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Local search

Question 1: ....

Simulated annealing cannot be used to solve the Traveling salesman problem:

Ⓐ True Ⓑ False

Question 2: ....

Simulated annealing can find the optimal solution with a probability that equals 1.

Ⓐ True Ⓑ False

Question 3: ....

To solve the 8-queens problem using Hill-climbing, the Manhattan distance (which computes the sum of the distances from the actual positions of the queens to their goal positions) can be used as an objective function. Ⓐ True Ⓑ False

Question 4: ....

At the beginning of the search in Simulated Annealing, the probability of accepting a bad move is almost zero. Ⓐ True Ⓑ False

Question 5: ....

The best search algorithm to use when the state space has several local optimum is Simulated Annealing.

Ⓐ True Ⓑ False

Question 6: ....

Given a minimization problem with a search space of size 10^5, you decide to use Hill Climbing 500 times, each time with a randomly selected starting point. The lowest value found is 1.3, the highest value is 4.9, and the average is 3.2. The algorithm on average takes 8 steps/loops to converge and return a result.

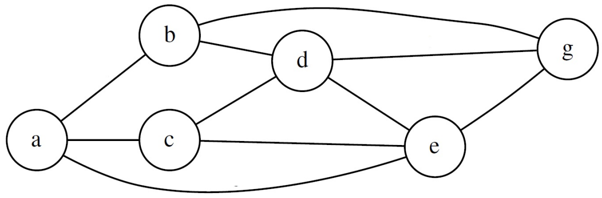
The global minimum is 1.3. Ⓐ True Ⓑ False

Question 7:...

Consider the following search space. Hill Climbing is used to search for the state with the minimum value of the objective function f.

n	f(n)
a	4
b	3
c	4
d	4
e	4
g	0

C



Give the sequence of nodes visited by hill-climbing if C is the initial state:

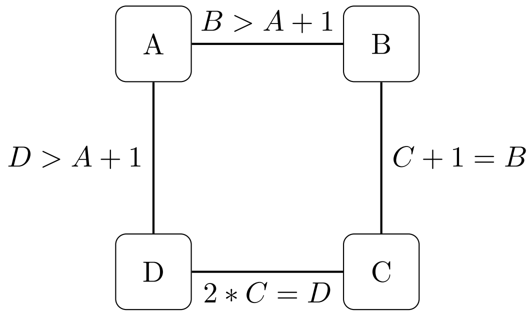
(A) C, E, G

(B) C, D, B, G

(C) C, A, B, G

(D) None of the above

CSP



2 3

2, 4, 6, 8

Table 1: AC3

Queue	A $\{1, 2, 3, 4\}$	B $\{1, 2, 3, 4\}$	C $\{1, 2, 3, 4\}$	D $\{1, 2, 3, 4\}$	added arcs
AB	**X** {2,3}				DA
BA		**Y** {3,4}			CB
AD	{2,3}				–
DA				{3,4} **Z**	CD
DC				{4}	AD
CD			{2} **W**		~~BC~~
BC		{3}			~~CB~~
CB			{2}		–
AD	{1}				

Apply AC3 algorithm to the following graph.

Question 8: ....

What is the value of **X** shown in Table 1:

$x = \{1, 2\}$

(A) $X = \{1\}$

(B) $X = \{1, 2, 3\}$

(C) $X = \{1, 2\}$

(D) None of the above

Question 9: ....

What is the value of **Y** shown in Table 1:

(A) $Y = \{4\}$

(B) $Y = \{3\}$

(C) $Y = \{3, 4\}$

(D) None of the above

Question 10: ....

What is the value of **W** shown in Table 1:

(A) $W = \{1, 2\}$

(B) $W = \{2, 3\}$

(C) $W = \{2\}$

(D) None of the above

Question 11: ....

What is the value of **Z** shown in Table 1:

(A) $Z = \{3\}$

(B) $Z = \{4\}$

(C) $Z = \{3, 4\}$

(D) None of the above

Question 12: ....

What is the final domain of the variables **A,B,C,D** after applying AC3 algorithm:

(A) $A = \{1\}$, $B = \{3\}$, $C = \{2\}$, $D = \{4\}$

(B) $A = \{1, 2\}$, $B = \{3\}$, $C = \{2\}$, $D = \{3, 4\}$

(C) $A = \{1, 2\}$, $B = \{3, 4\}$, $C = \{2\}$, $D = \{3, 4\}$

(D) None of the above

Adversarial search

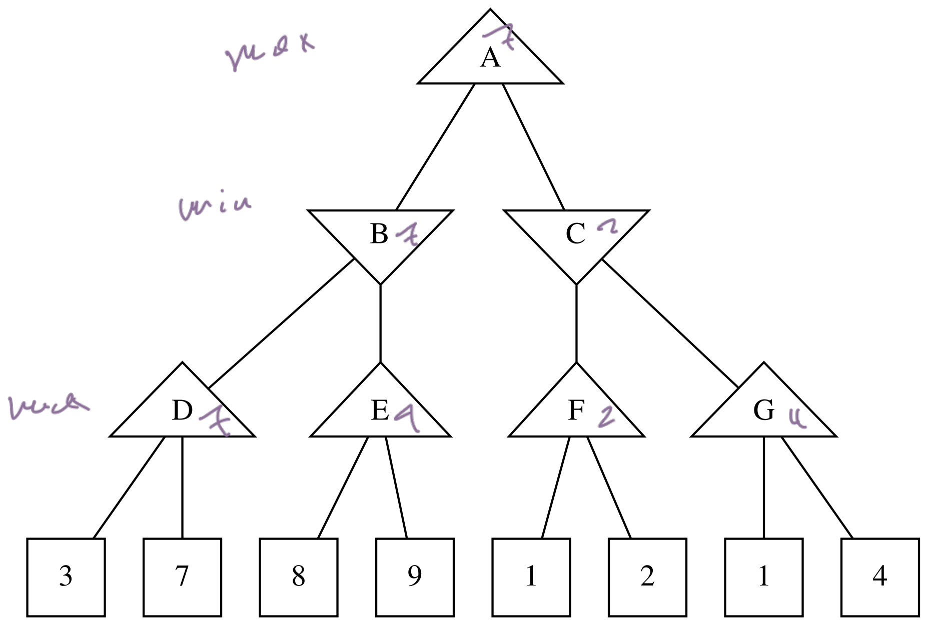


Figure 1:

After applying Minimax to the tree in Figure 1. Show the **final** obtained value at node **A,B,C**.

Question 13: ....

At node **A**:

(A) Minimax returns 7 for this node.

(B) Minimax returns 9 for this node.

(C) Minimax returns 2 for this node.

(D) None of the above.

Question 14: ....

At node **B**:

(A) Minimax returns 7 for this node.

(B) Minimax returns 9 for this node.

(C) Minimax returns 8 for this node.

(D) None of the above.

Question 15: ....

At node **C**:

(A) Minimax returns 4 for this node.

(B) Minimax returns 1 for this node.

(C) Minimax returns 2 for this node.

(D) None of the above.

Question 16: ....

Minimax gives the same results as Alpha-Beta pruning.

(A) True (B) False

Question 17: ....

Assume that MinimaxCutoff performs a cut at depth d. To evaluate all the nodes at depth d, MinimaxCutoff uses the utility function.

(A) True (B) False

Question 18: ....

A utility function applies:

(A) Only to non-terminal states.

(B) Only to terminal states.

(C) Both to terminal and non-terminal states.

(D) None of the above.

Question 19: ....

Minimax algorithm:

(A) Can always reach the terminal states of the tree of any adversarial search problem.

(B) Cannot reach the terminal states in most adversarial search problems since it has a limited time to reach these states.

(C) Can return a solution even if it did not reach the terminal states.

(D) None of the above.

Question 20: ....

A good order of the terminal states when applying $\alpha - \beta$ pruning :

(A) Can result in a solution with a higher utility value.

(B) Can increase the depth of search.

(C) Can in some cases give a better solution.

(D) None of the above.

Question 21: ....

Two evaluation functions are equivalent when applying MinimaxCutoff:

(A) Only if they give the same utility value for the solution.

(B) Only if they give the same value to the states that are at the cut-off level.

(C) Only if they give the same order to the states that are at the cut-off level.

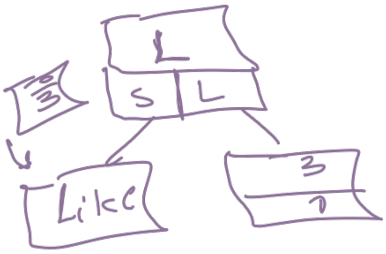
(D) None of the above.

Machine Learning

Consider the following examples that describe a user feedback on different movies.

$p_L = 1,\ n_L = 3$

$S = P_S = 3,\ n_S = 0$



Genre	Length	American	Feedback
Romance	Long	Yes	Dislike 0
~~Romance~~	~~Short~~	~~No~~	~~Like~~ 1
Romance	Long	Yes	Like 1
Romance	Long	Yes	Dislike 0
~~Action~~	~~Long~~	~~Yes~~	~~Dislike~~ 0
~~Action~~	~~Short~~	~~No~~	~~Like~~ 1
~~Action~~	~~Short~~	~~Yes~~	~~Like~~ 1

Figure 2 shows the structure of the obtained decision tree using ID3. The remainders for the first level of the tree are **R(Genre)=0.96,** **R(Length)=0.46,** **R(American)=0.69**.

3 1 2

Dislike is negative and Like is positive.

- For each decision node in Figure 2, choose the correct attribute and write its remainder.
- For each edge in Figure 2, choose the correct label.
- For each leaf node in Figure 2, choose the correct decision.

$$Remainder = \sum_{k=1}^{2} \frac{p_k + n_k}{p + n} B\left(\frac{p_k}{p_k + n_k}\right)$$

$$B(q) = -\left(q \log_2(q) + (1-q)\log_2(1-q)\right)$$

$GR : R \rightarrow P_R : 1\ \ N_R = 2 \qquad B = \left(\frac{1}{3}\right) \qquad \text{branch} = \frac{3}{4}$

$GA : A \rightarrow P_A : 0 \quad N_0 = 1 \qquad B = \left(\frac{0}{1}\right) = \frac{1}{4}\ ?$

$R(G) = \frac{3}{4} B\left(\frac{1}{3}\right) + \frac{1}{4} B\left(\frac{0}{1}\right) = \boxed{0.69}$

American: $Y \rightarrow P_Y = 1,\ N_Y = 3 \qquad B = \left(\frac{1}{4}\right) \qquad \text{branch} = \frac{4}{4} = 1$

$1 * B\left(\frac{1}{4}\right) = 0.81 \rightarrow$

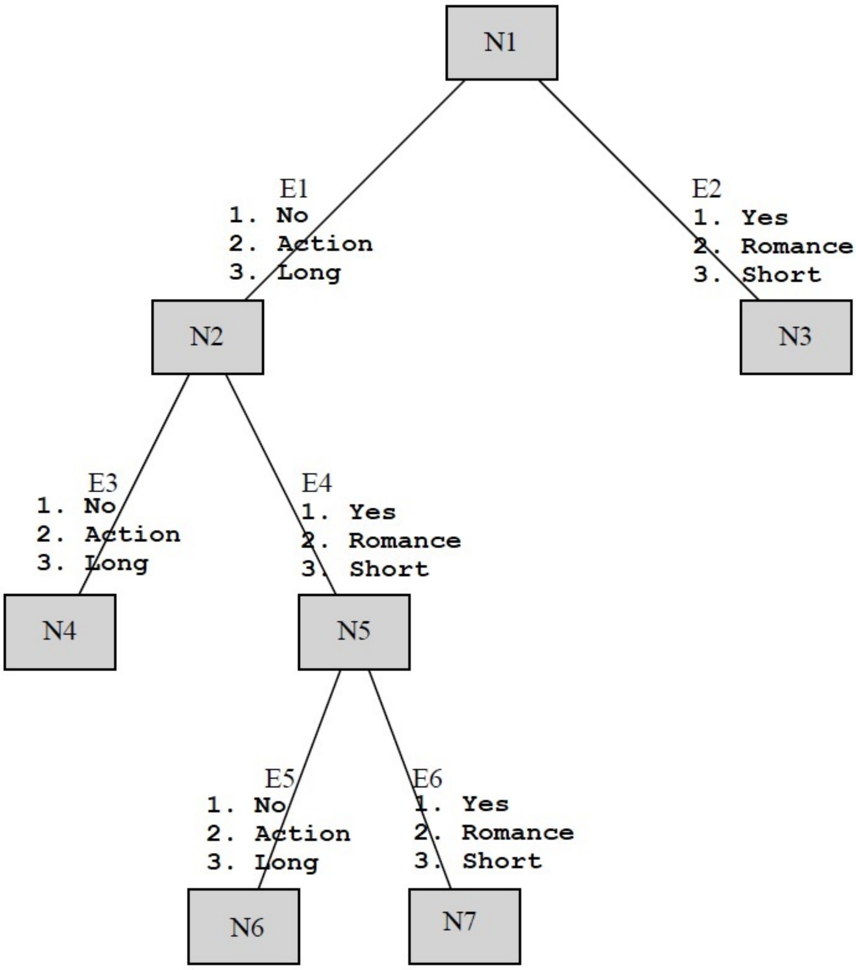


Figure 2: Decision tree

Question 22: ....

The node N1 is (A) American (B) Genre (C) Length

Question 23: ....

The node N2 is (A) American (B) Genre (C) Length

Question 24: ....

The node N3 is (A) Like (B) Dislike

Question 25: ....

The node N4 is (A) Like (B) Dislike

Question 26: ....

The node N5 is (A) American (B) Genre (C) Length

Question 27: ....

The node N6 is (A) Like (B) Dislike

Question 28: ....

The node N7 is (A) Like (B) Dislike

Question 29: ....

The edge E1 is (A) No (B) Action (C) Long

Question 30: ....

The edge E2 is (A) Yes (B) Romance (C) Short

Question 31: ....

The edge E3 is (A) No (B) Action (C) Long

Question 32: ....

The edge E4 is (A) Yes (B) Romance (C) Short

Question 33: ....

The edge E5 is (A) No (B) Action (C) Long

Question 34: ....

The edge E6 is (A) Yes (B) Romance (C) Short

Question 35: ....

ID3 algorithm is a supervised learning approach. (A) True (B) False

Question 36: ....

Unsupervised learning approaches need a training and a test set. (A) True (B) False

Question 37: ....

Always choose a hypothesis that is consistent with the data even if it does not generalize well. (A) True (B) False

Question 38: ....

A decision tree can be used to predict prices of houses based on their surfaces and the number of their rooms. (A) True (B) False

PL

Consider the following propositional KB and α: Q:

A1: $(U \wedge S) \implies Q$

A2: $(T \wedge P) \Leftrightarrow R$

A3: $R \implies U \vee Q$

A4: $T \wedge (P \wedge S)$

To prove α, a sequence of rules have been applied (as shown in Table **Choose the premise used to obtain** $A12, A13, A16$ **in the table. Choose the correct conclusion for** $A8, A9, A10, A14, A15$ **in the table.**

$T \land P \leftrightarrow R$

$T \land P \to R$

$\land\ R \to T \land P$

Table 2: Proof

Premises	**Conclusion**
A4	A5: T
A4	A6: P
A4	A7: S
A2	A8: (A) $T \land (P \to R) \land (T \land (R \to P)))$ (B) $((T \land P) \land R) \land (R \land (T \land P))$ (C) $((T \land P) \to R) \land (R \to (T \land P))$
A8	A9: (A) $T \land (P \to R)$ (B) $((T \land P) \to R)$ (C) $(T \land P) \land R$
A8	A10: (A) $T \land (R \to P)$ (B) $R \land (T \land P)$ (C) $R \to (T \land P)$
A5,A6	A11: $\boxed{T \land P}$
(A) A9,A11 (B) A9,10 (C) A11	A12: R $T \land P$ T $T \land P \to R$
(A) A3 (B) A3,A12 (C) A12	A13: $U \lor Q$ $R \to U \lor Q$ $\neg U \lor \neg S \lor Q$
A1	A14: (A) $\neg U \lor \neg S \lor Q$ (B) $(U \land S) \lor \neg Q$ (C) $\neg(U \land S) \land Q$ $\lor Q$
A13,A14	A15: (A) $\neg(U \land S)$ $\neg S$ (B) $U \land S$ F (C) $\neg S \lor Q$
(A) A14,A7 (B) A15,A7 (C) A15	A16 Q

Question 39: ....

A8 in Table 2 is:

Ⓐ $T \wedge (P \rightarrow R) \wedge (T \wedge (R \rightarrow P)))$

Ⓑ $((T \wedge P) \wedge R) \wedge (R \wedge (T \wedge P))$

Ⓒ $((T \wedge P) \rightarrow R) \wedge (R \rightarrow (T \wedge P))$

Question 40: ....

A9 in Table 2 is:

Ⓐ $T \wedge (P \rightarrow R)$

Ⓑ $((T \wedge P) \rightarrow R)$

Ⓒ $(T \wedge P) \wedge R$

Question 41: ....

A10 in Table 2 is:

Ⓐ $T \wedge (R \rightarrow P)$

Ⓑ $R \wedge (T \wedge P)$

Ⓒ $R \rightarrow (T \wedge P)$

Question 42: ....

The premise of A12 in Table 2 is:

Ⓐ A9,A11

Ⓑ A9,A10

Ⓒ A11

Question 43: ....

The premise of A13 in Table 2 is:

Ⓐ A3

Ⓑ A3,A12

Ⓒ A12

Question 44: ....

A14 in Table 2 is:

Ⓐ $\neg U \vee \neg S \vee Q$

Ⓑ $(U \wedge S) \vee \neg Q$

Ⓒ $\neg(U \wedge S) \wedge Q$

Question 45: ....

A15 in Table 2 is:

(A) $\neg(U \wedge S)$

(B) $U \wedge S$

(C) $\neg S \vee Q$

Question 46: ....

The premise of A16 in Table 2 is:

(A) A14,A7

(B) A15,A7

(C) A15

Question 47: ....

If a knowledge base KB entails a sentence α, then $\neg KB \vee \alpha$ is valid. (A) True (B) False

Question 48: ....

Forward chaining is a complete algorithm for Horn knowledge base. (A) True (B) False

Question 49: ....

$KB \models \alpha$ if and only if whenever α is true, KB is also true. (A) True (B) False

Question 50: ....

Depth first enumeration in propositional logic has an exponential space complexity. (A) True (B) False

Question 51: ....

Consider the following propositional logic KB in Horn form:

A1: $E \wedge F \implies K$	$T \wedge T \to T$	A5: A
A2: $C \wedge D \implies F$	$T \to D \equiv T$	A6: B
A3: $A \implies D$		A7: C
A4: $F \wedge B \implies Z$	$F \wedge T \to Z$	A8: E

Use **forward** chaining to prove Z (when more than one rule is applicable, follow the order specified above).

The rules are fired in the following order:

(A) A3, A2, A4 A3, A2

(B) No rule can be fired

(C) A3, A2, A1, A4

(D) None of the above

Question 52: ....

Convert the following propositional KB into CNF (Conjunctive Normal Form):

A1: $(U \wedge S) \implies Q$ $(\neg U \vee \neg S) \vee Q$

A2: $(T \wedge \neg P) \implies R$ $(\neg T \vee P) \vee R$

A3: $R \implies \neg(U \vee Q)$ $\neg R \vee (\neg U \wedge \neg Q)$

A4: $\neg R$

T

Select the list of clauses you obtained after converting KB into CNF :

(A) $\neg U \vee \neg S \vee Q$, $\neg T \vee P \vee R$, $\neg R \vee \neg U$, $\neg Q$, $\neg R$

(B) $\neg U \vee \neg S \vee Q$, $\neg T \vee P \vee R$, $\neg R \vee \neg U$, $\neg R \vee \neg Q$, $\neg R$

(C) $\neg U \vee Q$, $\neg S \vee Q$, $\neg T \vee P \vee R$, $\neg R \vee \neg U$, $\neg Q$, $\neg R$

(D) None of the above

FOL

$Male(x)$: x is a male.

$Female(x)$: x is a female.

$Parent(x, y)$: x is the parent of y.

$GrandFather(x, y)$: x is a grandfather of y.

$Sibling(x, y)$: x and y are siblings (have one or two parents in common).

$Uncle(x, y)$: x is an uncle of y.

$Mother(x)$: A function that returns the mother of x.

Choose the most appropriate translation:

Question 53: ....

The definition of $Mother$:

(A) $Mother(x) = y \Leftrightarrow Parent(y, x)$

(B) $Mother(x) = y \Leftrightarrow Parent(x, y)$

(C) $Mother(x) = y \Leftrightarrow Parent(y, x) \wedge Female(x)$

(D) $Mother(x) = y \Leftrightarrow Parent(y, x) \wedge Female(y)$

(E) None.

Question 54: ....

The definition of $GrandFather$:

(A) $GrandFather(x, y) \Leftrightarrow \exists z, Parent(x, z) \vee Parent(z, y)$

(B) $GrandFather(x, y) \Leftrightarrow \forall z, Parent(x, z) \wedge Parent(z, y)$

(C) $GrandFather(x, y) \Leftrightarrow \exists z, Parent(x, z) \wedge Parent(z, y) \wedge Male(z)$

(D) $GrandFather(x, y) \Leftrightarrow \forall z, Parent(x, z) \wedge Parent(z, y) \wedge Male(x)$

(E) None.

Question 55: ....

The definition of $Uncle$:

$\neg$ $\exists$,

Ⓐ $Uncle(x, y) \Leftrightarrow \exists z, Sibling(x, z) \wedge Parent(z, y)$

Ⓑ $Uncle(x, y) \Leftrightarrow \exists z, Sibling(x, z) \wedge Parent(z, y) \wedge Male(z)$

Ⓒ $Uncle(x, y) \Leftrightarrow \neg(\forall z, \neg Sibling(x, z) \vee \neg Parent(z, y) \vee \neg Male(x))$

Ⓓ $Uncle(x, y) \Leftrightarrow \forall z, Sibling(x, z) \vee Parent(z, y) \vee Male(z)$

Ⓔ None.

Question 56: ....

$\forall x, y, Sibling(x, y) \implies \forall z, Uncle(z, x) \implies Uncle(z, y)$

Ⓐ The uncle of one's sibling is one's uncle.

Ⓑ All siblings have the same uncle.

Ⓒ Any two siblings have at most one uncle.

Ⓓ None.

Question 57: ....

$\forall x, y, z, u, Parent(x, u) \wedge Parent(y, u) \wedge Parent(z, u) \wedge x \neq y \implies z = x \vee z = y.$

Ⓐ Everyone has at least two parents.

Ⓑ Everyone has at most two parents.

Ⓒ Everyone has exactly two parents.

Ⓓ None.

Question 58: ....

$\forall x, y, u, v, Mother(x) = u \wedge Mother(y) = v \wedge Mother(u) = Mother(v) \implies \neg Sibling(x, y).$

Ⓐ Two persons with the same mother and grandmother are siblings.

Ⓑ Two persons with different mothers are not siblings.

Ⓒ Two persons with the same maternal grandmother are not siblings.

Ⓓ None.

Question 59: ....

Given the following KB in FOL:

A1: $\forall x, Cat(x) \land HasLongHair(x) \implies Cute(x)$

A2: $\forall y, HasLongHair(y)$

A3: $Cat(Ziggy) \land Owner(John, Ziggy) \land Father(Ziggy, Tom)$

Choose the correct conversion of KB into PL:

(A)
A1: $Cat(x) \land HasLongHair(x) \implies Cute(x)$

A2: $HasLongHair(y)$

A3: $Cat(Ziggy) \land Owner(John, Ziggy) \land Father(Ziggy, Tom)$

(B)
A1: $Cat(Ziggy) \land HasLongHair(Ziggy) \implies Cute(Ziggy)$

A2: $HasLongHair(Ziggy)$

A3: $Cat(Ziggy) \land Owner(John, Ziggy) \land Father(Ziggy, Tom)$

(C)
A1: $Cat(Ziggy) \land HasLongHair(Ziggy) \implies Cute(Ziggy)$

A2: $Cat(John) \land HasLongHair(John) \implies Cute(John)$

A3: $Cat(Tom) \land HasLongHair(Tom) \implies Cute(Tom)$

A4: $HasLongHair(Ziggy)$

A5: $HasLongHair(John)$

A6: $HasLongHair(Tom)$

A7: $Cat(Ziggy) \land Owner(John, Ziggy) \land Father(Ziggy, Tom)$

(D) None