
بسم الله الرحمن الرحيم
In the name of ALLAH
the most Beneficent and the most merciful

‘t’ Test

BY

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‘t’ Test

- The two tests described above are applicable only to large samples. WS Gossett observed that the normal distribution gives biased results in case of small samples. He demonstrated that the ratio of the observed difference between ‘two values to the SE of difference follows a distribution called ‘t’ distribution and such a ratio is denoted as ‘t’.

‘t’ Test

- The ‘t’ test is an accurate method to test the significance of difference between two means or proportions in small samples. The table giving the probability of observing a higher ‘t’ value by chance with particular degrees of freedom, is known as ‘t’ table.

‘t’ Test

- The ‘t’ value is read from the table against the known degrees of freedom (df). The tabulated ‘t’ value at the chosen level of significance is to be compared with the ‘t’ value calculated as follows:

‘t’ Test

- For unpaired sample

$$t = \frac{\bar{X}_1 - \bar{x}_2}{\text{SE of difference between means}}$$

‘t’ Test

- For paired samples

$$t = \frac{\bar{d}}{\text{SE of } d}$$

- Where d = difference in the two values for each pair (total number of pairs being n).
- $\bar{d}$ = mean of the n values for d.
- It may be remembered here that SE of d = $\frac{\text{SD of } d}{\sqrt{n}}$

‘t’ Test

- In paired series, the two sets of observations are made on the same individuals and the difference is compared before and after exposure to some factor such as a drug.
- In unpaired series, the observations are made on two different groups of individuals and the difference between the two groups is compared.

‘t’ Test

- In case of unpaired series, degrees of freedom $df = n_1 + n_2 - 2$
- while in paired series, $df = n - 1$.
- If the estimated or calculated ‘t’ value is higher than the tabulated ‘t’ value, the difference is statistically significant; if it is less, the difference is insignificant.

Finding the Critical Value of t

- A probability table is used
- First determine degrees of freedom
- Decide the level of significance

Sampling Distribution for *t* test

Sampling distribution for *t* test				
Degrees of freedom	Probability (Level of significance)			
	0.1	0.05	0.01	0.001
1	6.314	12.706	63.657	636.619
2	2.920	4.303	9.925	31.598
3	2.353	3.182	5.841	12.924
4	2.132	2.776	4.604	8.610
5	2.015	2.571	4.032	6.864

Critical Value t (cont.)

- Example: degrees of freedom= 4

  α= .05

Sampling Distribution for *t* test

Sampling distribution for *t* test				
Degrees of freedom	Probability (Level of significance)			
	0.1	0.05	0.01	0.001
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3	2.353		5.841	12.924
5	2.015		4.032	6.864

- The critical value of t= 2.776

Critical Value t (cont.)

- If the calculated value of *t* is less than the critical value of *t* obtained from the table, the null hypothesis is not rejected.
- If the calculated value of *t* is greater than the critical value of *t* from the table, the null hypothesis is rejected.

Filling out Summary Table

- The following information is needed in a summary table

Descriptive statistics		
Mean Variance Standard deviation 1SD (68% Band) 2 SD (95% Band) 3 SD (99% Band) Number		
Results of *t* test		

Summary Table (cont.)

- Example: Data obtained from a experiment comparing the number of un-popped seeds in popcorn brand A and popcorn brand B.

A	B
26	32
22	35
30	20
34	33

Is the difference significant?

- Determine mean, variance and standard deviation of samples.

$$\text{Mean } \bar{x}_A = \frac{\Sigma x}{n} = \frac{26+22+30+34}{4} = 23$$

$$\text{Mean } \bar{x}_B = \frac{\Sigma x}{n} = \frac{32+35+20+33}{4} = 30$$

variance

$$\delta^2 = \frac{\Sigma (\bar{x} - x)^2}{n-1}$$

$$\text{Popcorn A} = \frac{(26-23)^2 + (22-23)^2 + (30-23)^2 + (34-23)^2}{3}$$

$$= \frac{9 + 1 + 49 + 121}{3} = \mathbf{60}$$

$$\text{Popcorn B} = \frac{(30-30)^2 + (35-30)^2 + (20-30)^2 + (33-30)^2}{3}$$

$$= \frac{0 + 25 + 100 + 9}{3} = \mathbf{44.67}$$

Standard deviation: $\delta = \sqrt{\delta^2}$

popcorn A

$$\sqrt{60} = 7.75$$

Popcorn B

$$\sqrt{44.67} = 6.68$$

Finding Calculated *t*

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{\delta^2{}_1 + \delta^2{}_2}{n}}}$$

$$t = \frac{23 - 30}{\sqrt{\frac{60 + 44.67}{4}}}$$

$$= \frac{7}{\sqrt{26.17}}$$

$$= \frac{7}{5.12} = \mathbf{1.38}$$

Determine critical value of t

- Select level of significance α=.01

- Determine degrees of freedom

  degrees of freedom of A= 3

  degrees of freedom of B= 3

  total degrees of freedom = 6

- Critical value of t = 3.707

Calculated value of t =1.38 is less than critical value of t from the table, 3.707.

The null hypothesis is not rejected.

Filling the Summary Table

Descriptive statistics	A	B
Mean		
Variance		
Standard deviation		
1SD (68% Band)		
2 SD (95% Band)		
3 SD (99% Band)		
Number		
Results of *t* test		


Thank You