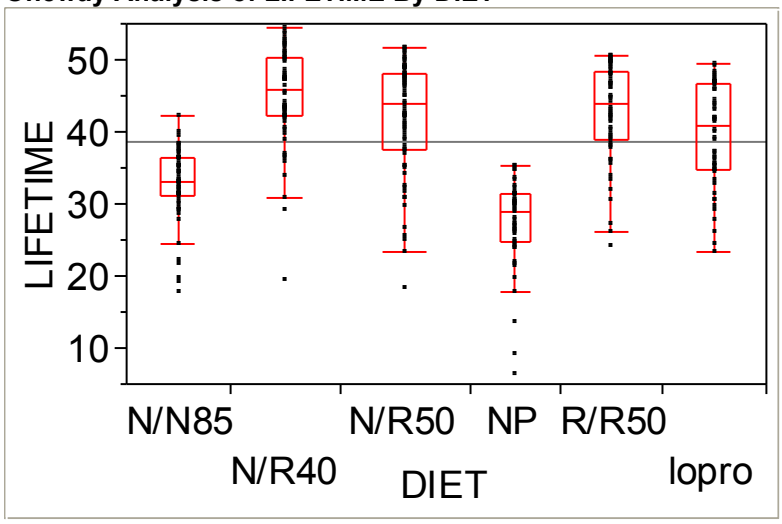
Comparisons Among Several Samples (Analysis of Variance) in JMP

We illustrate comparisons among several samples using case study 5.1.1. For doing the analysis in JMP, the data needs to be organized in two columns, one column containing the response variable (Y) and another column containing the group label (X). Make sure that the group label column is nominal.

1) Initial Graphical Assessment:

The first step in a statistical analysis should be to make an initial graphical examination of the data. For several samples, this is most easily done by making side-by-side box plots. Use Analyze, Fit Y by X, putting the response variable in Y and group label variable in X. Click on the red triangle next to Oneway Analysis, click on Display Options and click on Box Plots.

Oneway Analysis of LIFETIME By DIET



Another useful first summary of the data is the means, standard deviations and sample sizes. This is obtained by clicking on Means and Std Dev on the red triangle next to Oneway Analysis.

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
N/N85	57	32.6912	5.12530	0.67886	31.331	34.051
N/R40	60	45.1167	6.70341	0.86541	43.385	46.848
N/R50	71	42.2972	7.76819	0.92192	40.458	44.136
NP	49	27.4020	6.13370	0.87624	25.640	29.164
R/R50	56	42.8857	6.68315	0.89307	41.096	44.675
lopro	56	39.6857	6.99169	0.93430	37.813	41.558

As in the two-sample problem, initial graphical assessments helps to identify (1) the centers; (2) the relative spreads; (3) the general shapes of the distributions; and (4) the presence of outliers.
For checking whether the equal spread assumption is reasonable (i.e., whether the t-test and ANOVA inferences that assume equal spread will be valid), a rule of thumb is to look at whether the ratio of the largest sample standard deviation to the smallest sample standard deviation is less than two. Here the ratio is $7.77/5.13 = 1.51 < 2$. Thus, the t-tests and ANOVA analyses should be approximately valid here. If the spreads are quite different, transforming the data to a different scale should be considered.

It is evident that the distributions of lifetimes are skewed to the left. However, this should not be a problem because the sample sizes are large (greater than 30 in each group).

There are several outliers (below the mean), particularly in the N/N85 group and the NP group. These should be investigated using the outlier examination strategy in Display 3.6.

2) Comparing Any Two of Several Means:

To compare any two means, click on Compare Means, Each Pair, Student's t under Oneway Analysis of Variance. The following voluminous output appears.

Means Comparisons

Comparisons for each pair using Student's t

t	Alpha
1.96690	0.05

Abs(Dif)-LSD

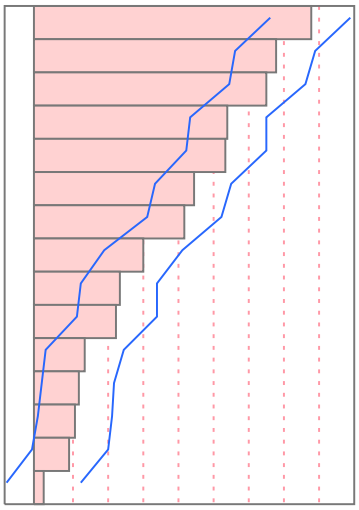
	N/R40	R/R50	N/R50	lopro	N/N85	NP
N/R40	-2.398	-0.210	0.516	2.990	9.996	15.185
R/R50	-0.210	-2.482	-1.759	0.718	7.723	12.914
N/R50	0.516	-1.759	-2.205	0.264	7.270	12.456
lopro	2.990	0.718	0.264	-2.482	4.523	9.714
N/N85	9.996	7.723	7.270	4.523	-2.460	2.730
NP	15.185	12.914	12.456	9.714	2.730	-2.654

Positive values show pairs of means that are significantly

Level			Mean
N/R40	A		45.116667
R/R50	A	B	42.885714
N/R50		B	42.297183
lopro		C	39.685714
N/N85		D	32.691228
NP		E	27.402041

Levels not connected by same letter are significantly

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value	
N/R40	NP	17.71463	1.285883	15.1854	20.24384	<.0001	*
R/R50	NP	15.48367	1.306365	12.9142	18.05317	<.0001	*
N/R50	NP	14.89514	1.240296	12.4556	17.33469	<.0001	*
N/R40	N/N85	12.42544	1.235213	9.9959	14.85498	<.0001	*
lopro	NP	12.28367	1.306365	9.7142	14.85317	<.0001	*
R/R50	N/N85	10.19449	1.256521	7.7230	12.66594	<.0001	*
N/R50	N/N85	9.60596	1.187682	7.2699	11.94201	<.0001	*
lopro	N/N85	6.99449	1.256521	4.5230	9.46594	<.0001	*
N/R40	lopro	5.43095	1.240856	2.9903	7.87160	<.0001	*
N/N85	NP	5.28919	1.301006	2.7302	7.84814	<.0001	*
R/R50	lopro	3.20000	1.262069	0.7176	5.68237	0.0117	*
N/R40	N/R50	2.81948	1.171097	0.5160	5.12292	0.0166	*
N/R50	lopro	2.61147	1.193550	0.2639	4.95907	0.0293	*
N/R40	R/R50	2.23095	1.240856	-0.2097	4.67160	0.0731	
R/R50	N/R50	0.58853	1.193550	-1.7591	2.93613	0.6223	



(Note: paste special => picture)

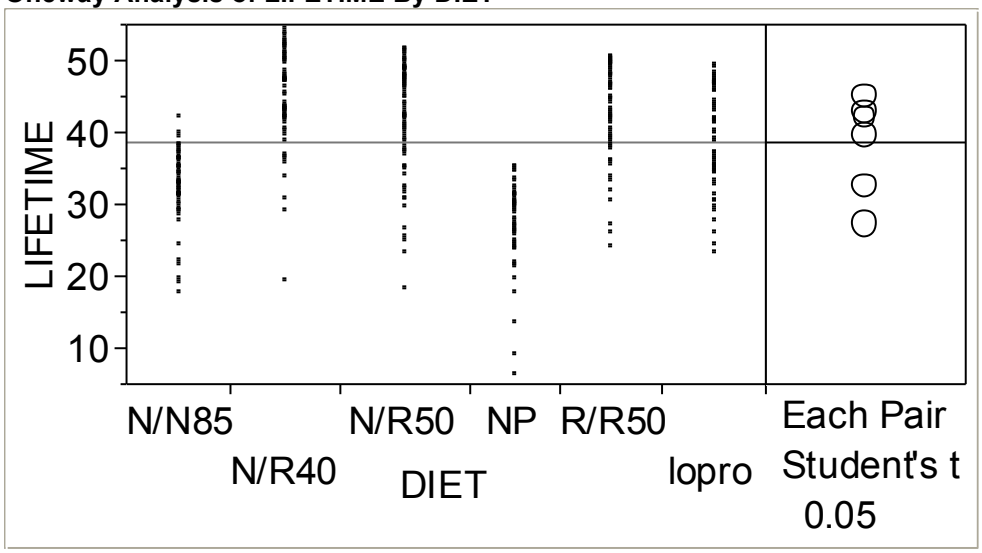
The first table shows which pairs of groups have significantly different means when compared using a t-test (with a pooled standard deviation that uses all groups), where significantly different means that the p-value of a two-sided test is less than 0.05. The pairs of groups which have a positive number in the table are significantly different. Thus, the treatment effects of N/R40 is significantly different from N/R50, lopro, N/N85

and NP but not from R/R50. Out of the 15 possible pairwise comparisons, 13 pairs are significantly different. **The numbers in the table are the absolute value of the difference in sample means minus the "least significant difference**." The least significant difference (LSD) is the smallest difference in sample means which would yield a p-value of a two-sided test that is less than .05. The LSD equals $t_{N-I}(.975)\frac{s_P}{\sqrt{n}}$ where s_P is the pooled sample standard deviation.

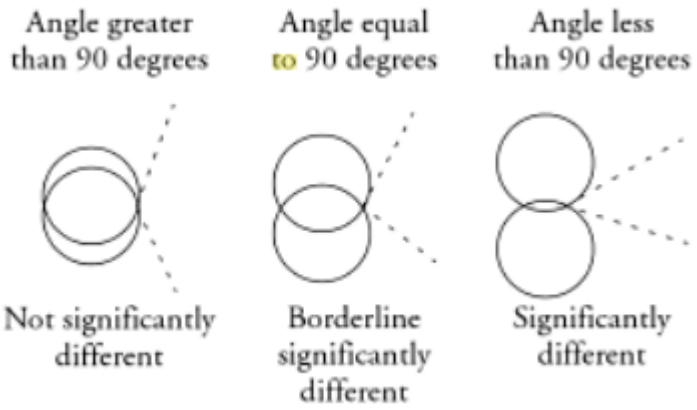
The confidence intervals for the difference between any two groups are listed in the third table.

The comparison circles which are printed next to the boxplots when running compare means provide a graphical display of which groups have significantly different means.

Oneway Analysis of LIFETIME By DIET



Each circle corresponds to a group (by clicking on a circle, the group which corresponds to it will be highlighted in red). If the circles of two groups do not overlap, the group means are significantly different. If the circles of two groups overlap, the group means are significantly different if the angle of intersection is greater than 90 degrees but not significantly different if the angle of intersection is less than 90 degrees.



3) One Way Analysis of Variance F test:

The test of $H_0 : \mu_1 = \mu_2 = ... = \mu_I$ versus H_1 :at least two means differ is carried out in JMP by clicking Means/ANOVA/t-test under the red triangle next to Oneway Analysis of Variance.

Oneway Anova

Oneway Anova

Summary of Fit

Rsquare	0.454275
Adj Rsquare	0.44632
Root Mean Square Error	6.678239
Mean of Response	38.79713
Observations (or Sum Wgts)	349

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
DIET	5	12733.942	2546.79	57.1043	<.0001 *
Error	343	15297.415	44.60		
C. Total	348	28031.357			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
lopro	56	39.6857	0.89242	37.930	41.441
N/N85	57	32.6912	0.88455	30.951	34.431
N/R40	60	45.1167	0.86216	43.421	46.812
N/R50	71	42.2972	0.79256	40.738	43.856
NP	49	27.4020	0.95403	25.526	29.279
R/R50	56	42.8857	0.89242	41.130	44.641

Std Error uses a pooled estimate of error

The test statistic is the F Ratio. The p-value is Prob>F. Thus, the p-value is <.0001 for the test that the means (treatment effects) of all the mice diets is the same; there is convincing evidence that the treatment effects of all the diets are not the same.

4) Residual analysis:

Check red triangle next to Oneway Analysis => save => save residuals
In the datasheet you'll find a new column which is the residual, i.e., the centered data by the "diet".
=> fit y by x => the new column into y and diet into x => get a residual plot

Practice: analyze the dataset case0502.jmp using the above steps 1) -4)