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**Assignment no 2**

**Title: Implement A star algorithm for any game search**

**Code:**

#include <bits/stdc++.h>

using namespace std;

#define N 3

struct Node

{

Node\* parent;

// stores matrix

int mat[N][N];

// stores blank tile coordinates

int x, y;

// stores the number of misplaced tiles

int cost;

// stores the number of moves so far

int level;

};

// Function to print N x N matrix

int printMatrix(int mat[N][N])

{

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

{

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

printf("%d ", mat[i][j]);

printf("\n");

}

}

// Function to allocate a new node

Node\* newNode(int mat[N][N], int x, int y, int newX,

int newY, int level, Node\* parent)

{

Node\* node = new Node;

// set pointer for path to root

node->parent = parent;

// copy data from parent node to current node

memcpy(node->mat, mat, sizeof node->mat);

// move tile by 1 position

swap(node->mat[x][y], node->mat[newX][newY]);

// set number of misplaced tiles

node->cost = INT\_MAX;

// set number of moves so far

node->level = level;

// update new blank tile coordinates

node->x = newX;

node->y = newY;

return node;

}

// bottom, left, top, right

int row[] = { 1, 0, -1, 0 };

int col[] = { 0, -1, 0, 1 };

// Function to calculate the number of misplaced tiles

// ie. number of non-blank tiles not in their goal position

int calculateCost(int initial[N][N], int final[N][N])

{

int count = 0;

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

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

if (initial[i][j] && initial[i][j] != final[i][j])

count++;

return count;

}

// Function to check if (x, y) is a valid matrix coordinate

int isSafe(int x, int y)

{

return (x >= 0 && x < N && y >= 0 && y < N);

}

// print path from root node to destination node

void printPath(Node\* root)

{

if (root == NULL)

return;

printPath(root->parent);

printMatrix(root->mat);

printf("\n");

}

// Comparison object to be used to order the heap

struct comp

{

bool operator()(const Node\* lhs, const Node\* rhs) const

{

return (lhs->cost + lhs->level) > (rhs->cost + rhs->level);

}

};

// Function to solve N\*N - 1 puzzle algorithm using

// Branch and Bound. x and y are blank tile coordinates

// in initial state

void solve(int initial[N][N], int x, int y,

int final[N][N])

{

// Create a priority queue to store live nodes of

// search tree;

priority\_queue<Node\*, std::vector<Node\*>, comp> pq;

// create a root node and calculate its cost

Node\* root = newNode(initial, x, y, x, y, 0, NULL);

root->cost = calculateCost(initial, final);

// Add root 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();

// if min is an answer node

if (min->cost == 0)

{

// print the path from root to destination;

printPath(min);

return;

}

// do for each child of min

// max 4 children for a node

for (int i = 0; i < 4; i++)

{

if (isSafe(min->x + row[i], min->y + col[i]))

{

// create a child node and calculate

// its cost

Node\* child = newNode(min->mat, min->x,

min->y, min->x + row[i],

min->y + col[i],

min->level + 1, min);

child->cost = calculateCost(child->mat, final);

// Add child to list of live nodes

pq.push(child);

}

}

}

}

// Driver code

int main()

{

// Initial configuration

// Value 0 is used for empty space

int initial[N][N] =

{

{1, 2, 3},

{5, 6, 0},

{7, 8, 4}

};

// Solvable Final configuration

// Value 0 is used for empty space

int final[N][N] =

{

{1, 2, 3},

{5, 8, 6},

{0, 7, 4}

};

// Blank tile coordinates in initial

// configuration

int x = 1, y = 2;

solve(initial, x, y, final);

return 0;

}

**Output:**

