UNIVERSITY OF GHANA

FIRST SEMESTER 2017/2018 EXAMINATIONS
DEPARTMENT OF COMPUTER ENGINEERING
LEVEL 400: CPEN 405: ARTIFICIAL INTELLIGENCE
3 CREDIT HOURS

TIME ALLOWED: 3 Hours

INSTRUCTION: Attempt All Questions

Q1. (a) Explain the different approaches used in defining artificial intelligence? **[4 marks]**

(b) How far is AI from reaching human-level intelligence? When will it happen? Support your answer with facts and figures from modern technological advancements. **[4 marks]**

(c) Describe briefly the Turing Test for artificial intelligence systems. **[4 marks]**

(d) If The Turing Test is passed does this show that computers exhibit intelligence? State your reasons. **[4 marks]**

(e) What advances do you think need to be made in order for The Turing Test to be passed? **[4 marks]**

Q2. (a) Consider the 8-puzzle problem described in the textbook and homework assignments. We would like to search for a solution using A^* - search. Describe the following aspects of the problem formulation: **a) states, b) successor function, c) goal test, d) step cost,** and **e) path cost.** **[8 marks]**

(b) For A^*-search the evaluation function, $f(n)$, consists of the path cost, $g(n)$, plus the heuristic function, $h(n)$. We will use the Manhattan distance between the current state and the goal state to be the heuristic function. Explain when a heuristic function is admissible and prove this fact for the Manhattan distance heuristic. **[5 marks]**

(c) Describe when a heuristic is consistent and proof this for the Manhattan distance heuristic. **[2 marks]**

(d) For each of the following activities, give a **PEAS** description of the task environment and characterize it in terms of **observability, number of agents, randomness, dynamism** and **continuity**.

i. Playing soccer. **[5 marks]**

ii. Taxi driving agent **[5 marks]**

Q3. Suppose you have the following search space:

State	Next	Cost
A	B	4
A	C	1
B	D	3
B	E	8
C	C	0
C	D	2
C	F	6
D	C	2
D	E	4
E	G	2
F	G	8

(a) Draw the state space of this problem. [2 marks]

(b) Assume that the initial state is **A** and the goal state is **G**. Show how each of the following search strategies would create a search tree to find a path from the initial state to the goal state:

i. Uniform cost search [4 marks]

ii. Iterative deepening search [4 marks]

At each step of the search algorithm, show which node is being expanded, and the content of fringe. Find the eventual solution found by each algorithm, and the solution cost.

Q4. (a) Name and describe the main features of Genetic Algorithms (GA). [10 marks]

(b) State the main difference betwwen Genetic algorithms and Simulated annealing methods of optimization. [5 marks]

(c) Assume we have the following test function for genetic algorithm optimization

$$f(x) = x^3 - 60x^2 + 900x + 100$$

where x is constrained to lie between $0 \leq x \leq 31$. We wish to maximize $f(x)$.

Using a binary representation we can represent x using five binary digits.

i. Prove from first principles using Calculus that the optimal value is $x = 10$. Find the corresponding $f(x)$ value. [6 marks]

ii. Given the following four chromosomes, give the values for x and $f(x)$

Chromosome	Binary String
P1	11100
P2	01111
P3	10111
P4	00100

α) If $P3$ and $P2$ are chosen as parents and we apply one point crossover show the resulting children, $C1$ and $C2$. Use a crossover point of 1 (where 0 is to the very left of the chromosome) [5 marks]

β) Do the same using $P4$ and $P2$ with a crossover point of 2 and create $C3$ and $C4$ [5 marks]

γ) Calculate the value of x and $f(x)$ for $C1, C2, C3$, and $C4$. [8 marks]

Q5. (a) What is Machine Learning? Give five (5) application areas. [7 marks]

(b) What is difference between supervised and unsupervised learning algorithms ? Give an example each of both supervised and unsupervised learning algorithms [4 marks]

(c) A tennis player came on a vacation. For a fortnight, she played tennis given the following weather conditions as given in Table 1 below.

Day	Outlook	Temperature	Humidity	Wind	PlayTennis
D1	Sunny	Hot	High	Weak	No
D2	Sunny	Hot	High	Strong	No
D3	Overcast	Hot	High	Weak	Yes
D4	Rain	Mild	High	Weak	Yes
D5	Rain	Cool	Normal	Weak	Yes
D6	Rain	Cool	Normal	Strong	No
D7	Overcast	Cool	Normal	Strong	Yes
D8	Sunny	Mild	High	Weak	No
D9	Sunny	Cool	Normal	Weak	Yes
D10	Rain	Mild	Normal	Weak	Yes
D11	Sunny	Mild	Normal	Strong	Yes
D12	Overcast	Mild	High	Strong	Yes
D13	Overcast	Hot	Normal	Weak	Yes
D14	Rain	Mild	High	Strong	No

i. Use the Iterative Dichotomiser 3 (ID3) algorithm to build a decision tree from the given tennis dataset. You should build a tree to predict PlayTennis, based on the other attributes (except the Day attribute). Show all of your work, calculations, and decisions as you build the tree. [25 marks]

ii. On the eve of D15 the weather forecast showed was [Outlook: Rain, Temperature: Hot, Humidity: High, Wind: Weak]. Predict whether the athlete will play tennis on that day. [4 marks]

iii. What is the classification accuracy? [3 marks]

Q6. (a) Consider the following Bayesian network as given in figure 1, where F = having the flu and C = coughing:

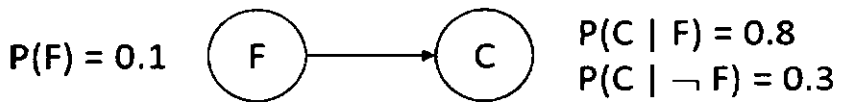

Figure 1: Bayesian network

i. Write down the joint probability table specified by the Bayesian network.[8 **marks**]

(b) We have a bag of three biased coins a, b, and c with probabilities of coming up heads of 20%, 60%, and 80%, respectively. One coin is drawn randomly from the bag (with equal likelihood of drawing each of the three coins), and then the coin is flipped three times to generate the outcomes X_1, X_2, and X_3.

i. Draw the Bayesian network corresponding to this setup and define the necessary CPTs.

[5 **marks**]

ii. Calculate which coin was most likely to have been drawn from the bag if the observed flips come out heads twice and tails once.

[5 **marks**]

(c) In your local nuclear power station, there is an alarm that senses when a temperature gauge exceeds a given threshold. The gauge measures the temperature of the core. Consider the Boolean variables A (*alarm sounds*), F_A (*alarm is faulty*), and F_G (*gauge is faulty*) and the multivalued nodes G (*gauge reading*) and T (*actual core temperature*).

i. Draw a Bayesian network for this domain, given that the gauge is more likely to fail when the core temperature gets too high.

[4 **marks**]

ii. Suppose the alarm works correctly unless it is faulty, in which case it never sounds. Give the conditional probability table associated with A.

[5 **marks**]

iii. Suppose the alarm and gauge are working and the alarm sounds. Calculate an expression for the probability that the temperature of the core is too high, in terms of the various conditional probabilities in the network.

[5 **marks**]