Stroop Task

January 18, 2019

0.1 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.

0.2 Questions For Investigation

Question 1:

What is our independent variable? What is our dependent variable?

Answer 1:

- Our independent variable will be the congruency of the word (congruent or incongruent).
- The dependent variable will be the time taken to name the ink color.

Question 2:

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

Answer 2: - **Null Hypothesis (H_0)**: Incongruency of word will have no effect or decrease the time taken to name the ink color. - **Alternative Hypothesis (H_1)**: The incongruency of word will increase the time taken to name the ink color.

$$H_0 : \mu_i \leq \mu_c$$

$$H_1 : \mu_i > \mu_c$$

Where, - μ_i = Population mean of time taken to name the ink color for incongruent words - μ_c = Population mean of time taken to name the ink color for congruent words

Statistical Test: *Paired one tail (positive) t-test* because both tests have been performed on the same set of users one after other. This means that both tests are dependent and paired. We will be performing one tail t-test because we are looking to compare means in one direction only. We are using t-test because population parameters are unknown.

Assumptions: - 95% Confidence Interval i.e. $\alpha = 0.05$

```
In [2]: # Use inline plotting
        %matplotlib inline

In [3]: # Import modules
        import matplotlib.pyplot as plt
        import numpy as np
        import pandas as pd

In [4]: # Read dataset
        df = pd.read_csv("Stroop-Dataset.csv")

In [5]: # View the dataset
        df.head(5)
```

Out[5]:

	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

```
In [6]: # Print dataset description
        df.describe()
```

Out[6]:

	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

```
In [7]: # Calculate median of values
        print("Median for congruent: {}".format(df['Congruent'].median()))
        print("Median for incongruent: {}".format(df['Incongruent'].median()))

Median for congruent: 14.3565
Median for incongruent: 21.0175
```

Question 3

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

Answer 3

Central Tendency - **Mean**: Congruent = 14.05, Incongruent = 22.01 - **Median**: Congruent = 14.3565, Incongruent = 21.0175

Variability - **Standard deviation**: Congruent = 3.559, Incongruent = 4.797

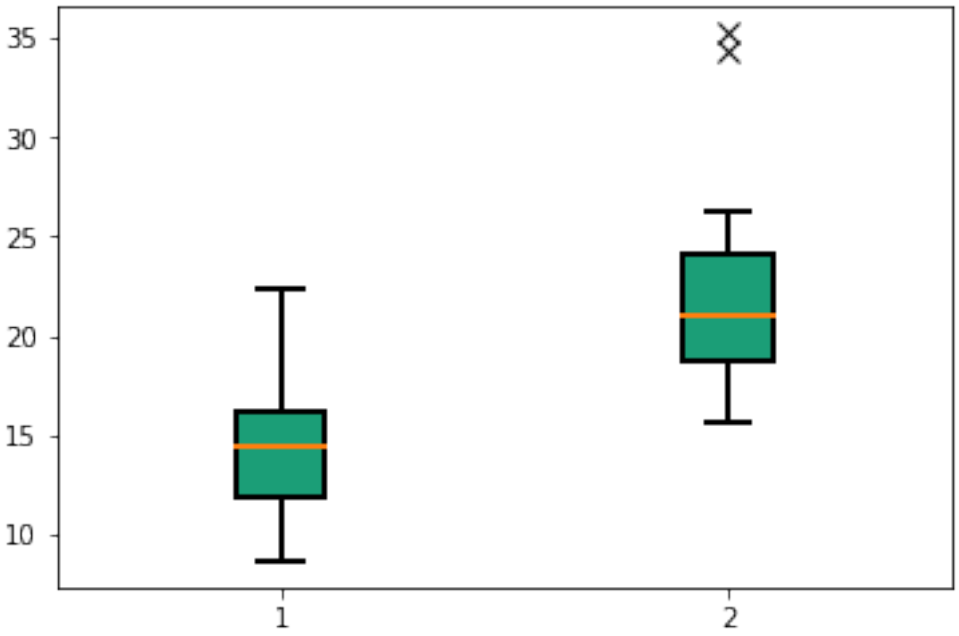
Question 4

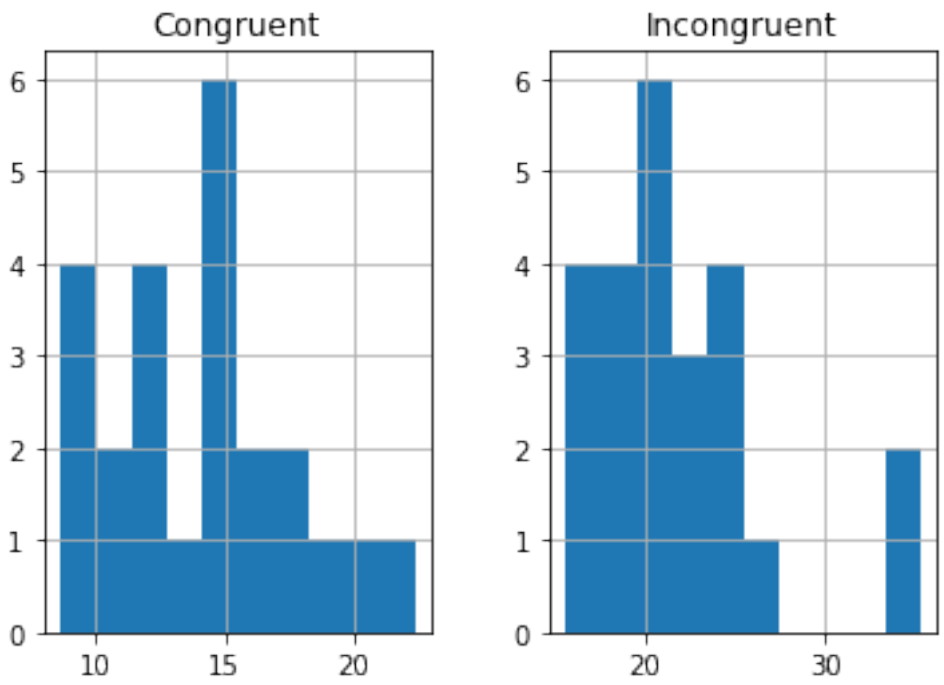
Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

In [26]:
```
dataset = np.genfromtxt('Stroop-Dataset.csv', delimiter=',',dtype=np.float32)
dataset=np.delete(dataset,(0),axis=0)
plot = plt.boxplot(dataset,vert=True,widths = 0.2,patch_artist=True)

plt.setp(plot['boxes'], linewidth=2, facecolor='#1b9e77')
plt.setp(plot['whiskers'], linewidth=2)
plt.setp(plot['caps'], linewidth=2)
plt.setp(plot['fliers'], marker='x', markersize=8)
plt.setp(plot['medians'], linewidth=2)

df.hist()
plt.show()
```





From the **histogram**, it's clear that both distributions are slightly positively skewed. The mean in both cases is also near the peak for each peak. From the **boxplot**, it's clear that the incongruent data has two outliers which can also increase the mean for that dataset.

Question 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?

```
In [28]: df
```

Out[28]:

	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 [29]: df['Difference'] = df['Incongruent'] - df['Congruent']
```

```
In [30]: df
```

```
Out[30]:     Congruent  Incongruent  Difference
0       12.079       19.278       7.199
1       16.791       18.741       1.950
2        9.564       21.214      11.650
3        8.630       15.687       7.057
4       14.669       22.803       8.134
5       12.238       20.878       8.640
6       14.692       24.572       9.880
7        8.987       17.394       8.407
8        9.401       20.762      11.361
9       14.480       26.282      11.802
10      22.328       24.524       2.196
11      15.298       18.644       3.346
12      15.073       17.510       2.437
13      16.929       20.330       3.401
14      18.200       35.255      17.055
15      12.130       22.158      10.028
16      18.495       25.139       6.644
17      10.639       20.429       9.790
18      11.344       17.425       6.081
19      12.369       34.288      21.919
20      12.944       23.894      10.950
21      14.233       17.960       3.727
22      19.710       22.058       2.348
23      16.004       21.157       5.153
```

```
In [31]: mean_difference = df['Difference'].mean()
```

```
In [32]: mean_difference
```

```
Out[32]: 7.964791666666667
```

```
In [36]: standard_deviation = np.std(df['Difference'],ddof=1)
```

```
In [37]: standard_deviation
```

```
Out[37]: 4.864826910359056

In [38]: standard_error = standard_deviation/np.sqrt(len(df['Difference']))

In [39]: standard_error

Out[39]: 0.9930286347783406

In [40]: t_statistic = mean_difference/standard_error

In [41]: t_statistic

Out[41]: 8.020706944109957

In [42]: # t_critical value at degree of freedom (24-1 = 23) = 1.714
```

Results are as follows:

- **Mean difference** = 7.965
- **Standard deviation** = 4.865 (corrected)
- **Standard error** = 0.993
- **t statistic** = 8.021
- **t critical** = 1.714
- **p value** < 0.0001 => **Result is significant** (since the p-value is less than 0.05)

Thus, the null hypothesis is **rejected**.

Question 6

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!

Answer 6

The lower time for congruent words maybe because of the habitual behavior. One part of the brain can recognize the color and the other can recognize the word. When both the results are same, it takes lesser time to give the result as no further correction is required (which is necessary in case of incongruent words).

A similar task can be a task where words are jumbled in such a manner that the first and last letters stay at the same place and users are asked to write them. In most cases, one can recognize the word if it's very familiar to him/her but while typing it, they will tend to write the correct spelling (because of muscle memory) and then fix it to write the given incorrect spelling. This in turn should take more time.