



## Inductive game theory: A basic scenario

Mamoru Kaneko<sup>a,\*</sup>, J. Jude Kline<sup>b</sup>

<sup>a</sup> Institute of Policy and Planning Sciences, University of Tsukuba, Ibaraki 305-8573, Japan

<sup>b</sup> Department of Economics, School of Business, Bond University, Gold Coast, QLD 4229, Australia

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### ABSTRACT

The aim of this paper is to present the new theory called “inductive game theory”. A paper, published by one of the present authors with A. Matsui, discussed some part of inductive game theory in a specific game. Here, we present a more entire picture of the theory moving from the individual raw experiences, through the inductive derivation of a view, to the implications for future behavior. Our developments generate an experiential foundation for game theory and for Nash equilibrium.

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## 1. Introduction

### 1.1. General motivations

In game theory and economics it is customary to assume, often implicitly and sometimes explicitly, that each player has well formed beliefs/knowledge of the game he plays. Various frameworks have been prepared for explicit analyses of this subject. However, the more basic question of where a personal understanding of the game comes from is left unexplored. In some situations such as parlour games, it might not be important to ask the source of a player’s understanding. The rules of parlour games are often described clearly in a rule book. However, in social and economic situations, which are main target areas for game theory, the rules of the game are not clearly specified anywhere. In those cases, players need some other sources for their beliefs/knowledge. One ultimate source for a player’s understanding is his individual experiences of playing the game. The purpose of this paper is to develop and to present a theory about the origin and emergence of individual beliefs/knowledge from the individual experiences of players with bounded cognitive abilities.

People often behave naturally and effectively without much conscious effort to understand the world in which they live. For example, we may work, socialize, exercise, eat, sleep, without consciously thinking about the structure of our social

\* Corresponding author. Fax: +81 29 853 5070.

E-mail addresses: [kaneko@shako.sk.tsukuba.ac.jp](mailto:kaneko@shako.sk.tsukuba.ac.jp) (M. Kaneko), [Jeffrey.Kline@bond.edu.au](mailto:Jeffrey.Kline@bond.edu.au) (J.J. Kline).

situation. Nevertheless, experiences of these activities may influence our understanding and thoughts about society. We regard these experiences as important sources for the formation of individual understanding of society.

Treating particular experiences as the ultimate source of general beliefs/knowledge is an inductive process. Induction is differentiated from deduction in the way that induction is a process of deriving a general statement from a finite number of observations, while deduction is a process of deriving conclusions with the same or less logical content with well-formed inference rules from given premises. Formation of beliefs/knowledge about social games from individual experiences is typically an inductive process. Thus, we will call our theory *inductive game theory*, as was done in Kaneko and Matsui (1999). In fact, economic theory has had a long tradition of using arguments about learning by experiences to explain how players come to know the structure of their economy. Even in introductory microeconomics textbooks, the scientific method of analysis is discussed: collecting data, formulating hypotheses, predicting, behaving, checking, and updating. Strictly speaking, these steps are applied to economics as a science, but also sometimes, less scientifically, to ordinary peoples' activities.

Our theory formalizes some part of an inductive process of an individual decision maker. In particular, we describe how a player might use his experiences to form a hypothesis about the rules and structure of the game. In the starting point of our theory, a player has little *a priori* beliefs/knowledge about the structure of the particular game. Almost all beliefs/knowledge about the structure of the particular game are derived from his experiences and memories.

A player is assumed to follow some regular behavior, but he occasionally experiments by taking some trials in order to learn about the game he plays. It may be wondered how a player can act regularly or conduct experiments initially without any beliefs or knowledge. As mentioned above, many of our activities do not involve high brow analytical thoughts; we simply act. In our theory, some well defined *default action* is known to a player, and whenever he faces a situation he has not thought about, he chooses this action. Initially, the default action describes his regular behavior, which may interpreted as a norm in society. The experimental trials are not well developed experiments, but rather trials taken to see what happens. By taking these trials and observing resulting outcomes from them, a player will start to learn more about the other possibilities and the game overall.

The theory we propose has three main stages illustrated in Fig. 1: the (early) *experimentation stage*; the *inductive derivation stage*; and the *analysis stage*. This division is made for conceptual clarity and should not be confused with the rules of the dynamics. In the experimentation stage, a player accumulates experiences by choosing his regular behavior and occasionally some alternatives. This stage may take quite some time and involve many repetitions before a player moves on to the inductive stage. In the inductive derivation stage he constructs a view of the game based on the accumulated experiences. In the analysis stage, he uses his derived view to analyze and optimize his behavior. If a player successfully passes through these three stages, then he brings back his optimizing behavior to the objective situation in the form of a strategy and behaves accordingly.

In this paper, we should stop at various points to discuss some details of each of the above stages. Since, however, our intention is to give an entire scenario, we will move on to each stage sacrificing a detailed study of such a point. After passing through all three stages, the player may start to experiment again with other behaviors and the experimentation stage starts again. Experimentation is no longer early since the player now has some beliefs about the game being played. Having his beliefs, a player may now potentially learn more from his experiments. Thus, the end of our entire scenario is connected to its start.

While we will take one player through all the stages in our theory, we emphasize that other players will experiment and move through the stages also at different times or even at the same time. The precise timing of this movement is not given rigorously. In Section 7.2 we give an example of how this process of moving through these stages might occur. We emphasize

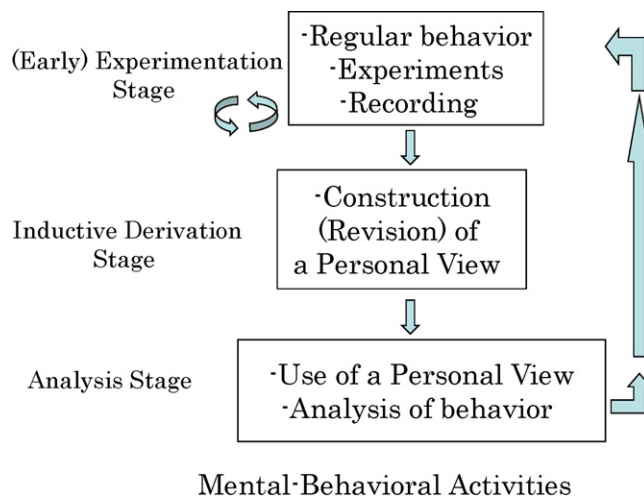


Fig. 1. Three stages of inductive game theory.

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