



AARHUS
UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE

2016 Annual Report



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Department of Computer Science, Aarhus University

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2016 in Short

2016 was great year for the department. We have educated a record number of Master's students in computer science and IT product development. Our graduates are in high demand, and they can easily get interesting and challenging jobs.

This year we have implemented restricted admission for new undergraduate students, and it seems to have led to a better match between students, competencies, and expectations.

Research-wise 2016 was also an excellent year for the department. We have hosted large international conferences as ALGO 2016 and 14th Participatory Design Conference. Moreover, we have received several research grants i.e. two Sapere Aude research leader grants, a Villum Young Investigator Award and two large projects funded by Innovation Fund Denmark about big data (DABAI) and digital production (MADE digital).

STAFF

In 2016, there have been the following changes in our tenured staff:

Gerth Stølting Brodal was appointed professor in Algorithms and Data Structures group from January 1.

Olivier Danvy was appointed professor in Programming Languages group from January 1.

Eve Hoggan has been employed as associate professor from September 1.

Thomas Dueholm Hansen has been employed as tenure-track assistant professor from August 1.

Tina Rudolph is reemployed in the Information office from February 1.

Peter Bro Miltersen resigned from his position as professor in April.

Michael E. Caspersen resigned from his position as associate professor in September.

AWARDS AND APPOINTMENTS

Lars Arge: Secretary General of the Royal Danish Academy of Sciences and Letters.

Lars Birkedal: Member of the Royal Danish Academy of Sciences and Letters.

Niels Olof Bouvin: Education Award, Science and Technology, Aarhus University.

Ivan Damgård: Knight of the Order of Dannebrog.

Andreas Mathisen and Søren Krogh Sørensen: Best Master's Thesis, Danish Society for Computer Science.

Henrik Bærbak Christensen: Teacher of the Year.

RESEARCH PROJECTS

The department receives approximately DKK 40 million a year in external research grants. Larger grants starting in 2016:

<p>Driving Growth and Productivity in Manufacturing through Digitalization, Kaj Grønbaek, Innovation Fund Denmark et al., DKK 11,1 million.</p>
<p>Danish Centre for Big Data Analytics driven innovation (DABAI), Kaj Grønbaek and Lars Arge, Innovation Fund Denmark, DKK 8.5 million.</p>
<p>Foundations of Cryptographic Computing, Claudio Orlandi, Sapere Aude, The Danish Council for Independent Research, Natural Sciences, DKK 7.1 million.</p>
<p>Language-Based Anonymity, Aslan Askarov, Sapere Aude, The Danish Council for Independent Research, Natural Sciences, DKK 6.9 million.</p>
<p>The limits of computation, Kasper Green Larsen, Young Investigator, Villum Kann Rasmussen Foundation, DKK 5.0 million.</p>
<p>Levitation with localized tactile and audio feedback for mid-air interactions, Jörg Müller, Horizon 2020, DKK 4.5 million.</p>
<p>Scalable Oblivious Data Analytics, Claudio Orlandi, Horizon 2020, Industrial Leadership, DKK 3.8 million.</p>
<p>Guarded Homotopy Type Theory, Lars Birkedal, Villum Kann Rasmussen Foundation, DKK 3.3 million.</p>
<p>Starting Grant, Aslan Askarov, Aarhus University Research Foundation, DKK 2.9 million.</p>
<p>Computational Lower Bounds, Kasper Green Larsen, Aarhus University Research Foundation, DKK 1.6 million.</p>
<p>Tools and Methods for Data Foundations, Ira Assent, Aarhus University Research Foundation, DKK 1.0 million.</p>
<p>CryptoAction, Claudio Orlandi, EU, DKK 1.0 million.</p>
<p>Innovative use of Big Data, Lars Arge, Alexandra Institute, 0.8 million.</p>
<p>The World Robot Olympiad, Søren Poulsen, Danish Ministry for Children and Education as well as private foundations, DKK 0.6 million.</p>
<p>Automatic Document ranking and search techniques for a Discovery Engine, Ira Assent, Innovation Fund Denmark, DKK 0.4 million.</p>

CONFERENCES, WORKSHOPS AND SUMMER SCHOOLS

During 2016, the department has hosted the following events:

<p>Theory and Practice of Secure Multiparty Computation, May 30 - June 3 (Ivan Damgård)</p>
<p>14th Participatory Design Conference, August 15-19 (PIT)</p>
<p>ALGO 2016, August 22-26 (Lars Arge)</p>
<p>Fall PIT Symposium, November 3 (Susanne Bødker)</p>
<p>Symposium on the work of Ivan Damgård, April 1</p>
<p>Symposium on the work of Susanne Bødker, October 14</p>
<p>Katrinebjerg career day, April 29 (Søren Poulsen)</p>

In addition, the department's employees have participated in numerous conferences, workshops, summer schools, and meetings all over the world.

RESEARCH DISSEMINATION

The department has arranged the following Friday Lectures with both local and external researchers:

What is a Compiler? We thought we knew...

by Mads Torgersen, Microsoft.

When size matters by Stephan Herhut, Google.

Variationer on Rice's Theorem

by Jean-Yves Moyen, University Paris 13.

Distribution, Reversibility and Robotics

by Ulrik Pagh Schultz, University of Southern Denmark.

Citizen science games: probing the border between human and artificial intelligence by Jacob Friis Sherson, Physics and Astronomy, Aarhus University,

Singular Choices for Multiple Choice by Olivier Danvy, professor in Programming Language group.

When learning works better than machine learning: Recovering damaged QR-codes with manual choice of image features to recognize by Michael Raskin, postdoc in Mathematical Computer Science group.

The C standard formalized in Coq, what's next? by Robert Krebbers, postdoc in Logic & Semantics group.

The Logic of Guarded Recursion by Ranald Clouston, postdoc in Logic & Semantics Group.

Additionally, we held our annual Computer Science Day on which the department's research groups presented selected activities.

DISSEMINATION AND RECRUITMENT ACTIVITIES

The department is involved in a wide range of activities for upper secondary, primary and lower secondary schools all over the country.

The activities are wide-ranging and were organized both locally at CS and in collaboration with ST, AU, and other external partners. Among other things, we have arranged and/or been involved in events, such as:

Study-related events:

- U-days
- Student internships for upper secondary school students
- On-the-job training for primary and secondary school students
- Visits from upper secondary school classes and primary school classes
- Det rullende universitet
- Student for a day
- University days for the Academy for Talented Youth

Competitions and camps:

- World Robot Olympiad, www.wrodenmark.dk
- Co-organizer of First LEGO League Aarhus
- IT-Camp for girls, www.itcamp.dk

Focused talent development programs:

- Student Guidance for upper secondary students in connection with study projects
- Theme about Cryptology for master class in Mathematics
- Visit from the Academy for Talented Youth

Research dissemination to the general public:

- Workshop and project demonstration at DOKK1, Aarhus Mini maker faire
- Educational stand at Danish Airshow
- Talk about Big Data and effective algorithms

Dissemination and further education of student teachers:

- Course in technology-based teaching development for didactics/CUDIM students

In the course of the year, we have had more than 800 visitors for events at the department. A great thank you to the PR committee and all others involved in the great work of communicating and sharing information about our study programmes.

STUDENT ACTIVITIES

The department's two very well-functioning student associations (DSAU and SOFA) actively contribute to create one of the country's best study environments for our approx. 800 students. Among their many excellent activities are:

Students from the department participated in this year's Danish championship in programming, and subsequently in the North-Western European championship in Linköping.

Students organized AU-Hack - Denmark's first and largest Major League Hacking event - www.auhack.org

Research trip to San Francisco for students in computer science and IT, in July.

Six companies have established themselves in HatchIT Lab, which is an innovation and entrepreneurial environment for students and newly qualified candidates from computer science and IT Product Development who aim to start their own business.

The majority of the companies in HatchIT Lab have gotten external funding and support from Innovation Fund Denmark, EU funds, or other private/public investment companies. Read more about the six companies at their websites:

BioRemind: www.bioremind.dk

CEPTU: www.fieldsenseapp.com

Cope IT: www.copeit.com

The Zeppelin Studio: www.zeppelinstudio.net

MONTEM: www.montem.io

Abrella: www.abrella.dk

STUDY PROGRAMMES

The department has two bachelor programs and two Master's degree programs. In addition, we have a diploma degree programme and an execute Master's degree programme (within the further and continuing education) as well as a PhD degree programme.

AWARDS

The award for student teacher of the year was presented to Ingo van Duijn and Asger Hautop Drewsen, while the student of the year award went to Mathias Pedersen, Mikkel Brown Jakobsen, and Thor Bagge for arranging Spare Time Teaching.

The ST Education Award went to the department this year, as Niels Olof Bouvin received the award for his very dedicated efforts as a teacher at several of the department's large courses.

As in previous years, the department's students have elected teacher of the year. The five nominees for the title were:

Aslan Askarov

Gerth Brodal

Henrik Bærbak Christensen

Kaj Grønbæk

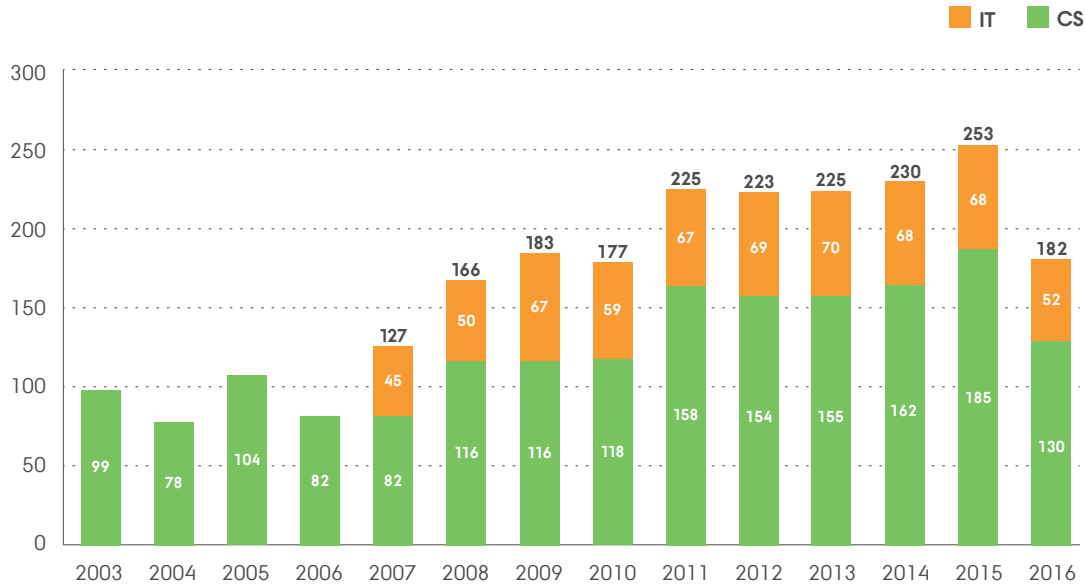
Kasper Green Larsen

The winner was Henrik Bærbak Christensen based on the following: "Henrik is an extraordinary teacher and he has succeeded in getting SoftArk and CloudArch to be two of the most instructive and interesting courses I have ever had".

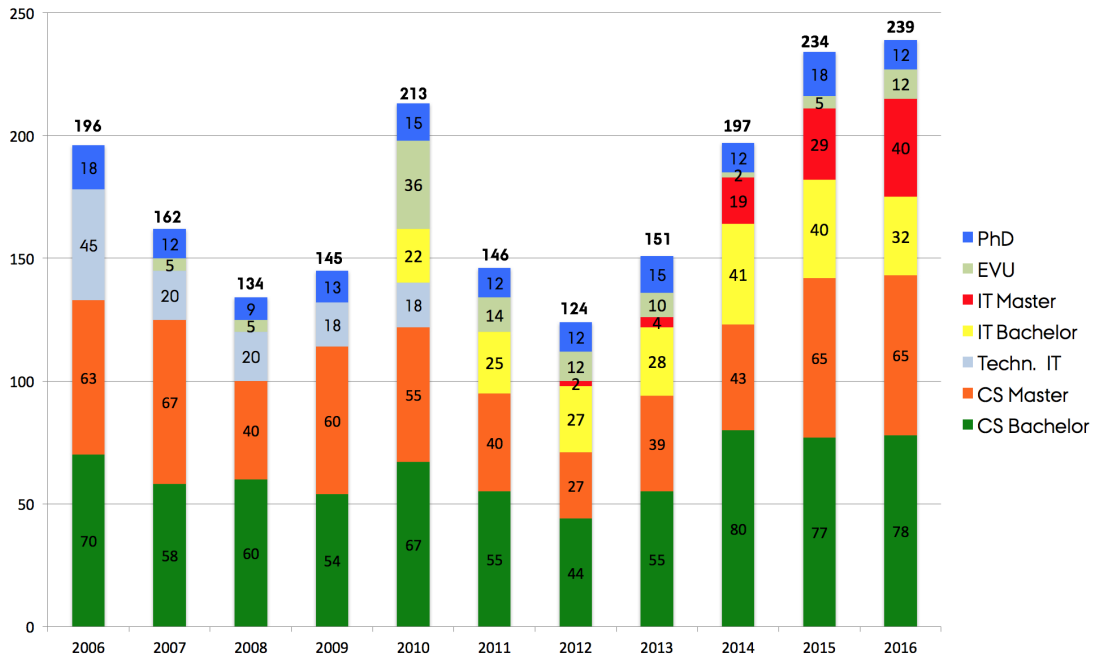
Admissions

In 2016, the department rolled out restricted admission for new undergraduate students. The department had a maximum student intake of 130 for Computer Science and 52 for IT Product Development. This resulted in a grade point average of 6.5 and 6.4 for admission. The aim of the restricted admission is to reduce the drop-out rate at the department's study programmes by accepting more motivated students and creating a better study environment. An initiative to create a better study environment is the opening of the study café "Javahulen". The study café is a place where students - during their first two academic years - can meet to study or get help from instructors.

The department's admissions to the Bachelor's degree programmes are illustrated below:



In 2016, 105 Master's in computer science and IT were produced, which is a new record. During 2016, the department has produced the following number of degrees:



Through "Datalogisk Uddannelsesforum" (DUF) the department has expanded contacts and cooperation with student organizations for computer science and IT, which will launch numerous initiatives to improve our study environment and degree programmes.

Lars Birkedal
Head of department

02

Research

From Basic Research to Applicable Spin-Off Technology

In 2016, the CFEM project - Center for Research in the Foundations of Electronic Markets - came to an end. CFEM has been running for six years and involved experts in computer science, economy, game theory, and mechanism design as well as industrial partners.

SMC is a powerful tool

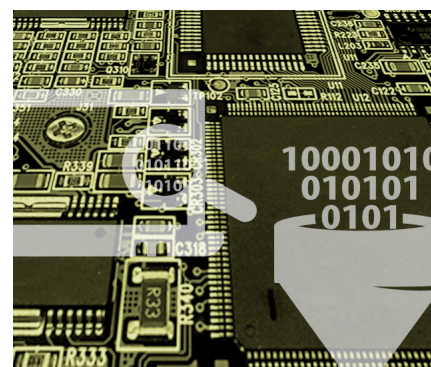
Secure Multiparty Computation (SMC) is one of the core technologies of the CFEM project. Thirty years ago, Secure Multiparty Computation was a theoretical concept, but today the technology is a powerful tool that allows us to perform complex computations on encrypted data. In the past, it would take days, but now it can be done in a few seconds. Therefore, the technology can be used in a wide range of industrial applications:

- Start-up company Sepior – a spinoff from the activities in CFEM – uses Secure Multiparty Computation in their encryption product for cloud services such as Dropbox.
- Other applications include benchmarking, credit rating, statistics and machine learning – or any other area where we want to perform computation on data without revealing the private data behind the computation.

Collaboration between research and industry continues

CFEM has established an international biannual workshop in Aarhus for researchers and people from industry. The workshop has become an insti-

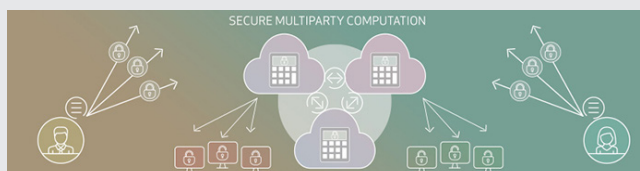
tution in the world of SMC and will therefore be continued. “This proves that the theory works in practice and is useful in real products”, says Ivan Bjerre Damgård, Professor at the Department of Computer Science at Aarhus University and one of the Center Managers of CFEM.

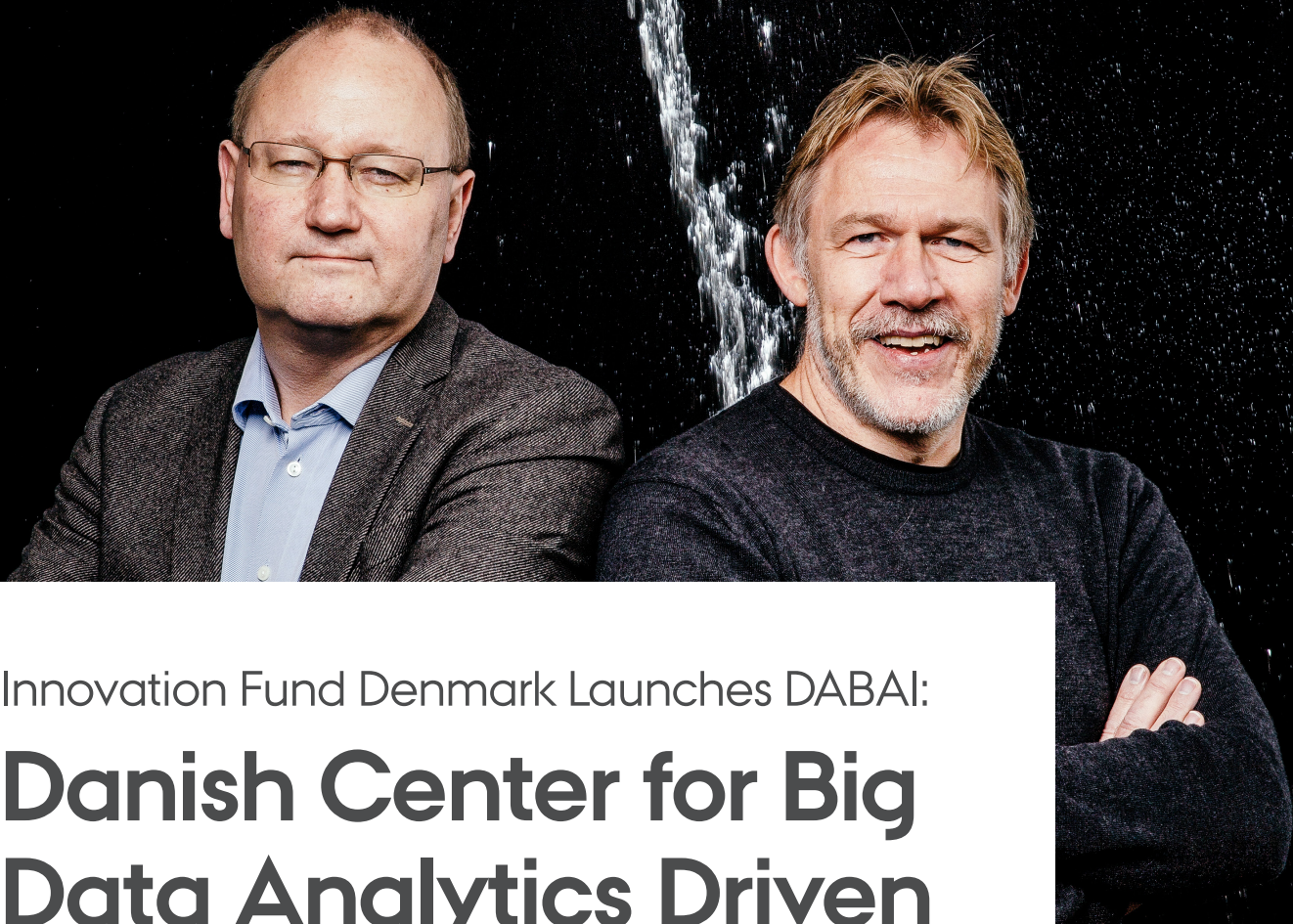


FACTS

CFEM – Center for Research in the Foundations of Electronic Markets – is an interdisciplinary collaboration between computer scientists specialized with cryptography, economics, and game theorists from CBS, KU, AU, and the Alexandra Institute as well as several Danish industry partners and international research institutions.

The aim of the project has in a wide sense been to design electronic market places such as auctions, credit ratings, and new types of markets on the internet.





Innovation Fund Denmark Launches DABAI:

Danish Center for Big Data Analytics Driven Innovation

The Danish Centre for Big Data Analytics driven Innovation (DABAI) is the name of a new big data research centre that was inaugurated on Friday 27 May 2016 at Aarhus University by Dean Niels Chr. Nielsen, Science and Technology. The Department of Computer Science plays a key role in DABAI, where big data will be systematically analysed to solve business-related and societal challenges in areas such as public administration, logistics, the environment, education, food and the agricultural sector.

The number of bytes of data generated every day from the web, social media, apps, production equipment and sensors in cities and buildings amounts to 2.5 quintillion (2.5 followed by 17 zeros). This corresponds to the content of 57.5 billion iPads (32 GB) – daily. However, less than three percent of the enormous amounts of data are analysed and converted to knowledge and innovation.

Something will now be done about this in a new community partnership called the Danish Centre for Big Data Analytics driven Innovation (DABAI). With a total budget of more than DKK 117 million, researchers and business people at DABAI will over the next four years develop efficient and useful methods and tools to analyse big data. The centre is the first of its kind in Denmark, where large amounts of data will be systematically and

efficiently used to find solutions to challenges in areas such as public administration, logistics, the environment, education, food and the agricultural sector.

Large audience at the opening

“The accelerating technological development is changing our daily lives by leaps and bounds. DABAI will help to create spaces and frameworks in

which entrepreneurship, collaboration and an international outlook prosper, so that ideas, knowledge and technologies are converted to viable businesses and innovative solutions for the benefit of society," said Dean Niels Chr. Nielsen, Science and Technology, on Friday 27 May when he opened DABAI in the Peter Bøgh Andersen Auditorium at Department of Computer Science.

The auditorium was packed with visitors who had come to hear representatives from universities and companies provide specific examples of previous big data projects, and which projects will be in focus at DABAI. The centre will be under the project management of the Alexandra Institute – a role that Professor Ole Lehrmann Madsen, CEO of the institute, described in advance when he presented the project's participants on Friday.

Better hospital logistics to ensure shorter waiting times

The Department of Computer Science at Aarhus University plays a key role in DABAI, and will be involved in a number of projects in the centre's three main business areas: public data, food industry data, and data from IT-based learning.

One of the initiators of the centre is

Professor Kaj Grønbæk, Department of Computer Science, who is responsible for the Interactive Visual Analytics area of research. In a previous project called PosLogistics, he developed a system to improve porter-related logistics based on indoor positioning in collaboration with Systematic – an IT company in Aarhus – as well as Aarhus University Hospital and Aalborg University Hospital.

At DABAI, Professor Grønbæk and Systematic will take this work further to analyse large amounts of anonymised patient flow data in order to understand the detailed patient flow and to improve the hospitalisation process right through the hospital. The aim is to have fewer cancellations of operations, shorter waiting times, and better utilisation of resources – and thereby better patient treatment.

Geodata can be used to predict flooding

Another DABAI initiator from the Department of Computer Science is Professor Lars Arge, who has the main responsibility for one of the project's focus areas – public data. Professor Arge is also director of the Danish National Research Foundation's Centre for Massive Data Algorithmics (MADALGO) at Aarhus

University.

Based on algorithmic research, Professor Arge previously developed in collaboration with SCALGO a unique online tool to predict flooding called SCALGO Live. In the DABAI project, Professor Arge and SCALGO will work together with companies and authorities including Orbicon, the Central Denmark Region, the Danish Meteorological Institute (DMI) and the Agency for Data Supply and Efficiency to develop tools that enable the state, municipalities and utilities to predict flooding and reduce negative after-effects of climate change. The tools make it possible to update and interact with data, and to simulate the impact of rising waters and cloudbursts. This means that decisions can be made on a very safe basis regarding where investments have the greatest effect to safeguard against climate change and flooding.

FACTS ABOUT DABAI

DABAI stands for **D**Anish Centre for **B**ig Data **A**nalytics driven **I**nnovation.

1

The aim of the collaboration is to develop general techniques and methods in the areas of **analysis algorithms, machine learning and interactive visual analysis**, all of which can be reused cutting across a number of cases in three business areas: public data, food industry data, and data from IT-based learning, where the many companies involved in DABAI have a clear business potential.

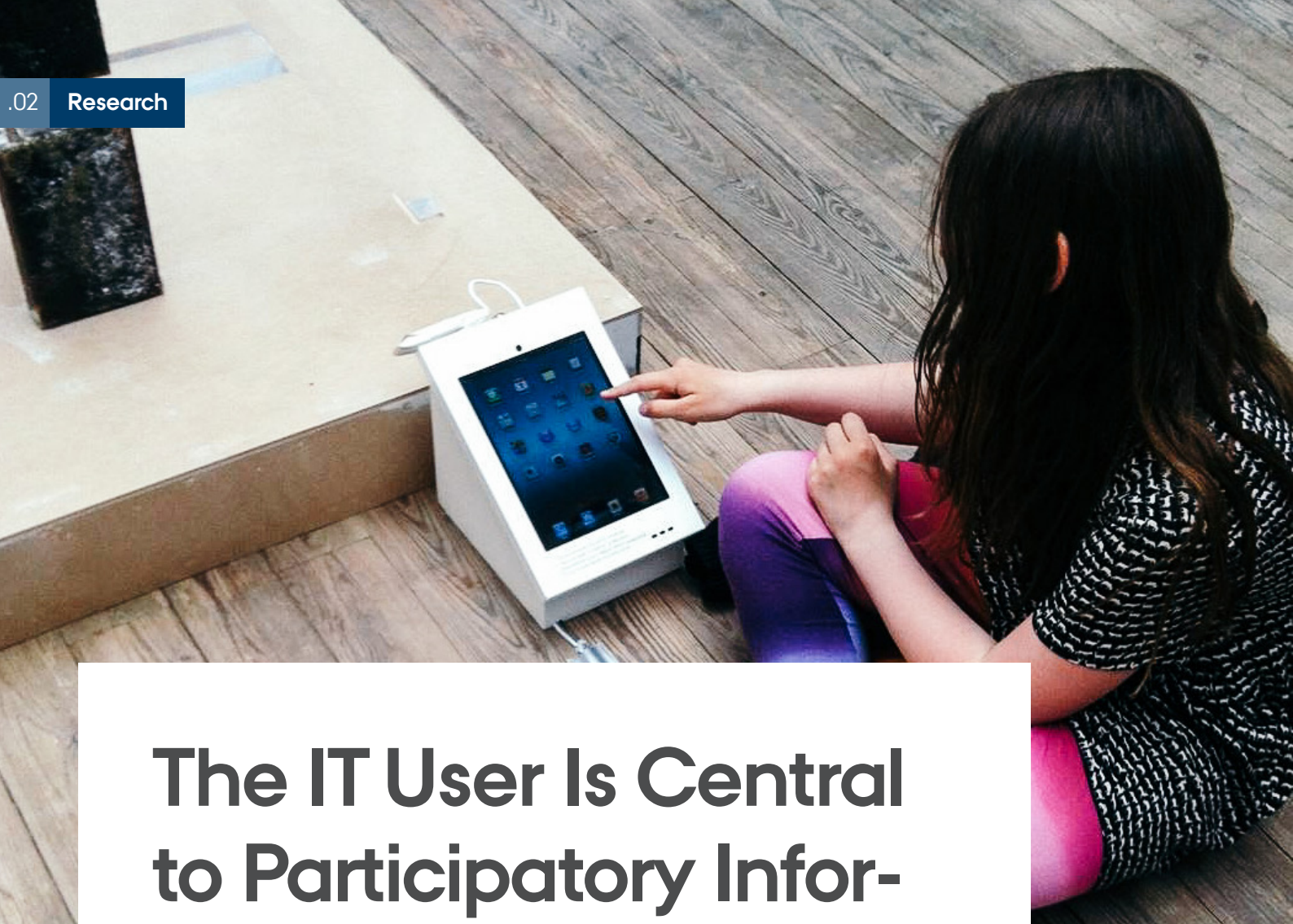
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The project is led by the **Alexandra Institute**, and the remaining core players are the **computer science departments** at the University of Copenhagen, the Technical University of Denmark and Aarhus University, as well as companies including **Systematic, Visma** and **BusinessMinds**, and authorities such as the **Danish Agency for Digitisation**, the **Danish Business Authority** and the **Central Denmark Region**. A considerable number of other private and public companies will also be involved in specific case activities at the centre.

3

DABAI has an initial budget of more than **DKK 117 million** for a period of four years from March 2016, DKK 45 million of which is financed by a grant from Innovation Fund Denmark. The remaining budget consists of **self-financed contributions** from the participating partners, including DKK 5 million in direct support from the Central Denmark Region.

4



The IT User Is Central to Participatory Information Technology Center (PIT)

The interdisciplinary center, the Participatory Information Technology Center (PIT), has for the past five years brought together researchers across Departments of Computer Science and Digital Design and Information Studies and has explored the perspectives and potentials that occur with the IT user's transformation into becoming a participant.

Previously, IT was something that programmers developed, and we just used the form made available by the designers. Today, IT users participate in the design process to a much higher degree. Perhaps even without us being aware that data collection about us is happening. At the same time, commercial communities such as Facebook, has become the users' preferred community platform. This can result in democratic challenges.

This is the message from Kim Halskov, Professor at the Department of Digital Design and Information Studies, and Susanne Bødker, Professor at Department of Computer Science, who over the past five years, have worked together in the interdisciplinary center, the Participatory Information Technology Center (PIT). Together with more than 30 senior researchers and PhD students, Susanne and Kim have explored perspectives and potentials

in the IT user's transformation into a participant.

A natural home at Katrinebjerg

The Center emerged, because numerous people at Katrinebjerg worked with participatory design or elements hereof. Participatory design is a research tradition with strong roots at Aarhus University, where both Kim Halskov and Susanne Bødker

The Participatory Information Technology Center (PIT) has for the past five years brought together researchers from the **Department of Digital Design and Information Studies** (digital aesthetics and interaction design) and **Department of Computer Science** (Computer-Mediated Activity and Ubiquitous Computing and Interaction).

started their research career. The tradition started in the 1970s, when researchers realised that it is a necessity that users, and not just the management and the establishment, should be able to specify requirements for the technology.

According to Susanne Bødker, this entire design tradition had lost its home, and this was the reason why they started the collaboration between computer science and people from Arts, working with digital aesthetics and interaction design.

“The collaboration succeeded. Even though Aarhus University’s internal financing of the center expires, we can clearly see that our colleagues wish to continue to collaborate,” explains Susanne Bødker.

During the center’s period of research, they have been working on how to involve users through new design methods and processes. In the past, the involvement of users was only related to work situations in a narrow sense. Today, user involvement has also moved out into the public space and in people’s homes and everyday life. The center has among other things focused on communities within smart city/urban space development and distribution of organic food products.

“In the old days your affiliation was related to your employment. You worked with a very specific group of people. But if you look at the people who use IT when they are on the move or are part of a community, the relations are completely different. As a consequence, the nature of their participation becomes different and more superficial. As opposed to previously, where you had some very specific constellations,” explains Kim Halskov.

Technology helps for better or worse

It also plays well together with the technology,” says Susanne Bødker. Because on the one hand, there are

currently many technological platforms, which help you to communicate and collaborate across an entire organization. On the other hand, there are also many challenges, which you did not see five years ago. But you see them clearly today.

“People participate in some things that they might not be aware of. When Facebook collects data about us, it affects not only on the advertisements we get. It also affects the entire way we relate to each other through Facebook. This also applies for the Amazon Mechanical Turk (online marketplace), which is used more and more to create data and which has an influence on where we can use the technology. But we do not know who the users of MTurk are and where they are. The anonymous participation will have an impact on all of us,” explains Susanne Bødker.

Take over the automation and machine learning

We also see a more data-driven design and here, the anonymised participation also creates challenges, that you hadn’t seen coming five years ago.

It is especially important to ask what it takes to get people to understand the data that is in the public space, and how they can use it. This is one of the issues the center is working with, which we can certainly continue working on. This work will also continue in Ira Assent’s FounData project, which is about how people interact with data.

“It’s a classic issue. Participatory research has for many years been about how you can create alternatives to this mainstream, which makes people in general understand and have influence on how IT is developed. When the nature of IT is the way it is today, it is important to ask how you make these processes more democratic and engaging,” says Kim Halskov.

“It brings the data problem to a head,

because do we at all understand the choices that are made around us. A lot of ‘massage’ of data is happening before we see them in e.g. visualisations, and will you as a person, even be able to recognize what is happening,” adds Susanne Bødker.

Important to think democracy and participation into the technology

Another thing the center’s researchers have discussed is why commercial communities such as Facebook, have ended up being used.

“Of course, obvious reasons are that Facebook provides facilities and that we are all on Facebook. You may wonder why no open source platforms offer themselves as alternatives. Earlier, Denmark had some. However, they chose to become more commercial,” says Susanne Bødker.

A core concept within participation is the democratic one, and here you may say that it sounds super-democratic that everyone has the opportunity to express himself/herself. But it is also a risk that everyone are now able to expose themselves to manipulation or take on an authority, they do not have. Both the Brexit vote and the American election campaign are good examples of how it requires knowledge to relate to such issues.

“It is important to carefully address how these discussions in the public communities can be mediated and enabled technologically. If no one supports you as a citizen, we may have a problem,” explains Kim Halskov.

Susanne Bødker adds: “With these things in mind, PIT has built a number of alternative technologies, which serve to explore alternatives for the users. At the same time they are solidly research related in a way that they also bring innovation on the research side.”

Grants

H2020 GRANT FOR PRIVACY-PRESERVING BIG DATA TECHNOLOGIES



Associate professor Claudio Orlandi has been granted DKK 3.5 million by Horizon 2020 for the SODA project (Scalable Oblivious Data Analytics).

More and more data is being generated, and analyzing this data drives knowledge and value creation across societies. Unlocking this potential requires sharing of (often personal) data between organizations, but it meets unwilling-

ness from data subjects and data controllers alike. Hence, techniques that protect personal information for data access, processing, and analysis are needed.

The SODA project will enable practical privacy-preserving analytics of information from multiple data assets using multi-party computation (MPC) techniques for which data does not need to be shared, only made available for encrypted processing. The main technological challenge is to make MPC scale to big data, where we expect to achieve substantial performance improvements.

We will combine expertise from the domains of MPC, differential privacy and data analytics into a

comprehensive privacy perspective following a use case-driven approach, exploiting Philips leading positions in healthcare applications.

The project will also ensure improved compliance with EU data privacy regulation (by performing legal analysis in a feedback loop with technical development) and making data subjects more confident to enable processing with our techniques (by performing user studies in a feedback loop with our consent control component).

The project is completed in collaboration with Philips Research, Eindhoven University of Technology, AU, Göttingen University, and the Alexandra Institute.

FET OPEN GRANT FOR "PROJECT LEVITATE"



Associate professor Jörg Müller has been granted DKK 4.5 million by FET Open for the research project "Levitation with localized tactile and audio feedback for mid-air

interactions". The project will run for 4 years starting January 1, 2017.

Project Levitate will be the first to create, prototype and evaluate a radically new human-computer interaction paradigm that empowers the unadorned user to reach into a new kind of display composed of levitating matter. This tangible display will allow users to see, feel, manipulate, and hear three-dimensional objects in space. The users can interact with the system in a

walk-up-and-use manner without any user instrumentation. It will be the first system to achieve this, establishing a new paradigm for tangible displays.

FET Open supports the early-stages of the science and technology research and innovation around new ideas towards radically new future technologies. It is part of the Horizon 2020 initiative under The EU Framework Programme for Research and Innovation.

VILLUM FOUNDATION SUPPORTS PROJECT ON GUARDED HOMOTOPY TYPE THEORY



Professor Lars Birkedal and Associate Professor Bas Spitters have received DKK 3.3 million from the Villum Foundation in support of a research project on Guard-

ed Homotopy Type Theory. Guarded dependent types provide a solid foundation for programming with, and reasoning about, infinite data types. At the same time, it is a convenient framework for expressing program logics.

Homotopy type theory is a new fundamental connection between type theory, from programming and proof assistants, and homotopy theory, the mathematical theory of continuous transformations. Homotopy type theory is currently revolutionizing the design of proof assistants. Our aim is to combine the two fields in order to develop new theories for, and

prototypes of, proof assistants, which can be used within both mathematics and computer science.

In the project we will build on our collaboration with Prof. Møgelberg's group at ITU and Prof. Coquand's research group at Chalmers. The project will fund Bas Spitters and a PhD student.

RESEARCH TALENT GETS 6.6 MILLION TO DEMONSTRATE THAT CERTAIN ALGORITHMS DO NOT EXIST



With DKK 5 million from the Villum Foundation and DKK 1.64 million from Aarhus University Research Foundation, Kasper Green Larsen can now assemble a team of researchers that will work on how fast you can search, calculate and analyze huge amounts of data.

The project aims at solving classic issues that theoretical computer scientists have tried to solve for more than 40 years.

Some of the core issues in computer science concern whether specific computational problems can be solved more efficiently (faster) by a computer or not.

With the funds, Kasper Green Larsen will expand his research group with two PhD students and a Postdoc. The research group will develop mathematical methods, which prove that computational problems cannot be solved more effectively. This will save both funding for research and time that otherwise would be spent on attempts to develop solutions that do not exist.

"There are lots of problems with calculations being too slow, because we do not have efficient algorithms. The interesting part is to ask whether it can be done.

In the project's first part we will investigate if it is possible to search databases more effectively, and the second part is focused on how fast you can calculate and analyze huge amounts of data," says Kasper Green Larsen.

TWO SAPERE AUDE GRANTS TO CS



Associate professor Aslan Askarov and Associate professor Claudio Orlandi both received the 2016 research leader grant from the Danish Council for independent research.

Aslan Askarov will lead the Language-Based Anonymity project. The goal is to develop a scientific framework for reasoning and enforcing strong

application-level anonymity requirements. There is an increasing interest in anonymity, but existing tools provide only low-level guarantees, resulting in applications that violate the anonymity expectations of their users. To address this, we will use novel techniques from programming-language theory to reason and enforce application anonymity requirements, and programming language techniques to specify and enforce these requirements. This project will result in a novel programming methodology for secure programming that will provide a firm ground for building practical tools to develop systems with high anonymity and confidentiality assurance.

Foundations of Cryptographic Computing will be led by Claudio Orlandi, who with the project aims to broaden our

understanding of cryptographic calculations by answering some of the most important - unanswered - questions in the field: What can be calculated in a safe way? How fast can it be done? How much communication and interaction is needed? How can we protect personal sensitive information, and still become wiser by sharing data?

The research leader grant is aimed at excellent researchers who are expected to have ambitious research goals, which require a longer period dedicated to research. The grant makes it possible to pursue inventive and ambitious goals by carrying out, and leading, a research project over a period of up to 5 years.

INNOVATION FUND SUPPORTS AUGMENTED REALITY AND SMART PRODUCTS IN MADE DIGITAL



Professor Kaj Grønbæk has been granted DKK 11,1 million DKK from Innovation Fund Denmark for Aarhus University's share in the project "MADE Digital: Driving Growth and Productivity in Manufacturing through Digitalization" for the period 2017-19.

MADE Digital addresses a number of core challenges in the so-called Indus-

try 4.0 trend and strengthens Danish Industry with digital technology. Kaj Grønbæk and the UBI group mainly contribute with research in Augmented Reality to provide digital assistance to human processes in production, commissioning, and service of industrial products. Industrial environments are particular challenging with respect to tracking, display, interaction and performance of Augmented Reality systems. Kaj Grønbæk and the UBI group also collaborate with Prof. Peter Gorm Larsen at ENG, AU on research within product ecosystems and Internet of Things to support development of Smart Products, that provide both physical functionality and digital services via internet connectivity, data collection, and cloud-based

functionality. The MADE Digital project is a 196 million DKK effort in total involving more than 50 industrial companies, 5 universities, as well as 3 GTS institutions, including the local Alexandra Institute. See more at www.made.dk.

Acknowledgments

SUSANNE BØDKER 60 YEARS:

THE MOST FREQUENTLY CITED DANISH HCI RESEARCHER



Susanne Bødker, Professor at Aarhus University (AU), turned 60 on October 1, 2016.

30 years ago she made the groundbreaking formulation of the ideal criteria for user interfaces and user experiences in her book "Through the Interface: A human activity approach to User Interface Design". When the user interface becomes transparent (i.e. "disappears") to the user, so that she only focus on her actual purpose - to write a text, to navigate from A to B, to search for information, etc. - without thinking about the tool in use, then the ideal and effective user experience is achieved. Her research over the past 30 years has built on this basic formulation in the form of methods and theories on how you as a system developer and user interface designer can work systematically to achieve the ideal of a transparent interface. The methods and theories apply to both traditional and in advanced modern user interfaces as well collaboration work with multiple users. Susanne is internationally highly recognized for this work and she is the most cited researcher

in Denmark within the field of Human Computer Interaction (HCI).

Susanne Bødker has been awarded several prestigious international awards for her work in the field of Human-Computer-Interaction: including ACM SigDOC Rigo award 2008 for her extraordinary contribution to participatory design, CSCW and human-computer interaction. Since 2010, Susanne has been a member of ACM CHI Academy.

Susanne Bødker (1956) took her PhD degree at Department of Computer Science in 1987, when computer science still belonged to Department of Mathematics at AU. In 1999 she took her doctoral degree and since 2001 she has held the title of Professor in Human-Computer-Interaction at AU. Since February 2012 Susanne Bødker has been a member of the university's board, and also a member of the Committee on diversity at the university, since the committee was established in 2012.

Since 1997, Susanne has been a member of a large number of different research councils: including the Danish Technical Research Council (1997-2003), chairman of National IT research grant's committee (2003-2004). Last but not least, Susanne has become member of the European Science Foundation's Standing Committee for Physical and Engineering

Sciences as well as the Council for Technology and Innovation.

Susanne Bødker has been head of the interdisciplinary research centre PIT (Participatory Information Technology), at Aarhus University which combines the areas of technology, development and users with a near-democratic practice in the workplace.

On the private front, Susanne is also very active. As a member of the Board of Directors of Mols Bjerge Nationalparkfond she is working on developing the national park and ensuring that the general public will be involved in decisions in this respect.

IVAN DAMGÅRD 60 YEARS: DENMARK'S GODFATHER OF CRYPTOGRAPHY



Ivan's research has made a major impact on the crypto scene worldwide, making him one of the most prolific and influential authors in the cryptographic research community.

His ideas have had a major impact in shaping many areas of cryptography such as foundations and practical deployment of multiparty computation protocols, design of hash functions, secret-sharing, zero-knowledge protocols, quantum cryptography, and more. Ivan's resume is hence very impressive, so below is just a glimpse of things he has done in his career up to today:

Ivan was born 17 April 1956, and received his PhD in Mathematics and Computer Science from Aarhus University in 1988. In 2005 he became professor in Computer Science, and still holds this position. Ivan has built up the cryptography group in Aarhus, which now is one of the strongest cryptography groups in Europe. During his time in Aarhus Ivan has supervised 50 Master thesis students, 30 PhD students and 15 postdocs.

Ivan has been very productive in attracting funding to facilitate his research, and at the moment he is in charge of two major research projects, Center for Research in the Foundation of Electronic Markets (CFEM) and an Advanced ERC Grant MPCPRO. In 2015 he co-authored the book "Multiparty Computation and Secret Sharing" with Cramer and Nielsen.

Ivan has received several honors and awards for his work within cryptography

and cryptography. To mention a few he was named Fellow of the IACR in 2010; he received the RSA Conference Award for Excellence in Mathematics in 2015. He is editor-in-chief for Journal of Cryptography, a board member at Rådet for Digital Sikkerhed and a member of the independent member-driven think-tank The Danish Academy of Technical Sciences (ATV). Ivan is co-founder of the IT companies Cryptomathic, Partisia and Sepior. In 2016 he was awarded the Order of the Dannebrog for his lifelong determined research results.

Besides his talent for research, Ivan is also an active musician within the Danish folk music genre. He plays both the violin and guitar, and plays in various bands. In 2007 he received a Danish Music Award (DMA) in the folk music category as Composer of the Year. In 2014 he was appointed Rigsspillemand, which is the finest appointment within the Danish Folk Music genre.

PROFESSOR LARS ARGE IS NEW SECRETARY GENERAL OF THE ROYAL DANISH ACADEMY OF SCIENCE AND LETTERS



Lars Arge, Professor in Computer Science at Aarhus University and Director of the Danish National Research Foundation Center for Massive Data Algorithms (MADALGO), has been appointed

new Secretary General of the Royal Danish Academy of Science and Letters as of October 27 2016.

- I am very honored to be chosen for this important and exciting position in the Academy, which represents the very top of Danish research, states Lars Arge.

The Royal Academy of Sciences is an almost 275 year old institution, founded in 1742 by King Christian VI. The Academy has 250 national and 250 international members. The aim of the Royal Acad-

emy is to help strengthen the position and significance of basic research in Denmark.

Approximately two-thirds of the members are from the humanities and social sciences and three-fifths from the natural sciences.

- The Academy serves as a meeting place for top researchers in Denmark. We gather approximately 15 times a year and engage in many interesting interdisciplinary discussions. As the new

Secretary General, I will be managing the secretariat of the Academy in close corporation with the head of secretariat. In addition I will e.g. participate in various grant and awards committees, protect the Academy's interests through meetings with relevant politicians and

government officials, and in general represent the Academy together with the President, says Lars Arge, who is also Director of the Danish National Research Foundation Center for Massive Data Algorithmics (MADALGO).

Apart from the closed meetings, the Royal Academy organizes a number of public events, symposiums and lectures, including lectures by Nobel Laureates.



PhD 2016

HALL OF FAME

The department has a long tradition for educating excellent PhDs. Since 1975, 272 have completed a PhD degree in computer science from Aarhus University. In 2016, 11 new PhDs completed their studies. Meet each of them on the following pages.



Michael Lind Mortensen

Data-Intensive Systems

Supervisor: Ira Assent

Date: January 29, 2016

Multi-Criteria Decision Support Queries in Exploratory & Open World Settings

When presented with a multitude of options to choose from (e.g., houses, cars, hotels, etc.), filtering those options to find the most interesting is an all too common and time-consuming task for normal users.

During his studies, Michael investigated how to alleviate some of this filtering burden through so-called multi-criteria decision support queries. These methods take the initial set of options and filter them into a smaller, more manageable, set that captures the preferences of users. Historically these techniques have been ill-suited for real users and real world contexts, either being ignorant to how users learn about their options or being unable to actually adapt to the real-world preferences of users.

Michael's research findings have contributed to bringing these techniques closer to real world application, introducing both techniques for supporting the user in exploring their options efficiently, as well as techniques for adapting multi-criteria filtering to the open world; i.e., the real, ever-expanding, and unknown world in which users actually make decisions, rather than the limited closed-world model defined by our database.



Rasmus W. Zakarias

Cryptography and Security

Supervisor: Ivan Damgård

Date: March 22, 2016

Practical Secure Computation with Pre-Processing

During his PhD studies, Rasmus Zakarias researched secure computation – a general tool enabling a group of distrusting stakeholders to compute any function over their assets (information). Specific applications include elections and auctions, where assurance that the outcome is correct is paramount while maintaining complete privacy of votes or bids.

When more than one third of the parties are potentially corrupt, secure computation is impractically inefficient. One way to overcome this is to allow a pre-processing phase where the parties prepare to do some computation in the future. Rasmus Zakarias further developed this line of work with several results that improve the theory of the current state of the art, as well as implementations and experiments demonstrating their usefulness in practice.



Matthias Nielsen

Ubiquitous Computing and Interaction

Supervisor: Kaj Grønbaek

Date: April 20, 2016

Interactive Visual Analytics of Big Data - a Web-Based Approach

During his studies, Matthias Nielsen researched how internet browsers can be used for enabling professional and private non-programmer users to perform exploratory visual analysis of Big Data. Traditionally, exploratory visual analysis of Big Data has been confined to extensive software suites and has been performed by expert users. To improve this, Matthias Nielsen has developed new apprehensible visual representation for visualizing large datasets. Furthermore, he has described and documented techniques for efficiently visualizing large datasets in internet browsers. Lastly, he has developed new ways of using input from touch-screens to interact with data interactive data visualizations.

Together, these contributions advance facilitating visual data analysis for non-programmer users by enabling apprehensible interactive visual analysis of large datasets in internet browsers.



Aleš Bizjak

Logic and Semantics

Supervisor: Lars Birkedal

Date: May 15, 2016

On Semantics and Applications of Guarded Recursion

In mathematics and computer science, it is often necessary to describe objects in a self-referential way. Guarded recursion is a way of ensuring that self-referential descriptions describe unique objects.

In the first part of his dissertation, Aleš Bizjak studied the semantics of programming languages with features such as non-deterministic and probabilistic choice, polymorphism and local state. These are difficult to reason about, especially in combination, and guarded recursion provides a simple solution to some of the challenges.

In the second part of his dissertation, Aleš Bizjak studied the semantic foundations for type theories with a special 'later' modality, which is used to guard self-references in recursive definitions. The semantic foundations ensure that the type theories are consistent, which roughly means that they cannot be used to construct things we do not want. These semantic foundations were used in the design of a type theory, the purpose of which is to aid in the construction of models of programming languages, such as the ones considered in the first part of the dissertation. The description of this type theory forms the final part of the dissertation.



Esben Andreasen

Programming Languages

Supervisor: Anders Møller

Date: August 24, 2016

Designing Abstractions for JavaScript Program Analysis

During his PhD studies, Esben Andreasen researched the use of program analysis for programs written in the JavaScript programming language.

Program analyses, such as dataflow analyses and type systems, can be used to guarantee behaviors of programs. A classic guarantee of interest is that analyzed programs do not crash; more technical guarantees can be used to optimize analyzed programs.

JavaScript is a widely used programming language, famously used for creating interactive web pages. However, programmers code JavaScript programs in so complex ways that program analyses often give up when trying to reason about them. Program analyses for other programming languages, e.g. Java, are often more useful since they are analyzing relatively simpler programs.

In his research, Esben Andreasen shows how various program analyses can be designed and improved to reason more precisely about real-world JavaScript programs.



Fabio Strocco

Programming Languages

Supervisor: Anders Møller

Date: September 8, 2016

Type Soundness in the Dart Programming Language

During his studies, Fabio Strocco researched novel type systems and program analysis techniques for Dart.

Dart is a programming language designed by Google to develop for the web, the mobile and the Internet of Things. The language was presented for the first time at the GOTO conference in Aarhus, in 2011.

Fabio Strocco built a mathematical model of Dart to use as a foundation for investigating some of the most controversial language design choices. He discovered that small reasonable changes of the specification can probably give more guarantees on programs' behavior and showed experimentally that some of these changes would not hinder programmers. Fabio Strocco designed and implemented a novel technique to find errors in existing Dart programs, which has been shown to be effective on a large set of Dart projects.

Together, these contributions can drive future language design choices and improve tool support for Dart and similar programming languages.



Allan Stisen

Ubiquitous Computing and Interaction

Supervisor: Kaj Grønbæk

Date: November 1, 2016

Mobile Sensing and Recognition of Human Activities to Support Work Coordination

During his studies, Allan Stisen has researched methods that can support the coordination of logistical tasks at hospitals. The methods he developed are based on data from modern smartphones, and the methods can automatically recognize the status of the logistical workers' (e.g., orderlies') tasks.

Moreover, the studies have also analyzed the work coordination that takes part in the logistical work, and they have focused on how the workers achieve overview. This has led to the development of different tools, which can support the workers in their decision making, when they have to plan their schedules. These tools will enable the orderlies to achieve efficient schedules, and enable more efficient flows at hospitals.



Mads Møller Jensen

Ubiquitous Computing and Interaction

Supervisor: Kaj Grønbæk

Date: November 2, 2016

Game Mechanics and Bodily Interactions: Designing Interactive Technologies for Sports Training

During his studies, Mads Møller Jensen researched the design and development of interactive systems for sports training inspired by computer game elements. Bridging computer technologies, sports training and game design holds multiple advantages for creating innovative sports training experiences, for example, flexibility in the number of players required in an exercise (including facilitating self-training in team sports), stronger motivation through game and competitive elements as well as novel training aspects, including cognitive processes and perception.

Mads designed and developed prototypes of such interactive games for sports training in football and handball, and studied how they are used by athletes and how they affect the training outcome as well as the player experience. His prototypes and studies show that bridging computer technologies, sports training and game design is possible and can facilitate the design and development of novel technologies that leverage quality, engagement and enjoyment of sports training.



Carsten Baum

Cryptography and Security

Supervisor: Ivan Damgård

Date: November 7, 2016

Towards More Efficient Secure Multiparty Computation in the Preprocessing Model

During his studies, Carsten researched the design of protocols for secure computation. Here, two or more computers exchange information over a network in order to evaluate an algorithm on input data that these computers provide. The aim is to obtain a correct result, while keeping the input secret - even in the presence of participants that actively try to learn (secret) information or tamper with the output of the computation. These interactive protocols have applications to e.g. online voting, auctions and the processing of medical or financial data.

The new research findings contribute to the understanding of the efficiency of these interactive computations in the so-called preprocessing model: Here, some algorithm is run in advance in order to speed up the overall computation. The results also lead to the design of efficient, secure protocols with new properties.



Hans Bugge Grathwohl

Logic and Semantics

Supervisor: Lars Birkedal

Date: December 6, 2016

Guarded Recursive Type Theory

Guarded recursion is a technique for ensuring uniqueness of objects defined using self-reference.

In his dissertation, Hans Bugge Grathwohl studies type theories which include a special modality used to guard self-references in recursive definitions. These guarded recursive type theories can both be seen as programming languages for which we get certain guarantees about programs handling potentially infinite recursive data (such as streams of data), and as frameworks for formalizing mathematical models of programming languages with features such as recursive types, higher-order store, and concurrency.



Tobias Sonne

Ubiquitous Computing and Interaction

Supervisor: Kaj Grønbæk

Date: December 20, 2016

Assistive Technologies to Empower Children with ADHD: **Conceptual Framework and Technical Solutions**

Approximately 5-7% of all children and young people suffer from ADHD (Attention Deficit Hyperactivity Disorder) and the disorder is, among other things, associated with poor concentration, sleep problems, social and academic challenges as well as poor quality of life. This constitutes a major loss for society and an even greater loss for the individual with ADHD, because the disorder will affect them throughout life.

During his PhD program, cand.scient. Tobias Sonne conducted research into the design and development of interactive technologies to strengthen and support children with ADHD. In his research he has collaborated with leading specialists, psychologists and researchers from Denmark and abroad to design innovative technologies that can support children and adolescents with ADHD. Tobias has developed three technological solutions, including a mobile application, each of which focuses on children's challenges with ADHD. The three developed technological solutions have been evaluated with children with ADHD and have shown an improvement in reported ADHD symptoms and improved sleep quality.

03

Education



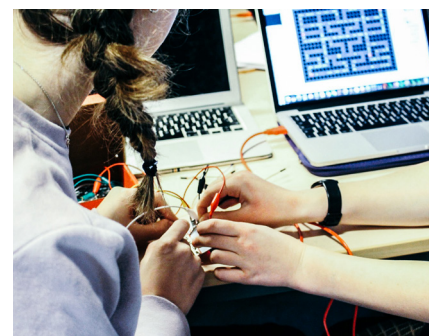
Successful IT Camp for Girls

In October, the department hosted IT camp for girls, which is an annual event for girls in upper secondary school. 37 girls took part in this year's event, making the IT-Camp as popular as ever in its 10 year lifespan.

During the three days, the girls participated in lectures, workshops, and company visits to give them a better understanding of what an education in Computer science or IT product development consist of and can result in.

In IT, women are generally under-represented. The IT camp is an initiative to get more girls interested in an education in IT, and in the longer run to get a more gender-balanced profession. From the event evaluation, it is clear that the camp meets its purpose of showing young girls that IT certainly is for women.

More info: itcamp.dk



Before the camp, did you think an education in IT was interesting?

Definitely	17%
Mainly Positive	40%
Maybe	23%
Mainly Negative	3%
Not at all	14%
Didn't know it existed	3%

After the camp, did you think an education in IT was interesting?

Definitely	46%
Mainly Positive	28%
Maybe	26%
Mainly Negative	0%
Not at all	0%
Didn't know it existed	0%

Join us at

AUHack

2017

**AROUND 200 STUDENTS, FROM ALL OVER THE
WORLD, ARE EXPECTED TO VISIT IT CITY
KATRINEBJERG FOR THE SECOND EDITION OF
"AUHACK" FROM MARCH 31 TO APRIL 2, 2017.**

AUHack is part of "Major League Hacking", and Aarhus University's largest hackathon. Over a 36-hour period, students interested in IT development and IT design will meet and collaborate intensively to create prototypes and concepts.

The goal is to bring students from different fields of study and universities together, and to set a framework where they can carry out projects and ideas. Students from all study programs are welcome, and everybody is there to help each other and to have fun.

Read more and apply at auhack.org!





New Online Test:

Measures How Much of a Computer Scientist You Are

Professor Michael Schwartzbach, from Department of Computer Science at Aarhus University, has created an online test where people considering a career in IT can test if they have the mindset of a computer scientist - before applying to Aarhus University. The test sums up how many percent computer scientist you are.

The test has gone viral and has been completed by more than 10,000 people since the introduction. Two of them are Daniel Hoffmann and Muhammad Gökhan from Aarhus Stats Gymnasium. The two boys are in their second year of high school, and still have some time to decide what they want to study. Both are interested in science subjects and expect to apply for a Master's degree within chemistry and medicine when finished with high school.

Armed with a calculator, pen and paper both boys are ready to complete the test. They expect to be challenged with questions about physics, math, programming and integral calculus.

"It is a really good idea with such a test, so you can get a sense of what the programme is all about before applying," says Muhammed.

"With the test we aim to inform peo-

ple that computer science is not only about technology and programming, but equally as much about logic and mathematics. The test is mainly made for fun, but I hope that it also can help to break some of the prejudices about computer science and at the same time align future students' expectations to the skills needed to become a computer scientist," says Michael Schwartzbach, who is excited about the fact that not only potential students take the test but

The test is created for potential new bachelor students but is open for all, anonymously, at www.cs.au.dk/erdudatalog

The test has 24 questions about topics such as hippos, shoes, bats and environmental poison. You will be tested within logic, linguistics accuracy, combinatorics, and probability. The test is currently only available in Danish.

also many people in the IT industry.

Let's test if you could become a computer scientist

More than 10,000 people have completed the test, and the statistics show that even though the test is hard many still get a really good result. Michael Schwartzbach has had many enquiries from computer scientists who wonder

why the test is based on math and logic rather than the more technical aspects a computer scientist works with.

"The aim of the test is not to figure out if you already are a computer scientist, but rather if you might want to become one. The test is created to pique curiosity and to give people an idea about which qualifications are needed to complete

the study programme. Based on the experiences and feedback, we aim to create an updated version for 2017," concludes Michael Schwartzbach.



KDAG 2017

KATRINEBJERG CAREER FAIR

7. APRIL 2017
11-16

NYGAARD BUILDING, FINLANDSGADE 23, 8200 AARHUS N
KDAG.AU.DK

**KDAG 2017 PRESENT A GREAT
POSSIBILITY FOR OUR STUDENTS TO ENGAGE
FACE TO FACE WITH IT COMPANIES LOOKING
FOR TALENTED GRADUATES AND STUDENTS
FROM OUR DEGREE PROGRAMMES.**

Around 40 companies will be waiting in line to present themselves at the intense One-minute-madness session, followed by conversation with students and visitors at the company stands in the Nygaard building.

Acknowledgments

ST EDUCATION AWARD 2016



The ST Education Award 2016 went to Associate Professor Niels Olof Bouvin, Department of Computer Science after being nominated by both students and the department.

“Niels Olof Bouvin is an extremely dedicated lecturer. Even though he teaches the courses with the highest number of students at the department, he takes his time to get

involved in each student project.

Niels Olof is also an extremely skilled lecturer. He is known to be a teacher who cares about the students' well-being during the course. He is very committed to the subject he teaches, which highly motivates the students. Moreover, he is not afraid to incorporate new elements in his lectures such as review of product videos that are subsequently dismantled and analyzed.

Niels Olof always publishes podcasts of his lectures. This gives the students the opportunity to check details in the course topics after the lectures, and helps streamline the preparation for exams.

In addition to all this, it should be mentioned that last year, the students at Computer Science voted for Niels Olof as 'Teacher of the Year'. The argument was that Niels Olof, with extraordinary knowledge and commitment manages to present the subject in a humorous and convincing manner”.

Congratulations to Associate Professor Niels Olof Bouvin with the ST Education Award 2016.

CS AWARD WINNERS

As it has been a tradition for the last couple of years at Computer Science Day, the winners of the Teacher of the Year, TA of the Year and student Awards were announced. The winners were:



Teacher of the Year 2016:
Henrik Bærbak Christensen

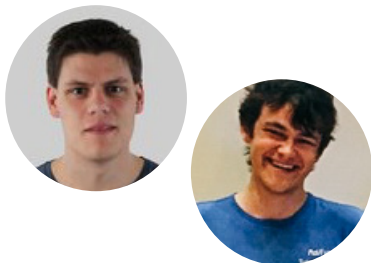
Five people were nominated for the award. They all got excellent teaching evaluations, however, Henrik got 33% of the votes.

STUDENT QUOTES FROM THE COURSE EVALUATION:

“Henrik is an extraordinary teacher and he has succeeded in getting SoftArk and CloudArch to be two of the most instructive and interesting courses I have ever had”

“Fantastic and total up-to-date technologies and theories”

“A highly competent teacher”



Teaching Assistants of the Year 2016:
Ingo van Duijn and Asger Hautop Drewsen

Awarded to two teaching assistants with consistent outstanding evaluation scores and remarks in course evaluations.

Student Award 2016:
Mathias Pedersen, Mikkel Brun Jakobsen and Thor Bagge for Spare Time Teaching

With Spare-Time teaching Mathias, Mikkel and Thor have contributed to the study-environment, originated extracurricular activities, or in other ways has initiated activities for the benefit of the dept.

Spare-Time Teaching is an open

learning platform, that organizes weekly Friday talks and monthly social events related to computer science.

Spare-Time Teaching was created for students who want to share ideas and experiences, find like minded students, or just want to learn more. Spare-Time Teaching is completely non-profit, and all the talks are held by student volunteers.

This also means that the subjects are usually outside of the university's

curriculum, or practical applications and experiences with the curriculum. Everybody is welcome to attend or present.

04

Outreach



Ceptu:

Space Technology Ensures Higher Yields for the Farmer

“FieldSense” is the name of a new application which gives farmers updates on the development of their crops using high-resolution imagery from earth observation satellites.

“FieldSense” is a good example of a Danish space technology which can contribute to the growth of both smallholder and large-scale agricultural businesses. The application for web and smartphone devices helps Danish farmers achieve higher crop yields by providing images of the crop vegetation from satellites. This allows farmers to take early action against pests, diseases, and other crop related issues, reducing the impact of such attacks on crop yield.

Earlier this year, the invention was acknowledged by the Ministry of Higher Education and Science in Denmark’s

national space strategy as a particular example of a Danish space technology, which contributes to growth. And even though the startup company Ceptu that is behind FieldSense is proud to be pointed out in the Danish government’s national space strategy, it was never an ambition from the beginning.

- It is important that the Danish government focuses on space technology and it’s nice to be identified as a positive example of sustainable growth. But with FieldSense we really just do what has always been our objective in Ceptu: to give Danish

farmers a tool to ensure greater yields by automatically being able to detect problems as well as to be able to manage more intelligently the amount of fertiliser and pesticides used,” says John Smedegaard, Managing Director at Ceptu.

Big Data analysis is the next step

FieldSense is thus a good example of how you can use Big Data and the satellite area to start up a new business area. The application sends farmers notifications about, for instance, growth issues or that more or less fertilizer is needed.

- Ceptu currently has 12 employees and is based in the incubation environment "HatchIT Lab" at Department of Computer Science at Aarhus University.
- The company has been working on the technology behind FieldSense since 2013.
- FieldSense was in May 2016 highlighted by the Ministry of Higher Education and Science in Denmark's national Strategy for Space, as a particular example of a Danish space technology that contributes to growth.

- The trend points in the direction of having fewer farms that simultaneously become larger and more difficult to monitor. Furthermore, technology in agriculture has seen a boom in recent

years and the next step will be solutions that make use of artificial intelligence. We are focusing on developing a unified platform that adds value to the agricultural sector and makes sense for

the individual farmer, says Martin Kjeld Pedersen, co-founder of Ceptu.





HatchIT Lab

Experimental innovation lab for student entrepreneurship and startups

HatchIT Lab is an experimental innovation lab and incubator environment based at the Department of Computer Science. The lab is created for IT students who wish to start their own business. All students from IT City Katrinebjerg have the opportunity to apply for a place in HatchIT Lab, including students from:

- Computer Science
- IT Product Development
- Engineering in Information Technology (IKT)
- Computer and Electronic Engineering

The aspiring entrepreneurs can apply for admission to HatchIT lab during the last half of their master program and 12 months after completing their studies.

An open innovation environment for IT students

In HatchIT Lab, you can develop a startup idea in a business-oriented incubation and innovation environment. The lab is located closely to the IT research and educational facilities at Aarhus University.

Hereby, HatchIT Lab contributes to

collaboration between students, researchers and companies. As an open innovation environment, HatchIT Lab supports sharing of knowledge and experiences between students, entrepreneurs, small and medium-sized businesses and well-established companies.

Follow HatchIT Lab:
facebook.com/hatchitlab

Six companies currently reside at Hatch It Lab:

Ceptu



Ceptu aims to build easy-to-use services for the agricultural industry. Founded in 2014 by a group of computer scientists, the startup combines state-of-the-art satellite technologies with the ubiquity of smartphone, tablet and web applications to bridge the gap between research and the practical application of farming technology. The company's app FieldSense helps farmers throughout Europe for the coming cultivation seasons.

MONTEM



MONTEM is a product development agency specialized in Internet of Things and smart consumer products. Based on current research trends, MONTEM designs and develops products with the end-user in mind. The people at MONTEM have a strong interdisciplinary background in Computer Science and Product Design from Aarhus University and Aarhus School of Architecture.

Cope IT



Cope IT strives to provide world-class digital solutions that support dental practitioners in providing superior experiences for patients. The company builds on a solid research background within patient care and technology-supported treatment of anxiety. For example "PI Dental" is an IT-based patient communication platform that increases patient treatment acceptance and attracts new patients.

Bioremind



BioRemind is a digital refreshing to an analog industry: By providing a platform for psychologists and therapists who wish to provide their treatment strategies digitally to their clients. The psychologist can fast and easy subscribe a customized app with their own content so the strategy is right at hand when the help and support is really needed.

Zeppelin



Zeppelin Studio was founded in Vienna, Austria in 2013, by two Game Engineering students. Using their award-winning pilot project Schein as a stepping stone, Zeppelin Studio has succeeded in establishing a solid foothold in the international gaming industry. The company is dedicated to delivering games with substance, where story, gameplay, art, and sound harmoniously intertwine.

Abrella



Abrella creates intelligent umbrella sharing systems, giving people access to umbrellas on-demand. The umbrellas are free to use and circulates the city on selected pick-up and delivering spots. Byaparaplyen.dk is currently available in Aarhus, Silkeborg and Herning, with more cities to come. In 2015, the Abrella-team won the Entrepreneur Award (Iværksætterprisen) in Business Region Aarhus, which is awarded to the most successful entrepreneurs in East Jutland.



EcoSense Results Produce New Research Challenges

The 4-year research project EcoSense has concluded and has resulted in many achievements that give rise to new research challenges in areas such as big data, visual analytics and mobile sensing.

EcoSense has approached various research challenges in connection with detecting, monitoring and dealing with our CO2 footprints and has explored this research theme from an ethnographic, environmental and computer science research perspective.

- It is important to combine hard and soft data and understand them in context. EcoSense has developed new visualisation tools that show this particular combination, so we can better analyse the gathered data. The project has also helped to un-

derstand human activity in traffic and in buildings via mobile sensing, and we have built robust data collection platforms, says Professor Kaj Grøn-bæk, who has led the research project in cooperation with a number of companies and other research institutions

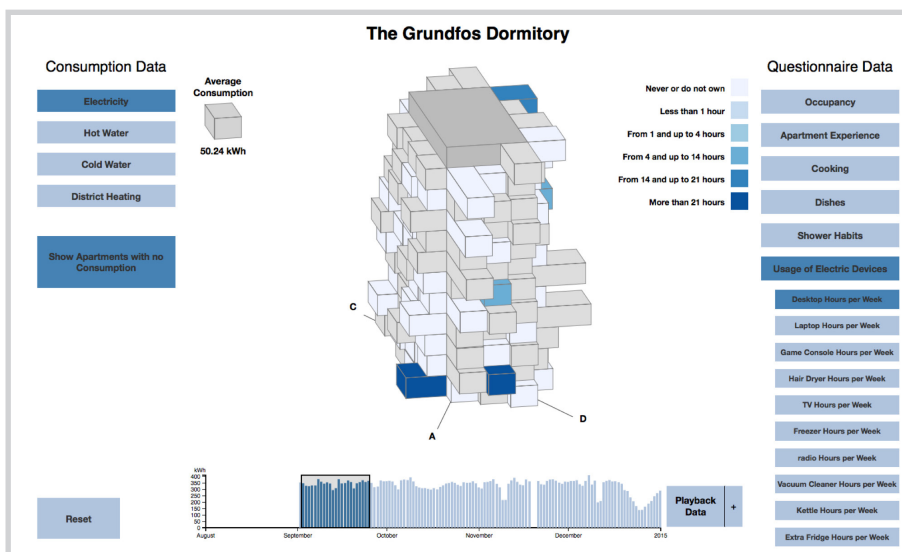
Research challenges

Platform and apps to detect traffic behavior

Researchers in the EcoSense project have collected data from mobile phones and sensors from buildings

with the aim of understanding and changing people's traffic behavior. They have primarily used mobile sensing techniques and worked to develop a robust method for detecting transportation mode – if people are walking, running or cycling and to get an overview of the carbon footprints produced during transportation. Combined with interventions such as apps that encourage people to cycle or choose an electric car.

They have developed a scalable and robust platform that collects data – i.e. Grundfos. In this context, a number of



apps have been developed:

- Ready for electric car
- Herning Bikes
- Zero bike

Four prototype apps perform analyses for the end users. All data are collected when running the app, and they get a complete picture of the transportation mode - anonymously. It is still a complicated research problem as it is difficult to obtain accurate recognition especially in the rush hour traffic. Slow driving in car parks may for example be interpreted as bike behavior. It is a balance between having the sensors always on or saving battery power.

The Grundfos dormitory as a living lab

EcoSense focused on the Grundfos dormitory at the harbour of Aarhus as a living lab. They used the 3-4000 sensors to collect all sorts of data in the building with very high frequency - e.g. water consumption, indoor climate etc.

The project carried out a number of experiments with the residents to change energy behavior and measure if it actually happened. Methods such as gamification - share resources with the room you live in. If you use much power you have few resources in the game. Awareness of low-cost periods.

Questionnaires provide a general

picture of the persons, their attitudes and values. Workshops provide input for project prototypes. Home visits/ qualitative interviews provide deeper insight into practice. They do not think of themselves as consumers of energy - we have developed a Contextual Wheel of Practice which illustrates their view on energy consumption and we have worked with it from multiple angles to understand how we can influence people's behavior.

The project has developed new visual analytic tools which is a way of involving the users and help them to better understand practices.

New tools for analysis and visualization

One of the research challenges has been to develop new tools for visualisation, so data can be attached to something recognisable. Hard data from the smartphones combined with disciplines that analyse human behavior in cooperation with environmental anthropologists. 100 kilobytes per second have been analysed and the project has developed analytical tools for this purpose. Visual analysis is an effective way for non-programmers to analyse large amounts of data. By working with visualisation of big data, we see surprising connections and patterns that we could not detect before knowing the context.

Future use of results

Huge amounts of data are stored and this is accumulating, however, only 3% of the data are tagged or analysed, where they come from and what they describe. In the future we will investigate the core areas within big data research:

- Scalable data acquisition platform to perform human activity analyses
- Transportation mode detection, crowd sensing technology, hospital logistics, machine learning - pattern recognition on raw data sets.
- Visual analytics allows us to continue working with interactive visual analysis
- Energy management through Big Data
- Traffic management through Big Data
- Flooding risk analysis

More accessible big data analytics tools will now be investigated in the new partnership DABAI (www.dabai.dk).



Discover Floods, Even Before the Rain Comes

A new digital map can predict where rainwater will run during a flood. This provides states, municipalities and utility companies a range of new possibilities for climate adjusting cities, and for knowing when emergency response must be deployed. The digital flood map is developed by SCALGO in cooperation with Aarhus University.

The start-up company SCALGO is an offshoot from the research center MADALGO, and is an example of how breakthroughs in research – in this case handling of large data sets – can be transformed into concrete tools.

Big Data provides opportunities for small businesses

Huge amounts of data are handled when simulating the consequences of a flood. SCALGO has developed very efficient algorithms to handle the large data sets, and the software has already been sold to a number of municipalities and governmental institutions, as well as engineering

firms in i.e. the UK and USA.

The company is a great example of how it is possible for smaller companies to get into the Big Data era. All over the world, governments have started to make public data available free of charge. This mainly happens in the USA. However, compared to other European countries, Denmark has been quick to make public data, which has previously cost money to access, available for free.

“We see trends in societies that we follow. First, a lot of data becomes very detailed and is therefore difficult

to handle for existing software. Secondly, geographical data is made available on a global scale as a kind of raw material. Governments realize that it might not be possible to finance the costs of having the data collected. Consequently, releasing the data creates more value as focus is shifted from ownership of the data to the benefits that can be created from and with the data. For a research-based company as SCALGO it is important, because we have the knowledge and people it takes to create new and unique applications and services based on the data,” says Morten Revsbæk, Director in SCALGO.

From research to business

Many of the techniques SCALGO uses in the flood map are derived from research breakthroughs in MADALGO. With the flood map, what by some can be perceived as abstract research is transformed into something very concrete and useful.

“The algorithm technology we use is derived from basic research, and in that way we have had a competitive edge in terms of handling large data sets. It is, of course, very satisfying to see how it develops into a practical tool that provides a more accurate representation of the world around us,” Morten continues.

The foundation for SCALGO was made in MADALGO, from which all employees have graduated as PhDs.

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