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THE KNOWLEDGE GAME – MOTIVATING KNOLEDGE SHARING AND TESTING ORGANIZATION POLICIES IN THIS CONCERN

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ABSTRACT

The ageing of nuclear experts and operating personnel and the lack of attractiveness of nuclear jobs to younger generation were emphasized as two of the most important factors that could jeopardize the preservation and sustainable development of the present body of nuclear knowledge worldwide. The willingness to share knowledge is at the inner core of any process involving transfer and dissemination of knowledge. This paper deals with the development of a tool to demonstrate the advantages of a culture inductive of knowledge sharing and cooperation from both the organization's and individual's viewpoints and coins the basics of reward policies that foster the development of desirable cultures.

The Knowledge Game is a software tool to: (a) show the importance of sharing knowledge to both the individual and the organization; (b) demonstrate the fact that collaborative behaviors achieve higher payoffs in the long run; (c) test organizational rewards policies. It is an agent based modeling tool in which users may play with other humans and/or built in agents with fixed strategies. Payoff rules, simulation speed, number of players and their strategies and number of cycles are set before beginning the simulation. Plots display results in real time and output files can be generated for further analysis.

Tests encompassing proof of concept and application confirm the game's great potential as a demonstration and policy testing tool. To test policies more effectively future implementations of intelligent agents coupled with fitness selection of players should be a very key lever.

1. INTRODUCTION

Ageing of the nuclear experts and operating personnel and at the same time lack of attractiveness of nuclear jobs for the young generation have been emphasized as two of the most important factors that could jeopardize the preservation and sustainable development of the present body of nuclear knowledge worldwide. By 2002 this issue started to be discussed at the IAEA and following the recommendations of several advisory committees, the International Atomic Energy Agency (IAEA) convened a meeting on Managing Nuclear Knowledge on 17-19 June 2002 with senior representatives from Member States.

In September 2003, the IAEA General Conference has acknowledged the importance of the issue and through resolution GC(47)/RES/10.B, urged the Secretariat to continue to strengthen its current and planned efforts in this area, recognizing the need for a focused and consolidated approach, and requested the Secretariat to assist Member States, particularly developing ones, in their efforts to ensure the preservation of nuclear education and training in all areas of nuclear technology for peaceful purposes. In 2004 and 2005 resolutions with similar intent have urged the Member states to address this problem. Since then, many organizations, principally in the advanced countries have launched knowledge management programs and initiatives.

In a position statement revised in 2006, the American Nuclear Society (ANS) pointed that by 2004, the average age of US nuclear workers was 48, with 28% eligible to retire within five years. Before the 11th March earthquake, nuclear engineering's upswing had been apparent in Europe as well. Sweden and Italy had ended their nuclear power bans and planned to build new reactors. Finland, Spain, and the United Kingdom were also ready to expand their nuclear energy programs. Following the Japanese nuclear emergency, however, Italy said it would be toning down its expansion plans. Presumably other European countries will be reviewing their plans, too Patel (2011).

So as it has been the situation for many years and, may be, it will continue to be so in the near future, nuclear technology development and new nuclear power constructions worldwide could stay as marginal activities only. This is true in most countries, probably with the exception of Korea, China, India and a few other nations that are still pursuing a vigorous nuclear program. Special mention to China that alone accounts for 27 of the 65 plants under construction worldwide.

On one hand, the need for the continuous deployment of nuclear energy to meet growing world electricity needs and at the same time avoid greenhouse emissions may be an inescapable truth. On the other, when such reality is finally more globally accepted, (nuclear) knowledge, the fundamental means for such delivery, could very scarce to meet the desired goals. Under this scenario, it is really of value that knowledge management (KM) is being taken seriously by nuclear organizations and policy makers. For business in general, KM has been a growing concern since 2000 and there is a large body of knowledge on the subject, of both theoretical and practical application nature. The generalities of the theme will not be discussed here, as we will go directly to the points that had motivated the present work.

It is not exaggerated to say that at the inner core of any process involving transfer and dissemination of knowledge there is an essential ingredient that is the willingness to share knowledge and this is highly dependent on the local culture and organizational policies. This fact has been recognized since the beginning of the KM wave. In 1999 the Financial Times published the results of a survey with 260 CEOs and directors of multinational organizations, where 94% of them agreed that people should share knowledge within their organizations. However, as people feel that their knowledge is important and valuable, they regard it as power and are reluctant to share; moreover they can look suspiciously upon knowledge from others.

Davenport and Prusak (1998) have stressed the importance of trust as an essential ingredient that supports a "knowledge market" for enabling knowledge sharing. This market, based on reciprocity, reputation and altruism, can only work effectively thanks to trust, that must be *visible* (members must see that passing their knowledge people receives real acknowledgement: they must experience reciprocity directly).

Therefore factors that hamper and help the sharing of knowledge in organizations have been duly studied. In this respect trust and social identification are the most widely recognized reasons causing positive effects for knowledge sharing see for instance (Adler 2001; Andrews and Delahaye 2000; Ciborra and Andreu 2001; De Cremer, Snyder, and Dewitte 2001; McEvily, Perrone, and Zaheer 2003; Newell and Swan 2000).

Organizations are also characterized by members' social identification and trust, which in the absence of power games are assumed to create a knowledge-sharing context. In this regard the work of Willens & Buelens (2009) have collected data through a questionnaire survey in the public sector. The sample consists of 358 cooperative episodes between departments in more than 90 different public sector organizations. Structural equation modeling reveals the importance of lateral coordination and trust. The combination of power games and informal coordination seems to be remarkably beneficial for knowledge sharing. Furthermore, compared with other public sector organizations, government institutions have organizational characteristics that are less beneficial for knowledge sharing.

The positive effects of the contextual organizational characteristics on knowledge sharing, such as trust and identification, are explicitly recognized in the literature. Alvesson (2000), Kogut and Zander (1996) and Robertson and Swan (2003) have emphasized the importance of social identification in a group or in the organization to leverage knowledge sharing. The importance of trust as a driver of knowledge sharing has been the most widely recognized (Adler 2001; Andrews and Delahaye 2000; Ciborra and Andreu 2001; De Cremer, Snyder, and Dewitte 2001). The negative effect of power games is also recognized (Husted and Michailova 2002). Power games refer here to the unjustified use of power / knowledge for personal aims.

The creation of conditions inductive and supportive of a knowledge sharing culture, symbolically named by Davenport and Prusak as knowledge market, requires continuous leadership, persistence and a right-balanced rewards policy.

All the above considerations, combined with the simple but powerful ideas behind the "iterated prisoner's' dilemma" have yielded the motivation for the creation of a simple tool that could serve for demonstrative purposes as well as testing bed for policy ideas.

2. THE DUAL PURPOSE KNOWLEDGE GAME

The software tools presented here are based on the iterated prisoner's dilemma, one of the best examples of game theory studies. Additional features and ideas were added to convey the demonstration and testing means that were found important for the knowledge sharing context, but they are based on same seminal idea.

In the prisoner's dilemma two suspects were arrested but there's not enough evidence to prove them guilt. They are separated for questioning and the police offer both the same deal. If one (suspect A) testifies against (defects) the other (Suspect B) and the first refuses to testify (cooperates), the defector (A) goes free and the (silent) cooperator (B) gets a one year jail sentence. If both remain silent (cooperate) both get a small one month jail sentence. If they betray each other, both (defectors) get a three month jail sentence. Also each prisoner will only know the other's choice (betray or remain silent) after the end of the investigation. Since the opportunities are symmetrical A and B above could be interchanged.

Let's consider this game from the point of view of a fair justice. It is known that a crime has been done which is deserving of a one year jail punishment from the State, however only circumstantial evidence exists, based on which they can only imprison the felony partners for one month. From the law point of view it is important to show to everyone that crime doesn't go unpunished and one month for each will send a dubious message. Therefore it is better to try something that will better demonstrate the power of the law and, for that matter to have both convicted for 3 months (2x3) or one convicted for 1 year is better than have both imprisoned for one month (2x1). Noting that the state considers the collective punishment, this justifies the offerings of the State to each one.

From the perspective of the suspects, since each doesn't know what the other will decide the temptation to defect is high because he can go free or at worst if the other defect too, he will get 3 months instead of one year in case he keeps silent (cooperating) and the other defect. On the other hand if they were considering themselves as an organization, their best practice would be to keep silent (cooperating), as their collective sentence would be 2 months (one for each one).

For the knowledge game one can imagine the context of a somewhat competitive, knowledge intensive organization. Then game play is induced by a task that is assigned to a worker, here designated by A. As he doesn't have the complete knowledge to do the task alone, he recognizes that, for instance, B has the complementary knowledge he needs. Now he is faced with two options: to approach B with openness and propose a fair collaboration and co-authorship, sharing the accomplishment credits, a choice named "to cooperate"; or he can try to take advantage of B and through dissimulation try to obtain as much as valuable information from him and give no credit to B, here named "to betray or to deny". Similar options are available for B when replying to A. Also note that this situation tends to occur with the same probability in a symmetrical fashion.

Here besides the payoff matrix for the players, one has to consider the "intrinsic payoff matrix" for the organization itself. This is a consideration implicitly alluded when the law enforcement perspective, for the prisoner's dilemma, was described. For the organization this has to be analyzed in terms of their knowledge capital, both implicit and explicit (codified).

2.1. The Organization's Perspective

Suppose that for the assigned task, A and B have equal and complementary knowledge, each one having an arbitrary value of 3 (units). Before the task gets to be completed, this is only implicit knowledge and there are three possible outcomes for the organization, as follows.

- A and B collaborate and the task gets done with the best content possible, so there will be an increase in the organizational explicit knowledge (OEK) of 6 units. At the same time the organizational implicit knowledge (OIK) will also be increased by 6 units, because A will have learned what B knew and vice-versa.
- A betrays and B collaborates, or vice-versa, then the task gets done but not as perfectly as in the previous situation, so there will be an increase in the OEK of 5 units. At the same time the OIK will be increased by only 2 units, because A will have learned a part of what B knew, but B will have learned nothing. The symmetrical configuration (vice-versa) can happen and for the organization the net result is exactly the same.

- A and B both betray (deny) and the task does not get done. As consequence there will no increase in both OEK and OIK.

The possibilities just described can be summarized in the organizational payoff matrix as follows.

Table 1. Organization's payoff matrix for knowledge gains

		B	B
		Collab.	Betrays
A	Collab.	Δ(OEK)=6	Δ(OEK)=5
		Δ(OIK)=6	Δ(OIK)=2
A	Betrays	Δ(OEK)=5	Δ(OEK)=0
		Δ(OIK)=2	Δ(OIK)=0

2.2. The Worker's Perspective

For the workers what it matters is how the organization rewards their efforts performing the tasks. Here there are four distinct outcomes that are presented in table 2 and explained later.

Table 2. Worker's Payoff (rewarding) matrix

		B	B
		Collab.	Betrays
A	Collab.	3 --> A	0 --> A
		3 --> B	5 --> B
A	Betrays	5 --> A	0 --> A
		0 --> B	0 --> B

Let us make explicit a couple simplifications that have to be made to make game evolution and outcomes more easily understandable and interpretable. The above matrix suggests that the organization logic is to reward what is presented explicitly. So if a task is not done no credits are assigned. It is arbitrarily assumed modular "sized" tasks of maximum value of 6 merit units. It is also being assumed that when a collaborating guy gets betrayed the betraying person is still able to take advantage of the collaborator's knowledge and get a 5/6 well appraised task.

It must be recognized that this payoff matrix reflects the rewarding policy of the organization and, given the latitude for the simplifications, the possible outcomes resemble what one normally sees in the organizations of today. If one gets apart from ethical principles the matrix numbers here, as it was in the prisoners' dilemma, put a strong temptation for a betrayal behavior, because the possibility of gains are higher. If a worker chooses to collaborate he can have at best 3 merit units and 0 at worst, while if he chooses to cooperate the odds become respectively 5 at best and 0 at worst.

3. THE GAME IMPLEMENTATION

The current state of the Knowledge Game KG3 has two versions: a *simulation tool* and an *educational tool*, both developed using NetLogo (Wilensky, 1999). NetLogo provides a great development environment, with tools specially designed for game theory simulations, easy to implement graphic user interface (GUI) and means to transform the game in a java applet that can be used through a web browser. The present version allows users to choose from 0 to 100 players for each of the built in strategies. This provides the users with means to make more realistic and statistically reliable simulations.

To watch the game evolution, in a natural way, two concepts have to be defined. They are tick and cycle. Tick is the basic game processing unit and one tick means the complete set of operations needed for: (a) two players have been chosen, (b) the interaction have occurred and (c) the outcomes of this interaction have taken place. Cycle is a macro processing unit, which extends the previous concept to the whole population of players. One cycle is therefore the complete set of operations for N players to interact, where N is total population of players. According to these definitions 1 cycle = N/2 ticks. The purpose of using cycles is that in a complete cycle the number of draws equals the number of players and then every player has an equal chance of interacting once each cycle. The use of cycle averaged values for the "performance indicators" of players or strategies makes easier to compare those values across simulations with different populations.

An interesting feature of this version is the possibility for the user to generate an ASCII output file to save the simulation results. This enables the user to post-process the output with excel to generate all the graphs that he/she would like to. Also it makes easier to use NetLogo's Behavior Space Tool.

Figures 01 and 02 show the GUI of KG3 simulation tool version and KG3 educational tool version respectively.

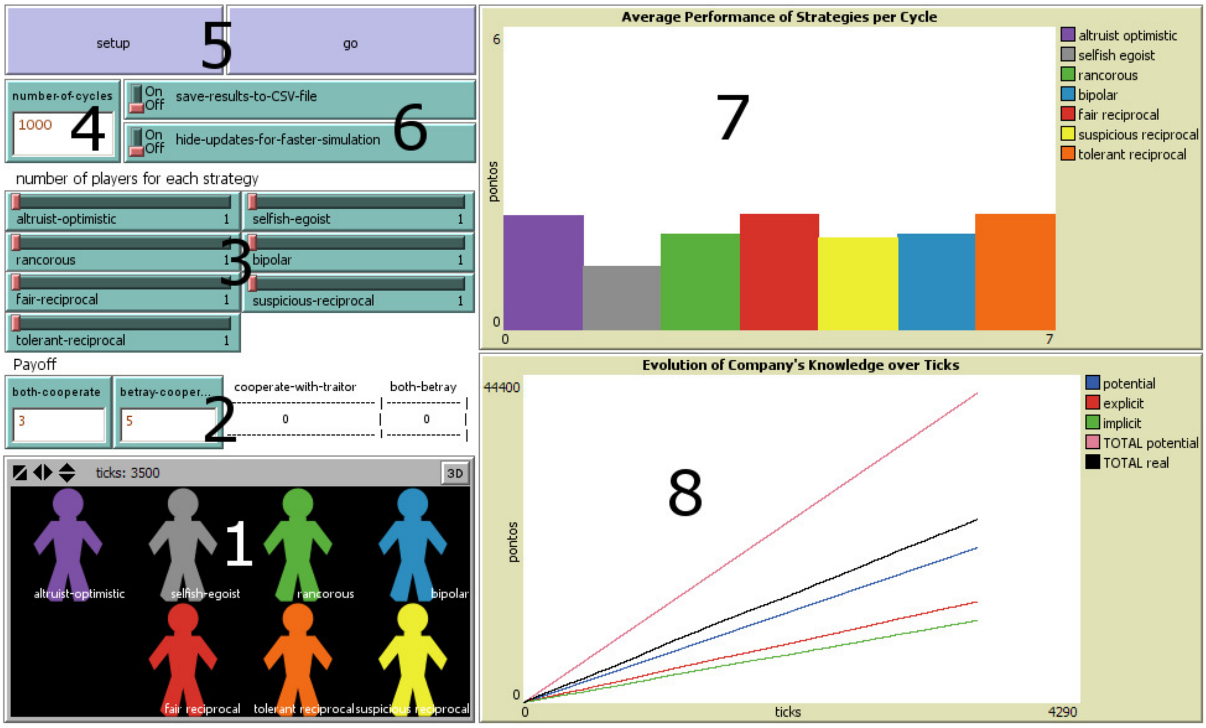

Figure 1. Knowledge Game Simulation Tool GUI.

The numbered fields in the screen shot are now explained. **1:** ***Players panel*** shows the strategy of the robot players; **2:** ***Payoff matrix*** shows awarded points in an interaction from the point of view of the first player; **3:** ***Strategies and Players Sliders*** let the user choose how many players of which strategy will participate in the game; **4:** ***Number of cycles box*** shows how many cycles will be simulated; **5:** ***Control buttons****:* "setup button" sets variables values chosen on fields 1 through 4 and "go button" starts the simulation. **6:** ***Output controls*** are two on/off buttons that allow users to save output to ASCII file and/or hide screen updates in fields 1, 7 and 8 to make simulations run faster. **7:** ***Average Performance of Strategies per Cycle plot***: shows in real time the average performance of each strategy per cycle in a histogram. **8:** ***Company knowledge plot*** shows in real time the development of the knowledge accumulated implicitly and explicitly by the company (both the real and potential values).

Since stochastic processes are being simulated in this game, the user should repeat many times the simulation, for each setup, in order to get statistically relevant results. Depending on the population size and variety, from a few to hundred thousand repetitions could be needed and that may be impracticable to do manually. NetLogo has a native tool for situations like this called *behavior space*. This tool systematically runs successive tests automatically according to simple rules created by the user. Using these rules, he/she can run a specified number of simulations store the results, change a few variables of the setup run it again and this sequence can be repeated again and again.

A second version, called "educational tool" serves the purpose of allowing humans to play with other humans and robots with strategies picked randomly or chosen by the game moderator. This version stops after each step (draft of players, picking attitude and computing the interaction) so the professor can explain what is going on in the game. The idea is to allow people that are not familiar with the game, or game theory itself, to understand the experiments on the simulation tool.

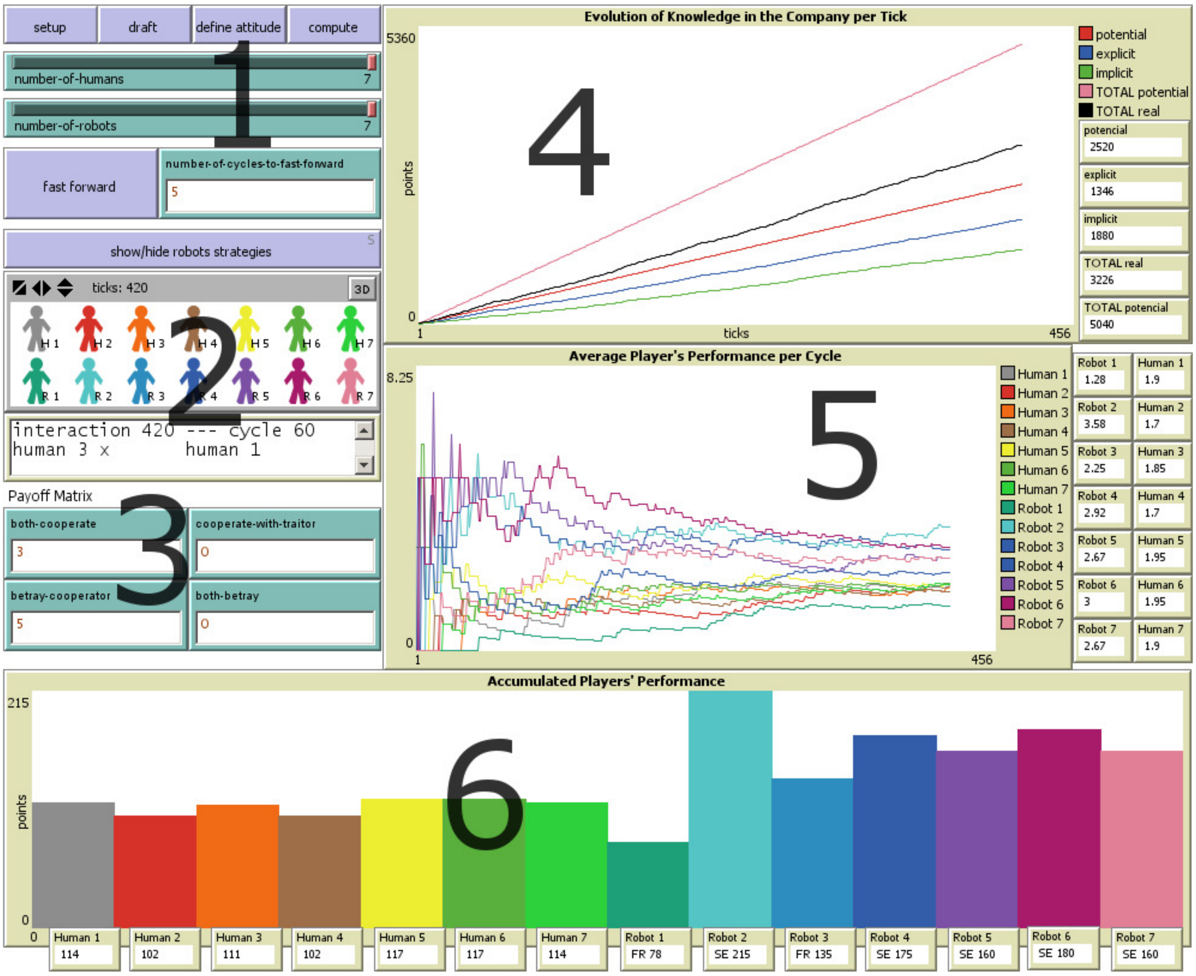

Figure 2. Knowledge Game Educational Tool GUI.

GUI features are as follows. ***1: Humans and Robots Sliders*** let the user choose how many humans and robots (with fixed strategies) will play (from 0 to 7 players and/or robots); ***Control buttons****:* "setup" button sets variables values chosen on fields 1 and 2, "draft" button" raffle two players to interact, "define attitude" button shows what players will do and allow humans to choose an attitude and "compute" button computes the result of the interaction, "fast forward" automates the running of a number of cycles specified in the "number-of-cycles" to speed up the interactions if needed. ***2: Game monitor output*** *shows information about the current game step.* ***3: Payoff matrix*** shows awarded points in an interaction from the point of view of the first player. ***4: Evolution of Knowledge in The Company Plot*** shows in real time the development of the knowledge accumulated implicitly and explicitly by the company. ***5:Average Players' Performance Plot*** show after the end of each cycle the average score of each player per cycle ***6: Accumulated Players' Performance Plot***: shows after the end of each cycle the accumulated points of each players in a histogram.

4. SOME RESULTS

First it must be noted that the one of the best demonstrations to an audience is to divide them in a few groups (4 to 7) and let them play "against each other". They will be represented by figures numbered designated from H1 to Hn (n being the number of groups). The spokesperson for each group is called upon to show simultaneously if they decide to cooperate or to betray when they are chosen in the draw. Groups that try to take advantage of others soon are recognized and after a promising start they soon get denied any other opportunity to take advantage of anyone.

Since there is a myriad of possibilities, only a few results of the educative version, using robots, will be showed and discussed below. The robots represent archetypes of persons (knowledge workers) that one usually finds in organizations.

- The **altruistic optimist**, a person that **always cooperate** with the others despite their previous history of interactions. In the game its robot will be represented by the initials AO/AC.
- The **selfish egoist**, a person that **never cooperate** with the others despite their previous history of interactions, thus behaving like a predator. In the game, his/her robot will be represented by the initials SE/NC.
- The **unforgiving rancorous**, a person that starts cooperating with anyone until he/she gets betrayed and then he/she doesn't cooperate anymore. In the game, his/her robot will be represented by the initials UR/GIM;
- The **fair reciprocal player**, a person that starts cooperating with anyone, then if he/she gets betrayed by a certain person he/she will cross this person out of his/her cooperation list, until this person cooperates with him/her. In the game, his/her robot will be represented by the initials FRP/TFT.
- The **tolerant fair reciprocal player**, a person that has a similar behavior as the FRP/TFT except that is more tolerant and has to be betrayed twice to deny further cooperation to the betrayer. In the game, his/her robot will be represented by the initials TFRP/TTFT.
- The **suspicious fair reciprocal player**, a person that has a similar behavior as the FRP/TFT except that is suspicious of the others at the beginning and denies cooperation. Her/she only starts to reciprocate to those who have cooperated with him/her first. In the game, his/her robot will be represented by the initials SFRP/STFT.
- The **bipolar** player, a person that doesn't exhibit a logical pattern in his/her behavior and in terms of programing him/her is represented by a random decision player. In the game, his/her robot will be represented by the abbreviation BP/Rand.

For the demonstration, just three archetypes were chosen as it follows. The FRP/TFT robot that represents a fair reciprocating person and whose behavior is to always begin collaborating, but if it is betrayed by the partner then in the next interactions with this person he will deny to cooperate until this person decide to cooperate. The SE/NC robot represents a predator whose behavior is to see the other as a person to be taken advantage of. The AO/AC robots represent a person that cooperates blindly without judging the partners.

4.1. Asymptotic theoretical analysis – players' perspective

In this didactic simulation 7 players were considered (2 of AO/AC, 4 of FRP/TFT and 1 of SE/NC). The chosen set up allows for a priory probabilistic appraisal of the game (average) results, which means to repeat the game a large number of times (ideally infinite) and then average the results. This experiment was conduct with a 1000 repetitions in such a way to get a discussion that can be instructive for the users. Note that from now on, whenever it is written expected value or behavior one is referring to those averaged values. To have some grounds to discuss the results of the simulations, the expected results, based on the probabilities, will be presented first.

Let us concentrate on discussing the average expected behavior, starting with the players' perspective.

From the game dynamics, at each tick there is a 2/7 probability that a given player will interact and after a large number of cycles, each player is expect to have interacted, on the average, once per cycle.

From the perspective of the SE/NC, it will take at least 6 ticks for he/she to interact with all the players and during this period he/she is expected to accumulate 6*5=30 points, which means an average performance of 5 points per tick. This would be the best possible starting scenario for the SE/NC, but from this point on he/she would score only when meeting with the AO/AC players. From this point on let us consider the expected average scenario. Any player has a 2/7 probability of being drawn each tick and once drawn the SE/NC has a 2/6 to have a positive interaction, so at each new tick, he/she has 2/21 probability of scoring 5 points, which means an average performance of 0.47619 points per tick or 1.66667 per cycle. After a large number of cycles, the asymptotic performance of this player should be 1.6667 per cycle.

From the perspective of each of other players (AO/AC and FRP/TFT), the same initial scenario would mean that each one would have interacted once with the SE/NC earning nothing. This would be the worst possible starting scenario for these players. Now considering the expected average scenario at each new tick the probability of AO/AC or FRP/TFT player the combine probability of being drawn and have a positive interaction is 15/21, for which he/she would earn 3 points. This means an average performance of 0.714286 points per tick or 2.5 per cycle.

In this context, some degree of fairness on the overall outcome is observed as on the average each player of the group AO/AC and FRP/TFT is achieving a 50% better performance than the "selfish egoist".

4.2. Game results – players' perspective

Figure 3a and 3b, below, shows the results of a simulation done using the educational version. Only robots were used. Robots 1 and 2 use the AO/AC strategy, 3, 4, 5 and 6 use a FRP/TFT strategy and robot 7 uses SE/NC strategy. As one can see in figure 3a, in the beginning, SE/NC player, robot 7, do well but after lot of cycles, shown in figure 3b, it is clear that FRP/TFT players stop cooperating with SE/NC. The average score per cycle of SE/NC lowers as FRP/TFT stop cooperating with them but SE/NC robot still scores when it plays with AO/AC.

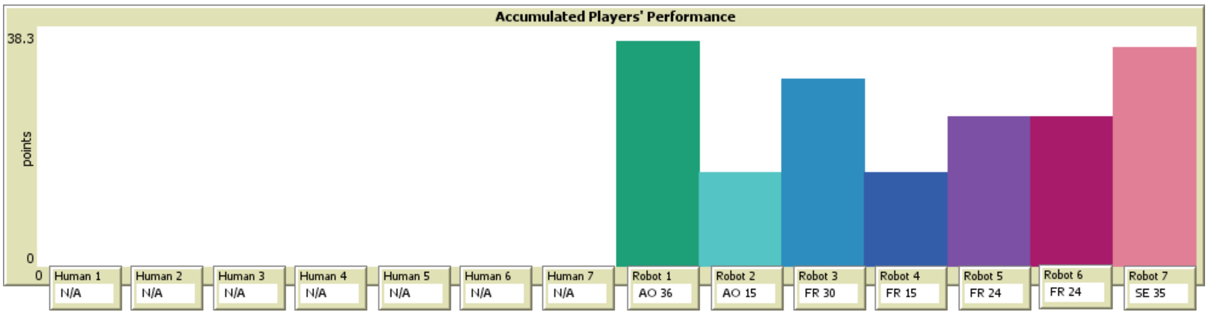

Figure 3a. After 10 cycles.

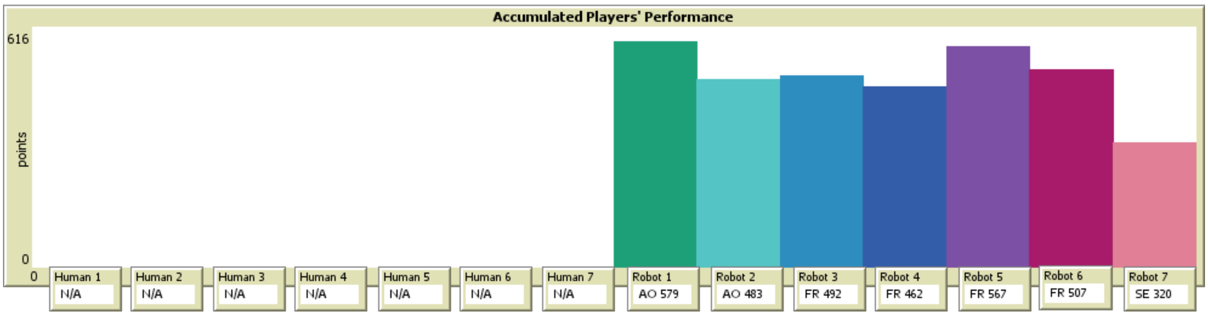

Figure 3b. After 200 cycles.

4.3. Analyzing game results and expected asymptotic behavior – players' perspective

Figure 4 shows the average of players' performance per cycle, this is, how many points a player scored on average per cycle. This plot makes it easier to understand the two moments presented on histograms of figures 3a and 3b. The pink line shows the development of robot 7. In the beginning it scores well but after a while the FRP/TFT players understand its strategy and stops cooperating with him/her. After that robot 7's average score drops considerably and stays that way after the system stabilizes.

From the theoretical analysis, it was reasonable to expect that for the first cycles the SE/NC would outperform all the other players and this can be seen in figure 3a and 4. On figure 4 it is observed that this player has an astonishing start, with a peak performance, 10 points per cycle, then dips down dramatically for the next 15 to 20 cycles and continues to drop more smoothly landing on its asymptotic value, which has practically been reached at around 100 cycles. From then on small variations around this value are due to the stochastic process.

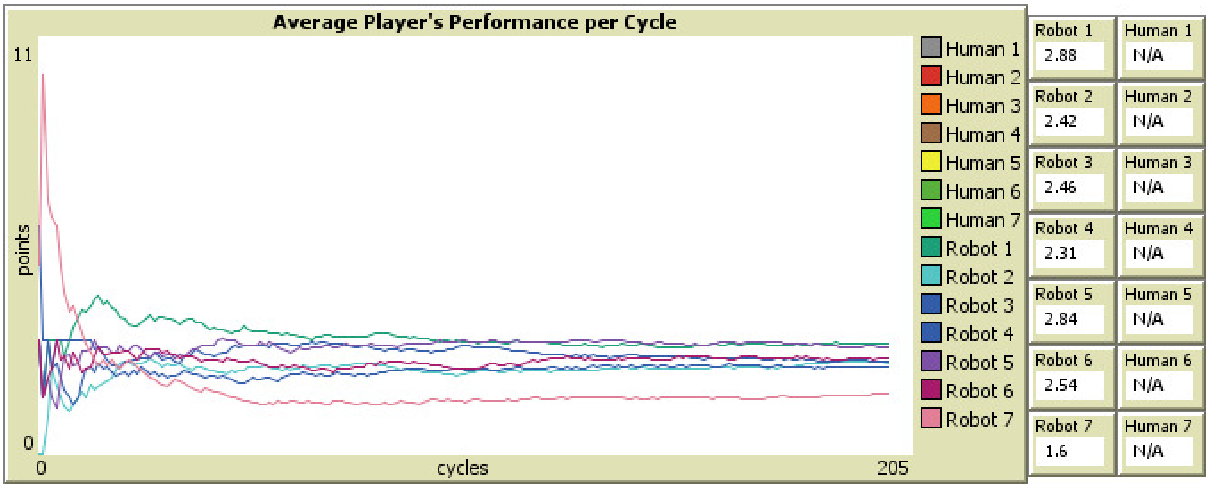

Figure 4. After 200 cycles.

To better understand the natural variation of the stochastic process and the foreseen asymptotic values, using the simulation tool 1000 automatized repetitions of the setup were simulated. Table 3 brings data comparing mean scores, its standard deviation, for a thousand simulations and scores for a single randomly chosen simulation. When comparing results for ten or fifty cycles it is possible to notice considerable differences in values but at the same time high standard deviation values, meaning that values vary a lot. For results of one hundred and two hundred cycles variation between results of one trial and one thousand trials vary much less and standard deviation values decay a lot. It should be observed that at two hundred cycles each simulation has practically reached its particular asymptotic behavior and the averaged (mean) results for the 1000 runs at this point (200 cycles) should substantially coincide with the theoretically calculated asymptotic values. Comparing these values for the AO/AC and FRP/TFT the discrepancies are less than 0.3% which is less than 5% of the standard deviation. For the SE/NC player the difference is 6.1%, a somewhat more noisy convergence.

Table 3. Comparing 1000 Trials Average and 1 Trial Results

	10 cycles			50 cycles			100 cycles			200 cycles		
	1 trial	1000 trials		1 trial	1000 trials		1 trial	1000 trials		1 trial	1000 trials	
		mean	SD (%)		mean	SD (%)		mean	SD (%)		mean	SD (%)
altruist optimist A	3.27	2.506	30.3	3.24	2.490	13.4	2.94	2.494	9.3	2.88	2.498	6.8
altruist optimist B	1.50	2.496	29.9	2.28	2.501	13.2	2.10	2.496	9.5	2.42	2.508	6.7
fair reciprocal A	3.00	2.474	30.7	2.88	2.521	13.5	2.85	2.517	9.7	2.46	2.498	6.7
fair reciprocal B	1.50	2.476	30.4	1.92	2.506	13.3	2.25	2.509	9.3	2.31	2.498	6.7
fair reciprocal C	2.40	2.470	31.3	2.88	2.512	13.5	3.00	2.497	9.3	2.84	2.508	6.6
fair reciprocal D	2.40	2.492	31.5	2.46	2.490	13.5	2.25	2.496	9.8	2.54	2.495	6.5
selfish egoist A	3.50	3.340	27.1	1.40	2.058	18.9	1.40	1.862	14.4	1.60	1.769	9.1

4.3. Further comments – organization's perspective

For the organization from the 21 different pairs that can be drawn at each interaction tick, the effective results can be summarized in table 4.

Table 4. Cost benefit analysis of the interaction types

		Knowledge gain of the organization					Merit units awarded by the organization			
		per outcome			Per tick	Per cycle	outcome		Per cycle	
Draws outcomes	number	Δ(OEK)	Δ(OIK)	ΔK	δK_t	δKc	Player A	Player B	Player A	Player B
Possible pairs (A-B)	21									
SE/NC - AO/AC type	2	5	2	7	0,6667	2,3333	5	0	1,6667	0
SE/NC - FRP/TFT type	4	0	0	0	0,0000	0,0000	0	0	0	0
All other types	15	6	6	12	8,5714	30,0000	3	3	2,5	2,5
Average outcome		4,7619	4,4762	9,2381	9,2381	32,3333				

As one can see interaction of the type SE/NC - AO/AC gives a return of 7 knowledge units (ku), but demands a cost of 5 merit units (mu) which means a 1.4 ku/mu performance coefficient. On the other hand, all other interaction types that don't involve the SE/NC player have a unitary return of 12 ku for a cost of 6 mu, resulting in a 2.0 ku/mu performance, a much better result. Interactions of the type SE/NC – FRP/TFT don't have cost and don't give return either and so can be seen as opportunity losses, but from a another point of view the frequency of this occurrence could be seen as indication of players (workers) of predatory behavior. Although the game robots represent archetypes, there are many persons whose behavior resemble very closely to those of these archetypes and rewarding/punishing policies could be envisioned and tested in such a way as to act as a filter to make life uncomfortable for those guys of predatory behavior and maybe screen them out of the organization.

5. CONCLUSIONS AND FUTURE ENHANCEMENTS

The purpose was mainly to show the development of a demonstration tool to motivate knowledge sharing. The small sample of results serves to hint that it has a great potential to fulfill the purpose for which it was developed. By the time this paper will be presented the game will be available over the net.

A large set of simulation setups are being tested and they will be published later to better demonstrate the game potential. Also three new features will be added to the game in the near future. The first will enlarge the possibilities of testing policies and will allow to the organization to automatically fire workers that get poor performance to accomplish a tasks, either failing a consecutive (x) number of times or by having an accomplishment performance below (y%), x and y being user's choice. The second will enable to add noise to the communication, in such a way that there will be a probability (chosen by the user) that a player gets a wrong information of the real behavior of its interacting partner. This feature is envisioned to show that transparency and good communications are essential to avoid the organization to loose knowledge. The third will include some "intelligent" robots that use some kind of optimization technique (such as genetic algorithms, Bayesian learning, etc.) to achieve maximum performance. This last feature will be especially interesting to test which kind of policies can be inductive of cooperation even for smart self-interested agents.

In addition to these features news forms to organize and display the results are being discussed and tested.

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