Sliding Puzzle Application

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Abstract

The project aims at building a game application based on Graphical User Interface, suitable Data Structures, and sorting Algorithm. The game starts with a Welcome frame which requires a player to enter their name. The game then starts as new window is opened. The game consists of a combination puzzle that challenges a player to slide pieces along certain routes on a board to establish a certain end-configuration. The pieces to be moved consist of parts of a larger picture. The pieces are to be pushed around over the board until the picture is complete. You can only move one piece at a time and you do it by clicking on it. If the player successfully solves the puzzle, their name, time taken, and moves are displayed. It is a challenging and entertaining game a person can enjoy playing in their free time.

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Introduction

Sports and games have been part of human society for thousands of years. The importance of these things should not be underestimated. A puzzle game has always been preferred as a way to enhance the brain intelligence. Much of young children's learning comes from participating in sports and games, and this same participation as adults can lead to happier, healthier and more productive lives. A study reported in the "New England Journal of Medicine" concluded that leisure activities, including board games, were associated with a decreased risk of dementia in senior citizens. Games have also long been used to educate children [1]. Games help people relax after being busy doing work whole day.

The Sliding Puzzle game we have made is a challenging, yet entertaining game which people can enjoy playing to relax. The game is written in Java. The game is very simple and easy to play yet hard to win. The interface and controls are kept simple to make the game as much user friendly as possible. The game provides a good mental exercise and improves cognitive abilities because one has to think hard how to solve the puzzle. It also provides gratification to the player when he completes the puzzle and sees the picture completed.

The game is made interesting by making it competitive using High Score mechanism. A player’s moves and time taken to solve the puzzle are recorded and specifically shown to the player when they have solved the puzzle. The score is also added to the list of High Scores giving the player a sense of achievement. People can play the game together by challenging each other to break their high scores or by collaborating with each other to solve a difficult puzzle. This can also improve a person’s teamwork abilities and social interactions. Player can also choose an image saved on their computer and the puzzle will be instantly made from that picture, this gives a personal touch to the game allowing the user to choose the type of images they like.

We have developed a GUI based Java application using Java AWT and Java’s Swing library. The application requires some essential Java libraries to run and since it is platform independent, it can be run from any Operating System.

Related Works

There have been numerous sliding games which are developed using different computer languages. There are many Sliding puzzle games available to play on the internet. The games are well made and fun to play. We have drawn inspiration from these games to make our own Sliding Puzzle game. Although the games available on the internet are nice, most of the games do not provide the feature of choosing a custom image and solving a puzzle of that image. Most games also do not provide the feature of disabling Numbers and Lines if a player wishes to do so. We have added these features to our game while also providing all the features which the online Sliding Puzzles games provide.

Description of the Data Structure Involved

Throughout this project, special focus has been put on how can we use suitable data structures which would allow the application to be efficient and the fulfillment of the primary goal of showing the understanding of Data Structures.

In the design of the application, Object-oriented approach was used. Objects of type Player, Rectangle, Line, String, Label and Button (all graphical entities with associated font, color, and dimensions attributes) were made.

In this application, two types of Data Structures have been used which are 2-Dimensional Arrays and Priority Queues.

2-Dimensional Arrays are primary data structure used as far as this project is concerned. It is used to draw the sliding puzzle frames which are of central importance. 2D array was the primary Data Structure used to make the game. The functionality of the whole game depends on 2D arrays. Two 2D arrays were populated with Integers, one array stored the solved state of the puzzle which the player should achieve after swapping Integers which were stored in the other array.

Two more 2D arrays were used, both of which were populated with small sub-images of the larger image whose puzzle was made. One of the arrays was used to store the current state of the puzzle after every move made by the player and the other array stored the solved state of the puzzle which was used to show the correct sub-image at the empty tile, this provided a hint to the player as to which tile should appear at which place and also made the puzzle even more visually appealing.

Another Data Structure used in this game is Priority Queues which was populated with the custom made class of Player. Priority Queue was used because it supports addition and removal of Data in log(n) time complexity.

The Object of Player is created when a player successfully solves the puzzle. It stores the Name of the player along with the Time Taken and Number of Moves taken by the player to solve the puzzle. The Player class also implements the Compareto method to facilitate the working of Priority Queue. The Compareto method compares the Player Objects according to the number of moves taken by them to solve the puzzle. The Player objects are added to the Priority Queue which sorts them in ascending order according to the Number of moves taken to solve the puzzle.

The Priority Queue objects are stored in a File for permanent storage. Priority Queues are used to arrange and display the high scores based on the performance of player. The performance is based on the number of clicks taken to complete the puzzle.

Other Important features:

Algorithms:

Merge-Sort Algorithm: Merge sort is a sorting technique based on divide and conquer technique. With worst-case time complexity being O(n log n), it is one of the most efficient algorithms.

Merge sort first divides the array into equal halves and then combines them in a sorted manner. **Usage:** Merge Sort was used to quickly count the number of Inversions in a Shuffled array. If the number of inversions is even, the puzzle is solvable otherwise the puzzle is unsolvable and the puzzle is shuffled again. The reason of choosing Merge-Sort was because it is efficient and faster with worst-case time complexity being O(nlogn).

Architecture of the Application:

The overall design of the application can be broadly classified into the following categories:

1. The graphical user interface (GUI): the buttons, text field, drawing 2D lines from Point class and Labels.
2. OOP techniques are extensively used. Multiple classes are created to aid the working of application. Some of the classes are of different Frames, Player class which holds the information and Stopwatch class in which Timer class is used to record the time taken to complete the puzzle.
3. **Filing.**

The different screens which appear at different points in the game are:

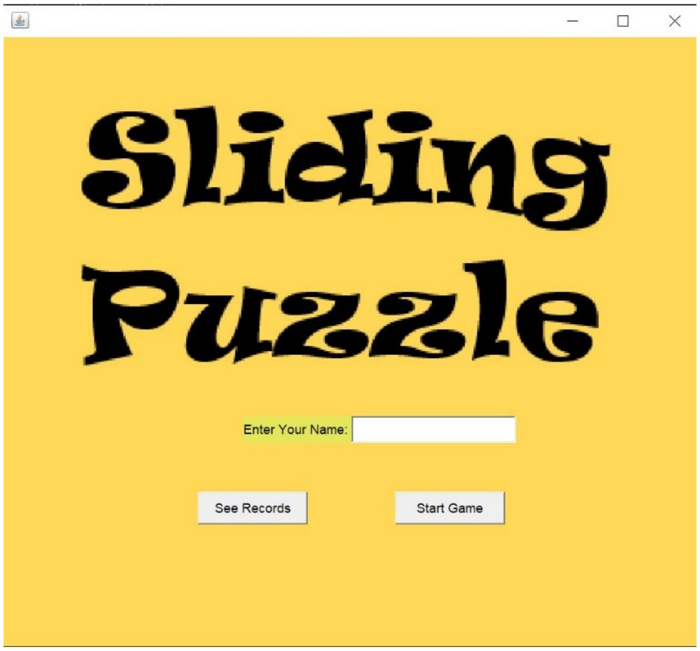
1. A Welcome Screen which displays the logo and contains buttons from which the user can start the game and see the High Scores
2. The Puzzle Screen which is the one on which the player actually plays the game. This frame contains essential components which are vital to this game.
3. A Winning Frame which is shown when a player successfully solves the puzzle.

Exception Handling is also applied extensively throughout the code.

Welcome Screen:

It displays the logo of the game and provides a Start Game button which the user can click to start playing the game. It also has a 'See Records' button which displays the Top 5 high scores with complete details including the Name of the Player, Moves and Time taken by the Player to solve the Puzzle.

The following is a snapshot of this window:

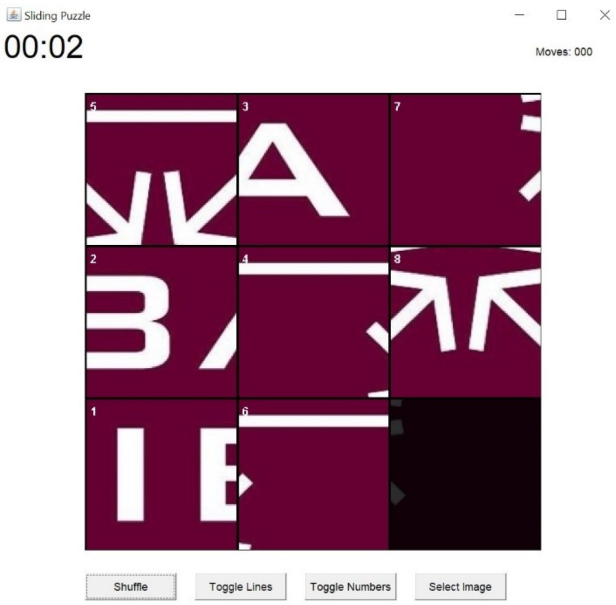


On clicking the 'Start Game' button the next screen, Sliding Puzzle screen is shown to the user.

The Puzzle Screen:

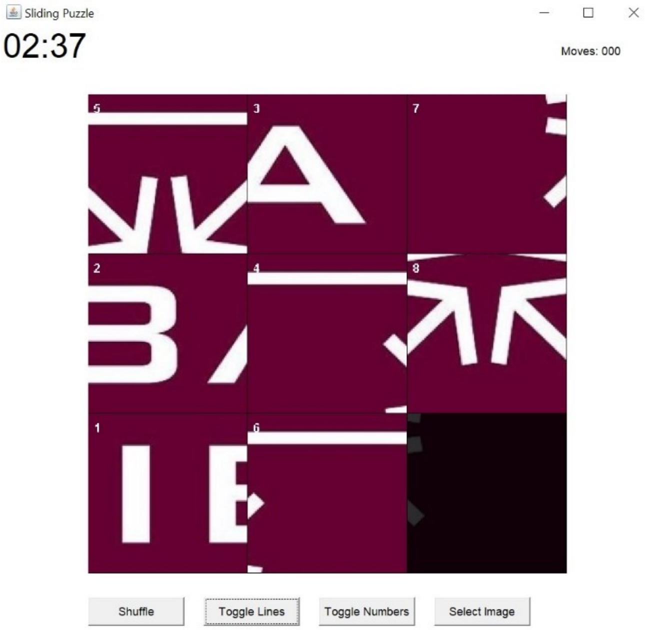
This screen is the one on which the player actually plays the game. In the center of the screen is a square made by the small tiles which are to be moved to solve the puzzle. The tiles are made of the sub-images of the larger picture. Above this square on the left is a timer which shows the time elapsed since the player started solving the puzzle and on the right side the number of moves made by the player are shown.

Following picture shows the puzzle screen:

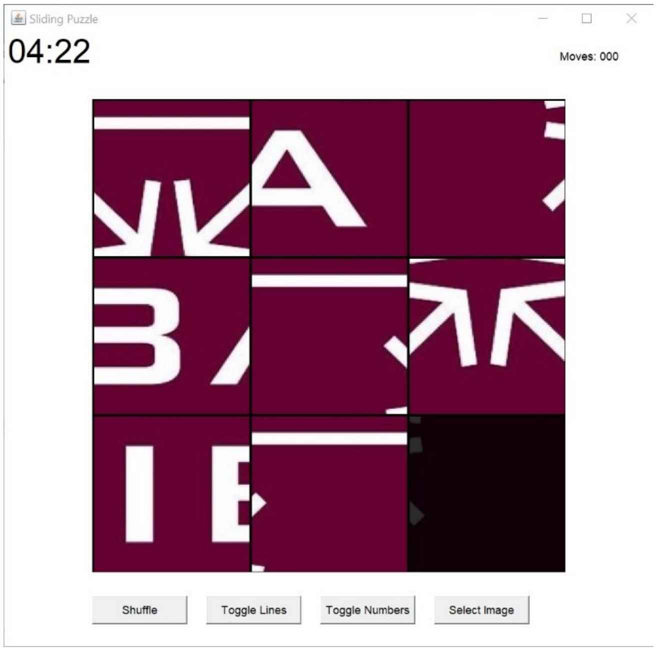


Below the square of puzzle, there are four buttons, the first button acts as a new game button. It Shuffles the puzzle and the timer and moves are also automatically reset.

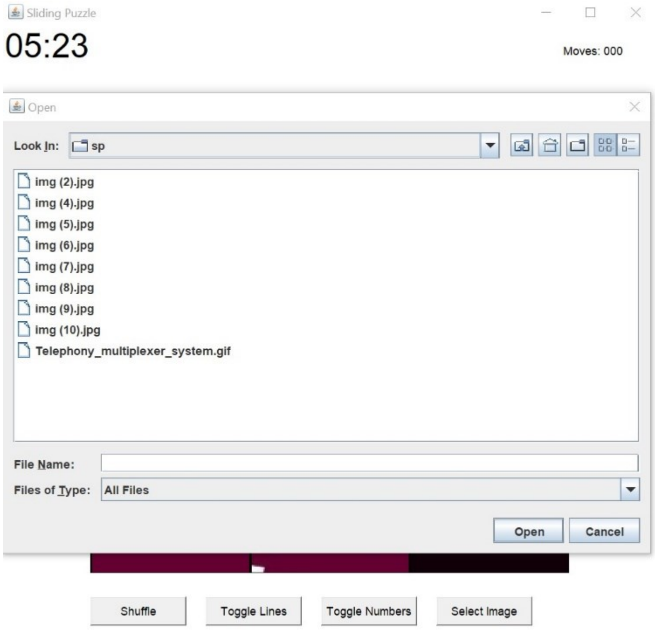
The next button Toggles the Lines which divide the tiles. If a user wishes to disable or enable the lines, they can press this button. Following picture shows the screen when lines are disabled:



The next button toggles the visibility of numbers on each tile. Following picture shows how the screen looks when Numbers are disabled:



The last button is a Choose Image button. Upon, clicking this button the player is shown a file chooser frame from which they can choose an image stored on their computer they wish to make a puzzle of. Following picture shows the File Chooser which appears when this button is clicked:


Sliding Puzzle

05:23

Moves: 000

Open

Look In: sp

img (2).jpg
img (4).jpg
img (5).jpg
img (6).jpg
img (7).jpg
img (8).jpg
img (9).jpg
img (10).jpg
Telephony_multiplexer_system.gif

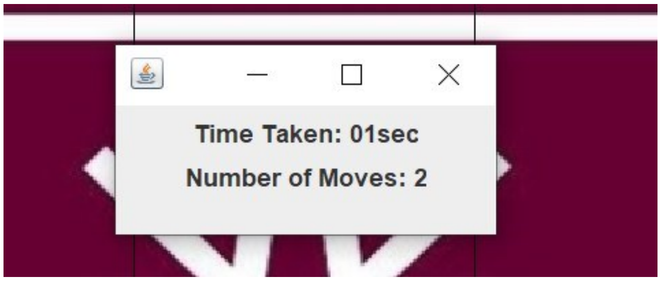
File Name:

Files of Type: All Files

When the puzzle is successfully solved by the user, the next frame Winning Frame is shown on top of this frame.

Winning Frame

The Last frame is a Win Frame which is shown when a player successfully solves the puzzle. It shows the number of moves and time taken to solve the puzzle. Following picture shows this frame:


Time Taken: 01sec

Number of Moves: 2

File storage:

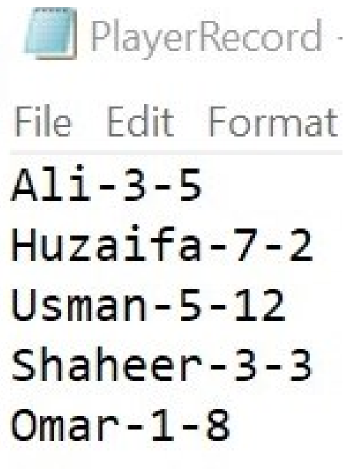
Filing is used to record the score of player. Java.io.file package provides the File class which is used to create a file by providing the path. Then FileWriter and FileReader is used to record the performance and displaying it on the menu frame when Check Record Button is pressed, respectively.

Each entry is stored in a separate line. Each entry consists of three attributes of a Player object namely, Name, Moves and Time Taken. These attributes are separated using a hyphen (-).

This is how the scores are stored in a file.

The Order: “Player’s name-Time Taken-Number of Clicks/Moves”

Player Ali played the game first followed by Huzaifa, Usman, Shaheer and Omar.



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Ali-3-5
Huzaifa-7-2
Usman-5-12
Shaheer-3-3
Omar-1-8
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Gameplay:

The player can click on any of the tiles which is next to an empty tile to move that tile to the empty space. In this way, the player can try and solve the puzzle by moving tiles to their correct places.

Conclusions:

Sliding Puzzle is a highly entertaining and challenging game with easy controls and beautiful visuals. This game can prove to be a nice free time activity for people especially if someone likes to solve puzzles and is up for a challenge. This game can help people relax and reduce their stress.

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