

Strategic Goals and Action Plan 2012-2016

February 9, 2012

1. Executive Summary

This plan describes the department's strategic goals for research, talent development, interaction with society and education. We also outline the initiatives and projects needed to reach the goals.

The latest strategic plans for the department were developed in 2003 and 2008. A central goal of these plans was to ensure a significant increase in the number of permanent academic staff. With some delay, many parts of the plans have been followed. However, the net growth of the permanent academic staff has been modest. Hence, there is still a need for a significant increase of the permanent academic staff. We strongly believe that the growth should be based on strategic considerations and on building on existing as well as new research areas.

Benchmarking with three other CS departments shows that the department performs very well – both qualitatively and quantitatively.

With respect to research we are highly productive, well-known internationally and considered to be the best Danish IT department. The main challenge is to extend the permanent academic staff from the present 25 to 35 persons by 2022. We want to increase the diversity of the staff by hiring more people from other universities and more women. We only want to hire top quality persons and hence the expansion must happen over a long period of years. We also want to develop the persons in the present staff – in particular the associate professors so that some of these reach the level of full professors. Finally, we want to stress the importance of academic leadership and make good leaders more visible.

With respect to talent development we have a rather high number of PhD students per person in the permanent academic staff. The main challenge in this area is to increase the number of PhD students from other universities and in particular from other countries. We also think that there is room for improving the supervision of our PhD students. Finally, we want to establish clear and coherent career tracks for postdocs and assistant professors. This will improve our possibilities to attract the best young talents to become candidates for our permanent positions.

The department has a long and solid tradition for interaction and knowledge exchange with private companies and public institutions. Over the last thirty years there have been numerous research projects with external participants. In this way our research has been made available to the Danish and international society. There have been approximately 15 spin-off companies (including Mjølnir, Cryptomathic, Cetrea and the Alexandra Institute) and a number of patent applications. We want to maintain the high level of interaction with private companies and public institutions. It produces a lot of interesting research themes ranging from smaller problems which can be tackled with innovative use of existing knowledge to more challenging problems which require long term basic research.

The department has two bachelor programmes and two master's programmes. We also have a diploma and master's programmes within part-time supplementary education. This means that the teaching load on the academic staff is high, and hence we have no plans to extend the number of educations. Nearly 20% of all new bachelors at the faculty enrol at our department. The main challenge in this area is to increase the percentage of bachelors who obtain a degree.

This document consists of six sections. Section 2 provides a brief introduction and a SWOT analysis identifying the strengths, weaknesses, opportunities and threats of the department. Section 3 contains a description of the department's organisation, research groups and staff. Section 4 describes the benchmarking with three other Computer Science departments and with the rest of the faculty. Section 5 describes the department's strategic goals for the next five years and relates these to the benchmarking results. Section 6 contains the initiatives and projects to be taken to reach the strategic goals. This includes a recruitment plan for the next five years. Finally, Appendix A describes the status and prospects for the research groups at the department, while Appendix B contains a set of criteria developed to evaluate candidates for permanent associate professorships.

2. Introduction

The contents of this plan have been discussed with:

- The department's permanent staff (November 4, December 2 and January 5),
- The department's joint cooperation committee (SU) (November 24 and January 13)
- The department's research committee (August 18-19, September 16, November 18 and December 13)
- The dean and two of the prodeans (Henrik Bindslev and Tom Vindbæk Madsen)(January 13)

Hence there is widespread consensus and support for the plan.

SWOT Analysis

This subsection contains a SWOT analysis identifying the strengths, weaknesses, opportunities and threats of the department.

<p><u>Strengths (external)</u></p> <ul style="list-style-type: none"> • High international reputation. • Well-developed network of international contacts. • Many interdisciplinary projects. • Several strong centres of excellence. • Close contact and cooperation with the IT industry. • Qualified and committed academic staff. • Competent and efficient support staff. • Uniform age profile for the academic staff. • Many PhD students. • Many bachelor and master's students. • Many students on part-time supplementary education. <p><u>Strengths (internal)</u></p> <ul style="list-style-type: none"> • Mutual respect between individual research groups and between academic and support staff. • High degree of delegation to and involvement of the individual research groups and committees. • Rapid and non-bureaucratic decision processes. • No bickering over minor problems and procedures. • Many initiatives to ensure good social contact. 	<p><u>Weaknesses</u></p> <ul style="list-style-type: none"> • Too small permanent academic staff. • High percentage of short-time external funding. • Too few foreigners in the academic staff. • Too few women in the academic staff. • Too few PhD students from other universities. • Too few female students at all levels.
<p><u>Opportunities</u></p> <ul style="list-style-type: none"> • High demand for high-qualified IT-professionals such as our masters and PhDs. • Good possibilities for obtaining external funding. • Co-location with information science, IT engineering and other organisations in the IT City Katrinebjerg. • Cooperation with the Alexandra Institute. • High attention from city council and region. • Extremely good buildings. 	<p><u>Threats</u></p> <ul style="list-style-type: none"> • Fierce competition with other universities and IT industry to hire the most talented young people. • Difficult to make solid long-term planning for permanent academic positions. • Difficult to offer attractive career tracks for the best young researchers. • Too few resources to hire postdocs and assistant professors in certain areas. • Inadequate (non-existing) incentive structure for the permanent academic staff.

3. Brief Description of the Department

Computer Science started at Aarhus University in 1971 as a part of the Department of Mathematics. In the period 1993-1998, Computer Science went through a rapid growth increasing the total staff from 80 to 160 people – primarily due to a dramatic increase in the amount of external funding. An independent Department of Computer Science was created in January 1998. Over the next 5-6 years, the department gradually moved to new buildings as a part of the university's plan to concentrate the ITC activities in the IT-City Katrinebjerg. There is a close and fruitful collaboration with many other organisations at Katrinebjerg.

The department is strong in both theoretical and experimental Computer Science. In the recent years we have seen a close cooperation between different research groups – even those which have traditionally been perceived as being far from each other (with respect to scientific goals/methods). Partly as a result of this, many projects at the department have targeted research themes and application areas that are interdisciplinary and multidisciplinary in nature.

Organisation

The recent reorganisation at Aarhus University (initiated with the March 2011 report) has had a quite limited effect on our department. The academic staff is totally unchanged. Two administrative persons have been transferred to the AU administration, but are still located at the department with nearly the same duties as before. Hence, we have seen no need for major changes of the department's organisation. This has been discussed with the research committee, the permanent staff and the joint cooperation committee (SU). They all fully back the decision. The only change in the organisation is that we now have an active working vice head of department (Michael Schwartzbach) who takes part in many of the daily decisions and discussions.

The department has a flat organisation. The head of department and the vice head of department have regular consultations concerning strategic issues with two elect professors representing the two main clusters of research groups (Christian S. Jensen and Kaj Grønbæk). Strategic issues are also discussed at meetings with the leaders of the research groups. Finally there are monthly meetings with the permanent academic staff and the permanent non-academic staff, quarterly meetings with postdocs and regular meetings with the Joint Cooperation Committee (SU). In addition to this there are committees for:

- Research
- PhD studies
- Bachelor and master studies
- Part-time supplementary studies
- PR
- Offices
- IT
- Library
- Seminars

Each committee is responsible for the daily decisions within their area. Larger and more political decisions are discussed with the department leaders, who meet with each committee 1-2 times a year to discuss the strategy, action plans and resources of the committee.

Research Groups

The permanent academic staff is distributed on the research groups listed below. A typical research group consists of 1 full professor, 1-2 associate professors and a number of postdocs, assistant professors and PhD students. A description of the current status and prospects for all research groups can be found in Appendix A. More detailed descriptions of the activities in the individual research groups can be found on:

cs.au.dk/research/areas/. Two full professors (Ole Lehrmann Madsen and Mogens Nielsen) and two associate professors (Ole Caprani and Henrik Bærbak Christensen) are outside the research groups.

Algorithms and Data Structures

Algorithms and data structures (in classical computational models, as well as newer models that take the hierarchical memory of modern machines into account), algorithm engineering. The group hosts a Danish National Research Foundation centre (MADALGO), which was recently extended for a second 5-year period after an extremely positive international review.

Data-Intensive Systems

Database and data management, including temporal, spatial, spatio-temporal, and spatio-textual data as well as clustering, outlier detection, classification, and similarity search.

Cryptography and Security

Public-key cryptography, cryptographic protocols, quantum cryptography, secure multiparty computation.

Mathematical Computer Science

Computational complexity theory, combinatorial optimization, algebraic algorithms, algorithmic game theory and mechanism design. Together with Cryptography and Security the group hosts a Danish National Research Foundation centre (CTIC).

Ubiquitous Computing and Interaction

Mobile computing (including mobile hypermedia and peer-2-peer), positioning and context awareness, interaction design for ubiquitous computing (including theoretical foundations, design methods and emerging interaction technologies).

Computer-Mediated Activity

New interaction techniques, methods and theories for computer-mediated activities of work and everyday life, mechanisms that support human development and appropriation of IT.

Use, Design and Innovation

Design methods for systems covering work places, public spaces and private homes. Most of the research is accomplished through large projects, where users, companies and researchers cooperate on analysing, designing, constructing and evaluating prototypes and use-processes.

Programming Languages

Design and analysis of languages and tools, functional languages and formal semantics, object-oriented languages and type systems.

Computer Graphics and Image Processing

Image processing, image syntheses. This is a newly formed group.

Bioinformatics

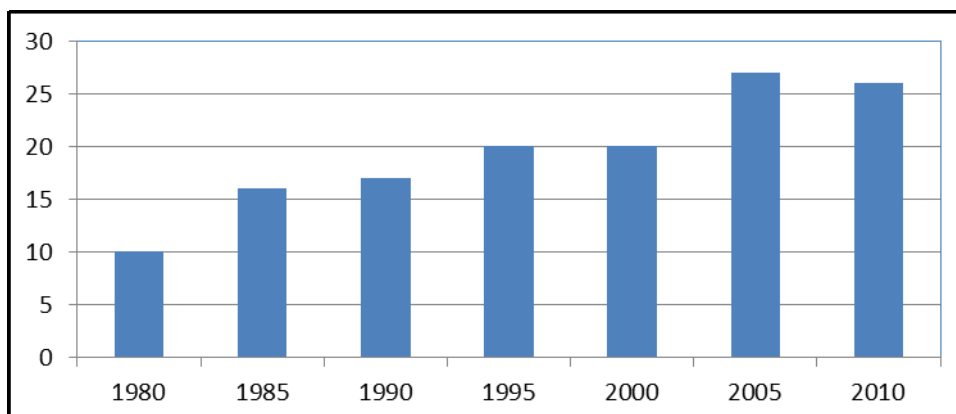
Development and application of computational methods for analysis of biological and biomedical data. The group is part of the Bioinformatics Research Centre (BiRC) which is an independent centre within our faculty.

Staff

Permanent Academic Staff

As it can be seen from the graph below, the permanent academic staff has been rather stable over the last 15 years and has not increased proportionally to the growth in the total staff. From 1995 to 2003 there were around 20 members of the permanent academic staff. Thereafter, the number was increased to 25. Today it is 25.5 (10 full professors and 16 associate professors, of which one is shared with Health). Two of the full professors (Ole Lehrmann Madsen and Mogens Nielsen) have most of their work assignments outside the department.

Permanent academic staff (number of persons)

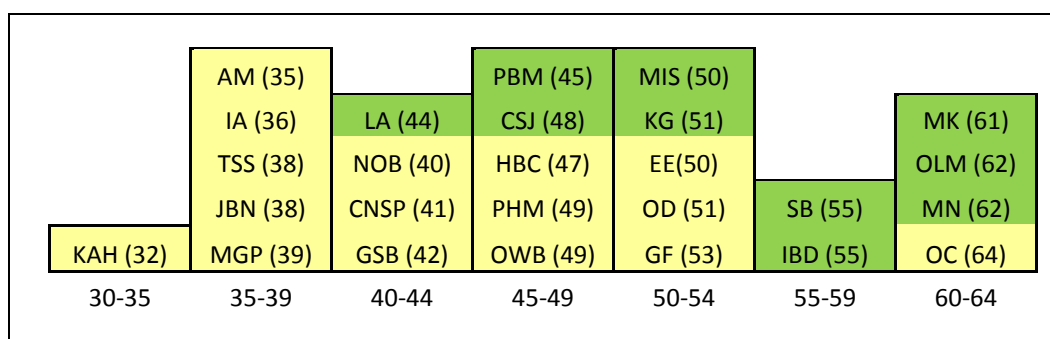


In 2010 and 2011 there have been the following changes in the permanent academic staff:

- Christians S. Jensen has been hired as full professor.
- Marianne Graves Petersen, Jesper Buus Nielsen, Kristoffer Arnsfelt Hansen, Niels Olof Bouvin, Ira Assent and Thomas Sangild Sørensen have been hired as associate professors.
- Professor Mogens Nielsen has returned to the department after a period where he was the leader of the PhD School.
- Associate professor Peter Møller-Nielsen has become an Emeritus.
- Associate professor Klaus Marius Hansen has left for a full professorship at Copenhagen University.

The graph below shows the age profile for the permanent academic staff. The profile is uniform except for a small gap in 55-59. With an expected retirement age of 67 years, we will only have four retirements due to age within the next ten years. It should, however, be noted that the department has “exported” a significant number of its permanent academic staff, who have won professorships at other universities in Denmark and abroad. During the last 20 years, we have lost 20 associate professors in this way. This is a clear witness to the excellent qualifications of our staff. There is no reason to believe that this trend will change over the next years, and hence we need to expect one career-motivated resignation per year.

Age profile for permanent academic staff
(full professors in green and associate professors in yellow)

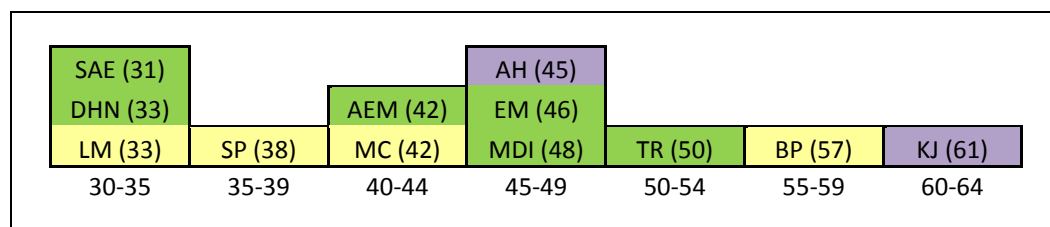


Permanent Non-academic Staff

The permanent non-academic staff consists of:

- Head of department (Kurt Jensen).
- Head of administration (Annemette Hammer).
- Six secretaries (of which 1.4 are paid by funding related to large externally funded centres).
- Four technical AC-TAPs (one study manager, two on external project funding and one librarian expected to be transferred to the AU administration).

Age profile for permanent non-academic staff
(secretarial staff in green and AC-TAPs in yellow)



In 2010 and 2011 there have been the following changes in the permanent non-academic staff:

- Sara Ølholm Eaton has been hired as secretary (research group coordinator).
- Tina Rudolph has replaced Hanne Friis Jensen in the information office.
- Karina Svanborg has been hired as study manager.
- Karina Svanborg and Arne Nis Jensen have been transferred to the AU administration, but they are still located at the department with nearly the same duties as before.

Overview of Staff

Professors	10	This includes Ole Lehrmann Madsen and Mogens Nielsen who have most of their work assignments outside the department.
Associate professors	16	One is shared with Health.
Assistant professors/researchers	2	Two more start March 2012.
Postdocs	25	
PhD students	65	
Technical AC-TAPs	4	One study manager, two on external project funding and one librarian.
Technical TAP	9	Part-time student programmers working with development of experimental research prototypes.
Administrative TAPs/AC-TAPs	8	Head of department, head of administration and six secretaries.
Total	139	

Expected Reductions in the Permanent Staff

Over the next five years we expect the following reductions in the permanent staff:

- One associate professor will become an Emeritus.
- One librarian will be transferred to the AU administration.
- An unknown number of associate professors will leave for full professorships at other universities. Over the last 20 years we have lost an average of one associate professor per year and we expect this trend to continue.

Experimental Research Infrastructure

The department has a few physical research labs, which are used for experiments within different application areas. The two most important of these are the iSpace used for experiments within Ubiquitous Computing and Interaction and the CfPH lab used for experiments within Pervasive Healthcare. The CfPH lab is under construction. It would be interesting for the department to establish a closer cooperation with Centre for Advanced Visualization and Interaction (CAVI). Until now our interaction with CAVI has been quite sparse. This may change when we get more permanent staff within Computer Graphics.

4. Benchmarking

This section describes the benchmarking with three other Computer Science departments. It also contains a benchmarking with the rest of our faculty.

Benchmarking with CS Departments

As benchmarking partners we have chosen a geographical mix of well-known CS departments to which we have good contacts (so that we can easily get the necessary benchmarking data):

- UCLA: University of California Los Angeles (<http://www.cs.ucla.edu/>)
- TU/e: Eindhoven University of Technology (<http://w3.win.tue.nl/en/>)
- KU: Copenhagen University (<http://www.diku.dk/english/>)

The CS department at UCLA is among the top-10 in the US according to the National Research Council, see: <http://chronicle.com/article/NRC-Rankings-Overview-/124721/>. The CS department at TU/e is one of the best in The Netherlands according to several national research evaluations. Moreover, it is ranked fourth in Europe (after Oxford, Zurich, and Cambridge) according to the 2011 Academic Ranking of World Universities (ARWU), see www.shanghairanking.com. All three departments have research areas similar to our department and to some extent similar economic conditions.

In the benchmarking the head of department Kurt Jensen is counted as professor (since this is the international standard). Ole Lehrmann Madsen and Mogens Nielsen are not included in the benchmarking data, since they have most of their work assignments outside the department

Staff

The following table shows the size of the academic staff distributed on the usual categories. TU/e has a large number of part-time professors (in particular in the group of full professors). They have their main job in industry and work up to 1 day per week at the department. The figures in parentheses indicate full-time equivalents (FTEs). Most of the assistant professors at TU/e are in permanent positions. This is not the case at the other departments, where all assistant professors are temporary.

	UCLA	TU/e	KU	AU
Full professors	22	17 (10.5)	9	9
Associate professors	5	5 (4.0)	15	16
Assistant professors	2	25 (23.4)	3	1
All professors	29	47 (37.9)	27	26
Postdocs	12	12	7	25

TU/e is the largest of the four departments. The other three departments have nearly the same size. AU has a significantly larger percentage of non-permanent academic staff than the other departments.

Publications and Citations

In Computer Science publications at top conferences are considered to be more important than publications in journals. This means that we cannot calculate publications and citations by means of Web of Science and it also means that we do not use article influence scores. Instead we have used the most reliable database for computer science publications (DBLP) together with Harzing's Publish or Perish and Google scholar My Citations. Unfortunately, they do not allow calculation of reliable statistics for departments, but only for individuals. Hence, the benchmarking focuses on the permanent academic staff only.

The following table shows the number of peer-reviewed publications and citations for the permanent staff. Publications are primarily calculated by means of DBLP. If two members of the permanent staff co-author a paper it is counted twice (this occurs seldom and has only a marginal effect on the result). The same is true for citations. They are calculated by means of Harzing's Publish or Perish / Google scholar My Citations.

	UCLA	TU/e	KU	AU
Publications	3,183	2,312	1,022	1,255
Publications in 2010	194	219	102	98
Citations	207,067	80,009	27,357	52,132
Citations to papers published after January 1, 2006	16,768	18,222	3,188	6,389

UCLA is a clear leader, while TU/e and AU follow. As mentioned before TU/e has a large number of temporary full professors and permanent assistant professors. This makes it difficult to make a fair comparison of the number of papers and citations per professor man-year. It seems that TU/e publishes more than AU (per person), while the publications from AU have more citations. With respect to the newest publications and citations, TU/e performs very well narrowing the gap to UCLA.

From the PURE registrations at Aarhus University, it can be seen that the total number of peer-reviewed publications from our department in 2008, 2009 and 2010 are 159, 159 and 152 (excluding the Bioinformatics research group).

H-indexes

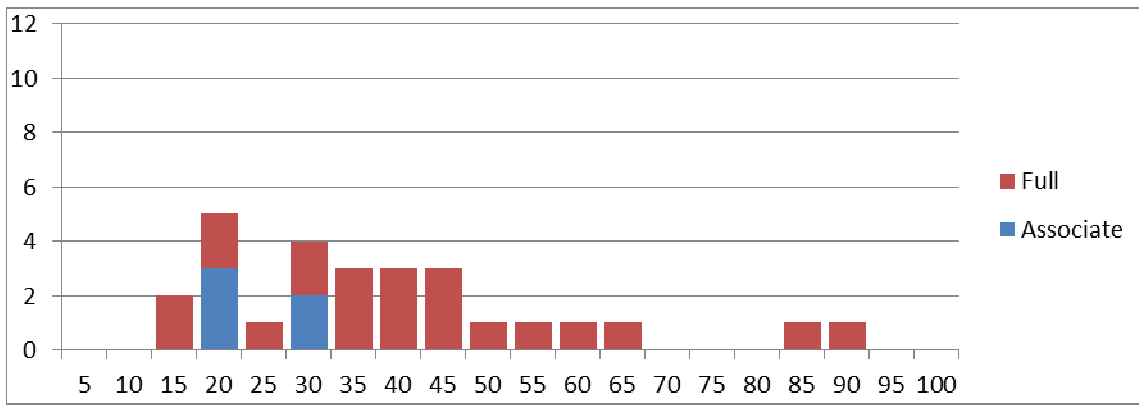
We have calculated the H-index for all full and associate professors plus the permanent assistant professors at TU/e. This is done by means of Harzing's Publish or Perish / Google scholar My Citations. The following table shows the average H-index for full and non-full professors.

	UCLA	TU/e	KU	AU
Full professors	39.9	27.6	19.4	33.1
Associate professors	22.4	16.0	12.3	15.0
Assistant professors	—	11.2	—	—

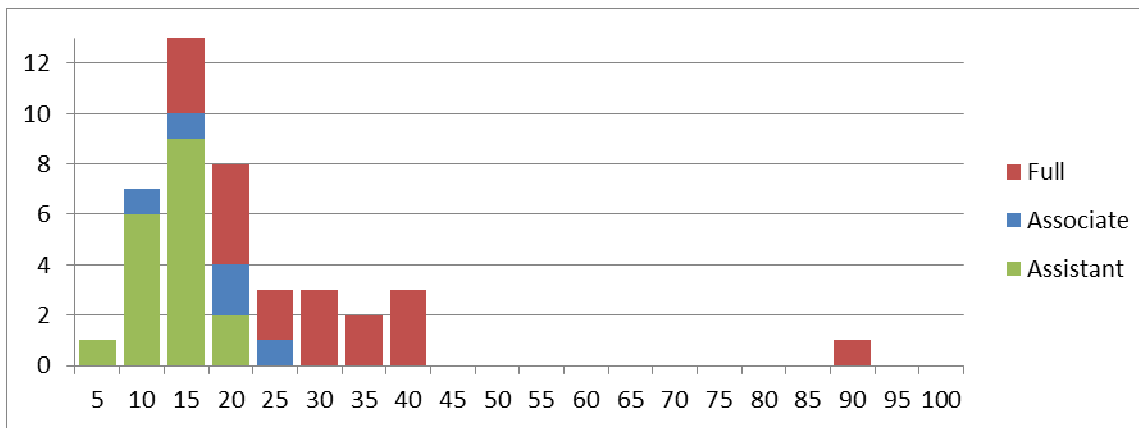
UCLA is a clear leader while AU and TU/e follow.

On the next page we give histograms showing the distribution of the H-indexes. A column labelled "n" contains all H-indexes in the interval $[n-4, n]$. This means that the intervals are 1-5, 6-10, 11-15, and so on.

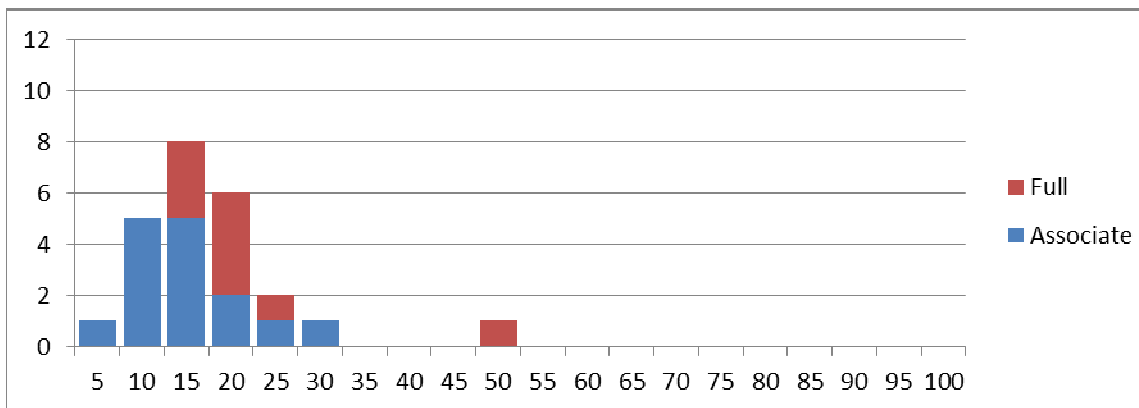
UCLA



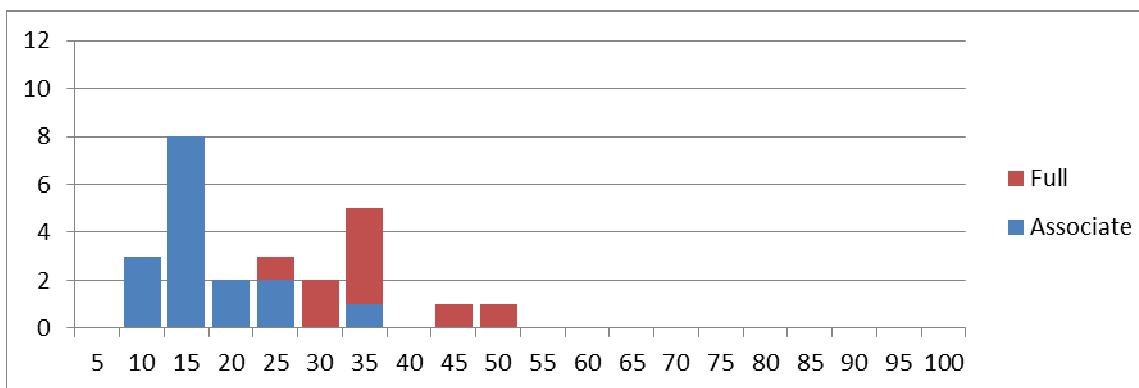
TU/e



KU



AU



Students

The following table shows the number of PhD students, the production of PhD degrees and the number of bachelor students.

	UCLA	TU/e	KU	AU
PhD students	210	49	29	65
PhD degrees in 2008-2010	81	30	27	36
Bachelor students admitted in 2010	131	81	180	177

UCLA has significantly more PhD students than the other departments. AU is a comfortable number two. KU and AU are leaders with respect to the number of bachelor students.

Benchmarking within the Faculty

Based on the figures distributed by the Faculty of Science and Technology in November 2011, we have calculated the following table, which shows percentages accounted for by Department of Computer Science relative to the entire faculty and a subset of the faculty.

	Entire Faculty	PHYS, GEO, CHEM, MATH and CS
Permanent academic staff	4.2 %	14.9 %
Peer-reviewed publications in 2008-2010	8.1 %	18.4 %
Number of active PhD students in 2010	8.5 %	29.2 %
Number of PhD degrees awarded in 2010	15.6 %	32.1 %
New bachelor students admitted in 2010	18.8 %	32.6 %
External funding (including consultancy for ministries)	3.7 %	19.1 %

The first column shows that with only 4.2% of the permanent academic staff, our department has produced 8.1% of all peer-reviewed publications, supervised 8.5% of all PhD students, produced 15.6% of all PhD degrees, admitted 18.8% of all new bachelor students, and received 3.7% of all external funding.

The second column gives the figures when we compare with those five departments which come from the old Faculty of Science and have not been significantly extended with new groups.

5. Strategic Goals

The department's strategy card can be seen on the next page. It gives an overview of:

- strategic goals,
- critical success factors,
- initiatives and projects to reach the strategic goals,
- quantitative goals to measure our progress,

Research	Strategic Goals	Critical Success Factors	Quantitative Goals	Initiatives and Projects to reach the Goals
<ul style="list-style-type: none"> Quality of research. 	<ul style="list-style-type: none"> Improve the department's high research level. 	<ul style="list-style-type: none"> Well-functioning research groups with high production (qualitatively and quantitatively). Secure a smooth generational hand-over by developing the associate professors. 	<ul style="list-style-type: none"> Increase the high number of peer-reviewed papers. At least 50% of the permanent staff increases their H-index by 5 or more. 	<ul style="list-style-type: none"> Maintain an employment politics where we only hire the best for permanent positions. Increase the competition for academic positions. Use the yearly staff development talks to improve the publication strategy of the individuals. Maintain a high administrative service level, so that the academic staff can concentrate on core business.
<ul style="list-style-type: none"> Interdisciplinary research. 	<ul style="list-style-type: none"> Maintain the high interdisciplinary cooperation. 	<ul style="list-style-type: none"> Well-functioning research groups with high external and internal cooperation. 	<ul style="list-style-type: none"> At least 50% of new associate or full professors shall be from areas outside the core competences of the present staff. 	<ul style="list-style-type: none"> Our recruitment plan prioritises hirings in areas outside or on the border of the competences of the present staff.
<ul style="list-style-type: none"> Impact and leadership in international and national research. 	<ul style="list-style-type: none"> Improve the department's high international reputation and secure our position as the best Danish CS department. 	<ul style="list-style-type: none"> Well-functioning research groups with international strength and good working conditions. 	<ul style="list-style-type: none"> Increase the number of papers in top conferences and journals. 75 % of all research group leaders shall have taken one or more courses on academic leadership. 	<ul style="list-style-type: none"> Define lists of top conferences and journals to focus on the importance of publishing at prestigious places. Use the yearly staff development talks to improve the publication strategy of the individuals. Encourage participation in courses on academic leadership. Make academic leadership more visible.
Talent Development				
<ul style="list-style-type: none"> Quality of PhD education. 	<ul style="list-style-type: none"> Improve the quality of PhDs. 	<ul style="list-style-type: none"> Produce PhDs who are attractive for a broad range of employments. 	<ul style="list-style-type: none"> Secure a low unemployment rate for our PhDs. 	<ul style="list-style-type: none"> Maintain high admission requirements. Improve the supervision of PhD students.
<ul style="list-style-type: none"> Recruit the best talents from home and abroad. 	<ul style="list-style-type: none"> Maintain the high number of PhD students and increase the diversity. 	<ul style="list-style-type: none"> Produce sufficient PhDs to meet the high demands of the IT industry, research institutions and universities. 	<ul style="list-style-type: none"> Maintain the number of PhD students. Increase the number of PhD students from other universities. 	<ul style="list-style-type: none"> Establish a number of elite master's programmes in English to attract more foreign students.
<ul style="list-style-type: none"> Establish clear and coherent carrier tracks. 	<ul style="list-style-type: none"> Significantly improve our ability to attract and hold on to the best young talents. 	<ul style="list-style-type: none"> Increase the diversity of the academic staff. 	<ul style="list-style-type: none"> At least 50% of new permanent academic staff comes from other universities. At least 25% of new permanent academic staff are women. 	<ul style="list-style-type: none"> Establish a pool of postdoc and assistant professor positions. Specify criteria to evaluate candidates for associate professorships. Increase our focus on recruitment of foreigners and women. Establish a tenure-track system.
Interaction with Society				
<ul style="list-style-type: none"> Innovation, cooperation and exchange of knowledge with industry. 	<ul style="list-style-type: none"> Maintain the high number of research projects with industrial partners. 	<ul style="list-style-type: none"> Our research shall contribute to growth and added welfare in the society. 	<ul style="list-style-type: none"> Maintain the high number of projects with active participation from private companies or public institutions. 	<ul style="list-style-type: none"> Offer active and highly-qualified matchmaking. Encourage PhD students and postdocs to follow courses on entrepreneurship.
Education				
<ul style="list-style-type: none"> Number of students. 	<ul style="list-style-type: none"> Maintain the high intake of students on our educations. 	<ul style="list-style-type: none"> Produce sufficient candidates to meet the high demands of the IT industry. 	<ul style="list-style-type: none"> At least 200 new bachelor students per year. At least 25 STÅ (study years) within part-time supplementary education. 	<ul style="list-style-type: none"> Continue the many PR and recruitment activities. Improve the visibility of our part-time supplementary education.
<ul style="list-style-type: none"> Quality of education. 	<ul style="list-style-type: none"> Improve the success rate of bachelor students. 	<ul style="list-style-type: none"> Produce sufficient candidates to meet the high demands of the IT industry. 	<ul style="list-style-type: none"> A higher percentage of the enrolled bachelor students earn a degree. 	<ul style="list-style-type: none"> Revise the Computer Science educations. Introduce and experiment with enrolment interviews. Exploit the potential of having two study managers. Continue to offer a high-quality study support system.
<ul style="list-style-type: none"> Study environment. 	<ul style="list-style-type: none"> Improve the physical and psychological study environment. 	<ul style="list-style-type: none"> Offer the best possible conditions to our students 	<ul style="list-style-type: none"> Improved scores in the evaluation of the physical and psychological study environment 	<ul style="list-style-type: none"> Continue and extend our study process interviews. Maintain and develop good student facilities, where all students have optimal conditions. Continue our support of and cooperation with the student associations.

Goals in more Detail

This subsection contains a more detailed description of the strategic goals, critical success factors, and quantitative goals from the strategy card.

Research

As indicated by the benchmarking results the department performs excellently with respect to research. We are highly productive, well-known internationally and considered to be the best Danish IT department. The main challenge is to extend the permanent academic staff from 25 to 35 persons. We want to increase the diversity of the staff by hiring more people from other universities and more women. We only want to hire top quality persons and hence the expansion must happen over a long period of years. We also want to develop the persons in the present staff – in particular the associate professors so that some of these reach the level of full professors. Finally, we want to stress the importance of academic leadership and make good leaders more visible. For research we have defined the following quantitative goals:

- 1) Increase the number of peer-reviewed papers. The PURE registrations (for the entire staff including postdocs and PhD students) in 2008, 2009 and 2010 are 159, 159 and 152 (excluding the Bioinformatics research group).
- 2) At least 50% of the members of the permanent staff shall increase their H-index by 5 or more (measured by means of Harzing's Publish or Perish / Google scholar My Citations).
- 3) At least 50% of the researchers in new permanent associate or full professorships shall be from research areas which are outside the core competences of the present staff. This is a continuation of a hiring strategy which was established with our strategic plan for 2008-2012.
- 4) Increase the total number of papers in top journals and conferences. Each of the research groups identifies the 10 most important publication venues in their area (e.g. 4 top journals and 6 top conferences). This is a way to measure the extent to which we are able to publish in the most prestigious places. The number of Top-10 publications from the permanent academic staff in 2008, 2009 and 2010 are 26, 24 and 36 (without doublets).
- 5) 75 % of all research group leaders shall have taken one or more courses on academic leadership.

Talent Development

As indicated by the benchmarking results the department has a rather high number of PhD students per person in the permanent academic staff. The main challenge in this area is to increase the number of PhD students from other universities and in particular from other countries. We also think that there is room for improving the supervision of our PhD students. Finally, we want to establish clear and coherent career tracks for postdocs and assistant professors. This will improve our possibilities to attract the best young talents to become candidates for our permanent positions. For talent development we have the following quantitative goals:

- 6) Secure a low unemployment rate for our PhDs. More than half of our PhD students find jobs in the IT-industry. It is important for us to continue to be able to produce PhDs who are attractive both for the industry and for universities and research institutions.
- 7) Maintain the high number of PhD students. In October 2011 we had 65 PhD students.
- 8) Increase of the number of PhD students from other universities. In October 2011 we had 17 PhD students from abroad and 4 from other Danish universities.
- 9) At least 50% of the researchers in new permanent associate or full professorships shall come from other universities.
- 10) At least 25% of the researchers in new permanent associate or full professorships shall be women.

Interaction with Society

The department has a long and solid tradition for interaction and knowledge exchange with private companies and public institutions. Over the last thirty years there have been numerous research projects with external participants. In this way our research has been made available to the Danish and international society. There have been approximately 15 spin-off companies (including Mjølner, Cryptomathic, Cetrea and the Alexandra Institute) and a number of patent applications. We want to maintain the high level of interaction with private companies and public institutions. It produces a lot of interesting research themes ranging from smaller problems which can be tackled with innovative use of existing knowledge to more challenging problems which require long term basic research. For interaction with society we have the following quantitative goal:

- 11) Maintain the number of projects with active participation from private companies or public institutions. By active participation we mean that the company/institution either sponsors part of the project or has employees who work in the project. Participation in reference groups etc. is not sufficient to count. In October 2011 we had 17 projects with active participation from private companies or public institutions.

Education

The department has two bachelor programmes and two master's programmes. We also have a diploma and master's programmes within part-time supplementary education. This means that the teaching load on the academic staff is high, and hence we have no plans to extend the number of educations. Nearly 20% of all new bachelors at the faculty enrol at our department. The main challenge in this area is to increase the percentage of bachelors who obtain a degree. This has been on the agenda for many years (both at the faculty level and at the department level). But unfortunately, it has turned out to be quite difficult to achieve. For educations we have the following quantitative goals:

- 12) At least 200 new bachelor students each year. Until 2005 we had a stable intake of 100 bachelor students per year. Due to a new bachelor programme and active recruitment this number has increased to more than 200. We want to maintain this high level.
- 13) At least 25 STÅ (study years) per year on our part-time supplementary educations. In 2010 we produced 30 STÅ within this kind of education. However, due to the financial crisis the private companies are now more reluctant to use time and money on further education of their staffs. This can be seen in the number of enrolments for courses in 2011.
- 14) A higher percentage of the enrolled bachelors earn a bachelor degree at the department within 4 years of study time.
- 15) Improved scores in the evaluation of the physical and psychological study environment.

6. Initiatives and Projects to achieve the Strategic Goals

This subsection contains a more detailed description of the initiatives and projects from the strategy card.

Research

- 1) We want to maintain an employment politics where we only hire the best for permanent academic positions. Short term capacity problems shall be handled by hiring non-permanent staff.
- 2) We want to increase the competition for academic positions. In this way we will get a better and more diverse staff.
- 3) We will use the yearly staff development talks (MUS) to improve the publication strategy of the individual staff members.
- 4) We will use departmental resources to maintain a high administrative service level, so that the academic staff can concentrate on research, talent development, interaction with society and education.
- 5) Our recruitment plan for permanent academic positions (in Sect. 6) gives priority to hirings in areas which are outside or on the border of the competences of the present staff.
- 6) Each of our research groups has identified the 10 most important publication venues in their area (e.g. 4 top journals and 6 top conferences). This list will be used as one way to measure the scientific production of the group and its individuals. This will put added focus on the importance to publish in the most prestigious places.
- 7) We will actively encourage potential leaders to participate in courses on academic leadership. When necessary the department will pay (fully or partly) for such courses.
- 8) We will make academic leadership more visible, e.g. through discussions at the yearly staff development talks (MUS).

Talent Development

- 9) Maintain the high admission requirements so that we only get PhD students of high quality.
- 10) Improve the supervision of PhD students, e.g., via supervision courses and use of peer-supervision. There are many different ways to supervise PhD students. We want to put more focus on this area and to accumulate best-practices to be shared among the supervisors.
- 11) We want to establish a number of elite master's programmes in English to attract more foreign students. The new programmes will be recommended routes through the existing master's programmes with focus on a particular subject, e.g., data bases. This will seldom require additional courses, since all master's programme courses are taught in English when there are participants who do not speak Danish. The new programmes are seen as an effective way to increase the number of PhD students coming from other universities.
- 12) We want to establish a pool of postdocs and assistant professor positions at the department. The pool can be used to attract more foreigners – also in areas where there for some reason is limited project funding. The pool can also be used to support promising local students for short periods – until they can find a suitable postdoc position elsewhere or until they can apply for a permanent position. Finally, the pool can be used to solve some of the acute teaching resource problems caused by having a permanent academic staff which is small compared to the teaching load.

- 13) We are specifying a set of criteria to evaluate candidates for permanent associate professorships. The criteria can be used to evaluate whether a position shall be opened for a particular candidate (in competition with others). They can also be used as guidance for external members of evaluation committees. Finally, they can be used by young researchers, who want to evaluate their own chances for obtaining a permanent associate professorship. A first version of the criteria can be found in Appendix B.
- 14) We will increase our focus on recruiting more foreigners and more women to PhD, postdoc and assistant professor positions. In this way we will increase the diversity of our temporary academic staff and eventually also of our permanent academic staff.
- 15) Together with the faculty we want to establish a tenure-track system which will be attractive for young researchers. This is expected to make it easier for us to attract top quality young foreign researchers.

Interaction with Society

- 16) Offer active and qualified matchmaking – in particular via the Alexandra Institute.
- 17) Encourage PhD students and postdocs to follow courses on entrepreneurship. There is a number of existing courses available within AU. If adequate these can be complemented by courses at the department.

Education

- 18) The department participates in more than 20 different kinds of PR and recruitment activities each year. Some of these are organised by the faculty while others are organised together with other partners. We want to continue the focus on this area, since we believe that this is one of the reasons for our high number of bachelor enrolments. To avoid overloading of the permanent academic staff, the PR activities are planned in such a way that they use, as far as possible, master's degree students, PhD students and postdocs.
- 19) We will improve the visibility of our part-time supplementary education. The goal is to recruit more students among our alumni and among other IT professionals.
- 20) We will start discussions on how to revise and improve the Computer Science bachelor and master educations. One source of inspiration will be some of the positive experiences from the IT bachelor and master educations.
- 21) We will try to develop a more efficient way to evaluate and guide students enrolling for bachelor studies. It seems attractive to experiment with different forms of enrolment interviews as recently proposed by the government.
- 22) The department will continue to have two study managers (of which one now refers to the AU study administration). The study managers make it possible for us to maintain close contact to our students – despite the large student/teacher ratio (we have nearly 1,000 students and only 30 teachers).
- 23) Over the last five years, the department has developed an excellent study support system known as CourseAdmin. We acknowledge the need of having a common system for AU, but we will expect the system to be open so that we can make add-ons with adequate features from CourseAdmin and in this way maintain the high quality which we have today, and which is highly appreciated by our students.
- 24) One year ago, we introduced study process interviews for first year students, and this has turned out to be useful – for students and the department. We will continue the development of these interviews and we will also consider extending them to other groups of students.
- 25) With the opening of the third phase of the IT-Park, we have obtained an excellent physical environment for our students closely integrated with the rest of the department. We will maintain and further develop the student facilities, so that students at all levels have optimal conditions for their work.
- 26) The department has active student associations (DSAU for the Computer Science students and SOFA for the IT students). In addition to this, there is an active student association UNITY that bridges all students at Katrinebjerg. We will continue the active cooperation with the student associations and support them as much as possible. They constitute an invaluable part of establishing a good study environment.

Recruitment Plan

The department covers many fundamental areas of Computer Science. However, our field is very broad and there are clearly important areas where we do not have real expertise, such as VLSI Design, Artificial Intelligence, Robotics and Operating Systems. Also, the areas we cover have changed over the years, reflecting both changes in the field and the flux of permanent staff. We have no ambition of covering all areas, but will adjust the profile of our research groups according to the current opportunities and strategic considerations.

The evident shortage of permanent academic staff at the full and associate professor levels is a serious bottleneck for further expansion of our activities. The department has a much smaller percentage of permanent academic staff than other comparable departments within Denmark and abroad, as evident from the benchmarking section. This means that the permanent academic staff uses a substantial part of their time for project applications, project administration, and project leadership. This obviously decreases the incitement and possibilities to start new projects. Hence, the department proposes to increase the permanent academic staff from the present 25 people to 35 people by 2022. To reach this goal the staff must be extended with an average of one person per year. During the last 20 years we have lost 20 associate professors to other universities. We expect this trend to continue, and hence we need to hire two new persons per year to get a net growth of one person per year. As specified in the strategic goals, we will use an active hiring strategy that aims to increase the number of staff members coming from other universities and to attract more female applicants.

Research Groups

This subsection provides a summary of the current strength and prospects of the department's research groups. A more detailed description of the individual groups can be found in Appendix A and on the web pages: cs.au.dk/research/areas/.

We have four theory groups: Algorithms and Data Structures, Data-Intensive Systems, Cryptography and Security and Mathematical Computer Science. These groups are at present very strong, with numerous larger grants including two Danish National Research Foundation centres and a substantial number of postdocs and PhD students. Also, the groups have a significant synergy, with joint research projects and joint publications. The department recognises a large potential in the strengthening and expansion of these groups.

Until recently, we had a large group in Human-Computer Interaction (HCI), which has now been split into three independent groups: Ubiquitous Computing and Interaction, Computer-Mediated Activity and Use, Design and Innovation. The division reflects gradual divergences in research focus and internal collaborations, but at the same time significant potentials for continued synergy exist. The largest of these groups is the Ubiquitous Computing and Interaction group, which has a number of significant research grants, a solid publication record and shows a good potential for expansion. The Computer-Mediated Activity group has a good track record, but is currently in need of new funding and additional staffing. The Use, Design and Innovation group has several research and innovation grants and a very strong track record of partnerships with public and private enterprises. The group, however, needs additional staffing and, preferably, increased funding.

The Programming Languages group has a solid publication record and has created a significant impact with modest means. Recently, a more expansive strategy has attracted several larger research grants and a significant influx of PhD students. This gives potential for further growths.

The newly formed Computer Graphics and Image Processing group has an associate professor and an assistant professor. It is a strategic goal of the department to expand this group as fast as first-rate talent can be recruited.

The Bioinformatics group is part of the Bioinformatics Research Centre (BiRC) which is independent of the department. The group's two associate professors are affiliated with the department. The Bioinformatics Research Centre has its own strategic plan and hence our recruitment plan does not incorporate positions in Bioinformatics.

New Positions

In the 5-year time frame of this strategic plan the department has proposals for 15 positions. Only some will be posted, and not all of these can be expected to be filled. With the expected attrition of the existing staff, this points to a net growth of approximately 5 permanent staff members. If the actual net growth turns out to be significantly larger, the plan should be reconsidered.

Based on the above evaluations of the research groups, an initial distribution of positions can be outlined. We seek a significant expansion of the theory groups with 6 new positions on top of the existing 9. The HCI groups should be expanded with 3 new positions on top of the existing 7, one in Ubiquitous Computing and Interaction and the remaining two in the broader area of Human-Computer Interaction, scanning the market for opportunities. The Programming Languages group will be boosted with at least one position on top of the existing 4, to maintain its recent momentum. For the Computer Graphics and Image Processing group we seek an expansion of 2 new positions on top of its existing single position in order for it to reach a viable size. Most of the above positions are expected to be filled with researchers who are between existing groups or at the border of existing groups.

Finally, a few positions are reserved for strategic adjustment of our research profile. We seek a position within Software Engineering, Multicore or Systems that can collaborate with some of the theory groups, Programming Languages and Ubiquitous Computing and Interaction. Similarly, a position in Machine Learning or Data Mining will be sought for collaboration with some of the theory groups and some of the HCI groups. Also, a position in Quantum Informatics is sought to enable collaborations between Cryptography and Security and the physics department, but this probably requires headhunting of an ideal candidate. A staff member filling one of the strategic positions described above can initially be associated with any of the relevant research groups, but eventually an independent research group can be formed.

All candidates that are considered for job interviews will be discussed in the department's research committee and no candidate will be further promoted against significant objections. Appendix B offers a generic description of a suitable candidate for a permanent position, which can be used to structure such evaluations.

Timeline for New Positions

A rough timeline for the announcements of the proposed positions is indicated below. Typically, the hiring process may take up to one year.

- Algorithms and Data Structures* 2012
- Data-Intensive Systems* 2012
- Ubiquitous Computing and Interaction 2012
- Programming Languages 2012
- Human-Computer Interaction 2013
- Machine Learning / Data Mining 2013
- Algorithms and Data Structures* 2014
- Cryptography and Security 2014
- Mathematical Computer Science 2014
- Computer Graphics and Image Processing 2014
- Computer Graphics and Image Processing 2015
- Software Engineering / Multicore / Systems 2015
- Theoretical Computer Science 2016
- Human-Computer Interaction 2016
- Quantum Informatics 2016

Deviations can always be suggested based on concrete opportunities or tactical considerations. It may also be desirable to add new positions if new opportunities emerge or existing permanent staff is lost. The three positions marked with an asterisk are part of contracts with the Danish National Research Foundation or start packages with new employees.

Most of the positions will be associate professorships, while one or two may be full professorships if the right persons are found. Some of the positions may be initiated as tenure-track positions or assistant professorships if this turns out to offer the best opportunities. The Algorithms and Data Structures position in 2012 has already been filled with an assistant professor.

As described above, we have firm principles for filling the positions, to ensure that we at the end of the planned period have found and hired the best possible candidates. Also, it can be expected that not all of the listed positions will in fact be filled during the time frame of this strategic plan.

It is always possible to pool position in order to survey the market and attract the most qualified persons. As an example, the Programming Languages position could be pooled with the Software Engineering position to look for candidates in the larger, combined area. If a pooled position reveals extraordinary candidates in two areas, we are prepared to (but certainly not required to) hire both. Pooling is expected to happen to a large extent, in particular among the HCI groups and among the theory groups.

Experimental Research Infrastructure

As mentioned at the end of Sect. 3, the department has a few physical research labs with advanced equipment. In order to ensure that these and our other experimental research infrastructure remain operational, we need assistance from highly skilled technical personnel with special knowledge. Until recently, such assistance was provided by the department's IT staff. Due to recent reorganisations, the IT staff was moved to NFIT and later to AU-IT. This renders it difficult for us to get the necessary technical assistance. We will discuss the problems with AU-IT and will try to reach an agreement that allows us to continue to use select members of the AU-IT staff to assist our projects and physical research labs.

There is also a need for student programmers to support our work with experimental research prototypes. The student programmers are our laboratory technicians. By tradition, they are often paid by external funding, but it is desirable that the department has sufficient resources to pay for a number of student programmers, e.g., to enable valuable prototypes to survive between and after the completion of externally funded projects. This

may also enable the research groups to transfer their prototypes into more robust systems, frameworks, and libraries that can be used for teaching purposes and further research.

Financing of the Action Plan

Most of initiatives and projects described above can be covered within the ordinary budget of the department. The two exceptions are:

- Extension of the permanent academic staff from 25 in 2012 to 35 in 2022.
- Establishment of a pool of postdoc and assistant professor positions at the department. The pool can be used to attract more foreigners – also in areas where there for some reason is limited project funding. The pool can also be used to support promising local students for short periods – until they can find a suitable postdoc position elsewhere or until they can apply for a permanent position. Finally, the pool can be used to solve some of the acute teaching resource problems caused by having a permanent academic staff which is small compared to the teaching load.

The expenses for these two items must be covered by the faculty. It should be noted that the pool of postdoc and assistant professor positions is supposed to replace a large number of individual funding agreements between the department and the faculty. Over the last 10-15 years the departments has had an average of around 2.0 MDKK per year in such funding covering (parts of) the salary of different young people. We do not propose a growth in these expenses, but the use of the money should be decided at the department without detailed negotiations with the faculty in each individual case.

Appendix A: Research Groups

This appendix describes the research groups at the department. Each description consists of a number of quantitative measures (size of permanent staff, peer-reviewed publications, citations, teaching/supervision, and external funding). This is followed by qualitative descriptions of the current status and prospects for further development.

The research groups are dynamic and change over time. For the moment there are the following groups:

- Algorithms and Data Structures.
- Data-Intensive Systems.
- Cryptography and Security.
- Mathematical Computer Science
- Ubiquitous Computing and Interaction.
- Computer-Mediated Activity.
- Use, Design and Innovation.
- Programming Languages.
- Computer Graphics and Image Processing.
- Bioinformatics.

The research group in bioinformatics is part of the Bioinformatics Research Centre (BiRC) which is an independent centre within our faculty. The group has a permanent academic staff consisting of two associate professors. One of them is employed at our department, while the other is employed directly at BiRC.

More detailed descriptions of the activities in the individual research groups can be found on:

cs.au.dk/research/areas/.

The quantitative data are calculated in October 2011. H-indexes are updated in January 2012.

- **Academic Staff** describes the actual staff in Oct 2011.
- All data for **Peer-reviewed Publications** are calculated by means of DBLP.
 - **Total** describes the total number of peer-reviewed publications published by those persons who are listed as permanent members of the academic staff. Publications by temporary members and by PhD students are not counted (unless they are co-authored by members of the academic staff). If two members of the permanent staff co-author a paper it is counted twice (for simplicity).
 - **2006-11** only deals with papers published in the period from Jan 2006 to Oct 2011. Otherwise, they are calculated by the same rules as the total number of papers.
 - **2006-11 Top-10** only deals with papers published in the 10 most important publication venues of the research area (e.g. 4 top journals and 6 top conferences) from Jan 2006 to Oct 2011. Otherwise, they are calculated by the same rules as the total number of papers.
- All data for **Citations** are calculated by means of Harzing's Publish or Perish / Google scholar My Citations.
 - **Total** is the total number of citations to publications published by those persons who are listed as permanent members of the academic staff. Citations to publications by temporary members and by PhD students are not counted (unless they are co-authored by members of the academic staff). If two members of the permanent staff co-author a paper citations to that paper is counted twice (for simplicity).
 - **2006-11** only deals with citations to papers published in the period from Jan 2006 to Oct 2011. Otherwise, they are calculated by the same rules as the total number of citations.
 - **H-indexes** are calculated for the individual members of the permanent academic staff.
- **PhD, Master's Thesis and STÅ Production** describes the group's contribution to the educational activities at the department.
 - **PhDs 2006-11** describes the number of PhDs who have finished from Jan 2006 to Oct 2011 with a supervisor from the group.
 - **MTs 2006-11** describes the number of Master's Thesis students who have finished from Jan 2006 to Oct 2011 with a supervisor from the group.
 - **STÅ 2010-11** is the number of full-time- study years earned on courses taught by members of the group in the academic year from August 2010 to July 2011.
- **External Funding** describes the amount of money spent at the department without overhead. Money spent by other project partners is not included.

Algorithms and Data Structures

Academic Staff

Permanent: Lars Arge, Gerth Stølting Brodal
Temporary: Constantinos Tsirogiannis, Lap-Kei Lee, Qin Zhan, Wei Yu, Elad Verbin,
Cicimol Alexander, Brody Sandel
PhD students: 11

Peer-reviewed Publications (Permanent Staff)

Total: 177
2006-11: 62
2006-11 Top-10: 23

Citations (Permanent Staff)

Total: 4,895
2006-11: 543
H-indexes: 33, 25

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 7
MTs 2006-11: 20
STÅ 2010-11: 27

External Funding (Spent)

2006-11: 26.9 MDKK
2010-11: 10.7 MDKK

Status

The group works on algorithms and data structures for fundamental problems in classical computational models, as well as in newer models that take the hierarchical memory of modern machines into account. It also has a focus on algorithm engineering. The group hosts the Danish National Research Foundation (Danmarks Grundforskningsfond) center of excellence named Center for Massive Data Algorithmics (MADALGO), which was recently extended for a second 5 year period after an international review that concluded that the center is world-leading in the area of massive dataset algorithmics. The group has received a number of prestigious research awards and acknowledgments recently, including an EliteForsk award and elections into the Royal Danish Academy of Science and Letters and into the Danish Academy of Technical Sciences. Group members also regularly receive invitations to speak at international conferences, summer schools and seminars. Finally, the group's permanent staff delivers substantial service to the scientific community, including participation in the editorial boards of 5 international journals and in numerous program committees, just as they have served as chairs of 4 international conferences (ICALP, ESA, SWAT, ALENEX) in the last 5 years.

Prospects

A generation change took place in the group around 10 years ago, and the new group has focused on research excellence while also trying to build interdisciplinary, multidisciplinary and industry collaboration. This has resulted in a group that is highly productive with strong international research cooperation. It is well-funded with a large number of postdocs and PhD students, and it collaborates closely with the Data-Intensive Systems group (through MADALGO), the Mathematical Computer Science and Cryptography and Security groups (through CTIC), and has strong multidisciplinary collaborations with biological and environmental researchers, e.g. through joint postdocs and PhD students. It also has a good cooperation with the industry (e.g. through the spin-off company SCALGO). The goal of the group is to maintain its high international standing within algorithms and data structures in general and in massive data algorithmics in particular. Until now the group's focus on excellence has resulted in a careful hiring strategy and the group has not hired permanent staff since 2004. Thus despite a high funding level and a large number of postdocs and students, the group only has two permanent staff. The group has good potential for additional expansion, but additional permanent staff is needed to realize this potential. The international MADALGO evaluation also concluded that expansion is needed to maintain the high productivity. Consequently, the recent MADALGO contract specifies that two additional permanent staff should be hired, and the group finds that it is important to maintain the focus on excellence in these hires (e.g. through the use of "tenure-track" hires). Hiring in related fields such as data-intensive systems, mathematical computer science or machine learning could also be useful for the group.

Data-Intensive Systems

Academic Staff

Permanent: Christian S. Jensen, Ira Assent
Temporary: Xuan-Hong Dang, Matteo Magnani, Bin Yang
PhD students: 7

Peer-reviewed Publications (Permanent Staff)

Total: 241
2006-11: 131
2006-11 Top-10: 53

Citations (Permanent Staff)

Total: 10,758
2006-11: 1,488
H-indexes: 50, 12

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 10
MTs 2006-11: 1
STÅ 2010-11: 12

External Funding (Spent)

2006-11: 0.3 MDKK
2010-11: 0.3 MDKK

Status

Data management is an important aspect of many or most real-world information systems, and the global data management research community is quite large, as evidenced by, e.g., many and large conferences. The research group adopts a systems-oriented approach and covers the general areas of database management and data-intensive systems. Important specific research topics and strengths include temporal, spatial, and spatio-temporal data management, as well as clustering, outlier detection, classification and similarity search. Within its topics, the group's research focuses on the invention and empirical evaluation of algorithms and indexing techniques that enable the efficient and effective processing of query and update workloads. The group delivers substantial service to the scientific community, including Editor-in-Chief, VLDB Journal; Associate Editor, ACM TODS; PC Chair, ICDE 2013, APWeb 2012, ACM SIGSPATIAL GIS 2011, TIME 2008, and MDM 2007; and keynote lectures at 7 conferences since 2006.

Prospects

Established in August 2010, the group has grown from two members to its current size of about 15 members during a short period of time. This growth was enabled primarily by four substantial, external grants that were acquired during the group's first year. Based on past performance, it is our assessment that the group has the potential to be among the top groups in Europe in terms of publications in top outlets and also has the potential to attract additional funding. However, to be competitive internationally, to be able to accommodate additional funding and to achieve a robust research environment, additional staff is needed. In the coming period, the group aims to hire two university-funded assistant professors and one associate professor. Should it not be possible to hire assistant professors due to administrative barriers, the group is interested in hiring two associate professors. The group needs to consolidate itself before branching into new research topics. Synergies with the Algorithms and Data Structures group will be pursued in the MADALGO center that the group will join in 2012. There may also be collaboration opportunities with the Ubiquitous Computing and Interaction group in relation to, e.g., geo-positioning and geographical data management.

Cryptography and Security

Academic Staff

Permanent: Ivan Damgård, Jesper Buus Nielsen
Temporary: Carmit Hazay, Tomas Toft, Sebastian Faust
PhD students: 9

Peer-reviewed Publications (Permanent Staff)

Total: 135
2006-11: 50
2006-11 Top-10: 23

Citations (Permanent Staff)

Total: 9,220
2006-11: 1,647
H-indexes: 42, 18

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 12
MTs 2006-11: 34
STÅ 2010-11: 27

External Funding (Spent)

2006-11: 22.6 MDKK
2010-11: 9.3 MDKK

Status

Cryptography and Security is an important discipline at any computer science department and it has been strong in Aarhus for many years. The current research group focuses on public-key cryptography, cryptographic protocols and quantum cryptography. In particular, the theory and practice of secure multiparty computation is an important focus area, which also internationally is an extremely "hot" research area. In 2009, the group was behind the first ever large-scale application of multiparty computation in practice. Members of the group have received several prestigious awards and grants since 2006, including Fellow of the IACR (ID), member of steering committee for the TCC conference (ID), large center grant (CFEM) from the Strategic Research council (ID) and grants from Sapere Aude and ERC (JBN).

Prospects

The group was quite small until about 5 years ago. Since then a number of grants have allowed us to expand and in particular we have tried to attain critical mass in our postdoc population, this has been quite successful over the last 2 years, and recent new grants give us a financial basis for maintaining and expanding our activities. We would like to build a better collaboration with the groups in complexity, algorithms and databases, which is very natural given the complexity-based foundations that much crypto is built on, and we would also like to keep our collaboration with the Physics Department on Quantum Information alive. We believe that the Aarhus Crypto group is one of the top-3 cryptography groups in Europe, and that expanding collaboration as mentioned will enable us to eventually be number 1. The risk is that with the current staff, the workload of grant management combined with teaching and supervision will prevent us from following this strategy. We would very much welcome new staff in the border area between Cryptography and Complexity and in the area of Quantum Information.

Mathematical Computer Science

Academic Staff

Permanent: Peter Bro Miltersen, Kristoffer Arnsfelt Hansen, Gudmund Skovbjerg Frandsen
Temporary: Elias Tsigaridas, Elad Verbin, Dominik Scheder, Wei Yu, Joshua Brody, Jie Zhang.
PhD students: 5

Peer-reviewed Publications (Permanent Staff)

Total: 140
2006-11: 59
2006-11 Top-10: 5

Citations (Permanent Staff)

Total: 1,964
2006-11: 267
H-indexes: 24, 6, 9

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 5
MTs 2006-11: 7
STÅ 2010-11: 30

External Funding (Spent)

2006-11: 7.8 MDKK
2010-11: 3.0 MDKK

Status

The Mathematical Computer Science group aims to cover "US-style" computer science theory (as opposed to "Euro-style" theoretical computer science, that is, with a stronger emphasis on quantitative aspects of computation than on logic and formal methods), in collaboration with the Cryptography group and the Algorithms and Data Structures group as these areas are also part of "US-style theory". The current research in the group can be roughly divided into four somewhat overlapping areas: 1. Computational Complexity Theory, 2. Combinatorial Optimization, 3. Algorithmic Game Theory and Mechanism design and 4. Algebraic Algorithms. The group leader is chair of the steering committee of the IEEE Conference on Computational Complexity and members of the group received best paper awards at STOC'11, the top theory conference and ISSAC'10 the top conference on symbolic and algebraic computation. The group is involved in two major projects, both in collaboration with the Cryptography group: CFEM, Center for the Foundations of Electronic Markets, and CTIC, Center for the Theory of Interactive Computation. The latter project is led by the group leader. In addition, the group has strong connections to and research collaborations with the Department of Mathematics (Algebra and Mathematical Programming groups); a connection that has previously received joint funding.

Prospects

The group aims at making Aarhus the best spot in Europe for "US-style Computer Science Theory". This goal is ambitious but not unrealistic (at least not if one excludes Israel as "Europe"), with the help of the Cryptography and Algorithms groups. With the present groups of postdocs and PhD students which are both very strong, with overlapping interests and "of critical mass" and with the activities that are being held by CTIC and CFEM we believe we are arguably achieving this goal already transiently. In particular, our current expertise on information theoretical complexity theory is extremely strong. The difficult challenge is to maintain such a position. In terms of expansion, the group seeks only to achieve this aim. An important resource for maintaining the expertise could be flexible "tenure track" style positions which could help bridging the gap between postdoc positions (for which we have the funding we need) and associate professorships.

Ubiquitous Computing and Interaction

Academic Staff

Permanent: Kaj Grøn­bæk, Niels Olof Bouvin, Marianne Graves Petersen
Temporary: Mikkel Baun Kjærgaard, Henrik Blunck, Mads Darø Kristensen
PhD students: 4

Peer-reviewed Publications (Permanent Staff)

Total: 192
2006-11: 65
2006-11 Top-10: 18

Citations (Permanent Staff)

Total: 3,917
2006-11: 450
H-indexes: 31, 12, 11

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 8
MTs 2006-11: 26
STÅ 2010-11: 54

External Funding (Spent)

2006-11: 16.2 MDKK
2010-11: 5.0 MDKK

Status

Ubiquitous Computing and Interaction is a core area of modern computer science departments, and it has emerged as a research area in Aarhus over the past 10 years. The research group currently focuses on three main research areas: 1) Mobile Computing including Mobile Hypermedia and Peer-2-Peer; 2) Positioning and Context Awareness; 3) Interaction Design for Ubiquitous Computing including theoretical foundations, design methods and emerging interaction technologies. The group has within a short time frame achieved international recognition for their work in the three sub-areas including several paper and design awards as well as keynote speeches. The Center for Interactive Spaces, embracing major parts of the group's work, has also made a significant impact on knowledge transfer to the Danish society in terms of industry collaboration and product spin-offs. The UBI group has recently conducted two prestigious Danish National High Technology Foundation (DANATF) projects with extensive industry involvement. The UBI group contributes with international academic services in premier venues, including recent examples: Programme Chair ACM Hypertext 2011 (KG), Program Co-Chair for ACM DIS 2010 (MGP), Conference Co-Chair ECSCW 2011 (NOB).

Prospects

The UBI group is an offspring of the former HCI group with a short independent history. The group has a strong focus on the development of the basic models, methods and technologies within the UBI sub-areas. Previous top venues in Hypermedia/Web have become secondary. There is a strong expansive momentum in the sub-area of positioning and context-awareness represented mainly by the work of the postdocs that grew out of the DANATF Galileo project. The group expects to fill a permanent position within this sub-area as already indicated in the recent strategy plan. The UBI group has an ambition over the next 5 years to be established among the renowned international groups in the field, supported e.g. by the new DSF EcoSense Grant. The UBI group is central in both development and teaching of the new ICT educations, implying a large teaching load. Thus we also see a need for new positions to develop a more extensive programme of research-based teaching for responsible for new ICT educations. Hirings in the related fields of Computer Graphics, Datamining/Machine Learning, Software Engineering/Architecture would constitute a useful synergy with the UBI group.

Computer-Mediated Activity

Academic Staff

Permanent: Susanne Bødker, Olav Wedege Bertelsen
Temporary: Clemens Nylandsted Klokmose
PhD students: 3

Peer-reviewed Publications (Permanent Staff)

Total: 101
2006-11: 32
2006-11 Top-10: 8

Citations (Permanent Staff)

Total: 4,798
2006-11: 281
H-indexes: 33, 12

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 5
MTs 2006-11: 12
STÅ 2010-11: 28

External Funding (Spent)

2006-11: 5.9 MDKK
2010-11: 1.7 MDKK

Status

The research on Computer Mediated Activity dates back before the area of Human-Computer Interaction was established internationally, and the members of the group have contributed to the development of this area and the areas of Participatory Design and Computer Supported Cooperative Work since their start. We understand computers as mediators of human activity. Our focus is on the development of new interaction techniques, methods and theories for computer-mediated activities of work and everyday life. Human activity is mediated and cooperative and we are concerned with computer-mediated activities in a work setting as well as in public service, democracy and the private sphere. The group is concerned with the definition of use as collaborative and mediated by IT. We study the mechanisms that support human development and appropriation of IT. We work through a combination of empirical studies of computer-mediated activities, theoretical work, method development and experiments with interaction techniques and architectures. The CMA group has a tradition of prestigious service, including in recent years: paper chairs CHI and DIS, general chairs of ECSCW and NordiCHI, foundational members of steering committees of NordiCHI and ECSCW, associate editor of ToCHI and IJHCS.

Prospects

As part of the much bigger HCI group, the CMA group has been productive and produced first-rate publications and students. The group does extensive teaching on graduate Computer Science education, and contributes to the IT bachelor program and IT-Vest open program. It has extensive local, national and international collaboration regarding teaching, PhD exchange and research. The group has had good research funding over the past years. Currently most of this funding has ended and the group is looking for new funding and new PhD students and postdocs. It is, furthermore, essential that the group gets more permanent affiliation of younger researchers to which end the hiring of 1-2 younger assistant or associate professors would help. In particular we would like to see a position within Information Visualization and eScience, which we see as a particularly interesting computer mediated activity. Such a position has links to Data-Intensive Systems, and to CAVI. We would also like to strengthen research within eDemocracy, privacy and participation. This has relations to Cryptography and Security as well as to the Use, Design and Innovation, and Ubiquitous Computing and Interaction groups. With the two latter groups we have discussed the possibility of an open associate professorship in Human Computer Interaction so as to attract international applicants.

Use, Design and Innovation

Academic Staff

Permanent: Morten Kyng, Preben Holst Mogensen
Temporary: Erik Grönvall
PhD students: 4

Peer-reviewed Publications (Permanent Staff)

Total: 76
2006-11: 15
2006-11 Top-10: 6

Citations (Permanent Staff)

Total: 5,507
2006-11: 195
H-indexes: 26, 18

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 2
MTs 2006-11: 10
STÅ 2010-11: 11

External Funding (Spent)

2006-11: 26.3 MDKK
2010-11: 7.3 MDKK

Status

The group works with empirical and theoretical research in use, design and innovation processes. Our focus is on Participatory Design, and in this area the people in the group have played a major role in shaping the international research agenda, including appointment to the ACM CHI Academy for leadership in the field of computer-human interaction. Currently the group focuses on design methods for systems covering work places, public spaces and private homes. In this area the group contributes with conference papers and journal articles at major PD conferences and journals as well as with textbook chapters. Most of our research is accomplished through large projects, where users, companies and researchers cooperate on analyzing, designing, constructing and evaluating prototypes and use-processes. The group has a very strong track record of partnerships with public and private enterprises. This includes a prestigious EU Integrated Project on pervasive computing. Currently most of our projects are within the areas of emergency management and healthcare. Work in the latter area is conducted in the Centre for Pervasive Healthcare. This centre has made significant contributions to Danish health-it through focused cooperation with hospitals, national health-IT organizations and industry, as well as establishment of a top-100 start-up.

Prospects

Use, Design and Innovation has sprung out of the former HCI group. The HCI group played a major role in the development of Participatory Design from the early 1970s to the late 1990s. With the recent formation of the UDI group, we have re-established a strong position in empirical PD and are currently expanding our theoretical footprint – a course we want to continue. In addition to the general focus on processes for developing systems covering work places, public spaces and private homes, we want to work more with models for private/public innovation. Internationally, user involvement in innovation is now recognized as the most promising practical approach to radical innovation. Through continued partnerships with public and private enterprises, we want to increase our empirically based research contributions to a transformation of the way organizations innovate. The main vehicles for this are increased project-based cooperation and targeted courses at bachelor and master levels. This requires continued major funding and implies a need for expanding the group with a senior colleague. In addition competencies in Physical Computing and Software Architecture/Infrastructure would constitute very useful supplements.

Programming Languages

Academic Staff

Permanent: Michael Schwartzbach, Olivier Danvy, Anders Møller, Erik Ernst
Temporary: Jan Midtgaard, Peter Jönsson
PhD students: 9

Peer-reviewed Publications (Permanent Staff)

Total: 258
2006-11: 70
2006-11 Top-10: 20

Citations (Permanent Staff)

Total: 8,824
2006-11: 820
H-indexes: 32, 33, 21, 11

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 10
MTs 2006-11: 49
STÅ 2010-11: 65

External Funding (Spent)

2006-11: 5.7 MDKK
2010-11: 2.7 MDKK

Status

Programming Languages is a fundamental discipline at any computers science department and it has always been strong in Aarhus. The current research group consists of three subgroups specializing in different fields: Design and Analysis of Languages and Tools (AM+MIS), Functional Languages and Formal Semantics (OD), and Object-Oriented Languages and Type Systems (EE). While these subgroups do not have joint publications, they collaborate in teaching and provide a joint forum for inspiration as well as a common community for PhD students. The PL group has a tradition of prestigious service, including since 2006: General Chair PLDI 2006 (MIS), Natural Research Council Member (MIS), Editor-in-Chief HOSC (OD), Program Chair ICFP 2011 (OD), Program Chair ECOOP 2007 (EE).

Prospects

The PL group has not had an expansive strategy, but has consistently been highly productive and produced first-rate publications and students at modest costs. Recently, AM has received a significant amount of prestigious major and minor external research funding, which has initiated an expansion in this field. The PL group needs to be boosted for both research and teaching, and the ideal candidate would exploit the existing strengths including the momentum of the AM expansion, and at the same time contribute to realizing the potential for collaboration. Hirings in related fields such as Systems or Software Engineering could also be useful for the PL group.

Computer Graphics and Image Processing

Academic Staff

Permanent: Thomas Sangild Sørensen
Temporary: Toshiya Hachisuka (assistant professor), Allan Rasmusson
PhD students: 3

Peer-reviewed Publications (Permanent Staff)

Total: 38
2006-11: 30
2006-11 Top-10: 10

Citations (Permanent Staff)

Total: 550
2006-11: 380
H-indexes: 14

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: none
MTs 2006-11: 7
STÅ 2010-11: 8

External Funding (Spent)

2006-11: none
2010-11: none

Status

The research group in Computer Graphics and Image Processing is a newly formed group. The Image Processing subgroup specializes in medical imaging (TSS) and the Computer Graphics group's main focus is image syntheses (TH). While the two subgroups have no joint publications yet, we strive to make this happen in the future. A teaching curriculum have been set up as of 2011 spanning introductory and advanced topics in computer graphics and image processing. Furthermore, a teaching collaboration has been initiated with the Department of Engineering, who supplements the curriculum with Computer Vision and Advanced Signal Processing courses. TSS serves on the programme committee for two conferences in medical image computing.

Prospects

The research group holds no major research grants currently, but has been able to (co-)fund PhD studies and a postdoc position by small dedicated grants. The group is ambitious in its attempt to attract continued and larger scale funding to expand its currently modest size with a number of PhD student and postdocs. The group also strives to seek research collaboration with the Computer Graphics group at the Alexandra Institute in order to facilitate technology transfer. The Computer Graphics subgroup needs to be consolidated by establishing two permanent positions at an associate professor level in the coming years. To strengthen our activities and support inter-subgroup interaction and research collaboration, the two positions in the Computer Graphics subgroup should focus in the areas of image synthesis and fluid/continuum mechanics simulation.

Bioinformatics

Academic Staff

Permanent: Christian Nørgaard Storm Pedersen, Thomas Mailund
Temporary: Søren Besenbacher
PhD students: 6

Peer-reviewed Publications (Permanent Staff)

Total: 117
2006-11: 69
2006-11 Top-10: 24

Citations (Permanent Staff)

Total: 1,811
2006-11: 423
H-indexes: 15, 15

PhD, Master's Thesis and STÅ Production

PhDs 2006-11: 6
MTs 2006-11: 36
STÅ 2010-11: 19

External Funding (Spent)

2006-11: 2.9 MDKK
2010-11: 1.2 MDKK

Status

Bioinformatics is a discipline focusing on the development and application of theoretical models and computational methods for analysis of biological and biomedical data. It draws upon and combines many disciplines of natural science, e.g. molecular biology, genetics, mathematics, statistics, chemistry, and computer science. The bulk of research activities in bioinformatics at AU take place at the Bioinformatics Research Centre (BiRC). Bioinformatics at CS has been an integral part of BiRC since BiRC's establishment in 2001. CNSP has been the director of BiRC since 2005, TM was associated to BiRC as a postdoc in 2003 and joined the permanent staff in 2010. CNSP and TM serve in program committees and editorial boards of bioinformatics conferences and journals. Common to all research activities at BiRC is the combination of theory and practice motivated by biological/medical questions. The activities involve algorithmic development, software development, statistical modelling and biological and medical data analysis. Research projects are often done in close collaboration with experimental collaborators.

Prospects

Bioinformatics at CS was strengthened in 2010 when TM was tenured at BiRC, and BiRC in general has been strengthened by 3 tenured positions in 2009-10 including TM. TM and CNSP form a subgroup at BiRC focusing on algorithmic aspects of bioinformatics, but are also individually involved in other subgroups at BiRC focusing on evolutionary genomics and structural biology. BiRC will expand in the coming years due to initiatives such as the AU iSequencing Centre and the Danish Platform for Large-scale Sequencing and Bioinformatics financed by HTF. We will be engaged in these large-scale activities focusing on developing efficient computational methods for analysing data collected by modern high-throughput sequencing techniques. We aim to publish individual method papers as well as being part of larger consortium papers. We will use modern high-performance computing facilities to a much larger scale than previously. Access to such facilities is important and additional expertise in areas related to algorithmic development for large scale data analysis using high-performance computing will benefit our activities.

Appendix B: Criteria for Associate Professorships

This appendix contains a set of criteria to evaluate candidates for permanent associate professorships. The criteria can be used to evaluate whether a position shall be opened for a particular candidate (in competition with others). They can also be used as guidance for external members of evaluation committees. Finally, they can be used by young researchers, who want to evaluate their own chances for obtaining a permanent associate professorship.

Publications

- Several papers in the top-conferences of the research area (number depends on the standard in the area).
- Independent production after PhD project.
- Good H-index (dependent on number of years after PhD).
- At least a couple of papers with good citation numbers.
- Journals papers count positively.

International Network

- Productive long-term visit at another university.
- International co-authors.
- Some experience from programme and/or organising committees.

Teaching

- Experience from undergraduate and graduate teaching.
- Development of teaching plans/material.
- Supervision of Master's thesis students and/or PhD students.
- Positive teaching evaluations.

Contribution to the Department's Profile

- Potential for strengthening of the research profile.
- Potential for contributing to research-based education.

Funding and Academic Leadership

- Elite funding such as Sapere Aude and ERC counts positively.
- Independent management of research projects or substantial parts of these counts positively.

Interaction with Society

- Experience from cooperation with private companies and public institutions counts positively.
- Good communication skills count positively.

Administration

- Commitment and competence count positively.