

北京大学数学科学学院期末试题

考试科目: 人工智能

考试时间: 2022 年 6 月 20 日

姓 名: _____ 学 号: _____

本试题共 8 道大题, 满分 100 分

注意: 可選用中文或英文答題, 但同一道題不能混用中英文。

- (15%) Decide if each of the following is true or false, and provide some explanation to follow your answer.
 - (3pts) The Turing test provides a kind of definition of intelligence.
 - (3pts) Simple reflex agents cope well with inaccessible environments.
 - (3pts) It is possible to write an exact evaluation function for Go.
 - (3pts) CSPs can be represented as SAT problems.
 - (3pts) Deep learning can replace all the other methods of machine learning.
- (15%) Consider the problem of placing k knights on an $n \times n$ chessboard such that no two knights are attacking each other, where k is given and $k \leq n^2$.
 - (7pts) Choose a CSP formulation, including the variables, the possible values of each variable and sets of constrained variables.
 - (8pts) Consider the problem of putting as many knights as possible on the board without any attacks. Write a pseudocode to solve this with local search, defining appropriate action and result functions and a sensible objective function.
- (15%) Victor has been murdered, and Arthur, Bertram, and Carleton are the only suspects (meaning exactly one of them is the murderer).

Arthur says that Bertram was the victim's friend, but that Carleton hated the victim. Bertram says that he was out of town the day of the murder, and besides, he didn't even know the guy. Carleton says that he saw Arthur and Bertram with the victim just before the murder. You may assume that everyone—except possibly for the murderer—is telling the truth.

- (a) (5pts) Formalize the premise and the conclusion in logical language.
 - (b) (5pts) Negate the conclusion and convert the premise and the negated conclusion into clauses.
 - (c) (5pts) Use Resolution to find the murderer, i.e., show that the conclusion follows from the premise.
4. (15%) The STRIPS operator $Ride(x, e, f_1, f_2)$ describes the action of a person x riding an elevator e from floor f_1 to floor f_2 , and is defined as follows:
- Action: $Ride(x, e, f_1, f_2)$,
 Precondition: $On(x, f_1) \wedge On(e, f_1) \wedge Working(e)$,
 Effect: $\neg On(x, f_1) \wedge \neg On(e, f_1) \wedge On(x, f_2) \wedge On(e, f_2)$.
- (a) (5pts) Write a definition for the STRIPS operator $Call(x, e, f)$ in which person x calls an elevator e from floor f so that the elevator (eventually) arrives at f .
 - (b) (5pts) Write down an effect axiom for the $Ride$ using the information contained in the STRIPS operator definition.
 - (c) (5pts) Write down one frame axiom that would be needed for this world, assuming that everything behaves as expected.
5. (10%) Propositions correspond to exactly one possible world that give values for possible assignments of all the random variables, which are also called atomic events. For example, with Boolean variables X_1, X_2, X_3 , the proposition $x_1 \wedge \neg x_2 \wedge \neg x_3$ fixes the assignment of the variables.

- (a) (5pts) Prove, for the case of n Boolean variables, that any two distinct atomic events are mutually exclusive; that is, their conjunction is equivalent to *false*.
- (b) (5pts) Prove that any proposition is logically equivalent to the disjunction of the atomic events that entail its truth.
6. (10%) We illustrate the current stalemate in Donbas of Russia-Ukraine conflict in the following table, which is a version of the prisoner's dilemma (called "Donbas game"). The table depicts a static position in the Donbas game with strategies for Ukraine and Russia respectively. Ukraine's options are given by the two rows: *Accept separation* (A) on the part of DL (the separatist Donetsk and Luhansk People's Republics) and *Regain territory* (R) by diplomatic or military means. Given that Ukraine would not agree to accept the separation, its strictly dominant strategy is given by the second row (Regain territory). Russian strategies are given by the two columns, *Keep intervening* (K), and *Stop intervening* (S). Given that Russian would realize the separation, its strictly dominant strategy is given by the first column (Keep intervening). Four outcomes in the table are (A, K) , (A, S) , (R, K) , and (R, S) , respectively.

Players	Strategies	<i>Russia</i>	
		Keep intervening	Stop intervening
<i>Ukraine</i>	Accept separation	(A, K)	(A, S)
	Regain territory	(R, K)	(R, S)

- (a) (4pts) Of the four outcomes, point out the best and the worst for Ukraine and Russia, respectively.
- (b) (6pts) Of the four outcomes, assign the payoff matrix. Which is a Nash equilibrium that provided the maximum payoff to both players. Why?

7. (10%) Answer each of the following and provide some explanation to follow your answer.
- (a) (5pts) Draw a decision tree to represent the three or more function for four inputs.
 - (b) (5pts) Consider neural networks with inputs in the range $[0, 1]$ and with g a step function. A network is defined by the weights on the links and the threshold value of g at each node. Draw a network to represent the “three or more” function for four inputs.
8. (10%) Answer each of the following with your explanation as detail as possible.
- (a) (5pts) What is a pre-trained neural language model?
 - (b) (5pts) How to do self-supervised learning in pre-training a language model.