HW7

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Question 1

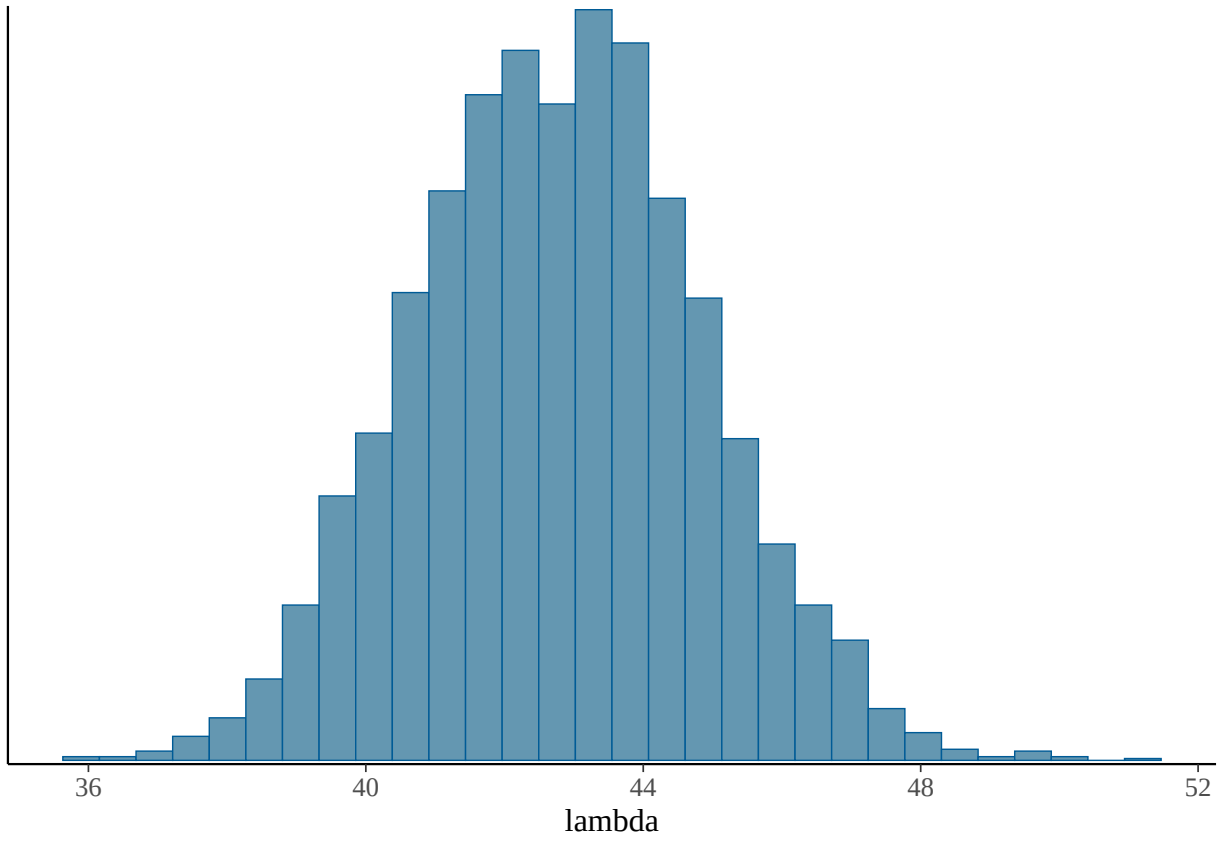
a)

```
data <- list(y = c(43, 35, 46, 38, 35, 50, 48, 42, 38, 53), n = 10)

fit <- stan(
  file = "q1.stan",
  data = data,
  chains = 4,
  warmup = 1000,
  iter = 2000,
  cores = 1,
  refresh = 0,
  seed = 740
  )
```

b)

```
mcmc_hist(fit, pars = c("lambda"))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

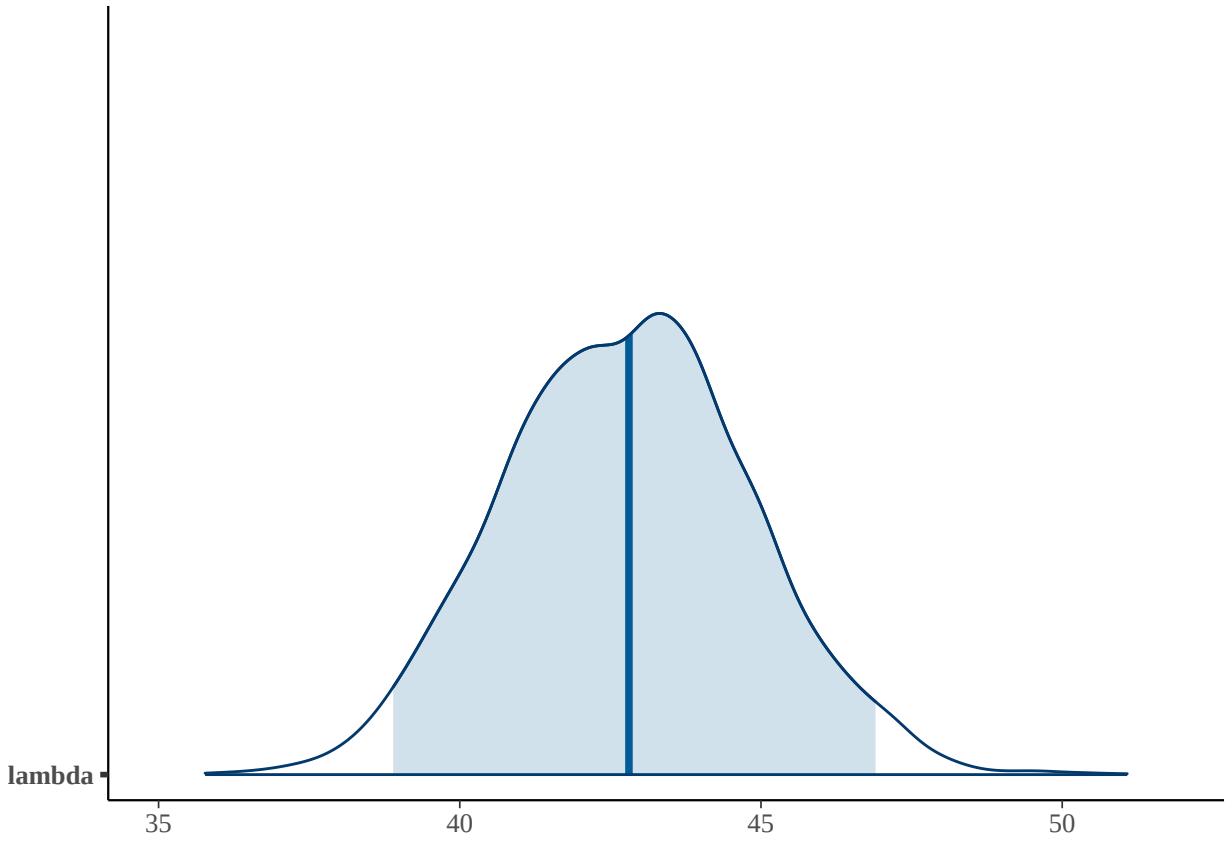


c)

```
summary(fit)$summary
```

```
##               mean    se_mean        sd       2.5%        25%        50%
## lambda   42.78232 0.05274130 2.0624643   38.89377   41.34329   42.81106
## lp__   1183.05549 0.01928675 0.7014375 1181.18150 1182.90137 1183.32511
##                75%      97.5%    n_eff     Rhat
## lambda   44.13724   46.90218 1529.224 1.002108
## lp__   1183.50184 1183.55544 1322.696 1.002516
```

```
mcmc_areas(fit, pars = c("lambda"), prob = 0.95)
```



95% Credible Interval: (38.89, 46.90)

d)

Posterior Mean: 42.78

e)

```
2.064643^2
```

```
## [1] 4.262751
```

Posterior Variance: 4.26

Question 2

a)

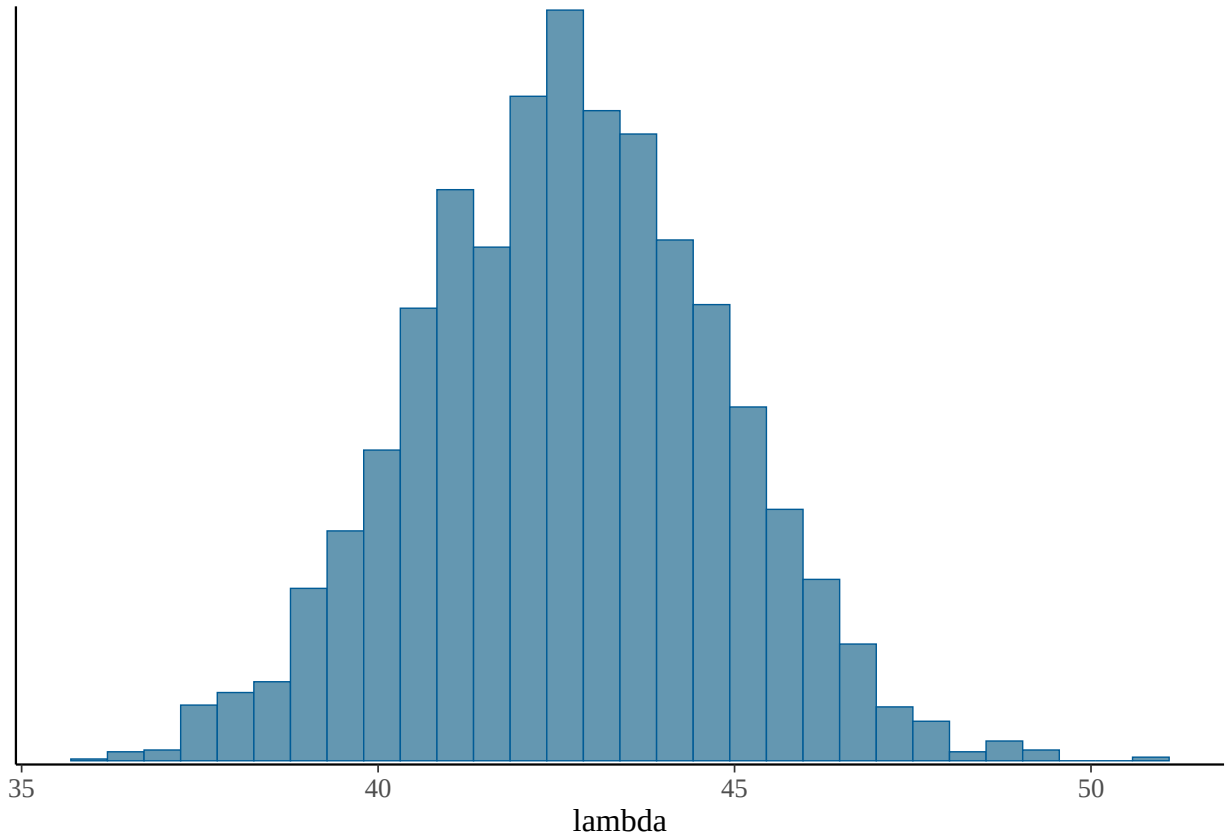
```
data2a <- list(y = c(43, 35, 46, 38, 35, 50, 48, 42, 38, 53), n = 10, mu = 0.025)

fit2a <- stan(
  file = "q2.stan",
  data = data2a,
```

```
  chains = 4,
  warmup = 1000,
  iter = 2000,
  cores = 1,
  refresh = 0,
  seed = 740
  )
```

b)

```
mcmc_hist(fit2a, pars = c("lambda"))
```

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

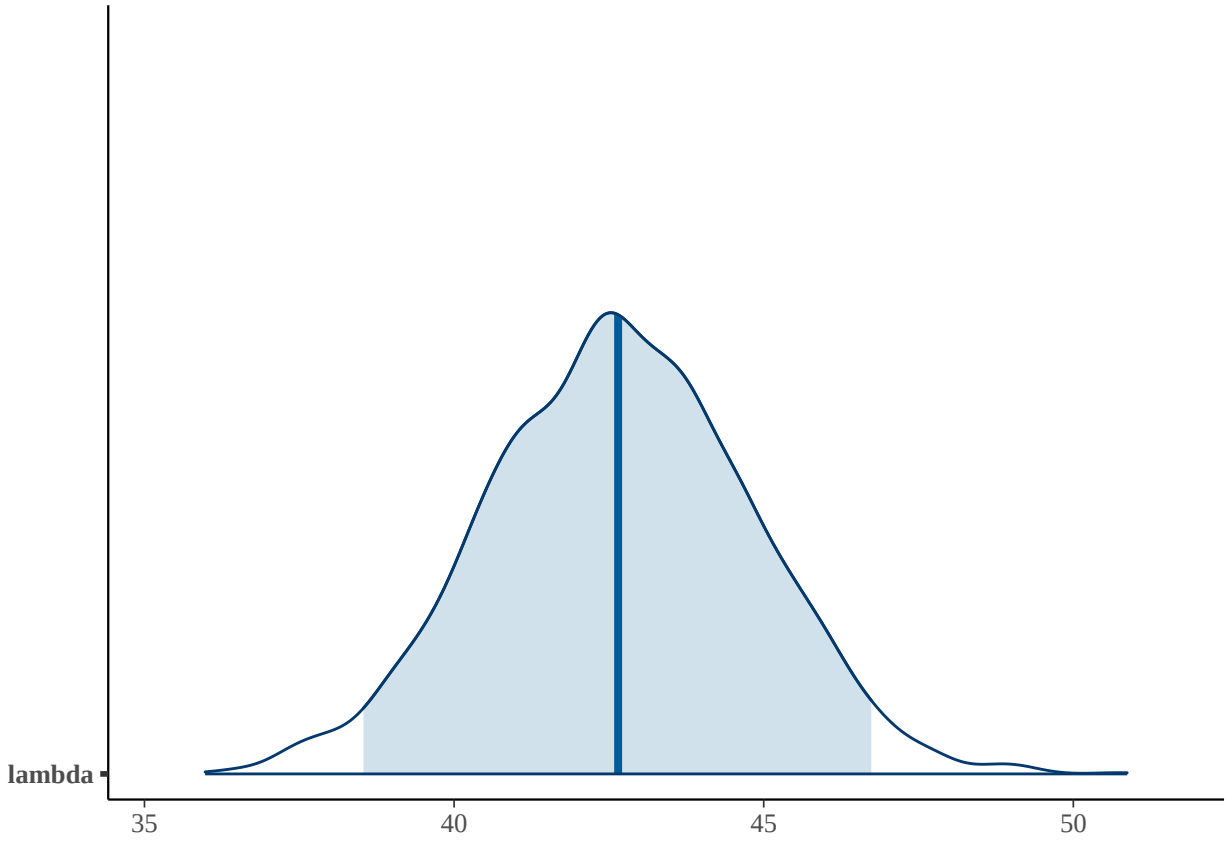


c)

```
summary(fit2a)$summary
```

```
##               mean    se_mean        sd       2.5%        25%        50%
## lambda   42.67529 0.05842667 2.1194341   38.53591   41.21327   42.64883
## lp__   1181.95292 0.01886725 0.7499904 1179.71805 1181.77502 1182.23273
##                75%      97.5%    n_eff     Rhat
## lambda   44.08142   46.73798 1315.884 1.005934
## lp__   1182.43199 1182.48420 1580.136 0.999481
```

```
mcmc_areas(fit2a, pars = c("lambda"), prob = 0.95)
```



95% Credible Interval:(3.854, 46.74)

d)

Posterior Mean: 42.68

e)

```
2.1194341^2
```

```
## [1] 4.492001
```

Posterior Variance: 4.49

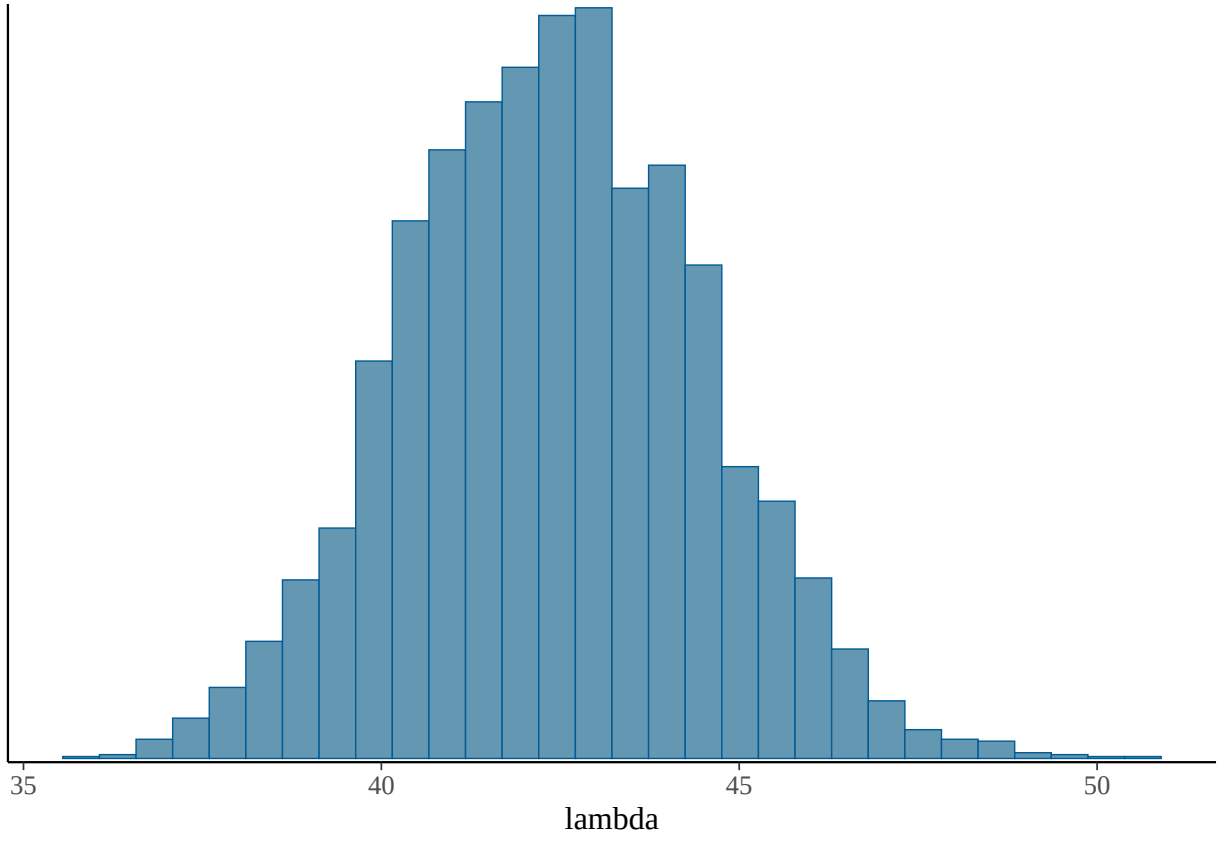
f)

```
data2b <- list(y = c(43, 35, 46, 38, 35, 50, 48, 42, 38, 53), n = 10, mu = 0.1)

fit2b <- stan(
```

```
  file = "q2.stan",
  data = data2b,
  chains = 4,
  warmup = 1000,
  iter = 2000,
  cores = 1,
  refresh = 0,
  seed = 740
  )

mcmc_hist(fit2b, pars = c("lambda"))
```

Mu = 10

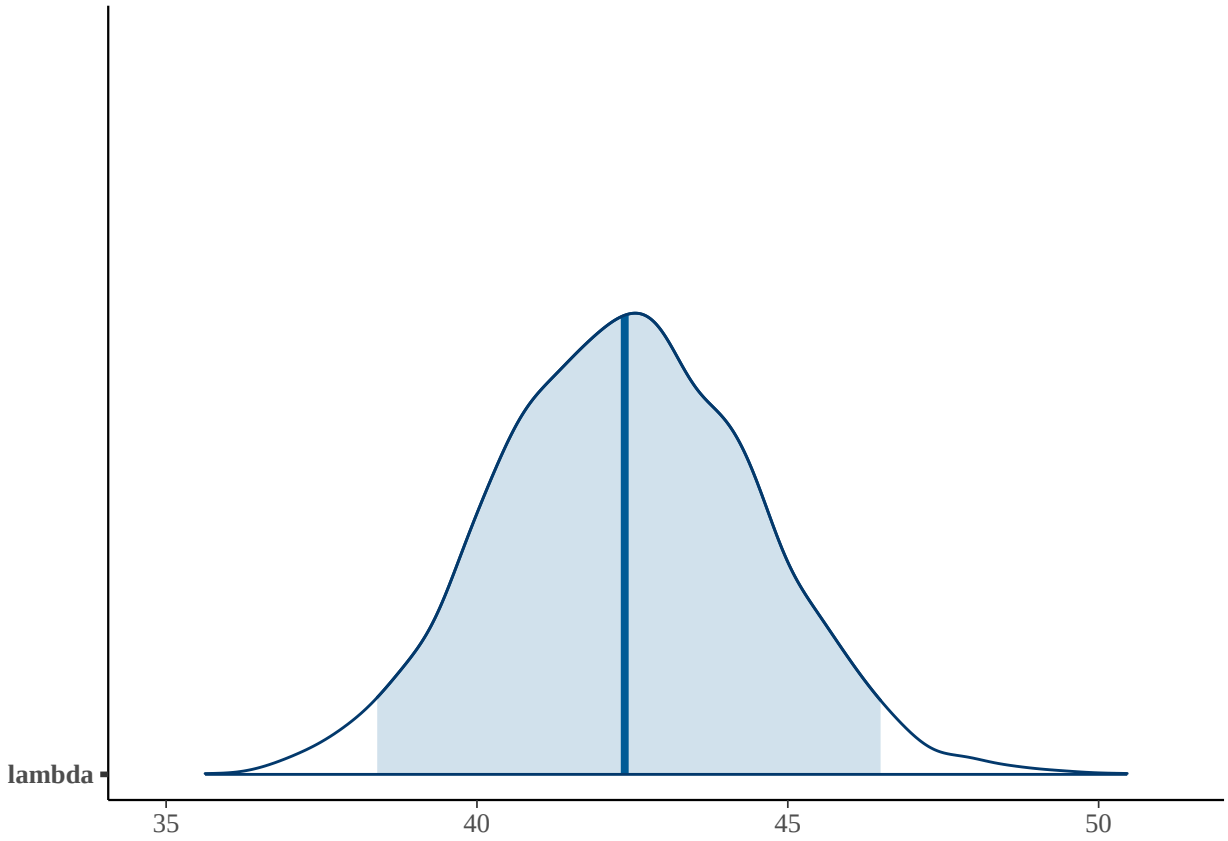
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
summary(fit2b)$summary
```

```
##             mean    se_mean        sd       2.5%        25%        50%
## lambda   42.4087 0.06096700 2.0887063   38.39584   40.93603   42.37796
## lp__   1178.7664 0.02085028 0.7249869 1176.61907 1178.60963 1179.03763
##               75%      97.5%    n_eff     Rhat
## lambda   43.85018   46.49233 1173.722 1.002122
## lp__   1179.23316 1179.28668 1209.029 1.007945
```

```
mcmc_areas(fit2b, pars = c("lambda"), prob = 0.95)
```




```
2.0887063^2
```

```
## [1] 4.362694
```

95% CE: (38.40, 46.49)

Posterior Mean: 42.41

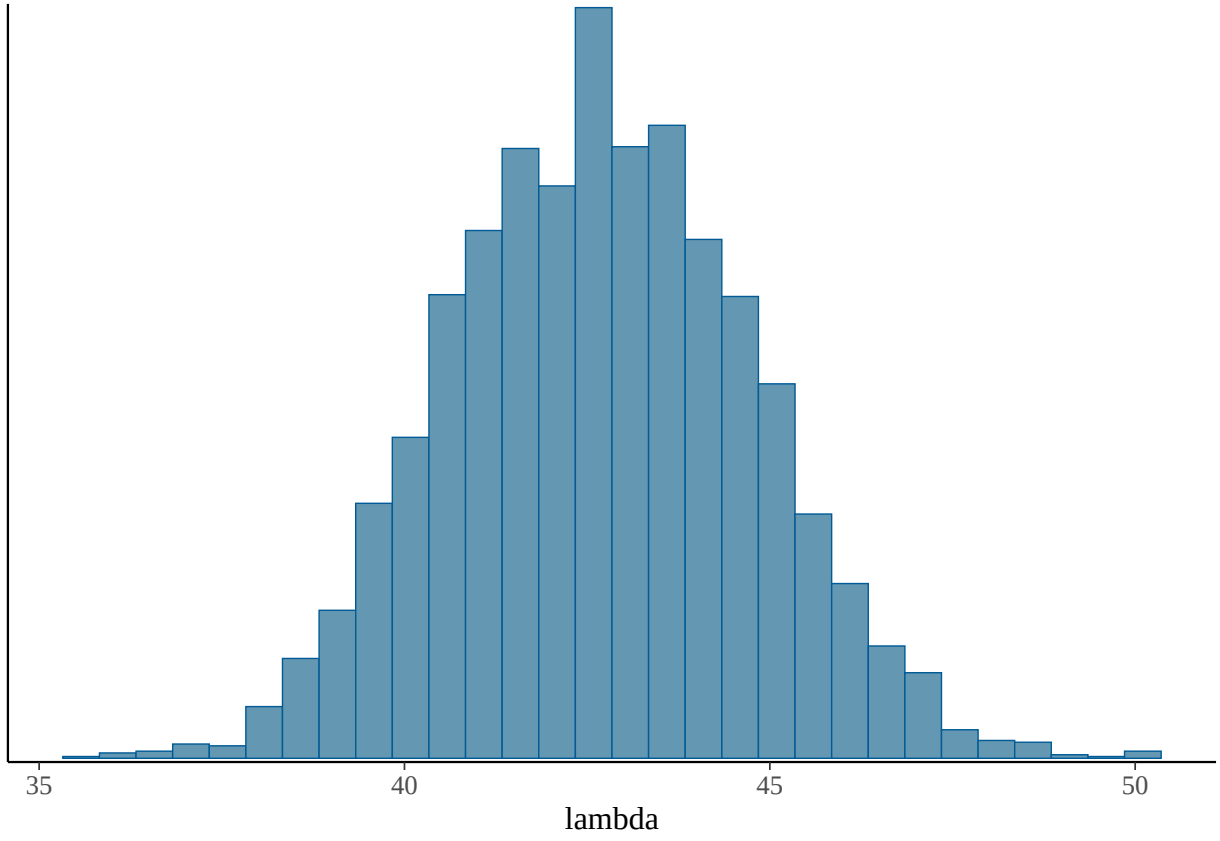
Posterior Variance: 4.36

```
data2c <- list(y = c(43, 35, 46, 38, 35, 50, 48, 42, 38, 53), n = 10, mu = 0.04)

fit2c <- stan(
  file = "q2.stan",
  data = data2c,
  chains = 4,
  warmup = 1000,
  iter = 2000,
  cores = 1,
  refresh = 0,
```

```
  seed = 740
  )

mcmc_hist(fit2c, pars = c("lambda"))
```

Mu = 25

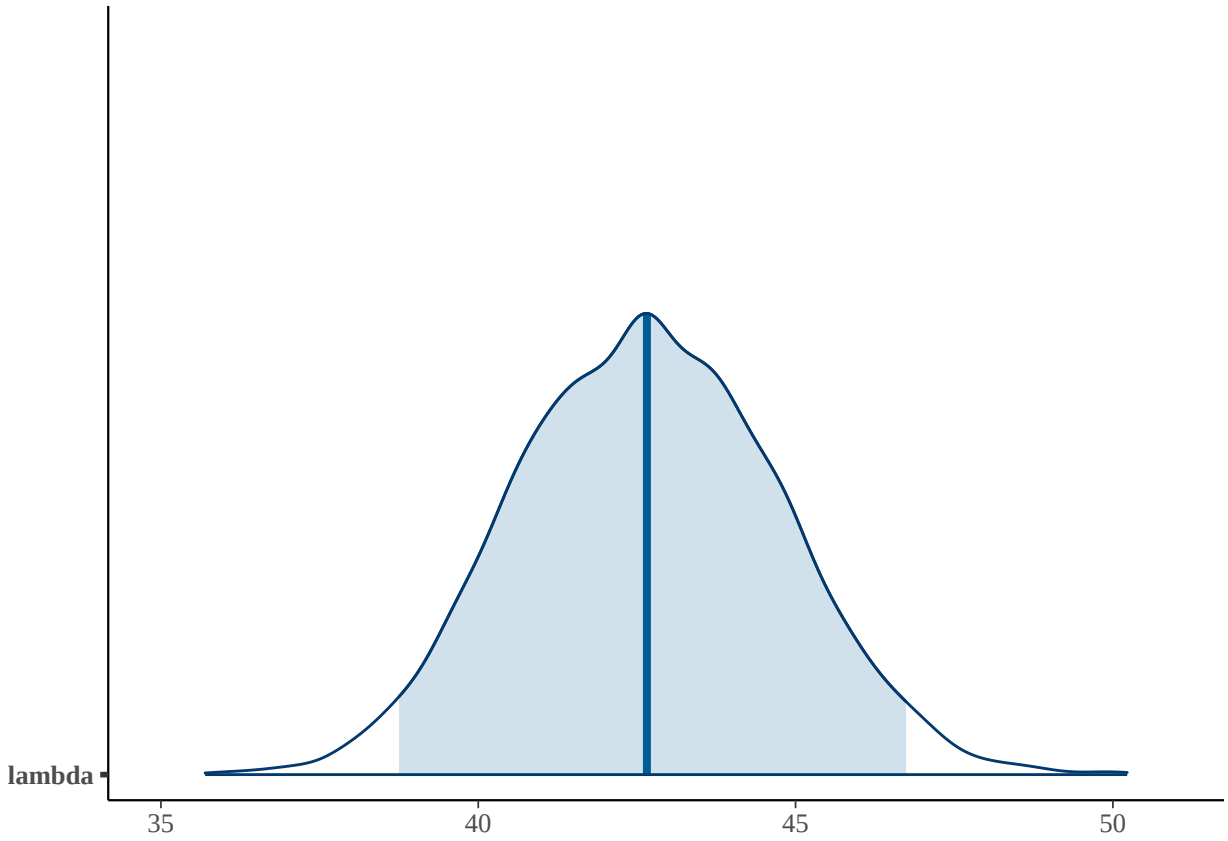
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
summary(fit2c)$summary
```

```
##               mean    se_mean       sd       2.5%        25%        50%
## lambda   42.67621 0.05546158 2.062179   38.75244   41.21725   42.65691
## lp__   1181.34180 0.01532380 0.694517 1179.49158 1181.18695 1181.60113
##               75%      97.5%    n_eff      Rhat
## lambda   44.0793   46.74185 1382.510 1.0035476
## lp__   1181.7887 1181.84304 2054.153 0.9996638
```

```
mcmc_areas(fit2c, pars = c("lambda"), prob = 0.95)
```




```
2.062179^2
```

```
## [1] 4.252582
```

95% CE: (38.75, 46.74)

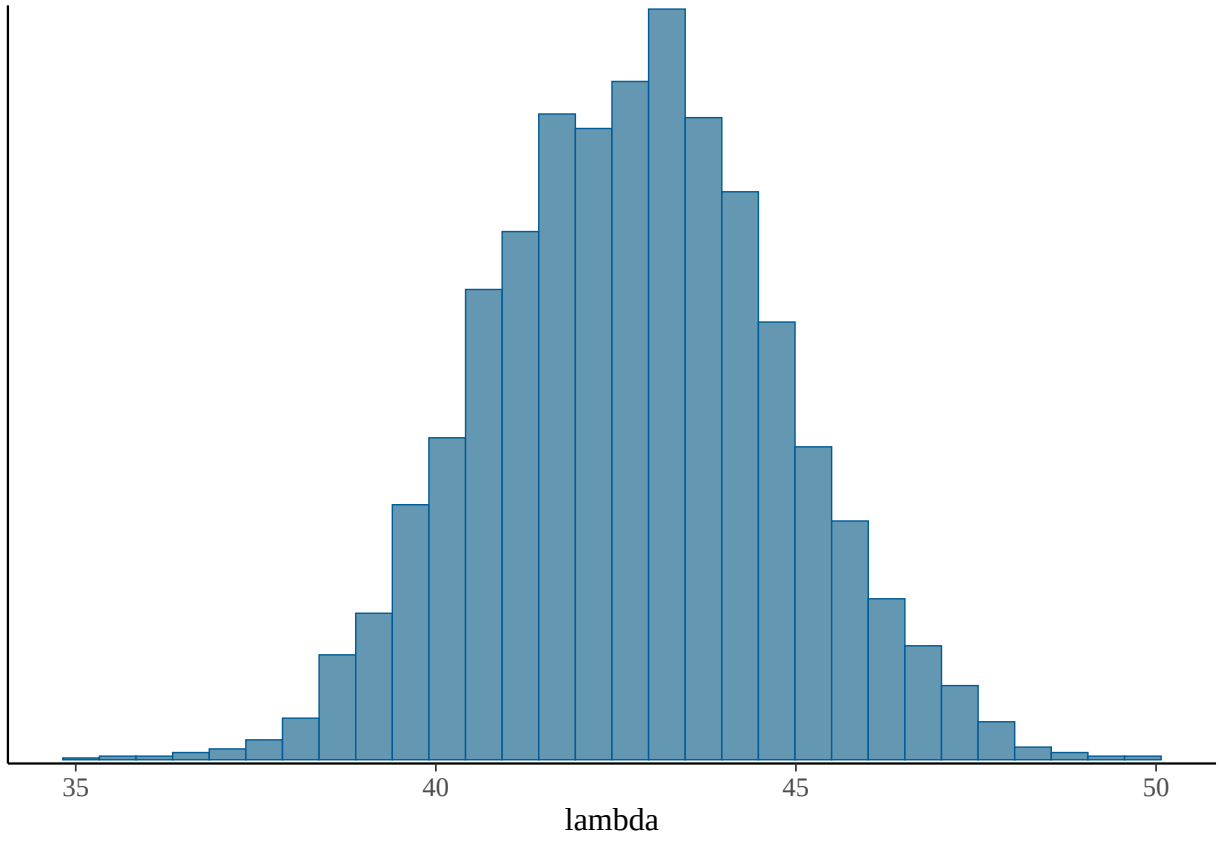
Posterior Mean: 42.68

Posterior Variance: 4.25

```
data2d <- list(y = c(43, 35, 46, 38, 35, 50, 48, 42, 38, 53), n = 10, mu = 0.01)

fit2d <- stan(
  file = "q2.stan",
  data = data2d,
  chains = 4,
  warmup = 1000,
  iter = 2000,
  cores = 1,
  refresh = 0,
  seed = 740
  )

mcmc_hist(fit2d, pars = c("lambda"))
```

Mu = 100

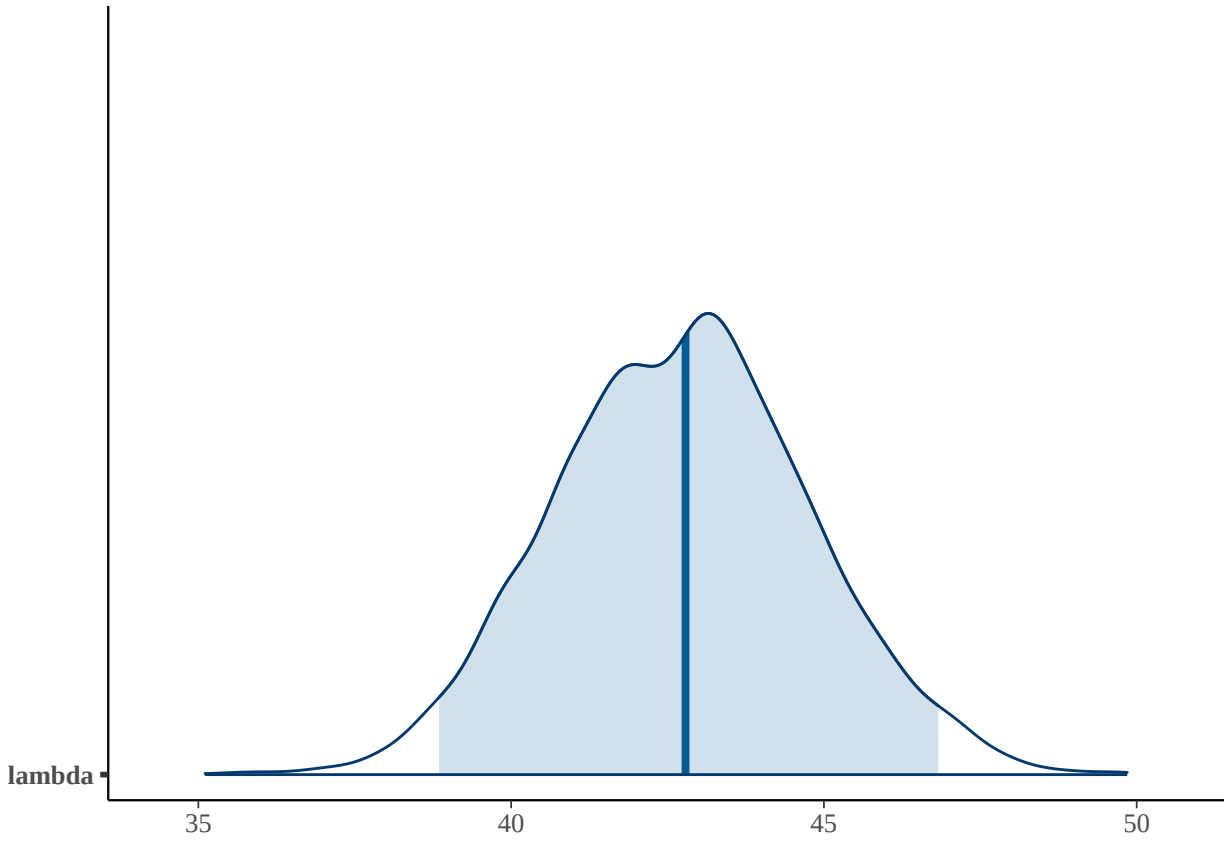
```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```




```
summary(fit2d)$summary
```

```
##             mean    se_mean        sd      2.5%        25%        50%
## lambda   42.7408 0.05679289 2.0375104   38.8478   41.34473   42.78586
## lp__   1182.6371 0.01851378 0.6945888 1180.7978 1182.49214 1182.90374
##               75%      97.5%    n_eff     Rhat
## lambda   44.11024   46.82938 1287.098 1.003682
## lp__   1183.07504 1183.12683 1407.555 1.003490
```

```
mcmc_areas(fit2d, pars = c("lambda"), prob = 0.95)
```




```
2.0375104^2
```

```
## [1] 4.151449
```

95% CE: (38.85, 46.83)

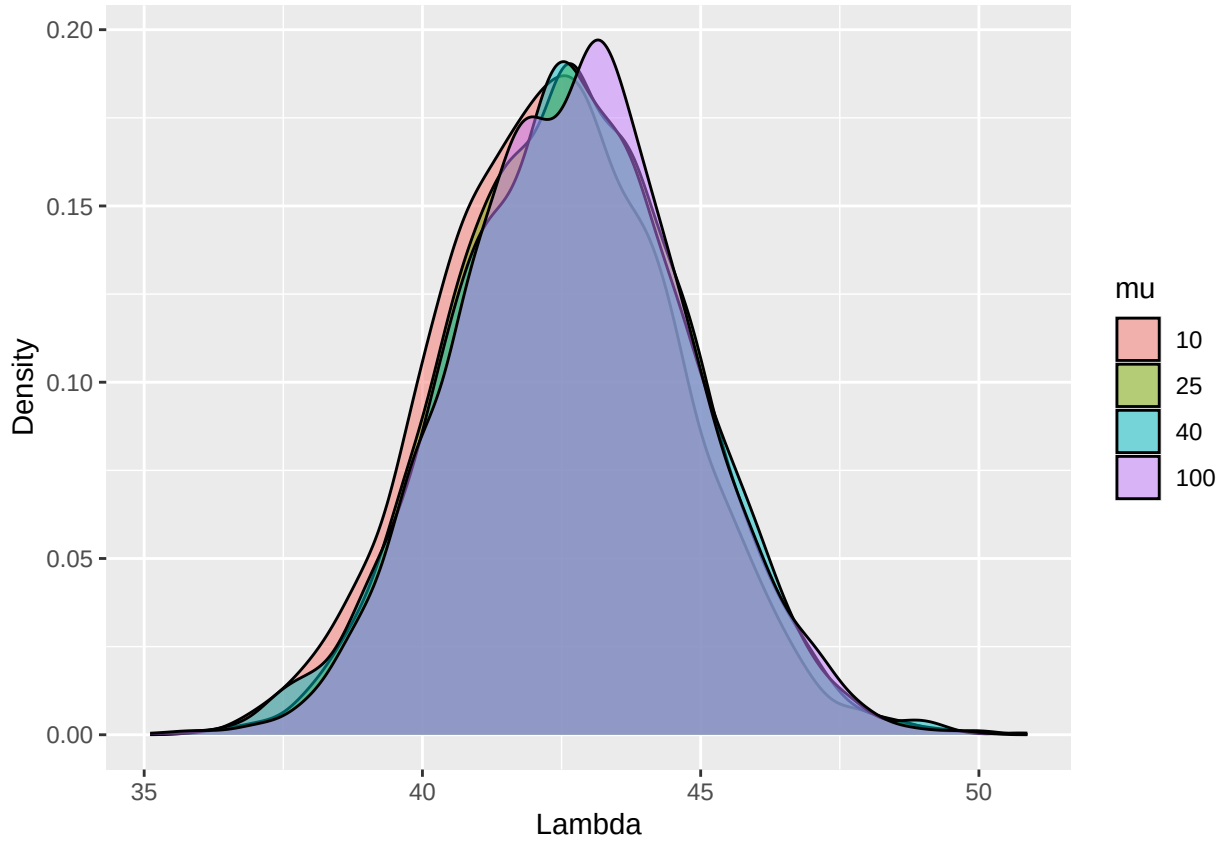
Posterior Mean: 42.74

Posterior Variance: 4.15

g)

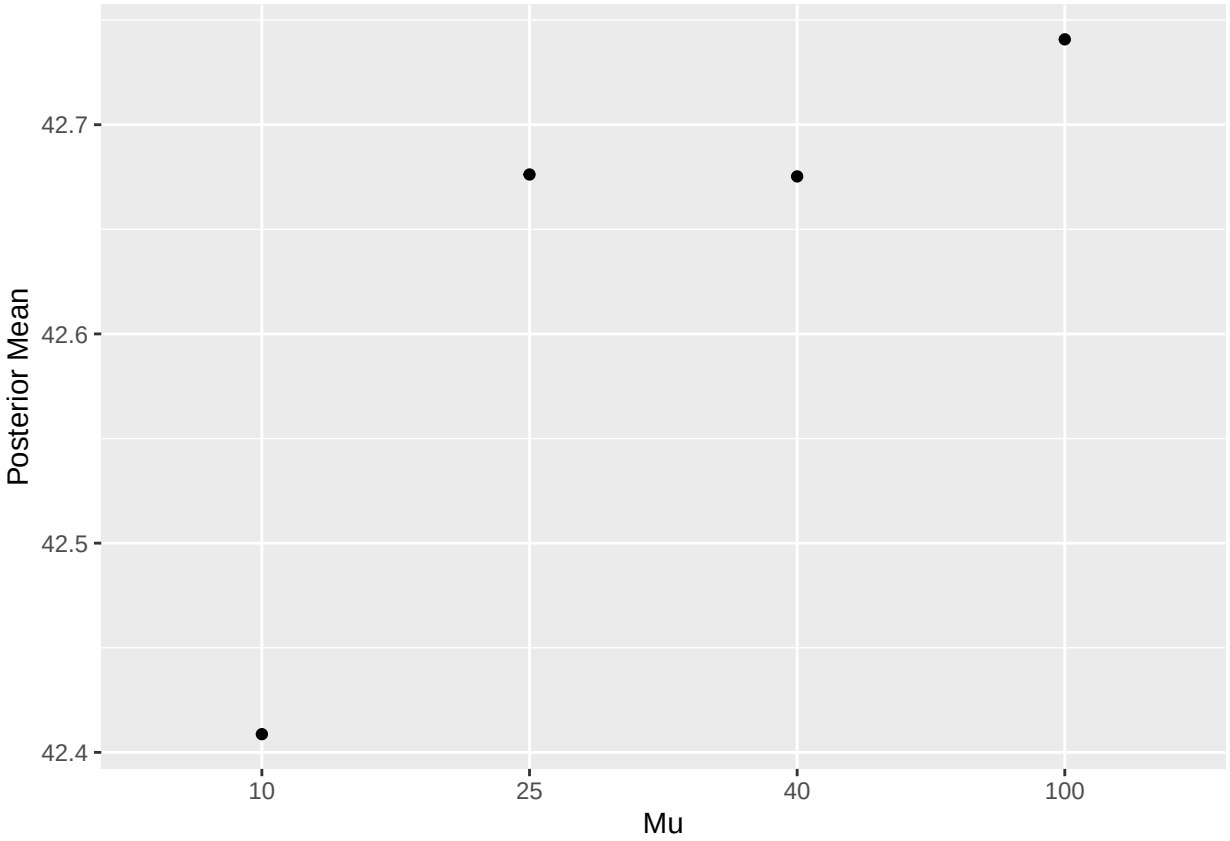
```
a <- extract(fit2a)$lambda
b <- extract(fit2b)$lambda
c <- extract(fit2c)$lambda
d <- extract(fit2d)$lambda

data <- data.frame(lambda = a, mu = 40)
datb <- data.frame(lambda = b, mu = 10)
datc <- data.frame(lambda = c, mu = 25)
datd <- data.frame(lambda = d, mu = 100)

dat_full <- rbind(data, datb, datc, datd)

dat_full |>
  ggplot(
```

```
    aes(x=lambda, fill=factor(mu))) +
  geom_density(alpha = 0.5) +
  labs(x = "Lambda",
       y = "Density",
       fill = "mu")
```



h)

```
post_means <- data.frame(mu=c(10,25,40,100), lambda=c(42.4087,42.67621,42.67529,42.7408))

post_means |>
  ggplot(
    aes(x=factor(mu),y=lambda)) +
  geom_point() +
  labs(
    x = "Mu",
    y = "Posterior Mean"
  )
```


Posterior Mean
42.7
42.6
42.5
42.4
10
25
40
100
Mu