Zero-Inflation Meta-analysis

Multiple regression

ANOVA

Repeated measure model

Animal model

Mixed model

Zero-Inflation

Survival analysis

ANCOVA

Split-Plot

Phylogenetic mixed model

Random Regression

Ridge Regression

MANCOVA

Censoring

Threshold model

GLM

Nested ANOVA

Over-dispersion

Logistic Regression

Generalised Linear Mixed Models
GLMM

Generalised Linear Mixed Models
GLMM

MCMCglmm: an R package for fitting Bayesian GLMM using Markov chain Monte Carlo

A Toy Example

y = rnorm(5, mean = 0, sd = sqrt(1))

0.256   -1.995   -0.362   0.685   0.118

A Toy Example

y = rnorm(5, mean = 0, sd = sqrt(1))

0.256 -1.995 -0.362 0.685 0.118

What is the mean and variance of the distribution these numbers were drawn from?

Likelihood

0.256

Pr(y | mean, variance)

μ

-1.995

Probability of the data *given* the parameters

-0.362

σ^2

0.685

0.118

Likelihood

0.256

Pr(y | mean, variance)

μ

-1.995

Probability of the data *given* the parameters

-0.362

σ^2

Bayesian

0.685

Pr(mean, variance | y)

Probability of the parameters *given* the data

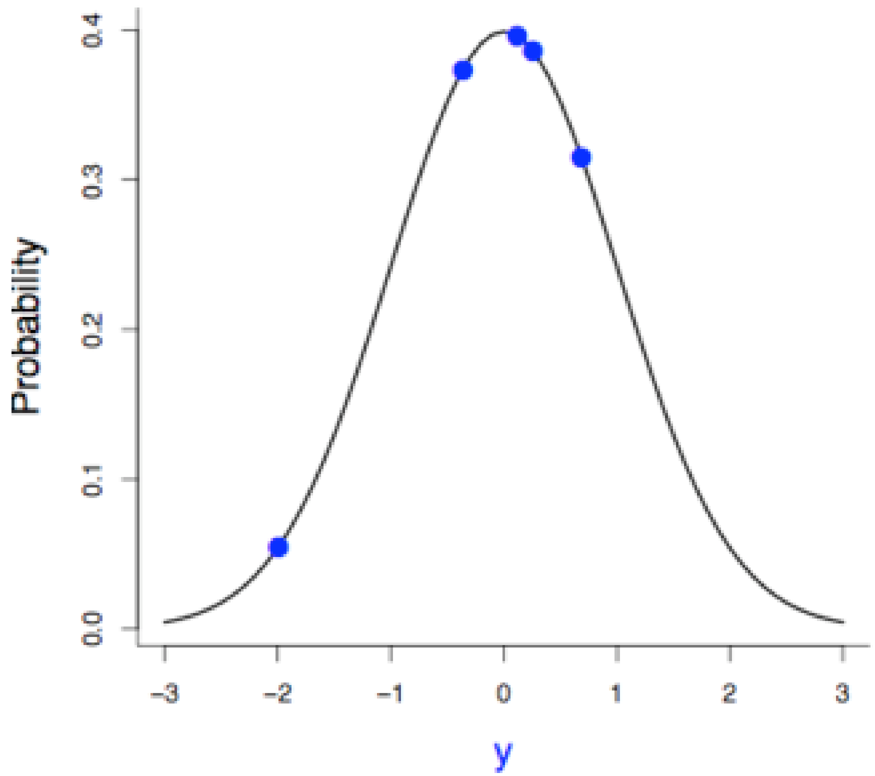
0.118

Likelihood

prod(dnorm(y, mean=0, sd=sqrt(1)))
0.00098

μ

σ^2



0.256

-1.995

-0.362

0.685

0.118

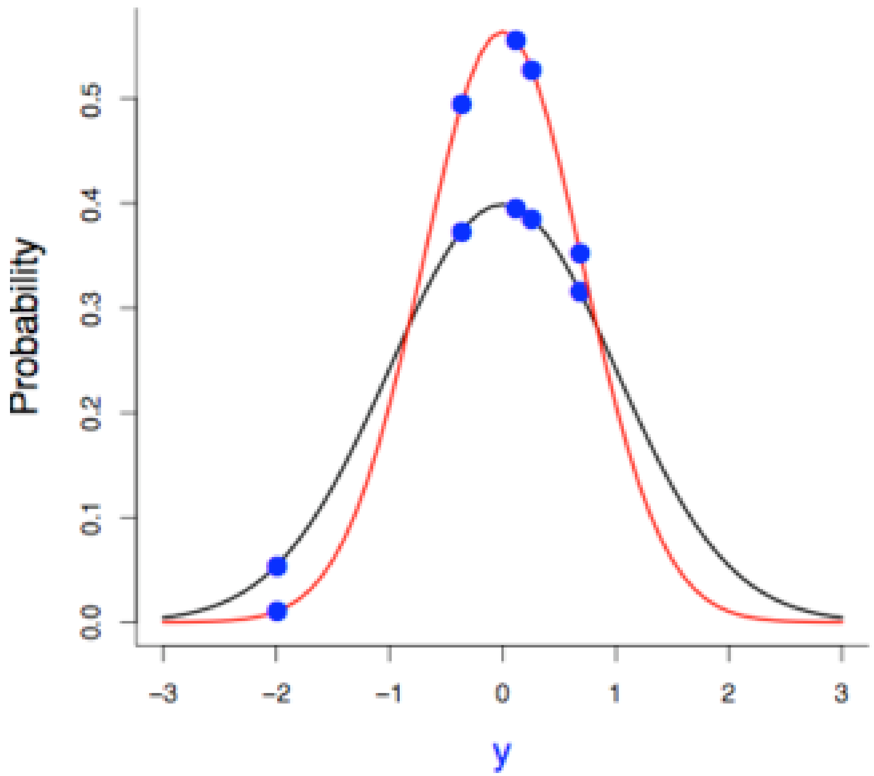
Likelihood

prod(dnorm(y, mean=0, sd=sqrt(0.5)))

0.00054

μ

σ^2



0.256

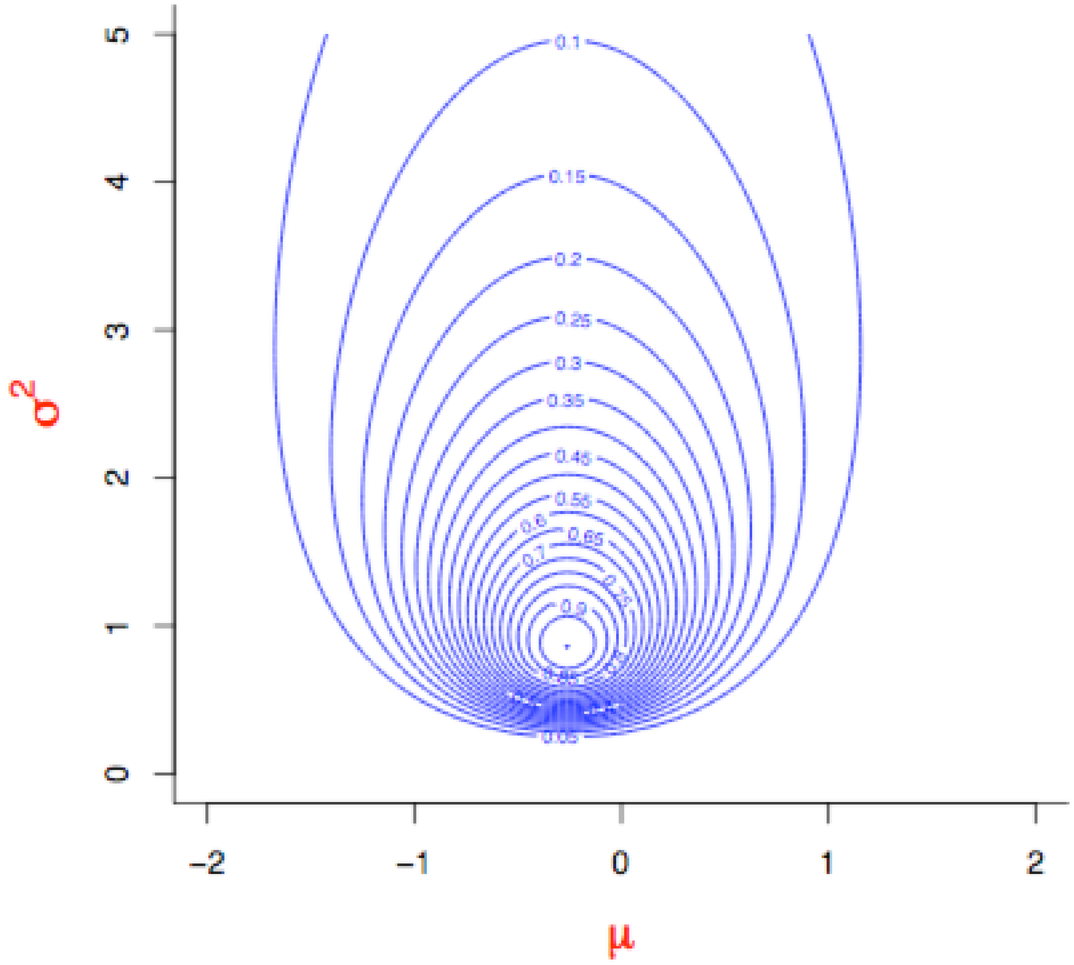
-1.995

-0.362

0.685

0.118

Likelihood



0.256

-1.995

-0.362

0.685

0.118

Maximum Likelihood

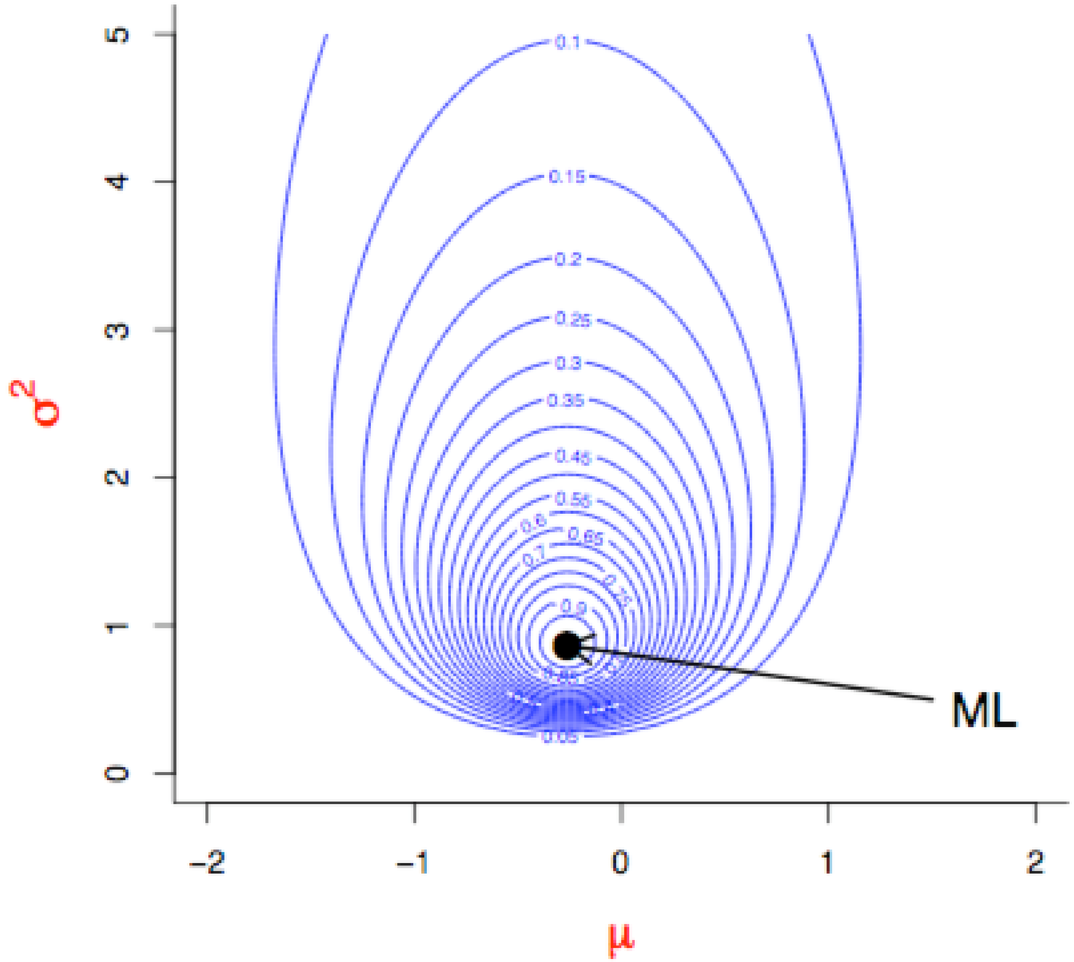
0.256

-1.995

-0.362

0.685

0.118



Maximum Likelihood

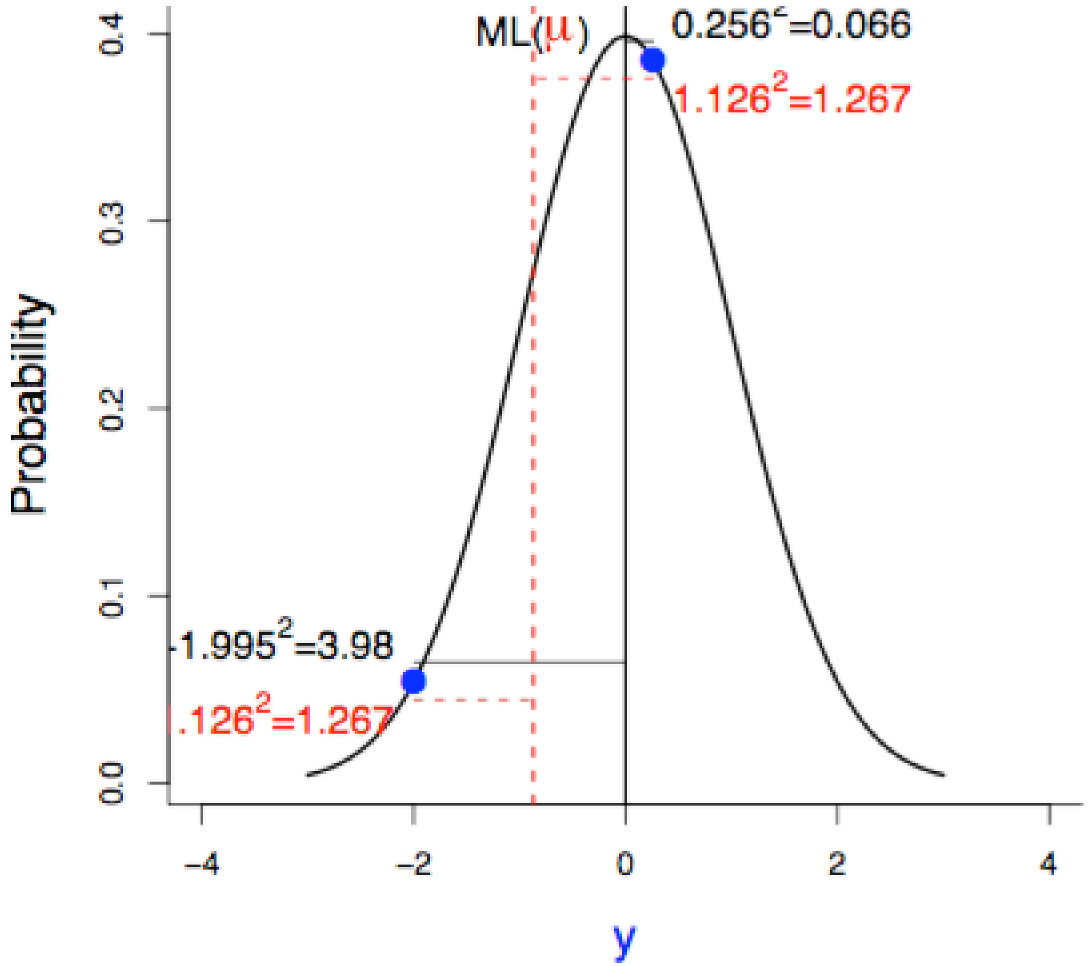
$$ML(\mu) = -0.2596 \quad ML(\sigma^2) = 0.8649$$

```
summary(glm(y~1))

Coefficients:
              Estimate Std. Error  t value    Pr(>|t|)
(Intercept)    -0.2596     0.4650   -0.558     0.606

(Dispersion parameter for gaussian 1.081121)
```

Restricted Maximum Likelihood



0.256

-1.995

-0.362

0.685

0.118

Bayesian

Pr(mean, variance | y)

0.256

Posterior distribution

μ

-1.995

-0.362

σ^2

0.685

0.118

Bayesian

Pr(mean, variance | y) 0.256

Posterior distribution

μ -1.995

=

Pr(y | mean, variance) -0.362

σ^2

Likelihood

0.685

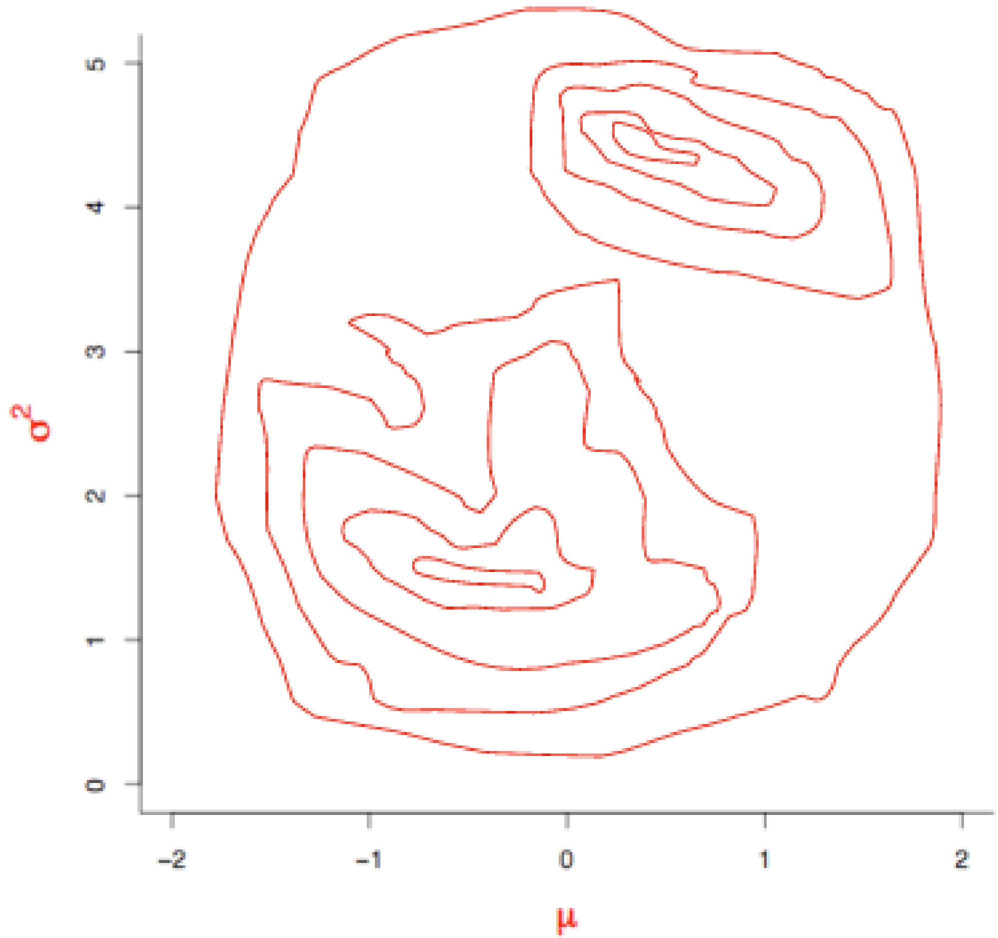
*

Pr(mean, variance) 0.118

Prior

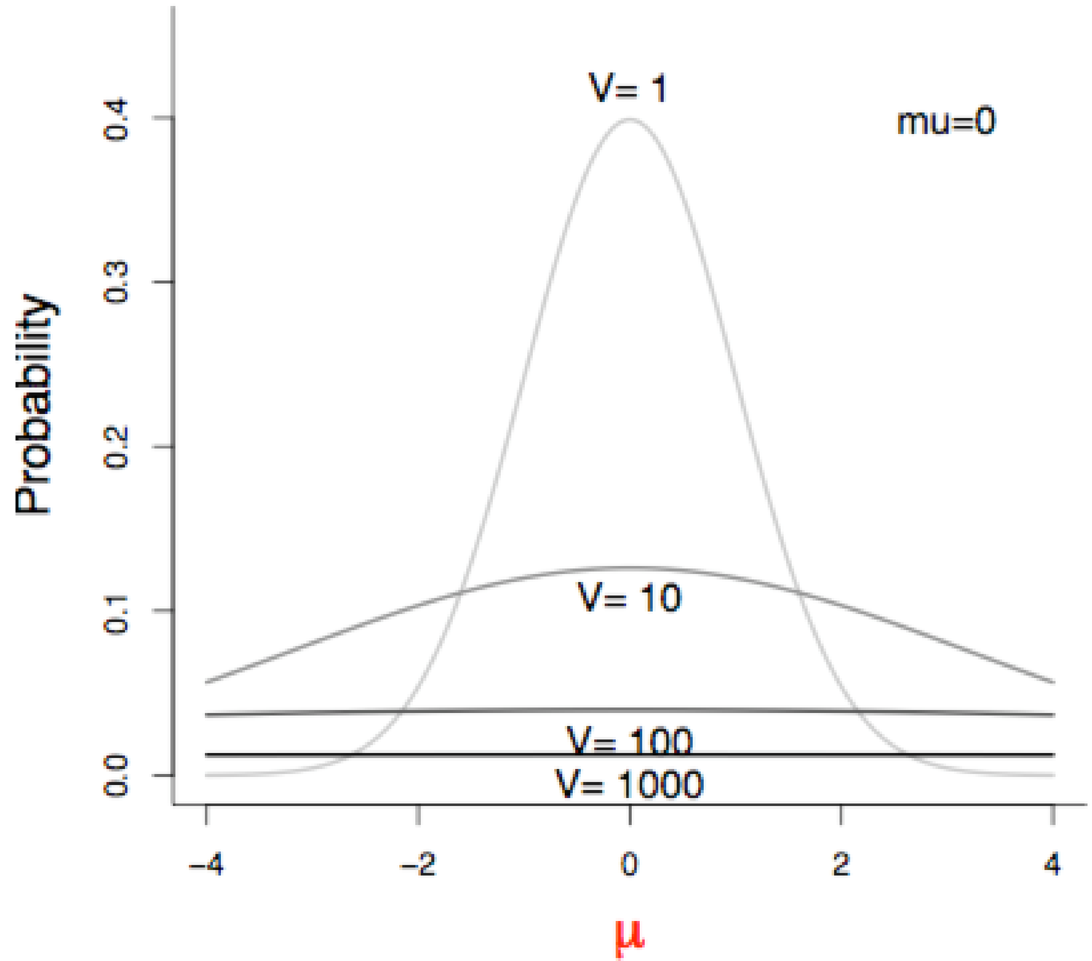
Prior

Pr(mean, variance)



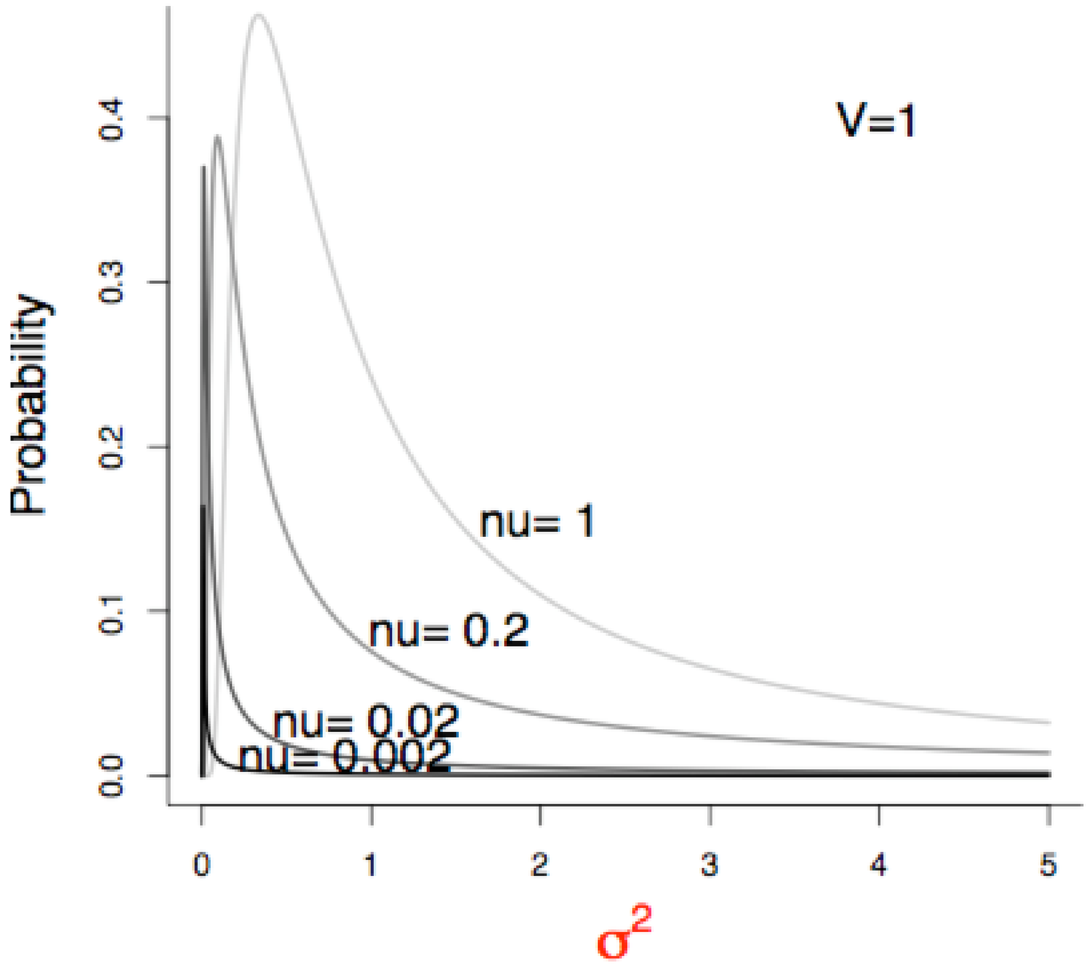
Prior

Pr(mean) ~ Normal(Bmu, BV)



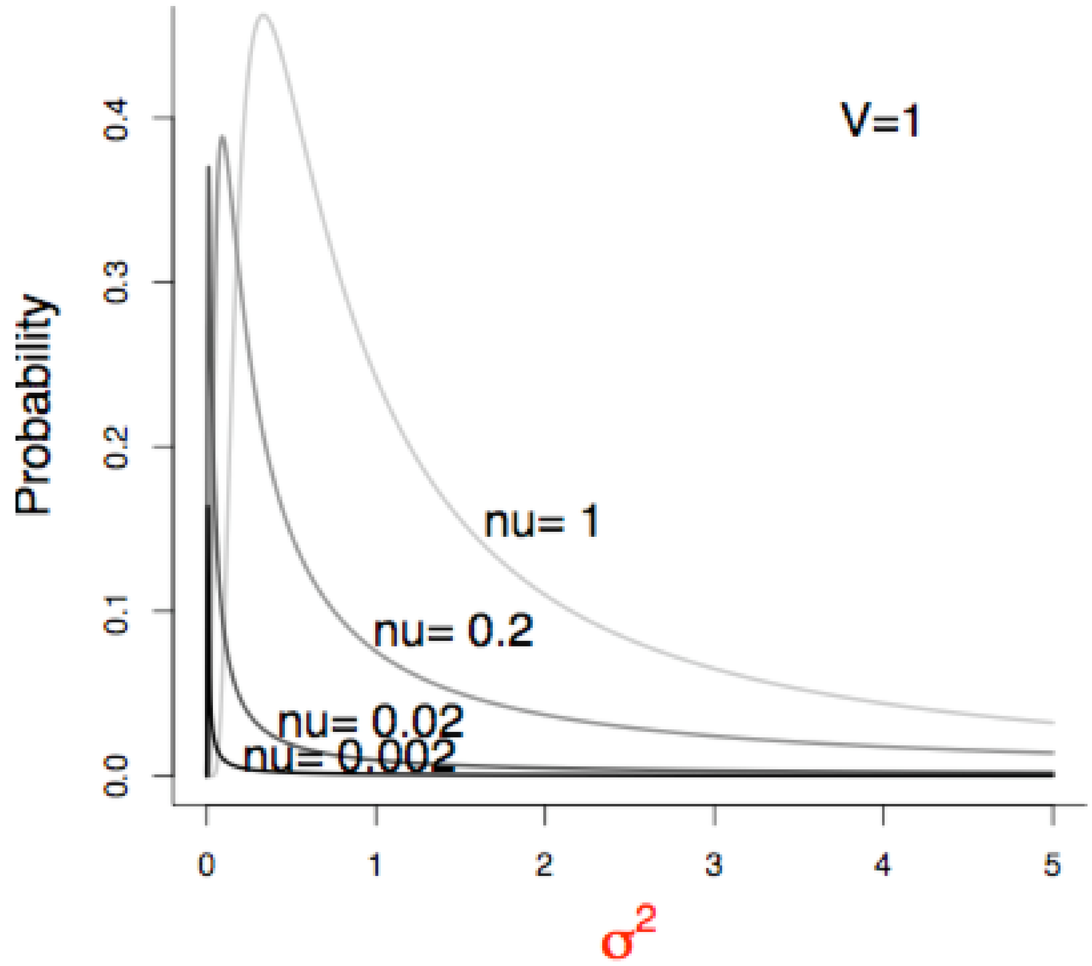
Prior

Pr(variance) ~ Inv-Wishart(RV, Rnu)



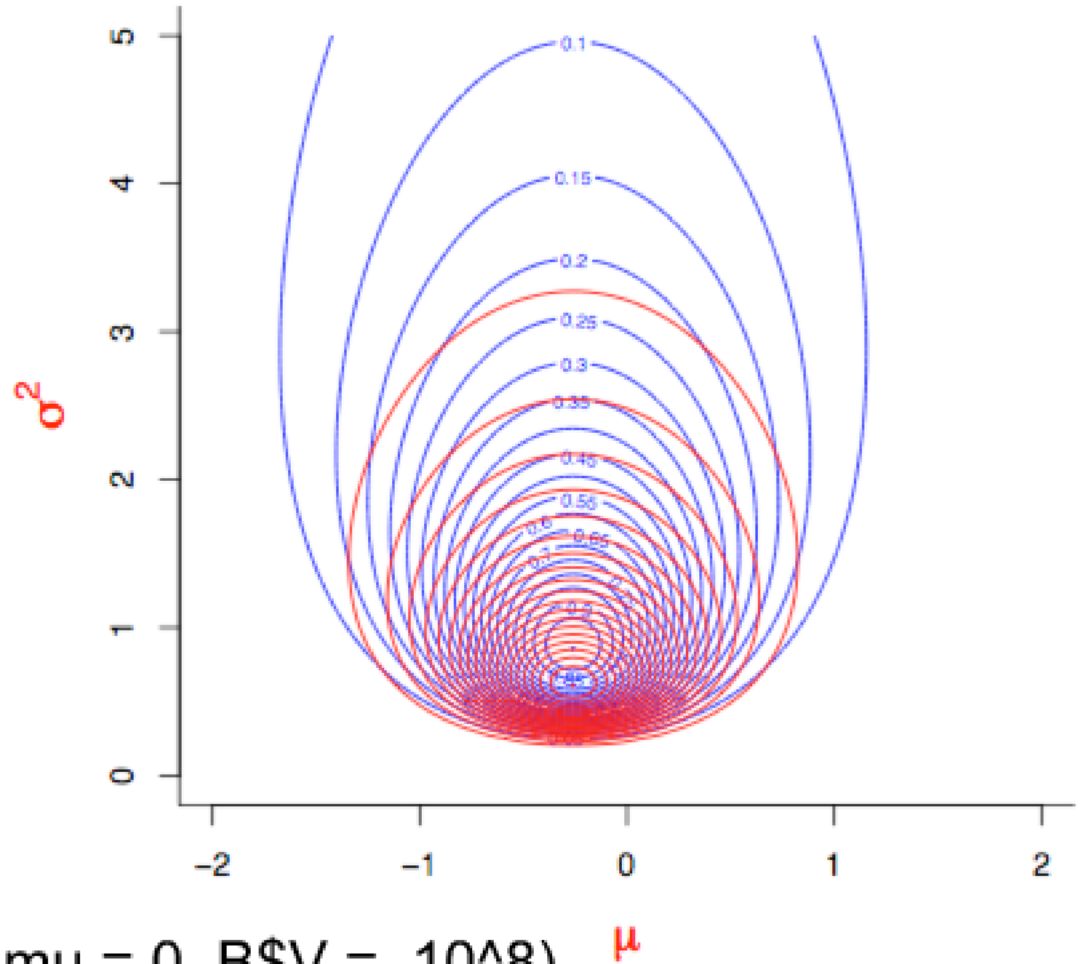
Prior

Pr(variance) ~ Inv-Wishart(RV, Rnu)



Posterior = Likelihood*Prior

Pr(variance) ~ IW(R$V = 1, R$nu = 0.002)



0.256

-1.995

-0.362

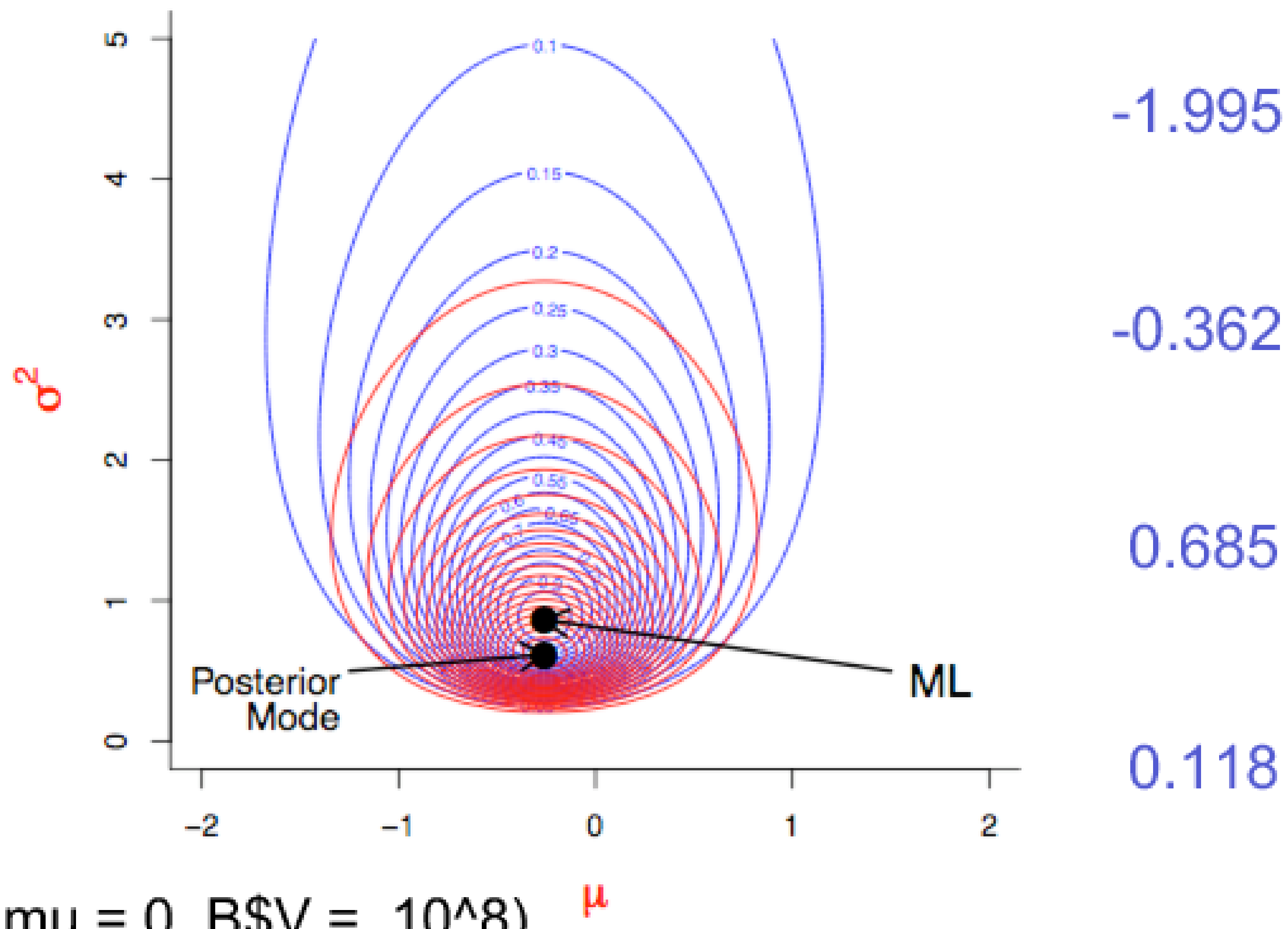
0.685

0.118

Pr(mean) ~ N(B$mu = 0, B$V = 10^8)

Posterior = Likelihood*Prior

Pr(variance) ~ IW(R$V = 1, R$nu = 0.002)



Pr(mean) ~ N(B$mu = 0, B$V = 10^8)

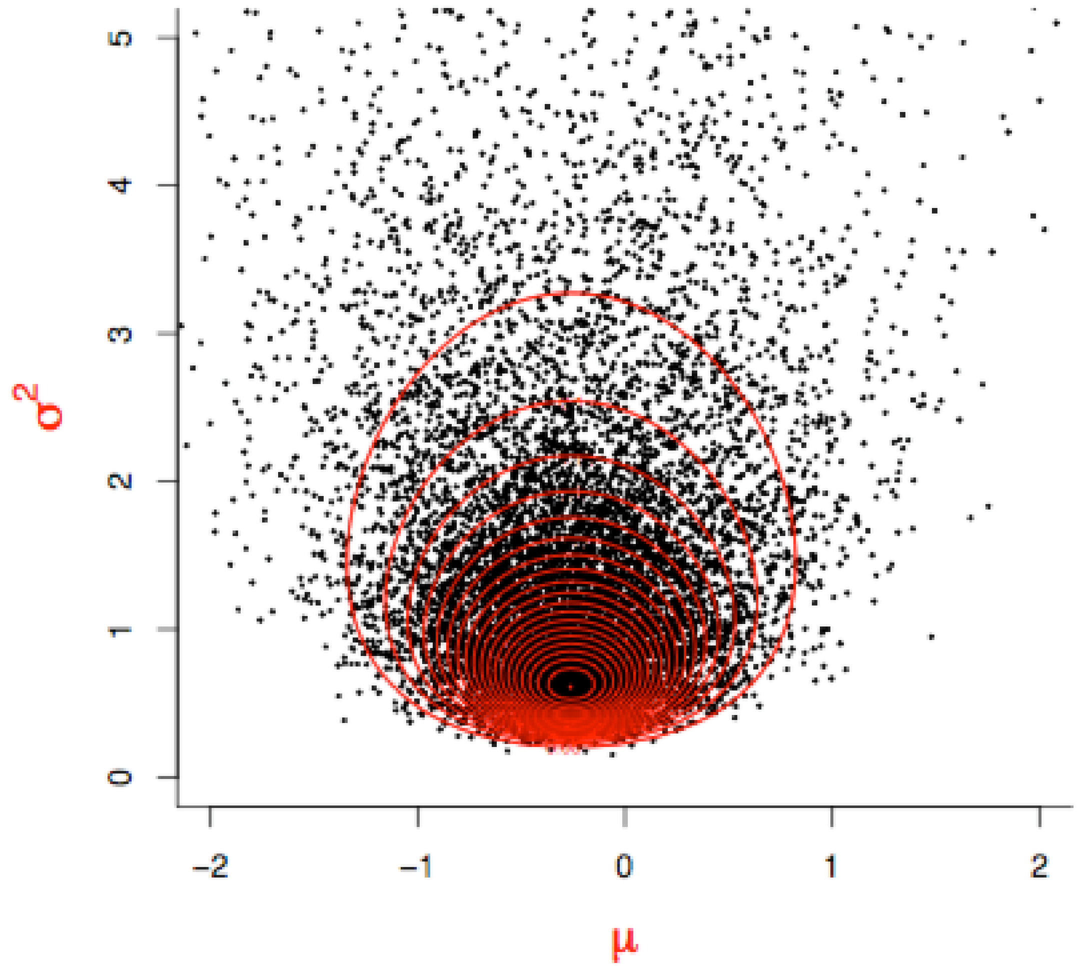
MCMC

```
prior=list(
B=list(mu=0, V=10^8)
R=list(V=1, nu=0.002)
)

model1<-MCMCglmm(y~1, prior=prior)

points(model1$Sol, model1$VCV)
```

Posterior = Likelihood*Prior



0.256

-1.995

-0.362

0.685

0.118

Marginal Posterior Distribution

0.256

Pr(-2 < μ < 2 & σ^2 < 5 | y)

-1.995

table(-2 > model1$Sol < 2 & model1$VCV < 5)

FALSE TRUE
0.0729 0.9271

-0.362

0.685

0.118

Marginal Posterior Distribution

0.256

Pr(-2 < μ < 2 & σ^2 < 5 | y)

table(-2 > model1$Sol < 2 & model1$VCV < 5)

-1.995

FALSE TRUE
0.0729 0.9271

-0.362

Pr(σ^2 < 5 | y)

0.685

table(model1$VCV < 5)

FALSE TRUE
0.0693 0.9307

0.118

Marginal Posterior Distribution

0.256

$$\Pr(\sigma^2 \mid y) = \int \Pr(\mu, \sigma^2 \mid y)\, d\mu$$

-1.995

Probability of the variance *given* the data, by *averaging over the uncertainty in the mean*

-0.362

0.685

0.118

Marginal Posterior Distribution

hist(model1$VCV)

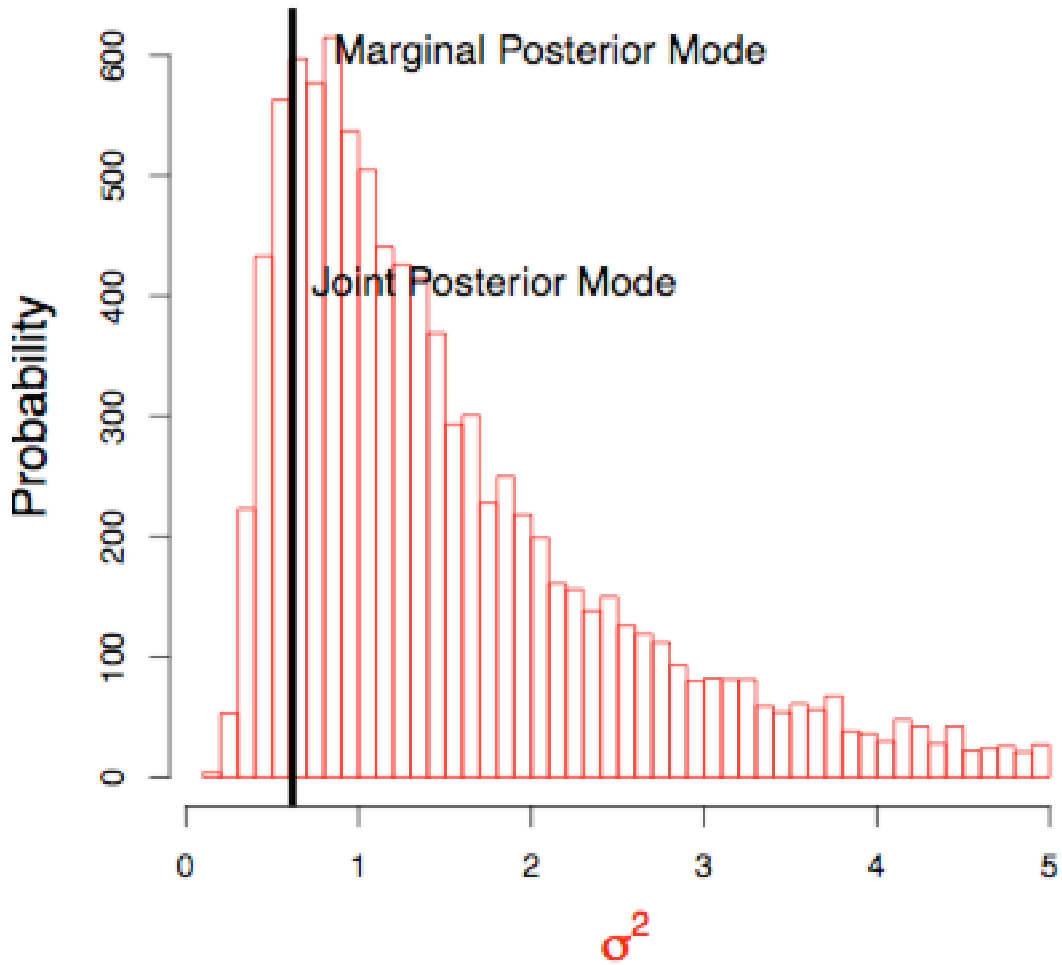
0.256

-1.995

-0.362

0.685

0.118



Improper Prior

A probability distribution must sum to one because a variable must have some value!

If we assume an equal probability for all values of the mean:

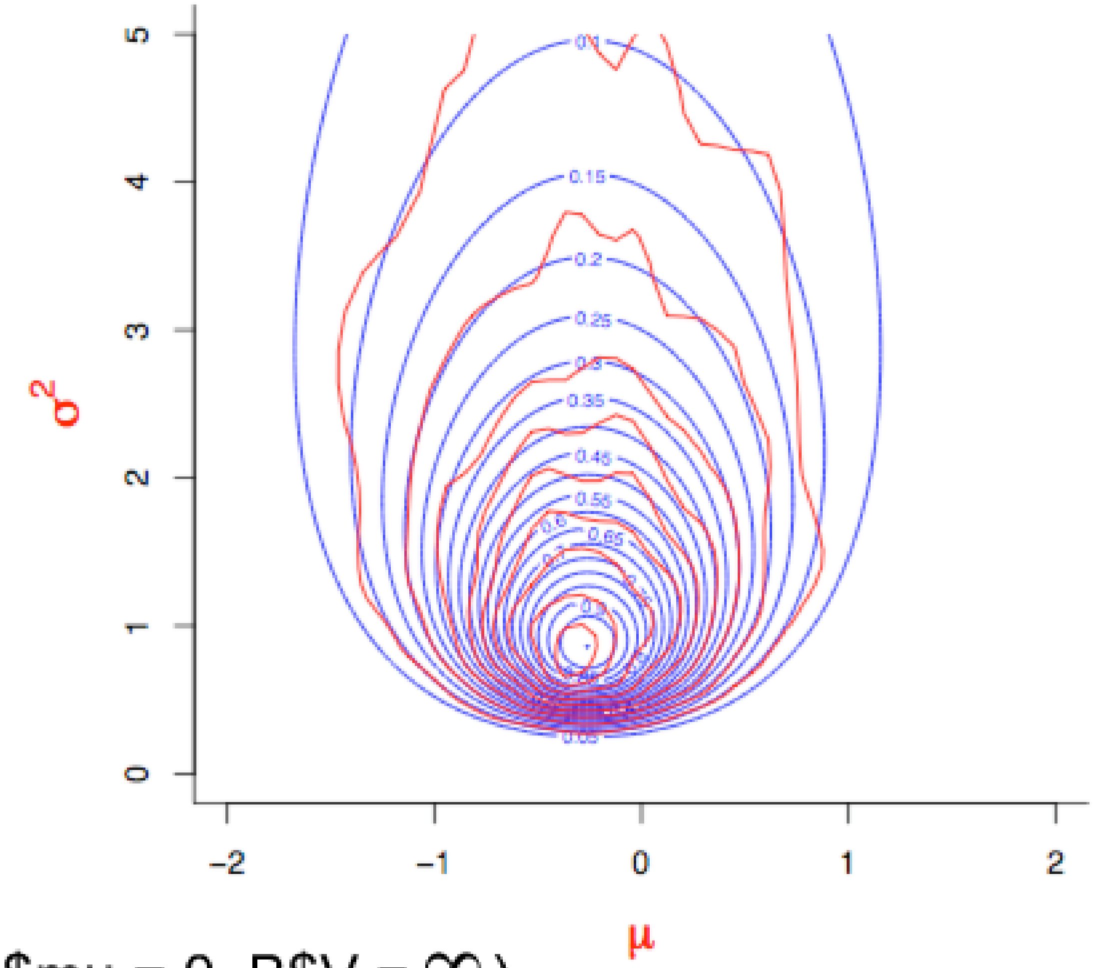
Pr(mean) ~ N(B$mu = 0, B$V = ∞)

then this is not true, and the distribution is *improper*.

Improper priors can be useful but be very careful!

Flat Improper Prior

Pr(variance) ~ IW(R$V = 0, R$nu = 0)



0.256

-1.995

-0.362

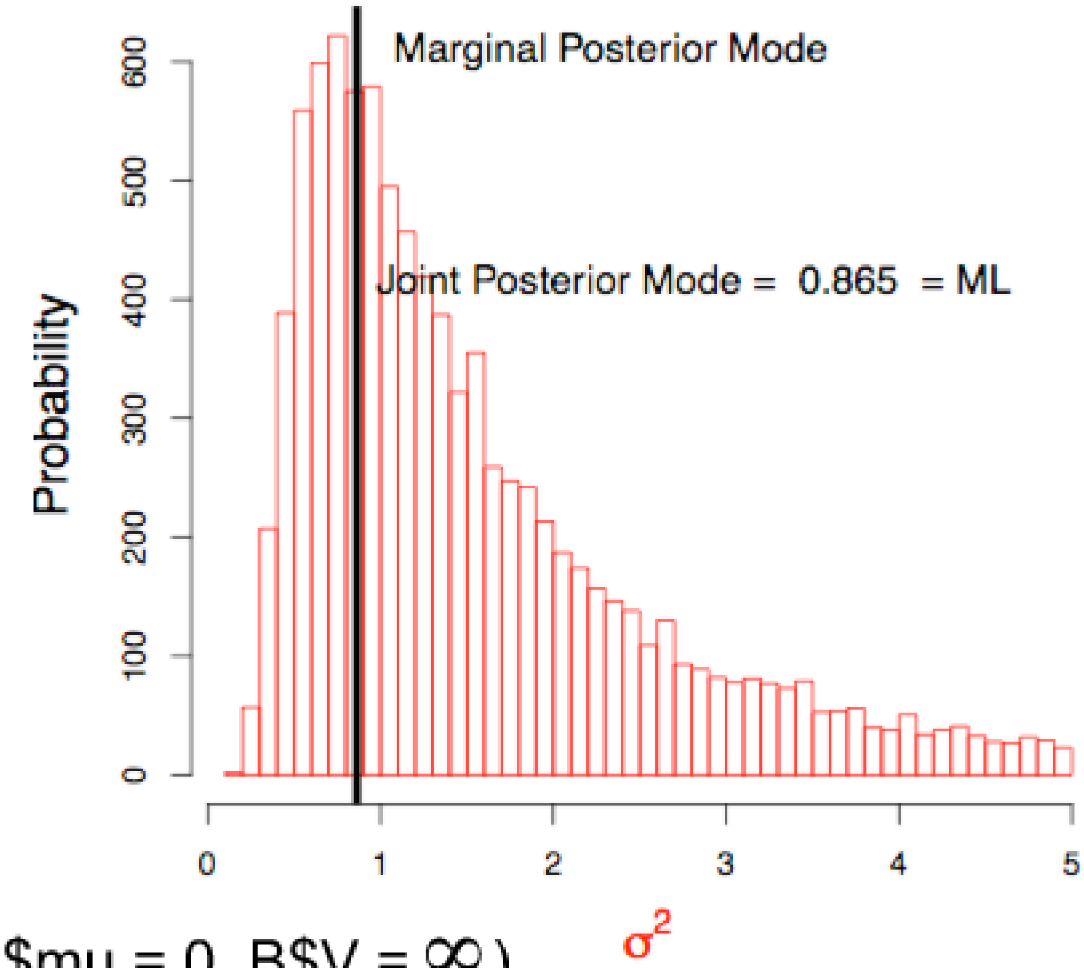
0.685

0.118

Pr(mean) ~ N(B$mu = 0, B$V = ∞)

Flat Improper Prior

Pr(variance) ~ IW(R$V = 0, R$nu = 0)



0.256

-1.995

-0.362

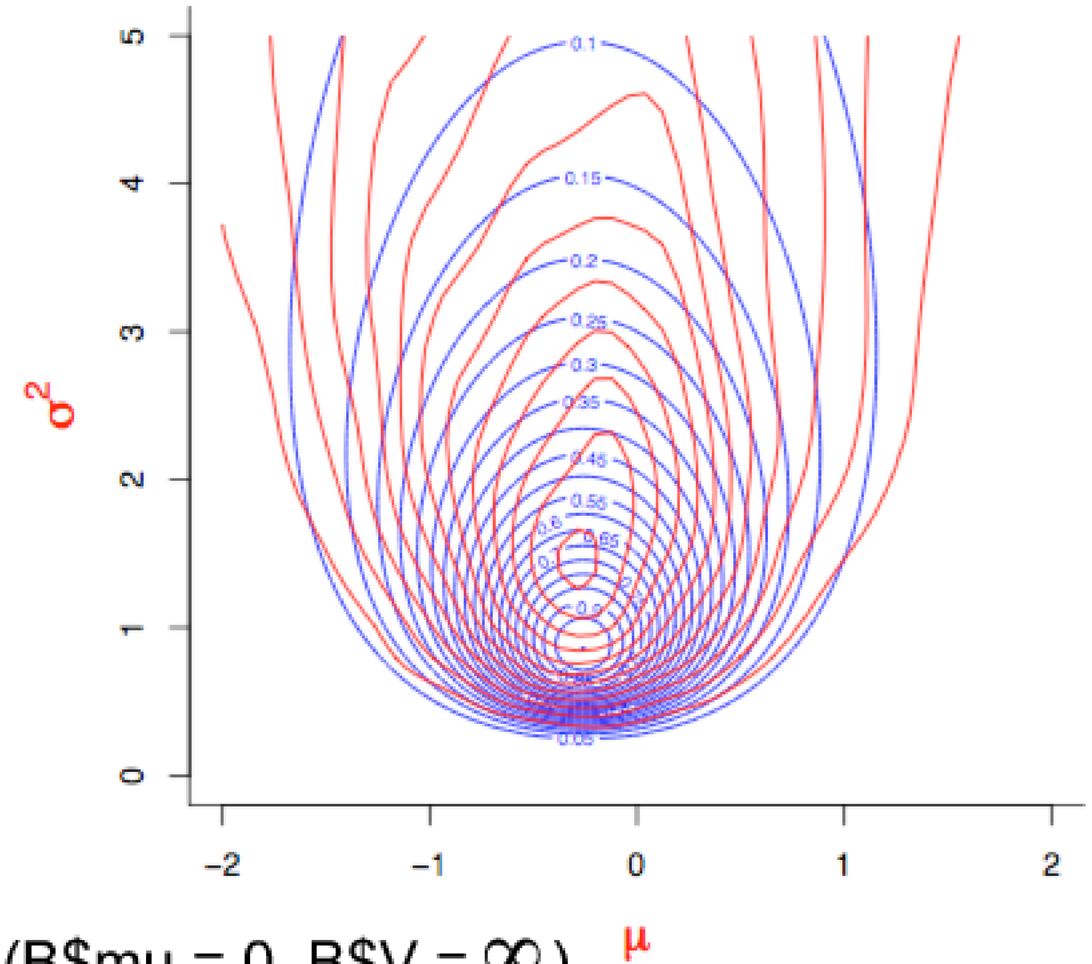
0.685

0.118

Pr(mean) ~ N(B$mu = 0, B$V = ∞)

Non-Informative Improper Prior

Pr(variance) ~ IW(R$V = 0, R$nu = -2)



0.256

-1.995

-0.362

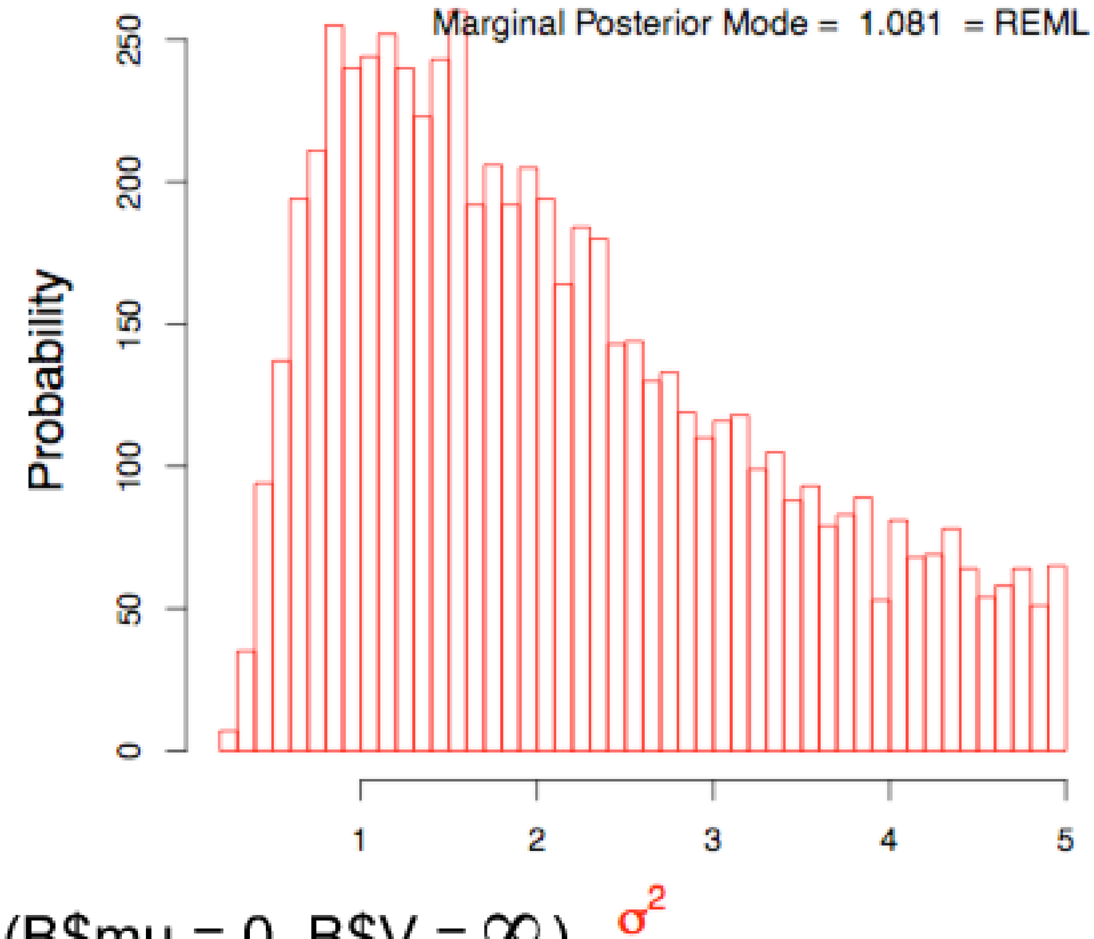
0.685

0.118

Pr(mean) ~ N(B$mu = 0, B$V = ∞)

Non-Informative Improper Prior

Pr(variance) ~ IW(R$V = 0, R$nu = -2)



0.256

-1.995

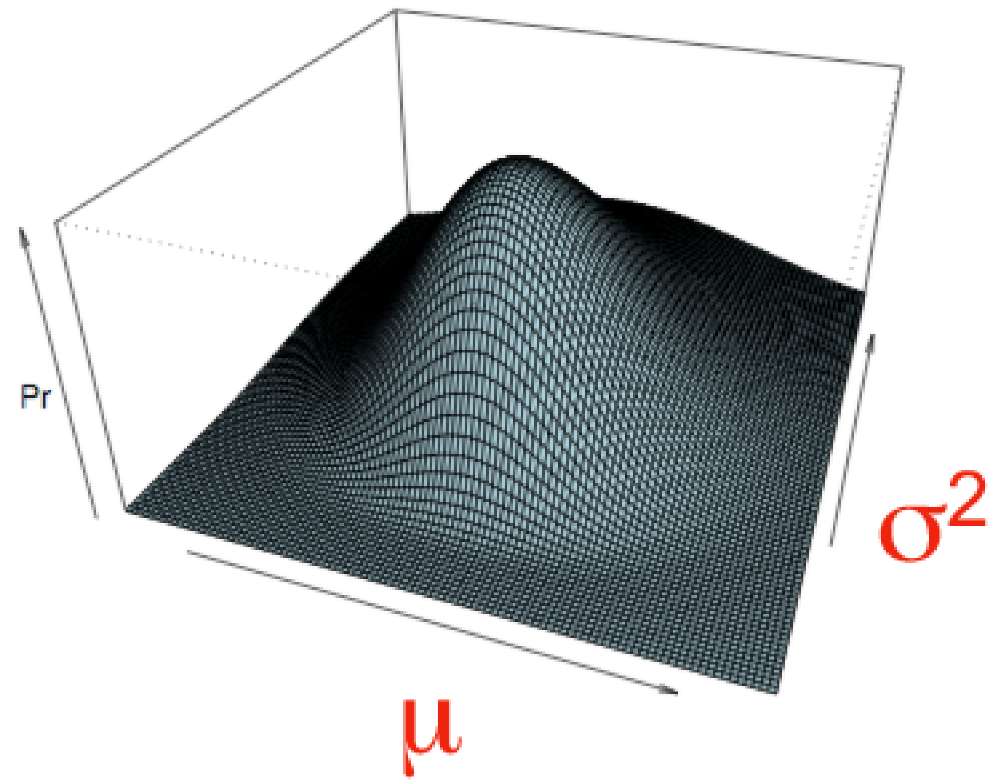
-0.362

0.685

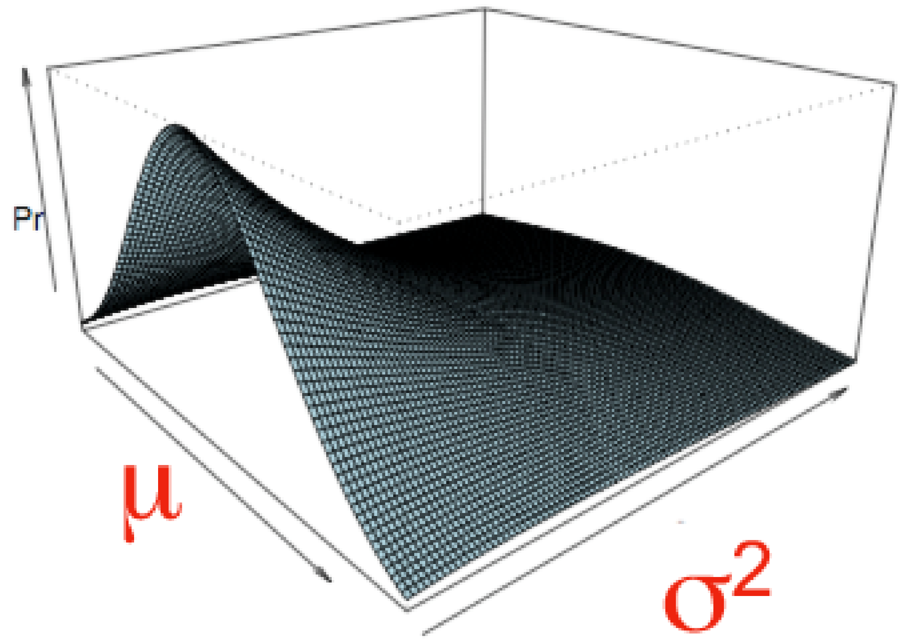
0.118

Pr(mean) ~ N(B$mu = 0, B$V = ∞)

MCMC Diagnostics



MCMC Diagnostics

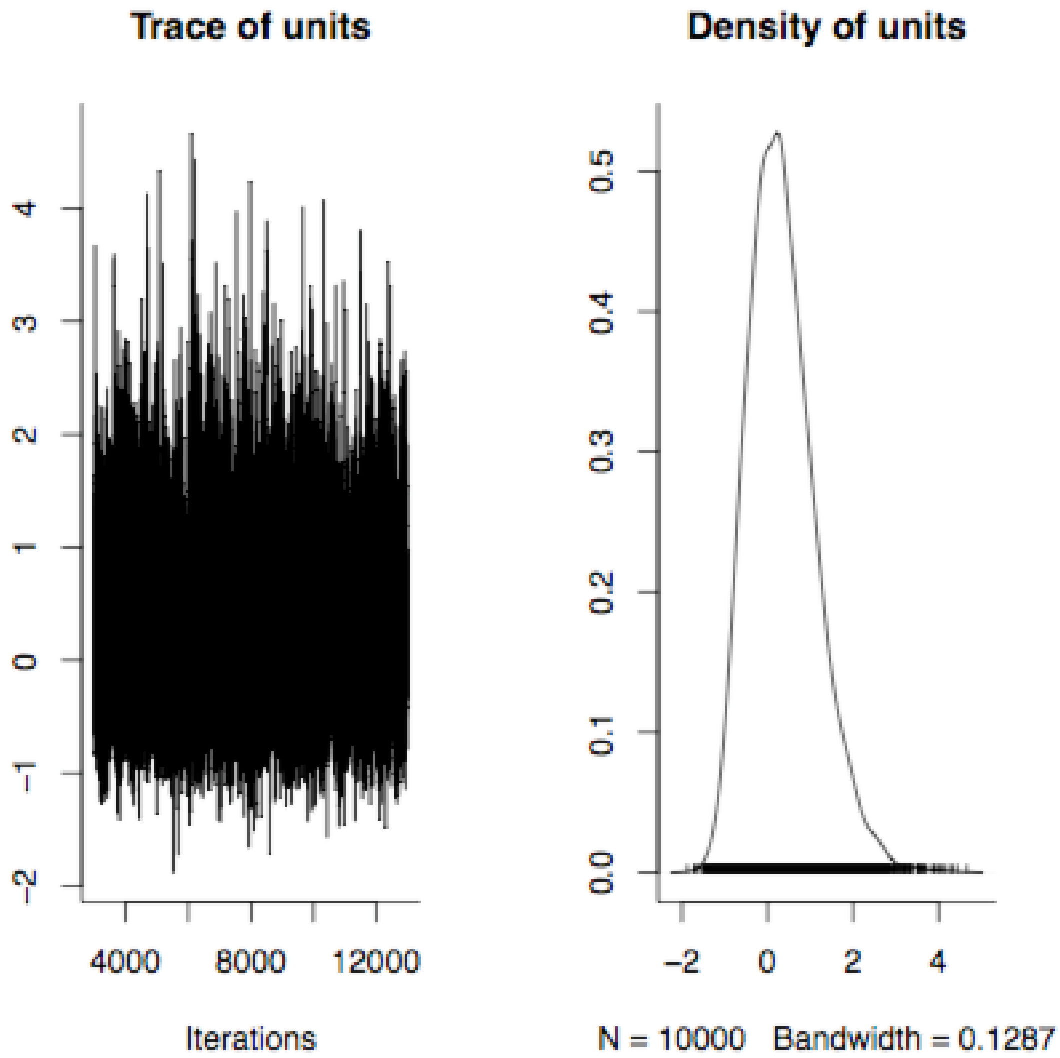


MCMC Diagnostics

plot(log(model1$VCV))

autocorr(model1$VCV)

, ,units
Lag 0 1.0000
Lag 1 0.2047
Lag 5 0.0011
Lag 10 0.007
Lag 50 0.013



MCMC Diagnostics

plot(model1$Sol)

autocorr(model1$Sol)

, ,(Intercpet)
Lag 0 1.00000
Lag 1 0.01251
Lag 5 0.00736
Lag 10 0.0077
Lag 50 0.0060