

UNIVERSITY OF KWAZULU-NATAL
School of Engineering
Discipline of Electrical, Electronic and Computer Engineering
(Howard College Campus)

Examinations: **September 2015**

ENEL4AI H2 : Artificial Intelligence

DURATION :2 HOURS

MARKS : 100

Examiners:

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Instructions:

1. Answer ALL 5 questions.
2. Start each question on a new page, and number all your answers clearly.
3. Scientific calculators may be used.
4. Ensure you have 4 pages, including this one.

Question 1: *Artificial Intelligence Concepts and Definitions*
[15 marks]

- (a) What is Artificial Intelligence? [2]
 - (b) Give two strengths and one weakness of fuzzy Logic. [3]
 - (c) How does an Artificial Neural Network model the brain? Describe two classes of learning paradigms used with Artificial Neural Networks. [10]
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Question 2: *Search and Control Strategies*
[20 marks]

- (a) Considering the TSP-problem for n cities and n -puzzle problems. What are the sizes of their respective search spaces? [6]
- (b) Consider the following search space, represented in figure 1, where we want to find a path from the start state **S** to the goal state **G**. Table 1 shows three different heuristic functions h_1 and h_2 .

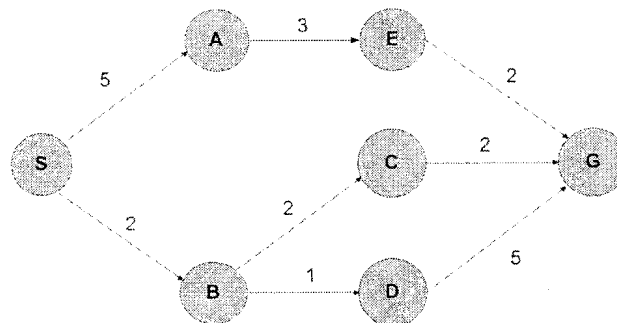


Figure 1: A graph

- (b.1) For each of the following search strategies, starting from **S**, indicate the order in which nodes will be chosen up to the goal node (**G**).
 - (i) Breadth-first search; break ties alphabetically. [3]
 - (ii) Depth-first search; break ties alphabetically. [3]
 - (b.2) Perform **A*** search using heuristics h_1 and h_2 to find a path from the start state **S** to the goal state **G** and analyze them with respect to monotonicity and informedness. Break ties alphabetically. [8]
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Table 1: Heuristics h_1 and h_2

Node	h_1	h_2
S	5	6
A	3	6
B	4	2
C	2	5
D	5	3
E	1	2
G	0	0

Question 3: *Logic, Knowledge Representation and Reasoning***[25 marks]**

- (a) Prove that $[(p \vee q) \Rightarrow (p \wedge q)] \iff (p \iff q)$ is valid? [4]
- (b) Translate the following sentences in first-order predicate logic.
- (i) Everyone who crosses a red robot, is either drunk, or any car they drive is fast. [2]
 - (ii) Every car that is fast is risky. [2]
 - (iii) Every Internet Engineering student is a Computer Engineering student. [2]
 - (iv) Every Internet Engineering has some sport car. [2]
 - (v) No sport car is risky. [2]
- (c) Transform the sentences from part (b) into conjunctive normal form. [5]
- (d) Based on the knowledge base above (statements b-(i) to b-(v)) and using propositional inference, prove formally that if every Computer Engineering student crosses the red robot, then every Internet engineering is drunk. [6]

Question 4: *Uncertainty, Fuzzy Logic and Systems***[20 marks]**

- (a) Differentiate between fuzzy and crisp Logic. Give an application of fuzzy logic. [4]
- (b) Given the set $X = \{1, 2, 3, 4, 5\}$, A and B subsets of X defined as follows:
- $\mu_A(1) = 0.5, \mu_A(2) = 0.2, \mu_A(4) = 1, \mu_A(5) = 0.15$
 - $\mu_B(1) = 0.75, \mu_B(2) = 0.18, \mu_B(3) = 0.1, \mu_A(4) = 1, \mu_A(5) = 1$
- Compute \overline{B} , $\overline{A} \cup A$, and $\overline{A} \cap B$. [6]

Table 2: Survey on insulators properties

<i>department</i>	<i>status</i>	<i>property 1</i>	<i>Property 2</i>
Strain	defectuous	31 ... 35	46 ... 50
Strain	normal	26 ... 30	26 ... 30
Strain	normal	31 ... 35	31 ... 35
Suspension	normal	21 ... 25	46 ... 50
Suspension	defectuous	31 ... 35	66 ... 70
Suspension	normal	26 ... 30	46 ... 50
Suspension	defectuous	41 ... 45	66 ... 70
Pin	defectuous	36 ... 40	46 ... 50
Pin	normal	31 ... 35	41 ... 45
Shackle	defectuous	46 ... 50	36 ... 40
Shackle	normal	26 ... 30	26 ... 30

- (c) Security services of the State has developed a scanner which determines whether a person is a terrorist. The scanner is fairly reliable; 90% of all scanned terrorists are identified as terrorists, and 98% of all upstanding citizens are identified as such. An informant tells the agency that exactly one passenger of 100 aboard an aeroplane in which you are seated is a terrorist. The agency decide to scan each passenger and the shifty looking man sitting next to you is the first to test positive. What are the chances that this man is a terrorist? [10]

Question 5: *Genetic algorithms and Machine Learning*

[20 marks]

- (a) Give a generic description of a genetic algorithm. [4]
- (b) Table 2 consists of training data from 11 insulators. Each line of the table has information on an insulator: the first column is the type of insulator, the second gives its status checked by a specialist and the 2 last columns are the range of values of properties that measure certain conditions of the insulator. In other words, if in the column property we have 31 ... 35 it means the magnitude of that particular property is between 31 and 35.
- You are tasked to use the data in table 2 to train a naïve Bayesian classifier that will give the status of an insulator given its type and properties (property 1 and property 2).
- (b.1) Given an insulator, **I**, what are the prior probabilities of the following events?
- (i) **I** is defectuous. [1]
- (ii) **I** is normal. [1]
- (b.2) Using Naive Bayes trained with maximum likelihood, predict the status of an insulator that the following unseen of the triplet (type, property 1, property 2):
- (Pin, 34,48) [14]
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