02458 Cognitive Modelling – Bayes Exercise 1

In this exercise we'll try and solve a perceptual problem using the Bayesian approach. The problem is to infer the 3-dimensional structure of a wireframe from a 2-dimensional projection image. The structure is called S and the image is called I. The Bayesian approach is to maximize the posterior probability P(S|I). For practical reasons we will minimize the negative logarithm of the posterior probability instead.

We'll use Matlab and the first thing you have to do is to get all the Matlab files that comes with the exercise and put them in your active directory.

Question 1

We'll first work with a cube. Open the Matlab function NeckerExercise.m. It is commented so try and read it to see what it does. It can almost solve the problem by numerically maximizing the posterior probability P(S|I). We use Matlab's optimization routine fminunc (*f*unction *min*imization *unc*onstrained). This routine calls the function NeckerError which is nested in the NeckerExercise function. The program is almost ready to run only the NeckerError function is not quite ready. All you have to do is specifying the negative logarithm of the posterior probability in the variable NegLogPost on line 77. Start with a uniform prior probability so that the posterior is simply the likelihood.

Inspect the figure visually. View it from different angles. Describe the solution you get. Is it a correct solution? Why (not)?

Now try using a prior. If you want you can use the calculation of the angles of the wireframe structure calculated in the variable Angels (a prior for right angles will work well for the cube). Inspect the figure visually. View it from different angles. Describe the solution you get. Is it a correct solution? Why (not)? Discuss whether it is realistic that the prior you used is the prior used by the visual system of the brain.

Question 2

Do the same thing with a hexagon cylinder to test whether the prior you came up with for the cube also works for a different structure. Open the Matlab function HexagonalExercise.m. It works just like NeckerExercise.m. Try a flat prior and try the prior you found in 5.1. Why doesn't it work? Can you come up with a prior that works? Is it a realistic model for how the brain works.

Question 3

Evolution gave us two eyes for a reason. So far you've solved the problem using only one eye. Now solve it using two. Do you still need the prior? Explain why/why not.