Multidimensional Scaling Presentation

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Electronic Devices

Typewriter

Desktop Computer

Laptop Computer

Tablet

Smart Phone

A Television Set

A Radio

Game Console

I. MODEL

To quote from Kruskal and Wish (1991), "The procedure is much harder to explain, however, than techniques for computing descriptive statistics such as the mean, standard deviation or correlation coefficient. . . Even for methods of data analysis as complicated as the analysis of variance and linear regression, the actual operations necessary for simple versions can be presented without too much difficulty. . . Multidimensional scaling calculations are much more complex, and even the simplest versions are never performed without the aid of a computer."

1) MDS requires data representing how close together or far apart items are, e.g., how close are Cleveland and Columbus, Cleveland and Chicago, Cleveland and New York, or Cleveland and Beijing. While geographical objects can be measured in kilometers (or feet) the strength of MDS is that it can analyze objects or concepts that cannot be simply measured with a ruler. Towards this end we constructed a simple questionnaire that asked respondents to estimate, in their own judgment how close (similar) or far apart (dissimilar) eight common technological objects are, and the responses were analyzed.

2) After MDS provided a map of the objects in multiple dimensions, these dimensions were correlated with 4 attributes that were assessed for each of the objects. They were how often were the objects used, how portable were they, how new were they and how amenable were they to multiple uses. That questionnaire follows:

Create a survey for your MDS

For each pair of devices below, indicate how far apart or near to one another you perceive them to be. Small values indicate that the devices are very similar and large values indicate that they are not at all sinilar. "0" means that you feel they are IDENTICAL and "100" means they are maximally DISSIMILAR.

Compare These Devices			Similarity/Dissimilarity 0-100	
Typewriter	and	A Television Set	_____	
Tablet	and	Smart Phone	_____	
Desktop Computer	and	A Radio	_____	
Typewriter	and	Desktop Computer	_____	
Desktop Computer	and	Game Console	_____	
Laptop Computer	and	Smart Phone	_____	
A Radio	and	Typewriter	_____	
A Radio	and	Game Console	_____	
A Television Set	and	Game Console	_____	
Laptop Computer	and	A Radio	_____	
Desktop Computer	and	Tablet	_____	
Typewriter	and	Laptop Computer	_____	
A Television Set	and	A Radio	_____	
Typewriter	and	Tablet	_____	
Smart Phone	and	A Radio	_____	
Tablet	and	Game Console	_____	
Desktop Computer	and	Smart Phone	_____	
Desktop Computer	and	A Television Set	_____	
Desktop Computer	and	Laptop Computer	_____	
Laptop Computer	and	Game Console	_____	
Tablet	and	A Radio	_____	
Typewriter	and	Smart Phone	_____	
Smart Phone	and	A Television Set	_____	
Laptop Computer	and	Tablet	_____	
Smart Phone	and	Game Console	_____	
Laptop Computer	and	A Television Set	_____	
Tablet	and	A Television Set	_____	
Game Console	and	Typewriter	_____	

(Circle one number for each)

	NEVER				How **OFTEN** do you use each of these devices						**VERY OFTEN**
Typewriter	0	1	2	3	4	5	6	7	8	9	10
Desktop Computer	0	1	2	3	4	5	6	7	8	9	10
Laptop Computer	0	1	2	3	4	5	6	7	8	9	10
Tablet	0	1	2	3	4	5	6	7	8	9	10
Smart Phone	0	1	2	3	4	5	6	7	8	9	10
A Television Set	0	1	2	3	4	5	6	7	8	9	10
A Radio	0	1	2	3	4	5	6	7	8	9	10
Game Console	0	1	2	3	4	5	6	7	8	9	10

	NOT at ALL				How **PORTABLE** is each device						**VERY**
Typewriter	0	1	2	3	4	5	6	7	8	9	10
Desktop Computer	0	1	2	3	4	5	6	7	8	9	10
Laptop Computer	0	1	2	3	4	5	6	7	8	9	10
Tablet	0	1	2	3	4	5	6	7	8	9	10
Smart Phone	0	1	2	3	4	5	6	7	8	9	10
A Television Set	0	1	2	3	4	5	6	7	8	9	10
A Radio	0	1	2	3	4	5	6	7	8	9	10
Game Console	0	1	2	3	4	5	6	7	8	9	10

	VERY OLD				How **NEW** is each device						**VERY NEW**
Typewriter	0	1	2	3	4	5	6	7	8	9	10
Desktop Computer	0	1	2	3	4	5	6	7	8	9	10
Laptop Computer	0	1	2	3	4	5	6	7	8	9	10
Tablet	0	1	2	3	4	5	6	7	8	9	10
Smart Phone	0	1	2	3	4	5	6	7	8	9	10
A Television Set	0	1	2	3	4	5	6	7	8	9	10
A Radio	0	1	2	3	4	5	6	7	8	9	10
Game Console	0	1	2	3	4	5	6	7	8	9	10

	SINGLE USE				How does each device allow **Variable USES**						**MANY USES**
Typewriter	0	1	2	3	4	5	6	7	8	9	10
Desktop Computer	0	1	2	3	4	5	6	7	8	9	10
Laptop Computer	0	1	2	3	4	5	6	7	8	9	10
Tablet	0	1	2	3	4	5	6	7	8	9	10
Smart Phone	0	1	2	3	4	5	6	7	8	9	10
A Television Set	0	1	2	3	4	5	6	7	8	9	10
A Radio	0	1	2	3	4	5	6	7	8	9	10
Game Console	0	1	2	3	4	5	6	7	8	9	10

II. RUNNING SPSS and III. SPSS OUTPUT (COMBINED)

```
GET
  FILE='C:\Users\2579945\Desktop\MDS\Tuesday Files\Compare 13.sav'.
DATASET NAME DataSet1 WINDOW=FRONT.
DESCRIPTIVES VARIABLES=Type_TV Tablet_Phone Desk_Radio Type_Desk Desk_Game Lap_Phone
Radio_Type Radio_Game TV_Game Lap_Radio Desk_Tablet Type_Lap TV_Radio Type_Tablet
Phone_Radio Tablet_Game Desk_Phone Desk_TV Desk_Lap Lap_Game Tablet_Radio Type_Phone
Phone_TV Lap_Tablet Phone_Game Lap_TV Tablet_TV Game_Type
  /STATISTICS=MEAN MIN MAX.
```

Descriptives

```
[DataSet1] C:\Users\2579945\Desktop\MDS\Tuesday Files\Compare 13.sa
```

Descriptive Statistics

	N	Minimum	Maximum	Mean
Type_TV	13	0	100	79.08
Tablet_Phone	13	5	70	27.31
Desk_Radio	13	0	100	69.23
Type_Desk	13	0	98	51.08
Desk_Game	13	5	75	39.46
Lap_Phone	13	5	75	37.77
Radio_Type	13	0	100	84.62
Radio_Game	13	0	100	78.85
TV_Game	13	5	80	52.62
Lap_Radio	13	0	95	58.85
Desk_Tablet	13	5	70	27.00
Type_Lap	13	0	96	54.08
TV_Radio	13	10	98	48.69
Type_Tablet	13	0	98	62.69
Phone_Radio	13	0	96	61.62
Tablet_Game	13	0	98	38.46
Desk_Phone	13	10	100	48.46
Desk_TV	13	0	90	40.23
Desk_Lap	13	0	90	14.62
Lap_Game	13	5	60	28.92
Tablet_Radio	13	0	95	62.62
Type_Phone	13	0	100	75.23
Phone_TV	13	0	100	65.00
Lap_Tablet	13	2	80	24.00
Phone_Game	13	5	90	34.62
Lap_TV	13	0	95	47.69
Tablet_TV	13	0	95	46.77

Run Descriptive on the 28 pairs of data to get the means of the 13 subjects. We will only use these means in the MDS program

Game_Type	13	0	100	85.62
Valid N (listwise)	13			

The Mean data are entered into an array. Note that the 8 columns are labeled with the 8 devices and each label ends with the number of the column. This is used to identify the correct row for each device since the rows are not labeled, just numbered. Row 1 is Type1, row 2 is Desk2 etc.

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Type_TV	13	0	10	79.08	33.482
Tablet_Phone	13	5	70		22.418
Desk_Radio	13	0	100	69.23	28.199
Type_Desk	13	0	98	51.08	34.565
Desk_Game	13	5	75	39.46	23.426
Lap_Phone	13	5	75	37.77	21.829

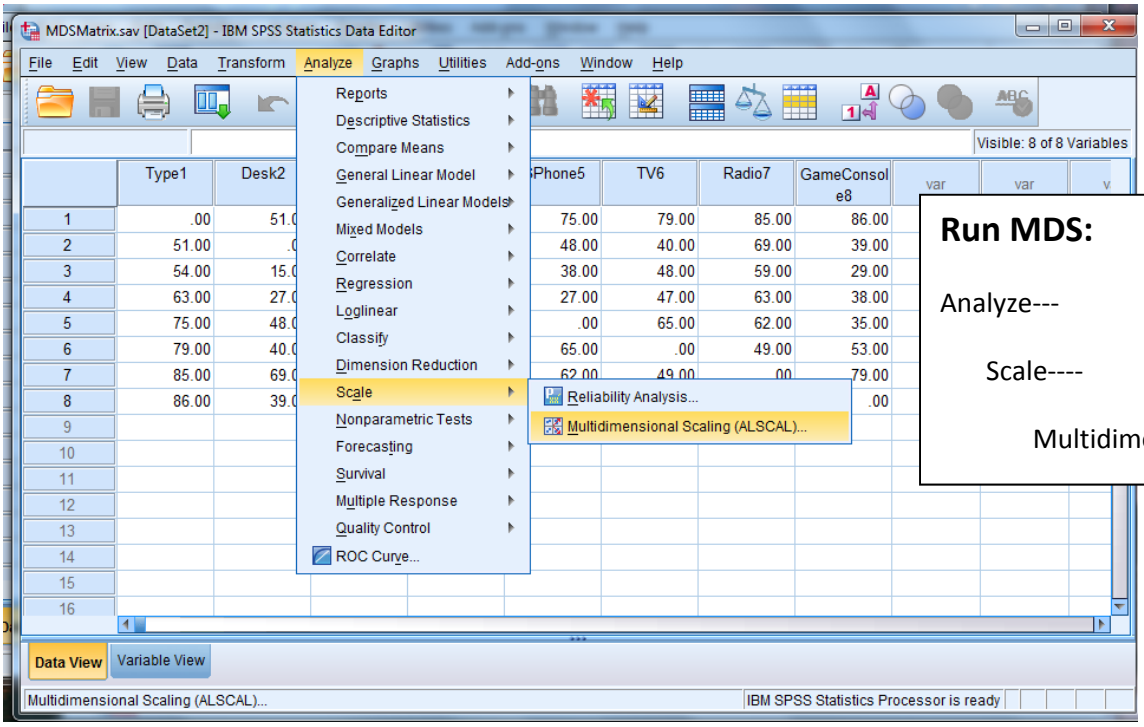
MDSMatrix.sav - SPSS Data Editor

File Edit View Data Transform Analyze Graphs Utilities Add-ons Window Help

1 : TV6 | 79

	Type1	Desk2	Laptop3	Tablet4	SPhone5	TV6	Radio7	GameConsole8	var
1	.00	51.00	54.00	63.00	75.00	79.00	85.00	86.00	
2	51.00	.00	15.00	27.00	48.00	40.00	69.00	39.00	
3	54.00	15.00	.00	24.00	38.00	48.00	59.00	29.00	
4	63.00	27.00	24.00	.00	27.00	47.00	63.00	38.00	
5	75.00	48.00	38.00	27.00	.00	65.00	62.00	35.00	
6	79.00	40.00	48.00	47.00	65.00	.00	49.00	53.00	
7	85.00	69.00	59.00	63.00	62.00	49.00	.00	79.00	
8	86.00	39.00	29.00	38.00	35.00	53.00	79.00	.00	
9									
10									
11									
12									

Valid N (listwise)	13					

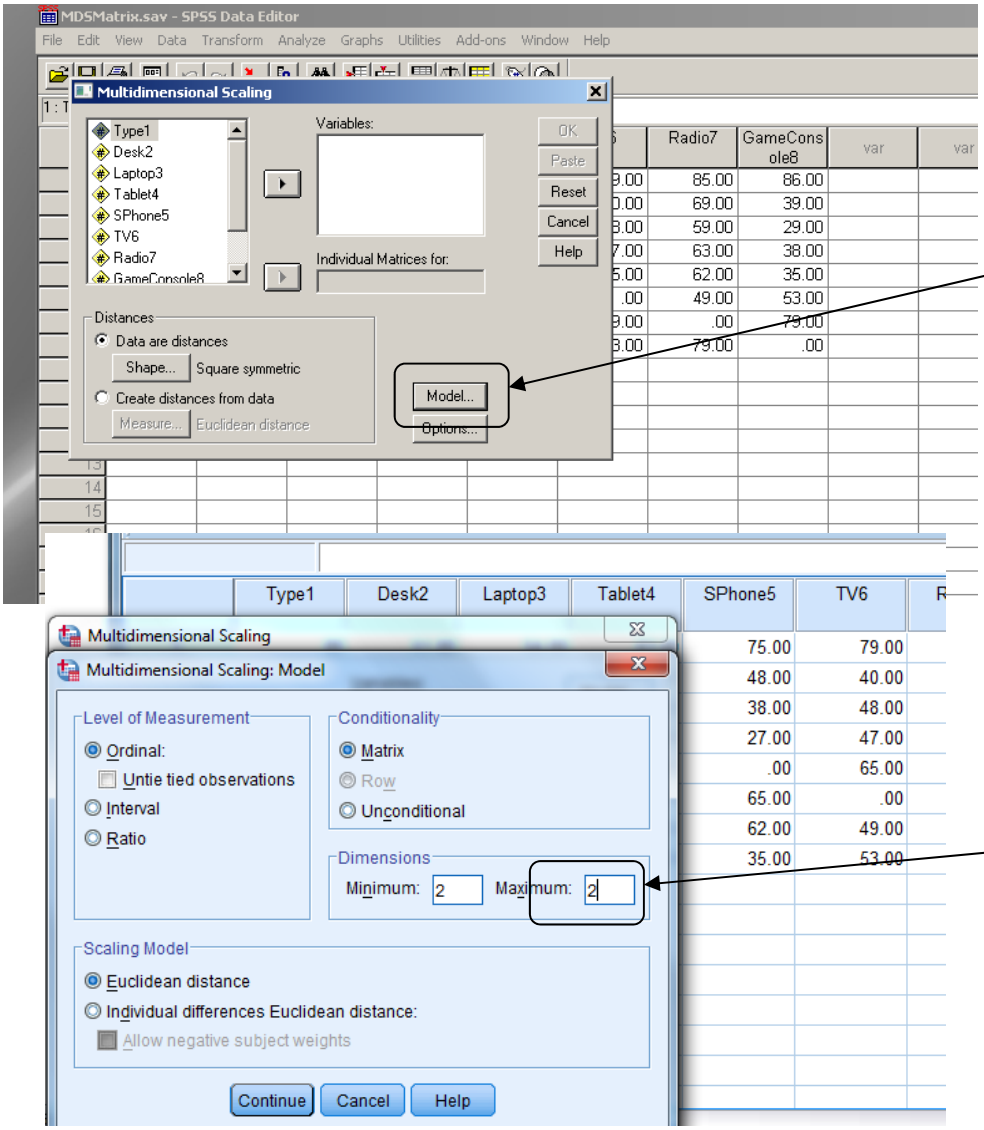


Run MDS:

Analyze---

Scale----

Multidimensional Scaling (ASCAL)



Move all 8 devices into the variable box and THEN click on MODEL button

The default for the dimensions of the model is 2. We need to change this to 3 (4 is too high)

```
GET
  FILE='C:\Users\2579945\Desktop\MDS\Tuesday Files\MDSMatrix.sav'.
DATASET NAME DataSet2 WINDOW=FRONT.
ALSCAL
  VARIABLES=Type1 Desk2 Laptop3 Tablet4 SPhone5 TV6 Radio7 GameConsole8
  /SHAPE=SYMMETRIC
  /LEVEL=ORDINAL
  /CONDITION=MATRIX
  /MODEL=EUCLID
  /CRITERIA=CONVERGE(0.001) STRESSMIN(0.005) ITER(30) CUTOFF(0) DIMENS(2,3).
```

Alscal

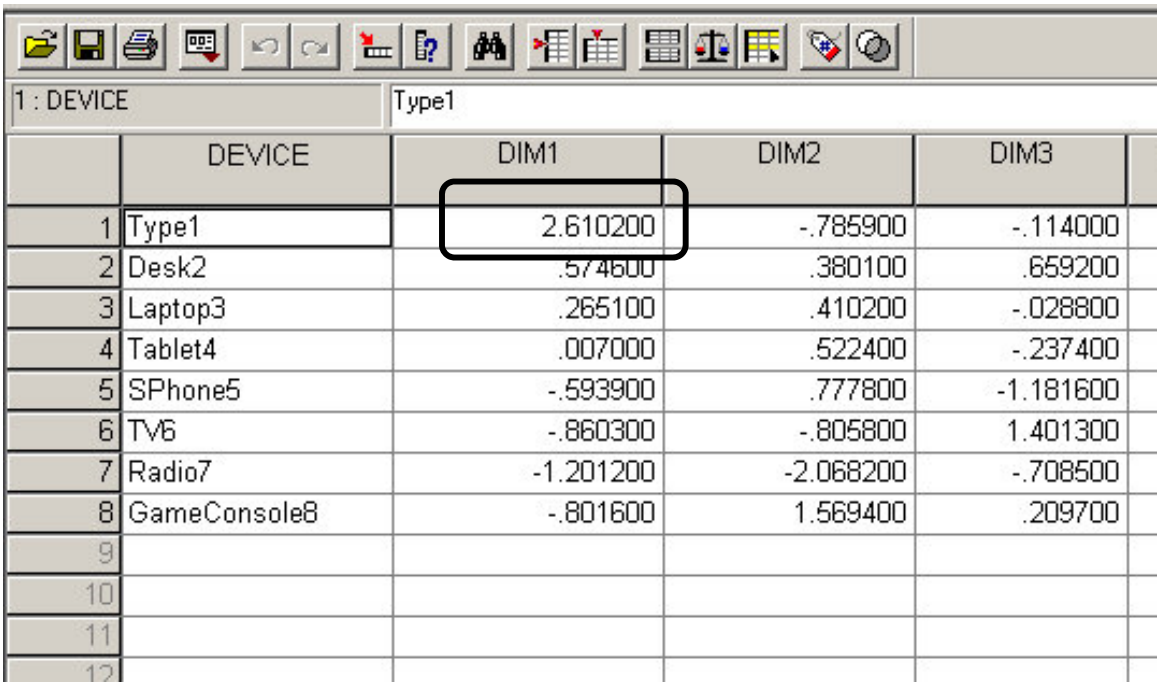
```
[DataSet2] C:\Users\2579945\Desktop\MDS\Tuesday Files\MDSMatrix.sav

Warning # 14654
The total number of parameters being estimated (the number of stimulus
coordinates plus the number of weights, if any) is large relative to the
number of data values in your data matrix.  The results may not be reliable
since there may not be enough data to precisely estimate the values of the
parameters.  You should reduce the number of parameters (e.g.  request fewer
dimensions) or increase the number of observations.
Number of parameters is 24.  Number of data values is 28

Iteration history for the 3 dimensional solution (in squared distances)

                Young's S-stress formula 1 is used.

             Iteration     S-stress      Improvement

                 1           .03232
                 2           .02338         .00894
                 3           .02097         .00241
                 4           .01934         .00164
                 5           .01812         .00121
                 6           .01719         .00093

                      Iterations stopped because
              S-stress improvement is less than   .001000


Stress and squared correlation (RSQ) in distances

   RSQ values are the proportion of variance of the scaled data (disparities)
in the partition (row, matrix, or entire data) which is accounted for by their
corresponding distances.
                  Stress values are Kruskal's stress formula 1.

             For  matrix
    Stress  =   .02558      RSQ =  .99552
```

Configuration derived in 3 dimensions

Stimulus Coordinates

Stimulus Number	Stimulus Name	Dimension 1	2	3
1	Type1	2.6101	-.7859	-.1140
2	Desk2	.5746	.3801	.6592
3	Laptop3	.2651	.4102	-.0288
4	Tablet4	.0070	.5224	-.2374
5	SPhone5	-.5939	.7778	-1.1816
6	TV6	-.8603	-.8058	1.4013
7	Radio7	-1.2012	-2.0682	-.7085
8	GameCons	-.8016	1.5694	.2097

Enter the 3 dimensions for each of the 8 objects into an array for graphing



1 : DEVICE | Type1

	DEVICE	DIM1	DIM2	DIM3
1	Type1	2.610200	-.785900	-.114000
2	Desk2	.574600	.380100	.659200
3	Laptop3	.265100	.410200	-.028800
4	Tablet4	.007000	.522400	-.237400
5	SPhone5	-.593900	.777800	-1.181600
6	TV6	-.860300	-.805800	1.401300
7	Radio7	-1.201200	-2.068200	-.708500
8	GameConsole8	-.801600	1.569400	.209700
9				
10				
11				
12				

MDS continues and gives the values for a 2 dimensional model which we will not use

Warning # 14654
The total number of parameters being estimated (the number of stimulus coordinates plus the number of weights, if any) is large relative to the number of data values in your data matrix. The results may not be reliable since there may not be enough data to precisely estimate the values of the parameters. You should reduce the number of parameters (e.g. request fewer dimensions) or increase the number of observations.

Number of parameters is **16**. Number of data values is **28**

Iteration history for **the 2 dimensional** solution (in squared distances)

Young's S-stress formula 1 is used.

Iteration	S-stress	Improvement
1	.14391	
2	.11974	.02418
3	.11143	.00831
4	.10879	.00264
5	.10752	.00127
6	.10682	.00070

Iterations stopped because
S-stress improvement is less than .001000

Stress and squared correlation (RSQ) in distances

RSQ values are the proportion of variance of the scaled data (disparities)in the partition (row, matrix, or entire data) which is accounted for by their corresponding distances.

Stress values are Kruskal's stress formula 1.

For matrix

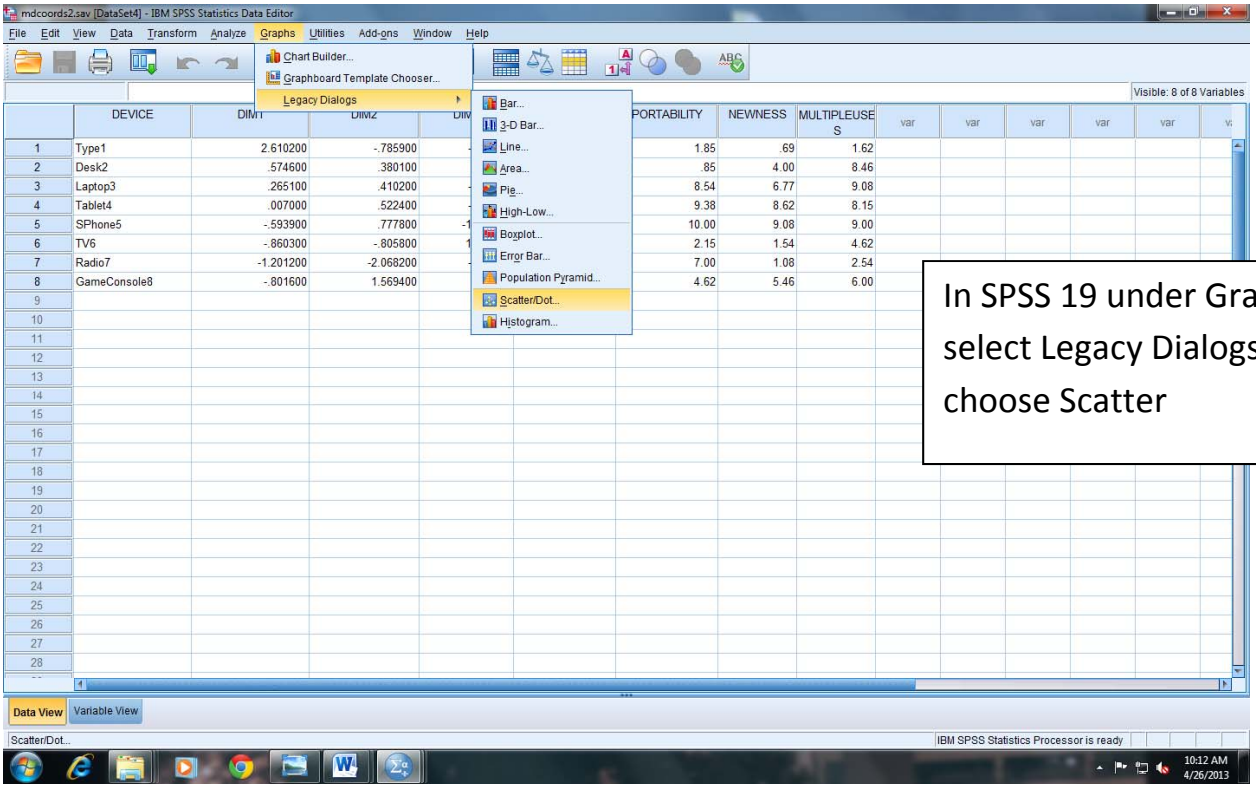
Stress = .10697 RSQ = **.95025**

Configuration derived in 2 dimensions

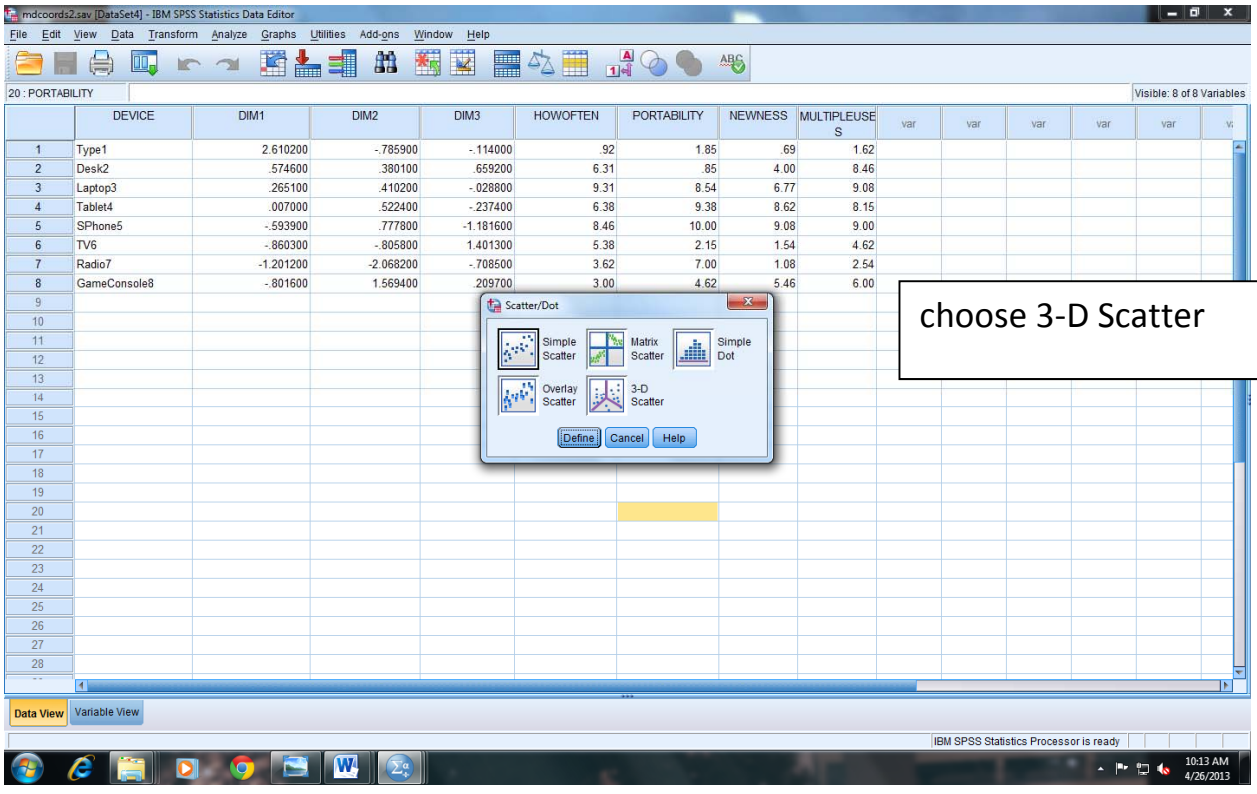
Stimulus Coordinates

Stimulus Number	Stimulus Name	Dimension 1	Dimension 2
1	Type1	2.4010	-.5625
2	Desk2	.4097	.1510
3	Laptop3	.1008	.3795
4	Tablet4	.0772	.3990
5	SPhone5	-.4472	.9681
6	TV6	-.6018	-1.1210
7	Radio7	-1.2416	-1.6238
8	GameCons	-.6981	1.409

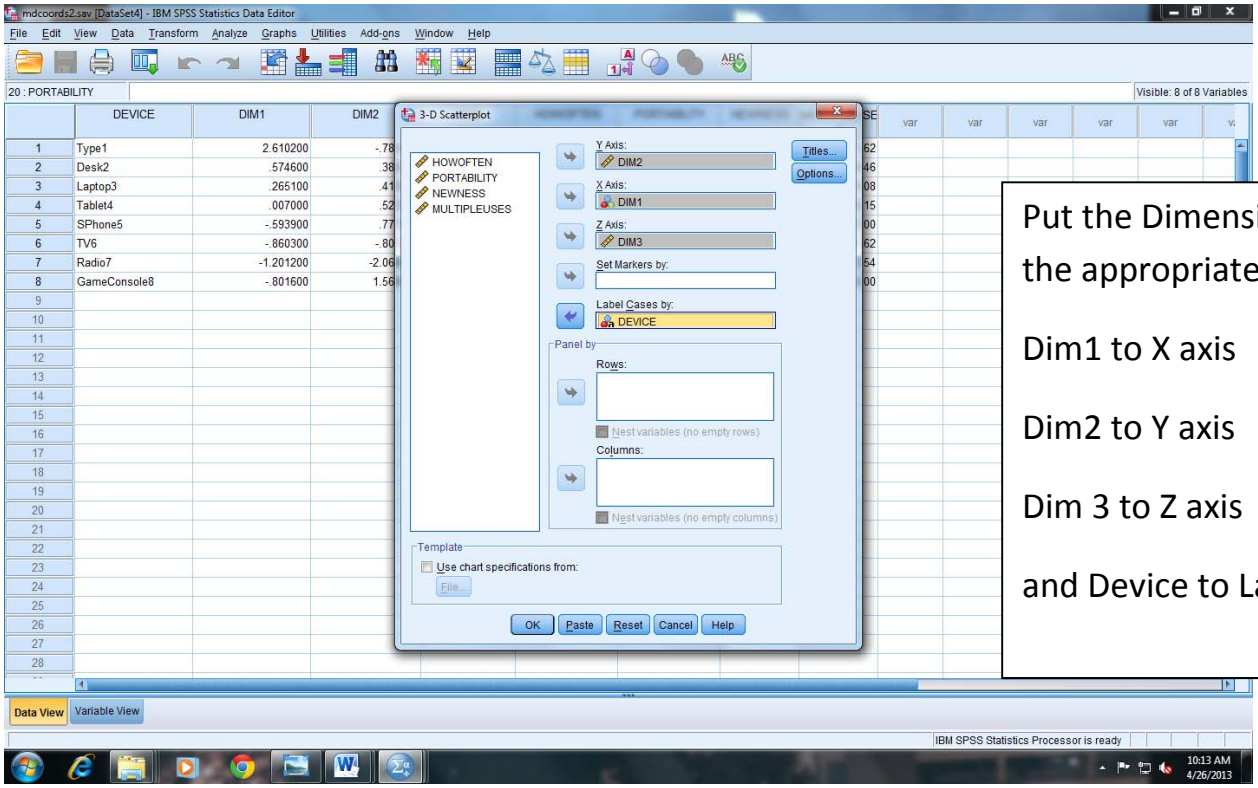
Graphing the Dimensions



In SPSS 19 under Graph select Legacy Dialogs and choose Scatter



choose 3-D Scatter



Put the Dimensions on the appropriate axis

Dim1 to X axis

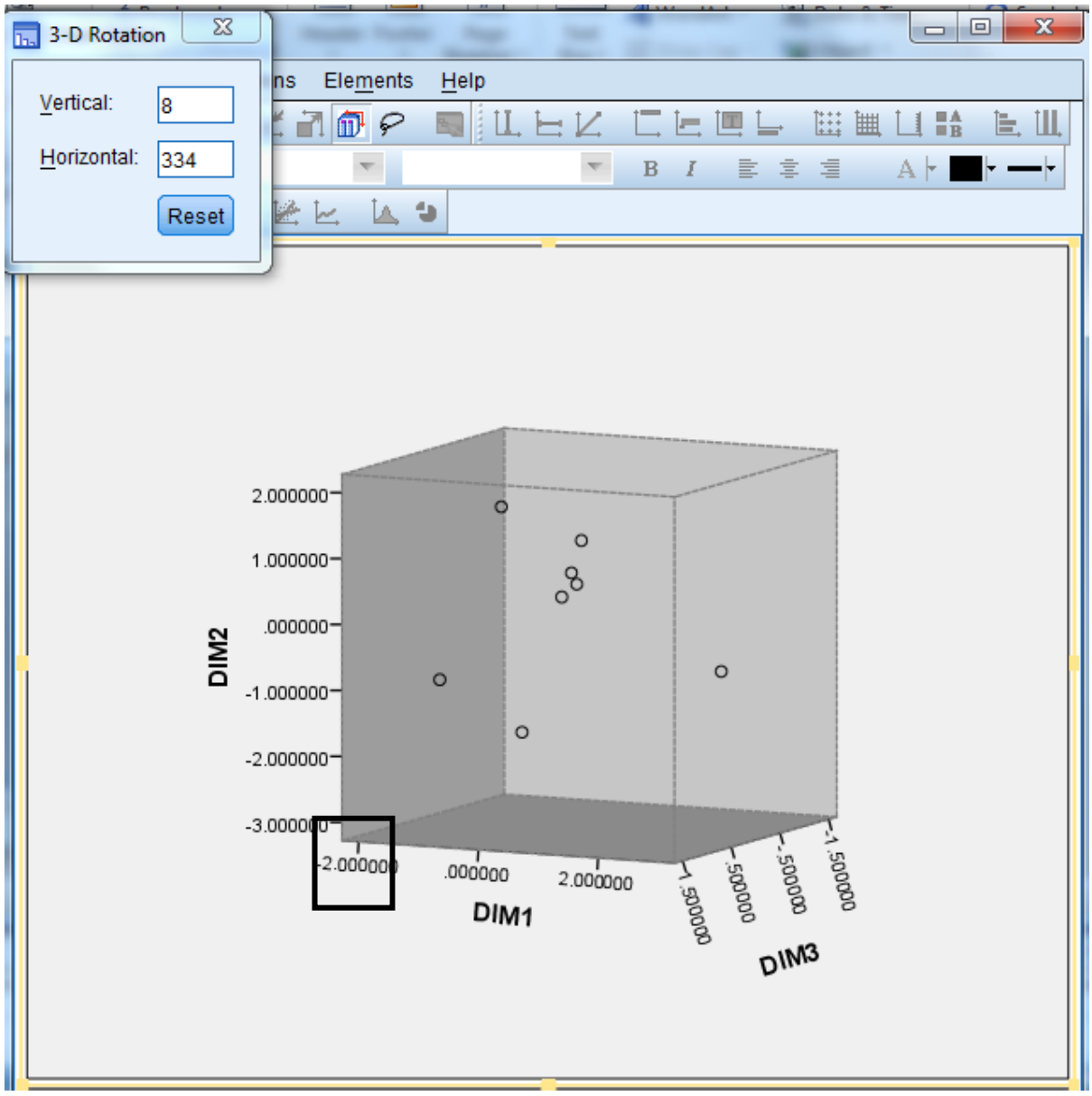
Dim2 to Y axis

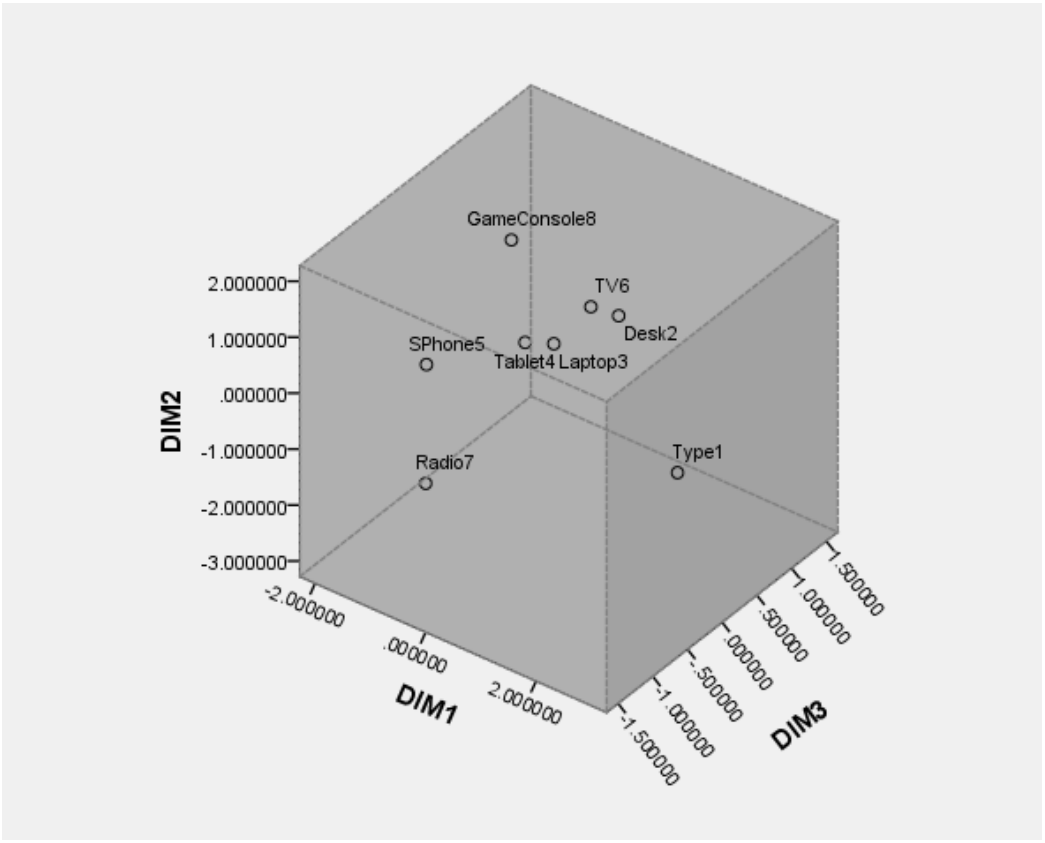
Dim 3 to Z axis

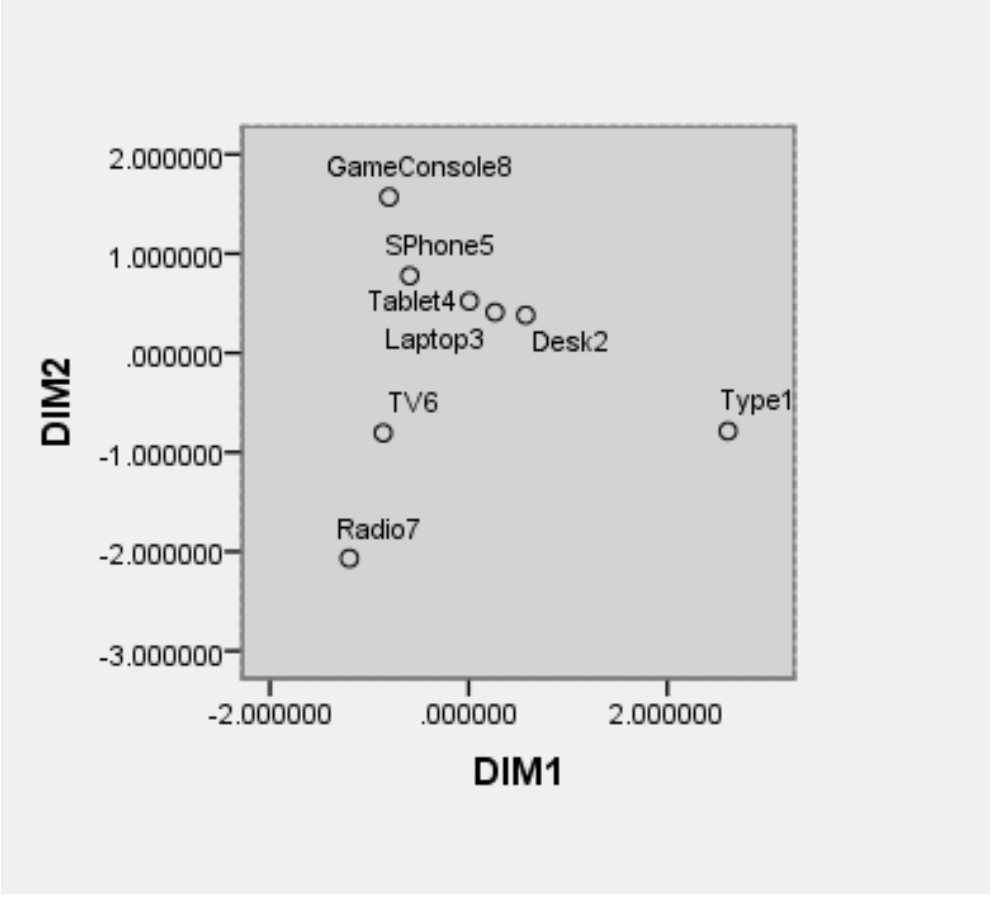
and Device to Label Cases

Double clicking on the cube brings up the edit graph function. Clicking on the rotation icon (next to the lasso) brings up the 3-D Rotation box with the Vertical and Horizontal coordinates. BUT you don't need to enter anything here to change the orientation. If you place the cursor on the cube it changes into a hand (?hand grabbing something) and allows you to drag the cube to rotate it.

Sorry -- the screen shot dosen't capture the hand




GameConsole8
TV6
Desk2
SPhone5
Tablet4
Laptop3
Radio7
Type1
2.000000
1.000000
.000000
-1.000000
-2.000000
-3.000000
DIM2
-2.000000
.000000
2.000000
DIM1
1.500000
1.000000
.500000
.000000
-.500000
-1.000000
-1.500000
DIM3


GameConsole8
SPhone5
Tablet4
Laptop3
Desk2
TV6
Type1
Radio7
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DIM2
-2.000000
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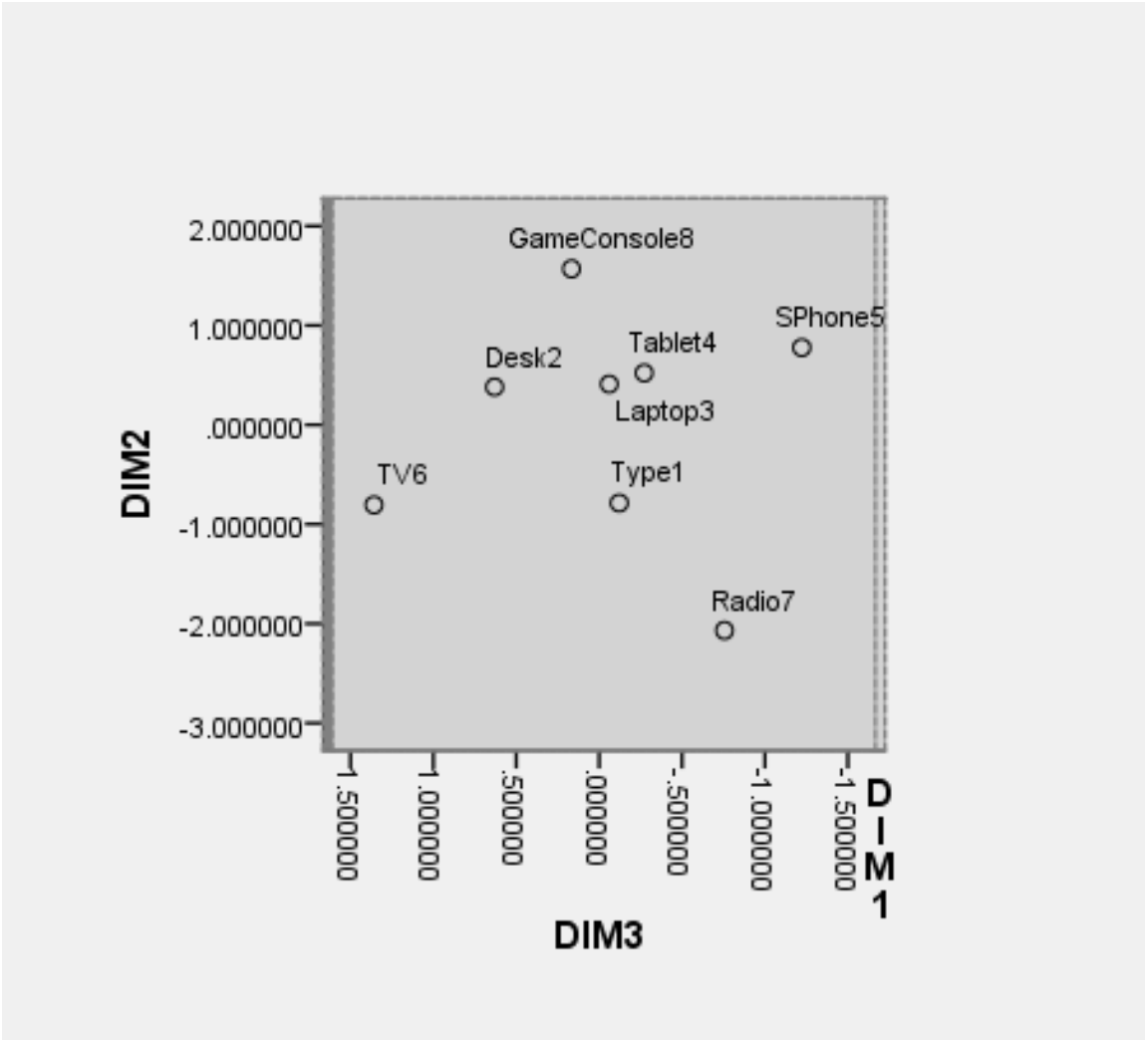
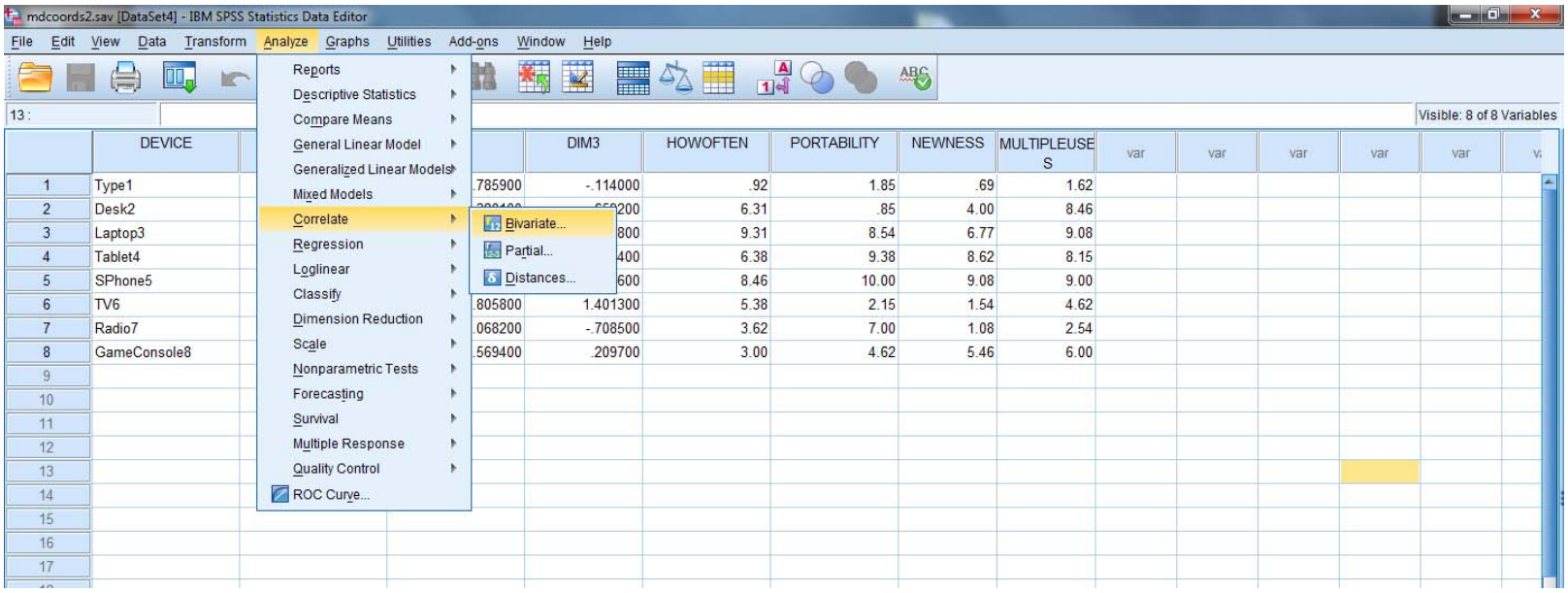
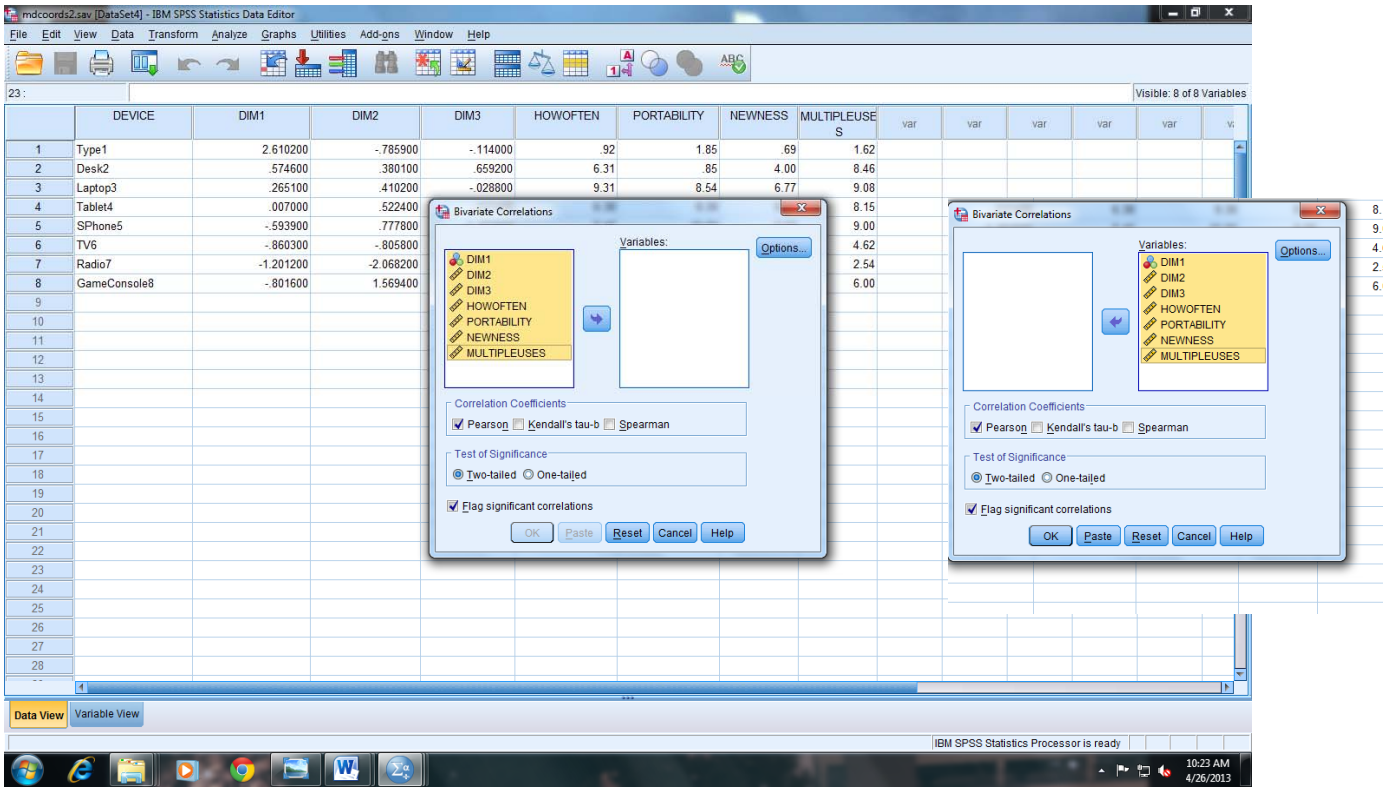
2.000000
DIM1


2.000000
1.000000
.000000
-1.000000
-2.000000
-3.000000
DIM2
GameConsole8
SPhone5
Tablet4
Desk2
Laptop3
TV6
Type1
Radio7
1.500000
1.000000
.500000
.000000
-.500000
-1.000000
-1.500000
DIM1
DIM3

Correlate the means of each of the 4 attributes (How often do you use it, how portable is it, how new is it and how amenable is it to multiple uses) with the 3 Dimensions





Correlations

		DIM1	DIM2	DIM3	HOWOFTEN	PORTABILITY	NEWNESS	MULTIPLEUSES
DIM1	Pearson Correlation	1	-.027	.037	-.328	-.393	-.225	-.222
	Sig. (2-tailed)		.950	.931	.428	.336	.593	.598
	N	8	8	8	8	8	8	8
DIM2	Pearson Correlation	-.027	1	-.008	.367	.207	.757*	.727*
	Sig. (2-tailed)	.950		.985	.371	.622	.030	.041
	N	8	8	8	8	8	8	8
DIM3	Pearson Correlation	.037	-.008	1	-.136	-.734*	-.422	-.091
	Sig. (2-tailed)	.931	.985		.749	.038	.298	.830
	N	8	8	8	8	8	8	8
HOWOFTEN	Pearson Correlation	-.328	.367	-.136	1	.570	.715*	.876**
	Sig. (2-tailed)	.428	.371	.749		.140	.046	.004
	N	8	8	8	8	8	8	8
PORTABILITY	Pearson Correlation	-.393	.207	-.734*	.570	1	.739*	.461
	Sig. (2-tailed)	.336	.622	.038	.140		.036	.250
	N	8	8	8	8	8	8	8
NEWNESS	Pearson Correlation	-.225	.757*	-.422	.715*	.739*	1	.868**
	Sig. (2-tailed)	.593	.030	.298	.046	.036		.005
	N	8	8	8	8	8	8	8
MULTIPLEUSES	Pearson Correlation	-.222	.727*	-.091	.876**	.461	.868**	1
	Sig. (2-tailed)	.598	.041	.830	.004	.250	.005	
	N	8	8	8	8	8	8	8

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

IV. TABLING RESULTS (this is in addition to the MDS graphs)

	How often used	How portable	How new	Multiple uses
Dimension 1	-.313 .451	-.376 .359	-.206 .624	-.208 .622
Dimension 2	.353 .391	.214 .611	.762* .028	.718* .045
Dimension3	-.155 .715	-.747* .033	-.443 .271	-.099 .816

* $p<0.05$

V. WRITEUP

The focus of this research was to explore the difference values subjects use when judging an electronic device. We collected data to assess the differences between each device using a 0-100 scale. Each subject rated how similar each device was by rating it close to 0 or how different a device was by rating it close to 100. We surveyed 13 subjects and had them rate 8 different devices. We also gathered data on the following attributes: How often a device was used, how new was the device, how portable was the device, and the number of multiple uses per device.

The results yielded a 3-dimensional solution from the data entered. Large differences between typewriter and smartphones, or typewriters and game consoles show that people perceive these devices differently. The first dimension seems to be one that discriminates between devices that require keyboarding, and those that do not. The second dimension seems to differentiate between older and newer devices. And the third dimension seems to be one of small vs. large devices, or portable vs. non-portable devices. Table 2 might help us confirm these interpretations of the dimensions by examining whether the dimensions are correlated with the four attributes measured. Our correlations show significances of dimension 2 with Newness and with Multiple Uses. The correlations for dimension 3 show a significance with Portability. None of the four attributes correlated strongly with dimension 1.