DARIEN OLIVA
ECON 453 – PSET 2

A) 95% Confidence Interval for overall average test score:

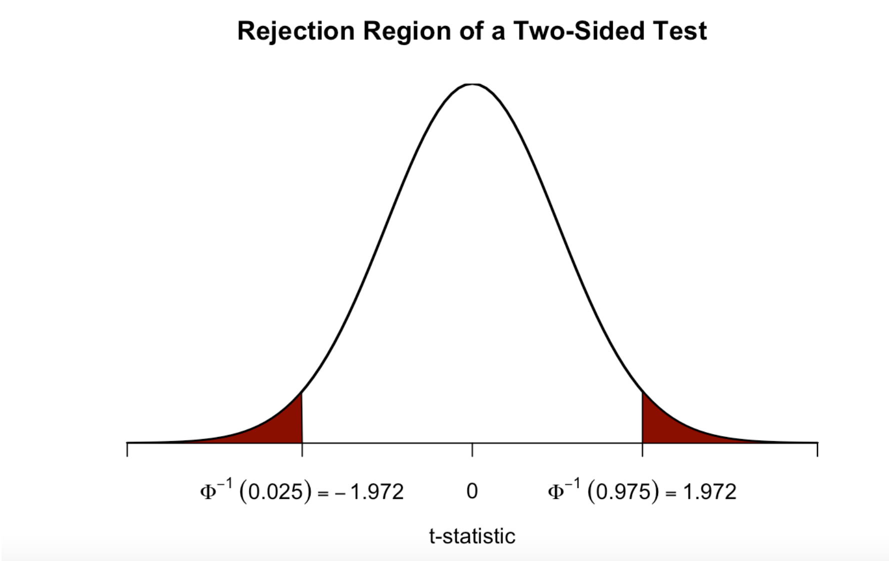
The 95% confidence interval for the overall average test score (using data from both years and schools) is between 59.11169 and 65.62831.

B) Test the null hypothesis:

Null: Overall average test score (both schools and both years combined) is 63.
Alternative: The average test score is not 63.

<u>Calculated in R:</u>
t =0.038128 df = 199 p-value = 0.7034
95% confidence interval: (59.11169, 65.62831)
Mean of x: 62.37

<u>RESULT:</u> ***DO NOT* REJECT THE NULL!**
If the p-value is greater than 5%, the null hypothesis is NOT rejected. Since the p-value is 0.7034 and greater than 5%, we know NOT to reject the null hypothesis. In this scenario we are not rejecting the null because the mean and the mu are so close that we can't appropriately do so. Also, 0.038128 is not in the rejection zone(s) so we do NOT reject the null.



C) Did test scores increase for both schools between 2014 and 2016? Verify one school at a time.

Null = there is no increase in scores between 2014 and 2016.
Alternative = there IS an increase in scores between 2014 and 2016.

FOR LINCOLN:

```
t.test(S2, S1, conf.level = 0.95, alternative = "greater")

Welch Two Sample t-test

data:  S2 and S1
t = 2.3879, df = 85.386, p-value = 0.009575
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.734471      Inf
sample estimates:
  mean of x mean of y
63.62     51.32
```

RESULTS: The p-value is less than 5%, therefore we REJECT the null. The means of scores from 2014 to 2016 increased.

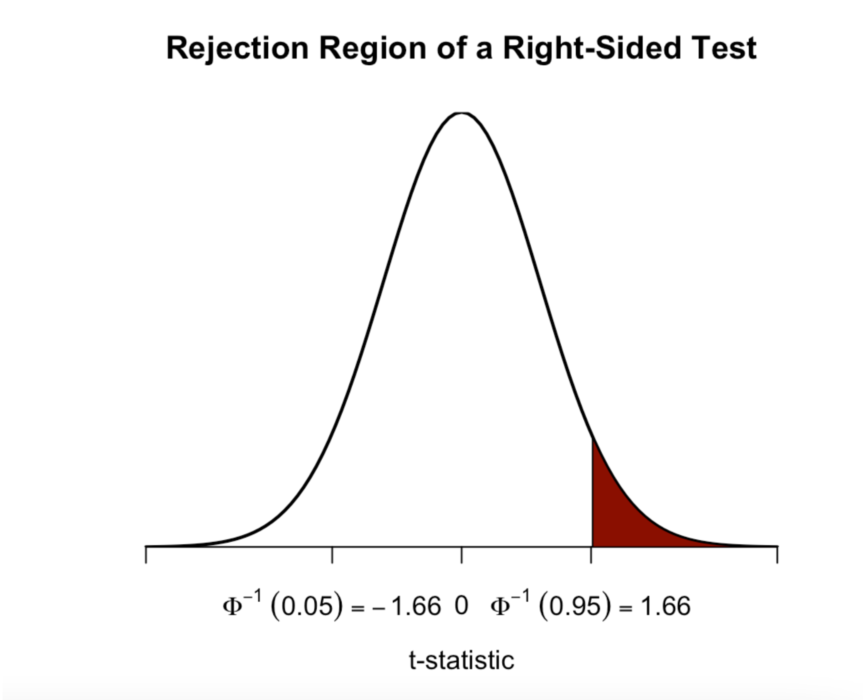
FOR KENNEDY:

```
Welch Two Sample t-test

data:  S6 and S5
t = 2.5608, df = 96.648, p-value = 0.005996
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.296676      Inf
sample estimates:
  mean of x mean of y
71.96     62.58
```

RESULTS: The p-value is less than 5%, therefore we REJECT the null. The means of scores from 2014 to 2016 increased.

PLOT OF REJECTION ZONE:



The t statistics for both schools falls within the rejection zone. Lincoln t stat = **2.387899.** Kennedy t stat = **2.560779.**

D) Does data support the claim that the performance of 4th graders does not differ between schools? Verify for 2014 and 2016 separately.

USING DATA/RESULTS FROM QUESTION C

2014: The data does NOT support the claim that the performance of 4th graders does not differ between schools. We know this is incorrect because in 2014 the mean of scores for Lincoln was 51.32 and for Kennedy it was 62.58.

2016: The data does NOT support the claim that the performance of 4th graders does not differ between schools. We know this is incorrect because in 2014 the mean of scores for Lincoln was 63.62 and for Kennedy it was 71.96.

E) Are the proportion of passing students the same for each school?

Null = proportion of students who pass the exam is the same for both schools.
Alternative = the proportions are not the same.

```
        Welch Two Sample t-test

data:  S7 and S8
t = 3.7255, df = 159.11, p-value = 0.0002703
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.08927554 0.29072446
sample estimates:
mean of x mean of y
     0.93      0.74
```

P-Value = **0.0002703**

RESULTS: The p-value is much less than 5%, therefore we REJECT the null. The proportion of students who pass the exam from each school is NOT the same. The mean of x and the mean of y are significantly different from each other.

F) Write a small report based on the results above (written for local newspaper/ non-technical):

Based on the data and results given above, we can make conclusions about the differences in scores by both years and schools. The data is about standardized test scores of 4th graders from the Lincoln and Kennedy schools for 2014 and 2016. For this exam a score of 40 is a passing score/grade.

In the years 2014 and 2016 we can see that the 4th graders at the Kennedy school perform better on the standardized exam than students at the Lincoln school. The increase in scores between schools has been almost 10 points, as reported in 2014 and 2016.

Between the years 2014 and 2016, both schools had an increase in the average scores for this exam. For the Lincoln school, the average score in 2014 was 51.32, and in 2016 it was 63.62. For the Kennedy school, the average score in 2014 was 62.58, and in 2016 it was 71.96. The increase in the average score for Lincoln was approximately 12 points, and for Kennedy it was an increase of approximately 9 points.

There are several important factors that cause differences in scores on standardized testing between schools. Some of these factors could include the teacher to student ratios, the curriculum, the funding available, and many more. This data can not show us the differences in how the schools operate, but it can show us the abilities of the students from an academic stance. It is extremely important to pick the correct school for your child with the most suitable conditions for their success, whether that is the place with higher standardized test scores, or the place that can offer them their unique needs for personal growth.

ADDENDUM

R Code : SCREENSHOTS FROM R

```
# ECON 435 - PSET 2 - DARIEN OLIVA

# QUESTION A

qt(0.975, 199)
[1] 1.971957
qt(0.025, 199)
[1] -1.971957

mean(pset1_data_2$score )-(sd(pset1_data_2$score )/sqrt(200))*qt(0.975, 199)
[1] 59.11169
mean(pset1_data_2$score )+(sd(pset1_data_2$score )/sqrt(200))*qt(0.975, 199)
[1] 65.62831

# OR WE CAN USE T TEST :

t.test(pset1_data_2$score,conf.level = 0.95)$"conf.int"
[1] 59.11169 65.62831
attr(,"conf.level")
[1] 0.95
```

```
#QUESTION B

n = nrow(pset1_data_2)
t_stat = (mean(pset1_data_2$score) - 63) / (sd(pset1_data_2$score) / sqrt(n))
t_stat
[1] -0.3812817
2*pt(t_stat, n-1)
[1] 0.703401

# OR WE CAN USE T TEST :

t.test(pset1_data_2$score, mu = 63,conf.level = 0.95, alternative = "two.sided")

One Sample t-test

data:  pset1_data_2$score
t = -0.38128, df = 199, p-value = 0.7034
alternative hypothesis: true mean is not equal to 63
95 percent confidence interval:
  59.11169 65.62831
sample estimates:
  mean of x
62.37

# DO NOT Reject null if p-value is greater than 5%. Therefore we DO NOT reject the null.
```

```
#Plot the t distribution density on the domain [-4,4].

qt(0.975, 199)
[1] 1.971957
qt(0.025, 199)
[1] -1.971957

curve(dt(x, df=n-1),
      xlim = c(-4, 4),
      main = "Rejection Region of a Two-Sided Test",
      yaxs = "i",
      xlab = "t-statistic",
      ylab = "",
      lwd = 2,
      axes = "F")

axis(1,
     at = c(-4,-1.972, 0, 1.972, 4),
     padj = 0.5,
     labels = c("",expression(Phi^-1~(.025)==-1.972), 0, expression(Phi^-1~(.975)==1.972), ""))

polygon(x = c(1.972, seq(1.972, 4, 0.01), 4),
        y = c(0, dt(seq(1.972, 4, 0.01), df=n-1),0),
        col = "darkred")
polygon(x = c(-4, seq(-4, -1.972, 0.01), -1.972),
        y = c(0, dt(seq(-4, -1.972, 0.01), df=n-1), 0),
        col = "darkred")
```

```
# QUESTION C

# Null = there is no increase in scores between 2014 and 2016.
# Alternative = there IS an increase in scores between 2014 and 2016.
# FOR LINCOLN:

S1 = pset1_data_2$score[pset1_data_2$school=='Lincoln' & pset1_data_2$year==2014]
S2 = pset1_data_2$score[pset1_data_2$school=='Lincoln' & pset1_data_2$year==2016]
S3 = pset1_data_2$score[pset1_data_2$year==2014]
S4 = pset1_data_2$score[pset1_data_2$year==2016]
S5 = pset1_data_2$score[pset1_data_2$school=='Kennedy' & pset1_data_2$year==2014]
S6 = pset1_data_2$score[pset1_data_2$school=='Kennedy' & pset1_data_2$year==2016]
t_stat = (mean(S2) - mean(S1))/sqrt((var(S2)/length(S2)+(var(S1)/length(S1))))
t_stat
[1] 2.387899

df=(((var(S2)/length(S2)+(var(S1)/length(S1))))^2)/
  +     (((var(S2)/length(S2))^2/(length(S2)-1))+((var(S1)/length(S1))^2/(length(S1)-1)))

1-pt(t_stat, df)
[1] 0.009575421

t.test(S2, S1, conf.level = 0.95, alternative = "greater")

Welch Two Sample t-test

data:  S2 and S1
t = 2.3879, df = 85.386, p-value = 0.009575
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.734471      Inf
sample estimates:
  mean of x mean of y
63.62     51.32

#RESULTS : P value is less than 5%, therefore REJECT NULL.
# Mean of scores increased from year 2014 to 2016.
```

```
# NOW FOR KENNEDY

t_stat_k = (mean(S6) - mean(S5))/sqrt((var(S6)/length(S6)+(var(S5)/length(S5))))
t_stat_k
[1] 2.560779

df=(((var(S6)/length(S6)+(var(S5)/length(S5))))^2)/
  + (((var(S6)/length(S6))^2/(length(S6)-1))+((var(S5)/length(S5))^2/(length(S5)-1)))
1-pt(t_stat_k, df)
[1] 0.005995696

t.test(S6, S5, conf.level = 0.95, alternative = "greater")

Welch Two Sample t-test

data:  S6 and S5
t = 2.5608, df = 96.648, p-value = 0.005996
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.296676      Inf
sample estimates:
  mean of x mean of y
71.96     62.58

#RESULTS : P value is less than 5%, therefore REJECT NULL.
# Mean of scores increased from year 2014 to 2016.



# QUESTION D

# COMPARE DATA / RESULTS FROM QUESTION C TO ANSWER THIS QUESTION.
```

```
# QUESTION E
# NULL = THE PROPORTION OF STUDENTS WHO PASS THE EXAM IS THE SAME FOR EACH SCHOOL.
# ALTERNATIVE = THE PROPORTION OF PASSES IS NOT THE SAME FOR EACH SCHOOL.

S7=pset1_data_2$pass[pset1_data_2$school=='Kennedy' ]
S8=pset1_data_2$pass[pset1_data_2$school=='Lincoln' ]
var(S7)*((length(S7)-1)/length(S7))
[1] 0.0651

t_stat_e = (mean(S7) - mean(S8))/sqrt((var(S7)/length(S7)+(var(S8)/length(S8))))
t_stat_e
[1] 3.725483

df=(((var(S7)/length(S7)+(var(S8)/length(S8))))^2)/
     (((var(S7)/length(S7))^2/(length(S7)-1))+((var(S8)/length(S8))^2/(length(S8)-1)))

2*(1-pt(t_stat_e, df))
[1] 0.0002703384


t.test(S7, S8, conf.level = 0.95, alternative = "two.sided")

Welch Two Sample t-test

data:  S7 and S8
t = 3.7255, df = 159.11, p-value = 0.0002703
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  0.08927554 0.29072446
sample estimates:
  mean of x mean of y
0.93      0.74

# RESULTS = P-VALUE IS MUCH SMALLER THAN 5%. THEREFORE, REJECT THE NULL THAT
# PROPORTION OF STUDENTS WHO PASS THE EXAM IS THE SAME FOR EACH SCHOOL.
# The mean of x and the mean of y is significantly different.
```

```
# QUESTION F
# WRITTEN RESPONSE, SUMMARY OF ALL RESULTS.
```

WRITTEN CODE: (copy and pasted from R)

```
# ECON 435 - PSET 2 - DARIEN OLIVA

# QUESTION A

qt(0.975, 199)
[1] 1.971957
qt(0.025, 199)
[1] -1.971957

mean(pset1_data_2$score )-(sd(pset1_data_2$score )/sqrt(200))*qt(0.975, 199)
[1] 59.11169
mean(pset1_data_2$score )+(sd(pset1_data_2$score )/sqrt(200))*qt(0.975, 199)
[1] 65.62831

# OR WE CAN USE T TEST :

t.test(pset1_data_2$score,conf.level = 0.95)$"conf.int"
[1] 59.11169 65.62831
attr(,"conf.level")
[1] 0.95



#QUESTION B

n = nrow(pset1_data_2)
t_stat = (mean(pset1_data_2$score) - 63) / (sd(pset1_data_2$score) / sqrt(n))
t_stat
[1] -0.3812817
> 2*pt(t_stat, n-1)
[1] 0.703401

# OR WE CAN USE T TEST :

t.test(pset1_data_2$score, mu = 63,conf.level = 0.95, alternative = "two.sided")

One Sample t-test

data:  pset1_data_2$score
t = -0.38128, df = 199, p-value = 0.7034
alternative hypothesis: true mean is not equal to 63
95 percent confidence interval:
```

```
  59.11169 65.62831
sample estimates:
  mean of x
62.37
```

DO NOT Reject null if p-value is greater than 5%. Therefore we DO NOT reject the null.

#Plot the t distribution density on the domain [-4,4].

```
qt(0.975, 199)
[1] 1.971957
qt(0.025, 199)
[1] -1.971957

curve(dt(x, df=n-1),
      xlim = c(-4, 4),
      main = "Rejection Region of a Two-Sided Test",
      yaxs = "i",
      xlab = "t-statistic",
      ylab = "",
      lwd = 2,
      axes = "F")

axis(1,
     at = c(-4,-1.972, 0, 1.972, 4),
     padj = 0.5,
     labels = c("",expression(Phi^-1~(.025)==-1.972), 0, expression(Phi^-1~(.975)==1.972), ""))

polygon(x = c(1.972, seq(1.972, 4, 0.01), 4),
        y = c(0, dt(seq(1.972, 4, 0.01), df=n-1),0),
        col = "darkred")
polygon(x = c(-4, seq(-4, -1.972, 0.01), -1.972),
        y = c(0, dt(seq(-4, -1.972, 0.01), df=n-1), 0),
        col = "darkred")
```

QUESTION C

Null = there is no increase in scores between 2014 and 2016.
Alternative = there IS an increase in scores between 2014 and 2016.
FOR LINCOLN

```
S1 = pset1_data_2$score[pset1_data_2$school=='Lincoln' & pset1_data_2$year==2014]
```

```
S2 = pset1_data_2$score[pset1_data_2$school=='Lincoln' & pset1_data_2$year==2016]
S3 = pset1_data_2$score[pset1_data_2$year==2014]
S4 = pset1_data_2$score[pset1_data_2$year==2016]
S5 = pset1_data_2$score[pset1_data_2$school=='Kennedy' & pset1_data_2$year==2014]
S6 = pset1_data_2$score[pset1_data_2$school=='Kennedy' & pset1_data_2$year==2016]
t_stat = (mean(S2) - mean(S1))/sqrt((var(S2)/length(S2)+(var(S1)/length(S1))))
t_stat
[1] 2.387899

df=(((var(S2)/length(S2)+(var(S1)/length(S1))))^2)/
  +     (((var(S2)/length(S2))^2/(length(S2)-1))+((var(S1)/length(S1))^2/(length(S1)-1)))


1-pt(t_stat, df)
[1] 0.009575421

t.test(S2, S1, conf.level = 0.95, alternative = "greater")

Welch Two Sample t-test

data:  S2 and S1
t = 2.3879, df = 85.386, p-value = 0.009575
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.734471      Inf
sample estimates:
  mean of x mean of y
63.62     51.32


#RESULTS : P value is less than 5%, therefore REJECT NULL. Mean of scores increased from year 2014 to 2016.

# NOW FOR KENNEDY

t_stat_k = (mean(S6) - mean(S5))/sqrt((var(S6)/length(S6)+(var(S5)/length(S5))))
t_stat_k
[1] 2.560779

df=(((var(S6)/length(S6)+(var(S5)/length(S5))))^2)/
  + (((var(S6)/length(S6))^2/(length(S6)-1))+((var(S5)/length(S5))^2/(length(S5)-1)))
1-pt(t_stat_k, df)
[1] 0.005995696
```

```
t.test(S6, S5, conf.level = 0.95, alternative = "greater")

Welch Two Sample t-test

data:  S6 and S5
t = 2.5608, df = 96.648, p-value = 0.005996
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
  3.296676      Inf
sample estimates:
  mean of x mean of y
71.96     62.58
```

#RESULTS : P value is less than 5%, therefore REJECT NULL. Mean of scores increased from year 2014 to 2016.

QUESTION D

COMPARE DATA / RESULTS FROM QUESTION C TO ANSWER THIS QUESTION.

QUESTION E

NULL = THE PROPORTION OF STUDENTS WHO PASS THE EXAM IS THE SAME FOR EACH SCHOOL.

ALTERNATIVE = THE PROPORTION OF PASSES IS NOT THE SAME FOR EACH SCHOOL.

```
S7=pset1_data_2$pass[pset1_data_2$school=='Kennedy' ]
S8=pset1_data_2$pass[pset1_data_2$school=='Lincoln' ]
var(S7)*((length(S7)-1)/length(S7))
[1] 0.0651

t_stat_e = (mean(S7) - mean(S8))/sqrt((var(S7)/length(S7)+(var(S8)/length(S8))))
t_stat_e
[1] 3.725483

df=(((var(S7)/length(S7)+(var(S8)/length(S8))))^2)/
    (((var(S7)/length(S7))^2/(length(S7)-1))+((var(S8)/length(S8))^2/(length(S8)-1)))

2*(1-pt(t_stat_e, df))
[1] 0.0002703384
```

```
t.test(S7, S8, conf.level = 0.95, alternative = "two.sided")

Welch Two Sample t-test

data:  S7 and S8
t = 3.7255, df = 159.11, p-value = 0.0002703
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
  0.08927554 0.29072446
sample estimates:
  mean of x mean of y
0.93      0.74

# RESULTS = P-VALUE IS MUCH SMALLER THAN 5%. THEREFORE, REJECT THE NULL
THAT PROPORTION OF STUDENTS WHO PASS THE EXAM IS NOT THE SAME FOR EACH
SCHOOL.
# The mean of x and the mean of y is significantly different.

# QUESTION F
# WRITTEN RESPONSE, SUMMARY OF ALL RESULTS.
```