

Who Likes Green Apples?

JMP applied to consumer research

Anne Hasted & Gemma Hodgson
Qi Statistics Ltd
www.qistatistics.co.uk





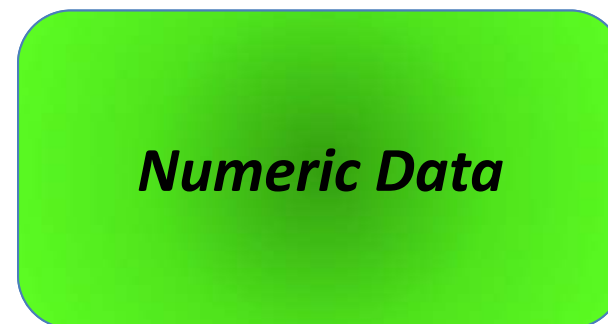
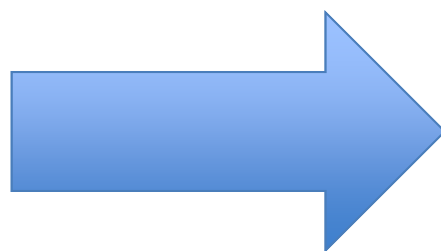
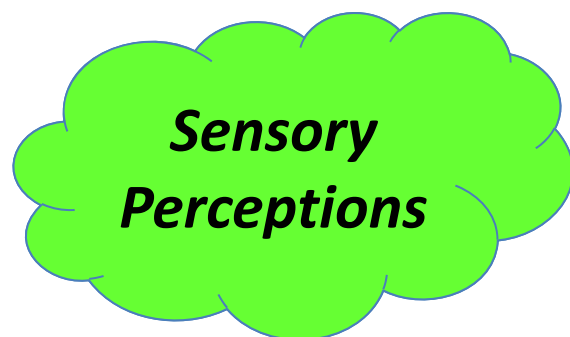
To understand consumer preferences for apples, look for possibilities of new cultivars

Starting Point: Range of European eating apples spanning differences in eating quality. 10 apple varieties selected (in market and new cultivars)



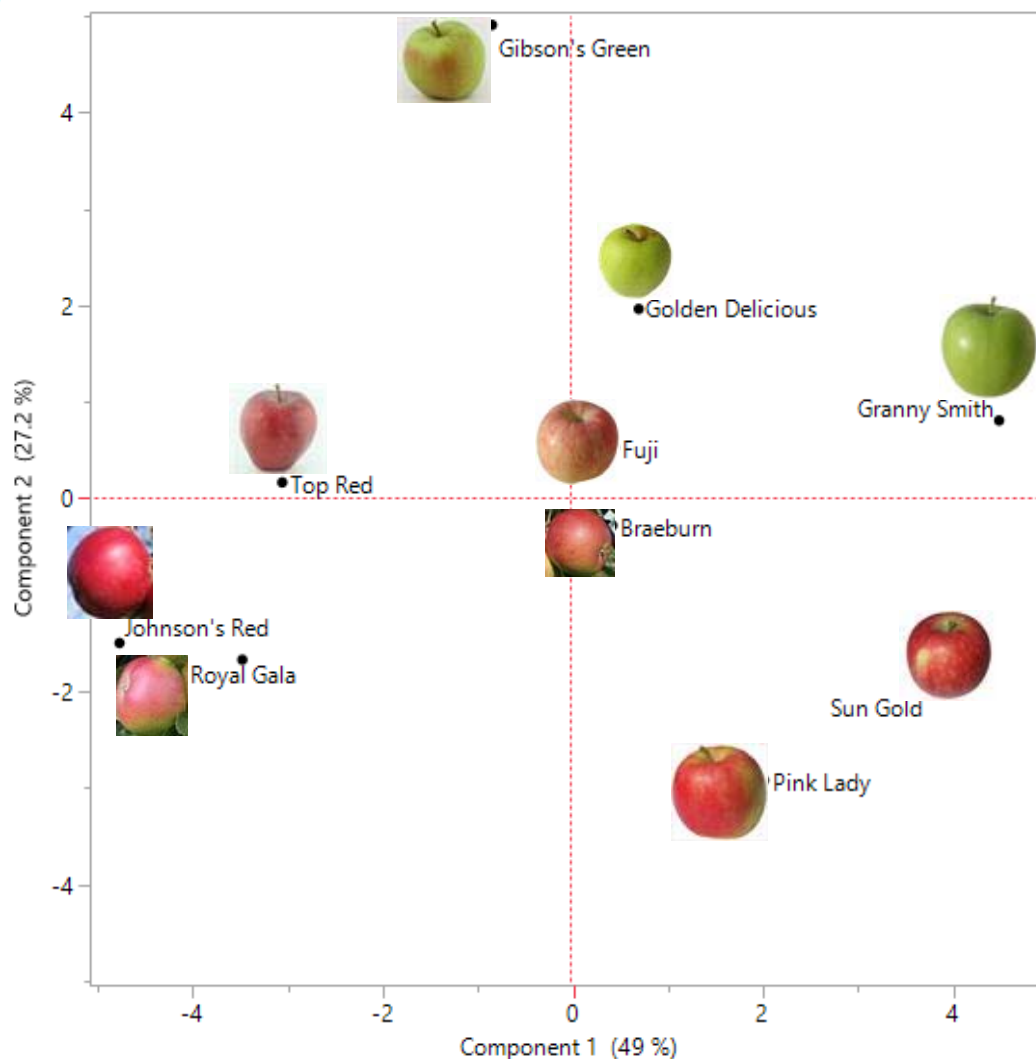
Sensory panel
Typically 12-14 people trained to score their sensory perception of products

- Appearance
- Aroma
- Texture
- Flavour



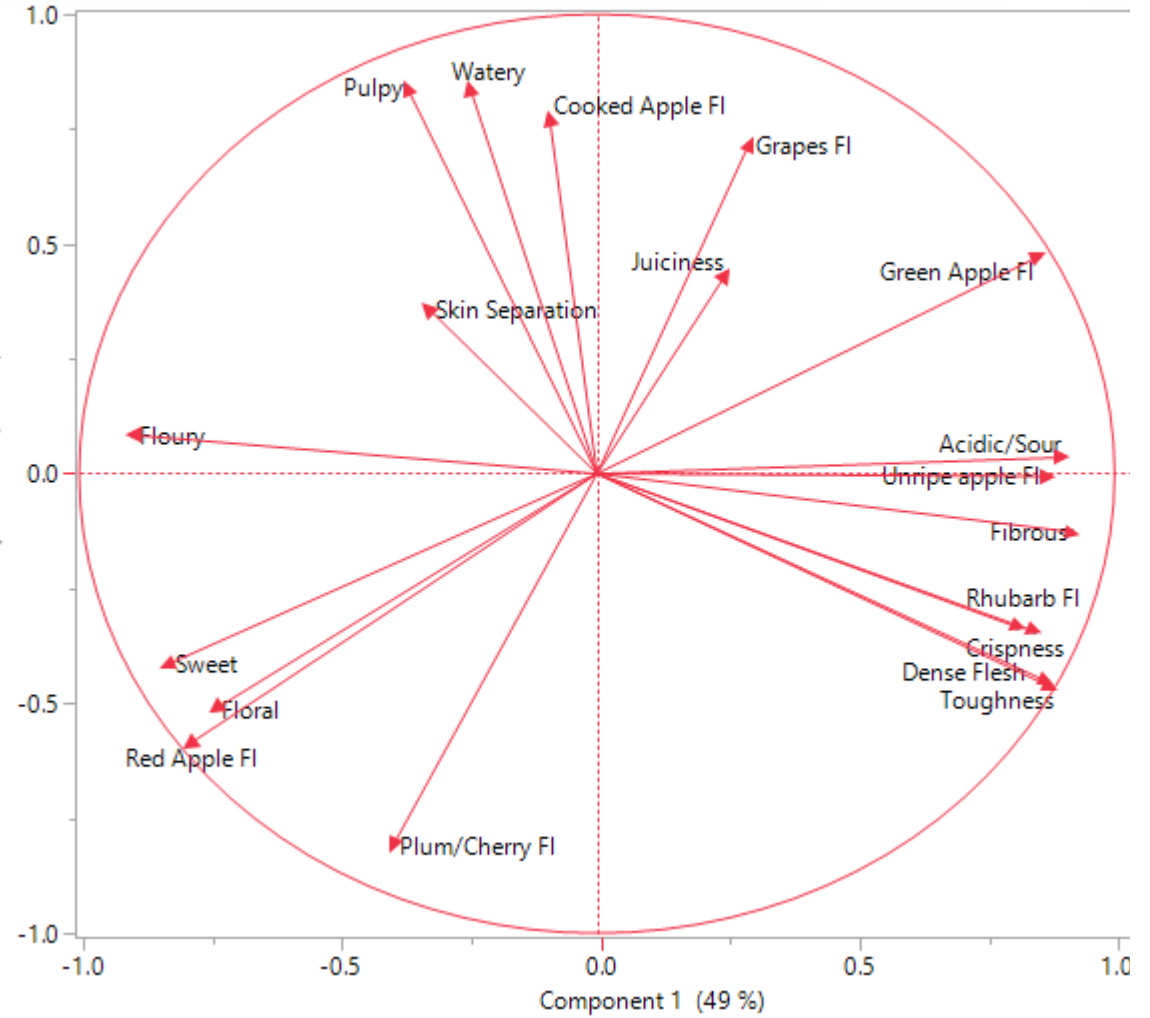
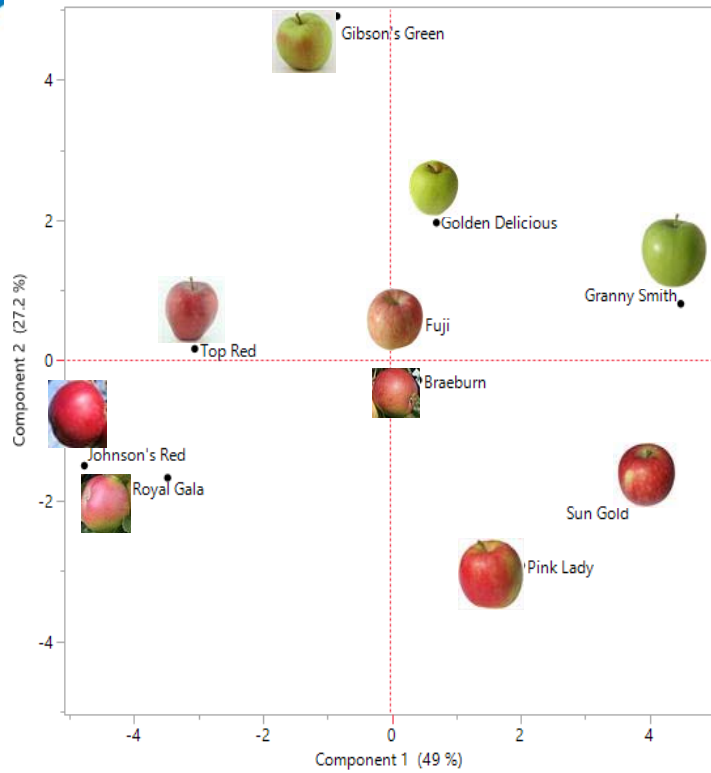
Apple	Crispness	Juiciness	Skin Separation	Toughness	Dense Flesh	Fibrous	Floury	Pulpy	Green Apple FI	Red Apple FI	Sweet	Acidic/Sour	Floral	Watery	Plum/Cherry FI	Unripe apple FI	Rhubarb FI	Cooked Apple FI	Grapes FI
Gibson's Green	38.7	51.0	52.2	32.8	29.4	4.2	13.3	18.1	54.5	2.2	29.4	38.0	1.6	26.9	1.8	8.9	0.5	6.7	7.2
Johnson's Red	38.7	47.1	51.8	33.5	28.2	3.0	18.9	7.6	3.9	57.5	49.6	10.3	18.1	15.6	25.2	0.1	0.2	0.5	0.2
Golden Delicious	54.9	56.9	40.7	42.4	43.5	9.4	3.4	7.4	43.4	10.0	35.3	23.9	2.4	24.2	4.7	3.6	1.3	0.7	12.7
Granny Smith	59.9	48.3	53.5	58.5	58.9	15.2	0.3	5.2	66.9	0.2	20.1	51.9	0.2	19.5	3.2	28.4	6.6	0.1	4.6
Pink Lady	66.9	45.4	38.6	61.0	67.5	10.2	0.6	3.7	36.4	27.8	36.5	45.5	11.1	6.2	23.0	13.6	4.3	0.2	2.0
Fuji	60.6	62.1	45.9	47.3	45.9	10.7	1.4	6.5	32.2	23.1	36.1	21.9	4.6	19.7	9.8	3.7	0.5	0.8	4.8
Top Red	47.1	51.5	61.5	38.9	38.0	7.0	10.0	10.4	7.5	49.4	38.1	14.1	19.0	27.1	12.2	0.5	0.2	0.2	0.9
Braeburn	59.7	55.6	48.4	49.2	49.6	7.1	2.9	6.8	33.0	21.6	34.1	30.8	4.4	13.6	16.8	5.9	1.3	0.7	3.4
Royal Gala	37.6	38.9	42.8	37.2	32.8	3.4	18.2	4.7	4.0	51.2	41.4	16.6	11.7	9.8	15.0	0.2	0.4	0.3	0.3
Sun Gold	67.7	50.4	43.4	62.5	67.9	13.7	0.2	3.2	43.9	19.0	30.6	46.7	4.6	6.5	12.3	17.5	9.8	0.6	1.1

Average sensory panel scores for 19 attributes (texture and (flavour) measured on a 100 point line scale



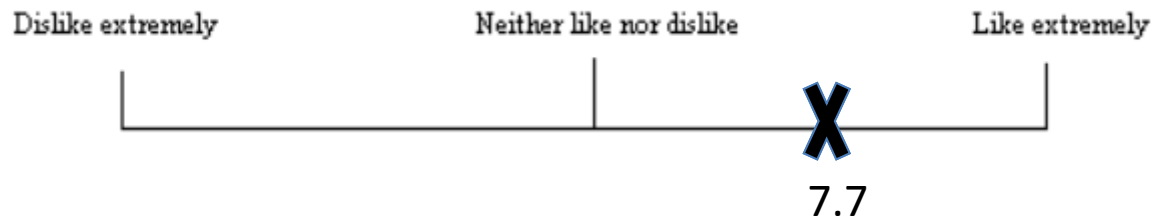
The correlation between the sensory attributes allows us to visualise 76% of the variation between the apples in two dimensions

Interpretation of Plot Dimensions using Loadings

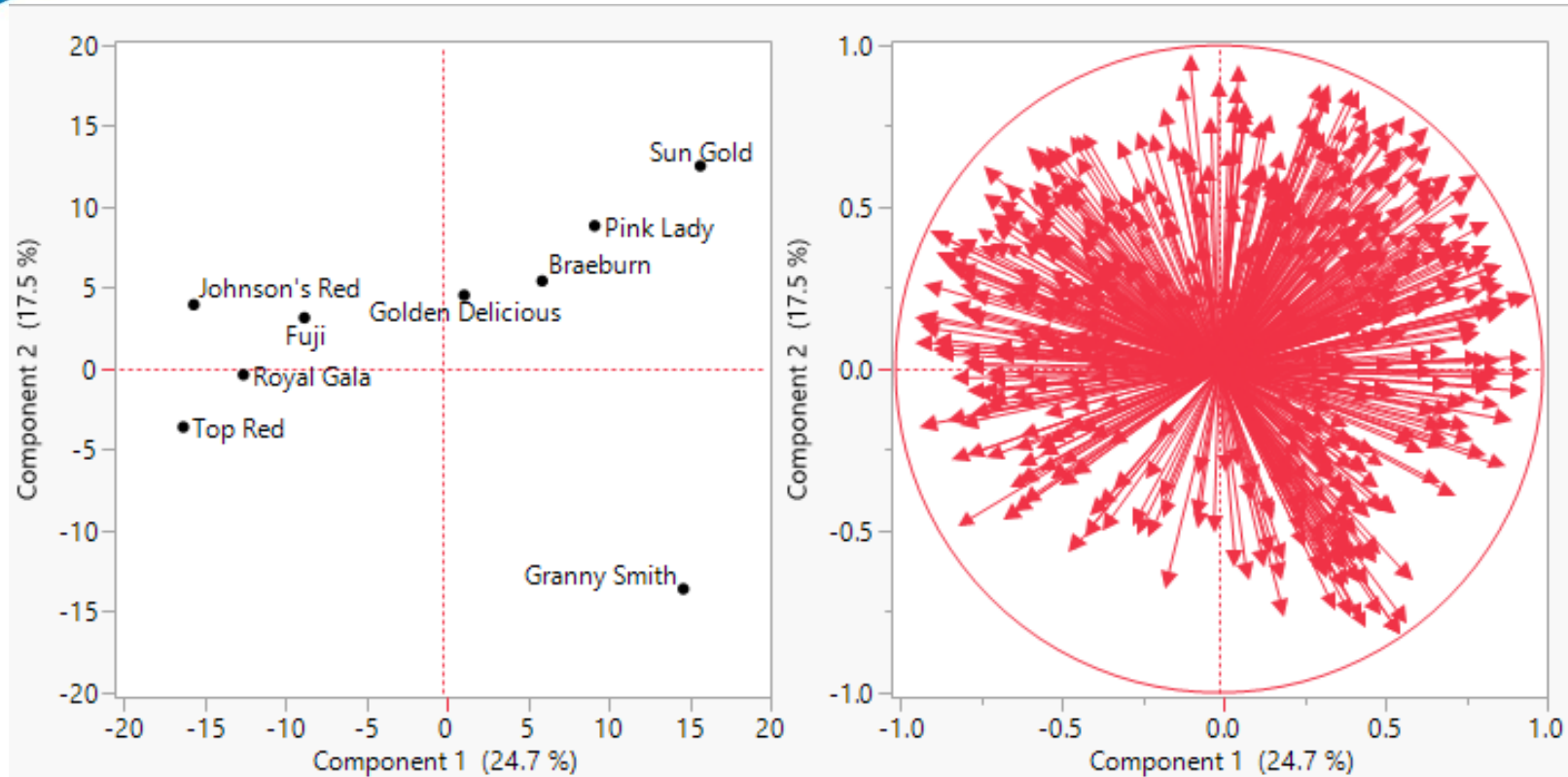




Consumers (604) were recruited in Italy and UK to taste the apples and score their liking. The test was designed so that the presentation order was balanced and the variety names were not revealed to the consumers

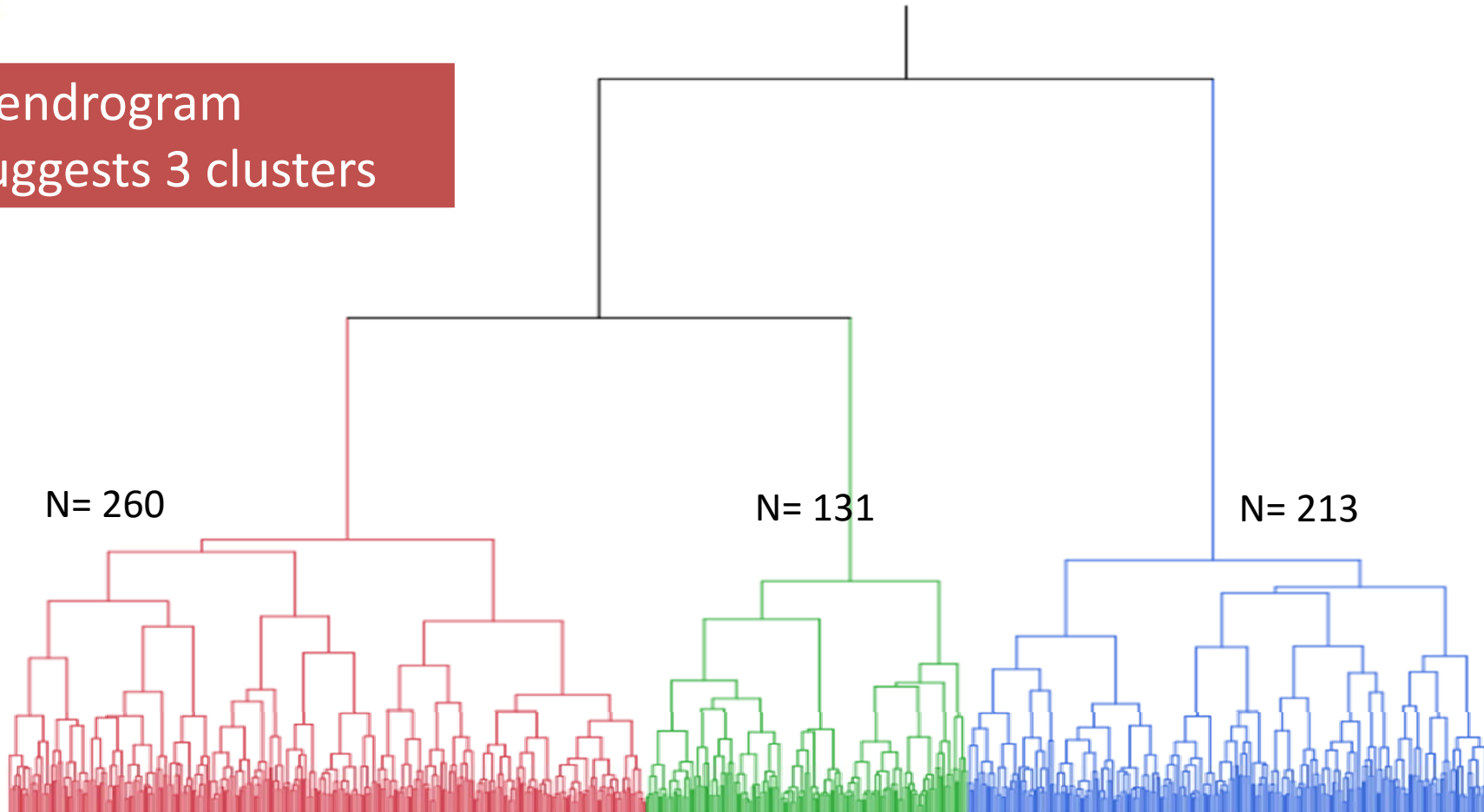


Liking score on a line scale, 0=Dislike extremely, 10=Like extremely

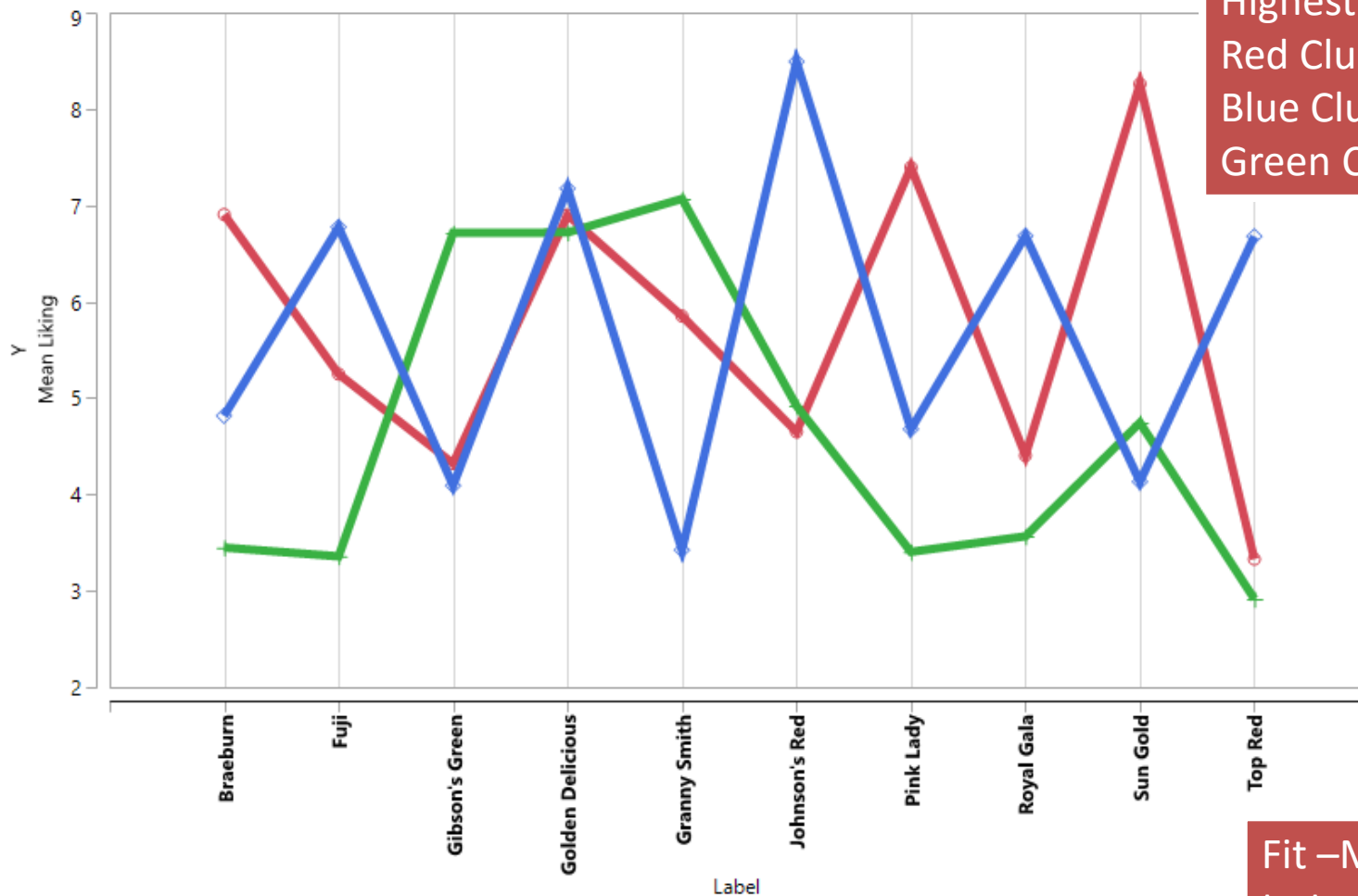


PCA of matrix(10 x 640) of liking scores –rows=products, columns=consumers
 Vectors show preference direction for each consumer. Indicates diversity in preference

Dendrogram suggests 3 clusters



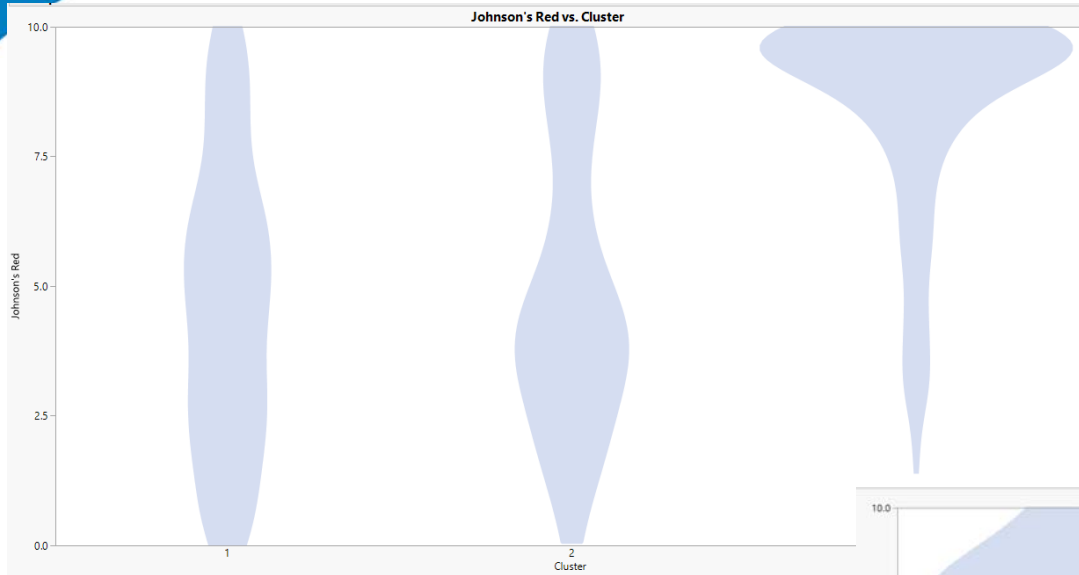
Overlay Plot Cluster Means



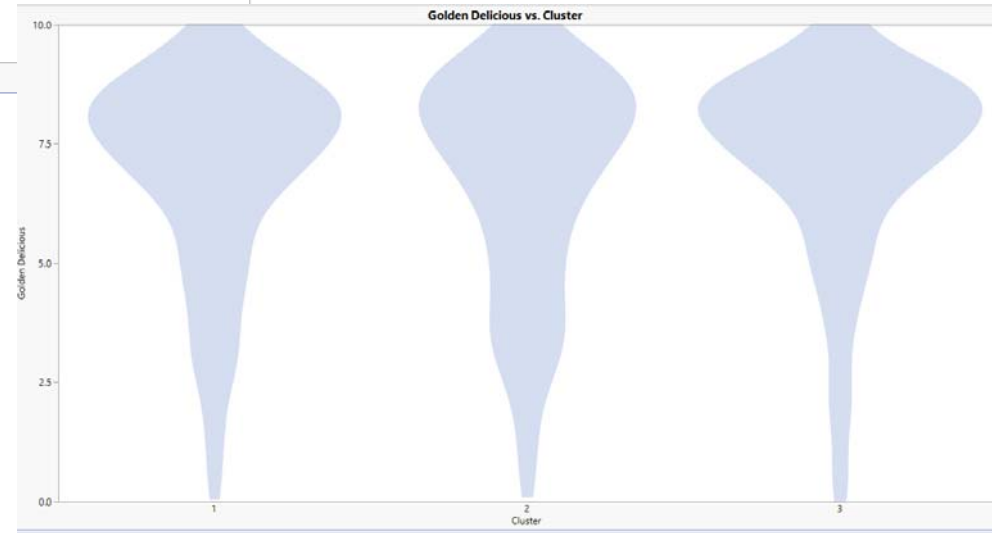
Highest Average Score
 Red Cluster – Sun Gold
 Blue Cluster – Johnson's Red
 Green Cluster-Granny Smith

Fit –Model would allow us to test for differences between cluster means for each variety.

Within Cluster Variation Violin Plot

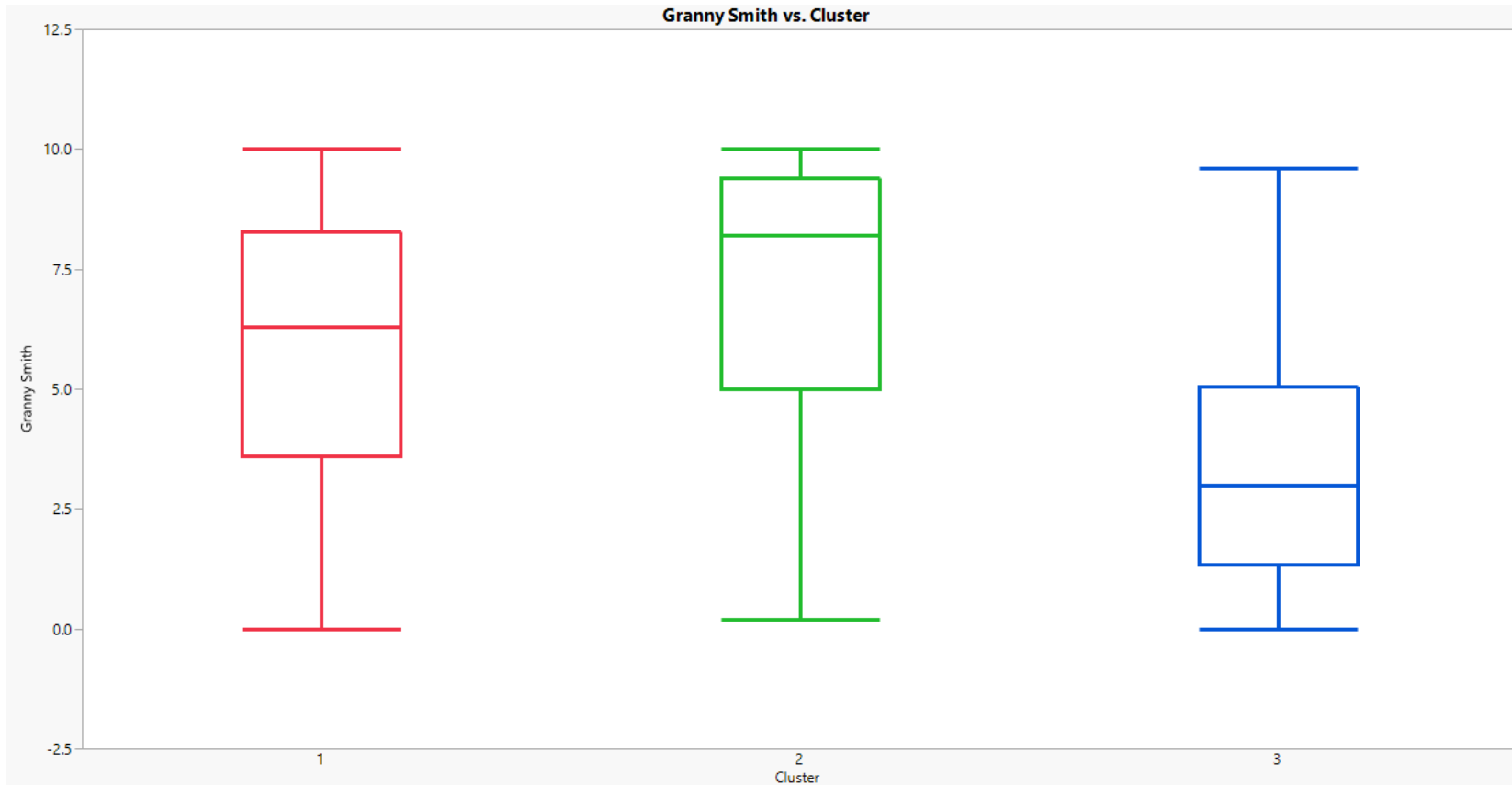


Johnson's Red

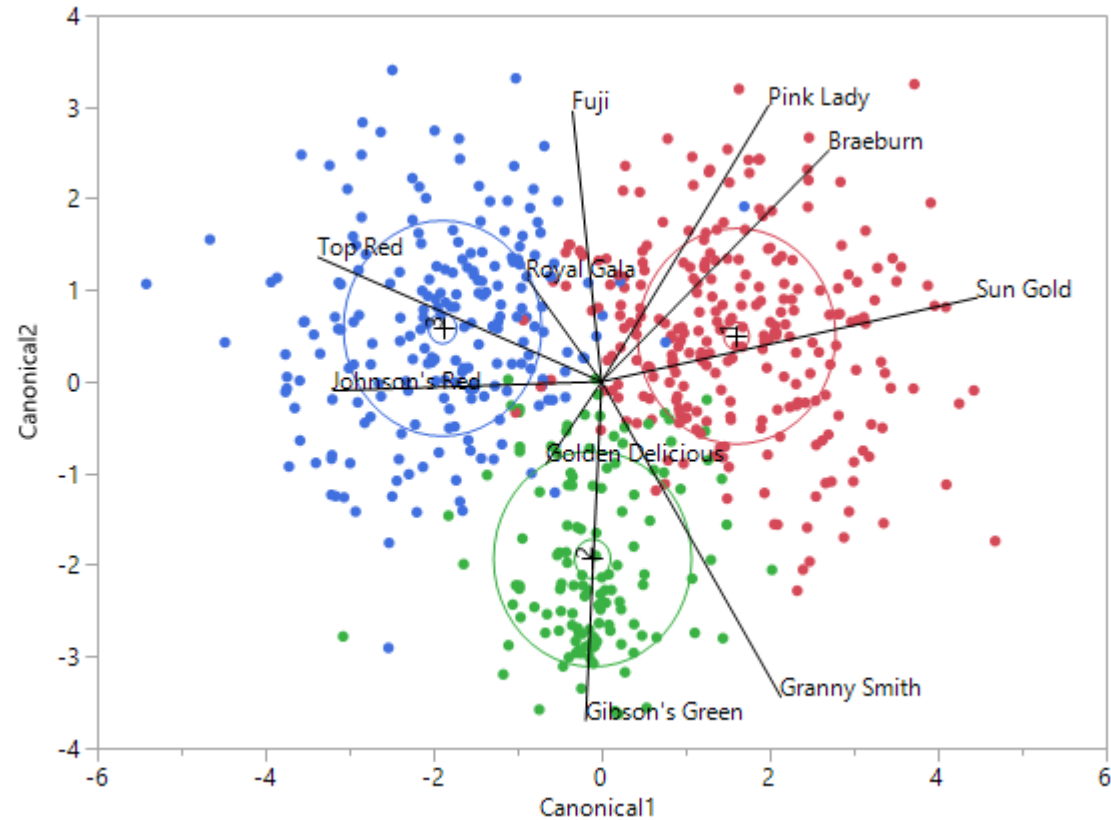


Golden Delicious

Within Cluster Variation Box Plot



Plot shows clear discrimination between the clusters and preference direction for the apple varieties



Analytical Sensory Profile

A small number of trained
professionals

A multi-criteria quantified description

No Hedonics

Consumers Study

A representative sample
of the target population

An overall hedonic score

No Description



Product Descriptors

Sensory
Analytic

Consumer responses

Overall Liking mean
Cluster Means
Individual consumer Scores



- Simple Correlations
- Principal Component Regression
- Partial Least Squares

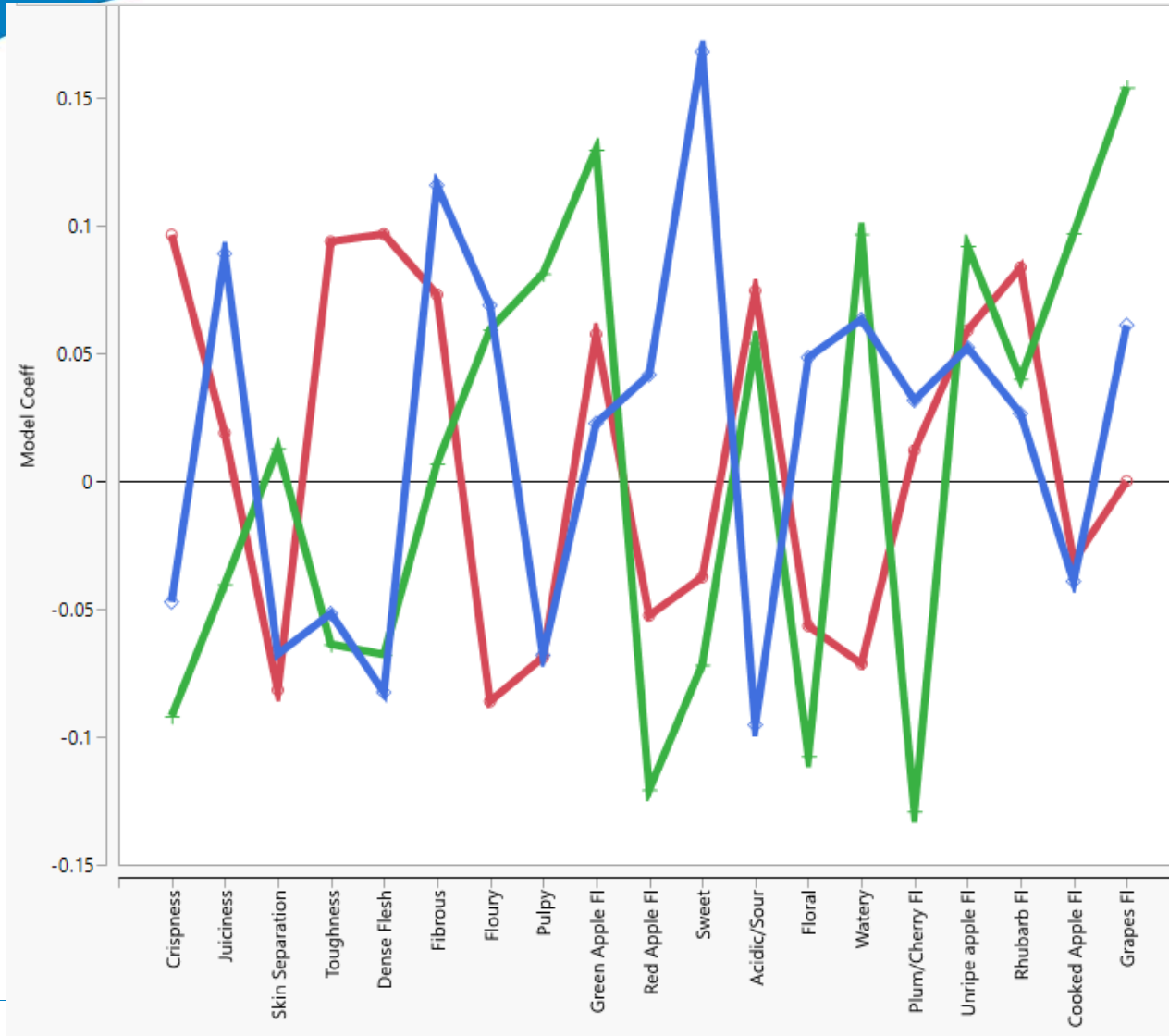
X Matrix

Apple	Crispness	Juiciness	Skin Separation	Toughness	Dense Flesh	Fibrous	Floury	Pulpy	Green Apple FI	Red Apple FI	Sweet	Acidic/Sour	Floral	Watery	Plum/Cherry FI	Unripe apple FI	Rhubarb FI	Cooked Apple FI	Grapes FI
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Braeburn	59.7	55.6	48.1	49.2	49.6	7.1	2.9	6.8	33.0	21.6	31.1	30.8	4.1	13.6	16.8	5.9	1.3	0.7	3.1
Royal Gala	37.6	38.9	42.8	37.2	32.8	3.4	18.2	4.7	4.0	51.2	41.4	16.6	11.7	9.8	15.0	0.2	0.4	0.3	0.3
Sun Gold	67.7	50.4	43.4	62.5	67.9	13.7	0.2	3.2	43.9	19.0	30.6	46.7	4.6	6.5	12.3	17.5	9.8	0.6	1.1

Y Matrix

Cluster	Cluster 1	Cluster 2	Cluster 3
Gibson's Green	4.3	6.7	4.1
Johnson's Red	4.7	4.9	8.5
Golden Delicious	6.9	6.7	7.2
Granny Smith	5.9	7.1	3.4
Pink Lady	7.4	3.4	4.7
Fuji	5.3	3.4	6.8
Top Red	3.3	2.9	6.7
Braeburn	6.9	3.5	4.8
Royal Gala	4.4	3.6	6.7
Sun Gold	8.3	4.7	4.1
N	260	131	213

PLS Model Coefficients – by Cluster



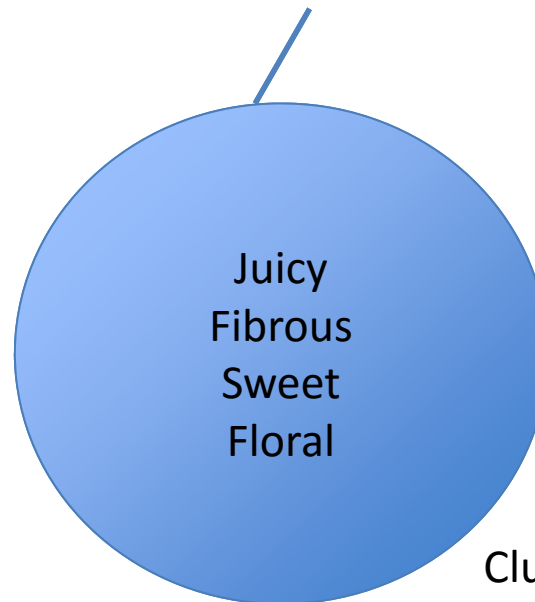
Cluster 1=Red
Cluster 2=Green
Cluster 3=Blue



Cluster 1 –Firm Textured Green Likers



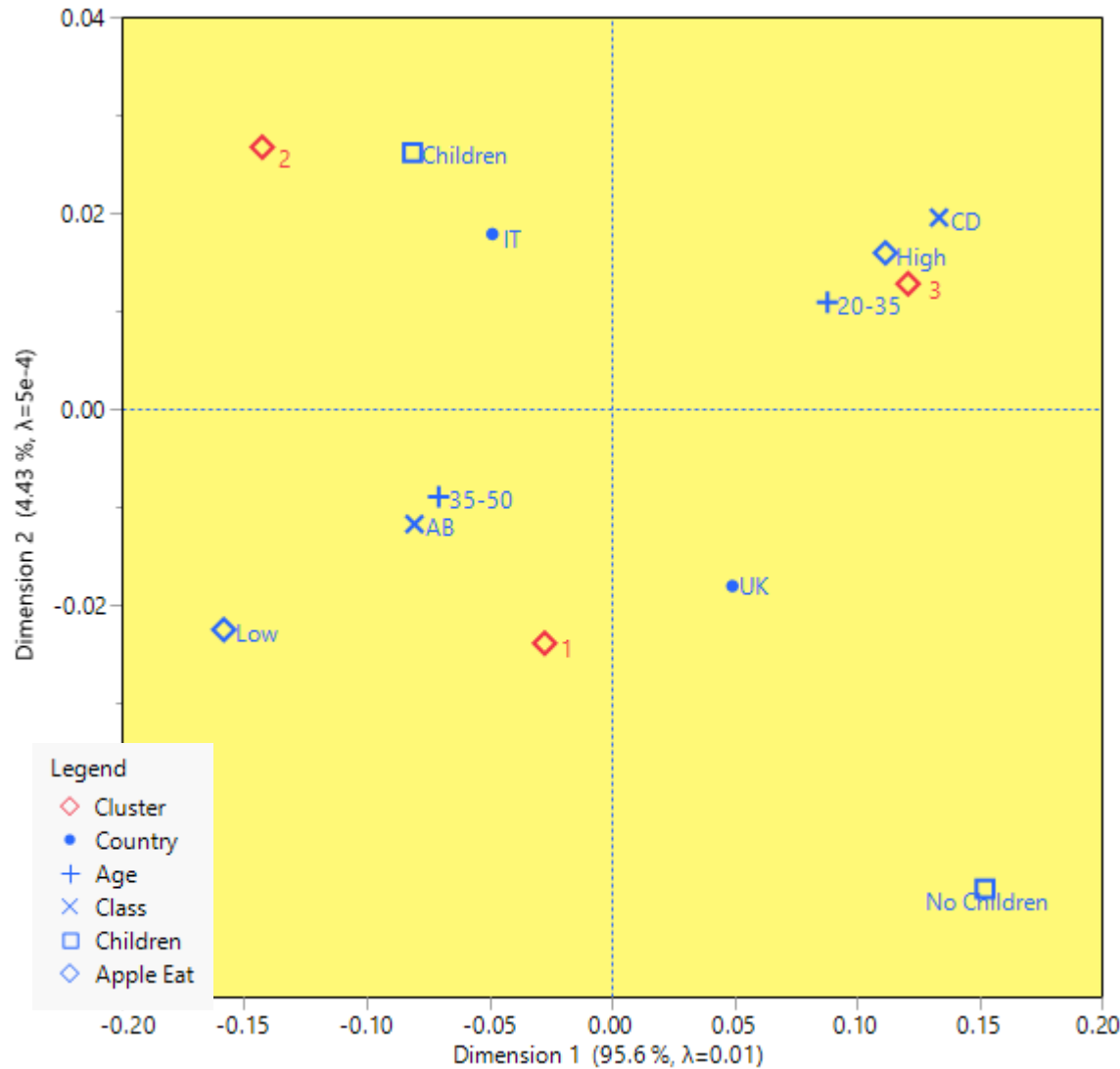
Cluster 2 –Softer Green Likers



Cluster 3 –Red Apple Likers

Drilling into the Clusters

Multiple Correspondence Analysis



Limited demographic information collected on each consumer

Age

Socio-Economic Group

Consumption Level of Apples

Children in family

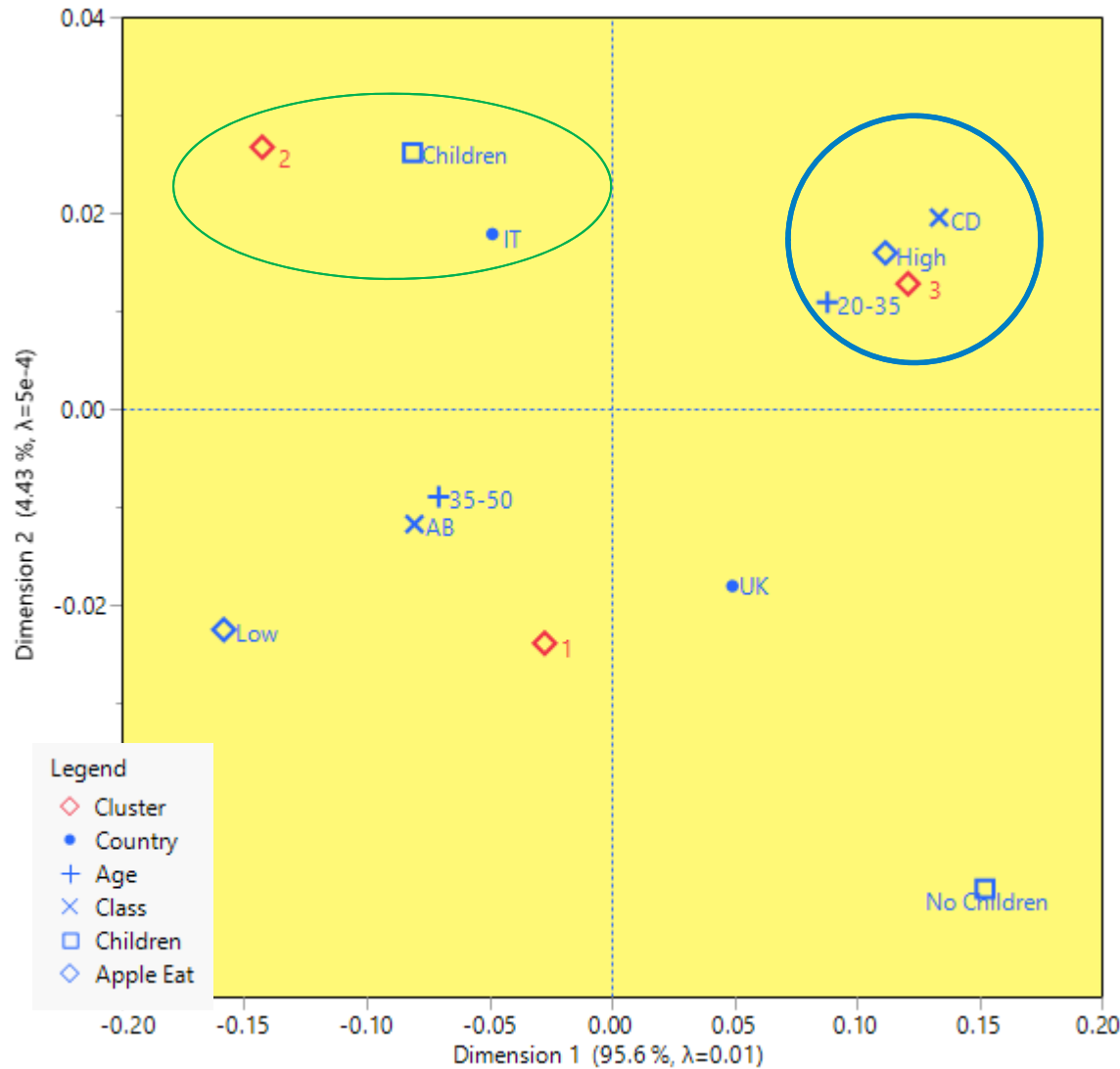
Multiple Correspondence

Y=Cluster

X=Demographics

Drilling into the Clusters

Multiple Correspondence Analysis



Cluster 3 –Red Likers
 Younger
 More High Apple eaters
 Lower Socio-Economic CD

Cluster 2-Green Likers
 Children
 Italy

Useful graphical way of spotting associations
 But check with simple cross tabs/Chi-Squared before reporting to marketing!!

- **Supports all standard methods of preference mapping**
- **Graphical Features are very useful**
 - *Wish there was more flexibility in formatting multivariate plot labels*
- **Additional features wish list**
 - *Overlay supplementary variables in PCA*
 - *Three way unfolding (e.g. Multiple Factor Analysis/ Statis/Generalised Procrustes)*
 - *MultiDimensional Scaling (MDS) for analysis of sorting data*
 - *Cochran's Q /McNemar for analysis of two way binary data*