
simula
20th anniversary

Simula Research Laboratory

Just over 20 years ago, Simula began building a new research organization with the aim of allowing scientists to focus on their work, free from many of the pressures common in academic settings.

Simula is now an organization of over 200 people doing high-quality work within information and communication technology. Simula's mission is to benefit society by solving important problems in science, educating the next generation, and developing profitable tech enterprises.

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Professor Aslak Tveito

Managing Director (CEO) since 2002

My ambition has always been to create a place where people can think.

How did Simula get started?

It might be surprising to hear, but Simula was not started by scientists, it was actually started by politicians. It all began with Norway building a new airport for the Oslo region and leaving behind an airport located in a beautiful place in Fornebu. There were many political discussions about what the old airport should be used for. One suggestion was to try to create a technology hub, and parliament decided that it was reasonable to have a research lab be part of that technology hub. They left the implementation of that tech hub to the Research Council of Norway who, in 2000, held a competition for university research groups that were within the information and communication technology field. They ultimately chose three groups, which came together to form Simula. Simula was officially established as a company in 2002.

And where did the name "Simula" come from? What does it mean?

In the late 1960's, Norwegian scientists Kristen Nygaard and Ole-Johan Dahl developed "Simula," the first object-oriented programming language. They received the A.M. Turing Award in 2001 and the IEEE John von Neumann Medal in 2002 for their work. It felt like an obvious choice to honor that achievement, and the bonus is that "Simula" is easy to pronounce in any language.

When you think back on the early days at Simula, did you think it would grow so much? It began as one company with just three research areas [communication systems, software engineering, and scientific computing] and has grown to have five research areas and has become a group of 6 companies with major collaborative partnerships and research centers.

In the very beginning, it felt like it was all about survival. We needed the Research Council to see Simula as something useful that they should continue funding. And, in order to be useful, I felt that we had to try to grow and expand. So Simula Research Laboratory was soon followed by Simula Innovation, Kalkulo—which was sold in 2019—and Simula School of Research and Innovation. After that came Simula UiB (a collaboration with the University of Bergen), Simula Metropolitan (a collaboration with Oslo Metropolitan University), and Simula Consulting. We've also formed other major collaborations with partners in Norway and abroad, for instance at the University of California, San Diego, the Technical University of Berlin, and The National Institute for Research in Computer Science and Automation (Inria) in France.

That seems like a lot of growth in just 20 years.
Yes, we have grown, but we've tried our best to do it in a systematic way where the Simula culture isn't lost. We have been thoughtful in establishing fruitful collaborations with other institutions, both in Norway and abroad. We've been growing at an average of about 10% per year, which is considerable growth over time but feels pretty manageable from one year to the next.

> *At Simula we are open to new possibilities—when we see a possibility we go after it. We're very opportunistic.*

What are some of the features that you think have allowed Simula to grow so much and to continue receiving government funding?
Since the beginning it has been clear that we should continue to be very active in basic research and in higher level education, and we have, but we've also made a point to always be looking for emerging areas of national and international need. So, for example, when IT security became a big issue of national importance about 10 years ago, we started focusing on that. The same thing happened with artificial intelligence and machine learning. At Simula we are open to new possibilities—when we see a possibility we go after it. We're very opportunistic and, because we're still small, we can move quickly.

What about Simula makes it an organization that's able to take on all of these new opportunities and create new things?
In Norway, you typically have either traditional universities or research institutes that are often very commercial and close to industry. Simula is something in-between. Because of that, we have been given a huge amount of freedom. We are not bound to a certain system that everyone has to adhere to. If we want to try to do something different, we do something different. Maybe we've also been given a lot of freedom because our owners trust that we will make good use of it.

What's the work environment like at Simula, and how do you try to contribute to that environment as a mentor?
Today we have close to 200 employees. I believe over half of the people working at Simula are not Norwegian and about 40 different countries are represented. You'll walk around and hear English, German, French, Mandarin—we're quite international. Even with so many more people than we had 20 years ago, Simula has continued to be a place where people work together and are kind to each other. As a mentor I want to give people the space to grow, to take responsibility for their work, and to become independent. Most of the work people create is very good, and different from what I might have come up with, because if they've been working hard on a problem they understand it better than I do. I generally enjoy leaving people alone to work on their projects, and do not interfere unless I see something that may challenge our values.

The way you describe your approach to mentorship reminds me of a quote I've come across at Simula: *"By thinking constantly about it."* Can you tell me a little about that?
Newton, when he was asked how he came up with the law of gravitation said, "By thinking constantly about it." It's a quote I come back to all of the time because I think it is at the very core of how science progresses, and that it's something we at Simula have always tried to do, and sometimes still struggle to do. If you visit almost any research group in the world, you will find a lot of stressed-out researchers with deadlines for grants and papers, but also teaching and other obligations. And my question is always, "when do these people think?" My ambition has always been to create a place where people can think. I don't think you can stress thinking or think on overdrive. You need to have peace.

> *As a mentor I want to give people the space to grow, to take responsibility for their work, and to become more independent.*

You're celebrating Simula's 20th anniversary and reflecting back on the last two decades, but I'm sure you're also thinking a lot about Simula's future. How do you think Simula will continue to grow?
I think one of Simula's biggest opportunities for growth is by collaborating with Norwegian universities as well as universities abroad. We'll continue to develop the collaborations that already exist and also form new ones. Another important area for growth is with companies—I think that Simula will be co-owner of many more companies in the future.

Research

Simula began twenty years ago, as the culmination of three research groups in the University of Oslo's computer science department: Communication Systems, Software Engineering, and Scientific Computing. Research at Simula has maintained its focus on these three research areas and added two more: Machine Learning and Cryptography. The research in these fields is conducted at Simula Research Laboratory, SimulaMet, and Simula UiB.

SIMULA RESEARCH LABORATORY (SRL)

SRL—the first of Simula's companies—was established in 2001. The majority of Simula's research group activities are organized under SRL, including Scientific Computing and Software Engineering.

SCIENTIFIC COMPUTING

Scientific Computing at Simula is focused on developing mathematical models, software tools, and computer simulations to build fundamental knowledge in a variety of research fields. This knowledge is used to address obstacles faced by society, including human health challenges such as heart disease and neurodegeneration. High-performance computing allows researchers to execute accurate and detailed simulations at high speed. There are three departments within Scientific Computing: High-Performance Computing (HPC), Computational Physiology (ComPhy), and Numerical Analysis and Scientific Computing (SCAN).

High-Performance Computing (HPC)

The HPC department at SRL makes large-scale computations for modeling and simulations possible. HPC research spans several topics, including methodologies of parallel programming, hardware-compatible and / or inspired numerical strategies, and software tools for user-friendly deployment and optimization of scientific code, plus real-world applications from various branches of computational science. The national research infrastructure eX3 (Experimental Infrastructure for Exploration and Exascale Computing), hosted by Simula, is the primary hardware testbed for the HPC department.

Computational Physiology (ComPhy)

Researchers in ComPhy are developing cutting-edge biological simulation tools. The group collaborates closely with both experimentalists and clinicians around the world to drive basic research and promote innovation.

Joakim Sundnes was one of the first graduate students through Simula's doors and, in 2002, became Simula's first PhD student to graduate. Fast forward to today and Joakim has supervised many of his own students.

This work could help clinicians select better treatments for their patients.

As is the case with many Simula employees, Joakim has held a variety of positions, from PhD student to postdoctoral researcher to his current role as a research professor in Scientific Computing. Today, Joakim's work is primarily in ComPhy, modeling heart physiology and, in particular, how the heart grows and adapts over time. "Most of the work in the field focuses on just a snapshot of how the heart works, typically a single or a few heartbeats," says Joakim. "We are trying to create models to predict how the heart evolves, particularly in response to heart disease." For example, when a person survives a heart attack, Joakim and colleagues want to know how that experience could affect the function of that person's heart in the future. "We ask, how will the heart adapt and change itself over time?"

One of the long-term goals of this work is to help clinicians make more accurate predictions about patient outcomes and then make decisions based on those predictions. "This work could help clinicians select better treatments for their patients," says Joakim.

Joakim's interest in this research began with the math itself. "Coming from an applied mathematics background, this was an interesting math problem to solve," he says. But solving that problem

to the best of his and his colleagues' abilities hinged on the successful collaboration between Scientific Computing and experts in physiology and cardiology. So what began as solving a challenging computational problem grew into a much more comprehensive approach to understanding and treating disease, and led to a long-standing relationship between Scientific Computing and scientists in unrelated fields.

Joakim has remained at Simula all of these years for a reason. "It's a good place to do science, and that's why I've stayed," he says. He has seen the incredible growth of Simula—research-related and otherwise—and is looking forward to what's next. One of his predictions for the future is that artificial intelligence will play an even greater role at Simula and make a lot of the research, including his own work in computational physiology, much more powerful.

> *It's a good place to do science, and that's why I've stayed.*

Numerical Analysis and Scientific Computing (SCAN)
SCAN aims to develop mathematical methods and scientific tools to reach a new understanding of complex physical processes.

Marie Rognes, a research professor in SCAN, comes from an applied mathematics background like Joakim. Marie started at Simula in 2009, creating better software for solving partial differential equations. She went on maternity leave in 2013 and, while sitting on her sofa one afternoon, completely exhausted, noticed a flashy headline on the newspaper in front of her: "Sleep Clears Brain of Toxic Waste." Although it felt a bit like clickbait, she was intrigued. "I started digging and I found medical papers supporting the headline and I thought, 'this is really interesting—this is something we could try to model.' So when I returned to Simula after maternity leave I started delving into this idea."

Marie became fascinated with the possibility of simulating the connection between brain fluid mechanics, neurodegenerative disease, and sleep. Marie was part of Simula's Centre of Excellence in Biomedical Computing and, at the time, they had some research focused on simulating fluid mechanics, so the methods and techniques were not completely foreign to her, but the research that had been done mostly focused on rare disorders related to the spinal cord.

Now, almost ten years later, Marie is the chief research scientist of Waterscales, a project funded by the European Research Council that bridges multiscale fluid mechanics and cellular electrophysiology to pioneer new families of mathematical models that couple macroscale, mesoscale and microscale flow with glial cell dynamics. Marie and her colleagues in Scientific Computing are modeling neurodegenerative diseases like Alzheimer's, Parkinson's, and Huntington's disease.

> *It's also important, and very fun, to tell the general public about what you're working on.*

In line with Simula's mission, Marie also sees the importance of communicating the work she does, both to other researchers and to the general public. "To advance the science, I think it's important to tell other researchers what you have found," she says. "I mean, we're working on something that's quite interdisciplinary. And of course, it's also important, and very fun, to tell the general public about what you're working on."

Marie says she sees Simula researchers as people who are interested in doing not only good science, but ambitious, groundbreaking science that will advance the state of knowledge. The potential for groundbreaking scientific work is a major part of what has kept Marie at Simula for 12 years, but the other part is the positive work environment. "I think we have a very open and inclusive work environment at Simula," she says. "And I think a lot of that has to do with our open-door policy where people stop by and discuss things with each other."

SOFTWARE ENGINEERING

Software Engineering at Simula focuses on improving the quality of software—its stability, testability, efficiency, and security. Within Software Engineering is the Department of Validation Intelligence for Autonomous Software Systems (VIAS), the Department of Data-Driven Software Engineering (dataSED), and the Department of Engineering Complex Software Systems (ComplexSE).

Validation Intelligence for Autonomous Software Systems (VIAS)
Simula's VIAS department tackles the challenges presented by autonomous software systems like self-driving cars and industrial robots. These systems are important tools for addressing societal challenges—environmental sustainability, for example—and are expected to plan, schedule, and execute complex tasks and safely react to unexpected hazards. VIAS plays a crucial role in validating the robustness, reliability, safety, and security of these systems.

Data-Driven Software Engineering (dataSED)
Research activities in dataSED build on the wealth of data produced during software development and support software engineers with the analysis, evolution, and operation of software-intensive systems. The department addresses four main areas of software engineering: cybersecurity, software resilience, intelligent analytics, and recommendation systems.

Engineering Complex Software Systems (ComplexSE)
ComplexSE's goal is to address the growing complexity of software systems today, which are often heterogeneous, open, networked and "smart"—composed of agents, sensors, actuators, information networks, and more. ComplexSE is dedicated to creating new software engineering paradigms—for instance, quantum software engineering—to more efficiently design, develop, test, and maintain novel software systems.

Research professor **Shaukat Ali** is head of the ComplexSE department, where he leads both basic and applied research. With basic research, scientists often play the long game and begin working on something that they think could greatly impact a variety of fields many years down the line. "Right now, one breakthrough research idea is creating quantum software for different applications," says Shaukat. "For example, if you had to make a new vaccine or a new drug, quantum software holds the potential to not only exponentially speed up their discovery, but provide much more accurate analysis than current computational tools."

Shaukat says working at Simula has allowed him the space and support to propose research that's the first of its kind, like is the case with quantum software engineering. "One day, I was talking with my colleague, research professor Tao Yue, and we just thought, let's try something different than what we typically work on," he says. "And we came up with this quantum software testing idea." Fortunately, Tao and Shaukat received the funding they needed to hit the ground running on that basic research project.

> *Having people from all over the world working together makes the research better and makes everyone more accommodating and open.*

When it comes to applied research, one of ComplexSE's projects is with the Cancer Registry of Norway. The Cancer Registry maintains cancer patient data that can be used, for example, to help clinicians make decisions about a patient's treatment. Right now, a major hurdle is processing that data efficiently—it can take a lot of time, and time is not something a patient always has. "We are working on improving their system more quickly," says Shaukat. "And we're using a variety of artificial intelligence techniques to ensure the quality of the system." Another applied research project is with Oslo's health services department (Oslo kommune Helseetaten), and Shaukat and other researchers in ComplexSE are working on optimizing sensor-based systems for things like at-home health monitoring and medication dispensing machines.

Shaukat grew up in Pakistan and studied in the UK and Canada before moving to Norway fourteen years ago, when his PhD advisor relocated to Simula. After finishing his PhD, Shaukat stayed at Simula as a postdoc and then as a research scientist. Just over two years ago, he became the head of ComplexSE. "Simula is very multinational. And yes, if you run a department with people of 10 different nationalities with 10 different cultures, it can get challenging, but it's much more fun. Having people from all over the world working together makes the research better and makes everyone more accommodating and open."

In February 2021, researchers from Simula's VIAS and Complex SE departments joined forces with researchers from France's National Institute for Research in Digital Science and Technology (Inria) to create

the Resilient Software Science (RESIST) team. The RESIST team is led by Mathieu Acher at the University of Rennes and Arnaud Gotlieb from Simula, and addresses the following challenges: observation data for assessing resilience under varying conditions, digital twins for continuous improvement of resilient autonomous/ smart systems, and resilient autonomous systems in the digital and physical world. The RESIST team is just one example of the growing collaborations between Simula and Inria, many of which are moving into research areas beyond Software Engineering.

> *It has been remarkable to experience the level of enthusiasm about the Inria collaboration.*

"We highly appreciate the close collaboration with Inria," says **Are Magnus Bruaset**, Director of Research at SRL, who also notes that Inria is one of the strongest research institutions in ICT, internationally. "While this collaboration started in the Software Engineering area, it has spread quickly to other research areas, and we are currently partners in several projects funded by the EU," he says. "It has been remarkable to experience the level of enthusiasm about the Inria collaboration all the way through the two organizations, from the individual researchers to the top management."

SIMULAMET

Simula Metropolitan Center for Digital Engineering (SimulaMet) is a research unit jointly owned by Simula Research Laboratory and Oslo Metropolitan University (OsloMet). The collaboration was driven by Simula and OsloMet's common interest in increasing the amount of high-quality research being done in the ICT field in Norway.

Within SimulaMet, Communication Systems is aimed at improving the robustness and security of digital infrastructures, and Machine Learning is focused on developing novel methodologies and algorithmic solutions to address problems that society faces, which range from cancer to infertility to climate change. Some of the work at SimulaMet is also focused in Software Engineering, including IT Management.

Marianne Sundet, the Deputy Director of SimulaMet, has been at Simula since 2007, when she was brought on as a management advisor. She then worked with Simula School of Research and Innovation and Simula Innovation, including Simula Garage, before starting her current position. "When I started at Simula I found it so different from what I was used to," she says. "It was refreshing. It was not a traditional university, even though they did things that reminded me of a university, but it wasn't a commercial-driven company either. It was something in-between."

> *When I started at Simula I found it so different from what I was used to. It was refreshing.*

Marianne has stayed at Simula for well over a decade for a variety of reasons, but she says the biggest one is the people. "With all of the Simula companies you will find that you get to meet some really highly educated, interesting people that do a lot of really interesting work," she says.

> *It's been the coolest job on the planet. It's been absolutely fantastic.*

Olav Lysne, the Director of SimulaMet, could not agree more. "I was extremely lucky with the people that I was able to bring to SimulaMet from Simula. They are extraordinarily talented and hard working," he says. "It's been the coolest job on the planet. It's been absolutely fantastic."

Olav believes the work that SimulaMet produces is incredibly important from a societal perspective. "Machine learning and artificial intelligence applied to human health," he says, "that has huge potential that I think everybody's aware of."

COMMUNICATION SYSTEMS

When new services or applications are created on top of a telecommunication infrastructure, opportunities are introduced for malfunctions, erroneous behavior, threats, and attacks. As society becomes increasingly dependent on applications running on top of the Internet, it's more important than ever that networks are robust and that harm to them is prevented.

Within Communication Systems are a variety of departments, including the Center for Resilient Networks and Applications (CRNA), which includes SimulaMet Interoperability lab (SMIL). Mobile Systems and Analytics (MOSAIC)—a department dedicated to designing and validating novel protocols and applications for future mobile systems—was also an important part of Communication Systems for many years but closed at the end of 2021.

The Center for Resilient Networks and Applications (CRNA)

CRNA, which is mainly funded by the Ministry of Local Government and Modernization, focuses on conducting long-term research and innovation on robustness and reliability of communications networks and applications. Research conducted within CRNA is extensive and includes network measurements, self-driving networks, security of mobile networks and digital value chains among others. Besides its scientific output, CRNA has continuously focused on informing policy both in Norway and beyond, for instance by publishing an annual empirical report on the robustness of Norwegian mobile networks. SimulaMet Interoperability lab (SMIL), which falls under the CNRA umbrella, supports a wide range of research activities at SimulaMet, including investigations into time-sensitive networking technologies for 5G networks between base stations and studying and improving mechanisms for network slicing to ensure successful co-use of 5G networks for critical applications.

Research professor **Ahmed Elmokashfi** has been the head of CRNA since 2018, and has enjoyed working on building infrastructures for monitoring existing networks and engaging with stakeholders who range from regulators to people who use the networks. "One thing that we've been doing over the past eight years is measuring the quality of mobile networks here in Norway from a customer's point of view," he says.

Ahmed, originally from Sudan, arrived at Simula in January 2007 to start his PhD following completion of a Master's degree in which he'd spent time in Sweden and Germany. When he thinks back on his arrival, he recalls that "Simula was filled with many young people who were trying to achieve great things." Over the years, Simula has become increasingly multi-cultural, which he says took a bit of navigating at first but has ultimately made the company an even better place to work, both from a social and research perspective. And even with all of those changes, Ahmed says that the growth of Simula has been relatively seamless. "Transitions over the years have been very organic—I never actually felt them, they weren't abrupt," he says. "Things just happened naturally."

> *Transitions over the years have been very organic—I never actually felt them, they weren't abrupt. Things just happened naturally.*

MACHINE LEARNING

Machine learning pervades almost every scientific and technological field today. SimulaMet is the home of Simula's research activities on machine learning, including the departments of Machine Intelligence (MIND) and Holistic Systems (HOST).

Machine Intelligence (MIND)

MIND was established to advance the frontiers of machine learning and data mining. Research activities in the department fall within three general areas: statistical learning and regularization theory, data mining with a focus on matrix and tensor factorization, and deep learning applications. In addition, MIND contributes to areas of system research related to machine learning, like security, performance, and model compression.

Holistic Systems (HOST)

Underneath applications like web search and mobile apps are large ecosystems of integrated building blocks each needed to enable a functional service. The HOST department addresses challenges posed to the system as a whole, from data creation to visualization of the results, and scientists take a comprehensive approach to understanding intelligent, distributed systems.

Milestones

2001

Simula is established, and its 41 employees move from the University of Oslo to Fornebu.

2002

Professor Aslak Tveito is appointed Managing Director, and SRL is established as a limited company.

2003

Simula's strategy of directed basic research is formulated and implemented.

2004

Simula Innovation is established.

2005

The Norwegian parliament extends Simula's research grant to 2015.

2006

Kalkulo is established.

The Centre for Resilient Networks and Applications (CRNA) is started.

Simula is awarded a Centre of Excellence in Biomedical Computing.

2007

Simula School of Research and Innovation is established.

2008

Simula is ranked 3rd on the Journal of Systems and Software's list of the world's most productive research institutions within systems and software engineering.

2009

The book *Simula Research Laboratory – by thinking constantly about it* is published by Springer.

2010

The Journal of Systems and Software ranks Simula as the world's most productive institution in systems and software research.

2011

Simula is awarded the Certus Centre for Research-based Innovation.

CRNA is given a new 5-year period by the Ministry of Transport

2012

In the national evaluation of research in ICT, Simula ranks 1st in all of Norway with respect to average scores.

2013

Simula Garage opens its doors for IT-oriented entrepreneurs.

Simula is awarded the Gender Equality Award by the Norwegian Ministry of Education and Research.

CRNA becomes a permanent research centre, funded indefinitely by the Ministry of Transport.

2014

As a kickstart of Horizon 2020, Simula gets a record turnout of EU projects within the LEIT-ICT.

2015

SUURPh (Simula-UiO-UCSD Research and PhD training program) is established, and is funded directly by the Ministry of Education and Research.

2016

Simula UiB opens, and is jointly owned by Simula and the University of Bergen.

The 1st volume of the open access series *Simula SpringerBriefs on Computing* is published.

2017

Simula surpasses 100 PhD students that have defended and were supervised by Simula researchers.

Simula's research areas are all given a score of "excellent" in the in-depth scientific evaluation by the Research Council of Norway.

2018

SimulaMet opens, and is jointly owned by Simula and Oslo Metropolitan University.

Simula is a founding member of NORA, the Norwegian Artificial Intelligence Research Consortium.

Simula announces the Baby Bonus, which promotes a family-friendly environment for all employees.

2019

Simula joins ERCIM, the European Research Consortium for Informatics and Mathematics.

Kalkulo is sold to Bluware.

2020

Simula Consulting is established to provide deep-tech R&D services to customers.

Simula develops the Smittestopp app for digital contact tracing of Covid-19.

Simula and Inria sign a memorandum of understanding.

2021

Simula@BI officially opens, and is a collaboration between Simula and BI Norwegian Business School.

Simula headquarters moves to its new location in downtown Oslo.

Michael A. Riegler is a research professor in HOST. Originally from Austria, Michael came to Simula in 2014 for an internship and decided to stay. “You can rely on the people you work with,” he says of Simula. He describes the environment as a healthy combination of supportive and challenging, because “Simula strives to always be excellent.”

> *I realized that I want to always work on problems where I can help society.*

During his PhD, Michael studied how to build AI-based systems for detecting colon cancer. The goal was to detect polyps—early, possible indicators of the disease—to increase the likelihood of patient survival. “The main reason I want to study this is probably because cancer runs in my family—several of my relatives, including my grandmother, died because they had breast or colon cancer,” he says. “Their cancer wasn’t caught early on. I feel like the work I’m doing could help change that.”

Michael says the first dataset he remembers working with for that project was a word file with two images pasted into it and a description from the doctor. Thankfully, things have significantly advanced since then. Michael and collaborators were able to publish the first big public data set in the colonoscopy field and many additional datasets have followed.

Michael continues to do work related to the early detection of colon cancer, but is using machine learning to tackle other fields of research as well. “I realized that I want to always work on problems where I can help society, but it doesn’t really matter to me if it's medicine-related, or climate-related, or in the social sciences,” he says. Most recently, he started working on a project related to child welfare that uses artificial intelligence to improve how maltreated children are interviewed by social services and the police.

Michael and his Simula colleagues are working with both social scientists in Norway and leading researchers in the field of police interview techniques. “It is a challenging topic to work on because of the content we get exposed to, but we feel it is important,” he says.

Michael is also involved in an artificial human reproduction project. During the in vitro fertilization (IVF) process, there’s still so little that scientists know about how to choose the sperm, egg, or embryo that has the greatest chance of leading to a successful pregnancy. Using machine learning, Michael and colleagues are looking at the entire development pipeline, from sperm and egg to birth. “We’re asking how all of this is connected,” he says. “And we’re using AI to predict if things will be successful or not. That way, embryologists are able to make more informed decisions throughout the process.”

SOFTWARE ENGINEERING

IT Management (ITM)

The goal of ITM at SimulaMet is to improve how software development is managed. The department conducts research on software development methods, human judgment and decision making in software development contexts, benefits management, cost estimation, risk and uncertainty management, and more.

Effective Digitalization of Public Sector (EDOS)

EDOS—a research center within ITM—is focused on the variables that lead to successful digitalization. Researchers in EDOS analyze data and conduct surveys on digitalization to provide assistance to the Ministry of Local Government and Modernization and other parts of the public sector.

SIMULA UiB

Simula UiB is a research unit jointly owned by Simula and the University of Bergen (UiB) whose main focus is Cryptography. The goal of Simula UiB is to increase security expertise in Norway through research and education.

The beginnings of an idea for Simula UiB were planted in 2012, when the Norwegian Research Council evaluated all information and communication technologies research institutions and companies in Norway. Of the five research groups in the country that received a grade of “excellent,” two were from Simula and two—including a cryptography group—were from UiB. In 2016, Simula and UiB formally joined forces, creating Simula UiB, a place where information security research and graduate student training could flourish.

CRYPTOGRAPHY

Keeping sensitive information secure has become increasingly important as services have moved online, and cryptography is the foundation of information security. Cryptanalytic assessment takes into account algebraic, statistical, and side-channel attacks so that researchers can develop an in-depth understanding of the level of protection provided by cryptographic algorithms while simultaneously creating a roadmap for improved protection. Simula UiB has two research sections focused on information security: Information Theory and Cryptography.

Information Theory

Simula UiB's Information Theory section considers the design and analysis of secure and reliable communications, networking, and storage solutions. Research focuses on distributed systems, including—but not limited to—topics in distributed computing and storage, like mobile edge computing and decentralized machine learning, as well as privacy-preserving technologies from both information-theoretic and coding-theory perspectives.

Cryptography

The Cryptography section develops and assesses cryptographic algorithms, implementations, and protocols, including those that are provably secure and efficient for complex tasks like e-voting, privacy-preserving data mining, and privacy-preserving blockchain applications. The Cryptography department is focused on not only constructing better tools but understanding the principal limitations of those tools.

> *Cryptography is all around us—it's hidden, but it's there. And we're the ones who look for any weaknesses.*

Research professor **Håvard Raddum** is head of Cryptography at Simula UiB. Håvard has been at Simula since 2013, before Simula UiB started in 2016. He sees the critical importance of crypto-graphy research, especially in a highly-digitalized country like Norway. "Cryptography is all around us," he says. "It's hidden, but it's there. And we're the ones who look for any weaknesses."

Håvard describes Simula UiB Cryptography as a "national resource center for crypto know-how" that's backed by the Norwegian government. He believes the work he and his colleagues do is in part successful because of Simula's environment. "The doors are always open here," he says. "If you have an idea that you want to discuss you can just walk right into an office and discuss it."

Håvard also uses the word "open" to describe his colleagues, who he says are willing to talk about both their successes and failures. "When people have a paper accepted, or are accepted into a conference, we congratulate them," he says. "But then sometimes our work or an application is rejected and we're disappointed and our colleagues will say 'that's okay, you can try again!' Being open about failure is a good thing, I think. It's refreshing."

> *When students consider doing a PhD in cryptography or information theory, we want Simula UiB to be their first choice.*

Mari Løchen, the Deputy Director of Simula UiB, sees it as a place where there's a willingness to try things. "New ideas are always welcome," she says. "If you have a new initiative or something you would like to try out, you can usually do it. That was one of the things that I noticed when I started working here—we're always trying to figure out a better way of doing things." Mari looks forward to the future of Simula UiB and its research as well as plans for increasing Simula UiB's reach. "I think one of the things that we'll focus on is becoming more visible, especially to potential PhD applicants," she says. "When students consider doing a PhD in cryptography or information theory, we want Simula UiB to be their first choice."

Education

Simula believes educating and training tomorrow's scientists and technology experts is an integral part of conducting excellent research.

In addition to the comprehensive joint ventures with Oslo Metropolitan University (SimulaMet) and the University of Bergen (Simula UiB), Simula has established educational collaborations with several other Norwegian, as well as international, partners. **SUURPh** is the largest of the international collaborations. SUURPh—which stands for Simula UiO UCSD Research PhD training —is a PhD program involving Simula, the University of Oslo (UiO), and the University of California, San Diego (UC San Diego). The program is funded by the Norwegian Ministry of Education and Research to promote multidisciplinary research in computational biology and medicine. Project topics span many areas in the field including electrophysiology, neuroscience, cardiac mechanics, and machine learning in biological systems.

Kimberly McCabe is the SUURPh Program Director and a PhD coordinator at Simula Research Laboratory (SRL). Kim's first interaction with Simula was in 2014, when she attended Simula's Summer School in Computational Physiology. She was a graduate student at the time, just starting her PhD at UC San Diego. "Afterward, I maintained some of the collaborations we'd developed during the course," says Kim. "So then in 2016 I was able to go back to Norway, for a month-long research trip, and work with Joakim Sundnes."

Kim became the SUURPh Program Director in 2019, following the completion of her PhD in **Andrew McCulloch's** lab at UC San Diego. Andrew, a SUURPh advisor and distinguished professor of Bioengineering and Medicine, has been involved with Simula since the early 2000s. "They had a small cardiac modeling group who I got to know, and they invited me to visit," says Andrew. "One of my earliest visits was to be the opponent for Joakim Sundnes's PhD defense." Since then, Andrew has formed many more collaborations, mainly with SRL's Computational Physiology department working on cardiac modeling research.

> *Science is necessarily global—more people leads to additional perspectives, which means things can move forward more quickly and more successfully.*

These collaborations have brought him to Simula almost every summer since then, and he says his lab's bioengineering and physiology expertise, combined with Simula's scientific computing knowledge, has proved to be a winning combination. "Having Simula's applied mathematics expertise has really allowed our collaborations to achieve things that we would never have achieved otherwise," says Andrew.

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In addition to the cutting-edge science, Andrew says he loves working with the people at Simula and traveling to Norway. "I think that's because it's actually quite similar to New Zealand, where I'm from," he says. "People stop every day for a coffee break or two that they have together in a common room, and share ideas." He says he finds the environment relaxed, devoid of the stress typical of many research settings, and believes that allows scientists to think a little more deeply.

A few years after his first trip to Simula, Andrew remembers the beginnings of a conversation about a new, international collaboration. That collaboration ultimately became SUURPh. SUURPh directly funds eight PhD students, all of whom are expected to do research at UC San Diego that will span three months to one year. The students often time their research visits so that they arrive in San Diego together, helping ease the transition and making the relocation abroad less intimidating. Kim sees the value in these experiences, and wishes they were more common throughout the research world. “I think it’s incredibly important for graduate students doing research to have an international experience,” she says. “Science is necessarily global—more people leads to additional perspectives, which means things can move forward more quickly and more successfully.”

Kim points out that, oftentimes, funding for research projects is limited to a couple of years, but that SUURPh is different. “You have this longer-term funding that allows for these collaborations to really flourish,” she says. “If you only have a couple of years to work on a project, collaborations can easily fizzle out. Many years of funding is reassuring to Simula’s collaborators because it means that they might have multiple students, over the course of many years, continue to work on a project.”

When asked about the future of SUURPh Kim says that, although the program is only six years old, they’re already expanding their reach beyond the bioengineering and neuroscience departments at UCSD. “It’s exciting—we now have students in math and in mechanical engineering and it’s allowing us to test out new, interesting collaborations,” she says. “I’m excited to see, over the course of many generations of SUURPh students, the work that’s able to come out of it—the high impact research that began with SUURPh’s first generation of scholars.”

SIMULA SCHOOL OF RESEARCH AND INNOVATION (SSRI)

Started in 2007, SSRI has also played an integral role in Simula’s education activities. SSRI was created to provide opportunities for Master’s and PhD students, as well as postdoctoral researchers, to develop skills —in scientific writing and communication for example —that would benefit them while they did research at Simula and into the future.

Creating SSRI was also a step toward addressing the country’s shortage of information and communications technology researchers with a PhD or Master’s degree. “Norway wanted more students with a graduate-level education,” says **Marianne Aasen**, former Director of SSRI. “But PhD students in Norway often weren’t graduating on time because they weren’t receiving enough support.” Marianne, who arrived at Simula in 2017, thinks SSRI allowed Simula to produce more PhD students who not only graduated on time but were better prepared for jobs post-graduation.

> *At Simula, if we see an opportunity in the market, like we did for training people in digital skills, we say ‘let’s do it!’ I think that’s why it’s so fun to work here.*

In addition to training graduate students at Simula, SSRI also created Prepare—a program dedicated to making science more appealing to high school students in the area. With Prepare, science and technology students, mainly at the University of Oslo, are trained by Simula in collaboration with Penn State University to become science ambassadors and travel to give presentations to local schools. Kodeskolen, or Code School, is another SSRI-run program, and focuses on coding literacy for the general public, particularly teachers, training them in the Python programming language.

At the end of 2021, SSRI underwent a major restructuring that led to the creation of two new units that took its place: **Simula Learning** and **Simula Academy**. Simula Learning will continue programs like Prepare, but expand Code School and create a whole new repertoire of digital courses and training for customers who would like to develop skills in information and communications technology.

Marianne, now the Director of Simula Learning, sees this change as yet another indicator that people at Simula are forward-thinking and believe change can be a really good thing. “At Simula, if we see an opportunity in the market, like we did for training people in digital skills, we say ‘let’s do it!’ I think that’s why it’s so fun to work here,” she says.

Rachel Thomas is the Director of Simula Academy and formerly Simula's Director of Corporate Development. She says that creating Simula Academy provided an important opportunity to step back and reflect. "We asked: What's missing? What kinds of training opportunities can we create for our employees—in particular our early career researchers—so they can develop the skills they need to do their best work?," says Rachel. "We also wanted to continue to provide the SSRI programs that had proven valuable over the years."

> *I'm really keen to provide great opportunities for our employees to build some of the skill sets they will need in their next jobs before they get promoted, to help set them up for success.*

Examples of programs that will continue, but now under Simula Academy, are Simula's Summer Internship Program and a graduate-level course in Communicating Scientific Research. With the Summer Internship Program, bachelor's and master's students in math, informatics, and technology are given the paid opportunity to be mentored by scientists at Simula, learning about and contributing to leading-edge research alongside their peers. The Communicating Scientific Research course teaches students how to effectively communicate their research in scientific presentations, papers, posters and films, and how to address a wide range of audiences, including the general public and decision-makers.

Stepping back to reflect has also led to a bunch of exciting new training offerings from Simula Academy, including training in transferable skills—like leadership—for PhD students and postdocs. Rachel views science as a field where oftentimes people are promoted to a new position without necessarily being equipped with the tools they need. "I'm really keen to provide great opportunities for our employees to build some of the skill sets they will need in their next jobs before they get promoted, to help set them up for success," she says.

Innovation

Innovation activities are an inherent part of technology research. Simula Innovation (SI) invests in promising start-ups and spin-offs that are using technology to disrupt and improve their sector, Simula Consulting provides R&D consulting services for companies and projects that fall under Simula's core competencies, and Simula Garage provides free incubation services, resources, community, and office space to tech entrepreneurs for 12 months.

SIMULA INNOVATION (SI)

SI manages Simula's investment portfolio and supports entrepreneurs during the startup phase. In order to evaluate suitable candidates for investment, Simula considers the technical aspects of the product as well as the company's commercial risk and business opportunities. Since 2015, SI has focused on building a substantial company portfolio consisting of companies from the Simula Garage, spinouts from Simula's internal research, and external tech startups. SI now has a portfolio of 36 companies and six exits, as of December 2021. In total, these companies have a revenue of 350M NOK (~$40 million USD) and have employed more than 350 people.

> *A very special feature of SI —that many investors don't have—is that we do our research due diligence through Simula Consulting.*

Ottar Hovind, the Director of Simula Innovation, has seen the impressive growth of SI first-hand, and believes there are some key factors that make it unique. "A very special feature of SI—that many investors don't have—is that we do our research due diligence through Simula Consulting," he says. "That's hugely important. We really get to know the technology."

SIMULA CONSULTING

Simula's newest daughter company, provides high-quality R&D consulting services. Simula Consulting expands on industrial contacts and a consulting concept already tested within Simula itself.

> *I think Aslak is someone who can see what people are capable of even if they don't realize it themselves.*

"We focus on engaging IT projects where the competence of highly experienced people from Simula is needed," says **Valeriya Naumova**, the Director of Simula Consulting whose background is in applied mathematics and machine learning. She says that, by being strongly integrated with Simula's research units, Simula Consulting has the advantage of being able to assemble a team of researchers that can deliver a tailored solution to each customer.

Valeriya mentions an interesting project Simula Consulting is helping with right now, working with an aquaculture company that's trying to automate fish-feeding. "Fish feeding is a challenging problem," she says. "Because it requires a lot of tedious and manual work to decide when to start feeding, when to stop feeding, and when to adjust feeding." And it's not only challenging, it's expensive—around 50% of an aquaculture company's total cost. Making it more efficient could mean healthier fish, less polluting of the environment, and a lot of money saved. "We analyze videos of the fish," says Valeriya. "And we've generated an algorithm that looks at their behavior and movement patterns to derive if they've eaten enough or are still hungry."

Valeriya played a large role in getting Simula Consulting up and running. She says that she wouldn't have necessarily seen herself in this role, but that the Simula environment and CEO Aslak Tveito made her feel more confident in taking it on. "I think Aslak is someone who can see what people are capable of even if they don't realize it themselves," says Valeriya. "And I think it really helps open up that potential."

SIMULA GARAGE (Gründergarasjen)

The Simula Garage was started in 2013, as an incubator for ambitious entrepreneurs working on early-stage ICT-related projects. These entrepreneurs are given a full year of 24/7 access to a free office space where, alongside other vibrant entrepreneurs, they have the opportunity to transform an idea into a viable business and turn prototypes into products. In addition, they receive support through a large network of researchers, students, and technology experts who provide mentorship, legal advice, and assistance in locating funding.

> *Innovation and entrepreneurship are no longer theoretical constructs written into a grant application.*

The rationale for starting the Simula Garage was two-fold: to inject entrepreneurial spirit into a more academic environment and to generate potential investments for Simula that would also help entrepreneurs. “We're publicly funded,” says **Christian Bjerke**, a Director of Innovation. “We’re supposed to give back to society, right?”

In 2017, Christian was tasked with building up and professionalizing the Simula Garage. Up until that point it was, according to Christian, a relatively passive environment. “But then we initiated a few projects that would grow the Garage, established traditional incubator services, and built up partnerships with specialists including lawyers and people involved in investments,” he says. Soon, the Simula Garage became far more selective with applicants, and in 2018 formed a second incubator with OsloMet.

In addition to helping entrepreneurs successfully build their companies, the Garage has presented many great investment opportunities for Simula, with companies like Unloc—a company revolutionizing how keys are used and shared—with whom Simula was able to preseed investors.

“The model we’ve built is quite unique,” says Christian. “It’s different from other incubators.”

Ranveig Strøm, who became a Director of Innovation at the Simula Garage in 2019, fully agrees. “We have a deep knowledge about, and useful networks within, both academia and the startup scene, and we’ve created something quite powerful where we have one foot inside an academic organization and one foot outside of it,” she says. “I see us as a catalyst for innovation by translating opportunities between startups, students, and researchers, and helping academic organizations succeed with innovation.”

Over the last few years, Simula has contributed to the development of a new Master's program in entrepreneurship at OsloMet, as well as several innovation courses and workshops to help students and researchers gain hands-on, practical experience on how to build and fund a venture. “We've shown that it's possible to create a successful incubator through also being in the university environment,” says Ranveig. “And we believe we can grow even more through these mutually beneficial partnerships.”

> *We’ve created something quite powerful where we have one foot inside an academic organization and one foot outside of it.*

“We have a bunch of entrepreneurs flying around our offices, sharing coffee with our researchers and I think that has had an impact,” says Christian. “Innovation and entrepreneurship are no longer theoretical constructs written into a grant application. These are things happening around you, and I think that has inspired several colleagues to pursue entrepreneurial ventures.”

“And it helps that the management is saying, ‘we're prioritizing this, we're supporting startups,’” says Ranveig. “I think that’s also influencing Simula’s culture and encouraging people to consider possibilities for their own work that they may not have before.”

Robert Ekrem and his company Völur (he is one of three co-founders) are one example of a Simula Garage success story. "We started the company to optimize a large and important industry, and to make it more sustainable," he says. Völur is creating a more sustainable meat and poultry industry by combining data and artificial intelligence (AI) to optimize the use of every animal. Before creating Völur, Robert worked in the meat industry, and his experiences gave him the idea for the AI technology. "I hypothesized that we could use technology for cutting and processing decisions," he says. "So I brought this idea to the other co-founders of Völur, and we started this journey of optimizing the industry."

> *We became part of the startup ecosystem. Being able to work alongside other tech companies made things interesting.*

In 2019, Robert and his fellow co-founders were accepted into the Simula Garage, where they received free office space and most importantly, according to Robert, a community. "We became part of the startup ecosystem," he says. "Being able to work alongside other tech companies made things interesting. We were provided communication resources as well as opportunities to speak with lawyers and other professionals who could help us with the process."

The support they received at the Simula Garage allowed the founders of Völur to turn their vision of creating a more sustainable meat industry into a reality. They arrived at the Simula Garage with no funding, and by the time they successfully exited they had received more than 5 million NOK (~$575,000 USD) from Innovation Norway and raised more than 6 million NOK (~$700,000 USD) from investors, including Simula Innovation.

Simula in numbers 2001 - 2021

PhD's supervised to completion:
156

MSc's supervised to completion:
496

Employees at the start:
41

Employees in 2021:
196

Published peer-reviewed articles:
2961

Published books:
93

Centers of excellence:[1]
4

Research projects funded by EU:
35

Simula Garage startups:
214

Companies with Simula ownership:[2]
48

Employees in companies SI has invested in:[2]
500+

Babies that have received the bonus:[3]
35

1. Hosted by Simula: Certus (SFI), CBC (SFF); Simula as partner: CCI (SFI), ProCardio (SFI).
2. Since 2004.
3. The Baby Bonus program began in 2018.