Applied Topology in Poznań 2025
Introduction to TDA Workshop
Book of Abstracts

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This is the book of abstracts of the Workshop “Introduction to Topological Data Analysis" that preceeds the Applied Topology in Poznań 2025 conference. The lectures will take place in Aula B of the Faculty of Mathematics and Computer Science - Adam Mickiewicz University Poznań.

Contents

Abstracts

1 Saturday

Title: tba

Bruno Benedetti
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Abstract. tba

Reasoning with AI – facts and myths

Bartosz Naskręcki
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Abstract. The rapid development of large language models over the past few years has led us to experiment with reasoning and recognize the potential usefulness of models in science. In the last two years, models have emerged that are gradually overcoming successive barriers in advanced deduction and are able to emulate the work of scientists to a certain extent. In this lecture, I will discuss the latest benchmarks verifying these achievements. I will discuss whether we are actually close to AI surpassing mathematicians and what this means in practical science. We will see how various new techniques, including reasoning token models and multi-agent models, achieve high effectiveness in some types of reasoning, but still fail completely in others. I will try to argue why this is the case and whether the end of scientific institutions is upon us.

Introduction to Persistence and Beyond

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Abstract. We begin this introductory lecture with the basics of topological persistence that is the cornerstone of topological data analysis (TDA). This basic concept has been extended to what is called zigzag persistence and multiparameter persistence. We mainly focus on the simplicial setting where a simplicial complex is filtered by an index set giving us a collection of indexed homology groups (over a field coefficient) with connecting homomorphisms. In zigzag persistence we allow inclusions of simplicial complexes both in forward and backward directions. In multiparameter setting, we extend the index set from $\mathbb{Z}$ to $\mathbb{Z}^d$, $d \geq 1$, or even to a general poset. In each case, we talk about mathematical foundations, invariants that (partially) characterize the algebraic structures of the input, and algorithms to compute them.

Mathematical thinking in times of the GenAI Hype

Maria Knorps
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Abstract. In the age of generative AI, critical and scientific thinking are more valuable than ever. This presentation highlights how strong mathematical skills and analytical reasoning will set you apart in the job market. Drawing from my experience at Modus Create, where we solve complex problems thanks to a team with academic backgrounds, we'll explore how these skills drive success in real-world challenges. Learn how your academic background can become a key asset for an industry job.

2 Sunday

Metrics on persistent modules

Wojciech Chachólski
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Abstract. The aim is to describe a rich space of metrics on persistent modules at the associated topologies. These metrics reflect interesting relations between algebraic properties of the category of persistent modules and continuous properties of real numbers.

Knotting the Algebraic and Topological: Lectures on categorification and Khovanov Homology

Radmila Sazdanovic
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Abstract. Knot theory, a central area of low-dimensional topology, has seen two major breakthroughs over the past four decades: the introduction of the Jones polynomial and its categorification, Khovanov homology. These lectures will offer a clear introduction to the fundamentals of knot theory, with a focus on Khovanov homology as a powerful algebraic invariant for distinguishing knots and links. We will explore how this tool serves as an algebraic descriptor of knots, similar to the topological summaries used in Topological Data Analysis (TDA), including an introduction to persistent Khovanov homology.

Title: Statistics and machine learning

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Abstract. The fields of statistics and machine learning share a common goal: to extract meaningful structures from data. However, they often diverge in how they approach complexity, uncertainty, and interpretability. In this talk, I will present a statistical perspective on modern machine learning, emphasizing methods that uncover low dimensional patterns and latent structures in high-dimensional settings.

I will begin by discussing statistical regularization techniques, such as ridge regression and LASSO, which address overfitting and model selection in large-scale regression problems. I will then move to Gaussian graphical models and demonstrate how regularization can be used to estimate interpretable dependency structures in multivariate data.

The second part of the talk will focus on the statistical identification of latent features. I will discuss the probabilistic principal component analysis (PPCA) as a generative model for dimensionality reduction and present PESEL—a principled criterion for selecting the number of components based on likelihood maximization. I will also discuss the varclust algorithm, which identifies sparse subspace clusters, revealing structured relationships among variables.