

PART A: The WinBUGS code for the best selected model sequentially fitted through R

```

model
{
osub[1] ~ dpois(lambda[1])
u[1] ~ dbern(p[1])
lambda[1] <- (1 - u[1]) * mu[1]
log(mu[1]) <- -mu[1]
mul[1] ~ dnorm(M[1],U)
C[1]<- b1 + b2*susub[1] +b3*fasub[1] + alphab*exp(-alphab*x2[1])
M[1]<-C[1] + (log(mu[1])- C[1])*exp(-phi)

logit(p[1]) <-c1 +c2*x1sub[1] + alphac*exp(-alphac*x2[1])

for(k in 2:19519) {

D1[k]<-alphab*exp(-alphab*x2[k])
D2[k]<-alphac*exp(-alphac*x2[k])
}

for(i in 2:j){

V1[i]<-mean(D1[start[i]:end1[i]])
V2[i]<-mean(D2[start[i]:end1[i]])

osub[i] ~ dpois(lambda[i])
u[i] ~ dbern(p[i])
lambda[i] <- (1-u[i]) * (mu[i]+mu[i-1])*0.5
log(mu[i]) <- -mul[i]
mul[i] ~ dnorm(M[i],U)
C[i]<- b1 + b2*susub[i] +b3*fasub[i] + V1[i]
M[i]<-C[i] + (log(mu[i-1])- C[i])*exp(-phi)

logit(p[i]) <-c1 +c2*x1sub[i] + V2[i]
}

U<-(2*phi)/(1-exp(-2*phi))

phi ~ dnorm( 0, 0.1)I(0, )

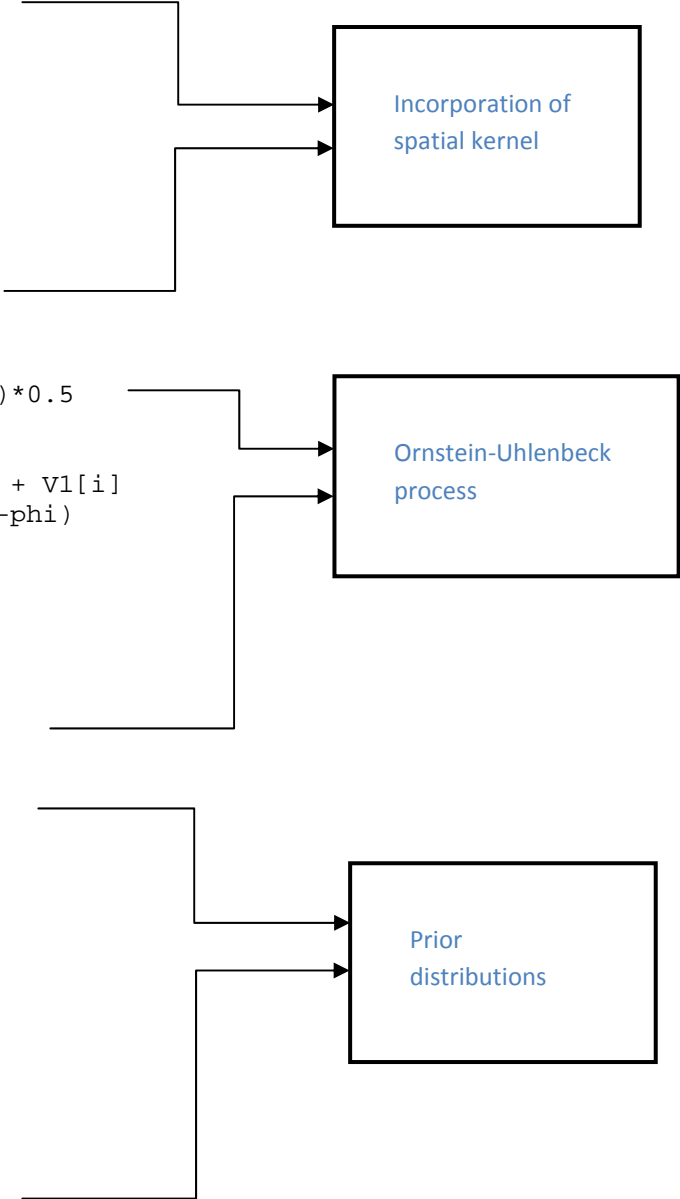
alphab~dnorm( 0, 0.001)I(0, )
alphac~dnorm( 0, 0.001)I(0, )

b1 ~ dnorm(0 , prec)
b2 ~ dnorm(0 , prec)
b3 ~ dnorm(0 , prec)
prec <- pow(tau,-2)
tau ~ dunif(0,0.1)

c1 ~ dnorm(0 , prec1)
c2 ~ dnorm(0 , prec1)
prec1 <- pow(taul,-2)
taul ~ dunif(0,0.1)

}

```



PART B: The R code for the sequential early warning monitoring system

```
library(R2WinBUGS)  
library(coda)  
library(rootSolve)
```

```
covariate_data <- read.table ("covariate_data.txt", header=TRUE)  
covariate_data
```

```
distance <- read.table ("distance.txt", header=TRUE)  
distance
```

```
start <- read.table ("start.txt", header=TRUE)  
start
```

```
y <- covariate_data$y  
y
```

```
y.df <- data.frame(y)  
y.df
```

```
x1 <- covariate_data$x1  
x1
```

```
x1.df <- data.frame(x1)  
x1.df
```

```
su <- covariate_data$sp  
su
```

```
su.df <- data.frame(su)  
su.df
```

```
fa <- covariate_data$fa  
fa
```

```
fa.df <- data.frame(fa)  
fa.df
```

```
x2 <- distance$x2  
x2  
x2.df <- data.frame(distance)  
x2.df
```

```
start <- start$start  
start
```

```
start.df <- data.frame(start)  
start.df
```

```
end1 <- start$end1  
end1
```

```
end1.df <- data.frame(end1)  
end1.df
```

Number of
sheep pox cases
(dependent
variable)

Covariates (avg
temp, summer,
fall)

Variable of
distances
between flocks
(x2) and
indicators for
distances for
each week (start,
end1)

```
T<-73
```

```
for (j in 10:T)
{
  ysub <- y.df[1:j, ]
  ysub
  x1sub <- x1.df[1:j, ]
  x1sub
  susub <- sp.df[1:j, ]
  susub
  fasub <- fa.df[1:j, ]
  fasub

```

Selection of
partial data for
running
sequential
analysis

```
data<-list("j", "ysub", "x1sub", "spsub",
"susub", "x2", "start", "end1")
```

```
inits <- function() {list (alphab=1, alphac=1,
b1=0,b2=0, b3=0,c1=0, c2=0)}
parameters <- c("alphab","alphac",
"b1","b2","b3","c1","c2")
model.sim<- bugs (data, inits, parameters,
codaPkg=FALSE, "model.bug", n.chains=1, n.iter=6000,
n.burnin=4000, n.thin=1,
bugs.directory="C:/...../WinBUGS14/", debug=FALSE)
```

Sequential
analysis for
obtaining the
early warning
indicator

```
b1 = model.sim$sims.array[,1,1]
b2 = model.sim$sims.array[,1,2]
b3 = model.sim$sims.array[,1,3]
alphab = model.sim$sims.array[,1,4]
```

```
lambda<-exp(median(b1) + median(b2)*su.df[j:j, ] + median(b3)*fa.df[j:j, ]
+ median(alphab)*exp(-median(alphab)*x2.df[j:j, ]))
```

```
f<-function (q, lambda1) exp(q*lambda1)-q*exp(lambda1)
root <- uniroot.all(f, c(0, 1),
tol = 0.0000001, lambda1=lambda)
print(root)
```

```
}
```

PART C: The data

```
y = c( 1, 0, 1, 1, 1, 2, 5, 5, 2, 5, 2, 3, 2, 2, 1, 0, 2, 1, 6, 5, 0, 0, 2, 1, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 4, 4, 12, 26,
4, 21, 15, 12, 23, 7, 10, 9, 10, 1, 1, 2, 4, 5, 1, 1, 0, 1, 0, 1, 0 ),
xl = c( 26.06667, 25.18571, 24.94286, 21.45714, 22.01429, 19.01429, 19.2, 11.5,
14.01429, 13.55714, 11.12857, 13.04286, 13.3, 11.22857, 10.81429, 5.6, 3.171429,
2.042857, 2.528571, 3.3, 4.728571, 4, 7.328571, 9.342857, 0.08571429, 5.485714,
11.4, 10.55714, 6.557143, 9.428571, 7.228571, 12.71429, 10.67143, 12.48571,
11.51429, 13.24286, 15.72857, 15.82857, 14.67143, 17.6, 19.38571, 20.7, 19.62857,
23.8, 21.02857, 23.4, 22.87143, 25.11429, 23.25714, 25.31429, 25.55714, 25.18571,
25.95714, 24.11429, 23.57143, 22.17143, 21.6, 19.3, 15.44286, 15.11429, 15.38571,
16.67143, 12.27143, 7.7, 9.685714, 12.6, 9.971429, 3.985714, 8.771429, 6.428571,
6.542857, 5.071429, 0.2) ,
su = c( 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0 ),
fa = c( 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0 ),
x2 = c( 0.52, 0.52, 12.48, 11.78, 17.36, 4.6, 4.47, 44.99, 44.11, 44.52, 10.01,
34.78, 24.29, 6.61, 0.56, 30.63, 6.01, 6.02, 10.47, 30.71, 10.77, 10.01, 6.41,
6.65, 10.43, 10.43, 28.56, 6.52, 3.32, 6.02, 0.82, 2.88, 2.45, 0.3, 5.33, 12.92,
12.77, 23.74, 69.93, 69.96, 52.27, 9.05, 69.86, 69.49, 69.27, 69.1, 22.86, 22.92,
0.45, 0.7, 72.56, 72.84, 72.86, 71.44, 61.82, 53.89, 69.12, 68.93, 68.16, 75.57,
65.14, 66.09, 64.9, 6.1, 39.09, 42.37, 48.59, 59.24, 52.27, 35.53, 48.01, 43.95,
42.62, 54.18, 65.65, 51.01, 51.66, 57.75, 32.2,
53.75, 61.82, 72.18, 77.43, 55.3, 61.78, 68.93, 46.13, 65.12, 65.6, 21.99, 74.79,
57.4, 25.97, 6.02, 76.64, 63.58, 78.81, 92.53, 74.71, 16.24, 82.58, 14.96, 5.34,
80.53, 20.98, 6.51, 18.64, 6.68, 0.52, 0.52, 12.48, 11.78, 17.36, 4.6, 4.47,
44.99, 44.11, 44.52, 10.01, 34.78, 24.29,
6.61, 0.56, 30.63, 6.01, 6.02, 10.47, 30.71, 10.77, 10.01, 6.41, 6.65, 10.43,
10.43, 28.56, 6.52, 3.32, 6.02, 0.82, 2.88, 2.45, 0.3, 5.33, 12.92, 12.77, 23.74,
69.93, 69.96, 52.27, 9.05, 69.86, 69.49, 69.27, 69.1, 22.86, 22.92, 0.45, 0.7,
72.56, 72.84, 72.86, 71.44, 61.82, 53.89, 69.12, 68.93, 68.16, 75.57, 65.14,
66.09, 64.9, 6.1, 39.09, 42.37, 48.59, 59.24, 52.27, 35.53, 48.01, 43.95, 42.62,
54.18, 65.65, 51.01, 51.66, 57.75, 32.2, 53.75, 61.82, 72.18, 77.43, 55.3, 61.78,
68.93, 46.13, 65.12, 65.6, 21.99, 74.79, 57.4, 25.97, 6.02, 76.64, 63.58, 78.81,
92.53, 74.71, 16.24, 82.58, 14.96, 5.34,
80.53, 20.98, 6.51, 18.64, 6.68, 0.52, 0.52, 12.48, 11.78, 17.36, 4.6, 4.47,
44.99, 44.11, 44.52, 10.01, 34.78, 24.29, 6.61, 0.56, 30.63, 6.01, 6.02, 10.47,
30.71, 10.77, 10.01, 6.41, 6.65, 10.43, 10.43, 28.56, 6.52, 3.32, 6.02, 0.82,
2.88, 2.45, 0.3, 5.33, 12.92, 12.77, 23.74, 69.93, 69.96, 52.27, 9.05, 69.86,
69.49, 69.27, 69.1, 22.86, 22.92, 0.45, 0.7, 72.56, 72.84, 72.86, 71.44, 61.82,
53.89, 69.12, 68.93, 68.16, 75.57, 65.14, 66.09, 64.9, 6.1, 39.09, 42.37, 48.59,
59.24, 52.27, 35.53, 48.01, 43.95, 42.62, 54.18, 65.65, 51.01, 51.66, 57.75, 32.2,
53.75, 61.82, 72.18, 77.43, 55.3, 61.78, 68.93, 46.13, 65.12, 65.6, 21.99, 74.79,
57.4, 25.97, 6.02, 76.64, 63.58, 78.81, 92.53, 74.71, 16.24, 82.58, 14.96, 5.34,
80.53, 20.98, 6.51, 18.64, 6.68, 0.52, 0.52, 12.48, 11.78, 17.36, 4.6, 4.47,
44.99, 44.11, 44.52, 10.01, 34.78, 24.29, 6.61, 0.56, 30.63, 6.01, 6.02, 10.47,
30.71, 10.77, 10.01, 6.41, 6.65, 10.43, 10.43, 28.56,
6.52, 3.32, 6.02, 0.82, 2.88, 2.45, 0.3, 5.33, 12.92, 12.77, 23.74, 69.93, 69.96,
52.27, 9.05, 69.86, 69.49, 69.27, 69.1, 22.86, 22.92, 0.45, 0.7, 72.56, 72.84,
72.86, 71.44, 61.82, 53.89, 69.12, 68.93, 68.16, 75.57, 65.14, 66.09, 64.9, 6.1,
```

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65.12, 65.6, 21.99, 74.79, 57.4, 25.97, 6.02, 76.64, 63.58, 78.81, 92.53, 74.71,
16.24, 82.58, 14.96, 5.34, 80.53, 20.98, 6.51, 18.64, 6.68, 0.52, 0.52, 12.48,
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10.01, 34.78, 24.29, 6.61, 0.56, 30.63, 6.01, 6.02, 10.47, 30.71, 10.77, 10.01,
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49.09, 59.75, 52.76, 36, 48.52, 44.44, 43.08, 54.69, 66.16, 51.51, 52.17, 58.26,
32.64, 54.27, 62.33, 72.69, 77.91, 55.8, 62.29, 69.43, 46.62, 65.61, 66.11, 22.4,
75.29, 57.9, 26.13, 6.35, 77.13, 64.07, 79.28, 92.95, 75.2, 15.85, 83.05, 15.23,
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69.49, 69.27, 69.1, 22.86, 22.92, 0.45, 0.7, 72.56, 72.84, 72.86, 71.44, 61.82,
53.89, 69.12, 68.93, 68.16, 75.57, 65.14, 66.09, 64.9, 6.1, 39.09, 42.37, 48.59,
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6.27, 18.85, 6.42, 0.52, 0.52, 12.48, 11.78, 17.36, 4.6, 4.47, 44.99, 44.11,
44.52, 10.01, 34.78, 24.29, 6.61, 0.56, 30.63, 6.01, 6.02, 10.47, 30.71, 10.77,
10.01, 6.41, 6.65, 10.43, 10.43, 28.56, 6.52, 3.32, 6.02, 0.82, 2.88, 2.45, 0.3,
5.33, 12.92, 12.77, 23.74, 69.93, 69.96, 52.27, 9.05, 69.86, 69.49, 69.27, 69.1,
22.86, 22.92, 0.45, 0.7, 72.56, 72.84, 72.86, 71.44, 61.82, 53.89, 69.12, 68.93,
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76.64, 63.58, 78.81, 92.53, 74.71,
16.24, 82.58, 14.96, 5.34, 80.53, 20.98, 6.51, 18.64, 6.68, 0.01, 12.19, 11.41,
17.01, 4.55, 4.97, 44.71, 43.82, 44.23, 10.36, 34.45, 23.85, 6.95, 0.59, 30.97,
6.34, 6.35, 10.77, 31.04, 11.12, 10.36, 6.72, 6.45, 10.73, 10.73, 28.92, 6.26,
3.82, 6.35, 0.55, 2.7, 2.23, 0.48, 5.25, 13.13, 12.96, 23.35, 70.43, 70.46, 52.77,
9.02, 70.36, 69.99, 69.77, 69.6, 22.45, 22.5, 0.58, 0.3, 73.07, 73.35,
73.36, 71.95, 62.33, 54.4, 69.62, 69.43, 68.66, 76.06, 65.63, 66.6, 65.41, 5.89,
39.58, 42.87, 49.09, 59.75, 52.76, 36, 48.52, 44.44, 43.08, 54.69, 66.16, 51.51,
52.17, 58.26, 32.64, 54.27, 62.33, 72.69, 77.91, 55.8, 62.29, 69.43, 46.62, 65.61,
66.11, 22.4, 75.29, 57.9, 26.13, 6.35, 77.13, 64.07, 79.28, 92.95, 75.2, 15.85,
83.05, 15.23, 5.26, 81.01, 20.87, 6.27, 18.85, 6.42, 0.52, 0.52, 12.48, 11.78,
17.36, 4.6, 4.47, 44.99, 44.11, 44.52, 10.01, 34.78, 24.29,
6.61, 0.56, 30.63, 6.01, 6.02, 10.47, 30.71, 10.77, 10.01, 6.41, 6.65, 10.43,
10.43, 28.56, 6.52, 3.32, 6.02, 0.82, 2.88, 2.45, 0.3, 5.33, 12.92, 12.77, 23.74,
69.93, 69.96, 52.27, 9.05, 69.86, 69.49, 69.27, 69.1, 22.86, 22.92, 0.45, 0.7,
72.56, 72.84, 72.86, 71.44, 61.82, 53.89, 69.12, 68.93, 68.16, 0.52, 0.52, 12.48,
11.78, 17.36, 4.6, 4.47, 44.99, 44.11, 44.52, 10.01, 34.78, 24.29, 6.61, 0.56,
30.63, 6.01, 6.02, 10.47, 30.71, 10.77, 10.01, 6.41, 6.65, 10.43,

15.05, 12.43, 6.09, 14.35, 14.35, 30.77, 5.69, 14.83, 12.64, 10.96, 9.16, 9.44,
11.5, 7.98, 14.11, 13.57, 12.02, 76.73, 76.69, 58.55, 7.9, 76.74, 76.37, 76.09,
75.89, 11.27, 11.33, 11.39, 11.51, 79.42, 79.68, 79.64, 78.34, 69.43, 61.67,
75.96, 75.75, 75.08, 81.37, 71.49, 73.28, 72.2, 13.73, 19.63, 28.1, 27.1,
27.48, 19.02, 17.48, 8.7, 17.67, 17.59, 33.16, 17.37, 17.36, 18.08, 32.84,
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14.65, 14.97, 17.07, 13.08, 16.9, 16.31, 6.92, 79.55, 79.48, 61.26, 11.73,
79.6, 79.22, 78.92, 78.71, 6.62, 6.68, 16.95, 17.13, 82.25, 82.49, 82.43,
81.19, 72.67, 65.05, 78.8, 78.58, 77.97, 83.67, 74.13, 76.31, 75.29, 11.62,
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8816, 9229, 9642, 10055, 10468, 10881, 11294, 11707, 12090, 12312, 12313,
12320, 12327, 12334, 12341, 12348, 12355, 12362, 12369, 12376, 12383, 12390,
12397, 12404, 12411, 12418, 12425, 12648, 12949, 13250, 13383, 13595, 13940,
14353, 14766, 15179, 15592, 16005, 16418, 16831, 17244, 17657, 18070, 18483,
18864, 19096, 19202, 19287, 19371, 19440, 19469, 19483, 19500, 19509, 19516,
19519)