Holy Theory - Algorithms

Binary search

Steps:

- Step 1 - Read the search element from the user.
- Step 2 - Find the middle element in the sorted list.
- Step 3 - Compare the search element with the middle element in the sorted list.
- Step 4 - If both are matched, then display “Given element is found!!!” and terminate the function.
- Step 5 - If both are not matched, then check whether the search element is smaller or larger than the middle element.
- Step 6 - If the search element is smaller than middle element, repeat steps 2, 3, 4 and 5 for the left sublist of the middle element.
- Step 7 - If the search element is larger than middle element, repeat steps 2, 3, 4 and 5 for the right sublist of the middle element.
- Step 8 - Repeat the same process until we find the search element in the list or until sublist contains only one element.
- Step 9 - If that element also doesn’t match with the search element, then returns -1;

Time Complexity:

- Worst case: O(log n)
- Average case: O(log n)
- Best case: O(1)

```
function binarySearch(nums: number[], target: number): number {
  let left: number = 0;
  let right: number = nums.length - 1;

  while (left <= right) {
    const mid: number = Math.floor((left + right) / 2);

    if (nums[mid] === target) return mid;
    if (target < nums[mid]) right = mid - 1;
    else left = mid + 1;
  }

  return -1;
}
```

```
class Solution {
    private static int binarySearch(int[] array, int target) {

        int low = 0;
        int high = array.length - 1;

        while(low <= high) {
            int middle = low + (high - low) / 2;
```

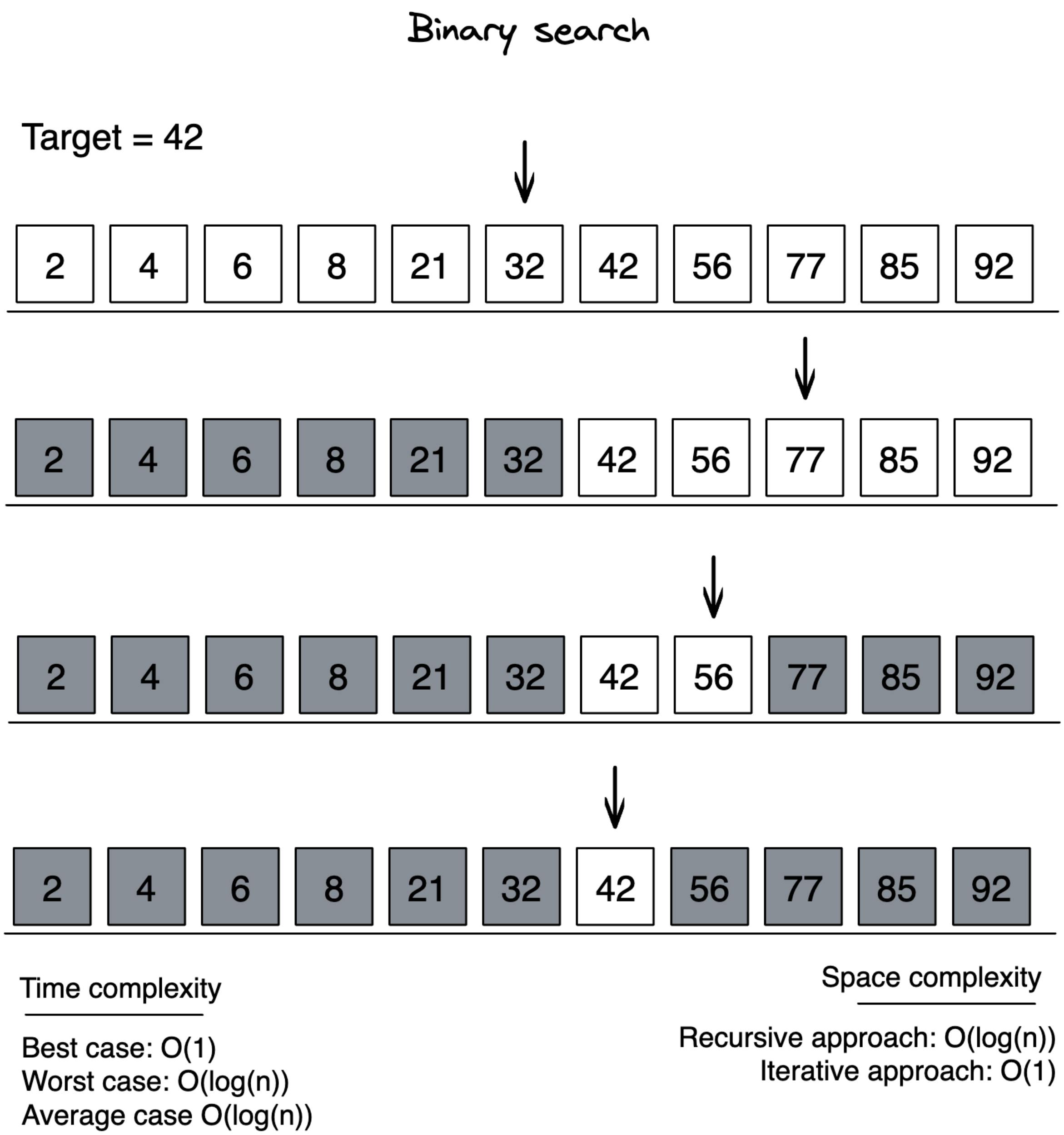

Figure 1: Binary search

```java
            int value = array[middle];

            if(value < target) {
                low = middle + 1;
            } else if(value > target) {
                high = middle - 1;

            } else {
                return middle;
            }
        }
        return -1;
    }
}
```

~~~~
def binary_search(list, item):
    low = 0
    high = len(list) - 1
    while low <= high:
        mid = (low+high)/2
        guess = list[mid]
        if guess == item:
            return mid
        if guess > item:
            high = mid - 1
        else:
            low = mid +1
    return None

my_list = [1, 3, 5, 7, 9]

res = binary_search(my_list, 3)

print(my_list[res])
```### Binary tree in order traversal


```java
class Solution {


    List<Integer> getInOrderTraversal(Node root) {
        List<Integer> list = new ArrayList<Integer>();
        Stack<Node> stack = new Stack<>();
        Node node = root;

        while(node != null || !stack.isEmpty()) {
            while(node != null) {
                stack.push(node);
                node = node.left;
            }
            list.add(stack.peek().data);
            node = stack.pop().right;
~~~~

```
        }

        return list;
    }
}
```

Binary tree postorder traversal

```
class Solution {

    void utility(Node root, List<Integer> traversal) {
        if(root == null) {
            return;
        }

        utility(root.left, traversal);
        utility(root.right, traversal);
        traversal.add(root.data);

    }

    List<Integer> getPostorderTraversal(Node root) {
        List<Integer> traversal = new ArrayList<Integer>();
        utility(root, traversal);
        return traversal;
    }
}
```

Binary tree preorder traversal

```
class Solution {

    void utility(Node root, List<Integer> traversal) {
        if(root == null) {
            return;
        }

        traversal.add(root.data);
        utility(root.left, traversal);
        utility(root.right, traversal);
    }

    List<Integer> getPreorderTraversal(Node root) {
        List<Integer> traversal = new ArrayList<Integer>();
        utility(root, traversal);
        return traversal;
    }
}
```

Bubble sort

```
function bubbleSort(array: number[] | string[]) {
    for (let i = 0; i < array.length; i++) {
        for (let j = 0; j < array.length - 1 - i; j++) {
            if (array[j] > array[j + 1]) {
                [array[j], array[j + 1]] = [array[j + 1], array[j]];
            }
        }
    }
    return array;
}

console.log(bubbleSort([2,5,2,6,7,2,22,5,7,9,0,2,3]))
```

```
    public static void bubbleSort(int[] array) {
        for(int i = 0; i < array.length - 1; i++) {
            for(int j = 0; j < array.length - i - 1; j++) {
                if(array[j] > array[j + 1]) {
                    int temp = array[j];
                    array[j] = array[j + 1];
                    array[j + 1] = temp;
                }
            }
        }
    }
```

Diffie hellman algorithm

```
function power(a: any, b: any, p: any) {
    if(b === 1) {
        return 1
    } else {
        return Math.pow(a,b) % p
    }
}


function DiffieHellman() {

    let P, G, x, a, y, b, ka, kb;

    P = 23

    console.log("The value of P :", P);

    G = 9;

    console.log("The value of G :", G);

    a = 4;
```

```
    console.log("The private key a for Alice : ", a);

    x = power(G,a,P);

    b = 3;

    console.log("The private key a for Bob : ", b);

    y = power(G,b,P);


    ka = power(y, a, P);
    kb = power(x, b, P);

    console.log("Secret key for the Alice is : ", ka);
    console.log("Secret key for the Bob is : ", kb);
}


DiffieHellman()
```

Graph adjacency list

```
public class GraphList {

    ArrayList<LinkedList<Node>> alist;


    GraphList() {
        alist = new ArrayList<>();
    }

    public void addNode(Node node) {
        LinkedList<Node> currentList = new LinkedList<>();
        currentList.add(node);
        alist.add(currentList);
    }

    public void addEdge(int src, int dst) {
        LinkedList<Node> currentList = alist.get(src);
        Node dstNode = alist.get(dst).get(0);
        currentList.add(dstNode);

    }
    public boolean checkEdge(int src, int dst) {
        LinkedList<Node> currentList = alist.get(src);
        Node dstNode = alist.get(dst).get(0);

        for(Node node: currentList) {
            if(node == dstNode) {
                return true;
```

```
            }
        }
        return false;

    }

    public void print() {
        for(LinkedList<Node> currentList : alist) {
            for(Node node: currentList) {
                System.out.print(node.data + " -> ");
            }
            System.out.println();
        }
    }
}
```

Graph adjacency matrix

```
public class Graph {
    ArrayList<Node> nodes;
    int[][] matrix;

    Graph(int size) {
        nodes = new ArrayList<>();
        matrix = new int[size][size];
    }

    public void addNode(Node node) {
        nodes.add(node);
    }

    public void addEdge(int src, int dst) {
        matrix[src][dst] = 1;
    }

    public boolean checkEdge(int src, int dst) {
        if(matrix[src][dst] == 1) {
            return true;
        } else {
            return false;
        }
    }

    public void print() {
        System.out.print("  ");
        for(Node node : nodes) {
            System.out.print(node.data + " ");
        }
        System.out.println();

        for(int i = 0; i < matrix.length; i++) {
            System.out.print(nodes.get(i).data + " ");
```

```
            for(int j =0; j < matrix[i].length; j++) {
                System.out.print(matrix[i][j] + " ");
            }
            System.out.println();
        }
    }
}
```

Insertion sort

TypeScript

```
function insertionSort(array: number[] | string[]) {
    for (let i = 1; i < array.length; i++) {
        let curr = array[i];
        let j = i - 1;
        for (j; j >= 0 && array[j] > curr; j--) {
            array[j + 1] = array[j];
        }
        array[j + 1] = curr;
    }
    return array;
}

console.log(insertionSort([1, 4, 2, 8, 345, 123, 43, 32, 5643, 63, 123, 43, 2, 55, 1, 234, 92]));
```

Java

```
    class Solution {
        void insertionSort (int[] arr) {
            int n = arr.length;
            for(int i = 1; i < n; i++) {
                int current = arr[i];
                int position = i - 1;
                while(position >= 0 && arr[position] > current) {
                    arr[position + 1] = arr[position];
                    position--;
                }
                arr[position + 1] = current;
            }
        }
    }
```

Interpolation search

```
class Solution {
```

```java
    private static int interpolationSearch(int[] array, int value) {
        int low = 0;
        int high = array.length - 1;

        while(value >=array[low] && value <= array[high] && low <= high) {
            int probe = low + (high - low) * (value - array[low]) / (array[high] - array[low]);
            if(array[probe] == value) {
                return probe;
            } else if(array[probe] > value) {
                low = probe + 1;
            } else {
                high = probe -1;
            }

        }

        return -1;
    }

}
```

Merge sort

Java

```java
class Solution {

    void merge(int[] arr, int low, int mid, int high) {
        int subArr1Size = mid - low + 1;
        int subArr2Size = high - mid;

        int [] subArr1 = new int[subArr1Size];
        int [] subArr2 = new int[subArr2Size];

        for (int i = 0; i < subArr1Size; i++) {
           subArr1[i] = arr[low + i];
         }
         for (int i = 0; i < subArr2Size; i++) {
           subArr2[i] = arr[mid + 1 + i];
        }
        int i = 0, j = 0, k = low;

        while(i < subArr1Size && j < subArr2Size) {
            if(subArr1[i] <= subArr2[j]) {
                arr[k] = subArr1[i];
                i++;
            } else {
                arr[k] = subArr2[j];
                j++;
            }
            k++;
```

```
        }
        while(i < subArr1Size) {
            arr[k++] = subArr1[i++];
        }
        while (j < subArr2Size) {
           arr[k++] = subArr2[j++];
       }
    }

    void mergesort(int[] arr, int low, int high){
        if(high > low) {
            int mid = (high + low) / 2;
            mergesort(arr, low, mid);
            mergesort(arr, mid + 1, high);
            merge(arr, low, mid, high);
        }
    }

    void mergeSort (int[] arr) {
        int n = arr.length;
        mergesort(arr, 0, n - 1);
    }
}
```

Quick sort

```
class Solution {

    int makePartition(int [] arr, int low, int high) {
        int pivot = arr[high];
        int currentIndex = low - 1;
        for(int i = low; i < high; i++) {
            if(arr[i] < pivot) {
                currentIndex++;
                int temp = arr[i];
                arr[i] = arr[currentIndex];
                arr[currentIndex] = temp;
            }

        }
        int temp = arr[high];
        arr[high] = arr[currentIndex + 1];
        arr[currentIndex + 1] = temp;
        return currentIndex + 1;
    }

    void quicksort(int[] arr, int low, int high) {
        if(low < high) {
            int pivot = makePartition(arr, low, high);
            quicksort(arr, low, pivot - 1);
            quicksort(arr, pivot + 1, high);
        }
```

```
    }

    void quickSort (int[] arr) {
        int n = arr.length;
        quicksort(arr, 0, n - 1);
    }
}
```

```
def quicksort(arr):
    if len(arr) < 2:
        return arr
    else:
        pivot = arr[len(arr)/2]
        less = [i for i in arr[1:] if i <= pivot]
        greater = [i for i in arr[1:] if i > pivot]
        return quicksort(less) + [pivot] + quicksort(greater)

print(quicksort([10,2,3,1,5,4]))
```

```
class Solution {
    static void swap(int[] array, int i, int j) {
        int temp = array[i];
        array[i] = array[j];
        array[j] = temp;
    }

    private static void quickSort(int[] array, int start, int end) {
        if(end <= start) return; // base case

        int pivot = partition(array, start, end);

        quickSort(array, start, pivot -1);
        quickSort(array, pivot + 1, end);
    }

    private static int partition(int[] array, int start, int end) {
        int pivot = array[end];

        int i = start - 1;

        for(int j = start; j <= end -1; j++) {
            if(array[j] < pivot) {
                i++;
                swap(array, i, j);
            }
        }
        i++;
        swap(array, i, end);

        return i;
    }
}
```

Selection sort

```
function selectionSort(array: any[]) {
  for (let i = 0; i < array.length - 1; i++) {
    let min = i;
    for (let j = i + 1; j < array.length; j++) {
      if (array[min] > array[j]) min = j;
    }
    [array[i], array[min]] =[array[min], array[i]]
  }
  return array;
}

console.log(selectionSort([1, 4, 2, 8, 345, 123, 43, 32, 5643, 63, 123, 43, 2, 55, 1, 234, 92]));
```

```
    public static void selectionSort(int[] array) {
        for(int i = 0; i < array.length - 1; i++) {
            int min = i;
            for(int j = i + 1; j < array.length; j++) {
                if(array[min] > array[j]) {
                    min = j;
                }
            }
            int temp = array[i];
            array[i] = array[min];
            array[min] = temp;
        }
    }
```

```
print('This is selection sort')

def find_smallest(arr):
    smallest = arr[0]
    smallest_index = 0
    for i in range(1, len(arr)):
        if arr[i] < smallest:
            smallest = arr[i]
            smallest_index = i
    return smallest_index

def selection_sort(arr):
    newArr = []
    for i in range(len(arr)):
        smallest = find_smallest(arr)
        newArr.append(arr.pop(smallest))
    return newArr

print(selection_sort([5,4,6,2,1,123, 2, 3,1,23 ,1,1,]))
```

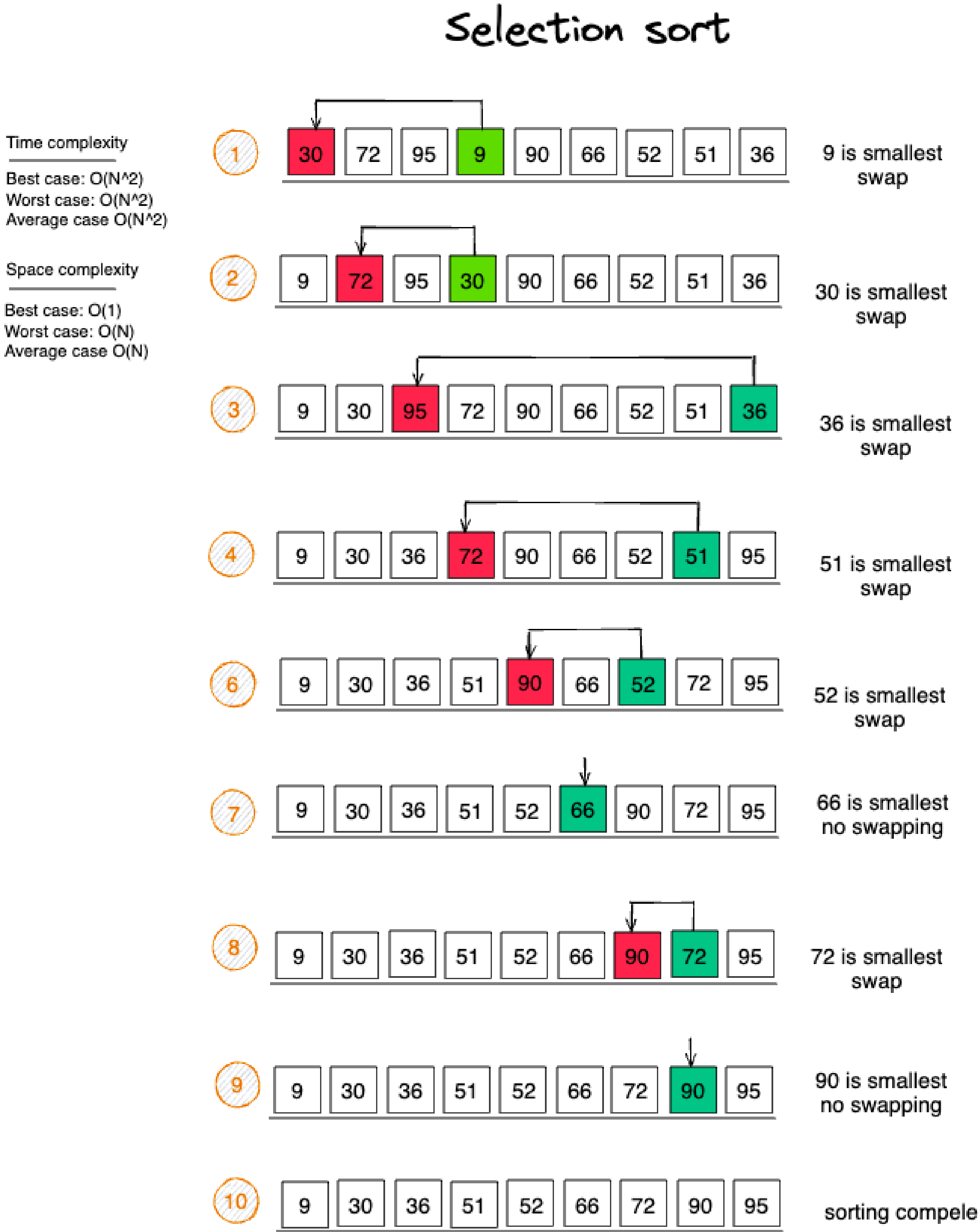

Figure 2: Selection sort