

**TABLE 18.1** Brief Description of Multivariate Statistical Techniques Covered

---

- < *Multiple regression analysis* enables the researcher to predict the level of magnitude of a dependent variable based on the levels of more than one independent variable.
  - < *Multiple discriminant analysis* enables the researcher to predict group membership on the basis of two or more independent variables.
  - < *Cluster analysis* is a procedure for identifying subgroups of individuals or items that are homogeneous within subgroups and different from other subgroups.
  - < *Factor analysis* permits the analyst to reduce a set of variables to a smaller set of factors or composite variables by identifying dimensions under the data.
  - < *Perceptual mapping* is appropriate when the goal is to analyze consumer perception of companies, products, brands, and so on.
  - < *Conjoint analysis* provides a basis to estimate the utility that consumers associate with different product features or attributes.
-

## **Discriminant Analysis**

### < Multiple Discriminant Analysis

N A procedure for predicting group membership on the basis of two or more independent variables.

### < Discriminant Score

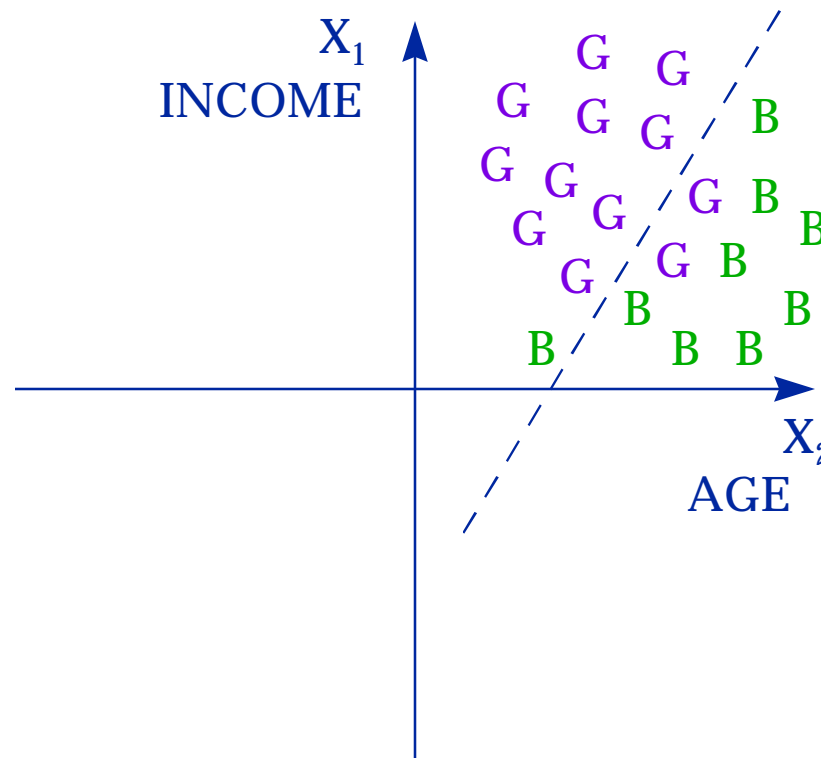
M The basis for predicting the group to which a particular object or individual belongs

### < Discriminant Coefficient

M Estimate of the discriminatory power of a particular independent variable

# The Essence of Discriminant Analysis

**PROBLEM: To discriminate between “good” and “bad” credit risks**

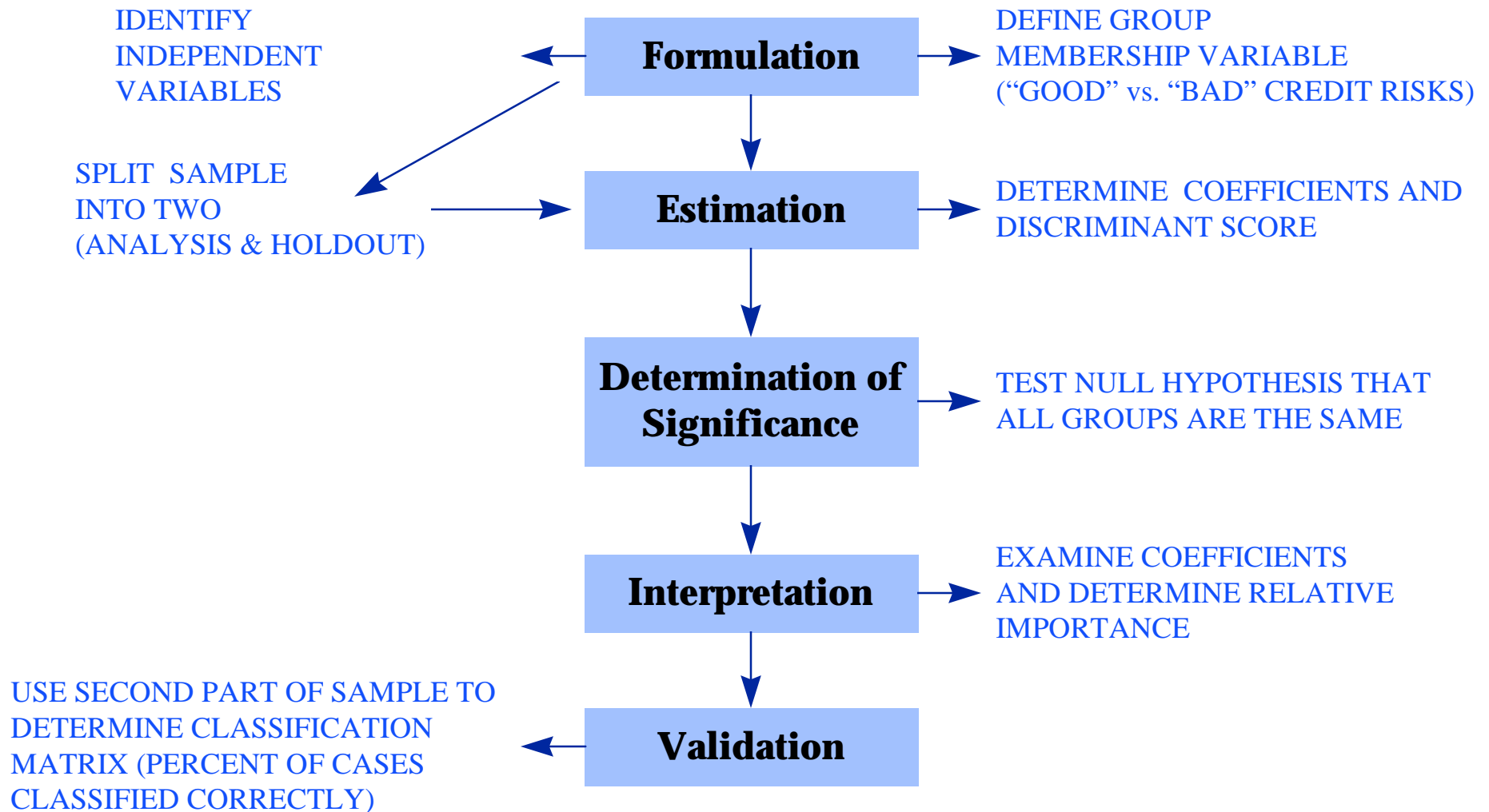


$$\begin{array}{c} \nearrow D \\ \text{DISCRIMINANT} \\ \text{SCORE} \end{array} = V_1 X_1 + V_2 X_2$$

$\nwarrow$  COEFFICIENTS

STATISTICAL CRITERION TO USE? Wilk's  $\Sigma = \frac{\text{WITHIN GROUP VARIANCE}}{\text{TOTAL VARIANCE}}$   
(MINIMIZE)

**Figure 20.1 Conducting Discriminant Analysis**



**TABLE 20.1**

**Similarities and Differences Among ANOVA, Regression and Discriminant Analysis**

	ANOVA	Regression	Discriminant Analysis
<i>Similarities</i>			
Number of dependent variables	One	One ↔ One	
Number of independent variables	Multiple	Multiple ↔ Multiple	
<i>Differences</i>			
Nature of the dependent variable	Metric	Metric ↔ Categorical	
Nature of the independent variables	Categorical	Metric ↔ Metric	

**FORGET ABOUT THIS**

**CONCLUSION: THE TWO TECHNIQUES ARE VERY SIMILAR, WITH DISCRIMINANT ANALYSIS HAVING MANY POTENTIAL APPLICATIONS IN MARKETING**

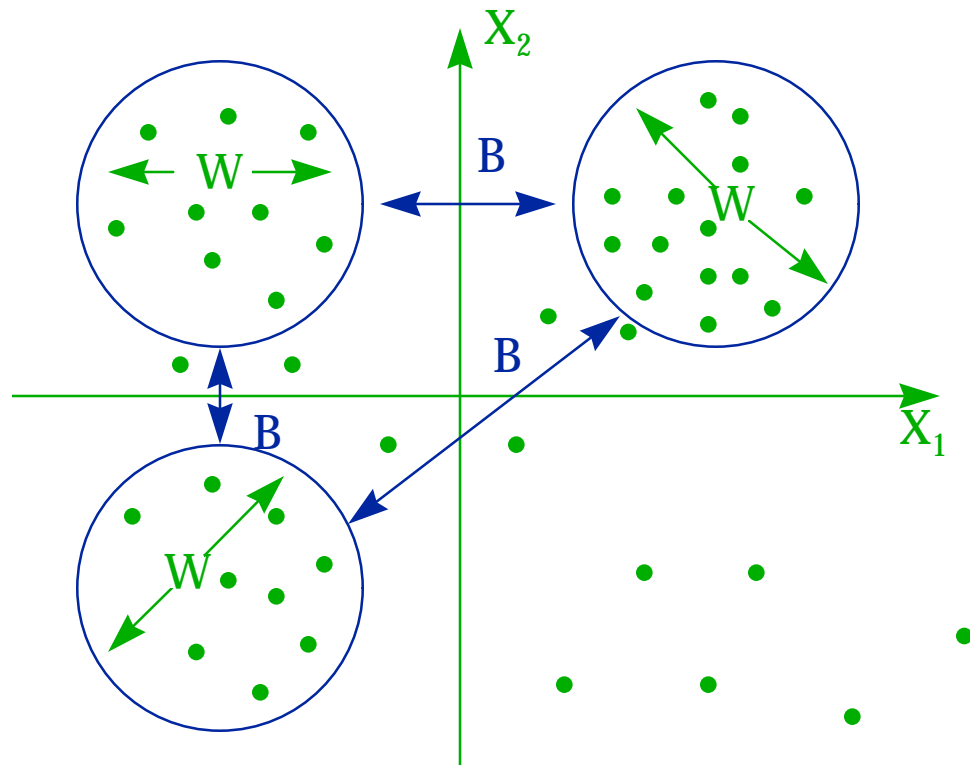
## **Cluster Analysis**

Procedures for classifying objects or people into some number of mutually exclusive and exhaustive groups on the basis of two or more classification variables.

# The Essence of Cluster Analysis

**PURPOSE:** To place objects/cases into clusters

**STEPS:** Decide on distance measure  
Decide on clustering criteria



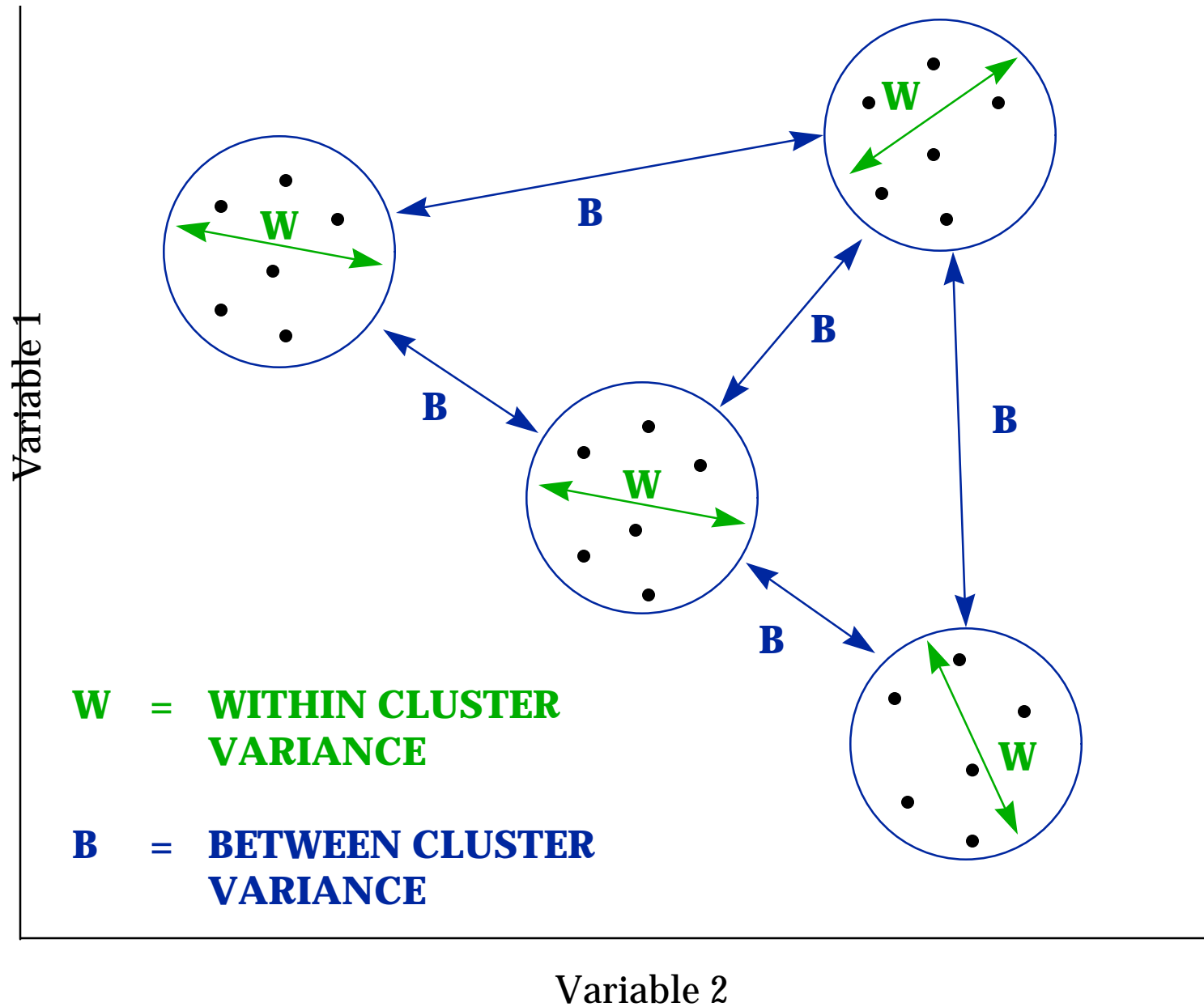
**W = WITHIN  
CLUSTER  
VARIANCE  
(OR S.S.)**

**B = BETWEEN  
CLUSTER  
VARIANCE (OR  
S.S.)**

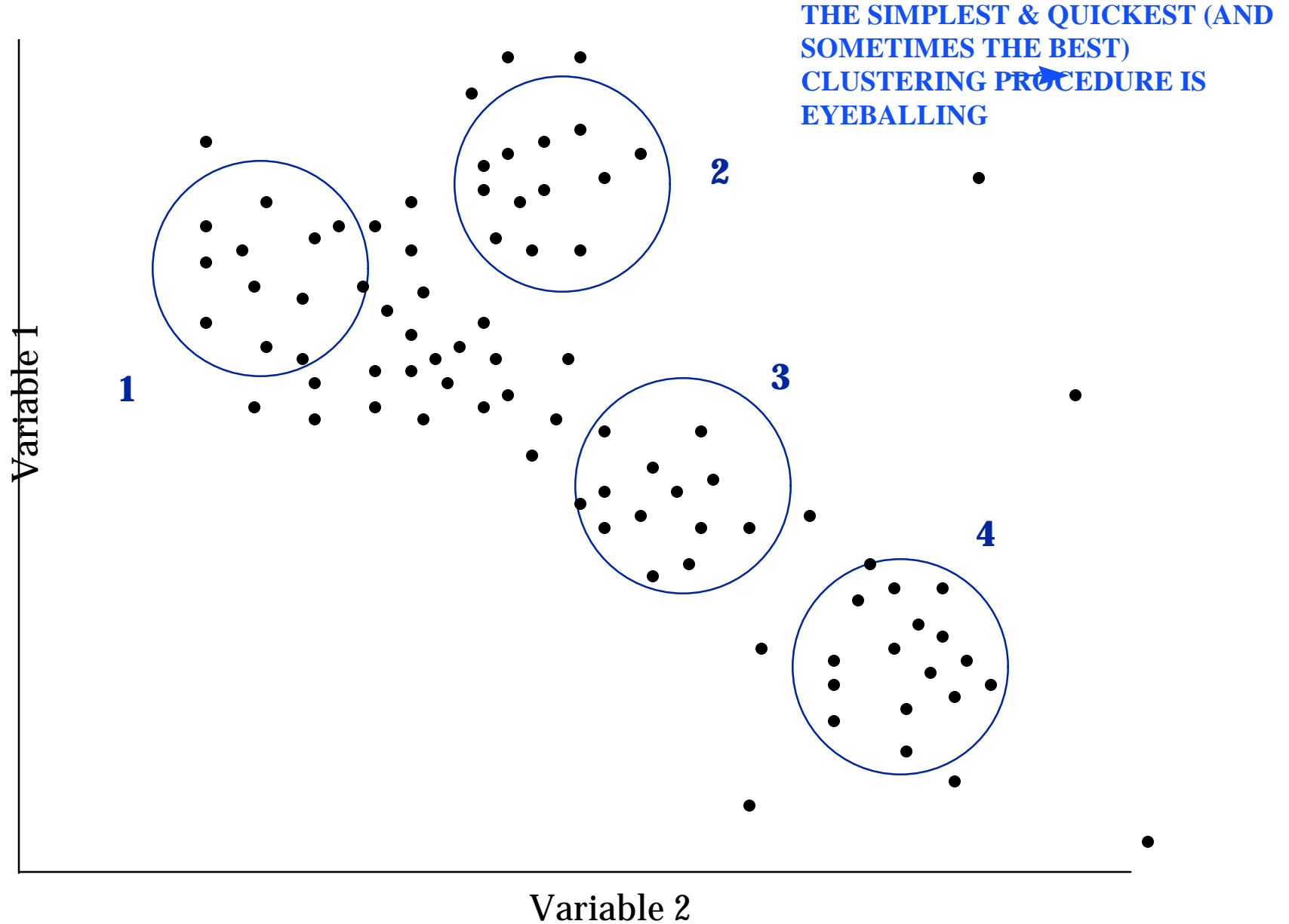
**MAIN CRITERION:** HOW MANY CLUSTERS?

**MAXIMIZE B/W**

**Figure 22.1 An Ideal Clustering Situation**



**Figure 22.2 A Practical Clustering Situation**

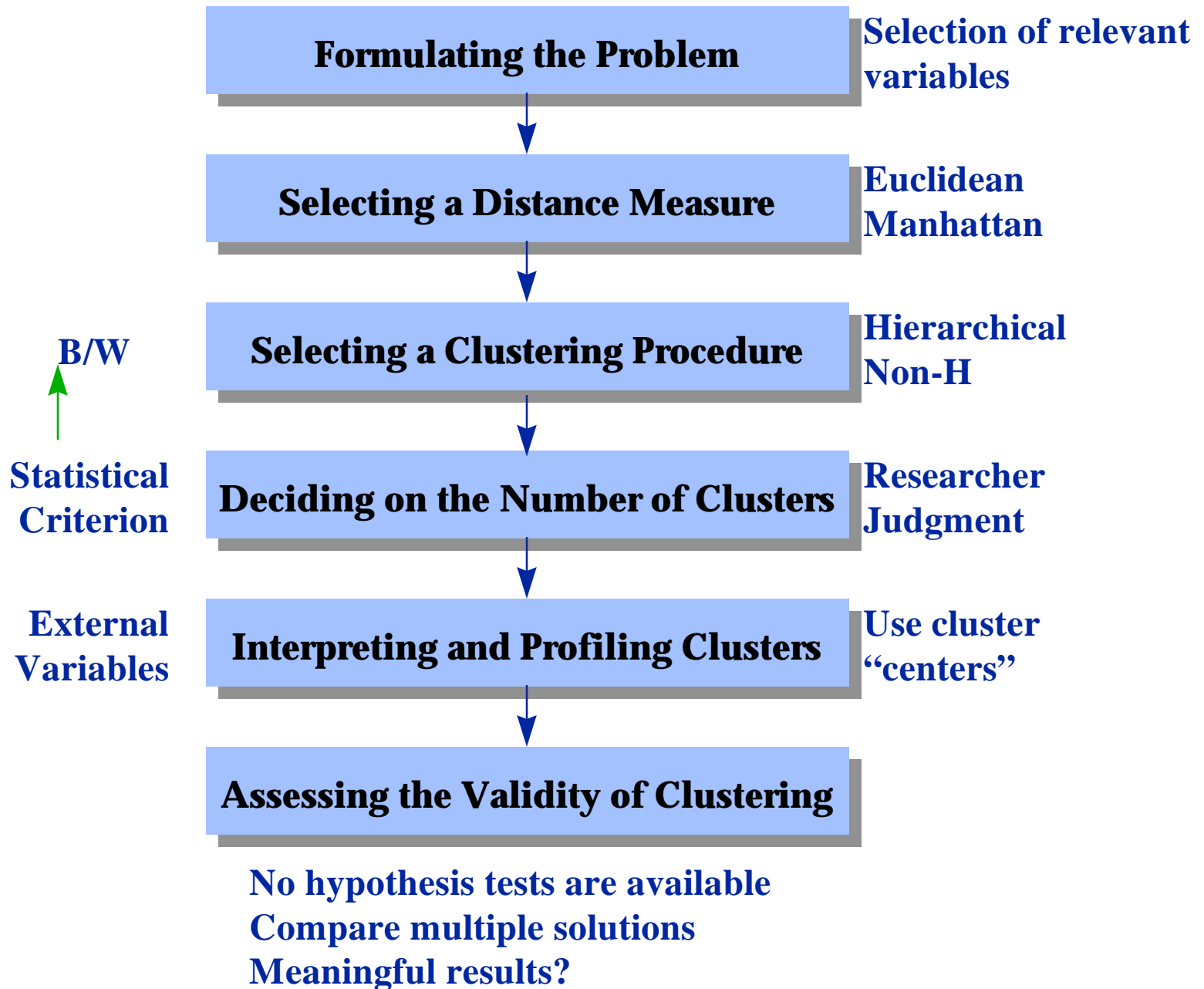


**A major problem with statistical clustering solutions is interpretation → # of clusters, cluster boundaries, outliers**

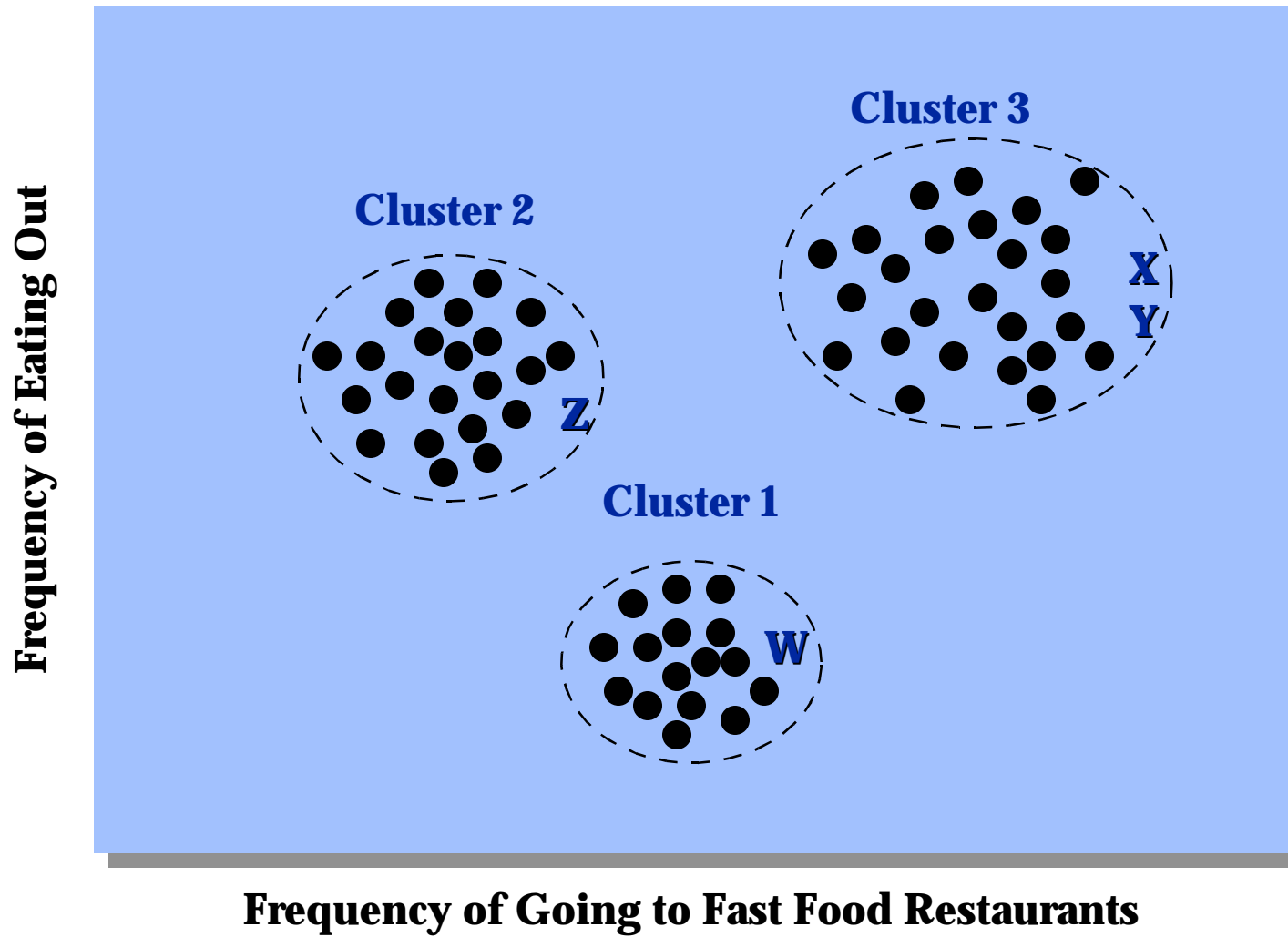
## **Applications of Cluster Analysis in Marketing**

1. Segmenting the market (geo-demographics)
2. Understanding consumer behavior (through psychographics)
3. Identifying opportunities for new products (attitude/attribute scaling)
4. Selecting test markets (representation)
5. Data reduction (collapsing observations into clusters)

**Figure 22.3 Conducting Cluster Analysis**



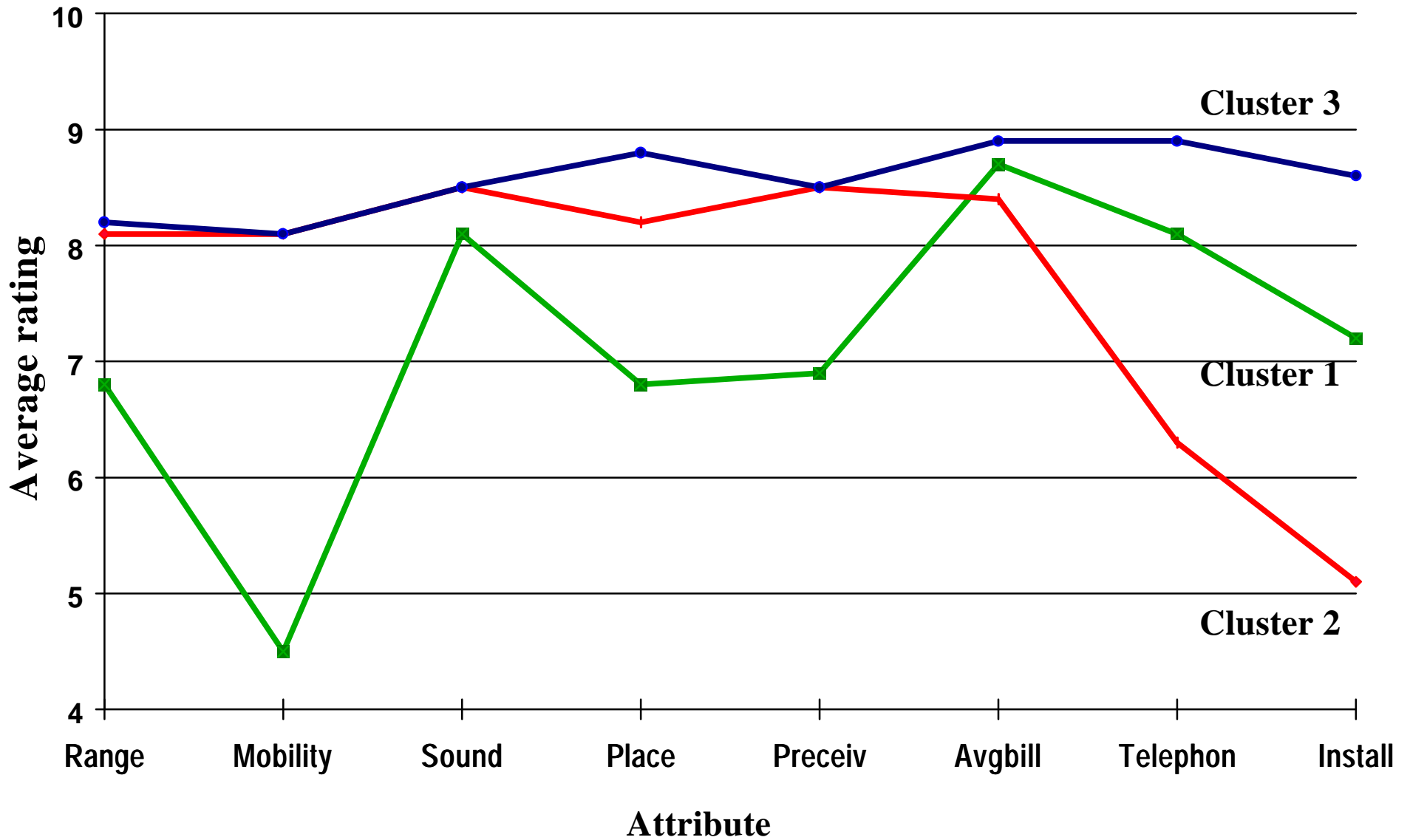
**Figure 18.1 Cluster Analysis Based on Two Variables**



**TABLE 18.4****Cluster Analysis Results with Cluster Size and Average Ratings on Attribute Importance Variable**

<b>VARIABLE</b>	<b>CLUSTER 1 (<i>n</i> = 62)</b>	<b>CLUSTER 2 (<i>n</i> = 55)</b>	<b>CLUSTER 3 (<i>n</i> = 83)</b>
RANGE	6.8	8.1	8.2
MOBILITY	4.5	8.1	8.2
SOUND	8.1	8.5	8.5
PLACE	6.7	8.3	8.7
PRECEIV	6.8	8.5	8.6
AVGBILL	8.6	8.4	8.8
TELEPHON	8.1	6.3	8.7
INSTALL	7.2	5.1	8.5

## Average Attribute Ratings - Three Clusters

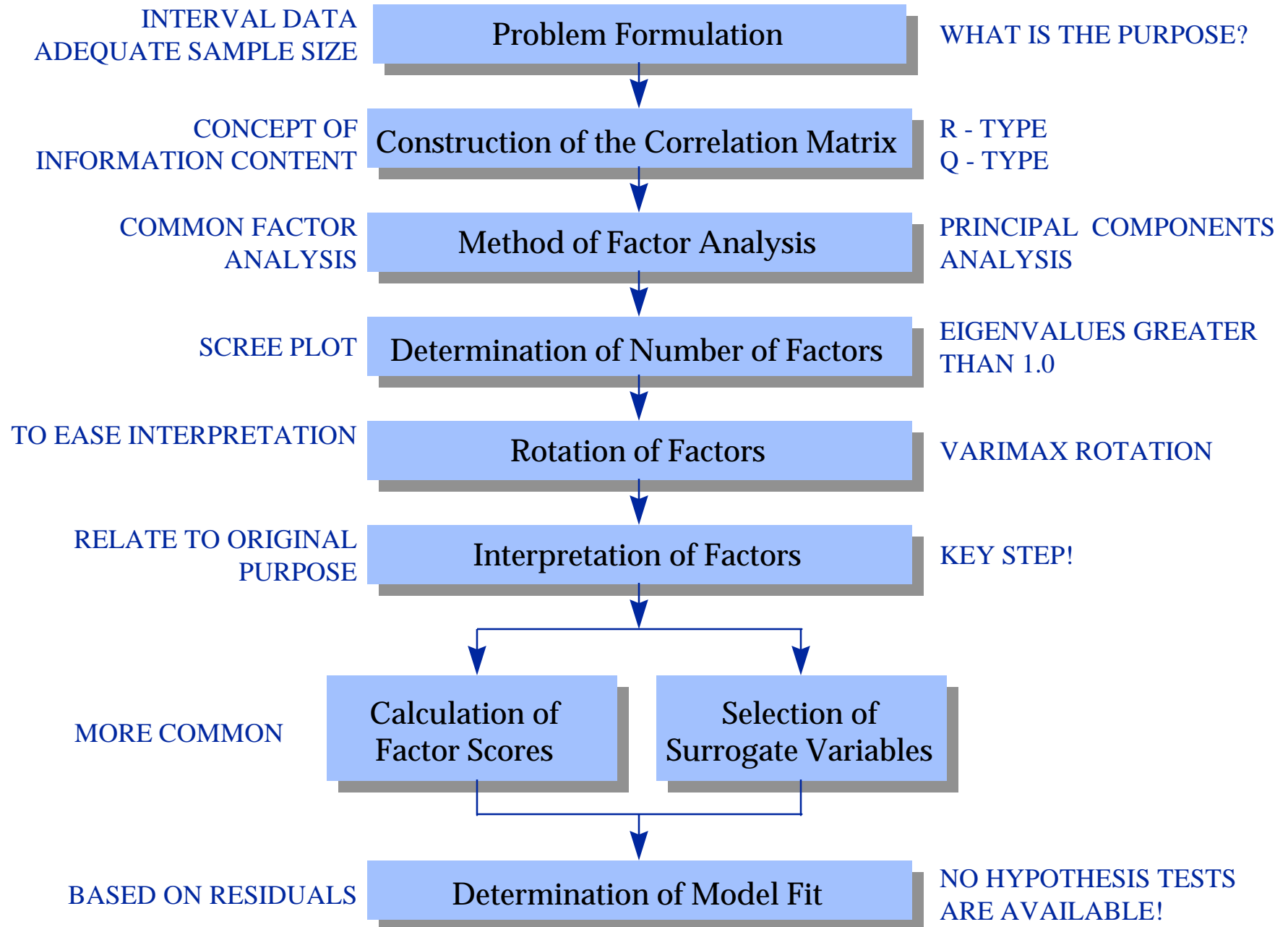


## **Factor Analysis**

Procedure for data simplification through reducing a set of variables to a smaller set of factors or composite variables by identifying dimensions underlying the data.

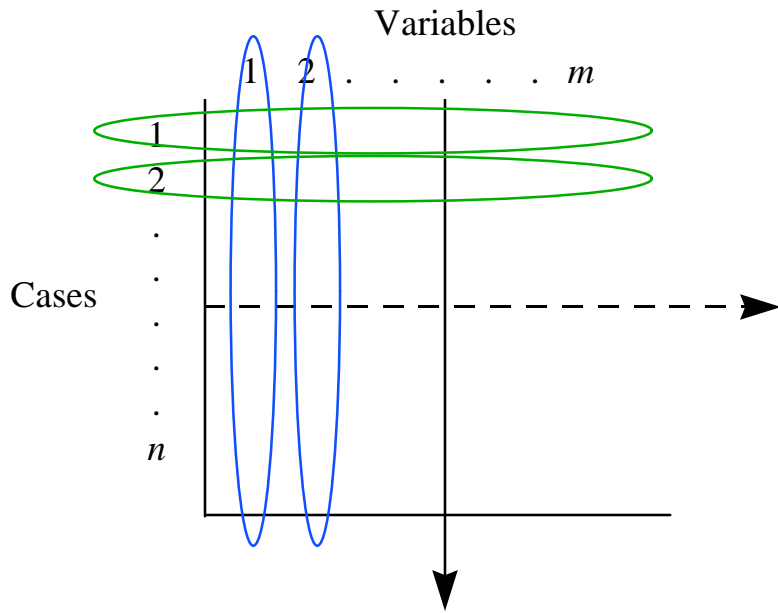
A CONCEPT THAT EVERY SET OF DATA HAS AN UNDERLYING “STRUCTURE” TO IT

**Figure 21.1 Conducting Factor Analysis**

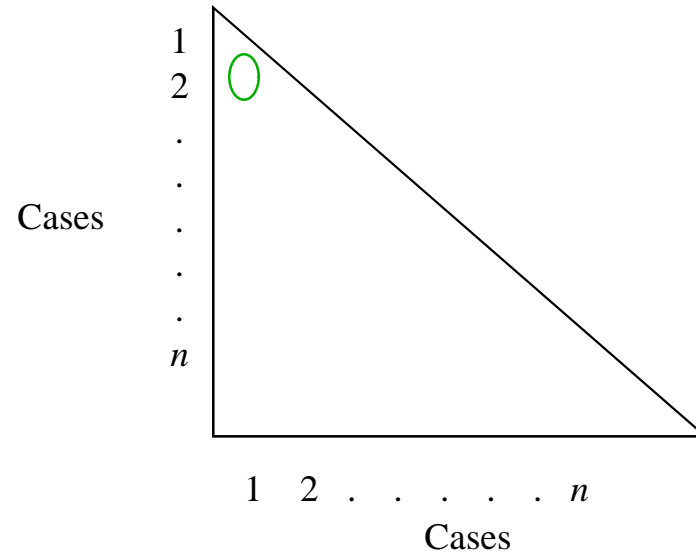


# Development of R- and Q-type correlation matrices

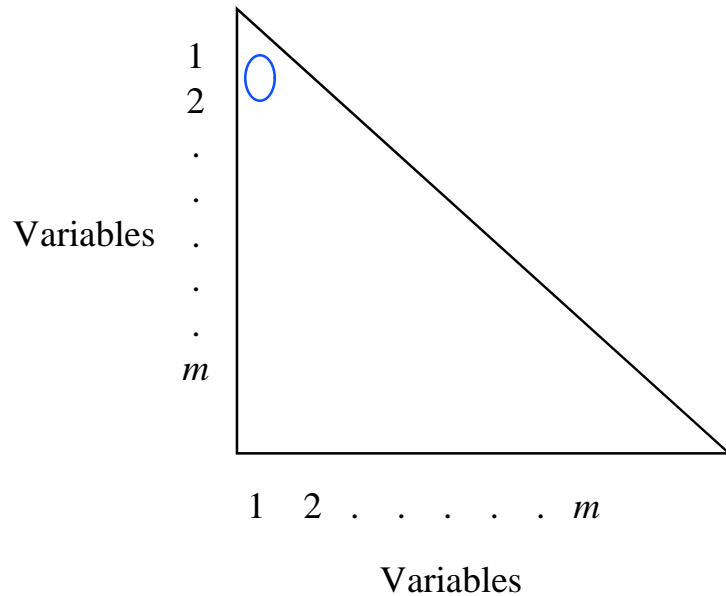
Original datamatrix



Q-type correlation matrix



R-type correlation matrix



**CONCEPT OF "INFORMATION CONTENT" IS KEY TO UNDERSTANDING FACTOR ANALYSIS**

## Factor Analysis

Main Purpose:  
(Data Reduction)

To see if a small number of factors can replace a large number of variables in terms of the information content of a data matrix

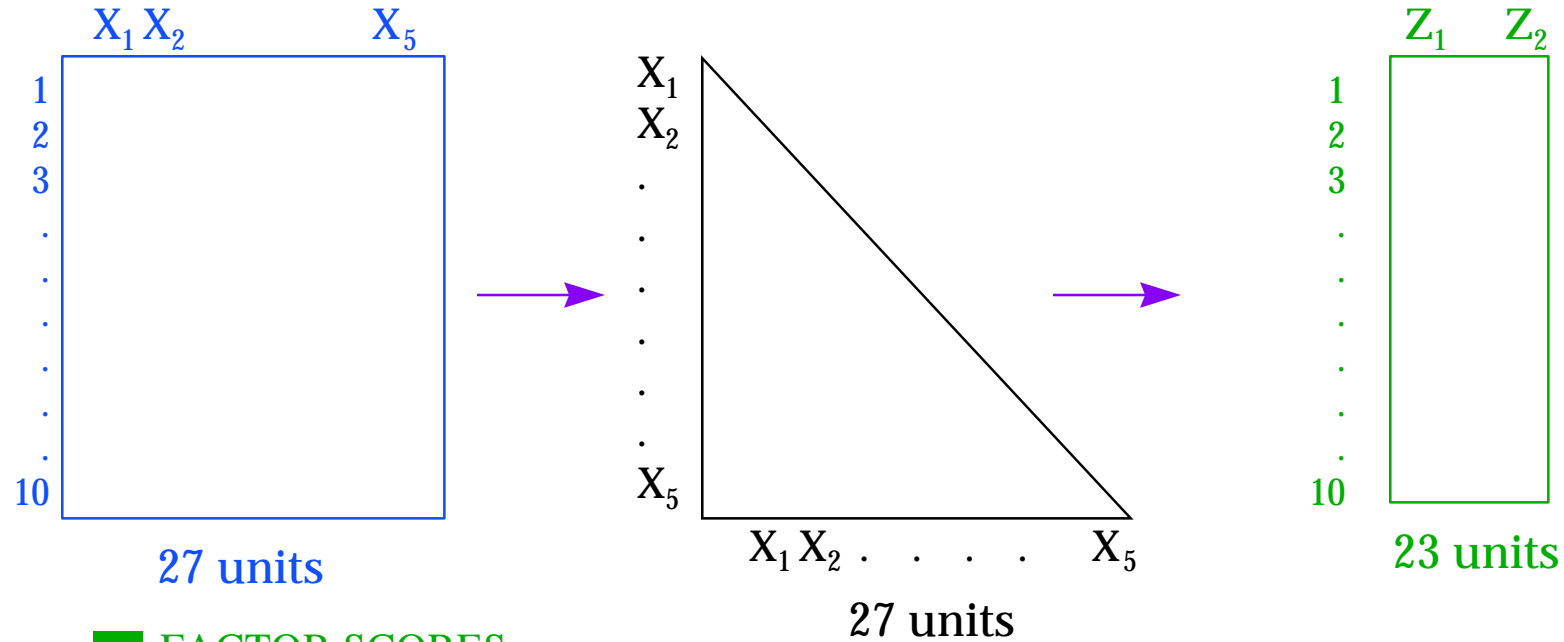
Secondary Purposes:  
(Data Representation)

1. Identify structure underlying a set of variables by removing redundancy
2. Develop a scale using several variables
3. Identify uncorrelated factors

Major steps in Factor Analysis:

1. Calculation of a correlation matrix
2. Extraction of initial factors
3. Rotation of factors
4. Interpretation

# The Essence of Factor Analysis



- FACTOR SCORES
- CORRELATIONS
- OBSERVATIONS

$$Z_1 = b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5$$

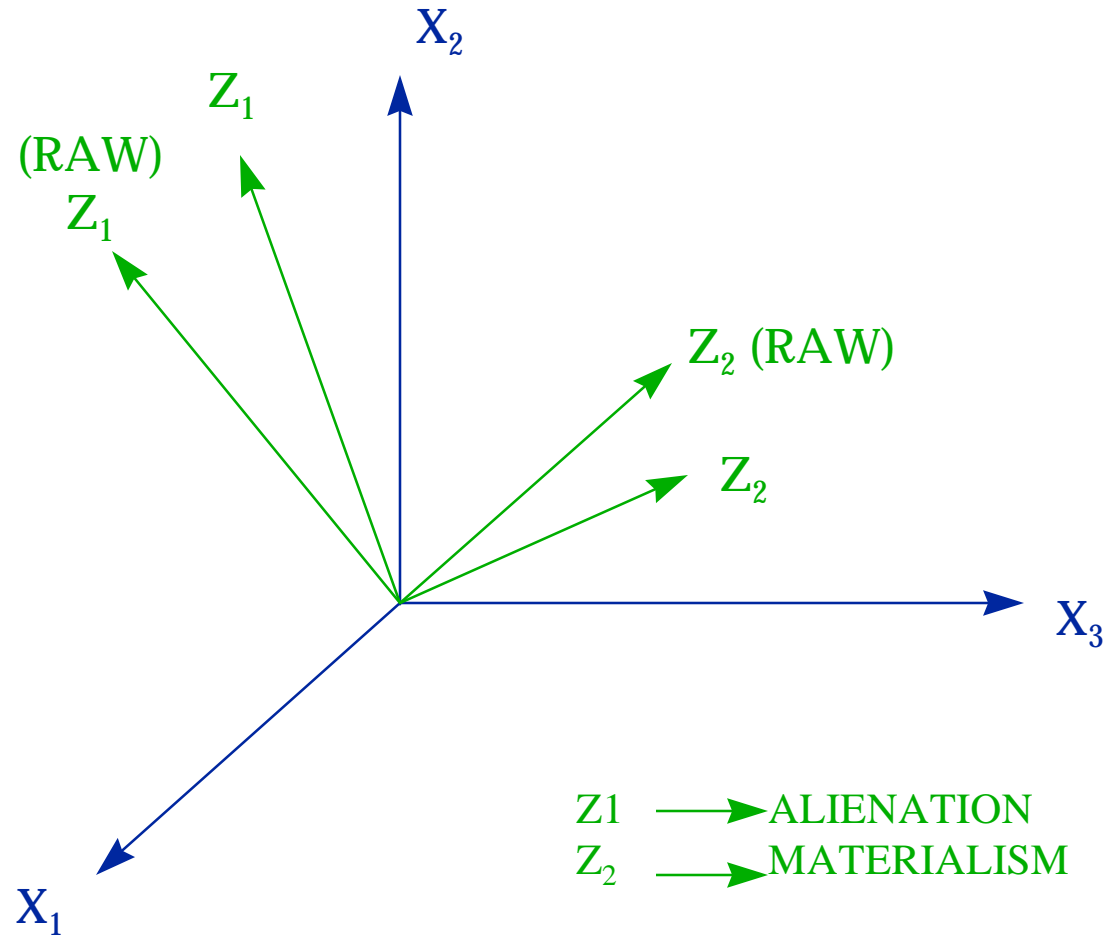
FACTOR LOADINGS

$$Z_2 = c_1 X_1 + c_2 X_2 + c_3 X_3 + c_4 X_4 + c_5 X_5$$

Needs Clarification ||

NOTES: Info. loss is minimized.  $Z_1$  &  $Z_2$  are usually uncorrelated. Factor solutions are not unique. Rotation aids interpretation.

# Understanding “Factor Rotation”



$Z_1$  → ALIENATION  
 $Z_2$  → MATERIALISM

$X_3$  = OWNERSHIP OF YACHT AND LUXURY CAR

$X_2$  = DRUG USE

$X_1$  = AGE

**TABLE 18.5****Ratings of a Luxury Automobile Assigned by Six Subjects**

<b>RESPONDENT</b>	<b>SMOOTH RIDE</b>	<b>QUIET RIDE</b>	<b>ACCELERATION</b>	<b>HANDLING</b>
Bob	5	4	2	1
Roy	4	3	2	1
Hank	4	3	3	2
Janet	5	5	2	2
Jane	4	3	2	1
Ann	5	5	3	2
Average	4.50	3.83	2.33	1.50

**TABLE 18.6****Average Ratings of Two Constructs**

<b>RESPONDENT</b>	<b>LUXURY</b>	<b>PERFORMANCE</b>
Bob	4.5	1.5
Roy	3.5	1.5
Hank	3.5	2.5
Janet	5.0	2.0
Jane	3.5	1.5
Ann	5.0	2.5
Average	4.25	1.92

**TABLE 18.7**    **Factor Loadings for Two Factors**

VARIABLE	CORRELATION WITH	
	<i>Factor 1</i>	<i>Factor 2</i>
$A_1$	.85	.10
$A_2$	.76	.06
$A_3$	.06	.89
$A_4$	.04	.79

**TABLE 18.8**    **Percent of Variation in Original Data Explained by each Factor**

FACTOR	PERCENT OF VARIATION EXPLAINED
1	55.0
2	37.5
3	4.8
4	2.7

**TABLE 18.9****Factor Loadings (Varimax raw) (pcstext.sta)  
Extraction: Principal Components**

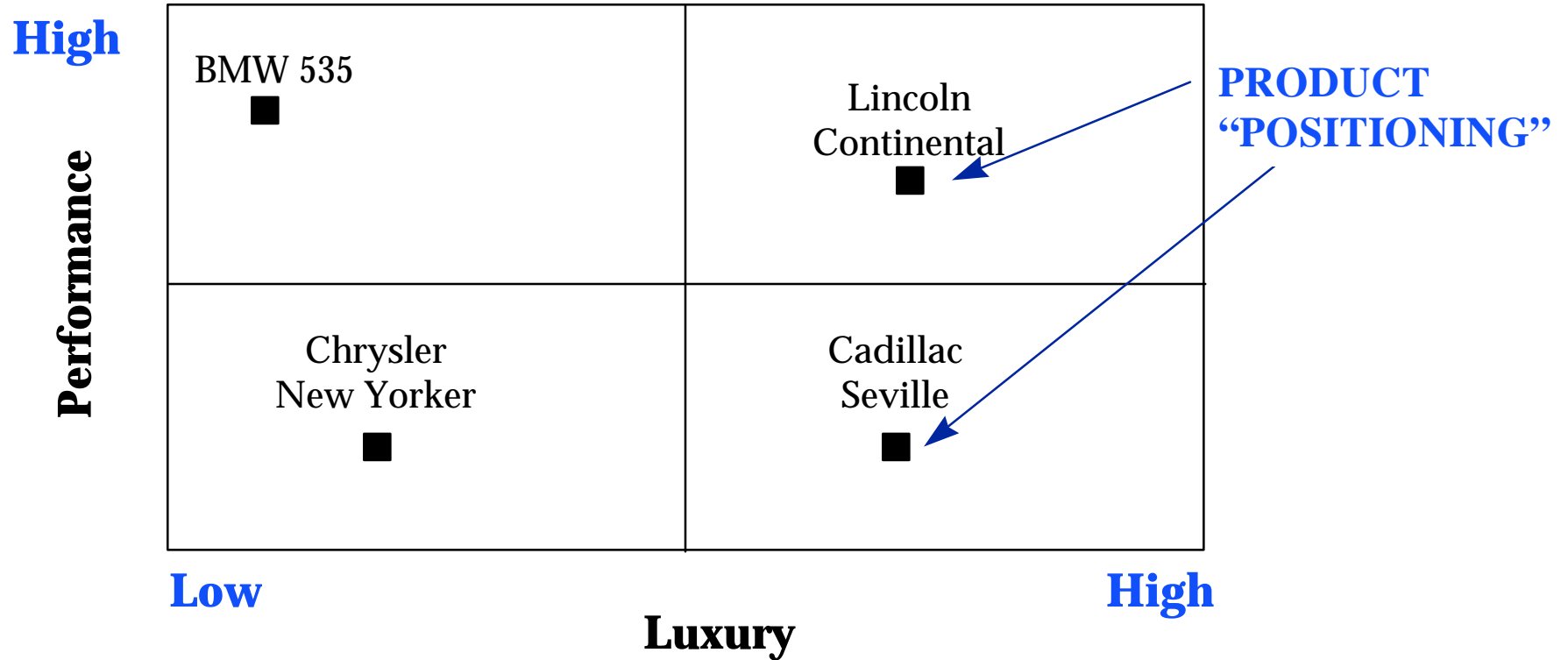
---

	<b>FACTOR 1</b>	<b>FACTOR 2</b>	<b>FACTOR 3</b>
RANGE	0.70	-0.10	0.39
MOBILITY	0.83	-0.09	0.07
SOUND	0.03	0.03	0.96
PLACE	0.85	0.19	-0.12
PRECEIV	0.91	-0.02	0.02
AVGBILL	-0.04	0.69	0.29
TELEPHON	-0.01	0.83	-0.11
INSTALL	0.06	0.77	0.02
Expl. Var	2.75	1.81	1.18
Prp.Totl	0.34	0.23	0.15

---

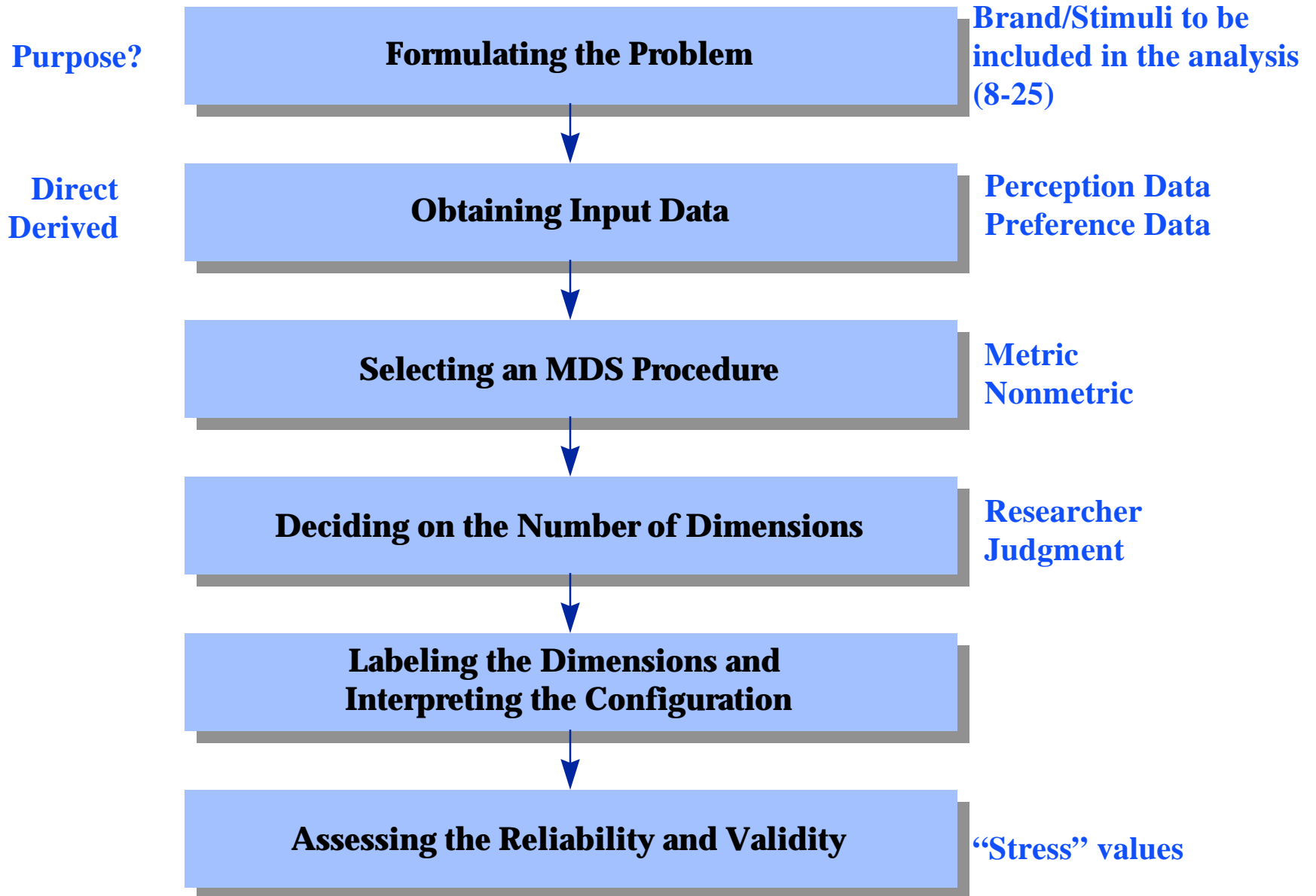
# Multidimensional Scaling

Visual representations of consumer perceptions of products, brands, companies or other objects

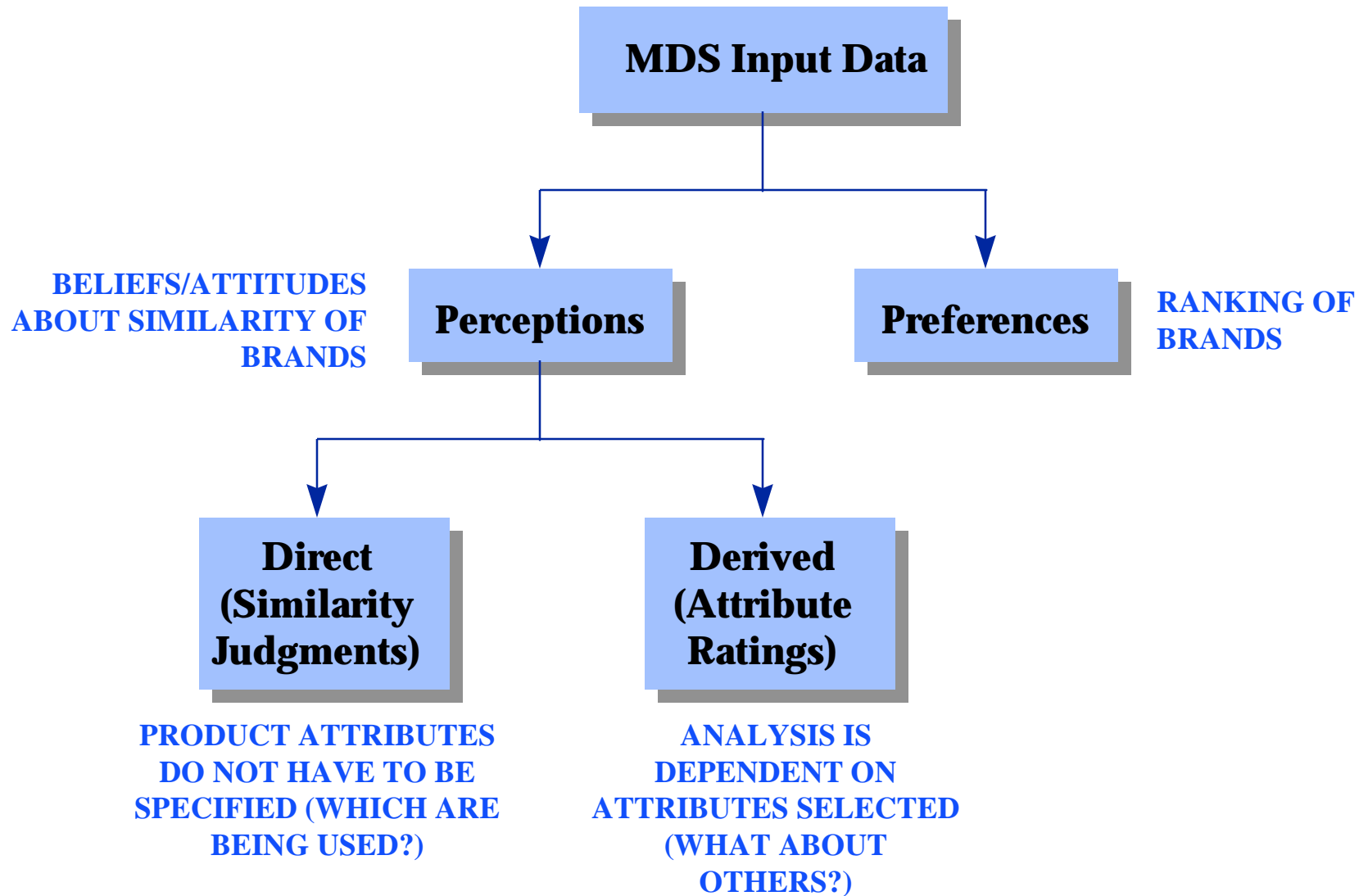


Concept of a "mental map" using psychological dimensions

**Figure 23.1 Conducting Multidimensional Scaling**



**Figure 23.2 Input Data for Multidimensional Scaling**

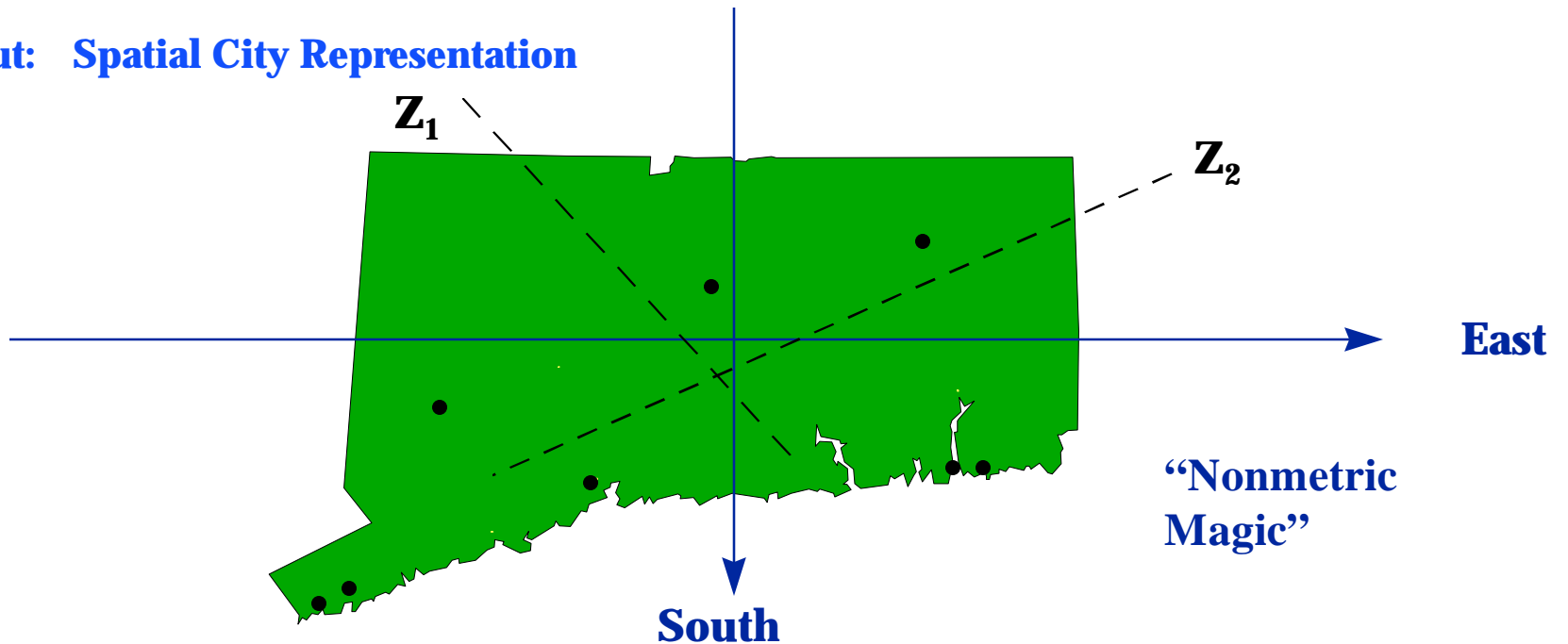


## Multidimensional Scaling (An Easy to Understand Example)

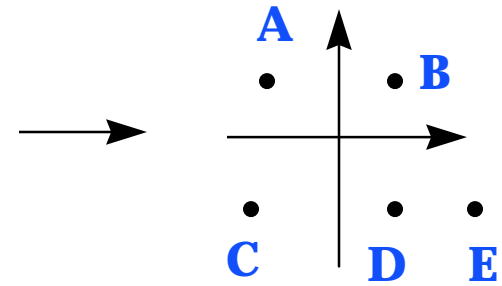
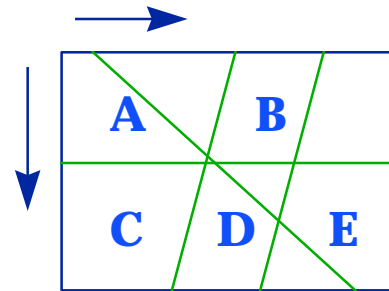
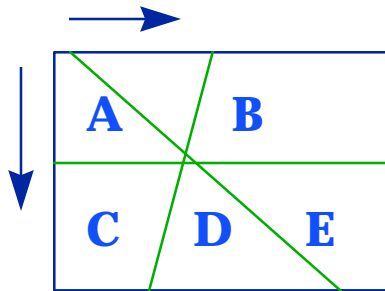
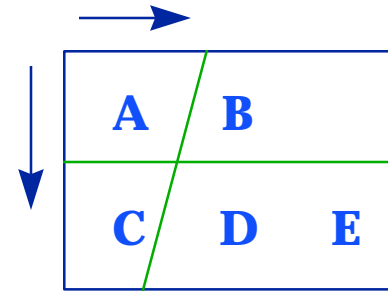
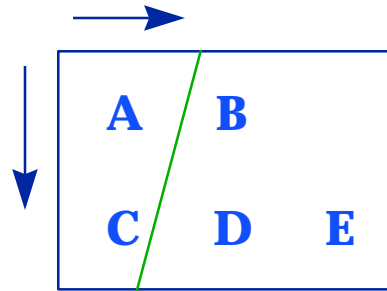
**Input: Inter-city Distance “Rankings”**

	H	S	D	ST	NL	G	GR	NH
<u>H</u> artford				<b>3</b>				
<u>S</u> tamford			<b>4</b>				<b>2</b>	
<u>D</u> anbury							<b>28</b>	
<u>S</u> torrs							<b>1</b>	
<u>N</u> ew <u>L</u> ondon							<b>27</b>	
<u>G</u> roton								
<u>G</u> reenwich								
<u>N</u> ew <u>H</u> aven								

**Output: Spatial City Representation**



# How "Nonmetric Magic" Works!



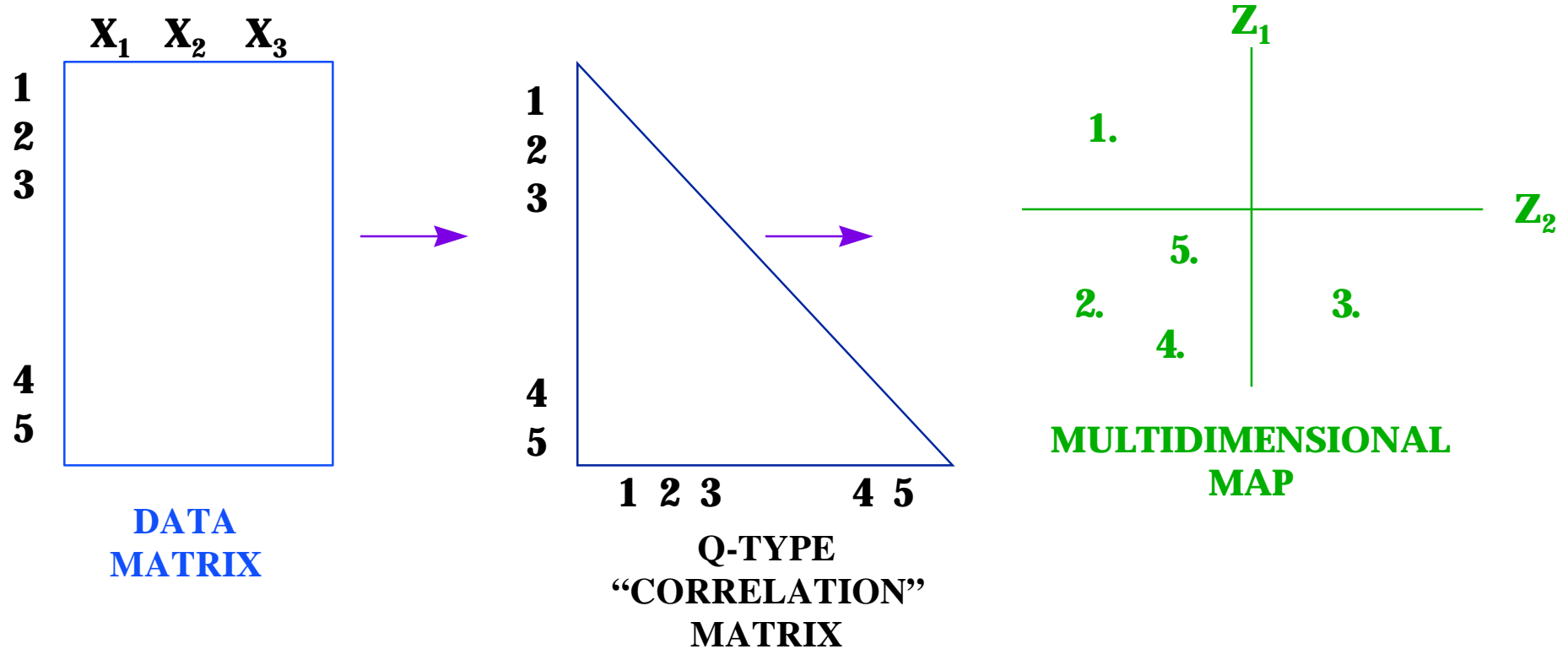
## The Essence of Multidimensional Scaling

### PURPOSE:

To position objects/cases in a reduced space of dimensions

### STEPS:

Decide on “similarities” measure. How many dimensions?



**IMPORTANT NOTE: THE “Z” DIMENSIONS ARE DERIVED FROM THE “X” VARIABLES**

## Q-Type “Correlation” Matrix (A.K.A. Similarities Matrix)

### Rank Order of Similarities Between Pairs of Car Models

---

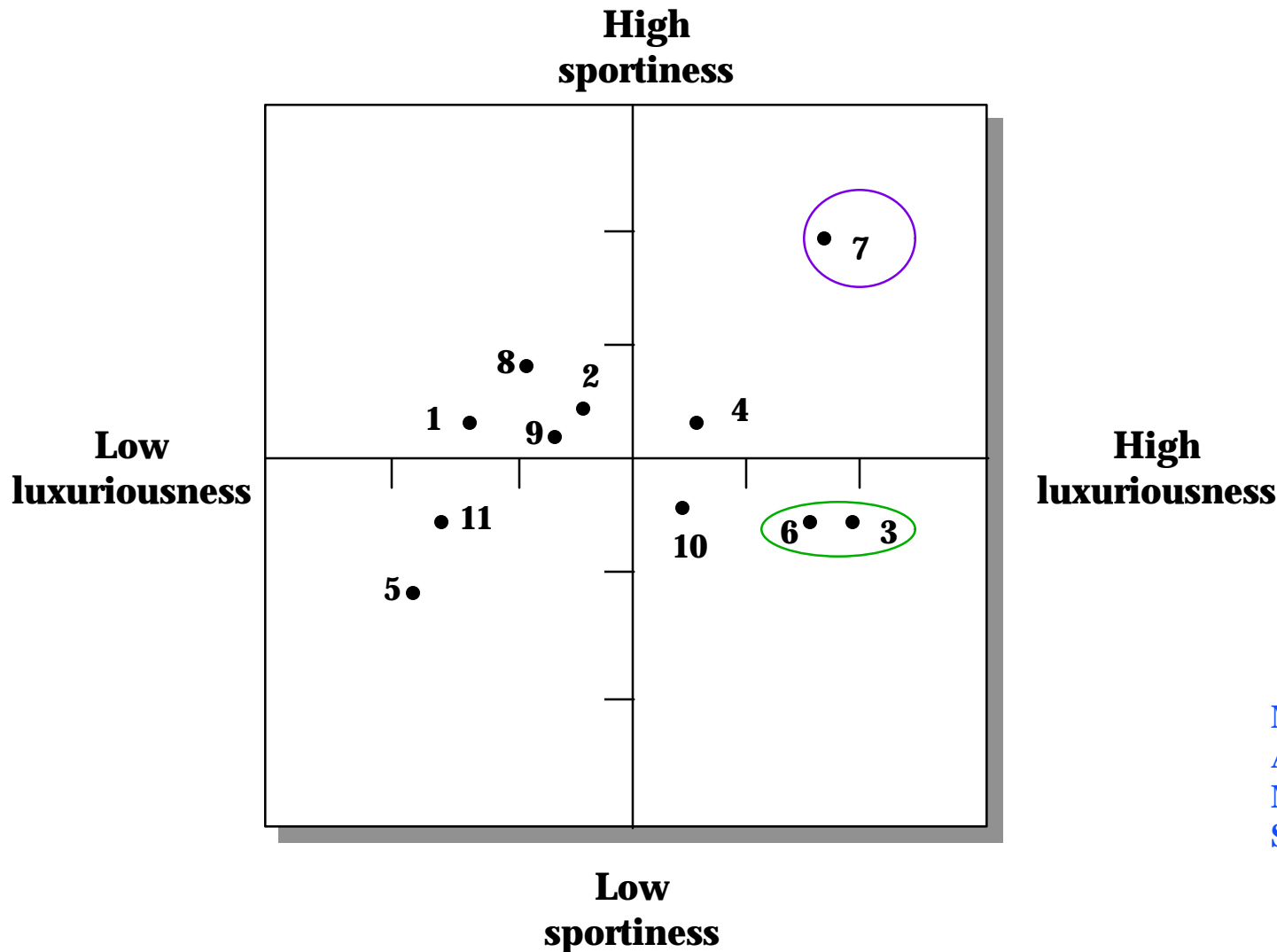
<b>Stimuli</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>
1	---	8	50	31	12	48	36	2	5	39	10
2		---	38	9	33	37	22	6	4	14	32
3			---	11	55	1	23	46	41	17	52
4				---	44	13	16	19	25	18	42
5					---	54	53	30	28	45	7
6						---	26	47	40	24	51
7							---	29	35	34	49
8								---	3	27	15
9									---	20	21
10										---	43
11											---

---

The rank number “1” represents the most similar pair.

Source: Paul E. Green and Frank J. Carmone, *Multidimensional Scaling*(Boston: Allyn & Bacon, 1970), p. 34.

Perceptual space solution based on data in Table [Source: Updated to 1991 by authors and from Paul E. Green and Frank J. Carmone, *Multidimensional Scaling* (Boston: Allyn & Bacon, 1970), p. 34.]



### 1991 Car Models

1. Ford Taurus
2. Mercury Sable
3. Lincoln Continental
4. Ford Thunderbird
5. Ford Escort
6. Cadillac Eldorado
7. Jaguar XJ Sedan
8. Mazda 626
9. Plymouth Sundance
10. Buick Le Sabre
11. Chevrolet Cavalier

MARKETING  
APPLICATIONS OF  
MULTIDIMENSIONAL  
SCALING

## **Conjoint Analysis**

Procedure used to quantify the value that people associate with different levels of product/service attributes

**Marketing Problem** → **How do consumers establish “trade-offs” between sneaker attributes**

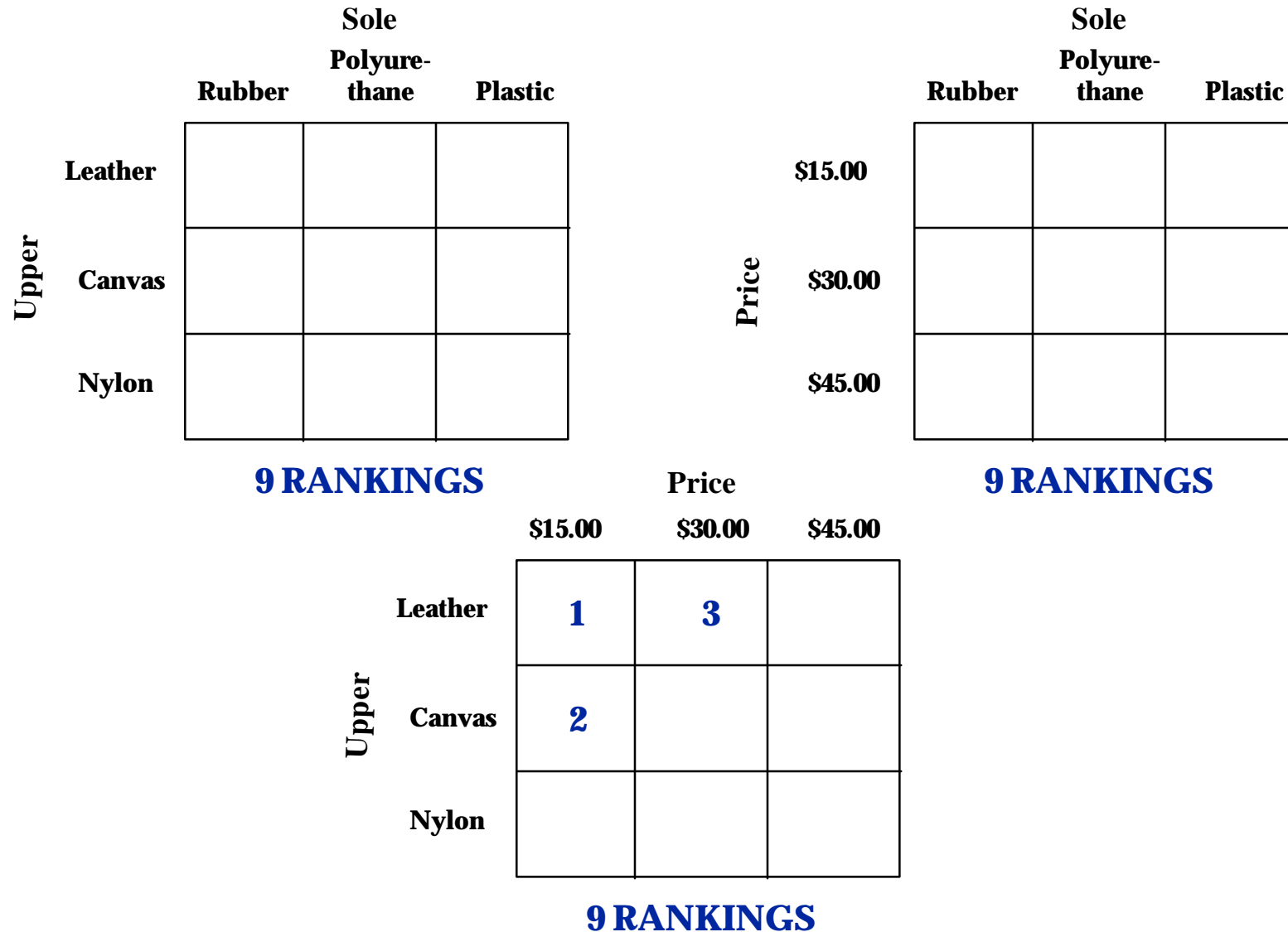
**TABLE 23.2**

**Sneaker Attributes and Levels**

<b>Attribute</b>	<b>LEVEL</b>	
	<b>No.</b>	<b>Description</b>
Sole	3	Rubber
	2	Polyurethane
	1	Plastic
Upper	3	Leather
	2	Canvas
	1	Nylon
Price	3	\$15.00
	2	\$30.00
	1	\$45.00

## Figure 23.9 Pairwise Approach to Collecting Conjoint Data

You will be presented information on sneakers in terms of pairs of features described in the form of a matrix. For each matrix, please rank the nine feature combinations in terms of your preference. A rank of 1 should be assigned to the most preferred combination and 9 to the least preferred.



**TABLE 23.3****Full-Profile Approach to Collecting Conjoint**

---

**EXAMPLE OF A SNEAKER  
PRODUCT PROFILE**

---

Sole	Made of rubber
Upper	Made of nylon
Price	\$15.00

---

**Rank**  
**27 Profiles in total**  
**(3 x 3 x 3)**

**NOTE: Need to limit number of profiles being ranked**

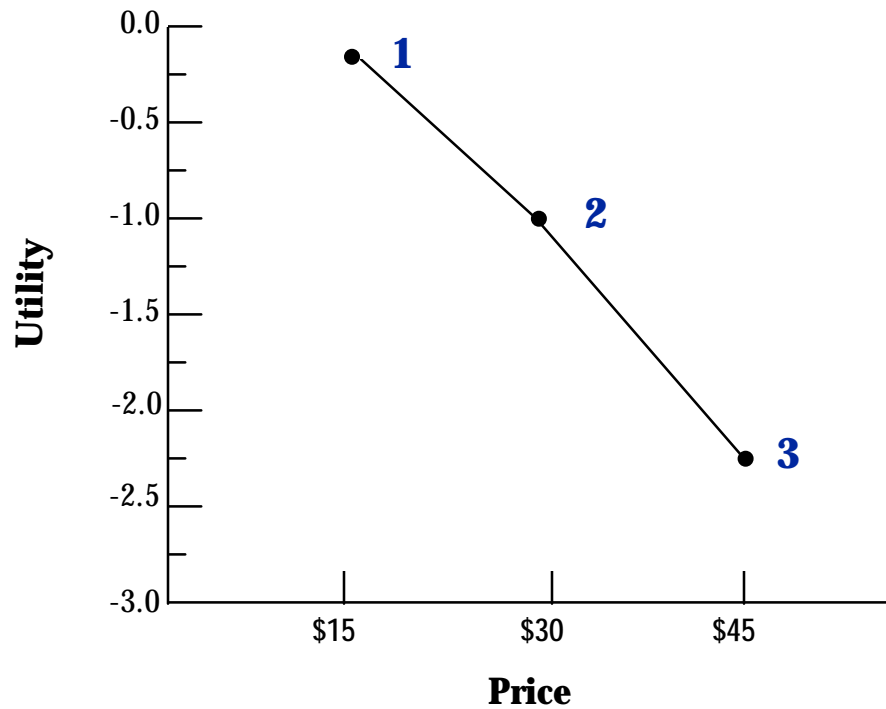
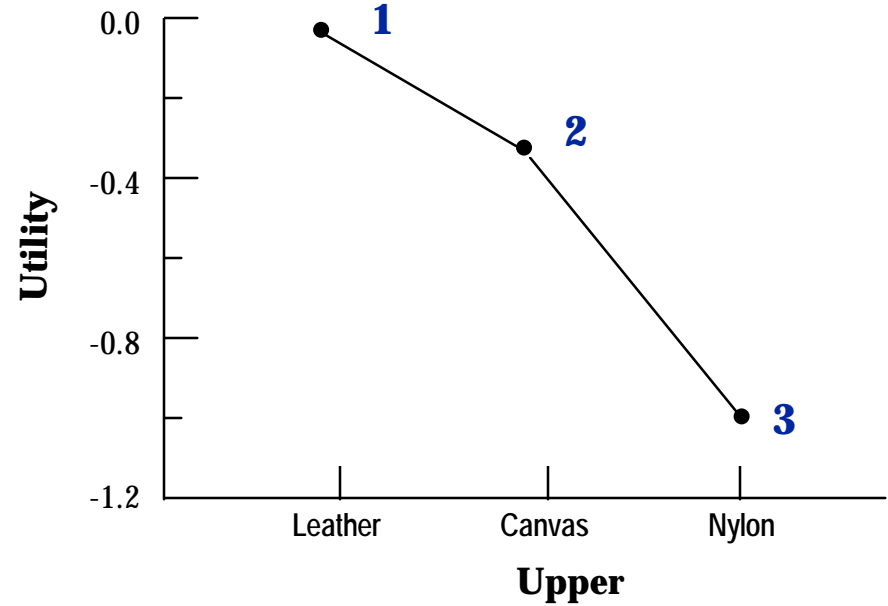
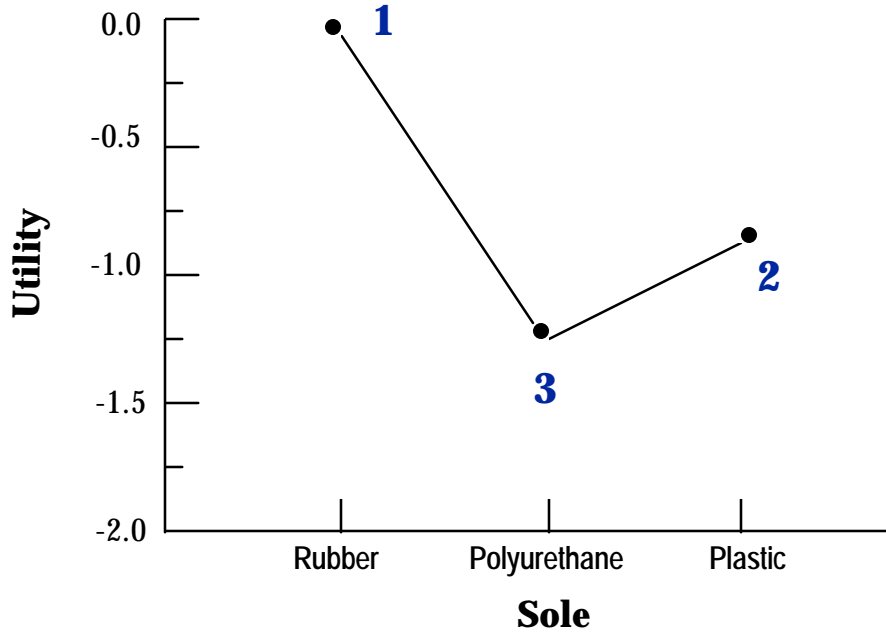
**TABLE 23.4**

**Sneaker Profiles and Their Ratings**

ATTRIBUTE LEVELS <sup>a</sup>				
Profile No.	Sole	Upper	Price	Preference Rating
1	1	1	1	9
2	1	2	2	7
3	1	3	3	5
4	2	1	2	6
5	2	2	3	5
6	2	3	1	6
7	3	1	3	5
8	3	2	1	7
9	3	3	2	6

<sup>a</sup>The attribute levels correspond to those in Table 23.2.

**Figure 23.10 Part-Worth Functions**



**CONJOINT ANALYSIS  
OUTPUT ALLOWS  
ESTIMATING HOW  
CONSUMERS “TRADE-OFF”  
ATTRIBUTES**

# Pairwise Data Collection for Conjoint Analysis

		PRICE		
		\$.55	\$.65	\$.75
FORM	DRY			
	MOIST			
	CANNED			

		GUARANTEE	
		YES	NO
FORM	DRY		
	MOIST		
	CANNED		

		ENDORSEMENT	
		YES	NO
FORM	DRY		
	MOIST		
	CANNED		

		NAME		
		MAMMA CAT PLUS	FORMULA 9	
FORM	DRY			
	MOIST			
	CANNED			

		PRICE		
		\$.55	\$.65	\$.75
NAME	DRY			
	MOIST			
	CANNED			

		GUARANTEE	
		YES	NO
NAME	DRY		
	MOIST		
	CANNED		

		ENDORSEMENT	
		YES	NO
NAME	DRY		
	MOIST		
	CANNED		

		GUARANTEE	
		YES	NO
PRICE	\$.55		
	\$.65		
	\$.75		

		ENDORSEMENT	
		YES	NO
PRICE	\$.55		
	\$.65		
	\$.75		

		ENDORSEMENT	
		YES	NO
GUARANTEE	YES		
	NO		

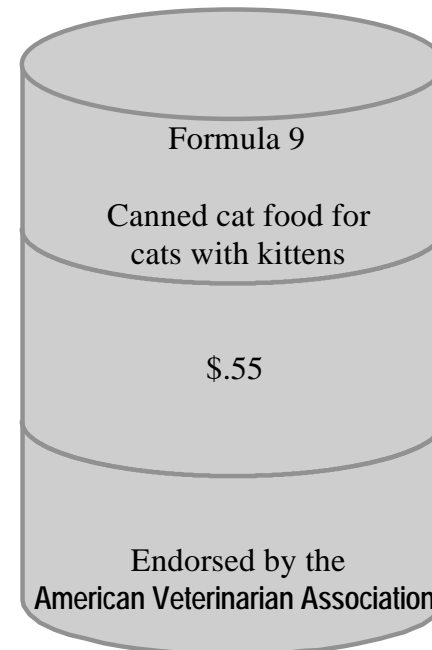
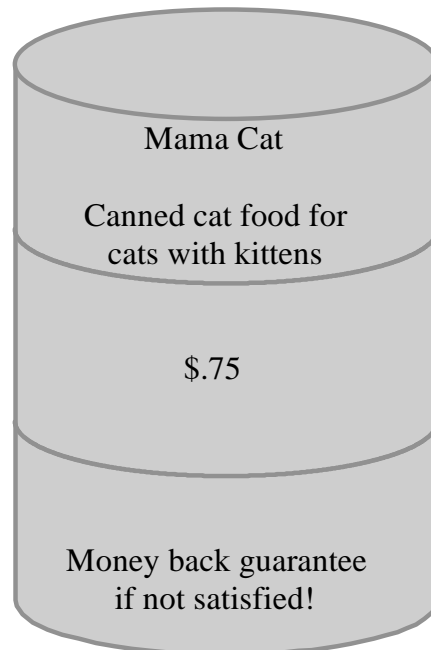
# Presentation Formats for a Full Profile Conjoint Study

## Cards

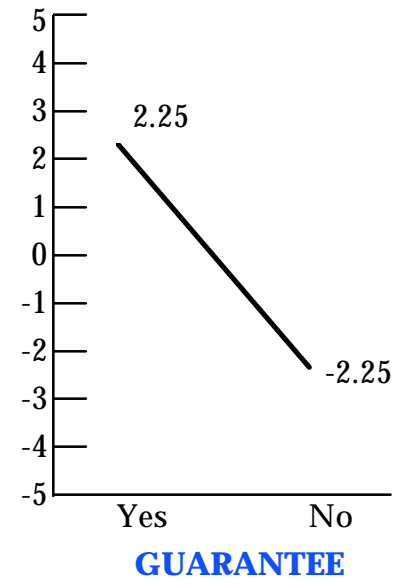
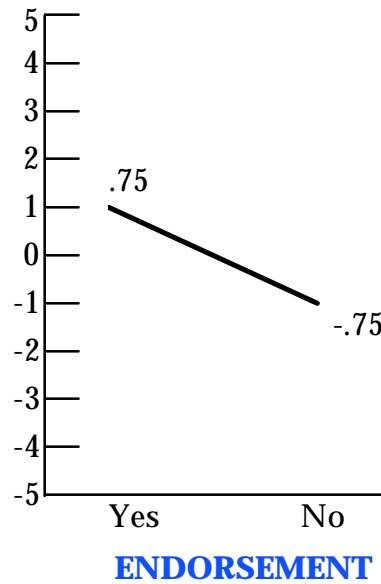
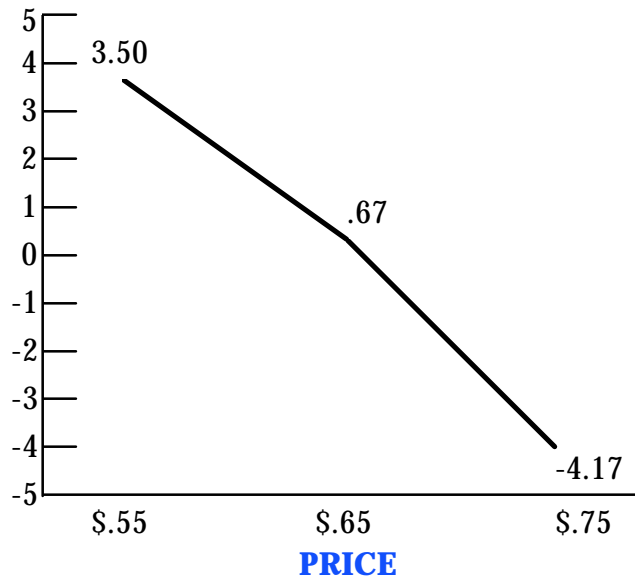
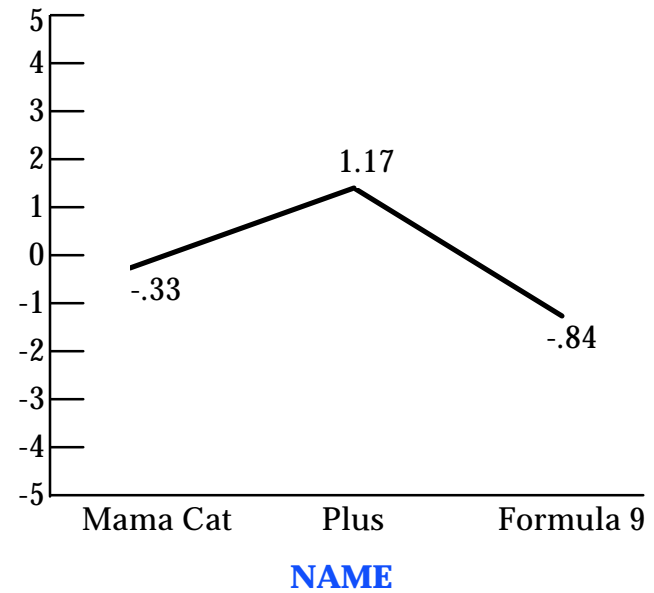
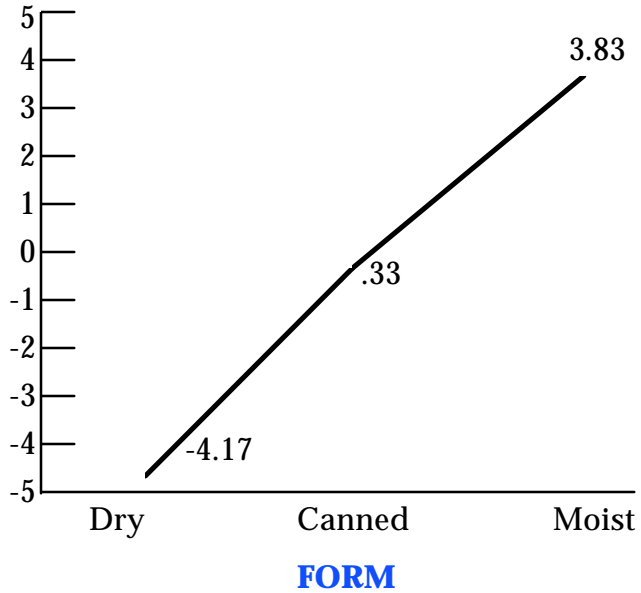
NAME  
MamaCat  
FORM  
Canned  
PRICE  
\$.75  
VETERINARIAN  
ASSOCIATION  
ENDORSEMENT  
No  
MONEY BACK  
GUARANTEE  
Yes

NAME  
Formula 9  
FORM  
Canned  
PRICE  
\$.55  
VETERINARIAN  
ASSOCIATION  
ENDORSEMENT  
Yes  
MONEY BACK  
GUARANTEE  
No

## Drawing of Package



# Graphic Display of Attribute Utilities for Cat Food



**TABLE 18.11****Traditional Nonconjoint Rankings of Distance and Ball Life Attributes**

<u>AVERAGE DRIVING DISTANCE</u>		<u>AVERAGE BALL LIFE</u>	
<i>Rank</i>	<i>Level</i>	<i>Rank</i>	<i>Level</i>
1	275 yards	1	54 holes
2	250 yards	2	36 holes
3	225 yards	3	18 holes

**TABLE 18.12****Conjoint Rankings of Combinations of Distance and Ball Life Considered Together for Golfer No. 1**

<u>DISTANCE</u>	<u>BALL LIFE</u>		
	<i>54 holes</i>	<i>36 holes</i>	<i>18 holes</i>
275 yards	1	2	4
250 yards	3	5	7
225 yards	6	8	9

**TABLE 18.13****Conjoint Rankings of Combinations of Distance and Ball Life Considered Together for Golfer No. 2**

<u>DISTANCE</u>	<u>BALL LIFE</u>		
	<i>54 holes</i>	<i>36 holes</i>	<i>18 holes</i>
275 yards	1	3	6
250 yards	2	5	8
225 yards	4	7	9

**TABLE 18.14****Ranks (in parentheses) and Combined Metric Utilities for Golfer No. 1--Distance and Ball Life**

DISTANCE	BALL LIFE		
	<i>54 holes</i> 50	<i>36 holes</i> 25	<i>18 holes</i> 0
275 yards	(1)	(2)	(4)
100	150	125	100
250 yards	(3)	(5)	(7)
60	110	85	60
225 yards	(6)	(8)	(9)
0	50	25	0

**TABLE 18.15****Conjoint Rankings of Combinations of Price and Ball Life Considered Together for Golfer No. 1**

PRICE	BALL LIFE		
	<i>54 holes</i>	<i>36 holes</i>	<i>18 holes</i>
\$1.25	1	2	4
\$1.50	3	5	7
\$1.75	6	8	9

**TABLE 18.16****Ranks (in parentheses) and Combined Metric Utilities for Golfer No. 1--Price and Ball Life**

PRICE	BALL LIFE		
	<i>54 holes</i> 50	<i>36 holes</i> 25	<i>18 holes</i> 0
\$1.25	(1)	(2)	(4)
20	70	45	20
\$1.50	(3)	(5)	(7)
5	55	30	5
\$1.75	(6)	(8)	(9)
0	50	25	0

**TABLE 18.17****Complete Set of Estimated Utilities for Golfer No. 1**

DISTANCE		BALL LIFE		PRICE	
<i>Level</i>	<i>Utility</i>	<i>Level</i>	<i>Utility</i>	<i>Level</i>	<i>Utility</i>
275 yards	100	54 holes	50	\$1.25	20
250 yards	60	36 holes	25	\$1.50	5
225 yards	0	18 holes	0	\$1.75	0

**TABLE 18.18****Ball Profiles for Simulation**

ATTRIBUTE	DISTANCE BALL	LONG-LIFE BALL
Distance	275	250
Life	18	54
Price	\$1.50	\$1.75

**TABLE 18.19****Estimated Total Utilities for the Two Sample Profiles**

ATTRIBUTE	DISTANCE BALL		LONG-LIFE BALL	
	<i>Level</i>	<i>Utility</i>	<i>Level</i>	<i>Utility</i>
Distance	275	100	250	60
Life	18	0	54	50
Price	\$1.50	5	\$1.75	0
Total Utility	105	110		