02

What we do

What we do	Research, education, and innovation
How we do it	Quickly, efficiently, and disruptively
Our aim	To be a high-quality, international research lab where excellent researchers, curious students, and creative innovators can thrive.
Characteristic	Concentrated efforts on important challenges
Values	Truth, courage, and a return on investment for the taxpayers

03

Mission
Simula Research Laboratory conducts research with long-term impact within the fields of communication systems, scientific computing, and software engineering. A strong focus on basic research is combined with the teaching of postgraduate students and the development of commercial applications of the research.

Organisation
Simula was established in 2001 and has been headed by Professor Aslak Tveito since 2002. The company combines academic traditions with recognised business management models. The lab is organised as a limited company owned by the Norwegian Ministry of Education and Research.

Simula Research Laboratory holds ownership in Simula Innovation (100 %), the Simula School of Research and Innovation (56 %), and Simula@UiB (51 %), in addition to ownership in 15 companies organised by Simula Innovation.

Financing
The lab is the recipient of basic allowances from the Norwegian Ministry of Education and Research, the Ministry of Trade and Industry, and the Ministry of Transport and Communications. These financial contributions are imperative and provide the degree of strategic freedom necessary for Simula to perform its unique role in the Norwegian research environment.

Projects are funded through various research and innovation programs, through both the Research Council of Norway and the European Union.

Norwegian Centre of Excellence

Centre for Research-based Innovation

Simula is the proud host of a Centre of Excellence and a Centre for Research-based Innovation.

Simula in Numbers

Key figures

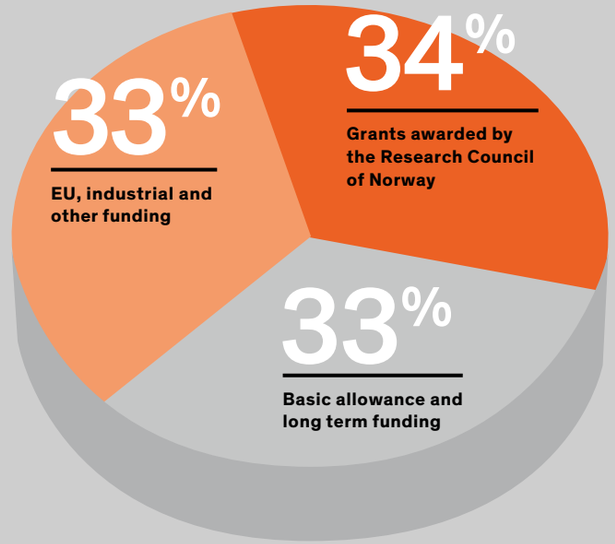
	2014	2015	2016
Operating Revenue	148.5 MNOK	190.8 MNOK	212.6 MNOK
Annual result	-0.5 MNOK	16.2 MNOK	15.2 MNOK
Employees year-end	140	144	151
Active PhD students year-end	34	34	35

Scientific evaluations

Simula sets high standards for its activities, and the efforts have been recognized in the evaluation reports conducted by international evaluation committees appointed by the Research Council of Norway.

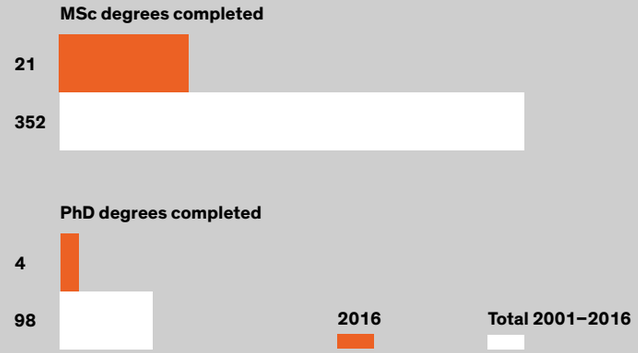
	2001 National evaluation of the initial research groups Scientific evaluation of Simula	2004 Scientific evaluation of Simula	2009 Scientific evaluation of Simula	2012 National ICT evaluation	2016 Scientific evaluation of Simula
Communication Systems	Good	Good, with some very good elements	Very good, with some excellent projects	Very good	Excellent
Scientific Computing	Excellent	Excellent	Excellent	Excellent	Excellent
Software Engineering	Good	Very good	Excellent	Excellent	Excellent

Income profile



Degrees

Since the inception in 2001, Simula's researchers have supervised 98 PhDs and 352 master's degrees to completion in collaboration with the University of Oslo and other academic partners.



All numbers as of 31.12.2016

“The Evaluation Committee is thoroughly impressed by the consistency and high quality of the research activities at Simula Research Laboratory as well as the continued growth in breadth and impact that is evident since the last evaluation.”

“The Evaluation Committee commends the ongoing development of the scientific focus in all three research departments, achieved while maintaining a very high level of the research. It is also encouraging that the organization has worked hard, and with focus, to continue to develop educational and business opportunities during the period of the evaluation.”

* Report from the international evaluation panel, 2017

Professor Aslak Tveito, Managing Director

Here we go again:

The 2016 evaluation is here

When Simula Research Laboratory was established in 2001, we had a contract stating that funding was secured for five years and could be extended for five more years, provided that an evaluation in 2004 proved successful. This fact served as major motivation during our first years and great efforts were made in preparing for the first evaluation. To our delight and great relief, the evaluation was very positive and our contract was renewed until 2010. We immediately started work to obtain a similar contract for a new 10-year period so that a successful evaluation in 2010 would guarantee funding until 2015. That proved extremely difficult. At the time, both universities and research institutes wanted to close Simula down and they pressured the Research Council of Norway and the Ministry of Research to that effect. To our surprise, we received no support from the Research Council in this battle and had to seek political support.

Fortunately, Simula received broad political support: The Norwegian Parliament unanimously decided that Simula should receive a contract until 2015.

The first period, from 2001 to 2005, was very much geared toward obtaining good results in the 2005 evaluation. The second period (2005–2010) was a very real fight for survival, and everyone who worked at Simula at the time could feel it. The evaluation in 2010 was absolutely critical for us to secure continued funding. Indeed, it was very successful and we were able to plan for further development of the lab. In 2012, we were part of a national evaluation, which turned out remarkably well for us: The committee stated that there were only five groups that rated as excellent in Norway in the field of ICT (down from nine in 2001) and two were at Simula. After that, any attempt to dismantle Simula was silenced, but some of our old adversaries have perhaps started to love us more than we appreciate.

From 2011 to today has been our finest period by far. A new generation of researchers has imbued Simula with bold, new ideas and renewed energy, researchers from all over the world contribute to a diverse and vibrant community, and we have many excellent female researchers, when earlier we had none. Our researchers publish outstanding papers in high-level forums, we excel in competitions for research grants from both the Research Council and the EU, we collaborate around the globe, and Simula has close friends in both Norway and California. Our role in the national arena, compared to a few years ago, is now completely different and we supervise many more master’s and PhD students than before. In addition, we own parts of 15 companies, whose gross income has increased from NOK 50 million to NOK 150 million over the last three years. These facts were fully appreciated in the 2016 evaluation of Simula, which praised all three of Simula’s scientific research fields for their significant progress.

Since the beginning, Simula—or parts of the lab—has been subject to no fewer than eight scientific evaluations. In all these evaluations, we received all sorts of advice, some of it very useful and that we carefully followed in later strategies. However, other advice was less well suited for Norwegian realities and was overlooked. The 2016 evaluation has provided an entire series of suggestions for the lab and these will be carefully assessed in the upcoming strategy process.

08

Board and Management

Board of Directors

Ingvild Myhre — **Chair of the Board** | Mats Lundqvist, Pinar Heggernes, Ingolf Søreide, Annik Myhre, Yngvild Wasteson, Silvija Seres, Sverre Gotaas — **Members of the board** | Özgü Alay, Ernst Gunnar Gran — **Employee representatives** | Jan Helgesen — **Deputy board member**

Management Group

Professor Aslak Tveito — **Managing Director** | Dr. Kyrre Lekve — **Deputy Managing Director / Acting Section Director of Communication Systems** | Professor Are Magnus Bruaset — **Director of Section for Computing and Software and the Simula School of Research and Innovation** | Professor Olav Lysne — **Director of Section for Communication Systems** | Ottar Hovind — **Director of Simula Innovation** | Monica Eriksen — **Finance Manager** | Marianne M. Sundet — **Director of Administration**

Scientific Advisory Board: The Simula Board of Directors appoints the Scientific Advisory Board (SAB) in order to ensure external advice concerning Simula's scientific activities. For this purpose, Simula engages internationally recognized researchers, ensuring total coverage of all the scientific fields represented at Simula.

Communication systems

Konstantina (Dina) Papagiannaki, Maha Abdallah, Torsten Hoefler, Kristian Gjøsteen

Software engineering

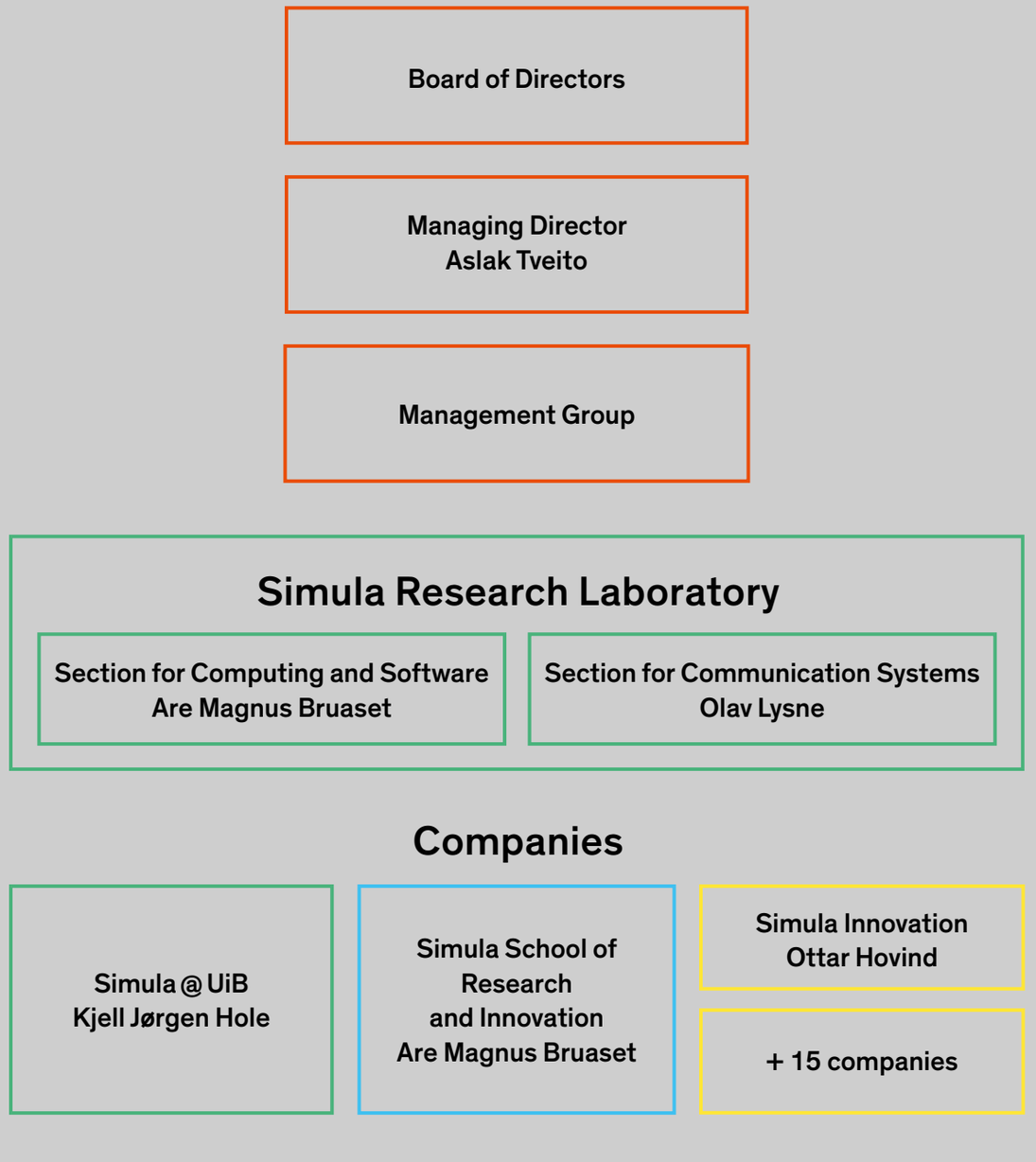
Antonia Bertolino, Laurence Duchien, Franz Wotawa

Scientific computing

Signe Haughton, Ellen Kuhl, Vanessa Diaz, Carsten Burstedde

09

Organisational structure



Diversity

When Simula was established in 2001, the scientific staff consisted mainly of male researchers with a Norwegian background. Over the years, this situation has certainly changed as Simula has matured into a truly cross-cultural workplace represented by both women and men.

So what was the cause of this change? The increased portion of female scientists is a result of targeted efforts. In 2009, Simula decided to take action in terms of improving the gender balance. At the time, a few female PhD students and postdoctoral fellows were employed, but no female research scientists. Goals were set to improve the situation, and specific measures were taken. The work concentrated on the recruitment processes, development of the female talents already employed at Simula, as well as improvement of the working environment in general. This gave good results, and as the figure on the right shows, the female portion is now much better balanced.

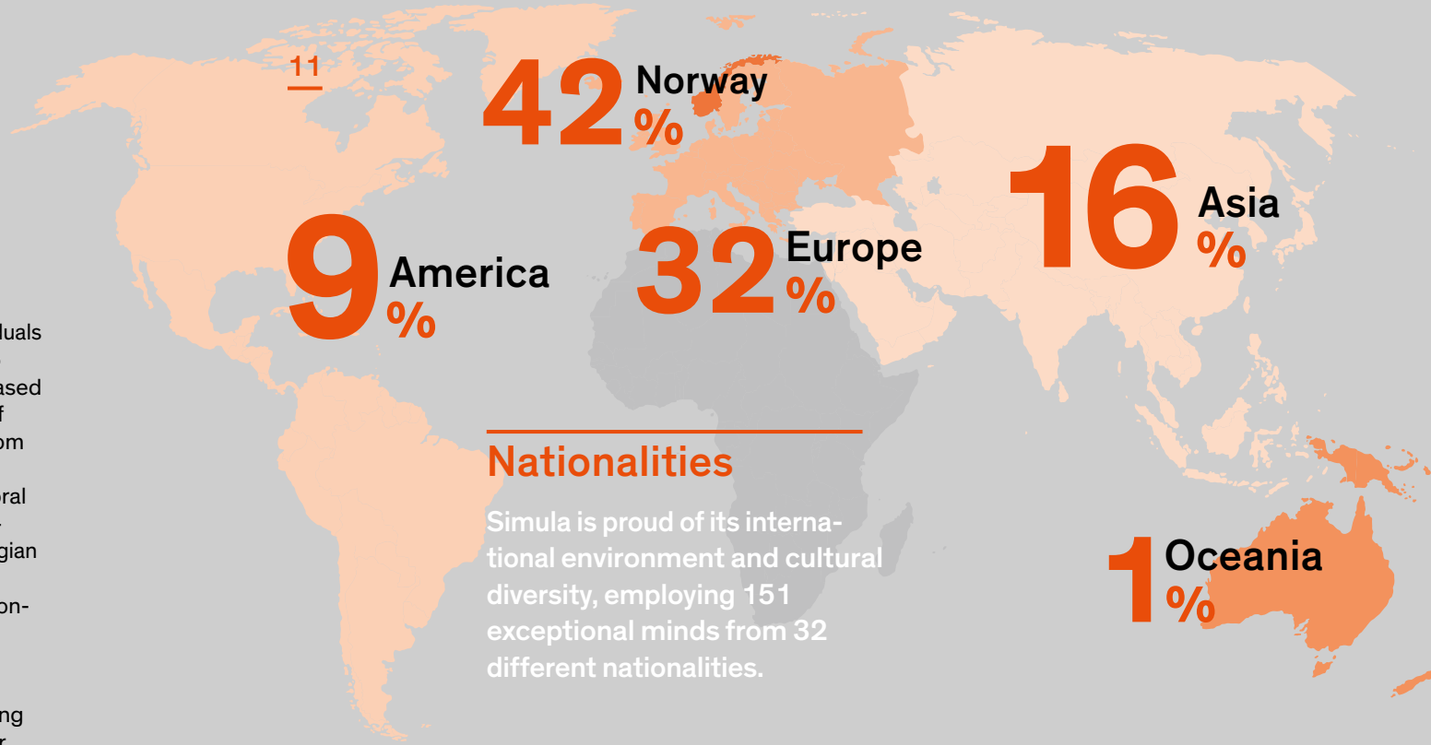
In addition, due to recruiting talented individuals worldwide, the ratio of non-Norwegian to Norwegian employees has steadily increased over the years. Among the total workforce of just over 150 employees, 58 % are not from Norway. Zooming in on the employment categories of PhD students and postdoctoral fellows, the ratios are 69 % and 79 % respectively. Simula supports the non-Norwegian staff in several ways in order to make the transition to their new workplace and environment as easy as possible.

The Minister of Education and Research, Thorbjørn Røe Isaksen, stated the following when Simula received the Ministry's Gender Equality award[1]:

"*Simula has world-class research groups, they hire only the best, and they know that the best are found among both women and men, and from all countries. They prove in practice that diversity can contribute to international success and research excellence.*" (Translation by Simula)

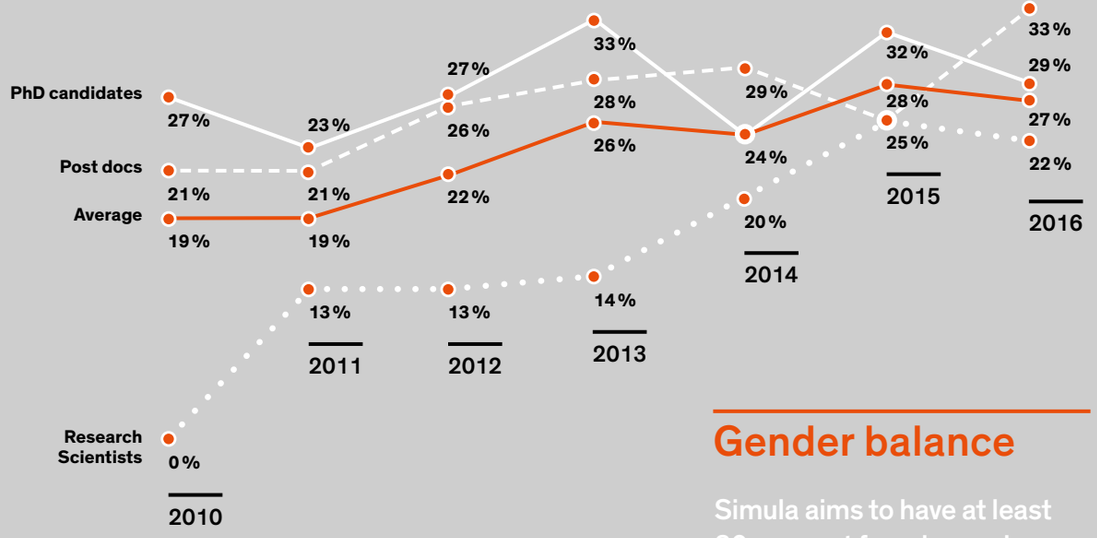
The statement goes directly to the core of the issue: Simula aims to hold a position as a research organisation with excellent results. The only way to achieve this is through an excellent workforce consisting of highly talented individuals – irrespective of national origin, gender, or cultural background. In order to attract, recruit and retain such a group of employees, Simula is committed to providing excellent working conditions. A firm goal for the years to come is to continuously nurture and improve the organisational framework to keep Simula as an attractive workplace for all employees.

[1] **The Gender Equality Award 2013: http://kifinfo.no/nb/2016/05/kvinnesatsing-pa-teknologifeltet-ga-likestillingspris**



Nationalities

Simula is proud of its international environment and cultural diversity, employing 151 exceptional minds from 32 different nationalities.



All numbers as of 31.12.2016

Gender balance

Simula aims to have at least 30 per cent female employees in scientific positions by 2017.

In memory of

Hans Petter Langtangen

1962 – 2016

Professor Hans Petter Langtangen passed away on October 10th, 2016 after an 18-month battle with cancer. He was a brilliant and beloved scientist, author, and educator whose passion and dedication to research resulted in several careers' worth of scientific work. His extraordinarily prolific scientific production encompasses eight books, and numerous publications. His contribution served in many ways to define his field.

Hans Petter's research revolved around numerical methods and scientific software tools for continuum mechanical problems. His approach was truly interdisciplinary: combining mathematics, statistics and computer science to address problems in physics, geoscience, physiology and medicine.

In 2001, Hans Petter joined Simula Research Laboratory as one of its founding professors, and remained a cornerstone of the research and educational environment at Simula. In 2007, he established the Center for Biomedical Computing (CBC), a Norwegian Centre of Excellence dedicated to developing and applying new simulation technologies to reach a deeper understanding of complex physiological processes affecting human health. At the CBC, Hans Petter continued his pivotal role as a visionary driver and advocate for Python-based numerical software, in particular through the FEniCS Project, an open source platform for automated scientific computing. In addition, Hans Petter spearheaded the use of mathematical modelling and numerical simulation in new application areas associated with cardiovascular or neurological disorders such as stroke and dementia.

Prof. Hans Petter Langtangen
Photo: Sverre Jarild

At Simula, Hans Petter had the position of Simula Fellow, which gave him the freedom to do whatever he wanted – and what Hans Petter wanted was to research, program, teach and mentor students.

Hans Petter will be fondly remembered because of his passion for teaching, for his patience and willingness to make sure that his students understood the subject, and for his connection with both students and colleagues. He was an unusually inspirational and visionary man, always providing colleagues and students with enthusiasm, encouragement, inspiration and insight. In 2016, Hans Petter was awarded the Olav Thon Foundation Prize for Excellence in Teaching for his pioneering role as innovator in the teaching of computer programming and in other fields. His courses, ranging from the introductory to the graduate level, became the most popular courses at the Department of Informatics at the University of Oslo. Hans Petter supervised nearly 100 MSc and PhD students, and he was exceptionally dedicated to mentoring and advancing young researchers and scientists.

He will be deeply missed by his family, friends and colleagues all over the world.

Research Education Innovation

A general introduction

Simula is a research laboratory undertaking fundamental research on information technology. The main objective is to drive scientific progress that is of genuine value to society. Our activities are threefold as we combine fundamental research with the education of future scientists and the development of commercial ventures.

Research
The research at Simula is distributed across three main areas within the field of ICT. In the research area Communication Systems, researchers seek to improve the national network infrastructure through the testing of current network applications, and the research and development of more robust networked systems with less latency. In Scientific Computing, scientists are developing computer models of physiological processes in the human body in order to develop new, patient-specific treatment methods. These models require extreme computing power, and as a response to the growing importance of data-intensive systems, Scientific Computing encompasses the development of software that provides easier access to supercomputers for researchers. Large-scale systems are becoming more prevalent, and due to their scale, they are a challenge to test with traditional methods. The research in the field of Software Engineering ensures improved testing through automation. The aim is to reduce downtime and ensure data validity in large-scale software systems. Another branch of the research in Software Engineering aims at improved planning and management of large-scale software development projects.

Education
A large part of striving to provide excellent research is to educate tomorrow's scientists and technology experts. Simula provides educational opportunities from the Master's level through the postdoctoral stage, where the educational activities are closely integrated with research and innovation. Students are involved with cutting edge research, often collaborating with top tier national and international academic institutions. One particular example of such collaboration is SUURPh, a PhD program that ties Simula, the University of Oslo and the University of California San Diego together in addressing research challenges at the frontier of computational physiology.

Innovation
Innovation activities are an inherent part of technology research, as the conceptual work is applied to real life. Simula's innovation activities have produced a total of fifteen spin-off companies, where some of these spin-offs are a result of research carried out at Simula that has been commercialised, and some are the result of investments. Simula is host to the Certus Centre, which is a Centre for Research-based Innovation (SFI) that works with real-life software verification and validation issues in collaboration with industrial partners. Reaching out to local entrepreneurs, Simula provides a focused space in the heart of the research centre for those seeking to build their own technology business. In "Gründergarasjen", or the Simula Garage, entrepreneurs are provided with free office space, relevant support services, and the room to work on their idea.

Mathematics as a New Path to Understanding Human Physiology

Quick facts

Dr. Marie Rognes
Chief Research Scientist, project leader

Research interests: Scientific computing, applied mathematics, numerical methods, partial differential equations, neuroscience

In 2016 Dr. Marie Rognes received the prestigious Starting Grant from the Europan Research Council. The grant is given to young and promising research leaders to promote independence and career development. Within this framework Rognes has recently established a new research group that is devoted to the Waterscales project.

Dr. Marie Rognes
Photo: Bård Gudim

"During the next five years I will work on the Waterscales project, a project dedicated to the mathematical and computational foundations for modeling cerebral fluid flow. The project is funded by a five-year European Research Council Starting Grant and aims at ground-breaking research within Mathematics. ERC Starting Grants are designed to encourage young researchers to gain independence early on in their careers, and I am truly honoured and grateful for this opportunity.

Over the next decades, mathematics and numerics could play a crucial role in gaining new insight into the mechanisms driving water transport through the brain. Indeed, medical doctors express an urgent need for multiscale modeling and simulation – to overcome fundamental limitations in traditional techniques. Surprisingly little attention has been paid to the numerics of the brain's waterscape, however, in stark contrast to the role of simulation in other fields of neuroscience, and key mathematical models and methods are missing. To address this important challenge, the overall ambition of the Waterscales project is to establish the mathematical, numerical and computational foundations for predictively modeling fluid flow and solute transport through the brain across spatiotemporal scales – from the cellular to the organ level.

If successful, Waterscales can open up a new research area bridging the fluid mechanics across scales and the electrophysiology of the brain – with ample opportunities for further mathematical and more applied study. The Waterscales research plan only begins to explore this field. The methods developed will unlock doors in the modeling and simulation of other types of biological tissue and geophysics. The algorithms and computational models developed in Waterscales will be distributed as open source software, and the generic components can readily be used in other modeling and simulation projects.

The societal interest in the brain's waterscape stems from its role in a wide range of neuropathologies. As Europe's population is aging, pathological conditions associated with the cerebral nervous system (brain and spinal cord) such as dementia represent a monumental challenge. Neurological diseases such as Alzheimer's disease, Parkinson's disease and Dementia with Lewy bodies are all associated with abnormal deposition or aggregation of protein fragments within the brain tissue. The brain's waterscape is tightly linked also to other conditions such as oedema, and it is even conjectured to play a crucial role in the purpose of sleep. This project will provide the field with a sorely needed, new avenue of investigation understand these physiological processes and conditions, with long-term clinical impact."

Using Model-based Engineering to Ensure Data Validity

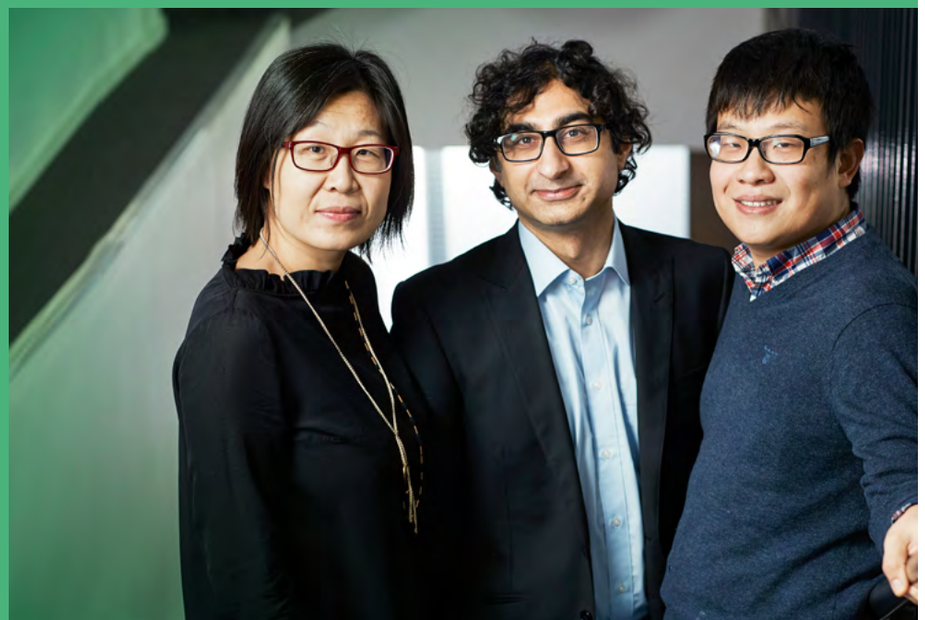
Quick facts

Dr. Tao Yue
Chief Research Scientist, project leader

Dr. Shaukat Ali
Senior Research Scientist

Shuai Wang
Postdoctoral Fellow

MBE-CR: An Innovative Approach for Long-standing Development and Maintenance of the Automated Cancer Registry System



Drs. Yue, Ali and Wang are working with the Cancer Registry of Norway as part of a collaboration with the Certus Centre, a Centre for Research-based Innovation for which Simula is host. Certus collaborates with industry partners in order to develop software engineering solutions for real-life challenges with large-scale software systems, for which the vast database of the Cancer Registry is a prime candidate.

From the left: Dr. Tao Yue, Dr. Shaukat Ali, and Dr. Shuai Wang
Photo: Bård Gudim

> “The Model Based Engineering (MBE-CR) project between Simula Research Laboratory and the Cancer Registry of Norway (CRN) aims at employing model-based engineering (MBE) to facilitate the evolving of the automated cancer registry system of CRN. The key goal of such a system is to validate and check the correctness of cancer data inputted from various medical entities (e.g., clinic hospitals), which relies on a large number of medical cancer coding rules defined by medical experts at CRN. However, a more systematic approach is needed in the current practice of CRN to maintain such a large number of rules, which would make the validation of cancer data costly and error-prone.
>
> The MBE-CR project contributes to dealing with this challenge from both research and innovation perspectives. In terms of research, we first proposed a model-based framework coined as MBF4CR to capture domain knowledge and specify medical coding rules. Second, to further make medical coding rules easy to maintain, we proposed a refactoring approach (named as SBORA) with the aim to improve the understandability and maintainability. We evaluated our approaches using case studies from the Cancer Registry and results demonstrated that our approaches are able to facilitate the current practice of CRN by significantly reducing the maintenance effort of medical coding rules.
>
> With respect to the innovation perspective, we have developed a tool framework named as GURI on the top of our research approaches. GURI can assist medical experts from CRN in 1) managing and maintaining the medical cancer coding rules (e.g., addition and modification); 2) validating and checking the correctness of cancer data collected from medical entities; and 3) reporting errors and warnings to medical experts to take further actions. In particular, we designed an interactive object constraint language (OCL) specification tool named iOCL to reduce the effort and modeling knowledge required from medical experts and thereby facilitating the specification of cancer coding rules as OCL constraints. The GURI framework is currently being tested by medical experts, which will be deployed at CRN soon.
>
> We envision that the MBE-CR project is beneficial to the current practice of the Cancer Registry of Norway as it will ensure the quality of the data in their automated registry. The model-based frameworks under development in this project can be promoted to similar contexts in the healthcare domain.”

100 PhDs at Simula

On Friday the 13th of January Øyvind Evju became the 100th PhD candidate to defend his thesis at Simula.

From left:
Dr. Øyvind Evju and Dr. Joakim Sundnes
Photo: Karl Braanaas

Evju's thesis, titled *Computational hemodynamics in cerebral aneurysms: Robustness of rupture risk indicators under different model assumptions*, investigates how to create computer simulations of blood flow through aneurysms in the brain, which are liable to burst and cause life-threatening strokes.

Joakim Sundnes, now a Senior Research Scientist, was the first to defend his thesis at Simula's Fornebu offices in March 2002. Since then, an increasing number of candidates have completed their dissertation at Simula.

The educational activities at Simula leading to degrees rely on collaboration with universities in Norway or abroad. The University of Oslo (UiO) is the most important collaborator and, by far, most of the degrees supervised at Simula have been awarded by UiO, which also awarded the degrees of both Evju and Sundnes

In the years 2011–2016 Simula has had a yearly average of 8,7 PhD candidates defend their thesis. The completion rate of the PhD students is high and comparable to the high numbers of the national university colleges and business schools. Between 2001 and 2016, 82 % of the PhD candidates have successfully completed their degrees.

Quick facts

Dr. Valeriya Naumova

Senior Research Scientist, Deputy Section Director

Research focus: Inverse and ill-posed problems, statistical learning theory, regularisation theory, signal and image processing

Unlocking the Potential of Machine Learning

Dr. Valeriya Naumova
Photo: Bård Gudim

In the past year Dr. Valeriya Naumova has organised a series of workshops on machine learning. This emerging technology has the potential to revolutionise industry across several platforms and even the way scientists do their research.

"Machine learning is the science of making computers act intelligently without being explicitly programmed in what to search for or what to do. Machine learning has progressed significantly over the past two decades, starting from a minor curiosity in laboratories to practical technologies in widespread commercial use affecting our daily lives without us even knowing it. Examples include voice recognition apps on our smartphones, personalized web searches, recommendation systems on Amazon, Netflix, and self-driving cars.

Machine learning, artificial intelligence, data science, and big data in general, are currently buzzwords in various scientific communities, but also in high-impact scientific journals such as Nature and Science. Regularly, newspaper articles highlight the current impact, but more importantly, project the potential these fields have on future technological developments impacting our everyday lives. E.g., The New York Times claimed these technologies could potentially "reinvent computing itself", and similar quotes can be found in Der Spiegel or Harvard Business Review. However, despite this prosperous prediction of the field, criticism remains strong and hard evidence of true impact is admittedly lacking.

Nowadays, an increasing amount of diverse scientists have started to realize the potential of machine learning, either as an efficient tool for biomedical image analysis or as an accurate predictive tool in biology and genomics, just to mention a few examples. However, even if one wants to learn this new and fascinating field, a newcomer faces challenges of finding relevant or adequate courses, literature, since the material has grown exponentially.

Working closely with the mathematical aspects of machine learning, I have tried to communicate foundational aspects by organizing entry-level courses and tutorials through inviting world-renowned experts to give seminars of a wider scientific interest. In particular, together with Arnaud Gotlieb, we have organized crash-courses on Machine learning gathering 60 international participations, with follow-up seminar series by external guests. In 2017, Simula hosts two international schools together with renowned experts from MIT, University of Genova, Helmholtz Zentrum Munich, and representatives from high-tech companies.

I would love to see usefulness of these courses to be applied in the research of others, and first efforts are truly satisfactory. In a long term, I would like to see one of the research directions at Simula in connection with machine learning, not only as users of the tools, but also as advancers of the field."

Quick facts

Dr. Sven Arne Reinemo
CEO and Co-founder of Fabriscale

Prof. Tor Skeie
CTO and Co-founder of Fabriscale

From Research Project to Start-up Company

As a start-up that springs from the research at Simula, Fabriscale is a good representative of a research and innovation success story. Seven people are presently working for the company, which started as a research project.

From left to right:
Prof. Tor Skeie and Dr. Sven Arne Reinemo
Photo: Bård Gudim

"Fabriscale creates software that controls computer networks. Think of it as software similar to the air traffic control service found at all airports. Air traffic control is responsible for organising and expediting the flow of air traffic, while Fabriscale's fabric management software is responsible for configuring and woptimising the communication going on in a computer network. Fabriscale specialises in smart algorithms that simplify network configuration, management and routing, which improves network performance, network reliability and network monitoring beyond what existing products can provide.

Fabriscale's product is based on more than 10 years of research at Simula Research Laboratory AS and was founded with a wish tocommercialise parts of this research. The commercialisation process for Fabriscale started with a grant in 2010 when the founders received € 20 000 in funding from the Research Council of Norway as part of the FORNY program. The purpose then was to verify the existence of a market for fabric management software based on our research. After several grants from FORNY the technology was verified in 2014 and Fabriscale was founded in September 2014 funded by Simula Innovation AS. Fabriscale completed a second round of funding from private investors in 2016 and we are now in the bring to market phase.

There were many challenges during the transition phase from research concept to start-up company. The first major challenge and one of the hardest was to make the decision to leave research and Simula to focus fully on commercialisation. Another tough challenge was to find employees with the right skill set and the willingness to work for a start-up with limited funds, but we worked this out and now have a great team. It is also tough to be a visionary, which is a responsibility you automatically get when founding a company. Putting the vision on a slide is easy, but implementing it takes a lot of hard work. At our current stage our main challenge is to gain the trust of customers, which I guess is challenging for most start-ups.

Our main focus for 2017 is to build sales through the right partnerships. And we constantly have to focus on maintaining our edge over the competition. In five years Fabriscale will be the world's premier enabler of the software defined data centre."