

QUEEN MARY, UNIVERSITY OF LONDON

MTH 4106

Introduction to Statistics

Practical 11

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This week we will see how to do the 1-sample z test and also how to find the corresponding confidence interval.

1 (Two-sided one-sample z-test) Suppose that we have collected the following data on the thrust of a rocket engine. (These are famous data, but nobody ever gives the units of measurement!) Type the data into column C1.

999.1	1003.2	1002.1	999.2	989.7	1006.7
1012.3	996.4	1000.2	995.3	1008.7	993.4
998.1	997.9	1003.1	1002.6	1001.8	996.5

First we assume that the data are normally distributed with standard deviation 6.

Rocket scientist A thinks that the true mean thrust is 997. To perform a two-sided hypothesis test on this at the 5% significance level, use

Stat → Basic Statistics ► 1-Sample Z...

and enter C1 for **Samples in columns**. Set the standard deviation as 6, tick the box to perform the hypothesis test, and set the hypothesised mean as 997. Then click on OK.

Among the output in the **Session Window** are the sample mean, the sample standard deviation (notice that the latter is quite close to 6), the observed value of the test statistic and the P-value. What calculation has Minitab done to obtain the test statistic?

What is the P-value? How does it compare with the significance level?

We can find the outcome of a test with given significance level α by seeing if the P-value is less than or more than α . Let's use a 5% significance level. We find that we reject scientist A's hypothesis, because the P-value is less than 0.05.

2 (Confidence interval) The output in the **Session Window** also includes a 95% confidence interval for the mean thrust. Write down this confidence interval below.

This interval does *not* contain 997, which is another way of seeing that the null hypothesis should be rejected at the 5% significance level.

3 (Showing it all on a graph) Do the same test again, but now click on Graphs... in the dialogue box, and choose to draw a boxplot. You should find exactly the same output in the **Session Window**, but, in addition, the data are summarized on a boxplot and the confidence interval is drawn in blue.

4 (Different null hypotheses) Rocket scientists B, C and D think that the true mean thrust should be 999, 1001 and 1003 respectively. Perform the same test for each of their null hypotheses. You should find that they each have different P-values.

Summarize the results for scientists A, B, C and D below.

scientist	assumed mean	P-value	reject null hypothesis?
A			
B			
C			
D			

Note that, although the four scientists all had different null hypotheses, we are able to reject only one of them at the 5% significance level.

You should also find that the confidence interval does not change.

5 (Changing the significance level) Minitab's default value for confidence intervals is 95%, just as its default significance level is 5%. You can change this by using `Options...` in the dialogue box. Find 90% and 99% confidence intervals for the mean (remove the tick for the hypothesis test). How do the intervals change as the confidence level changes?

confidence level	confidence interval
90%	
95%	
99%	

6 (One-sided one-sample z-test) Now suppose that we are interested in the null hypothesis that the population mean is 997 against an alternative that it is more than 997. Use the `Options...` in the dialogue box to choose the appropriate alternative hypothesis, then perform the test at significance level 5%. What does the **Session Window** show now?

What happens if you include a boxplot?

7 (More practice) You may prefer to spend the remaining time today asking your tutor about Assignment 10, and leave this question for your revision.

In a famous experiment, published in 1798, the physicist Henry Cavendish made 23 measurements to try to determine the density of the Earth relative to the density of water. His values are given below.

5.36	5.29	5.58	5.65	5.57	5.53
5.62	5.29	5.44	5.34	5.79	5.10
5.27	5.39	5.42	5.47	5.63	5.34
5.46	5.30	5.75	5.68	5.85	

The true value is now known to be 5.517.

Test the hypothesis that 5.517 is the true mean for Cavendish's data using $\alpha = 0.05$ and a two-sided alternative. Assume that the population standard deviation is known to be 0.15.