CS295-7 Homework #3

Due before class on Mar. 16

Goals

1. To familiarize you with particle filtering and test your understanding of recursive Bayesian estimation techniques.
2. To get you to implement a particle filter and to use it to successfully decode neural data.
3. To encourage you to experiment with different likelihoods and to understand the consequences of doing so.

The Assignment

Your task is to implement an SIS/Bootstrap particle filter (as described in either Arulampalam et al or Doucet et al, the two being largely equivalent) and use it to decode neural data. At the minimum you should implement and run the particle filter with a linear Gaussian (Kalman) likelihood and prior. You may also experiment with likelihoods similar to that described in the Brockwell et al paper. Use the same data you used in the first two homework assignments.

What to Hand In

A "lab report" and your code. Your report will be graded according to the rubric posted on the newsgroup. Your code will be checked for uniqueness and commenting. The report should *minimally* contain plots of reconstructed *x* and *y* position vs. actual direction and speed and an analysis of the decoding method. It should also contain a numerical analysis of your results including correlation coefficient and mean square error. It should also introduce, review, and discuss your particle filtering technique and how it worked (or why it didn't). Additionally, compare the results to your population vector and linear filtering results. Explain the differences and comment on why they exist. Explain the priors and likelihoods that you tried, even if you only implemented the linear Gaussian variety. Report relevant decoding results for all.

Extra Credit

1) How does the number of particles affect the decoding results? How does the innovation factor (proposal variance) affect the decoding results? Show plots of decoding accuracy vs. number of particles. Explain.

2) In the linear Gaussian likelihood you fit a covariance matrix. Try zeroing the non-diagonal elements of that covariance matrix. Providen an interpretation and examine how doing so affects decoding results?