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Analysis of multi-group data in a three-way structure

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Multi-group data have N observations partitioned into m groups sharing the same set of P variables. This type of data is commonly found in industrial applications where production takes place in groups or layers, so the observations can be linked to the specific groups of products, creating a multiple-group structure in the data. The commonly used methodological solution for modelling such grouping structure is multi-group PCA. The model aims at finding common variability or common signals among different groups enabling the understanding of the set of P variables across the groups.

Yet many industrial applications are also concerned with understanding the set of P variables extended in a third dimension, typically defined by time or production batches. Modelling techniques that consider this three-way structure have been available in the case of a single grouping structure as in the case of PARAFAC models. Motivated by the extension of production processes that are nowadays delivering data organised in multiple groups and containing the information of P variables along a third dimension, we propose a methodological approach that allows modelling the multiple groups in a three-way structure. This solution is based on the unsupervised approach of PARAFAC using the ideas of common variability for multiple groups and applied to manufacturing data. The proposed methodology enables comprehension of the relationship between a collection of common variables across groups and the third dimension reflecting time or production batches. We will outline the basic principles of the proposed technique and will apply it to a real-life dataset to showcase its added value.

Keywords

Multi-group data, PCA, PARAFAC, Three-way data

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