Chapter 3
Game Models in Various Applications

ABSTRACT

Recently, game-theoretic models have become famous in many academic research areas. Therefore, many applications and extensions of the original game theoretic approach appear in many of the major science fields. Despite all the technical problems, the history of game theory suggests that it would be premature to abandon the tool, especially in the absence of a viable alternative. If anything, the development of game theory has been driven precisely by the realization of its limitations and attempts to overcome them. This chapter explores these ideas.

INTRODUCTION

In game theory, a lot of game models have been developed; each game has several features. Usually, games are broadly divided based on weather players make decisions independently or not. According to this criterion, game models can be broadly classified into two different groups; non-cooperative games and cooperative games. However, some special games contain the mixed features of non-cooperative and cooperative games.

The goal of this chapter is to explain the basic ideas for each game model, and give the readers some insights on how to model network design problems by means of game theory. In addition, the main concepts and properties for each model are illustrated. Therefore, readers can compare advantages and disadvantages of different game models.

NON-COOPERATIVE GAMES

In non-cooperative games, players make decisions independently and are unable to make any collaboration contracts with other players in the game. Therefore, a family of non-cooperative games is presented in which players do not cooperate and selfishly select a strategy that maximizes their own utility. Initially, traditional applications of game theory developed from these games. There are various kinds of non-cooperative games.

DOI: 10.4018/978-1-4666-6050-2.ch003

Static Game

If all players select their strategy simultaneously, without knowledge of the other players' strategies, these games are called static games. Sometimes, static games are also called strategic games, one-shot games, single stage games or simultaneous games. Traditionally, static games are represented by the normal form; if two players play a static game, it can be represented in a matrix format. Each element represents a pair of payoffs when a certain combination of strategies in used. Therefore, these games are called matrix games or coordination games.

One example of matrix games is the stag hunt game (Skyrms, 2004). In this game situation, two hunters go out on a hunt. Each can individually choose to hunt a stag or a hare. Each hunter must choose an action without knowing the choice of the other. If an individual hunts a stag, he must have the cooperation of his partner in order to succeed. An individual can get a hare by himself, but a hare is worth less than a stag. This is taken to be an important analogy for social cooperation. Therefore, the stag hunt game is used to describe a conflict between safety and social cooperation. Formally, the payoff matrix for the stag hunt is pictured in Table 1, where A (a) > B (b) ≥ D (d) > C (c).

A solution concept for static games is Nash equilibrium. In the stag hunt game, there are two Nash equilibria when both hunters hunt a stag and both hunters hunt a hare. Sometimes, like as the Prisoner's Dilemma, an equilibrium is not an efficient solution despite that players can get a Pareto efficient solution. Due to this reason, many researchers focus on how to drive a game where players have a non-cooperative behavior to an optimal outcome.

Table 1. Sample matrix for the prisoners' payoffs

	Stag	**Hare**
Stag	A, a (e.g., 2,2)	C, b (e.g., 0,1)
Hare	B, c (e.g., 1,0)	D, d (e.g., 1,1)

Dynamic Game

Dynamic games are mathematical models of the interaction between different players who are controlling a dynamical situation. Players in a dynamic game have at least some information about the strategy chosen by the others and play a similar stage game dynamically (Han, Niyato, Saad, Başar, & Hjørungnes, 2011). Therefore, strategies of players influence the evolution over time. Based on the history of selected strategies, players select their strategies sequentially based on the mapping between the information available to the player and his strategy set. Unlike static games, the threats from other players can encourage cooperation without the need for communication among the players. Dynamic games are classified into three different classes - repeated games, sequential games and stochastic games.

Sequential Game

Sequential games constitute a major class of dynamic games in which players select their strategy following a certain predefined order. In a sequential game, a player can observe the strategies of other players who acted before him, and make a strategic choice accordingly. Therefore, each player can take alternate turns to make their selections, given information available on the selected strategies of the other players (Hossain, Niyato, & Han, 2009). In sequential games, the sequence of strategic selection made by the players strongly impacts the outcome of the game. If players cannot observe the actions of previous players, this game is a static game. Therefore, static game is a special case of sequential game.

According to the role of information, sequential games one can distinguish between perfect