Homework 4 - CSE 276C - Math for Robotics

Due: 21 November 2021

1. In robotics it is typical to have to recognize objects in the environment. We will here use the German Traffic Sign dataset for recognition of traffic signs. You can download the dataset from the link below.

   To reduce computational time, please use the file Train_subset.csv to read in the train set. Similarly, please use the file Test_subset.csv to read in the test set.

   https://www.kaggle.com/meowmeowmeowmeowmeow/gtsrb-german-traffic-sign

   Compute subspaces for the PCA and LDA methods. Provide illustration of the respective 1st and 2nd eigenvectors.

   Compute the recognition rates for the test set. Report

   - Correct classification
   - Incorrect classification

   Provide at least one suggestion for how you might improve performance of each method.

2. Consider a predator-prey dynamics such as the simple Lotka-Volterra model

$$\begin{aligned} \mathbf{x}' &= \mathbf{f}(\mathbf{x}) \\ \mathbf{x} &= \begin{pmatrix} x_1 \\ x_2 \end{pmatrix} = \begin{pmatrix} Prey\ polution \\ Predator\ population \end{pmatrix} \\ \mathbf{f}(\mathbf{x}) &= \begin{pmatrix} (b - px_2)x_1 \\ (rx_1 - d)x_2 \end{pmatrix} \end{aligned}$$

   Without predators, the prey population increases (exponentially) without bound, whereas without prey, the predator population diminishes (exponentially) to zero. The nonlinear interaction, with predators eating prey, tends to diminish the prey population and increase the predator population. Use your Runga-Kutta to solve this system, with the values b = p = r = d = 1, $x_1(0) = 0.3$, and $x_2(0) = 0.2$.

For all questions provide a description of the approach adopted, the associated code and a description of your results.