PanelCheck – A Tool for Monitoring of Assessor and Panel Performance

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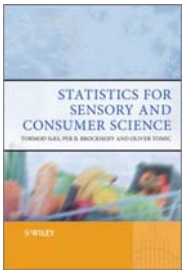
OUTLINE

- What is PanelCheck and why use it?
- Data structure & data import
- Tucker-1 and Manhattan plots
- One-way ANOVA for panelist performance
- Export of plots

Literature

- Chapter 3 on sensory panel performance
- Tormod Næs, Per Brockhoff, Oliver Tomic

- Book info:
  - ISBN: 978-0-470-51821-2
  - Hardcover
  - 300 pages
  - June 2010



Literature

- O. Tomic, A. Nilsen, M. Martens, T. Næs, Visualization of sensory profiling data for performance monitoring, LWT 40 (2005), 262-269
  - F plot, MSE plot, p*MSE plot (one-way ANOVA)
  - Correlation plot, Eggshell plot
- T. Dahl, O. Tomic, J.P. Wold, T. Næs, Some new tools for visualising multi-way sensory data, Food Quality and Preference 19/1 (2008), 103-113
  - Tucker-1 plots
  - Manhattan plots
- O. Tomic, G. Luciano, A. Nilsen, G. Hyldig, K. Lorensen, T. Næs, Analysing sensory panel performance in a proficiency test using the PanelCheck software, European Food Research and Technology 230 (2010), 497-511
  - Workflow
  - Comparison of performance from multiple panels
- O. Tomic, C. Forde, C. Delahunty, T. Næs, Performance indices in descriptive sensory analysis - a complimentary screening tool for assessor and panel performance, Food Quality and Preference 28 (2013), 122-133
  - Performance indices

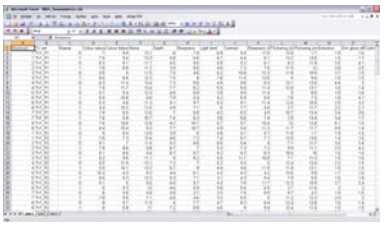
What is PanelCheck and why use it?

What is PanelCheck and why use it?

«LARGE» AMOUNT OF NUMBERS (for non-statisticians)

- Example:
  - 10 assessors
  - 8 products
  - 2 replicates
  - 20 attributes

- → 160 rows of data
- → 3200 cells of data



What is PanelCheck and why use it?

How to extract relevant information?

- Is the variation in your data based on:
  - Differences between the produts?
  - Poor performance of the asssessors?
- Is your sensory panel well enough trained?

What is PanelCheck and why use it?

Which statistical method to use?

GPA

Assessor models

Control charts

P values

Consonance index

Egg Shell Plot

PCA

Cluster analysis

MS Error

What is PanelCheck and why use it?

Which statistical method to use?

- Plenty of different statistical methods available
- Various commercial data analysis software packages (costly)
- Data collection software contain some methods
- Various open source free software packages (might require programming skills)

What is PanelCheck and why use it?

PanelCheck for practitioners and researchers

- An easy-to-use software tool for monitoring of sensory panel performance
- Taylor made for analysis descriptive analysis data
- Visual approach for performance analysis
- Does not require detailed knowledge in statistics
- Free open source software

What is PanelCheck and why use it?

GENERAL PanelCheck CONCEPT

- There is no single plot / statistical method showing / yielding ALL the information in your data
- Use different plots (based on different statistical methods) to reveal different type of important information
- Use joint information from plots to get a comprehensive overview over performance (individuals, panel)

What is PanelCheck and why use it?

WHAT CAN PanelCheck BE USED FOR?

- Checking performance of assessors and panel
- Checking performance of multiple panels in inter-collaborative tests
- Analysis of tested products

What is PanelCheck and why use it?

Where to download and get information?

- www.panelcheck.com
- Download PanelCheck software
- Download posters, find info, etc
- LinkedIn: PanelCheck user group

What is PanelCheck and why use it?

PanelCheck history and facts

- Collaboration between
  - Nofima (former Matforsk)
  - Technical University (DTU)
  - Norwegian industry
  - Danish industry
- First release in 2005
- About 20 000 downloads since
- Users from 94 countries

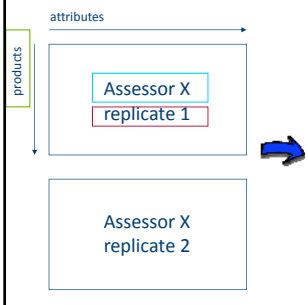
What is PanelCheck and why use it?

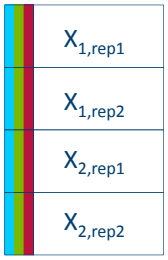
PanelCheck history and facts

PHILIPS · NYCOMED · PEPSI · QUAKER · Cadbury Schweppes · Ford · illy · NOKIA Connecting People · Arla · HARIBO · Unilever · symrise always inspiring more... · British American Tobacco

Data structure & data import

Data structure & data import



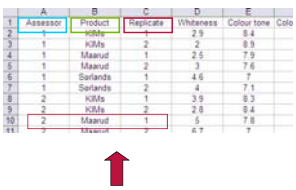


Column 1: assessors
Column 2: products
Column 3: replicates

Data structure & data import

How to organise the data

- Columns:
  - Column 1: assessor names
  - Column 2: product names
  - Column 3: replicate names
  - Column 4 ++ : attributes
- Rows:
  - Each row represents one tasting of one assessor
  - Order of rows is not important



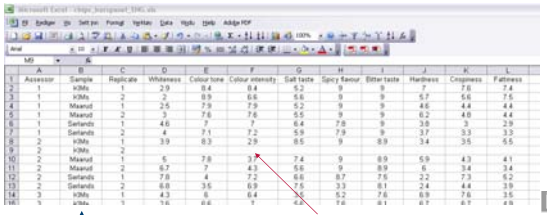
	A	B	C	D	E
1	Assessor	Product	Replicate	Whiteness	Colour tone
2	1	KiMs	1	2.9	8.4
3	1	KiMs	2	2	8.9
4	1	Maarud	1	2.5	7.9
5	1	Maarud	2	3	7.6
6	1	Sørlands	1	4.6	7
7	1	Sørlands	2	4	7.1
8	2	KiMs	1	3.9	8.3
9	2	KiMs	2	2.8	8.4
10	2	Maarud	1	5	7.8

Unique combination of keys for each row

Data structure & data import

Balanced and unbalanced data

- ALL assessors need to have tested ALL products
- ALL assessor need an IDENTICAL number of replicates
- Unbalanced part will be stripped away (either assessor or product)



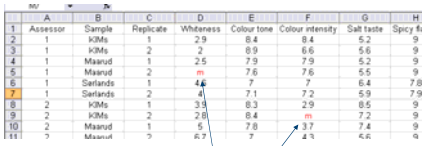
Order of products in NOT important

Whole row missing
➔ unbalanced data

Data structure & data import

Missing data

- Missing data in single cells are OK and will be imputed



Missing data

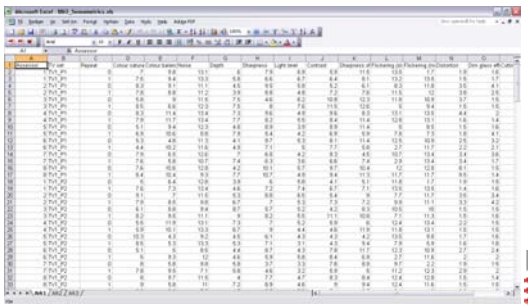
Data structure & data import

File formats and ways of importing data

- Supported file formats:
  - .txt (delimited by: tab, comma, semicolon)
  - .csv
  - .xls
- Import through:
  - File ➔ Import
  - File ➔ Import recent
  - Drag & drop
  - Right-click on file and open with 'PanelCheck'

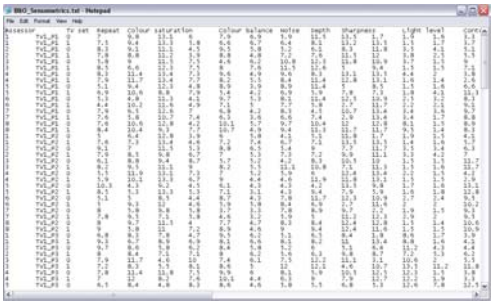
Data structure & data import

EXCEL FILE (.xls)



Data structure & data import

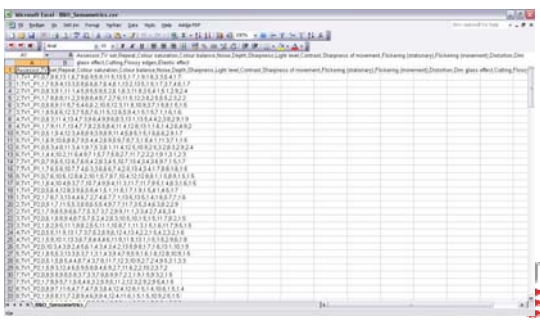
TEXT FILE (.txt)



(tab-delimited)

Data structure & data import

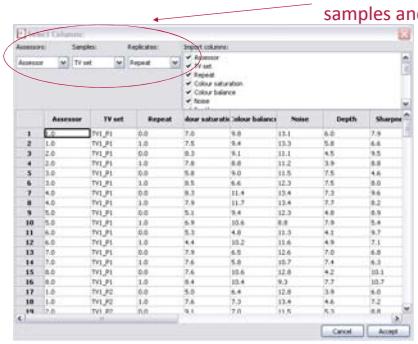
COMMA SEPARATED VALUE TEXT (.csv)



Data structure & data import

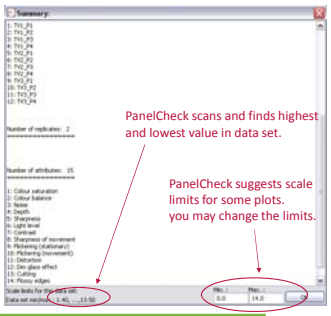
IMPORT DIALOG

Select columns for assessor, samples and replicates.



Data structure & data import

SUCCESSFUL DATA IMPORT



Workflow

In which order should plots be analysed?

Workflow

- There is no "right" or "wrong" way of:
  - which plots should be considered
  - in wich order they should be used
- Workflow only a recommendation based on our own experience

Workflow

PanelCheck menu:
Help ➔ Workflow

Plots based on Principal Component Analysis (PCA)

Results used in:

- » *Tucker plot*
- » *Manhattan plot*
- » *Analysis of panel consensus*

Plots based on Principal Component Analysis (PCA)

- For full details on Tucker-1 and Manhattan plots please read:

Available online at www.sciencedirect.com
ScienceDirect
Food Quality and Preference 19 (2008) 103–113
Food Quality and Preference
www.elsevier.com/locate/foodqual

Some new tools for visualising multi-way sensory data

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Available online 20 July 2007

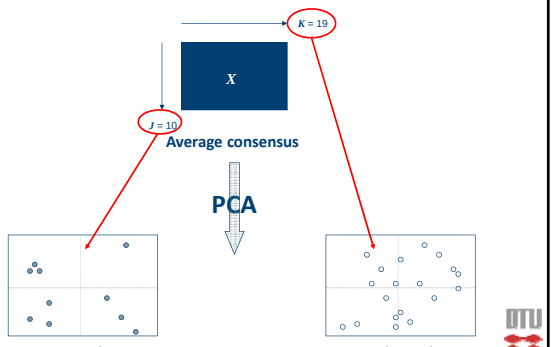
PCA basics

Example data

- 10 products
- 19 attributes
- (10 assessors, 2 reps)

average consensus

PCA basics



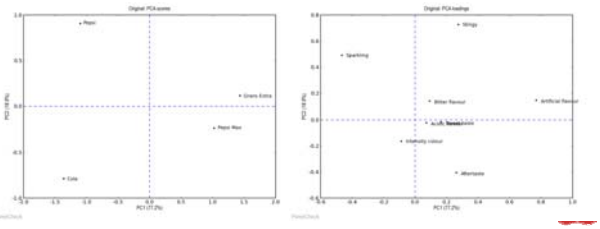
PCA basics

Data → Systematic variation + Noise

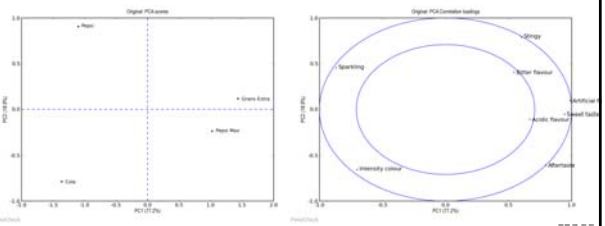
- Principle components (PC's) are orthogonal (uncorrelated)
- Each PC explains a certain amount of the total variance
- Scores provide information on the products
- Loadings provide information on how the attributes have contributed to the variation in the data

PCA basics

- Products that are close to each other are very similar and vice versa
- Attributes that are close to each other are highly correlated
- Superimpose scores and loadings plots to understand variation in data



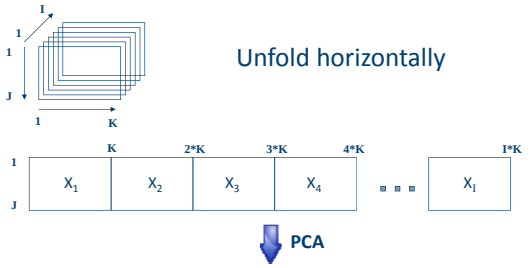
PCA basics



PCA – Tucker 1

TUCKER-1 plot –
DISPLAYING AGREEMENT BETWEEN ASSESSORS

PCA – Tucker 1 – common scores



Unfold horizontally

Common scores plot showing J objects

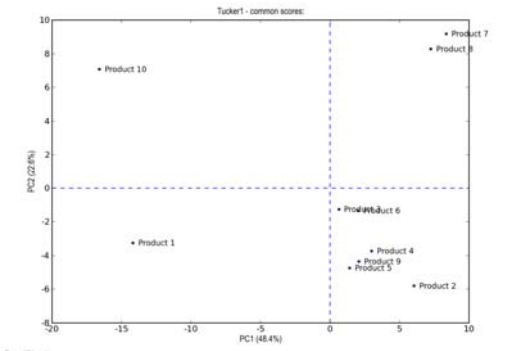
Loadings or correlation loadings plot showing $I*K$ variables

PCA – Tucker 1

What is shown in the plots?

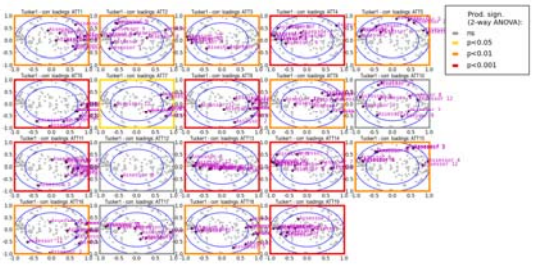
- Common scores plot: Shows how samples relate to each other
- Correlation loadings plots:
  - Shows $I * K$ dots in plot:
    - I: number of assessors
    - K: number of attributes
  - Each dot represents the attribute of one assessor
  - Focus on either assessors or attributes
  - Inner circle: 50% explained variance
  - Outer circle: 100% explained variance
  - Focus on assessor or attribute

PCA – Tucker 1 – common scores

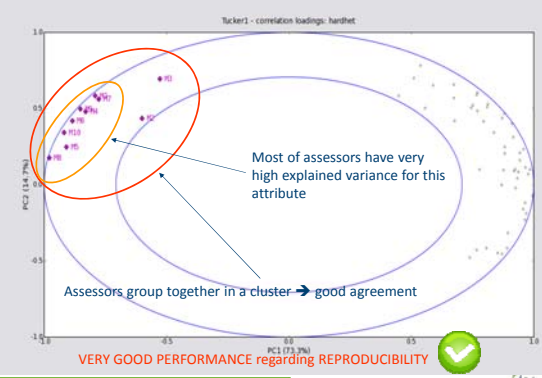


PCA – Tucker 1

TUCKER1 – CORRELATION LOADINGS: OVERVIEW PLOT



PCA – Tucker 1 – correlation loadings



Most of assessors have very high explained variance for this attribute

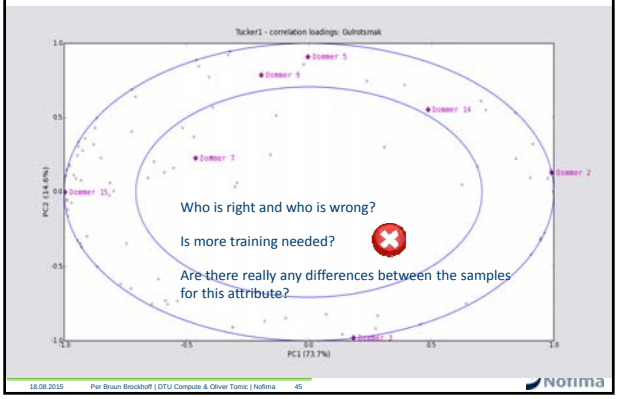
Assessors group together in a cluster → good agreement

VERY GOOD PERFORMANCE regarding REPRODUCIBILITY

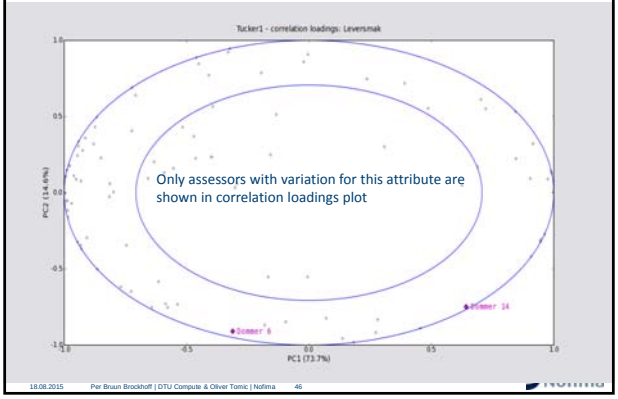
PCA – Tucker 1 – correlation loadings

PCA – Tucker 1 – correlation loadings

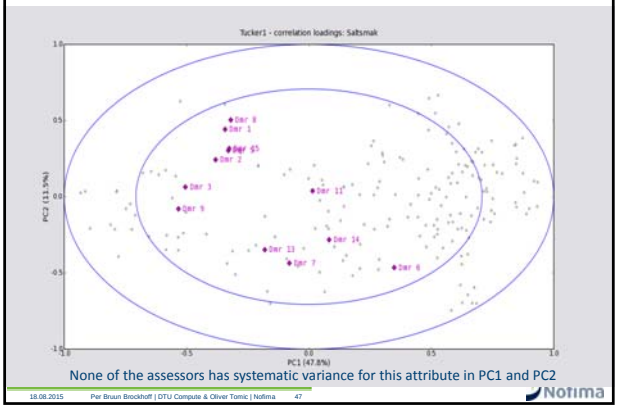
PCA – Tucker 1 – correlation loadings



PCA – Tucker 1 – correlation loadings



PCA – Tucker 1 – correlation loadings



PCA – Tucker 1 – correlation loadings

SUMMARY TUCKER-1 PLOTS

- Features:
  - Provides information about reproducibility across panel
  - Provides information about systematic variation for each assessor – attribute combination
- Weakness:
  - No information on use of scale

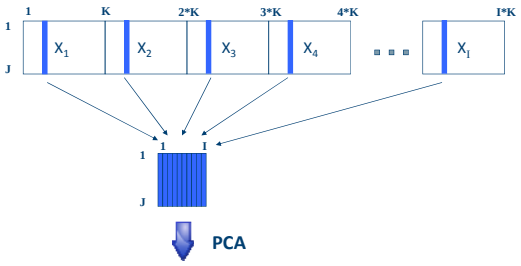
PCA – Tucker 1 – one attribute

Tucker 1 with a little twist

- Look at only ONE attribute at the time
- ➔ detach from influence of other attributes
- ➔ easier to evaluate agreement across assessors

- When agreement data should be unidimensional
  - ➔ explained variance should be as close as possible to 100% in PC1
  - ➔ all assessors should cluster together on one side of PC1

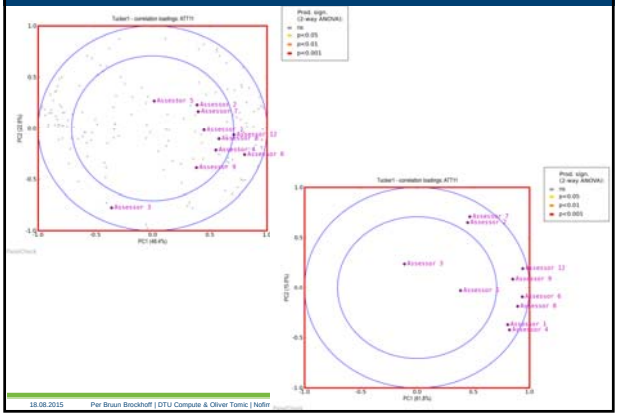
PCA – Tucker 1 – one attribute



Common scores plot showing J objects

Correlation loadings plot showing I variables

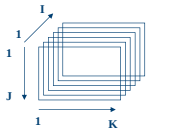
PCA – Tucker 1 – one attribute



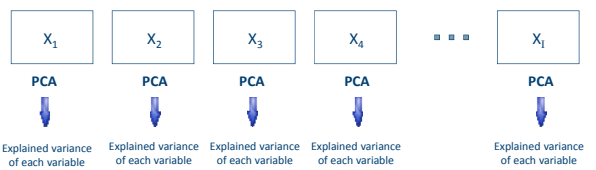
PCA – Manhattan plot

Manhattan plot –
A SCREENING TOOL FOR CHECKING GENERAL DATA STRUCTURE

PCA – Manhattan plot

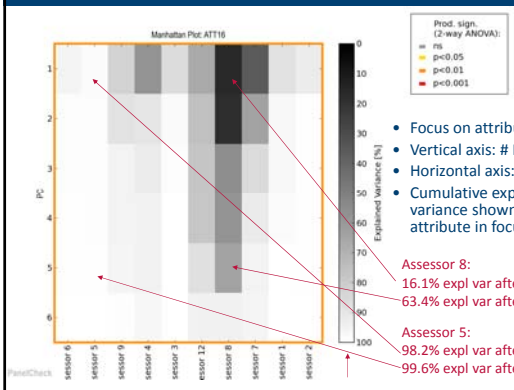


PCA on data from each assessor



Visualise in Manhattan plot

PCA – Manhattan plot



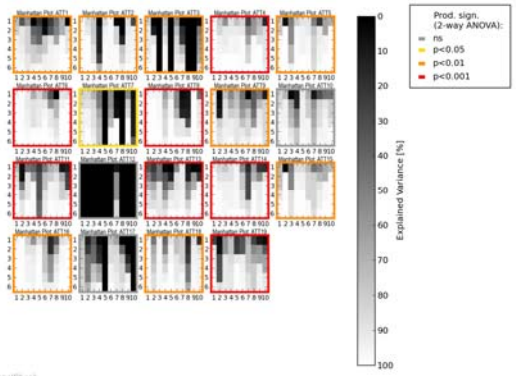
- Focus on attributes
- Vertical axis: # PC's
- Horizontal axis: assessors
- Cumulative explained variance shown for attribute in focus

Assessor 8:
16.1% expl var after PC1
63.4% expl var after PC5

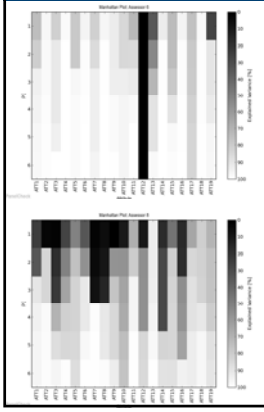
Assessor 5:
98.2% expl var after PC1
99.6% expl var after PC5

Indicator scale

PCA – Manhattan plot



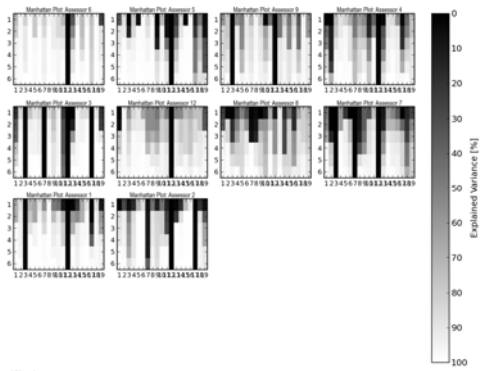
PCA – Manhattan plot



- Focus on assessors
- Vertical axis: # PC's
- Horizontal axis: attributes
- Cumulative explained variance shown for attribute in focus

Cumulative explained variance of attributes of assessor 6 are often far higher than those of assessor 8.

PCA – Manhattan plot



PCA – Manhattan plot

SUMMARY MANHATTAN PLOTS

- Features:
  - Provides quick information data structure for each assessor
  - Provides insight "deep" into data (beyond PC2)
- Weakness:
  - No information about repeatability
  - No information on use of scale
  - No information on how prodcuts are distributed

Plots based on one-way ANOVA

Results used in:

» *F plot*
» *MSE plot*
» *p*MSE plot*

One-way ANOVA

- Applied on data from only ONE assessor at a time
- Requires a minimum 2 replicates
- Main effect: products (fixed)

One-way ANOVA

- Cumbersome to do this manually for each assessor and each attribute
- Example:
  - 10 assessors
  - 30 attributes
  - ➔ 10 * 30 = 300 analyses in Minitab
- PanelCheck does this automatically for the user
- Results are used in various plots

One-way ANOVA – p*MSE plot

p * MSE plot –
SIMULTANIOUSLY CHECK ASSESSOR'S REPEATABILITY AND PRODUCT DISCRIMINATION ABILITY

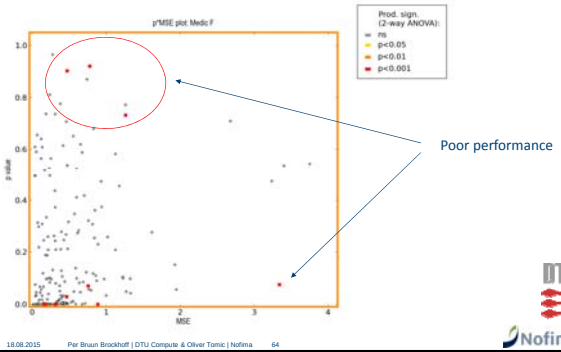
One-way ANOVA – p*MSE plot

What is shown in the plots?

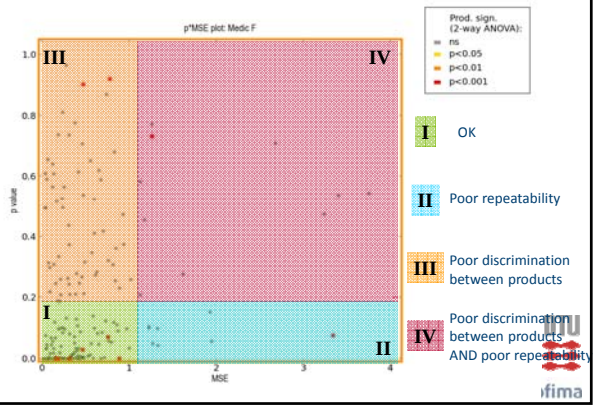
- Shows $I * K$ dots in plot:
  - I: number of assessors
  - K: number of attributes
- Each dot represents the attribute of one assessor
- Focus on either assessors or attributes

One-way ANOVA – p*MSE plot

FOCUS ON ATTRIBUTE

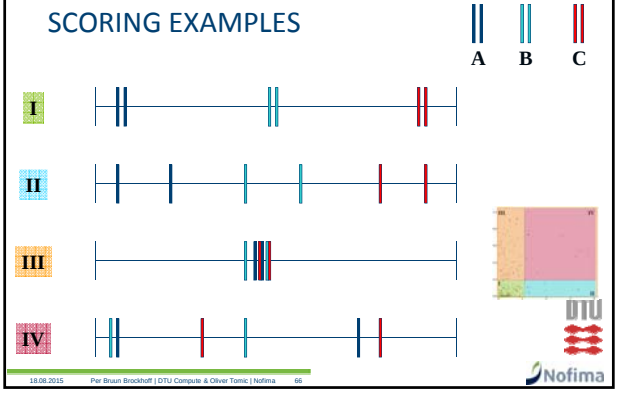


One-way ANOVA – p*MSE plot



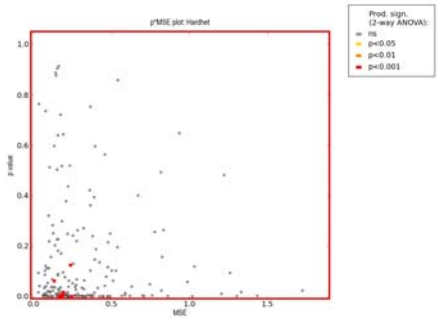
One-way ANOVA – p*MSE plot

SCORING EXAMPLES



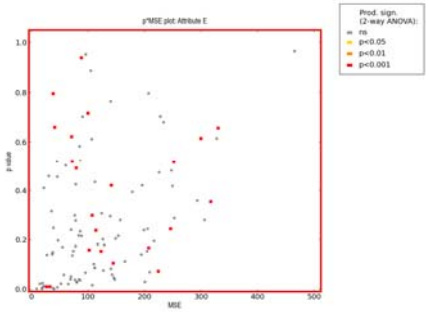
One-way ANOVA – p*MSE plot

GOOD PERFORMANCE



One-way ANOVA – p*MSE plot

POOR PERFORMANCE



One-way ANOVA – p*MSE plot

p * MSE PLOT - SUMMARY

- Features:
  - Provides information about assessor's repeatability AND ability to discriminate between samples
  - Shows all attributes and assesors in one plot
- Weakness:
  - No information about sample ranking (scale upside down?)

One-way ANOVA – F plot

F plot – CHECK ASSESSOR'S PRODUCT DISCRIMINATION ABILITY

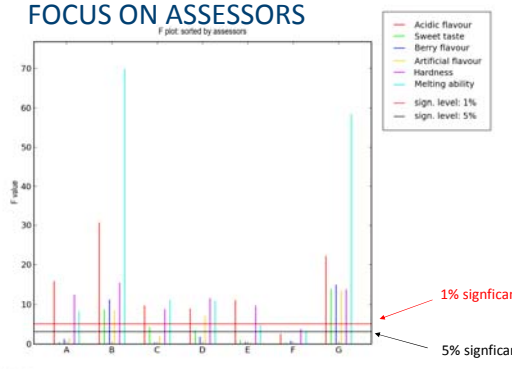
One-way ANOVA – F plot

What is shown in the plots?

- Shows $I * K$ vertical lines in plot:
  - I: number of assessors
  - K: number of attributes
- Each line represents one attribute of one assessor assessor
- Focus on either assessors or attributes

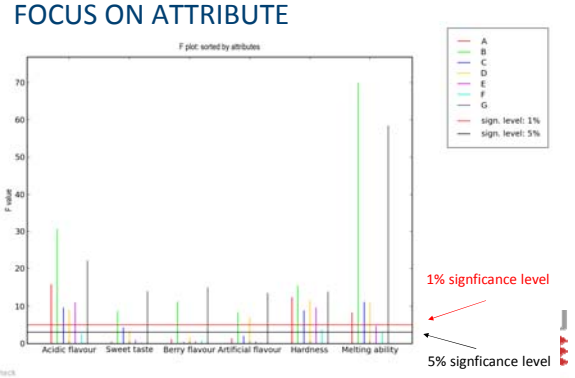
One-way ANOVA – F plot

FOCUS ON ASSESSORS



One-way ANOVA – F plot

FOCUS ON ATTRIBUTE



1% signficance level

5% signficance level

One-way ANOVA – F plot

F plot - SUMMARY

- Features:
  - Shows all assessors and all attributes in one plot
  - Easy to compare assessors/attributes with each other
  - Info about whether an assessor can discriminate between products or not
- Disadvantages:
  - No information about use of scale
  - No information about quality of replicates
  - No information about product ranking

One-way ANOVA – MSE plot

MSE plot –
CHECK ASSESSOR'S REPEATABILITY

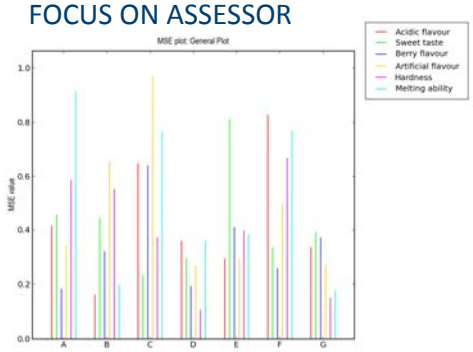
One-way ANOVA – MSE plot

What is shown in the plots?

- Shows $I * K$ vertical lines in plot:
  - I: number of assessors
  - K: number of attributes
- Each line represents one attribute of one assessor assessor
- Focus on either assessors or attributes

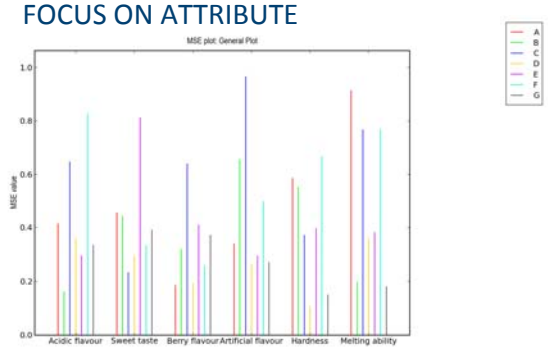
One-way ANOVA – MSE plot

FOCUS ON ASSESSOR



One-way ANOVA – MSE plot

FOCUS ON ATTRIBUTE



One-way ANOVA – MSE plot

MSE plot - SUMMARY

- Features:
  - Shows all assessors and all attributes in one plot
  - Easy to compare assessors/attributes with each other
  - Info about whether an assessor can discriminate between products or not
- Disadvantages:
  - No information about use of scale
  - No information about quality of replicates
  - No information about product ranking

Export of plots and results

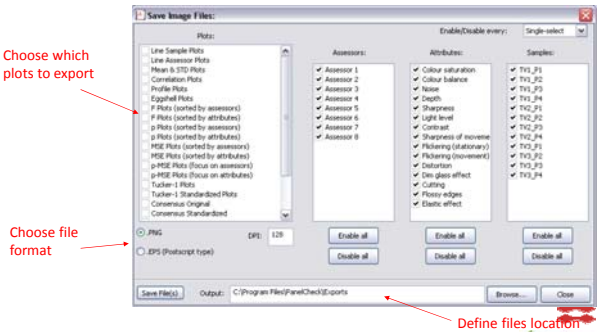
Export of plots and results

WAYS TO EXPORT PLOTS

- Copy (ctrl-c) and paste (ctrl-c)
- Save images to files:
  - All selected images are being saved to .png-files
  - .png-files should be handled most programs (like .jpg-files)
- Save images to PowerPoint:
  - All selected files are exported to a new PowerPoint-file
  - All selected images are being saved to .png-files

Export of plots and results

SAVE IMAGES TO FILES



Export of plots and results

SAVE IMAGES TO POWER POINT