Test a Perceptual Phenomenon

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Analyzing the Stroop Effect:

Stroop Effect is an experiment you are required to say the color of the word, not what the word says. For example, for the word, RED, you should say "Blue." There will be two set of experiments to collect data from congruent and incongruent words and analyse those results.

(1) What is the independent variable? What is the dependent variable?

The independent variable: The variable you have control over, what you can choose and manipulate (congruent and incongruent words)

The dependent variable: The A dependent variable is what you measure in the experiment and what is affected during the experiment (response time)

(2) What is an appropriate set of hypotheses for this task? Specify your null and alternative hypotheses, and clearly define any notation used. Justify your choices.

(2a)Hypotheses

i - Mean of incongruent population's response time. c - Mean of congruent population's response time.

Ho - Null Hypothesis: There is no significant difference in the population average response time in viewing the congruent words vs viewing the incongruent words.

i - c = 0

Ha - Alternative Hypothesis: There is a significant difference, positive or negative, in the population average response times.

(i - c 0)

(2b)Statistical test

The paired sample t-test, sometimes called the dependent sample t-test, is a statistical procedure used to determine whether the mean difference between two sets of observations is zero.

Following assumptions were required:

- Interval or ratio scale of measurement (approximately interval)
- Random sampling from a defined population
- Samples (here the sample size is less than 30) or sets of data used to produce the difference scores are linked in the population through repeated measurement, natural association, or matching
- Scores are normally distributed in the population; difference scores are normally distributed

- Each participant is exposed to both conditions and tested for each so the structure of the data is dependent samples.

```
In [11]: %matplotlib inline
         import pandas as pd
         import matplotlib.pyplot as plt
         import plotly.plotly as py
         import seaborn as sns
         import scipy.stats as stats
```

```
In [2]: dfStroop = pd.read_csv('stroopdata.csv')
        dfStroop
```

Out[2]:

	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 [3]: dfStroop.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 24 entries, 0 to 23
Data columns (total 2 columns):
Congruent      24 non-null float64
Incongruent    24 non-null float64
dtypes: float64(2)
memory usage: 464.0 bytes
```

(3) Report some descriptive statistics regarding this dataset. Include at least one measure of central tendency and at least one measure of variability. The name of the data file is 'stroop-data.csv'.

```
In [4]: dfStroop.describe()
```

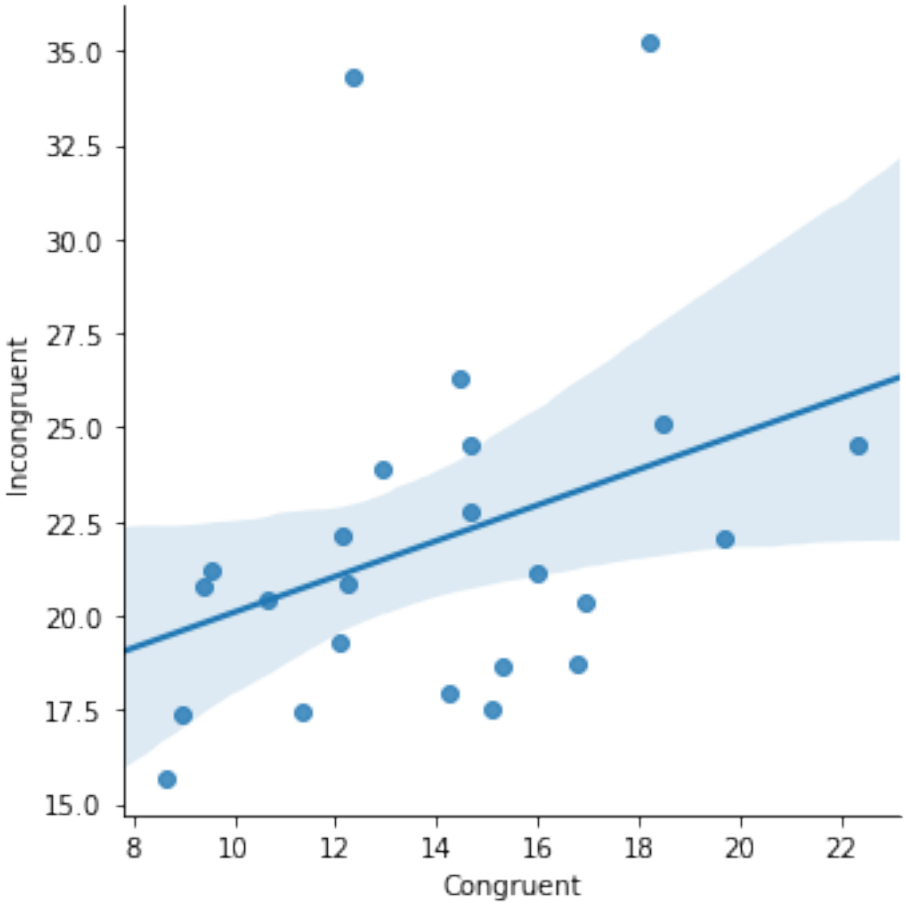
Out[4]:

	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

Congruent Mean = 14.051125 Incongruent Mean = 22.015917 Congruent Standard Deviation = 3.559358 Incongruent Standard Deviation = 4.797057

(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.

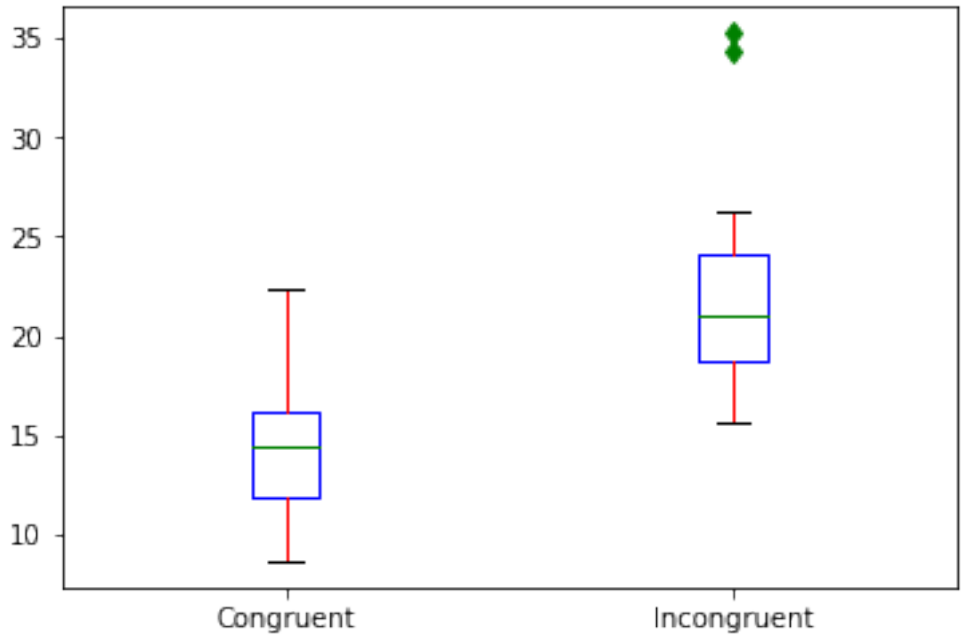
```
In [15]: sns.lmplot(x='Congruent', y='Incongruent', data=dfStroop)
         plt.show()
```



lmplot displays the linear trend between Incongruent and Congruent. The regression line shows the probability will change when multiple readings were taken.

```
In [24]: color = dict(boxes='Blue', whiskers='Red', medians='Green', caps='Black')
         dfStroop.plot.box(color = color, sym = 'gd')
```

```
Out[24]: <matplotlib.axes._subplots.AxesSubplot at 0x7fbddfa95860>
```



Boxplot displays the median of Incongruent is higher than Congruent. It means, participant's take more time to say out loud the color of the ink in which the word is printed.

(5) Now, perform the statistical test and report your results. What is your confidence level or Type I error associated with your test? What is your conclusion regarding the hypotheses you set up? Did the results match up with your expectations? **Hint:** Think about what is being measured on each individual, and what statistic best captures how an individual reacts in each environment.

```
In [29]: # Calculte the mean of each test
         congurent_mean = dfStroop['Congruent'].mean()
         incongurant_mean = dfStroop['Incongruent'].mean()

         #point estimate of i - c -> PE (in seconds)
         point_estimate = congurent_mean - incongurant_mean

         # Calculate Square of Sums of difference of sample means
```

```
ssd = sum(((dfStroop['Congruent']-dfStroop['Incongruent'])-point_estimate)**2)

# Calculate the variance of difference
vd = ssd / (24 -1)

# Calculate Standard Deviation of Differences
sdd = vd ** (1/2)

#  calculate the t-statistic for the difference
tstatistic = point_estimate / ( sdd / ( 24 ** (1/2) ) )

# Calculate the Degrees of Freedom (n -1)
df = 23

# Calculte the chances of seeing a result as extreme
# as the one we observed (known as the p-value)
pvalue = stats.t.cdf(x = tstatistic, df = 23 ) * 2

# Clacute t-critical for alpha level 0.005 (aiming to 99% confidence level)
alpha = 0.005
tcritical = stats.t.ppf(q=alpha, df=23)

print("t-critical values :  tc  =", -tcritical, tcritical)
print("t-Statistic(df) : t(23) =", tstatistic)
print("p-value : p =", pvalue)
```

```
t-critical values :  tc  = 2.80733568377 -2.80733568377
t-Statistic(df) : t(23) = -8.02070694411
p-value : p = 4.10300058571e-08
```

t-Statistic > t-critical Therefore, reject the null hypothesis that there is no statistically significant difference between the two populations.

(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!

People recognise the color first and then started reading the words. The longer word takes more time read and recognise the color compared to the shorter words and recognising the color. Similar task is identifying the color using the Color Blind Tests.

Reference:

1. https://labwrite.ncsu.edu/po/variablespo.htm
2. http://hamelg.blogspot.sg/2015/11/python-for-data-analysis-part-24.html
3. https://github.com/rouseguy/intro2stats
4. http://greenteapress.com/thinkstats/thinkstats.pdf
5. https://www.statisticssolutions.com/manova-analysis-paired-sample-t-test/
6. http://www.allaboutvision.com/eye-exam/color-blind-tests.htm
7. http://www.psychology.emory.edu/clinical/bliwise/Tutorials/TOM/meanstests/assump.htm)