Instructions

This homework is a check, and should be done individually. It is due in two weeks from handout, i.e. 28 April 2009. Submit by emailing a PDF to Alex.

Question 1: Tracking

We have a linear dynamical system with states $X_i$. In particular, $X_i$ is a normal random variable with mean $D X_{i-1}$ and covariance $\Sigma_d$. At each time step, there are two components to the measurement $Y_i$. The components are $Y_{i1}$ and $Y_{i2}$. One of these two components is a normal random variable with mean $M X_i$ and covariance $\Sigma_m$. The other is a normal random variable with mean 0 and covariance $\Sigma_n$. We do not know which of the components is informative. $P(X_1)$ is Gaussian.

**Part 1:** Show that, if $P(X_{i-1}|Y_1, ..., Y_{i-1})$ is a mixture of $k$ Gaussians, then $P(X_i|Y_1, ..., Y_{i-1})$ is a mixture of $k$ Gaussians.

**Part 2:** Show that, if $P(X_i|Y_1, ..., Y_i)$ is a mixture of $k$ Gaussians, then $P(X_i|Y_1, ..., Y_i, \text{first component of measurement is informative})$ is a mixture of $k$ Gaussians.

**Part 3:** Show that the posterior, $P(X_i|Y_1, ..., Y_i)$ is a mixture of Gaussians, with $2^i$ mixture components.

**Part 4:** We cannot use an exact representation of the posterior in this case, because there are two many components. Suggest a strategy for managing this problem.

Question 2: Finding Pedestrians

Read the paper “Histograms of Oriented Gradients for Human Detection” by Navneet Dalal and Bill Triggs (International Conference on Computer Vision & Pattern Recognition - June 2005), and prepare a brief (one page) evaluation and critique. What are the major strengths of the method? what are its major weaknesses? what should be done about them?

Question 3: Pictorial structures

In class, I described a method called pictorial structures, which is used to find the configuration of a person in an image given a model of appearance and of inter segment relations.

**Part 1:** What problems would result using this method for a lateral view of a person in a walking configuration where you can see both legs? (hint: one leg is usually better than the other). What can be done about this?

**Part 2:** Pictorial structure models preserve a tree of spatial relations between body components. Is this tree a sufficient representation? what other relations might exist between body parts? what might be the consequences of ignoring them?