AI, data and digitalisation @ TU Delft

A collection of activities, highlights and successes throughout the university







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Foreword

Since OpenAI launched ChatGPT in 2022, everyone seems to be fascinated with artificial intelligence. At TU Delft we have been focusing on AI, data and digitalisation a lot longer. We see unprecedented developments, in speed and scale, as well as in exploration and uptake in science, society and economy. We are researching AI and its potential benefits and risks in numerous applications, teaching our students, and collaborating with companies and organisations.

TU Delft created the AI Initiative to help support, kickstart and coordinate AI activities throughout our 8 faculties, and as Pro Vice Rector Magnificus AI, data and digitalisation, I am extremely happy to see the amazing interdisciplinary efforts and accomplishments. We collect some of them in this booklet, to show the great highlights in AI, data and digitalisation throughout the entire TU Delft.

All these efforts combined show TU Delft's strength: we know what responsible (AI) technology is, and we can also design and build it. The interaction between what technology can do, what its limits are and what you want it to do, is exactly what we at TU Delft have been doing for over 180 years.

I hope you enjoy reading this booklet.

Geert-Jan Houben Pro Vice Rector Magnificus Al, Data & Digitalisation



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AI Initiative

AI, data and digitalisation are becoming increasingly important for solving major scientific and societal issues. That's why TU Delft has made huge investments in education and research on AI, data and digitalisation. Currently, about 1,500 TU Delft scientists are active in the field of AI, and the role of AI technologies is also growing in our innovation activities.

'At TU Delft, we research, design and build both the AI technology itself and ways to use it, and we design innovations together with industry. AI education is offered to all students, and AI plays a key role in research across all of our faculties.'

Geert-Jan Houben, Pro Vice Rector Magnificus AI, data & digitalisation

The TU Delft AI Initiative coordinates these activities and acts as a central platform for AI, data and digitalisation research, education and innovation. It facilitates the intensive collaboration of all TU Delft faculties with multiple partners and programmes and touches all kinds of disciplines and application domains. It's our ambition to retain and strengthen our position as a world-renowned University of Technology by developing an integrated state-of-the-art programme for research, research-driven education and innovation, in and with AI, data & digitalisation. TU Delft established Mondai | House of AI as a place where AI research, education and innovation come together, connecting students, scientists and professionals. The TU Delft AI Initiative also coordinates and stimulates the Convergence collaboration between TU Delft, Erasmus University Rotterdam and Erasmus MC. Likewise the AI Initiative initiates and supports close collaboration with regional, national and international partners and networks. For example, the Dutch AI Coalition (NL AIC) AI-hub Zuid-Holland; Digitalzh; Innovation Quarter; Innovation Centre for AI (ICAI); ELLIS (European Laboratory for Learning and Intelligent Systems); Leiden-Delft-Erasmus Universities; Universities of the Netherlands; and many other organisations and companies.

AI, data and digitalisation @ TU Delft

Renée Koster

AI Communication team

Willem-Paul Brinkman | Joost Poort | Simon Goede

Geert-Jan Houben | Alessandro Bozzon

Sonja Nollen-Smith | Nanny van den Boogaart Al Initiative programme team

Joost Poort | Fred Herrebout | Caroline Duterloo Tim Meijster | Helma Dokkum | Christine Bel Venkatesh Chandrasekar | Roos-Anne Albers Emma Nota

Al Innovation team

Shivaani Harmsen AI Education team Willem-Paul Brinkman | Christoph Lofi Matthijs Spaan | Susanne van Aardenne

Wendy Jansen | Esmeralda van den Berg

Alessandro Bozzon | Maria Luce Lupetti Nadia Metoui | Nazli Cila | Mahnam Saeednia Pradeep Murukannaiah | Ujwal Gadiraju Venkatesh Chandrasekar | Charlotte Boelens

AI Labs & Talent team

Geert-Jan Houben, and consists of a close-knit team of academic and support staff that connects all involved

stakeholders. Below is a list of the teams and people to reach out to for questions.

The TU Delft AI Initiative is led by

Al Initiative team

AI in numbers



24 TU Delft AI labs

with 120 academics

24 faculty members and 96 PhD candidates

TU Delft academics involved

1,500

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e

> 130 AI related courses Involved in

ICAI labs 5 FI SA labs A NWO LTP programmes

> 470

3 programmes

AI related student projects

AI Education programme AI Labs & Talents programme Al Research & Innovation programme

AI Labs & Talent programme

The AI Labs & Talent programme is committed to education, research and innovation in AI, data and digitalisation. It involves a university-wide investment and commitment to a new generation of talented AI researchers and educators.

The programme aims to accelerate research and innovation in all relevant scientific disciplines and to increase educational capacity. Its labs and talents together embody the bridge between fundamental research in AI and applications with AI. They foster cross-fertilisation between talent and expertise, working to increase the impact of AI in the fields of applied sciences, design techniques and society.

The programme funds 24 TU Delft AI labs, 24 talent programme faculty members and 96 PhD candidates for 5 years. The 96 PhDs are given 5 years instead of 4 in order to focus an additional year on education and teaching.

Overall, there are 53 lab directors and over 50 other faculty staff involved in this programme. The labs together have grown substantially with an additional 45 PhDs and 8 Postdocs. All perform research in Al-related areas and are an integral part of the Al-related education in their faculty. 'The great thing about TU Delft is that researchers work together, which I believe is necessary to develop and design the desired AI technology. In the TU Delft AI Labs & Talent programme, the technological, ethical, and design perspectives come together, and dialogue takes place. That is actually what society asks of us, and our students learn this too. Not only do they learn to work together, but they come to understand what it takes to create AI and systems that will have a positive impact on the world.'

Alessandro Bozzon, chair Al Labs & Talent programme





>200 academic staff

135 PhD and Postdoc projects

TU Delft Faculties & AI Labs



Featured

Agathe Balayn defended her PhD on October 4th 2023, titled: On Developers' Practices for Hazard Diagnosis in Machine Learning Systems. She is also an artist and designed the artwork for the cover of her dissertation. Her artwork reflects the balance between the potential of AI on the one hand and its risks on the other.

Agathe: 'In Greek mythology, Icarus could fly thanks to the wings his father crafted. Despite his father's warning, Icarus flew too close to the sun and fell from the sky, because his wings were made of beeswax that melted. From Icarus' story, one can reflect on any technology. For me, it is Artificial Intelligence (AI). In past years, AI, like Icarus' wings, has shown its great potential for supporting humans in various ways and diverse contexts. However, AI can also lead to a fall — it can have a negative, social, environmental, and economic impact, depending on how it is built and how it is used.

My cover illustrates this double-edged sword that is AI technology. Pink, sometimes argued to be unnatural (or even artificial?), is found on Icarus wings, as it is found in the city's technological infrastructures (street lights) that can power applications of AI (phones and cars). The sky, while brightly hopeful in some places, also turns cloudy in others.'







AI*MAN Lab

Transparent & Traceable AI in Human-AI Teamwork

AE EEMCS

Anahita Jamshidnejad | Myrthe Tielman | Mirko Baglioni Carolina Jorge | Ruben Verhagen | Maria Morão Patrício Filip Surma | Catholijn Jonker | Max Mulder | Guido de Croon Mark Neerincx

The AI*MAN Lab is studying and improving many aspects of human-AI teamwork. We develop AI agents that are able to take autonomously decisions that are optimal for the entire team, keeping those decisions transparent to humans. For example, one of the human-AI teams that we do research on includes a search-and-rescue team where autonomous robots and human rescuers collaborate to map unknown search areas, localise victims and share tasks efficiently.

PhD Ruben Verhagen is the first author of 'Personalized Agent Explanations for Human-Agent Teamwork: Adapting Explanations to User Trust, Workload, and Performance' (2023). For human-agent teams to be successful, agent explanations are crucial. 'We conducted an online experiment to compare personalized agent explanations against a baseline of non-personalized explanations. We implemented four agents who adapted their explanations during a search and rescue task, either randomly or based on human workload, performance or trust. Results show that personalized explanations can increase explanation satisfaction and trust in the agent, but also decrease performance.'



'We can build many things, but what should we?'

AI Futures Lab

Rights & Justice

IDE TPM

Dave Murray-Rust | Ben Wagner | Floris van Krimpen Jorge Constantino Torres | Aarón Moreno Inglés | Mahan Mehrvarz Marie-Therese Sekwenz | Sofie-Amelie Torp Dideriksen Andy Sanchez | Konstantinos Tsiakas | Filippo Santoni de Sio Hans de Bruijn | Ibo van de Poel

The AI Futures Lab explores configurations of people and AI around rights and justice, aiming to expand both scientific knowledge and public understanding of AI capabilities. Our goal is a tangible and vibrant set of prototypes, experiences and theories that map out ways in which design can be engaged to deploy AI and machine learning in support of rights and justice. The lab translates the ideal of rights and justice in human-centric AI into actionable design strategies for stakeholders, in particular designers, policy-makers and users looking at the future of work.

Co-director Dave Murray-Rust: 'We can build many things, but what should we? We are interested in bringing human values into algorithmic systems, looking at how we can use speculation and prototyping to shift the balances of power between various stakeholders. Through creating tangible experiences, we help not just the making of fairer decisions, but also the choice of the right decisions to make in the first place.' Deploying novel 3D methods for vehicle localisation, object detection and scene reconstruction. >

'The kind of models I use are constantly getting more complex and delivering better results'

3DUU Lab



3D Urban Understanding

ABE ME

L Liangliang Nan | Julian Kooij | Mubariz Zaffar | Nail Ibrahimli | Shenglan Du | Shiming Wang

The 3DUU Lab aims to intelligently understand real-world scenes, and to create realistic and accurate 3D models of objects in the scenes using data from different sources such as aerial photos and laser scanners. Our research addresses three main challenges: locating 2D images in 3D space; recognizing objects from images or multiple sensors; and reconstructing 3D scenes by leveraging object recognition. We also explore diverse applications of methods and results, such as autonomous driving and urban planning.

PhDs Nail Ibrahimli and Shenglan Du reflect in the BK story 'How to advance architecture with AI' on the current status of their PhD projects. Nail builds AI models that combine photogrammetry with artwork analysis to create stylised 3D objects. Shenglan aims to build a model that can correctly label urban objects in images.

For Nail, his PhD project has undergone tremendous transformations since 2020. He needs to update his goals almost every month due to the dynamic pace of progress in the field: 'The advances in OpenAI convinced me to try building a programme which lets you edit 3D objects by simply writing prompts.' Shenglan anticipates that her main challenge will be real-world data's lower quality and lack of annotation. Recent advances in AI are not as disruptive for her project as for Nail's, but she still notices the changes: 'The kind of models I use are constantly getting more complex and delivering better results. In the future, we will increasingly rely on semi-supervised or even unsupervised programmes to build our models.'

> 'In the future, we will increasingly rely on semi-supervised or even unsupervised programmes to build our models'

DeTAIL Lab

Training & innovation in tensor-based AI methods for biomedical signals

EEMCS ME

Borbála Hunyadi | Kim Batselier | Frederiek Wesel | Eva Memmel Sofia-Eirini Kotti | Seline De Rooij | Clara Menzen | Aybüke Erol Metin Çaliş | Hanie Moghaddasi | Ruben Wijnands | Afra Kilic Albert Saiapin

The DeTAIL Lab focusses both on the development of novel low-rank tensor methods and on their application for biomedical signal processing, thereby enabling a much faster – and more energy-sustainable – training of Al models from large datasets without any loss of accuracy.

The DeTAIL Lab developed the MSc course 'Tensor Networks for Green AI and Signal Processing'. This course provides a solid mathematical foundation for tensor networks and discusses their use in machine learning and signal processing. Green AI aims to decrease the environmental footprint of AI computation and increase the inclusivity of AI research by becoming more independent of expensive computer hardware needed for training. This course also discusses how to exploit multidimensional information inherent in the data in biomedical and other signal processing applications.





Design @ Scale Lab

Human-AI Collaboration in Design for Social Good

IDE EEMCS

Evangelos Niforatos | Ujwal Gadiraju | Jie Yang | Denis Bulygin | Tianhao He Garrett Allen | Lorenzo Corti | Gerd Kortuem



'Generative AI models have taken the world by storm, but the jury is still out on whether this is bad news or good news'

The Design at Scale Lab is developing new methods for 'Hybrid Intelligence'. Our research will establish new methods for integrating Human-centred Design, Crowd Computing and AI, ultimately enabling designers to better address complex societal problems. We aim to reduce design complexity for large-scale societal interventions.

Generative AI models have taken the world by storm, but the jury is still out on whether this is bad news or good news. Do the resulting opportunities outweigh the unmistakable threats? And where do crowd computing and human intelligence fit within this evolving jigsaw puzzle? What do advances in the realms of generative AL mean for the role of human input in propagating trustworthy and responsible technologies? The Design@Scale Lab hosted a fantastic event 'Crowd Computing in the age of generative AI models', in which we unpacked these exciting questions with talks from experts in the field, illuminating panel discussions and showcase talks from TU Delft AI lab students.

Our research will establish new methods for integrating Human-centred Design, Crowd Computing and AI, ultimately enabling designers to better address complex societal problems.

HERALD Lab

Human-aware robust AI for automated driving

ME

Luca Laurenti | Arkady Zgonnikov | Frederik Mathiesen Steven Adams | Julian Schumann | Ashwin George | David Abbink Simeon Calvert | Jens Kober | Manuel Mazo | Luciano Cavalcante Siebert

The HERALD Lab is developing new AI methods to enable automated driving systems to interact with the humans around them in a responsible and robust way. To do this, we combine machine learning, cognitive modelling, control theory, and multi-agent simulations. Our goal is to foster a new generation of researchers and engineers who will lay a foundation for autonomous vehicles that are truly reliable partners for the humans around them.

One of HERALD Lab's PhD projects is 'Emergent behaviour and responsibility in mixed-traffic interactions'. This project develops a framework for quantifying responsibility in traffic interactions that include multiple human-driven and automated vehicles. Combining traditional agent-based simulations with cognitively plausible models of human behaviour, this research investigates attribution and diffusion of responsibility from the complex systems perspective, focusing on the roles, duties and expectations of multiple agents.



'The HIPPO Lab develops next generation, natureinspired and hyper-heuristic optimisation methods'

HIPPO Lab



AI for fair, efficient, and interpretable policy analysis

TPM EEMCS

Jazmin Zatarain Salazar | Pradeep Murukannaiah | Damla Akoluk | Palok Biswas | Zuzanna Osika Shubhalaxmi Mukherjee | Edgar Salas Gironés | Catholijn Jonker | Jan Kwakkel | Frans Oliehoek Alexander Verbraeck

To make a real impact, AI techniques must consider all stakeholders, and that includes minimizing conflict and protecting vulnerable groups. The HIPPO Lab develops next generation, nature-inspired and hyper-heuristic optimisation methods – the methods that can capture conflicts across multiple sectors, regions and generations. We use AI-based decision support for addressing complex real-world problems such as climate change mitigation and adaptation.

One of HIPPO Lab's PhD projects is 'Supporting Climate Change Deliberations via Al'. This project will contribute towards the development of a hybrid-intelligence (HI) platform that supports climate change deliberations and negotiations. The HI deliberation platform will support humans with AI (specifically, via natural language processing and by using knowledge representation and reasoning techniques). This will be applied to tasks such as recognizing the deliberative structure of discussions, clustering and visualizing arguments and perspectives, finding novel objectives, and modelling opinion dynamics.

Designing Intelligence Lab

Humans and AI designing the future in dialogue

IDE EEMCS

Senthil Chandrasegaran | Catharine Oertel | Vera van der Burg Jesse Nijdam | Morita Tarvirdians | Deborah van Sinttruije Catholijn Jonker | Peter Lloyd | Almila Akdag Salah Frans Oliehoek

At the Designing Intelligence Lab, our overarching goal is to identify and design the conditions, methods, and tools needed for human and artificial intelligence to work together creatively. We split this into the following topics: multimodal processes, hybrid intelligence, creative modalities, and next-generation design methods.

The Designing Intelligence Lab is involved in TU Delft's Human Language Technologies (HLT) research community. This community, led by Jie Yang (EEMCS), is aiming to advance the design, development, governance and use of the next generation of HLT that are reliable, safe and trustworthy. At the HLT kick-off, DI Lab co-director Senthil Chandrasegaran talked about 'Understanding and Simulating Design Practice through Language'. He discussed how language can reveal aspects of design thinking and be an affordance for AI in designing, but to unlock this potential we need to develop interactive human-in-the-loop approaches to explore and make sense of linguistic and multimodal data in designing contexts. At the event's fireside chat on the topic of 'How can Human Language Technologies better serve Humans?', Peter Lloyd, one of the lab co-founders and associated faculty, talked about how 'language is a great way of connecting the subjects of design and computer science in an integrated way,' and remarked that the HLT showed how this was possible.

> 'Language is a great way of connecting the subjects of design and computer science in an integrated way'



If we gave drones human-like fingers, they would be able to help humans in difficult situations at height. By embodying the sense of touch, drones can feel the environment in the same tactile way as humans, in the absence of light.



BioMorphic Intelligence Lab

Biologically inspired solutions for aerial robotics

AE EEMCS

Salua Hamaza | Nergis Tömen | Anton Bredenbeck | Jane Ramirez | Chengming Feng | Aurora Micheli Liming Zheng | Sunyi Wang | Hesam Araghi | Suryansh Sharma | Chaoxiang Ye

The BioMorphic Intelligence Lab aims to tackle autonomy and efficiency challenges for interacting drones, using biologically inspired solutions for both the 'body' and the 'brain' and applying embodied intelligence and neuromorphic AI techniques. These solutions can be implemented across three key areas for robot performance: sensing their environment, processing this information and acting upon the results.

BIOMORP MORPHIC PHICLAB

'Drones capable of physical interaction with their surroundings can deliver a tangible impact on our efforts against climate change', according to co-director Salua Hamaza. The BioMorphic Intelligence Lab has developed an innovative research platform for long-term bioacoustics surveys: a lightweight drone capable of perching on tree branches and a custom-made 2-gram audio sensor that can record a wide range of forest sounds. Together with researchers from ETH Zurich and Aarhus University we have developed a team of robots to survey 100 hectares of rainforest in 24 hours. This collaboration led us to participate in the finals of the worldwide XPRIZE Rainforest challenge, competing for a 10 million dollars prize in 2024.

'Together with researchers from ETH Zurich and Aarhus University we have developed a team of robots to survey 100 hectares of rainforest in 24 hours'



Lightweight flapping winged drones take inspiration from insects and birds in the way they fly. Airflow sensing embodied in their wing can improve their agility and make them less susceptible to environmental phenomena. New cutting-edge MEMS technologies are being developed for this purpose.

'With these seminars, we aim to bring together people from all over TU Delft who are doing research on graphs and data, so we can benefit from the exchange of ideas with colleagues on different topics'



AidroLab

AI research into resilient and sustainable water management



Riccardo Taormina | Elvin Isufi | Alexander Garzón Díaz | Roberto Bentivoglio | Mohammad Sabbaqi Maosheng Yang | Bishwadeep Das | Tianlong Jia | Bulat Kerimov | Xueqin (Ned) Chen | Tuğba Yıldızlı Andrea Cavallo | Chengen Liu

AidroLab develops innovative solutions to enable resilient and sustainable urban water systems, focusing on modelling the physical processes within water networks and during flooding events. We believe that Graph Neural Networks (GNNs) – an extension of deep learning to graph data structures – are the most promising techniques for developing such tools. AidroLab is committed to advancing the fundamental aspects of GNNs, as these foundational improvements are crucial for effectively addressing our specific challenges in the water domain.

Every first Thursday of the month the AidroLab organises a series of 'Seminars Graphs&Data@TU Delft'. With these seminars, we aim to bring together people from all over TU Delft who are doing research on graphs and data, so we can benefit from the exchange of ideas with colleagues on different topics. AidroLab leads AI-related education at the CEG Faculty, in collaboration with other members of the TU Delft AI Initiative.

AIFluids Lab

AI and fluid mechanics: for better planes and wind farms

AE

Davide Modesti | Anh Khoa Doan | Babak Mohammadikalakoo Thomas Hunter | Aneek Chakraborty | Kherlen Jigjid Tyler Buchanan | Renzhi Tian | Mengjie Zhao | Stefan Hickel Richard Dwight | Steven Hulshoff | Marios Kotsonis | Daniele Ragni Marc Gerritsma | Hadi Hajibeygi

In the AIFluids Lab, we focus on two major challenges of fluid mechanics: predicting and controlling complex, unstable and turbulent flows by using new AI techniques combined with past physical understanding of flows. Using this combination of AI and physics-based approaches, our research will lead to models that can be used to design more efficient aircraft and wind farms.



PhD Thomas Hunter received a North America Travel Grant for AI PhDs from the Delft University Fund: 'I will be doing 4 months of research at the University of Waterloo (Canada). The cooperation stems from a common interest in the topic of passive flow control and surrogate modelling for aeroacoustics, as well as complimentary expertise in machine learning techniques applied to both aeroacoustic simulations and flow field reconstruction, at the AIFluids lab and the University of Waterloo respectively. This visit will result in advancements in both machine learning techniques for data augmentation using experiments and improved accurate surrogate models for aeroacoustics characterisation and modelling.'

AiDAPT Lab

AI for a sustainable and resilient built environment

ABE

Seyran Khademi | Charalampos Andriotis | Casper van Engelenburg Fatemeh Mostafavi | Filippo Molaioni | Prateek Bhustali Ziead Metwally | Anna Maria Koniari | Pablo Morato Pablo Martinez Alcaraz | Burak Yildiz

A key lever for necessary sustainability transitions is the empowering of architects' and engineers' decision-making processes through AI, across different scales and lifecycle design phases of the built environment. At AiDAPT, computer vision, data science and decision optimisation methods come together through the development of deep learning, reinforcement learning, and uncertainty quantification frameworks that can contribute to a more reliable and sustainable built environment.





Interview with Seyran Khademi and Charalampos Andriotis

Empowering energy-sustainable buildings through AI-driven decision-making

The AiDAPT Lab received an ICLEI Action Fund 2.0 grant for the DE-CIST project. What is it about?

'The DE-CIST project stands for 'Developing Energy Communities with Intelligent and Sustainable Technologies'. It's a collaboration between TU Delft; Erasmus University Rotterdam; the Institute of Housing and Urban Development Studies; the Resilient Delta Initiative; the Erasmus Centre for Data Analytics; and the City of Rotterdam. DE-CIST is supported by the ICLEI Action fund 2.0 and backed by a 1 million Euro grant from Google.org. This project is dedicated to gathering and exploiting comprehensive data on building energy performance and retrofit, merging it with meteorological, air quality, emission and socio-economic data.'

What is the AiDAPT Lab going to do in DE-CIST?

'We aim to craft cutting-edge AI solutions, enabling intelligent decision-making for building energy retrofit solution packages. These solutions are designed to transform the city of Rotterdam by integrating a rich variety of data, including imagery, building simulations, social insights and climate data. The overarching goal is to shape a sustainable future for our urban planning environments.'



The impact on the built environment is at the core of our discussions. We reflect on the physical applications to draw input for our simulations and reconsider our approaches to achieve well-established and integrated decisions.



'Machine learning helps physical models go beyond their limitations and assumptions'

Modern materials deform due to intricate mechanisms at very small scales. Relating these interactions at tiny scales with behaviour observed at higher scales is one of the main challenges in solid mechanics.

SLIMM Lab

AI for smart materials modelling

CEG EEMCS

Iuri Rocha | Hanne Kekkonen | Anne Poot | Joep Storm Leon Riccius | Marina Alves Maia | Chris van Vliet Frans van der Meer | Joris Bierkens

In the SLIMM Lab, scientists from CEG and EEMCS are working together to speed up the process of testing smart materials using AI. Knowing the properties of materials requires a lot of testing, and with virtual test models and AI, simulations and experiments can be carried out much faster. As a result, the great potential of smart materials for the energy transition, for example, can be exploited faster.

luri Rocha: 'High-performance materials are everywhere, and we need to quickly design highly-specialised materials for very specific applications. Currently, reaching a new design takes an inordinate amount of time and thousands of complex computer simulations. Our goal is to use machine learning to drastically accelerate this process and develop tools for quick, efficient, sustainable and transparent computational material design.'

The SLIMM Lab is looking at ways to design new materials for high-performance structures, such as airplanes and wind turbine blades. Right now this process takes several years and involves a huge set of expensive experiments and a lot of wasted material in order to arrive at a design that is certifiably safe and efficient. With the tools we are working on, the bulk of this process could be performed virtually through computer simulations, and involve only a very limited number of real experiments. The right machine learning techniques allow these simulations to be performed thousands of times faster.' Iuri Rocha and his colleagues at SLIMM Lab are looking for the best ways to combine machine learning models with decades of old-school knowledge on physical laws, using cutting edge data-driven techniques: 'Machine learning helps physical models go beyond their limitations and assumptions, while the classical models help machine learning to give more robust predictions.'



AI DeMoS Lab

AI as Deliberative Multimodal Systems

TPM IDE

Olya Kudina | Nazli Cila | Dmitry Muravyov | Jordi Viader Karin Bogdanova | Meike Hardt | Syafira Fitri Auliya Ibo van de Poel | Sabine Roeser | Alessandro Bozzon Pieter Desmet | Aaron Ding

The AI DeMoS Lab focuses on developing AI for democracy. We look at how AI can mitigate amid multiple perspectives, and how to craft a space for public interaction and deliberation. We intend to contribute to the development of multimodal AI systems that foster deliberation and critical engagement by citizens. This will enable people to take informed decisions.

Olya Kudina, co-director of Al DeMoS Lab, at the TU Delft Opening of the Academic Year 2023-2024, about the ethical implications of Al: 'More important than the faculty, it's the students who will be the defining force in an attempt to build Al as a complex socio-technical system. Understanding why we need to develop new Al technology and what it takes to do so responsibly should be a starting point of any project. Studying in Delft will equip you with the critical mindset and the instruments to weave this future now.'

> 'More important than the faculty, it's the students who will be the defining force'

AID

AB

IRIS Lab



AI for quantitative bioimaging

AS ME

David Maresca | Arjen Jakobi | Carlas Smith | Dylan Kalisvaart | Serafim Korovin Maarten Joosten | Alok Bhradwaj | Jelmer Cnossen | Daniel Spengler

The IRIS Lab (Intelligent & Reliable Imaging Systems) develops AI-based technology that improves the precision of microscopy methods for biomedical use. The methodology will be demonstrated on electron, optical and ultrasound imaging but could also be applied to a range of other applications. It will be able to unravel biological processes, from a molecular level up to the whole organ scale.

IRIS Lab researchers lay theoretical foundations for an optical super-resolution method called Iterative Single-Molecule Localization Microscopy. This method uses illumination patterns to zoom in on individual molecules. To do so, the researchers use results from previous experiments to place the patterns closer and closer to molecules. This makes it possible to increase the sharpness of the image exactly where the molecules are. The IRIS Lab has published a scientific article that points out the fundamental limitations of super-resolution microscopy: 'We provide a new calculation method to determine the maximum resolution. This method will help other researchers to make more informed choices,' said Dylan Kalisvaart, IRIS Lab PhD student and first author of the publication.

'We provide a new calculation method to determine the maximum resolution. This method will help other researchers to make more informed choices'



Sensor AI Lab

AI for Sensor Networks

ME EEMCS

Manon Kok | Raj Thilak Rajan | Ruiyuan Li | Thomas Edridge Zhonggang Li | Clara Menzen | Ellen Riemens | Frida Viset Haoyu Jia | Geert Leus | Ajay Seth | Alle-Jan van der Veen

The Sensor AI Lab unites the fields of sensor fusion and AI, bringing physical knowledge into AI to enable the extraction of more information from available sensor data. We focus on developing novel algorithms, and on applying these tools in different fields. Examples include human motion estimation, distributed learning in sensor networks, and navigation of swarms of multiagent systems such as robots, ships, drones and satellites.

To combine data from different sources, it is important to know when to trust which source of information. That's why it is essential to make use of probabilistic modelling. Among the most promising probabilistic methods for AI are Gaussian processes. One of the PhD research projects at Sensor AI Lab focuses on incorporating various forms of physical knowledge into Gaussian process regression. This fundamental research in AI has strong connections to the topic of the three other PhDs as well as to our ongoing work on indoor localisation, underwater localisation, drone navigation and satellite swarms.



'Noise-polluted soundscapes have profound effects on our mental and physical health, potentially leading to cardiovascular diseases and sleeping disorders'

CityAI Lab



A place where data, AI and behavioural theory come together.

TPM CEG

Sander van Cranenburgh | Simeon Calvert | Oded Cats | Francisco Garrido | Lion Cassens Lucas Spierenburg | Yiru Jiao | Gabriel Nova | Nicholas Smeele | Maarten Kroesen | Hans van Lint

The future liveability of cities around the world is under pressure as they face crumbling social cohesion, income inequality, overcrowding of public spaces and unhealthy local environments (caused by heavy traffic, noise pollution, etc). The CityAI Lab examines the pivotal role that the urban environment plays in tackling such challenges by focusing on how the urban environment and human behaviour interact.

CityAl Lab PhD student Lion Cassens is involved in one of the MSc elective course Fundamentals of Al Programme (FAIP) projects. Noise-polluted soundscapes have profound effects on our mental and physical health, potentially leading to cardiovascular diseases and sleeping disorders. In order to tackle noise pollution, it is paramount first to identify the sources that contribute to noise in a certain area. This project aims to develop deep learning models that detect common noise sources, such as traffic, construction sites, animals and nightlife, using a novel battery-powered noise sensor. Afterwards, the accuracy of developed models is tested on a sensor in the urban environment.



We aim to create highefficiency, real-time, AIdriven feedback and control in biomedical applications

BIOLab

Biomedical Intervention Optimisation lab

AS EEMCS

BIO

Kristin Gruβmayer | Wendelin Böhmer | Nergis Tömen | Zoltan Perkó | Daan Brinks | Miyase Tepkinar Laurens Engwegen | Alejandro Castañeda | Mikolaj Stryja

The BIOLab combines expertise from multiple imaging and machine learning domains. We aim to create high-efficiency, real-time, Al-driven feedback and control in biomedical applications. Our focus is on improving the efficiency of machine learning algorithms by designing novel artificial neural network architectures; developing new reinforcement learning and generative algorithms; and incorporating biologically inspired neural network models. Examples of applications include optimizing tumour irradiation protocols with missing information and limiting irradiation damage to living samples in smart microscopy.

BIOLab co-director Kristin Grußmayer in TU Delft story 'Pushing the boundaries of microscopy to understand cells better': 'I look from a physicist's perspective at how to work with biological components. You need knowledge from different disciplines to apply microscopy to biology: physics, a bit of maths, biology and chemistry all have to come together. With my group at the Bionanoscience department I explore super resolution microscopy methods based on single molecules. I develop these methods to figure out new things about how cells work.'



Delft AI Energy Lab

AI for sustainable, reliable and effective energy systems



Jochen Cremer | Peyman Mohajerin Esfahani | Ali Rajaei Mert Karacelebi | Shabnam Khodakaramzadeh | Mohammad Boveiri Viktor Zobernig | Haiwei Xie | Lucas Narbondo | Basel Morsy Nikolina Čović | Demetris Chrysostomou | Olayiwola Arowolo Benjamin Habib | Luca Hofstadler

Energy systems are the backbone of our modern society. It is of great importance that these systems are sustainable, reliable and effective, now and in the future. The Delft AI Energy Lab investigates how new AI-based methods can contribute to the management of dynamic energy systems. Therefore we combine groundbreaking machine learning with reliable physical energy system theory.

'It was great fun to organise the Learning to Run a Power Network (L2RPN) Delft 2023 competition. This competition, co-facilitated by RTE, the electricity transmission system operator of France, was about training an AI agent to operate a power network. We had 90 registrations in several teams from around the world, each bringing their own interesting and unique approaches to the problem. The top 3 teams received their prizes at the PowerWeb Conference on 27 September. The University of California Santa Cruz team won the first prize.'

Advanced Al-based mathematical models together with scalable algorithms offer reliable diagnosis and predictive tools for modern energy systems.

We had 90 registrations in several teams from around the world, each bringing their own interesting and unique approaches to the problem'

SELF Lab

Smart Edge Lab for Healthcare

EEMCS ME

Rajendra Bishnoi | Cosimo Della Santina | Amin Yaldagard | Chuhan Zhang | Ali Siddiqi | Anteneh Gebregiorgis | Christos Strydis | Dante Muratore | Luis Miranda da Cruz

An ever-increasing number of connected internet-ofthings (IoT) devices now collect data, requiring, at the edge, more storage and computational capacity and more intelligence. The SELF Lab targets the design and development of smart edge computing engines, based on computation-in-memory architecture. We will demonstrate their superiority for personalised healthcare such as early epilepsy detection.

Edge AI utilises algorithms and models directly on devices, eliminating the need for cloud computing or remote servers. Resistive random access memory (RRAM)-based computation-in-memory (CIM) architectures can meet the unprecedented energy efficiency requirements needed to execute these algorithms directly on edge devices. However, the readdisturb problem associated with these architectures can lead to accumulated computational errors.

> An EEG device and IC design are integrated to control a robot arm. Neuromorphic deep learning methods can be utilized to process the EEG data.

To achieve the necessary level of computational accuracy, these devices must undergo a reprogramming process, which is a static approach and needs a large counter. To address this, we proposed a real-time RRAM read-disturb detection methodology based on monitoring the RRAM states ratio. This method outperforms static methods in terms of energy efficiency, enabling dynamic reprogramming. The proposed methodology promises a 2x increase in writing operation energy efficiency by reducing redundant writes. Lab PhD Amin Yaldagard presented this methodology at the '2023 IEEE 5th International Conference on Artificial Intelligence Circuits and Systems (AICAS)'. A prototype of this work has been submitted for fabrication, and measurement results will be published upon chip delivery.





CHEME AI Lab

Chemical Engineering & Medical Imaging AI Lab

AS

Qian Tao | Artur Schweidtmann | Yidong Zhao Lukas Schulze Balhorn | Qinghe Gao | Max Theisen Giacomo Lastrucci | Tanuj Karia | Yi Zhang

The CHEME AI Lab investigates knowledge-driven AI and demonstrates its potential within two applied science domains in particular – chemical engineering and imaging physics.

Our research also explores fundamental ways to instil knowledge into all key components of AI: data acquisition, algorithm design, user interaction and deployment. Such knowledge-driven AI aims to be more interpretable and reliable than purely data-driven AI.

Qian Tao, co-director of the CHEME AI Lab, in interview series Rising star health initiative:

'To bring AI to the next stage, we need to study the rigour of algorithms. And adding a reliable measure of uncertainty to AI output, for example, can increase the trust of the end-users, such as radiologists and cardiologists. I would also like to 'see' inside AI – to understand its inner workings. My work at the CHEME AI Lab adds prior knowledge and boundary conditions, such that the output of an AI algorithm is properly regularized, increasing the fitness of the outcome even with insufficient or unexpected data.'



'I would also like to 'see' inside AI – to understand its inner workings'



MACHINA Lab

Machine Intelligence Advances for Materials



Alejandro Aragón | Deepesh Toshniwal | David Tax | Martin van der Schelling | Surya Narayanan Yuko Kato | Taylan Turan

The MACHINA Lab aims at creating a new route for designing novel materials and Al algorithms. We are working towards speeding up material simulations; facilitating sharing of data and material models across different labs worldwide; improving optimization algorithms by fusing them with machine learning; and aiming towards true inverse design of materials.

One of MACHINA Lab's PhD projects is 'Topology optimization enhanced by neural networks'. Inverse design is particularly challenging with classical algorithms, but recent work is showing that artificial neural networks can enhance the process. Can we go much further and create radically new geometries due to the use of machine learning? The objective of this project is to investigate the use of machine learning not only as a forward design strategy to challenge commonly used techniques like topology optimization, but also to use machine learning for inverse design and identification.

XAIT Lab

eXplainable AI Twins for Resilient Cities

CEG EEMCS

Panchamy Krishnakumari | Emir Demirović | Marco Rinaldi Elif Arslan | Konstantin Sidoriv | Mahsa Movaghar | Weiming Mai

The XAIT Lab develops novel approaches that focus on the explainable aspect of AI for mobility. We incorporate explainability into three core modules within mobility decision support systems: state estimation, prediction and optimization. Such approaches provide tangible and concrete decision support that helps resilient cities to tackle urban problems such as evacuation, energy, longterm planning and infrastructure operations.

XAIT lab is involved in the development of various courses about AI & data science related to mobility. One example is the course 'Advanced Data Science for Traffic and Transportation Engineering' for MSc students from the Civil Engineering master programme, in which students develop a machine learning solution for realworld problems from the industry. XAIT's lab directors are also closely involved in the coordination and development of 'Fundamentals of AI Programme' - a 15 ECTS elective course, on which all masters students at TU Delft can enrol and learn to apply AI knowledge within their own field.



AiBLE Lab

Activating Intelligence in Building Lasting and Liveable Environments

ABE EEMCS

Tong Wang | Luciano Cavalcante Siebert | Cemal Koray Bingöl | Tian Xia | Amir Homayounirad Antonio Mone | Aksel Ersoy | Catholijn Jonker | Ellen van Bueren | Frank Broz | Frans Oliehoek Paul Chan

The AiBLE lab investigates how to develop and use AI in energy transition and circularity challenges. Our aim is to help reach effective, transparent and lasting decisions and agreements. This means incorporating human feedback into the loop, iteratively improving information sharing and driving behaviour changes. By using AI to augment human intelligence and support deliberation continuously, the AiBLE Lab will potentially reduce the policy-practice gap in a responsible and inclusive way.

PhD Amir Homayounirad published 'Designing the Built Environment Through Hybrid Intelligence' (2023). Using hybrid intelligence, this study proposes a method that integrates value, and design pattern theories, to support deliberation during the design process. By integrating diverse perspectives into the loop through continuous deliberation, the proposed method incorporates stakeholders' value for extracting design patterns that address primary design goals and challenges such as energy transition in the built environment.

'The AiBLE lab investigates how to develop and use AI in energy transition and circularity challenges'



Meet our talent programme faculty members

Name	Faculty	Lab director at
Charalampos Andriotis	ABE	AiDAPT Lab
Seyran Khademi	ABE	AiDAPT Lab
Anh Khoa Doan	AE	AIFLuids Lab
Nick Eleftheroglou	AE	
Vahid Yaghoubi Nasrabadi	AE	
Artur Schweidtmann	AS	CHEME AI lab
Qian Tao	AS	CHEME AI Lab
Guillaume Rongier	CEG	
Hongrui Wang	CEG	
Mahnam Saeednia	CEG	
Jing Sun	EEMCS	
Jochen Cremer	EEMCS	Delft Al Energy Lab
Evangelos Niforatos	IDE	Design@Scale Lab
Maria Luce Lupetti	IDE	
Pan Wang	IDE	
Arkady Zgonnikov	ME	HERALD Lab
Luca Laurenti	ME	HERALD Lab
Helma Torkamaan	TPM	
Nadia Metoui	TPM	
Olya Kudina	TPM	AI DeMoS Lab

TU Delft AI Talent programme

The TU Delft AI Labs & Talent programme funds 24 faculty members positions. Ten of these are also lab directors in TU Delft AI labs. They all perform research in AI-related areas and are an integral part of the AI-related education in their faculty.

What are they working on – a few highlights

Process-based fluvial models at (sub) reservoir scale

The process-based fluvial models at (sub)reservoir scale project aims to enhance our ability to predict the distribution of deposits from past rivers in the subsurface. Guillaume Rongier (CEG) is leading the project, in collaboration with Joep Storms (CEG) and Vincent Crombez (CSIRO). Once in the subsurface, sedimentary deposits from rivers contain essential resources for our society, including groundwater, heat and metals, among others. However, available data in the subsurface are both scarce and of low quality. These limitations mean that AI models, on their own, cannot effectively locate these valuable resources. This project will build a platform to generate numerical models of fluvial deposits based on the physical processes that formed them. Such a platform will support the development of AI models that can compensate for the limitations of subsurface data to make more accurate predictions.



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AI and climate science

One of the flagship projects of the TU Delft's Climate Action Programme is 'Machine Learning for Regional Climate'. In this project **Jing Sun** (EEMCS) combines AI & climate science, working to develop AI-based climate models that not only rival traditional models in precision but also offer transparency and robustness. By harnessing AI methodologies that prioritize interpretability, physical consistency, and adaptability to complex and uncertain data, this project seeks to improve regional climate projections.





Neural Architecture Search for Smart Monitoring

At the Faculty of Aerospace Engineering **Vahid Yaghoubi Nasrabadi**'s research group is dedicated to advancing the frontiers of 'Neural Architecture Search (NAS)' to optimize AI algorithms for resource-constrained monitoring applications in the aerospace industry. Their focus lies on Non-Destructive Testing (NDT) and Structural Health Monitoring (SHM), where real-time data acquisition and analysis are crucial for ensuring the safety and integrity of critical structures.

To address the challenges of limited computational resources and uncertainty in sensor data, his team is developing a 'Trustworthy and Resource-efficient NAS' framework. This framework aims to design AI algorithms that are efficient in terms of hardware requirements and capable of handling the inherent uncertainties in real-world monitoring data. By achieving this balance, the lab envisions empowering resource-constrained edge devices with uncertainty-aware AI capabilities, enabling real-time, reliable monitoring solutions. The overarching goal of this lab is to create a 'Trustworthy digital twin for processes and structures' that can be used for certifications in the aerospace industry.

AI, data and digitalisation education at TU Delft

Integrating AI into our society so that it is valuable, ethical and productive is important. This increasingly means training and bringing together both AI specialists and application-oriented AI professionals. The AI specialists, such as computer scientists, focus on technical and theoretical aspects, and work *in* AI. Professionals who apply AI in their own domain possess in-depth knowledge of their own discipline and of the context in which AI systems and solutions can be deployed. They can make relevant connections and work *with* AI.

TU Delft aims to provide every student with AI education that embraces both *with* AI and *in* AI learning. By equipping every student with a better and wider understanding, we can together build a society that's capable of integrating AI responsibly and successfully. AI is part of many educational programmes across all faculties and disciplines. We also offer cross-programme training and continuing education in AI, data and digitalisation-related subjects for our own staff and PhDs, and for alumni and professionals.

Education team

Willem-Paul Brinkman | Christoph Lofi | Matthijs Spaan Susanne van Aardenne | Wendy Jansen | Esmeralda van den Berg 'Every student should learn about AI, regardless of their field of study. That's why, starting from the academic year 2023-2024, all students can choose AI courses in their curriculum. By working closely together with all faculties, students learn to use AI as a tool to come up with solutions for global challenges.'

Willem-Paul Brinkman, Academic Lead AI Initiative Education



Curricular AI Education	0	Ф	BSc	MSc	Ħ	ij	X	•
Bachelor Computer Science & Engineering	•		•		٠			
Minor Computer Science	•	•	•			•	•	
Minor Robotics	•	•	•			•	•	
Minor Engineering with AI (30 ECTS)	•	•	•			•	•	•
Coordinating Bachelor Electives	•	•	•			•		
Honours Programme	•	•	•			•	•	•
Master Computer Science	•			•	•			
Master Robotics	•			•	•			
Master Data Science and Al Technology	•	•		•	•	•		
Coordinating Master Electives	•	•		•		•		
Master Blocks (FAIP and IAAIP, 15 ECTS)	•			•		•		•

Legend

Current
In development
Faculty level
University wide
University & beyond

Regional themes Energy & Sustainability, Health & Care, Port & Maritime, Peace, Justice & Security, Technical Industry

Non-Curricular Al Education

Online education & Lifelong Learning	•	•	•	•	•	•	•
PhD Training		•			•		
Teach the Teacher (staff)	•	•		•	•	•	
Educational resources		•			•	•	

Sharing a Vision on Al Education

Alignment national Al, education & human capital agendas 🛛 🖉 🔴 🔴 🔴 🔴 🔴

Bachelor education in AI, data and digitalisation

One Bachelor

Bachelor Computer Science & Engineering

Our Bachelor Computer Science & Engineering shows students how to develop software and data processing for the intelligent systems of today and the future. Examples include self-driving cars, smartphone navigation, personalised offers based on people's surfing behaviour, and robots used in healthcare.

A broad variety of bachelor courses (selection)

Al is included in a multitude of courses across all disciplines and faculties. A small selection:

- Image analysis
- Medical Imaging
- Computational Intelligence
- Collaborative Artificial Intelligence
- Signal Processing
- Human-Computer Interaction
- Design Analytics
- Machine Learning for Design
- Collaborative Artificial Intelligence

Three AI Minor programmes

Minor Engineering with AI

The Minor Engineering with AI (30 ECTS) is for students with an interest in creating their own AI-enabled solutions. This requires a technical understanding of both underlying data fed into the AI system and the AI system algorithm. This minor is one out of three minors developed under the AI, Data and Digitalisation Convergence and was launched in 2021.

Minor Robotics

The Minor Robotics (30 ECTS) is for students with a strong interest in developing a robotic prototype. They learn what it is like to work in a multidisciplinary team, and build a working robotic prototype for a customer.

Minor Computer Science

The Minor Computer Science (30 ECTS) is for students with an interest in two of the hottest topics in the field: modern software development and data science. You will learn to program in Python, and to apply algorithms and data structures on a variety of problems in domains such as data science. This will include working in teams, using modern development and collaboration tools.

Capstone projects in Minor Engineering with Al

Junzi Sun is a lecturer in Air Traffic Management (AE) and supervises students in the AI minor. He asked his students if they could predict delays better with the help of AI: 'Flight delays are an important and major problem in air traffic management. And it's complex, because there are many airports in Europe, and even more planes and flights. I wanted to see if students could make accurate predictions through a machine learning algorithm. They started with simple models, but I was impressed with their progress. By the end of the project, they were able to develop very serious AI models.'

Huib Baetsen, student (AS), did a Capstone project to apply AI to imaging a specific protein structure: 'When I started this minor, I didn't know how broad its application was. I always thought that physics and AI were far apart, but they are not. All kinds of new possibilities arise when you combine these fields. It's super interesting to at least learn what the possibilities are when using AI in your field or area of study. AI offers extra possibilities across all courses at TU Delft. You can get really new information and new kinds of results using AI. That was a big eye-opener for me.'

Master education in AI, data and digitalisation

For master students with an interest in artificial intelligence and technology, who want to further strengthen their capabilities in AI, we have master tracks and numerous courses and modules focusing on AI, data and digitalisation.

Master programmes

Master Computer Science

The MSc programme Computer Science is built on the strengths and innovative powers of our research groups. It is currently being revised, and from 2024 will provide students the possibility to master at least two of the following advanced subject areas: Algorithmics, Computer Graphics, Cyber Security, Data Engineering, Distributed Computing, Embedded and Networked Systems, Programming Languages, Quantum Computing, and Software Engineering. This helps them to develop themselves as a responsible computer scientist who can tackle real-world problems.

Master Robotics

The MSc programme Robotics lies on the intersection between mechanical engineering and artificial intelligence. It focuses on the development of intelligent robots that perceive the environment, plan and make decisions, and control or propel themselves in a place where humans are also at work.

Master elective courses (a selection)

Fundamentals of AI

Fundamentals of AI programme (FAIP) offers a coherent and broad introduction to AI. Students also do a project in which they learn to apply an AI solution in their own domain. This full 15 ECTS elective course, launched in 2022, is available to MSc students from all faculties of the TU Delft and requires little to no prior AI knowledge.

Interdisciplinary Advanced Artificial Intelligence project

The large MSc elective course (15 ECTS) Interdisciplinary Advanced Artificial Intelligence project (IAAIP) provides students with a unique experience to work in a project team, in which they learn about, develop and apply Al to a real-world challenge. They work on a large interdisciplinary project that is run by TU Delft AI labs, with a group of 4-6 students. This course, launched in 2022, is aimed at MSc students from all TU Delft faculties, who have already been introduced to the fundamentals of AI and have obtained 20 ECTS in AI-related courses.

MSc Programme Data Science and Artificial Intelligence Technology

The planned MSc Programme Data Science and Artificial Intelligence Technology is designed to develop graduates who master both data science and artificial intelligence; are able to design and engineer Aland data-driven software systems; can act responsibly and with integrity; and are able to deal with different perspectives and the impact of their work on society. Students have the possibility to master at least two of the following advanced subject areas: Advanced Machine Learning, Bioinformatics, Data Information and Management, Human-Centred Al. Interactive Data Science, Language and Speech Technology, Optimisation and Reasoning, Probabilistic Decision Making, Software Engineering for Data Science and AI, and Visual Computing. This programme is currently in the process of being formally reviewed and accredited. If all goes well, the new programme will start in the academic year 2024-2025.

MSc programme Robotics

Student Kirsten Heyns did a bachelor's degree in engineering medicine, but always had an interest in medical robotics, for example using robotics to find tumours on MRI scans, or developing exoskeletons for people who have difficulty walking. Her graduation project is an exoskeleton for the upper arms. This is intended for people with muscle disease, so that they can pick up items again, allowing them to function in everyday life.

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Online education and Lifelong Learning in AI, data and digitalisation

We offer courses and programmes that cater to the needs of a wide range of professionals, including managers and business leaders who are interested in gaining new skills, tools and insights in the field of AI, data and digitalisation. In cooperation with the Delft Extension School, we have developed a series of AI Massive Open Online Courses (MOOCs). The lecture videos for these MOOCs are designed with the vision that they are suitable for multiple audiences and usable for different learning paths. Therefore, these MOOC videos are also used for the MSc elective 'Fundamentals of AI Programme', accessible to all TU Delft students in their second master year.

AI MOOCs

AI Skills for Engineers: Data Engineering and Data Pipelines

Good data is central to effective AI applications. This course teaches the basics of data for AI, covering what data is needed, how to extract data from existing databases, and basic data skills, including setup of a Python notebook environment, basic data exploration and simple data visualizations.

Data Creation and Collection for Artificial Intelligence via Crowdsourcing

This course is about crowdsourcing and how it offers a viable means to leverage human intelligence at scale for data creation, enrichment and interpretation – demonstrating a great potential to improve both the performance of AI systems and their trustworthiness, and to increase the adoption of AI in general.

AI Skills for Engineers: Supervised Machine Learning

Participants will learn the fundamentals of machine learning to help them correctly apply various classification and regression machine learning algorithms to real-life problems using the Python toolbox scikit-learn.

AI Skills: Introduction to Unsupervised, Deep and Reinforcement Learning

In this course participants will learn the fundamentals and principal AI concepts around clustering, dimensionality reduction, reinforcement learning and deep learning, with the aim of solving real-life problems.

Ethics in Al Design

Al systems have great potential to improve society across a wide range of applications. The challenge is to do so responsibly. Al systems can lead to discrimination, loss of human control and a lack of explainability, to name a few of the ethical dilemmas they may present. Because of the great impact of Al and Machine Learning, we need to ensure that we design and use systems in a way that meets ethical standards.



Al in Practice: Preparing for Al and Applying Al

These two courses are for anyone interested in learning about the implementation and practical aspects of Al. They show how to recognize and understand the implications of Artificial Intelligence for organizations; the importance of compliance and ethics when Al is applied in practice; and how to write a plan for applying Al in their own organization in a step-by-step manner.

> 'AI systems have a great potential to improve society, across a wide range of applications. The challenge is to do so responsibly'

Helping to teach machine learning

An interview with Tom Viering and Gosia Migut (founders of the TU Delft Machine Learning Teachers Community)

TU Delft is on an important mission: to make AI education available to all students. Since the technology has now become woven into the fabric of our everyday lives, it is ever-more important to equip students with an innovative AI education.

Driven by this goal, educators at TU Delft are joining forces to ensure that students gain an in-depth understanding of machine learning. Among them, Tom Viering and Gosia Migut stand out as the pioneers and co-founders of the TU Delft Machine Learning Teachers Community. This community is an accessible platform where teachers can collaborate, share resources, and learn from each other to drive educational excellence.

> Tom Viering: 'In 2020, I began developing a course for the Al minor 'Engineering with Al', and I didn't know where to start. There was a vast amount of material available, as many courses on machine learning already existed – but they weren't necessarily of the quality I required.'

Gosia Migut had been developing a machine learning course for the bachelor's programme, and shared a similar story: 'We knew machine learning was being taught, but I did not know where to find a good starting point, or who to reach out to. That's when the idea arose: why not bring machine learning teachers together?' Susanne van Aardenne (a member of the Al Initiative Education Team) was instrumental in helping Tom and Gosia to join forces, as she knew that they both had ideas for more collaboration on machine learning education.

Creating a community for collaboration

Tom and Gosia's vision was to create a community where teachers could engage easily with each other to share resources, collaborate, and reduce redundancy in their work. Gosia: 'Everyone seemed to be doing double the work, and reinventing the wheel over and over again. It seemed that it would be much more efficient to work together and share resources.'

Tom said that they also recognized the importance of fostering connections among teachers: 'The first step was to get to know each other. I saw all those names in the study guide, but I did not really know anyone. It was extremely helpful to match a name with a face, and overcome the initial barrier to reach out to them.' Gosia said that the community's goal was to make resources readily accessible to all TU Delft educators, from teaching PhDs to Professors: 'The idea was to do something low threshold, so we could easily find each other and, importantly, address questions to each other.

AI EDUCATION

'We want to build better relationships with other machine learning educators, so everyone knows who can answer questions, and everyone has what they need to share and collaborate more easily'



Sharing experiences and best practises

Staff from across the faculties joined in with the first meeting enthusiastically, and many shared their wish for more interaction and collaboration. Gosia said that a relaxed atmosphere proved conducive to sharing experiences and grappling with common challenges: 'So many people had the same questions and struggles from students, such as installing Python packages or teaching students with little to no programming experience. It was a good moment to acknowledge that many of us are in the same boat, and it was indeed a confirmation that such an initiative was needed.'

The community has provided a platform for teachers to learn from each other and improve their own courses. They get a chance to present their courses or teaching methods, ask each other questions, and exchange working methods and approaches. Tom said that one presentation was particularly inspiring, when colleague Sicco Verwer discussed an interesting method to incorporate peer feedback into his course – an approach he found extremely effective: 'Machine learning doesn't have only one-stop solutions, or one way to reach a goal, so it's very useful to look at each other's work in open-ended machine learning assignments. Through peer feedback, students learn a lot from each other's work and approaches, exchanging thought processes and figuring out intermediate steps. I had not considered this method before, so this was great peer feedback for me.

'I've applied this to my own course, and learned that students value seeing each other's work and learning different innovative approaches and ways of thinking. It's a useful alternative to reproducing the instructor's methods.'



Machine learning for different disciplines

An interesting insight for Gosia was how to introduce machine learning to students without a background in computer science – a challenging task for any computer scientist. A colleague at the teachers' lunches, Seyran Khademi, shared how AI can be introduced within architecture, where it is not necessarily an obvious element to learn or apply. By integrating machine learning applications step by step, in familiar applications and areas of use, students are convinced of AI's applicability and merit.

Gosia: 'Integration is great, convincing students of the utility of machine learning, and that's a valuable lesson to bear in mind when teaching. Relating machine learning to familiar concepts allows students to engage more easily, and it enriches your teaching with valuable examples, keeping your subject relevant and up to date. As someone who wants to improve machine learning education, this is right up my alley. Interactions with other educators allows us to reflect on our own teaching, tools and resources.'

Shared and open teaching materials

Another important goal is to create and share open teaching materials. Tom and Gosia are working on pilot projects with the AI Initiative's education team. They want to create platforms for open teaching materials and exchange of material so that teachers can learn from each other's expertise, create high quality material and save time.

Gosia: 'I have already used Tom's ethics slides from his ethics lecture. It really added value to my classes and allowed me to focus on adapting the material rather than starting from scratch.' Tom: 'I have made use of Gosia's assignments for my course too. Not only do we exchange materials, but we also take a deep look at them and help each other to improve them. Using a similar assignment is also very nice for our shared teaching assistant, saving him time as well.'

Gosia and Tom see a bright future for the community, reflecting the goal of teaching high quality machine learning at TU Delft and beyond. Gosia: 'We want to build better relationships with other machine learning educators, so everyone knows who can answer questions, and everyone has what they need to share and collaborate more easily.' Tom: 'We want to take small steps towards expanding activities and possibly broadening the scope. Our aim is to scale up with other universities, establishing a wider network so we can work more efficiently and learn from each other. Open discussions and shared materials ultimately contribute to a useful, interesting and high-quality machine learning education.'

AI Teachers' Programme

This project aims to develop a broad programme where 'in-Al' and 'with-Al' teachers are supported in developing Al education. It may involve exchanging knowledge on how to teach Al within a specific discipline area, but will also include focus groups so that teachers can together take stock of what it takes to integrate Al into the curriculum. Al staff members will emerge with a better understanding of Al and its applications within education. They will be able to keep pace with the impact of Al within their discipline, and tailor the curriculum accordingly. Within this programme, the Machine Learning Teachers Community was established in 2023.

Open Educational Resources

Developing open educational resources (OERs) is a central TU Delft policy, and the AI Initiative's education team is driving this for AI educational materials. In cooperation with other educational institutions, we aim to develop a repository of AI educational materials that every AI teacher can use. For this, we need clear frameworks of how AI can be applied within different subject areas. Publishing educational materials freely and openly online for a broad student population will ultimately attract more students to develop their AI knowledge within their domain. Frans Oliehoek is using reinforcement learning to teach smart systems to make a series of decisions, enabling them to think in more abstract terms. Oliehoek: 'As a result, self-driving cars can deal with uncertainties, such as the effect of rain on road holding. Or anticipate other smart systems. The point of the simulations is to test the fundamental principles.'

Frans Oliehoek, Director ELLIS Delft Unit

ELLIS Delft

In 2019 TU Delft was selected by the European Laboratory for Learning and Intelligent Systems (ELLIS) as an ELLIS unit for research into artificial intelligence and machine learning with societal impact. The ELLIS Delft Unit brings together leading researchers from different disciplines and connects them with European counterparts, thereby ensuring a significant acceleration of knowledge. They focus on using learning techniques as a key enabling technology to deal with complex tasks, and on making intelligent systems adapt to their environment including social circumstances.

Research & innovation

The continued and successful application of an Al-driven approach demands a convergence of both research *in* Al that advances the field of Al and research *with* Al that advances the state of the art of a specific research field. We develop not only the fundamentals around Al, data & digitalisation but also their application and uptake in contexts of science, engineering, design and society. Close collaboration in innovation projects, with industry and societal partners, is therefore key.

Within the TU Delft AI Initiative, for research and innovation, we focus on 5 'vertical' programme lines associated with five strong areas of application: Peace, Justice, Security and Public Services; Ports and Maritime; Health and Care; Energy and Sustainability; and the Technology Industry. Next to that, we focus on 2 'horizontal' programme lines related to fundamental and characteristic aspects of AI: Human-Centred AI Systems and Machine Learning.

Al Innovation team

Joost Poort | Fred Herrebout | Caroline Duterloo | Tim Meijster Helma Dokkum | Christine Bel | Venkatesh Chandrasekar Roos-Anne Albers | Emma Nota

Innovation clusters and fieldlabs

Validating and demonstrating

MONDAI | HOUSE OF AI DO IOT FIELDLAB DIGICAMPUS MOBILITY INNOVATION CENTRE DELFTROBOHOUSE SAM XL THE GREEN VILLAGE BIOTECH CAMPUS DELFT UNMANNED VALLEY QUANTUM DELFT DIGITAL ZH ZUID-HOLLAND AI DELFT DIGITAL ETHICS CENTRE

AI Ecosystem

Start-ups/scale-ups

Building a start-up community, by attracting and setting up startups

IMPACT STUDIO **XO SIGHT** COUNCYL YES! DELFT DUCKDUCKGOOSE CUURIOS PLOTWISE BLUEGEN MOMO MEDICAL **GRADUATE ENTREPRENEUR** ALMENDE BIRDS.AI WHIFFLE OUALINX JAIDE NEXT DELFT DELFT ENTERPRISES

Knowledge institutes

Participating in major national and international networks related to research and education in AI, Data & Digitalisation.

TU DELFT (ALL FACULTIES) NEDERLANDSE AI COALITIE ELLIS HUMANE AI CLAIRE TAILOR ICAI CONVERGENCE ERASMUS ERASMUS MC Companies and organisations

Interacting with companies in the TU Delft Campus network

AHOLD DELHAIZE			ALLI	ANDER	KICKSTART.	AI PRORAIL					
NS	SAS	DSM	ING	ING PROVINCIE ZUID-HOLLAND							
ZUID-HOLLAND SME AI CLINIC INNOVATION						QUARTER					
POL	ITIE	ZUID-H	DLLAN	D MKB [DATA STUDIO	JETBRAINS					

TU Delft's Mondai | House of AI

Mondai | House of AI is a home for Research & Innovation in AI. It creates value and impact connecting stakeholders in the research, development and application of AI, enabling collaborative research, smart partnerships, research & innovation facilities and entrepreneurship. In the region Mondai provides the lead in the Convergence AI, Data & Digitalisation programme, and houses and supports the AI Hub Zuid-Holland and Digitalzh. Nationally, it is an active member of the NL AIC and ICAI, engaging all stakeholders in the national AI ecosystem. Since 2022, Mondai | House of AI has provided community management, developing programming and communications around entrepreneurship in the AI ecosystem, and will continue to do so on a larger scale.

In 2023, plans for Phase II were approved: the expansion of Mondai | House of Al. In this phase, Mondai's community team and the Al innovation team will grow to a larger scale and actively connect companies in the ecosystem – to each other, researchers and talent, and the broader network both regionally and nationally.

Mondai excels in entrepreneurial dynamics. We offer attractive surroundings and facilities at the NEXT Delft community, and provide a suitable context for the next steps in its development.

'At the heart of the AI ecosystem, Mondai | House of AI is expanding. With Phase II at the NEXT Delft community building we have the opportunity to grow into an exciting new stage.'

Joost Poort, Director Mondai | House of AI



'AI, data and digitisation are increasingly essential for solving the major scientific and social issues of our time. At TU Delft alone, around 1500 scientists are working on AI. The TU Delft Campus innovation ecosystem also has a strong focus on AI and digitisation. It includes several field labs. In order to realise the great potential of AI, cooperation between all these parties is crucial, and TU Delft is taking the lead with Mondai | House of AI.'

Tim van der Hagen, Rector Magnificus

TU Delft ICAI Labs

TU Delft is part of the Dutch National Innovation Center for Artificial Intelligence (ICAI), which works to keep the Netherlands at the forefront of knowledge and talent development in AI. An ICAI lab is a multi-year strategic collaboration with a focus on technology and talent development. It is a research collaboration between industry, government or non-profit partners, and knowledge institutes. ICAI labs must meet requirements for data, expertise and capacity. They are expected to operationalise outcomes for the real world.

In 2023 TU Delft established and launched 5 new ICAI labs, bringing the total to 10 TU Delft ICAI labs.

'In addition to the 24 AI labs, we have also set up several ICAI labs where we're working with major companies – DSM, Ahold Delhaize, ING – on the development and implementation of AI in specific sectors. The advantage of these labs is that they enable us to work on very concrete applications and to access data sets that are not otherwise available.'

Geert-Jan Houben, Pro Vice Rector Magnificus AI, Data and Digitalisation.

AI for Software Engineering Lab

TU DELFT

Arie van Deursen | Maliheh Izadi

JETBRAINS

TU Delft and JetBrains combine their knowledge and expertise on AI and software development in the AI for Software Engineering Lab (AI4SE). The goal of the collaboration is to develop a deep understanding of how novel AI technologies can strengthen the effectiveness and efficiency of software engineering processes.

How can we engineer better software by using artificial intelligence (AI)?

The emergence of advanced Al-driven tools has led to a wide range of opportunities and transformations in software engineering practices and education. Recognizing this potential, JetBrains and Delft University of Technology established the AI for Software Engineering Lab (AI4SE). This is a five year collaboration comprising researchers, advisors, 5 PhD students at TU Delft and 5 at JetBrains. They conduct cutting-edge research on the impact and utilisation of AI methodologies in software engineering. Focus areas include software development, testing, and programming education. The objective of AI4SE is to employ and advance AI techniques to revolutionise software development tools and boost software developer productivity. A key mechanism will be generative AI and the use of Large Language Models (LLMs) for coding.

With its 2,000 employees, JetBrains is a leading provider of essential tools for software developers and teams, including IntelliJ IDEA. Its tools are used across the world by organisations such as Google and NASA.

'The AI4SE lab is a big new chapter for us at JetBrains Research. We are excited to be working shoulder to shoulder with the talented scientists and students of TU Delft. We are looking forward to making AI4SE a fruitful collaboration with long-term impact far beyond JetBrains and the research community.'

Vladimir Kovalenko, Head of the ICTL Research Lab at JetBrains.



'A collaboration between TU Delft, Erasmus MC, and software company SAS'

REAiHL Lab

TU DELFT

Jeroen van den Hoven | Jacobien Oosterhoff | Stefan Buijsman

ERASMUS MC SAS

In the Responsible and Ethical AI in Healthcare Lab (REAiHL), PhD students, nurses, medical doctors, data scientists, data engineers and ethicists are working together to develop guidelines for the development and implementation of ethically responsible and clinically relevant AI for healthcare.

In the future, will doctors discontinue medical treatment based on information provided by a computational model?

This may be one of the most difficult questions regarding the application of AI in healthcare. But there are many more, and less formidable, questions. For example, whether it will be safe for a patient recovering from surgery to be discharged a few days earlier – a decision that both benefits the patient and frees up hospital resources. Or whether an ICU nurse assisted by AI can provide high-quality care to more patients. The REAiH Lab, a collaboration between TU Delft, Erasmus MC, and software company SAS, aims to answer these questions.

'The ICAI lab formula, in which five PhD students collaborate closely with companies or societal organizations for five years, has proven a great success, also for TU Delft. Within the ROBUST long term programme we will create many more of those fruitful collaborations: in total with over 50 different partners. There is critical mass and cross fertilization – the perfect way to address the crucial challenge of trustworthy AI.'

Arie van Deursen, Head of Software Technology at the faculty of Electrical Engineering, Mathematics, and Computer Science and member of the ICAI Advisory Board In January 2023 we launched 3 new Delft ICAI labs, awarded by the NWO ROBUST programme. The new labs are the AI for Energy Grids lab, the RAIL lab and the GENIUS lab. These labs are respectively looking at improving energy storage capacity, increasing overall railway logistics capacity and the reliable development of collaborative knowledge structures – contributing to more accurate decision-making.

'The energy system, and in particular the distribution grid, is becoming increasingly dynamic, complex and stochastic. However, the methods used to plan and manage the grid rely on passive structures and simple worst-case assumptions. This lowers the performance of the current grid, and therefore becomes a barrier to the energy transition. It is now time to catch up and transform grid companies' methods. AI will make an important contribution to such a future energy system.'

Jochen Cremer, co-director Delft Al Energy Lab and lab manager ICAI lab Al for Energy grids

AI for Energy Grids Lab

TU DELFT

Jochen Cremer | Simon Tindemans | Peter Palensky | Roel Dobbe Han La Poutre | Lucas Narbondo | Shaohong Shi Charlotte Cambier van Nooten | Eva de Winkel

RADBOUD UNIVERSITY UNIVERSITY OF TWENTE HAN ALLIANDER

The AI for Energy Grids Lab focuses on developing methods and tools that use grid data to improve the efficiency, sustainability and reliability of the mediumlow voltage grid. It combines the expertise of Alliander data scientists and electrical engineers, along with the latest digitalisation programs for grid data, with academic expertise on methods from AI.

How can we increase the grid's capability?

At present, the Netherlands' electricity grid is reaching the limits of its distribution capacity. A strong and smart electricity grid is essential for the energy transition, so it is essential to improve the grid's transport capacity. The AI for Energy Grids Lab focuses on expanding that transport capacity in two ways – by improving grid operations, and by conducting research into infrastructure expansion. This will involve analysing grid data, and developing new AI methods and tools that learn from this data.

AI, data and digitalisation @ TU Delft

RAIL Lab

TU DELFT

Mathijs de Weerdt | Sebastijan Dumancic | Anna Lukina Alexander Verbraeck | Bart De Schutter | Rob Goverde

UNIVERSITY UTRECHT NS PRORAIL

The RAIL Lab is a research lab dedicated to developing AI technology to increase overall logistic rail capacity. The lab works towards algorithmic support to ensure safe and reliable logistic operations and capacity planning that is trusted by human experts.

What is the RAIL Lab's research focused on?

Based on a joint future vision of NS and ProRail, the RAIL Lab is researching ways to increase the efficiency and use the maximum capacity of the rail whilst at the same time make the system more robust and less fragile during disturbances. The researchers are focusing on how all rail traffic at so-called hubs in the network can best be managed, with the combined expertise of human experts and AI. They will use AI to optimise the movement of more trains to and from rail yards and their servicing and parking there. One of the biggest challenges for the project is how the algorithms will deal with disturbances in the service.

'The creation of schedules for train servicing is becoming more and more challenging with an increasing number of trains without an increase in rail capacity. Moving trains around a shunting yard is becoming like a sliding puzzle with just a single free space. Reasoning about how to use this space efficiently can be supported with computation, allowing more trains on a shunting yard, and thus more effective use of the available capacity.'

Mathijs de Weerdt, professor in Algorithms for Planning and Scheduling

Generative AI brings enormous potential to accelerating human work. We are excited by TU Delft's partnership with Maastricht University, Kickstart.AI, and DSM-Firmenich to pioneer new generative AI solutions that safely and reliably support human experts in various domains

Jie Yang, Lab Manager of GENIUS

GENIUS Lab

TU DELFT

Jie Yang | Alessandro Bozzon | Geert-Jan Houben | Ujwal Gadiraju Jeroen van den Hoven | Stefan Buijsman

MAASTRICHT UNIVERSITY DSM KICKSTART AI

The GENIUS Lab (Generative Enhanced Next-Generation Intelligent Understanding Systems) seeks to extend and improve generative AI methods, to support human experts through collaborative semantic knowledge engineering between people and AI systems. The lab will demonstrate trustworthy collaborative knowledge engineering solutions for safe, resilient and trustworthy decision-support applications.

At big companies, knowledge management is a challenge. Knowledge comes from everywhere, and capturing and storing it efficiently is already a challenge. When creating reports, plans or presentations, you want to be able to search through and retrieve desired knowledge that is hidden and scattered across various sources. But how can you do this? The researchers in the GENIUS lab focus on how humans and AI can collaborate together for knowledge management at large companies. They will be developing human-centred approaches that will involve humans in extracting, organizing and accessing stored knowledge.

The first 5 ICAI labs

AIRLab - AI for Retail

TU DELFT

Martijn Wisse | Jens Kober | Javier Alonso Mora Carlos Hernandez Corbato | Filippo Santoni de Sio Marco Rozendaal

AHOLD DELHAIZE

Al for Retail (AIR) Lab Delft is an industry lab consisting of a robotics research program and test site focused on developing state-of-the-art innovations in the retail industry. By expanding its focus to robotics, AIRLab Delft will further drive innovations for daily business while building more knowledge of the intersection between retail, AI and robotics.

AFR Lab - AI for Fintech Research

TU DELFT

Arie van Deursen | Luis Miranda da Cruz | Asterios Katsifodimos Georgios Gousios | Jan Rellermeyer | Annibale Panichella Claudia Hauff | Ujwal Gadiraju | Cynthia Liem | Diomidis Spinellis

ING

The mission of the AI for Fintech Research (AFR) Lab is to perform world-class research at the intersection of AI, Data Analytics, and Software Analytics in the context of FinTech. Its researchers are working on projects that focus, among other things, on autonomous software engineering, data integration, analytics delivery, and continuous experimentation.

AI4B.io Lab - AI for Biosciences Lab

TU DELFT

Marcel Reinders | Jana Weber

DSM

The AI4B.io Lab focuses on improving production technologies and developing bio-based products using AI. AI4B.io Lab is the first of its kind in Europe to apply artificial intelligence to full-scale biomanufacturing, from microbial strain development to process optimisation and scheduling.

Mercury Machine Learning Lab

TU DELFT

Frans Oliehoek | Matthijs Spaan

UNIVERSITY OF AMSTERDAM BOOKING.COM

The Mercury Machine Learning Lab focuses on the development and applications of AI to the specific domain of online travel booking and recommendation service systems. Research projects cover fundamental research topics, for example model-based exploration, parallel model-based reinforcement learning, and prediction methods that correct for undesired feedback loops and selection bias.

National Police Lab AI

TU DELFT

Alexander Verbraeck | Jan Kwakkel | Odette Scharenborg Robert Babuska | Javier Alonso-Mora | Laura Ferranti

UTRECHT UNIVERSITY UNIVERSITY OF AMSTERDAM NATIONAL POLICE

The National Police Lab AI aims to develop state-of-theart AI techniques to improve safety in the Netherlands in a socially, legally and ethically responsible way. The TU Delft contribution focuses on anonymization of speech, control of teams of micro-aerial vehicles for search operations, and using simulation and optimisation models in situations that ask for immediate action.

AI, data and digitalisation @ TU Delft

ELSA labs

TU Delft participates in 5 ELSA labs. ELSA labs are public-private partnerships that set up learning communities to develop research on Human-centred AI. In this research, technological development and ethical, legal and societal aspects (ELSA) are studied in relation to each other, based on concrete cases.

ELSA Lab Defence

The introduction of AI technology in defence raises ethical, legal and social questions. How can AI systems be kept under meaningful human control and how do you maintain the human touch when giving autonomy to machines? The ELSA Lab Defence, led by TNO, develops a future-proof, independent and consultative ecosystem for the responsible use of AI in defence.

ELSA Lab AI for Multi-Agency Public Safety issues (AI-MAPS)

Public Safety is vital for the functioning of societies. Data generated by multiple agents play an increasingly important role in preventing, preparing for and mitigating harm or disaster. The development of an ecosystem of trust regarding Al-assisted public safety promotion is central to this ELSA Lab application.

ELSA Lab Citizens and Society in the Energy Transition (CaSET)

The CaSET lab investigates the ethical, legal and societal implications of the role of AI in the future energy system and the transition to this future. CaSET provides transdisciplinary, fundamental insights on generalisable factors and processes that affect the efficiency, valuealigned utility and trustworthiness of AI.

ELSA Lab Contestable Urban AI

This lab is developing solutions for municipalities and public institutions that want to develop urban digital twins that will have long-term social backing. The guiding concept is contestability by design, a methodology that makes it possible to construct and permanently reconstruct an AI application in consultation with users and stakeholders.

ELSA Lab AI4Access

Auditory or visual impairments or low literacy can limit access to knowledge and services essential for cultural, social, and political participation. This leads to social inequality and insufficient representation of specific population groups in political debates and decisionmaking processes. The AI4Access ELSA Lab develops new co-design methods and inclusive AI technology that contributes to making knowledge and services accessible for everyone, helping create a more inclusive society.

CROP XR

DE

The Dutch institute CropXR integrates plant biology, computational modelling and AI into 'smart breeding methods'. These will be used to develop crop varieties that are more resilient to climate change and less dependent on chemical crop protection. In CropXR, TU Delft works together with Utrecht University, Wageningen University and Research, the University of Amsterdam and dozens of plant breeding, biotech and processing companies. This includes basic scientific research, data collection and data sharing, education, and advancing broad application of the results. From TU Delft, Luca Laurenti, Manuel Mazo (ME) together with Marcel Reinders, Christoph Lofi and Geert-Jan Houben (EEMCS) contribute to Crop-XR with their expertise in control and formal methods, AI and machine learning. Apart from NWO's Long Term Programme PlantXR, Crop-XR also received funding from the Dutch National Growth Fund.

Featured

There is so much going on around AI. Here are a few more examples highlighted.

Delft Digital Ethics Centre



'For twenty years, we in Delft have been taking the lead in the field of combining ethics and engineering. We don't just have a nice story to tell about values – we also know what it means to build or design something.'

Jeroen van den Hoven, professor of Ethics and Technology

Together with government agencies and companies, the TU Delft Digital Ethics Centre bridges the gap between abstract discussions on ethical values and concrete digital innovations. The centre is led by Jeroen van den Hoven, professor of Ethics and Technology (TPM), and

Catholijn Jonker, professor of Interactive Intelligence



(EEMCS).

Delft FinTech Lab

Advances in AI and digital technologies are disrupting the financial sector. Delft FinTech lab provides a unified front of TU Delft's expertise in this area, formed to help the financial industry solve the increasingly complex challenges in this domain. In the lab, led by Arie van Deursen (EEMCS), more than 50 researchers with expertise that includes cybersecurity, fraud detection, anti-money laundering, privacy compliance and more are working together with financial institutions. **Centre for Meaningful Human Control**

The concept of meaningful human control (MHC) emerges as a critical concept, aiming to ensure that humans retain control and are empowered to bear moral responsibility for their actions. To formally establish and catalyse TU Delft's position as the world's lighthouse on MHC expertise, we are establishing a Centre for Meaningful Human Control over AI. Its main goal is to provide a robust understanding, connections, and success stories that can support shaping the future of AI development in a beneficial and responsible manner.

'It's important that human users feel the right level of responsibility, and have a realistic chance to intervene. This is when we speak of meaningful human control – a concept that ethicists, business experts, designers and engineers have to consider together. It is both scientifically and socially complex.'

David Abbink, Professor in Haptic Human-Robot Interaction

Team Epoch

Robert van Poeteren | Emiel Witting | Brian Witmer Jasper van Selm | Jeffrey Lim | Tolga Kopar | Hugo de Heer Suusje Helwegen

Team Epoch is one of TU Delft's dream teams, the Artificial Intelligence Dream Team. Every year there is a new team of students dedicated to putting Al on the map to create a better future. Team Epoch is on a mission to explore the incredible potential of Al while striving to align with the United Nation's Sustainable Development Goals. They are focussing on winning Al competitions while also making Al more explainable and engaging.

Team Epoch is very successful in the competitions they participate in. They secured 21st place in the AI BioMassters competition, ranking them among the top 3% of the 976 international competitors. They created an AI algorithm that accurately predicts the biomass of a forest region in Finland using satellite images. For this achievement they also won the Computable Award 2023 for Sustainable Tech.

Team Epoch IV started in August 2023 with a competition 'Detect Sleep States', in which the assignment is to produce an AI code that accurately predicts the start and end of someone's sleep.

The port of the future: AI for port & maritime

To make ships navigate more efficiently and sustainably, Rudy Negenborn (ME) is researching interactions between control and optimisation algorithms. 'At the drive level, we can use smart control techniques to bring about a more efficient injection of fuel into engines that are combined with fuel cells. At the ship level, we can optimise the energy supply on board. If, moreover, we introduce the environment to this mix, we can optimise the route planning as well.'

AiNed Fellowship grant

Charlotte Frenkel (EEMCS) received an AiNed Fellowship grant for neuromorphic chips. She leads the project SynergyAl, that aims to simultaneously merge neuroscience with Al research, and to bridge the gap between analogue and digital computing, potentially revolutionizing the field of computing and Al. 'I want to contribute to a future in which computers are smaller and more adaptive. This means they will have a far smaller footprint on our society, in terms of resources but also in terms of capital that is needed to update and replace them.'

Colophon

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