Python Basics

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1 Python Test/Implementation of Concepts

- Please find the code here.
- Note: I meant to leave errors in the code to show some possible errors.

2 Python Basic Concepts

- Python Operations
  Assignment: create an object and assign reference
- Data Types
  int, float, str, list, tuple, set, dictionary
- Mutable Variables / Immutable Variables
- Pass by Value / Pass by Reference
- Deep Copy / Shallow Copy
- Iterator / Generator / Decorator
- Class
- *args / **kwargs
- Map / Lambda / Apply
- try-exception-else-finally
- range / xrange
- pickling / unpickling
- continue / break / pass
- yield / return

3 Python General Concepts

- Interpreted Language
- Machine Language
- Programming Language
- Scripting Language
- Programming Language vs. Scripting Language (Pros and Cons)
- Namespace

4 Data Structure

4.1 General Data Structure Concepts

- Data Structure Definition
- Linear Data Structure
  Array, Linked List, Stack, Queue
- Non-linear Data Structure
  Tree, Graph, Table, Set
- Time Complexity / Space Complexity
- Data Structure in procedural languages like C is done with the help of structures and pointers, etc.
- Data Structure in object oriented language like Python is down using classes and objects.

4.2 Array / Linked List

- Comparison of Array and Linked List
- Double-linked List

4.3 Stack

- FILO
- Push / Pop / Peek(Top)
- Application 1: Valid Parentheses
- Application 2: Postfix Expression Evaluation

4.4 Queue

- FIFO
- Dequeue / Enqueue / Get Front Element of Queue / Get Reat Element of Queue
- Application: BFS algorithm to find shortest distance between two nodes in a graph
- Priority Queue

4.5 Hash Table / Hash Map / Python Dictionary

Hash tables are called dictionaries in Python.

4.5.1 Hash Table General

- Comparison between Hash Table and Array
- Python Implementation of Hash Table class
- Collision
- Time Complexity of get/set in Hash Table
  O(1) **assuming the hash function distributes elements uniformly in space**

4.5.2 Collision in Hash Table

Collision: Different keys point to the same location.

- Chaining / Separate Chaining
  Linked list at each location.
  TC: normally O(1), worst case O(n)
- Linear Probing
  When an location is occupied, go the the next location.
  Probing: searching for an empty slot to store the value

4.6 Tree

- Binary Tree
  A binary Tree is a special type of tree where each node can have at most two children.
- Binary Tree Traversals
  Preorder Traversal: Root-Left-Right
  Inorder Traversal: Left-Root-Right
  Postorder Traversal: Left-Right-Root
  Level Traversal

- **Recursion for Tree Problems!**

4.7 Graph

4.7.1 Graph Concepts

- Vertices / Nodes
- Edges
- Graph Representation: Adjacency Matrix / Adjacency List
- BFS: level-by-level traversal / implement with queue
- DFS: follow a path from start node to end node / implement with stack
- Complete Directed/Undirected Graph
- Weighted Directed/Undirected Graph
- DFS/BFS: Spanning Tree of a Graph
- Minimum Cost Spanning Tree (MST) of a Weighted Graph
- Directed Cyclic Graph
- Directed Acyclic Graph (DAG)
- Directed Graph

4.7.2 Minimum Cost Spanning Tree (MST) of a Weighted Graph

- Prim Algorithm (Greedy)
- Kruskal Algorithm

4.7.3 Detect Cycle in Directed Graph

- DFS
- Topological Sorting
  - Activity On Vertex (AOV) Network
  - If all vertices in the AOV Network are in the topological sorting output, there's no cycle in the graph, otherwise there's cycle.

4.7.4 Shortest Distance in Weighted Graph

- Dijkstra Algorithm (Greedy)

4.8 Heap

- Definition: complete binary tree
  A binary tree is said to be complete if all levels are completely filled except possibly the last level and the last level has all elements towards as left as possible
- Max Heap
  The data element present at the root node must be greatest among all the data elements present in the tree. This property should be recursively true for all sub-trees of that binary tree.
- Min Heap
  The data element present at the root node must be the smallest (or minimum) among all the data elements present in the tree. This property should be recursively true for all sub-trees of that binary tree.

5 Algorithm Ideas

- Divide and Conquer
- Dynamic Programming
- Branch and Bound
- Greedy Algorithm
- Recursion
  $$f_n = f_{n-1} + f_{n-2}$$
- Backtracking
- Depth First Search / DFS
- Breadth First Search / BFS

6 Sorting Algorithms

- Insertion Sort
- Bubble Sort
- Quick Sort
- Selection Sort
- Heap Sort
- Merge Sort
- Time Complexity and Space Complexity of Sorting Algorithms

7 Searching Algorithms

- Linear Search
- Binary Search
- Fibonacci Search
- Time Complexity and Space Complexity of Searching Algorithms