The effect of redacted information on multiple-party conflict

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Abstract

There are multiple words to describe different situations of being uninformed: the information is redacted, or it is omitted, or it is chosen deliberately to be uninformed. This renders multiple interpretations for the simulation result, depending on one's preference. Usually it is good practice to hold multiple contingencies. I simulate a 3 player sequential Hawk Dove game with agents using different information structure, under evolutionary selection force. The result is that: A sequential game that is transparent gives full advantage to the first mover. But in a multiple party conflict, negotiation power can come from manipulating the information structure of the game (i.e. the way one sees the world) including to uninform oneself from the situation. This should be done in a game theoretically public way, so that the ignorance becomes common knowledge.

1 On conflicts and negotiation of conflicts

I have always wanted to do something about the war (i.e. sustained conflict). In this realm, naturally it is about the Hawk Dove game. Since professor Epstein makes a reasonable case on why computer program can be a legitimate deductive proof, I feel safer doing evolutionary agent based model.

The Hawk Dove game tries to capture the situation of conflicting interests among different parties. Therefore it has been used to study war situation in human society. There is a prize V. Player can choose to fight (to be hawkish) or to be peaceful (to be dovish). The cost to fight is C (V < C). If both party fight, they both have 50% chance of winning, and both suffer the cost C. So they both have the expected payoff of $\frac{V-C}{2}$. If one party fights and the other stays peaceful, the fighter gets the prize and the other gets nothing. If both play peaceful, they share the prize.

Aumann says that if we share the same prior, we would not be able to agree to disagree. However, it also means that if we have different data history, different gene settings (which we do), conflict is inevitable. Also, human race has distributed almost everywhere across the earth surface. We has reached a point of being so crowded, it guarantees conflicts. We also have evolved to a certain level of sophisticated civilisation that requires delicacy in dealing with these conflicts. At the hottest spots where powerful players cross paths and multiple causes intertwine, conflicts have been relentlessly fuelled for many generations causing lots of collateral damages. Sometimes the war goes on for so long the cause is lost and the war becomes personal. Many times it has become so much harder to figure out the right, the good, and the should-be for the complicated situation.

In this study, firstly, I study the 3 player Hawk Dove game structure to model a conflict situation that involves more than two players. It turns out that the information structure and (deliberate or not) omission of information becomes so much richer compared to the 2 player situation. Sometimes no information at all (i.e. ignorance) is better than knowing only part of the information. I can also study a version of the Hawk Dove game in which one party is a bit weaker. The motivation is that if conflicts are inevitable, and there are parties that insist on going for a sustained conflict, maybe we can do something about the collateral damages, i.e. people that are called refugees or immigrants instead of expats. Maybe there would be a choice for people who do not fight the war of rich men. Even the finitely repeated Hawk Dove game can provide a rational option of equality (or peaceful situation). There could be region of patient that leads to peace being sustained for some short period of time. If the game becomes infinite, with role play. When the game becomes infinite, without role play, it supports the middle situation (fair or peace) as a legit Nash equilibrium. In this case, the Hawk Dove game becomes the Nash Demand game as a natural extension. Unfortunately, as discussed in the previous chapter, this Nash Demand game if repeated, still allows equilibria in which players act aggressively in the negotiation process, causing inefficiency for the society as a whole.

Since Epstein argues that simulation has a certain satisfactory degree of deductive reasoning, I would take the argument as granted assumption to justify my simulation. I would speak briefly about the game and some obvious variations then I would simulate the sequential 3 player Hawk Dove game with different information structure and let the populations evolve.

2 The standard Hawk Dove game and some variations

3HD	2 Hawks	1 Hawk	0 Hawk
Hawk	$\frac{v-2c}{3}$	$\frac{v-c}{2}$	v
Dove	0	0	$\frac{v}{3}$

Table 1: Standard Hawk Dove Game, $v < c$

3HD	Hawk	Dove	Hawk	Dove
Hawk	$-\frac{8}{3}$	-1	-1	4
Dove	0	0	0	$\frac{4}{3}$
		Hawk		Dove

Table 2: 3 player Hawk Dove game, conventional values V = 4, C = 6

3HD	Hawk	Dove	Hawk	Dove
Hawk	$-\frac{8}{3},-\frac{8}{3},-\frac{8}{3}$	-1,0,-1	-1,-1,0	**4,0,0**
Dove	0,-1,-1	**0,0,4**	**0,4,0**	$\frac{4}{3},\frac{4}{3},\frac{4}{3}$
		Hawk		Dove

Table 3: 3 player Hawk Dove game, full matrix

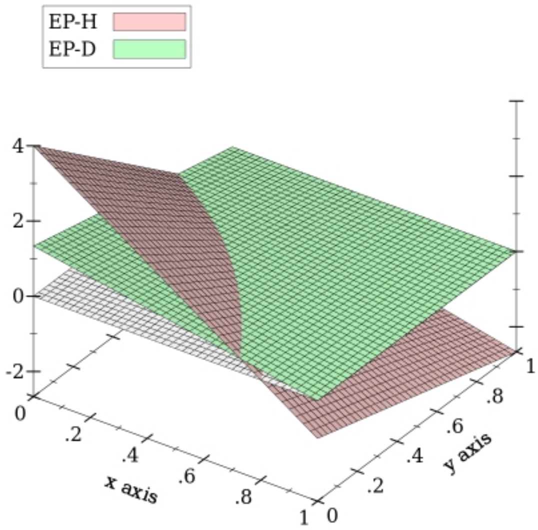

Figure 1: 3 player Hawk Dove game: more players, less Hawk, less payoff

When we add another player, the punishment for being Hawkish gets bigger which decreases the number of Hawk, but at the same time, the prize also shrinks when shared which increases the Hawk. Overall, the area of best response to play Hawk is smaller. In the 2 player game, it would be 2/3 to play Hawk. In the 3 player game, players are aggressive in a smaller curvy area. With more players, the percentage of aggressive behavior reduces.

2.1 Payoff variations

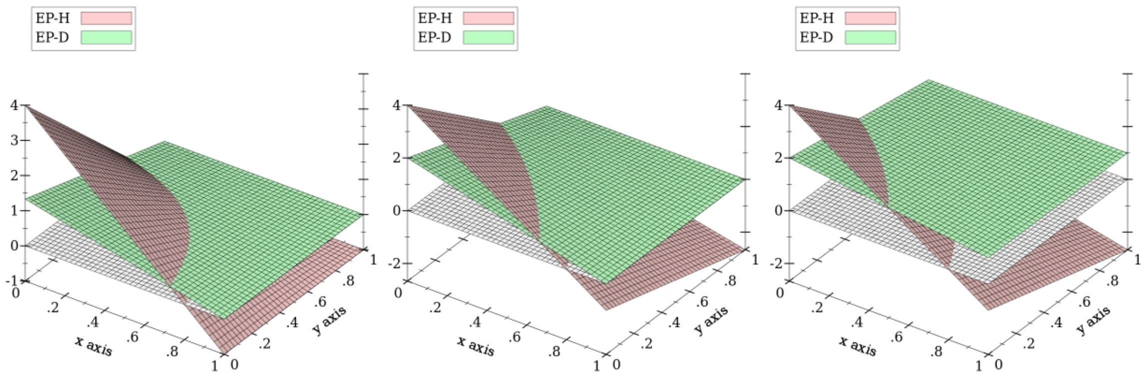

Figure 2: Increase the punishment, reward dove more, increase compensation: Hawk decreases − > average payoff increases

In the mixed equilibrium of the standard game, the rate of Hawk is 0.4 and the average payoff is 0.4. Less rate of Hawk compared to the 2 player game, but also less average payoff.

2.2 One population

If the game is played within one population, the aggressive rate is 0.4 and the average payoff is very small 0.2

2.3 Compensation for the dovish party

We modify the dovish payoff of P3. Whenever someone plays Hawk and P3 choose to run (i.e Dove), the payoff of P3 is not 0 anymore. In one case, it is -0.5, in another case it is 0.5. The equilibria of the game do not change, but the rate

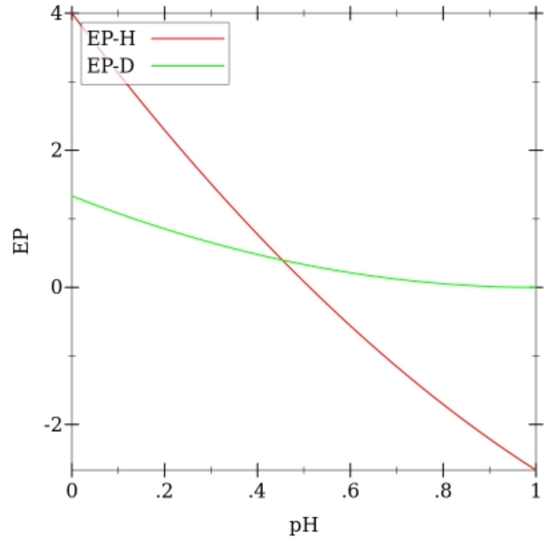

Figure 3: 3 player Hawk Dove game: more players, less Hawk, less payoff. One population

of P3's aggressive behavior in the equilibrium changes. When she gets minus by running, it makes her more aggressive. When she gets compensated by running, she becomes less aggressive and the basin of attraction for P1 and P2's dominant equilibria get bigger. Findings: When P3 is compensated for running, the propensity to win of others increases (the basins of attraction leading to their advantage grow bigger).

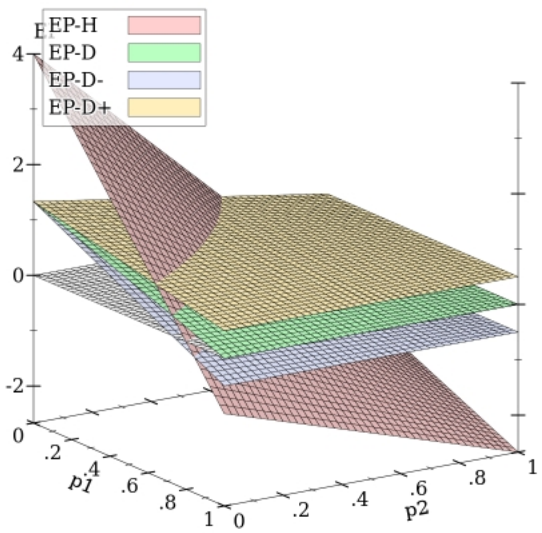

Figure 4: Same Hawk payoff, different Dove payoffs

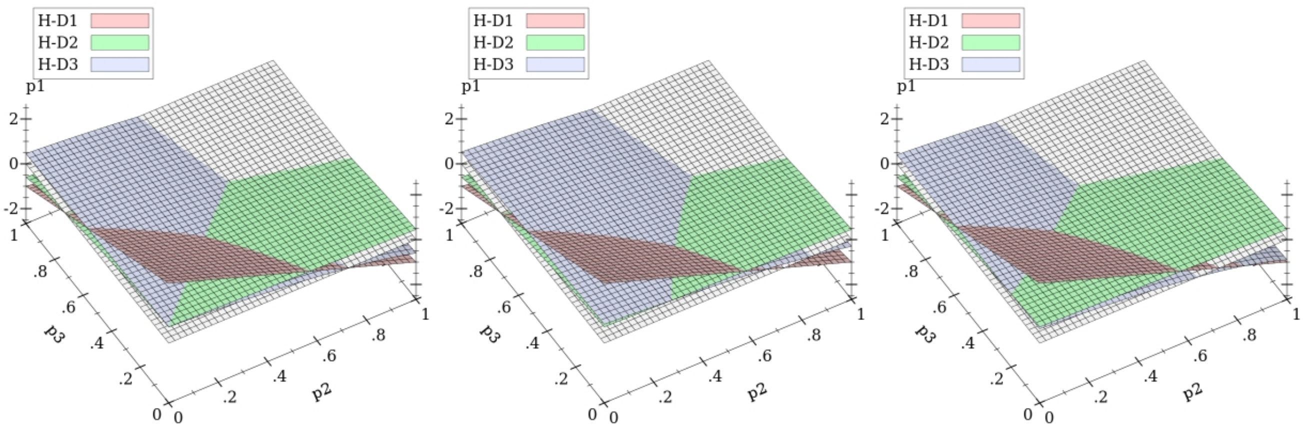

Figure 5: a. P3's payoff for running is 0 b. -0.5 c. +0.5

3 The sequential 3 player Hawk Dove game: Information structure

I would speak briefly on the theoretical substance of this game in the following exemplary cases.

3.1 Case 1: Fully sequential game

When the game is fully sequential, the equilibrium is (4,0,0).

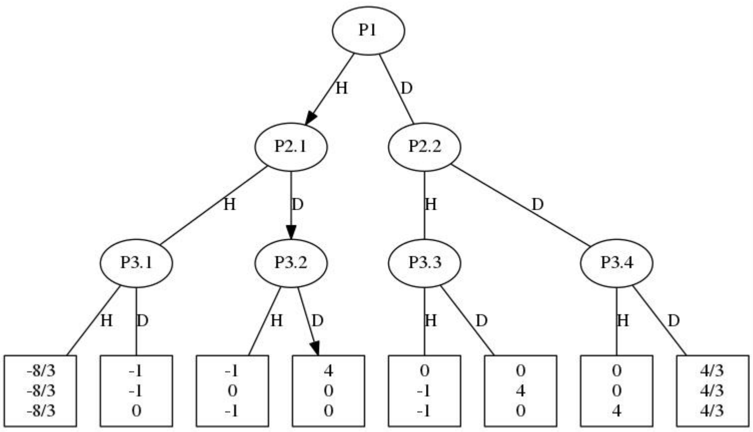

Figure 6: Case 1: Fully sequential HDG

3.2 Case 2: All simultaneous game

When the game is simultaneous, it is as the normal form.

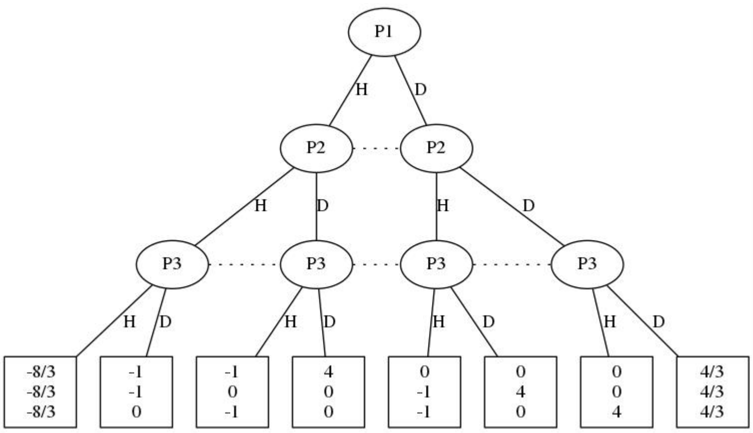

Figure 7: Case 2: All simultaneous game

3.3 Case 3: First two moves simultaneously

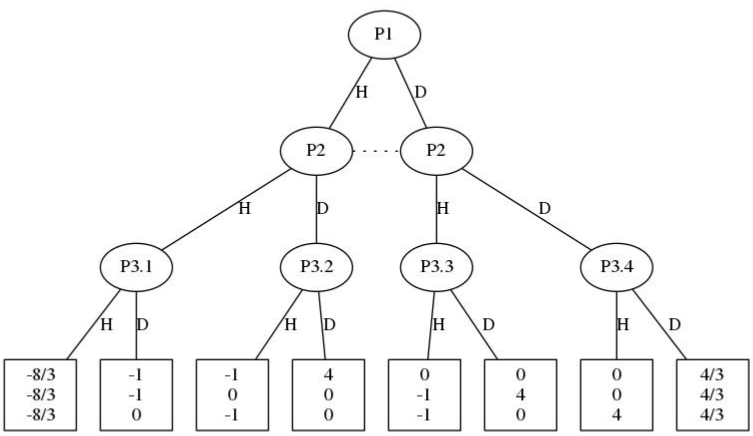

Figure 8: Case 3: First two moves simultaneously

The third player plays with certainty. dove 3 out of 4 times and in the last node, play hawk. Anticipating this, the game of first two players become the simultaneous game for 2 players, but with the dovish payoff being 0. because playing dove becomes less comforting, they are much more aggressive (hawk 4/5), and get average payoff of 0. the third player gets $4/25 = 0.16$. The first move advantage becomes disadvantage when two of them move first.

3.4 Case 4: Third player sees part of the information

In this situation, player 1 moves simultaneous with player 2. but player 3 only observes player 1's move. he doesnt know what will player 2 choose. and player 2 doesnt have the chance to see anyone move, but she knows that player 3 cannot see her move, only player 1's move.

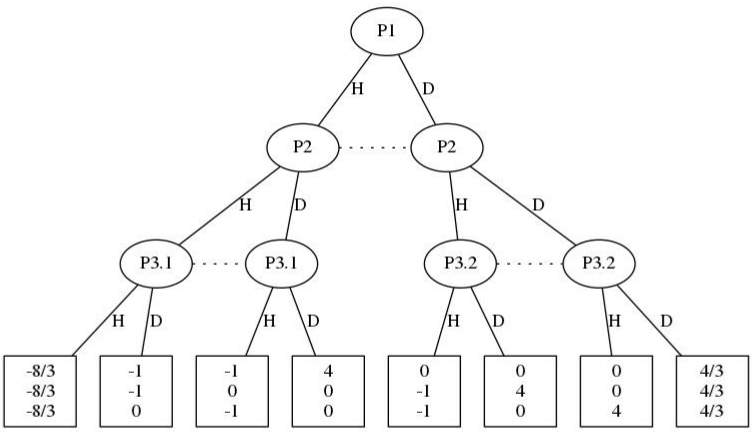

Figure 9: Case 4: Redacted information

Player 1 and 2 plays hawk with probability 8/11, they gets 4/11. This push the player 3 to play dove for sure, and gets 12/121. In this situation in which information is manipulated. the first two players are able to push player 3 to play dove and gets very little.

3.5 Case 5: Third player sees nothing

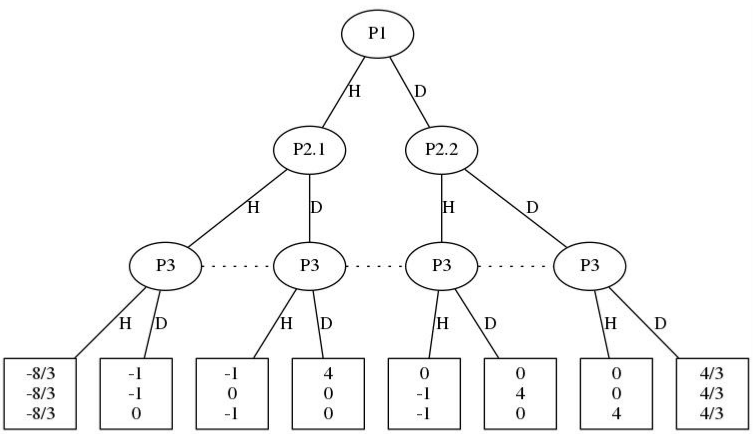

Figure 10: Case 5: Redacted information

This is like the previous case. Player 2 sees player 1's move. she is forced to play dove. player 1 and 3 plays hawk with probability 8/11

3.6 Case 6: Player 1 moves first, the last two simultaneously

In the left subgame, for both player 2 and 3, playing hawk is dominated. So they go dove. In the right subgame, they mix with probability 8/11. But player 1 anticipates this, he goes hawk. And gets everything. The first move advantage is the same as when everything is sequential.

4 Short findings: The effect of redacted information

The game is very different when the information structure or timing changes. With the same kind of situation (hawk and dove) and players, when all parties try to collect more information or try to take advantage in some kind, they all push the game dynamics to different direction resulting in different consequences.

Case 1: Full information: Player 1 knows that P2 and P3 would see her move. P2 sees P1's move and P2 knows that P3 would see her and P1's move. P3 sees P1 and P2's move and she knows that they know that she knows. P1 gets the first move advantage in a transparent (i.e. full information) situation and gets everything.

Case 2: No information: All 3 move simultaneously and do not know what the other chooses. This is the normal form game, there are pure equilibria (winner takes all) and a mixed equilibrium in which people are aggressive at the rate of 0.4 and each gets around 0.4.

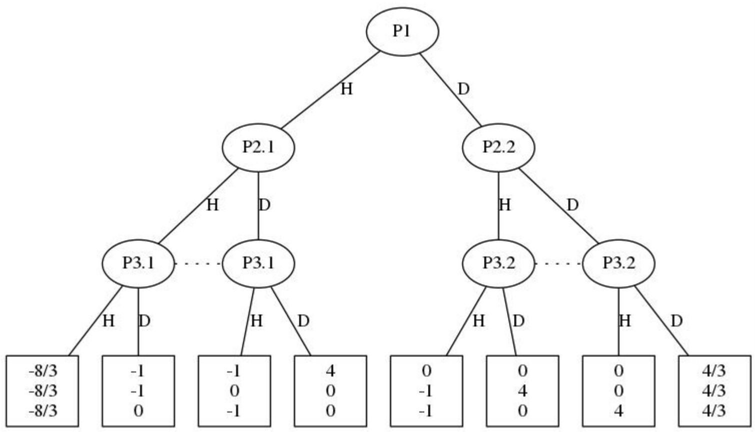

Figure 11: Case 6: P1 moves first, P2 and 3 move simultaneously

Redacted information:

Case 3: P1 and P2 move together and they move before P3 (they don't know what P3 chooses). P3 observes both P1 and P2. So P3 can play with certainty, she plays Dove 3 out of 4 times and in the case both P1 and P2 play Dove, she plays Hawk. Anticipating this, the game between P1 and P2 becomes a simultaneous game for 2 players, but the shared prize becomes 0. Because it is no longer comforting to play Dove anymore, both would become more aggressive. P1 and P2 play Hawk with probability 4/5 and gets 0. P3 gets $4/25 = 0.16$. When there are 3 players, the first move advantage becomes disadvantage if there are more than 1 attempting to get the first move. Everybody loses.

Case 4: This is similar as in case 1, as P1 and P2 move simultaneously first. But P3 no longer sees everything, she only sees P1's move. In this case, P3 is pushed to play Dove for sure, while P1 and P2 play Hawk with 8/11 (and get 4/11 0.36). P3 gets 12/121   0.01. P1 and P2 gets close payoff to the no-information situation, P3 gets almost 0.

Case 5: P1 and P2 move sequentially but P3 sees nothing. This is actually the same as case 2. P2 observes part of the information, she sees P1's move but she doesn't know what P3 would choose. So P2 is forced to play Dove. P1 and P3, either moves first and don't see other choices or sees nothing, play Hawk with 8/11.

Case 6: P1 moves first. P2 and P3 moves simultaneously. In the left subgame where P1 goes Hawk, for both P2 and P3, playing Hawk is dominated, so they go Dove. In the right subgame (where P1 goes Dove), they mix with 8/11. P1 don't know other choice, but she anticipate according to the choice structure, she goes Hawk and gets everything. This is the same as full information (i.e. sequential) game.

When more than one players attempt to get the first move advantage together, they turn it into disadvantage for both of them. Because P3 takes advantage of the information she knows, she makes a contingent plan that plays Hawk in a node. This situation is bad for everyone, particular the first two movers. When there is only one couple playing simultaneously, the other can move first gets everything. When there are two couples playing simultaneously separately, the one who sees nothing or moves first and don't care would push the one who sees part of the information to go Dove and gets 0.

First and only first move is the best for self interest. Two attempting first-movers (one simultaneous couple) make both the worst. Two simultaneous couples, the one who sees a bit more information is forced to play Dove (the worst off). So if you are in a game that people are dealing separately behind the scenes, if you see something, it's already too late. Sometimes ignorance can be better than manipulated information.

5 Simulation

As the game is sequential, I take the definition of the game to be in the following building blocks: a set of player, a set of information nodes and a set of action. A behavior strategy for each player is a function that inputs her set of all information nodes and output the actions for these information nodes. If we put together three behavior strategies of three players, we are able to track down the tree and come to the end to see the outcome and corresponding payoff.

For example, in the fully information sequential 3 person Hawk Dove game above, player 1 has a single node 1.0, player 2 has 2 nodes 2.0 and 2.1, player 3 has 4 nodes 3.0, 3.1, 3.2 and 3.3. This is important because this is where we decide whether each player is fully informed about what she is supposed to be informed about the game at each point or not.

For example, player 1 always moves first, hence she always has no idea what is going on. It is like she is at the end of the game but all her nodes are connected in dots. However, is it really that she knows nothing? She, would know the structure of the game hence would be able to make logical deduction from that information and act accordingly with her best interest. For example, she knows that the game is fully sequential and she can solve the game by backward induction. The natural path to take is to prescribe Hawk at her only node. The others would follow, player 2 would do Dove in her 2.0 node, player 3 would do Dove in her 3.1 node. The outcome of the game is (H, D, D) and the payoff is (4, 0, 0).

Now if we connect the two nodes of player 2, she cannot distinguish between them anymore, she is forced to treat the two nodes as a single one hence she has to prescribe one single action for that single node. Because she has no idea about player 1's move just as player 1 has no idea about her move, this is the simultaneous game for player 1 and player 2. Player 3 has to act accordingly. See the solution of this situation in the section above.

5.1 Simulation implementation: Evolutionary selection

I would generate 3 populations representing 3 players. Each population has 100 agents. At the beginning of the cycle, i.e. the matching phase, I triple-match 3 agents from 3 populations respectively and let them play the game. I do this for the whole population, hence there would be 100 matches of this sequential game. After being matched, they each have their own payoff. From this point on, the calculation is done for each population separately. In other words, each population would evolve separately. I would use the payoffs to calculate agents' corresponding fitness. In the regeneration phase, I let 10% of the population to switch to a different strategy. The support to randomise from is the fitness vector which collects all current strategies in the population. One agent switches from strategy a to strategy b (because there is a higher propensity to choose strategy b) means that the better strategy would profilerate at the expense of the poor performers. That ends the regeneration phase. In the mutation phase, I let x% of the population to mutate their strategy. This would bring new variety into the selection pool and help the selection process a great deal. That is the end of one cycle. I shuffle the population. The next cycle starts again with the matching phase.

5.2 Simulation implementation: Players and strategy experiments

Player 1 holds only one information: node 1.0 and what to do at node 1.0. Player 2 has two nodes hence she can choose to connect these nodes or she can choose to change her action at each node. When she chooses to connect her nodes (to become ignorance or to uninform herself from the situation), the actions of two nodes become one action only. Player 3 has 4 nodes hence she can do a lot of things with her information structure and action.

I would generate players with random information structure and random action from the start. She can come into the world fully informed or not. Along the selection process, she can imitate others who seem to be doing better than her or choose to make new way out of the current materials. In this study the experimenting behavior (i.e. the mutation) is very important. It is about the rate of making new strategy by modifying the information structure (including crossing out her understanding of the world) as well as changing the action under the current information structure she is holding. This is especially for player 3 because she has 4 information nodes to experiment with. The others I consider to be more rigid but they shape the course of the game in their own rigid way. Power comes from all there is.

For example, player 1 has only one node hence she can only change her action in that node. But she is the first move player, holding a huge advantage. It is easy for her to set the course of the game by playing Hawk and others follow sequentially. Once she changes her action, it shapes the game completely different for other players. Player 2 has more flexibility in the ways she can go about. She can choose to connect her only two nodes (to go ignorant) or she can choose another action. The effect of her choice has significant impact on the course of the game (she is second in line). Player 3 has the most versatile endowment. She has 4 information nodes, she can connect two or three, or let them be etc. I suspect that player 3 has to mutate her strategy so much faster to be able to have impact on the whole power play.

6 Simulation settings

I run with the one shot game. Each player comes into the game with different information structure and action plan. They play the game and modify their plan along the way (including changing action and changing the way they see the world).

7 Pilot

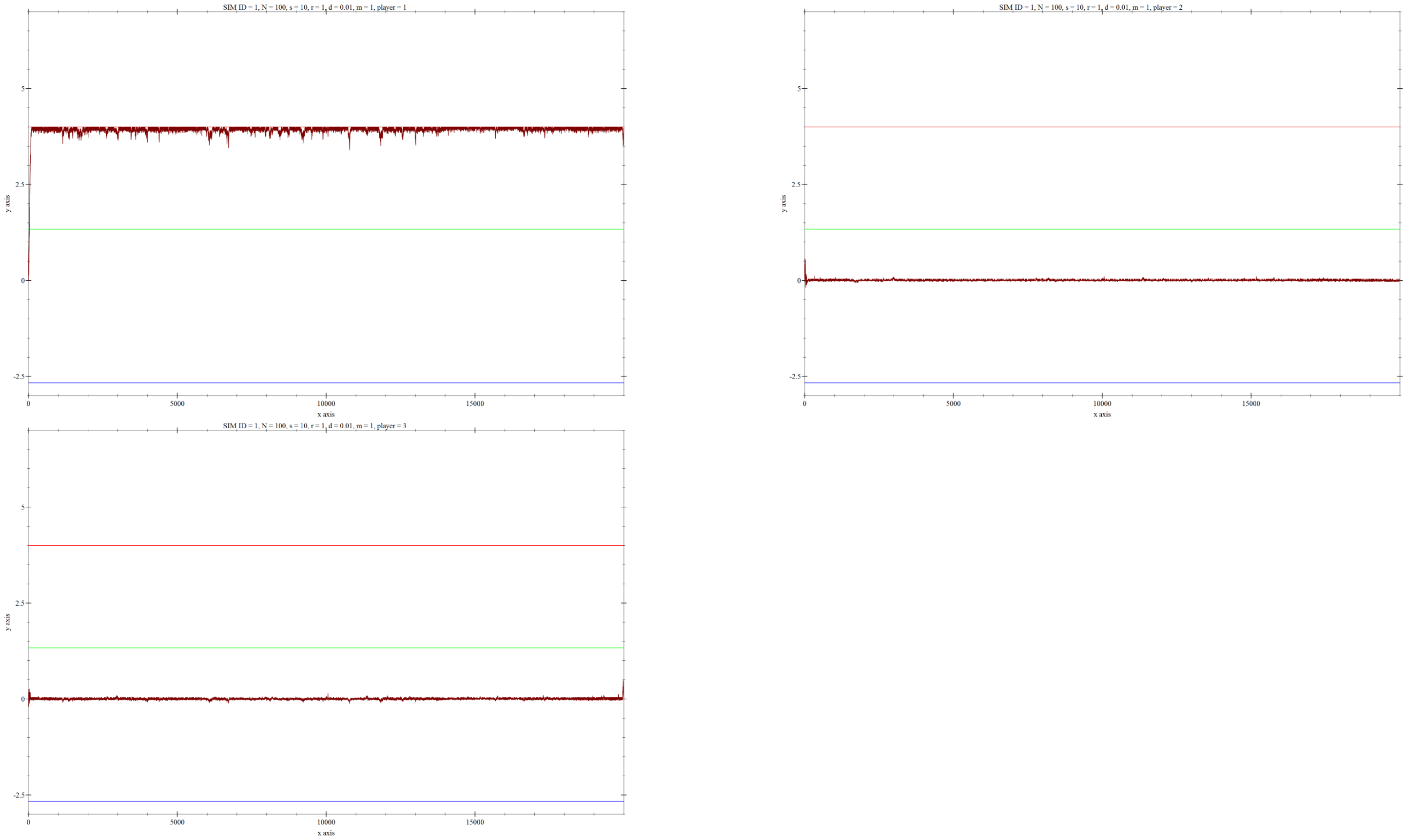

Figure 12: A usual case. First mover gets all.

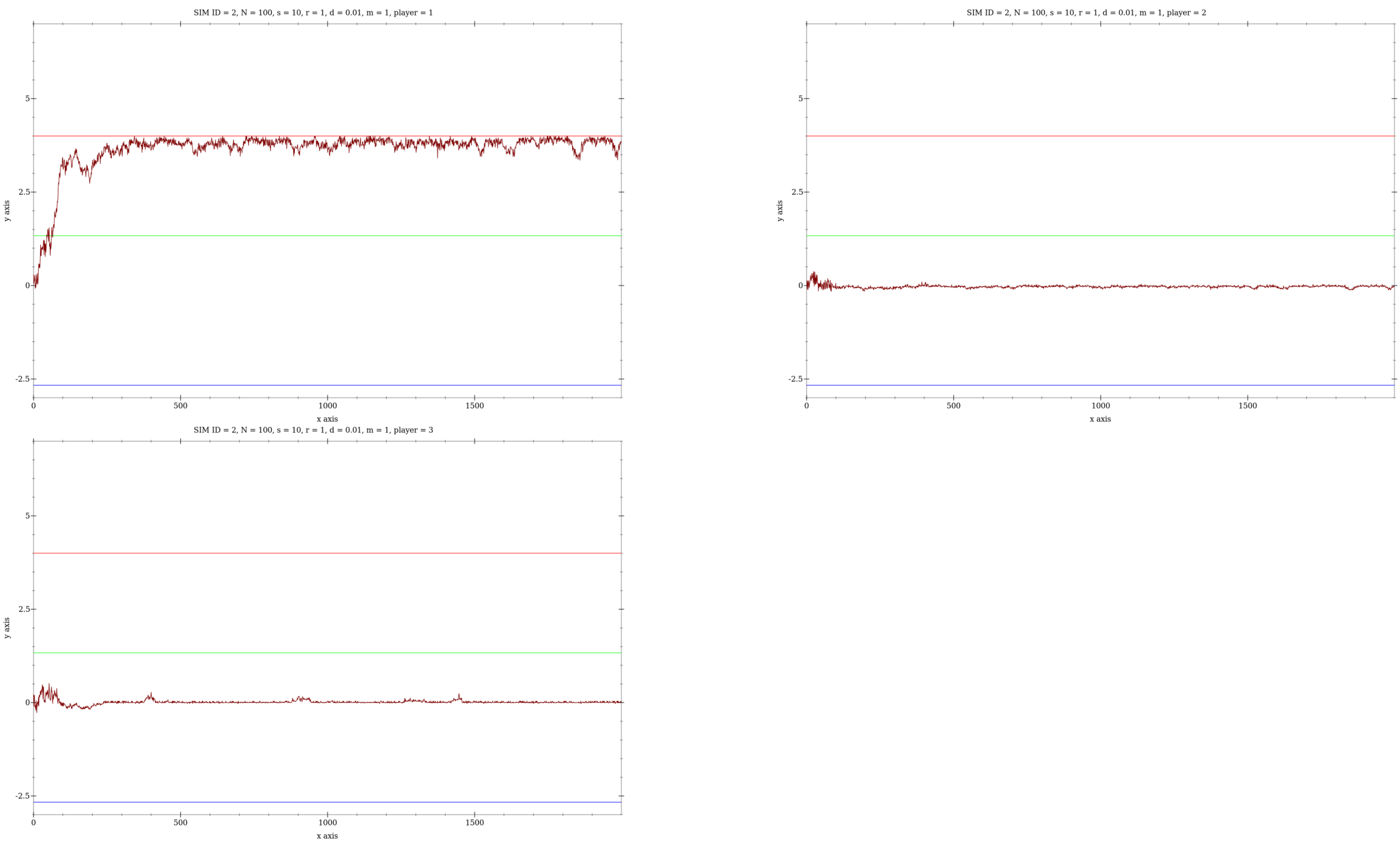

Figure 13: An unusual case, when player 3 mutates faster, at 5%, the others at 1%. Somehow due to the speculation that certain information is redacted from the worldview of player 2 and 3, player 2 is able to dominate.

7.0.1 Simulation 1

I run simulations with different rates of mutation for different players. It happens that this is a rare case. Usually they settle that player 1 gets all. For this case, player 3 mutates way too slow to change her behavior in the equilibrium: she connects all her nodes (i.e. refuse to receive any information) and stays true to hawkish strategy. The rate of player 2

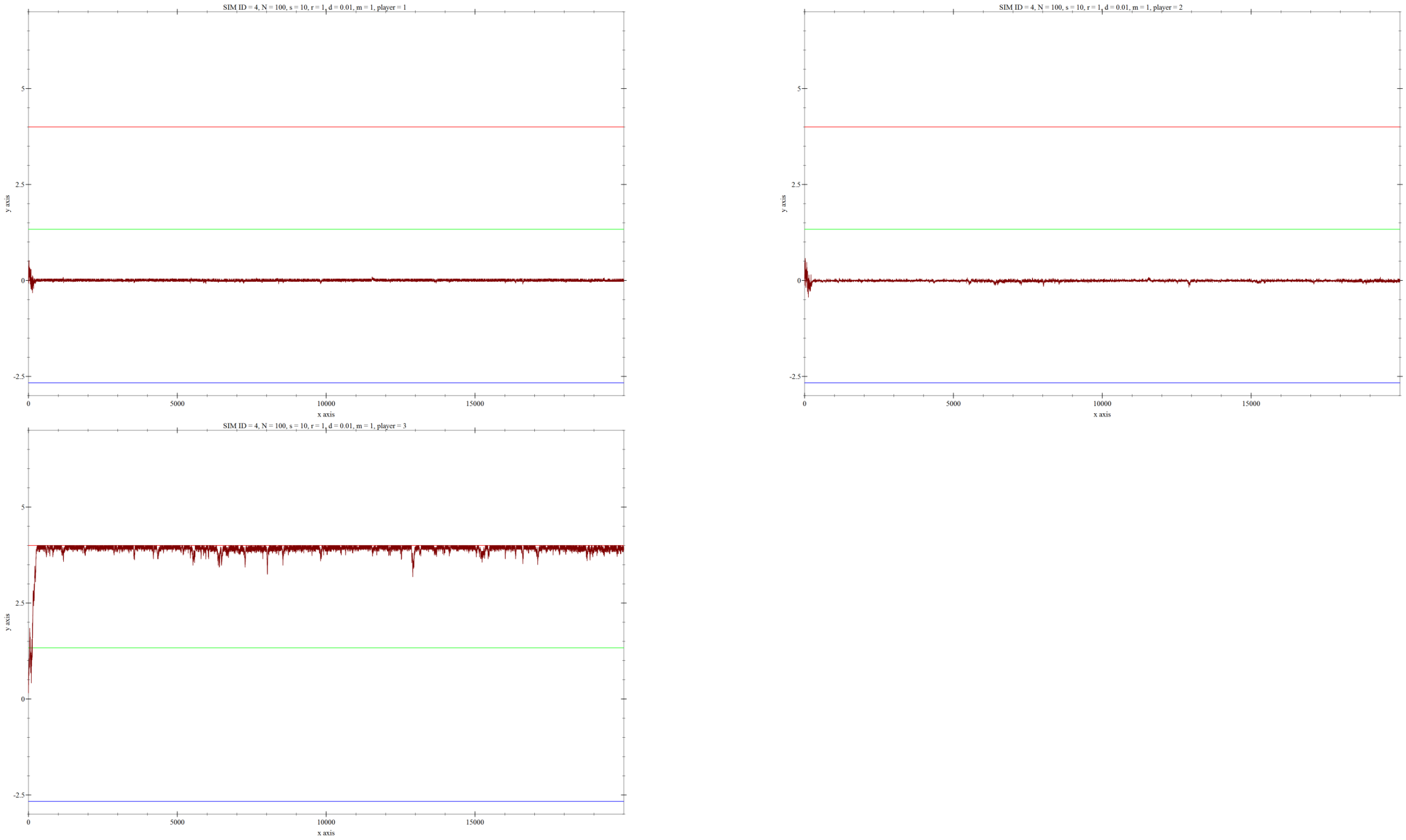

Figure 14: An unusual case. Player 3 gets all because in the initial phase where everybody is still figuring it out to coordinate, it sets in that player 1 plays Dove, and player 3 uninforms herself of all the information nodes to stay true to being hawkish. A crucial factor is that she mutates way too slow hence it locks in the change, even though player 2 mutates at higher rate.

change is not slow, but it does not matter. And it remains that population 2 has a mixture of strategy that connects her nodes and strategy that the nodes stay separated. Because player 2 is second in line, what matters to her is that player 1 settles on playing Dove and the selection force created by player 3 is too strong to make player 1 deviate from playing Dove, even though player 1 mutates not slow according to her nature (i.e. of having only 1 node with 2 actions). Somehow player 3 becomes and enjoy the first mover advantage. The payoff is (0,0,4).

7.0.2 Simulation 2

Player 1 changes her action slowly. And somehow in this study, the early phase is all that matters. In the early period, player 1 learns to play Dove because population 2 (representing player 2) has a portion of strategy that is ready to play Hawk if player 1 goes Hawk. This threat keeps player 1 in place and it locks in the action of player 1. Player 3, mutating fast, figures out that she uninforms herself of everyone, and insists on playing Hawk. This tames the other branch in the strategy of player 2: to play Dove. Hence population 2 develops 2 strategies (just like in the previously discussed case), one to be uninformed and claim Dove regardless, one to distinguish between nodes but it remains that that strategy plays Hawk if player 1 goes Hawk and it plays Dove on the other branch. Hence the outcome is (D,D,H) and the payoff is (0,0,4) despite the fact that player 3 changes pretty quick. These changes are not able to undermine the equilibrium.

8 Conclusion

In my simulation, the new equilibrium is not out of ordinary. It is still in the grip of the Nash equilibrium concept (once it sets in, no player has individual incentive to deviate).

When the game is sequential, the first mover advantage is the determinating factor of the outcome of the game. The opportunity to reverse that natural course is little as shown in the simulation. And when it appears, it requires a specific combination of multiple factors. One important one is for player 3 to erase her nodes of information from her set. Another defining feature is the ability to mutate (to change). It has to be fast enough for player 3 and 2. Another one is that the early period matters. When everybody is still figuring out the appropriate course of actions, it is easier for an equilibrium to kick in. After that, to move from an equilibrium to another, it requires very high level of mutation: a lot of change happening at the same time, probably we have to make mistake faster than when we can even learn from it.

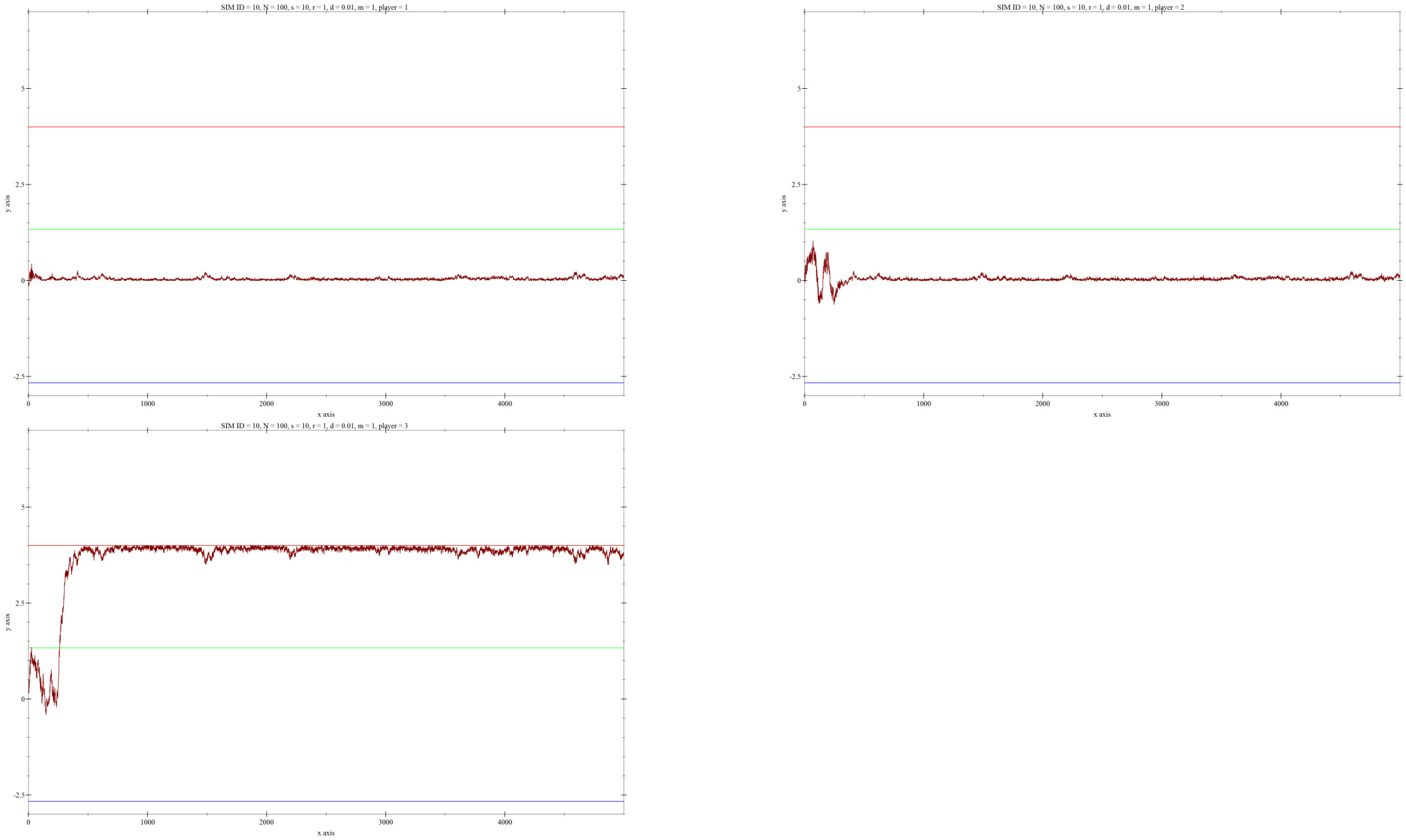

Figure 15: An unusual case. Player 3 gets all because player 1 mutates too slow and in the initial period, she learns early to play Dove because player 2 has a strategy to play Hawk if player 1 goes Hawk. This dynamics of the first two powers threatening each other helps player 3 to settle in with the strategy that she ignores everyone and plays Hawk, even though player 3 mutates pretty fast. The change is not enough to erode away the equilibrium.

9 References

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