Q1:

(a) Explain the difference between the views of “strong AI” and “weak AI”. [2 marks]

(b) In the context of artificial intelligence, what is the difference between “human” and “rational” actions? For each case, give an example of a situation where it would be advantageous for a system to be able to act this way. [3 marks]

(c) What is a reflex agent? What is its major limitation? [2 marks]

(d) Define the terms “goal-based agent” and “utility-based agent”. List two advantages of utility-based agents over goal-based agents. [4 marks]

(e) For search problems, a node is removed from the agenda, expanded, and its children are added to the agenda. What type of data structure (or queuing function) is associated with each of the following search algorithms: (i) Depth-first search (ii) Breadth-first search (iii) Uniform cost search [3 marks]

(f) (NOTE: There is literally no way to explain the graph for this question. Its basically a graph of Romania with the cities connected to each other with different numerical wieghtings.)  
  
Given the road map in Figure 1, use uniform cost search to find a route from Fagaras to Craiova. Show all working, including the agenda and node which is expanded at each step. You may abbreviate names of towns to their initial letter (e.g. F for Fagaras). [11 marks]

Q2:

(a) Consider the n-queens problem discussed in lectures: you are required to place n queens on an n × n chess board so that no pair of queens attack each other (i.e. no two queens share the same row, column or diagonal). Give a detailed description of: (i) your formulation of the problem (ii) the hill-climbing search algorithm applied to the problem. [9 marks]

(b) How would you modify the algorithm from Part (a) above to use local beam search instead? How would you choose a suitable beam width? [3 marks]

(c) What limitation of hill climbing does local beam search address? Name another approach aimed at solving this problem. [2 marks]

(d) (NOTE: Same question as the CW)   
  
A two-player game has the following game tree for the last four moves. MAX tries to score the largest value and MIN the smallest one. It is MAX’s turn to play.   
  
Use the minimax algorithm to calculate the value at each node of the tree. (You will need to copy the whole tree into your answer book.) What sequence of moves (left or right branch) is selected by each player at each level? [5 marks]

(e) Simulate the execution of α-β pruning on the tree from Part (d), searching from left to right. Which branches are pruned and why? Refer to nodes by (depth, position), where depth is counted from the root (depth 1) and position from the left (also starting at 1). E.g. the second leaf, value 4, is at node (5,2). [6 marks]

Q3:

The table below contains some observations of the weather conditions on particular days and whether or not Mary rode her bike to university on that day. Using the ID3 algorithm, build a decision tree classifier which can predict whether or not Mary rides her bike given the weather conditions, based on the training data in the table. Make sure that you show and explain all working. Draw the resulting decision tree, and use it to determine whether Mary rides her bike when there is rain and snow but no wind. [13 marks]

|  |  |  |  |
| --- | --- | --- | --- |
| **Rain** | **Wind** | **Snow** | **RideBike** |
| yes | Yes | No | No |
| No | Yes | No | Yes |
| No | No | yes | Yes |
| No | Yes | Yes | No |
| Yes | Yes | Yes | No |
| Yes | No | No | No |
| No | No | no | Yes |

(b) Draw a diagram of a basic perceptron, and give the equation(s) relating its inputs, parameters and outputs. [5 marks]

(c) Show how a single perceptron can implement each of the following: (i) And gate (ii) Or gate [4 marks]

(d) Perceptron networks usually have a hidden layer of neurons. What is the main advantage and main disadvantage of using hidden layers? [3 marks]

Q4:

(a) Using the two predicates Parent(x, y) (x is a parent of y) and Female(x) (x is female), for each of the following predicates, write a first order predicate calculus formula defining it:   
  
(i) Brothers(x, y), where x and y are full biological brothers   
(ii) Ancestor(x, y), where x is an ancestor of y (parent or parent’s parent, etc.) [9 marks]

(b) Consider the following logical statements:   
  
∀xGreater(Inc(x), Zero)   
∀x∀y((Greater(Inc(x), Inc(y)) → Greater(x, y)) intersect (Greater(x, y) → Greater(Inc(x), Inc(y))))   
  
(i) Convert the formulae into conjunctive normal form, showing all working.   
(ii) Use resolution to prove that Greater(Inc(Inc(Inc(Zero))), Inc(Zero)) [9 marks]

(c) A company wants to drill for oil in a region where they believe the chance of success is one in twenty thousand. After performing preliminary tests which gave a positive result, they want to make a press release to tell investors the news. The preliminary tests are nearly always correct: they have a false negative rate of 0.5% and a false positive rate of 2%. Given the evidence of the tests, what is the new probability of finding oil in the region? What would you advise the company to tell investors based on the test results?