MZUZU UNIVERSITY

FACULTY OF SCIENCE, TECHNOLOGY AND INNOVATION

DEPARTMENT OF INFORMATION AND COMMUNICATION TECHNOLOGY

BACHELOR OF SCIENCE IN INFORMATION AND COMMUNICATION TECHNOLOGY

BICT 4801: ARTIFICIAL INTELLIGENCE

END OF SEMESTER EXAMINATION

DATE: DECEMBER, 2020 **TIME ALLOWED: 3 HOURS**

INSTRUCTIONS

1. Answer **ALL** questions.
2. Marks for each question are indicated.
3. Write your answers clearly.
4. Indicate the question number for each answer.
5. This paper contains **THREE** pages. Please check.

1. Agents constitute a central concept in Artificial Intelligence.

   a. With the aid of schematic diagrams, describe each of the following types of agents:

      i. Model-based agent **[3 marks]**

      ii. Learning agent **[6 marks]**

   b. Making necessary assumptions, write pseudocode programs for the following agents

      i. Goal-based agent. **[5 marks]**

      ii. Utility-based agents **[6 marks]**

2. Problem solving (PS) agents solve problems by searching a state space.

   a. Describe four dimensions you would use to evaluate (search) strategies in PS agents **[4 marks]**

   b. Describe four items (variables) that are used to define a problem in PS agents **[4 marks]**

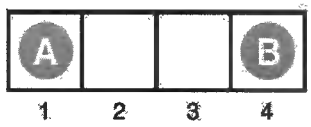
   c. Suppose two friends live in different cities on a map, such as the Romania map. On every turn, we can simultaneously move each friend to a neighboring city on the map. The amount of time needed to move from city i to neighbor j is equal to the road distance $d(i, j)$ between the cities, but on each turn the friend that arrives first must wait until the other one arrives (and calls the first on his/her cell phone) before the next turn can begin. We want the two friends to meet as quickly as possible

      i. Write a detailed formulation for this search problem. (Use the four items of problem definition, and you will find it helpful to define some formal notation here) **[4 marks]**

      ii. Let $D(i, j)$ be the straight-line distance between cities i and j. Explain when will $\frac{D(i, j)}{2}$ be a dominating admissible heuristic. **[4 marks]**

3. Adversarial search (or game playing) is a unique area in Artificial Intelligence

a. Prove that for every game tree, the utility obtained by Max using minimax decisions against a suboptimal MIN will never be lower than the utility obtained playing against an optimal MIN. **[4 marks]**



The starting position of a simple game. Player A moves first. The two players take turns moving, and each player must move his token to an open adjacent space in either direction. If the opponent occupies an adjacent space, then a player may jump over the opponent to the next open space if any. (For example, if A is on 3 and B is on 2, then A may move back to 1.) The game ends when one player reaches the opposite end of the board. If player A reaches space 4 first, then the value of the game to A is $+1$; if player B reaches space 1 first, then the value of the game to A is -1.

Figure 1: A simple game.

b. Consider the two-player game described in **Figure 1.**

i. Draw the complete game tree using the following 3-point conventions, assuming the initial State of (1,4):

- Write each state as (S_A, S_B) where S_i denotes the player locations.
- Put each terminal state in a square box and write its game value in a circle.
- Put *loop states* (states that already appear on the path to the root) in double square boxes. **[6 marks]**

ii. Describe two conditions that would ensure that A always wins, assuming both players are optimal **[4 marks]**

4. Propositional Logic, PL, constitutes a vital concept in Artificial Intelligence.

a. Convert the following PL sentences to canonical normal form , CNF:

i. $A \Leftrightarrow (B \vee E)$ **[6 marks]**

ii. $(A \vee B) \wedge (A \Rightarrow C) \wedge (B \Rightarrow D) \wedge (C \Rightarrow G) \wedge (D \Rightarrow G)$ **[4 marks]**

b. Prove, using resolution, that the sentence in 4(a)(ii) entails G **[6 marks]**

c. A sentence is in disjunctive normal form, DNF, if it is the disjunction of conjunctions of literals. For example $(A \wedge D) \vee (\neg B \wedge C)$ is in DNF.

i. Any PL sentence is logically equivalent to the assertion that some possible world in which it would be true is in fact the case. From this observation, prove that any sentence can be written in DNF. **[4 marks]**

ii. From your understanding of the CNF algorithm, construct a non-trivial algorithm that converts any PL sentence into DNF. **[5 marks]**

iii. Convert the knowledge base, $KB = (A \Rightarrow B) \wedge (B \Rightarrow C) \wedge (C \Rightarrow \neg A)$, into DNF applying the algorithm constructed in 4(c)(ii) **[10 marks]**

5. From your understanding of First Order Logic, FOL, and the vocabulary given in **Table 1**, write the following paragraph in FOL:

There exists a lecturer all of whose clients are students. Every student is a client of a lecturer. Thondoya has a father who is a lecturer. Thondoya is neither a student nor a lecturer.

[15 marks]

Table 1: Basic Vocabulary	
L	: Lecturer
S	: Student
F	: Father
T	: Thondoya
$D(p,d)$	: Person p has designation d
$C(x,y)$	: Person x is a client of person y

END OF QUESTION PAPER