

Introduction to Artificial Intelligence
Question @ Answers

Question 1

Briefly explain what contributions, if any, the individuals below provided to the field of Artificial Intelligence.

- David Hilbert
- Bertrand Russell
- Alfred North Whitehead
- Albert Einstein
- Werner Heisenberg
- Kurt Gödel
- Alan Turing
- John W. Mauchly
- John P. Eckert
- Claude Shannon
- Allen Newell
- Herbert Simon
- John McCarthy
- Marvin Minsky
- Hubert Dreyfus
- Ray Kurzweil
- Bill Joy
- Jaron Lanier

Question 2

Briefly describe the Turing Test for intelligence.

What does the Turing test say about the nature of intelligence?

Can you formulate a better test for intelligence?

The Turing test represents an imitation game. The participants in the game comprise of an interrogator and two individuals of opposite gender. The male and female is separated from the interrogator by a curtain, and their identity is only known as either person A or person B. The interrogator will ask questions for approximately thirty minutes to determine that person A is either the male or the female. The time limit allocated for the interrogating process may be adjusted to ensure that it is not a limiting factor for the interrogator to derive a conclusion. The communication between the interrogator and the two individuals is established by using a computer terminal. This method helps to completely conceal the gender of each individual.

During the test person A is replaced with a computer executing an Artificial Intelligence (AI) system. The AI system answers any questions that the interrogator may have for person A. If the interrogator is unable to determine the gender of person A (the computer) and person B, then the computer system displays intelligence equal to a human. This leads to a definition of Artificial Intelligence; AI is the enterprise of constructing a physical-symbol system that can reliably pass the Turing test.

The Turing test is a very difficult test to pass considering current constraints in technology and computer science. The Turing test requires that the expert systems span across many problem domains. The interrogator could ask questions ranging from sports to any gender related emotional issues. But would passing this test be truly indicative of representing intelligence. Passing such a test is difficult for humans as well. The test completely ignores that intelligence can be measured at different levels. Intelligence is not a measure for bivalent logic where True = Intelligence and False = No Intelligence. Instead people share different degrees of membership in the domain of intelligence. In this regard the Turing test is limited in determining if a system displays intelligence.

A system displays intelligence when it executes tasks it was designed to perform. It does not matter how the system performed such a task, it was capable of performing the task ! It is not required for a system to be human in order to be intelligent. Displaying human behavior and likeness is a nice feature to make humans more comfortable dealing with a machine, but does not constitute as requirements for systems to be considered intelligent. For a system to display intelligence and be useful, it must be able to interact with humans and perform the job it was designed for. These systems already exist in many fields, i.e. AI systems help pilots fly airplanes by detecting pilot errors and automatically correcting them if necessary. When a system performs to its designed specifications it displays intelligence by demonstrating such capabilities.

Question 3

It is not possible to enter into a moral contract with non-human animals; therefore society cannot assign legal rights to non-human animals. The legal world has recognized this issue and many discussions have been held how to protect not only non-human animals, but also land and associated vegetation, etc. Should the scientific community be concerned with animating human intelligence through AI? Do we have moral obligations towards machines?

Question 4

Bill Joy states that a goal should be to force scientists to recognize the heightened risk associated with modern research. The scientific community could require a Hippocratic Oath and a self-imposed system of ethics to regulate research and technology design.

State your opinion.

Question 5

Allen Newell and Herbert A. Simon proposed that intelligent systems require at a minimum a physical symbol system and heuristic search capabilities to perform intelligent actions.
What is a heuristic search algorithm?

Question 6

Who attended the Dartmouth Summer Conference in 1956?
What was the intent (goal) behind the conference?

Question 7

What is the difference, if any, between Computational Intelligence (CI) and Artificial Intelligence (AI).

Question 8

Provide a short description of each CI system and where they may be applied.

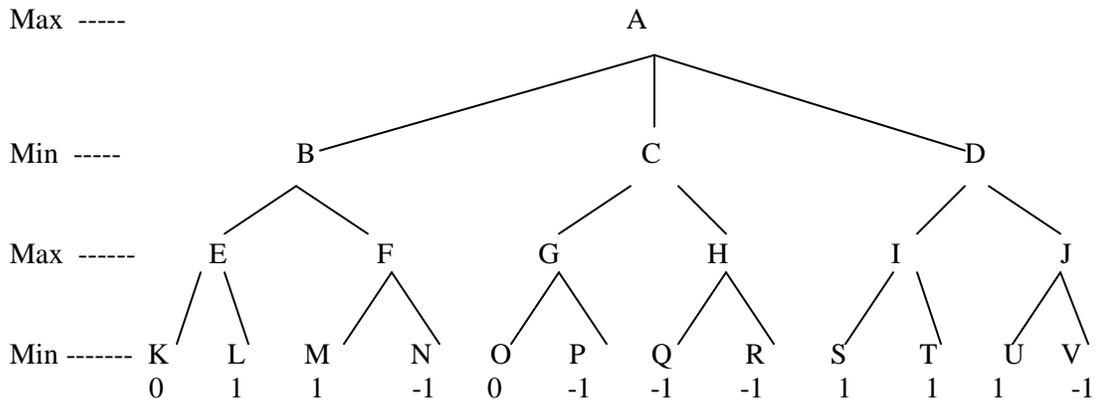
- AI systems
- Expert Systems
- Neural Networks
- Fuzzy Expert Systems

Question 9

What is a rational agent?

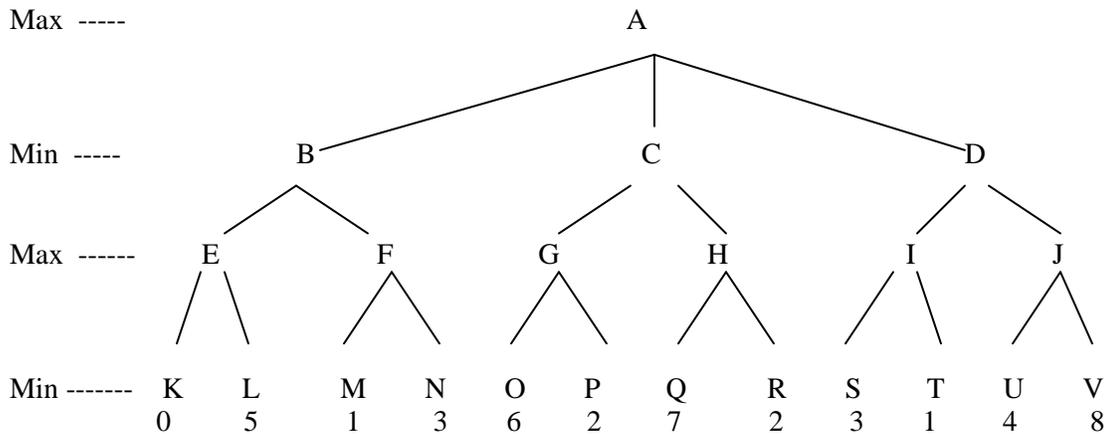
Question 10

Apply the min-max algorithm.



Question 11

Apply alpha-beta pruning. Only visit the minimum number of nodes to ensure a win. Clearly show which branches are NOT visited by the algorithm. Min will win with a score of 0 to 4, Max will win with a score of 5 to 9.

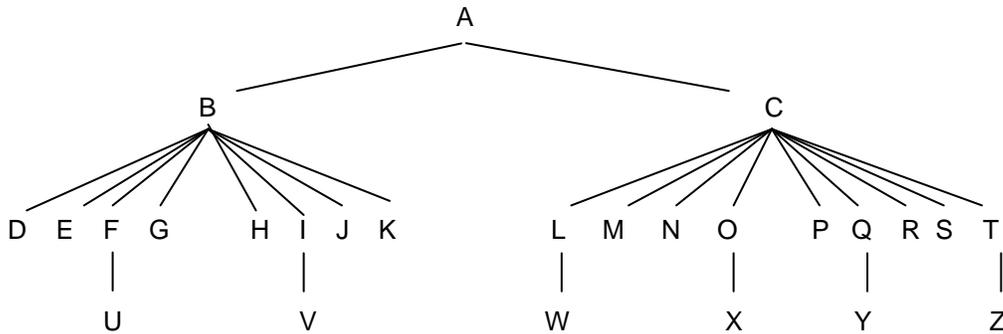


Question 12

Given the search tree in question 11, show the order by which Depth-First-Search visits each node. What is the maximum number of nodes required to be stored on the stack?

Question 13

Given the tree below, perform depth-first search for the goal node V. Show the content on the stack.

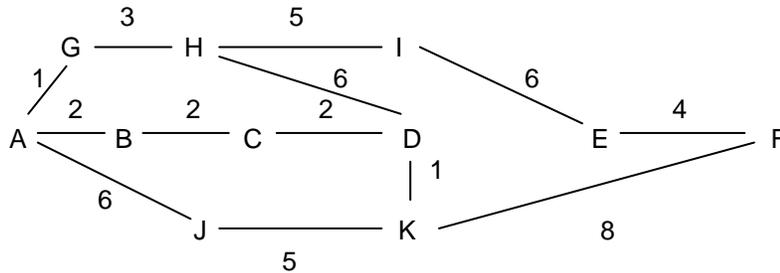


Question 14

Given the tree in Question 13, perform a breadth-first search for goal node X. Show the content on the Queue.

Question 15

Given the graph below, convert the graph into a search tree.



Question 16

Refer to the graph in question 15. What algorithm would one use to determine if a particular node is reachable from a specified node; i.e., is node E reachable from node J? Explain how the algorithm works.

Question 17

Refer to the graph in question 15. What computational problems do we encounter if the graph is comprised of a large number of nodes and edges?

Question 18

Given the tree in Question 15, perform a breadth-first search for goal node X. Show the content on the Queue.

Question 19

What are the advantages and disadvantages of Depth-First-Search and Breadth-First-Search?

Question 20

Explain why iterative deepening is considered better than either breadth-first or depth-first search. What is the only problem with iterative deepening? Why is this not considered to be too serious a problem?

Comparing the algorithms Depth-first and Breadth-first Search one immediately notices that the Breadth-first Search algorithm requires more space in memory than Depth-first Search. For large search trees the space requirements for a Breadth-first search would become cost prohibited.

The Depth-first Search algorithm can also perform a search faster in time than Breadth-first Search especially when the search node is located on the left half side of the tree. Depth-first Search pursues the search down the tree visiting the left most nodes first. A problem occurs if the tree is infinite. The search would never backup to follow another branch down the tree; therefore the algorithm may not find a goal node at all. The Depth-first Search algorithm also fails finding the shallowest goal node when multiple goal nodes are located in the search tree. Breadth-first Search performs better finding the shallowest node.

An Iterative-deepening Search algorithm searches depth first, but the depth is curtailed. Since the depth is incremented when the search fails, iterative-deepening will find the goal node at the shallowest level. This algorithm can search infinite trees because it visits nodes in breadth before the depth is iterated. A cost trade-off exist using Iterative-deepening when the goal node resides at the fringe of the tree. The search starts with the starting node each time the depth is iterated. This requires additional time, because nodes at the root of the tree are visited numerous times.

Question 21

Discuss the issues identified with Hill Climbing and Simulated Annealing.

Question 22

What are Constraint Satisfaction Problems?
Provide a semi-formal definition.

Question 23

Why did the Sudoku puzzles become of great interest to the Computer Science and AI community?

Question 24

What is a constraint inconsistency?
How is it resolved?

Question 25

What is search rearrangement in CSP?

Question 26

What is the trade-off providing an optimum solution using Iterative Deepening and Alpha-Beta Pruning versus a heuristic algorithm when solving the Rubik's Cube?

Hint: An optimum solution solves every Rubik's cube in less than 22 moves. A heuristic algorithm emulating a human methodology requires a minimum of 60 moves.

Question 27

Given a graph and a sub-graph (extracted from the graph) what algorithm/method would you use to show that the sub-graph matches the graph? Provide a short description of the algorithm/ method.

Note: You are not asked to implement it.

Question 28

Convert the following facts to First Order Logic.

- a) Everyone is related to someone who is retired.
 $\forall(x) \exists(y) \text{Related}(x, y) \rightarrow \text{Retired}(y)$
- b) For any x and y, if x is older than y, then y is younger than x.
 $\forall(x) \forall(y) \text{Older}(x, y) \rightarrow \text{Younger}(y, x)$
- c) All freighters are ships.
 $\forall(x) \text{Freighter}(x) \rightarrow \text{Ship}(x)$
- d) The mother of the child is the female parent.
 $\forall(p) \forall(c) \text{Mother}(p, c) \rightarrow \text{Female}(p) \wedge \text{Parent}(p, c)$
- e) Some intelligent students study computer science.
 $\forall(x) \text{Students}(x) \wedge \text{Intelligent}(x) \wedge \text{Study}(x, \text{ComputerScience})$

Question 29

Using a functional/logic language provide a definition for mother, father, brother, and sister.

male(buford).
male(ben).
male(larry).
male(jesse).
male(james).
male(benard).

female(latoya).
female(kamelia).
female(amelia).
female(amy).
female(bessie).
female(albertine).

parent(larry, latoya).
parent(larry, buford).
parent(larry, kamelia).
parent(jesse, larry).
parent(benard, ben).
parent(james, amelia).

parent(amelia, latoya).
parent(amelia, buford).
parent(amelia, kamelia).
parent(amy, larry).
parent(bessie, amelia).
parent(albertine, ben).

father(A,B):-male(A),parent(A,B).
mother(A,B):-female(A),parent(A,B).
brother(A,B):-male(A),parent(X,A),parent(X,B),A\=B.
sister(A,B):-female(A),parent(X,A),parent(X,B),A\=B.

Question 30

Use generalized resolution to provide a proof tree for $\text{True} \rightarrow E(x)$ given the facts below. Include the substitution in the tree, i.e. $\{x / y\}$.

$A(x) \rightarrow B(x)$
 $B(y) \rightarrow C(y)$
 $C(z) \rightarrow E(z)$
 $Q(z) \rightarrow E(z)$
 $E(x) \rightarrow F(z)$
 $\text{True} \rightarrow E(y) \vee Q(y)$

Question 31

Prove that F can be derived from KB. $KB = \{A, G\}$.

Note: Be specific and show which rules of resolution you apply to derive F.

Rules:

$$A \rightarrow B \wedge C \wedge D$$

$$B \wedge D \rightarrow E$$

$$C \wedge E \rightarrow F \vee G$$

Question 32

Identify some of the necessary features required for robotic creatures.

- A creature must cope appropriately and in a timely fashion with changes in its dynamic environment.
- Creature should be robust with respect to its environment; minor changes in the properties of the world should not lead to total collapse of the creature's behavior; rather one should expect only a gradual change in capabilities of the creature as the environment changes more and more.
- A creature should be able to maintain multiple goals and, depending on the circumstances it find itself in change which particular goals it is actively pursuing; thus it can both adapt to surroundings and capitalize on fortuitous circumstances.
- A creature should do something in the world; it should have some purpose in being.

Question 33

Provide a top level diagram for the Kalman filter

Question 34

What are the four stages of a fuzzy expert system?

- Fuzzification
- Inference
- Composition
- De-Fuzzification