DIMAP Retreat (25-27 March 2013)

Abstracts of the talks

PhD presentations

Ebrahim Ardeshir Larijani (CS)

Verifying Quantum Communication Protocols

My research concerns with developing algorithms and tools for verification of quantum communication systems. Classical communication protocols have been studied extensively in the context of formal verification. With emergence of quantum information processing, there is a need to develop techniques and tools for formal analysis of quantum communication systems since analysing them with existing techniques is not computationally feasible. In this talk I describe a new algorithm and tool for verification of quantum systems.

Aistis Atminas (Maths)

Deciding Well-Quasi-Ordering for Factorial Languages

Language is factorial if it is closed under taking factors (i. e. contiguous subwords). Every factorial language can be described by an antidictionary, i.e. a minimal set of forbidden factors. We show that the problem of deciding whether a factorial language given by a finite antidictionary is well-quasi-ordered under the factor containment relation can be solved in polynomial time.
Joint work with Vadim Lozin and Mikhail Moshkov

Rafael Barbosa Da Ponte (CS)

The Restricted Strip Covering Problem

In this presentation, I will talk about a one-dimensional sensor cover problem, known as the Restricted Strip Covering (RSC) problem. It can be defined as follows. We are given an interval U of the real line, and a set of n sensors, each of which covers some subinterval of U and is powered with a battery of limited duration. The RSC problem consists in assigning a starting time to each sensor so that the whole interval U is covered for as long as possible. For the non-preemptive version of this problem, I will present the best approximation factor known for this problem, as well as an inapproximability bound. Also, I will show a polynomial-time algorithm that computes an optimal schedule for the preemptive version.

Andrew Collins (Maths)

Factorial Properties of Graphs

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Michail Fasoulakis (CS)

Computation of Nash Equilibria

John Nash proved that every finite general – sum game has at least one Equilibrium. This existence fact has naturally led to questions about the computation of the Nash Equilibria. We know that Nash Equilibria exist but can we compute them efficiently? We provide a short overview of this area from an algorithmic, complexity and approximability point of view that leads to new research routes.

Matthew Felice Pace (CS)

Parallel Suffix Array Construction by Accelerated Sampling

A deterministic BSP algorithm for constructing the suffix array of a given string is presented, based on a technique which we call accelerated sampling. It runs in optimal $O(n/p)$ local computation and communication, and requires a near optimal $O(\log\log p)$ synchronisation steps. The algorithm provides an improvement over the synchronisation costs of existing algorithms, and reinforces the importance of the sampling technique.

Sarah Gunnels (WBS)

Game Theory for Product Portfolio Management: A study of the UK Motor Insurance Market

Recent changes in regulations and increasing investigations against insurers have given rise to questions regarding the use of "add-ons" for increased income. In the past, Game Theory has been used in the Insurance Industry for economic and risk assessment. However, using recent research into Game Theory for Product Portfolio Management, we will be exploring the possibility of applying this to "add-on" structuring by insurers in the UK Motor Insurance Industry.

Tereza Klimosova (Maths)

Hereditary Properties of Permutations are Strongly Testable

Property testing is a topic with growing importance with many connections to various areas of mathematics and computer science. A property tester is an algorithm that decides whether a large input object has the considered property by querying only a small sample of it. Since the tester is presented with a part of the input structure, it is necessary to allow an error based on the robustness of the tested property of the input. The most investigated area of property testing is testing graph properties. One of the most significant results in this area is that of Alon and Shapira asserting that every hereditary graph property, i.e., a property preserved by taking induced subgraphs, is testable. Hoppen, Kohayakawa, Moreira, Sampaio obtained the similar result for permutations, showing, that every hereditary property of permutations is weakly testable, i.e., testable with respect to the rectangular distance, and they conjectured the same to be true with respect to a finer measure called the Kendall's tau distance. We have resolved this conjecture in the affirmative by showing that for every such property P and every $\varepsilon_0 > 0$, there exists an integer M such that if a permutation π is ε_0-far from P in the Kendall's tau distance, then a random subpermutation of π of order M has the property P with probability at most ε_0. Joint work with Dan Kral.

Lehilton Leslis Chaves Pedrosa (CS)

Squared Metric Facility Location Problem and Variants

We have studied variants of the metric facility location problem (FLP) that consider different distance functions. Namely, we have studied the Squared Metric FLP (SMFLP), when the distance function is a squared metric, and some other relaxed metric functions. We have introduced a new technique to bound factor-revealing linear programs, and showed how to use this to analyse primal-dual algorithms for the Metric FLP, and obtain good approximations for the SMFLP. Also, a reanalysis of the standard LP-rounding algorithm for the FLP (Chudak and Shmoys 2003, etc.) achieves the approximation lower bound for the SMFLP of 2.040..., unless P = NP. In this talk, we briefly summarize this results and ask whether we can obtain approximation factor for variants of Metric FLP using other distance functions. For example, in the multi-level facility location, each client should connect a facility in several levels; in the k-fault-tolerant version, a client should be connected to k different facilities; the stochastic FLP aims at minimizing the expected solution cost, when a given client can be at different locations with different probabilities etc.

Lukas Mach (CS)

Amalgam Width of Matroids

We introduce a new matroid width parameter based on the operation of *matroid amalgamation*, which we call *amalgam width*. We show that any property expressible in the monadic second order logic can be decided in linear time for matroids with bounded amalgam width. This unifies several earlier algorithmic results, e.g., polynomial testability of monadic second order properties for matroids with bounded branch width representable over finite fields. We also prove that the Tutte polynomial can be computed in polynomial time for matroids with bounded amalgam width.

Nicolaos Matsakis (CS)

The Longest Queue Drop Online Strategy

We discuss about the Longest Queue Drop online policy (LQD), which is one of the most commonly used methods of directing the packet flow in buffering problems. According to this policy, when the buffer is not full it accepts all arrived packets until the point it gets full; otherwise it drops one or more packets from the longest queue currently in the buffer and accepts arrived packet(s), balancing the lengths of the queues. It has been shown that LQD is 2-competitive and at least 1.41-competitive. In our talk we derive an optimal strategy for the problem, we show that the ratio of transmitted packets (OPT/LQD) cannot be greater than

1.5 for specific sequences of packet arrivals and we show that the currently best lower bound of 1.41 cannot be modified in any way (regarding the memory size and number of arrived packets) in order to achieve a lower bound greater than 1.5, if such one may exist.

Christopher Purcell (Maths)

Boundary Properties of the Satisfiability Problem

Satisfiability is perhaps the most well known problem in computational complexity theory, and is of course NP-complete in general, and under a variety of restrictions. Finding the strongest possible restrictions under which a problem remains NP-complete is important for establishing the NP-completeness of new problems, and for understanding the boundary between tractable and intractable instances of the problem. We use the language of graph theory to address the second issue and reveal the first boundary property of graphs representing instances of Satisfiability. Joint work with Vadim Lozin.

Jan Volec (Maths)

Density Profiles of 3-vertex Graphs

For two graphs H and G, let $p(H,G)$ be the probability that $|H|$ vertices of G chosen uniformly at random induces a copy of H. Let H_k, $k = 0,\ldots,3$, be the k-edge 3-vertex graph. A vector (p_0,p_1,p_2,p_3) is a 3-profile if there exists graphs G_i of increasing orders such that $p(H_k,G_i)$ converges to p_k. A full description of the set of all 3-profiles would have many interesting implications in extremal combinatorics, e.g., it would imply the recent result of Razborov on density of triangles.

Our goal is more modest: determining all the 2-dimensional projections of the body. This line of research was initiated by Huang, Linial, Naves, Peled, and Sudakov who described the projection (p_0,p_3). We believe to be able to determine the remaining projections.

This is a work in progress joint with Roman Glebov, Andrzej Grzesik, and Dan Kral.

Chenlan Wang (WBS)

Price of Anarchy in Nonatomic Congestion Games under Stochastic Demand

We consider traffic assignment problem under the uncertainty of traffic demand. Mixed strategy is adopted to model the user equilibrium and system optimum under stochastic demand. For user equilibrium, each traveller aim to maximize the expected individual utility at a cost of whole system efficiency. For system optimum, all the network resources are well organized and assigned in the most efficient way. Existence and uniqueness conditions of the user equilibrium will be presented in this talk. The upper bounds of the price of anarchy are studied based on linear cost functions and polynomial cost functions.

Tuesday: 16:15-18:15 Research in DIMAP

Roman Glebov (Maths)

Hamiltonicity of Random Graphs

Since the early 80'ths, we know from results of Bollobás and Komlós and Szemerédi what the threshold for Hamiltonicity of $G(n,p)$ is, and also understand the hitting time phenomenon. The questions we consider in this talk can be expressed as "HOW hamiltonian is the random graph once it is a.a.s. hamiltonian?" We present several interpretations of this question and consider resilience, packing/covering, counting, and playing games.

Ben Sach (CS)

Tight Cell-Probe Bounds for Online Hamming Distance Computation

In this talk I will discuss my recent work on time complexity lower bounds in the cell-probe model. In this work we showed tight bounds for online Hamming distance computation. The task is to output the Hamming distance between a fixed string of length n and the last n symbols of a stream. We give a lower bound of $\Omega((d/w) \cdot \log n)$ time on average per output, where d is the number of bits needed to represent an input symbol and w is the word size. We argue that this bound is tight within the model. The lower bound holds under randomisation and amortisation. This is joint work with Markus Jalsenius and Raphael Clifford from the University of Bristol, UK which appeared in SODA 2013.

Juraj Stacho (Maths)

Hereditary Graph Properties

A graph property/class is hereditary if it is closed under the removal of vertices. The talk will discuss certain structural questions related to hereditary classes of graphs.

Justin Ward (CS)

Local Search Algorithms for k-Set Packing Problems

In the k-set packing problem, we are given a collection C of sets, each containing at most k elements, and an objective function f assigning a value to each sub-collection S of C. The goal is to find a sub-collection S of pairwise disjoint sets that maximizes the objective value $f(S)$. One of the simplest algorithmic approaches to this problem is local search, in which we repeatedly attempt to add some collection of sets A to S, removing all sets in S that conflict with A, until no such modification improves S. Surprisingly, this general approach gives the best known approximation results for several variants of k-set packing. In this talk, I will discuss current upper and lower bounds on the approximation performance of local search algorithms in the cases where $f(S)$ is: the cardinality function $|S|$, a linear function, and a monotone submodular function. Additionally, I will present recent, improved approximation algorithms for both the cardinality and monotone submodular cases.

Stanislav Živný (CS)

The Complexity of Finite-valued CSPs

Let L be a set of rational-valued functions on a fixed finite domain; such a set is called a finite-valued constraint language. We are interested in the problem of minimising a function given explicitly as a sum of functions from L. We establish a dichotomy theorem with respect to exact solvability for all finite-valued languages defined on

domains of arbitrary finite size. We present a simple algebraic condition that characterises the tractable cases. Moreover, we show that a single algorithm based on linear programming solves all tractable cases. Furthermore, we show that there is a single reason for intractability; namely, a very specific reduction from Max-Cut.
To appear in STOC'13; joint work with J. Thapper.

Wednesday, 14:00-15:20 Research in DIMAP

Endre Csoka (Maths)

Sampling and Local Algorithms in Large Graphs

Classical graph theory misses to describe some concepts about its motivation. For example, when we speak about similarity between two social networks, this concept is clearly not related to graph isomorphism. However, local properties, e.g., distributions of constant-radius neighbourhoods of the vertices seem to be better for this goal. To understand this concept, we should know which properties of a large graph are determined by its local properties. A strongly related question is when we want to create a structure on the graph, e.g., an almost maximum matching, whether we can do it locally, namely deciding about each edge based only on its constant-radius neighbourhood. I will give a brief introduction about these topics, including some of my recent results.

Vladimir Deineko (WBS)

Euclidean TSP with 4-point Conditions

Identifying polynomially solvable cases of NP-hard optimisation problems is one of the known branches in combinatorial optimisation. We consider Euclidean travelling salesman problem with matrices that satisfy 4-point conditions. We give complete complexity classification as well as describe algorithms for recognising permuted matrices with this special structure.

Andrzej Murawski (CS)

Algorithmic Games for Full Ground References

We present a full classification of decidable and undecidable cases for contextual equivalence in a finitary ML-like language equipped with full ground storage (both integers and reference names can be stored). The simplest undecidable type is unit -> unit -> unit. At the technical level, our results marry game semantics with automata-theoretic techniques developed to handle infinite alphabets. On the automata-theoretic front, we show decidability of the emptiness problem for register pushdown automata extended with fresh-symbol generation.