Test a Perceptual Phenomenon

April 20, 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, upload that PDF/HTML into the workspace here (click on the orange Jupyter icon in the upper left then Upload), then use the Submit Project button at the bottom of this page. This will create a zip file containing both this .ipynb doc and the PDF/HTML doc that will be submitted for your project.

(1) What is the independent variable? What is the dependent variable? The independent variable is the word that we manipulate in this task to check if it has a congruent or incongruent condition. The dependent variable is time it takes to recognize the ink colors of the mismatch word.

(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. Hypotheses:

H_0: $\mu_C = \mu_I$

H_a: $\mu_C \neq \mu_I$

Where:

-H_0 represents the null hypothesis

-H_a represents the alternative hypotheses respectively

-μ_C represents the population average reading time for congruently colored words

-μ_I represents the population average reading time for incongruently colored words

In plain english, the null hypothesis claims that the average printed-color identification time for a list of congruently colored words will be statistically identical to the printed-color identification time of a like-sized list of incongruently colored words over the population. This hypothesis is framed such that if it is true, the independent variable (cogruency) has no significant effect on the dependent variable (color identification time). That is the effect that I will quantify and statistically (in)validate.

Test: In order to infer the population parameters and accept/reject the null hypothesis from the samples provided, I will perform the the paired t-test with significence $\alpha = 0.05$ where α is the significance value. The test will definitively indicate with a single metric whether or not there is enough statistical evidence in the sample data to accept/reject the null hypothesis.

The t-test is chosen because here, we are comparing two different sample means ($\bar{x}$) in order to infer population means (μ). Specifically, the t-test is the right test in this case (as opposed to, say a z-test) because:

-The population parameters here are unknown

-The sample size is < 30

-I have made no assumptions about population normality

This test is a paired t-test because the same subject is being tested under two separate conditions. I am choosing a 2-tailed test here because, though (or because) I have an intuition as to how congruency will affect the outcome, I would like the test to be performed in an unbiased manner where I am not testing against an expected outcome at all. I am ready to be surprised.

(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 'stroopdata.csv'.

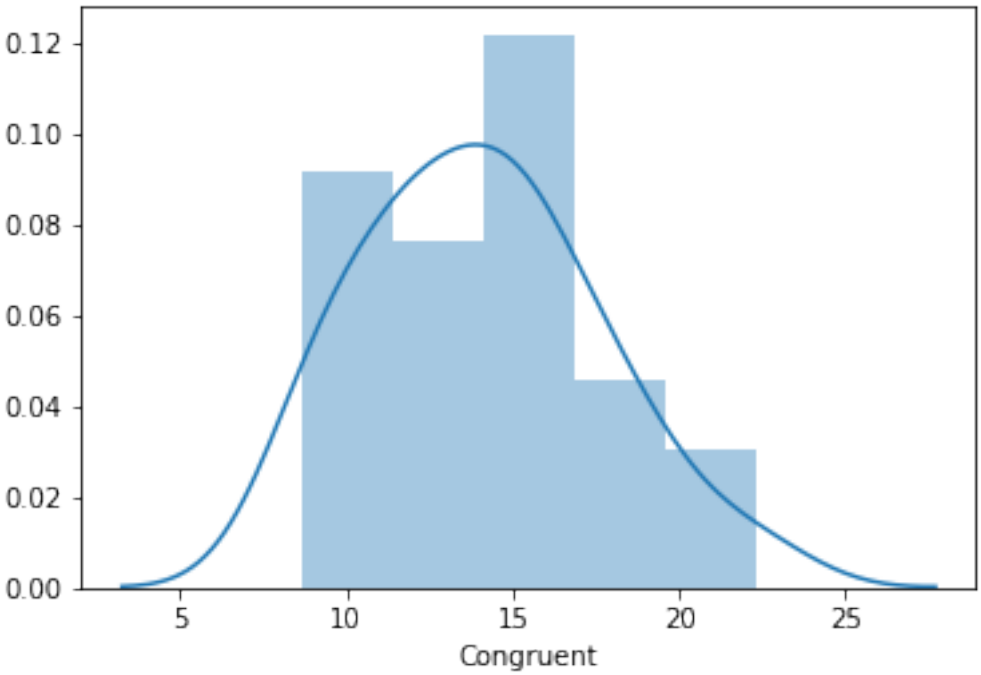
```
In [5]: import pandas as pd

In [7]: df = pd.read_csv('stroopdata.csv')

In [8]: print(df)
```

```
    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 [9]: congruent = df['Congruent']
        incongruent = df['Incongruent']
        congruent.median(), incongruent.median()

Out[9]: (14.3565, 21.0175)
```

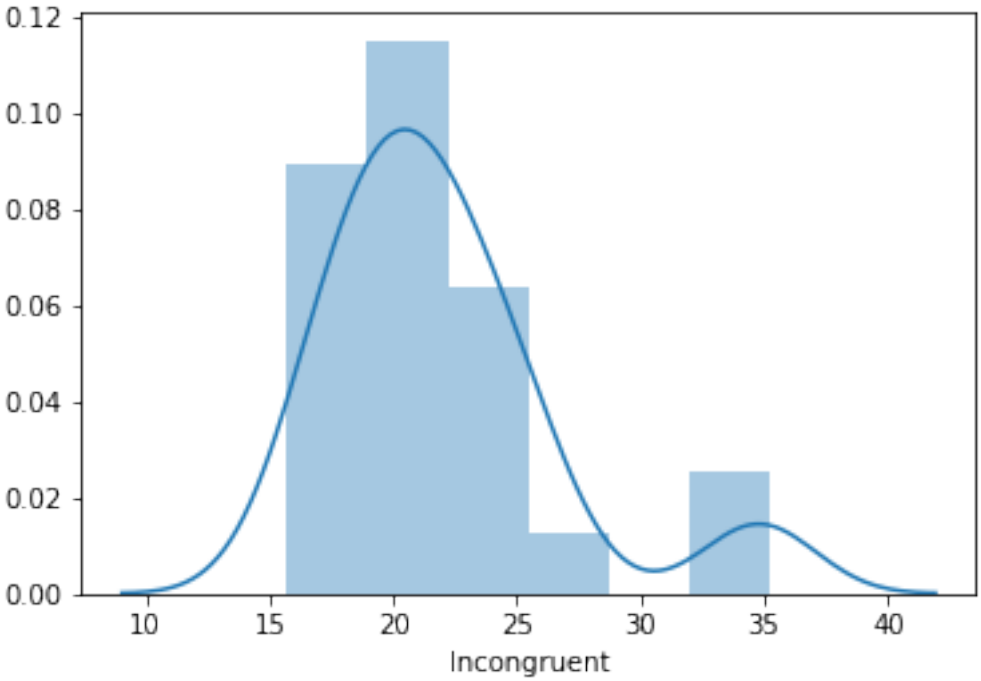
(4) Provide one or two visualizations that show the distribution of the sample data. Write one or two sentences noting what you observe about the plot or plots.

```
In [39]: %matplotlib inline
         import seaborn as sns

In [40]: sns.distplot(df['Congruent'])

Out[40]: <matplotlib.axes._subplots.AxesSubplot at 0x7fb8c6984898>
```



The data seems to be normally distributed.

```
In [41]: sns.distplot(df['Incongruent'])

Out[41]: <matplotlib.axes._subplots.AxesSubplot at 0x7fb8c6984518>
```



The only unexpected scenario is that the upper end of this distribution is skewed right, but every thing else is normally what we guessed.

(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 [28]: import math
         from scipy.stats import t

In [18]: # Both of our samples are of same size
         print(df['Congruent'].size)
         print(df['Incongruent'].size)
```

```
24
24
```

```
In [29]: # Critical value
         t.ppf(.95, 23)
```

```
Out[29]: 1.7138715277470473
```

Our point estimate for the difference of the means is: 22.02 - 14.05 = 7.97

```
In [22]: # Our standard deviation of the differences of the means is
         df['Difference'] = df['Congruent']-df['Incongruent']
         df['Difference'].std(axis=0)

Out[22]: 4.8648269103590556

In [26]: # Thus our t-static will be
         7.97/(4.8648 / math.sqrt(24))

Out[26]: 8.025996238275749
```

Because our t-statistic (8.02) is greater than our critical value (1.7139), we reject the null hypothesis.This means that it does take much less time to do the congruent task than it does to do the incongruent task. This matches up with what we expected.

(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! In my opinion it's a subconscious or habitual behaviour where commonly used words are glanced over and easily recognized in our 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.

Resources http://www.statstutor.ac.uk/resources/uploaded/paired-t-test.pdf https://github.com/dpipkin/udacity-stroop http://www.statisticshowto.com/probability-and-statistics/hypothesis-testing/t-score-vs-z-score/