In [1]:

```
######################################################################
#                      Practica No.3
# Pregunta 1
######################################################################

#Descomentar para instalar los paquetes
#install.packages("R2WinBUGS")
#install.packages("mcmcplots")

library(R2WinBUGS)
library(coda)
library(boot)
library(mcmcplots)
```

```
Warning message:
"package 'R2WinBUGS' was built under R version 3.4.4"Loading required packag
e: coda
Warning message:
"package 'coda' was built under R version 3.4.4"Loading required package: boo
t
Warning message:
"package 'mcmcplots' was built under R version 3.4.4"
```

In [2]:

```
#Directorio de WinBUGS
WINBUGS.DIR <- "D:/bin/WinBUGS14/"

#Nombre de archivo
NAME.FILE.MOD1.BUG <- "Practica-03-mod1.bug"
NAME.FILE.MOD2.BUG <- "Practica-03-mod2.bug"
NAME.FILE.MOD3.BUG <- "Practica-03-mod3.bug"

#Ruta archivo
PATH.FILE <- "https://raw.githubusercontent.com/jgomezz/MscEstadisticaAplicada
-UNALM-2018-2/master/MLG/Practica-03/molinos.csv"
```

In [3]:

```
#Lectura de datos
molinos.data <- read.csv(PATH.FILE, header = TRUE)
head(molinos.data)
```

| viento | corriente |
|---|---|
| 5.0 | 1.582 |
| 6.0 | 1.822 |
| 3.4 | 1.057 |
| 2.7 | 0.500 |
| 10.0 | 2.236 |
| 9.7 | 2.386 |

In [4]:

```
# Se tiene que usar una variable intermedio para
# pasar los valores, se usa vectores
viento <- molinos.data$viento
corriente <- molinos.data$corriente
n <- nrow(molinos.data)

# Se define arreglo de titulos de datos
datos <- list("viento","corriente","n")
```

In [5]:

```
####################################################################
# MODELO LINEAL NORMAL :  Modelo 1: Eta_i= Beta_0 + Beta_1*x_i
####################################################################

# Inferencia Clásica
fit1.model<-lm(molinos.data$corriente ~ molinos.data$viento)
summary(fit1.model)
```

```
Call:
lm(formula = molinos.data$corriente ~ molinos.data$viento)

Residuals:
     Min       1Q   Median       3Q      Max 
-0.59869 -0.14099  0.06059  0.17262  0.32184 

Coefficients:
                    Estimate Std. Error t value Pr(>|t|)    
(Intercept)          0.13088    0.12599   1.039     0.31    
molinos.data$viento  0.24115    0.01905  12.659 7.55e-12 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.2361 on 23 degrees of freedom
Multiple R-squared:  0.8745,	Adjusted R-squared:  0.869 
F-statistic: 160.3 on 1 and 23 DF,  p-value: 7.546e-12
```

In [6]:

```
# Aplicando Bayesianos
modelo <- function(){
  # verosimilitud
  for (i in 1:n) {
    mu[i] <- beta.0 + beta.1*viento[i];
    corriente[i] ~ dnorm(mu[i],tau);
  }
  # Las priori : estoy usando priori no informativos
  # porque le estoy dando un rango amplio ( 0.0 en casi todos los modelos)
  beta.0 ~ dnorm(0.0,1.0E-4);      # 1er parametro
  beta.1 ~ dnorm(0.0,1.0E-4);      # 2do parametro
  tau    ~ dgamma(1.0E-3,1.0E-3);  # 3er parametro , la precisión , uso gamma

  # con valores pequeño para tener una varianza grande
  sigma2 <- 1/tau;
}

# Grabar archivo
write.model(modelo, NAME.FILE.MOD1.BUG)

# Parametros
parametros <- c("beta.0","beta.1","tau","sigma2")

# Inicializa : asigna valores aleatorios para inicializarlos
iniciales <- function() { list(beta.0=rnorm(1),
                          beta.1=rnorm(1),
                          tau=rgamma(1,1,1))}

# Inferencia Bayesiana
fit1 <- bugs(data = datos,
             inits =  iniciales,
             parameters.to.save =  parametros,
             model.file= NAME.FILE.MOD1.BUG,
             n.chains=2,
             n.iter=20000,
             n.burnin=10000,
             n.thin=1,
             bugs.directory=WINBUGS.DIR,
             clearWD=TRUE,
             debug=FALSE)
```

In [7]:

```
#Mostrar resultados de la simulación
print(fit1,4)
```

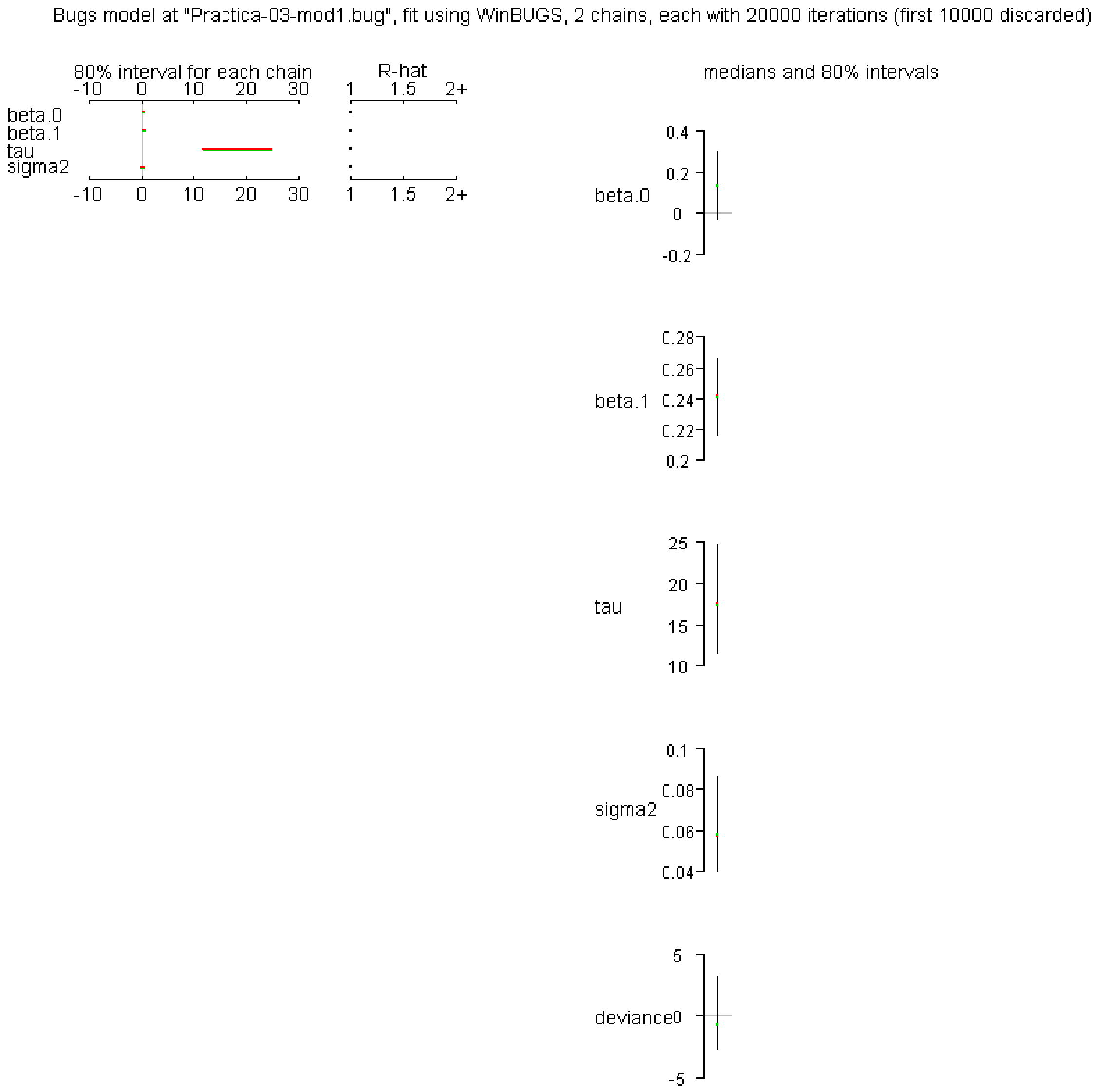
```
Inference for Bugs model at "Practica-03-mod1.bug", fit using WinBUGS,
 2 chains, each with 20000 iterations (first 10000 discarded)
 n.sims = 20000 iterations saved
            mean     sd    2.5%     25%     50%     75%   97.5%   Rhat n.eff
beta.0    0.1328 0.1314 -0.1290  0.0462  0.1330  0.2189  0.3925 1.0010 20000
beta.1    0.2409 0.0198  0.2024  0.2278  0.2409  0.2540  0.2803 1.0010 20000
tau      17.8848 5.2740  9.1159 14.0900 17.3850 21.0900 29.6200 1.0010 20000
sigma2    0.0612 0.0197  0.0338  0.0474  0.0575  0.0710  0.1097 1.0010 20000
deviance -0.1616 2.5452 -3.0860 -2.0360 -0.7978  1.0192  6.4210 1.0011 14000

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).

DIC info (using the rule, pD = Dbar-Dhat)
pD = 3.1 and DIC = 2.9
DIC is an estimate of expected predictive error (lower deviance is better).
```

In [8]:

```
#Diagnostico de Convergencia
plot(fit1)
```



In [9]:

```
#Mostrar resultado por navegador de trace, density, autocorrelation
mcmcplot(fit1)
```

In [10]:

```
######################################################################
# Modelo Lineal Normal - Modelo 2 : Eta_i= Beta_0 + Beta_1*1/x_i
######################################################################

# Inferencia Clásica -
fit2.model<-lm(molinos.data$corriente ~ I(1/molinos.data$viento))
summary(fit2.model)
```

```
Call:
lm(formula = molinos.data$corriente ~ I(1/molinos.data$viento))

Residuals:
     Min       1Q   Median       3Q      Max 
-0.20547 -0.04940  0.01100  0.08352  0.12204 

Coefficients:
                         Estimate Std. Error t value Pr(>|t|)    
(Intercept)                2.9789     0.0449   66.34   <2e-16 ***
I(1/molinos.data$viento)  -6.9345     0.2064  -33.59   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09417 on 23 degrees of freedom
Multiple R-squared:   0.98,	Adjusted R-squared:  0.9792 
F-statistic:  1128 on 1 and 23 DF,  p-value: < 2.2e-16
```

In [11]:

```
# Aplicando Bayesianos
modelo <- function(){
  # verosimilitud
  for (i in 1:n) {
    mu[i] <- beta.0 + beta.1*(1/viento[i]);
    corriente[i] ~ dnorm(mu[i],tau);
  }
  # Las priori : estoy usando priori no informativos
  # porque le estoy dando un rango amplio ( 0.0 en casi todos los modelos)
  beta.0 ~ dnorm(0.0,1.0E-4);      # 1er parametro
  beta.1 ~ dnorm(0.0,1.0E-4);      # 2do parametro
  tau    ~ dgamma(1.0E-3,1.0E-3);  # 3er parametro , la precisión , uso gamma

  # con valores pequeño para tener una varianza grande
  sigma2 <- 1/tau;
}

# Grabar archivo
write.model(modelo, NAME.FILE.MOD2.BUG)

# Parametros
parametros <- c("beta.0","beta.1","tau","sigma2")

# Inicializa : asigna valores aleatorios para inicializarlos
iniciales <- function() { list(beta.0=rnorm(1),
                               beta.1=rnorm(1),
                               tau=rgamma(1,1,1))}

# Inferencia Bayesiana
fit2 <- bugs(data = datos,
             inits =  iniciales,
             parameters.to.save =  parametros,
             model.file= NAME.FILE.MOD2.BUG,
             n.chains=2,
             n.iter=20000,
             n.burnin=10000,
             n.thin=1,
             bugs.directory=WINBUGS.DIR,
             clearWD=TRUE,
             debug=FALSE)
```

In [12]:
```
#Mostrar resultados de la simulación
print(fit2,4)
```

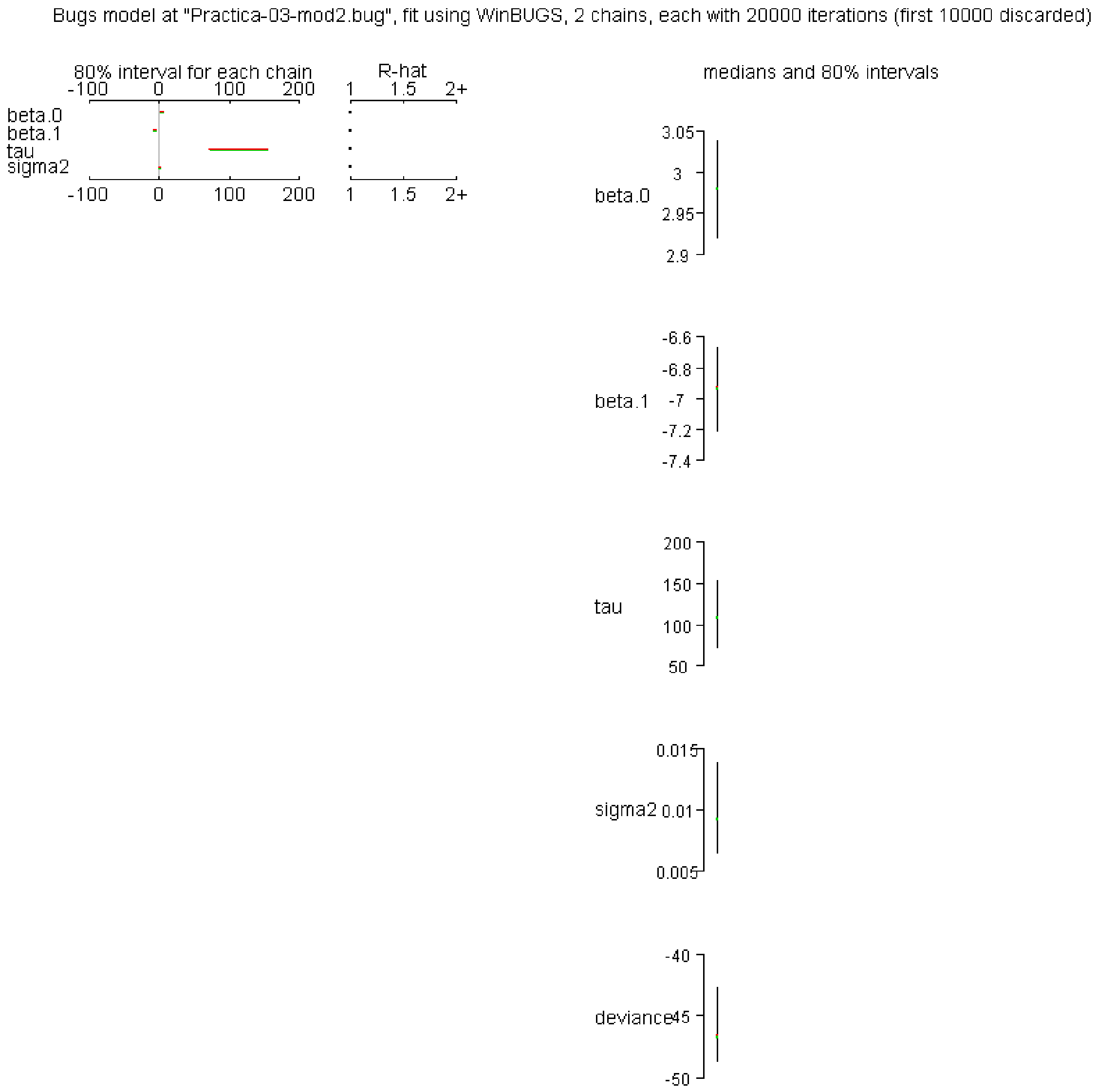
```
Inference for Bugs model at "Practica-03-mod2.bug", fit using WinBUGS,
 2 chains, each with 20000 iterations (first 10000 discarded)
 n.sims = 20000 iterations saved
             mean      sd     2.5%      25%      50%      75%    97.5%   Rhat
beta.0     2.9796  0.0470   2.8850   2.9490   2.9800   3.0100   3.0720 1.0010
beta.1    -6.9376  0.2158  -7.3560  -7.0800  -6.9380  -6.7950  -6.5080 1.0010
tau      111.4552 32.8664  56.8095  87.7800 108.3000 131.4000 184.6000 1.0010
sigma2     0.0098  0.0032   0.0054   0.0076   0.0092   0.0114   0.0176 1.0010
deviance -46.0906  2.5581 -49.0300 -47.9725 -46.7300 -44.9100 -39.4700 1.0011
         n.eff
beta.0   20000
beta.1   20000
tau      20000
sigma2   20000
deviance 14000

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).

DIC info (using the rule, pD = Dbar-Dhat)
pD = 3.1 and DIC = -43.0
DIC is an estimate of expected predictive error (lower deviance is better).
```

In [13]:

```
#Diagnostico de Convergencia
plot(fit2)
```



In [14]:

```
#Mostrar resultado por navegador de trace, density, autocorrelation
mcmcplot(fit2)
```

In [15]:

```
####################################################################
# Modelo Lineal Normal - Modelo 3 : Eta_i= Beta_0 + Beta_1*log(x_i)
####################################################################

# Inferencia Clásica -
fit3.model<-lm(molinos.data$corriente ~ I(log(molinos.data$viento)))
summary(fit3.model)
```

```
Call:
lm(formula = molinos.data$corriente ~ I(log(molinos.data$viento)))

Residuals:
     Min       1Q   Median       3Q      Max 
-0.31619 -0.07685  0.02395  0.11139  0.23029 

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)    
(Intercept)                 -0.83036    0.11083  -7.493  1.3e-07 ***
I(log(molinos.data$viento))  1.41677    0.06234  22.728  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.1376 on 23 degrees of freedom
Multiple R-squared:  0.9574,	Adjusted R-squared:  0.9555 
F-statistic: 516.6 on 1 and 23 DF,  p-value: < 2.2e-16
```

In [16]:

```
# Aplicando Bayesianos
modelo <- function(){
  # verosimilitud
  for (i in 1:n) {
    mu[i] <- beta.0 + beta.1*log(viento[i]);
    corriente[i] ~ dnorm(mu[i],tau);
  }
  # Las priori : estoy usando priori no informativos
  # porque le estoy dando un rango amplio ( 0.0 en casi todos los modelos)
  beta.0 ~ dnorm(0.0,1.0E-4);      # 1er parametro
  beta.1 ~ dnorm(0.0,1.0E-4);      # 2do parametro
  tau    ~ dgamma(1.0E-3,1.0E-3);  # 3er parametro , la precisión , uso gamma

  # con valores pequeño para tener una varianza grande
  sigma2 <- 1/tau;
}

# Grabar archivo
write.model(modelo, NAME.FILE.MOD3.BUG)

# Parametros
parametros <- c("beta.0","beta.1","tau","sigma2")

# Inicializa : asigna valores aleatorios para inicializarlos
iniciales <- function() { list(beta.0=rnorm(1),
                               beta.1=rnorm(1),
                               tau=rgamma(1,1,1))}

# Inferencia Bayesiana
fit3 <- bugs(data = datos,
             inits =  iniciales,
             parameters.to.save =  parametros,
             model.file= NAME.FILE.MOD3.BUG,
             n.chains=2,
             n.iter=20000,
             n.burnin=10000,
             n.thin=1,
             bugs.directory=WINBUGS.DIR,
             clearWD=TRUE,
             debug=FALSE)
```

In [17]:
```
#Mostrar resultados de la simulación
print(fit3,4)
```

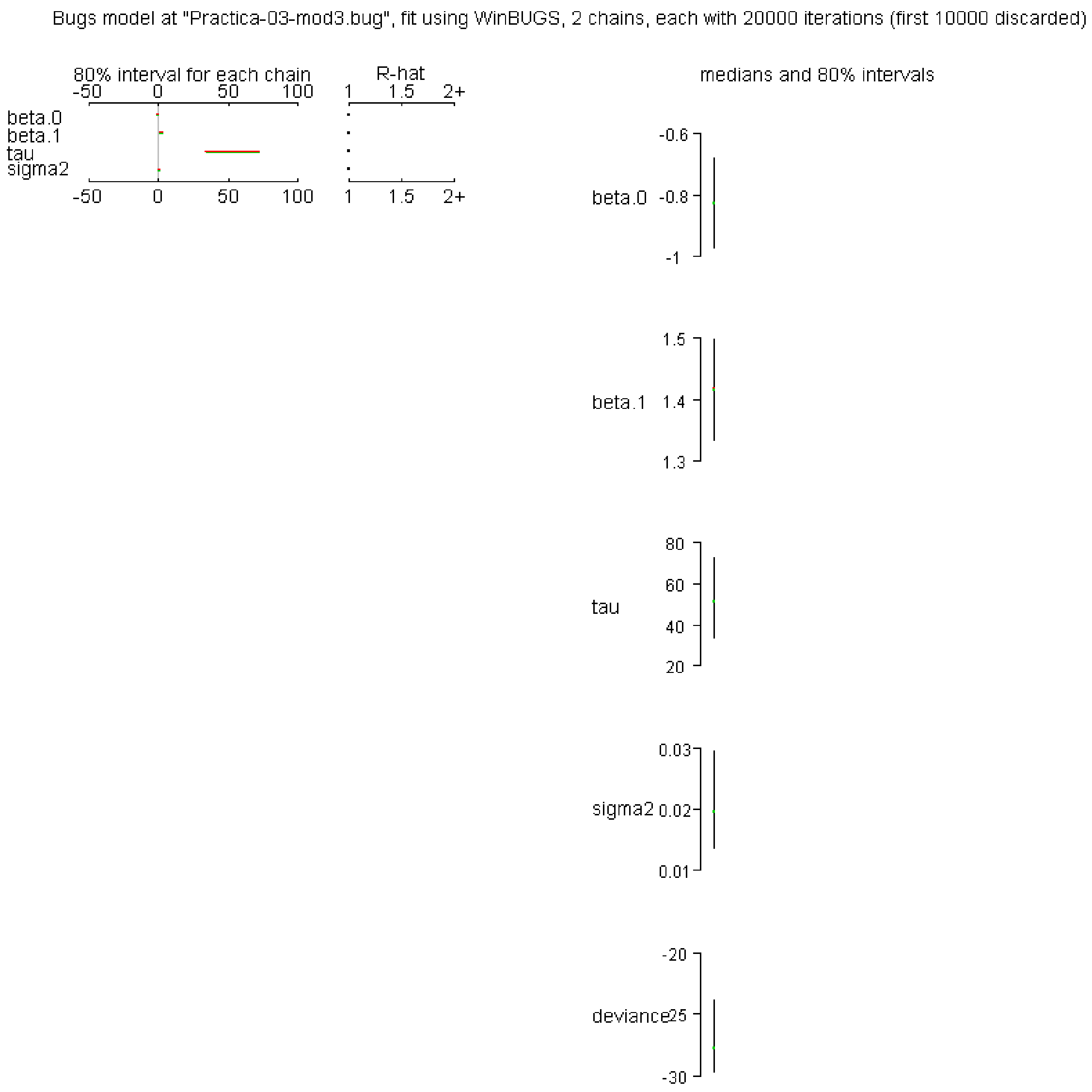
```
Inference for Bugs model at "Practica-03-mod3.bug", fit using WinBUGS,
 2 chains, each with 20000 iterations (first 10000 discarded)
 n.sims = 20000 iterations saved
             mean      sd     2.5%      25%      50%      75%    97.5%   Rhat
beta.0    -0.8286  0.1157  -1.0590  -0.9046  -0.8284  -0.7523  -0.6008 1.0010
beta.1     1.4158  0.0650   1.2900   1.3730   1.4160   1.4590   1.5450 1.0010
tau       52.4982 15.4810  26.7597  41.3500  51.0300  61.9000  86.9502 1.0010
sigma2     0.0208  0.0067   0.0115   0.0162   0.0196   0.0242   0.0374 1.0010
deviance -27.1516  2.5498 -30.0800 -29.0300 -27.7900 -25.9700 -20.5500 1.0011
         n.eff
beta.0   20000
beta.1   20000
tau      20000
sigma2   20000
deviance 14000

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).

DIC info (using the rule, pD = Dbar-Dhat)
pD = 3.1 and DIC = -24.1
DIC is an estimate of expected predictive error (lower deviance is better).
```

In [18]:

```
#Diagnostico de Convergencia
plot(fit3)
```



In [19]:

```
#Mostrar resultado por navegador de trace, density, autocorrelation
mcmcplot(fit3)
```