Q6: A* Search: Batch Node Expansion

Problem 6: A* Search: Batch Node Expansion

Part 1

0.0/8.0 points (ungraded)

Recall that A* graph search can be implemented in pseudo-code as follows:

```
1:  function A*-GRAPH-SEARCH(problem, fringe)
2:      closed ← an empty set
3:      fringe ← INSERT(MAKE-NODE(INITIAL-STATE[problem]), fringe)
4:      loop do
5:          if fringe is empty then return failure
6:          node ← REMOVE-FRONT(fringe)
7:          if GOAL-TEST(problem, STATE[node]) then return node
8:          if STATE[node] is not in closed then
9:              add STATE[node] to closed
10:             child-nodes ← EXPAND(node, problem)
11:             fringe ← INSERT-ALL(child-nodes, fringe)
```

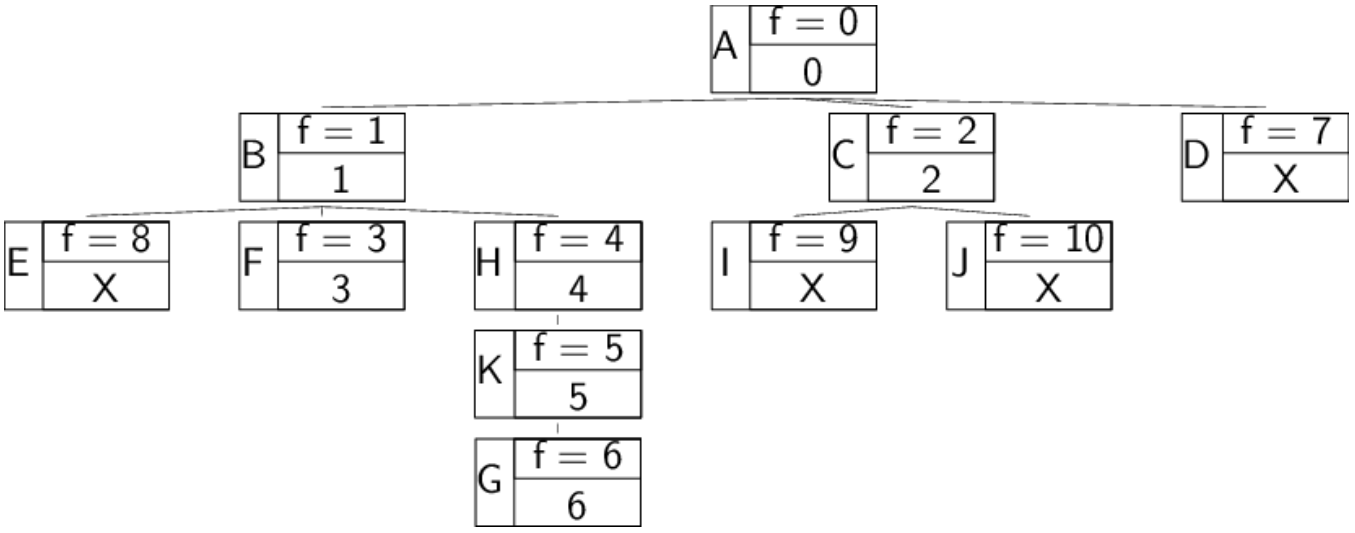
Now consider the following batch version of A* graph search.

```
1: function A*-Batch(problem, fringe, k)
2:     closed ← an empty set
3:     fringe ← Insert(Make-Node(Initial-State[problem]), fringe)
4:     loop do
5:         i ← 0
6:         next-set ← an empty set
7:         while i < k and fringe is not empty do
8:             next-set ← Insert(Remove-Front(fringe))
9:             i ← i + 1
10:        for node in next-set do
11:            if Goal-Test(problem, State[node]) then
12:                return node
13:            if State[node] not in closed then
14:                closed ← Insert(State[node])
15:                child-nodes ← Expand(node, problem)
16:                fringe ← Insert-All(child-nodes, fringe)
```

Rather than process the nodes from the fringe one at a time, this code instead pulls k nodes off the fringe, and processes them in a random order.

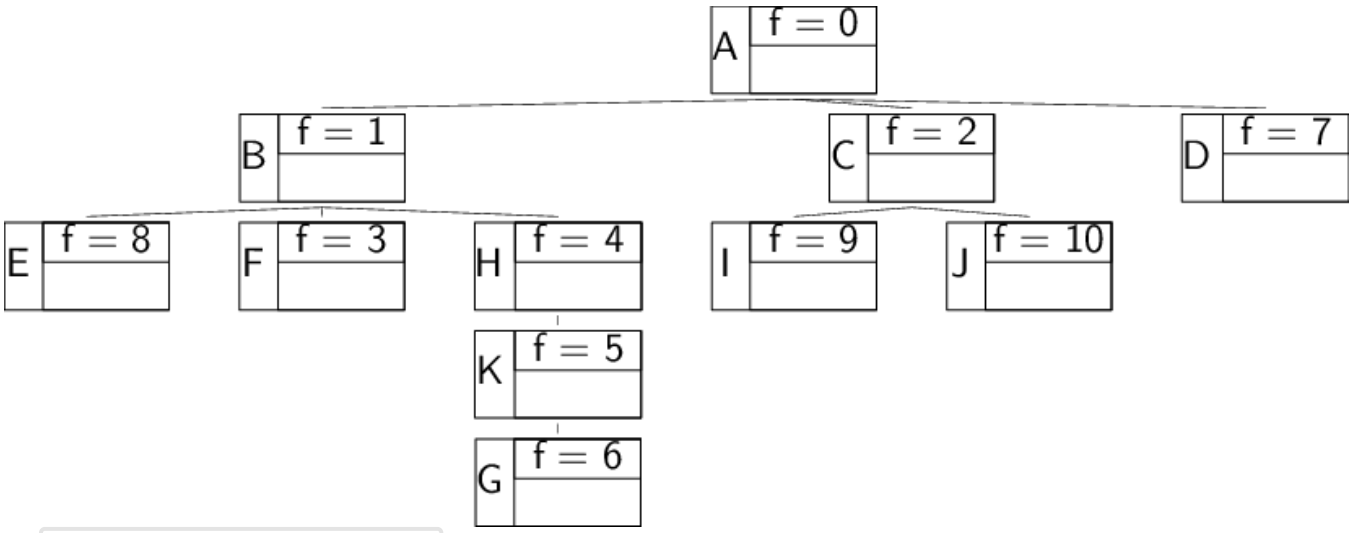
For this problem, we are interested in determining the iteration of the outermost loop at which each node is expanded.

Consider running this new A*-BATCH algorithm on a search problem with the search tree shown in the diagram below with $k = 1$. Each node is drawn with the state at the left, the f-value at the top-right $(f(n) = g(n) + h(n))$, and the iteration at which a node was expanded is at the bottom-right, with an 'X' if that node was not expanded. G is the unique goal node. In the diagram below, we can see that the start node A was expanded during iteration 0, then node B was expanded during iteration 1, node C was expanded during iteration 2, node F was expanded during iteration 3, node H was expanded during iteration 4, node K was expanded during iteration 5, and node G was expanded during iteration 6. Nodes D,E,I,J were never expanded.



In this question you'll complete similar diagrams by filling in the node expansion iterations for the cases of $k = 2$ and $k = 3$. Note that now multiple nodes can (and typically will!) be expanded during any given iteration.

For each node below, fill in the node expansion iterations for the case of $k = 2$ and fill in an 'x' for any node that is not expanded.



A: 0 **Answer:** 0

B: 1 **Answer:** 1

C: 1 **Answer:** 1

D: 3 **Answer:** 3

E: x **Answer:** x

F: 2 **Answer:** 2

H: 2 **Answer:** 2

I: x **Answer:** x

J: x **Answer:** x

K: 3 **Answer:** 3

G: 4 **Answer:** 4

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Answers are displayed within the problem

Part 2

0.0/8.0 points (ungraded)

For the same tree, fill in the node expansion iterations for the case of $k = 3$ and fill in an 'x' for any node that is not expanded.

A: 0 **Answer:** 0

B: 1 **Answer:** 1

C: 1 **Answer:** 1

D: 1 **Answer:** 1

E: 2 **Answer:** 2

F: 2 **Answer:** 2

H: 2 **Answer:** 2

I: 3 **Answer:** 3

J: 3 **Answer:** 3

K: 3 **Answer:** 3

G: 4 **Answer:** 4

Submit You have used 0 of 2 attempts

Answers are displayed within the problem