A Preference Theory Approach to Decision Analysis in Resource Allocation

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Abstract. This paper studies the allocation of discrete resources among multiple agents from a preference theory perspective. More specifically, the paper explores the process of decision making where:

(a) information is obtained about the preference profiles of each agent
(b) the information acquired is then used as a basis for finding a 'socially' optimal resource allocation,
and
(c) the costs involved in acquiring information are considered as an integral part of the process.

Key words. Decision making, resource allocation, preference theory.

1. Introduction

Decisions dealing with the problem of allocation of scarce resources among multiple agents are of critical importance in all functional areas of management. Such problems have to be routinely solved by various decision makers, including government planners and non-profit organizations in non-competitive environments. One illustrative study of resource allocation problems is that of Parker and Srinivasan [10] on the allocation of primary health-care facilities to different locations in a regional population in the 'best possible way', i.e., in such a way as to maximize the total welfare [15, 16].

Similar resource allocation problems have traditionally interested economists who have proposed solutions under various assumptions [1, 3, 6, 11]. For example, the assumptions involve:

– the availability of exact information about an agent's utility function
– the differentiability of utility functions
– the assumption that the solution mechanism can ignore the experimental process of utility elicitation, and information transfer.

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These assumptions are often unreasonable. The assumption of complete information about a utility function and its differentiability is too strict for many decision problems. One never has complete information before making a decision. It is also unrealistic to assume that every decision maker is willing to, or even able to specify a closed form utility function. Again, it is obvious that every step in the process of utility elicitation entails a cost, and hence a resource allocation solution that does not take this into account is suboptimal.

This paper looks at the allocation of discrete resources among multiple agents in terms of a preference theory perspective. More specifically, the paper dispenses with the traditional assumptions, and explores the process of decision making where:

(a) information is obtained about the preference profiles of each agent,
(b) the information acquired is then used as a basis for finding a 'socially' optimal resource allocations that maximize total net welfare, and
(c) the costs involved in acquiring information are considered as an integral part of the process.

Throughout this paper, minimal assumptions are made about the problem environment: all individual agents are simply assumed to be rational, i.e., they have preferences that are total, reflexive and transitive.

We show that the process of information gathering and decision making becomes a challenging task in view of the extremely large number of possible different profiles for each agent. Given the complex combinatorial nature of problems of modest size, determination of optimal cost effective allocations is dependent on choosing intelligent information gathering and decision making strategies. Thus the study builds on individual agent’s values and preferences for resources, and isolates information theoretic concepts that would be useful for decision making in resource allocation problems.

The paper is structured as follows. Section 2 sets the scenario for the problem. Section 3 formally describes the decision model with sequential information acquisition that is used for problem analysis. Section 4 details a specific example which uses the preference theory approach to finding a satisfactory set of candidate resources for allocation. The illustration chosen is similar to one often seen in marketing literature [2, 7]. It deals with the process of allocation of resources among the members of a household, so as to maximize household satisfaction, while being cognizant of the costs involved in the process. The analysis is developed first for a single agent situation and then extended for two agents. Section 5 concludes and summarizes the paper.

2. The Scenario

This paper examines problem solving in a multiple agent environment as applied to discrete resource allocation problems. The problem of obtaining information about the preferences of each agent is explored. The information thus acquired is then used as a basis for finding a resource allocation to maximize net welfare. Initially minimum assumptions are made about the problem environment: all individual agents are