

MAS: Activity 10 – Agent Coalitions

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In this activity, the objective is to implement mechanisms for forming *stable* agent coalitions, whereby the purpose of forming the coalition is that of obtaining a higher utility, than is possible for each individual agent (given its resources).

The problem setting is that of a series of *buyer* agents, each with constrained resources (money). There agents must obtain one instance (or part thereof) *from each type* of a set of products. For each product type, there are several available versions, each with a value and a cost.

The agent resource are given in such a way, that each agent cannot single-handedly acquire instances of each product type. Therefore, the agents have to form coalitions, where they *cooperate* in order to buy higher-valued product items. While doing so, two aspects have to be observed:

- The formed coalition of agents has to be stable, i.e. no agent must have the *rational* incentive to leave this coalition for another.
- To maintain stability, fairness of the value distribution among coalition agents has to be ensured. This means that agents have to receive a total value that is *proportional* to their *contribution* to the coalition.

Agent Setup.

The problem setup is similar to the Ice-Cream Game from slide 20 of the attached class presentation. However, in our setup there are two product types (**r1** and **r2**), each with a given lineup of product instances, characterized by value and price. The agents must consider the *fairness* distribution for each product type (i.e. a value distribution proportional, *for that product type*, with the contribution *for that product type*).

The task of the agents is to interact with one another and propose that they form a coalition. To simplify the task of carrying out coalition formation negotiations, the agents are given turns in which they opt to *join* a new coalition or to *quit* their existing one. **At any moment, an agent can be part of a single coalition.**

Each coalition has a *coalition leader*, which is the agent that negotiates on behalf of the coalition. The *coalition leader* is the agent which has *the highest amount of resources (money)* in the coalition. If two agents have the same amount of resources, they are sorted in alphabetical order of their names.

Communication Setup. The support code features a `CoalitionManager`, which manages the following interactions:

- It handles a token to the *buyer* agents in *decreasing* order of their resources (money). Only the agent which has a token is allowed to initiate requests for creating new coalitions and/or deleting existing ones (in which it was a member).
- Buyer agents have to announce the *end of their turn* after they have negotiated their belonging to a coalition. Note that a turn can end without any new action, if the agent is already satisfied with his coalition membership.

- When the `CoalitionManager` finishes a round (a token passage through all the buyer agents) it checks to see if the coalition configurations have changed from the beginning of the round. If they have, the `CoalitionManager` will initiate a new round, until the coalition configurations do not change.
- At each turn, the buyer agent can opt between *joining an existing coalition* or *creating a new one with agents that are not part of a coalition*. Buyer agents *cannot* break-up existing coalitions (this is a simplification of the general mechanism).
- When a new coalition is created, the *coalition leader* publishes the coalition configuration (making a request to the `CoalitionManager`), which is then broadcast by the manager to all other buyer agents.
- Buyer agents can submit requests to *delete a coalition configuration* to the `CoalitionManager` which is, similarly, broadcast to the other buyer agents

Roadmap.

Your tasks are the following:

- Implement a method by which an agent computes **his ideal, fair** share in total coalition value, if he were to join an existing coalition. The agent must ultimately choose whether to join a larger coalition, only if his expected utility increases.
- Implement an interaction protocol by which two agents (the agent of the *current turn* and the *coalition leader* of an existing coalition) negotiate the formation of a new coalition. Use the FIPA Request Protocol as the basis for this interaction. Initially, each agent is part of a single-individual coalition composed of itself.
- The Request is always initiated by the agent who has the token. The message *must* contain:
 - the contribution of the agent per product type (i.e. how much money for product type `r1` and how much for `r2`).
 - the expected share in value per product type
- The *coalition leader* will either refuse the cooperation if the new agent leads to a decreased utility for the existing coalition (according to the new redistribution of value), or accept the new agent and publish a new coalition composition as a result.