**WORKSHEET 2**

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

**EMPIRICAL BAYES**

Refresh your memory of Empirical Bayes and the Global Shrinkage Prior example. Use the script *em1.m* to investigate the following:

* Hit a key to see further EM iterations. Are the errors in estimating the effect sizes bigger at the beginning or end of optimsation ?
* How accurate are EM estimates compared to ML ?
* Re-run this with a new data set (from\_disk=0 at line 22). How is the accuracy of EM (versus ML) affected by the number of voxels (in the brain) and the number of data points at each voxel ?
* Why, for some voxels, are ML and EM estimates very similar ?
* Plot gamma(i) as a function of voxel i.What does this parameter mean ?

**NONLINEAR MODELS**

We’ll focus on the ‘approach to limit’ model in the subdirectory *lif*. Use the *lif\_time\_series.m* script to generate data from the model.

* The P vector contains the two model parameters. What is the effect of changing P(1) and of P(2) ? You can also add more observation noise by increasing sigma\_e.

Let’s look at the model prior and likelihood. Use the script *lif\_surface.m* to investigate the following:

* You’ll see that with the default parameters the posterior is very similar to the likelihood. How much do you need to change the prior variances by to make the prior have a visible effect ?
* What does this tell you about the problem ? and how is this affected by increasing the observation noise ?

We’ll now focus on model estimation using the script *lif\_vl.m*. Investigate the following:

* Run the script a number of times. Initial estimates M.P (drawn as x) are drawn from the prior so should be different on each run. The Variational Laplace (VL) algorithm should converge on every run.
* Set M.P by hand to points near and far from the true value. Does it still converge ?
* Why are some steps bigger than others ?
* VL uses a prior over the observation noise precision. This is set using M.hE and M.hC. These are the mean and variance of the log precision. Generate samples of the precision from this prior using spm\_normrnd.m
* How does changing M.hE and M.hC affect the convergence of VL ? Why is this ?

Mini project: Write your own script to generate data from the function y=alpha\*exp(-(t-t0)/tau)+e with known alpha and tau parameters. Write a script to estimate these parameters using VL.