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Monotone decomposition of 2-additive Generalized Additive Independence models

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Abstract

The GAI (Generalized Additive Independence) model proposed by Fishburn is a generalization of the additive value function model, which need not satisfy preferential independence. Its great generality makes however its application and study difficult. We consider a significant subclass of GAI models, namely the discrete 2-additive GAI models, and provide for this class a decomposition into nonnegative monotone terms. This decomposition allows a reduction from exponential to quadratic complexity in any optimization problem involving discrete 2-additive models, making them usable in practice.

Keywords: conjoint measurement, multicriteria decision making, capacity, generalized additive independence, multichoice game

1 Introduction

Conjoint measurement provides an adequate and widely studied framework for the representation of preferences in decision making with multiple objectives or criteria (see, e.g., the monograph of Krantz et al. (1971), as well as the survey paper by Bouyssou and Pirlot (2016), containing many references). The most representative model in conjoint measurement is the additive value function model $U(x) = \sum_i u_i(x_i)$, whose characteristic property is (preferential) independence, stipulating that the preference among two alternatives should not depend on the attributes where the two alternatives agree.

However, it is well known that in real situations, preferential independence could be easily violated, because of the possible interaction between objective/criteria. Referring to the example of evaluation of students in Grabisch (1996) where students are evaluated on three subjects like mathematics, physics and language skills, the preference

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