Project :-

In this project, you will investigate a classic phenomenon from experimental psychology called the Stroop Effect. You will learn a little bit about the experiment, create a hypothesis regarding the outcome of the task, then go through the task yourself. You will then look at some data collected from others who have performed the same task and will compute some statistics describing the results. Finally, you will interpret your results in terms of your hypotheses.

Statistics: The Science of Decisions Project Instructions

Background Information

In a Stroop task, participants are presented with a list of words, with each word displayed in a color of ink. The participant's task is to say out loud the *color of the ink* in which the word is printed. The task has two conditions: a congruent words condition, and an incongruent words condition. In the *congruent words* condition, the words being displayed are color words whose names match the colors in which they are printed: for example RED, BLUE. In the *incongruent words* condition, the words displayed are color words whose names do not match the colors in which they are printed: for example PURPLE, ORANGE. In each case, we measure the time it takes to name the ink colors in equally-sized lists. Each participant will go through and record a time from each condition.

1. What is our independent variable? What is our dependent variable?

The word/colour congruence is the variable being manipulated in the experiment is known as Independent variable.

And Dependent variable is the time it takes to recognize/name the ink colors of the mismatch word/colour congruency

2. What is an appropriate set of hypotheses for this task? What kind of statistical test do you expect to perform? Justify your choices.

Null Hypothesis, H0 - The mismatch of color to word will have no effect or decrease time to recognize and say the color

Alternate Hypothesis, H1 - The mismatch of color to word will increase time to recognize and say the color

H0: $\mu i \leq \mu c$ (μi - population mean of incongruent values, μc - population mean of congruent values)

H1: $\mu i > \mu c$ (μi - population mean of incongruent values, μc - population mean of congruent values)

statistical test choices and assumptions

- 95% confidence interval
- Paired one tail t-test -> with two tests per participant this test show if the mean of incongruent words is statistically significantly different from the congruent words at an alpha of 0.05.

assumptions/why: I will be using a t-test instead of a z-test because 1) the population standard deviation is unknown and 2) the sample set is less than 30. The t-test will be a one tailed t-test i.e. my directional alternative hypothesis is that participant's incongruent sample mean will be larger than the participant's congruent sample mean

A paired t-test (or dependent sample test), will be used because the data set is of one group of participants tested twice under different conditions (word/colour congruency). This will also facilitate either rejecting or accepting the null hypothesis.

Question:3 Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability

In [2]:

```
import math
import seaborn as sns
import numpy as np
import pandas as pd
from scipy.stats import t as pt
import matplotlib.pyplot as plt
%matplotlib inline
```

In [3]:

```
#Take all the data from the csv file and print
data = pd.read_csv("stroopdata.csv")
data
```

Out[3]:

	Congruent	Incongruent
0	12.079	19.278
1	16.791	18.741
2	9.564	21.214
3	8.630	15.687
4	14.669	22.803
5	12.238	20.878
6	14.692	24.572
7	8.987	17.394
8	9.401	20.762
9	14.480	26.282
10	22.328	24.524
11	15.298	18.644
12	15.073	17.510
13	16.929	20.330
14	18.200	35.255
15	12.130	22.158

16	18.495	25.139
17	10.639	20.429
18	11.344	17.425
19	12.369	34.288
20	12.944	23.894
21	14.233	17.960
22	19.710	22.058
23	16.004	21.157

In [4]:

```
#Find the mean,Median and standard deviation for congruent and incongruent
#Find the mean
c_mean = data['Congruent'].mean()
i_mean = data['Incongruent'].mean()

#Find the median
c_median = data['Congruent'].median()
i_median = data['Incongruent'].median()

#Find the standard deviation
c_std = data['Congruent'].std()
i_std = data['Incongruent'].std()

#print mean,median and standard deviation in a table
ls = [[int(24),int(24)],[c_mean,i_mean],[c_median,i_median],[c_std,i_std]]
detail = pd.DataFrame(ls,index=['Sample Size','Mean','Median','Standard Deviation'],columns=['Congruent','Incongruent'])
detail
```

Out[4]:

	Congruent	**Incongruent**
Sample Size	24.000000	24.000000
Mean	14.051125	22.015917
Median	14.356500	21.017500
Standard Deviation	3.559358	4.797057

In [5]:

```
#More Detail About the dataset
data.describe()
```

Out[5]:

	Congruent	Incongruent
count	24.000000	24.000000
mean	14.051125	22.015917
std	3.559358	4.797057
min	8.630000	15.687000
25%	11.895250	18.716750
50%	14.356500	21.017500
75%	16.200750	24.051500
max	22.328000	35.255000

4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

Plots

Please see below a boxplot and histogram which show the distribution of data from both congruent and incongruent conditions.

Observations

From the boxplot, there are two somewhat obvious outliers or extraneous data which would possible skew the true mean of incongruent values. And from the histogram plots, although both graphs visually appear somewhat positively skewed, the mean is pretty close to the peak in both graphs which would indicate a normal distribution. Provided these are samples from the population, the sampling mean would be similar to the population mean.

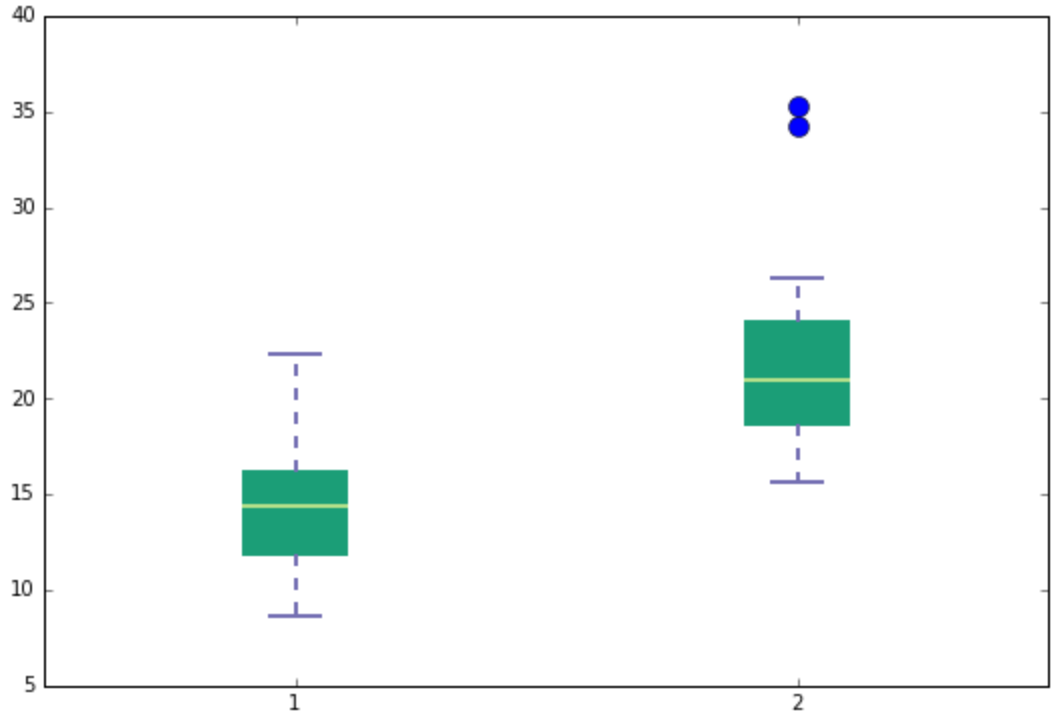
In [59]:

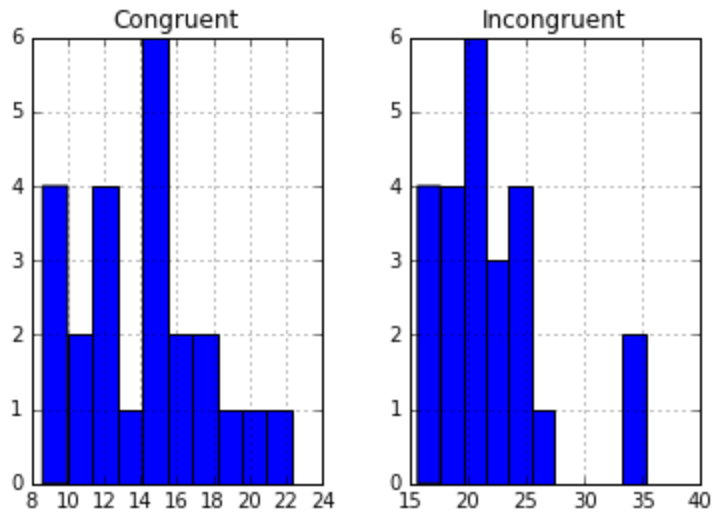
```
data = np.genfromtxt('stroopdata.csv', delimiter=',',dtype=np.float32)
plt.figure(1, figsize=(9, 6))

plot1 = plt.boxplot(data,vert=True,widths = 0.2,patch_artist=True)

plt.setp(plot1['boxes'], color='#1b9e77', linewidth=2, facecolor='#1b9e77')
plt.setp(plot1['whiskers'], color='#7570b3', linewidth=2)
plt.setp(plot1['caps'], color='#7570b3', linewidth=2)
```

```
plt.setp(plot1['fliers'], color='#e7298a', marker='o', markersize=10)
plt.setp(plot1['medians'], color='#b2df8a', linewidth=2)

# histogram
stroop.hist()
```

Out[59]:

```
array([[<matplotlib.axes._subplots.AxesSubplot object at 0x11e7c3b50>,
        <matplotlib.axes._subplots.AxesSubplot object at 0x11e684b10>]], dtype=object)
```





5. Now, perform the statistical test and report your results. What is your confidence level and your critical statistic value? Do you reject the null hypothesis or fail to reject it? Come to a conclusion in terms of the experiment task. Did the results match up with your expectations?

mean difference, dbar = 7.964

yi is incongruent, xc is the congruent values, n is the sample set

standard deviation, sd = 4.86

standard error of the difference, SE(dbar) = sd/√n = 4.86/√24 = 0.99

t-statistic, T = dbar/SE(dbar) = 7.964/0.99 = 8.04 on 23df

t-distribution with n-1 degrees of freedom (df = 23). Using the t-distribution table to find p-value...

The value of **p is < 0.0001**. The result is **significant at p < 0.05%**

Hypothesis

I reject the null hypothesis, the word/colour incongruent does cause a greater time response

Conclusion

The results match my expectations.

In [5]:

```
stroop = pd.read_csv("stroopdata_updated.csv")
print(stroop)
```

	Congruent	InCongruent	Difference	Mean Difference	Std Deviation
0	12.079	19.278	7.199	7.964792	4.864827
1	16.791	18.741	1.950	NaN	NaN
2	9.564	21.214	11.650	NaN	NaN
3	8.630	15.687	7.057	NaN	NaN
4	14.669	22.803	8.134	NaN	NaN
5	12.238	20.878	8.640	NaN	NaN
6	14.692	24.572	9.880	NaN	NaN
7	8.987	17.394	8.407	NaN	NaN
8	9.401	20.762	11.361	NaN	NaN
9	14.480	26.282	11.802	NaN	NaN
10	22.328	24.524	2.196	NaN	NaN
11	15.298	18.644	3.346	NaN	NaN
12	15.073	17.510	2.437	NaN	NaN
13	16.929	20.330	3.401	NaN	NaN
14	18.200	35.255	17.055	NaN	NaN

15	12.130	22.158	10.028	NaN	NaN
16	18.495	25.139	6.644	NaN	NaN
17	10.639	20.429	9.790	NaN	NaN
18	11.344	17.425	6.081	NaN	NaN
19	12.369	34.288	21.919	NaN	NaN
20	12.944	23.894	10.950	NaN	NaN
21	14.233	17.960	3.727	NaN	NaN
22	19.710	22.058	2.348	NaN	NaN
23	16.004	21.157	5.153	NaN	NaN

6. Optional: What do you think is responsible for the effects observed? Can you think of an alternative or similar task that would result in a similar effect? Some research about the problem will be helpful for thinking about these two questions!

I believe it's a subconscious or habitual behaviour where commonly used words are glanced over and easily recognized in your mind and therefore, because the color and words match, it takes little effort to say the word/colour. However, when the word and colour are mismatched, we first think of the word and then need to correct ourselves to say the colour causing either errors or more time to provide the correct response.

I imagine replacing letters with numbers in the experiment would yield the same results.

Another similar task: being shown a list of words and asking the user to type (on a qwerty keyboard) commonly used words. First, use a list words with no spelling mistakes and then the same list of words with obviously misspelling or a number in the middle of the word. The reflects of knowing where the keys are positioned and the knowledge of the correctly spelt word would allow cause the users to produce a fast time for correctly spelt words and a longer time to recognize that the word is spelt incorrectly and having to change their habitual behaviour, causing a lag and longer time to complet the word.

References

https://en.wikipedia.org/wiki/Stroop_effect

https://faculty.washington.edu/chudler/java/timesc.html

http://www.statisticshowto.com/when-to-use-a-t-score-vs-z-score/