Aalto University, Department of Computer Science JR

CS-E4800 Artificial Intelligence

Examination, April 9, 2020

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 pts) What areas of everyday life (at home, work, society in general) do you think A.I. will (or could) change the most in the next one or two decades? What type of A.I. technologies are relevant for this change? What types of A.I. will *not* be possible in the next 20 years? (Answer with no more than 20 lines of text.)

Question 2 (7.5 pts) Which of the following claims hold?

(a) $J \to K$ is satisfiable.
(b) $(J \vee \neg K) \wedge (K \vee \neg J)$ is satisfiable.
(c) $K \to (L \to K \wedge L)$ is valid.
(d) $B \to C \models \neg C \to \neg B$
(e) $C \to (D \to C)$ is valid.

Question 3 (6 pts) How many satisfying valuations do the following formulas have? For each formula, consider only valuations over the atomic formulas occurring in the formula itself: with n atomic formulas there are 2^n valuations.

(a) $B \vee C$
(b) $C \leftrightarrow D$
(c) $(B \vee C) \wedge (D \vee E) \wedge (F \vee G) \wedge (H \vee I)$
(d) $(C \to D) \wedge (D \to E) \wedge (E \to F) \wedge (F \to G)$

Question 4 (10 pts) Consider the following Markov decision process.

- States: s_0, s_1
- Actions: move, stay
- Transitions: $P(s_0, \text{move}, s_1) = 1$, $P(s_1, \text{move}, s_1) = 0.2$, $P(s_1, \text{move}, s_0) = 0.8$, $P(s_0, \text{stay}, s_0) = 1$, $P(s_1, \text{stay}, s_1) = 1$
- Rewards: $R(s_0, \text{move}, s_1) = 1$, and rewards for other transitions are 0.0.
- $\gamma = 0.9$

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.

Question 5 (10 pts) The current belief state is (0.9,0.1). It assigns the given probabilities respectively to states s_0, s_1. Now we observe *obs1*. The observation probabilities are $P(obs1|s_0) = 0.7$, $P(obs1|s_1) = 0.2$. Compute the new belief state after the observation.

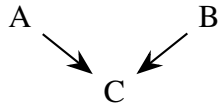
Question 6 (10 pts) Consider the following two games.

	C	D
A	$-4, -1$	$-1, -8$
B	$-6, -9$	$-7, 4$

	G	H
E	$2, -4$	$-1, 1$
F	$-1, -1$	$5, -3$

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 7 (10 pts) Consider the following Bayesian network and the CPTs for all nodes.



$P(A)$
0.2

$P(B)$
0.4

		$P(C\|A,B)$
A	B	0.5
A	$\neg B$	0.6
$\neg A$	B	0.1
$\neg A$	$\neg B$	0.8

Answer the following questions.

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

Question 8 (6 pts) Consider the following structure.

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

Which of the following formulas are true in this structure?

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

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, but no other written sources.
3. Use of calculator is allowed.

Grading

Maximum from the exam is 10+7.5+6+10+10+10+10+6 = 69.5 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.