

ETH Zürich Foundation

Uplift

The impact of giving **N°9**

**Game changer in
transport planning**

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language models**

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**Artificial
intelligence**

Innovation and critical reflection



ETH Zurich/Markus Bertschi

Joël Mesot
President of ETH Zurich

Artificial intelligence (AI) is a well-established part of our everyday lives: when we talk to Siri, when Netflix recommends films to us or the doctor diagnoses a skin tumour, one form or other of AI is involved. ETH launched its AI Center in autumn 2020, bringing together the numerous activities of ETH in this area. The Center is intended to establish itself as an interface to the economy both on a national and international scale, and bring about even more innovation and spin-offs. The researchers also focus closely on the ethical aspects of AI.

In this rapidly growing area, which is benefiting from huge investment worldwide, young researchers are a key success factor. The ETH AI Center has therefore set up a fellowship programme that attracts talent from all over the world. You will be introduced to one of these young researchers in this issue. ETH can afford this important programme partly thanks to the commitment of a circle of philanthropists and a foundation. Read on for details of what else the promotion of research and teaching at ETH can achieve!

IMPRINT

Publisher ETH Zurich Foundation **Editorial team** Isabelle Vloemans, Isabelle Herold
Design and illustration Kristina Milkovic **Photography** Unless otherwise stated: Das Bild – Judith Stadler and André Uster, Zurich **Printing** Neidhart + Schön Print AG, Zurich **Proofreading and translation** Supertext AG, Zurich **Contact** www.ethz-foundation.ch, uplift@ethz-foundation.ch, +41 44 633 69 66

Cover image: Pioneer Fellow Lukas Ambühl, see page 4 (© ETH Foundation / Alessandro Della Bella)

Full of drive for transport

Pioneer Fellow Lukas Ambühl is developing a tool that he can use to simulate the transport system of any town or city. Artificial intelligence allows for a planning approach that keeps everyone rolling.

More than half of the world's population already lives in towns and cities, and the trend is rising. One of the biggest challenges posed by increasing urbanisation is the efficient organisation of transport. How can we make sure that the huge numbers of cars, bicycles, trams and buses keep moving? How can traffic jams be avoided? What is the impact of roadworks – and what about when self-driving cars are added to the equation in the future? Good transport planning helps to protect the environment and avoid stress, as well as saving time and money. And last but not least, it makes it safer to be on the road.

Lukas Ambühl, who has a doctorate in civil engineering from ETH Zurich and is a recent Pioneer Fellow, is convinced: artificial intelligence opens up huge opportunities here. With his Transcality project, he is developing a tool that not only digitally maps traffic movements in a town or city in real time, but also allows possible scenarios to be simulated and thus supports long-term traffic planning. "Mobility is extremely complex, as it is influenced by many different interactions and dependencies. Static models are not really up to the task," says the budding entrepreneur. By systematically and automatically processing data, the "digital city twin" can instantly simulate the

way in which interventions in the transport system, such as building a tunnel or creating a car-free zone, will affect the rest of the city.

One step ahead with the digital twin

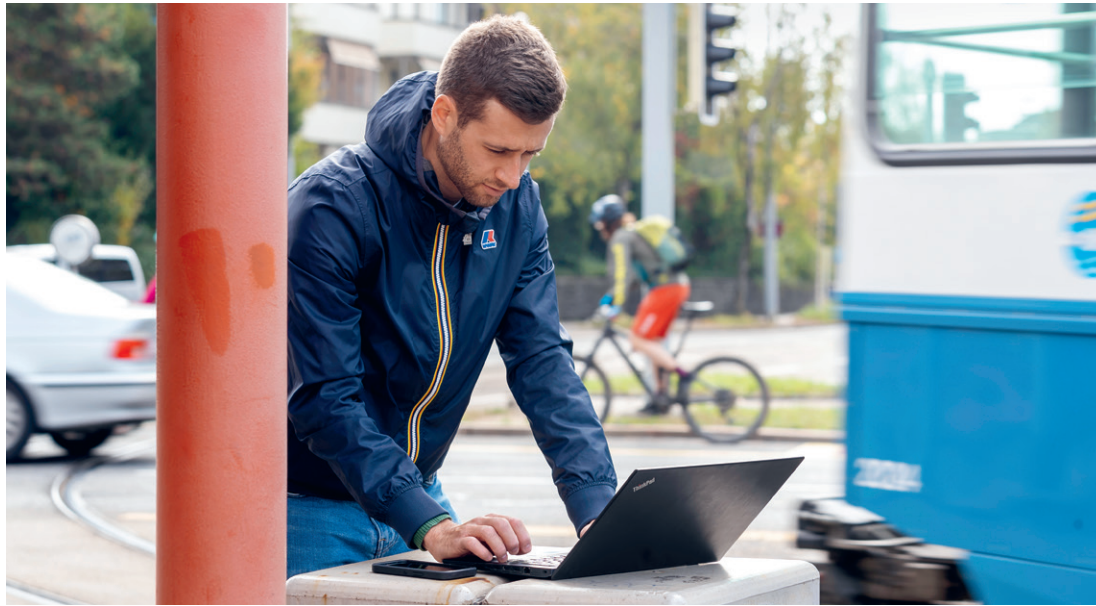
In developing his algorithms, Ambühl makes use of two key aspects: first, that many cities already record data on a regular basis, e.g. measuring how many vehicles pass a certain intersection within a certain period of time; and second, that there are patterns in traffic behaviour that always take the same form, e.g. traffic jams always emerge in a comparable manner – whether in Zurich, Berlin or Tokyo. What makes Transcality unique is that it is a modular tool that collates data from different sources and can thus be applied to cities of any size.

The demand for such a tool is demonstrated by the fact that Lukas Ambühl is already running two pilot projects: in a large Swiss city, he is investigating the traffic-related impact of the reconstruction of a long section of motorway. And in London he is helping the city authorities to analyse why congestion has increased compared to the time before Covid, despite there being fewer cars on the roads. With the aid of Transcality simulations, hypotheses can be tested and conclusions drawn for future transport planning.



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In future it will be possible to use the Transcality tool to simulate traffic movements not only in London, but also in any other city.



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Pioneer Fellowship as confirmation

It means a lot to Ambühl that he can already use and test his tool in practice during development. After all, it is precisely this practical relevance that motivates him in his work: "I want to actively shape the environment and solve problems." Not only does he benefit from the extensive theoretical knowledge he built up during his dissertation at the Institute for Transport Planning and Systems, but also from the large international network of partners from industry and administration.



More about Transcality: www.transcality.com
More about the Pioneer Fellowship programme: www.ethz-foundation.ch/en/pioneer-fellowships

Made possible by partners

The Pioneer Fellowships receive valuable support from numerous foundations, companies and now also over 200 private individuals. Recently, Fondation Alcea, a foundation that aims to support motivated people and innovative business ideas, also became involved. The Pioneer Fellowship programme supports outstanding, highly entrepreneurial and ambitious young talent from ETH research on their way to a market-ready product.

There were two particular aspects that encouraged Ambühl to venture into young entrepreneurship: on the one hand, he breathed the air of Silicon Valley during an exchange semester in nearby Berkeley, and was very taken with the relaxed attitude towards start-ups and possible "failures". On the other hand, his success in the tough selection process for the Pioneer Fellowship, and in convincing the jury of the potential of Transcality, has provided him with confirmation that he is on the right track. "The funding is one aspect, and the individual coaching is also extremely valuable – but what means the most to me is the trust placed in me and my project."



A critical view of the engine room

When algorithms reinforce biases: doctoral student Afra Amini is studying automated human language processing and its pitfalls.

“The more people work on trustworthy AI, people with different backgrounds, the more certain we can be that we’re moving in the right direction.”

Afra Amini

You are researching as a fellow at the ETH AI Center, a very coveted position – how did you get there?

AFRA AMINI – Following my Bachelor’s degree at Sharif University of Technology in Tehran, I spent a year working as a data scientist at one of Iran’s biggest tech companies. I already knew ETH Zurich from a three-month Student Summer Research Fellowship. I had great memories of the research environment and therefore accepted when I was offered an Excellence Scholarship for the Master’s programme – even though I could have gone straight to the University of Waterloo in Canada for my doctorate. Thanks to the scholarship, I was able to focus on my studies and perform at my best, and this helped when I applied to be a doctoral student at the AI Center.

What are you researching in the context of your fellowship?

Simply put, “natural language processing”, or NLP for short, is a field of computer science that focuses on teaching computers to learn human language, for example by means of so-called “deep learning”. This approach is built on the technical basis of artificial neural networks. They enable tools such as Google Search, the online translator DeepL or the digital voice assistant Siri to work well. I work at the interface of this field with the social sciences, where we deal with practical applications of language mod-

els. These applications have consequences for people’s lives – consequences that can be problematic if we fail to reflect on them.

Problematic in what way?

The models can be biased. One example is software that screens CVs and predicts whether someone is suitable for a particular job. Here, biases such as gender stereotypes have very real consequences. If the model was trained with a dataset containing 80 percent male doctors and only 20 percent female, for example, it would be unsurprising to see the model conclude that a man would be a more suitable candidate for a vacancy than a woman. Gender bias also emerges when working with languages that use gender-specific terminology. In German, for example, both personal pronouns and nouns can be gender-specific: “er” versus “sie”, and “Arzt” for a male doctor versus “Ärztin” for a female doctor. English has “he” and “she”, but only “doctor”. Turkish and Persian, on the other hand, do not have equivalents for the distinction between “he” and “she” or for “male doctor” and “female doctor”. In the past, Google Translate has always translated the Persian phrase “[He/She] is a doctor”, “او یک پزشک است” into the masculine form “He is a doctor”, while the Persian phrase “[He/She] is a nurse”, “او یک پرستار است”, has always been translated into the feminine form “She is a nurse”. These are simple examples, but many cases are far more complicated and can be explored using methods from the social sciences.

What might be the practical implications of your research?

The first step is to show that these distortions exist, and then we have to find a way to fix the errors. Our models must not reinforce existing stereotypes. We can start with the data used to train the algorithms, for example. This is tricky, however, because the huge amount of data is a crucial factor for success, and you can’t just disregard one part. But it’s certainly easier to improve a flawed algorithm than to reduce human bias.



The ETH AI Center fellowship programme promotes interdisciplinary collaboration between excellent young researchers, and aims to have a positive impact on society.

How does your research benefit from your work at the ETH AI Center?

The interdisciplinary approach of the Center is great for my project, which is supervised by two professors from different fields – Ryan Cotterell from the Department of Computer Science, and Elliott Ash from the Department of Humanities, Social and Political Sciences. The other fellows here work at the interface of AI on a wide variety of topics, from pure mathematics to robotics. Working with such a diverse range of talent is also really exciting for me.

Lots of people feel a sense of unease when it comes to AI. What do you say to them?

The more people work on trustworthy AI, people with different backgrounds, the more certain we can be that we’re moving in the right direction. Drug research, wildlife conservation or personalised learning: AI can be put to a whole range of good uses and help make life easier for many people. We shouldn’t miss out on that.



More about the Excellence Scholarships programme: www.ethz-foundation.ch/en/esop

Funded fellowship

Afra Amini’s doctoral project is supported by the Asuera Foundation. Based at the upper end of Lake Zurich, one of the foundation’s focus areas is modern technologies.
www.asuerastiftung.ch

Researchers looking into AI

Artificial intelligence is having a growing impact on our daily lives, and is also revolutionising research. The ETH AI Center currently comprises around 102 professors from all 16 departments of the university, with research also being conducted by 17 doctoral students and 8 post-doctoral researchers. This is part of a fellowship programme funded by private individuals on a philanthropic basis and the Heidi Ras Stiftung.

 More about the ETH AI Center: www.ai.ethz.ch

A selection of the research personalities and their questions:

Andreas Krause

How can machines be trained to learn and support humans?

Krause is one of Europe's leading researchers in the field of machine learning. His approach combines mathematical elegance with a sense of social responsibility.

Julia Vogt

How can computer science and medicine be combined so that patients benefit from personalised treatments?

With her interest in precision medicine, Vogt is focusing on one of the megatrends of modern medicine.

Jelena Trisovic

How can the scope of autonomous systems, e.g. construction robots, be expanded?

The former Excellence Scholar is researching the connection between computer vision and system control in her doctorate.

Benjamin Dillenburger

How can the potential of additive manufacturing be used in building construction?

Dillenburger focuses on the development of building technologies based on the interaction of computer-aided design methods, digital manufacturing and new materials.

Jakub Macina

How can research in the fields of artificial intelligence and learning sciences be brought together?

Doctoral student Macina's vision is to make education more personalised and more widely accessible.

Gisbert Schneider

How can new medicines be designed on a computer?

Schneider uses AI models that independently design molecular structures with one or more desired property.

Daniela Domeisen

How can extreme events such as heat waves be successfully predicted weeks to months in advance?

Domeisen uses statistical tools and data science to enable people to better prepare.

3 questions

for Alessandro Curioni

Like ETH, IBM is involved in AI research on a broad scale. How do the activities of large tech companies and university research benefit each other in Zurich?

Many key research questions in AI have both a foundational and impact dimension, for example establishing trust in AI algorithms. It is very important that we actively seek out and leverage synergies across academia and industry.

How do you view the international significance of the ETH AI Center?

The ETH AI Center is a wonderful initiative that brings together leading ETH professorships and their research areas to address impact areas of the utmost importance to Switzerland and the world. This type of institution is a great vehicle for exposing cutting-edge research to a wider audience and offering a platform for collaboration.

Like the leading minds at ETH, you also emphasise the importance of creating a more trustworthy AI – what are the criteria that AI needs to meet in this regard?

For AI to be trusted, we have to focus on the four pillars of fairness, transparency, explainability and privacy. As AI researchers we need to demonstrate that AI can be made free of bias, and explain how it makes decisions, is robust against adversarial attacks and does not reveal data that should be protected.

Alessandro Curioni,
Head of IBM Research
Zurich

Connected to ETH over three generations

Talking to the architects and ETH donors Erica and Lea Rickenbacher about their studies draws out exciting insights into contemporary history.

Lea Rickenbacher's professional practice, on the other hand, raises questions highly relevant to today.

How do you remember your student days?

ERICA RICKENBACHER – I grew up in a household of master builders, where there was a lot of discussion and modern architecture was a common topic. Despite this, I experienced my studies as a dramatic broadening of my horizons, once ETH had entered my life with a bang. I studied in the turbulent times of '68, and the architecture department was housed temporarily in the Globus building. The educational programme was very broad, sociology was strongly present and there was a lot of reading and discussion. Our sociopolitically relevant act at the beginning of our studies was to buy a sofa on which we could spend a lot of time doing just that. *(Laughs)*

LEA RICKENBACHER – My experience was also that a "window of discourse" opened up for me with my studies at ETH. Here you have the opportunity to study with some of the best in the world, to be in close contact with the latest developments. We were the first class to learn how to draw on the computer. It was an intense time, with lots of nights spent working. It's important to have such places that focus on

"It's important to have places like ETH that focus on bringing about further developments and ensuring excellence."

Lea Rickenbacher

bringing about further developments and ensuring excellence. ETH taught me never to stand still.

But both of your histories with ETH actually stretch even further back.

ER – Indeed. My grandmother would have liked to study, but wasn't allowed to. My mother was then allowed to go to university. She enjoyed working in the lab, and decided to study pharmacy at ETH. There were also practical considerations: working at a pharmacy had the advantage that it could be done on a part-time basis and was thus compatible with bringing up a family. This activity outside the home was very important to my mother – she wouldn't have "had to" go to work, as it was still thought of at the time.



On a stroll through Lea Rickenbacher's former place of study on the Hönggerberg campus. In the background, a student project from Annette Spiro's Chair of Architecture and Construction.

Why are you ETH Zurich donors today?

ER – I'd like to enable others to have the same formative experiences I enjoyed at this university.

LR – Out of gratitude, and pride. It makes me happy whenever I see a university ranking. ETH enjoys a worldwide reputation: before starting at ETH, I spent a year studying art and design in New York, which made me realise I wanted to study architecture. My lecturer said: "Why don't you go home? ETH is one of the best architecture schools in the world!"

Lea, a few years after graduating, you went into business with a former fellow student and set up "Rickenbacher Zimmerli Architektur". What interests you about architecture as a profession?

LR – Architecture is about aesthetics as well as functionality and practicality, and also always has to be "state of the art". The current issue in architecture is sustainability. Keeping all these different aspects in mind, it's important to find the optimal point. Construction also has a sociopolitical dimension: Switzerland is small, space is finite, and our society is getting older – how do we deal with all that? At ETH you learn to think and discuss in these dimensions. We also enjoy having these discussions with our clients, who come mainly from the area of residential construction.

You two have interesting living arrangements in close proximity to each other – what are the advantages of this for you?

ER – One of the advantages is definitely that the model allows the working generation to benefit from support when there are small children to look after. That's how I do it with Lea together with the whole family, and that's how my mother did it with me.

LR – The pace in architecture has been getting faster and faster in recent years. The flexibility associated with this physical proximity is very valuable.

Lea, you have a daughter. Do you hope she'll carry on the family tradition and study at ETH?

ER – Sometimes we actually joke that we're already working on the fourth generation.

LR – My daughter is free to do what she wants. All I can tell her is that I loved studying here!

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www.ethz-foundation.ch/en/projects

"I'd like to enable others to have the same formative experiences I enjoyed at this university."

Erica Rickenbacher

How AI helps children with cleft lip and palate

Leading experts today rely on the support of artificial intelligence, even in the medical treatment of the youngest children. In a joint research project by the University of Basel and ETH Zurich, for example.



Cleft lip and palate are among the most common malformations in newborns, occurring in 1 out of 700 births. In addition to the aesthetic impairment, these malformations also cause problems with breathing and feeding as well as speaking for the children affected. There are many strategies for treatment, with the most common approach involving multi-stage surgical procedures. Treatment of the malformation begins in advance of the operation with the production of an individualised palate plate made of plastic. This plate is inserted as soon as possible after birth, ensuring that the tongue no longer enters the cleft palate and thus this cleft passively reduces in size. This is beneficial for subsequent surgical closure. A palate impression is currently required to make the plate fit accurately, however, it puts the child's breathing at risk.

Gentler treatment thanks to AI


The aim of a project supported by the Botnar Research Centre for Child Health (BRCCH) in Basel is to develop a gentle and simple digital method for measuring the cleft and producing a palate plate, and to make this method accessible to as many children as possible. The project's lead scientists are Andreas Müller, oral and maxillofacial surgeon at the University Hospital Basel, and Barbara Solenthaler, Senior Research Scientist at the Computer Graphics Laboratory of ETH Zurich: "We are fulfilling the BRCCH's vision to develop new, digitally-based treatments for common childhood malformations." Other participants include Markus Gross, ETH professor and Director of DisneyResearch|Studios, and partners from clinics in Poland and India.

The novel treatment is made possible by the use of artificial intelligence. In a first step, the researchers are mapping the palates of large numbers of patients by means of images and scans. These datasets are supplemented with scans of existing plaster casts of palates, and this data is evaluated with the aid of AI and used to digitally construct a 3D model: the more datasets that are included, the more accurate the model. In a second step, the aim is to be able to map the individual cleft based on a few smartphone photos. A suitable palate plate will then be calculated automatically, and produced using a 3D printer.

A plaster cast of a palate impression of a child with a cleft lip and palate is processed in a 3D scanner.

From Basel, Warsaw and India, out into the world

3D printing of palate plates is already in use at the participating clinics in Basel. As many patients as possible worldwide should benefit from the fast and inexpensive digital workflow – initially in Warsaw and in Hyderabad, India. Another advantage of this treatment strategy is that, following palate plate therapy and cleft reduction, palate closure can usually be achieved in just one operation. This leads to fewer treatments, which is a great relief for the affected children and their families.

 Find out more about the BRCCH: www.brc.ch



"Artificial intelligence will become the defining technology of the 21st century and will irrevocably change the use of data. Being able to confidently use AI will become a key success factor for science, society and business."

Heinrich Fischer,
Member of the Board of Trustees,
ETH Foundation
Chair of the Board of Directors,
Hilti Corporation

Funded by the Fondation Botnar

The Botnar Research Centre for Child Health (BRCCH), jointly founded by the University of Basel and ETH Zurich, opened in 2019. The research centre combines the competence of the two universities as well as the University Children's Hospital Basel and the Swiss Tropical and Public Health Institute. The focus is on developing new methods for the benefit of children and young people worldwide. The BRCCH received initial funding of 115 million Swiss francs from the Basel-based Fondation Botnar. The foundation was established in 2003 by Marcela Botnar to continue her philanthropic commitment and that of her late husband Octav. Their only daughter, Camelia, died in a car accident at the age of 20.

THANK YOU!



ETH doctoral student Rosa Visscher is working with clinicians to research better treatment for young patients with cerebral motor impairment. Her vision: worldwide collaboration is making the predictions of artificial intelligence ever more accurate.

Your contribution to our future

Science and technological innovation are more important than ever. We need answers to challenges that affect us all: from climate change to our health. The keys to success are exceptional talent, excellent research and teaching, strong partners – and you. **Help support talent and research at ETH Zurich.**



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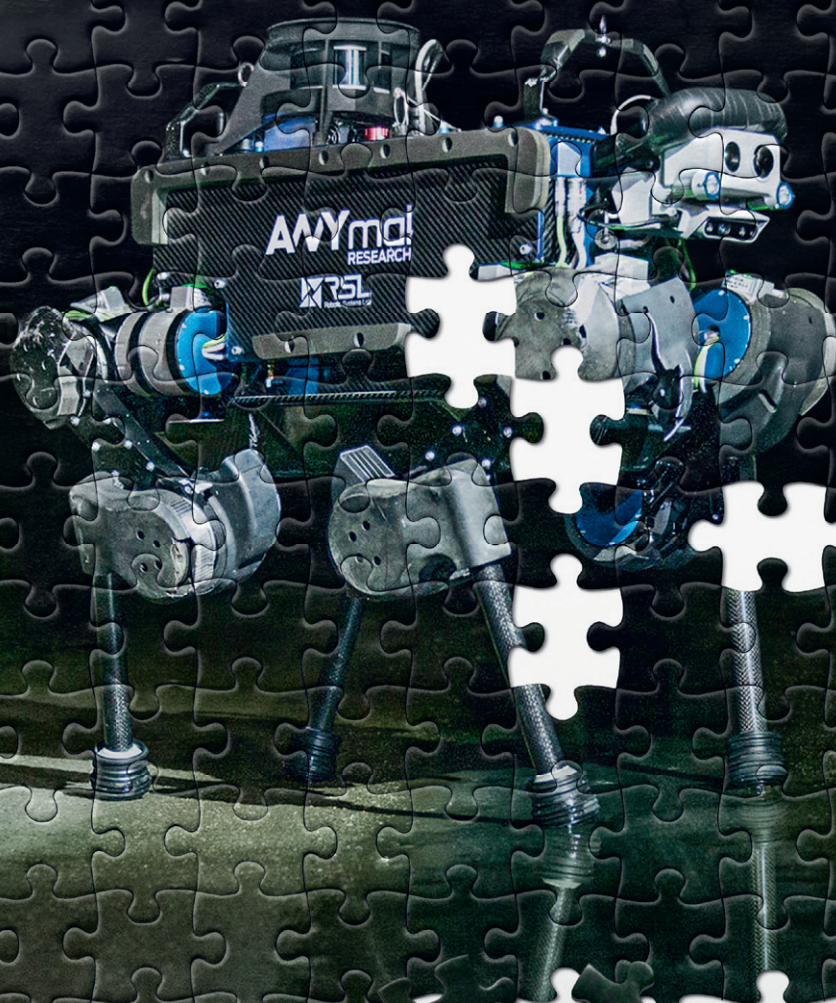
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