ORIE 678 — D. Ruppert
R2WinBUGS example: multivariate normal with unknown mean and covariance matrix

R program:

```
library(R2WinBUGS)
library(MASS)  # need to mvrnorm
library(MCMCpack) # need for rwish

# Generate synthetic data
N = 500
S = matrix(c(1,.2,.2,5),nrow=2)
y = mvrnorm(N,c(1,3),S)

# Set up for WinBUGS
mu0 = as.vector(c(0,0))
S2 = matrix(c(1,0,0,1),nrow=2)/1000
S3 =  matrix(c(1,0,0,1),nrow=2)/10000
data=list("y","N","S2","S3","mu0")
inits=function(){list( mu=mvrnorm(1,mu0,matrix(c(10,0,0,10),nrow=2) ),
tau = rwish(3,matrix(c(.02,0,0,.04),nrow=2)) )}

# Run WinBUGS
multi_norm.sim = bugs(data,inits,model.file="mult_normal.bug",
parameters=c("mu","tau","Sigma"),n.chains = 2,n.iter=4010,n.burnin=10,n.thin=1,
bugs.directory="c:/Program Files/WinBUGS14/",codaPkg=FALSE)

print(multi_norm.sim,digits=3)
```

Bugs program:

```
model{
for(i in 1:N)
{
y[i,1:2] ~ dmnorm(mu[],tau[,])
}
mu[1:2] ~ dmnorm(mu0[],S2[,])
tau[1:2,1:2] ~  dwish(S3[,],3)
Sigma[1:2,1:2] <- inverse(tau[,])
}
```

Output:

```
Inference for Bugs model at "mult_normal.bug", fit using winbugs,
 2 chains, each with 4010 iterations (first 10 discarded)
 n.sims = 8000 iterations saved
              mean    sd     2.5%      25%      50%      75%    97.5%  Rhat
mu[1]         0.928 0.044    0.841    0.897    0.928    0.958    1.015 1.001
mu[2]         2.851 0.098    2.662    2.784    2.849    2.917    3.044 1.001
tau[1,1]      1.036 0.066    0.910    0.991    1.034    1.079    1.172 1.001
tau[1,2]     -0.042 0.021   -0.083   -0.056   -0.042   -0.028   -0.002 1.001
tau[2,1]     -0.042 0.021   -0.083   -0.056   -0.042   -0.028   -0.002 1.001
tau[2,2]      0.210 0.013    0.185    0.201    0.210    0.219    0.237 1.002
Sigma[1,1]    0.979 0.063    0.863    0.936    0.977    1.019    1.111 1.001
Sigma[1,2]    0.196 0.097    0.008    0.132    0.196    0.259    0.390 1.001
Sigma[2,1]    0.196 0.097    0.008    0.132    0.196    0.259    0.390 1.001
Sigma[2,2]    4.833 0.303    4.268    4.622    4.823    5.030    5.475 1.002
deviance   3613.562 3.200 3609.000 3611.000 3613.000 3615.000 3622.000 1.001
           n.eff
mu[1]       6200
mu[2]       5600
tau[1,1]    4900
tau[1,2]    8000
tau[2,1]    8000
tau[2,2]    1900
Sigma[1,1]  4500
Sigma[1,2]  8000
Sigma[2,1]  8000
Sigma[2,2]  1800
deviance    8000

For each parameter, n.eff is a crude measure of effective sample size,
and Rhat is the potential scale reduction factor (at convergence, Rhat=1).

pD = 5.0 and DIC = 3618.5 (using the rule, pD = Dbar-Dhat)
DIC is an estimate of expected predictive error (lower deviance is better).
```