9. MANOVA

Multivariate analysis of variance

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Agenda

- An introduction to MANOVA
- MANOVA assumptions
  - Testing for the assumptions
- Conducting a MANOVA (one-way)
- Reporting MANOVAs

An introduction to MANOVA

- But first let us talk about

- **ANOVA**

An introduction to MANOVA

- The Multivariate Analysis of Variance (MANOVA) is an extension of the ANOVA
- The ANOVA test allows us to select one Dependent Variable, but MANOVA enables us to use multiple Dependent Variables in our model
- By omitting repeated testing on the same variables: No Type 1 Error
  - Wait! But what was the Type 1 Error?
- Similar to ANOVA, the MANOVA test make use of the mean score to test for group differences. It is suitable to test DVs that are linked to one another either in the model you develop or in literature – e.g., testing motivation, interest, and curiosity across different groups

An introduction to MANOVA

- Similar to ANOVAs, there are between and within subjects MANOVAs
- If you use one Independent variable to test for differences across several Dependent variables then you are conducing a one-way between/within subjects MANOVA; if there are two IVs, it is a two-way between/within MANOVA
- A test that mixes both between AND within IVs is **called mixed MANOVA**

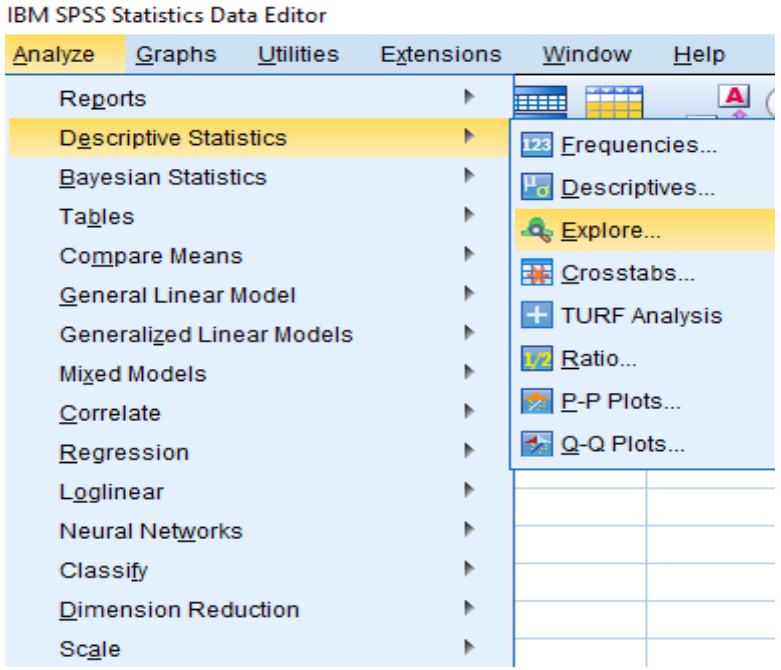
This semester we will focus on 'one-way MANOVA'

An introduction to MANOVA

1. Normality (Shapiro Wilk)
2. Univariate Outliers (Boxplots)
3. Multivariate Outliers (Mahalanobis Distances)
4. Multicollinearity (Correlation)
5. Linearity (Scatterplot)
6. Homogeneity of variance-covariance matrices (Box's *M*)

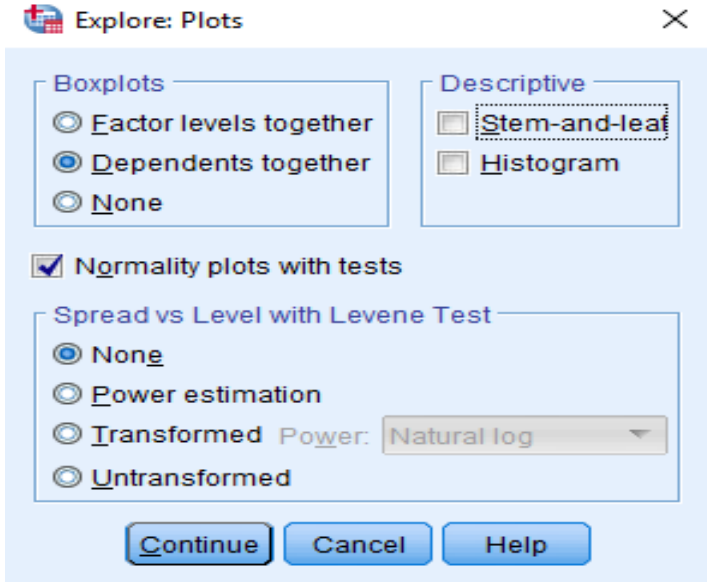
1. Normality testing

Go Analyze -> Descriptive Statistics -> Explore



1. Normality testing

Select the variables



1. Normality testing

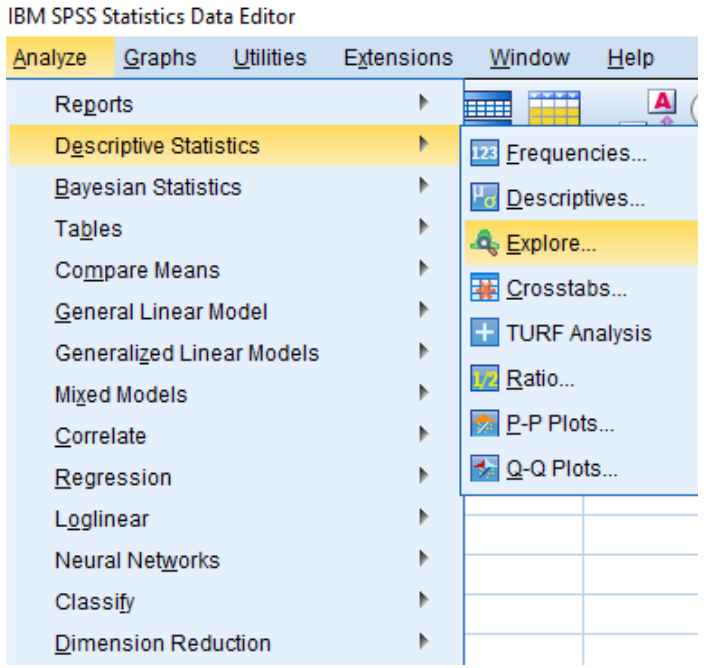
GOOD NEWS:

MANOVA is generally robust to a moderate violation of normality, we will continue to do the analysis for now.

2.Univariate Outliers

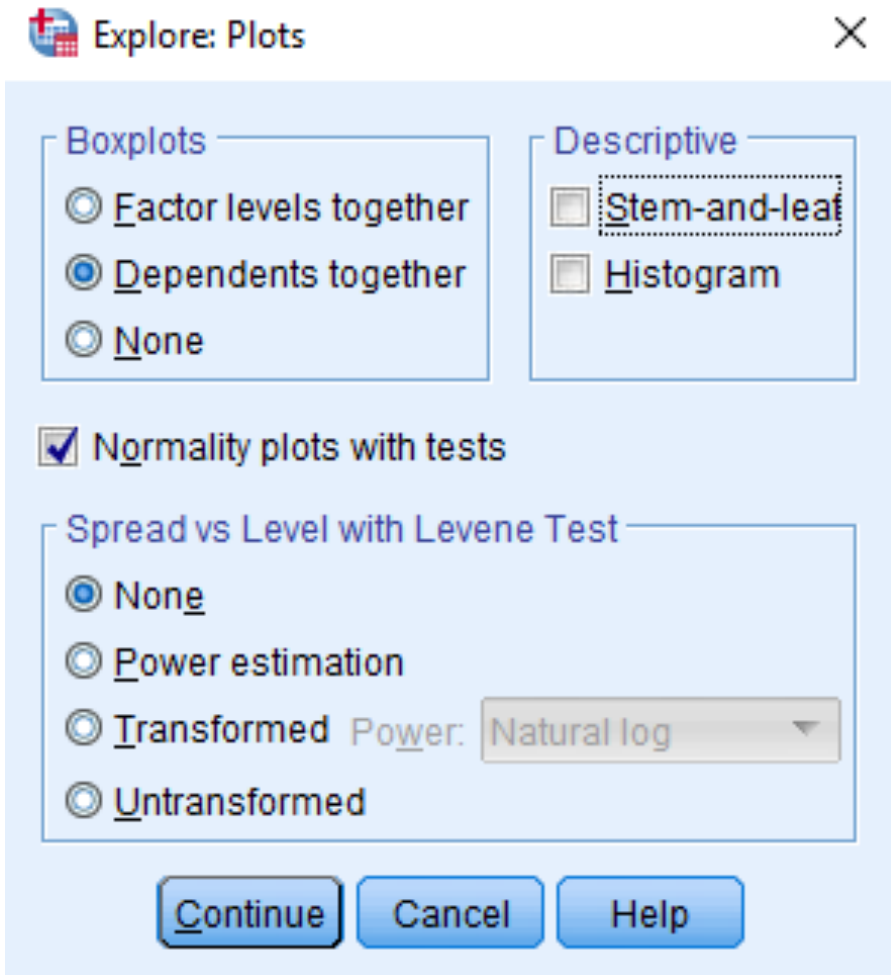
The assumption of univariate outliers can be tested via inspecting boxplots

Analyze -> Descriptive Statistics -> Explore



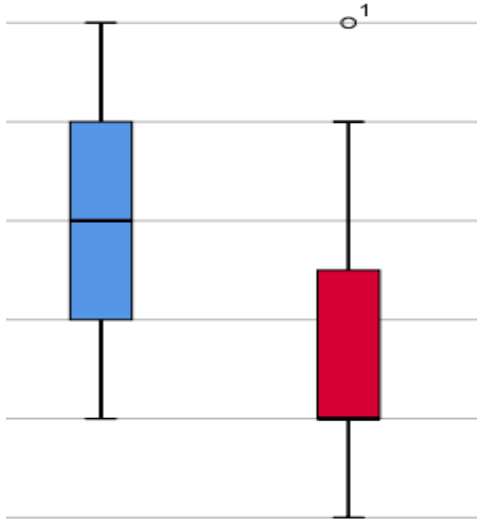
2.Univariate Outliers

Place your variables



2.Univariate Outliers

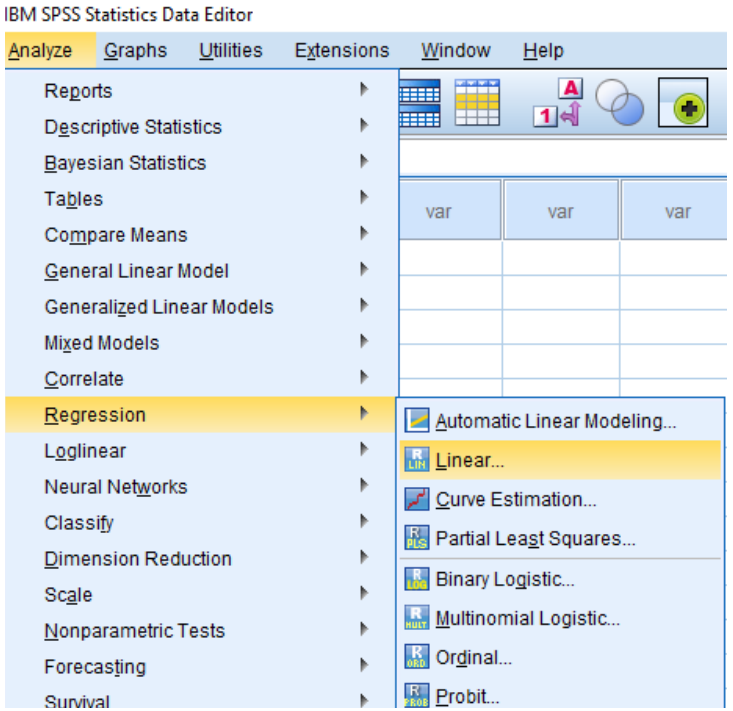
Look at the boxplots to identify possible outliers. In the slide below there is one outlier



3. Multivariate outliers

This assumption can be tested via the Mahalanobis Distances

- Analyze - Regression - Linear



3. Multivariate outliers

Under Residuals Statistics, **Maximum** Malal. Distance = 9.653

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	3.2186	3.3821	3.3601	.04555	249
Std. Predicted Value	-3.107	.483	.000	1.000	249
Standard Error of Predicted Value	.042	.122	.049	.019	249
Adjusted Predicted Value	3.1835	3.3940	3.3602	.04577	249
Residual	-2.38211	.78143	.00000	.58993	249
Std. Residual	-4.030	1.322	.000	.998	249
Stud. Residual	-4.040	1.351	.000	1.002	249
Deleted Residual	-2.39398	.81649	-.00008	.59455	249
Stud. Deleted Residual	-4.172	1.354	-.002	1.009	249
Mahal. Distance	.233	9.653	.996	2.185	249
Cook's Distance	.000	.053	.004	.008	249
Centered Leverage Value	.001	.039	.004	.009	249

a. Dependent Variable: AwareofLearningDifficulties

4. Multicollinearity

- **In order to test for multicollinearity you need to conduct a correlation analysis**

  - Go to Analyze -Correlate - Bivariate

4. Multicollinearity

- **Correlation tells you what happens to the other variable as variable increases or decreases in value**

- Correlation values

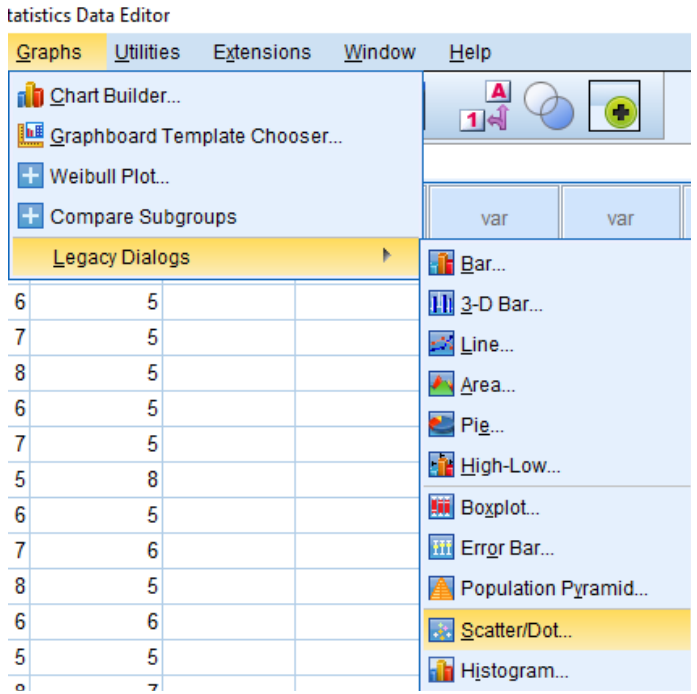
0.3-05 low correlation
05-0-7 moderate
0.7 and above is considered as a high value

- Covariance

5. Linearity

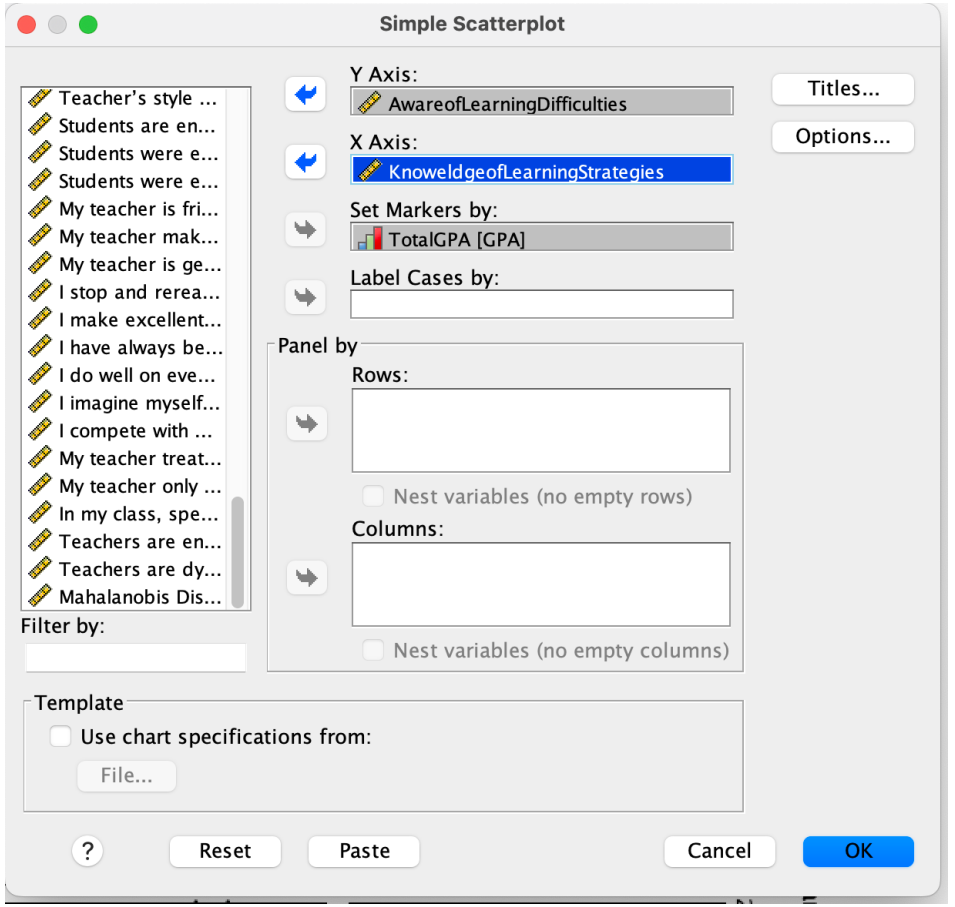
This assumption can be tested using *scatterplots*

- Graphs -Legacy Dialogs -Scatter/Dot - Simple Scatter - Define



5. Linearity

Go Graphs - Legacy Dialogs - Scatter/Dot - Simple Scatter - Define



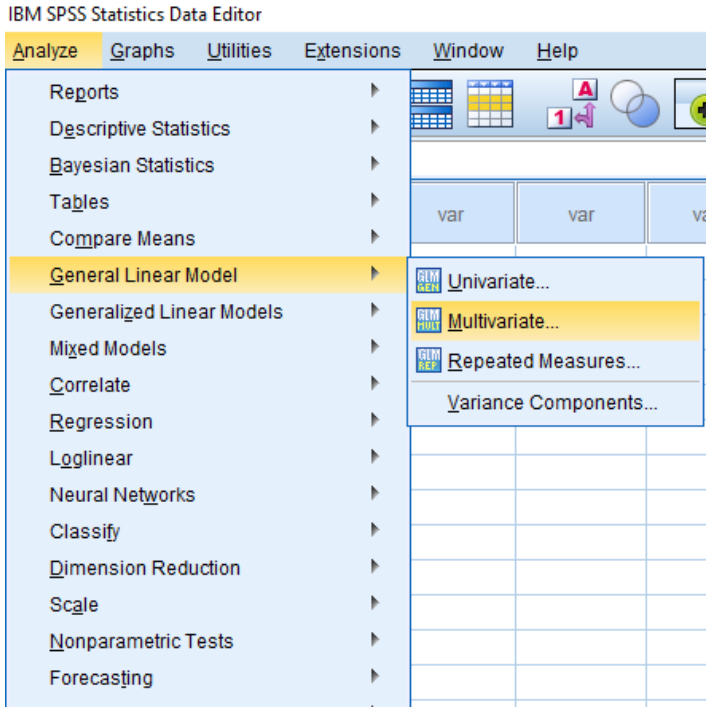
5. Linearity

Once an output file is produced for you then please double clic on the SCATTERPLOT which will then open a new window- THE CHART EDITOR.

Step 1: Click on Elements - Fit Line at Subgroups
Step 2: Make sure that ‘Linear’ is selected as the Fit Method
Final step: If the lines are strait, it can be concluded that the assumption has been satisfied

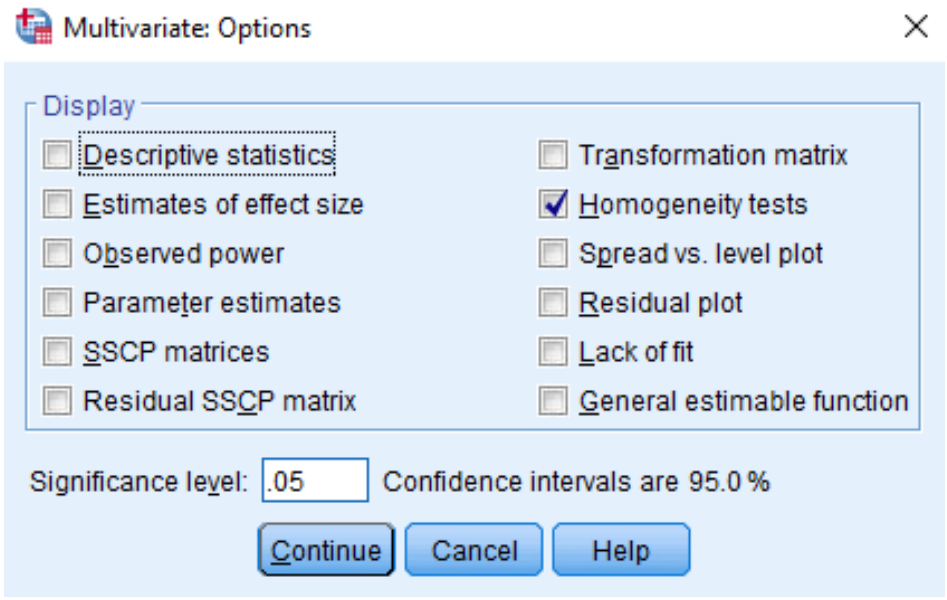
6. Homogeneity of variance-covariance matrices

- Analyze -> General Linear Model -> Multivariate



6. Homogeneity of variance-covariance matrices

- Place your variables



6. Homogeneity of variance-covariance matrices

- Look at literature
- In order to satisfy this assumption, the Box's *M* value should be *non-significant* at **α = .001**
-

Box's Test of Equality of Covariance Matrices[a]

Box's M	10.130
F	.786
df1	12
df2	4271.499
Sig.	.666

Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

a. Design: Intercept + GPA

6. Homogeneity of variance-covariance matrices

Output shows Levene's Test of Equality of Error Variances, where a *non-significant* Levene Statistic at α = .05 would indicate *equality* of variances

Levene's Test of Equality of Error Variances[a]

		Levene Statistic	df1	df2	Sig.
Teachers are enthusiastic about teaching	Based on Mean	.125	2	232	.882
	Based on Median	.013	2	232	.987
	Based on Median and with adjusted df	.013	2	229.228	.987
	Based on trimmed mean	.035	2	232	.966
Teachers are dynamic and energetic when teaching	Based on Mean	1.556	2	232	.213
	Based on Median	.408	2	232	.665
	Based on Median and with adjusted df	.408	2	228.471	.665
	Based on trimmed mean	1.548	2	232	.215
AwareofLearningDifficulties	Based on Mean	.082	2	232	.921
	Based on Median	.012	2	232	.988
	Based on Median and with adjusted df	.012	2	223.390	.988
	Based on trimmed mean	.083	2	232	.920

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + GPA

7. Before you conduct a MANOVA

Based on your data please select the `right`test

Multivariate Test	Sample Size	Levels of IVs	Robustness			Collinearity
			Uneven Cell Sizes	Unequal variance	Non-normal Data	
Pillai's Trace	Small	> 2	Y	Y	Y	Low to medium
Wilk's Lambda	Medium to large	> 2	N	N	N	Low to medium
Hotelling's Trace	Medium to large	= 2	N	N	N	Low to medium
Roy's Largest Root	Medium to large	> 2	N	N	N	Medium to high

8. Conducting a one-way MANOVA

How would you report MANOVA results?