CSE140: Introduction to Intelligent Systems (Winter 2023)
Mid-Sem

Date of Examination: 15.04.2023 Duration: 1 hr Total Marks: 25 marks

---

Instructions –

- Attempt all questions.
- MCQs have a single correct option.
- State any assumptions you have made clear.
- Standard institute plagiarism policy holds.
- No evaluation without suitable justification.

Section A

1. (a) (1 point) Choose the correct option -
   1. Deductive Reasoning is probabilistic
   2. Abductive Reasoning is deterministic
   3. Inductive Reasoning is probabilistic
   4. Abductive Reasoning can be both deterministic and probabilistic based on the scenario.

   Answer - 3

   (b) (1 point) Which of the following inference rules is valid-
   1. $p \rightarrow q$ is true, $\neg$ p is true implies $\neg q$ is true
   2. $p \rightarrow q$ is true, p is true implies $\neg q$ is true
   3. $p \rightarrow q$ is true, $\neg q$ is true implies $\neg p$ is true
   4. $p \rightarrow q$ is true, $\neg q$ is true implies q is true

   Answer - 3 (modus tollens)

   (c) (1 point) Which of the following best describes the difference between RNN and CNN in relation to spatial and temporal patterns?
   1. RNNs are better suited for spatial pattern recognition, while CNNs are better suited for temporal pattern recognition.
   2. RNNs are better suited for temporal pattern recognition, while CNNs are better suited for spatial pattern recognition.
   3. RNNs and CNNs are equally suited for both spatial and temporal pattern recognition.
   4. Neither RNNs nor CNNs are suited for spatial or temporal pattern recognition.

   Answer - 2

   (d) (1 point) A factory wants to detect defective products on an assembly line. Which technique is most suitable for this task?
   1. Computer vision
   2. Natural language processing
   3. Both A and B
   4. None of the above

   Answer - 1

(e) (1 point) Which of the following is an unethical use of large language models (LLMs) in academic settings?

1. Using LLMs to generate ideas and inspiration for academic writing.
2. Using LLMs to generate assignments.
3. Using LLMs to check grammar and spelling errors in academic writing.
4. Using LLMs to augment personal knowledge and understanding of a topic.

Answer - 2

Section B

2. (2 points) Define intelligent systems. What are its characteristics and components?

Intelligent systems are computer programs or machines that can perform tasks that typically require human-level intelligence, such as learning, problem-solving, decision-making, and pattern recognition. These systems use techniques from fields such as artificial intelligence, machine learning, and natural language processing to mimic human cognitive abilities and improve decision-making processes.

Characteristics of intelligent systems:

1. Adaptability: Intelligent systems can learn and adapt to new situations and environments, improving their performance over time.
2. Autonomy: Some intelligent systems can operate independently without human intervention, such as self-driving cars.
3. Interpretability: Intelligent systems can provide explanations or justifications for their actions or decisions, making them more transparent and understandable to users.
4. Interaction: Intelligent systems can interact with humans using natural language or other interfaces, allowing for more seamless communication.

Components of intelligent systems:

1. Data: Intelligent systems require large amounts of data to learn from and make decisions based on that data.
2. Algorithms: Intelligent systems use algorithms to analyze and process data, recognize patterns, and make decisions.
3. Knowledge representation: Intelligent systems use knowledge representation techniques to store and manipulate information.
4. Inference engine: The inference engine is the part of an intelligent system that uses logical reasoning to make decisions based on available information.
5. User interface: Intelligent systems require a user interface to interact with users, such as a chatbot or virtual assistant.
6. Learning mechanisms: Intelligent systems use learning mechanisms, such as neural networks or decision trees, to improve their performance over time through experience and feedback.

Overall, intelligent systems are designed to improve decision-making processes and automate tasks, leading to greater efficiency and productivity.

Rubric- There will be no specific answer. 1 marks for defining intelligent system. 1 marks for its characteristics and components.

3. (2 points) A well-defined learning task can be represented by <P,T,E>. Explain all three elements with suitable examples.

[1 mark] A computer program is said to learn from experience E in context to some task T and some performance measure P, if its performance on T, as was measured by P, upgrades with experience E.

[**1 mark**] - Certain examples that efficiently defines the well-posed learning problem are:

1. To better filter emails as spam or not
Task – Classifying emails as spam or not
Performance Measure – The fraction of emails accurately classified as spam or not spam
Experience – Observing you label emails as spam or not spam
2. A checkers learning problem
Task – Playing checkers game
Performance Measure – percent of games won against opposer
Experience – playing implementation games against itself
3. Handwriting Recognition Problem
Task – Acknowledging handwritten words within portrayal
Performance Measure – percent of words accurately classified
Experience – a directory of handwritten words with given classifications
Or any other suitable example.

4. (2 points) In what ways can computer vision technology be used in retail stores to improve the shopping experience of customers? Explain at-least 4 interventions.

   1. Personalized recommendations - analyzing customer behavior and preferences
   2. Security and surveillance - detecting shoplifting and identifying suspicious behavior
   3. Inventory management - product recognition and tracking
   4. Virtual try
   5. Automated checkout

   Rubrics - Give marks for points mentioned or any other valid point given by the student. (0.5 marks for each)

   1. Personalized recommendations - Computer vision can analyse customer behavior and preferences to give personalized recommendations that are of interest to the user.
   2. Security and surveillance - Computer vision can help in detecting shoplifting and identifying suspicious behavior.
   3. Inventory management using smart shelves: Computer vision can be used to create smart shelves that automatically detect when a product is running low or out of stock.
   4. Virtual Try: Computer vision can be used to create virtual try-on systems that allow customers to see how clothing items or accessories would look on them without needing to physically try them on.

5. (2 points) "Aeronautical engineering texts do not define the goal of their field as making 'machines that fly so exactly like pigeons that they can fool even other pigeons.'" How does the above quote relate to the concept of the Turing test and the goals of AI research? Do you believe that passing the Turing test should be the primary evaluation criteria of an intelligent system? Provide justifications and examples to support your argument.
   The quote highlights that the goal of aeronautical engineering is not to imitate nature but rather to create efficient and effective machines. Similarly, in AI research, the goal is not necessarily to create machines that can pass the Turing test and mimic human behavior, but rather to create intelligent systems that can solve complex problems and improve human life. The Turing test is a measure of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human. While passing the Turing test can be a useful benchmark for evaluating an intelligent system, it should not be the primary evaluation criteria. Instead, the primary criteria should be based on the system's ability to solve real-world problems and improve human life.
   For example, a medical diagnosis system that accurately identifies diseases and recommends appropriate treatments would be considered intelligent, even if it doesn't pass the Turing test. Similarly, a chatbot that can effectively communicate with customers and resolve their queries is considered intelligent, even if it doesn't pass the Turing test. In conclusion, while the Turing test can be a useful evaluation criteria

for measuring the intelligence of a machine, it should not be the sole criterion. The ultimate goal of AI research should be to create intelligent systems that can solve real-world problems and improve human life.

6. (2 points) What is the focus of discriminative models and generative models? What type of probability distribution do these models aim to learn, and why is this relevant to their respective aims?
The focus of discriminative models is to learn the boundary or decision boundary between classes or categories in a dataset. They aim to learn the conditional probability distribution P(Y|X), where Y is the label or class variable and X is the input or feature variable. This is relevant to their aim of classification or prediction, where given an input X, they predict the corresponding label Y.
On the other hand, the focus of generative models is to learn the joint probability distribution P(X,Y) of the input and label variables in a dataset. They aim to learn how the data is generated, and can be used to generate new samples that are similar to the training data. This is relevant to their aim of data generation and modeling, where they can generate new samples of data or estimate missing data in a dataset.

Section C

7. (2 points) Consider the following statements-
    1. If if is raining outside then the ground is wet
    2. If the ground is wet then the grass will be slippery
    3. The grass is not slippery

    Convert the above statements into proper propositional logic statements using proper inference rules. Also, prove that - "It is not raining outside".
    Solution -
    P : It is raining outside
    Q : The ground is wet
    R : The grass is slippery
    i) $Q \rightarrow R$ is true, R is false
    So, Q is false [modus tollens]
    ii) $P \rightarrow Q$ is true, Q is false
    So, P is false [modus tollens]
    OR
    i) $P \rightarrow Q$ is true, $Q \rightarrow R$ is true
    So $P \rightarrow Q$ is true [hypothetical syllogism]
    ii) $P \rightarrow R$ is true, R is false
    So, P is false [modus tollens]
    Rubrics - Full marks are to be given if variables are defined before use and proper inference rules are used to draw the conclusion.

8. (3 points) The following predicates are defined in a prolog knowledge-base-
    - male(X) - means X is a male
    - female(X) - means X is a female
    - parent(X,Y) - means X is the parent of Y

    Now using the above predicates, write the rules for the following predicates -
    1. father(X,Y)
    2. mother(X,Y)
    3. brother(X,Y)
    4. sister(X,Y)
    5. grandfather(X,Y)

6. grandmother(X,Y)

Rubrics – marks to be given if each rule is correct as per semantic meaning as well as prolog syntax.
i) father(X,Y) :- male(X), parent(X,Y).
ii) mother(X,Y) :- female(X), parent(X,Y).
iii) brother(X,Y) :- male(X), parent(Z,X),parent(Z,Y), X $\neq Y$.
$iv)sister(X,Y) : -female(X), parent(Z,X), parent(Z,Y), X \neq Y.$
$v)grandfather(X,Y) : -male(X), parent(X,Z), parent(Z,Y).$
$vi)grandmother(X,Y) : -female(X), parent(X,Z), parent(Z,Y).$

9. (3 points) As taught in the last class, in an encoder-decoder architecture, the encoder takes the input and converts it into an encoded representation, while the decoder takes the encoded representation and reconstructs the original input. Assuming logarithm as the encoding operation, identify the input and output for the encoder as well as the decoder and of the entire encoder-decoder architecture. Additionally, what could be a suitable error function for this system to measure the performance of the system?
Rubric + Answer:
Encoder (0.5 mark):
Input: x (or Sequence of values) (0.25 mark)
Output: y = log_a(x) or logarithm of the sequence of values (0.25 mark)
Decoder(0.5 mark):
Input: log$a$(x) or the sequence of logarithms (0.25 mark)
Output: $a^{log(x)}$ = x or the original sequence of values (0.25 mark)
Encoder-Decoder Architecture (1 mark):
Input: x (or Sequence of values) (0.5 mark)
Output: $a^{log(x)}$ = x or the original sequence of values (0.5 mark)
Suitable error function of this system could be the Mean Squared Error function. (1 mark)

10. (2 points) Suppose we want to predict the monthly electricity bill for a household based on the number of people living in the house and the average daily usage of electricity. We created a model based on the entire data of NCR region and now we deployed the model for 5 different households, and our model predicts the following monthly bills:

Household	**Predicted bill (INR)**	**Actual bill (INR)**
1	1500	1200
2	1100	900
3	1800	1500
4	900	800
5	2100	1800

Now, Mean Squared Error (MSE) is a commonly used metric to measure the performance of regression models. It measures the average squared difference between the predicted and actual values in a dataset. Calculate the MSE for the above sample data.

$$MSE = \frac{1}{n}\sum(Actualbill - PredictedBill)^2 \quad (1)$$

where n is the no. of households,

$$MSE = \frac{1}{5}[(1200 - 1500)^2 + (900 - 1100)^2 + (1500 - 1800)^2 + (800 - 900)^2 + (1800 - 2100)^2] \quad (2)$$

$$= \frac{1}{5}[(-300)2 + (-200)2 + (-300)2 + (-100)2 + (-300)2]] \quad (3)$$

$$= \frac{1}{5} * 320000 = 64000 \tag{4}$$