Distributed optimization methods for learning and control with application to cooperative robotics

Metodi di ottimizzazione distribuita per “learning” e controllo applicati a robotica cooperativa

**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 the development of methodologies for the solution of optimization problems modeling learning, decision and control problems over networks. At a theoretical level the candidate will develop methods and algorithms to solve constrained, possibly combinatorial and mixed-integer, problems under a distributed, peer-to-peer computational framework, with a particular focus on iterative solutions to apply in dynamic scenarios. Tools from Optimization, Control and Graph Theory will be combined in order to design and analyze these methods. Some of the developed methodologies will be applied to the solution of relevant decision-making and control problems in mobile robotic networks.

L'attività di ricerca mirerà a sviluppare metodologie per la soluzione di problemi di ottimizzazione che modellano problemi di “learning”, decisione e controllo su reti. Da un punto di vista teorico il candidato svilupperà metodi e algoritmi per risolvere problemi di ottimizzazione vincolati, possibilmente combinatori e misto-interi secondo un modello di calcolo di tipo distribuito e peer-to-peer, con particolare attenzione a soluzioni da applicare in modo iterativo in scenari dinamici. Tali metodi saranno sviluppati e analizzati combinando strumenti dalla teoria dell'ottimizzazione, del controllo e della teoria dei grafi. Le metodologie sviluppate saranno applicate a problemi di decision-making e controllo in reti di robot mobili.

3. **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 constrained, combinatorial and mixed-integer problems;

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

• study and model application scenarios in the context of cooperative robotic teams, and apply the methodologies developed at a theoretical level in experimental tests;

• attend national and international courses and conferences.