Ch2-3

In this notebook, you will find my solutions to some exercises from Chapter 2 and 3 of *Statistical Rethinking* and the assigned exercises from this course.

Chapter 2

Exercise 2E1

Question: Which of the expressions below correspond to the statement: *the probability of rain on Monday*?

1. Pr(rain)
2. Pr(rain|Monday)
3. Pr(Monday|rain)
4. Pr(rain, Monday)/Pr(Monday)

Answer: **(2)** Pr(rain|Monday) and **(4)** Pr(rain, Monday)/Pr(Monday)

Explanation:

Option (1) is the unconditional probability of rain on any day

Option (3) is the probability that it is Monday given that it is raining

Option (4) Pr(rain, Monday)/Pr(Monday) is mathematically equivalent to Pr(rain|Monday) by the definition of conditional probability, so this is also correct.

Both options (2) and (4) are correct.

Exercise 2E2

Question: Which of the following statements corresponds to the expression: Pr(Monday|rain)?

1. The probability of rain on Monday.
2. The probability of rain, given that it is Monday.
3. The probability that it is Monday, given that it is raining.
4. The probability that it is Monday and that it is raining.

Answer: **(3)** The probability that it is Monday, given that it is raining.

Exercise 2E3

Question: Which of the expressions below correspond to the statement: *the probability that it is Monday, given that it is raining*?

1. Pr(Monday|rain)
2. Pr(rain|Monday)
3. Pr(rain|Monday) Pr(Monday)
4. Pr(rain|Monday) Pr(Monday)/Pr(rain)
5. Pr(Monday|rain) Pr(rain)/Pr(Monday)

Answer: **(1)** Pr(Monday|rain) and **(4)** Pr(rain|Monday) Pr(Monday)/Pr(rain)

Explanation:

Option (1) is the direct notation for the conditional probability

Option (4) represents Bayes' theorem: $\Pr(\text{Monday}|\text{rain}) = \Pr(\text{rain}|\text{Monday}) \times \Pr(\text{Monday})/\Pr(\text{rain})$

Chapter 3

```
library(rethinking)
```

```r
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 )
```

Exercise 3E1

Question: How much posterior probability lies below $p = 0.2$?

Answer:

```r
sprintf("%.4f", sum(samples<0.2)/1e4)
```

```
[1] "0.0004"
```

Exercise 3E2

Question: How much posterior probability lies above $p = 0.8$?

Answer:

```r
sprintf("%.4f", sum(samples>0.8)/1e4)
```

```
[1] "0.1116"
```

Exercise 3E3

Question: How much posterior probability lies betwen $p = 0.2$ and $p = 0.8$?

Answer:

```r
sprintf("%.4f", sum(samples>0.2 & samples<0.8)/1e4)
```

```
[1] "0.8880"
```

Exercise 3E4

Question: 20% of the posterior probability lies below which value of p ?

Answer:

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

```
      20%
0.5185185
```

Exercise 3E5

Question: 20% of the posterior probability lies above which value of p?

Answer:

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

```
      80%
0.7557558
```

Exercise 3E6

Question: Which values of p contain the narrowest interval equal to 66% of the posterior probability?

Answer:

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

```
    |0.66     0.66|
0.5085085 0.7737738
```

Exercise 3E7

Question: Which values of p contain 66% of the posterior probability, assuming equal posterior probability both below and above the interval?

Answer:

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

```
      17%       83%
0.5025025 0.7697698
```

Course Exercises

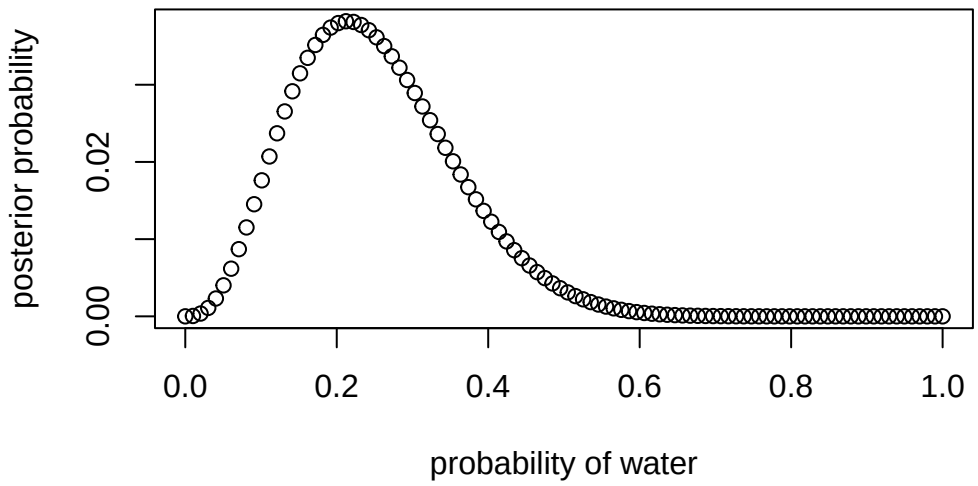
Exercise 1

Question: Suppose the globe tossing data (Lecture 2, Chapter 2) had turned out to be 3 water and 11 land. Construct the posterior distribution.

Answer:

```
library(rethinking)

p_grid <- seq(from = 0, to = 1, length.out = 100)
prior <- rep(1/100, 100)
likelihoood <- dbinom(3, 14, prob=p_grid)
unstd.posterior <- likelihoood * prior
posterior <- unstd.posterior / sum(unstd.posterior)
plot(p_grid, posterior, type="b", xlab="probability of water", ylab="posterior probability")
```




```
samples <- sample(p_grid, prob=posterior, size=1e4, replace=TRUE)
w <- rbinom(1e4, size=5, prob=samples)
simplehist(w, xlab="dummy water count")
```