MINDGRID:NUMBER TILE PUZZLE

A MINI PROJECT REPORT

Submitted by

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MAY 2025

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BONAFIDE CERTIFICATE

Certified that this project report **"MINDGRID:NUMBER TILE PUZZLE"** is the bonafide work of **"HARIVARSAN S (220701333)"** who carried out the project work (CS19611-Mobile Application Development Laboratory) under my supervision.

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ABSTRACT

MindGrid: Number Tile Puzzle is an Android-based mobile game designed to test and improve users' logical thinking and problem-solving abilities. The game features a classic 3x3 sliding puzzle where players must rearrange shuffled numbered tiles into the correct sequence. Once the "Shuffle" button is pressed, the tiles are randomly mixed, and a timer starts to track how quickly the player completes the puzzle. Additionally, each move is counted, encouraging players to strategize their actions and aim for optimal efficiency.

With its sleek and intuitive user interface, MindGrid ensures an enjoyable and frustration-free experience for users of all ages. The game not only entertains but also enhances cognitive skills such as memory, critical thinking, and quick decision-making. By recording time and move counts, MindGrid offers measurable performance feedback, motivating players to challenge themselves and improve with each attempt.

Developed using Android Studio, this project merges casual gaming with mental exercise, delivering an engaging and stimulating experience that promotes continuous learning and brain development. MindGrid stands out as a perfect blend of fun and focus, offering hours of replayable gameplay and mental challenge.

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CHAPTER 1
INTRODUCTION

1.1 GENERAL

In today's fast-paced digital era, mobile games have evolved beyond entertainment, becoming tools for cognitive development and mental stimulation. Puzzle-based games, in particular, serve as excellent brain trainers that improve logical reasoning, memory retention, and problem-solving skills. MindGrid: Number Tile Puzzle is a mobile game developed using Android Studio, designed to provide an engaging and intellectually stimulating experience. It challenges players to rearrange a shuffled 3x3 grid of numbered tiles into the correct sequential order. The simple yet captivating gameplay is ideal for users of all ages, combining the elements of fun, strategy, and mental exercise.

The game interface is clean and minimalistic, allowing users to focus on the challenge at hand without distractions. A timer starts once the grid is shuffled, recording the time taken by the player to complete the puzzle. The application also tracks the number of moves made, encouraging players to solve the puzzle in the fewest possible steps. This adds a competitive edge to the gameplay, motivating users to improve their performance over time. By providing both time and move-based goals, MindGrid enhances replayability and user engagement.

1.2 OBJECTIVE

The primary objective of *MindGrid: Number Tile Puzzle* is to deliver a mobile gaming experience that sharpens cognitive abilities while keeping users engaged through interactive gameplay. The specific goals include:

- Enhancing logical thinking and spatial awareness through a structured tile-arrangement challenge.

- Encouraging players to improve their memory and decision-making skills by minimizing moves and time taken.

- Providing an intuitive and accessible interface suitable for all age groups.

- Offering measurable feedback (time and move count) to motivate continuous self-improvement.

- Utilizing Android Studio for seamless mobile development and optimization across devices.

Through this project, we aim to combine the essence of classic sliding puzzles with modern app design principles, offering users a fun yet mentally stimulating experience on their mobile devices.

1.3 EXISTING SYSTEM

Several sliding puzzle games exist in the current digital marketplace, such as the classic 15-puzzle and similar logic-based games available on both Android and iOS platforms. These games vary in complexity and design, but most follow the same principle of arranging shuffled tiles into a predefined sequence.

However, many existing systems lack features that promote continuous improvement or player performance tracking. Some games may not include detailed move counters or timers, which are essential in evaluating a player's strategy and progress. Others may have cluttered interfaces or poor optimization, which can negatively impact the user experience. Additionally, not all puzzle games are designed with accessibility and cognitive development in mind, limiting their educational value.

The absence of personalized feedback and performance metrics in many existing apps means users are less likely to stay engaged or benefit from repeated gameplay. Therefore, there is a need for a puzzle game that not only entertains but also challenges users to think critically and enhance their cognitive skills over time.

1.4 PROPOSED SYSTEM

To address the limitations of existing systems, *MindGrid: Number Tile Puzzle* introduces a more structured and goal-oriented approach to puzzle gaming. The proposed system includes a 3x3 sliding puzzle with numbered tiles (1–8), where the player's objective is to arrange the tiles in order using a blank space to slide adjacent tiles.

Key features of the proposed system include:

- **Random Shuffle Functionality**: A built-in algorithm randomly shuffles the tiles each time the user taps the "Shuffle" button, ensuring a new challenge in every game.

- **Move Counter**: Every user action is recorded, helping players focus on making fewer, smarter moves to reach the goal.

- **Timer**: A timer runs from the moment the puzzle is shuffled, giving players a sense of urgency and enabling them to track improvements in speed.

- **Performance Tracking**: At the end of each puzzle session, the system displays the total moves and time taken, encouraging users to beat their personal best.

The proposed system aims to enhance the user's logical thinking, planning, and analytical skills in a fun and engaging environment. By integrating performance metrics, *MindGrid* not only provides entertainment but also supports mental growth through gameplay, setting itself apart from many existing alternatives.

CHAPTER 2

2.1 LITERATURE SURVEY

The genre of puzzle-based games has gained widespread popularity in both academic research and the mobile application industry due to its potential to stimulate cognitive functions, improve mental agility, and enhance decision-making abilities. Various studies and existing mobile applications have been reviewed to identify the gap that *MindGrid: Number Tile Puzzle* aims to address.

2.1 Cognitive Benefits of Puzzle Games

According to research by Green and Bavelier (2003), puzzle and logic-based games can significantly enhance visual attention, problem-solving abilities, and decision-making speed. These games require players to remember patterns, plan ahead, and make calculated moves, thereby activating multiple cognitive processes simultaneously. Games involving number manipulation and tile arrangements, such as sliding puzzles, have been proven to promote logical reasoning and strategic thinking.

A study published in the *Journal of Cognitive Enhancement* (2018) suggested that regular interaction with problem-solving games results in improved working memory and reasoning capabilities. Therefore, integrating these benefits into a mobile gaming platform supports the idea that games can be both entertaining and educational.

2.2 Existing Number Tile Puzzle Applications

The sliding puzzle, also known as the 8-puzzle or 15-puzzle, has been a popular problem-solving activity for decades. Mobile adaptations of this classic game are

widely available on platforms like Android and iOS. Games like **Classic 15 Puzzle**, **Slide Puzzle**, and **Unblock Me** have been successful in attracting users with their straightforward gameplay. However, several limitations are commonly noted in existing systems:

- Lack of proper performance tracking (such as time taken and number of moves).
- Inadequate user interface design, leading to a cluttered or confusing experience.
- Limited replay value due to repetitive design or lack of feedback for improvement.
- Poor responsiveness and lack of optimization for different screen sizes and devices.

These shortcomings have opened up an opportunity to design a more user-friendly, engaging, and cognitively beneficial version of the tile puzzle game.

2.3 Role of Gamification in Learning

Gamification refers to applying game-design elements in non-game contexts to enhance user engagement. Research conducted by Deterding et al. (2011) indicates that integrating gamified elements such as point tracking, time challenges, and performance feedback boosts motivation and learning outcomes. In puzzle games, these features can lead to more immersive gameplay and a deeper sense of achievement, encouraging players to challenge themselves further.

Games like *Sudoku*, *2048*, and *Candy Crush* effectively use gamification principles to keep users engaged while promoting critical thinking and planning. By incorporating these principles into *MindGrid*, the game not only entertains but also promotes mental training in a measurable way.

2.4 Technological Feasibility

The Android platform, supported by Android Studio, provides a robust framework for developing interactive and high-performance mobile applications. Its vast ecosystem of libraries, layout managers, and UI tools makes it suitable for designing games with responsive interfaces and real-time user interaction. Multiple studies and developer communities have highlighted Android Studio's capabilities in developing low-latency, memory-efficient mobile games with real-time data tracking.

2.5 Gap in Existing Literature and Market

While many mobile puzzle games exist, few combine educational value with performance tracking in a clean, minimalist design. Most lack adaptive difficulty, motivation through feedback, or visual simplicity, which are essential for attracting a broad user base across age groups. The literature points to a need for a game that incorporates cognitive training with user-friendly design and measurable growth metrics.

CHAPTER 3
SYSTEM DESIGN

3.1 GENERAL

System design refers to the process of planning the architecture, components, modules, and data flow for the application. In the case of *MindGrid: Number Tile Puzzle*, the system is designed to ensure smooth gameplay, efficient logic processing, user-friendly interfaces, and accurate tracking of player performance (i.e., moves and time).

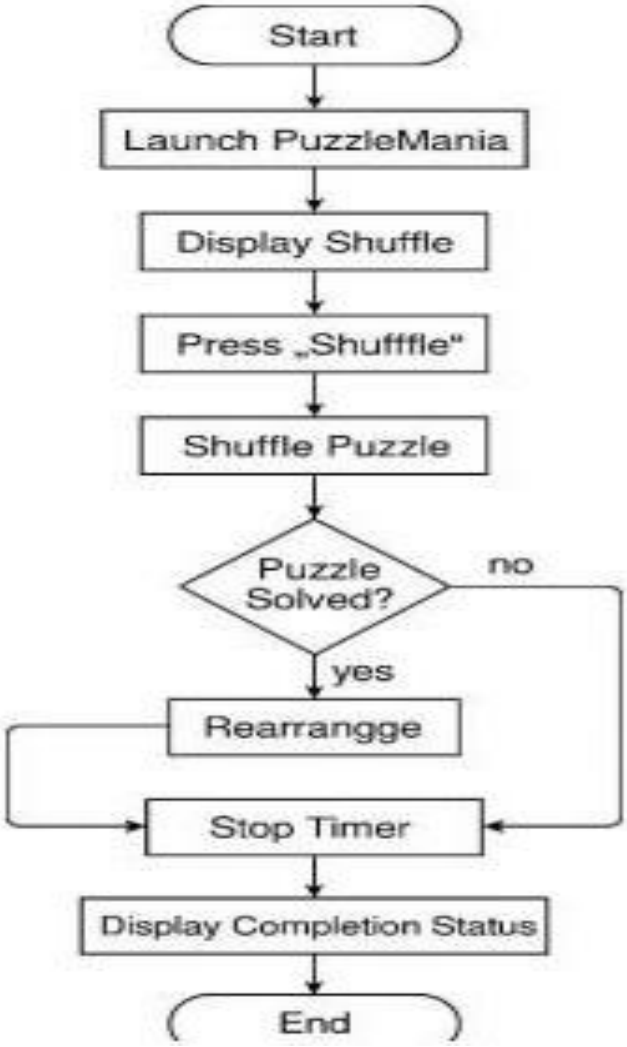
This section of the design focuses on how the user interacts with the game and how internal components communicate and function together. The major components of the system include the **user interface**, **shuffle logic**, **tile swapping mechanism**, **timer module**, **move counter**, and **result evaluation module**. The system also includes feedback loops such as "Game Complete" status that alerts users when they successfully arrange the tiles in the correct order.

The overall architecture follows the Model-View-Controller (MVC) pattern:

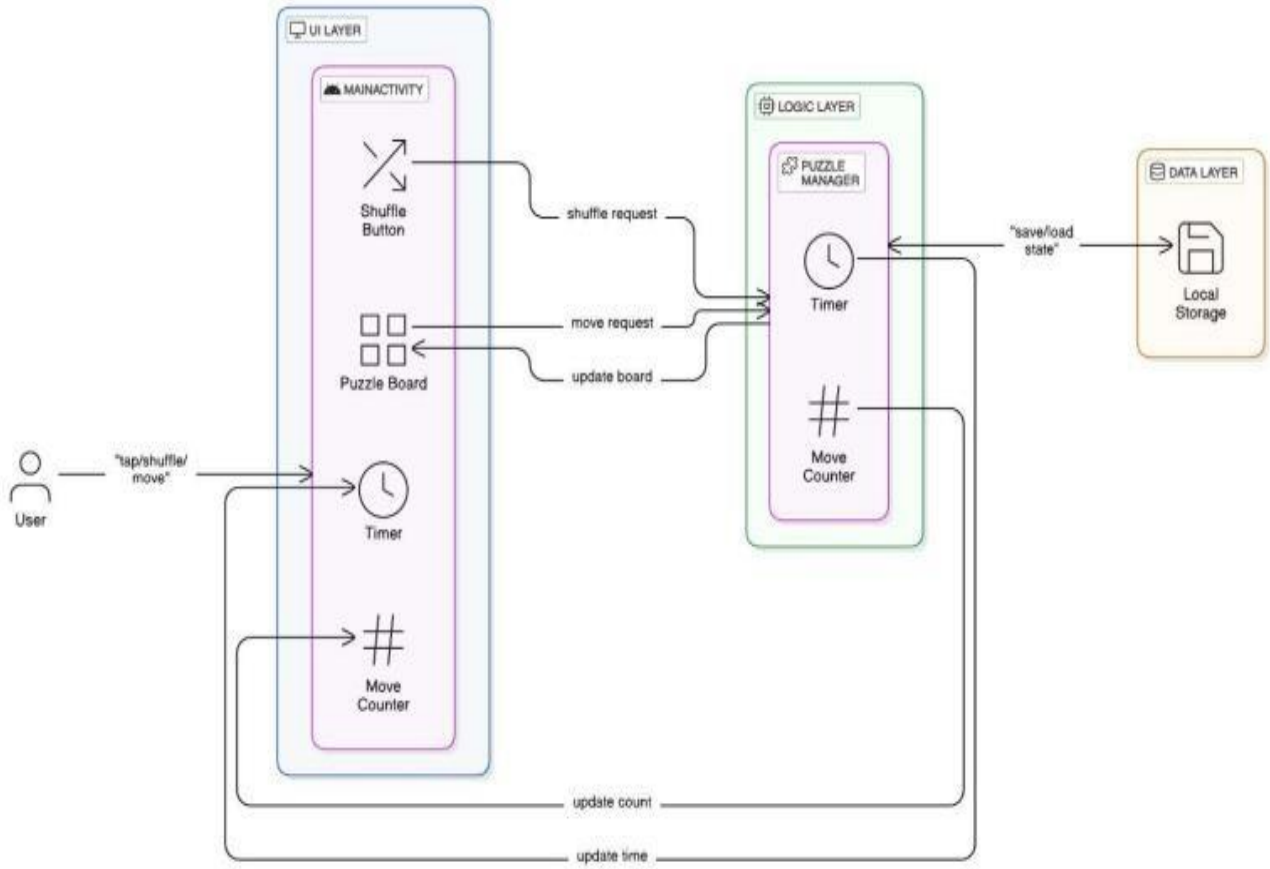
- **Model** – Holds the game state, tile positions, move count, and time.
- **View** – Displays the 3x3 grid, buttons, timer, and result.
- **Controller** – Handles user interactions like tapping tiles and pressing the shuffle button, updating both the model and view accordingly.

This architecture ensures separation of concerns, making the app more maintainable, scalable, and testable.

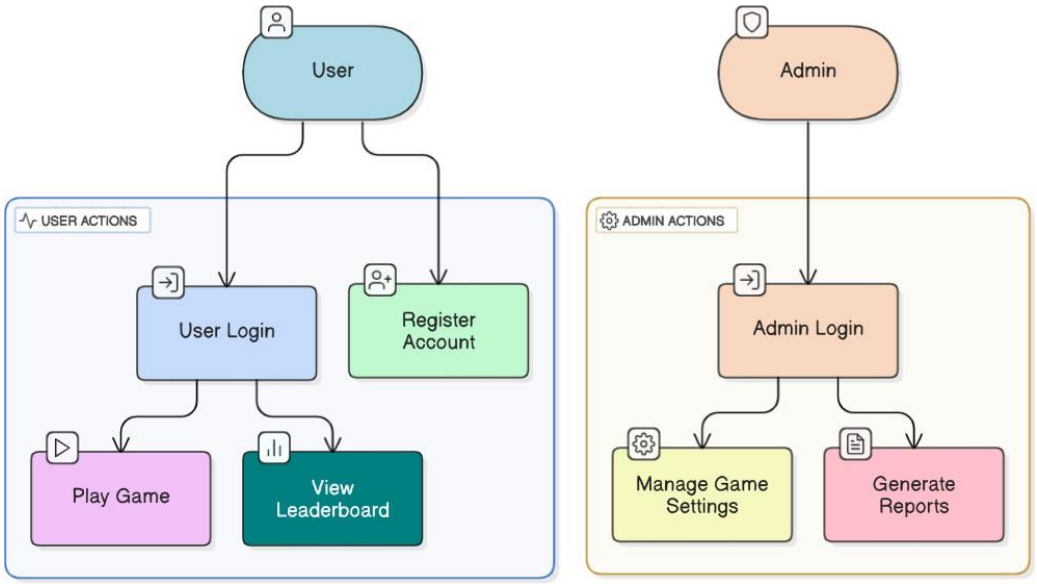
3.1.1 SYSTEM FLOW DIAGRAM



3.1.2 ARCHITECTURE DIAGRAM



3.1.3 USE CASE DIAGRAM



CHAPTER 4

PROJECT DESCRIPTION

MindGrid: Number Tile Puzzle is an Android-based mobile game that challenges users' cognitive abilities through a classic 3x3 sliding puzzle. The objective of the game is to rearrange shuffled numbered tiles into their correct order. Upon pressing the "Shuffle" button, the tiles are randomly mixed, and a timer begins, recording the time taken to complete the puzzle. The game also tracks the number of moves made by the player, encouraging strategic thinking and planning.

The design of MindGrid prioritizes user experience with a sleek and intuitive interface, making it easy for players of all ages to engage with. The game’s goal is not only to entertain but also to improve key cognitive functions such as memory, logic, problem-solving, and quick decision-making. The combination of a timed challenge and move counter provides players with measurable feedback, motivating them to improve their performance with each attempt.

Built using Android Studio, MindGrid combines casual gaming with mental exercise, offering a fun yet challenging gameplay experience. The game provides users with the opportunity for continuous learning and brain development, making it an excellent tool for mental fitness. Its simple yet addictive nature ensures hours of replayable content, making it ideal for both casual players and those looking to improve their cognitive skills.

4.1 METHODOLOGY

The development of MindGrid follows a systematic approach to create an engaging and user-friendly mobile game. The methodology for developing the game can be broken down into several key phases:

1. **Conceptualization**:
    - Defining the purpose of the game (improving logical thinking and problem-solving skills).
    - Designing the core mechanics of the sliding puzzle game.
2. **Design and User Interface (UI)**:
    - Creating an intuitive and visually appealing interface that allows players of all ages to engage effortlessly.
    - Focus on ease of use, accessibility, and providing a frustration-free gaming experience.
3. **Development**:
    - **Game Engine**: Using Android Studio, the game logic, timer, and move counter were implemented.
    - **User Interaction**: Programming the tile shuffle mechanism, drag-and-drop functionality, and win condition check.
4. **Testing**:
    - Conducting usability testing to ensure the game is user-friendly and functions correctly.

- Testing the responsiveness of the UI and making adjustments for better performance across different Android devices.

5. **Performance Feedback**:

    - Implementing a feedback system that tracks the player's time and moves, allowing them to compare their performance across multiple attempts.

    - Designing a system for storing and displaying player statistics.

4.1.1 MODULES

The MindGrid game consists of the following primary modules:

1. **User Interface Module**:

    - This module handles the overall game layout, including the tile grid, buttons (e.g., Shuffle, Restart), and feedback displays (time and moves).

    - It ensures a smooth, interactive user experience by providing intuitive navigation and gameplay controls.

2. **Game Logic Module**:

    - This is the core engine behind the puzzle mechanics. It handles the tile shuffling, checking the puzzle's win condition, and calculating the number of moves and time taken to solve the puzzle.

    - It includes functions for detecting the tile position, validating moves, and updating the game state.

3. **Timer Module**:

- The timer module starts as soon as the user presses the "Shuffle" button, keeping track of the elapsed time for each puzzle-solving attempt.

- It also includes logic to reset the timer when the puzzle is shuffled again and provides feedback to the player regarding the time spent on each puzzle.

4. **Move Counter Module**:

    - This module counts the number of moves made by the player during the game.

    - It is integrated with the game logic module, tracking each move made and displaying it in the UI for feedback.

5. **Statistics and Feedback Module**:

    - This module is responsible for tracking the player's performance. It records the time and move count for each game session.

    - After each game, it provides feedback to the player, including their performance and suggestions for improvement.

6. **Game State Management Module**:

    - This module ensures that the game state (shuffled tiles, timer, move count, etc.) is saved and restored when needed.

    - It includes logic to reset the game after completion and manage transitions between different game states (e.g., playing, paused, completed).

CHAPTER 5
CONCLUSION

5.1 GENERAL

MindGrid: Number Tile Puzzle successfully merges casual gaming with cognitive enhancement, offering an engaging and stimulating experience for users of all ages. By incorporating a classic sliding puzzle mechanic, the game not only entertains but also challenges players' logical thinking, problem-solving abilities, and quick decision-making skills. Through the use of performance feedback such as time and move count, MindGrid motivates players to improve and track their progress, fostering continuous learning and mental development.

The game’s development utilized Android Studio, ensuring a smooth, responsive, and user-friendly interface that can be enjoyed across a wide range of Android devices. By blending entertainment with mental exercise, MindGrid provides a valuable tool for individuals looking to improve their cognitive skills while having fun.

Ultimately, MindGrid stands as a perfect example of how mobile gaming can be both fun and beneficial. With its simple yet addictive nature, the game offers endless replayability, making it a great choice for users looking to sharpen their minds in a casual and enjoyable way. The project not only fulfills its goal of entertaining users but also serves as an excellent educational tool for brain development, ensuring that users can engage in mental exercises at their convenience.

APPENDICES

APPENDIX A: SOURCE CODE SNIPPETS

A.1 MainActivity.kt

```
package com.example.mindgrid
import android.content.Intent
import android.os.Bundle
import android.widget.Button
import android.widget.Toast
import androidx.appcompat.app.AppCompatActivity

class MainActivity : AppCompatActivity() {

    private lateinit var btnStartGame: Button
    private lateinit var btnHowToPlay: Button
    private lateinit var btnExit: Button

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_main)

        btnStartGame = findViewById(R.id.btnStartGame)
        btnHowToPlay = findViewById(R.id.btnHowToPlay)
        btnExit = findViewById(R.id.btnExit)
```

```
        btnStartGame.setOnClickListener {
            val intent = Intent(this, GameActivity::class.java)
            startActivity(intent)
        }

        btnHowToPlay.setOnClickListener {
            Toast.makeText(this, "Rearrange the tiles in order from 1 to 8 using the
empty space. Press 'Shuffle' to start.", Toast.LENGTH_LONG).show()
        }

        btnExit.setOnClickListener {
            finishAffinity()
        }
    }
}
```

A.2 GameActivity.kt

```
package com.example.mindgrid

import android.os.Bundle
import android.os.Handler
import android.os.SystemClock
import android.widget.Button
import android.widget.GridLayout
import android.widget.TextView
import androidx.appcompat.app.AppCompatActivity
import kotlin.random.Random
```

```
class GameActivity : AppCompatActivity() {

    private lateinit var gridLayout: GridLayout
    private lateinit var tvMoves: TextView
    private lateinit var tvTimer: TextView
    private lateinit var btnShuffle: Button

    private var buttons = ArrayList<Button>()
    private var emptyIndex = 8
    private var moveCount = 0

    private var startTime = 0L
    private val handler = Handler()
    private val timerRunnable = object : Runnable {
        override fun run() {
            val elapsedTime = (SystemClock.elapsedRealtime() - startTime) / 1000
            tvTimer.text = "Time: ${elapsedTime}s"
            handler.postDelayed(this, 1000)
        }
    }

    override fun onCreate(savedInstanceState: Bundle?) {
        super.onCreate(savedInstanceState)
        setContentView(R.layout.activity_game)

        gridLayout = findViewById(R.id.gridLayout)
```

```
    tvMoves = findViewById(R.id.tvMoves)
    tvTimer = findViewById(R.id.tvTimer)
    btnShuffle = findViewById(R.id.btnShuffle)

    setupBoard()
    btnShuffle.setOnClickListener {
        shuffleBoard()
        startTimer()
    }
}

private fun setupBoard() {
    for (i in 0..8) {
        val btn = Button(this)
        btn.text = if (i != 8) (i + 1).toString() else ""
        btn.textSize = 24f
        btn.setOnClickListener { moveTile(i) }

        buttons.add(btn)
        gridLayout.addView(btn, 250, 250)
    }
    emptyIndex = 8
}

private fun shuffleBoard() {
    val numbers = (1..8).toMutableList()
    numbers.shuffle(Random(System.currentTimeMillis()))
```

```
    numbers.add(0) // Representing the empty tile

    for (i in 0..8) {
        val text = if (numbers[i] == 0) "" else numbers[i].toString()
        buttons[i].text = text
    }

    emptyIndex = numbers.indexOf(0)
    moveCount = 0
    tvMoves.text = "Moves: $moveCount"
}

private fun moveTile(index: Int) {
    val neighbors = listOf(
        index - 1, index + 1,
        index - 3, index + 3
    ).filter { it in 0..8 && isValidMove(index, it) }

    if (emptyIndex in neighbors) {
        buttons[emptyIndex].text = buttons[index].text
        buttons[index].text = ""
        emptyIndex = index
        moveCount++
        tvMoves.text = "Moves: $moveCount"

        if (isSolved()) {
            showCompletionDialog()
```

```
        }
    }
}


private fun isValidMove(from: Int, to: Int): Boolean {
    val fromRow = from / 3
    val fromCol = from % 3
    val toRow = to / 3
    val toCol = to % 3
    return (fromRow == toRow && kotlin.math.abs(fromCol - toCol) == 1) ||
            (fromCol == toCol && kotlin.math.abs(fromRow - toRow) == 1)
}

private fun startTimer() {
    startTime = SystemClock.elapsedRealtime()
    handler.removeCallbacks(timerRunnable)
    handler.post(timerRunnable)
}

override fun onDestroy() {
    handler.removeCallbacks(timerRunnable)
    super.onDestroy()
}

private fun isSolved(): Boolean {
    for (i in 0..7) {
```

```
            if (buttons[i].text != (i + 1).toString()) return false
        }
        return buttons[8].text == ""
    }
    private fun showCompletionDialog() {
        handler.removeCallbacks(timerRunnable)
        val elapsedTime = (SystemClock.elapsedRealtime() - startTime) / 1000

        val message = "Congratulations! You solved the puzzle in $moveCount
moves and $elapsedTime seconds."

        val dialog = androidx.appcompat.app.AlertDialog.Builder(this)
            .setTitle("Puzzle Solved!")
            .setMessage(message)
            .setCancelable(false)
            .setPositiveButton("Play Again") { _, _ ->
                shuffleBoard()
                startTimer()
            }
            .setNegativeButton("Exit") { _, _ ->
                finish()
            }
            .create()

        dialog.show()
    }
```

}

A.3 Activity_game.xml

```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    android:id="@+id/gameLayout"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="vertical"
    android:padding="16dp"
    android:gravity="center"
    android:background="#FAFAFA">

    <TextView
        android:id="@+id/tvMoves"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Moves: 0"
        android:textSize="18sp"
        android:layout_marginBottom="8dp" />

    <TextView
        android:id="@+id/tvTimer"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Time:                    0s"
```

```
        android:textSize="18sp"
        android:layout_marginBottom="16dp" />

    <GridLayout
        android:id="@+id/gridLayout"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:columnCount="3"
        android:rowCount="3"
        android:layout_marginBottom="24dp" />

    <Button
        android:id="@+id/btnShuffle"
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="Shuffle" />
</LinearLayout>
```

A.4 activity_main.xml

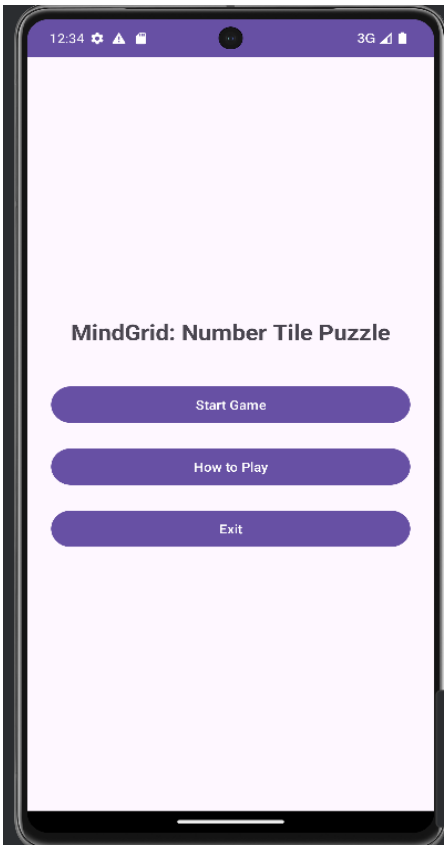
```
<?xml version="1.0" encoding="utf-8"?>
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:id="@+id/homeLayout"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:gravity="center"
    android:orientation="vertical"
```

```
android:padding="24dp"
tools:context=".MainActivity">

<TextView
    android:id="@+id/appTitle"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="MindGrid: Number Tile Puzzle"
    android:textSize="24sp"
    android:textStyle="bold"
    android:gravity="center"
    android:layout_marginBottom="40dp" />

<Button
    android:id="@+id/btnStartGame"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:text="Start Game"
    android:layout_marginBottom="20dp" />

<Button
    android:id="@+id/btnHowToPlay"
    android:layout_width="match_parent"
    android:layout_height="wrap_content"
    android:text="How to Play"
    android:layout_marginBottom="20dp" />
```

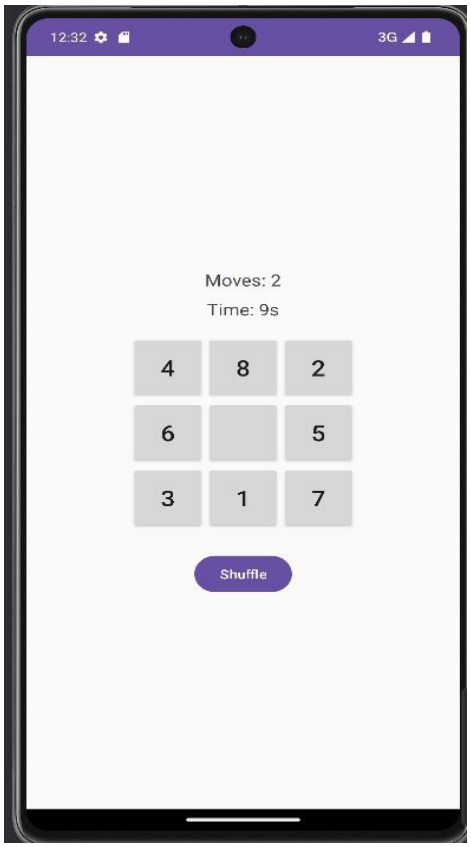
```
    <Button
        android:id="@+id/btnExit"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:text="Exit" />
</LinearLayout>
```

APPENDIX B: APPLICATION SCREENSHOTS

3.4 DASHBOARD



3.5 PLAY GAME



APPENDIX C: TOOLS AND TECHNOLOGIES USED

C.1 Programming Language

1. Kotlin

- Used as the primary programming language for Android app development.
- Provides modern syntax, null safety, and full interoperability with Java.

C.2 Development Environment

1. Android Studio

- The official Integrated Development Environment (IDE) for Android development.
- Offers tools for layout design, code editing, debugging, and performance testing.

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