STATE UNIVERSITY OF BANGLADESH (SUB)

Course No:

Course Name:

Semester:

Submitted to:

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```
#include<bits/stdc++.h>
using namespace std;
#define D(x) cerr<<__LINE__<<" : "<<#x<<" -> "<<x<<endl
#define rep(i,j) for(int i = 0; i < 3; i++) for(int j = 0; j < 3; j++)
#define PII pair < int, int >
typedef vector<vector<int>> vec2D;
const int MAX = 1e5+7;
int t=1, n, m, l, k, tc;
int dx[4] = {0, 0, 1, -1};
int dy[4] = {1, -1, 0, 0};
vec2D init{
 {8, 1, 2},
 {3, 6, 4},
 {0, 7, 5}
};
vec2D goal{
 {1, 3, 2},
 {8, 0, 4},
 {7, 6, 5}
};
//vec2D init{// {1, 2, 3},
// {8, 6, 0},
// {7, 5, 4}
//};
//vec2D goal{
// {1, 2, 3},
// {8, 0, 4},
// {7, 6, 5}
//};
```

```
//vec2D init{
// {1, 3, 2},
// {4, 0, 7},
// {6, 5, 8}
//};
//vec2D goal{
// {0, 2, 4},
// {1, 3, 8},
// {6, 5, 7}
//};
struct Box {
 vec2D mat{ { 0,0,0 },{ 0,0,0},{ 0,0,0} };
 int diff, level;
 int x, y; int lastx, lasty;
 Box(vec2D a,int b = 0, int c = 0, PII p = {0,0}, PII q = {0,0}) {
 rep(i,j) mat[i][j] = a[i][j];
 diff = b;
 level = c;
 x = p.first;
 y = p.second;
 lastx = q.first;
 lasty = q.second;
 }
};
bool operator < (Box A, Box B) {
 if(A.diff == B.diff) return A.level < B.level;
 return A.diff < B.diff;
}
int isEqual(vec2D a, vec2D b) {
```

```
 int ret(0);
 rep(i,j) if (a[i][j] != b[i][j]) ret--;
 return ret;
}
bool check(int i, int j) { return i>=0 and i<3 and j>=0 and j<3;
}
void print(Box a) {
 rep(i,j)
 cout << a.mat[i][j] << (j == 2 ? "\n" : " ");
 D(-a.diff);
 D(-a.level);
 cout << "(" << a.x << "," << a.y <<")\n\n";
}
void dijkstra(int x, int y) {
 map < vec2D, bool > mp;
 priority_queue < Box > PQ;
 int nD = isEqual(init, goal);
 Box src = {init, nD, 0, {x,y}, {-1,-1}};
 PQ.push(src);
 int state = 0;
 while(!PQ.empty()) {
 state++;
 Box now = PQ.top();
 PQ.pop(); print(now);
 if(!now.diff) {
 puts("Goal state has been discovered");
 cout << "level : " << -now.level << "\n";
 D(state);
 break;
```

```
 }
 if(mp[now.mat]) continue;
 mp[now.mat] = true;
 for(int i = 0; i < 4; i++) {
 int xx = now.x + dx[i];
 int yy = now.y + dy[i];
 if(check(xx, yy)) {
 if(now.lastx == xx and now.lasty == yy) continue;
 Box temp = now;
 swap(temp.mat[temp.x][temp.y], temp.mat[xx][yy]);
 temp.diff = isEqual(temp.mat, goal);
 temp.level = now.level - 1;
 temp.x = xx;
 temp.y = yy;
 temp.lastx = now.x;
 temp.lasty = now.y;
 PQ.push(temp);
 } }
 }
}
signed main() {
 puts("Current State:");
 rep(i,j) cout << init[i][j] << (j == 2 ? "\n" : " ");
 puts("");
 puts("Goal State:");
 rep(i,j) cout << goal[i][j] << (j == 2 ? "\n" : " ");
 puts("\n.....Search Started.....\n");
 rep(i,j) if(!init[i][j]) dijkstra(i,j);
 return 0;
```

}

OUTPUT:

```
Current State:
8 1 2
3 6 4
0 7 5

Goal State:
1 3 2
8 0 4
7 6 5

.....Search Started.....

8 1 2
3 6 4
0 7 5
76 : -a.diff -> 6
77 : -a.level -> 0
(2,0)

8 1 2
3 6 4
7 0 5
76 : -a.diff -> 5
77 : -a.level -> 1
(2,1)

8 1 2
3 0 4
7 6 5
76 : -a.diff -> 3
77 : -a.level -> 2
(1,1)

8 1 2
0 3 4
7 6 5
76 : -a.diff -> 4
77 : -a.level -> 3
(1,0)
```

```
0 1 2
8 3 4
7 6 5
76 : -a.diff -> 3
77 : -a.level -> 4
(0,0)

1 0 2
8 3 4
7 6 5
76 : -a.diff -> 2
77 : -a.level -> 5
(0,1)

1 3 2
8 0 4
7 6 5
76 : -a.diff -> 0
77 : -a.level -> 6
(1,1)

Goal state has been discovered
level : 6
94 : state -> 7


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