Problem Solving Techniques

1 Data Structure-Based

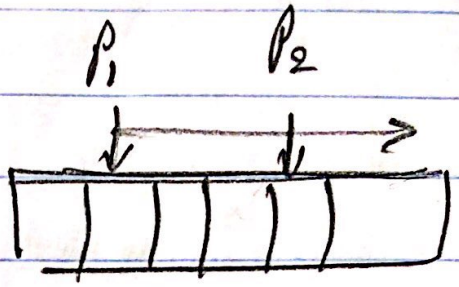
- Strings / Arrays
- Matrix
- Linked List
- Binary Tree
- Graphs
- Heaps

- Mathematics
- Geometry

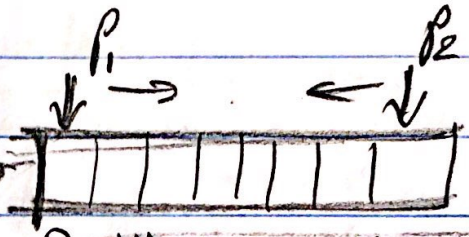
2 Independent techniques

- Dynamic Programming
- Divide & Conquer
- Brute Force
- Greedy Algorithms
- Search Problems (AI)

1 Arrays



① Sliding window



② Multiple Pointers
- many from start
- one start, one end

firstMin, secondMin, ---

③ Sorting trick (what if arr is sorted)
- merge sort
- quick sort

④ Data structure to keep track of Data
- stacks / queues
- Maps / Sets
- tree
- heaps

⑤ Divide & Conquer

⑥ Definition of problem
- ex: definition of median of 2 sorted arrays

⑦ Search Problem
- word ladder

⑧ Binary Search

① Easier version of the problem to solve yours
- 2sum closest → 2sum, 2sum II
- intersection of 2 sorted arrays → what if they have same length

② Start from end

③ Juggle (no extra space)

④ Dynamic Programming

Jump pointers
arr[arr[i]]

Arrays

⑤ try Dp[i]
accumulation trick

① No extra space

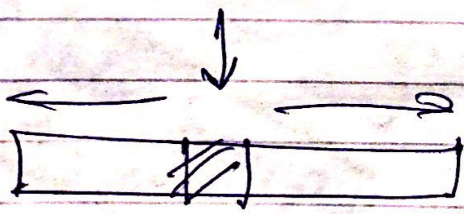
→ use 2 variables (if small storage)

→ else -ve mark of
more variables and arr[i] ∈ [1-n]

② Glued idea (scan from left / right)
→ on your left → scan once from left
→ on your right → scan once from right

③ Bucket sort
→ sorting is required (bottleneck)
→ ranges are limited

④ fanning-out trick



Strings

* scan both from left
or both from right

[2] Matrix

smart traversal

① Traversal

```
for row = 0 to m
    for col = 0 to n
```

② Search DFS

→ with Dynamic Programming

→ use BFS for shortest path

③ Bounding index

→ left, right, top, Bottom

④ Spread matrix into array

```
k = row * n + col
col = k % n
row = k // n
```

⑤ Accumulation Trick

→ sum of col/row values up to this cell

⑥ Aux space

→ use some row/col as aux space

→ use any cell as aux space

- ex: DFS use "X" as your flag instead of extra set
- ex: change to known value (game of life)
- ex: shift operation to hold many things
- Juggling → Rotate image

Extras

① optimize direction moves

- dx = [0, 0, -1, 1]
- dy = [1, -1, 0, 0]

② Reduce to our problem

- using accum trick

③ Disjoint sets / Trie implement as arrays

3 Linked Lists

① Slow/fast Pointer

② Fake head
→ Very common for solutions

③ Pointer Manipulation
→ Reverse List, delete specific

④ No Extra space
→ Chain to existing list (keep order correct)
ex: Copy with random pointer

[3] Binary Trees

[1] Must-Know Traversals

- inorder, preorder, postorder
- Level-order
- Morris Traversal

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① Top-down Solution:
→ iterative : level-order
→ Recursive : DFS

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② Bottom-up Solution (Recursive)
→ Base case
→ Definition of problem

~~Recursive Iterative Stack~~

---

③ Traversal
→ mostly inorder

~~Traversal with Use Stack~~

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left limit & right-limit validation trick

track of BFS using one queue only counter to keep track of level

definition of problem

stack

Dynamic Programming

[1] Brute-Force Top-down solution

→ find brute-force, top-down solution

[2] Dynamic Programming

→ identify problem:

① Recursive solution (brute-force)

② overlapping subproblem

→ (arriving at i, j many times)

[3] Formulate Problem Definition of Problem

→ F(n) = ∅ (F(n-1))

→ identify subproblems

[4] DP solution

→ Top-down & memoization

→ Bottom-up?

Accumulation trick

$$dp[i] = max \begin{cases} dp[i-1] \\ arr[i] + dp[i-2] \end{cases}$$

5 Graphs

directed / undirected

adjacency matrix / adjacency list

1 Traversal
- BFS O(V+E)
- DFS O(V+E)

2 Shortest Path (Single Source)
directed & undirected →
- Unweighted (BFS)
- Weighted
  - directed + Undirected → * Dijkstra O(E+VlogV) (+ve weights)
  - * Bellmanford O(VE) (directed can handle -ve weights)

3 Minimum Spanning Tree
- * Prim (V+ElogE)
- * Kruskal (ElogE)

4 Disjoint Sets
- * makeset O(1)
- * union O(logk)
- * findset O(logk)

1 Cycle
- Undirected (BFS/DFS/disjoint)
- directed DFS

2 Topological Sort
- DFS

3 Critical
- Edges (Bridges)
- Nodes (Articulation)

4 Strongly Connected Components