California State University, Fresno

Computer Science Department

CSCI 264

Artificial Intelligence

Assignment 1

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Submitted by

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Introduction

Sliding tile puzzle is a tour puzzle that challenges a player to slide (frequently flat) pieces along certain routes (usually on a board) to establish a certain end-configuration. The pieces to be moved may consist of simple shapes, or they may be imprinted with colors, patterns, sections of a larger picture (like a jigsaw puzzle), numbers, or letters.

Sliding puzzles are essentially two-dimensional in nature, even if the sliding is facilitated by mechanically interlinked pieces (like partially encaged marbles) or three-dimensional tokens. As this example shows, some sliding puzzles are mechanical puzzles. However, the mechanical fixtures are usually not essential to these puzzles; the parts could as well be tokens on a flat board that are moved according to certain rules.

Unlike other tour puzzles, a sliding block puzzle prohibits lifting any piece off the board. This property separates sliding puzzles from rearrangement puzzles. Hence, finding moves and the paths opened up by each move within the two-dimensional confines of the board are important parts of solving sliding block puzzles.

Breadth First Search(BFS) is an algorithm for traversing or searching tree or graph data structures. It starts at the tree root(or some arbitrary node of a graph, sometimes referred to as a 'search key) and explores the neighbor nodes first, before moving to the next level neighbors.

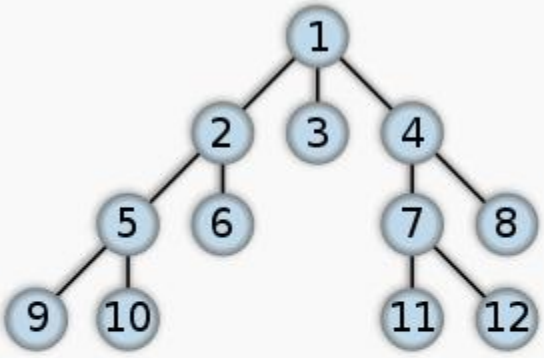
BFS was invented in the late 1950s by E. F. Moore, who used it to find the shortest path out of a maze, and discovered independently by C. Y. Lee as a wire routing algorithm (published 1961).

BFS Code:

```
Breadth-First-Search (Graph, root):
    for each node n in Graph:
        n.distance = INFINITY
        n.parent = NIL
 create empty queue Q
     root.distance = 0
```

```
    Q.enqueue(root)
while Q is not empty:
    current = Q.dequeue()
  for each node n that is adjacent to current:
        if n.distance == INFINITY:
            n.distance = current.distance + 1
            n.parent = current
            Q.enqueue(n)
```

Breadth-first search



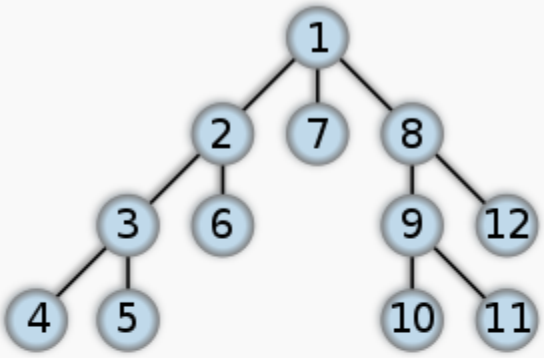
Order in which the nodes are expanded

Class	Search algorithm
Data structure	Graph
Worst case performance	$O(\|E\|) = O(b^d)$
Worst case space complexity	$O(\|V\|) = O(b^d)$

Depth First Search (DFS) is an algorithm for traversing or searching tree or graph data structures. One starts at the root(selecting some arbitrary node as the root in the case of a graph) and explores as far as possible along each branch before back tracking.

A version of depth-first search was investigated in the 19th century by French mathematician Charles Pierre Trémaux as a strategy for solving mazes.

Depth-first search



Order in which the nodes are visited

Class	Search algorithm
Data structure	Graph
Worst case performance	$O(\|E\|)$ for explicit graphs traversed without repetition, $O(b^d)$ for implicit graphs with branching factor *b* searched to depth *d*
Worst case space complexity	$O(\|V\|)$ if entire graph is traversed without repetition, O(longest path length searched) for implicit graphs without elimination of duplicate nodes

A* Search Algorithm

A* (pronounced as "A star" is a computer algorithm that is widely used in pathfinding and graph traversal, the process of plotting an efficiently traversable path between multiple points, called nodes. Noted for its performance and accuracy, it enjoys widespread use. However, in practical travel-routing systems, it is generally outperformed by algorithms which can pre-process the graph to attain better performance, although other work has found A* to be superior to other approaches.

Program Code

```
class tiles
{
    public static int newTable [] ;
    public static int table [] = {2,3,1,4,5,0,6,7,8};
    public static int goalTable[] ={0,1,2,3,4,5,6,7,8};
    public static int blankSpot;
    public static int a=0, b=0, c=0, x;
    public static int numCorrect=0;
    public static int origNum, leftNum,rightNum,upNum,downNum;

       public static void main(String args[])
            {
                    puzzSolver();
              }

//Solves puzzle
    static void puzzSolver()
    {
              int a;
              printinitvalues();       //Prints the puzzle

              for (a=0; a<5; ++a)
                   {
                        countTiles();
                        branch();
                        System.out.println(numCorrect);
                   }
    }

//Solves puzzle
```

```
    static void branch()
    {
            if (numCorrect<9)
                {
                    countTiles();
                    locateSpace();                      //Locates the position of the blank space
                    //System.out.println(numCorrect);
                    checkNum();
                    getLarge();
                    //System.out.println(x);

                    if(x==leftNum)
                        changeTableLeft();
                            else if(x==rightNum)
                                changeTableRight();
                                    else if(x==upNum)
                                        changeTableUp();
                                            else
                                                changeTableDown();
                    printinitvalues();
                }
    }

//Counts tiles in correct placement
    static void countTiles()
    {
            int i;
            numCorrect =0;
            for (i=0; i<9; ++i)
                {
                    if (newTable[i]==goalTable[i])
                    {
                        numCorrect = numCorrect + 1;
                    }
                }
    }
//Check correct placement after each possible move

    static void checkNum()

    {
            makeMoveLeft();
            //printNewValues();             //Prints the puzzle
            locateSpace();                      //Locates the position of the blank space
            countTiles();
            leftNum = numCorrect;
            //System.out.println(leftNum);
            resetTable();

            makeMoveUp();
            //printNewValues();             //Prints the puzzle
            locateSpace();                      //Locates the position of the blank space
```

```
            countTiles();
            upNum = numCorrect;
            //System.out.println(upNum);
            resetTable();

            makeMoveRight();
            //printNewValues();          //Prints the puzzle
            locateSpace();                  //Locates the position of the blank space
            countTiles();
            rightNum = numCorrect;
            //System.out.println(rightNum);
            resetTable();

            makeMoveDown();
            //printNewValues();          //Prints the puzzle
            locateSpace();                  //Locates the position of the blank space
            countTiles();
            downNum = numCorrect;
            //System.out.println(downNum);
            resetTable();
    }

//Checks which move made greatest impact

    static void getLarge()
    {
            x=leftNum;

            if (x<rightNum)
                {
                    x=rightNum;
                }

            if (x<upNum)
                {
                    x=upNum;
                }

            if (x<downNum)
                {
                    x=downNum;
                }
    }

    static void changeTableLeft()
    {
            makeMoveLeft();
            int a;
            for (a=0; a<9; ++a)
            {
                table[a] = newTable[a];
            }
```

```
    }
    static void changeTableRight()
    {
            makeMoveRight();
            int a;
            for (a=0; a<9; ++a)
                {
                    table[a] = newTable[a];
                }
    }
    static void changeTableDown()
    {
            makeMoveDown();
            int a;
            for (a=0; a<9; ++a)
                {
                    table[a] = newTable[a];
                }
    }
    static void changeTableUp()
    {
            makeMoveUp();
            int a;
            for (a=0; a<9; ++a)
                {
                    table[a] = newTable[a];
                }
    }
//Makes moves of blank tiles to the left--does error checking to ensure move is allowed
    static void makeMoveLeft()
    {
            if(blankSpot!=0)
            {
                if (blankSpot !=3)
                {
                    if (blankSpot !=6)
                    {
                        int temp;
                        temp = table[blankSpot-1];
                            if (temp != goalTable[blankSpot-1])
                                {
                                    newTable[blankSpot-1]=table[blankSpot];
                                    newTable[blankSpot] = temp;
                                    countTiles();
                                }
                    }
                }
            }
            //else makeMoveUp();
    }
//Makes moves of blank tiles to right
    static void makeMoveRight()
    {
```

```
            if(blankSpot!=2)
                {
                    if (blankSpot !=5)
                        {
                            if (blankSpot !=8)
                                {
                                    int temp;
                                    temp = table[blankSpot+1];
                                    if (temp != goalTable[blankSpot+1])
                                        {
                                            newTable[blankSpot+1]=table[blankSpot];
                                            newTable[blankSpot] = temp;
                                            return;
                                        }
                                }
                        }
                }

    }
//Makes moves of blank tiles up

    static void makeMoveUp()
    {
            if(blankSpot!=0)
                {
                    if (blankSpot !=1)
                        {
                            if (blankSpot !=2)
                                {
                                    int temp;
                                    temp = table[blankSpot-3];
                                    if (temp != goalTable[blankSpot-3])
                                        {
                                            newTable[blankSpot-3]=table[blankSpot];
                                            newTable[blankSpot] = temp;
                                        }
                                }
                        }
                }
    }
//Makes moves of blank tiles down
    static void makeMoveDown()
    {
            if(blankSpot!=6)
                {
                    if (blankSpot !=7)
                        {
                            if (blankSpot !=8)
                                {
                                    int temp;
                                    temp = table[blankSpot+3];
                                    if (temp != goalTable[blankSpot+3])
                                        {
```

```
                                        newTable[blankSpot+3]=table[blankSpot];
                                        newTable[blankSpot] = temp;
                                    }
                                }
                            }
                        }
    }
/*I used this method to print the values that are stored for the puzzle*/
    static void printinitvalues()
            {
                int t, i=1;
                for (t=0; t<9; ++t)
                    {
                        System.out.print(table [t] + "  ");
                            if (i == 3)                                 //I use this loop to create a new row
                                {
                                    System.out.println();
                                    i = i - 3;
                                }
                        i = i + 1;
                    }
                        System.out.println();
                        System.out.println();
            }
//Printing the Goal State
    static void printGoalvalues()
    {
                int t, i=1;
                for (t=0; t<9; ++t)
                    {
                        System.out.print(goalTable [t] + "  ");
                            if (i == 3)                                 //I use this loop to create a new row
                                {
                                    System.out.println();
                                    i = i - 3;
                                }
                        i = i + 1;
                    }
                        System.out.println();
                        System.out.println();
    }
//Prints the modified table
    static void printNewValues()
            {
                int t, i=1;
                for (t=0; t<9; ++t)
                    {
                        System.out.print(newTable [t] + "  ");
                            if (i == 3)                                 //I use this loop to create a new row
                                {
                                    System.out.println();
                                    i = i - 3;
                                }
```

```
                    i = i + 1;
                }
                    System.out.println();
                    System.out.println();
        }

//I used this method to locate the blank space in the puzzle
    static void locateSpace()
    {
        int t;
        for (t=0; t<9; ++t)
            {
                if (table[t]==0)
                    {
                        blankSpot = t;
                        return;
                    }
            }
    }
//End of method
//Resets the testing table
    static void resetTable()
    {
        int i;
        for (i=0; i<9; ++i)
        {
            newTable[i]=table[i];
        }
    }
```