WORKSHOP ON PARAMETERIZED COMPLEXITY

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ABSTRACTS OF TALKS

Towards a Fully Multivariate Algorithmics: Some New Results and Directions in Parameter Ecology by Michael R. Fellows, Parameterized Complexity Research Unit, Office of the DVC (Research), The University of Newcastle.

This talk provides some history and background of Parameterized Complexity, and reports on three recent directions and results pushing into multivariate complexity analysis.

Combining Two Worlds: Parameterized Approximation for Vertex Cover by Ljiljana Brankovic, Computer Science and Software Engineering, The University of Newcastle.

We explore opportunities for parameterizing constant factor approximation algorithms for vertex cover. We provide a simple algorithm that works on any approximation ratio of the form (2l+1)/(l+1), and has complexity that outperforms not only a naive algorithm but also an algorithm derived from the best known exact parameterized algorithm and the best known polynomial constant factor approximations for graph with bounded degree.In particular,we obtain a factor 1.5-approximation with a parameterized algorithm that runs in time O*(1.09^k).

Parameterized Complexity in Practice: Examples in Bioinformatics by Luke Mathieson, Centre for Bioinformatics, Biomarker Discovery & Information-Based Medicine (CIMB), The University of Newcastle.

Parameterized Complexity is a practical, algorithm oriented toolkit that has wide application across informatics. This talk aims to give a brief argument for the usefulness of Parameterized Complexity in bioinformatics, with some illustrative examples from work done at the Centre for Bioinformatics, Biomarker Discovery & Information-Based Medicine at the University of Newcastle.

Parameterized Complexity in Constraint Programming by Toby Walsh, NICTA Research Group Leader and UNSW Computer Science.

I survey recent results in constraint programming using parameterized complexity. I highlight some important and unifying themes including tree width, cutsets, dynamic programming and backdoors.

Propagating Conjunction of All-Different Constraints by Nina Narodytska, NICTA, UNSW.

We study propagation algorithms for the conjunction of two AllDifferent constraints. Solutions of an AllDifferent constraint can be seen as perfect matchings on the variable/value bipartite graph. Therefore, we first investigate the problem of finding simultaneous bipartite matchings. We present an extension of the famous Hall theorem which characterizes when simultaneous bipartite matchings exists. Unfortunately, finding simultaneous matchings on bipartite graphs is NP-hard in general. However, we prove a surprising result that finding a simultaneous matching on a convex bipartite graph takes just polynomial time.

Based on these theoretical results, we provide the first polynomial time bound consistency algorithm for the conjunction of two AllDifferent constraints. We identify a pathological problem on which the bound consistency propagator is exponentially faster compared to existing propagators. We also study fixed parameter tractable algorithms for the conjunction of two AllDifferent constraints Our experiments show that this new propagation algorithm can offer significant benefits compared to existing methods.

A Fixed-Parameter Tractable Algorithm for Spatio-Temporal Calendar Management by Jochen Renz, NICTA and ANU.

Calendar management tools assist users with coordinating their daily life. Different tasks have to be scheduled according to the user preferences. In many cases, tasks are at different locations and travel times have to be considered. Therefore, these kinds of calendar management problems can be regarded as spatio-temporal optimization problems and are often variants of traveling salesman problems (TSP) or vehicle routing problems. While standard TSPs require a solution to include all tasks, prize-collecting TSPs are more suited for calendar management problems as they require a solution that optimises the total sum of “prizes” we assigned to tasks at different locations. If we now add time windows that limit when tasks can occur, these prize-collecting TSPs with time windows (TW-TSP) are excellent abstractions of spatio-temporal optimisation problems such as calendar management.

Due to the inherent complexity of TW-TSPs, the existing literature considers mainly approximation algorithms or special cases. We present a novel algorithm for TW-TSPs that enables us to find the optimal solution to TW-TSP problems occurring in real-world calendar management applications efficiently. Our algorithm is a fixed-parameter tractable algorithm that depends on the maximal number of tasks that can be revisited from some other task, a parameter which is small in the application scenario we consider.

The Adaptive Analysis of Algorithms by Vladimir Estivill-Castro, School of Information and Communication Technology, Griffith University.

This talk will describe the origins of the adaptive analysis of algorithms. The adaptive analysis of algorithms aims at providing fundamental insights into the performance of the implementations of algorithms. It is closely related to Parameterized Complexity Theory, because adaptive analysis extends the one-dimensional view of input-size of the instance to a multi-dimensional view. It therefore considers that an instance of a problem has a certain degree of instance easiness. The performance of algorithms is then quantified by a function of the input instance and a measure of instance easiness.

We will review this in light of problems that fall in the polynomial-time category, like sorting, and show some of the theory behind this in this case. Interestingly, it enables worst-case analysis as well as expected-case analysis. We then explore some problems which are NP-Complete and discuss the possibility of applying this approach in combination with parameterized complexity to clustering problems from machine learning.

Fixed-Parameter Algorithms for Covering Points with Lines by Apichat Heednacram, School of Information and Communication Technology, Griffith University.

Problems like the Line Cover (finding if we can cover *n* points in the plane with at most *k* lines) have many applications; however, finding the best solution is computationally hard. It is one of those problems known to be NP-hard. However, with the techniques of parameterized complexity, we have the potential of finding efficient and exact algorithms for NP-hard problems. This talk shows new reduction rules for the problem of covering points with lines. We implement six new algorithms and four other algorithms that have appeared in the literature. We experimentally evaluate these algorithms to determine the impact and trade-offs of several reduction rules. Our approach provides tractability for a larger range of values of the parameter and larger inputs, improving the execution time by several orders of magnitude. Finally, we present overall progress we have made in solving hard geometric problems motivated by variants of the traveling salesman problem.

Parameterized complexity in computational game theory by Mahdi Parsa, School of Information and Communication Technology, Griffith University.

One of the core concepts in computational game theory is the notion of Nash equilibria. It is a solution concept of a game with two or more players, when if each player knows the equilibrium strategies of the other players, then no player has intensive to change his own strategy unilaterally. Although finding a Nash equilibrium (NE) is not a decision problem, most decision problems regarding NE have shown to be NP-Complete. Therefore, it makes sense to study these problems using parameterized complexity. In this talk will present some of our recent results:
- Finding a Nash equilibrium with smallest support is W[2]-hard.
- Finding a uniform Nash equilibrium is W[2]-complete.

- Finding a Nash equilibrium in r-sparse imitation symmetric games is in FPT.
- Finding a Nash equilibrium in a given subset is in FPT.
- Finding a best Nash equilibrium in congestion games is in FPT.

Finding Distances Between Phylogenetic Trees by Catherine McCartin, Computer Science School of Engineering and Advanced Technology, Massey University, New Zealand.

This paper presents an FPT algorithm for finding distances between phylogenetic trees, the techniques used also give classical and parameterized approximation algorithms.

Parameterized Complexity of Some Problems in Logic and Security by Ron van der Meyden, Computer Science and Engineering, UNSW.

The talk will describe some problems concerning an agent's ability to deduce information from incomplete information. Such problems often have a two-part structure: a (possibly large) body of data, and a (typically small) query concerning that data. The talk will describe both old results and some open problems in this setting.

Fixed-Parameter Algorithms for Kemeny Scores and other Voting Problems by Frances Rosamond, Parmeterized Complexity Research Unit, Office of the DVC (Research), The University of Newcastle.

This talk describes FPT algorithms for various parameterizations of Kemeny Score and discusses the application of parameterized complexity to other such problems of social choice.

Treewidth Governs the Complexity of Target Set Selection by Danny Hermelin, Max Planck Institute, Saarbrucken, Germany.

The Target Set Selection problem proposed by Kempe, Kleinberg, and Tardos, gives a nice clean combinatorial formulation for many problems arising in economy, sociology, and medicine. Its input is a graph with vertex thresholds, the social network, and the goal is find a subset of vertices, the target set, that "activates" a prespecified number of vertices in the graph. In this talk we will present evidence that the complexity of this problem is mainly affected by the treewidth of the given input graph. This evidence is an algorithm showing that the problem can be solved in polynomial-time when the treewidth is constant, and a lower bound argument showing that when the treewidth grows proportionally (at any rate) with the input size, the problem is unlikely to have any polynomial-time solution.