Distributed iterated elimination of strictly dominated strategies

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Abstract We characterize epistemic consequences of truthful communication among rational agents in a game-theoretic setting. To this end we introduce normal-form games equipped with an interaction structure, which specifies which groups of players can communicate their preferences with each other. We then focus on a specific form of interaction, namely a distributed form of iterated elimination of strictly dominated strategies (IESDS), driven by communication among the agents. We study the outcome of IESDS after some (possibly all) messages about players’ preferences have been sent. The main result of the paper, Theorem 4, provides an epistemic justification of this form of IESDS.

Keywords Communicating processes · Strategy elimination
1 Introduction

1.1 Motivation and framework

One of the main topics in the area of multiagent reasoning is study of epistemic reasoning of communicating agents in a distributed setting, see, e.g., [15,12]. Game theory focuses on interaction between different types of agents, namely rational agents, whose objective is to maximize their utility.

Our interest is to analyze epistemic reasoning of agents who exhibit both characteristics, i.e. who communicate and are rational. We assume that such agents are involved in distributed decision making, by which we mean an interactive process during which agents repeatedly combine their local information with new information obtained through communication with other agents in order to arrive at a (possibly common) conclusion by means of a deductive process.

To make such a general study meaningful we focus on a specific instance of distributed decision making, namely iterated elimination of strictly dominated strategies (IESDS) [18] driven by the acquisition of new information through communication. In our setup each agent repeatedly combines local information about his preference among his strategies with new information acquired through interaction with other agents. This allows each agent to increasingly eliminate more strategies. We are interested in characterizing knowledge of each agent at the end of this decision making process.

To formalize this setting we introduce a game-theoretic framework which combines locality and interaction. We assume a setting of imperfect information in which the players’ preferences are not commonly known. Instead, the initial information of each player only covers his own preferences, and the players can truthfully communicate this information in the fixed groups to which they belong. So locality refers to the information about preferences and interaction refers to communication within (possibly overlapping) groups of players.

To realize this framework we augment a normal-form game with an interaction structure of [3] that consists of (possibly overlapping) groups of players within which synchronous communication is possible.

More precisely, we make the following assumptions:

– the players initially know the interaction structure and their own preferences,
– they are rational, in the sense that they would not play a strictly dominated strategy,
– they can communicate atomic information about their preferences within any group they belong to,
– once a message is communicated, it is commonly known within the group,
– communication is truthful and synchronous,
– the players have no knowledge other than what follows from these assumptions,
– the above assumptions are common knowledge.

In our communication setting, intuitively, information can be either unknown to some player or commonly known in a group. Acting on partial information thus necessitates to figure out precisely which information is commonly known in a group. Note that in this context strategic (i.e., possibly untruthful) communication conveys no conclusive information. Consequently, study of epistemic consequences of such communication requires additional assumptions, like probability distributions over statements and meanings, and can be carried out only after the setting with truthful communication has been investigated. We therefore focus on truthful communication and return briefly to this matter in Sect. 5.

The following example illustrates the general procedure that we examine.