Intelligent Agents Report

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ABSTRACT

In this paper, a brief description of the protocol used in the Intelligent Agents Class Tournament is proposed, the strategy of the Agent24 that has participated in the tournament is described alongside a statistical analysis of the achieved results throughout the tournament. As well as, suggestions to improve the performance of the agent for future tournaments are introduced.

1. INTRODUCTION

The protocol used for each negotiation during the tournament, is the Stacked Alternating Offers Protocol, in which each agent can take one of the following actions: either make an offer, or accept the last proposed offer or walk way. This process is repeated in a turn until reaching an agreement or reaching the deadline without any agreement. [2]

Each agent has its own preference profile that is represented by means of additive utility functions that are computed as a weighted sum of the values associated with each of the issues. [3]

The proposed strategy for Agent24 is basically based on the time, the received opponents' offers and the accepted offers by opponents throughout the whole negotiation.

For this purpose, an array list has been used to store for each round of the negotiation the corresponding normalized time at which an action is taken, the corresponding ID of the agent that takes the action, the action itself, and the bid that has been offered or accepted as well as its corresponding utility.

Pseudocode of the main strategy is presented in Appendix A.

2. STRATEGY

As mentioned earlier, the strategy of the Agent24 for choosing an action is based on both the time and the opponents' actions throughout the negotiation. Mainly, the strategy consists of four subsequent sub-strategies, each of them is described in detail in the following sub-sections.

The main criteria for Agent24 is reaching an agreement while achieving a relatively good utility and maximizing the social welfare by taking the opponents' actions into consideration. It can also be seen that Agent24 is approximately following a conceding strategy over time by reducing the utility threshold of the offered or accepted bids, while trying to achieve as much utility and as best Nash distance as possible.

In general, Agent24's strategy seems to be very simple. It starts by offering 90% of its maximum utility. When the time passes, it follows the orthogonal strategy [1] by offering the same opponent's bid if it achieves specific utility threshold and thus obtaining the best Nash distance possible. Later, it offers the same bid that opponent has accepted, and before the time reaches its limit it reduces significantly the utility threshold for the offered or accepted bids in order to avoid reaching a disagreement.

2.1 Sub-Strategy1

In the beginning of the negotiation and until 0.1 of the normalized time, the agent starts by only offering the bid that achieves 90% of its maximum utility.

2.2 Sub-Strategy2

In the period from time 0.1 till time 0.4, the agent checks the opponents' offers that are stored in the array list and offers the same bid that any of the opponents has offered if it achieves a utility equal or bigger than 80%. Otherwise, it accepts the last received offer if it achieves a utility equal or bigger than 80%.

If none of the previous conditions is fulfilled, it offers the bid that achieves approximately the average utility between the last received offer's utility and the Agent24 last offered bid's utility.

After that, during the time interval between 0.4 and 0.6, the same strategy followed in the previous time period is used while decreasing the utility threshold from 80% to 75%.

Same applied for the period from time 0.6 to time 0.8 with utility threshold being decreased from 75% to 70%.

2.3 Sub-Strategy3

In the time interval from 0.8 to 0.9, the agent checks again the array list and searches for the offers that opponents has accepted and offers the same bid that any of them has accepted if it achieves a utility equal or bigger than 75%.

Otherwise, it accepts the last received offer if it achieves a utility equal or bigger than 75%. If none of the previous conditions is fulfilled, it offers the bid that achieves approximately the average utility as followed in the sub-strategy2.

Later, during the period from time 0.9 till time 0.95, the same strategy followed in the previous time interval is almost applied while decreasing the utility threshold from 75% to 71%, except the fact that the average utility bid that is offered in case of not fulfilling any of the conditions, is calculated by adding the utilities of the last received offer and the Agent24 last offered bid and dividing them by 1.95.

Knowing that in both strategies sub-strategy2 and sub-strategy3, the agent offers the bid that achieves approximately its maximum utility every 0.05 of the time during the corresponding time intervals. That is mainly to overcome the decreasing utility in case of offering the mentioned average utility bid.

2.4 Sub-Strategy4

In the period from time 0.95 till time 0.97, the agent accepts the last received offer if it achieves a utility equal or bigger than 69%. Otherwise, it offers a bid with utility of around 80%.

Similarly, during the time interval from 0.97 to 0.98, the agent accepts the last received offer if it achieves a utility equal or bigger than 67%. Otherwise, it offers a bid with utility of around 75%.

After that, during the time interval from 0.98 to 0.989, the agent accepts the last received offer if it achieves a utility equal or bigger than 65%. Otherwise, it offers a bid with utility of around 75%.

Later, during the time interval from 0.989 to 0.994, the agent accepts the last received offer if it achieves a utility equal or bigger than 57%. Otherwise, it offers a bid with utility of around 80%.

Finally, during the time interval from 0.989 to 1.00, the agent accepts the last received offer if it achieves a utility equal or bigger than 37%. Otherwise, it offers a bid with utility of around 75%.

Knowing that the time intervals and utilities thresholds have been chosen heuristically by running the agent through exhaustive number of tournaments for each new values.

3. ANALYSIS

First of all, the results of all the negotiations that finished with an agreement for each domain were extracted, after that, a statistical analysis of the obtained results has been done using data analysis tools that are provided in Microsoft Excel.

Figure 1 illustrates the total number of negotiations in each domain, as well as the number of agreements and disagreements that have been reached. It could be seen that in domain0 the total number of disagreements is the minimum with a percentage of 2.1% of the total number of negotiations. While this percentage increases in domain1 to be 5.56% and in domain2 it reaches a very high value of 24.26%.

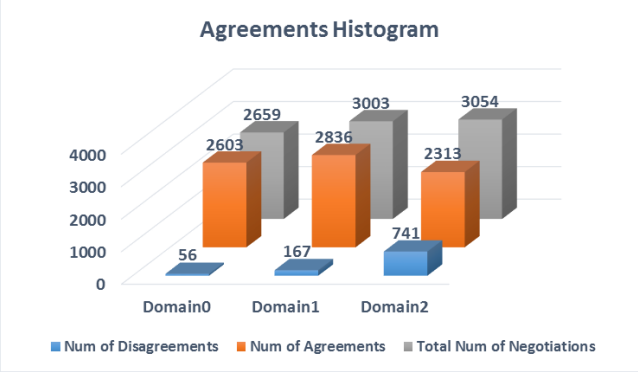

Figure 1. Agreements Histogram

The average utility, the average distance to Nash and the average distance to Pareto that are achieved in each domain are declared in figure 2. It could be noticed again that the performance of Agent24 in domain 0 is the best considering all the three parameters, while the values in domain1 come next leaving the domain2 in the last position, even though it achieves a slightly better distance to Pareto than what's achieved in domain1.

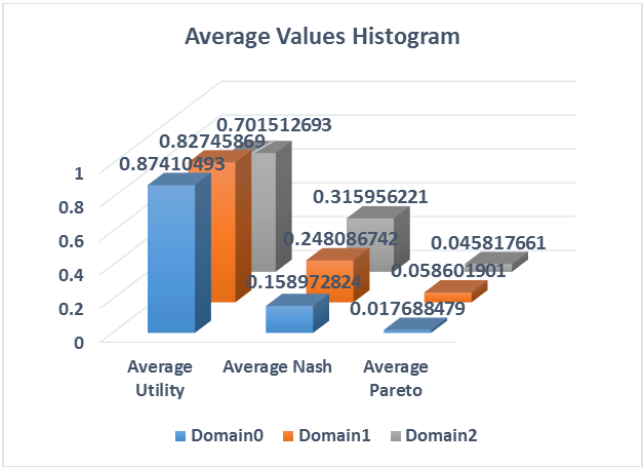

Figure 2. Average Values Histogram

Figure 3 illustrates the detailed achieved utilities in each domain being grouped into specific ranges.

Most of the achieved utilities in domain0 are around the range 0.95, while the range 1 comes next and that explains clearly why the performance in domain0 is the best.

In domain1, most of the achieved utilities lie in the range 1 which is quite good. However by taking into consideration the utilities in the other ranges, the performance in this domain is slightly less than the one achieved in domain0.

On the other hand, the domain2 has the least performance since most of the utilities belong to the range 0.8.

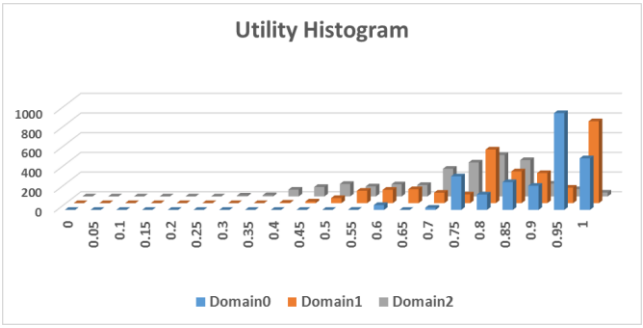

Figure 3. Utility Histogram

The achieved Nash distance and the achieved Pareto distance in each domain are shown in figure 4 and figure 5 respectively.

Same conclusion made in the utility analysis could be concluded again regarding the performance.

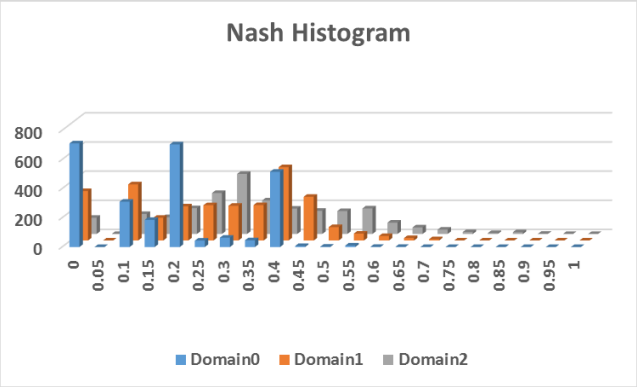

Figure 4. Nash Histogram

With respect to Pareto distance, the results achieved are outstanding, since the mode in all the three domains is the value 0. Meaning that, no further improvement of the utility of any agent can be made without decreasing the utility of the other agents.

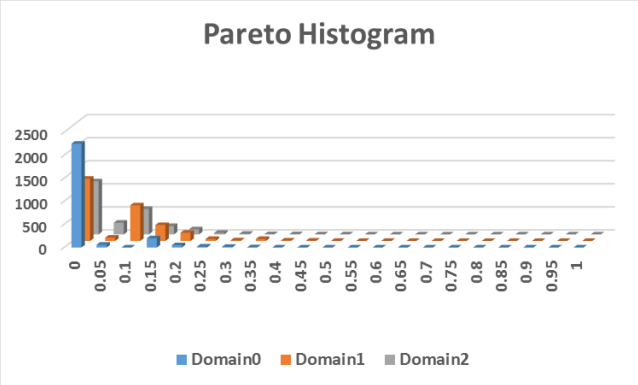

Figure 5. Pareto Histogram

4. CONCLUSION

Based on the results of analysis, it could be concluded that Agent24 achieves relatively good results with a total rank of 9 out of 36 participating agents, especially in the small domains.

While in the larger domains, the results were not that good considering the fact that generating bids throughout each negotiation was not based on choosing specific values for the corresponding issues of the preference profile, but rather on the overall bid utility in which the values for issues were chosen randomly.

In addition, although this way of offering/accepting bids results in the requested utility, it also may lead to unsatisfying Nash distance because it does not take the opponents' most preferred issues into its consideration.

Better results can be obtained by taking into consideration the previous disadvantages and generating bids more precisely. However, this could result in less efficiency regarding memory and time of making a decision especially in the large domains, since the values of issues for each bid have to be stored and analyzed.

5. REFERENCES

[1] Somefun, D.J.A., Gerding, E.H., Bohte, S.M. and La Poutre, J.A. (2004) Automated Negotiation and Bundling of Information Goods In, Faratin, P., Parkes, D.C., Rodriguez-Aguilar, J.A. and Walsh, W.E. (eds.) Agent-Mediated Electronic Commerce V: Designing Mechanisms and Systems, Springer Lecture Notes in AI, vol. 3048. Springer-Verlag pp. 1-17.

[2] How does Stacked Alternating Offers Protocol for Multilateral Negotiation work https://github.com/tdgunes/ExampleAgent/wiki/Stacked-Alternating-Offers-Protocol

[3] Domains & Preference Profiles https://github.com/tdgunes/ExampleAgent/wiki/Domains-&-Preference-Profiles

6. APPENDIX A: Pseudocode for Agent24's Strategy

```
procedure subStrategy1(utilityThreshold){
  offerRandomBidWithUtility(utilityThreshold)
}
procedure subStrategy2(utilityThreshold){
    if (time is almost a multiple of 0.05)
        offerRandomBidWithUtility(maxUtility)
    else
        if (maxUtilityBidOfferdByOpponent > utilityThreshold)
            offer(bidOfferdByOpponent)
        else if (lastRecievedOfferUtility > utilityThreshold)
            accept(lastRecievedOffer)
        else
            offerRandomBidWithUtility(lastRecievedOfferUtility+l
            astOfferedUtility)
}
procedure subStrategy3(utilityThreshold){
    if (time is almost a multiple of 0.05)
        offerRandomBidWithUtility(maxUtility)
    else
       if (maxUtilityBidAcceptedByOpponent > utilityThreshold)
            offer(bidAcceptedByOpponent)
        else if (lastRecievedOfferUtility > utilityThreshold)
            accept(lastRecievedOffer)
        else
            offerRandomBidWithUtility(lastRecievedOfferUtility+l
            astOfferedUtility)
}
procedure subStrategy4(acceptedUtility, offeredUtility){
    if (lastRecievedOfferUtility > acceptedUtility)
        accept(lastRecievedOffer)
    else
        offerRandomBidWithUtility(offeredUtility)
}
procedure mainStrategy {
    if (time < 0.1)
        subStrategy1(0.9)
    else if (time >= 0.1 && time < 0.4)
        subStrategy2(0.8)
    else if (time >= 0.4 && time < 0.6)
        subStrategy2(0.75)
    else if (time >= 0.6 && time < 0.8)
        subStrategy2(0.7)
    else if (time >= 0.8 && time < 0.9)
        subStrategy3(0.75)
    else if (time >= 0.9 && time < 0.95)
        subStrategy3(0.71)
    else if (time >= 0.95 && time < 0.97)
        subStrategy4(0.69 , 0.8)
    else if (time >= 0.97 && time < 0.98)
        subStrategy4(0.67 , 0.75)
    else if (time >= 0.98 && time < 0.989)
        subStrategy4(0.65 , 0.75)
    else if (time >= 0.989 && time < 0.994)
        subStrategy4(0.57 , 0.8)
    else
        subStrategy4(0.37 , 0.75)
}
```