Practice Session 2

Part 1 : Measures of central tendency & Measures of spread for quantitative data

1.1 Calculating the Sample Standard Deviation by Hand

Here is the formula for the sample mean:

$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$

And here is the formula for the sample standard deviation:

$s = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2}$

Using the above data, perform the following calculations. Complete the table

for calculating the sample standard deviation.

Cost $$$	b. Deviations (x_i - $\bar{x}$)	c. Deviations squared (x_i - $\bar{x}$)^2
850		
900		
1400		
1200		
1050		
750		
1250		
1050		
565		
1000		
a. mean = _____		

d. Sum of squared deviations $\sum_{i=1}^{n}(x_i - \bar{x})^2$ = _____

e. Sum of squared deviations divided by n - 1: $\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$ = _____

$\sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}}$

f. Take the square root to get s: = _____ = s

1.2 Five-Number Summary

Using the numbers from the previous exercise, do the following:

- Find the 5-number summary (minimum, Q1, median, Q3, maximum)
- Check your work using R functions

```
# your code here
```

1.3 Boxplots and Histograms

Consider the `mtcars` data set. This data is built into R, so you can access it directly; no downloads required! First, create a histogram of the variable `mpg`. Then create a boxplot of `mpg`.

1. How do these two plots compare?
2. Create a boxplots of `mpg` per number of cylinders `cyl`.

```
# your code here
```

1.4 Quantitative data : histograms and outliers

Generate histograms for each of the following data sets. Use the `$` command to access the individual data sets. For each histogram, add the mean to the plot using `abline()`. Do you see any potential outliers? Also calculate the five-number summary for each using R.

```
set.seed(999)
s2_data = data.frame(
  dat1 = -rchisq(1000, df = 1),
  dat2 = rchisq(1000, df = 1),
  dat3 = runif(1000),
  dat4 = rnorm(1000),
  dat5 = sample(c(rnorm(1000, mean = 2), rnorm(1000, mean = 10)), size = 1000)
)
```

1.5 Percentiles

Compute the 25th, 50th, and 75th percentile for the 5 data sets in the `s2_data` data.frame. Which has the smallest median? Which as the largest?

```
## your code here
```

1.6 Normal Distribution and +/- 2 Standard Deviations

The normal distribution (also known as the "bell-curve") occurs very frequently in mathematics, statistics, and the natural and social sciences. Which of the 5 data sets in the `s2_data` data.frame appears to be normally distributed?

Using this data set, find the mean and standard deviation, then calculate 2 standard deviations above, and 2 standard deviations below the mean. What percentiles do these values correspond to?

1.7 Z-Scores

Read the following description on Z-scores, then answer the question below.

5.1 Standardizing with *z*-Scores

Expressing a distance from the mean in standard deviations *standardizes* the performances. To **standardize** a value, we subtract the mean and then divide this difference by the standard deviation:

$$z = \frac{y - \bar{y}}{s}$$

NOTATION ALERT

We always use the letter z to denote values that have been standardized with the mean and standard deviation.

The values are called **standardized values**, and are commonly denoted with the letter z. Usually we just call them ***z*-scores**.

z-scores measure the distance of a value from the mean in standard deviations. A z-score of 2 says that a data value is two standard deviations above the mean. It doesn't matter whether the original variable was measured in fathoms, dollars, or carats; those units don't apply to z-scores. Data values below the mean have negative z-scores, so a z-score of -1.6 means that the data value was 1.6 standard deviations below the mean. Of course, regardless of the direction, the farther a data value is from the mean, the more unusual it is, so a z-score of -1.3 is more extraordinary than a z-score of 1.2.

15. Temperatures A town's January high temperatures average 2°C with a standard deviation of 6°, while in July the mean high temperature is 24° and the standard deviation is 5°. In which month is it more unusual to have a day with a high temperature of 13°? Explain.

Part 2 : The Relationship Between Two Quantitative Variables: Correlation and Regression

In this session you might use the formula of the correlation between two quantitative variables:

$r_{xy} = \frac{1}{(n-1)s_z s_y} \sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})$

Remember that the fitted regression line is defined by the equation:

- $\hat{y} = a + bx$, or
- $\hat{\text{Response}} = a + b \cdot (\text{Explanatory})$
- Residuals = observed - predicted = y - $\hat{y}$

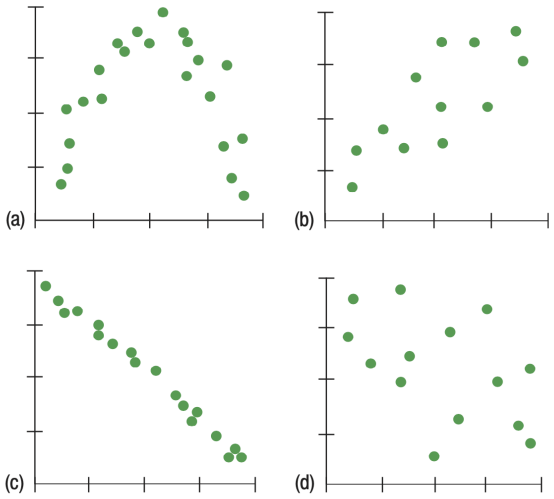
Where:

- Response: is the response variable or the dependent variable
- Explanatory: is the independent variable
- a: is the y-intercept
- b: is the slope of the regression line

You may use the following R functions: `plot()`, `lm()`, `cor()`, `abline()`. And you might need to download Lock5Data using `library(Lock5Data)`.

2.1 Describe scatterplots and Correlation

Here are several scatterplots. The calculated correlations are 0.006, - 0.977, - 0.487, and 0.777. Match each scatter plot with the appropriate correlation coeffecient.



Answers:

a.
b.
c.
d.

2.2 Create scatterplots in R

Load the data `FloridaLakes` from library(Lock5Data).

1. Describe the type of each of the variables: `pH`, `Calcium`, and `Alkalinity`.
2. Create a three scatter plots for each pair of variables: pHvsCalcium`,` `pH` vs `Alkalinity`, and `Calcium` vs `Alkalinity` . Add the main title to each plot.
3. What is the correlation coefficient between `pH` and `Calcium`? Is it positive or negative?
4. What do these coefficients mean in the context of this data?
5. Try to calculate the correlation coefficient between `pH` and `Calcium` without using the `R` function for correlation.

Answers:

```
# download the data and load it into R
library(Lock5Data)
data(FloridaLakes)
```

1.
2.
3.
4.
5.