MAS: Activity – 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

The game setup follows these indications:

- Model ACME and each of the contractor companies as an agent.
- The environment keeps a record of each agent and knows what services they can provide (i.e. structural design, building, electrical and plumbing work, interior design).
- The environment maintains a state of two different interaction phases: *auction phase* and *negotiation phase*.
- In the *auction phase* the environment keeps track of current auction item, current auction round, companies that have secured a spot to the negotiation phase
- In the *negotiation phase* the environment will facilitate an `MonotonicConcessionNegotiation` instance for each of the agents that were selected by ACME during the *auction phase*.
  - ACME is always the initiator of the negotiation. ACME will try to start at lower price, and bring it back up to the value of auction phase.
  - Company agents are always the responders in the negotiation protocol. Company agents decide if they accept lowering the received budget for the construction item.
  - Company agents **do not know** the offers made in the negotiation by other agents, but they **do know** how many agents have entered the negotiation.

3 Other specifications

Each student has to implement a strategy for ACME and a strategy used by company agents. Final lab evaluation will be **team based** one: two solutions will be pitted against each other - one student gives the strategy for ACME, while the other one gives the strategy for the company agents. The evaluation file will be based on a config similar to test setup number 2 (see below).

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 (`config-companies-1.cfg`) 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 (`config-companies-2.cfg`), the cost values are distributed to companies according to a normal distribution, 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!*