Comparison of means t test in Python

Overview

This procedure will give instructions on how to make a python program that performs two-tailed t tests comparing the means (averages) of two groups when population standard deviations are unknown. The comparison of means t test determines if two groups are significantly different from each other or not. Examples of its use are comparing test grades between two sections of a class, or heights between men and women.

This process is done by calculating a test statistic and comparing it to a critical value given by the t distribution table which is provided below. The formula for the test statistic is:

Formula: $$t = \frac{\bar{x}_1 - \bar{x}_2 - \Delta}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

(Source: https://www.cliffsnotes.com/study-guides/statistics/univariate-inferential-tests/two-sample-t-test-for-comparing-two-means)

The numerator is the mean of the first group minus the mean of the second group, minus 0. The denominator is the standard error, which is the square root of the variance of the first group divided by the sample size of the first group, plus the variance of the second group divided by the sample size of the second group.

If the test statistic is greater than the critical value, the two groups are significantly different. If the test statistic is less than or equal to the critical value, the two groups similar enough to be considered the same.

Procedure

1. Create a new file called 'meanstest.py'

2. Install the statistics and math modules. They will make some calculations easier.

```
import statistics
import math
```

3. Collect the values for the data in each group from the user and make each value its own item in the list. In this example the groups are called group x and group y. Note: they must be integers for this program to work.

```
x_values = input("Enter the integer values for the x group: ")
x_values = x_values.split()
```

```
y_values = input("Enter the integer values for the y group: ")
y_values = y_values.split()
```

4. The lists contain the values for groups x and y as strings, but we need to convert them to integers to perform calculations. It helps to do this in its own function.

```
i = 0
for item in x_values:
x_values[i] = int(x_values[i])
   i += 1
```

Then do the same for group y.

5. Use a loop to find the means of groups x and y.

```
x_values_sum = 0
for item in x_values_int:
   x_values_sum += item

x_values_mean = x_values_sum / len(x_values_int)
```

Do the same for group y.

6. Find the difference of the two means and use the abs() function take the absolute value of it. This value will be the numerator in your test statistic.

```
means_diff = x_mean - y_mean
means_diff = abs(means_diff)
```

7. Calculate the degrees of freedom. For this specific test, the degrees of freedom are the sample size of the smaller group, minus 1.

```
if len(x_values_int) < len(y_values_int):
      df = len(x_values_int) - 1
   elif len(x_values_int) > len(y_values_int):
      df = len(y_values_int) - 1
   elif len(x_values_int) == len(y_values_int):
      df = len(x_values_int) – 1
```

Be sure to print the degrees of freedom. You will need to know the value later on.

8. Find the variance of both groups using the statistics module.

```
x_var = statistics.variance(x_values_int)
y_var = statistics.variance(y_values_int)
```

9. Calculate the sample size for both groups, the standard error and test statistic. Use the math module to easily take the square root for the standard error.

```
n_x = len(x_values_int)
n_y = len(y_values_int)

se = math.sqrt((x_var/n_x)+(y_var/n_y))

test_statistic = means_diff / se
```

Print the test statistic.

10. Next, the program will ask the user to enter the critical value. To find the critical value, you need the t distribution table, degrees of freedom, and significance level. Most t tests use a 5% significance level.

Example: If the degrees of freedom are 10 and the significance level is 5%, the critical value is 2.228

```
critical_value = float(input('Enter the critical value from the t table, using degrees of freedom and significance level (usually 0.05): '))
```

Degrees of freedom	Significance level					
	20% (0.20)	10% (0.10)	5% (0.05)	2% (0.02)	1% (0.01)	0.1% (0.001)
1	3.078	6.314	12.706	31.821	63.657	636.619
2	1.886	2.920	4.303	6.965	9.925	31.598
3	1.638	2.353	3.182	4.541	5.841	12.941
4	1.533	2.132	2.776	3.747	4.604	8.610
5	1.476	2.015	2.571	3.365	4.032	6.859
6	1.440	1.943	2.447	3.143	3.707	5.959
7	1.415	1.895	2.365	2.998	3.499	5.405
8	1.397	1.860	2.306	2.896	3.355	5.041
9	1.383	1.833	2.262	2.821	3.250	4.781
10	1.372	1.812	2.228	2.764	3.169	4.587
11	1.363	1.796	2.201	2.718	3.106	4.437
12	1.356	1.782	2.179	2.681	3.055	4.318
13	1.350	1.771	2.160	2.650	3.012	4.221
14	1.345	1.761	2.145	2.624	2.977	4.140
15	1.341	1.753	2.131	2.602	2.947	4.073
16	1.337	1.746	2.120	2.583	2.921	4.015
17	1.333	1.740	2.110	2.567	2.898	3.965
18	1.330	1.734	2.101	2.552	2.878	3.922
19	1.328	1.729	2.093	2.539	2.861	3.883
20	1.325	1.725	2.086	2.528	2.845	3.850
21	1.323	1.721	2.080	2.518	2.831	3.819
22	1.321	1.717	2.074	2.508	2.819	3.792
23	1.319	1.714	2.069	2.500	2.807	3.767
24	1.318	1.711	2.064	2.492	2.797	3.745
25	1.316	1.708	2.060	2.485	2.787	3.725
26	1.315	1.706	2.056	2.479	2.779	3.707
27	1.314	1.703	2.052	2.473	2.771	3.690
28	1.313	1.701	2.048	2.467	2.763	3.674
29	1.311	1.699	2.043	2.462	2.756	3.659
30	1.310	1.697	2.042	2.457	2.750	3.646
40	1.303	1.684	2.021	2.423	2.704	3.551
60	1.296	1.671	2.000	2.390	2.660	3.460
120	1.289	1.658	1.980	2.158	2.617	3.373
∞	1.282	1.645	1.960	2.326	2.576	3.291

(Source: https://www.biologyforlife.com/t-test.html)

11. If the test statistic is greater than the critical value, the two groups are significantly different. If the test statistic is less than or equal to the test statistic, the two groups are considered the same. Use an if-else statement to print the results.

```
if critical_value < test_statistic:
   print('Reject the null hypothesis. There is evidence of a difference between the two means.')
else:
   print('Fail to reject the null hypothesis. The means are the same.')
```

12. The program can be adjusted to be able to read in text files with data in them.

Refefences

Statistics. (n.d.). Retrieved April 23, 2020, from https://www.cliffsnotes.com/study-guides/statistics/univariate-inferential-tests/two-sample-t-test-for-comparing-two-means

Statistics – Mathematical statistics functions. (n.d.). Retrieved April 22, 2020, from https://docs.python.org/3/library/statistics.html

T-test. (n.d.). Retrieved April 24, 2020, from https://www.biologyforlife.com/t-test.html