2.3 Auction

2.3.1 General Description

A class of negotiation protocols, which provide us with methods for allocating goods/resources, based upon competition among self-interested parties.

There are different types of auctions like the simple ones: English, Dutch, FPSB-First price sealed bid, Vickrey and then Multi-unit, Multi-attribute, Combinatorial and Others …

2.3.2 Application to Practical work

In case the Scouts would compete to get different or specialized routes they could bid to get different routes and then the ScoutCoordinator will choose to whom assign the specific route.

If this was the case we would choose a FPSB- First price sealed bid in which all of the scouts will bid of a specific route/position and then the one with the less cost/max performance will be the winner for that specific position/route, all of the scouts bids without knowing the others bids.

The harvester coordinator could make an auction for each group of garbage units to determine which harvester(s) should go there. The bids of the harvesters could depend on their current position, the position of the garbage, its current state (idle, on its way to another garbage collection, going to the recycling centre, pending garbages, …)

This could be for example a FPSB where each of the Harvesters will bid (communicate its positions in regards to the garbage they want to  collect and how much it will cost them to get there) without knowing each of the other harvesters.

There could be multi-unit auctions, if several garbage points are located close to one another and they are auctioned together.

There could be a combinatoric auction of all the garbage at a certain point in time.

Collected garbage could also be auctioned between recycling centers, if they were autonomous agents in this case the recycling centers will bid on which are closer to a specific harvester and its type of garbage

2.3.3 Advantages and Disadvantages

The advantage of an auction is that it creates competition; it enhances the seller’s bargaining power, this means that the harvester will really compete for getting a job as collecting a garbage and the coordinator (seller) will get to choose which is the best bid.

Flexibility, as protocols can be tailor-made

Advantages of multi-attribute auctions:

They allow more degrees of freedom for bidders: price may not be the only attribute of interest and more efficient information exchange among the market participants

Disadvantages:

The direally doesn't apply to our problem.. most are related to real bidding problems, like lying, shills, that doesn't apply to these agents

2.4 Coalitions

2.4.1 General Description

Coalition formation involves several agents creating a possibly temporary group to help achieve tasks that could either not be achieved individually, or in order to complete the task more efficiently by working together.

2.4.2 Application to Practical work

**Applicability to practical work**

Coalitions are definitely applicable to our garbage collection problem as the MAS has agents that are cooperative, communicate, and deliberative.

The different agents in our garbage collection problem have different and complementary abilities to achieve the common goal of collecting garbage as efficiently as possible. We have five different agents, as well as clones of scouts and harvesters. A coalition would bring together different agents (not clones) to help achieve the common goal more efficiently.

Joint action is possible regardless of whether the agents are cooperative or selfish, as long as a coalition is beneficial for the agents involved *(Coalition structure generation: A survey)*.  For instance, the scouting coordination and harvesting coordination are selfish in the sense that the agents involved act selfishly with regard to their tasks, acting in its own best interest with its own goal. In our case however, how the agents are structured, despite their own ‘selfish’ goals, they already contribute to the overall goal of the system to collect and recycle trash as efficiently as possible.

“When the task is completed, the payoff is distributed, the coalition is disbanded and agents continue to pursue their own agendas”

**Scouting Coordination**

The scouts are told where to go by the scout coordinator. They are purely reactive, as all they do is respond to find trash and communicate this information. A coalition between the scout agents only would not be useful as they do not have a common goal other than walking around as efficiently as possible. This efficiency has to be determined by the scout coordinator.

**Harvesting Coordination**

As suggested in the slides, the harvester agents could form a coalition given a list of detected garbage. This would include their current position, the position and quantify of garbage remaining to be collected, the agent’s capacity (in case they are already loaded with garbage), and their state (whether their waiting or in the process of picking up or recycling garbage). A coalition is dismantled once the task is completed.

**Vehicle Coordination**

The vehicle coordination could work using a coalition between scouts and harvesters. When scouts and harvesters are working on fulfilling their own tasks, if they encounter one another, there is a conflict has to be resolved in order to continue. Forming a coalition could help avoid these conflicts, in order for each to complete their tasks more efficiently. This could work for instance by forming a coalition when agents are within a certain distance of one another. If an agent notes other agents within its personal radius, it can form a coalition to ensure that they efficiently get past each other without colliding and/or waiting longer than necessary. Additionally, the scouts and harvesters do not communicate with each other. However, it could be possible for instance if a scout and harvester are close to each other, and the scout spots some garbage along its path, that this information is immediately passed to the harvester.

2.4.3 Advantages and Disadvantages

The evident advantage of coalitions is that they allow agents to work together to increase efficiency; theoretically they are only formed if a better outcome can be achieved by working together.

A core issue of working with coalitions is to identify which coalitions should be formed in order to achieve a goal *(Algorithms paper)*. “This usually requires calculating a value for every possible coalition, known as the *coalition value*, which indicates how beneficial that coalition would be if it was formed.” It always requires a lot of communication between the agents who have to decide which coalitions to form, and they have to decide which mechanisms to use for the formation.

**References**

Article: Coalition structure generation: a survey (T.Rahwan, T.Michalak, M.Wooldridge, N.Jennings) - Artificial Intelligence, 2015

Article: Methods for task allocation via agent coalition formation (O.Shehory, S.Kraus)

Algorithms for coalition formation in multi-agent systems (PhD, T.Rahwan, 2007)

3.2 Harvesting Coordination

For the harvesting coordination we have chosen to implement three different cooperation mechanisms: voting for the garbage ordering, contract nets to assign the harvester to the garbage, and coalition for idle harvesters.

For the ordering of pending garbage, not yet picked up and unassigned, a voting mechanism will be implemented. The harvest coordinator will announce which garbage is pending, and each harvester agent will respond with an ordered list of the pending garbage that they could pick up most efficiently. Only the available harvesters will vote for the garbage.

In order to assign a harvester to a specific garbage collection task, we have chosen to use contract nets. In the order determined by the voting, the harvester agents bid if they are willing and able to pick-up the garbage in question. The coordinator then chooses the best fitting agent for this task and assigns it to the garbage.

In order for the idle harvesters to be more purposeful, they will form a coalition with the scouts. As the idle scout has no task to complete in the current state, it will follow a scout around in order to be closer to potential garbage to be discovered.