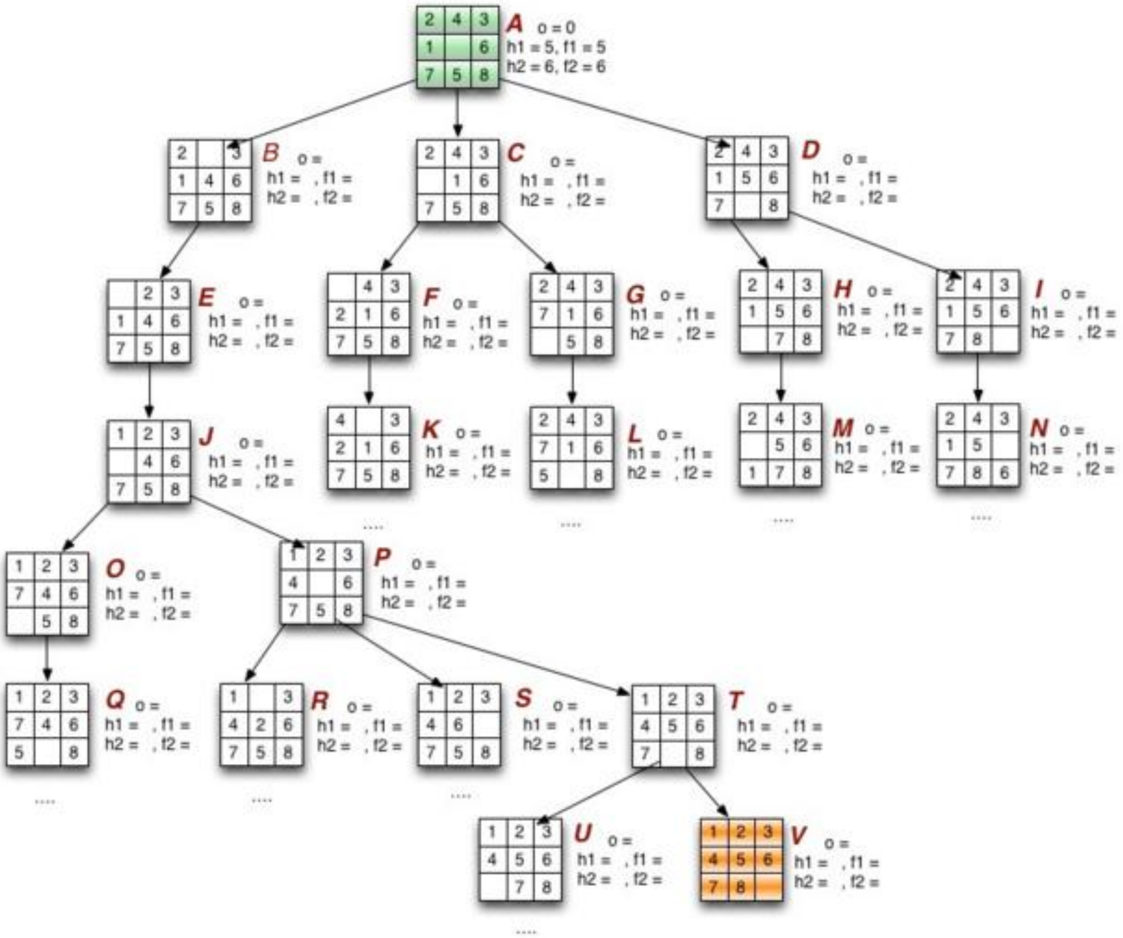
PAI – Solutions Theoretical Test 1

Search 1.1

For the following question, we will examine the 8-Puzzle. For the given start state we have the following (pruned) search tree in the image below.



For the A* algorithm, we will use the following two heuristics:

- h1(node) = #misplaced blocks
- h2(node) = Sum(Manhattan distances from current position to normal position of each block)

We recall that for A*, f = g+h and we will use g(node) = #moves.

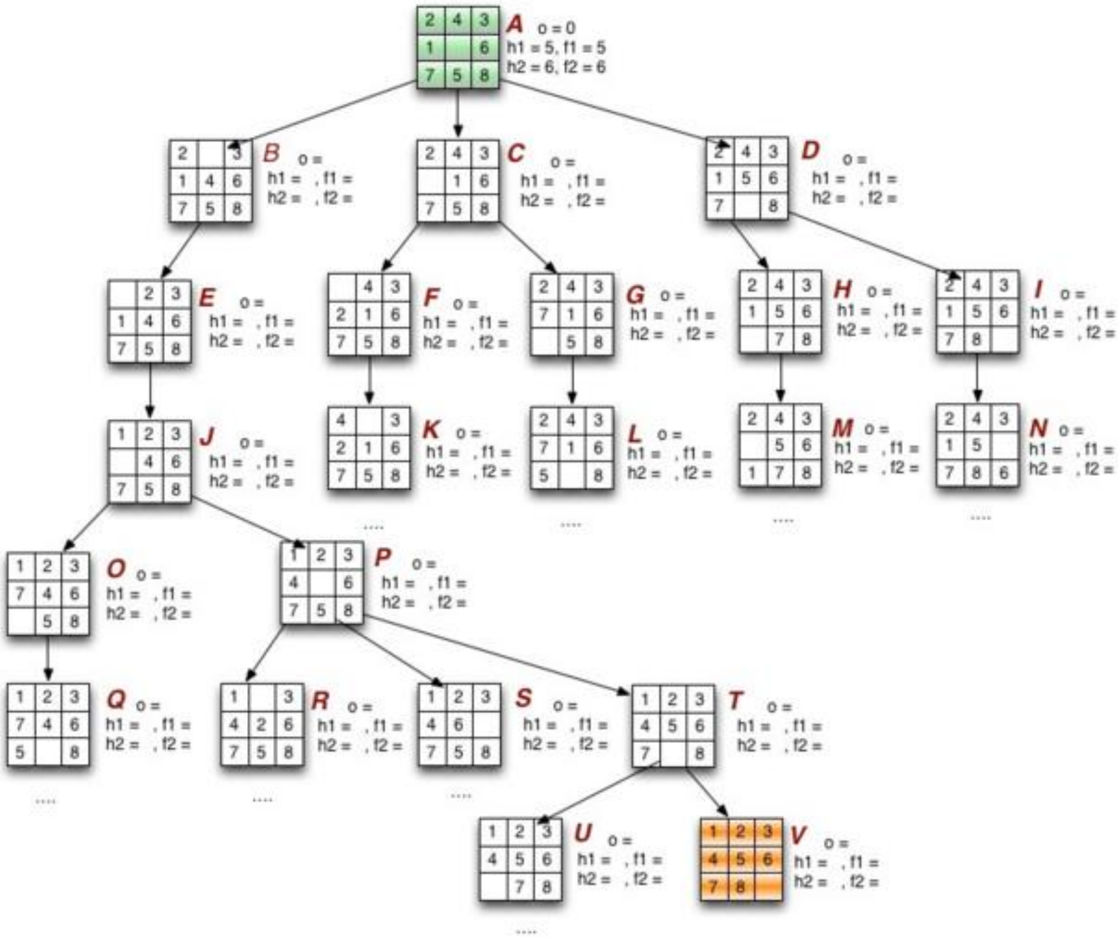
We will use A* with f2 as a main function and break the ties using f1.

What will be the value of f2 in node C?

- ○ f2 will not be calculated because C will not get expanded
- ○ 7
- ◉ 8
- ○ 1
- ○ None of the other answers is correct

Search 1.2

For the following question, we will examine the 8-Puzzle. For the given start state we have the following (pruned) search tree in the image below.



For the A* algorithm, we will use the following two heuristics:

- h1(node) = #misplaced blocks
- h2(node) = Sum(Manhattan distances from current position to normal position of each block)

We recall that for A*, f = g+h and we will use g(node) = #moves.

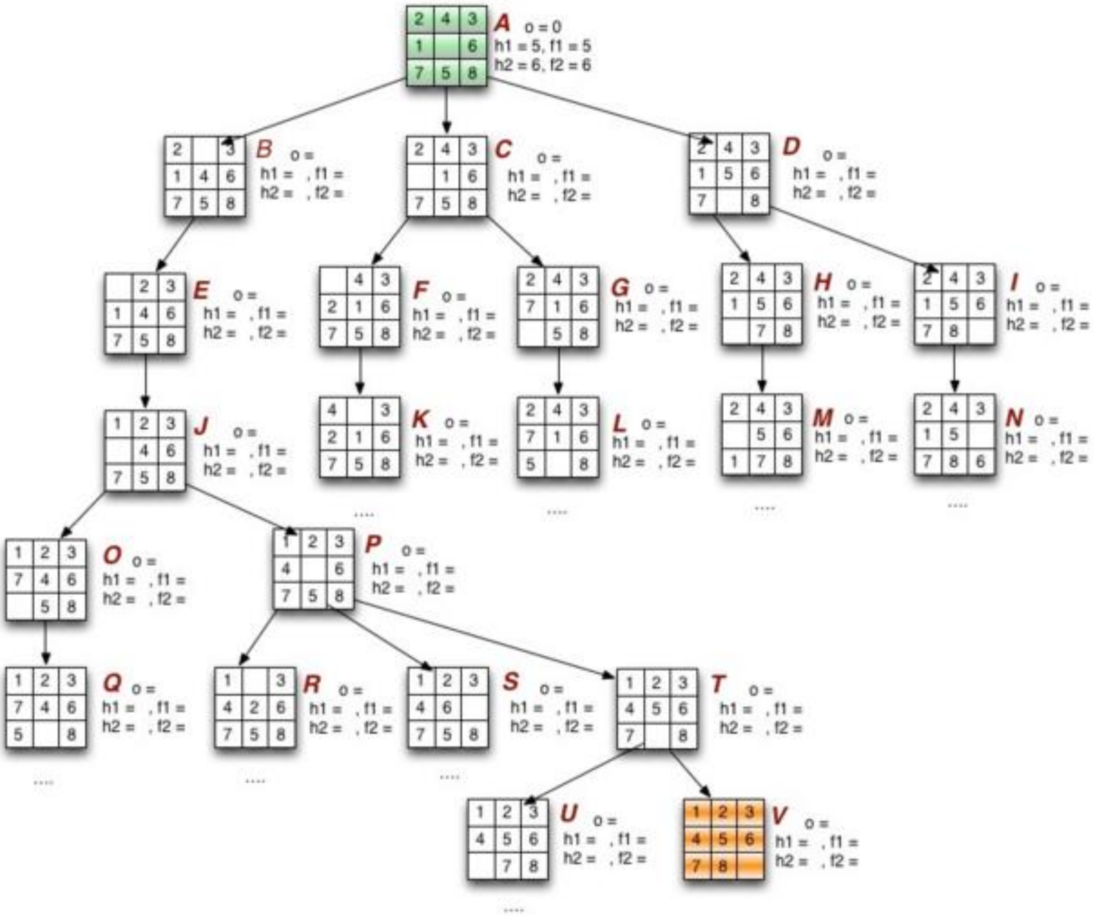
We will use A* with f2 as a main function and break the ties using f1.

What will be the value of o (the order in which the node is expanded, NOTE that the o of node A is 0) for node O

- (●) It will be in the fringe but it will never get expanded
- ( ) It will never ever be in the fringe
- ( ) 4
- ( ) 5
- ( ) 6
- ( ) 7
- ( ) None of the other answers is correct

Search 1.3

For the following question, we will examine the 8-Puzzle. For the given start state we have the following (pruned) search tree in the image below.



For the A* algorithm, we will use the following two heuristics:

- h1(node) = #misplaced blocks
- h2(node) = Sum(Manhattan distances from current position to normal position of each block)

We recall that for A*, f = g+h and we will use g(node) = #moves.

We will use A* with f2 as a main function and break the ties using f1.

What will be the value of o (the order in which the node is expanded, NOTE that the o of node A is 0) for node P

- It will be in the fringe but it will never get expanded
- It will never ever be in the fringe
- 4
- 5
- 6
- 7

Search 2.1

Assume a directed, connected graph with a source s and a sink t. We try to find a path form s to t with minimal path cost.

Futhermore, for this exercise, assume that:

- We have that the costs for every edge e c(e) are strictly positive, i.e., $c(e) > 0 \ \forall e$
- All discussed heuristics (whether admissible or not) consist only of strictly positive, rational numbers.

Which of the following statements are true?

- [ ] Running A* with a heuristic function which is **not admissible** may not find a path from s to t, as A* may run in circles and may not terminate.
- [x] Running A* with a heuristic which is **not admissible** will find a path from s to t, but there might exist another path with lower cost.
- [ ] Using an **admissible** heuristc function allows to already terminate A* when t is first entered into the fringe, while in A* with a **non-admissible** heuristic function, we would have to wait until t gets extended to make sure we found an optimal solution.
- [x] Consider a heuristic function which estimates the costs from any node to t exactly right. By using such a function in A*, every expanded node is also part of an optimal solution.

AS 1.1

Before answering the questions, **download the following file** which contains the instructions.

When coming back from node C to node B, what will happen to the values of alpha and beta of node B?

- (x) Beta gets updated to 3
- ( ) Beta gets updated to 1
- ( ) The values will not be changed
- ( ) Alpha gets updated to 1
- ( ) Alpha gets updated to 3
- ( ) None of the other answers is correct

AS 1.2

Before answering the questions, **download the following file** which contains the instructions.

What are the eval function of the states of the nodes G1 and G2 (use the given formula)

- ( ) 1 and 8
- ( ) 8 and 1
- ( ) 9 and 5
- ( ) 4 and 4
- (x) None of the other answers is correct

AS 1.3

Before answering the questions, **download the following file** which contains the instructions.

What nodes will not be explored due to a cut?

- ( ) I.1-I.4
- ( ) H.1-H.3, I.1-I.4
- (x) G.2-G4, H.1-H.3, I.1-I.4
- ( ) H.2-H.3, I.1-I.4
- ( ) D, G.1-G.4, H.1-H.3, I.1-I.4
- ( ) All the drawn vertices will be explored. There is no cut being done

AS 1.4

Before answering the questions, **download the following file** which contains the instructions.

What will the values of alpha and beta be for node A after we finish exploring all the subtree with root B?

- ( ) (infinity, 9)
- ( ) (infinity, 3)
- ( ) (-infinity, 9)
- ( ) (-infinity, 3)
- (x) (3, infinity)
- ( ) (9, infinity)
- ( ) None of the other answers is correct

AS 2.1

Which of the following statements are true?

- [x] The effectiveness (the runtime) of $\alpha-\beta$ pruning is highly dependent on the order in which the states (nodes) are examined.
- [ ] For any heuristic function, the worst-case runtime of $\alpha-\beta$ pruning is strictly smaller than the worst-case runtime of MINIMAX (which is $O(b^m)$)
- [ ] One of the biggest advantages of $\alpha-\beta$ pruning is that it prevents from the repeated evaluation of identical game states.
- [x] For an alpha-beta chess agent with unlimited computational capacities, the heuristic function h it uses for evaluating leaf nodes doesn't matter, as long as *h(winning)* > *h(draw)* > *h(loosing)*.

CS 1.1

Which one of the following formulations would be a good formulation for the 8 Queens problem?

- ( ) We have variables for each square of the chessboard, $\mathbf{x_{i,j}}$, with i in {1,...8}, j in {1,...8}

  The **domain** for each variable is **{0,1}**

  The **constraints** are:

  Between any two squares $x_{i,j}$ and $x_{k,l}$ with i != k and j != l: $\mathbf{x_{i,j} + x_{k,l} <= 1}$

- (•) We have variables for each queen, $\mathbf{q_1, ..., q_8}$ and each queen will have her own column, with the index representing the column.

  The **domain** for each variable is **{1,...,8}**, representing the row

  The **constraints** are:

  Between any queens q_i and q_j with i != j : **(q_i != q_j) && (i-q_i != j-q_j) && (i+q_i != j+q_j)**

- ( ) None of the other answers is correct

CS 1.2

Which of the following statements are true?

- [x] Backtracking and Arc Consistency can be used to solve a graph coloring problem.
- [ ] If for a specific instance of the graph coloring problem, there is no feasible solution, Backtracking may not terminate and loop forever.
- [x] If we consider a standard sudoku with 81 fields, the domain of every field which is not prefilled is {1,2,3,4,5,6,7,8,9}.
- [ ] "Least constraining variable first" and "Most constraining value first" are two popular techniques to improve the speed of a Backtracking Algorithm.