I/O magazine

ICT RESEARCH PLATFORM NEDERLAND

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PAUL KLINT

Towards FOMO-free policy

Humans are herd animals. Unfortunately, herd behaviour may force the herd off a cliff.

Sheep always fear that they will miss the best meadow if they do not follow their fellow sheep. Scientists always have the "Fear Of Missing Out" in the latest scientific trends. Policymakers fear that they will miss out on the trends spotted by their international colleagues. Have you ever seen a Prolog computer as promised by Japan's Fifth Generation Computer Programme that we feared so much at the time? The list of "promising" developments that did not deliver or only partially delivered usable results is long. Ambient computing, robots for healthcare, nuclear fusion, room temperature superconductivity, and many others come to mind. More recent policy darlings are blockchain, AI, and quantum computing.

After 7 years of trying, and many millions of subsidy, the Dutch Blockchain Coalition has died silently without delivering successful pilot projects. Clearly a "solution" in search of a problem, but a policy darling, nonetheless. Enough has been said about AI and its winters, so let us focus on quantum computing. Over the last few years, the Netherlands has invested over 600 M€ in quantum computing, but no results are in sight. Compare this with the yearly budget of NWO, the Dutch Research Council, and you realise that these science policy darlings are killing all other research fields.

Can this herd behaviour be stopped? Years ago when he was the Prince of Orange, the current King of the Netherlands Willem-Alexander was laughed at when he selected "water management" as his primary focus. On the contrary, I think it was a very clever choice to exploit a unique strength of our country. Our century-long struggle with water has made us specialists in everything related to water and Dutch companies in this sector are thriving worldwide.

Herd behaviour can be stopped by focusing on unique, country-specific strengths and opportunities and supporting these with wise economic and scientific policies that leave sufficient room for individual scientists to excel. Towards FOMO-free policy!

NWO

IPN ICT-ONDERZOEK PLATFORM NEDERLAND

STREAMLINING DUTCH INVESTMENTS IN DIGITAL INFORMATION TECHNOLOGIES

The first Knowledge and Innovation Agenda (KIA) Digitalisation has been published, which broadly describes the Dutch knowledge and innovation challenges for the digital transformation of society.

By Bennie Mols

Images iStock, NWO, ECP, NLDigital

In 2023, the share of the IT sector to the GDP of the total Dutch economy was estimated at 4.4 percent, and 670,000 IT professionals were employed within various business branches of the Dutch economy. In addition, IT leads to productivity gains, for example, at banks, insurers and in retail, as well as the creation of entirely new activities such as platforms for booking hotel stays. IT clearly cuts across all sectors of society and the economy. And with increasing digitalisation, the demand for IT staff is only growing.

How can the government best manage this digitalisation? That is why the first Knowledge and Innovation Agenda (KIA) Digitalisation was drawn up. 'For the period 2024-2027 the KIA provides a framework for future investment and innovation in digital technology', says Frits Grotenhuis, director of Top Sector ICT, which coordinates the KIA Digitalisation. 'With this new KIA, we coordinate and direct research and innovation, we set priorities, we encourage public-private partnerships, and we strengthen the international competitiveness of the Netherlands.'

To indicate the phase of digitalisation we are in, Grotenhuis draws a comparison with the appearance of the first cars in the late 19th century: 'Back then, you had something called the Red Flag Act which said that for safety reasons automobiles had to be led by a pedestrian waving a red flag to warn bystanders of the vehicle's approach. Those early automobiles were also only allowed to drive at six kilometres per hour because there were no headrests, seatbelts or airbags. And

KIA DIGITALISATION

KIA stands for Knowledge and Innovation Agenda. The KIA Digitalisation provides a framework and guiding principles for future IT research and IT innovation with the main aim of managing the digital transition of Dutch society. Top Sector ICT is the initiator and coordinator of the KIA. It drew up the agenda for the four-year period 2024-2027.

It has been agreed to invest a total of about €5.7 billion in IT research and innovation in the Netherlands. The KIA Digitalisation aligns with five central missions formulated by the Ministry of Economic Affairs to make the Netherlands future-proof: 1) energy transition, 2) circular economy, 3) healthcare, 4) agriculture, water and food, and 5) security.

outside the car, there were no pavements, traffic lights and road signs. With digitalisation, we are now at a similar stage where regulations are being made, such as the Digital Services Act or the AI Act in the EU, and where we are making great technical strides to support and protect society.'

Christiane Klöditz

'Each year, we review which new thematic research programmes should be launched'

Three main lines

The KIA Digitalisation was created through close cooperation between representatives from government, industry and the knowledge community. Industry was represented by the association NLdigital, representing some six hundred companies that enable the digital transformation in the Netherlands. These include global players as well as hundreds of scale-ups and SMEs. NWO was at the table on behalf of the knowledge community.

Lotte de Bruijn

'The biggest challenge is to involve SMEs'

In terms of content, the KIA Digitalisation has been formulated along three main lines, Grotenhuis explains. 'The first one is innovating in digital information technologies. This is about developing fundamental knowledge, think about the foundations of large language models as part of AI. The second one is innovating with digital information technologies, which is about the applications of the fundamental knowledge, specifically in the fields of 1) energy transition, 2) circular economy, 3) healthcare, 4) agriculture, water and food, and 5) security. The other Top Sectors are also involved in this. Finally, the third line is reflecting on digital information technologies.'

When reflecting on digital information technologies, the central question is what kind of society we want to live in in the Netherlands. Which ethical, legal and social issues should play a role in the design of digital information technologies? How can new applications meet the needs of a sustainable and digitally sovereign Netherlands?

'It is important to make such questions part of the research from the very beginning, rather than having a social scientist called in at the end', says Christiane Klöditz, head of Mathematics & Computer Science at NWO. 'NWO will contribute 138 million euros annually between 2024 and 2027 in four instrument lines for the Knowledge and Innovation Covenant (KIC). This includes €18 million a year for the line for applied research (universities of applied sciences). Each year, together with representatives of knowledge institutes, industry, and government, we review which new thematic research programmes should be launched. Within the fields of digitalisation, the KIA Digitalisation will be leading in this. Digital Identities is an example of such a thematic research programme.'

Multiple links

The KIA Digitalisation also seeks cross-fertilisation with the KIAs of other Top Sectors. 'For example, we are preparing a research call on data sharing in the context of energy transition', says Grotenhuis. 'Due to the energy transition, more decentralised energy is being generated, for example by solar panels, and either consumed or stored. These decentralised systems generate, store and process decentralised data and more interactions than before between European, national, regional and local systems. Digitised data exchange enables an energy system that can accelerate, automate, plan and anticipate processes much better than it does today.'

The KIA talks about a quadruple helix that involves academia, industry, public authorities, and citizens. 'For researchers', Klöditz says, 'this KIA offers new opportunities to work on interesting research issues that deal with fundamental questions on the one hand, but at the same time enable responsible applications. For companies, public-private partnerships are interesting because they have a front-row seat in world-class research and the opportunity to train new talent for their companies.'

Lotte de Bruijn, managing director of NLdigital, stresses the importance of closing the gap that exists in the Netherlands between theory and practice: 'We do very well in scientific research, but not so well in its practical application. That is why it is so important that the KIA Digitalisation also considers from the outset what business has to gain from a particular line of research. This could be done, for example, by involving vocational education more.'

NLdigital is the central point of contact for the business community. De Bruijn: 'We organise meetings with our members, we can connect people, and we also get concrete enquiries coming in. For example, we recently received a question about using AI in human resource management. The biggest challenge is to involve SMEs, because they have a shorter horizon than most research plans. One of the things we can do is to bring SMEs together in a project when it is too much for one small company alone.'

Frits Grotenhuis

'The KIA provides a framework for future investment and innovation'

Labour shortage

De Bruijn also holds the role of Human Capital Ambassador. 'Many people think the biggest labour shortage is in healthcare', de Bruijn says, 'but the biggest labour shortage is in IT. By 2023, there were a total of 105,000 vacancies and the shortage is only growing because of the increasing digitalisation. Some people say we can solve that with AI. Of course, that will help, but it will also create new demand. Then there will be new positions for which people need new skills again.'

According to de Bruijn, ensuring there are enough IT professionals starts with the foundation: education. 'Ensuring digital literacy should actually start from the first day of primary school. I see it as my mission to keep hammering on about that. But it is still too little integrated in all layers of education, and so we provide retraining and refresher courses.'

The KIA was drafted for four years but digitalisation will, of course, continue beyond that. What do Klöditz, Grotenhuis and de Bruijn hope to have achieved by 2027 and how should things proceed after that?

'I hope that by then we will have managed to ensure that the three pillars are sufficiently visible in all the activities we have undertaken', says NWO's Christiane Klöditz. 'So that we want to both strengthen the foundations, and apply new technologies, and do so responsibly.'

Director of Top Sector ICT, Frits Grotenhuis, hopes that the KIA will ensure that the broad spectrum of the IT field grows closer together, as well as strengthening organisational capacity and infrastructure. Grotenhuis: 'As a result, I also expect the future beyond 2027 to come into view naturally. Where will research and innovation be then? What will the geopolitical landscape be like then? What will be the most important new technological developments? Are we going to see a combination of AI and quantum technology, for instance, or has neuromorphic computing made a big step?'

'I would love it if we could show that projects that started on paper have found a place in practice', says NLdigital's Lotte de Bruijn. 'I hope that the end user, and that could be a citizen, a patient or a traveller, thinks: *now that's useful, that's something for me.*'

SEVEN DIGITAL AND INFORMATION TECHNOLOGIES

In 2023, the Ministry of Economic Affairs, together with NWO and TNO, defined seven digital and information technologies that the Netherlands should invest in, and which are explicitly named in the KIA Digitalisation:

- Artificial Intelligence
- Data science, data analytics and data spaces
- Cyber security technologies
- Software technologies and computing
- Digital connectivity technologies
- Digital twinning and immersive technologies
- Neuromorphic technologies

MORE INFORMATION

kia-digitalisering.com
topsector-ict.nl/en
www.nldigital.nl/
www.nwo.nl/en/researchprogrammes/knowledge-and-innovation-covenant/kic-2024-2027
topsector-ict.nl/en/key-enabling-technologies

Whether it is for climate modelling, materials science, astronomy or developing large language models, scientific research increasingly needs large-scale computing and data facilities. Recently, the Netherlands joined the LUMI consortium, securing guaranteed Dutch access to Europe's most powerful and publicly accessible supercomputer.

Using the most powerful European supercomputer

By Sonja Knols Image LUMI

LUMI (Large Unified Modern Infrastructure) is an HPE Cray EX system with a sustained computing power of 380 petaflop per second. This makes it one of the world's leading artificial intelligence platforms. The supercomputer is owned by the European High-Performance Computing Joint Undertaking (EuroHPC JU) and is located in Finland.

'Since 2017, EuroHPC has been striving to develop a world-class supercomputing ecosystem in Europe', explains Walter Lioen, Domain Manager Research Services at SURF. 'The Netherlands was among the first seven countries to participate in this initiative.' Over the years, EuroHPC has procured nine European supercomputers. LUMI is currently the fastest of the so-called pre-exascale facilities. Last March, SURF signed an agreement to officially join the LUMI consortium. By making its own investment in LUMI, the Netherlands now has bought itself dedicated access to the system.

SKIP THE LINE

Lioen: 'EuroHPC is the economic owner of LUMI, granting access for half of its capacity to researchers in Europe. The other half is divided over the partners in the LUMI consortium. The Netherlands has the right to divide some one percent of the facilities' capacity over Dutch users only.' In practice, this means that researchers working at Dutch knowledge institutes who want to use the supercomputer do not have to compete with the entire EU but instead can enter a Dutch-only competition for computing time. SURF facilitates this access in collaboration with NWO, in exactly the same way as both organisations have been doing for over 40 years now for computing time on the Dutch supercomputer facilities, like Snellius. Besides using a uniform process, the time between applying for resources and gaining access to LUMI is significantly shorter than when using the EuroHPC access routes.

NWO has incorporated LUMI into its standard, continuous computing time calls. Applications are assessed based on project organisation, scientific aspects and need of access to the computer facilities. Six times a year, the large applications are granted. 'SURF can help applicants in the process', emphasises Lioen. 'We are not only experts on the available hardware, but we also have domain expertise in biology, chemistry, computer science and physics, for example. Therefore, our people can advise you on what facility would best suit your needs and how to set up your algorithms or models in such a way that you make optimal use of the power of the system. That is particularly important since, in your application, you must demonstrate that you will use the desired large-scale, complex infrastructure efficiently.'

> 'We have the right to divide some one percent of the facilities' capacity over Dutch users only'

LUMI is 14 times faster than the Dutch supercomputing workhorse Snellius, and is specifically suitable for applications that require the use of GPUs. 'It is perfect for machine learning applications, and for applications in, among others, computational chemistry and materials science', Lioen says. 'Unfortunately, far too many Dutch researchers are not aware of the possibility to make use of computing facilities like these without additional costs. So, my message to the scientific field is: if you have a computationally challenging problem, please come to SURF. You know your own research, we know where to go, and we can help you get there!'

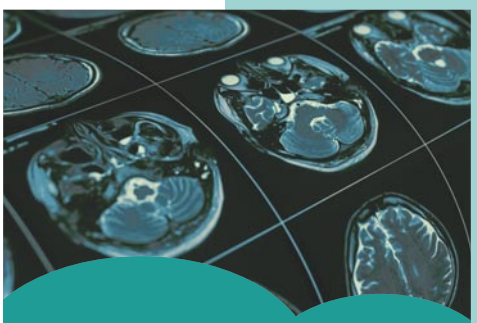
More information
www.lumi-supercomputer.eu

IPN PLACES COMPUTER SCIENTISTS IN THE SPOTLIGHT

IPN has opened up a new section on its website (ict-research.nl). In a series of personal portraits, computer scientists working at Dutch knowledge institutions introduce themselves, their work, and their ambitions. Do you want to be portrayed in this section, or do you know anyone who should be included? Drop us a message at ipn@nwo.nl.

IMPACT EXPLORER FOR UNEXPECTED RESULTS

If you obtain unexpected results during your research then you often cannot do anything with these since the research budget does not allow any unplanned investigations. Therefore, with its Impact Explorer call, NWO provides small top-up grants of up to 30,000 euros per project to explore such results.
Last spring, 7 of these top-up projects were awarded funding. One of these was an investigation into the applications of brain-inspired AI in real-world sound processing, led by Elia Formisano from Maastricht University. His project seeks to bridge the gap between groundbreaking neuroscientific research and practical applications by exploring the societal impact of AI algorithms inspired by brain function that are specifically designed for sound recognition.



NEW HTSM CALL OPENED

The Netherlands faces major societal and economic challenges. The high-tech sector plays a crucial role in the transitions needed to overcome these. The new HTSM call 2024, a collaboration with top sector Holland High Tech, aims to stimulate fundamental and application-oriented research in the field of High Tech Systems and Materials in the Netherlands. This year's call revolves around two key technologies from the National Technology Strategy, namely energy materials and imaging technologies. For the latter theme, the call aims to (further) develop technologies with applications within the imaging chain, ranging from image acquisition to image reconstruction.
The total budget for this call is 7.5 million euros, which is enough to fund about 8 projects. The deadline for submitting applications is Thursday, 10 October 2024.

IMPROVING DIGITAL INFRASTRUCTURE

The first five so-called 'bottleneck projects' from the Thematic Digital Competence Centers have been awarded a total of more than 732,000 euros. The three Thematic Digital Competence Centers are network organisations focussed on Life Sciences and Health, Natural and Engineering Sciences (NES), and Social Sciences and Humanities.
The TDCC roadmaps describe bottlenecks in their respective fields and dedicated funding is available for each TDCC to quickly tackle these bottlenecks.
The five projects awarded so far address best practices for developing, managing and preserving software in a sustainable way; solutions to improve the long-term financial sustainability of research software; data interoperability, preserving research software, and adopting FAIR practices across disciplines; the development of a dedicated NES community; and FAIR+ data creation guidelines.

THE FUTURE OF INDUSTRY ENSHRINED IN CODE

There is no better example for the transition the Siemens Digital Industries division is going through than the programmable logic controller (PLC). This piece of hardware, the very symbol of digitalisation in industry, used to automate anything from a coffeemaker to a complete production plant, is currently undergoing a controller virtualisation process. In general, the pace of change is fast and moving towards software.

By Leendert van der Ent Images iStock, Siemens

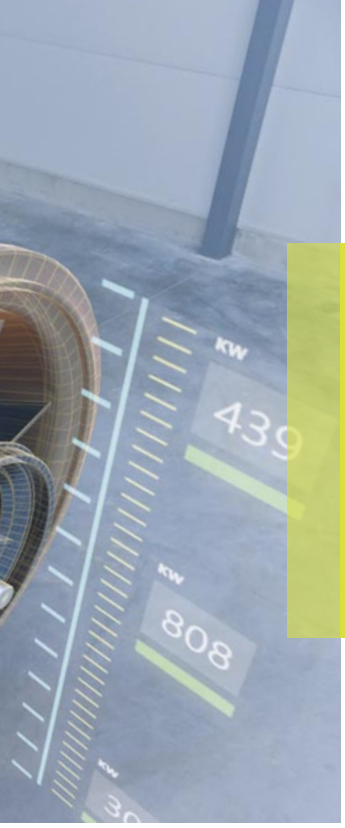
'The digital transformation also encompasses the digitalisation of industry', says Daniël Kofman, Education Xcelerator at Siemens Nederland. 'Industry needs software to boost its goals of greater efficiency and flexibility. Sustainability has joined as a purpose. These are the themes our Digital Industries division is about. As the digital transformation proceeds, more and more people will work with an increasing number of applications. This means that ease of use is key for the success of the digital transformation – also in industry.'

There is a huge R&D effort to enable the digital transformation in industry. More software has to be generated with less people. Domain knowledge has to be embedded in software to secure continuity of expertise in a labour market where specialists are scarce and less qualified people are required to be enabled to work with complex systems. Siemens is therefore involved in the Low-code Development Platform Mendix.

CORE RESEARCH THEMES

Kofman: 'There are also other scientific challenges we'd like to boost. Our eleven corporate core research themes are clustered and included topics like "advanced manufacturing and circularity", "simulation and digital twins" and "data analytics and AI". More specific research topics vary from more sustainable chips through less energy consumption and more calculation power, photonics and novel chip substrate materials. New materials are also on the radar, as is disassembly for circularity. Other areas involve error-free software development and large language models for operators on the shop floor.'

At the international level, the Siemens Research and Innovation Ecosystem is organised in sixteen clusters of universities. Kofman is currently helping to set up the Aachen cluster, in which, among others, KU Leuven and Delft University of Technology are involved. Apart from that, Siemens participates in several Horizon Europe research projects. Kofman: 'But generally speaking, the long- and medium-term research is organised at the corporate level, whereas collaborations in applications mostly exist at the national level. This is typically done with consortia of technical universities and universities of applied sciences.'



SIEMENS IN THE NETHERLANDS

Siemens Nederland NV employs about 1,300 people. They concentrate on two specialisations, namely Smart Infrastructure and Digital Industries. In total, Siemens employs around 3,000 people in the Netherlands, including Siemens Nederland, Siemens Healthineers, Siemens Mobility, Siemens Digital Industries Software and Mendix.

FROM CONCRETE TO NERVES

An example is the development of a 3D concrete printer factory with Eindhoven University of Technology and Fontys University of Applied Sciences. PhD students develop the concept and students in higher professional education focus on solving the practical problems. Siemens is involved with controllers and support. Another interesting project is Flow Bot with Delft University of Technology, aimed at optimising propulsion of rowers and swimmers in water. TU Delft focuses on insight in water flows around the blades in rowing and the hands during swimming. The installation is equipped with Siemens CNC Controls, drives and the control software. Also, there is the TU Delft field lab SAM XL for large-scale manufacturing in the STUNNING project, which is about advanced welding of thermoplastics for huge aerospace components. Kofman: 'This production automation project is all about vision technology and dynamic establishment of the optimal location of the welds.' Kofman himself is involved in an NWO Veni project with TU Delft assistant professor Yasemin Vardar of the Haptic Interface Technology Group (HITLab) on emulating tactile textures. Siemens is in the user committee to investigate if haptic interface technology can be applied in industry.

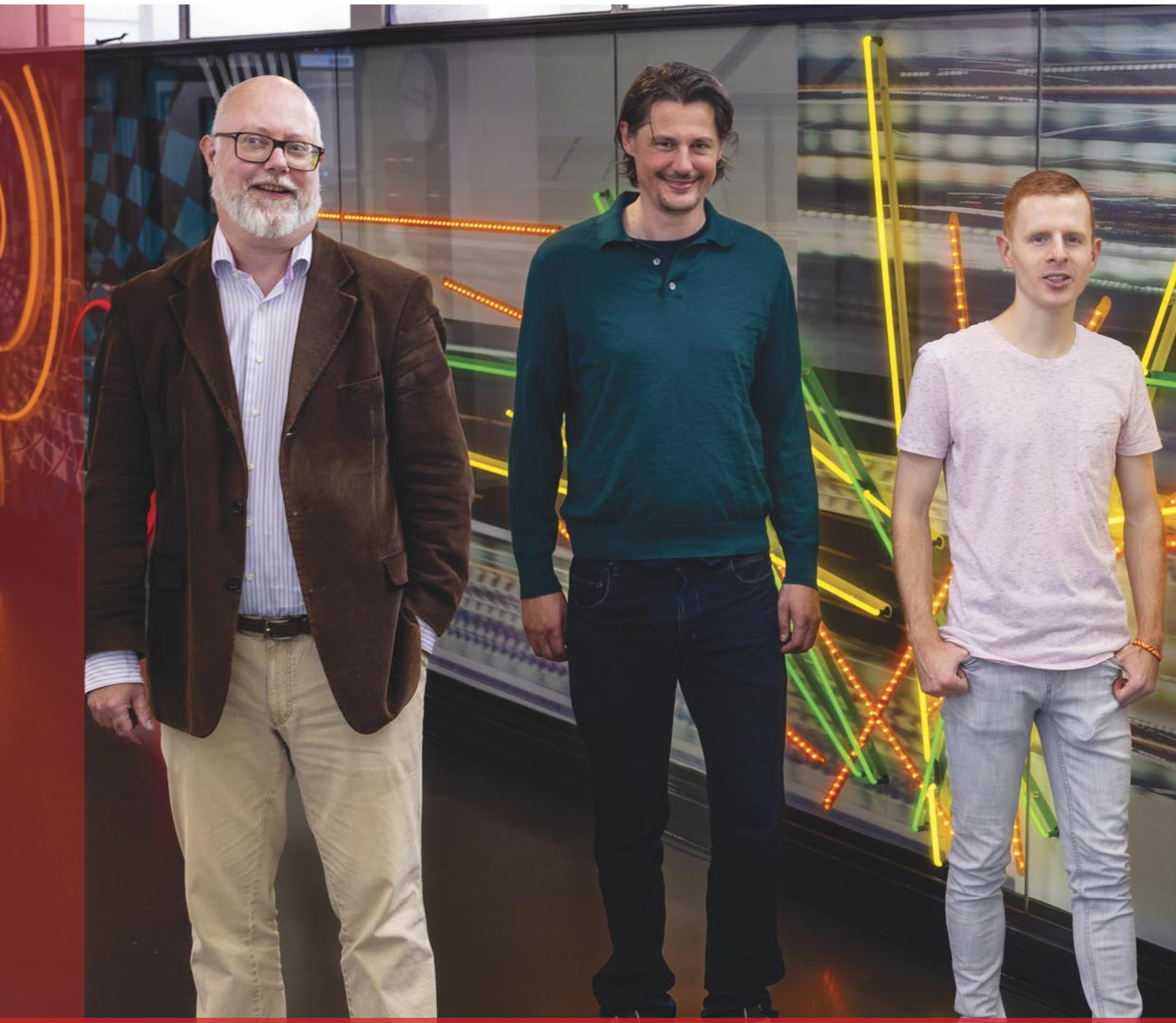
'THE MOVE IN INDUSTRY IS DEFINITELY TOWARDS SOFTWARE'

Daniël Kofman

INTEGRATION

The final example of innovation collaboration Kofman gives is the recently opened Field Lab and Experience Center for sustainable, data-driven vertical farming at Infinite Acres in The Hague. 'An important part of our involvement revolves around a digital twin of the system to simulate timing and location of resource deployment to optimise the growth process', he says. 'The aim is to attain maximum yield with minimum use of water and nutrients.'

With the integration of Operational Technology (OT) and Information Technology (IT) for sustainability, this project touches the heart of Siemens' technology with a clear purpose. Kofman: 'Robustness, stability, scalability and maintainability are the core features in our industries. It's vital to realise that what goes for IT does not automatically go for OT. For example, when it comes to updates, the motto is to not touch the system unless it is absolutely necessary. But all the while, the move in industry is definitely towards software. Even the PLC is now becoming a software solution.'



Smart and human-centred handling of information, knowledge and language

By Bennie Mols Images Ivar Pel

GROUP PASSPORT

RESEARCH FIELD

Data engineering, data management, information systems, text mining, knowledge engineering, knowledge representation, knowledge systems, knowledge extraction

INSTITUTION

HAN University of Applied Sciences

EMPLOYEES as of October 2024)

1 professor (group leader), 7 researchers, 4 lecturers-researchers, 1 developer-researcher, 30 master students (throughout the year).

WEBSITES

Lectureship Data & Knowledge Engineering: **www.han.nl/onderzoek/lectoraten/lectoraat-data-and-knowledge-engineering/**

SPRONG project DEMAND: **www.han.nl/projecten/2023/demand/**

Project 'Flexible work instructions': **www.han.nl/projecten/2023/flexibele-werkinstructies/**

Project SCEPA (Scaling up the Energy Poverty Approach): **www.han.nl/artikelen/2023/10/project-scepa-samen-strijden-tegen-energiearmoede/**

The Data and Knowledge Engineering lectureship of HAN University of Applied Sciences focuses on practical applications of existing knowledge. Projects include automating work instructions for SMEs and tackling energy poverty by providing insight into unstructured data.

Stijn Hoppenbrouwers

Whereas academic research groups develop new knowledge, research groups in higher vocational education (HBO), called lectureships, make existing knowledge better and more publicly applicable. Stijn Hoppenbrouwers leads the *Data and Knowledge Engineering lectureship* at HAN University of Applied Sciences, a group of 12 researchers.

'What binds the group together', says Hoppenbrouwers, 'is a love of developing computational applications to deal with information, knowledge and language in a smart and human-centred way. For us, the question is how to apply existing generic knowledge in our teaching and in our collaboration with parties in practice. Then, the focus is not on the leaders, including companies like ASML, but on the peloton, such as small and medium-sized enterprises and municipalities.'

Maya Sappelli

'The focus is not on the leaders, but on the peloton'

A good example is the two-year RAAK SME project *Flexible work instructions*. This project investigates how work instructions can be made and used in a context-sensitive and flexible way. Hoppenbrouwers: 'Suppose a heating technician needs to repair a boiler. What, then, is the best way to present a work instruction? From my lectureship, we are investigating how to generate work instructions automatically from various sources. The *Media Design* lectureship investigates how the information can best be presented so that it is usable for different types of boilers, for example. Ultimately, we want to offer SMEs a toolbox to support flexible work instructions.'

Another lectureship with which Hoppenbrouwers works closely is *Applied Science & AI*. 'That lectureship emerged from our group early this year because it started to grow too big', he says. 'The new lectureship is more on the data analytics side. We are more on the linguistic side with knowledge representation, data quality and things like that.'

When it comes to data-driven work, there is still a big gap between what the big tech giants do and what, for example, SMEs do. To close that gap, the SPRONG project DEMAND was created, a collaboration between various institutes, lectureships and business partners, supported by the governing body SIA.

Marijn Siebel

The project is led by the HAN. 'In this project', Hoppenbrouwers explains, 'we can use our expertise in data quality, availability and management. DEMAND is also starting to act as a magnet, prompting external parties to come to us with their questions.'

Ambiguous concepts

Senior researcher Maya Sappelli started five years ago in Hoppenbrouwers' group as a specialist in language technologies like text mining and information retrieval, in which she had gained her PhD. 'What I like about our research group', Sappelli says, 'is that we have a lot of interaction with other parties. At a university, researchers are more concerned with just their own little research domain.'

For example, Sappelli is working on a project with Alliander, the company that develops and manages energy networks. They want to improve the use of information within their own company. 'Part of this is a conceptual framework: what terms are used within the company? And how do employees use those terms in practice? Take a concept like the Dutch term "aanslui-ting". In Dutch, this is unambiguous: it is a physical connection. At Alliander, however, they also use "aansluiting" in the interpretation of a 'customer'. Detecting those terms with multiple interpretations are important to make knowledge graphs and large language models more usable. Eventually, Alliander wants to build a kind of chat interface that allows employees to efficiently query the company's data sources.'

Searching spider

The headquarters of the *Data and Knowledge Engineering* lectureship is at in the Arnhem location of the HAN. That is where the researchers and lecturers meet physically, but a lot of work is also done from home or from workplaces in the Nijmegen part of HAN. 'We are very flexible about that', says Marijn Siebel, another senior researcher in the *Data and Knowledge Engineering* lectureship. 'We have a lot of freedom in with whom and how we want to collaborate, including with the other lectureships within HAN.'

As a specialist in query-driven knowledge systems, Siebel's work includes the project SCEPA: *Scaling up the Energy Poverty Approach*. With energy bills rising in recent years, more and more European citizens have run into financial difficulties. Siebel: 'Within the SCEPA project, we are investigating the smartest way to tackle energy poverty in a country, municipality, city or neighbourhood. The project runs until 2027. By then, we want to have a well-grounded framework on how to look at energy poverty. Which information from which sources do we need? How can we make it easier and more intuitive to access this information? I like to think of it as creating a spider that searches for you in a web of information. Ultimately, we want to have a beta version ready, which can be used to take better measures against energy poverty, tailored to the local situation.'

Stacey Jeffery gained her PhD from the University of Waterloo's Institute for Quantum Computing, in Canada, before doing a postdoctoral fellowship at the Institute for Quantum Information and Matter at Caltech. Since 2017, she has been a Senior Researcher at CWI, where she has held a Veni Grant and currently holds an ERC Starting Grant. She is also affiliated with QuSoft. Last year, she and Julia Cramer won the first Quantum Delta NL Award for their work in founding WIQD (Women in Quantum Development).

FASCINATED BY RANDOM WALKS

Quantum computing is an exciting field of research, according to CWI researcher Stacey Jeffery. Last May, she also became professor by special appointment of quantum information at the University of Amsterdam. Here, she describes her research and her ambition to attract more women to the field.

By Marysa van den Berg
Image Ivar Pel

How did you get involved in quantum development?

'When I was a bachelor's student in computer science at the University of Waterloo in Canada, I knew nothing about quantum computing. It sounded super cool though, so I took an introductory course. I was immediately fascinated by the idea of using quantum mechanics to perform computational tasks. It was a totally new field back then, and it felt like there was so much uncharted territory to explore.'

In your inaugural lecture, you compared quantum algorithms to random walks in the park. What did you mean?

'Quantum algorithms are different from algorithms for classical computers. Some classical algorithms are deterministic, going from one step to the next in a predetermined way. Others make random choices. Many of these can be modelled by something called a random walk. While quantum algorithms are not the same as classical algorithms, these random walk algorithms are a good analogy. If we augment random walks with something called interference, meaning two paths can cancel, like when 1 and -1 add to 0, then we get a model powerful enough to describe all quantum algorithms.'

What developments did you witness in the field and how will the field progress in the future?

'The most dramatic change has been a shift in the makeup of the research community from almost entirely academic to having a large component from companies and government agencies. I think it will be increasingly important to work together, as in the coming decades, we might start seeing industrial applications of quantum computers. Right now, we are developing algorithms that we cannot run. But in the future we expect this to change, which will also impact how algorithms are developed.'

Besides your research, you also try to get more women involved in quantum development. Why is that so important?

'There is something called the leaky pipeline, which is the phenomenon of women leaving many STEM (science, technology, engineering and mathematics) fields at a higher rate than men at all levels. I believe that one reason for this is that it is hard to be a minority. When things get difficult, women do not always have colleagues of the same gender to go to for advice or to commiserate with. That is why Julia Cramer of Leiden University and I founded Women in Quantum Development (WIQD, pronounced 'Wicked'), a supporting network for women in the field.'

REBUILDING CYBERSECURITY FROM THE GROUND UP

By Bennie Mols Image iStock

The new Gravitation programme 'Challenges in Cybersecurity' aims to rebuild cybersecurity by jointly addressing cryptography, software and physical security.

Everyday digital security is a lot like putting out fires: rushing out when the fire is already around rather than preventing it from starting in the first place. But unlike real fires, in cybersecurity the responsibility for extinguishing is usually placed on the innocent user. 'When I talk with my mom about cybersecurity', says professor Tanja Lange of Eindhoven University of Technology (TU/e), 'she goes like: "Oh yeah, I have to change my password", or "they make me feel I'm doing something wrong". We are loading too much responsibility on the user, because we failed to build it in the right way.'

As the stakes of good digital security rise with the increasing digitalisation of society, the new Gravitation programme 'Challenges in Cybersecurity' (CiCS) wants to take a very different approach. 'We focus on rebuilding cybersecurity on a solid foundation', says Lange. She is the main applicant of the programme which involves more than thirty researchers and four other principal investigators from CWI, Eindhoven University of Technology, Radboud University, University of Amsterdam, and VU Amsterdam. CiCS will run for five years and if it receives a positive evaluation, it will be extended for another five years. In that case, the total funding would amount to 21.5 million euros.

Three pillars

A unique aspect of CiCS is that it combines the three fundamental pillars of cybersecurity: cryptography, software security and physical security. For each of these, three fundamental challenges are formulated. Two challenges in the cryptography pillar are developing cryptography that cannot be broken by a future quantum computer, so-called post-quantum cryptography, and developing highly efficient cryptography. 'We are still seeing places where cryptography is not used', states Lange, 'for example, at internet exchanges, because it is too inefficient. So, we want to get cryptography where cryptography hasn't gone so far.'

In the software security pillar, one of the challenges is verifying the correctness of software. And in the physical security pillar, the defence against side-channel attacks is an example of a challenge. Lange thinks that for each of the three pillars there is a good chance that whatever is built in CiCS will eventually be used in practice: 'How quickly it will be applied is partially a question of how urgent a particular security risk is. In cybersecurity there are not many steps between development and real-world usage. That is something I like about the area, but it can also lead to sleepless nights, because of the responsibility that you feel.'

To avoid researchers staying comfortably within just their own expertise, CiCS ensures that all researchers must be active in more than one pillar and that joint seminars are organised. Furthermore, methodologies like AI, formal verification and optimisation, cut across all three pillars, which contributes to a natural way of working together.

'My own research is primarily in cryptography', Lange concludes, 'but there is also overlap with the other two pillars. As a mathematician specialised in number theory, I can come up with a wonderful piece of cryptography, but someone in hardware security might point out to me that my solution drains a phone's battery in no time. This example shows that we need the full breadth of expertise for a solid new foundation of cybersecurity.'

ICT TO COMBAT POWER GRID CONGESTION

By Marysa van den Berg
Images WAT ontwerpers, iStock

The electricity grid in the Netherlands is being overwhelmed by an increasing energy consumption and production. And this development is set to get more extreme in the near future due to the ongoing transition to renewable sources of energy and the introduction of electrified heating and transport alternatives like heat pumps and electric cars. ICT is becoming essential in keeping energy services running smoothly when things are getting out of control.

Solar energy parks that cannot be built, companies that are waiting too long to be connected to the grid and electric cars that are banned from charging in city centres. Every week, there are new stories about grid congestion in the Netherlands. 'Net congestion is the situation where the grid is not able to transport the energy market outcome', explains George Trienekens, electricity market developer at TenneT. 'This is a very big problem because it already hinders entrepreneurs in doing business. That phenomenon is directly impacting our economy.'

The reasons behind the problems are very clear. 'People want to cook electrically, have an electric car, place solar panels on their roof, and so on', says Johann Hurink, professor of Operations Research with a focus on Energy Management at the University of Twente. 'This is great, of course, because we need the energy transition, but if the entire neighbourhood is charging their car at 5 pm when they come home from work, the grid cannot cope. We are quite lucky that we have not had any major energy blackouts yet. But this cannot go on forever.' So, work needs to be done to face these challenges. And ICT could be one of the solutions.

'IF THE ENTIRE NEIGHBOURHOOD IS CHARGING THEIR CAR AT 5 PM WHEN THEY COME HOME FROM WORK, THE GRID CANNOT COPE'

CONTRACTS AND SMART GRIDS

In the Netherlands, we have a so-called Dutch grid code. 'In this grid code there is a description of congestion products purchased by grid operators', explains Trienekens. 'One is called the capacity restriction contract (CRC), which is a contract between the customer and the grid operator to restrict the amount of energy production or consumption. This contract can be activated on the day before closing of the Day-Ahead (DA) market.'

Let us give an example of this. A producer wants to deliver the six megawatt hours that he sold on the electricity market. 'If the outcome of grid security analysis foresees a congestion the system operator can prevent congestion by activating the CRC', says Trienekens. 'This implies that the producer does not deliver energy and he will be remunerated." However, the six missing megawatts do need to be delivered because supply and demand need to be balanced. So, another party who does have enough transport capacity needs to step in. This whole system is called congestion management and TenneT and the distribution system operators are leading this.

The previous example is the national and regional way of combating congestion. But what about the local problems? 'Have you seen those little transformer houses in the neighbourhood with a lightning symbol on it?', asks Roland van Rijswijk-Deij, professor of Design and Analysis of Communication Systems and research partner of Hurink at the University of Twente. 'Those can be extra sensitive to deal with grid congestion. And that is because of the kind of ICT they use.'

Take a typical neighbourhood in the Netherlands. Around 25 percent of those homes have solar panels installed. 'Let us imagine they all run the same software, and this software decides to turn off production if the market price becomes negative, which happens when too much electricity is produced. At the same time, people are incentivised to start using more electricity, because essentially, they get paid to do that. As a result, the grid cannot meet the electricity demand in times when there should be an excess of electricity. You need ICT to control this, but not the selfish ICT that only optimises for one producer/consumer.'

That is the reason why Hurink, Van Rijswijk-Deij and their colleague Gerwin Hoogsteen, assistant professor in Hurink's group, are now working on so-called smart grids. 'These are cyber-physical systems that use smart software to coordinate and balance energy production and usage on a local scale', states Hoogsteen. 'Our own open source energy management system (EMS) is called DEMKit. Its algorithm works by creating energy profiles of buildings by assessing the energy production and consumption of several devices and consequently balances energy profiles among multiple buildings to prevent overloading of the local grid.'

THE NEW NORMAL

This EMS concept is now being tested at different locations in the country. One is the headquarters of ASR Nederland in Utrecht. 'They are concerned about the climate and have invested heavily in renewable energy sources, like solar panels on the roof and charging stations for electric cars. But as you can imagine this amount of energy can lead to local grid congestion. The EMS developed, in collaboration with OpenToControl, is now ensuring that everything stays within the limits. This could mean the cars get less energy on cloudy days than on sunny days, but each car will get its owner home.'

The EMS also needs to be robust to errors and reliably operate under all conditions to avoid power outages in the future. To reach this goal, the team wants to create an "immune" system so that the EMS can still sufficiently operate during cyber-attacks. 'In Ukraine, there are a lot of these attacks on energy infrastructure and they show us the damage they can do', says Van Rijswijk-Deij. 'Turning off the local grids could lead to upstream cascading failures and even global blackouts. So, we better not take the risk by implementing prevention software in our EMS from the beginning.'

Trienekens also thinks that smart grids are the way to go. 'We need those if we want to build the most efficient and reliable European energy system. Smart grids should unlock flexibility to wholesale markets and offer balancing and congestion products to system operators. I think grid operators, like TenneT, need to facilitate the market to reach this goal.'

What about building new and improved electricity infrastructure? That will not solve the problem, thinks Hoogsteen. 'We have about 220,000 kilometres of electricity cables, mostly under our roads. Imagine digging them all up to replace them. That cannot be done.' He and his colleagues think grid congestion is here to stay and will never be truly solved. 'But smart grids ease the pain by taking congestion as the new normal and finding ways to cope with it as it comes.'

'SMART GRIDS SHOULD UNLOCK FLEXIBILITY AND OFFER BALANCING AND CONGESTION PRODUCTS'

DECISIVE IMPULSE

By Sonja Knols

Mark Winands

Chair of the Department of Advanced Computing Sciences at Maastricht University

'For us, the first sector plan round came exactly at the right time. We had just combined all of our natural sciences and engineering efforts into a dedicated Faculty of Science and Engineering, and as such had established a connection with the national organisation of science faculty deans.

Until that time, computer science as a discipline was not very visible at our university, since our work in the fields of artificial intelligence, data science, computer science, applied mathematics and robotics used to be accommodated by two different departments. We did have a strong track record in data science and AI though. The sector plans forced us to rethink and refine our mission and vision when it came to research in these fields.

We decided to open up two senior positions and supply some additional funding for the new hires to start their own groups. One of these positions is related to data fusion and intelligent interaction, and the other position, which we hired Nava for, is oriented towards explainable AI. Explainability is a strong theme at our university, and we wanted to give a boost to research into explainable, human-oriented systems. While searching for the right candidate for this position, I went to the SIKS research day. There, Nava was one of the keynote speakers. After her talk I turned over to my colleague and said: "We have found her". Nava was and is the perfect match with what our department needed and wished for.

The sector plan funds have put us as a relatively young department on the map, not only within our own university, but also on a national level. For example, through Nava, we have now established two of the three ICAI labs here in Maastricht, and our department has managed to establish closer connections to other groups within the university.

Developments like these are not only important for the university but also for our region as a whole. Maastricht University is at the heart of the Euregion Meuse-Rhine. Many of our students end up in companies in the region. I am afraid that with the current plans to cut down on sector plan funding, the process of building and strengthening a strong regional IT ecosystem here in the south of the Netherlands will come to a screeching halt.'

The two successive sector plans have resulted in a significant number of new hires at various Dutch universities. Mark Winands, Chair of the Department of Advanced Computing Sciences at Maastricht University, states that sector plan funding is instrumental in building a regional IT ecosystem. Nava Tintarev, Professor in Explainable AI and Director of Research at the same department, explains how her sector plan position has been decisive for her career.

Nava Tintarev

Professor in Explainable AI at Maastricht University since October 2020

'I have been working on explainable artificial intelligence ever since obtaining my PhD. When Maastricht University decided to dedicate part of the sector plan funds to a chair on human-centred explainable AI, that was a perfect match for me. I have a rather unusual approach for a computer scientist, since I include user studies in my research. I generate explanations and then evaluate the efficacy and efficiency of these explanations. How helpful are explaining systems to end users? Do the explanations given help them in making good decisions?

One of the topics I am currently working on is related to filter bubbles and fake news. We are developing ways of making people aware that they are consuming information that is skewed. We started off by diving into disputed, yet relatively "safe" topics like school uniforms and intellectual property. We built explanation interfaces to create awareness about viewpoints and stance: is certain information more in favour of the topic or more against, and why is that the case? My ambition is to help people who want to be aware of their biases take note of alternative viewpoints. Not to persuade them, but to show the plurality as a countermeasure against polarisation.

The two things I like best about Maastricht University are the team-science-minded way of working, and the fact that it is a general university, allowing me access to the social sciences and humanities.

In addition to managing my own group, I am also part of the department's management team. As I have worked in different groups in different countries over the course of my career, I can make a valuable contribution to the team. My main aim as research director is to support early career researchers, for example in writing and pitching grant proposals.

Overall, the sector plan position has been decisive for my career, since it allowed me to start my own group and move my research agenda forward. But also nationally, the impact of this type of funding is huge. The first sector plan round created critical mass on several topics that are important for the Netherlands and Dutch society, like explainable AI. And it has done a lot in terms of increasing diversity. For example, here in Maastricht, the sector plan has directly resulted in a growth in the number of female (associate and full) professors.

The fact that the sector plan funds are now under debate will have significant consequences. It will limit our capacity to grow and keep up with developments in fields like AI with the associated risk that we will fall behind in comparison to our neighbouring countries. We cannot let that happen.'

PUTTING PEOPLE FIRST

By Leendert van der Ent Image Sjoerd van der Hucht

The Netherlands has a long and rich tradition in Human-Computer Interaction, consistently holding a worldwide top-10 position in the field, with room for further improvement. This strong position, enabled by a tight-knit and talented research community, offers ample research, education, and valorisation opportunities. Yet, the HCI field is hardly recognised in the national funding landscape, as it does not fit the pre-designed boxes. Therefore, Alessandro Bozzon and his colleagues are striving to better represent the field in the funding landscape.

'We are in the middle of a digital transition which means that more digital technology will affect more people. The success of that transformation – for the optimal contribution to society – depends on digital technology being designed around people. In other words, its is understood, designed and engineered in a human- and society-centric way. The field of Human-Computer Interaction is crucial to digitalisation.'

CROSS-DISCIPLINARITY

'This can only be done by combining knowledge from various fields. Human-Computer Interaction was the first cross-disciplinary field in computer sciences, featuring collaborations with fields such as psychology, sociology, economics and design. These collaborations led to a rich and diverse methodological approach centred around making things work by design. It is a matter of knowing how to integrate knowledge that sometimes already exists. That makes HCI competences uniquely valuable in computer science.'

ADDED VALUE

'HCI has an extremely high economic added value, thanks to its demand-driven orientation that proves vital for adopting, accepting and using new digital technologies. In HCI, the starting point is not necessarily a technology, but a human need that needs to be addressed or a human problem that has to be solved. Complexity only emerges when something is not designed around people. HCI strives to make technology part of the solution and not the problem.'

Alessandro Bozzon is a full professor in Human-Centred Artificial Intelligence with the Department of Sustainable Design Engineering at the Faculty of Industrial Design of TU Delft. Human-Computer Interaction is an important topic in his research, as are human computation, user modelling and machine learning. Alessandro acts as spokesperson for IPN's new Special Interest Group Human-Computer Interaction, together with Judith Good, Judith Masthoff and Pablo Cesar. He is part of the LobbyCHI task force, which represents the broader CHI.NL community in the Netherlands.