Aalto University, Department of Computer Science JR

CS-E4800 Artificial Intelligence

Examination, April 15, 2021

Wrong answers to yes/no questions will give half the points negatively, e.g. for a 2-point question this means -1 points. If you are not sure about the answer, it's best to answer 'DontKnow'! Answers to numeric questions 'close enough' will yield full points, and answers a bit off still yield some points.

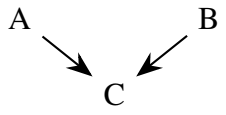
Question 1 (10.00 pts) Consider the following two games.

	C	D
A	$5, -5$	$-1, 1$
B	$0, -1$	$2, -2$

	G	H
E	$-4, -6$	$7, -9$
F	$-5, -8$	$-2, 0$

Both games have exactly one Nash equilibrium (either in pure or in mixed strategies). Find those Nash equilibria. What are the probabilities of playing the strategies A, C, E and G? Return your answer as the vector $(P(A), P(C), P(E), P(G))$.

Question 2 (12.00 pts) Consider the following Bayesian network and the CPTs for all nodes.



$P(A)$
0.70

$P(B)$
0.80

		$P(C\|A,B)$
A	B	0.20
A	$\neg B$	0.60
$\neg A$	B	0.30
$\neg A$	$\neg B$	0.40

Answer the following questions.

(a) What is the probability $P(A, B, C)$?
(b) What is the probability $P(C)$?
(c) What is the conditional probability $P(A|\neg B)$?

Question 3 (8.00 pts) True or false?

(a) If h_1 and h_2 are admissible heuristics, then also $h(s) = \max(h_1(s), h_2(s))$ is necessarily admissible.
(b) For a network on the Euclidian plane, the Manhattan distance can over-estimate the cost of the shortest path at most by a factor of $\sqrt{2}$.
(c) IDA* never performs more search steps than A*.
(d) If run long enough, Monte Carlo Tree Search is guaranteed to eventually return a best possible move.

Question 4 (10.00 pts) Consider the following structure.

universe U = {1,2,3,4}
constant a = 1
constant b = 2
predicate Q = $\{2, 3\}$
predicate P = $\{(4, 1), (4, 2), (4, 3), (4, 4)\}$

Which of the following formulas are true in this structure?

(a) $\forall x\ \exists y\ (Q(x) \leftrightarrow Q(y))$
(b) $\forall x\ (\exists y\ P(x, y) \wedge \exists y\ P(y, x))$
(c) $\exists x\ (Q(x) \vee \exists y\ P(x, y))$
(d) $\exists y\ \forall x\ P(x, y) \rightarrow \forall x\ \exists y\ P(x, y)$

Question 5 (10.00 pts) The current belief state is (0.30,0.70). It assigns the given probabilities respectively to states s_0, s_1. Now we observe *obs1*. The observation probabilities are $P(obs1|s_0) = 0.65$, $P(obs1|s_1) = 0.15$. Compute the new belief state after the observation.

Question 6 (10.00 pts) Which of the following claims hold?

(a) $\neg K \wedge L$ is satisfiable.
(b) $(A \rightarrow B) \wedge (\neg A \rightarrow C) \wedge \neg(B \vee C)$ is satisfiable.
(c) $K \rightarrow L$ is valid.
(d) $D \rightarrow E \models F \rightarrow (D \rightarrow E)$
(e) $D \rightarrow (E \rightarrow D)$ is valid.

Question 7 (10.00 pts) Consider the following Markov decision process.

- States: s_0, s_1
- Actions: act1, act2
- Transitions: $P(s_0, \text{act1}, s_1) = 1.00$, $P(s_1, \text{act1}, s_1) = 0.30$, $P(s_1, \text{act1}, s_0) = 0.70$, $P(s_0, \text{act2}, s_1) = 1.00$, $P(s_1, \text{act2}, s_0) = 1.00$
- Rewards: $R(s_0, \text{act2}, s_1) = 3.00$, and rewards for other transitions are 0.0.
- $\gamma = 0.80$

Run the Value Iteration algorithm for 3 rounds starting from the initial value function V_0 in which all states have value 0 (represented by the vector $(0, 0)$). Return the value functions V_1, V_2, V_3.

Exam Rules

1. Any **communication** with other people by any means is **not allowed**.
2. You are allowed to use the CS-E4800 course material and general sources such as Wikipedia or the Russell-Norvig textbook.
3. Use of calculator is allowed.

Grading

Maximum from the exam is 10.00+12.00+8.00+10.00+10.00+10.00+10.00 = 70.00 points. These points are not directly comparable to the exercise points, and will be scaled and aggregated with the exercise points to determine the course grade.