Programme

Dutch Mathematical Congress (NMC)

EDITION 54

3 – 4 April 2018 | Koningshof in Veldhoven

Organisation under auspices of KWG, NWO & PWN

NMC.WISKGENOOT.NL

Sponsors

The organisers gratefully acknowledge support from:

(KWG-PhD prize)

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Program of NMC 2018

Veldhoven, The Netherlands

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Karen Aardal (TUD, CWI)
Marius Crainic (UU)
Marie-Colette van Lieshout (CWI, UT)
Jan van Neerven (TUD)

Contents

Word of welcome

Dear Participant,

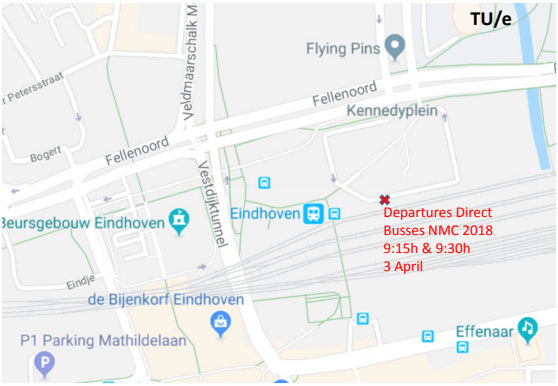
Welcome to the Nederlands Mathematisch Congres 2018, organised under auspices of the Koninklijk Wiskundig Genootschap. This is the first time the NMC is organised in a new setting and with a new setup of the program. This NMC new-style is possible thanks to generous financial support from NWO.
The organising committees have put together an exciting scientific program, with six plenary lectures by prominent mathematicians including the Beeger lecture, sessions organised by the mathematics clusters and many new aspects, such as sessions on Machine Learning, Mathematics in Industry and Quantum Software and a session on Publication Policies. In addition, the program has many interesting shorter meetings and sessions: speeddating with industry, a session by EWM-NL (European Women in Mathematics, Netherlands) on the role of women in the field of mathematics, information sessions concerning the Wiskunderaad and Tafel Wiskunde.
There will be a conference dinner on April 3 followed by an evening program and concluded by drinks.
The session Docentendag on April 4 will include the presentation of the Pythagoras prize for the best high school final project in mathematics.
On Wednesday afternoon four young researchers will give short presentations on their PhD research, thereby competing for the PhD prize. In the same session the winners of the Stieltjes prize will present their work. The prize ceremony will be at the closing of the congress.
There will be many activities during this conference and many opportunities for talking to colleagues from other discplines within mathematics, and we hope you will enjoy your stay here!

The local organisers: Mark van Assem, Joke Blom, Remco Duits, Laura Jansen, André Ran, Wil Schilders.

General Information

Venue: NH Koningshof, Veldhoven

There will be two dedicated buses going from Eindhoven Railway Station to the conference location NH Koningshof in the morning of April 3, one at 9:15 and one at 9:30. The buses depart from the north side (TU/e side) of the Station. Note that the second bus may not arrive on time for registration due to the morning rush hour.



At other times take the Bus 19/319 to Koningshof. The bus trip takes about half an hour.
At NH Koningshof wireless internet is available.

Lunches, dinner, coffee and tea breaks, evening program

Lunches are included in the registration fee, as is the conference dinner. The lunches and coffee breaks will be served around the main lecture hall, the Brabant hall, in the Limburg and Meijerij foyers. The conference dinner will be served in the Kempen hall, which is adjacent. The evening program will be in the main lecture hall again, followed by the possibility to have drinks and a chat in the Metro Bar located in the basement.

Registration desk

Should you have any questions or encounter any problems please contact the registration desk which will be open during early mornings and the breaks. The hotel registration desk is open full time for non-conference-related questions.

Stands

In the Limburg and Meijerij foyers there will be stands of the following organizations:

- European Women in Mathematics-NL
- Epsilon Uitgaven (3 April)
- Koninklijk Wiskundig Genootschap (KWG)
- Platform Wiskunde Nederland (PWN)
- Optische Fenomenen (4 april)
- Vierkant voor Wiskunde (4 April)
- Nederlandse Vereniging van Wiskundeleraren (NVvW) (4 April)
- Internationale School voor Wijsbegeerte (ISVW) (4 April)
- 4TU.AMI

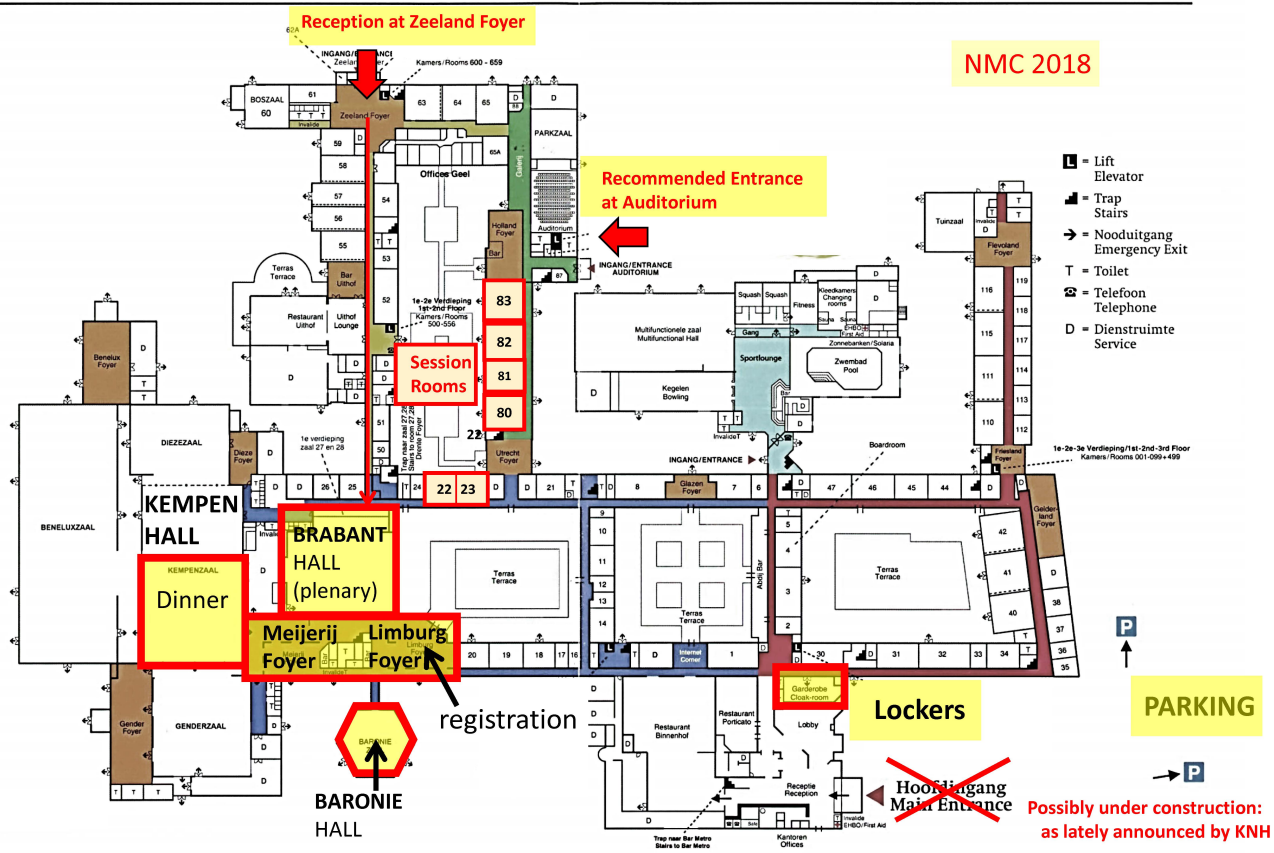
Veiling van oude boeken voor de ontsluiting van het Brouwer-archief

In april 2018 gaat het KWG een flink aantal 19e-eeuwse boeken – en enkele uit de 18e en vroege 20e eeuw – veilen. Het merendeel van de boeken handelt over wiskunde maar er zijn ook enkele over astronomie bij. De boeken komen uit het archief van het KWG.
De opbrengst van de veiling komt ten goede aan het ontsluiten van het Brouwer-archief dat in 2016 aan het Noord-Hollands Archief in Haarlem is overgedragen.
Een prachtige aanwinst voor uw eigen boekenkast, of misschien een mooi kado voor die gewaardeerde collega die binnenkort vertrekt, zodat hij kan zien dat wiskunde er ook al was voordat hij bij u begon te werken!
De lijst van de boeken met begin-biedingen kunt u vinden op

wiskgenoot.nl/veiling-van-oude-kwg-boeken.

Hier vindt u ook enkele titelpaginas van boeken uit de veiling.
Een belangrijk deel van te veilen boeken zullen ter inzage liggen bij de KWG-stand op het Nederlands Mathematisch Congres op 3 en 4 april 2018 in Veldhoven. Daar kan men ook een schriftelijk bod uitbrengen op de boeken.

Danny Beckers en Herman te Riele


Reception at Zeeland Foyer
NMC 2018
Recommended Entrance at Auditorium
L = Lift Elevator
= Trap Stairs
= Nooduitgang Emergency Exit
T = Toilet
= Telefoon Telephone
D = Dienstruimte Service
Session Rooms
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KEMPEN HALL
Dinner
BRABANT HALL (plenary)
Meijerij Foyer
Limburg Foyer
registration
BARONIE HALL
Lockers
PARKING
Hoofdingang Main Entrance
Possibly under construction: as lately announced by KNH

Program of NMC 2018

Tuesday, April 3

April 3		Activity and location
9:00-10:00	Registration	Limburg and Meijerij foyer
10:00-10:15	Opening	Brabant hall: Niek Lopes Cardozo (NWO) Gerrit Timmer (Ortec) Erik van den Ban (KWG)
10:15-11:15	Plenary lecture	Brabant hall: Jean-François Le Gall *Random planar geometry*
11:15-11:45	Coffee break	Limburg and Meijerij foyer
11:45-12:45	Plenary lecture	Brabant hall: Adriana Garroni *Variational models in Materials Science: the importance of having defect*
12:45-14:00 13:15-13:55	Lunch Lunch session	Limburg and Meijerij foyer Brabant hall: EWM-NL Session Maria Vlasiou
14:00-16:00	7 Parallel sessions	Room 82 DISC Room 80 QuSoft Brabant Networks Room 83 Sci Comp/NDNS+ Room 81 Young Mathematicians in industry Room 22 GQT Room 23 Publication Policies
16:00-16:30	Coffee break	Limburg and Meijerij foyer
16:30-17:40	Laudatio Beeger lecture	Brabant hall: Serge Fehr Fernando Rodriguez Villegas *Hypergeometric motives*
17:45-18:15	NWA session	Brabant hall: Stan Gielen Moderator: Frank den Hollander
18:15-19:15	Drinks Poster session Speeddate with Industry	Limburg and Meijerij foyer Baronie hall. Moderator: Wil Schilders
19:30-21:30	Dinner	Kempen hall
21:30-22:30	Evening program	Brabant hall: Ars et Mathesis
22:30-01:00	Drinks	Metro Bar (Irish Pub in the basement)

Wednesday, April 4

April 4		Activity and location
09:00-09:30	Opening	Brabant hall: Frank van der Duijn Schouten Presentatie Wiskunderaad Sjoerd Verduyn Lunel (PWN)
09:30-10:30	Plenary lecture	Brabant hall: Yi Ma *Low-dimensional Structures and Deep Models for High-dimensional Data*
10:30-11:00	Coffee break and poster session	Limburg and Meijerij foyer
11:00-12.00	Plenary lecture	Brabant hall: Bruno Stoufflet Industrial main speaker *Computational Science and Engineering Achievements in the Designing of Aircraft*
12:00-14:00 12:30-12:45 12:45-13:45	Lunch Lunch session	Limburg and Meijerij foyer Brabant hall: Presentatie Wiskundetafel, Jan Bouwe van den Berg Brabant hall: KWG leden vergadering
14:00-16:00	7 Parallel sessions	Brabant hall Docentendag Room 22 Diamant Room 80 Machine Learning Room 82 STAR Room 83 Sci. Comp./NDNS+ Room 81 SWI Room 23 KWG-PhD prize, Stieltjes prize
16:00-16:30	Coffee break	Limburg and Meijerij foyer
16:30-17:30	Plenary lecture	Brabant hall: William Slofstra *Quantum entanglement, Tsirelson's problem, and group theory*
17:30-18:00	Closing	Brabant hall: Prize ceremony KWG-PhD prize and Stieltjes prize

Further information regarding program elements

On the next pages some information is provided regarding the Beeger lecture, the KWG-PhD Prize, and the annual meeting of the members of the KWG.

About Beeger, the Beeger lecture, and the Beeger lecturer

Dr. N.G.W.H. Beeger was a Dutch mathematician. He was born in Utrecht, in 1884, and he died in Amsterdam, in 1965. He wrote a PhD thesis on Dirichlet series in 1916. Until the age of 65, he worked as a teacher, but in the evening hours he managed to produce about thirty papers and many reviews on elementary and algebraic number theory. One of his last publications was a table of prime numbers in the eleventh million. After his retirement as teacher, he started an extensive correspondence with other mathematicians like Gloden, Golubev, Ferrier, Bianchini, and Lehmer. Beeger had good contacts with the then Mathematical Centre in Amsterdam (now CWI) and he bequeathed part of his inheritance to this government research institute. The returns of this legacy allow CWI to cover the expenses of the *Beeger lecture*. This biennial lecture was established in 1989 by the board of trustees of the Mathematical Centre in Amsterdam. Its purpose is to promote research and exchange of ideas in the field of algorithmic and computational number theory. As a rule, the Beeger lecture is delivered during the annual congress of the Royal Dutch Mathematical Society (KWG). Until now, twelve Beeger lectures have been presented, namely, by Carl Pomerance (1992), Hugh Williams (1994), John Conway (1996), Hendrik Lenstra (1998), Peter Borwein (2000), Bjorn Poonen (2002), Manjul Bhargava (2004), Manindra Agrawal (2006), Dan Bernstein (2008), Florian Luca (2010), Yuri Bilu (2012), Daniele Micciancio (2014) and James Maynard (2016). The fourteenth Beeger lecture will be given during NMC 2018 by *Fernando Rodriguez-Villegas*.

About the KWG-PhD Prize

On Wednesday afternoon there will be lectures by candidates for the KWG-PhD Prize. The Prize ceremony will be held at the closing of the NMC 2018. Four PhD students will have the opportunity to present their work (at most 20 minutes, including questions). At the end of the day, the winner selected by the jury receives a trophy and a cash prize.
The presentations will be aimed at a general mathematical audience, and the student's ability to make the subject accessible to non-specialists is an important criterion for winning the award. The candidates are currently PhD

students (or recently defended their PhD) in mathematics at a university or research institution in the Netherlands.
The jury consists of Bas Edixhoven (chair, UL), Karen Aardal (TUD, CWI), Marius Crainic (UU), Marie-Colette van Lieshout (CWI, UT), and Jan van Neerven (TUD).
The KWG-PhD Prize is sponsored by Bronstee.com.

About the Stieltjes Prize

On behalf of Stichting Compositio Mathematica, every year the Stieltjes Prize is awarded for the best PhD thesis in The Netherlands. All mathematics PhD theses written in The Netherlands automatically participate in the competition.
For the year 2016, the jury consisted of Aernout van Enter (RUG), Barry Koren (TU/e), Frans Oort (UU), Richard Gill (UL), Marc Uetz (UT) and Odo Diekmann (UU, chair). In total 79 PhD theses have been considered; after a first selection 11 of them have been subjected to review by experts, after which a shortlist of 6 was selected.
The jury was impressed by the high average level of the PhD theses. Unanimously the jury was of the opinion that each of the theses making the short list would have been worthy winners. After a lot of discussion the short list of 6 was reduced to 2. This concerns the theses of

- Djordjo Milovic (UL), promotor: Peter Stevenhagen, *On the 16-rank of class groups of quadratic number fields*

- Richard Kraaij (TUD), promotoren: Frank Redig en Frank den Hollander (UL), *Semigroup methods for large deviations of Markov processes*

Milovic did his PhD on a subject in number theory. With a new approach he succeeds in solving a special case of a problem originating with Gauss, on which Hasse has worked, and on which Cohen and Lenstra formulated a conjecture, based on heuristic grounds, but which has since stagnated in the sense that any attempt at progress proved to be fruitless and was hence abandoned. Noteworthy is Milovic's mathematical inventiveness in combining algebraic and analytical points of view and of various technical methods. His work is truly groundbreaking.
Kraaij is working on the boundary between probability theory and functional analysis. In his PhD thesis he builds in and impressive way a firm theoretical framework for the analysis of large deviations of Markov processes, combining a multitude of technically complicated arguments in a sublime way. One referee expresses it as follows: "He views far, has guts, and is technically strong." The PhD thesis is very clearly written. In the mean time Kraaij is occupying

himself with the translation of his results to the motivating applications in physics.
Milovic and Kraaij have a lot in common, and are otherwise incomparable. Both have received their PhD cum laude, both have primarily single author papers and both have obtained very strong letters of references. The difference is in the area of research as well as in the type of research. On account of the high quality of these two theses and at the same time the large difference in the area and type of research, the jury has proposed to award the Stieltjes Prize to both Richard Kraaij and Djordjo Milovic.
The Prize ceremony will be held at the closing session of NMC 2018. Both winners will present their work at the NMC 2018.

Tafel Wiskunde

Wednesday, April 4, 12:30-12:45, Brabant hall

Jan Bouwe van den Berg. Het nieuwe domein ENW (Exacte en Natuurwetenschappen) van NWO heeft onlangs de Tafel Wiskunde ingesteld als een van de zeven disciplinaire adviescommissies. Tijdens deze bijeenkomst zal de Tafel Wiskunde zich kort presenteren en vragen proberen te beantwoorden.

Annual meeting of the members of the KWG

Wednesday, April 4, 12:45-13:45, Brabant hall

Founded in 1778, the Dutch Royal Mathematical Society (Koninklijk Wiskundig Genootschap) is the oldest of all present-day national mathematical societies. The society serves as professional organization of the Dutch mathematics community. Besides organising conferences, it also issues journals and magazines such as Indagationes Mathematicae, Nieuw Archief voor Wiskunde and Pythagoras. Together with the Dutch society of mathematics teachers, it participates in PWN (Platform Wiskunde Nederland). The society also represents the Dutch mathematical community internationally in the EMS and IMU.
The annual meeting of the Dutch Royal Mathematical Society is traditionally held during the NMC.

Speed date with industry

Tuesday, April 3, 18:15–19:15, Baronie hall

Speed dating Event at NMC 2018
The Local Organising Committee has invited companies to delegate employees to provide inspiration, ideas and guidance to PhD students and other participants at the NMC 2018 Speed Dating Event. The session will offer an invaluable opportunity to gain a better understanding of the variety of career paths. Companies are encouraged to talk generally about the role of mathematics and to discuss job opportunities within their organisation. On the first day of the NMC, a form will be available to register for the speed dating event. The companies and their representatives are listed here:

- EY (Ernst & Young) - http://www.ey.com/nl/en/home

  Diederik Fokkema, Executive Director, EY Advisory FS Risk

  Jarno Hartog, Senior Advisor, EY Advisory FS Risk

- Philips Lighting - http://www.lighting.philips.nl/home

  Wilbert IJzerman, Head of Sector Technology Innovation, Philips Lighting

- VORtech - https://www.vortech.nl/

  Bas van t Hof, partner, expert scientific software engineer

  Jok Tang, senior mathematical consultant

- Witteveen+Bos http://www.witteveenbos.com

  Arie de Niet, senior consultant data science, business line Deltas, Coasts and Rivers

- Sioux LIME - http://www.limebv.nl/

  Jord Boeijink, Senior Mathware Engineer

- ASML http://www.asml.com

  2 representatives will be present

- SynerScope B.V. - http://www.synerscope.com

  Tom Nijhuis, Solutions Engineer

  Stef van den Elzen, VP Engineering

Evening program April 3

Tuesday, April 3, 21:30–22:30, Brabant hall

WOW !! Chaotic objects showing several Faces

The Math Art by Hans Kuiper and Walt van Ballegooijen

What seems to be a chaotic object at first impression turns out to be very structured on closer inspection. "Wow!" sounds from the audience when the shadow of the "GEB-object" of a random chaos suddenly turns into a square with a portrait in it. And another one. And another one! Hans Kuiper and Walt van Ballegooijen work together to create Math Art. So far in 3 projects. They have the goal to surprise the audience. In 2012 they succeeded, after a long search, to develop a Minimal Art Object based on a Sudoku puzzle. It is an object consisting of 81 cubes, all connected to each other. How they did that search, they will show you on 3 April. In 2015 they were inspired by an object on the cover of Hofstadter's book "Gödel, Escher, Bach". This object contained, in three perpendicular directions, the letters G, E and B, the initials of their names. Would it be possible to make an object that would contain the portraits of Gödel, Escher and Bach? Hans and Walt set to work and developed a Minimal Art Object with 256 interconnected cubes, based on a Latin square of 16 16. Each cube was perforated in three directions. All these perforations together form an image with the faces of the three gentlemen. This 3D-printed artwork was chosen in 2016 at the International Bridges Conference on Math Art in Finnish Jyväskylä, by the participants from more than 250 entries to "Best of Show". Is it possible to put more than 3 images in one object? Or do you need more than 3 dimensions? One more dimension immediately provides in 3 extra faces. But such an object could only be made visible in its projections and not be tangible. Walt and Hans developed a tangible object that contains the faces of the 4 Beatles. It is based on the truncated octahedron. They will show that too.

Hans and Walt are both board members of Ars et Mathesis. Ars et Mathesis (https://www.arsetmathesis.nl) is a platform for people with an interest in Art in relation to Mathematics. Ars et Mathesis organizes an annual symposium on every third Saturday of November.

Abstracts

Abstracts of plenary talks

Jean-François Le Gall (Université Paris-Sud Orsay, Probability & Statistics Group)
Random planar geometry (Tuesday April 3, 10:15-11:15)
Much recent work has been devoted to the metric properties of large random graphs drawn in the plane or on the sphere, which are also called random planar maps. Starting from a triangulation of the sphere with a given number of faces (triangles) and chosen uniformly at random, one considers the metric space consisting of the vertex set of the triangulation equipped with the graph distance. When the size of the triangulation tends to infinity, this suitably rescaled random metric space converges in distribution, in the Gromov-Hausdorff sense, to a random compact metric space called the Brownian map. We will survey recent results showing that the Brownian map is indeed a universal model of random geometry in two dimensions. We will also discuss related models such as the Brownian disk and the Brownian plane, which is an infinite-volume version of the Brownian map. If time permits, we will also discuss very recent developments concerning isoperimetric inequalities and the existence of small separating cycles in the Brownian map.

Adriani Garroni (Università di Roma La Sapienza, Department of Mathematics Guido Castelnuovo)
Variational models in Materials Science: the importance of having defects (Tuesday April 3, 11:45-12:45)
Many modern problems in Applied Mathematics and the Calculus of Variations are connected to important issues in Materials Science. The study of behaviors of matter beyond elasticity (such as in damage, plasticity or fracture) requires multi-scale analysis which is strongly influenced by the presence of defects and their interaction.
These defects may be represented as 0-dimensional, 1-dimensional or 2-dimensional (codimension-1) structures on which energy is concentrated and that interact in a complex, sometimes unexpected, manner.
The variational treatment of these defects can be performed using tools of Geometric Measure Theory (such as functions of bounded variations and rectifiable currents), while their interaction (static and dynamic) and the formation of complex structures may be described by means of the theory of Relaxation and Homogenization.

Fernando Rodriquez Villegas (Abdus Salam International Centre for Theoretical Physics.)
Hypergeometric motives (Beeger lecture Tuesday April 3, 16:30-17:40 Brabant hall)
The families of motives of the title arise from classical one-variable hypergeometric functions. This talk will focus on their explicit calculation, particularly of their corresponding L-functions. Hypergeometric motives represent a class of motives that is accessible for detail study and still large enough to cover a wide range of possible parameters. For example, they yield families over the rationals with all possible Hodge vectors with no gaps up to rank 21.

Yi Ma (EECS Department, UC Berkeley)
Low-dimensional Structures and Deep Models for High-dimensional Data (Wednesday April 4, 9:30-10:30)
In this talk, we will discuss a class of models and techniques that can effectively model and extract rich low-dimensional structures in high-dimensional data such as images and videos, despite nonlinear transformation, gross corruption, or severely compressed measurements. This work leverages recent advancements in convex optimization from Compressive Sensing for recovering low-rank or sparse signals that provide both strong theoretical guarantees and efficient and scalable algorithms for solving such high-dimensional combinatorial problems. We illustrate how these new mathematical models and tools could bring disruptive changes to solutions to many challenging tasks in computer vision, image processing, and pattern recognition. We will also illustrate some emerging applications of these tools to other data types such as 3D range data, web documents, image tags, bioinformatics data, audio/music analysis, etc. Throughout the talk, we will discuss strong connections of algorithms from Compressive Sensing with other popular data-driven models such as Deep Neural Networks, providing some new perspectives to understand Deep Learning.
This is joint work with John Wright of Columbia, Emmanuel Candes of Stanford, Zhouchen Lin of Peking University, Shenghua Gao of ShanghaiTech, and my former students Zhengdong Zhang of MIT, Xiao Liang of Tsinghua University, Arvind Ganesh, Zihan Zhou, Kerui Min of UIUC.

Bruno Stoufflet (VP of R&D and advanced business, Dassault Aviation)
Computational Science and Engineering Achievements in the Designing of Aircraft (Wednesday, 11:00-12:00)
This presentation will give an overview of what Computational Science and Engineering has brought in design capacities these last years in the aeronautics industry. The unceasing increase in computing resources and remarkable improvements of solving methods have enabled industry to perform computations that were not conceivable several before. An emphasis will be scoped to

optimization methods as actual engineering tools utilized for industrial applications, in particular for aerodynamic shape design. Numerical formulation and implementation issues will be recalled and illustrations of applications will be discussed. The study of efficient multidisciplinary approaches will be also addressed.
New field of applications of Computational Science and Engineering have emerged these last years. Stochastic methods are in the process to take more and more an important place in the toolset of the design engineer and beyond. Some examples of application will be given.
The presentation will end with the challenges related to Computational Science and Engineering for aeronautical industry.

William Slofstra (Department of Pure Mathematics University of Waterloo) *Quantum entanglement, Tsirelson's problem, and group theory* (Wednesday 16:30-17:30)
A key feature of quantum mechanics is that the results of measurements on two particles can be correlated, even if the particles are physically separated. This feature, which can be observed experimentally in Bell inequality experiments, is called quantum entanglement.
To completely understand quantum entanglement, we'd like to have a way to model physically separated subsystems. Somewhat surprisingly, there are two natural ways to do this in quantum mechanics: via the tensor-product framework, and via the commuting-operator axiom. In finite-dimensional models, these two frameworks are equivalent, but in infinite-dimensional models, they are potentially different. Tsirelson's problem asks whether these two frameworks lead to the same observable consequences, and in particular, whether every infinite-dimensional model has an equivalent finite-dimensional model. This latter question is called the strong Tsirelson problem.
In this talk, I will explain how the strong Tsirelson problem can be answered (in the negative) by making a connection to a classical problem in group theory: whether every finitely-presented group is residually-finite (roughly speaking, whether a finitely-presented group can always be recovered from its finite-dimensional models).

Abstracts of parallel session talks

DISC

Tuesday 14:00-16:00 **Lecture hall 82**
Organizer: Jan Willem Polderman

Giulia Giordano (TUD) **14:00-14:15**
Structural stability of dynamical networks: a Lyapunov approach and biochemical applications.
Dynamical networks are systems composed of several dynamic subsystems that interact according to a given topology. Structural analysis aims at assessing general properties that exclusively rely on the system structure (the topology of the interaction graph, or hyper-graph, along with qualitative information about the system), without any quantitative knowledge of the system parameters. The so-called "BDC-decomposition" will be presented as a local and global tool for the structural analysis of dynamical networks, with a special focus on biochemical systems. In particular, it will be shown how, based on this decomposition, criteria can be obtained to assess structural stability of equilibria for a wide class of nonlinear dynamical networks, exploiting linear differential inclusions and piecewise-linear Lyapunov functions.

Erik Steur (TUD) **14:15-14:45**
Emergence of oscillations in networks of coupled inert systems.
We consider networks of single-input-single-output systems that interact via linear coupling functions, which may include time-delays. The systems themselves are inert, that is, their solutions converge to a globally stable equilibrium. However, in the presence of coupling, the network of systems exhibits ongoing oscillatory activity. We study the emergence of these oscillations by finding conditions for 1. the solutions of the time-delay coupled systems to be bounded, 2. the network equilibrium to be unique, and 3. the network equilibrium to be unstable. The network of coupled inert systems is oscillatory if the aforementioned three conditions are satisfied. In addition, we identify the patterns of synchronized oscillation that may emerge.

Paul van den Hof (TU/e) **14:45-15:15**
Identifiability in Dynamic Networks.
Dynamic networks are structured interconnections of dynamical systems (modules) driven by external excitation and disturbance signals. In order to identify their dynamical properties and/or their topology consistently from measured data, we need to make sure that the network model set is identifiable. We introduce the notion of network identifiability, as a property of a parameterized model set, that ensures that different network models can be distinguished

from each other when performing identification on the basis of measured data. Different from the classical notion of (parameter) identifiability, we focus on the distinction between network models in terms of their transfer functions. For a given structured model set with a pre-chosen topology, identifiability typically requires conditions on the presence and location of excitation signals, and on presence, location and correlation of disturbance signals. Because in a dynamic network, disturbances cannot always be considered to be of full-rank, the reduced-rank situation is also covered, meaning that the number of driving white noise processes can be strictly less than the number of disturbance variables. This includes the situation of having noise-free nodes.

Kanat Camlibel (RUG) **15:15-15:30**

Structural controllability of systems defined over graphs.

This talk deals with structural controllability of networks of dynamical systems. The main result is a necessary and sufficient condition in terms of the so-called zero forcing sets of a given graph. After presenting the main results, we will discuss computational issues regarding zero forcing sets of a graph and look at particular graph classes for which zero forcing sets can be computed easily.

Ming Cao (RUG) **15:30-15:45**

Control of Evolutionary Games on Networks.

Abstract: We investigate the control of evolutionary games on networks, in which each edge represents a two-player repeated game between neighboring agents. After each round of games, agents can update their strategies based on local payoff and strategy information, while a subset of agents can be assigned strategies and thus serve as control inputs. We seek here the smallest set of control agents needed to drive the network to a desired strategy state. After presenting an exact solution that is practical only for small networks due to its computational complexity, we design a fast algorithm for approximating the solution to a simplified problem on tree networks. We then show how to extend this approach to the general problem on arbitrary networks using a weighted minimum spanning tree and strategy propagation algorithm. We show that the resulting approximation is exact for certain classes of games on complete, ring, and star networks.

Wilbert Rossi (UT) **15:45-16:00**

The harmonic influence in social networks and its distributed computation.

15 mins.

The identification of the most influential nodes is an important issue in the study of networks and dynamical processes on them. Different notions of centrality have been proposed, depending on the process and the control objective. One of these notions is the harmonic influence. It quantifies the ability

of a leader node to alter the average opinion of a social network, where and an adversary leader is present and the interaction are linear and described by an undirected weighted graph. The computation of the harmonic influence is equivalent to solve, for every node, a discrete Dirichlet problem associated to a grounded Laplacian. Using a distributed message passing algorithm, it is possible to obtain a meaningful approximation of the measure concurrently for every node. The algorithm is inspired by an electrical analogy and is exact whenever the network is a tree.

Analysing the dynamical system formed by the messages, using some monotonicity properties and tools from linear algebra, we prove that the algorithm converges asymptotically, under the only assumption of the interaction Laplacian being symmetric. However, the convergence value does not in general coincide with the harmonic influence: our simulations show that when the network has a larger number of cycles, the algorithm becomes slower and less accurate, but nevertheless provides a useful approximation. Simulations also indicate that the symmetry condition is not necessary for convergence and that performance scales well in the number of nodes of the graph.

QuSoft

Tuesday 14:00-16:00 **Lecture hall 80**
Organizer: Harry Buhrman

Laura Mančinska (Copenhagen University) **14:00-14:30**
Quantum inspired relaxations of graph isomorphism
During the last 50 years, the study of equivalence for relational structures has developed into a vast theory embracing combinatorics, optimization, algebra, and mathematical logic. In this context, graph isomorphism (GI) and its hierarchy of relaxations constitute a central topic, not only for its elusive complexity, but also for its mathematical richness. We develop two frameworks which not only provide a new and unifying perspective of well-known relaxations of GI such as fractional isomorphism and graph equivalence but also allow us to define new relaxations of GI. For instance, using our nonlocal games-based framework we can introduce and study variants of GI inspired by different physical postulates. This leads us to notions of quantum and non-signaling graph isomorphism. In the second part of our investigation, we consider conic relaxations of GI.
For all of the considered relaxations we investigate whether they coincide with existing relations. For example, we were surprised to find that our notion of non-signaling isomorphism is equivalent to fractional isomorphism and doubly-nonnegative-isomorphism coincides with graph equivalence. We show that all of the introduced isomorphism relations form a strict hierarchy nested between GI and non-signalling isomorphism. The complexity of testing these relations ranges from linear time (non-signalling isomorphism) to undecidable (quantum isomorphism). The techniques and ideas employed span across quantum information, algebra, combinatorics, and complexity theory.
This is a joint work with Albert Atserias, Robert Šamal, David Roberson, Simone Severini, and Antonios Varvitsiotis.

Yfke Dulek (QuSoft & CWI) **14:30-15:00**
Quantum computing on authenticated data
How can we make sure that a quantum message remains unaltered when we send it over an insecure channel? How do we protect a quantum state from being corrupted when it is stored someplace where adversarial parties can potentially access it? And, especially relevant in the current era of cloud computing, how can we have an untrusted third party perform computations on such authenticated data? In this talk, I will give an overview of the different techniques of quantum computing on authenticated data, both interactive and noninteractive. The main protagonist of the story will be a specific quantum authentication code called the "trap code" (Broadbent et al., 2013), which has proven to be very useful in several quantum cryptographic tasks. It

also has a weakness, however: an adversary can learn information about the ciphertext structure by altering it in a specific way, and observing whether or not the corrupted ciphertext is still accepted. The trap code is vulnerable to these types of attacks, because it lacks a property called strong purity testing (Portmann, 2017). I will discuss the strengths of authentication codes that do have this property, and I will also show how the trap code can be strengthened to a strong-purity-testing code. This talk is based on joint work with Florian Speelman (University of Copenhagen; QMATH).

Michael Walter (QuSoft & University of Amsterdam) **15:00-15:30**
Quantum marginal problem, tensor scaling, and invariant theory
Given a vector in a rational representation, can it be distinguished from zero by an invariant polynomial? This problem of deciding semi-stability is a fundamental problem in geometric invariant theory. I will explain why it can be usefully thought of as a vast generalization of linear programming and describe some situations where it is particularly interesting, including the quantum marginal problem in quantum information theory. I'll then present a geometric algorithm, called tensor scaling, that solves this problem exactly.

Jeroen Zuiddam (CWI & QuSoft) **15:30-16:00**
The asymptotic spectrum of tensors
The row and column operations on matrices naturally generalise to slice operations on tensors. Let T and S be k-tensors. Deciding whether T can be obtained from S by slice operations is NP-hard. We study the asymptotic version: find the smallest nonnegative real numberβ such that the nth tensor power of T can be obtained from the $(\beta n + o(n))$th tensor power of S by slice operations when n goes to infinity.
For tensors from a family F this problem reduces to analysing the asymptotic spectrum of F (Strassen; Crelle 1988). The asymptotic spectrum of F is the collection of all maps from F to the nonnegative reals that are non-increasing under slice operations, multiplicative under tensor product, additive under direct sum and appropriately normalised on diagonal tensors. (This is a representation in the sense of KadisonDubois.) Our main theorem is a simple explicit construction of elements in the asymptotic spectrum of all complex tensors. No such construction was known for thirty years. Our approach is via quantum information theory, invariant theory and moment polytopes.
The recently obtained solution to the cap set problem (EllenbergGijswijt; Ann. Math. 2017) can be recovered from the asymptotic spectrum of a tensor family over the finite field with three elements. A better understanding of our new construction may lead to further progress on related combinatorial questions.
This is joint work with Matthias Christandl (University of Copenhagen) and Péter Vrana (Budapest University of Technology and Economics).

NETWORKS

Tuesday 14:00-16:00 **Brabant hall**
Organizers: Jop Briët and Frank den Hollander

Justin Salez (Université de Paris VII (Denis Diderot)) **14:00-15:00**
Mixing time and cutoff for random walk on large directed graphs.
The time it takes for a random walk to forget its initial position and converge to equilibrium is a gauge for an array of properties of the underlying graph: distances between vertices, local traps, global bottlenecks, isoperimetric profile, expansion, etc. It also plays an essential role in real-world-network applications, such as linked-based ranking algorithms. In recent years, the understanding of large random graphs has become sufficiently developed to allow for a detailed analysis of their mixing time, and a rigorous proof of the celebrated cutoff phenomenon. The aim of this lecture is to describe these results in detail on a simple directed-graph model. This is joint work with C. Bordenave and P. Caputo.

Daniel Valesin (RUG) **15:00-15:30**
The contact process: recent results on finite-volume phase transitions
The contact process is a model for the spread of an infection in a population. At any given point in time, vertices of a graph (interpreted as individuals) can be either healthy or infected; infected individuals recover at rate 1 and transmit the infection to neighbours at rate lambda. On finite graphs, the infection eventually disappears with probability one. In many cases, the time it takes for this to occur depends sensitively on the value of the parameter lambda, and this finite-volume phase transition can be linked to a phase transition of the contact process on a related infinite graph. We will survey recent works in this direction, including some general results which hold on large classes of graphs, as well as results on specific graphs, such as finite d-ary trees and the random graph known as the configuration model.
This talk includes joint work with M. Cranston, T. Mountford, J.C. Mourrat, Bruno Schapira and Q. Yao.

Jacobien Carstens (UvA) **15:30-16:00**
Symmetry in Markov chains for sampling graphs with fixed degree sequence
The sampling of graphs with fixed degree sequence has become an important quantitative tool in network analysis. For instance, it is used in community detection and motif finding; techniques which derive meaning from a networks topology. Mathematically, the sampling of bipartite graphs with fixed degree sequence is equivalent to sampling binary matrices with fixed row and column sums. Sampling matrices is seen as one of the most useful null-model

approaches in ecology in deciding if an observed data matrix shows extremal behaviour.
Even though sampling algorithms are widely used by practitioners, the underlying theory has not yet been fully developed. In particular, there is no known method which can be proven to sample both uniformly and efficiently (i.e. runs in polynomial time), yet existing algorithms are used to create samples for statistical analysis of real-world data. There is no guarantee that those samples are unbiased.
In this talk we focus on Markov chain approaches to this problem, where close-to-random graphs are generated by making a large number of small changes to a given graph. In particular, we discuss two results from recent work on analysing the mixing time of such Markov chains. The first result is a state space decomposition that allows for a mixing time comparison of the well-known switch chain and of the intuitively faster Curveball algorithm. The second result reduces the size of the state space by removing certain redundant symmetries. This improves the mixing time and makes certain previously intractable problems finite.

Scientific Computing / NDNS+

Tuesday 14:00-16:00 **Lecture hall 83**
Organizers: Jason Frank and Mark Peletier

KaYin Leung (Stockholm University) **14:00-14:30**
Epidemics on networks with social distancing
In the presence of an epidemic in a population, individuals may decide to take preventive measures to avoid infection. This could lead to changes in the contact pattern in the population over the course of an epidemic. In this talk we use mathematical models to study social distancing as one such preventive measure. We consider an epidemic on a social network whose structure changes as the epidemic evolves. Susceptible individuals may distance themselves from infectious neighbours to avoid infection. They may choose to drop the connection completely and thereby reduce their number of neighbours. Alternatively, they may replace the social connection with another individual in the population in their desire to maintain their number of social contacts. From an individual-level perspective, social distancing cannot increase ones risk to become infected. However, social distancing can have negative consequences for population-level epidemic outcome. This talk is based on joint work with Frank Ball (Nottingham University), Tom Britton (Stockholm University), and David Sirl (Nottingham University).

Artur Palha (TU/e, TUD) **14:30-15:00**
Algebraic dual polynomials for mimetic spectral element methods
In this work the High Order Mimetic Discretization Framework, [1] will be presented together with a discussion of one fundamental aspect for the construction of structure-preserving discretizations: the definition of the discrete degrees of freedom of physical field quantities. These degrees of freedom are associated to geometric objects (points, lines, surfaces and volumes), and a relation to differential forms will be remarked. It will be shown that it is possible to construct discrete polynomial function spaces of arbitrary degree associated to these geometric degrees of freedom. Moreover, these function spaces constitute a discrete de Rham complex:

$$\mathbb{R} \longrightarrow V_h^0 \subseteq H(\nabla, \Omega) \xrightarrow{\nabla} V_h^1 \subseteq H(\nabla\times, \Omega) \xrightarrow{\nabla\times} V_h^2 \subseteq H(\nabla\cdot, \Omega) \xrightarrow{\nabla\cdot} V_h^3 \subseteq L^2(\Omega) \longrightarrow 0\,.$$

In this way it is possible to exactly discretize topological equations even on highly deformed meshes. All approximation errors are included in the constitutive equations. This leads to discretizations that exactly preserve the divergence free constraint of velocity fields in incompressible flow problems and of magnetic fields in electromagnetic problems, for example.

An important aspect in the numerical solution of partial differential equations is the efficient construction of the system matrix and its subsequent solution. Given a polynomial basis Ψ_i which spans the polynomial vector space $\mathcal{P}$, this work addresses the construction and use of the algebraic dual space $\mathcal{P}'$ and its canonical basis, [2]. It will be shown that a primal-dual formulation using these algebraic dual basis results in a very sparse system matrix where two of the sub-matrices consist of only incidence matrices. The method will be applied to a Dirichlet and Neumann problem and it is shown that the finite dimensional approximations satisfy $\phi^h = \nabla \cdot \boldsymbol{q}^h$ on any grid. The dual method is also applied to a constrained minimization problem, which leads to a mixed finite element formulation. The discretization of the constraint and the Lagrange multiplier will be independent of the grid size, grid shape and the polynomial degree of the basis functions.
This is joint work with V. Jain, Y. Zhang and M. Gerritsma.

References

[1] A. Palha, P. P. Rebelo, R. Hiemstra, J. Kreeft, and M. Gerritsma. "Physics-compatible discretization techniques on single and dual grids, with application to the Poisson equation of volume forms." In: Journal of Computational Physics 257 (2014), pp. 1394–1422.

[2] V. Jain, Y. Zhang, A. Palha, and M. Gerritsma. "Construction and application of algebraic dual polynomial representations for finite element methods." In: (2017). arXiv: 1712.09472.

Fredrik Jansson (CWI)

15:00-15:30

Resolving clouds in a global weather model - a multiscale approach

Clouds are challenging to incorporate in global weather and climate models, since they involve processes on length scales smaller than the typical simulation grid resolution. Therefore clouds are usually not fully resolved, but represented in a simplified way using so-called parametrization schemes. Accurate cloud modeling is important, since one of the largest remaining uncertainties in climate simulations is related to clouds and the strong effects of cloud feedback on the climate.

I will present our project about replacing the cloud parametrization scheme in a global weather model by another small-scale model which can explicitly resolve the cloud processes. This can be seen as a nesting of a high-resolution model inside selected grid columns of the global model. The global weather model in our case is OpenIFS, a version of the European operational weather model used for forecasts. The high-resolution model is DALES, a 3D large-eddy simulation code.

This scheme, also called a superparametrization, can potentially lead to more accurate simulations, at the cost of requiring more computational power. It

also opens the possibility to compare the prediction of the cloud parametrization scheme with the results from the cloud-resolving model and can thus provide a way to validate or improve the cloud parametrizations.
The project is a collaboration with Gijs van den Oord at the Netherlands eScience Center, Pier Siebesma at Delft University of Technology, and Daan Crommelin at CWI.

Matthias Schlottbom (UT) **15:30-16:00**
A perfectly matched layer approach for radiative transfer in highly scattering regimes
We consider the numerical approximation of boundary conditions in radiative transfer problems by a perfectly matched layer approach. The main idea is to extend the computational domain by an absorbing layer and to use an appropriate reflection boundary condition at the boundary of the extended domain. A careful analysis shows that the consistency error introduced by this approach can be made arbitrarily small by increasing the size of the extension domain or the magnitude of the artificial absorption in the surrounding layer. A particular choice of the reflection boundary condition allows us to circumvent the half-space integrals that arise in the variational treatment of the original vacuum boundary conditions and which destroy the sparse coupling observed in numerical approximation schemes based on truncated spherical harmonics expansions. A combination of the perfectly matched layer approach with a mixed variational formulation and a PN-finite element approximation leads to discretization schemes with optimal sparsity pattern and provable quasi-optimal convergence properties. As demonstrated in numerical tests these methods are accurate and very efficient for radiative transfer in the scattering regime.
(This is joint work with Herbert Egger, TU Darmstadt)

Young mathematicians in Industry

Tuesday 14:00-16:00 **Lecture hall 81**
Organizer: Martijn Zaal

Lotte Sewalt (KPMG) **14:00-14:30**
Sustainability at KPMG and the role of analytic thinking
Upon receiving my Master's diploma in Mathematics, I continued my career at Leiden University by pursuing a Ph.D in the field of pattern formation. In September 2016 I obtained my degree. Although I struggled making the decision, I knew eventually that I would leave academia. I started working as a consultant/advisor KPMG Sustainability. What's great about KPMG is that employees get a lot of opportunities to learn and obtain training, and the company's clients are usually very interesting, often multinational, firms. Therefore, working for these clients really has an impact. The sustainability department attracted me in particular, because after all those years in academia, I felt like I needed to do something for society. Our projects vary from the monetization of impact, to circular economy, sustainable supply chains and sustainability assurance. A lot of times, our solutions for clients are based on data and academic research, but most people in the team do not have a Ph.D. or a technical background. For me, that means that the projects which are the most data heavy get on my plate, and my expertise is appreciated. My Ph.D. research was not necessary for the job I'm in now, but especially the perseverance, dedication and academic work ethic fits the job perfectly.

Joep Evers (ASML) **14:30-15:00**
Life as a Mathematician at ASML
Until 2015, I was a master and PhD student at Eindhoven University of Technology. My focus was on applied analysis, studying mainly partial differential equations and in particular their connection to self-organisation in social systems. After completing my PhD, I spent two years as a postdoc in Canada. In the summer of 2017 I returned to the Eindhoven area and started a new job at ASML. Currently, I am a member of the metrology department, where measurement data is converted into algorithms for machine calibration and adjustments, and for diagnostics regarding contamination and defects. In this presentation, I will give an idea of the problems I work on. I will also explain how I still use general skills that I acquired during my time in the academic world.

Britt Mathijsen (CQM) **15:00-15:30**

From PhD to Consultancy: Applied Mathematics at CQM

After finishing my PhD research, which concerned the analysis of large-scale queueing systems, at Eindhoven University of Technology last year, I decided to leave academia and start a new job as a mathematical consultant at Consultants in Quantitative Methods (CQM). Being a team of 35+ consultants with an academic background in mathematics or fields alike, CQM specializes in supply chain analytics, R&D, planning, optimization and many other fields related to data science. During this talk, I will elaborate on the considerations I had before choosing a career in industry after my PhD and, more specifically, for joining CQM. I will review my experiences concerning the transition from research to consultancy, and which experiences from my PhD have proven useful in my work today. Last, to give more insight into my daily activities, I will discuss one of the many mathematically interesting cases that I have worked on the in the past year in more detail.

Jeroen Hazewinkel (DAREL consultancy) **15:30-16:00**

Patterns in Organizations, Selforganization and large Corporations

What makes a mathematician working for a major company to study the self-organisation of teams? How do teams often repeat the same patterns after re-organisation. In this talk I will describe the career-path I followed after leaving academia in 2011 as a postdoc in California. I will describe the work of a mathematically trained person in a major company and what kind of challenges and advantages a PhD brings to the workforce. After some examples of the advantages for the more technical roles, I will describe how I became increasingly more interested in the pattern dynamics of groups. And how pursuing that interest led to the decision the start a new company. Throughout I will highlight some of the key challenges in the energy transition today's complex business poses and how a mathematician might just have the mindset to solve these.

GQT

Tuesday 14:00-16:00 **Lecture hall 22**
Organizers: Gil Cavalcanti

Chris Wendl (Humboldt-Universitt, Berlin) **14:00-15:00**
On symplectic manifolds with boundary, or "when is a Stein manifold merely symplectic?"
Symplectic manifolds are widely known as the natural geometric setting for Hamiltonian mechanics, but they also arise in many other contexts, e.g. in complex geometry, one sometimes considers Stein manifolds, which have natural symplectic structures containing contact hypersurfaces. The goal of this talk will be to explain why, for a large class of Stein manifolds in complex dimension two, complex geometry is largely irrelevant and symplectic topology is all that matters, i.e. two such manifolds have deformation-equivalent complex structures if and only if their symplectic structures are deformation equivalent. One can think of this as a kind of middle ground between the extremes of "rigidity" and "flexibility" that typically characterize important insights about symplectic manifolds. The proof is based on a topological characterization of Stein structures in terms of Lefschetz fibrations, together with an analytical result presenting the latter as foliations by pseudoholomorphic curves. Along the way, I'll explain how contact structures arise on boundaries of symplectic manifolds, and give some examples of interesting questions that contact topologists think about, and the methods they use to attack them. There will be lots of pictures, and some of them will move.

Oscar Garcia Prada (CSIC and ICMAT, Madrid) **15:00-16:00**
Higgs bundles and higher Teichmller components
Some connected components of a moduli space are mundane in the sense that they are distinguished only by obvious topological invariants or have no special characteristics. Others are more alluring and unusual either because they are not detected by primary invariants, or because they have special geometric significance, or both. In this talk, I will describe examples of such exotic components in moduli spaces of G-Higgs bundles on closed Riemann surfaces or, equivalently, moduli spaces of surface group representations into a semisimple Lie group G. These exotic components are then related to higher Teichhmller theory, and the notion of positive Anosov representations recently developed by Guichard-Wienhard.

PWN session on Publication Policies

Tuesday 14:00-16:00 **Lecture hall 23**
Organizers: Tom Koornwinder, Wil Schilders

Tom Koornwinder **14:00-14:05**
Introduction

Thierry Bouche (University de Grenoble Alpes) **14:05-14:35**
Math publishing: What next?
Thierry Bouche is the chair of the EMS Committee on Publications and Electronic Dissemination (http://euro-math-soc.eu/committee/publications-and-electronic-dissemination). He will summarize the current trends and stakes in math publishing, with a (somewhat biased) overview of the public initiatives in Europe trying to build public open access infrastructures.

Jos Baeten (CWI) **14:35-15:05**
Fair Open Access
Jos Baeten is president of the Foundation Mathematics in Open Access (MathOA) and board member of the Fair Open Access Alliance (FOAA). In this talk, he will discuss the principles of fair open access, and the efforts to switch mathematics journals to fair open access publication.

Esther van Vroonhoven (Noordhoff & Pythagoras) **15:05-15:15**
De uitdagingen van het wiskundetijdschrift voor jongeren Pythagoras
Tijdschriften en jongeren lijkt anno 2018 niet meer bij elkaar te horen. In haar presentatie zal Esther ingaan op welke stappen het MT van Pythagoras zet om een interessant kanaal te zijn voor middelbare scholieren en om zo de interesse voor wiskunde verder te vergroten.

Discussion Moderators: Tom Koornwinder and Wil Schilders. **15:15-16:00**

KWG-PhD Prize and Stieltjes Prize

Wednesday 14:00-16:00 **Lecture hall 23**
Organizer: Bas Edixhoven

For information on the KWG-PhD prize, see p. 10, for information on the Stieltjes Prize, see p. 11.
In this session there will be two lectures by winners of the Stieltjes Prize and four lectures by candidates for the KWG-PhD Prize. Each of the lectures will be twenty minutes.
The Prize ceremonies will be held at the closing ceremony of the NMC 2018.

Richard Kraaij (Ruhr Universität Bochum) **14:00-14:20**
Path-space moderate deviation principles for the random field Curie-Weiss model (Stieltjes Prize)
We analyze the fluctuations for macroscopic observables of the dynamic random field Curie-Weiss model, a basic model for disordered ferromagnets. Our moderate deviation results complement existing law of large numbers and central limit theorems and indicate that the asymptotics depend crucially on the phase we consider and moreover, the space-time scale range for which fluctuations can be proven is restricted by the presence of the disorder.
This talk is based on a joint work with Francesca Collet(Delft).

Djordjo Milovic (UL) **14:20-14:40**
Vinogradov sequences and the 16-rank (Stieltjes Prize)
Recently, problems concerning the 16-rank of class groups in certain one-prime-parameter families of quadratic number fields have become tractable via a method where arithmetic invariants are embedded into sequences conducive to a Vinogradov-type prime sieve. We will give an overview of the successes and limitations of this method.

Nick Lindemulder (TUD) **14:40-15:00**
A Randomized Difference Norm for Vector-valued Fractional Sobolev Spaces
Since Sobolev's publication in 1950, the L_p-based Sobolev spaces W_p^k ($p \in (1,\infty)$, $k \in \mathbb{N}$) have become a crucial instrument in the theory of partial differential equations. This on the one hand has stimulated and on the other hand has been stimulated by the development of a rich theory of these and related function spaces. One particular development, after sufficiently strong Fourier multiplier theorems had been established, was the introduction of the Bessel potential spaces H_p^s ($p \in (1,\infty)$, $s \in \mathbb{R}$) in 1960, which are also referred to as fractional Sobolev spaces due to the fact that $W_p^k = H_p^k$.
During the last 25 years, *maximal regularity* has turned out to be an important tool in the theory of nonlinear partial differential equations. Maximal

regularity means that there is an isomorphism between the data and the solution of the problem in suitable function spaces. Having established maximal regularity for the linearized problem, the nonlinear problem can be treated with tools as the contraction principle and the implicit function theorem.
In the maximal L_p-regularity approach to parabolic partial differential equations, such as the heat equation, an important role is played by Sobolev and Bessel potential spaces of Banach space-valued functions/distributions. As in many other parts of Banach-space valued analysis, there are close connections between the theory of these function spaces and the geometry of Banach spaces.
One thing that makes the theory of fractional Sobolev spaces in the scalar-valued setting so rich is the large number of alternative descriptions of these function spaces. Fractional Sobolev smoothness can for instance be measured by means of atoms, differences, Littlewood-Paley decompositions, local means, oscillations, quarks and wavelets. These scalar-valued results directly extend to but not beyond the Hilbert space-valued setting. In fact, the validness of the naive extension of one of these characterizations to the X-valued setting characterizes X as being isomorphic to a Hilbert space. However, already since the early 1980's, random sums have turned out to be the appropriate substitute in Banach space-valued analysis for the fundamental orthogonality relations in Hilbert spaces. Indeed, with this insight, many classical Hilbert space-valued results have been extended to the setting of Banach spaces with the so-called UMD property, and many of these extensions in fact characterize the UMD property. One instance of the latter is the coincidence $W_p^1 = H_p^1$. Among the just mentioned alternative descriptions for the classical scalar-valued Bessel potential spaces, by now there only exist randomized versions of the Littlewood-Paley decomposition and the difference norm characterization in the general UMD Banach space-valued setting.
In this talk we discuss the randomized difference norm characterization for Bessel potential spaces in the UMD Banach space-valued setting obtained by the author in [1]. By means of this result we take a look into a few different ways to measure fractional Sobolev smoothness and into the principle of randomization in Banach space-valued analysis.

[1] N. Lindemulder. Difference norms for vector-valued Bessel potential spaces with an application to pointwise multipliers. *J. Funct. Anal.*, 272(4):1435–1476, 2017.

Marnix Mornev (UvA, UL) **15:00-15:20**

Formulas of Tamagawa type in positive characteristic

The equivariant Tamagawa number conjecture (ETNC) aims to express special values of L-functions via motivic cohomology. It generalizes classical

results such as the Leibniz formula for and Euler's Basel identities, as well as the famous conjecture of Birch and Swinnerton-Dyer, one of the Millenium prize problems. The ETNC is wide open and is out of reach of current methods.
Recent research suggests that a similar problem makes sense and is much more amenable for certain unusual number systems, the so-called rings of positive characteristic. Lenny Taelman discovered that an analog of the BSD conjecture holds for one number system of this sort, the ring of polynomials with coefficients in a finite field. Inspired by the original ETNC I generalized his result to a wide class of similar number systems. In this talk I will discuss examples of the beautiful and deep formulas which follow from the equivariant Tamagawa number conjecture and its analog in positive characteristic.

Eni Musta (TUD) **15:20-15:40**
Smooth nonparametric estimation under monotonicity constraints
A typical problem in nonparametric statistics is estimation of an unknown function on the real line, which may, for instance, be a probability density, a regression function or a failure rate. In many cases, it is natural to assume that this function is monotone and incorporating such a prior knowledge in the estimation procedure leads to more accurate results. We consider smooth monotone estimators, constructed by combining an isotonization step with a smoothing step. We analyze their pointwise asymptotic behavior (in the Cox proportional hazard model) and show that they are asymptotically equivalent with a Gaussian limit distribution. Moreover, we investigate the global behavior of smooth isotonic estimators and obtain central limit theorems for their L_p error. We also discuss some applications of our results in hypothesis testing and construction of confidence intervals.
Joint work with Hendrik P. Lopuhaä.

Clara Stegehuis (TU/e) **15:40-16:00**
How community structure affects epidemics
Many objects of interest can be thought of as networks. Examples include social networks, the internet, biological networks, food webs, the brain or communication networks. Most of these networks contain communities: groups of densely connected vertices. In social networks communities may for example correspond to groups of friends or groups of people with similar interests.
Networks are typically modeled by random graphs. Most random graph models however are 'locally tree-like': they contain only few cycles. This makes them unfit to model networks with community structures. In this talk, I will introduce a random graph model that does include community structures, and investigate how an epidemic process spreads over the network model. By comparing this to the behavior of the same process on traditional random

graph models without community structures, we are able to find how community structure influences the spread of epidemics. Interestingly, community structures speed up the spread of an epidemic in some networks, but slow it down in other networks, depending on the exact community shapes. This illustrates the importance of using community structures in network models.

Docentendag

Woensdag 14:00-16:00 **Brabant zaal**
Organisatoren: Wim Caspers en Swier Garst

Jos Tolboom en Johan Gademan (SLO) **14:00-14:40**
De nieuwe examenprogrammas wiskunde havo/vwo: bedoelingen en eerste uitkomsten
In 2017 en 2018 zijn de eerste eindexamens afgenomen op havo respectievelijk vwo volgens het nieuwe examenprogramma. Komend studiejaar zullen de eerstejaarsstudenten dus een gedeeltelijk andere wiskundige achtergrond hebben dan voorheen. Wat waren de bedoelingen achter het invoeren van het nieuwe programma en wat zijn de eerste uitkomsten ervan?

Bob Rink (VU) **14:40-15:20**
Dynamische systemen - van Fermats kleine stelling tot complexe netwerken
Dynamische systemen kom je in de gekste uithoeken van de wiskunde tegen, en in mijn verhaal passeert een aantal voorbeelden de revue. Ik zal laten zien hoe een chaotisch dynamisch systeem een stelling van Fermat uit de getaltheorie bewijst. We kijken naar filmpjes van biljarten, die nog altijd niet wiskundig begrepen zijn. In een eenvoudig model voor klimaatverandering, zien we hoe evenwichten ontstaan. En we eindigen met een hot topic - de vraag waarom complexe netwerken kunnen synchroniseren.

Derk Pik (Pythagoras, Maimonides College en UvA) **15:20-16:00**
Pythagoras Profielwerkstukwedstrijd
Het is het derde jaar dat de prijs wordt uitgereikt. De drie beste leerlingen zullen een korte voordracht houden, waarna het publiek het beste, mooiste, meest interessante werkstuk mag uitkiezen. De Pythagoras Profielwerkstukwedstrijd was vorig jaar een groot feest. Het niveau was uitzonderlijk hoog. Leerlingen kwamen zeer veel verder dan het gewone middelbareschoolniveau. Tjeu Kayim van het Zwijsen College in Veghel won de eerste prijs met Errorcorrectie van QR-codes. Hij leverde een compleet algoritme en gaf een volledige algebrasche verklaring voor de werking van zijn coderingsprogramma.

Diamant

Wednesday 14:00-16:00 **Lecture hall 22**
Organizer: Robin de Jong

Frank Vallentin(University of Cologne) **14:00-15:00**
Coloring the Voronoi tessellation of lattices
In this talk I will introduce the chromatic number of a lattice: It is the least number of colors one needs to color the interiors of the cells of the Voronoi tessellation of a lattice so that no two cells sharing a facet are of the same color. I will introduce two lower bounds for the chromatic number: the sphere packing lower bound and the spectral lower bound. Using them I will show how to compute, sometimes using polynomial optimization, the chromatic number of several important lattices. Based on joint work with David Madore and Mathieu Dutour Sikiric.

Ada Boralevi (Politecnoci di Torino) **15:00-16:00**
Spaces of matrices of constant rank, vector bundles, and truncated graded modules
A space of matrices of constant rank is a vector subspace V, say of dimension $n+1$, of the set of matrices of size $a \times b$ over a field k, such that any nonzero element of V has fixed rank r. It is a classical problem to look for examples of such spaces of matrices, and to give relations among the possible values of the parameters a, b, r, n. In this talk I will report on several joint projects with D. Faenzi, P. Lella, and E. Mezzetti, introducing new methods to classify and produce examples of such spaces. The techniques that I will explain involve vector bundles on projective spaces, and in particular globally generated bundles and instanton bundles, as well as finitely generated graded modules over the ring of polynomials $k[x_0, ..., x_n]$.

Mathematics of Machine Learning

Wednesday 14:00-16:00 **Lecture hall 80**
Organizer: Peter Grünwald

Peter Grünwald (CWI and Leiden University) **14:00-14:02**
Introduction: The Mathematics of Machine Learning

Tim van Erven (Leiden University) **14:02-14:40**
Online Convex Optimization: From Gambling to Minimax Theorems by Playing Repeated Games
Modeling sequential decision problems as repeated games has a long history in statistics, information theory and machine learning. Using the modern unified setting of online convex optimization, I will highlight applications that range from betting on the outcomes of football games to proving von Neumann's minimax theorem, and I will introduce open questions at the frontier of current research related to a basic model for portfolio selection in finance and to optimization of deep learning methods in machine learning.

Wouter Koolen (CWI Amsterdam) **14:40-15:20**
Bandit Algorithms for Best Arm Identification and Game Tree Search
Sequential allocation problems with partial feedback (aka Bandit problems) have a rich tradition including applications to drug testing, online advertisement and more recently min-max game tree search. We will start by looking at the fundamental statistical identification problem. In particular, we will see how sample complexity lower bounds can be "inverted" to derive matching optimal algorithms. We will then look at extensions of the framework suitable for finding the optimal move in min-max game trees. Throughout, the talk will focus on the main statistical and computational challenges and ideas.

Rui Castro, (TU/e) **15:20-16:00**
On adaptive sensing and active learning for inference of high dimensional sparse signals
In many scenarios where machine learning and statistics tools are used one typically starts with a set of previously collected data, in order to learn generic relations between the various observed variables. This means such approaches rely on passive data collection methodologies. However, in many practical scenarios it is possible to adjust the data collection process based on information gleaned from previous observations, in the spirit of the "twenty-questions" game, in what is known as adaptive sensing, active learning, or sequential design of experiments. The intricate relation between data analysis and acquisition in adaptive sensing paradigms is extremely powerful, but creates

complicated data dependencies making it challenging to devise simultaneously practical and theoretically sound learning methodologies. In this talk I consider estimation and detection of high-dimensional sparse signals in noise, and present (near) optimal adaptive sensing procedures that provably outperform the best possible inference methods based on non-adaptive sensing. The methods developed can also be used also for adaptive compressive sensing and for detection of (sparse) correlations, as well dealing with dynamical scenarios where the signal is changing as the data is being collected (this talk is based mainly on joint works with Ervin Tánczos).

Scientific Computing / NDNS+

Wednesday 14:00-16:00 **Lecture hall 83**
Organizers: Jason Frank and Mark Peletier

Sarah Gaaf (UU) **14:00-14:30**
Projection techniques for problems involving large-scale matrix equations
I would like to discuss various iterative procedures in development for problems involving large-scale Sylvester equations. I will treat two interesting sub problems:
(1) Consider the Sylvester equation $AX - XB = C$. An important issue when solving this matrix equation is the sensitivity of the solution X to perturbations in the matrices A, B, C. It turns out that the sensitivity is inversely proportional to the separation between the matrices A and B. How to compute this quantity for large-scale problems will be addressed in this talk.
(2) Consider a more general Sylvester type of equation, a system of linear matrix equations:

$$\begin{aligned} AX + YB &= C, \quad (1) \\ DX + YE &= F. \quad (2) \end{aligned}$$

I will first introduce an algorithm to solve the small-scale problem. Then I will show some ideas for the development of an iterative method for the problem when the matrices involved are large and sparse.

Erik Bekkers (TU/e) **14:30-15:00**
Nilpotent Approximations of Sub-Riemannian Distances for Fast Perceptual Grouping of Blood Vessels in 2D and 3D
We propose an efficient approach for the grouping of local orientations (points on vessels) via nilpotent approximations of sub-Riemannian distances in the 2D and 3D roto-translation groups SE(2) and SE(3). In our approximations we consider homogeneous norms on nilpotent groups that locally approximate SE(n), and which are obtained via the exponential and logarithmic map on SE(n). In a qualitative and quantitative validation we show that the norms provide accurate approximations of the true sub-Riemannian distances. Quantitative results are obtained by evaluating perceptual grouping performance of retinal blood vessels in 2D images and curves in challenging 3D synthetic volumes. The results show that: 1) sub-Riemannian geometry is essential in achieving top performance; and 2) that grouping via the fast analytic approximations performs almost equally, or better, than numerical data-adaptive fast marching approaches on $\mathbb{R}^n$ and SE(n).

Dirk van Kekem (RUG) **15:00-15:30**

Birth of waves in the Lorenz-96 model

The Lorenz-96 model [3] is, due to its simplicity, widely used as a test model for various applications, such as data assimilation methods. This symmetric model contains $\mathbb{Z}_n$-symmetry and has as free parameters the forcing $F \in \mathbb{R}$ and the dimension of the state space $n \in \mathbb{N}$. We explored the dynamics of the monoscale Lorenz-96 model for both positive and negative F using analytical and numerical means.

In this talk, we show that different type of waves arise through different bifurcation routes, depending on the dimension n and the sign of F. For $F > 0$ the first bifurcation of the trivial equilibrium is either a supercritical Hopf or a double-Hopf bifurcation and the corresponding periodic attractor represents a travelling wave. For $F < 0$ and odd n the first bifurcation is again a supercritical Hopf bifurcation. On the other hand, if n is a multiple of 2, resp. 4, then for $F < 0$ a supercritical Hopf bifurcation occurs after one, resp. two subsequent, supercritical pitchfork bifurcations for all generated stable equilibria simultaneously. These Hopf bifurcations give rise to two, resp. four stationary waves that coexist for the same parameter values n and F. Finally, we discuss the occurrence of two or more coexisting stable waves via multiple double-Hopf bifurcations.

This is joint work with Alef Sterk [1], [2].

[1] Kekem, D.L. van and Sterk, A.E. (2017), 'Symmetries in the Lorenz-96 model', *Nonlinearity* (submitted), arXiv:1712.05730.

[2] Kekem, D.L. van and Sterk, A.E. (2017), 'Wave propagation in the Lorenz-96 model', *Nonlinear Processes in Geophysics* (submitted), doi.org/10.5194/npg-2017-56.

[3] Lorenz, E.N. (2006), 'Predictability – A Problem partly solved', in: Palmer, T.N. & Hagedorn, R. (eds.), *Predictability of Weather and Climate*, Cambridge University Press, chap. 3, pp. 40–58.

Jeroen Wouters (University of Copenhagen) **15:30-16:00**

Sampling extreme heat waves using a rare event algorithm

Studying extreme events and how they evolve in a changing climate is one of the most important current scientific challenges. Starting from complex climate models, a key difficulty is to be able to run long enough simulations to observe those extremely rare events. In physics, chemistry, and biology, rare event algorithms have recently been developed to compute probabilities of events that cannot be observed in direct numerical simulations. Here we apply such an algorithm to the sampling of extreme heat waves. This approach

gives an improvement of more than two orders of magnitude in the sampling efficiency. We describe the dynamics of events that would not be observed otherwise. We show that European extreme heat waves are related to a global teleconnection pattern involving North America and Asia. This tool opens up a wide range of possible studies to quantitatively assess the impact of climate change.
This is joint work with Francesco Ragone and Freddy Bouchet.

STAR

Wednesday 14:00-16:00 **Lecture hall 82**
Organizers: Ernst Wit and Bert Zwart

Richard Samworth (Univ. Cambridge) **14:00-15:00**
Isotonic regression in general dimensions
We study the least squares regression function estimator over the class of real-valued functions on $[0,1]^d$ that are increasing in each coordinate. For uniformly bounded signals and with a fixed, cubic lattice design, we establish that the estimator achieves the minimax rate of order $n^{-\min\{2/(d+2),1/d\}}$ in the empirical L_2 loss, up to poly-logarithmic factors. Further, we prove a sharp oracle inequality, which reveals in particular that when the true regression function is piecewise constant on k hyperrectangles, the least squares estimator enjoys a faster, adaptive rate of convergence of $(k/n)^{\min(1,2/d)}$, again up to poly-logarithmic factors. Previous results are confined to the case $d \leq 2$. Finally, we establish corresponding bounds (which are new even in the case $d = 2$) in the more challenging random design setting.
There are two surprising features of these results: first, they demonstrate that it is possible for a global empirical risk minimisation procedure to be rate optimal up to poly-logarithmic factors even when the corresponding entropy integral for the function class diverges rapidly; second, they indicate that the adaptation rate for shape-constrained estimators can be strictly worse than the parametric rate.

Henk Don (RUG) **15:00-15:30**
Metastability of the contact process on the configuration model and Erdos-Renyi graphs
A central question for the contact process is if there exists a metastable solution. In this talk I will present the idea to bound the extinction time from below by looking at the number of edges between a set of nodes and its complement. If this is large enough, the extinction time will be exponential in the number of nodes. This approach can be applied both to the configuration model and the Erdos-Renyi model and leads to conditions on the model parameters under which a metastable solution exists. Joint work with E.A. Cator

Wioletta Ruszel (TUD) **15:30-16:00**
Random interface models
An interface in physical systems is a boundary which separates different matter (take oil and water). In this talk we will discuss some examples of stochastic models for interfaces. Each position of the interface at some fixed point can be modeled by a random variable and it's shape by how these variables

are depending on each other (correlation structure). This is typically called the microscopic level of the model since it describes what the components do. Important quantities of interests are limits such as infinite-volume measures or scaling limits since they describe how the system looks like from a macroscopic point of view.
In this talk we will review some developments for two classes of discrete and continuous interface models. In particular we will mention long-range Ising models, odometers of sandpile models and the membrane model.
Some results of this talk are joint work with Alessandra Cipriani (TU Delft), Rajat Hazra (ISI Kolkata), Aernout van Enter (U Groningen), Arnaud Le Ny (U Paris Creteil) and Loren Coquille (U Grenoble).

Studygroup Mathematics in Industry

Wednesday 14:00-16:00 **Lecture hall 81**
Organizers: V. Rottschäfer and A. Di Bucchianico

Vivi Rottschäfer and Alessandro di Bucchianico (UL, TU/e)
The Joy of Applying Mathematics to Real-World Problems - Experiences with the Study Group Mathematics with Industry
The goal of this session is to give an impression of the advantages of participating as a mathematician in a Study Group Mathematics with Industry.
The Study Group Mathematics with Industry (SWI) is a combined industrial/academic one-week workshop where mathematics is used to tackle problems presented by companies and other organisations outside academia. Between fifty and eighty mathematicians, both from industry and academia, gather during the week to collaborate intensively on industrial problems.
The format follows the original Oxford model, dating back to 1968, which is used worldwide in similar study groups. Six companies present their problem on Monday after which the participants enthusiastically devote the rest of the week to solving these problems in smaller groups.
Since 1998, the SWI has been organised in the Netherlands every year, see http://www.swi-wiskunde.nl with continuous funding provided by NWO. A national committee, consisting of the 2 organisers of this session, takes care that the SWI is organised every year by a different local organisation committee.
In this session we showcase several of the problems tackled during the SWI over the years. After an introduction of the general concept of a Study Group, several participants, academic as well as from companies, present their experience with the SWI. This session contains talks by
- a PhD student who participated in the latest SWI in 2018,
- a senior participant who has experience with follow-up projects after an SWI,
- a company representative who formulated a problem in 2018
The speakers in his session are:
Jan van Doremalen (CQM)
Mark van den Bergh (Leiden University)
Kees Vuik (TU Delft)
Alessandro di Bucchianico (TU Eindhoven)
Vivi Rottschäfer (Leiden University)

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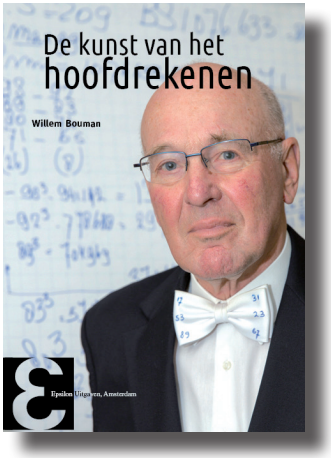

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