Evidence for Learning to Learn Behavior in Normal Form Games
Supplemental Information

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Appendix A: Details on Interview Response Classification

In examining the responses to the interview questions, there were 17 different categories of learning behavior identified. Graphs showing their frequency of use can be found in tables 1-3. Brief definitions of each of the rules that were followed for the classification procedure are as follows:

1. Random - Choosing randomly or for no particular reason.

2. Reinforcement - Choosing a strategy because it has performed well in the past.

3. Inverse Reinforcement - Choosing a strategy that has performed poorly in the past. The reasoning is that it will be unexpected.

4. Step-1 Reinforcement - Assuming your opponent is using a reinforcement learning rule and choosing a best response to that.

5. Step-1 Inverse Reinforcement - Assuming your opponent is using an inverse reinforcement learning rule and choosing a best response to that.

6. General Belief Updating - Choosing based on examining an opponent's play history and choosing a perceived best response to it. This category used when the response was not able to be categorized into one of the more specific belief updating subclasses.

7. Fictitious Play - Choosing a best response to the probability distribution of your opponent's entire history of plays.

8. Limited History Fictitious Play - Choosing a best response to the probability distribution of your opponent's most recent five or so plays.

9. Cournot - Choosing a best response to the most recent play by an opponent.

10. Inverse Cournot - Choosing the worst, again in anticipation of it being unexpected.

11. BMCP - Best Response to the Most Common Play of an Opponent.

12. BLCP - Best Response to your opponent's Least Common Play.

13. Step-1 - Choosing a best response to your opponent's best response to what your belief is of their belief of your intended choice.

Rule	Period 10	Period 20	Period 30	Period 40
Random	0.11	0.09	0.25	0.39
Reinforcement	0.04	0.03	0.00	0.00
Inverse Reinf	0.00	0.00	0.04	0.04
Step-1 Reinf	0.00	0.00	0.00	0.09
Inv Step-1 Reinf	0.00	0.00	0.00	0.00
Ganeric BU	0.07	0.18	0.04	0.04
Fictitious Play	0.04	0.00	0.00	0.00
5 Pd. Fic Play	0.04	0.03	0.04	0.00
Cournot	0.07	0.00	0.04	0.00
Inv Cournot	0.04	0.03	0.00	0.00
BMCP	0.11	0.12	0.04	0.09
BLCP	0.14	0.00	0.04	0.04
Step-1	0.11	0.12	0.08	0.09
Step 2	0.00	0.00	0.08	0.00
Pattern Recog	0.11	0.21	0.13	0.13
Pattern Avoid	0.07	0.09	0.04	0.00
Pattern Create	0.07	0.09	0.17	0.09

Table 1: Fraction of the subjects in the type A sessions who reported using the various decision rules after each reporting period.

14. Step-2 - Assuming your opponent is choosing according to a Step-1 rule and choosing a best response to that.

15. Pattern Recognition - Choosing based on a perceived pattern in an opponent's play.

16. Pattern Avoidance - Choosing intending to avoid creating a pattern.

17. Pattern Creation - Choosing intending to create a pattern that you can try to exploit.

Appendix B: Experiment Instructions

Upon entering the lab for the experiments, the subjects were asked to read and sign a consent form and sit at any of the available computers. Once all of the subjects were present, they were asked to turn to their computers and enter their name and Social Security number to login to the system. This information was kept for accounting purposes only and the subjects were informed of this. After logging in to the system, an introductory screen appeared with the following language:

Introduction

You have chosen to participate in an economic experiment on decision making. Please be sure to read and sign the consent form offered before continuing further. If you have any questions please raise your hand and ask the proctor.

In this experiment, you will be randomly paired with another participant and each of you will be making a series of decisions for 40 rounds. Each period, the decisions made by you and your opponent will be matched together to determine the payoff each of you receives. At the end of the experiment, your payoffs from each period will be added up. The points you earn will be converted into dollars at the rate of 6.6 points = 1 dollar and rounded to the nearest 50 cents. Your earnings will be paid to you in cash at the end of the experiment.

Rule	Period 10	Period 20	Period 30	Period 40
Random	0.23	0.17	0.19	0.28
Reinforcement	0.27	0.13	0.08	0.00
Inverse Reinf	0.00	0.09	0.04	0.00
Step-1 Reinf	0.04	0.04	0.04	0.11
Inv Step-1 Reinf	0.04	0.04	0.00	0.00
Ganeric BU	0.12	0.04	0.23	0.22
Fictitious Play	0.00	0.00	0.00	0.00
5 Pd. Fic Play	0.00	0.00	0.00	0.00
Cournot	0.00	0.00	0.00	0.06
Inv Cournot	0.00	0.09	0.08	0.00
BMCP	0.00	0.04	0.08	0.06
BLCP	0.00	0.00	0.00	0.00
Step-1	0.00	0.00	0.00	0.00
Step 2	0.00	0.00	0.00	0.00
Pattern Recog	0.12	0.17	0.23	0.22
Pattern Avoid	0.04	0.00	0.00	0.00
Pattern Create	0.15	0.17	0.04	0.06

Table 2: Fraction of the subjects in the type B sessions who reported using the various decision rules after each reporting period.

Rule	Period 10	Period 20	Period 30	Period 40
Random	0.17	0.12	0.22	0.33
Reinforcement	0.15	0.07	0.04	0.00
Inverse Reinf	0.00	0.03	0.04	0.02
Step-1 Reinf	0.02	0.02	0.02	0.10
Inv Step-1 Reinf	0.02	0.02	0.00	0.00
Ganeric BU	0.09	0.14	0.14	0.12
Fictitious Play	0.02	0.00	0.00	0.00
5 Pd. Fic Play	0.02	0.02	0.02	0.00
Cournot	0.04	0.00	0.02	0.02
Inv Cournot	0.02	0.05	0.04	0.00
BMCP	0.06	0.09	0.06	0.07
BLCP	0.07	0.00	0.04	0.02
Step-1	0.06	0.07	0.04	0.07
Step 2	0.00	0.00	0.04	0.00
Pattern Recog	0.11	0.21	0.18	0.17
Pattern Avoid	0.06	0.05	0.02	0.00
Pattern Create	0.11	0.12	0.10	0.07

Table 3: Fraction of all the subjects in the experiment who reported using the various decision rules after each reporting period.

If at any point you have a question, please raise your hand and a proctor will help you. Please refrain from talking during the experiment and from looking at the screens of other participants.

Upon pressing the button marked "Continue" on the introductory screen, they began the main help system. This system consisted of a screen such as is found in figure 1 in which a series of instructions were delivered to the subjects. Subjects could progress at their own pace through the instructions and were encouraged to test the interface liberally to be sure they were familiar with it. In the first screen, all of the buttons except the "Continue" button were de-activated. As the subjects made their way through the instructions, the relevant sections of the interface were highlighted and activated. Note that this figure was the one used for type A or unconstrained sessions. The one used for type B sessions did not have the "Opponent Choice" column. Instruction sets for both sessions follow.
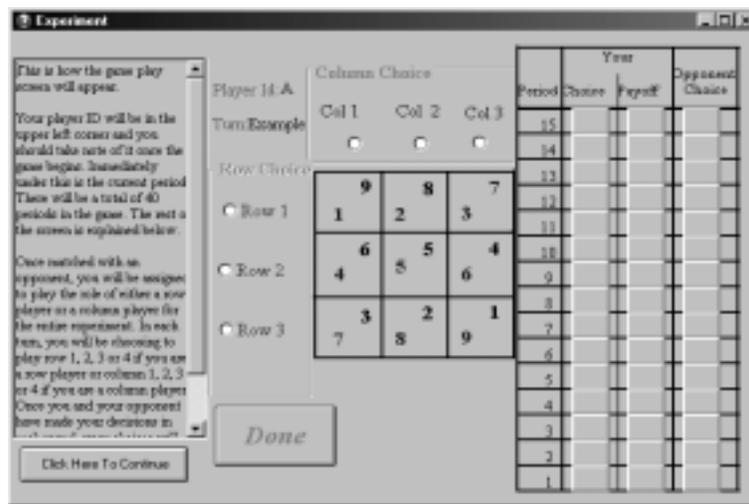

Figure 1: Sample Help screen.

Help Screen 1 - A & B

This is how the game play screen will appear.

Your player ID will be in the upper left corner and you should take note of it once the game begins. Immediately under this is the current period. There will be a total of 40 periods in the game. The rest of the screen is explained below.

Once matched with an opponent, you will be assigned to play the role of either a row player or a column player for the entire experiment. In each turn, you will be choosing to play row 1, 2, 3 or 4 if you are a row player or column 1, 2, 3 or 4 if you are a column player. Once you and your opponent have made your decisions in each round, your choices will be matched up and payoffs assigned according to the payoff matrix.

Help Screen 2 - A & B

The payoff matrix is the box located in the center of the screen. As you can see, there are 3 rows and 3 columns in the example. The matrix used for the real game will have 4 rows and 4 columns but will otherwise appear and function the same. In each cell of the matrix, there are two payoffs. The one in the lower left corner is the payoff to the row player if that cell is reached and the number in the upper right corner is the payoff to the column player. Thus according to this matrix, if in a turn the row player picked row 3 and

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the column player picked column 1 then the row player would receive a payoff of 7 while the column player would receive a payoff of 3.

Note: Once the game has begun, your payoff for a row and column combination will be highlighted in blue as they are for the row player now.

Help Screen 3 - A

To help in your decision process you can choose to view information on the history of the game. On the far right side of the screen are three columns of buttons. The first two contain information concerning your payoff and strategy choice history and the third contains information on the history of your opponent's past plays. For the previous 15 turns of the experiment you can choose to view the payoff you received and the you strategy used by clicking on the button in the payoff column (clicking on the buttons in the strategy column does nothing). The third column allows you to choose to view the strategy used by your opponent in each of those rounds. You can select to view as much or as little information as you like.

Try clicking on some of the buttons now to see how they work. You can try as many as you like but you must choose one from both your opponent's past plays list and your payoff history list to continue.

Help Screen 3 - B

To help in your decision process you can choose to view information on the history of the game. On the far right side of the screen are two columns of buttons. They contain information concerning your payoff and strategy choice history. For the 15 previous turns of the experiment you can choose to view the payoff you received and the strategy you used by clicking on the button in the payoff column (clicking on the buttons in the strategy column does nothing). You can select to view as much or as little information as you choose.

Try clicking on some of the buttons now to see how they work. You can try as many as you like but you must choose to view at least one period's worth of information before continuing.

Help Screen 4 - A

Once you have made your decision in a round, select the row or column you wish to play by clicking on the circle by that row or column.

You may change your decision as many times as you like. When you have finally decided click on the button marked "Done" to continue. Once you have, you will have to wait until the others are finished and then you will be told what your payoff was for that round and you will move on to the next period.

Make choices for both a row and a column player and then click on the "Done" button now to see how it works. You can try this many times, but you must do so at least once to continue. Clicking on the "Continue" button now will begin the game..

When subjects made strategy selections and pressed the "Done" button, a dialog would appear informing them of what payoff each player would receive for these choices. Subjects were encouraged to try this several times to make sure they understood how payoffs worked.

During the type B sessions, when the information institution was changed, a dialog appeared to explain the additional information available.

Information Institution Change Help Screen - B

The game has now changed slightly. From now on, instead of just being able to see information on your own past payoff history, you can now choose to view information on the history of your opponents past plays. You can do so by clicking on the cells of the new column marked "Opponent Choice".

Note: You can still view as much or as little information as you like. You can also choose to view any combination of past payoffs of your own or past plays made by your opponent. Otherwise the game works exactly as it did before.