setwd("C:/R files BHMRA")

require(rube)

require(mcmcse)

options(scipen=999)

Sys.setenv(BUGSDIR="c:\\users\\p congdon\\documents\\WINBUGS14")

attach("DS\_10\_12.Rdata")

**# MODEL 1**

model1= "model {# age effects for eta[1:X] (first order random walk)

wage[1] <- 1; adjage[1] <- 2; nage[1] <- 1

wage[(X-2)\*2 + 2] <- 1; adjage[(X-2)\*2 + 2] <- X-1; nage[X] <- 1

for (x in 2:X-1) {wage[2+(x-2)\*2] <- 1; adjage[2+(x-2)\*2] <- x-1

wage[3+(x-2)\*2] <- 1; adjage[3+(x-2)\*2] <- x+1; nage[x] <- 2}

eta[1:X] ~ car.normal(adjage[], wage[], nage[], tau[1])

# Area effects

for (i in 1:N) {r.c[i] <- r[i]-kappa

step.r[i] <- step(r[i]-kappa)}

for (i in 1:NN) {r.neigh[i] <- r[adj[i]]-kappa}

for (i in 1:NM2) {r[i] ~ dnorm(R[i],taur[i])

R[i] <- kappa+lam\*sum(r.neigh[cum[i]+1:cum[i+1] ])/(1-lam+lam\*D[i])

taur[i] <- tau[2]\*(1-lam+lam\*D[i])}

for (i in NM1:N) {r[i] ~ dnorm(kappa,tau[2])}

# Likelihood

for (i in 1:n) { for (t in 1:T) {d[i,t]~dbin(mu[i,t],p[i,t]);

logit(mu[i,t]) <- u[state[i],t,age[i]]

pmd[i,t] <- p[i,t]-d[i,t]

LL[i,t] <- logfact(p[i,t])-logfact(d[i,t])-logfact(pmd[i,t])+

d[i,t]\*log(mu[i,t])+(p[i,t]-d[i,t])\*log(1-mu[i,t])

log(L[i,t]) <- LL[i,t]}}

# Effect by areas (states) i, times t, ages x

for (i in 1:N) { for (t in 1:T) {for (x in 1:X) { u[i,t,x] ~ dnorm(U[i,t,x],tau[4])

U[i,t,x] <- r[i]+eta[x]+(rho1[x]+rho2[i])\*(t-8.5)}}}

# Priors

kappa~ dnorm(0,0.0001)

lam ~ dunif(0,1)

**# Linear slopes by age (rho1) and area (rho2)**

for (x in 1:X) {rho1[x] ~ dnorm(0,0.01)}

for (i in 1:N) {rho2[i] ~ dnorm(0,tau[3])}

for (k in 1:4) {tau[k] ~ dgamma(1,0.01)

sig[k] <- 1/sqrt(tau[k])}

Dv <- -2\*sum(LL[,]) }

"

**# initial values and estimation**

u0 <- array(0, dim=c(51,16,13)); r0 <- rep(0,51)

init1 <- list(tau=rep(10,4),lam=0.5,kappa=-6,rho1=rep(0,13),r=r0,rho2=r0,eta=rep(0,13),u=u0)

init2 <- list(tau=rep(100,4),lam=0.6,kappa=-5.5,rho1=rep(0,13),r=r0,rho2=r0,eta=rep(0,13),u=u0)

init <- list(init1,init2)

r = rube(model1, DS\_10\_12, init)

summary(r)

pars <- list("sig","kappa","lam","rho1","rho2","r.c","eta","Dv")

r1.c = rube(model1, DS\_10\_12, init, pars, n.burn=200, n.thin=2, n.chains=2,n.iter=2000)

summary(r)

# estimate WAIC

pars <- list("LL")

r1.r = rube(model1, DS\_10\_12, init, pars, n.burn=200, n.thin=2, n.chains=2,n.iter=2000)

# 10608 total observations (13 ages, 51 states, 16 years)

c1 <- c2 <- numeric(10608)

for (i in 1:10608) {c1[i] <- log(mean(r1.r$sims.array[,,i])); c2[i] <- sd(r1.r$sims.array[,,i+10608])^2}

WAIC <- -2\*(sum(c1)-sum(c2))

**# MODEL 2**

model2 = "model {# age effects for eta[1:X] (first order random walk)

wage[1] <- 1; adjage[1] <- 2; nage[1] <- 1

wage[(X-2)\*2 + 2] <- 1; adjage[(X-2)\*2 + 2] <- X-1; nage[X] <- 1

for (x in 2:X-1) {wage[2+(x-2)\*2] <- 1; adjage[2+(x-2)\*2] <- x-1

wage[3+(x-2)\*2] <- 1; adjage[3+(x-2)\*2] <- x+1; nage[x] <- 2}

eta[1:X] ~ car.normal(adjage[], wage[], nage[], tau[1])

# Area effects

for (i in 1:N) {r.c[i] <- r[i]-kappa

step.r[i] <- step(r[i]-kappa)}

for (i in 1:NN) {r.neigh[i] <- r[adj[i]]-kappa}

for (i in 1:NM2) {r[i] ~ dnorm(R[i],taur[i]);

R[i] <- kappa+lam\*sum(r.neigh[cum[i]+1:cum[i+1] ])/(1-lam+lam\*D[i])

taur[i] <- tau[2]\*(1-lam+lam\*D[i])}

for (i in NM1:N) {r[i] ~ dnorm(kappa,tau[2])}

# Likelihood

for (i in 1:n) { for (t in 1:T) {d[i,t]~dbin(mu[i,t],p[i,t]);

logit(mu[i,t]) <- u[state[i],t,age[i]]

pmd[i,t] <- p[i,t]-d[i,t]

LL[i,t] <- logfact(p[i,t])-logfact(d[i,t])-logfact(pmd[i,t])+d[i,t]\*log(mu[i,t])+(p[i,t]-d[i,t])\*log(1-mu[i,t])}}

# Effects for areas i, times t, ages x

for (i in 1:N) { for (t in 1:T) {for (x in 1:X) { u[i,t,x] ~ dnorm(U[i,t,x],tau[4])

U[i,t,x] <- r[i]+eta[x]+rho[i,x]\*(t-8.5)}}}

# Priors

kappa~ dnorm(0,0.0001); lam ~ dunif(0,1)

for (x in 1:X) {rho.x[x] <- mean(rho[,x]); for (i in 1:N) {rho[i,x] ~ dnorm(0,tau[3])}}

for (k in 1:4) {tau[k] ~ dgamma(1,0.01); sig[k] <- 1/sqrt(tau[k])}

Dv <- -2\*sum(LL[,]) }

"

**# initial values and estimation**

u0 <- array(0, dim=c(51,16,13)); rho0 <- matrix(0,51,13)

init1 <- list(tau=rep(10,4),lam=0.5,kappa=-6,r=rep(0,51),rho=rho0,eta=rep(0,13),u=u0)

init2 <- list(tau=rep(100,4),lam=0.6,kappa=-5.5,r=rep(0,51),rho=rho0,eta=rep(0,13),u=u0)

init <- list(init1,init2)

r2.c = rube(model2, DS\_10\_12, init); summary(r)

pars <- list("sig","kappa","lam","rho.x","r.c","eta","Dv")

r2.r = rube(model2, DS\_10\_12, init, pars, n.burn=100, n.thin=2, n.chains=2,n.iter=2000)

summary(r2.r,limit=51)

# multivariate effective sample size

multiESS(as.data.frame(r$sims.array))