Jeem negotiator: multi negotiations AI agent

Mark Vexler markvexler@hotmail.com; Eyal Elboim eyal.elboim1@gmail.com ;

Jacob Gigron jacob.o.gidron@gmail.com

Introduction: Jeem negotiator was developed for the contest of ANL 2025. This negotiator is supposed to negotiate in both scenarios in which it is the center negotiator and the side negotiator. The agent was designed to handle different negotiation types that can appear in ANL 2025. The strategy was developed as general strategy with some deviations for different types of negotiations.

Design of Jeem negotiator: The negotiator is composed of the following sections:

1. Defines- values that tweak the negotiator behavior
2. Init, on_negotiation_start, on_round_start functions that overwrite the ANL2025Negotiator functions. In those functions the negotiator initializes all internal parameters and prepares data structure it will used later in the round or in the negotiation.
3. Respond and response function that implement the negotiation itself
4. Helper function that constructs the internal data structures and calculate different values.

Jeem negotiator concept:

The negotiator refers to the negotiations in 2 aspects:

- Edge agent or center agent: edge agent has only one negotiation and therefore the utility it can gains is the maximum it can gains in this negotiation, while center utility has few negotiations that impact its utility
- Center utility is single agreement side utility or multi agreement side utility: in single agreement side utility the center agent utility in each negotiation is not dependent on other negotiations results and therefore can treat such negotiation as independent and try to maximize each negotiation.
  In multi agreement the final utility might be dependent on the specific combination of the agreements the center agent managed to achieve

At the beginning of each negotiation:

- The agent calculates the current utility achieved so far
- A sorted list of potential utilities and the bids in this negotiation that can achieve to this utility. This is done at the beginning of the negotiation so there is no need to calculate the sorted list in each round- less calculations in each round meaning that more calculations can be made at the beginning of the negotiation and more outcomes can be calculated.

The sorted list:

- For edge agent the sorted list is simple- descending values of utilities and the bid that reaches this utility.
- For center agents there are 2 cases
  - For single agreement the list is sorted utility list similar to the edge list, in which the utility is only for this negotiation. The concept behind it is that each negotiation is independent, and its utility has no impact on the utility of other negotiations and therefore the agent shall concentrate in this negotiation only on the utility of this negotiation.
  - For multi negotiations utility, the agreement of this negotiation might impact the future utility and not only on the current negotiation. The concept here was to open all possible outcomes from this negotiation till the end and create a list of sorted potential utilities and the current bids that leads to those potential utilities.
    - When the number of possible outcomes was too big and might not be feasible to calculate we chose randomly big number of outcomes (1,000,000 in current implementation) that hopefully are representative enough to cover the best bids in this negotiation.

- Even when the number of possible outcomes was too big at the first negotiations as the center agent progress in the negotiations, the number of possible outcomes drop exponentially and reaches a feasible number to calculate quite early- that means that even if in the first negotiations it didn't calculate all possible outcomes and used a representative set, it is still managed to calculate all possible outcomes in the later stages.
- In addition, for each potential utility and each bid, the agent calculates how many possible outcomes there are to reach this bid. This number is used as a secondary priority after the bid- meaning that the list is order first by utility and in the same utility it is ordered by the number of possible outcomes that can reach this utility for a specific bid in this negotiation. The counter also appears for edge agent and center agent in single negotiation utility, but it is always 1 and therefore has no meaning

The strategy:

- The edge agent is stubborn at the first rounds and propose (and accepts) only the bids with the maximum utility. As the rounds continue the edge agent is willing to compromise and is willing to propose (and accept) bids that reach X% of the best utility. The X is decreasing linearly with the rounds. There is a limit of minimum percentage that beyond this the agent is not willing to compromise. In the last round the agent is accepting the bid if the utility is better than no agreement at all. The concept is that better to get as much utility as possible even if it means a compromise because there is only one negotiation for the edge agent.
- The center agent has 2 flavors:
    - Single negotiation utility- in this type of negotiation the center agent strategy is similar to the one described for the edge agent- at the beginning of the negotiation the agent insists only on bids that lead to the best utility. At some round (after 50% of the rounds in the negotiation) the agent starts to compromise and is willing to a lower utility (similar to the edge agent). There is a low threshold for the percentage of utility it is willing to compromise (propose and accept). The difference between the edge agent is that on the last round it will not accept any offer that is better than no agreement because it expects the edge agent to compromise in the last round.
    - In multi negotiation utilities the agent has small divergence: since the agreements in the negotiations are not independent at the first negotiations the agent doesn't compromise at all and propose (and accepts) only bids whose potential utility is the best utility that can be achieved at this stage- the best future utility that can be achieved with the previous agreements.

On each round:

The agent calculates the compromise it is willing to accept (both for proposal and response). It is called the discount at the code, and it is calculated as described in the clause above. After calculating the discount, the agent goes over the sorted utilities list and takes all the bids whose potential utility (for edge agent it is the exact utility) is bigger than the best utility that can be achieved at this point * discount factor. The list that is created is a set- each bid can appear only once. The bids are organized in descending order from best potential utility to lowest. In addition, as described above for multi negotiations utility within same utility the bids are ordered in secondary priority according to the number of possible outcomes that can reach the potential utility- more potential outcomes the better. In each round the agent proposes the next bid in the list till it finishes the list. At the first round the list of bids to propose is empty and it is created. In the following round the agent checks the list- if it is empty, it calculates the discount and creates new list but if it is not empty the agent continues to pop bids from it and propose them. When a new list is created the agent start with the bids that have the best utility potential even if they were already proposed in the previous rounds- the concept is that center agent should be more stubborn and try the best bids first before going to worse bids.

Propose and respond:

Since all the calculations are done at the beginning of the negotiations and the rounds the functions of propose() and respond() are quite simple and straight forward.

Propose:

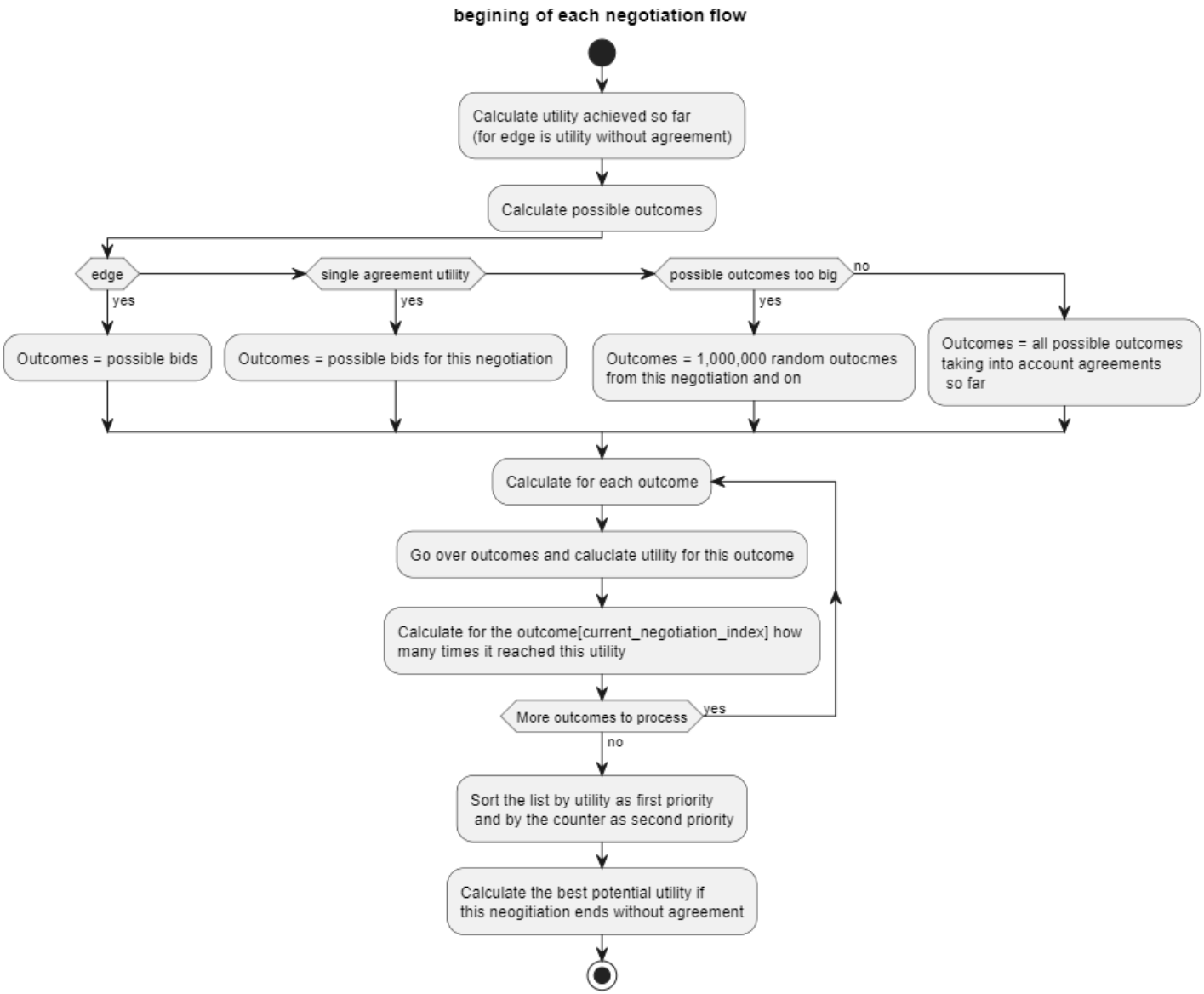
The agent pops the first bid in the set created at the function on_round_start(). In the extreme case in which the list is empty the agent proposes None and finishes the negotiation.

Respond:

The agent checks the proposed bid: if is either

- Exists in the list of bids that were already proposed to the other agent or
- The bid exists in the list of the bids it is willing to propose in the future

Then the agent accepts the offer. In addition, as described above- if it is an edge agent, this is the last round, and the utility of the bid is better than no agreement, the agent will accept the offer even if it is a compromise.



begining of each round flow