ACC1012/53: Professional Skills for Accounting and Finance

Practical session: Confidence intervals and hypothesis tests in Minitab

What you need to do

The aim of this practical session is to illustrate the use of Minitab for finding confidence intervals and for performing hypothesis tests for the population mean. Don't forget – a more comprehensive instruction manual for Minitab is available to download from the ACC1012/53 webpage, in the `Minitab` section.

To load `Minitab` follow the steps below; then work through the questions overleaf, which all relate to material in Chapter 6 of the lecture notes. You can access `Minitab` via RAS, or you can even buy your own copy from ISS (about £10).

1. Login to a PC (using your usual university username and password).
2. `Minitab` is started by clicking on the Windows Start icon, then selecting:
   `All Programs` → `Minitab` → `Minitab 17 Statistical Software`
3. Via RAS, you will find `Minitab` in the `Statistical Software` folder.

None of this work is assessed; however, it is very important that you work through all of the questions very carefully, as you will find this material extremely useful/necessary for your current case study work. Question 5 gives some hints and tips about using Minitab in your case study.

Your written/practical work for case study 3 is due in by **4pm, Friday 11th May 2018**. As always, your work should have a cover sheet attached and should be posted through the homework submission letterbox on the 3rd floor of the Herschel Building.

See the end of this handout for information on saving `Minitab` worksheets. You can copy-and-paste any of the graphs you produce in the following questions by right-clicking on the graph in `Minitab`, selecting `Copy Graph`, and then, for example, selecting `Paste` in a word-processing application such as Microsoft Word.

1. Recall **Example 6.1** from the lecture notes:

> *Geordie Sparkz* are an electrical company based in Newcastle producing circuitboards for large plasma televisions. One of their machines punches tiny holes in these curcuitboards that should be 0.5mm in diameter. A sample of 30 circuitboards off the production line is inspected; the average diameter of the holes produced by this machine, for this sample, is 0.54mm.
>
> Assuming the machine is set to ensure a standard deviation of $\sigma = 0.12$mm, calculate the 95% confidence interval for the population mean diameter of holes produced by this machine. Do you think there is a real problem with this machine?

We worked through this example in the lectures, and we found that the 95% confidence interval for μ was

$$(0.497\text{mm}, 0.583\text{mm}).$$

We will now see how `Minitab` can be used to compute such intervals.

(a) Notice that this is "case 1", as the population standard deviation σ is known. Thus, we use the standard Normal distribution Z in our construction of confidence intervals.

(b) Click on `Stat`→`Basic Statistics`→`1-Sample Z`.

(c) Select `Summarized data` and then enter the `Sample size`, `Mean` and `Standard deviation`.

(d) Click `OK`. You should get the following output:

One-Sample Z

```
The assumed standard deviation = 0.12

 N    Mean  SE Mean        95% CI
30  0.5400   0.0219  (0.4971, 0.5829)
```

This gives the 95% confidence interval of (0.4971, 0.5829) – exactly the same as our hand–calculated interval, to 3 decimal places!

(e) Would the corresponding 90% confidence interval be wider or narrower?

Let's see if you're right. Follow steps (b)–(d) above; however, before clicking `OK`, select `Options` and change the confidence level from the default (95%) to 90%. Were you right?

(f) Would the corresponding 99% confidence interval be wider or narrower?

Follow what you did in part (e) to find the 99% confidence interval, and comment.

2. Recall **Example 6.2** from the lecture notes:

> A credit card company wants to determine the mean income of its card holders. It also wants to find out if there are any differences in mean income between males and females. A random sample of 225 male card holders and 190 female card holders was drawn, and the following results obtained:
>
> | | Mean | Standard deviation |
> |---|---|---|
> | Males | £16 450 | £3675 |
> | Females | £13 220 | £3050 |
>
> Calculate 95% confidence intervals for the mean income for males and females. Is there any evidence to suggest that, on average, males' and females' incomes differ? If so, describe this difference.

We worked through this example in the lectures, and obtained the following confidence intervals for male and female mean income:

$$\begin{aligned} \text{Male} &: (£15969.80, £16930.20) \\ \text{Female} &: (£12786.31, £13653.69) \end{aligned}$$

We will now use `Minitab` to reproduce these results.

(a) Recall that this is "case 2" as we are given standard deviations from the sample, not the population. Thus, we use the t distribution in our construction of confidence intervals.

(b) Click on `Stat`→`Basic Statistics`→`1-Sample t`.

(c) Now follow what you did in question 2(c) by entering your summaries for male income.

(d) Click `OK`. You should get the following output:

One-Sample T

```
  N   Mean  StDev  SE Mean       95% CI
225  16450   3675      245  (15967, 16933)
```

This gives the 95% confidence interval of (15967, 16933). Can you explain why this interval is slightly different to the one we calculated by hand in class?

(e) Repeat parts (b)–(d) above but now to find the 95% confidence interval for mean female income.

3. Recall the example in Section 6.3.2 of the lecture notes:

> A chain of shops believes that the average size of transactions is £130, and the population variance is known to be £900. The takings of one branch were analysed and it was found that the mean transaction size was £123 over the 100 transactions in one day. Based on this sample, test the null hypothesis that the true mean is equal to £130.
>
> Since σ^2 is known (we are given that $\sigma^2 = 900$), this corresponds to case 1: population variance known (think back to confidence intervals).

We will now see how to perform this hypothesis test in `Minitab`.

(a) Notice that this is "case 1", that is, the population variance is known (we are told that $\sigma^2 = 900$). Thus, we use the standard Normal distribution Z to construct the test statistic, and so this is often called a **One sample z–test**.

Write down your null and alternative hypotheses in the space below – `Minitab` doesn't do this for you! As we did in the lecture notes, uses a two–tailed alternative.

$$H_0 \quad :$$

$$H_1 \quad :$$

(b) In `Minitab`, click on `Stat`→`Basic Statistics`→`1-Sample Z`.

(c) Select `Summarized data`, and then enter the `Sample size`, the `Mean` (the sample mean!), and the standard deviation (not the variance!). Notice this is exactly what we did in question 2 for confidence intervals.

(d) Before clicking `OK`, tick the box which says `Perform hypothesis test`, and enter the `Hypothesized mean` (according the null hypothesis). Now click `OK`!

In the lecture, we found that the test statistic was

$$z = \frac{|123 - 130|}{\sqrt{900/100}} = 2.33;$$

we also found that the corresponding p–value lies between 1% and 5%. `Minitab` goes one step further, and it tells us the *exact* p–value! Look at your output... can you see the test statistic, and the *exact* p–value? Do they match up with the solution from the lecture?

4. In the lectures we considered the following example:

> The batteries for a fire alarm system are required to last for 20000 hours before they need replacing. 16 batteries were tested; they were found to have an average life of 19500 hours and a standard deviation of 1200 hours. Perform a hypothesis test to see if the batteries do, on average, last for 20000 hours.

(a) This question is "case 2" – population variance unknown. Why?

(b) We will use the following hypotheses for μ:

$$\begin{aligned} H_0 &: \mu = 20000 \\ H_1 &: \mu < 20000 \end{aligned}$$

Can you see why a one–tailed alternative might be appropriate here?

(b) Since this is "case 2", we make use of the t distribution instead of the standard Normal distribution; hence, the corresponding hypothesis test is often called a **One sample *t*–test**.

(c) Click on `Stat`→`Basic Statistics`→`1-Sample t`. Now follow exactly what you did in question 3 parts (c) and (d); *however*, before clicking `OK`, click on `Options` and change the `Alternative` to `less than`.

(d) What are your conclusions?

5*. Go to the ACC1012/1053 homepage:

`http://www.mas.ncl.ac.uk/~nlf8/teaching/acc1012`

Click on Case studies in the task bar; scroll down to Case study 3, and click on the link for your group's dataset.

Remember, this link should work automatically from within a FireFox or Google Chrome web browsers. In Internet Explorer, you will need to right-click the link, and save the file as "NightClub.MTW". Once the file has downloaded, you should be able to open the file by clicking on the filename itself.

(a) Consider confidence intervals for both of your samples. How could you interpret these?

(b) Consider a test for two means for your datasets. What do the results of this test tell you?

(c) You should also consider simple numerical and graphical summaries to aid your discussion; see previous practical sessions.

Saving and retrieving worksheets and projects

When you have been using Minitab, you will often want to save the contents of your Worksheet for future use. To save a Worksheet, first click on it in order to make it active, then select File → Save Current Worksheet As. Make sure that your current drive is Documents (H:) in the Save in: field, and give an appropriate name for the file before clicking on Save. Note that on the university Windows clusters, drive H: is synonymous with My Documents.

Note that saving a Worksheet only saves the Worksheet contents. It does not save any plots you have produced, or the contents of the session window. To save your complete workspace, including the session window, all open worksheets, and any plots, select File → Save Project As and select an appropriate folder and file name. This can be reloaded at a later stage by selecting File → Open Project or by clicking on the small yellow "open file" icon on the Minitab toolbar. Projects are often more convenient than worksheets for a "project" you are working on. However, they are less useful for long term data storage, as the project files tend to be very large.

Exiting and logging out

When you are finished working with Minitab, it is important that you exit the program and then log out of the Windows network properly; this will ensure that all of your work is saved properly and that your files are not corrupted.

To exit Minitab, select File → Exit. You will have an opportunity to save your project if you haven't already done so (see the instructions above).

Once you have exited Minitab, you can log out of the cluster by selecting the Windows Start icon and then selecting Log off. Don't do this until the end of your practical session!