475.101/102/107/108
STATISTICS

Assignment 5, Semester 1, 2000
Due: 4pm Thursday, 25th May

Instructions for handing in: PLEASE

1. Use (standard) **A4** sized paper.
2. Number each page in the top centre and **print** your name legibly at the **top right hand corner** of each page with the surname or family name underlined.
3. Attach a white *Department of Statistics Assignment Cover Sheet* to the front of the assignment. Staple or clip all pages together in the extreme top left hand corner.
4. Fold the paper length-wise so that the printed side of the cover sheet faces out.
5. **Print** your name, paper number and assignment number on the outside of the cover sheet. **Print** your ID number on the inside of the cover sheet.
6. **Hand the assignment in** to the appropriate hand-in box in the basement of the Maths/Physics building.

Notes:

- Assignment 5 will be marked out of 60 marks, 55 marks for questions 1 - 5 as shown below and 5 marks for communication, style and presentation. Please refer to Section C, Questions 17 to 19, in your Lecture Workbook / Course Resource Book for examples of how to set out your assignment answers. Your final mark will be converted to a mark out of 10 which will be recorded towards your course work.

Question 1. [12 marks]

(a) For each of the following descriptions of studies, state whether:
- they are experiments or observational studies.
- they are paired designs or produce two independent samples.

(i) Samples of river water are taken from just by the riverbank and also in the centre of the river at each of 20 randomly chosen locations on a river. The level of sulphur content was measured in sample and the results for riverbank samples were compared to the mid-river samples.

(ii) Two types of marine paint are compared by painting the left side of the boat with one brand and the right side with the other. This was repeated on 15 boats with which side using which brand of paint being allocated randomly. After a year, the colour retention of the paint on each side of each boat was assessed.

(iii) 30 English towns, which have separate high schools for boys and girls, are chosen at random. The towns cover a wide range of socio-economic conditions. The pass rates in mathematics are recorded for each of the 60 schools and average pass rates are compared between boys and girls.

(b) The signs of 10 differences that were calculated for a Sign test are:

- - 0 - + - - 0 - -

Calculate the *P-value* for testing the hypotheses: H_0: $\tilde{\mu}_{\text{Diff}} = 0$ vs H_1: $\tilde{\mu}_{\text{Diff}} \neq 0$.

(c) An experiment conducted on 5 groups (with sample sizes 8, 11, 9, 10 and 12) resulted in the following AVOVA table:

Analysis of Variance for Time					
Source	DF	SS	MS	F	P
Group	$\mathbf{df_1}$	862.28	215.57	$\mathbf{f_0}$	0.023
Error	$\mathbf{df_2}$	3082.05	68.49		
Total	$\mathbf{df_{tot}}$	3944.33			

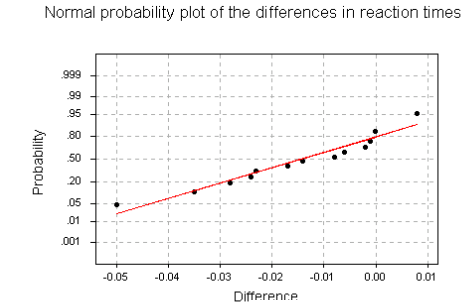
What are the values of df_1, df_2, df_{tot} and f_0?

Question 2. [11 marks]

A sports scientist is studying reaction times of male 100 metre elite sprinters, where reaction time is a measure of the time taken (in seconds) for the sprinter to start once the starter's gun has sounded. The sports scientist is interested in investigating whether a sprinter's reaction time changes as he advances in the competition.

Below are the reaction times from sprinters running in round 1 and round 3 of the men's 100 metres at the 1996 Atlanta Summer Olympics.

		Round 1	Round 3
Nobuharu	Asahara	0.148	0.147
Donovan	Bailey	0.172	0.170
Ato	Boldon	0.137	0.145
Linford	Christie	0.160	0.125
Jon	Drummond	0.140	0.132
Davidson	Ezinwa	0.152	0.146
Frank	Fredericks	0.156	0.142
Michael	Green	0.175	0.152
Anninos	Markoullides	0.214	0.164
Michael	Marsh	0.185	0.157
Dennis	Mitchell	0.165	0.141
Eric	Nkansah	0.189	0.189
Bruny	Surin	0.168	0.151
Obadele	Thompson	0.184	0.184



W-test for Normality
R: 0.9724
P-Value(approx) > 0.1000

(a) Is there a significant difference in reaction time between round 3 and round 1? Using either *Excel*, *MINITAB* or a graphics calculator, carry out a 2-sided *t*-test to investigate this question. Note: a 95% confidence interval for this difference is [–0.02364, –0.00493]. State the hypotheses being tested and interpret your results.

(b) Above is the Normal Probability plot of the differences in reaction times between round 1 and round 3. State the hypotheses being tested. Interpret the plot and the relevant test.

(c) Using parts **(a)** and **(b)** write a brief report summarising your results with particular reference to:

(i) answering the question "What happens to reaction times as the sprinters advance in the competition"?

(ii) the applicability of the *t*-test and confidence interval.

Question 3. [12 marks]

Is it harder to maintain your balance while you are concentrating? Nine elderly (6 men and 3 women) and eight young men were subjects in this experiment. Each subject stood barefoot on a "force platform" and was asked to maintain a stable upright position and to react as quickly as possible to an unpredictable noise by pressing a hand held button. The noise came randomly and the subject concentrated on reacting as quickly as possible. The platform automatically measured how much each subject swayed in millimetres in both the forward/backward and the side-to-side directions.

The data below gives the amount of forward/backward sway experienced by the two groups of subjects (young and elderly) while taking part in the reaction time test.

Elderly: 19 30 20 19 29 25 21 24 50

Young: 25 21 17 15 14 14 22 17

In this question you will perform two different types of analyses on the above data. Not all of these tests are appropriate; you will discuss this issue in **(b)**. For each of the tests you should clearly state your hypotheses and interpret the results.

(a) **(i)** Is there a significant difference in the average amount of forward/backward sway experienced by the "elderly" and "young" groups? Using either *Excel*, *MINITAB* or a graphics calculator, carry out a 2-sided *t*-test to investigate this question. **Note:** a 95% confidence interval for this difference is [0.3, 16.1].

(ii) Below is the *MINITAB* output for the Mann-Whitney test investigating if there is a significant difference in the average amount of forward/backward sway experienced by the "elderly" and "young" groups. State the hypotheses being tested.

MANN-WHITNEY TEST FORWARD – BACKWARD BALANCE

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Mann-Whitney Confidence Interval and Test

elderly  N =   9     Median  =       24.00
young    N =   8     Median  =       17.00
Point estimate for ETA1-ETA2 is        6.00
95.1 Percent CI for ETA1-ETA2 is (2.00,13.00)
W = 104.0
Test of ETA1 = ETA2  vs  ETA1 not = ETA2 is significant at 0.0304
The test is significant at 0.0299 (adjusted for ties)
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(b) Draw an appropriate plot(s) for this dataset either using a computer or by hand. Which of the two tests from **(a)** is most appropriate for this data? Justify your answer.

Question 4. [14 marks]

As part of safety tests, four fabrics were tested for flammability. The test involves a paper tag being attached to the dress made of a fabric, the paper tag being set alight and the total time (in seconds) that the tag burned for recorded. The test is conducted on five samples for each of the four types of fabric.

A copy of computer output for analysing the burn time (Time) by type of fabric (Fabric) is included on the following page.

(a) Briefly comment on what the dotplot of the data shows.

(b) It was suggested that it would have been better to use boxplots instead of dotplots. Comment on this.

(c) Would the outcome of the test on one piece of fabric have any effect on the test of another piece? What does this tell us about the assumptions for the *F*-test on these data?

(d) Calculate the ratio of the sample standard deviation from the most variable group to the sample standard deviation from the least variable group.

(e) Briefly comment on the validity of the *F*-test.

(f) If the *F*-test is not valid, name the alternative non-parametric test to use in its place.

(g) Assume that an *F*-test is an appropriate test to use here.
- **(i)** State the null hypothesis for the test both in words and using symbols.
- **(ii)** State the alternative hypothesis for the test in words.
- **(iii)** What does the result of your *F*-test tell you about the average flammability of the four fabrics? Explain your answer in 1-2 sentences using plain English.

(h) Assuming the Tukey's pairwise comparisons are valid:
- **(i)** Which fabric(s), on average, burned for the longest time.
- **(ii)** Which fabric(s), on average, burned for the shortest time.
- **(iii)** Give an interval estimating the difference in average burning times between fabric 2 and fabric 4.

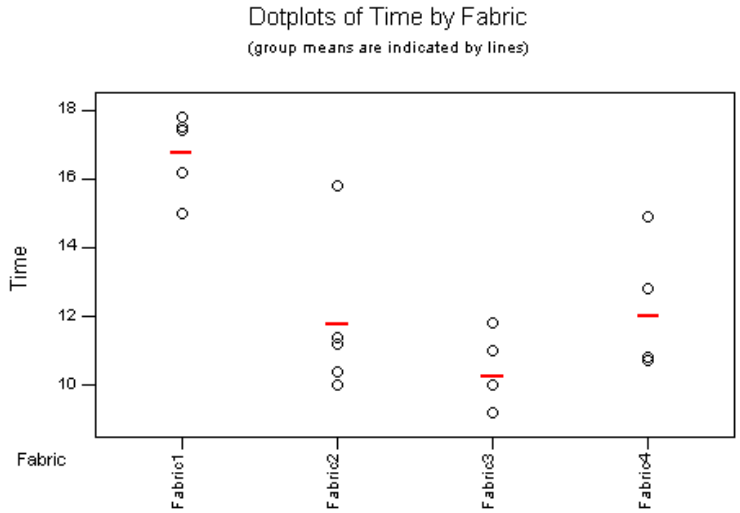
Question 5. [6 marks]

For each of the situations below write a brief report in which you:
- Describe an experiment you could use to investigate the problem posed. Include details of how you would allocate treatments to subjects. Justify your choice of experimental design.
- Describe what hypotheses you would test.

(a) A market researcher is interested in whether the response rates to consumer surveys differ between using two different incentive methods: the first where respondents are entered into a draw for a single $500 prize and the second where there are five draws each for a $100 prize. The next survey (of 1000 households) can be used for the experiment. There is a budget of $1000 for prizes.

(b) An automotive engineer is interested in the comparative fuel consumption when using two different types of carburettors. The comparisons need to be made under actual driving conditions (as opposed to at a test track), but using the same model car. It is known that fuel consumption rates can vary heavily depending on the type of journeys made and the type of driver. 20 cars (of the same make and model) are available to be used for one month. A sample of 20 people willing to help by driving the experiment cars instead of their regular cars for a month was chosen. Responses to be compared are the average fuel consumption per kilometre travelled.

Computer output for question 4:

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One-way Analysis of Variance

Analysis of Variance for Time
Source     DF        SS        MS        F        P
Fabric      3    120.50     40.17    13.89    0.000
Error      16     46.26      2.89
Total      19    166.76

                                    Individual 95% CIs For Mean
                                    Based on Pooled StDev
Level       N     Mean     StDev  --+---------+---------+---------+----
Fabric1     5   16.780     1.167                        (----*----)
Fabric2     5   11.760     2.330       (----*-----)
Fabric3     5   10.240     1.144   (----*-----)
Fabric4     5   11.980     1.862       (----*----)
                                    --+---------+---------+---------+----
Pooled StDev =    1.700              9.0      12.0      15.0      18.0

Tukey's pairwise comparisons

    Family error rate = 0.0500
Individual error rate = 0.0113

Critical value = 4.05

Intervals for (column level mean) - (row level mean)

            Fabric1     Fabric2     Fabric3

 Fabric2      1.940
              8.100

 Fabric3      3.460      -1.560
              9.620       4.600

 Fabric4      1.720      -3.300      -4.820
              7.880       2.860       1.340
```