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Q. No.: 1

1) b
2) d
3) e
4) d
5) c
6) d
7) a
8) b
9) a
10) b

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Q. No.: 1

(B)

7) Cooperative vs Competitive environments :-

i) An agent is said to be in a competitive environment when it competes against another agent to optimize the output.

ii) The game of chess is a competitive environment as the agents compete with each other to win the game which is the output.

iii) An agent is said to be in cooperative environment when multiple agents cooperate to produce the desired output.

iv) When multiple self driving cars are found on the roads, they cooperate with each other to avoid collisions and reach their destination which is the desired output.

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(B)

2) The pros and cons of backtracking are:-

Pros

i) Backtracking can almost solve any problem due to its brute force nature

ii) All existing solutions can be found out for problem

Cons

i) Very slow as uses brute force

ii) Computational cost is very high as it is recursive and even after the search might not find the soln depending on data.

3) i) Alpha - Beta pruning is a modified version of min max algorithm and is an optimization technique for min max algo.

ii) Pruning is a technique in which we can compute the correct min max decision by calculating and taking the decision to split the tree at respective pruning node. This technique requires special parameters for future computations which are alpha and beta.

iii) Alpha can be defined as the best (highest value) choice we have found so far at any point along the path

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of maximized. The initial value of alpha is $-\infty$

5) i) It is also called "error due to squared bias", bias is the amount that a model's prediction differs from the tagged value compared to the training data.

ii) Bias error results from simplifying the assumptions used in a model so the target functions are easier to approximate.

iii) Bias can be introduced by model selection

iv) Resampling can affect bias as resampling data is the process of extracting new samples from a dataset in order to get more accurate results.

6) AI techniques are those procedures which are used to enable computers to show human like intelligent activities.

The various AI techniques are :-

i) Natural language processing
ii) Knowledge presentation
iii) Automated reasoning
iv) Machine learning
v) Computer vision
vi) Robotics

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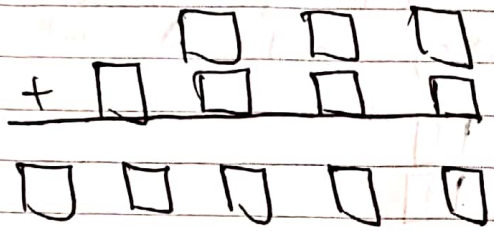
Q. No.: 2

1) We have to solve for :-

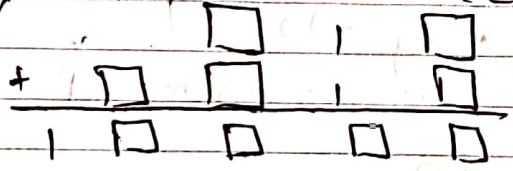
```
  E A T
+ T H A T
---------
A P P L E
```

∴



Solution Steps

→ As the sum (Apple) has 1 extra digit than the words added (EAT and THAT) and all letters can have values between 1-9, so the maximum carry possible is 1, hence A = 1 (extra 1 after)



A = 1 everywhere

→ Extra letter of 2nd word T has 9 as max carry possible is 1 and also need to generate carry for letter A we just filled so 9 will be only possible number that will generate carry.

∴ T = 9

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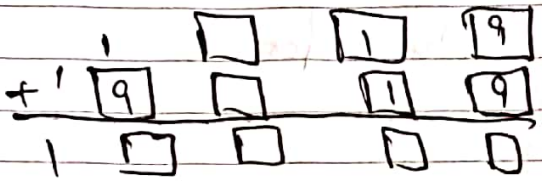
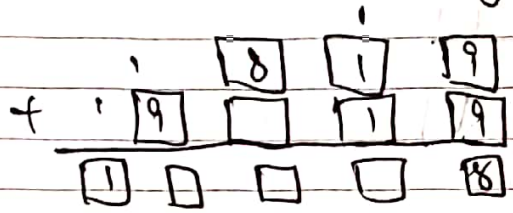
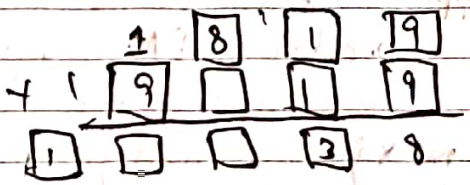


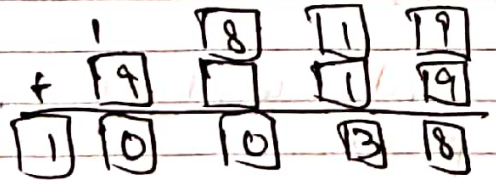
→ Last letter of sum (E in apple) will be 9+9 = 18 1 carry and 8 will be E



→ Now 1+1+1 = 3 = L

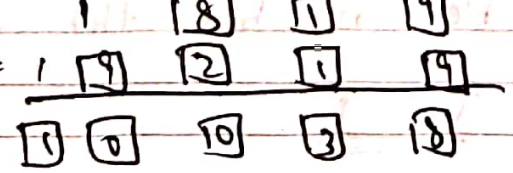


→ Now 9(7) + 1 carry = 10 1 will be carry 0 will be in sum = P.



P = 0

→ H = 2 as we need 1 carry



∴ E = 3, A = 1
T = 9, H = 2,
P = 0, L = 3

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Q. No.: 2

2)

Greed BFS algorithm	A* algorithm
- uses minimal estimated cost $h(n)$ to goal node It uses evaluation func $f(n) = h(n)$ which is heuristic i.e. estimate cost to goal	- is best search for minimizing the total cost as it uses $f(n) = g(n) + h(n)$ which is travelled distance + predicted distance
- not complete as can get stuck in loops	- complete unless there are infinitely many nodes
- Time complexity $O(bm)$	- exponential time complexity $O(b^d)$
- Space complexity $O(bm)$	- keeps all nodes in memory $\rightarrow O(b^d)$
- not optimal as obtains best first solution	- optimal depending upon search algo and heuristic property.
- uses less memory	- uses more memory.

b : branching factor
m : maximum depth of state space
d : depth of least cost solution

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Q. No.: 3

1) Converting into First Order Logic

a) There is a bunny who is a cute.

→ $\exists x$ IsaBunny $(x) \wedge$ IsCute (x)

b) Every child who has a UNO card is cool

→ $\forall x, y$ IsChild $(x) \wedge$ hasUNO $(y) \wedge$ owns (x,y) is Cool (x)

c) Everyone at Mumbai is smart

→ $\forall x$ (At $(x$, Mumbai$)) \longrightarrow$ isSmart (x)

d) Blue databases are better than other databases.

→ $\forall x, y$ Database $(x) \wedge$ Database $(y) \wedge$ isBlue $(x) \wedge \neg$ isBlue $(y) \longrightarrow$ isBetter (x, y)

e) The best score in A12 is always ~~better~~ higher than best score in A11

→ $\forall$ semester $\exists x \forall y$ score $(x$, A12, semester$) >$ score $(y$, A11, semester$)$

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Q. No.: 3

2) Baye's theorem describes the probability of occurrance of an event related to any condition. It is also considered for the case of conditional probability.

- The baye's theorem is expressed in the following formula :-

$$P(A|B) = \frac{P(B|A) \cdot P(A)}{P(B)}$$

where $P(A|B)$ → the probability of event A occuring given the event B has occured

$P(B|A)$ → the probability of event B occuring given event A has occured

$P(A)$ → probability of event A

$P(B)$ → probability of event B

- Hypothesis - Evidence

likelyhood of evidence given hypothesis

$$P(A|B) = \frac{P(B|A)\ P(A)}{P(B)}$$

$P(A|B)$ ← Posterior probability of hypothesis given evidence

$P(A)$ ← Prior probability of hypothesis

$P(B)$ ← Normalizing constant

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Let us now take an example.
Bag 1 contains 4 white and 6 black balls
Bag 2 contains 3 white and 3 black balls
One ball is drawn at random from one of the bags and is found to be black. Find probability of it being drawn from bag 1.

Let E_1 be event of choosing bag 1
E_2 be event of choosing bag 2
A be the event of drawing black ball

$P(E_1) = P(E_2) = 1/2$

$P(A/E_1)$ = P(drawing black from bag 1)
$= 6/10$
$= 3/5$

$P(A/E_2) = 3/7$

By bayes theorem

$$P(E_1/A) = \frac{P(E_1) \cdot P(A/E_1)}{P(E_1) P(A/E_1) + P(E_2)(P(A/E_2))}$$

$$= \frac{1/2 \times 3/5}{\frac{1}{2} \times \frac{3}{5} + \frac{1}{2} \times \frac{3}{7}} = \frac{7}{12}$$

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Q. No.: 4

1) Variance error

i) Variance error is the variation of scores caused by the influence of variables which are other than the independent variables in our data.

ii) It is caused by external factors like imprecision in measurement. It indicates how much random fluctuation is expected

iii) It can be incredibly difficult to actually try and control or remove such factors

High variance models	Low variance models
i) known as overfitting	known as underfitting
ii) tries to completely fit the data	cannot model the training data
iii) learns the noise and external factors of training set.	unable to learn the given dataset (training) at all
iv) New data can be generalized but less performance	cannot be generalized
v) can be fixed in decision tree by pruning	cannot be fixed and hence needs to try other ML algos

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Q. No.: 4

2) Decision tree is a structure that solves the problem of machine learning by transforming the data into a tree representation. It contains nodes and edges and is built from a dataset.

The advantages of ID3 induction algorithm:-

i) Decision tree can be used for both classification and regression problems
ii) Understandable prediction rules are created from the training data.
iii) It does not require normalization or scaling of data
iv) Finding leaf nodes enables test data to be pruned, hence reducing the number of tests.
v) Missing data values do not affect the process of building a decision tree and it is robust to outliers.

The disadvantages of ID3 induction algorithms:-

i) Overfitting is the problem in decision tree leading to wrong predictions.
ii) Due to overfitting, there's a high chance of high variance in the output leading to errors in final estimation and high in accuracy.

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iii) A small change in the data can cause a large change in the structure of the decision tree, causing instability.

iv) It is not suitable for large data sets and training is relatively expensive as complexity and time is taken more.

v) It also takes higher time to train the model.