win.win | a negotiating agent for mutual benefit

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ACM Reference Format:
Jochem Brouwer, Saul Gebhardt, Wouter van Hartskamp, and Otto Mättas. 2021. win.win | a negotiating agent for mutual benefit. 1, 1 (March 2021), 2 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 PEAS MODEL

1.1 Performance measure

When creating a new agent, the first step is to determine what the performance measure is to which the newly created agent should aspire. [Russell and Norvig 2009, Ch. 2.3.1] The agent that will be created is a negotiation agent, so the most obvious performance measure should be the utility that is received after a negotiation.
One problem with the received utility as a performance measure however, is that the received utility differs from the domain that negotiations were made in and the agent that was negotiated with. Therefore, the agent can be evaluated in a couple of different metrics.

1.1.1 Creating a test environment. The agent will be competing in an ANAC(Automated Negotiating Agents Competition)-like tournament. One of the lessons learned from these tournaments is that there exists no single strategy that outperforms all other strategies over all possible negotiation scenarios. [Baarslag et al. 2015]
The domain that the tournament will be run in, is unknown. Therefore, there does not exist a single domain which can be used to get an indication of the agents' performance in the tournament.
Therefore, it would be best to set up a test environment which would test the created agent against already existing agents on a couple of different domains. These domains would ideally be somewhat varied in size. That way testing the agent in the test environment will give the most diverse and general results.
The agents that would be chosen to be part of the test environment should also be varied in performance. The agent should be capable of performing well against good agents (agents that participated with ANAC), but also should be able to perform well against more simple agents, who usually do not perform well against more advanced agents. Furthermore, the agent should be tested against both cooperative and non-cooperative agents.
A test environment with these properties should be considered a good enough test environment to test an agent on. With this, we can define the performance measures of said agents.

1.1.2 Utility. The first performance measure that should be considered is the utility score. The utility score can be used as a performance measure by taking the average utility that any agent has received by running it in a tournament in the test environment. The previously mentioned issues with taking the utility score as a performance measure, do not apply in this case, since the agent negotiates with a set amount of agents (which are the same in every tournament) and over a variety of different domains (which are also the same in every tournament), there is no longer a problem with using the average utility as a performance measure.

1.1.3 Quickness. In a time-based negotiation, (as opposed to round-based negotiations) both parties can benefit a lot if the agents are able to accept and create bids quickly, since both parties are able to consider and create more bids than whenever both agents take a lot of time to consider bids.
Another way of considering quickness is the time to reach an agreement as a percentage of the total time allowed in a negotiation session.

1.1.4 Percentage of successful negotiations. Another very important performance measure is the percentage of successful negotiations in the test environment. Since the agent will be competing in the final tournament with all kinds of different agents, the agent should be able to reach agreements with all kinds of agents.

1.1.5 Alternative possible performance measures. There are two final possible performance measures that could be considered; the average distance from the Pareto frontier and the average distance from the Nash point. These two performance measures could be used in a way to determine if the agent gets to fair agreements, which is an indication whether the agent is cooperative or non-cooperative.

1.2 Environment

The agent is designed to be able to negotiate in a multi-agent environment. The goal of interaction is to reach a mutually acceptable agreement between two (or more) agents which all have conflicting interest and a desire to cooperate to reach an outcome. For simplicity, only entities bidding against each other and for a mutual deal are considered agents. For generalisation purposes, the notion of objects can still be considered while the agents will not be interacting with such objects or additional entities. Also, the agent has to be able to interact through different domains and scenarios with generalised approach.

1.2.1 Competitiveness. As the tournament environment will never be a zero-sum game, it can be considered a cooperative environment even when certain competitive aspects are present in the form of

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XXXX-XXXX/2021/3-ART $15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

different individual interest. In considered scenarios, agents' behaviour is best described as maximising a performance measure whose value depends on the other agents' behavior. For distinction, other agent(s) are furthermore deemed opponents.

1.2.2 Observability. Opponent's actions are known through bids which advances the word state for the agent. Communication emerges as rational behaviour. Even randomised action can be considered rational as it avoids the pitfalls of predictability. This adds to the agent's success certainty of achieving its goal. At the same time, this makes the environment only partially observable. Additionally, the negotiation session's length varies and is not predetermined. Overall, this makes the environment non-deterministic.

1.2.3 Adaptiveness. The environment can not change while an agent is deliberating, thus rendering the environment static for the agent. World state change is brought about in steps as a result of interaction between the agent and its opponent(s). There is no need for the agent to keep track of the state outside of the interaction. While every interaction is discrete in its own right, the world itself is continuous as the bids are not predetermined. As explained before, they can be rational even when randomised.

1.2.4 Summary. Some is known about the environment. For example, the fact that agent has an incentive to cooperate with its opponents as this is an inherent feature for all the parties in a negotiation session. On the other hand, much is left unknown. For example the exact way opponents interact during bidding, their strategy for accepting bids and making them. To conclude, we gather all the properties of the environment. We can say it is *partially observable, cooperative, non-deterministic, !sequential/episodic, static, continuous and unknown multi-agent environment.*

1.3 Actuators

In this model, the agents both can offer different strategies to the other agent. The other agent should act upon this strategy: the agent can accept the bid, or it can send another offer.

1.4 Sensors

Where an agent is interacting with it's environment with actuators, the agent perceives it's environment through its sensors. The sensors are the list of input devices the agent has, quite literally the eyes and ears of the agent. With this input, the agent decides on a course of action out of the actuators and handles accordingly. Examples Our example What to do with this input for actuators Mathematic shiezzle

2 BOA COMPONENTS

High level strategy description:

- Bid Array
- Randomized bidding
- First bid at percentage of maximum utility
- Opponent modelling with bayesian learning

2.1 Bidding Strategy

2.2 Opponent Model

2.3 Acceptance Strategy

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