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N-puzzel *Document*

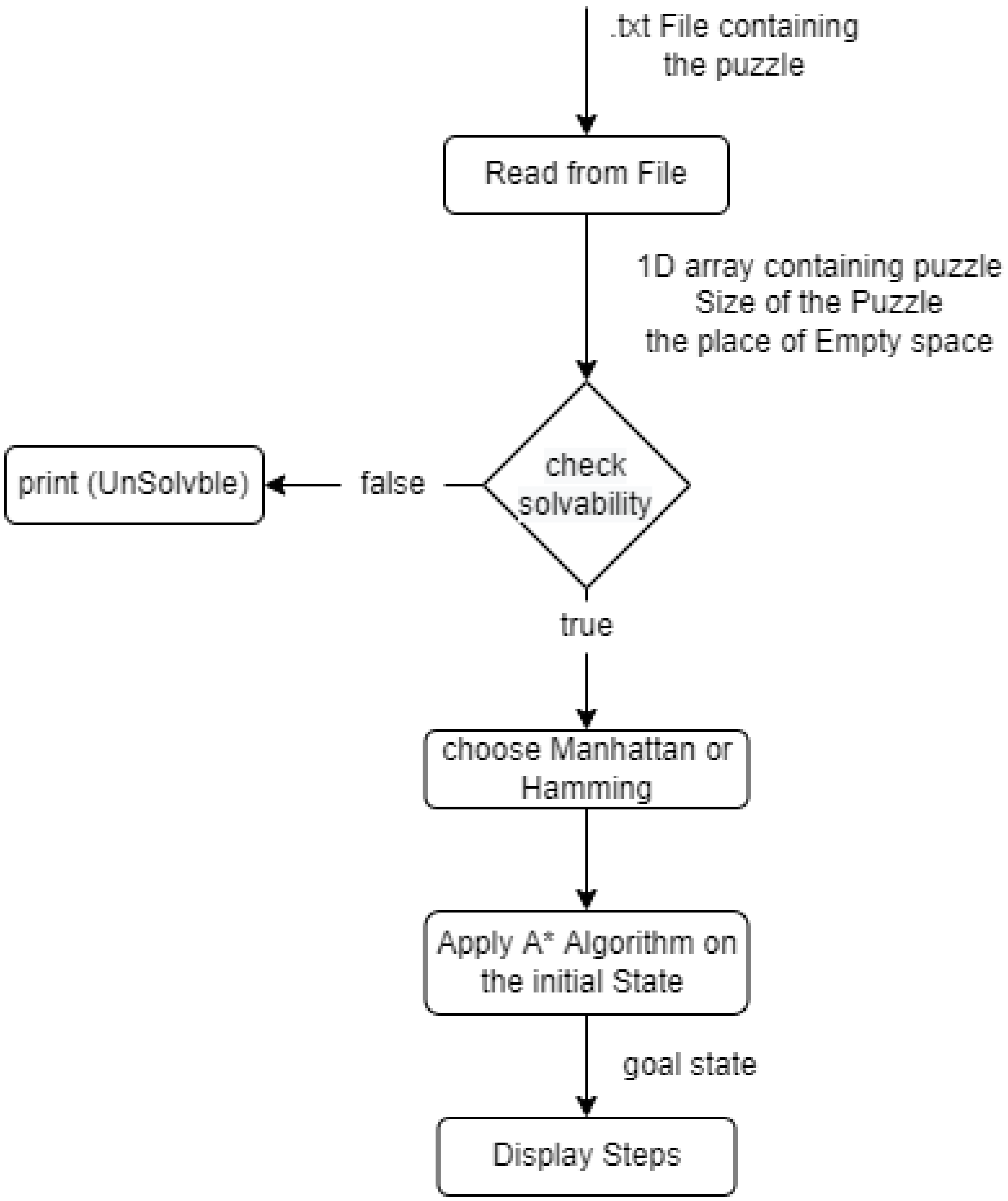
1)Introduction:

N-Puzzle is a board game. It consists of (N) numbered squared tiles in random order, and one blank space The goal is to rearrange the tiles in order by making sliding moves that use the empty space, using the fewest moves.

Our Program is an N-Puzzle Solver to read a Puzzle from a text file then check if the puzzle has a solution or not.

If it has a solution we create a node for our initial state and start solving it using A* search algorithm, our program has two types of heuristic value which are Manhattan and hamming distance the user can choose either of them to be the heuristic value of A*, and if it doesn’t have a solution print “Unsolvable” then the program terminates.

2)pipeline:


.txt File containing the puzzle
Read from File
1D array containing puzzle
Size of the Puzzle
the place of Empty space
check solvability
false
print (UnSolvble)
true
choose Manhattan or Hamming
Apply A* Algorithm on the initial State
goal state
Display Steps

readFromFile():

Input: A text file containing the puzzle.
Output: A 2D array with the puzzle ,1D array with the puzzle, Row and column of the blank space and the puzzle size.
Description: This function takes the content of the text file and parse it to integers so we can solve it in our program.

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calculateInvCount():

Input: 1D array with the puzzle and the puzzle size.
Output: The inversion counts of the given puzzle.
Description: This function takes the puzzle and iterate over each element if the we find the number after a given item smaller than it we increment the inversion count.

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cheackSolvability():

Input: 1D array of the puzzle and the puzzle size and the row of the blank space.
Output: True if the puzzle has a solution and False if it doesn't.
Description: It checks if the size of the puzzle is odd and the inversion count is even then it has a solution, else if the puzzle size is even we check for the row given in input if it's odd and inversion count is even and vice versa then the puzzle is solvable if not one of these cases then it doesn't have a solution.
……………………………………………………………………………………………

AstarAlgorithm():

Input: Initial state of the puzzle.
Output: Goal state of the puzzle.
Description: This function searches for the solution in a Priority Queue it add the initial state then generate the possible moves (using **generateNextMoves()**) according to the position of the blank space, it iterates till we find a state with a heuristic value of zero which means no misplaced numbers and that's the goal state.

generateNextMoves():

input: State Node
output: Void
Description: This function takes a node as parent and checks for the possibility for a new move with each move available it creates a new node calculate its heuristic value and add to the priority queue for next inspection in **AstarAlgorithm()**

………………………………………………………………………………………………………

calculateHaming:

Input: 2D array with the puzzle and the puzzle size.
Output: hamming cost
Description:hamming distance is The number of blocks in the wrong position
it compare the goal matrix with the matrixes if they aren`t equal increase the hamming cost by 1.

………………………………………………………………………………………………………

calculateManhattan

Input: 1D array with the puzzle and the puzzle size.
Output: Manhattan Distance
Description: sum of the distances of each tile from its goal position

………………………………………………………………………………………………………

3)The* source *code:

- **The Main Function:**

```
using System;
using System.Diagnostics;
using System.IO;
using System.Linq;
using System.Text.RegularExpressions;

namespace Npuzzle
{
    class Program
    {
        static void Main(string[] args)
        {
            int size = 0;                        θ(1)
            int blankRow = 0, blankCol = 0;      θ(1)
            int[] puzzle1D;                      θ(1)


            int[,] puzzle2D = readFromFile("TEST.txt", out puzzle1D, out size, out blankRow,
            out blankCol); //TBD


            //Main menue
            if (cheackSolvability(puzzle1D, size, blankRow))
            {
                Console.WriteLine("Solvable");                  θ(1)
                Console.WriteLine("---------------------------");
                Console.WriteLine("Choose the heuristic Value type");
                Console.WriteLine("[1] Hamming Distance");
                Console.WriteLine("[2] Manhattan Distance");
                int type = Convert.ToInt32(Console.ReadLine()); θ(1)
                int heruicValue = 0;                            θ(1)


                if (type == 1)
                {
                    Stopwatch stopwatch = new Stopwatch();
                    // Begin timing
                    stopwatch.Start();

                    System.Threading.Thread.Sleep(500);

                    Console.WriteLine();
                    heruicValue = AstarFunctions.calculateHamming(puzzle2D, size);  O(S^2)
                    State_Node initState = new State_Node(puzzle2D, size, blankRow, blankCol,
                    heruicValue, 0, null, 1);         θ(1)

                    State_Node goal = AstarFunctions.AstarAlgorithm(initState);  O(E log(V))
                    int minMoves = goal.currentSteps; θ(1)
                    if (size == 3)
                        AstarFunctions.displaySteps(goal);
                    Console.WriteLine("Minimum # Of Moves = " + minMoves);   θ(1)
                    Console.WriteLine();

                    // Stop timing
                    stopwatch.Stop();

                    Console.WriteLine("Time : {0}", stopwatch.Elapsed);
                }

                else if (type == 2)
                {
                    Stopwatch stopwatch2 = new Stopwatch();
                    // Begin timing
                    stopwatch2.Start();

                    System.Threading.Thread.Sleep(500);


                    Console.WriteLine();
                    heruicValue = AstarFunctions.calculateManhattan(puzzle2D, size); O(S^2)
                    State_Node initState = new State_Node(puzzle2D, size, blankRow, blankCol,
                    heruicValue, 0, null, 2);     θ(1)
                    State_Node goal = AstarFunctions.AstarAlgorithm(initState); O(E log(V))
                    int minMoves = goal.currentSteps;     θ(1)
                    if (size == 3)
                        AstarFunctions.displaySteps(goal);
                    Console.WriteLine("Minimum # Of Moves = " + minMoves);   θ(1)
                    Console.WriteLine();

                    // Stop timing
                    stopwatch2.Stop();

                    Console.WriteLine("Time : {0}", stopwatch2.Elapsed);
                }

            }
            else
                Console.WriteLine("UnSolvable");        θ(1)

            // Stop timing


        }
```

```
//Total of the function = O(N^2)
public static int[,] readFromFile(string path, out int[] p, out int s, out int
blankRow, out int blankCol)
{
    /*This function reads the puzzle from the file and Parse it into 1D AND 2D array
   and we save the position of blank cell to for later Operations/*

    string contet = File.ReadAllText(path);
    contet = Regex.Replace(contet, @"\s+",",");
    if (contet[contet.Length - 1] == ',')        θ(1)
        contet = contet.Remove(contet.Length - 1);
    int[] puzzle1D = contet.Split(' ', ',').Select(z =>
   Convert.ToInt32(z)).ToArray();
    int size = puzzle1D[0];                     θ(1)
    int bR = 0, bC = 0;                         θ(1)
    puzzle1D = puzzle1D.Skip(1).ToArray();

    int[,] puzzle2D = new int[size, size];      θ(1)
    int c = 0;                                 θ(1)

    //Total = θ(N^2) * θ(1) = θ(N^2)
    for (int x = 0; x < size; x++)
    {
        for (int y = 0; y < size; y++)
        {
            puzzle2D[x, y] = puzzle1D[c];
            if (puzzle2D[x, y] == 0)
            {
                bR = x;
                bC = y;
            }
            c++;
        }
    }
    blankRow = bR;     θ(1)
    blankCol = bC;     θ(1)
    s = size;          θ(1)
    p = puzzle1D;      θ(1)
    return puzzle2D    θ(1)

}
```

```
        //Total = //θ(S^2)
        static int calculateInversionCount(int[] puzzle, int size)
        {
            //Calculate invCount for all numbers except blank space
            int inversionCount = 0;        θ(1)

            //θ(S^2)
            for (int i = 0; i < size * size - 1; i++)
            {
                for (int j = i + 1; j < size * size; j++)
                {
                    if (puzzle[i] != 0 && puzzle[j] != 0 && puzzle[i] > puzzle[j])    θ(1)
                        inversionCount++;                                            θ(1)
                }
            }
            return inversionCount;
        }


        //Total = θ(S^2)
        static bool cheackSolvability(int[] puzzle, int size, int blankIndex)
        {
            int inversionCount = calculateInversionCount(puzzle, size);//θ(S^2)
            //checking if the puzzle has a solution
            if (size % 2 != 0)                θ(1)
            {
                if (inversionCount % 2 == 0)   θ(1)
                    return true                θ(1)
            }
            else if (size % 2 == 0)            θ(1)
            {
                if (inversionCount % 2 != 0 && blankIndex % 2 == 0)
                    return true;               θ(1)
                else if (inversionCount % 2 == 0 && blankIndex % 2 != 0)
                    return true;               θ(1)
            }
            return false;                      θ(1)
        }

    }
}
```

- **The PriorityQ Class:**

```
using System;

namespace Npuzzle
{
    class PriorityQ
    {

        State_Node[] heapArr;          θ(1)
        int length = 0;                θ(1)


         Total =  θ(1)
        public PriorityQ()
        {
            heapArr = new State_Node[100000000];
        }


          θ(1)
        public void insertKey(State_Node key)
        {
            length = length + 1;        θ(1)
            heapArr[length] = null;     θ(1)
            increaseKey(length, key);   O(log(V))
        }

        //Total = O(log(V))
        public void increaseKey(int i, State_Node key)
        {
            heapArr[i] = key;             θ(1)
            while (i > 1 && heapArr[i / 2].cost >= heapArr[i].cost)
            {
                exchange(ref heapArr[i / 2], ref heapArr[i]);     θ(1)
                i = i / 2;                θ(1)
            }
        }


        // Total = O(log(V))
        public State_Node extractMin()
        {
            if (length == 0)                     θ(1)
            {
                throw new InvalidOperationException("Queue is Empty");
            }
            State_Node minimum = heapArr[1];    θ(1)
            heapArr[1] = heapArr[length];       θ(1)
            length = length - 1;                θ(1)
            minHeapify(1, length);              O(log(V))
            return minimum;                     θ(1)

        }

        // Total = θ(1)
        public bool isEmpty()
        {
            if (length == 0)
                return true;

            return false;
        }



        // Total = O(log(V))
        void minHeapify(int i, int heapSize)
        {
            int left = 2 * i;           θ(1)
            int right = 2 * i + 1;      θ(1)
            int least;                  θ(1)

            if (left <= heapSize && heapArr[left].cost < heapArr[i].cost)        θ(1)
                least = left;
            else                        θ(1)
                least = i;
            if (right <= heapSize && heapArr[right].cost < heapArr[least].cost)  θ(1)
                least = right;
            if (least != i)             θ(1)
            {
                exchange(ref heapArr[i], ref heapArr[least]);                    θ(1)
                minHeapify(least, heapSize);                                     O(log(V))

            }
        }

        // Total = θ(1)
        void exchange(ref State_Node x, ref State_Node y)
        {
            State_Node t = x;
            x = y;
            y = t;
        }

    }
}
```

- **Node class:**

```
namespace Npuzzle
{
    class State_Node
    {
        θ(1) - for all lines
        public int[,] state;
        public int huristicType;
        public State_Node parent = null;
        public int blankRow;
        public int blankCol;
        public int currentSteps;
        public int cost;
        public int heruicValue;
        public int puzzleSize;
        public bool down, up, left, right;

        // Total = θ(1)
        public State_Node(int[,] state, int puzzleSize, int blankRow, int blankCol, int
        heruicValue, int level, State_Node parent, int huristicType)
        {

            this.state = state;
            this.puzzleSize = puzzleSize;
            this.parent = parent;
            this.blankRow = blankRow;
            this.blankCol = blankCol;
            this.currentSteps = level;
            this.heruicValue = heruicValue;
            this.huristicType = huristicType;

            /*We assign the moves state according to the position of the blank cell in row
              and coloumn so we know what moves can be done*/
            if (this.blankRow > 0)                          θ(1)
                this.up = true;
            if (this.blankRow < this.puzzleSize - 1)        θ(1)
                this.down = true;
            if (this.blankCol > 0)                          θ(1)
                this.left = true;
            if (this.blankCol < this.puzzleSize - 1)        θ(1)
                this.right = true;
        }


    }

}
```

- **AstarFunctions class:**

```
using System;


namespace Npuzzle
{
    class AstarFunctions
    {
        public static PriorityQ Q = new PriorityQ();            θ(1)


        Total = O(E log (V))
        public static State_Node AstarAlgorithm(State_Node initailState)
        {
            Q.insertKey(initailState);            O(log(V))
            State_Node min;                       θ(1)

            //Total = O(E) * O(Log(V)) = O(E log(V))
            while (!Q.isEmpty())
            {
                //Extracting the top of the heap which has the minimum cost;
                min = Q.extractMin();             O(log(V))

                /*if the heuristic value = 0 that means no misplaced values and that's the
                   goal state*/
                if (min.heruicValue == 0)         θ(1)
                    return min;                   θ(1)

                //getting the possibilites of the moves then add it to the Queue
                AstarFunctions.generateNextMoves(min);     Total = O(log (V))

            }
            return null;     θ(1)
        }



        //Total = O(log (V))
        public static void generateNextMoves(State_Node Parent)
        {
            //What I need to do here is to get the child Nodes then add it to the Queue
            /*Create a new node with each new state and add it to the queue if it's diffrent
               from its GrandParent*/
            //Calculate Hamming OR Manhattan for every new state
```

```
if (Parent.up)             θ(1)
{
    //This means that (blankCell) can move up
    if (Parent.huristicType == 1)       θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];   θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);
        //θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow - 1, Parent.blankCol]);                   θ(1)
        int hammingDistance = calculateHamming(newState,
        Parent.puzzleSize);                                                θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow - 1, Parent.blankCol, hammingDistance,
        Parent.currentSteps + 1, Parent, 1);                               θ(1)

        if (!((Parent.parent != null && newNode.blankRow ==
               Parent.parent.blankRow && newNode.blankCol ==
               Parent.parent.blankCol)))                                  θ(1)

        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;    θ(1)
            Q.insertKey(newNode);                                        O(log(V))
        }
    }
    else if (Parent.huristicType == 2)              θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];  θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);  θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow - 1, Parent.blankCol]);          θ(1)
        int ManhattanDistance = calculateManhattan(newState,
        Parent.puzzleSize);                                       θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow - 1, Parent.blankCol, ManhattanDistance,
        Parent.currentSteps + 1, Parent, 2);                      θ(1)

        if (!((Parent.parent != null && newNode.blankRow ==
               Parent.parent.blankRow && newNode.blankCol ==
               Parent.parent.blankCol)))                          θ(1)

        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;  θ(1)
            Q.insertKey(newNode);                                O(log(v))
        }
    }
}
```

```
if (Parent.down)     // Total = θ(1)
{
    //This means that (blankCell) can move down
    if (Parent.huristicType == 1)//θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];   θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);//θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow + 1, Parent.blankCol]);   θ(1)
        int hammingDistance = calculateHamming(newState,
        Parent.puzzleSize);                                θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow + 1, Parent.blankCol, hammingDistance,
        Parent.currentSteps + 1, Parent, 1);

        if (!((Parent.parent != null && newNode.blankRow ==
               Parent.parent.blankRow && newNode.blankCol ==
               Parent.parent.blankCol)))                    θ(1)

        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;  θ(1)
            Q.insertKey(newNode);        O(log(V))
        }
    }
    else if (Parent.huristicType == 2)      Total = θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];   θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);//θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow + 1, Parent.blankCol]);           θ(1)
        int ManhattanDistance = calculateManhattan(newState, Parent.puzzleSize);
           θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow + 1, Parent.blankCol, ManhattanDistance,
        Parent.currentSteps + 1, Parent, 2);   θ(1)
        if (!((Parent.parent != null && newNode.blankRow ==
               Parent.parent.blankRow && newNode.blankCol ==
               Parent.parent.blankCol)))      θ(1)
        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;   θ(1)
            Q.insertKey(newNode);              O(log(V))
        }
    }

}
```

```
if (Parent.left)// Total = θ(1)
{
    //This means that (blankCell) can move left
    if (Parent.huristicType == 1)       θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];   θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);  θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow, Parent.blankCol - 1]);            θ(1)
        int hammingDistance = calculateHamming(newState,
        Parent.puzzleSize);                                         θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow, Parent.blankCol - 1, hammingDistance,
        Parent.currentSteps + 1, Parent, 1);                        θ(1)
        if (!((Parent.parent != null && newNode.blankRow ==
               Parent.parent.blankRow && newNode.blankCol ==
               Parent.parent.blankCol)))                            θ(1)
        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;  θ(1)
            Q.insertKey(newNode);                                 O(log(V))
        }
    }
    else if (Parent.huristicType == 2)                            θ(1)
    {
        int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];  θ(1)
        Array.Copy(Parent.state, newState, Parent.state.Length);θ(state.Length)
        swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
        newState[Parent.blankRow, Parent.blankCol - 1]);          θ(1)
        int ManhattanDistance = calculateManhattan(newState,
        Parent.puzzleSize);                                       θ(N^2)
        State_Node newNode = new State_Node(newState, Parent.puzzleSize,
        Parent.blankRow, Parent.blankCol - 1, ManhattanDistance,
        Parent.currentSteps + 1, Parent, 2);                      θ(1)
        if (!((Parent.parent != null && newNode.blankRow ==
              Parent.parent.blankRow && newNode.blankCol ==
              Parent.parent.blankCol)))                           θ(1)
        {
            newNode.cost = newNode.currentSteps + newNode.heruicValue;    θ(1)
            Q.insertKey(newNode);                                O(log(V))

        }
    }

}
```

```
        if (Parent.right)   Total = θ(1)
        {
            //This means that (blankCell) can move right
            if (Parent.huristicType == 1)                         θ(1)
            {
                int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];   θ(1)
                Array.Copy(Parent.state, newState, Parent.state.Length);//θ(state.Length)
                swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
                newState[Parent.blankRow, Parent.blankCol + 1]);                  θ(1)
                int hammingDistance = calculateHamming(newState,
                Parent.puzzleSize);                                               θ(N^2)
                State_Node newNode = new State_Node(newState, Parent.puzzleSize,
                Parent.blankRow, Parent.blankCol + 1, hammingDistance,
                Parent.currentSteps + 1, Parent, 1);                              θ(1)

                if (!((Parent.parent != null && newNode.blankRow ==
                       Parent.parent.blankRow && newNode.blankCol ==
                       Parent.parent.blankCol)))                                  θ(1)
                {
                    newNode.cost = newNode.currentSteps + newNode.heruicValue;    θ(1)
                    Q.insertKey(newNode);         O(log(V))
                }
            }
            else if (Parent.huristicType == 2)    Tatal = θ(1)
            {
                int[,] newState = new int[Parent.puzzleSize, Parent.puzzleSize];  θ(1)
                Array.Copy(Parent.state, newState, Parent.state.Length);  θ(state.Length)
                swapBlank(ref newState[Parent.blankRow, Parent.blankCol], ref
                newState[Parent.blankRow, Parent.blankCol + 1]);          θ(1)
                int ManhattanDistance = calculateManhattan(newState,
                Parent.puzzleSize);                                       θ(N^2)
                State_Node newNode = new State_Node(newState, Parent.puzzleSize,
                Parent.blankRow, Parent.blankCol + 1, ManhattanDistance,
                Parent.currentSteps + 1, Parent, 2);                        θ(1)

                if (!((Parent.parent != null && newNode.blankRow ==
                       Parent.parent.blankRow && newNode.blankCol ==
                       Parent.parent.blankCol)))                            θ(1)
                {
                    newNode.cost = newNode.currentSteps + newNode.heruicValue;  θ(1)
                    Q.insertKey(newNode);          O(log(V))
                }
            }
        }

    }
```

```
//Total = θ(N^2)
public static int calculateHamming(int[,] puzzle2D, int size)
{
    /*This function gets the hamming distance by comparing the puzzle with a sample
      of its goal when we find a diffrence in place we increament the distance*/
    int[,] gaolSample = new int[size, size];        θ(1)
    int hamming = 0, s = 1;                         θ(1)

    //Total = θ(1) * θ(N^2)
    for (int i = 0; i < size; i++)
    {
        for (int j = 0; j < size; j++)
        {
            gaolSample[i, j] = s;                   θ(1)
            if (puzzle2D[i, j] != 0 && puzzle2D[i, j] != gaolSample[i, j])   θ(1)
                hamming++;                          θ(1)
            s++;

        }
    }
    return hamming;    θ(1)
}

//Total =θ(N^2)
public static int calculateManhattan(int[,] Puzzle2D, int size)
{
    /*This function gets the manhattan distance by calculating the horizontal and
      vertical distance between the current cell and the correct one in the goal/*
    int manhattanDistance = 0, correctRow = 0, correctCol = 0;    θ(1)
    int currentRow = 0, currentCol = 0;                           θ(1)

    //Total = θ(S^2)
    for (int i = 0; i < size * size; i++)
    {
        currentRow = i / size;     θ(1)
        currentCol = i % size;     θ(1)
        if (Puzzle2D[currentRow, currentCol] != 0)   θ(1)
        {
            correctRow = (Puzzle2D[currentRow, currentCol] - 1) / size;     θ(1)
            correctCol = ((Puzzle2D[currentRow, currentCol] - 1) % size);   θ(1)

            manhattanDistance += Math.Abs(correctRow - currentRow) +
            Math.Abs(correctCol - currentCol);θ(1)
        }

    }
    return manhattanDistance;
}
```

```
    //Total = θ(1)
        static void swapBlank(ref int oldBlank, ref int newBlank)
        {
            //Noraml Swap
            int tmp = oldBlank;
            oldBlank = newBlank;
            newBlank = tmp;
        }


        //Total = θ(1) + θ(1) + T(N^2)

        public static void displaySteps(State_Node s)
        {
            //To display the movements we took to reach goal state in 8-Puzzle
            if (s == null)
                return;

            displaySteps(s.parent);

            for (int i = 0; i < 3; i++)
            {
                for (int j = 0; j < 3; j++)
                    Console.Write(s.state[i, j] + " ");

                Console.WriteLine();
            }
            Console.WriteLine("-------------------");
        }

    }
}
```

4)Comparing Table:

Hamming & Manhattan

File Name	Manhattan time	Hamming Time	Number Of Moves
50 Puzzle.txt	00:00:00.6170554	00:00:01.0008608	18
99 Puzzle – 1.txt	00:00:00.5550396	00:00:00.5412025	18
99 Puzzle – 2.txt	00:00:00.5390743	00:00:00.5365375	38
9999 Puzzle.txt	00:00:00.5637809	00:00:00.5349893	4

V large test

File Name	Manhattan time	Hamming Time	Number Of Moves
Test.txt	00:00:37.3268703	00:01:22.4732168	56