UNIVERSITY OF AMSTERDAM
Faculty of Science

ANNUAL REVIEW 2018

# research

# education

# valorisation

Dear reader,

Research breakthroughs, grants, degrees awarded and collaborations; these are some of the highlights we traditionally present in our annual overview. Indeed, as dean of the Faculty of Science, I am proud of what we achieve year after year. But these 'highlights' themselves are not what makes my job so rewarding; it is seeing the dedicated people who are making these remarkable discoveries, writing those grant proposals based on their newest ideas, and inspiring our students to achieve their full potential. That is hard work for all of us, challenging work and – at times – frustrating work, as not all efforts get the reward they deserve.

More and more, we are asked to demonstrate the value of our research to society. Why is what we do here, in our labs, in our offices, in our classrooms, so important? In some cases, the answer is easily understood: our research contributes to discovering new cures or medications for pervasive diseases; our research contributes to crop protection; our research aids in making the transition to sustainable and renewable energy; our research leads to technological innovations that help in decision-making or automation of complicated logistical processes.

In this annual overview, we introduce our two new valorisation themes 'Smart' and 'Green'. Rapid developments in artificial intelligence are transforming the way we work and live, and the full potential of quantum computing is still to be discovered: two examples in the 'Smart' theme where research and collaboration with partners is key. Likewise, in the 'Green' theme, we aim to gain new scientific insights on crop improvement, the mitigation of climate change or the transition to a carbon-neutral and circular economy. 'Smart' and 'Green' are prime examples of how our world-class research contributes to addressing these challenges. Prime examples, in other words, of why our research matters.

But at other times, the answer is less tangible. As scientists, we are often driven by a curiosity we might not be able to fully explain. Why is our research important? 'Because we want to know how it works.' Why? 'Because we might learn something we did not yet know.' And then? 'Then we might discover something else we do not yet have an answer to.' We understand the intrinsic value of learning new things, even if we do not know yet where it might lead to. In a world of alternative truths we must cherish the value of fundamental research and at the same time acknowledge that it is a privilege to be able to choose the topic of our research; a privilege that can only be earned by letting the world know about all the wonderful discoveries.

Without a doubt, answering the 'Why?' is important. But from my perspective, the question of 'Who?' is equally interesting. Who are these people with that insatiable curiosity? How are they creating impact through their research and teaching? Whom are they working with? What motivates them? How would they answer the 'Why?' question in their own words?

To show you the people who are making the Faculty of Science such an inspiring place to work, we chose to give our annual review a bit of a make-over this year. With more of a 'magazine' look and feel, it is still packed with the same highlights you are used to from us. But rather than merely celebrating our achievements, it celebrates the people without whom those achievements would not be possible.

**Prof. Peter van Tienderen**
*Dean of the Faculty of Science*

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Frank Nack

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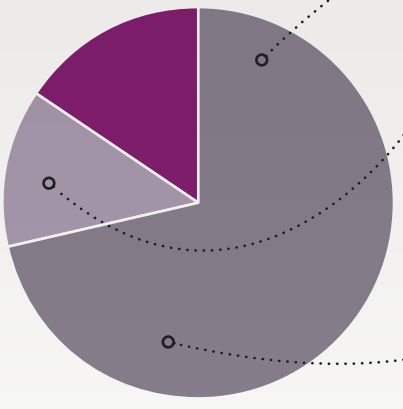


## FUNDING

Direct government funding **72%**

Government funding via a research organisation **13%**

Contract research funding **15%**

total **€158.2** million

## Restructure of management team

The Faculty of Science management team was restructured in June. Going forward, the management team is comprised of the dean, a vice-dean, a director of Operational Management and a director of Personnel and Administration. Peter van Tienderen continues his role as dean, responsible for the research and valorisation portfolios. Rudi Rust, formerly director of Finance, is now director of Operational Management which includes the finance portfolio, as well as ICT, technology, housing development and business development. Mariska Enneking was named director of Personnel and Administration, responsible for the portfolios for personnel affairs and administrative affairs (including the executive office), as well as location facilities, health & safety and environment. With the position of vice-dean being vacant up until then, it was announced in early 2019 that Lex Kaper would be appointed as the new vice-dean, responsible for the education portfolio.

## WORKS COUNCIL ELECTIONS 2018

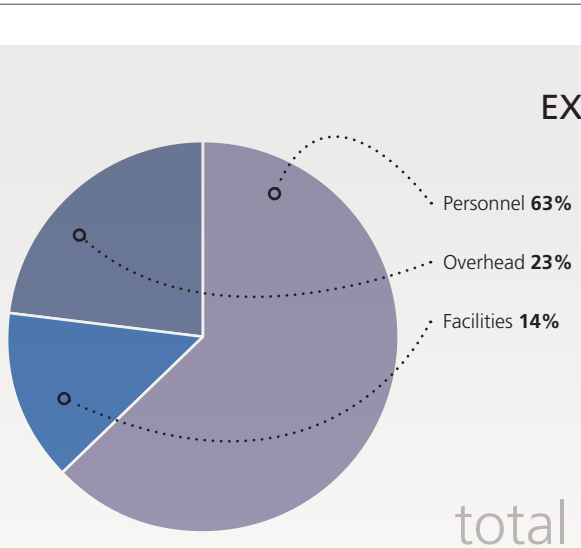
In May, elections took place for the Faculty of Science Works Council. As of 1 July, the council consists of: Isabel Smallegange (new, Chair), Piet Rodenburg (vice-Chair and Central Works Council delegate), Leen Torenvliet (member of the Executive Committee), Emma Cohen de Lara, Garry Corthals, Patrick Decowski (new), Erik Kooistra (new), Leendert Hamoen (new), Theo Nieuwenhuizen, Breanndán Ó Nualláin, Robert Spreeuw (new), Martin van Steeg, Chris Stolk, Taco Walstra (Central Works Council delegate) and Rudy Wijnands (new).

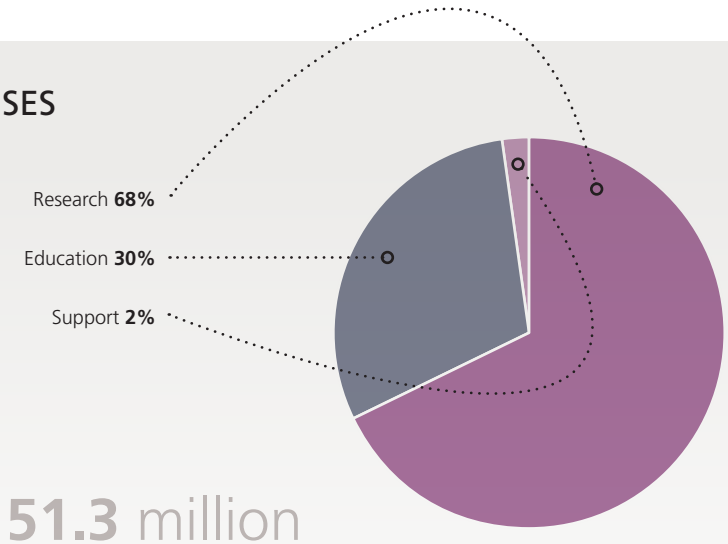
The Faculty Works Council will be in office until 1 July 2021, with new elections to be held in May of that year.

## Jeroen van Dongen appointed confidential adviser Academic Integrity

In January, the University of Amsterdam appointed five confidential advisers for Academic Integrity. Prof. Jeroen van Dongen was appointed for the Science Park campus. He serves as a point of contact for questions and complaints about academic integrity, but can also mediate complaints or refer complainants to the relevant supervisor in the event of an interpersonal conflict. The confidential adviser additionally informs complainants and potential complainants regarding the procedure for submitting a complaint to the Academic Integrity Committee.

## EXPENSES




total **€151.3** million

# Education

## AT THE FACULTY OF SCIENCE

At our Amsterdam Science Park campus, we educate nearly 7,000 students in our research-based Bachelor's and Master's programmes.

Students at the Faculty of Science are driven by different motivations; some want to go deep into one subject, others want to know how it all connects. Some are bitten by the research bug and will want to keep going, others are more eager to take what they have learned into another direction.

With our portfolio of specialised programmes and programmes that cross the boundaries of discipline, we offer a home to all of them. With an unwavering curiosity and eagerness to learn in common, they are part of a community of dedicated and intelligent peers and lecturers. Lecturers who are themselves always eager to learn more, whether it is to develop their own didactic skills or to innovate their teaching in order to help students take charge of their own learning process.

All with one clear aim: to inspire the next generation of scientists and set them on their own road to discovery.

# A student-approach to

## OFF TO A FLYING START

**Roundtable on teaching innovation: lecturers Monique Quaedackers and Nina Scheres in conversation with first-year Bachelor's students Biomedical Sciences Anouk Kreuger, Kaiden Sewradj and Milan Vervoordeldonk about the programme's new student-centred introduction course.**

How can we get first-year students off to a flying start? This was one of the key challenges for Monique Quaedackers when she and bioinformatics researcher Timo Breit first came together to redesign the introduction course in the first year of the Biomedical Sciences Bachelor's programme. As head of the expertise team Academic Skills & Student-centred Education, her focus was on offering students the best possible learning experience that they can take with them throughout their studies.

'Even though we had different expertises, we had the same vision: to create a student-centred learning environment where students can become confident and autonomous learners,' Quaedackers says. 'With the renewal of the course, we had three main goals. First, we wanted to give the students a basic knowledge of cell biology, which lays the foundation of many courses that follow. Secondly, we wanted to facilitate students in their transition from secondary school to university, to introduce them to the academic environment and what it means to study at university. And last but not least, we were focused on fostering motivation, commitment and engagement.'

### Laying a foundation

They came up with the idea to split the introduction in two separate but connected parts: a broad introduction course that shouldn't just familiarise students with the field of biomedical sciences, but also with studying at university, and an in-depth course called 'The Cell'; a name that is as straightforward as its contents are complicated for first-year students fresh out of secondary school.

Nonetheless, the students were able to keep up. 'I thought the transition from the general introduction to The Cell worked really well,' says Anouk Kreuger, with Kaiden Sewradj adding: 'I like how both courses prepared us for the rest of the programme. For example, some of the concepts we learned in The Cell actually gave us a foundation for what we were later learning in our genetics course.'

### Just in Time Teaching

An important factor in helping the students to master the complicated course contents, were the interactive lecture days, designed according to the principles of Just in Time Teaching (JiTT). Traditionally, assignments and small-scale tutorials follow the topical lectures, which in a programme with as many students as Biomedical Sciences (115 first-years in 2018-2019) are at risk of getting impersonal and going over people's heads. JiTT reverses that order: through self-study assignments and in mandatory seminars, students actively prepare for the lectures. The idea being that the thorough preparation allows for a better 'landing' of the lecture.

And if the students are to be believed, it works. 'Doing it in this order really helped me to keep up during the lecture,' says Kreuger. Fellow student Milan Vervoordeldonk notes that it makes it easier to engage students, telling lecturer Nina Scheres: 'You guys would ask us questions about things you were yet to present, knowing that we had actually already done the reading.'

Scheres, a microbiologist and didactic specialist in Quaedackers' team, played a big part in designing the interactive lecture days. 'Because we expected the students to come to class prepared, we composed a learning guide which gave a detailed overview of the course structure, how all the topics are linked, the most important reading, the figures and concepts to study and videos to watch. And students really loved this, one actually called it 'a blessing' in the course evaluation.'

### Creating an active learning environment

However, it was not a matter of handing students everything on a silver platter. The lecturers were keen on creating an active learning environment. 'We chose not to record our lectures,' Scheres continues, 'because to have an interactive lecture, you want the students to actually be present for the lecture.' This also meant the interactive lecture days were intensive, for both students and teachers.

# centred teaching

During the morning seminar, rather than handing responsibilities over to student-assistants, the lecturers are present to answer students' questions. This also gives them the opportunity to informally assess the students' knowledge level, which comes in handy later in the day, when they need to prepare the afternoon lecture. 'By being there to answer questions, but also to challenge them a bit with questions of our own, we got a really good insight into what they know and what they don't know. And sometimes, that can be really surprising. For example, when I thought the students would already know everything about DNA-replication, and it turned out they didn't.'

Vervoordeldonk recognises this: 'I sometimes noticed that I didn't fully understand something when I first read it, but then the questions the teachers asked in the tutorials or in the lectures brought it home for me,' says the former. Kreuger nods in agreement: 'Or you thought you knew, but then they would ask us to look at it from another angle, and you'd realise that you actually didn't have the full picture yet.' Another benefit, Scheres notes: 'You actually get to know the students a bit better, and – at least for me – that makes teaching a lot more fun.'

The morning session is completed with an individual knowledge quiz the students take online. While they then go off to lunch, the lecturers come together in the 'pressure cooker', using their interactions from the morning sessions and the results of the knowledge quiz as input to adjust the lecture to the students' learning needs – 'just in time' before the lecture starts.

In the afternoon lectures, the teachers use several techniques to foster active participation, such as interactive quizzes and polls. The catchbox microphone (a soft padded box that contains a microphone) is also a trusted partner. 'The catchbox is not only useful to throw to students who have questions for us, but also to throw to students sitting in the back, chatting away and ask them a question ourselves,' Scheres says.

## Not a bus driver

With the goal of inspiring confidence in students firmly in mind, students were given an exam merely two weeks into the introduction. Counterintuitive as this may seem, it is a key factor in the success of the new approach. 'The message we want to give them is that if you are there, if you keep up and go to every class, you will be well-prepared for the exam,' says Scheres.

'The exam gave me an immediate idea of where I stood,' says Kreuger, adding that the course gave her the confidence that she can succeed in the programme. Sewradj feels the same way. 'It was a lot, but very doable and I think it gives students a lot of confidence to take an exam this early,' he says. Although he found the course intensive and jokes that - for a brief moment - he wondered whether he might be better off becoming a bus driver, by the end of the course he was excited to get on with the rest of the programme. 'I felt capable and was ready to be challenged even more.' Of course, this is music to Quaedackers' ears: 'This is exactly what we were aiming for.'

## Increase in student advancement

In the end, as ever, the proof is in the pudding. With the new introduction course as the only notable difference in the programme, student advancement to the second year increased from 62% in the 2016-2017 cohort to 80% in the 2017-2018 cohort. And although these numbers speak for themselves, Quaedackers also has lecturers from other courses coming up to her to confirm: 'They tell me that the students are asking a lot more questions, are more assertive and more engaged. So I really think that we are helping them to become self-directed learners, and that is of course a competence that they can use throughout their studies.' ■

In the 2018 reaccreditation cycle, both the Bachelor's and Master's programmes for Biomedical Sciences received a final rating of 'Good', meaning the programmes 'consistently surpass the standard quality level'. The Accreditation Organisation of the Netherlands and Flanders (NVAO) praised the programmes' clear vision and position and focus on new biology ('omics'), as well as the emphasis on training students to conduct research and develop academic and practical skills.


♡ INSPIRING

## FRUIT BOWL

A project proposal from Robert van Wijk, lecturer in Information Sciences, was awarded UvA Grassroots funding of €10,000. Grassroots are awarded to projects where ICT is used for teaching innovation. In the so-called 'Fruit Bowl' project, lecturers develop their own teaching innovation for feedback or peer-feedback for their course in Canvas, making use of the FeedbackFruits tool. With the help of experts, the lecturers address didactic and technical issues to make their innovation more efficient and are assisted by students in the development of course materials.

## Explanimation

Another UvA Grassroots project delivered its first fruits in 2018, when a team of lecturers led by Ilja Boor, lecturer in the Psychobiology Bachelor's programme, published a series of explanimation videos with the theme 'Learning to self-direct your learning'. The videos explain what is meant with student-directed learning, the behaviours that are beneficial and the learning activities and -formats students can apply to become self-directed, motivated and pro-active learners. This self-awareness is beneficial for their study results and equips them for a life-time of learning. While the videos were specially made for first-year Psychobiology students, they are freely accessible for all to view and benefit from.

## LEARNING CURVE CREATOR

Boor was also awarded a Comenius Senior Fellowship for innovation in teaching by NWO, worth €100,000, for the development of a 'Learning Curve Creator'. This online tool will allow students to take control over their own learning process, integrating personal study results with the structure and coherence in the curriculum.

## Placemaking

Joris Buis, lecturer at the Institute for Interdisciplinary Studies, received the Comenius Teaching Fellowship worth €50,000. He received the award to further develop teaching methods in the IIS course 'Placemaking' where each semester a new group of students takes over from their predecessors to address a local issue.

## Advanced UTQ certificates for four Faculty of Science lecturers

On Friday 16 February, Faculty of Science lecturers Adam Belloum (Computer and Computational Science), Tom van Engers (Information Studies), Martijn Rep (Life Sciences) and Moniek Tromp (Chemistry) received their Advanced University Teaching Qualification (Advanced UTQ). To obtain the certificate they completed an intensive programme that consisted of a lecture series and an individual assignment on an issue in their own teaching practice.

## Lecturer of the Year: Faculty of Science Top 3

### 1. Frank Nack

Lecturer and programme director in the Master's programme Information Studies. 'In every course he teaches, he provides fantastic and supportive guidance.' Nack went on to win UvA Lecturer of the year 2018.

### 2. John van Boxel

Lecturer in the Bachelor's programme Future Planet Studies. Besides his 'amazing shirts', his enthusiasm and passion for his field are 'eye-opening'.

### 3. Leo Dorst

Lecturer in the Bachelor's programmes Computer Science, Artificial Intelligence and Natural and Social Sciences, and in the Master's programme Artificial Intelligence. 'He made the hardest course in AI seem easy to me.'

## Earth Sciences Master's students selected for ESA's Spin Your Thesis! Programme

Earth Science Master's students Carlijn Snoek, Fleur van Langen and Mabel Gray were selected by the European Space Agency (ESA) for the Spin Your Thesis! programme 2018. As Team Avalanche, they were given the opportunity to carry out an experiment in the Large Diameter Centrifuge (LDC) at the European Space Research and Technology Centre (ESTEC) in Noordwijk, a large centrifuge that can simulate up to 20 times the Earth's gravity.

The goal of the experiment was to find a relationship between avalanches and gravity, by looking at how these processes occur on multiple planets and under differing circumstances. Avalanches are abundant, not only on Earth, but also on celestial bodies such as Mars and the moon, and they are one of the most important influences in the process of landscape formation. Carlijn's graduation research project focused on the technique behind the 3D recording of the avalanches, a novel method in the field. Fleur zoomed on the sorting processes of avalanches, while Mabel studied the parallels between scientific and artistic research.


# Students as researchers

## Bachelor's students publish paper on neutrino decay

Usually, scientific publications come from experienced researchers at the PhD level and beyond. However, sometimes students – even Bachelor's students – succeed in making interesting contributions to science. Nine students in the UvA-VU Bachelor's programme Physics and Astronomy took part in a four-week workshop supervised by UvA-IoP/GRAPPA researchers Shin'ichiro Ando and Bradley Kavanagh, where they investigated radiative neutrino decay and its impact on the cosmic microwave background radiation. Their work resulted in a paper, published in Physical Review D on 2 July.

Shin'ichiro Ando: 'Theoretical physics and astrophysics might have a relatively short span in publishing papers compared with other fields, but still, supervising bachelor students for only for four weeks to get an outcome worth publishing was an extraordinary challenge. But the students were extremely motivated and very professional in how they worked together as a group. I am proud of their achievement.'

## StationLab 2018: How do travelers find their way?

For the second year in a row, students in the Psychobiology Bachelor's programme were able to conduct 'field research' in the NS StationLab, a joint project between the University of Amsterdam and the National Railway (NS), ProRail, and the National Science Weekend. Supervised by lecturer and neuroscientist Tonny Mulder, the students studied how travelers find their way at Utrecht Central Station. Using eye-trackers and GPS-tracking, they recorded how new and familiar travelers navigate the station. What happens in the brain and how does the environment play a role in finding the correct and fastest route? In addition, the team studied effects of stress on the navigation choices.
Student Jim Monkel: 'This was a unique opportunity to bring the theory we learned about the brain into practice.' Fellow student Sylvia Korhorn shared his enthusiasm: We had the opportunity to show everyone how interesting the brain really is, and we were given the freedom to use our own creativity. This was a project I couldn't just let pass me by.'

# Prizes & awards

FOR STUDENTS AND ALUMNI

## National Interuniversity Mathematical Olympiad

For the first time, a team of UvA students won the National Interuniversity Mathematical Olympiad (LIMO). Mathematics Bachelor's students **Mike Daas, Wouter Rienks, Siebe Verheijen** and **Koen Doodeman** of team 'Mückenheim Transfinity' beat out the runner up from Radboud University Nijmegen by just one point.

## Young Talent Incentive Award

On November 26, five Faculty of Science Bachelor's students received a Young Talent Incentive Award for obtaining the best results in their first-year cohort from the Royal Holland Society of Sciences (KHMW) in Haarlem. **Justin Baars** (Mathematics), **Michelle van Dongen** (Chemistry, UvA-VU), **Jildou Hollander** (Physics and Astronomy, UvA-VU), **Lucas Reidstra** (Computer science) and **Annemarie Vermeulen** (Biology).

## East-West Seed Graduation prize for Plant Sciences

**Amber Woutersen**, graduate of the Biological Sciences Master's programme won the East-West Seed Graduation prize for Plant Sciences. She received the young talent graduation prize, worth €5,000, for her thesis on the Origin and Evolution of the Nitrariaceae. Supervisor Dr Carina Hoorn (IBED): 'Amber's thesis stood out because of the novel approach in studying the history of an important plant family that so far has received little attention. She has the vision and ability to work with and integrate different types of datasets, which makes her an exceptional young researcher.'

## Young KNCV poster competition

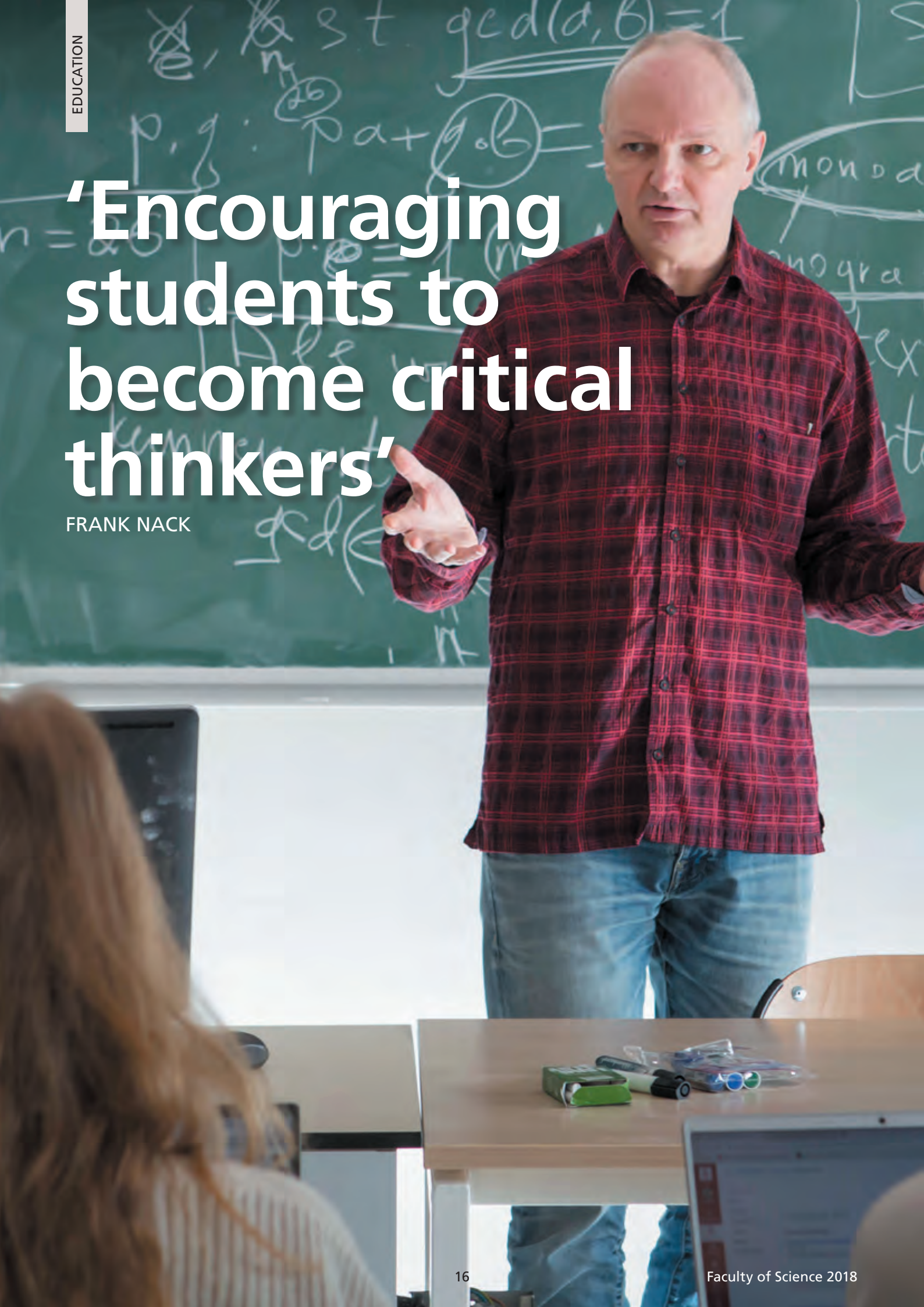
Students from the UvA-VU Chemistry Master's programme dominated the 'Young KNCV poster competition', sponsored by the Royal Netherlands Chemical Society, at the national chemistry students PAC symposium, held on 8 March in Utrecht. **Wowa Stroek** took home the first prize, **Stephan Falcao Ferreira** was runner-up, and **Brendan Horst** secured the third prize.

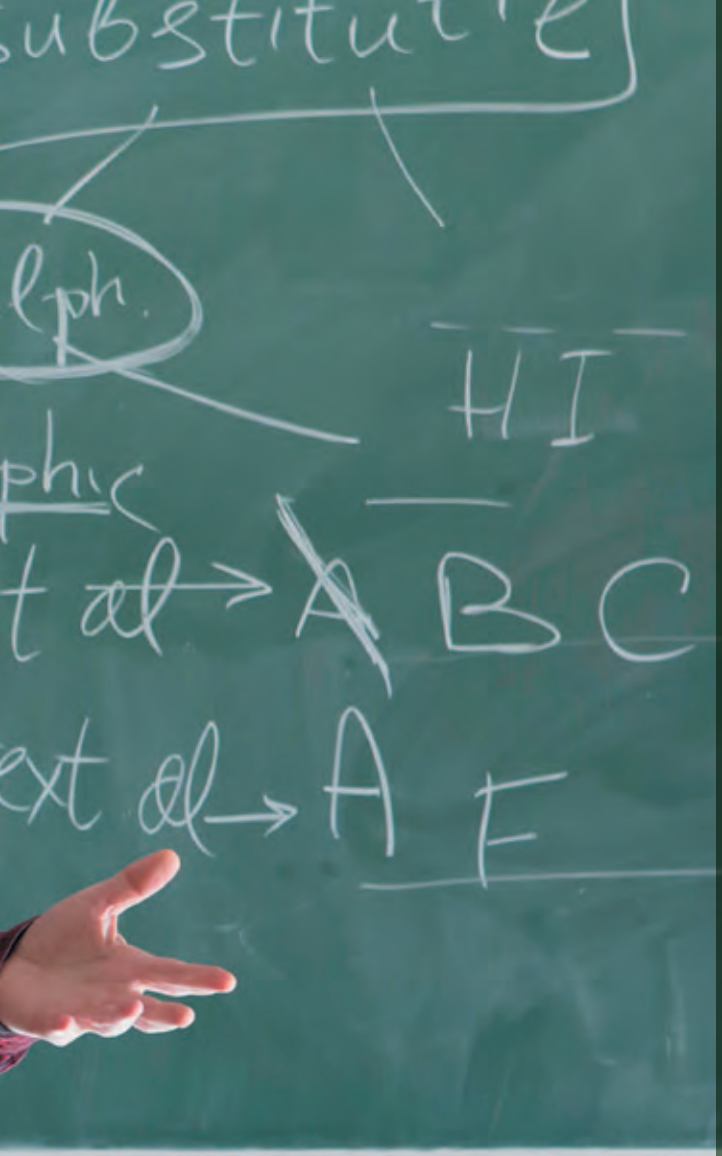

## DigitalGlobe's international GBDX for Sustainability Challenge

UvA Earth Science alumni won DigitalGlobe's international GBDX for Sustainability Challenge. Their winning project, Global Green City Watch, makes it possible to monitor the quality of green spaces in a city based on satellite imaging, and use insights from these data to improve the quality of urban green spaces. The team, consisting of **Nadine Galle**, **Chris van Diemen**, **Jim Groot** and **Anjelika Romeo-Hall**, and Urban Studies Master's student **Stella Balikci**, received advice and support from IBED researcher Dr Emiel van Loon.

# ‘Encouraging students to become critical thinkers’

FRANK NACK





**Reflection, reflection, reflection. Ask Frank Nack about the key objective of his teaching, as a lecturer and as the programme director of the Information Studies Master's programme, and this would be his answer. 'Information studies is a quickly developing field, and rather than expand on all the latest trends, it is important that students develop the skills to cope with an agile field even after they have left university.'**

## Educating creative knowledge workers

Getting his students to reflect on the trends and their implications is of greater importance than explaining even more hardware, data structures or algorithms, says Nack. 'Of the latter I know: in ten years' time the technological functionality will have changed immensely. But reflection, working creatively, that will still be asked of our students, any knowledge worker actually, in ten years, even 100 years from now. Perhaps with more machine support, but as humans we will continue to have to develop products and services.'

'Take speech as an interaction method, for example. Many systems nowadays are based on speech. But can we really apply it everywhere? What are the consequences when we proceed in this direction? I travel to Japan a lot, and there you can use your phone on the tube for everything, except to make phone calls. Speaking out loud in this context is considered a social no-go. So of course, we will look at technical, social, and the HCI (human-computer interaction) issue of how information is shared and distributed, but we won't dedicate an entire semester to learning all the ins and outs of what is – ultimately – a trend that will pass.'

## The other, the different, the 'hard to imagine'

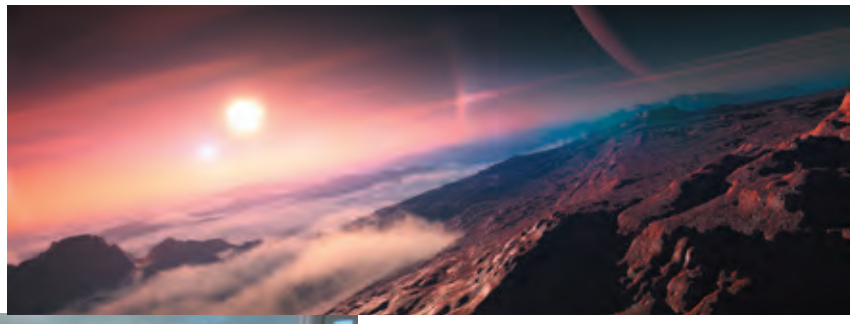
One sure-fire way to stimulate reflection and creativity is to take students out of the comfort zone of what they know and take for granted. For example, Nack will ask students to think about what would happen if you take away the objective of profit behind platforms such as Uber, Facebook or Amazon. 'These corporations have an immense influence on the behaviour and structure of society. But what happens if we change the business model from profit to societal wealth? How would that change the use of technology? I try to confront students with the 'other', the 'different', the 'hard to imagine', and to get them to a point where they consciously establish an understanding of reflective practice, a capacity for introspection, a willingness to learn more and an ability to make informed choices.'

'Of course they need to understand how the technology works. I mean, there are still facts. So I do teach classes on the technology's state of the art. But by letting students debate and ponder issues of that state and its history, by confronting them with sources such as the TV series Black Mirror to show the extremes, they start to understand that the way they look at technologies shape the way they want to make technology work. If you ask me, this is why we are a university. To push students to think about alternatives. So that when they ultimately take up a job in industry, we have taught them to reflect on multiple levels on what they are doing out there. That they see how their work has an effect on society at small and large.'

## UvA Lecturer of the Year

His approach to teaching does not go unnoticed. In 2018 students elected him as UvA Lecturer of the Year, a recognition he considers 'a great honour'. 'Frank encourages us to become critical thinkers' was the recurring theme in the students' motivations to vote for him. Funnily, here too, he particularly appreciates that it's 'not just to a vote, but there's a reflection step', as students have to motivate their votes.

The award also got Nack to reflect more on his own work. 'To be honest, I didn't think much about getting such recognition for my work, I just did what I always do. I still do, but now, more often, with the idea of how could I do better. Even though it's a jolly good title to have, I don't think I am a better lecturer than others. Rather, I would call myself lucky for the recognition and the honour.' ■



Chemistry Master's student Rick Broers is interviewed by a news programme for children in March, at the peak of the slime-making hype.

## How to build an alien?

In January, sixteen second- and third-year students from different disciplines gave a poster presentation for the honours course How to build an alien. The aim of the course, which was developed by a group of enthusiastic lecturers from API, SILS, IBED and HIMS, was for students to design an organism that could survive on a known exoplanet. In an intensive series of lectures, the students learned about the building blocks of life, extremophiles, alternative life, exoplanets and more. Next, in five subgroups, they had to design an alien and demonstrate how it would be able to survive on their assigned exoplanet by means of calculations, literature and models.

## Biotechnology course wins Create a Course Challenge

The third UvA Create a Course Challenge, organised by IIS, was won by Nils Boonstra, Ida van Koolwijk, Tijmen Kuyper and Julie Maas for the course 'Biotechnology: from pharma to Frankenstein'. With the course, the students aim to make biotechnology understandable for students from different disciplines. 'By the end of this course, students should have mastered the basics of biotechnology. The objective is for students to draw connections between their own field and a specific challenge, such as lab-grown meat. For instance, Economics students could look at the impact of such meat on supermarkets, whereas students from other fields could investigate its ethical aspects,' the winners explained.

## NWO TOP Grant for Master's student Thomas Aalders

Thomas Aalders, Master's student of Green Life Sciences at the University of Amsterdam, was awarded a TOP Grant by NWO. This is the largest personal grant for Master's students to obtain. He wrote his proposal in collaboration with Frank Takken and Harrold van den Burg in the Molecular Plant Pathology group. He will use the grant money, over €300,000, to do research on the infamous plant fungus Fusarium, which causes wilt disease in various crops. An understanding of how the fungus operates on the molecular level will aid in improving crop protection.

## DRONELYMPICS

In April, students in the interdisciplinary course Brain Powered demonstrated the method they developed for directing drones with brain waves. The course gives students from the Bachelor's programmes Psychobiology, Artificial Intelligence and Computer Science the opportunity to gain experience with solving real-world problems in a multi-disciplinary team. For example, while the 'Dronelympics' were a bit of fun, technology for directing vehicles or robots with brain waves has applications in the creation of solutions for people with paralysis.

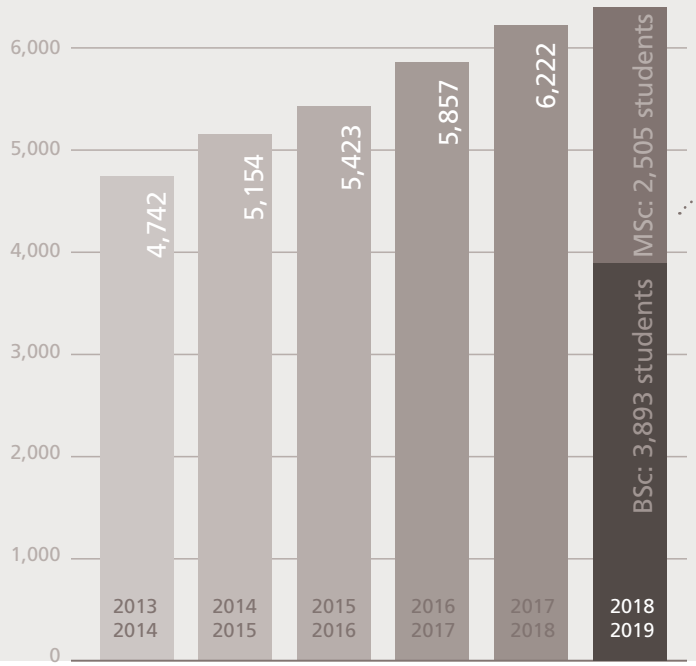
## 'Top Programme' honours Logic and System and Network Engineering

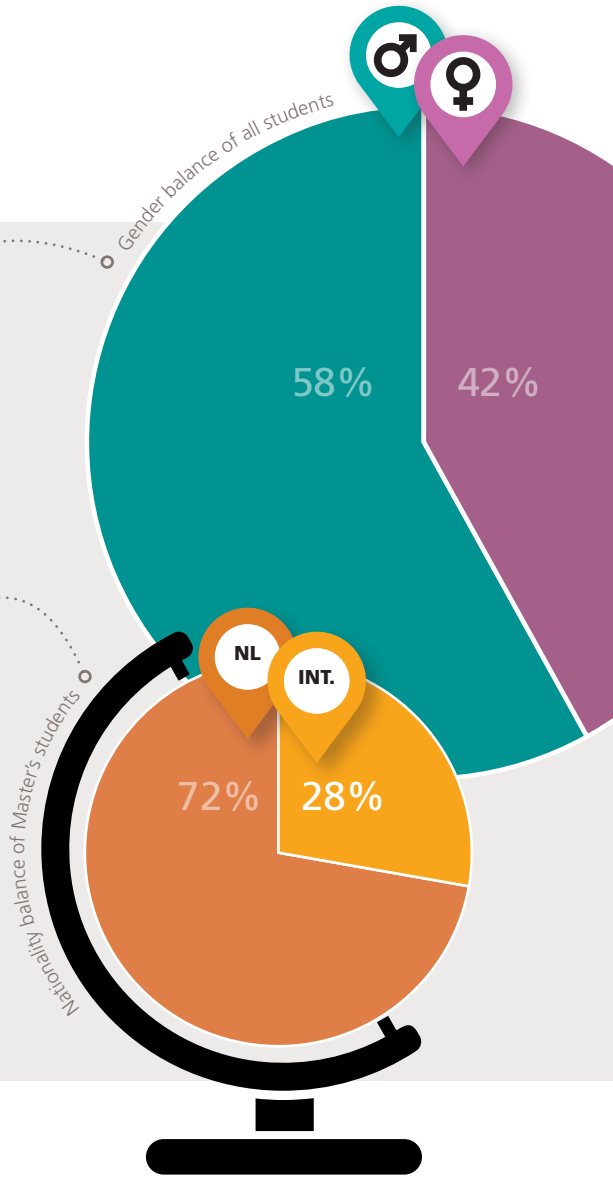
For the sixth year in a row, the Master's programme Logic was bestowed the Top Programme honour by the Universities Study Guide. The Master's System and Network Engineering (since renamed Security and Network Engineering), also received the Top Programma designation. The evaluation is for 80% based on students' ratings in the National Student Survey, and for 20% on reports from the Accreditation Organisation of the Netherlands and Flanders. Both programmes scored 90 out of a 100 points.

# Facts & figures students

## TOTAL STUDENTS 2018-2019

FULLTIME




## BACHELOR'S STUDENTS

FULLTIME | ALL PROGRAMMES TAUGHT IN DUTCH

### ARTIFICIAL INTELLIGENCE

| | | | |
|---|---|---|---|
| students | 409 | ▼ 1% | 43 |
| first year enrolment | 108 | ▼ 41%* | |

25% female
75% male

* due to new enrolment quota

### COMPUTER SCIENCE

| | | | |
|---|---|---|---|
| students | 337 | ▲ 9% | 54 |
| first year enrolment | 116 | ▲ 17% | |

9% female
91% male

### INFORMATION STUDIES

| | | | |
|---|---|---|---|
| students | 284 | ▲ 3% | 60 |
| first year enrolment | 98 | ▲ 15% | |

24% female
76% male

▲▼ compared to 2017-2018

## BIOLOGY

| | | | | |
|---|---|---|---|---|
| students | 171 | ▼ 2% | 34 | 47% female |
| first year enrolment | 53 | ▼ 12% | | 53% male |

## BIOMEDICAL SCIENCES

| | | | | |
|---|---|---|---|---|
| students | 329 | ▼ 8% | 113 | 65% female |
| first year enrolment | 115 | ▼ 4%* | | 35% male |

* enrolment quota

## PSYCHOBIOLOGY

| | | | | |
|---|---|---|---|---|
| students | 617 | ▼ 3% | 149 | 80% female |
| first year enrolment | 197 | ▼ 2%* | | 20% male |

* enrolment quota

## CHEMISTRY*

| | | | | |
|---|---|---|---|---|
| students | 156 | ▼ 16% | 50 | 41% female |
| first year enrolment | 46 | ▼ 26% | | 59% male |

* joint degree with VU University Amsterdam

## MATHEMATICS

| | | | | |
|---|---|---|---|---|
| students | 148 | ▼ 5% | 37 | 30% female |
| first year enrolment | 49 | ▲ 9% | | 70% male |

## PHYSICS AND ASTRONOMY*

| | | | | |
|---|---|---|---|---|
| students | 345 | ▼ 1% | 71 | 19% female |
| first year enrolment | 101 | ▼ 19% | | 81% male |

* joint degree with VU University Amsterdam

## FUTURE PLANET STUDIES

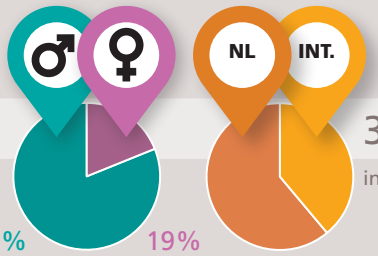
| | | | | |
|---|---|---|---|---|
| students | 578 | ▲ 7% | 120 | 47% female |
| first year enrolment | 180 | ▲ 8% | | 53% male |

## NATURAL AND SOCIAL SCIENCES

| | | | | |
|---|---|---|---|---|
| students | 445 | ▼ 7% | 118 | 45% female |
| first year enrolment | 106 | ▼ 6% | | 55% male |

# MASTER'S STUDENTS

FULLTIME | ALL PROGRAMMES TAUGHT IN ENGLISH




## ARTIFICIAL INTELLIGENCE

| | | |
|---|---|---|
| students | 397 | ▲ 25% |
| first year enrolment | 183 | ▲ 30% |

39

81% 19%

39%
international

## COMPUTATIONAL SCIENCE*

| | | |
|---|---|---|
| students | 129 | ▲ 21% |
| first year enrolment | 58 | ▲ 18% |

21

78% 22%

30%
international

* joint degree with VU University Amsterdam

## COMPUTER SCIENCE*

| | | |
|---|---|---|
| students | 34 | ▲ 31% |
| first year enrolment | 17 | ▲ 240% |

20

82% 18%

24%
international

* joint degree with VU University Amsterdam

## INFORMATION STUDIES

| | | |
|---|---|---|
| students | 215 | ▲ 3% |
| first year enrolment | 165 | ▲ 5% |

168

70% 30%

23%
international

## LOGIC

| | | |
|---|---|---|
| students | 89 | ▼ 9% |
| first year enrolment | 35 | ▼ 8% |

27

82% 18%

71%
international

## SOFTWARE ENGINEERING

| | | |
|---|---|---|
| students | 51 | ▼ 2% |
| first year enrolment | 36 | ▼ 8% |

48

90% 10%

20%
international

## SECURITY & NETWORK ENGINEERING

| | | |
|---|---|---|
| students | 23 | ▼ 30% |
| first year enrolment | 13 | ▼ 46% |

25

91% 9%

4%
international

## BIOINFORMATICS AND SYSTEMS BIOLOGY*

| | | |
|---|---|---|
| students | 33** | ▲ 100%*** |
| first year enrolment | 18 | |

67% 33%

15%
international

* joint degree with VU University Amsterdam ** 15 students switched from Life Sciences *** new programme since 2018

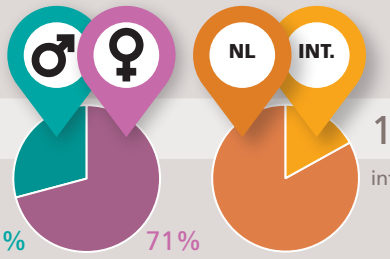
## BIOLOGICAL SCIENCES

| | | |
|---|---|---|
| students | 183 | ▲ 16% |
| first year enrolment | 68 | ▲ 19% |

37

47% 53%

28%
international




## BIOMEDICAL SCIENCES

students 415 ▲ 2%
first year enrolment 149 ▲ 7%

117

29% 71%

17% international

## EARTH SCIENCES

students 95 ▼ 2%
first year enrolment 25 ▼ 11%

23

47% 53%

36% international

## CHEMISTRY*

students 238 ▲ 14%
first year enrolment 65 ▲ 3%

80

57% 43%

6% international

* joint degree with VU University Amsterdam

## MATHEMATICAL PHYSICS

students 8 ▼ 11%
first year enrolment no new students allowed*

1

100%

100% international

* programme ends in 2021

## MATHEMATICS

students 67 ▲ 22%
first year enrolment 23 ▼ 12%

13

82% 18%

15% international

## PHYSICS AND ASTRONOMY*

students 279 ▲ 3%
first year enrolment 121 ▲ 32%

99

72% 28%

25% international

* joint degree with VU University Amsterdam

## STOCHASTICS AND FINANCIAL MATHEMATICS

students 29 ▼ 22%
first year enrolment 5 ▼ 58%

6

76% 24%

34% international

## FORENSIC SCIENCE

students 74 ▼ 6%
first year enrolment 32 ▲ 19%

29

19% 81%

35% international

## BRAIN AND COGNITIVE SCIENCE RESEARCH MASTER

students 138 ▲ 3%
first year enrolment 47 ▼ 4%

38

29% 71%

34% international

# Research

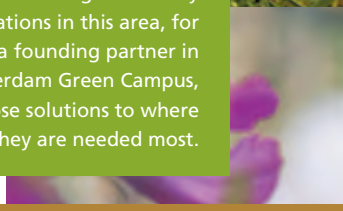
## AND VALORISATION AT THE FACULTY OF SCIENCE

Researchers at the Faculty of Science are driven by a shared passion for wanting to know how things work. Our eight research institutes cover the full range from astronomy to life, earth, physical, molecular, mathematical and information sciences. Whether our chosen instrument is a microscope or a telescope, whether we are unraveling the origins of life on earth or shaping its future for generations to come, we find each other in a curiosity that knows no bounds.

But our interest goes beyond satisfying our own curiosity; we want our research to have impact. Therefore, collaboration is a given. With each other, with our colleagues at the neighbouring research institutes at Amsterdam Science Park, and with peers at the national and international level. And also with societal partners and partners in industry. Where our research is often fundamental in nature, it is boosted by collaboration with application-oriented partners. We are positioned at the beginning of the knowledge value chain: our research has the potential to lead to innovation and new products through further development in society and industry. The many examples in this magazine illustrate that road from curiosity to impact.

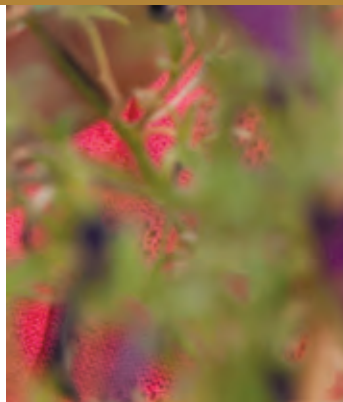
**Green**

The transition to a sustainable, circular economy is one of the most important developments in society today. The Faculty of Science has much to offer in addressing this challenge, from expertise in developing alternative energy sources to finding green ways for crop protection. Through our many collaborations in this area, for example as a founding partner in the Amsterdam Green Campus, we bring those solutions to where they are needed most.



**Smart**

An increasingly complex and data-rich world calls upon our widely recognised expertise in fields such as language processing, networks, data science, quantum technology, computational science and artificial intelligence. With the establishment of the Innovation Centre for Artificial Intelligence (ICAI), consisting of a number of partnership labs in the field of AI, the plans for a new co-creation building for the information sciences at Amsterdam Science Park and the start of the iqClock consortium, the Faculty of Science solidifies its position as a 'smart' partner in research.




SCIENCE
904

# Veni, Vidi, Vici

## VENI

The Netherlands Organisation for Scientific Research (NWO) awarded Veni grants worth up to €250,000 to six Faculty of Science researchers. The Veni gives promising young scientists the opportunity to further elaborate their own ideas over a three-year period.

### Dr Matteo Biagetti (IoP): Looking for cosmic fingerprints from billions of years ago

Billions of years ago, the Universe expanded exponentially, giving rise to countless spinning particles. Biagetti will look for imprints of those primordial particles in today's astronomical observations, testing theories of cosmic expansion and opening a window to our early Universe.

### Dr Joen Hermans (HIMS): The molecular structure of oil paint

Oil paint ages, sometimes with dramatic consequences for the appearance of paintings. In this research, Hermans will recreate the molecular structure of oil paint. With advanced spectroscopic techniques, Hermans will investigate how indoor climate and restoration methods can be adapted to optimise paintings conservation.

### Dr Andrew Jupp (HIMS): From nitrogen gas to useful products

Nitrogen gas is all around us, but it is very unreactive. Jupp will study the trapping and activation of nitrogen with main-group compounds to afford a range of interesting and industrially relevant products, including dyes and molecular switches.

### Dr Janne-Mieke Meijer (IoP): Revealing big consequences of small defects

Defects can always occur in any crystalline material. Even the smallest defects can completely change the behaviour of the bulk crystal. To improve crystalline materials, Meijer will combine smart particles and new microscopy techniques to unravel how defects form, move and interact on the smallest scale.

### Dr Emily Petroff (API): Astronomy's newest mystery: fast radio bursts

Fast radio bursts are short powerful radio pulses from other galaxies. They release more energy in 1 millisecond than the sun does in a day, but their origins are still a mystery. This project will study a large sample of bursts to uncover the sources and the physics driving them.

## VIDI

Four researchers at the Faculty of Science were awarded a Vidi grant by NWO, worth up to €800,000. The Vidi is aimed at experienced researchers who have carried out successful research for a number of years after obtaining their PhD. The grant will enable the researchers to develop their own innovative line of research and set up their own research group.

### Dr Miranda Cheng (IoP and KdVI): Moonshine in String Theory

String theory is a physical theory aiming at a uniform description of all laws of nature. The word moonshine refers to a mysterious relation between two different types of mathematical structures: special functions and finite groups. In this project, Cheng and fellow researchers will solve the puzzle of the origin of this relation by studying it in the context of string theory.

### Prof. Evangelos Kanoulas (IvI): Conversational Search Engines

Searching for information in digital repositories plays a central role in today's life. In this project, Kanoulas and fellow researchers will develop intelligent agents able to converse with users to accurately retrieve information in complex domains such as medical and legal.

### Dr Mingmin Shen (KdVI): Algebraic or not?

Shen proposes to develop an obstruction theory to the integral Hodge conjecture by studying it in special - but important - cases and by relating it to the Grothendieck-Katz conjecture. He will then use the results to attack some long-standing rationality problems.

### Dr Jean-Michel Désert (API): Weather on Alien Worlds

To better understand the nature, origins and fates of the planets outside the Solar System, Désert will retrieve their atmospheric composition, clouds, and weather systems occurring on these exoplanets.

# EUROPEAN Grants

The European Research Council (ERC) stimulates high-quality research in Europe by making funds available and supporting groundbreaking research.

## STARTING GRANT

A Starting Grant is a personal grant of around €1.5 million that gives talented researchers the opportunity to conduct research for a period of five years. This year, the ERC awarded the starting grant to:

**Dr Silke Allmann (SILS)** The goal of Allmann's research is to unravel the molecular mechanisms of volatile perception in both plants and insects, since it is not known how plants perceive their volatiles and how they generate a functional response to them.

**Dr Jayne Birkby (API)** Birkby will study the atmospheres of other worlds beyond our Solar System to understand the processes that formed the incredibly diverse array of exoplanets that we see in the Milky Way.

## CONSOLIDATOR GRANT

The Consolidator Grant, averaging around €2 million, is meant for researchers who obtained their PhDs between seven and twelve years ago to enable them to consolidate their position as independent researchers.

**Dr Raquel Fernández (ILLC)** received the Consolidator Grant for her research in which she aims to establish a new computational model of a dialogue agent that can learn to take part in conversation directly from data about language use. Her model is grounded in linguistic theories of dialogue, but exploits recent advances in computational learning that allow the agent to learn the representations that it manipulates directly from experience.

## ADVANCED GRANT

The Advanced Grant, totalling €2.5 million, is awarded on the basis of a researcher's academic excellence and research proposal.

**Prof. Hal Caswell (IBED)**, a biologist and demographer, will investigate kin dynamics. Family networks affect demographic, economic, and health-related aspects of life and society. Despite their undeniable importance, remarkably little formal theory exists to show how kin dynamics are determined by mortality, fertility, and other variables.

## MARIE CURIE FELLOWSHIP

As part of the Horizon 2020 programme, two researchers received a Marie Curie Fellowship from the European Committee to conduct research at IBED: **Dr Thomas Blankers** will visit from Cornell University (Ithaca, New York) to conduct research in the group of Prof. Astrid Groot, and **Dr Yoshi Maezumi** (University of Exeter) will join Dr Will Gosling's group. **Dr Bart Schimmel** (also IBED) received a Marie Curie to go abroad and conduct research at the University of Bern (Switzerland).

## VICI

Two Faculty of Science researchers received a Vici grant from NWO in 2018. The Vici, worth €1.5 million, is one of the largest personal grants in the Netherlands and is targeted at outstanding senior researchers who have successfully demonstrated the ability to develop their own innovative lines of research and to act as coach to younger researchers.

**Dr Joeri van Leeuwen (API/ASTRON): The Newly Visible Universe**
It turns out space and time too are 'stuff' that can stretch. We feel that space-time curvature as gravity. Like other stretchy things, space-time can also flutter. By quickly pointing our sensitive radio telescopes the next time gravitational waves are observed, Van Leeuwen's aim is to determine what creates these gravitational waves.

**Dr Ulle Endriss (ILLC): Collective Information**
Combining information supplied by different people plays an important role in a variety of scientific domains. Examples include the ballots voters fill in during an election or the answers participants give in a survey. Endriss' project aims to develop a general approach for processing such collective information.

## NWO RUBICON

**Dr Colet te Grotenhuis (HIMS)**, who completed her PhD with professors Bas de Bruin and Joost Reek in 2018, was awarded an NWO Rubicon grant, intended for recent PhD's to gain international research experience. She will work with the group of Prof. Alexander Radosevich at MIT's Department of Chemistry for two years.

The lunar eclipse on 27 July drew a large crowd to Science Park 904, where API had set up multiple telescopes and was on hand to explain the eclipse to the public.

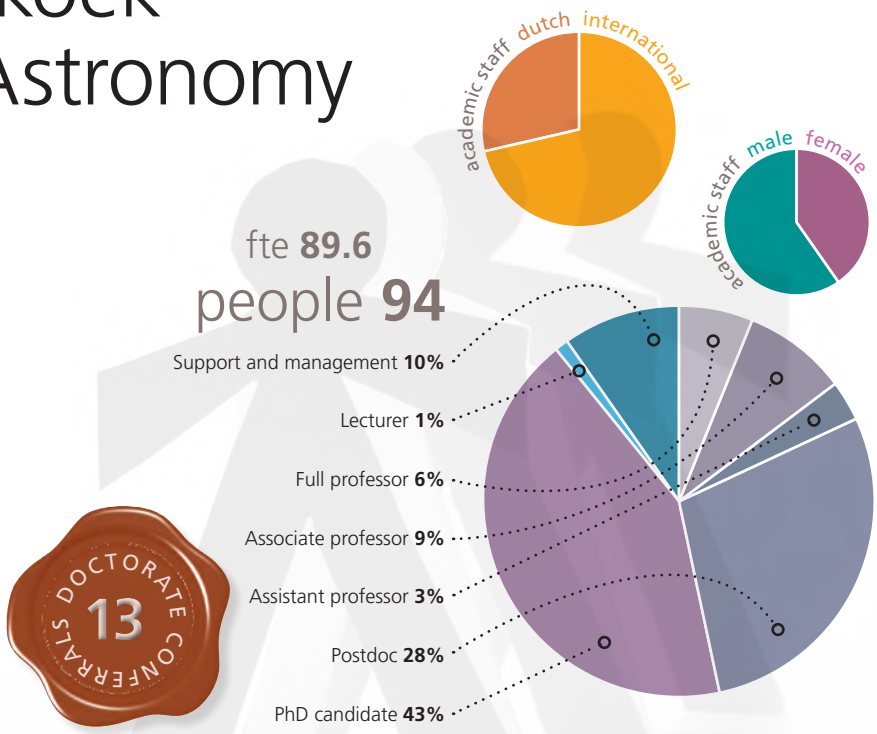
## Many more massive stars than expected

An enormous star-forming region in the Large Magellanic Cloud, a satellite galaxy of the Milky Way, contains far more massive stars than previously thought possible. An international team of astronomers, including API's Alex de Koter and Selma de Mink, came to this conclusion after determining the respective masses of a record amount of individual stars rather than looking at the combined light of all the heavy stars to estimate their mass distribution. De Mink: 'This study changes how we see the final stages of heavy stars. If you extend these results, there may be 70 percent more supernovae and even 180 percent more black holes.' The results were published in Science in January.

The Tarantula Nebula hosts many more massive stars than expected. Credit: NASA/ESA/ P. Crowther (University of Sheffield).

# Anton Pannekoek Institute for Astronomy

**Researchers at the Anton Pannekoek Institute for Astronomy (API) seek to understand the universe, the objects in it and their history. They test the laws of nature and find new laws.**

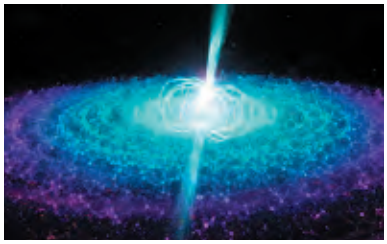



## Einstein's theory still passes the test

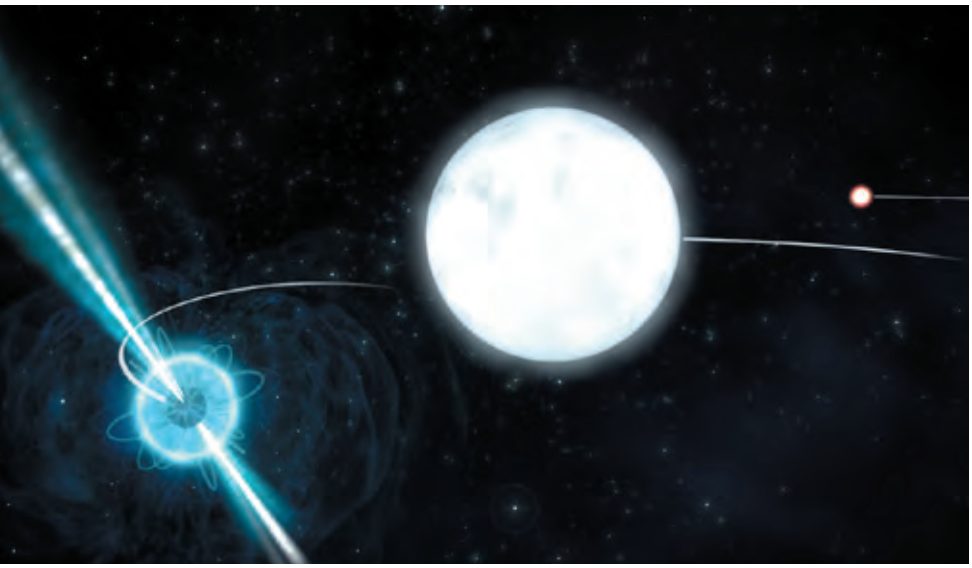
Einstein's theory of gravity, general relativity, predicts that all objects fall in the same way, regardless of their mass or composition. But most alternative theories predict that objects with extreme gravity, like neutron stars, fall a little differently than weak gravity objects. An international team of researchers, including lead author Anne Archibald, Nina Gusinskaia and Jason Hessels from API, was able to test that hypothesis by studying a neutron star and white dwarf gravitating to another white dwarf further away. They found that any difference between the accelerations of the neutron star and white dwarf is too small to detect. 'If there is a difference, it is no more than three parts in a million,' explains PhD candidate Nina Gusinskaia. As such, their findings, published in Nature on 5 July 2018, prove that Einstein's theory still passes the test in extreme conditions.

## First observation of strongly magnetised neutron star with jets

A team of astronomers led by API's Jakob van den Eijnden was the first ever to use the Very Large Array (VLA) to observe a strongly magnetised neutron star producing jets. Thus far, general opinion held that the strong magnetic field prevented the formation of plasma streams because the gas was prevented from getting close enough to the neutron star. This new discovery opens a field of research in line with a recently developed model. 'For example, we can now test whether the rotational speed of an object determines the strength of the jets. Many jet models predict this, but up until now there was no strong proof for it,' says second author Nathalie Degenaar. The results were published by Nature in September.



A neutron star with a strong magnetic field (white circles) and two jets (broad vertical stripes). Around the start an accretion disk rotates (purple blue). Image: ICRAR/UvA.



The pulsar and the inner white dwarf are in a 1.6-day orbit. This pair is in a 327-day orbit with the outer white dwarf, much further away. Image: SKA Organisation.

# ‘New waves in

The research field of astrophysicist Selma de Mink is currently hip and happening. A story about massive stars, gravitational waves, the importance of fundamental research and collegiality.

‘The most fascinating thing about massive stars is that they are objects that really challenge us,’ says Selma de Mink. ‘I love how they require us to think of many use many different types of physics. You need to combine hydrodynamics, thermodynamics, classical mechanics, nuclear physics, quantum mechanics, particle physics, molecular chemistry, special and general relativity. It is a physics problem for people that want to go deep and be broad at the same time.’

## MacGillavry

De Mink became fascinated by astronomy when she was studying mathematics and physics at Utrecht University. She went on to get her Master’s and PhD in Astrophysics, both cum laude, which launched a fast-track career at, among others, NASA and CalTech. In 2014 she was offered the MacGillavry Fellowship at the University of Amsterdam’s Anton Pannekoek Institute for Astronomy, where she is now an Associate Professor. On top of this she also received the prestigious Marie Curie Research Fellowship, an ERC grant and a Vidi grant.

## Gravitational waves

Her main research interest lies with massive stars, especially binary stars. De Mink explains: ‘At the moment, gravitational waves are the most exciting new aspect of my field. My original field of expertise, the study of the evolution of stars, is a very classic field within astronomy. It blossomed midway through the last century, but after that, it got a bit quiet. But our recently acquired ability to detect gravitational waves made it hip and happening again. And it is so exciting to be in the middle of that.’

## Binary black holes

As an example of the impact of the detection of gravitational waves, De Mink says: ‘It has truly opened up a new research field. A few years ago we had no clue that such heavy stellar mass black holes existed. We certainly did not know that they come in pairs that merge. Now we have ten of such detections and this is only the beginning. This is the type of data we didn’t even dare to dream of a few years ago, an entirely new way to study these fascinating objects.’

## Big questions

This relates to De Mink’s answer when it comes to the importance of fundamental science. ‘Astronomy is about Big Questions. It tries to answer the question where we come from. In the end, we are all made from the dust of heavy stars from the earliest stage of the universe. Astronomy fascinates, offers us perspective. It makes you think about the fragility of life, and our planet.’

## Collaboration

Another thing that has changed for De Mink over the years is her perception of what it means to work as a scientist. ‘As a child I used to have this stereotypical idea of a scientist being someone who works alone in a room in the attic,’ she says, laughing. ‘But collaborations are so important. The more complex a question is, the more people need to work together to solve it, all with their own expertise.’

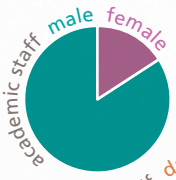
## Collegiality

‘I am very happy to work here at the University of Amsterdam,’ she continues, ‘because of the combination of a collegial and supportive atmosphere with very high quality research.’ Judging by the very large number of NWO and ERC grants you might think that it would be a very competitive place. But at the Anton Pannekoek Institute, everybody knows and supports each other. The level of collegiality is remarkable. That makes working at this institute really great.’ ■

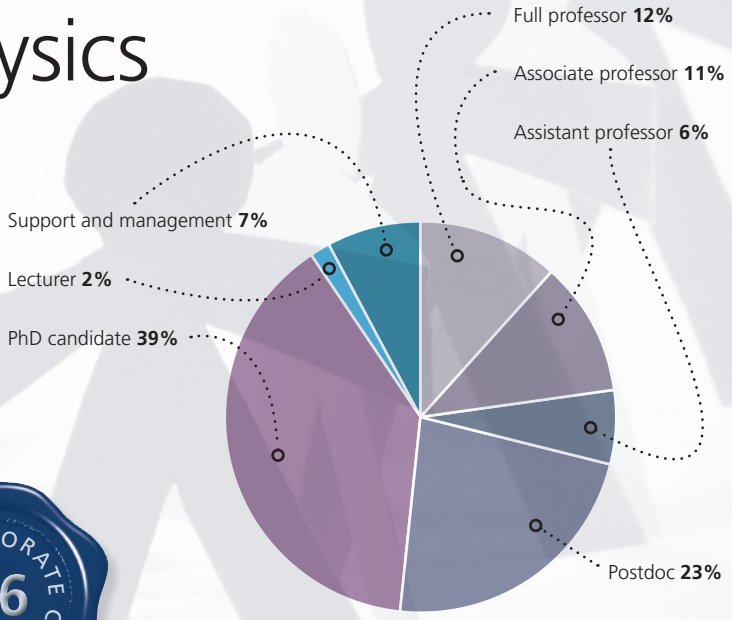
# an old field’

# Institute of Physics

**The Institute of Physics covers a broad spectrum of both experimental and theoretical physics. Topics range from string theory, particle physics and astrophysics to hard and soft condensed matter and quantum computing.**






people **180**

fte **169.2**

## A new era in the quest for dark matter

Since the 1970s, astronomers and physicists have been gathering evidence for the presence in the universe of dark matter: a mysterious substance that manifests itself through its gravitational pull. However, thus far, none of the new particles proposed to explain dark matter have been discovered. In a review that was published in Nature in October, IoP's Gianfranco Bertone and Tim Tait (IoP and UC Irvine) argue that the time has come to broaden and diversify the experimental effort, and to incorporate astronomical surveys and gravitational wave observations in the quest for the nature of dark matter. Combining current searches in experiments like XENON1T (see below) with these modern methods should give the search for dark matter a major boost in the near future.

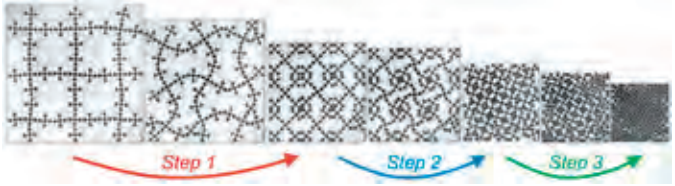
Technicians at work in the dark matter detector XENON1T. Photo: XENON1T.

## New results of dark matter detector XENON1T

In 2018, scientists of the XENON-collaboration, which involves several UvA physicists, presented new results of the most sensitive dark matter experiment in the world. Based on an unprecedented number of measurements, the results are in line with the expectation of only background noise in the detector. Patrick Decowski (IoP and Nikhef): 'The experiment itself is performing great, but possibly WIMPs (a category of dark matter particles) have an even smaller chance to collide with ordinary matter than we already thought. Another possibility is that dark matter consists of a different type of subatomic particle.'
His colleague Auke Pieter Colijn adds: 'Of course, we hoped to find dark matter particles, but they are hard to catch.
One year from now, we will have an even better detector, ten times more sensitive. Then, hopefully, we'll be able to outsmart nature after all.'

## Designing a self-folding metamaterial

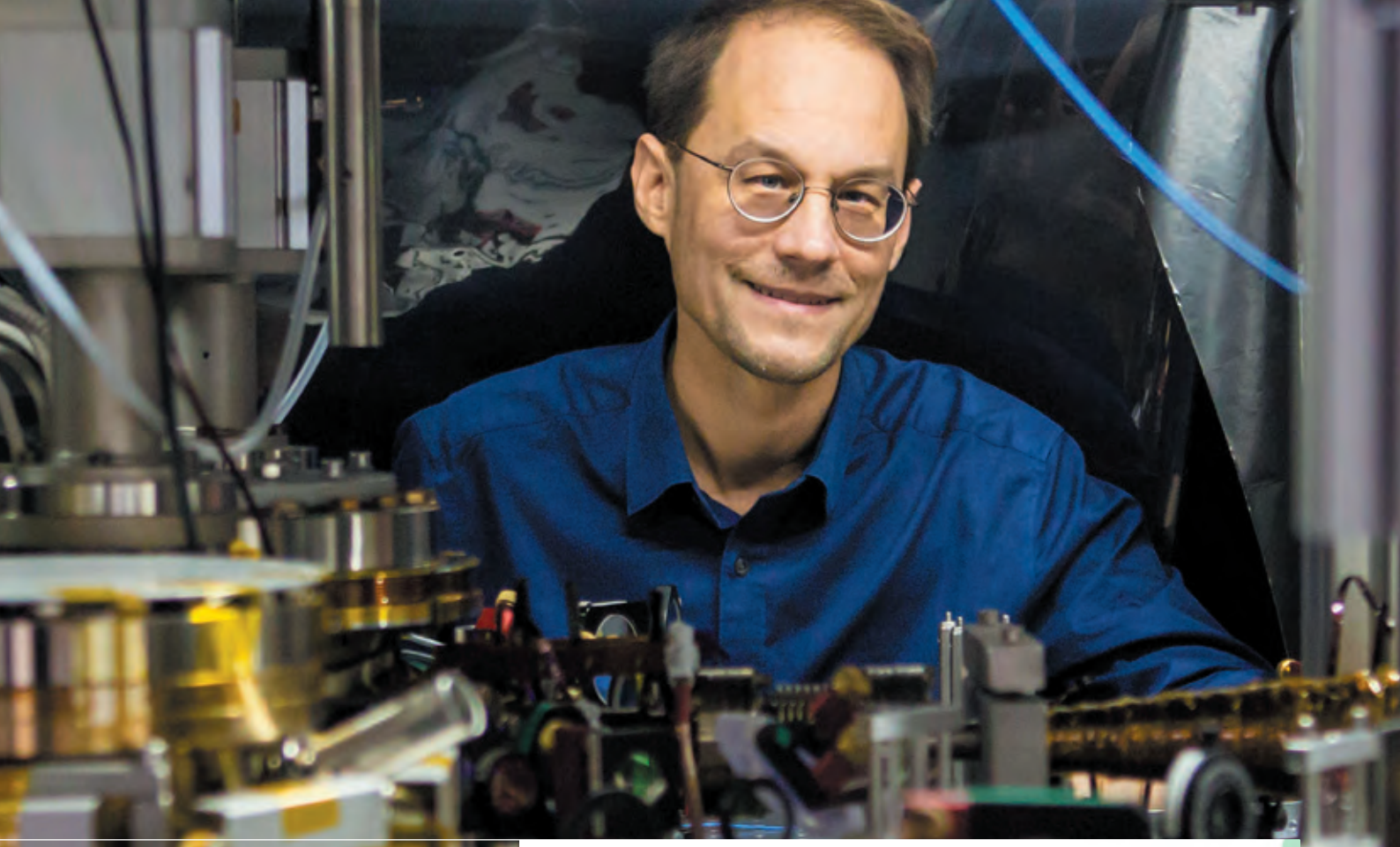
IoP's Corentin Coulais was one of the authors of a paper on self-folding metamaterials published in Nature in September. Together with colleagues from Leiden University, the researchers designed a construction that folds itself up by applying slight pressure on the sides and with an inbuilt correction mechanism, not unlike those found in nature. Coulais: 'Proteins fold themselves up in several steps, including inbuilt self-corrections.
In technology, however, such steps do not occur autonomously and several motors are required. We wanted to see if you could make artificial materials that have an inbuilt, automatic, multistage folding process so that folding motors are no longer required.' The results will have valuable applications in – among other things – space technology, where many small motors are often required to fold up an instrument.




A metamaterial that folds itself up in three steps. Image: M. van Hecke et al.

## Many colours from a single dot

Physicists Bart van Dam and Katerina Newell (Dohnalova), in collaboration with Emanuele Marino and Peter Schall (all UvA-IoP) and colleagues from the University of Twente and Jiljin University in China, demonstrated how a separate single nanoparticle can be used to emit different colours of light. Their results, which were published in the nano- and microphysics journal Small, show that so-called carbon dots may be a very efficient and versatile tool to produce light of all colours at tiny scales. Their tunable colour makes them an interesting material for, for example, bio-imaging, as they are more versatile than the organic dyes often used for this purpose.



# From quantum LEGO to quantum clock

Florian Schreck made quite a few heads turn in October 2018, when it was announced that the iqClock consortium, a brain child of Schreck and Yeshpal Singh (University of Birmingham), was granted €10 million from the EU Flagship Initiative for quantum technologies. Together with colleagues in Torun, Copenhagen, Vienna and Innsbruck and industry partners across Europe, the consortium aims to develop ultra-precise and easily transportable quantum clocks. So precise in fact, that they would go wrong by only a second if they were to run for fourteen billion years, the entire age of the universe.

Earlier in the year, Schreck and his team, together with colleagues from Nicolaus Copernicus University in Torun, Poland and from Durham University in the UK, published an article in Nature Physics. They had made a breakthrough that allows them to build ultracold molecules out of strontium and rubidium at temperatures only one millionth of a degree above the absolute zero temperature, thereby expanding the set of available 'quantum LEGO' building blocks from which ultracold molecules can be made. Schreck: 'With this knowledge, it should soon be possible to make an ultracold, high density gas of rubidium-strontium molecules.'

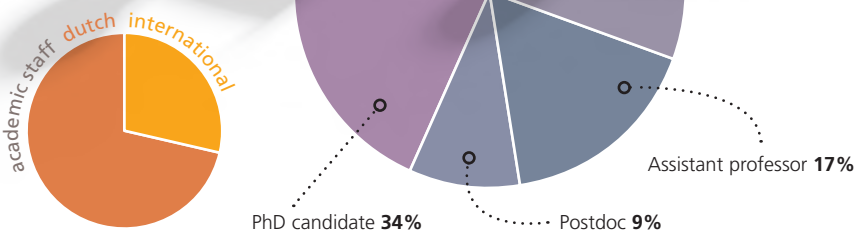
A dense gas of such particles has exciting applications in tests of fundamental physics, quantum-controlled chemistry and the study of many-body systems. And, indeed, in the building of a quantum clock. Clocks that can be used to increase navigation system precision to the scale of centimetres, revolutionising the way in which we measure the Earth. Or in astronomy, for the ultra-precise synchronization of telescopes all over the planet into what is effectively one giant telescope the size of Earth. Transportable optical clocks are also great for the detection of gravitational waves by satellites that are thousands of kilometres apart. A more practical application lies in increasing the performance of telecommunication networks. And then, of course, there is always the unexpected: when new technology becomes available on a wide scale, industry will inevitably find novel ways to employ it.

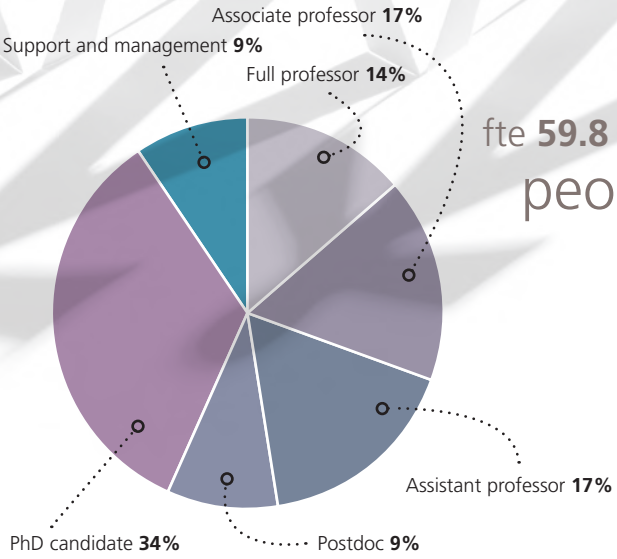
As Schreck himself phrases it: 'Ten years from now, we will probably still be late for appointments, but super-precise clocks may very well have changed the way we look at our planet and the universe.'

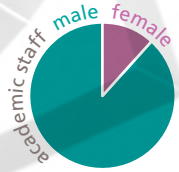
Florian Schreck in his lab at the UvA Faculty of Science. Photo: Liesbeth Dingemans.

# Korteweg-de Vries Institute for Mathematics

**The Korteweg-de Vries Institute advances the science of mathematics, both in its theoretical and applied aspects, and aims to stimulate the application and appreciation of mathematics in other academic disciplines and in society as a whole.**




fte **59.8**

people **65**


## New applications of dynamical systems in graph theory

KdVI is highly visible in an exciting new direction of research on the interplay between graph theory, statistical physics, algorithmic complexity and dynamical systems. Han Peters and Guus Regts solved a conjecture of Sokal concerning roots of the independence polynomial. The research crosses traditional boundaries between research groups in the institute, and includes interactions and collaborations with physicists and theoretical computer scientists, leading to surprising new results.

## Eric Opdam invited speaker at the Abel Conference in honour of Robert Langlands

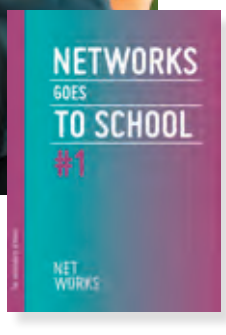
Eric Opdam was an invited speaker at the Abel conference celebrating the work of Robert P. Langlands, who was the recipient of the 2018 Abel Prize for 'for his visionary programme connecting representation theory to number theory.' The Langlands programme, a web of far-reaching and influential conjectures about connections between number theory and geometry proposed by Robert Langlands (1967, 1970), is one of the focus areas of KdVI's research programme Algebra, Geometry and Mathematical Physics.

## Special issue of Journal of Statistical Physics devoted to Complex Networks

Complex networks constitutes a multi-disciplinary research field that is rapidly growing and diversifying. It is a crossroad of concepts, ideas and techniques that brings together scientists from different disciplines, all facing the major challenges that arise from dealing with the measurement, simulation, modelling and analysis of (typically very large) real-world networks, as well as with questions of their optimisation and control. Networks are center stage in probability theory, combinatorics, algorithmics, statistical physics, population genetics, and complexity science. In 2018 the Journal of Statistical Physics devoted a special issue to Complex Networks. KdVI's Michel Mandjes, project leader of the national NETWORKS gravitation programme, was one of the editors.

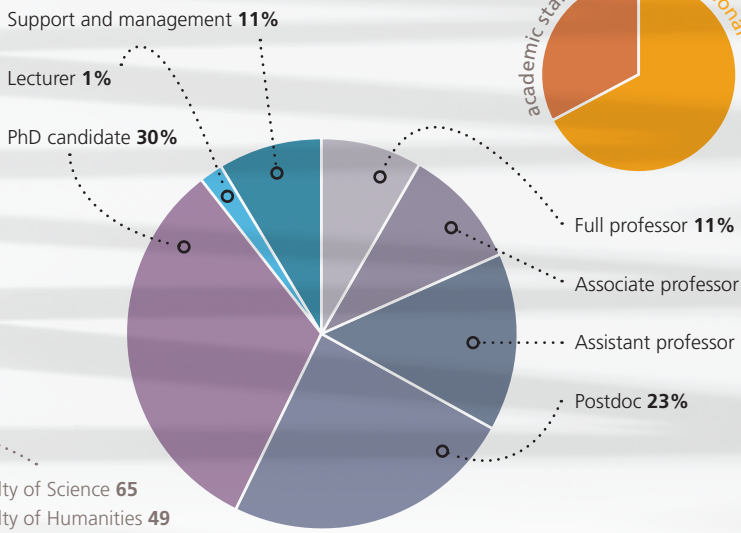
**NETWORKS goes to school**

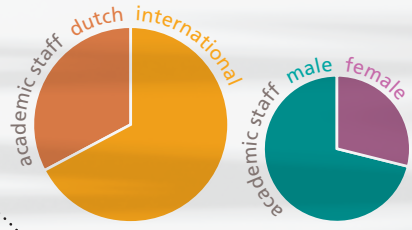
On 18 and 23 April UvA and Leiden University hosted a masterclass on networks and their applications for students from international schools in the Netherlands and their teachers. Driven by an intrinsic interest to expand their mathematical knowledge, about 25 students participated in the programme, which consisted of lectures, discussions, games and reading sessions. The course materials were later bundled in the 'NETWORKS goes to school' workbook for use in the classroom. Photo: NETWORKS.



# Institute for Logic, Language and Computation

**ILLC studies the processes involved in the encoding, transmission and comprehension of information. The concept of 'information' is given a broad interpretation, encompassing not only the characteristics of formal languages and information flows in natural language processing, but also human cognitive activities such as reasoning and listening to music.**




Faculty of Science **8**
Faculty of Humanities **5**

13 DOCTORATE CONFERRALS

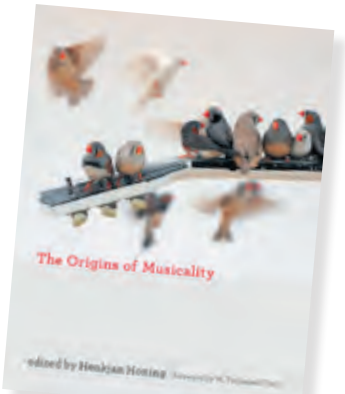
people **114** Faculty of Science **65** Faculty of Humanities **49**

fte **100.2** Faculty of Science **57.7** Faculty of Humanities **42.5**

## Multi-year machine translation project bears fruit

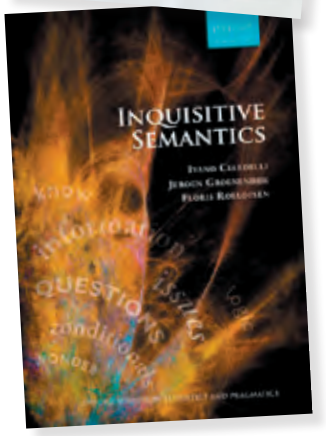
Translating a policy document or legal text requires a completely different vocabulary and a different type of translation than, for example, a newspaper report. For proper machine translation it is necessary to train the machine with reliable sources and datasets that contain the relevant type of words. In 2013, a project called DatAptor, led by ILLC's Khalil Sima'an, received a major grant from technology foundation STW to deal with this problem. And with success. The results have now been implemented by TAUS, an important think tank in the field of machine translation. They offer the new technology under the name Matching Data.


## Notable publications by ILLC researchers




**The origins of musicality, Editor: Henkjan Honing**
This volume offers interdisciplinary perspectives on the capacity to perceive, appreciate and make music. Scholars from biology, musicology, neurology, genetics, computer science, anthropology, psychology and other fields consider what music is for and why every human culture has it; whether musicality is a uniquely human capacity; and what biological and cognitive mechanisms underlie it.

**Judgment Aggregation with Rationality and Feasibility Constraints, Ulle Endriss**
In this conference paper presented at AAMAS 2018, Endriss introduces a model of judgment aggregation that allows for an explicit distinction between rationality and feasibility constraints. He also illustrates how it can be used to simulate several common voting rules, including the well-known Borda rule, for which finding a natural counterpart in judgment aggregation has long been an elusive quest.



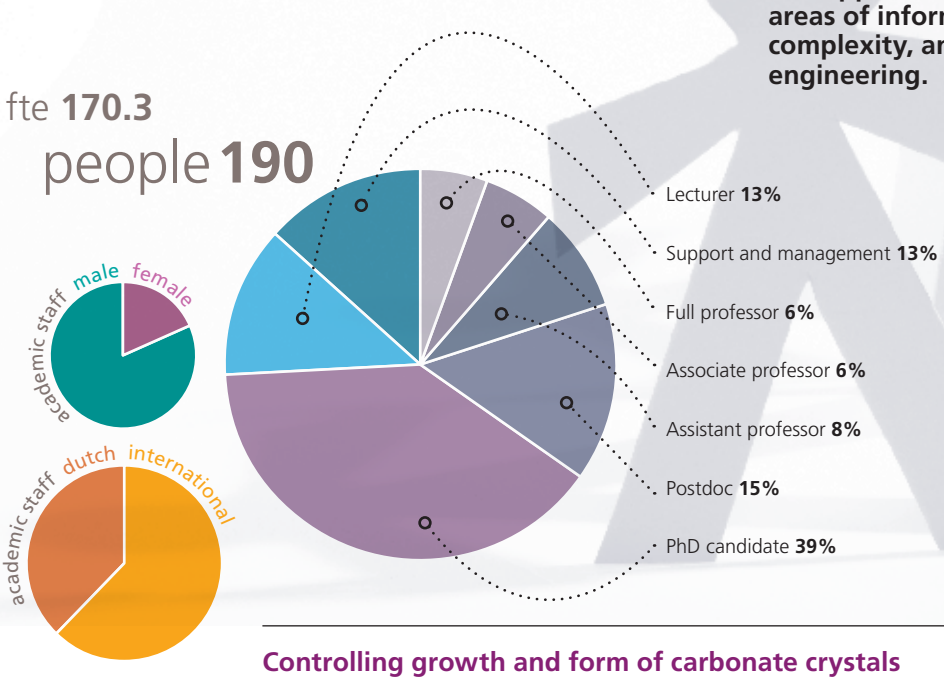

**Inquisitive semantics, Ivano Ciardelli (LMU, Munich) and Jeroen Groenendijk and Floris Roelofsen (both ILLC)**
Inquisitive semantics presents a new logical framework to capture the meaning of sentences in conversation. The traditional approach equates meaning with truth-conditions: to know the meaning of a sentence is to know under which circumstances it is true. This volume provides a new formal notion of meaning, which makes it possible to model various concepts that are crucial for the analysis of linguistic information exchange in a more refined and principled way.

# Informatics Institute

**The Informatics Institute (IvI) conducts fundamental and applied research in the areas of information, complexity, and system engineering.**

fte **170.3**

people **190**





## Controlling growth and form of carbonate crystals

In a study published in PNAS, an international research team, including Jaap Kaandorp from the Computational Science Lab, presented new results about bio-inspired controlled crystal growth using experiments and computational models. The results highlight that even the simple interplay between different physical and chemical phenomena already can lead to highly complex shapes. Understanding and ultimately controlling these processes forms a formidable fundamental challenge with direct practical ramifications in fields ranging from medical implants for the promotion of bone growth, to completely artificial functional materials such as optical micro-architectures.

Growth and form of BaCO3 crystals (in pink and white) nucleated on CaCO3 crystals (blue). Image: Ling Li, Jinjin Zhong (Virginia Tech.) and Wim Noorduin (AMOLF).

A shanty town in Bangalore. Photo: Chloe Pottinger Glass.

## New data yields deeper understanding of poverty in India

An international study led by UvA researchers Peter Sloot and Michael Lees has yielded extensive data on slums in Bangalore, providing a detailed insight into the problem of poverty in India. The highly granular data, which was collected through a field survey of 36 slums, could lead to a better understanding of poverty and to more effective strategies for managing and improving conditions for slum dwellers. The results were published in the journal Nature Scientific Data.

## Cees Snoek presents first-ever body language recognition software

Human body language can only be understood if you can visually recognise someone's gestures, posture, eyes and movement. This applies to both people and computers. Until now, automated visual monitoring that identifies what people are doing in video footage did not exist. But during his inaugural lecture on video intelligence on Friday, 14 December, Cees Snoek, professor of Intelligent Sensory Information Systems, gave a preview of the world's first-ever body language recognition software. The software, developed by UvA spin-off Kepler Vision Technology Ltd, 'looks' into videos and recognises a human's body language, body poses and actions. 'Video intelligence brings together computer vision, deep learning and artificial intelligence and is developing rapidly. In the near future, it will be possible for software to interpret video images better and quicker than any human can,' says Snoek, who is also Chief Scientific Officer at Kepler.

Artist impression of a virtual digital twin. Image: CompBioMed.

## Your digital twin: closer than you think

Imagine your doctor has a digital copy of you stored on his or her computer. Your digital twin is like a volunteer that is always there for you, on which treatment of any disease you may have can be tested. This virtual clone can breathe and walk, but can also break a leg or develop cardiovascular diseases. It might sounds futuristic, but researchers around the world, including IvI's Alfons Hoekstra and Peter Sloot, are working on making this a reality as part of the European research consortium CompBioMed. In March, the consortium published a video on YouTube explaining the concept of the Virtual Human.

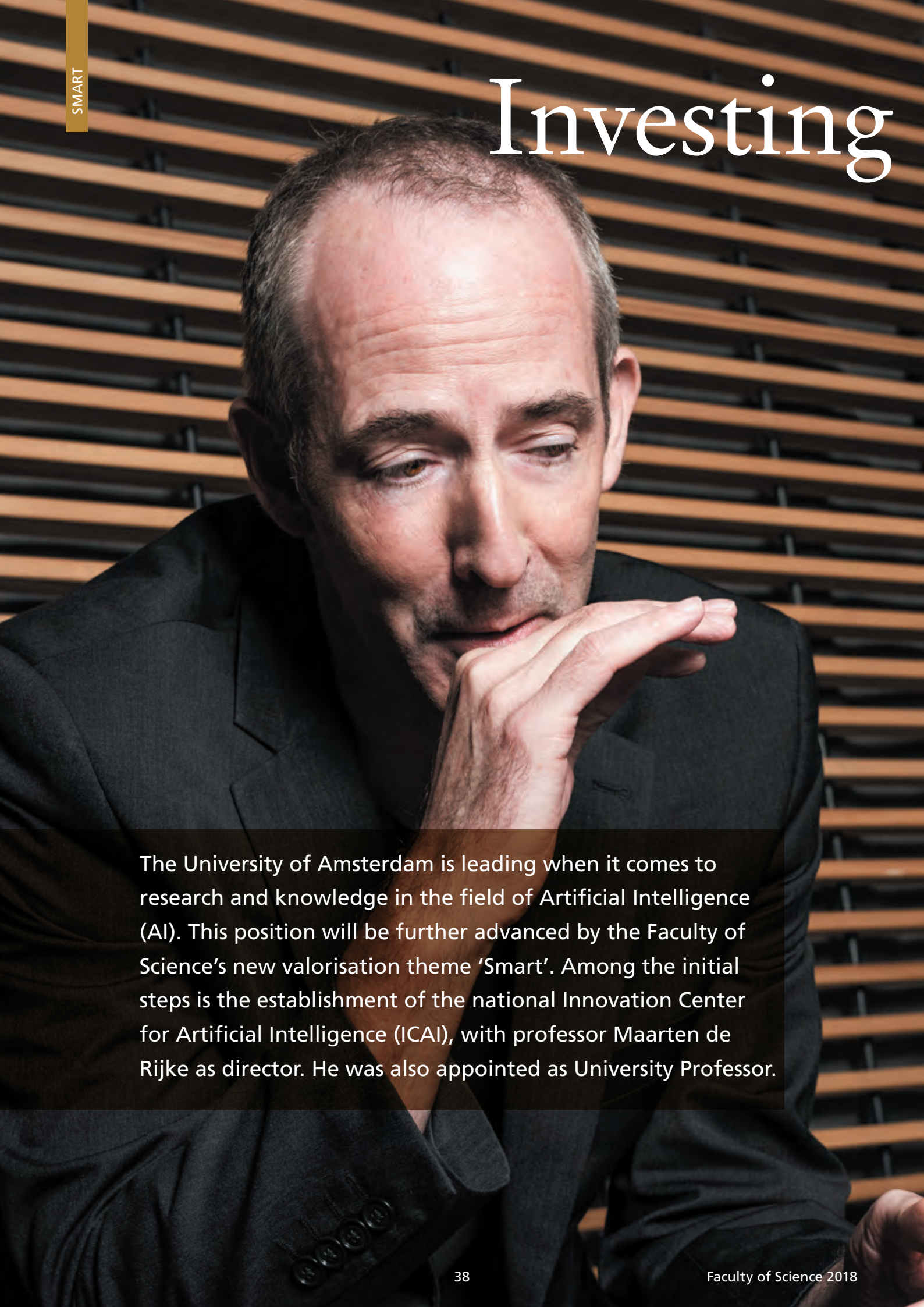
Under the constraints of a shrinking caregivers workforce, body recognition software can help the elderly to live independently for as long as possible. Photo: Kepler Vision.

## Conferences

**Computer vision:** Six publications by researchers from the Informatics Institute were accepted to be presented at the leading IEEE Conference on Computer Vision and Pattern Recognition (CVPR), held in Salt Lake City in June – a record for a Dutch University. CVPR is the only conference in the Top 100 of most cited sources in Google Scholar, which further consists of journals and arXiv preprints.

**Machine learning:** Three conference papers from UvA Informatics researchers were accepted by the leading International Conference on Machine Learning (ICML) and another five by the Uncertainty in Artificial Intelligence conference (UAI). With general acceptance rates of both conferences being low (ICML: ~25% and UAI: ~30%), these numbers demonstrate that the Informatics Institute is successful in its mission of being a leading AI institute in the world. It is worth noting that three of the co-authors of the accepted articles, Tim Davidson, Luca Falorsi and Nicola De Cao, were MSc students.

# Investing



The University of Amsterdam is leading when it comes to research and knowledge in the field of Artificial Intelligence (AI). This position will be further advanced by the Faculty of Science's new valorisation theme 'Smart'. Among the initial steps is the establishment of the national Innovation Center for Artificial Intelligence (ICAI), with professor Maarten de Rijke as director. He was also appointed as University Professor.

# in Smart

Just like the Faculty of Science's other valorisation theme, 'Green', 'Smart' stands for many things. It describes our strength in the field of quantum mechanics, and the ability of our researchers to use new technologies to find smart solutions for all kinds of challenges within society. And obviously, Smart also stands for AI.

## Search Engines

Professor Maarten de Rijke of the Informatics Institute is one of the University's leading researchers in AI. He is specialised in information retrieval. 'I focus on systems that connect people to information: search engines, recommender systems, conversational systems,' says De Rijke. 'The systems my team and I work on try to understand documents and they try to understand people's information needs and intents. Behaviour is difficult to interpret, even for humans. And people's intents are notoriously hard to fathom. Moreover, they change while people interact with a search engine or recommender system. This makes it complex for a machine to understand. What makes it AI, is that systems like these rely heavily on machine learning techniques and on learning from their interactions with people.'

## Cross connections

In September 2018 De Rijke became the first of the UvA's four new University Professors with a focus on AI. Their task is to get involved in topics that transcend their own institute or faculty. De Rijke: 'There are many algorithmic challenges in AI and the Faculty of Science harbours some really top notch talent to tackle those challenges. But technology doesn't exist in isolation. How can we use it to help solve today's societal challenges? And the technology has socio-economic implications as well as ethical and legal impact. It is important that we exploit the fact that we are a broad-based university with a rich set of disciplines. Under a single roof, we develop AI technology, we push the envelope in AI application areas such as medicine or retail, and we reflect on the legal and ethical impact of AI.'

There are now five University Professors here at the UvA. Three more will be appointed shortly: one of them in the practical application of AI, one in the field of Humanities, and one in Law. De Rijke: 'It is up to us to grow university-wide collaborations around AI and to deepen cross connections between our fields so as to help not just our disciplines but advance society.'

## ICAI

Next to his professorship De Rijke is also director of the newly launched national Innovation Center for Artificial Intelligence (ICAI), which aims to establish an environment for AI innovation based on public-private collaborations. It is a federation of public-private collaborations in AI ('labs') that is meant to grow the AI ecosystem in the Netherlands, by creating new knowledge and by attracting, training and retaining AI talent. Its head office is located at Amsterdam Science Park. At present, ICAI labs are located in Amsterdam (Science Park and Zuidas), Delft and Utrecht, with further labs planned to launch at every other Dutch university with an AI programme. In a few years ICAI will move into a to-be-developed building next to Science Park 904, which will also house UvA's Informatics Institute and the Institute for Logic, Language and Computation, and offer accommodation for start-up and scale-up companies.

## Investments

'Artificial Intelligence is the most important technological development of our time. The countries surrounding us have already invested heavily in it. Not just in the technology, but also in talent programmes, in regulation, and in leaving no-one behind. Here in the Netherlands, a national AI strategy is missing and governmental investments in AI are noticeably absent,' says De Rijke. 'We need to take action ourselves. I am really excited about the new developments here at the UvA: investments in AI staff across the university, in a research priority area, and in a new building here at the Science Park. These are bold moves that are incredibly important for AI in The Netherlands.' ■

### Elsevier AI Lab

In October it was announced that the University of Amsterdam and VU University Amsterdam will partner up with Elsevier to open the Elsevier AI Lab within ICAI. The lab offers data scientists from Elsevier the opportunity to collaborate with academics, contribute to teaching and conduct doctoral research. At the same time, academics gain better insights into how AI is used in practice. Alexander van Boetzelaer, Executive Vice President at Elsevier: 'The Elsevier AI Lab gives a new impulse to the collaboration between academia and industry. We will gain insights on how to best service our clients. At the same time, with our head offices also located in Amsterdam, we invest in the talent development, job creation and attracting AI talent to the region.'

### AIRLab: AI for retail

In April, the first AI lab within ICAI was announced. In AIRLab, a partnership with Ahold Delhaize, seven PhDs will conduct research into socially responsible algorithms that can be used to make recommendations to consumers and into transparent AI technology for managing goods flows for the Ahold Delhaize brands Albert Heijn and bol.com.

In addition, AIRLab will focus on talent development tracks. Frans Muller, deputy CEO Ahold Delhaize: 'We look forward to working with ICAI. Artificial Intelligence offers countless possibilities for the retail industry, the consumer and society at large.' De Rijke adds: 'This partnership is of major importance because with it we are making a serious investment in the development of AI talent and AI technology outside of the traditional technology sector.'

Artist impressions of the new building. Copyright: Benthem Crouwel Architects.

# New building

WITH CONTRIBUTION FROM
CITY OF AMSTERDAM

In March, the University of Amsterdam announced plans to invest in a new building at Amsterdam Science Park where education, research and collaboration in the information sciences all come together.

An increase in students, staff, PhD candidates and new partnerships means that Science Park 904 is no longer large enough to house the entire Faculty of Science. Seizing the opportunity, the UvA decided to combine the need for more space with the desire to foster more intensive collaboration with industry and social partners in the information sciences in general and Artificial Intelligence in particular.

**UvA President Geert ten Dam:**
'In recent years we have established excellent partnerships with, among others, Bosch in the Deltalab and Qualcomm in the QUVA lab. In this new building we can create more of these types of partnerships in order to tackle the technological and social challenges of AI. Artificial Intelligence offers numerous opportunities for issues relating to health care, safety and sustainability. Because AI also has major legal, ethical and cultural implications, the UvA as a comprehensive institution is ideally equipped to research these aspects from various disciplinary perspectives.'

**City of Amsterdam pledges €4 million for new build**
The City of Amsterdam is contributing €4 million to the initiative. Simone Kukenheim, alderman for Education: 'By establishing an Artificial Intelligence hub at Amsterdam Science Park, the City of Amsterdam and the UvA will strengthen Amsterdam's knowledge economy as well as the position of Amsterdam and Amsterdam Science Park as one of Europe's most important centres for science education and research.'

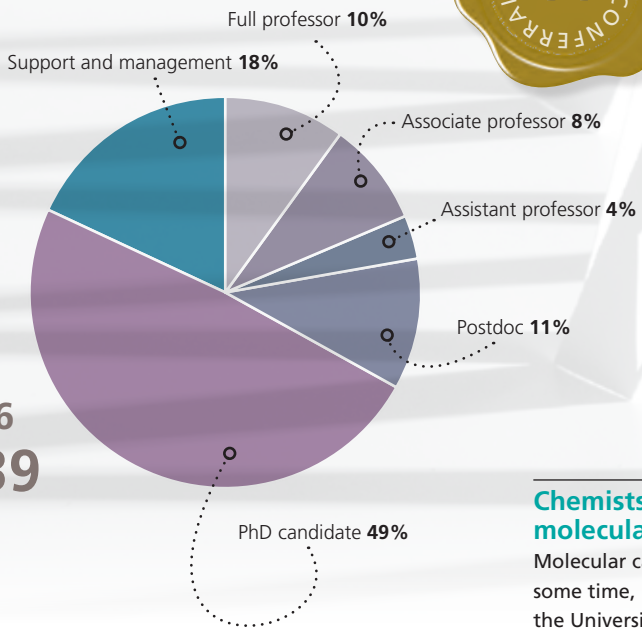
**Benthem Crouwel selected to design the new building**
After a European tendering procedure, Benthem Crouwel Architects were selected to design the new building, provisionally called ASP942. The winning design from Benthem Crouwel Architects stood out in particular because of the way in which the building will be able to capitalise on its usage; less use will mean less heating, whereas more intensive use will result in a notification being sent to Building Management telling them that the toilets will need to be cleaned more often, for example. Neatly arranged spaces will ensure ample daylight and views and plenty of plants will lend the building a pleasant, healthy indoor climate.

**Architect Joost Vos: 'Sustainability is integral to our design'**
Joost Vos from Benthem Crouwel Architects is responsible for the design of the new building. The architect designed a flexible building, that allows for moving around floors and walls. Creating a sustainable and healthy environment is integral to its design. 'That means responsible use and reuse of materials, optimal use of daylight and natural heat from the sun wherever possible, lots of green and an energy-saving heat-cold storage.'

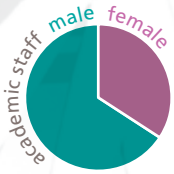
The architects also have the ambition to pioneer in certain areas. 'For example, is it possible to 3D print internal walls or sun screens making use of our own waste? Or can we reuse concrete from demolished buildings? It would be great if we can show this is possible and contribute to research in these areas.' ■

# Van ‘t Hoff Institute for Molecular Sciences

**The Van ‘t Hoff Institute for Molecular Sciences (HIMS) performs internationally reknowned chemistry research, curiosity driven as well as application driven, within four recognisable themes: Computational-, Analytical- and Sustainable Chemistry, and Molecular Photonics.**






fte **126**

people **139**

## RESEARCH HIGHLIGHTS

Francesco Mutti at work in his lab. Photo: Liesbeth Dingemans.

### Biocatalysis project showcased in magazine ‘EU Research’

The European research project Biosusamin and its principal investigator Dr Francesco Mutti featured in the summer edition of the magazine ‘EU Research’. The Biosusamin project, funded through Francesco Mutti’s ERC Starting Grant, aims at developing biocatalytic cascades for producing amines from renewable resources in a process that minimizes waste. In general, research in Mutti’s lab aims at the development of novel atom-efficient and sustainable biocatalytic routes for the manufacture of high value chemical products and materials.

### Chemists make bicycle-like molecular drive

Molecular cars have been known for some time, but scientists at HIMS and the University of Murcia have now synthesized molecules that operate like the pedals of a bicycle. Fueled by light, the molecules can be used as molecular switches that pave the way for the design of functional molecular systems effective under severe spatial restrictions.

Image: HIMS.

### Oil paint from the lab offers insight into ageing of Old Masters

A team of chemists from HIMS and the Rijksmuseum has uncovered new details about the ageing processes in oil paintings. A specially developed model paint was rapidly aged, while the process was continuously followed with infrared spectroscopy. The experiments showed that ‘metal soaps’, a class of compounds that are often associated with paint degradation, form rather easily if an oil paint contains free fatty acids. Lambert Baij, Joen Hermans, Katrien Keune and Piet Iedema published their results in the prestigious journal Angewandte Chemie.

In the ‘Still Life with Asparagus’ (1697) by Coorte, the white paint of the asparagus has become transparent as a result of the aging of the paint; the dark underpaint shines through at the end of the asparagus. Image: Rijksmuseum.

Jan van Maarseveen presents his pretzel-like double ring peptides to representatives of chemical industries at ACID 2018

## VALORISATION HIGHLIGHTS

**Sustainable Chemistry**

Turn to page 50 for highlights in the area of Sustainable Chemistry.

### Sparkling launch for new HIMS spin-off 'Spark904'

In May, Spark904, a spin-off company by HIMS, was launched at the Startup Village at Amsterdam Science Park. Spark904 provides access to the state-of-the-art and routine analysis equipment of universities and premier institutes, for outsider scientists who so far had no access - at least not on a day-to-day basis. But founder and director Monalisa Goswami stressed that Spark904 is not merely a matching platform: 'Once the match is made, we perform the analysis and analyse the data. So we are a real research and knowledge partner.'

### 'Behind the scenes' at Amsterdam Chemistry Innovation Day

On Friday 19 October, HIMS, together with the Innovation Lab Chemistry Amsterdam and the Port of Amsterdam, hosted the annual Amsterdam Chemistry Innovation Day (ACID).
The Royal Association of the Dutch Chemical Industry VNCI joined in with the celebration of its 100th anniversary. The event attracted 180 participants, ranging from students to researchers and captains of industry. VNCI chairman Bernard Wientjes concluded by emphasizing the importance of chemistry for the sustainability of our society and the transition to a circular economy.

### Sophisticated free app for molecular visualization

A team of computational chemists including HIMS' David Dubbeldam launched a freely available, sophisticated app for molecular visualizations. iRASPA is a visualization package with editing capabilities aimed at materials science. It produces high quality images of complex molecules, metals, metal-oxides, ceramics, biomaterials, zeolites, clays, and metal-organic frameworks.
A commenter in the app store writes: 'A must have for any scientist working with porous materials.'

Spark904 founder Monalisa Goswami toasts with Jan Overberg, CFO of UvA Ventures Holding at the launch of Spark904.

Visitors get a tour of the HIMS laboratories during ACID 2018.

A pair of vigilant sooty mangabey monkeys. Photo: Bryndan van Pinxteren for Tai Chimpanzee Project.

## Mangabey monkeys profit from nut-cracking skills of chimpanzees

An international team led by IBED's Karline Janmaat is the first to describe nut scavenging behaviour of sooty mangabey monkeys. The monkeys scavenge on the energy-rich remnants of nuts cracked by chimpanzees and red river hogs. This allows them to obtain the inside of nuts, which they would not have been able to have obtained otherwise. The results, which were published in the American Journal of Primatology, reveal previously unknown interactions between different species and give more insight into the origin of human decision-making skills. Janmaat, who calls the mangabeys' behaviour intriguing: 'Sometimes the monkeys seem to be scared of these potential yet infrequent predators, while at other times they approach chimpanzees within metres to profit from their tool-using skills, almost as if they have learned to anticipate the other species' "mood".'

Nutcracking chimpanzee. Photo: Liran Samuni for Tai Chimpanzee Project.

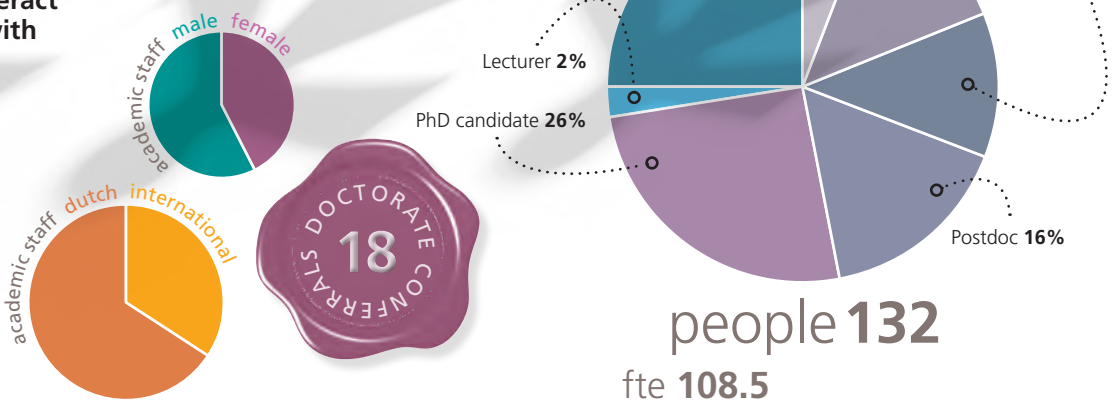
## Biggest palm fruits increasingly disappear from rainforests

In a study published in Proceedings of the Royal Society B, IBED's Renske Onstein and Daniel Kissling showed that palm trees around the world adapt differently to global change. Latin American palms with the largest fruits seem to have gone extinct with increasing rates, whereas large-fruited palms in South-East Asian regions seem to be adapting by producing smaller fruits. Kissling: 'Large-fruited plants have it increasingly difficult to survive in our human dominated world. The loss of large animals due to, for example, hunting or habitat loss, leads to a reduced seed dispersal and less regeneration of these tall and massive plants.'

A bird feeding on palm fruits. Photo: Daniel Kissling.

# Institute for Biodiversity and Ecosystem Dynamics

**IBED aims to increase our understanding of the diversity and dynamics of ecosystems, from the molecular and genetic level to entire ecosystems. How do organisms interact with each other and with their non-biological environment?**



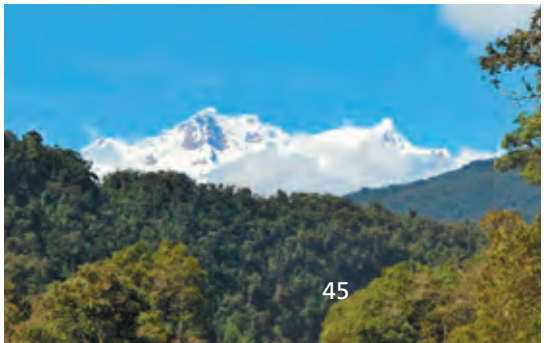

## Peter de Ruiter retires, Annemarie van Wezel takes over as scientific director

In October, it was announced that Annemarie van Wezel would succeed Peter de Ruiter as IBED's scientific director. De Ruiter retired at the end of the year. Starting 1 January 2019, Van Wezel was also appointed professor of Environmental Ecology, embedded within the research department Freshwater and Marine Ecology.

Annemarie van Wezel. Photo: Dirk Gillissen.

## Ecosystem shows resilience to prolonged human modification

The cloud forests of the Andes are some of the most biodiverse and endangered terrestrial environments on earth. 'To successfully conserve and restore these forests, it is essential to understand their history', says palaeoecologist Will Gosling. In a collaboration with colleagues from Spain and the UK, the biologists reconstructed the human impact on the cloud forests of Ecuador in the Quijos Valley for the past 1000 years and demonstrated that it takes the cloud forest about 130 years to recover from human impact. The findings, published in Nature Ecology and Evolution offer hope that areas degraded by intensive agriculture can, in time, be restored. Gosling: 'A question that remains is how characteristic this region is of the Andes as a whole. Our aim is to expand the scope of our research across the eastern Andean cloud forests of Ecuador.'



The Andes. Photo: Nick Loughlin (Flickr CC).

## Global expansion of cyanobacterial blooms

An international team of scientists led by aquatic ecologist Jef Huisman published a review about the worldwide expansion, causes and risks of cyanobacterial blooms in Nature Reviews Microbiology. Toxic cyanobacteria have become a growing concern in the water-quality management of lakes and brackish waters across the globe. The review summarizes several insights, information and solutions for these blooms.

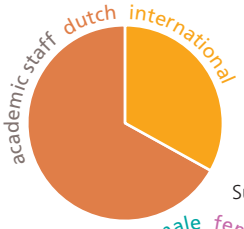
## The long history of biodiversity patterns

The biodiversity patterns on volcanic oceanic islands that we see today have been shaped by the way island groups were arranged during long-term sea levels fluctuations in the distant past. The findings of the study, published in Global Ecology and Biogeography, highlight the importance of considering the duration and frequency of different archipelago configurations in the past. 'It is now clear that the influence of past sea levels on island biodiversity goes back much further in time than we previously thought,' says PhD candidate Sietze Norder, who was first author on the study.

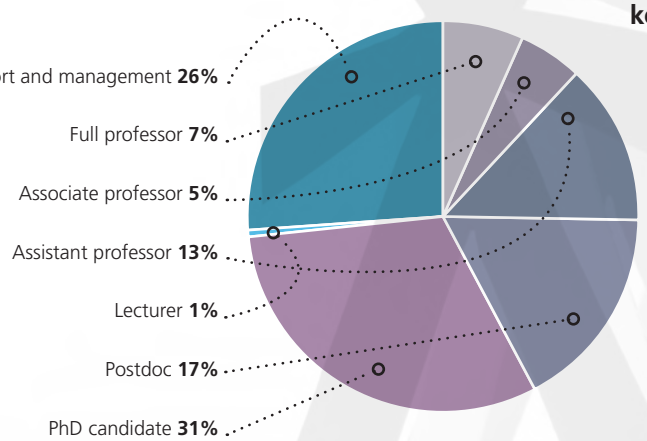
Volcanic oceanic islands São Jorge and Pico, seen from Terceira. Photo: Paulo Borges.

# Swammerdam Institute for Life Sciences

**Research at SILS spans the biological processes in humans, animals, plants and micro-organisms. The exchange of information and extension of research across disciplinary boundaries is a key characteristic.**








people **208**
fte **199.8**


A new forensic tool will make it possible to predict a person's age based cells in the blood.

## Epigenetic-based chronological age-prediction: a new tool for forensic case work

A team of researchers led by Pernette Verschure and Ate Kloosterman has developed an age prediction tool for forensic application based on measuring epigenetic DNA methylation changes in white blood cells. The tool is expected to become useful for forensic case work. For instance to narrow down a pool of suspects, to help identify unknown persons, or to determine illegal movement of individuals below adult age across borders. The team's findings were published in three successive articles in Forensic Science International: Genetics.

## Researchers discover human-specific genes possibly responsible for larger brain

The evolution of larger brains in the last 3 million years played an important role in our ability as a species to think, problem-solve and develop culture. Two international studies, one co-led by Frank Jacobs, have identified a gene family, called NOTCH2NL, that appears to play an important role in human-specific cortex development and may have been a driving force in the evolution of our brains. 'We are only beginning to understand what different dosages of NOTCH2NL might do to our brains,' says Jacobs. 'The optimal dosage of NOTCH2NL may as yet be unsettled in our species and is perhaps subject to ongoing evolution as part of normal human variation.' The results were published on 31 May in the journal Cell.

## Differences in DNA modifications are sufficient for hybrid vigour

It was thought for a long time that hybrid vigour – the phenomenon that the offspring of two different parents perform better for a given trait than the parents – is only the result of genetic differences between the parental lines. Research by, among others, SILS-biologists Kathrin Lauss, Rurika Oka and Maike Stam shows that not only the DNA building blocks, but also the differences in the amount of chemical modifications present can lead to better properties. The results were published in Plant Physiology.

Researchers have discovered an enzyme that helps plants survive frost.

## Oil enzyme protects plants from freezing

Cold temperatures can lay waste to crops. An international research group led by Steven Arisz from the lab of Teun Munnik has shed light on a novel metabolic pathway that helps plants to survive frost. They discovered an enzyme which produces an oil, triacylglycerol, that protects the plant against the formation of ice crystals. Such crystals damage the plant cells. The study was published in Plant Physiology.

'A banana plant of the Gros Michel variety in Costa Rica attacked by the wilt organism.' From: Banana Wilt (1919), E.W. Brandes.

# Biologists find potential Achilles heel of infamous banana fungus

The team of SILS biologist Martijn Rep has uncovered a potential Achilles heel of the infamous fungus Fusarium oxysporum. Banana plantations worldwide are currently under threat from this fungus, that causes banana plants to wither and die. With a related fungal disease in tomato plants in mind, Rep's team identified a protein and the associated gene that makes the fungus so extremely aggressive. Rep: 'We can now start looking for a banana variant that is able to 'recognise' this fungal protein, and is therefore immune to the disease. Similar to what has been done with tomato plants.'

**Professor Michel Haring is principal investigator within the Faculty of Science's Green Life Science research section and also presides over the board of the Amsterdam Green Campus initiative. He explains the many meanings of 'Green', which – next to 'Smart' – is one of the Faculty's core valorisation themes.**

'In The Netherlands, people usually do not think about Amsterdam when you mention green research,' says Haring. 'But here at the UvA we have more than 150 researchers that have dedicated themselves to this topic.'

'Green' stands for different things; it can be biology, chemistry or physics. The central issue is the transition towards a more sustainable society. Whether it is through sustainable energy solutions, such as improved solar panels, renewable materials and new recycling techniques, or solutions for more sustainable crop management. All are research themes here at the UvA's Faculty of Science.

Haring himself is a researcher in the field of plant physiology. He summarises: 'We study the impact of the outside world on plants, and the other way around, the impact of plants on their environment.' He and his colleagues are mainly interested in plant-insect interactions. They study volatiles that plants produce in response to an attack by insects, and their effect. These compounds can for instance be toxic to insects, but can also be a warning to other plants that a threat is just around the corner. Volatiles can also attract natural enemies of pests. Useful knowledge in a world that increasingly calls for more sustainable and environmentally friendly agricultural methods. 'We don't work in isolation,' Haring stresses. 'If you want your work to have any real impact, it is very important to collaborate. We work closely with main players in the world of plant breeding and agriculture. And we disseminate our knowledge internationally through the many seminars we organise.'

Haring also aims to bring the Faculty's ecology, life science and chemistry institutes closer together in the Amsterdam Green Campus.

'At the moment we are setting up joined projects. In the future we also want to offer courses and workshops for both biology, chemistry and physics students. Students nowadays don't think in terms of the traditional fields of science. They are focused on the big questions. Climate change, sustainable food production, circular economies or changes in biodiversity. If you want to be innovative, it helps to put different types of minds together.'

The Amsterdam Green Campus is a platform to share questions concerning sustainability on multiple levels. 'It is the only platform in the Netherlands that involves teaching institutions at the higher and practical education level. Policy bodies, such as the municipality of Amsterdam, are also involved.'

The different organisations involved in the platform exchange, for instance, the nature of research being conducted at university, the topics students get taught at different educational levels, and information about initiatives the municipality is currently involved in. With the aim of knowledge valorisation, keeping teachers and lecturers up to date about the latest developments in their field, and economic growth of the green sector. Haring: 'All of this, of course, with the ultimate goal of creating a sustainable, innovative environment that will help us achieve a better future.' ■

# Our many shades of Green

## Solar Fuels could become competitive in 2030

Renewable fuels are a valuable future alternative for current fossil based products. Industrially synthesized renewable hydrogen, syngas, methanol and diesel could become competitive within the next two decades. This follows from a techno-economic analysis by chemists from the University of Amsterdam together with TNO, published the journal Energy & Environmental Science.

Photo: Ivar Pel

## PHYSICS2MARKET GRANT FOR COLD TOLERANT PLANTS

UvA researchers have found a way to improve the plant's resilience to low temperatures. The first results are promising and the agricultural sector has already expressed its interest. For the further development of their method, the team of Teun Munnik (SILS) and Wybren Jan Buma (HIMS) received a grant from the Physics2Market Fund of Innovation Exchange Amsterdam.

## NWO Partnership grant for pest control in potatoes

Harro Bouwmeester (SILS) was awarded an NWO Partnership grant, worth €1.2 million, for the development of alternative approaches to pest control in potato crops. Potato production in The Netherlands is threatened by the potato cyst nematodes G. pallida and G. rostochiensis. In the past, large amounts of pesticides were used to protect the crops against these nematodes, but many of these pesticides have been banned. Therefore, there is a great need for alternative control methods based on natural plant resistance.

## €1.2 million for project to limit bird mortality by wind farms

In the transition to sustainable energy, the Dutch government is strongly committed to building wind farms at sea. But these wind parks are not completely environmentally friendly: every year probably thousands of birds die from collisions with the rotating blades. A project led by scientists from the University of Amsterdam received €1.2 million from NWO-TTW to understand and predict bird behavior above the North Sea so that it can be applied to develop science based mitigation measures.

## Millions for sustainable materials and sustainable chemistry

Our chemists and physicists obtained many large grants this year for the development of sustainable materials and sustainable chemistry. Most notable are the large grants by NWO for four different projects and the €1.2 million euro from Advanced Research Center for Chemical Building Blocks Consortium (ARC CBBC) for projects by Joost Reek and Bas de Bruin (both HIMS). The projects range from topics such as improved solar cells to new types of batteries and sustainable paint.

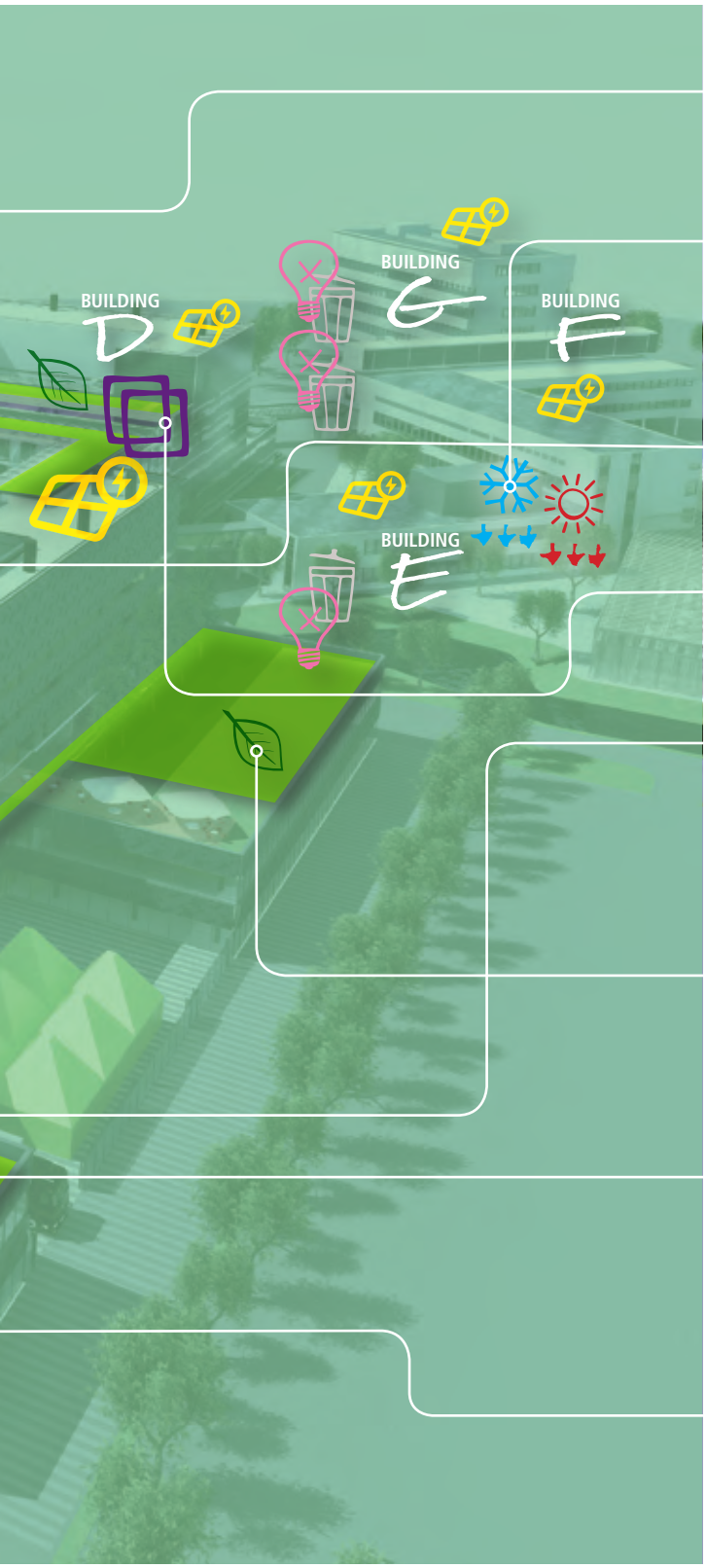
## €5 MILLION FOR BOOSTCROP CONSORTIUM

The 'Boostcrop' consortium with researchers from HIMS and SILS has been awarded nearly €5 million from the European 'Future and Emerging Technologies' programme. Boostcrop aims to increase yields in agri- and horticulture with a new approach based on the development and application of molecular temperature controllers.

# Sustainability

## AT SCIENCE PARK 904

**The aim to contribute to a sustainable future for our planet is what drives a significant portion of research and teaching at the Faculty of Science. Just think about the valorisation theme 'Green', including our many collaborations in these areas, or, for example, the Bachelor's programme Future Planet Studies and the Science for Energy and Sustainability track within the Master's programmes Chemistry and Physics & Astronomy. But we also think 'green' when it comes down to our facilities. Take a closer look at the sustainable choices we made to help us conserve energy and take a conscious approach to processing waste:**




**SOLAR PANELS:** Science Park 904 boasts **1,075 solar panels** on its roofs, yielding **275,000 kWh** annually. This is comparable to the annual energy supply for **92 households**.

**THERMAL ENERGY STORAGE:** Science Park 904 has a thermal energy storage for **climate control**. During summer, **residual heat is stored** for use in the colder months. Conversely, **cold air is stored** and used to lower the indoor temperature in summer. This system reduces the energy needed for climate control.

**LIGHTING:** With the exception of Building C, all centrally controlled lighting is **switched** OFF **at night and during the weekend**. This includes hallways and toilet areas. Lights in the offices operate on motion sensors.

**SUN PROTECTIVE WINDOW FILM:** The atrium roof lights of Buildings B and D are fitted out with a window film that reduces the heat of sunlight. **This lowers the need for air conditioning** in summer.

**HELIUM RECOLLECTION:** At the Faculty of Science, helium – a scarce natural resource – is used in experiments that require extremely low temperatures. The labs in Building D are installed with a helium recollection system. The helium is **recollected in special cylinders**. After processing by the supplier it becomes available for use again.

**SEDUM ROOF:** **40%** of the building's roof surface is covered with sedum. The plants **isolate** and **takes up particle pollution** from the air. The sedum plants also **decrease** the drainage of water into the sewer and work as a water purifier. In addition, the green roof is a stimulant for **biodiversity**.

**WATER FOR WINDOW CLEANING:** Professional window cleaning is done with **purified water**, because this better absorbs dirt and dust than regular tap water. At Science Park 904 we have a tank full of this water for watering the plants in the greenhouses. Tapping straight from this tank eliminates the need for water transport, reducing carbon footprint.

**WASTE SEPARATION:** In several locations throughout the building you will find **separate recycling bins** for plastic, glass, paper and 'other' waste. There is also a **battery collection box** and a **'pen recycling tower'**.

# Prizes & honours

## APPOINTMENTS AND AWARDS

**Selma de Mink**, associate professor of Astrophysics (API) has been appointed a member of The Young Academy of the Netherlands Academy of Arts and Sciences (KNAW). She joins a select group of top young researchers, together with two other UvA academics and seven fellow academics from other universities.

The UvA and VU Amsterdam founded a new platform for talented young researchers in Amsterdam: the Amsterdam Young Academy (AYA). Among the first thirty members named to the academy were Faculty of Science researchers **Sebastian Altmeyer** (IvI), **Thomas Mensink** (IvI) and **Umberto Olcese** (SILS).

**Rajamani Krishna**, emeritus professor of Chemical Reactor Science (HIMS), was featured in the 2018 list of the world's 'Most Influential Scientific Minds' compiled by Clarivate Analytics. Krishna is the only Dutch researcher in the chemistry category of the authoritative listing.

The prestigious Massachusetts Institute of Technology named **Taco Cohen**, PhD candidate in Machine Learning (IvI) and staff engineer at Qualcomm, one of Europe's best innovators under 35. The jury: 'His neural network multiplies by ten the efficiency of data to turn deep learning into an expert on medical images.'

**Harro Bouwmeester,** professor of Plant Hormone Biology (SILS), won the Sandmeyer Award 2018. Together with three scientists of Syngenta Crop Protection AG in Switzerland, Bouwmeester received the accolade for pioneering work on strigolactones, a family of plant hormones produced by the plant's roots. The researchers explored novel areas of application for this group of hormones.

The Austrian Society of Analytical Chemistry (ASAC) awarded the 2018 Fritz-Pregl Medal to **Peter Schoenmakers**, professor of Analytical Chemistry (HIMS). This is the highest ASAC award, and honours scientists who have made outstanding contributions to the analytical sciences. The award was presented to Schoenmakers at the 32nd International Symposium on Chromatography, held 23-27 September in Cannes-Mandelieu, France.

**Ellen Backus**, professor by special appointment of Non-Linear Spectroscopy of Surfaces and Interfaces (IoP), was awarded the Nernst-Haber-Bodenstein prize by the German Bunsen society for her original and unique experimental contribution to unravel the structure and dynamics of molecules, especially water, at interfaces.

**Bob Pirok**, PhD candidate in the Analytical Chemistry group (HIMS) won the Journal of Chromatography A Young Scientist Award. The award was presented to him at the 42nd International Symposium on Capillary Chromatography, held from 18-23 May in Riva del Garda, Italy.

In March, **Zeno Geradts,** professor of Forensic Data Science (IvI), was voted President-elect of the American Academy of Forensics Sciences. As President-elect he serves as spokesperson next to the current president, and will take office in the year 2019-2020.

The book 'The Riemann Hypothesis: A Million Dollar Problem', authored by emeritus professor **Jan van de Craats** (KdVI) and **Roland van der Veen** (Leiden University and formerly KdVI), won the Beckenbach Book Prize. This prize is awarded by the Mathematical Association of America for distinguished and innovative books on mathematics.

## FELLOWSHIPS

### Humboldt Research Fellowship for Chris Slootweg

Dr Chris Slootweg, associate professor at HIMS, was awarded a Humboldt Research Fellowship for experienced researchers. The fellowship is awarded by the German Alexander von Humboldt foundation which has a long standing tradition of fostering academic cooperation between excellent scientists from Germany and abroad. The selection of Chris Slootweg is a recognition of his academic record and introduces him into the 'Humboldt Family' which, amongst others, enables German PhD students to apply for Humboldt post-doc grants to work at the Slootweg laboratory. Organic chemist Slootweg will be a guest researcher at the University of Regensburg (Germany) with professors Manfred Scheer and Robert Wolf.

### Gadi Rothenberg appointed Lady Davis visiting professor at Hebrew University of Jerusalem

Prof. Gadi Rothenberg, who heads the Heterogeneous Catalysis & Sustainable Chemistry group (HIMS) was appointed Lady Davis Visiting Professor at the Hebrew University of Jerusalem. The appointment will strengthen the ties between the two universities by allowing senior staff to visit and collaborate. Rothenberg will work with Dr Elad Gross on elucidating the mechanisms of catalytic processes using in situ spectroscopy. The visit will build further the connections between the Institute of Chemistry at the Hebrew University and the UvA's Research Priority Area Sustainable Chemistry.

### Maarten de Rijke named first of four new University Professors AI

In September, Prof. Maarten de Rijke was appointed University Professor of AI and Information Retrieval at the University of Amsterdam. De Rijke combines his new chair, affiliated with the Faculty of Science, with his position as director of the Innovation Center for Artificial Intelligence (ICAI). An important objective of the chair is to foster and strengthen knowledge exchange in the field of AI with other UvA faculties and the three other University Professors. De Rijke's research results will form part of the UvA's teaching curriculum in AI. Algorithmic advances will be used in teaching. De Rijke will also help shape discussions around AI and its impact, both inside and outside academia.

# Professorial appointments

### Michel Haring appointed distinguished research professor

In December, it was announced that Prof. Michel Haring would be appointed distinguished research professor at the Faculty of Science as of 1 January 2019. As Professor of Plant Physiology and as distinguished research professor, Haring will concern himself with the Faculty focal area 'Green', as well as with coordinating the University of Amsterdam's participation in setting up a Biology Sector Plan and involvement in projects related to the Amsterdam Green Campus, such as the Next Level Floriculture Plant Breeding initiative.

# Full professors

2018

JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE

In June, **Martijn Rep** was appointed professor of Phytopathology at SILS. His research focuses on the interaction between plants and pathogens (phytopathology) and his research group leads the international field in uncovering the molecular basis of the pathogenicity of the plant-pathogenic fungus Fusarium oxysporum. This fungus causes wilt disease or root-and/or bulb rot in many plant species that are important for agriculture and horticulture. Rep co-created and developed the Bachelor's course Molecular Cell Biology at the UvA. Earlier this year he obtained an Advanced University Teaching Qualification and now coordinates The Living Cell, a first-year's course which forms part of the Bachelor's programme in Biology.

**Helmut Kessels** was appointed professor of Cellular and Computational Neuroscience at the Swammerdam Institute for Life Sciences. His research focuses on learning and memory, more specifically: how synaptic plasticity is responsible for storing and recalling a memory and also how these processes are perturbed when Alzheimer-related memory problems arise.

In November, **Franciska de Vries** was appointed professor of Earth Surface Science at the Institute for Biodiversity and Ecosystem Dynamics. In her research, De Vries focuses on the crucial role soils play in ecosystem response to global change. Alongside her research, she will also have important teaching duties especially within the Bachelor's programme Future Planet Studies (IIS) and the Master's programme Earth Sciences. De Vries also aims to play a role in promoting transparency, equity and diversity in academia.

In January, **Cees Snoek** was appointed professor of Intelligent Sensory Information Systems. He heads up the Intelligent Sensory Information Systems Lab at the Informatics Institute. The focus of this group is on semantic image understanding, image and video search, and interactive image analysis. Snoek is also the head of the QUVA Lab, the joint research lab set up by Qualcomm and the UvA for research on deep learning and computer vision.

In September, **Arian van Asten** was appointed professor of Forensic Analytical Chemistry and On-Scene Chemical Analysis at HIMS. It concerns a chair sponsored by the Netherlands Forensic Institute (NFI). Van Asten will focus on developing methods for forensic chemical identification and for the chemical characterisation of evidence. In August, he was also appointed programme director of the Master's Forensic Science at the Institute for Interdisciplinary Studies. Together with Prof. Maurice Aalders, Van Asten is the driving force behind the Co van Ledden Hulsebosch Center (CLHC), the interdisciplinary center of expertise in forensic scientific and medical research in Amsterdam, of which he has been co-director since 2013.

**Paul Groth** was appointed professor of Algorithmic Data Science per 1 November 2018. Groth's research focuses on methods and systems for the integration and reuse of data, determining the provenance of data and making the origins of datasets more transparent and understandable. These themes are also the focus of the newly established Intelligent Data Engineering Lab (INDE Lab) at the Informatics Institue, which Groth leads. He will teach in the Data Science track of the Master's programme in Information Studies.

# Professors by special appointment

JULY | AUGUST | SEPTEMBER | OCTOBER | NOVEMBER | DECEMBER

2018

In January, **Erik Garnett** was named professor by special appointment of Nanoscale Photovoltaics at the Institute of Physics. The chair was established on behalf of the Foundation for the Promotion of Atomic and Molecular Physics. Garnett obtained his PhD from the University of California Berkeley (US) in 2009, following which he worked as a postdoctoral researcher at Stanford University. In 2012, he joined AMOLF where he created and will continue to lead his own research group.

In April, **Tim Dokchitser** was named professor by special appointment of Computer Algebra at the Korteweg-de Vries Institute for Mathematics. The chair was established on behalf of the Computer Algebra in the Netherlands Foundation. Dokchitser combines this professorship with a position as professor at the University of Bristol.

In September, **Hinda Haned** was named professor by special appointment of Data Science. The chair was established on behalf of the Science Plus Foundation and is attached to the Informatics Institute. Haned's research focuses on building algorithmic and intelligent learning systems in order to assist users in data-driven decision making. She is principal data scientist at Ahold Delhaize, where her activities involve designing and building solutions to answer business questions with data mining and machine learning techniques. Haned works for AIRLab, one of the nine research labs in ICAI.

**Ellen Backus** was named professor by special appointment of Non-Linear Spectroscopy of Surfaces and Interfaces. This chair was designated on behalf of the Science Plus Foundation (Stichting Bèta Plus) and is attached to the Institute of Physics. Backus will be involved in research currently being carried out on Soft Matter, which is the priority area for the faculty, and, as such, serve as a bridge between the IoP, the Van 't Hoff Institute for Molecular Sciences (HIMS) and the FOM Institute AMOLF, amongst other organisations.

**Saskia Hogenhout** was named professor by special appointment of Molecular Plant-Microbe-Insect Interactions, a chair established on behalf of the Science Plus Foundation. Hogenhout is a pioneer and leader in the field of Molecular Plant-Microbe-Insect Interactions (MPMII), and line manager of the John Innes Centre Entomology Facility (Norwich, UK), which has the capability to rear quarantine/exotic invertebrates and insect-vectored plant pathogens. At the Faculty of Science she collaborates with various research groups, particularly those of the Green Life Sciences cluster of SILS and IBED.

**Sander Bohté** was named professor by special appointment of Cognitive Neurobiology, attached to SILS. The chair was designated on behalf of the Science Plus Foundation (Stichting Bèta Plus). Bohté combines his professorship with his position as senior researcher at the National Research Institute for Mathematics and Computer Science (CWI). At CWI, he leads the research into neural computation within the Machine Learning group. In addition, Bohté has been teaching the Bachelor's course Cognitive Computational Neuroscience at the UvA since 2014.

# Gender balance

## AT THE FACULTY OF SCIENCE

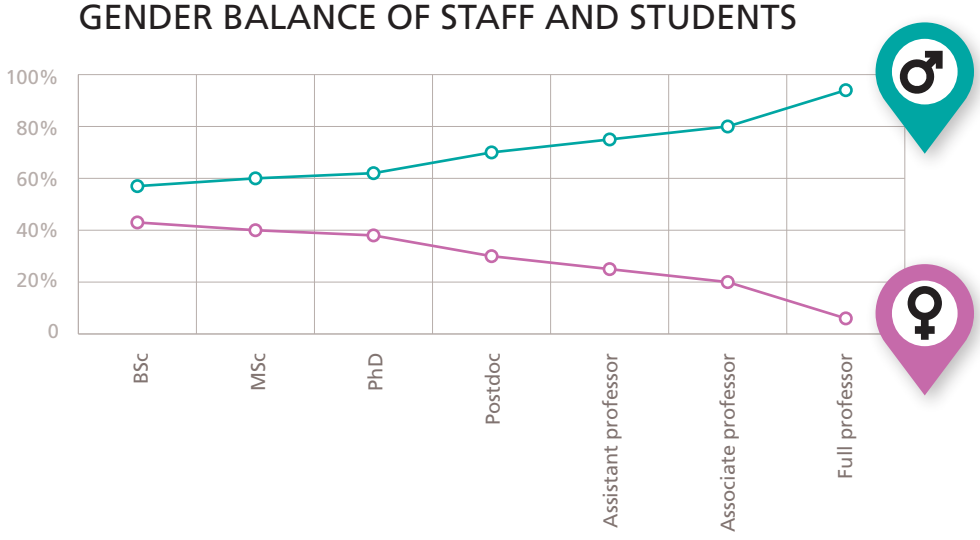
**In 2018, the Faculty of Science rolled out an action plan to improve the gender balance in senior academic positions at the Faculty. The plan marked an initial step in the necessary shift towards a culture where a more balanced distribution of academic positions across genders becomes the norm.**

The number of women in senior academic positions (assistant, associate and full professor) at the Faculty of Science lags far behind the number of men. This negative correlation between the seniority of a post and the proportion of women that hold it is not limited to our Faculty, but whereas women hold 20% of professorships nationally and 19% UvA-wide, at the Faculty of Science this figure stood at only 6% at the time the plan was announced in May 2018. 'Waiting for the balance to correct on its own, is quite obviously not an option anymore,' noted dean Peter van Tienderen at the time of the plan's rollout. 'With the action plan we aim to address our gender balance goals with specific measures. And by monitoring our efforts, we can learn from what works and what doesn't.'

The action plan describes measures in three areas: attracting, selecting and retaining female talent. The directors of the research institutes at the Faculty of Science had a big say in the plan coming about and the Faculty's Works Council also gave its approval to the plan. Van Tienderen reckons this shared understanding is essential for ensuring the plan's success. 'The point is that we came to clear agreements with each other on how we want to address the gender balance among scientific staff. This way, we can also keep each other accountable.'

## Facts & figures gender balance

### GENDER BALANCE OF STAFF AND STUDENTS



## Some of the measures

- Targets: Recognising that there are pros and cons to setting targets (or quota), the Faculty of Science's research institutes did decide to set targets for the number of women in senior positions until at least 2020. This enables the Faculty to evaluate the effects of our policy and presents us with a specific tool to monitor the recruitment and mobility of female academic staff.
- Science Plus Foundation chairs: The Science Plus Foundation manages 19 chairs by special appointment, including five 'gender balance' chairs, established to redress the gender imbalance among natural sciences professors. Three of these chairs were appointed in 2018: Ellen Backus (IoP), Hinda Haned (IvI) and Saskia Hogenhout (IBED).

The other two are expected to be announced in 2019.

- Composition of selection committees: All the research directors committed to ensure that at least one woman is included in the selection and appointment committees consisting of four or less members. Committees with five members or more should have at least two female members, one of whom may be appointed from outside the Faculty.
- Bias training: The Faculty of Science now offers frequent opportunities for bias training. Furthermore, the Faculty strives to ensure that, in any case, all permanent selection and appointments committee members receive this training over the next year.

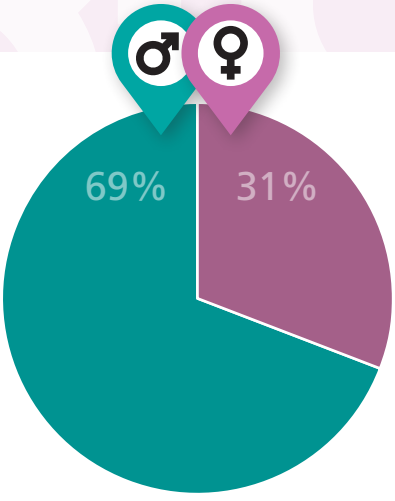
## New round of MacGillavry Fellowship announced for 2019

In December 2018 the Faculty of Science announced that it would open a new round of the MacGillavry Fellowship, a tenure track programme for talented female researchers working in the fields of astronomy, informatics, biodiversity and Earth sciences, physics, mathematics, life sciences or chemistry. This is the third round; earlier editions were held in 2010 and 2013. The new MacGillavry Fellows are expected to be announced in the Spring of 2019. ■

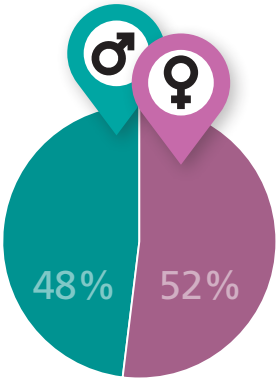
## More women appointed associate professor, but new influx stays behind

At the annual meeting of the Women in the Faculty of Science network (WiF), Chair Alejandra Castro presented data on the number of women in senior research positions. Although the number of female associate professors saw a notable increase in the past year (from 11 to 18), the number of female assistant professors dropped by approximately the same amount (from 31 to 25); likely the result of promotions within the Faculty staff.

'On the one hand, women getting promoted is a positive development,' Castro noted, 'but it is disconcerting that the number of female assistant professors didn't stay at the same level. Where is the new influx?' One of the priorities for WiF in 2019 is to get a better insight into mobility within the Faculty. 'We need to know whether the fluctuations are merely due to internal movements. Are women getting ahead, or are they leaving? Is there enough female talent coming in at all levels?'




**977**
academic staff members




**604**
support staff members

# Facts & figures nationalities

**55** nationalities
**354** international students

## EXCHANGE STUDENTS 2018-2019

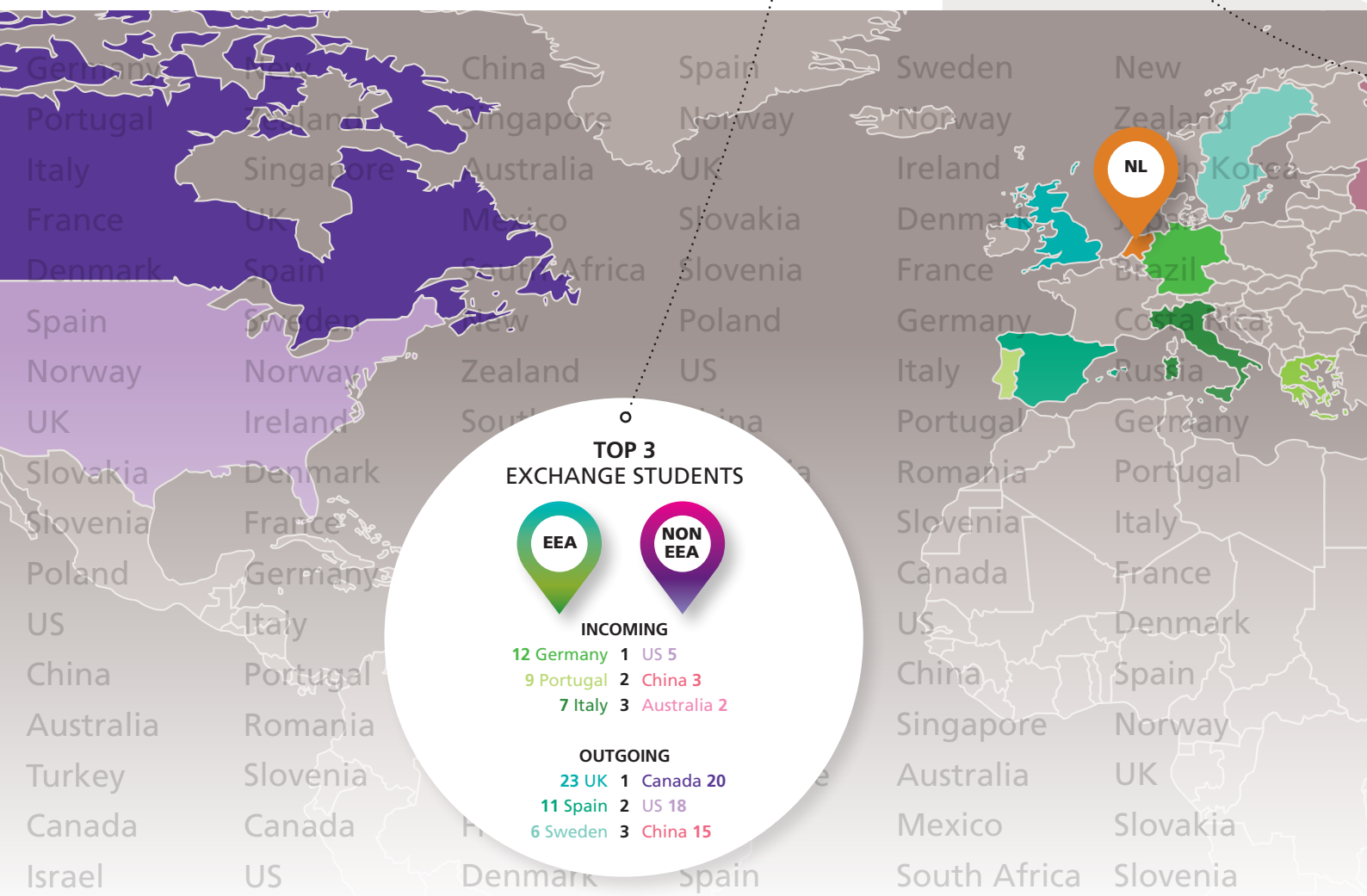
| INCOMING STUDENTS | | EEA | NON-EEA |
|---|---|---|---|
| students | 69 | 53 | 16 |
| countries | 19 | 11 | 8 |

| OUTGOING STUDENTS | | EEA | NON-EEA |
|---|---|---|---|
| students | 144 | 58 | 86 |
| countries | 25 | 12 | 13 |

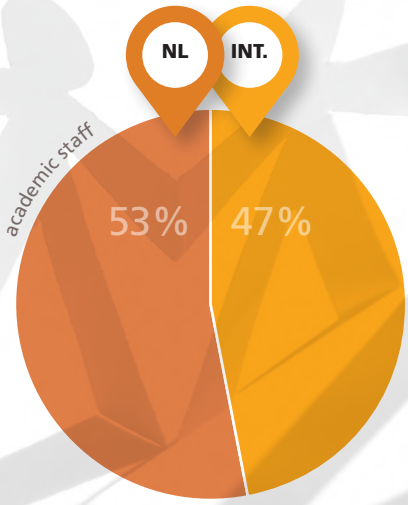
EEA: European Economic Area

## INTERNATIONAL MSc STUDENTS 2018-2019

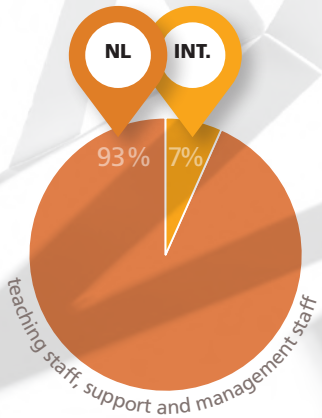
FULLTIME



## NATIONALITY OF STAFF


**869** people




**773** people

### TOP 5 INTERNATIONAL MSc STUDENTS

| EEA | | NON EEA |
|---|---|---|
| 45 Germany | 1 | India 23 |
| 31 Greece | 2 | China 22 |
| 27 UK | 3 | US 13 |
| 26 Italy | 4 | Iran 4 |
| 25 Spain | 5 | Russia 6 |

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