QMUL & Warwick DIMAP PhD Workshop

Warwick's Maths Dept. MS.02, 13.00-18.00

Wednesday 6^{th} March 2013

1 Programme

12.00-13.00 **Lunch**
13.00-15.00 **Talks**

13.00: Trevor Pinto: Biclique covers and partitions
13.25: Neville Ball: Rigorous confidence intervals on percolation thresholds
13.50: Kitty Meeks: List-colouring problems on graphs of bounded treewidth
14.15: Lukáš Mach: Amalgam width of matroids
14.40: Jan Volec: Subcubic triangle-free graphs have fractional chromatic number at most 14/5

15.00-15.30 **Coffee break**
15.30-17.45 **Talks**

15.30: Aistis Atminas: Deciding well-quasi-ordering for factorial languages
15.55: Sune Jakobsen: Information inequalities
16.20: Justin Ward: Non-oblivious local search and submodular maximization
16.45: Paul Mortimer: Lattice path enumeration
17.10: Benjamin Sach: Parameterized matching in the streaming model

18.00-18.30 **Dinner**

2 Abstracts

Deciding well-quasi-ordering for factorial languages
Aistis Atminas (Warwick)
Abstract. A 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. This is joint work with Vadim Lozin and Mikhail Moshkov.

Rigorous confidence intervals on percolation thresholds
Neville Ball (QMUL)
Abstract. Historically there have been two types of results on the values of percolation thresholds; rigorous bounds which are generally quite weak, and high precision heuristic estimates. Bollobás and Stacey (1997) and then Balister, Bollobás and Walters (2005) introduced a technique for generating an intermediate type of result for two dimensional lattices, namely they were able to prove rigorous confidence intervals. We briefly look at this method and see how a similar type of result can be gained in higher dimensions.

Information inequalities
Sune Jakobsen (QMUL)
Abstract. In 1948 Shannon defined the entropy, $H(X)$, of a random variable X, and showed three inequalities satisfied by this entropy measure. For discrete random variables X the entropy is non-negative ($H(X) \geq 0$), entropy is increasing ($H(X) \leq H(X, Y)$), and mutual information is non-negative

$(H(X) + H(Y) \geq H(X,Y))$. Later he also showed that relative mutual information is non-negative $(H(X) + H(X,Y,Z) \leq H(X,Y) + H(X,Z))$. In 1998 Zhang and Yeung showed a new more complicated inequality, and since then infinitely many other independent inequalities have been found. In the talk I am going to define entropy, explain what is know about information inequalities and why they are interesting. The talk will not contain any original results.

Amalgam width of matroids
Lukáš Mach (Warwick)
Abstract. 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.

List-colouring problems on graphs of bounded treewidth
Kitty Meeks (QMUL)
Abstract. In this talk I will consider the parameterised complexity of list colouring problems when the treewidth of the input graph is taken as the parameter. The main technical content will be a combinatorial result, which proves a special case of the List (Edge) Colouring Conjecture. I will then explain how this result, and an analogous result for total colourings, can be applied to demonstrate that the List Edge Chromatic Number and List Total Chromatic Number problems are both fixed parameter tractable with respect to treewidth, resolving an open question of Fellows et. al. (2011).

Lattice path enumeration
Paul Mortimer (QMUL)
Abstract. I will be giving a general overview of techniques used in enumerating lattice paths. I will begin by demonstrating how to use lattice path decompositions to find generating functions. I will then show how to describe the problem of two directed walks in a slit as one self-intersecting walk in a bounded domain. Finally I will give a short example of the algebraic kernel method.

Biclique covers and partitions
Trevor Pinto (QMUL)
Abstract. An r-local biclique cover of a graph, G, is a collection of complete bipartite (biclique) subgraphs of G, the union of whose edges is $E(G)$, where every vertex is in no more than r of the bicliques. An r-local biclique partition is an r-local biclique cover where all bicliques are disjoint. The local biclique cover (resp. partition) number of G, $lbc(G)$ (resp. $lbp(G)$), is the smallest r for which G has an r-local biclique cover (resp. partition). Trivially $lbp(G) \geq lbc(G)$; motivated by a result of Tuza and Erdös-Pyber, we investigate how loose this inequality can be.

Parameterized matching in the streaming model
Benjamin Sach (Warwick)
Abstract. We study the problem of parameterized matching in a stream where we want to output matches between a pattern of length m and the last m symbols of the stream before the next symbol arrives. Parameterized matching is a natural generalisation of exact matching where an arbitrary one-to-one relabelling of pattern symbols is allowed. We show how this problem can be solved in constant time per arriving stream symbol and sublinear, near optimal space with high probability. Our results are surprising and important: it has been shown that almost no streaming pattern matching problems can be solved (not even randomised) in less than $\Theta(m)$ space, with exact matching as the only known problem to have a sublinear, near optimal space solution. Here we demonstrate that a similar sublinear, near optimal space solution is achievable for an even more challenging problem. The proof is considerably more complex than that for exact matching.

Subcubic triangle-free graphs have fractional chromatic number at most 14/5
Jan Volec (Warwick)
Abstract. We show that every subcubic triangle-free graph has fractional chromatic number at most 14/5, thus confirming a conjecture of Heckman and Thomas [A new proof of the independence ratio of

triangle-free cubic graphs. Discrete Math. 233 (2001), 233–237]. This is joint work with Zdeněk Dvořák and Jean-Sébastien Sereni.

Non-oblivious local search and submodular maximization

Justin Ward (Warwick)

Abstract. Recently there has been a great deal of interest in combinatorial optimization problems in which the traditional linear objective function is replaced by a *submodular* function. Submodularity may be viewed as the discrete analogue of convexity, and models the common economic scenario of diminishing returns. In this talk, I will briefly cover the definition of submodularity, and present recent, improved approximation algorithms for a wide class of constrained maximization problems involving submodular functions. The algorithms are all simple variations on the standard local search algorithm, which itself may be regarded as the discrete analogue of hill-climbing or gradient ascent. A common feature is that these algorithms are guided by a modified potential function, rather than the problem's given objective. By carefully choosing this function, we obtain local search algorithms with improved approximation guarantees.