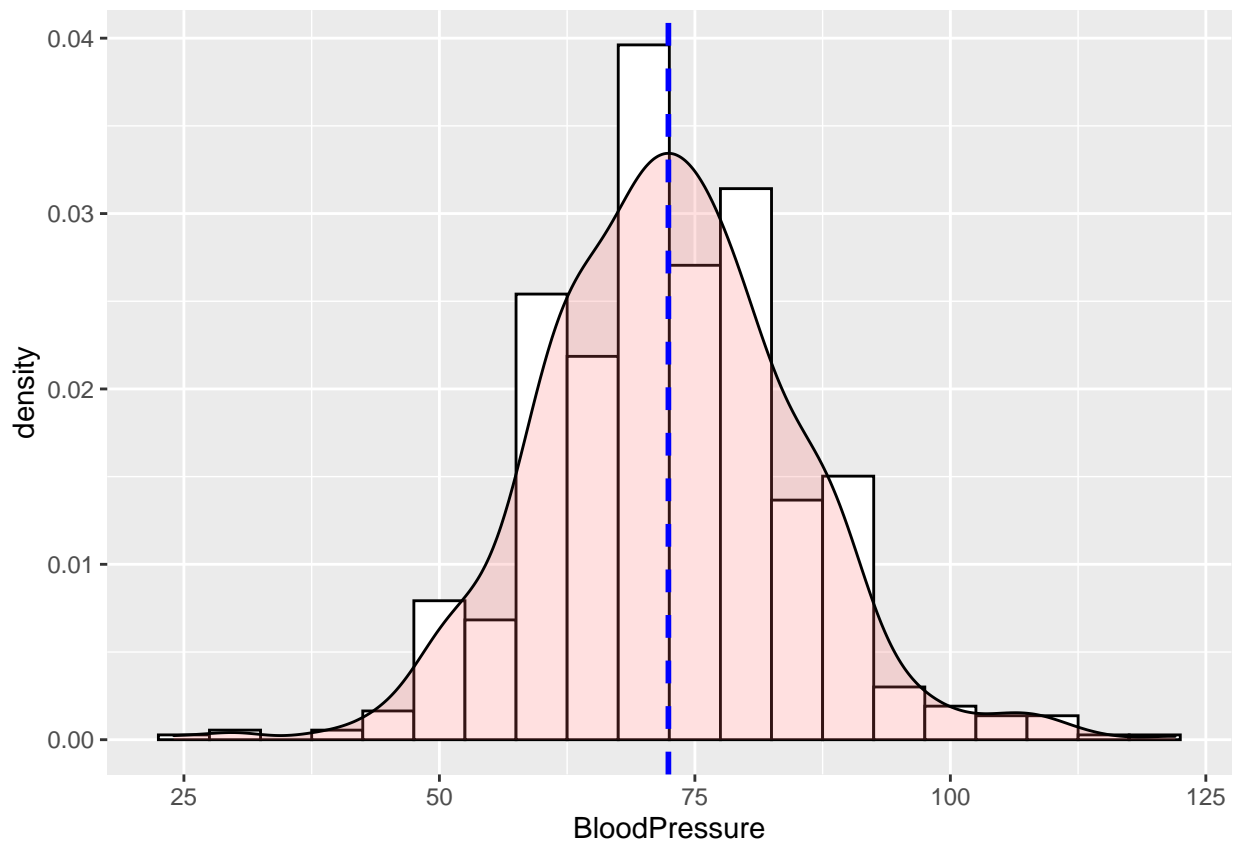


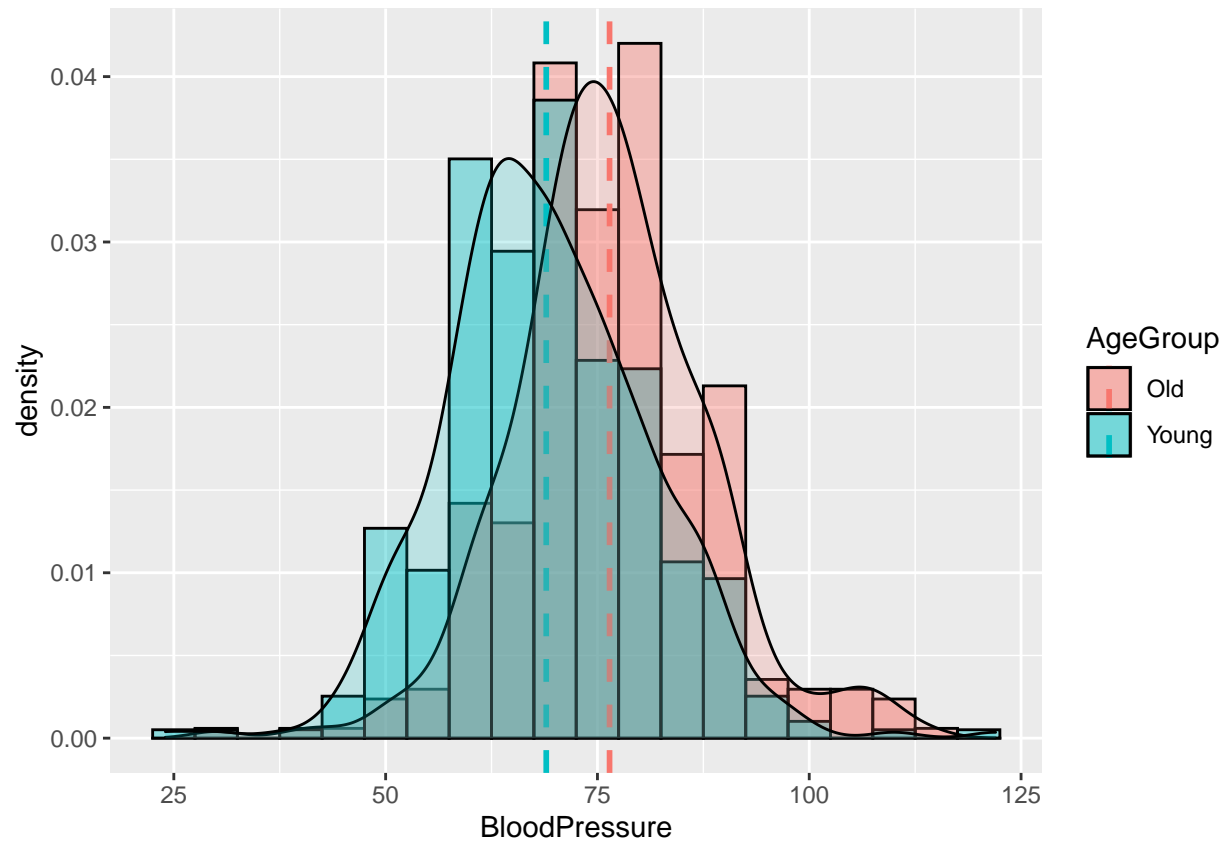
BDA - Assignment 7

7/10/2021

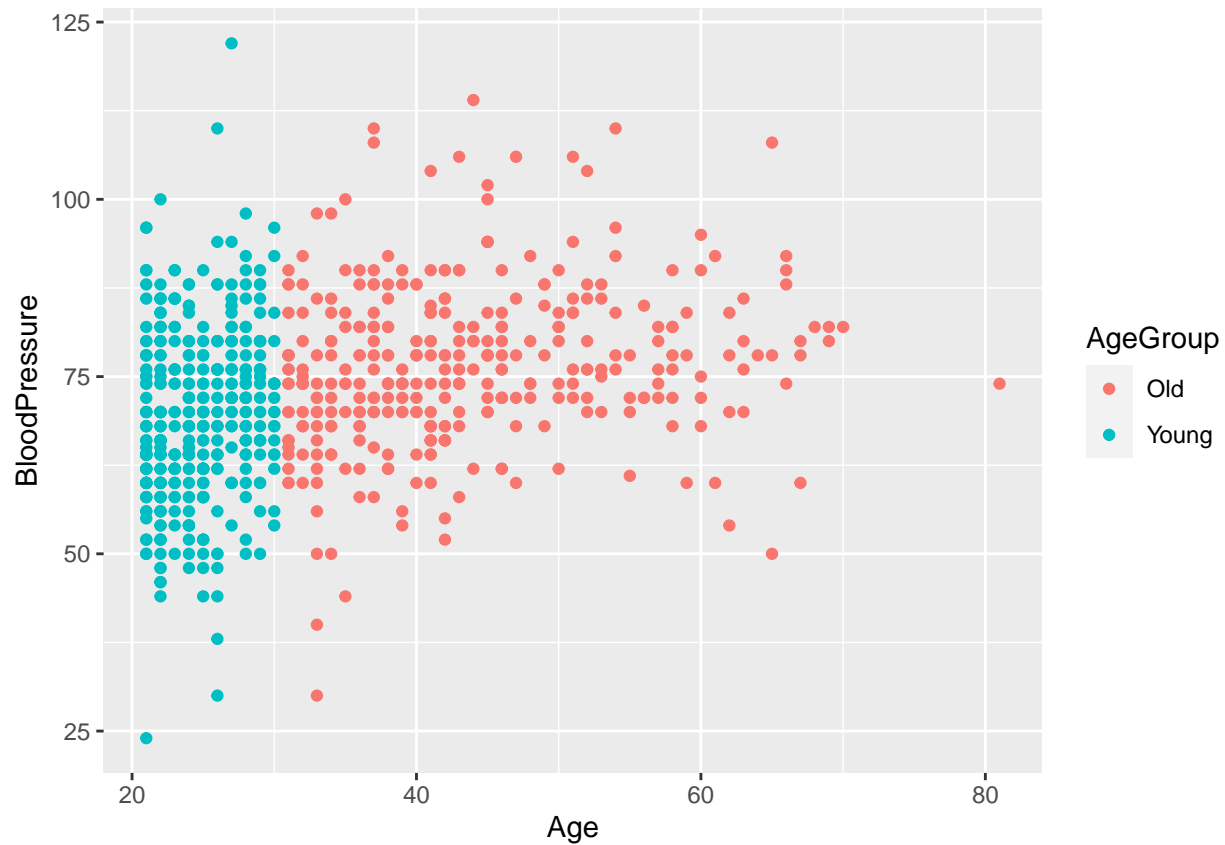
```
data <- data %>%  
  filter(BloodPressure > 0) %>%  
  mutate(AgeGroup = case_when(  
    Age <= 30 ~ "Young",  
    Age > 30 ~ "Old")  
  ) %>% head(-1)  
#data
```



```
means <- data %>%  
  group_by(AgeGroup) %>%  
  summarise(mean = mean(BloodPressure), n = n())  
  
ggplot(data, aes(x=BloodPressure, fill=AgeGroup)) +  
  geom_histogram(aes(y=..density..), binwidth = 5, colour="black", position = "identity", alpha = 0.4) +  
  geom_vline(data = means, aes(xintercept=mean, color = AgeGroup), linetype="dashed", size=1) +  
  geom_density(alpha=.2)
```



```
ggplot(data, aes(x=Age, y=BloodPressure, color=AgeGroup)) + geom_point()
```



```

data {
  int<lower=0> N;                //Amount of data points
  vector[N] y;                  //
  real mean_mu_prior;           //
  real<lower=0> mean_sigma_prior; //
  real<lower=0> var_prior;       //
}

parameters {
  real mu;
  real<lower=0> sigma;
}

model {
  //prior
  mu ~ normal(mean_mu_prior, mean_sigma_prior);
  sigma ~ inv_chi_square(var_prior);
  //likelihoods
  y ~ normal(mu, sigma);
}

generated quantities {
  real ypred;
  vector[N] log_lik;
  ypred = normal_rng(mu, sigma);
  for (n in 1:(N)){

```

```

    log_lik[n] = normal_lpdf(y[n] | mu, sigma);
  }
}

data_old <- data %>%
  filter(AgeGroup == "Old")

mean_mu_prior_old = mean(data_old$BloodPressure)
mean_sigma_prior_old = 10
var_prior_old = 20
data_nonhiera_old <- list(
  y = data_old$BloodPressure,
  N = length(data_old$BloodPressure),
  mean_mu_prior = mean_mu_prior_old,
  mean_sigma_prior = mean_sigma_prior_old,
  var_prior = var_prior_old
)

fit_nonhiera_old = sampling(nonhieramodel,
  data = data_nonhiera_old,          # named list of data
  chains = 4,                        # number of Markov chains
  warmup = 1000,                     # number of warmup iterations per chain
  iter = 2000,                       # total number of iterations per chain
  cores = 1,                         # number of cores (could use one per chain)
  refresh = 0                        # no progress shown
)

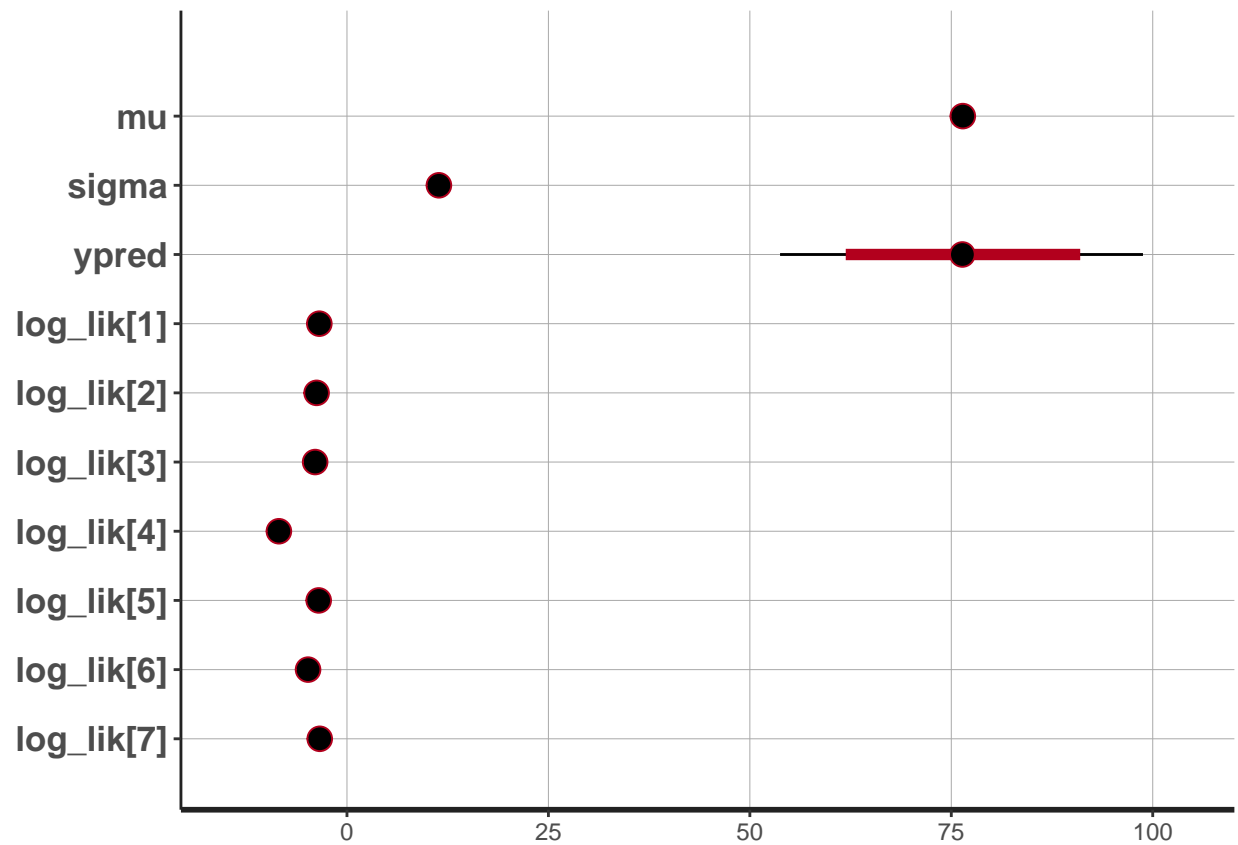
head(monitor(fit_nonhiera_old, print = FALSE), 3)

##      mean se_mean      sd 2.5% 25% 50% 75% 97.5% n_eff Rhat valid  Q5  Q50
## mu      76.4 0.00996  0.599 75.2 76.0 76.4 76.8 77.6 3598    1    1 75.4 76.4
## sigma 11.4 0.00774  0.446 10.6 11.1 11.4 11.7 12.4 3290    1    1 10.7 11.4
## ypred 76.4 0.18113 11.431 53.8 68.8 76.4 84.3 98.8 3975    1    1 57.9 76.4
##      Q95 MCSE_Q2.5 MCSE_Q25 MCSE_Q50 MCSE_Q75 MCSE_Q97.5 MCSE_SD Bulk_ESS
## mu      77.4    0.0326 0.01475 0.01024 0.0134    0.0327 0.00704    3650
## sigma 12.2    0.0163 0.00855 0.00892 0.0105    0.0318 0.00549    3317
## ypred 95.3    0.3581 0.30230 0.22841 0.2043    0.4295 0.12809    3977
##      Tail_ESS
## mu          2585
## sigma       2386
## ypred       4022

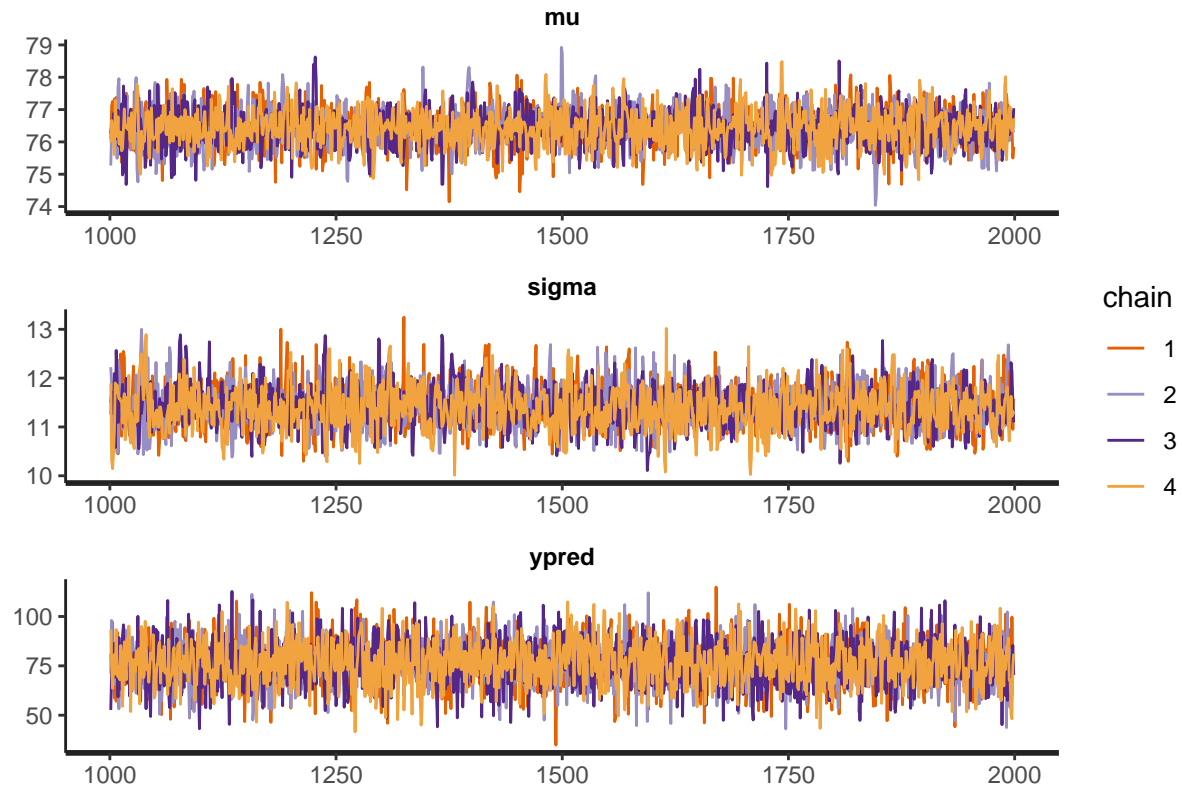
plot(fit_nonhiera_old)

## 'pars' not specified. Showing first 10 parameters by default.
## ci_level: 0.8 (80% intervals)
## outer_level: 0.95 (95% intervals)

```



```
traceplot(fit_nonhiera_old, inc_warmup = FALSE, nrow = 3, pars=c("mu", "sigma", "ypred"))
```



```
data_young <- data %>%
  filter(AgeGroup == "Young")
```

```
mean_mu_prior_old = mean(data_young$BloodPressure)
```

```
mean_sigma_prior_old = 10
```

```
var_prior_old = 20
```

```
data_nonhiera_young <- list(
  y = data_young$BloodPressure,
  N = length(data_young$BloodPressure),
  mean_mu_prior = mean_mu_prior_old,
  mean_sigma_prior = mean_sigma_prior_old,
  var_prior = var_prior_old
)
```

```
fit_nonhiera_young = sampling(nonhieramodel,
  data = data_nonhiera_young,          # named list of data
  chains = 4,                          # number of Markov chains
  warmup = 1000,                       # number of warmup iterations per chain
  iter = 2000,                         # total number of iterations per chain
  cores = 1,                           # number of cores (could use one per chain)
  refresh = 0                          # no progress shown
)
```

```
head(monitor(fit_nonhiera_young, print = FALSE), 3)
```

```
##      mean se_mean      sd 2.5% 25% 50% 75% 97.5% n_eff Rhat valid  Q5  Q50
## mu    69.0 0.00995   0.619 67.8 68.5 69.0 69.4  70.2  3874    1    1 67.9 69.0
```

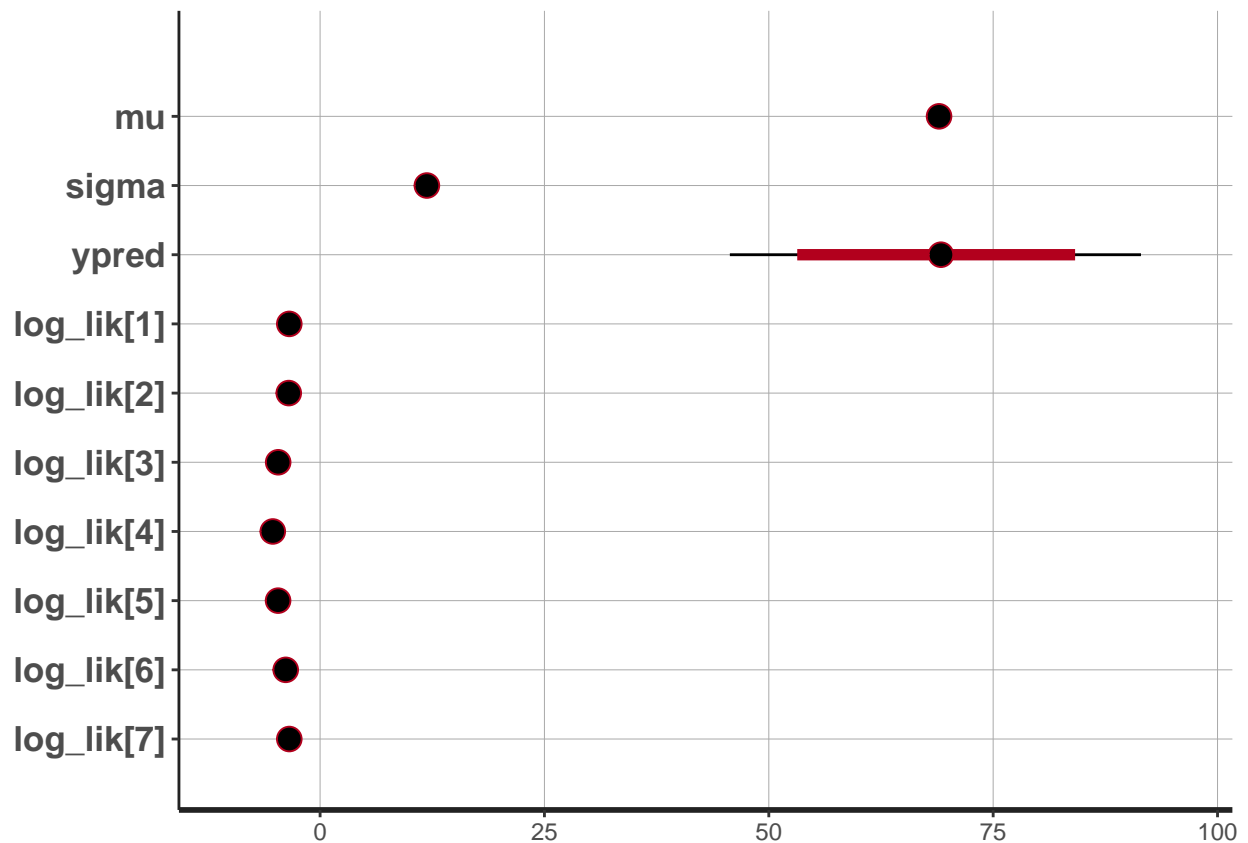
```
## sigma 11.9 0.00654 0.420 11.1 11.6 11.9 12.2 12.8 4118 1 1 11.2 11.9
## ypred 68.9 0.19222 12.004 45.7 60.5 69.2 77.1 91.5 3865 1 1 49.0 69.2
##      Q95 MCSE_Q2.5 MCSE_Q25 MCSE_Q50 MCSE_Q75 MCSE_Q97.5 MCSE_SD Bulk_ESS
## mu      70.0      0.0199 0.01456 0.01214 0.01676      0.0292 0.00703      3862
## sigma 12.6      0.0196 0.00726 0.00865 0.00973      0.0150 0.00464      4152
## ypred 88.3      0.3882 0.24828 0.25978 0.28759      0.4800 0.13635      3903
##      Tail_ESS
## mu      2921
## sigma 2757
## ypred 3934
```

```
plot(fit_nonhiera_young)
```

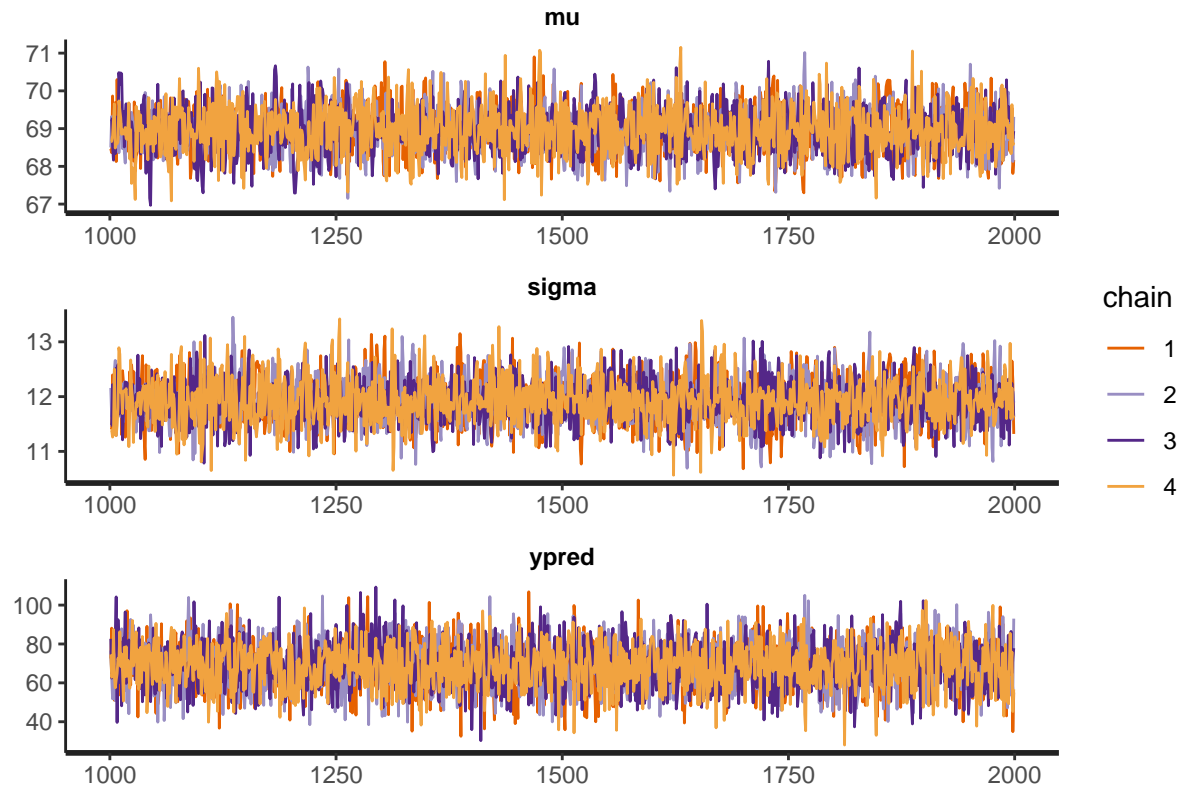
```
## 'pars' not specified. Showing first 10 parameters by default.
```

```
## ci_level: 0.8 (80% intervals)
```

```
## outer_level: 0.95 (95% intervals)
```



```
traceplot(fit_nonhiera_young, inc_warmup = FALSE, nrow = 3, pars=c("mu", "sigma", "ypred"))
```



```
data {
  int<lower=0> N;           //Amount of data points
  vector[N] y;            //
  real mean_mu_prior;      //
  real<lower=0> mean_sigma_prior; //
  real<lower=0> var_prior;  //
}

parameters {
  real mu;
  real<lower=0> sigma;
  real mu_hypo;
  real<lower=0> tau;
}

model {
  //hyperpriors
  mu_hypo ~ normal(mean_mu_prior, mean_sigma_prior);
  tau ~ inv_chi_square(var_prior);
  //prior
  mu ~ normal(mu_hypo, tau);
  sigma ~ inv_chi_square(var_prior);
  //likelihoods
  y ~ normal(mu, sigma);
}
```



```

generated quantities {
  real ypred;
  vector[N] log_lik;
  ypred = normal_rng(mu, sigma);
  for (n in 1:(N)){
    log_lik[n] = normal_lpdf(y[n] | mu, sigma);
  }
}

mean_mu_prior = mean(data$BloodPressure)
mean_sigma_prior = 10
var_prior = 20
data_hiera_old <- list(
  y = data_old$BloodPressure,
  N = length(data_old$BloodPressure),
  mean_mu_prior = mean_mu_prior,
  mean_sigma_prior = mean_sigma_prior_old,
  var_prior = var_prior
)
data_hiera_young <- list(
  y = data_young$BloodPressure,
  N = length(data_young$BloodPressure),
  mean_mu_prior = mean_mu_prior,
  mean_sigma_prior = mean_sigma_prior,
  var_prior = var_prior
)

fit_hiera_old = sampling(hieramodel,
  data = data_hiera_old,          # named list of data
  chains = 4,                    # number of Markov chains
  warmup = 1000,                 # number of warmup iterations per chain
  iter = 2000,                   # total number of iterations per chain
  cores = 1,                     # number of cores (could use one per chain)
  refresh = 0                     # no progress shown
)

fit_hiera_young = sampling(hieramodel,
  data = data_hiera_young,        # named list of data
  chains = 4,                     # number of Markov chains
  warmup = 1000,                 # number of warmup iterations per chain
  iter = 2000,                   # total number of iterations per chain
  cores = 1,                     # number of cores (could use one per chain)
  refresh = 0                     # no progress shown
)

head(monitor(fit_hiera_old, print = FALSE),3)

##          mean se_mean    sd 2.5%  25%  50%  75% 97.5% n_eff Rhat valid   Q5  Q50
## mu          76.4 0.01630 0.615 75.2 76.0 76.4 76.8 77.6 1399    1    1 75.4 76.4
## sigma       11.4 0.00898 0.434 10.6 11.1 11.4 11.7 12.3 2296    1    1 10.7 11.4
## mu_hypo     76.4 0.01637 0.618 75.2 76.0 76.4 76.8 77.6 1411    1    1 75.4 76.4
##          Q95 MCSE_Q2.5 MCSE_Q25 MCSE_Q50 MCSE_Q75 MCSE_Q97.5 MCSE_SD Bulk_ESS
## mu          77.5    0.0363    0.0219    0.0188    0.0177    0.0463 0.01153    1419
## sigma       12.2    0.0172    0.0109    0.0108    0.0156    0.0273 0.00638    2336
## mu_hypo     77.5    0.0362    0.0220    0.0152    0.0188    0.0481 0.01157    1427
##          Tail_ESS

```

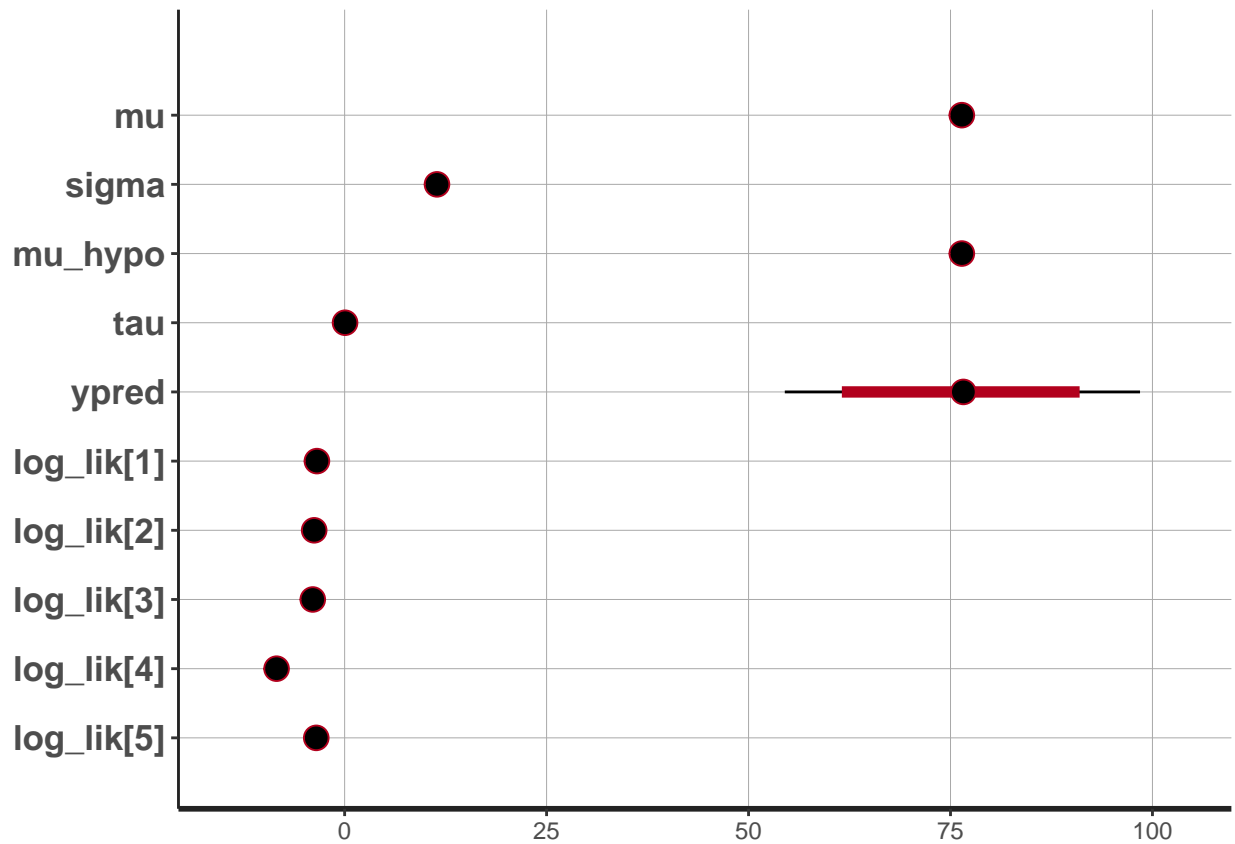
```
## mu          1548
## sigma       2165
## mu_hypo     1539
```

```
plot(fit_hiera_old)
```

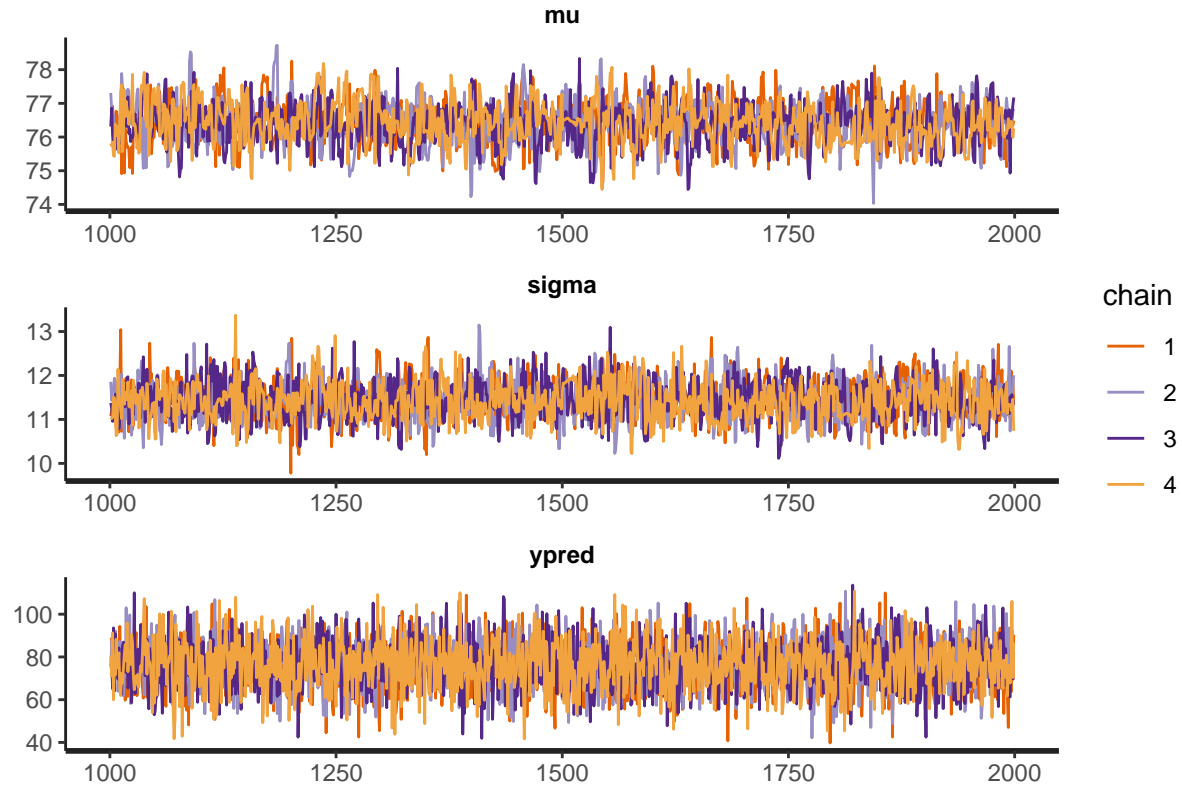
```
## 'pars' not specified. Showing first 10 parameters by default.
```

```
## ci_level: 0.8 (80% intervals)
```

```
## outer_level: 0.95 (95% intervals)
```



```
traceplot(fit_hiera_old, inc_warmup = FALSE, nrow = 3, pars=c("mu", "sigma", "ypred"))
```



```
head(monitor(fit_hiera_young, print = FALSE), 3)
```

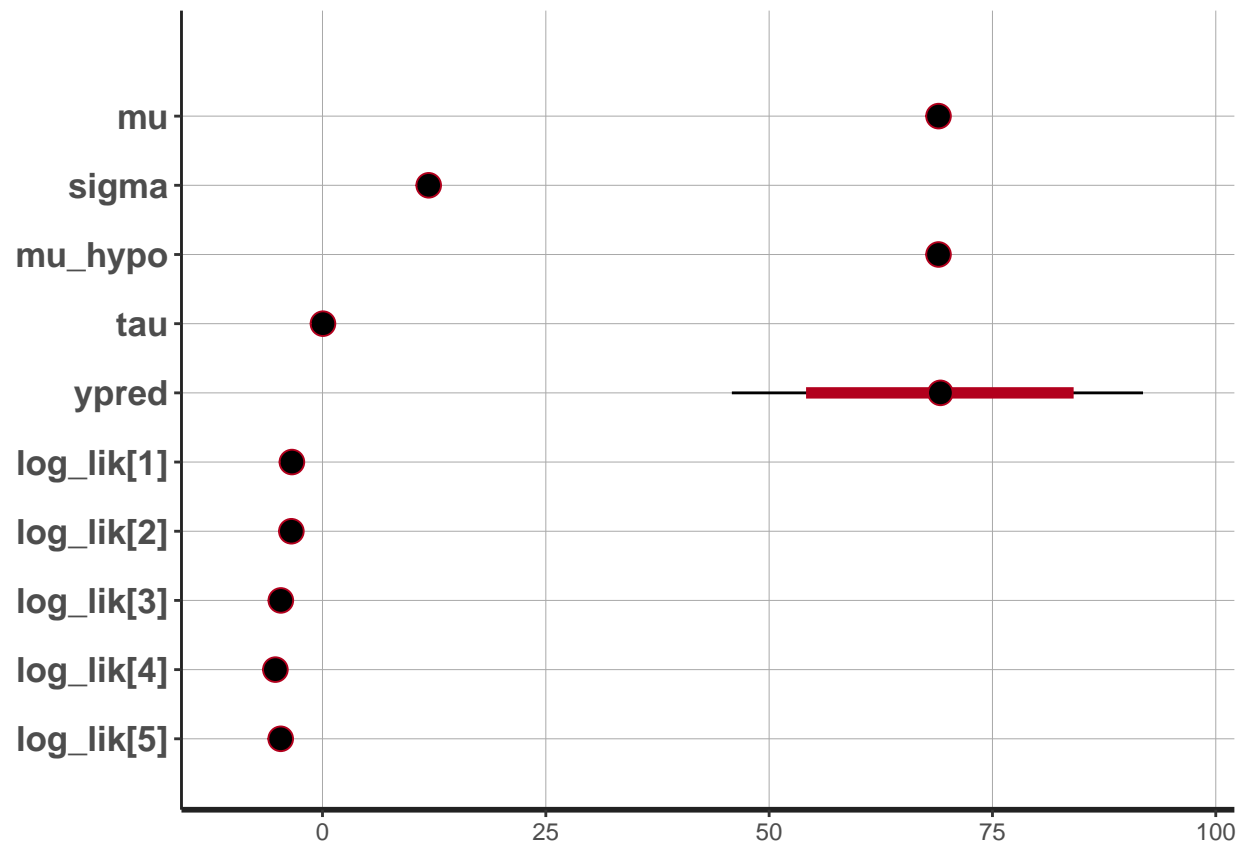
```
##          mean se_mean    sd 2.5% 25% 50% 75% 97.5% n_eff Rhat valid  Q5  Q50
## mu       68.9  0.0182 0.629 67.7 68.5 69.0 69.4 70.1 1195   1    1 67.9 69.0
## sigma    11.9  0.0102 0.421 11.1 11.6 11.9 12.2 12.8 1699   1    1 11.2 11.9
## mu_hypo  68.9  0.0184 0.633 67.7 68.5 69.0 69.4 70.1 1184   1    1 67.9 69.0
##          Q95 MCSE_Q2.5 MCSE_Q25 MCSE_Q50 MCSE_Q75 MCSE_Q97.5 MCSE_SD Bulk_ESS
## mu       70.0   0.0641   0.0291   0.0202   0.0204   0.0373 0.01285   1205
## sigma    12.6   0.0174   0.0111   0.0116   0.0138   0.0312 0.00725   1731
## mu_hypo  70.0   0.0463   0.0236   0.0214   0.0193   0.0298 0.01299   1193
##          Tail_ESS
## mu          1347
## sigma        2032
## mu_hypo      1404
```

```
plot(fit_hiera_young)
```

```
## 'pars' not specified. Showing first 10 parameters by default.
```

```
## ci_level: 0.8 (80% intervals)
```

```
## outer_level: 0.95 (95% intervals)
```



```
traceplot(fit_hiera_young, inc_warmup = FALSE, nrow = 3, pars=c("mu", "sigma", "ypred"))
```

