



# What is Iterative Deepening Search?

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Iterative Deepening Search (IDS) is an iterative graph searching strategy that takes advantage of the completeness of the Breadth-First Search (BFS) strategy but uses much less memory in each iteration (similar to Depth-First Search).

IDS achieves the desired completeness by enforcing a depth-limit on DFS that mitigates the possibility of getting stuck in an infinite or a very long branch. It searches each branch of a node from left to right until it reaches the required depth. Once it has, IDS goes back to the root node and explores a different branch that is similar to DFS.

## Time & space complexity

Let's suppose that we have a tree where each node has  $b$  children. We will consider this our branching factor and take  $d$  as the depth of the tree.

Nodes at the bottom-most level, which would be level  $d$ , will be expanded exactly once; whereas, nodes on level  $d-1$  will be expanded twice. The root node of our tree will be expanded  $d+1$  times. If we sum all these terms up, it will be:

$$(d)b + (d-1)b_2 + \dots + (3)b_{d-2} + (2)b_{d-1} + b_d$$

This summation will result in time complexity of  $O(b_d)$

The space complexity for IDS is  $O(bd)$ . Here, we assume that  $b$  is a constant, and all children are generated at each depth of the tree and stored in a stack during DFS.

## Performance analysis

It may look like IDS has a large overhead in the form of repeatedly going over the same nodes again and again, but this turns out to be much of a big deal. This is because most nodes in a tree are at the bottom levels, which are visited only once or twice by the algorithm. Because of this, the cost is kept to a bare minimum since the upper-level nodes do not make up the majority of the nodes in a tree.

Let's see the pseudocode for this strategy and run it on an example:

```
IDS(root, goal, depthLimit){
  for depth = 0 to depthLimit
    if (DFS(root, goal, depth))
      return true
```

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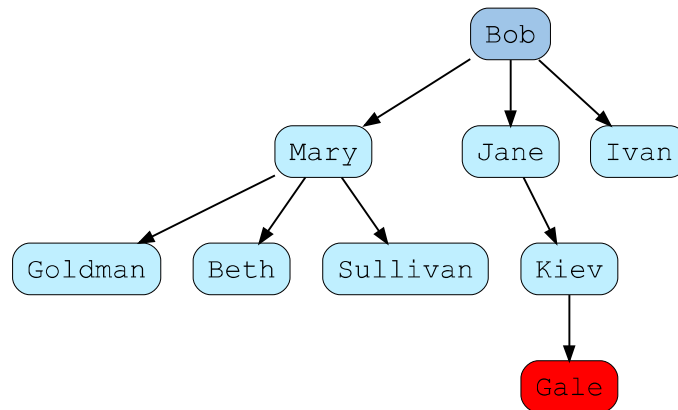


```

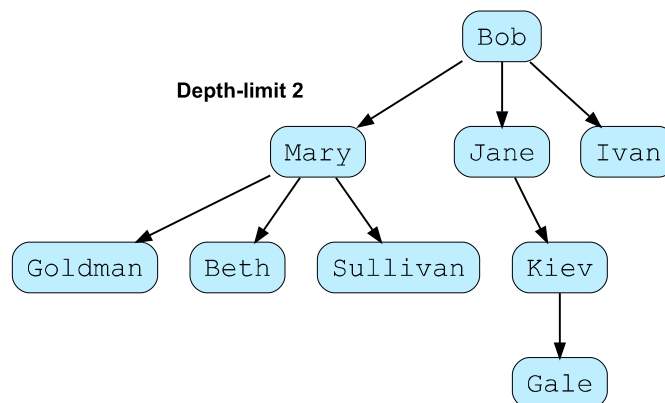
return false
}

DFS(root, depth){
  if root == goal
    return true
  if depth == 0
    return false
  for each child in root.children
    if (DFS(child, goal, depth - 1))
      return true
  return false
}

```



With a depth-limit of 2, iterative-deepening will never encounter Gale since it is on the 3rd level.



1 of 12



## When to use iterative deepening

As a general rule of thumb, we use iterative deepening when we do not know the depth of our solution and have to search a very large state space.

Iterative deepening may also be used as a slightly slower substitute for BFS if we are constrained by memory or space.

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