CS_335 Foundations of Artificial Intelligence

(Attempt 2 questions out of 3)

Question 1

a) Describe the early AI system SIR. What were its limitations? [**5 marks**]

b) Outline Shank's theory of conceptual dependency and indicate how it may be implemented. Use a script for `going to a library` in your explanation. What do you consider are the limitations to this approach for understanding stories? [**7 marks**]

c) i) Construct a definite clause grammar (DCG) to recognise simple English sentences built from the following vocabulary:

```
nouns:              horse, boy, dog, bear
adjectives:         big, small, brown, white
determiners:        the, a, all, many
transitive verbs (past tense): chased, raced, followed
modifiers for adjectives: very, moderately, somewhat
```

Only the past tense third person singular and plural are to be used and at most one adjective with a possible modifier can appear in a noun phrase. Examples of sentences are:

All big dogs chased the very white horse; some very brown bears raced many boys; a somewhat small dog raced the brown dog.

You may use a predicate `add_s(X,Y)` which adds an 's' to the end of an identifier in order to create plural nouns. [**7 marks**]

ii) Modify the grammar so that the passive form of the sentence is also constructed. For example

`phrase(sentence(S),[the,big,dog,chased,some,white,horses])` will succeed in instantiating `S` to

`[some,white,horses,were,chased,by,the,big,dog].` [**6 marks**]

Question 2

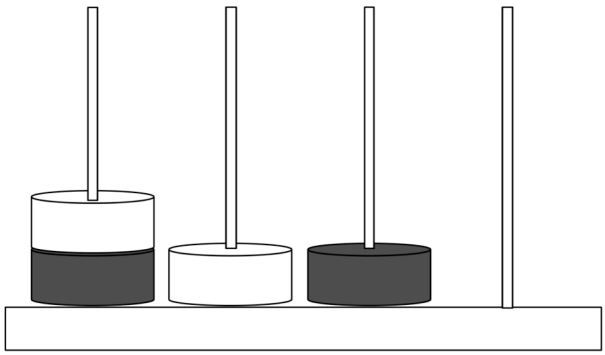
a) A very simple form of the game Sudoku can be played on a 4x4 grid, an illustrative example being given below:

a		d	
b		a	
		c	

The letters `a` to `d` are to be entered into the vacant squares so that each row, column and sub-square all have exactly the four distinct letters. Outline how the generate and filter technique can be used to solve this type of puzzle. You should give Prolog code for a possible generator and filter for the above puzzle. [**8 marks**]

Explain why this naïve algorithm would be inefficient to play the standard Sudoku puzzle on a 9x9 grid with digits 1 to 9. [**4 marks**]

b) i) A form of connect 3 is played as follows:



Players I and II alternatively drop black and white disks onto one of the four rods. The first player to obtain a row or column of three *adjacent* disks of their colour is the winner. The above is the position after four moves with player I (black) about to play. There can be at most four disks on any one rod. Describe the mini-max algorithm with a suitable heuristic for this game for determining a move for a player. [**6 marks**]

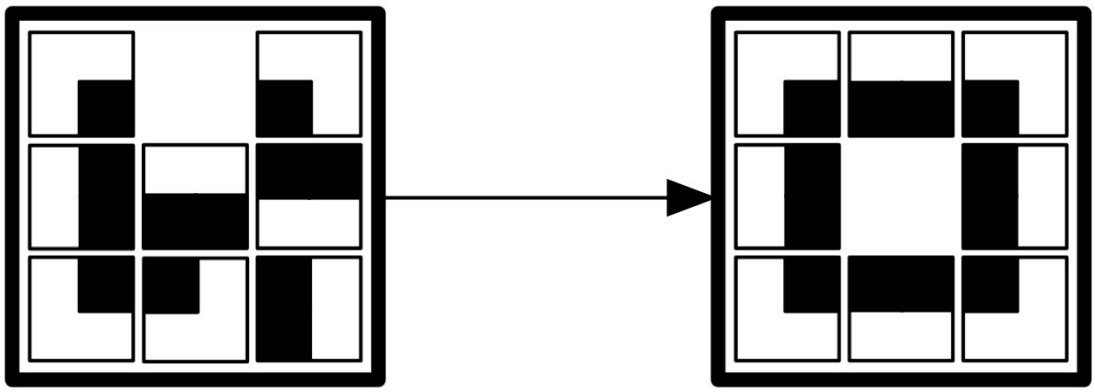
ii) By taking a two move look-ahead in the mini-max algorithm, find the move suggested for player I using your heuristic starting from the above state. [**5 marks**]

iii) Indicate which leaf nodes do not need to be evaluated if the alpha-beta pruning technique is adopted. [**2 marks**]

Question 3

a) Describe, using pseudo-code, the tree algorithm A^T and the best-first-search algorithm A*. Prove if the heuristic used in A* is *admissible*, then A* will find an optimal solution if one exists? **[6 marks]**

b) A version of the 8-puzzle is illustrated below. The start state has to be transformed into the goal state by sliding tiles in the grid.



A heuristic function `h` is defined by taking the sum over all tiles of the Manhattan distance of a tile from its final position in the goal state plus an extra 1 if there is a tile in the centre square. Use this heuristic in A* to find a sequence of moves to reach the goal state. **[7 marks]**

c) i) A logic puzzle is specified by a set of clues (simple facts) together with a set of queries. Show how a puzzle can be represented in Prolog as a fact `puzzle(Clues,Queries,Solution)` and describe and explain a general scheme `solve_puzzle(Puzz,Soln)` for solving such puzzles. **[5 marks]**

ii) Four students live on different floors of a hall of residence building. They have different colour eyes, different first names and like different sports. The following clues are given:

1) The student with brown eyes plays golf and lives immediately below the student with blue eyes.

2) Bill, who plays cricket, lives on the top floor.

3) Alan lives below the student who likes soccer and immediately above the student with hazel eyes.

4) Colin plays rugby and lives below Denis.

5) The blue eyed student likes soccer.

The queries are:- Q1: What is the colour of Alan's eyes and what sport does he like? and Q2: Who is the grey eyed student? **(continued)**

Use a term `stdnt(Name,Eyes,Sport)` to represent each student and a list to indicate the four students in the order of their floor (the last element being the top floor). **Without** finding the solution, give the main Prolog procedures and facts for solving this problem. Your program should include code for `below`, `immediately_below`, `immediately_above` and `top`.

[**7 marks**]