AI/ML
Assignment 2 2020BTECS00087 OMKAR UGALE

M	T	W	T	F	S	S

Page No.:
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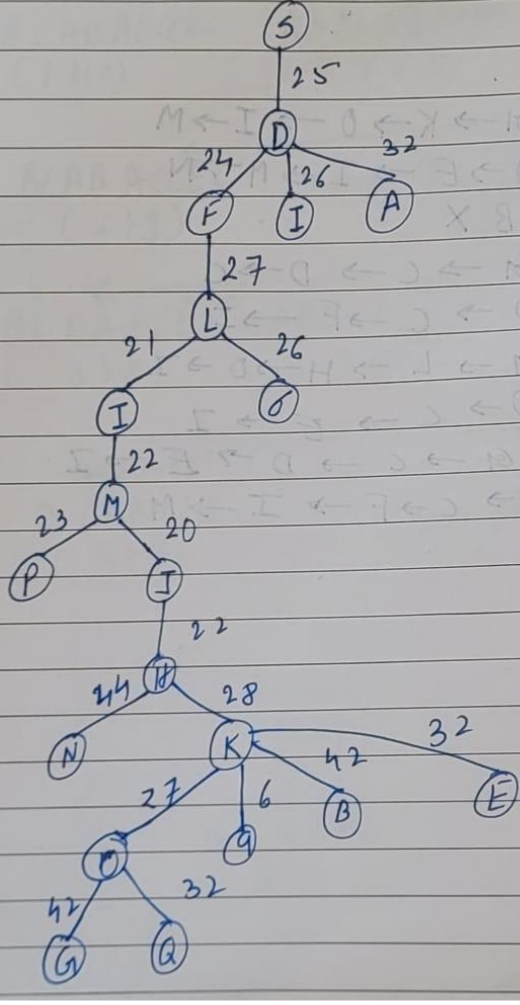
YOUVA

Q1. S(0,0), F(2,0), J(3,1), G(6,3), A(0,3), O(5,1)
P(5,4), I(3,3), N(4,6), K(2,6)



Page No.:
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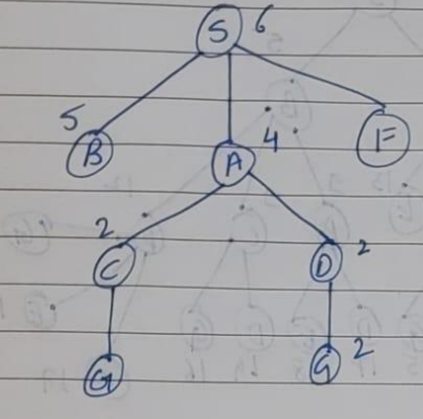
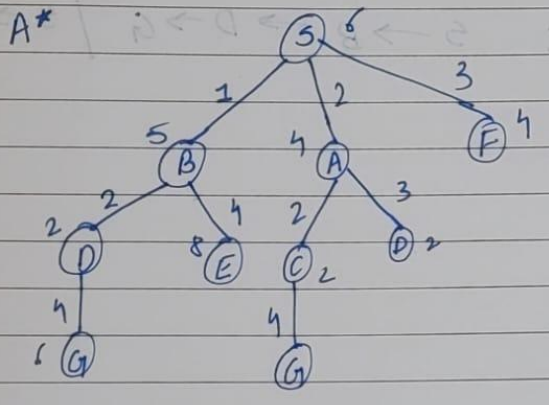
Q2. Best First Search:-



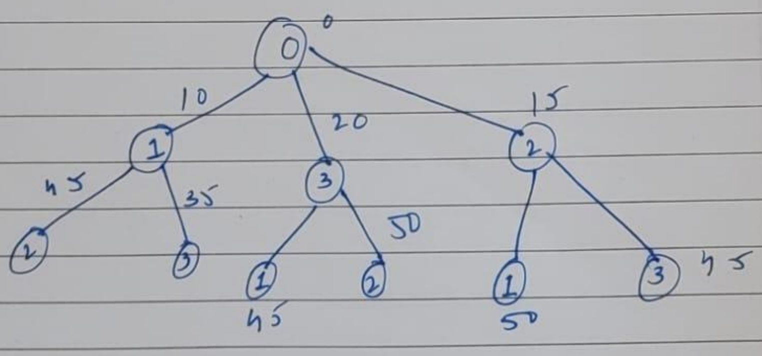
TC : O(N log N)
SC : O(V)

A*



TC : (O(E)
SC : O(V)

Q4)



Path: 0 → 1 → 3 → 2 → 0
Total cost = 80

```cpp
/* Editor: Omkar Ugale
DATE - 22-Sep-2022 TIME - 10:02:50*/
#include <bits/stdc++.h>
using namespace std;
typedef long long int ll;
#define mod 1000000007
#define N 4
void file()
{
#ifndef ONLINE_JUDGE
    freopen("input.txt", "r", stdin);
    freopen("output.txt", "w", stdout);
#endif
}
ll binpow(ll a, ll b)
{
    ll ans = 1;
    while (b > 0)
    {
        if ((b & 1) == 1)
            ans *= a;
        a *= a;
        b = b >> 1;
    }
    return ans;
}
ll gcd(ll a, ll b)
{
    if (b == 0)
        return a;
    return gcd(b, a % b);
}
ll lcm(ll a, ll b)
{
    return (a / gcd(a, b)) * b;
}
struct Node
{
    vector<pair<ll, ll>> path;
    ll rm[N][N];
    ll c;
    ll v;
    ll l;
};
Node *newNode(ll pm[N][N], vector<pair<ll, ll>> const &path, ll l, ll
i,
              ll j)
{
    Node *node = new Node;
    node->path = path;
    if (l != 0)
        node->path.push_back({i, j});
    memcpy(node->rm, pm,
           sizeof node->rm);
    for (ll k = 0; l != 0 && k < N; k++)
    {
        node->rm[i][k] = INT_MAX;
        node->rm[k][j] = INT_MAX;
    }
    node->rm[j][0] = INT_MAX;
    node->l = l;
    node->v = j;
    return node;
}
ll rowReduction(ll rm[N][N], ll row[N])
{
    fill_n(row, N, INT_MAX);
    for (ll i = 0; i < N; i++)
    {
        for (ll j = 0; j < N; j++)
        {
            if (rm[i][j] < row[i])
            {
                row[i] = rm[i][j];
            }
        }
    }
    for (ll i = 0; i < N; i++)
    {
        for (ll j = 0; j < N; j++)
        {
            if (rm[i][j] != INT_MAX && row[i] != INT_MAX)
            {
                rm[i][j] -= row[i];
            }
        }
    }
    return 0;
}
ll columnReduction(ll rm[N][N], ll col[N])
{
    fill_n(col, N, INT_MAX);
    for (ll i = 0; i < N; i++)
    {
        for (ll j = 0; j < N; j++)
        {
            if (rm[i][j] < col[j])
            {
                col[j] = rm[i][j];
            }
        }
    }
    for (ll i = 0; i < N; i++)
    {
        for (ll j = 0; j < N; j++)
        {
            if (rm[i][j] != INT_MAX && col[j] != INT_MAX)
            {
                rm[i][j] -= col[j];
            }
        }
    }
    return 0;
}
```

```cpp
ll total(ll rm[N][N])
{
    ll c = 0;
    ll row[N];
    rowReduction(rm, row);
    ll col[N];
    columnReduction(rm, col);
    for (ll i = 0; i < N; i++)
    {
        c += (row[i] != INT_MAX) ? row[i] : 0;
        c += (col[i] != INT_MAX) ? col[i] : 0;
    }
    return c;
}
struct minHeap
{
    bool operator()(const Node *lhs, const Node *rhs) const
    {
        return lhs->c > rhs->c;
    }
};
ll solve(ll graph[N][N])
{
    priority_queue<Node *, vector<Node *>, minHeap> pq;
    vector<pair<ll, ll>> v;
    Node *root = newNode(graph, v, 0, -1, 0);
    root->c = total(root->rm);
    pq.push(root);
    while (!pq.empty())
    {
        Node *min = pq.top();
        pq.pop();
        ll i = min->v;
        if (min->l == N - 1)
        {
            min->path.push_back(make_pair(i, 0));
            return min->c;
        }
        for (ll j = 0; j < N; j++)
        {
            if (min->rm[i][j] != INT_MAX)
            {
                Node *child = newNode(min->rm, min->path, min->l + 1,
i,
                                      j);
                child->c = min->c + min->rm[i][j] + total(child->rm);
                pq.push(child);
            }
        }
        delete min;
    }
    return 0;
}
void solve()
{
    ll graph[N][N] = {{INT_MAX, 10, 15, 20},
                      {10, INT_MAX, 35, 25},
                      {15, 35, INT_MAX, 30},
                      {20, 25, 30, INT_MAX}};
    cout << endl
         << "Total Cost : " << solve(graph) << endl;
}
int main()
{
    file();
    ios_base::sync_with_stdio(false);
    cin.tie(NULL);
    int t = 1;
    // cin >> t;
    while (t--)
    {
        solve();
    }
    return 0;
}
```