Nederlands Mathematisch Congres

NMC Series 2021

David John Aldous
University of California, Berkeley
(Brouwer medal)

David Harvey
UNSW, Sydney
(Beeger lecture)

Assaf Naor
Department of Mathematics,
Princeton University

January 28, 2021
Stieltjes Prize & NWO Impact Prize

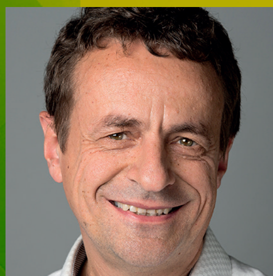
March 11, 2021
Speed dates with industry

April 6 & 7, 2021
NMC Scientific Days

May 20, 2021
KWG PhD Prize

September 24, 2021
Onderwijs meets Onderzoek

Laure Saint-Raymond
Ecole Normale Supérieure
de Lyon



Bernd Sturmfels
Max-Planck Institute, Leipzig
and University of California,
Berkeley

MORE INFORMATION AND REGISTRATION: **www.mathematischcongres.nl**

Organisation under the auspices of
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Wim Caspers (TU Delft)
Swier Garst (NVvW)
Paul Drijvers (University of Utrecht)
Heleen van der Ree (NvVW)

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Word of Welcome

Dear participants,

Welcome to the *Nederlands Mathematisch Congres, NMC 2021!*

Last year we had to cancel the live congress. Organisation of a fully or partly online congress, within a few weeks only, was impossible by then. This year we are glad to offer you an online congress at least.

Major parts of last year's congress programme have been carried over to this year's programme, among others almost all award ceremonies. Despite the lack of a real get-together, we hope that you will like the programme.

Enjoy the congress!

The organising committees of NMC 2021

General Information

The NMC Scientific Days are hosted through Zoom, using the same link for the two days, both for the keynote lectures and parallel sessions. The parallel sessions will be in two breakout rooms. In the menu you will find an option “Breakout rooms”; if you click on this item, you can join the parallel session of your choice.

Next to Zoom, we offer the opportunity to meet informally in Gather.town. Gather is a webbased application in which we built an online conference center. From April 5th 19:00h you can access this space, walk around and talk to other participants who are nearby or are at the same table.

In order to get the link to the Zoom meetings and or to gather, you have to register for the event here:

`https://mathematischcongres.nl/event/nmc2021-light/`

Program Outline

Tuesday, April 6

Time	Activity
09:30-09:40	Opening by Barry Koren (chair of KWG) Arian Steenbruggen (NWO Domain Science)
09:40-10:40	Keynote lecture by Laure Saint-Raymond *Dynamics of a hard sphere gas*
10:40-11:00	Short break
11:00-12:30	Parallel sessions: STAR and QSC
12:30-13:30	Break
13:30-15:00	Parallel sessions: NETWORKS and DIAMANT
15:00-15:30	Short break
15:30-16:30	AI and Mathematics (AIM)
16:30-17:30	Ceremony Brouwer medal: David John Aldous
17:45-18:30	Annual meeting of the KWG

Wednesday, April 7

Time	Activity
09:30-10:30	Beeger lecture: David Harvey
10:30-11:00	Short break
11:00-12:30	Parallel sessions: GQT and NDNS+
12:30-13:30	Break
13:30-15:00	Parallel sessions: 4TU.AMI and History of Mathematics
15:00-15:30	Short break
15:30-16:30	Keynote lecture by Bernd Sturmfels *3264 Conics in a Second*
16:30-17:30	Keynote lecture by Assaf Naor *An average John theorem*
17:30-17:35	Closing by Barry Koren (chair KWG)

Plenary Sessions

Keynote Lectures

Tuesday, April 6

Laure Saint-Raymond (ENS Lyon) **09:40-10:40**
Dynamics of a hard sphere gas.

Consider the Hamiltonian dynamics of a system of hard spheres, such as billiard balls or marbles. In the kinetic limit (when the number of spheres tends to infinity), the system is described by the Boltzmann equation which is irreversible. As the microscopic dynamics is reversible, this may be seen as a paradox. We will explain that the emergence of the irreversibility in the kinetic limit is related to singular dynamical correlations with an intricate structure going through all scales. We shall discuss the combinatorial techniques that can help analysing the departure from chaos.

Wednesday, April 7

Bernd Sturmfels (MPI Leipzig, University of California) **15:30-16:30**
3264 Conics in a Second.

Enumerative algebraic geometry counts the solutions to certain geometric constraints. Numerical algebraic geometry determines these solutions for any given instance. This lecture illustrates how these two fields complement each other, especially in the light of emerging new applications. We start with a gem from 19th century geometry, namely the 3264 conics that are tangent to five given conics in the plane. Thereafter we turn to current problems in statistics, with focus on maximum likelihood estimation for linear Gaussian covariance models.

Assaf Naor (Princeton University) **16:30-17:30**
An average John theorem.

A classical theorem of Fritz John implies that any n-dimensional normed space embeds with distortion $\sqrt{n}$ into a Hilbert space. This bound is sharp, but can we do better if we relax the worst case (pairwise) bi-Lipschitz requirement by asking for distances to be preserved only on average? We will show that a suitable formulation of this question has a positive answer whose proof borrows from the theory of nonlinear spectral gaps. Specifically, we will show that the average distortion decreases in general to $O(\sqrt{\log n})$, and under additional geometric assumptions even better bounds are possible. We will explain applications of this theorem to major questions in metric geometry and algorithms.

Brouwer Lecture **Tuesday, April 6, 16:30-17:30**

David John Aldous (University of California)
Gambling under unknown probabilities as a proxy for real world decisions under uncertainty.

We give elementary examples within a framework for studying decisions under uncertainty where probabilities are only roughly known. The framework, in gambling terms, is that the size of a bet is proportional to the gambler's perceived advantage based on their perceived probability, and their accuracy in estimating true probabilities is measured by mean-squared-error. Within this framework one can study the cost of estimation errors, and seek to formalize the "obvious" notion that in competitive interactions between agents whose actions depend on their perceived probabilities, those who are more accurate at estimating probabilities will generally be more successful than those who are less accurate. The mathematics in this talk is entirely elementary, but the conceptual background is more sophisticated.

The Beeger Lecture **Wednesday, April 7, 09:30-10:30**

David Harvey (UNSW Sydney)
Number theory and fast arithmetic.

Modern computational number theory depends crucially on fast algorithms for solving basic problems in integer arithmetic, such as multiplication and division. In this lecture, I will outline the state of the art for these problems, and I will give a tour of a few number-theoretic applications of fast arithmetic that have come up in my research.

KWG Annual Meeting **Tuesday, April 6, 17:45-18:30**

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 organisation 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 Platform Wiskunde Nederland. The society also represents the Dutch mathematical community internationally in the European Mathematical Society and International Mathematical Union.

The annual meeting of the Dutch Royal Mathematical Society is traditionally held during the NMC.

AI and Mathematics **Tuesday, April 6, 15:30-16:30**

Christoph Brune (University of Twente)
Deep learning of normal form autoencoders for universal, parameter-dependent dynamics.

A long-standing goal in dynamical systems is to construct reduced-order models for high-dimensional spatiotemporal data that capture the underlying parametric dependence of the data. In this work, we introduce a deep learning technique to discover a single low-dimensional model for such data that captures the underlying parametric dependence in terms of a normal form. A normal form is a symbolic expression, or universal unfolding, that describes how the reduced-order differential equation model varies with respect to a bifurcation parameter. Our approach introduces coupled autoencoders for the state and parameter, with the latent variables constrained to adhere to a given normal form. (Joint work with Manu Kalia, Steven Brunton, Hil Meijer and Nathan Kutz)

Allard Hendriksen (CWI Amsterdam)
Practical deep denoising for tomography without reference data.

In X-ray computed tomography, a 3D model of the interior of an object is computed from a sequence of X-ray images. As the exposure time of the X-ray acquisition is reduced, noise is introduced in the images and the reconstructed model. For removing this noise, deep convolutional neural networks (CNNs) have been shown to be effective, but have so far required a dataset of noise-free target images for training. Our research suggests that it is possible to train such networks without any additional noise-free data by changing the training strategy. This opens the doors for application of deep CNNs in applications where obtaining noise-free images is infeasible, such as battery research and tomography of quickly evolving dynamic systems.

Oxana Manita (TU Eindhoven)
Universal Approximation in Dropout Neural Networks.

Dropout is a commonly used regularization algorithm. During training with dropout edges or nodes of a network are randomly deleted in order to prevent coadaptation. In this talk the approximation properties of dropout networks are discussed. We consider two versions of dropout networks – networks with random output and networks with deterministic output obtained by replacing random filters by their expected values. The latter is commonly used in practice mode of operation. It turns out that for a given function, one can construct a dropout network that approximates it well in both modes simultaneously. (Joint work with M. Peletier. J. Portegies, J. Sanders and A. Senen-Cerda)

Mathias Staudigl (Maastricht University)
Generalized Self-concordant analysis of Frank-Wolfe Algorithms.

Projection-free optimization via different variants of the Frank-Wolfe method has become one of the cornerstones in large scale optimization for machine learning and computational statistics. Numerous applications within these fields involve the minimization of functions with self-concordant like properties. Such Generalized Self-Concordant (GSC) functions do not necessarily feature a Lipschitz continuous gradient, nor are they strongly convex. Indeed, in a number of applications within machine learning, e.g. inverse covariance estimation or distance-weighted discrimination problems in support vector machines, the loss is given by a GSC function having unbounded curvature, implying absence of theoretical guarantees for the existing Frank-Wolfe methods. This paper closes this apparent gap in the literature by developing provably convergent Frank-Wolfe algorithms with standard O(1/k) convergence rate guarantees. If the problem formulation allows the efficient construction of a local linear minimization oracle, we develop a Frank-Wolfe method with linear convergence rate. (Joint work with Kamil Safin (Moscow Institute of Physics and Technology), Pavel Dvurechensky (Weierstrass Institute for Applied Analysis and Stochastics), Shimrit Shtern (Technion-The Israel Institute of Technology))

Lara Scavuzzo (Delft University of Technology)
Learning to branch for Mixed Integer Programming.

Mixed Integer Programming is a powerful mathematical modeling tool for optimization problems, with numerous applications in real-world scenarios. In spite of the NP-hardness of Mixed Integer Programs (MIPs), our capabilities to tackle such problems have dramatically increased as a result of advancements in the algorithms that solve them. However, in practice, solving MIPs to optimality remains challenging. In this talk, I will discuss the potential of Machine Learning (ML) tools to augment algorithms for Mixed Integer Programming. In particular, how ML can support decision-making for critical tasks within the solver, such as choosing a branching candidate.

Parallel Sessions

STAR **Tuesday, April 6, 11:00-12:30**

Henk Don (Radboud Universiteit)

A lower bound for connection probabilities in critical percolation.

In this talk we consider critical percolation on $\mathbb{Z}^d$. In particular we are interested in the probability to have an open path from the origin to some point x as a function of x. In dimensions 3-6 not much is known about this function, as the techniques for dimension two and those for high dimensions fail. We will present a lower bound on the connection probabilities in these intermediate dimensions. (Joint work with Rob van den Berg).

Luca Avena (University of Leiden)

Explorations of networks through random rooted forests.

In the 1990s David Wilson introduced a simple algorithm based on loop-erased random walks to sample uniform spanning trees and, more generally, rooted weighted trees and forests spanning a given graph. I will consider the probability measure obtained when Wilson's algorithm is used to sample rooted forests with a scale-parameter controlling the number of trees.The resulting forest measure has a rich, flexible and explicit mathematical structure which makes it a powerful tool to design algorithms to explore networks in a dynamic fashion by tuning the scale-parameter.

I this lecture I will focus on fundamental aspects of this measure and its relations with other objects of relevance in probability and statistical physics. In particular, I plan to describe the main static and dynamic properties of associated observables (e.g. set of roots, induced partition) and discuss some progress in understanding related asymptotics.

At the end I will briefly mention how this forest can be used to design algorithms to analyze network-based data sets.

Daniel Valesin (Rijksuniversiteit Groningen)

Percolation on stationary distributions of interacting particle systems.

We discuss certain models of site percolation on the d-dimensional integer lattice in which long-range dependence among the states of vertices is present. In the presence of such dependence, proving that a percolation phase transition occurs can be challenging. In this talk we will address models in which the states are sampled from probability distributions obtained from the equilibrium states of interacting particle systems. We will discuss two important classes of interacting particle systems, namely the voter model and the contact process. In both cases, we prove that (under certain assumptions on the system dynamics) a percolation phase transition is present. (Joint work with Balázs Ráth (BME, Hungary)).

Simon Apers (CWI Amsterdam, ULB Brussels)

Quantum algorithms for graph sparsification, cut approximation and Laplacian solving.

Graph sparsification is a key tool in modern combinatorial optimization. It reduces the number of edges of a graph to near-linear in the number of nodes, while approximately preserving quantities of interest such as the cut or spectral structure of the graph. This is an important routine in efficient algorithms for approximating the minimum and maximum cut in a graph, or for solving a linear system in the graph Laplacian.

In this talk I will formally introduce graph sparsification, and I will show how quantum computers can speed up this key technique. This leads to faster quantum algorithms for the aforementioned problems of cut approximation and solving a Laplacian system.

Jana Sotáková (QuSoft, University of Amsterdam)

Isogeny graphs in post-quantum cryptography.

Public-key cryptography is nowadays an essential part of our daily lives, be it internet banking or credit card transactions. However, ever since the 1990s when Shor developed his quantum factoring algorithm, it has been known that the cryptosystems we use nowadays can be broken using a sufficiently large quantum computer. The search for replacement post-quantum cryptosystems, that is, protocols that will be secure even against adversaries with a quantum computer, has been accelerated by the 2017 NIST competition. One of the proposals, SIKE, uses isogenies of elliptic curves to achieve a practical encryption protocol and subsequently spawned a lot of research in the area. We will discuss how the underlying algebraic structure of isogeny problems opens up exciting possibilities to analyze these isogeny graphs.

Michael Walter (University of Amsterdam)

Tensors, invariants, and optimization.

Given a vector in a representation, can it be distinguished from zero by an invariant polynomial? This classical question in invariant theory connects to a diverse set of problems in mathematics and computer science. In quantum information, it captures the quantum marginal problem and recent notions of tensor ranks. We will see that the general question can be usefully thought of as an optimization problem over non-commutative groups and discuss a rigorous algorithm for solving it.

Shankar Bhamidi (University of North Carolina)
David Aldous and the mathematics of networks.

The aim of this talk is to describe a personal view of the impact of David Aldous (the 2020 recipient of the Brouwer award) in the world of networks through the following three settings:

(a) Mathematical foundations of exponential random graphs: one of the most well used models of networks especially in areas such as sociology, political science and epidemiology are the so called exponential random graph models. I will describe how Aldous's fundamental contributions in understanding mixing time of Markov Chains leads to an understanding of MCMC algorithms to sample from this distribution. If there is time, I will also describe how the Aldous-Hoover theory of exchangeability is fundamental in understanding the large network asymptotics of these models as proven by Chatterjee and Diaconis.

(b) First passage percolation, Preferential attachment models and branching process: I will describe the impact of Aldous's work (a by-product of trying to understand local weak convergence of random tree models) in elucidating connections between fundamental results on continuous time branching processes laid by Athreya-Ney and Jagers-Nerman and structural properties of network models such as preferential attachment models and understanding information diffusion models such as first passage percolation.

(c) Strong disorder models and the minimal spanning tree: We will finally end with how Aldous's work in understanding coagulation models in statistical physics turned out to be one of the fundamental ingredient in understanding the behavior of objects such as the minimal spanning tree on network models with iid edge weights.

Much of this work is with many collaborators. I will intersperse the talk with advice given to me by David at various crucial times in my career.

Pieter Kleer (Max-Planck-Institut für Informatik)
The switch Markov chain for sampling graphs with given degrees.

The uniform sampling (or generation) of graphs with given degrees is an important problem in the analysis of complex networks. One of the simplest approaches to this problem is the switch Markov chain. Given some starting graph, one repeatedly switches two edges uniformly at random, while preserving the degree sequence. How many switches are needed before the resulting network is close to a uniform sample from the set of all graphs with the given degrees? The answer to this question is still open for general degree sequences.

In this talk we will sketch a novel proof approach for the analysis of the switch Markov chain, based on Sinclair's multi-commodity flow method. The analysis relies on combinatorial arguments (no knowledge of Markov chains is required beyond the basic definition). In particular, our proof approach allows us to extend the existing range of degree sequences for which the switch Markov chain is known to be rapidly mixing (the chain is called rapidly mixing if only a polynomial number of switches is needed to get close to a uniform sample). We will also discuss an extension of the problem, where in addition degree correlation constraints may be specified on the graphs to be generated.

Juan Peypouquet (University of Groningen)
A fast convergent first-order method bearing second-order information.

We propose a model for a class of first-order methods as an inertial system with Hessian-driven damping. The model combines several features of the Levenberg-Marquardt algorithm and Nesterov's acceleration scheme for first-order algorithms. We obtain a second-order system (in time and space), which can be interpreted as a first-order one by an appropriate transformation. The resulting method is more stable than classical accelerated methods, and just as fast.

Lola Thompson (Utrecht University)
Summing $\mu(n)$: an even faster elementary algorithm.

We present a new elementary algorithm for computing $M(x) = \sum_{n\leq x} \mu(n)$, where $\mu(n)$ is the Möbius function. Our algorithm takes

$$\text{time} \quad O_\epsilon\left(x^{3/5}(\log x)^{3/5+\epsilon}\right) \quad \text{and space} \quad O\left(x^{3/10}(\log x)^{13/10}\right),$$

which improves on existing combinatorial algorithms. While there is an analytic algorithm due to Lagarias-Odlyzko with computations based on the integrals of $\zeta(s)$ that only takes time $O(x^{1/2+\epsilon})$, our algorithm has the advantage of being easier to implement. The new approach roughly amounts to analyzing the difference between a model that we obtain via Diophantine approximation and reality, and showing that it has a simple description in terms of congruence classes and segments. This simple description allows us to compute the difference quickly by means of a table lookup. This talk is based on joint work with Harald Andrés Helfgott.

Cecilia Sagado (Rijskuniversiteit Groningen)
Large Mordell-Weil rank jumps and the Hilbert Property.

We discuss recent progress on the variation of the Mordell-Weil rank in families of elliptic curves. We show that if the underlying surface admits a conic bundle structure then the subset of fibres for which the Mordell-Weil rank is strictly larger than the generic rank is not thin, as subset of the base of the fibration. We obtain larger rank jumps (+2 and +3) also on non-thin subsets of the line under extra hypotheses on the elliptic fibration. The results presented are based on joint work with D. Loughran (Bath) and on work in progress with R. Dias (UFRJ).

Diletta Martinellin (University of Amsterdam)
On the birational classification of algebraic varieties.

The classification of algebraic varieties is one of the central questions and guiding problems in algebraic geometry. For smooth complex projective curves we have a very satisfactory classification in terms of the genus that leads to three main types of curves: the projective line, elliptic curves, and curves of general type. I will explain how, thanks to the so-called Minimal Model Program, it is possible to recover this trichotomy for higher dimensional varieties and obtain three main pure types: Fano varieties, Calabi-Yau and canonically polarised varieties. I will conclude explaining some current research questions inspired by the geometry of Fano varieties.

Annegret Burtscher (Radboud Universiteit)
On the metric structure and convergence of spacetimes.

Riemannian manifolds naturally carry the structure of metric spaces, and standard notions of metric convergence interact with the Riemannian structure and curvature bounds. No such profound theory is yet available for Lorentzian manifolds because the Lorentzian distance does not give rise to a metric structure. For spacetimes with suitable time functions, however, the recently introduced null distance provides an alternative metric that naturally interacts with the causal structure and yields an integral current space. In this talk we compare the metric space structures of Riemannian and Lorentzian manifolds and show how the convergence of a sequence of warped product spacetimes can be studied using the null distance.

Alessandra Cipriani (TU Delft)
Random interfaces and Liouville quantum gravity.

In this talk, we will introduce random interfaces in the context of conformal field theories. We will focus on the Gaussian free field (GFF), which appears as scaling limit of different statistical mechanics models and has been central in defining two-dimensional Liouville quantum gravity. We will review the most important results on the Liouville measure constructed as an exponential of the GFF, the study of thick points of such measure, and finally extensions of this construction in four (or rather, even) dimensions via another random interface, the membrane model.

Stefanie Sonner (Radboud Universiteit)
Continuum models for spatially heterogeneous biofilm communities.

Biofilms are dense aggregations of bacterial cells attached to a surface and held together by a self-produced matrix of extracellular polymeric substances. Such multi-cellular communities are a very successful life form and are able to tolerate harmful environmental impacts that would eradicate free floating individual cells.

Biofilms affect many aspects of human life and play a crucial role in natural, medical and industrial settings. Mathematical models for their growth have been developed for several decades. We focus on deterministic continuum models for spatially heterogeneous biofilm communities that are formulated as quasilinear reaction-diffusion-systems. Their characteristic and challenging feature are the two-fold degenerate diffusion coefficients for the biomass fractions comprising a power-law degeneracy (known from the porous medium equation) and a super diffusion singularity.

The prototype growth model is discussed as well as recent variations and extensions that take additional biofilm processes into account. Analytical results are shown and numerical simulations presented to illustrate the model behavior.

Frits Veerman (University of Leiden)
Toll roads and freeways: the role of cholesterol on the stability of bilayer interfaces.

We study a multi-component extension of the functionalised Cahn-Hilliard equation, which provides a framework for the formation of patterns in fluid systems with multiple amphiphilic molecules. The assumption of a length scale dichotomy between two amphiphilic molecules allows the application of geometric techniques for the analysis of patterns in singularly perturbed reaction-diffusion systems. For a generic two-component system, we show that solutions to the four-dimensional connection problem provide the leading order approximation for solutions to the full eight-dimensional barrier problem, which can be obtained through a perturbative expansion in the layer width. In this general context, we show that the presence of a weakly hydrophilic molecule such as cholesterol can stabilise phospholipid bilayer patterns. Moreover, we show that a saddle-node bifurcation of bilayer solutions in the four-dimensional connection problem acts as a source of so-called defect solutions, i.e. solutions to the barrier problem that are not also solutions to the connection problem. The analysis combines geometric singular perturbation theory with centre manifold theory in an infinite-dimensional context.

Daniele Avitabile (VU Amsterdam, Inria MathNeuto Team)
Canards and slow passage through bifurcations in infinite-dimensional dynamical systems.

Ordinary Differential Equations (ODEs) in which state variables evolve according to disparate time scales are known to support solutions exhibiting slow passages through bifurcations and canard segments. These solutions are indeed considered to be footprints of time-scale separation, and they have been studied extensively in the past decades to explain a vast repertoire of temporal patterns including mixed-mode oscillations, bursting, and excitable dynamics.

The literature on the topic deals primarily with finite-, and usually low-, dimensional dynamical systems. In the mathematical neuroscience community, for instance, there exists a well-defined methodology for single-cell models with time-scale separation, but not for spatially-extended or network models.

I will present a rigorous framework for the local analysis of canards and slow passages through bifurcations in a large class of infinite-dimensional dynamical systems with time-scale separation. The framework, which relies on a centre-manifold reduction proposed by Iooss and coworkers, is applicable to models where an infinite-dimensional dynamical system for fast variables is coupled to a finite-dimensional dynamical system for slow variables. I will discuss examples where the fast variables evolve according to systems of local and nonlocal reaction-diffusion PDEs, integro-differential equations, or delay-differential equations. This approach opens up the possibility of studying spatio-temporal canards and slow passages through bifurcations in spatially-extended systems, and it provides an analytical foundation for several numerical observations recently reported in literature.

Remco Duits (TU Eindhoven)
Equivariant deep learning via PDEs on the space of positions and orientations.

We present PDE-based Group Convolutional Neural Networks (PDE-G-CNNs) that generalize Group equivariant Convolutional Neural Networks (G-CNNs). In PDE-G-CNNs a network layer is a set of PDE-solvers where geometrically meaningful PDE-coefficients become trainable weights.

The underlying PDEs are morphological and linear scale space PDEs on the homogeneous space M of positions and orientations. They provide a geometrical and probabilistic PDE-design of the equivariant network. Equivariance means that roto-translation of input yields the same roto-translation of the output.

The network is implemented by morphological convolutions with approximations to kernels solving nonlinear HJB-PDEs (for morphological α-scale spaces), and to linear convolutions solving linear PDEs (for linear α-scale space). In the morphological setting, the parameter α regulates soft max-pooling over balls, whereas in the linear setting the cases $\alpha = 1/2$ and $\alpha = 1$ correspond to the Poisson and Gaussian semigroup respectively.

We prove that our analytic approximation kernels are accurate and show that they are practical. We build on a key isomorphism between the linear and nonlinear PDEs via the (approximate) Fourier-Cramér transform. This connects the underlying α-stable Lévy processes to Bellman processes on M. The equivariant PDE-G-CNN network implementation consists solely of linear and morphological convolutions on M. Common ad-hoc nonlinearities in CNNs are now obsolete and excluded.

We present blood vessel segmentation experiments in medical images that show clear benefits of PDE-G-CNNs compared to state-of-the-art G-CNNs: increase of performance along with a *huge reduction* in network parameters. We also present experiments that reveal clear benefits of the equivariant CNNs over normal CNNs on mitosis/cancer detection in medical images.

This is joint work of the presenter with B.M.N. Smets, J.W. Portegies, M. Veta (TU/e) and E.J. Bekkers (UvA).

Dirk van der Hoeven (University of Leiden)
Exploiting the surrogate gap in online multiclass classification.

I will talk about the online multiclass classification setting with a surrogate loss. The setting proceeds in rounds 1 to T, and in each round the learner has to issue a prediction based on a d-dimensional feature vector, after which the learner either gets to see the correct answer (full information) or only whether he was right or wrong (bandit information). The goal of this sequential setting is to provide upper bounds on the number of mistakes the learner makes with respect to a surrogate loss, for example the hinge loss or the logistic loss. I will talk about the standard approach to control the number of mistakes and I will explain how one can improve upon the standard approach by exploiting the gap between the zero-one loss and the surrogate loss. In the full information version of the online multiclass classification setting one can improve the standard $\sqrt{T}$ bound to a bound that is independent of the number of rounds T. In the bandit version the standard bound depends on the dimension of the feature vector, which can be improved to a bound that is independent of the dimension of the feature vector.

Jelmer Wolterink (University of Twente)
Machine learning on graphs and meshes for 3D blood vessel analysis.

Deep learning has had a tremendous impact on (medical) image analysis. Convolutional neural networks (CNNs) allow routine processing of medical images to extract e.g. high-quality triangular mesh segmentations of organs, or graphs representing the structure of vessel trees. A natural next step is to apply machine learning to these representations to extract additional clinically valuable information. However, current CNNs do not generalize to data that is not organized on a regular grid. In this talk, I will review how recent developments in graph and mesh convolutional networks can be leveraged to extract more structural, anatomical, and functional information from medical images, with applications in the improved analysis of 3D blood vessels.

History of Mathematics **Wednesday, April 7, 13:30-15:00**

Gerard Alberts (University of Amsterdam)
Historical introduction: What is algorithmic about algorithmic knowing?

Algorithms are attributed agency, these days, especially in discussions on deep learning or ArtificiaI Intelligence. In particular they may be said to hold biases; how human a trait.

The pātī- or procedural traditions in mathematics acquired a proper name when a selection of techniques composed by the man from Khwarizm turned into the standard textbook: Al Khwarizmi. While unquestioned reckoning has been a ubiquitous manifestation of mathematical thought in everyday culture, the field of algorithms has gone largely unnoticed by historians of mathematics.

In the 1950s, confronted with the challenge of leaving the computations to such obscure scientific instruments as automatic calculators and still trust the outcomes, Heinz Rutishauser and Hermann Bottenbruch were among the numerical analysts suggesting one should think in terms of algorithms. Alternative answers were suggested, like thinking in terms of control and feedback (under the slogan of cybernetics), or in terms of flowcharts, but "algorithm" won the day as the core concept of computer science. By the end of the decade ALGOL, for ALGOrithmic Language, emerged as the key programming language (with strong participation from Dutch researchers). The algorithmic approach stood for clarity and transparent use of computing machinery, as opposed to the black-boxing culture of cybernetics.

Today, by contrast, the "algorithmic" symbolizes the opaque, the lack of transparency, in which algorithms are vested with mysterious agency; like one would expect in the cybernetic tradition. Time for historians to step in and try to understand the alternating role of "algorithmic".

Merel Noorman (Tilburg University)
Responsibility for ethical algorithms.

Algorithms are not neutral. This has become increasingly clear in recent years with the rising number of scandals involving, for instance, risk-assement, face recognition or predictive analytics algorithms. Algorithms reflect the interests, assumptions and prejudices of those who build them. But it is not just developers that build in their values and worldview; the choices and constraints that underlie the structure of algorithms are shaped within broader networks of human actors, including users, managers, funders, and policy makers,. The ethics of algorithms is thus a responsibility of multiple actors, that each affect these algorithms in different ways. In this talk I will sketch the sociotechnical networks in which algorithms are embedded and discuss how these networks play a role in the development of ethical algorithms. I will focus in particular on the responsibilities of these different actors.

Sennay Ghebreab (University of Amsterdam)
On AI, bias and society.

Artificial Intelligence (AI) systems are widely used in society today to make decisions that may have a direct impact on human life, for example in credit risk assessments, employment decisions and criminal suspects predictions. Over the past few years, it has increasingly become clear that human and social biases have made their way into AI systems through data, potentially discriminating entire populations based on gender, race, age and other differences. In this talk I will be addressing two emerging research directions in AI. The first aims at deeper insight of human and social biases to help identify and mitigate possible harmful biases in AI systems. The second aims at using biased data and AI systems as a magnifying lens to uncover and deal with systemic social bias, inequality and exclusion.

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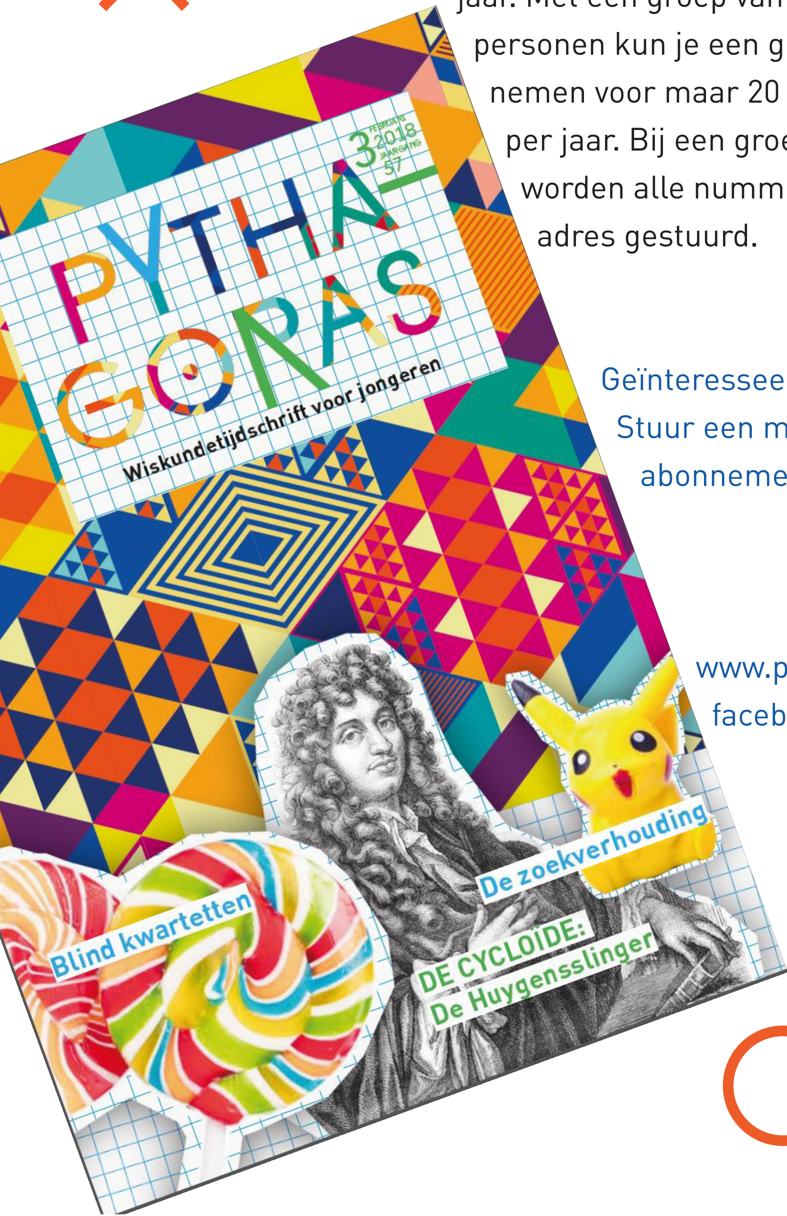

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