Mini-projects for the SOCN course "Behavioral approach to system theory"

Ivan Markovsky

"The challenge is finding a balance between exploring new ideas and acquiring the skills to realize them."

Ken Robinson

As we've seen in the exercises, in case of exact data the data-driven methods solve the problems exactly, *i.e.*, they give equivalent results to model-based methods that use the data-generating system $\mathscr{B}$ instead of the data w_{d}. The equivalence between data-driven and model-based method no longer holds true when w_{d} is inexact. Indeed, the true data-generating system can not be recovered from inexact data. Moreover, different identification methods deliver different models. The fundamental difficulty in dealing with inexact data is that the problems are nonconvex. All currently known methods can be viewed as heuristics for solving the underlying nonconvex optimization problem.

The mini-projects in Section 1 explore the performance of the methods in case of inexact data w_{d}. We use different types of prior knowledge and observe its effect on the accuracy. The theoretically best performance is the one of methods using the true data-generating system (or equivalently exact data). Of particular interest is a comparison of the direct and indirect approaches. For the indirect approach, you can use methods implemented in the System Identification Toolbox of Matlab in order to obtain the model from the data. Section 2 has two projects related to practical applications. One is from the field of metrology and the other is about free fall in a gravitational field. Section 3 lists three current research projects of mine: recursive algorithm for exact identification, data-driven frequency response estimation, and computing distance measures between systems. You can also propose to work on a mini-project of your own choice (for example, a subproblem appearing in your own research topic).

1 Further experiments with direct data-driven methods

- Noisy data in the errors-in-variables setup
- High-order linear time-invariant system
- Unstable systems
- Nonminimum-phase systems
- Stiff systems
- Real-data from DAISY

2 Practical applications

Sensor speed-up

Free fall in a gravitational field

3 Research projects

Recursive algorithm for exact identification

Data-driven frequency response estimation

Distance between systems