Exercises Lecture 3

1. To recognize a person, we do not care about viewing angle and lighting conditions. Write down a generative model for this task and use it to explain how a Bayesian observer would have to infer a person's identity.
2. We have considered two different views of a perceptual observation: one is the "internal representation" of a stimulus. For example, if the true orientation of a line is 90°, then the internal representation might be 87°. The other view is the neural activity elicited by the stimulus, e.g. a population code in V1 representing the 90° line. How are these two views related? Is the population code more informative or not than the "internal representation"? Why?
3. Two objects are moving at unknown speeds. Denote speed by v and the noisy observations of the objects' speeds by x and y. Suppose the generative model, i.e. $p(x|v)$ and $p(y|v)$, as well as the prior distribution over speed, $p(v)$, are known. Using this knowledge, how does a Bayesian observer infer, based on x and y, whether the objects were moving at the same speed?
4. Find two visual illusions (other than the Ponzo and the horse/frog illusion, which were discussed in class). For each, draw a generative model to indicate the statistical dependencies between the variables. For each, use the generative model to write down a formal Bayesian model to explain the illusion. (The two illusions must have different generative models.)
5. A bar moving behind a circular aperture is generally perceived as moving in a direction perpendicular to its own orientation, even though its motion is consistent with a wide range of directions. Explain this in a Bayesian framework using a prior preference for low speeds.

Reading for Lecture 4:

M.O. Ernst and M.S. Banks (2002), Humans integrate visual and haptic information in a statistically optimal fashion, Nature 415, 429-33.

Another set of exercises will be given in Lecture 4. Both sets are due next Tuesday, March 31.