Mixed Tree and Spatial Representations of Dissimilarity Judgments

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Abstract: Whereas much previous research, focusing on the comparative fit at the aggregate level, has shown that either tree or spatial representations of dissimilarity judgments may be appropriate, we investigate whether there exist classes of subjects differing in the extent to which dissimilarity judgments are better represented by additive tree or spatial multidimensional scaling models. We develop a mixture model for the analysis of dissimilarity data that entails both representation and measurement model components. The latter involves distributional assumptions on the measurement error and enables estimation by maximum likelihood. The former component allows dissimilarity judgments to be represented either by an additive tree structure or by a spatial configuration, or a mixture of both. To investigate the appropriateness of additive tree versus spatial representations, the model is applied to twenty empirical data sets. We compare the fit of our model with that of aggregate additive tree and spatial models, as well as with mixtures of additive trees and mixtures of spatial configurations, respectively. We formulate some empirical generalizations on the relative importance of tree versus spatial structures in representing dissimilarity judgments.

Key words: Multidimensional scaling; Additive trees; Mixture models; Dissimilarity judgments

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1. Introduction

Perceptions have been studied using graphical representations of dissimilarity judgments of stimuli that either take the form of trees or spatial configurations. The assumption underlying the analysis of dissimilarity judgments is that subjects compare the stimuli on the basis of a number of attributes, that are either discrete features or continuous dimensions (Garner 1978; Johnson and Fornell 1987; Johnson, Lehmann, Fornell, and Horne 1992; Tversky 1977; Tversky and Gati 1978). Those attributes are recovered through the analysis of dissimilarity judgments with models that represent them as a tree (see Barthélémy and Guénoche 1991; Carroll and Chang 1973; Corter 1996; De Sarbo, Manrai, and Manrai 1993; De Soete and Carroll 1996; Gascuel and Levy 1996; Sattath and Tversky 1977) or as a spatial configuration, respectively (see Carroll and Arabie 1998; Carroll and Green 1997; Green, Carmone, and Smith 1989). The choice between tree and spatial models is based (a) on prior theory on the attribute-types discerned by subjects for the stimuli in question, (b) on the basis of the relative fit of the two models, or (c) on such diagnostic measures as the skewness of the dissimilarity judgments (Ghose 1998; Glazer and Nakamoto 1991; Pruzansky, Tversky, and Carroll 1982).

The question is, however, whether tree structures and spatial configurations should be considered as substitutes or as complements. Carroll (1976, p. 455) stated: "I am increasingly inclined to think of tree structures and spatial structures not so much as competing models as complementary ones, each of which captures certain aspects of a reality which is probably in fact much more complex than either model alone". Or as formulated by Shepard (1980, p. 397): "It would be a mistake to ask which of these various scaling, tree-fitting, or clustering methods is based on the correct model. Different models may be more appropriate for different sets of stimuli or types of data. Even for the same set of data, moreover, different methods of analysis may be better suited to bringing out different, but equally informative aspects of the underlying structure." Recently, Ghose (1998) stated: "...items such as the nature of the stimuli and the way consumers process information influence the nature of the input data sets. Coupled with the dimensional versus feature based structure of spaces and trees, this demonstrates that spaces and trees should be considered complementary approaches for representing data."

These insights have given rise to the development of mixed or hybrid models, i.e., models that contain a tree structure as well as a spatial configuration. In recent literature reviews, hybrid models have been mentioned as