I/O magazine
ICT RESEARCH PLATFORM NEDERLAND
VOLUME 18 APRIL 2021 NO 1

SERIOUS GAMES

10 Developing evidence-based means of learning

SECURE COMPUTING

12 Protecting clouds and Delta Works

CONTAINING; KEYNOTES ICT.OPEN < 4 > WINNER NETHERLANDS PRIZE FOR ICT RESEARCH < 20 > MASTERCLASS ARTIFICIAL INTELLIGENCE < 22 > VISION ON SECOND SOFTWARE CRISIS < 24 >

12

Creating secure computing environments

Portrait of the recently established Computer Security group at CWI.

20

Balancing power and understandability

In conversation with Felienne Hermans.

4 **Innovating with data**

ICT.OPEN keynote speakers Anne-Marie Kermarrec and Boris Otto.

8 **Aiding scientists in digitalisation**

Local Digital Competence Centres provide help with data, computing and software.

9 **IPN/NWO news**

Computing time, Take-off grants, budget for delays, adjustments in Veni.

10 **ICT in business**

Developing serious games as effective means of learning.

COLOFON

I/O Magazine is a publication of the ICT Research Platform Nederland (IPN) and is sent free of charge to ICT researchers and relations of IPN four times a year. IPN consists of the ICT research schools ASCI, IPA, and SIKS; the ICT-related themes of NWO domains Science (ENW) and Applied and Engineering Sciences (AES); the institutes of the technical universities, united in NIRICT; the institutes of the general universities; SURF; e-Science Center; CWI; Dutch Platform for Mathematics; Data Science Platform Netherlands; Dutch Tech Center for Life Sciences; VERSEN; TNO and COMMIT.

IPN (ICT Research Platform Nederland) unites all Dutch academic research groups that have ICT science as their core, and as such acts as a single point of contact for all matters relating to ICT innovation and its importance for our current and future society. IPN is supported by the NWO Domain Science.

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16 Cleaning up legacy software
How TNO develops solutions for a wide-spread problem.

17 A long-lasting relationship
Structurally connecting government and higher education.

22 Neural networks and beyond
Masterclass on artificial intelligence.

24 Averting the second software crisis
Vision of Vadim Zaytsev, associate professor of Software Evolution.

BY PAUL KLINT, DEDICATED TO ANNEKE GROOS

Unmentioned partners in research

Our mostly unmentioned partners are more important for research than ever.

Every I/O column has passed Anneke's scrutiny. 'This too sarcastic?' or 'I don't think this is funny' or just 'It's acceptable, but this isn't one of your best columns' are examples of her totally honest feedback. After Anneke suddenly passed away in November, one of the many things I did while grieving and trying to explore the black hole in which I suddenly found myself was to start reflecting on Anneke's influence on my professional life. She often questioned the wisdom of applying for yet another grant proposal or starting yet another project. The times she helped me to say 'no' to unreasonable demands of the academic system. The questions she asked about the people I was dealing with professionally. The times she wanted to know about the scientific problems that kept me awake. The times she encouraged me when I did not see how to bring certain activities to a good end.

All of a sudden, I realised that as researchers, we try to meticulously give credit to co-workers, colleagues, or students who have contributed even the tiniest of ideas to our professional work. Or to the sponsors of our research. At the same time, we tend to forget or do not sufficiently recognise the important immaterial contributions of our other partners in research. Be it life partners, family members or friends. Our unmentioned partners.

The pressure to innovate, to publish, to collect citations, to collect prizes, to write grant proposals, to teach, to review, to manage, to supervise, to popularise, and to compete for jobs is enormous. The academic system has evolved to a state where researchers are reduced to lab rats. On many occasions, we just hope that we manage to press the right lever to get some food or drink. This has a negative impact on the quality of research and on researchers' quality of life. It is obvious to me that this system is not sustainable and has to be changed. In the meantime, while enduring the current very stressful academic system, our unmentioned partners are more important than ever for us to survive and hopefully to change the system. And this is even more the case in these pandemic times.

Our unmentioned partners in research: appreciate, acknowledge, cherish and love them.

Thank you Anneke.

NWO
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NEWS
World
Business
Tech
Sport
Public opinion

INNOVATING WITH DATA

By Bennie Mols Images EPFL-Alain Herzoog, Boris Otto, Istockphoto

This year's two keynote lectures at ICT.OPEN focused on innovating with data. Anne-Marie Kermarrec showed the role of fast data in news recommendation systems and Boris Otto discussed data-sharing in business ecosystems.

When the internet was built in the 1970s, it was designed as a distributed, collaborative system. However, in the last twenty years, a few very large companies have come to dominate it. Both of this year's keynote speakers at ICT.OPEN have a vision of the future in which data-sharing applications will once again be decentralised and collaborative. 'The world is ready for it', says the French professor Anne-Marie Kermarrec in an interview. 'If you still want to use Google and give away your data for free, go ahead, but in my vision of the future, we will have better alternatives. Computing power is now large enough to run decentralised systems, and, thanks to the smartphone, these are within the reach of every citizen.' Since January 2020, Anne-Marie Kermarrec has been professor of Scalable Computing Systems at EPFL in Switzerland. Before that she led the French start-up company Mediego for five years, which provides content personalisation services for online publishers. Mediego was sold to a larger company and is doing very well.

'I was very happy to work on a start-up', Kermarrec says. 'It was the right moment to do it and I learned a lot about making a business plan, talking to investors and getting everyone in the company behind me. But now, I am also happy to be back in academia. Students like it when they read about my entrepreneurial spirit in my resume. Some of them come to me to discuss what it's like to start a company.'

Recommendations

In her keynote presentation, Kermarrec described her journey to news recommendation systems. 'I especially wanted to show the role of fast data. News recommenders not only deal with a lot of data, but also with data that are highly dynamic. News has a short lifetime. You do not usually recommend a news article from days ago. And also, users' interests are volatile. I, for example, like skiing a lot, but I am not usually interested in the sports results of ski competitions. However, I might be interested if a French guy suddenly starts to perform really well.'

The most important research question in her field is how to scale applications like news recommenders when the amount of dynamical data grows rapidly. That leads to related challenges like how to minimise the use of bandwidth and how to minimise energy use. Kermarrec: 'These questions are not just about which algorithm to use. It's also about how you implement the algorithm efficiently. Which storage system is needed for the data? What type of architecture is needed to provide real-time news recommendation?' Another challenge is how to deal with bias in news recommendation, or even with information bubbles. Here, however, Kermarrec notices an important difference between social media companies and journalistic media. Kermarrec: 'Social media create information bubbles on purpose, in order to have users stay around on their platforms as long as possible. But newspapers have a contract with their readers. They want to avoid bubbles of interest and provide readers with a diversity of news. This can be realised, for example, by applying explicit rules, like give a particular reader at least X articles about sports and at least Y articles about international news.'

Twenty years ago, Kermarrec was pioneering peer-to-peer systems. 'At that time, such systems were associated with illegal file sharing', she says. 'But the digital world has changed dramatically and therefore I say that now is the time for decentralised and collaborative systems to make a comeback.'

Business ecosystems

The second keynote speaker, Boris Otto, has a vision of the future in which high-quality data for all goods and services can be easily shared within the EU and beyond. Otto holds the Chair of Industrial Information Management at TU Dortmund University and he is also the executive director of the Fraunhofer Institute for Software and Systems Engineering ISST in Dortmund. 'Companies, non-profit organisations and individuals are increasingly sharing data', Otto says in an interview. 'Take the example of a mobility service that provides customers with end-to-end mobility. So, you book a trip, and the mobility service orchestrates all the different means of transportation that you need: planes, trains, cars, scooters, et cetera. Obtaining this service in one stop requires all the actors in the mobility chain to team up. They need to share data on timetables and availability, and preferably also contextual data about the weather and traffic jams. Everybody understands that they will all be better off if data are shared.'

Anne-Marie Kermarrec:

'Now is the time for decentralised and collaborative systems to make a comeback'

The downside, however, is that data might be misused and privacy compromised. Therefore a business ecosystem is needed in which, just like in a biological ecosystem, the whole as well as the individual members prosper. An important solution is the creation of so-called data spaces.

Otto is also the vice president of the board of directors of the International Data Spaces Association (IDSA). IDSA has more than 125 member organisations worldwide and tries to standardise the creation of data spaces. Otto: 'The idea is that participants in the data-sharing process do not dump their data in one central store,

Boris Otto:

‘Control should be at the level of the society of individuals and not at one company or at one government’

but bilaterally exchange the data instead. IDSA took up the idea of data spaces and is adding concepts to it like trust among participants and ensuring data sovereignty. Participants can specify under which conditions their data can be shared.’

Some fundamental research questions need to be answered to create such data spaces, says Otto. What are the design principles for a federated data architecture? What should a federated data architecture look like? How can we ensure trust in a network where data are shared? How do we finance federated data systems?

Ownership

The question as to how to finance data spaces has become very urgent in the EU. Otto: ‘In its data strategy, the EU explicitly calls for the establishment of nine data spaces. That’s nice, but they don’t state how this has to be done and who is taking care of it. At present, we often see that there is a keystone company that drives and owns the data-sharing platform. But in Europe, we have the vision that it shouldn’t be a single company, but rather an alliance or consortium of different players. How a data-sharing ecosystem can emerge in such an alliance-driven approach is another interesting and urgent research question.’

Otto imagines that in the future, we will have data spaces in all important societal and economic sectors, from industrial production to mobility and healthcare. Otto himself is involved in creating a mobility data space in Germany: ‘Let’s take a metropolitan area as an example. Here we have individuals who drive a car or a scooter, we have car manufacturers, we have providers of weather data, we have the charging services for electric cars, but also the public transport companies and the municipalities that run the traffic management. For better mobility services and better traffic management, they would need one data space to make use of the data, protect the data providers’ interests, and create new value via this data space.’

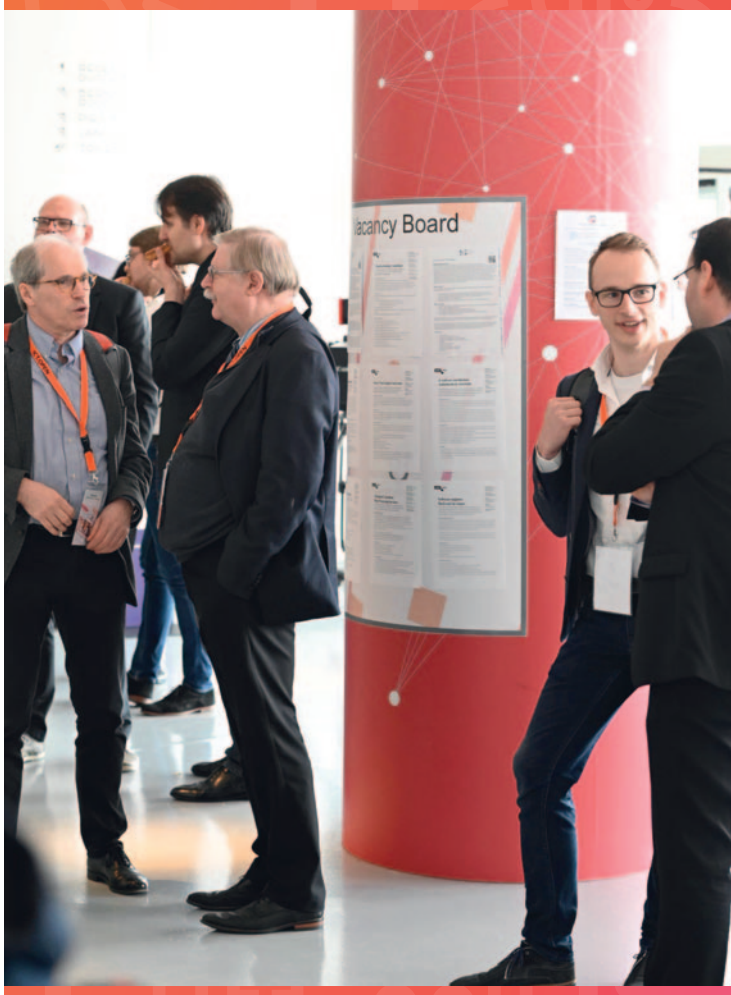
Such a data space should be taken to the EU level, according to Otto. ‘Control should be at the level of the society of individuals and not at one company like in the US or at one government like in China. We want a data-sharing system that respects the European values.’

ICT.OPEN 2021

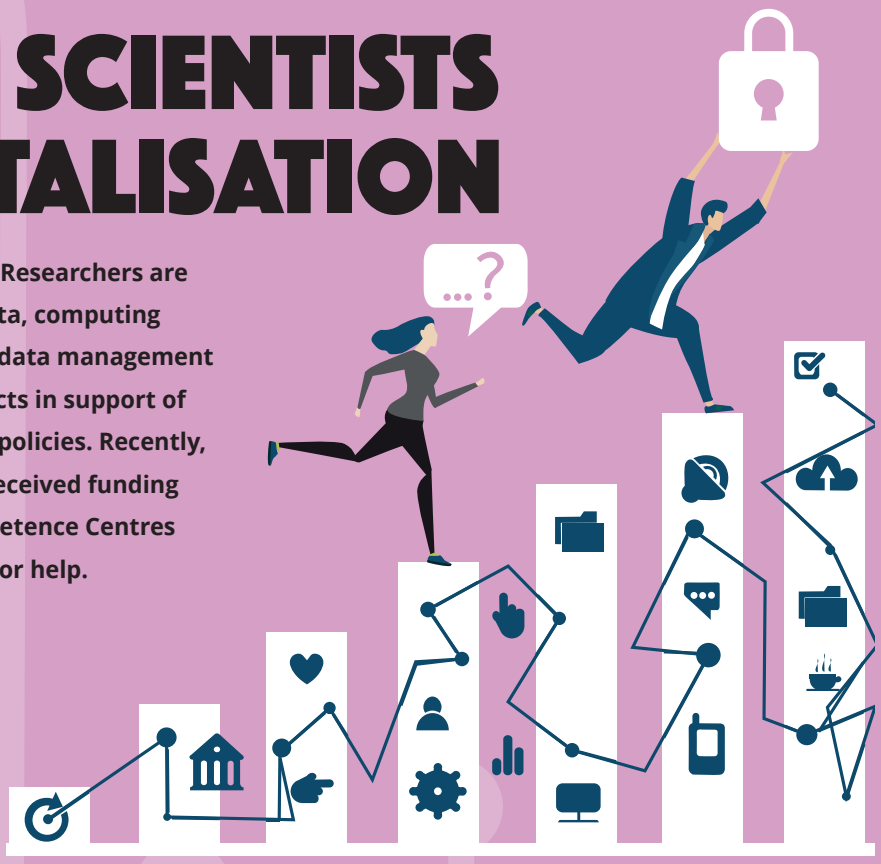
ICT.OPEN annually brings together some five hundred researchers from both fundamental and applied ICT research in the Netherlands. The conference is organised by the Dutch Research Council (NWO) and the ICT Research Platform for the Netherlands (IPN).

This year ICT.OPEN was organised for the ninth time and due to the pandemic, the event took place online. The programme included two keynote speakers (Anne-Marie Kermarrec and Boris Otto), six different scientific tracks, invited speakers and panel discussions. The programme ended with a presentation by the winner of the Dutch Prize for ICT Research 2021, Felienne Hermans.

www.ictopen.nl



AIDING SCIENTISTS IN DIGITALISATION



Science is digitalising rapidly. Researchers are now expected to deal with data, computing and software, and draft solid data management plans for their research projects in support of Open Science and Open Data policies. Recently, Dutch knowledge institutes received funding to develop Local Digital Competence Centres that researchers can turn to for help.

By Sonja Knols
Image Istockphoto

Locally based Digital Competence Centres (DCCs) bundle expertise in the field of FAIR (Findable, Accessible, Interoperable and Reusable) data, software and computing to support the researchers at their institution on a central level. 'Existing organisations like SURF, eScience Centre and DANS already do a lot of good work in this field. However, individual researchers are often struggling with very down to earth questions they need help with at short notice', NWO policy officer Joep van Wijk explains. 'For example, the local DCCs can help individual PhD students store, maintain and disclose their data sustainably, or gain access to proper computing facilities. While SURF, DANS, eScience Centre and a number of thematic DCCs are doing an excellent job supporting researchers in their computational research, local expertise in the digitalisation of research brings another level of support with a much lower entry level.'

As part of the Permanent Committee for Large-Scale Research Facilities, the committee Apers wrote an advisory report on the investment needed for the further digitalisation of scientific research in the Netherlands. Based on this advice, NWO drafted an implementation plan and published a call for proposals for all Dutch universities and academic medical centres, and the NWO and KNAW institute organisations. They could apply for impulse funding to either establish or further develop a centralised DCC at their institution. In the first round, 4.2 million euros was available to top up investments made by the institutions themselves. 'We received applications from almost all of them, and awarded all applications', Van Wijk says with satisfaction.

INTER-INSTITUTIONAL INSPIRATION

To facilitate exchange of ideas and best practices between the individual DCCs, the application procedure was explicitly not set up as a competition, Van Wijk adds. 'The applicants shared their first drafts, and were able to get inspired by each other's examples. That allowed the organisations to learn from each other, and at the same time, maintain a model that fits best within their organisation.'

The local DCCs will all take part in a federated network of Digital Competence Centres, which is coordinated by SURF. 'Best practices will be shared through both this national network and the existing National Coordination Point Research Data Management (LCRDM)', Van Wijk says. Meanwhile, policymakers are working on a more thematic follow-up call. Van Wijk: 'We are currently consulting the field on the desires for setting up an instrument to support these thematic DCCs. This calls for an integrated vision on the support of computational research, with the ultimate goal of assisting researchers in the best possible way.'

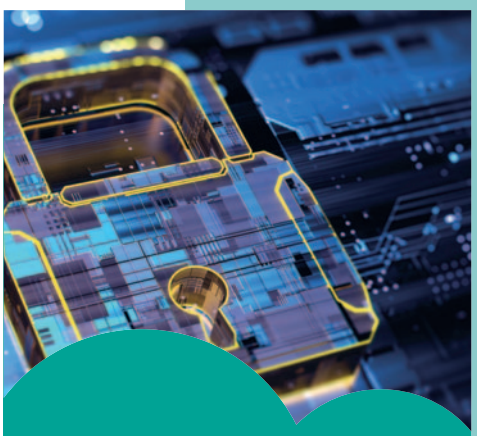
More information:
www.nwo.nl/en/calls/local-digital-compentence-centres

APPLY FOR COMPUTING TIME

From January 2021 onwards, researchers can once again apply for computing time and data storage on the National Computer Systems: HPC Cloud, Custom Cloud Solutions, Lisa computing cluster, Cartesius supercomputer (or successor) and/or Data Processing (Grid/Spider). The advanced national computer facilities are used for technical-scientific research in which major computational problems need to be solved and where the computational facilities of the individual institutions are inadequate. In the Netherlands, several systems are available for national use and are hosted by SURF. Researchers can request large amounts of computing time for a project duration of two years via NWO. Applications can be submitted to NWO on a continuous basis. The NWO Committee for the Scientific Use of Supercomputers (WGS) meets six times a year to assess the applications that are complete at that moment.

ADJUSTMENTS IN VENI PROGRAMME

From the 2021 round onwards, NWO will increase the amount to be applied for in the Veni grant scheme from €250,000 to €280,000. The NWO Executive Board has decided to take this step to reduce the pressure on universities to contribute financially to Veni projects. The total budget for the Veni round will be increased by 4.8 million euros from 2021 onwards but the total number of awards will remain the same.



TWO CYBERSECURITY TAKE-OFF AWARDS

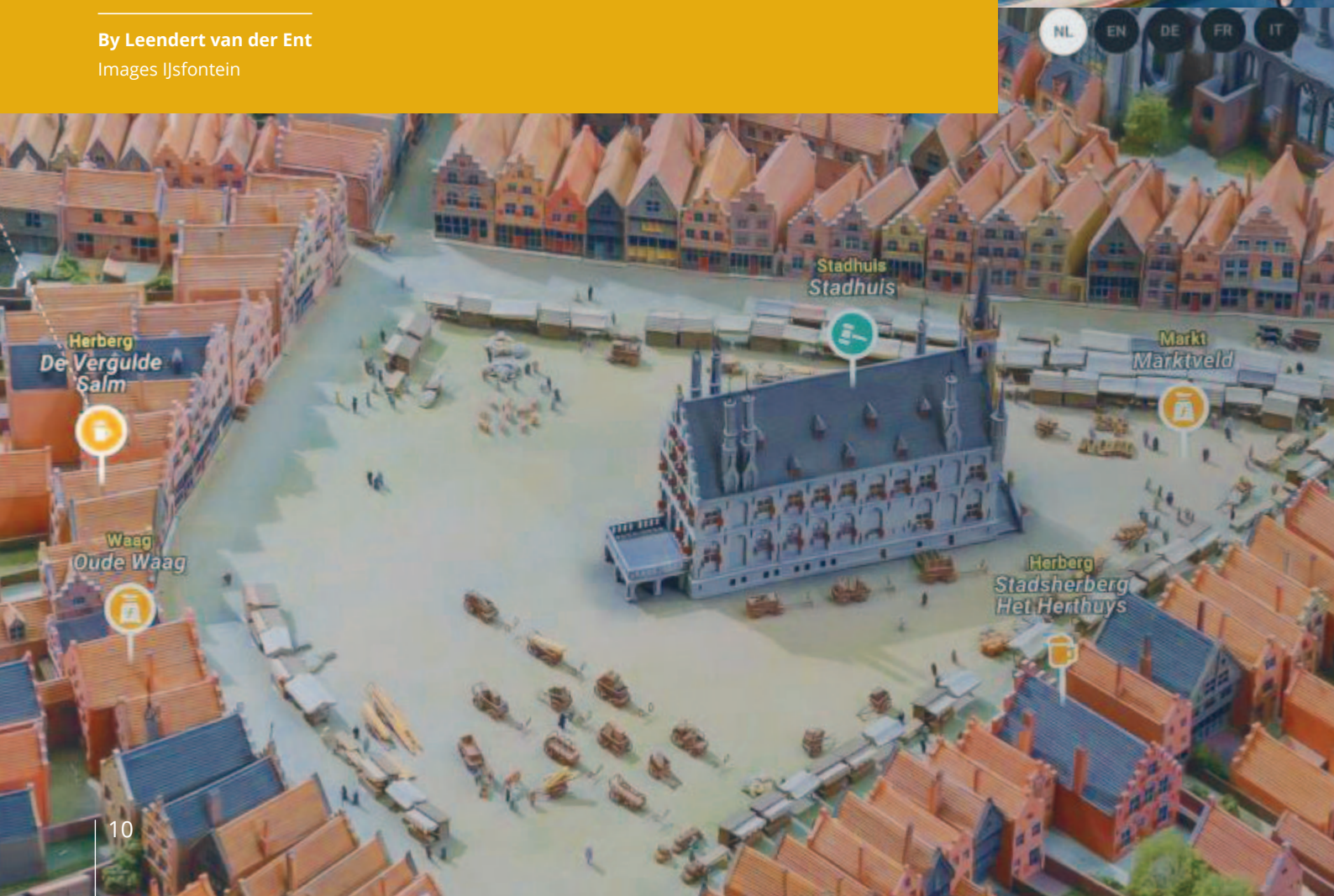
Last December, two research projects received funding within a dedicated cybersecurity round of Take-off, which The Hague City Council supports. The first project concerns increasing the security of software ecosystems by better registering vulnerabilities in the software. The second is about anonymising privacy-sensitive data in large data collections. The researchers awarded funding will be able to spend six months conducting a feasibility study into how their research can be translated into a commercial application. A maximum of 40,000 euros has been awarded per study. The projects awarded funding are: TrustSECO: A Trust infrastructure for a resilient Software ECosystem - Dr S.R.L. Roijackers (Utrecht University); and Tabular Data Synthesizer (TDS) -Dr L.Y. Chen (TU Delft).

BUDGET FOR SCIENTISTS AFFECTED BY DELAYS

NWO and the Association of Universities in the Netherlands (VSNU) have agreed on how to distribute the 20 million euros that was made available for scientists delayed by the coronavirus. The amount will be distributed among universities (including UMCs), the Royal Netherlands Academy of Arts and Sciences (KNAW) and NWO institutes, as well as young researchers on temporary contracts at foreign universities as part of NWO's Rubicon grant programme. The largest share, amounting to over 18 million euros, will go to the universities, while over one million will go to institutes and over half a million euros will be available for Rubicon laureates employed by foreign universities.

MAKING SERIOUS GAMES SERIOUSLY

By Leendert van der Ent
Images IJsfontein



Operational director Hans Luyckx of serious games company IJsfontein in Amsterdam knows his data when it comes to proving the effectiveness of serious gaming as a means of learning. Similarly, IJsfontein is committed to "evidence-based design", designed according to proven effective methods. Nearly two dozen PhD theses vouch for that by now.

"Master of the Universe Physics" was an early hit in IJsfontein's 24-year young history. It won a BAFTA – the revered "British Oscar". 'It's a fact that people love to play', Luyckx opens. 'We apply that insight to serious games for schools, for the military, for the medical sector – basically for anyone who sees the added value. We don't target any particular market. We have our preferences – working on awareness of climate change and white privilege, enhancing people's professional and soft skills and inducing behavioural change. But in general, craftspeople don't think in terms of markets; they just do what they are good at. The craft is the strategy. That involves design by involving emotions, attractive and comprehensible human-machine interfaces, and scalability of the game by applying the latest technology, for example.'

The mechanisms and emotions that encourage players to keep on going are well understood by the game sector. This involves some basic starting points: players receive only positive feedback, get the possibility to keep on trying until they succeed, play in teams rather than individually. 'You don't play because your parents press you to make something of your life, but because you like it', says Luyckx. 'Because you can save the princess, have autonomy, are able to help, can search for the treasure and because you can give away stuff. We always aim at keeping you motivated and curious.'

HOMO LUDENS

That is the beauty of serious games, says Luyckx. 'Fifty percent of people don't finish their course of antibiotics. But they do finish their game – couldn't we combine both to enhance therapy compliance? Normal education is much too language-oriented, which is a disadvantage for people with a low socioeconomic status or with a mild mental disability. Fifteen percent of people have limited digital skills and have difficulty searching via Google. Wouldn't it be better in that situation to provide supply-driven knowledge instead of questioning them? That's the success of Tinder – only supply and no demand. I'm convinced the mechanics of games can work wonders in education.' It's not something he makes up, Luyckx stresses. 'At the turn of the twentieth century, the great historian Johan Huizinga pointed out in his Homo ludens (the playing human) how game elements were fundamental to our entire culture and our basic institutions. So our culture exists, in part, thanks to the unrelenting attraction of games.' The meagre success of MOOCs – only 7 percent of the participants finish courses – or e-learning stands in sharp contrast to that, not to mention the present corona-driven drama of online education for hundreds of thousands of depressed students. 'So', Luyckx says, 'if we want to promote therapy compliance, a healthy diet, finishing education, empathy for unrelated people with dementia or learning from a museum visit, then we should make use of the toolbox of thirty to forty gaming mechanisms.'

'We apply evidence-based design to many of our games; then we know they work'

Hans Luyckx

EVIDENCE-BASED

For instance, to make it to the GGZ (mental healthcare) app store, apps need to be approved according to principles regarding quality process management. Luyckx: 'But they don't have to achieve what they were meant for. That makes no sense. And that is why we apply evidence-based design to many of our games; then we know they work. We know that medical students learn quicker to stabilise a trauma patient from our game than from their teachers. Not because we guess, but because a PhD student spent five years establishing that for his thesis. Likewise, nearly twenty industrial designers and psychologists have written their PhD theses based on research into our games.'

IJsfontein develops many apps with double-blind testing, just like in clinical trials. 'The difference is that we already introduce double-blind testing with the paper prototype, in other words from the first stages of game development onwards', says Luyckx. 'We do that according to the falsi-fiability principles of Karl Popper; not bending evidence in the desired direction, but trying to find the flaws. That allows us to eliminate the errors early on.'

Creating secure computing environments

By Bennie Mols Images Ivar Pel

GROUP PASSPORT

RESEARCH FIELD

Formal methods; cyber-physical system security (including hardware security); secure processor technology and key management; machine learning and security

EMPLOYEES

3 Professors
1 tenure track researcher
3 scientific programmers
5 PhD students

INSTITUTION

Centrum Wiskunde & Informatica (CWI) based at Amsterdam Science Park. CWI is part of the Institutes Organisation of NWO.

WEBSITE

CWI research group computer security:
www.cwi.nl/research/groups/computer-security

Dutch Secure Autonomous Cloud:
portals.project.cwi.nl/dutch-secure-autonomous-cloud/

Marten van Dijk

Modern computing environments can have many points of attacks from hackers. Proving that certain attacks can never be possible is the aim of the new CWI research group Computer Security.

After 18 years of working in the USA, Marten van Dijk returned to the Netherlands, where, in June 2020, he started to lead the new research group Computer Security at the Centrum Wiskunde & Informatica (CWI). 'Being given the opportunity to establish my own research group is a fantastic challenge', says van Dijk. 'I worked for many years at MIT's computer science and AI lab, CSAIL. The motto there was: shoot for the stars. I feel that we can do the same at CWI.'

Van Dijk's new Computer Security group is an extension of the CWI Formal Methods group, which has a long history. Van Dijk's aim is to use the same rigorous style of thinking that characterises formal methods to create secure computing environments. Van Dijk: 'Let's say you want to fill in your tax papers on a virtual desktop that runs in the cloud. Then you want to be sure that by running it in the cloud, you don't create any extra security risk.'

As tests can never prove that a computing environment is secure, rigorous analysis is needed. It's just much harder to apply it to a complex computing environment, which has many possible points of attack, then to a cryptographic protocol. That's the big challenge of the Computer Security group. Apart from the Formal Methods subgroup, the new research group has three other subgroups: cyber-physical system security, secure processor technology and key management, and machine learning and security. Van Dijk himself has worked in all these fields. 'My expertise is new for the Netherlands', he says. 'And what we do at CWI is also complementary to what happens at the Dutch universities.'

One of his ambitions is to create a Dutch Autonomous Secure Cloud (DUSAC), for which he is already collaborating with academics from the computer security and computer systems community in the Netherlands. Van Dijk: 'Europe depends too much on American tech companies. It's vitally important that we develop our own secure computing environment in the Netherlands. I hope that in five to ten years DUSAC will be a reality, and that we will have managed to make it interdisciplinary by incorporating legal, policy and economic aspects of computing security. People from academia and businesses who want to join are welcome to contact us.'

Protect land against water

Leader of the cyber-physical system security subgroup is the Chinese tenure track researcher Chenglu Jin. 'In my research, I am interested in securing critical infrastructure systems, like the flood defence in Zeeland', says Jin. He did his PhD research with van Dijk in the USA and considered it a great opportunity to help build a new research group at CWI. Jin: 'Marten and I share the same security philosophy. Furthermore, the Netherlands has top researchers working on critical infrastructure systems protecting land from water.'

Chenglu Jin

Farhad Arbab

Cyber-physical systems are systems in which a digital system controls a physical system. The physical systems typically contains all kind of controllers, sensors and actuators. Applications vary from simple smart home devices to complex industrial control systems, power grids and flood defence systems. 'In my work, I formally model especially the interactions between various devices in cyber-physical systems', states Jin.

As Jin started his job last October in the middle of the pandemic unfortunately, he hasn't met any of his colleagues in real life yet. 'But every Friday we have an informal virtual coffee meeting, and every second Tuesday, we have more formal virtual discussions in which one group member presents his or her research.'

New dimensions

Having worked in the formal methods subgroup for some thirty years, Farhad Arbab is a kind of grandfather of the group. Although officially retired, he happily continues to do research and to inspire new talent. 'What I like about the new group is that it adds new security dimensions that we had not previously addressed', he says.

Arbab works on building new protocols and languages for the interaction between active entities in a computer system. Arbab: 'Increasing the number of agents or cyber threats rapidly leads to an exponential explosion of the number of interactions. At present, we only have low-level languages to reason over such interactions. It's like having to write a non-trivial Java program in assembly code. I try to develop higher level languages that make it easier to formally analyse the security of such systems.'

Expansion of the formal methods group to address security concerns allows Arbab to more widely apply his experience. 'One of the new projects I am working on is in cyber-physical systems. Take the example of a drone that has to survey crops. We want to diagnose exactly what can go wrong and why, and ultimately prevent it from happening or take compensatory actions.'

Creating a group culture without the opportunity to meet in person hasn't been easy over the last year, but Arbab is surprised how well the new collaborations have taken off: 'In spite of the pandemic and no face-to-face meetings, we have found a lot of common ground in all our virtual meetings.'

CLEANING UP LEGACY SOFTWARE

Arjan Mooij is a senior research fellow in TNO's ESI - Embedded Systems Innovation research group and works on understanding and cleaning up legacy software. Mooij: 'What fascinates me is the reduction of complex code down to its essence. To an elegant piece of software.'

By Reineke Maschhaupt
Image Istockphoto

It was ESI's high-tech partners themselves who brought their legacy problems to Mooij and his colleagues' attention. Their proprietary software systems have been in development for decades; over time, this software has gradually been expanded and extended. What was once effective had to be done faster or slightly differently a few years later. In the process, developers found themselves with less and less time for the old code and preferred to work around it. Today, nobody knows exactly what those millions of lines of code do.

PEELING THE ONION

Mooij's favourite metaphor for explaining the legacy problem is the onion: if you peel back an onion layer by layer, you end up with tears in your eyes. This is the general feeling of Mooij's industrial partners. Mooij: 'The problem is immense. Most companies cannot afford to stand still to clean up their own code, yet software maintenance is desperately needed. Those on the work floor lose an incredible amount of time to understand what the existing software does. As if that's not enough, they are required to innovate as well.'

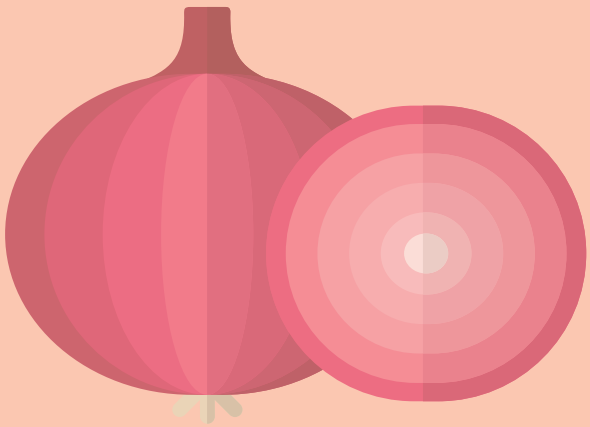
ESI works with the industry-as-lab approach. Four days a week, researchers work on-site at the partners' companies in parallel to the normal development process. Mooij: 'First of all, we want to give more insight into a company's software because the developers can immediately benefit from being able to work faster.'

BACK TO BASICS

Mooij: 'The second step – making the code simpler and shorter – is extremely challenging and exciting. Rejuvenation is the most thorough approach to this and makes major interventions possible. In this approach, you don't look at how something is done, but rather at what it should do. You then generate new code for that. At Phillips, we used this technique to make a system component almost three times smaller. By peeling back each layer of the onion, we can observe all of the trends in software from the past ten or twenty years.'

Another frequently-used technique is restructuring, says Mooij. 'Thanks to the restructuring technique, you do not need to know what the system does. With this, we can make structured adaptions to millions of lines of code at once. In doing so, we examine the implementation aspect instead of the essential functionality.'

'The biggest challenge is finding an approach that you can easily customise,' he continues. 'There is no single solution that we can roll out everywhere at the simple push of a button. Each situation requires a specific approach. What makes our high-tech partners unique is that they want to learn from each other. If we develop something for one partner, the others know about it.'



A LONG-LASTING RELATIONSHIP

By Amanda Verdonk
Images WAT ontwerpers

The Dutch national government is urgently looking for young IT talent, while higher education institutions are keen to conduct societally relevant research. The I-Partnership programme aims to structurally connect both parties. The result after one year? Over a hundred assignments have started, and several innovation labs are taking off.

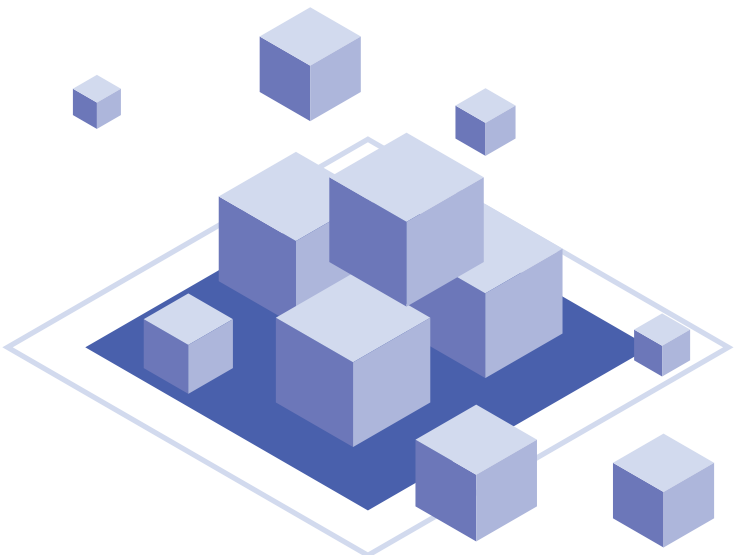
If students want to receive a discount at a sports club or at a bookshop, they must be able to present a valid diploma or proof of registration at an educational institution. But how can they do that safely and reliably in a digital society? Blockchain, the encrypted technology behind the crypto-currency bitcoin, can offer a solution. Students keep their certificates in their own digital wallet and only share what they want and with whom they want. Dienst Uitvoering Onderwijs (DUO), the government body that executes, for instance, the national student finance programme, wants to experiment with blockchain for the certification of diplomas. It is therefore working with Hanze University of Applied Sciences in Groningen on establishing a new innovation lab. The aim is to converge the technological and practical knowledge base from Hanze with the operational practice of a government organisation. Although the official go-ahead has yet to be given, both parties are already eagerly looking forward to the collaboration. 'We hope this lab will create knowledge and mass on this specific topic', says Thijs Teisman, manager at DUO and liaison officer for the innovation lab. 'And we also want to make students enthusiastic about working for the government', says Roland Hiemstra, programme director of the Digital Society Hub at Hanze University of Applied Sciences, who is also looking forward to the cooperation. 'So far many of our contacts with government agencies and companies have been fragmented. We now want to establish more structural connections in learning communities and build long-term relationships so that the knowledge acquired can be further developed.' Apart from blockchain, related themes such as data science and artificial intelligence will possibly become part of the lab.

FORGING COLLABORATIONS

The innovation lab is part of the I-Partnership programme, which started in May last year and aims to stimulate structural collaborations between the national government and higher education in the field of IT. Programme managers Cocky de Wolf (Utrecht University) and Marc-Jan Kraaijenzank (Ministry of the Interior and Kingdom Relations) lead a taskforce of regional duos, which each consist of a representative from both the government and an educational institution. 'The influx of young talent into the government is absolutely necessary', says Kraaijenzank. 'The age of the average IT professional is now 48.5 years. Technical developments happen rapidly and current staff do not always have up-to-date knowledge. With this programme, we want to build a long-lasting relationship.' Educational institutions benefit as well, according to De Wolf. 'Researchers and students in higher education want to contribute to solving societal issues, such as the digitalisation of government processes. Collaborative research resulting in context-rich assignments for students will allow us to align our education with the professional field.'

'WE WANT TO MAKE STUDENTS ENTHUSIASTIC ABOUT WORKING FOR THE GOVERNMENT'

So far, the taskforce has been very successful; over a hundred assignments and requests were received in ten months. Above expectations, says De Wolf. In addition to DUO, the partnership has helped the National Police, the National Cyber Security Centre, the Ministry of Defence and the Social Insurance Bank (SVB), and several other parties to start collaborating with higher education institutions. Until now, most collaborations revolve around student assignments in higher professional education. De Wolf: 'We are currently putting



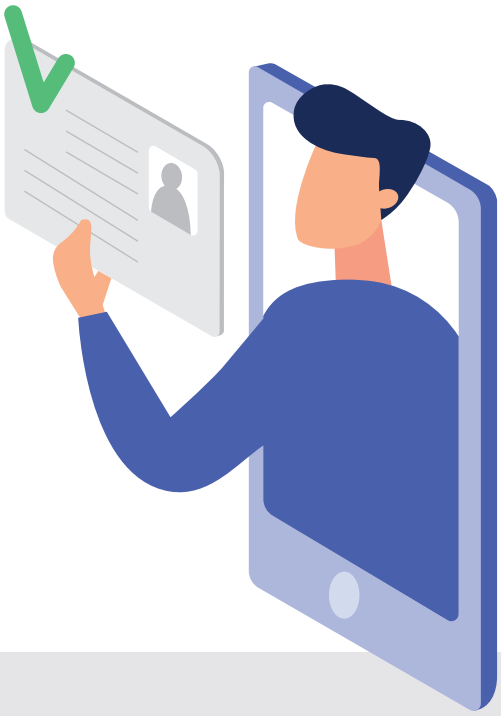
a lot of effort into forging collaborations related to the knowledge questions of tomorrow and the day after tomorrow, aimed at university students and PhD students. For example, the PhD programme on artificial intelligence run by the National Police.' Most of the innovation labs are in the start-up phase. 'We are still looking into how to best design the innovation labs', says De Wolf. 'It doesn't necessarily have to be a physical location. The labs are mainly about doing research and innovating together, as well as creating a community.'

EUROPEAN DIPLOMA EXCHANGE

DUO will have a physical location on the Hanze University of Applied Sciences campus, and the National Police, the Netherlands Vehicle Authority (RDW) and the Netherlands Radiocommunications Agency (AT) will have physical locations too. According to Hiemstra, this physical presence is important. 'Valuable time is lost if you literally have to go back to your own organisation every time. When you mingle with students, teachers and researchers daily, you automatically create a learning community. You learn to understand each other's organisations. I also believe innovations will more easily come to fruition at an external location.' Teisman already has ideas about the issues he would like to tackle with the students. 'DUO has joined the European Blockchain Services Infrastructure, an initiative of the European Union to build a joint blockchain infrastructure. This should enable a safe diploma exchange in Europe, allowing students to study abroad. Realising a service on this infrastructure could be a great group assignment.'

'MINGLING WITH STUDENTS, TEACHERS AND RESEARCHERS DAILY AUTOMATICALLY CREATES A LEARNING COMMUNITY'

The I-Partnership programme aims to make working for the government more attractive to young people. Not only for a necessary influx of young talent, but also to enable the government to become less dependent on temporary IT staff. A known issue, according to Teisman from DUO. 'Governmental IT projects are often carried out largely by external experts. In the final project phase, an enormous knowledge drain often occurs, which is risky. It is wise to invest in your own IT talents. That is why I am very committed to making this programme a success.'



INNOVATION LABS

The I-Partnership programme focuses on structural collaboration between various government departments and higher education institutions. In an innovation lab, parties work together on specific themes for a long time. In addition to the innovation lab in Groningen, there are two more physical labs:

Name: National Police Lab AI
Location: Utrecht and Amsterdam
Partners: University of Amsterdam, Utrecht University and National Police
Theme: Development and implementation of artificial intelligence techniques in digital processes
Status: Founded in 2017, 17 PhD students and 3 postdoctoral researchers in 2020

Name: Centre for Security and Digitalisation
Location: Apeldoorn
Partners: Municipality of Apeldoorn, University of Twente, the Tax and Customs Administration of the Netherlands, Saxion University of Applied Sciences, Police Academy and Royal Netherlands Marechaussee
Theme: Digital security, fraud and detection
Status: The cooperation agreement was signed in December 2020 and the centre will have its own location in Apeldoorn by the end of 2021.

Felienne Hermans (1984) is an associate professor at the Leiden Institute of Advanced Computer Science (LIACS) at Leiden University where she leads the research on programming for all, with a special focus on children. In March 2020, she launched programming language Hedy, built for children. She studied computer science at Eindhoven University of Technology and received her PhD in software engineering from TU Delft.

BALANCING POWER AND UNDERSTANDABILITY

During the online 2021 edition of ICT.OPEN, Felienne Hermans received the 2021 Netherlands Prize for ICT Research. She was awarded the prize for her research on making computer science and programming accessible to a wide audience and for her pioneering role in establishing a new direction within Dutch ICT research and education.

By Bennie Mols
Image Elodie Burrillon

What is the focus of your research?
'The core of my research is how to find a balance between a programming language that is powerful and a programming language that is understandable. Programmers often want to add more and more features to their programming language. But every addition makes it more difficult to use and more error-prone. To solve this dilemma, I combine computer science, cognitive science and linguistics.'

How did this play a role in building the programming language Hedy, which you released last year?
'The reason for building Hedy is that in the classroom, we see that children have difficulties in proceeding from a programming language like Scratch, especially built for children, to a serious programming language like Python. Hedy builds a bridge between the two. The end of Hedy is the beginning of Python. In building Hedy, I used the latest findings on what we know about how children learn.'

What is special about Hedy?
'In Hedy, children do not learn all the grammatical rules at once, but gradually. The lowest level has few rules so that children can slowly get used to them. Each higher level has slightly more rules. Quotation marks are added or parentheses. Hedy looks nice and easy, but to build it was a big technical challenge. No one had ever built such a gradual programming language before.'

How do you see the future of your research field?
'There is a growing awareness of the cognitive side of programming. For a long time, programming was thought to be more akin to maths than to language. Last year, an article in the scientific journal *Nature* showed that how good you are at learning programming strongly correlates with how good you are at learning a regular language. That really revolutionised how we think about learning to program.'

What are you planning to do with the prize money?
'For sure something with Hedy. One option is to strengthen Hedy technically. We could build cool new features or make the interaction with the users easier. The second option is to do an observational study in the classroom. How are children really using Hedy? What can we learn from it to improve the programming language? If it weren't for the corona lockdown, we would already have started on that. Now we have to wait until classroom studies are allowed.'

NEURAL NETWORKS AND BEYOND

By Amanda Verdonk

Artificial intelligence was a dormant science area for decades. Due to a major breakthrough in neural networks, the field is now in the spotlight again. However, improvements in the techniques are still needed, says Cees Snoek, professor of Intelligent Sensory Information Systems at the University of Amsterdam.

People can easily see the difference between a tree and a lamppost, but how does computer software do that? Computers are excellent at calculating, but recognising objects requires other skills, such as following pre-programmed rules or looking for patterns in millions of images. Computers with these abilities are considered to be artificial intelligence. 'AI makes machines smart', says Cees Snoek. 'This allows them to perform cognitive tasks that we usually assign to people, such as recognising pictures and speech, translating texts and planning routes.' The technology has been around since the 1950s and was hot from time to time, but also underwent several so-called 'AI winters' when high expectations could not be met and funding diminished.

Neurons and synapses

Until 2012, when PhD researcher Alex Krizhevsky caused a breakthrough. In the annual competition of ImageNet, a large photo database, computer systems have to classify the objects in a thousand images; is it an apple or a pear? That result is compared to a human classification. Krizhevsky's computer correctly labelled 85 percent of the objects, while the competition had not gone beyond 72 percent. He used a so-called deep neural network, which the British scientist Geoffrey Hinton developed. The technique is also known as deep learning and is a specific form of machine learning. Confusing, all those terms? Snoek explains: 'Machine learning is a form of AI in which the system does not learn by simply following rules, but by searching for patterns in large databases in order to arrive at a judgment. In the case of neural networks, these patterns are discovered by using a kind of neurons and synapses stacked together in different layers (hence the addition "deep") to exchange information at lightning speed.'

Hinton's neural networks caused a landslide in the field. Google immediately saw the potential, bought the intellectual property and now uses it in its search engine, translation and navigation software, and voice assistant. Other big tech companies such as Amazon, Apple and Microsoft soon followed. Neural networks have limitations, however,

DUTCH AI INNOVATION INITIATIVES

Hybrid Intelligence Centre
The Hybrid Intelligence Centre is a collaboration of top AI researchers from VU Amsterdam, the University of Amsterdam, TU Delft, and the Universities of Groningen, Leiden, and Utrecht. The HI centre will create a national and international focus point for research on all aspects of Hybrid Intelligent systems and is funded by a 10-year Gravitation grant from the Dutch Ministry of Education, Culture and Science.

ICAI
The Innovation Center for Artificial Intelligence ICAI is a national network aimed at technology and talent development between knowledge institutes, industry and government in the area of artificial intelligence.

NL AIC
The Netherlands AI Coalition (NL AIC) is a public-private partnership in which the government, the business sector, educational and research institutions, as well as civil society organisations collaborate to accelerate and connect AI developments and initiatives. The ambition is to position the Netherlands at the forefront of knowledge and application of AI for prosperity and well-being.

stresses Snoek. 'They don't understand causality, the relationship between cause and effect. They cannot reason or indicate how they arrive at a particular decision. So now there is also a lot of debate on whether we should supplement neural networks with traditional, rule-based techniques. In that case, you wouldn't need so much training data. The use of neural networks is now particularly beneficial to big tech or big state because of this need for data and computing

'The trick is to let computers learn from little data, without labels'

power. The trick is to let computers learn from little data, without labels.' Snoek and his colleagues have shown that this is possible. He showed a computer, fed with knowledge about physical laws, one waving flag. That was enough for the computer to determine the wind speed, without ever having seen other flags. So this computer learned from knowledge and not from examples.

Dutch AI giants

It looks like mainly American companies are able to showcase AI successes, such as winning chess or GO games or launching new AI-based products and services. Still, the Netherlands is at the forefront of AI research, says Snoek. 'Dutch universities were among the first to offer AI programmes. We are lagging behind in terms of investments and we have to be careful not to lose Dutch AI talent. Two of my PhDs recently left for Google. But the momentum is needed now and with policy initiatives such as the National Growth Fund and the Netherlands AI Coalition, I expect more resources to come soon.' Moreover, the Netherlands has plenty of AI giants. 'For example, Max Welling and Maarten de Rijke from the University of Amsterdam and Frank van Harmelen from VU University Amsterdam. Welling, for example, is working on incorporating physical theories into neural networks – super exciting.' AI will also lead to breakthroughs in very different research areas, Snoek thinks. 'Many researchers are busy finding patterns. AI can do that much better than humans, because it can browse through larger data sets. Many disciplines use human observation, which means you can only test theories on small numbers. The use of AI could be revolutionary here.'

AVERTING THE SECOND SOFTWARE CRISIS

By Reineke Maschhaupt Image Ivar Pel

According to associate professor Vadim Zaytsev, we need to act now to solve the second software crisis. Zaytsev: 'If we only train software engineers who are used to using fun tools and languages, we will have beautiful websites and apps in a few years' time, but the backend will fall apart.'

'I spent four years working for a company that helped other companies with legacy problems in order to understand the legacy problem from the inside out. This experience taught me that there are fundamental problems, which the industry will not be able to solve itself. Solutions will have to be provided by the universities. However, university education does not currently devote enough attention to this. I returned to the academic world because I can exert more influence on the curriculum from the inside.

The first software crisis arose in the 1960s. At that time, programmers reached a point of complexity that they could no longer solve. The discipline of software engineering arose in answer to this crisis. These days, our problem is that the latest generation of software engineers is highly trained in constructing software and learning fun new programming languages, but no longer knows how to deal with the old, existing systems. We are heading towards a second software crisis.'

COCKTAIL OF OLD LANGUAGES

'Half of all the major banks run on programming languages from the 1960s, such as COBOL or PL/I. They have gigantic code bases of hundreds of millions of lines of code with a cocktail of five to ten different languages. Students no longer learn most of those languages. According to the latest statistics, there is an eighty or ninety percent chance that the use of your bank card depends on COBOL running in the background. If there is nobody to keep that system alive then, eventually, your bank card will stop working.

I think that we can solve the second software crisis. At the end of the 1990s, we also managed to solve the Y2K problem (Millennium bug, ed.) because people raised the alarm on time. We need to create awareness in education and teach more of the other techniques that we know, not in small projects but systematically. We need to produce more experts who are not afraid to work with complexity and old languages. In addition, we must continue to do a lot of research into new techniques.

In the future, I want to continue teaching at the university, but I also want to work together with industry. That would be my sweet spot. Then I can witness how a new generation of people grows up, and I'd be able to change things if I feel that a different approach is needed.'

Vadim Zaytsev has been associate professor of Software Evolution at the University of Twente since July 2020. Before that, he worked as Chief Science Officer at Raincode Labs. In the past, he was a lecturer at the University of Amsterdam, postdoc at CWI and a researcher at the University of Koblenz-Landau. He gained his PhD from VU Amsterdam and completed his degree in Applied Mathematics and Computer Science at the Southern Federal University in Russia.