Array Problem Patterns and Techniques

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| Question | Pattern / Technique |
| Largest Element in an Array | Traversal |
| Second Largest Element in an Array without sorting | Traversal |
| Check if the array is sorted | Traversal |
| Remove duplicates from Sorted array | Two-Pointer |
| Left Rotate an array by one place | Traversal |
| Left rotate an array by D places | Traversal |
| Move Zeros to end | Two-Pointer |
| Linear Search | Traversal |
| Find the Union | Hashing / Two-Pointer (if sorted) |
| Find missing number in an array | Prefix Sum / XOR / Hashing |
| Maximum Consecutive Ones | Sliding Window / Traversal |
| Find the number that appears once | Bit Manipulation (XOR) |
| Longest subarray with given sum K (positives) | Sliding Window / Prefix Sum |
| Longest subarray with sum K (Positives + Negatives) | Prefix Sum + Hashing |
| Sort an array of 0's 1's and 2's | Two-Pointer / Dutch National Flag |
| Majority Element (>n/2 times) | Hashing / Boyer-Moore |
| Kadane's Algorithm | Sliding Window / Greedy |
| Print subarray with maximum subarray sum | Kadane's + Tracking Indices |
| Stock Buy and Sell | Greedy |
| Rearrange the array in alternating positive and negative items | Two-Pointer / Extra Space |
| Next Permutation | Greedy + Reverse |
| Leaders in an Array problem | Traversal from End |
| Longest Consecutive Sequence in an Array | Hashing / Sorting |
| Set Matrix Zeros | Matrix Traversal + Marker Arrays |
| Rotate Matrix by 90 degrees | Matrix Layer Rotation |
| Print the matrix in spiral manner | Matrix Layer Traversal |
| Count subarrays with given sum | Prefix Sum + Hashing |
| Pascal's Triangle | Mathematical Construction |
| Majority Element (n/3 times) | Hashing / Extended Boyer-Moore |
| 3-Sum Problem | Sorting + Two-Pointer |
| 4-Sum Problem | Sorting + Two-Pointer / Hashing |
| Largest Subarray with 0 Sum | Prefix Sum + Hashing |
| Count number of subarrays with given xor K | Prefix XOR + Hashing |
| Merge Overlapping Subintervals | Sorting + Merging |
| Merge two sorted arrays without extra space | Two-Pointer + GAP Method |
| Find the repeating and missing number | Math / XOR |
| Count Inversions | Merge Sort / Divide & Conquer |
| Reverse Pairs | Merge Sort / Divide & Conquer |
| Maximum Product Subarray | Greedy / Kadane Variant |

# Shortcut Rules to Identify Patterns

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| --- | --- | --- |
| If the question asks for... | Likely Pattern | Examples |
| Max/Min value or condition check | Traversal | Largest element, Check if sorted, Leaders in array |
| Modify array in-place (remove duplicates, move zeroes, sort 0s 1s 2s) | Two-Pointer | Move zeros, Remove duplicates, Sort 0s 1s 2s |
| Count subarrays with sum/XOR or match prefix/suffix condition | Prefix Sum / XOR + Hashing | Subarray with given sum, XOR, 0 sum |
| Find subarrays with max/min length or sum | Sliding Window / Kadane’s | Kadane’s, Longest subarray with K |
| Array rearrangement (alternating pos/neg, next permutation) | Greedy / Two-Pointer | Rearranging pos/neg, Next Permutation |
| All elements appear twice except one | Bit Manipulation (XOR) | Find unique number |
| Involves sorted arrays and combining/merging | Two-Pointer / Sorting | Union, Merge arrays, 2-Sum/3-Sum |
| Majority element frequency (>n/2 or >n/3) | Hashing / Boyer-Moore | Majority element problems |
| Subproblems can be merged efficiently | Divide & Conquer | Count inversions, Reverse pairs |
| Modifying or printing matrix | Matrix Layer Technique | Rotate, Spiral print, Set zeros |
| Interval merging or combining ranges | Sorting + Merging | Merge Intervals |
| Maximize/minimize profit/value over time | Greedy | Stock Buy/Sell |

# Quick Decision Tree for Array Pattern Identification

Quick Decision Tree:  
  
*- Needs sum, frequency, or XOR? →* ***Prefix Sum / Hashing / XOR*** *- Only 1 unique number, others repeated? →* ***Bit Manipulation****- Check, find, or compare values? →* ***Traversal****- Rearranging or moving in-place? →* ***Two-Pointer****- Subarray problems (max/min length or sum)? →* ***Sliding Window / Kadane's*** *- Matrix structure involved? →* ***Matrix Traversal/Rotation*** *- Repeated merging or overlapping? →* ***Sorting + Merge*** *- Requires optimized search (sorted arrays)? →* ***Two-pointer / Binary Search****- Frequency > n/2 or > n/3? →* ***Boyer-Moore / Hashing****- Divide-and-conquer logic? → Merge Sort Variant*

**✅ Pattern Shortcut Rules**

* "Max/Min in Array, Check Sorted?" → **Traversal**
* "Remove/Arrange Elements In-Place?" → **Two-Pointer**
* "Count Subarrays or Use Prefix/XOR?" → **Prefix Sum + HashMap**
* "Subarray Max/Min Length/Sum?" → **Sliding Window / Kadane’s**
* "Next Permutation or Arrangement?" → **Greedy**
* "Unique Element (Non-Repeating)?" → **Bit Manipulation (XOR)**
* "Sorted Array Merge or Compare?" → **Two-Pointer/Sorting**
* "Matrix Row/Col Change or Rotate?" → **Matrix Traversal**

#### 📦 ARRAY + MATRIX + SLIDING WINDOW PATTERNS

| **🧩 Pattern** | **📋 Questions** | **🌸 Baba's Analogy / Trick** |
| --- | --- | --- |
| **Traversal** | Largest Element  Second Largest  Is Array Sorted  Linear Search  Leaders in Array  Rotate by 1/D | Check every gift in a line to find the biggest one 🎁 |
| **Two-Pointer** | Remove Duplicates  Move Zeros  Sort 0s/1s/2s  Merge Sorted Arrays  Rearrange Pos/Neg | Like two monkeys cleaning a rope from both ends 🐒↔️🐒 |
| **Sliding Window** | Max Consecutive 1s  Longest Subarray Sum K (Pos)  Kadane’s  Print Max Subarray Sum | Baba’s magic window sliding over array to catch treasure 💰 |
| **Prefix Sum + Hashing** | Longest Subarray with Sum K (Pos+Neg)  Count Subarrays with Given Sum  Largest Subarray with 0 Sum | Baba keeps a sum diary 🧾 — finds where he was before to catch loops or patterns 🔁 |
| **Greedy** | Stock Buy/Sell  Next Permutation  Max Product Subarray | Baba picks best mangoes in every turn without waiting 🥭 |
| **Bit Manipulation** | Find Number Appears Once  Find Repeating + Missing Number | Baba uses XOR as magic — odd number of times shows true item 🎩 |
| **Matrix Traversal** | Set Matrix Zeros  Rotate Matrix 90°  Spiral Print | Baba peels onion layer-by-layer 🧅 or rotates Rubik’s cube 🔄 |
| **Sorting + Two-Pointer** | 2Sum, 3Sum, 4Sum  Find Union | Like setting up perfect jodis for dance — sorted and matched 💃🕺 |
| **Divide & Conquer** | Count Inversions  Reverse Pairs | Baba breaks the team into squads and counts who broke order during merge ⚔️ |
| **Hashing / Boyer-Moore** | Majority Element (>n/2, >n/3) | Like elections — eliminate opposite votes till winner is crowned 🗳️ |
| **Math / Constructive** | Pascal’s Triangle  Pow(x, n)  Fibonacci | Baba builds triangle with his divine triangle-powder 🔺✨ |
| **Prefix XOR + Hashing** | Count Subarrays with XOR K | XOR diary with sparks — finds treasure hiding between sparks ⚡ |
| **Greedy + Reverse** | Next Permutation  Rearranging Pos/Neg | Rearranging ladoos and modaks for perfect pooja 🍥✨ |
| **Gap Method (In-place Merge)** | Merge Sorted Arrays Without Extra Space | Two shelves being joined without extra bookshelves 📚 |
| **Matrix Layer Trick** | Rotate Matrix  Spiral Print | Peeling jalebi 🍬 round by round and turning it into swirls |

#### 🔁 RECURSION + BACKTRACKING + SUBSEQUENCES

| **🔁 Recursion Pattern** | **📋 Used In Problems** | **✨ Trick + Code Glimpse** |
| --- | --- | --- |
| **Subsequence (Include/Exclude)** | Subset Sum  Print All Subsequences  Combination Sum  Power Set | Take/Don't Take: f(idx+1, take) f(idx+1, notTake) |
| **Backtracking** | Generate Parentheses  N-Queens  Word Break | Try → Recurse → Undo ➡️ Backtrack!  Close only if open brackets exist 😉 |
| **Partition Based** | Palindromic Partitioning  String Splits | Try all partitions, move ahead only if valid (like palindrome check) |
| **Decision Tree Recursion** | Permutations  Letter Combinations of Phone Numbers | Recurse for every letter in keypad like T9 Nokia phones ☎️ |
| **Mathematical Recursion** | Pow(x, n)  Fibonacci  Pascal’s Triangle | Baba splits problem like pizza 🍕 and combines answers |
| **Stack Recursion** | Reverse Stack  Sort Stack | Pop all, insert at bottom during backtrack 📚 |
| **Recursive Conversion** | Implement Atoi  Count Good Numbers | Recursively convert string or digits — like unrolling a scroll 📜 |

#### 🌉 GRAPH ALGORITHMS – Baba’s Sutradhar for Connectivity

| **🌐 Graph Pattern** | **📋 Used In Problems** | **🌟 Baba’s Trick / Intuition** |
| --- | --- | --- |
| **DFS / BFS Traversal** | Detect Cycle in Graph  DFS Traversal  BFS Traversal | Baba sends monkeys (DFS) deep or birds (BFS) level-by-level 🐒🕊️ |
| **Disjoint Set (Union-Find)** | Kruskal's MST  Detect Cycle in Undirected Graph | Forests of people joining hands — with baba's union-find yagna ✋🌳 |
| **Topological Sort** | Task Scheduling  Course Prerequisites  Kahn’s Algo | Baba arranges books on shelf where one depends on another 📚📚 |
| **Shortest Path** | Dijkstra  Bellman-Ford  Floyd-Warshall | Baba drops coins (weights) and finds cheapest way to reach temple ⛩️💰 |
| **Minimum Spanning Tree** | Prim’s  Kruskal’s | Baba connects villages using least amount of wires ⚡🌉 |
| **Bridges / Articulation** | Tarjan's Algo  Critical Connections | Baba finds weak points in kingdom walls — break this and graph falls 🧱 |