Learning Models of Human Motion

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In this project you will explore the use of time series models such as HMM, Linear system, and Switching linear system to model the dynamics of human motion. A small dataset of motions obtained through motion capture is provided. It consists of joint angle measurements from a human body model across a sequence of motion. You will need to preprocess this data and then explore the effect of different model choices. A minimum project would involve the application of HMM's and linear systems. A more advanced project would explore the use of SLDS models. The Extended Probabilistic Model Toolkit is provided, which contains routines for learning all of these model classes. You are free to use other Matlab toolboxes as well.

1. Preliminaries

Download the data and the EPMT toolkit and follow the instructions for compiling it under Matlab. An important preprocessing step is to apply PCA to the joint angle data to reduce the effective number of parameters. This makes sense since most motions to not utilize the full range of values that are possible and reduced representation will make learning more reliable. After projecting each data item down onto its PCA basis, cluster the resulting set. Explore the effect of number of PCA bases and number of clusters on the representation of the motion.

2. HMM and Linear System

Fit an HMM model to the data. What regimes in the motion has the HMM identified? Fit a single linear system to the data, by estimating the motion parameters in a linear state space model. Sample from both the HMM and the linear system model to synthesize new motions. How do these two approaches compare? What order of linear model gives the best results?

3. SLDS

Using the EPMT code, learn switching linear dynamic system models for the data. Explore issues of representation size and quality of fit, as in problem 2.