Name: Vinayak Madan Shete

Roll No.: TYCOC303

Div: C   Batch: C4

Course Name: Design and Analysis of Algorithms Laboratory

Course Code: BCE5412

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Assignment 06:Implementing Job Assignment Problem.

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Input:

```
// Program to solve Job Assignment problem
// using Branch and Bound
#include <bits/stdc++.h>
using namespace std;
#define N 4

// state space tree node
struct Node
{
     // stores parent node of current node
     // helps in tracing path when answer is found
     Node* parent;

     // contains cost for ancestors nodes
     // including current node
     int pathCost;

     // contains least promising cost
     int cost;
```

```
    // contain worker number
    int workerID;

    // contains Job ID
    int jobID;

    // Boolean array assigned will contains
    // info about available jobs
    bool assigned[N];
};
// Function to allocate a new search tree node
// Here Person x is assigned to job y
Node* newNode(int x, int y, bool assigned[],
               Node* parent)
{
    Node* node = new Node;

    for (int j = 0; j < N; j++)
        node->assigned[j] = assigned[j];
    node->assigned[y] = true;

    node->parent = parent;
    node->workerID = x;
    node->jobID = y;

    return node;
}
// Function to calculate the least promising cost
// of node after worker x is assigned to job y.
int calculateCost(int costMatrix[N][N], int x,
                    int y, bool assigned[])
{
     int cost = 0;

     // to store unavailable jobs
     bool available[N] = {true};
     // start from next worker
     for (int i = x + 1; i < N; i++)
     {
          int min = INT_MAX, minIndex = -1;

          // do for each job
          for (int j = 0; j < N; j++)
          {
               // if job is unassigned
               if (!assigned[j] && available[j] &&
                    costMatrix[i][j] < min)
               {
                    // store job number
                    minIndex = j;

                    // store cost
                    min = costMatrix[i][j];
               }
          }
          // add cost of next worker
          cost += min;

          // job becomes unavailable
          available[minIndex] = false;
     }
     return cost;
}
// Comparison object to be used to order the heap
struct comp
{
     bool operator()(const Node* lhs,
                    const Node* rhs) const
     {
          return lhs->cost > rhs->cost;
     }
};
// print Assignments
void printAssignments(Node *min)
{
     if(min->parent==NULL)
          return;
     printAssignments(min->parent);
     cout << "Assign Worker " << char(min->workerID + 'A')
          << " to Job " << min->jobID << endl;
}
// Finds minimum cost using Branch and Bound.
int findMinCost(int costMatrix[N][N])
{
     // Create a priority queue to store live nodes of
     // search tree;
     priority_queue<Node*, std::vector<Node*>, comp> pq;

     // initialize heap to dummy node with cost 0
     bool assigned[N] = {false};
     Node* root = newNode(-1, -1, assigned, NULL);
     root->pathCost = root->cost = 0;
```

```
root->workerID = -1;
// Add dummy node to list of live nodes;
pq.push(root);
// Finds a live node with least cost,
// add its childrens to list of live nodes and
// finally deletes it from the list.
while (!pq.empty())
{
// Find a live node with least estimated cost
Node* min = pq.top();
// The found node is deleted from the list of
// live nodes
pq.pop();
// i stores next worker
int i = min->workerID + 1;
// if all workers are assigned a job
if (i == N)
{
     printAssignments(min);
     return min->cost;
}
// do for each job
for (int j = 0; j < N; j++)
{
     // If unassigned
     if (!min->assigned[j])
     {
     // create a new tree node
     Node* child = newNode(i, j, min->assigned, min);
     // cost for ancestors nodes including current node
     child->pathCost = min->pathCost + costMatrix[i][j];
```

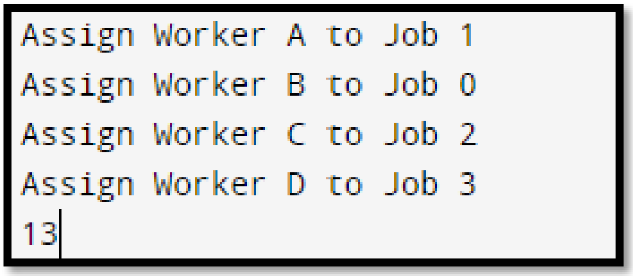
```
            // calculate its lower bound
            child->cost = child->pathCost +
                 calculateCost(costMatrix, i, j, child->assigned);
            // Add child to list of live nodes;
            pq.push(child);
            }
        }
        }
}
// Driver code
int main()
{
        // x-coordinate represents a Worker
        // y-coordinate represents a Job
        int costMatrix[N][N] =
        {
            {9, 2, 7, 8},
            {6, 4, 3, 7},
            {5, 8, 1, 8},
            {7, 6, 9, 4}
        };
        /* int costMatrix[N][N] =
        {
            {82, 83, 69, 92},
            {77, 37, 49, 92},
            {11, 69, 5, 86},
            { 8, 9, 98, 23}
        };
        */
        /* int costMatrix[N][N] =
        {
```

```
        {2500, 4000, 3500},
        {4000, 6000, 3500},
        {2000, 4000, 2500}
    };*/

    /*int costMatrix[N][N] =
    {
        {90, 75, 75, 80},
        {30, 85, 55, 65},
        {125, 95, 90, 105},
        {45, 110, 95, 115}
    };*/
    cout << "\nOptimal Cost is "
        << findMinCost(costMatrix);

    return 0;
}
```

Output:



```
Assign Worker A to Job 1
Assign Worker B to Job 0
Assign Worker C to Job 2
Assign Worker D to Job 3
13
```

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