



## **Experiment No. 4**

**Title:** Implementation of problem using Greedy Programming Approach



**Batch: A2****Roll No: 16010421059****Experiment No.:4**

**Aim:** To study Greedy Programming approach for implementation of problem statement to obtain optimal solution.

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**Resources needed:** Text Editor, C/C++ IDE

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### **Theory:**

Greedy Programming is a problem-solving strategy that makes locally optimal decisions at each stage to achieve a globally optimum solution. This simple, intuitive algorithm can be applied to solve any optimization problem which requires the maximum or minimum optimum result

### **What is Greedy Programming?**

A greedy algorithm is any algorithm that follows the problem-solving heuristic of making the locally optimal choice at each stage. In many problems, a greedy strategy does not produce an optimal solution, but a greedy heuristic can yield locally optimal solutions that approximate a globally optimal solution in a reasonable amount of time.

Greedy algorithms work on problems for which it is true that, at every step, there is a choice that is optimal for the problem up to that step, and after the last step, the algorithm produces the optimal solution of the complete problem. To make a greedy algorithm, there is need to identify an optimal substructure or subproblem in the problem.

### **Steps for creating Greedy Algorithm -**

By following the steps given below, you will be able to formulate a greedy solution for the given problem statement:

Step 1: In a given problem, find the best substructure or subproblem.

Step 2: Determine what the solution will include (e.g., largest sum, shortest path).

Step 3: Create an iterative process for going over all subproblems and creating an optimum solution.

### **Why to use Greedy Programming -**

Here are some reasons for using Greedy Programming Approach –

- The greedy approach has a few tradeoffs, which may make it suitable for optimization.
- One prominent reason is to achieve the most feasible solution immediately. In the activity selection problem (Explained below), if more activities can be done before finishing the current activity, these activities can be performed within the same time.
- Another reason is to divide a problem recursively based on a condition, with no need to combine all the solutions.

### Example – Greedy Programming approach to find minimum number of coins.

Given a value  $V$ , if we want to make change for  $V$  Rs, and we have infinite supply of each of the denominations in Indian currency, i.e., we have infinite supply of  $D = \{ 1, 2, 5, 10, 20, 50, 100, 500, 1000 \}$  valued coins/notes, what is the minimum number of coins and/or notes needed to make the change?

Input:  $V = 121$

Output: 3

Here, we need a 100 Rs note, a 20 Rs note and a 1 Rs coin.

The idea to implement Greedy Algorithm is start from largest possible denomination and keep adding denominations while remaining value is greater than 0. Below is complete algorithm.

- 1) Initialize result array  $S$  as empty.
  - 2) Find the largest denomination that is smaller than  $V$ .
  - 3) Add chosen denomination to result. Subtract value of chosen denomination from  $V$ .
  - 4) If  $V$  becomes 0, then print result.
- Else repeat steps 2 and 3 for new value of  $V$

### Limitation –

The limitation of the greedy algorithm is that it may not provide an optimal solution for some denominations. For example, the above algorithm fails to obtain the optimal solution for  $D = \{1, 6, 10\}$  and  $V = 13$ . In particular, it would provide a solution with four coins, i.e.,  $S = \{10, 1, 1, 1\}$ .

However, the optimal solution for the said problem is three coins, i.e.  $S = \{6, 6, 1\}$

The reason is that the greedy algorithm builds the solution in a step-by-step manner. At each step, it picks a locally optimal choice in anticipation of finding a globally optimal solution. As a result, the greedy algorithm sometimes traps in the local optima and thus could not provide a globally optimal solution.

As an alternative, we can use a dynamic programming approach to ascertain an optimal solution for general input.

### **Activity:**

You are given a number  $N$ .

You are required to form two numbers  $X$  and  $Y$  such that:

- The sum of frequency of each digit in  $X$  and  $Y$  is equal to frequency of that digit in  $N$ .
- The sum of numbers  $X$  and  $Y$  must be minimum.

Your task is to determine the minimum possible sum of  $X$  and  $Y$ .

### **Input format**

The first line contains an integer  $T$  that denotes the number of test cases.

For each test case:

The first line contains an integer  $N$ .

### **Output format**

For each test case, you are required to print the minimum possible sum of  $X$  and  $Y$  in a new line.

### **Constraints**

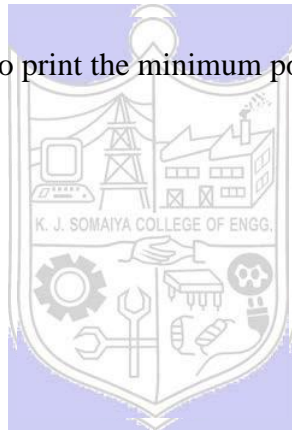
$$1 \leq T \leq 10^5 \quad 10 \leq N \leq 2 \times 10^{18}$$

### **Sample Input**

```
2
1321
42255
```

### **Sample Output**

```
25
270
```



### **Solution:**

```
#include <bits/stdc++.h>

using namespace std;

int main()
{
    int t;
    int i;

    cout<<"Enter the number of test cases: ";
    cin>>t;
    for(i=0;i<t;i++)
```

```

{
    int s;
    cout<<"Enter the number: ";
    cin>>s;
    vector<int> a;
    vector<int> b;
    vector<int> c;
    while(s>0)
    {
        a.push_back(s%10);
        s/=10;
    }
    sort(a.begin(), a.end());
    for(int i=0; i<a.size(); i++)
    {
        if(i%2==0)
        {
            b.push_back(a[i]);
        }
        else
        {
            c.push_back(a[i]);
        }
    }
    int result = 0;
    for (auto d : b)
    {
        result = result * 10 + d;
    }

    long long int result_1 = 0;
    for (auto d : c)
    {
        result_1 = result_1 * 10 + d;
    }
    cout<<"The required output is: ";
    cout<<result+result_1<<endl;

}

return 0;
}

```

```
Enter the number of test cases: 2
Enter the number: 14397
The required output is: 186
Enter the number: 93774
The required output is: 426

...Program finished with exit code 0
Press ENTER to exit console.
```

Log ID: 226968996 / Mar 01, 2023 12:19 PM IST

RESULT: Sample Test Cases Passed ?

[? Refer judge environment](#)

Note: When you **Compile & Test code**, the code is run against sample inputs. When you **Submit code**, the code is run against sample input as well as multiple hidden test cases. In order to solve the problem, your code must pass all of the test cases.

Time (sec)	Memory (KiB)	Language
0.010228	2	C++17

#### Input

```
2
1321
42255
```

#### Output

```
25
270
```

#### Expected Correct Output

```
25
270
```

### Test against custom input



Test against custom input ▲

Compile &amp; Test code

Submit code

```
4
1321
4563
7632
1382
```

Log ID: 226968883 / Mar 01, 2023 12:16 PM IST

RESULT: ❌ Wrong Answer

[? Refer judge environment](#)

Note: When you **Compile & Test code**, the code is run against sample inputs. When you **Submit code**, the code is run against sample input as well as multiple hidden test cases. In order to solve the problem, your code must pass all of the test cases.

Time (sec)	Memory (KiB)	Language
0.010103	2	C++17

## Input

```
4
1321
4563
7632
1382
```

## Output





















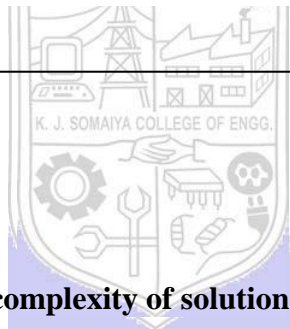
## Output

```
25
81
63
41
```

RESULT:  Partially accepted[Refer judge environment](#)

Score	Time (sec)	Memory (KiB)	Language
0	0.26731	356	C++17

Input	Result	Time (sec)	Memory (KiB)	Score	Your Output	Correct Output	Diff
Input #1	✓ Accepted	0.099323	356	4			
Input #2	✗ Wrong answer	0.082065	356	0			
Input #3	✗ Wrong answer	0.059107	356	0			
Input #4	✓ Accepted	0.008937	2	20			
Input #5	✓ Accepted	0.008981	2	20			
Input #6	✗ Wrong answer	0.008895	2	0			

**Outcomes:****CO2: Analyse the time and space complexity of solution and optimize the solution.****Conclusion: (Conclusion to be based on the objectives and outcomes achieved)**

We Understood the Greedy Programming approach for implementation of problem statement to obtain optimal solution.



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**References:**

1. <https://tutorialspoint.dev/algorithm/greedy-algorithms/greedy-algorithm-to-find-minimum-number-of-coins>
2. <https://www.baeldung.com/cs/min-number-of-coins-algorithm>

