# Homework 5

Min, Dayeong
2018/05/24

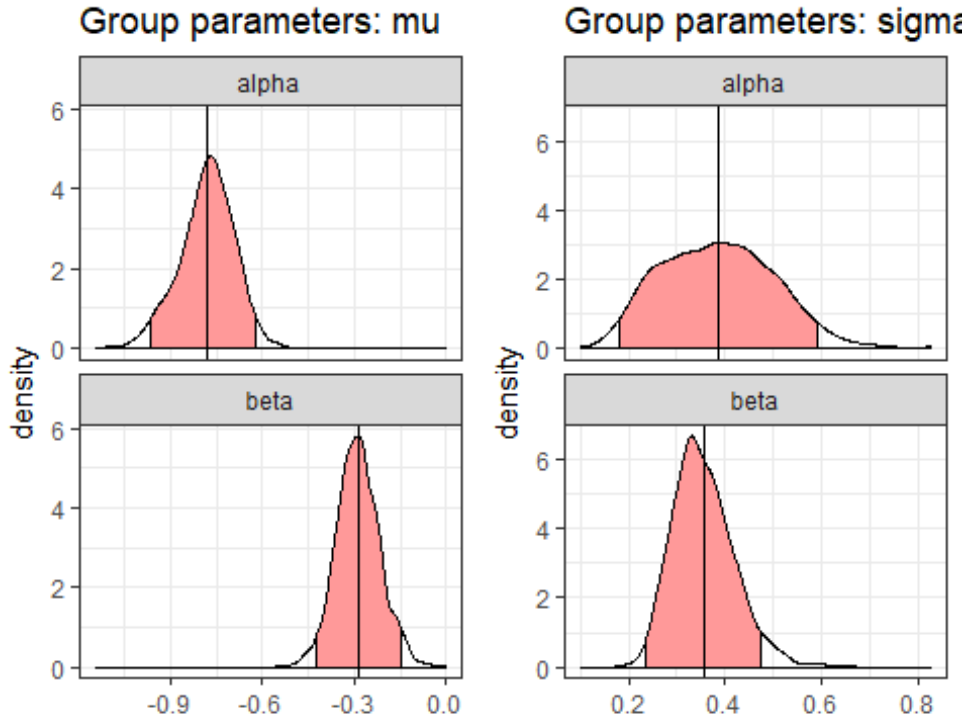
## 1. Simulation and parameter recovery using a simple reinforcement learning model

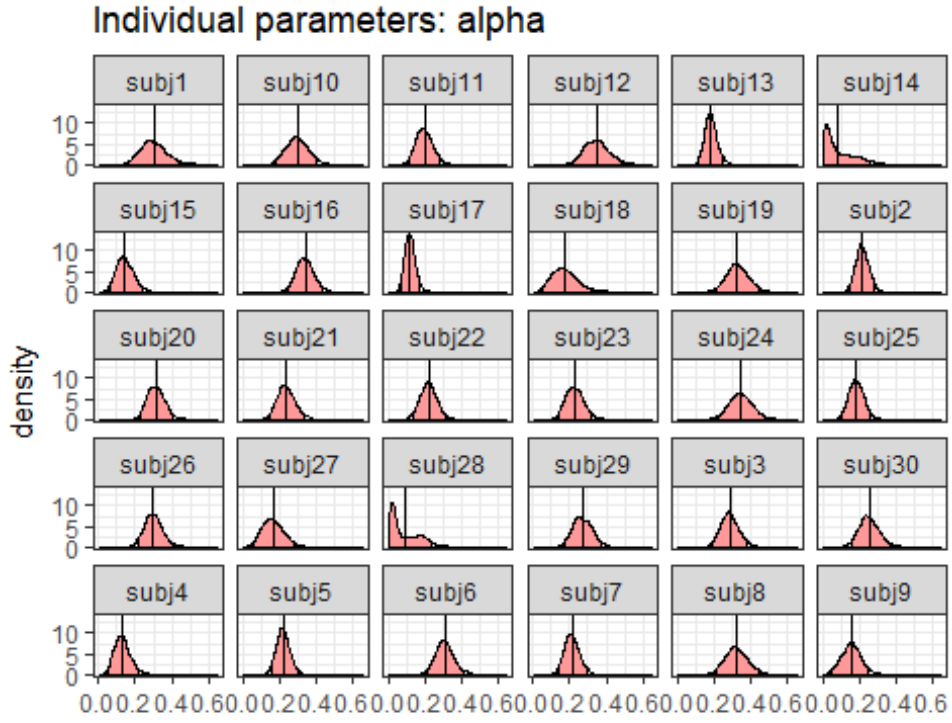
### *1.1. Generate simulated data.*

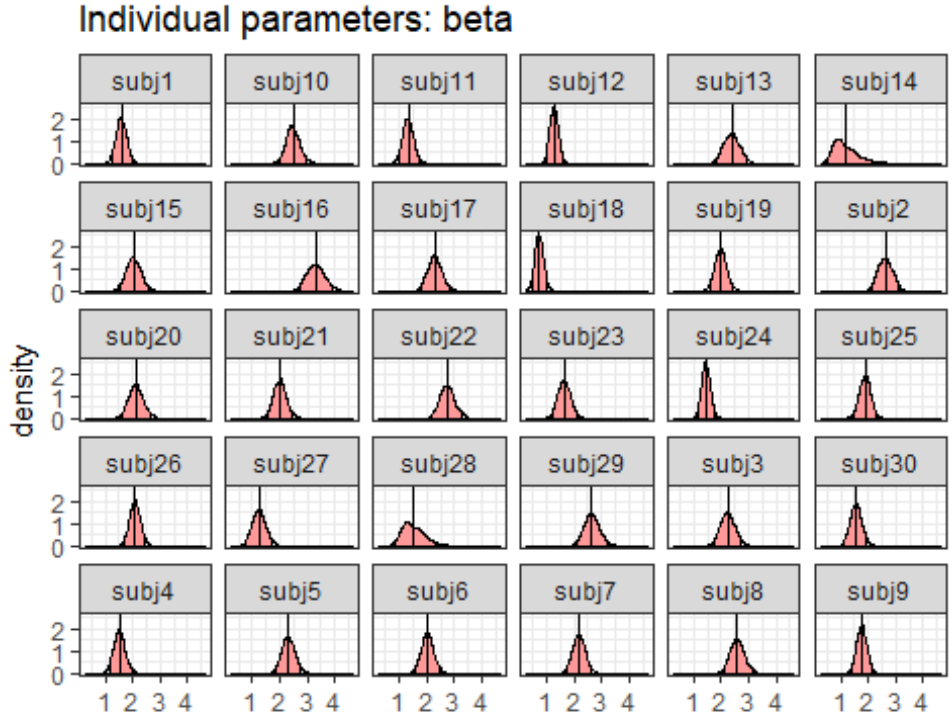
FILE: simul_data_hw5_model1.txt

### *1.2.a. Find the posterior distribution of individual and group (hyper) parameters*

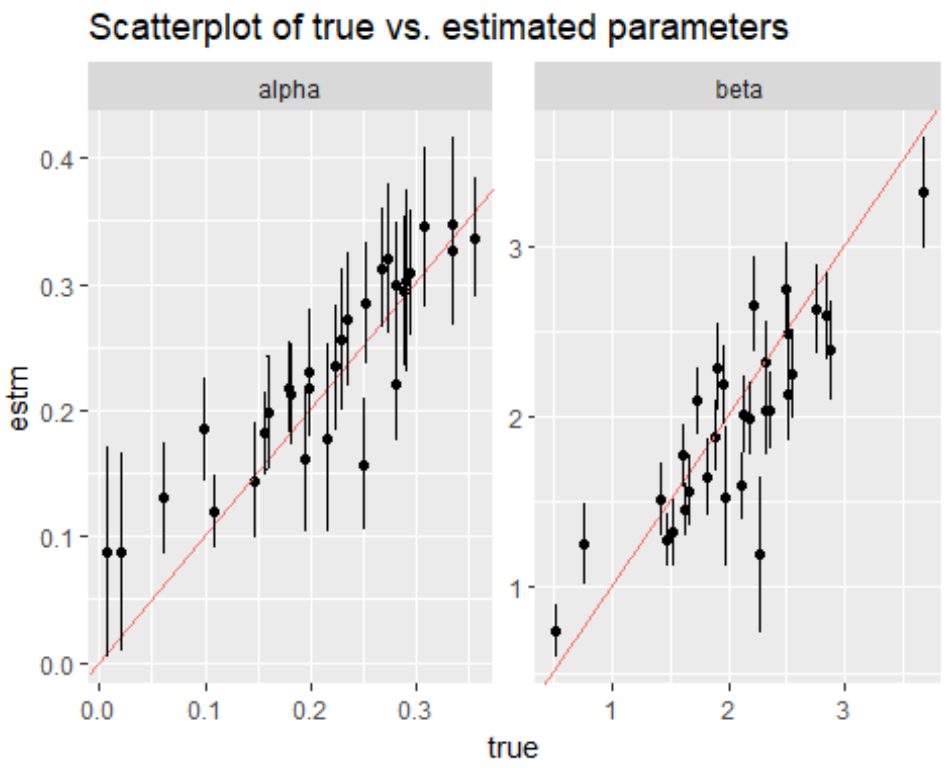
FILE: hw5_model1.R, hw5_model1.stan




Individual parameters: alpha
subj1
subj10
subj11
subj12
subj13
subj14
subj15
subj16
subj17
subj18
subj19
subj2
subj20
subj21
subj22
subj23
subj24
subj25
subj26
subj27
subj28
subj29
subj3
subj30
subj4
subj5
subj6
subj7
subj8
subj9
density
0
5
10
0.0 0.2 0.4 0.6


Individual parameters: beta
subj1
subj10
subj11
subj12
subj13
subj14
subj15
subj16
subj17
subj18
subj19
subj2
subj20
subj21
subj22
subj23
subj24
subj25
subj26
subj27
subj28
subj29
subj3
subj30
subj4
subj5
subj6
subj7
subj8
subj9
density
0
1
2
1 2 3 4

### *1.2.b. Draw a scatterplot of true parameters and estimated parameters*

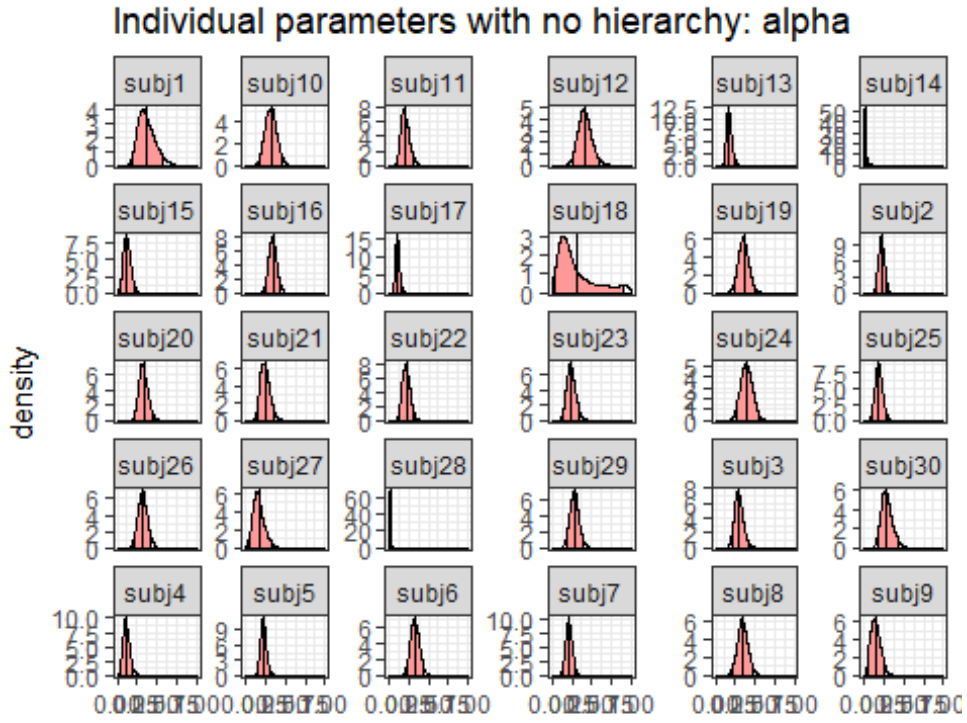


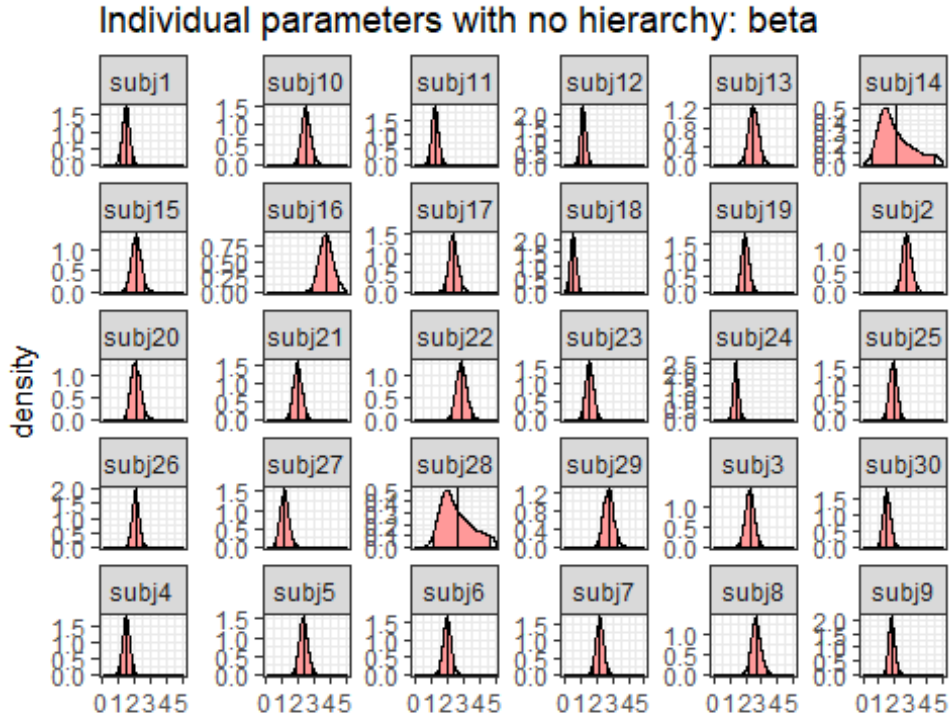

Generally, the range of estimated paramters covers the value of true parameters.

## 2. Comparing the outputs from hierarchical and non-hierarchical Bayesian models.

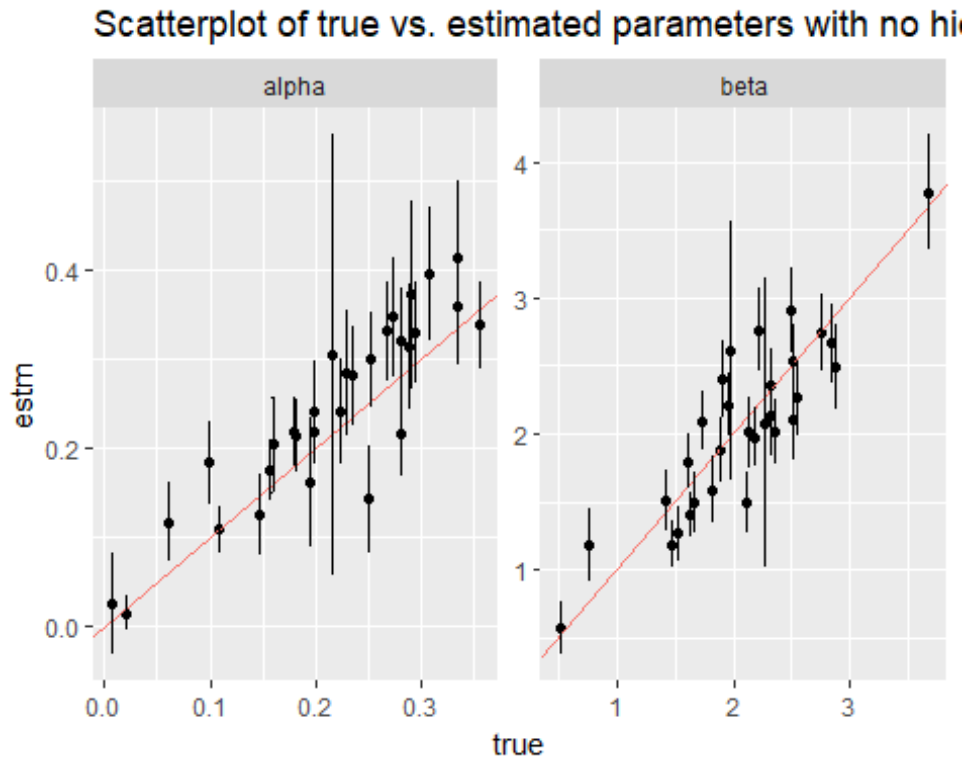
### *2.1.*

FILE: hw5_model2.R, hw5_model2.stan




Individual parameters with no hierarchy: beta
density
subj1
subj10
subj11
subj12
subj13
subj14
subj15
subj16
subj17
subj18
subj19
subj2
subj20
subj21
subj22
subj23
subj24
subj25
subj26
subj27
subj28
subj29
subj3
subj30
subj4
subj5
subj6
subj7
subj8
subj9
0 1 2 3 4 5

***2.2.***


Scatterplot of true vs. estimated parameters with no hi
alpha
beta
estm
true
0.0
0.2
0.4
0.1
0.3
1
2
3
4

## *2.3.*

1. The estimated parameters with no hierarchy have values more closer to the true values than thoes with a hierarchy. The difference seems to come from the fact that true parameters of some subjects are quite extreme. Since there happens shrinkage effect within a hierarchical structure, the true extremeness would have been diminished.
2. Also, the error bars in the estimated parameters with no hierarchy are generally narrower than those with a hierarchy. By pulling an individual's extreme parameter to more moderate value, this certainly makes a gap between the collected data and the estimation, thus creating more errors in the hierarchical structure.

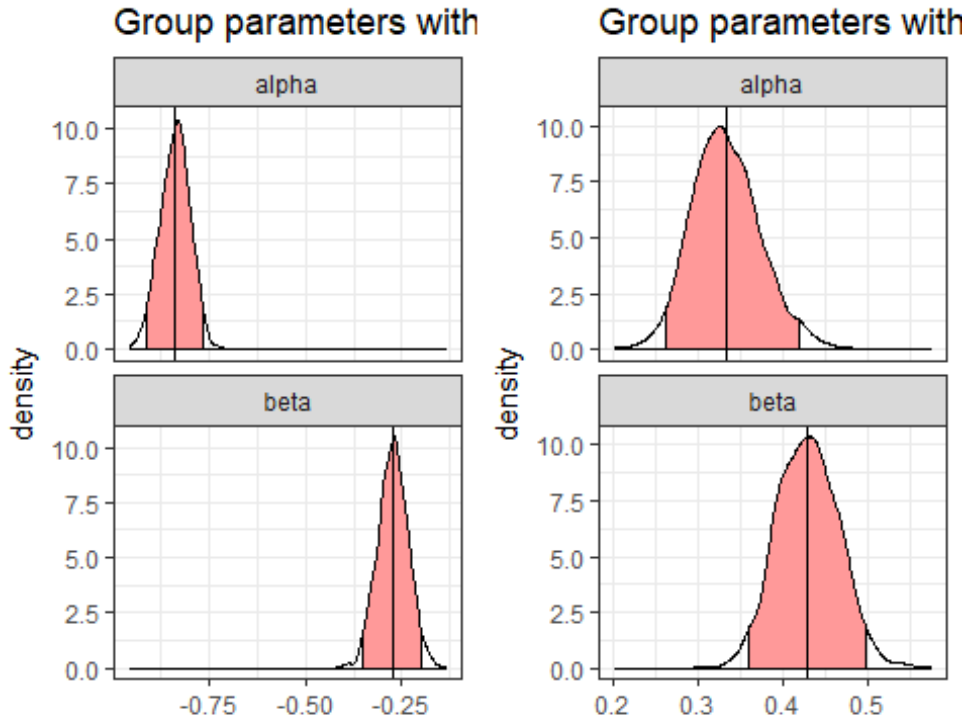
## 3. “Shrinkage” in hierarchical Bayesian data analysis.

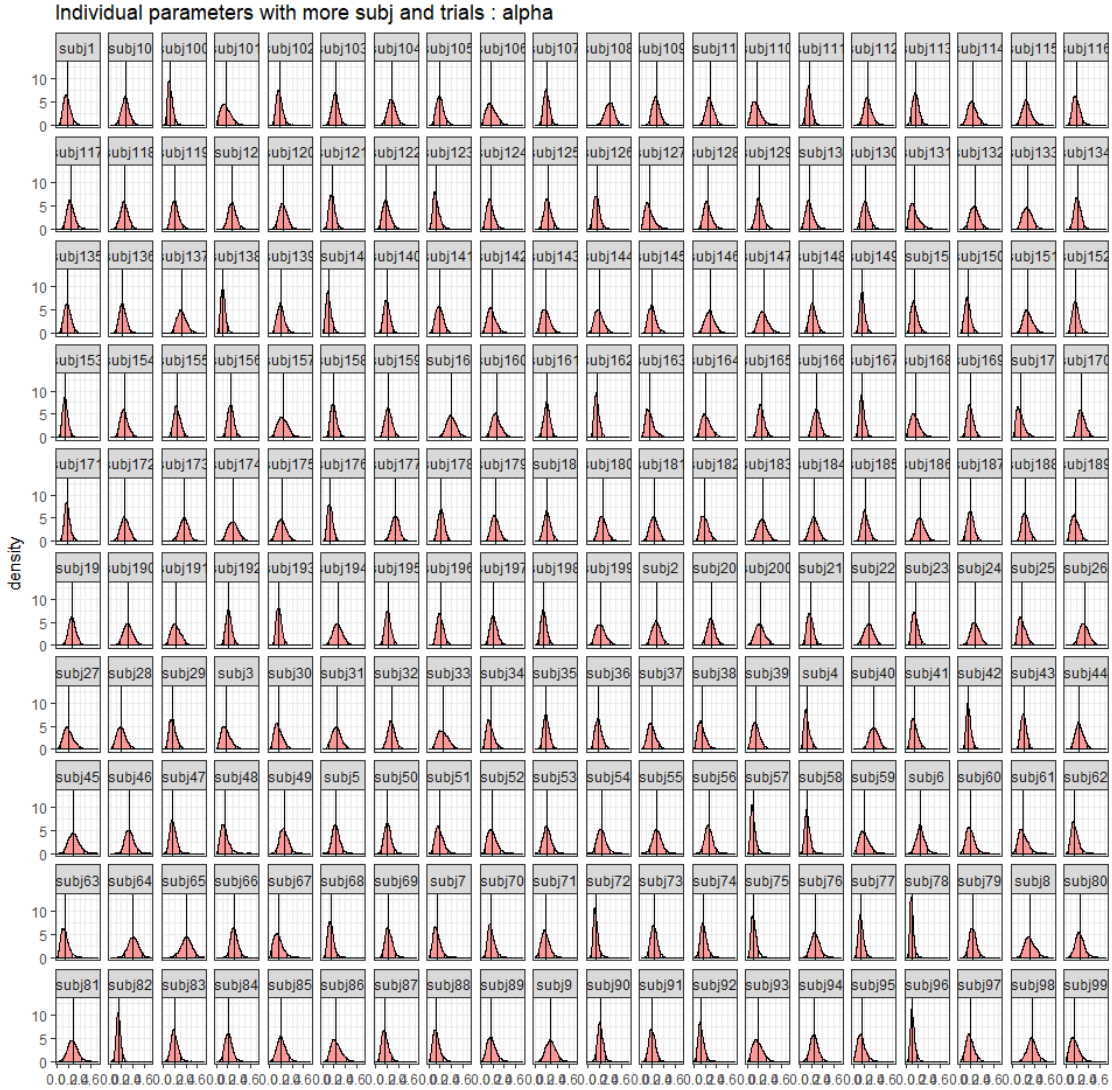
### *3.1.Set num_subjs = 200, num_trials=100 and generate 200 fake subjects’ data.*

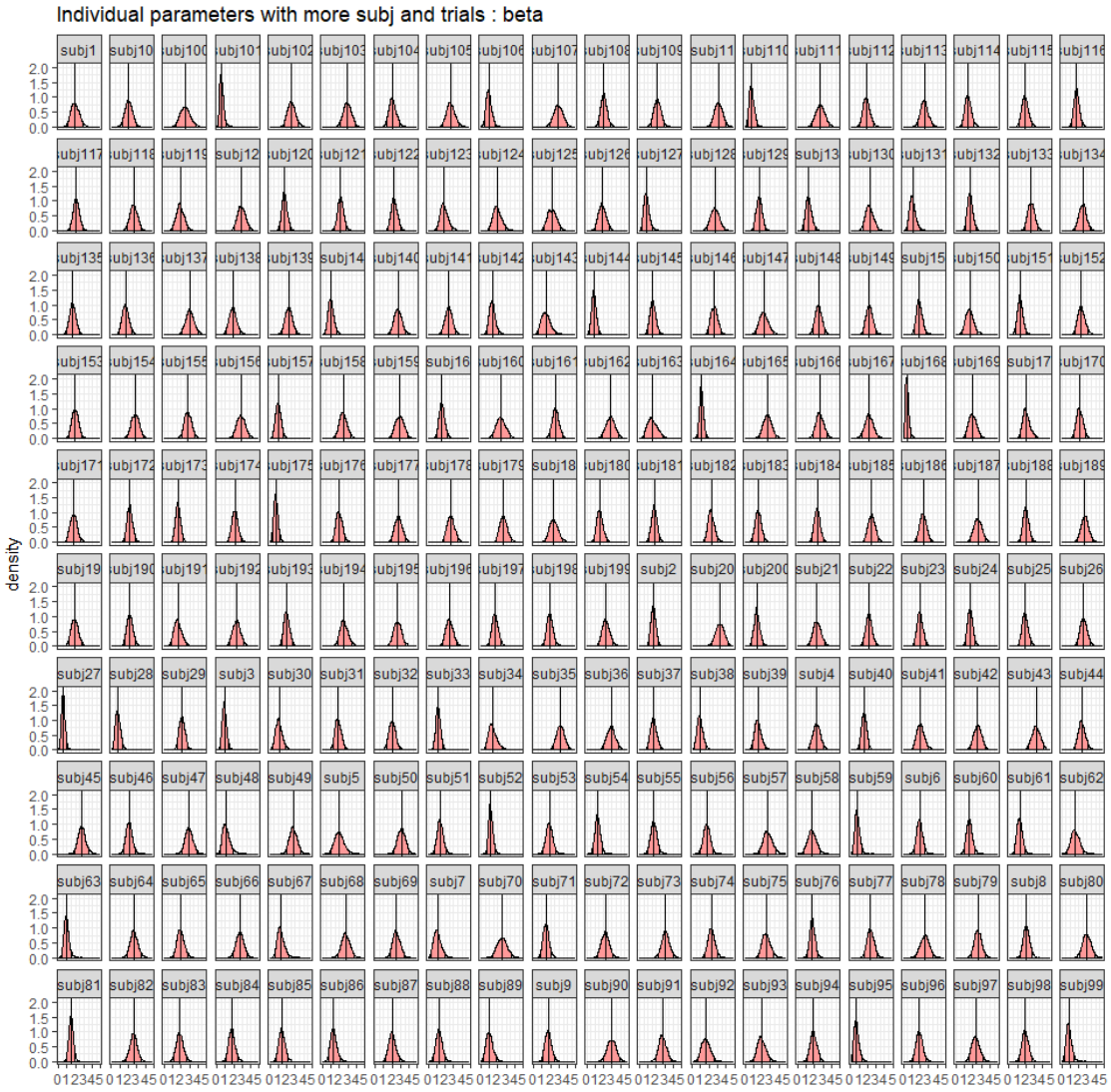
FILE: simul_data_hw5_model1.1.txt

### *3.2.*

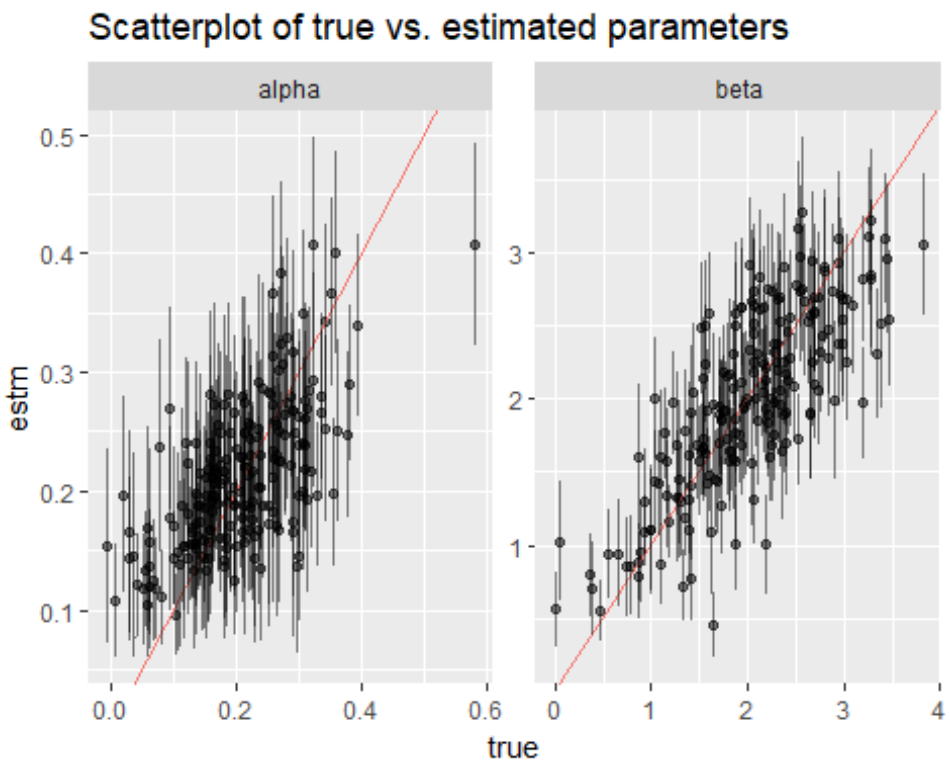
FILE: hw5_model1.1.R




Individual parameters with more subj and trials : alpha
density


Individual parameters with more subj and trials : beta
density

### *3.3.*



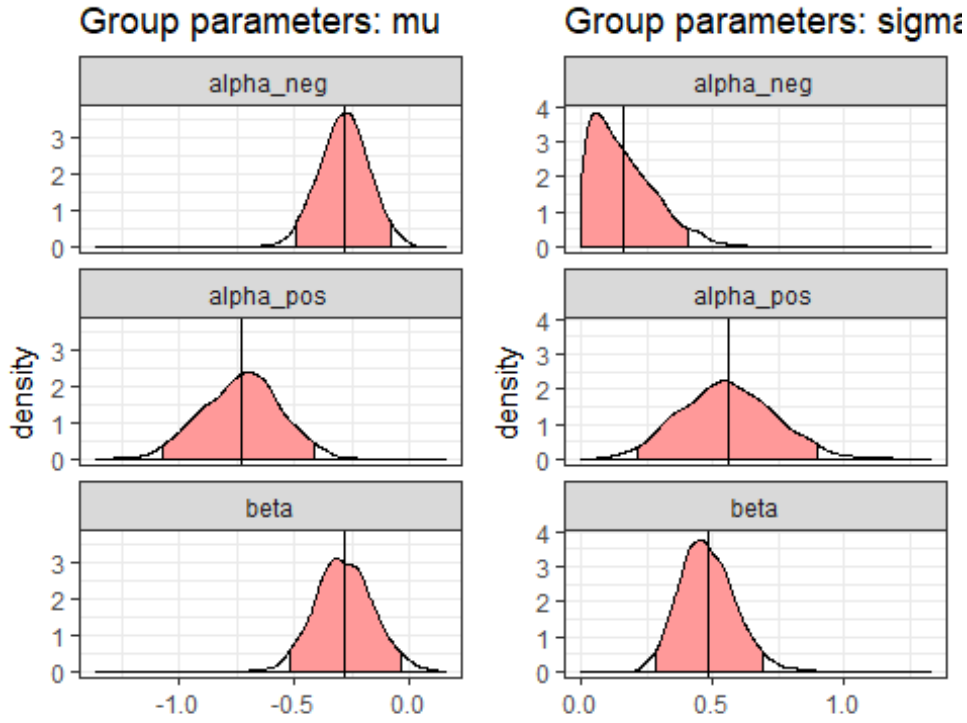

### *3.4. Do you notice "shrinkage" in one parameter but not so much in the other parameter? Can you explain why?*

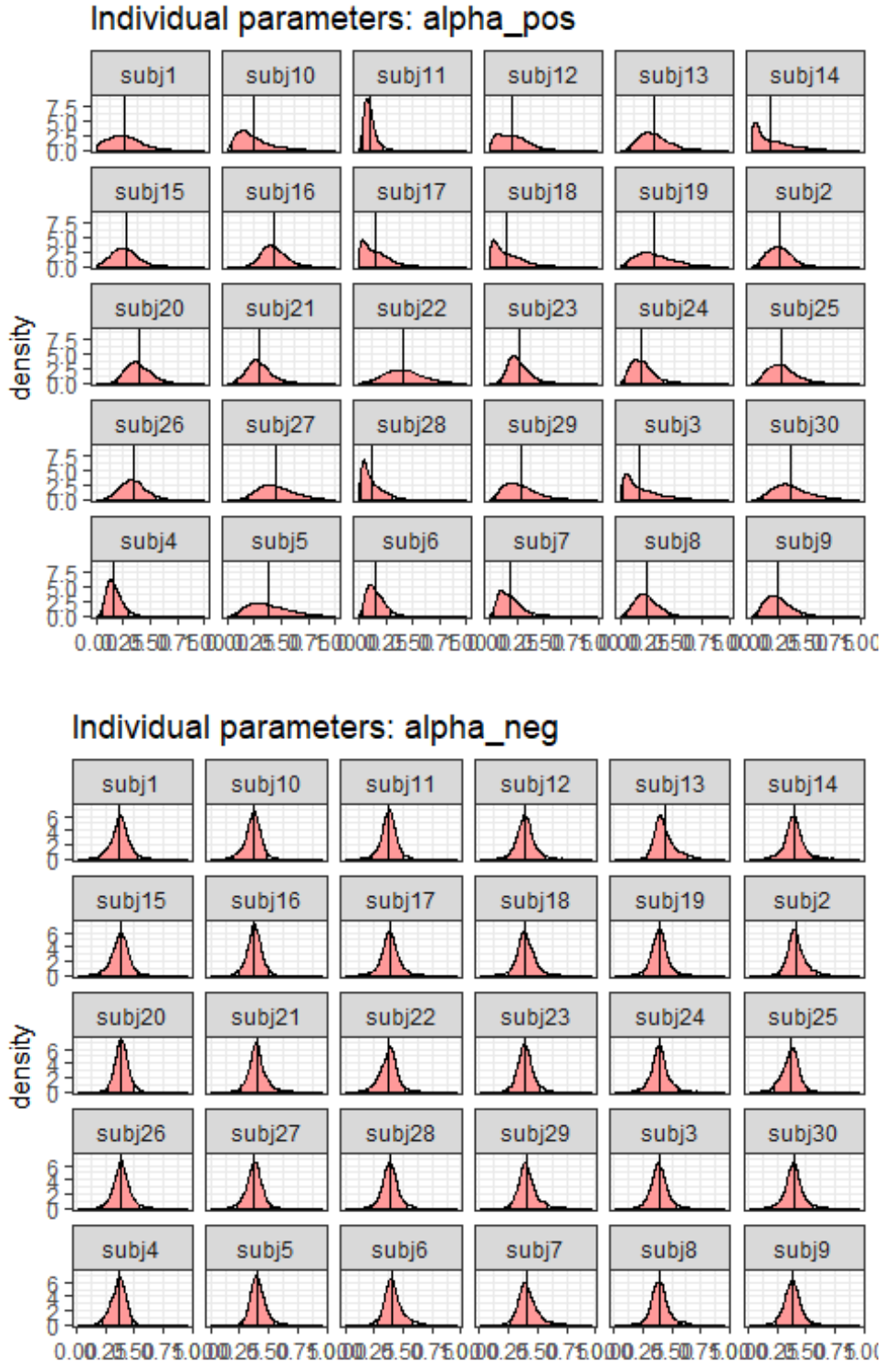
The shrinkage effect is more obvious in the alpha. The reason why is that the true values of the alpha are more extreme in their range than those of beta. Therefore, the shinkage effect plays more role in the alpha.

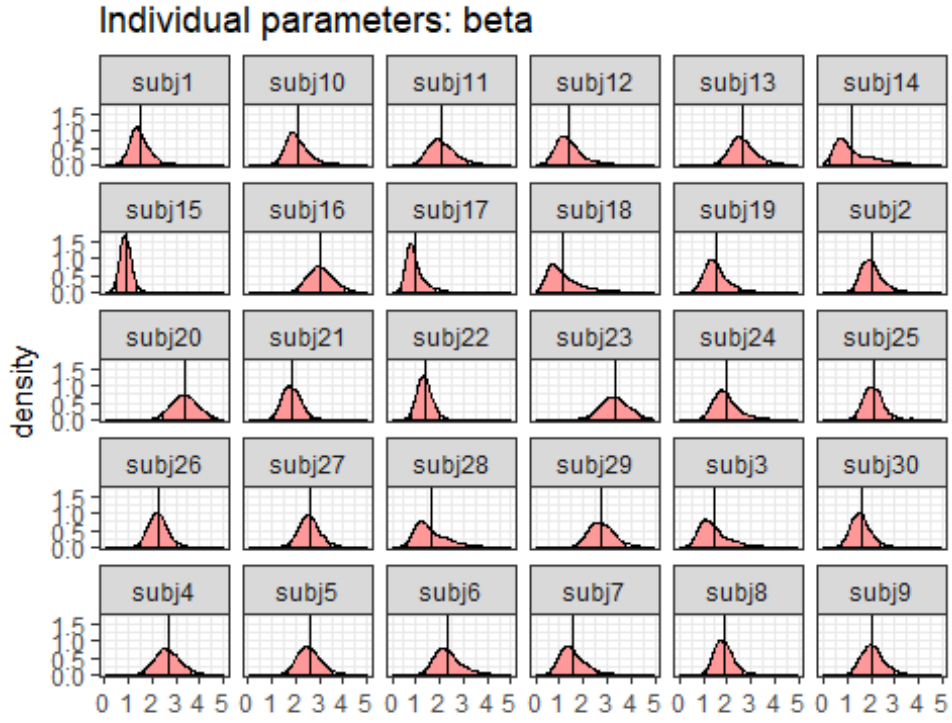
## 4.Modify provided Stan and R codes so that we can allow two learning rates in the reinforcement learning model.

### *4.1. Find the posterior distribution of individual and group (hyper) parameters.*

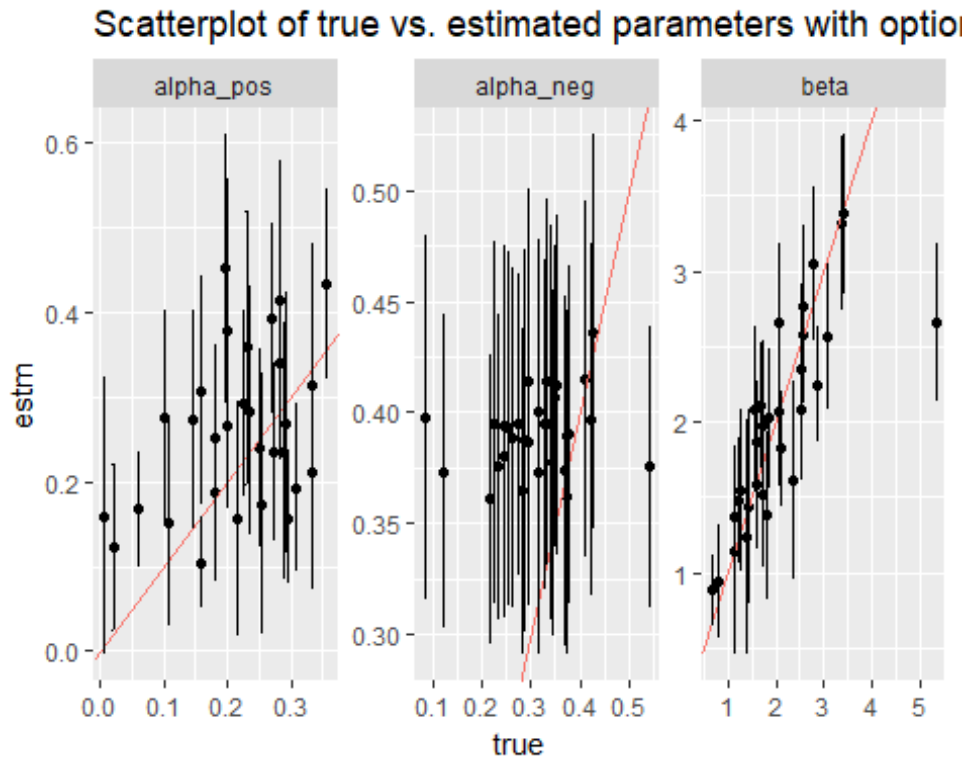
FILE: hw5_bonus.R, hw5_bonus.stan, simulate_hw5_bonus.R




Individual parameters: alpha_pos
subj1
subj10
subj11
subj12
subj13
subj14
subj15
subj16
subj17
subj18
subj19
subj2
subj20
subj21
subj22
subj23
subj24
subj25
subj26
subj27
subj28
subj29
subj3
subj30
subj4
subj5
subj6
subj7
subj8
subj9
density
Individual parameters: alpha_neg
density




***4.2. Draw a scatterplot of true parameters and estimated parameters.***



***4.3.***


***4.4. Do you notice any difference between what you found in (2) and (3)? Try to explain what made the difference.***

The estimated parameters of (2) do not cover the true parameters very well than (3) does. The reason why is the shortage of enough trial numbers. By separating alphas into two different parameters by PE, the necessary number of trials would have been doubled. Thus, by increasing the trial numbers from 100 to 300, the estimated parameters are more appropriate in (3).