ACC1012/53: Professional Skills for Accounting and Finance

Practical session: Further Minitab

What you need to do

The aim of this practical session is to build on what we covered in the introductory Minitab session three weeks ago. 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 Chapters 5–6 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.

Some of this work is assessed, and will go towards your overall mark for the module. The starred questions from this practical, as well as those from the last practical session, should be submitted together as a single piece of work by **4pm, Friday 20th April 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. In Chapter 5 we looked at the Normal distribution as a probability model for continuous data. Recall the example about the IQ of graduate applicants to a company:

> An employer is interested in X: the IQ of it's graduate applicants, not only their degree classification. A previous study suggests a normal distribution with mean $\mu = 100$ and standard deviation $\sigma = 15$. Thus, we have $X \sim N(100, 15^2)$.

(a) We can use `Minitab` to find the probability that a graduate applicant has an IQ less than 85, i.e. $P(X < 85)$, by clicking on `Calc` $\rightarrow$ `Probability Distributions` $\rightarrow$ `Normal`; selecting `Cumulative probability`; entering the `Mean` and `Standard deviation`; and then entering the `Input constant` as `85`. Clicking `OK` should give $P(X < 85) = 0.158655$ – the same as we got in the lecture, to 4 decimal places.

(b) Use the same approach as in part (a) to find the probability that a graduate applicant has an IQ less than 110.

(c) How would you use your answer to part (b) to find the probability that a graduate applicant has an IQ *greater than* 110?

(d) Use `Minitab` to find the probability that a graduate applicant has an IQ between 95 and 115.

2.* This is an assessed question.

Recall question 5 from Section 5.4 of the lecture notes:

> As Production Manager, you are responsible for buying a new piece of equipment for your company's production process. A salesman from one company has told you that he can supply you with equipment for which the time to first breakdown (in months) follows an exponential distribution with $\lambda = 0.11$.
>
> Another salesman (from another company) has told you that the time to first breakdown of their machines is also exponentially distributed but with $\lambda = 0.01$.
>
> It is very important that the equipment you purchase does not break down for at least six months.

For each company, use `Minitab` to find the Probability of a machine breakdown within the first six months. Include the relevant output from `Minitab` in your solutions, and write a sentence which explains your recommendations to the board. *[Hint: `Minitab` asks for the `Scale`, which is equal to $1/\lambda$; you should leave the `Threshold` as 0.0]*

3. Recall question 3 from Section 5.4 of the lecture notes:

> A coach is due to arrive in Newcastle from London at 23.00. However, it is equally likely to arrive anywhere between 15 minutes early to 45 minutes late, depending on traffic conditions. Let the random variable X denote the amount of time (in minutes) that the coach is delayed.

Use `Minitab` to find the probability that the coach

(a) is less than 5 minutes late;

(b) arrives between 22.55 and 23.20.

4. Recall the data in Table 6.1 of the lecture notes. Here, the number of transactions at all 1,000 branches of *The Vintage Clothing Co.* was recorded on Sunday 24th February 2013. Since we have taken a *census* of *all* shops in this chain, we can work out the true population mean μ as

$$\mu = \frac{282 + 258 + \ldots + 477}{1000} = 320 \text{ transactions.}$$

Now suppose we didn't know the population mean.

(a) Open up a *FireFox* web browser, and go to the ACC1012/53 course webpage:

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

Click on the Minitab tab in the taskbar, and scroll down to the section for Practical 2. Here, you'll see the link Vintage 2; click on this, and a `Minitab` worksheet should automatically open. **If the worksheet doesn't open automatically, then right-click the file, save in a convenient place and then open the worksheet from within Minitab. Ask for help if you're not sure!**

Once opened, scroll down and familiarise yourself with the worksheet.

- There should be two columns of data across 100 rows in the worksheet
- Each row represents a random sample of 2 observations from Table 6.1
- That is, we have taken 100 samples of size $n = \mathbf{2}$ from the data in Table 6.1, and stored each of these random samples in a row in the `Minitab` worksheet

(i) By hand, work out the sample mean for the first sample, $\bar{x}_1$. How does it compare the the true population mean?

(ii) By hand, work out the sample mean for the second sample, $\bar{x}_2$. How does it compare to the true population mean?

(iii) Now ask `Minitab` to calculate all 100 sample means, $\bar{x}_1, \bar{x}_2, \ldots, \bar{x}_{100}$. To do this, click on `Calc`→`Row Statistics`; select `Mean`; In the `Input variables` box enter `C1-C2` (the columns which store the data); tell `Minitab` to `Store result in` column `C4`; then click `OK`.
You should notice that `Minitab` has stored the means for all 100 samples of size 2 in column `C4`. As a check, compare your hand–calculated means from parts (i) and (ii) to those `Minitab` has calculated for samples 1 and 2. Label the column with the sample means as xbar.

(iv) Now look at the distribution of your sample means by selecting `Graph`→`Histogram`→`Simple`... What do you notice?
Do not discard your graph – you will need it later!
You should see that your histogram covers the range of values from 100–550.

(v) Now find the mean of your sample means, and the variance of your sample means, by clicking on `Stat`→`Basic Statistics`→`Display Descriptive Statistics`; enter `C4` as your `Variable` and click `OK`. You should find that

$$\text{Mean of means} = 324.63 \quad \text{and} \quad \text{Variance of means} = 84.46^2 = 7133.4916$$

This question continues on the next page...

(b) **Samples of size $n = 5$**
Now go back to the ACC1012 webpage, and click on the link for Vintage 5. This file contains 100 samples of size $n = 5$ from Table 6.1. Repeat parts (iii)–(v) of (a) above, but now for your 100 samples of size 5; you will have to carefully amend the options in part (iii) to account for your increased sample size.

Once you have produced your histogram, double–click on any of the numbers on the x–axis; an `Edit Scale` box should appear. "Untick" the `Minimum` and `Maximum` boxes, and then enter the values that your graph in part (a) covered. What do you notice?
Do not discard your graph – you will need it later!

Make a note of the mean of your means, and the variance of your means, in the space below:

Mean of means $=$ and Variance of means $=$

(c) **Samples of size $n = 10$**
Repeat part (b), but now after clicking on the link for Vintage 10. What do you notice?
Do not discard your graph – you will need it later!

Make a note of the mean of your means, and the variance of your means, in the space below:

Mean of means $=$ and Variance of means $=$

(d) **Samples of size $n = 100$**
Finally, repeat part (b), but now after clicking on the link for Vintage 100.

Make a note of the mean of your means, and the variance of your means, in the space below:

Mean of means $=$ and Variance of means $=$

(e) **Overall assessment**
Overall what do you notice in the histograms as you move from part (a) through to part (d)?

(f) **Central Limit Theorem**
In parts (a)–(d) you should have noticed the *Central Limit Theorem* in action. This tells us that

$$\bar{X} \sim N\left(\mu, \frac{\sigma^2}{n}\right).$$

Recall that we actually know the true value of μ:

$$\mu = 320.$$

Similarly, we can work out the true value of σ^2, the population variance, as

$$\sigma^2 = 14859.61.$$

(i) How do the "mean of your means", from parts (a)–(d), compare to μ?
(ii) How do the "Variance of your means", from parts (a)–(d), compare to σ^2/n?

5.* This is an assessed question.

For this question, I want you to summarise your findings from question 4.

(a) Copy–and–complete this table in your solutions:

	μ	Mean of $\bar{x}$'s	σ^2/n	Variance of $\bar{x}$'s
$\boldsymbol{n = 2}$	320	324.63	7429.805	7133.4916
$\boldsymbol{n = 5}$				
$\boldsymbol{n = 10}$				
$\boldsymbol{n = 100}$				

(b) Include four histograms in your solutions, showing the distribution of the sample mean $\bar{x}$ for (i) $n = 2$, (ii) $n = 5$, (iii) $n = 10$ and (iv) $n = 100$.

(c) Using your table in part (a), and the histograms in part (b), comment briefly on how the distribution of sample means compares to the true value for μ. What happens to the variability in $\bar{x}$? What does this tell you about using $\bar{x}$ as an estimator for μ?

Once you have finished working through the questions, follow the instructions overleaf for saving your worksheets and exiting `Minitab`.

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!