Chapter VIII
Introducing Social Issues into a Minority Game by Using an Agent Based Model

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ABSTRACT

In this chapter, the authors perturb a minority game (MG) with some sociological issues, first by implementing a social network among the involved agents, through which they can somehow communicate their decision to a group of “friends,” a local subset of those participating the game. Thus, the emergent aggregate behaviour will be very far from that of the original MG; the stress here is on the possibility of an agent changing his or her own decision, after getting the information from other n agents. Two different communication protocols among the agents will be examined: a synchronous one and the more realistic asynchronous one. Additionally, in some experiments a memory is introduced, acting as a selection mechanism. Last, some special agents, called Opinion Leaders, whose influence over the others is higher than normal, are implemented in order to study how this can change the aggregate results.

INTRODUCTION

Game theory (GT) is a distinct and interdisciplinary approach to the study of strategic behaviour. The disciplines most involved in game theory are mathematics, economics, and the other social and behavioural sciences. GT was founded by the great mathematician John von Neumann.

The key link between neoclassical economics and game theory is rationality. Neoclassical economics is based on the assumption that human beings are absolutely rational in their economic
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choices. The kind of rationality which is usually assumed in economics—perfect, logical, deductive rationality—is extremely useful in generating solutions to theoretical problems, but it fails to account for situations in which rationality is bounded (because agents can not cope with the complexity of the situation) or when ignorance about other agents’ ability and willingness to apply perfect rationally leads to subjective beliefs about the situation. Even in those situations, agents are not completely irrational: They adjust their behaviour based on what they think other agents are going to do, and these expectations are generated endogenously by information about what other agents have done in the past. On the basis of these expectations, the agent takes an action, which in turn becomes a precedent that influences the behaviour of future agents. This creates a feedback loop: Expectations arise from precedents and then create the actions which, in turn, constitute the precedents for the next step.

GT was intended to confront just this problem: to provide a theory of economic and strategic behaviour when people interact directly, rather than through the market. In game theory, “games” have always been a metaphor for more serious interactions in human society.

The minority game (MG) is a simple, generalized framework, belonging to the GT field, which represents the collective behaviour of agents in an idealized situation where they have to compete through adaptation for some finite resource.

While the MG was born as the mathematical formulation of the “El Farol Bar” problem considered by Arthur (1994), it goes beyond this one, since it generalizes the study of how many individuals may reach a collective solution to a problem under adaptation of each one’s expectations about the future. In Arthur (1994), the “El Farol Bar” problem was posed as an example of inductive reasoning in scenarios of bounded rationality.

The original formulation of this problem is as follows: N people, at every step, take an individual decision among two possibilities. Number one is to stay at home, number two is to go to a bar. Since the space in the bar is limited (finite resource), the time there is enjoyable if and only if the number of the people there is less than a fixed threshold \( aN \), where \( a<1 \). Every agent has his or her own expectation of the number of people in the bar, and according to their forecast decides whether to go or not. The only information available to the agents is the number of people attending the bar in the recent past; this means that there is no deductively rational solution to this problem, but there can be plenty of models trying to infer the future number according to the past ones.

An interesting aspect of the problem is that if most agents think that the number of people going to the bar is \( >aN \), then they won’t go, thus invalidating their own prevision. Computer simulations of this model shows that the attendance fluctuates around \( aN \) in a \( (aN, (1-a)N) \) structure of people attending/not attending. The bar problem has been applied to some proto-market models: At each time step agents can buy (go to the bar) or sell an asset and after each time step, the price of the asset is determined by a simple supply-demand rule.

The MG has been first described in Challet and Zhang (1997) as a mathematical formalization and generalization of the bar problem. It is assumed that an odd number of players take a decision at each step of the simulation; the agents that take the minority decision win, while the others loose. Stepping back to the bar problem, we can see it as a MG with two possible actions: \( a1 = 1 \) (to go to the bar) and \( a2 = -1 \) (not to go to the bar). After each round, the cumulative action value \( A(t) \) is calculated as the sum of each value given to the single actions. The minority rule sets the comfort level at \( A(t) = 0 \), so that agent is given a payoff \( -ai(t)g[A(t)] \) at each time step with \( g \) being an odd function of \( A(t) \).

The MG has been chosen in this work since it’s a model that could be used as a metaphor in many fields—it’s intrinsically interdisciplinary.