1. Star

#include <bits/stdc++.h>

#define n 3

const bool SUCCESS = true;

using namespace std;

using i64 = long long int;

class state

{

public:

int board[n][n], g, f;

state \*came\_from;

state()

{

g = 0;

f = 0;

came\_from = NULL;

}

static int heuristic(state from, state to)

{

int ret = 0;

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

for (int j = 0; j < n; j++)

if (from.board[i][j] != to.board[i][j])

ret++;

return ret;

}

bool operator==(state a)

{

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

for (int j = 0; j < n; j++)

if (this->board[i][j] != a.board[i][j])

return false;

return true;

}

void print()

{

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

{

for (int j = 0; j < n; j++)

cout << board[i][j] << " ";

cout << endl;

}

cout << "g = " << g << " | f = " << f << endl;

cout << "---------------------------" << endl;

}

};

vector<state> output;

bool lowerF(state a, state b)

{

return a.f < b.f;

}

bool isinset(state a, vector<state> b)

{

for (int i = 0; i < b.size(); i++)

if (a == b[i])

return true;

return false;

}

void addNeighbor(state current, state goal, int newi, int newj, int posi, int posj, vector<state> &openset, vector<state> closedset)

{

state newstate = current;

swap(newstate.board[newi][newj], newstate.board[posi][posj]);

if (!isinset(newstate, closedset) && !isinset(newstate, openset))

{

newstate.g = current.g + 1;

newstate.f = newstate.g + state ::heuristic(newstate, goal);

state \*temp = new state();

\*temp = current;

newstate.came\_from = temp;

openset.push\_back(newstate);

}

}

void neighbors(state current, state goal, vector<state> &openset, vector<state> &closedset)

{

int i, j, posi, posj;

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

for (j = 0; j < n; j++)

if (current.board[i][j] == 0)

{

posi = i;

posj = j;

break;

}

i = posi, j = posj;

if (i - 1 >= 0)

addNeighbor(current, goal, i - 1, j, posi, posj, openset, closedset);

if (i + 1 < n)

addNeighbor(current, goal, i + 1, j, posi, posj, openset, closedset);

if (j + 1 < n)

addNeighbor(current, goal, i, j + 1, posi, posj, openset, closedset);

if (j - 1 >= 0)

addNeighbor(current, goal, i, j - 1, posi, posj, openset, closedset);

}

bool reconstruct\_path(state current, vector<state> &came\_from)

{

state \*temp = &current;

while (temp != NULL)

{

came\_from.push\_back(\*temp);

temp = temp->came\_from;

}

return SUCCESS;

}

bool astar(state start, state goal)

{

vector<state> openset;

vector<state> closedset;

state current;

start.g = 0;

start.f = start.g + state ::heuristic(start, goal);

openset.push\_back(start);

while (!openset.empty())

{

sort(openset.begin(), openset.end(), lowerF);

current = openset[0];

if (current == goal)

return reconstruct\_path(current, output);

openset.erase(openset.begin());

closedset.push\_back(current);

neighbors(current, goal, openset, closedset);

}

return !SUCCESS;

}

int main()

{

state start, goal;

cout << "Initial State : " << endl;

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

for (int j = 0; j < n; j++)

cin >> start.board[i][j];

cout << "Goal State : " << endl;

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

for (int j = 0; j < n; j++)

cin >> goal.board[i][j];

cout << "---------------------------" << endl;

if (astar(start, goal) == SUCCESS)

{

for (int i = output.size() - 1; i >= 0; i--)

output[i].print();

cout << "Success" << endl;

}

else

cout << "FAIL" << endl;

return 0;

}

Output:

/tmp/H7aemuaYji.o

Initial State :

2 8 3

1 6 4

7 0 5

Goal State :

2 0 3

1 8 4

7 6 5

---------------------------

2 8 3

1 6 4

7 0 5

g = 0 | f = 3

---------------------------

2 8 3

1 0 4

7 6 5

g = 1 | f = 3

---------------------------

2 0 3

1 8 4

7 6 5

g = 2 | f = 2

---------------------------

Success