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Revisiting games of incomplete information with analogy-based expectations

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Abstract

This paper studies the effects of analogy-based expectations in static two-player games of incomplete information. Players are assumed to be boundedly rational in the way they forecast their opponent's state-contingent strategy: they bundle states into analogy classes and play best-responses to their opponent's average strategy in those analogy classes. We provide general properties of analogy-based expectation equilibria and apply the model to a variety of well known games. We characterize conditions on the analogy partitions for successful coordination in coordination games under incomplete information [Rubinstein, A., 1989. The electronic mail game: Strategic behavior under 'almost common knowledge'. Amer. Econ. Rev. 79, 385–391], we show how analogy grouping of the receiver may facilitate information transmission in Crawford and Sobel's cheap talk games [Crawford, V.P., Sobel, J., 1982. Strategic information transmission. Econometrica 50, 1431–1451], and we show how analogy grouping may give rise to betting in zero-sum betting games such as those studied to illustrate the no trade theorem.

JEL classification: C72; D82

Keywords: Analogy expectation; Bayesian games; Bounded rationality; Coordination; Incomplete information; Betting; Strategic information transmission

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1. Introduction

In games involving many states, it is implausible to assume that players understand the strategy of their opponent state by state. In this paper, we take the view that players understand only the average behavior of their opponent over bundles of states. Players are then characterized by how finely they understand the strategy of their opponent together with their information and payoff structure.

The class of games that we consider are two-player games of incomplete information. Our only departure from standard approaches lies in the modeling of players' expectations about their opponent' strategy. Players bundle states into analogy classes and play best-responses to their opponent's average strategy in those analogy classes. More precisely, given the prior probabilities of states of the world and the strategy σ_j of player j in every state, one can infer for every analogy class α_i of player $i \neq j$ the average behavior of player j in α_i. Call $\overline{\sigma}_j$ the strategy of player j that specifies that in any state belonging to α_i player j plays according to the average behavior in α_i. In equilibrium, σ_i is assumed to be a best-response to $\overline{\sigma}_j$ given player i's information partition for i, $j = 1, 2$ and $j \neq i$, where $\overline{\sigma}_j$ is interpreted as i's perception of j's strategy.

The equilibrium that is so obtained is the analog for static games of incomplete information of the solution concept considered in Jehiel (2005) for extensive form games. It is called the analogy-based expectation equilibrium, and it is interpreted in Section 3 as the limiting outcome of a learning process involving populations of player $i = 1, 2$ who would get a coarse feedback about the past behavior of players in population $j \neq i$ and no feedback on their own past performance until they exit the system.[1]

One of our main objectives is to apply the approach to a number of classic games such as coordination games (with noisy signals), strategic information transmission games and betting games. For each application, we illustrate the working of the approach, and how the obtained outcomes differ from those obtained with the standard approach. We consider various analogy groupings throughout the applications.

In one application, the e-mail game (Rubinstein, 1989), many states correspond to the same underlying payoff structure (whether the enemy is prepared or not). Our leading result for this application considers the payoff-relevant analogy partition which groups states according to the underlying payoff structure (as opposed to the fine details of the state which include the higher order beliefs of the two players). That is, our equilibrium in the payoff-relevant analogy case assumes that the only feedback transmitted from one generation of players to the next (in the underlying dynamic learning model sustaining the approach) is the average probability of attack conditional on whether or not the enemy was prepared (and not conditional on how many messages were sent back and forth). Such a view on feedback agrees with the recent literature on robust implementation (Bergemann and Morris, 2005) which points out that it may be hard to have access to (and thus have feedback about) others' beliefs and higher order beliefs.

In Crawford and Sobel's (1982) information transmission game, there is a natural notion of proximity between states as payoffs vary continuously with the state and states are linearly ordered. Our analogy partition in this application is the interval analogy partition that groups states into intervals so as to reflect the view that the feedback aggregates the communication strategy of the senders over nearby states.

[1] The latter assumption is automatically satisfied whenever each individual player plays only once.