Use of symbolic principal component analysis to account for imprecision within the sensory map of products

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Key words: Sensory analysis; Symbolic data; Fuzzy data; Principal Component Analysis

QDA: **Quantitative Descriptive Analysis**:

- One of main descriptive analysis techniques in sensory evaluation
- Ten to twelve trained assessors
- Steps: Panel recruitment, panel training, sensory evaluation

Pros and **cons**:

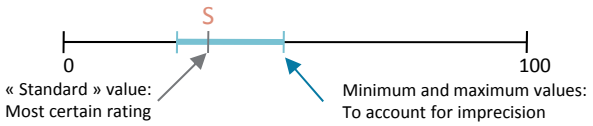
- Repeatability, reproducibility
- Reliability
- High cost and significant duration
- Cumbersome for the panel

Can one use fuzzy data for an untrained panel QDA in order to overcome the stages of selection and training?

Datasets

- 14 trained assessors / 34 untrained assessors
- 8 products: compotes with different levels of added sugar and malic acid
- 9 descriptors : Fluidity, Granulosity, Sugar, Acidity, Bitter, Aroma overall intensity, Raw apple Flavor, Cooked apple Flavor, Oxydized apple Flavor

Rating scheme



Panel comparaison on standard values

2-Factors ANOVA on standard values

$$X_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \varepsilon_{ijk}$$

With:

α_i ($i = 1, \ldots, 8$) assessor effect

β_j ($j = 1, \ldots, 34$) assessor effect j (random)

$(\alpha\beta)_{ij}$ interaction product i x assessor j

ε_{ijk} error associate at the model

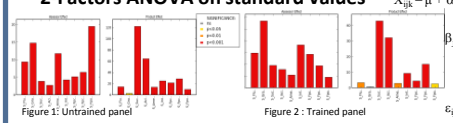


Figure 1: Untrained panel — Figure 2 : Trained panel

ACP on standard values

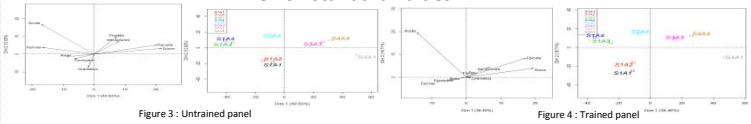


Figure 3 : Untrained panel — Figure 4 : Trained panel

Similar results for the two panels in terms of :

⇨ **discrimination of products**

⇨ **principal components related to sugar and acidity intensity.**

Degree of use of intervals

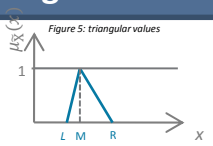


Figure 5: triangular values

Table 1: Percentage of interval utilisation

Panel	Fluidity	Granulosity	Sugar	Acidity	Bitter	Aroma overall intensity	Raw apple Flavor	Cooked apple Flavor	Oxydized apple Flavor	TOTAL
Untrained	91 %	94 %	94 %	91 %	91 %	91 %	94 %	91 %	91 %	92 %
Trained	100 %	100 %	100 %	100 %	86 %	100 %	93 %	100 %	93 %	96 %
TOTAL	95.5 %	97 %	97 %	95.5 %	88.5 %	95.5 %	93.5 %	95.5 %	92 %	

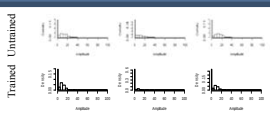


Figure 6 : Distribution of interval amplitudes

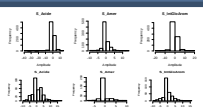


Figure 7: Distribution of the gap between interval middle and standard value

Untrained assessors use intervals for all descriptors like trained assesors. Most of time, the standard value corresponds to the middle of the interval. Untrained assessors intervals are not wider than trained assessors intervals

Sensory product map based on triangular values

LMR1-PCA (Coppi et al., 2006): as in PCA, the aim is to minimise the difference between the observed data and the estimated ones. In the case of LMR1-PCA, each observation unit is an hyperrectangle whose vertices correspond to the lower and upper bounds of the intervals. The observation units are represented in the product map as rectangles.

Minimisation of δ :

$$\delta = (2^J+1)\ M-M*\ _2 + 2^J\text{-}1\ L-L*\ _2 + 2J\text{-}1\ R-R*\ _2 - 2\,\mathrm{Jtr}[(M-M*)^T\ (L-L*)]+2^J\ \mathrm{tr}[(M-M*)^T\ (R-R*)]$$

with J: number of descriptors

M, L* and R*: estimated matrices of M, L et R (matrix of standard values, lower bounds and upper bounds of the intervals).*

Figure 8: Vector representation of untrained panel

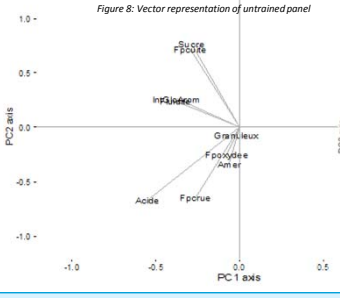
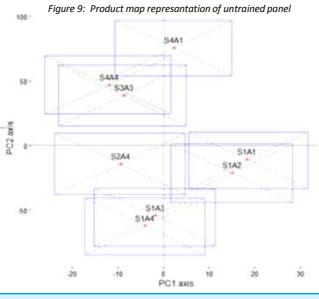


Figure 9: Product map represantation of untrained panel



We find same axes than with standard values of trained panel and representations are submitted to a rotation. Map product is similar with trained panel map product.

Conclusion:

- ✓ **Two performing panels**
  - Untrained panel is not a naive one
  - Straightforward product space
- ✓ **Taking into account the imprecision in scoring**
  - Psychological dimension of fuzzy concept
  - Uniform use of interval exhorting
- ✓ **Promising use of fuzzy data**
  - Taking into account the imprecision of the assessors in the product map
  - Similar product maps with or without fuzzy rating
- ✓ **Further works :**
  - Computation of indicators associated to the method
  - Analoguous representation of the variability

Sources: ***CAZES P., CHOUAKRIA A., DIDAY E., SCHEKTMAN Y., 1997.*** *– Extension de l'ACP à des données de type intervalle. Revue de Statistique Appliquée,* ***XLV*** *(3), pp. 5-24,* ***COPPI R., GIORDANI P., D'URSO P., 2006.*** *Component Models for Fuzzy Data. Psychometrika,* ***71****, pp. 733-761.*