Stroop Effect Analysis

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.

Questions For Investigation

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

Independent Variable: Congruent words and Incongruent words.
Dependent Variable: Time it takes to name the ink colors in equally-sized lists of congruent and incongruent words.

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

Hypotheses for stroop effect:

Null hypotheses: The time it takes to name the incongruent words have no effect or takes lesser time than the time it takes to name the congruent words.

$H_0 = \mu_{incongruent} \leq \mu_{congruent}$

$\mu_{incongruent}$ is population mean of incongruent values and $\mu_{congruent}$ is population mean of congruent values.

Alternative hypotheses: The time it takes to name the incongruent words takes more than the time it takes to name the congruent words.

$H_A = \mu_{incongruent} > \mu_{congruent}$

Dependent t-test for paired samples is used due to two conditions are within subject designs. I have chosen t-test instead of z-test because the sample size is small as well as we do not know population parameters. Based on hypotheses one tailed test in positive direction is performed.

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

Descriptive statistics is computed in python which includes mean, median and standard deviation, IQR.

Code:

```
# import pandas and numpy
import matplotlib.pyplot as plt
import pandas as pd
import numpy as np
import seaborn as sns

sns.set()

#read data from csv
stroopData = pd.read_csv("stroopeffect.csv")
print(stroopData)
```

Output:

```
    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
```

# Descriptive statistics
stroopData.describe()

	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

Mean and median represents the measure of central tendency. Range, standard deviation and IQR represents the measure of variability.

The mean and median for incongruent values is more than the congruent values so we can say that the time taken to name the ink colors of incongruent words is more that the congruent words. The range for incongruent words is 19.568 and for congruent words is 13.698.

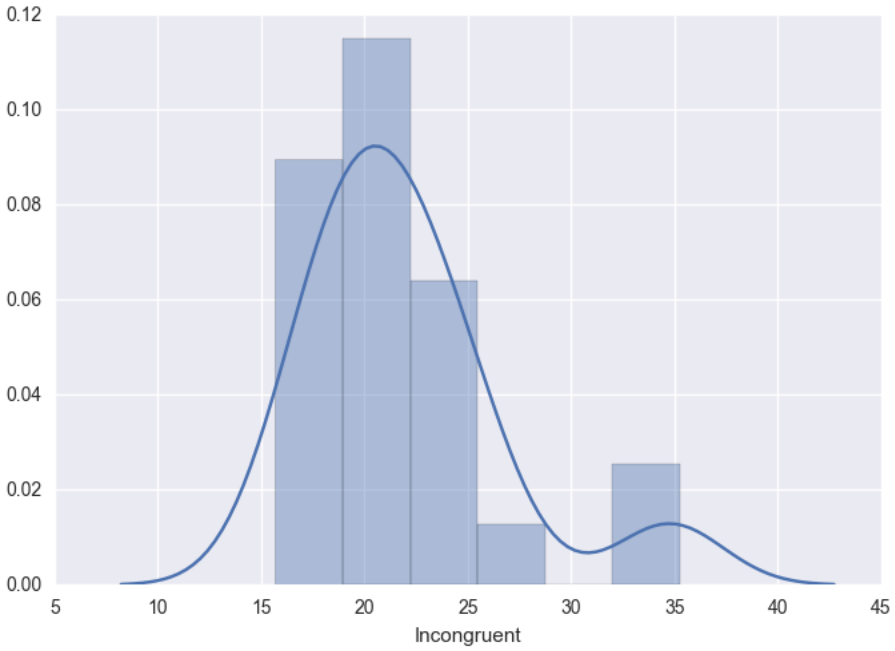
4. Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

Using distplot() we can observe the univariate distribution in the dataset. Boxplot and histogram are as follows:

Code:

```
# Distplot for Incongruent words
sns.distplot(stroopData['Incongruent'])
plt.show()
```

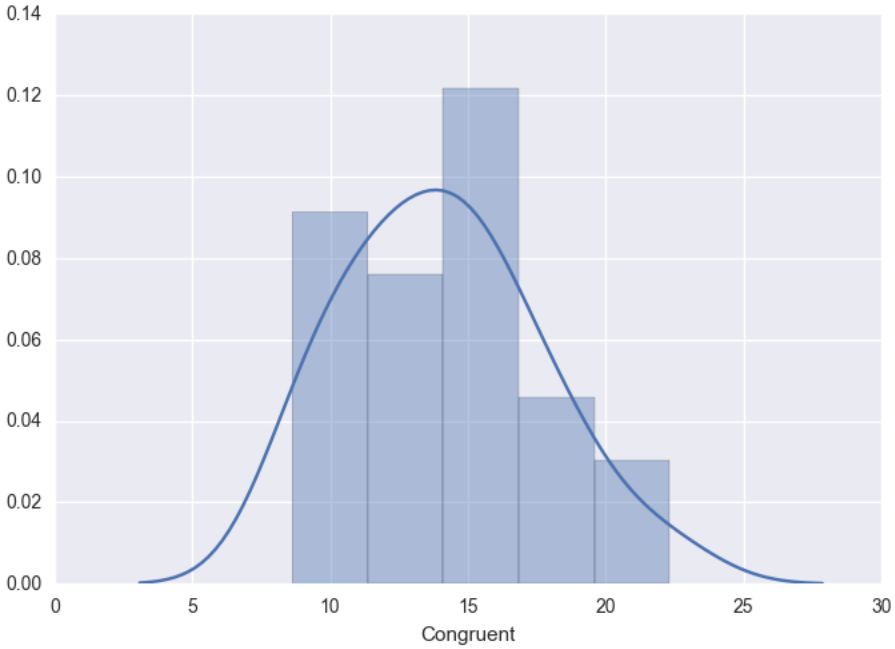
Output:



Code:

```
#Distplot for congruent words
sns.distplot(stroopData['Congruent'])
plt.show()
```

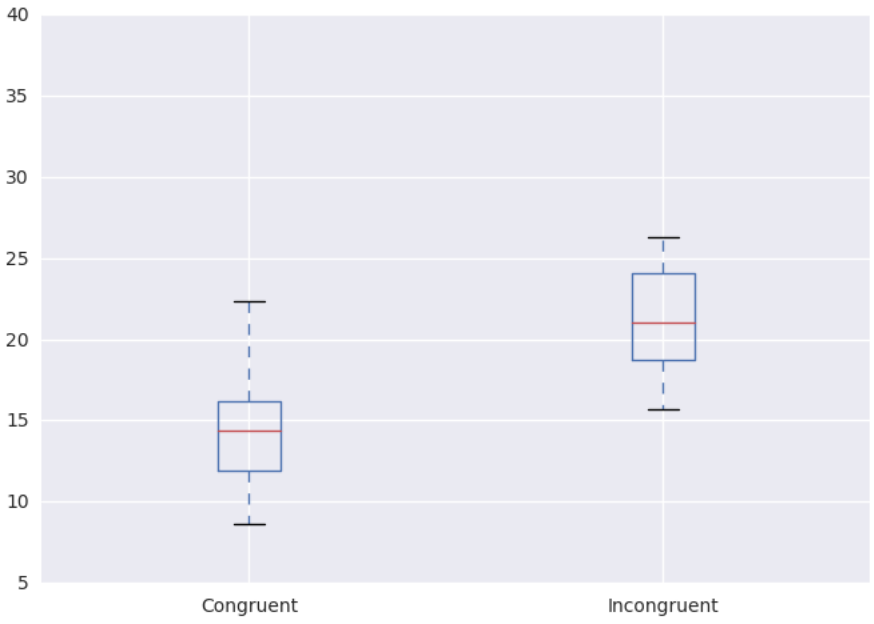
Output:



Code:

```
#Boxplot for both the conditions
df = pd.DataFrame(stroopData, columns=['Congruent', 'Incongruent'])
df.plot.box()
plt.show()
```

Output:



From the above plots, median for incongruent is higher than the congruent values. The distribution for congruent values is normal where as for incongruent the distribution of values are slightly narrow.

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?

Calculating the confidence interval for 95%, one-tailed, df = 23 and $\propto$ = 0.05

Code:

```
#Creating a new column Difference to compute statistics
df['Difference'] = df['Incongruent'] - df['Congruent']
print df
```

Output:

	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

Code:

```
# Calculating mean and standard deviation for Difference Column
```

```
print df['Difference'].mean()
print df['Difference'].std()
```

Output:

```
7.96479166667
4.86482691036
```

Degree of freedom : 23
Standard error : std/sqrt(n) = 4.864/4.899 = 0.993
t-statistic : Difference mean/standard error = 7.965/0.993 = 8.021
$t_{critical}$: 1.714
Margin of error: $t_{critical}$ * standard error = 1.714 * 0.993 = 1.702
Correlation = t_{stat}^2 / t_{stat}^2 + df = 64.336/87.336 = 0.736
p-value: Based on the graphpad calculator,
The result is for t=8.021 DF=23 The two-tailed P value is less than 0.0001
By conventional criteria, this difference is considered to be extremely statistically significant.

We reject the null hypotheses because 8.021 is in the critical region as well as the p-value is less than the $\propto$ level and is statistically different.

Based on the experiment task we reject the null hypotheses and accept the alternative hypotheses that is we take more time to name the incongruent words than the congruent words. The results matched up with my expectations.

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!

Initially as we start reading we learn the meaning of the words and it becomes a practice. Due to this practice we feel confused to read the congruent words so it takes more time to process them in our brain. I think the similar task that would result in a similar effect is to color only first and last letter of each word.

References:

https://en.wikipedia.org/wiki/Stroop_effect
https://researchbasics.education.uconn.edu/confidence-intervals-and-levels/
https://seaborn.pydata.org/tutorial/distributions.html#distribution-tutorial

https://d2l.deakin.edu.au/d2l/eP/presentations/presentation_preview_popup.d2l?presId=67655