I/O magazine
ICT RESEARCH PLATFORM NEDERLAND
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PAUL KLINT

Questions

Questions that came to my mind during the COVID-19 lockdown.

Conspiracy theories

- What is the origin of conspiracy theories about, for instance, the relationship between COVID-19 and 5G?
- Why do so many laymen with very modest spreadsheet skills make bold statements about the state and future of the pandemic?
- Is the belief in conspiracies inherently human?
- Who benefits from conspiracy theories?
- Is "fake news" the cause of conspiracy theories or does it only amplify them?
- Can we delegate the regulation of fake news to commercial companies like Facebook and Twitter?
- How can we combat fake news?
- How can we balance the regulation of fake news and the freedom of the press and the freedom of expression?

Science and policy making

- It was claimed that the policy of the Dutch government during the COVID-19 outbreak was strongly based on science and used advice from experts in virology and epidemiology. Was this good and/or sufficient?
- Which disciplines were missing, if any?
- How closely can scientists and policy makers cooperate?
- Has the National Institute for Public Health and the Environment (RIVM) damaged the trust of the general public in academic research?
- What can we do as researchers to better avoid confusion between our role as a scientist and other possible societal or industrial roles?
- What can we do as researchers to keep or even strengthen the trust of the general public in research?

Tracing app

- Is there any evidence that COVID-19 contact tracing apps can be effective?
- Is there any technical evidence that the Dutch "CoronaMelder" contact tracing app guarantees privacy?
- If so, which insights from behavioural sciences can help to convince the general public of this fact?
- What are potentially more effective tracing approaches?

Preparing for the future

- As ICT researchers, what research questions can we study to help us prepare for the next pandemic?

Answers, please.

NWO
IPN ICT-ONDERZOEK PLATFORM NEDERLAND

UNITING A DIVIDED DUTCH CYBERSECURITY LANDSCAPE

By Bennie Mols Images Shutterstock and Sjoerd van der Hucht

After four years, the Dutch cybersecurity platform for higher education and research dcypher will cease to exist in its current appearance. What legacy does it leave behind?

Threats to the digital security of citizens, companies and governments are commonplace: from computer viruses, computer hostages, hacking, DDOS attacks and phishing to digital espionage. The dcypher platform was established in 2016 to improve knowledge and expertise about cybersecurity in Dutch higher research and education. After more than four years, the platform in its current format ceases to exist in October. What is its legacy for research and education, which a follow up initiative can build on?

For the research field, these are three things, according to Erik Poll, Associate Professor of Cybersecurity at Radboud University in Nijmegen and also a member of the dcypher advisory board: 'First of all, the cybersecurity field is much more united than it used to be. Second, the field has become more multidisciplinary instead of mainly technology focussed. And finally, a new version of a research agenda has been drawn up, with a lot of attention for this multidisciplinary approach.'

Community building

'Both within universities, and between universities and industry, people know how to find each other much better thanks to dcypher', says Poll explaining the community building over the last four years. Annual dcypher meetings brought researchers together in an accessible way. And as soon as research proposals could be submitted, matchmaking events brought together people from universities and industry. In addition, many collaborations between universities and industry started with students who could conduct their graduation research in a company.

Another great example of community building is the Capture the Flag event "Challenge the Cyber" which dcypher co-organised. It's a hacking competition for students from universities and high schools that was organised for the first time in 2019. Poll: 'Thanks to this event I have now more contacts with other educators in higher education. It's a great initiative that also stimulates cooperation.'

Before the advent of dcypher, cybersecurity was mainly seen as a technical topic. dcypher changed that. Poll: 'The latest version of the research agenda emphasises that cybersecurity is not just a technical subject, but a multidisciplinary subject that also requires lawyers, economists, psychologists and organizational experts, for example.'

These experts can investigate questions such as: What drives cyber criminals? How does their organisation work? Which cybersecurity standards are needed? What laws and regulations are required? How can the behaviour of IT users be changed effectively to reduce cybercrime?

Education agenda

Professor of Cybersecurity Governance Bibi van den Berg of Leiden University, who is also a member of the Cybersecurity Council, has worked hard in recent years on setting up cybersecurity education. She is particularly pleased that dcypher, after initially focusing on cybersecurity research, has drawn up a cybersecurity education agenda in the last eighteen months. Van den Berg: 'That is a great piece of work that shows where the needs in cybersecurity education lie. And it runs from primary education to post-university education. Before the arrival of dcypher, we had little insight into how cybersecurity education in the Netherlands was organised.'

The cybersecurity education agenda is in line with the analysis that the Netherlands is training too few skilled cybersecurity professionals and that a lot of talent is leaving and going abroad. Erik Poll has personally seen the brain drain happen a number of times: 'We see young researchers leaving for Germany or the UK, where there is more money for research. We asked a former PhD student of ours, who now works in the UK, to become a professor in the Netherlands. But he replied that he could get better funding for his research in the UK and therefore did not want to return.'

Van den Berg is pleased that the research agenda aims to increase attention for cybersecurity throughout the entire education chain. 'We currently have a massive shortage of well-trained teachers. We can only turn that tide by starting early in education. We can already teach children that cybersecurity is a relevant societal theme, that you can do exciting things in it and also get a nice, good job.' Van den Berg would also like to see the multidisciplinary character of dcypher's research agenda reflected more in cybersecurity education. 'Both higher professional education and university education have a number of wonderful cybersecurity courses, some mainly technical, others with a mixture of a technical orientation and an orientation from the humanities and behavioural sciences. But on the whole, I think that the behavioural sciences and the humanities should be given an even greater role in cybersecurity education.'

Erik Poll:

'The cybersecurity field is much more united than it used to be'

Given the mission of dcypher, a lot has been achieved in a short time, says Van den Berg. But if she has to mention one aspect that has been less successful, then it is the valorisation of cybersecurity research. 'The bond between science and industry has become stronger through dcypher, but there are still not many ideas from science that connect seamlessly with industry and vice versa. We can do better there.' Poll had hoped that dcypher could have secured long-term, structural research funding, but unfortunately that did not work out. 'The problem here is that cybersecurity cuts across various ministries and that each ministry is an individual compartment.' Van den Berg agrees that this compartmentalisation is an obstacle: 'Both our research and education agendas are deliberately integrated and broad. But then things go wrong in terms of financing within a compartmentalized ministerial landscape. We have to find a solution for this.'

Delta Commissioner

Van den Berg sees an opportunity in appointing a kind of Delta Commissioner for cybersecurity, or setting up an umbrella body that falls under the Ministry of General Affairs. 'Then you can say: this is our leading cybersecurity agenda, this ministry is about this part and that ministry is about that part. We are now making one large multi-year plan with that much budget. However, my most important lesson for the future is: embrace the current dcypher research and education agendas and do not let the networks and collaborations that have been carefully built up go to waste. Whatever platform comes after dcypher, that should be its main mission.' Poll agrees with van den Berg's conclusion, adding one final,

optimistic remark: 'The Netherlands can actually benefit from the fact that it is such a small country. The lines here are short and informal. Within the community dcypher has been able to develop, we have the right expertise together to make a real impact.'

What's next?

In a letter to the House of Representatives, on 9 April 2020, State Secretary Mona Keijzer of the Ministry of Economic Affairs and Climate Policy announced the establishment of a new cybersecurity collaboration platform as a follow-up to dcypher.

Shortly after, five Quartermasters (representing research, higher education, business and government) started to write an advice, which was submitted to the Ministry mid-August. In their advice, a platform is proposed that on the one hand builds on the dcypher heritage, and on the other hand develops better connections in the chain 'knowledge-education-innovation-valorisation'. While dcypher established a strong foundation, the quartermasters advise to involve partners from the entire chain more explicitly. This results in the ambition 'to effectively bring together supply, demand and funding for cybersecurity education, research, innovation and application'.

In addition to an agenda-setting role, as dcypher played, the new platform is therefore also assigned a programming role. That role of translating theme selection into concrete programs and projects must be granted by the funders, including governments, NWO and the business community. Obtaining a mandate for a thematic and chain-oriented approach will be the major challenge for the coming months. The objective is to achieve a smooth transition from dcypher to the new platform.

Bibi van den Berg:

'Do not let the networks and collaborations that have been carefully built up go to waste'

DCYPHER IN SHORT

The platform dcypher (Dutch cybersecurity platform for higher education and research) was founded in April 2016 by the Ministry of Justice & Security, the Ministry of Education, Culture & Science, the Ministry of Economic Affairs & Climate, together with NWO. In 2018, the Ministry of Defence joined as well. The platform ceased to exist on 1 October 2020.

The goal of dcypher was to improve knowledge and expertise about cybersecurity in the Netherlands by stimulating scientific research and higher education and by bringing all the diverse cybersecurity parties in the country together.

In recent years, dcypher has produced a research agenda and an education agenda, among other things. The research agenda has been drawn up as a guideline for public-private partnerships within national research into cybersecurity. The research is divided into five pillars: design, attacks, defence, governance and privacy. Each pillar requires contributions from computer science, technology, social sciences and the humanities.

Finally, dcypher has succeeded in community building: the previously fragmented Dutch cybersecurity landscape has become far more unified in in terms of research and education.

More information

About dcypher: www.dcypher.nl
dcypher research agenda:
www.dcypher.nl/en/research-agenda
dcypher education agenda:
www.dcypher.nl/en/education-agenda

ICT PROMOTED TO TOP SECTOR

Since 1 January 2020, ICT has been promoted from a cross-cutting theme to a fully-fledged top sector. Fred Boekhorst, Director Team Dutch Digital Delta (ICT), tells about the significance of this for opportunities in ICT innovation and research.

By Sonja Knols

At the start of 2011, the Dutch government initiated the top sector's approach. Nine top sectors were designated within which funding was made available for public-private partnerships, and fifteen associated Top Consortia for Knowledge and Innovation (TKIs) were established. At that time, ICT was not designated as a top sector but as a cross-cutting theme that was added to the roadmaps of the Top Sector High Tech Systems & Materials.

'In the new decree for the top sectors, which became effective on 1 January 2020, the decision was taken to designate ICT as a separate top sector, a clear recognition of this field's importance for the Netherlands from both a societal and economic perspective', says Fred Boekhorst, who is leading this transition from within Dutch Digital Delta. 'This expands our possibilities, for example in the area of international connections and participating in strategic grants for which extra funding is now becoming available.'

The top sector has decided to concentrate on a limited number of key enabling technologies, he says. 'In addition to this, we want to concentrate on innovation in the key areas but also innovation with the key areas, which amongst other things will focus on the themes chosen by the Dutch cabinet in the context of the mission-driven innovation policy.' 'Meanwhile, as ICT, we already participate in discussions and dialogues with all parties concerned', says Boekhorst with satisfaction. 'It's fantastic to see how a handful of key enabling technologies are meaningful for every sector. For example, the AI specialists in the hospital help to establish more accurate diagnoses, but that technology can equally help to make precision agriculture possible. In our vision and mission document, we have described how missions and key enabling technologies go hand in hand.'

PROFILING OURSELVES MORE

Researchers will experience few immediate changes, he says. For example, the ICT sector will remain to be served by the TKI office of High-Tech Systems and Materials. 'However, researchers will certainly notice that the ICT sector profiles itself more. In recent years, we have put several subjects on the agenda such as big data, blockchain and AI. Now we are busy with similar initiatives for cybersecurity and beyond 5G. Furthermore, we will not only devote a lot of attention to knowledge acquisition but also to knowledge dissemination and valorisation. Our explicit objective is to make new digital innovations available for all parties, whether those are SMEs or multinationals.'

Although the designation as a top sector is a significant recognition of the importance of ICT, a lot of mission work still needs to be realised, notes Boekhorst. 'Even though the other top sectors can see the importance of digitalisation for their sector, they still tend to focus too much on what they have already done. As an ICT community, we need to join forces. For example, the ICT Research Platform Nederland can help us by providing a clear vision about what is possible in the future and stating what is needed to complete the knowledge chain from fundamental research to start-ups and scale-ups.'

MORE INFORMATION: DUTCHDIGITALDELTA.NL/EN

NWO AND CORONA

NWO has announced guidelines that it will apply in the event of changes to ongoing NWO research that is delayed as a result of the corona crisis. There are four starting points for these guidelines:

- Extension of the starting date
- A four month delay for all reporting deadlines for ongoing research
- Adjustments within the framework and budget of ongoing research
- Any problems with the delivery of co-funding are to be reported to NWO immediately

The pausing and restarting of the operational process has caused many shifts in the timetables of funding instruments. On its website, NWO has created an overview of these changes in the form of an integral call planning in which the upcoming deadlines for pre-proposals and full proposals until the end of June 2021 are listed. More detailed information about instruments can be found on the relevant grant pages.

More information: nwo.nl/corona

IMPLEMENTATION GUIDELINES FOR PLAN S

Plan S – an initiative of European research funders to accelerate the transition to open access – will apply to all new NWO calls published as of 1 January 2021. To give researchers sufficient time to prepare, NWO has announced how it will implement the guidelines for Plan S in its grant rules.

Publications resulting from calls put out after 1 January 2021 must be available immediately (with no embargo) with an open copyright (CC BY) licence in open access according to one of the following routes:

- Publication in an open access journal or platform registered in DOAJ
- Publication in a subscription journal and simultaneous archiving of at least the author version in a registered open access repository
- Publication in a journal under a VSNU/UKB transformative agreement or in a transformative journal approved by cOAlition S.

More information: nwo.nl/en/policies/open+science/plan+s

TEKNOWLOGY

TEKNOWLOGY is the Dutch festival where technology, science, innovation and valorisation meet. At TEKNOWLOGY visitors are shown the technical innovations of the future and how Dutch science is prepared for these. The next edition will be held both live on location and online from 16 - 20 November 2020. Admission is free, and the festival is held in English.

More information: teknowlogy.nl

NEW MEMBER NWO EXECUTIVE BOARD

The Minister of Education, Culture and Science has appointed Jan de Boer as a member of the Executive Board of the Dutch Research Council (NWO). He also became the new chair of NWO's Science domain.

Jan de Boer is professor of theoretical physics at the University of Amsterdam. He has been involved in various broad research initiatives such as GRAPPA, Delta ITP and DIEP. Jan de Boer also helped to set up NWO's Science domain and became a member of this domain's board after the transition.

DRIVEN TOWARDS SOFTWARE BY SOCIETAL CHALLENGES

By Leendert van der Ent
Images Shutterstock and Cisco Nederland

Cisco is all about routers and switches, right? Right – and wrong. Societal challenges have transformed the operation of Cisco Nederland into a largely software-driven business. The company aims at joint demand development with customers and the subsequent realisation of digital platforms on the basis of interconnected 5G, Wi-Fi and Internet-of-Things. In a rapidly digitalising society, business development has therefore become software-driven.

Countries with a digital agenda generally have a better development of their gross national income', Edwin Prinsen, general director Cisco Nederland notes. 'In these countries, such as Sweden, Australia, Singapore, Israel and the Netherlands, Cisco strives to support the national digitalisation agenda. We call this policy, born out of societal responsibility as well as a business perspective, "Country Digitalisation Acceleration". For obvious reasons, we've adopted "Digitale Versnelling Nederland (DVN)" as an alternative name for the Dutch version of this policy.'

DVN focuses on a number of key sectors: infrastructure, education, healthcare and (cyber)security. Contacts regarding the execution of this policy take place on the highest level, as Cisco CEO Chuck Robbins first met prime minister Rutte at the World Economic Forum in Davos. Afterwards, the two met once again in Rutte's office "het Torentje".

SMART SECTORS

'The Netherlands has an outstanding infrastructure. This includes physical infrastructure such as railways, ports, motorways, the power grid, water purification and airports, but also digital infrastructure and technology acceptance', says Prinsen. 'The latter enables us to roll out new technology here, especially new digital infrastructure to optimise the use of physical infrastructure.'

Hence Cisco's deep involvement in the Port of Rotterdam's "Smartest Port" programme. Prinsen: 'Enabling unmanned shipping demands a coordinated deployment of 5G, Wi-Fi and Internet-of-Things and data-integration in a dashboard that shows parameters such as saltiness and water height.' Cisco and their partners are currently busy fitting out the port with loads of sensors to enable this. As Schiphol nears its capacity limits, Cisco is involved in digital support to optimise passenger logistics. Prinsen gives some other examples: 'On behalf of the Ministry of Justice and Security, we analyse internet traffic to assess safety threats. Together with the University of Twente, we work on making their campus and library smart, with a joint effort to develop new demand. It is an activity that we enjoy a lot: to explore the forefront of new technology in close collaboration with our customers.'

HACKING SPIKE

Also, in the healthcare sector, a lot is going on at the moment. 'Remote consultation, which allows the patient to stay safely at home, has now really taken off', says Prinsen. 'The same goes for bedside connectivity that enables on-the-spot analysis. An example is X-rays taken at the patients' bedside, which are instantly transferred via Wi-Fi to be filed.'

A data chain is set up between all relevant disciplines, such as the hospital pharmacy. 'And all of this should, of course, be absolutely safe', Prinsen remarks. 'The sad truth is that during the coronavirus crisis, hacking attempts have spiked globally. Criminals regard poorly secured working-from-home connections as an excellent hacking opportunity. On behalf of UMC Utrecht, we enabled an accelerated roll-out for 6,000 employees to work safely from home.'

Edwin Prinsen

INTEGRATED APPROACH

This close collaboration with government, universities and hospitals rises above Cisco's original claim to fame, supplying internet hardware like routers and switches. Prinsen: 'As you can learn from the cases mentioned before, our call has become far more general. We develop integrated, scalable solutions based on our architecture in close collaboration with our customers. This is more about big data analysis on secured software platforms than about hardware – although I must admit that is also important.'

A new development is to connect these major platforms and ecosystems on a meta-level, for instance to link airport data to railway data. Prinsen: 'How can you connect data safely and in such a way that it remains for the owner's eye only? This involves blockchain technology of course. These aspects of the software layer on top of networks has changed our scope drastically.'

Networks, for instance, have to be scaled so rapidly nowadays; that scaling can only be carried out auto-matically – by software. Prinsen sums up: 'Our analysis activities: software. Security: software. Platforms and connectivity: also software-driven. It is therefore safe to say that the more extensive our assignments have become, the more we have evolved into a software company.'

Computing that truly improves people's wellbeing

By Bennie Mols Images Ivar Pel

GROUP PASSPORT

RESEARCH FIELD

Human-centred computing: human-robot interaction; mobile and wearable computing; personalised, adaptive, and recommender systems; affective and empathic computing; persuasive technology, e-coaching, and serious games; computer-supportedcollaborative work and crowd computing; interactive data analytics.

INSTITUTION

Utrecht University

EMPLOYEES

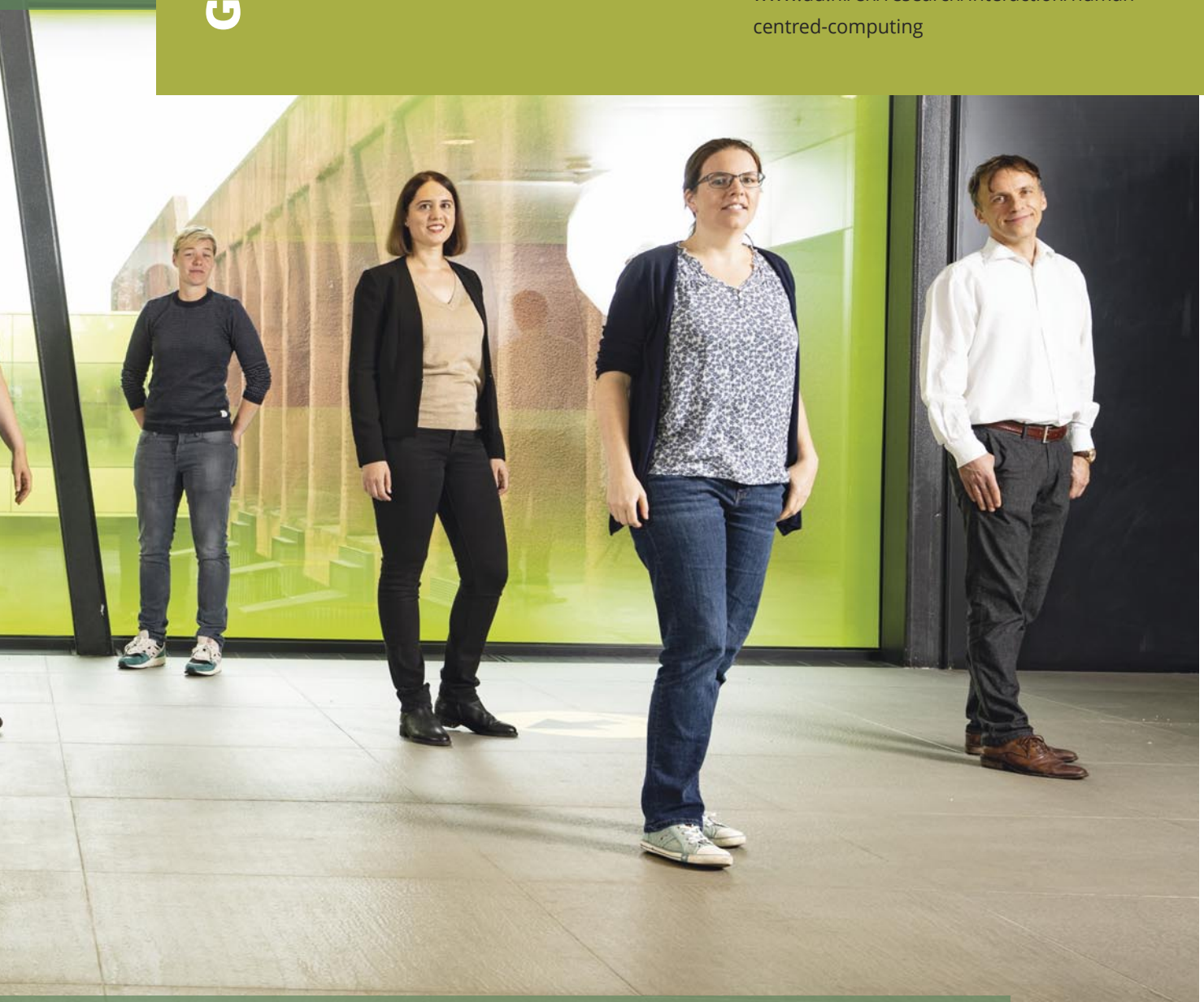
1 Professor
9 Assistant Professors
14 PhD students

FACILITIES

Ideation & Creation space; reconfigurable area for user studies

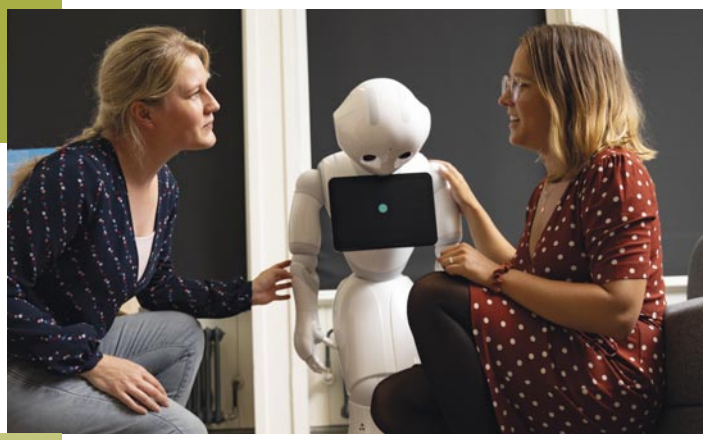
WEBSITE

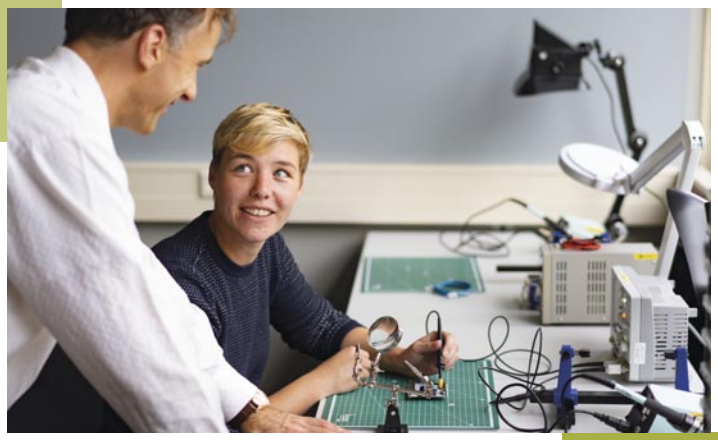
www.uu.nl/en/research/interaction/human-centred-computing



How can we create intelligent support for online collaborations? How can a sensor-based e-coach prevent us from burning out? These are two examples of questions that the young research group 'human-centred computing' at Utrecht University tries to answer.

Judith Masthoff





In June 2018, professor Judith Masthoff started a new research group at Utrecht University: human-centred computing. The core idea is that the success of computing does not just depend on the technology itself, but also — and sometimes even more so — on the interaction with the user.

The field of human-computer-interaction (HCI) was already investigated in the 1960s by computer pioneers such as Douglas Engelbart (inventor of the computer mouse) and Joseph Licklider (pioneer of interactive computing). Masthoff's group exploits both the miniaturisation and increasing power of computing hardware and recent advances in artificial intelligence to develop future HCI and human-centred artificial intelligence (AI). 'My dream is that computing truly improves people's wellbeing', Masthoff says. 'My research group is interested in both computing and humans. Our computing research is always inspired by what people do, what they want, what is good for them and what they think of the technology. How can interactive computing and AI be used to persuade passengers to spread more evenly over the day in public transport? How can it help create more efficient teams in online collaborations? How can autonomous systems explain their decisions? This is the type of questions that we investigate.'

To study such questions, the researchers in Masthoff's group combine an interest in computer science, especially AI, with an interest in social sciences, especially psychology.

Masthoff's group had just set up two laboratories when the corona crisis broke out. 'One lab had just been commissioned, but it was not yet at the proper location. We call that lab the Ideation & Creation lab. Here people can be creative, generate new ideas and immediately start prototyping them. It is equipped with things like 3D-printers, soldering equipment, sensors and other electronics. Another lab is a Reconfigurable area for user studies. There we perform studies that involve users. We can do things like eye-tracking, video-recording user behaviour, and measuring how users feel. We also have a Pepper-robot and some other, smaller robots to study human-robot interaction.'

Egon van den Broek

Pattern recognition

One of the most technical members of the human-centred computing group is Assistant Professor Egon van den Broek. He studies pattern recognition in both humans and machines. 'There is an awful lot that machines can still learn from humans', he says. 'I take the human as an example, and based on this, I develop mathematical models that can improve the way machines recognise patterns. For example, I have been looking at categorising colours and at recognising emotions. One of my favourite results is from earlier this year: we showed that emotions should be classified more as a continuous space than as separate categories, as it is traditionally done. Our results can be used in human-robot interaction where the robot has to recognise human emotions.'

Van den Broek earned two PhD degrees, one in the social sciences and one in electrical engineering, mathematics and computing science, a combination which fits perfectly in the human-centred computing group. 'I like the fact that there is a lot of energy in the group, that it combines a wide range of interests and that it is very social. What remains a challenge in the field of human-computer interaction in general, and also in our group, is to work not just in a multi-disciplinary way — people with different backgrounds sitting next to each other — but in a truly interdisciplinary way — to integrate methods from various disciplines. That is crucial if the field is to become mature.'

Ioanna Lykourentzou

Improving online collaborations

Ioanna Lykourentzou is another Assistant Professor in the group. She investigates online collaborations and develops software to improve them. 'Because of the corona crisis, my work has suddenly become even more relevant than before', she tells. 'Many people have to work from home, while at the same time collaborating in online teams. But how can you build the best team if there are team members you have never met in real life?'

To solve this problem, she has already built an algorithm that matches people based on their personality traits. Lykourentzou: 'For complex tasks, you often need people with a variety of skills: some people should have leadership qualities; others should excel at focusing on details, while others need to have good social skills. In its core, this is an optimisation problem, which at the same time needs to consider human nature. Our algorithm matches people with people to form the best team. We tested it with teams of crowd workers who had to create an advertisement for a new coffee product and it proved to work really well. With this approach, digital collaborations can become very creative.'

As somebody developing tools to improve collaboration, what does she think about the teamwork in her own human-centred computing group? 'I like the diversity in the group, and the fact that things come about in a very human manner without an imposed hierarchy. Sometimes, taking decisions might take a bit longer than in more hierarchical groups, but in the end you have a much stronger team.'

Pablo Cesar is the group leader of the Distributive and Interactive Systems group at Centrum Wiskunde & Informatica (CWI) and Associate Professor at TU Delft. His research focuses on modelling and controlling complex collections of media objects (including real-time media and sensor data) that are distributed in time and space. Originally from Spain, he earned his PhD at Helsinki University of Technology (now part of Aalto University) in Finland. www.pablocesar.me

COMPUTER SCIENCE CLOSE TO REAL WORLD

Pablo Cesar, group leader of the Distributive and Interactive Systems group at Centrum Wiskunde & Informatica (CWI) and Associate Professor at TU Delft, is the recipient of the 2020 Netherlands Prize for ICT Research. His work is about modelling and controlling complex collections of media objects. 'We need human-centred computing, as otherwise, we may get the wrong type of intelligent machines'.

By Bennie Mols
Image Elodie Burrillon

How would you characterise your work?
'The two main pillars of my group's work are affective computing and human-centred multimedia systems. First, you need to understand and model the context, intention and state of the users. After that, you can optimise the multimedia system for that intention and context. Examples of the latter include algorithms for better compressing multimedia signals or for orchestrating different media streams in an optimal manner.'

Can you give some concrete examples?
'We are exploring social virtual reality as a new medium for remote communication and collaboration. Social virtual reality consists of highly immersive and multi-sensory VR-systems. For example, we work together with the Netherlands Institute for Sound and Vision to investigate how to enrich remote access to their collection, and we are trying to start a project with a Dutch hospital to study how to optimise remote consultation, based on SocialVR principles.'

What are the big challenges in your field?
'One big challenge is understanding of the activity and context of users in real life. This problem can only be studied by combining various scientific disciplines. The second big challenge is to optimise the quality of the experience by transmitting and orchestrating the important bits. The question is not about how fast the bits are transported, but how well they are utilised. The end goal must always be to provide the best possible experience for the user.'

You study systems in a realistic setting. What is the added value?
'My aim is to bring our research as close as possible to the real world. Lab results are essential, but labs never show the actual high noise in data that you experience in the real world. For example, we are planning to put an installation in the Netherlands Institute for Sound and Vision to gather data from users accessing the archives. Via these data, we can understand the real experience of visitors instead of the experience in some artificial laboratory context. In the past, we have followed this methodology in-the-wild, for example during a theatre play at the National Theatre of China.'

What drives you in your work?
'We need human-centred computing, as otherwise, we may get the wrong type of intelligent machines. The Netherlands needs to better support human-computer interaction research in computer science, as already happens in the USA or Germany. I hope that the Netherlands Prize for ICT Research helps to further improve the recognition of this important field. In the future, multimedia systems will be intelligent and data-centric. It is up to us to make them human-centred and empathic as well.'

MANAGING THE UNMANAGEABLE

By 2030, there will be about three hundred billion devices connecting to the internet worldwide. How do you secure such a network of systems? In the eight-year INTERSECT programme, researchers from various disciplines are formulating guidelines for the design, management and maintenance of smart connected applications such as coffee makers, street lighting, and body sensors.

By Sonja Knols

'The Internet-of-Things offers possibilities that greatly exceed the computer systems we know today,' says programme leader Sandro Etalle from Eindhoven University of Technology. 'But the impact of an Internet-of-Things systems hack can be huge. Take the example of smart houses: instead of arriving with a screwdriver or glass cutter, burglars can now open your front door remotely through a targeted hacking attack.' In addition, IoT-devices themselves can be used to perform Distributed Denial of Service (DDoS) attacks, such as the 2016 attack on DNS provider Dyn by hundreds of thousands of infected devices like digital video recorders and IP cameras.

SPACE, TIME AND STRUCTURE

Within the INTERSECT programme, more than 45 affiliated partners examine both the design and security as well as the management of Internet-of-Things systems. The researchers focus not just on technical questions, but explicitly on the relevant governance, criminological and legal aspects too. Three research dimensions have been defined within the programme, focussing on space, time and structure. Questions that are tackled vary from 'How do you patch a myriad of completely different devices all over the world, even in places where there is little access?' to 'How can we make sure necessary software updates are provided for older systems, even when the original manufacturer has gone bankrupt?' and 'Which design choice leads to which governance model?'

The researchers launch attacks on Internet-of-Things devices themselves in a test setting to see where the vulnerabilities are and how attackers can take advantage of them. In addition, they study the subject from a criminological point of view: What priorities does an attacker set? And to what end? They also investigate how attacks can be prevented or repelled. What vulnerabilities should definitely be fixed because they are of interest to attackers? And which are less important? Etalle: 'Every system is full of vulnerabilities, but you don't have to fix all of them. We focus on the vulnerabilities that can be and actually are exploited.'

A LOT OF INTEREST

This subject is clearly relevant to civil society organisations, companies and universities, says Etalle. 'This is the first major multidisciplinary project in the field of cybersecurity, and a lot of companies immediately expressed their interest in committing to it. INTERSECT is about how to secure something that is inherently unmanageable. That is a great challenge we will firmly dig in to over the coming years.'

INTERSECT: AN INTERNET OF SECURE THINGS

The INTERSECT project is funded by the first round of the Dutch Research Agenda – Research along routes by Consortia (NWA-ORC) programme.

Size: 8.2 million euros, 35 FTE
Duration: 01/11/2019 to 31/10/2027
Consortium: more than 45 participants from universities, companies, NGOs and government, led by Eindhoven University of Technology

Land-based GPS keeps the roads safe

Tall buildings, tunnels and parking garages pose a major challenge for the accurate positioning of self-driving cars. Satellite navigation is inadequate for this purpose, so researchers are developing a wireless terrestrial GPS.

By Amanda Verdonk
Image Shutterstock

Somewhere in the foreseeable future, self-driving cars will fill the streets. Unfortunately, in densely built-up areas with tall buildings, tunnels or parking garages, the built-in GPS fails. Even when smart software determines the precise location of a vehicle, it remains an educated guess. To allow self-driving cars to drive around in urban areas without causing trouble, a more accurate positioning system is needed.

FAILING GPS

'GPS was developed for military purposes in the 1960s', says Christian Tiberius, Associate Professor of Geoscience and Remote Sensing at TU Delft. 'It was used to determine the position of tanks, fighter planes and ships, but now it is also used in commercial ships and smartphones. It was never intended for those applications.' GPS satellites send a signal to a receiver on earth. The receiver determines its location based on the time it takes for the signal to travel from the satellite to the receiver, multiplied by the speed of light. The location is then determined by measuring the distance between the satellites and the receiver. The problem is that there is a lot of signal reflection in built-up areas: the GPS signal bumps into all kinds of objects such as buildings before it reaches the receiver. Tiberius: 'At the Weena in Rotterdam, near the sky scraper of Nationale Nederlanden, I once did a position calculation with a simple receiver. It was hundreds of meters off.'

Tiberius and his colleagues are now working on a solution to this problem. They are developing a land-based GPS with an accuracy of one decimetre instead of metres. In contrast to satellite navigation, they use transmitters the size of a Wi-Fi modem that emit very short radio pulses on the ultra-wide-band. The signal receiver of could eventually be placed in a small chip. Sending short pulses implicates that more bandwidth of the radio spectrum is required. 'But the great thing is that the bandwidth is not needed all the time, probably just a millisecond every second.' The receivers could be combined with the 5G communication network because the range should be similar.

It already works in the lab, says Tiberius. 'Now the biggest challenge is to make it work in practice.' This summer a trial in The Green Village started, an experimental village on the TU Delft campus where a real living environment is simulated with streets, houses, traffic and, of course, residents. The researchers will attach their transmitters to lampposts and build a receiver themselves. 'For now, the receiver will be put in a large storage box from IKEA, but ideally it will fit in a navigation system or smartphone.' For this test it is essential that the transmitters are all well synchronized. Therefore a fibre optic connection will be established with VSL, the Netherlands Metrology Institute, which is also in Delft. A laser pulse with the time indication is sent from the institute with picosecond accuracy.

To accurately know the time, an important role is reserved for the so-called time-frequency reference equipment, which has been developed by OPNT, a spin-off of VU Amsterdam. OPNT was also one of the initiators of the SuperGPS project.

'We are experts in time distribution', says Marco Gorter, co-founder and Chief Operations Officer at OPNT. 'And TU Delft is particularly good at wirelessly sending the signal.' The company developed a time distribution system based on the universal UTC traceable time. Gorter: 'Many vital infrastructures, like telecommunications, the financial sector and the energy sector, depend on accurate timing using GPS, but you could jam or spoof those signals. For example, financial transactions cannot take place without a UTC traceable timestamp, and spoofing power plants with a false timing reference can lead to black outs, when power plants start to drift in phase in relation to the rest of the energy grid. For these markets, we have developed a terrestrial timing service, which we operate via fibre optics.' The next step, however, is making this timing service wireless. This is where the SuperGPS project comes in. Apart from car navigation, it

> 'I once did a position calculation with a simple receiver near a skyscraper. It was hundreds of meters off'

could also serve as a very accurate navigation for people in buildings such as hospitals, shopping centres or supermarkets, or to locate people who have made an emergency call. If the trial at The Green Village yields good results, then as far as Tiberius is concerned, the next step is to test the equipment near a main road. 'Autonomous driving is seen as the most important application. That will probably first happen on main roads. And the Netherlands already has fibre infrastructure along all motorways.' Although the project will officially end next year, all project partners want to continue to further develop the technology. Gorter: 'I'm convinced that we will be able to distinguish ourselves with this technology worldwide and that the major car brands will show interest.'

SUPER GPS

Project name: SuperGPS: Accurate timing and positioning through an optical-wireless distributed time and frequency reference

Participating institutes: TU Delft (and VU Amsterdam in the initial phase)

Principal researchers: Christian Tiberius, PhD, Associate Professor Geoscience and Remote Sensing at TU Delft, and Gerard Jansen, PhD, Associate Professor Circuits and Systems at TU Delft

Duration: 1 November 2016 - 30 April 2021
Funding: NWO Open Technology Programme
Partners: KPN, VSL, Fugro and OPNT
Budget: € 1.3 million

DIGITAL TWINS: IMPROVED TWIN SYSTEM GENERATES OPPORTUNITIES

By Rianne Lindhout

The Internet-of-Things is about far more than just smart coffee machines or thermostats. Networks of sensors, for example, are vital for enabling so-called digital twins to simulate the real world far more accurately. What are these rapidly emerging digital twins and which scientific questions do they elicit?

For a long time, industry has used digital models to predict how to best adjust the parameters in a complex system. These models are called digital twins. 'Such a model can assume a wide range of forms, varying from a 3D drawing to a mathematical model,' explains Bayu Jayawardhana, Professor of Mechatronics and Control of Nonlinear Systems at the University of Groningen. 'Digital twin is an umbrella term for many different things. However, these all work based on static knowledge such as natural laws, chemistry and thermodynamics. They also assume ideal conditions and normal behaviour, whereas the reality is often different.'

Jayawardhana leads the Perspectief programme DIGITAL TWIN (Integration of Data-drIven and model-based enGIneering in fuTure industriAL Technology With value chaIn optimizatioN). Within this programme, six universities, eleven companies and TNO are integrating various forms of models to ensure that they are able to learn from data. Through this approach, digital twins will be able to describe the reality even better still.

New style: an adaptive controller

The ideal is a digital twin that contributes ideas because it measures changes in variables and can ultimately make independent changes in the process. It can help to realise a new error-free system faster, but also monitor and adjust a running process.

Jayawardhana gives an example: 'Philips places shaving heads on shavers. The steel these are made of is sometimes a bit thinner or thicker, depending on the supplier. Previously, an operator had to keep on making adjustments to the machine during the start-up of the production line. Soon there will be a digital twin that will receive information from each supplier about the steel thickness and will then propose the correct adjustment to the machine at the right moment. Ultimately, such a twin could even make the adjustments itself. The digital twin is then not only a simulator, but is also capable of communicating with the system.'

Another example comes from the steel producer Tata Steel. In a gigantic, white-hot reactor, iron ore, limestone and coke are mixed to produce the liquid pig iron for the production of steel. How can you make this process as cheap and

YOUR OWN DIGITAL TWIN

At Dutch universities, a huge variety of research projects in the area of digital twins are being realised. Even our own bodies are a complex system. A doctor could test a treatment on a digital twin of yourself. Completely virtual hearts are already beating in computers and realistic computer models of, for example, the skeleton, muscles, lungs and blood vessels have been realised. A fast computer can retrieve the specific characteristics of an individual from scan images. We are getting closer to treatment based on personal characteristics instead of the properties of drugs. Such research is being realised at the University of Amsterdam, for example; see tinyurl.com/y282uu8w.

environmentally friendly as possible? How high should the pressure in the reactor be? And when and how fast should you add the limestone?

'Digital twin is an umbrella term for many different things, varying from a 3D drawing to a mathematical model'

With an old-style digital twin, Tata Steel designed a new reactor that hugely simplifies the production of liquid pig iron: now, just a single reactor is needed instead of two process steps. 'This reactor, HIsarna, is now available as a demo version. We want to help the company make the step to production faster and safer,' says Jayawardhana. This step is precarious. If something goes wrong, the new reactor will have to be stopped, and that will easily cost hundreds of thousands of euros.

Robot cars in formation

The many researchers involved, nineteen of whom have been specifically appointed for the project at the participating universities, face considerable challenges in developing optimal, reliable digital twins. In subprojects, involving varying collaborations between universities, progress towards the goals is gradually being made. For example, how do you manage the complexity of data in enriched software models? How can you let these models improve a control system?

The research leader of DIGITAL TWIN is working with his group on his own subproject with robot cars. In an NWO video, you can see these driving neatly in formation, like fighter jets or swarms of sparrows in the sky. Jayawardhana's proud smile can be perceived over the phone as he explains it. 'We try to let the mobile robots work together to achieve a group goal. Not by giving a single robot instructions, but by making all of them intelligent. Each of them measures where its immediate neighbours are, and they maintain the distance between each other perfectly. If one of the robots makes a miscalculation, things do not immediately go wrong. This robustness is important because if they are, for instance, tasked with transporting an aircraft wing, it must not be allowed to fall and break.'

More information about the DIGITAL TWIN programme: tinyurl.com/yytwu25d

HOOKED ON DIGITISATION

By Amanda Verdonk Photo Ivar Pel

With his new position as director of the Netherlands eScience Center, historian Joris van Eijnatten makes his entrance in a world still dominated by the exact sciences. His "hidden" agenda: enthusing researchers in the social sciences and humanities for digital research methods.

'As a digital historian, I work with data all the time, so I consider myself in part a natural scientist. I have been advocating the use of digital methods in the humanities for a long time already, but it is a difficult objective to achieve. The eScience Center was established nine years ago to accelerate digitisation in science. We finance research projects, mainly in kind, by providing expertise. Besides our support staff, we employ about sixty research software engineers or RSEs – a relatively new profession that is not yet well-positioned either nationally or internationally. RSEs are not just support staff who write a piece of code, but applied scientists who speak the language of different disciplines.'

SERVE ALL DISCIPLINES

'With our new strategy for the next five years, we want to serve all disciplines. We want to create a community of researchers who are able to find and apply digital methods themselves, giving them more autonomy. This also applies to humanities researchers. I think they should be less dependent on computer scientists, because the two groups don't always speak each other's language. A discussion between the blind and the deaf doesn't work. If you become more proficient in using digital methods and start looking into the black box of these methods, a whole world will open up for you with potentially very interesting outcomes.'

'We live in a world in which artificial intelligence is entrenched in everything. The universities of today must train a new generation of citizens who are better equipped to deal with this technology. But the history curriculum, for example, is still the same as fifty years ago. A basic course in algorithmic thinking and a digital thread throughout the educational programme is becoming unavoidable. Other groups, such as biologists, could also benefit from digitisation, for instance by studying satellite images or tagged animals with GPS transmitters.'

'I started programming in Python, the simplest language. I'm totally hooked! Every week I try to write a piece of code. Coding gives you access to gigantic datasets, such as parliamentary data available from 1814 or newspapers from the 17th century onwards. Data analysis enables you to oversee huge periods at once, generate research output in no time and display it in beautiful and intuitive visualisations. I think that's fantastic.'

Since 1 January 2020, Joris van Eijnatten has led the Netherlands eScience Center. Before that, he was Professor of Cultural History at Utrecht University and VU University Amsterdam.