Test a Perceptual Phenomenon

January 28, 2018

0.0.1 Analyzing the Stroop Effect

Perform the analysis in the space below. Remember to follow the instructions and review the project rubric before submitting. Once you've completed the analysis and write up, download this file as a PDF or HTML file and submit in the next section.

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

The independent variable is the test given (congruent or incongruent). The dependent variable is the participant's reaction time.

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

In this task, we are examining a small sample of a population in order to determine whether or not the stroop effect is present. We do this by comparing the time differences of the two tests set forth - the first being the congruent test, and the second being the incongruent test.

Null Hypothesis (H0) The null hypothesis states that there is no difference in the mean (average) time it took to complete both the incongruent (i) and congruent (c) tests and, therefore, that the Stroop effect is not present.

H0: c = i

Alternative Hypothesis (H1) The alternative hypothesis is that there is a statistically significant difference in the response times of the congruent and incongruent tests, thereby proving that the Stroop effect had occurred. The incongruent test should take more time than the congruent test.

H1: c < i

Since we are comparing two sample sets of data, we will use a paired t-Test. A paired t-Test compares the means of two related groups to see if there are statistically significant differences between them.

We have a very small number of entries (only 24 unique tests). Since each entry of the congruent and incongruent times is from the same individual, we use a paired t-test to see if the mean of the difference is 0 and, if it is not, the null hypothesis is refused.

We are assuming that in the population the dependent variable (time of response) is normally distributed

(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 [2]: # Perform the analysis here

        import pandas as pd

        stroop = pd.read_csv('stroopdata.csv')

        print(stroop)

        stroop.describe()
```

```
    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
```

```
Out[2]:        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
```

For the congruent set: The mean is 14.05 and the median is 14.35. The standard deviation is

3.559. For the incongruent set: the mean is 22.02 and the median is 21.02. The standard deviation is 4.797.

In both, the standard deviation is relatively smaller than the mean.

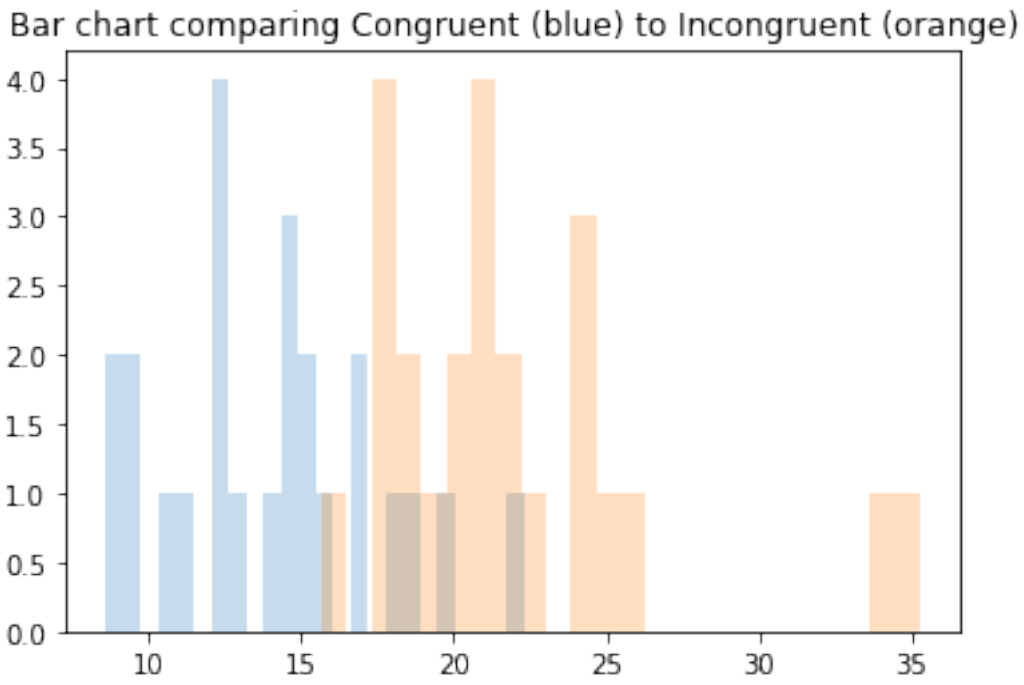
Since the mean and median in both are very close, we know that the distribution will be symmetrical.

Finally, we can see that there is a distinct difference in the timing for each of these datasets- as we initially believed, the Stroop effect could be reasonably occurring as the congruent data set's average is 7 seconds faster than the average of the incongruent data set.

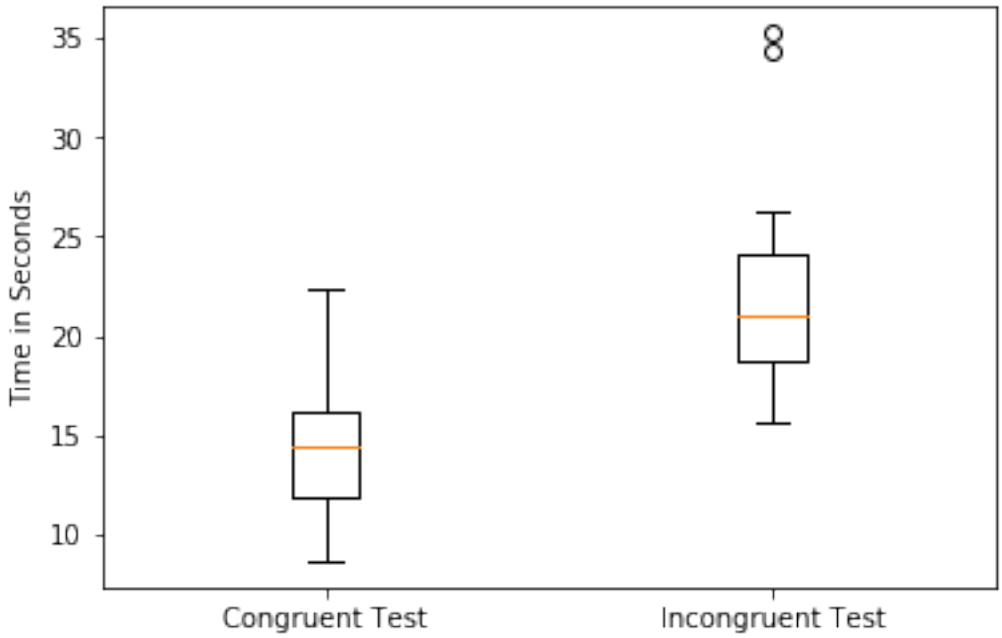
(4) Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

```
In [5]: # Build the visualizations here
        import numpy as np
        import matplotlib.pyplot as plt

        x = stroop['Congruent']
        y = stroop['Incongruent']

        n, bins, patches = plt.hist(x, 24, alpha=0.25)
        n, bins, patches = plt.hist(y, 24, alpha=0.25)
        plt.title('Bar chart comparing Congruent (blue) to Incongruent (orange)')
        plt.show
```

```
Out[5]: <function matplotlib.pyplot.show>
```



```
In [6]: fig, ax = plt.subplots()
        ax.boxplot(stroop.T)

        plt.ylabel('Time in Seconds')
        plt.xticks([1,2], ['Congruent Test', 'Incongruent Test'])
        plt.show()
```



The first thing I noticed is that there's more overlap that I initially expected between the congruent and incongruent sets (between 15-20 seconds in the first bar chart).

For this reason, I created a box plot, to try to see how much overlap there really was- in fact, the box plot shows they don't overlap that much- more than 75% doesnt overlap with other 75%.

(5) Now, perform the statistical test and report the results. What is the 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?

```
In [7]: #check if variance equal or not
        import scipy.stats as stats

        stats.bartlett(x, y)
```

```
Out[7]: BartlettResult(statistic=1.9756393730727815, pvalue=0.15985054445707891)
```

```
In [8]: #same variance
        #p-val is over 0.05
```

```
In [16]: import math
         import numpy as np
```

```
In [17]: diff = x - y

In [32]: #check work / compute without scipy
         #t-stat = (mean(a) - mean(b)) / (standard_deviation(a - b)/square_root(N))

         mean_c, mean_i = pd.DataFrame.mean(stroop)

         std_diff = np.std(diff)

         N = len(stroop)

         paired_t = (mean_c - mean_i) / (std_diff / math.sqrt(N))

         print(paired_t)

-8.19321500097


In [25]: #using SciPy to compute:

         stats.ttest_1samp(diff, 0)

Out[25]: Ttest_1sampResult(statistic=-8.020706944109957, pvalue=4.1030005857111781e-08)

In [28]: #The above results are different, because the SciPy formula uses N-1 instead of just N,

         paired_t_check = (mean_c - mean_i) / (std_diff / math.sqrt(N-1))

         print(paired_t_check)

-8.02070694411
```

In both cases, the p-value is under 0.05, thereby disproving the null hypothesis.

The p-value for this test is very low (-8.1932)

Since the p-value is well below 0.05, our null hypothesis is rejected- the stroop effect is occurring.

6. Optional Question: What is responsible for the effects observed? What is a similar task that would have the same effect?

These effects are caused by the Stroop Effect. It's taking particiapants a longer time to correctly identify the colors in the incongruent test.

A similar task could be trying to identify anything incorrectly labelled- perhaps an apple labeled as 'pear' (though, we'd have to account for other indicators present, as the smell and taste could also affect results).