DISTRACT

Distributed Optimization and Estimation for Synergic Automatic Control

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Abstract

- Developing novel distributed optimization and estimation algorithms
- tailoring the results for controlling complex and geographically distributed processes (specially power consumptions in networks of datacenters and buildings)

The importance of distributed computations

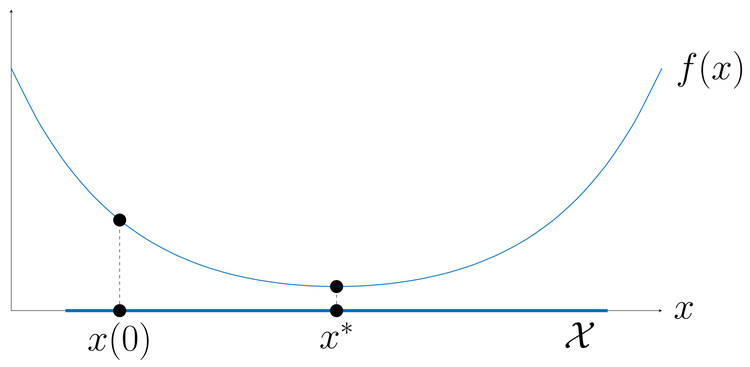
- key point: everything is connected

Distributed computations aim at enabling synergies between entities that, otherwise, would not collaborate. E.g., networks of electrical devices can exchange information and cooperate so to minimize fluctuations in the daily energy demands.

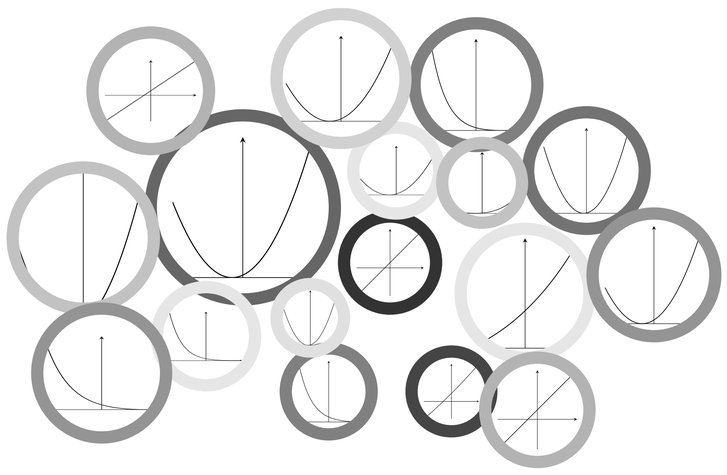
Distributed optimization - the building block of distributed computations

- key point: decisions-taking problems can always be cast as optimization problems

A ***centralized optimization algorithm*** is a numerical strategy for which a computer seeks to maximize / minimize a cost $f(x)$ starting from an initial guess $x(0)$ and subject to certain constraints $\mathcal{X}$. Importantly, in centralized strategies the computing entity knows ***all the available information***.



A ***distributed optimization algorithm*** is a numerical strategy for which a network of computers seek to maximize / minimize a cost $f(x)$ that is defined (usually) as the sum of the local costs $f_i(x)$ of the various computers, starting from a set of initial guesses $x_i(0)$ and subject to the intersection of the local constraints $\mathcal{X}_i$. Importantly, in distributed strategies the various computing entities know ***only part of the available information***.



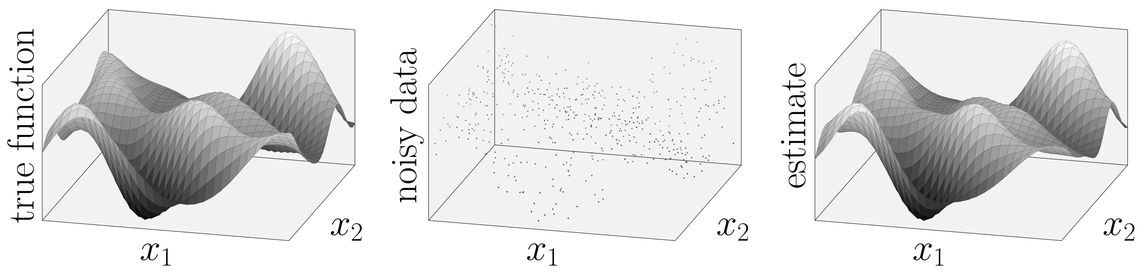
First aim of this project: extend existing distributed Newton-Raphson methods so to

- handle equality constraints;
- handle convex inequality constraints through logarithmic barrier functions;
- dynamically auto-tune descent stepsizes.

Distributed estimation - how to cooperatively learn the current situation

- key point 1: it is better to take decisions when knowing what is the current situation
- key point 2: estimation algorithms can always be cast as optimization algorithms

A ***centralized estimation algorithm*** is a numerical strategy for which a computer seeks to minimize the uncertainty of its knowledge about something (e.g., about the temperature profile in a room) by analyzing information coming from either sensors or humans. Importantly, in centralized strategies the computing entity knows ***all the available information***.



A ***distributed estimation algorithm*** is a numerical strategy for which a network of computers seek to minimize the uncertainty of their knowledge by analyzing information coming from either sensors or humans. Importantly, in distributed strategies the various computing entities know ***only part of the available information***.

Second aim of this project: extend existing distributed estimation methods so to

- handle dynamics of the unknown quantities;
- fasten the convergence properties of the estimators;
- overcome limitations posed by Gaussian assumptions through the usage of copulas.

Exploitation plan

- key point: we aim at applying the theoretical research to practical scenarios through the following exploitation projects:

load following and shifting with networks of datacenters	district heating for networks of buildings

Third aim of this project: developing algorithms for

- forecasting cooling needs for datacenters;
- performing electrical load following and shifting with networks of datacenters;
- forecasting city-wise district-heating requirements;
- coordinating district heating stations and buildings so to minimize daily variations in the heat requirements.

Partners

	datacenters	*district heating*
industrial	▸ ABB ▸ Centek	▸ Luleå Energi ▸ KYAB ▸ Akademiska Hus
academic	▸ SICS ▸ Cloudberry ▸ LTU's "Enabling ICT"	▸ LTU's "Attractive built environment" ▸ LTU's "Intelligent industrial processes"