Testing Research Hypotheses by Comparing Nested Models

The researcher wanted to test the hypothesis that students with internal versus external locus of control had scholastic performance differences beyond what could be accounted for by differences In motivation and self concept. Testing this hypothesis involved comparing a reduced model including self concept and motivation scores, with a full model that included these variables and also a set of five performance measures.

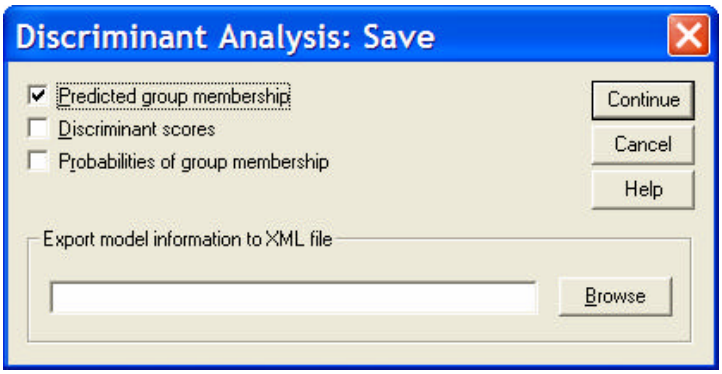
These data are from the TALENT data set. "External" and "internal" students are identified following the procedure offered in the manual.

```
compute ext_int = locus.
recode ext_int (lo thru -.25 = 0) (.25 thru hi = 1).
```

← categorizing based on IE score

The analysis was run using only those with 0 & 1 values !!

Use the "Save" window to have SPSS save the group membership predicted by each ldf model that you analyze.



SPSS Output for the reduced model:

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.314[a]	100.0	100.0	.174

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.970	6.091	2	.048

Standardized Canonical Discriminant Function Coefficients

	FUNC 1
CONCPT	.40722
MOTV	.77895

Structure Matrix:

	FUNC 1
MOTV	.92492
CONCPT	.68644

Group Centroids

Group	FUNC 1
0	-.15628
1	.19891

```
Classification Results -
                     No. of    Predicted Group Membership
   Actual Group       Cases          0          1
--------------------  ------   --------   --------
Group       0            97         52         45
                                   53.6%      46.4%
Group       1            88         36         52
                                   40.9%      59.1%
Ungrouped Cases          15
Percent of "grouped" cases correctly classified:  56.22%
```

SPSS Output for the reduced model:

Eigenvalues

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	.140[a]	100.0	100.0	.351

a. First 1 canonical discriminant functions were used in the analysis.

Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.877	25.551	2	.001

Standardized Canonical Discriminant Function Coefficients

	FUNC 1
CONCPT	.23834
MOTV	.23353
RDG	.53896
WRTG	-.14275
MATH	.07573
SCI	.00976
CIV	.60538

Structure Matrix:

	FUNC 1
CIV	.80125
RDG	.74319
WRTG	.61795
SCI	.60704
MOTV	.43742
CONCPT	.32464
MATH	.22648

Group Centroids

Group	FUNC 1
0	-.33046
1	.42058

Classification Results -

Actual Group	No. of Cases	Predicted Group Membership 0	1
Group 0	97	64	33
		66.0%	34.0%
Group 1	88	30	58
		34.1%	65.9%
Ungrouped Cases	15		

Percent of "grouped" cases correctly classified: 65.95%

The full model (65.95%) performed better than the reduced model (56.22%). Notice "how" the model got better -- there was little improvement in the ability to correctly classify members of group 1, but there was substantial improvement in the ability to correctly classify members of group 0. This type of "asymmetry" is common and often important!

Comparing Two Nested Models

Model comparison is the simplest when: 1) there are two groups and 2) the models are nested. In that case, the three "summaries" of the model are nearly equivalent, the Chi-square test of sphericity, the R^2, and the % correct.

Comparing Nested Models using the Sphericity Test Information

The X^2 values are an index of the goodness-of-fit of each model, so we can compute the difference in the fit of the two models by looking at the difference between X^2 value used to test each. The difference between two X^2 values is a X^2 value, with df = the difference between the two dfs. Our research hypothesis is that the full model will fit the data better (have a larger X^2 because it is "less spherical") than will the reduced model.

$X^2\Delta$ = X^2 (from full model) - X^2 (from reduced model) = 25.551 – 6.091 = 19.460

dfΔ = df (from full model) - df (from reduced model) = 7 - 2 = 5

Critical X^2 -- $X^2(5, \alpha = .01) = 15.086$

Since $X^2\Delta$ > Critical X^2, we would conclude that the full model fit the data better than did the reduced model.

Comparing Nested Models using the R^2

This test is the same as is used to test R^2 for multiple regression (and is also limited to comparing nested models -- although Hotelling's t-test can be used for non-nested models):

$$F\Delta = \frac{(.3509^2 - .1745^2) / (7 - 2)}{(1 - .3509^2) / 185 - 7 - 1} = 3.70$$

F-critical = $F(5,177, \alpha = .01) = 2.29$

Since FΔ > F-critical, we would conclude that the full model accounts for more between group variation than does the reduced model

Comparing Nested Models using the % correct reclassification

If the full model is better than the reduced model then it should lead to better reclassification. Specifically, there should be fewer cases uniquely incorrectly reclassified by the full model than are uniquely incorrectly reclassified by the reduced model.

Remember that we asked SPSS to save the predicted group membership for each analysis. These will be saved as dis_1, dis_2, etc. – one for each analysis. For this example dis_1 holds the classifications for the reduced model (which we requested first) and dis_2 holds the classifications for the second.

We need to score each set of classifications against the correct group membership, so we know who was correctly and incorrectly reclassified by each model.

```
if (ext_int eq dis_1) reduced = 1.
if (ext_int ne dis_1) reduced = 0.
```
← **determines who was correctly and incorrectly classified by the reduced model**

```
if (ext_int eq dis_2) full = 1.
if (ext_int ne dis_2) full = 0.
```
← **determines who was correctly and incorrectly classified by the full model**

```
value labels  full reduced 0 'wrong' 1 'correct'.

crosstabs tables = full by reduced.
```
← gets the counts needed to test the hypothesis

SPSS Output:

FULL by REDUCED

	REDUCED	Count
	wrong	correct
FULL	.00	1.00
.00 wrong	37	26
1.00 correct	44	78

misclassifications unique to the full model

misclassifications unique to the reduced model

The research hypothesis is that there will be fewer misclassifications using the full model than using the reduced model. Thus, we want to test if 26 < 44.

$$X^2 = \frac{(\text{misses unique to reduced model} - \text{misses unique to full model})^2}{\text{misses unique to reduced model} + \text{misses unique to full model}} = \frac{(44 - 26)^2}{44 + 26} = 4.628$$

X^2-critical (1, .05) = 3.84

Since $X^2 > X^2$-critical, we would conclude that the full model (65.59 % correct reclassification) yields better classification than does the reduced model including only motivation and self-concept (56.22 %).