**# Example 6.7 Earthquake Magnitudes (Kernel Model)**

library(raster) # for operations with rasters

require(jagsUI)

library(ggplot2)

setwd("C:/R files BHMRA")

**# earthquake locations (with magnitude)**

quake <- read.table("DS\_6\_6.txt",header=T)

N=nrow(quake)

nsamp=round(N/10)

quake = quake[sample(1:N, nsamp,replace=F),]

quake.coord <- list(x= quake$Lon,y= quake$Lat)

**# Plot of earthquake locations**

par(mai=c(0.5,0.4,0.4,0.1))

plot(quake.coord, cex=0.1, main=NULL)

D=data.frame(x=quake$Lon,y= quake$Lat,Magnitude=quake$magnitude)

plot=ggplot(D,aes(x=x,y=y,color=Magnitude)) + geom\_point(size=0.05) +labs(x="Longitude",y = "Latitude")

plot + guides(color = guide\_legend(override.aes = list(size=5)))

**# define raster grid**

ext <- extent(-31, 46, 33, 74) # raster extent (based on min and max actual coordinates)

nrow=10; ncol=10

raster.def <- raster(ext, nrow=nrow, ncol=ncol)

xycoords <- data.frame(x = quake.coord$x, y = quake.coord$y)

**# raster cell counts**

rst <- rasterize(xycoords, raster.def, fun = "count")

**# Edge list**

rst.adj <- adjacent(rst, 1:ncell(rst), directions=4, pairs=T)

**# raster counts (replace NA counts, empty cells, by 0)**

rst[is.na(rst)] <- 0

rast.count <- extract(rst, 1:ncell(rst))

**# raster cell coordinates**

rast.coord <- xyFromCell(rst,1:ncell(rst))

coord=as.data.frame(rast.coord)

**#**

**# Single Intercept**

**#**

D <- list(n=nrow(quake),m=nrow(coord),t1=coord$x, t2=coord$y,y=quake$magnitude,

x1= quake$Lon, x2= quake$Lat)

cat("model { for (i in 1:n) { y[i] ~ dnorm(mu[i],1/sd^2)

mu[i] <- beta0+sum(Kw[i,])

# site effects

A[i] <- sum(Kw[i,])

s[i] <- A[i]-mean(A[])

for (j in 1:m) { d1[i,j] <- pow(x1[i]-t1[j],2)

d2[i,j] <-pow(x2[i]-t2[j],2)

# Kernel

K[i,j] <- (1/6.28) \*exp(-sqrt(d1[i,j]+d2[i,j]))

Kw[i,j] <- K[i,j]\*w[j]}}

# priors

beta0 ~ dnorm(0,0.001)

for (j in 1:m) {w[j] ~ dnorm(0,1/sd.w^2)}

sd.w ~ dunif(0,100)

sd ~ dunif(0,100)

for (i in 1 : n) { # probs of extreme values of s

ext.s[i] <- step(s[i])}}

", file="convol.jag")

inits1 <- list(beta0=4,sd.w=1,sd=1)

inits2 <- list(beta0=4.5,sd.w=2,sd=2)

inits=list(inits1,inits2)

pars <- c("beta0","sd.w","sd","mu","ext.s")

R <- autojags(D, inits, pars,model.file="convol.jag",2,iter.increment=200, n.burnin=100,Rhat.limit=1.1, max.iter=1000, seed=1234, codaOnly= c('mu','ext.s'))

mu.samps <- as.matrix(R$sims.list$mu)

mu.mean=apply(mu.samps,2,mean)

cor(D$y,mu.mean)

**#**

**# Intercept Mixture**

**#**

D <- list(n=nrow(quake),m=nrow(coord),t1=coord$x, t2=coord$y,y=quake$magnitude,

x1= quake$Lon, x2= quake$Lat,pi=c(0.95,0.05))

cat("model { for (i in 1:n) { y[i] ~ dnorm(mu[i],1/sd^2)

mu[i] <- beta0.s[G[i]]+sum(Kw[i,])

G[i] ~ dcat(pi[1:2])

# site effects

s[i] <- mu[i]-mean(mu[])

for (j in 1:m) { d1[i,j] <- pow(x1[i]-t1[j],2)

d2[i,j] <-pow(x2[i]-t2[j],2)

# Kernel

K[i,j] <- (1/6.28) \*exp(-sqrt(d1[i,j]+d2[i,j]))

Kw[i,j] <- K[i,j]\*w[j]}}

# priors

for (j in 1:2) { beta0[j] ~ dnorm(0,0.01)}

beta0.s <- sort(beta0)

for (j in 1:m) {w[j] ~ dnorm(0,1/sd.w^2)}

sd.w ~ dunif(0,100)

sd ~ dunif(0,100)

for (i in 1 : n) { # indicators of extreme site effects

ext.s[i] <- step(s[i])}}

", file="convolmx.jag")

inits1 <- list(beta0=c(4,4),sd.w=1,sd=1)

inits2 <- list(beta0=c(4.5,4.5),sd.w=2,sd=2)

inits=list(inits1,inits2)

pars <- c("beta0.s","sd.w","sd","mu","ext.s")

R <- autojags(D, inits, pars,model.file="convolmx.jag",2,iter.increment=200, n.burnin=100,Rhat.limit=1.1, max.iter=1000, seed=1234, codaOnly= c('mu','ext.s'))

**# Summary of Estimates**

R$summary

**# Assess fit**

mu.samps <- as.matrix(R$sims.list$mu)

mu.mean=apply(mu.samps,2,mean)

cor(D$y,mu.mean)

**# significance of site magnitude effects**

ext.s.samps <- as.matrix(R$sims.list$ext.s)

ext.s.mean=apply(ext.s.samps,2,mean)

sum(ext.s.mean<0.05)+ sum(ext.s.mean>0.95)

**# plot out significance categories for site magnitude effects**

sig.s=1+ifelse(ext.s.mean<0.05,1,0)+ifelse(ext.s.mean>0.95,2,0)

sig.s=factor(sig.s,levels = c(1,2,3),labels = c("0.05-0.95", "Under 0.05", "Over 0.95"))

palette(c("blue","pink","green"))

plot(x=quake$Lon,y= quake$Lat, col=sig.s, pch=19,xlab="Longitude",ylab = "Latitude",

main="Figure 6.6 Significance of Site Effects")

legend(24, 73, legend=c("0.05-0.95", "Under 0.05", "Over 0.95"),col=c("blue", "pink","green") ,

title="Significance Group",lty=1:2, cex=1.2,pch=1,lwd=3)

palette(c("gray90","gray65","black"))

plot(x=quake$Lon,y= quake$Lat, col=sig.s, pch=19,xlab="Longitude",ylab = "Latitude",

main="Figure 6.6 Significance of Site Effects")

legend(24, 73, legend=c("0.05-0.95", "Under 0.05", "Over 0.95"), title="Significance Group",col=c("gray90", "gray65","black"),cex=1.2,pch=1,lwd=3)