**WORKSHEET 1**

You will need SPM on the search path for some questions.

**INFERENCE**

Refresh your memory of Bayes rule. Using the *aneurysm.m* script investigate the following.

* Plot the posterior probability of aneurysm given (a) positive test result and (b) negative test result as a function of the prior probability of aneurysm (pA1) eg vary it from 0 to 1. Plot these curves.
* Where is the knee in the curve?
* How does the position of the knee change as you modify the sensitivity and specificity of the

test ?

**SENSOR FUSION**

Refresh your memory of Bayes rule for univariate Gaussians. Investiate sensor fusion with Gaussian priors and Gaussian likelihoods using the function *normal\_prior.m* or *bayes\_ug.m*. You can control the prior standard deviation, s0, and the prior mean, m0.

* Look in the function normal.prior.m. What is the standard deviation of the likelihood, s, and what is the mean of the likelihood, m ?
* What value do you have to set s0 to so that the posterior mean, m1, is half-way between the prior mean and likelihood mean ?
* Why is the posterior always peakier than either the likelihood or the prior ?

Refresh your memory of Bayes rule for multivariate Gaussians. Now use the function *bayes\_bg.m* to look at bivariate Gaussians.

* What happens if you change the prior precision of beta1 from 1 to 0.3 ?
* And if you also do this for beta2 ?
* Which variable, beta1 or beta2, is most affected if you make the priors ten times as precise (wrt initial values of 1) ? Why is this ?
* Try setting the prior to be positively correlated and the likelihood negatively correlated. You should be able to find a setting such that eg. the posterior mean for beta2 is bigger than either the prior mean for beta2 or the likelihood for beta2. Is this counter-intuitive or can you provide a good explanation ?

AN EXAMPLE: sigm0\_inv=[2 -1; -1 1]; sigmad\_inv=[5 2; 2 1];

**LINEAR MODELS**

Refresh your memory of Bayesian Inference for linear models. We now consider a GLM with three columns in the design matrix. The first two describe potential hemodynamic responses to the presentation of images of faces, in an fMRI experiment. The third is a column on 1’s modelling mean activity in a region. Using the script *glm\_demo.m* investigate the following:

* Why are the Bayesian regression coefficients always smaller than the ML regression coefficients ?
* How is this affected by the prior variance (glm.pv) ?
* Edit the script to repeat the data generation and model fitting process. For each repetition compute the squared error between the true and estimated parameters. Which procedure estimates the parameters more accurately: Bayes or ML ?

Refresh your memory of Bayesian model comparison for linear models. Using the script *glm\_sample\_size.m* investigate the following:

* How many scans do we need to infer that this brain region is involved in face processing ?
* How does this depend on the true regression coefficients (effect sizes) ?
* How does this depend on the prior variance (glm.pv) ?
* How does this depend on the observation noise (glm.sigma) ?