A Social Dilemma Videogame

Um Videojogo sobre Dilemas Sociais

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Resumo

O presente artigo descreve um videojogo que visa estudar os efeitos da identidade social sobre os resultados de dilemas sociais. Este objectivo será atingido pela análise do comportamento dos jogadores num jogo de equipa. Um jogo de equipa representa um tipo específico de dilema social em que problemas de acção colectiva podem ocorrer a diversos níveis da estrutura hierárquica. Neste artigo descrevemos o jogo sob a perspectiva de teoria de jogos e apresentamos uma previsão dos possíves resultados de acordo com a teoria da escolha racional.

Palavras- chave: Teoria de jogos, dilema social, identidade social, jogo de equipa.

Abstract

This article describes a videogame to study the effects of social identity upon the results of social dilemmas. The game will do this by setting up the players in a team game. A team game represents a specific type of social dilemma in which collective action problems occur simultaneously at several levels of an hierarchical structure. We describe the game theoretical analysis of the proposed game and the prediction of its possible outcomes according to rational choice theory.

Keywords: Game theory, social dilemma, social identity, team game.

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1. Introduction

Social dilemmas can be defined in broad terms, as social situations in which conflict arises from the contradicting results prescribed by the immediate egoistic interest of an individual and the collective interest of the community in which the individual develops his interactions with (Dawes, 1975). Social dilemmas are at the core of most worldwide issues which society faces nowadays, such as the problem of overpopulation, depletion of natural resources and global warming, with the wide-range applicability interest in this multi-disciplinary field continuing to grow (Biel, Eek, and Garling, 2008).

Tajfel (1972, p. 292) defines social identity as “that part of the individual’s self-concept which derives from his knowledge of his membership of a social group (or groups) together with the value and emotional significance attached to that membership”. Several studies referred by support the claim that social identity plays an important role upon the behaviour of individuals in social dilemmas (Weber, Kopelman, and Messick, 2004; Kollock, 1998). For instance, Brewer and Kramer (1986, 1984) reported in their experiments that subjects would be more likely to restrain their consumption, therefore to act cooperatively, when social identity is promoted in a common resources dilemma. Similarly, in public good games this same manipulation resulted in individuals being more willing to contribute to the common good and therefore to cooperate.

It is our purpose to develop a serious game that will allow researchers working in the field of social dilemmas and social identity to parametrize experiments where they can control factors like game structure and social identity priming. The participants will be playing the videogame interacting with other humans and artificial agents.

In terms of contribution to experimental studies, the introduction of virtual agents to simulations of social dilemmas enables the development of experiments with a high number of interacting parties (human and virtual), which could be otherwise difficult to achieve. Nevertheless, for effective simulations the believability of the virtual agents is an indispensable attribute. The perception of an artificial agent as believable will allow for an increased real-life validity of experimental results obtained in mixed environments and consequently experimental flexibility. Thus, part of the team’s effort will be spent on developing socially aware and believable artificial intelligence.

The paper is organized as follows. Section 2 describes the main concepts of social dilemmas. Section 3 delves into the theories related with social identity. Section 4 presents the proposed framework of team games and Section 5 describes a possible scenario of the framework. Finally, Section 6 presents the conclusions of the work.

2. Social dilemmas and game theory

A social dilemma is a situation in which individual rationality can be at conflict with social rationality (Liebrand, 1983). Individual rationality is a concept commonly used in game theory and economics, which explains and predicts human behaviour in terms of the attempts of an individual to maximize his expected utility, that is to say, the expected satisfaction according to his own particular preferences (Mailath, 1998). Conversely, social rationality is usually measured using the Pareto optimality principle. This criterion states that a given state of the world is deficient if there is another state in which no individual is worse off and at least one individual is better off (Bates, 1995, p. 28). Hence, the decision of an agent can be qualified as socially rational if it leads to a socially efficient outcome, according to the Pareto criterion.

Social dilemmas as scenarios of conflict are suitable to analyse the behaviour of real persons as well as of social aware artificial intelligence agents. In this sense, social dilemmas can be used to investigate three different dimensions: a) how people behave in such situations and how external factors can induce modifications in the behaviour of individuals, b) how to design virtual believable agents and c) how human and artificial intelligence behave and cooperate in conflict settings.

Behaviour of people in social dilemmas

Using the archetypes of game theory it is possible to have an enhanced understanding of how to design conflict situations in which certain external factors, such as the one of social identity, can be manipulated and analysed in detail.

For instance, one can design a social dilemma game ignoring the external incentives to cooperation and focusing on monetary values. In such scenario, if humans display a behaviour different from the one predicted by game theory one can hypothesize that an external factor, such as social identity, is somewhat altering the incentives of the player. By manipulating such factor in an isolated manner the impact of the trait can be examined.

Believability of virtual agents in social dilemmas

Game theory can also play an important role in how to achieve believability of artificial intelligence since it allows formulating theories regarding the rational behaviour of individuals in social dilemmas. While designing believable virtual agents, the predictions of game theory can be then used as the foundations or as important parts of the reasoning mechanisms employed by virtual agents in situations of conflict. The confluence of game theory with studies from psychological and sociological fields can thus derive more believable artificial agents.

Interaction between virtual and human agents in social dilemmas

Notwithstanding the importance of the believability of virtual agents in some experimental settings, agents can also be designed having different goals in mind. For instance, virtual agents can be used to introduce complex strategies to social dilemmas as a mean to study the learning behaviour of humans when faced with complex strategies employed by such interacting parties. In this context, game theory can provide important insights on how to design agents that attain the maximization of their expected outcomes.

Furthermore, agents could be designed to produce social institutionalized behaviour creating hierarchies or employing moderator mechanisms (Tennenholtz, 2008) to overcome the dilemma situations and reconcile individual and social types of rationality.

3. Social identity

The concept of social identity was devised in the field of social psychology to explain how the integration of an individual in a group influenced his cognition. The essential idea is that groups are not only external features of reality but they are internalized in the individual in such a manner that they contribute to a person's perception of oneself. The interest in this notion first arose from the experimental studies of Tajfel (1970) which attempted to identify the minimal conditions that lead members of one group to favour their group in detriment of an out-group. The remarking conclusions of Tajfel et. Al (1971) and subsequent studies was that the mere act of individuals categorizing themselves as group members was sufficient to generate in-group favouritism. In this context social identity was defined by Tajfel (1972, p. 292) as "that part of the individual's self-concept which derives from his knowledge of his membership of a social group (or groups) together with the value and emotional significance attached to that membership".

Experimental studies provided evidence that social identity positively influenced cooperation rates in social dilemmas. Brewer and Kramer (1986, 1984) showed in their studies that subjects would be more willing to restrain their consumption, therefore to act cooperatively, when a superordinate group identity appeared in a common resources dilemma. Similarly, in public good games this same manipulation led individuals to contribute more to the shared good resulting in higher cooperation rates. This can be explained by the fact that when a social identity is salient, people are more likely to see themselves and others as interchangeable components of a larger social unit rather than unique individuals (Tajfel, 1972; Turner et al., 1987). Consequently, there is a shift of their motives from self-interest to group interest and the pursuit of the group's interest becomes an expression of self-interest.

Furthermore, in their experimental studies, Bornstein and Ben-Yossef (1994) set out to study how the integration of a social dilemma in an intergroup conflict (a "team game") could promote cooperation in the in-group game. The authors reported that subjects were almost twice as likely to cooperate in a team game than in a standard dilemma.

4. Framework of team games

The framework of inter-group social dilemmas proposed in this article is inspired for the most part by the work of Rapoport and Amaldoss (1999). The games proposed are designated as "team games" (Bornstein, 2003) which are games in which both inner and outer group conflicts are present. In such games players are assigned into groups with each group facing an in-group social dilemma and an out-group strategic game.

The framework will be described the following three structural elements: (1) type of social dilemma used to model the in-group conflict, (2) the out-group game and (3) distribution rule which determines how the out-group prize is distributed.

In-group games

The proposed general model assumes the existence of a set of m groups, each group participating in an in-group game G_k defined by the tuple $< P_k, S_k, U_k >$ where:

$P_k = \{1, ..., n_k\}$ defines players of group k $(n_k \geq 2)$
$\epsilon_{ki} \in \mathbb{R}_0^+$ defines the endowment of player i in k
$\epsilon_k = \{\epsilon_{ki}, \epsilon_{-ki}\} \in S$ defines an endowment profile
$S_{ki} \in [0, \epsilon_{ki}]$ defines the strategy set of each player i
$S_k = S_{k1} \times ... \times S_{kn}$ defines the set of strategy sets
$s_{ki} \in S_k$ defines a strategy selected by player i
$s_k = \{s_{ki}, s_{-ki}\} \in S$ defines a strategy profile
$u_{ki} : S_k \mapsto \mathbb{R}$ defines the payoff function of each player
$U_k = \{u_{k1}, ..., u_{kn}\}$ defines the set of payoff functions

It is assumed that each player of a group is assigned with an endowment of ε_{ki} and he faces the decision s_{ki} of how much of the endowment to contribute to a common good to be distributed among the community. The outcome of each player is defined by his decision and by the decisions of the other members as defined in payoff function (1).

$$u_{ki}(s_k) = \alpha_k(\epsilon_{ki} - s_{ki}) + q_{ki}(n_k, \epsilon_k, s_k) f_k(s_k) \qquad (1)$$

The contribution of all players is used to produce the common good according to a production function (f_k). The good is distributed according to a quota function (q_{ki}). The remaining amount of the player's endowment after his contribution is assigned to a private account. The interest rate of the private account is designated by (α_k).

Table 1: Categorization of in-group games.

Dimension	Variations	Game
Quota	β_{ki}, $\beta_{ki} \in [0,1]$	Fixed distribution
	$s_{ki} * \beta_{ki}$, $s_{ki} * \beta_{ki} \in [0,1]$	Mixed distribution
	$\frac{s_{ki}}{\sum_{i=1}^{n_k} s_{ki}}$	Distribution by contribution
Production Function	Linear	Linear production
	Non-linear	Non-linear production
Strategy Space	$S_{ki} = \{0,1\}$	Binary
	$S_{ki} = \{0, ..., m_k\}$, $m_k \in \mathbb{R}_o^+$	Discrete
	$S_{ki} \in \mathbb{R}_o^+$	Continuous

Table 2: Categorization of out-group games.

Dimension	Variations	Game
Quota	γ_k, $\gamma_k \in [0,1]$	Fixed distribution
	$c_k * \gamma_k$, $c_k * \gamma_k \in [0,1]$	Mixed distribution
	$\frac{c_k}{\sum_{k=1}^{m} c_k}$	Distribution by contribution
	Step-level function	Step-level distribution E.g. $\begin{cases} 1, \\ c_k = \max(c) \\ 0, \text{cc} \end{cases}$
Production Function	Linear	Linear production
	Non-linear	Non-linear production

To ensure that the game modeled in (1) is a social dilemma of the kind described by Eaton and Eswaran (2002) two conditions must be considered: 1) the expected individual own payoff change for decreasing one's contribution must be equal or greater than zero and 2) when all players contribute their endowments to the public good the expected payoff of all players is higher than in a situation in which all contributions equal zero.

It is possible to develop a taxonomy of in-group dilemmas according to the type of quota, production function and strategy spaces of players as presented in Table 1.

Out-group games

In the framework proposed in this article the out-group conflict can be any kind of strategic game. Accordingly, each group k in K = {1, …, m} participate in the out-group game G defined by the tuple < K,C,P > where:

$K = \{1, 2, ..., m\}$ defines the set of groups $(m \geq 2)$
$C_k \in \mathbb{R}_0^+$ defines the contribution set of group k
$C = C_1 \times ... \times C_k$ defines the set of contribution sets
$c_k \in C_k$ defines the contribution of group k
$c = \{c_k, c_{-k}\} \in S_k$ defines a contribution profile
$p_k : C \mapsto \mathbb{R}$ defines the payoff function of group k
$P = \{p_1, ..., p_k\}$ defines the set of payoff functions

The contribution c_k of group k can be determined by the sum of payoffs of all its members playing the game G_k (2) or by the outcome of the production function in the game (3).

$$c_k = \sum_{i=0}^{n_k} u_{ki}(s_k) \quad (2)$$

$$c_k = \sum_{i=0}^{n_k} q_{ki}(n_k, \epsilon_k, s_k) f_k(s_k) \quad (3)$$

It is assumed that groups share the same payoff function defined as follows.

$$p_k(c) = d_k(m, c) g_k(c) \quad (4)$$

As in the case of the in-group game it is possible to develop a taxonomy of out-group games according to the distribution function (d_k) and production function (g_k) of the payoff function as presented in Table 2.

Distribution rule of out-group outcome

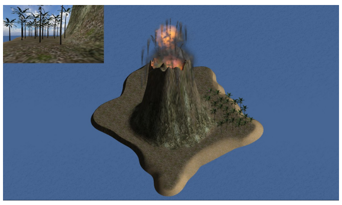
The rule determines how of the out-group outcome is distributed among group members yields the taxonomy of Table 3.

Table 3: Distribution rule of out-group outcome.

Dimension	Variations	Game
Quota	δ_{ki}, $\delta_{ki} \in [0,1]$	Fixed distribution
	$s_{ki} * \delta_{ki}$, $s_{ki} * \delta_{ki} \in [0,1]$	Mixed distribution
	$\frac{s_{ki}}{\sum_{i=1}^{n_k} s_{ki}}$	Distribution by contribution

5. Scenario

Even though the mathematical properties of the proposed games are relevant it is also important to provide illustrative examples of the possible games. This section illustrates a game scenario. The scenario takes place in a common stage: the one of a deserted island in which a plane crashed and survivors formed several groups. In the game, players have a limited number of actions that they can perform during a game round. Each player can use his actions either to collect gold pellets (the individualistic choice) or to gather wood (the social choice).



Social identity will be manipulated by how the groups are formed and by the incentives each group will face as well as by using framing and priming techniques.

Scenario with Fixed distribution of threshold production

This Scenario illustrates a situation in which each individual is rewarded with an egalitarian portion of a fixed prize when the group effort reaches a given threshold. For instance, consider the case in which each group of survivors decides to build a raft to sail to another nearby island. The raft can only be built when the group collects a given amount of wood. After building the raft and sailing to the other island, the group can sell the raft and receive a fixed prize, which will be distributed evenly among group members.

Formalization of the game follows. It is assumed the existence of a set of groups $K = \{1,...,m\}$ with each group k having its members participating in an in-group game G_k where $u_{ki}(s)$ defines the outcome in gold pellets of a player. Each player faces the decision to dedicate s_{ki} number of actions to gather wood and $(\varepsilon - s_{ki})$ actions to search for gold. An individual's decision to search for gold yields him $\alpha(\varepsilon - s_{ki})$ gold pellets and the decision to gather wood yields θs_{ki} wood to the group. The payoff function of each player defines his number of gold pellets according to the decisions of all survivors with λ, θ in R+:

$$u_{ki}(s) = \alpha(\epsilon - s_{ki}) + \begin{cases} \frac{1}{n}\vartheta, & \text{if } \sum_{i=0}^{n_k} \theta s_{ki} > \lambda \\ 0, & \text{otherwise} \end{cases}$$

Accordingly, each individual will receive as much α gold pellets as his individual search effort for gold and an even fraction the prize received after selling the boat at the nearby island (if the survivors manage to gather enough wood for the boat's construction).

6. Conclusions

In this article we presented the theoretical research supporting the conception of a new type of serious games: the team games. Team games are games in which social dilemmas can occur at different levels of an hierarchical structure. A number of studies provided evidence that social identity plays an important role in eliciting cooperation in social dilemmas, more particularly in team games. After presenting the main concepts related with game theory, social dilemmas and social identity a framework of team games was proposed.

The presented framework wishes to be a general solution for the development of environments in which human and virtual agents can interact and be exposed to reasoning paradoxes such as the ones involved in social dilemmas. Although the framework allows for the parametrization of several games, we have provided a particular fictional scenario where the mathematical constructs are conveyed through an interactive story that takes place in a 3D environment. It was our goal to outline the interest in this type of games and related problematic.

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