List of Abstracts BSSM 2023

Lundi-Monday

Sonja Hohloch

Title: Introduction to Hamiltonian systems and integrability

Abstract: Many important phenomena in mathematics, physics, chemistry, engineering, and biology can be modelled by means of so-called Hamiltonian dynamical systems. We will define what Hamiltonian systems are and consider some examples. Then we discuss the most striking features and properties of Hamiltonian systems. Eventually we will consider more generally what it means to have more than one conserved quantity.

Senne Trappeniers

Title: From Knot Theory to Skew Braces

Abstract: Knot theory is an ancient branch of mathematics which still drives research up to this day, with an indispensable role therein being played by knot invariants. An example of such an invariant is tricolorability, which is the ability of a knot to be colored using three colors while respecting certain rules. When one wants to obtain invariants by colorings with more than three colors and possibly different rules, the Yang–Baxter equation appears in a natural way.

To every solution of the Yang–Baxter equation one can associate two groups. Studying these groups already tells us a lot about the original solution, but for certain classes of well-behaving solutions we can do better and combine these two groups to obtain a novel algebraic structure called a skew brace. In current research, these algebraic structures are the main tool for studying and moreover classifying solutions of the Yang–Baxter equation.

In this talk we will define all of the above notions and, guided by intuitive examples, discover this beautiful interplay between knot theory and algebra.

Yelena Yudistky

Title: What makes some hard problems easier to solve?

Abstract: There are problems for which efficient algorithms are not known. Finding an efficient algorithm for one of those problems will grant the solver a prize of US $1,000,000 and will resolve the famous P versus NP question. In this talk I will discuss a few interesting cases for which such problems have efficient algorithms.

Mardi-Tuesday

Alexander Lazar

Titre: Graphs, Algebra and Enumeration

Abstract: Graphs are extremely simple combinatorial objects which are ubiquitous in pure and applied mathematics. In this talk I will briefly introduce some basic notions of graph theory, and then go over some ways in which very basic algebraic techniques allow us to gain a surprising amount of insight into the structure of graphs.

Quiz mathématique

Titre: Un quiz

Abstract: L'équipe de la BSSM vous invite à un quiz mathématique.

Mercredi-Wednesday

Marino Gran

Title: Categories, groups and non-abelian algebraic structures

Abstract: Category theory provides an interesting way of looking at mathematical structures by emphasizing the relations between them. A key idea comes from the observation that some peculiar properties of a given structure can be better understood by looking at the way this structure interacts with the other structures of the same type. Accordingly, structure preserving morphisms play a crucial role in this approach. This has led to many new results and to an abstract way of thinking in mathematics. In this talk I shall focus on some basic definitions and properties in category theory, which will be illustrated by some algebraic examples. After recalling the classical notion of abelian category which plays a central role in homological algebra, I shall explain the research direction that has led to the introduction of the notion of semi-abelian category. In this approach many fundamental properties groups, rings and Lie algebras have in common are captured by a simple list of axioms, whose interesting consequences are still being explored in modern categorical algebra.

Vivien Meurice

Title: Statistics : when assumptions break

Abstract: Basic assumptions required to use many usual statistics methods are often not met. Indeed, theoretical standards of the sample being made of independent observations all drawn from the same probability distribution -let alone a Gaussian one - can be unrealistic in many situations. In this talk, we look at various examples of such assumptions being violated and how statisticians have tried to deal with those situations. This should give the audience an insight in ways we mitigate assumptions-related problems by relaxing or bypassing them altogether.

Maxime Weytens

Title: Visualising operations in Clifford algebras

Abstract: Clifford algebras have applications in geometry and theoretical physics mainly because of their link with Spin groups and therefore with symmetry. However, the geometry behind Clifford algebras can be quite hidden in textbooks and only reveals itself at the second or third read (sometimes even later for particularly obscure manuscripts). The purpose of this talk is to jump straight at that hidden geometry and learn from pictures while staying well away from the algebraic gobbledygook.

Jeudi-Thursday

Stijn Vansteelandt

Title: Causality, causal graphical models and causal machine learning

Abstract: Many, if not most, scientific studies aim to draw cause-effect relationships from data. In medicine, one wishes to learn whether, for instance, new treatments for Type II diabetes adversely affect cardiovascular outcomes. In socio-economic studies, one evaluates the impact of more stringent speed limits on the expected number of road casualties, for instance, or the impact of imprisonment on the risk of recidivism. Such studies are complicated: while data can inform us about associations between measurements, such associations may arise even in the absence of a causal effect. For instance, when treatment for Type II diabetes is more likely given to individuals with poor cardiovascular health, then one may observe worse cardiovascular outcomes in the treated individuals - and thus seemingly a harmful treatment effect - even when treatment is beneficial or has no effect.

In the first part of this talk, I will develop insight into the differences and connections between association and causation, using intuitive examples to illustrate. For this, I will introduce the popular theory of causal graphical models

and d-separation developed by Judea Pearl, one of the 'giants' in the field of artificial intelligence.

In the second part of the talk, I will explain how the causal effect of an exposure on an outcome can be inferred from data. I will argue that traditional statistical and machine learning approaches both have strong limitations, and give a conceptual discussion on how these can be overcome using modern techniques from the field of causal machine learning.

Felix Küng

Title: Homology and Homotopy

Abstract: We give an introduction to two classical invariants of topological spaces, Homotopy groups and Homology groups. In the process of doing this we will encounter different ways of characterizing continuous maps, homotopy and homology. We will finish by comparing these two different topological invariants and their drawbacks/benefits.

Daniel Drimbe

Title: Rigidity theory for von Neumann algebras

Abstract: In the early 1940s, Murray and von Neumann found a natural way to associate a von Neumann algebra L(G) to any countable group G. The classification of von Neumann algebras has since been a central theme in operator algebras driven by the following question: what aspects of the group G are remembered by L(G)? The goal of this talk is to present major breakthroughs in the theory of von Neumann algebras and to survey some of the progress made recently using Popa's deformation/rigidity theory. We emphasize results which provide classes of groups that can be completely recovered from their von Neumann algebras.

Vendredi-Friday

Jean Doyen

Title: Nombres irrationnels, transcendants et normaux: leur histoire, leurs beautés et leurs mystères
Abstract: Contrairement à ce qu'on pourrait penser, il y a encore énormément de problèmes non résolus concernant les nombres réels. On présentera et discutera quelques uns des plus importants, dans une perspective historique. On verra aussi que certaines propriétés peu connues des nombres réels sont à la fois très belles et tout à fait surprenantes. L'exposé sera accessible aux étudiants de fin du secondaire.

Stéphane Lhaut

Title: Prédire les extrêmes : le théorème central limite pour les maxima

Abstract: Il y a de cela près d'un siècle, Ronald A. Fisher et Leonard H.C. Tippett obtenaient en 1928 le premier résultat de ce que l'on peut appeler "l'étude des valeurs extrêmes". Ils montrent que la classe des distributions qui apparait comme limite faible des maxima de variables aléatoires indépendantes et identiquement distribuées sur la droite réelle, quand leur nombre tend vers l'infini, est caractérisée par un nombre fini de paramètres. En quelque sorte, ce résultat est l'équivalent du bien connu "théorème central limite" qui concerne les sommes de variables aléatoires indépendantes. Il faut cependant attendre près de 40 ans pour que, dans la thèse de Laurens de Haan, soit établie une théorie mathématiquement comparable à celle entourant l'étude des sommes de variables aléatoires. Les applications qui découlent de cette théorie sont maintenant essentielles dans de nombreux domaines où une quantification précise des extrêmes est primordiale : météorologie, assurance, finance, ...

Dans cet exposé, nous aborderons certains résultats clés de la théorie des valeurs extrêmes et présenterons quelques applications de celle-ci à des problèmes concrets. Plus récemment, la théorie a également été étendue à l'étude des maxima de vecteurs aléatoires indépendants et identiquement distribués pour lesquels la classe des distributions limites n'est plus paramétrique. Nous discuterons cette extension en fin d'exposé, ainsi que son utilité pour la prévision d'extrêmes multivariés.

Benoît Van Vaerenbergh

Title: Carreler la sphère est impossible

Abstract: Carreler la sphère est impossible et pourtant, après avoir exposé pourquoi, nous nous y attellerons dans cet exposé. Ce problème a en effet de nombreuses applications qu'on discutera. A l'aide d'outils d'analyse, de topologie et de géométrie, nous viendrons avec une réponse quantitative à l'obstruction. Nous discuterons aussi de l'équivalent du problème en dimension supérieure après l'avoir motivé.