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Towards Analysis of Cooperative Learning-Behaviour in Social Dilemma Games

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Abstract: Beside individual learning advances, players also adapt their strategies when playing repeatedly with others in multiplayer group scenarios. We describe a setup for a Social Dilemma Game, tightly connected to Facebook, measuring users' behaviour and game results and connect these data to social network information to create a graph model that can simulate and predict the group behaviour. Thus, results are expected to support the hypotheses about the relation between friendship or player attribute similarity with the probability of choosing a cooperative strategy in dilemma situations. This will support further research and design for group training games, scenarios and team-building peer matching algorithms.

Keywords/Key Phrases: group cooperation, group learning, social dilemma, serious games, collaborative learning

1. Motivation

Single-player games are already well-established in the field of Serious Games for Learning, Education, Sports and Health. Research has proven the motivational benefits and the advantages of games' adaption and personalization for individuals learning progress, but when it comes to multiplayer simulation games and training, the scientific findings are still limited and models and empirical results are needed for such group scenarios.

1.1 Serious Games for Simulation and Training

Successful research projects reveal the possibilities in quality and quantity of simulation and training for teams (Mansour & El-Said 2008). 3D environments are used to practice coordination and trust in team members to reach a collective goal as it appears in training for police, military and action forces (Susi et al. 2007). When it comes to understanding team behaviour for the creation of Serious Games to support group cooperation, single player approaches with Non-Player Characters (NPCs) are not suitable for training of complex human behaviour and reasoning. Thus, much research in this field focussed on supporting group communication (Hildebrandt et al. 2008), realistic scenario reproduction (Wechselberger 2008), and integration of Game Mastering (Peinado & Gervás 2004; Tychsen 2008).
Beside the findings to optimize the outcome of single game situations, it remains an open question, how people might adapt strategies and improve their cooperative behaviour in *repeating* group training situations. In order to investigate this, we use well-defined group decision scenarios that can be (re)played several times.

1.2 Social Dilemma Games

One good example of such a well-defined group decision scenario that exists in different characteristics is the *social dilemma scenario* where each individual in a group has to make a decision, but the resulting personal benefit and the benefit for the group as a whole depend on all group-members' decisions (e.g. see prisoner's dilemma in (Axelrod 1985)). The individual's dilemma is the less beneficial own result if any other individual decides for a non-cooperative alternative. But if some (or all) decide for cooperation the outcome is optimal for all. We use the existing research results about decisions and interdependencies of people in such social dilemma situations (Kollock 1998; Macy & Flache 2002) as a base to investigate the influence of group composition and intermediate level of trust to cooperative behaviour and *strategy adaption* in repeating game situations. Especially the composition of the group (only friends or with strangers) and the level of fluctuation within group members (joining and leaving) is expected to influence individuals strategy and team performance in whole.

1.3 Social Network Analysis

Social network platforms like Facebook allow the embedding of the gaming application directly into the user interface and enables access to the (meta-)data about the social network of friends around individual players. Thus individual's attributes can be used to calculate measures like their centrality, indicators for mutual level of trust and for creation of different types of teams (Scott 1988; Golbeck 2005). With the attributes the interdependencies of people's decisions can be modelled as an event-based random graph model and convergence can be simulated (Robins et al. 2007). A comparison of simulated and recorded development of repeating games allows conclusions about the quality of the found model.

1.4 Related Work

A lot of research (Steinkuehler 2004; Childress & Braswell 2006) has been done regarding learning or cooperation in Massive Multiplayer Online Roleplay Games (MMORPGs). (Voulgari & Komis 2008) propose a framework for the investigation and design of effective collaborative learning within MMOGs.

A comprehensive overview of collaborative learning can be found in (Dillenbourg 1999). (D. W. Johnson & R. T. Johnson 1999) investigated cooperative learning concepts. Their findings "indicate that cooperative experiences promote greater interpersonal attraction than do competitive or individualistic ones". Based on these thoughts, (Hämäläinen et al. 2006) investigated the effects of collaboration in a 3-D virtual game environment.

The different strategies group members can adopt in social dilemma situations are described and investigated by (Kollock 1998; Macy & Flache 2002). They are used to recognize and classify the group members' behaviour in our scenarios. (Glance & Huberman 1994) analysed the setup of diner's dilemmas menus and the influence to individuals' decisions.

The reasons for the success of recent Social Casual Games, especially on the social network platform Facebook, have been investigated by (Loreto & Gouaïch 2004). The authors focus on the psychological needs served by the games and the motivations to play. The effect of interpersonal relationship to initial game play in this environment and the enhancement of relationships by (indirect) game interaction have been shown by (Wohn et al. 2009). These effects can be used in the project at hand to motivate more users to participate.

The Social Network Analysis has proven its applicability in several research projects investigating cluster structures, clan communication and centrality of individuals in massive multiplayer online games (Ducheneaut et al. 2006). Additionally, there are beneficial results from analysis effectiveness of team communication in organizations and the influence of closeness to team productivity (Zenk et al. 2010). The underlying *Exponential Random Graph Models* (ERGMs) are acknowledged as a suitable tool for dynamic social network data analysis (Robins et al. 2007).

2. Approach

2.1 Components

To measure the influence of the group composition and level of trust onto individual's strategic behaviour in the cooperative dilemma situations we decided to create a Social Dilemma Game connected to Facebook for the reasons stated above. Following the criteria and models for *Social Games* our application incorporates the concepts of casual multiplayer and (round-based) asynchronous play to provide players with a game interface of low complexity, multiplayer awareness and the ability to play decoupled at a time that suits themselves most. This keeps first-use barrier and discontinuation rate low (Jarvinen 2010; Loreto & Gouaïch 2004; O'Neill 2008).

Within the game, called *Diners Dilemma*, a number of players sitting at a virtual restaurant table are offered two menu options. Each round, every player may choose either the cheap or the expensive menu; however, the bill will be divided equally among all players. The game is played for a fixed number of rounds or as an ongoing game (lasting for days or even months with each player making a choice from time to time).

To generally breed strategic behavior, players can access statistics (table and graph) about how many games a player already played, how many rounds already took place at the table and which decision has been taken by whom in the past.

Users can open new dining tables, choose to join existing games (at tables), and invite friends from Facebook to join. When opening new tables, restrictions like *only for friends*, a *fixed number of game rounds* or *closed table* (only joinable by invitation) can be selected.

The game-related event data that is written into a game log database contains who joined which table when, which decision was taken in which game-round and what are the game-results (for all individuals). This data is merged with the overall game-experience (number of tables and games played) as well as the extracted profile data and social graph of friendships taken from the online social network (see Figure 1, step 1 “Data Collection” and it’s deliverables to step 2).

2.2 Graph Models

With this data – first individuals’ decisions over time, second the game rounds’ characteristics and third the profile data and social graph interdependencies with other players – we create an event-based social graph (see Figure 1, in step 2 “Graph Creation”). A list of possible significant attributes is then derived from current players’ behaviour and former research results (“Attribute Selection”). The mentioned analysis by using ERGMs is robust against the influence of many (probably insignificant) attributes and delivers conclusions about the relevant attributes influencing the individuals’ strategic behaviour in the social dilemma situations.

Based on these attributes and the consolidated merged *Social Dilemma Event Graph*, several models are defined to simulate the development of future game rounds (see Figure 1, step 3.). For this, first an assumption about the attribute dependencies is drawn from the observed graph data to estimate and define (all) statistically influential parameters for each model. By identification of restrictions and definition of constraints the models are then simplified to be calculable in reasonable time.

The following simulation uses the initial situations of recorded games and the initial state of the Social Dilemma Event Graph with the models. Finally, the simulated final game state is compared with the recorded one to estimate model accuracy. The simulation also delivers the list of significant attributes of the graph’s participating nodes for the final graph state (in Figure 1, step 4 “Simulation” and deliverables).

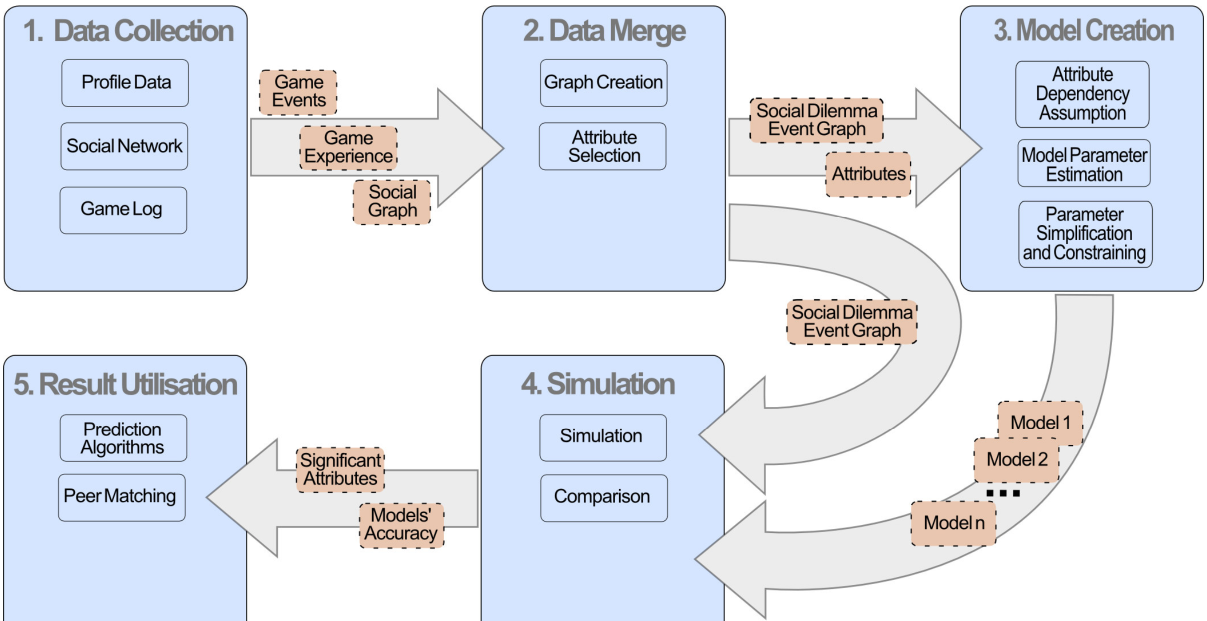

Figure 1: Workflow diagram of model creation process

3. Hypothesis

Based on the related work concerning decisions in social dilemma situations, it is expected to find evidence for:

H1: Strong friendships (as an indicator for trust), low fluctuation of group members and small size of group are all independently and positively related to individual cooperative strategy adoption and overall group performance

H2: Similar user attributes (like geo-location, friends-of-friends, age or gender) are positively correlated with cooperative behaviour

H3: Users with similar attributes (see above) choose similar strategies in comparable game-situations

4. Future work

Currently, we are finishing the prototype and defining the evaluation scenario to collect enough data about played game rounds to build a thorough model. If the hypothesises can be proven, the approach will be adapted and further developed to be applicable in the field of Serious Games for Learning and team training. It is expected that then an approach can be found to build adaptive models for *Peer Matching* in training games and/or cooperation in games to maximize their individual learning outcome, e.g. create teams in which the favourite strategies or behaviours complement.
Additionally, these results will be integrated into the design of more complex social dilemma scenarios in team training multiplayer Serious Games to sensitize players for team effects and levels of trust.
Finally, it is envisioned to extend the model creation and analysis of players' behaviour in Serious Games to find a model to predict (cooperative) behaviour in order to recommend other (playing) individuals for mutual knowledge exchange on a meta-level in order to support each other's advances in game and thus in reaching the learning targets (see Figure 1, step 5 "Result Utilisation").

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Towards an Analysis of Cooperative Learning-Behaviour in Social Dilemma Games

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Motivation:

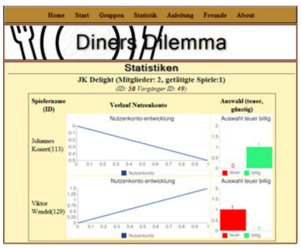
Group decision scenarios are used for practicing coordination and trust in team members to reach a collective goal. It remains an open question, how people might adapt strategies and improve their cooperative behaviour in *repetitive* group training situations.

Results here help in understanding team behaviour and the creation of better game adaption and player-matching in multi-user-environments.

Social Dilemma Game

User Groups

facebook



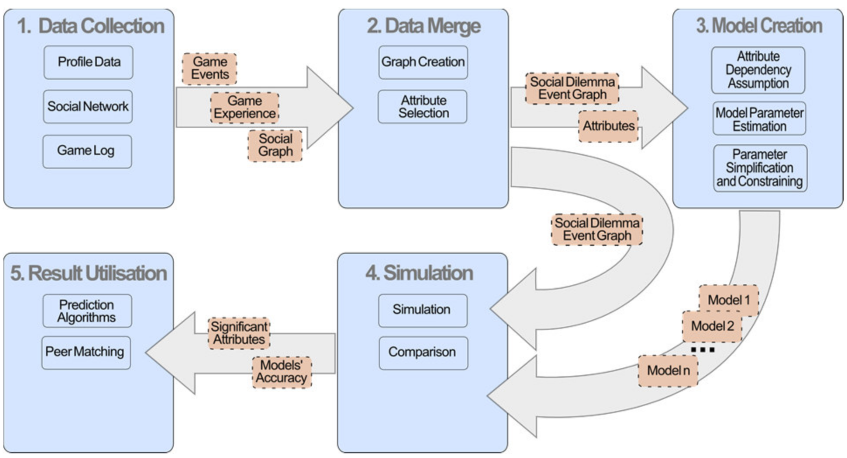
Research aims:

R1: a. Strong friendships (as an indicator for trust),
b. low fluctuation of group members and
c. small size of group are positively related to individual cooperative strategy adoption

R2: Similar user attributes (like friends, age) are positively correlated with coop. behaviour

R3: Users with similar attributes (see above) choose similar strategies

Approach:



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Dipl.-Inform. Viktor Wendel and their colleagues investigate the field of Serious Games for Learning as part of their PhD studies at Technische Universität Darmstadt, Germany. Here they focus on Game Mastering, Cooperative Play and Social Network Integration.
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