Using the words we learned in this class, answer all questions succinctly; you will lose points for rambling. Where you can't otherwise do the math, provide all the `R` code necessary to answer the problem, indicating clearly which variable(s) contain the answer.

1. The Capital Asset Pricing Model (CAPM) is a financial model that assumes returns on a portfolio are normally distributed. Suppose a portfolio has an average annual return of 14.7% (i.e. an average gain of 14.7%) with a standard deviation of 33%. A return of 0% means the value of the portfolio doesnt change, a negative return means that the portfolio loses money, and a positive return means that the portfolio gains money.

   (a) What percent of years does this portfolio lose money?

   (b) What is the cutoff for the highest 15% of annual returns with this portfolio?

   (c) What is the probability that a portfolio makes money?

2. In 1846, the Donner party (Donner and Reed families) left Springfield, Illinois for California in covered wagons. After reaching Fort Bridger, Wyoming, the leaders decided to find a new route to Sacramento. They became stranded in the eastern Sierra Nevada mountains at a place now called Donner Pass when the region was hit by heavy snows. By the time the survivors were rescued on April 21, 1847, 40 out of 87 had died. Below is a reduced dataframe, named `donner`, of some of the members. Answer the questions following the dataset.

```
##    ageLess30 ageGreater30 female male survived
## 1          1            0      0    1        0
## 2          1            0      1    0        1
## 3          0            1      0    1        0
## 4          1            0      0    1        0
## 5          1            0      0    1        0
## 6          1            0      0    1        1
## 7          0            1      0    1        0
## 8          1            0      1    0        1
## 9          1            0      1    0        1
## 10         0            1      1    0        1
## 11         1            0      1    0        0
## 12         0            1      1    0        0
## 13         1            0      0    1        1
## 14         0            1      0    1        0
## 15         1            0      0    1        0
## 16         0            1      1    0        0
## 17         1            0      1    0        1
```

```
## 18          1          0      0   1       1
## 19          0          1      0   1       0
## 20          1          0      0   1       1
```

(a) Compute the lift for the following two rules: $\{age > 30, female\} \rightarrow \{survived\}$ and $\{age > 30, male\} \rightarrow \{survived\}$.

(b) Suppose you found the following numbers. Interpret the two values, separately and together.

```
## female   male
##   0.74   0.00
```

3. An airline charges the following baggage fees: \$25 for the first bag and \$35 total for two bags. Suppose 54% of passengers have no checked luggage, 34% have one piece of checked luggage and 12% have two pieces. We suppose a negligible portion of people check more than two bags.

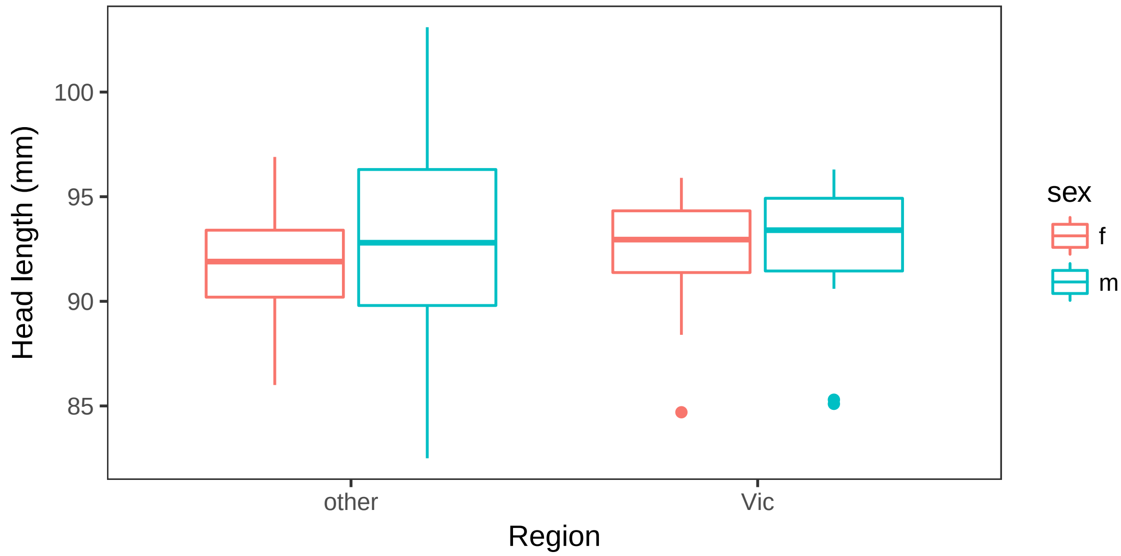
   (a) What is the probability mass function for baggage fees? Hint, draw a table.

   (b) About how much revenue should the airline expect for a flight of 120 passengers?

   (c) The current exchange rate for one U.S. dollar (\$) to one Euro is .82. What is the expected revenue in Euros?

4. A random sample of 104 Australian possum were trapped in either Victoria or Other (New South Wales or Queensland).

```
possum <- read.csv("https://roualdes.us/data/possum.csv")
qplot(factor(pop), headL, data=possum, geom="boxplot", colour=sex) +
    labs(x="Region", y="Head length (mm)") +
    theme(panel.grid.major=element_blank(), panel.grid.minor=element_blank())
```



(a) Identity the observations and sample size.

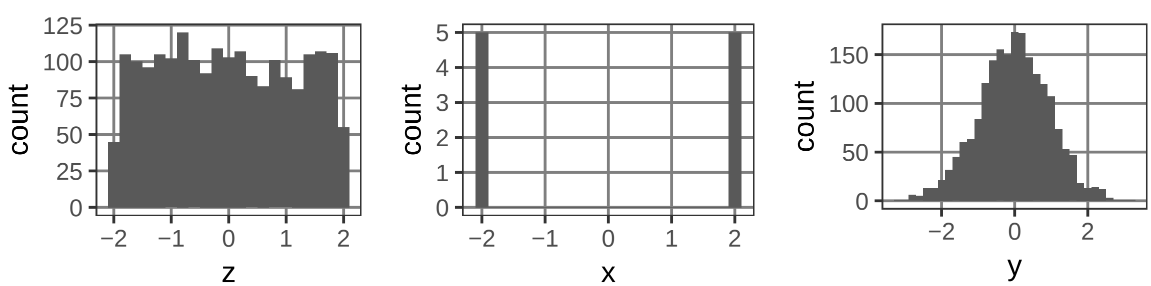
(b) Identify the variables and their types.

(c) Identify the explanatory and response variables.

(d) Identify the type or design of the study.

(e) Describe at least two interesting things about the relationship between the variables.

5. The three histograms below have the same mean, $\mu_x = \mu_y = \mu_z = 0$. Without doing any calculations, rank the variables x, y, z in order of increasing standard deviation. Explain your answer.



6. Assume $x_1, \dots, x_N \sim_{iid} Poisson(\lambda)$. The simplified log-likelihood for the Poisson distribution is

$$\log(\lambda) \sum_{n=1}^{N} x_n - N\lambda$$

(a) Write the simplified log-likelihood in `R` code.

```
## start simplified log-likelihood





## end
```

(b) Write `R` code to call `optim` to find the maximum likelihood estimator for λ. Some hints are9 in comments.

```
poisson_data <- rpois(1001, 5)
optim(                                      , # starting point
                                            , # function
      method="L-BFGS",
      lower=                                , # lambda can't be 0
                                            , # pass in data
)
```