A low-rank matrix completion approach to data-driven signal processing

Ivan Markovsky
Vrije Universiteit Brussel
Department General Electricity
Pleinlaan 2, Building K
B-1050 Brussels, Belgium

e-mail: ivan.markovsky@vub.ac.be

In filtering, control, and other mathematical engineering areas it is common to use a model-based approach, which splits the problem into two steps:

1. model identification and
2. model-based design.

Despite its success, the model-based approach has the shortcoming that the design objective is not taken into account at the identification step, i.e., the model is not optimized for its intended use.
In this talk, we show a data-driven approach, which combines the identification and the model-based design into one joint problem. The signal of interest is modeled as a missing part of a trajectory of the data generating system. Subsequently, the missing data estimation problem is reformulated as a mosaic-Hankel structured matrix low-rank approximation/completion problem. A local optimization method, based on the variable projections principle, is then used for its numerical solution.
The missing data estimation approach for data-driven signal processing and the local optimization method for its implementation in practice are illustrated on examples of control, state estimation, filtering/smoothing, and prediction. Currently, we are missing fast algorithms with provable properties in the presence of measurement noise and disturbances. Development of such methods will make the matrix completion approach for data-driven signal processing a practically feasible alternative to the model-based methods.
The talk is based on a technical report, available from:

http://homepages.vub.ac.be/~imarkovs/publications/ddsp.pdf