Distributed methods for large-scale optimization with application to cooperative decision-making and control in cyber-physical networks

Metodi distribuiti per ottimizzazione su larga scala applicata a problemi di decisione e controllo in reti cyber-fisiche

Piano di attività per Assegno di Ricerca

RESEARCH PROJECT

1. Context

Optimization is an important building block for numerous estimation, learning, decision and control tasks arising in complex network systems. Thus, solving optimization problems in a peer-to-peer, distributed framework represents an important and timely challenge. The main methodological goal is to design distributed algorithms in which identical processors, with a partial knowledge of a global optimization problem, solve it by performing local computation and by exchanging data only with neighboring processors. Then, another key goal is to apply these distributed optimization methods to the solution of estimation, learning, decision and control problems in smart cyber-physical networks.

2. Research Activity (Attività di ricerca)

The research activity will focus on developing methodologies for the solution of nonlinear, large-scale/big-data and constrained optimization problems arising in cyber-physical network systems. At a theoretical level the candidate will develop methods and algorithms to solve nonlinear and constrained, possibly dynamic, optimization problems arising in this context under a distributed, peer-to-peer computational framework. Tools from Optimization, Control and Graph Theory will be combined in order to design and analyze novel distributed optimization strategies. The developed methodologies will be applied to the solution of relevant learning, decision and control problems arising in cyber-physical network systems with possible focus on dynamic schemes.

L’attività di ricerca mirerà a sviluppare metodologie per la soluzione di problemi di ottimizzazione non lineari, a elevate dimensioni e vincolati che si presentano in reti di sistemi cyber-fisici. Da un punto di vista teorico il candidato svilupperà metodi e algoritmi per risolvere problemi di ottimizzazione non lineari vincolati, possibilmente dinamici, secondo un modello di calcolo di tipo distribuito e peer-to-peer. Tali metodi saranno sviluppati combinando strumenti dalla teoria dell’ottimizzazione, del controllo e della teoria dei grafi. Le metodologie sviluppate saranno applicate a problemi di apprendimento, decisione e controllo in reti di sistemi “cyber-fisici” con possibile attenzione a schemi dinamici.

2. Activity Plan

The researcher will acquire or consolidate, preliminarily or in parallel with the research activity, advanced methodologies useful for the subject of investigation, and be able to use suitable mathematical and software tools. In particular, to reach the theoretical and application research goals, the researcher will:
• perform a detailed study of the state of the art on advanced methods for distributed optimization with special focus on nonlinear, possibly dynamic, constrained optimization problems;

• develop methodologies for the classes of optimization problems under investigation, test them in simulations, and analyze them;

• study and model application scenarios especially in the context of decision and control, and apply the methodologies developed at a theoretical level;

• attend national and international courses and conferences.