Chapter Questions

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```
library(rethinking)
```

Chapter 3

```
p_grid <- seq(from=0, to=1, length.out=1000)
prior <- rep(1, 1000)
likelihood <- dbinom(6, size = 9, prob = p_grid)
posterior <- likelihood * prior
posterior <- posterior / sum(posterior)
set.seed(100)
samples <- sample(p_grid, prob=posterior, size=1e4, replace=TRUE)
```

Easy

3E1

```
sum(posterior[p_grid < 0.2])
```

```
## [1] 0.0008560951
```

```
sum(samples < 0.2) / 1e4
```

```
## [1] 5e-04
```

3E2

```
sum(posterior[p_grid > 0.8])
```

```
## [1] 0.1203449
```

```
sum(samples > 0.8) / 1e4
```

```
## [1] 0.1117
```

3E3

```
sum(posterior[p_grid > 0.2 & p_grid < 0.8])
```

```
## [1] 0.878799
```

```
sum(samples > 0.2 & samples < 0.8) / 1e4
```

```
## [1] 0.8878
```

3E4

```
quantile(samples, 0.2)
```

```
##       20%
## 0.5195195
```

3E5

```
quantile(samples, 0.8)
```

```
##       80%
## 0.7567568
```

3E6

```
HPDI(samples, prob = 0.66)
```

```
##     |0.66     0.66|
## 0.5205205 0.7847848
```

3E7

```
PI(samples, prob = 0.66)
```

```
##       17%       83%
## 0.5005005 0.7687688
```

Medium

3M1

```
p_grid <- seq(from=0, to=1, length.out=1000)
prior <- rep(1, 1000)
likelihood <- dbinom(8, size = 15, prob = p_grid)
posterior <- likelihood * prior
posterior <- posterior / sum(posterior)
set.seed(100)
samples <- sample(p_grid, prob=posterior, size=1e4, replace=TRUE)
```

3M2

```
HPDI(samples, prob = 0.9)
```

```
##      |0.9      0.9|
## 0.3243243 0.7157157
```

3M3

```
w <- rbinom(1e4, size = 15, prob = samples)
table(w)[9] / 1e4 # Proportion ('probability') of 8 waters from 1e4 draws of size 15 each.
```

```
##      8
## 0.1475
```

3M4

```
w <- rbinom(1e4, size = 9, prob = samples)
table(w)[7] / 1e4
```

```
##      6
## 0.1766
```

3M5

```
prior <- c(rep(0, 500), rep(1, 500)) # Puts basically zero probability on proportion of water = 0
likelihood <- dbinom(8, size = 15, prob = p_grid)
posterior <- likelihood * prior
posterior <- posterior / sum(posterior)
set.seed(100)
samples <- sample(p_grid, prob=posterior, size=1e4, replace=TRUE)

HPDI(samples, prob = 0.9)
```

```
##      |0.9      0.9|
## 0.5005005 0.7077077
```

```
w <- rbinom(1e4, size = 15, prob = samples)
table(w)[8] / 1e4 # No samples of 0, so indexing changesrelative to ## 3M3
```

```
##      8
## 0.1617
```

```
w <- rbinom(1e4, size = 9, prob = samples)
table(w)[7] / 1e4
```

```
##      6
## 0.2376
```

Hard

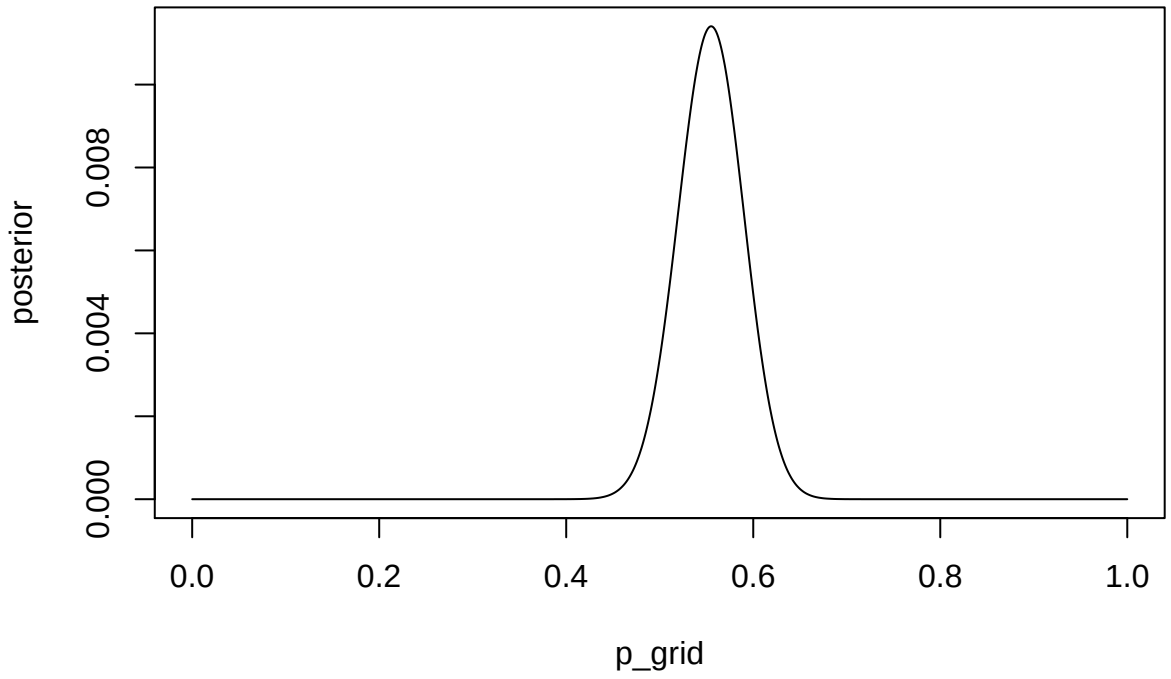
```
data(homeworkch3)
```

3H1

```
p_grid <- seq(from = 0, to = 1, length.out = 1000)
prior <- rep(1, 1000)
likelihood <- dbinom((sum(birth1) + sum(birth2)), size = 200, prob = p_grid)
```

```
posterior <- likelihood * prior
posterior <- posterior / sum(posterior)

plot(posterior ~ p_grid, type = "l")
```



3H2

```
set.seed(100)
samples <- sample(p_grid, prob=posterior, size=1e4, replace=TRUE)

HPDI(samples, prob = 0.5)
```

```
##      |0.5      0.5|
## 0.5315315 0.5765766
```

```
HPDI(samples, prob = 0.89)
```

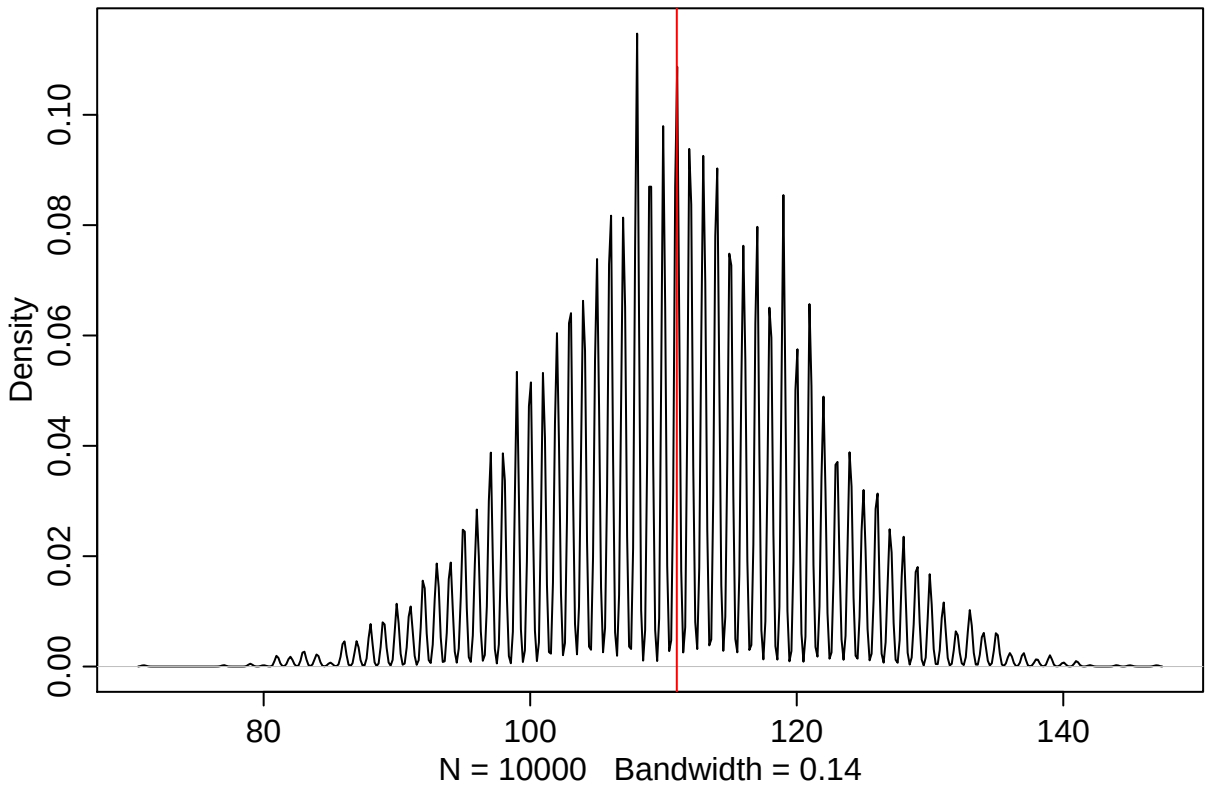
```
##     |0.89     0.89|
## 0.4974975 0.6076076
```

```
HPDI(samples, prob = 0.97)
```

```
##     |0.97     0.97|
## 0.4774775 0.6276276
```

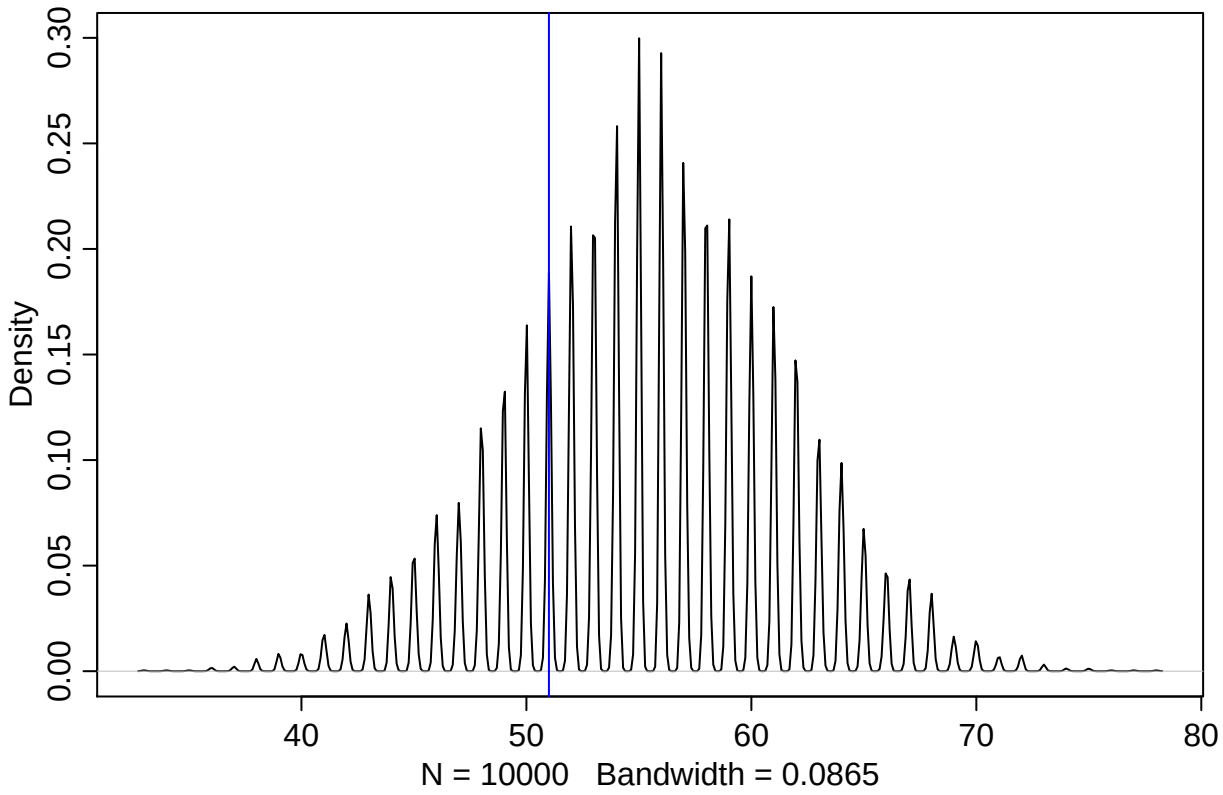
3H3

```
w <- rbinom(1e4, size = 200, prob = samples)
boys_born = sum(birth1 + birth2)
dens(w, adj = 0.1)
abline(v = boys_born, col = "red")
```



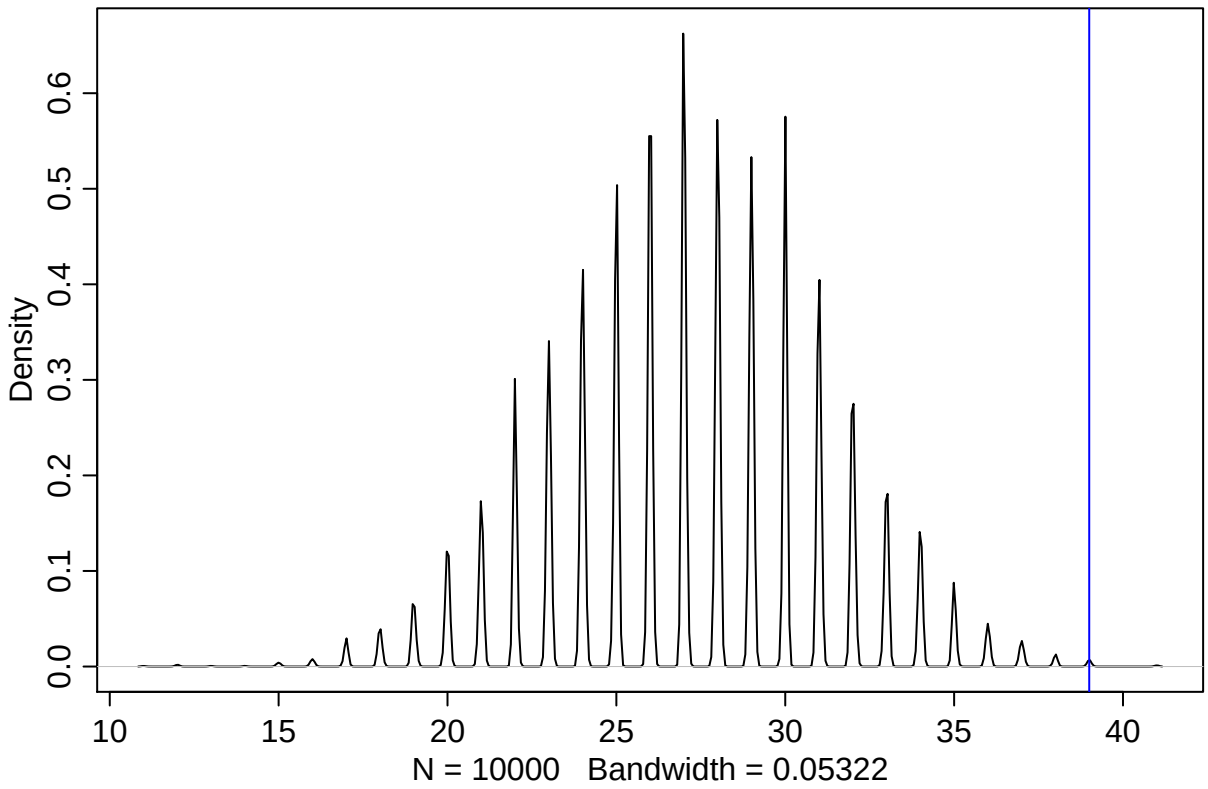
3H4

```
w <- rbinom(1e4, size = 100, prob = samples)
dens(w, adj = 0.1)
abline(v = sum(birth1), col = "blue") # Does not fit number of boys in birth1 well (not represented on
```



3H5

```
# Number of second birth boys given first birth was a girl
births_after_girls <- length(birth2[birth1 == 0]) # 49 second births after female first birth
posterior_predictive_distribution <- rbinom(1e4, size = births_after_girls, prob = samples)
dens(posterior_predictive_distribution, adj = 0.1)
abline(v = sum(birth2[birth1 == 0]), col = "blue") # Posterior predictive distribution does not capture
```



Chapter 4

Easy

$$y_i \sim Normal(\mu, \sigma)\mu \sim Normal(0, 10)\sigma \sim Uniform(0, 10)$$

4E1

$y_i \sim Normal(\mu, \sigma)$ is the likelihood

4E2

2 parameters in the posterior, μ and σ

4E3

$$Pr(\mu, \sigma|y_i) = \frac{Pr(y_i|\mu, \sigma)Pr(\mu)Pr(\sigma)}{Pr(y_i)} = \frac{\Pi_i Normal(y_i|\mu, \sigma)Normal(\mu|0, 10)Uniform(\sigma|0, 10)}{\int\int \Pi_i Pr(y_i)Normal(y_i|\mu, \sigma)Normal(\mu|0, 10)Uniform(\sigma|0, 10)d\mu d\sigma}$$

4E4

$\mu_i = \alpha + \beta x_i$ is the linear model

4E5

3 parameters in the posterior, α, β and σ

Medium