Assignment 1

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```r
library(tidyverse)
```

```
## -- Attaching packages ------------------------------------------------------------------------

## v ggplot2 3.2.1     v purrr   0.3.2
## v tibble  2.1.3     v dplyr   0.8.3
## v tidyr   0.8.3     v stringr 1.4.0
## v readr   1.3.1     v forcats 0.4.0

## -- Conflicts ---------------------------------------------------------------------------------
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

1. Calculate the following sums.

```r
x <- c(1:2019)
y <- c(1, -1)
z <- x*y

S1 = print(sum(x))
```

```
## [1] 2039190
```

```r
S2 = print(sum(x^3))
```

```
## [1] 4.158296e+12
```

```r
S3 = print(sum(x^x))
```

```
## [1] Inf
```

```r
S4 = print(sum(z^x))
```

```
## [1] Inf
```

```r
S5 = print(sum(1/(x^2)))
```

```
## [1] 1.644439
```

```r
S6 = print(sum(1/x))
```

```
## [1] 8.187821
```

```r
S7 = print(sum(1/(x^3)))
```

```
## [1] 1.202057
```

```r
S8 = print(sum(1/z))
```

```
## [1] 0.6933948
```

2. The rnorm function generate random variables from normal distribution. Generate a sample of 1000 values from normal distribution with the mean 10 and standard deviation 1.

```r
a <- rnorm(1000, 10, 1)
```

a. Calculate the mean and standard deviation of the sample.

```r
mean(a)
```

```
## [1] 9.982354
```

```r
sd(a)
```

```
## [1] 0.9420853
```

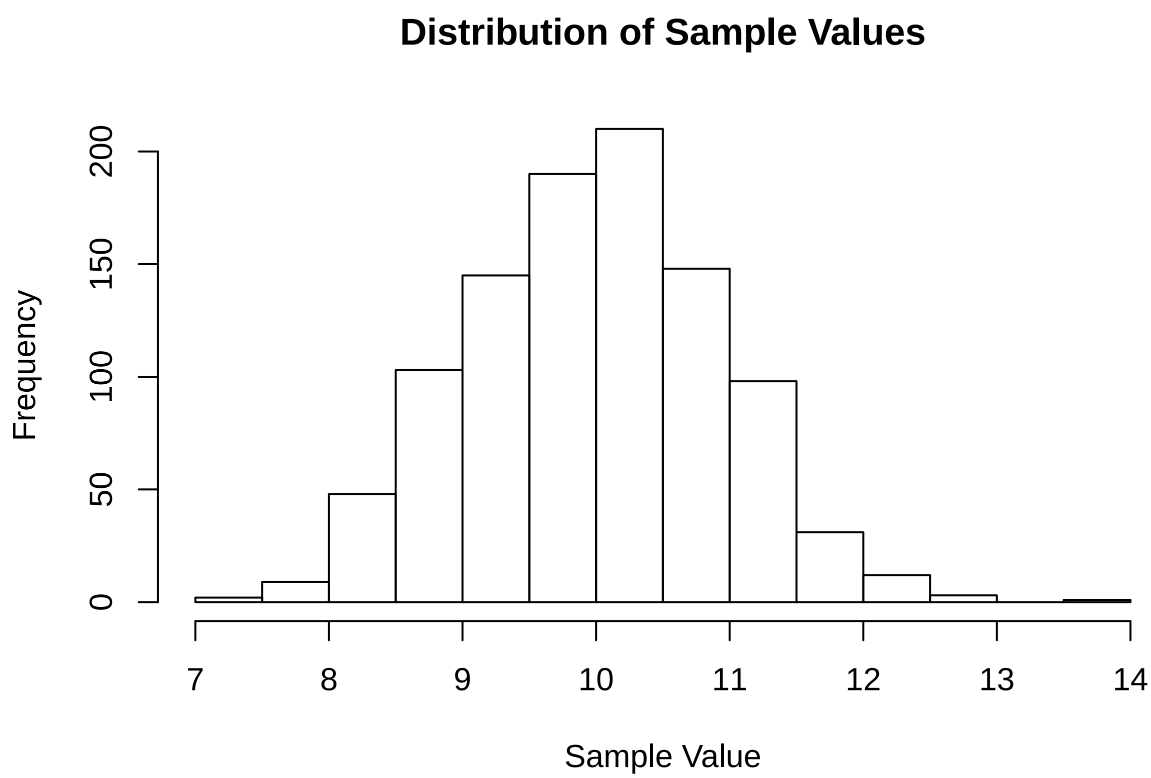
b. Out of 1000 samples, how many do you think are that great than 10? Check your estimation.

```r
# I think that about 500 will be greater than 10.
sum(a > 10)
```

```
## [1] 503
```

c. Use hist() function to show the histogram of the sample.

```r
hist(a, xlab = "Sample Value", main = "Distribution of Sample Values")
```



d. Estimate P(X > 1), where X N(2, 1)

```
b <- c(rnorm(10000, 2, 1))
sum(b > 1)/10000
```

```
## [1] 0.8421
```

3. Consider an experiment of tossing a fair dice.

a. Use the sample (with replacement) function to generate a sample of 1000 values from the experiment.

```
x <- sample(c(1:6), 1000, replace = TRUE)
```

b. Calculate the mean and standard deviation of the sample.

```
mean(x)
```

```
## [1] 3.559
```

```
sd(x)
```

```
## [1] 1.717402
```

c. How many times the 6 occured?

```
sum(x == 6)
```

```
## [1] 184
```

d. Use table function to show the frequency of the values.

```
table(x)
```

```
## x
##   1   2   3   4   5   6
## 164 149 176 170 157 184
```

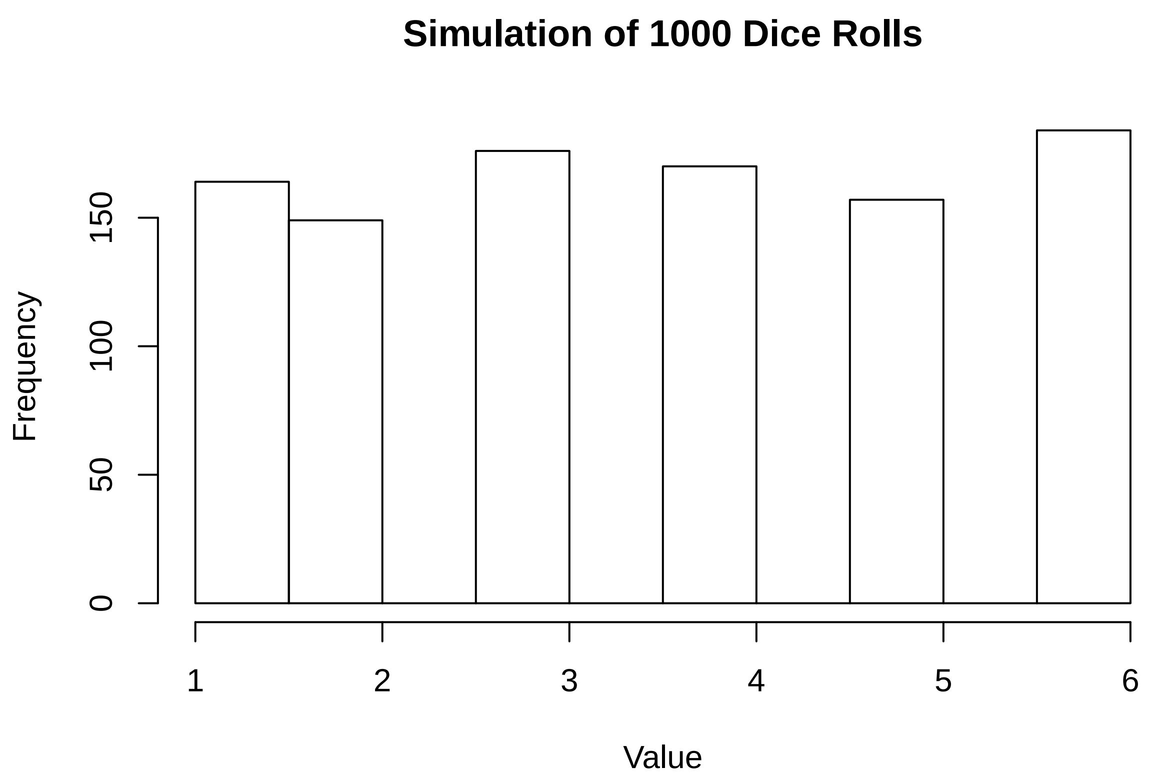
e. Use prop.table(table()) to show the relative frequency of the values.

```
prop.table(table(x))
```

```
## x
##     1     2     3     4     5     6
## 0.164 0.149 0.176 0.170 0.157 0.184
```

f. Plot the frequency of the values.

```
hist(x, xlab = "Value", main = "Simulation of 1000 Dice Rolls")
```



4. Consider an experiment of tossing a dice 3 times. Let X1, X2, and X3 be the number of tossing the first time, second time and third time, respectively. Use simulation to estimate the following probabilities:

```
X1 <- sample(c(1:6), 1000, replace = TRUE)
X2 <- sample(c(1:6), 1000, replace = TRUE)
X3 <- sample(c(1:6), 1000, replace = TRUE)

sum(X1 > (X2 + X3)) / 1000
```

```
## [1] 0.092
```

```
sum(X1^2 > (X2^2 + X3^2)) / 1000
```

```
## [1] 0.232
```

5. Using simulation, estimate the probability of getting three tails in a row when tossing a coin 3 times. Hint: one way is to generate a matrix with three columns where each rows is an observation of tossing a coin three times.

```
x <- matrix(sample(c(0, 1), 3000, replace = TRUE), ncol = 3)

sums <- x[,1] + x[,2] + x[,3]

sum(sums == 3)/1000
```

```
## [1] 0.129
```

6. (Extra Credits/Optional) Using simulation, estimate the probability of getting three tails in a row when tossing a coin 10 times.

```
x <- matrix(sample(c("H", "T"), 10000, replace = TRUE), ncol = 10)

consec = function(x, val = "T"){
  with(rle(x), max(lengths[values == val]))
}

counts <- apply(x, MARGIN = 1, consec)

sum(counts >= 3) / 1000
```

```
## [1] 0.515
```

7. Central Limit Theorem (CLT). The CLT said that the mean of a sample of a distribution A (no matter what A is) follows normal distribution with the same mean as A. Following the below steps to confim the CLT when A is uniform distribution.

- Generate 100 samples of uniform distibution from 0 to 1. Each sample has 1000 observations. Use the runif function to do this.

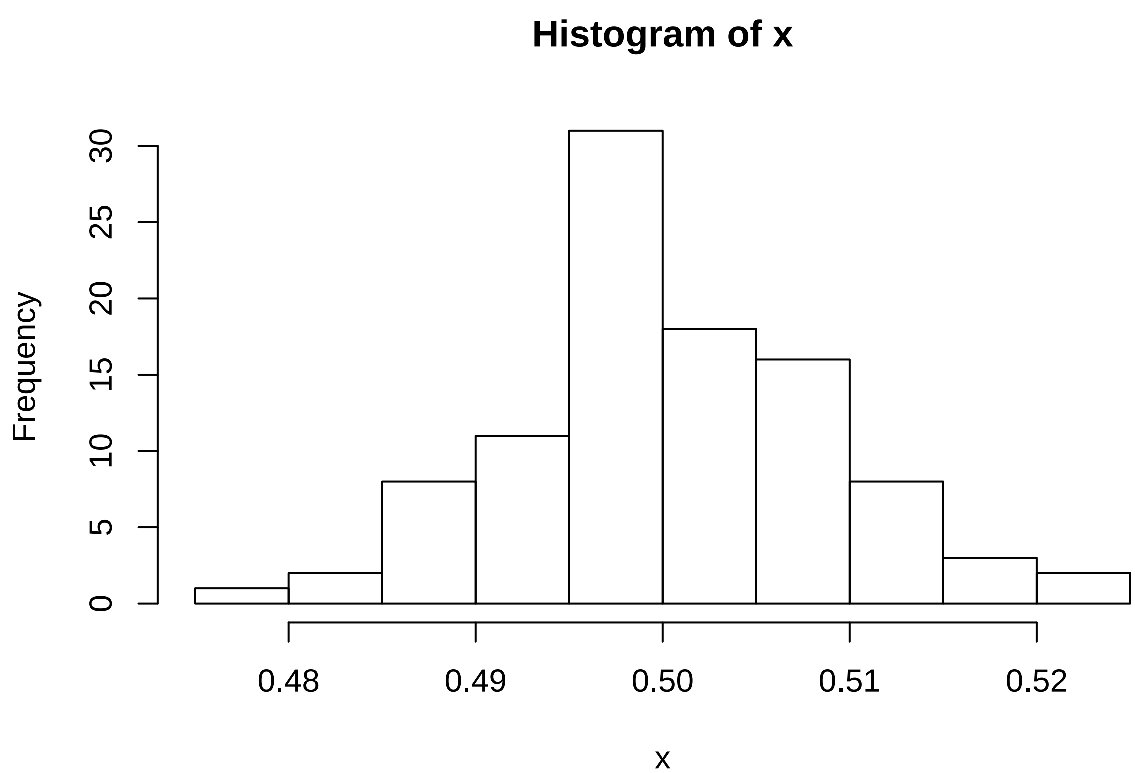
```r
CLTmatrix <- matrix(runif(100000), ncol = 1000)
```

- Compute the means of the 100 samples. Create vector x containing these means. Hint: You want to put all the samples in a matrix and use rowSums or colSums function.

```r
x <- rowMeans(CLTmatrix)
```

- By CLT, x must follow normal distribution. Check this by plotting the histogram of x. Does it look like normal distribution? Use hist(x) to plot the histogram of x.

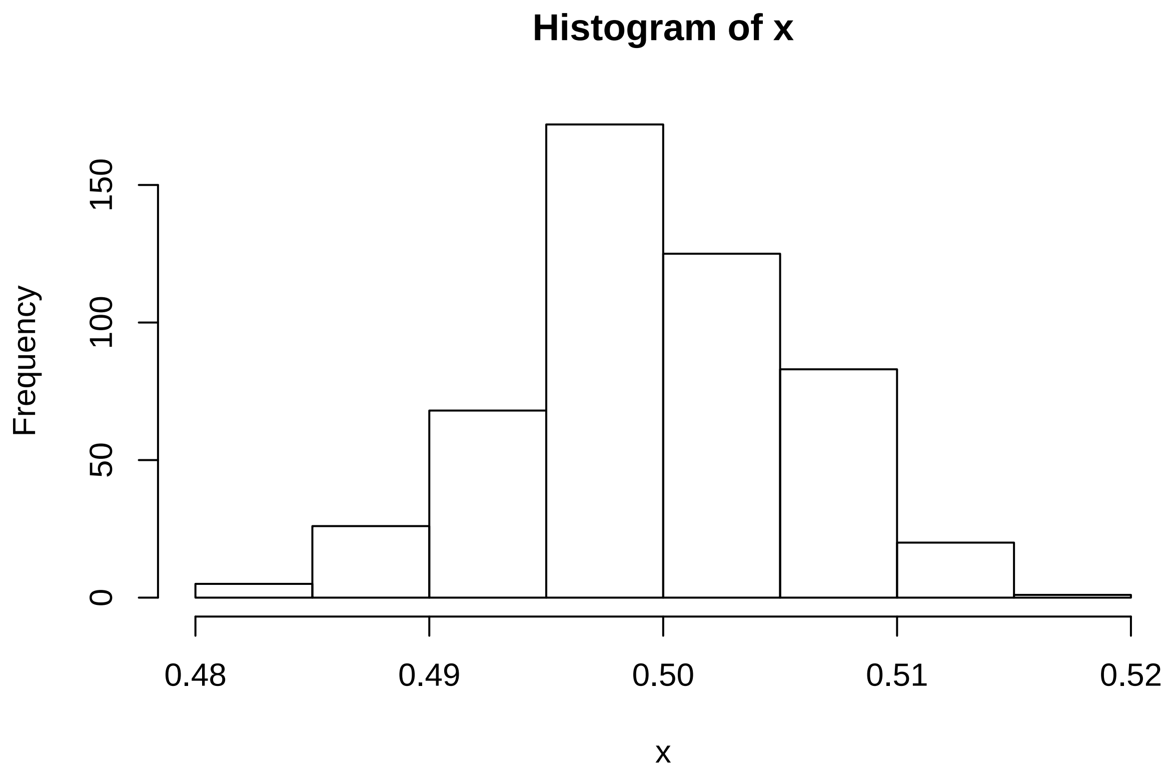
```r
hist(x)
```




```r
#It appears that X follows a normal distribution.
```

- Increase the number (100 and 1000) to see if the distribution of x looks more like normal distribution.

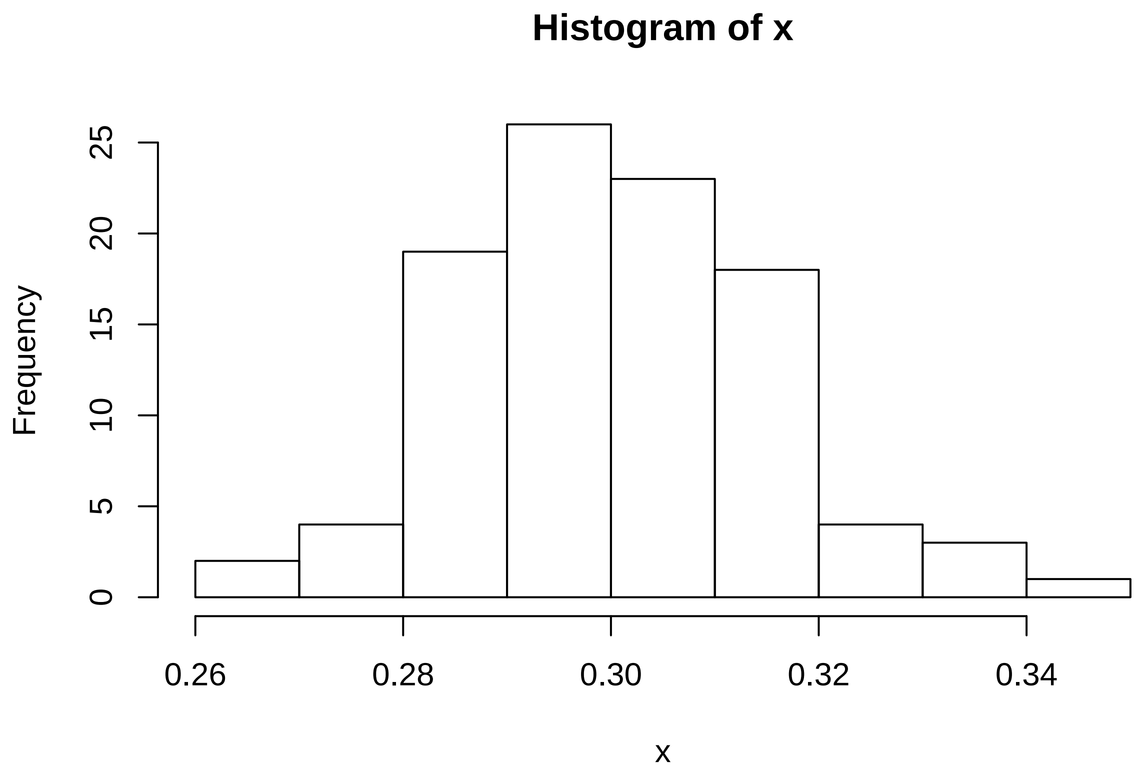
```r
CLTmatrix2 <- matrix(runif(1000000), ncol = 2000)
x <- rowMeans(CLTmatrix2)
hist(x)
```



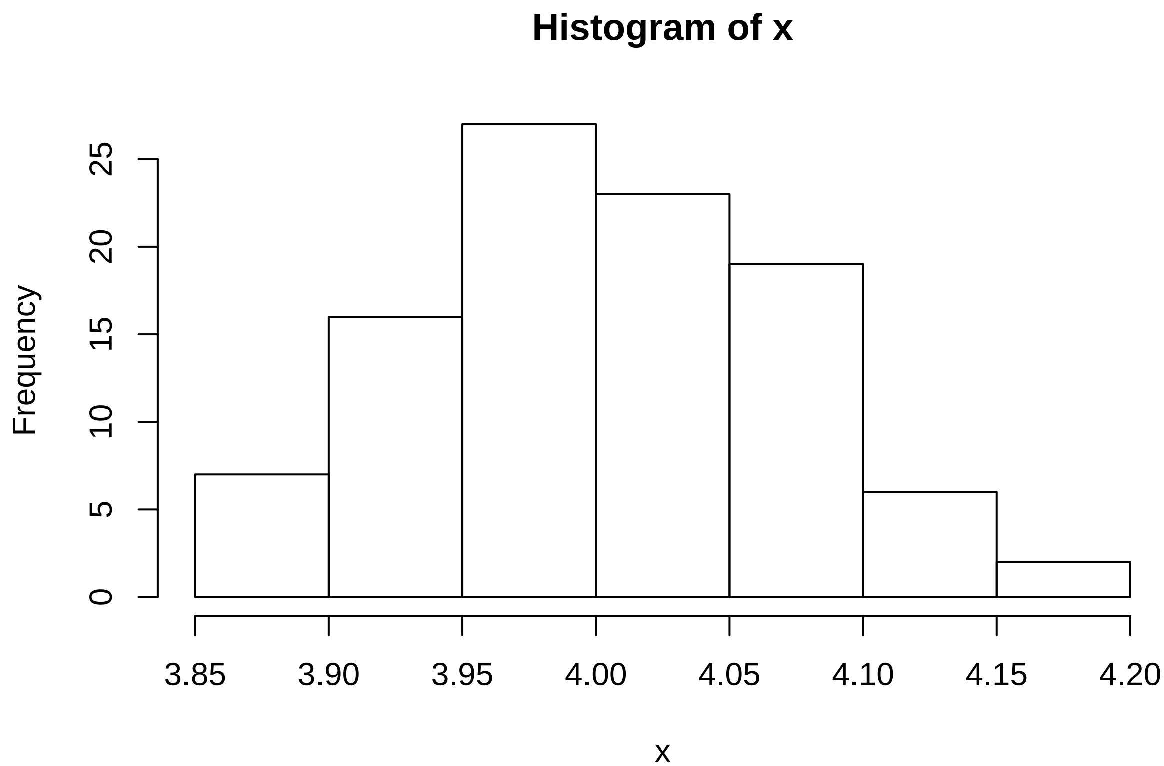

```
#After increasing both the number of samples and the number of observations in each sample, the means a
```

- Try the same procedure with two other distributions for A.

```
CLTmatrix.binom <- matrix(rbinom(100000, 1, 0.3), ncol = 1000)
x <- rowMeans(CLTmatrix.binom)
hist(x)
```




```
CLTmatrix.pois <- matrix(rpois(100000, 4), ncol = 1000)
x <- rowMeans(CLTmatrix.pois)
hist(x)
```



7. Use read.csv function to read in the titanic dataset. You can find the dataset on Blackboard or at Kaggle.com. Use str function to see a summary of the data.

```r
titanic.data <- read.csv("titanic.csv")
str(titanic.data)
```

```
## 'data.frame':    891 obs. of  12 variables:
##  $ PassengerId: int  1 2 3 4 5 6 7 8 9 10 ...
##  $ Survived   : int  0 1 1 1 0 0 0 0 1 1 ...
##  $ Pclass     : int  3 1 3 1 3 3 1 3 3 2 ...
##  $ Name       : Factor w/ 891 levels "Abbing, Mr. Anthony",..: 109 191 358 277 16 559 520 629 417 58
##  $ Sex        : Factor w/ 2 levels "female","male": 2 1 1 1 2 2 2 2 1 1 ...
##  $ Age        : num  22 38 26 35 35 NA 54 2 27 14 ...
##  $ SibSp      : int  1 1 0 1 0 0 0 3 0 1 ...
##  $ Parch      : int  0 0 0 0 0 0 0 1 2 0 ...
##  $ Ticket     : Factor w/ 681 levels "110152","110413",..: 524 597 670 50 473 276 86 396 345 133 ...
##  $ Fare       : num  7.25 71.28 7.92 53.1 8.05 ...
##  $ Cabin      : Factor w/ 148 levels "","A10","A14",..: 1 83 1 57 1 1 131 1 1 1 ...
##  $ Embarked   : Factor w/ 4 levels "","C","Q","S": 4 2 4 4 4 3 4 4 4 2 ...
```

8. Use knitr::kable function to nicely print out the first 10 rows of the data in markdown.

```r
knitr::kable(titanic.data[1:10,])
```

PassengerId	Survived	Pclass	Name	Sex	Age	SibSp	Parch
1	0	3	Braund, Mr. Owen Harris	male	22	1	0
2	1	1	Cumings, Mrs. John Bradley (Florence Briggs Thayer)	female	38	1	0
3	1	3	Heikkinen, Miss. Laina	female	26	0	0
4	1	1	Futrelle, Mrs. Jacques Heath (Lily May Peel)	female	35	1	0
5	0	3	Allen, Mr. William Henry	male	35	0	0
6	0	3	Moran, Mr. James	male	NA	0	0
7	0	1	McCarthy, Mr. Timothy J	male	54	0	0
8	0	3	Palsson, Master. Gosta Leonard	male	2	3	1
9	1	3	Johnson, Mrs. Oscar W (Elisabeth Vilhelmina Berg)	female	27	0	2
10	1	2	Nasser, Mrs. Nicholas (Adele Achem)	female	14	1	0

9. Use is.na function and sum function to count the total number of missing values in the data. Count the number of missing values in each columns.

```
sum(is.na(titanic.data))
```

```
## [1] 177
```

```
colSums(is.na(titanic.data))
```

```
## PassengerId    Survived      Pclass        Name         Sex         Age
##           0           0           0           0           0         177
##       SibSp       Parch      Ticket        Fare       Cabin    Embarked
##           0           0           0           0           0           0
```

10. Calculate the average Age of the passengers. You may want to use the parameter na.rm = TRUE in the function mean

```
mean.age <- mean(titanic.data$Age, na.rm = TRUE)
```

11. Replace the missing values of age by the average age calculated previously.

```
titanic.data <- titanic.data %>%
  mutate(Age = ifelse(is.na(Age), mean.age, Age))
```

12. Remove columns Name, PassengerID, Ticket, and Cabin.

```
titanic.data <- titanic.data %>%
  select(-Name, -PassengerId, -Ticket, -Cabin)
```

13. Calculate the mean age of female passengers

```
mean(filter(titanic.data, Sex == "female")$Age, na.rm = TRUE)
```

```
## [1] 28.21673
```

14. Calculate the median fare of the passengers in Class 1

```r
median(filter(titanic.data, Pclass == 1)$Fare, na.rm = TRUE)
```

```
## [1] 60.2875
```

15. Calculate the median fare of the female passengers that are not in Class 1

```r
median(filter(titanic.data, Sex == "female" & Pclass != 1)$Fare, nna.rm = TRUE)
```

```
## [1] 14.45625
```

16. Calculate the median age of survived passengers who are female and Class 1 or Class 2

```r
median(filter(titanic.data, Survived ==1 & Sex == "female" & Pclass %in% c(1,2))$Age, na.rm = TRUE)
```

```
## [1] 30
```

17. Calculate the mean fare of female teenagers survived passengers

```r
mean(filter(titanic.data, Sex == "female" & Survived == 1 & Age > 12 & Age < 20)$Fare, na.rm = TRUE)
```

```
## [1] 49.17966
```

18. Calculate the mean fare of female teenagers survived passengers for each class

```r
titanic.data %>%
  filter(Sex == "female" & Survived == 1 & Age > 12 & Age < 20) %>%
  group_by(Pclass) %>%
  summarise(mean = mean(Fare))
```

```
## # A tibble: 3 x 2
##   Pclass   mean
##    <int>  <dbl>
## 1      1 108.
## 2      2  20.0
## 3      3   8.77
```

19. Calculate the ratio of Survived and not Survived for passengers who are who pays more than the average fare

```r
nobs <- nrow(filter(titanic.data, Fare > mean(Fare)))
survive <- sum(filter(titanic.data, Fare > mean(Fare))$Survived)

survive/(nobs - survive)
```

```
## [1] 1.482353
```

20. Add column that standardizes the fare (subtract the mean and divide by standard deviation) and name it sfare

```r
titanic.data <- titanic.data %>%
  mutate(sfare = (Fare - mean(Fare))/ sd(Fare))
```

21. Add categorical variable named cfare that takes value cheap for passengers paying less the average fare and takes value expensive for passengers paying more than the average fare.

```r
titanic.data <- titanic.data %>%
  mutate(cfare = ifelse(Fare < mean(Fare), "cheap", "expensive"))
```

22. Add categorical variable named cage that takes value 0 for age 0-10, 1 for age 10-20, 2 for age 20-30, and so on

```r
titanic.data <- titanic.data %>%
  mutate(cage = trunc(Age / 10) * 10)
```

23. Show the frequency of Ports of Embarkation. It appears that there are two missing values in the Embarked variable. Assign the most frequent port to the missing ports. Hint: Use the levels function to modify the categories of categorical variables.

```r
summary(titanic.data$Embarked)
```

```
##       C   Q   S
##   2 168  77 644
```

```r
levels(titanic.data$Embarked) <- c("S", "C", "Q", "S")
```