



Formulating generalised ‘goal games’ against nature: An illustration from decision-making under uncertainty in agriculture

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Abstract

The games-against-nature approach to the analysis of uncertainty in decision-making relies on the assumption that the behaviour of a decision-maker can be explained by concepts such as maximin, minimax regret, or a similarly defined criterion. In reality, however, these criteria represent a spectrum and, the actual behaviour of a decision-maker is most likely to embody a mixture of such idealisations. This paper proposes that in game-theoretic approach to decision-making under uncertainty, a more realistic representation of a decision-maker’s behaviour can be achieved by synthesising games-against-nature with goal programming into a single framework. The proposed formulation is illustrated by using a well-known example from the literature on mathematical programming models for agricultural-decision-making.

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Keywords: Games-against-nature; Agriculture; Decision analysis; Goal programming; Uncertainty; Satisficing

1. Introduction

A game-theoretic model is reducible to an equivalent linear programme as shown formally a while back by Dantzig [1] and hitherto several decision criteria have been used to represent the aspirations of a decision-maker in such a model. For agricultural decision-making models, the most widely used criteria include the maximin Wald, the minimax regret Savage and the benefit Agrawal–Heady criterion. A single-criterion model however is unsatisfactory and to capture the reality of decision-making in a game-theoretic model, it would be preferable to use a mixture of several criteria such as “maximising the minimum outcome”, “minimising the largest possible regret” and “maximising the minimum benefit”, recognising the relative importance that the decision-maker may accord to anyone of these criteria, see: Romero and Rehman [2]. This paper presents such an approach to decision-making under uncertainty to generate “satisficing” or “best-compromise” strategies, within a “goal game” context.

In the Operational Research literature, the inclusion of multiple pay-offs in game-theoretic models is well established (for example, see: Zeleny [3], Bergstresser and Yu [4], Corley [5] and Fernández and Puerto [6]) even though that work deals with cooperative and non-cooperative games mostly to generalise the Nash equilibrium points for games with multiple pay-offs. However, a consideration of multiple pay-offs in “games-against-nature” models is almost neglected, particularly in the mathematical programming literature dealing with decision-making in agriculture, where such games are particularly relevant. Only two exceptions in that literature are the parametric games proposed by Hazell [7] and the generalised constrained games suggested by Kawaguchi and Maruyama [8]. Hazell [7] uses a parametric gross margin (difference between gross returns and expenditure) expectation constraint to generate the trade-off curve between the criterion chosen and the expected gross margin, whereas Kawaguchi and Maruyama [8] establish the trade-off curve between the minimum gross margin and the maximum “regret”. These approaches have recently been amalgamated using the multi-criteria paradigm (see: Romero and Rehman [2]) into a theoretical structure, “compromise games”, leading to compromise strategies. The current paper however provides a more general and logically rigorous approach to generate pure or mixed strategies closest to a “target vector” as defined by a set of relevant criteria. Thus games-against-nature are fused into goal programming using the Simonian [9] logic of “satisficing” behaviour.

The “satisficing” strategy thus obtained is not necessarily the optimal solution to the choice problem, but is a realistic one in that it is “good enough” for

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