Decentralized Coordination
Competing for the best strategy!

Intelligent Agents Course

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The Drawbacks of Centralized Coordination

- Centralized Coordination:
  - Tasks known in advance
  - Company has complete information about the parameters
  - The vehicles blindly follow the orders of the company

- the central plan can be unfair
  - NOT incentive compatible

Decentralized Coordination

- agents negotiate and distribute the tasks among themselves
- create a **market**, where tasks are **sold** to the agents that are the most willing to take them
- the competition leads to an efficient delivery solution

Assumptions

- Agents are self-interested and rational
  - Utility = reward – transportation costs
  - agents accept only profitable tasks
  - agents maximize their utility

- Market interaction protocol:
  - tasks are auctioned sequentially (one after another)

Our Setting

- one agent is **ONE company**
- the Auctioning House auctions the tasks to the available agents
  - sequential auction (one task at a time)
- agents bid for tasks
  - bid = requested reward per km to deliver the task.
- every task is allocated to the lowest bidder
  - reward received by the winning bidder = lowest bid (first price auction) x distance (on the shortest path) between pickup and delivery
- **bids are binding**

Placing Bids

- lowest bid = (marginal cost) / distance(pickup,delivery)

- marginal cost depends on the context
  - equals the supplementary cost of delivery

Marginal cost to A_i of task t given a remaining set of tasks T:

$$c_{add}(A_i, t) = cost(A_i, T \cup t) - cost(A_i, T)$$

Marginal Cost Example

- A vehicle *V* without any task
- Task T1:
  - Geneva -> Lausanne
  - Marginal cost: travelling from the present location to Geneva, and then to Lausanne
- Task T2:
  - Lausanne -> Bern
  - Marginal cost (When *V* already has *T1*): just the supplementary cost, i.e. travelling from Lausanne to Bern.

Considering the future

- when placing bids, speculate about the future tasks that might be auctioned
  - e.g. you have [T1:G -> L], you might be more likely to accept [T2: B -> Z] because you expect a future task [Ti: L -> B]

- consider the probability distribution of tasks

Considering the other agents

- use the feedback from the previous auctions to derive information about the other competitors

- e.g., you might request a higher price if you see that the other competitors are not very efficient

The Competition

- every group has one agent
- every agent controls a company with two vehicles
- we may introduce several dummy agents to check if your agent is at least performing better than our dummy agents
- the competition consists of several runs (each consists of rounds)
- in every round agents compete against the other agent during auctioning of N tasks
- winner is based on the results of all rounds

One competition run

- The Auctioning House receives a list of tasks (drawn randomly from the common distribution)
- all agents are initialized at random
  - random location for the vehicles
  - random costs per km,
  - random max load, speed (do not matter)
- tasks are auctioned and assigned to the lowest bidders
- the platform verifies that each agent delivers all assigned tasks

Rules

- agents can be disqualified if they win tasks but do not deliver them (in the best case the tasks are being auctioned again).
- No cheating (no stealing information about future tasks, use only information which is given in the signals).
- timeout for computing bids = 5 mins (can vary on a machine, so better have some mechanism to check the time elapsed)
- Competition in pairs/groups, winner from each competes with the other winner until only one left

TO DO

- Implement an agent that can participate in the auctions
- implement a bidding strategy (and plan the delivery of assigned tasks)

- WIN THE COMPETITION!

Deliverable

- Deadline specified on the Moodle
- Report of maximum of 3 pages (explain your bidding strategy)

- 100 points
- reward for the winners – to be announced