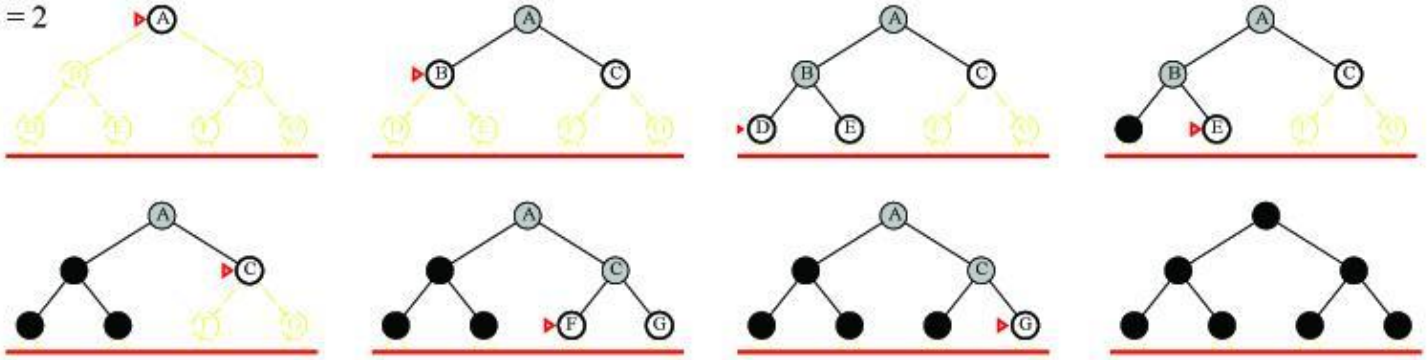
Iterative Deepening Search

- Depth First Iterative Deepening (DFID): DFS with depth bound
- QueuingFn is LIFO as with DFS
  - Expand(state) only returns children such that depth(child) <= threshold
  - This prevents search from going down infinite path
- First threshold is 1
  - If do not find solution, increment threshold and repeat

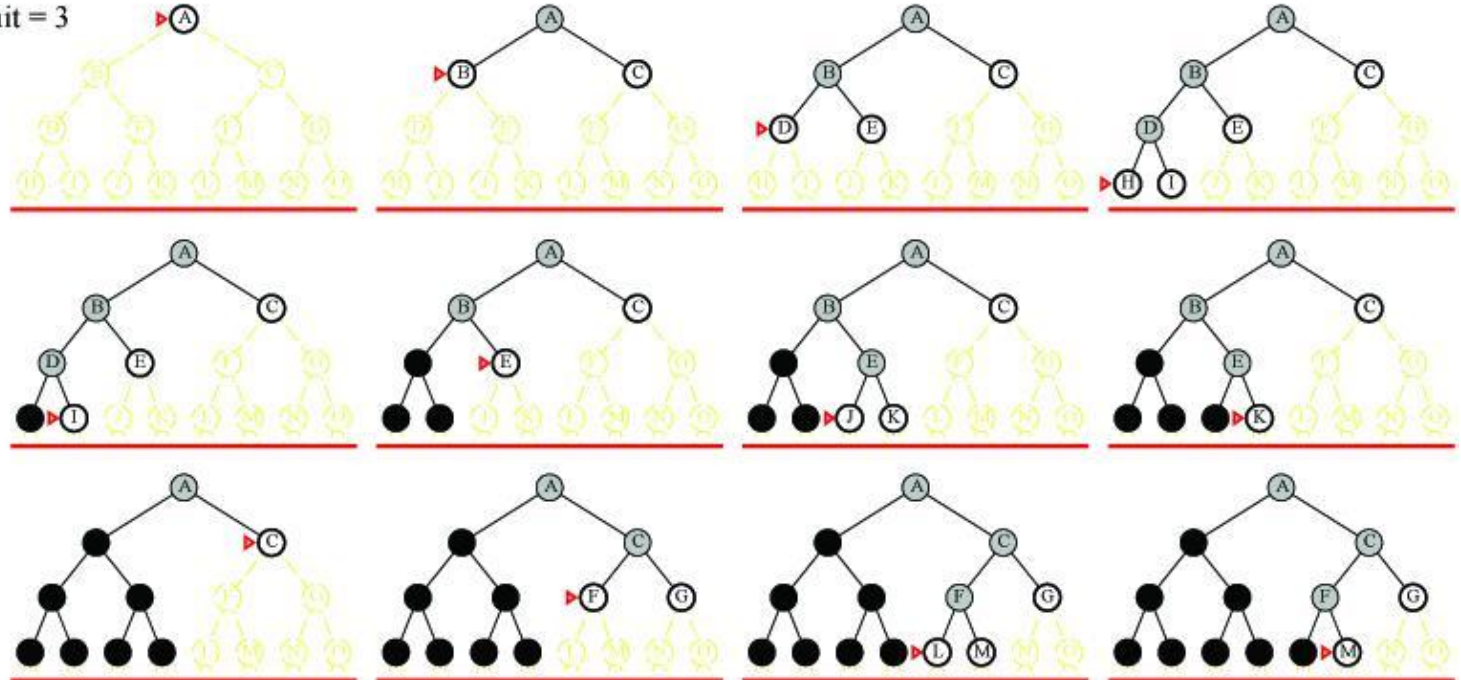
Limit = 0

Limit = 1

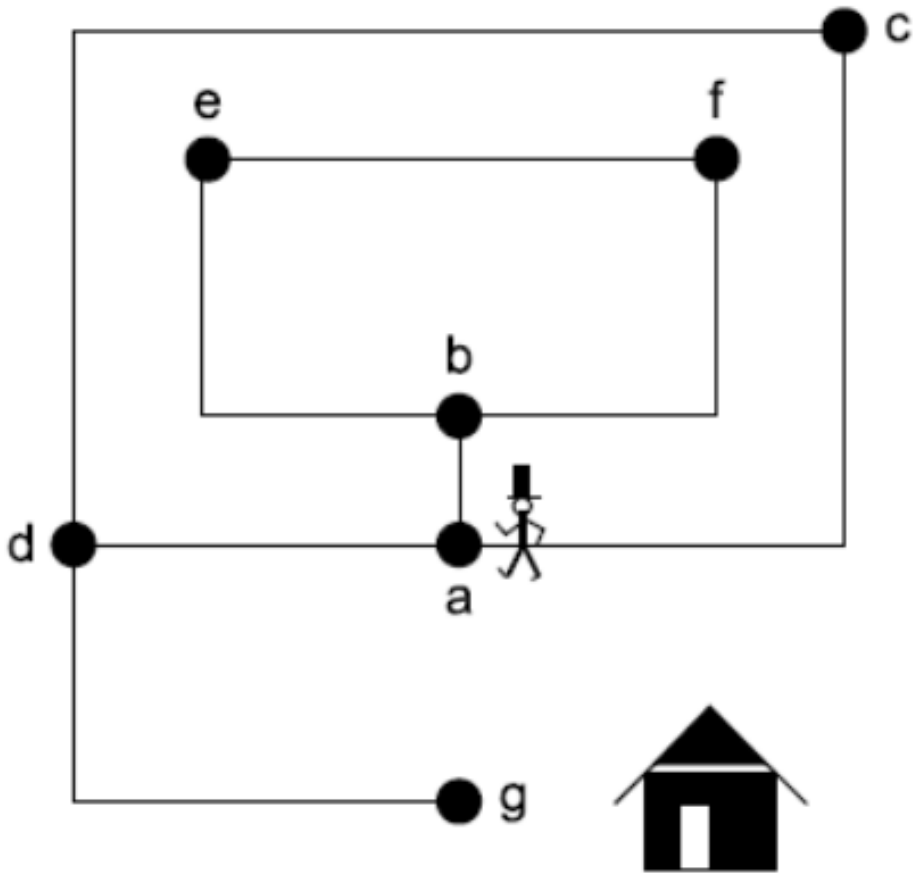
Limit = 2



Limit = 3



Example



Analysis

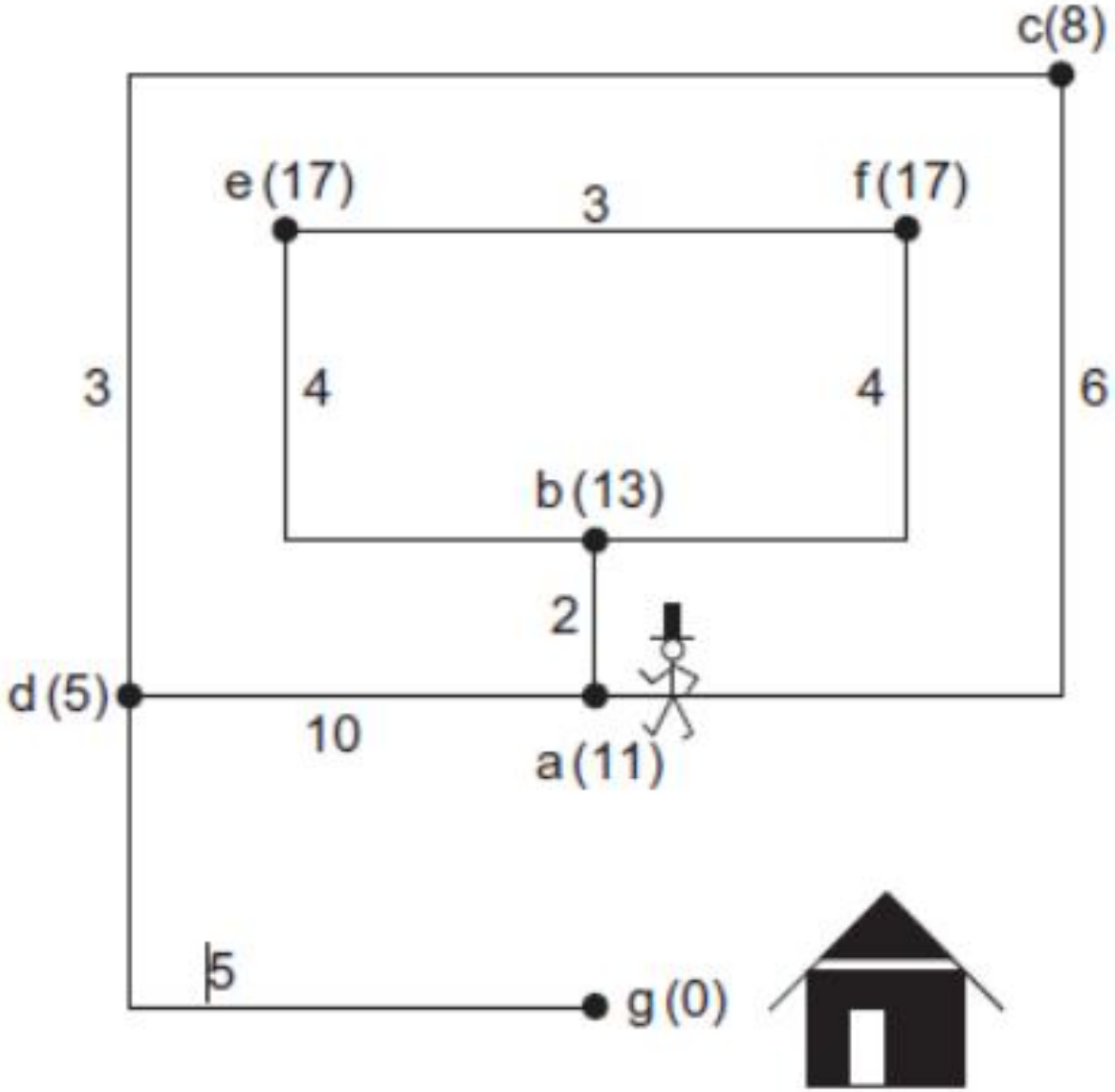
- What about the repeated work?
- Time complexity (number of generated nodes)
  - $[1+b] + [1+b + b^2] + .. + [1+b + b^2 + .. + b^d]$
  - $d+(d)b + (d-1)\, b^{2\,+} \ldots + (1)\, b^d$
  - $O(b^d)$
- Repeated work is approximately 1/b of total work
  - Negligible
  - Example: b=10, d=5
  - N(BFS) = 1,111,100
  - N(DFID) = 123,450
- Features
  - Shortest solution, not necessarily least cost
  - Is there a better way to decide threshold?

Comparison of Search Techniques

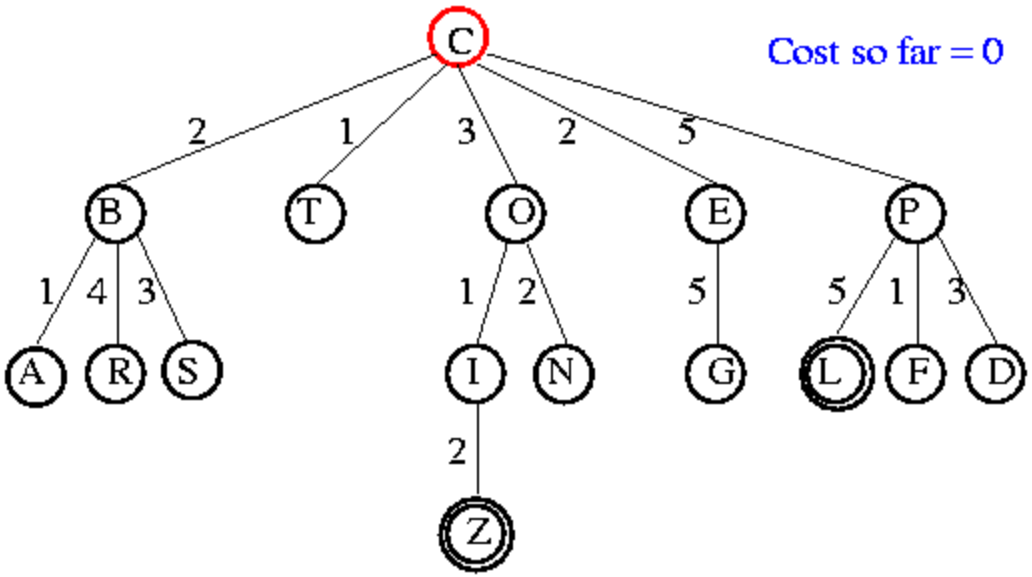
	DFS	BFS	DFID
Complete	N	Y	Y
Optimal	N	N	N
Heuristic	N	N	N
Time	b^m	b^{d+1}	b^d
Space	bm	b^{d+1}	bd

Uniform Cost Search

- QueueingFn is SortByCostSoFar
- Cost from root to current node n is g(n)
  - Add operator costs along path
- First goal found is least-cost solution
- Space & time can be exponential because large subtrees with inexpensive steps may be explored before useful paths with costly steps
- If costs are equal, time and space are $O(b^d)$
  - Otherwise, complexity related to cost of optimal solution

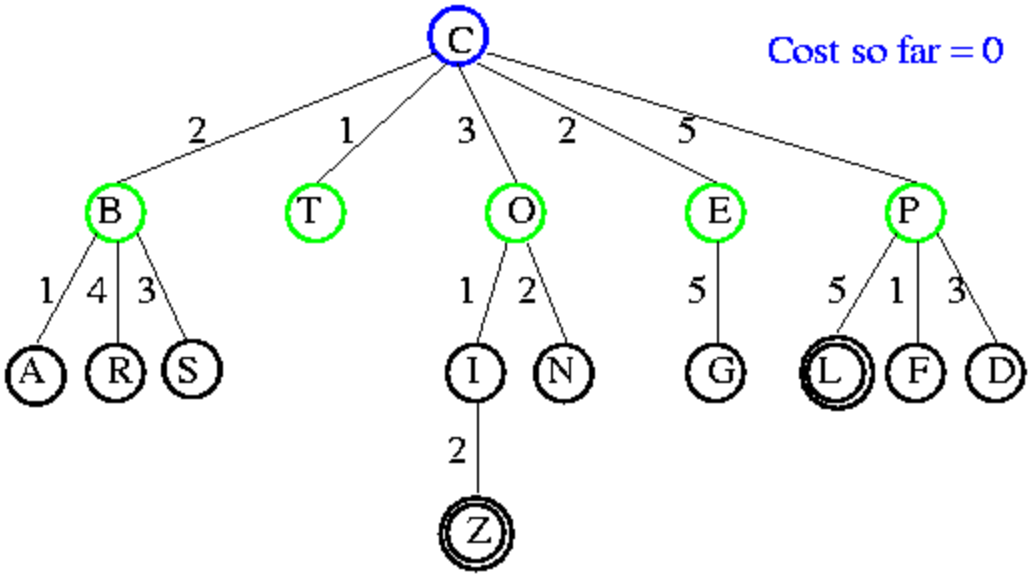

c(8)
e(17)
3
f(17)
3
4
4
6
b(13)
2
d(5)
10
a(11)
5
g(0)

UCS Example



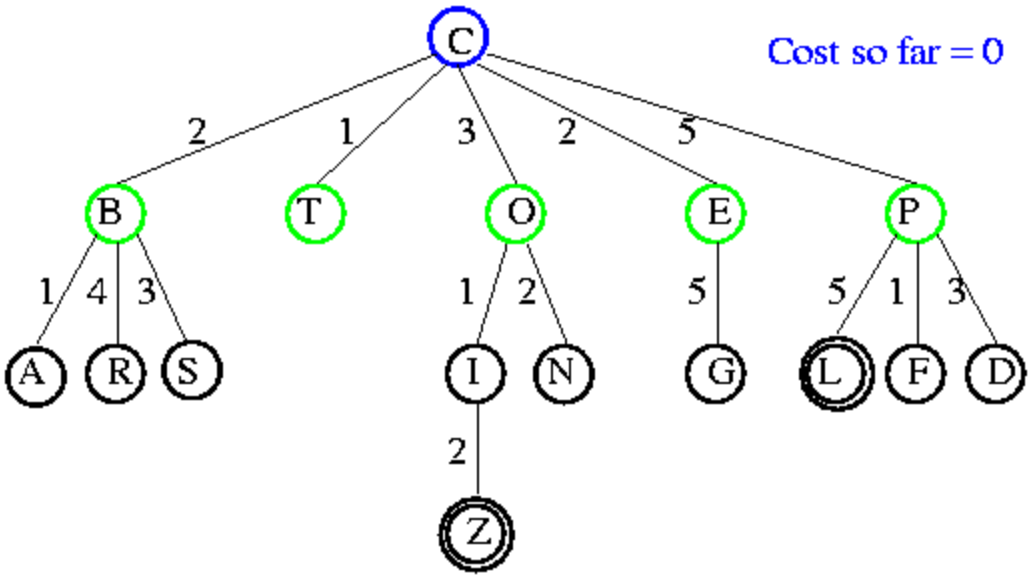
Open list: C

UCS Example



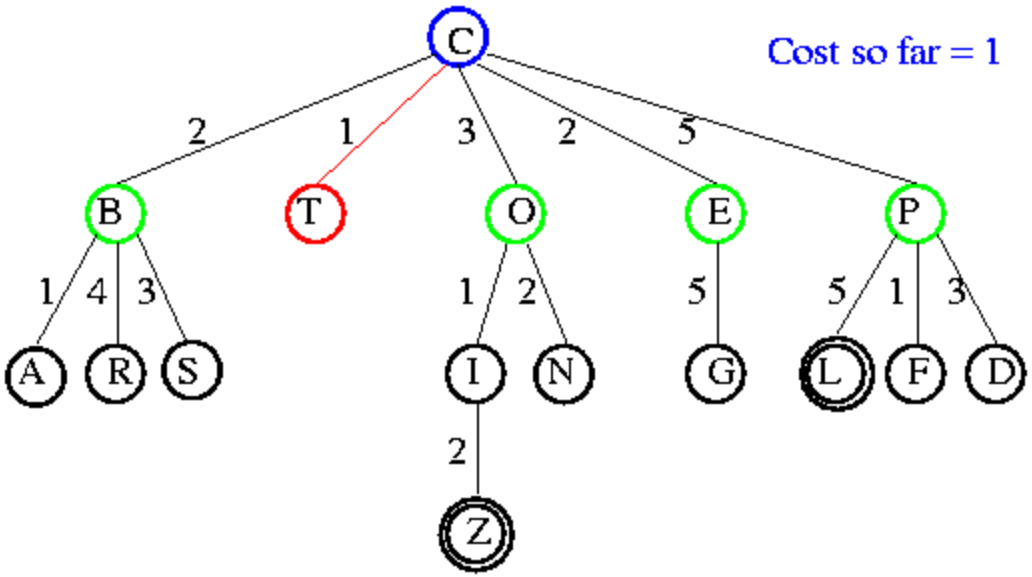
Open list: B(2) T(1) O(3) E(2) P(5)

UCS Example



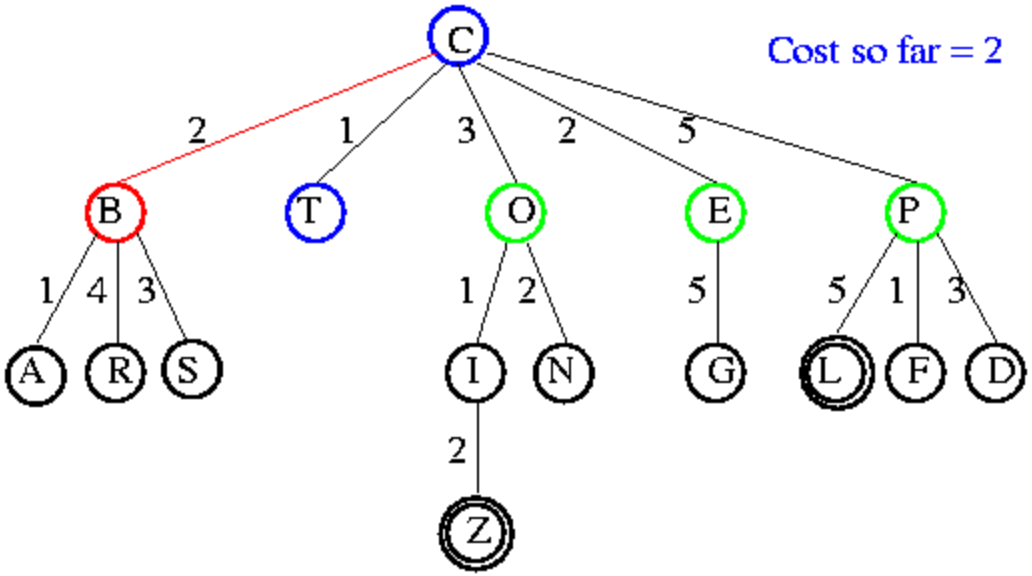
Open list: T(1) B(2) E(2) O(3) P(5)

UCS Example



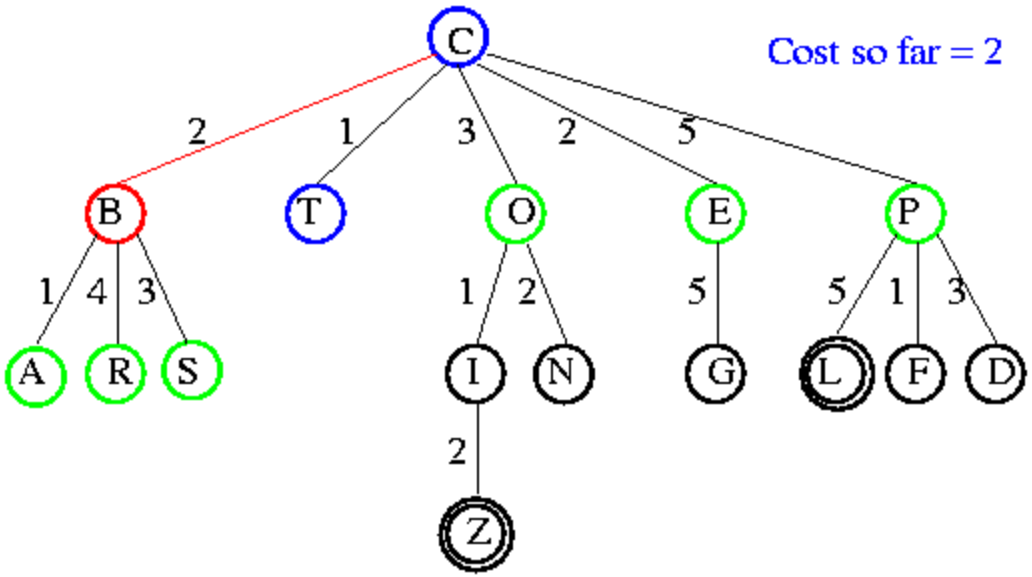
Open list: B(2) E(2) O(3) P(5)

UCS Example



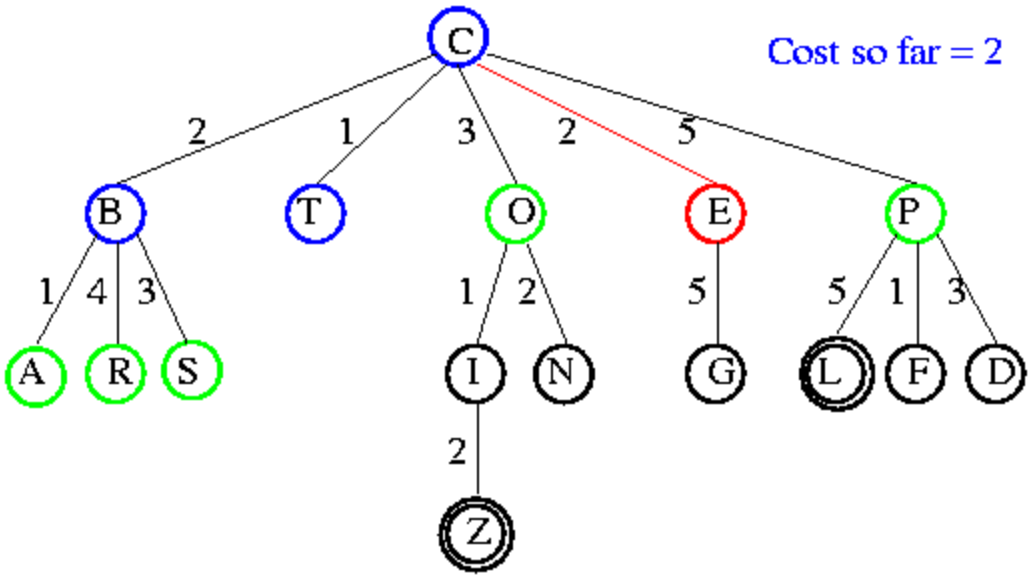
Open list: E(2) O(3) P(5)

UCS Example



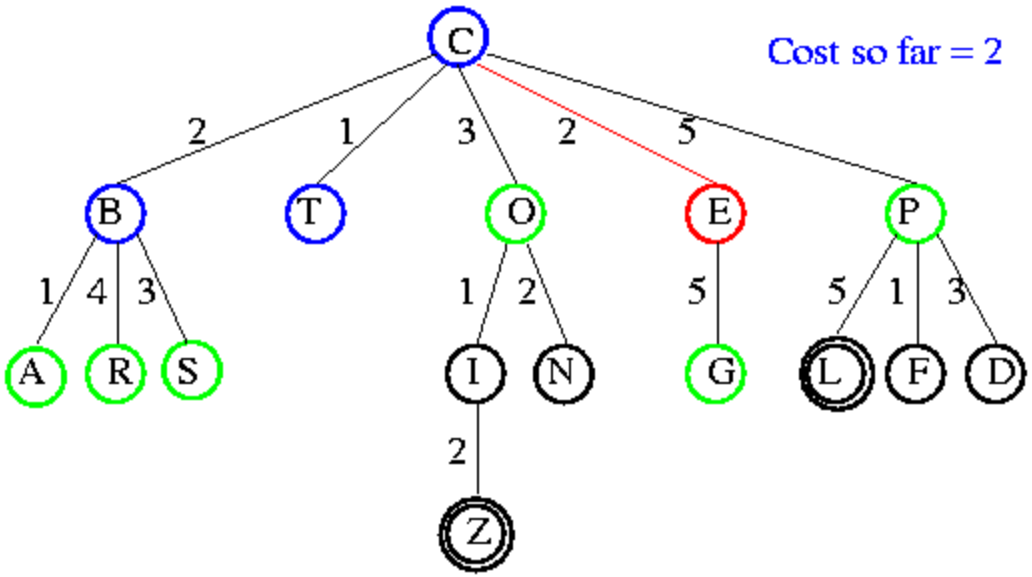
Open list: E(2) O(3) A(3) S(5) P(5) R(6)

UCS Example



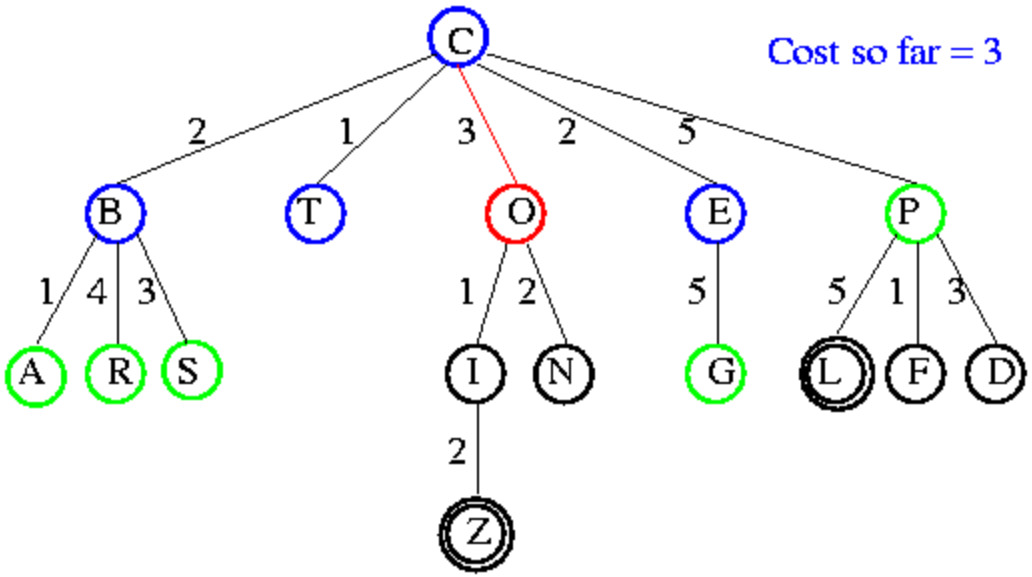
Open list: O(3) A(3) S(5) P(5) R(6)

UCS Example



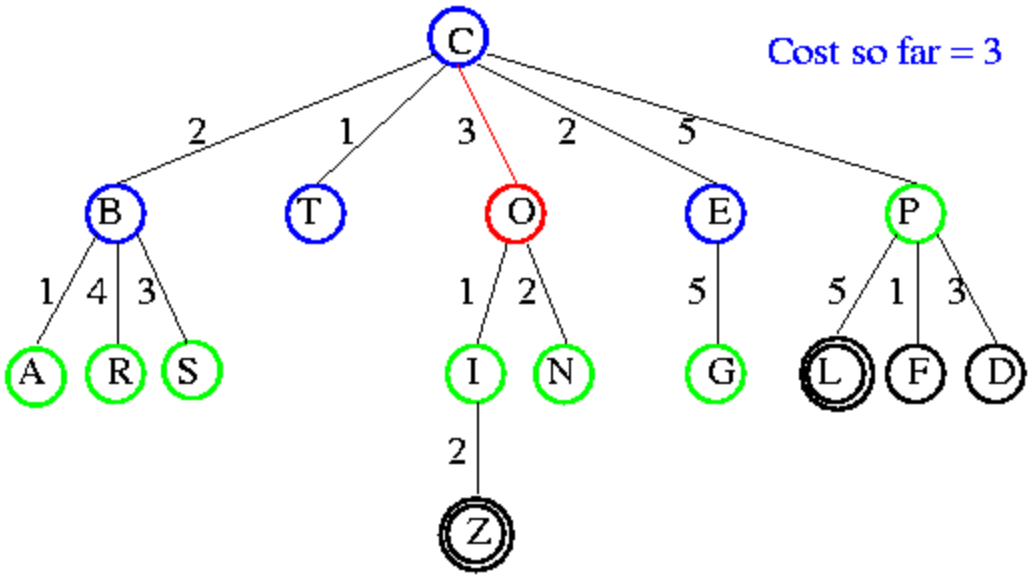
Open list: O(3) A(3) S(5) P(5) R(6) G(7)

UCS Example



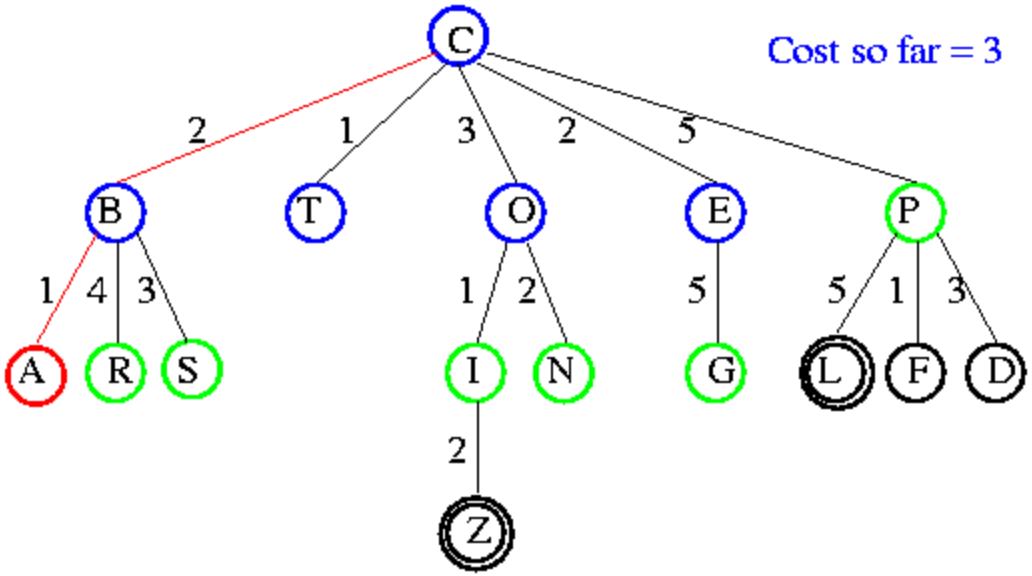
Open list: A(3) S(5) P(5) R(6) G(7)

UCS Example



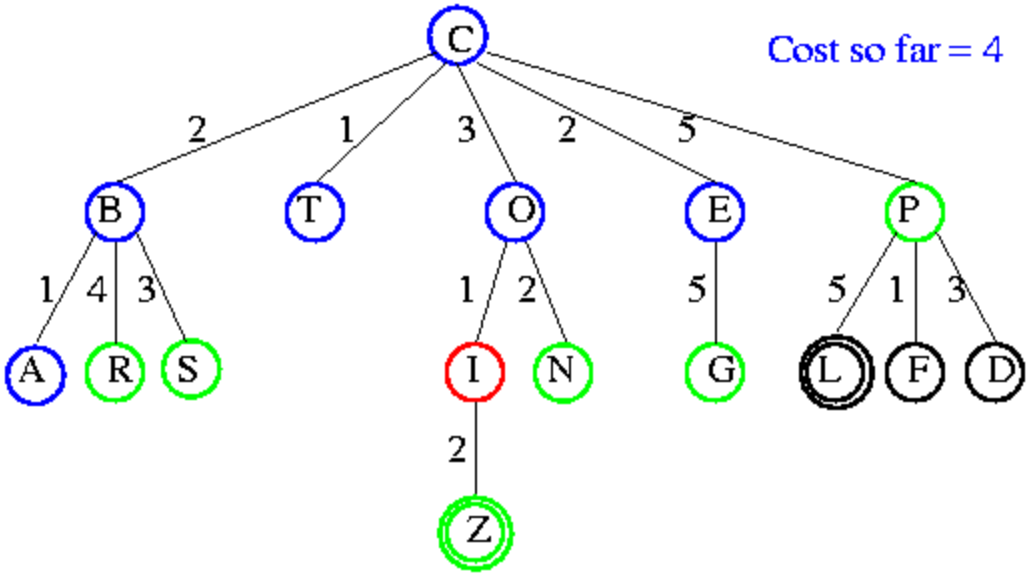
Open list: A(3) I(4) S(5) N(5) P(5) R(6) G(10)

UCS Example



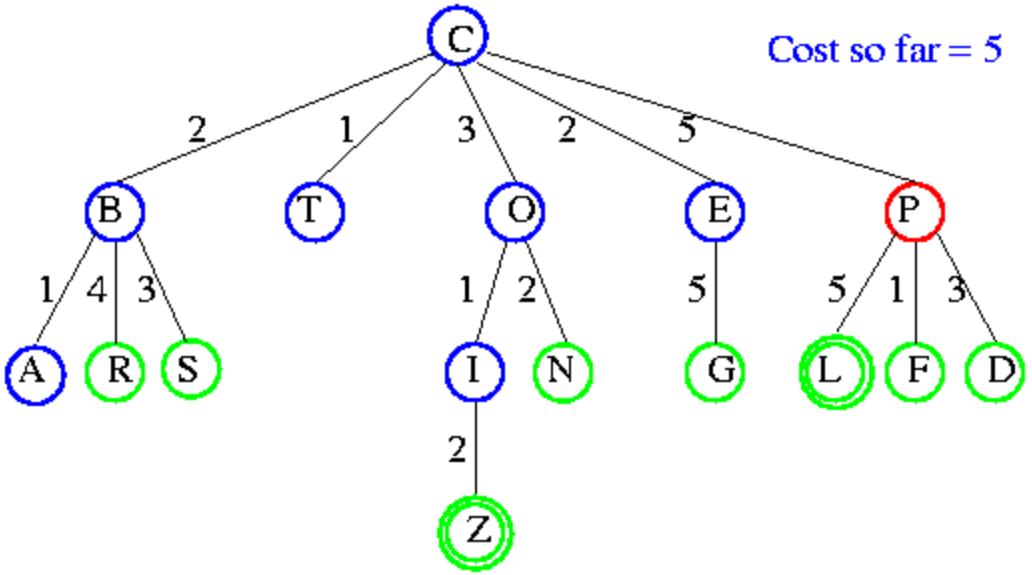
Open list: I(4) P(5) S(5) N(5) R(6) G(10)

UCS Example



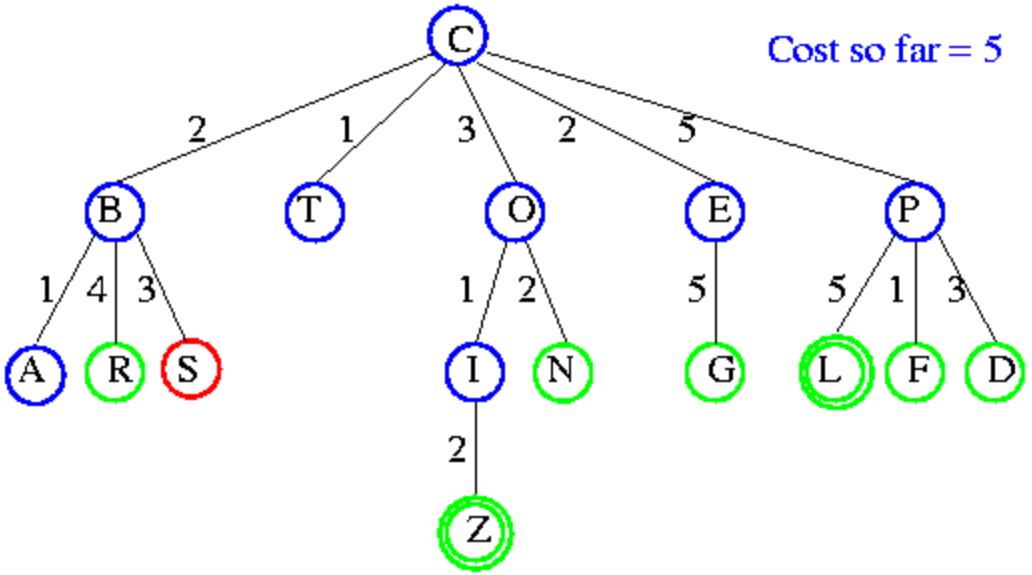
Open list: P(5) S(5) N(5) R(6) Z(6) G(10)

UCS Example



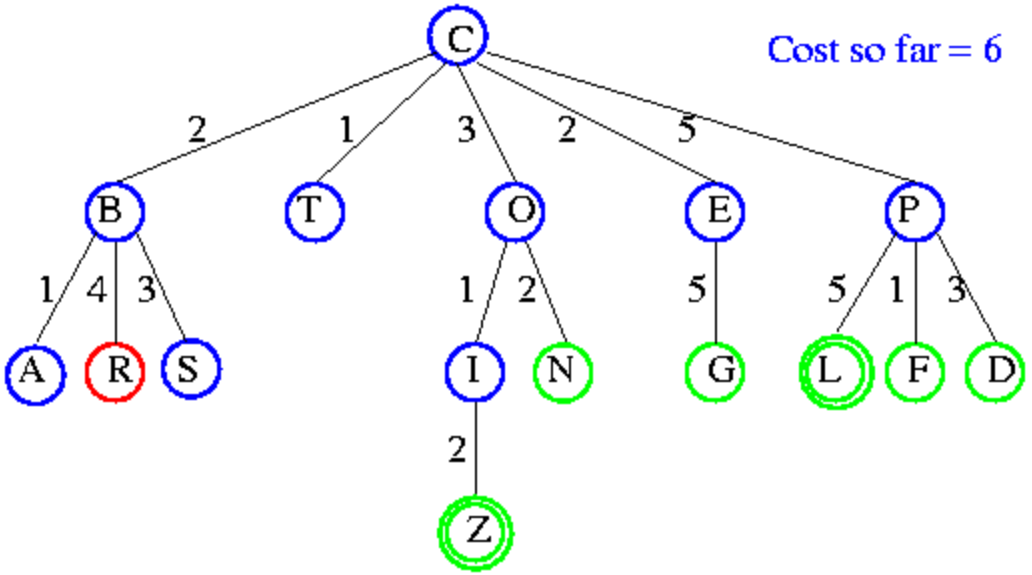
Open list: S(5) N(5) R(6) Z(6) F(6) G(7) D(8) L(10)

UCS Example



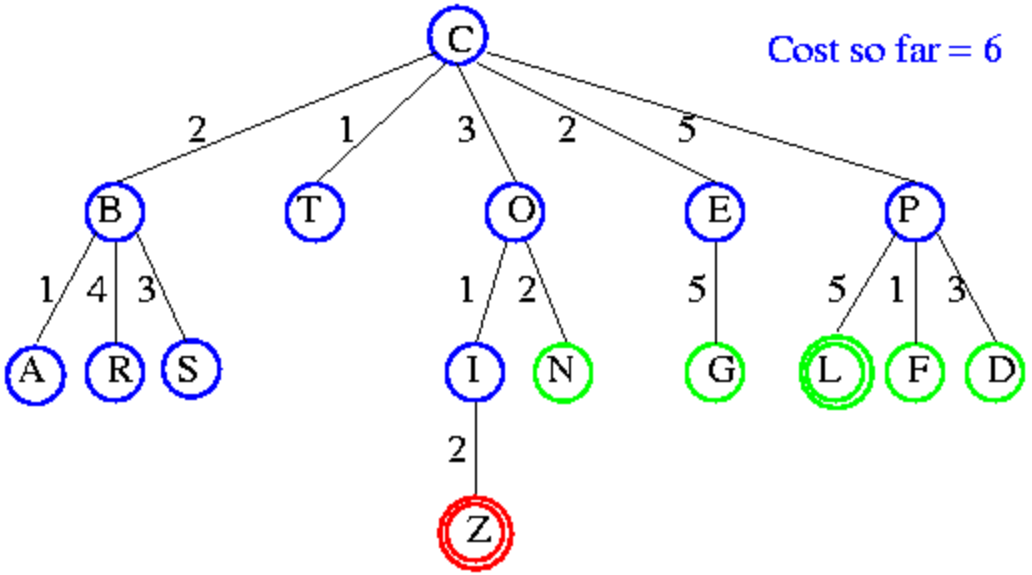
Open list: N(5) R(6) Z(6) F(6) D(8) G(10) L(10)

UCS Example



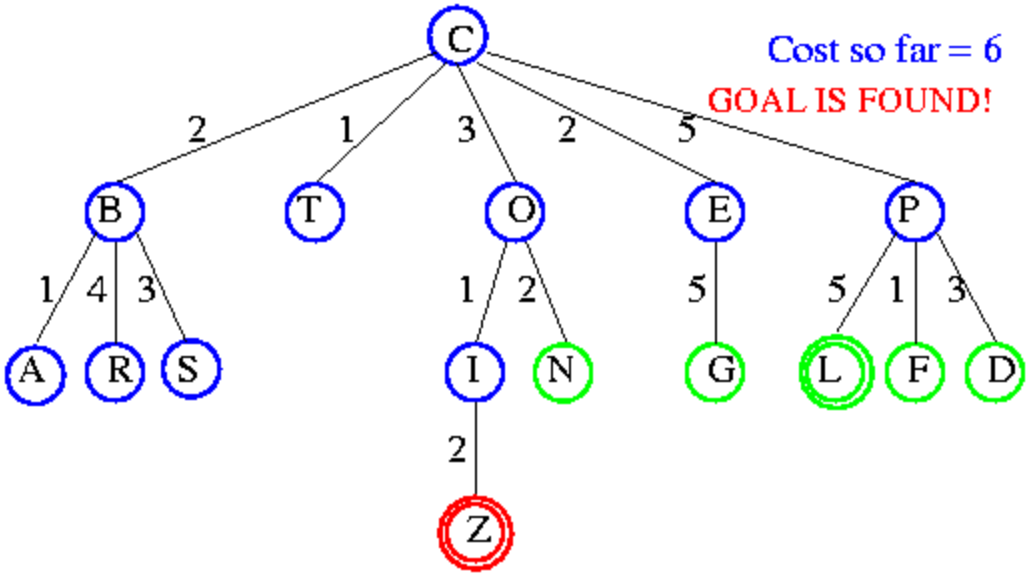
Open list: Z(6) F(6) D(8) G(10) L(10)

UCS Example



Open list: F(6) D(8) G(10) L(10)

UCS Example


C
Cost so far = 6
GOAL IS FOUND!
2
1
3
2
5
B
T
O
E
P
1
4
3
1
2
5
5
1
3
A
R
S
I
N
G
L
F
D
2
Z

Comparison of Search Techniques

	DFS	BFS	UCS	DFID
Complete	N	Y	Y	Y
Optimal	N	N	Y	N
Heuristic	N	N	N	N
Time	b^m	b^{d+1}	b^m	b^d
Space	bm	b^{d+1}	b^m	bd