

**Tutorial 6**

1. An experiment was conducted to examine the effect of age on heartbeat rate when a person is subjected to a specific amount of exercise. Male subjects were selected at random from four age groups. Each subject walked a treadmill at a fixed grade for 12 minutes and the increase in heartbeats per minute was recorded.

Age group				
	10–19	20–39	40–59	60–69
	29	24	37	28
	33	27	25	29
	26	33	22	34
	27	31	33	36
	35	21	28	21
	33	28	26	20
	29	24	30	25
	36	34	34	24
	22	21	27	33
		32	33	32
Totals	270	275	295	282

$$CM = 32279.08, \quad \sum_i \sum_j x_{ij}^2 = 33180.$$

- (a) Test for differences in the mean increase of heartbeat per minute among the four age groups (construct the ANOVA table and draw your conclusion).
- (b) Test for a difference between the age groups 10–19 and 20–39.

2. Water samples were taken at three different locations in a river to determine whether the quantity of dissolved oxygen, a measure of water pollution, varied from one location to another. Location 1 was selected above an industrial plant; Location 2 was adjacent to the industrial water discharge for the plant; and Location 3 was slightly downriver in midstream. Fifteen water specimens were randomly selected at each location. The data are shown in the accompanying table (The greater the pollution, the lower will be the dissolved oxygen readings).

Location 1	Location 2	Location 3
5.9	4.8	6.0
6.1	5.0	6.1
6.3	4.3	5.8
6.1	4.7	5.6
6.0	5.1	5.7

$$\sum \sum x_{ij} = 83.5, \quad \sum \sum x_{ij}^2 = 470.25.$$

- (a) Test whether the data provide sufficient evidence to indicate a difference in mean dissolved content for the three locations by using an analysis of variance.
- (b) Test whether there is a difference in mean dissolved content between Location 1 and Location 3 using a  $t$ -test.
- (c) Conduct a 95% simultaneous test using the Bonferroni method.

## Computer Exercises 6

1. Let us consider an experimental study of drugs to relieve itching. Five drugs (N3-N7) were compared to a placebo (N2) and no drugs (N1) with 10 volunteer male subjects aged 20-30.

N1	N2	N3	N4	N5	N6	N7
174	263	105	199	141	108	141
224	213	103	143	168	341	184
260	231	145	113	78	159	125
255	291	103	225	164	135	227
165	168	144	176	127	239	194
237	121	94	144	114	136	155
191	137	35	87	96	140	121
100	102	133	120	222	134	129
115	89	83	100	165	185	79
189	433	237	173	168	188	317

- (a) Enter the above data.

Data can be read from the internet as follows:

```
x = read.table(file =  
url("http://www.maths.usyd.edu.au/stat2912/r/itching.txt"),header=T)
```

Alternatively, you can copy and paste the following commands:

```
N1 = c(174, 224, 260, 255, 165, 237, 191, 100, 115, 189)
```

```
N2 = c(263, 213, 231, 291, 168, 121, 137, 102, 89, 433)
```

```
N3 = c(105, 103, 145, 103, 144, 94, 35, 133, 83, 237)
```

```
N4 = c(199, 143, 113, 225, 176, 144, 87, 120, 100, 173)
```

```
N5 = c(141, 168, 78, 164, 127, 114, 96, 222, 165, 168)
```

```
N6 = c(108, 341, 159, 135, 239, 136, 140, 134, 185, 188)
```

```
N7 = c(141, 184, 125, 227, 194, 155, 121, 129, 79, 317)
```

- (b) Obtain side by side boxplots of the seven groups.
- (c) Perform a one-way ANOVA on the data, and state the conclusion.
- (d) Obtain a normal quantile plot of the residuals from the aov function.
- (e) Obtain a 95% CI to compare the placebo (N2) and the no treatment (N1) groups.
- (f) Perform a multiple comparison test using the Holm method and report any pairs for which the means are significantly different at overall level  $\alpha = 0.05$ .