**Principal Components Analysis**

For this set of analyses, you will use a data set contained in the file *“kinematicsData.mat.”* These data consist of the joint angles of an animal performing a reach-to­-grasp task. The animal is grasping a variety of different objects, which are to differing extents eliciting different joint trajectories.

Helpful functions: *pca*

The Matlab function “*pca*” can be used to reduce the dimensionality of the space of joint angles. Structure the data in such a way that it can be used with *pca*. Then, use *pca* to perform a principle components analysis, in which you will acquire the principal component coefficients, the representation of your trajectories in principal component space, and the eigenvalues for your principal components.

Normalize all of the eigenvalues and plot them in rank order. What percentage of the variance does the first PC explain? The first two PCs? The first three? How many PCs do you need to account for 90% of the variance in the kinematic data?

Helpful functions: *sort*

In order to visualize the principle components, generate two synthetic trajectories that consist of only the first and second PCs, respectively. This can be done by creating a sequence of multiples of the PCs, i.e. multiply the PC by x:d:y, and recombining with the mean. To find an appropriate range for scaling, use x = min(score) and y = max(score) for each PC, which will show the full range of motion seen in the data. Then, convert the synthetic trajectories to a .mot file and visualize the PCs using OpenSim (see README.txt for directions on how to do that). Describe what aspects of the joint trajectories are represented by each of the PCs.

Helpful functions: *repmat or bsxfun,*

Take the first trial from the data set and reconstruct the trajectory of wrist flexion angle (‘wr\_flexion\_1’) using reduced dimensionality: 1) the trajectory reconstruction using only the first PC, 2) the trajectory reconstruction using the first 2 PCs and 3) the reconstruction using the first 3 PCs, 4) the reconstruction using all the PCs. Compare each of these to the original trajectory in a new figure by plotting the measured trajectory and the three reconstructed trajectories of the selected joint angle.

Using the same sample trial, get the projection of the trajectory onto each of the first three principle components. In a single subplot, plot the trajectories of the first three principle components over time, using a different color for each PC. In an adjacent subplot, show the trajectory through 3-dimensional PC space. Inspect some of the less informative PCs. What do you notice about the amplitude and frequency content of their projections as they decrease in eigenvalue (and thus explain less of the variance of the set)?

Helpful functions: *subplot, plot3*