Open Invited Track

Distributed Optimization for Learning and Control in Smart Networks

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Abstract

Optimization problems arise as building blocks in several applications of modern cyber-physical network systems. These problems are typically large-scale so that classical optimization algorithms are either inapplicable or do not scale well for problem instances of such a large size. Moreover, in many interesting applications, computing processors have typically a partial knowledge of the problem (e.g. a portion of the cost function or a subset of the constraints) and have to cooperate to compute a global solution of the whole problem.

The objective of this open invited track is to bring together leading researchers working in distributed and large-scale optimization and addressing the main challenges arising in this area. The open invited track focuses on novel algorithmic schemes and analysis tools to enhance the current state of the art in this area and on the application of these methodologies in learning and control problems arising in smart networks. As for theoretical contributions, novel methodologies are sought addressing main challenges arising in distributed optimization both in terms of network communication and in terms of problem set-up, including novel contributions in addressing the considered problems via system theoretic analysis tools. As for the applications, proposed contributions will show how distributed optimization algorithms can be applied to relevant learning and control problems in smart networks, as, e.g., smart grids and robotic networks.

Description

Cyber-physical network systems give rise to many important estimation, learning and control problems. In many of these problems, the goal is to find solutions to some optimization problems. Optimization problems arising in this context are typically large-scale, in the sense that a large set of decision variables, constraints or both are involved. Moreover, in many interesting applications these problems are logically and/or spatially distributed in the sense that the computing units have only partial knowledge of the problem (e.g., a portion of the cost function or a subset of the constraints).

Standard computation paradigms cannot be applied to these new challenging problems, but rather novel distributed solutions, decomposition methods, block splitting approaches, and/or randomization techniques need to be considered.

The field of distributed optimization in cyber-physical network systems presents challenges that lie at the intersection of communication, optimization, and control. Because of the interdisciplinary nature of the field, open dialogue among researchers is essential for its continued advancement. The motivation of this open invited track, "Distributed Optimization for Control and Learning in Smart Networks" is to bring together contributions in terms of new theoretical methods and numerical tools to handle the new challenges raised by this optimization framework.

The objective of this session is to bring together leading researchers working on challenging new problems in distributed optimization and its application to relevant control and learning problems in smart networks. The session focuses on the development of novel algorithmic methodologies and analysis tools to enhance the current state of the art. Specifically, emphasis will be provided on system theoretic tools for the design and the analysis of novel or existing distributed optimization algorithms. In particular, there are four main novel contributions that the session would provide to the community:

1. distributed optimization methods for challenging classes of problems as, e.g., nonsmooth (convex), nonconvex, large-scale, uncertain and combinatorial problems;
2. distributed optimization methods dealing with computation challenges as, e.g., convergence rates, finite-time guarantees and data-driven paradigms;
3. distributed optimization methods addressing communication challenges as, e.g., time-varying, event-triggered, asynchronous and/or unreliable communication;
4. distributed optimization algorithms suitably customized to learning and control applications in smart cyber-physical networks, as, e.g., distributed optimal control in smart grids and cooperative robotics.

By bringing together the researchers from different area working on this interdisciplinary area, we will be able to highlight some of the major new challenges and solution methodologies in distributed optimization and their application to cyber-physical networks. The presentation of new problems in the field, as well as efficient and scalable solutions to existing problems, should be of interest to researchers in a wide variety of disciplines. Moreover, the interdisciplinary character of distributed optimization has the potential of attracting researchers from many different fields, thus bringing together complementary expertise that may give further insights to the area.

Additional material and Links

A recent tutorial paper on distributed optimization is Notarstefano et al.,"Distributed Optimization for Smart Cyber-Physical Networks", *Foundations and Trends® in Systems and Control (to appear)*, where a detailed list of relevant set-ups in learning and control is given. Moreover, in order to introduce novel researchers to this research topic, several approaches widely adopted in distributed optimization literature are presented along with their convergence analysis. This activity has been carried out within the project OPT4SMART (more details at www.opt4smart.eu).

For additional information and updates, see the website of this open track at www.opt4smart.dei.unibo.it/ifac2020opentrack.

IFAC Technical Committee for Evaluation

The open invited track will be supported by the IFAC Technical Committee 1.5 Networked Systems.