Intelligent Systems – Exam Block 1, 8th January 2025 (Type A)
Test A (1,75 points) <u>score</u>: max (0, (corrects – incorrects/3)*1,75/9)

Surname:						**Name**:		
Group:	A	B	C	D	E	F	G	4IA

1) What condition is neccessary for a β cut to happen in the alpha-beta pruning?

   A. The value of α in a MAX node is greater or equal than the value of β in a MIN parent node visited before.
   B. The value of β in a MIN node is less or equal than the value of α in a MAX parent node visited before.
   C. The value of α in a MIN node is greater than that of a MAX child node visited afterwards.
   D. The values of α and β are different in an internal node.

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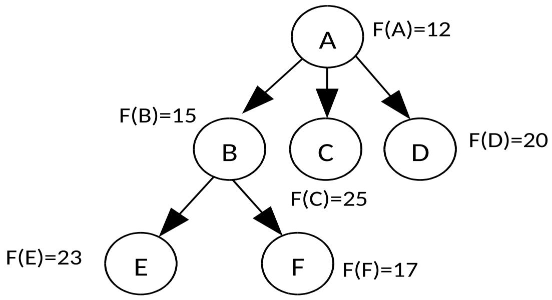
2) The tree in the figure represents the resulting **partial exploration** of the RBFS algorithm where only the F values are shown. Indicate the **CORRECT** answer:



   A. The bound b in node B is b(B) =25
   B. The bound b in node C is b(C) =20
   C. In the next step the RBFS algorithm will update the F value of B to F(B)=17.
   D. In the next step the RBFS algorithm will expand the node F and the bound of F will be b(F) =20.

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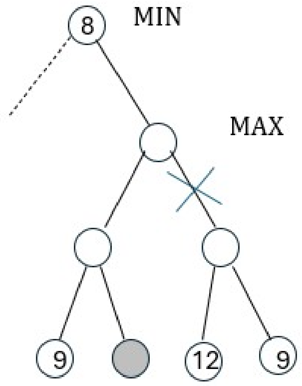
3) After applying the Iterative Deepening Search (IDS) algorithm based on backtracking, a solution is found at level d being the root node at level 0. Indicate the **INCORRECT** answer:

   A. The IDS algorithm generates d+1 trees to find the solution.
   B. A Breadth-First Search algorithm will also find a solution at level d.
   C. The number of nodes generated in the tree of depth d will always be higher than that in the tree of depth d-1.
   D. The application of the Depth First Search algorithm based on backtracking provided a maximum depth m=d generates the same number of nodes than IDS for the tree of depth d.

4) When applying alpha-beta pruning, what value must contain the shaded node so that the cut does **NOT** happen?



A. Less than 8
B. Less or equal to 8
C. Greater or equal to 8
D. The cut is not generated independently from the value of the node

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5) Provided a fact in an RBS representing a set of shops that only sell three types of products. For example:

(sales shop 1 p1 p3 p2 shop 2 p2 p5 p4 shop 3 p1 p6 p4 shop 4 p2 p8 p3)

where the integer number after the symbol "shop" is the shop identifier, followed by the three types of products sold in the shop. In addition, there is a fact to select a type of product, for example, (product p2). What is the left-hand side of a rule to select any shop selling the selected type of product?

A. (product ?p) (sales shop ?id $?list_p $?)
B. (product ?) (sales $? shop ?id $?x ?p $?y $?)
C. (product ?p) (sales $? shop ?id $? ?p $?y)
D. None of the above answers is correct.

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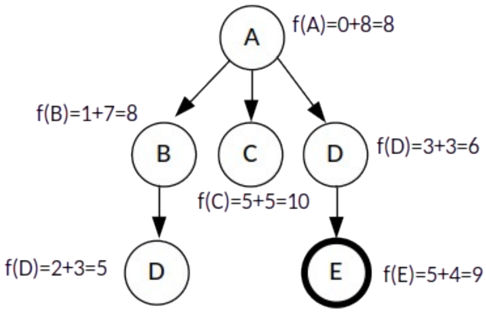
6) Let us consider an A* algorithm to solve a problem and let G be the solution node found. Indicate the **CORRECT** answer:

A. If $h(n)$ is consistent, then $\forall$ n1, n2 being n2 a child node of n1, it is always true that $h(n2)>=h(n1)$
B. $\forall$n1, n2, so that n1 and n2 are two nodes in the solution path to G, and n1 is an ancestor node of n2, it is always true that $g(n1)+h^*(n1)<g(n2)+h^*(n2)$
C. $\forall$n, so that n is a node in the solution path to G, it is always true that $f(n) <= g(G)$
D. None of the answers above is correct.

7) The IDA* algorithm is applied to the tree in the figure below where the goal node is E. Indicate the **INCORRECT** answer:



A. The maximum number of nodes in memory (PATH) in the first search tree is 3.
B. The maximum number of nodes in memory (PATH) in the second search tree is 4.
C. IDA* generates two search trees to find the solution.
D. The bound of the first search tree is b = 8.

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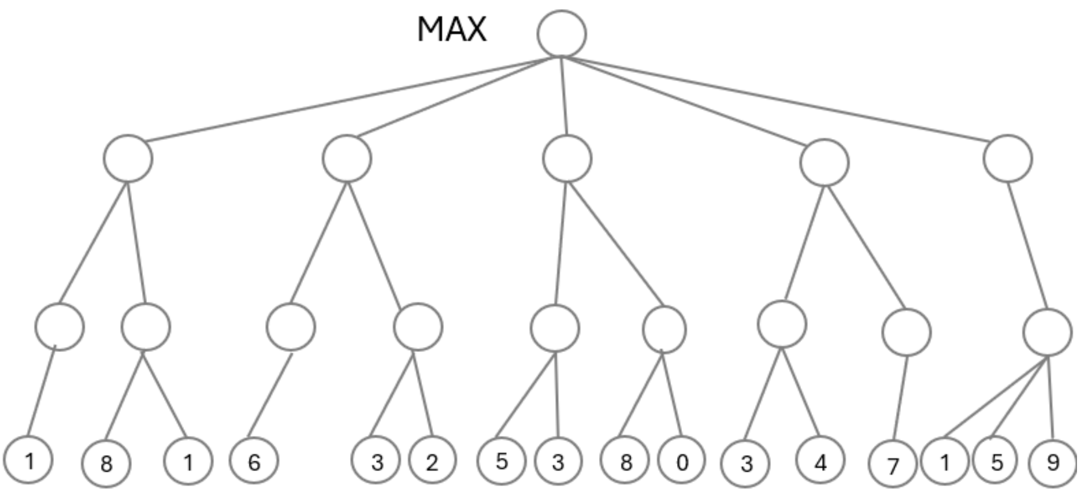
8) How many terminal nodes are not generated due to the application of the alpha-beta algorithm?



A. 2
B. 3
C. 4
D. 0

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9) Provided the facts F={(list 1 a c d e a f)(list 2 c b a c d f c)}, and the LHS of rule R1, how many instances of this rule are generated in the pattern-matching process?

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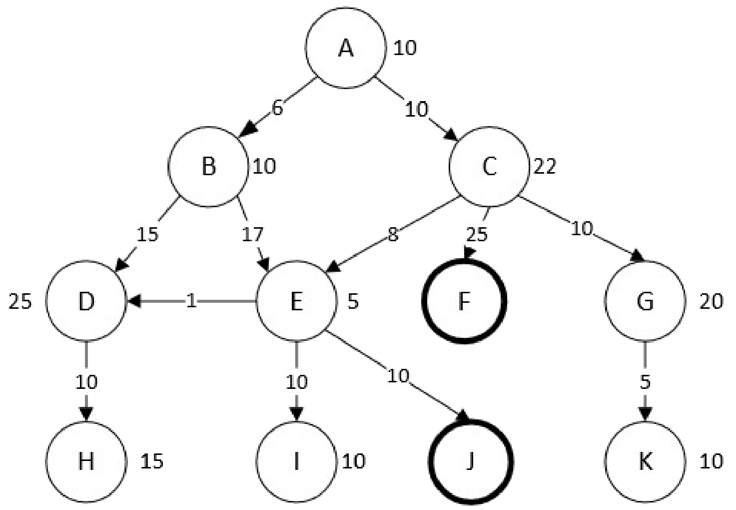
(defrule R1
    (list ?n1 $?x1 ?e $?y1)
    (list ?n2 $?x2 ?e $?y2)
    (test (not (eq ?n1 ?n2)))
=>
```

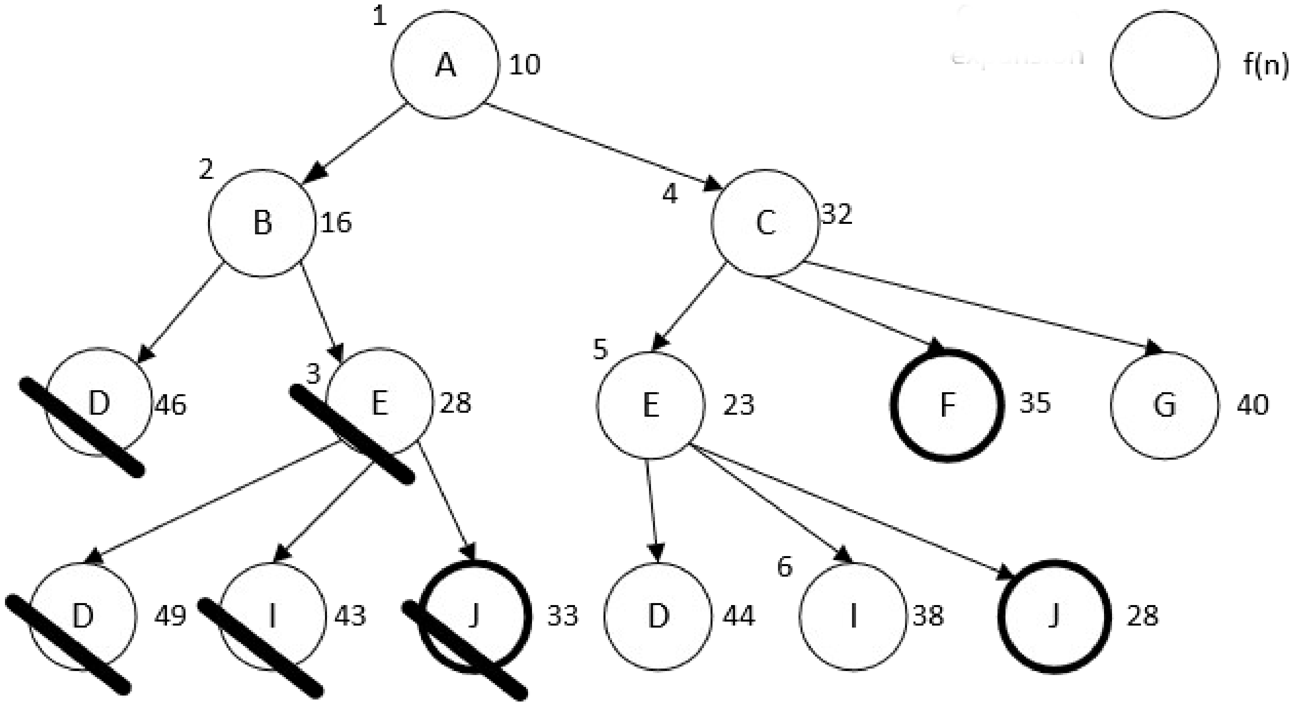
A. 7
B. 10
C. 14
D. 18

Intelligent Systems – Exam Block 1, 8th January 2025
Problem: 2 points

The following graph represents the state space of a problem. The nodes in the graph are states of the problem, the edges connect each state with its successor, and the integer value on each edge represents the cost of traversing that edge. The value next to each node represents the value of the heuristic function h(n) for that node. The initial state of the problem is node A and the final states are F and J.



1) (1 point) Draw the search tree generated when applying an A algorithm with control of repeated nodes in OPEN and CLOSED (nodes in the CLOSED set are reinserted in OPEN, if needed). During the trace, show the content of OPEN and CLOSED as it changes, the solution PATH and its cost. In case of nodes with the same f value, select them in alphabetical order.
2) (0.4 points) Regarding the solution found by the A algorithm, is it the optimal solution? Is the heuristic function admissible? Is it consistent? Justify your answers.
3) (0.6 points) Apply the DFS algorithm with an OPEN stack and assume that a PATH list is also maintaned to return the list of nodes in the solution to the goal state. Draw the resulting search tree and the content of OPEN and PATH as it changes. What is the solution found? What is the maximum number of nodes stored in memory (OPEN+PATH) during the trace? Justify your answers.



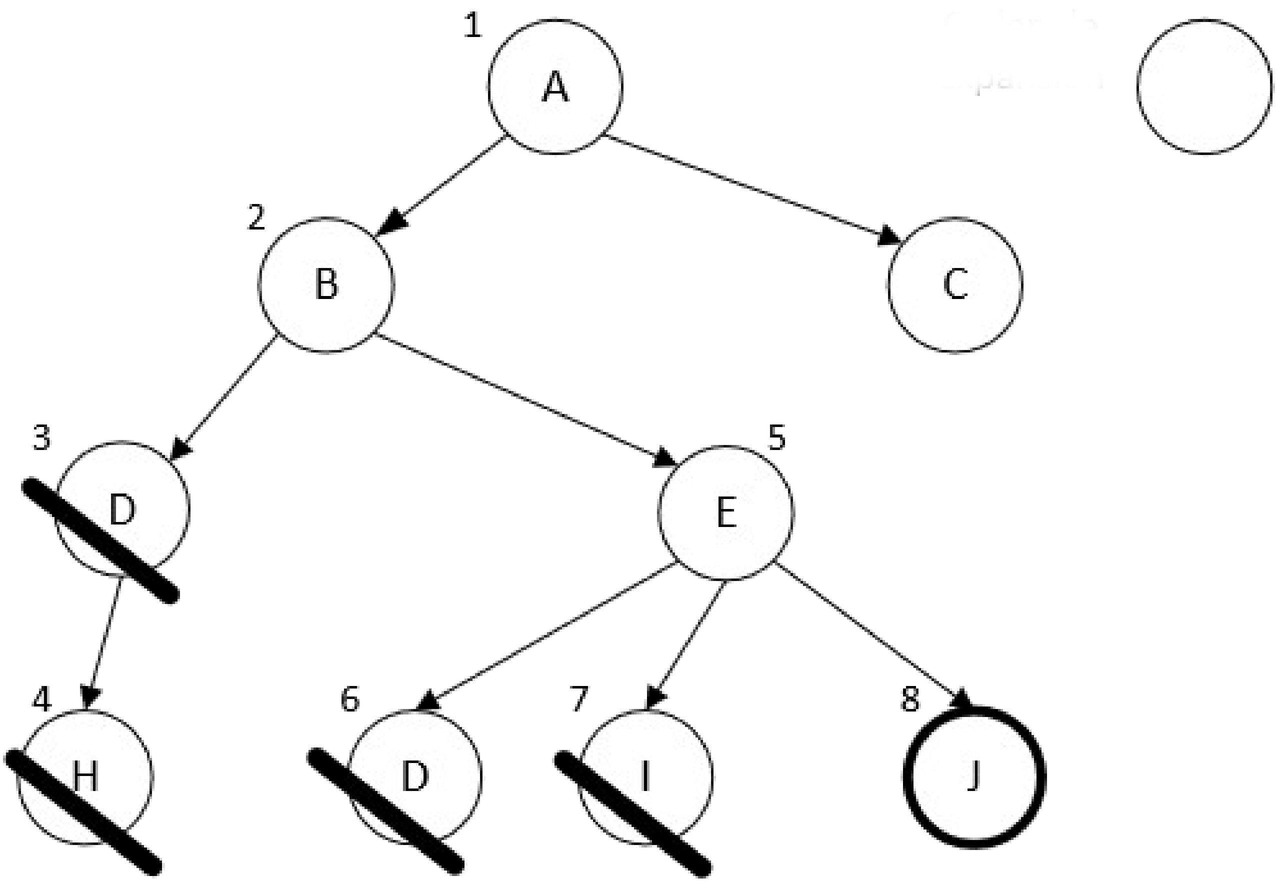
OPEN	CLOSED
A(10)	
B(16) C(32)	A(10)
E(28) C(32) D(46)	A(10) B(16)
C(32) J(33) I(43) D(46)	A(10) B(16) E(28)
E(23) J(33) F(35) G(40) I(43) D(46)	A(10) B(16) C(32)
J(28) I(38) F(35) G(40) D (44)	A(10) B(16) C(32) E(23)
I(33) F(35) G(40) D(44)	A(10) B(16) C(32) E(23) J(28)

The solution path is ACEJ with cost 28.

2) The solution is optimal. The other two possible solutions are ACF with cost 35 and ABEJ with cost 33.

It is not admissible. Node C has h(n)=22 and its h*(n) (through E) is 18. Then h(n)>h*(n) not fulfilling the admissibility condition.

It is not consistent. We have for C that h(n) is 32. Its child node E has an h(n) of 23 and the cost of going from C to E is 5, then h(parent)<=h(child)+cost(parent->child) is not fulfilled since we have 32 > 23+5



OPEN	PATH
A(0)	
B(-1) C(-1)	A
D(-2) E(-2) C(-1)	A B
H(-3) E(-2) C(-1)	A B D
E(-2) C(-1)	A B D H
E(-2) C(-1)	A B D
E(-2) C (-1)	A B
D(-3) I(-3) J(-3) C(-1)	A B E
I(-3) J(-3) C(-1), H(-4)	A B E D
I(-3) J(-3) C(-1)	A B E D H
I(-3) J(-3) C(-1)	A B E D
I(-3) J(-3) C(-1)	A B E
J(-3) C(-1)	A B E I
J(-3) C(-1)	A B E
C(-1)	A B E J

The solution you would find would be A B E J as seen in the PATH of the table above.
The maximum number of nodes stored in memory would be 8, when you have IJC in open and ABEDH in path.