoral studies, staffing and recruitment are still a key concern for sustained development. The panel recommends developing clear and appealing research career paths which encourage international mobility and recruitment especially at postdoctoral level. The panel finds that Finnish computer science researchers are well networked nationally and internationally. However, the panel recommends that opportunities in EU Framework Programme projects be more effectively used. The evaluated research units have strong industrial links, although the panel recommends that the universities further develop their IPR strategies and aim to be more proactive in development of commercially exploitable knowledge.	
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Julkaisun nimi	Computer Science Research in Finland 2000–2006: International Evaluation	
Tiivistelmä	Suomen Akatemia kutsui kansainvälisen asiantuntijapaneelin arvioimaan tietotekniikan tieteenalan Suomessa vuosina 2000–2006. Paneelin jäsenet olivat prof. Hans Gellersen (puheenjohtaja), prof. Lars Birkedal, prof. Letizia Jaccheri, prof. Fionn Murtagh, prof. Tatsuo Nakajima, prof. Enrico Nardelli, prof. Naftali Tishby ja prof. Herb Yang. Kolmeenkymmeneenviiteen tutkimusyksikköön, joiden katsottiin kuuluvan arvioinnin piiriin, lähetettiin itsearviointilomake täytettäväksi, ja paneeli vieraili ja haastatteli näistä yksiköistä 28 välillä 25.–29. kesäkuuta 2007. Tämä arviointiraportti sisältää asiantuntijapaneelin havaintoja suomalaisesta tietotekniikan tutkimuksesta niin koko tieteenalan kuin osa-alueidenkin kannalta. Havaintojen perusteella paneeli on tehnyt suosituksia yleisellä tasolla ja kunkin haastatellun yksikön kohdalla. Raportin liitteeseen on koottu tilastotietoja yksiköiden tutkimushenkilöstöstä, rahoituksesta, julkaisuista ja opetustoiminnasta. Asiantuntijapaneelin mukaan suomalainen tietotekniikan tieteenala on terveellä pohjalla ja julkaisutuotanto ja kansainvälinen näkyvyys ovat korkeatasoisia. Tästä huolimatta paneeli suosittelee, että tutkimusryhmät kehittäisivät julkaisustrategiaansa vieläkin vaikuttavammaksi. Paneeli myös ehdottaa, että tieteenalan yhteisö valvoisi aktiivisemmin etujaan, jotta yleistyvät bibliometriset arviointimenetelmät olisivat sellaisia, jotka ottaisivat tietotekniikan alan paremmin huomioon. Vaikka tutkijakoulut ovat vaikuttaneet myönteisesti niin valmistumisaikoihin kuin uusien tohtorien määriinkin, henkilöstö ja uusien työntekijöiden värväys ovat edelleen ongelmallisia kestävän kehityksen kannalta. Asiantuntijapaneeli suosittelee selkeiden ja houkuttelevien tutkijaurien kehittämistä. Erityisesti kannustusta tarvitaan tutkijoiden kansainväliseen liikkuvuuden ja värväyksen lisäämiseksi heti tohtorintutkinnon suorittamisen jälkeisenä aikana. Suomalaiset tietotekniikan tutkijat ovat asiantuntijapaneelin mukaan hyvin verkottuneita kansallisella ja kansainvälisellä tasolla. Paneeli kuitenkin suosittelee, että EU:n puiteohjelmien mahdollisuudet käytettäisiin paremmin hyödyksi. Arvioiduilla tutkimusyksiköillä on vahvoja teollisuuskytkentöjä, joskin paneeli suosittelee, että yliopistot kehittäisivät immateriaalioikeusstrategiaansa ja olisivat ennakoivampia kaupallisesti hyödynnettävien tutkimustulosten suhteen.	
Asiasanat	Tietotekniikka, tutkimuspolitiikka, tutkimusrahoitus, arviointi	
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Preface

The Research Council for Natural Sciences and Engineering decided at its meeting on 18 December 2006 to commission an international evaluation of computer science research in Finland. The primary objective of the evaluation was to determine the scientific quality of the field of computer science in Finland during the period of 2000–2006. The evaluation covers research activities carried out at universities and research institutes representing the field.

The Research Council appointed a Steering Group to lead and support the execution of the evaluation. The members of the Steering Group were Professor Hannu Hänninen (Chair, member of the Research Council for Natural Sciences and Engineering; Helsinki University of Technology), Professor Timo Jääskeläinen (member of the Research Council for Natural Sciences and Engineering; University of Joensuu), Research Professor Tuija Pulkkinen (member of the Research Council for Natural Sciences and Engineering; Finnish Meteorological Institute), Director Eero Silvennoinen (Tekes, the Finnish Funding Agency for Technology and Innovation), Application Specialist Johanna Blomqvist (CSC – Finnish IT Center for Science), and Senior Manager Barbara Heikkinen (Nokia Research Center). As from June 1, Johanna Blomqvist was replaced by Customer Relations Manager Tuija Raaska, (CSC). On behalf of the Academy, the evaluation process was managed by the Evaluation Team composed of Director Susan Linko, Senior Science Adviser Pentti Pulkkinen, Project Secretaries Henriikka Katila and Katriina Korhonen, and Project Assistant Antti Perälä. The scientific coordinator of the evaluation was Dr Mikko Syrjäsuo. The Coordinator assisted the Evaluation Panel in preparation and editing of this evaluation report.

The Steering Group defined the scope of the evaluation to include those research units at universities that produce degrees in computer science and have it in their curriculum. Furthermore, the computer science research units in the Government research centre (VTT) were included in the evaluation. This totals 28 units that were also interviewed as part of the evaluation. In addition, seven units, more in the boundaries or application side of computer science, were asked to provide written information on their scientific output during the evaluation period. This data from all the 35 units was used in the statistics part of the evaluation report (Appendix A).

To undertake the evaluation the President of the Academy of Finland appointed an international evaluation panel with eight distinguished scientists. The chair of the panel was Professor Hans Gellersen (Lancaster University, UK). The other members to serve on this evaluation panel were Professor Lars Birkedal, (IT University of Copenhagen, Denmark), Professor Letizia Jaccheri, (Norwegian University of Science and Technology, Norway), Professor Fionn Murtagh, (University of London, UK), Professor Tatsuo Nakajima, (Waseda University, Japan), Professor Enrico Nardelli, (Università di Roma, Italy), Professor Naftali Tishby, (Hebrew University-Givat-Ram, Israel), and Professor Herb Yang, (University of Alberta, Canada). See Appendix B for more details of the evaluation panel.

The evaluation panel was asked to evaluate the quality of computer science research in Finland compared with international standards. The evaluation covers computer science research as a whole, within different sub-fields of computer science, and in each evaluated and interviewed unit. The Terms of Reference document presented in Appendix C further states that other important objectives of the evaluation included national and international collaboration, multidisciplinary and collaboration with other fields of science, available resources, and researcher training.

The evaluation was based on the material provided by the units to be assessed according to the standardised questionnaire (Appendix D) and on the site visits carried out during the week of 25 to 29 June 2007.

Executive Summary

The Academy of Finland invited an international panel of experts to evaluate the scientific quality of computer science research in Finland for the period 2000–2006. The panel was asked to assess computer science research as a whole as well as the different sub-fields of computer science and individual research units. This report presents the observations, findings and recommendations of the evaluation panel.

The main recommendations of the panel are as follows:

1) The panel is in general impressed with the publication activity and resulting international visibility of Finnish computer science. However, the panel recommends that all units adopt publication strategies focused on venues that are highly respected and selective, or in other ways effective for achieving impact.
2) Staffing and recruitment are key concerns for sustaining and further developing the strength of Finnish computer science. The panel recommends: (i) to provide clear and appealing research career paths for attracting the brightest and best doctoral students to pursue a career in academia; (ii) to foster mobility and international recruitment at all career stages but specifically at the postdoctoral level; (iii) to provide support actions to improve gender balance in the field.
3) The graduate school system evidently has a positive impact on the completion rates and times of doctoral studies, but the panel found that most research units have research staff and part-time students at postgraduate level whose status and progress toward a doctoral degree is uncertain. The panel recommends that units systematically monitor research training of all students and researchers at postgraduate level, and that units focus on recruiting and training research students and research assistants who are motivated toward completion of an advanced degree.
4) The panel finds that many units have a good and balanced funding portfolio. Although EU Framework Programme (FP) projects have problematic aspects, they nonetheless represent a great opportunity, and the panel recommends that achieving success in FP projects should be very actively encouraged and supported.
5) Finnish computer science researchers are well networked nationally and internationally, but the mobility of researchers tends to be limited. The panel recommends development of incentives and policies to foster mobility as well as extension of European and international collaborations.
6) A singular and highly successful feature of research groups interviewed is their industrial linkage and their links with spin-offs. The creation of spin-off and start-up companies is fairly ad hoc but nonetheless very successful. The panel recommends that universities further develop their IPR strategies and aim to be more proactive in development of commercially exploitable knowledge.
7) The panel suggests that the computer science research community, in view of increasing the use of bibliometrics for assessment of impact, actively lobby for the use of data sources that are more inclusive of computer science research than the ones in current use, to ensure that its impact is recognised.

Abbreviations

ÅA	Åbo Akademi University
ACM	Association for Computing Machinery
EU	European Union
FP	(EU) Framework Programme, the current one is FP7
FTE	Full-time equivalent. This refers to annual full-time work including paid holidays and other statutory days off. FTE-year = 12 person-months
HCI	Human-computer interaction
HIIT	Helsinki Institute for Information Technology
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IETF	Internet Engineering Task Force
IPR	Intellectual Property Rights
LUT	Lappeenranta University of Technology
MSc	Master of Science
No.	Number
PhD	Doctor of Philosophy; in this report all doctoral degrees are referenced with PhD, including Doctor of Science and Technology
R&D	Research and development
Tekes	Finnish Funding Agency for Technology and Innovation
TKK	Helsinki University of Technology
TUT	Tampere University of Technology
UH	University of Helsinki
UJ	University of Jyväskylä
UJO	University of Joensuu
UKU	University of Kuopio
UO	University of Oulu
UT	University of Turku
UTA	University of Tampere
UV	University of Vaasa
VTT	Technical Research Centre of Finland
W3C	World Wide Web Consortium

1 Introduction

1.1 Background to the evaluation

This report captures observations and recommendations of an international evaluation panel on the status of computer science research in Finland, covering the period from 2000 to 2006.

The evaluation was initiated by the Research Council for Natural Sciences and Engineering of the Academy of Finland, as part of an ongoing evaluation campaign in the engineering sciences that started in 2006. The principal aim of these evaluations is to gauge the scientific quality of research in the respective fields in Finland in relation to the international state of the art.

Computer science has been an area of particular emphasis for the Research Council in the reporting period. The Research Council funded a number of specific programmes in this field, in particular, on software development, proactive computing, and modelling and simulation, and has further programmes in preparation. In addition, the field has received a relatively large proportion of graduate school funding, and many computer scientists are among those who received individual Fellowship awards. The Research Council thus felt that an evaluation would be very timely, as it would help assess the impact of its investment.

The Research Council appointed a Steering Group chaired by Professor Hannu Hänninen to oversee the execution of the evaluation, and a panel of international experts to carry out the evaluation. Short biographies of the panel members are found in Appendix B and the list of the Steering Group members is included in the Terms of Reference (Appendix C).

1.2 Terms of Reference

The evaluation panel was given the objective to evaluate the scientific quality of computer science research in Finland in 2000–2006. It was asked to comment on the quality of:

1 computer science research as a whole,
2 different sub-fields of computer science,
3 each evaluated and interviewed unit.

The panel was further asked to provide recommendations on improvement on unit level and on general level. It was also asked to comment on academic collaboration (national and international); multidisciplinary collaboration with other fields of science; research funding and environment; research training; and impact of the research.

The detailed Terms of Reference are provided in Appendix C.

1.3 Evaluation Process

The Steering Group defined the scope of the evaluation and identified 35 units with research activity in computer science. These units were given a questionnaire, or self-assessment form, for collection of material on their research activity in 2000–2006 (cf. Appendix A). The reports returned by the units, as well as statistics compiled by the Academy on the basis of the collected data, formed the basis for the present evaluation. The panel commends all participating units for providing detailed data and self-assessments.

Based on the reported research activity, 28 units were chosen for further evaluation. The selection comprised all university units that produce degrees in computer science. In addition, two units from VTT, the Technical Research Centre of Finland, were included – these contract research units are in the field of computer science. The Academy arranged a programme of meetings and visits for representatives of each unit to be interviewed by at least three, and in most cases four members of the international review team. The panel greatly enjoyed meeting the research teams, for their excellent presentations and lively and very open discussions.

1.4 Notes on Terminology and Style

The international panel as a whole is responsible for this report. However, the different parts of the report were initially contributed by different panel members, resulting in variations in style that will still be visible in the final report.

As a general note, the length of discussion in different parts of the report should not be interpreted to reflect the scientific quality of the discussed sub-field or unit of research. Naturally, some observations gave rise to more discussion in the panel than others.

The terminology used in the Finnish university system was not always easy for the panel to interpret correctly and also tends to vary from institution to institution. For example, 'senior researcher' remains an ambiguous term in the review of staff profiles.

In this report we will use 'undergraduate student' for a student aiming at an MSc degree and 'doctoral student' for a postgraduate-level student aiming towards a PhD degree. Also, we will use 'PhD' in reference to any doctoral degree (including Doctor of Science in Technology), 'postgraduate' for any researcher who holds a first degree prior to a PhD, and 'postdoctoral researcher' for a researcher who holds a PhD but does not have a position with independent research responsibility. We refer to more senior positions of independence as 'research leaders'. The Finnish universities also have 'lecturers' and 'docents' (also called 'adjunct professors'). Technically lecturers and docents are teaching positions but the practice varies and usually they are also active in research.

2 General Perceptions and Recommendations

The panel was impressed with the breadth and quality of the computer science research it reviewed, and with the excitement and enthusiasm of the units and individuals that participated in site visits and meetings. Finnish computer science is without doubt healthy, and the morale in the computer science community is perceived to be high.

Finland clearly has developed a leading position in high technologies and in particular in telecommunications and information technology since the early 1990s. This development is underpinned by the likewise rapid expansion of computer science research, some of which build on traditional strengths, in particular, artificial intelligence, machine learning and data analysis, and some respond to industrial needs with applied research, while others move into emerging fields which are at the intersection of computer science with other disciplines, in particular biology.

2.1 Profile of Computer Science Research in Finland

Almost all universities in Finland are active in computer science research and education. Some units made reference to a strong axis Helsinki–Tampere–Oulu but it was evident to the panel that computer science is also well positioned (in most cases with distinct strengths) in other parts of the country (Joensuu, Jyväskylä, Kuopio, Lappeenranta, Turku and Vaasa).

The profile seen is comparable to that in many other countries. Newer, regional universities are focused and selective in their research. They are small, and have good internal linkages; they achieve 4-year or better completion times for PhDs; they have local expertise in intellectual property; and they are well-supported by R&D funding (Tekes). Older-established, large universities have large departments or multi-unit research institutes, with leaders in their respective fields. They attract large-scale funding through national, in particular, and sometimes European programmes, and industrial funding. However, some areas do not scale linearly – for example, numbers of PhDs – nor do they necessarily scale qualitatively in terms of inter-departmental or interdisciplinary linkages.

A distinct strength of Finnish computer science is its close collaboration with other sciences. There is a particularly strong linkage with electrical engineering and signal processing but the panel was also impressed to see new MSc courses in emerging interdisciplinary areas, for example, courses in bioinformatics, computational biology, and in bio-information technology.

Finnish computer science is well grounded in industrial and societal needs and there is a strong emphasis on application of computer science to ‘real-world’ problems. Much of this research involves fundamental aspects, but research activity on theoretical foundations has otherwise a comparatively limited presence in Finnish computer science. A large proportion of the research evaluated appears to be more reactive to short-term needs of Finnish industries than proactive in development of new theories and knowledge.

2.2 Quality of Research Output

The panel is in general impressed with the publication activity and scientific quality of the outputs of Finnish computer science. As one indicator for increased quality, most units have increased the proportion of journal publications in their portfolio. Many units were also able to present strong indicators for impact of their research. The panel also reviewed the lists of selected publications provided by the units and found that these were generally of good quality. A considerable number of the publications were in the best journals in particular sub-fields, however, there was less evidence for a strong and sustained presence of Finnish computer science in the top conferences in the field. Possibly as a consequence of publication strategy rather than of actual quality, citation rates for published work listed as "best of" were on average not very high.

The panel is cautious that publications rates in themselves are not necessarily a good measure for scientific quality. Having clarified this point, the total publication output of Finnish computer science has increased significantly since 2000. However, the output per FTE has only increased very little since 2001, and is still significantly below the rate reported for 2000. The drop in publication rate from 2000 to 2001 is largely, but not fully, explained by inclusion of the more applied research units at VTT in the records as of 2001. The proportion of papers published in journals as opposed to conferences and other venues has increased notably. The panel also saw evidence for other valuable forms of output, for example, an increase in the number of patents, and contribution to standards and open source software. Overall, the reported figures look strong, also in international comparison.

The panel observed three issues for further improvement of the quality of research output and its impact in the international computer science research community:

First, many units do not seem to have a very strategic approach to publication. The list of 'best' publications provided for evaluation in many cases contained publications in less impressive venues, for example, conference series that are known to have low review standards and high acceptance rates. The panel took this as indicator not necessarily for low quality research but for a lack of awareness of the largely varying quality levels associated with different journals and conferences. The panel recommends that units adopt publication strategies better informed by knowledge of the relative quality of journals and conferences in their sub-field, such as indicated by acceptance rates, review standards and quality of editorial boards and programme committees. Awareness of the relative standing of conferences and journals should be promoted as part of researcher training and funding decisions. Publication activity should be focussed on venues that are highly respected and selective, or in other ways effective for achieving impact. The panel would generally advise to focus on quality over quantity, and to measure success in terms of publication in the best venues rather than the overall publication rate.

Second, the panel observed that Finnish computer scientists generally do not have a sustained presence in the top conferences of their sub-field. It is highly commendable that outputs are primarily targeted at journals as these are generally perceived as representing more rigorous review and higher quality. However, in some sub-fields of computer science, publication in a leading conference is very important for fast dissemination and international visibility. The panel thus recommends that research groups consider systematic targeting of the top conferences in their sub-fields, and that they develop pride in success in top conferences (in some cases, units did not include top conference papers in their 'best of' listings).

Third, the panel suggests that the computer science research community, in view of increasing the use of bibliometrics in quality assessments, actively lobby for the development and use of data sources that are more inclusive of computer science research than the ones in current use. In the present evaluation, the panel has seen reference to impact factors published by the Institute for Scientific Information (ISI): these are not sufficiently inclusive of computer science publications and may provide a skewed view of the impact of computer science research in comparison with other fields.

2.3 Research Personnel

The number of researchers active in computer science has grown very notably in the first half of the evaluation period, in particular in number of postgraduates, presumably closely connected to the introduction of graduate schools. The growth has not continued in the second half of the reporting period; however, the number of postdoctoral researchers is still increasing, as a larger number of postgraduates are now coming through doctoral research training and moving on to fill postdoctoral positions. In most cases, university faculty is all-Finnish.

Recruitment

Problems of staffing have ensued from the rapid growth of the Finnish economy in the 1990s. Teaching, to a significant degree, is carried out using MSc graduates.

Clear and appealing research career paths are highly important for attracting the brightest and best research students to pursue a career in the sector. This implies a pathway leading from PhD work into an early career researcher track with good mid-career perspectives.

Short-term secondments between university and industry, in both directions, can be mutually rewarding and personally enhancing. The linkage between university research and industrial R&D is a most impressive feature of Finnish computer science research.

There are only a limited number of international researchers employed in Finland. This situation stems from the usual reasons: difficulty of learning and of benefiting from learning the Finnish language, restrictions in the labour market, and perceived risk of hiring internationally. This means that many units end up employing researchers that they have educated themselves and as a result there is a danger of 'inbreeding'. The panel is concerned about this with respect to mobility (discussed below) as well as recruitment.

In relation to non-Finnish personnel hires, the postdoctoral area is perhaps a key one. (After all, family/personal reasons may be most flexible at this time.) However, Academy of Finland postdoctoral funding is based on named candidates, and with one selection process per year and many months before a decision is known. This is very limiting. The panel recommends an open selection process, or one with more frequent submission deadlines.

Gender balance

Nationwide, the share of women involved in computer science, at the various levels from doctoral students to professors, is very low. The data collected in the evaluation initiative indicates that the percentage of women at the PhD level in computer science is 17 per cent, lower than the 21 per cent recorded for a PhD in engineering (traditionally a male-dominated area) and much lower than the 41 per cent registered for PhDs in science in general. An Academy of Finland publication (No. 9/2003) reports that in the period 1990–2002 the percentage of women among university professors is 21 per cent over all areas and a mere 8 per cent in the area of Natural Sciences and Technology.

The panel therefore recommends that both communication actions and supporting actions be taken to ensure a more gender-balanced situation among researchers in computer science, which could certainly be beneficial both for the research area itself and for Finnish society as a whole. More specifically, it is critical to increase the presence of female researchers in computer science, and that specific efforts are made so that good role models can be presented to girls and young women in the years when they make choices for their adult career. Also, it is important to have a good mentoring support system to encourage, promote and sustain those embracing a research career in computer science.

Mobility

The panel has found that there is limited mobility among Finnish researchers, both nationally and internationally. The panel finds that universities should consider measures to increase mobility, since increased mobility will contribute to exchange of new ideas, techniques and approaches to research. At many leading international universities there are policies that ensure, for instance, that PhDs continue with postdoctoral positions at other institutions than the one at which they have completed their doctoral degrees.

There is very limited international mobility at the postdoctoral level. Research units tend to hire "home-grown" researchers into postdoctoral positions, and, unlike in many other countries, there does not appear to be any strong expectation for Finnish researchers to spend time abroad as postdoctoral fellows in order to develop their international profiles.

The mobility of professors and senior researchers is also very limited. In many academic systems, senior researchers are entitled to sabbaticals and expected to use these to foster international exchange. However, in the Finnish university system this is not the case. Support for sabbaticals can be obtained from the Academy of Finland, but according to the Academy there is less competition than for other funding forms, indicative of limited interest.

The panel is of the view that Finnish computer science would very much benefit from improved mobility of researchers at all career stages, and recommends that incentives and policies be developed that encourage and facilitate more mobility.

Mobility is also of great importance in the European context. Significant elements of the digital society are now in place in Finland. The mobility of researchers at the European level, however, is still to be fully accomplished. Achieving this goal represents a great opportunity for Finnish researchers to lead in various subdisciplines of computer science. A "Researchers' Europe" also points to the need for Finnish researchers to play a full and active part in this important process.

2.4 Research Training

The number of dissertations completed in the area of computer science has doubled in the evaluation period. In 2006, 112 doctoral degrees were awarded in computer science, which represents 8% of all PhDs awarded. One reason is certainly due to the introduction of graduate schools, with nine schools funded in the area of computer science. Around 150 graduate school positions are allocated to computer science, which is about 10% of all graduate school positions.

The graduate school system evidently has also had a positive impact on the quality of doctoral research training and the completion times of doctoral studies. The average age for obtaining a PhD has markedly dropped, for instance from 36.3 years in 2004 to 33.8 in 2006, but is still very high by international standards. The actual duration required for completing a PhD was not reported by the units and many units do not appear to monitor the progress of their doctoral students systematically, although it would seem to be a key metric for efficiency of research training.

At some universities (Oulu, Tampere) most PhDs are working part-time with industry; or (University of Helsinki and others) in conjunction with research positions. Part-time PhDs normally require lengthy time to complete their degrees. Unlike PhDs funded by the graduate schools, the progress of part-time doctoral students and research staff is hardly monitored, and there is apparently little or no pressure for them to graduate within a reasonable timeframe. Moreover, even in the very best of the visited institutes the panel learned that not all research staff employed at the PhD level were actually working toward a dissertation: it appears to be up to individual researchers whether they had the ambition or motivation to complete a PhD in conjunction with their research positions. The panel finds this situation undesirable and unhealthy for the academic research environment, as research training (supervision and infrastructure) should be focused on graduates who have the ambition and dedication to complete an advanced degree. The panel recommends introducing more systematic monitoring of doctoral training activity, for example, by extending the processes now in place in graduate schools to include all researchers at the doctoral level.

2.5 Research Funding and Infrastructure

Funding levels have been stable since 2002, with limited growth roughly at inflation rate.

The panel finds that many of the units have a good funding portfolio (for some units, external funding constitutes more than 50% of the total funding of the unit), although there are, of course, large variations. Generally, it appears that it is a lot easier to obtain funding for projects with industry – either contract research or through Tekes-funded projects – than it is to obtain funding for more basic research from the Academy of Finland. One problem with Tekes-funded projects is that most of them run only for short periods; this makes it somewhat challenging to use them for funding of doctoral students toward a PhD dissertation. It also means that senior faculty have to spend a lot of time on preparing funding proposals.

Several units expressed concern about how difficult it is to obtain funding for postdoctoral researchers. At present, Academy funding for postdoctoral researchers can usually only be obtained for named candidates and this makes it difficult to attract international researchers. The panel recommends that units seek support for hiring postdoctoral researchers as part of standard grant applications (e.g. the Academy's general research grants), and that funding instruments are reviewed and developed to address this issue.

Take-up of European funding has increased over the reporting period but is greatly overshadowed by national funding. This is understandable, given the great divergence of effort required in proposal preparation; competitiveness and rates of success; bureaucracy associated with funded projects; and the close-to-market aspect of Framework Programme (FP) projects. However, EU projects also offer advantages: profile and leadership at European level; linkage with large corporations and small and medium enterprises across Europe; and being close-to-market may aid commercialisation. So although EU FP projects have many problematic aspects, they nonetheless represent a great opportunity. Achieving success in FP projects should be (very) actively supported.

The physical environment, as observed by the panel, is very good, including sometimes new and well-proportioned buildings, and cross-institutional facilities for computer science research. There is generally excellent infrastructure in place: the city of Oulu, for example, has a metropolitan-area open access wireless network.

2.6 Research Collaboration

All evaluated units engage in research networks and collaborations. For smaller units this tends to be focused on regional networks. However, the panel was also impressed with the international networks developed in some of the smaller units (e.g. at the University of Joensuu). Larger units generally maintain bigger networks both on national and international level, and in some cases with very impressive visitor programmes and exchange activities (e.g. at the Institute of Signal Processing, Tampere University of Technology).

The panel is of the impression that Finnish computer science has generally a very open and positive attitude to collaboration, for example, with cross-institutional collaborations in Helsinki and Turku, collaboration of smaller regional units for joint operation of graduate schools, and excellent local networks with research users.

International networks are also in place but, as discussed above, mobility of researchers tends to be limited. Participation in European collaborative projects has increased but only very few groups exercise leadership in this area. The panel recommends that research collaboration be further fostered and extended on European and international levels.

2.7 Industrial Collaboration and Impact

The industrialisation chain through the following appears to be well developed: (i) basic research, prototypes and demonstrators; (ii) operational strength and deployed systems; (iii) commercialisation. Phases (ii) and (iii) may rely on different industrial partners, (ii) through supplier or even start-up intermediary, R&D driven, (small and nimble) companies; and (iii) through companies with strong market share and possibly global reach. In Finland these linkages appear to be outstanding.

A singular and highly successful feature of the research groups interviewed is their industrial linkage in general, their linkage with Nokia in most cases, and their links with spin-offs. From what the panel was told, the creation of spin-off and start-up companies is fairly ad hoc (Innovation Office support may be available in some universities) but nonetheless very successful.

The general attitude towards Intellectual Property Rights (IPR) is that all results are freely available and that start-ups are encouraged. As from 2007, through new regulation, a researcher now surrenders their rights to their university. The university will take out protection. But with companies, though a consortium commercialisation agreement exists, the company has ownership and includes the researcher as joint owner. Credibility rather than direct gain is the way that this is viewed. An alternative view is that this implies a significant contribution to the excellent, industrial strength R&D in Finland that is produced at universities and subsidised by the university system.

The panel recommends that universities should continue to develop more awareness of IPR concerns and establish policies to selectively decide if the rights on proposed innovations should be retained by the research teams, the cooperating companies, or a combination of this. Universities should seek not only to help the companies following their short-term commercial interests, but also strive to influence Finnish companies by providing new validated theoretical knowledge. In general, Finnish universities should aim to be more proactive with respect to industries.

2.8 Societal Impact

Finnish computer science researchers are well grounded in society and operate with attention to interactions and relations between their science and technology and societal needs. This is less pronounced, naturally and rightly so, in those units pursuing more theoretical and basic research and those research areas that are more fundamental in nature. Indeed, it has to be commended that research in all the evaluated units appears well aligned with respect to societal issues.

All units have firm and solid relations with entities (industry, schools) in their surrounding region that are more relevant to their mission, including upper secondary school students orienteering, study programmes, post-degree placement, and research projects. From what the panel has seen it is rather standard for students in Master's degree programmes to carry out their theses in the context of an industrial project. This certainly provides the beneficial effects of a smooth transition from academic studies to work in industry, one of the critical elements in the process of appropriately preparing the labour force for the requirements of modern society.

3 Evaluation of Research Quality in Sub-fields

Finland has research activity in a wide range of subjects within computer science. Subject areas of particular strength include machine learning, pattern recognition and data analysis and mining; Finland's research is without doubt world-leading in these areas. Finland is also a leading force in communications and wireless networking, and has pockets of excellence in many other areas of computer science.

The Academy of Finland uses eleven categories for classification of computer science into sub-fields, and these were also used in the self-assessment forms sent to the units. The evaluation panel's review of sub-field strength largely follows this scheme, with the only exception being discussing computer vision jointly with image processing. However, the panel had lively discussions concerning the classification of computer science research into sub-fields, and indeed concerning the remit of computer science as a field. The panel suggests that the Finnish computer science community review classifications in use with the Academy and other funding organisations, possibly for a clearer alignment with other classification systems such as the ACM's.

The following discussion of individual research areas varies in length: this should not be taken to reflect the scientific quality or importance of the respective sub-fields, and only reflects that some observations gave rise to more discussion in the panel than others.

3.1 Theory of Computation

Research on the theoretical foundations of computer science (including automata, computability, computational complexity, quantum computing theory) is not widely covered in the evaluated units (only 8 out of the 28 visited units have reported some effort in this area). An exception is a large concentration of effort (129 person-months out of 328 in total) in the Fundamentals of Computing and Discrete Mathematics unit at the University of Turku. The subjects covered in this area are mainly automata theory, coding theory, computational logic, computational complexity, cryptology, mobility, and new models of computing. The limited resources put into this area have produced for the aforementioned subjects an internationally recognised output.

3.2 Algorithms and Data Structures

Research activity in this area is carried out in many of the visited units (17 out of the 28 units report some effort in this area), with a wide variety in intensity (from 3 to 153 person-months, with a total of 809), focus, and outcome.

It is very positive that many researchers in this sub-field have been able, while staying grounded in theoretical work, to expand the use of algorithmic tools and methods to problems of specific and immediate interest in various application areas. Application problems that have been successfully considered have come both from other scientific areas (e.g. biology) and from Finnish industries (e.g., pulp and paper, telecommunications). This open-minded attitude of researchers in this sub-field, though, is not common to all units, and should therefore be encouraged in all research on algorithms and data structures, without compromising the fundamental nature of their work. It has to be kept in mind that computer science in general, and algorithmics in particular, will only benefit from keeping in touch with real-life problems.

Both the more theoretically inclined groups in this sub-field and those that are more application-oriented are able to publish consistently in highly rated journals and conferences of their communities, obviously with some variability across the evaluated units. The University of Helsinki and Helsinki University of Technology have groups active in this area that have obtained results published in world-class venues (Department of Computer Science, Laboratory of Computer and Information Science, Laboratory of Software Technology), and also the University of Turku (Department of Information Technology) and the University of Tampere (Department of Computer Science) have produced research of high quality.

3.3 Programming Languages

In comparison with other areas of research, there is only a small amount of research on programming languages in Finland (only 2 of 28 units reported activity in this sub-field). As a consequence, Finland is not well represented in the international research community in programming languages.

The research is spread out among different units: there is some research in compilers for embedded systems with multi-cores at the Laboratory for Software Technology at Helsinki University of Technology, and the research on formal methods at Åbo Akademi University is based on semantics of programming languages and contributes to the development of programming logics. The research in computational logic at the Laboratory for Theoretical Computer Science at Helsinki University of Technology is related to programming languages research.

The panel finds that there are good opportunities for employing and extending the strengths of the units at Åbo Akademi University and Helsinki University of Technology to contribute to some of the internationally active research areas in programming languages, in particular in the sub-area of software model checking. This should also be of interest to Finnish industry, since correctness of software for mobile phones and other embedded systems is of great importance.

3.4 Software Engineering

Eighteen of the 28 visited units report to cover software engineering (including formal methods, algorithm design, and computer programming) as one of their research areas. Among these 18 units, six reported to have more than 25% of their research efforts in software engineering. Finnish companies whose business model is centred on software systems – such as Nokia – have contributed to drive education programmes to produce high-quality software engineers.

Software engineering is about technologies (concepts, principles, methods, techniques, tools) that support development and maintenance of software systems. Software engineering technologies that have high societal importance and that will need considerable improvements in the next decade include component-based software engineering, agile development processes, global software development and open source software, estimation methods, software for mobile computing, and software process improvement and empirical software engineering. Overall, Finnish software engineering does not have a strong presence internationally. However, there is some evidence for highly rated contributions at international level, for example, on agile software development.

The panel recommends that Finnish software engineering research continue to provide short-term help to Finnish software companies. In the long run, however, research groups in this area should further push the frontier of software engineering research by developing and validating new theories in software engineering technology as outlined above.

3.5 Concurrent, Parallel and Distributed Systems

About half of the evaluated units report some activity in this sub-field, but in most units it has a relatively small role. The panel has seen some research related to middleware and infrastructures underpinning mobile and distributed computing systems, but less to more fundamental aspects of parallel programming and distributed systems technologies. Finland has some international visibility through outputs in this area but this does not amount to a strong presence in the international research community in this field.

Expanding research in this area will impact the leadership of Finland in future mobile and ubiquitous computing. Research groups active in this space should strive to develop a stronger presence in the leading conferences and journals in the field.

3.6 Databases and Data Mining

Helsinki University of Technology represents established research on a world scale since the work of T. Kohonen in the 1980s. Many leading researchers in Finland have come from this background, including E. Oja and from him, H. Mannila. Personnel now in other Finnish institutes have, not infrequently, come from this background. Data mining and closely associated machine learning work is carried out in many of the evaluated units, and has been published in the leading journals and conferences in this area (Neural Information Processing Systems, Knowledge Discovery and Data Mining, etc.), and also in the foremost biological, medical and other applications journals.

Additional database research in the area of physical access layer is carried out, with top-level results, in the Laboratory of Software Technology at Helsinki University of Technology.

3.7 Communications

Computer science research related to communications (including networking, cryptography, and multimedia) is carried out in eleven of the 28 evaluated units, and in many of these units it is an area of particular emphasis.

Communications research in Finland is based on an excellent relationship with industrial companies such as Nokia. Also, many research groups are very actively involved in working groups of standard organisation such as the Internet Engineering Task Force and the World Wide Web Consortium. In particular, the quality of research in mobile networking is excellent. However, Finnish research in this area does not have a strong presence in the very best conferences in networking (*ACM SIGCOMM, IEEE INFOCOM*).

The groups in this area are already very active in European research, but collaboration with leading research groups world-wide has the potential to further increase the impact of Finnish networking research.

3.8 Computer Architecture

Computer architecture (including computer organisation and operating systems) research in Finland appears to be very applied and largely driven by the telecommunications sector. The only evaluated unit that reported larger investment of effort in this area is the telecommunications unit of VTT, linked also with the University of Oulu.

The research activity in this area does not have strong international visibility in terms of publications, possibly because research in this area is to a large extent industry-funded and confidential, with primary impact through industrial exploitation. However, it is noteworthy that some of the research published on network-on-chip technology has become very widely cited.

3.9 Human-computer Interaction

Human-computer interaction (HCI) is firmly established within Finnish computer science, with activity reported by 18 of the evaluated units. HCI in itself is a very broad field, and activities in Finland include research on computer-supported collaborative work, usability engineering, user interface technologies, and specifically HCI challenges in mobile and ubiquitous computing.

The TAUCHI group at the University of Tampere has emerged as the strongest Finnish group in HCI, but there are also very good, and very distinctive efforts in other units. Finnish HCI research has good visibility internationally, and very good visibility in various areas of specialisation such as human-computer interaction with mobile devices.

3.10 Artificial Intelligence, Machine Learning

Machine learning and probabilistic methods took over much of the traditional artificial intelligence research in most places. In Finland, there is activity in this area in 19 of the 28 assessed units.

This is arguably the strongest single area of computer science in Finland, and stems from the seminal work of the Academician T. Kohonen since the 1960s. World-class activity in this field is present in many of the units evaluated, and is enhanced by excellence in related engineering fields, such as signal processing and information theory (mainly Minimum Description Length methods). Most notable in this field are the Computer and Information Science Laboratory at Helsinki University of Technology, the University of Helsinki Computer Science Department, and the

University of Tampere Signal Processing Laboratory. Excellent work is also done in Oulu and in the VTT units.

However, much of the Finnish work in this area is concentrated on unsupervised methods and pattern matching algorithms. It could have an even stronger international profile by diversifying and enriching its activities with other related methodologies, and gain from a more extensive collaboration with the excellent theoretical computer science groups in Finland, which may provide a complementary rigorous approach to machine learning research, as to some extent already done at the University of Helsinki Computer Science Department and Computer and Information Science Laboratory at Helsinki University of Technology.

3.11 Computer Vision, Image Processing and Computer Graphics

The paper industry and other areas of Finland's natural resources have often motivated industrial machine vision. The panel has seen excellent work in the engineering of vision systems. Researchers play a role in the international machine vision and pattern recognition community, publishing in the leading journals, and presenting at the leading international conferences. Various groups at the Universities of Tampere, Oulu, Lappeenranta and Helsinki are all contributing very strongly to this area. Robotics is represented in other departments (Oulu). A wide range of other applications of imaging (including biometrics, medical imaging, biological imaging) is pursued in other institutes. The strength of this work is strongly supported by the local industrial linkages. It is desirable to have greater coverage of subfields such as distributed sensor networks, image-based rendering and computer graphics.

3.12 Emerging Topics

Finland has an excellent tradition in combining ideas and methodologies from statistical physics and electrical engineering into computer science. Represented in particular by the Laboratory of Computational Engineering and the Centre of Excellence in Computational Complex Systems Research of Helsinki University of Technology, this work is unique with many publications in physics, system biology – both bioinformatics and neuroscience, photonics, medicine, social networks and economy, and other areas, in addition to core computer science and engineering. Most of this activity is at the basic research level, but has the potential of becoming much more influential in technology and industry.

4 Evaluation of Individual Units

4.1 Åbo Akademi University, Department of Information Technologies (ÅA/IT)

Overview, mission and strategy

Åbo Akademi University IT Department has eight professors, ten lecturers, and eleven post-doctoral researchers and 60–65 researchers. The department has been recently formed from merging the Department of Computer Science and the Department of Information Systems. A substantial number of the postdoctoral researchers and faculty come from abroad. Also, currently, some 50% of doctoral students come from abroad. The department has two research centres, the Centre for Reliable Software Technology (CREST) and the Institute for Advanced Management Systems Research (IAMSR).

Research profile

CREST, which is a Centre of Excellence (2002–2007), consists of the Distributed Systems, Embedded Systems, Learning and Reasoning, and Software Construction laboratories. The focus within this research centre is on methods for building correct and reliable software systems. This includes both theoretical issues in software construction, applications of formal methods in different areas of software development, building tools to support formal methods, and carrying out larger case studies.

Scientific quality, impact and viability

Research laboratories in the centres are well coordinated and have produced good research outputs for many years especially in the area of formal methods and their applications. Their research results have been published extensively in journals and international conferences. There are several start-up companies from the department. Several programs developed in the department are publicly available as open source software and have been used in industrial research laboratories and other academic research groups. Also, their research results are used in teaching logic in secondary and higher education. They have strong research culture and extended long-standing research into new application areas led by younger researchers.

Research environment

This unit has recently become co-located with other computer science activities in Turku and in the shared facility, which is clearly beneficial. Students are supported by the Turku area and TUCS graduate school. Likewise, the unit has a systematic way to hire students as programmers for developing software to implement research results. Research laboratories in the centres are encouraging young researchers to publish their research results.

Research networks

The department has established good international research networks. They have many foreign doctoral students as postdoctoral researchers, which makes it easy to collaborate with foreign research groups. They also have a large number of collaboration with industries.

Recommendations

The department has produced a large number of very good research outputs and has good research networks. The panel anticipates that the impact of their research could be increased if they publish in top-tier international conferences that are attended by a large number of industrial researchers. This would make the international visibility of the research outputs more prominent.

The panel believes that there is good potential for the unit to increase their activities to become a strong group in software model checking.

4.2 Helsinki Institute for Information Technology (HIIT)

Overview, mission and strategy

This is a joint institute of the University of Helsinki and Helsinki University of Technology (TKK). Some of its members have joint affiliations of HIIT and one of the parent universities, and some are affiliated with HIIT only (the latter of them are on limited-term funding). There are over 100 researchers. The key goal of the Institute is to foster research that benefits from the collective expertise of the two parent institutions. Research group leaders can be either tenured professors, or senior researchers on limited-term funding. Currently there are 15 groups working in four Research Programmes.

Research profile

Basic research that is carried out at the Institute spans a wide range of fields with clear application drivers.

Scientific quality, impact and viability

The first activity was started in 2000 and the number of publications essentially took off (most impressively) in 2002. It may be noted that there is a very large overlap between the activities reported by this Institute and the activities reported by the units in the parent universities. Impact is measured in different ways, dependent on the field. This ranges over leading journals (e.g. Journal of the Association for Computing Machinery) and conferences (ACM Symposium on Theory of Computing (STOC), Symposium on Foundations of Computer Science (FOCS)) for theoretical computer science and algorithmics, through other journals and leading conferences that are appropriate for data mining and machine learning; standardisation activities; and conferences for some new areas (mobile/ubiquitous computing, etc.). Impact of the 50-strong networking work is with reference to the Internet Engineering Task Force and the World Wide Web Consortium standardisation work; Open Source software; and influencing Nokia and Ericsson.

Research environment

EU Framework Programme (FP) funding is of increasing importance (HIIT has been active from FP6 onwards). Tekes funding is at twice the level of funding compared to Academy funding. Some of the research group leaders are on limited-term funding.

Research networks

In a range of areas (data mining, machine learning, applications in fields that include bioinformatics), there is world renown on the part of individuals associated with HIIT. HIIT researchers host a large number of collaborative research visitors and lead many research collaborations worldwide.

Recommendations

There is tremendous potential for major future achievements in computational and cognitive neuroscience, linked to past achievements of Academician T. Kohonen, and also motivated by such initiatives internationally as the Bernstein-Centers for Computational Neuroscience in Germany. There is also a strong orientation towards bioinformatics, which is valuable and represents a clear focus. The issue of mobility of HIIT staff should be carefully monitored. International recruiting, especially in the area of postdoctoral researchers, is effective with a range of impressive examples noted. However, faculty- and senior-level researchers are not – generally – internationally recruited. Processes for change in the selection (and indeed for managing the life-cycle) of the (currently 15) research groups as the mechanisms for the overall direction of growth and evolution are at an early stage. The issue of evolution of (renewal, additions to, etc.) research programmes within HIIT points to the need to inform and/or be informed by national (research and industrial) strategy.

4.3 Lappeenranta University of Technology, Laboratory of Information Processing (LUT/IP)

Overview, mission and strategy

The Laboratory consists of two major groups: the Machine Vision and Pattern Recognition (MVPR) Group and a younger Software Engineering Research (SWE) Group.

The MVPR group has one professor and four senior researchers (two docents), nine doctoral students, four visitors and one industry coordinator who is shared with other groups in the department. The research spans from basic academic research to industrial applications. Basic research projects include object detection and localisation, 3D and 2D face recognition, active and robot vision, and biomolecular computing. Applied research projects include applications in the forestry and printing industry, visual control systems, and in medical imaging. The SWE group has one professor, three postdoctoral researchers, and seven doctoral students. Their focus is on requirements, architecture, context of software and system development, software organisation, and testing organisation.

Research profile

All research covered by the unit is in the core of computer science with a clear focus on machine vision, pattern recognition and software engineering.

Scientific quality, impact and viability

With respect to publication, the MVPR group produced 52 journal papers while the SWE group produced four papers during the period 2000–2006. For the MVPR group, it is encouraging to see that the quality of papers has improved recently with some papers published in top-tier venues. Likewise, they are very successful in applying their techniques in practical applications. It is evident that they have established very good relationships with industrial partners who take up their results. Because the SWE group has started recently, they have only begun to produce publications in good conferences.

Research environment

The Laboratory provides a vibrant research environment with many interesting industry-funded research projects, which provide very good training opportunities for doctoral students and senior researchers. The panel has the impression that the unit has a positive and supportive research culture.

Research networks

The Laboratory has many national and international collaboration networks and engages in international exchanges including the professorial level in spite of the fact that the small size of the unit naturally limits professorial leave arrangements. On the regional level, the unit has established very strong collaboration with industry.

Recommendations

The panel is very impressed with the quality of the research produced by the Laboratory. Both groups are encouraged to execute their current plans. Additionally, they are advised to continue and expand international exchange activities. For the MVPR group, while the panel appreciates their aspiration of becoming the largest research group in machine vision and pattern recognition, the panel also encourages them to consider joining forces with other machine vision groups in Finland, as the groups might benefit from potential synergies.

4.4 Helsinki University of Technology, Laboratory of Computer and Information Science (TKK/CIS)

Overview, mission and strategy

Helsinki University of Technology hosts some of the best scientific and technological leading groups in Finland. It seems to have changed over the years from a more limited-scope technical school and deals today with much more basic research as well. The Laboratory of Computer and Information Science was established in 1965 by the Academician T. Kohonen and is still impacted by his influential research tradition. It currently has five professors and over 65 doctoral students and postdoctoral researchers with strong international component. It has two national Centres of Excellence (one jointly with UH/CS) and is considered one of the top world laboratories in its field, broadly defined as “Adaptive Informatics” and Algorithmic Data Analysis, or the synergistic interaction between Computer Science, probabilistic modelling, and statistical analysis of natural data. It has strong affiliation with industry, resulting in several spin-off companies.

Research profile

The unit’s current research is divided into five major categories: (i) algorithms and methods of data analysis (ii) bioinformatics and neuroinformatics (iii) computational cognitive science (iv) multimodal interfaces, and (v) adaptive informatics applications. The unifying theme of all the areas is the machine learning methodology, with strong emphasis on dimension reduction methods (Principal Component Analysis, Independent Component Analysis, and other information theoretic techniques), Self-Organising Maps and other unsupervised learning algorithms. This is a rather specialised profile applied very successfully, in particular to biological data, both molecular and neural, and specific cognitive science applications. The research focus is less influenced by the supervised learning trends (e.g. kernel methods) one finds in many other places.

Scientific quality, impact and viability

The Laboratory has generated outstanding research in its areas and is considered among the world's top. Its national leadership is evident by the two national Centres of Excellence in Adaptive Informatics and Algorithmic Data Analysis. It is strongly associated with the Computer Science Department at the University of Helsinki and shares one of its Centres of Excellence with it. It is less connected with the theoretical Computer Science group at TKK, mainly due to its emphasis on real world data and less on rigorous algorithmic analysis. Like the UH/CS department, it pursues industrial applications, from proofs of concepts to the creation of spin-off companies. The panel was very impressed with the focus and breadth of the department and with its international leadership. It has a consistent outstanding publication record at top conferences and journals with spectacular citation impact.

Research environment

The research environment and facilities at TKK seem impeccable. The research funding is among the strongest the panel has seen in Finland. Unlike many other places, most doctoral students work full time at the university and they attribute it to good financial support at the graduate level provided by the university. The panel considers this a good example for other places and believes that research money should be specifically allocated to encourage full-time research students. The Laboratory attracts international students and postdoctoral researchers, who expressed themselves as very happy with the support and research facilities. Like many other places, new faculty members are often hired from among own students, leading to a lack of diversity and coverage of new research areas.

Research networks

The Laboratory has a strong and excellent network of collaborations and international connections, but mostly one-sided: people come to Finland to learn the laboratory specialties, but faculty members are not sufficiently encouraged or willing to travel abroad to bring home with them methodologies developed by others. This is perhaps a general weakness the panel identified in Finland's computer science. There are very strong industrial connections inside Finland, and several applications developed in the Laboratory are implemented in products and marketed by spin-off companies.

Recommendations

As one of the leaders in Finnish computer science and technology the Laboratory should continue to enhance its excellent tradition. The funding situation is excellent.

More emphasis can be given to diversify and enrich the excellent research scope of the Laboratory, maybe by hiring more faculty members with different background. The Laboratory can also benefit from stronger interaction with the theoretical computer science group at TKK and UH, establishing a stronger rigorous basis to some of its unique unsupervised analysis techniques. It should also be encouraged to target further collaboration by playing a leading role within the European community.

4.5 Helsinki University of Technology, Communications Laboratory (TKK/Comlab)

Overview, mission and strategy

This evaluation only concerns the 15% of the Laboratory's activities that falls under the computer science area. Work in this area is carried out by two professors – one employed since 2001 and one since 2006 – and a small number of doctoral students. The professors conduct research on communication protocols for both wired and wireless networks and basic research in information theory. Traditionally, there has also been some research in human factors in telecommunications, but that has declined in later years with the retirement of a professor.

Research profile

The research in information theory is basic research in combinatorial algorithms. In radio networks, the research is in communications engineering (layer 1 and 2), techniques for resource allocation.

Scientific quality, impact and viability

The unit has a good number of journal publications in information theory, and has also recently published a monograph in that area. It is too early to evaluate the new research in communication protocols in the unit.

Research environment

The unit appears to suffer somewhat from a high teaching load (in particular with respect to the number of undergraduate students) and the fact that the unit is situated at the Department of Electrical and Communications Engineering makes it challenging to educate students in the computer science activities of the unit. The group has sufficient funding and has no problems with attracting Tekes and Academy funding.

Research networks

In information theory, there is good collaboration with international researchers and with other researchers in Finland, at TKK in particular.

Recommendations

The panel recommends that TKK considers whether the research potential of this unit is fully exploited or whether some internal restructuring could help to realise better the research potential of the unit.

4.6 Helsinki University of Technology, Laboratory of Computational Engineering (TKK/LCE)

Overview, mission and strategy

The Laboratory is funded by the Academy of Finland, Tekes, Ministry of Education, and Helsinki University of Technology with an annual funding of 3.6M€. It consists of five professors, twelve adjunct professors, 17 doctoral students, 38 undergraduate students, eleven research associates and four administrative personnel. The mission of the Laboratory is to perform computational analysis of complex systems – be it physical, biological or societal.

Research profile

The research areas include four main topics, namely, 1) models and methods, 2) engineered and artificial systems, 3) cognitive and social systems, and 4) computational systems biology. The focus is to apply statistical techniques in analysing complex systems. Although there is no significant coverage of the core of traditional computer science topics, the research may be an emerging topic in computer science. The projects are on fundamental issues and may lead to a new discipline of complex systems science.

Scientific quality, impact and viability

The unit has produced an enviable publication record with papers in top-tier venues. Currently, they have very large impact in the academic research community, in particular, in applying statistical physics to other areas. However, there is potential for significant long-term impact in other areas, too. As just one example, their work in social networks could have many applications in areas from security to economy. As evidence of their high quality, they were awarded twice the Centre of Excellence status.

Research environment

The Laboratory appears to be well funded and has excellent facilities for high performance computing with access to data from brain research and from computational systems biology.

Research networks

There is an extensive international collaboration network but it appears that there is little or no interaction with researchers in other Finnish universities.

Recommendations

The unit has produced outstanding research results in many areas. The panel is very impressed with the depth and the breath of their research. However, to further enhance their impact, they could consider further consolidation in their research areas. To seek funding support from Tekes may provide application oriented research problems to complement their current basic research agenda. The Laboratory has established an extensive international collaboration network, and is encouraged to establish a national collaboration network for research on complex systems. Another avenue the panel would like them to consider is to participate in relevant EU initiatives not only to broaden their source of funding but also to widen their international contacts.

4.7 Helsinki University of Technology, Networking Laboratory (TKK/Netlab)

Overview, mission, and strategy

The Networking Laboratory focuses on layer 3 and above of network communication, and it has substantial intersection with computer science. The Laboratory consists of four professors, each with their own research groups. The first group currently consists of eight researchers. The second group consists of eight researchers. The third group consists of ten researchers, and the last group consists of nine researchers.

Research profile

The Teletraffic Theory and Performance Analysis Group is working on various topics including balanced fairness, ad-hoc networks and multi-hop wireless networks, advanced scheduling methods, traffic characterisation, estimation and load balancing, peer-to-peer networks, optical networks, fountain coding, approximation methods, and simulation methods. The Networking Technology Group is conducting traffic measurement and performance analysis, routing, and quality of service. The Protocols, Services and Telecommunication Software Group is working on adaptive error control for real-time packet media, multimedia signalling protocols, application protocol design principles, and delay-tolerant networking. The Network Economics Group covers two areas: techno-economic analysis of wireless network investments and statistical analysis of mobile services adoption.

Scientific quality, impact and viability

The Laboratory has published papers in top-level international conferences. Also, they are actively involved in several standard activities such as the Internet Engineering Task Force and the World Wide Web Consortium (W3C), and have contributed to Internet drafts (RFC: Request For Comment) and W3C standards. The Laboratory is also involved in several EU research projects. The educational unit is substantial and produces 40–50 MSc theses and 1–2 PhDs per year.

Research environment

The unit has very strong collaboration with many industrial companies. They are involved in many standardisation committees. The undergraduate and doctoral students are particularly attracted to industries and this makes it difficult to hire good postdoctoral researchers to conduct large-scale experiments.

Research networks

The Laboratory has good collaboration with other Finnish universities. They are involved in several EU projects. The excellent activities in standardisation committees conducted by the Laboratory bring possibilities to start new international collaborations.

Recommendations
The research quality of the Laboratory is high. The panel recommends continuing high-quality research through collaboration with industrial companies. Also, the Laboratory should continue to be involved in standardisation committees. Increasing the number of doctoral students will be important to strengthen the research activity of the laboratory.

4.8 Helsinki University of Technology, Software Business Laboratory (TKK/SBL)

Overview, mission and strategy
The Software Business Laboratory (SBL) focuses on providing novel and practical research insights to help software companies strengthen and sustain their competitive advantage. The work of this Laboratory is in the areas of software engineering and information systems, and is focused on software business. A view (cf. one of the stated aims of the Volendam Manifesto) of near future developments is that business issues – such as business models, value propositions and partnership networks – will dominate over technology in the sense of being the driving force. The software business area is a strategically important one for the Finnish economy.

Research profile
SBL is strongly oriented towards business aspects in software firms and software development. It was set up through an industrially funded Chair, established in 2003. Dr. Messerschmitt from University of California, Berkeley is a visiting professor at SBL. Close to 1M€ per year is taken in, in research funding. Currently there are about 40 students, 18 of which are doctoral students.

Scientific quality, impact and viability
Multidisciplinarity is stressed, involving academic rigour, industrial experience, and business expertise. A prime model employed is that a few companies participate in a project, a number of SBL personnel are associated with the work – mostly doing PhDs – and Tekes funding is obtained. Tekes funding amounts to 65% of total SBL funding.

Research environment
The group is well funded. However, continuity of service is not guaranteed (see recommendations).

Research networks
SBL is linked (in a leading role) with international initiatives such as the Volendam Manifesto and ISERN (International Software Engineering Research Network). While no European funding is currently obtained, the unit is very well connected with initiatives in relevant fields in Europe and worldwide.

Recommendations
The group has a very great deal to offer in regard to computer science and engineering in other universities. For example, the SBL group are hard-nosed and business-like, in

a well-founded way, in their attitudes towards Intellectual Property Rights; whereas most of what the panel has observed in other units has manifested an attitude which is very laissez-faire and hands-off. Continuity: the Chair position in SBL is only guaranteed until the end of 2007, which represents a threat to the (clearly successful) work of the Laboratory. The panel recommends that this work, and this post, be continued.

4.9 Helsinki University of Technology, Software Business and Engineering Institute (TKK/SoberIT)

Overview, mission, and strategy

The unit is the Software Business and Engineering Institute (SoberIT) of Helsinki University of Technology (TKK). The unit has five professors and a total of around 34 FTE research active staff. The number of completed dissertations in the period is 15. The group TKK/SBL was created in 2005 by division from this unit. SoberIT covers research topics primarily in software engineering and information systems.

Research profile

The profile is on applied empirical software engineering and human computer interaction. There is some experimental research.

Scientific quality, impact and viability

The publication level could be improved even if the panel observes a positive trend both in quantity and quality. The group is aware that it wants to increase its publication level aiming at two publications per person/year on average. The group is conscious of the importance of aiming at good journals with impact.

Research environment

The building is new and functional. The group exploits up to date research methods and tools for management of empirical software data.

Research networks

The group has some international relations with the University of Illinois at Chicago and the Massachusetts Institute of Technology. Moreover, there are relations to three Chinese universities.

Recommendations

The group should continue to focus on aiming at increasing quantity and quality of publications. Concerning the balance between research issues and industry collaboration, the group seems to have found a good aid in scientific methods for empirical software engineering. Here the panel's recommendation is to focus on fewer research methods and become experts in these. At the same time, they should choose a smaller defined set of best practices that are ground in existing literature and use them as theoretical context for industrial validation. One of the challenges of the group is to increase the research activity level of the doctoral students who are working in industry.

The group should build on the existing good international relations and, at the same time, try to strengthen the collaboration to other research groups in Europe, particularly other Nordic countries. Balance between industrial relations and scientific quality will be achieved if the group continues to develop its strategy. The relationships to other national and local software engineering groups like TKK/SBL should become stronger.

4.10 Helsinki University of Technology, Laboratory of Software Technology (TKK/SWT)

Overview, mission, and strategy

The unit focusing on computer science has currently five professors, four senior researchers and doctoral students for a total of 24 FTEs. The research work is focusing mainly on Algorithms, Databases, Embedded Systems, Visualisation and Education.

Research profile

Research work has historically been mainly focused on problems related to the physical layer of databases (with both theoretical and experimental activity) and on pattern matching problems on strings. More recently, problems of a more applied nature have been considered (e.g. content-based routing and filtering, bioinformatics, visual query languages). Visualisation is concerned with tools supporting learning of programming and evaluation of students, while considers the effect of such tools. A very recent and interesting line of research is combining algorithms, software visualisation and query languages to support forensic needs in information technology.

Scientific quality, impact and viability

Scientific quality of research produced in algorithms and databases is of first class, with the other areas producing result always of good quality. Five Finnish universities and one from USA have adopted the learning environment produced by the Visualisation and Education group. The majority of graduates (almost 40 each year) are absorbed by local organisations, where they have usually carried out their Master's degree work on a very wide array of basic computer science subjects. Many start-up companies have come out from former students.

Research environment

Current teaching load is a severe limiting factor to unit productivity, since the unit is responsible for the basic computing courses for all students of Helsinki University of Technology. The amount of external funding is too small and, taken together with the high teaching load, severely limits the capability of the Algorithms/Databases and of the Embedded Systems research groups to reach a more reasonable size.

Research networks

The amount of national cooperation is good, but the level of cooperation at the international level is not adequate for the high scientific relevance of the unit. Also, there is no project funded by the European Union, which is a limiting factor for the international visibility of the unit.

Recommendations

TKK should consider whether to have such a high teaching load for this unit is the best way to capitalise on their competences. Several of the theoretical research contributions of the unit could be a valuable asset for industry and the panel suggests industry connections be strengthened: this can lead to new methods and techniques. The unit should try to plan efforts to get more external funding and to invest in this direction. It is needed to increase the exchange of visits and to work actively so to attract more international students and candidates for open positions. In the area of Embedded Systems the panel recommends international collaborations to be strengthened.

4.11 Helsinki University of Technology, Laboratory of Theoretical Computer Science (TKK/TCS)

Overview, mission, and strategy

The Laboratory for Theoretical Computer Science has four professors, six postdoctoral researchers and 15 doctoral students (one professor position is currently vacant). The Laboratory consists of four groups, Computational Logic, Computational Complexity, Cryptology, and Mobility/distributed Computing Group. The Computational Logic Group studies automated reasoning techniques for solving challenging engineering problems and develops methodology for computer-aided verification and testing of distributed reactive systems. The Computational Complexity Group is focused on efficient methods for the design, analysis and management of large information networks. The Cryptology Group develops and applies different cryptanalytic methods for systematic cryptographic primitives. The Mobility Group has been developing methods and applications for secured communication in hostile wireless networks.

Research profile

The research area of the laboratory is theoretical computer science.

Scientific quality, impact and viability

The impact of their research is outstanding, both in scientific communities and industries. The group has published 72 journal papers and 220 conference papers in seven years. Also, they have developed open source software that is widely available. There are three start-up companies based on the research results in this group. As well, completed doctoral students have taken positions both at universities and industries. The Laboratory has much collaboration with industrial companies. Also, they have a strategic future plan for continuing high quality research.

Research environment

The research environment of the Laboratory is very good. They have a lot of funding from the Academy of Finland, Tekes and industrial companies. Also, they hire many doctoral students and postdoctoral researchers for conducting high-quality research.

Research networks

Their research networks are very well organised. There are many research collaborations with other Finnish universities. Also, they have much collaboration with research groups in other countries. Many researchers have visited the Laboratory, and there are 66 papers co-authored with international researchers.

Recommendations

The research quality of the Laboratory is of very high level. The panel recommends that the Laboratory should continue to maintain their approach to research, bridging theory and applications. The Laboratory should take leadership in future EU projects. They should continue to keep an effort to start new start-up companies based on research results in the Laboratory.

4.12 Helsinki University of Technology, Telecommunications Software and Multimedia Laboratory (TKK/TSM)

Overview, mission, and strategy

The unit has currently five professors, twelve senior researchers and doctoral students for a total of 49 FTEs. The research work of the unit is focusing mainly on Multimedia Technology, Computer Graphics and Interactive Systems, and Telecommunications Software. There is also a group working on business process simulation and development, but it was not part of the evaluation.

Research profile

Research activity is of applied nature in all areas and with a multi-disciplinary approach. Some of their activities are technology driven.

Scientific quality, impact and viability

Scientific quality of research products is of good level and quantitatively in line with the average (for journals) or better (for refereed proceedings). The unit has been active in international standardisation organisations (the World Wide Web Consortium, the Internet Engineering Task Force) with impressive results. Collaboration with industry is very strong and absorbs almost completely the about 70 annual Master graduates, also allowing transition from industry back to academic positions. Also, both local industry and international companies have largely absorbed PhDs. Some of them have continued their academic career in Finland. Their research work has usually been done while carrying out project work under Tekes funding. This was felt somewhat limiting, since the Academy of Finland funding is more suitable for basic research work. The unit has started several spin-off companies, some doing well commercially, and expects the number of spin-offs to increase in the future.

Research environment

The unit produces on average one PhD per professor per year. The biggest limitation is the number of available postdoctoral researcher positions, which, if increased, could allow doubling the number of doctoral students, which could help in raising and improving research outcome.

Research networks

International relations with research groups are very good and supported by formal instruments. The unit has the potential to participate more in European projects.

Currently most of the external funding comes from Tekes. Very good relations support multi-disciplinary research with national centres in other areas such as Art and Design departments.

Recommendations
The unit should explore possibilities of collaboration with the other TKK laboratories active in related areas, e.g. Netlab. Standardisation activities should be continued.

In some areas there is a focus on high-level publications: the panel suggests this should be extended to the whole unit. The group should continue its technology driven work, which is crucial to attract interest of good students, industry, and cultural communities. Moreover, given the good publication record in theoretical area, the group should have the potential to produce theoretical innovations from the technology driven activities. The unit should continue trying to increase the number of international projects and to fund more postdoctoral researcher positions.

4.13 Tampere University of Technology, Institute of Human-centred Technology (TUT/IHTE)

Overview, Mission, Strategy
The Institute of Human-centred Technology was founded in 2006, to bring together and further develop usability-related research and teaching activities that had previously been disparate, embedded in other institutes. The Institute is led by two professors with a team of over 20 researchers, of which half are at the doctoral level with the other half more junior. The mission of the Institute is to provide research and education on human-centred design of interactive technologies. The Institute focuses on user-centred design, contextual user research, and usability of technologies in strategic application directions, including mobile and pervasive technologies, as well as machine automation and industrial systems.

Research profile
Within the remit of this evaluation, IHTE is focussed entirely on human-computer interaction (HCI). This involves multidisciplinary perspectives, for instance on integration of user-centred design in software engineering. The HCI research of the Institute is primarily of an applied nature, using established user research methods to study design challenges in application projects. However, there is also a prospect that studies in partnership with users that may lead to more fundamental contributions, for instance, on understanding the use of interactive technologies, and on methodology.

Scientific quality, impact and viability
The research team are enthusiastic and ambitious, and have identified clear targets for developing international visibility. Naturally, the Institute is at an early stage of developing its research, and only beginning to establish a publication record. The biggest asset of the Institute is its close relationship with industries in the Tampere region. This has helped the Institute to obtain Tekes funding at a significant level, but more importantly it provides the research team with a concrete focus for contextual

studies in relevant application directions. While the evaluation took place at a very early stage in the group's activities the panel was impressed by their potential.

Research environment

The Institute is set up as a self-contained unit separate from neighbouring areas of computer science, with considerable investment of TUT in new facilities including usability research laboratories. As a result, there is a strong sense of identity and coherence within the team. However, it is also desirable that human-centred design research is made more integral in a larger software engineering and technology research context. The environment appears well developed for PhD research, with training in basic and multi-disciplinary research skills, and participation in a graduate school coordinated by the University of Tampere.

Research networks

The research team have an excellent network of users, i.e. industries that participate in collaborative research and provide access to concrete use cases, for instance, in field studies. It is noteworthy that the Institute maintains links to different domains and is less dependent on particular industrial partners than many other research groups that have been evaluated. The team are working to establish links nationally and internationally, and have engaged in a few first exchanges.

Recommendations

The team should continue to establish their focus, vision, and links with application partners to develop their fundamental contributions.

4.14 Tampere University of Technology, Software Systems Institute (TUT/IT)

Overview, mission, and strategy

The TUT/IT unit is an institute within the Department of Information Technology. The unit has eight professors and had a total of 31 FTEs in 2006. The research is focused on software engineering, mobile systems, embedded systems, artificial intelligence, and formal verification of concurrent systems.

Research profile

The profile has become more and more applied during the years under evaluation. A sound empirical framework helps in balancing between industry collaboration and software engineering foundations. There is some theoretical research in formal verification with some influential publication impacts.

Scientific quality, impact and viability

The publications are in standard conferences and journals in the area of software engineering and theoretical Computer Science, and the publication rate is average.

Students (both undergraduate and graduate) are constantly being recruited by local industries and in that sense the unit has a lot of impact locally. The unit has both national research projects and European ones, for example the Eureka ITEA project SERIOUS (2005–2007).

Research environment
The unit is housed in a building since 1999, which facilitates communication and cooperation among unit members. Overall, the funding situation is good and the unit is able to acquire adequate equipment for mobile and embedded systems research. In the sub-area of formal verification, the group has struggled more with recruiting students and with getting sufficient funding and attention from industry. The graduate schools SOSE and TISE support postgraduate training.

Research networks
The group has decreased its international relations in terms of visitors and guest lectures. On the other hand, the graduate school gives good opportunities for inviting guests. The unit also makes uses of industrially sponsored opportunities for leave.

Recommendations
The theoretical part of the research will be important in the long term as well as the empirical part. The panel encourages the unit to keep the theoretical research alive, and to consider strengthening the national relationships. This group is active in research collaboration. Software engineering researchers should aim at the well-established journals and conferences. The group has the potential to expand their research activities by participating in EU projects.

4.15 Tampere University of Technology, Institute of Signal Processing (TUT/SP)

Overview, mission and strategy
The Institute consists of ten professors, one emeritus professor, one senior researcher, six adjunct professors, two lecturers, two senior assistants, and 120 doctoral students with an annual funding of over 5M€. Their goal is to provide basic research in signal processing, in the areas of digital signal processing, image and video processing, speech and audio, multimedia and virtual reality, and signal processing for systems biology.

Research profile
The research of the Institute can be categorised as theoretical signal processing with some emphasis on computationally efficient algorithms. More recently, they have extended their work into systems biology.

Scientific quality, impact and viability
The research results of the Institute are published in top-tier conferences and journals. They are recognised for their contributions in signal processing with many international awards, fellowships, and the award of the Centre of Excellence. The panel is impressed that the unit is building on their long standing strength in signal processing to contribute to the development of new fields, such as signal processing for systems biology and biomedical applications.

They have local impact by collaborating with Nokia as well as with other smaller companies. Internationally, their impact is felt by their high-quality published papers.

As well, graduates of the units have moved on to the best laboratories around the world.

Research environment

All the presented groups show a vibrant research environment. Each has attracted a significant amount of funding and a large number of doctoral students.

They have successfully bridged to other disciplines such as biology in recruiting students. Based on their research results, several spin-off companies have been created.

The panel noted that this unit, unlike other units, has an international staff profile on which they very successfully build for recruitment and collaboration.

Research networks

With respect to international collaboration, this unit is the best the panel has seen in this evaluation. The panel is impressed with a large number of inbound and outbound visits. They also exercise leadership in the community in their areas in organising conferences.

Recommendations

The Institute is definitely a leader in signal processing with their impressive publication record. They should continue their efforts in bridging computer science and electrical engineering. As a very strong group, they are encouraged to enhance their already strong leadership role at the European level.

4.16 University of Helsinki, Department of Computer Science (UH/CS)

Overview, mission and strategy

The University of Helsinki has been the leading Finnish centre of research since its establishment in 1640 and its track record in mathematical sciences is superb. The Department of Computer Science was established in 1967, currently containing 13 professors and a total of over 120 FTE research-active staff, clearly continuing this excellent tradition. It has specialised in five major areas: (i) algorithms – in particular algorithmic data analysis (ii) information management – mainly data mining and applications to bioinformatics and language technology (iii) intelligent systems – machine learning, information theoretic (Minimum Description Length) methods, advance data structures, and probabilistic modelling (iv) software engineering – software design and architecture, object oriented frameworks, and quality prediction (v) distributed systems and data communication with emphasis on mobile computing and networking.

Research profile

The Department activity is at the core of computer science covering in particular research in algorithmic data analysis, string matching methods, machine learning theory, probabilistic and Bayesian methods and modelling, information theoretic applications in computer science, and distributed systems and data communications. It pursues utilisation of these results, application to other areas such as engineering, bioinformatics, and natural language modelling.

Scientific quality, impact and viability

The Department has established a critical mass and excels in most of the above-mentioned areas, as evident from its national Centre of Excellence in algorithmic data analysis (FDK) and in its successful partnership with the Helsinki Institute for Information Technology (HIIT) and with the Laboratory of Computer and Information Science and TKK.

The panel was very impressed with the focus and depth of the Department, with its ability to integrate theory and applications, and with its international leadership in several important fields. It has a well-balanced and consistent publication record at the top conferences and journals, with spectacular citation impact. The Department attracts outstanding students and has excellent international network of collaborations and exchange visits. It is very well funded and excels in particular in securing research funding from external competitive sources, which enables much lower dependence on local industry (Nokia) than some other places. It contributes to international conference organisation, networks of excellence, open source communities, internet drafts, and standardisation. It has led to several industrial spin-offs and made significant contributions to other sciences.

Research environment

The facility and funding is excellent. The research environment is vibrant with many exciting projects. The students are very enthusiastic about their research; however, there is a noticeable weakness in the low completion rate of doctoral students (about 50%), which may be due to many students who work in research but with no intention to complete their degrees.

Research networks

The Department works in close collaboration with HIIT and TKK and has an extensive international network of collaborations (19 international projects, 4 EU networks of excellence), including very good links with top laboratories in the field. They also have extensive national collaborations, which include 16 other Finnish universities and research institutes.

Recommendations

As an obvious leader in Finnish computer science the Department should continue to develop and enhance its many excellent aspects. The funding situation is very good. Higher priority should be given to improve the completion rates of doctoral students. The unit should consider developing a more systematic approach to supervision and appraisal, and may allocate more funding to support doctoral students. The panel believes that the Department can enrich its fields of research by hiring new faculty not only from its own students but also by encouraging faculty members to take more frequent sabbaticals out of Finland. The unit has the potential to become an even brighter star and an international leader in more areas of computer science, and is encouraged to do so.

4.17 University of Jyväskylä, Department of Mathematical Information Technology (UJ/MIT)

Overview, mission and strategy

The department has ten professors and about 50 FTE research active staff in total. The number of PhDs awarded in the period 2000–2006 was 39, which is significantly above average. The fields of research and teaching are mobile computing, software engineering, embedded systems, scientific computing, telecommunication technology, and teacher education. Unifying aspects between the fields are provided by a common mathematical background and collaboration with industry. The Department educates ICT professionals, researchers, as well as teachers. Due to the Bologna process, the two-cycle model for degrees has been in use since 2002.

Research profile

Research and applications are in the fields of telecommunication and industrial mathematics (i.e., scientific computing).

Scientific quality, impact and viability

A start-up company in numerical simulation for paper industry employs an impressive number of PhDs, i.e. six. The Department has been awarded a FiDiPro award. Technology transfer is a major strength of this Department. A singular feature of groups interviewed, including this department, was their industrial linkage in general, their linkage with Nokia in most cases, and their links with spin-offs. Faced with rapid expansion in Jyväskylä there has been a need to cater for software engineering. The historical and very solid basis for the group has been in scientific computation. Research strength lies in the latter area. A good job is being done though, in regard to teaching of software engineering.

Research environment

This Department is a sizable one, and produces a large number of PhDs. In addition, they have had rapid growth. Teaching was typically of the order of 2–3 courses per professor per year. Research training is supported by the Department's involvement in two graduate schools.

Research networks

Outbound visits of faculty are very limited. There is no systematic policy in regard to sabbaticals, other than through Academy-funded replacement salary. It appears that there is a lack of interest of faculty to apply for this funding.

Recommendations

Given the links with local industry and the health sector, metrics of success based on these are of particular importance. The role played by the Department, especially in teaching and training, and in technology transfer, is very important. However, the changing perspective on Intellectual Property Rights (IPR) should be monitored very closely, and perhaps ownership of IPR by the university, on behalf of university personnel, should be viewed in a more assertive way.

4.18 University of Joensuu, Department of Computer Science and Statistics (UJO/CSS)

Overview, mission and strategy

The University of Joensuu has a comparatively small activity in computer science, with five professors, in a joint Department with Statistics. The general emphasis is toward human aspects in computer science with media computing and educational technology as major topics. The specific research themes are speech and image processing, colour research, psychology of programming and use of information technologies as tool for learning.

Research profile

The unit has a very distinct research profile in Finland's computer science, both in terms of specialisation on topics not covered in other computer science units, and in terms of work with other disciplines, in particular educational research and cognitive systems.

Scientific quality, impact and viability

The research activity within this unit is exciting and impressive. The unit has an excellent strategy with clear profiles and focus, in particular in areas that are not mainstream in computer science but clearly relevant and important, and in some respects very progressive. The unit has over the last few years very successfully built on its distinct expertise to increase its research activity and output significantly, in terms of publications, impact factors, and new PhDs recruited. A large proportion of the publications are in top journals, for instance the prestigious IEEE Transactions. All research teams are very visible internationally, and engage strongly with other leading groups worldwide in their respective areas of research. The strength and quality of the research is also evident in their success in acquiring external funding from a range of sources.

Research environment

The unit has new facilities available at the Science Park and its environment includes support, for example, for developing collaborations with partners in the region. The geographic location of the University limits intake to local students but the unit has been very successful in developing international programmes of recruiting postgraduates from around the world, notably including developing regions. The staff structure looks very healthy with excellent leadership and committed teams but it is very good that the unit is also seeking to sustain and further grow its research by creating new faculty and postdoctoral researcher positions.

Research networks

The unit has international activities and exchanges on a truly global scale, and is very progressive in building relationships with universities and institutes in developing regions, for instance, African countries. The unit also has an impressive network of international collaborations with first-rate science and education institutes. Regional development funds have been put to excellent use to develop international programmes that attract computer science students and research talents from outside Europe, many of whom take up employment in the region and some are recruited to continue in doctoral research. Finnish doctoral students are routinely placed internationally on longer-term exchanges, and one of the recent Finnish graduates of the unit has been appointed to a faculty position in Tanzania. In addition to their international activity, the unit is engaged in many networks nationally and regionally, including shared programs and graduate schools with other universities, as well as networking with user communities, in particular schools in the region.

Recommendations

The unit has a very clear profile and focus, and the panel feels that the unit is positioning itself excellently, and carrying out very good research in its areas of specialisation. Moreover, the unit is very progressive in how it responds to recruitment challenges and has developed global activities. Its links with the developing world are unique and pioneering in the area of ICT4D (ICT for Development) and the panel recommends that this Department be further supported by all appropriate means. The unit has an excellent eight-point strategy and is very much encouraged by the panel to execute it.

4.19 University of Kuopio, Department of Computer Science (UKU/CS)

Overview, mission and strategy

The unit is the Department of Computer Science at the University of Kuopio (UKU/CS). The research focus of the university is "health, environment, and wellbeing." The unit has 47 FTEs in 2006. There are five professors and three research directors. The number of doctoral students has increased from six in 2000 to 30 in 2006.

Research profile

Three areas are covered: software engineering, algorithmic computer science, and communication and data security. The research profile can be classified as applied, mainly in the areas of software engineering and partially in biomedical computing.

Scientific quality, impact and viability

The group has a number of publications in standard quality software engineering conferences and a small number of publications in the pattern recognition area. The publication level is slightly below the average in Finland. The unit has established a special programme for developing doctoral education in software engineering financed by EU regional funding, called KYTKY. KYTKY students started in 2004. The research has some societal impacts. As an example, we mention the connection to the paper industry and the Mobile Identity project with security issues. Moreover, the unit educates both undergraduate and doctoral students who are employed in the local industry.

Research environment

The group has a very good space and equipment situation but space will be limited if the unit expands.

Research network

The national research contacts are mainly with the University of Tampere. The unit has limited international collaboration.

Recommendations

The group should build on its strengths that are a good balance between employed personnel and doctoral students, good production of undergraduate students, and relationships to local enterprises. Moreover, the KYTKY programme can be used as a way to structure and strengthen the research of the unit. Doctoral students should be encouraged to participate in graduate schools at the national level to increase the level of national relationships. Frameworks should be developed that increase international networking, including provisions for sabbatical years and international research visits of doctoral students and postdoctoral researchers. Long-term research issues should be planned, to balance research driven by industries. The unit is encouraged to balance between the industry pressure for both education and short-term applied research and long-term projects grounded in theoretical foundations. Publications in higher-level conferences and journals are encouraged.

4.20 University of Oulu, Department of Information Processing (UO/IPS)

Overview, mission and strategy

The unit is the Department of Information Processing Science (UO/IPS). It has nine permanent professor positions and six temporary professor positions. The department has undergone a dramatically fast growth during the period resulting in 95 FTEs in 2006. The total number of completed PhDs in the period is 25. Their goal is to double the number of doctoral students per year.

Research profile

The profile is mainly applied, principally in software systems, information systems and mobile computing. Moreover there is some theoretical work in information theory and coding.

Scientific quality, impact and viability

The publications are in standard software engineering and information systems conferences and journals. The number of publications in journals and conferences is acceptable.

Research environment

The unit has struggled to allocate personnel to available positions, which were opened due to increasing enrolment. It appears that the main objective of their doctoral student training is to fill teaching positions. During the period under evaluation, 25 doctoral students finished their degrees. Teaching and how to train people to fill the teaching positions has been a concern for the whole period, which has dominated over research concerns.

Research networks

The group has good relations with local industry and has an active international research network both in Europe and in the USA. International visitors to the unit are utilised in the unit's doctoral student education.

Recommendations

In recent years, the strategy has been influenced by fast growth. At this time, the unit should develop a strategic plan for research. The group should build on its strengths and on the relations among the different groups, like mobile work and HCI. All in all, more focus and long term research planning including publication planning is suggested. Also, this group has the potential to consolidate its research. The panel encourages the group to increase the already established connections to other software engineering units in Finland and to take advantage of funding opportunities in existing graduate schools. To become a leading research unit, they should encourage doctoral students to be full-time students. Moreover, faculty members should improve their international connections, possibly via sabbatical stays or visits. The unit would benefit from increasing the number of international postdoctoral researchers.

4.21 University of Oulu, Intelligent Systems Group (UO/ISG)

Overview, mission and strategy

The central theme of the Group is that of smart environment, involving adaptability and context-awareness. The principal means towards this objective involves activity, and sentient recognition. Applications include robotics, biomedical signal processing, and intelligent user interaction.

Underpinning technologies provide commonality across application areas: Atomic framework for assembling electronic systems; RFID in interfaces; embedded systems; sensor networks.

This is an integration systems laboratory, with a strong orientation towards systems engineering and systems building rather than, for example, theoretical innovation.

Research profile

In the presentation, figures were given of four professors, seven postdoctoral researchers. Research funding of 1.3M€ was received in 2006 in addition to basic university funding. The total amount for the period 2000–2006 was 3.5M€. In 2005, there were ten, and in 2006, 14 journal publications. In 2005, there were two, and in 2006 four PhDs completed. There are six spin-off companies. Intellectual Property Rights are handled in a customised way, which is very similar to the approach taken by other units the panel visited. Current EU Framework Programme (FP) projects are a STREP (Specific Targeted Research Project) on robot swarms and IP (Integrated Project) with about 10% of a 10M€ project. This is impressive.

Scientific quality, impact and viability

The major strength of this Group lies in its links with local industry and the health sector. Theoretical innovation primarily originates elsewhere and is applied in the group's R&D. The Group has also a significant training role, reinforcing its linkage with local industry. The demos and prototypes (including the ground units and a flying unit, that the panel was shown) are an excellent means towards dissemination and public understanding in this area. Particular strengths of the Group include the significant number of spin-off companies; and the integrated and well-resourced physical environment of the group. There is a perceived need by the Group for greater benefit to be drawn from EU funding. National-level funding is described in the self-assessment evaluation report as being unduly bureaucratic.

Research environment

The unit has specialist facilities for its research, for instance a large laboratory (90 sq m) with a pressure-sensitive floor; mobile robots were demonstrated; a flying unit was shown. Wireless-based telecommunications are used throughout the group's work. Plans were mentioned in regard to a public, urban information orientation system in Oulu. Overall, the group is very well equipped and plays a unique role in robotics in Finland.

Research networks

Of particular note are the excellent linkages with local companies and the local health sector. One of the presentations was by a group member who had recently returned from a collaborative period in a Japanese laboratory. Nearly all one-month or longer visits to the unit were intern/trainee students, which is useful. This reflects the close application and industry ties. A good range of international collaborations is listed in the self-assessment evaluation report.

Recommendations

Given the links with local industry and the health sector, metrics of success based on these are of particular importance. R&D work, as compared with more theoretical and conceptual research, is very well suited to FP funding. The unit has had some notable successes in this area and this is very much to be encouraged.

4.22 University of Oulu, Machine Vision Group (UO/MVG)

Overview, mission and strategy

The research group is in the Information Processing Laboratory within the Department of Electrical and Information Engineering. It has three faculty members, four researchers, four postdoctoral researchers and 17 doctoral students with an annual funding of 1.6M€.

Research profile

The Group's research focuses on computer vision, in particular texture analysis using local binary patterns, and face recognition, human-computer interface, mobile computing, and geometric image and video analysis. The research spans from basic fundamental problems in image processing to more applied face recognition.

Scientific quality, impact and viability

The research results are published in top-tier journals and conferences such as IEEE Transactions on Pattern Analysis and Machine Intelligence and European Conference on Computer Vision. Many companies and research groups have adopted the group's technique (Local Binary Pattern (LBP) texture operator) in various vision systems. The panel was advised of several spin-off companies that have been formed based on their research results.

Research environment

The group is housed in a new building with very nice facility. They have established an international reputation to attract students and postdoctoral researchers from outside of Finland. Although the group has been very successful in supervising doctoral students, they appear reluctant to supervise more, due to limited longer-term funding.

Research networks

The group has established extensive national and international collaborations.

Recommendations

The panel has the impression that the Group is somewhat focused on one single technique (LBP). While the Group is very successful in developing LBP and applying it to many different areas, they are encouraged to also highlight their other activities and to further diversify into other methodologies. The panel also encourages the Group to seek longer-term funding and to increase the number of postdoctoral positions. One suggestion is to participate in relevant EU projects. Another possibility is to take leadership to collaborate with other machine vision groups in Finland to form a Centre of Excellence in Machine Vision, which would increase the chance of getting more funding from varying agencies in Finland, the EU and from industries. With respect to Intellectual Property Rights, the group holds the common view that the company which sponsors the research or funds the filing of patents holds the ownership of the Intellectual Property. Although this view may be the prevalent one in Finland, it does not appear to be consistent with the view of the rest of the world. The panel encourages the Group to discuss this issue with officials at their University as well as with their colleagues at other universities. The panel encourages them to convince the University of Oulu to establish an office to develop a more consistent policy regarding IPR.

4.23 University of Turku, Fundamentals of Computing and Discrete Mathematics (UT/FUNDIM)

Overview and mission

The unit consists of four professors, two senior researchers, three Academy Research Fellows, two postdoctoral researchers, and 13 postgraduate students. The research of the unit concentrates on three different areas of theoretical computer science and discrete mathematics: theory of automata and words, theory of new models of computing and coding theory. The unit concentrates on research and doctoral education, while Master education is part of that of the Department of Mathematics.

Research profile

The unit performs basic research in theoretical computer science and discrete mathematics. The coding theory area has some applications in telecommunications and some collaboration with Nokia has been initiated.

Scientific quality, impact and viability

The unit has a good number of excellent publications, including several monographs, handbook chapters, and a Journal of the Association for Computing Machinery paper. All four professors are internationally recognised with good citation indices. The unit is clearly conscious of which venues they choose for publishing their research. The unit also participates in organising and hosting international conferences in Turku. It is also worth noting that the unit has obtained five of the very competitive Academy Research Fellow positions during the evaluation period. The doctoral students are able to obtain good postdoctoral researcher positions internationally.

Research environment

The research environment is very good. The unit participates in the Turku Centre for Computer Science and has a very good number of top international visitors. The unit clearly has a very strong scholarly culture. The unit also participates in organising and hosting international conferences in Turku, including a successful edition of International Colloquium on Automata, Languages and Programming (ICALP). Approximately two postgraduate students start and finish per year. The average age upon completion for postgraduate students is around 30 years (lower than average in Finland).

Research networks

The unit has intensive international collaboration with leading international researchers. That is very important for this area of research and should be continued. The unit has initiated collaboration with Russian centres, not only with the aim of research collaboration but also to attract new postgraduate students. The unit also has good collaboration with the other partners in Turku Centre for Computer Science.

Recommendations

The panel recommends the unit continue to focus on international relations and agrees that the collaboration with Russian centres could be very useful for future recruiting of postgraduate students. The unit might consider entering into a Marie Curie training network or similar formalised international researcher training network. The panel appreciates the efforts of the unit on establishing connections with application areas and suggests that those efforts be continued.

4.24 University of Turku, Department of Information Technology (UT/IT)

Overview, mission, and strategy

The Information Technology Department was formed in 2002 by merging parts of the Departments of Mathematical Sciences and Applied Physics, and has activity in computer science, information systems, communication systems, and micro-electronics. The part of the Department that is focusing on computer science has currently five professors, seven senior researchers and postgraduate students for a total of 26 FTEs.

The research work is focusing mainly on algorithms, bioinformatics, and software engineering, with a large number of other areas also covered. Artificial intelligence (learning, speech, decision making, data mining, fuzzy sets, computer games) is seen as an area providing basic tools and techniques.

Research profile

The unit combines a solid theoretical knowledge with the ability to effectively tackle real-life applied research problems. The work is mainly of an applied nature, even if pure theoretical subjects are studied. The group has a good background in theoretical computer science but is also able to talk with local industry in order to understand applied research topics and put them into proper relation with more fundamental questions.

Scientific quality, impact and viability

Algorithmic and bioinformatics work is done in large quantity and has a good relevance, both in terms of publication and for what regards its industrial usage. Tight relations with the local industry have been important also for the purpose of getting research results published. On the other hand, research activity in software engineering appears to be much less intense.

Graduated MSc students and doctoral students are mostly recruited by industry. Their software products for optimisation problems are of very high quality and widely used in Finland. A spin-off company in software systems for production control was started from algorithmic research and is already internationally active. From bioinformatics a spin-off was started, while two spin-offs started in the software area.

Links have been activated with upper secondary schools to contact early good candidates and to counter the effect of decreasing number of enrolments. An Alumni Association of Computer Science is also active to strengthen the sense of community and relations with the local societal environment.

Research environment

The unit is housed in a wide, well-designed and modern (2006) building, shared with other research units in computer science in the same area.

The unit supports a Master's degree programme in Engineering (ICT & Electronics), a Master's degree programme in Science (Information and Computation Sciences) and two international Master's degree programmes in Science (Information Technology and Bioinformatics). The needs of Master students training result in a very high teaching load. TUCS provides strong support for PhD training, and its programme for postgraduate training is able to attract a large proportion of international students.

Research networks

The unit has good national cooperation within computer science and also interdisciplinary links with Turku University Hospital, Turku Centre for Biotechnology, and the Centre for Plant Physiology. International cooperation is in place but exchange of visits (both incoming and outgoing) is somewhat rare.

Recommendations

Cooperation with biological research puts the unit in a very good position in an area that will be more and more important in the years to come. The unit is already aware of this and should definitely implement their plans. Also the strong algorithmic background of the unit is a valuable asset for many future applications in computational areas. International relations should be strengthened. The strong results of the group provide a good foundation for even more influential impact on international research. The panel observed that the unit was concerned with further growth of international activities due to its structure and recommends the unit to address it. Research effort should be more focused on the main strength areas of the unit.

4.25 University of Tampere, Department of Computer Science (UTA/CS)

Overview, mission and strategy

The unit focusing on computer science has currently 6.5 professors, three senior researchers and postgraduate students for a total of 66 FTEs. The largest area of activity is human-computer interaction (HCI) with three professors and a postdoctoral researcher leading groups working in Visual Interaction; Multimodal Interaction; Speech-based and Pervasive Interaction; Emotion, Sociality, and Computing. Other areas of research are in Algorithms and Data Analysis, Data Management, and, on a smaller scale, Software and Information Systems.

Research profile

The unit's work in algorithms and data analysis has both a theoretical and applied nature with a large and appraisable array of multi-disciplinary collaborations (medicine, psychology, signal analysis, occupational health, biomedical engineering, information research, and bioinformatics). Also research activity in human-computer interaction spans basic and applied research.

Scientific quality, impact and viability

The scientific quality of research products in algorithms and data analysis and human-computer interaction is generally high (e.g. publications in the HCI area are both in the best journals and conferences in the field), whereas outcomes of other research areas do not appear to be as strong. The majority of graduates are absorbed by local industry (dominated by Nokia), and also many postgraduate students find positions there, with positive effects on the development of good relations with regional companies. Alumni activity is also very important in keeping the good links with the strong industrial IT sector of the region. The human-computer interaction group has also implemented software applications for public services and produced a small number of patents (in Finland and Russia).

Research environment

The unit has a Master's degree programme for each of their four research areas. Usually undergraduate students study only part-time because of the strong pressure from IT industry to hire them. In each of the groups doctoral student training is done half in schools, half in projects. A high number of PhD theses have been completed, mainly in the human-computer interaction area (three per year on average, half of them in industry). The panel was impressed that the unit demonstrates a strategic approach to PhD education and career development. Senior staff has a heavy teaching/supervising load with not many postdoctoral positions to share the burden of research leadership. The unit has excellent laboratories, at an outstanding level for carrying out HCI research or HCI-related research and a potentially highly valuable asset for doing subcontracted research work for industries.

Research networks

Both national and international (EU, USA, Japan, Canada, South Africa) cooperation is active and alive with joint projects and publications and a very strong programme of mutual visits. The unit has also coordinated several EU projects. The collaboration highlights include a new project with Stanford University in HCI and the extensive cooperation between the algorithmic area and medical researchers at Tampere University Hospital and Helsinki University Hospital.

Recommendations

The panel recommends that research effort should be concentrated in areas of strength within the unit, including HCI. The strong competence in human-computer interactions is seen as a valuable asset for future developments of research, and is also important from the teaching viewpoint since it provides education for jobs that are not easily outsourced.

4.26 University of Vaasa, Department of Computer Science (UV/CS)

Overview and mission

The Department consists of four professors, three lecturers, and approximately 20 doctoral students. The range of topics covered is wide, and includes knowledge management in organisations, models for semi-structured data, and basic research in telecommunications. The unit focuses a lot of its efforts on research collaboration with local industry and has been committed to an extensive programme on adult education for engineering and economics students. The Department offers three study programmes for undergraduate students and participates in one international Master's programme in telecommunications.

Research profile

A lot of the research is project-oriented applied research, topics decided mostly by local industry, with the research in telecommunications being an exception.

Scientific quality, impact and viability

The unit is small and yet tries to cover many topics. Overall, the research of the whole unit has limited impact in the international scientific community, with the exception of the telecommunications area. The research done in collaboration with local industry seems to be focused almost solely on the needs of industry rather than on curiosity-driven research questions.

Research environment

There are good facilities and equipment for research, in particular the facilities provided by Technobothnia. Because of a lack of critical mass in the topics covered, the research environment could be better. For example, it appears that there are only few international visitors, and no colloquium series.

Research networks
The department has collaborations with local industry and with TKK (in telecommunications), but only limited international collaboration. The international Master's programme could be a good start to more formalised research collaboration also at the postgraduate level.

Recommendations
The panel recommends the unit to focus their effort on fewer topics to create higher critical mass and to get more impact. On the other hand, the wide range of topics covered means that the unit can offer Master's programmes on a wider range of subjects. However, the panel believes that three study programmes are too many for such a small unit and recommends reviewing its profile. Further, the panel recommends that plans be developed to increase the number of postgraduate students and external funding. In particular, the panel recommends that the unit develop their industry links for local industry to sponsor more doctoral students. The panel appreciates the efforts to collaborate with local industry but suggests that more of these efforts should result in publishable research papers.

4.27 Technical Research Centre of Finland, Digital Information Systems (VTT/DIS)

Overview, mission and strategy
This unit represents one of VTT's seven Knowledge Clusters. The unit currently has nine research professors, over 80 senior researchers and about 170 research staff in total, located in Espoo and partly in Tampere. The unit's areas of competence are in data analysis and management, media and interactive technologies, and ICT systems and applications. As part of VTT, the core mission of the unit is to achieve impact in terms of industrial application. The unit broadly investigates systems that involve analysis and interaction with data and media.

Research profile
This unit has a very broad profile and touches in its activities on many areas of computer science, with an emphasis on integration and application to other domains and disciplines. The unit has many interactions with other disciplines, such as biomedical engineering and environmental monitoring.

Scientific quality, impact and viability
This unit is strong in adopting new developments in ICT, and in combining these to develop new methods and systems that address new application opportunities and challenges in specific application fields. The work is generally of high quality and there is clear evidence for industrial impact. The unit is also very active in publishing their work, with general visibility at the international level as well, but not focused on a strong and sustained presence in any particular sub-field. However, it is noteworthy that the unit is developing leading know-how in some application areas, such as satellite image processing applied to environmental information systems.

Research environment
The facilities of the unit are excellent. As part of VTT, the unit benefits from links to other parts of the organisation for its research of ICT application into other areas. The staff structure and unit size are such that the breadth of activities can be well supported. There is encouragement and support for staff to create spin-offs based on their ideas. In the evaluation period, ten research staff members completed their PhDs.

Research networks
The unit maintains a very impressive number of collaborations, with excellent research networks in Finland and internationally. VTT has an important societal impact serving the role of industrial greenhouse for start-up companies and technological spin-offs, and this unit is active in this respect. The unit has very good connections to universities in its immediate environment.

Recommendations
This unit has a very broad remit of activities. There is a sense that many of the activities are well linked and that the unit is successful in combining different ideas to develop novel solutions. It is less clear, however, on which areas of research the unit is focused. This should be addressed in the future with a clearer profile.

VTT has the capacity to strongly contribute to the international visibility of Finnish computer science, and this does not seem to be fully exploited. Various members of the unit achieve publications in venues of high standing, with evidence for significant impact in terms of citations, but there appears to be limited awareness of strategic targeting of publications and of recognition for publication success.

4.28 Technical Research Centre of Finland, Telecommunications (VTT/TL)

Overview, mission and strategy
Telecommunications is one of seven Knowledge Clusters in VTT. The unit has seven professors, about 57 senior researchers and close to 260 research staff in total, with most of the activity located in Oulu. The core knowledge of the unit lies in communication technology, wireless networking, computer architecture, software technology, and mobile interaction. VTT is a contract-based R&D organisation with a mission of innovation and technology transfer. The Telecommunications unit has its focus on development of next generation technologies for wireless communications.

Research profile
As a contract-based research organisation, VTT has a very different profile from most of the units evaluated. Most of the research carried out in the unit is applied; however, some of the research involves more basic science. It is noteworthy that 30% of the research is confidential. The research is largely focused within computer science, in particular applied software, systems and networking research.

Scientific quality, impact and viability

The Telecommunications unit has a strong track record of research and development of 2, 2+ and 3G cellular systems. The unit is very involved in European collaborative research, has participated in all major EU research programmes on wireless networking, and has also positioned itself very strongly for EU Seventh Framework Programme with involvement in a large number of consortia with the key players in telecommunications in Europe. The research is of high quality. It is very strong in terms of its primary mission, i.e. industrial impact, but also good in terms of dissemination in the international research community. This includes real highlights in terms of publication in the best conferences and high citation impact, for instance agile software development and network-on-a-chip research. However, a large research unit such as this could also target a more sustained presence in major conferences in the field.

Research environment

The unit has excellent research facilities, and as part of VTT generally a very strong environment in terms of expertise in a range of technology and application fields. The staff structure differs largely from that found in university units, with a large proportion of research staff hired at graduate level and not studying toward a PhD. However, over the evaluation period, nine PhDs have been completed their degrees in the unit.

Research networks

The unit has an excellent research network in Finland and very good internationally, mostly through European programmes. VTT has a strong impact on society at both regional and national levels, with a role of industrial greenhouse for start-up companies and technological spin-offs. However, transfer activities in this unit are very focused on one major industrial partner. The unit also has good connections with universities in Finland and particularly close ties with the University of Oulu.

Recommendations

The unit has an important role between academia and industry in Finland's telecommunication research and development, and is very active and productive. One of the unit's distinct strength is its role in European research, and it should seek to exploit this further and develop and broaden its direct links to industry.

In order to further develop international visibility of the unit's research, a more strategic approach to publication should be developed. This should consider reputation and impact of journals and conferences. In this research area, conferences can be more important than journals and the unit should recognise the value of publication in first rank conferences.

A. Statistics on Finnish Computer Science Research 2000–2006

The statistics compiled in this Appendix have been produced by the Academy of Finland on the basis of data reported by the participating research units. A summary of the collected data is provided at the end of this Appendix in Section A.8. It is important to note that the data has limitations; it was collected in a relatively short timeframe, and a few units noted during the evaluation that not all their data was accurate.

A.1 Research Units and Their Host Organisations

The evaluation of computer science in Finland 2000–2006 covered a total of 35 research units from universities around Finland as well as VTT. All the evaluated units were sent a self-assessment form, from which the data shown in this document was collected. The evaluation panel also interviewed the majority of the units (28 units) in June 2007 in order to meet the units' researchers and key personnel and to get a better view on the units.

The overview of the distribution of units by their host organisations is shown in Figure 1. A total of 33 units were university research units, from which ten units were from TKK. One of the evaluated units was HIIT, a joint research institute of UH and TKK. Two units were from VTT. For basic information and the abbreviations of the units, see Table 1. More detail is provided in the unit sheet in Section A.9.

Figure 1. Distribution of evaluated units by their host organisations. Units that were not interviewed by the panel are separated with a '+'.

Table 1. Evaluated units and their host organisations. A grey background indicates that the panel did not interview the unit. The part in the abbreviation before the '/' refers to the unit's host organisation and the latter part refers to unit's name.

Abbreviation	Name of department	Percentage of computer science	Research personnel 2006 (FTE-year)*
ÅA/IT	Department of Information Technologies	100	87
HIIT	Helsinki Institute for Information Technology (HIIT)	95	114
LUT/IP	Laboratory of Information Processing	90	25
TKK/CIS	Laboratory of Computer and Information Science	100	79
TKK/Comlab	Department of Electrical and Communications Engineering	15	4
TKK/LCE	Laboratory of Computational Engineering	55	23
TKK/Netlab	TKK Networking Laboratory (Netlab): TKK Department of Electrical and Communications Engineering	70	42
TKK/SBL	Software Business Laboratory	40	9
TKK/SoberIT	Software Business and Engineering Institute SoberIT	75	34
TKK/SWT	Laboratory of Software Technology	100	24
TKK/TCS	Laboratory for Theoretical Computer Science	100	23
TKK/TSM	Telecommunications Software and Multimedia Laboratory	85	49
TUT/IHTE	Institute of Human-centered Technology	100	7
TUT/IT	Software Systems Institute: Department of Information Technology	100	31
TUT/SP	Institute of Signal Processing	50	105
UH/CS	Department of Computer Science	100	128
UJ/MIT	Department of Mathematical Information Technology	80	48
UJO/CSS	Department of Computer Science and Statistics	95	73
UKU/CS	Department of Computer Science	100	47
UO/IPS	Department of Information Processing Science	100	95
UO/ISG	Computer Engineering Laboratory: Intelligent Systems Group	100	33
UO/MVG	Information Processing Laboratory: Machine Vision Group	100	26
UT/FUNDIM	FUNDIM (Fundamentals of Computing and Discrete Mathematics)	60	30
UT/IT	Department of Information Technology	50	26
UTA/CS	Department of Computer Sciences	95	66
UV/CS	Department of Computer Science	50	12
VTT/DIS	Digital Information Systems	85	162
VTT/TL	Telecommunications	87	203
TUT/DCS	Institute of Digital and Computer Systems	50	23
LUT/CE	Laboratory of Communications Engineering	80	14
TKK/SPL	Signal Processing Laboratory	8	1
TUT/ICE	Institute of Communications Engineering	40	13
UKU/ENVI	Department of Environmental Sciences: Research Group of Environmental Informatics	80	9
UTA/INFO	Department of Information Studies	40	13

* This represents the amount of FTE-years used in the given computer science percentage of the evaluated unit. It is not necessarily the same as the unit's total FTE-years (unless the unit is 100% computer science-focused).

The units were asked to estimate the percentage of their active research time that was used on computer science research. This was due the fact that most of the units were not pure computer science units. This evaluation focuses only on the given percentage shown in Table 1. From this point on, when we mention the size (or any other feature) of an evaluated unit, we mean the size of the part that is focused on computer science. When this is not the case, we will clearly state it.

As seen in Table 1, the evaluation covers units of various sizes and focuses on computer science. Twenty-one units have a major focus (at least 80%) on computer science, but five units have that percentage less than 50%. The median percentage was 85.

Both of the VTT units (VTT/TL and VTT/DIS) dominate in size, having 203 and 162 FTE-years of active research staff in 2006, respectively. Five units had less than ten FTE-years in 2006, TKK/SPL scoring the lowest with only one FTE-year in 2006. Average size of an evaluated unit in 2006 was 49 FTE-years and there were ten units that exceeded this in 2006. The median size in 2006 was 31 FTE-years.

A.2 Research Profile within Computer Science and Other Relevant Fields

The units were asked to describe their research within different areas of computer science. Computer science was divided into twelve subcategories with eleven labelled categories and one category for everything else. The research profiles within computer science reported by individual units are shown in Table 2. However, note that the size differences between units have not been taken into account. For instance, the 100% computer science research time allocated to human-computer interaction in TUT/IHTE has actually fewer FTEs than the 5% in unit VTT/TL. With this warning, note that, in terms of spreading of study of areas, there is a clear division between a group of six more "popular" areas (artificial intelligence, machine learning, and computer vision – studied in 21 units; software engineering – 20 units, human computer interaction – 19, parallel and distributed systems – 19, algorithms and data structures – 18, databases and data mining – 18) and the remaining ones. In terms of importance of areas for units (as evaluated by the fact that the area has more than 20% of unit's active computer science research time) there is a clear division between a group of three more relevant areas (artificial intelligence, machine learning, and computer vision – with 9 units considering it important, communications – 8 units, software engineering – 8) and the remaining ones.

When considering the distribution of FTE-years among areas of computer science, we obtain the result shown in Figure 2 (see also Table 16 in Section A.8). The largest areas are artificial intelligence (including machine learning and computer vision), communications and software engineering, the annual average of full-time researchers being 222, 200 and 179, respectively. The smallest field is programming languages with the annual number of full-time researchers being less than eight.

The 'other' field contains numerous subfields (some of which were already covered in some specific field) and the most common ones were computer science education or education research and digital media research.

Table 2. Research profiles within areas of computer science in 2000–2006. The number shown in this table are percentages of unit's active research time focused on computer science. Percentages of more than 20 are in bold. A grey background indicates that the panel did not interview the unit.

Unit	Theory of Computation	Algorithms and data structures	Programming languages	Software engineering	Parallel and distributed systems	Databases, data mining	Communications	Computer architecture	Human-computer interaction	Artificial intelligence, machine learning, computer vision	Computer graphics	Other
ÅA/IT				**40**	20	10			10	20		
HIIT		5			5	**25**	**25**		10	20		10
LUT/IP				**30**	2	3				**55**	10	
TKK/CIS		10				20			10	**60**		
TKK/Comlab		**45**					45		10			
TKK/LCE					5				15	**80**		
TKK/Netlab		10			10	10	**70**					
TKK/SBL				**100**								
TKK/SoberIT				**65**		5			**30**			
TKK/SWT		**25**	5	15	5	20			10	5		15
TKK/TCS	17	7		12	17	1	**27**		1	18		
TKK/TSM							**50**		**35**		15	
TUT/IHTE									**100**			
TUT/IT				**45**	**35**			5		5		10
TUT/SP	5	10		5	10	10	15		5	10	**30**	
UH/CS	5	20		5	10	20	20			20		
UJ/MIT		20		5	5	5	**30**			5		**30**
UJO/CSS	4	4		10					12	**24**	14	**32**
UKU/CS	3	5		**55**	5		10	2		8		12
UO/IPS	5			**25**					15			**55**
UO/ISG					10	**30**			5	**55**		
UO/MVG								5	10	**85**		
UT/FUNDIM	**70**	5	20								5	
UT/IT		**26**		12	5	12				**24**	3	18
UTA/CS		12		4		14			**50**	20		
UV/CS		**30**		20								**50**
VTT/DIS		12		6		6	17		12	12	6	**29**
VTT/TL	5	10		15	15	5	**25**	15	5	5		
LUT/CE					15		**70**		10		5	
TKK/SPL					**30**							**70**
TUT/DCS		10	5	15	5	5	15	**40**		3	2	
TUT/ICE					15		**85**					
UKU/ENVI				**30**		**30**				**40**		
UTA/INFO												**100**

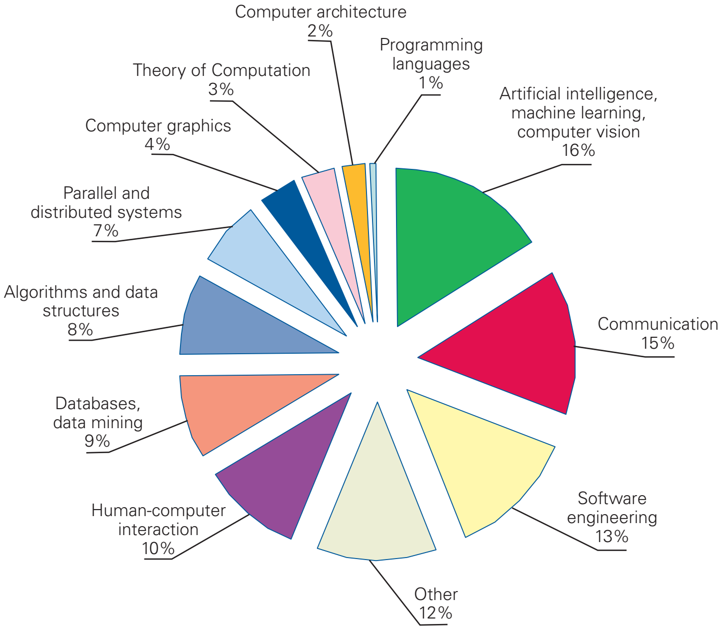

Figure 2. The distribution of active research time in FTE by areas of computer science in 2000–2006. Note that the average annual FTE is 1,370. For further details, see Table 16.

The units were also asked to provide information about their research collaboration with areas outside of computer science. The self-assessment form listed 16 other disciplines and the multidisciplinary collaboration is summarised in Table 3. The strongest interaction took place in the fields of signal processing, electrical engineering and mathematics. Only a few units listed any interaction with chemistry or nanoscience.

Another type of collaboration is to include researchers from other disciplines in the computer science group. This type of interaction (named "integration" in the self-assessment forms) took place especially in the field of mathematics, which is natural since some of the evaluated units were, as a matter of fact, departments of mathematics. Furthermore, many applied mathematicians turn later into researchers of computer science. Other notable disciplines were signal processing and modelling.

The 'other' field here included, among other things, education, economy and linguistics (such as speech technology and industrial management).

Table 3. Collaboration with other related research areas. ('1'=collaboration, '2'=joint projects, '3'= integrated in the group). The abbreviation "ALL" denotes areas in which units had all types of interaction (i.e. '1,2,3'). A grey background indicates that the panel did not interview the unit.

Unit	Mathematics	Physics	Chemistry	Process technology	Automation technology	Signal processing	Electrical engineering	Information systems science	Bioinformatics	Biomedical engineering	Psychology	Modelling and simulation, computational science	Biology	Medicine	Nanoscience	Other
ÅA/IT	1,3	2,3	2	2	2,3	**ALL**	2,3	2,3	2,3			2,3	1	1	2	2
HIIT	1	1,2				1			**ALL**		**ALL**	**ALL**	1,2	**ALL**		**ALL**
LUT/IP	1	1,2	1	1,2	1,2	1,2	1,2	1,3		1,2	1,2	1,3		1,2	1,2	1,2
TKK/CIS	3		2	2	2	3	2	3	2,3	2	1	3	2	2	1	2
TKK/Comlab	1,3	2			**ALL**	**ALL**	**ALL**		1			**ALL**				
TKK/LCE		2,3							3		3	3	3	3	3	
TKK/Netlab	3							1			1	3				3
TKK/SBL								**ALL**			1					**ALL**
TKK/SoberIT								1,3			1,2	1				1,2
TKK/SWT									1							1,3
TKK/TCS	1,2	1,2			1,2	1,2	1,2					1				
TKK/TSM					1	**ALL**	1,2				1	**ALL**		1		**ALL**
TUT/IHTE					2	1,2	1	3			**ALL**					**ALL**
TUT/IT		2				1,2	1,2				2					1,2
TUT/SP	3					**ALL**	**ALL**	3	**ALL**	**ALL**		**ALL**				
UH/CS	1	1,2	1,2			1	1,2	1,2	**ALL**		**ALL**	**ALL**	1,2	**ALL**		**ALL**
UJ/MIT	**ALL**	1,2	1	1,2	1	**ALL**		1,2			1,2	**ALL**	1		1,2	1
UJO/CSS	3	3				3				2	1,2		2	2	3	**ALL**
UKU/CS	3					3		2,3	2			2		1		
UO/IPS							2	3			2			2	2	2,3
UO/ISG	3	1			3	**ALL**	2,3	2		**ALL**	1	3	1	1,2		
UO/MVG	3	3		2	**ALL**	**ALL**	3		1	1,2	1	2	2	1,2		1,2
UT/FUNDIM	**ALL**	1							**ALL**							
UT/IT	**ALL**			2	1,2	**ALL**		1,2	**ALL**	1		3	1,2	1,2		**ALL**
UTA/CS	3					1,2	**ALL**	**ALL**	1	1	1,3	1,2	3	**ALL**		
UV/CS	3				1		1	3				1				1,3
VTT/DIS	**ALL**	1,2		**ALL**	**ALL**	**ALL**	1,2	**ALL**	1,2	**ALL**	**ALL**	**ALL**		**ALL**		
VTT/TL	**ALL**	1		1	1,2	**ALL**	**ALL**	**ALL**	1,2	1		**ALL**		1	1	
LUT/CE	1		1		2		1					2				2
TKK/SPL						1,2						1				
TUT/DCS	2					**ALL**	**ALL**	1								
TUT/ICE						**ALL**	**ALL**									
UKU/ENVI		1	2	2	2	1		1	2	1		1				2
UTA/INFO						1,2			1,2							1,2

A.3 Academic Staff Resources

The total number of academic staff, or active research personnel, FTE-years was 644 in 2000, whereas the same number was 1,674 in 2006 (see Tables 10–12 in Section A.8). Active research personnel include persons who plan, produce and publish new knowledge, theories and methods as well as products and processes based on them and lead research projects. This academic staff is further categorised into professors, senior researchers, postdoctoral researchers, doctoral students and other academic staff. Senior researchers are typically research group leaders as opposed to the other non-professor-level researchers. The other academic staff category comprises research personnel without a PhD degree.

The annual development of academic staff is shown in Figure 3. The actual increase is not as dramatic as it first seems, when considering that the two VTT units are not counted for the year 2000. This is due to an organisational change in VTT that made it impossible to trace the personnel figures reliably for the year 2000. Considering this and the size of VTT, it is reasonable to show academic staff statistics both including (years 2001–2006) and excluding VTT (years 2000–2006) separately. Note that there are other units, too, that are not included in the first years. The first number for TUT/IHTE is from 2006, UT/IT from 2002, LUT/IP from 2002, TKK/SoberIT from 2002, TKK/Comlab from 2001 and TKK/SBL from 2005. These units are all below average size, so their impact is not (at least FTE-years–wise) as significant as the impact of VTT.

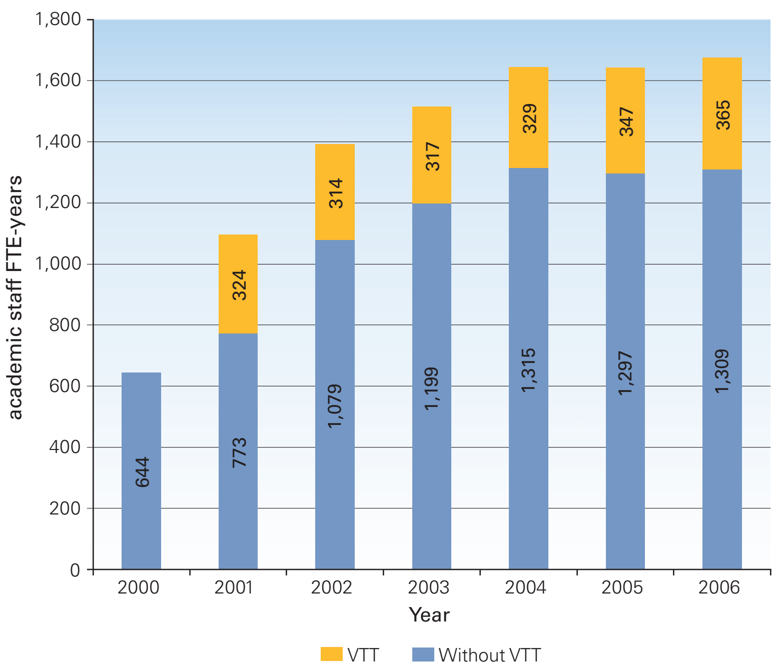

Figure 3. The allocation of academic staff in FTE-years by year. The two VTT units are shown separately.

Excluding VTT from the year 2006, we obtain 1,309 FTE-years, which means that the number of academic staff has doubled since 2000.

Figure 4 shows the annual development of academic staff in the six main types including the VTT units. The number of professors has increased by 33% (116 to 155), senior researchers by 65% (100 to 164), post-doctoral researchers by 240% (54 to 186) and the number of doctoral students by 63% (369 to 603). The numbers of other academic staff and visiting researchers and visiting research students have also increased by 14% and 70%, respectively.

Figure 5 shows the annual academic staff development excluding the VTT units. The increases are for professors 53% (91 to 139), senior researchers 137% (38 to 89), postdoctoral researchers 326% (34 to 145), and doctoral students 98% (305 to 603). The numbers of other academic staff and visiting researchers and students have increased by 68% and 124%, respectively.

VTT holds an integral part of the academic staff resources in the evaluated units. This applies to all staff types except doctoral students, where VTT has none.

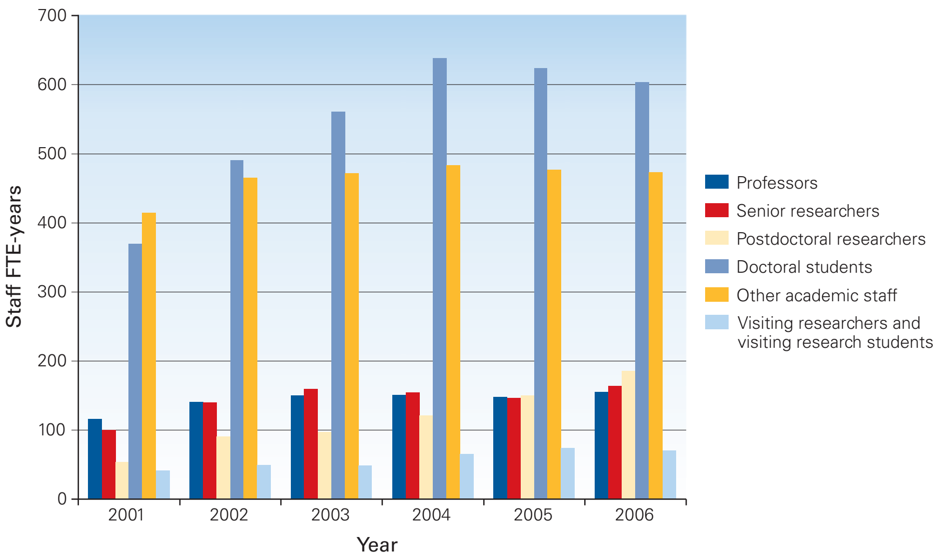

Figure 4. The allocation of academic staff in FTE-years by year, including VTT.

During the seven-year period, a total of 9,589 FTE-years of academic staff was recorded, without counting VTT academic staff for 2000. Of this amount, 942 FTE-years (about 10%) were professors and 905 FTE-years (about 9%) were senior researchers.

The distribution of the number of academic staff members per professor FTE-year and per professor and senior researcher FTE-year is shown in Table 4. Most of the units had five to ten members of academic staff per one professor FTE-year, the percentage of professors being 10%. Professors and senior researchers made annually about 20% share of the total academic staff.

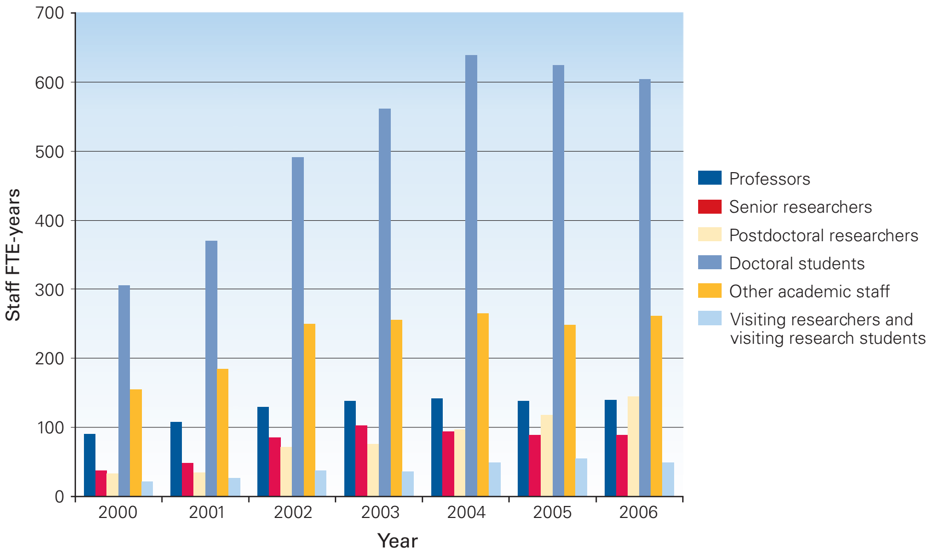

Figure 5. The allocation of academic staff in FTE-years by year, excluding VTT.

Table 4. The distribution of the number of academic staff members per professor-FTE-year and per professor and senior researcher FTE-year in 2000–2006, without counting VTT academic staff for 2000. The most common values are in bold.

Academic staff members per professor FTE-year	Number	Academic staff members per professor and senior researcher FTE-year	Units Number
1..5	7	1..3	5
5..10	**13**	**3..6**	**15**
10..20	11	6..10	12
20..	3	10..	2
Total	34	Total	34

The units also provided information about their non-academic staff such as administrative and technical personnel. This support staff formed about one fifth of the total staff in the evaluated units. A total of 1,042 FTE-years of administrative staff and 1,502 FTE-years of technical staff were recorded in 2000–2006, without counting VTT support staff for 2000. For the annual development, see Figure 6. The total amount of VTT administrative and technical staff has been decreasing in 2001–2006 from 204 FTEs to 74 FTEs.

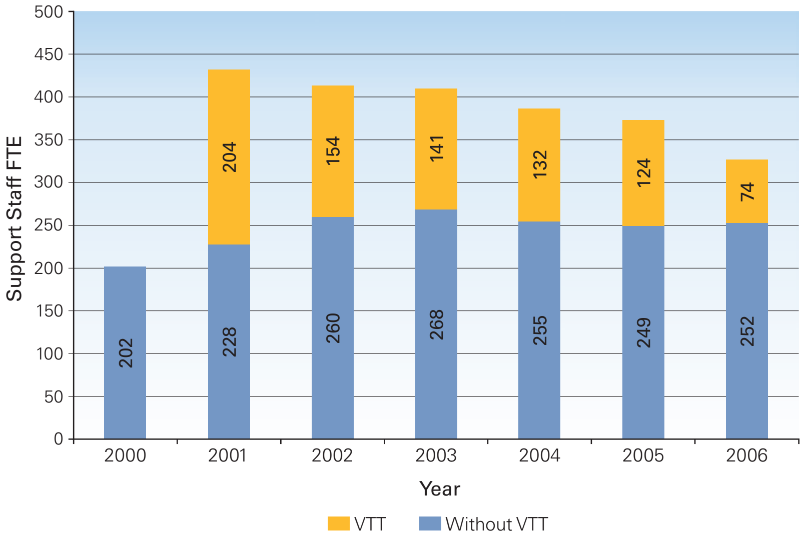

Figure 6. The allocation of administrative and technical staff in FTE-years by year with VTT units shown separately.

A.4 Core and External Funding

The total funding – combined core and external funding – in the evaluation period was 712.8M€, not counting VTT funding for years 2000 and 2001, since the two VTT units were not able to reliably trace funding amounts for those two years due to organisational changes. The reader should note that no adjustment for inflation rate has been taken into account. However, inflation was not significant in 2000–2006.

Of the total funding, 47% (331.5M€) were core funding and 53% (376.3M€) external funding (see Tables 13–15 in Section A.8). Core funding comprised the units' budgetary funding from their host organisations and other core funding sources. About 90% (298.0M€) of the overall core funding was budget funding.

The two VTT units received the largest amount of total funding, 88.7M€ for VTT/TL and 105.5M€ for VTT/DIS (without counting what they received for 2000 and 2001). For funding details, see Table 15.

External funding was divided into seven categories (see Figure 9). More than one third of all external funding (125.0M€) came from Tekes and 28% (103.5M€) from industry. The funding from the Academy of Finland was 56.2M€, which represents 15% of the total external funding.

Not all units were able to provide detailed information on the structure of their external funding. This means, for instance, that they were able to give information on the total amount of external funding, but unable to clarify the distribution from different sources. Therefore Figure 9 might be slightly misleading.

During the seven-year period, the average amount of total funding per academic staff FTE-year was 83,000€ and the median was 73,000€ – these figures were calculated by using periods for which complete data were available. There was no

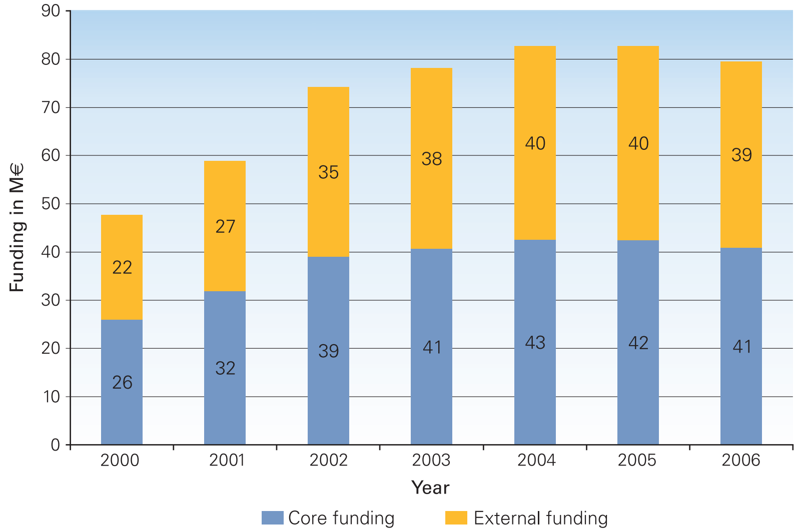

Figure 7. The allocation of core and external funding by year. Note that the two VTT units are completely excluded.

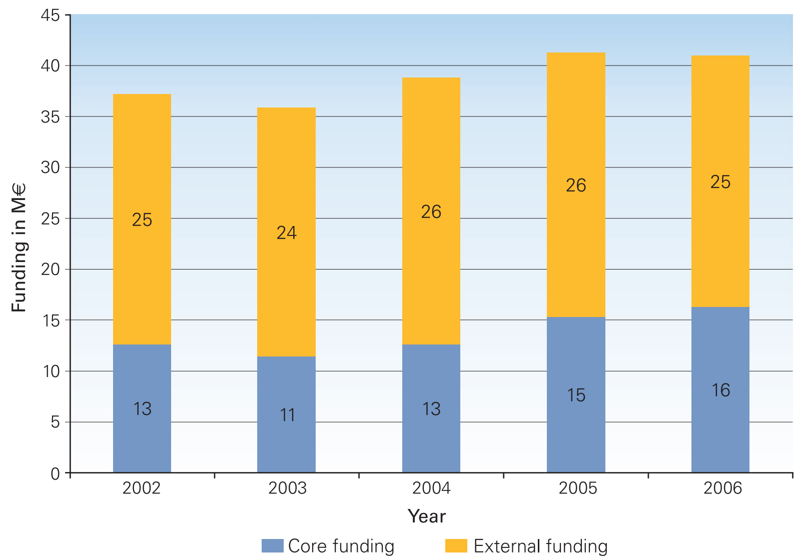

Figure 8. The allocation of core and external funding by year. This plot only includes data from the two VTT units.

significant correlation between the unit's size and the amount of total funding received per academic staff FTE-year. The amount of total funding per academic staff FTE-year by unit is shown in Figure 11. The funding per academic staff FTE-year varied between 14–180k€.

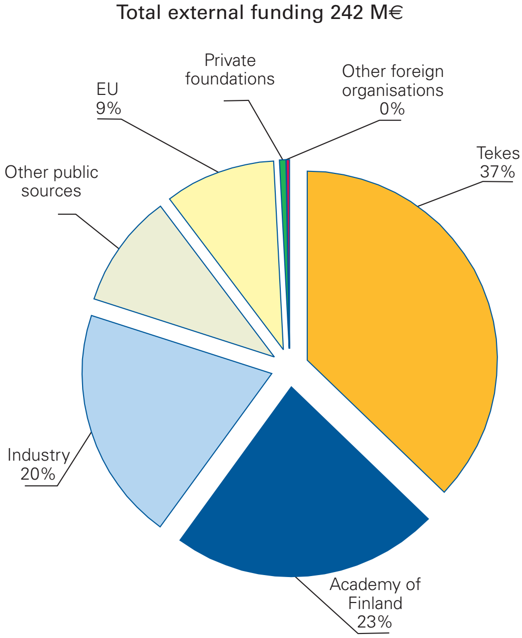

Figure 9. The distribution of external funding by source in 2000–2006 excluding VTT.

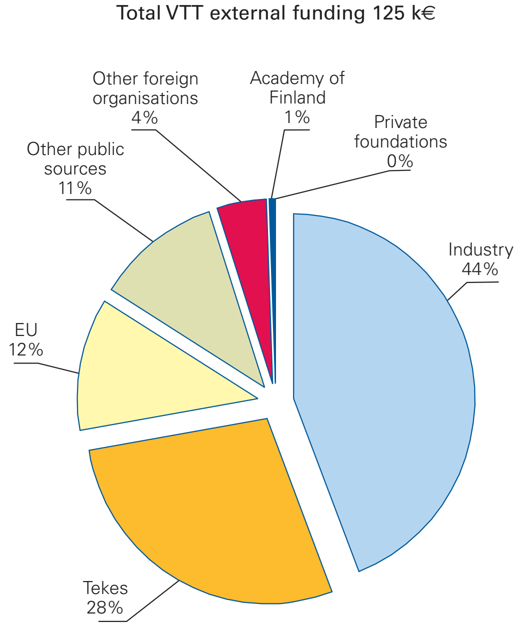

Figure 10. The distribution of VTT external funding by source 2002–2006.

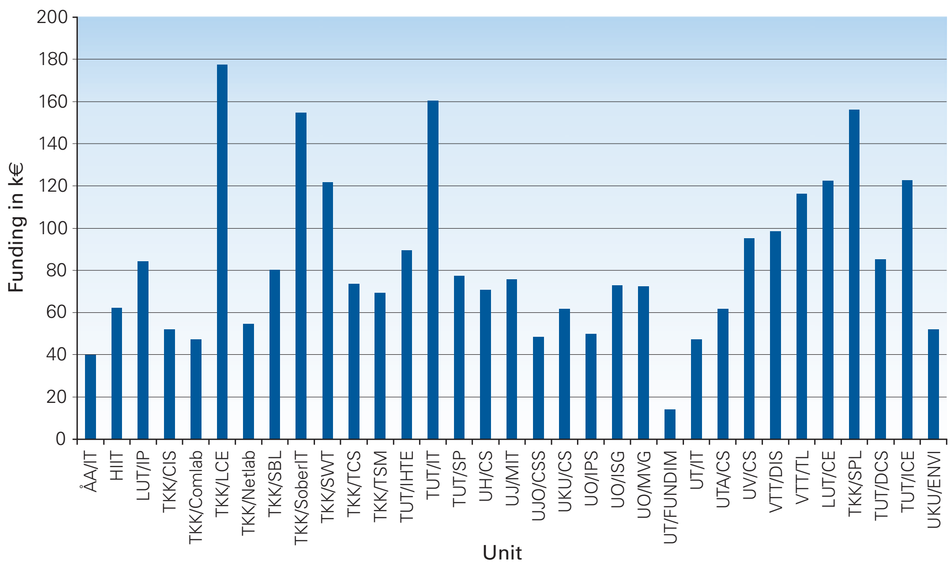

Figure 11. The amount of funding per academic staff FTE-year by unit in 2000–2006. The median value is 73 k€.

The distribution of annual external funding by source is shown in Figure 12 (excluding VTT) and in Figure 13 (only VTT). VTT receives a particularly large share of industrial funding (55M€ per annum, which is 53% of all industrial funding to all units) and other foreign organisations (6M€, which is 92% of all funding from that source). The Academy of Finland's share of VTT's external funding is 1% (less than 1M€). The structure of funding has been quite stable during the seven-year period.

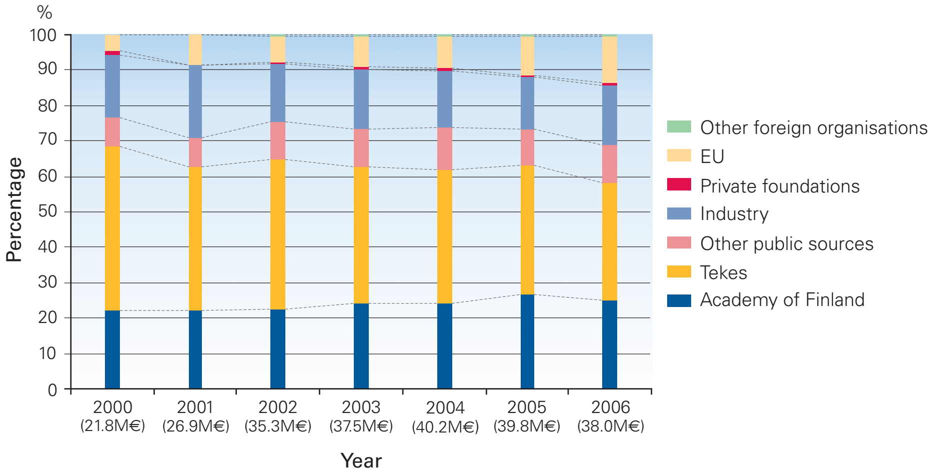

Figure 12. Structure of external funding by source by year, excluding VTT.

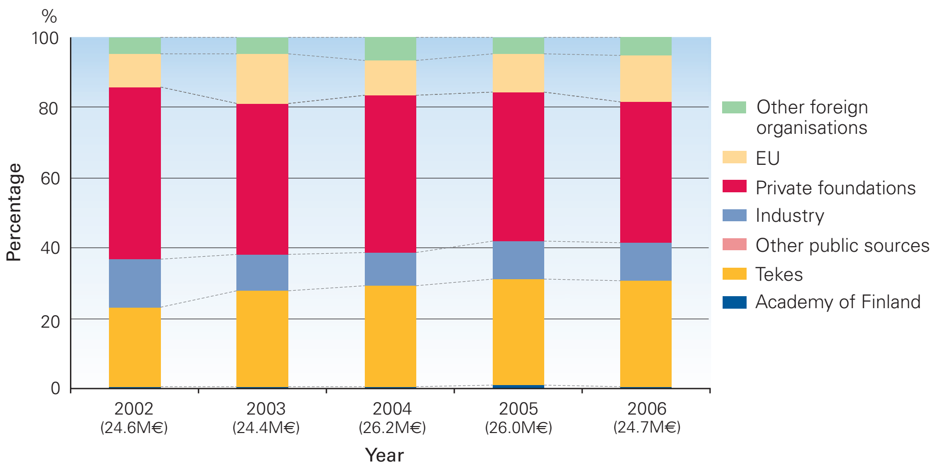

Figure 13. Structure of external funding in VTT.

We can study the funding of the research area in computer science by using the unit research profiles and total funding of the unit. With a rough assumption that every percent of a unit's research time was equally funded, communications and artificial intelligence received the most funding (110M€ per annum each). Software engineering, human-computer interaction, algorithms and data structures, databases and parallel and distributed systems all received more than 50M€ per annum. The least funded area is programming languages, where few units reported research, with less than 300k€ per annum. Based on the same naïve assumptions, 25% of the Academy of Finland funding was for artificial intelligence research and a large share of Tekes and industrial funding goes to communications research.

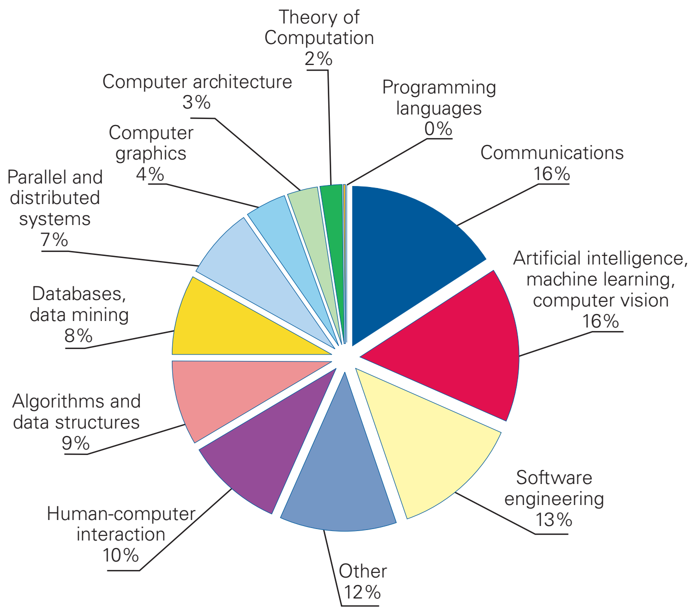

Figure 14. Distribution of total funding by research area in 2000–2006. Note that this distribution is based on a rough assumption that every percent of a unit's research time was equally funded.

A.5 Publication Activity and Other Scientific Output

The units reported their scientific production in terms of publications and other output produced during the evaluation period. All the output is classified into ten categories, which are all listed in Table 5, providing their quantitative distribution by year during 2000–2006. Note that a number of joint publications were reported separately by each authoring unit, which leads to inaccuracies in the statistics.

The number of articles published annually in refereed scientific journals has doubled in 2000–2006 (from 282 to 592) with an average annual growth* of 13%. The number of patents and computer programs has tripled. Note that publications of VTT units for years 2000 and 2001 are included but VTT publication activity in 2000–2005 is taken from numbers of its previous organisations, namely, VTT Electronics and VTT Information Technology.

* This is calculated with the formula: A=(R6/R0)1/t-1 , where R6 is the number of refereed articles in 2006, R0 is the number of refereed articles in 2000 and t is the length of period under investigation .

Table 5. Publications by the evaluated units by year. (The numbers shown in this table are rounded to the nearest integer.) Lectures by the unit's staff given during a visit are reported in visiting lectures.

	Articles in refereed scientific journals	Articles in refereed scientific edited volumes and conference proceedings	Monographs published	Other scientific publications	Text books and other research-related publications	Patents	Computer programs and algorithms	Visiting lectures	Articles, radio and television programmes and journals popularising science	Other output
2000	282	854	41	168	75	8	20	56	168	19
2001	314	813	42	171	72	12	30	85	144	14
2002	392	1,061	74	248	103	12	28	118	158	34
2003	444	1,106	65	335	87	21	50	113	146	39
2004	462	1,404	77	337	74	31	54	129	169	38
2005	516	1,465	62	282	96	24	46	168	173	96
2006	592	1,385	78	254	92	23	60	151	117	100
Total	3,002	8,088	439*	1,794	599	131	288	820	1,075	340

* Monographs may include PhD theses and monographs in university report series (example taken from unit UH/CS).

The numbers of articles in refereed scientific journals (called simply "journals" for shortness in the following) and in refereed scientific edited volumes and conference proceedings (called simply "volumes and refereed proceedings" in the following) by academic staff are shown in Figure 15 (see also Table 17 and Table 18 in Section A.8). Note that in some areas of computer science refereed conference proceedings are a major and very significant forum.

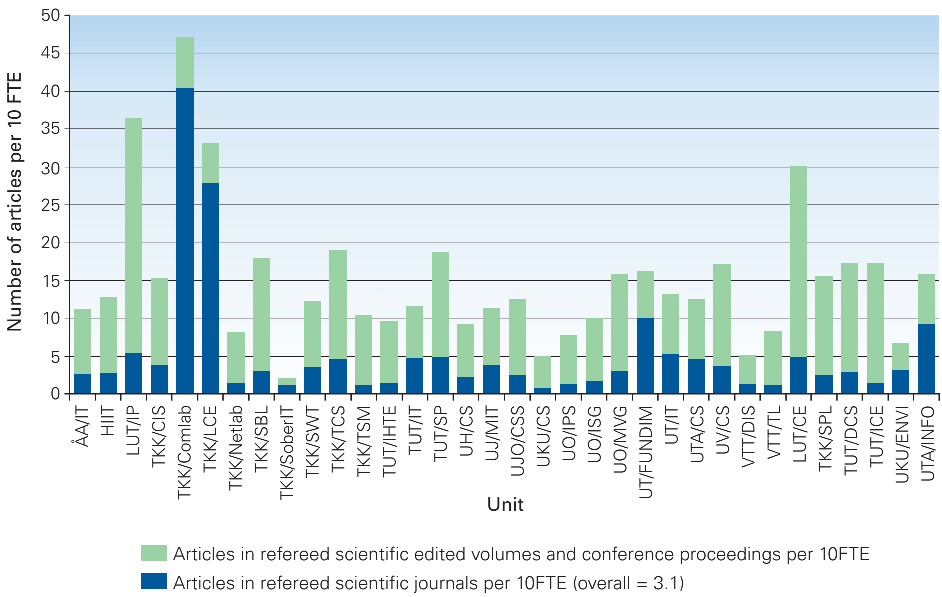

Figure 15. The number of articles in journals and in volumes and refereed proceedings per 10 FTE-year by unit in 2000–2006. Note that these numbers are averages of those periods for which there are data. For example, the figures for VTT units are from 2001–2006.

Table 6. The average number of articles in journals and in volumes and refereed proceedings per professor, senior and postdoctoral researcher (i.e. PhD) FTE-years by unit in 2000–2006. Only those years for which complete data were available were used in the calculations. The values exceeding the average are in bold. A grey background indicates that the panel did not interview the unit.

Unit	Articles in refereed scientific journals per PhD-FTE-year	Articles in refereed scientific edited volumes and conference proceedings per PhD FTE-year
ÅA/IT	0.92	2.99
HIIT	**1.4**	**4.92**
LUT/IP	**1.4**	**7.88**
TKK/CIS	**1.47**	**4.47**
TKK/Comlab	**13.33**	2.22
TKK/LCE	**8.3**	1.56
TKK/Netlab	0.69	**3.38**
TKK/SBL	1.11	**5.33**
TKK/SoberIT	1.05	0.69
TKK/SWT	0.74	1.82
TKK/TCS	**1.95**	**5.95**
TKK/TSM	1.04	**7.81**
TUT/IHTE	0.71	**4.24**
TUT/IT	1.15	1.64
TUT/SP	**2.14**	**5.86**
UH/CS	0.98	**3.21**
UJ/MIT	0.62	1.24
UJO/CSS	**1.51**	**5.74**
UKU/CS	0.33	1.69
UO/IPS	0.6	2.87
UO/ISG	0.85	**3.9**
UO/MVG	0.89	**3.81**
UT/FUNDIM	**2.13**	1.31
UT/IT	**1.32**	1.9
UTA/CS	**2.38**	**4.03**
UV/CS	0.82	3.05
VTT/DIS	0.35	1.02
VTT/TL	0.64	**3.75**
LUT/CE	0.81	**4.17**
TKK/SPL	1.14	**5.71**
TUT/DCS	**1.49**	**7.35**
TUT/ICE	0.86	**8.71**
UKU/ENVI	**1.98**	2.24
UTA/INFO	**2.34**	1.69
Average	1.16	3.13
Median	1.08	3.57

Table 6 presents the number of articles in journals and in volumes and refereed proceedings for each unit over the evaluation period. The values reflect the output of professors, senior researchers and postdoctoral researchers, or all researchers having a PhD. The average number of refereed scientific articles published per year was 1.16 per PhD.

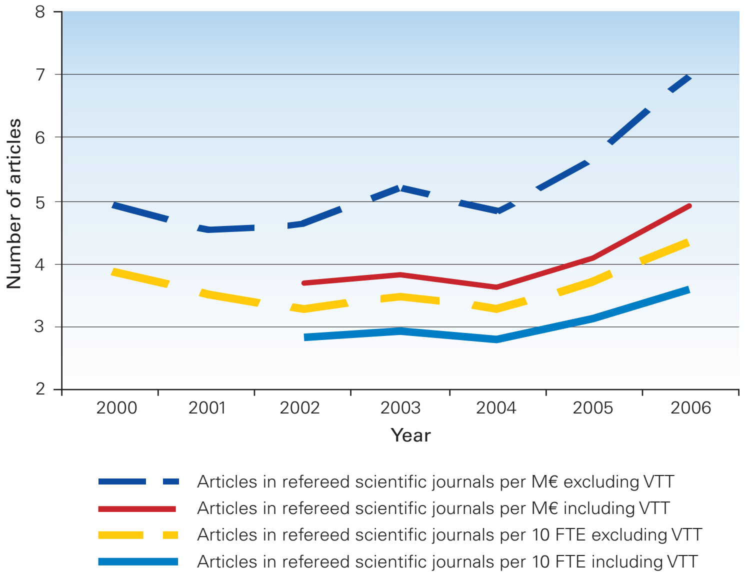

Figure 16. The number of articles in journals per 10 FTE-years with VTT (2002–2006) and without VTT during 2000 to 2006.

While all the evaluated units have produced at least some articles in journals, not all of them have been active in patent or computer program production, or at least have not kept accurate record of these activities. As a result, many units did not report any patents or computer programs (see Table 19 in A.8). The VTT units produced almost half of all the patents awarded (58 out of 131).

When considering the units' efforts for disseminating computer science research results to the general public, the VTT Digital Information Systems unit stands out with 645 out of a total of 1,075 articles, radio and television programmes and journals popularising science.

A.6 Doctoral and Master-level Training

During the seven-year period the evaluated units produced 506 doctoral dissertations and 5,905 Master's degrees. Also, 1,895 doctoral students started their postgraduate studies in the evaluated units. However, VTT does not provide formal education for doctoral or MSc students: their students are always associated with universities. Thus, all figures in the following implicitly typically exclude VTT, unless the student supervision has been performed jointly between VTT and a university.

Roughly one third of MSc students continued with doctoral studies. In 2006, the number of doctoral degrees in the evaluated units was 112, which represents 8% of the total number of doctoral degrees in all disciplines of science in Finland in 2006. Table 20 in A.8 provides a breakdown of doctoral dissertations by year and by unit.

The distribution of doctoral degrees by age* is shown in Figure 17. The average age for completing the degree was 33.8 years and the median 32. Two doctoral students managed to complete their dissertation before the age of 25 and the oldest was 62 years old. About 35% of the doctoral dissertations were completed before the age of 30 and 75% before the age of 35. As a reference, the average age for completing a doctoral degree in Finland was 36.3 in 2004 and 30% completed their degree before the age of 30.

The number of doctoral theses completed per year has doubled since 2000 (from 57 to 112) and 17% of these were written by women. In 2000–2006, the percentage of doctoral theses written by women in engineering was 21% and 41% in science. Six units had at least one third of doctoral theses written by women.

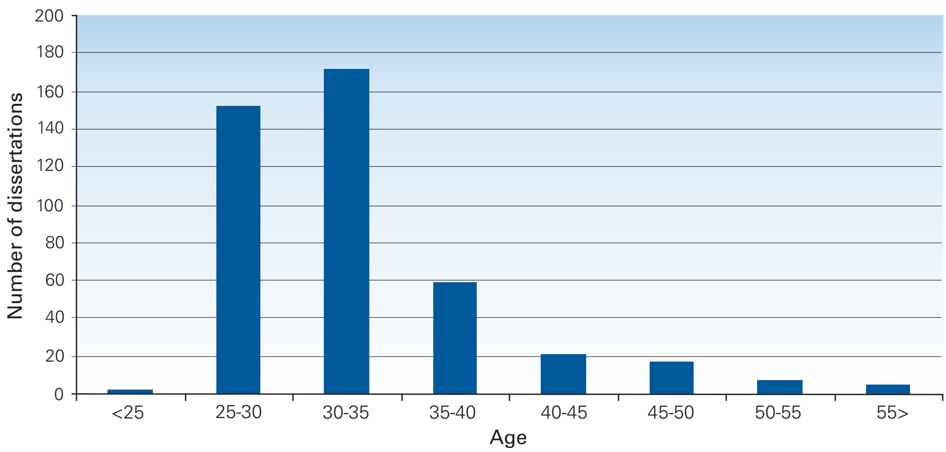

Figure 17. The distribution of doctoral dissertations by age (n=435)

The annual number of doctoral thesis and Master's degrees per M€ of funding is shown in Table 8. Once again, note that this is not the only output produced by the evaluated units for the received funding. During the whole evaluation period, the average number of doctors per M€ was 0.9 and the number of Masters 11.0. The number of doctors and Masters per M€ steadily increased in the period 2004–2006, and in both cases the highest overall numbers were from 2006.

Distribution of Master's degrees completed and doctoral studies started by unit is seen in Figure 18. HIIT is involved in Master's and doctoral teaching, but the studies are carried out in the host universities UH and TKK. However, if HIIT personnel carry out at least half of the student supervision, they have reported the results as their output. Furthermore, UT/FUNDIM provides only doctoral student training. Again, the VTT units' students are associated with universities because VTT does not

* The age for completing a doctoral dissertation was calculated by subtracting the year of birth from the year of completion of dissertation.

Table 7. Average number of doctoral dissertations per professor-FTE in 2000–2006 and in 2006.

Average number of doctoral dissertations per professor 2000-2006	Number of units	Average number of doctoral dissertations per professor in 2006	Number of units
0–1	4	0–0.25	10
1–3	10	0.25–0.5	4
3–5	13	0.5–0.75	6
5–7	3	0.75–1	4
7–9	2	1–1.25	6
9–11	1	1.25–1.5	0
11–	1	1.5–	4
Total	34	Total	34

Table 8. Doctors and Masters per M€ by year. The largest value is in bold and those exceeding average are in red. Note that the VTT units are excluded from the two last columns.

	Doctors	Masters		Doctors per M€	Masters per M€
2000	57	584		1.1	10.9
2001	41	728		0.6	11.7
2002	63	786		0.8	10.0
2003	49	917		0.6	11.2
2004	86	935		0.9	10.3
2005	93	**986**		1.1	11.4
2006	**112**	967		**1.4**	**11.9**
Total	501*	5,905	Average	0.9	11.0

*The number shown in this Table does not match the 506 mentioned earlier. This is because not all doctoral dissertations were properly recorded.

provide formal education. No student completed any type of degree in UKU/ENVI during the evaluation period. A couple of units, most notably TKK/SoberIT, had more new doctoral students than produced Master's degrees – students from other groups join TKK/SoberIT for their doctoral studies.

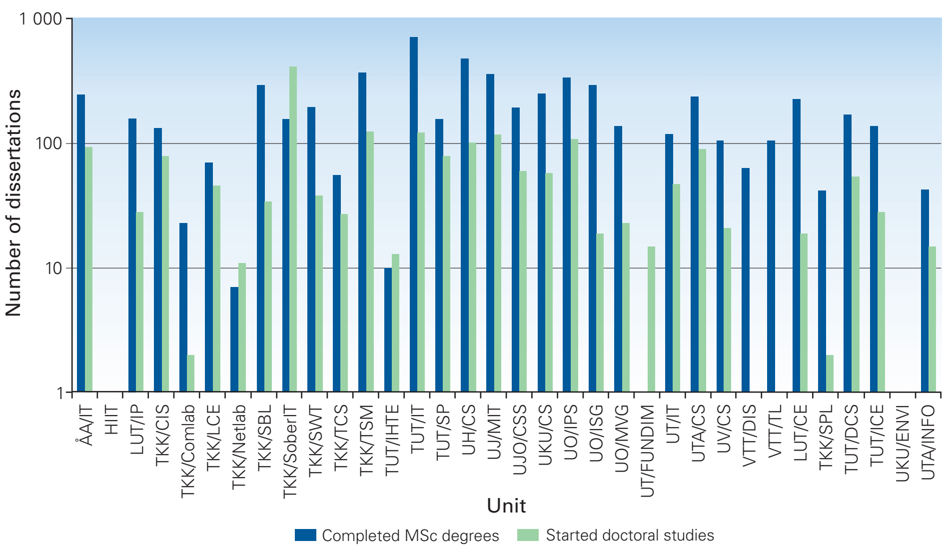

Figure 18. The distribution of Master's degrees and doctoral studies started by unit.

The number of doctoral students per professor and senior researcher by unit is shown in Figure 19. Each senior researcher typically supervises one to three postgraduate students.

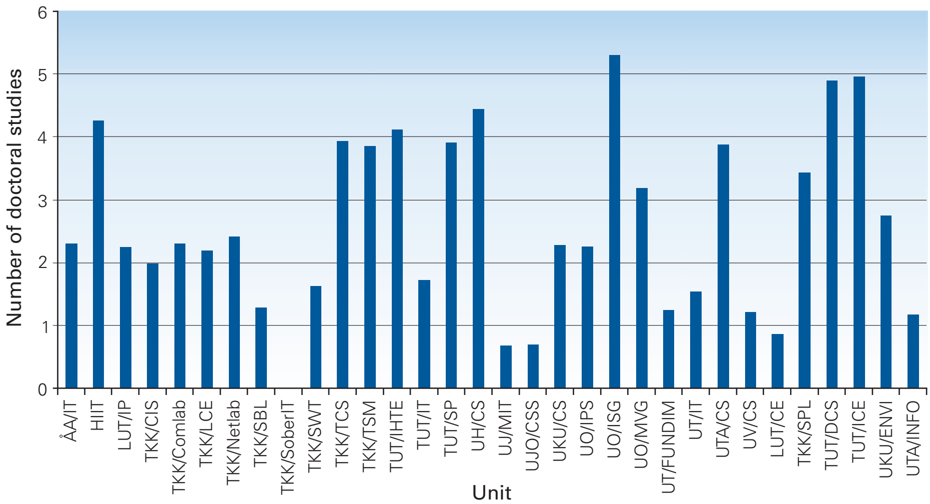

Figure 19. The number of doctoral students per professor and senior researcher by unit in 2000–2006.

A.7 International Collaboration

The units were asked to list all their visits to research labs abroad during 2000–2006 with at least one-month duration (and also some shorter but particularly important visits) and all foreign researchers visiting them. A total of 376 visits abroad (total duration 2,154 person-months) were made and the number of foreign visits to the evaluated units was 963 (total duration being 7,875 person-months). The average duration of a visit abroad was six months and eight months for visits to the units. VTT units also reported visits done before their current organisational structure was in effect – these visits were made by personnel in the current units.

Table 9. Distribution of visits (minimum duration one month per visit) by person-months by unit in 2000–2006.

Person-months	Visits abroad	Visits to unit
0	3	3
1–10	7	6
11–30	6	9
31–50	5	1
51–100	6	3
101–200	2	4
201–500	4	2
500–	0	4
Total (2,154 & 7,875)	33	32

The evaluated units had visits to more than 60 countries around the world. In the case of visits to the units, TUT/SP really stands out here with 570 visits (4,018 person-months) from about 40 countries around the world. Among its greatest strengths the unit also mentions internationality, multicultural mixture and strong international networks.

The most common countries to visit were the USA, the U.K., France, Germany and Japan. They are shown in Figure 20 along with some other countries that had more than ten visits. The USA alone had more than one third of all visits abroad with a total of 133 visits (825 person-months). Also, 19 units had visits to the USA, twelve units to the U.K. and ten units to Germany and France.

The countries that had a significant number of visitors to the evaluated units are shown in Figure 21. However, 570 of 963 visits to units were made to TUT/SP. This

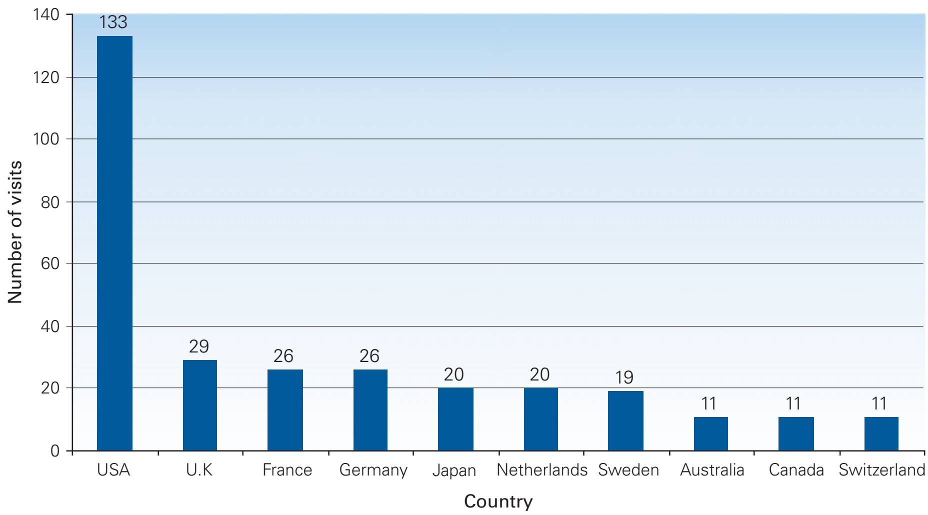

Figure 20. Countries that were visited the most by the evaluated units in 2000–2006.

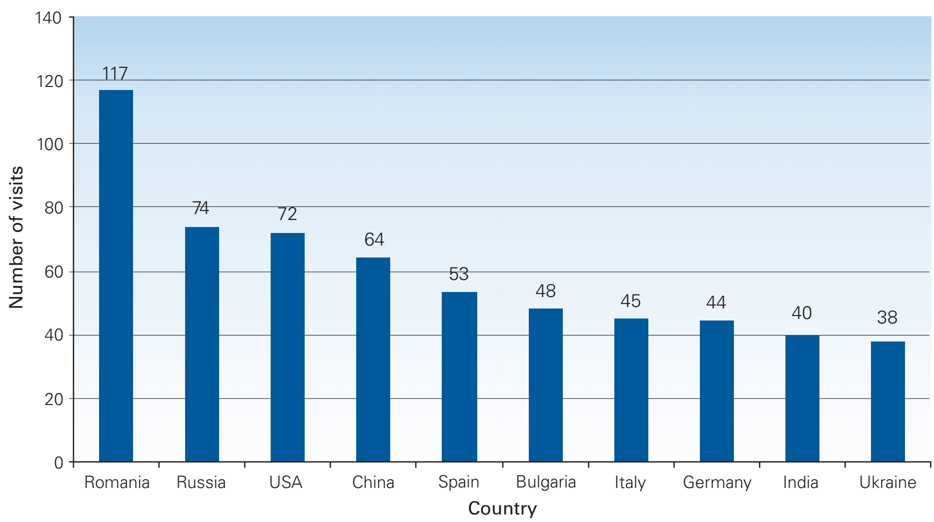

Figure 21. Countries that had the largest number of visitors to the evaluated units (including TUT/SP) in 2000–2006.

included, for instance, 109 out of 117 visits from Romania motivated by long-standing collaboration between TUT/SP and Romanian researchers. Countries with the most visits to units excluding TUT /SP are shown in Figure 22.

The most common origins of the researchers visiting the evaluated units were Romania, Russia, USA, China and Spain. Fifteen units were visited by visitors from the USA and Germany, 14 from Russia, twelve from China and eleven from Japan.

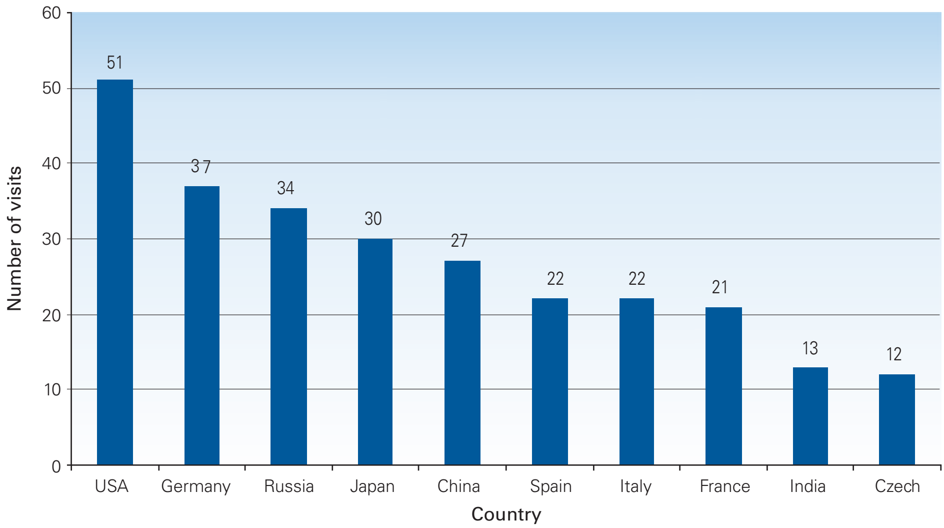

Figure 22. Countries that had the largest number of visitors to the evaluated units (excluding TUT/SP) in 2000–2006.

A.8 Summary of Data Reported by the Units

The following tables summarise data on staffing, funding, activity profile, research output and doctoral training reported by the evaluated units. Some units did not provide total values over the period, in which case we have calculated that value by summing the annual numbers. Some units reported totals that deviated from the sum of the annual numbers, which could be corrected only in cases the error was trivial. As a result, there are some inconsistencies in the data reported below. There are missing values in the following tables, which are denoted by '–'. The lack of data is either due to the non-existence of the unit or incomplete information.

Data on Staff Resources

Table 10. Total active research staff in FTE-years.

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT	69.0	82.0	90.0	91.0	92.0	85.0	87.0	596.0
HIIT	3.6	22.0	52.8	79.0	93.3	100.9	113.9	465.4
LUT/IP	–	–	16.1	20.0	21.9	20.8	24.6	101.8
TKK/CIS	48.7	54.2	60.9	70.8	80.8	81.4	79.0	475.8
TKK/Comlab	–	0.2	0.3	0.3	0.4	2.4	3.9	7.4
TKK/LCE	11.2	13.3	14.9	15.2	17.7	19.4	23.0	114.7
TKK/Netlab	21.8	32.8	31.8	44.3	46.3	41.7	41.5	260.3
TKK/SBL	–	–	–	–	–	6.9	9.3	16.2
TKK/SoberIT	–	–	29.7	46.8	46.1	37.8	33.6	193.9
TKK/SWT	11.3	15.0	17.5	21.1	21.6	22.1	23.9	132.6
TKK/TCS	14.5	18.3	25.5	22.3	25.2	23.8	23.4	153.0
TKK/TSM	28.8	29.3	46.3	42.1	53.6	51.3	48.5	299.8
TUT/IHTE	–	–	–	–	–	–	7.3	7.3
TUT/IT	13.0	21.4	23.8	24.8	25.5	30.8	30.8	170.1
TUT/SP	62.5	67.5	81.5	89.3	106.4	110.5	104.8	622.4
UH/CS	84.1	93.2	110.9	114.8	127.4	116.0	127.8	763.3
UJ/MIT	4.8	5.7	48.4	54.5	58.2	65.9	47.7	274.7
UJO/CSS	36.0	38.0	63.5	77.0	75.2	67.5	72.5	429.7
UKU/CS	17.3	30.0	30.0	33.0	50.3	50.0	46.7	257.3
UO/IPS	79.0	88.0	96.0	91.0	106.0	92.0	94.5	646.5
UO/ISG	10.0	11.0	14.6	13.9	21.6	23.6	32.6	127.3
UO/MVG	14.7	18.2	17.3	18.3	19.0	21.1	26.1	134.5
UT/FUNDIM	18.5	20.6	24.5	28.7	30.2	31.4	30.3	184.2
UT/IT	–	–	34.0	37.5	33.8	28.8	26.3	160.5
UTA/CS	44.9	49.8	62.1	74.0	73.5	74.4	65.6	444.3
UV/CS	6.4	9.8	9.2	9.5	9.8	9.9	11.5	66.1
VTT/DIS	–	162.2	183.4	190.3	189.8	183.0	162.3	1,070.9
VTT/TL	–	162.0	130.3	127.1	139.0	163.5	202.6	924.4
LUT/CE	3.4	5.9	7.9	10.0	9.8	12.5	13.5	63.1
TKK/SPL	2.6	2.6	2.6	2.6	2.5	1.3	1.3	15.5
TUT/DCS	21.7	26.1	35.3	31.8	28.2	29.2	23.2	195.3
TUT/ICE	6.3	7.0	11.6	11.9	14.3	13.4	13.2	77.7
UKU/ENVI	1.4	1.1	5.6	10.0	10.5	9.9	9.2	47.7
UTA/INFO	8.7	9.8	14.7	13.5	14.3	15.2	13.1	89.2
Total	644.2	1,096.8	1,392.6	1,516.2	1,644.2	1,643.5	1,674.1	9,588.6
Median	10.0	18.2	25.5	28.7	28.2	29.2	30.3	170.1

Table 11. Total staff in FTE-years (includes administrative and technical staff).

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT	79.0	92.0	99.0	100.0	101.0	94.0	96.0	661.0
HIIT	4.6	24.5	58.1	84.5	100.2	108.1	122.3	502.0
LUT/IP	-	-	16.1	20.0	21.9	20.8	24.6	101.8
TKK/CIS	51.7	57.2	63.9	73.9	83.5	84.4	82.0	496.6
TKK/Comlab	-	0.2	0.3	0.3	0.4	2.6	4.3	7.9
TKK/LCE	11.8	14.0	16.0	16.4	18.9	20.6	24.2	122.0
TKK/Netlab	24.3	36.8	36.4	48.3	50.3	45.7	45.8	287.6
TKK/SBL	-	-	-	-	-	8.0	10.6	18.6
TKK/SoberIT	-	-	34.7	53.7	53.3	43.0	37.5	222.3
TKK/SWT	13.9	19.7	21.9	25.0	25.3	25.8	27.5	159.2
TKK/TCS	22.3	25.1	33.7	35.3	32.9	35.4	32.3	216.9
TKK/TSM	30.8	30.5	48.2	44.9	56.5	54.1	50.5	315.5
TUT/IHTE	-	-	-	-	-	-	7.8	7.8
TUT/IT	17.0	25.4	27.8	28.8	29.5	34.8	34.8	198.1
TUT/SP	104.8	123.1	130.2	128.1	145.6	140.2	134.8	906.8
UH/CS	102.8	106.8	126.4	132.3	146.3	133.1	145.6	882.5
UJ/MIT	4.8	5.7	68.2	74.4	72.4	81.2	60.8	356.8
UJO/CSS	42.0	44.0	71.5	86.0	84.2	76.5	80.5	484.7
UKU/CS	24.3	37.0	37.0	41.0	56.3	56.0	52.7	304.3
UO/IPS	99.0	116.0	130.0	125.0	142.0	134.0	142.5	888.5
UO/ISG	22.3	21.3	26.3	38.6	44.3	41.8	55.3	249.8
UO/MVG	25.7	29.3	27.7	25.3	26.7	29.8	32.8	197.1
UT/FUNDIM	19.2	21.3	25.2	29.3	30.8	32.1	31.5	189.3
UT/IT	-	-	37.5	41.0	37.3	32.3	29.8	178.0
UTA/CS	52.7	59.8	73.9	85.8	85.2	86.2	76.6	520.0
UV/CS	8.6	11.8	11.2	12.5	12.8	12.9	14.5	84.3
VTT/DIS	-	244.8	263.8	267.5	255.9	238.3	188.2	1,458.5
VTT/TL	-	283.7	203.5	191.2	204.7	231.9	250.9	1,365.8
LUT/CE	3.4	5.9	7.9	10.0	9.8	12.5	13.5	63.1
TKK/SPL	2.6	2.6	2.6	2.6	2.5	1.3	1.3	15.5
TUT/DCS	53.6	62.2	63.0	55.6	47.7	47.1	40.9	370.0
TUT/ICE	13.6	14.9	20.3	20.4	23.3	22.2	22.8	137.3
UKU/ENVI	1.4	2.0	8.0	13.0	13.5	12.9	11.2	62.0
UTA/INFO	10.0	11.4	16.3	15.2	15.9	16.9	14.8	100.5
Total	846.1	1,528.8	1,806.2	1,925.8	2,030.9	2,016.5	2,000.9	12,131.9
Median	13.6	21.3	33.7	38.6	37.3	35.4	34.8	216.9

Table 12. Professor and senior researcher FTE-years.

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT	12.0	16.0	18.0	18.0	19.0	17.0	15.0	115.0
HIIT	1.0	1.1	6.4	9.9	10.6	12.3	13.8	55.8
LUT/IP	–	–	4.0	4.0	4.0	3.4	2.6	18.0
TKK/CIS	8.3	11.9	14.5	15.3	14.5	13.4	12.5	90.4
TKK/Comlab	–	0.2	0.3	0.3	0.4	0.6	0.6	2.3
TKK/LCE	3.1	2.8	2.6	3.0	3.2	3.2	3.7	21.6
TKK/Netlab	5.0	4.3	4.0	5.5	5.2	6.0	7.0	37.0
TKK/SBL	–	–	–	–	–	1.0	1.9	2.9
TKK/SoberIT	–	–	4.3	4.6	5.5	5.2	4.2	23.8
TKK/SWT	3.4	3.9	5.8	5.0	5.2	5.7	7.0	36.0
TKK/TCS	3.0	3.6	4.2	3.9	3.2	3.5	3.5	24.8
TKK/TSM	3.7	3.8	3.5	4.1	4.7	5.0	5.0	29.8
TUT/IHTE	–	–	–	–	–	–	1.4	1.4
TUT/IT	6.0	8.3	7.8	7.8	9.0	9.0	8.8	56.7
TUT/SP	10.1	10.2	10.8	22.8	20.4	14.0	13.5	101.8
UH/CS	10.7	13.2	14.6	16.8	17.1	15.1	16.7	104.0
UJ/MIT	4.8	5.7	22.9	26.2	19.5	19.0	16.4	104.0
UJO/CSS	5.0	6.0	5.5	6.0	5.2	6.5	5.0	39.2
UKU/CS	5.3	10.0	10.0	9.0	10.0	8.0	9.3	61.6
UO/IPS	12.0	16.0	18.0	19.0	19.0	20.0	19.0	123.0
UO/ISG	1.0	2.0	2.6	2.6	3.6	3.6	3.6	18.9
UO/MVG	3.0	3.0	3.2	4.0	4.1	4.2	5.7	27.1
UT/FUNDIM	8.0	8.6	8.8	10.3	9.7	11.4	13.4	70.2
UT/IT	–	–	14.0	13.6	13.0	11.2	9.3	61.8
UTA/CS	8.0	8.5	9.0	9.5	9.0	8.5	8.5	61.0
UV/CS	2.4	3.5	4.0	4.0	4.0	4.7	6.6	29.2
VTT/DIS	–	45.2	51.6	51.3	53.2	50.1	53.2	304.4
VTT/TL	–	14.6	14.8	16.8	17.4	17.3	37.9	118.8
LUT/CE	2.3	3.8	4.5	4.8	4.5	4.5	3.5	27.8
TKK/SPL	0.6	0.6	0.6	0.6	0.5	0.3	0.3	3.5
TUT/DCS	5.2	4.8	4.8	4.4	4.0	3.2	3.2	29.4
TUT/ICE	1.0	1.5	1.5	1.5	1.5	1.5	1.5	10.0
UKU/ENVI	–	–	1.0	1.0	1.6	2.0	2.0	7.6
UTA/INFO	3.5	3.5	3.9	4.5	4.5	4.5	4.5	28.9
Total	128.4	216.5	281.3	309.8	306.0	294.7	319.9	1,847.6
Median	3.0	3.8	4.5	4.8	5.2	5.2	5.7	29.8

Data on Funding

Table 13. Core funding in k€.

Unit	2000	2001	2002	2003	2004	2005	2006	Total core	% of total funding
ÅA/IT	1,628	2,303	2,390	2,397	2,192	2,510	1,979	15,398	62
HIIT	281	535	961	1,119	1,047	1,132	1,417	6,492	22
LUT/IP	547	316	825	787	732	606	756	4,569	53
TKK/CIS	1,354	1,696	1,692	2,033	2,457	2,185	2,118	13,535	55
TKK/Comlab	–	14	15	10	11	74	72	196	56
TKK/LCE	791	835	975	1,142	1,144	1,146	1,175	7,208	35
TKK/Netlab	644	804	698	833	964	1,057	1,139	6,139	43
TKK/SBL	–	–	–	–	–	67	138	205	16
TKK/SoberIT	–	–	1,548	1,411	1,721	1,414	0	6,094	20
TKK/SWT	1,163	1,450	1,812	1,932	1,811	1,657	1,714	11,588	72
TKK/TCS	340	551	704	690	660	615	771	4,331	39
TKK/TSM	1,271	1,166	1,261	1,317	1,497	1,397	0	7,908	68
TUT/IHTE	–	–	–	–	–	–	118	118	18
TUT/IT	1,927	1,745	2,191	2,386	2,386	2,872	2,894	16,730	61
TUT/SP	3,405	3,224	3,020	2,720	3,320	3,396	4,300	23,385	49
UH/CS	3,225	3,384	4,393	5,336	5,454	5,150	5,113	32,055	59
UJ/MIT	0	1,693	1,619	1,785	2,118	1,965	2,278	11,458	55
UJO/CSS	1,304	2,075	2,121	1,290	1,451	1,320	1,421	10,982	53
UKU/CS	1,378	1,909	2,092	2,088	1,639	1,559	1,501	12,166	77
UO/IPS	2,051	3,000	3,083	3,566	3,432	3,669	3,755	22,556	72
UO/ISG	354	308	345	616	585	683	604	3,495	38
UO/MVG	392	418	441	460	467	596	802	3,575	37
UT/FUNDIM	0	0	0	0	384	0	0	384	13
UT/IT	–	–	1,232	1,112	1,011	1,230	890	5,475	72
UTA/CS	1,645	1,818	2,203	2,262	2,278	2,153	1,992	14,351	56
UV/CS	616	631	728	758	838	977	962	5,510	87
VTT/DIS	–	–	7,123	6,560	7,254	8,301	6,975	36,214	35
VTT/TL	–	–	5,520	4,898	5,360	7,026	9,348	31,852	36
LUT/CE	336	364	630	584	553	622	645	3,734	48
TKK/SPL	40	40	50	50	50	50	50	330	27
TUT/DCS	476	574	770	832	1,259	1,209	1,200	6,318	38
TUT/ICE	549	598	695	611	565	696	731	4,446	47
UKU/ENVI	0	0	0	0	0	0	80	80	3
UTA/INFO	300	450	520	480	520	460	320	3,000	49
Total	26,017	31,901	51,657	52,065	55,160	57,794	57,257	331,876	
Median	476	574	975	1,115	1,095	1,146	962	6,139	

Table 14. External funding in k€.

Unit	2000	2001	2002	2003	2004	2005	2006	Total external	% of total funding
ÅA/IT	603	864	1,251	1,780	1,827	1,431	1,647	9,323	38
HIIT	378	1,596	2,660	3,546	4,335	4,733	5,257	22,505	78
LUT/IP	198	572	432	384	510	873	1,050	4,019	47
TKK/CIS	1,259	1,254	1,729	1,624	1,628	1,799	1,926	11,219	45
TKK/Comlab	–	0	0	8	21	56	69	154	44
TKK/LCE	1,592	1,824	1,786	1,886	1,857	1,888	2,319	13,152	65
TKK/Netlab	718	790	1,050	1,324	1,587	1,274	1,357	8,100	57
TKK/SBL	–	–	–	–	–	534	559	1,093	84
TKK/SoberIT	–	–	3,797	3,758	3,945	3,020	0	23,894	80
TKK/SWT	1,155	611	817	681	429	545	300	4,538	28
TKK/TCS	759	737	892	1,011	1,120	1,312	1,074	6,904	61
TKK/TSM	425	428	349	496	963	1,092	0	3,754	32
TUT/IHTE	–	–	–	–	–	–	531	531	82
TUT/IT	1,088	1,214	1,565	1,618	1,722	1,634	1,713	10,548	39
TUT/SP	2,907	3,112	3,793	3,808	3,463	4,259	3,394	24,736	51
UH/CS	2,274	2,395	2,398	2,890	3,849	3,712	4,437	21,955	41
UJ/MIT	0	1,579	1,806	1,634	1,551	1,321	1,441	9,331	45
UJO/CSS	368	549	648	1,701	2,577	2,080	1,855	9,778	47
UKU/CS	62	111	548	499	647	759	1,070	3,696	23
UO/IPS	1,812	1,821	1,670	1,051	855	830	838	8,877	28
UO/ISG	522	758	615	1,079	946	962	1,201	5,785	62
UO/MVG	898	1,095	897	710	781	926	826	6,162	63
UT/FUNDIM	329	369	354	389	15	339	405	2,582	87
UT/IT	–	–	400	507	309	430	467	2,113	28
UTA/CS	771	1,095	1,594	1,768	2,340	1,964	1,770	11,302	44
UV/CS	54	10	0	121	227	214	167	793	13
VTT/DIS	–	–	15,069	15,353	14,649	13,043	11,176	68,222	65
VTT/TL	–	–	9,503	9,048	11,550	12,944	13,479	56,560	64
LUT/CE	683	1,273	938	573	243	99	185	3,994	52
TKK/SPL	180	150	130	130	120	100	70	880	73
TUT/DCS	1,681	1,782	1,986	1,570	867	919	1,257	10,316	62
TUT/ICE	783	628	494	623	907	746	904	5,085	53
UKU/ENVI	—	—	—	—	—	—	—	2,400	97
UTA/INFO	270	320	650	350	510	460	490	3,100	51
Total	21,769	26,936	59,821	61,919	66,349	66,297	63,235	377,400	
Median	402	620	894	1,031	927	926	1,050	6,162	

Table 15. Total funding in k€. Professors are included in senior researchers.

Unit	2000	2001	2002	2003	2004	2005	2006	Total	Funding per senior researcher FTE-year
ÅA/IT	2,232	3,166	3,641	4,176	8,038	3,940	3,627	23,722	215
HIIT	659	2,131	3,620	4,665	5,382	5,866	6,674	28,997	520
LUT/IP	725	888	1,257	1,151	1,242	1,479	1,806	8,588	477
TKK/CIS	2,613	2,950	3,421	3,657	4,085	3,984	4,044	24,754	274
TKK/Comlab	–	14	15	18	32	130	141	350	156
TKK/LCE	2,383	2,659	2,761	3,028	3,001	3,034	3,494	20,360	943
TKK/Netlab	1,362	1,594	1,748	2,157	2,551	2,331	2,496	14,239	385
TKK/SBL	–	–	–	–	–	601	697	1,298	445
TKK/SoberIT	0	0	5,346	5,170	5,643	4,444	0	20,603	1,261
TKK/SWT	2,317	2,111	2,629	2,613	2,240	2,201	2,015	16,126	448
TKK/TCS	1,099	1,287	1,596	1,701	1,780	1,927	1,845	11,235	452
TKK/TSM	3,866	2,198	3,192	3,496	4,210	3,880	0	20,841	392
TUT/IHTE	–	–	–	–	–	–	649	649	458
TUT/IT	3,015	2,959	3,755	4,003	4,360	4,580	4,606	27,279	481
TUT/SP	6,312	6,336	6,813	6,528	6,783	7,655	7,694	48,121	473
UH/CS	5,500	5,779	6,791	8,226	9,303	8,861	9,550	54,010	519
UJ/MIT	0	3,272	3,425	3,419	3,668	3,286	3,719	20,789	200
UJO/CSS	1,663	2,624	2,769	2,991	4,028	3,400	3,276	20,751	530
UKU/CS	1,440	2,020	2,640	2,587	2,286	2,318	2,571	15,862	258
UO/IPS	4,313	4,821	5,052	4,617	4,287	4,499	4,593	32,182	256
UO/ISG	866	1,066	960	1,695	1,531	1,645	1,805	9,290	491
UO/MVG	1,320	1,513	1,338	1,170	1,248	1,521	1,628	9,737	359
UT/FUNDIM	329	369	354	389	399	339	405	2,582	42
UT/IT	0	0	1,632	1,619	1,320	1,660	1,357	7,588	123
UTA/CS	2,668	3,163	4,047	4,280	4,868	4,367	4,013	27,406	421
UV/CS	670	641	728	879	1,065	1,191	1,129	6,303	216
VTT/DIS	–	–	14,881	21,913	21,903	21,344	18,151	105,503	343
VTT/TL	–	–	15,059	13,946	16,910	19,970	22,827	88,712	745
LUT/CE	1,019	1,637	1,568	1,157	796	721	830	7,728	278
TKK/SPL	220	190	180	180	170	150	120	2,420	346
TUT/DCS	2,157	2,355	2,756	2,402	2,381	2,128	2,457	16,633	565
TUT/ICE	1,332	1,227	1,190	1,234	1,472	1,442	1,635	9,532	953
UKU/ENVI	–	–	–	–	–	–	80	2,480	327
UTA/INFO	600	800	1,200	800	1,000	900	800	6,100	211
Total	50,679	59,770	106,364	115,865	127,982	125,793	120,734	712,770	
Median	1,440	2,111	2,756	2,613	2,551	2,325	2,236	15,994	

Research Activity Profile

Table 16. Distribution of research staff FTE-years by research area.

Unit	Theory of Computation	Algorithms and data structures	Programming languages	Software engineering	Parallel and distributed systems	Databases, data mining	Communications	Computer architecture	Human-computer interaction	Artificial intelligence, machine learning, computer vision	Computer graphics	Other	Total
ÅA/IT				238	119	60			60	119			596
HIIT		23			23	116	116		47	93		47	465
LUT/IP				31	2	3				56	10		102
TKK/CIS		48				95			48	285			476
TKK/Comlab		3					3		1				7
TKK/LCE					6				17	92			115
TKK/Netlab		26			26	26	182						260
TKK/SBL				16									16
TKK/SoberIT				126		10			58				194
TKK/SWT		33	7	20	7	27			13	7		20	133
TKK/TCS	26	11		18	26	2	41		2	28			153
TKK/TSM							150		105		45		300
TUT/IHTE									7				7
TUT/IT				77	60			9		9		17	170
TUT/SP	31	62		31	62	62	93		31	62	187		622
UH/CS	38	153		38	76	153	153			153			763
UJ/MIT		55		14	14	14	82			14		82	275
UJO/CSS	17	17		43					52	103	60	138	430
UKU/CS	8	13		142	13		26	5		21		31	257
UO/IPS	32			162					97			356	647
UO/ISG					13	38			6	70			127
UO/MVG								7	13	114			135
UT/FUNDIM	129	9	37								9		184
UT/IT		42		19	8	19				39	5	29	161
UTA/CS		53		18		62			222	89			444
UV/CS		20		13								33	66
VTT/DIS		129		64		64	182		129	129	64	311	1,071
VTT/TL	46	92		139	139	46	231	139	46	46			924
LUT/CE					9		44		6		3		63
TKK/SPL					5							11	16
TUT/DCS		20	10	29	10	10	29	78		6	4		195
TUT/ICE					12		66						78
UKU/ENVI				14		14				19			48
UTA/INFO												89	89
Total	328	809	53	1,252	629	821	1,400	237	959	1,552	387	1,162	9,589

Publication Activity

Table 17. Articles in refereed scientific journals.

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT	17	14	28	19	24	25	30	157
HIIT		2	17	23	20	30	41	133
LUT/IP	6	6	4	12	5	12	11	56
TKK/CIS	18	21	34	26	26	25	31	181
TKK/Comlab		3	5	5	9	6	2	30
TKK/LCE	34	29	37	49	59	55	57	320
TKK/Netlab	4	5	3	4	4	3	13	36
TKK/SBL				(1)	(5)	3	2	5
TKK/SoberIT			3	2	11	5	4	25
TKK/SWT	2	6	1	9	8	13	8	47
TKK/TCS	12	13	4	10	9	14	10	72
TKK/TSM	4		5	7	4	9	8	37
TUT/IHTE						1		1
TUT/IT	1	20	3	5	18	14	20	81
TUT/SP	28	30	43	53	45	56	56	311
UH/CS	6	9	26	25	21	36	43	166
UJ/MIT	12	10	22	21	14	9	16	104
UJO/CSS	13	14	11	13	11	16	34	112
UKU/CS	2	3	1	2		3	10	21
UO/IPS	12	7	7	11	9	19	22	87
UO/ISG	3	1	1	5	5	3	5	23
UO/MVG	5	5	5	5	5	6	9	40
UT/FUNDIM	23	20	31	26	30	26	29	185
UT/IT			13	23	9	20	21	86
UTA/CS	22	24	25	30	44	35	28	208
UV/CS		3	2	3	2	4	10	24
VTT/DIS	17	19	23	18	24	23	17	141
VTT/TL	16	24	16	11	9	14	22	112
LUT/CE	3	4	3	6	8	4	3	31
TKK/SPL				1	1	1	1	4
TUT/DCS	8	5	8	6	13	10	7	57
TUT/ICE		2		1	1	3	5	12
UKU/ENVI	1	3	1	3	2	1	4	15
UTA/INFO	13	12	10	10	12	12	13	82
Total	282	314	392	444	462	516	592	3,002

Table 18. Articles in refereed scientific edited volumes and conference proceedings.

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT	42	28	82	75	105	100	77	509
HIIT		3	60	77	103	115	108	466
LUT/IP	41	30	44	55	59	54	32	315
TKK/CIS	75	70	67	83	76	96	82	549
TKK/Comlab	1	2				2		5
TKK/LCE	7	9	5	8	11	12	8	60
TKK/Netlab	17	13	20	21	33	33	39	176
TKK/SBL	–	–	–	(3)	(16)	13	11	24
TKK/SoberIT	–	–	2	1		7	6	16
TKK/SWT	12	14	20	15	24	12	18	115
TKK/TCS	24	19	29	38	43	33	34	220
TKK/TSM	39	40	47	38	47	42	23	276
TUT/IHTE	–	–	–	–	–	6		6
TUT/IT	14	5	18	17	12	26	24	116
TUT/SP	130	106	118	101	112	148	138	853
UH/CS	43	63	48	69	109	109	100	541
UJ/MIT	27	14	39	48	29	22	28	207
UJO/CSS	41	23	65	41	102	63	91	426
UKU/CS	3	2	7	7	14	35	40	108
UO/IPS	47	58	62	60	75	59	58	419
UO/ISG	17	7	3	10	19	31	18	105
UO/MVG	22	16	16	27	27	26	38	172
UT/FUNDIM	13	23	13	10	26	13	16	114
UT/IT	–	–	10	11	29	38	36	124
UTA/CS	42	40	35	54	67	77	38	353
UV/CS	4	3	7	9	19	20	27	89
VTT/DIS	55	48	60	54	58	66	73	414
VTT/TL	63	98	82	73	103	110	123	652
LUT/CE	13	16	25	24	19	26	36	159
TKK/SPL	3	3	2	3	4	3	2	20
TUT/DCS	34	51	48	49	34	35	30	281
TUT/ICE	15	5	16	19	28	21	18	122
UKU/ENVI			1	3	4	4	5	17
UTA/INFO	10	4	10	6	13	8	8	59
Total	854	813	1,061	1,106	1,404	1,465	1,385	8,088

Table 19. Patents.

Unit	2000	2001	2002	2003	2004	2005	2006	Total
ÅA/IT								0
HIIT			1	2	5	3		11
LUT/IP								0
TKK/CIS					1			1
TKK/Comlab								0
TKK/LCE								0
TKK/Netlab			4					4
TKK/SBL								0
TKK/SoberIT								0
TKK/SWT								0
TKK/TCS			2	6	4	1	6	19
TKK/TSM				1			1	2
TUT/IHTE								0
TUT/IT						1		1
TUT/SP					3	1	2	6
UH/CS				2	5	3		10
UJ/MIT	1				1			2
UJO/CSS								0
UKU/CS								0
UO/IPS					1			1
UO/ISG		1		1	1			3
UO/MVG	1	1		1	1			4
UT/FUNDIM								0
UT/IT								0
UTA/CS			1		1		1	3
UV/CS								0
VTT/DIS	2	2		6	6	8	8	32
VTT/TL	4	8	4	1	1	4	4	26
LUT/CE								0
TKK/SPL								0
TUT/DCS				1	1	3	1	6
TUT/ICE								0
UJ/TBA								0
UKU/ENVI								0
UTA/INFO								0
Total	8	12	12	21	31	24	23	131

Doctoral Dissertations

Table 20. Doctoral dissertations. The last column is dissertations per senior researcher FTE-years. Professors are included in senior researchers.

Unit	2000	2001	2002	2003	2004	2005	2006	Total	Per senior researcher
ÅA/IT	4	3	3	1	5	7	8	31	0.3
HIIT	1	0	2	0	4	2	6	15	0.3
LUT/IP	2	0	2	3	1	2	2	12	0.7
TKK/CIS	4	2	4	5	7	2	7	31	0.3
TKK/Comlab	–	0	0	0	0	0	0	0	0.0
TKK/LCE	2	2	3	2	5	8	9	31	1.4
TKK/Netlab	0	1	1	2	1	1	3	9	0.2
TKK/SBL	–	–	–	–	–	0	0	0	0.0
TKK/SoberIT	3	1	3	0	1	3	4	15	0.6
TKK/SWT	0	0	2	1	1	1	0	5	0.1
TKK/TCS	2	0	2	2	1	5	4	16	0.6
TKK/TSM	0	1	3	1	3	2	5	15	0.5
TUT/IHTE	–	–	–	–	–	1	0	1	0.7
TUT/IT	0	1	0	1	1	5	4	12	0.2
TUT/SP	8	8	8	6	5	14	9	58	0.6
UH/CS	5	3	3	8	8	3	5	35	0.3
UJ/MIT	2	5	5	3	9	6	9	39	0.4
UJO/CSS	1	1	1	1	2	3	3	12	0.3
UKU/CS	0	0	0	0	1	0	1	2	0.0
UO/IPS	6	2	4	0	4	4	5	25	0.2
UO/ISG	0	0	0	0	3	2	4	9	0.5
UO/MVG	1	1	2	2	0	1	1	8	0.3
UT/FUNDIM	0	0	4	2	2	2	0	10	0.1
UT/IT	5	1	1	1	2	5	3	18	0.3
UTA/CS	2	2	6	2	5	4	4	25	0.4
UV/CS	0	0	0	1	0	1	2	4	0.1
VTT/DIS	2	0	1	1	1	2	3	10	0.03
VTT/TL	1	3	0	1	3	1	0	9	0.1
LUT/CE	0	1	1	0	1	2	0	5	0.2
TKK/SPL	0	0	0	0	1	0	0	1	0.3
TUT/DCS	3	3	1	2	5	2	6	22	0.7
TUT/ICE	0	0	0	0	2	2	4	8	0.8
UKU/ENVI	0	0	0	0	1	0	0	1	0.1
UTA/INFO	3	0	1	1	1	0	1	7	0.2
Total	57	41	63	49	86	93	112	501	

B. Members of the Evaluation Panel

Lars Birkedal

Professor, Programming, Logic and Semantics Group,
The IT University of Copenhagen, Copenhagen, Denmark

Lars Birkedal is Head of the Programming, Logic, and Semantics group at the IT University of Copenhagen. His research interests are in the semantics of programming languages, program logics and type theories, and models for ubiquitous computing. He is a board member of the FIRST graduate school and has served as referee to numerous international journals, as program member to conferences, and as reviewer to funding agencies from around the world. Lars Birkedal holds an MSc degree from the University of Copenhagen, and a PhD degree from Carnegie Mellon University. He has been on the faculty at the IT University of Copenhagen since 2000.

Hans Gellersen

Professor, Department of Computing, Lancaster University, Lancaster, UK

Hans Gellersen is Professor for Interactive Systems in the Computing Department of Lancaster University. His research interests are in ubiquitous computing, embedded interactive systems, and user interface technologies. He was founder of the *Ubicomp* conference series, now established as premier event in ubiquitous computing, is one of the editors of *Personal and Ubiquitous Computing*, and serves on the editorial board of *IEEE Pervasive Computing*. He has been in his current position at Lancaster since 2001, and was previously affiliated with the University of Karlsruhe, Germany. Hans Gellersen holds an MSc and PhD in Computer Science, both from Karlsruhe.

Letizia Jaccheri

Professor, Department of Computer and Information Science,
Norwegian University of Science and Technology, Trondheim, Norway

Letizia Jaccheri is Professor in Software Engineering at the Department of Computer and Information Science of the Norwegian University of Science and Technology (NTNU) since 2002. She is adjunct professor at the Department of Informatics of the University of Oslo since 2006. She has been active in software engineering research since 1988. Her research focus is on software intensive processes with special focus on open source software, artistic software, and empirical software engineering. She holds a PhD from the Turin Polytechnic (2004) and an MSc from the University of Pisa (1988).

Fionn Murtagh

Professor, Department of Computer Science,
University of London, London, UK

Fionn Murtagh is Professor of Computer Science in the University of London, and Head, Department of Computer Science, Royal Holloway, University of London. He previously held Chairs in Computer Science at Queen's University Belfast, and the University of Ulster. He served for more than a decade with the Space Science Department of the European Space Agency, in Garching, Munich. His PhD is in Mathematical Statistics from the University of Paris 6. He is Editor-in-Chief of the *Computer Journal*, which is one of the longest established scholarly computer science journals – 50 years in 2007. Fionn Murtagh is now taking up the post of Director of ICT at Science Foundation Ireland.

Tatsuo Nakajima

Professor, Department of Compute Science,
Waseda University, Tokyo, Japan

Tatsuo Nakajima is a professor of the Department of Computer Science and Engineering in Waseda University. He is also chair of Japan Embedded Linux Consortium and Forum on Service Platform for Information Appliances. His research interests are dependable operating systems, distributed middleware infrastructures, Sensor-based interaction systems, and interaction design. He was a researcher of Department of Computer Science in Carnegie Mellon University in 1990–1992, a research engineer of Olivetti & Oracle Research Lab. in 1998, and a visiting fellow of Nokia Research Center in 2005.

Enrico Nardelli

Professor, Faculty of Sciences,
University of Roma "Tor Vergata", Rome, Italy

Enrico Nardelli is Full Professor of Computer Science, affiliated since 2002 with the University of Roma "Tor Vergata". Previously he was with the University of L'Aquila (since 1992) and earlier with the Italian National Research Council. His research is focusing on: algorithms and data structure; data models, tools and environments for inter-organisational information systems. He has authored more than 120 refereed papers in the fields of interest, published in the most reputed international scientific journals and conference proceedings, for which he has also acted as a referee. He has been a consultant to the Italian Public Administration on security and certification issues in e-Government services and is a reviewer for funding proposal in both basic and applied computer science research at national and international levels. Since 2003, he serves as President of the Italian Association of University Professors in Computer Science (GRIN – grouping the more than 700 computer science professors all over Italy).

Naftali Tishby

Professor, School of Engineering and Computer Science,
The Hebrew University – Givat-Ram, Jerusalem, Israel

Naftali Tishby is on the faculty of the School of Computer Science and Engineering at the Hebrew University of Jerusalem. He was the founding chair of the Hebrew University Computer Engineering program and a founding member of its Interdisciplinary Center for Neural Computation (ICNC) and the Sudarsky Center for Computational Biology. He received his PhD in theoretical physics from the Hebrew university in 1985 and was a research staff member at MIT, Bell Labs, AT&T, NECI, Princeton University, University of Pennsylvania, UCSB, and IBM research. His research focuses on the interface between computer science, statistical physics, and biology, introducing various methods from statistical mechanics and information theory into machine learning, with applications to biological information processing.

Herb Yang

Professor, University of Alberta, Edmonton, Alberta, Canada

Herb Yang was on the faculty in the Department of Computer Science, the University of Saskatchewan from 1983 to 2001 and served as Graduate Chair from 1999 to 2001. Since July 2001, he is Professor in the Department of Computing Science, University of Alberta. He served as Associate Chair (Graduate Studies) in the same department from 2003 to 2005. His research interests cover a wide range of topics from computer vision to computer graphics. He is Senior Member of the IEEE and is on the editorial board of the journal *Pattern Recognition*. In addition, he has served as referee to numerous international journals, as program member to conferences, and as reviewer to funding agencies from around the world.

C. Terms of Reference

1 Organisation

The Board of the Academy of Finland approved the general agenda for the evaluation of Finnish Computer Science during 2007. The Research Council appointed a Steering Group to lead and support the execution of the evaluation.

The members of the Steering Group are

Hannu Hänninen, Professor, Helsinki University of Technology,
Member of the Research Council for Natural Sciences and Engineering,
Academy of Finland, Chairman of the group

Timo Jääskeläinen, Professor, University of Joensuu,
Member of the Research Council for Natural Sciences and Engineering,
Academy of Finland

Tuija Pulkkinen, Research Professor, Finnish Meteorological Institute,
Member of the Research Council for Natural Sciences and Engineering,
Academy of Finland

Johanna Blomqvist, Application specialist, CSC Finnish IT Center for Science

Barbara Heikkinen, Senior Manager, Research Strategy, Nokia Research Center

Eero Silvennoinen, Director, Software and Telecommunications Technologies, Tekes

The list of invited Evaluation Panel members, the list of evaluation documents to be submitted, and the Terms of Reference have been reviewed and approved by the Steering Group.

2 Evaluation Panel

The external evaluation will be carried out by an independent Panel of experts. The Academy of Finland has invited eight distinguished scientists as Evaluators:

Prof. Hans Gellersen, University of Lancaster, UK
Prof. Lars Birkedal, IT University of Copenhagen, Denmark
Prof. Letizia Jaccheri, Norwegian University of Science and Technology, Trondheim, Norway
Prof. Fionn Murtagh, University of London, UK
Prof. Tatsuo Nakajima, Waseda University, Japan
Prof. Enrico Nardelli, University of Roma, Italy
Prof. Naftali Tishby, Hebrew University, Israel
Prof. Herb Yang, University of Alberta, Canada

3 Objectives of the evaluation

The objective is to evaluate computer science research in Finland during the period 2000–2006. The main objective is to evaluate the scientific quality of the research. Other important issues are

- Recommendations on improvement on unit level and on general level
- National and international collaboration
- Multidisciplinarity and collaboration with other fields of science
- Available resources
- Researcher training
- Future objectives of the research groups
- Strengths, weaknesses and success stories
- Opportunities, challenges and threats
- The impact of the research (on science, societal, and on the unit itself)

The evaluation includes research units in universities and research institutes, identified by the Steering Group.

The main emphasis is on scientific evaluation. The panel is asked to evaluate and write general comments on the quality of

1 computer science research as a whole,
2 different sub-fields of computer science,
3 each evaluated and interviewed unit.

The quality, innovativeness and efficiency of the research will be compared with international standards. The Panel should ensure that the evaluation takes into account all of the relevant material they will receive.

Some groups are taking part in the evaluation only through submitting the questionnaire but they will not be interviewed. No detailed evaluation will be written on these units; they will be included in the general parts 1 and 2 stated above.

The Panel is also asked to characterise Finnish Computer science as a whole and provide recommendations on its future development. In addition to the research itself these may concern the following:

- Resources (facilities, personnel, economic resources).
- Research network and data management infrastructures
- Education and career policies
- Impact of the field on other research fields and on society in general
- Any other issue the panel considers important

The Panel is asked to provide a written statement on the general recommendations. All these are published in the final report of the evaluation.

4 Evaluation material, site visits, and interviews

The evaluation is based on the written material in response to the questionnaire submitted to the evaluated groups as well as a summary provided by the Academy of Finland. Additional important information will be obtained during the site visits and interviews. The evaluation panel may use also any additional public material, such as citation indices.

A sample of researches will be interviewed during the site visits e.g.:

- Heads of Units (research)
- Senior staff, professors, post-doctoral researches, visiting foreign scholars etc.

The specific timetable and instructions will be provided by the Evaluation Team in due time.

5 Coordination of evaluation

The evaluation process is operationally coordinated by the Evaluation Team set up by the Academy of Finland: Director Susan Linko, Senior Science Adviser Pentti Pulkkinen, Project Secretary Henriikka Katila, and Project Assistant Antti Perälä together with the Coordinator Dr Mikko Syrjäsuo. The Coordinator will assist the Evaluation Panel on site visits and in preparation and editing of the evaluation report. The duties of the Project Secretary are to compile the evaluation documents, organize the practical details of the site visits and provide administrative support.

6 Confidentiality of the evaluation and conflicts of interest

Panel members undertake not to make use of and not to divulge to third parties any non-public facts, information, knowledge, documents or other matters communicated to them or brought to their attention in the performance of the evaluation. The evaluation and the ratings are only for official use and confidential until the final summary evaluation report is published.

The possible questions of conflicts of interest will be discussed between the evaluator and Academy of Finland.

7 Evaluation report and publicity

The evaluation report including the main recommendations is based on the evaluation criteria defined by the Academy of Finland. The evaluation report will be written and edited by the Panel members with the assistance of the Coordinator. Prior to the final editing and publishing, the units of assessment get to review the report to correct any factual errors. The evaluation report is confidential and only for official use until publication. Evaluation report will be published in the Publications of the Academy of Finland in both printed and electronic form. The Academy of Finland has all the rights to the written material submitted by the evaluated units and the evaluation report.

8 Funds

The evaluation is funded completely by the Academy of Finland. The Academy of Finland will pay an expert fee to the Panel members. All travel expenses related to the Panel's visits and accommodation in Finland will be covered or reimbursed by the Academy of Finland.

Helsinki, 24 May, 2007

Hannu Hänninen
Chair of the Steering Group
Academy of Finland

Hans Gellersen
Chair of the Evaluation Group
University of Lancaster

D. Self-assessment Form

Evaluation of Computer Science in Finland (2000–2006)
Submission Form

GENERAL INFORMATION

Organisation	
Department or equivalent	
Address	
Phone	
Internet home page	
Head of the Department	
Phone	
Email	
Contact person for the Evaluation	
Phone	
Email	

G.1. Percentage that computer science represents in the research carried out in the unit[1]

G.2. Unit's research profile within computer science
(give estimate of the percentage)

Research field	**(%)**
Theory of computation	
Algorithms and data structures	
Programming languages	
Software engineering	
Parallel and distributed systems	
Databases, data mining	
Communications	
Computer architecture	
Human-computer interaction	
Artificial intelligence, machine learning, computer vision	
Computer graphics	
Other (what)	

[1] Please see the instructions at the end of this document

G.3. Other relevant fields connected to unit's research profile

(Mark with x the columns 1, 2 or 3, where 1=collaboration, 2=joint projects, 3=integrated in the group. More than one column can be marked in the same row.)

Research field	1	2	3
Mathematics			
Physics			
Chemistry			
Process technology			
Automation technology			
Signal processing			
Electrical engineering			
Information systems science			
Bioinformatics			
Biomedical engineering			
Psychology			
Modelling and simulation, computational science			
Biology			
Medicine			
Nanoscience			
Other (what)			

1. RESOURCES

1.1. Staff in 2000–2006 (person-months)

	2000	2001	2002	2003	2004	2005	2006	Total
Professors								
Other senior researchers								
Postdoctoral researchers								
Postgraduate students								
Other academic staff								
Visiting researchers and visiting research students								
Total active research staff								
Administrative personnel								
Technical personnel								

1.2. Senior and postdoctoral researchers

Name	Title	Period

2. RESEARCH OUTPUT

2.1. Describe the Unit's research (max. 4 pages)

2.2. Number of scientific publications and other outputs 2000–2006

Type of output	2000	2001	2002	2003	2004	2005	2006
1. Articles in refereed scientific journals							
2. Articles in refereed scientific edited volumes and conference proceedings							
3. Monographs published							
4. Other scientific publications							
5. Text books and other research-related publications							
6. Patents							
7. Computer programs and algorithms							
8. Visiting lectures							
9. Articles, radio and television programmes and journals popularising science							
10. Other output							

2.3. Lists of most important publications by researchers with doctoral degree (max 7 publications/person)

2.4. Copies of the Unit's best publications

(Append copies of publications, maximum number of publications = number of senior researchers but a minimum of five publications)

3. DOCTORAL TRAINING

3.1. Number of students who in 2000–2006

	2000	2001	2002	2003	2004	2005	2006
Completed their Master degree							
Started post-graduate studies							

3.2. List of doctoral dissertations in 2000–2006 and present employment

Name (family name, given name)	Year of birth	Gender	Topic of dissertation	Year of completing the degree	Present employment (job description, organisation)

4. NATIONAL AND INTERNATIONAL COLLABORATION

4.1. National collaboration

Organisation	Type of collaboration	Field of science

4.2. Visits abroad (minimum duration of visit: one month)

Name	Target organisation	Country	Purpose of the visit	Duration (in months)

4.3. Visits to the Unit (minimum duration of visit: one month)

Name of visitor	Home organisation	Country	Purpose of the visit	Duration (in months)

4.4. Short but particularly important visits

Name of visitor	Home organisation	Country	Purpose of the visit

4.5. Most important foreign collaborators

Name and organisation	Type of collaboration	Country

4.6. Describe the most important outcomes of the visits and collaboration contacts (max. 1 page)

4.7. Non-academic collaboration

Name and organisation	Type of collaboration	Country

5. OTHER SCIENTIFIC AND SOCIETAL ACTIVITIES

5.1. Invited presentations in scientific conferences

Name	Topic of presentation	Name and time of the conference

5.2. Memberships in editorial boards of scientific journals

Name	Journal	Period

5.3. Prizes awarded to researchers, honours and scientific positions of trust

Name	Prize, position etc.

5.4. Memberships in committees and in scientific advisory boards of business companies or other similar tasks of no primarily academic nature

Name	Tasks	Period

6. THE UNIT'S SELF-ASSESSMENT

6.1. SWOT – evaluation of the Unit's scientific strengths, weaknesses, opportunities and threats (expertise, funding, facilities, organisation; max. 2 pages)

6.2. Evaluate the Unit in relation to its leading scientific competitors (max 1 page)

6.3. The Unit's research strategy 2008–2010 (relation to the parent organisation's strategy, priority areas in research, development measures; max 2 pages)

6.4. The societal impact of the Unit's activities (max. 1 page)

6.5. Assess the academic and societal need for doctoral training within the Unit's research fields and the Unit's role in doctoral training (max. 1 page)

6.6. Assess the research infrastructure available (max 1 page)

7. FUNDING

7.1. The Unit's core and external funding received from the parent rganisation.

Source of Funding		2000	2001	2002	2003	2004	2005	2006	Total
Core funding	Budget funding								
	Other								
External funding	Academy of Finland								
	Tekes								
	Other public sources								
	Industry								
	Private foundations								
	EU								
	Other foreign organisations								
Total									

Notes (if applicable)

7.2. Evaluate the role of the funding by Academy of Finland in promoting the scientific and societal impact of research (max. 1 page)

7.3. Evaluate the role of funding awarded by different funding organisations in promoting the scientific and societal impacts of research, excluding funding from the Academy of Finland (max. 1 page)

Instructions to submission form

General information

G.1. This evaluation covers research only in computer science. The branches of computer science are defined in question G.2. In your Unit there may be many other fields of science represented, but we ask you to give the percentage that computer science stands for. **In the following questions, you are asked to concentrate only in this portion of research.**

G.2. Unit's research profile

The percentages should add up to 100. If there are more "Other" fields, you may add more lines. A more detailed division of computer science could be:

Theory of computation

Automata theory
Computability theory
Computational complexity theory
Quantum computing theory

Algorithms and data structures

Analysis of algorithms
Algorithms
Data structures

Programming languages and compilers

Compilers
Programming languages

Software engineering

Formal methods
Software engineering
Reverse engineering
Algorithm design
Computer programming

Concurrent, parallel, and distributed systems

Concurrency
Distributed computing
Parallel computing

Databases

Relational databases
Data mining

Communications

Game theory
Networking

Cryptography
Computer Audio

Computer architecture
Computer architecture
Computer organization
Operating systems

Human-Computer Interaction

Artificial intelligence
Artificial intelligence
Automated reasoning
Robotics
Computer vision
Machine learning
Natural language processing/Computational linguistics

Computer graphics
Computer graphics
Image processing

G.3. Other relevant fields

The interaction between computer science and other fields are studied. Three levels are given: 1, normal collaboration with joint publications; 2, common scientific projects i.e. consortia; 3, integration through scientists working in the group

1. Staff

1.1. Indicate information on the staff in full time equivalents (FTE) in computer science. Full time equivalent refers to annual full-time work including paid holidays and other statutory days off. Other holidays, leaves of absence etc. shall be deducted from the calculatory working time.

One person-workday is 8 hours 15 minutes and one person workweek 41 hours 15 minutes effective working time (lunch hours included, 1 hour/day). If the person's working time is less than the norms of normal office hours, the amount of person-work is calculated using the working time norm as divider.

Active research staff includes persons who plan, produce and publish new knowledge, theories and methods as well as products and processes based on them and lead research projects. Technical personnel refer to persons working under the supervision of active research staff to carry out projects but who are not involved in the theoretical planning, publishing or other related activities. Administrative personnel refer to persons who take care of administrative tasks related to the research, such as financial and personnel administration or other office duties but who are not normally involved with the technical implementation of the projects.

Persons under the following titles will always be listed in the active research staff:

- Academy Professor (In Finnish: akatemiaprofessori)
- Academy Research Fellow (akatemiatutkija)
- Assistant (assistentti)
- Chief Research Scientist (johtava tutkija)
- Clinical Teacher (kliininen opettaja, apulaisopettaja)
- Doctoral Assistant (tohtoriassistentti)
- Group Leader (ryhmänjohtaja)
- Head of Research (tutkimuspäällikkö)
- Laboratory Director (laboratorionjohtaja)
- Postdoctoral Research Fellow (tutkijatohtori)
- Professor (professori)
- Research Professor (tutkimusprofessori)
- Research Director (tutkimusjohtaja)
- Research Lecturer (tutkijalehtori)
- Senior Curators (yli-intendentti)
- Senior Researcher (vanhempi tutkija)
- Specialist Researcher (erikoistutkija)
- University Lecturer (yliopistonlehtori)

Moreover, the following persons should always be included in the active research staff:

a) Postdoctoral researchers

b) Postgraduate students belonging to either of the following groups:

- Persons with at least an MA or MSc (or equivalent) degree who have been employed by the university as full-time researchers or assistant researchers to do doctoral studies for a period of no less than six months.
- Persons with at least an MA or MSc (or equivalent) degree who, for a period of no less than six months, have fulfilled the following two criteria: they a) have been affiliated with the Unit as full-time researchers or assistant researchers to do doctoral studies and b) have been receiving research funding from some other source than another university or research institute.

These groups include, e.g. postgraduate students employed by graduate schools.

Postgraduate students who do not fulfil either of the above criteria, i.e. who have not been employed by the university and have not been receiving other funding, can also be included in the active research staff for the period they are not holding a post in another university or research institute. The Unit can decide case by case whether to include these postgraduate students. It is worth observing that it is not necessarily advisable to include postgraduate students who do not have substantial publications from the period 2000-2006.

According to its choice, the Unit can also include other members of the staff in the active research staff, e.g. departmental amanuenses (amanuenssi).

1.2. In case person's duties have changed during the period under review (e.g. from technical personnel to active research staff), indicate the person's both tasks and period according to the format.

2. Research output

2.1. This question surveys how the research carried out in the Unit has impacted research in its own field(s). Describe the orientation of scientific publishing, most important research results and the role of multidisciplinarity or interdisciplinarity etc. Also, describe the role of basic and applied research.

In case the research carried out in the Unit is clearly specialised in the different fields of computer science, describe each field separately (see also question 6.3).

2.2. In the summary table, calculate the number of each type of outcome in the list during the period under review.

2.3. Each senior researcher will list seven of his/her key publications during the period under review, indicated in the order of quality. Unlike other information, the list may also include manuscripts published in 2007 or manuscripts approved for publication but still unpublished.

References to books should give the names of any editors, place of publication, editor, and year.

2.4. For ensuring easy readability do not make the font size smaller when copying publications. The copies of publications shall be two-sided.

3. Doctoral training

3.1 Give the number of Master degrees and of those, new post-graduate students to indicate the ratio enrolled in the doctoral training.

3.2 If at least half of the doctoral dissertation has been supervised and done at a research institute, the research institute can also list the doctoral dissertation as its own outcome. In this case indicate also the university (in year of completion) where the doctoral dissertation has been presented for approval. In present employment, indicate the type of organisation (university, business company, research institute, state, municipality or other).

4. National and international collaboration

4.1. List the national collaboration partners of the Unit. Collaborator refers to a person or a research team with whom the cooperation has either generated or is expected to generate within the next three (3) years one of the outcomes indicated in item 2.2. Types of collaboration include e.g. joint projects, researcher mobility. In ”Field of science”, give the main field of the collaborator (physics, chemistry, mechanical engineering etc.).

4.2–4.4. List the visits per year. List the visits of each year by country in the alphabetical order. In item ”Purpose of the visit” indicate clearly the objective of the visit.

4.5. List the most important foreign collaborators, as defined in item 4.1.

4.6. Describe here e.g. key joint publications, researcher training, adoption and use of new technologies or new approaches.

4.7. List here the Non-academic collaboration, e.g. industry contacts.

5. Other scientific and societal activities

5.1. Invited plenary talks, and other invited talks

5.2.-5.4. Give only the most important memberships and prizes

6. The Unit's self-assessment

Self-assessment is an important part of the evaluation. Please answer carefully.

6.1. and 6.2. In addition to strengths and weaknesses it is also important to assess what the present strengths or developable strengths enable in the future and what kinds of threats are related to the weaknesses.

6.3. Describe the Unit's research programme for the next few years, the key research objectives and means to achieve these objectives. What is the role of basic and applied research? Is there need for new knowledge, facilities, is the present level of funding sufficient for attaining the objectives laid down? Do the strategies of the parent organisation and the Unit support each other? How do you take into account the possible ethical questions within research?

6.4. Describe here how the Unit's research activities and cooperation with other actors in society have promoted the activities of other societal actors, e.g. industry of SMEs.

6.6. Describe the use and availability of research infrastructures, e.g. computer resources, research equipment, both from the parent organisation and outside.

7. Funding

7.1. Core funding applies to the Unit's budget funding and possible other funding for research awarded by the parent organisation. The funding covers both the salary costs with social charges of the staff and the operational costs which include consumption costs and investment costs for research activities.

Use of research funding received from external sources, indicated per year. Academy of Finland fellowships should also be involved and counted. Salaries should be counted as 1.33 * gross salary.

7.2 Describe how the funding awarded by the Academy has promoted the scientific and societal impact of the Unit's activities. Scientific impact refers to the contribution of the research carried out by the Unit to the development of the field. Societal impact refers to the ability of the research activities to promote values that are considered as important in society.

7.3 Describe the contribution of the funding awarded by different funding organisations to the scientific and societal impacts.

The Finnish computer science research is healthy with impressive publication activity and international visibility, and Finnish computer science researchers are well networked nationally and internationally. These are the opinions of an international panel of experts that has evaluated the scientific quality of computer science research in Finland in 2000–2006.

This evaluation report describes the panel's observations not only on the quality of computer science research but on its different subfields and interviewed units. Observations are accompanied by recommendations for improvement both on general and unit level.

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