STATS 1000 / STATS 1004 / STATS 1504
Statistical Practice 1
Assignment 5
2020

DEADLINE:

- Wednesday 20th May 2020 (Week 10) 5:00pm

CHECKLIST

□: Have you shown all of your working, including probability notation where necessary?

□: Have you given all numbers to **3 decimal** places.

□: Have you included all R output and plots to support your answers where necessary.

□: Have you made sure that all plots and tables each have a caption.

□: If before the deadline, have you submitted your assignment via the online submission on MyUni?

□: Is your submission a single word document or pdf file - correctly orientated, easy to read? If not, penalties apply.

□: Penalties for more than one document - 10% of final mark for each extra document. Note that you may resubmit and your final version is marked, but the final document should be a single file.

□: If after the deadline, but within 24 hours, have you contacted us via the enquiry page on MyUni and then submitted your assignment online via the online submission on MyUni?

□: Penalties for late submission - within 24 hours 40% of final mark. After 24 hours, assignment is not marked and you get zero.

□: Assignments emailed instead of submitted by the online submission on MyUni will not be marked and will recieve zero.

□: Have you checked that the assignment submitted if the correct one, as we cannot accept other submissions after the due date.

□: Do not write directly on the question sheet.

- **Communicating Statistics - Executive Summary**

  In practical 8 you were shown how to complete a matched pairs t-test. Following these instructions, you will find the completed analysis on the Maths Marks data you completed in that practical. It is presented as a complete Statistical appendix. This assignment requires you to complete the exectutive summary to accompany that anysis and present it in the form of a statistical report.

  This project aims to extend your abilities from understanding the tests and how to do them, to being able to explain the outcome to a wider audience.

  As such, the project will not be in the usual form of your assignments, but in a report form; with a plain English exectutive summary which explains your findings to go with the statistical appendix which explains how you got your findings. This document includes a template, with instructions, on how to complete the executive summary and there is also a completed, example report for you to see on MyUni.

- **Background**

  The data, Maths Marks, was collected by a Maths lecturer at the University of Adelaide and consists of marks for the first two assignments their students completed in their course. The lecturer is worried that their assignments may not be consistently difficult so is interested in whether there is a difference in the marks received between the two assignments.

  Students who got zero for either or both assignments have been removed from this data set. Both assignments were out of 50 marks in total.

- **Instructions**

  Given the background above, identify the research question and, using the statistical appendix, report your findings using the template on the following pages. Check the marking rubric at the end of this document for more information on what is required for this project.

1. The following will detail the elements you need to include in your executive summary.

   (a) **Title** - The title should not be "Assignment 5" or "Math Marks Assignment", but rather the title of the report you have created. For example, a report on the diving behaviour of seals might read "The Diving Behaviour of Seals in Antarctica".

   [1 mark]

(b) **Aims** - The aim of the Report, not the assignment. For example, "To ascertain how deep seals dive and the how far they travel from shore on those dives".

[1 mark]

To ascertain if there is a difference in marks between Assignments 1 and 2.

(c) **Background** - Where the data came from. That is, everything you were told about the data before you started analysing it (copy-paste from the assignment instructions is totally ok here).

[1 mark]

It is OK this is copy/pasted from instructions.

The data was collected by a math lecturer at the University of Adelaide and consists of marks for the first two assignments their students completed in their course. The lecturer is worried that their assignments may not be consistently difficult so is interested in whether there is a difference in the marks received between the two assignments.

Students who got zero for either or both assignments have been removed from this data set.

This should not include any statistical terminology or any information about the type of analysis being completed. There should also not be any reference to this being an assignment.

(d) **Findings** - Feel free to use dot points for this section

   i. Prioritise your findings! Make sure the most important, most awesome, most awe-inspiring finding comes first.

   ii. Only talk about significant/important findings (unless you have been specifically asked to do otherwise). You don't want to lose your audience in a sea of irrelevance.

   iii. Be CONCISE. Short, sharp and accurate is what we want to see.

   iv. Reference every finding with a table/figure (figure 1). (Figures/tables go in the Statistical appendix).

1. Students earned between 4.4 and 5.6 marks more on Assignment 1 than on Assignment 2 (Table 2).

This must state there is a difference, the difference must be in the correct direction, it should include a confidence interval of the difference, have a reasonable number of decimal places and be in plain English.

(e) **Discussion** - Do not just repeat your findings here.

Any weirdness in your findings that needs to be explored further or retested should be discussed here. Highlight missing data and possible sources of confounding or lurking variables.

The whole executive summary should only take 1 to 1.5 pages.

[3 marks]

As every student completed the assignments in the same order, there may be order effects present. It could be the case that students approached assignment 2 differently because of their feedback on assignment 1, meaning these assignments are not independent. This may mean our findings are showing the effect of this ordering, rather than the effect of a change in assignment difficulty.

To take this into consideration, the order in which the assignments were given should have been randomized among the students.

The main point here is to identify the order effect, state the implications of this on the findings in plain English and provide a solution to the problem for a future study.

(f) **Formatting**

There will be five marks assigned for the five following elements of the execututive summary:

i. The summary is clear and easy to read.

ii. The summary is concise and gets straight to the point.

iii. The summary is completely unambiguous and does not use statistical terminology.

iv. There are a reasonable number of decimal places presented.

```
##           A1     A2
## mean 38.701 33.706
## sd     5.186  5.413
## min   17.000  9.000
## max   47.000 43.000
```

Table 1: Descriptive statistics of marks on assignments 1 and 2. This shows that assignment one had a higher average mark than assignment 2.

v. No misleading statements beyond the reach of analysis have been made.

[5 marks]

[Total: 15]

2. **Statistical Appendix**

(a) **Computational methods**

All analysis was completed using R verison 3.5.1 "Feather Spray".

(b) **Results**

Initial inspection of the data revealed data that looked left skewed and had multiple outliers for both assignments (Figure 1). The median for assignment one did appear higher than assignment 2 (Figure 1). Must provide a summary of the data in terms of skewness, location and outliers with refence to a plot. Boxplot of Marks for Assignments 1 and 2.

Looking at the descriptive statistics in Table 1, we see that the mean mark for assignment 1 was 38.7 (sd $= 5.19$) , which was higher than the mean for assignment 2 at 33.7 (sd $= 5.41$):

To test whether this is a significant difference or not, a matched pairs t-test was conducted because this is repeated measures data (it's the same people in both groups) with null and alternative hypotheses:

$H_0 : \mu_D = 0$

$H_a : \mu_D \neq 0$

Where μ_D is the population mean difference mark between assignments 1 and 2.
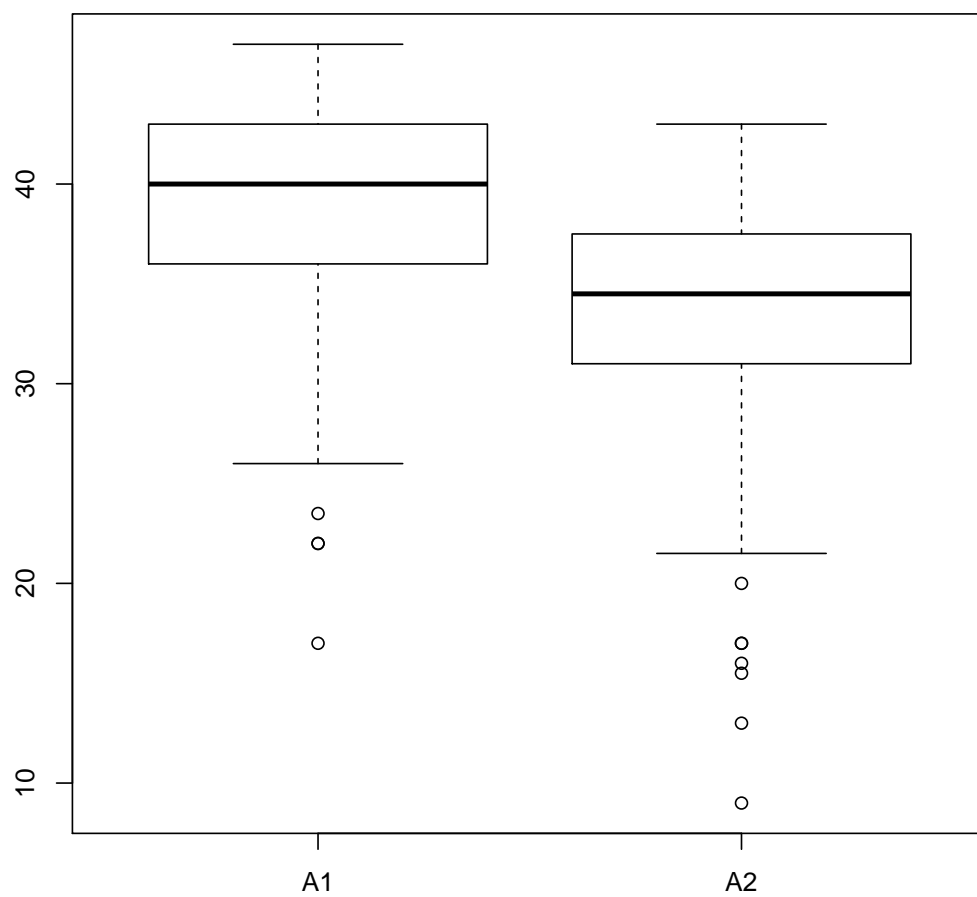
Figure 1: The boxplot of marks for Assignment one and Assignment two. This shows that students had a higher median mark for assignment one than assignment 2.

```
## 
##   One Sample t-test
## 
## data:  marks$A1 - marks$A2
## t = 17.272, df = 285, p-value < 2.2e-16
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##   4.425536 5.563974
## sample estimates:
## mean of x
##   4.994755
```

Table 2: Results from the matched pairs t-test showing a significant difference between assignments 1 and 2.

Table 2 shows that our p-value is less than .05 so we can reject the null hypothesis that there is no difference between the marks on assignments 1 and 2. We can therefor accept the alternative hypothesis that there is a difference between the marks on the assignments and, using the confidence interval in Table 2, say we are 95% confident that the average assignment one mark is truly somewhere between 4.4 and 5.6 marks higher than the average mark on assignment 2.

Checking the assumption of normality, Figure 2 shows the data mainly falls along the center line, suggesting our data is normally distributed.

The assumption of independence is less clearly met. As every student first completed assignment 1 and then assignment 2, there may be carry-over effects or order effects that are confounding our results. There is no guarantee that the difference we have observed here is purely because of the difficulty of the assignment due to this confounding. The order in which students completed the assignment would need to be randomized to be able to meet the assumption of independence.
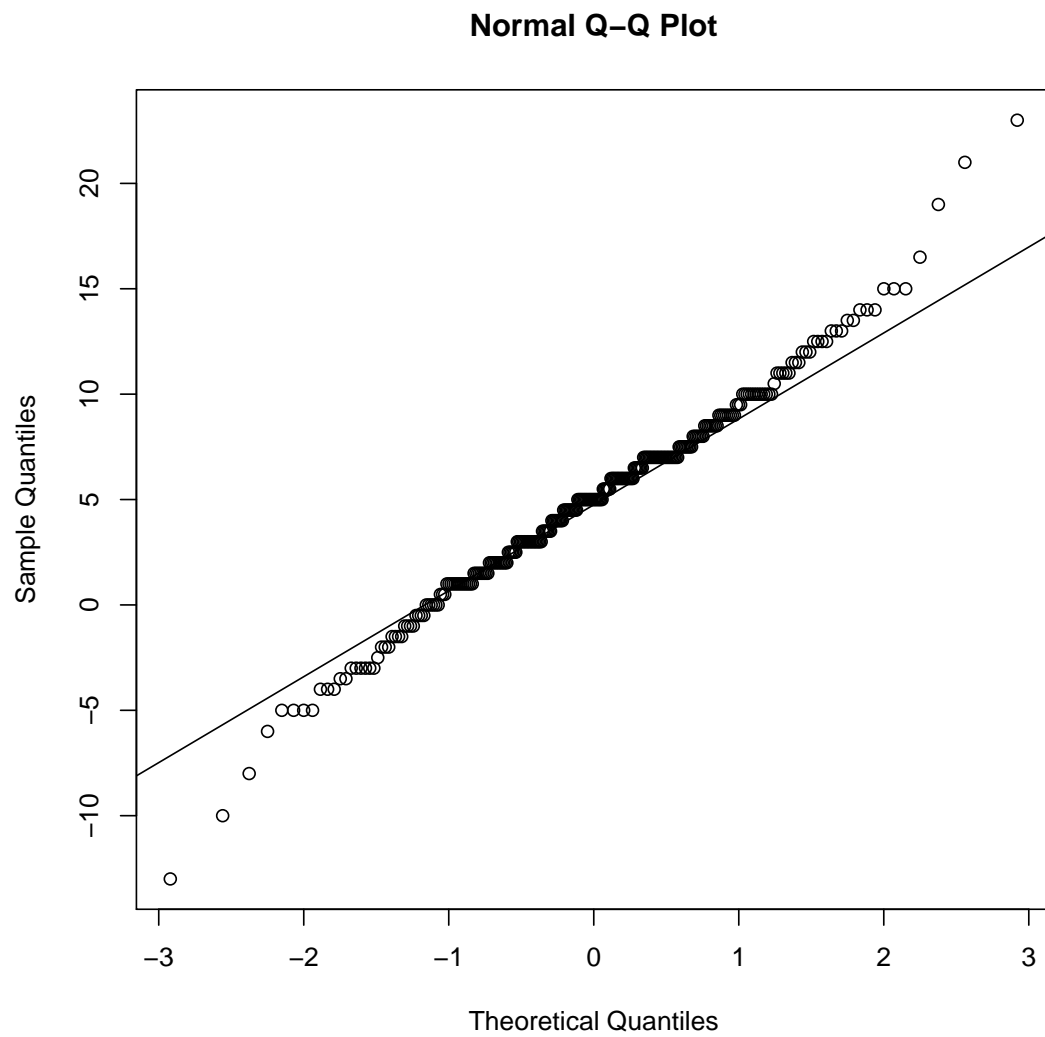
[[Assignment total: 15]]

Figure 2: Normal Q-Q plot of the difference between the marks on assignments 1 and 2. The majority of the points fall along the center line suggesting the assumption of normality is met.