Home Assignment - 5

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Due on or before: 04.10.2024

System Identification refers to the technique of discovering governing equations of a system from experimental data. For scientists and engineers, system identification is a major application area of machine learning. In this homework, we will find the governing equation of a simple pendulum from experimental data. The data are presented in the pendulum_data.csv file. The data file contains three columns: theta (angular displacement), theta_dot (angular_velocity), theta_double_dot (angular acceleration). A row of the data file indicates the angular displacement $\left(\theta\right)$, angular velocity $\left(\dot{\theta}\right)$, and angular acceleration $\left(\ddot{\theta}\right)$ of the pendulum at a given time instant.

Our goal is to discover the governing equation of the pendulum. In general, $\ddot{\theta}$ could be a function of $\theta, \sin\theta, \dot{\theta}, \dot{\theta}^2$

(a) Calculate correlation matrix, scatter plots and any other related metrics to qualitatively propose possible hypotheses and create the hypotheses space.

(b) Using linear or nonlinear regression with ridge regularization find appropriate parameters.

(c) Use cross validation to finalize your hypothesis.

Submission:

1. Report (maximum 5 pages): .docx (or .tex) file that includes (a) problem statement and solution procedure (~ 1 page), (b) plots, (d) results and discussion, (e) conclusion
2. Computer program