

PRACTICAL NO : 06

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Date : 14/10/25

Aim: Construction of OBST

Problem Statement: Smart Library Search
Optimization

Task 1:

Scenario:

A university digital library system stores frequently accessed books using a binary search mechanism. The library admin wants to minimize the average search time for book lookups by arranging the book IDs optimally in a binary search tree. Each book ID has a probability of being searched successfully and an associated probability for unsuccessful searches (when a book ID does not exist between two keys).

Your task is to determine the minimum expected cost of searching using an Optimal Binary Search Tree (OBST).

Code :

```
#include <stdio.h>
#include <stdlib.h>
#include <float.h>
#define MAX 100
double e[MAX][MAX];
double w[MAX][MAX];
int root[MAX][MAX];
double min(double a, double b) {
    return a < b ? a : b;
}
int main() {
    int n;
    printf("Enter the number of book IDs (n): ");
    scanf("%d", &n);
    int keys[n + 1];
    double p[n + 1];
```

```
double q[n + 2];

printf("Enter %d space-separated book IDs:\n", n);

for (int i = 1; i <= n; i++) {

    scanf("%d", &keys[i]);

}

printf("Enter %d space-separated probabilities of
successfu searches (p[1] to p[%d]):\n", n, n);

for (int i = 1; i <= n; i++) {

    scanf("%lf", &p[i]);

}

printf("Enter %d space-separated probabilities of
unsuccessful searches (q[0] to q[%d]):\n", n + 1, n);

for (int i = 0; i <= n; i++) {

    scanf("%lf", &q[i]);

}

printf("\n Book IDs and Probabilities:\n");

for (int i = 1; i <= n; i++) {

    printf("Key: %d, Success Probability (p[%d]): %.2lf\n",
keys[i], i, p[i]);

}

for (int i = 0; i <= n; i++) {

    printf("Unsuccessful Probability (q[%d]): %.2lf\n", i, q[i]);
```

```
}
```

```
for (int i = 0; i <= n; i++) {
```

```
    e[i][i] = q[i];
```

```
    w[i][i] = q[i];
```

```
}
```

```
for (int l = 1; l <= n; l++) {
```

```
    for (int i = 0; i <= n - l; i++) {
```

```
        int j = i + l;
```

```
        e[i][j] = DBL_MAX;
```

```
        w[i][j] = w[i][j - 1] + p[j] + q[j];
```

```
        for (int r = i + 1; r <= j; r++) {
```

```
            double cost = e[i][r - 1] + e[r][j] + w[i][j];
```

```
            if (cost < e[i][j]) {
```

```
                e[i][j] = cost;
```

```
                root[i][j] = r;
```

```
            }
```

```
        }
```

```
    }
```

```
}
```

```
printf("\n Minimum expected cost of the Optimal Binary  
Search Tree:%.4lf\n", e[0][n]);  
  
return 0;  
  
}
```

Output :

```
Enter the number of book IDs (n): 4  
Enter 4 space-separated book IDs:  
10  
20  
30  
40  
Enter 4 space-separated probabilities of successfu searches (p[1] to p[4]):  
0.1  
0.2  
0.4  
0.3  
Enter 5 space-separated probabilities of unsuccessful searches (q[0] to q[4]):  
0.05  
0.1  
0.05  
0.05  
0.1  
  
Book IDs and Probabilities:  
Key: 10, Success Probability (p[1]): 0.10  
Key: 20, Success Probability (p[2]): 0.20  
Key: 30, Success Probability (p[3]): 0.40  
Key: 40, Success Probability (p[4]): 0.30  
Unsuccessful Probability (q[0]): 0.05  
Unsuccessful Probability (q[1]): 0.10  
Unsuccessful Probability (q[2]): 0.05  
Unsuccessful Probability (q[3]): 0.05  
Unsuccessful Probability (q[4]): 0.10  
  
Minimum expected cost of the Optimal Binary Search Tree:2.9000  
  
=== Code Execution Successful ===
```

Task 2:

<https://www.geeksforgeeks.org/problems/optimal-binary-search-tree2214/1>

Problem Solved Successfully ✓

Test Cases Passed: **104 / 104**

Attempts: Correct / Total: **1 / 2**

Accuracy: 50%

Points Scored: **8 / 8**

Time Taken: **0.33**

Your Total Score: 8 ↑

Solve Next

- Fixing Two nodes of a BST
- Strictly Increasing Array
- Word Wrap

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```
1 class Solution {
2
3 private static int sum(int freq[], int i, int j) {
4     int s = 0;
5     for (int k = i; k <= j; k++) s += freq[k];
6     return s;
7 }
8
9 static int optimalSearchTree(int keys[], int freq[], int n){
10     int[][] dp = new int[n][n];
11     for (int i = 0; i < n; i++)
12         dp[i][i] = freq[i];
13
14     for (int l = 2; l <= n; l++) {
15         for (int i = 0; i <= n - l; i++) {
16             int j = i + l - 1;
17             dp[i][j] = Integer.MAX_VALUE;
18
19             for (int r = i; r <= j; r++) {
20                 int cost = ((r > i) ? dp[i][r - 1] : 0) +
21                     ((r < j) ? dp[r + 1][j] : 0) +
22                     sum(freq, i, j);
23                 dp[i][j] = Math.min(dp[i][j], cost);
24             }
25         }
26     }
27     return dp[0][n - 1];
28 }
29
30 public static void main(String[] args) {
31     int keys[] = {10, 12, 20};
32     int freq[] = {34, 8, 50};
33     int n = keys.length;
34     System.out.println("Minimum cost of BST is: " + optimalSearch
35         freq, n));
36 }
37 }
```

Code :

```
class Solution {

    private static int sum(int freq[], int i, int j) {

        int s = 0;

        for (int k = i; k <= j; k++) s += freq[k];

        return s;

    }

    static int optimalSearchTree(int keys[], int freq[], int n){

        int[][] dp = new int[n][n];
```

```

for (int i = 0; i < n; i++)
    dp[i][i] = freq[i];
for (int l = 2; l <= n; l++) {
    for (int i = 0; i <= n - l; i++) {
        int j = i + l - 1;
        dp[i][j] = Integer.MAX_VALUE;
        for (int r = i; r <= j; r++) {
            int cost = ((r > i) ? dp[i][r - 1] : 0) +
                ((r < j) ? dp[r + 1][j] : 0) +
                sum(freq, i, j);
            dp[i][j] = Math.min(dp[i][j], cost);
        }
    }
}
return dp[0][n - 1];
}

```

```

public static void main(String[] args) {
    int keys[] = {10, 12, 20};
    int freq[] = {34, 8, 50};
}

```

```
int n = keys.length;  
  
System.out.println("Minimum cost of BST is: " +  
optimalSearchTree(keys,  
freq, n));  
  
}  
  
}
```