

Joint Workshop of Mathematics Departments UP IAM and UP FAMNIT

Rogla, Slovenia, May 17 - May 19, 2013

TIMETABLE

Friday, May 17th

20:00 – 20:05 Opening remarks

20:05 – 21:00 E. PAŠALIĆ: Introduction to Cryptography and some State-of-art Directions

Saturday, May 18th

9:30 – 9:55 P. MEDVEDEV: Genome Sequencing and Error Correction Algorithms

10:00 – 10:25 G. VERRET: Cayley Graphs on Abelian Groups

10:30 – 11:00 - - - *Break* - - -

11:00 – 11:25 M. OREL: Adjacency Preservers

11:30 – 12:00 B. KUZMA: On Homomorphisms of Commuting Graph

12:00 – 14:00 - - - *Lunch* - - -

14:00 – 14:25 I. ANTONČIČ: A Classification of Tetravalent Half-arc-transitive Weak Tetacirculants of Girth 4

14:30 – 14:55 K. POČKAJ: Construction of Rational Spline Motions of Low Degree

15:00 – 19:00 Free discussion, research work, sports activities

Sunday, May 19th

9:30 – 9:55 J. MA: A Method of Finding G-submodules

10:00 – 10:25 M. RAIČ: Central Limit Theorems in Stochastic Geometry

10:30 – 11:00 - - - *Break* - - -

11:00 – 11:25 M. MILANIČ: Graph Classes: Interrelations, Structure, and Algorithmic Issues

TALKS

A Classification of Tetravalent Half-arc-transitive Weak Metacirculants of Girth 4

Iva Antončič, —

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A graph is said to be half-arc-transitive if the automorphism group of the graph acts transitively on the vertex set and the edge set of the graph, but not on the arc set of the graph. Let $m \geq 1$ and $n \geq 2$ be integers. An automorphism of a graph is called (m, n) -semiregular if it has m orbits of size n and no other orbits on the vertices of the graph. We call a graph X a *weak (m, n) -metacirculant* if there is a (m, n) -semiregular automorphism ρ of X and another automorphism σ of X normalizing ρ , that is $\sigma^{-1}\rho\sigma = \rho^r$ for some $r \in \mathbb{Z}_n^*$, and cyclically permuting all of the orbits of ρ . We say that a graph X is a *weak metacirculant*, if it is a weak (m, n) -metacirculant for some m and n . In this talk we present the complete classification of tetravalent half-arc-transitive weak metacirculants of girth 4.

This is joint work with Primož Šparl.

On Homomorphisms of Commuting Graph

Bojan Kuzma, —

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A commuting graph of the algebra of complex n -by- n matrices is a simple graph with all nonscalar matrices as the vertex set, and where two distinct vertices are connected if the corresponding matrices commute. It is known that for $n > 2$ the commuting graph is connected with diameter four. We present some recent results towards the classification of its surjective homomorphisms.

A Method of Finding G-submodules

Jicheng Ma, —

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A method of finding all the G-submodules will be introduced, which is well applied in the classification of symmetric abelian regular covers of symmetric graphs.

Genome Sequencing and Error Correction Algorithms

Paul Medvedev, —

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Genome sequencing is a technology by which biologists can extract pieces of DNA sequence (called reads) from a genome. Though the sequence of each read is known, its location in the genome is not. Due to continuing technological advances, it is becoming feasible to sequence thousands of genomes. In this talk I will give an introduction to ongoing sequencing projects and the algorithmic challenges they pose. I will further present an error-correction algorithm for sequencing data. The algorithm is based on defining a simple likelihood model and finding the maximum likelihood assignment to either erroneous or correct buckets. Finally, I will present performance results on sequencing data.

Graph Classes: Interrelations, Structure, and Algorithmic Issues

Martin Milanič, —
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In many applications of graph theory, it is of crucial importance to be able to efficiently detect various kinds of substructures in graphs (matchings, cliques, stable sets, dominating sets, etc.). Often, the respective computational problems turn out to be intractable in general. A possible approach in this case is to identify restrictions on input instances under which the problems can still be solved efficiently. Such restrictions can be systematically described and studied using the notion of graph classes, that is, sets of graphs closed under isomorphism. Perhaps the best known example of a graph class is the class of perfect graphs. Four decades after Berge posed the so-called Strong Perfect Graph Conjecture regarding the characterization of perfect graphs by means of their forbidden induced subgraphs, the conjecture was proved by Chudnovsky, Robertson, Seymour and Thomas in 2002 and became known as the Strong Perfect Graph Theorem. A lot of research has also been devoted to the study of numerous subclasses of perfect graphs such as chordal graphs, interval graphs, split graphs, bipartite graphs, comparability graphs, etc. In the first part of the talk, we will give a brief overview of some of the most important classes of perfect graphs, their interrelations, characterizations and algorithmic properties.

While the above classes are typically defined in purely combinatorial terms, numerical characterizations of graph classes have also played an important role in (pure and algorithmic) graph theory. They will be the subject of the second part of the talk. A possible way to define a graph class numerically is via the following generic framework: Fix a property P , meaningful for vertex or edge subsets of a graph (for example, P can be a matching, a clique, a stable set, a dominating set, a total dominating set, etc.). Given a graph G , does G admit positive integer weights on its vertices (edges) and a set T such that $P(S)$ holds if and only if the sum of the weights of elements of S belongs to T ? For a proper choice of property P and a restriction on the set T , several graph classes can be defined this way, for example, threshold graphs, domishold graphs and equistable graphs. After giving an overview of these classes and their properties, we will discuss the advantages and limitations of the above framework. We will conclude the talk with an interesting family of numerically defined graphs: circulant graphs.

For all graph classes discussed throughout the talk, we will address known results regarding the complexity of their recognition and of four classical graph optimization problems: COLORABILITY, CLIQUE, INDEPENDENT SET and DOMINATING SET. Several open questions will be presented.

Adjacency Preservers

Marko Orel, —
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Matrices A and B are adjacent if the rank of their difference is minimal nonzero. Most often this means that $\text{rank}(A - B) = 1$. In that case a map Φ preserves adjacency if $\text{rank}(\Phi(A) - \Phi(B)) = 1$ whenever $\text{rank}(A - B) = 1$. In this talk I will present characterizations of adjacency preserver $\Phi: \mathcal{M} \rightarrow \mathcal{M}$ for several sets \mathcal{M} .

Results in this mathematical area and/or their proofs are related to several other disciplines, including graph theory, geometry, special theory of relativity etc.

Introduction to Cryptography and some State-of-art Directions

Enes Pašalić, —
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In this talk we give a brief introduction to cryptography and its applications. Two fundamentally different encryption approaches known as public key and symmetric key encryption are briefly overviewed. The problems related to homomorphic encryption and the relation between cryptography and graph theory are also discussed. Some specific open problems related to certain (non)permuting mappings over finite fields are also mentioned.

Construction of Rational Spline Motions of Low Degree

Karla Počkaj, —
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Motions with piecewise rational point trajectories, the so-called rational spline motions, prove to be very useful in many industrial applications. An important task is to construct a rational spline motion that matches a given sequence of positions, i.e. points and orientations of a moving object. In this talk a construction of rigid body motions will be presented. It can be divided into two parts. First, a rotational part of the motion is constructed and then the translational part is added. Algorithms for interpolation of rotation data with the help of quaternions will be used because they are fast and stable.

To construct rational motions of lower degree, geometric interpolation techniques that generate spline motions only from given geometric data can be used. One practically important scheme with G^1 Hermite rational spline motion of degree six will be presented and numerical examples which confirm the theoretical results will be shown.

Central Limit Theorems in Stochastic Geometry

Martin Raič, —
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Roughly speaking, the classical central limit theorem (CLT) says that a sum of sufficiently many independent and identically distributed random variables with sufficiently nice distributions is approximately normally distributed. These conditions can be relaxed in many ways: the summands need not be identically distributed and they even need not be independent. Important extensions of the classical CLT include local dependence, where a summand is only related to the summands in its dependence neighborhood.

In stochastic geometry, we take a random set (e. g., a Poisson point process) and for each point, we consider a certain quantity of local nature, i. e., depending only on the points in its neighborhood, e. g., the distance to its closest neighbor. Then, under appropriate conditions, the sum over all points is approximately normally distributed. Notice that in contrast to the classical CLT, the number of summands may also be random.

An important issue is the estimation of the error. We shall focus on the case where the normal approximation of the tail probabilities holds with a small relative error. Proofs are based on moments and cumulants. One of the crucial steps is based on Faa di Bruno's formula (extension of the chain rule to higher derivatives), which can be considered as a purely combinatorial fact.

Cayley Graphs on Abelian Groups

Gabriel Verret, —
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Let G be a group and let S be an inverse-closed subset of G . The *Cayley graph* $\text{Cay}(G, S)$ is the graph with vertex-set G and with g being adjacent to h if and only if $gh^{-1} \in S$. It is easy to see that G acts regularly as a group of automorphisms of $\text{Cay}(G, S)$ by right multiplication. Moreover, if G is abelian and ι is the automorphism of G mapping every element to its inverse, then ι acts as an automorphism of $\text{Cay}(G, S)$ fixing the identity. We prove that, in an appropriate sense, almost all Cayley graphs on an abelian group G have $G \rtimes \langle \iota \rangle$ as their full automorphism group. This settles a conjecture of Babai and Godsil from 1982. This is joint work with Ted Dobson and Pablo Spiga.

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