

Decentralized learning in control and optimization for networks and dynamic games

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Objectives

- Cooperative setting
- Provide a survey of recent advances in distributed optimization techniques

$$\min \sum_{i=1}^m f_i(x)$$

- m independent agents **cooperating** towards a single objective
- How can they reach the desired minimizer?
- How much should they communicate?
- How fast can they reach the objective?

Objectives

- Competitive setting
- Provide a survey of recent advances in convergence to Nash Equilibria in games

$$\forall i = 1, \dots, m, \quad \min_{x_i} f_i(x_i, x_{-i})$$

- m independent agents **competing** towards different objectives
- Does the notion of Nash Equilibrium make sense?
- Are there natural learning algorithms leading to NEs?
- Can agents / players select socially efficient NEs?
- How fast can they reach equilibrium?

Applications

- Large networked systems
 - Internet
 - AdHoc networks
 - Data centers
 - Sensor networks
 - Social networks
 - Economic networks
 - ...
- New interaction paradigms
 - Resource allocation
 - Coordination
 - Estimation
 - Games over networks
 - ...

Decentralized interactions

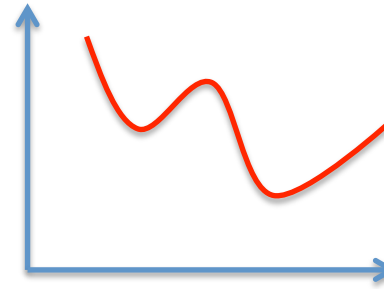
- We need new tools to understand the way agents interact in these large-scale networked complex systems
- Challenges
 - Lack of central authority
 - Network dynamics
 - Stochastic phenomena
 - Lack of (or partial) local communication among agents
 - ...

Concrete examples

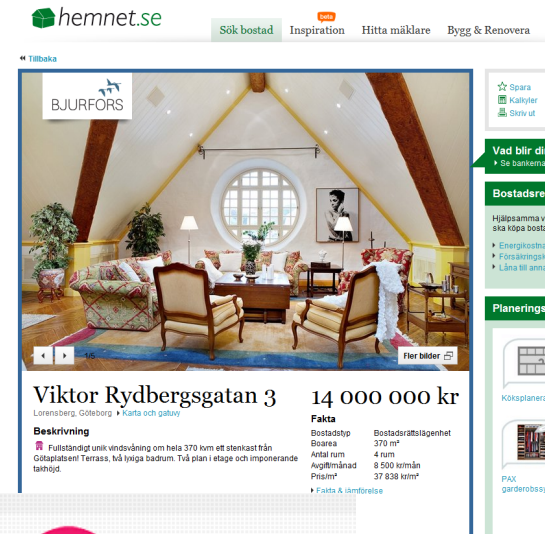
- Resource allocation in communication networks
 - Internet Congestion Control
 - Power control in wireless systems
 - Routing
 - Load balancing
- Games
 - Load balancing games
 - Routing games
 - Power control games
 - Marriage problems
 - ...

On the way, you'll learn

- How to optimize a function



- How to sell your house

A screenshot of a real estate listing on the website hemnet.se. The listing is for a house at Viktor Rydbergsgatan 3 in Lorensberg, Göteborg, priced at 14 000 000 kr. The main image shows a bright, modern living room with a large window and a circular skylight. The listing includes a description, a table of facts, and a sidebar with additional information.

hemnet.se Sök bostad Inspiration Hitta mäklare Bygg & Renovera

• Tillbaka

BJURFORS

Viktor Rydbergsgatan 3 14 000 000 kr
Lorensberg, Göteborg • [Karta och gatvy](#)

Beskrivning
Fullständigt unik vindsvåning om hela 370 kvm ett stenkast trån
Goloplastenill Terrass, två ljuga badrum. Två plan i etage och imponerande
fakhöjd.

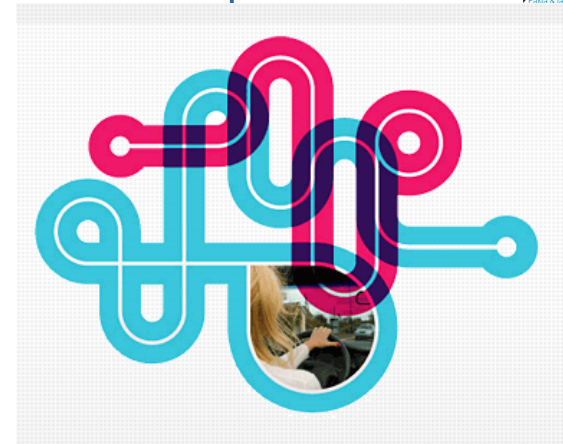
Fakta

Bostadstyp	Bostadsrättslägenhet
Boarea	370 m ²
Kvadratrum	4 rum
Avgift/månad	8 500 krmån
Pisarm ²	37 838 krm ²

• [Fakta & jämförelse](#)

• Se bankernas
• Vad blir din
• Bostadsrea
• Hjälpsamma ve
• ska köpa bosta
• Energibeskriva
• Försäkringsko
• Läsa till arna
• Planeringsv
• Kökplanerar
• PÅX
garderobssy

- How to choose your way to work



On the way, you'll learn

- How to optimize your portfolio



- How to gamble



- How to select your boy/girl friend



Outline

- Part I: Centralized optimization
- Part II: Distributed optimization
- Part III: Bandits and adversarial optimization
- Part IV: Dynamics in games

Part I

- Gradient-free (or 0th order) methods
 - Hit and run algorithm
 - Oblivious random direct search
 - Random local search
 - Simulated annealing
 - Gradient estimation methods
- Gradient-descent (or 1st order) methods
 - Unconstrained optimization
 - Constrained optimization: duality
- Fixed point iterations

Part II

- Internet congestion control
 - Distributed optimization with separable objective function
- Two miracles in resource allocation in wireless networks
 - Distributed optimization with un-separable objective function, and without message passing
 - Power control
 - Carrier Sensing Multiple Access
- Parallel computations
 - Joint consensus and gradient descent methods
 - Just gradient descent
- Colorings
 - Combinatorial optimization: a sampling approach
- Distributed gradient free optimization

Part III

- Multi-armed bandit problems
 - Notion of regret
 - Stochastic bandits
 - Adversarial bandits
- Stochastic bandit problem
 - IID setting
 - Lower bound on regret
 - UCB policies, finite time analysis
 - Asymptotically optimal policies
- Adversarial bandit problems
 - Models
 - Multiplicative update algorithms

Part IV

- Nash Dynamics
- Fictitious play
- No-regret algorithms
- Trial and error learning

How to reach me?

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