ISSUE 13 AUTUMN 2020

NEWSLETTER

INSTITUTE OF MATHEMATICS OF THE POLISH ACADEMY OF SCIENCES

IN JUNE 2016

IMPAN RECEIVED ***THE HR EXCELLENCE IN RESEARCH AWARD***

AS A PROVIDER OF A STIMULATING AND FAVORABLE WORK ENVIRONMENT

HR EXCELLENCE IN RESEARCH

IMPAN participates in

The **H**uman **R**esources **S**trategy for **R**esearchers (HRS4R) process.

The goal of HRS4R Action Plan in IMPAN is to ensure that:

1) Rights as a professional are recognised and enhanced

2) Mobility experience is valued

3) Work-life balance is respected

4) Recruitment will follow a transparent process

We created and respect OTMR policy -

Open, **T**ransparent and **M**erit-based **R**ecruitment of Researchers

SEE WWW.IMPAN.PL/EN/INSITUTE/HR-STRATEGY TO FIND OUT MORE!

Current Events: The Banach Centre and the Będlewo Conference Centre

Adam Skalski

Recent months have been very eventful for the Banach Center; both for positive and negative reasons. On the bright side, we have completed a key project: the construction of a new purpose-built (or rather purpose-adapted out of one of the historical buildings) lecture hall. The building work started in 2018, and was to a large extent funded by a grant-in-aid provided by the Ministry of Science and Higher Education. The new lecture hall is connected to other buildings, has seating capacity of 150 and total volume of more than 2000 cubic meters. It offers easy access for people with disabilities.

At the same time, as practically all the mathematical conference centres in the world, the Banach Centre and Będlewo in particular, have been strongly affected by the ongoing pandemic. The last BC event before the COVID-19 outbreak in Europe took place in early March; since then most of the workshops have been either cancelled, postponed or shifted online (5 events). Two notable exceptions were a small workshop in late August, when regulations allowed hosting meetings, naturally respecting strict hygienic requirements, run in hybrid format, with 13 local and 9 remote participants; and a research group in the end of September. The annual spring meeting of the Scientific Council, which assesses conference applications, was run fully online.

The new situation poses obviously a big challenge to mathematical centres around the world; some of them shifted all of their events online (for example the ICMS in Edinburgh), some run hybrid events (MFO in Oberwolfach), some offer both forms (CIRM in Luminy). We are in touch with other European institutions, discussing the quickly changing situation and possible means of dealing with the current unprecedented difficulties. Currently the Banach Center offers limited support for purely online events – for example a professional Zoom license for events including up to 200 participants – as well as the possibility of organizing hybrid events. The Będlewo centre with its new lecture hall, allows direct streaming of on-site lectures to external participants as well as transmission of lectures delivered externally to those who attend events in person.

We naturally hope that the future state of affairs will allow us to restart the usual conference programme from the next spring. The Banach Centre calendar for 2021 is as expected already practically fully booked, especially in the spring and summer months. We all hope to see you at our events before long, and meanwhile wish you good health and patience for these unusual times!

The new auditorium at Będlewo built with significant support from the Ministry of Science and Higher Education (photographs by Sławomir Malecha).

DIOSCURI
CENTRE IN TOPOLOGICAL DATA ANALYSIS

Jointly sponsored by

Dioscuri Centre in Topological Data Analysis at IM PAN

Paweł Dłotko

On October 15th 2020, in the main building of the Mathematical Institute of the Polish Academy of Sciences, we hosted an official opening of the *Dioscuri Centre in Topological Data Analysis*. The history of the Centre starts a bit earlier – the Centre is operating from July 2020; our first PhD students arrived at late September. The grant proposal for the centre was written in February 2019 while the interview process concluded (successfully) in October 2019.

The program of Dioscuri Centres of Scientific Excellence was initiated by the Max Planck Society (MPG), jointly managed with the National Science Centre in Poland (NCN), and mutually funded by the Polish Ministry of Science and Higher Education (MNiSW) and the German Federal Ministry of Education and Research (BMBF). There are so far five Dioscuri Centres, including ours. Two of them were established in late 2019 and the remaining three in 2020. The other centres are all in the fields of biology and biochemistry.

The Dioscuri Centre in Topological Data Analysis is lead by Paweł Dłotko. We plan to have 2-3 postdocs and at least 3 PhD students permanently employed within the Centre. We are located on the ground floor of the IM PAN building at Śniadeckich 8, and you can find us online at https://dioscuri-tda.org/. Each Centre has a partner institution from Germany. Our partner is Prof. Dmitry Feichtner-Kozlov and the Institute of Algebra, Geometry, Topology and their Applications at the University of Bremen. We already started an exchange of PhD students between our two institutes.

The scientific mission of the Centre is to use topology (and geometry) to better understand various data that are of interest to researchers both inside and outside mathematics. This, at first, may be quite surprising; Topology is an abstract branch of mathematics considered to be far from applications. Aleksandr Solzhenitsyn, who was a mathematician by training, presented in "The First Circle" a sceptical view about applicability of topology:

"Topology! The stratosphere of human thought! In the twenty-fourth century it might possibly be of use to someone..."

Yet, the history has proven him wrong. The ability to quantify the shape of spaces up to continuous deformation is a surprisingly useful notion. Human perception is much closer to topological flexibility than geometrical rigidity. The same flexibility allows to create general and robust descriptors of data.

Applied topology is a branch of applied mathematics. Often times I am asked – *"what applied mathematics really is?"*. Let me present my view on this; I believe that a work in mathematics counts as *applied*, if its purpose is to answer a question from *outside mathematics* using rigorous language and non-trivial methods of mathematics. Applied Mathematics therefore does not seek to prove a long standing conjecture that is important for a very specific sub-field inside mathematics. Instead, its aim is to make mathematics useful for other disciplines. Applied mathematicians need a broad knowledge in algorithms and programming as well as the ability to learn and interact with

different disciplines. From my personal experience, often the abilities of a good salesperson are useful to convince scientists in other disciplines to learn more mathematics. The main tools of Topological Data Analysis include (persistent) homology theory and the Mapper graphs. Those two methods are briefly explained in Figure 1. In both cases, the input for analysis is discrete data (here in a form of point cloud). We also deal with other types of finitely presented data like images, discretizations of functions, finite time series, graphs, trees, general meshes etc.

Mapper graphs (top of the Figure) provide graph–based summaries of data $f:D\to\mathbb{R}^n$ by building discrete analogs of *Reeb graphs*. In that case clusters in the inverse images of elements of a cover of $\mathbb{R}^n$ correspond to vertices of the Mapper graph. Two vertices are joined with an edge if the corresponding clusters have a non-empty intersection.

Persistent homology (bottom of the Figure) builds a nested sequence (a filtration) of spaces, keeping track of creation and destruction of homological features. To be more precise, in Figure 1, for r = 0 we have 25 separated connected components and no homology groups in higher dimension. For r= 1 only two of those connected components persist, and remaining 23 are merged. For r = 2, a cycle in dimension 1 homology is created. It persist till r = 8. All of this information about the lifespan the of the representatives of the generators of the homology groups is stored and summarized in a form of *persistence diagram*.

In the Centre we work on extending and enriching the standard techniques from Figure 1. For instance, assuming a finite sampling of an unknown manifold we research how to estimate its dimension and injectivity radius. We are constantly looking for new ideas from pure mathematics that can be brought to the world of applications.

We use our toolboxes to provide new geometric and algebraic invariant of porous materials, neural trees, complex networks and more. We intensively collaborate with groups in material science and chemical engineering, neuroscience, medical sciences, economics , finance and more. To make our work useful we develop and maintain a number of computational libraries implemented in C++, Python, Matlab and R.

Our target, in addition to promoting applied and computational topology, is to promote research in applied mathematics in general and to help the Polish mathematical community getting closer to other fields of science.

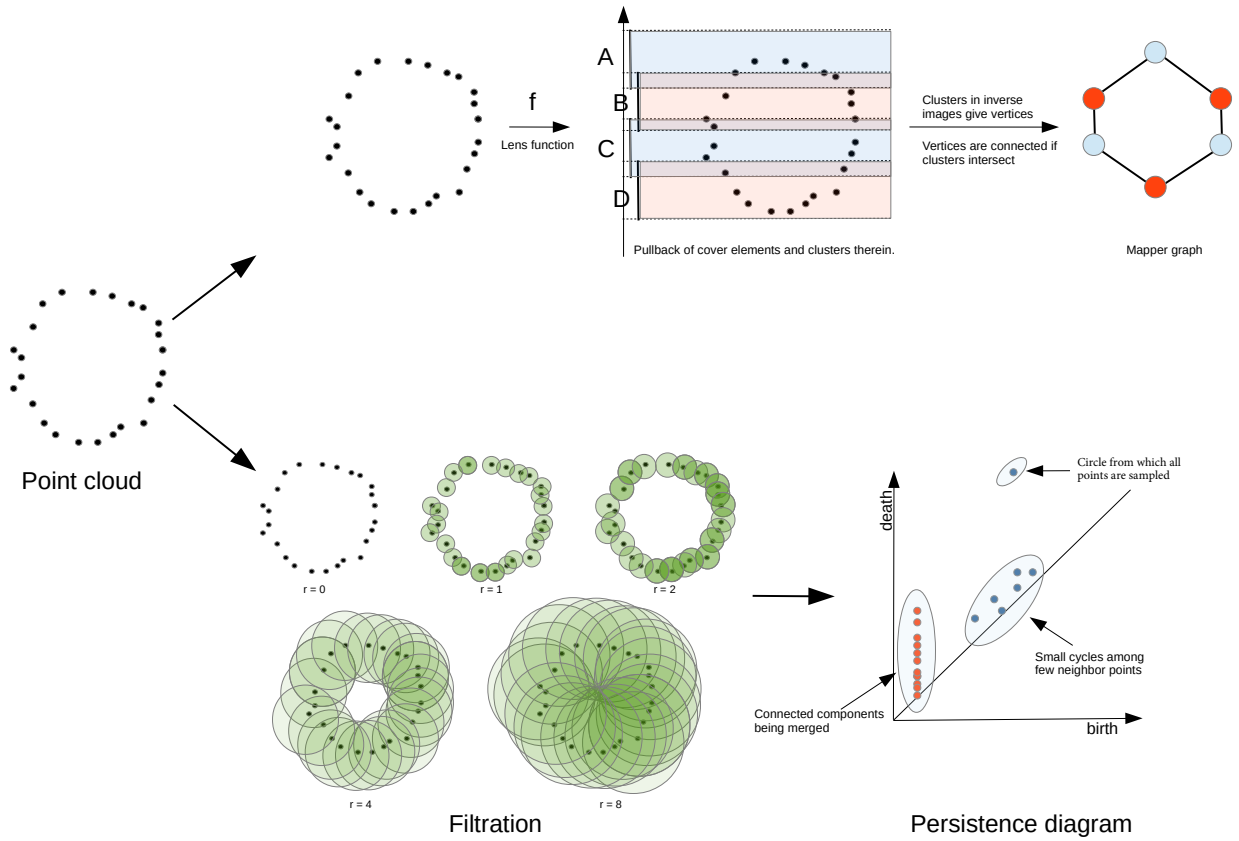
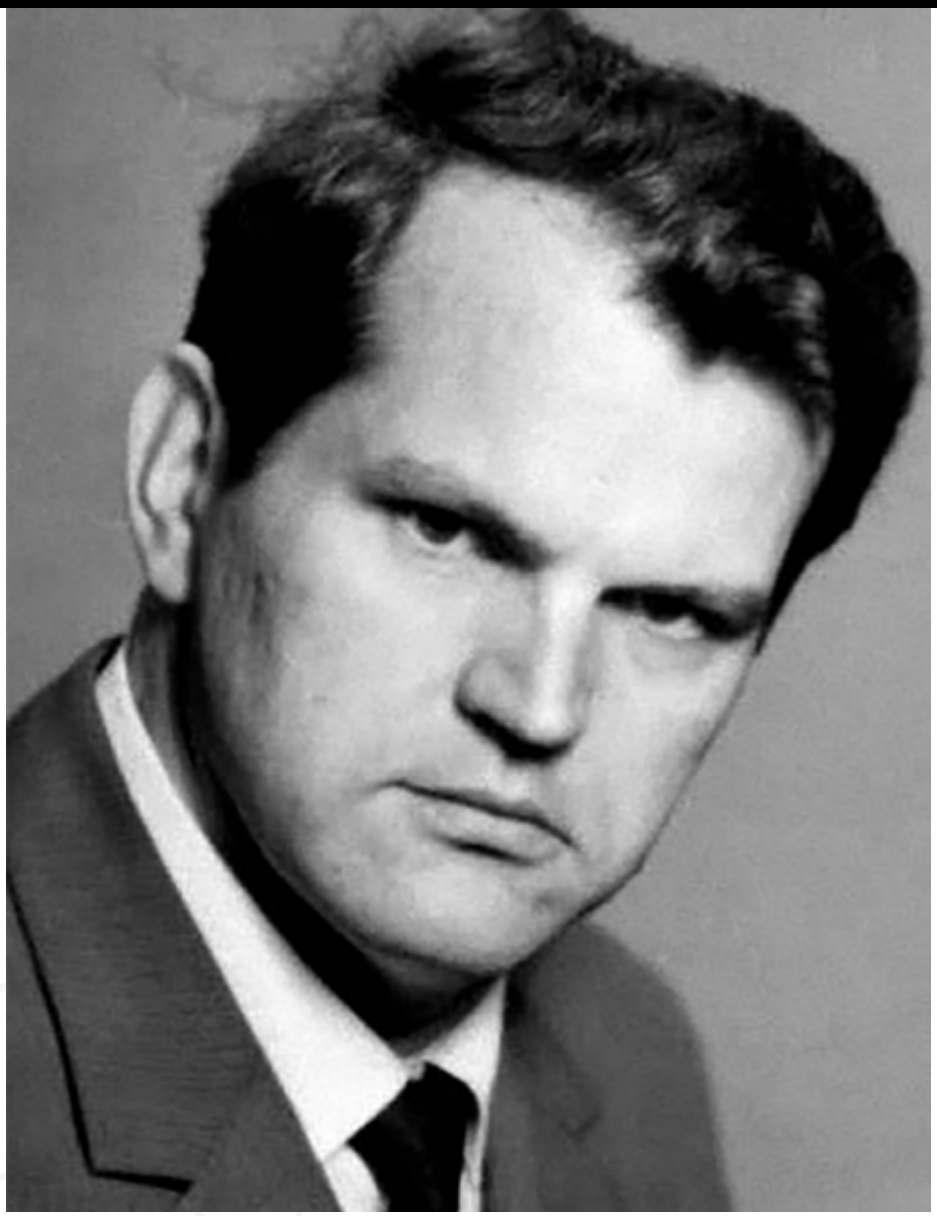


Figure 1. Idea of persistent homology and Mapper.



The life and work of Professor Zbigniew Ciesielski

Tomasz Szarek

On October 5th, 2020, Professor Zbigniew Cisielski passed away. He was one of the most influential Polish mathematicians after World War II.

Zbigniew Ciesielski was born in Gdynia in 1934. In 1958 he graduated in mathematics from the Adam Mickiewicz University in Poznań. Only two years after his master degree, in 1960 he obtained his Ph.D. degree under the supervision of Władysław Orlicz, one of the founders of functional analysis. In 1963 he defended his habilitation at the Institute of Mathematics of the Polish Academy of Sciences in Warsaw. In 1969 he was appointed as an associate professor. In 1974 he became a full professor. In 1973 he became a corresponding member of the Polish Academy of Sciences. Since 1986 Professor Ciesielski had been a full member of the Academy. In 2001 he became also a corresponding member of the Polish Academy of Art and Sciences and in 2013 he became a regular member. In 2013 the University of Gdańsk awarded Professor Ciesielski a Honorary Doctorate Degree (HDD).

Professor Ciesielski received almost all prestigious awards conferred to Polish mathematicians including the Prime Minister Award for Excellence in Research in 2000; the First Class Governmental Polish Award in 1988; the Banach Medal in 1992; the Orlicz Medal in 1994, the Sierpiński Medal in 2000; the Award of the Alfred Jurzykowski Foundation in New York in 1983; the Heweliusz Award conferred by the City of Gdańsk in 1996. In 2011, on the anniversary of 50 years of obtaining his Ph.D. he was conferred anew a doctoral degree by the Adam Mickiewicz University of Poznań. It is worth mentioning here that in 1974 Professor Ciesielski was an invited speaker at the International Congress of Mathematicians in Vancouver.

Professor Ciesielski published over 100 papers in prestigious journals. His interests were quite broad. He was an excellent expert in probability theory, stochastic processes, functional analysis, and related fields. His most known results are devoted to Gaussian processes and Brownian motions, and the theory of Schauder bases. In 1969 Professor Ciesielski constructed a Schauder basis for the space of continuously differentiable functions on the square, solving an old open problem posted by Stefan Banach. His papers about spline systems are of great importance for the theory of wavelets which in turn is used in image compression. His construction of the Wiener process is widely known in the literature as the *Ciesielski construction*. The complete list of scientific achievements obtained by Professor Ciesielski would be much longer. Indeed, the outstanding contributions to Mathematics of the late Professor Ciesielski are hard to be overestimated. Moreover Professor Ciesielski had also great achievements in the education of the younger generation of mathematicians. He was the supervisor of twelve Ph.D. students, four of them being full professors at this time; four others have successfully defended their habilitation. Two of his students, Prof. Stanisław Kwapień and Prof. Jerzy Zabczyk are full members of the Polish Academy of Sciences. The Mathematics Genealogy Project lists 77 descendants. He was instrumental in establishing three centres for the study of Probability: in Gdańsk, Warsaw and Toruń.

Professor Ciesielski played an active role in the Polish and international mathematical communities. He was the President of the Polish Mathematical Society from 1981 to 1983. He was in the Presidential Committee of the Polish Academy of Sciences from 1993 to 1995; he was a member of the Scientific Committee of the International Stefan Banach Mathematical Centre in Warsaw.

Last but not least, he was a Vice Director of the Institute of Mathematics of the Polish Academy of Sciences and, in the years 1973-1999, the head of the Gdańsk Branch of the Institute.

He showed interest in the Institutes's scientific wellness until his last days. We will miss him.

Photograph on p. 6 from the archive of Polskie Towarzystwo Matematyczne.
Photograph on p. 7 from the archive of Zbigniew Ciesielski.

New OPUS grant "Chaos, fractals, not only conformal dynamics"

Michał Rams

Perhaps not uniquely among the branches of Mathematics, the field of dynamical systems can be easily explained in layman terms. The main ideas are very intuitive, the investigated objects are natural, the questions we ask are understandable for everybody. Naturally, this kind of explanation omits all technical details (which are the most important part, as always), and it is most emphatically not true that a high school student can start proving theorems the next day after I explain to her what I am doing in my work. But I can explain what I am working on, and I can do it in five minutes flat. Let me prove this by providing an example: a short and totally understandable explanation of the goals of our grant.

The grant is called "Chaos, fractals, not only conformal dynamics", its team consists of Prof. Feliks Przytycki from IM PAN, Prof. Janina Kotus and Dr. Ludwik Jaksztas from the Warsaw University of Technology, and myself -- together with our foreign collaborators. It is a three year Opus grant, starting in early 2020.

So, let us start from the dynamical systems themselves, what are they? Basically, they are models. In natural sciences, when we investigate any phenomenon (be it a movement of a pendulum, number of wolves and rabbits in a particular forest, internet traffic, weather, or anything else), we start by creating a model: a space (describing the possible situations that can happen) and a dynamic (describing what will happen in the future if the present situation is such and such). That is, a pair: a space $\boldsymbol{X}$ (the phase space) and a semigroup action $\boldsymbol{T}$ on $\boldsymbol{X}$, where the acting semigroup plays the role of time. For example, sometimes the dynamics may be described by a simple map from $\boldsymbol{X}$ to $\boldsymbol{X}$ (if this year the number of wolves and rabbits is (w,r) then next year this number will be $(w',r')=f(w,r)$), in this case the semigroup acting is $\boldsymbol{N}$ (or $\boldsymbol{Z}$, if the dynamics are invertible). Sometimes the dynamics may be described by a differential equation on $\boldsymbol{X}$, in this case the acting group is $\boldsymbol{R}$.

Given a model, what is our basic question? Obviously, we want to know what will happen. Knowing the starting situation at time t_0 we want to know the state of system at a given time $t > t_0$. And our working assumption is that the system we study is too complicated to simply solve the dynamics. This means we can never answer this question, full stop.

... But we can try to do something almost equally good. Two „somethings", actually. One, we can try to describe the behaviour of a system in probabilistic terms. We can not say today whether it will be snowing in Warsaw on New Year Eve in the year 2073, but maybe we can say today what is the probability of such an event? Two, we can try to describe the long term average behaviour of a system. We can not predict the temperature in Warsaw on New Year Eve in the year 2073, but maybe we can predict the average temperature in Warsaw w.r.t. all New Year Eves in the XXI century?

This is why we have come to study the behaviour of not a single trajectory but the distribution of trajectories, described by probabilistic measures supported on the phase space. We look at properties of such measures, the most important of them being *ergodicity*, a notion defined long ago by Ludwig Boltzmann in the XIX century. Ergodicity of a measure means that the future distribution of the trajectory of almost every point (with respect to this measure) is again this measure itself. That is, the time average (along almost every trajectory) of any observable equals its space average. Knowing the structure of ergodic measures for a given dynamical system we can obtain both the probabilistic and long time average behaviour of a typical trajectory.

This leaves the question of *atypical* behaviour of a dynamical system, and that is precisely the topic of our investigation. Atypical behaviours - what are they? What *else* can happen in the system? And most importantly, how often those atypical behaviours can appear? We ask (and hopefully we will answer) questions about the size of the set of exceptional starting positions (positions starting from which the dynamical system will behave in a prescribed atypical way), which we can describe in terms of entropy or Hausdorff dimension. We can also try to describe the probability that the long term average behaviour is far away from the predicted one (large deviation approach). And this is the moment where further explanation would involve getting into technical details, which means it is the right time to stop.

HR Excellence in Research Award

Tomasz Adamowicz & Jarosław Mederski

In June 2016 IM PAN received the HR Excellence in Research Award from the European Commission as a provider of a stimulating and favourable work environment. The award gives public recognition to research institutions that implement and respect the human resources policies and principles set out in the European Charter & Code for Researchers. Those principles include, in particular:

- recognition of the profession,
- career development,
- value of mobility,
- recruitment principles,
- selection criteria and scientific appointments, see the link: euraxess.ec.europa.eu/euraxess/charter-code-researchers

The Institute has committed to implement fair and transparent recruitment and appraisal procedures for researchers. Our long-standing goal is the OTMR (Open, Transparent and Merit-based Recruitment of Researchers) policy, which is the key element in our HR strategy. IM PAN created the so-called HRS4R Action Plan in order to ensure that the Charter & Code has been implemented, i.a. rights of professionals are recognised and enhanced, mobility experience is valued, work-life balance is respected and recruitment follows a transparent process.

The EU Commission carried out an internal review in January 2019, two years after the EU logo had been awarded. IM PAN passed this internal audit, however some improvements have to be taken into account before the next decisive external audit. In particular,

- the entire research community should be informed about the HR activity and the Institutes's strategic vision and goals must be discussed in view of employees' expectations and performance,
- more active and branding-oriented advertising and application phases are needed.

On behalf of IM PAN we would like to bring to your attention the benefits of holding the HR Excellence in Research Award. In order to renew the award, in the beginning of 2022 we expect a site visit by the European Commission (EC) to examine the work conditions and whether we respect the OTMR policy at IM PAN. Moreover, the EC may interview randomly selected scientific employees during their site visit in 2022.

Therefore, it is vital for the whole Institute to know and follow the HR Strategy at IM PAN. It is beneficial for the whole IM PAN community that all employees are involved in „designing the future" according to their expectations and performance. The Institute would like to encourage and invite all employees to propose ideas regarding implementation of the HRS4R Action Plan.

There are several ways of communicating with the Directors, the Steering Committee as well as with the HR Working group responsible for the implementation of HRS4R, for example: each week one of the Directors is available during coffee breaks (Mon-Fri at 13.45, r. 408), anonymous HR questionnaires for scientific staff and PhD students are available, as well as mentoring questionnaires for young researchers and their mentors, or direct communication with members of the HR Working Group: Dr. Tomasz Adamowicz, Dr. Jarosław Mederski and Dr. Masha Vlasenko.

Poster by Agnieszka Kaliszewska.

Simons Semesters at the Banach Center 2015-2019

Teresa Regińska

The Simons Semesters at the Banach Centre were a 5 years research and training program at IM PAN. Prof. Feliks Przytycki, the director of IM PAN at the time, was the main inspirer and organizer of the project. The Institute was an awardee in the 2015 competition: Targeted Grants for Institutes, by the Simons Foundation. The support of the Simons Foundation was intended to cover the costs of the participation of senior and young leaders from abroad. Matching funding for the program was provided by the Ministry of Science and Higher Education of Poland. Prof. Teresa Regińska was the main coordinator of the program.

The program comprised 12 semesters organized at the Stefan Banach International Mathematical Centre

1. Dynamical Systems
2. Algebraic Geometry
3. Noncommutative Geometry The Next Generation
4. CrossFields PDEs
5. Emergent Trends of Complex Analysis and Functional Analysis
6. Symmetry and Geometric Structures
7. Mathematical Biology
8. PDEs/SPDEs & Functional Inequalities
9. Varieties: Arithmetic and Transformations
10. Stochastic Modelling and Control
11. Geometric and Analytic Group Theory
12. Geometry and Analysis in Function and Mapping Theory on Euclidean and Metric Measure Spaces

Each semester focused on one, possibly broad, field of modern mathematics and provided, on the one hand, an excellent environment for interaction between the best experts in this field, and on the other hand, training opportunities for young scientists. The best semester proposals were selected through competitions based on the opinion of the members of the International Scientific Council of the Banach Centre.

37 local organizers from Poland participated directly in the organization of the semesters in cooperation with some leaders from abroad. The ceremonial inauguration of the project took place on 14 September 2015 with the participation of the cultural attaché of the USA Embassy, the vice-president of the Polish Academy of Sciences and the directors of several institutes of the Polish Academy of Sciences. The summary conference was held on December 16-20, 2019. This meeting was an opportunity to evaluate the project and discuss perspectives and directions for subsequent editions of the Simons Semesters program.

In each semester, regular research was carried out on key themes identified in the program of the semester, and conferences and workshops were held. In total, 20 conferences and 19 workshops were organized. There were regular seminars, tutorials and working groups. An important part of each semester were various types of training introducing participants to the subject of the semester and preparing young people to cooperate with leaders. In total, 8 schools, 46 mini-courses, 15 series of lectures and over 30 special lectures conducted by leaders were organized. The number of semester participants ranged from seventy to two hundred. In total, about 2,000 people participated in at least one scientific events.

The result of the project is a rich list of publications including among others two volumes of Banach Centre Publications: Vol. 115 consisting of 5 survey articles on Dynamical Systems and Vol. 116 with 8 articles on Algebraic Geometry. Moreover, 103 items were published in various very good international journals. In addition there are 21 arXiv preprints which have not been published yet and the forthcoming Vol. 122 of Banach Centre Publications with 16 articles on Stochastic Modelling and Control. The complete list may be viewed in the Web of Science bibliographic database for research sponsored by the Simons Foundation grant no. 346300.

The program will be continued in the framework of the new three-year Simons Foundation grant.

Simons Semesters at the Banach Centre 2021-2023

Piotr Gwiazda

The „Simons Semester at Banach Centre: 2020s Vision" project is a laureate of the prestigious Targeted Grants to Institutes program financed by the Simons Foundation. Founded in New York by Jim and Marilyn Simons, the foundation aims to promote fundamental research of particular importance for understanding phenomena in the modern world. The project, which is a continuation of a similar action carried out at the Institute in 2015-2019, received funding in the amount of USD 597,960 for a period of 3 years (2021-2023). The aim of the project is to organize thematic semesters at the Banach Centre devoted to the most recent themes of mathematics and theoretical computer science, which have significantly developed in recent years. The project involves the cooperation of outstanding, open to cooperation, scientists from all over the world, whose engagement gives the possibility of further scientific development for researchers in Poland. Great results from the previous edition, established contacts and published papers, indicate a high interest by scientists, both among experienced scientists and those at the beginning of their careers, in this type of program and have a significant impact on the recognition of the Institute. The Simons Semester at the Banach Centre program remains the only innovative project of this type in Central and Eastern Europe. The project opens up new perspectives for young researchers starting their careers. The participants of the semesters will be PhD students and young post-docs from IM PAN and other mathematical institutes and faculties from Poland, the region and the world.

Each semester will focus on one (broad) theme, bringing together leading researchers as well as excellent young people. Semesters will be run by small but international groups of organizers and include both long-term participants and short-term visitors attending workshops, schools and conferences.

The basic premise of the program is collaborative research and mentoring, run by a group of scientists, in most cases including foreign researchers, including 2-4 conferences/workshops, schools and series of lectures. The following activities are planned:

- 6 Regular Simons Semesters (3-4 months each, approx. 100 participants),
- 3 Simons Mini-Semester (2 months, approx. 60 participants),
- 9 Simons Focus Programs (up to 2 weeks, approx. 30 participants) run by one or two scientists, concentrated on a particular topic, including one event (conference/workshop/working group).

Open calls for the organization of events will be published.

Participants of one of the Simons Semesters (2015-2019) at IM PAN (photograph by Jarosław Buczyński).

Prizes awarded by IM PAN in 2020

Renata Podgórska-Zając

- **The IM PAN Scientific Prize**

The IM PAN Scientific Prize is awarded annually for exceptional accomplishments in the field of Mathematics. The laureate is chosen by a Jury, whose 7 members are appointed by the Director of IM PAN after consulting the Scientific Council of IM PAN.

The 2020 IM PAN Scientific Prize was awarded to Damian Osajda from the Institute of Mathematics of the University of Wrocław and from the Wrocław branch of IM PAN. The prize is given in recognition of his achievements in the field of geometric group theory, with a special focus on non-positive simplical curvature and its generalization. Whilst developing the theory of graph small deletions, the theory of bucolic complexes, and the theory of Helly graphs and groups, he solved many open problems and hypotheses. In particular he constructed the long sought-after examples of groups, whose Cayley graphs contain isometrically very special graphs called expanders.

- **The Kuratowski Award**

The Kuratowski Prize is awarded annually by IM PAN and the Polish Mathematical Society to a young Polish mathematician (age limit: 30). In 2020 the Prize was awarded to Mateusz Wasilewski for a series of papers on the approximation properties of operator algebras.

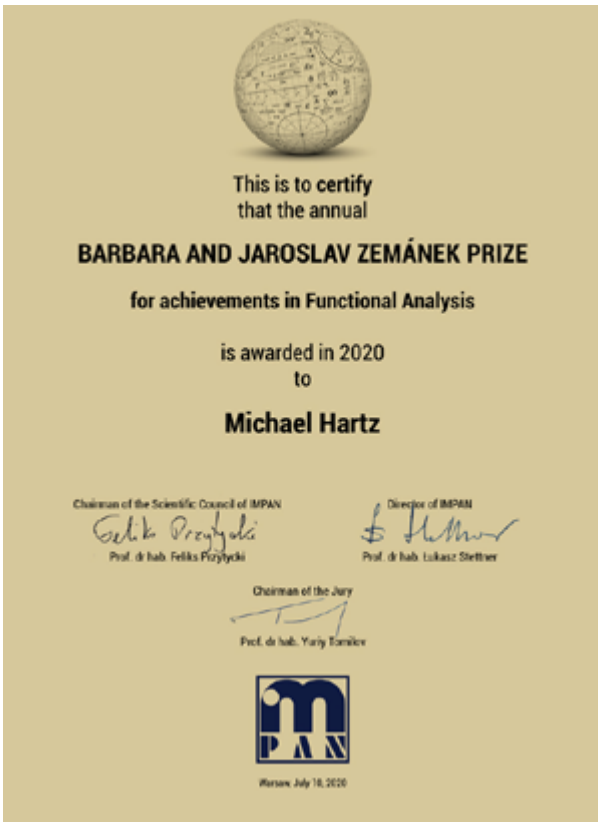
- **The Barbara and Jaroslav Zemánek prize**

The prize was established based funds transferred by Prof. Zemánek and his wife to IM PAN, the institution in which Prof. Zemánek worked for many years. The Prize is awarded annually for achievements in functional analysis, with special emphasis on operator theory. The Laureate is chosen by a Jury appointed by the Director of IM PAN. In 2020 the Prize was awarded to Professor Michael Hartz from the University of Saarbrücken.

- **The Wacław Sierpiński Medal**

Prof. Feliks Przytycki was awarded the Wacław Sierpiński Medal in 2020.

For more information see:
https://www.IM PAN.pl/en/events/awards



Photographs on this page by Anna Karolak.

New Faculty Autumn 2020

Renata Podgórska-Zając

Open calls for temporary research positions

3—7 years positions:

- Artem Dudko, professor of IM PAN position, Dynamical Systems,
- Michał Lasoń, adiunkt position, Topology,
- Jan Rozendaal, adiunkt position, Functional Analysis,
- Maciej Malicki, professor of IM PAN position, Foundations of Mathematics,
- Mariia Vlasenko, adiunkt position, Algebra and Algebraic Geometry,

½ - 2 years positions:

- Adrian Gonzalez-Perez, adiunkt position, Functional Analysis,
- Michał Łasica, adiunkt position, Differential Equations,
- Piotr Suwara, assistant position, Differential Equations,
- Janusz Adamus, professor of IM PAN position, Algebra and Algebraic Geometry,
- Bartosz Bieganowski, adiunkt position, Differential Equations,
- Bidisha Roy, assistant position, Algebra and Algebraic Geometry,
- Justyna Szpond, adiunkt position, Algebra and Algebraic Geometry

1-2 years positions for young mathematicians

- Tymoteusz Chojecki, adiunkt position, Differential Equations,
- Witold Świątkowski, adiunkt position, Probability Theory,
- Xiao Han, assistant position, Noncommutative Geometry,
- Devarshi Mukherjee, assistant position, Noncommutative Geometry,
- Suvrajit Bhattacharjee, assistant position, Functional Analysis,
- Bruno Stonek, adiunkt position, Algebra and Algebraic Geometry,
- Glenier Bello, assistant position, Functional Analysis,

Open calls for permanent Professor positions in special fields

- Jarosław Mederski, professor of IM PAN position, Differential Equations,

Open calls for temporary professor positions in special fields

- Karolina Kropielnicka, professor of IM PAN position, Differential Equations,
- Grigor Sargsyan, professor of IM PAN position, Foundations of Mathematics,

Positions in the framework of ERC grants

- Gabriela Guzman, adiunkt position, Algebra and Algebraic Geometry,
- Feliks Rączka, assistant position, Algebra and Algebraic Geometry,
- Sven Raum, professor of IM PAN position, Topology,

Positions in the framework of NCN grants

- Stephen Moore, adiunkt position, Functional Analysis,
- Michał Miśkiewicz, adiunkt position, Differential Equations

Optimizing the supply of renewable energy

Łukasz Kuciński, Paweł Kołodziej, Piotr Miłoś,
Robert Adamski

The project described in this article aimed to optimize the power input and output of a wind energy converter. It was done as a part of a broader initiative of IM PAN to collaborate with industry and was done in cooperation with the company BizOn Sp. z o.o.

Wind energy refers to the process of generating power using the energy created by air movement. The airflow sets the turbine's blades in motion, causing them to rotate and convert the wind power into mechanical energy. This way of acquiring energy has several benefits, including cost-effectiveness, sustainability of the energy source, and relative little impact on the environment when compared to conventional power plants. It does, however, have its own set of challenges. The ones that were the driving force behind this research, are the inability to dispatch the energy on-demand and unpredictable fluctuations in the production output.

Without energy storage infrastructure, the wind turbine is a "pay-as-you-go" system: every energy output is sold to the power grid. However, when energy storage is available, optimizing the outgoing and incoming power supply becomes an interesting stochastic optimal control problem, of finding a profit-maximizing strategy. A classical and powerful technique in this domain is known as Dynamic Programming (DP). It exploits the underlying Markovian structure of the problem and solves it by combining solutions for, potentially overlapping, subproblems (which is formalized by the Bellman equations). The modern approach to DP takes the form of Reinforcement Learning (RL), one of the pillars of modern Machine Learning.

In more detail, we consider a wind turbine, which produces power from a highly stochastic air movement. The production output can be sold to the power grid or stored in energy storage. The referential selling price, CRE[1], for the next day is published by TGE[2] everyday at 17:00 for the next day, starting from 0:00 till 23:00, in 1-hour intervals. The control system is depicted in Figure 1, where the arrows show the possible flow of energy. The power storage has several important parameters[3]: a) capacity, which governs the amount of power that can be stored, b) efficiency, which describes the energy loss in the charge-discharge cycle, and c) discharge power, i.e. the amount of power that can be extracted from the storage in a unit of time. We assume that the loss of energy is experienced only

1. This stands for Cena Referencyjna Energii.
2. This stands for Towarowa Giełda Energii.
3. We considered the following two energy storage solutions: a) Tesla Megapack with capacity 3 MWh, efficiency 75% and discharge power 1.5 kW, and b) Energy Vault with capacity 20 MWh, efficiency 90%, and discharge power 4 kW. We assumed that the battery can be charged with the maximal power of the wind turbine, which in our case was 1.5MWh.

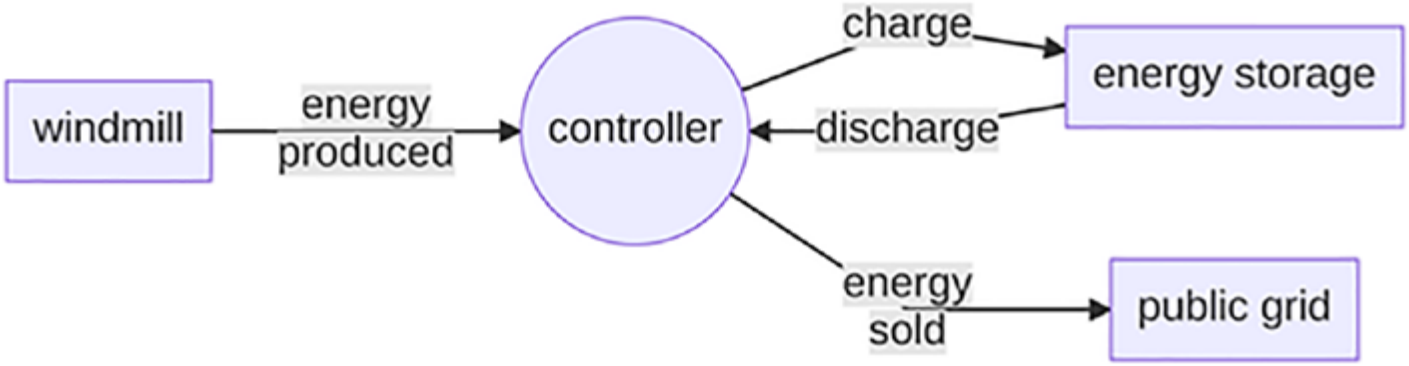


Figure 1. The control system of a wind turbine. The arrows indicate the flow of energy.

No¤	Algorithm¤	PLN/24h¤
1¤	MPC,·*superoptimal*·(real·production·in·future·is·known)¤	1317¤
2¤	MPC,·wind·prediction·is·constant·(annual·average)¤	1305¤
3¤	MPC,·wind·forecast·from·ICM¤	1302¤
4¤	heuristic·based·on·price¤	1118¤
5¤	zero·(no·storage)¤	1000¤

Table 1. Normalized results for selected methods and 121days horizon.

during battery charge[4]. Additionally, we assumed that any excess of the power output from the turbine was sold to the grid, and no energy from the power grid was purchased.

The control system presented in Figure 1 was implemented as a closed feedback loop, called *environment*[5]. At each timestep (1 hour interval), the environment is given an action, and returns the next state together with the outcome of the action (sometimes called reward). The action is represented by a number $a \in [-1,1]$, where positive values correspond to charging the battery, while negative values correspond to a battery discharge.

During the study, we were interested in two types of control solutions. The first one, was the classical optimal solution adaptable to the natural filtration of the underlying dynamics. The second one, called superoptimal, assumed the knowledge of future power output of the turbine. This unrealistic assumption, allows to get a sense of the upper bound on achievable results.

Our solution was based on Dynamic Programming. Since full fledged DP requires access to the underlying dynamics of the system and the ability to evaluate the value function in every future state, we made the following simplifying assumptions. First, the state space was discretized (the energy storage was described with the precision of 1kWh). Second, we discretized the action space. We tested multiple granularity levels, but since the results were not very sensitive to this assumption, we settled on only three action values: $a \in \{-1,0,+1\}$. Third, we assumed the following variants of wind power predictions: a) a constant prediction amounting to the historical average (which amounted to 310kWh), and b) a meteorological forecast generated by the Interdisciplinary Centre for Computational Modelling (ICM) at the University of Warsaw. Finally, at a given point in time, the optimal sequence of actions was derived for the period where energy prices were known (roughly the next 24 hours), and recomputed when necessary. Having this setup in place, the actual solution used Model Predictive Control (MPC), that is for each point in time we would recompute the optimal sequence of actions, as described above, and take the first action in the sequence. MPC is a well known approach, and it can significantly improve performance, particularly when the prediction deviates from actual production. We also performed experiments using PPO, a strong RL algorithm. Although this did not yield a satisfactory outcome, it is possible that the results would be close to optimal, after more tuning or a different algorithm choice. Overall, roughly 2000 numeral experiments were performed[6]. Selected results are presented in Table 1, where the overall time horizon consisted of 121 days. Table 1 is normalized to the "pay-as-you-go" case (i.e. the whole power output is sold). We also included the result of a heuristic strategy, which charges the battery when the current price is lower than the average of the next 8 hours, and discharges the battery otherwise.

To conclude, the problem can be solved using well tuned variants of classical methods. It is still an interesting question, how the modern tools of Machine Learning can be utilized in such problems. As a byproduct to the study, we can answer the question whether it is profitable to purchase power supply currently available on the market. At the moment the answer is negative, however it may change in the upcoming future.

4. For instance, charging an empty Tesla Megapack to 3MWh, requires 4MWh, due to 25% power loss.

5. To do that, we used real historical power data from a wind turbine, historical wind power predictions and historical CRE prices. As a side note, this environment was later generalized and a more sophisticated environment was designed and implemented. It combines several classic problems solved by dynamic programming (purchase with a deadline, machine repair, inventory control).

6. The computational experiments presented in this paper were run on the PLGRID infrastructure within the Prometheus cluster.

Obituary: Professor Jerzy Płonka (1930-2020)

Adam Marczak & Adam Nowak

On September 17th 2020 Prof. Jerzy Płonka passed away. He was not only an outstanding mathematician, but also a remarkable person and a friend of many of us.

Professor Płonka was born in 1930 in Kończyce Małe, a village in the region of Cieszyn, Silesia. In his early youth he permanently lost his sight. Surprisingly, this traumatic event did not discourage him from realizing of his plans and dreams.

In the beginning of his professional career Prof. Płonka worked with blind children giving them voice lessons. Simultaneously, in 1953 he finished the Higher School of Music in Wrocław. Shortly after he was encouraged to teach blind children other subjects, particularly mathematics. Therefore, he started mathematical studies at the University of Wrocław. His mathematical talent was quickly noticed by Prof. Edward Marczewski, a recognized Polish mathematician who nota bene was at that time the rector of the University.

Under the scientific guidance of Marczewski mathematics became a passion of Jerzy Płonka. He defended his MS thesis in 1961 and PhD thesis in 1964, both under the supervision of Marczewski. Since then Prof. Płonka devoted his entire professional life to scientific work, his main research area being algebra.

Professor Jerzy Płonka was employed by IM PAN in 1964, and in 1967 he obtained a habilitation. In 1980 he obtained the title of professor of mathematical sciences. Professor Płonka was connected with IM PAN until his retirement in 2007. In the period 1973-1994 he also worked at the Higher Pedagogical School in Opole.

Professor Płonka authored or co-authored 135 scientific works in the fields of algebra and graph theory, the vast majority of them published in reputable algebraic journals. Moreover, he was an advisor of 10 doctoral dissertations. The name of Prof. Płonka is attached to a notion of a diagonal algebra which was first defined and studied by him. There is also an exceptional construction of an algebra based on a directed system of algebras which is commonly called in the literature *Płonka's sum*. This construction turned out to be essential in various representations of algebras, as well as in numerous characterization theorems, and even in some results in mathematical logic.

Despite of the limitations caused by his blindness, Prof. Płonka was always cheery and open minded. He was always modest and ready to help other people and very approachable particularly for young mathematicians. His collaborators were continuously impressed by his wide knowledge, depth of understanding, extraordinary intuition, and great ability to solve sophisticated mathematical problems solely in his mind, without writing a single note or computation. The spirit of Professor Jerzy Płonka will remain with them and the next generations of algebraists.

Photograph by Edmund S. Szczepański.

Obituary: Professor Julian Ławrynowicz (1939-2020)

Adam Skalski

Professor Julian Ławrynowicz was born in Łódź on the 8th of April 1939, and died there on September 21st 2020. Most of his scientific career was linked to the University of Łódź and to IM PAN; in particular he worked at IM PAN from 1961 to 2000, beginning already as an assistant. For his PhD thesis, "Variational methods in the theory of conformal and quasi-conformal maps", written under the supervision of Zygmunt Charzyński and defended in 1964 in Łódź, he was awarded the Polish Mathematical Society prize for young mathematicians. In 1976 he was granted the title of a Full Professor. He had for many years led both the Łódź Branch of IM PAN (since 1982) and IM PAN's Independent Laboratory of Complex Analysis and Differential Geometry (since 1974). His original research interests were linked with complex analysis, and the study of conformal and biholomorphic invariants, but then broadened to include differential geometry and its applications to mathematical physics or biology, and further to the history and ethics of science.

Julian Ławrynowicz successfully supervised 15 PhD students (12 in mathematics, 3 in physics). Throughout his career he was a very active member of the Scientific Society of Łódź and the main editor of its journal, Bulletin de la Société des Sciences et des Lettres de Łódź. Série: Recherches sur les Déformations; he was also involved in several initiatives gathering Christian scientists, such as the Christian Forum of Scientists. His list of publications as seen on MathSciNet has 195 entries, and the actual number is significantly higher. He was a keen organizer of scientific meetings: even in recent years, after his formal retirement, he run annual "Hypercomplex Seminars", meetings in Będlewo gathering mainly (but not only) mathematicians and physicists from Poland and Ukraine. Earlier he was a visiting Professor in Helsinki, Pisa (Scuola Normale Superiore), Rome (La Sapienza), Göttingen, Mexico City (CInvEstAv), and Tokyo. He is survived by his wife, a distinguished mycologist, and their three children.

When preparing this note I used the note written by Antoni Pierzchalski on the occasion of the renewing of the doctorate of Professor Ławrynowicz by the University of Łódź in 2019.

Top photograph from the archive of Antoni Pierzchalski.
Bottom photograph from the archive of Łódzkie Towarzystwo Naukowe.

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IMPANGA 20	11-17.07.2021	C. Eyral, G. Kapustka, M. Kapustka, et al.	Będlewo
Summer school Algebraic Combinatorics Kraków 2021	12- 16.07.2021	M. Dołęga, M. Kowalski, T. Szemberg, et al.	Cracow

Photograph by Sławomir Malecha

Title	Date	Organizers	Place
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