COOPERATION AND DISRUPTIVE BEHAVIOUR – LEARNING FROM A MULTI-PLAYER INTERNET GAMING COMMUNITY

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ABSTRACT

In this paper we report possibilities and experiences from employing Counter-Strike, a popular multi-player Internet computer game and its resulting online community in research on cooperative behaviour. Advantages from using this game include easy availability of rich data, the emphasis on team-playing, as well as numerous possibilities to change the experiment settings. We use descriptive game theory and statistical methods to explore cooperation within the game as well as the way the player community deals with disruptive behaviour. After a quick introduction to the basic rules of Counter-Strike, we describe the setup of the Internet game server used. We then present empirical results from the game server logs where cooperation within the game is analyzed from a game theoretic perspective. Finally we discuss the applications of our results to other online communities, including cooperation and self-regulation in open source teams.

KEYWORDS

Game theory, cooperation, communication, internet community

1. INTRODUCTION

With the ever expanding possibilities of the Internet, understanding when and why individuals trust each other and cooperate to achieve their goals together becomes more and more important. Concepts like electronic commerce, groupware, virtual teams, digital universities and many more require as a prerequisite established trust and cooperation in an electronic context. But unfortunately it seems that trust is harder to achieve in the impersonal electronic context than it is with conventional face-to-face contact (Rocco, 1998). In this paper we use a popular multi-player Internet computer game to investigate cooperative behaviour in a pure electronic context. For this research we use a game theoretic approach.

In the area of normative game theory much work on strategic behaviour, where to cooperate is a possible strategy, has already been done (Neumann and Morgenstern, 1944; Nash, 1950; Nash, 1950a; Nash 1951). Normative game theory analyzes consequences of strategic behaviour by superrational players. However, in real settings, like electronic consumer-to-consumer commerce, rationality of human players is limited. Human players do not always exactly know what they want and it is also common that they do not posses complete knowledge of the rules and the possible pay-offs of their various actions. This limits the direct application of solution concepts of normative game theory, like the Nash equilibrium, dominant strategies, incredible threats and so on. However, we use these concepts as benchmarks for descriptive game theory to compare the normative solutions with the actual behaviour of real players.

Using computer games for academic purpose is not a new idea, for example Laird describes the research of his group in building agents with artificial intelligence within the setting of the game Quake II (Laird, 2001), and a similar game, Doom, has been used as a user interface for system process management (Chao, 2001). For our research we use the wide-spread and freely available Counter-Strike modification for one of the most highly acclaimed games in the last years, Half-Life. This environment offers excellent graphical representation and therefore entertainment and high usage. In this game, two teams of several players have to achieve conflicting goals, e.g. one team tries to rescue a number of hostages, while the other team tries to prevent this. Counter-Strike therefore aims at enhancing the team-playing aspect while also offering text chat and voice communication, and thus is especially suitable for analysing cooperative behaviour.

2. GAME AND EXPERIMENT SETUP

Using a multi-player computer game offers several advantages: incentive structure compatible for players, virtual reality environment, almost perfect information for analyses using log files, possibilities to change the setting, fun factor, communication maybe using several channels like text chat or voice, and presence of emotion for the players. While the incentive compatibility ensures the players actions in accordance to the goals, the virtual reality environment and fun factor guarantee a sufficient number of players. It is one of the most consistent and robust findings in sociological literature that communication has a positive effect on cooperation and trust (Kollock, 1998). As multi-player computer games today nearly always feature at least one form of communication between the players, in the simplest variant a text chat facility, these effects can also be included in research using these games. Using a multi-player computer game entails using human subjects. As has been shown by Bazzan and Bordini (2001), the presence of emotions increases the rate of cooperators. In their article, they have considered the emotions anger, joy, distress and pity, which each individual agent might display. Given the incentive structure, human players might experience them all.

Counter-Strike is a game based on the Half-Life-Engine by Valve Software, distributed by Sierra Studios. Since its release in 1998, Half-Life has won several awards, was named PC CD-ROM Game of the Year by over 50 publications worldwide, and a community of programmers has used the game-engine to create new modifications, maps and other tools. Counter-Strike is a modification that enhances the multi-player aspect of Half-Life towards a more team-oriented approach in a setting of terrorism and police strike forces. After its first beta release in June 1999, Counter-Strike has been one of the most widely played online-game worldwide in the last years. Players have also formed so-called Clans, some based on themes like only female players, which compete in tournaments and leagues both national and internationally. Membership may be subject to prior tests of skill, and is expressed by adding the appropriate initials to the character name when playing. In this game, there are two types of players/actors, forming two teams, Terrorists and Counter-Terrorists, which constitute additional actors. There are several maps (or settings) which are played consecutively. On each map a number of rounds are played. Depending on the map, each team has to achieve a set goal in the round. The team's goals are mutually exclusive, therefore ensuring strict conflict of interest between the teams. Possible goals include for the Counter-Terrorists rescuing a number of hostage, respectively preventing this for the Terrorists. When the goal is achieved, this team wins the round. Each round has a time limit, and one team is defined to be winner when this limit is reached without prior goal achievement by one team. The pre-defined winner is depending on the setting (in the hostage rescue example above, the Terrorist team wins). Another way to win the game is by eliminating all members of the other team. The game is played with mouse and keyboard. Mouse movement sets the sight and aiming of the character, keyboard controls movement, e.g. forwards or backwards, and several other commands. Each character can carry a limited number of weapons and equipment like bomb defuse kit or nightvision goggles. Enough hits, depending on the weapon, eliminate a character. This player can then not re-enter the round, but has to wait until it ends by one team's success. In this time period, he can watch the proceedings of the other players from several perspectives, and can chat with the other eliminated players. Each player has a certain amount of starting money to be spent on weapons, ammunition and equipment in each map, and gains money depending on his and his team's success. A certain amount is awarded at the start of each round.

We installed the Half-Life server with Counter-Strike modification. Also employed is a modification called AdminMod, allowing for additional types of votes and parameters in the game. In addition, the tool PsychoStats is installed to provide statistics covering several game sessions on the World Wide Web based on the log files. Both the game itself and the statistics on the WWW are accessible for everyone using the Internet. Experiences and player opinions show that this server outperforms most others in the vicinity due to processing power and high bandwidth. Due to the Internet's limitations on connection speed, most players come from countries in Central Europe. Game settings include a maximum number of 16 players and an automatic punishment of one round suspension for team killings. An extension to AdminMod has been programmed in order to record positional information for each player each second in the log files. This information was necessary for the following analyses. We have also implemented a program in Java using these positions to visualize the movements and positions of the players in a round. There are several advantages of using especially Counter-Strike for the following analyses, foremost the incentive structure. Counter-Strike allows for several incentives for the players. These include a high-score list within the game, and when using a free statistics program and log analyzer (e.g. PsychoStats) a website with detailled ranking according to overall performance with a skill system (see Figure 1), several other categories and an award system. This adds an element of persistence to the game (Day, 2001), as these statistics span a time interval which can be customized. In addition, the rules provide incentives for successful behaviour, as death within one round only allows subsequent spectation of proceedings until the start of the next round. As this period of forced inactivity is undesirable, realistic and successful playing will be encouraged.


Player Rankings for [AI] Research Server - Netscape

File Edit View Go Communicator Help

Player Ranks

In 13 days 257 players ranked out of 2500 total

Rank	Player Name	Kills	Deaths	K:D	KPM	Skill
1	-]stinka[-nR.1	928	394	2.36	0.82	1589
2	lala	143	38	3.76	1.05	1512
3	X-MEN	124	25	4.96	1.92	1503
4	dada	272	103	2.64	0.94	1481
5	lala	197	76	2.59	0.88	1469
6	brauch_nix	268	124	2.16	0.86	1461
7	zaxxiehexxie	335	117	2.86	1.02	1460
8	H8U	115	29	3.97	1.39	1459
9	ruru	86	14	6.14	1.29	1440
10	muha	669	293	2.28	0.18	1418
11	Freundeskreis	91	19	4.79	1.32	1413
12	-|00|- tofix -]aCg[-	114	45	2.53	0.87	1408
13	TMP-RULA	144	47	3.06	1.18	1405
14	]AV[-One-]	98	30	3.27	1.17	1401
15	baki	275	142	1.94	0.72	1399
16	Overlord	149	62	2.40	0.81	1395
17	darky	637	375	1.70	0.64	1394

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Figure 1: Screenshot of WWW-statistics ranking players

Additional advantages of Counter-Strike are the virtual reality afforded by the Half-Life game-engine and the Counter-Strike modification with very good visual and audio impressions, and a fun aspect, which can be easily seen given the numbers for popularity and usage of this game. If so configured, the game records most important events in a log file. In addition, APIs are provided for writing additional information into the logs. We have used these APIs for including positional information in the log files, which are not recorded automatically. Therefore the success and the behaviour of the players can easily be analysed. As a further advantage, Counter-Strike offers several possibilities for changing the game and therefore the experiment setting. These include the selection of available maps, the maximum number of players, and several other variables of the game like automatic punishment of team killings, necessary number of votes for map changes or player kicks, and the activation of automatic team balancing. Usage of a statistics program allows for changing the ranking and award system, and the AdminMod extension allows for additional types of in-game votes, and also for arbitrary limitations in the available equipment. Counter-Strike features several communication channels, a text chat facility within the game, and since release 1.3 also a voice channel. While the positive effects of communication on cooperation and trust are undisputed (Kollock, 1998), also the modality of communication has been found to influence this effect, with voice communication performing significantly better than text-to-speech, text chat or no communication (Jensen et al., 2000). Therefore Counter-Strike will possibly capture this effect and together with higher ease-of-use during game-play compared to typing text, cooperation is assumed to increase due to the new voice channel. The messages passed using text chat are recorded in the log files, allowing for analysis of these exchanges between players. As a last advantage, given the type of game and the incentive structure, emotions are experienced by the players. This can be verified by both analysis of the text chat messages and listening in to the voice communication. As has been shown, this presence of emotions increases the ratio of cooperators in an iterated Prisoner’s Dilemma (Bazzan and Bordini, 2001).

3. COMMUNICATION WITHIN THE GAME

As has been said, Counter-Strike offers a text chat facility for communication. There are four possible channels for communication, one for all players in the game who are still active in a given round, one for the players already eliminated, and one for each team to allow for strategy coordination without the other team listening in. All messages are recorded in the log files. These have been analysed to uncover what this facility is used for. During a 14-day period, 6783 different words have been used, for a word count of 50494. All 319 words having at least 20 occurrences which total 36053 occurrences have been ordered in six broad categories. One word could possibly be in several categories, and some words, e.g. ’I’ were not categorised at all. Table 1 gives the results. As can easily be seen, the expression of emotions, both positive and negative, is predominant. This proves the assumption that players experience emotions during play. As is not surprising, the text chat is also used for communication concerning the game itself, for example to coordinate strategies. These messages tend to be rather short, as they are used during the game, where time-consuming typing is rather dangerous should an enemy be encountered. The text chat is also used to communicate about perceived disruptive behaviour, for example to pledge a mistake or to acknowledge this. Discussions about cheating behaviour do not seem very extensive. One explanation would be that it can not be unambiguously detected. The high usage for social interactions like greetings when entering the game or trying to establish out-of-game contacts, e.g. using instant messaging services like ICQ, seem to indicate a high level of both social awareness and also persistence, as many players recognize each others from prior contacts on this server or elsewhere. There are also some commands sent to the server using the text chat facility which are defined as an own category.

Table 1: Categories of chatwords

CATEGORY	EXAMPLES	DIFF. WORDS	TOTAL
Emotion	lol,haha,shit	89	12289
Comm. concerning Game	yes,teams,ok	33	5708
Social Interaction	hi,cu,thx	14	2859
Comm. conc. Disr. Behaviour	sorry,np,kick	14	1665
Game Commands	mapvote,timeleft	7	1661
Comm. concerning Cheating	kick,admin,noob	11	362

4. COOPERATION WITHIN TEAMS

For the analysis of cooperation within teams, a simplified model is necessary. One game is defined as the play of one round, ending with the victory of one of the teams. A game consists of the two teams (Terrorists and Counter-Terrorists), each with a variable number of players. Each of these players has two possible actions (or moves) available, namely cooperate (C) or defect (D). All players choose their action for the game simultaneously at the beginning. If only a single game is considered, players have empty information sets. Each player's strategy set or strategy space therefore consists of one strategy, playing cooperate (C) or defect (D) each with a given probability. Playing cooperative (C) is defined using the spatial distance between the player and his teammates during game-play. When the players stay together, they can help each other and are much more effective. Players who for example stick behind waiting for the others to take most of the load might have a chance for bigger payoff, but the team performance might decrease. Figure 2 shows a screenshot of our visualizer tool, which shows as dots each player's position in a given moment. In addition, each player is surrounded by a circle depicting the maximum range for cooperative behaviour. One player is defined as cooperating with another player if he is within a given radius centered on this player (the cooperating players are highlighted in the figure). As the distance between the players can change during the course of one round, a player is defined as playing the action cooperative (C) when is he is cooperating two thirds of his time in a round. The time span when not enough players in a team remain (less than four) is not counted. In addition, the first 10 seconds of a round are also discarded, as each team has one starting point, therefore enforcing cooperative behaviour without conscious choice by the players.

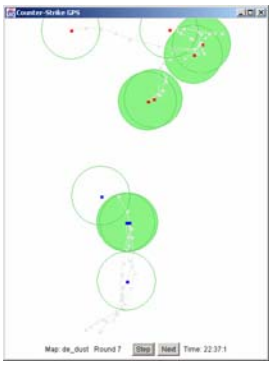

Figure 2: Screenshot of Visualizer with cooperating players

Each team also constitutes a separate player of different type in the game. The action set of each team consists of two actions, namely cooperation within the team (C) or defection within the team (D). The information set of each team consists of the action profile for all players in the respective team. The game therefore consists of two stages, with players first choosing their actions, then the teams, having observed their players' choices. There is only one strategy in the teams' strategy set, which is to play cooperation when two thirds of the team's players cooperate, or else play defection. Each player gets a payoff, which is the expected utility as a function of the actions chosen by himself, his team and the opposing team. Therefore we deal with a 2x2x2 payoff matrix, resulting in a cube. A player's utility can be derived from the combination of the number of kills he achieves, the presence or absence of his own death, the time actively having played (until his death or the end of the game), whether his team was victorious and the degree of action he experienced. This last component is measured by the number of hits to and by other players per minute actively played. The preferences might differ between players according to their ranking of these goals.

From the data we have collected from the log files, we have empirically determined for a period of 15 days for all games the actions of each player, the actions of both teams and the resulting payoff for each player. In the following we consider only one of the possible maps (de_dust), as the results depend on the setting. During an interval of 15 days, about 6,000 rounds are played by about 1,500 different players. For analysis, we first consider the aspect of the two teams playing against each other. This constitutes a collapsed version of the 3-player 2x2x2 game. Table 2 gives the payoff matrix for this game. In this case, the only payoff component shown is the number of kills achieved, which can be shown to be highly correlated with the time actively having played and the team's win. The number of kills shown is the mean for the players in the team over all observed games. As can be seen, for the team T (Terrorist) playing defection (D) is the dominant strategy. Given this finding, the team CT (Counter-Terrorist) should choose to play cooperation (C). Therefore this combination constitutes a Nash equilibrium.

Table 2: Team T vs. Team CT

	CT: C	CT: D
T: C	0.720;0.662	0.634;0.708
T: D	0.738;0.643	0.682;0.610

Next, we consider the aspect of a Terrorist player playing with his team T (Table 3). This again constitutes a collapsed version of the 3-player 2x2x2 game, with the enemy (CT) team collapsed using its empirically determined action distribution. Analogous results for a CT player with his team CT are also shown (Table 3). Again, the mean number of kills is shown as the only payoff component. As can easily be seen, for both types of players, playing defect is the dominant strategy. Therefore, there is no conflict between the Terrorist players and their team, as both would rationally choose to play D. For the other team, there is a conflict, as it would be better for the team to play C in order to arrive at the Nash equilibrium, but the individual player has incentive to play defect. We have investigated which actions are indeed taken by the players and therefore teams. Figure 3 shows the game of a Counter-Terrorist player playing with his team in extensive form. The edges of this tree are labelled with the action and it's empirically determined probability. Only the payoffs for the player are given at the leaf nodes, although this time the action component is also given together with the number of kills. As can be seen, the players choose to play cooperate with more than 75%. Given the payoff presented above, this seems a counter-intuitive result. There are several possible explanations for this behaviour: As can be seen from Figure 3, cooperation increases the payoff component action to a large degree. Therefore incentive exists to adopt this behaviour. The high percentage for cooperation would then hint at a high preference for action within the population. While we have at this moment considered a single game, this game in fact is repeated. These repetitions will sometimes incorporate the same players, which stay at the server or return later. As the communication shows, the players also do develop social contacts, even using other channels. Therefore the situation allows for learning effects, for example which players tend to follow cooperative strategies, and that cooperation might be favourable for the team overall (Weibull, 1995; Fudenberg and Levine, 1998; Aumann et al., 1995).

Table 3: Player vs. Team

	T: C	T: D
P: C	0.700;0.701	0.668;0.726
P: D	0.707;0.701	0.793;0.726

	CT: C	CT: D
P: C	0.647;0.658	0.638;0.687
P: D	0.718;0.658	0.741;0.688

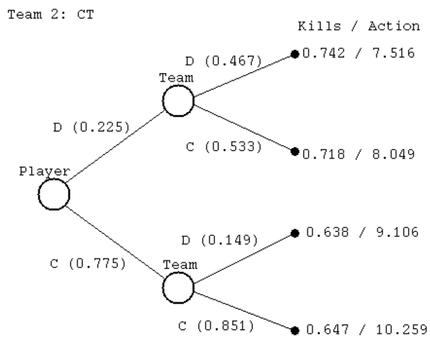

Figure 3: Player vs. Counter-Terrorist team in extensive form

5. COOPERATION AND DISRUPTIVE BEHAVIOUR

Disruptive behaviour within the game, i.e. attacking the team mates or cheating using additional or modified software, is possible. This can pose a problem for the other players (Day, 2001). We analysed how the other players deal with this behaviour, and what causes it, e.g. a streak of failures or accusations of cheating. The strategies available to other players are to resort to this behaviour themselves, i.e. attacking this player, which might lead to more aggression and maybe degeneration of the game (’retaliation’ strategy), to try to kick the player from the server using a vote, or to leave the server. The success of the ’vote’ strategy is contingent on the experiment settings, i.e. the number of votes necessary for kicking as a percentage of players in the game (currently 60% are used), and the behaviour of the other players during the vote. As attacks on team mates are not visible to members of the opposing team, this might include some intercourse using the chat facilities to obtain the necessary number of supporters. These messages are also logged and can therefore be analysed. As has been shown in the respective section, this possibility is indeed used, for example to pledge a mistake or for excuses. It can be assumed that acquaintances between players and reputation will play an important role for the ability to convince others. It has indeed been found that initial face-to-face contact can promote trust in electronic contexts, in which it is otherwise difficult to achieve (Rocco, 1998). In addition, results have shown that structure in online interactions increases the chance for a group to reach consensus in contrast to standard chat discussions, which are currently provided by Counter-Strike (Farnham et al., 2000). This might impair the use of this ’vote’ strategy. In addition to these strategies, the presence of an administrator, who has the means of kicking any player from the server at his disposal, changes the situation. Players confronted with disruptive behaviour who know of the administrator’s presence might do nothing hoping for him to act, or use the chat facility to encourage punishment by him. Even if no administrator is online, e-mail messages might be sent to him complaining about other player’s disruptive behaviour and wishing for retribution. Success of both on- and to an even greater extent offline appeals might depend on acquaintance with the administrator and reputation of the players involved, i.e. the accuser and the perpetrator. The empirical results retrieved from the log files for players employing both the ’vote’ and ’retaliation’ strategy are strong. The effects of different time spent playing by the players have been eliminated. There is a significant correlation of 0.101 for the players between being attacked by a team member and starting a vote to kick someone. Interestingly the correlation between being killed and starting a vote is not significant. Empirical results seem to indicate that in this case a ’retaliation’ strategy is employed. The correlation between being attacked and being killed by a team member at 0.587 demonstrates that not all team attacks succeed in killing, either because this is not intended or other measures like self-defense prevent this. Intention to kill might be missing because the attack has been a mistake, or because counter-measures by other players or the server, which can be configured to enforce one round of inactivity after at teamkill, are feared when actually following through with the attack. These might be avoided if the attacks are stopped short of killing. Empirical results for the success of employing the ’vote’ strategy show that there are significant if low correlations between having a kick vote started against a player, and this player having attacked (0.115) or killed (0.111) a team member. There is also a relatively low correlation of 0.179 between having a vote started and actually being kicked due to it, indicating that the votes rarely succeed. Of course, there is a similar correlation between attacking and killing a team member of 0.615 to being attacked and being killed. The same comments as given above apply again. Results for the ’retaliation’ strategy clearly indicate that this strategy is more often employed. The correlations between being attacked or killed by and attacking or killing a team member are considerably higher than for starting a kick vote, e.g. 0.612 for being attacked and attacking compared to 0.101 for being attacked and starting a vote. It can also be seen that an attack is more often answered by an attack than by a kill (0.612 compared to 0.316). In summary, the empirical results clearly show that both strategies (’vote’ and ’retaliation’) are employed by the players, with the ’retaliation’ strategy having a considerably higher acceptance. This may in part be explained given the low success rate of the ’vote’ strategy. Of course, the experiment setting currently at 60% can be changed to allow a vote to succeed with a smaller percentage of players, possibly altering this strategy’s acceptance. In addition, retaliation can more easily be accomplished due to the user interface and has a quicker result.

6. APPLICATION TO A REAL WORLD SETTING

The results concerning cooperation and communication in the game are of interest for several fields in which electronic communication, team-building and trust play an important role. One excellent example is the development of open source software. In this model for software development, a large number of voluntary participants cooperate to create and improve a software artefact (Raymond, 1999). The best known example for this kind of project is the Linux operating system, others include the Apache Web server or the Perl programming language. These programmers form a virtual organization without central management, as all participation is strictly voluntary (Dafermos, 2001). There are several explanations for the motivation to spend time on these projects without direct monetary compensation, including a reputation model, where the main motivating force is recognition by the peers within the community, also termed ’gift culture’ (Raymond, 1999; Bergquist and Ljungberg, 2001), the sheer joy of hacking (Raymond, 1999; Torvalds and Diamond, 2001), altruism or investment in the own human capital (Hars and Ou, 2001). Especially the competition for status and reputation has been mentioned as a possible problem in this type of software development (Bezroukov, 1999), as individual maximization does not necessarily lead to the successful progress of the project overall. Therefore the situation faced is similar to the game setup in our experiments. As the participants most often are geographically dispersed to an extent that face-to-face contact is not possible, communication is limited to electronic channels, mainly mailing lists and e-mail. In addition, some projects have also begun to implement voting mechanisms for decision-making (Fielding, 1999). The resemblances therefore are striking between this setting and our experiment, allowing for transfer of results from the game.

7. CONCLUSION

In this paper we have reported on the use of a popular multi-player Internet computer game in research on cooperative behaviour. The game used is Counter-Strike, a free modification of one of the most highly acclaimed games of the last years, Half-Life. Counter-Strike offers several advantages for our research, including easy availability of rich data, the emphasis on team-playing, as well as numerous possibilities to change the experiment settings. In addition, it offers several channels for communication and highly engaging graphics in the game. This aspect can be seen from usage statistics on the Internet, where Counter-Strike continues to be one of the most often played games, with users numbering from 40,000 to 60,000 at any given moment. We have detailed how the communication facilities afforded by the game are used to facilitate cooperation, to display emotions and to discuss matters like disruptive or cheating behaviour. We next have presented an analysis of the cooperation in playing the game using descriptive game theory. The results clearly show that at least in one team the individual maximization of payoff would result in a suboptimal team strategy and therefore performance. On the other hand, the results also show that cooperative behaviour is nevertheless adopted to a high degree. We have presented several explanations for this. Also analysed were the ways in which players deal with both disruptive and cheating behaviour. Both types were defined, and possible counter-strategies for the other players were detailed. Results show that most often a 'retaliation' strategy is employed against disruptive behaviour, as it is shown to be difficult to punish the perpetrator using the vote mechanisms provided. We have then detailed one area, the development of open source software, which shows remarkable resemblance to the experiment setting in the reputation games which might arise in these virtual communities. Other possible areas in which results from this research could be transferred would include digital universities, groupware or any other virtual community-building in which a conflict of goals between the individual and the group might arise.

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