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Research Profile:
Prof. Necoara is the head of Distributed Optimization and Control Group (DOC), see http://acse.pub.ro/person/ion-necoara). The main topics of interest are:

- Theory and methods for Convex/Distributed/Big Data Optimization. Developing optimization algorithms with a focus on structure exploiting. Mathematical guarantees about performance of numerical optimization algorithms.
- Applying optimization techniques for developing new advanced controller design algorithms for complex systems (Embedded and Distributed Control/Model Predictive Control).
- Practical applications include: Big Data Models, Data Analytics and Mining (machine learning, smart electricity grids, traffic networks, weather forecasts, distributed control, compressive sensing, image/signal processing), Embedded Control, Control of Robots, Automotive Industry and general dynamical network systems.

PhD Advisor from 2015.

- 3 phd thesis were finalized.
- 1 ongoing phd thesis (see http://acse.pub.ro/person/ion-necoara)

Mentorship: Former phd student A. Patrascu is now assistant professor at University of Bucharest. Dr. Quoc Tran-Dinh, who collaborated directly with me during his phd, is now a professor at University of North Carolina at Chapel Hill. Former phd student Valentin Nedelcu is team leader at Asystem Romania.

Publications. Author of more than 100 research papers: 2 books, 30 papers in top ISI journals with cumulative impact factor larger than 60, 8 book chapters, and about 70 papers in refereed international conferences.

Research projects:

- Involved in several EU-FP7 projects: EMBOCON (principal investigator) 2010-2013, HD-MPC (member) 2007-2008, HYCON (member) 2004-2006;
- National projects: METNET 2010-2013, MoCOBiDS 2015-2017 (principal investigator).

Proposed phd thesis subjects:

1. Scalable optimization algorithms for Big Data optimization

New algorithms will be designed based on the structure present in the problem, such as data structure (sparsity, low-rank, convexity, stochasticity) or structure in objective function (least-square or composition between a strongly convex function with a linear map) and based on different models of computations, such as parallel or distributed computing, on-line or asynchronous. To obtain scalable algorithms, coordinate descent framework will be combined with fast optimization schemes such as accelerated gradient, second order methods or Gauss-Newton methods. A crucial feature of the new optimization algorithms is the theoretical proof of mathematical guarantees about their computational performance. Applications to real world problems from machine learning, medicine, biology are also expected, in collaboration with Universite Catholique de Louvain and N-side company, both from Belgium.

2. **Stochastic proximal methods for machine learning problems**

New stochastic optimization algorithms will be developed using Moreau approximation at different levels of the objective function. These methods have recently gained more attention as it has been shown that further structural assumptions such as sparsity can be treated within this framework and they are much more robust with respect to parameters and initializations than other first other methods. We plan to combine the proximal map with coordinate descent framework in order to tackle large dimensional problems. Also randomness will be utilized in this context. The regularization properties of stochastic first order methods, especially under structured sparsity assumptions will be also investigated. We plan to apply the newly developed methods to tomographical applications and other machine learning applications and show that they can lead to good reconstructions even after the first pass through the data. The phd student will visit CentraleSupelec and IFPEN company (France) during his studies for collaborations.

3. Scale-free techniques for control of complex network systems

In order to be able to control large–scale networks we first investigate optimization based-model reduction techniques for obtaining accurate models of reasonable dimension for dynamical network systems. Then, we will combine these models with scale-free optimization methods, such as coordinate descent or stochastic algorithms, in order to derive scalable optimal control strategies for network systems. Application to real world problems is expected, such as power systems in collaboration with the company Electrica.