Foundations of Agents Resit Exam, 26.01.2016

1 Markov Decision Process

Consider an MDP (S, A, t, r) where $S = \{s, t\}, A = \{a, b\}$, and the functions $t : S \times A \times S \to [0, 1]$ and $r : S \times A \times S \to \mathbb{R}$ are specified by the following table:

S	A	S	t	r
s	a	s	0.5	2
s	a	t	0.5	4
t	a	s	0.1	4
t	a	t	0.9	2
s	b	s	0.1	0
s	b	t	0.9	2
t	b	s	0.9	1
t	b	t	0.1	0

Apply Q-Learning to this MDP with the sequence of $(s, a, s, a, t, b, s, a, t, b, s, b, t)$.

2 BDI Logic

Consider an *irrational* agent. This agent intends to do action a while believing that he will never be able to do action a.

1. Give a specification of the beliefs, desires and intentions of that agent using Bratman's BDI model.

2. Specify a Kripke structure in which those beliefs, desires and intentions hold.

3 Doxastic Logic

Consider the following Kripke structure for two agents: $\mathcal{I} = (S, I, R_1, R_2)$.
The agent classes R_1^B and R_2^B are *serial*, *transitive*, *euclidean*.

1. Draw an example of a Kripke structure where there holds:

$$(\mathcal{I}, s) \models B_1 p \to B_2 p$$
$$(\mathcal{I}, s) \models B_2 \neg(p \wedge \neg q)$$

2. Prove, that the following statement holds using doxastic logic:

$$\{B_1 p \to B_2 p, B_2 \neg(p \wedge \neg q)\} \vdash \neg B_1 p \vee B_2 q$$

4 Dynamic + Epistemic Logic

Consider the Byzantine Generals problem: General 1 and General 2 fight in a battle for Byzantium. Each General rules an army on the opposite of the enemy army. They have to attack at the same time in order to win, otherwise they lose. General 1 is the General to decide the moment of attack.

1. Give a Kripke representation of the knowledge of General 1 and General 2 after General 1 decides the moment of attack; before it is communicated with General 2. The knowledge of each General has the properties of S5.

General 1 now sends a courier to General 2 in order to inform him about the the moment of attack. The courier successfully delivers his message to General 2 through the enemy lines.

2. Extend the Kripke structure to represent, that the courier has successfully delivered his message to General 2.

General 2 now sends the courier back to General 1 in order to confirm his receipt of the message. The courier successfully passes through the enemy lines, delivering the message to General 1.

3. Extend the Kripke structure to represent, that the courier has delivered the receipt message to General 1.

4. Is there common knowledge in any state of the Kripke structure? Motivate your answer using your Kripke structure.