DATA STRUCTURES

ARRAYS – HARD LEVEL

1. What is the time complexity of finding the median of two sorted arrays of size n each (using divide and conquer)?
   A) O(n)
   B) O(log n)
   C) O(n log n)
   D) O(n^2)
   Answer: B

2. Which algorithm can find the majority element (> n/2 frequency) in O(n) time and O(1) space?
   A) Merge Sort
   B) Boyer–Moore Voting Algorithm
   C) Quick Select
   D) Binary Search
   Answer: B

3. The maximum subarray sum problem is efficiently solved using:
   A) Divide and conquer
   B) Kadane's Algorithm
   C) Dynamic programming
   D) All of the above
   Answer: D

4. What is the worst-case complexity of Quickselect for kth smallest element in an array?
   A) O(log n)
   B) O(n)
   C) O(n^2)
   D) O(n log n)
   Answer: C

5. Which approach is best for finding duplicates in an array of size n with elements in range [1..n]?
   A) Sorting
   B) Hashing
   C) Index marking in-place
   D) Nested loops
   Answer: C

6. The number of inversions in an array can be counted using:
   A) Quick sort
   B) Merge sort modification
   C) Bubble sort
   D) Selection sort
   Answer: B

7. Which algorithm is used to find the kth smallest element in expected O(n)?
   A) Heap sort
   B) Binary Search
   C) Quickselect
   D) Merge sort
   Answer: C

8. The lower bound for comparison-based sorting of arrays is:
   A) O(n log n)
   B) O(log n)
   C) O(n)
   D) $O(n^2)$
   Answer: A

9. Which of these algorithms sorts in linear time but only for integers with bounded range?
   A) Merge sort
   B) Counting sort
   C) Quick sort
   D) Heap sort
   Answer: B

10. If you rotate an array of size n by k elements using the reversal algorithm, the complexity is:
    A) O(1)
    B) O(k)
    C) O(n)
    D) O(n log n)
    Answer: C

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11. Which method finds the equilibrium index in an array efficiently?
    A) Prefix sum technique
    B) Binary search
    C) Divide and conquer
    D) Stack-based traversal
    Answer: A

12. The maximum subarray XOR problem is solved using:
    A) Greedy approach
    B) Tries + Bitwise operations
    C) Divide and conquer
    D) Hashing
    Answer: B

13. The best method to find two elements in a sorted array that sum to a given value is:
    A) Nested loops
    B) Hashing
    C) Two-pointer technique
    D) Divide and conquer
    Answer: C

14. Which is the space complexity of dynamic programming solution for Longest Increasing Subsequence (LIS)?
    A) O(1)
    B) O(n)
    C) O(log n)
    D) O(n²)
    Answer: B

15. The complexity of LIS using patience sorting technique is:
    A) O(n²)
    B) O(n log n)
    C) O(n)
    D) O(log n)
    Answer: B

16. Which of these can detect duplicates in O(n log n) without extra space?
    A) Sorting
    B) Hashing
    C) XOR
    D) Divide and conquer
    Answer: A

17. The maximum sum subarray of size k can be found using:
    A) Sliding window
    B) Divide and conquer
    C) Binary search
    D) Merge sort
    Answer: A

18. To find missing number in array of size n containing numbers from 1 to n+1, best method is:
    A) Sorting
    B) XOR of all numbers
    C) Binary search
    D) Hashing
    Answer: B

19. Which algorithm finds the maximum product subarray?
    A) Greedy
    B) Dynamic programming
    C) Divide and conquer
    D) Brute force
    Answer: B

20. What is the best complexity of searching in an unsorted array?
    A) O(1)
    B) O(n)
    C) O(log n)
    D) O(n log n)
    Answer: B

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21. Which approach can solve the trapping rain water problem in O(n)?
    A) Precomputing left and right max arrays
    B) Brute force
    C) Sorting
    D) Divide and conquer
    Answer: A

22. Which of these finds kth smallest element in O(k + (n-k) log k)?
    A) Min-heap
    B) Max-heap
    C) Binary search
    D) Quick sort
    Answer: B

23. The “median of medians” algorithm guarantees Quickselect runs in:
    A) O(log n)
    B) O(n)
    C) O(n log n)
    D) $O(n^2)$
    Answer: B

24. Which of these problems can be solved using prefix sum arrays?
    A) Range sum queries
    B) Subarray sums divisible by k
    C) Equilibrium index
    D) All of the above
    Answer: D

25. Which technique solves maximum circular subarray sum?
    A) Kadane’s algorithm (twice)
    B) Divide and conquer
    C) Hashing
    D) Binary search
    Answer: A

26. The “Dutch National Flag” problem is solved using:
    A) Merge sort
    B) 3-way partitioning
    C) Stack
    D) Heap
    Answer: B

27. Which algorithm is best to find maximum sum of non-adjacent elements in an array?
    A) Greedy
    B) Dynamic programming
    C) Divide and conquer
    D) Sorting
    Answer: B

28. Finding the maximum element in a bitonic array takes:
    A) O(n)

B) O(log n)
C) O(n log n)
D) O(1)
Answer: B

29. To merge k sorted arrays efficiently:
    A) Use divide and conquer
    B) Use a min-heap
    C) Concatenate and sort
    D) Use quick sort
    Answer: B

30. Which of these is true for arrays vs hash tables?
    A) Arrays allow O(1) random access, hash tables don't
    B) Hash tables are always more memory efficient
    C) Arrays cannot be used for searching
    D) Hash tables guarantee sorted order
    Answer: A

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31. Which is the complexity of finding the longest consecutive subsequence in an unsorted array using hashing?
    A) O(n log n)
    B) O(n)
    C) $O(n^2)$
    D) O(log n)
    Answer: B

32. The maximum subarray sum in 2D arrays is solved using:
    A) Kadane's algorithm in 2D
    B) Divide and conquer
    C) Greedy
    D) Dynamic programming only
    Answer: A

33. Which of these is an efficient method to count distinct elements in an array?
    A) Sorting + scan
    B) Hashing
    C) Binary search
    D) Nested loops
    Answer: B

34. What is the complexity of merging two sorted arrays of size m and n?
    A) O(m+n)
    B) O(log(m+n))
    C) O(mn)
    D) $O(n^2)$
    Answer: A

35. Which of these is not a valid array application?
    A) Sparse matrix representation
    B) Stack implementation
    C) Queue implementation
    D) Hashing with chaining
    Answer: D

36. What is the best method to find 3 numbers with maximum product in an array?
    A) Sorting and picking candidates
    B) Hashing
    C) Binary search
    D) Divide and conquer
    Answer: A

37. To rotate an array by k using juggling algorithm, complexity is:
    A) O(1)
    B) O(k)
    C) O(n)
    D) O(n log n)
    Answer: C

38. Which data structure supports Range Minimum Query (RMQ) efficiently on arrays?
    A) Segment tree
    B) Binary tree
    C) Stack
    D) Queue
    Answer: A

39. Which structure answers range sum queries with updates efficiently?
    A) Segment tree
    B) Fenwick tree (BIT)
    C) Sparse table
    D) Both A and B
    Answer: D

40. The Sparse Table technique is best for:
    A) Static RMQ queries
    B) Dynamic updates
    C) Rotations
    D) Hashing
    Answer: A

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41. Which of these is true about arrays used in hash tables with open addressing?
    A) Must be dynamic
    B) Store keys directly in array
    C) Need linked lists
    D) Cannot handle collisions
    Answer: B

42. Which of these allows prefix sums with dynamic updates?
    A) Segment tree
    B) Fenwick tree
    C) Both A and B
    D) Sparse table
    Answer: C

43. Which algorithm finds maximum subarray product in O(n)?
    A) Greedy
    B) Kadane's algorithm modified
    C) Divide and conquer
    D) DP with sorting
    Answer: B

44. Which problem uses arrays + sliding window efficiently?
    A) Maximum of all subarrays of size k
    B) Median of subarrays
    C) Longest increasing subsequence
    D) Counting inversions
    Answer: A

45. The maximum subarray length with sum = k can be solved using:
    A) Hashing prefix sums
    B) Divide and conquer
    C) Binary search
    D) Heap
    Answer: A

46. Which of these is not solved using arrays directly?
    A) Heap implementation
    B) Graph adjacency list
    C) Sparse matrix
    D) Binary tree using pointers
    Answer: D

47. The "maximum sum rectangle" in a matrix reduces to:
    A) 1D maximum subarray problem
    B) Divide and conquer
    C) Binary search
    D) BFS traversal
    Answer: A

48. The time complexity to sort an array of n elements using heap sort is:
    A) O(n)
    B) O(n log n)
    C) $O(n^2)$
    D) O(log n)
    Answer: B

49. Which algorithm uses partitioning in arrays?
    A) Quick sort

B) Quickselect
C) Dutch National Flag
D) All of the above
Answer: D

50. Which is the best data structure for dynamic array resizing?
A) Static array
B) Linked list
C) Dynamic array (vector, Python list)
D) Queue
Answer: C