### Assignment #1



**Q: What is the complexity (in space and in time) of the following search methods:**

**Time Complexity:**

The [**Time complexity**](https://en.wikipedia.org/wiki/Time_complexity) is the computational complexity that describes the amount of time it takes to run an algorithm.

[**Space Complexity**](https://courses.cs.northwestern.edu/311/html/space-complexity.html)**:**

The [**Space complexity**](https://courses.cs.northwestern.edu/311/html/space-complexity.html) is a measure of the amount of working storage an algorithm needs. That means how much memory, in the worst case, is needed at any point in the algorithm.

**Depth-First Search:**

Depth First Search has a time complexity of **O(b^m),** where b is the maximum branching factor of the search tree and m is the maximum depth of the state space.

The space complexity is **O(bm)**, i.e., space linear in length of action sequence. Need only store a single path from the root to the leaf node, along with remaining unexpanded sibling nodes for each node on path.

**Breadth-First Search:**

When using the breadth-first search algorithm, is the space complexity **O(b^d),** where b is the branching factor and d the length of the optimal path.

Breadth First Search has a time complexity of **O(b^d), O(vertices + edge)**

**Best-First Search:**

The worst-case time complexity for Best First Search is **O(n \* log n)** where n is the number of nodes. In the worst case, we may have to visit all nodes before we reach goal.

In the worst case, the time and space complexity for best- first search is the same as with BFS: O(bd+1) for time and **O(bd)** for space.

**Greedy Search:**

The worst-case complexity for greedy search is **O(bm),** where m is the maximum path length. **Its space complexity is the same as its time complexity**, but the worst case can be substantially reduced with a good heuristic function.

**Q: Explain the differences and similarities between depth-first search and breadth-first search. Give examples of the kinds of problems where each would be appropriate.**

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| --- | --- | --- | --- |
| **Search Algorithms** | **Similarities** | **Differences** | **uses** |
| Breadth First Search | * Uninformed * Traversal | * Use stack * Use FIFO * Consume more memory * No backtracking | * When target is close. * Broadcasting * GPS |
| Depth First Search | * Uninformed * Traversal | * Uses queue * Use LIFO * Consume less memory * Backtracking | * When target is far. * Solving puzzles |

**Q: Provide a definition of the word “heuristic.” In what ways can heuristics be useful in search? Name three ways in which you use heuristics in your everyday life.**

**Heuristics:**

Heuristics are mental shortcuts that allow people to solve problems and make judgments quickly and efficiently. These rule-of-thumb strategies shorten decision-making time and allow people to function without constantly stopping to think about their next course of action.

The value of the heuristic function is always positive. In everyday life we use this approach in different scenarios such as:

1. Finding a short way to get on destination. For example, if I want to go to university there are multiple ways to get there but trying to find the best ways which saves time and cost is heuristic approach.
2. If a teacher in class wants to explain something, there are multiple ways to describe that thing but the try to pick only that way which is more understandable for students.
3. There are multiple games to play but we should choose which is best for our health and takes less time and we can play anywhere(indoor and outdoor) such as badminton.