Handling individual scales in determining preferences functions

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Sensory analysis where assessors give scores on a structured or semi-structured scale from low to high intensity for a series of objects is usually called sensory profiling or descriptive sensory analysis. Sensory profiling can alternatively be carried out as paired comparisons where assessors give scores to one product compared to another product on a structured or semi-structured scale from low preference to high preference. The aim of the present paper is to discuss interpretation and data handling of information from estimated individual profiles obtained from paired comparisons. The main theme will be differences between assessors in using the scale and whether it is possible to correct for such effects before or within data analysis.

The problem of individual scales has been discussed in several papers, e.g. Næs (1991), Næs and Solheim (1991) and Brockhoff and Skovgaard (1994). These authors discuss the use of analysis of variance and Procustes rotation and the last mentioned authors present a parametric model taking into account scale and variance differences between assessors. An iterative partial maximisation algorithm estimates parameters and likelihood ratio test is applied.

Assume that A assessors have performed paired comparison of P products on a continuous scale and let $\{y_{a,i,j}\}$ be the estimated preference of object j over object i for assessor a. Since preference functions are considered we have $y_{a,i,j} = y_{a,i,k} + y_{a,k,j}$ .This hypothesis is discussed in Gabrielsen (2000). Following Brockhoff and Skovgaard (1994) the hypothesis of individual scales can be formulated

$$y_{a,i,j} = \beta_a \nu_p + \varepsilon_{a,i,j}, \quad \mathrm{var}(\varepsilon_{a,i,j}) = \sigma_a^2, \tag{1}$$

where $\{\varepsilon_{a,i,j}\}$'s are normally distributed random variables with zero expectations. The model states that the products are assumed to have some (unknown) values ν_p , p = 1,…,P, with respect to the property assessed. The assessors are assumed to score in agreement with these values, but possibly with different use of scale, and standard deviations.
Although the model intuitively looks attractive it allows negative estimates of β_a's being difficult to interpret. This indicates that the model (1) in some sense is too comprehensive. One solution to the problem is to impose the restrictions $\beta_a > 0$. This may, however, often result in maximum likelihood estimates on the boundary of the parameter space.

The approach in the present paper is as a first step to add a further hypothesis

$$\beta_a = \alpha\sigma_a^2. \tag{2}$$

The hypothesis says that if an assessor uses a large range of the scale in scoring preferences these scorings will have a high variance compared to the case where the assessor only uses a

small part of the scale. The hypothesis can be tested using a likelihood ratio test and, furthermore, under the hypothesis (2) the estimates of the β's are positive.

As a second step we apply an alternative parameterisation whish for each individual separates the scale and the "configuration" by using polar coordinates. Interpretation and estimation of the parameters is discussed as well as the testing of hypotheses.

The discussion is based on examples, which are illustrating the hypotheses and the interpretation of the results.

References

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