TEK5010 Multiagent systems

Lecture 2: Agents, communication and cooperation

Exercise: Decision theory

Question 1

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:

1) Optimization does not take other agents' actions into account
2) Environment is static
3) One shot/round

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, agents Ag_1, and Ag_2, and their corresponding available states e, with utility u and probabilities p of ending up in the different e's (i.e. over all the possible different runs r).

where

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

$E = \{e_0, e_1, \ldots, e_6\}$ is the set of possible states,

e_0 is the initial state

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

$\tau\left(e_0 \overset{\alpha_1}{\rightarrow}\right) = \{e_4, e_5, e_6\}$ is state transform of action α_1

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

By example, we have probability of ending up in another state

$$P\left(e_0 \overset{\alpha_0}{\rightarrow} e_1 \middle| Ag_1, Env\right) = 0.3$$

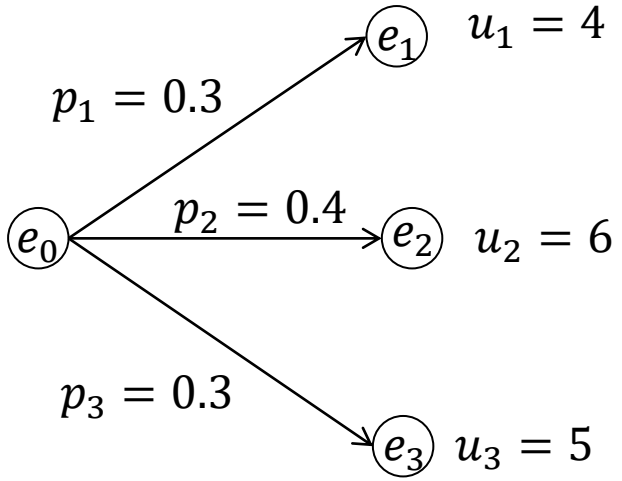
The corresponding utility of ending up in that state is, by example

$$u\left(e_0 \overset{\alpha_0}{\rightarrow} e_1\right) = 4$$

b) Given these definitions, determine the expected utility of agents Ag_1 and Ag_2 with respect to Env and u, and explain which agent is optimal with respect to Env and u.

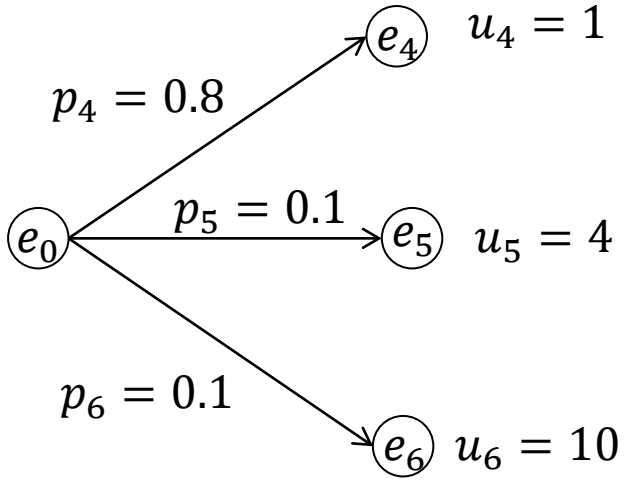
We need to calculate the expected utility of both agents using their actions.

Ag_1:



$$\hat{u}(Ag_1) = E(u) = p_1u_1 + p_2u_2 + p_3u_3$$
$$= 0.3 \cdot 4 + 0.4 \cdot 6 + 0.3 \cdot 5 = 5.1$$

Ag_2:



$$\hat{u}(Ag_2) = E(u) = p_4u_4 + p_5u_5 + p_6u_6$$
$$= 0.8 \cdot 1 + 0.1 \cdot 4 + 0.1 \cdot 10 = 2.2$$

$\Rightarrow Ag_1$ using action α_0 is optimal in this environment since expected utility is higher for this agent than for agent 2

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