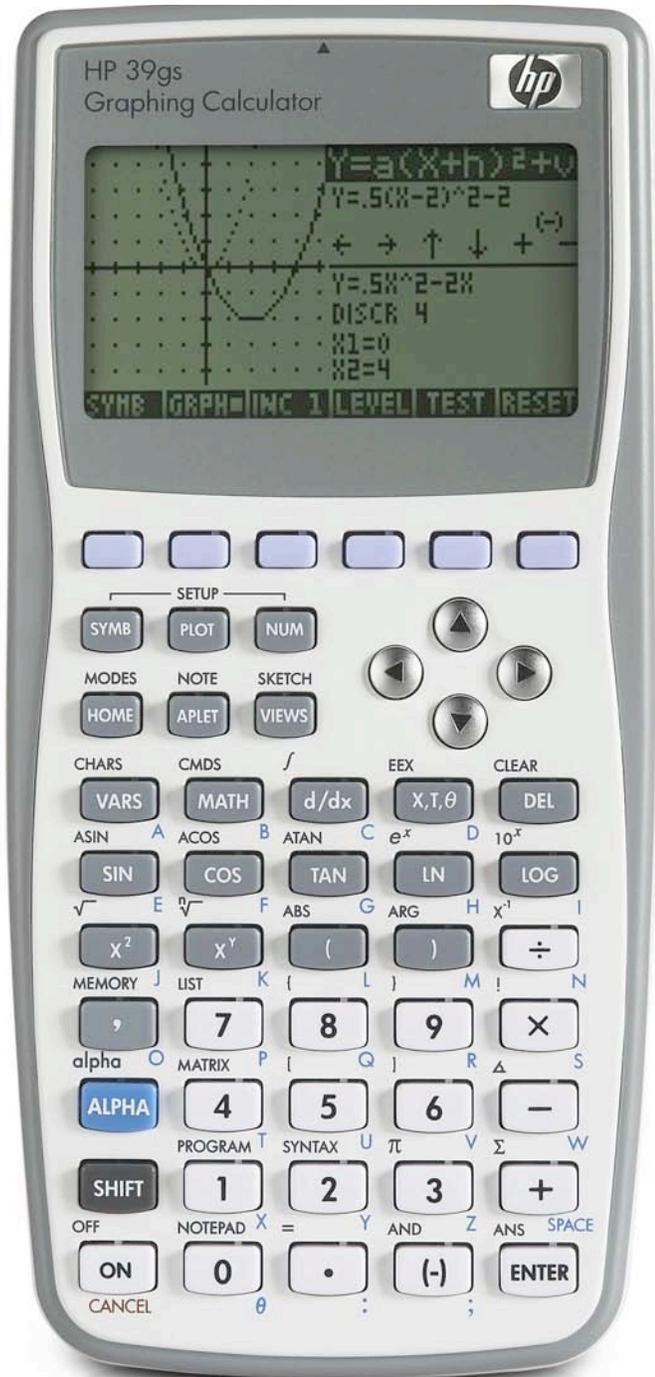# hp calculators

HP 39gs Inference and Hypothesis Testing

Are there really 50 matches per box?

Does my data prove my theory?

Are there really 50 matches per box? I

A company makes boxes of matches which are supposed to contain an average of 50 matches. A student has counted the contents of 20 boxes and found the results below. Using a 5% confidence level, decide whether the company's claim is correct.

Begin by entering the data into the Statistics aplet. The values of the mean and standard deviation will be transferred from here to the Inference aplet.

Matches per box
47, 50, 52, 51, 53, 51,
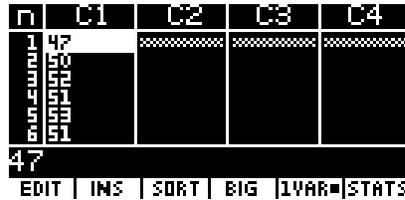49, 49, 52, 53, 54, 48,
53, 55, 52, 54, 54, 53,
48, 48

Figure 1

Figure 2

Change to the Inference aplet and choose the test and the alternate hypothesis. In this case we are working with a single sample and we do not know the standard deviation of the underlying population, so we will use the Student-t test and choose the alternate hypothesis that the mean of the real underlying population from which the sample was drawn is not equal to that of the proposed population.
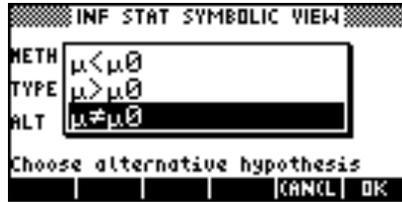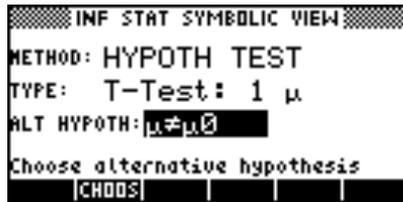
Figure 3

Figure 4

Figure 5

Change now to the NUM SETUP view to enter the required values for analysis. Rather than entering them by hand, press the IMPORT key. If you have more than one copy of the Statistics aplet (under other names), as in the case shown below, then you will be presented with a list of aplets from which to choose.

Figure 6

Figure 7

Figure 8

Once the aplet is chosen, you need to nominate the column from which to import the data. The default is column C1, which is what we want in this case.

Enter the population mean of Mu = 50, and check that the test level is correct at 0.05 (5%).

Figure 9

Changing to the NUM view will show the inferential values in numeric form. The test Student-t value is given as 2.392 and the probability of obtaining such a value as 0.0272. The critical t values for this test level of 5% are given as ± 2.093 and the critical boundaries for the sample mean as 48.86 and 51.14.
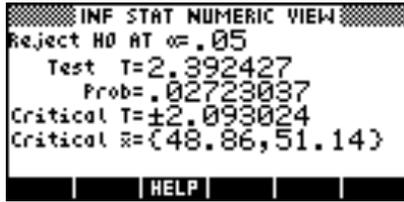
Sample t value is outside rejection range.
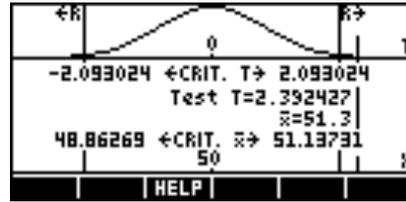
Figure 10

Figure 11

The same information can be seen in the PLOT view. The critical range for the t values is shown above, while the equivalent critical sample mean range is below. The test value for the Student-t and the sample mean are listed in the middle of the screen and the rough position of these values is shown by a vertical line in both the upper and lower diagrams. The regions for rejection of the null hypotheses are shown at the very top of the screen by the <-R and R->.

In this case it is clear that the null hypothesis should be rejected, with less than a 5% chance of this rejection being incorrect. The alternate hypothesis that the mean is not 50 should be accepted. Of course in this case, despite some boxes containing less than 50 matches, the actual mean seems to be above 50 so we can hardly condemn the company for putting more matches in the boxes than they need to!

Does my data prove my theory?

A teacher has developed a new teaching technique for hearing-impaired students which he believes is producing significantly better results. He wishes to publish a paper on this and needs to check his results statistically.

A standardized test is available for which it is known that the normal performance of hearing-impaired students at the same stage of study has a mean of 53.6% and a standard deviation of 12.2%.

When he applies this test to his class of 23 students their scores are shown below. The teacher believes that this data shows that his students are scoring significantly better and wishes to test this at a 5% confidence level.

Test results: {57, 72, 42, 50, 55, 58, 59, 38, 45,53, 77, 57, 52, 69, 50, 55, 59, 68, 62, 63, 53, 56}

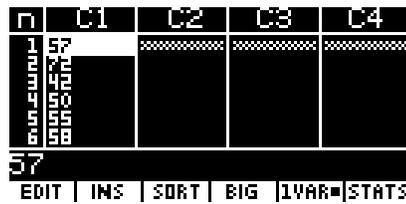Enter the data into column C1 of the Statistics aplet.

Figure 12

Changing to the Inference aplet, we choose a Hypothesis test using Z-test: 1 Mu, since we know the population standard deviation.
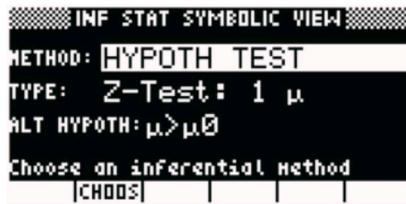

Figure 13

The hypotheses are:

H_0:   The sample is drawn from a population whose mean is the same as the standardized population ($Mu=Mu_0$).
H_A: The sample is drawn from a population whose mean is larger than that of the standardized population ($Mu>Mu_0$).

Change to the NUM SETUP view, you can use the import facility to import the summary statistics from the Statistics aplet.
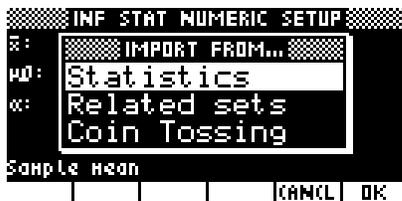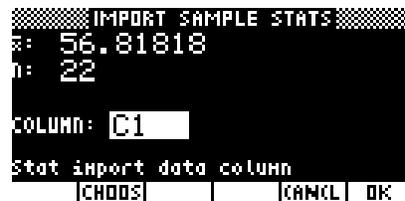

Figure 14

Figure 15

Now enter the values for the mean and standard deviation of the standardized test, and finally enter the significance level of 0.05 (5%).
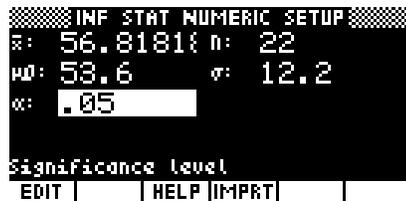

Figure 16

If we now change to the NUM view we can see that the test z score is less than the required critical z*, and the probability of obtaining a mean of the value found is 0.1080, which is larger than the required test value of 0.05.

Figure 17

In the PLOT view, we can see visually that the vertical line representing the sample mean is not within the region of rejection marked by the R->.

Figure 18

From the evidence the teacher must reject the alternate hypothesis and conclude that it is not possible to say at the 5% level of significance that his class has averaged significantly higher than the standardized population from which the test was drawn. He should re-think either his proposed paper or his new teaching method. Alternatively, from the diagram in the PLOT view it seems that his mean is not far from being significant. Perhaps he simply needs to collect more data in the hope that this may back up his view. The result he has obtained is, after all, only a probability and further investigation may give a different view.