Exercises on Non-Parametric Tests

1) It was reported that during a six-month period, new salespersons in an insurance company spent an average of 119 hours per month in the field. Suppose that a random sample of 16 new salespersons was taken from another insurance company and the number of hours in the field recorded. The data is in the file ***ihours.csv***.

   a) Test the hypothesis that the median of the population from which this sample was drawn is 119 hours.
   b) Explain whether or not this test is advantageous over the t-test for the population mean.

2) Monthly salary data was obtained from a random sample of 6 males and 8 females in management position in companies located in a particular city. The data shown below is also in the file, ***mfsalary.csv***.

Male	Female
5047	4386
8317	5159
3763	6432
10950	11582
12944	6513
8634	4304
	5929
	5405

a) Use a Mann-Whitney U test to determine whether males in management position in this city earn significantly more than females in equivalent positions. Test at the 5% level of significance.
b) What alternative testing procedure could be used? Explain whether or not the Mann-Whitney U test is advantageous over this alternative test.

3) In manufacturing, does worker productivity drop on Friday? In an effort to determine whether it does, a company personnel analyst randomly selects five workers from a manufacturing plant who make the same part. He measures their output on a Wednesday and again on the Friday of the week and obtains the following results.

Worker	Wednesday Output	Friday Output
1	71	53
2	56	47
3	75	52
4	68	55
5	74	58

These data are also in the file ***wfprod.csv.***

a) Use the Wilcoxon Paired Signed-Ranks procedure to test if the samples provide sufficient evidence that production drops on Fridays.
b) What alternative testing procedure could be used? Explain whether or not the Wilcoxon Paired Signed-Ranks test is advantageous over this alternative test.

4) A management consulting company presents a three-day seminar on project management to various clients. The seminar is basically the same each time it is presented. However, sometimes, it is presented to managers at different levels, namely senior managers, middle-level managers and junior managers. The seminar organisers believe evaluations of the seminars may vary with the audience. Suppose that the following data are some randomly selected evaluation scores from different levels of managers. The ratings are on a scale of 1 to 10 with 10 being the highest.

Senior Level	Middle Level	Junior Level
7	8	5
7	9	6
8	8	5
7	10	7
9	9	4
	10	8
	8	

The data is in the file, ***smjcores.csv***.

a) Use the Kruskal-Wallis testing procedure to determine whether there is a significance difference in the evaluations according to manager level. Test at the 5% level of significance.
b) Explain why the Kruskal-Wallis testing procedure is appropriate for the data at hand whereas the completely randomised design testing procedure is not.

5) A tyre company has developed a new tyre and has conducted tread-wear tests to determine whether or not there is a significant difference in the tread-wear of the tyre if the average speed at which a car is driven, varies. The company set up an experiment with three treatment levels: slow speed (car is driven at 30 km/h), medium speed (car is driven at 60 km/h) and high speed (car is driven at 90 km/h). Company researchers realised that several possible variables could confound the study. One of these variables is supplier of rubber from which the tyres are made. The company uses five different suppliers of rubber. The researchers used supplier as a blocking variable in the analysis. Fifteen sets of tyres were selected for the study, three sets of which were made from the rubber of each of the five suppliers. Each of the 15 cars fitted with these tyres, was driven over different periods of time, until 10,000 kilometres was covered within a

given time frame. Thereafter, the tyre tread-wear depth was measured in millimetres. Note that the deeper the thread, the less the wear on the tyres. The data from the experiment are given below.

	Speed		
Supplier	Slow	Medium	Fast
1	2.3	2.8	1.9
2	2.1	2.4	1.8
3	2.2	2.6	1.9
4	2.0	2.2	1.6
5	2.4	3.0	2.1

This data has been rearranged in the file ***tyre.csv***

a) Using the Friedman test, can it be concluded at the 5% level of significance that there is a treatment effect, i.e., if there is evidence of differences in median tread-wear depth across the three speed categories.
b) What alternative testing procedure could be used? Explain whether or not the Friedman test is advantageous over this alternative test.