Distributed Control with Game Theory

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Abstract

Many current distributed control algorithms provide strong convergence results with extremely local information sharing and decision making. My work seeks to relax some of the locality restrictions in order to bound and improve their efficiency. The amount of relaxation and the quality of improvement induces a spectrum of value on information in this class of games.

Distributed Control

Local Decisions

based on

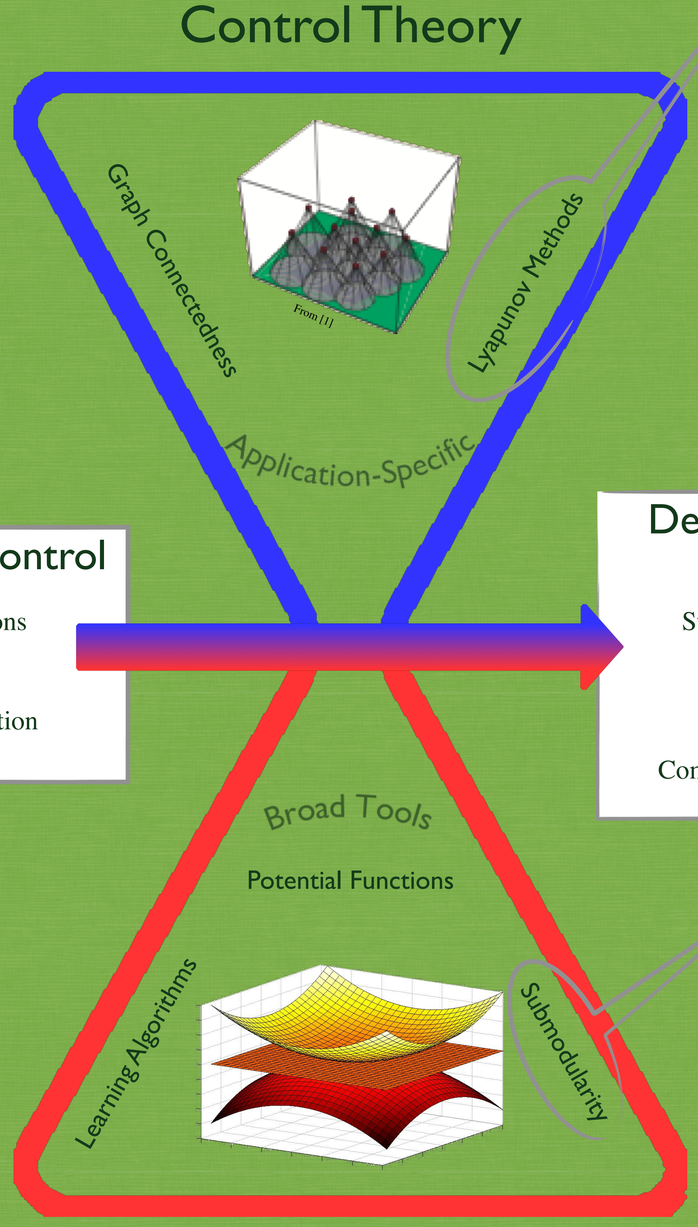
Local Information

What is a game?

All games have three main components:

- A set of *players*: $N = \{1, 2, \ldots, n\}$
- Each player has a set of *actions*:
  $\mathcal{A}_i = \{a_{i_j}\}, \quad \mathcal{A} = \mathcal{A}_1 \times \cdots \times \mathcal{A}_n$
- Each player orders the outcomes according to a *utility function*:
  $u_i : \mathcal{A} \to \mathbb{R} \quad \forall i \in N$

When no player prefers a unilateral deviation to any of its other actions, the game is at a *Nash Equilibrium*.



State of the Art

Distributed algorithms—such as those found in [1]—provide guarantees on convergence, but cannot provide any bounds on the efficiency of these solutions.

We have shown that the root of inefficiency is social disparity.

Desirable Global Behavior

Stability/Convergence

Efficiency

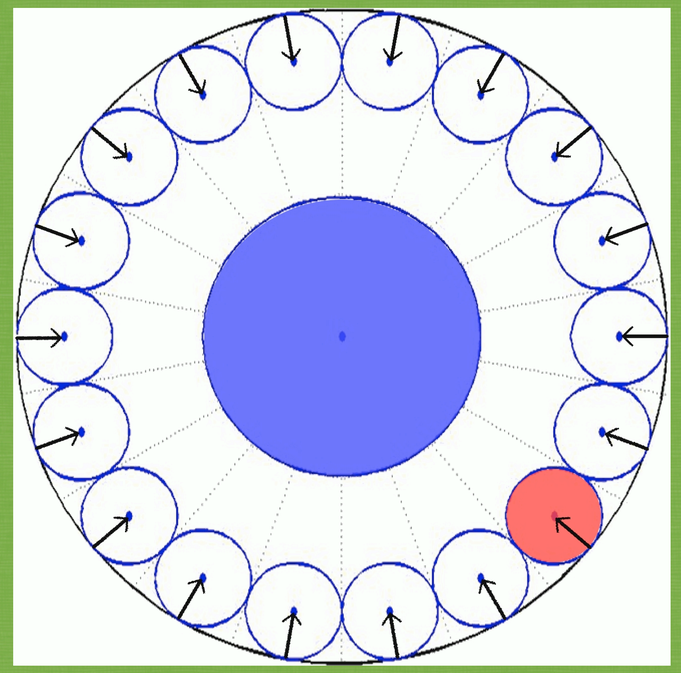
Locality

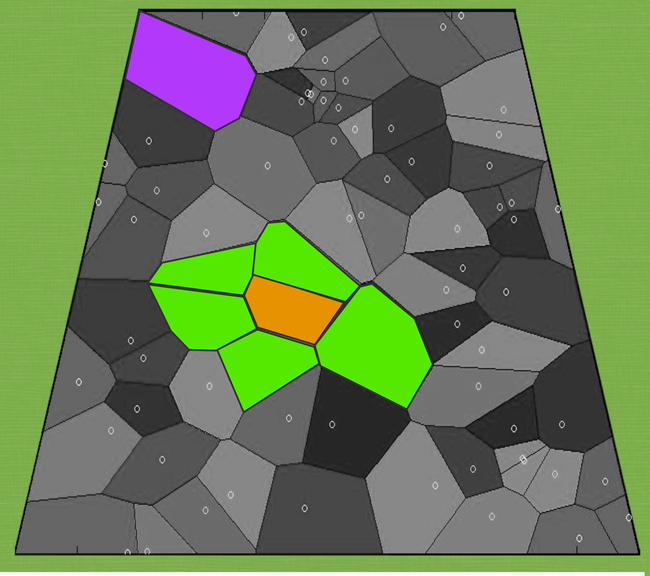
Computationally Tractable

Employ Game Theory and Expand Information

To combat social disparity, endow players with the ability to share information with, for example,

- Their immediate neighbors
- The player currently receiving the biggest payoff





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Reference:
[1] S. Martinez, J. Cortez, and F. Bullo. "Motion Coordination with Distributed Information." CSM, vol. 27, no. 4, pp. 75-88, 2007.