BRAM Agent

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Abstract. BRAM considers the other agent as a partner in a negotiation process (and not as an opponent) since its strategy is to reach a solution which will satisfy the other agent, while maintaining its' own utility threshold. BRAM has four main characteristics that guide it through the tournament: simple and fast, compromises as time elapses, seeks a win-win agreement and interrupts modeling attempts by others. BRAM amounted to the 4^{th} place in the ANAC2011 competition.

1 Introduction

BRAM was developed in the GENIUS negotiation simulator environment, and was designed for the ANAC2011 competition[1]. According to the rules of the competition, a negotiation session is conducted in a specific domain and includes two agents who interact using an alternating offer protocol. Each negotiation session is limited to 180 seconds. Once an agreement is reached, each agent receives its corresponding utility score based on the agreement. Otherwise, both agents receive a constant no-agreement score. The BRAM agent was designed to be domain-independent in order to cope with different domains and utility functions, including domains with discount factor (discount as a function of time).

BRAM's strategy is outlined as follows. First, BRAM searches for a win-win agreement that will satisfy both parties. We hypothesized that by considering the other agent not as an opponent, but as a partner with common interests, BRAM will be able to achieve better agreements in a shorter amount of time. Second, the extent

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http://mmi.tudelft.nl/negotiation/index.php/Genius

[1] http://mmi.tudelft.nl/negotiation/index.php/Automated_Negotiating_Agents_Competition_%28ANAC%29

T. Ito et al. (Eds.): Complex Automated Negotiations, SCI 435, pp. 213–216.
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to which BRAM is willing to compromise increases as time elapses. The decision whether to accept an offer made by the other agent, and the decision of which offer to make, are based on a utility threshold that is reduced during the negotiation. Lastly, BRAM attempts to interrupt modeling attempts by the other party. This is done by switching strategies during the negotiation session, and by including randomization in various stages of the decision process. We hypothesized that if the other agent will not be able to discern that BRAM compromises as time elapses, it will make it compromise more quickly. Finally, BRAM can generate responses to offers made by the other agent very quickly. This allows to reach agreement more quickly and benefits both parties.

2 BRAM's Strategy

At the beginning of a negotiation session, BRAM creates a bid array which contains all the possible bids in the given domain. The array creation time is limited to 2 seconds. If the set of optional bids is very large, only a random sample of these bids will be included in the array. The bid array is sorted in a descending order according to the utility values for BRAM. This bid array will be used in cases when a win-win offer was not found, in order to make a random offer.

BRAM's decision making process is presented as a flow chart in Figure 1. When BRAM receives an offer from the other agent, it first compares the utility score of this offer with its current utility threshold. If the utility to BRAM is above the threshold, it will accept the offer. Otherwise, BRAM will make an alternative offer. First, it will try to make a win-win offer which is beneficial for both parties.

In order to create win-win offers, BRAM estimates the preferences of the other agent. We assume that the more the other agent requests a given value for an issue, the more it prefers this value. Also, the other agent may change offers over time and therefore BRAM will only refer to the last 10 bids made by the other party. Based on these assumptions, BRAM creates a histogram for each issue according to the offers received from the other agent. BRAM offers a bid which gives it the highest expected score for bids that are also beneficial to the other party.

An example of the histograms of the last 10 offers made by the other agent in the Laptop domain can be viewed in Figure 2. The Laptop domain includes 3 issues, and each issue contains 3 values. It is obvious that in the *Laptop Brand* issue, the other agent clearly prefers *Dell* over *Macintosh* and *HP. F*or the *External Monitor* issue, there is no clear distinction between *19"*, *20"* and *23"*, so the other agent may be indifferent between these values. Finally, in the *Hard Disk* issue, BRAM can infer that the other agent prefers the *120 GB* over *60 GB* and *80 GB*, but it may compromise.

In each round, BRAM tries to create a new offer which will give BRAM a utility score that is at least as high as its current utility threshold. If BRAM fails to create such an offer, it will use the bid array previously mentioned to make a random offer that is above its threshold. Specifically, from its last offer's position (in the array),

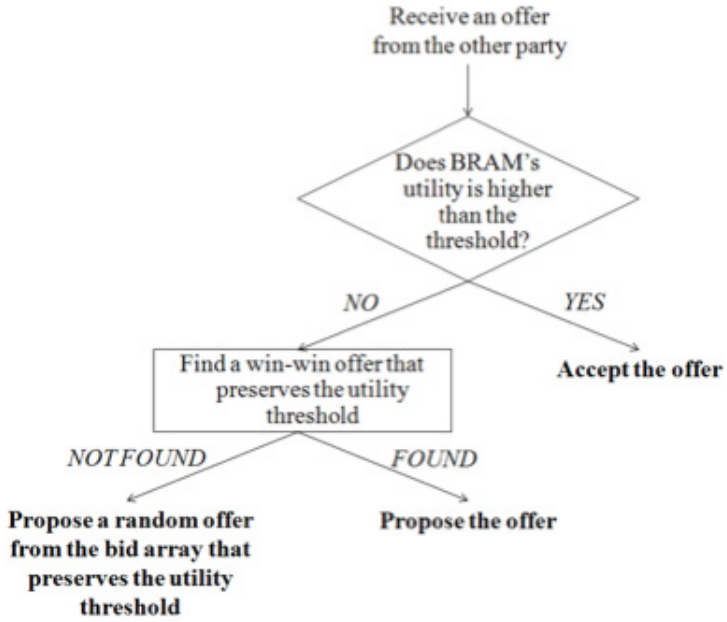

Fig. 1 Illustration of BRAM's decision making process for a single round of a negotiation process

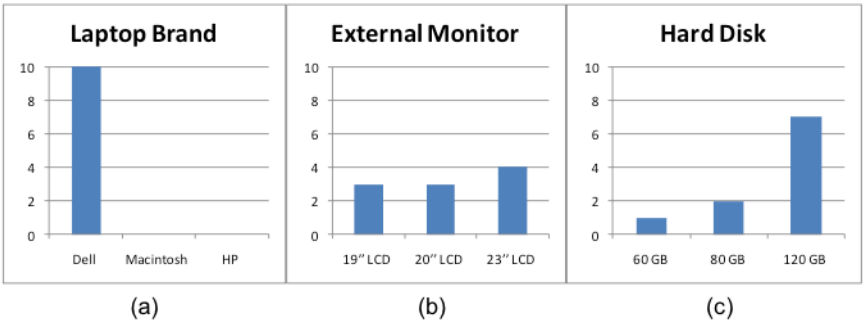

Fig. 2 An example of the histograms of the last 10 offers made by the other agent in the *Laptop* domain. Each histogram refers to an issue in this domain: (a) *Laptop Brand* issue, (b) *External Monitor* issue, and (c) *Hard Disk* issue.

BRAM chooses randomly a nearby bid from a predefined range. The range size is calculated as a function of the number of optional bids in the current domain. If the selected offer's utility is lower than the threshold value, BRAM will offer the same bid that was previously suggested by it. The number of times a bid can be offered is limited, in order to enlarge the variety of bids made by BRAM.

As mentioned, BRAM uses a utility threshold in order to decide whether to accept a given offer, or what offer to make next. The threshold is calculated as a pre-defined percentage of the maximum utility that can be achieved at the current moment and decreases as time elapses. By running empirical simulations with all of the agents in last year's competition (ANAC 2010) and our classmates who also developed agents for ANAC2011 tournament, we determined the following threshold function: during the first 60 seconds, the threshold value is 93% of the maximum utility; during the next 90 seconds it is 85% of the maximum utility; next, during the following 25 seconds it is 70%; and finally 20% (during the remaining 5 seconds).

3 Tournaments Results

In essence, BRAM is a cooperative agent, and while playing with other cooperative agents, it received quite high utilities. However, due to the fact the BRAM compromises as time elapses, playing against non-cooperative agents led to lower utilities. BRAM participated in a national tournament with agents written by students at Ben-Gurion and Bar-Ilan Universities, and received the 1^{st} place with an average utility of 0.7705. Then, at the qualifying results of the ANAC2011 competition, BRAM received a utility of 0.6904 and finished in the 6^{th} place. Because the distance from the 1^{st} place was very small, we decided (based on empirical simulations) to toughen BRAM's approach and set the utilities thresholds to higher percentage values. In the final competition, BRAM won the well respected 4^{th} place in ANAC2011 by receiving an average utility of 0.6746.

A posthoc analysis of the results revealed that in many of its agreements, BRAM and its partners reached the Nash-Equilibrium point. Moreover, BRAM failed to reach agreement with its partner in just 2 out of 385 negotiation sessions (˜0.005%). These results were consistent across domains, further demonstrating the efficacy of our negotiation strategy.