Applied Statistics (Chapter 6)

Yasuhiro Omori

A1A2 term, 2019-2020

University of Tokyo

Chapter 6

Section 6.2

```
# Define 6 × 6 matrix P
P=matrix(c(.5,.5,0,0,0,0,.25,.5,.25,0,0,0,
0,.25,.5,.25,0,0,0,0,.25,.5,.25,0,
0,0,0,.25,.5,.25,0,0,0,0,.5,.5),
nrow=6,ncol=6,byrow=TRUE)
# Print P
P
# We generate X_n, n = 1,...,50,000 and save in s
# s is a 50,000 × 1 vector with zeros
s=array(0,c(50000,1))
# Initialize X_1 = 3 (s[1]=3)
s[1]=3
```

Section 6.2

```
# Generate X_n  n = 2,...,50,000 given X_{n-1}
for (j in 2:50000)
s[j]=sample(1:6,size=1,prob=P[s[j-1],])
# Compute relative frequencies of each state
# using X_1,...,X_m,  m = 500, 200, 8000, 50000
m=c(500,2000,8000,50000)
for (i in 1:4)
print(table(s[1:m[i]])/m[i])
# Define a true stationary distribution vetor w
w=matrix(c(.1,.2,.2,.2,.2,.1),nrow=1,ncol=6)
# Compute wP and see wP = w
w%*%P
```

Section 6.7, 6.8 using WinBUGS

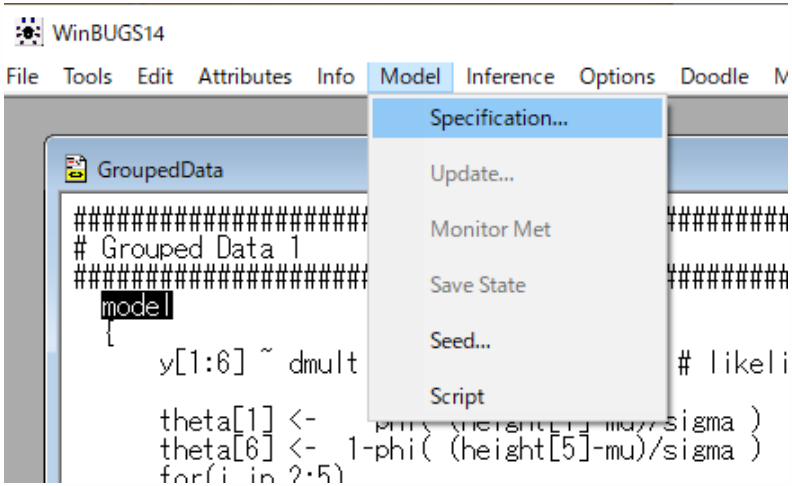
```
# First we specify the statistical model
model
{
# y = (y_1, ..., y_6)' ~ Mulitnomial(n, θ), θ = (θ_1, ..., θ_6)'
y[1:6] ~ dmulti(theta[1:6], n) # likelihood
# θ_1 = Φ((height_1 − μ)/σ), θ_6 = 1 − Φ((height_5 − μ)/σ)
theta[1] <- phi( (height[1]-mu)/sigma )
theta[6] <- 1-phi( (height[5]-mu)/sigma )
# θ_i = Φ((height_i − μ)/σ) − Φ((height_{i−1} − μ)/σ), i = 2, ..., 5
for(i in 2:5)
{
theta[i]<- phi( (height[i]-mu)/sigma ) - phi(
(height[i-1]-mu)/sigma )
}
```

Section 6.7, 6.8 using WinBUGS

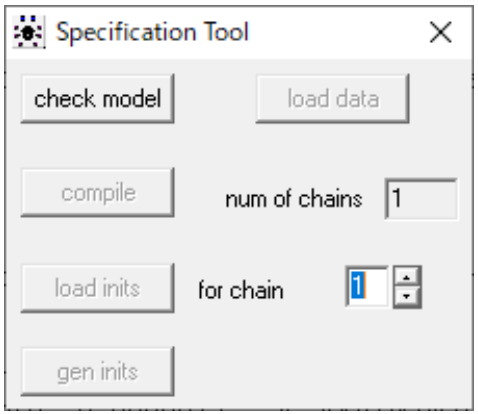
```
# Prior:  μ ~ N(0, 10^6)
mu ~ dnorm(0, 0.000001)
# Prior:  log σ ~ N(0, 10^6)
lsigma ~ dnorm(0, 0.000001)
# Prior:  σ = exp(log σ)
sigma <- exp(lsigma)
# the end of the model statement
}
# define variables for the dataset
list( n = 211, y = c(14, 30, 49, 70, 33, 15),
height = c(66, 68, 70, 72, 74))
# set initial values for MCMC
list( mu = 70, lsigma=0 )
```

Introduction to WinBUGS

1. Highlight the **model** statement
2. **Model** menu → **Specification...**

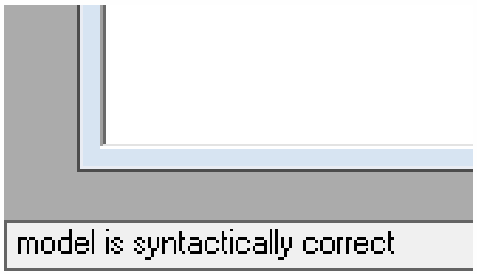


3. Click on **check model**

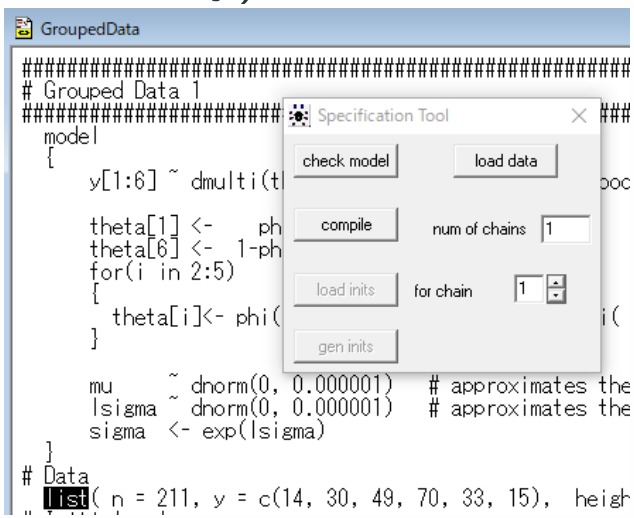


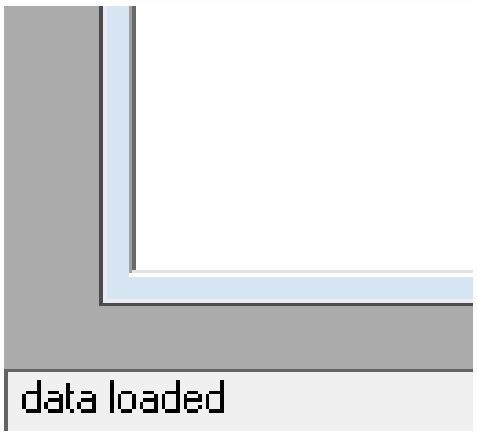
Introduction to WinBUGS

4. Check the message at the bottom



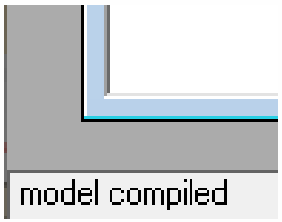
5. Highlight **list** and click on **load data** (repeat this step if necessary)



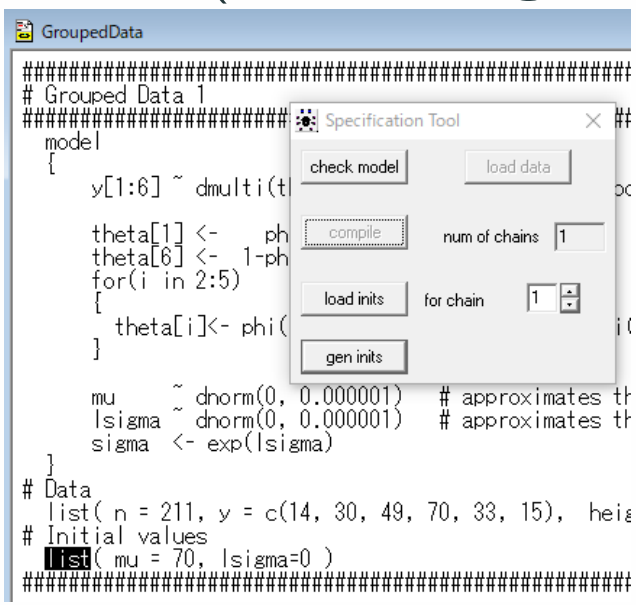


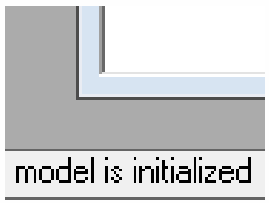
Introduction to WinBUGS

6. Click on **compile** and check the message at the bottom



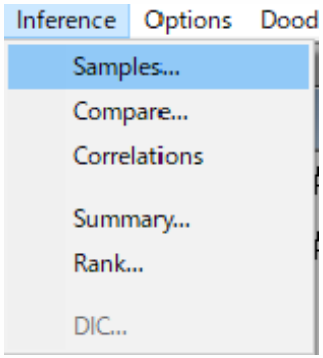
7. Highlight **list** and click on **load inits** to set initial values of MCMC (or click on **gen inits** to generate initial values)



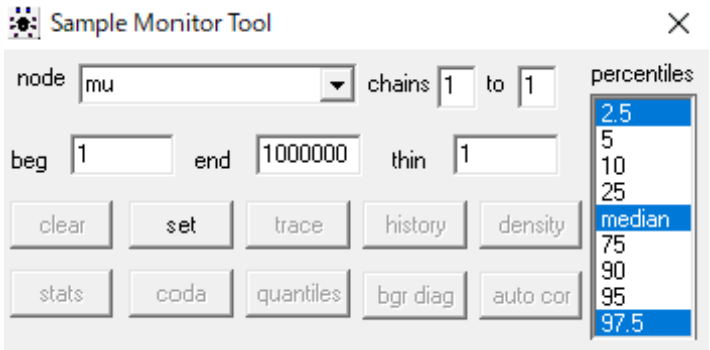


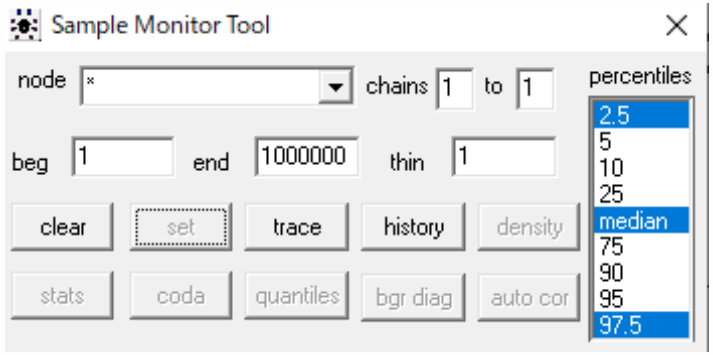
Introduction to WinBUGS

8. **Inference** menu → **Samples...**



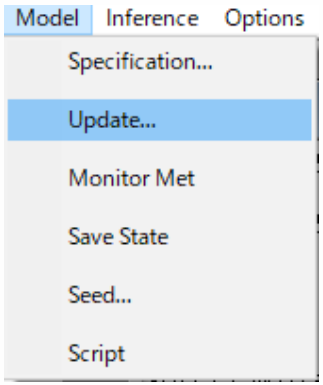
9. Enter **mu** for **node** and click on **set**
10. Enter **lsigma** for **node** and click on **set**
11. Enter **sigma** for **node** and click on **set**
12. Enter * for **node** and click on **trace**

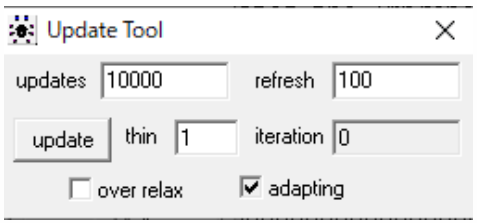




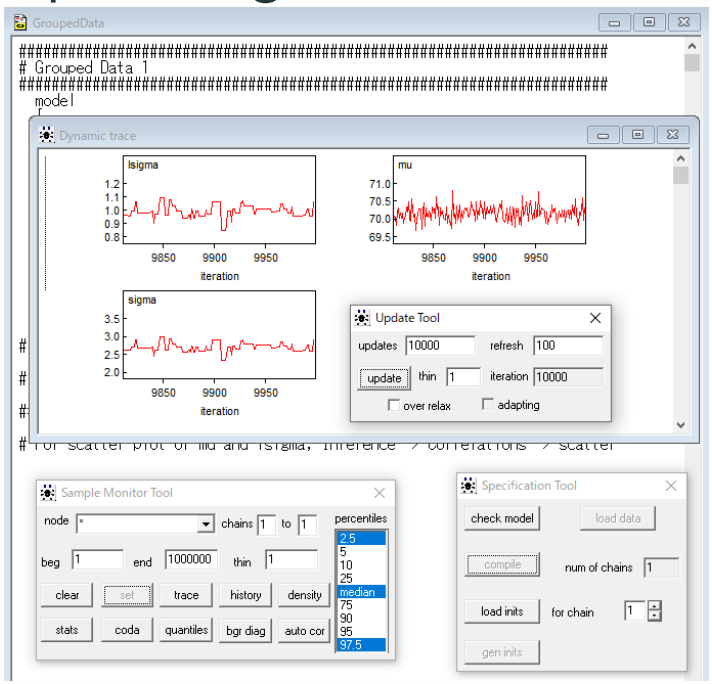
Introduction to WinBUGS

13. **Model** menu → **Update...**



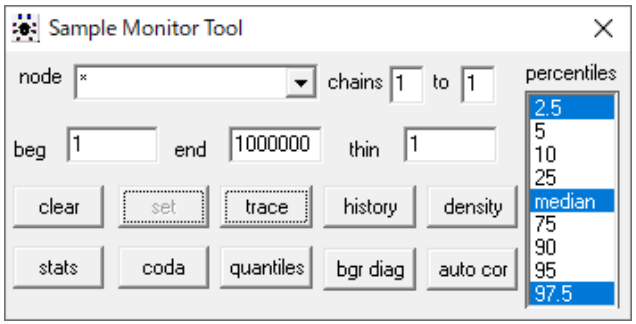


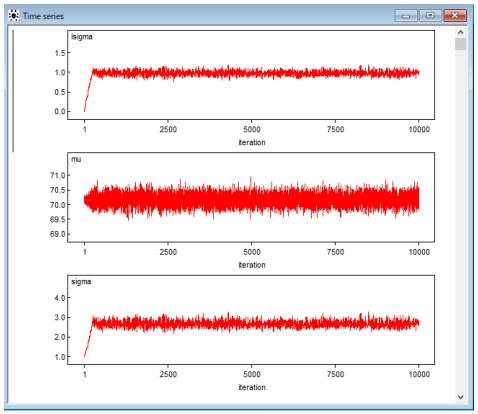
14. Update e.g. 10,000 for MCMC iterations and click on **update**



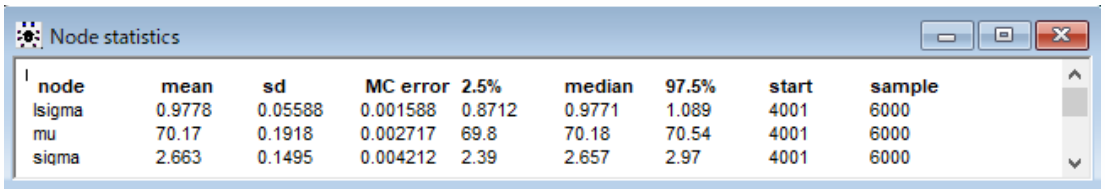
Introduction to WinBUGS

15. Click on **history** in Sample Monitor Tool for the traceplot



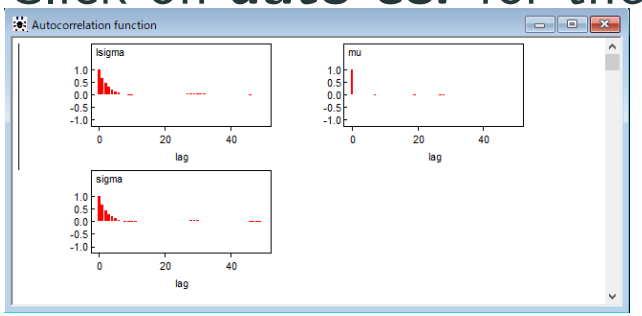


16. Click on **stats** in Sample Monitor Tool for the summary statitistics



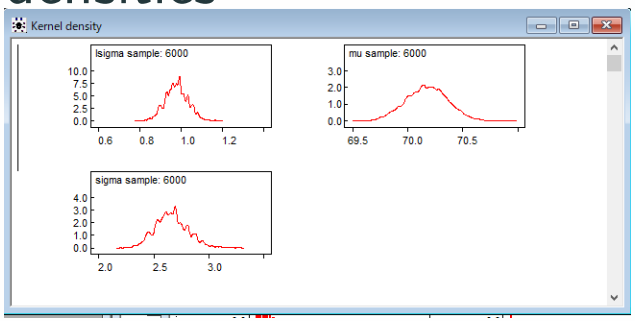
node	mean	sd	MC error	2.5%	median	97.5%	start	sample
lsigma	0.9778	0.05588	0.001588	0.8712	0.9771	1.089	4001	6000
mu	70.17	0.1918	0.002717	69.8	70.18	70.54	4001	6000
sigma	2.663	0.1495	0.004212	2.39	2.657	2.97	4001	6000

17. Click on **auto cor** for the autocorrelations



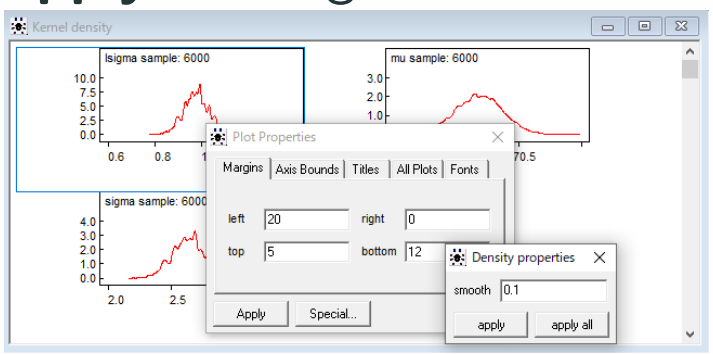
Introduction to WinBUGS

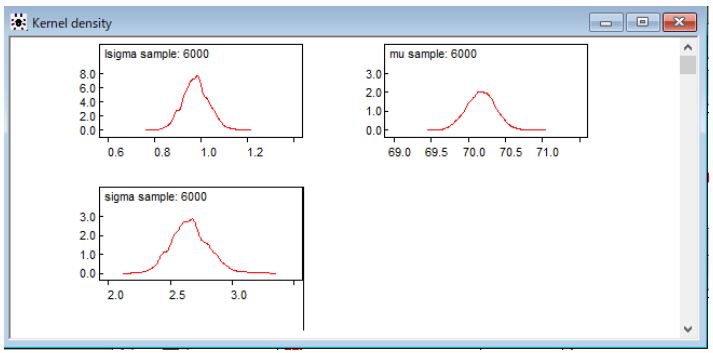
18. Click on **density** in Sample Monitor Tool for the posterior densities



19. Right click on one of the figures and choose **Properties...**

20. Click on **Special** and enter **0.1** in **smooth** box. Click on **apply all** to get smooth curves.





Introduction to WinBUGS

21. Click on **quantiles** in Sample Monitor Tool for the traceplot of sample quantiles
22. Click on **coda** in Sample Monitor Tool for the MCMC samples