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Practical 6

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).

Input Format

First line: integer n — number of book IDs.

Second line: n integers representing the sorted book IDs (keys).

Third line: n real numbers — probabilities of successful searches (p[i]).

Fourth line: n+1 real numbers — probabilities of unsuccessful searches (q[i]).

Keys: 10 20 30 40

P[i]: 0.1 0.2 0.4 0.3

Q[i]: 0.05 0.1 0.05 0.05 0.1

Output Format

Print the minimum expected cost of the Optimal Binary Search Tree, rounded to 4 decimal

places.

CODE :

```
#include <stdio.h>

#include <float.h>


// Function to find the minimum expected cost of OBST

void optimalBST(int n, int keys[], double p[], double q[]) {

    double e[n + 2][n + 1];  // Expected cost

    double w[n + 2][n + 1];  // Weight (sum of probabilities)

    int root[n + 1][n + 1];  // Root table (for possible reconstruction if needed)


    // Initialization for trees with zero keys

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

        e[i][i - 1] = q[i - 1];

        w[i][i - 1] = q[i - 1];

    }


    // Compute optimal cost for all chain lengths

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

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

            int j = i + l - 1;

            e[i][j] = DBL_MAX;

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

```
            // Try all possible roots for the subtree
            for (int r = i; r <= j; r++) {
                double t = e[i][r - 1] + e[r + 1][j] + w[i][j];
                if (t < e[i][j]) {
                    e[i][j] = t;
                    root[i][j] = r;
                }
            }
        }
    }

    printf("\n---------------------------------------------\n");
    printf("  Optimal Binary Search Tree Construction\n");
    printf("---------------------------------------------\n");
    printf("Minimum Expected Cost of Search = %.4f\n", e[1][n]);
    printf("---------------------------------------------\n");
}

int main() {
    int n;
    printf("Enter number of book IDs: ");
    scanf("%d", &n);

    int keys[n];
    double p[n], q[n + 1];

    printf("Enter the sorted book IDs:\n");
    for (int i = 0; i < n; i++)
```

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

    printf("Enter the probabilities of successful searches (P[i]):\n");
    for (int i = 0; i < n; i++)
        scanf("%lf", &p[i]);

    printf("Enter the probabilities of unsuccessful searches (Q[i]):\n");
    for (int i = 0; i <= n; i++)
        scanf("%lf", &q[i]);

    optimalBST(n, keys, p, q);

    return 0;
}
```

OUTPUT:

Output | Clear

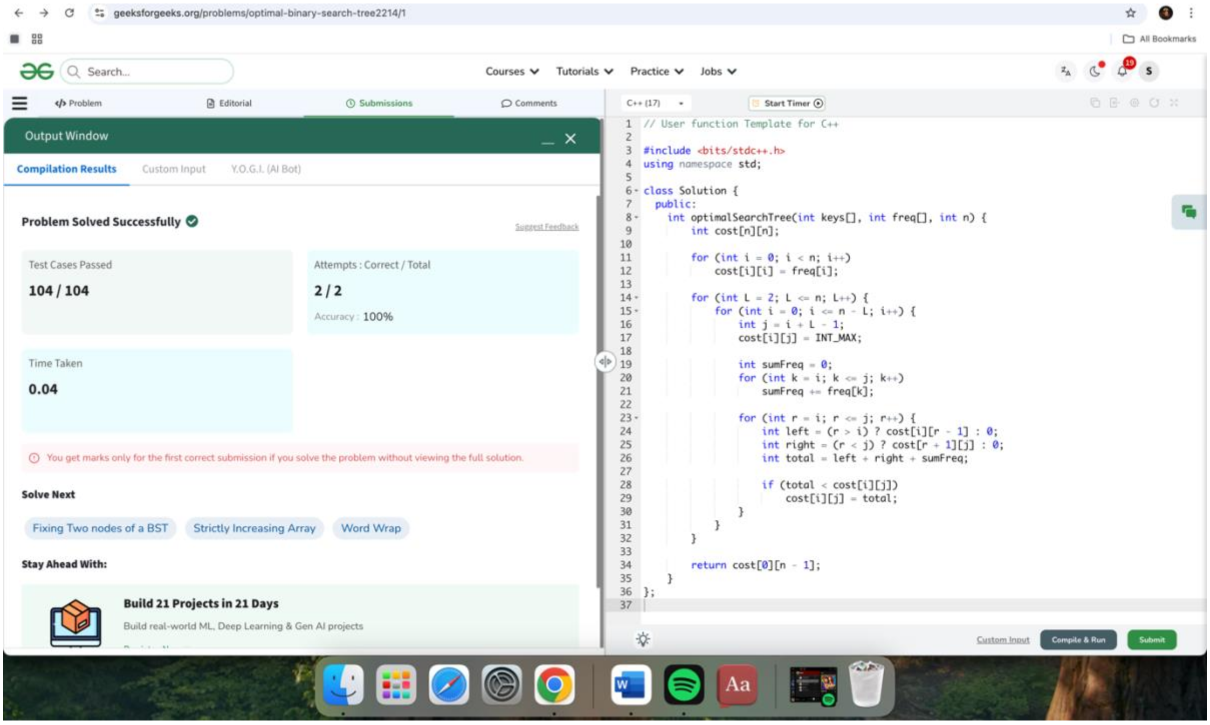
```
Enter number of book IDs: 4
Enter the sorted book IDs:
10
20
30
40
Enter the probabilities of successful searches (P[i]):
0.1
0.2
0.4
0.3
Enter the probabilities of unsuccessful searches (Q[i]):
0.05
0.1
0.05
0.05
0.1

---------------------------------------------
  Optimal Binary Search Tree Construction
---------------------------------------------
Minimum Expected Cost of Search = 2.9000
---------------------------------------------


=== Code Execution Successful ===
```

Task 2:

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




```
#include <bits/stdc++.h>
using namespace std;

class Solution {
 public:
  int optimalSearchTree(int keys[], int freq[], int n) {
    int cost[n][n];

    for (int i = 0; i < n; i++)
      cost[i][i] = freq[i];

    for (int L = 2; L <= n; L++) {
      for (int i = 0; i <= n - L; i++) {
```

```
            int j = i + L - 1;
            cost[i][j] = INT_MAX;

            int sumFreq = 0;
            for (int k = i; k <= j; k++)
                sumFreq += freq[k];

            for (int r = i; r <= j; r++) {
                int left = (r > i) ? cost[i][r - 1] : 0;
                int right = (r < j) ? cost[r + 1][j] : 0;
                int total = left + right + sumFreq;

                if (total < cost[i][j])
                    cost[i][j] = total;
            }
        }
    }

    return cost[0][n - 1];
}
};
```