

STA 6352, Report 6.7

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Problem Setup

Use Stan to reproduce the results in for the example in Section 2.2.3. (Use the uniform prior structure for the variance components in (2.2.15).)

Solution

```
model_ind <- "  
  data {  
    int n;  
    int K;  
    matrix[n, K] y;  
    real<lower=0> Ba;  
    real<lower=0> Be;  
  }  
  parameters {  
    real mu;  
    vector[n] a;  
    real<lower=0, upper=Ba> sigma_a;  
    real<lower=0, upper=Be> sigma;  
  }  
  model {  
    mu ~ normal(0, sqrt(1000));  
    for (i in 1:n) {  
      a[i] ~ normal(0, sigma_a);  
      y[i] ~ normal(mu + a[i], sigma);  
    }  
  }  
"  
model_cor <- "  
  data {  
    int n;  
    int K;  
    matrix[n, K] y;  
    real<lower=0> Ba;  
    real<lower=1> c;  
  }  
  parameters {
```

```

    real mu;
    vector[n] a;
    real<lower=0, upper=Ba> sigma_a;
    real sigma;
  }
  model {
    mu ~ normal(0, sqrt(1000));
    // sigma ~ uniform(0, 10);
    sigma ~ uniform(0, sigma_a * sqrt(c - 1));
    for (i in 1:n) {
      a[i] ~ normal(0, sigma_a);
      y[i] ~ normal(mu + a[i], sigma);
    }
  }
}
"

```

```

##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1:
## Chain 1: Gradient evaluation took 3.1e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:      1 / 10000 [ 0%] (Warmup)
## Chain 1: Iteration: 1000 / 10000 [ 10%] (Warmup)
## Chain 1: Iteration: 2000 / 10000 [ 20%] (Warmup)
## Chain 1: Iteration: 2001 / 10000 [ 20%] (Sampling)
## Chain 1: Iteration: 3000 / 10000 [ 30%] (Sampling)
## Chain 1: Iteration: 4000 / 10000 [ 40%] (Sampling)
## Chain 1: Iteration: 5000 / 10000 [ 50%] (Sampling)
## Chain 1: Iteration: 6000 / 10000 [ 60%] (Sampling)
## Chain 1: Iteration: 7000 / 10000 [ 70%] (Sampling)
## Chain 1: Iteration: 8000 / 10000 [ 80%] (Sampling)
## Chain 1: Iteration: 9000 / 10000 [ 90%] (Sampling)
## Chain 1: Iteration: 10000 / 10000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 0.218 seconds (Warm-up)
## Chain 1:                0.66 seconds (Sampling)
## Chain 1:                0.878 seconds (Total)
## Chain 1:

## Warning: There were 2 divergent transitions after warmup. See
## https://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
## to find out why this is a problem and how to eliminate them.

```

```

## Warning: There were 1 chains where the estimated Bayesian Fraction of Missed
## https://mc-stan.org/misc/warnings.html#bfmi-low

## Warning: Examine the pairs() plot to diagnose sampling problems

## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess

##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1: Rejecting initial value:
## Chain 1:   Error evaluating the log probability at the initial value.
## Chain 1: Exception: normal_lpdf: Scale parameter is -1.08955, but must be p
## Chain 1: Rejecting initial value:
## Chain 1:   Error evaluating the log probability at the initial value.
## Chain 1: Exception: normal_lpdf: Scale parameter is -0.747494, but must be
## Chain 1: Rejecting initial value:
## Chain 1:   Error evaluating the log probability at the initial value.
## Chain 1: Exception: normal_lpdf: Scale parameter is -0.106624, but must be
## Chain 1:
## Chain 1: Gradient evaluation took 2.9e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 10000 [ 0%] (Warmup)
## Chain 1: Iteration: 1000 / 10000 [ 10%] (Warmup)
## Chain 1: Iteration: 2000 / 10000 [ 20%] (Warmup)
## Chain 1: Iteration: 2001 / 10000 [ 20%] (Sampling)
## Chain 1: Iteration: 3000 / 10000 [ 30%] (Sampling)
## Chain 1: Iteration: 4000 / 10000 [ 40%] (Sampling)
## Chain 1: Iteration: 5000 / 10000 [ 50%] (Sampling)
## Chain 1: Iteration: 6000 / 10000 [ 60%] (Sampling)
## Chain 1: Iteration: 7000 / 10000 [ 70%] (Sampling)
## Chain 1: Iteration: 8000 / 10000 [ 80%] (Sampling)
## Chain 1: Iteration: 9000 / 10000 [ 90%] (Sampling)
## Chain 1: Iteration: 10000 / 10000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 0.125 seconds (Warm-up)
## Chain 1:                0.54 seconds (Sampling)
## Chain 1:                0.665 seconds (Total)
## Chain 1:

## Warning: There were 3655 divergent transitions after warmup. See

```

```

## https://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
## to find out why this is a problem and how to eliminate them.

## Warning: Examine the pairs() plot to diagnose sampling problems

##
## SAMPLING FOR MODEL 'anon_model' NOW (CHAIN 1).
## Chain 1: Rejecting initial value:
## Chain 1:   Log probability evaluates to log(0), i.e. negative infinity.
## Chain 1:   Stan can't start sampling from this initial value.
## Chain 1: Rejecting initial value:
## Chain 1:   Error evaluating the log probability at the initial value.
## Chain 1: Exception: normal_lpdf: Scale parameter is -0.0206306, but must be
## Chain 1: Rejecting initial value:
## Chain 1:   Error evaluating the log probability at the initial value.
## Chain 1: Exception: normal_lpdf: Scale parameter is -0.529717, but must be
## Chain 1:
## Chain 1: Gradient evaluation took 3.3e-05 seconds
## Chain 1: 1000 transitions using 10 leapfrog steps per transition would take
## Chain 1: Adjust your expectations accordingly!
## Chain 1:
## Chain 1:
## Chain 1: Iteration:    1 / 10000 [ 0%] (Warmup)
## Chain 1: Iteration: 1000 / 10000 [ 10%] (Warmup)
## Chain 1: Iteration: 2000 / 10000 [ 20%] (Warmup)
## Chain 1: Iteration: 2001 / 10000 [ 20%] (Sampling)
## Chain 1: Iteration: 3000 / 10000 [ 30%] (Sampling)
## Chain 1: Iteration: 4000 / 10000 [ 40%] (Sampling)
## Chain 1: Iteration: 5000 / 10000 [ 50%] (Sampling)
## Chain 1: Iteration: 6000 / 10000 [ 60%] (Sampling)
## Chain 1: Iteration: 7000 / 10000 [ 70%] (Sampling)
## Chain 1: Iteration: 8000 / 10000 [ 80%] (Sampling)
## Chain 1: Iteration: 9000 / 10000 [ 90%] (Sampling)
## Chain 1: Iteration: 10000 / 10000 [100%] (Sampling)
## Chain 1:
## Chain 1: Elapsed Time: 0.117 seconds (Warm-up)
## Chain 1:                0.362 seconds (Sampling)
## Chain 1:                0.479 seconds (Total)
## Chain 1:

## Warning: There were 7996 divergent transitions after warmup. See
## https://mc-stan.org/misc/warnings.html#divergent-transitions-after-warmup
## to find out why this is a problem and how to eliminate them.
## Warning: Examine the pairs() plot to diagnose sampling problems

## Warning: The largest R-hat is 1.23, indicating chains have not mixed.

```

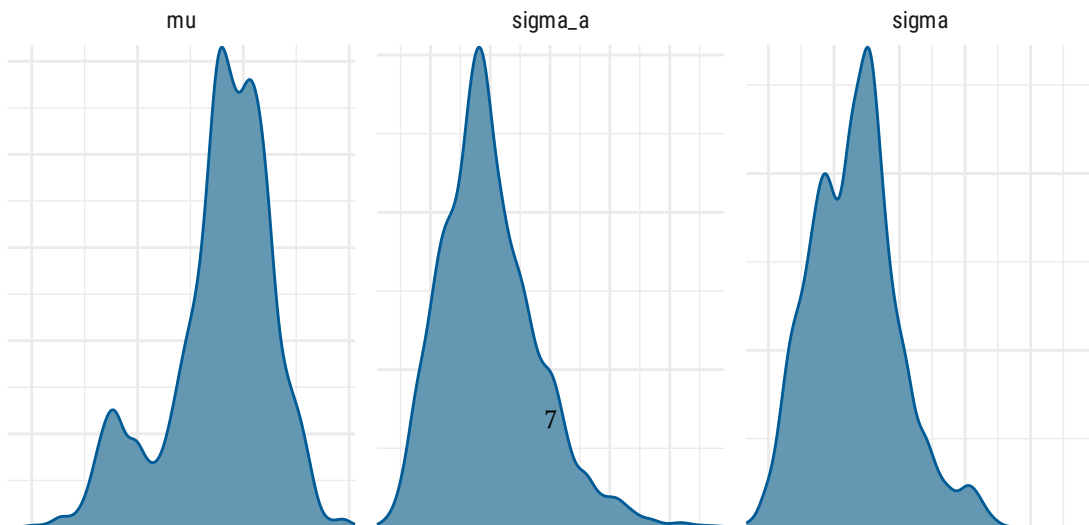
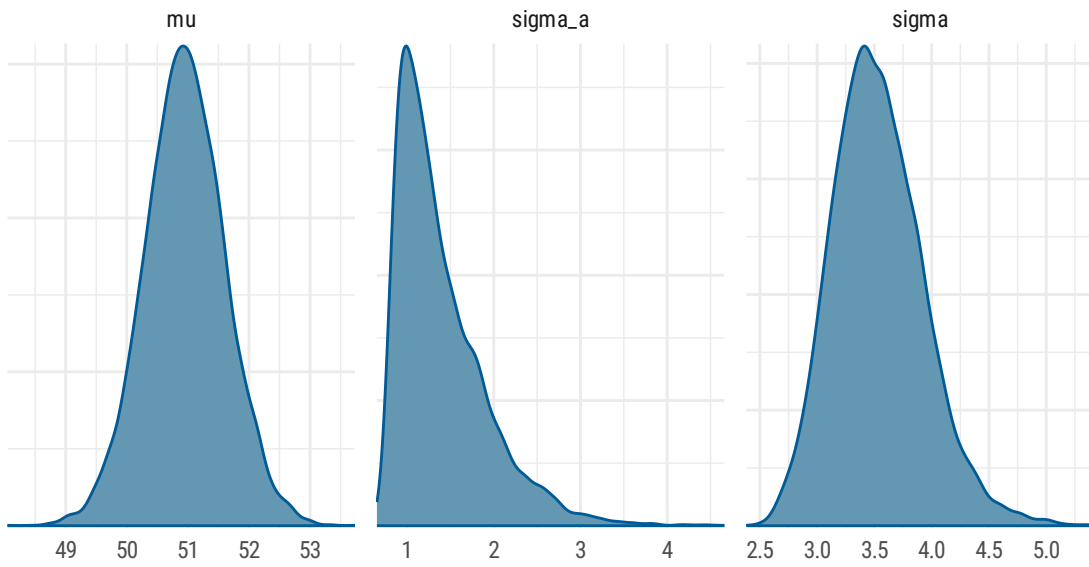
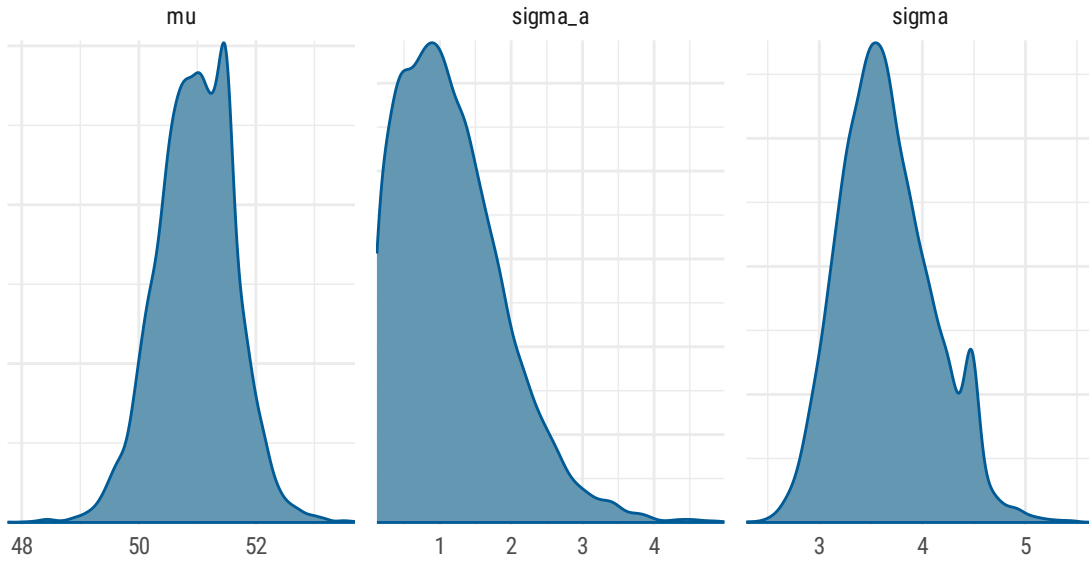
```
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#r-hat
```

```
## Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#bulk-ess
```

```
## Warning: Tail Effective Samples Size (ESS) is too low, indicating posterior
## Running the chains for more iterations may help. See
## https://mc-stan.org/misc/warnings.html#tail-ess
```


Results from Stan

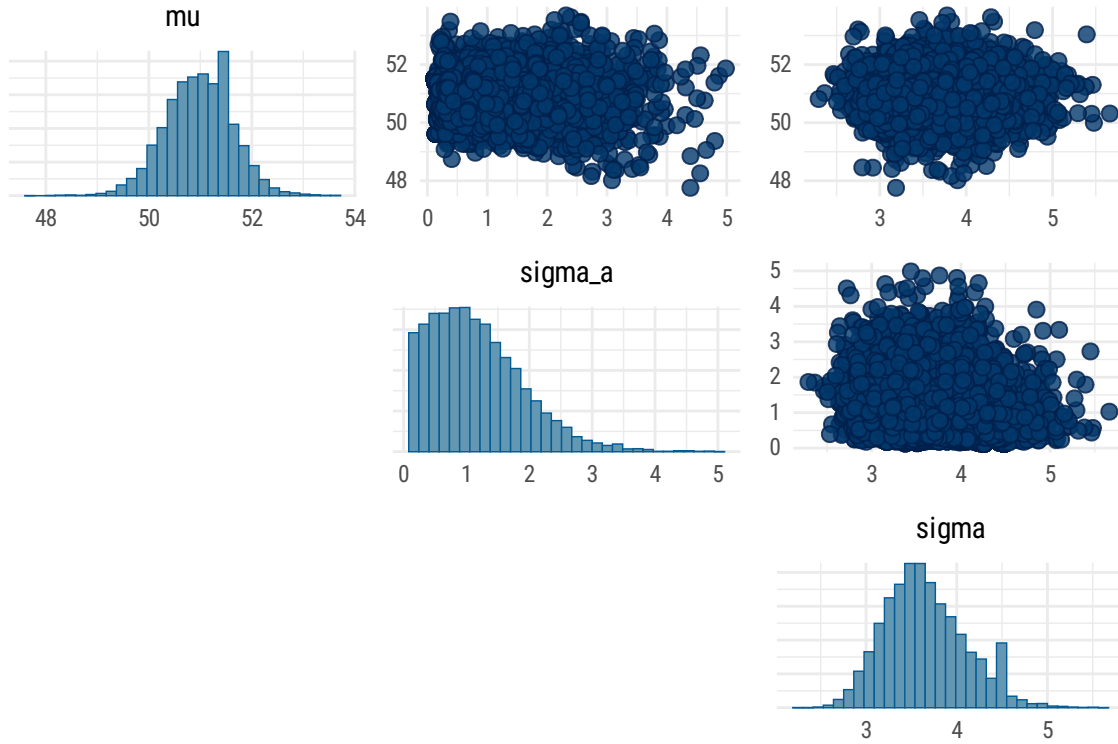
Posterior Densities for Independent (top), 5% Correlation (middle) and 75% Correlation (bottom)



Pairs Plots for Posterior Densities

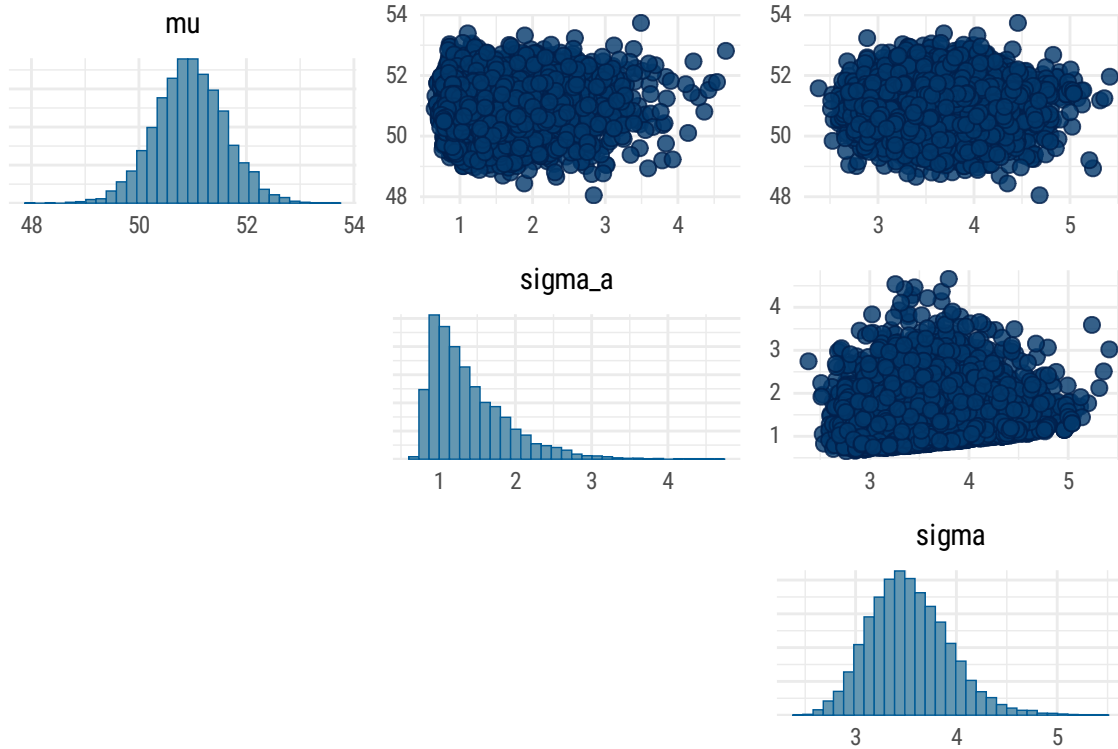
Independent

Warning: Only one chain in 'x'. This plot is more useful with multiple chains.



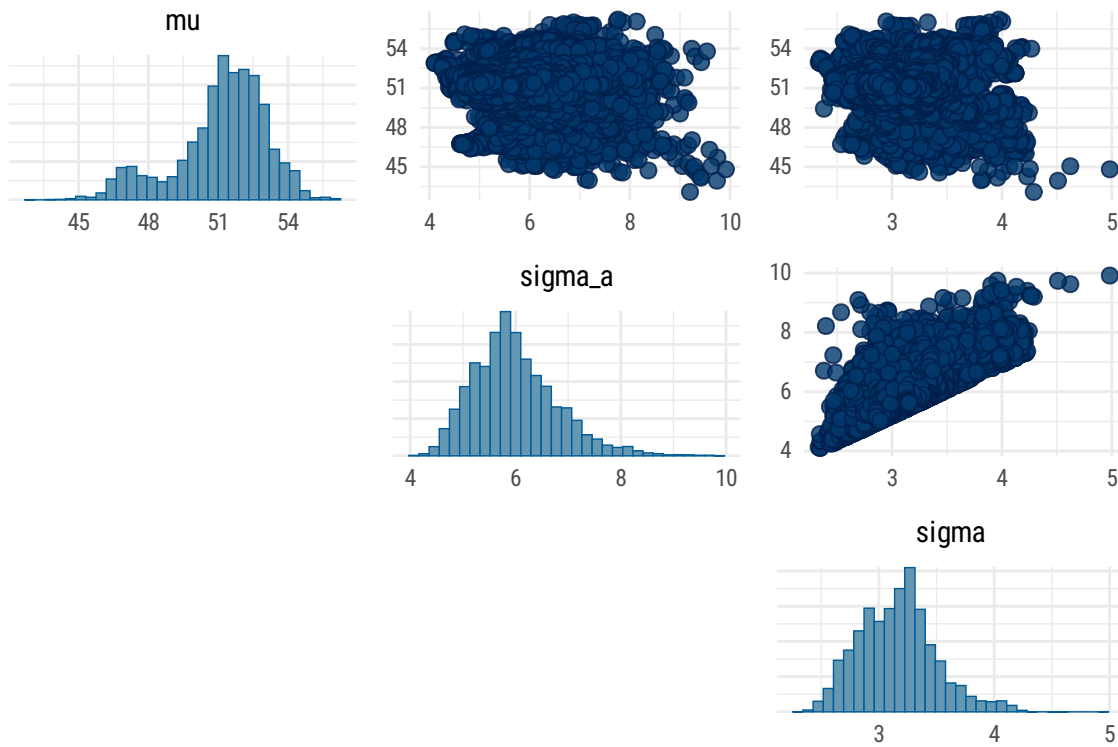
5% Correlation

Warning: Only one chain in 'x'. This plot is more useful with multiple chains.



75% Correlation

Warning: Only one chain in 'x'. This plot is more useful with multiple chains



What Happened...

Comparing these results to the results in the notes, there does not seem to be any major differences other than the actual estimates for the parameters, but this makes sense because of the data being used to compute the likelihood with uniform priors for the variance parameters.