An Experimental Study of Strategic Information Sharing

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Abstract:

Information exchange is an integral part of group decision making. Existing research indicates that individuals share information to some degree strategically. Reasons for strategic actions are mainly differences in preferences. Differences in information processing were mainly neglected. I propose an experiment that investigates specifically in strategic information sharing when differences in information processing exist. The experiment is a common group decision experiment in which individuals receive private signals about the color of an urn and can share this information to come to a more informed group decision. The difference to previous experiments is that a single individual plays with two bots in one group. The bots are biased in their information processing and the bias is known to the participants. This enables participants to react to the bias and act strategically in their signal sharing behavior. The game was implemented on nodegame as a single player game with two automated players whose actions take place on the server. A risk task and questionnaire help to estimate the effect of risk preferences and cognitive abilities on the strategic behavior of individuals.

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Introduction

Whenever decisions are made in committees or small groups information is shared among the group members. However, not all group members process information the same way. Differences in information processing can lead to differences in posterior beliefs. To avoid undesired outcomes, strategic agents might hide some private information from other agents. The question that remain is to which degree do strategic agents use their knowledge about individual biases and strategically hide pieces of information?

Whenever individuals are processing information in a similar way and preferences are aligned credible information transmission is possible between agents in various settings. However, as soon as preferences diverge this becomes more difficult. In their seminal work Crawford and Sobel (1982) show that in a game with one sender and one receiver only partially informative signals can be sent and only if interests are not too dissimilar. Experimental evidence shows that partial common interest is a coarse predictor of communication (Blume et al., 2001; Cai and Wang, 2006).

The difference between the situation of communication in normal sender-receiver games as described above to committees is that in committees the final decision is taken by a majority vote of all agents while in a sender-receiver game only the receiver makes the decision. In committees where individuals receive a private signal and there is no communication there are situations in which sincere voting cannot be a Nash equilibrium (Feddersen and Pesendorfer, 1998). However, when communication is possible, a sincere revelation strategy with an informative signal in the first stage and sincere voting in the second stage can be a Nash equilibrium strategy when individual preferences do not diverge too much (Coughlan, 2000). Experimental evidence shows that if communication is possible, individuals tend to share information truthfully and that deliberation improves decision making generally (Goeree and Yariv, 2011).

All of this previous research assumes that individuals who share information might have different preferences, but are similar in their way of processing information. But a lot of research questions this assumption and investigates situations where agents suffer from different cognitive biases like correlation neglect or confirmatory bias (Rabin and Schrag, 1999; Levy and Razin, 2015; Ortoleva and Snowberg, 2015). Empirical evidence supports the existence of these cognitive biases and shows that the degree to which people suffer from those biases varies between individuals (Enke and Zimmermann, 2017; Eyster and Weizsäcker, 2011). However, there is no conclusive research that shows how individuals react on facing other individuals who suffer from any cognitive bias.

Previous experimental designs were unable to uncover the strategic reactions on differences in information updating behavior because individuals could not interact long enough with another to uncover these differences, making strategic adaption impossible. In my experimental design humans interact in a group with automated player. The predictability of automated players behavior enables the experimenter to tell participants the cognitive biases of group members and observe strategic behavior of individuals when facing differences in information updating.

The Experimental Design

The experiment is a single player version of the urn game used on previous experiments on committee decision making (Goeree and Yariv, 2011). In this game participants have the task to make a decision on the color of an urn following some majority decision rule. The urn can either be blue or red, and both states of the world are equally likely. Every participant receives a private signal that is correlated with the true state of the world. Participants are paid if their final decision is the same color as the color of the urn they were facing.

The experiment that I propose is a variant of the described urn game in which a single human participant plays with two automated players. The three members committee still has the single task to decide on the color of an urn. They each receive between 0 and 3 private and independent signals about the true color of the urn. Table 1 shows the probability for receiving 0, 1, 2 or 3 signals respectively. With a probability of 0.6 a signal shows the same color as the urn with a probability of 0.4 it shows a different color.

Table 1:

Number of Signals	p
0	0.027
1	0.189
2	0.441
3	0.343

After seeing the signals the human player has to decide whether and which signals she wants to communicate to the automated players. Since the number of received signals is unknown, it is impossible to uncover for the automated players whether a signal was hidden or not. Players cannot lie about the color that a signal shows which resembes a situation with verifiable information. The automated players always share all of the signals they received truthfully.

In the second step of the experiment, the participants receive the information which signals were shared by each group member and then have to vote about the color of the urn, either red or blue. The automated players also receive all shared signals and make their decision as follows:

1. They count the number of red and blue signals.
2. They multiply each number with a known bias parameter.
3. They vote for the color that has the higher number.

The bias parameters differ between different treatment groups. The *control* group has a parameter of 1 for both colors. Therefore the decision process is not biased at all. The *low bias* treatment group has a bias parameter of 1.3 for the red signals and a bias parameter of 1 for the blue signals. This means they overvalue red signals slightly. In the low treatment the bias is rather unlikely to affect the voting behavior of the automated players. The high bias treatment group has a bias parameter of 1.7 for the red signals and a bias parameter of 1 for the blue signals. In such situation it very likely that the bias affects the voting decision of the automated players. Rational actors would only hide signals strategically if it is beneficial for them meaning that it prevents the automated players from making an incorrect voting choice.

H1: The higher the bias that automated players have in information processing, the more frequently do participants hide information.

However hiding information in order to change the voting decision of the automated players is a risky strategy as it is an active manipulation of the information pool of the committee members. More risk loving participants should be more willing to manipulate the information they present in order to change the automated players' behavior.

H2: The more risk loving a participant is, the more frequently does the participant hide information.

In the experiment, I use the risk task by Holt and Laury (2005) to measure the risk preferences of individuals. The task is a standard measurement for risk preferences and gives a relatives fine-grained measurement of risk attitudes.

Implementation

The experiment was implemented using nodegame (Balietti, 2017), a javascript based software. The structure of the game is defined in *game.stages*-file. My game includes a first stage in which participants are informed about their rights and how the data is used. The next stage introduces the rules of the urn game are presented. A short quiz tests the participants understanding of the instructions. After answering the quiz the actual game starts which consists of three different steps. In the first step the participants receive up to three signals. The signals are the result of multiple random drawn numbers. First, a random number decides whether the color of the urn is red or blue. A second randomly drawn number decides whether a signal contains a color or is empty and a third number decides whether the true color or the wrong color is contained in the signal. For each signal, the player has a *radio button* to decide whether this particular signal should be shared with the automated players or hidden. Submitting the decision and moving on to the next step saves the color of the urn, the signals and the decisions on the server.

In the next step the voting takes place. Most of the implementation of this step runs on the server side. Here, based on the previously chosen color of the urn, the signals for the automated players are drawn. Automated players always share all signals that are non-empty. Further their voting decision is calculated based on the signals the automated players received, the participant shared and the bias of the treatment that the participants are in. Further the committee decision is made. This is possible because both automated players work and vote equally. Therefore, the vote of the participant is never pivotal and the automated players decide alone on the committee decision. On the players side, the signals that were sent by the server are presented to the player and she has to vote whether the urn is red or blue. The vote does not change the committee's decision but the players are paid for a correct voting decision.

The voting action saves the participant's voting decision and committee's decision in the data and leads to the last step in the game in which participants receive feedback about the previous game to be able to learn from their previous behavior. On the server side data from previous rounds is retrieved, decisions are checked and payoffs are calculated. Then everything is sent to the player and displayed. Participants play the game three times.

After the actual experimental task, participants decide on the risk task by Holt and Laury (2005). For the implementation I use the widget *Risk Gauge*. Since the task is monetarily incentivized, it necessary to create a feedback page after the widget that informs the player about the lottery that was actually played and the payoff she receives from the chosen lottery. The last two stages consist of a questionnaire that measures cognitive ability and some demographic questions. In the end, participants are informed about their final payment.

Since this game is a single player game there were no major problems with the interaction between different players or a necessity to program bots. Existing widgets like the *Risk Gauge* or *Choice Manager* made the implementation easier. My main problem was understanding how messages are sent from the player to the server and the other way around. The difficult part here was to understand that messages can only be sent within the same step and to get the players ID. The wiki page was my main source that helped me implement the game. A second challenge was retrieving data from previous stages. Again, the wiki page helped me to solve this problem.

I was unable to create a working back-button and a working info-button in the header. The main problem here seems that I have to destroy these buttons at some point in the game, but they do not disappear. I have not yet figured out how to solve this problem, but it should be solvable with some more time.

Conclusion

I implemented a game that modeled a group decision in which one human interacts with two automated players. Since the game is only played by a single player, difficulties of games that are played by multiple players who have to interact are avoided. I am convinced, that this makes my game also quite stable and insusceptible for technical bugs. Since the experiment is just a first step on a larger research agenda, my data can only answer a small part of the overarching research question.

Further, the game is very abstract and the artificial biases of automated players barely reflect the rather subtle biases that humans encounter and react to in real life. Therefore results have be treated with caution and future research that puts participants in more difficult situations is needed.

However for future research, the game might be extended by playing this game with larger groups of three automated and biased players and two human participants. In this case both participants would also need to receive the shared signals of their partners. The implementation should not be too difficult, as in this case a loop through all IDs of all players in one room would still lead to the same results. The implementation of the payment might be slightly different, as payments have to be assigned to the correct player.

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