Real Statistics Using Excel
Everything you need to do real
statistical analysis using Excel

Two Sample t Test: equal variances

We now consider an experimental design where we want to determine whether there is a difference between two groups within the population. For example, let's suppose we want to test whether there is any difference between the effectiveness of a new drug for treating cancer. One approach is to create a random sample of 40 people, half of whom take the drug and half take a placebo. For this approach to give valid results it is important that people be assigned to each group at random. Such samples are independent.

When the population variances are known, hypothesis testing can be done using a normal distribution, as described in Comparing Two Means when Variances are Known. But population variances are not usually known. The approach we use instead is to pool sample variances and use the t distribution.

We consider three cases where the t distribution is used:

- Equal variances
- Unequal variances
- Paired samples

We deal with the first of these cases in this section.

Theorem 1: Let $\bar{x}$ and $\bar{y}$ be the sample means of two sets of data of size n_x and n_y respectively. If x and y are normal, or n_x and n_y are sufficiently large for the Central Limit Theorem to hold, and x and y have the same variance, then the random variable

$$t = \frac{(\bar{x} - \bar{y}) - (\mu_x - \mu_y)}{s \sqrt{\frac{1}{n_x} + \frac{1}{n_y}}}$$

has distribution $T(n_x + n_y - 2)$ where

$$s^2 = \frac{(n_x - 1)s_x^2 + (n_y - 1)s_y^2}{(n_x - 1) + (n_y - 1)}$$

Observation: s, as defined above, can be viewed as a way to pool s_x and s_y, and so s^2 is referred to as the **pooled variance**. Also note that the degrees of freedom of t is the value of the denominator of s^2 in the formula given in Theorem 1.

Click here for a proof of Theorem 1.

Real Statistics Excel Functions: The following functions are provided in the Real Statistics Resource Pack.

VAR_POOLED(R1, R2) = pooled variance of the samples defined by ranges R1 and R2, i.e. s^2 of Theorem 1

STDEV_POOLED(R1, R2) = pooled standard deviation of the samples defined by ranges R1 and R2, i.e. s of Theorem 1

STDERR_POOLED(R1, R2, b) = pooled standard error of the samples defined by ranges R1 and R2. This is

equal to the denominator of t in Theorem 1 if b = TRUE (default) and equal to the denominator of t in Theorem 1 of [Two Sample t Test with Unequal Variances](#) if b = FALSE. When the sample sizes are equal, b = TRUE or b = FALSE yields the same result.

Observation: Each of these functions ignores all empty and non-numeric cells.

Example 1: A marketing research firm tests the effectiveness of a new flavoring for a leading beverage using a sample of 20 people, half of whom taste the beverage with the old flavoring and the other half who taste the beverage with the new favoring. The people in the study are then given a questionnaire which evaluates how enjoyable the beverage was. The scores are as in Figure 1. Determine whether there is a significant difference between the perception of the two flavorings.
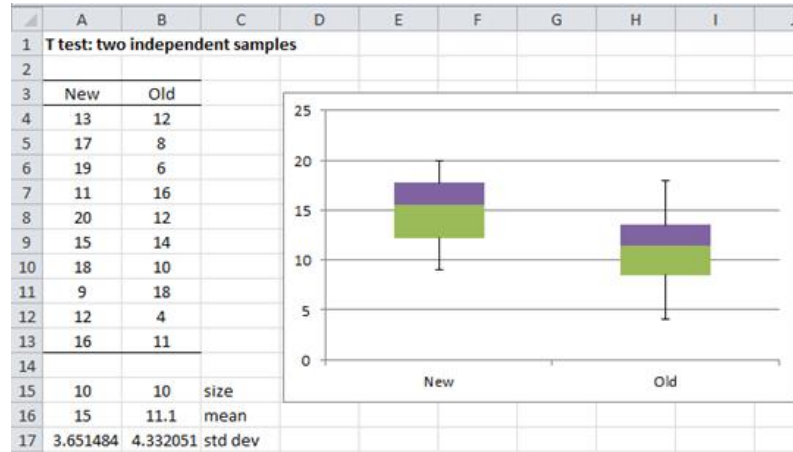

Figure 1 – Data and box plot for Example 1

As we can see from the box plot in Figure 1 the data in each sample is reasonably symmetric and so we use the t test with the following null hypothesis:

H_0: $\mu_1 - \mu_2 = 0$; i.e. there is no difference between the two flavorings

Since the sample variances are similar we decide that the population variances are also likely to be similar and so apply Theorem 1.

$$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 - 1) + (n_2 - 1)} = \frac{(10 - 1)13.33 + (10 - 1)18.77}{(10 - 1) + (10 - 1)} = 16.05$$

And so $s = \sqrt{16.05} = 4.01$. Now,

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - (\mu_1 - \mu_2)}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} = \frac{(15 - 11.1) - 0}{4.01\sqrt{\frac{1}{10} + \frac{1}{10}}} = \frac{3.9}{1.79} = 2.18$$

$$df = n_1 + n_2 - 2 = 10 = 10 - 2 = 18$$

Since p-value = TDIST(t, df) = TDIST(2.18, 18) = .043 < .05 = α, we reject the null hypothesis, concluding that there is a significant difference between the two flavorings. In fact, the new flavoring is significantly more enjoyable.

The same result can be obtained by use of Excel's **Two-Sample Assuming Equal Variances** data analysis tool, the results of which are as follows.

t-Test: Two-Sample Assuming Equal Variances

	New	Old
Mean	15	11.1
Variance	13.33333	18.76667
Observations	10	10
Pooled Variance	16.05	
Hypothesized Mean Difference	0	
df	18	
t Stat	2.176768	
P(T<=t) one-tail	0.021526	
t Critical one-tail	1.734064	
P(T<=t) two-tail	0.043053	
t Critical two-tail	2.100922	

Figure 2 – Output from Excel's data analysis tool

Observation: The Real Statistics Resource Pack also provides a data analysis tool which supports the two independent sample t test, but provides additional information not found in the standard Excel data analysis tool. Example 3 in [Two Sample t Test: Unequal Variances](#) gives an example of how to use this data analysis tool.

Example 2: To investigate the effect of a new hay fever drug on driving skills, a researcher studies 24 individuals with hay fever: 12 who have been taking the drug and 12 who have not. All participants then entered a simulator and were given a driving test which assigned a score to each driver as summarized in Figure 3.
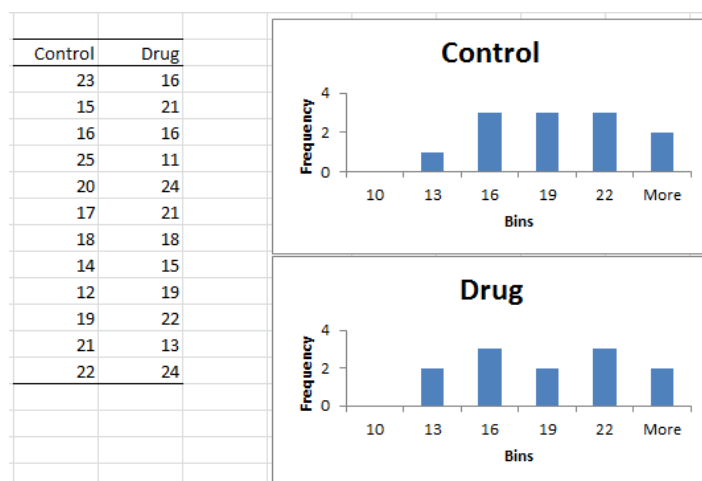

Figure 3 – Sample data and histograms for Example 2

As in the previous example, we plan to use the t-test, but with a sample this small we first need to check to see that the data is normally distributed (or at least symmetric). This can be seen from the histograms. Also the variances are relatively similar (15.18 and 17.88) and so we can again use the t-Test: Two-Sample Assuming Equal Variances data analysis tool to test the following null hypothesis:

H_0: $\mu_{control} = \mu_{drug}$

t-Test: Two-Sample Assuming Equal Variances

	Control	Drug
Mean	18.5	18.333333
Variance	15.18182	17.878788
Observations	12	12
Pooled Variance	16.5303	
Hypothesized Mean Difference	0	
df	22	
t Stat	0.100412	
P(T<=t) one-tail	0.460463	
t Critical one-tail	1.717144	
P(T<=t) two-tail	0.920927	
t Critical two-tail	2.073873	

Figure 4 – Two sample data analysis results

Since t_{obs} = .10 < 2.07 = t_{crit} (or p-value = .921 > .05 = α) we retain the null hypothesis; i.e. we are 95% confident that any difference between the two groups is due to chance.

Observation: The t-test is quite robust even when the underlying distributions are not normal provided the sample size is sufficiently large (usually over 25 or 30). The t-test can be valid even with smaller sample sizes, provided the samples have similar shape and are not too skewed.

Effect size

The Cohen effect size *d* can be calculated as in [One Sample t Test](#), namely:

$$d = \frac{|\mu_1 - \mu_2|}{\sigma}$$

This is approximated by

$$d = \frac{|\bar{x}_1 - \bar{x}_2|}{s_{pooled}}$$

Example 3: Find the effect size for study in Example 2.

$$d = \frac{|\bar{x}_1 - \bar{x}_2|}{s_{pooled}} = \frac{|18.5 - 18.33|}{\sqrt{16.53}} = 0.041$$

This means that the control group has a driving score 4.1% of a standard deviation more than the group that is taking the hay fever medication.

87 Responses to *Two Sample t Test: equal variances*

Vie *says:*
March 2, 2016 at 1:35 pm

I just wanna know if the formula for t-test foe mean is same as the formula for t-test for correlation coefficient? thanks

Reply

> **Charles** *says:*
> March 2, 2016 at 3:57 pm
>
> Vie,
> They are not the same formula, but it turns out that there is a relationship between the two. See the following webpages for details:
> Correlation in Relationship to t-test
> T test for correlation
> Charles
>
> Reply

roniel *says:*
February 26, 2016 at 10:56 am

Hi Charles,

I want to ask which appropriate test will be used in this situation, I want to study the difference of the competency of criminology students in developing latent fingerprint using fingerprint powder and cyanoacrylate with the same respondents.

I only selected 35 students,they used both powder and cyanoacrylate. Each of them has 8 different items to test their competency. I have already computed the mean of every items. Can you help me? I think paired t-test will be used because of the same tespondents.,or t test equal variance?

Reply

Charles *says:*
February 26, 2016 at 3:24 pm

Since the same students are using each approach you need to use the paired t-test (provided the assumptions for the test are met).
Charles

Reply

Aderemi muhydeen *says:*
February 21, 2016 at 7:16 pm

Pls if a question is saying dat we av mean A as 700 and mean B as 695,, sample size A is 10 while sample size B is 15 … ..… . Sample variance A 40 and sample variance B is 40 as well. Which test statistics is applicable to solve dis question . is it t test or z test.. .. … . pls reply or yu can drop in my mail

Reply

Charles *says:*
February 22, 2016 at 12:33 am

Aderemi,
If your objective is to determine whether there is a significant difference between the population means for A and B, then you should use the t test (assuming the assumptions for the test are met). The results from the z test will generally be similar, but the t test is preferred.
Charles

Reply

Wendy Foo *says:*
February 5, 2016 at 1:24 pm

Hi, I have a research on variation of CT number for one sample at 60 kVp and 120 kVp. Each kVp has 10 values. Which type of t-test should I perform? If I want to conduct my research for more kVp, can I still analyse the data using t-test? My last question, if 60 kVp data is normally distributed but 120 kVp data is not normally distributed which test should I proceed?

Many thanks in advance.

Reply

Charles *says:*
February 6, 2016 at 12:20 am

Wendy,
I don't know what a CT number is, but in general if you are trying to compare two samples, you can use the t test. If you have more than two samples, you can use ANOVA.
If one of the samples is not normal, then you can still use these tests provided the data is not too far from normal, in fact the tests should work pretty well if the data is reasonably symmetric.
Charles

Reply

Wendy Foo *says:*
February 15, 2016 at 4:55 pm

The research is performed on the same sample with different kVp, I want to compare the result of two different kVp, does it mean I need to use Two Paired Samples?

Reply

Charles *says:*
February 25, 2016 at 12:13 pm

Wendy,
If you have a sample of n subjects and you measure two different kVp values for each subject in the sample, then you don't have two independent samples (since the two values are derived from the same subject). In this case you need to use a paired sample test (e.g. the paired t test) and not the two independent sample t test.
Charles

Reply

Dan *says:*
January 20, 2016 at 6:03 pm

Hi, I'm in need of some help.

I'm looking to test the difference between two datasets for solar panels. One of the datasets is the recorded output in kWh and the other is the modelled output I've calculated (in kWh). The datasets are 12 numbers, one for each monthly output. My issue is that the month of the year has a large effect on the output, so is it ok to do a T-Test? Or will I get results that aren't related to one another but more the effect of the month of the year, as they correlate in its effect. I'd also like to know which T-Test I'd need to choose for this. Any help would be great thanks.
Dan

Reply

Charles *says:*
January 22, 2016 at 5:01 pm

Dan,

Since you have time-series data, you need to account for potential autocorrelation and seasonality. A t test assumes that each sample is random, which won't be the case when there is autocorrelation. Instead you may need to use other techniques. I am in the process of showing how to perform such analyses and hope to have this ready in a few weeks.

You could test for autocorrelation. If there isn't a significant level of autocorrelation, you could use the standard t test. One such test for autocorrelation (restricted to first-order autocorrelation) is described on the webpage Durbin-Watson Test

The following is a paper which shows how to modify a t test when there is autocorrelation. I have not read this paper, so I won't comment further on it.

http://www.ncbi.nlm.nih.gov/pubmed/26011524

Charles

Reply

Reayldon *says:*
November 13, 2015 at 4:01 am

Hi, Charles

I came across one question which the standard deviations for two variables are 1.22 and 1.64 respectively. Also, the variances for these two are 1.49 and 2.70,

So which t-test should I use? equal variance or unequal variance?

Reply

Charles *says:*

November 13, 2015 at 8:36 am

Generally as long as one variance is not more than 3 or 4 times the other you can use the equal variance test. But when in doubt you should always use the unequal variance test, since if the variances are really equal then the two tests will yield almost the same result. In this case, I would expect the two tests to have very similar p-values.
Charles

Reply

Sailent Simaremare *says:*

October 29, 2015 at 2:20 pm

Hi Charles, i have difficulty to distinguish the t test,
when should i use the two sample t-test and paired sample t-test,

Reply

Charles *says:*

October 30, 2015 at 11:13 am

Use the two sample t test with two independent samples (e.g. 50 school teachers and 45 students).
Use the paired sample t test with a sample of paired values where each member of the pair is not independent of the other member of the pair (e.g. 40 students with one score in the morning and the other score in the evening).
Charles

Reply

sebantee ganguly *says:*

September 26, 2015 at 3:47 pm

ttest result with my datas are like 2.38689E-05, what does it mean ??

Reply

Charles *says:*

September 26, 2015 at 4:28 pm

The result is in scientific notation. 2.38689E-05 is the same as 2.38689×10^{-05}), i.e. 0.0000238689, which is a very small number.
Charles

Reply

sebantee ganguly *says:*

September 27, 2015 at 5:34 am

so, when the result of my t test is like 2.38689×10^{-05}, what should be the inference ? the null hypothesis may be rejected …right ? is the result statistically significant ?

Reply

Charles *says:*

September 27, 2015 at 7:07 am

This is a very small number, and so the null hypothesis may be rejected; the result is statistically significant.
Charles

Reply

amit *says:*
August 8, 2015 at 6:47 pm

want to know these things:
1. I am planning for one intervention :
I will be adminsterg pre-test to both expermtl grp and contrl group
then intervention- exptl grp

then post test to both exp and control group.
to check normality I will be performing independent t-test Pre-test of exptl and pre-test of control.
then again post-test of expl and post test of control I want to perform independent t-test.

also will be performing paired t-test on pre-test and post -test of exptal group.

similarly will be performing paired t-test on pre-test andpost -test of control group after intervention.

Also ANOVA after doing incase we get siginfincet difference in 1,2,and 3 varaibles
then want to go for t -test between 1 and 2
t-test betwee, 1 and 3
t test between 2 and 3 ....I will be using independent t-test am I correct
please guide.

Also I am confused what 2 use a. independent t -test for equal variances
b.independent t -test for unequal variances
can I use independent t -test for unequal variances in excel?

Reply

> **Charles** *says:*
> August 8, 2015 at 8:36 pm
>
> Regarding the follow up tests to ANOVA, you need to be careful about the experiment-wise error.You should read the
> Planned Comparisons and Unplanned Comparisons webpages.
>
> Regrading t test for independent samples, you can always use the test for unequal variances. Even when the variances
> are equal the unequal variance test gives pretty good results.
>
> Charles
>
> Reply

>> **Vernika** *says:*
>> February 3, 2016 at 1:45 pm
>>
>> Hello Sir,
>>
>> I am also working on a similar problem as Amit.
>> However after drawing the histogram of the variables, it doesnt seem that the variables are normally
>> distributed.
>>
>> What should be done ?
>> Should I use Welch and unequal variances ?
>>
>> Reply

>>> **Charles** *says:*
>>> February 3, 2016 at 8:14 pm
>>>
>>> Vernika,
>>> The t test is pretty robust to violations of normality, and so usually I would just run the t test. If the
>>> data is quite different from normal, then I would use a non-parametric test — e.g. Wilcoxon signed-
>>> ranks test.

The situation is similar for ANOVA. If the data departs a lot from normality then you could use Kruskal-Wallis if the homogeneity of variances assumption holds.
Charles

Reply

> **Vernika** *says:*
> February 5, 2016 at 6:24 pm
>
> Thankyou Sir.
>
> My problem is only a post test analysis. I have the data for both the treatment and control group after intervention so is it possible that apart from the ttest, I get the results of my impact variables due to an intervention with the help of regression alaysis also creating a treatment dummy? Can I do such a regression by controlling other factors or I can just compare the means of the variable using the t test ?

>> **Charles** *says:*
>> February 6, 2016 at 10:22 am
>>
>> Sorry Vernika, but I still don't understand your question. E.g. I don't know what you mean by "impact variables", nor what it means for these variables to be "due to an intervention", nor why you decided to use "regression analysis" or needed to create "a treatment dummy" (whatever that is).
>> Charles

Tobee *says:*
July 20, 2015 at 3:15 pm

I am trying to write my thesis on the comparison between patient and doctor of response to therapy in psoriatic arthritis. I am setting the doctor's responses as the control and the overraters and underraters are being compared. I have set the doctor's responses as control. How would I set up a T-test in excel? I already know it will be a 2 tailed t-test but am unsure the type I should do? For example what am I to enter into excel to get the deciding P-value?

I already have this in excel:
=TTEST(array1,array2,2,type?) what would type be according to my case?

If I could get some help as soon as possible that would be great thanks.

Reply

> **Charles** *says:*
> July 21, 2015 at 8:15 am
>
> From your description, it sounds like you have three groups: control, overraters and underraters, in which case you would need ANOVA and not just a t test.
>
> In any case, if you have just two groups and these groups are independent of each other then you can use type = 3. You could use type = 2 if you knew that the variances of the two groups were similar, but there really isn't much to lose by not assuming this since the p-value of the type = 2 and type = 3 tests would almost be identical in this case.
>
> If the the two groups were not independent then you would need to use type = 1.
>
> Charles
>
> Reply

aween *says:*
June 10, 2015 at 9:49 am

hello, this was really useful but could you please help me i do not know which type to use. i have two groups A and B and both groups did a PRE and POST test. the tests were the same in both groups

Reply

> **Charles** *says:*
> June 10, 2015 at 6:47 pm
>
> I am not sure which types you are referring to. Equal vs unequal variances? single sample vs two independent samples vs paired samples? Please explain.
> Charles
>
> Reply

> > **Rajesh** *says:*
> > July 26, 2015 at 4:10 am
> >
> > hello sir
> > what is difference between equal variance and uneual variance in t-test
> >
> > Reply

> > > **Charles** *says:*
> > > July 26, 2015 at 7:01 am
> > >
> > > Hello Rajesh,
> > > You use the equal variance version of the t test when the variances of the two samples are reasonably similar and you use the unequal variance version of the test when the variances are not similar. The good news is that you can always use the unequal variance version of the test since when the variances are almost equal the unequal variance version and the equal variance version of the t test produce pretty much the same result.
> > > Charles
> > >
> > > Reply

isaac *says:*
June 2, 2015 at 8:03 am

hi, good article! but i have a question: when using a two sample t test (independent), when should you assume equal variances?

Reply

> **Charles** *says:*
> June 2, 2015 at 11:00 pm
>
> To be on the safe side you can always use the unequal variances test. If the variances are close to equal the equal variances test will be quite similar to the unequal variances test.
> Charles
>
> Reply

Jessica *says:*
June 1, 2015 at 2:48 pm

Charles,

The t-stat number was negative at -5.97472 and I conducted a one tailed test so the P is 8.54E-07. I am not sure why the t-stat was negative. The MD was 10.7 between pre and post.

Reply

Jessica *says:*

May 29, 2015 at 2:06 am

Charles,

I am in graduate school trying to write my research paper. I am struggling with the statistics I must include. I used a quasi experimental one group pretest posttest design. The pretest mean was 72.9 and the SD was 22.019. The posttest mean was 83.6 and the SD was 20.71. I am having trouble deciding which t-test to use? Do I use a one tailed t-test paired two sample for means?
Jessica

Reply

Charles *says:*
May 29, 2015 at 6:53 am

Jessica,
It sounds like you have one sample and got a measurement for each member of the group at two moments in time (pretest and posttest). If this correct, then you should use a paired samples t test (assuming the assumptions for a t test are satisfied).
Charles

Reply

Jessica *says:*
May 29, 2015 at 3:31 pm

Charles,

I read this on your website...Another approach is to take a sample of 20 people and have each person drink a glass of wine and take a memory test, and then have the same people drink a glass of beer and again take a memory test; finally we compare the results. This is the approach used with paired samples.
I am just confused by statistics in general. I guess my brain does not think that way.
I used an online calculator to do the one tailed t-test paired for two sample means and it gave me T value 1.899552, P value 0.031234 and result is significant at p<0.05. I do not understand what this means. Is there any way to put this in every day language?
Confused

Reply

Charles *says:*
May 29, 2015 at 10:19 pm

Jessica,

A lot of people have trouble understanding the basic concept of hypothesis testing. It does take some getting used to.

In your example, you are trying to test whether the paired samples come from populations whose means are the same (or at least equal enough so that any difference may be due to random processes). The way the testing works is that you assume this (null) hypothesis is true (i.e. the two samples do come from populations with the same mean). The testing shows that (based on the null hypothesis being true) the probability that the sample data exhibit the obtained test statistic of 1.899552 is only 3.1234%, which is not so high. Since this probability is less than 5%, we are doubtful that the null hypothesis is really true, and so we reject this hypothesis and so conclude there is likely to be a significant difference between the means.

You can get more information on the webpage Hypothesis Testing.

Charles

Reply

Jessica *says:*

May 30, 2015 at 4:08 am

I appreciate your help. The more I read, the more confused I seem to get. The figures I gave you were from an online calculator but when I put the numbers in Excel and did the t-test, I got different numbers with no explanation about if it is statistically significant or not. Again, thank you for trying to help me.
Jessica

Jessica *says:*
May 30, 2015 at 6:43 pm

Charles,

Here I go again....
These are the results I got when I did a one tailed t-test paired: two sample for means. What does this mean? Why is there a negative number when the posttest scores were higher than the pretest? Is this statistically significant or not?

t-Test: Paired Two Sample for Means

Variable 1 Variable 2
Mean 72.9 83.6
Variance 501.5413793 443.6965517
Observations 30 30
Pearson Correlation 0.899895057
Hypothesized Mean Difference 0
df 29
t Stat -5.974725464
P(T<=t) one-tail 8.54E-07
t Critical one-tail 1.699127027
P(T<=t) two-tail 1.70719E-06
t Critical two-tail 2.045229642

I hope you can clarify this for me.

Charles *says:*
May 31, 2015 at 9:44 pm

Jessica,
A p-value less than .05 is usually considered to be statistically significant. For the two-tailed test you show a value of 1.70719E-06. This equivalent to the decimal number .00000170719, which is clearly less than .05. This statistically significant.
I don't see any negative number, unless you are referring to the exponent in 1.70719E-06. This not a negative number. A negative exponent just moves the decimal point to the right (as described above).
Charles

Vu Nguyen *says:*
May 26, 2015 at 3:49 pm

Dear Charles,

Could you help to interpret the below result from pairs sample t-test for a group of inspector before & after applied kappa statistic:
. # of inspectors: 23

t-Test: Paired Two Sample for Means

Variable 1 Variable 2
Mean 0.002449451 0.001223162
Variance 6.37156E-06 8.40796E-07
Observations 23 23
Pearson Correlation 0.252600165
Hypothesized Mean Difference 0
df 22
t Stat 2.392373093
P(T<=t) one-tail 0.012857038
t Critical one-tail 1.717144374
P(T<=t) two-tail 0.025714076
t Critical two-tail 2.073873068

The result showed that, p value = 0.025<0.05, so we reject the null hypothesis.
It means that, there is a significant mean different between two period of times (before and after applied kappa) ?

Please help to advise me to fully interpret the result.

Best regards,
Vu Nguyen

Reply

Charles *says:*
May 26, 2015 at 9:34 pm

Yes, if p value = 0.025<0.05, you would reject the null hypothesis, which means that there is a significant mean different between two period of times (before and after).
Charles

Reply

Laudy Peters *says:*
May 25, 2015 at 5:44 am

Hi,
can you give a formula of T-Test for related measures if the S as X and S1 as Y?? Cause i don't really understand about this.
I'm a student of university and i have a subject about apply statistic.

Reply

Charles *says:*
May 25, 2015 at 5:53 am

Sorry, but I don't understand your question.
Charles

Reply

aparna *says:*
May 15, 2015 at 5:05 am

Hi
I am taking a survey on expected and percieved service levels and then conduct a t test, to know the difference is significant or not. So the participants have to be different for expected and percieved? and do i have to assume equal variance or unequal variance

Thank you

Reply

Charles *says:*

May 15, 2015 at 6:40 am

You can create two samples with different participants. If the sample variances are quite similar then you can use the equal variance test. Otherwise you should use the unequal variance test.

It is likely (depending on the exact nature of the surveys) that you can create one sample and test expected and perceived service levels with all the participants in the single sample. In this case you would use the paired t test.

Charles

Reply

aparna *says:*
May 15, 2015 at 10:19 am

Thank you very much

Reply

debashri boruah *says:*
May 14, 2015 at 8:28 am

Hi,
I have 2 different samples from 2 different states. I want to perform a statistical test to detect p-value. In case of comparing the same disease results of two different samples,which test we can use?

Reply

Charles *says:*
May 14, 2015 at 9:14 am

If the assumptions for the t test are satisfied you can use the two sample t test. If the variances of the two samples are similar then you can use the t sample t test with equal variances. This test is pretty forgiving about what "similar" means. E.g. generally even if one sample has variance 4 and the other has variance 8, the equal variances test will usually work quite well. If the variances are very different (say one has variance 4 and the other has variance 40) then you should use the two sample t test with unequal variances. When in doubt use the two sample t test with unequal variances.
Charles

Reply

Ken *says:*
May 10, 2015 at 9:27 am

Can I use t test if the actual distribution not normal?

Reply

Charles *says:*
May 10, 2015 at 10:54 pm

Ken,
The t test assumes that the data is normal, but it is pretty forgiving of violations of normality. The test should work quite well unless the data is very skewed, in which case the Mann-Whitney test may be a better solution.
Charles

Reply

George Szmn *says:*
April 12, 2015 at 4:21 am

I just want to make sure that I am doing this correctly.

N1 126 Salaries for mlb team that gained a playoff spot btwn 2000 and 2014
N2 324 Salaries for mlb team that didnt gain a spot.
compared the means using t test non paired gave me statistically differente
I assumed that variances were equal Ftest 1.54 prob 0.999

can you correct me if i´m wrong

Reply

Charles *says:*
April 13, 2015 at 7:16 pm

George Szmn,
Unless for some strange reason the two samples are highly skewed (not likely to be a problem), the approach you used looks correct.
Charles

Reply

Melody *says:*
April 10, 2015 at 6:24 pm

Hello

How can i prove that the p-value of 2 sample t-test with equal variance is the same as the p-value of a one-way Anova with 2 samples?

Thank you

Reply

Charles *says:*
April 15, 2015 at 4:42 pm

Melody,
I have not tried to do this, but I wouldn't be surprised if you needed to use the fact that F.DIST(x,df,1,TRUE) = T.DIST(x,df,TRUE)^2; i.e. Property 1 of the webpage http://www.real-statistics.com/chi-square-and-f-distributions/f-distribution/.
Charles

Reply

Rebecca *says:*
April 9, 2015 at 11:26 am

Hi,

I am trying to find out if there is a significant improvement between a groups mental wellbeing scores at 2 different points of time (ie. before intervention and after intervention).

Rather than having each individuals score to use for calculations, I have the mean score for each question on the questionnaire before intervention and the mean score after intervention.

For example my data table looks like this

Question Average Initial Score Average Final Score
Feeling useful 2.5 4.6
Feeling relaxed 2.5 4.6
Feeling loved 2.5 4.6
Feeling cheerful 2.5 4.6

Using excel, would I use a t-test, two tailed, and type 1?

Reply

> **Charles** *says:*
> April 9, 2015 at 4:28 pm
>
> Rebecca,
> You should use the detailed data not the sums or average scores (since you also need to know the sample sizes and variances). This will be a paired samples (aka repeated measures) t test (which if I remember correctly is type 1). Generally you would use a 2 tailed test (unless you are very confident that the scores won't go down after intervention).
> Charles
>
> Reply

Jess *says:*
April 8, 2015 at 12:39 pm

Hi

Are you still able to perform a Ttest when there are different numbers of participants for each component?

Thanks

Reply

> **Charles** *says:*
> April 8, 2015 at 1:20 pm
>
> Jess,
> You can perform a two sample t test even if the samples have a different number of elements.
> Charles
>
> Reply
>
> > **Jess** *says:*
> > April 8, 2015 at 5:04 pm
> >
> > Perfect thanks for you help!
> >
> > Reply

aldiz *says:*
April 5, 2015 at 6:14 pm

I also have another question. I want to perform a t test for means, I have a sample (with a mean and variance) and a reference value. The classic formula for the t statistic uses means and variances. I know how to compare it by using the t test formula. But what if my reference value has a standard deviation? Do I use the formula and assume my reference is a sample too and use n = 1 for my "reference sample"? For example, I have a sample with mean 3,4 and variance 1,2, and I want to compare it to a reference value of 3, and I assume that my reference value has a variance of 2...

Reply

> **Charles** *says:*
> April 6, 2015 at 7:30 am
>
> I don't completely understand your question, especially since I don't know what you mean by "reference value". Based on how you describe the problem, the approach you suggest might be appropriate, although it is more likely that you need to use a sample size for the second "sample" equal to the sample size of the first sample.
> Charles
>
> Reply

aldiz *says:*

April 6, 2015 at 5:10 pm

Ok, for example : I have a distribution of 50 temperatures, with the mean and standard deviation. Then, I want to compare it with a reference value. For example, in that time of the day, in a particuliar place the real temperature should be 20 degrees, with a standard deviation of ± 5 degrees. This reference value is not a distribution, I only have one value. In the formula, the result depends on n, but if I take n = 1 for the reference, the test will be very easy to pass, on the other side if I take n = 50 for both, its not really true beceause I only have one value for the reference...

Reply

Charles *says:*

April 15, 2015 at 6:37 pm

As you can see from Theorem 1 of the referenced webpage, for each sample you need to know the sample mean, sample variance and sample size of each sample to conduct a t test. Without this information, you won't be able to conduct the test.
Charles

Reply

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aldiz *says:*

April 5, 2015 at 6:08 pm

Hi, I have a specific problem. I have 2 different distributions (samples) i.e. in measure in 2 different conditions. I want to perform a statistical test to detect a mean difference of at least 5 between the 2 samples. My H0 hypothesis is : M1 − M2 = 5, my H1 hypothesis is M1-M2 < 5 (because I want to prove that the difference between the 2 means is less than 5 units). How can I do that with Excel?

Reply

Charles *says:*

April 6, 2015 at 7:22 am

You can use Excel's **t test** data analysis tool as described on the referenced webpage. Insert 5 in the **Hypothesized Mean Difference** field and look at the one tail results.
Charles

Reply

aldiz *says:*

April 6, 2015 at 5:13 pm

Ok, I cant have directly the p value or statistic of that in one excel cell (I want the excel sheet to be already ready and I just plug the data)?

Reply

Charles *says:*

April 15, 2015 at 6:33 pm

If I understand correctly, you want to conduct a one-tailed two independent sample t test. In Excel this can be done using the **Two-Sample Assuming Equal Variances** data analysis tool. Click on the **Data** ribbon and choose the **Data Analysis** tab. Select T**wo-Sample Assuming Equal Variances** data analysis tool (assuming the variance are similar; otherwise choose the **Two-Sample Assuming Unequal Variances** data analysis tool). Fill in the dialog box with the input ranges and fill in the **Hypothesized Mean Difference** field with the value 5.
Charles

Reply

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jaynos cortes *says:*

April 2, 2015 at 1:15 pm

Hello. Can anybody help me with my problem? I have a research and initially had 3 treatments, so I proposed ANOVA as my statistical tool in determining the significant difference. But along the experiment it happened that one of the 3 treatments did not respond to my procedure. So, my results have only 2 treatments to determine the difference. Is it applicable to shift to T-test instead of ANOVA since I only have to get the significant difference of two treatments because the third treatment has no variance?

Reply

> **Charles** *says:*
> April 2, 2015 at 5:00 pm
>
> Yes you would use a t-test. You could use ANOVA, but in this case you would not include the treatment with no results. The results will be the same as for the t test, but the t test is probably easier to calculate and interpret. When you report your results, you should explain that you had planned to analyze three treatments and explain why you got no data for this treatment.
> Charles
>
> Reply

Pingback: *About Significant Test | Lin Chen's Blog*

Kennedy *says:*
March 10, 2015 at 1:49 am

I typed a comment last evening asking for help trying to decide how to handle a statistics problem. I need to form a hypothesis where two groups of students at a Private Catholic School one group who lives in North Bethesda (120 observations) are said to receive higher grades on the SATs. Those students living in South Bethesda (132 observations) received lower test scores on the SAT. Sample mean is 86 and 87 respectively with 8.1 and 7.3 populations variances and an .01 level of significance. Is there evidence that students living in South Bethesda may be getting lower grades on the SATs?

Reply

> **Charles** *says:*
> March 10, 2015 at 8:51 am
>
> Kennedy,
>
> I sent a response yesterday. I am resending it below:
>
> Since you have the population variances you can use a two sample test using the normal distribution, as described in Theorem 1 of Comparing Two Means.
>
> The null hypothesis is mean1 >= mean2 (these are population means). The test statistic is z = (m1-m2)/stdev, where m1-m2 = 88-87 = 1 (sample means) and stdev = sqrt(var) where var = v1^2/n1 + v2^2/n2 = 6.2^2/132 + 7.0^2/125. If NORMSDIST(z) > .99 then you reject the hypothesis that the the workers receive the same pay. This is a one tailed test. If you want a two-tailed test you need to replace .99 by .995.
>
> If instead of the population variance you had the sample variances you would use Theorem 1 of Two Sample t Test instead.
>
> Charles
>
> Reply

Nikita *says:*
March 9, 2015 at 1:07 pm

What do you do if the number of cases are not equal? How would you calculate the df then?

Reply

> **Charles** *says:*

March 9, 2015 at 1:20 pm

The formulas and functions on the referenced webpage don't require that the number of cases be the same. Just use the formulas and functions shown on the webpage.
Charles

Reply

Dilshodjon *says:*
February 11, 2015 at 6:18 am

Hi Charles,
In the first example, can I know the meanings of data entered in Old and New columns?
For example, does the greater the number explain the greater the enjoyment?
What scale could be used?
Clarification could be helpful.
Thank you in advance for the post and the answer as well.

Reply

Charles *says:*
February 11, 2015 at 9:15 am

Presumably the higher the score the more enjoyable the beverage (although for the t test it really doesn't matter whether a higher score represents more or less enjoyment). Scale also really doesn't matter, but let's assume that each point represents the more enjoyment option in a series of True/False questions.
Charles

Reply

Swarup *says:*
December 16, 2014 at 7:42 am

a number of samples 170, in 2012 mean 12366 std dev 3891 and in year 2011 mean 12549 std dev 4232 . corelation-coeff .92879. Can it be concluded that the value of stock holding decreased? how to solve this problem using excel? i mean i am facing trouble to determine std err

Reply

Charles *says:*
December 17, 2014 at 12:05 am

You are referencing the webpae regarding two sample t-test with independent samples, but the correlation coeffcient of .92879 shows that these samples are not likely to be independent. Perhaps you are trying to run a two paired samples test — e.g. where the stock holdings are in say 170 different factories, comparing 2011 with 2012. In this case you might be able to use the fact that var(x-y) = var(x) + var(y) – cov(x, y) and cov(x,y) = corr(x,y) * sqrt(var(x))*sqrt(var(y)). This is the best I can do with the information you have provided. I hope that it is helpful.
Charles

Reply

Noemi *says:*
October 26, 2014 at 6:59 pm

Assuming I have 2 treatments and three trials per treatment. How should I solve the statistical problem of this?

Reply

Charles *says:*
October 31, 2014 at 9:10 pm

Noemi,

Are you saying that you have two treatments and a sample of 3 for each treatment? You aren't going to do much with such a small sample, but it is probably best to use the Mann-Whitney test instead of a t-test in this case.
Charles

Reply

marzieh *says:*
September 6, 2014 at 8:51 am

Dear Charles
First , many thanks for sharing such valuable knowledge . I have a question regarding this page . In example 1 , while I understand that the null hypotheis is rejected because of P value of tow-tail is lower than 0.05, I can not understand this sentence that you have added at the end of example :"In fact, the new flavoring is significantly more enjoyable." I do not know how should I recognize whether the dependent variable in sample one is increased or decreased significantly compared to the sample 2. All my appreciation for any advice as I am stucked in it

Reply

> **Charles** *says:*
> September 9, 2014 at 4:46 pm
>
> Dear Marzieh,
> Before you collect data and conduct the test you don't know whether the mean of the sample will be in the right tail, left tail or neither. After the test you have evidence as to whether or not the sample mean is in one of the tails and if so which tail. It is on this basis that I drew a conclusion. Of course this conclusion won't always be correct, but the evidence points in the direction indicated.
> Charles
>
> Reply

Jo G. *says:*
June 3, 2014 at 12:33 pm

I am using a t test to compare before and after weights using a diet. n=78. In excel, I am not sure whether to use 1, 2, or 3, under type in the formula box. Can you explain clearly the differences? Thanks.

Reply

> **Charles** *says:*
> June 3, 2014 at 9:45 pm
>
> Jo,
>
> You use type = 1 when the two samples are not independent. E.g. (1) when the first sample contains men and the second contains their wives or, as in your case (2) the first sample contains each person's weight before dieting while the second sample contains their weight after dieting. In example (2) the same person is being sampled and so the samples can't be independent.
>
> Type 2 and 3 are used when the two samples are independent. E.g. 20 people are selected at random and half are randomly put in group 1 and half are randomly put in group 2. The difference between type 2 and type 3 relates to the variances of the populations from which the samples are drawn. If the variances are equal then use type = 2, while if the variances are unequal use type = 3. In reality the variance don't have to be identical to use type = 2. Even if they are close you will usually get good results You usually judge two populations to have equal variances if the two samples have variance that are not too different; in fact even if one sample has a variance which is 4 times the other, the results will be pretty good even if you use type = 2.
>
> For your situation, it looks like you want to use type = 1.
>
> Charles
>
> Reply