SM2001/FSM3001 DATA-DRIVEN METHODS IN ENGINEERING

Homework #3

Problem 1

Consider the data in the file `DataHw3Q1.mat`. The variable `t` denotes the time, while the first and second columns of the variable `x` contain the corresponding values of two states $x_1(t)$ and $x_2(t)$ for a particular dynamical system. Assume that the dynamics for this system can be described by the ordinary differential equations (ODEs):

$$\dot{x}_1 = \sum_{j,k} c_{j,k} x_1^j x_2^k,$$
$$\dot{x}_2 = \sum_{j,k} d_{j,k} x_1^j x_2^k,$$

where j and k are non-negative integers, and we only expect to have non-zero terms when the following is satisfied: $j + k \leq 3$. Using the sparse identification of non-linear dynamics methodology (SINDy), find the non-zero coefficients $c_{j,k}$ and $d_{j,k}$ which provide a set of ODEs that accurately fit the provided data. Note: if you load the `.mat` file in Python, use the SciPy `io.loadmat` function. *Hint:* Expect to find a total of 6 non-zero coefficients.

Problem 2

Choose an example from the course, *e.g.* one of the cases discussed in the lectures, practical sessions or in the homework problems, and try to study it using an appropriately-chosen neural network. The example should be one that we did not previously study with neural networks. Compare your results with those obtained not using neural-network methods. If necessary, you can adjust some of the parameters of the problem, for instance how much data is used to train your model.