1QBit

Symposium Series: Mathematical Programming and Quantum Optimization

October 18, 2016

This symposium is designed to bring together experts in optimization theory and quantum optimization to create initiatives for interdisciplinary collaboration. Invited experts and 1QBit researchers will deliver talks in optimization theory and its applications in combinatorial optimization and machine learning. Open discussion will follow each presentation.

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Location: Bentall 5, Suite 458 - 550 Burrard Street, Vancouver, BC, V6C 2B5

Agenda

9:00am	**Coffee** – *Breakfast snacks and coffee will be available prior to the session.*
9:30am	**Opening Remarks** – *Welcome and introduction.*
9:45am	**Multi-Flows, Multi-Cuts and Treewidth** – Bruce Shepherd (McGill University) *Much of the work in combinatorial optimization has focused (rightly or wrongly) on relaxations and integer duals. For example, the notion of flow-cut gap is an extremely well-studied concept and appears in various guises and communities. We survey some of the results in these areas and discuss open problems connected to bounded treewidth (and low-genus) graphs.*
10:45am	**Sparse Optimization** – Michael P. Friedlander (University of British Columbia) *Many applications in signal processing and machine learning need to solve sparse optimization problems. The aim is often to find the "best" compact representation of some object. Convex optimization plays a key role. These problems are often deceptively simple, yet challenge our very best approaches. I will describe the fundamental building blocks, and survey some of the main research threads in sparse optimization, including my own research in the area.*
11:45am	**Optimization for Machine Learning** – Mark Schmidt (University of British Columbia) *Convex optimization is now ubiquitous in machine learning, due to the rise of many successful techniques like support vector machines, conditional random fields, structured sparsity, and rank minimization. Unfortunately, classical convex optimization algorithms are unable to cope with the desire to model increasingly-complex phenomena and to handle the ever-increasing dataset sizes. This talk will overview the different ways that researchers have been "opening up the black box" of convex optimization algorithms in order to derive new algorithms that are substantially faster at fitting large and complex datasets than classical methods.*
12:30pm	**Lunch** – *Lunch and beverages will be served at 1QBit's bartop.*
1:30pm	**Graph Sparsifiers: A Survey** – Nick Harvey (University of British Columbia) *Can any graph be approximated by a sparse graph? For several useful notions of approximation, the answer is "yes". We will survey the topics of cut sparsifiers, which approximate a graph's cuts, and spectral sparsifiers, which approximate a graph's spectral properties. Cut sparsifierse merged in Karger's work on fast algorithms for cut and flow problems. Spectral sparsifiers were developed as part of Spielman and Teng's fast solver for systems of linear equations. In the past few years there have been several intriguing developments.*
2:30pm	**Empirical Hardness Models: Methods and Uses** – Lars Kotthoff (University of British Columbia) *Large parts of AI research are concerned with solving hard combinatorial problems more efficiently. Yet a theoretical analysis of the complexity of such algorithms and the no free lunch theorem tell us that on average all of these algorithms behave the same. Why is there any point in such research then? In this talk, I will motivate empirical hardness, which analyses the empirical behaviour of algorithms, rather than their theoretical behaviour. I will introduce methods of leveraging and exploiting empirical hardness models, and briefly outline advances in solving hard combinatorial problems that have been achieved as a result.*
3:15pm	**Coffee** – *Coffee and snack break before the afternoon talks.*
3:45pm	**Adiabatic Quantum Computation: Theory and Practice** – Hamed Karimi (1QBit) *Adiabatic quantum computation (AQC) is one of the interesting paradigms of quantum computation. Current implementations of AQC hardware, the quantum annealing processors manufactured by D-Wave Systems, have boosted research efforts towards understanding the limitations and advantages of quantum annealers at both the theoretical and practical level. In this talk, I'll give a brief survey of known theoretical and practical advantages of quantum annealers.*
4:15pm	**Solving Constrained Binary Quadratic Problems Using a Quantum Annealer** – Sahar Karimi (1QBit) *Quantum annealing is perceived as a useful method for solving unconstrained binary quadratic problems. Current implementations of quantum annealing systems, however, have limitations and suffer from several sources of noise; therefore, optimization methods that are efficient at handling these limitations are of great interest. We present a few optimization techniques that allow us to employ currently available quantum annealers for solving constrained binary quadratic optimization problems.*
4:45pm	**Neuro-dynamic Programming Using Quantum Annealing** – Pooya Ronagh (1QBit) *Some machine learning applications can be carried out by gradient-based optimization methods that require Boltzmann sampling. In this talk I will survey some results on the usage of quantum annealing and simulated quantum annealing as samplers, and discuss the potential applicability of quantum annealers in machine learning.*
5:15pm	**Closing Remarks** – *Session summary before continuing the discussion over beer and wine.*