

Analysis of Variance

ANOVA

F-Test

Analysis of Variance

- Data sets are often succinctly described by giving their Mean (for a description of the center) and Standard Deviation (to describe the variation)
- Variance is the square of the Standard Deviation
- The **F-test** is used to determine if there is a Statistically Significant difference among three or more Means

Analysis of Variance

- ANOVA test is used to test the difference of means among three or more independent normally distributed samples
- **Example**
 - There are three types of training given to our workers. Do they result in different effects on worker performance?

Analysis of Variance

Criteria for using the ANOVA test

- Normally distributed quantitative samples
- The groups have assumed equal variances
- Testing the difference among three or more means

$$F = \frac{MST}{MSE}$$

= **F score**

Analysis of Variance

Null Hypothesis: There is No difference among different means

Alternative Hypothesis: At least one mean differs from the rest of other means

Analysis of Variance

There are 3 types of ANOVA

- **1-Way Single Factor**
- 2-Way without Replication
- 2-Way with Replication

Analysis of Variance

A researcher wishes to try three different techniques *to lower blood pressure of individuals diagnosed with high blood pressure.*

The subjects are randomly assigned to three groups; the first group takes medication, the second group exercises, and the third group follows a special diet.

After four weeks, the reduction in each person's blood pressure is recorded.

Analysis of Variance

Medication

Exercise

Diet

10

6

5

12

8

9

9

3

12

15

0

8

13

2

4

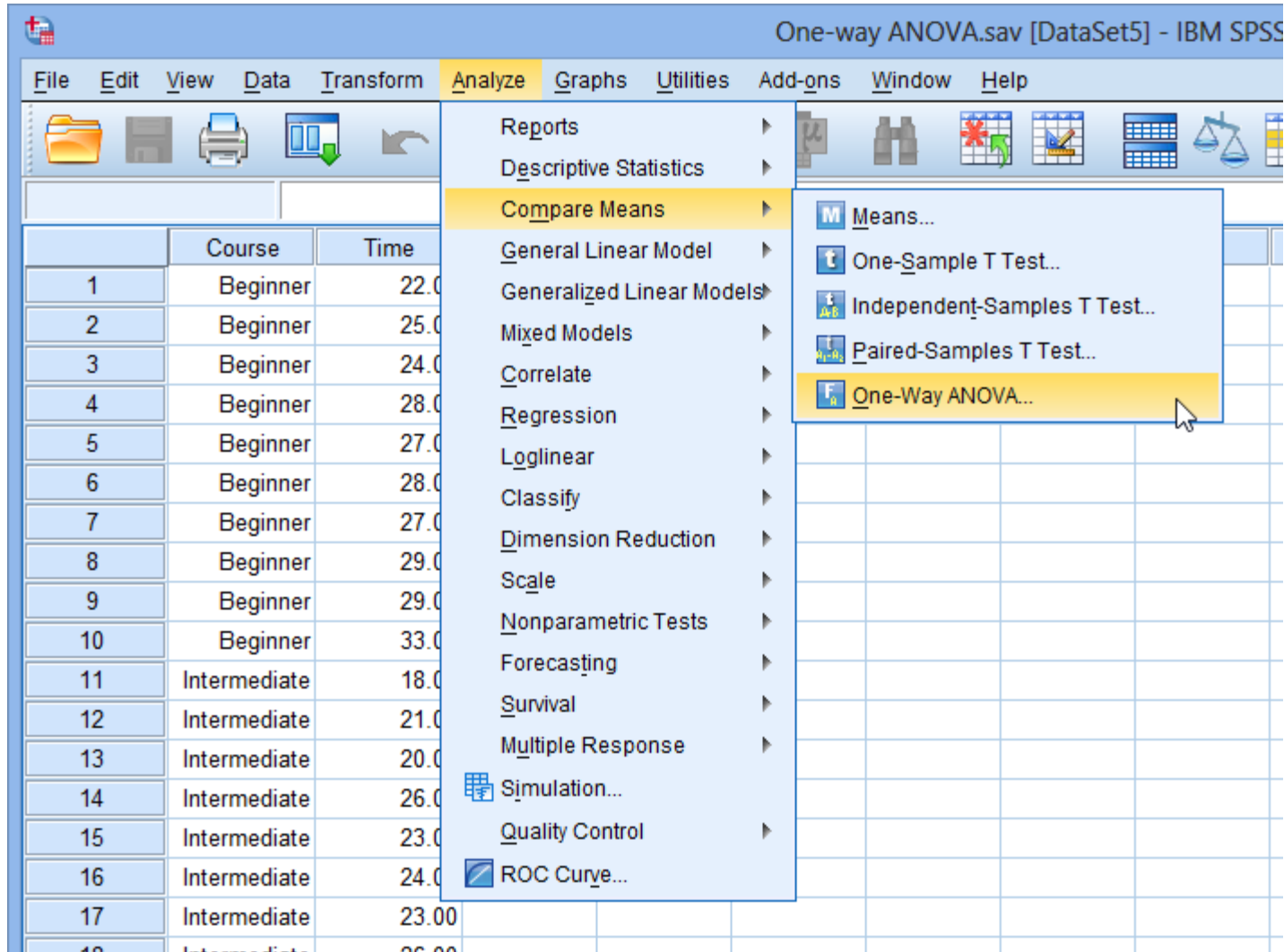
Analysis of Variance

Post-hoc Test

Post hoc tests are designed for situations in which the researcher has already obtained a significant F-test with a factor that consists of three or more means and additional exploration of the differences among means is needed to provide specific information on which means are significantly different from each other

Least Square Difference (LSD)

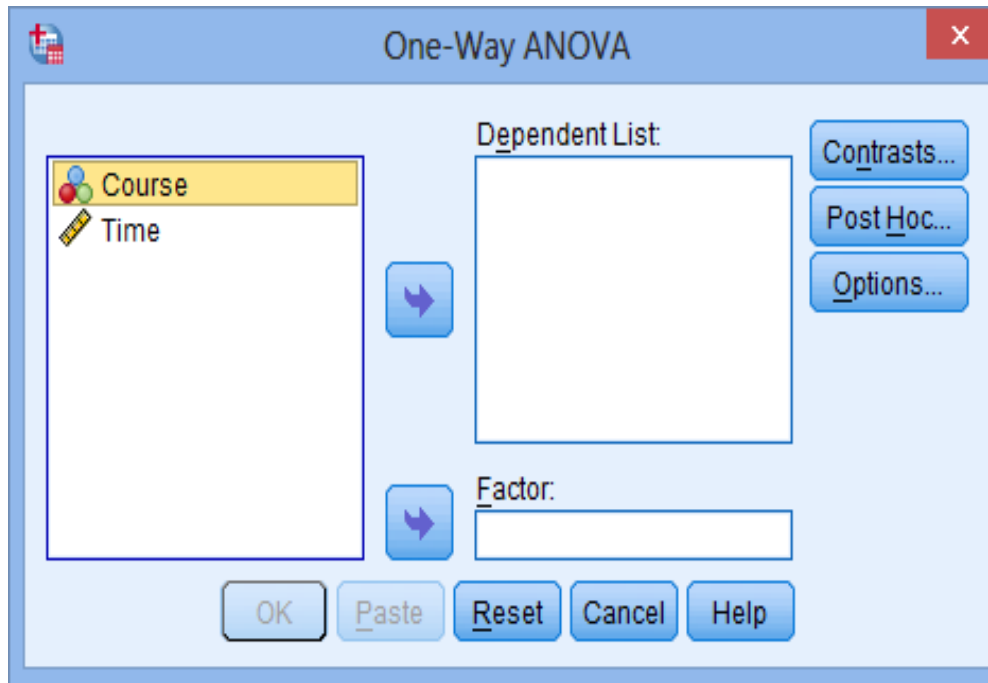
Analysis of Variance



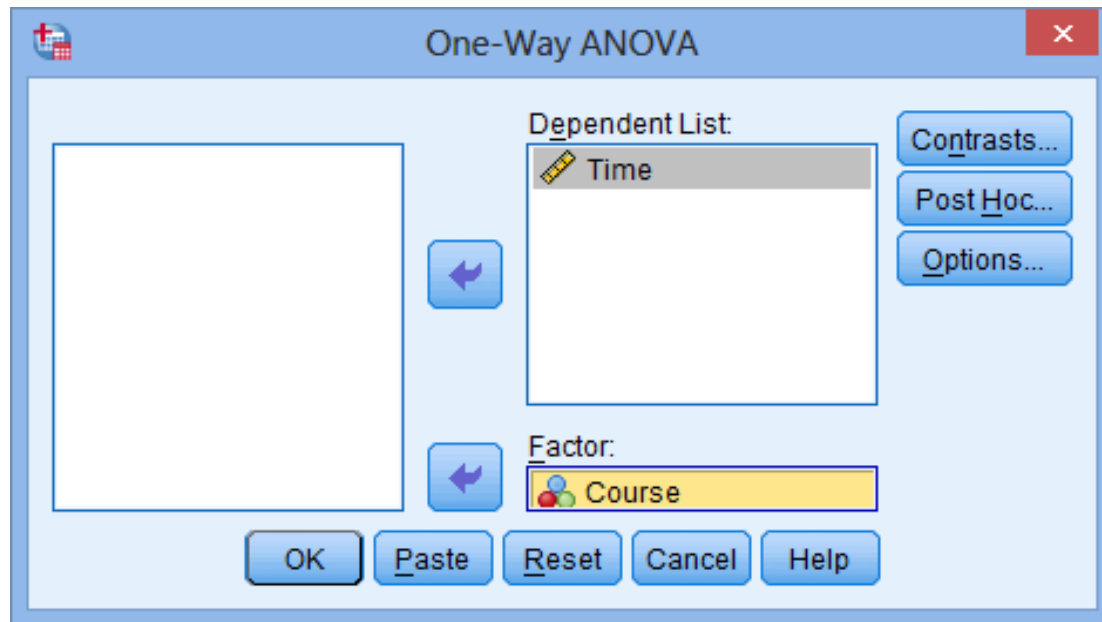
The screenshot displays the IBM SPSS interface for a file named 'One-way ANOVA.sav [DataSet5]'. The 'Analyze' menu is open, and the 'Compare Means' option is selected. A sub-menu is visible, listing several statistical tests, with 'One-Way ANOVA...' highlighted by the mouse cursor. The background shows a data grid with columns for 'Course' and 'Time'.

	Course	Time
1	Beginner	22.0
2	Beginner	25.0
3	Beginner	24.0
4	Beginner	28.0
5	Beginner	27.0
6	Beginner	28.0
7	Beginner	27.0
8	Beginner	29.0
9	Beginner	29.0
10	Beginner	33.0
11	Intermediate	18.0
12	Intermediate	21.0
13	Intermediate	20.0
14	Intermediate	26.0
15	Intermediate	23.0
16	Intermediate	24.0
17	Intermediate	23.00
18	Intermediate	26.00

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One-Way ANOVA: Post Hoc Multiple Comparisons

Equal Variances Assumed

<input type="checkbox"/> LSD	<input type="checkbox"/> S-N-K	<input type="checkbox"/> Waller-Duncan
<input type="checkbox"/> Bonferroni	<input checked="" type="checkbox"/> Tukey	Type I/Type II Error Ratio: 100
<input type="checkbox"/> Sidak	<input type="checkbox"/> Tukey's-b	<input type="checkbox"/> Dunnett
<input type="checkbox"/> Scheffe	<input type="checkbox"/> Duncan	Control Category: Last
<input type="checkbox"/> R-E-G-W F	<input type="checkbox"/> Hochberg's GT2	Test
<input type="checkbox"/> R-E-G-W Q	<input type="checkbox"/> Gabriel	<input checked="" type="radio"/> 2-sided <input type="radio"/> < Control <input type="radio"/> > Control

Equal Variances Not Assumed

<input type="checkbox"/> Tamhane's T2	<input type="checkbox"/> Dunnett's T3	<input type="checkbox"/> Games-Howell	<input type="checkbox"/> Dunnett's C
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Significance level: 0.05

Continue Cancel Help

You are planning an experiment that will involve 4 equally sized groups, including 3 experimental groups and a control. Each group will contain (n) observations.

Your expectation is that each of the 3 experimental treatments will have approximately the same effect, and that this effect will be small over the control

	Control	Exp1	Exp2	Exp3
1	118	107	133	134
2	121	165	154	176
3	97	121	91	171
4	86	126	63	159
5	118	87	62	118
6	45	135	164	125
7	119	83	96	100
8	92	100	129	60
9	91	144	128	163
10	72	119	105	111