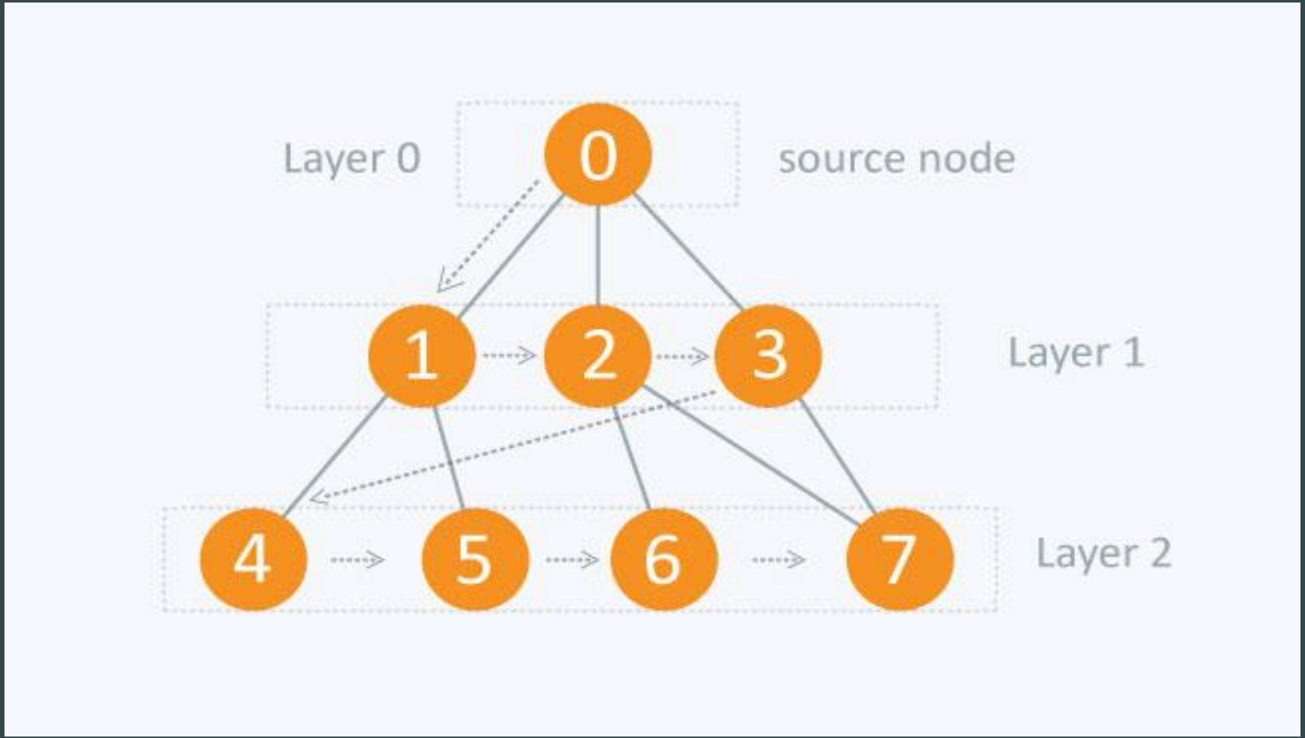
Prove each of the following statements, or give a counterexample

a. Breadth-first search is a special case of uniform-cost search.

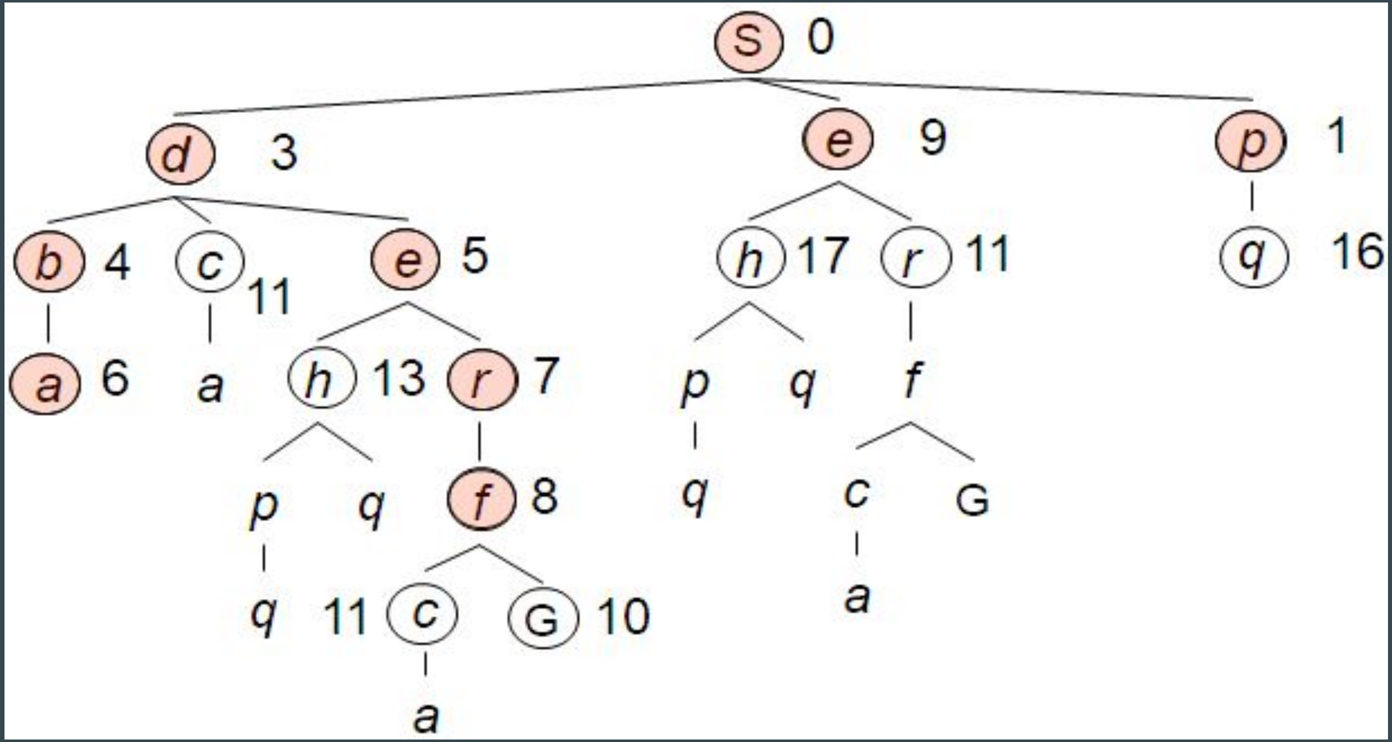
When all step costs are equal (and let's assume equal to 1), $g(n)$ is just a multiple of depth n. Thus, breadth-first search and uniform-cost search would behave the same in this case $f(n) = g(n) = 1*(\text{depth of } n)$

$g(n)$: a path cost to n from a start state

Breadth First Search (BFS)



Uniform Cost Search (USC)



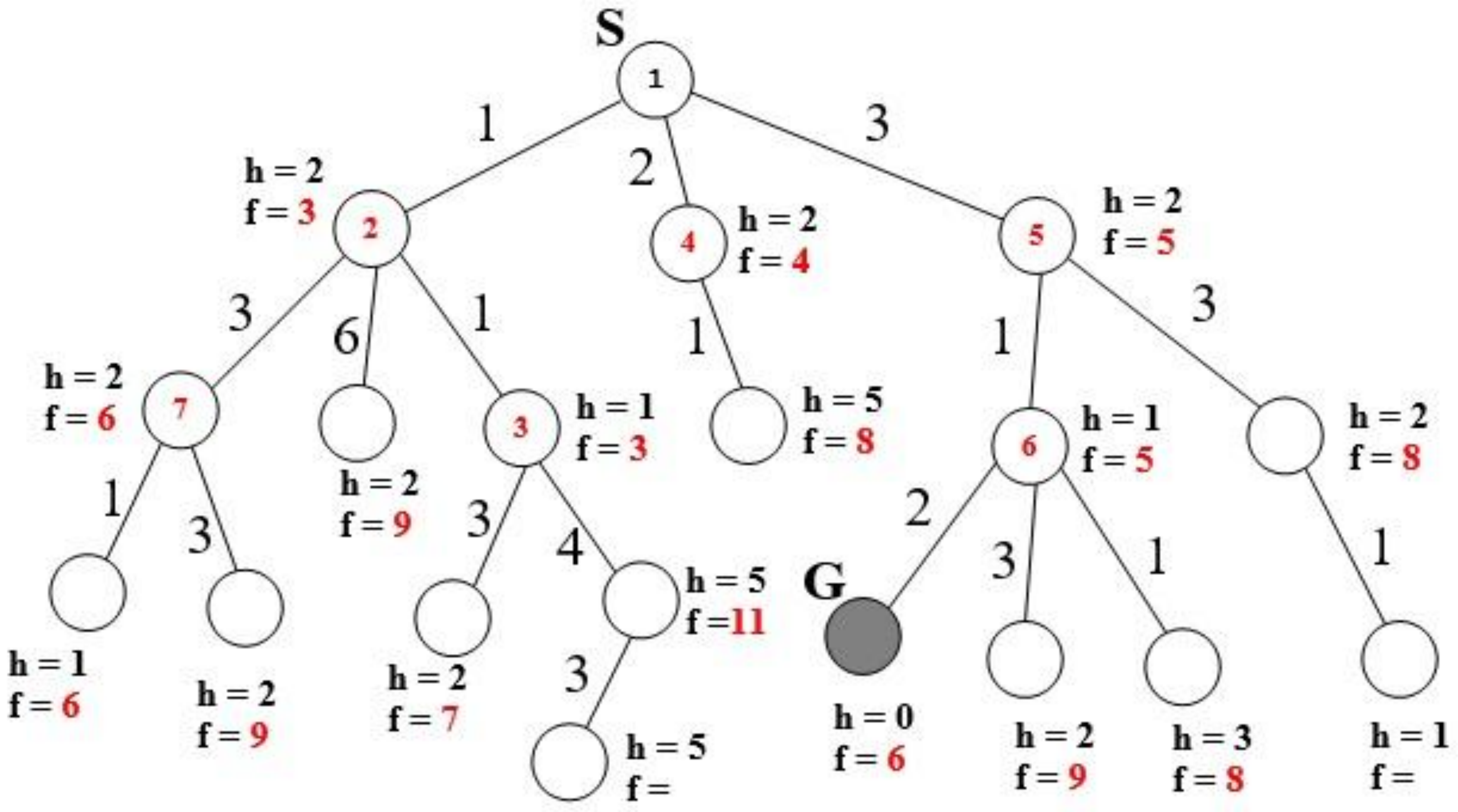
b. Depth-first search is a special case of best-first tree search.

Breadth-first search is best-first search with $f(n) = depth(n)$; depth-first is best-first search with $f(n) = -depth(n)$.

c. Uniform-cost search is a special case of A∗ search.

A* search: $f(n) = g(n) + h(n)$ Uniform-cost search: $f(n) = g(n)$ Thus, for $h(n) = 0$, uniform cost search will produce the same result as A* search

$h(n)$: a heuristic estimate of cost from n to a goal state
$g(n)$: a path cost to n from a start state



S
1
2
3
h = 2
f = 3
2
4
h = 2
f = 4
5
h = 2
f = 5
3
6
1
1
1
3
h = 2
f = 6
7
h = 1
f = 3
3
h = 5
f = 8
h = 1
f = 5
6
h = 2
f = 8
h = 2
f = 9
1
3
3
4
2
3
1
1
h = 5
f =11
G
h = 1
f = 6
h = 2
f = 9
h = 2
f = 7
3
h = 0
f = 6
h = 2
f = 9
h = 3
f = 8
h = 1
f =
h = 5
f =

Evaluation function: $f(n) = (2 - w)g(n) + wh(n)$

- **Completeness**

w = 0: f(n)=2g(n) --> Uniform Cost Search, which is complete.

w = 1: f(n)=g(n) + h(n) --> A*, which is complete.

w = 2: f(n)=2h(n) --> greedy Best First Search, which is not complete.

Cost > 0 so f(n) > 0.

$f(n) = (2 - w)g(n) + wh(n)$

$0 \leq w < 2$

Evaluation function: $f(n) = (2 - w)g(n) + wh(n)$

- **Optimality**

The algorithm is guaranteed to be optimal for $0 \leq w \leq 1$, since scaling $g(n)$ by a constant has no effect on the relative ordering of the chosen paths, but, if $w > 1$ then it is possible the $wh(n)$ will overestimate the distance to the goal, making the heuristic inadmissible. If $w \leq 1$, then it will reduce the estimate, but it is still guaranteed to underestimate the distance to the goal state.

Evaluation function: f(n) = (2 − w)g(n) + wh(n)

- **Search behavior with w = 0, 1, 2**

w	$f(n)$	Algorithm
$w = 0$	$f(n) = 2g(n)$	Uninformed best-first search
$w = 1$	$f(n) = g(n) + h(n)$	A* search
$w = 2$	$f(n) = 2h(n)$	Greedy best-first search