Name: ______________________________ SID: ____________________

Collaborators: ____

Week 5 Problem Set

Hypothesis tests about a mean and a proportion
PHW142

You must put your name and SID at the top of the page.

Part 1. Vitamin C loss in wheat soy blend

1. **(6 points)** It may be helpful to use Baldi and Moore's "4 step process" from inside the front cover.

   These are the same data as we used in problem set 4 to calculate a confidence interval. Please see the directions for problem set 4 for more details about the dataset `wsbhaiti.csv`.

   The assumptions for using t distributions for hypothesis tests are exactly the same as the assumptions for confidence intervals, so you've already checked them using the plots, but we will add the Shapiro-Wilk test to our assumption checking tools.

   If you did not save a new dataset while working problem set 4, you will need to recalculate the values for the Vitamin C loss,

   US factory amount – Haiti amount   which we called diff in problem set 4.

   These are the essential data for the analysis.

   1.1 State the null and alternative hypotheses for the Shapiro-Wilk test about the distribution of the difference values, get the P value from the function `shapiro.test()`, and interpret the results. **1 point**

1.2 Paste your Shapiro-Wilk test output here: **1 point**

1.3 State your conclusion here: **1 point**

1.4 The practical concern is about vitamin C is loss in shipment and storage. Based on this, what is the alternative hypothesis to use for the test? **½ point**

1.5 What is the null hypothesis? **½ point**

You have the standard error of the difference values from problem set 4 (or from the key).

1.6 Calculate the test statistic, using the average difference and the standard error. **1 point**

1.7 Find the degrees of freedom for the test, and find the P value.(Use OOMPH Stat or the `pt()` function.)

If you use the `pt` function, paste your code and output here. **1 point**

If you use OOMPH Stat, paste your output here.

Use the `t.test()` function to carry out the appropriate test using the differences. Paste your output here:

1.8 Write a succinct summary for a disaster relief agency, answering these questions:

- Is there evidence that vitamin C is being lost? Explain
- Use $P < 0.05$ as the criterion for your test conclusion

1 point

Part 2. Probability of having twins

2. **(4 points)** The overall probability of having twins for US mothers is close to 1 in 90. This probability is thought to vary with a number of factors, including age, race, and parity.

   In a random sample of 538 hospital records for women giving birth under age 20, 2 had twins.

   Do these data provide evidence that the probability of twins for mothers giving birth under the age of 20 is **not the same as** the overall probability for US mothers?

   2.1 What are the null and alternative hypotheses? **1 point**

   2.2 Explain what method should be used to find the P value for the test. **1 point**

Carry out the test.

Include all relevant calculations and outputs here.

2.3 What is the P value for your test, and what do you conclude? **2 points**

Part 3. Breast cancer and family history

3. **(7 points)** It is hypothesized that a woman whose mother had breast cancer has a greater chance of developing the disease. Suppose that in a random sample of 10,000 women ages 50 to 54 whose mothers had breast cancer, 400 of them had developed breast cancer.

   Do these data provide evidence that the population proportion of breast cancer for women ages 50 to 54 whose mother had breast cancer is `higher than` the overall US proportion of .02 for women ages 50 to 54?

   3.1 What are the null and alternative hypotheses? **1 point**

   Carry out the test using the exact binomial calculations and paste your results here. While you can find the P value directly using the function `pbinom()`, also use `binom.test()`.

3.2 What is the P value, and what is your conclusion?

3.3 Explain why the normal approximation may also be used to carry out a test.
and the expected number of women with no breast cancer 10000 * .98 = 9800

3.4 Calculate the normal approximation test statistic. Show all details.

3.5 Find the P value using the normal approximation.

3.6 What is your conclusion, based ono the normal approximation P value?

3.7 Interpret the confidence "interval" in the output from function `binom.test()`.Give a concrete interpretation, using the context of the problem. **1 point**

Part 4. Exploring the power of a test about a mean

4. **(7 points)**

All of these tests have the null hypothesis $\mu = 65$

Use the `pwr.t.test()` function to find the power or sample size. Although we are giving you functions you need, you need to spend some time with them to be sure you know what they are doing to answer the questions.

It is a very good idea to copy and paste your results and graphs into a Word document to use for completing this problem set and for future study, but **do not include any output in your problem set submission, just the graphs.**

With R power functions, we need to calculate the Cohen effect size; this software does not allow us to specify the means for the null and alternative hypotheses and the standard deviation directly.

For tests about a mean, the effect size is size $\delta = \frac{\mu_a - \mu_0}{\sigma}$ where μ_0 is the null hypothesis value of the population mean, 65 in this exercise, and μ_a is the specific alternative hypothesis value of the population mean.

For $\mu_a = 60$ and $\sigma = 15$, $\sigma = \frac{60-65}{15} = \frac{-5}{15} = \frac{-1}{3}$
For $\mu_a = 57.5$ and $\sigma = 15$, $\sigma = \frac{57.5-65}{15} = \frac{-7.5}{15} = \frac{-1}{2}$
For $\mu_a = 60$ and $\sigma = 20$, $\sigma = \frac{60-65}{20} = \frac{-5}{20} = \frac{-1}{4}$

The `pwr.t.test()` function will take fractions for d, so we will use – 1/3 rather than a decimal approximation.

A. $\mu_a = 60$; standard deviation = 15; one-sided $H_a : \mu < 65$; $\alpha = 0.05$
sample sizes 25, 50, and 100

```
pwr.t.test( type = "one.sample", d = - 1/3, n = c(25, 50, 100),
            alternative = "less", sig.level = .05)
```

B. $\mu_a = 57.5$; standard deviation = 15; one-sided $H_a : \mu < 65$; $\alpha = 0.05$
sample sizes 25, 50, and 100

```
pwr.t.test( type = "one.sample", d = - 1/2, n = c(25, 50, 100),
            alternative = "less", sig.level = .05)
```

C. looking at sample sizes to get power = 0.90 with
$\mu_a = 60$; standard deviation = 15; one-sided $H_a : \mu < 65$; $\alpha = 0.05$

```
pwr.t.test(type = "one.sample", d = - 1/3, power = .90,
             alternative = "less", sig.level = .05)

pwr_n_60 <- pwr.t.test(type = "one.sample", d = -1/3, power = .90,
            alternative= "less", sig.level = .05)
plot(pwr_n_60)
```

D. looking at sample sizes to get power = .90 with
$\mu_a = 57.5$; standard deviation = 15; one-sided $H_a : \mu < 65$; $\alpha = 0.05$

```
pwr.t.test(type = "one.sample", d = - 1/2, power = .90,
             alternative = "less", sig.level = .05)


pwr_n_57.5 <- pwr.t.test(type = "one.sample", d = -1/2, power = .90,
            alternative= "less", sig.level = .05)
plot(pwr_n_57.5)
```

E. looking at power and sample size with $\sigma = 20$
$\mu_a = 60$; standard deviation = 20; one-sided $H_a : \mu < 65$; $\alpha = 0.05$

```
pwr.t.test( type = "one.sample", d = - 1/4, n = c(25, 50, 100),
            alternative = "less", sig.level = .05)

pwr_s_20 <- pwr.t.test(type = "one.sample", d = -1/4, power = .90,
            alternative= "less", sig.level = .05)
plot(pwr_s_20)
```

Answer these questions.

using A. and C.

one-sided $H_a : \mu < 65$ standard deviation = 15 $\alpha = 0.05$

4.1 When μ really is 60, what is the power of the test for sample sizes 25, 50, and 100? **1 point**

4.2 From your graph, what is the smallest sample size for which the power is at least .90? **1 point**

using B. and D.

one-sided $H_a : \mu < 65$ standard deviation = 15 $\alpha = 0.05$

4.3 When μ really is 57.5, what is the power of the test for sample sizes 25, 50, and 100? **1 point**

4.4 From your graph, what is the smallest sample size for which the power is at least .90? **1 point**

using C. and D.

one-sided $H_a : \mu < 65$ standard deviation = 15 $\alpha = 0.05$

4.5 Compare the sample sizes need to get power of at least 0.90 for the alternative hypothesis value of 60 and 57.5. What do you see? **1 point**

using A. and E.

4.6 When μ really is 60, coompare the power of the test for $\sigma = 15$ and $\sigma = 20$ for sample sizes 25, 50, and 100. What do you see? **1 point**

4.7 Compare the sample sizes need to get power of least .90 for the alternative hypothesis value of 60 for $\sigma = 15$ and $\sigma = 20$. What do you see? **1 point**