Solution to exercises from lecture 2 (agents, communication and cooperation) TEK5010 Multiagent systems 2020

Question 1

a) Could you give a definition of an agent?

1) 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], or equivalent, with emphasize on the points:
a. Objective/goal is to affect the environment in some desirable way.
b. Autonomy is the only generally accepted requirement.
c. Acting on behalf of someone.
d. Reactivity – respond to changes in the environment.
e. The intelligent agent is also proactive – initiate goal-directed behaviour on its own.
f. The intelligent agent engages in social activities – like cooperation, coordination, negotiation, competition.

b) How would you define a multiagent system?

1) Definition of MAS: "Multiagent systems are systems composed of multiple interacting computing elements, known as agents", [Wooldridge, 2009], or equivalent.
a) Reactive agents can produce complex collective properties/performance - this is often modelled by swarm intelligence.
b) Intelligent agents engage in strategic interaction - this is often modelled by game theory.

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 it does not involve multiple agents.
1) Environment is static
2) One run

Definition of expected utility

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

Where $\sum P(*) = 1$ makes it a proper density function.
We must decide stakeholders, Ag_1 and Ag_2, and their corresponding available states, with outcomes and probabilities of the different outcomes.

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

With $E = \{e_0, e_1, e_2, e_3, e_4, e_5\}$ set of possible states, e_0 is initial state.

$\tau\left(e_0 \overset{\alpha_0}{\rightarrow}\right) = \{e_1, e_2, e_3\}$ is state transform function for action α_0

$\tau\left(e_0 \overset{\alpha_1}{\rightarrow}\right) = \{e_4, e_5\}$ is state transform function for action α_1

We have two "agents"

$Ag_1(e_0) = \alpha_0$ uses action 0

$Ag_2(e_0) = \alpha_1$ uses action 1

We also have probability of ending in another state, by example

$$\left(e_0 \overset{\alpha_0}{\rightarrow} e_1 \middle| Ag_1, Env_1\right) = 0.5$$

The corresponding utility of ending up in that state

$$u_1\left(e_0 \overset{\alpha_0}{\rightarrow} e_1\right) = 8$$

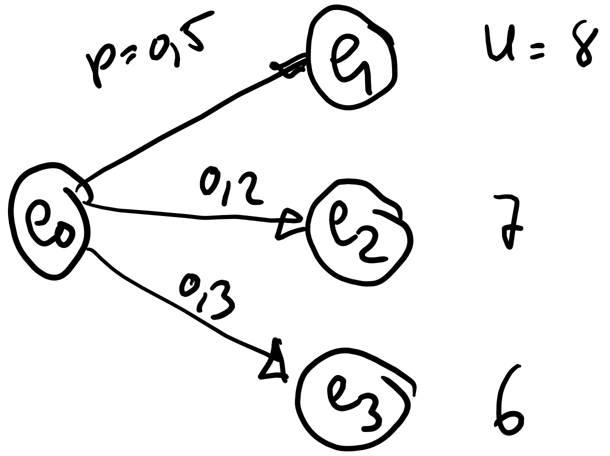
Lets calculate if $\sum p(\cdot) \overset{?}{=} 1$

$$\left.\begin{aligned} p(e_0 \overset{\alpha_0}{\rightarrow} e_1) &= 0,5 \\ p(e_0 \overset{\alpha_0}{\rightarrow} e_2) &= 0,2 \\ p(e_0 \overset{\alpha_0}{\rightarrow} e_3) &= 0,3 \end{aligned}\right\} = 1$$

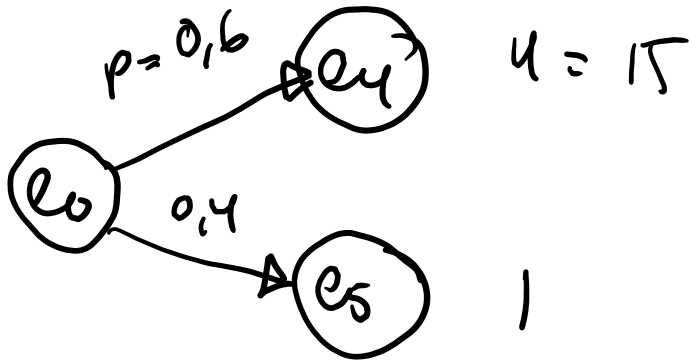
$$\left.\begin{aligned} p(e_0 \overset{\alpha_1}{\rightarrow} e_4) &= 0,6 \\ p(e_0 \overset{\alpha_1}{\rightarrow} e_5) &= 0,4 \end{aligned}\right\} = 1$$

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

Calculate the expected utility of both agents (strategies/actions).



$$\hat{u}_1 = 0{,}5 \cdot 8 + 0{,}2 \cdot 7 + 0{,}3 \cdot 6 = 7{,}2$$



$$\hat{u}_2 = 0{,}6 \cdot 15 + 0{,}4 \cdot 1 = 9{,}4$$

$\Rightarrow Ag_2$ (strategy) using action α_1 is optimal in this environment

$$\hat{u}(Ag_1, Env) < \hat{u}(Ag_2, Env)$$