Minitab Tutorial for Repeated Measures

Problem description

An investigator is interested in comparing the cardiovascular fitness of elite runners on three different training courses, each of which covers 10 miles. The courses differ in terms of terrain, Course 1 is flat, Course 2 has graded inclines, and Course 3 includes steep inclines. Each runner's heart rate is monitored at mile 5 of the run on each course. Ten runners are involved, and their heart rates measured on each course are shown below.
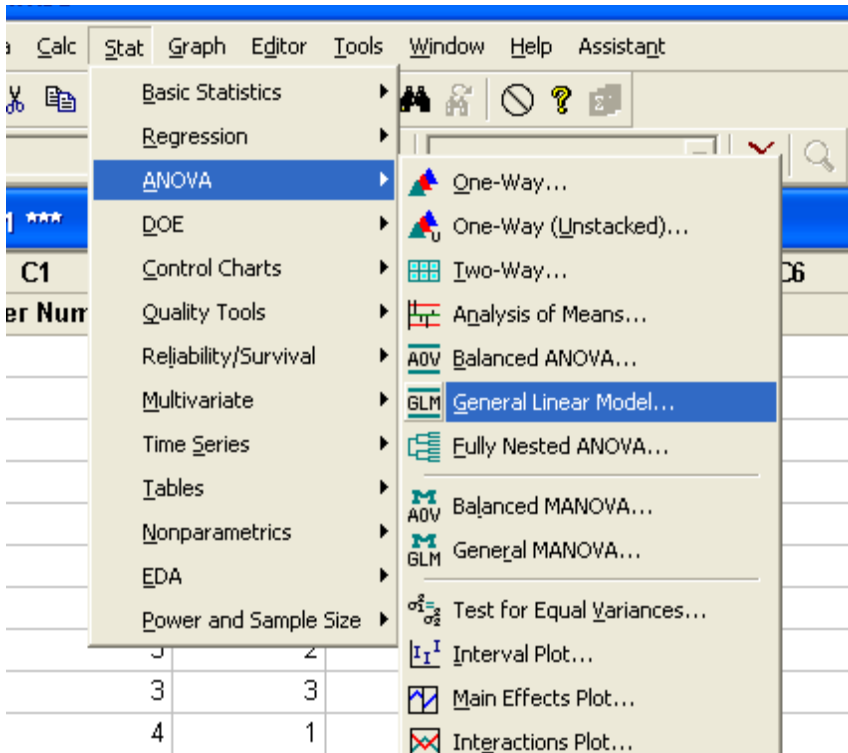
Runner number	Course1	Course2	Course3
1	132	135	138
2	143	148	148
3	135	138	141
4	128	131	139
5	141	141	150
6	150	156	161
7	131	134	138
8	150	156	162
9	142	145	151
10	139	165	160

In Minitab, the data should be entered as picture below.

Repeated Measure ANOVA

Click on **Stat-ANOVA- General Linear Model** in the pull down menus to start the process.

We need to define which of our variables is the dependent variable and which is the factor variable. In the window for the test, in **Responses** enter the dependent variable (Heart Rate), in **Model** enter the Case Number variable (Runner Number), the Factor variable (Course), in **Random factors** enter the Case Number variable. Click **Ok**.
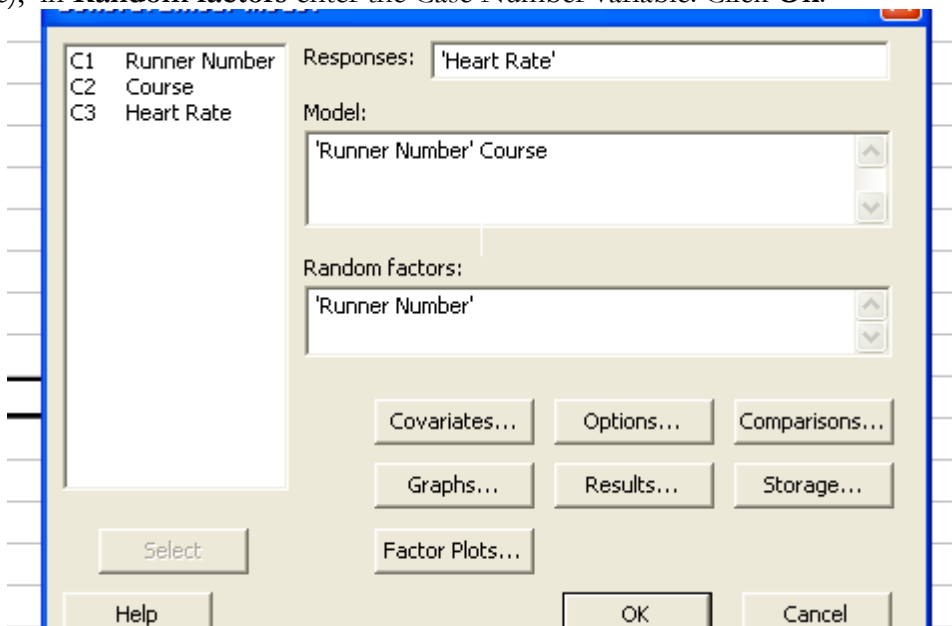
Output

Recall that the null hypothesis in ANOVA is that the means of all the groups are the same and the alternative is that at least one is different. So for our example with 3 treatment groups

$H_0: \mu_1 = \mu_2 = \mu_3$

$H_A:$ At least one mean is different

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Session

General Linear Model: Heart Rate versus Runner Number, Course

Factor          Type     Levels  Values
Runner Number   random       10  1, 2, 3, 4, 5, 6, 7, 8, 9, 10
Course          fixed         3  1, 2, 3


Analysis of Variance for Heart Rate, using Adjusted SS for Tests

Source          DF   Seq SS   Adj SS   Adj MS      F      P
Runner Number    9  2224.53  2224.53   247.17  16.19  0.000
Course           2   476.47   476.47   238.23  15.60  0.000
Error           18   274.87   274.87    15.27
Total           29  2975.87


S = 3.90773   R-Sq = 90.76%   R-Sq(adj) = 85.12%


Unusual Observations for Heart Rate

Obs  Heart Rate       Fit  SE Fit  Residual  St Resid
 28     139.000   149.500   2.471   -10.500     -3.47 R
 29     165.000   155.300   2.471     9.700      3.20 R
R denotes an observation with a large standardized residual.
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We will use the Runner Number line, as that is the Factor of interest. Here SSb is 476.47 and SSw is 274.87. The p-value is .000 and thus we reject the null hypothesis and conclude that there is significant difference in runner's heart rate among the courses.