14:00-14:35 Ohad Shamir (Weizmann)

Title: Elephant in the Room: Non-Smooth Non-Convex Optimization

Abstract:
It is well-known that finding global minima of non-convex optimization problems is computationally hard in general. However, the problem of finding local minima-like points (at least in terms of gradient and Hessian properties) is tractable, and received much attention in the machine learning community in recent years. The resulting literature has been largely motivated by the rising importance of non-convex optimization problems such as deep learning, but in fact, does not quite address them: Nearly all computationally efficient guarantees in this area require the objective function to be smooth, which is seldom satisfied in deep learning problems. This highlights the importance of understanding what we can do efficiently on such non-convex, non-smooth optimization problems. In this talk, I'll describe some results, challenges, and possible approaches to tackle this fundamental question.

14:45-15:20 Shimrit Shtern (Technion)

Title: First-order methods for nonsmooth and non-strongly convex bilevel optimization

Abstract:
Simple bilevel problems are optimization problems in which we want to find an optimal solution to an inner problem that minimizes an outer objective function. Such problems appear in many machine learning and signal processing applications as a way to eliminate undesirable solutions. However, since these problems do not satisfy regularity conditions, they are often hard to solve exactly and are usually solved via iterative regularization. In the past few years, several algorithms were proposed to solve these bilevel problems directly and provide a rate for obtaining feasibility, assuming that the outer function is strongly convex. In our work, we suggest a new approach that is designed for bilevel problems with simple outer functions, such as the l1 norm, which are not required to be either smooth or strongly convex. In our new ITerative Approximation and Level-set EXpansion (ITALEX) approach, we alternate between expanding the level-set of the outer function and approximately optimizing the inner problem over this level-set. ITALEX guarantees that at each iteration of the algorithm the outer objective function is super-optimal, a property that is not known for other bilevel algorithms. We show that optimizing the inner function through first-order methods such as proximal gradient and generalized conditional gradient results in a feasibility convergence rate of O(1/k), which up to now was a rate only achieved by bilevel algorithm for smooth and strongly convex outer functions. This is a joint work with Lior Doron.

15:30-16:05 Reuven Cohen (Bar-Ilan University)

Title: Efficient covering of convex domains by congruent discs

Abstract:
The problem of covering a plane region with unit discs has various applications such as facility location and cellular network design. We will present improved upper and lower bounds on the number of discs needed for such a covering, depending on the area and perimeter of the region, as well as pseudo-polynomial time algorithms for efficient covering of convex polygonal regions using unit discs.
(Joint work with Shai Gul and Simi Haber)

16:15-16:50 Rami Katz (Dept. of Electrical Engineering, Tel-Aviv University)

Title: Sampled-data control of parabolic partial differential equations (PDES)
Abstract:
Parabolic PDEs describe a variety of important phenomena in physics and engineering, including flame propagation, viscous flow, and chemical reactions. Therefore, control of parabolic PDEs has attracted much attention in recent decades. Such control problems are theoretically challenging for several reasons. First, access to the full state of the system is seldom available and a construction of an observer (state estimator) from partial measurements is required. Second, modern control methods rely on digital implementation via communication networks, which leads to network-induced delays in both measurement and control input. Finally, practical applications require constructive and easily implementable control strategies, which are backed by theoretical guarantees.
In this talk, we will consider sampled-data control of a 1D linear heat equation. As a preliminary, we will discuss the non-delayed case and review basic notions of control, observation, and stabilization. We will then describe a finite-dimensional observer-based controller, obtained using discrete (in time) point measurements. To prove the exponential stability of the closed-loop system, a direct Lyapunov approach, which leads to linear matrix inequalities (LMIs), will be presented. Theoretical guarantees on the derived LMIs will be described. Finally, numerical examples will demonstrate the efficiency of our approach.

Joint work with Prof. Emilia Fridman, Dept. of Electrical Engineering, Tel-Aviv University:
R. Katz and E. Fridman - Finite-dimensional control of the heat equation: Dirichlet actuation and point measurement. The European Control Conference (ECC 2021).

17:00-17:35 Eran Treister (Ben-Gurion University of the Negev)

Title: Novel Architectures for Graph Neural Networks Motivated by Partial Differential Equations

Abstract:
Graph neural networks are increasingly becoming the go-to approach in various fields such as computer vision, computational biology, and chemistry, where data is naturally explained by graphs. However, unlike traditional convolutional neural networks, deep graph networks do not necessarily yield better performance than shallow graph networks.
This behavior usually stems from the over-smoothing phenomenon. In this work, we propose a family of architectures
to control this behavior by design. Our networks are motivated by numerical methods for solving Partial Differential Equations (PDEs) on manifolds, and as such, their behavior can be explained by similar analysis. Moreover, as we demonstrate using an extensive set of experiments, our PDE-motivated networks can generalize and be effective for various types of problems from different fields. Our architectures obtain better or on par with the current state-of-the-art results for problems that are typically approached using different architectures.