

STATISTICAL ANALYSIS
WITH SPSS / PASW:

A NON-STATISTICIAN'S GUIDE & TUTORIAL

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CHAPTER 6: Hypothesis Test for One Sample

In this chapter we shall walk through the steps for conducting a t-Test for One Sample. For this test, a single variable is chosen, a sample mean is computed, and that sample mean is compared to some specified value.

Suppose you wanted to know whether the PhD learners have a mean GPA that differs from 3.50. The null hypothesis (H_0) and alternate hypothesis (H_a) would be:

H_0 : The mean GPA of PhD learners equals 3.50

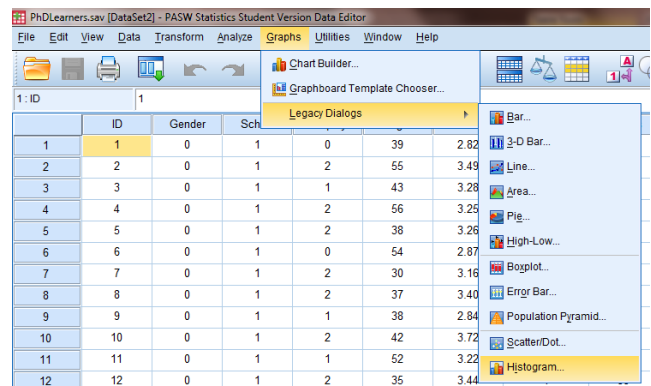
H_a : The mean GPA of PhD learners does not equal 3.50

The only variable being tested here is the GPA. Note that "PhD learners" is not a variable since all of the data being analyzed is from PhD learners (it is merely a descriptor for the target population in this case).

Since we are testing a sample mean against a hypothesized value, we shall use a t-Test for One Sample. To do so, there is an assumption that the GPA is normally distributed.

We really only need to visually check the data to see if it "appears" normal.

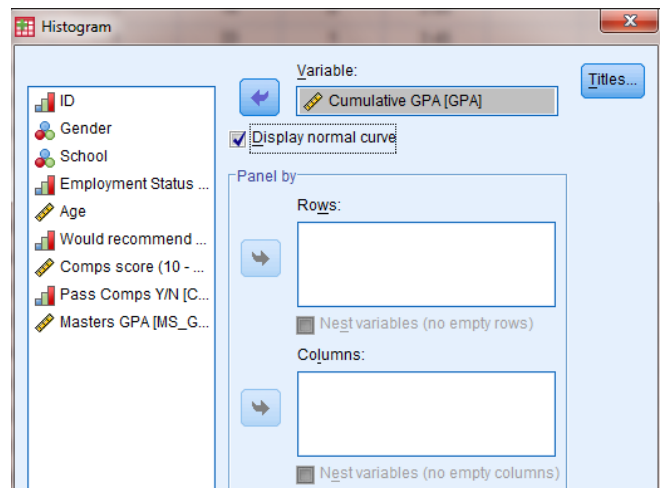
Go to **GRAPHS** → **LEGACY DIALOGS** → **HISTOGRAM**



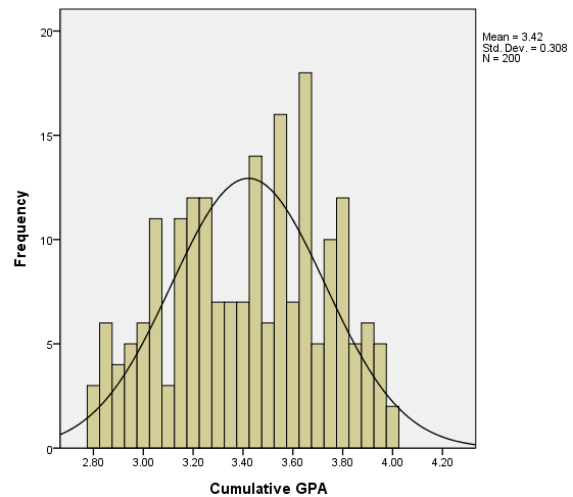
Choose GPA as the *Variable* by clicking on the arrow to enter it in the box as shown here.

Check the box marked *Display Normal curve*.

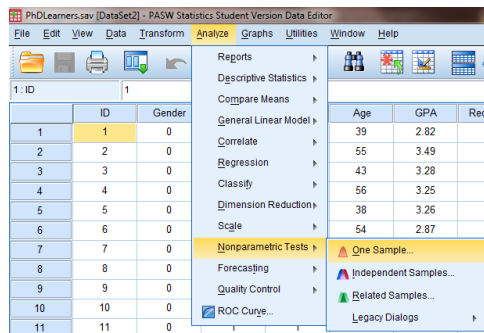
Click *OK*



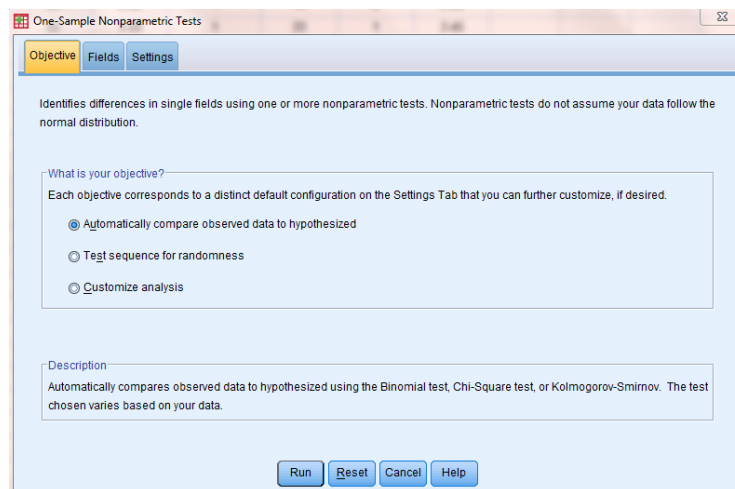
Now a truly normal curve is shaped like a bell that peaks in the middle and is perfectly symmetrical. This histogram does not appear to have a perfect bell-shaped pattern, but I wouldn't expect it to (remember that you are only looking at a sample, not the entire population). There is more data in the middle, and less toward the two extremes. Additionally, it appears that about half of the data are above and half are below the mean. Also, there aren't any unusually large or small numbers at either extreme (known as outliers). Based on these observations, the assumption of normality appears reasonable, so we can proceed with the t-test. If you weren't sure, you could conduct a Kolmogorov-Smirnov test to evaluate the normality assumption.



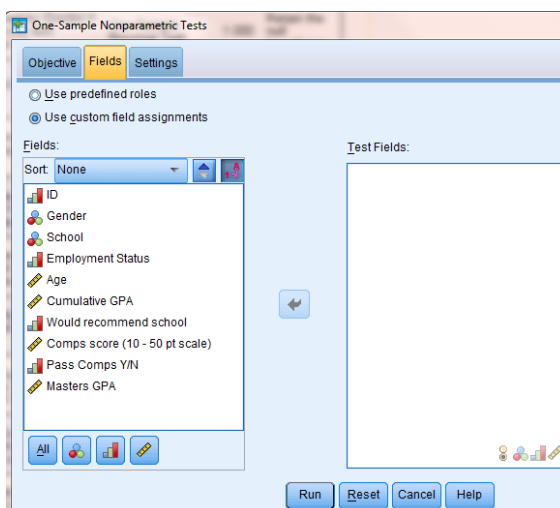
To conduct the Kolmogorov-Smirnov test, go to ANALYZE → *NONPARAMETRIC TESTS* → ONE SAMPLE



This window (new to the latest version of the software) asks you if you wish to test every variable or specific ones. Click on **FIELDS**.



The default is for every variable to be a test field. Choose the **USE CUSTOM FIELD ASSIGNMENTS** option to remove all of the variables so you can choose the one you want.



Choose Cumulative GPA and click the arrow so it is moved into the **TEST FIELDS**. Then click **RUN**.

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The distribution of Cumulative GPA is normal with mean 3.421 and standard deviation 0.308.	One-Sample Kolmogorov-Smirnov Test	.202	Retain the null hypothesis.

Asymptotic significances are displayed. The significance level is .05.

The hypotheses being tested is

Ho: The distribution of GPAs is normal.

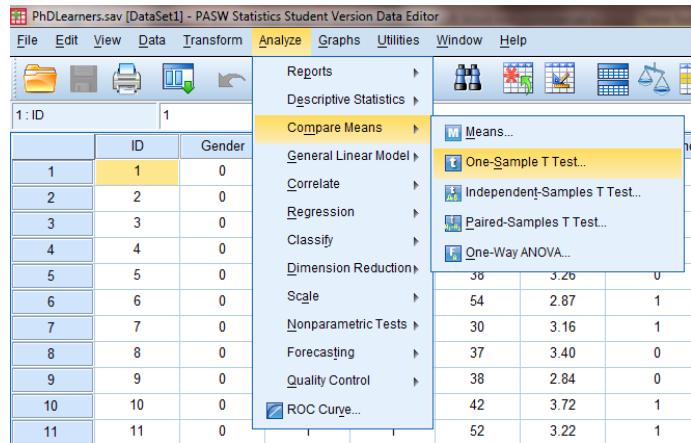
Ha: The distribution of GPAs is not normal.

The results show a **SIG.** value of .202 (this is also known as the p-value). The p-value tells you the probability of getting the results you got if the null were actually true (i.e., it is the probability you would be in error if you rejected the null hypothesis). If the p-value is less than .05, you reject the normality assumption, and if the p-value is greater than .05, there is insufficient evidence to suggest the distribution is not normal (meaning that you can proceed with the assumption of normality). Since the p-value is .202, there is no reason to doubt the distribution is normal, so you can safely proceed with the t-test.

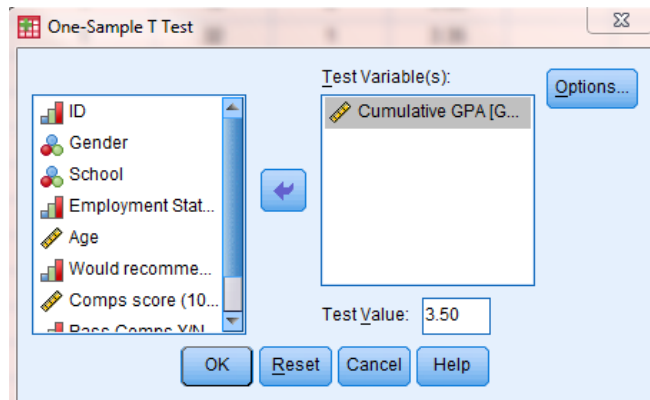
NOTE: While the decision here states **RETAIN THE NULL HYPOTHESIS**, it is not the best choice of wording. A null hypothesis should never be accepted or retained. We either reject the null hypothesis or fail to reject the null hypothesis, just as a defendant on trial is either found "guilty" (reject the null that he is innocent), or "not guilty" (do not reject the null that he is innocent). He is never found innocent, as there is either enough evidence to convict or insufficient evidence to convict, but he is never proven innocent. Hypothesis testing is all about gathering evidence to suggest the null is not true, and the lack of such evidence warrants a "Do not reject" decision. So throughout this book, I will never **RETAIN THE NULL HYPOTHESIS** regardless of what the output shows; I will instead **FAIL TO REJECT THE NULL HYPOTHESIS**. I assure you that this is the standard found in textbooks and academic journals.

Now that we established the assumption of normality has been met (or at least, it hasn't been conclusively violated), let's move on to testing the mean GPA as planned.

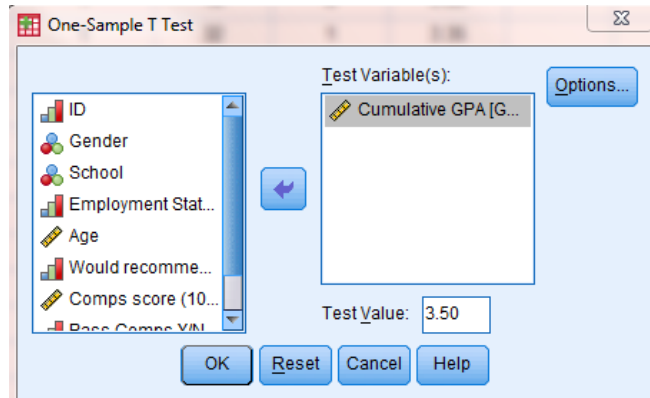
Go to ANALYZE → COMPARE MEANS → ONE-SAMPLE T-TEST



Choose GPA as the TEST VARIABLE and 3.50 as the TEST VALUE. Then click OK.



Choose GPA as the TEST VARIABLE and 3.50 as the TEST VALUE. Then click OK.



One-Sample Statistics				
	N	Mean	Std. Deviation	Std. Error Mean
Cumulative GPA	200	3.4214	.30841	.02181

One-Sample Test						
Test Value = 3.50						
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Cumulative GPA	-3.602	199	.000	-.07855	-.1216	-.0355

The output here shows an N of 200 (i.e., the sample size) and a *Mean* of 3.4215 (i.e., the average). The t-test output has a *Sig. (2-tailed)* / p-value of .000. A p-value of .000 means that the probability of a randomly drawing a sample of 200 from a population with a mean of 3.50 and getting a sample mean as low as 3.42 purely by chance is 0.00%. In other words, it is unlikely to have occurred by chance and is more likely the case that the mean is not as hypothesized.

We typically set a significance level at .05, but sometimes we adjust it to as little as .01 or as much as .10. Our decision to adjust it is based on our tolerance for the two types of error (i.e., rejecting the null hypothesis that is true vs. not rejecting a null that is false). For now let's go with .05, which has become a default for most studies. Since the p-value is less than .05 (our chosen significance level), we reject the null. When we reject the null, we are basically declaring the alternate hypothesis to be true; when we fail to reject the null, we state that there is insufficient evidence to declare the alternate hypothesis to be true (but you need to write in accordance with the wording of the specific hypothesis instead of just making a generic statement about the null or alternate, as shown in the next paragraph).

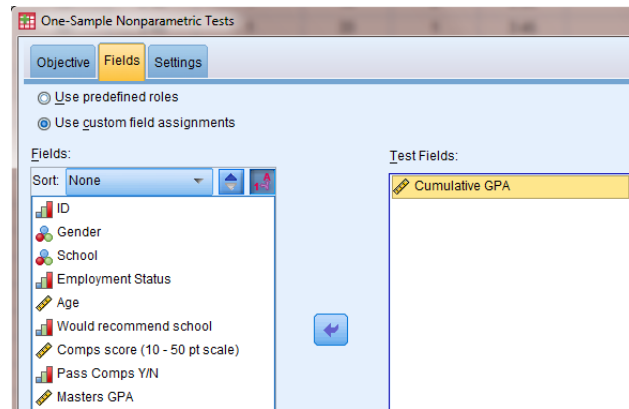
Had we not rejected the null hypothesis, we would state that there is insufficient evidence to conclude the mean GPA differs from 3.50. Remember that under no circumstances should you ever "accept" the null and/or conclude the mean equals 3.50 as it is impossible to prove the null is true (and think about how silly it would be if you had a sample mean of 3.55 which wasn't quite large enough to reject the null, and so you concluded that the mean was therefore exactly 3.50, which is smaller than your sample mean).

As for this case of testing the GPA, however, we did reject the null hypothesis, so we should conclude that the mean GPA of PhD learners differs from 3.50. Since the sample mean is 3.42, we can get more specific and state that the mean GPA is less than 3.50.

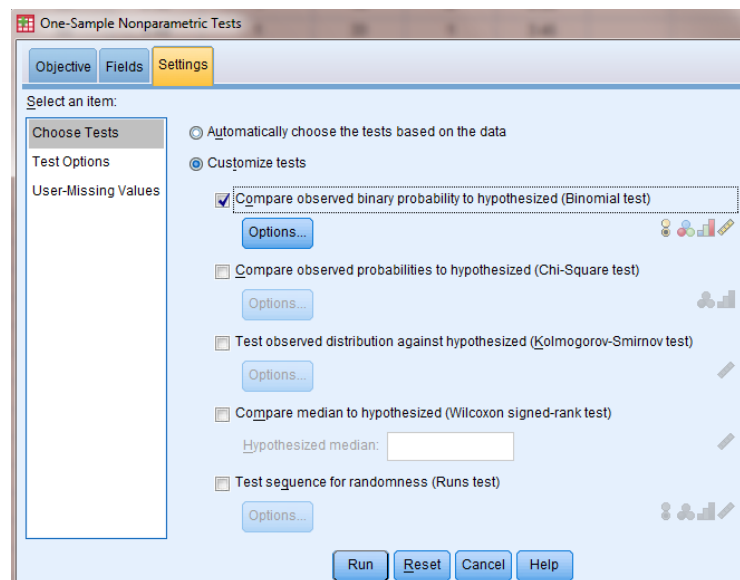
At this point, I recommend going one extra step with the conclusion. Does it make sense? What does it really mean? In this case, you might state that, contrary to rumors, grades do not appear to be inflated, as the mean GPA leans closer to the B range than to the A range. Anything more should be saved for Chapter 5 of your dissertation, when you tie the results to the literature and make suggestions for future research.

Now what if the normality assumption did not hold up, or the sample size was relatively small (often considered to mean less than 30 per sample)? In such cases, you can conduct a nonparametric test that essentially tests the same principle without the parameter (i.e., the mean) and without the assumptions. In this case, we shall use a Binomial test.

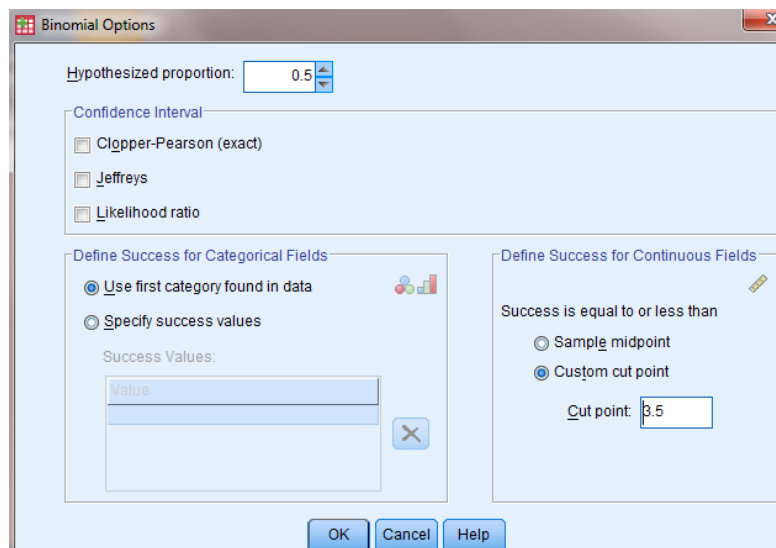
To conduct the Binomial test, go to ANALYZE → NONPARAMETRIC TESTS → ONE SAMPLE. Then click on FIELDS and choose the USE CUSTOM FIELD ASSIGNMENTS option. Select Cumulative GPA as the TEST FIELD. Then click on SETTINGS.



Choose CUSTOMIZE TESTS and check the first box to run the BINOMIAL TEST. We skipped this before because it automatically ran the test for normality, but now we need to tell it what we want done. Click on OPTIONS.



The HYPOTHESIZED PROPORTION is already set to a default of .50, which is what we want. In the bottom right, choose CUSTOM CUT POINT and enter 3.50. This will test if 50% of the GPAs are above 3.50 and 50% are below. In a normal distribution where the mean is 3.50, you would expect to see a perfect 50/50 split, so this is essentially the equivalent without testing the mean. Click OK and RUN.



The output here shows that the GPA was broken down into two groups: ≤ 3.5 and > 3.5 . 56% of the GPAs are less than 3.5 and 44% are greater. If the mean were 3.50 and the distribution were normal, you would expect to see 50% above / below 3.50. If the mean were 3.50 and the distribution were normal, you would expect to see 50% above / below 3.50. The p-value of .138 is greater than .05, so the null hypothesis is not rejected and there is insufficient evidence to conclude that the percentage of GPAs above 3.50 is not 50%. Notice that the t-test resulted in rejecting H_0 , while the Binomial test did not. This is not unusual. A parametric test (like the t-test) is more powerful and more capable of detecting significant differences, while a nonparametric test (like the Binomial test) is weaker and more conservative in its likelihood of finding a difference to be significant. This is why we try to use parametric tests whenever possible, but when it is not an option, at least we have a viable alternative, albeit a little weaker.

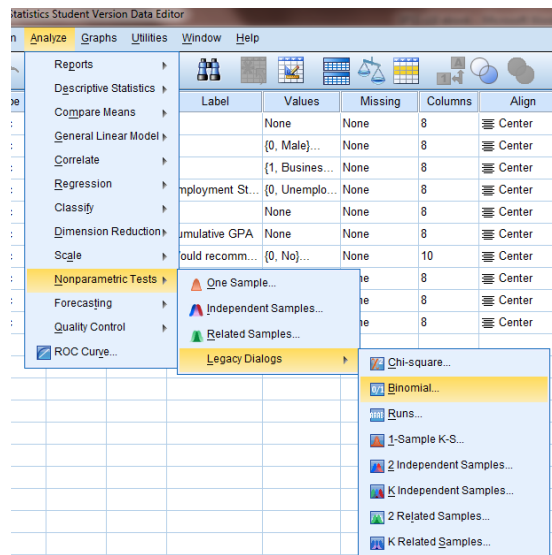
Hypothesis Test Summary

	Null Hypothesis	Test	Sig.	Decision
1	The categories defined by Cumulative GPA ≤ 3.5 and > 3.5 occur with probabilities 0.5 and 0.5.	One-Sample Binomial Test	.138	Retain the null hypothesis.

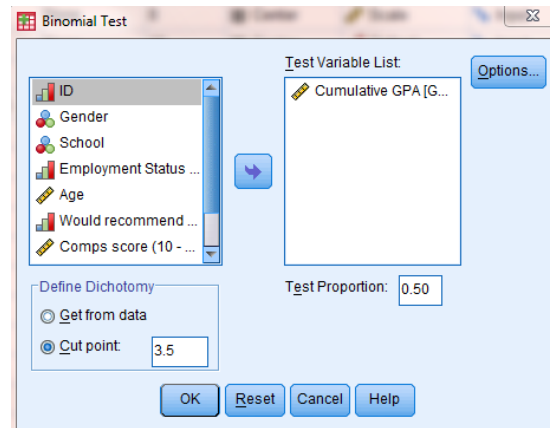
Asymptotic significances are displayed. The significance level is .05.

Now what if you wish to see more than just the HYPOTHESIS TEST SUMMARY? Personally I prefer to see the entire output so I can draw more detailed conclusions. Here's how.

To conduct the Binomial test, go to **ANALYZE → NONPARAMETRIC TESTS → LEGACY DIALOGS → BINOMIAL.**



Choose Cumulative GPA as the TEST VARIABLE. Set the CUT POINT to 3.50 and the TEST PROPORTION to 0.50 since we are testing if half of the data are above / below 3.50. Click OK.



Here we get to see that 111 of the 200 were below 3.50 and the other 89 were above 3.50. The ASYMP. SIG. (2-TAILED) of .137 is greater than .05, so we fail to reject the

	Category	N	Observed Prop.	Test Prop.	Asymp. Sig. (2-tailed)
Cumulative GPA	Group 1 <= 3.5	111	.56	.50	.137 ^a
	Group 2 > 3.5	89	.44		
Total		200	1.00		

a. Based on Z Approximation.

null hypothesis. Personally I prefer this to the other display (especially since it erroneously uses the RETAIN word), and you will need this for journals or dissertations, but you can do whatever works for you. SPSS is great in that it gives you many options.

So let's review.

State the hypotheses:

Ho: The mean GPA of PhD learners equals 3.50

Ha: The mean GPA of PhD learners does not equal 3.50

Choose a significance level → .05

State the assumption(s):

PhD GPAs are normally distributed.

→ evaluate graphically or with a Kolmogorov-Smirnov test

Conduct t-Test for One Sample

Compare the sig.value / p-value to .05. If greater than .05, do not reject Ho and then state that there is insufficient evidence to conclude the mean GPA differs from 3.50. If less than .05, reject Ho and conclude that the mean GPA in the PhD program is not 3.50 (specify whether it is greater or less than 3.50). Then feel free to add some insights in English, but be careful not to overstate beyond what you tested.

If the normality assumption does not hold, conduct a Binomial test with the following hypothesis →

Ho: The GPAs of PhD learners are distributed with 50% above 3.50