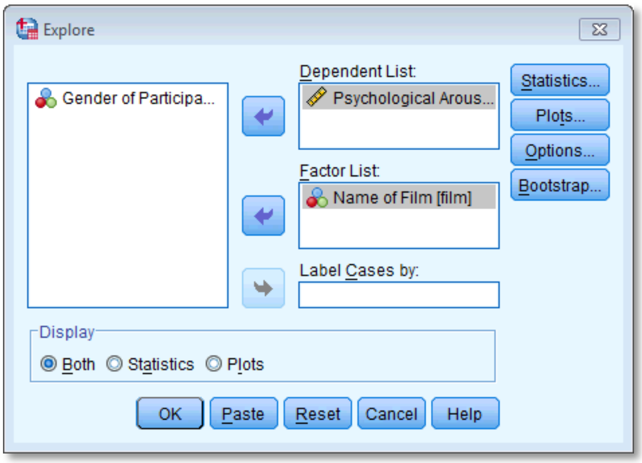
Chapter 5: The beast of bias

Smart Alex's Solutions

Task 1

> *Using the* ***ChickFlick.sav*** *data from Chapter 4, check the assumptions of normality and homogeneity of variance for the two films (ignore gender): are the assumptions met?*

The output you should get is reproduced below (I used the *explore* function described in Chapter 5).



Gender of Participa...

Dependent List: Psychological Arous...

Factor List: Name of Film [film]

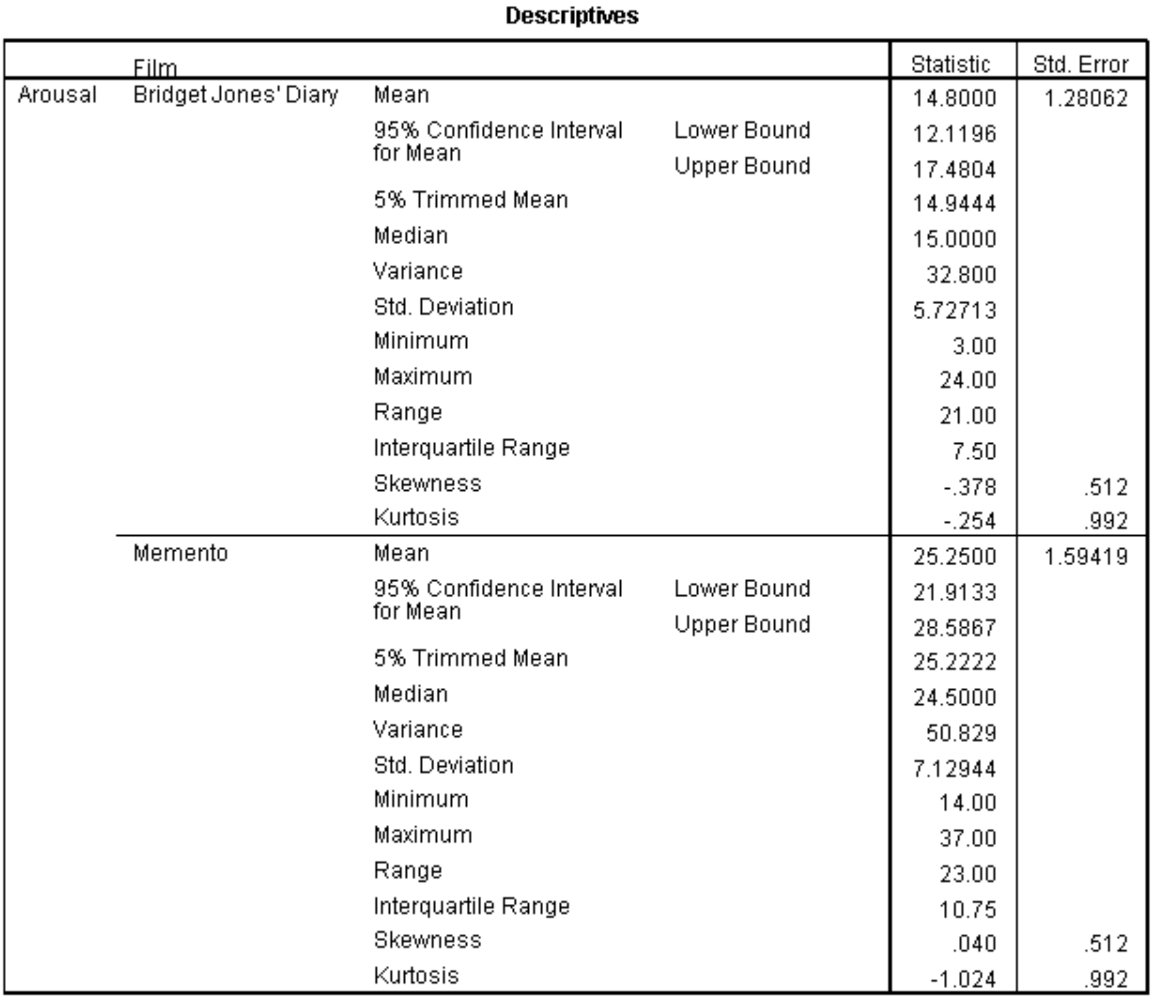
Display: ● Both ○ Statistics ○ Plots

The skewness statistics gives rise to a *z*-score of −0.378/0.512 = –0.74 for *Bridget Jones's Diary*, and 0.04/0.512 = 0.08 for *Memento*. These show no significant skewness. For kurtosis these values are −0.254/0.992 = –0.26 for *Bridget Jones's Diary*, and –1.024/0.992 = –1.03, which again are both non-significant.

The Q-Q plots confirm these findings: for both films the expected quantile points are close to those that would be expected from a normal distribution (i.e. the dots fall close to the diagonal line).

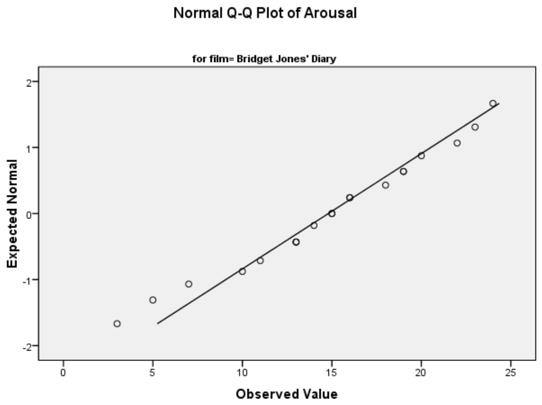
The K-S tests show no significant deviation from normality for both films. We could report that arousal scores for *Bridget Jones's Diary*, *D*(20) = 0.13, *ns*, and *Memento*, *D*(20) = 0.10, *ns*, were both not significantly different from a normal distribution. Therefore we can assume normality in the sample data.

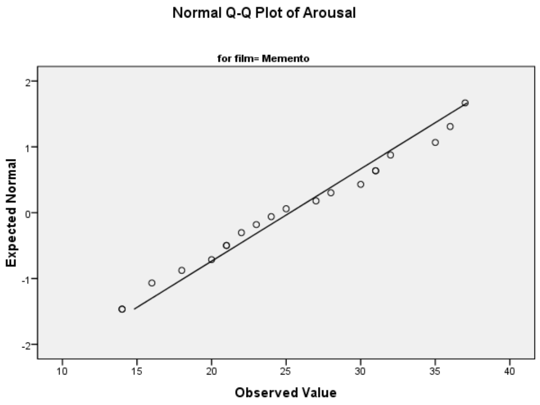
In terms of homogeneity of variance, Levene's test shows that the variances of arousal for the two films were not significantly different, *F*(1, 38) = 1.90.

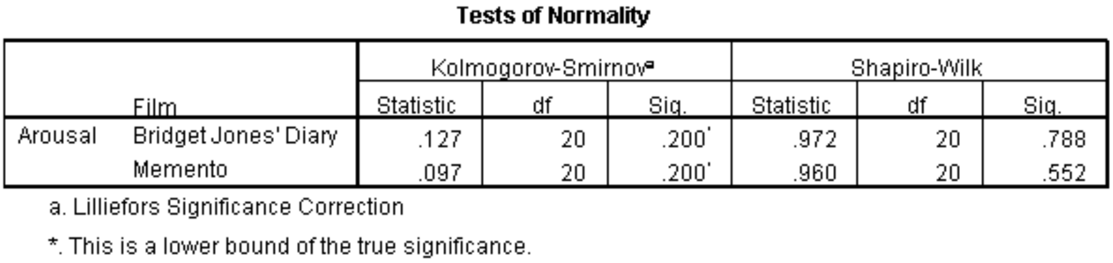


Descriptives

	Film			Statistic	Std. Error
Arousal	Bridget Jones' Diary	Mean		14.8000	1.28062
		95% Confidence Interval for Mean	Lower Bound	12.1196	
			Upper Bound	17.4804	
		5% Trimmed Mean		14.9444	
		Median		15.0000	
		Variance		32.800	
		Std. Deviation		5.72713	
		Minimum		3.00	
		Maximum		24.00	
		Range		21.00	
		Interquartile Range		7.50	
		Skewness		-.378	.512
		Kurtosis		-.254	.992
	Memento	Mean		25.2500	1.59419
		95% Confidence Interval for Mean	Lower Bound	21.9133	
			Upper Bound	28.5867	
		5% Trimmed Mean		25.2222	
		Median		24.5000	
		Variance		50.829	
		Std. Deviation		7.12944	
		Minimum		14.00	
		Maximum		37.00	
		Range		23.00	
		Interquartile Range		10.75	
		Skewness		.040	.512
		Kurtosis		-1.024	.992





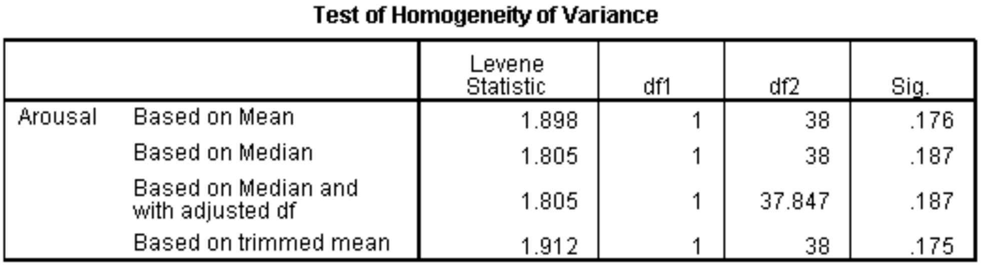


Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Film	Statistic	df	Sig.	Statistic	df	Sig.
Arousal	Bridget Jones' Diary	.127	20	.200*	.972	20	.788
	Memento	.097	20	.200*	.960	20	.552

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.



Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Arousal	Based on Mean	1.898	1	38	.176
	Based on Median	1.805	1	38	.187
	Based on Median and with adjusted df	1.805	1	37.847	.187
	Based on trimmed mean	1.912	1	38	.175

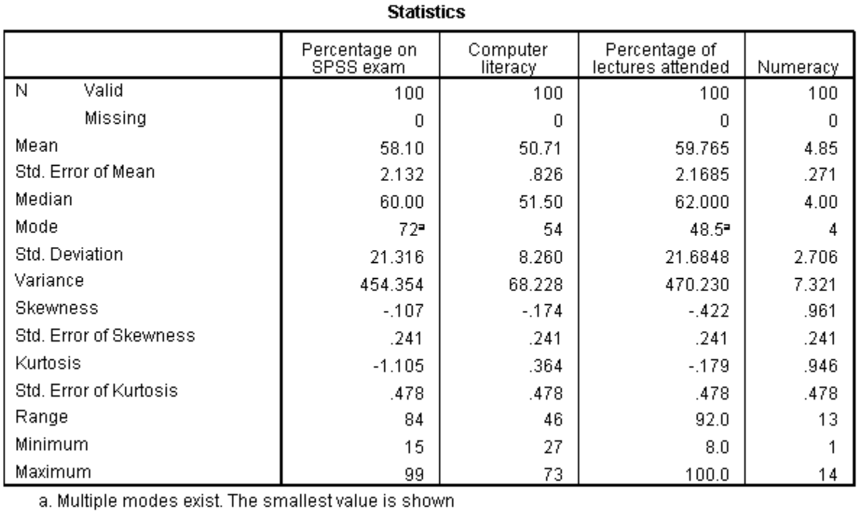
Task 2

> *The file **SPSSExam.sav** contains data regarding students' performance on an SPSS exam. Four variables were measured: **exam** (first-year SPSS exam scores as a percentage), **computer** (measure of computer literacy in percent), **lecture** (percentage of SPSS lectures attended) and **numeracy** (a measure of numerical ability out of 15). There is a variable called **uni** indicating whether the student attended Sussex University (where I work) or Duncetown University. Compute and interpret descriptive statistics for **exam**, **computer**, **lecture**, and **numeracy** for the sample as a whole.*

To see the distribution of the variables, we can use the *frequencies* command, which we came across in the previous section (see Section 5.3.2). Use this dialog box and place all four variables (**exam**, **computer**, **lecture** and **numeracy**) in the *Variable(s)* box. Then click on Statistics... to select the *Statistics* dialog box and select some measures of central tendency (mean, mode, median), measures of variability (range, standard deviation, variance, quartile splits) and measures of shape (kurtosis and skewness). Also click on Charts... to access the *Charts* dialog box and select a frequency distribution of scores with a normal curve. Return to the main dialog box by clicking on Continue and once in the main dialog box, click on OK to run the analysis.

The output shows the table of descriptive statistics for the four variables in this example. From this table, we can see that, on average, students attended nearly 60% of lectures, obtained 58% in their SPSS exam, scored only 51% on the computer literacy test, and only 5 out of 15 on the numeracy test. In addition, the standard deviation for computer literacy was relatively small compared to that of the percentage of lectures attended and exam scores. These latter two variables had several modes (multimodal).

The output provides tabulated frequency distributions of each variable (not reproduced here). These tables list each score and the number of times that it is found within the data set. In addition, each frequency value is expressed as a percentage of the sample (in this case the frequencies and percentages are the same because the sample size was 100). Also, the cumulative percentage is given, which tells us how many cases (as a percentage) fell below a certain score. So, for example, we can see that 66% of numeracy scores were 5 or less, 74% were 6 or less, and so on. Looking in the other direction, we can work out that only 8% (100 – 92%) got scores greater than 8.



Statistics

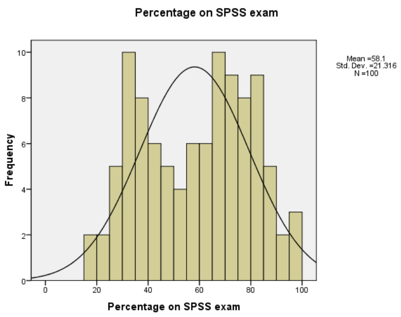
		Percentage on SPSS exam	Computer literacy	Percentage of lectures attended	Numeracy
N	Valid	100	100	100	100
	Missing	0	0	0	0
Mean		58.10	50.71	59.765	4.85
Std. Error of Mean		2.132	.826	2.1685	.271
Median		60.00	51.50	62.000	4.00
Mode		72[a]	54	48.5[a]	4
Std. Deviation		21.316	8.260	21.6848	2.706
Variance		454.354	68.228	470.230	7.321
Skewness		-.107	-.174	-.422	.961
Std. Error of Skewness		.241	.241	.241	.241
Kurtosis		-1.105	.364	-.179	.946
Std. Error of Kurtosis		.478	.478	.478	.478
Range		84	46	92.0	13
Minimum		15	27	8.0	1
Maximum		99	73	100.0	14

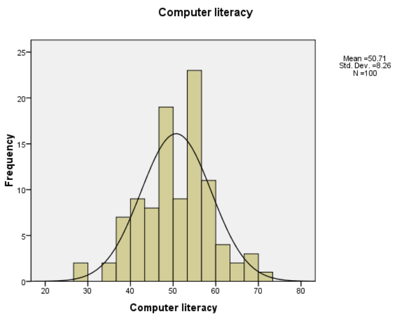
a. Multiple modes exist. The smallest value is shown

Output

Finally, we are given histograms of each variable with the normal distribution overlaid. These graphs show us several things. The exam scores are very interesting because this distribution is quite clearly not normal; in fact, it looks suspiciously bimodal (there are two peaks, indicative of two modes). This observation corresponds with the earlier information from the table of descriptive statistics. It looks as though computer literacy is fairly normally distributed (a few people are very good with computers and a few are very bad, but the majority of people have a similar degree of knowledge) as is the lecture attendance. Finally, the numeracy test has produced very positively skewed data (the majority of people did very badly on this test and only a few did well). This corresponds to what the skewness statistic indicated.

Descriptive statistics and histograms are a good way of getting an instant picture of the distribution of your data. This snapshot can be very useful: for example, the bimodal distribution of SPSS exam scores instantly indicates a trend that students are typically either very good at statistics or struggle with it (there are relatively few who fall in between these extremes). Intuitively, this finding fits with the nature of the subject: statistics is very easy once everything falls into place, but before that enlightenment occurs it all seems hopelessly difficult!





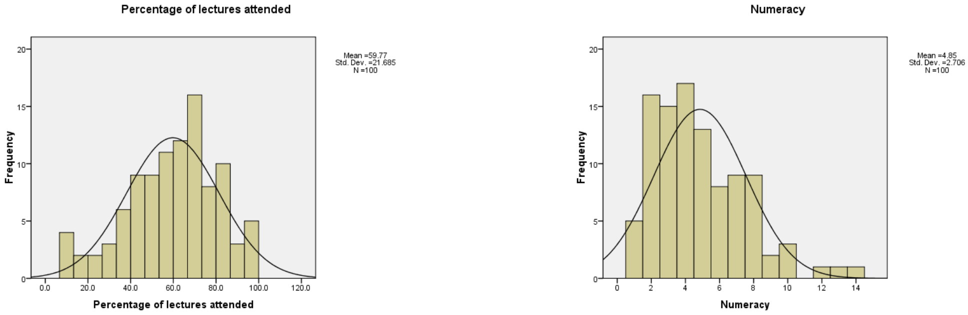


Figure: Histograms of the SPSS exam data

Task 3

Calculate and interpret the z-scores for skewness for all variables.

For the SPSS exam scores, the *z*-score of skewness is –0.107/0.241 = –0.44. For numeracy, the *z*-score of skewness is 0.961/0.241 = 3.99. For computer literacy, the z-score of skewness is −0.174/0.241 = −0.72. For lectures attended, the z-score of skewness is −0.422/0.241 = −1.75. It is pretty clear then that the numeracy scores are significantly positively skewed (p < .05) because the *z*-score is greater than 1.96, indicating a pile-up of scores on the left of the distribution (so most students got low scores). For the other three variables, the skewness is non-significant, p < .05, because the values lie between −1.96 and 1.96.

Task 4

Calculate and interpret the z-scores for kurtosis for all variables.

For SPSS exam scores, the *z*-score of kurtosis is −1.105/0.478 = −2.31, which is significant, p < .05, because it lies outside −1.96 and 1.96.

For computer literacy, the *z*-score of kurtosis is 0.364/0.478 = 0.76, which is non-significant, p < .05, because it lies between −1.96 and 1.96.

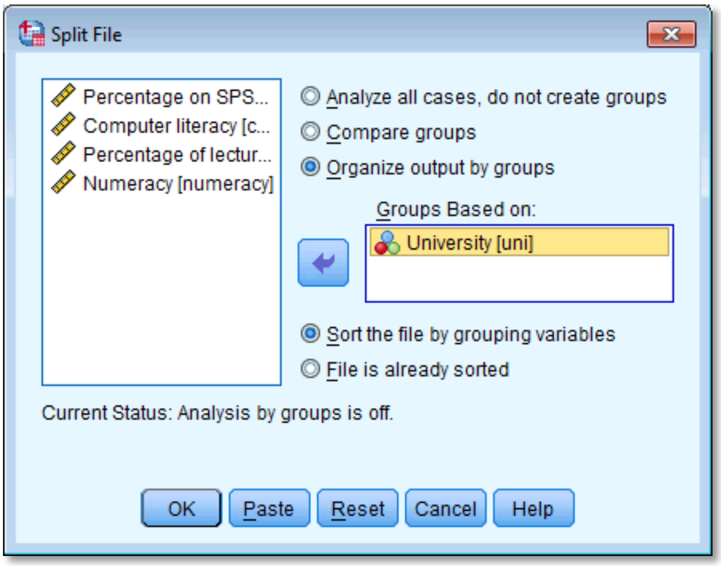
For lectures attended, the *z*-score of kurtosis is −0.179/0.478 = −0.37, which is non-significant, p < .05, because it lies between −1.96 and 1.96.

For numeracy, the *z*-score of kurtosis is 0.946/0.478 = 1.98, which is significant, p < .05, because it lies outside −1.96 and 1.96.

Task 5

Use the split file *command to look at and interpret the descriptive statistics for* ***numeracy*** *and* ***exam****.*

If we want to obtain separate descriptive statistics for each of the universities, we can split the file, and then proceed using the *frequencies* command. To split the file, select Data Split File... or click on . In the resulting dialog box select the option *Organize output by groups*. Once this option is selected, the *Groups Based on* box will activate. Select the variable containing the group codes by which you wish to repeat the analysis (in this example select **Uni**), and drag it to the box or click on ➡. By default, SPSS will sort the file by these groups (i.e. it will list one category followed by the other in the data editor window). Once you have split the file, use the *frequencies* command. Let's request statistics for only **numeracy** and **exam** scores for the time being.



○ Analyze all cases, do not create groups
○ Compare groups
● Organize output by groups

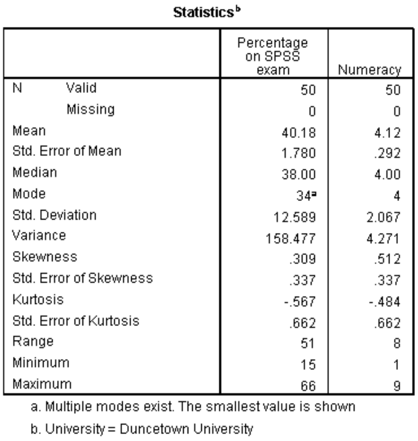
Groups Based on: University [uni]

● Sort the file by grouping variables
○ File is already sorted

Current Status: Analysis by groups is off.

Dialog box for the *split file* command

Duncetown University



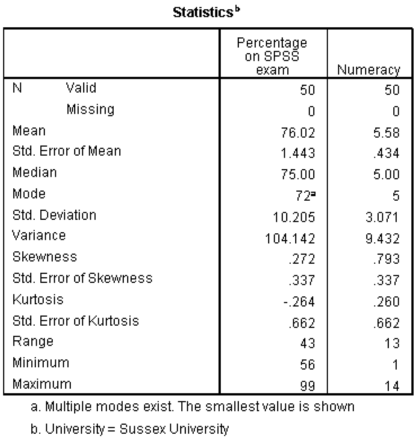
Statistics[b]

		Percentage on SPSS exam	Numeracy
N	Valid	50	50
	Missing	0	0
Mean		40.18	4.12
Std. Error of Mean		1.780	.292
Median		38.00	4.00
Mode		34[a]	4
Std. Deviation		12.589	2.067
Variance		158.477	4.271
Skewness		.309	.512
Std. Error of Skewness		.337	.337
Kurtosis		-.567	-.484
Std. Error of Kurtosis		.662	.662
Range		51	8
Minimum		15	1
Maximum		66	9

a. Multiple modes exist. The smallest value is shown

b. University = Duncetown University

Sussex University



Statistics[b]

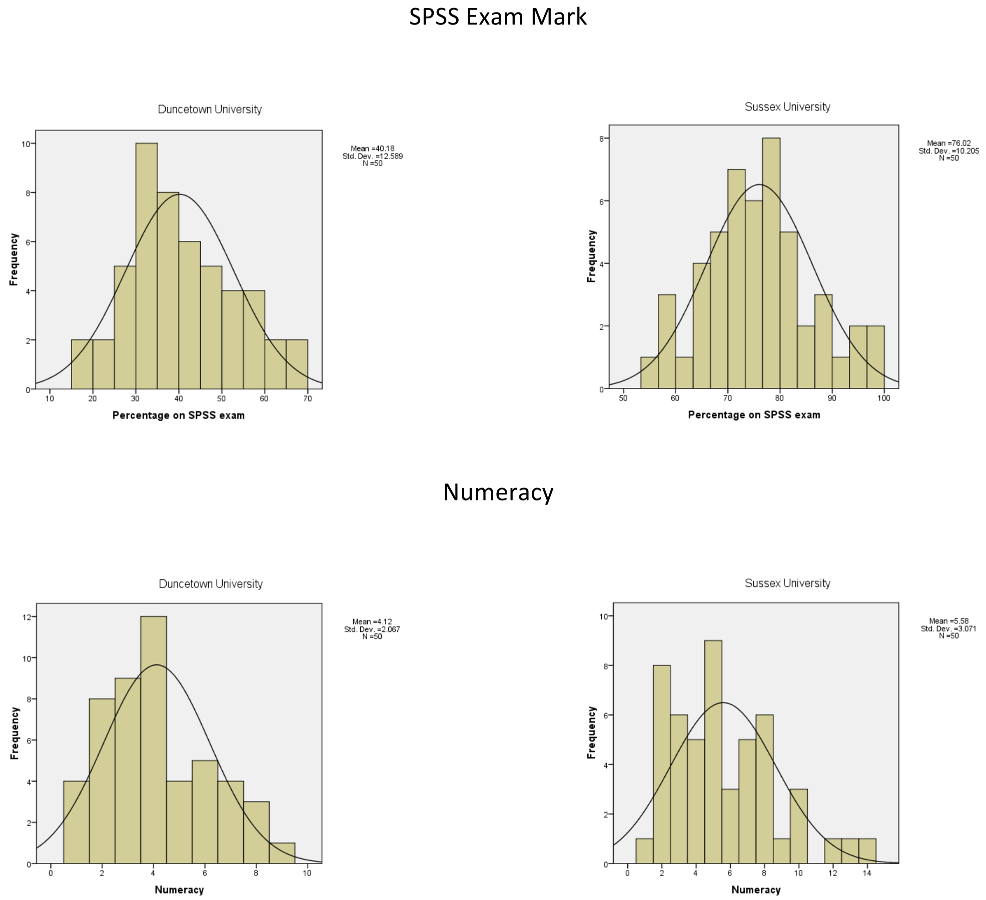
		Percentage on SPSS exam	Numeracy
N	Valid	50	50
	Missing	0	0
Mean		76.02	5.58
Std. Error of Mean		1.443	.434
Median		75.00	5.00
Mode		72[a]	5
Std. Deviation		10.205	3.071
Variance		104.142	9.432
Skewness		.272	.793
Std. Error of Skewness		.337	.337
Kurtosis		-.264	.260
Std. Error of Kurtosis		.662	.662
Range		43	13
Minimum		56	1
Maximum		99	14

a. Multiple modes exist. The smallest value is shown

b. University = Sussex University

SPSS output

The SPSS output is split into two sections: first the results for students at Duncetown University, then the results for those attending Sussex University. The output shows the two main summary tables. From these tables it is clear that Sussex students scored higher on both their SPSS exam and the numeracy test than their Duncetown counterparts. In fact, looking at the means reveals that, on average, Sussex students scored an amazing 36% more on the SPSS exam than Duncetown students, and had higher numeracy scores too (what can I say, my students are the best).



SPSS Exam Mark

Numeracy

Distributions of exam and numeracy scores for Duncetown University and Sussex University students

The figure shows the histograms of these variables split according to the university attended. The first interesting thing to note is that for exam marks, the distributions are both fairly normal. This seems odd because the overall distribution was bimodal. However, it starts to make sense when you consider that for Duncetown the distribution is centred around a mark of about 40%, but for Sussex the distribution is centred around a mark of about 76%. This illustrates how important it is to look at distributions within groups. If we were interested in comparing Duncetown to Sussex it wouldn't matter that overall the distribution of scores was bimodal; all that's important is that each group comes from a normal distribution, and in this case it appears to be true. When the two samples are combined, these two normal distributions create a bimodal one (one of the modes being around the centre of the Duncetown distribution, and the other being around the centre of the Sussex data!). For numeracy scores, the distribution is slightly positively skewed (there is a larger concentration at the lower end of scores) in both the Duncetown and Sussex groups. Therefore, the overall positive skew observed before is due to the mixture of universities. When you have finished with the *split file* command, remember to *switch it off* (otherwise SPSS will carry on doing every analysis on each group separately). To switch this function off, return to the *Split File* dialog box and select *Analyze all cases, do not create groups*.

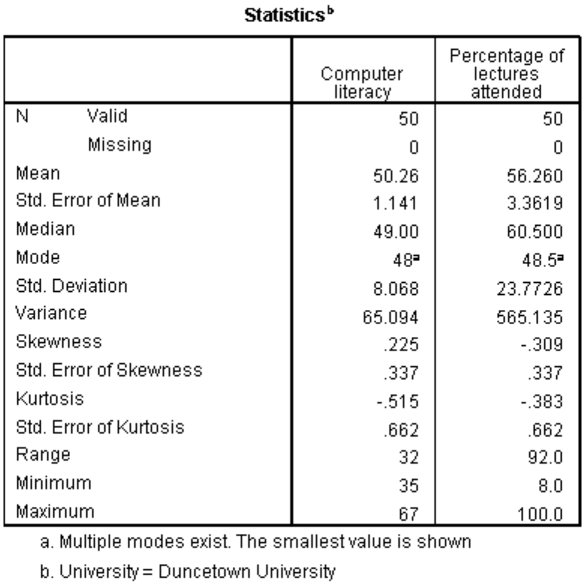
Task 6

Repeat Task 5 but for the computer literacy and percentage of lectures attended.

The SPSS output is split into two sections: first, the results for students at Duncetown University, then the results for those attending Sussex University. From these tables it is clear that Sussex and Duncetown students scored similarly on computer literacy (both means are very similar). Sussex students attended slightly more lectures (63.27%) than their Duncetown counterparts (56.26%).

The histograms are also split according to the university attended. All of the distributions look fairly normal. The only exception is the computer literacy scores for the Sussex students. This is a fairly flat distribution apart from a huge peak between 50 and 60%. It's slightly heavy-tailed (right at the very ends of the curve the bars come above the line) and very pointy. This suggests positive kurtosis. If you examine the values of kurtosis you will find that there is significant (p < .05) positive kurtosis: 1.38/0.662 = 2.08, which falls outside of −1.96 and 1.96.

Duncetown University



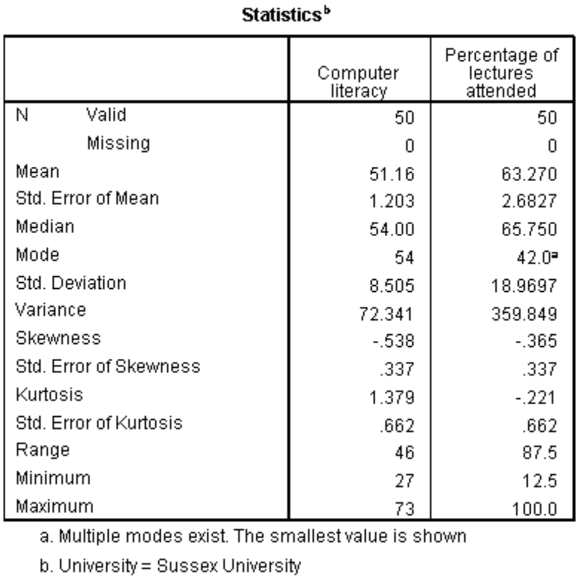
Statistics[b]

		Computer literacy	Percentage of lectures attended
N	Valid	50	50
	Missing	0	0
Mean		50.26	56.260
Std. Error of Mean		1.141	3.3619
Median		49.00	60.500
Mode		48[a]	48.5[a]
Std. Deviation		8.068	23.7726
Variance		65.094	565.135
Skewness		.225	-.309
Std. Error of Skewness		.337	.337
Kurtosis		-.515	-.383
Std. Error of Kurtosis		.662	.662
Range		32	92.0
Minimum		35	8.0
Maximum		67	100.0

a. Multiple modes exist. The smallest value is shown

b. University = Duncetown University

Sussex University



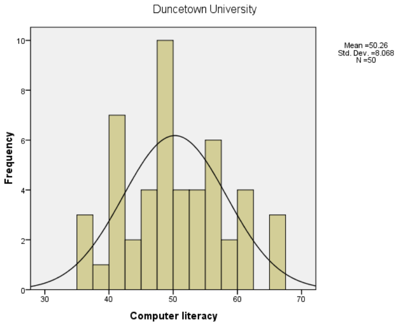
Statistics[b]

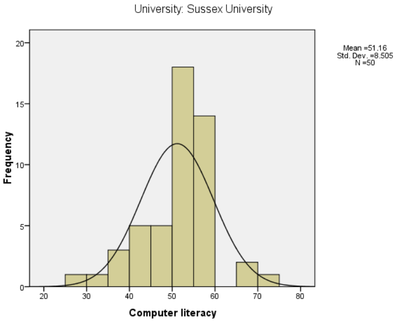
		Computer literacy	Percentage of lectures attended
N	Valid	50	50
	Missing	0	0
Mean		51.16	63.270
Std. Error of Mean		1.203	2.6827
Median		54.00	65.750
Mode		54	42.0[a]
Std. Deviation		8.505	18.9697
Variance		72.341	359.849
Skewness		-.538	-.365
Std. Error of Skewness		.337	.337
Kurtosis		1.379	-.221
Std. Error of Kurtosis		.662	.662
Range		46	87.5
Minimum		27	12.5
Maximum		73	100.0

a. Multiple modes exist. The smallest value is shown

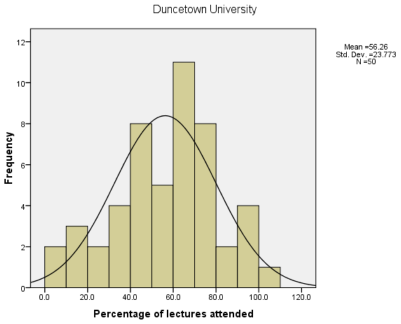
b. University = Sussex University

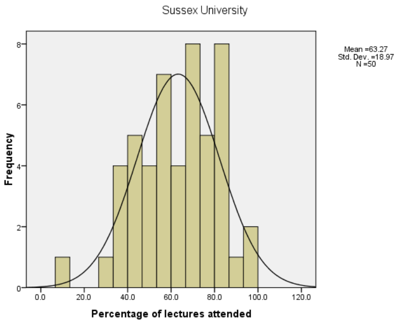
Computer Literacy





Percentage of Lectures Attended

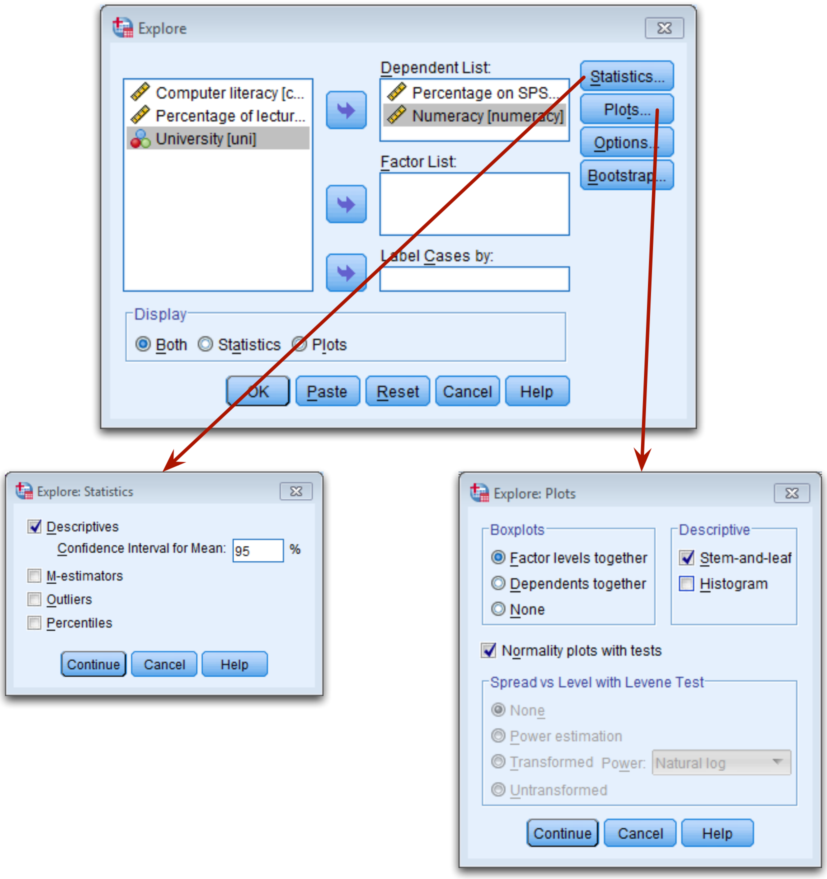




Task 7

Conduct and interpret a K-S test for ***numeracy*** *and* ***exam****.*

The Kolmogorov–Smirnov (K-S) test can be accessed through the *explore* command (Analyze Descriptive Statistics ▸ Explore...). First, enter any variables of interest in the box labelled *Dependent List* by highlighting them on the left-hand side and transferring them by clicking on ➔. For this example, just select the exam scores and numeracy scores. It is also possible to select a factor (or grouping variable) by which to split the output (so if you select **Uni** and transfer it to the box labelled *Factor List*, SPSS will produce exploratory analysis for each group — a bit like the *split file* command). If you click on Statistics... a dialog box appears, but the default option is fine (it will produce means, standard deviations and so on). The more interesting option for our current purposes is accessed by clicking on Plots... . In this dialog box select the option ☑ Normality plots with tests, and this will produce both the K-S test and some graphs called *normal Q-Q plots*. Click on Continue to return to the main dialog box and then click on OK to run the analysis.



Explore

Computer literacy [c...
Percentage of lectur...
University [uni]

Dependent List:
Percentage on SPS...
Numeracy [numeracy]

Factor List:

Label Cases by:

Display
● Both ○ Statistics ○ Plots

Explore: Statistics

☑ Descriptives
Confidence Interval for Mean: 95 %
□ M-estimators
□ Outliers
□ Percentiles

Explore: Plots

Boxplots
● Factor levels together
○ Dependents together
○ None

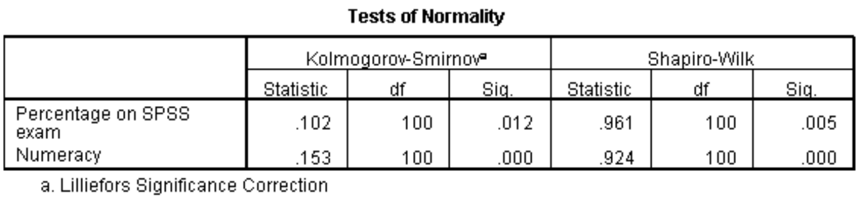
Descriptive
☑ Stem-and-leaf
□ Histogram

☑ Normality plots with tests

Spread vs Level with Levene Test
● None
○ Power estimation
○ Transformed Power: Natural log
○ Untransformed

Dialog boxes for the *explore* command

The first table produced by SPSS contains descriptive statistics (mean, etc.) and should have the same values as the tables obtained using the frequencies procedure. The important table is that of the K-S test, which includes the test statistic itself, the degrees of freedom (which should equal the sample size) and the significance value of this test. Remember that a significant value (*Sig.* less than .05) indicates a deviation from normality. For both numeracy and SPSS exam scores, the K-S test is highly significant, indicating that both distributions are not normal. This result is likely to reflect the bimodal distribution found for exam scores, and the positively skewed distribution observed in the numeracy scores. However, these tests confirm that these deviations were *significant*. (But bear in mind that the sample is fairly big.)



Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Percentage on SPSS exam	.102	100	.012	.961	100	.005
Numeracy	.153	100	.000	.924	100	.000

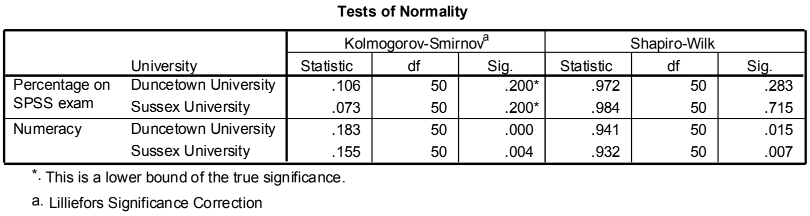
a. Lilliefors Significance Correction

SPSS Output

We can report the results in the SPSS output in the following way:

- The percentages on the SPSS exam, $D(100) = 0.10$, $p < .05$, and the numeracy scores, $D(100) = 0.15$, $p < .001$, were both significantly non-normal.

As a final point, bear in mind that when we looked at the exam scores for separate groups, the distributions seemed quite normal; now if we'd asked for separate tests for the two universities (by placing **Uni** in the box labelled *Factor List*) the K-S test might not have been significant. In fact if you try this out, you'll find that the percentages on the SPSS exam are indeed normal within the two groups (the values in the *Sig.* column are greater than .05). This is important because if our analysis involves comparing groups, then what's important is not the overall distribution but the distribution in each group.



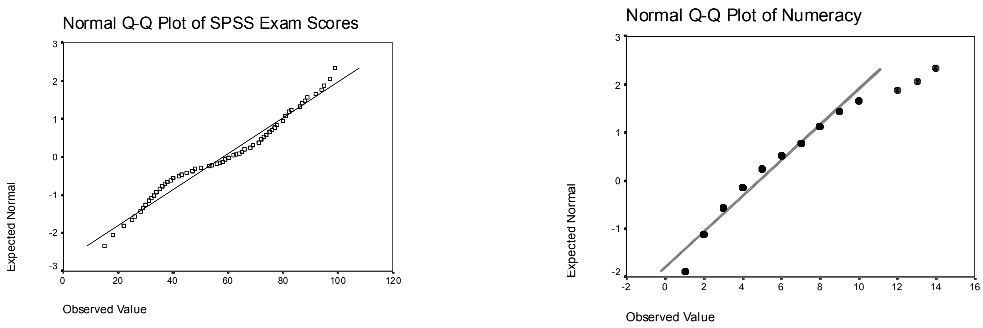
Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	University	Statistic	df	Sig.	Statistic	df	Sig.
Percentage on SPSS exam	Duncetown University	.106	50	.200*	.972	50	.283
	Sussex University	.073	50	.200*	.984	50	.715
Numeracy	Duncetown University	.183	50	.000	.941	50	.015
	Sussex University	.155	50	.004	.932	50	.007

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

SPSS Output



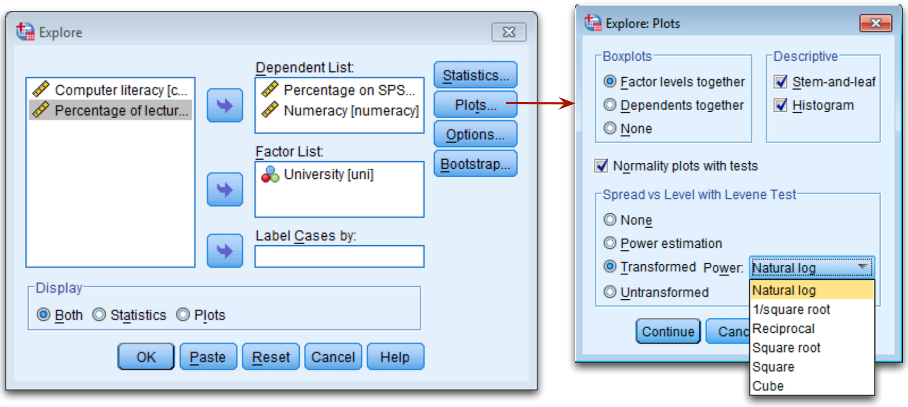
Normal Q-Q plots of numeracy and SPSS exam scores

SPSS also produces a normal Q-Q plots. In both of the variables analysed we already know that the data are not normal, and these plots confirm this observation because the dots deviate substantially from the line. It is noteworthy that the deviation is greater for the numeracy scores, and this is consistent with the higher significance value of this variable on the K-S test.

Task 8

*Conduct and interpret a Levene's test for **numeracy** and **exam**.*

We can get Levene's test using the *Explore* menu: Analyze Descriptive Statistics ▸ Explore... . Transfer the SPSS exam scores and the numeracy scores from the list on the left-hand side to the box labelled *Dependent List* by clicking on the ➡ next to this box, and because we want to split the output by the grouping variable to compare the variances, select the variable **Uni** and transfer it to the box labelled *Factor List* by clicking on the appropriate ➡. Then click on Plots... to open another dialog box. To get Levene's test we need to select one of the options where it says *Spread vs. level with Levene's test*. If you select ● Untransformed Levene's test is carried out on the raw data (a good place to start). When you've finished with this dialog box click on Continue to return to the main *Explore* dialog box and then click on OK to run the analysis.



Dependent List:
Percentage on SPS...
Numeracy [numeracy]

Factor List:
University [uni]

Label Cases by:

Display: ● Both ○ Statistics ○ Plots

Boxplots: ● Factor levels together ○ Dependents together ○ None

Descriptive: ☑ Stem-and-leaf ☑ Histogram

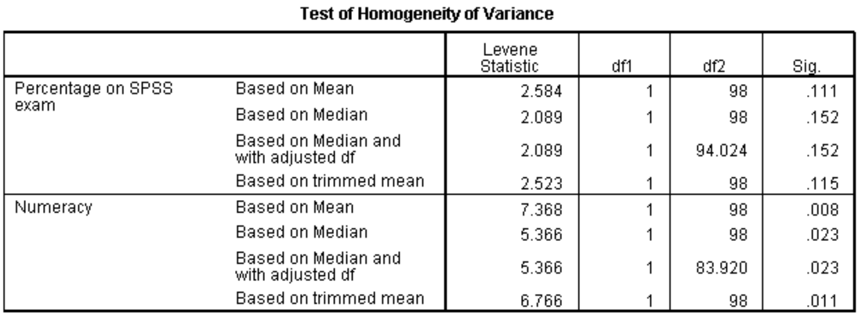
☑ Normality plots with tests

Spread vs Level with Levene Test: ○ None ○ Power estimation ● Transformed Power: Natural log ○ Untransformed

Exploring groups of data and obtaining Levene's test

Levene's test is non-significant for the SPSS exam scores (values in the *Sig.*column are more than .05), indicating that the variances are not significantly different (i.e. they are similar and the homogeneity of variance assumption is tenable). However, for the numeracy scores, Levene's test is significant (values in the *Sig.* column are less than .05), indicating that the variances are significantly different (i.e., they are not the same and the homogeneity of variance assumption has been violated). We can also calculate the variance ratio. For SPSS exam scores the variance ratio is 158.48/104.14 = 1.52 and for numeracy scores the value is 9.43/4.27 = 2.21. Our group sizes are 50 and we're comparing two variances so the critical value is (from the table in the additional material) approximately 1.67. These ratios concur with Levene's test: variances are significantly different for numeracy scores (2.21 is bigger than 1.67) but not for SPSS exam scores (1.52 is smaller than 1.67). We could report these findings as follows:

- For the percentage on the SPSS exam, the variances were equal for Duncetown and Sussex University students, *F*(1, 98) = 2.58, *ns*, but for numeracy scores the variances were significantly different in the two groups, *F*(1, 98) = 7.37, *p* < .01.



Test of Homogeneity of Variance

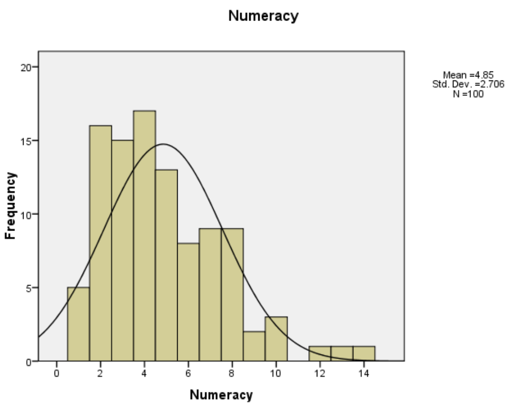
		Levene Statistic	df1	df2	Sig.
Percentage on SPSS exam	Based on Mean	2.584	1	98	.111
	Based on Median	2.089	1	98	.152
	Based on Median and with adjusted df	2.089	1	94.024	.152
	Based on trimmed mean	2.523	1	98	.115
Numeracy	Based on Mean	7.368	1	98	.008
	Based on Median	5.366	1	98	.023
	Based on Median and with adjusted df	5.366	1	83.920	.023
	Based on trimmed mean	6.766	1	98	.011

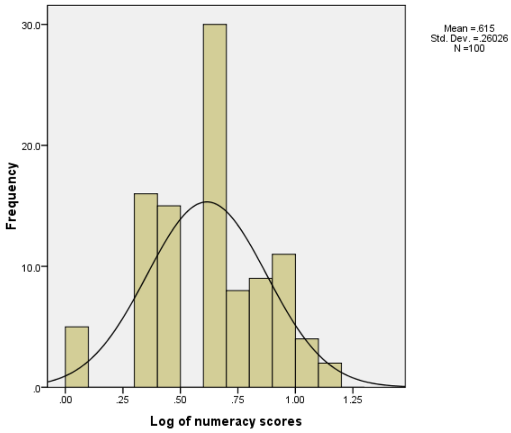
SPSS output

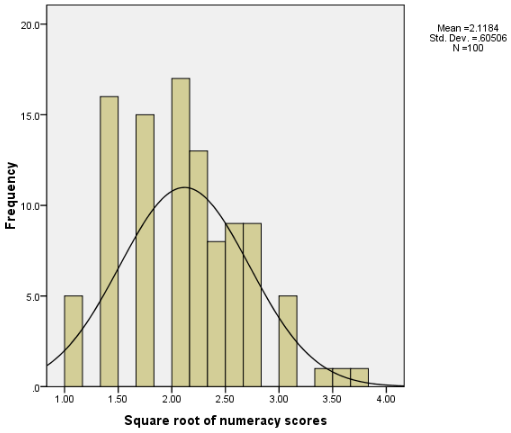
Task 9

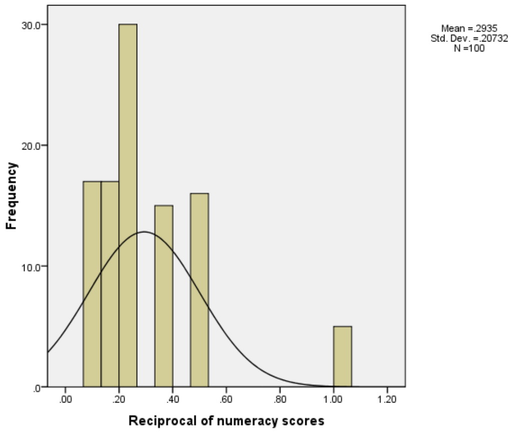
*Transform the **numeracy** scores (which are positively skewed) using one of the transformations described in this chapter. Do the data become normal?*

These are the original histogram and those of the transformed scores (I've included all three transformations discussed in the chapter):

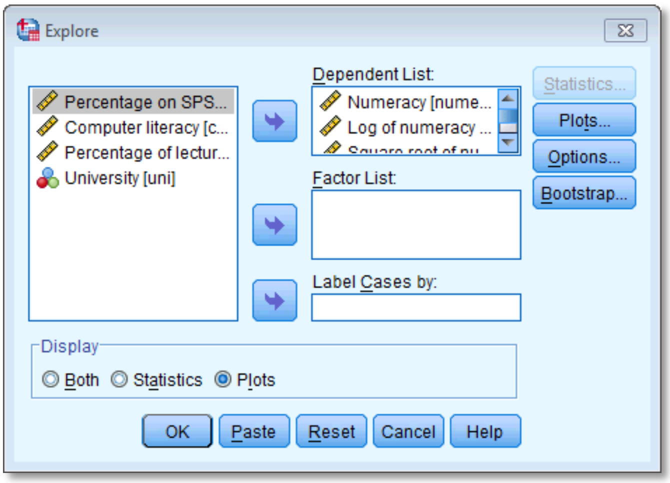


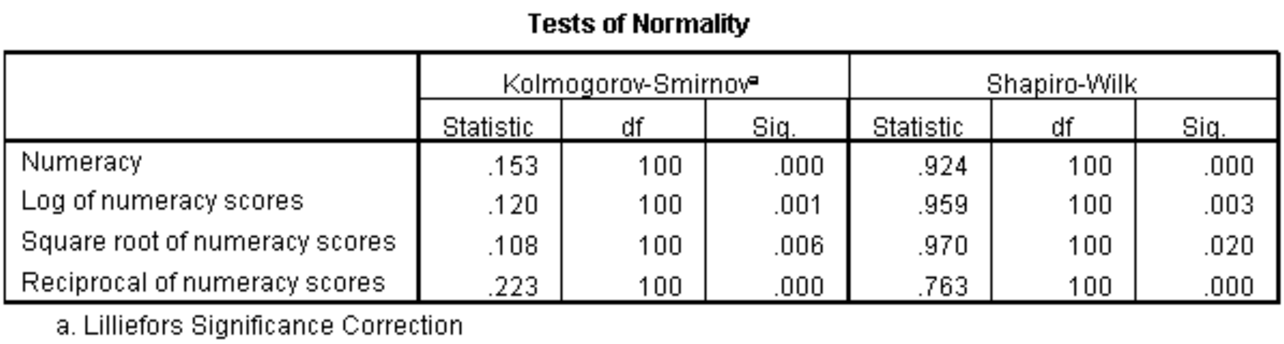






None of these histograms appear to be normal. Below is the table of results from the K–S test, all of which are significant. The only conclusion is that although the square root transformation does the best job of normalizing the data, none of these transformations actually works!





Tests of Normality

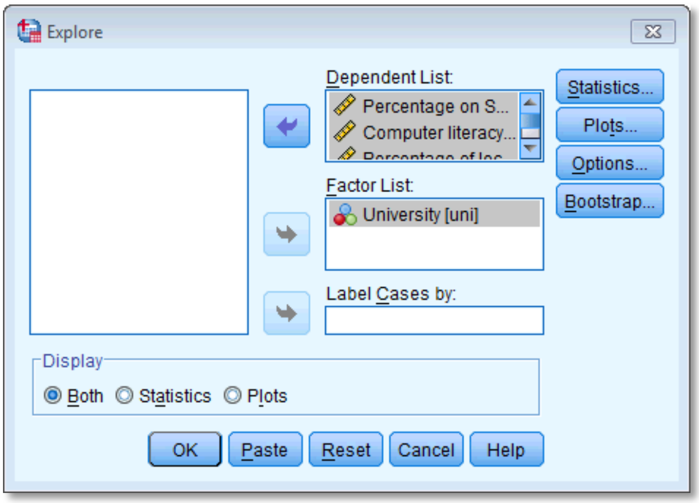
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Numeracy	.153	100	.000	.924	100	.000
Log of numeracy scores	.120	100	.001	.959	100	.003
Square root of numeracy scores	.108	100	.006	.970	100	.020
Reciprocal of numeracy scores	.223	100	.000	.763	100	.000

a. Lilliefors Significance Correction

Task 10

Use the explore *command to see what effect a natural log transformation would have on the four variables measured in* ***SPSSExam.sav****.*

The completed dialog boxes should look like this:



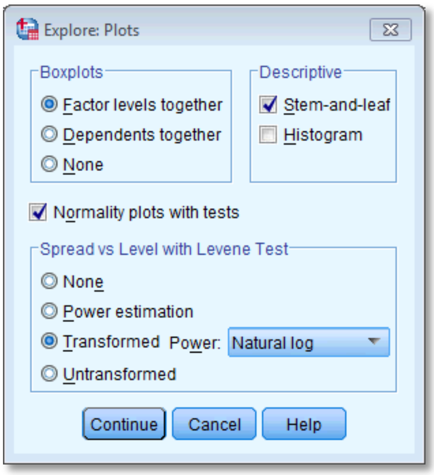
Explore

Dependent List:
- Percentage on S...
- Computer literacy...
- Percentage of lec

Factor List:
- University [uni]

Label Cases by:

Display: ● Both ○ Statistics ○ Plots



Explore: Plots

Boxplots
- ● Factor levels together
- ○ Dependents together
- ○ None

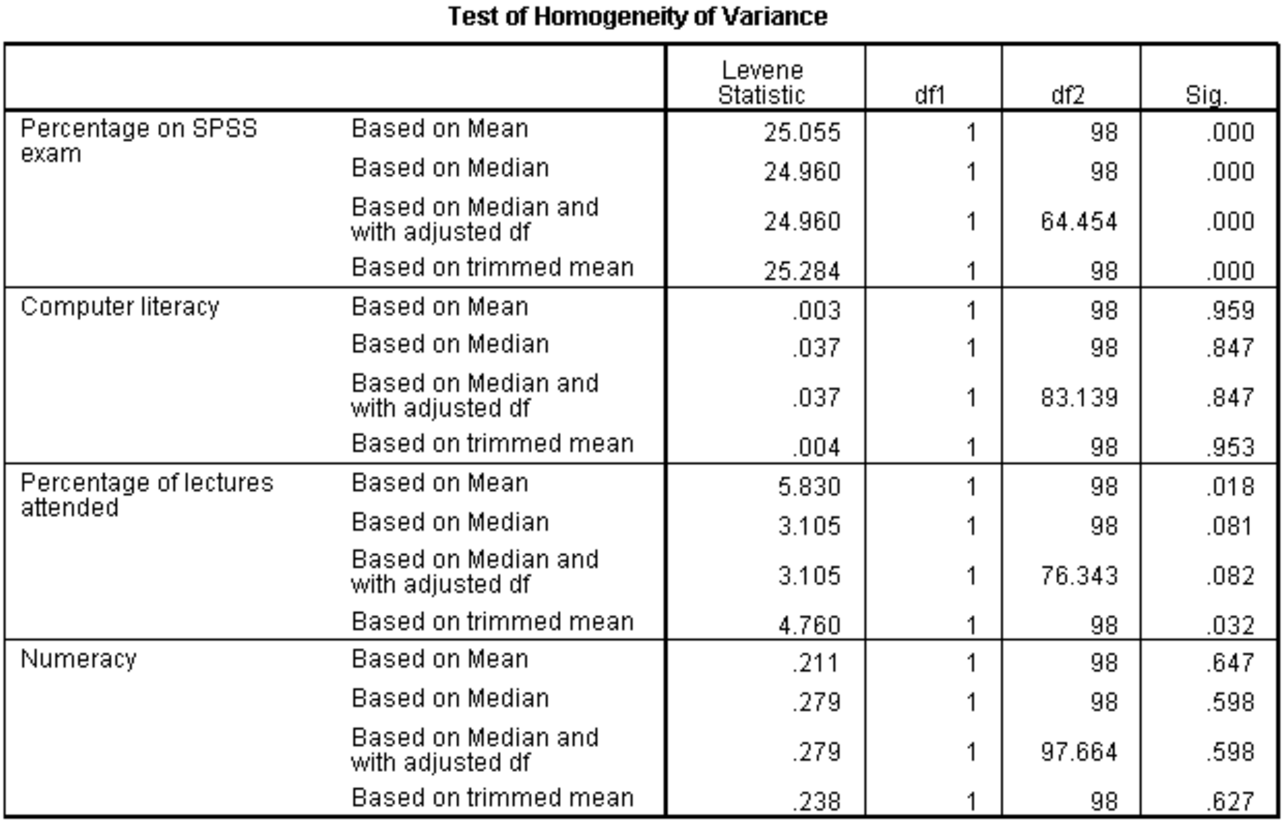
Descriptive
- ☑ Stem-and-leaf
- □ Histogram

☑ Normality plots with tests

Spread vs Level with Levene Test
- ○ None
- ○ Power estimation
- ● Transformed Power: Natural log
- ○ Untransformed

The SPSS output below shows Levene's test on the log-transformed scores. Compare this table to the one in the book (which was conducted on the untransformed SPSS exam scores and numeracy). To recap the book chapter, for the untransformed scores Levene's test was non-significant for the SPSS exam scores (the value in the column labelled *Sig.* was .111, more than .05) indicating that the variances were not significantly different (i.e., the homogeneity of variance assumption is tenable). However, for the numeracy scores, Levene’s test was significant (the value in the column labelled *Sig.* was .008, less than .05) indicating that the variances were significantly different (i.e. the homogeneity of variance assumption was violated).

For the log-transformed scores (below), the problem has been reversed: Levene’s test is now significant for the SPSS exam scores (values in the column labelled *Sig.* are less than .05) but is no longer significant for the numeracy scores (values in the column labelled *Sig.* are more than .05). This reiterates my point from the book chapter that transformations are often not a magic solution to problems in the data!



Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Percentage on SPSS exam	Based on Mean	25.055	1	98	.000
	Based on Median	24.960	1	98	.000
	Based on Median and with adjusted df	24.960	1	64.454	.000
	Based on trimmed mean	25.284	1	98	.000
Computer literacy	Based on Mean	.003	1	98	.959
	Based on Median	.037	1	98	.847
	Based on Median and with adjusted df	.037	1	83.139	.847
	Based on trimmed mean	.004	1	98	.953
Percentage of lectures attended	Based on Mean	5.830	1	98	.018
	Based on Median	3.105	1	98	.081
	Based on Median and with adjusted df	3.105	1	76.343	.082
	Based on trimmed mean	4.760	1	98	.032
Numeracy	Based on Mean	.211	1	98	.647
	Based on Median	.279	1	98	.598
	Based on Median and with adjusted df	.279	1	97.664	.598
	Based on trimmed mean	.238	1	98	.627