Alps-Adria Seminar on Algebra and Analysis
(12th meeting)

October 10, 2026

Department of Mathematics
Faculty of Mathematics and Physics
University of Ljubljana
Jadranska ulica 21
10000 Ljubljana, Slovenia

Schedule

All talks will be in Lecture Room P.02, ground floor

10:00–10:25	Damjana Kokol Bukovšek: *Symmetric nonnegative trifactorization rank of matrices with a given pattern without a four cycle*
10:30–10:55	Andrei Asinowski: *Rectangulations: generating functions, bijections, and patterns*
11:00–11:25	Slaven Kožić: *Yangians and quantum vertex algebras*
	Coffee break
12:00–12:25	Janko Bračič: *Similarities of subspace lattices in Banach spaces*
12:30–12:55	Manfred Buchacher: *A differential analogue of Tutte's invariant method*
13:00–13:25	Marko Vrdoljak: *Classical Solutions to Optimal Design Problems*
14:00–	**Lunch** at the restaurant Pod Vrbo, Ziherlova ulica 36, 1000 Ljubljana

Abstracts

Rectangulations: generating functions, bijections, and patterns

Andrei Asinowski
University of Klagenfurt

A *rectangulation* of size n is a partition of a rectangle into n rectangles. Rectangulations form a combinatorial class under either of two kinds of equivalence: the *weak equivalence* which preserves segment-to-rectangle adjacencies, and the *strong equivalence* which (also) preserves rectangle-to-rectangle adjacencies. Equivalence classes are, accordingly, are called *weak rectangulations* and *strong rectangulations*. A rectangulation is *guillotine* if its size is 1 or if it can be recursively obtained by gluing two smaller guillotine rectangulations.

In my talk, I will first review classical enumerative results on weak rectangulations: I will demonstrate how analytic methods (generating functions and kernel method) can be used to show that weak guillotine rectangulations are enumerated by Schröder numbers and all weak rectangulations are enumerated by Baxter numbers. Then, I will describe representation of rectangulations by permutation classes and posets. Finally, I will present recent results on pattern avoidance in rectangulations (joint work with Michaela Polley).

Similarities of subspace lattices in Banach spaces

Janko Bračič
University of Ljubljana

A collineation of a subspace lattice $\mathfrak{L}$ in a complex Banach space X is an invertible operator S on X with the property that the image SM of a subspace M belongs to $\mathfrak{L}$ if and and only if M belongs to it. Hence, S is a collineation of $\mathfrak{L}$ if and only if it implements an order automorphism of $\mathfrak{L}$.

We discuss the group of all collineations of $\mathfrak{L}$. One of the main questions that we consider is whether the group of all invertible operators that fix every subspace in $\mathfrak{L}$ is a complemented subgroup in the group of all collineations of $\mathfrak{L}$. For certain subspace lattices, such as some realizations of the diamond or the double triangle, some nests in the space of continuous functions on $[0, 1]$, and the classical Volterra nest in $L^1[0, 1]$, the answer is affirmative, and we are able to characterize the complements.

A differential analogue of Tutte's invariant method

Manfred Buchacher
University of Graz

The research this talk is about is part of the collective effort of enumerating restricted lattice walks by solving the functional equations their generating functions satisfy. I will talk about one of the many methods these equations can be approached with: Tutte's invariant method (as introduced by Bernardi, Bousquet-Mélou and Raschel). I will recall the method, discuss what it relies on, and present a differential analogue thereof.
The talk is based on https://arxiv.org/abs/2404.10377 and joint and ongoing work with Charlotte Hardouin.

Symmetric nonnegative trifactorization rank of matrices with a given pattern without a four cycle

Damjana Kokol Bukovšek
University of Ljubljana

We consider a symmetric nonnegative matrix A of order $n \times n$. A factorization of the form $A = BCB^T$, where B is a nonnegative matrix of order $n \times k$ and C is a symmetric nonnegative matrix of order $k \times k$, is called symmetric nonnegative trifactorization (SNT for short) of A. Minimal possible k in such factorization is called the SNT-rank of A. The zero-nonzero pattern of a matrix can be described by a simple graph that allows loops. The SNT-rank of a graph G is the minimal SNT-rank of all symmetric matrices with pattern determined by G, and it can be characterized combinatorially using set-join covers of G. In the talk we will consider a family of graphs that do not contain four cycles. We will present an algorithm on the graph for computing SNT-rank of such graphs.

Yangians and quantum vertex algebras

Slaven Kožić
University of Zagreb

The Yangians form a family of quantum groups associated with rational solutions of the quantum Yang–Baxter equation. In this talk, I will give an introduction to the Yangian of type A, which is closely related to the general linear Lie algebra and its affinization. Finally, I will discuss its connections to the theory of quantum vertex algebras.

Classical Solutions to Optimal Design Problems

Marko Vrdoljak
University of Zagreb

Optimal design problems deal with finding the best spatial distribution of two or more given materials to optimize specific properties, usually expressed by an integral functional. A fundamental difficulty in this field is that such problems generally lack classical solutions. As minimizing sequences of domains occupied by specific materials tend to develop oscillations and degeneracies, solutions consisting exclusively of pure materials rarely exist.

To overcome this issue, two main strategies have emerged in the mathematical literature. The first approach restricts the class of admissible domains by imposing extra regularity conditions. This ensures compactness and guarantees the existence of classical shapes. Important contributions in this direction include Chenais's uniform cone condition, Šverák's constraint on the number of connected components, and various perimeter constraints used in the works of Ambrosio and Buttazzo. As a continuation to develop analysis, optimality conditions and consequently numerics, the shape differentiation approach, which has its roots in the work of Hadamard, has been well developed.

The second approach tackles the problem by relaxing and enlarging the set of admissible solutions. This is most commonly done using the homogenization method, which introduces generalized, composite materials by mixing the original phases on a micro-scale. This method builds on the pioneering works of Spagnolo on G-convergence and Murat and Tartar on H-convergence.

A proper comparison of these two main approaches requires benchmark examples that actually have classical solutions, which naturally appear in the context of heat energy maximization for spherically symmetric problems. Although these optimal designs are found using the homogenization method, the shape differentiation approach can be used to rigorously justify their stability, additionally uncovering several unexpected local maxima.