Mapping products with the CVAS R-package

Caroline Peltier & Pascal Schlich

CSGA, CNRS, INRA, Université Bourgogne Franche-Comté, 21000, Dijon, France
E-mail : *caroline.peltier@dijon.inra.fr*

Abstract

Sensory profiling data features a panel of trained panelists having scored the intensities of a number of sensory attributes, possibly belonging to several sensory modalities, on a number of products to be compared. To summarize the differences between products in a visual way, most panel leaders produce a product map obtained from a Principal Component Analysis (PCA) of the product mean table. This method maximizes the variability of the product means, but does not take into account the disagreement of the subjects around these means. The Canonical Variate Analysis (Peltier, Visalli, & Schlich, 2015a) proposes an alternative based on a two-way MANOVA model extending the commonly used ANOVA model: score = product + panelist + product*panelist.
The CVA package computes MANOVA and produces corresponding CVA biplots of products and attributes with product confidence ellipses. This package optionally corrects the "scaling effect" (heterogeneity of panel in terms of individual variances of scoring) as defined in the Mixed Assessor Model (Brockhoff, Schlich, & Skovgaard, 2015).This correction can be done either with a different scaling coefficient by attribute and panelist or with a unique one per panelist (Peltier, Visalli, & Schlich, 2015b). The latter strategy assumes that the scaling effect would be mainly due to psychological causes rather than individual differences in physiological responses.
This poster presents how to use the CVA package and its different options and how to interpret them based on the analysis of an example of profiling dataset.

Keywords: Canonical Variate Analysis, product mapping, scaling, MAM

1. Introduction

A sensory profiling dataset is composed of intensities of sensory attributes given by subjects on several products, most of the time with replications. This dataset is usually analyzed with Principal Component Analysis to obtain a product map describing the differences between products.

This method is based on the table of product means (with products in lines and attributes in columns). Consequently, the variability of the subject scores around the product means is not taken into account with this method. Porcherot and Schlich (2000) used the Canonical Variate Analysis in the analysis of sensory profiling to raise this issue. This method is based on a statistical multivariate model and reflects product discrimination instead of multivariate variability of product means. Peltier et al. (2015a) also claimed that CVA was more appropriate for sensory profiling data and proposed an R-package allowing using it.

PCA also does not take into account the fact that some subjects use a larger/smaller part of the scale than the panel (so-called scaling effect). This effect is included into the univariate Mixed Assessor Model (Brockhoff, 2015). Later, Peltier et al. (2015b) decomposed the scaling effect into two components: a physiological one (due to the descriptor) and a psychological one (valuable for all descriptors).

This paper presents maps taking the scaling effect into account (MAM-CVA) and how to use the CVAS package to plot CVA and MAM-CVA maps.

2. Material and methods

In this paper, a mapping method taking scaling effect into account is proposed: the MAM-CVA. It is based on the multivariate extension of the MAM, and has two options:

- correcting the scaling effect by descriptor as presented in the MAM ("mam" option). In this case, the scaling effect is removed from the interaction product*subject term in order to obtain a "pure" disagreement term freed from scaling effect.
- taking the scaling effect into account only when it is psychological or common for all descriptors ("overall" option). In this case the correction of scaling is done in the same way for all descriptors.

Both maps are based on the diagonalization of $D^{-1}B$ where D is the matrix of covariance of disagreement (freed from scaling effect) and B is the matrix of covariance of product effect.

Ellipses representing the pure disagreement around the product means are plotted. Though, for each product*subject pair, the pure disagreement is projected on the map as supplementary individual. Under binormality assumptions, the obtained scatterplots allow plotting confidence ellipses. Hotelling T2 tests are also run order to detect multidimensional significant differences between products. Not significant different products are linked with segments ($p>0.05$).

The CVAS R package is freely available on www.timesens.com (after free inscription). The package must be loaded as a zip file in the R Commander. The data should be with column names as "product", "subject", "rep", "attribute 1", …,"attribute p" (not necessarily in this order).

As an example, a balanced dataset (data) containing 6 products (cheeses), 12 descriptors, 16 subjects and 3 replicates is used.

Then, the following commands should be entered to obtain the CVA calculations:

- resTw=CVA(data, option="tw") for the classic two way model
- resOverall=CVA(data, option="overall") for the MAMCVA taking overall scaling into account

3. Results and interpretation

When PlotCVA(resTw) is entered in the R console, the map presented Figure 1 is obtained whereas PlotCVA(resOverall) represents the results of the overall MAMCVA (Figure 2).

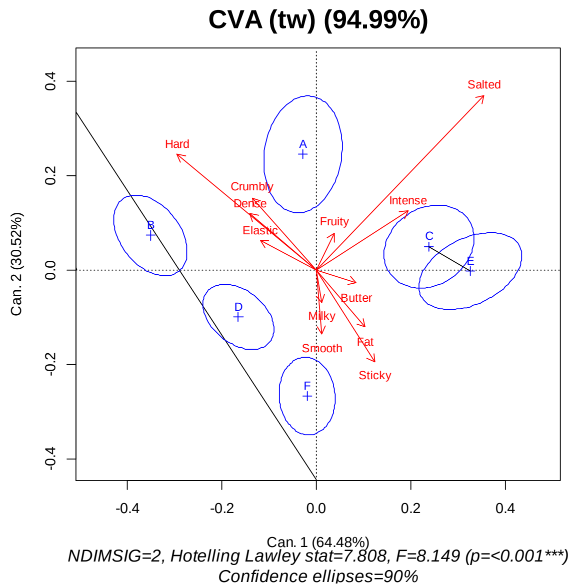

Figure 1: CVA of cheese data

The CVA map shows sensory differences between the products. For example, A, C and E seem more Salted than G, D and F. The link between C and E indicates that the products are not significantly different with the Hotelling T2 test. The other products are all distinct.

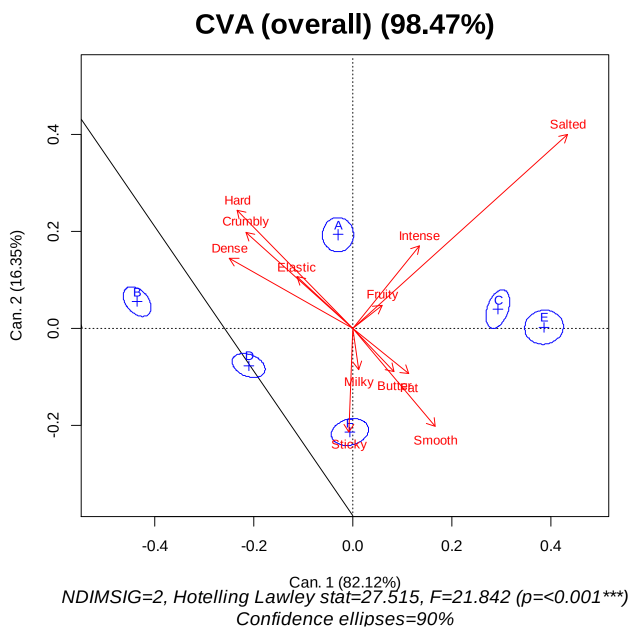

Figure 2: Overall MAM-CVA of cheese data

Regarding the MAMCVA, the sensory interpretation seems quite similar to CVA. However, several differences can be noted:

- The selected axes are not the same
- The F-statistic is higher for Overall CVA
- Confidence ellipses are smaller and C and E are different

The reduction of disagreement around the product means represent the main advantage of MAM-CVA. Indeed, the scaling effect is removed from disagreement test, allowing better product discrimination.

As a limit of CVA and MAM-CVA, computation issues can occur because of an inversion of an ill-conditioned matrix. To avoid ill-conditioned matrix, one should select only the significant attributes to plot the map. Otherwise, the package allows plotting PCA.

Conclusion

The CVAS package allows plotting maps in agreement with the discrimination concept, taking optionally the scaling effect into account. It also plots ellipses representing the pure disagreement of the product means giving strong indications about multidimensional differences between products.

References

Brockhoff, P. B., Schlich, P., & Skovgaard, I. (2015). Taking individual scaling differences into account by analyzing profile data with the Mixed Assessor Model. *Food Quality and Preference, 39*(0), 156-166.

Peltier, C., Visalli, M., & Schlich, P. (2015a). Canonical Variate Analysis of sensory profiling data. *Journal of Sensory Studies, 30*, 316-328.

Peltier, C., Visalli, M., & Schlich, P. (2015b). Multiplicative decomposition of the scaling effect in the Mixed Assessor Model into a descriptor specific and an overall coefficients. *Food Quality and Preference, 48*(A), 268–273.

Porcherot, C., & Schlich, P. (2000). FLASH table and canonical mapping of potato varieties. *Food Quality and Preference, 11*(1/2), 163-165.