

## hcm NEWS 2/2021



## Discrete Mathematics for Green Route Planning

How can parcels and freight be delivered in a more resource-saving and sustainable way? Since 2017, the University of Bonn and the Deutsche Post DHL Group cooperate in the area of route planning. The Research Institute for Discrete Mathematics has developed an algorithm that exploits the considerable optimization potential and is already being used successfully in practice. Therefore, the Deutsche Post DHL has founded the subsidiary company Greenplan that aims at using the algorithm for a wide variety of applications. The cooperation will now be continued for an unlimited period.

“The collaboration with the logistic experts at Greenplan was very fruitful from the start”, says Jens Vygen, from the Research Institute for Discrete Mathematics. “We developed an algorithm that is not only flexibly applicable but also delivers excellent results after only a short computation time.” A novelty is that the algorithm considers travel times that do not only depend on the distance, but also on the time of day. The routes can, for example, avoid traffic jams and can facilitate considerable savings in cost and emission. For this, Greenplan received the PostEurop Innovation Award last year.

Dirk Müller, who leads the software development at the Research Institute for Discrete Mathematics, explains the difficulties: “Even the calculation of the best route from A to B is difficult when the travel time and cost depend on traffic situations.” The question of how much the cost of a tour increases if a new assignment is added at the optimal position is much more difficult and must be answered millions of times by the program. “And this with a total computation time of only a few minutes.”

Clemens Beckmann, CEO of Greenplan, studied mathematics himself and is delighted by the close cooperation with the university: “The great professionalism in the collaboration, as well as the geographical proximity, have been the basis for the extremely fast development, during which the logistic and scientific expertise complemented each other optimally.” Today, the young company can therefore offer their customers from logistics, external work planning (for example technicians, installers), and e-commerce a route planning tool that is efficient as well as sustainable and that can be



used quickly and flexibly for a variety of applications. “With the new contract we have further strengthened our cooperation and we are looking forward to our future collaboration.”

### With the Number of Cities, the Number of Routes Increases Extremely

The scientists led by Jens Vygen are experts for Combinatorial Optimization. In recent years, they have developed better and better algorithms, especially for the Traveling Salesman Problem. Here the aim is to find the shortest round trip through different cities. For 15 cities there are already more than 87 billion different round trips, and for 20 cities, even a computer can no longer try out all the options.

### Award for the Research Team

Now the scientists even succeeded in finding a better approximation ratio for the Capacitated Vehicle Routing; the first one in 30 years. The authors Jannis Blauth, Vera Traub, and Jens Vygen will receive the Best Paper Award at IPCO 2021, which will be held in May and which is the worldwide leading conference on Integer Programming and Combinatorial Optimization.

## HAUSDORFF PEOPLE



## Danica Kosanović and Vera Traub Receive Hausdorff Memorial Prize

As every year the Mathematics Department of the University of Bonn honors the best mathematics PhD thesis with the Hausdorff Memorial Prize. The many excellent nominations from various mathematical fields induced the jury to the unanimous decision to present the Hausdorff Memorial Prize for 2019/2020 twice: to Danica Kosanović and to Vera Traub. Johannes Beck, the Dean of the Faculty of Mathematics and Natural Sciences of the University of Bonn, awarded the prizes digitally because of the corona pandemic on the 27th January.

**Danica Kosanović** spectacularly proves in her PhD thesis a 30-year-old conjecture about invariants of classical knots, that is the embedding of a circle in the three-dimensional Euclidean space. The classification of knots has long been a topic in topology and is addressed from various points of view and mathematical fields. Two knots can look completely different and still be the „same“ topologically, in the sense that they are identical up to a homeomorphism. It is hence difficult to prove that two knots are not the same. One, therefore, takes an indirect way such as searching for knot invariants. Danica Kosanović shows in her work that the classical knot invariants introduced by Vassiliev and Kontsevich are universal in important cases. The PhD thesis excels through an impressive range of methods, technical virtuosity, and brilliant presentation. Her work was supervised by Peter Teichner from the Max Planck Institute for Mathematics in Bonn.

In her dissertation, **Vera Traub** achieved important breakthroughs in open questions regarding the so-called Traveling Salesman Problem (TSP), the most prominent problem in combinatorial optimization. The problem is famous all over the world and was first formulated in 1930: Given a start, an endpoint and further points which have to be visited, the aim is to find the shortest tour passing through all the points by optimizing the order of the points to be visited. Vera Traub has found better approximation algorithms, i.e. efficient algorithms that are guaranteed to find a good solution. In the asymmetric case, that is with “one-way streets”, she showed, for the first time, that the integrality gap is constant; this measures how good a classical fast-computable estimate is. In the symmetric case, surprisingly, she was even able to undercut the integer gap. She also showed how the problem can be reduced to the case where the starting and endpoint coincide. Vera Traub has introduced various new techniques and methods which can be applied not only to the TSP, but to various parts of combinatorial optimization. Hence, her dissertation goes far beyond the TSP. The thesis was supervised by Jens Vygen from the Research Institute for Discrete Mathematics in Bonn.

Every year the Hausdorff Memorial Prize is presented in honor of Felix Hausdorff around his death day, the 26th January, during the Hausdorff Colloquium. Every professor and private lecturer may make a nomination. The final decision is made by a jury appointed by the Mathematics Department. The award consists of a 500 Euro prize money and a book prize.

## HAUSDORFF PEOPLE



## Awards for the Best Bachelor Theses

The “Bonn Mathematical Society” awards the best mathematics bachelor theses with 250 euros. For the academic year 2019/2020 the following bachelor graduates were awarded:

- **David Aretz**  
*The noncommutative geometry of symplectic singularities*  
Supervisor: Christian Blohmann
- **Elena Demattè**  
*Spectral Theorem for Bounded Self-adjoint Operators*  
Supervisor: Juan Velázquez
- **Nicolai Gerber**  
*Anderson Localization: Fractional Moment Method and Critical Disorder*  
Supervisor: Margherita Disertori
- **Branko Juran**  
*Orbifolds and Orbispaces*  
Supervisor: Stefan Schwede
- **Anton Ullrich**  
*Starke isoperimetrische Ungleichung*  
Supervisor: Herbert Koch

Rainer Kaenders presented the awards during the virtual Hausdorff Colloquium. Congratulations to all students!

Herzlichen Glückwunsch!

## Florian Brandl: New Bonn Junior Fellow and the First Argelander Professor



How can different parties make joint decisions when they have different information or face uncertainties? This and other questions are tackled by mathematician and theoretical economist Dr. Florian Brandl, who will take up an Argelander Professorship at the University of Bonn on 1. April and at the same time start as a Bonn Junior Fellow at our HCM. He is the first researcher to hold such a professorship, as these are new positions created by the University of Bonn for outstanding up-

and-coming professors who distinguish themselves by combining different disciplines. Florian Brandl's research combines mathematics, economics and computer science.

No scientific discipline alone can answer major societal challenges and the complex questions associated with them. This is a thought that led the University of Bonn to establish six university-wide so-called Transdisciplinary Research

## HAUSDORFF PEOPLE

Areas (TRAs), one and a half years ago, with various thematic focuses in the course of the Excellence Strategy funding program. The concept includes new professorships which are rooted there and tailored to different career stages.

“The Argelander Professorships are an important part of our university’s transdisciplinary approach. With Florian Brandl, we have gained an outstanding scientist who conducts research at the interface of different subjects at the highest level”, emphasizes Andreas Zimmer, Vice-Rector for Research and Innovation at the University of Bonn.

The first Argelander Chair, which has now been filled, is special because it is a permanent professorship, made possible by a cooperation of the Transdisciplinary Research Area “Mathematics, Modelling and Simulation of Complex Systems” with the Faculty of Law and Economics and the HCM. Florian Brandl is also appointed Bonn Junior Fellow, which allows him to develop his own research program.

“Florian Brandl is an extremely talented and productive young scientist whose research combines methods and approaches from economic theory, mathematics, and computer science. This makes him an ideal appointment to the Argelander Chair and an asset to the Institute for Microeconomics,” emphasizes Jürgen von Hagen, Dean of the Faculty of Law and Economics at the University of Bonn.

### What underlies decision-making?

In his research, Florian Brandl explores topics in microeconomic theory, especially social choice theory, decision theory, and game theory. His aim is to further develop the theoretical

foundations of individual and collective decision-making. He investigates, for example, the impact of uncertainty and asymmetric (unequal) information on collective decision-making or how to distribute resources fairly across multiple individuals. Moreover, he studies how strategic behavior affects these problems. One approach to answering his research questions can be to design algorithmic solutions so that his work also intersects with theoretical computer science.

“The expertise in microeconomic theory and the interdisciplinary research areas with mathematics and computer science make the University of Bonn an excellent place for me to work. The Argelander Professorship and the Bonn Junior Fellowship allow me to contribute to these areas and help to interconnect them,” says Florian Brandl.

He received his doctorate from the Technical University of Munich in 2018 and most recently worked as a postdoctoral researcher at Stanford University and Princeton University on a research fellowship from the German Research Foundation.

The now jointly filled professorship is the result of strong collaboration with the Transdisciplinary Research Area. The close cooperation is also reflected in other areas, including the joint event series “HCM meets TRA1”, which brings together researchers from both associations.



## Eugen Hellmann Receives Research Award from Münster University

Eugen Hellmann was honored by the University Münster with the Research Award 2020. He was educated at our Mathematical Institute (Supervisor of his doctorate: Michael Rapoport) and was a member of the HCM for many years. A few years ago he received a professorship at the University of Münster and is now a member of the excellence cluster “Mathematics Münster”. In this [video](#), some of his scientific colleagues commend him for this award, including Peter Scholze, his longtime companion.

## HAUSDORFF PEOPLE



## The IRUs are „Picking up Pace” – Welcome, Alexander Effland and Kevin Thurley!

The enormous progress made in recent years in the experimental life sciences provides a wealth of data on the functioning of living organisms. There is general consensus that in order to turn these data into knowledge about the functioning of this system, mathematical modeling, as well as theoretical and numerical analysis in conjunction with experimental data, is essential for future progress. ImmunoSensation and HCM, provide the ideal environment to make substantial advances in this direction. Hence the clusters have decided to particularly strengthen this cooperation institutionally by creating three internationally visible junior research groups in the field of mathematical modeling in life and medical sciences, the so-called Interdisciplinary Research Units (IRUs) in the area of “Mathematics and Life Sciences”. Jan Hagenauer has been with us for a long time and has already expanded his group “Computational Biology” substantially. Newly appointed into an IRU were Alexander Effland, who will bring together the group “Medical Image Processing”, and Kevin Thurley, who will establish the group “Biomathematics – Systems Biology of Inflammation” at the UKB. We briefly introduce both of them here.

**Alexander Effland** has joined the Institute for Applied Mathematics as a tenure track professor (W2) in April 2021. After he finished his PhD thesis at the University of Bonn in 2017, he joined the Institute of Computer Graphics and Vision at the Graz University of Technology. His research interests include mathematical image processing/computer vision (variational methods, PDE-based approaches, machine learning, deep learning), mathematics of deep learning, efficient optimization algorithms, shape analysis,

and discrete Riemannian geometry. He especially focuses to apply these methods to problems in immunology or radiology, for example, new learning base methods for undersampled MRI reconstruction, automated analysis of medical images and the credibility of these approaches as well as image enhancement of microscopy data. Currently, multiple research projects in close cooperation with the University Hospital Bonn and the Cluster of Excellence ImmunoSensation are planned.

**Kevin Thurley** works as a professor for biomathematics at the University Hospital Bonn since February 2021. He finished his doctoral research in theoretical biophysics in Berlin and Cambridge in 2011. As a postdoc, he stayed in Berlin and San Francisco and joined by the Leibnitz Association supported junior research group of the German Rheumatism Research Center in Berlin. His research focuses on a point of intersection of biology and mathematics. He made contributions in several research areas, for example, the biological clock, stochastic intracellular signals, and regulations of cell motility. A focus of his work is the analysis of networks of cell-cell-communication in the immunity system. His group, therefore, develops spatial models in the form of reaction-diffusion systems as well as complex network models which allow the integration of directly measurable changes of states of cells on the basis of Semi-Markov processes. It is a special concern of Kevin Thurley to improve the collaboration of biologists and mathematicians and to facilitate mutual understanding. At the Bonn site, he, therefore, wants to contribute to this through interdisciplinary teaching events in both subjects.

## HAUSDORFF PEOPLE

## László Lovász was awarded the Abel Prize

The Norwegian Academy of Science and Letters has decided to award the Abel Prize for 2021 to László Lovász from the Eötvös Loránd University in Budapest, and Avi Wigderson from the Institute for Advanced Study, Princeton for their foundational contributions to theoretical computer science and discrete mathematics. The Abel Prize was established in 2002 on the occasion of the 200th birthday of Niels Henrik Abel, a Norwegian mathematician, as a sort of “Mathematical Nobel Prize”. The prize amount is 7,5 million Norwegian kroner (750.000 Euro). Lovász is a mathematics professor at the Eötvös Loránd University in Budapest. Since 1984 he is also an honorary professor at the Research Institute for



Discrete Mathematics at the University of Bonn and a member of the institute's scientific board of directors. “We are delighted that László Lovász was honored with this high-caliber prize and wholeheartedly congratulate him,” says Bernhard Korte, director of the Research Institute for Discrete Mathematics. The laureate was a visiting professor in Bonn for more than two years. He has also done numerous shorter research stays at our university. His students and colleagues from the Institute of Mathematics of the Hungarian Academy were often guests at the research institute in Bonn.

## Ulrike Tillmann is New Director of the Isaac Newton Institute

Our longtime SAB-chair Ulrike Tillmann was appointed to be the new director of the Isaac Newton Institute, a sort of peer institute of our HIM (see photo). She will start in her new position on 1. October. She will remain a part of the SAB, but she will step down as chair at the next opportunity.



## HAUSDORFF EVENTS



## Third Bonn Night of Mathematics with 1000 Spectators

On “Pi-Day”, 14th March, which was some years ago declared to be the “International Day of Mathematics”, the third Bonn Night of Mathematics broke all records. The four afternoon workshops for children and young people, all held by students from the HCM school team, were very well attended with 100 participants and more. For the evening program Katja Dörner, Bonn’s major, gave a short welcoming speech in which she proudly emphasized how outstanding Bonn as a location for mathematics is, also from a global perspective. During the final panel discussion, as always perfectly led by Thoralf Räsch, the two researchers in math education, Johanna Heitzer and Rainer Kaenders, together with teacher trainer Wolfgang Riemer, HCM speaker Wolfgang Lück and student Janna Schmidt

discussed the goals and problems concerning the study program for future mathematics teachers. After that Peter Scholze gave a lecture on the topic “Condensed Mathematics”, a new mathematical concept developed by him and Dustin Clausen and considered as an alternative to the classical topological spaces. Here the Zoom conference was “fully booked” with 300 people, and even at a second Zoom conference offered in parallel via screen sharing, there were still almost 200 people in some cases. The other lectures held by Jens Vygen, Franca Hoffmann, and the “Late Night Talk” by Dominik Liebl also continued to be well visited and fascinated the audience.

## HCM Meets TRA: Hausdorff Forum with Hanno Becker



The Hausdorff Forum is being continued as usual – now however as a joint event of the HCM and the TRA1 “Mathematics, Modelling and Simulation of Complex Systems” within the scope of a joint event series “HCM meets TRA”. The first lecturer for this new project was the former BIGS PhD student Hanno Becker, who now works as a Staff Cryptography Research Engineer at Arm Ltd. in Cambridge, United Kingdom.

He gave an impressive insight into post-quantum cryptography. There are still no working quantum computers. As soon as there are, our current cryptography methods do not offer any sort of protection. When looking for a method that cannot be “cracked” by even a quantum computer, grid-based methods become the center of interest. These require different mathematical foundations than the currently used RSA or EEC technologies. To better understand and develop the demanding mathematics necessary for this new post-quantum method, Hanno Becker requested Bonn number theorists to contact him during his speech. Is this perhaps something you have strong links with?

## HAUSDORFF MIXED

## As Mathematics Student in Bonn City Council



Friederike Dietsch is 19 years old and is actually studying mathematics and social sciences to become a teacher in Bonn. She would normally be in her third semester, however, her studies have been paused for a few months. She is now doing an internship at the German Corporation for International Cooperation GmbH (GIZ) in Bonn – and is for the Grünen (German political party) part of the Bonn City Council. As their youngest member, she is head of the committee for mobility and transport. Recently there was an article about Friederike Dietsch in the Bonner General-Anzeiger (local german newspaper). We have asked her some additional questions:

### Is Bonn's local politics more interesting than the studies to become a mathematics teacher?

**Friederike:** Bonn's politics is closer oriented on real life and a lot is happening. It is more concrete and more agile - in this respect, it is very interesting. I find the contact with many different people with various different perspectives and life experiences to be especially gripping. Mathematics is fun as well because it is very logical. Both are definitely challenging and time-consuming.

### Why are so few mathematicians active in politics?

**Friederike:** Is that the case? Well, they are at least not over-presented. Mathematicians often remain in the world of mathematics. Politic sand society however naturally concerns mathematicians just as well as lawyers and judges.

### Will one ever see you stand in front of a class as a mathematics teacher or will you get started completely in politics?

**Friederike:** I was elected for 5 years and I am planning to get my studies right during this time. I at least want to get my degree and the occupation as a teacher is very attractive to me. An insight into real politics can surely not be wrong( for my second subject). I cannot foresee what my future in politics will look like.



## Bonn Math Circle with Lisa Hartung

The children and youths of the Bonn Math Circle may now have the following idea of a typical mathematician: young, female, and communicative because, after Franca Hoffmann, Lisa Hartung visited the Bonn Math Circle. She gave an account of her academic career and recounted exciting application of the Galton Watson process, stochastic branching processes, which is part of her research. These processes are also a foundation of epidemiological models like the spread of COVID-19 such that the students got a feeling for modeling such a process and what role the „R-Value“ (reproduction number) plays with regard to the dynamic. Maybe the female role models are a reason for the rising quote of females in our Bonn Math Circle which has increased immensely over the past couple of months: from 10% to now 30-40%!

## IMPRINT

Hausdorff Center for Mathematics  
Endericher Allee 62  
53115 Bonn  
[presse@hcm.uni-bonn.de](mailto:presse@hcm.uni-bonn.de)

**Person responsible:** Stefan Hartmann  
**Editorial Staff:** Stefan Hartmann  
**Photos:** Arithmeum, Barbara Frommann, WWU Münster/Peter Leßmann, Isaac Newton Institute, Screenshots, privat  
**Graphics:** Carmen Wolfer

[CLICK HERE TO UNSUBSCRIBE](#)

