Q1.

The dataset you used for exercise 2, [Employee_data.csv](), gives a *sample* of salaries of students who graduated from the MIM program. Suppose we know that the *population* mean and standard deviation of all MIM graduates' salaries are mean = $36,000 and std = $20,000 respectively

a) What is the sample mean? How does it compare to the population mean?
   i) The sample mean is 34419.57
   ii) Compared to the population mean, it is lower by around 1500 dollars.

b) What is the standard error of the mean? How does this compare to the standard deviation of the population?
   i) The standard error of the mean is 918.6304. The sample standard deviation is 17075.66
   ii) When we compare these to the population standard deviation, we see that there is a good amount of error associated; almost 1000 dollars' worth.

c) Formulate a null and alternative hypothesis about how our sample compares to the population of MIM graduates (see the "Lecture 4 Outline" for an example).
   i) Null: Salaries in the sample are the same as salaries in the population, and any differences observed are due to sampling error
   ii) Alternative: Salaries in the sample are not the same as salaries in the population.

d) Using R, estimate the likelihood of getting a sample as extreme as we did given the null hypothesis. What would you conclude about our sample?
   i) Calculating the standard error of the mean and adding the SE to the sample mean before plugging it into pnorm with the population mean and sd
   ii) This tells us how far our sample is from the population mean, and by adding that value to the population mean, we can run pnorm to check the probability of getting this value with the population parameters.
   iii) pnorm((918.6304+34419.57), 36000, 20000) = 48.68%
   iv) Alternatively, in a random sample of five, the mean was 25110, standard deviation = 5649.049, and SEM = 8944.272. In a random sample of 50, mean = 35341, sd = 17420.16, and SEM = 2828.427.
   v) Both means from the random samplings are lower than the population mean. This supports the idea that the salaries in the sample tend to not be the same as salaries in the population.

Q2.

Answer these questions about standard errors (which you now know refers to the standard deviation of the sampling distribution).

a) If the standard error of the mean is 10 for N = 12, what is the standard error of the mean for N = 22?
    i) x =10*sqrt(12)
       x/sqrt(22)
       7.39

b) If the standard error of the mean is 50 for N = 25, what is it for N = 64?
    i) x =50*sqrt(25)
       x/sqrt(64)
       31.25

c) If numerous samples are taken from a uniform distribution and a frequency distribution of the means is drawn, what would be the shape of the frequency distribution according to the Central Limit Theorem?
    i) The shape would approach a normal distribution.

d) True/false: The standard error of the mean is smaller when n = 100 than when n = 50 (n is the sample size).
    i) True

e) True/false: The standard error of the mean is smaller when $\sigma = 2.0$ than when $\sigma = 2.5$ (σ is the standard deviation of the population distribution).
    i) True

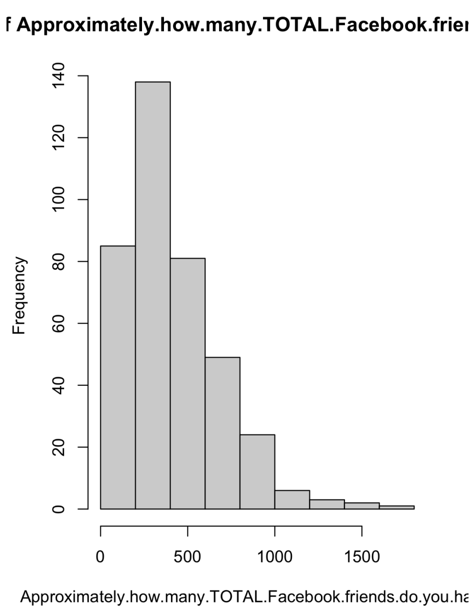
Q3.
Robin Dunbar a famous anthropologist argued that humans only have the capacity to keep track of so many people at a time. He argued that the maximum number of people humans could keep track of is 150. This number is called Dunbar's number. Some have interpreted this to mean that any individual person has on average about 150 friends.

Some technologists have argued that social media and modern information technology allow individuals to keep track of more people. For example, Facebook algorithmically organizes and presents information about our Facebook friends in a centralized feed lowering the costs associated with keeping in contact with all these people.
Fortunately we can evaluate this claim because our colleague Prof. Vitak has collected data on Facebook usage among college students at a large university. Using this sample data and the codebook which explains the variables evaluate the technologists's claim.

Using the theoretical population mean and the sample provided conduct a one-sample t-test (with significance level alpha = 0.05) to determine whether individuals have more friends than would be expected by Dunbar's number.

Please report your answers to the following questions using full sentences (like you would in a report or paper).

a) Graph the total Facebook friend values for the sample. What is the shape?



   i)
   ii) This distribution is right skewed, with most values congregating below 500.

b) State your null and alternative hypotheses.
   i) Null: The average number of Facebook friends in the sample is the same as the average number of friends presented by Dunbar's number, and any differences observed are due to sampling error.

   ii) Alternative: The average number of Facebook friends in the sample is not the same as the average number of friends presented by Dunbar's number.

c) Calculate your t-statistic
   i) The t-value is 31.016 when calculated with t.test, and 21.486 when calculated manually as tvalue <- (mean-150)/(sd/sqrt(437)). This may be in part due to how I handled null values in calculating the mean and standard deviation; I simply dropped them.

d) Look up the probability for the t-statistic
   i) The probability comes out to be 100%.

e) What is the effect size?
   i) Running the values through Cohen's d yields 1.03.

f) What would you conclude?
   i) There is an adequate number of samples to suggest that the average number of Facebook friends is more than what would be expected by Dunbar's number. The p value indicates that it is statistically significant, and therefore we reject the null hypothesis that the average number of friends is equal to Dunbar's number.

g) What are the limitations, if any?
   i) When we look at the summary of the column "Approximately how many total Facebook friends do you have," we already see that there is a large range of values. Some individuals reported a maximum of 1700 Facebook friends, an alarmingly large number. While this may be true, this may also have been an estimate of their true value; self-reported values tend to be skewed and students may not have actually checked their friends list before reporting their value. In addition, this sample, despite being large, is only representative of students who use Facebook. As an older social media, individuals may not use it as often.

Q4.
Much has been made of the concept of experimenter bias, which refers to the fact that for even the most conscientious experimenters there seems to be a tendency for the data to come out in the desired direction. Suppose we use students as experimenters.

All the experimenters are told that participants will be given caffeine before the experiment, but half the experimenters are told that we expect caffeine to lead to good performance, and half are told that we expect it to lead to poor performance.

The dependent variable is the number of simple arithmetic problems the participant can solve in two minutes. The obtained data are saved in the week 6 module as “caffeine experiment”.

a) Do a two-sample t-test. What would you conclude from these results?
    i) Since the p-value is greater than 0.05, the deviation from the null hypothesis is not statistically significant.
    ii) Therefore, caffeine can be said to have no noticeable effect on performance.

Welch Two Sample t-test

data: num_correct_answers by expected_performance
t = -0.85749, df = 15.517, p-value= 0.4042
alternative hypothesis: true difference in means between group bad and group good is not equal to 0
95 percent confidence interval:
 -5.797475 2.464142
sample estimates:
 mean in group bad mean in group good
         17.33333   19.00000

Q5.

a) Brescoll and Uhlmann (2008) investigated the hypothesis that when an observer views a videotape of a male expressing anger as opposed to sadness, the male in the anger condition is accorded higher status than the male in the sadness condition. For 19 males the mean and standard deviation (in parentheses) of the anger condition were 6.47 (2.25). For the 29 men in the sad condition the mean and standard deviation were 4.05 (1.61). Is this difference significant?
    i) The difference is significant since p-value < 0.05, therefore H0 is rejected. The test statistic T equals 4.3463, which is not in the 95% region of acceptance.

b) Brescoll and Uhlmann (2008) found the reverse effect for females. They thought that perhaps this latter result was related to the way anger is judged in females compared to males. When they compared judgments of a video of a group of 41 females who expressed anger without an attribution for the source of anger, women's perceived status had a mean and standard deviation of 3.40 (1.44). When the women on the video gave an external attribution for their anger (an employee stole something), their perceived status had a mean and standard deviation of 5.02 (1.66). Is this difference significant?
    i) This question does not clearly state the number of samples in group 2, so I assumed that the women in sample 2 are the same as the women in sample 1, therefore N = 41 for group 1 and group 2.
    ii) Using these stats, since p-value < 0.05, H0 is rejected and the difference is significant. The test statistic T equals -4.7203, which is not in the 95% region of acceptance: [-1.9901 : 1.9901].

c) What is the effect size for question 5b?
    i) The observed effect size d is large, 1.04. This indicates that the magnitude of the difference between the averages is large.

    The actual effect size is 0.46.