Foundations of Artificial Intelligence

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Exercise Sheet 6

Due: Wednesday, July 19, 2017, before the lecture

Exercise 6.1 (Planning)

Consider the following STRIPS-Task $\Pi = \langle \mathcal{S}, O, I, G \rangle$:

- $\mathcal{S}$: {X, Y, Z, G}
- $O : \{A, B, C, D, E, F\}$ where

$$
\begin{aligned}
A:&\ \mathit{pre}(A) = \{X\}, && \mathit{eff}(A) = \{Y, Z\} \\
B:&\ \mathit{pre}(B) = \{X\}, && \mathit{eff}(B) = \{\neg X, Z\} \\
C:&\ \mathit{pre}(C) = \{\neg Y\}, && \mathit{eff}(C) = \{Z\} \\
D:&\ \mathit{pre}(D) = \{\neg Z\}, && \mathit{eff}(D) = \{Y\} \\
E:&\ \mathit{pre}(E) = \{\neg X, Y\}, && \mathit{eff}(E) = \{\neg Y, G\} \\
F:&\ \mathit{pre}(F) = \{Z\}, && \mathit{eff}(F) = \{\neg Z, G\}
\end{aligned}
$$

- I: {X, Y}
- G: {G}

(a) State for each operator from O if it is applicable in I or not. For each applicable operator also give the resulting state after applying that operator in I.

Operator	Applicable?	Resulting State
A		
B		
C		
D		
E		
F		

(b) Give an applicable plan π that leads from I to G.

Exercise 6.2 (Value iteration algorithm)

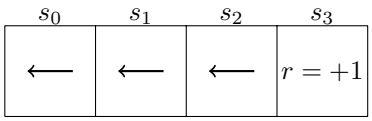
Consider the following grid world. The u values specify the utilities after convergence of the value iteration and r is the reward associated with a state. Assume a discount $\gamma = 1$. The agent can perform four possible actions: **North**, **South**, **East** und **West**. With probability 0.7 the agent reaches the intended state, with probability 0.2 it moves to the right of the intended direction, and with probability 0.1 to the left.

$u = 8$	$u = 15$	$u = 12$
$u = 2$	$r = 2$	$u = 10$
$u = 7$	$u = 16$	$u = 11$

Which is the best action an agent can execute if he is currently in the center state of the grid world? Justify your answer. Which utility does the center state have?

Exercise 6.3 (Policy iteration algorithm)

Let $\gamma = 0.5$ be the discount and **East** and **West** the only actions. With probability 0.9 the agent reaches the intended state (or stays where he was, if the action would move him out of the grid), and with probability 0.1 he moves in the opposite direction. The reward in the three western states is -0.05 each.



Perform one step of the policy iteration algorithm. The initial policy is given by the arrows in the states. Give the linear system of equations for the first policy evaluation, a solution to the system as well as the first improved policy π_1.

Exercise 6.4 (Decision Tree Learning)

Two candidates O and M who appeal to different parts of the population run for a political office. The following table shows the preferences of seven voters of different age, income and educational background.

No.	Age	Income	Education	Candidate
1	≥ 35	High	Highschool	O
2	< 35	Low	University	O
3	≥ 35	High	College	M
4	≥ 35	Low	Highschool	M
5	≥ 35	High	University	O
6	< 35	High	College	O
7	< 35	Low	Highschool	M

(a) Use the learning algorithm from the lecture to compute a minimum-size decision tree correctly classifying all examples wrt the preferred candidate based on the attributes *age*, *income*, and *education*. For the root node, give the information gains associated with all candidate attributes.

(b) Deduce from the decision tree a logical formula which is satisfied iff candidate O is preferred.

The exercise sheets may and should be worked on in groups of three (3) students. Please write all your names and the number of your exercise group on your solution.