

```

#Model 1
model
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]

eta1[j,i,1]<-(b0[i]+(b[1,i]*B1[j]+b[2,i]*B2[j]+b[3,i]*B3[j]+b[4,i]*B4[j]))*delta[j]+a1[1]*B1[j]+a1[2]*
B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+b1[i]

eta2[j,i,2]<-(b0[i]+(b[1,i]*B1[j]+b[2,i]*B2[j]+b[3,i]*B3[j]+b[4,i]*B4[j]))/delta[j]+a2[1]*B1[j]+a2[2]*
B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+b2[i]+beta[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

  # Spatial priors
  b[1:4,1:N]~ mv.car(adj[],weights[],num[],omega[,])
  omega[1:4,1:4]~ dwish(R[,],4)
  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)
  }

  # other priors ,such as the intercepts,fixed effects,relative weight and variances
  alpha[1]~dnorm(0.0,100)
  OR.alpha[1]<-exp(alpha[1])
  alpha[2]~dnorm(0.0,1000)
  OR.alpha[2]<-exp(alpha[2])

  sigma2.beta<-1/tau.beta

  tau.beta~dgamma(5,0.0005)

  for (P in 1:4){
    a1[P]~dnorm(0.0,100)
    OR.a1[P]<-exp(a1[P])
    a2[P]~dnorm(0.0,1000)
    OR.a2[P]<-exp(a2[P])
  }
}

```

```

    }
    for( i in 1:N) {
      b0[i] ~ dnorm(0.0,100)
      OR.b0[i]<-exp(b0[i])
      b1[i] ~ dnorm(0.0,100)
      OR.b1[i]<-exp(b1[i])
      b2[i] ~ dnorm(0.0,1000)
      OR.b2[i]<-exp(b2[i])
    }

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
  logdelta[j]~ dnorm(0.0,100)
  delta[j]<-exp(logdelta[j])
  #ratio(relative risk of disease 1 associated with shared component ) to disease 2
  associated with shared component
  OORatio[j]<-pow(delta[j],2)
}

#ouput
for (i in 1:N){
  OR.beta1[i]<-exp(beta[1,i])
  OR.beta2[i]<-exp(beta[2,i])
  OR.beta3[i]<-exp(beta[3,i])
  OR.beta4[i]<-exp(beta[4,i])
  OR.beta5[i]<-exp(beta[5,i])
  OR.beta6[i]<-exp(beta[6,i])
  OR.beta7[i]<-exp(beta[7,i])
  OR.beta8[i]<-exp(beta[8,i])

OR11[i]<-exp( (b0[i]+(b[1,i]*B1[1]+b[2,i]*B2[1]+b[3,i]*B3[1]+b[4,i]*B4[1]))*delta[1]+a1[1]*B1[1]+
a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+b1[i])

OR12[i]<-exp( (b0[i]+(b[1,i]*B1[2]+b[2,i]*B2[2]+b[3,i]*B3[2]+b[4,i]*B4[2]))*delta[2]+a1[1]*B1[2]+
a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+b1[i])

OR13[i]<-exp( (b0[i]+(b[1,i]*B1[3]+b[2,i]*B2[3]+b[3,i]*B3[3]+b[4,i]*B4[3]))*delta[3]+a1[1]*B1[3]+
a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+b1[i])

OR14[i]<-exp( (b0[i]+(b[1,i]*B1[4]+b[2,i]*B2[4]+b[3,i]*B3[4]+b[4,i]*B4[4]))*delta[4]+a1[1]*B1[4]+
a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+b1[i])

OR15[i]<-exp( (b0[i]+(b[1,i]*B1[5]+b[2,i]*B2[5]+b[3,i]*B3[5]+b[4,i]*B4[5]))*delta[5]+a1[1]*B1[5]+
a1[2]*B2[5]+a1[3]*B3[5]+a1[4]*B4[5]+b1[i])

```

```
OR16[i]<-exp( (b0[i]+(b[1,i]*B1[6]+b[2,i]*B2[6]+b[3,i]*B3[6]+b[4,i]*B4[6]))*delta[6]+a1[1]*B1[6]+
a1[2]*B2[6]+a1[3]*B3[6]+a1[4]*B4[6]+b1[i])
```

```
OR17[i]<-exp( (b0[i]+(b[1,i]*B1[7]+b[2,i]*B2[7]+b[3,i]*B3[7]+b[4,i]*B4[7]))*delta[7]+a1[1]*B1[7]+
a1[2]*B2[7]+a1[3]*B3[7]+a1[4]*B4[7]+b1[i])
```

```
OR18[i]<-exp( (b0[i]+(b[1,i]*B1[8]+b[2,i]*B2[8]+b[3,i]*B3[8]+b[4,i]*B4[8]))*delta[8]+a1[1]*B1[8]+
a1[2]*B2[8]+a1[3]*B3[8]+a1[4]*B4[8]+b1[i])
```

```
OR21[i]<-exp( (b0[i]+(b[1,i]*B1[1]+b[2,i]*B2[1]+b[3,i]*B3[1]+b[4,i]*B4[1]))/delta[1]+a2[1]*B1[1]+
a2[2]*B2[1]+a2[3]*B3[1]+a2[4]*B4[1]+b2[i]+beta[1,i])
```

```
OR22[i]<-exp( (b0[i]+(b[1,i]*B1[2]+b[2,i]*B2[2]+b[3,i]*B3[2]+b[4,i]*B4[2]))/delta[2]+a2[1]*B1[2]+
a2[2]*B2[2]+a2[3]*B3[2]+a2[4]*B4[2]+b2[i]+beta[2,i])
```

```
OR23[i]<-exp( (b0[i]+(b[1,i]*B1[3]+b[2,i]*B2[3]+b[3,i]*B3[3]+b[4,i]*B4[3]))/delta[3]+a2[1]*B1[3]+
a2[2]*B2[3]+a2[3]*B3[3]+a2[4]*B4[3]+b2[i]+beta[3,i])
```

```
OR24[i]<-exp( (b0[i]+(b[1,i]*B1[4]+b[2,i]*B2[4]+b[3,i]*B3[4]+b[4,i]*B4[4]))/delta[4]+a2[1]*B1[4]+
a2[2]*B2[4]+a2[3]*B3[4]+a2[4]*B4[4]+b2[i]+beta[4,i])
```

```
OR25[i]<-exp( (b0[i]+(b[1,i]*B1[5]+b[2,i]*B2[5]+b[3,i]*B3[5]+b[4,i]*B4[5]))/delta[5]+a2[1]*B1[5]+
a2[2]*B2[5]+a2[3]*B3[5]+a2[4]*B4[5]+b2[i]+beta[5,i])
```

```
OR26[i]<-exp( (b0[i]+(b[1,i]*B1[6]+b[2,i]*B2[6]+b[3,i]*B3[6]+b[4,i]*B4[6]))/delta[6]+a2[1]*B1[6]+
a2[2]*B2[6]+a2[3]*B3[6]+a2[4]*B4[6]+b2[i]+beta[6,i])
```

```
OR27[i]<-exp( (b0[i]+(b[1,i]*B1[7]+b[2,i]*B2[7]+b[3,i]*B3[7]+b[4,i]*B4[7]))/delta[7]+a2[1]*B1[7]+
a2[2]*B2[7]+a2[3]*B3[7]+a2[4]*B4[7]+b2[i]+beta[7,i])
```

```
OR28[i]<-exp( (b0[i]+(b[1,i]*B1[8]+b[2,i]*B2[8]+b[3,i]*B3[8]+b[4,i]*B4[8]))/delta[8]+a2[1]*B1[8]+
a2[2]*B2[8]+a2[3]*B3[8]+a2[4]*B4[8]+b2[i]+beta[8,i])
```

```
}
```

```
}
```

```
# Data
```

```
list(M=8,N =7,
```

```
      O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,
90.67,97.74,93.63,85.18,109.08,119.29,101.42,
```

```

260.63,269.23,286.95,290.23,327.03,324.13,272.79,
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),

```

```

O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),

```

```

n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),

```

```

n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),

```

```

R=structure(.Data = c(1,0,0,0,0,1,0,0,0,1,0,0,0,0,1),.Dim = c(4,4)),

```

#with one knot at year 1997

```

B1= c(0.000,0.618,0.490,0.238,0.061,0.022,0.001,0.000),
B2= c(0.000,0.082,0.420,0.482,0.315,0.191,0.038,0.000),
B3= c(0.000,0.003,0.090,0.271,0.499,0.521,0.331,0.000),
B4= c(0.000,0.000,0.000,0.010,0.125,0.266,0.630,1.000),

```

```

num = c(2, 3, 2, 2, 2, 2, 1
),
adj = c(
7, 4,
6, 5, 3,
4, 2,
3, 1,
6, 2,
5, 2,
1
),
sumNumNeigh = 14)

```

```

#inits for 1997

```

```

list(alpha=c(-1,-0.5),a1=c(0.005,0.002,-1,-0.5),a2=c(0.005,0.002,1,1),tau.beta=10000,

```

```

omega=structure(.Data=c(5.5,1.5,-0.8,0.1,1.5,5.4,0.2,-0.8,-0.8,0.2,4.0,-2.0,0.1,-0.8,-2.0,8.2),.Dim
= c(4,4)))

```

```

inits2

```

```

list(alpha=c(-1.1,-0.04),a1=c(0.1,0.7,0.4,0.8),a2=c(1,1,-1,-1),tau.beta=9000,tau.beta1=9000,tau.be
ta2=9000,
      b0=c(1,1,1,1,1,1,1),          b1=c(-0.1,-0.1,-0.2,-0.15,-0.17,-0.17,-0.13),
b2=c(-0.3,-0.6,-0.6,-0.5,-1.0,-0.9,-0.8),

```

```

      omega=structure(.Data = c(1,0,0,0,0,1,0,0,0,0,1,0,0,0,0,1),.Dim = c(4,4)))

```

```

)

```

Model 2

model

```
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]
      eta1[j,i,1]<-b0[i]*delta[j]+a1[1]*B1[j]+a1[2]*B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+b1[i]

eta2[j,i,2]<-b0[i]/delta[j]+a2[1]*B1[j]+a2[2]*B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+b2[i]+beta[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

# Spatial priors

  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)

  }

# other priors ,such as the intercepts,fixed effects,relative weight and variances
  alpha[1]~ dnorm(0.0,100)
  OR.alpha[1]<-exp(alpha[1])
  alpha[2]~ dnorm(0.0,1000)
  OR.alpha[2]<-exp(alpha[2])

  sigma2.beta<-1/tau.beta

  tau.beta~dgamma(5,0.0005)

  for (P in 1:4){
    a1[P]~ dnorm(0.0,100)
    OR.a1[P]<-exp(a1[P])
    a2[P]~ dnorm(0.0,1000)
    OR.a2[P]<-exp(a2[P])
  }
  for( i in 1:N) {
    b0[i] ~ dnorm(0.0,100)
    OR.b0[i]<-exp(b0[i])
  }
}
```

```

        b1[i] ~ dnorm(0.0,100)
        OR.b1[i]<-exp(b1[i])
        b2[i] ~ dnorm(0.0,1000)
        OR.b2[i]<-exp(b2[i])

    }

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
    logdelta[j]~ dnorm(0.0,10)
    delta[j]<-exp(logdelta[j])
    #ratio(relative risk of disease 1 associated with shared component ) to disease 2
    #associated with shared component
    ORratio[j]<-pow(delta[j],2)
}

#output
for (i in 1:N){
    OR.beta1[i]<-exp(beta[1,i])
    OR.beta2[i]<-exp(beta[2,i])
    OR.beta3[i]<-exp(beta[3,i])
    OR.beta4[i]<-exp(beta[4,i])
    OR.beta5[i]<-exp(beta[5,i])
    OR.beta6[i]<-exp(beta[6,i])
    OR.beta7[i]<-exp(beta[7,i])
    OR.beta8[i]<-exp(beta[8,i])

    OR11[i]<-exp(b0[i]*delta[1]+a1[1]*B1[1]+a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+b1[i])
    OR12[i]<-exp(b0[i]*delta[2]+a1[1]*B1[2]+a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+b1[i])
    OR13[i]<-exp(b0[i]*delta[3]+a1[1]*B1[3]+a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+b1[i])
    OR14[i]<-exp(b0[i]*delta[4]+a1[1]*B1[4]+a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+b1[i])
    OR15[i]<-exp(b0[i]*delta[5]+a1[1]*B1[5]+a1[2]*B2[5]+a1[3]*B3[5]+a1[4]*B4[5]+b1[i])
    OR16[i]<-exp(b0[i]*delta[6]+a1[1]*B1[6]+a1[2]*B2[6]+a1[3]*B3[6]+a1[4]*B4[6]+b1[i])
    OR17[i]<-exp(b0[i]*delta[7]+a1[1]*B1[7]+a1[2]*B2[7]+a1[3]*B3[7]+a1[4]*B4[7]+b1[i])
    OR18[i]<-exp(b0[i]*delta[8]+a1[1]*B1[8]+a1[2]*B2[8]+a1[3]*B3[8]+a1[4]*B4[8]+b1[i])

    OR21[i]<-exp(b0[i]/delta[1]+a2[1]*B1[1]+a2[2]*B2[1]+a2[3]*B3[1]+a2[4]*B4[1]+b2[i]+beta[1,i])

    OR22[i]<-exp(b0[i]/delta[2]+a2[1]*B1[2]+a2[2]*B2[2]+a2[3]*B3[2]+a2[4]*B4[2]+b2[i]+beta[2,i])

    OR23[i]<-exp(b0[i]/delta[3]+a2[1]*B1[3]+a2[2]*B2[3]+a2[3]*B3[3]+a2[4]*B4[3]+b2[i]+beta[3,i])

    OR24[i]<-exp(b0[i]/delta[4]+a2[1]*B1[4]+a2[2]*B2[4]+a2[3]*B3[4]+a2[4]*B4[4]+b2[i]+beta[4,i])

```

```

OR25[i]<-exp(b0[i]/delta[5]+a2[1]*B1[5]+a2[2]*B2[5]+a2[3]*B3[5]+a2[4]*B4[5]+b2[i]+beta[5,i])

OR26[i]<-exp(b0[i]/delta[6]+a2[1]*B1[6]+a2[2]*B2[6]+a2[3]*B3[6]+a2[4]*B4[6]+b2[i]+beta[6,i])

OR27[i]<-exp(b0[i]/delta[7]+a2[1]*B1[7]+a2[2]*B2[7]+a2[3]*B3[7]+a2[4]*B4[7]+b2[i]+beta[7,i])

OR28[i]<-exp(b0[i]/delta[8]+a2[1]*B1[8]+a2[2]*B2[8]+a2[3]*B3[8]+a2[4]*B4[8]+b2[i]+beta[8,i])

}

```

```

}

# Data
list(M=8,N =7,
      O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,
90.67,97.74,93.63,85.18,109.08,119.29,101.42,
260.63,269.23,286.95,290.23,327.03,324.13,272.79,
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),

```

```

      O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),

```

```

      n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),

```

```

      n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,

```

```

593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),

```

```

#with one knot at year 1997

```

```

B1= c(0.000,0.618,0.490,0.238,0.061,0.022,0.001,0.000),
B2= c(0.000,0.082,0.420,0.482,0.315,0.191,0.038,0.000),
B3= c(0.000,0.003,0.090,0.271,0.499,0.521,0.331,0.000),
B4= c(0.000,0.000,0.000,0.010,0.125,0.266,0.630,1.000),

```

```

num = c(2, 3, 2, 2, 2, 2, 1

```

```

),

```

```

adj = c(

```

```

7, 4,

```

```

6, 5, 3,

```

```

4, 2,

```

```

3, 1,

```

```

6, 2,

```

```

5, 2,

```

```

1

```

```

),

```

```

sumNumNeigh = 14)

```

```

#inits

```

```

list(alpha=c(0.4,-7.7),a1=c(-8.4,2.5,-1.6,-0.5),a2=c(10.2,0.4,5.7,4.4),tau.beta=50,

```

```

      b0=c(3.2,3.0,3.2,3.1,3.0,3.1,3.0),

```

```

      b1=c(-3.2,-3.5,-3.7,-3.5,-3.7,-3.9,-3.8),

```

```

      b2=c(-0.3,-0.6,-0.6,-0.5,-1.0,-0.9,-0.8))

```

```

inits2

```

```

list(alpha=c(-0.4,7.7),a1=c(8.4,-2.5,1.6,0.5),a2=c(-10.2,-0.4,-5.7,-4.4),tau.beta=10,

```

```

      b0=c(-3.2,-3.0,-3.2,-3.1,-3.0,-3.1,-3.0),

```

```

      b1=c(3.2,3.5,3.7,3.5,3.7,3.9,3.8),

```

```

      b2=c(0.3,0.6,0.6,0.5,1.0,0.9,0.8))

```

### Model 3

```
model
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]

      eta1[j,i,1]<-(b0[i]+(b[1,i]*B1[j]+b[2,i]*B2[j]+b[3,i]*B3[j]+b[4,i]*B4[j]))*delta[j]+a1[1]*B1[j]+a1[2]*
      B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+b1[i]

      eta2[j,i,2]<-(b0[i]+(b[1,i]*B1[j]+b[2,i]*B2[j]+b[3,i]*B3[j]+b[4,i]*B4[j]))/delta[j]+a2[1]*B1[j]+a2[2]*
      B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+b2[i]+beta[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

  # Spatial priors
  b[1:4,1:N]~ mv.car(adj[],weights[],num[],omega[,])
  omega[1:4,1:4]~ dwish(R[,],4)

  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)
  }

  # other priors ,such as the intercepts,fixed effects,relative weight and variances
  alpha[1]~dnorm(0.0,100)
  OR.alpha[1]<-exp(alpha[1])
  alpha[2]~dnorm(0.0,1000)
  OR.alpha[2]<-exp(alpha[2])

  sigma2.beta<-1/tau.beta

  tau.beta~dgamma(5,0.0005)

  for (P in 1:4){
    a1[P]~dnorm(0.0,100)
    OR.a1[P]<-exp(a1[P])
  }
}
```

```

a2[P]~dnorm(0.0,1000)
OR.a2[P]<-exp(a2[P])
}
for( i in 1:N) {
  b0[i] ~ dnorm(0.0,100)
  OR.b0[i]<-exp(b0[i])
  b1[i] ~ dnorm(0.0,100)
  OR.b1[i]<-exp(b1[i])
  b2[i] ~ dnorm(0.0,1000)
  OR.b2[i]<-exp(b2[i])
}

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
  logdelta[j]~ dnorm(0.0,10)
  delta[j]<-exp(logdelta[j])
  #ratio(relative risk of disease 1 associated with shared component ) to disease 2
  #associated with shared component
  ORratio[j]<-pow(delta[j],2)
}

#output
for (i in 1:N){
  OR.beta1[i]<-exp(beta[1,i])
  OR.beta2[i]<-exp(beta[2,i])
  OR.beta3[i]<-exp(beta[3,i])
  OR.beta4[i]<-exp(beta[4,i])
  OR.beta5[i]<-exp(beta[5,i])
  OR.beta6[i]<-exp(beta[6,i])
  OR.beta7[i]<-exp(beta[7,i])
  OR.beta8[i]<-exp(beta[8,i])

  OR11[i]<-exp((b0[i]+(b[1,i]*B1[1]+b[2,i]*B2[1]+b[3,i]*B3[1]+b[4,i]*B4[1]))*delta[1]+a1[1]*B1[1]+
  a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+b1[i])

  OR12[i]<-exp( (b0[i]+(b[1,i]*B1[2]+b[2,i]*B2[2]+b[3,i]*B3[2]+b[4,i]*B4[2]))*delta[2]+a1[1]*B1[2]+
  a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+b1[i])

  OR13[i]<-exp( (b0[i]+(b[1,i]*B1[3]+b[2,i]*B2[3]+b[3,i]*B3[3]+b[4,i]*B4[3]))*delta[3]+a1[1]*B1[3]+
  a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+b1[i])

  OR14[i]<-exp( (b0[i]+(b[1,i]*B1[4]+b[2,i]*B2[4]+b[3,i]*B3[4]+b[4,i]*B4[4]))*delta[4]+a1[1]*B1[4]+
  a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+b1[i])

```

OR15[i]<-exp( (b0[i]+(b[1,i]\*B1[5]+b[2,i]\*B2[5]+b[3,i]\*B3[5]+b[4,i]\*B4[5]))\*delta[5]+a1[1]\*B1[5]+  
a1[2]\*B2[5]+a1[3]\*B3[5]+a1[4]\*B4[5]+b1[i])

OR16[i]<-exp( (b0[i]+(b[1,i]\*B1[6]+b[2,i]\*B2[6]+b[3,i]\*B3[6]+b[4,i]\*B4[6]))\*delta[6]+a1[1]\*B1[6]+  
a1[2]\*B2[6]+a1[3]\*B3[6]+a1[4]\*B4[6]+b1[i])

OR17[i]<-exp( (b0[i]+(b[1,i]\*B1[7]+b[2,i]\*B2[7]+b[3,i]\*B3[7]+b[4,i]\*B4[7]))\*delta[7]+a1[1]\*B1[7]+  
a1[2]\*B2[7]+a1[3]\*B3[7]+a1[4]\*B4[7]+b1[i])

OR18[i]<-exp( (b0[i]+(b[1,i]\*B1[8]+b[2,i]\*B2[8]+b[3,i]\*B3[8]+b[4,i]\*B4[8]))\*delta[8]+a1[1]\*B1[8]+  
a1[2]\*B2[8]+a1[3]\*B3[8]+a1[4]\*B4[8]+b1[i])

OR21[i]<-exp( (b0[i]+(b[1,i]\*B1[1]+b[2,i]\*B2[1]+b[3,i]\*B3[1]+b[4,i]\*B4[1]))/delta[1]+a2[1]\*B1[1]+  
a2[2]\*B2[1]+a2[3]\*B3[1]+a2[4]\*B4[1]+b2[i]+beta[1,i])

OR22[i]<-exp( (b0[i]+(b[1,i]\*B1[2]+b[2,i]\*B2[2]+b[3,i]\*B3[2]+b[4,i]\*B4[2]))/delta[2]+a2[1]\*B1[2]+  
a2[2]\*B2[2]+a2[3]\*B3[2]+a2[4]\*B4[2]+b2[i]+beta[2,i])

OR23[i]<-exp( (b0[i]+(b[1,i]\*B1[3]+b[2,i]\*B2[3]+b[3,i]\*B3[3]+b[4,i]\*B4[3]))/delta[3]+a2[1]\*B1[3]+  
a2[2]\*B2[3]+a2[3]\*B3[3]+a2[4]\*B4[3]+b2[i]+beta[3,i])

OR24[i]<-exp( (b0[i]+(b[1,i]\*B1[4]+b[2,i]\*B2[4]+b[3,i]\*B3[4]+b[4,i]\*B4[4]))/delta[4]+a2[1]\*B1[4]+  
a2[2]\*B2[4]+a2[3]\*B3[4]+a2[4]\*B4[4]+b2[i]+beta[4,i])

OR25[i]<-exp( (b0[i]+(b[1,i]\*B1[5]+b[2,i]\*B2[5]+b[3,i]\*B3[5]+b[4,i]\*B4[5]))/delta[5]+a2[1]\*B1[5]+  
a2[2]\*B2[5]+a2[3]\*B3[5]+a2[4]\*B4[5]+b2[i]+beta[5,i])

OR26[i]<-exp( (b0[i]+(b[1,i]\*B1[6]+b[2,i]\*B2[6]+b[3,i]\*B3[6]+b[4,i]\*B4[6]))/delta[6]+a2[1]\*B1[6]+  
a2[2]\*B2[6]+a2[3]\*B3[6]+a2[4]\*B4[6]+b2[i]+beta[6,i])

OR27[i]<-exp( (b0[i]+(b[1,i]\*B1[7]+b[2,i]\*B2[7]+b[3,i]\*B3[7]+b[4,i]\*B4[7]))/delta[7]+a2[1]\*B1[7]+  
a2[2]\*B2[7]+a2[3]\*B3[7]+a2[4]\*B4[7]+b2[i]+beta[7,i])

OR28[i]<-exp( (b0[i]+(b[1,i]\*B1[8]+b[2,i]\*B2[8]+b[3,i]\*B3[8]+b[4,i]\*B4[8]))/delta[8]+a2[1]\*B1[8]+  
a2[2]\*B2[8]+a2[3]\*B3[8]+a2[4]\*B4[8]+b2[i]+beta[8,i])

}

}

# Data

list(M=8,N =7,

O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,

```

90.67,97.74,93.63,85.18,109.08,119.29,101.42,
260.63,269.23,286.95,290.23,327.03,324.13,272.79,
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),

```

```

O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),

```

```

n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),

```

```

n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),

```

```

R=structure(.Data = c(1,0,0,0,0,1,0,0,0,0,1,0,0,0,0,1),.Dim = c(4,4)),

```

```

#with one knot at year 2000

```

```

B1= c(0.000,0.470,0.556,0.303,0.078,0.028,0.002,0.000),
B2= c(0.000,0.057,0.347,0.495,0.371,0.232,0.048,0.000),
B3= c(0.000,0.002,0.060,0.203,0.503,0.577,0.403,0.000),
B4= c(0.000,0.000,0.000,0.000,0.048,0.162,0.548,1.000),

```

```

num = c(2, 3, 2, 2, 2, 2, 1
),
adj = c(
7, 4,
6, 5, 3,
4, 2,
3, 1,
6, 2,
5, 2,
1
),
sumNumNeigh = 14)
#inits for 2000
# list(alpha=c(0.4,-7.7),a1=c(-8.4,2.5,-1.6,-0.5),a2=c(10.2,0.4,5.7,4.4),tau.beta=50,
      b0=c(3.2,3.0,3.2,3.1,3.0,3.1,3.0),      b1=c(-3.2,-3.5,-3.7,-3.5,-3.7,-3.9,-3.8),
      b2=c(-0.3,-0.6,-0.6,-0.5,-1.0,-0.9,-0.8),
      omega=structure(.Data
c(6.8,1.7,-2.0,-0.8,1.7,4.6,0.6,-1.1,-2.0,0.6,3.5,-2.2,-0.8,-1.1,-2.2,7.5),.Dim = c(4,4)))

inits2
# list(alpha=c(-0.4,7.7),a1=c(8.4,-2.5,1.6,0.5),a2=c(-10.2,-0.4,-5.7,-4.4),tau.beta=10,
      b0=c(-3.2,-3.0,-3.2,-3.1,-3.0,-3.1,-3.0),      b1=c(3.2,3.5,3.7,3.5,3.7,3.9,3.8),
      b2=c(0.3,0.6,0.6,0.5,1.0,0.9,0.8),
      omega=structure(.Data = c(1,0,0,0,0,1,0,0,0,0,1,0,0,0,0,1),.Dim = c(4,4)))

```

#### Model 4

```
model
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]
      eta1[j,i,1]<-b0[i]*delta[j]+a1[1]*B1[j]+a1[2]*B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+b1[i]

eta2[j,i,2]<-b0[i]/delta[j]+a2[1]*B1[j]+a2[2]*B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+b2[i]+beta[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

  # Spatial priors

  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)

  }

  # other priors ,such as the intercepts,fixed effects,relative weight and variances
  alpha[1]~ dnorm(0.0,100)
  OR.alpha[1]<-exp(alpha[1])
  alpha[2]~ dnorm(0.0,1000)
  OR.alpha[2]<-exp(alpha[2])

  sigma2.beta<-1/tau.beta

  tau.beta~dgamma(5,0.0005)

  for (P in 1:4){
    a1[P]~ dnorm(0.0,100)
    OR.a1[P]<-exp(a1[P])
    a2[P]~ dnorm(0.0,1000)
    OR.a2[P]<-exp(a2[P])
  }
  for( i in 1:N) {
    b0[i] ~ dnorm(0.0,100)
```

```

        OR.b0[i]<-exp(b0[i])
        b1[i] ~ dnorm(0.0,100)
        OR.b1[i]<-exp(b1[i])
        b2[i] ~ dnorm(0.0,1000)
        OR.b2[i]<-exp(b2[i])

    }

    #scaling factor for relative strength of shared component for each disease
    for (j in 1:M){
        logdelta[j]~ dnorm(0.0,5.9)
        delta[j]<-exp(logdelta[j])

        #ratio(relative risk of disease 1 associated with shared component ) to disease 2
        #associated with shared component
        ORratio[j]<-pow(delta[j],2)
    }

#ouput
for (i in 1:N){
    OR.beta1[i]<-exp(beta[1,i])
    OR.beta2[i]<-exp(beta[2,i])
    OR.beta3[i]<-exp(beta[3,i])
    OR.beta4[i]<-exp(beta[4,i])
    OR.beta5[i]<-exp(beta[5,i])
    OR.beta6[i]<-exp(beta[6,i])
    OR.beta7[i]<-exp(beta[7,i])
    OR.beta8[i]<-exp(beta[8,i])

    OR11[i]<-exp(b0[i]*delta[1]+a1[1]*B1[1]+a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+b1[i])
    OR12[i]<-exp(b0[i]*delta[2]+a1[1]*B1[2]+a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+b1[i])
    OR13[i]<-exp(b0[i]*delta[3]+a1[1]*B1[3]+a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+b1[i])
    OR14[i]<-exp(b0[i]*delta[4]+a1[1]*B1[4]+a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+b1[i])
    OR15[i]<-exp(b0[i]*delta[5]+a1[1]*B1[5]+a1[2]*B2[5]+a1[3]*B3[5]+a1[4]*B4[5]+b1[i])
    OR16[i]<-exp(b0[i]*delta[6]+a1[1]*B1[6]+a1[2]*B2[6]+a1[3]*B3[6]+a1[4]*B4[6]+b1[i])
    OR17[i]<-exp(b0[i]*delta[7]+a1[1]*B1[7]+a1[2]*B2[7]+a1[3]*B3[7]+a1[4]*B4[7]+b1[i])
    OR18[i]<-exp(b0[i]*delta[8]+a1[1]*B1[8]+a1[2]*B2[8]+a1[3]*B3[8]+a1[4]*B4[8]+b1[i])

    OR21[i]<-exp(b0[i]/delta[1]+a2[1]*B1[1]+a2[2]*B2[1]+a2[3]*B3[1]+a2[4]*B4[1]+b2[i]+beta[1,i])

    OR22[i]<-exp(b0[i]/delta[2]+a2[1]*B1[2]+a2[2]*B2[2]+a2[3]*B3[2]+a2[4]*B4[2]+b2[i]+beta[2,i])

    OR23[i]<-exp(b0[i]/delta[3]+a2[1]*B1[3]+a2[2]*B2[3]+a2[3]*B3[3]+a2[4]*B4[3]+b2[i]+beta[3,i])

    OR24[i]<-exp(b0[i]/delta[4]+a2[1]*B1[4]+a2[2]*B2[4]+a2[3]*B3[4]+a2[4]*B4[4]+b2[i]+beta[4,i])

```

```
OR25[i]<-exp(b0[i]/delta[5]+a2[1]*B1[5]+a2[2]*B2[5]+a2[3]*B3[5]+a2[4]*B4[5]+b2[i]+beta[5,i])
```

```
OR26[i]<-exp(b0[i]/delta[6]+a2[1]*B1[6]+a2[2]*B2[6]+a2[3]*B3[6]+a2[4]*B4[6]+b2[i]+beta[6,i])
```

```
OR27[i]<-exp(b0[i]/delta[7]+a2[1]*B1[7]+a2[2]*B2[7]+a2[3]*B3[7]+a2[4]*B4[7]+b2[i]+beta[7,i])
```

```
OR28[i]<-exp(b0[i]/delta[8]+a2[1]*B1[8]+a2[2]*B2[8]+a2[3]*B3[8]+a2[4]*B4[8]+b2[i]+beta[8,i])
```

```
}
```

```
}
```

```
# Data
```

```
list(M=8,N =7,
```

```
  O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51  
90.67,97.74,93.63,85.18,109.08,119.29,101.42  
260.63,269.23,286.95,290.23,327.03,324.13,272.79  
137.51,139.75,130.87,130.86,150.21,155.2,149.59  
171.37,179.06,175.18,193.18,192.44,214.1,187.67  
174.42,184.09,161.06,175.28,183.91,202.62,178.61  
201.08,209.98,187.69,216.31,208.69,251.24,231.02  
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),
```

```
  O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81  
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40  
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83  
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20  
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80  
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22  
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62  
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),
```

```
  n1=structure(.Data=c(548,615,611,523,773,658,597,  
496,595,584,482,655,668,599,  
678,706,762,760,852,844,716,  
553,586,568,534,631,633,598,  
524,564,556,632,599,686,561,  
537,593,504,561,571,646,528,  
541,567,508,597,556,712,597,  
516,529,471,556,511,692,551),.Dim=c(8,7)),
```

```
  n2=structure(.Data=c(647,644,658,601,776,704,658,  
596,616,607,554,712,691,614,
```

```

702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),

```

```

#with one knot at year 2000

```

```

B1= c(0.000,0.470,0.556,0.303,0.078,0.028,0.002,0.000),
B2= c(0.000,0.057,0.347,0.495,0.371,0.232,0.048,0.000),
B3= c(0.000,0.002,0.060,0.203,0.503,0.577,0.403,0.000),
B4= c(0.000,0.000,0.000,0.000,0.048,0.162,0.548,1.000),

```

```

num = c(2, 3, 2, 2, 2, 2, 1

```

```

),

```

```

adj = c(

```

```

7, 4,

```

```

6, 5, 3,

```

```

4, 2,

```

```

3, 1,

```

```

6, 2,

```

```

5, 2,

```

```

1

```

```

),

```

```

sumNumNeigh = 14)

```

```

#inits

```

```

list(alpha=c(0.4,-7.7),a1=c(-8.4,2.5,-1.6,-0.5),a2=c(10.2,0.4,5.7,4.4),tau.beta=50,

```

```

      b0=c(3.2,3.0,3.2,3.1,3.0,3.1,3.0),

```

```

      b1=c(-3.2,-3.5,-3.7,-3.5,-3.7,-3.9,-3.8),

```

```

b2=c(-0.3,-0.6,-0.6,-0.5,-1.0,-0.9,-0.8))

```

```

inits2

```

```

list(alpha=c(-0.4,7.7),a1=c(8.4,-2.5,1.6,0.5),a2=c(-10.2,-0.4,-5.7,-4.4),tau.beta=10,

```

```

      b0=c(-3.2,-3.0,-3.2,-3.1,-3.0,-3.1,-3.0),

```

```

      b1=c(3.2,3.5,3.7,3.5,3.7,3.9,3.8),

```

```

b2=c(0.3,0.6,0.6,0.5,1.0,0.9,0.8))

```

Model 5 ( The final model)

```
model
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]

eta1[j,i,1]<-b0[i]*delta[j]+a1[1]*B1[j]+a1[2]*B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+a1[5]*B5[j]+b1[i]

eta2[j,i,2]<-b0[i]/delta[j]+a2[1]*B1[j]+a2[2]*B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+a2[5]*B5[j]+b2[i]+bet
a[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

# Spatial priors

  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)

  }

# other priors ,such as the intercepts,fixed effects,relative weight and variances
  alpha[1]~ dnorm(0.0,100)
  OR.alpha[1]<-exp(alpha[1])
  alpha[2]~ dnorm(0.0,1000)
  OR.alpha[2]<-exp(alpha[2])
  # prior 1
  sigma2.beta<-1/tau.beta
  tau.beta~dgamma(5,0.0005)
  #prior 2
  #sigma.beta~dunif(0,1)
  # tau.beta<-1/(sigma.beta*sigma.beta)
  #prior 3
  # sigma2.beta~dnorm(0.0,100)|l(0,)
  # tau.beta<-1/sigma2.beta
```

```

    for (P in 1:5){
      a1[P]~ dnorm(0.0,100)
      OR.a1[P]<-exp(a1[P])
      a2[P]~ dnorm(0.0,1000)
      OR.a2[P]<-exp(a2[P])
    }
  for( i in 1:N) {
    b0[i] ~ dnorm(0.0,100)
    OR.b0[i]<-exp(b0[i])
    b1[i] ~ dnorm(0.0,100)
    OR.b1[i]<-exp(b1[i])
    b2[i] ~ dnorm(0.0,1000)
    OR.b2[i]<-exp(b2[i])

  }

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
  logdelta[j]~ dnorm(0.0,10)
  delta[j]<-exp(logdelta[j])
#delta 1
  # logdelta[j]~ dnorm(0.0,5.9)
  # delta[j]<-exp(logdelta[j])
#delta 2
  # logdelta[j]~ dnorm(0.0,2.86)
  # delta[j]<-exp(logdelta[j])
#delta 3'
  # logdelta[j]~ dunif(0.2,1.5)
  # delta[j]<-exp(logdelta[j])
  # delta[j]~ dunif(0.2,5)
  #ratio(relative risk of disease 1 associated with shared component ) to disease 2
  #associated with shared component
  ORratio[j]<-pow(delta[j],2)
}

#ouput
for (i in 1:N){
  OR.beta1[i]<-exp(beta[1,i])
  OR.beta2[i]<-exp(beta[2,i])
  OR.beta3[i]<-exp(beta[3,i])
  OR.beta4[i]<-exp(beta[4,i])
  OR.beta5[i]<-exp(beta[5,i])
  OR.beta6[i]<-exp(beta[6,i])
  OR.beta7[i]<-exp(beta[7,i])
  OR.beta8[i]<-exp(beta[8,i])

```

$$\text{OR11}[i] < -\exp(b0[i] * \text{delta}[1] + a1[1] * B1[1] + a1[2] * B2[1] + a1[3] * B3[1] + a1[4] * B4[1] + a1[5] * B5[1] + b1[i])$$

$$\text{OR12}[i] < -\exp(b0[i] * \text{delta}[2] + a1[1] * B1[2] + a1[2] * B2[2] + a1[3] * B3[2] + a1[4] * B4[2] + a1[5] * B5[2] + b1[i])$$

$$\text{OR13}[i] < -\exp(b0[i] * \text{delta}[3] + a1[1] * B1[3] + a1[2] * B2[3] + a1[3] * B3[3] + a1[4] * B4[3] + a1[5] * B5[3] + b1[i])$$

$$\text{OR14}[i] < -\exp(b0[i] * \text{delta}[4] + a1[1] * B1[4] + a1[2] * B2[4] + a1[3] * B3[4] + a1[4] * B4[4] + a1[5] * B5[4] + b1[i])$$

$$\text{OR15}[i] < -\exp(b0[i] * \text{delta}[5] + a1[1] * B1[5] + a1[2] * B2[5] + a1[3] * B3[5] + a1[4] * B4[5] + a1[5] * B5[5] + b1[i])$$

$$\text{OR16}[i] < -\exp(b0[i] * \text{delta}[6] + a1[1] * B1[6] + a1[2] * B2[6] + a1[3] * B3[6] + a1[4] * B4[6] + a1[5] * B5[6] + b1[i])$$

$$\text{OR17}[i] < -\exp(b0[i] * \text{delta}[7] + a1[1] * B1[7] + a1[2] * B2[7] + a1[3] * B3[7] + a1[4] * B4[7] + a1[5] * B5[7] + b1[i])$$

$$\text{OR18}[i] < -\exp(b0[i] * \text{delta}[8] + a1[1] * B1[8] + a1[2] * B2[8] + a1[3] * B3[8] + a1[4] * B4[8] + a1[5] * B5[8] + b1[i])$$

$$\text{OR21}[i] < -\exp(b0[i] / \text{delta}[1] + a2[1] * B1[1] + a2[2] * B2[1] + a2[3] * B3[1] + a2[4] * B4[1] + a2[5] * B5[1] + b2[i] + \text{beta}[1, i])$$

$$\text{OR22}[i] < -\exp(b0[i] / \text{delta}[2] + a2[1] * B1[2] + a2[2] * B2[2] + a2[3] * B3[2] + a2[4] * B4[2] + a2[5] * B5[2] + b2[i] + \text{beta}[2, i])$$

$$\text{OR23}[i] < -\exp(b0[i] / \text{delta}[3] + a2[1] * B1[3] + a2[2] * B2[3] + a2[3] * B3[3] + a2[4] * B4[3] + a2[5] * B5[3] + b2[i] + \text{beta}[3, i])$$

$$\text{OR24}[i] < -\exp(b0[i] / \text{delta}[4] + a2[1] * B1[4] + a2[2] * B2[4] + a2[3] * B3[4] + a2[4] * B4[4] + a2[5] * B5[4] + b2[i] + \text{beta}[4, i])$$

$$\text{OR25}[i] < -\exp(b0[i] / \text{delta}[5] + a2[1] * B1[5] + a2[2] * B2[5] + a2[3] * B3[5] + a2[4] * B4[5] + a2[5] * B5[5] + b2[i] + \text{beta}[5, i])$$

$$\text{OR26}[i] < -\exp(b0[i] / \text{delta}[6] + a2[1] * B1[6] + a2[2] * B2[6] + a2[3] * B3[6] + a2[4] * B4[6] + a2[5] * B5[6] + b2[i] + \text{beta}[6, i])$$

```
OR27[i]<-exp(b0[i]/delta[7]+a2[1]*B1[7]+a2[2]*B2[7]+a2[3]*B3[7]+a2[4]*B4[7]+a2[5]*B5[7]+b2[i]
]+beta[7,i])
```

```
OR28[i]<-exp(b0[i]/delta[8]+a2[1]*B1[8]+a2[2]*B2[8]+a2[3]*B3[8]+a2[4]*B4[8]+a2[5]*B5[8]+b2[i]
]+beta[8,i])
```

```
}
```

```
}
```

```
# Data
```

```
list(M=8,N =7,
```

```
      O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,
90.67,97.74,93.63,85.18,109.08,119.29,101.42,
260.63,269.23,286.95,290.23,327.03,324.13,272.79,
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),
```

```
      O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),
```

```
      n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),
```

```
      n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
```

```

587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),

```

```

#with 2 knots at year 1997,2000

```

```

B1= c(0.000,0.523,0.111,0.000,0.000,0.000,0.000,0.000),
B2= c(0.000,0.174,0.689,0.432,0.111,0.041,0.003,0.000),
B3= c(0.000,0.007,0.200,0.522,0.482,0.315,0.067,0.000),
B4= c(0.000,0.000,0.000,0.046,0.359,0.482,0.383,0.000),
B5= c(0.000,0.000,0.000,0.000,0.048,0.162,0.548,1.000),

```

```

num = c(2, 3, 2, 2, 2, 2, 1
),

```

```

adj = c(

```

```

7, 4,

```

```

6, 5, 3,

```

```

4, 2,

```

```

3, 1,

```

```

6, 2,

```

```

5, 2,

```

```

1

```

```

),

```

```

sumNumNeigh = 14)

```

```

#inits for 1997,2000

```

```

list(alpha=c(-1.1,0.0),a1=c(-0.4,0.9,0.0,0.8,0.7),a2=c(0.0,0.0,0.0,0.0,0.0),tau.beta=50,

```

```

      b0=c(-0.2,-0.3,-0.2,-0.2,-0.4,-0.3,-0.3),

```

```

      b1=c(0.0,-0.4,0.0,0.2,-0.5,-0.3,0.0),

```

```

b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))

```

```

inits2

```

```

list(alpha=c(1.1,0.0),a1=c(0.4,-0.9,0.0,-0.8,-0.7),a2=c(0.0,0.0,0.0,0.0,0.0),tau.beta=10,

```

```

      b0=c(0.2,0.3,0.2,0.2,0.4,0.3,0.3),

```

```

      b1=c(0.0,0.4,0.0,-0.2,0.5,0.3,0.0),

```

```

b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))

```

```

#prior 2

```

```

#inits for 1997,2000

```

```

list(alpha=c(-1.1,0.0),a1=c(-0.4,0.9,0.0,0.8,0.7),a2=c(0.0,0.0,0.0,0.0,0.0),

```

```

      b0=c(-0.2,-0.3,-0.2,-0.2,-0.4,-0.3,-0.3),

```

```

      b1=c(0.0,-0.4,0.0,0.2,-0.5,-0.3,0.0),

```

```

b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))

```

inits2

```
list(alpha=c(1.1,0.0),a1=c(0.4,-0.9,0.0,-0.8,-0.7),a2=c(0.0,0.0,0.0,0.0,0.0),  
      b0=c(0.2,0.3,0.2,0.2,0.4,0.3,0.3),          b1=c(0.0,0.4,0.0,-0.2,0.5,0.3,0.0),  
      b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0))
```

## Model 6

```
model
{
  for(j in 1:M) {
    for( i in 1:N) {
      O1[j,i]~ dbin(p1[j,i],n1[j,i])
      O2[j,i]~ dbin(p2[j,i],n2[j,i])
      logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
      logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]

eta1[j,i,1]<-b0[i]*delta[j]+a1[1]*B1[j]+a1[2]*B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+a1[5]*B5[j]+b1[i]

eta2[j,i,2]<-b0[i]/delta[j]+a2[1]*B1[j]+a2[2]*B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+a2[5]*B5[j]+b2[i]+bet
a[j,i]
    }
  }

  # weights for the spatial adjacency matrix
  for(k in 1: sumNumNeigh){
    weights[k]<-1
  }

# Spatial priors

  for(j in 1:M) {
    beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)

  }

# other priors ,such as the intercepts,fixed effects,relative weight and variances
alpha[1]~ dnorm(0.0,100)
OR.alpha[1]<-exp(alpha[1])
alpha[2]~ dnorm(0.0,1000)
OR.alpha[2]<-exp(alpha[2])

sigma2.beta<-1/tau.beta

tau.beta~dgamma(5,0.0005)

for (P in 1:5){
  a1[P]~ dnorm(0.0,100)
  OR.a1[P]<-exp(a1[P])
  a2[P]~ dnorm(0.0,1000)
  OR.a2[P]<-exp(a2[P])
}
```

```

    }
    for( i in 1:N) {
      b0[i] ~ dnorm(0.0,100)
      OR.b0[i]<-exp(b0[i])
      b1[i] ~ dnorm(0.0,100)
      OR.b1[i]<-exp(b1[i])
      b2[i] ~ dnorm(0.0,1000)
      OR.b2[i]<-exp(b2[i])

    }

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
  logdelta[j]~ dnorm(0.0,5.9)
  delta[j]<-exp(logdelta[j])
  #ratio(relative risk of disease 1 associated with shared component ) to disease 2
  #associated with shared component
  ORratio[j]<-pow(delta[j],2)
}

#ouput
for (i in 1:N){
  OR.beta1[i]<-exp(beta[1,i])
  OR.beta2[i]<-exp(beta[2,i])
  OR.beta3[i]<-exp(beta[3,i])
  OR.beta4[i]<-exp(beta[4,i])
  OR.beta5[i]<-exp(beta[5,i])
  OR.beta6[i]<-exp(beta[6,i])
  OR.beta7[i]<-exp(beta[7,i])
  OR.beta8[i]<-exp(beta[8,i])

  OR11[i]<-exp(b0[i]*delta[1]+a1[1]*B1[1]+a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+a1[5]*B5[1]+b1[
i])

  OR12[i]<-exp(b0[i]*delta[2]+a1[1]*B1[2]+a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+a1[5]*B5[2]+b1[
i])

  OR13[i]<-exp(b0[i]*delta[3]+a1[1]*B1[3]+a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+a1[5]*B5[3]+b1[
i])

  OR14[i]<-exp(b0[i]*delta[4]+a1[1]*B1[4]+a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+a1[5]*B5[4]+b1[
i])

  OR15[i]<-exp(b0[i]*delta[5]+a1[1]*B1[5]+a1[2]*B2[5]+a1[3]*B3[5]+a1[4]*B4[5]+a1[5]*B5[5]+b1[

```

i))

OR16[i]<-exp(b0[i]\*delta[6]+a1[1]\*B1[6]+a1[2]\*B2[6]+a1[3]\*B3[6]+a1[4]\*B4[6]+a1[5]\*B5[6]+b1[i])

OR17[i]<-exp(b0[i]\*delta[7]+a1[1]\*B1[7]+a1[2]\*B2[7]+a1[3]\*B3[7]+a1[4]\*B4[7]+a1[5]\*B5[7]+b1[i])

OR18[i]<-exp(b0[i]\*delta[8]+a1[1]\*B1[8]+a1[2]\*B2[8]+a1[3]\*B3[8]+a1[4]\*B4[8]+a1[5]\*B5[8]+b1[i])

OR21[i]<-exp(b0[i]/delta[1]+a2[1]\*B1[1]+a2[2]\*B2[1]+a2[3]\*B3[1]+a2[4]\*B4[1]+a2[5]\*B5[1]+b2[i]+beta[1,i])

OR22[i]<-exp(b0[i]/delta[2]+a2[1]\*B1[2]+a2[2]\*B2[2]+a2[3]\*B3[2]+a2[4]\*B4[2]+a2[5]\*B5[2]+b2[i]+beta[2,i])

OR23[i]<-exp(b0[i]/delta[3]+a2[1]\*B1[3]+a2[2]\*B2[3]+a2[3]\*B3[3]+a2[4]\*B4[3]+a2[5]\*B5[3]+b2[i]+beta[3,i])

OR24[i]<-exp(b0[i]/delta[4]+a2[1]\*B1[4]+a2[2]\*B2[4]+a2[3]\*B3[4]+a2[4]\*B4[4]+a2[5]\*B5[4]+b2[i]+beta[4,i])

OR25[i]<-exp(b0[i]/delta[5]+a2[1]\*B1[5]+a2[2]\*B2[5]+a2[3]\*B3[5]+a2[4]\*B4[5]+a2[5]\*B5[5]+b2[i]+beta[5,i])

OR26[i]<-exp(b0[i]/delta[6]+a2[1]\*B1[6]+a2[2]\*B2[6]+a2[3]\*B3[6]+a2[4]\*B4[6]+a2[5]\*B5[6]+b2[i]+beta[6,i])

OR27[i]<-exp(b0[i]/delta[7]+a2[1]\*B1[7]+a2[2]\*B2[7]+a2[3]\*B3[7]+a2[4]\*B4[7]+a2[5]\*B5[7]+b2[i]+beta[7,i])

OR28[i]<-exp(b0[i]/delta[8]+a2[1]\*B1[8]+a2[2]\*B2[8]+a2[3]\*B3[8]+a2[4]\*B4[8]+a2[5]\*B5[8]+b2[i]+beta[8,i])

}

}

# Data

list(M=8,N =7,

    O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,  
90.67,97.74,93.63,85.18,109.08,119.29,101.42,  
260.63,269.23,286.95,290.23,327.03,324.13,272.79,

```
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),
```

```
O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),
```

```
n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),
```

```
n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
568,602,544,627,568,739,627),.Dim=c(8,7)),
```

```
#with 2 knots at year 1997,2004
```

```
B1= c(0.000,0.575,0.290,0.054,0.000,0.000,0.000,0.000),
B2= c(0.000,0.124,0.572,0.525,0.175,0.064,0.004,0.000),
B3= c(0.000,0.005,0.138,0.402,0.575,0.428,0.101,0.000),
B4= c(0.000,0.000,0.000,0.020,0.250,0.485,0.531,0.000),
B5= c(0.000,0.000,0.000,0.000,0.000,0.023,0.364,1.000),
```

```
num = c(2, 3, 2, 2, 2, 2, 1
```

```

),
adj = c(
  7, 4,
  6, 5, 3,
  4, 2,
  3, 1,
  6, 2,
  5, 2,
  1
),
sumNumNeigh = 14)
#inits for 1997,2000
list(alpha=c(-1.1,0.0),a1=c(-0.4,0.9,0.0,0.8,0.7),a2=c(0.0,0.0,0.0,0.0,0.0),tau.beta=50,
      b0=c(-0.2,-0.3,-0.2,-0.2,-0.4,-0.3,-0.3),          b1=c(0.0,-0.4,0.0,0.2,-0.5,-0.3,0.0),
      b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))

inits2
list(alpha=c(1.1,0.0),a1=c(0.4,-0.9,0.0,-0.8,-0.7),a2=c(0.0,0.0,0.0,0.0,0.0),tau.beta=10,
      b0=c(0.2,0.3,0.2,0.2,0.4,0.3,0.3),          b1=c(0.0,0.4,0.0,-0.2,0.5,0.3,0.0),
      b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))

```

## Model 7

```

model
{
    for(j in 1:M) {
        for( i in 1:N) {
            O1[j,i]~ dbin(p1[j,i],n1[j,i])
            O2[j,i]~ dbin(p2[j,i],n2[j,i])
            logit(p1[j,i]) <-alpha[1]+eta1[j,i,1]
            logit(p2[j,i]) <-alpha[2]+eta2[j,i,2]

eta1[j,i,1]<-b0[i]*delta[j]+a1[1]*B1[j]+a1[2]*B2[j]+a1[3]*B3[j]+a1[4]*B4[j]+a1[5]*B5[j]+a1[6]*B6[
j]+b1[i]

eta2[j,i,2]<-b0[i]/delta[j]+a2[1]*B1[j]+a2[2]*B2[j]+a2[3]*B3[j]+a2[4]*B4[j]+a2[5]*B5[j]+a2[6]*B6[
j]+b2[i]+beta[j,i]
        }
    }

    # weights for the spatial adjacency matrix
    for(k in 1: sumNumNeigh){
        weights[k]<-1
    }

    # Spatial priors

    for(j in 1:M) {
        beta[j,1:N] ~ car.normal(adj[],weights[],num[],tau.beta)

    }

    # other priors ,such as the intercepts,fixed effects,relative weight and variances
    alpha[1]~ dnorm(0.0,100)
    OR.alpha[1]<-exp(alpha[1])
    alpha[2]~ dnorm(0.0,1000)
    OR.alpha[2]<-exp(alpha[2])
    # prior 1
    sigma2.beta<-1/tau.beta
    tau.beta~dgamma(0.1,0.001)
    #prior 2
    #    sigma.beta~dunif(0,1)
    #    tau.beta<-1/(sigma.beta*sigma.beta)
    #prior 3
    #    sigma2.beta~dnorm(0.0,100)l(0,)
    #    tau.beta<-1/sigma2.beta

    for (P in 1:6){

```

```

        a1[P]~ dnorm(0.0,100)
        OR.a1[P]<-exp(a1[P])
        a2[P]~ dnorm(0.0,1000)
        OR.a2[P]<-exp(a2[P])
    }
    for( i in 1:N) {
        b0[i] ~ dnorm(0.0,100)
        OR.b0[i]<-exp(b0[i])
        b1[i] ~ dnorm(0.0,100)
        OR.b1[i]<-exp(b1[i])
        b2[i] ~ dnorm(0.0,1000)
        OR.b2[i]<-exp(b2[i])

    }

#scaling factor for relative strength of shared component for each disease
for (j in 1:M){
#delta 1
# logdelta[j]~ dnorm(0.0,5.9)
# delta[j]<-exp(logdelta[j])
#delta 2
# logdelta[j]~ dnorm(0.0,2.86)
# delta[j]<-exp(logdelta[j])
#delta 3'
# logdelta[j]~ dunif(0.2,1.5)
# delta[j]<-exp(logdelta[j])
delta[j]~ dunif(0.2,5)
#ratio(relative risk of disease 1 associated with shared component ) to disease 2
associated with shared component
    ORratio[j]<-pow(delta[j],2)
}
#output
for (i in 1:N){
    OR.beta1[i]<-exp(beta[1,i])
    OR.beta2[i]<-exp(beta[2,i])
    OR.beta3[i]<-exp(beta[3,i])
    OR.beta4[i]<-exp(beta[4,i])
    OR.beta5[i]<-exp(beta[5,i])
    OR.beta6[i]<-exp(beta[6,i])
    OR.beta7[i]<-exp(beta[7,i])
    OR.beta8[i]<-exp(beta[8,i])

    OR11[i]<-exp(b0[i]*delta[1]+a1[1]*B1[1]+a1[2]*B2[1]+a1[3]*B3[1]+a1[4]*B4[1]+a1[5]*B5[1]+a1[

```

$$6]*B6[1]+b1[i])$$

$$OR12[i]<-\exp(b0[i]*\delta[2]+a1[1]*B1[2]+a1[2]*B2[2]+a1[3]*B3[2]+a1[4]*B4[2]+a1[5]*B5[2]+a1[6]*B6[2]+b1[i])$$

$$OR13[i]<-\exp(b0[i]*\delta[3]+a1[1]*B1[3]+a1[2]*B2[3]+a1[3]*B3[3]+a1[4]*B4[3]+a1[5]*B5[3]+a1[6]*B6[3]+b1[i])$$

$$OR14[i]<-\exp(b0[i]*\delta[4]+a1[1]*B1[4]+a1[2]*B2[4]+a1[3]*B3[4]+a1[4]*B4[4]+a1[5]*B5[4]+a1[6]*B6[4]+b1[i])$$

$$OR15[i]<-\exp(b0[i]*\delta[5]+a1[1]*B1[5]+a1[2]*B2[5]+a1[3]*B3[5]+a1[4]*B4[5]+a1[5]*B5[5]+a1[6]*B6[5]+b1[i])$$

$$OR16[i]<-\exp(b0[i]*\delta[6]+a1[1]*B1[6]+a1[2]*B2[6]+a1[3]*B3[6]+a1[4]*B4[6]+a1[5]*B5[6]+a1[6]*B6[6]+b1[i])$$

$$OR17[i]<-\exp(b0[i]*\delta[7]+a1[1]*B1[7]+a1[2]*B2[7]+a1[3]*B3[7]+a1[4]*B4[7]+a1[5]*B5[7]+a1[6]*B6[7]+b1[i])$$

$$OR18[i]<-\exp(b0[i]*\delta[8]+a1[1]*B1[8]+a1[2]*B2[8]+a1[3]*B3[8]+a1[4]*B4[8]+a1[5]*B5[8]+a1[6]*B6[8]+b1[i])$$

$$OR21[i]<-\exp(b0[i]/\delta[1]+a2[1]*B1[1]+a2[2]*B2[1]+a2[3]*B3[1]+a2[4]*B4[1]+a2[5]*B5[1]+a2[6]*B6[1]+b2[i]+\beta[1,i])$$

$$OR22[i]<-\exp(b0[i]/\delta[2]+a2[1]*B1[2]+a2[2]*B2[2]+a2[3]*B3[2]+a2[4]*B4[2]+a2[5]*B5[2]+a2[6]*B6[2]+b2[i]+\beta[2,i])$$

$$OR23[i]<-\exp(b0[i]/\delta[3]+a2[1]*B1[3]+a2[2]*B2[3]+a2[3]*B3[3]+a2[4]*B4[3]+a2[5]*B5[3]+a2[6]*B6[3]+b2[i]+\beta[3,i])$$

$$OR24[i]<-\exp(b0[i]/\delta[4]+a2[1]*B1[4]+a2[2]*B2[4]+a2[3]*B3[4]+a2[4]*B4[4]+a2[5]*B5[4]+a2[6]*B6[4]+b2[i]+\beta[4,i])$$

$$OR25[i]<-\exp(b0[i]/\delta[5]+a2[1]*B1[5]+a2[2]*B2[5]+a2[3]*B3[5]+a2[4]*B4[5]+a2[5]*B5[5]+a2[6]*B6[5]+b2[i]+\beta[5,i])$$

$$OR26[i]<-\exp(b0[i]/\delta[6]+a2[1]*B1[6]+a2[2]*B2[6]+a2[3]*B3[6]+a2[4]*B4[6]+a2[5]*B5[6]+a2[6]*B6[6]+b2[i]+\beta[6,i])$$

$$OR27[i]<-\exp(b0[i]/\delta[7]+a2[1]*B1[7]+a2[2]*B2[7]+a2[3]*B3[7]+a2[4]*B4[7]+a2[5]*B5[7]+a2[6]*B6[7]+b2[i]+\beta[7,i])$$

```
OR28[i]<-exp(b0[i]/delta[8]+a2[1]*B1[8]+a2[2]*B2[8]+a2[3]*B3[8]+a2[4]*B4[8]+a2[5]*B5[8]+a2[6]*B6[8]+b2[i]+beta[8,i])
```

```
}
```

```
}
```

```
# Data
```

```
list(M=8,N =7,
```

```
  O1=structure(.Data=c(94.03,87.68,87.15,85.66,114.64,106.33,91.51,
90.67,97.74,93.63,85.18,109.08,119.29,101.42,
260.63,269.23,286.95,290.23,327.03,324.13,272.79,
137.51,139.75,130.87,130.86,150.21,155.2,149.59,
171.37,179.06,175.18,193.18,192.44,214.1,187.67,
174.42,184.09,161.06,175.28,183.91,202.62,178.61,
201.08,209.98,187.69,216.31,208.69,251.24,231.02,
185.59,191.62,172.37,195.77,183.91,231.54,205.2),.Dim=c(8,7)),
```

```
  O2=structure(.Data=c(89.63 ,71.58 ,78.41 ,76.09 ,93.53 ,107.95 ,85.81,
87.17 ,77.23 ,82.49 ,80.21 ,97.31 ,116.19 ,89.40,
219.98 ,211.14 ,231.82 ,231.56 ,268.24 ,276.43 ,231.83,
123.12 ,117.91 ,113.18 ,116.39 ,133.72 ,138.47 ,139.20,
165.52 ,147.01 ,148.95 ,177.71 ,169.85 ,182.16 ,167.80,
166.18 ,157.69 ,141.87 ,159.98 ,167.09 ,178.98 ,163.22,
193.01 ,187.00 ,174.74 ,189.66 ,189.38 ,215.60 ,205.62,
178.56 ,174.48 ,162.66 ,176.22 ,172.77 ,202.04 ,189.26),.Dim=c(8,7)),
```

```
  n1=structure(.Data=c(548,615,611,523,773,658,597,
496,595,584,482,655,668,599,
678,706,762,760,852,844,716,
553,586,568,534,631,633,598,
524,564,556,632,599,686,561,
537,593,504,561,571,646,528,
541,567,508,597,556,712,597,
516,529,471,556,511,692,551),.Dim=c(8,7)),
```

```
  n2=structure(.Data=c(647,644,658,601,776,704,658,
596,616,607,554,712,691,614,
702,699,751,738,835,844,727,
593,598,599,593,668,631,679,
587,578,590,706,618,670,625,
594,631,545,630,610,671,603,
601,629,560,643,582,731,658,
```

```
568,602,544,627,568,739,627),.Dim=c(8,7)),
```

```
#with three knots at year 1997,2000,2004
```

```
B1= c(0.000,0.523,0.111,0.000,0.000,0.000,0.000,0.000),
```

```
B2= c(0.000,0.170,0.581,0.176,0.000,0.000,0.000,0.000),
```

```
B3= c(0.000,0.011,0.308,0.732,0.318,0.116,0.007,0.000),
```

```
B4= c(0.000,0.000,0.000,0.092,0.550,0.479,0.124,0.000),
```

```
B5= c(0.000,0.000,0.000,0.000,0.132,0.382,0.504,0.000),
```

```
B6= c(0.000,0.000,0.000,0.000,0.000,0.023,0.364,1.000),
```

```
num = c(2, 3, 2, 2, 2, 2, 1
```

```
),
```

```
adj = c(
```

```
7, 4,
```

```
6, 5, 3,
```

```
4, 2,
```

```
3, 1,
```

```
6, 2,
```

```
5, 2,
```

```
1
```

```
),
```

```
sumNumNeigh = 14)
```

```
#inits for prior 1 and prior2
```

```
list(alpha=c(-1.1,0.0),a1=c(-0.5,1.1,0.1,0.5,0.6,0.7),a2=c(0.0,0.0,0.0,0.0,0.0,0.0),tau.beta=45,
```

```
      b0=c(-0.2,-0.3,-0.2,-0.2,-0.3,-0.3,-0.2),
```

```
      b1=c(0.0,-0.4,-0.1,0.2,-0.5,-0.3,0.0),
```

```
b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))
```

```
inits2
```

```
list(alpha=c(1.1,0.0),a1=c(0.5,-1.1,-0.1,-0.5,-0.6,-0.7),a2=c(0.0,0.0,0.0,0.0,0.0,0.0),tau.beta=10,
```

```
      b0=c(0.2,0.3,0.2,0.2,0.3,0.3,0.2),
```

```
      b1=c(0.0,0.4,0.1,-0.2,0.5,0.3,0.0),
```

```
b2=c(0.0,0.0,0.0,0.0,0.0,0.0,0.0))
```