Gahboninho: Strategy for Balancing Pressure and Compromise in Automated Negotiation

Mai Ben Adar, Nadav Sofy, and Avshalom Elimelech

Abstract. "Gahboninho" agent was first introduced in the ANAC'11 competition. The underlying strategy it implemented follow the assumption it will be matched with other automated agents which vary in their compromising level. Thus, it tries to tackle strong opposition by putting pressure on the opponent. The stubbornness of the agent is also balanced based on the behavior of its opponent in order to achieve higher utilities.

1 Introduction

Our agent (*Gahboninho*) was submitted to the Automated Negotiation Agents Competition (ANAC'11) held in the international Joint Conference on Autonomous Agents and Multi-Agent Systems (AAMAS2011). The agent implemented an original strategy and has reached the second place in the tournament. The strategy itself was motivated by the results of a preliminary experiment with automated agents we took part of, in which the most successful strategy was to decide whether the opponent is susceptible to pressure or is entirely stubborn, then to act rationally. The paper describes our attempt to translate that approach into the competition's settings.

2 Gahboninho's Adaptation Strategy

The agent begins the negotiation without compromising at all in an attempt to quickly pressure the opponent as much as possible. In fact, if it would not pose a threat to the agent's own utility, it may be worthwhile for the agent to propose

Mai Ben Adar · Nadav Sofy · Avshalom Elimelech
Bar-Ilan University, Israel

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the worst possible outcome for the opponent instead of the best outcome for itself. While such actions may prevent the opponent from accurately constructing the agent's preference profile, the expected rounds count often permits[1] expending many rounds before sending realistic suggestions without the risk of missing Pareto-efficient outcomes.

As the negotiation continues, the agent examines the opponent's behavior. If the opponent expresses an effort[2] to find a realistic and compromising outcome (instead of insisting on certain minimal utility threshold) then unless the time constraints or the discount factor pressure greatly, there is no reason to compromise significantly as it is not likely to drive the opponent to suggest better outcomes. At the same time, the agent may also accurately model the opponent's preferences. Since the opponent's attempt of modeling the agent's preferences is limited to little information, the outcomes suggested by the opponent rely almost entirely on its own preferences thus expected to be genuine. On the other hand, if the opponent will not compromise at all, the agent avoids prolonging the deadlock and gives up utility in accordance to the pressure. As the pressure rises the agent may give up his utility faster, but would never go below the utility of the best outcome suggested by the opponent and neither below a certain pre-determined constant which depends on the amount of competitors in the tournament. Once the agent has enough information about the opponent's preferences or is either pressured enough, it will try filtering the domain of most of the inefficient outcomes in order to insure that the critical, last rounds are relevant and effective.

3 Facing Varied Opponents

Facing a compromising opponent, which avoid expending rounds and rarely insists on a certain utility threshold, is relatively simple as this behavior may be easily identified and exploited by the agent's strategy. Predict the outcome when facing uncompromising opponents is harder, since the reason behind that behavior may be one of the following:

i. The opponent is greedy, gives up his own utility using a predetermined curve and might suggest somewhat compromising outcomes only in the last, pressured rounds. While in this case the agent's strategy copes and practically gives up, which highly benefits the opponent, such an opponent is also much more likely to reach a break-off when facing irrational opponents.

[1] For example, In the competition's qualifying round the average rounds count per negotiation is about 7400, while the domains' possible outcomes count, excluding "energy distributer" domain, averages on 1975 only (the energy domain's was unproportionate and including it turns the average to 24836)

[2] Such estimation may be done, for example, using a heuristic over both the agent's personal utility from the incoming proposals, and the variance of the amount of different issue values in each of the incoming and outgoing outcome proposals (as implemented in our agent)

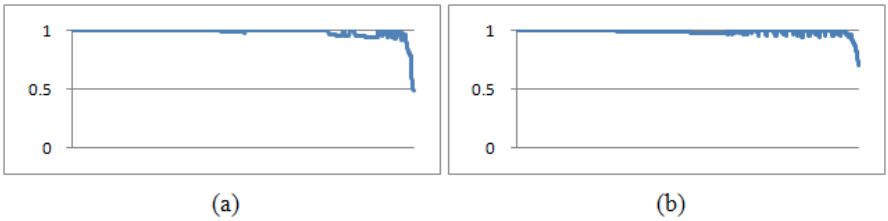

Fig. 1 Illustration of the utility of our agent's proposals as a function of point in time when negotiating with exemplary opponent which is (a) using a predetermined utility curve (b) rewarding cooperation but keeps insisting in other cases

ii. The opponent's strategy is similar to the agent's. In this case, the negotiation will turn into a hawk-dove game where the fine tuning of the agents determines its result.
iii. The opponent rewards cooperation, but insists if the agent does not compromise. In this case, each time the agent gets pressured a new starts cycle where both the agent and the opponent reveal some more of their preferences by suggesting more compromising outcomes, then the agent returns to insisting, and then the opponent returns to insist as well. Such opponents may reach break-off when facing either greedy agents, or other agents similar to themselves.

Considering all cases, the agent's success in a competition is threatened if there are very few greedy opponents (so their benefit outweighs their break-offs' penalty), or if there is another similar agent(s) which is slightly less compromising.

4 NiceOrDie Domain

As part of the competition, we were required to design and provide a negotiation domain in addition to the agent itself. The purpose of our domain (*NiceOrDie)* was separating the highly greedy agents from the rest, since they pose the greatest threat to the agent, as depicted in the previous section. The domain offers only three possible outcomes. Therefore, the ability to reach an agreement in this domain depends only on the agent's final, minimal personal utility threshold when facing a seemingly greedy opponent. This splits the agents into two groups – those that benefit from each other by compromising, who gain the highest possible utility, and those that won't reach an agreement and will fail at this domain entirely.

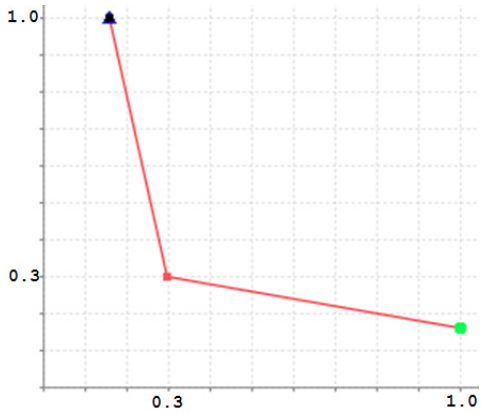

Fig. 2 Illustration of NiceOrDie domain's Pareto-efficient frontier

5 Results and Conclusion

Our agent has reached the first place on the qualification round of the competition and dropped to the second place in the final round. We attribute the agent's success to its ability to be as greedy as a compromising agent can be, thus exploiting compromising opponents as well as most greedy agents, while avoiding break-offs when facing uncompromising opponents. This is evident in the competition's detailed qualification round result, where only two of the eight leading agents[3] reached less break-offs than our agent, and these two agents were highly exploited by our agent during the tournament, as they probably were far less greedy. As described in previous sections, the strategy's success also relies on the participating opponent. Our assumption when designing the agent's strategy was that most competitors would avoid the greedy approach since it is predictable. However, in fear the opponent had chosen that approach exactly, and considering the fact it is simple to identify and counter such an opponent, we assumed that most of the participants will take measures to adapt themselves to such opponents. It is hard to assess how many agents were exploited by our agent's app roach, but in retrospect, it appears that the assumption was fairly accurate. It is worth mentioning the agent implemented a relatively simple opponent model. Additionally, discount factors, which were more significant in the final round than in the qualification round, were handled poorly by the agent's strategy since the pace of the opponent's compromise was not taken in consideration. This may explain the agent's drop in the final round of the competition. Accordingly, extending the agent's strategy and implementation in these areas may increase its success even further.

[3] Gahboninho had 70 break-off, IAMhaggler2011 had 61 and BRAMAgent had only 38 break-offs