Exercise L2 Agents, comms & coop 2021

Question 1

a) Could you give a definition of an agent?

"An agent is a computer system that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its delegated objectives." [Wooldridge & Jennings, 1995]

1) Objective/goal is to affect the environment in some desirable way.
2) Autonomy is the only generally accepted requirement.

3) Acting on behalf of someone.
4) Reactivity - respond to changes in the environment.
5) The intelligent agent is also proactive - initiate goal-directed behaviour on its own.
6) The intelligent agent engages in social activities - like cooperation, coordination, negotiation, competition.

b) How would you define a multi-agent system?

"Multiagent systems are systems composed of multiple interacting elements, known as agents."
[Wooldridge, 2009]

1) Reactive agents can produce

complex collective properties/performance - this is often modelled by swarm intelligence.

2) Interactive or intelligent agents engage in strategic interaction - this is often modelled by game theory.

3) Research goal is to connect micro scale behaviour with macro scale properties/effects, and vice versa.

Question 2

a) Is this a decision-making problem or a problem of strategic interaction? Explain the variables used. What are the requirements for maximizing expected utility?

This is a decision-making problem since optimization does not take other agents actions into account.

1) Environment is static
2) One shot/round

Definition of expected utility

$$\bar{u}(Ag, Env) = \sum_{r \in R(Ag, Env)} u(r) P(r \mid Ag, Env)$$

where $\sum P(*) = 1$ makes it a proper density function

We must decide stakeholders, Ag_1 and Ag_2, and their corresponding available states e, with out comes w and probabilities p of different runs r

$Env_1 = \langle E, e_0, \tau \rangle$ is the environment

with $E = \{e_0, e_1, e_2, e_3, e_4, e_5, e_6\}$ is the

set of possible states, e_0 is the initial state

$T(e_0 \xrightarrow{\alpha_0}) = \{e_1, e_2, e_3\}$ is state transform function for action α_0

$T(e_0 \xrightarrow{\alpha_1}) = \{e_4, e_5, e_6\}$ is state transform function for action α_1

So we have two agents, Ag_1 uses action α_0 and Ag_2 uses action α_1.

We have probability of ending in another state, by example

$$P(e_0 \xrightarrow{\alpha_0} e_1 \mid Ag_1, Env_1) = 0,7$$

The corresponding utility of ending up in that state is, by example

$$u_1(e_0 \xrightarrow{\alpha_0} e_1) = 10$$

Lets calculate if $\sum p(\cdot) = 1$

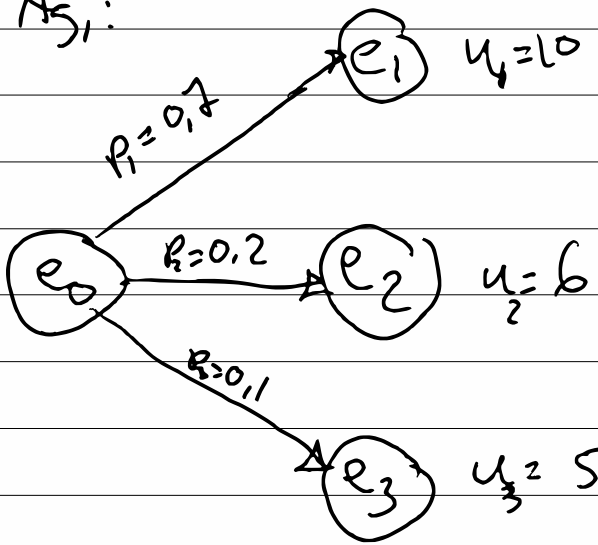
$$\left.\begin{aligned} p(e_0 \xrightarrow{\alpha_0} e_1 \mid Ag_1, Env_1) &= 0,7 \\ p(e_0 \xrightarrow{\alpha_0} e_2 \mid Ag_1, Env_1) &= 0,2 \\ p(e_0 \xrightarrow{\alpha_0} e_3 \mid Ag_1, Env_1) &= 0,1 \end{aligned}\right\} = 1$$

$$\left.\begin{aligned} p(e_0 \xrightarrow{\alpha_1} e_4 \mid Ag_2, Env_1) &= 0,6 \\ p(e_0 \xrightarrow{\alpha_1} e_5 \mid Ag_2, Env_1) &= 0,3 \\ p(e_0 \xrightarrow{\alpha_1} e_6 \mid Ag_2, Env_1) &= 0,1 \end{aligned}\right\} = 1$$

b) Given these definitions, calculate the expected utility of agent Ag_1 and Ag_2 with respect to Env and u. Which agent is optimal with respect to Env_1 and u_1?

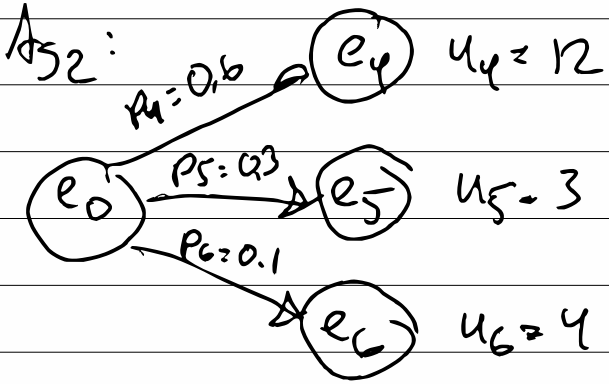
We need to calculate the expected utility of both agents (strategies/actions).

A_{S_1}:



$$\hat{u}_{A_{S_1}} = E(u) = p_1 u_1 + p_2 u_2 + p_3 u_3$$
$$= 0.7 \cdot 10 + 0,2 \cdot 6 + 0.1 \cdot 5 = \underline{8.7}$$

A_{S_2}:



$$\hat{u}_{A_{S_2}} = E(u) = p_4 u_4 + p_5 u_5 + p_6 u_6$$
$$= 0.6 \cdot 12 + 0.3 \cdot 3 + 0.1 \cdot 4 = \underline{8.5}$$

$\Rightarrow Ag_1$ (strategy) using action a_0 is optimal in this environment

$$\hat{u}(Ag_1, Env_1) > \hat{u}(Ag_2, Env_1)$$