Intelligent Control – Interactive Session on Locally Weighted Regression

February 14, 2018

Problem 1:

Consider a pendulum with the equation of motion:

$$\frac{ml^2\ddot{\theta}}{3} + \frac{mgl\cos\theta}{2} = \tau$$

where m is the mass of the pendulum, l is the length, θ is the angle from horizontal, and τ is the torque applied at the base of the pendulum. We are going to do locally-weighted regression with the local model:

$$y = w_0 + w_1 q + w_2 \dot{q} + w_3 \ddot{q}.$$

(a) Get data. Load the file "pendulumdata.mat" into your Matlab workspace. It contains vectors of joint positions, velocities, and accelerations along with torques sampled from the motion of a single pendulum. Look at the minimum and maximum values of each input varable to choose the diagonal elements m_j in the Euclidean distance metric matrix M.

(b) functions. Write matlab functions for the distance and a Gaussian kernal. The inputs to the Gaussian kernel should be the bandwidth hyperparameter h, and the distance d.

(c) initial try. Pick a value of h and do LWR using all the data for training. Use each training input as a query and predict the output for each training input. Compute the expected variance of the output at the query point.

(d) cross-validation. Write code to do leave-one-out cross validataion. Play with the value of h to get a smaller mean squared leave-one-out cross validation error.