AUTONOMOUS AGENTS AND MULTI-AGENT SYSTEMS (AASMA)

2018/2019

LAB 6 – SOCIAL WELFARE AND NEGOTIATION

1. GOALS

1. Agent coordination using principles from social welfare;
2. Agent coordination under auction-based behavior;
3. One-to-one coordination using principles from game theory.

2. SOCIAL WELFARE DECISIONS (ONE-SHOT NEGOTIATION)

Consider the Loading Dock scenario introduced in previous classes. Once all the boxes are in the shelves, the robots are now solicited to seal the boxes. Each colored box is sealed in a unique way. Robots seal each colored box with varying degree of perfection:

	Red box	Green box	Blue box	Yellow box
Agent 1	**1**	**-1**	**2**	**2**
Agent 2	**1**	**3**	**2**	**0**
Agent 3	**2**	**1**	**0**	**3**

An agent reward for sealing a particular box is given by the quality (degree of perfection) of the undertaken task. The overall reward is the sum of the rewards associated with the sealed boxes.

2.1 What is the distribution of boxes among the agents when assuming a (linear) **utilitarian social welfare**?

2.2 Give a possible distribution of boxes among the agents when assuming an **egalitarian social welfare?** Compare the total and minimum individual reward against the utilitarian approach.

2.3 Are previous protocols Pareto optimal? Calculate the **Nash collective utilitarian** solution for this task.

2.4 Based on the previous conclusions, implement in Java/NetLogo a **on-shot negotiation** protocol in the *Loading Dock* scenario for the allocation of sealing activities.

3. AUCTION-BASED BEHAVIOR

Assume that the agents do not know the sealing ability of other agents (i.e. they cannot access the previous reward table). In this context, sealing tasks are allocated based on an auction for each pair of colored boxes.

Assume that: agents are not willing to give more than the perceived reward, agent 1 has preference in case of a tie, and agent 2 is the most efficient and impulsive.

3.1 Calculate the bid, winner and total reward using each of the following auction protocols:

- English auction (reservation price = 1)
- Dutch auction (initial price = 5)
- Sealed bid

3.2 Compare these results with the welfare-driven centralized form of coordination.

3.3 Implement these auction-based interactions in the Loading Dock scenario.

4. Game Theory

Consider that agents 2 and 3 proactively establish interactions between them in order to decide on the allocation of unsealed boxes per agent. To this end, the allocation decisions on each pair of colored boxes are modelled within a bi-matrix:

		Agent 3	
		No	Yes
Agent 2	No	*boxes sealed by agent 1 (rewards divided)*	*2 boxes sealed by agent 3*
	Yes	*2 boxes sealed by agent 2*	*1 box sealed by agent 2, 1 box sealed by agent 3*

Illustrating, the rewards of decisions associated with red boxes are given by:

		Agent 3	
		No	Yes
Agent 2	No	**1, 1**	**0, 4**
	Yes	**2, 0**	**1, 2**

4.1 Draw the remaining three game boards (blue, green and yellow boxes) and calculate the overall reward assuming a utilitarian social welfare.

4.2 Compare this solution against alternative strategies based on greedy vs. cooperative beliefs and actions.

4.3 Implement these interactions in NetLogo or Java using deterministic beliefs placed on the actions of the interacting agent.

4.4 Implement an alternative stochastic solution by decomposing belief in a percentage that models the perceived greedy *vs*. cooperative trait of the interacting agent.