MAS: Activity 7-8 – Auctions and Negotiations

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The Multi-Agent Oriented Programming (MAOP) Paradigm is well suited for application scenarios that involve interactions between multiple parties that have a stake in a given objective, though possibly different interests.

This assignment aims to make use of two interactions that are typically encountered in the multi-agent literature: auctions and negotiations.

1   Problem Description

The problem description that makes use of these interactions is that of *a company (ACME) that wants to build a new headquarters and needs to sign contracts for the following items: (i) structural design, (ii) building, (iii) electrical and plumbing work, (iv) interior design.*

The contracting occurs by the following assumptions and rules:

- The contracting company is called ACME and it **has a given budget each construction item**;
- The contractors are companies A – F. Each company is specialized in a subset of the 4 construction tasks (e.g. structural design and interior design, building and electrical/plumbing work, etc). Each company has a **lower limit for the price at which it will take on each type of construction task** – its actual cost.
- The goal of ACME is to complete the headquarters **and to save as much money as possible** from the overall budget.
- The goal of each contractor company is to participate in **at least one contract**, since this builds up serious reputation. At the same time, each company wants to ensure it turns in as much of a profit as possible.

To perform the contracting for each task, ACME employs the following strategy:

- It first holds a variation of the **Dutch (descending auction)** (**see Negotiation lecture**) to establish a preliminary list of companies who are willing to do the task at a given price. The variation is that ACME will start from a low price and continuously raise it, until one (or more) companies place a bid. ACME is allowed to raise the price **at most 3 times**.
- With each interested company, ACME enters a negotiation using the **monotonic concession protocol** (see Negotiation lecture) to try and bring the price further down. ACME holds at most 3 rounds of concession. After the negotiations, it will select the company with the lowest price (or one randomly if each has the same offer).

2   Multi-Agent Modeling

Follow these indications when developing your MAS solution for the given problem.

- Model ACME and each of the contractor companies as an agent.
- The contractor companies register with the Directory Facilitator agent to specify which services they can provide (i.e. structural design, building, electrical and plumbing work, interior design).
- For each agent, maintain a state of different interactions within the agent class. See the `ContractingStatus` class for this purpose.
- Model each step of the **Dutch auction** using a Contract Net Protocol.
- Create a custom set of interactions for the **monotonic concession protocol**.
  - Define a *conversation id* for your interactions
  - Start with a FIPA REQUEST message and then continue with FIPA PROPOSE messages, until the protocol finishes. Use a FIPA INFORM performative for the last message from one agent in the protocol.

3   Other specifications

This assignment is intended for two labs. You must first implement the auction protocol and then the monotonic concession protocol. Work in teams of two: one designs the strategy for ACME and the other one the strategy for each company. DO NOT COMMUNICATE YOUR STRATEGIES :-)

For testing purposes, you have two test setups. In both setups, ACME has the following budget:

- structural design: 5000
- building: 10000
- electric/plumbing: 4000
- interior design: 5000

For the contractors:

- In the first one (`data/Companies.json`) you have a manual setup of the company cost values for each contracting stage.
  - company A: structural design - 5000, interior design: 5000
  - company B: structural design - 4000, building - 8000
  - company C: building - 9000, interior design: 3500
  - company D: building - 7500, electric and plumbing - 2500
  - company E: building - 7200, electric and plumbing - 3700
  - company F: structural design - 4000, interior design: 4000
- In the second one (`data/Companies2.json`), the cost values are distributed to companies according to a <u>normal distribution</u>, with mean equal to the budget of ACME and a standard deviation of 20% from the max budget (e.g. for building, mean = 10000, std = 2000). For this second setup, *both ACME and the contractor companies know how budget and costs are distributed!*

Hints:

- use the conversation id for building item;
- use `ACLMessage.getPerformative(int)` to print performative names;
- the ContractNetResponder behavior only handles on Contract Net iteration;
- use message content to store proposed values; for conversions, use `String.valueOf(int)` and `Integer.parseInt(String)`.

Cum să raportați activitatea:

- **la sfârșitul laboratorului:** trimiteți arhiva conform cu instrucțiunile de mai jos.
- **la terminarea taskurilor** aferente laboratorului (înainte de următorul laborator, altfel cu depunctare): trimiteți din nou arhiva, conform cu aceleași instrucțiuni, eventual adăugând ceva la nume.

Conținutul arhivei: numai directorul `src`, arhivat într-o arhivă cu numele `PrenumeNume_MAS-N.zip`, unde N este numărul laboratorului pe care l-ați rezolvat.

Cum trimiteți: trimiteți arhiva în atașament la un mesaj către adresa alex.sorici+mas@gmail.com. Dacă adresa este corectă și există atașament, veți primi un mesaj automat de confirmare.

Notă: Folosiți adresa de mai sus numai pentru a trimite activitatea de laborator. Pentru alte probleme folosiți modalitățile de contact indicate la curs.