Operationalising the interplays of self-interest, trust and fairness in sharing the gains from cooperation

Abstract

Many real life situations involve independent players forming a coalition to take joint actions and sharing the gains from cooperation. A fundamental question arises is how to share the gain which is reasonably acceptable to every player or a group of players. We provide an answer to this question in a scenario when the players are self-interested, look for a fair treatment, and may or may not have complete trust on other members of the coalition. We propose a cooperative game theoretic framework and a payoff allocation rule which consider the co-existence and interplays of self-interest, fairness and trust. To the best of our knowledge cooperative game theory is yet to provide a measure of trust, hence we propose a framework to capture the notion of trust. The core and the Shapley value are well known solution concepts for cooperative games; while the former promotes self-interest, the later promotes fairness. We define a few classes of games where we combine the three concepts and present some interesting insights.

Keywords: cooperative games; sharing; people-centric operations

1 Introduction

We have been sharing our home space, car, etc. with our families and friends for ages. Technological advancements have made it possible to extend these age old activities of sharing a house, a car, etc. far beyond our families and friends. Now a days we welcome strangers into our homes and share a spare bedroom with them (e.g. Airbnb); hop into a stranger’s car and share
a ride with them (e.g. Uber, BlaBlaCar). These new ways of doing familiar activities give rise to a phenomenon called sharing economy (Sundararajan, 2016). Our interest in this paper lies in the following aspects of a sharing economy activity:

- An activity involves a set of players (decision makers) who are independent and self-interested. The players know that there is economic gain from cooperation.
- The gain from cooperation should be distributed among the players involved in an activity according to a reasonable payoff allocation mechanism which is accepted to all.
- A player may or may not have full trust on other players. So the cooperation faces some degree of risk.

Keeping the above aspects in our mind, we ask the following research questions: How to share the gain from cooperation in a reasonably fair and rational manner so that the members of the coalition do not break away, under the scenarios when

1. there is a complete trust among the players?
2. there is a lack of trust among the players?

2 The Model

In this paper, we use cooperative game theory to answer the above research questions. Cooperative game theory, a branch of game theory, provides a framework to model and analyse coalition formation and sharing the gain from cooperation. A payoff allocation scheme, which is technically called a solution concept, is a set of prescriptions about characteristics of the outcomes of a game. Two important characteristics considered in the literature are—stability and fairness. An outcome is said to be stable, if no coalition has incentive to deviate from it (which ensures that self-interest is fulfilled). An outcome is said to be fair, if it satisfies some fairness axioms, e.g. the Shapley axioms (efficiency, symmetricity, dummy player and additivity axioms). An important
factor behind the rapidly growing sharing economy is how and why we trust others. However, the literature on measuring trust is still evolving (Fukuyama, 1995; Glaeser et al., 2000). To the best of our knowledge cooperative game theory is yet to provide a measure of trust, hence we propose our own framework. We assume that a lack of trust results in uncertainty which makes the players to cooperate under a risky payoff situation. We use chance-constrained games (Charnes and Granot, 1977; Granot, 1977) to model such situation. When the cooperation takes place under the complete trust, the randomness of payoff vanishes and the game is modelled as a characteristic function form game. The core is a set of outcomes which is stable. It means that in the core outcome every player is better-off and their self-interest is fulfilled. The Shapley value allocates the payoffs based on the average marginal contribution, a widely accepted notion of fairness in game theory. In this paper, we use the notions of the core and the Shapley value to capture self-interest and fairness respectively. It is not common to achieve both self-interest and fairness at the same time. There are only a few instances in cooperative games where the Shapley value lies in the core. We propose a new solution concept that guarantees the outcome which ensures both self-interest and fairness. The new solution concept is characterised as the subset of the core in which every player gets at least their share of the Shapley value. We provide conditions for the non-emptiness of the solution space under both complete and partial trust.

References


