Machine Learning for Robotics SS 2017
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Exercise Sheet 5
May 18, 2017

Since 25th May is a public holiday there will be 2 exercise sheets for 1. June.

1 Clustering

You get data from a robot with wheels that is driven by an unknown controller and you should find out which behaviors the robots was doing.

The datafile `4Wheeled.log` contains some comments (lines with '#') and two columns, corresponding to the velocity and the rotational velocity of the robot.

1.1 Linkage-based clustering

(a) Perform a linkage-based clustering (use 'ward' or 'average' method)

(b) find a suitable number of clusters and perform a clustering

(c) visualize the clusters in the input space (consider plotting not every data point)

(d) visualize which behavior was active at which time for the time interval (12000,15000) together with the time trace of the velocities.

(e) Also try 'single' linkage (with every 5th data point). What do you observe.

1.2 Kmeans clustering

(a) Implement Loyd's algorithm for K-Means clustering.

(b) Perform a clustering of the `4Wheeled.log` data with different k. (use also k=8) (If your implementation is slow, then take only every 10th datapoint, my naive implementation takes about 15s for all data).

(c) do the same visualization as above

2 Dimensionality Reduction

The data from the wheeled robot is low-dimensional and easy to analyse. Now you get data from a more crazy robot, see Fig. 1, which is traveling in an arena from back and forth, see Video (see also course website). For those that are interested, the controller is described in [1].

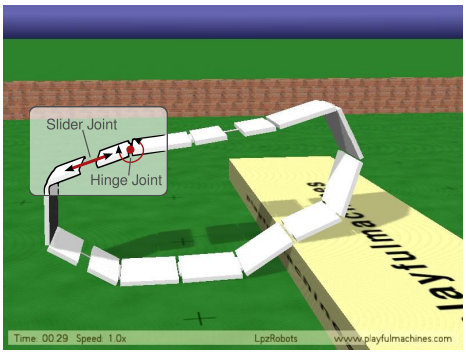

Figure 1: Armband robot

You get two datafiles with the following conversions: Lines starting with '#' are comments and the line starting with '#C' contains the labels for each column.

(a) `Sliderwheelie-pimax-env.x.log` contains the sensor readings which are the joint angles and slider positions. First column is the time, which is to be ignore. The remaining 18 columns contain the data.

(b) `Sliderwheelie-pimax-env.v2.log` contains the velocity of the robot in horizontal and vertical direction, which is something the robot has **no** access to in reality.

2.1 Principle Component Analysis

Implement PCA and apply it to the sensor data (file (a)).

(a) Visualize the original data by plotting some sensor readings agains others and also against time

(b) Visualize the data in its first two principle components. What do you find.

(c) Check how many PCA components you need to explain 80% of the variance.

(d) Also read the file (b) and check whether the compoments tell us something about the velocities. What do you observe and why do you think this is the case.

References

[1] R. Der and G. Martius. Novel plasticity rule can explain the development of sensorimotor intelligence. *Proceedings of the National Academy of Sciences*, 112(45):E6224–E6232, 2015.