Bipolar Model in Collective Choice

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INTRODUCTION

Collective choice is a sub-domain of decision analysis (a discipline comprising the philosophy, theory, methodology, and professional practice necessary to address important decisions in formal manner according to Wikipedia) that addresses decision making problems where a certain number of decision makers must select a subset (possibly reduced to a singleton) of alternatives from a large set of potential alternatives in order to achieve some collective as well as individual objectives, preferences, or desires. Such decision making problems are encountered in many practical situations such as management, engineering, economics, social, politics etc., see for instance (Bouyssou *et al.*, 2000), Steuer (1986), and references therein for some real world applications even though in these references the problems are most of the time treated as a single decision maker problems. The existence of many decision makers necessitates to have a *coordination mechanism* (how to aggregate the view points of all decision makers) to address collective choice problems. The purpose of this chapter is to address such coordination mechanism. Using bipolar analysis that consists in evaluating alternatives by two opposite measures (a measure gathering positive aspects of the alternative and that resuming its negative aspects) with regard to pursued objectives at individual level as well as at community level permits in some extent to embed human attitude into the decision process.

The remainder of this chapter is organized as follows. In the second section a background on (collective) choice problems resolution methods will be recalled; then the main focus of this chapter will be presented in third section; section four will be dedicated to the main contribution of

this chapter: bipolar framework for modeling and solving collective choice problem; section five presents a sketch of future directions researches; a conclusion is presented in section six and finally references, additional reading, and some keys terms and definitions end the chapter.

BACKGROUND

In political science, methods for realizing a collective choice (mapping individual preferences onto collective preferences) are dominated since the advent of democracy by simple majority voting process (Picavet, 1996). But many theoretical results such as that of Borda, see (Borda, 1781), Arrow impossibility theorem (Arrow, 1951) show that this way of aggregating individuals preferences can lead to inconsistency. In decision analysis, that actually does have many steps such as formulating decision goal or objectives, identifying attributes that characterize potential alternatives that can respond to the decision goal and making recommendation regarding these alternatives given the decision goal, choice is the final step. But to choose, one must evaluate first; the construction of an evaluation procedure, often carried up by an expert known in the literature as the analyst (Bouyssou *et al.*, 2000) is an important step in the decision process; this step is the main purpose of this chapter. This construction consists in aggregating individual preferences, understood in a broad sense to obtain a way that permits to rank, at least partially, different potential alternatives. Classically, two main approaches have dominated evaluation process in modern decision analysis: value or utility type approach (a value function or an utility measure is derived for each

alternative to represent its adequacy with decision goal), see for instance Steuer (1986) and Saaty (1980); outranking methods (a pair comparison of alternatives is carried up under each attribute or criteria to derive a pre-order over the alternatives set), see (Bouyssou *et al.*, 2000), (Brans *et al.*, 1986, 1986a). The approach that will be described in this chapter can be considered as an intermediate one compared to those two approaches evoked previously; indeed by using numerical values to evaluate alternatives look like utility type approach, but as two "opposite" measures are used, it permits incomparability as it is the case in outranking approaches.

MAIN FOCUS OF THE ARTICLE

In many situations, collective decision making is made through a majority voting process where each decision maker casts a ballot for only one alternative and the alternative that obtains the maximum of voices is considered as the community choice. But voting process does not capture in our opinion all attitudes of human beings such as ambiguity, indecision, social values consideration, etc. Indeed, decision makers often face uncertainties (impossibility of decision makers to clearly express their objectives, to elicit and assess attributes, etc.) and interactions (a decision maker may be influenced by other decision makers when expressing his or her judgment). Furthermore, French mathematician Jean-Charles de Borda and other have noticed since 18th century that in an election where the winner is the candidate who got the majority of votes and where there are more than 3 candidates, candidate who obtains the majority of voices is not necessarily the preferred one by the majority of voters. In this chapter we adopt an approach that highlights *bipolarity notion* between all components of collective decision analysis problem. We are motivated by the fact that cognitive psychologists have observed for long time that human evaluate alternatives by considering separately their positive aspects and their negative aspects, see for instance (Caciopo & Berntson, 1994) and (Osgood *et al.*, 1957). To this end, we introduce *supporting* and *rejecting* notions (Tchangani, 2010) that relate attributes to objectives leading to an evaluation model in terms of two measures or indices (selectability and rejectability) for each alternative in the framework of satisficing game theory (Stirling, 2003) so that a decision maker can be in position of not being able to discriminate between two alternatives. These notions permit to partition attributes set into three subsets given an objective: attributes that support this objective, attributes that reject this objective and attributes that are neutral with regard to this objective; of course only supporting and rejecting attributes are interesting for evaluation process. Selecting and rejecting degrees of an attribute with regard to an objective may be assessed using known techniques such as analytic hierarchy process (AHP), see (Saaty, 1980) or any method that could assign a measure to an attribute with regard to a pair of objective and alternative. This model allows alternatives to be characterized by heterogeneous attributes (at individual level) and possibly different attributes from an individual to another; it allows also incomparability between alternatives in terms of Pareto-equilibrium, see (Pareto, 1896). Collective decision making situations with such issues are pervasive in real world applications; for instance a government evaluating projects that belong to different domains such as health, infrastructures, social, economics, etc. with the main objective to enhance a country developing process (Tchangani, 2015). In such situations, though attributes characterizing projects may be completely different, the important thing is their adequacy with regards to the pursued objectives, so that alternative projects can be ultimately compared on the same basis (decision maker' desires). The social influence between decision makers and decision makers' attitude will be taken into account through different degrees such as concordance/discordance degrees within the group, selfishness degree, risk averse degree, see (Tchangani, 2014). When making decision in complex situation, it

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