Multistate Lights Out Mobile Game with Integrated Linear Algebra Solver

Cluster Innovation Centre
University of Delhi

Mentor : Prof. Shobha Bagai

Gaurav Kumar Jha (152222) gauravkumarjha306@gmail.com
Raj Shakya (152238) rajshakya.orai18@gmail.com
Vishwajeet Nand Yaduraj (152256) vishwajeetnandyaduraj786@gmail.com

Introduction

This project explores the convergence of mobile game development, linear algebra, and cloud-based data management through the creation of a multi-state Lights Out puzzle game using Flutter/Dart. Traditionally, the Lights Out game has focused on two-state grids, where cells toggle between two states. Here, we extend this concept to grids with 2, 3, 4, and 5 states per cell, introducing fresh challenges in puzzle design and solver implementation.

Objective

Generalize the Lights Out puzzle game to multiple states and dimensions while ensuring a user-friendly UI. Explore diverse grid configurations for engaging gameplay across varying complexity levels.

Methods

We used linear algebra methodologies for puzzle solving and employed Firebase Authentication and Firestore for user authentication and data storage.
In our methodology, we harnessed the capabilities of the Flutter framework for the entirety of game development, ensuring a seamless and responsive user interface.

	Invertible Cases	Non-Invertible Cases
RREF Methodology	✓	✗
Using Basis (NULL Spaces)	–	✓

Methodology Summary

	2 States Involved	k - States Involved
Grid size (2,3,6,7,8,10,....)	✓	✓
Grid size (4,5,9,14,16,....)	✓	✗

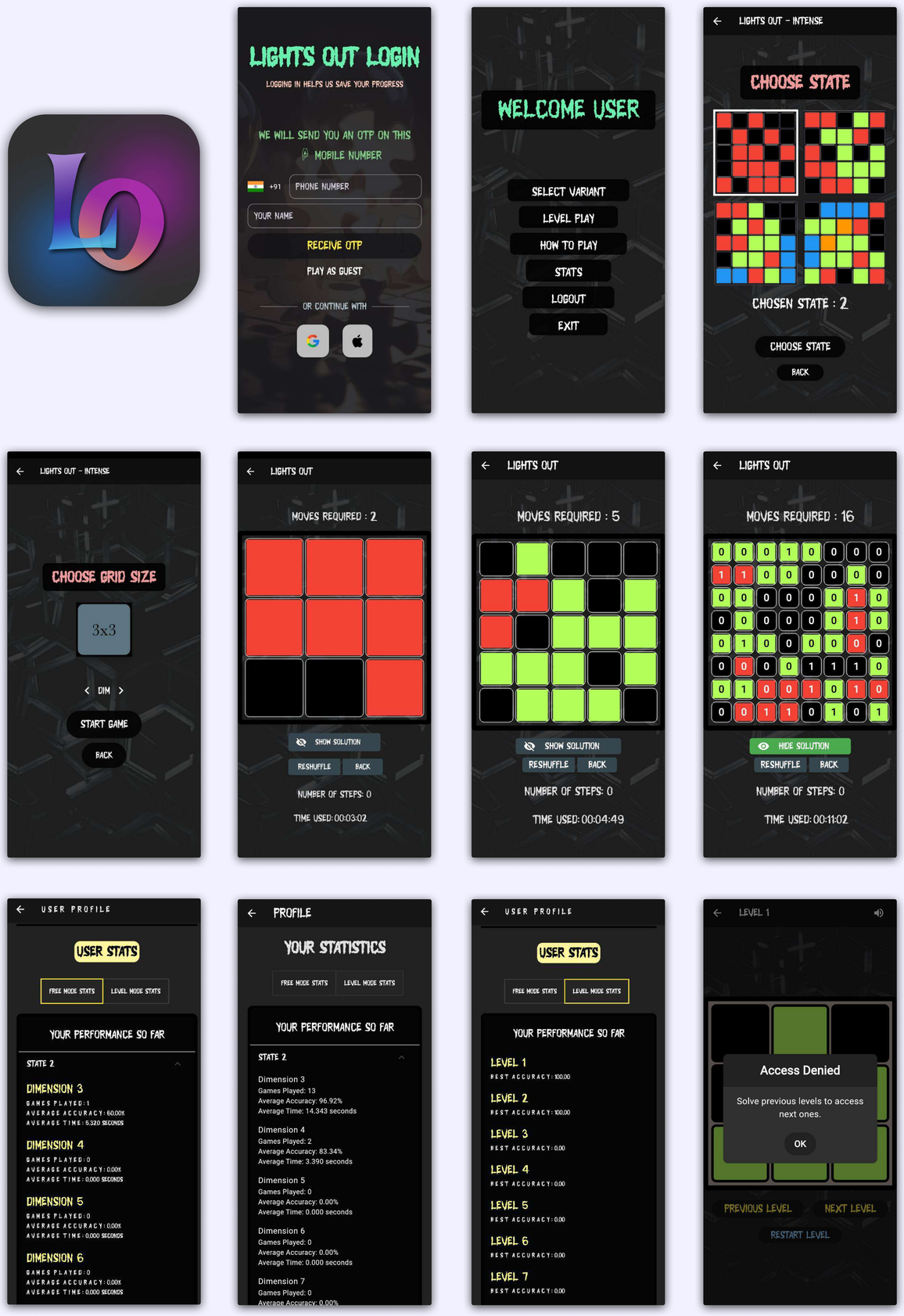
Limitations Summary

Puzzles in dimensions 4 and 5, where free variables exist, required a sophisticated handling of the basis of the null space. By thoroughly exploring the null space of the matrix, we identified all potential solutions to the puzzle. Subsequently, we employed a selection process to determine the minimum solution based on predefined criteria, ensuring optimal results for the user.
In summary, our methodology combined the precision of linear algebra with the real-time capabilities of Firebase and the user-friendly design of Flutter. This integrated approach not only solved complex puzzles but also delivered a seamless and enjoyable user experience.

Future Work And Objective

For future work, we plan to enhance the user interface by incorporating interactive elements such as bird cages. Users will click on a cage to open or close it, affecting both the cage and its neighboring cages. Upon opening all cages, birds will be released, adding excitement and engagement, especially for children.
Additionally, we aim to develop an engine capable of analyzing gameplay data to provide users with insights into their puzzle-solving strategies. This feature will offer players a deeper understanding of their performance and gameplay techniques, further enhancing their experience and learning outcomes.

App Screenshots



Technology Used

Flutter · Dart · Firebase · Mathematica · Figma

References

Lights Out Solver. (n.d.).
Scherphuis, Jaap. (n.d.). Lights Out Mathematical Puzzles
Wolfram Cloud. (n.d.) The Lights Out Puzzle
Meyer, Rebecca S. (2013). The Game of Lights Out. EWU Masters Thesis Collection, 167
Madsen, M. A. (2010). Lights Out: Solutions Using Linear Algebra. Summation, 3, 36–40

Appendix

GitHub Link

APK

Apk Download