ETH zürich
NO. 3/2020

GLOBE

Everything AI?

The rise of human-machine partnerships

PAGE 12

Inspiration doesn’t come from a blank sheet of paper

Robin Phillips, Director of SpaceLab
Every space project is different and demands creative solutions. That’s why our SpaceLab Director Robin collects unusual components from motors and gearheads to get inspiration. This is how he came up with the key idea for the brushless drive that is used in the Perseverance rover. This and other motors will handle the valuable samples of Martian soil that are intended to be brought back to Earth by a later mission.
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A centre for artificial intelligence

Joël Mesot, President of ETH Zurich

Quick! Grab your smartphone, unlock it and say: “Hey Siri, remind me that the ETH AI Center opens on 20 October!” This reminder function is just one of many examples of how artificial intelligence, or AI, has become part of our everyday lives. Starting in October, ETH Zurich will pool its numerous AI-related activities together under the umbrella of the ETH AI Center, both accelerating and enhancing the visibility of this important area of research.

The centre’s mission is to provide continued support for the core areas of artificial intelligence and its applications in other research areas. As a prominent interface to national and international industry, it will serve to speed up the development of innovation and knowledge transfer in the form of spin-offs. The team behind it will also grapple with the ethical issues surrounding AI. In this fast-growing field, which is attracting huge investments from governments and corporations around the globe, one of the keys to success lies in the next generation of scientists and researchers. The ETH AI Center will therefore start by launching a fellowship programme. ETH Zurich anticipates attracting young talent from all around the world to embark on interdisciplinary projects and inject new ideas.

It seemed appropriate to devote this issue of *Globe* to the topic of AI. From medicine and disaster management to news production in the media, *Globe* examines the interaction between humans and machines in the wide variety of fields where AI is already present and considers the opportunities and challenges that lie ahead.

Have a great read!

Title, Illustration: Ray Oranges
Editorial, Image: Markus Bertschi

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Globe is also available as a free tablet version.

Images: Wojciech Gajek; Giulia Marthaler; Studio Lacaton

NEW AND NOTED

Architecture

CROOKED TO THE MILLIMETRE

Shadow play, acoustic effects and other aesthetic architectural features can be created by placing bricks at special angles. But to keep the building stable, the bricks must be positioned with millimetre accuracy. Timothy Sandy, a specialist in robotics and an ETH Pioneer Fellow, has developed a new technology for this purpose based on augmented reality. It has already been used successfully in a pilot project in Greece.

A wine cellar at the foot of Mount Olympus: the technology creates visual effects in the brickwork.

Health sciences

IRON DEFICIENCY REDUCES VACCINE EFFICACY

About 40 percent of children around the globe suffer from anaemia because they do not consume enough iron. Recent studies by ETH researchers have shown that iron deficiency also reduces the protection provided by vaccinations. In their first study, a research group led by Michael Zimmermann from the Department of Health Sciences and Technology worked together with international scientists. Using blood samples from 303 Kenyan children followed from birth to age 18 months, they determined their levels of iron and antibodies against antigens from the administered vaccines.

Over half the children were already suffering from anaemia at the age of ten weeks, and by 24 weeks more than 90 percent had low haemoglobin and red blood cell counts. Despite several vaccinations, the risk of finding a lack of protective antibodies against pneumococci and other pathogens in the blood of 18-month-olds was more than twice as high in anaemic infants compared to those who were not anaemic.

In a second study, the researchers administered a powder containing micronutrients to 127 infants slightly over six months old on a daily basis for four months – either with or without iron. When the children were vaccinated against measles at the age of nine months as stipulated by the vaccination schedule, the children whose dietary supplement included iron developed a stronger immune response in two respects: not only did they have more measles antibodies at the age of 12 months, but their antibodies were also better at detecting the pathogens.

Muscle biology

OPTIMISED TRAINING

Our muscle mass declines continuously from the age of 40 – at a rate of about six percent over ten years. Researchers from ETH Zurich and ZHAW are now working on a method that can help optimise training strategies to combat age-related muscular atrophy. To do this, the researchers make use of the acceleration sensors in smartphones to precisely map resistance exercise on machines and record missing comparative figures.

Strength training to combat muscular atrophy

Images: Michael Lyrenmann; Mladen Zivkovic/iStock

Biocommunication

HUNGRY BUMBLEBEES

Bumblebees are key pollinators of fruit and vegetable crops. Unlike honeybees, which found new colonies by swarming, bumblebee colonies die out at the end of summer – so right about now – with only the fertilised queens surviving through winter. In spring, as early as February or March, these new queens emerge from hibernation and seek out suitable sites for new nests. For the colony to thrive, bumblebees need plenty of flowers as their food source.

ETH Zurich researchers have now discovered a surprising behaviour that bumblebees adopt to mitigate a shortage of pollen in spring. When pollen is in short supply, the bees pierce the leaves of plants that have not yet flowered, which stimulates them to produce flowers more quickly. This occurs both in greenhouses and outdoors. In the experiments, tomato plants bitten by bumblebees flowered up to a month earlier than expected.

Seasonal anomalies due to climate change can disrupt the delicate balance between the flowering season and pollinator populations and cause insects and plants to become increasingly out of sync in their development. It remains to be seen whether the bees' behaviour is an effective response to the challenges of a changing climate.

→ biocommunication.ethz.ch

Image: Hannier Pulido

Earth sciences

Thousands of seismometers on a single cable

Fibre-optic cables are emerging as a valuable tool for geoscientists and glaciologists. They offer a relatively inexpensive way of measuring even the tiniest glacial earthquakes – plus they can also be used to obtain more accurate images of the geological subsurface in earthquake-prone megacities.

Project manager Fabian Walter (at rear) and his colleague Małgorzata Chmiel check if the cable is fully functional.

Today's fibre-optic cables move data at tremendous speeds, enabling us to stream films and TV shows in HD or even 8K resolution. Modern telecommuters rely on these superfast broadband fibre-optic networks – but optical fibres also lend themselves to more unusual applications. For example, operators of critical infrastructure have long used fibre-optic cables to monitor their facilities. "The idea of using optical fibres for multiple purposes is nothing new," says Andreas Fichtner, a professor of geophysics in the Department of Earth Sciences at ETH Zurich. Together with Fabian Walter, a professor at the Laboratory of Hydraulics, Hydrology and Glaciology (VAW), he is now exploring a new technique that could massively expand the potential applications of optical fibres. Working on the Rhône Glacier in the Swiss Alps, the two ETH professors are measuring tiny glacial earthquakes at a far greater resolution than ever before.

Fichtner's primary interest lies in the potential that fibre-optic cables offer in seismology. As a glaciologist, Walter is determined to gain a better understanding of glacier movement and the associated seismic activity in the ice: "I'm particularly interested in tiny earthquakes that originate in the glacier bed."

High-resolution measurements

In late June 2020, the researchers laid a nine-kilometre-long cable across the surface of the Rhône Glacier and connected it to a measuring instrument known as an interrogator. The researchers pitched their tents on the moraine and occupied them in week-long shifts for two months. Each week, a team of two was on site to monitor the equipment, replace the mobile hard drives when they were full and keep the power generator running.

The technique used by the researchers is relatively simple. Laser pulses of a specific wavelength are directed through the optical fibre in a continuous sequence. Any pressure or tension on the cable changes the pattern of the light waves that are scattered back towards the interrogator by tiny defects within the fibre. The interrogator measures the interference in the returning signals, enabling researchers to calculate where quakes occurred and how powerful they were. This can be determined at a very high spatial and temporal resolution. "You're basically replacing thousands of seismometers with a single cable," says Fichtner. Although the cable is less sensitive than a high-quality seismometer, it has the major advantage of offering a huge number of measurement points.

The quantity of data generated by this high-resolution method is enormous. "Analysing it will be a tremendous job," Fichtner says with a smile. "We will have to come up with methods to cope with the sheer quantity of data." They expect the measurement campaign to produce around 20 terabytes of raw data – ten to 100 times more than they would collect by distributing ten seismometers across the glacier.

Fichtner and Walter carried out their first tests with a short cable in the spring of 2019. These were presented in a scientific paper that recently appeared in the scientific journal Nature Communications. As well as confirming just how much potential their new technique has to offer, this paper also revealed that glacier quakes primarily occur in clusters, especially at the boundary between the ice and the glacier bed. Clusters of this kind would imply that the ice does not slide smoothly, but rather moves forward in a jerky motion. "That's not what you would expect based on current theories," explains Walter. "Glaciologists assumed that glaciers could slide because the glacier bed was well lubricated with meltwater." Some of the mini quakes in the Rhône Glacier occur as often as once a second.

"My new hypothesis is that the sliding motion of glaciers is comparable to that of tectonic plates," adds Walter. Most of the quakes measured in the Rhône Glacier have a magnitude of −1 to −2. "That's roughly equivalent to ice cracking when you skate on a frozen lake," he says. "It's not something that you can feel like a real earthquake."

In Antarctica, however, scientists have recorded glacial earthquakes with a magnitude of 3 to 4, and in one extreme case magnitude 7 (for comparison, the 2015 Gorkha quake in Nepal had a magnitude of 7.8). But there's apparently one key difference: compared to conventional earthquakes, large-magnitude glacial quakes unfold slowly and can last for several minutes. That makes them less destructive than earthquakes that are caused by tectonic plate movement.

Glaciologist Martin Funk carries the cable reel across the glacier on a horn sledge.

Fibre-optic networks to boost earthquake preparedness

Geophysicist Fichtner hopes to use fibre-optic cables for more than just measuring glacial earthquakes. He envisions one day using the fibre-optic networks in big cities to study the geological subsurface. Known as seismic tomography, this technique can be used to detect weak layers of rock and critical fractures. The goal is to map the subsurface by measuring the speed and duration of earthquake waves captured by fibre-optic cables. This would allow scientists to better assess the risk of earthquakes. One option might be to harness the fibre-optic networks of major conurbations that face significant danger from earthquakes, such as Istanbul, Athens and San Francisco.

Fichtner demonstrated how this could work by carrying out a feasibility study in Bern. Together with the internet service provider Switch, he and his team measured human-made seismic activity using a straight six-kilometre-long fibre-optic cable. "That's equivalent to about 3,000 small seismometers. Setting up that many devices so close together is simply impossible," says Fichtner.

He set up the interrogator in the server room at the University of Bern. The data from the fibre-optic cable ultimately allows the team to create a detailed map of the Bern subsurface. "The fibre geometry was very simple – that's one reason why Bern was the ideal test site," Fichtner reflects. Learning to harness even more complex fibre-optic networks is simply a matter of time, plus the possibility of performing the necessary measurements in big cities. — Peter Rüegg

Image: Wojciech Gajek

Images: Wojciech Gajek

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Computer science

ULTRA-FAST DATA TRANSMISSION

Researchers from ETH Zurich have achieved something that has eluded scientists for the past 20-odd years. As part of their work on the European Horizon 2020 research projects, they manufactured a chip in their lab that can convert fast electronic signals directly into ultra-fast light signals – with practically no loss of signal quality. This represents a significant breakthrough in the efficiency of optical communication infrastructures that use light to transmit data, such as fibre-optic networks.

These fibre-optic networks are already being used to deliver high-speed internet, digital telephony, TV, and network-based video and audio services. However, by the end of this decade, even these optical communication networks may reach their limits when it comes to rapid data transmission. "We will need new solutions to meet rising demand," says Jürg Leuthold, ETH Professor of Photonics and Communications. "The key to this paradigm shift lies in combining electronic and photonic elements on a single chip."

ETH researchers have now achieved exactly this combination in collaboration with partners in Germany, the US, Israel and Greece. This is a huge step forward in technical innovation, because these elements currently have to be manufactured on separate chips and then connected up with wires. That approach is far from ideal. For one thing, manufacturing the electronic and photonic chips separately is expensive. For another, this arrangement reduces the efficiency of converting electronic signals into light signals, which limits transmission speed in fibre-optic communication networks.

Institute of Electromagnetic Fields
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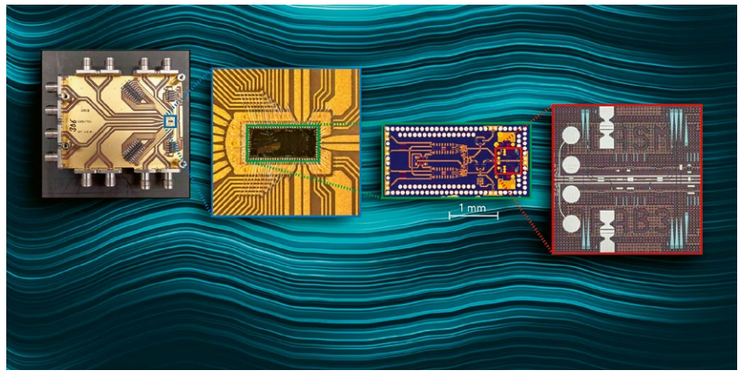


The new, highly compact chip brings together the fastest electronic and light-based elements in a single component for the first time.

Images: ETH Zurich / Nature Electronics; courtesy of Fanny Yang, Giulia Marthaler

Podcast

MACHINE LEARNING IN MEDICINE

ETH scientists Fanny Yang and Julia Vogt work in the field of machine learning and medicine. In this podcast, the two researchers discuss what attracted them to this field – and explain why machines will never replace humans in the medical profession.

→ www.ethz.ch/podcast

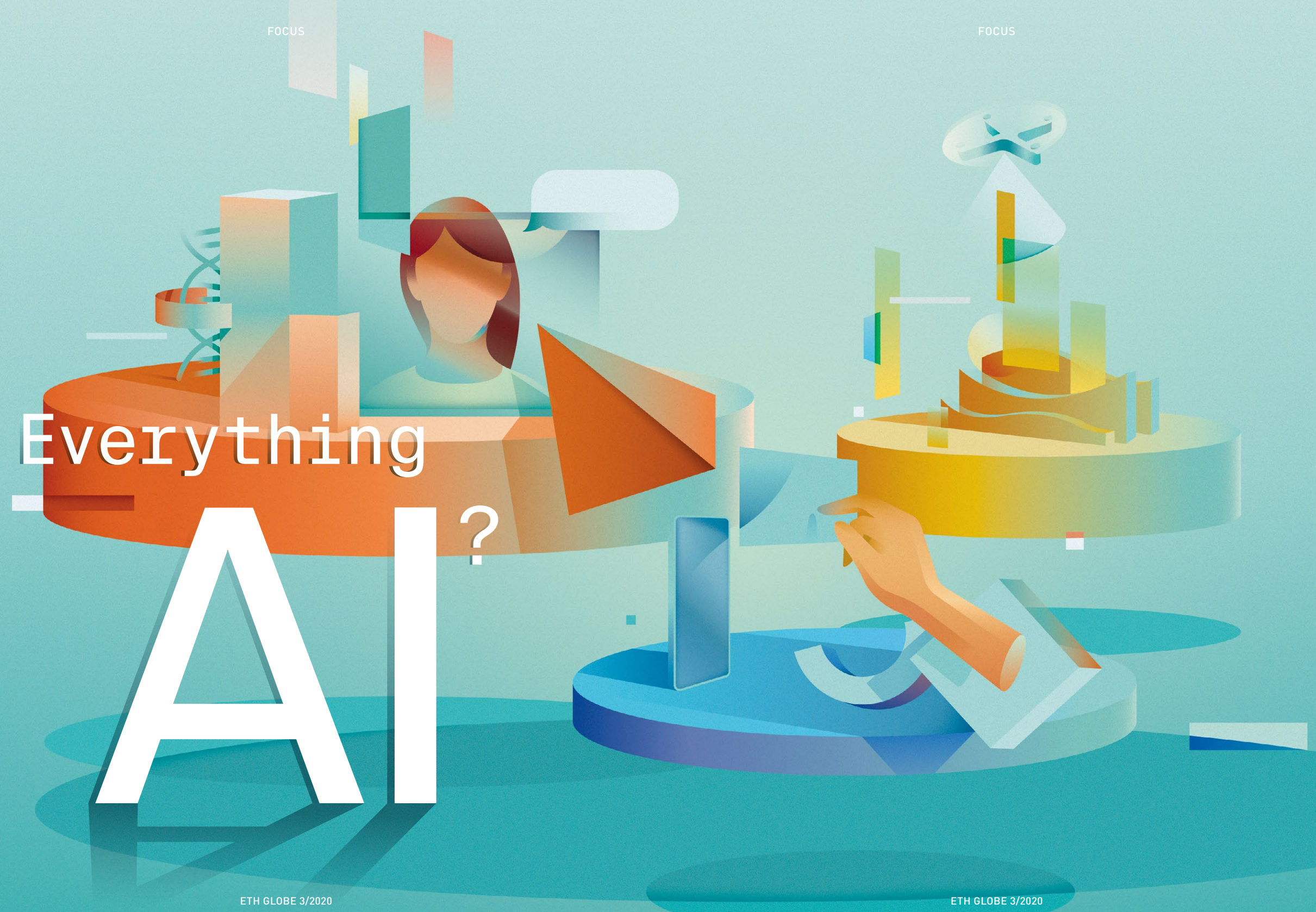
Science Task Force

ETH PROFESSOR APPOINTED AS NEW TASK FORCE HEAD

During the coronavirus pandemic, the government is relying more than ever on scientific expertise. This prompted the formation of the Swiss National COVID-19 Science Task Force in the spring. Martin Ackermann, Professor of Microbiology at ETH Zurich and Eawag, took over as the head of the task force at the start of August. His predecessor was Matthias Egger.

Learn more about this topic and read other research news from ETH Zurich at:
→ www.ethz.ch/news-en

Everything AI?



Artificial intelligence is having a growing impact on our daily lives and is also revolutionising research. ETH Zurich recognises its responsibility in this area and is striving to promote innovation and trust in this fast-evolving technology.

TEXT Florian Meyer
ILLUSTRATIONS Ray Oranges

Sometimes a machine takes everyone by surprise. A recent example occurred at the opening event of Scientifica 2019, where ETH robotics specialists had trained a drone to welcome visitors by writing the word “enjoy”.

At first everything seemed normal as the drone, known as Voliro, began to write. It started with the first letter, just as a human would. But when it got to the second letter, it did something nobody expected: it simply left out the vertical line of the “n” and went on to write all the other letters. Only then did it fly back to the “n” to add the missing line. The final result was perfectly correct, but the way in which it jumped back and forth while writing was very different to how humans write. Of course that wasn’t how Voliro had been programmed! In fact its creator was just as surprised as everyone else. In all the rehearsals, Voliro had simply written the letters in their normal order. It wasn’t until just before the final performance that the drone learned to do it in a way it considered to be more efficient.

When a machine like Voliro changes its behaviour unexpectedly, we automatically think of intelligence. And in fact Voliro – an autonomous flying robot made by an ETH spin-off of the same name – is a good example of what artificial intelligence (AI) is capable of nowadays. What seems like human decision-making when viewed from the outside actually has its origins in statistical, data-driven processes that we call machine learning. These processes are a subset of AI.

Overhyped – and underrated

Machine learning is when computers learn by themselves to recognise patterns and regularities in data sets based on experience gained from training data. As they continue to learn from huge amounts of data, intelligent programs automatically improve their success rate. Machine learning methods can find valuable results that humans would fail to spot, especially when faced with very large, complex or heterogeneous data sets.

“Artificial intelligence, or AI, refers to technologies that enable computers to help humans with tasks that can only be solved by intelligence,” says Andreas Krause, Professor of Computer Science and a specialist in machine learning. AI research has been around since the 1950s, and it is a tale of both unfulfilled expectations and unexpected success stories. What’s changed more recently is that AI has become a far more tangible and visible presence in our day-to-day lives: automatically created photo albums and smartphone voice assistants are just two examples.

AI’s increasing ubiquity stems from the convergence of three technological trends. Firstly, computer hardware has become incredibly powerful. A modern smartphone is as fast as a supercomputer from the mid-1990s, and a laptop has enough computing power to develop viable AI models. Secondly, software implementations for many AI learning methods are freely available online, which has boosted the number of developers and users. The third trend is the availability of large amounts of data – much of it on the internet – that can be used to train AI systems. Scientists are making new advances on an almost daily basis and this, in turn, is greatly expanding our mathematical understanding of these learning methods.

“The result of these technological breakthroughs in AI is a multifaceted disruption to science, industry and society with far-reaching consequences that are both overhyped and underrated.” This was the conclusion drawn by AI researchers at ETH Zurich when they took stock of how far AI had come in the summer of 2019.

New division of labour

In fact, AI and machine learning not only have an impact on individual users and industrial workflows, but also change the way in which work is divided between researchers and computers. Gisbert Schneider, Professor of Computer-Assisted Drug Design, Associate Vice President for ETH Global and founder of the ETH “think-and-do” tank RETHINK, uses AI to develop new drugs on the computer. “We have an AI model for virtual medicinal chemistry that automatically generates molecular structures possessing one or more desired properties,” he says. This method allows the team to obtain new chemical entities and then synthesize and test these computer-designed compounds to see if they exhibit the calculated bioactivities. “AI methods enhance researchers’ creativity, yielding surprising suggestions that they hadn’t thought of themselves,” says Schneider.

Many applications require a certain amount of decision-making autonomy. Lothar Thiele, a professor at the Computer Engineering and Networks Laboratory and Associate Vice President for Digital Transformation, develops technologies for sensor networks that collect data under extreme conditions. In collaboration with various partners, his group is studying the impact of climate change on permafrost in the Swiss Alps and the destructive processes it is triggering. Their results are also useful for early warning systems. “Huge amounts of data are collected on a continuous basis,” explains Thiele. “So individual sensors have to make their own decision on whether an event is relevant or not. That’s where we have found AI to be very successful.”

Schneider and Thiele are not the only ones using AI in their research: AI applications are now widespread across all fields of science at ETH. In principle, any area of research can benefit from AI-enhanced methods. Comparisons with other countries confirm how influential AI research has become at ETH and in Switzerland. According to Stanford University’s *AI Index 2019*, Swiss researchers publish the second-largest number of AI articles per inhabitant after Singapore. What’s more, citation rates show that Swiss publications are among the most influential.

The growing importance of AI can also be seen in ETH student numbers. While only a few hundred students attended a course in machine learning and AI methods in 2012–13, this figure has now risen to well over 3,000. “Introduction to Machine Learning” is attended by more students than any other lecture. Most students come from the core subjects of computer science, electrical engineering, mechanical engineering and mathematics. Equally striking is the fact that every academic department at ETH now has students taking courses in AI. To meet this demand, ETH launched both a Master’s degree programme and a continuing education programme in data science in 2017.

“ETH Zurich’s strengths in AI lie in its outstanding basic research in mathematics, computer science, ›

“We want to fundamentally rethink how we develop AI models to ensure they are trustworthy.”
Andreas Krause

“AI methods enhance researchers’ creativity, often yielding surprising suggestions that they hadn’t thought of themselves.”
Gisbert Schneider

information technology and data science, as well as the quality of its infrastructure,” says Detlef Günther, Vice President for Research. “But we also have huge potential to develop innovative AI methods by combining our excellence in AI fundamentals with the top-class research we conduct in the variety of disciplines we offer.”

A connected future

Governments, corporations and universities are implementing AI strategies to address AI’s growing economic and social impact. The US and China are investing particularly heavily in AI. That raises the question of how Switzerland, and indeed Europe, can position themselves globally, and how ETH Zurich can continue to expand its status in the AI field.

One strategy that was proposed recently in an interview with Thomas Hofmann – an AI researcher at ETH and co-director of the Max Planck ETH Center for Learning Systems – is to link up Europe’s AI centres of excellence, which include Zurich, Lausanne and Lugano, in order to create a Europe-wide AI network that includes ETH researchers.

With this strategy in mind, ETH Zurich took the decision in May 2020 to extend its partnership with the Max Planck Society by another five years. Launched in 2015, this partnership in the field of learning systems connects ETH Zurich with the Max Planck Institutes in Tübingen and Stuttgart, two other European centres of excellence in AI. A new initiative that is linking up AI researchers across Europe is the European Laboratory for Learning and Intelligent Systems (ELLIS). Launched in December 2019, ELLIS comprises 17 European AI centres of excellence. ETH Zurich has been involved in the initiative right from the start through its ETH ELLIS Unit.

Reliable, ethical AI

A third new aspect concerns ETH itself, more specifically how it connects its AI researchers to the wider world and gives broader visibility to “AI@ETH”. On 20 October 2020, the university will hold an opening ceremony to launch its new ETH AI Center.

“The AI Center will set the stage for an interdisciplinary dialogue with industry, government and society on how to continue developing artificial intelligence in a way that fosters innovation and inspires trust,” says Günther.

In terms of its organisational structure, the centre builds on the strengths of ETH and combines the fundamentals of AI theory and methodologies with expertise from the various disciplines. The core group comprises some 20 professors who conduct research in key AI fields such as machine learning, big data and statistics. Around this is a wider circle of researchers who develop AI methods for their particular subject area or who study the effects of AI. The centre is also open to guests from other AI research institutes and from industry.

“The AI Center is not a virtual network,” says Andreas Krause, the designated head of the centre. “It is a real meeting point where AI scientists from research and industry can exchange ideas and embark on joint research projects.” Due to the extremely rapid pace of development in the field of AI, the plan is to build up the AI Center gradually, with a focus on interdisciplinary projects and promoting talent.

The centre’s strategy is rooted in characteristic human traits that no intelligent machine can compete with, namely motivation, curiosity, creativity and flexibility in evolving situations. “Our aim is to get the centre up and running by focusing firmly on talent, starting with a fellowship programme,” says Krause. “Doctoral students and postdocs will play a key role in interdisciplinary research partnerships. They will offer fresh perspectives on how to link up research topics and develop new AI tools.” The new centre had plenty of positive experiences to draw on, including the doctoral programme run by the Max Planck ETH Center as well as the Master’s degree programme in data science, where computer science students develop AI solutions for other fields of research. “Both those programmes are producing exciting results and have provided valuable inspiration,” says Krause.

In terms of content, the ETH AI Center will deal with fundamental issues relating to AI. For example, there are a number of AI methods that are used in practice but are still short on theory. Plugging these gaps would mean not only seeing whether an AI method works, but actually getting to the root of why. “We want to fundamentally rethink how we develop AI models so that they work safely and reliably and produce results that are explainable, interpretable and fair,” says Krause. “I see reliability and transparency as essential when it comes to the societal impact and ethics of AI.” Safe, reliable and fair AI solutions can make a real difference, particularly in research areas that play to ETH Zurich’s strengths, such as mobility, health, manufacturing, energy, climate and the environment. With some AI experts arguing that responsible and reliable AI could represent a major opportunity for Europe, the ETH AI Center is committed to making trustworthy AI a top priority. ○

FUNDED BY PHILANTHROPY

The new ETH AI Center and in particular its fellowship programme are supported by the ETH Foundation’s Escher Circle, which brings together key figures from industry and research. The Escher Circle’s philanthropic mission is to promote outstanding talent, groundbreaking ideas and innovative programmes.

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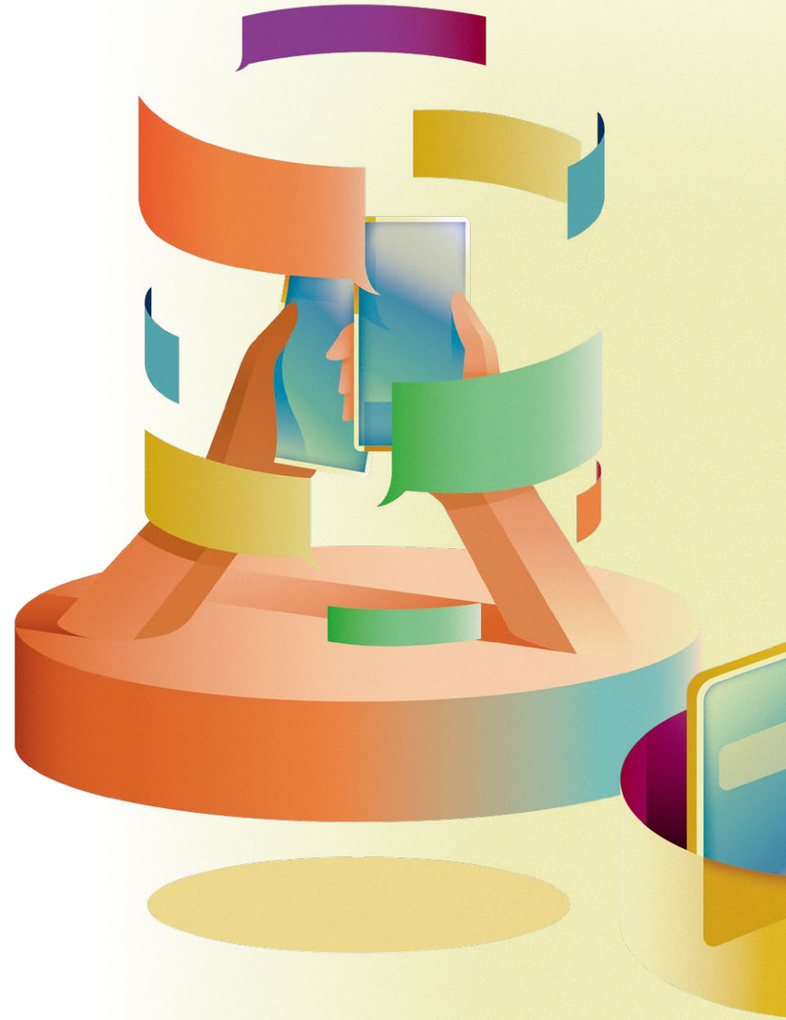

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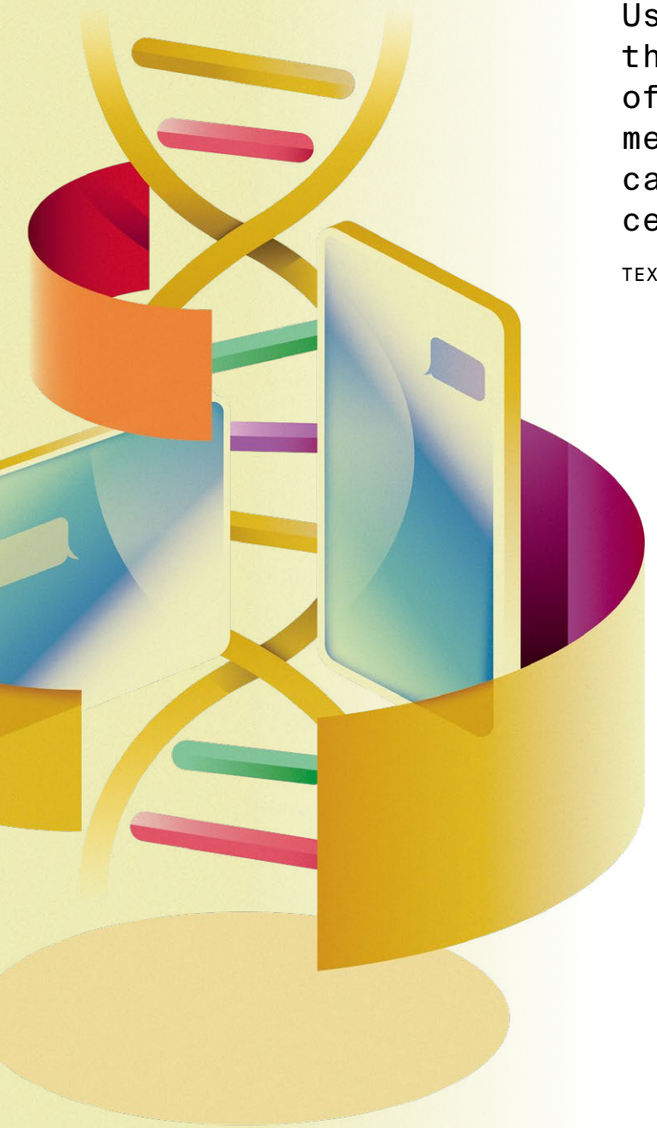

Mapping the depths of the genome

Using algorithms to analyse the whole-genome sequence of a tumour can make treatment more successful – and can even help determine how cells become cancerous.

TEXT Fabio Bergamin

Detailed genetic analysis of tumour tissue samples has become standard practice at a small number of the world's leading hospitals specialising in cancer treatment. Experts extract DNA from the samples and use it to sequence the whole cancer genome. Together with information on the activity of individual genes, this helps doctors define the type of cancer more precisely and predict which treatment options and drugs the patient will respond to best.

Yet whole-genome sequencing of a patient's tumour produces several hundred gigabytes of raw data that first have to be analysed. This would not be possible without efficient machine learning algorithms, says Niko Beerenwinkel, Professor of Computational Biology at the Department of Biosystems Science and Engineering, who specialises in the analysis of high-throughput molecular biological data.

Modern DNA sequencers may be fast and powerful, but they deliver "noisy" raw data that can only be interpreted by advanced computer analysis. "Algorithms reduce the noise by comparing the raw data of a genomic analysis with a multitude of other genomic analyses and deciding what is most probably noise and what isn't," says Beerenwinkel.

Finding a needle in a haystack

But that's only the start of the analysis process. "In many cases, thousands of small changes will have accrued in the tumour genome, only a few of which are relevant," says Beerenwinkel. "What's more, some of these changes might be insignificant in themselves from a medical standpoint but play a decisive role in combination with other changes." Once again, computer algorithms can help extract medically relevant information from these large amounts of data. Equally important is the fact that tumours are composed of different cell types that differ from each other, both genetically and in terms of their function. Tumours contain not only cancer cells but also a variety of other cells, including blood vessel and immune cells. Because the genome of cancer cells evolves so rapidly, a tumour contains several genetically distinct populations of these malignant cells, which in general will respond differently to the same drug.

Together with his research group, Beerenwinkel is developing machine learning methods and software that can identify and interpret the significant genetic diversity in tumours. "Current cancer therapies tend to take only the most frequently occurring cell populations into account – future forms of treatment will be able to address all of them," says Beerenwinkel.

Prognosis and therapies

Valentina Boeva, Professor of Biomedical Informatics in the Department of Computer Science at ETH Zurich, also uses machine learning algorithms. One focus of her research is on epigenetic changes in tumour cells. These are temporary and reversible changes in the genome; they are not permanent genetic alterations.

"One result of these epigenetic changes is that different genes are active in the tumour cells than in the original healthy cells, and different proteins are produced," says Boeva. She uses databases of anonymised patient data that have been made available to researchers and analyses these using computer algorithms. In one of her as yet unpublished research papers, she was able to show why epigenetic changes are associated with increased aggressiveness in certain tumours: the changes enable tumours to evade the body's immune response. Since these changes can be reversed with drugs, her findings could offer useful pointers for potential new treatment options.

Another example is the search for genome segments that regulate gene activity. Mutations in these segments are also a relevant factor in cancer development. These segments are often located in close proximity to the gene that they regulate. But if they are further away, they can be hard to find. "Another challenge is to find out which gene this type of segment regulates," says Boeva. She turned to a modern method of machine learning that was developed in computer linguistics to determine the meaning of a text. Using this method, Boeva analysed genomic data to determine the "meaning" of individual genome segments. In this way, she successfully uncovered previously unknown regulatory sequences.

But Boeva doesn't always need cutting-edge analytical methods for her work. "Sometimes I get the results I need using statistical methods that scientists developed decades ago," she says. There are plenty of methods to choose from, she says, and it is often hard to tell beforehand which method is most likely to solve a particular problem, so trying out multiple options is crucial. "But machine learning is getting better all the time," she says – so there may well be algorithms in the future that can select the best machine learning method automatically.

Crucial career skills

There is a great deal of interest in machine learning among students. The pharmaceutical industry has also identified machine learning and artificial intelligence as core technologies. As well as playing a role in Beerenwinkel's and Boeva's field of molecular biomarkers, these technologies are also being used to develop new drug molecules. "I'm already seeing significant interest from industry in working with us on research projects and employing our graduates," says Beerenwinkel.

If Valentina Boeva succeeds in finding new cancer-relevant genome segments, it's not only patients in state-of-the-art hospitals who will benefit. Even less specialised hospitals are increasingly carrying out limited genetic analyses for cancer patients. Instead of tackling the whole genome, these analyses look at just a few dozen segments. These are the segments and mutations that Boeva, Beerenwinkel and many other researchers all over the world have discovered with the help of machine learning – and whose function they have successfully decoded. ○

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ETH GLOBE 3/2020

Giving computers a voice

From Alexa and Siri to translation programs and computer-generated news, anything seems possible these days.The Media Technology Center is searching for applications that could lend a hand with day-to-day editorial work.

TEXT Martina Märki

Every time you talk to Siri on your phone and ask a question or give a command, you are communicating with artificial intelligence. The only problem is that this intelligence has its limits. In fact, compared to human intelligence, Siri could even be described as fairly stupid, says Ryan Cotterell, a professor who has worked at ETH Zurich since February 2020. Appointed through the ETH media technology initiative as a Professor of Computer Science, Cotterell brings together linguistics, automated language processing and artificial intelligence. "The only reason Siri works is because people typically use very simple questions and commands when they speak to their phone," he says.

Cotterell insists that we shouldn't expect the same from AI as we do from human intelligence. None of us have any trouble learning our native language, he says, and English speakers can intuitively spot grammatical mistakes in an English sentence. Yet computer programs still struggle to identify whether an English sentence is grammatically correct or not – and that's because a language processing program works very differently to the human brain. "No translator has ever had to learn the sheer number of words we need to train a translation program," he says.

Modern translation programs learn using big data, honing their abilities with millions of pairs of sentences. Yet coming up with multiple alternatives for translating an individual sentence is a lot harder. Human translators can do it easily, but translation programs typically offer just one solution. Cotterell hopes to change that: "We want users to have multiple options rather than just being presented with one result. That would allow users to choose the best-fit sentence for each specific context." Yet developing a viable algorithm for this purpose is no easy task, he cautions.

A further challenge is creating translation programs and voice assistants for languages that are only used by relatively small numbers of people. "It's very hard to develop a good system for languages that are low on data," says Cotterell. Hence his enthusiasm for a voice assistant program that speaks Swiss dialects, which was developed by the Media Technology Center (MTC) at ETH Zurich.

The Swiss German challenge

This is a truly remarkable achievement, not only because there are so many regional variants of Swiss dialect, but also because these languages lack a standardised form of spelling. The MTC's voice assistant has been fluent in a Bernese dialect called "Bärndütsch" since 2019, and further dialects are now in the pipeline. To develop their Swiss German assistant, researchers partnered with Swiss Radio and Television (SRF). The benefit of technologies that translate standard German into Swiss German or read local news and weather in specific dialects is their ability to provide regional authenticity – even when automatically converting text to speech.

A computer-generated media experience

More research is needed into linguistic diversity in Switzerland and Europe, especially since most language processing systems come from English-speaking areas, including those suitable for use in media. "That's why we can't just take what American and English media are doing with computerised language processing and simply apply it here," says Cotterell. With support from the media companies NZZ and TX Group, he is planning a translation system that will translate high-quality articles from German into French. Severin Klingler, Managing Director of the Media Technology Center, explains the thinking behind this move: "The idea is to identify existing technologies from English-speaking areas and make them accessible for other languages, too."

The realm of new media presents its own challenges. Filter bubbles and fake news are now part and parcel of our day-to-day media experience, but could AI offer a means of countering this? This is one of the questions currently being explored by the Media Technology Center. As part of the Anti-Recommendation Engine for News Articles project, researchers are seeking to combat filter bubbles by programming a system to search for relevant counterarguments. MTC is also running a project that aims to computerise comment sorting based on content-related criteria. "This could help make differences of opinion more visible," says Klingler.

The only caveat is that the same methods could also be used to generate filter bubbles and fake news. Earlier this summer, news headlines were dominated by cutting-edge language-processing AI from the Californian company OpenAI. Known as GPT-3, this massive language model overshadows everything that has come before. "The dimensions are so huge that it would be impossible for universities to build or even test it," says Cotterell. One of the reasons the system attracted so much attention was the potential risk of AI-generated fake news. Given just a few sample news items, GPT-3 can generate plausible news stories in English. It looks like Ryan Cotterell and his fellow researchers at the Media Technology Center still have plenty of work ahead of them. ○

SUPPORT FOR INNOVATIVE SWISS MEDIA CENTRE

Ryan Cotterell serves as an Academia Expert at ETH Zurich's Media Technology Center (MTC). Support for the professorship and the Center comes from the media companies Ringier, TX Group (formerly known as Tamedia), SRG SSR and NZZ, the Swiss media association VSM and other partners.

www.ethz-foundation.ch/en/media-technology

The "black box" problem

A bioethicist and a neuroinformatics scientist discuss how machines are becoming more intelligent and why the advances in technology are leading to new ethical challenges.

INTERVIEW Martina Märki / Corinne Johannssen

AGATA FERRETTI
Scientific assistant and doctoral student at the Health Ethics and Policy Lab, Department of Health Sciences and Technology at ETH Zurich

bioethics.ethz.ch

BENJAMIN GREWE
Assistant Professor of Systems and Circuits Neuroinformatics at the Institute of Neuroinformatics, Department of Information Technology and Electrical Engineering at ETH Zurich

www.ini.uzh.ch/en/research/groups/grewe

Benjamin, while doing community service you worked with children with cognitive impairments. What did you learn from this experience?

BENJAMIN GREWE – What became apparent is that for many impairments, things like motivation and humour are often fully intact even when higher-level functions such as understanding complex concepts are compromised. The human brain is highly complex.

Is it possible for AI to compete with human intelligence?

GREWE – When I started out in machine learning, I programmed an artificial neuronal network with the goal of reverse engineering emotional (fear) learning in humans – but the network didn't learn well. In fact, it got depressed – everything you showed it produced the same output: fear. The idea behind AI is to copy some aspects of human intelligence, but definitely not all. We don't want to create an intelligent car that says, "I'm too afraid to drive you today."

AGATA FERRETTI – AI today is task-oriented, meaning it tries to solve a particular problem like driving a car or diagnosing a disease. Its emotional level doesn't even come close to that ›

Images: courtesy of Agata Ferretti; Giulia Marthaler

of humans. Human intelligence can't be reduced to the ability to excel in one task. In this sense, you could even say that AI is quite dumb – it's not fit for many purposes.

GREWE – But increasingly, the goal in AI is to move beyond specialisation for one task. People are trying to develop smarter voice assistants, for example, using huge text databases from sources on the internet. The resulting algorithms can produce text that's grammatically correct, but they don't understand the meaning of the words they produce. They write "dog", but have never seen or touched a dog, let alone been bitten by one.

FERRETTI – We see something similar in the medical field when AI is deployed to recognise from images what's likely to be cancer. Whereas doctors base their assessment on their medical knowledge and experience, AI refers to things like the light or edges in the picture – aspects that are relevant for identifying patterns but don't always have clinical significance for doctors. The validity of the correlation is different for the doctor and the machine.

GREWE – Yes, this is an important point. For example, in adversarial attacks, researchers try to trick deep artificial networks. They show a picture of a dog, then change three special pixels and the network predicts that it's a cat. This would never fool a human.

Mistaking a dog for a cat sounds funny, but obviously the stakes are a bit higher when diagnosing cancer…

FERRETTI – Indeed, and yet trust is an issue even when the system works correctly – patients may not trust the results if they don't understand the reasoning behind them. Both doctors and patients will trust a system more once it has proved itself to be reliable and they see that there's a culture of openness about its implications. A commitment to users' rights to an explanation and a certain degree of transparency would boost trust in these systems, and hence their usability.

But today even scientists admit that there are systems where we don't really know what and how they're really learning…

GREWE – This points to a bigger problem in machine learning. Until recently, researchers would train a robot by writing a line of command code such as: "to grab this cup, move your hand to the right and close your hand at position XY." They knew exactly what the robot was doing. Now they just feed the robot a lot of data, it tries out many movements, and when it grabs the cup they say, "That was good, do it again." So we're moving away from engineering where we understand every step in the process and moving towards just letting the algorithms learn what we want them to do. But it really is a black box. No one understands how these algorithms work – and the biggest problem is that they sometimes fail, and we don't know why.

> "The biggest problem is that these algorithms sometimes fail, and we don't know why."
> Benjamin Grewe

So what we need is interpretable machine learning, where transparency is built in right from the start?

FERRETTI – Yes, some degree of interpretability could be useful. It might also increase accountability if something goes wrong. If you use this technology in health care, for example, it's important to say who'd be liable for a wrong diagnosis: Is the misdiagnosis due to a doctor's error or flawed logic in the AI system?

GREWE – It's vital for engineers and industries to understand why and when AI systems make errors. If a human makes a decision, we can ask them about their reasons. We can't yet do this with a machine learning algorithm.

FERRETTI – We also need to discuss what type of data we feed these machines with. If we start from the assumption that our world is full of biases and injustices, we run the risk that the unsupervised machine will reproduce these limitations. What's more, selective biases in the data could lead to discrimination. For example, if you feed the machine with more high-quality data of tumours on light skin, the system probably won't recognise a tumour on dark skin. Another very important ethical principle is guaranteeing fairness. These systems should be rigorously tested to ensure the data are reliable and unwanted biases are mitigated.

How can these kinds of ethical standards be enforced?

FERRETTI – It's difficult. In our lab, we've talked about developing quality assurance systems and frameworks that can be used to test the technologies. The ethical and legal tools used so far in medical research must be adapted to address the new issues of AI algorithms. The challenge is this: how can we develop a system that can keep pace with evaluating and monitoring these fast-evolving technologies?

Do we need new guidelines?

FERRETTI – We need to clarify how to interpret and implement the ethical principles that guide AI development. Although nowadays there are plenty of ethical guidelines for AI, there's uncertainty about how to integrate the views of various stakeholders. At the same time, there are stringent guidelines for using sensitive data like medical data collected in hospitals, but not for data recorded on social media or in fitness apps, which could be used for similar purposes. So how do you manage the mixture of these data? We need a broader governance framework that can ensure data protection, guarantee fairness, promote transparency and also monitor how the tech evolves.

Tech companies have much more computing power than universities. Does this restrict you as a researcher?

GREWE – In certain areas, such as language modelling, this is already a problem because universities aren't com-

petitive. These models are trained using text drawn from the whole internet, with millions of dollars spent on computing resources. Well, I haven't read the whole internet, but I hope that I'm in some sense smarter than these models. At some point, even leveraging statistics and big data may reach its limits. In my opinion, we need a fundamentally different concept of learning to generate algorithms with problem-solving skills that are more robust and universal.

Different in what way?

GREWE – It may well be time to move away from statistical learning and big data and start learning more like children. I'm thinking here of embodied systems that start by learning basic things to build very simple abstract concepts. Based on these, they could learn more and more complex interactions and schemata. Basically we need to "grow" AI step-by-step. If human-like intelligence is our goal, then we need to implement this kind of developmental approach. In addition, we need to carry out algorithm research in a much more interdisciplinary fashion – combining, for example, machine learning with robotics, neuroscience and psychology.

Agata, do you think this approach would lead to more or fewer ethical problems with AI?

FERRETTI – Eventually more, but I wonder what kind of timeframe we're looking at here. For the time being, task-oriented tools that may simplify and improve people's lives are what we have to deal with. The ethical issues with these tools are already challenging enough, but the future is going to be exciting! ○

"Selective biases in the data could lead to discrimination."
Agata Ferretti

Who makes the final decision?

Protecting citizens in the face of disaster often requires far-reaching decisions to be made. Any assistance is welcome – including from AI.

TEXT Corinne Johannssen

Wildfires are increasingly getting out of control, as shown by recent events in California and Australia. Yet firefighters continue to battle tirelessly against the flames – and nowadays they have more at their disposal than just water and controlled burns. Digitisation has long been part of their arsenal in the form of geoinformation systems, webcams and drones. These have become key tools in predicting and controlling wildfires, yet the huge quantities of data they produce quickly pushes human expertise to its limits. "AI is always useful when you're dealing with masses of data," says Benjamin Scharte, who heads the Risk and Resilience Research Team at the ETH Center for Security Studies (CSS). Recently, he and his colleague Kevin Kohler teamed up to analyse the use of AI in civil protection.

"Being able to use algorithms to make predictions is pretty exciting," says Kohler. Which direction is the fire front heading? Where should we set the next controlled burns? By crunching all the available data, AI-based modelling tools can help answer these questions. This data might include weather forecasts, drought duration, wind direction – and even the potential amount of fuel available to the fire. The resulting predictions can make disaster response more efficient. In the best-case scenario, they can even act as a form of prevention.

Civil protection is particularly responsive to the use of AI because, all too often, it is a matter of life and death – and every minute counts. Experts are often expected to make snap decisions with far-reaching consequences, so they are grateful for any assistance that can underpin those decisions with more robust data. Ultimately, however, the quality of a decision always depends on the quality of the data. "However smart my algorithm, it will be of little use in an emergency if I can't supply it with the right data for the disaster," Kohler cautions.

Even the highest quality data can never fully replace the experience gained by experts over many years, so the question of whether a human or a machine should make the final decision is highly complex. Taken as a whole, the algorithm might conceivably produce a lower economic loss or fewer casualties than its human counterpart, but it may also make decisions in individual cases that we find unacceptable. "It's clear to me that we, as a society, will continue to struggle with the idea of leaving decisions to autonomous machines," Scharte says.

A matter of trust

So at what point might we be willing to let a machine make its own decisions? Scharte and Kohler agree that this depends on the context: "Civil protection is sometimes a matter of life or death. Humans should play a part in making those decisions – it's not the place for machines to make fully autonomous decisions."

A crucial factor is how much faith people have in the algorithm. Trust paves the way for acceptance, and both are enhanced when we are able to clearly follow what an algorithm is doing. For example, when doctors understand the decision logic of an algorithm, they are more likely to trust it and incorporate it in their work. Numerous studies have confirmed this – but Scharte sounds a note of caution: "Transparency and explainability don't always increase security." There are even cases where transparency might be a disadvantage, including man-made hazards such as cybercrime and terrorism. "If you reveal exactly how an algorithm detects suspicious patterns of behaviour, then adversarial actors have better odds of deliberately outsmarting it," warns Scharte. ○

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ETH PODCAST
We also recommend listening to the ETH podcast "Can AI help tackle climate change?": www.ethz.ch/podcast

The algorithm on my team

The automation of work is increasing at a tremendous pace. But how well do technology and humans really work together in a digitised world?

TEXT Samuel Schlaefli

Smart robots, self-driving cars, drones and ubiquitous sensors – for some people, these images raise hopes of huge productivity gains and corporate profits, but for others they set alarm bells ringing. In 2013, economist Carl Benedikt Frey and engineer Michael A. Osborne from Oxford University published a study in which they estimated that 47 percent of jobs in the US might soon be lost to automation due to rapid advances in robotics and artificial intelligence. So might the Fourth Industrial Revolution be leading us directly to mass unemployment?

Gudela Grote doesn't think so. A Professor of Work and Organisational Psychology at ETH, she notes that Frey und Osborne's findings have been questioned on multiple occasions since they were published. One objection is that the authors did not consider the fact that automation tends to eliminate individual tasks rather than entire jobs. "What's more likely is that people and machines will work together even more closely in the future," says Grote. "So the questions we should really be asking are how jobs will change, which tasks can be performed better by humans, and which can be performed better by machines."

Construction robots and autonomy

Automation has been a focus of research in organisational psychology since the Industrial Revolution, or perhaps even earlier. Yet today's technological advances and their impact on people's day-to-day work are markedly different to previous revolutions. "Technology itself is increasingly becoming a key player," says Grote. Huge quantities of data combined with artificial intelligence and machine learning are laying the foundations for intelligent, self-learning systems, enabling the automation of ever more complex and cognitively demanding processes. The construction industry is a good example. Once upon a time, robots were limited to carting around bricks and sacks of cement – but now they are on the verge of being able to build load-bearing walls by themselves.

Within the framework of the Digital Fabrication National Centre of Competence in Research (NCCR), Grote conducts research into how work processes and job profiles are evolving in the construction industry as a result of increasing digitisation. "In the future, we might see bricklayers working with 3D glasses and supported by a robot," she says. A system of this kind was developed recently by ETH robotics specialist Timothy Sandy. Whether employees perceive this as a gain or a loss depends on their perception of how much autonomy they have in their work, says Grote. Psychological research conducted over the past 70 years has shown that the freedom employees have to organise their own work plays a decisive role in their job satisfaction, motivation, creativity, performance and health.

Predicting the unpredictable

While Gudela Grote is interested in how people respond to machines, Melanie Zeilinger focuses on teaching machines to cooperate better with humans. An Assistant Professor at the Institute for Dynamic Systems and Control, Zeilinger heads up a group specialising in the development of algorithms for learning control systems. Human-machine interaction is an important application of these kinds of systems. Successful interaction requires the machines to make continuous predictions as to how humans might act next. "Humans are not deterministic. We always react slightly differently to the same given situation, plus of course each individual person is different," says Zeilinger. "That's why we have to work with stochastic systems and probabilities and allow the systems to adapt." She emphasises the importance of safety, which must be guaranteed by the control algorithm, explaining how this can be achieved while allowing machines to learn directly from humans. As an example, she cites a case where she enables interaction to take place between a human worker and a KUKA robotic arm – the type often used on production lines – via a passive triple joint. Sensors are mounted on the arm to transmit its movements to the robot, allowing the control algorithm to learn the movements and train a predictive model for movement sequences. In the factory of the future, the robotic arm will need to be able to anticipate the movements of its human counterpart.

Zeilinger refers to the results of this kind of research as "human-in-the-loop" control systems. One concrete application is the Lokomat, a robotic gait orthosis used in the rehabilitation of patients with neurological disorders. Developed by the company Hocoma AG in collaboration with the Sensory-Motor Systems Lab at the Department of Health Sciences and Technology, the Lokomat features an interface that allows therapists to control a therapeutic system based on 13 parameters. Zeilinger's group has developed an algorithm that offers suggestions on parameter adjustments. The algorithm teaches itself by recording adjustments made by therapists and learning based on their decisions. "The goal was to incorporate the therapists' expertise into our algorithm," says Zeilinger. Although the target function of the system – namely, achieving a good and healthy gait – is difficult to define in mathematical terms, a trained therapist can evaluate this function easily.

It took an average of fewer than ten parameter adjustments for the system to adapt to a healthy test subject. It even provided the therapist with alternative suggestions that the therapist assessed positively.

Education in Industry 4.0

Increasing human-machine interaction also raises political issues, says Gudela Grote. "Automation is forcing us to constantly reassess our education system," she says, arguing that it is still unclear how many professionals and academics will be required in Industry 4.0. According to Grote, society will also have to make tough decisions on what degree of automation it actually wants, especially in complex and potentially hazardous systems such as nuclear power plants and aircraft. Faced with a risk situation, who makes the final decision: humans or artificial intelligence? And who is responsible for the consequences?

As an organisational psychologist, Grote admits that advising engineers and questioning their assumptions can be frustrating: "Even though organising work is part of an engineer's job, we're often regarded as troublemakers." Now, however, she is noticing a generational shift – a wind of change blowing through the corridors of ETH. Melanie Zeilinger does not currently have an organisational psychologist in her research group, but she says that is likely to change in the future. "Personalising intelligent, self-learning systems is one of the keys to successful human-machine interaction," says Zeilinger. ○

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Managing with machines

More and more companies say that AI will be an important tool in the future. AI could also be useful for administration and management – but this journey has only just begun.

TEXT Martina Märki

A chatbot is now available to answer ETH members' questions about the IT services offered by the university. The IT Services team recently introduced the bot to help people help themselves. But IT Director Rui Brandao admits they still have some way to go. "In about half the cases, the answers are useful, but the rest of the time the chatbot misses the point of the question," he says.

Infrastructure for research

The chatbot is one of the first AI projects in the field of ETH administration. "We use a number of rule-based systems, but they are not yet what I would call AI," says Brandao. The chatbot, on the other hand, gets better over time by learning from user input and responses. Its primary purpose is to answer the questions on IT services that students typically have when they start their course. Chatbots are also used by customer service departments at Ikea and other companies, says Brandao, though he adds that most of these systems are at a fairly embryonic stage. IT Services has to provide reliable technology to thousands of people on a daily basis, he notes, so AI can only be deployed in isolated cases. "The systems we use on a daily basis need to be robust," he explains.

One application in which Brandao and the IT Services team have opted for AI is a key piece of research infrastructure known as the Leonhard cluster, which is specially designed for big data analytics and machine learning. "It offers features unmatched by any other cluster in the world and is very popular in biomedical research and other areas," says Brandao.

AI for business

And it's not just researchers who are currently wowed by the potential of AI, says Stefan Feuerriegel, ETH Professor of Management Information Systems. "Companies will find that AI gives them a competitive edge in the long run. But it will be five years or more before that becomes visible," he says, explaining that we are still in the early stages. "Companies are just starting to experiment with AI – and we're here to help," says Feuerriegel. He cites the example of AMAG, Switzerland's biggest car dealer, which commissioned him and his team to define the most potentially exciting AI applications for the company and to launch some initial projects on that basis. Feuerriegel's team is also helping online retailer Digitec Galaxus develop an intelligent system that will analyse customer behaviour on the website. The aim is to identify hesitant customers and provide them with additional information at the right moment in order to boost their resolve to go through with a purchase.

Feuerriegel argues that predictive analytics – in other words, data-based forecasting systems – are a promising area for AI applications, whether in marketing and sales, healthcare and insurance or logistics. AI can also help with traditional administrative tasks, as demonstrated by a recent ETH spin-off. The idea is that, in future, repetitive tasks such as entering invoices, checking delivery notes and processing expense receipts could all be carried out by machine learning algorithms. The key is to create algorithms that can read and process invoices and receipts even if they are not specifically available in a computer-readable format. The solution developed by BLP Digital is based on a combination of two technologies: image and text recognition. BLP expects to see interest from customers in all sectors where administrative processes consume significant resources. "We know that even processing a simple invoice takes an average of 8 to 12 minutes," says Feuerriegel – meaning that AI could achieve major time savings in this context.

This sounds appealing – but what does it mean for jobs? Studies suggest that AI could lead to the loss of a good 20 percent of jobs in the administrative arena. That might seem like cause for concern at first glance, Feuerriegel admits, but he insists that AI will also provide plentiful opportunities for more interesting and higher-qualified jobs than we have today. "We'll always need the human factor," says Feuerriegel, noting that this trend will only unfold at a gradual pace, not a disruption that will change everything from one moment to the next. "We can't purchase intelligent systems off the shelf as if they were smartphones," he says. It is still a matter of developing the right solution for each individual product, and this process takes time.

Part of the digital strategy

ETH is steadily digitalising processes for resource and business management, human resources management and services for students. "AI is part of our digital strategy," says Robert Perich, Vice President for Finance and Controlling at ETH. That puts AI for administrative processes firmly on the ETH agenda in the context of continuous organisational development and digitalisation, for example within the framework of the rETHink project. His colleague Paul Cross explains what this means: "Our aim is to take a 360-degree approach to digitalisation and ensure that we have the kind of solid foundations for AI that allow us to properly align people, processes, data, systems and governance." The idea is to work closely with ETH researchers and harness existing relationships with experts in machine learning, natural language processing and other areas of AI. "We can draw on world-class expertise at ETH," says Cross. In return, he argues that the process of digitalisation can supply researchers with use cases that they can put into practice. Cross is confident that AI will become a valuable tool for administration at ETH within just a few years – a tool that will offer plentiful advantages to students, staff and other broad groups of stakeholders. ○

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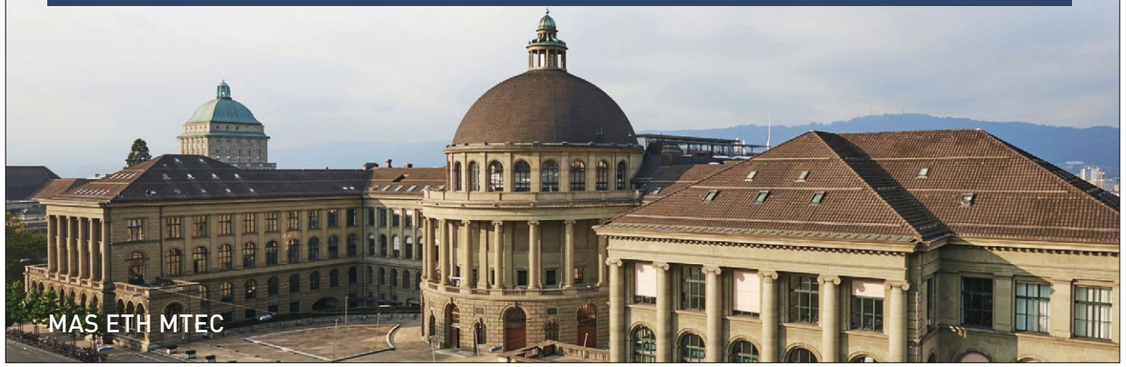

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A bird's-eye view of Früebüel with the Rigi in the background

AgroVet-Strickhof

FRÜEBÜEL UNVEILS MAJOR IMPROVEMENTS

The renovation and extension of Früebüel research station in the canton of Zug has been completed. AgroVet-Strickhof – which is supported by ETH Zurich, the University of Zurich and Strickhof – now has state-of-the-art research and higher education facilities at all four of its locations.

The construction project primarily focused on renovation and extension work. Key improvements included adding a free stall for suckler cows to an old barn, modernising and extending the laboratory infrastructure and building a winter shelter with spacious pens for fallow deer.

Früebüel's new facilities will be used for research into breeding cattle, suckler cows, sheep and fallow deer. Located 1,000 metres above sea level, Früebüel is particularly suited to investigating specific issues related to farming work in mountain pastures and alpine foothills. Research here will primarily be conducted by AgroVet-Strickhof's partners – in particular, ETH professors in animal sciences, plant ecology and grassland sciences.

Melissa Terranova, head of research at AgroVet-Strickhof, argues that the higher education and research programmes run by AgroVet-Strickhof at Früebüel are of national and international interest. "AgroVet-Strickhof is the only facility in Switzerland to carry out university-level education and research that is directly linked to vocational training and agricultural practice," she says. "That really underlines the systemic importance of this one-of-a-kind collaboration."

Botnar Research Center

PARTNERS AGAINST COVID-19

The Botnar Research Centre for Child Health (BRCCH) launched an emergency initiative this spring to help combat the global coronavirus pandemic. As well as seeking solutions to the most pressing challenges, the initiative also aims to develop longer-term approaches that could help the world get a better grip on similar situations in the future.

The Fondation Botnar, which financed the establishment of the centre with a donation, has now promised additional funding dedicated to this goal. The funds will be used to support projects run by the four participating institutions over a period of two and a half years. The Botnar Research Center for Child Health was founded jointly by ETH Zurich and the University of Basel in 2019 to promote the health of children and adolescents worldwide.

The ETH Foundation is seeking further partnerships:
→ www.ethz-foundation.ch/en/corona-impulse-fund-2

Images: Alessandro Della Bella; Gerd Altmann on Pixabay

Singapore-ETH Centre

Interdisciplinary cooperation

Ten years ago, ETH took the bold step of establishing a presence abroad in the form of its very own research centre. This year, the Singapore-ETH Centre launched its third research programme – and new insights are already making their way back to Switzerland.

ETH Singapore Month brings together graduate students to share their ideas in lively exchanges.

Unlike most base camps, this one is not at the foot of a remote mountain, but in the middle of a bustling city. The Singapore-ETH Centre (SEC) is the first research centre established by ETH outside Switzerland. It was founded in 2010 in partnership with Singapore's National Research Foundation (NRF) with the goal of addressing key challenges of urbanisation. "Asia is seeing huge growth in city sizes and populations. We need to be close to those challenges to address them properly," says former Managing Director Remo Burkhard. He was involved with the SEC from the very beginning, travelling to Asia to set up the centre together with SEC Director Gerhard Schmitt. The research community there grew to 100 people after just 15 months – and by next year, the SEC will have over 200 researchers from 25 disciplines and 20 different countries.

Cooperation with practical benefits

Singapore is not just a gateway to Asia: it also offers a start-up culture that has the energy and enthusiasm to make the best use of new ideas. The CREATE campus, where the SEC is located, was set up at breakneck speed. Its open and welcoming format – including spin-offs from leading universities – gives rise to all sorts of unplanned encounters between researchers. "It's a fascinating and tremendously vibrant ecosystem," says Detlef Günther, Vice President for Research and Corporate Relations at ETH and Co-Chair of the SEC Governing Board. "We're keen to foster interactions with other universities on site and in Singapore," says current Managing Director Thomas Rufener. He notes that spontaneous encounters have often led to exciting research projects such as Natural Capital Singapore, which seeks to assess the quality of Singapore's ecosystems as well as their environmental and socioeconomic value. At the core of the SEC are its five-year research programmes in which the SEC acts as lead partner. The first programme, Future Cities Laboratory, combined science and design to promote a sustainable and liveable urban future. Collaboration with industry and the Singapore authorities enables rapid implementation of development concepts such as 3for2, an energy-efficient building cooling system developed by a team led by Arno Schlüter. This system offers space savings, which provide economic leverage while using 40 per cent less energy than conventional buildings.

The tenure of SEC Director Peter Edwards (2013–2017) included the launch of the Future Resilient Systems programme, which aims to make complex infrastructure systems more robust and resilient. At the start of this year, the SEC embarked on its latest research programme, Future Health Technologies. In collaboration with Singapore's universities and hospitals, researchers will be developing more patient-centric digital technologies for prevention and care, including chatbots. "Our goal is to find answers to pressing questions on ethics, data security, the usability and usefulness of AI algorithms, and much more," says Günther. COVID-19 has added a whole new dimension to their research work: with many patients reluctant to attend doctors' offices in person during the pandemic, the development of chatbots and virtual medical consultations looks set to attract greater interest in many regions, including Europe.

Inspiration from Asia

All the SEC's research programmes have been extended based on their success so far. Rufener argues that this has been possible thanks to the SEC's reputation as a reliable partner with a long-term focus, which is seen as an important quality in Asia. In addition to acting as Switzerland's calling card, the SEC has paved the way for more in-depth interaction with the private sector. "There was significant transfer of knowledge from Europe to Asia in the first few years, but this flow of information is increasingly coming full circle. Key findings can now circulate freely between Singapore and Switzerland," says Schmitt.

In 2019, Zurich's urban planning department sent a delegation to Singapore to draw inspiration from the Cooling Singapore research project. The results of research on urban heat islands in Singapore has now been incorporated into the city of Zurich's technical plans for heat reduction. The Future Cities Lab Global research programme, which is currently at the planning stage, aims to further strengthen interaction between ETH, the SEC, local partners and beyond. Its goal is to examine and compare urbanisation in Switzerland with urbanisation in tropical and subtropical regions facing similar issues.

"We want to keep evolving and growing together. We will need to forge closer and more interdisciplinary ties between individual research programmes if we hope to make major contributions to global challenges," says Günther, laying out his vision for the SEC. Gerhard Schmitt refers to the centre as a living lab – a laboratory that works with a user-centric methodology in real-life contexts – and he is already seeing a great deal of interest in opening similar centres in Africa, India and China. — Stéphanie Hegelbach

Philanthropy

togETHer

By Donald Tillman

The success of ETH hinges on the endeavours of many researchers and students. Likewise, the ETH Foundation achieves a huge impact by combining many small contributions, as well as larger sums, from donors and partners. When people who share the same goal join forces, great things are made possible.

The campaign we launched in June to promote health research garnered support from many quarters within the first two months, including hundreds of alumni and alumnae. The donations included many two- and three-digit contributions and even larger sums. This joint effort will now help drive forward a number of coronavirus-related research projects. One example is a serological study that will regularly analyse the immune status of several thousand test subjects over the course of a year in order to heighten our understanding of the spread of the infection and the extent of immune protection. In future, each and every donor will be able to look back with pride on the part they played in opening up these insights.

→ www.ethz-foundation.ch/en

Image: Singapore-ETH Centre, Carlina Teteris

Image: Eline Keller-Soerensen

Rosengarten

NEW HOUSING FOR STUDENTS

The Foundation for Student Housing Zurich was established in 1987 by ETH Zurich, the University of Zurich, the City of Zurich and the WOKO student housing cooperative. Its most recent project is the new Rosengarten student residence, an extraordinary building that offers living space for 130 students. The whole district will benefit from facilities and services for childcare, commercial space for small businesses and a public park.

ETH alumni

NEW AFFILIATE ORGANISATION

The interdisciplinary Master's degree programme in Energy Science and Technology, which focuses on sustainable energy systems, now has its own alumni group. The group aims to maintain and foster contact between graduates all around the world once they complete their course. Johanna Vorwerk is serving as the first president of the group.

The award is usually presented at the ETH Foundation's Thanksgiving event, but this year's ceremony was limited to a small gathering due to the coronavirus pandemic.

Prize donor Max Rössler, recipient Paola Picotti and ETH President Joël Mesot (from left to right) at the award ceremony

ETH Foundation

PAOLA PICOTTI AWARDED 2020 RÖSSLER PRIZE

Systems biologist Paola Picotti has received this year's Rössler Prize for her groundbreaking work in the field of proteomics. She has developed a method of measuring changes in thousands of proteins at the same time, paving the way for personalised therapies.

At the age of 43, Picotti has achieved what others would regard as a life's work. She was appointed Associate (Tenured) Professor in 2017 and has headed a research group of 20 people ever since. The 2020 Rössler Prize is the latest in her series of achievements. As well as obtaining two grants from the European Research Council (ERC), she also received an EMBO Gold Medal in 2019 for internationally acclaimed contributions to the life sciences. Worth 200,000 Swiss francs, the Rössler Prize is the most highly endowed research award at ETH Zurich and was made possible by a gift to the ETH Foundation from ETH alumnus Max Rössler.

Donation to Corona Impulse Fund
Picotti plans to spend some of the prize money on developing her research team and acquiring new laboratory equipment. She has also donated part of the money to the Corona Impulse Fund launched by the ETH Foundation. "I hope that in this way I can support ETH research into COVID-19 and help students experiencing financial hardship," she says.

Find out more about the Rössler Prize:
→ www.ethz-foundation.ch/en/roessler-prize

Images: Karin Gauch and Fabien Schwarz; Nicola Pitaro

Transfer

Sustainable outdoor clothing

Outdoor clothing is booming on the back of growing enthusiasm for hiking, walking and running. And the coronavirus has made protective clothing a more pressing issue than ever. Yet many of these products leave behind toxic substances in the environment: membrane residues are found not just in remote lakes and mountains, but also in the blood of wild animals such as polar bears. Determined to change this, a group of ETH researchers set up Dimpora, an ETH spin-off that produces sustainable membranes for outdoor clothing that do not pollute the environment.

The membrane developed by Dimpora is laminated onto a textile. The waterproof, breathable and fluorine-free membrane is based on polyurethane, but recyclable polymers – including biodegradable options – can also be used for the process. It is even possible to apply the membrane directly to ready-made jackets or trousers by spraying, printing, painting or dip-coating the fabric. This method reduces waste and avoids the loss of membrane function that cutting, sewing and seam-taping entail.

In addition to outdoor clothing, Dimpora's membranes can also be applied to protective clothing and workwear.

Dimpora
ETH spin-off: founded in 2019
Product: environmentally friendly membrane for outdoor clothing
→ dimpora.com

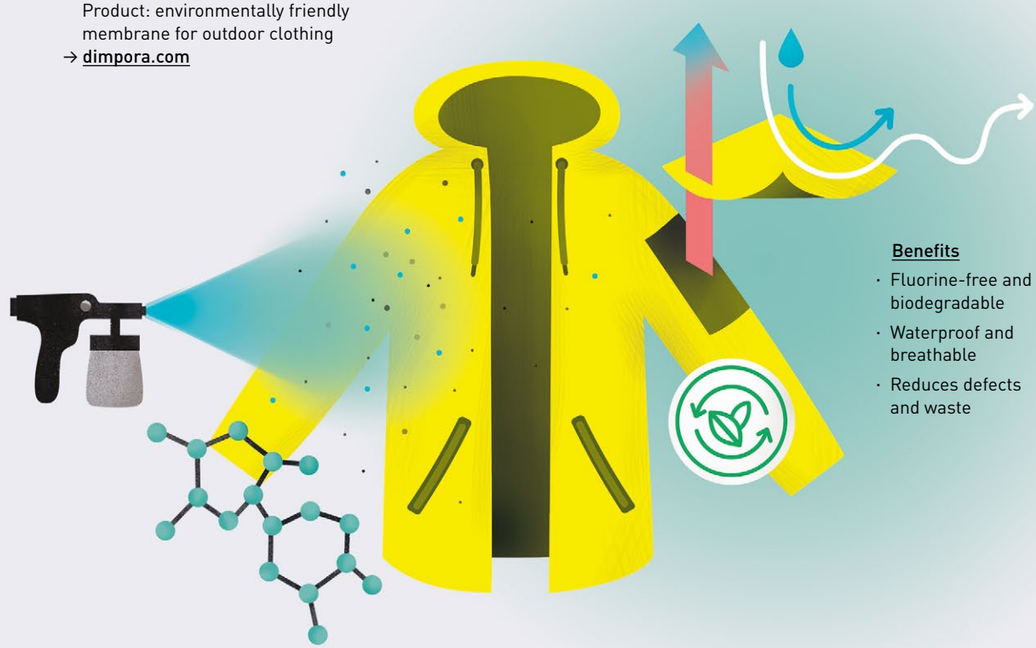


Illustration: Carolin Eitel

A university for the guardians of the rainforest

The Inga hope a university will keep their indigenous heritage alive, safeguard the natural habitat of the Colombian rainforest and give the younger generation a future. Anne Lacaton, Professor of Architecture and Design, spent two semesters supporting the project with her students.

TEXT Samuel Schlaefli IMAGE Studio Lacaton

On the Caquetá river with Inga leader Hernando Chindoy

Students on their hike through Inga territories

It's late one evening in October 2019, and a group of students from ETH Zurich and Javeriana University are crossing the Caquetá river on their way back to Villagarzón. The sky above them is clear and black, studded with the sparkling stars of the Milky Way. The river is as dark and smooth as a pool of oil, and the boat is surrounded by the polyphonic humming of tropical insects in the dense tropical forest on both banks. "The students were so quiet," says Zurich-based artist Ursula Biemann. "That night-time boat trip and the sheer beauty of the moment is something we will never forget."

Armed drug traffickers and environmental destruction

This extraordinary experience was the culmination of hours of hiking through the lush, almost impenetrable terrain of Putumayo – a trip that confronted the students not only with the wonders of nature, but also the more harrowing aspects of life in this region. Their route took them past oil platforms that are steadily encroaching on the rainforest, coca plantations tended by farmers living in abject poverty, and the whining sound of chainsaws clearing trees to make room for herds of cattle. The 17 students had travelled to southern Colombia to get first-hand experience of a territory they had been studying for weeks – a territory that is home to the Inga people.

The Inga are one of Colombia's 87 indigenous ethnic groups. They are descended from the Incas, who, in the 15th century, expanded their empire along the Andes mountain chain and made their way through the Ecuadorian Amazon basin to the Colombian rainforest. Today, there are over 15,000 Inga scattered across tens of thousands of hectares and multiple Colombian departments. They live in fragmented and often hard-to-access territories dotted across an area stretching from the foothills of the Andes to the Amazon basin. Many Inga earn a living growing coca, the raw material used for producing cocaine. The region is also known for opium cultivation, which has led to large-scale deforestation. As a result, Inga territory was long at the heart of armed conflicts over drug production and trafficking that had raged between FARC guerrillas, paramilitaries and the army since the 1960s. The Inga were largely abandoned to their fate in the face of rampant violence and persecution.

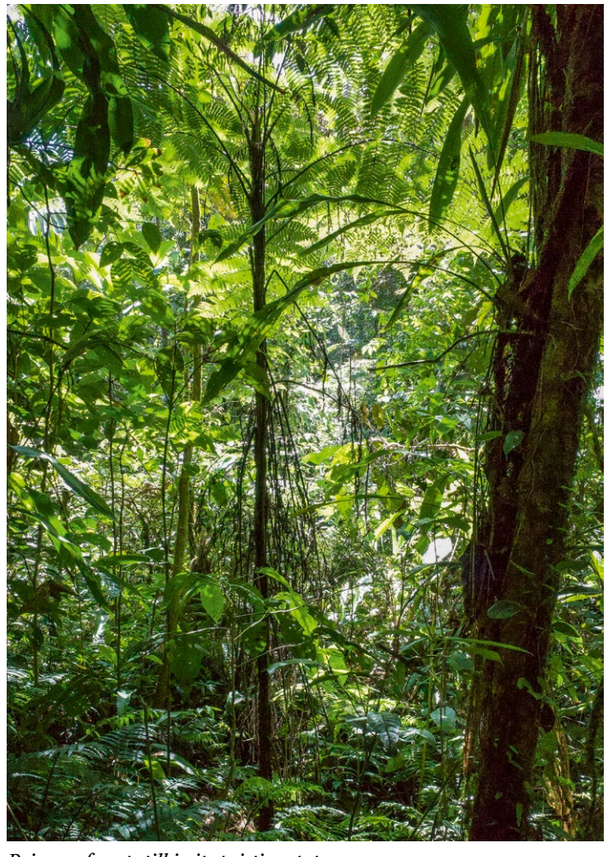
In 2004, their predicament prompted an extraordinary act of self-empowerment in the town of Aponte, which is situated at an altitude of 2,000 metres. Inspired by an indigenous women's organisation and with government support, the local community began to reforest and cultivate areas that had been degraded by drug production, reclaiming the soil through the use of organic fertilisers and plentiful manual labour. Instead of coca, they planted coffee and fruit trees. The driving force behind this transformation was Hernando Chindoy, a charismatic community leader who represents the Inga on their quest for greater self-determination, resistance and cultural renewal.

The humility of not knowing

Zurich-based video artist Ursula Biemann met Chindoy in the summer of 2018 while she was working on an assignment for the Art Museum of ›

the National University of Colombia. Her preparation included a five-week excursion through Putumayo department. Access to this region had been restored in 2016 following the signing of a peace and disarmament agreement between the Colombian government and FARC, and Chindoy signed up as her guide. “On the last day, just before I left, Hernando said to me: ‘We want to establish a university here. Will you help us?’” Biemann carried his message back to Switzerland, telling Philip Ursprung about the Inga’s request for help. Ursprung, at that time the Dean of the Department of Architecture at ETH Zurich, responded positively to the idea, rounding up a group of professors so that Biemann could present the project.

The group included Anne Lacaton, Professor of Architecture and Design. “I’m always open to pursuing completely new avenues,” she says. The French architect is well known for her work with the architecture studio Lacaton & Vassal, which encompasses museums, social housing and the transformation of existing residential buildings, primarily in France. “In all our projects, we start from the perspective that we know nothing about the context in which we will be building,” says Lacaton, describing how she works. “That forces us to really open our eyes and find our own way of responding appropriately to each specific situation.” She describes this attitude as the humility of not knowing, and she also extended it to the project in the Colombian rainforest. Lacaton devoted a two-semester studio to the concept of an indigenous university. Right from the start, she insisted that her studio would not develop any ready-made solutions – that is, no concrete plans, visualisations or calculations for a university campus. Instead, she wanted to take a journey with the students to explore, document and understand the socio-economic, political and territorial context of the Inga people. “You can still be an architect without actually building anything,” Lacaton says, outlining her ideas of the architect as an ethnographer and the studio as a catalyst for articulating indigenous people’s needs.



Primary forest still in its pristine state

Combining different cultures of knowledge

The Inga had their own ideas for “their” university right from the start of the process, says Ivan Vargas, a Colombian member of the project team. “When it comes to answering research questions, the indigenous people do more than just reading texts,” he explains. “One of the ways they approach learning and research is by visiting the ‘chagra’, a communally managed plot of land where crops are grown to feed the community and celebrate the diversity of plants. We see this as an equally important approach to learning.” The goal from the outset was therefore to embark on an inter-epistemic dialogue to bring together the learning and research traditions of the indigenous people with those of established modern science. This would provide a basis for ensuring the Inga people’s own store of knowledge – much of which is only transmitted orally by shamans – would survive into the 21st century.

> “Even without a campus, the university can at least start off in an existing school.”
>
> Anne Lacaton

Equally important is to make the university a space where the Inga can honour and develop their ethnic identity. Indigenous people are marginalised in Colombia – just as in the majority of South American countries – and their language and customs are increasingly threatened with extinction. Although the government has built primary schools for the Inga, a university education is only available in the cities of Medellin or Bogotá. But university courses in the city do not equip young Inga people with the skills they need to return to their community, so many of them never come back. Inga representatives therefore agreed that the key requirements for an indigenous university should include environmental studies and ecological agriculture, traditional medicine, and territorial governance based on indigenous ethics and Earth rights. The curriculum would be rounded off with linguistics, semiotics and history. The idea is for teaching to be provided on equal footing by indigenous masters of knowledge and Western professors, with the primary goal of learning with and from each other. At the same time, the university would act as a conservation centre to safeguard the region’s unique natural environment. Although parts of the Inga territory already have national park status, no park wardens have been trained, and no methods have been developed to protect the park against poachers, loggers and unlicensed copper and gold mines.

Left: Illegal logging in the rainforest
Right: Footbridge to a centre for Inga women

Decentralised and ecological

In June, the ETH students presented their work in a virtual event and discussed it with professors and experts from Switzerland and Colombia. In line with Lacaton’s concept, the five workgroups did not present any final architectural proposals, but instead elaborated five strategies for setting up a university. These included the idea of decentralising the campus and distributing it across the widely dispersed Inga communities. Suitable locations would depend on the course content in each case but could include an urban centre, an agricultural area in the lowlands and a cloud forest region at higher altitudes. One of the other groups delved deeper into the teaching content and came up with a suggested course curriculum including a breakdown of each semester. Other topics included consideration of ongoing decision-making processes and strategies for continuing to develop the university in the years ahead.

Lacaton and her students have now produced a book of essays, photographs, studies, plans and first-hand accounts from the field. This is currently being translated into Spanish. Ursula Biemann intends to return to the Putumayo region in autumn to continue her creative work and hopes to discuss the ideas with the Inga while she is there.

ETH also looks likely to continue with the project. Although Anne Lacaton became an emeritus professor in July, Teresa Galí-Izard – who was appointed as Professor of Landscape Architecture in January – has already expressed an interest in continuing work on the Inga university. Lacaton hopes that the indigenous university will soon be up and running: “Even without a campus, the university can at least start off in an existing school.” She thinks of the university not as a finished product, but rather as an ongoing, iterative process. “What’s interesting about this project is not only setting up an indigenous university in Colombia, but also what it can teach us about architectural projects in Europe,” Lacaton argues. ○

Agenda

KNOWLEDGE

5 November 2020, 6.30 p.m.

Smart, sustainable investing

Olga Miler is a marketing and innovation expert who specialises in women and finance. Her webinar provides an introduction to sustainable investing. In addition to learning more about key concepts, participants will also get a breakdown of providers and tools as well as tips and tricks on how to make their money work harder – both for them and for the planet.
Find out more and sign up:
→ alumni.ethz.ch/en/events

Online since 4 May 2020

Mutual interplay

Entropie is a new blog that went online on 4 May this year. It provides a platform for ETH students to blog on how knowledge changes society, and vice versa. Students of natural sciences, engineering and humanities can contribute their expertise to discussions at the interface between academia and society. The world moves ever onwards – and so does science.
→ entropie.ethz.ch

Robot pianist TeoTronico and pianist Roberto Prosseda

Concert

ROBOT VS HUMAN

13 October 2020, 7.30 p.m.

This unique project sees pianist Roberto Prosseda pitting his skills against a robot pianist named TeoTronico. They will each play the same pieces, giving the audience the chance to pick out the differences between their two performances.

ETH Zurich, Zentrum campus, Semperaula
More information and tickets:
→ musicaldiscovery.ch

Podcasts

GLOBAL CHALLENGES

Listen to more podcasts:
→ www.ethz.ch/podcast

Podcast by the Center for Security Studies (CSS): "How likely is a war between the US and China?"
→ css.ethz.ch/usa-china

Podcast series by the NADEL Center for Development and Cooperation: "1.90 a day – rethinking international cooperation" (in German)
→ nadel.ethz.ch/outreach-activities/podcast

Images: Nadine Wüthrich; Musical Discovery

DISCOVER

Until 15 November 2020

Franz Gertsch. Looking Back.

To mark the 90th birthday of renowned Swiss artist Franz Gertsch, the ETH Zurich Graphische Sammlung is running an exhibition that focuses entirely, and unusually, on his early work. The art from this period clearly shows the extent to which Gertsch tried out various forms of expression in his early years.
ETH Zurich, Rämistrasse 101, Graphische Sammlung
→ gs.ethz.ch/en/current

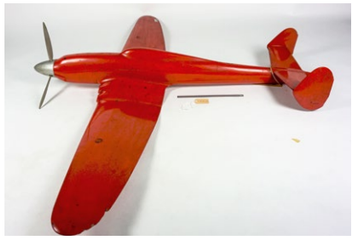
*Franz Gertsch (*1930), Daphnis und Chloe, 1948*

Start-up: the documentary

Unless they are famous, scientists and entrepreneurs often remain invisible to the public eye. The documentary mini-series *Start-up* shines a light on the work of early-stage entrepreneurs and pays a visit to their labs and workshops.
→ startup-documentary.com

8 December 2020, 6.15 p.m.

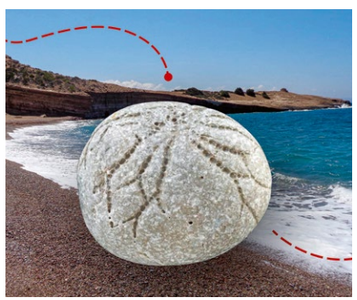
Aircraft models and measuring instruments



The collection of scientific instruments and teaching aids features historical aircraft models from the former Institute of Aerodynamics. Participants can also visit the wind tunnel at the current Institute of Fluid Dynamics.
Meeting point: ETH Zurich, Rämistrasse 101, ETH Library
Find out more about this and other tours:
→ tours.ethz.ch

Travel with stones

Join forces with *focus*Terra on the virtual exhibition "Travel Stones". Add your favourite stones and the stories that you associate with them – whether they come from your front garden or the other side of the world!
→ reisesteine.ethz.ch/en



Images: © Franz Gertsch; collection of scientific instruments and teaching aids, ETH Library; © *focus*Terra, illustration by Marion Deichmann; Carl Hanser Verlag

Recommended reading

THE WILDERNESS, THE SOUL, NOTHINGNESS

ETH philosophy professor Michael Hampe presents a fascinating exploration of philosophical and literary concepts that encourages us to examine the principles by which we live our lives.

How do we find real life? By retreating into untouched nature? After death, in immortality? Through the lives of our children? These questions also preoccupied fictional poet and philosopher Moritz Brandt. Sorting through his estate, his friend Aaron comes across diaries and essays in which Brandt reflects on what constitutes real life. The more he immerses himself in the texts, the more frequently Aaron asks himself: where does this desire to change, to become real, come from? Hampe masterfully combines narrative and reflection in order to illuminate how distinguishing between appearance and reality prevents us from coming to terms with our lives.

Author: Michael Hampe
Carl Hanser Verlag
ISBN: 978-3-446-26577-6
in German

Citizen in uniform

Germaine J. F. Seewer is the first woman to hold the rank of Major General in the Swiss Armed Forces. Her new role as Commander of the Armed Forces College has forged even closer ties to her alma mater.

TEXT Felix Würsten IMAGE Daniel Winkler

Germaine J. F. Seewer is not particularly keen on press events – least of all when the focus is on her. Yet she says she was glad to accept the invitation to speak to ETH *Globe*: "I still have very strong ties to ETH Zurich. My time there shaped who I am today." She is also conscious of the example she has set by becoming the first woman to rise to the rank of Major General in the Swiss Armed Forces. Women now have access to all the branches of the armed forces, as shown by pioneering figures such as Switzerland's first female fighter jet pilot Fanny Chollet, who appeared at a media briefing on the proposed purchase of new fighter jets. Overall, however, women continue to be something of an exception. "It's not enough to just promote women as equal partners," says Seewer. "You also need a welcoming environment that actively encourages more young women to sign up." In part, this relies on women like Seewer acting as role models to prove that women can reach the highest ranks of the armed forces.

Seewer herself views the situation pragmatically. She praises the choice to appoint Viola Amherd as Switzerland's first-ever female defence minister: "The public really like her," she says. "But she has to perform the same duties as a man. I personally don't see any difference."

Always at the forefront

Originally from the Swiss canton of Valais, Seewer has a matter-of-fact approach that probably stems from the fact that she has spent her entire career in male-dominated environments. When she began her degree in chemistry at ETH Zurich, there were fewer than ten women in her class. She still has fond memories of those first few months, recalling the old chemistry building and the steeply banked lecture hall, though it took a while to find her bearings in the Main Building.

Seewer comes across as quiet and reserved, yet her ascent in the ranks clearly demonstrates her healthy reserves of tenacity and determination. She deliberately keeps a low profile and reveals little about herself in conversation. But, just occasionally, she alludes to the fact that there have always been people in her life who influenced her career at key moments. One of these was a teacher at her secondary school in Brig, who managed to get a young Seewer interested in chemistry. The subsequent transition from peaceful Valais to ETH went without a hitch. "I was well aware that ETH gives people rather less leeway than other universities," she remarks with a smile. "I had done my homework and I knew what to expect!"

Just across the road

Her academic career initially led her from chemistry to animal science. "I liked being able to literally just cross the road to apply what I had learned," she says. At that time, the chemists and animal scientists were still housed relatively close to the ETH Main Building, just on the other side of a small residential street. In her doctoral thesis, Seewer investigated how pork meat quality is affected by gender, breed and different feeds.

At first, it appeared that Seewer was set to make a career as a researcher. She completed her postdoctoral studies at AU Foulum, a food and agricultural research centre in Denmark, and then worked as a scientist at the Swiss Federal Research Station for ›

GERMAINE JOSEPHINE FRANÇOISE SEEWER

Born in the Swiss canton of Valais in 1964, Seewer became the first Swiss woman to achieve the rank of Major General in January 2020 – the second-highest peacetime rank in the Swiss Armed Forces. As Commander of the Armed Forces College AFC and Deputy Chief of the Training and Education Command, she is responsible for the training and education of the professional forces and senior cadres in all branches of the armed forces. Seewer has some 220 staff members working for her in this capacity. She was previously in charge of the 41st Command Support Brigade, becoming the first woman to command a brigade. Seewer regularly participates in the Patrouille des Glaciers,the world's biggest ski mountaineering race.

"The French-speaking part of Switzerland has a word that really reflects what I feel: *citoyen-soldat.*"

Animal Production in Posieux. "I chose to do my postdoc in Denmark because, unlike the Americans, the Danes' ideas about meat quality are similar to ours," she says.

Fascination with people

Today she is a high-ranking staff officer working in a very different field, yet she can still apply much of what she learned during that period. Skills that immediately spring to mind include analytical thinking and the importance of rigorously checking one's sources – plus a distinct flair for numbers and the ability to see beyond the statistics. ETH also taught her valuable lessons about thinking in a connected way.

Seewer's career has advanced in leaps and bounds since she joined the military intelligence service as a specialist instructor in 1998. Her assignments have included serving as a staff officer with the Swisscoy troops in Kosovo, working as a UN military observer in Ethiopia and Eritrea, and her deployment from 2008 to 2010 as Commander of the Swiss Air Force's leadership training college once she joined the ranks as a career officer. One of her biggest promotions came in 2013, when she was appointed as Brigadier General by the Swiss Federal Council and took on the role of the Armed Forces' Head of Human Resources in parallel. Five years later she became the first woman to command a brigade.

"I find the diverse mix of people fascinating," she once said when asked what she enjoyed about her job. She enjoys how the armed forces brings people together from different parts of the country and different social classes to tackle a job together. "The French-speaking part of Switzerland has a word that reflects exactly what I feel: *citoyen-soldat*." Seewer readily accepts that the armed forces must adapt continuously to changing social conditions. "Today's 20-year-olds have a different mindset to the one we had when we were 20," she acknowledges. "But we had different attitudes to those that came before us, too!"

A spring to remember

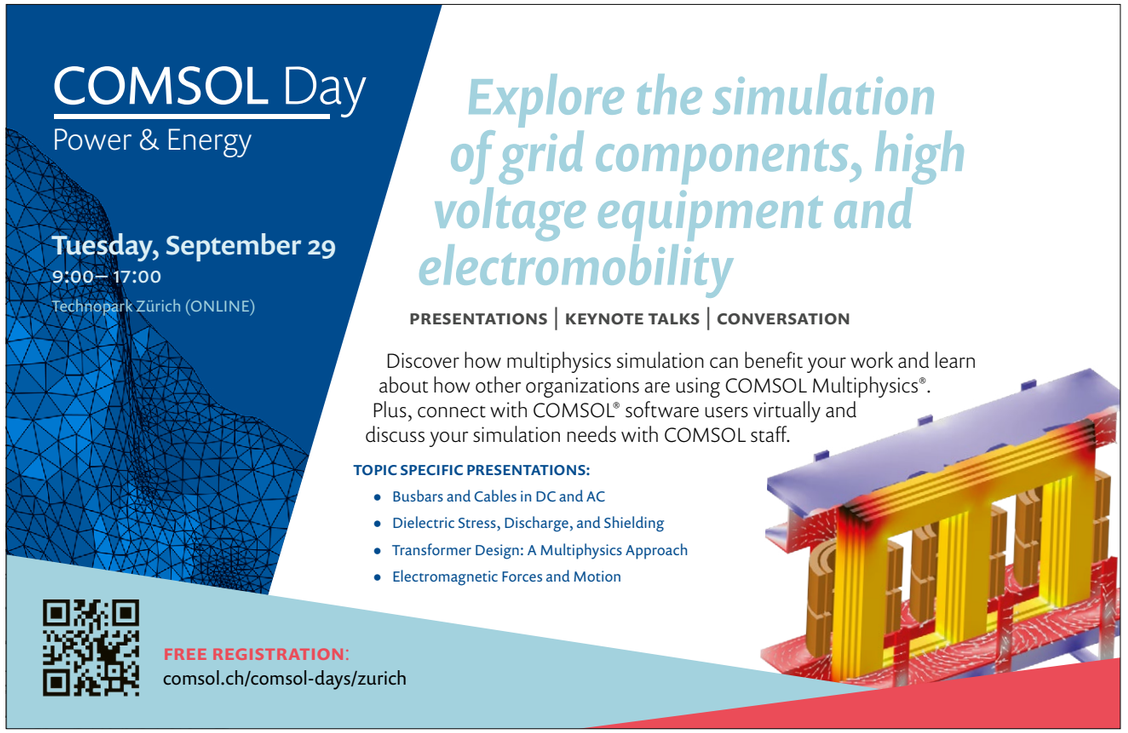
Earlier this year, Seewer was appointed as Commander of the Armed Forces College AFC. "It's nice how my career has led me back into education," she says. This will mean she has more contact with ETH in the future, because the ETH Military Academy (MILAC) plays an important role in training career officers. "I was scheduled to pay an official visit to ETH Zurich President Joël Mesot and Rector Sarah Springman," she says. "But we had to postpone that due to the current circumstances."

The coronavirus crisis has certainly put the armed forces in an unusual situation. "We've seen the focus shifting to troops that wouldn't normally expect to get so much attention, such as the medical corps," Seewer says. She acknowledges that the armed forces have done a good job and points to positive feedback from the health service, government and the population at large. Although she herself wasn't directly involved in the armed forces' response to the coronavirus, a major effort was still required in her area of responsibility. "We had to introduce new training formats overnight because our normal face-to-face classes were no longer possible," she says.

Don't forget your roots

Seewer emphasises that her ties to ETH have never been broken: "I've always stayed in touch with the university as a member of the Alumni Association. And since the MILAC graduation ceremonies and annual meetings are always held in the ETH Main Building, I've had the opportunity to pop back to my alma mater every now and then." As an alumna, she also supports the Excellence Scholarship & Opportunity Programme through the ETH Foundation, which provides excellence scholarships to outstanding Master's students. "I'm proud of where I studied and happy to be able to give something back," Seewer says. She's delighted that ETH is such a highly ranked university and acknowledges the importance of maintaining an international focus to remain successful in the future. "But I very much hope that ETH will never forget its roots as a Swiss federal university," she remarks. "It's part of the fabric of our nation and something we should always nurture." ○

Anzeige



5 QUESTIONS

Immunologist Emma Wetter Slack develops innovative oral vaccines against pathogenic intestinal bacteria in farm animals – and against coronaviruses in humans.

You're currently working on an optimised COVID-19 vaccine. What's your goal here?
We want to ascertain how much protection against SARS-CoV2 can be achieved by immune responses to parts of the virus that are identical in many coronaviruses, including those causing certain common colds in humans. This will help us understand the spread of the current pandemic and might help to design vaccines for the epidemics of the future.

What are the advantages of an oral vaccine that doesn't need to be injected?
Our vaccines can also be administered through the nose! The advantages are 1) that you can activate a local immune response in the part of your body where infection first occurs and 2) that these vaccines are much easier to pack and distribute in low-resource settings as they don't need clean needles or trained medical personnel to administer them.

Emma Wetter Slack is Professor of Food Immunology at the Department of Health Sciences and Technology.
→ foodimmunology.ethz.ch

You're developing vaccines against coronaviruses in humans and also against pathogenic intestinal bacteria in farm animals. Are there any parallels?
There are a lot of differences. But very broadly, in both cases there's good evidence that a type of antibody, called IgA, provides protection. We can use the same tricks to induce these antibodies against either SARS-CoV-2 or E. coli.

What has been your experience of working in interdisciplinary teams?
My most successful collaborations have grown out of attending a seminar on a topic outside my comfort zone and starting a discussion. Where there's a common will to solve a problem across disciplines, really exciting things can happen. One of the real pleasures of working at ETH is that people are so open to collaborating like this.

"Our research could help to design vaccines for the epidemics of the future."

The proportion of female professors in your department is rather high. Why might this be?
Typically, the Department of Health Sciences and Technology has over 60% female Bachelor's students, 50% female PhD candidates, yet only 28% female professors. Yes, we're above average, but the pipeline is still leaky! That said, strong role models and the motivation to improve diversity in the departmental leadership is a good starting point. — Interview conducted by Karin Köchle

Image: Stefan Weiss

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