



ADVANCED SOFTWARE ENGINEERING

# PROJECT DESIGN AND REPORT

*Presented by*

**Group – 6**

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# Abstract

This report presents the study, design and analysis of a software project targeted at creating a web-based game application that consists of N-Queens problem, Polysphere Problem in 2 Dimension and Polysphere Problem in 3 Dimension. This project is developed as a part of the course module Advanced Software Engineering as a tool to learn software development in large scale IT industries and to understand distinct methodologies involved for the development. The project has been created by the collaborative and determined efforts of the team members of Group-6.

## Acknowledgement

The team members of Group – 6 expresses sincere gratitude to our teacher and module convenor Prof. Hsi-Ming Ho for his constant support and invaluable insights throughout the course of this project. His expertise and guidance has been crucial in achieving success through the journey of the project development.

Furthermore, a heartfelt thank you to all the members of Project Group 6. The dedicated hard work, sheer determination and collective effort of all the team members have played an important role in achieving the goals of developing this project. The commitment to excellence and working together has made this journey fulfilling and has provided a rewarding experience to all. Thank you all for your valuable contributions.

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# INTRODUCTION

## *Overview*

This comprehensive report unfolds an in-depth study and analysis, delving into a purposeful software initiative aimed at the development of web-based game application. The primary objective of this application is to engage users in the interactive exploration and resolution of puzzles, specifically focusing on the N-Queens puzzle, the Polysphere Puzzle in a 2-dimensional grid, and the Polysphere Puzzle in a 3-dimensional pyramid. The central emphasis of this web application development project is to empower users to independently engage with and solve these intricate puzzles.

This web application is developed to offer users the capability to actively participate in the puzzle-solving process. It is designed to let users navigate through the N-Queens puzzle, strategically placing queens on a chessboard, and tackling the Polysphere Puzzles in both 2D and 3D environments by placing different shapes on the grids. Furthermore, the application is equipped to present solutions to these puzzles upon user request, to help users understand, compare and reevaluate their solutions.

The primary recipients of this report encompass the esteemed professor, referred to as the client, and the dedicated members constituting Project Group 6. The journey of the development of this project serves as an educational tool for an immersive and hands-on learning experience in software development procedures. To replicate the authentic experience of an enduring software development project, the development approach involved the adoption of the agile methodology. This strategic choice allowed all parties to proactively respond to the evolving needs and preferences of the client by delivering requested features and valuable feedback in a timely manner.

## *Project Tasks*

The project consisted of the systematic implementation of the three widely recognized puzzles - N-Queens Problem, the Polysphere Puzzle in a 2D grid, and the Polysphere Puzzle in a 3D pyramid - undertaken in distinct stages. The following sections provide a detailed briefing on each of the puzzles incorporated into the project.

### **N-Queens Problem**

The N-Queens problem requires the strategic placement of N number of Queen chess pieces on an  $N \times N$  chessboard so that no two Queens attack each other. This means that the user must place the Queen pieces in such a way that no two Queens can be placed facing each other in a straight line or diagonally. This classic puzzle is implemented in the project for Chessboard sizes  $4 \times 4$  to  $10 \times 10$  for 4 Queens and 10 Queens respectively.

### **Polysphere Problem - 2 Dimension**

In the 2D Polysphere Problem, the user will be presented with a white grid board and a selection of puzzle pieces, each uniquely fashioned with a specific arrangement of spheres and distinct colours. The challenge lies in the user's ability to strategically place each puzzle piece on the board, ensuring that every shape effectively covers all the white spaces while also preventing any overlap between two puzzle pieces.

### **Polysphere Problem - 3 Dimension**

Similar to the 2D Polysphere Problem, the user 3D Polysphere Problem in will be presented with a selection of puzzle pieces, each uniquely fashioned with a specific arrangement of spheres and distinct colours. However, unlike the 2D Polysphere Problem, here the user will be given a 3 dimensional pyramid board. Here the challenge is that the user must strategically position each puzzle piece on the pyramid without distorting its shape, effectively covering all the white spaces without overlap between two puzzle pieces.

# DEVELOPMENT

## *Development Methodology*

This section includes the methods used to develop the project

## *Software Tools*

This section includes the software tools used to develop the project

## *Design Plan*

This section includes the flow charts and diagrams used to plan the project

## *Implementation*

This section includes the problem wise coding strategies and algorithms used to develop the project

# TESTING

Following sections lists the test cases and results for each game to evaluate the software functionality is as expected and meets the specified functional requirements. The goal of this phase is to ensure the functionality and reliability of the implemented code and algorithm fulfilling its intended purpose.

## *N-Queens Problem*

S.No.	Test Case	Expected Result	Results
1	To test the successful launch of N-Queens Server	Successful Launch of Server	Server launched successfully.[Fig-1]
2	To test the display of chess board is in accordance with the size selected.	The Chessboard is displayed when range is between 4-10 size. In case of 'out of range' input by the user, the server displays a pop up indicating incorrect range input. Display of chessboard should be accurate.	The results are as expected.[Fig-1][Fig-2]

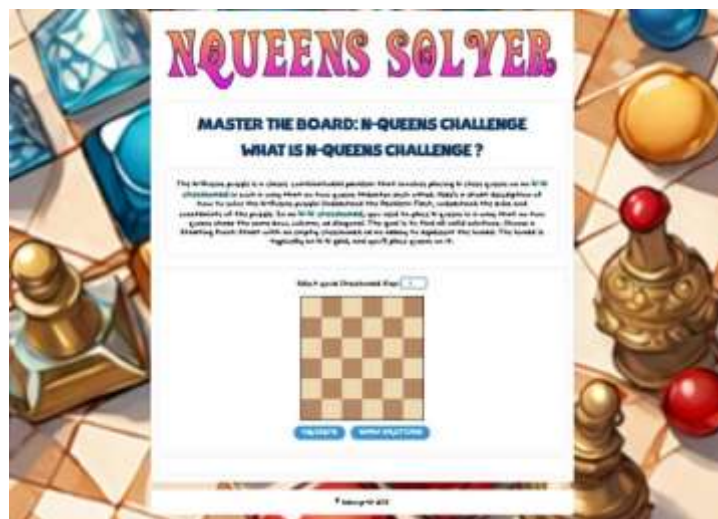


Figure 1





Figure 2

S.No.	Test Case	Expected Result	Results
3	To test the validation of solution presented to user	<b>Case 1:</b> Display pop up to the user if the validation of their solution is correct.	Results are presented in [Fig-3]
		<b>Case 2:</b> Display pop up to the user if the validation of their solution is incorrect.	Results are presented in [Fig-4]



Figure 3



Figure 4

S.No.	Test Case	Expected Result	Results
4	To test placement and removal of Queen Pieces by clicking.	First click on chessboard should place the Queen piece on that position and Second Click on the Queen piece should remove the said piece.	Each expected action is performed successfully. [Fig-5][Fig-6]



Figure 5

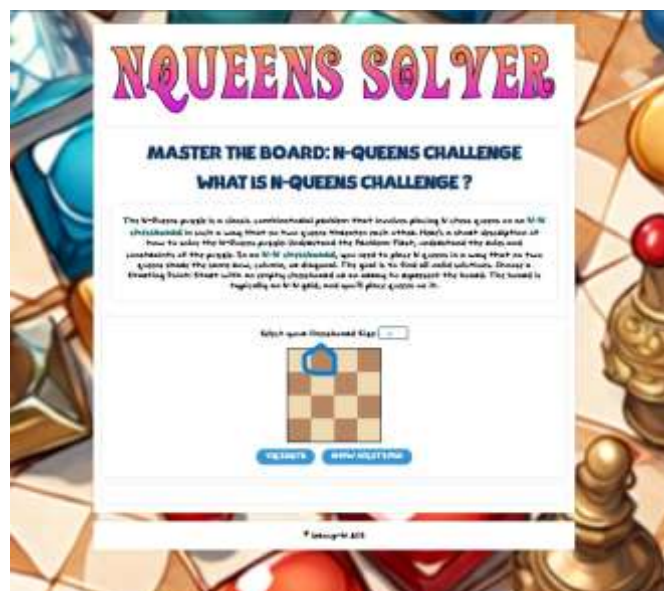


Figure 6

S.No.	Test Case	Expected Result	Results
5	To test the number of Queen pieces placed is not more than the corresponding size of the Chessboard.	To ensure if user attempts placing Queens more than the size of the Chessboard, an error pop up is displayed to the user.	The user is displayed the error pop up message as expected.[Fig-7]



Figure 7

S.No.	Test Case	Expected Result	Results
6	To verify the accuracy of the presented solutions	Accurate solutions are displayed after clicking “Show Solution” button according to the partially filled or empty chessboard and solutions are hidden after clicking “Hide Solution” button.	The presented solutions are accurate as per the rules of the game.[Fig-8][Fig-9]



Figure 8



Figure 9

## Polysphere Puzzle-2D

S.No.	Test Case	Expected Result	Results
1	To test the successful launch of Polysphere Puzzle -2D Server	Successful Launch of Server	Server launched successfully.[Fig-10]

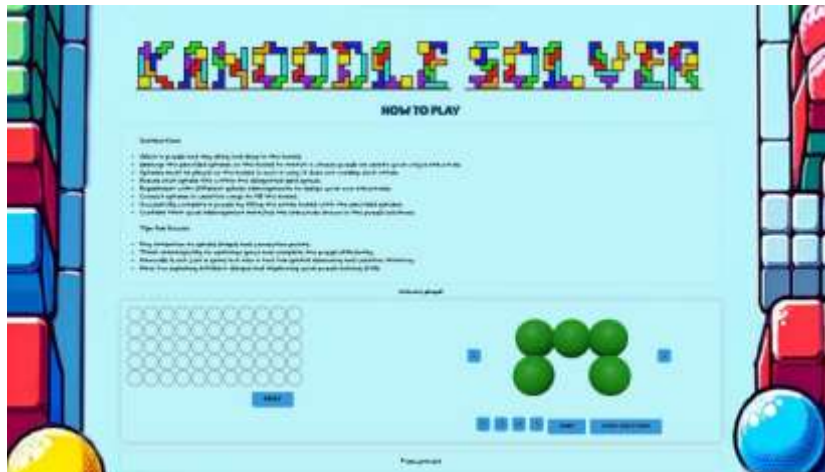


Figure 10

S.No.	Test Case	Expected Result	Results
2	To test the placement of polysphere pieces into the board.	Accurate placement of the pieces by dragging and dropping polysphere pieces onto the board as per user's expectation and removal of the last placed piece by clicking "undo" button.	Dragging and dropping action is as expected [Fig-11][Fig-12] as well as "undo" action. [Fig-13][Fig-14]

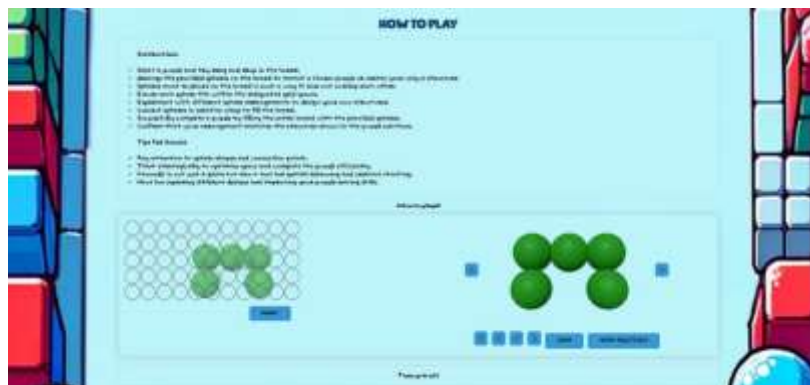


Figure 11



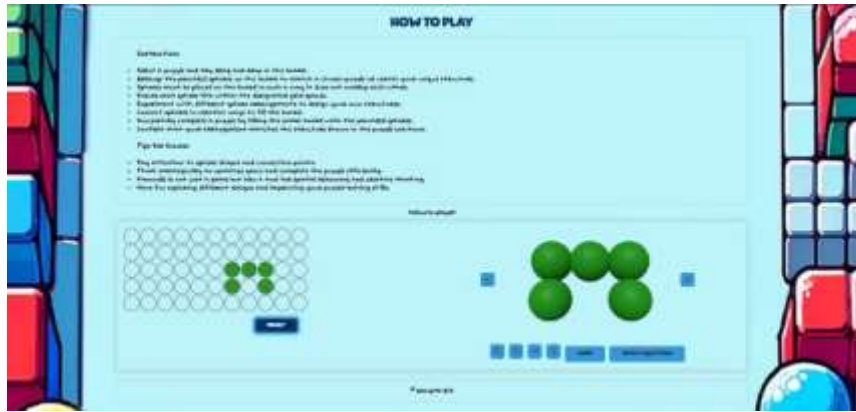


Figure 12

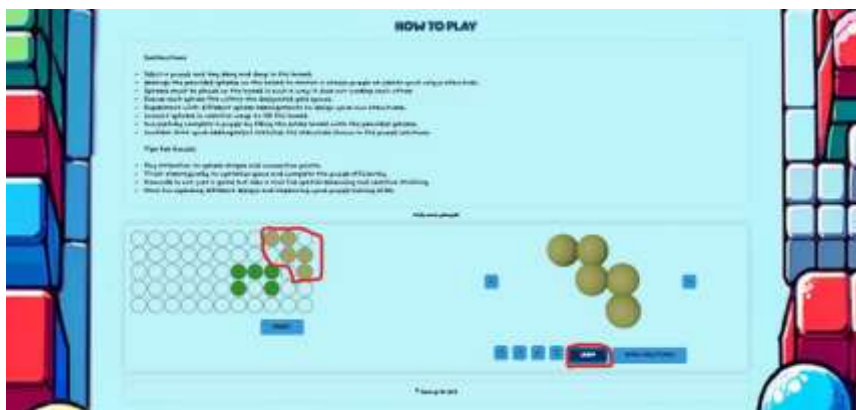


Figure 13

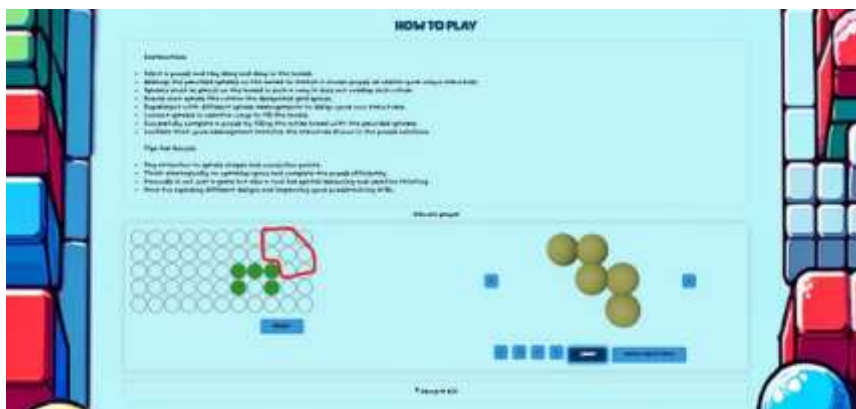


Figure 14

S.No.	Test Case	Expected Result	Results
3	To test the accuracy of rotation and restructuring of the polysphere pieces using the provided buttons.	<p><b>Case 1:</b> Verification of left and right rotate symbol buttons.</p> <p>90 degrees left or right Rotation of the polysphere pieces by click of each respective left or right rotate symbol button.</p>	<p>Button functions are as expected. [Fig-15][Fig-16] [Fig-17]</p>
		<p><b>Case 2:</b> Verification up-down and side-to-side flip symbol buttons.</p> <p>180 degrees' flip of the polysphere pieces by click of up-down or side-to-side flip symbol buttons.</p>	<p>Button functions are as expected. [Fig-18][Fig-19] [Fig-20]</p>

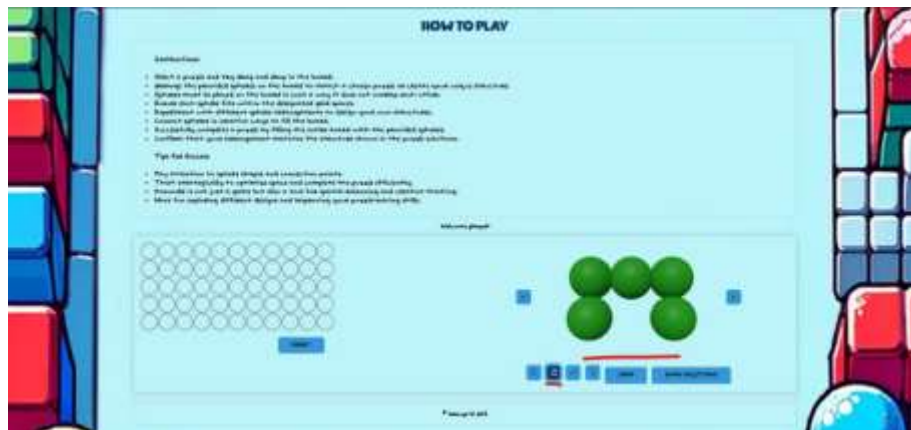


Figure 15

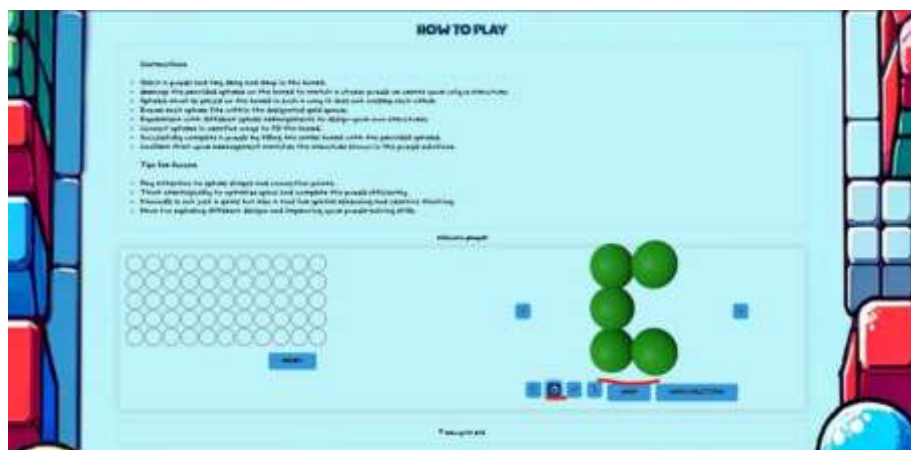


Figure 16

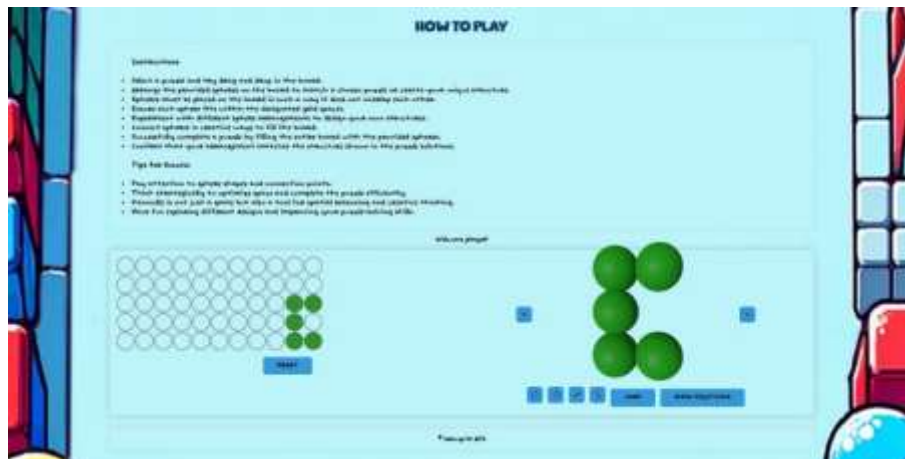


Figure 17

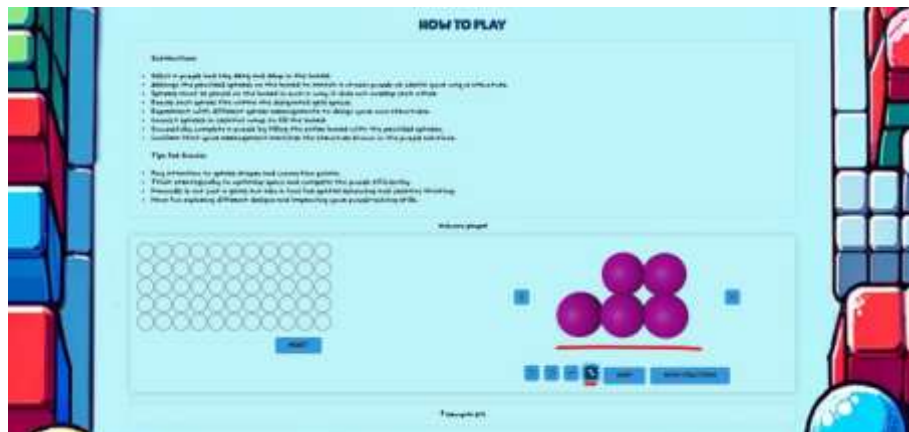


Figure 18

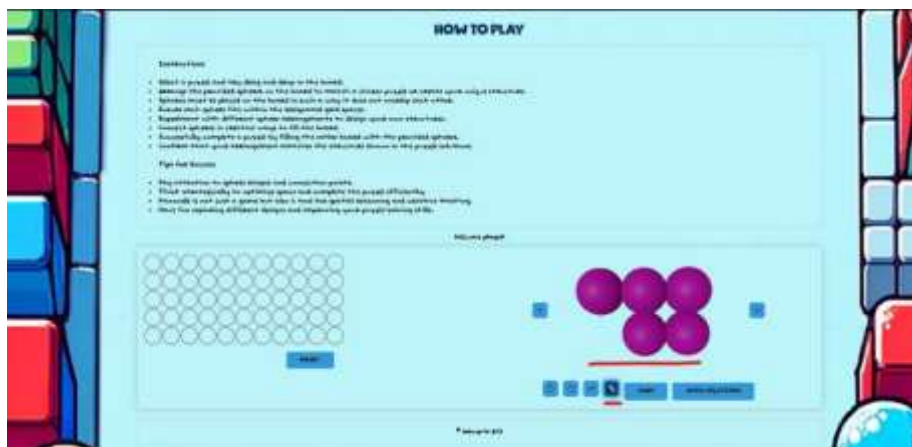


Figure 19



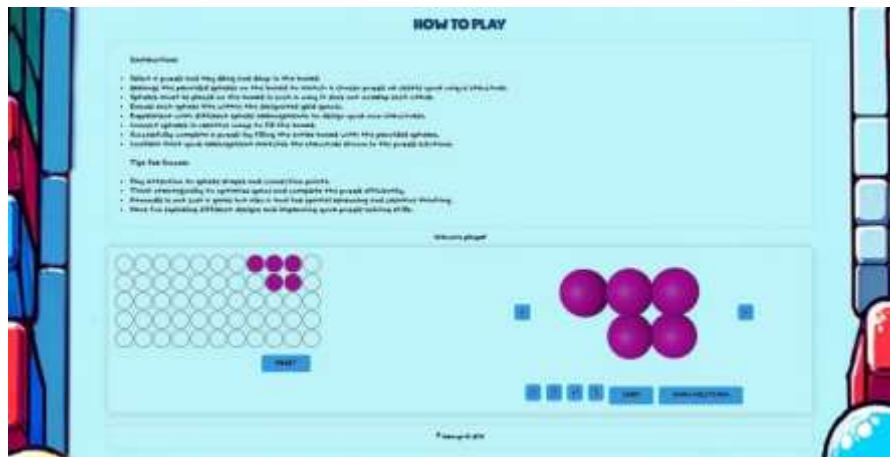


Figure 20

S.No.	Test Case	Expected Result	Results
4	To test the accuracy of the presented solutions.	<p><b>Case 1:</b> To verify functionality of “Show Solution” Button</p> <p>Solutions are displayed after clicking “Show Solution” button and in case of no possible solutions for user’s piece arrangement on board, a message is displayed</p>	Button function is as expected. [Fig-21]
		<p><b>Case 2:</b> To verify the accurate solution is presented.</p>	Accurate solution is presented.[Fig-22]

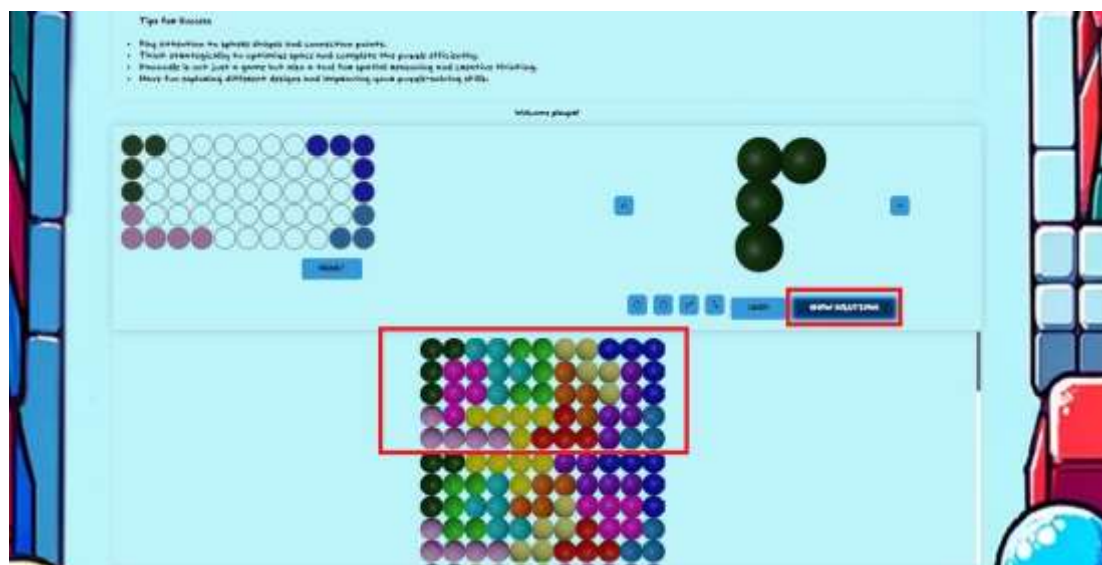


Figure 21



Figure 22

S.No.	Test Case	Expected Result	Results
5	To test the Reset button	The "Reset" button should clear all the pieces from the board.	Button function is as expected. [Fig-23][Fig-24]

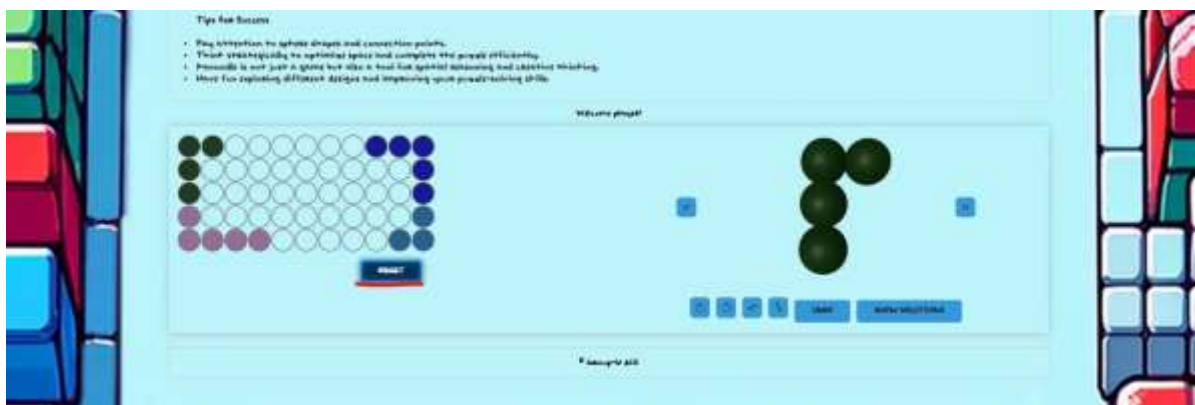


Figure 23

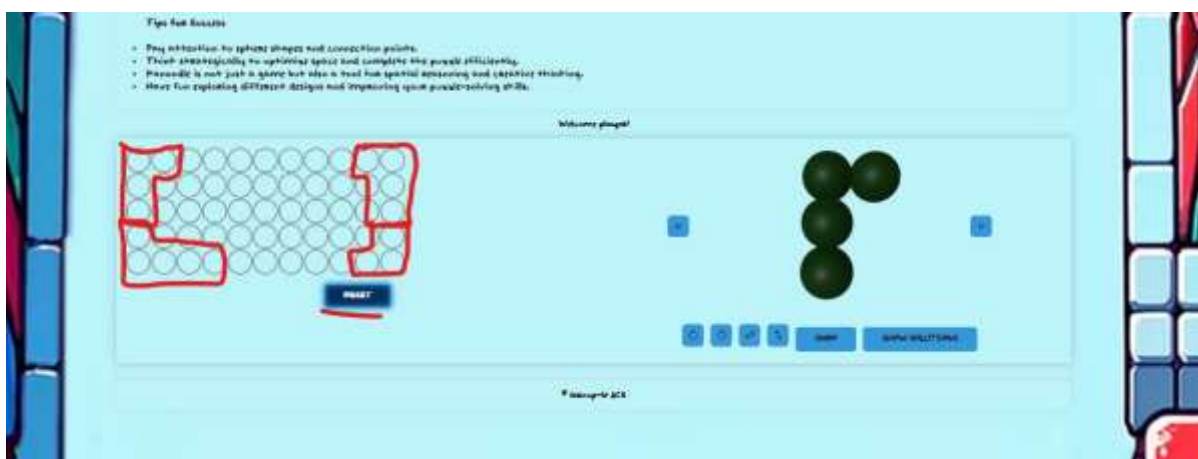


Figure 24

## *Polysphere Problem – 3-Dimension*

S.No.	Test Case	Expected Result	Results
1	To test the successful launch of Polyshpere Puzzle -3D Server	Successful Launch of Server	Server launched successfully.[Fig]

S.No.	Test Case	Expected Result	Results
2	to test the 3D rotation of the polyshpere pyramid.	Dragging of the mouse should display the view of the pyramid from 3-dimensional perspective.	

S.No.	Test Case	Expected Result	Results
3	To verify selection of the shapes	Display of the choices of the shapes by selecting right or left swipe buttons.	

S.No.	Test Case	Expected Result	Results
4	To test the colouring of the spheres in the pyramid according to shape selected by the user.	<b>Case 1:</b> Clicking on the spheres should colour it in the shade of the shape selected by the user	
		<b>Case 2:</b> Colouring of the spheres should be restricted to the shape selected. The number of spheres in the pyramid that can be coloured should be equal to the number of spheres in the shape displayed as selected by the user.	

S.No.	Test Case	Expected Result	Results
5	To test the Solve, Clear and Stop functions.	<b>Case 1:</b> "Solve" button should give the number of solutions as well as visual representation of the solutions on the pyramid for partial and empty configuration.	
		<b>Case 2:</b> "Stop" button will stop the listing of solutions and Clear button should clear all the coloured spheres in the pyramid to reset the game.	

S.No.	Test Case	Expected Result	Results
6	To test the visual aspects of the pyramid.	The slider button should display the visual representation of the pyramid according to the number of layers selected in 2-D as well as 3-d.	

# CONCLUSION

In conclusion, this comprehensive report outlines a purposeful software initiative focused on the development of a web-based game application, emphasizing interactive puzzle resolution. The project's central objective is to empower users to independently engage with and solve intricate puzzles, including the N-Queens puzzle and the Polysphere Puzzles in both 2D and 3D dimensions.

The web application is designed to facilitate active user participation in the puzzle-solving process, allowing navigation through chessboard scenarios, strategic queen placements, and the placement of various shapes on grids for Polysphere Puzzles.

The project is implemented through agile methodology to provide requested features and feedback from the client. Utilized GitHub as the central platform for tracking all development activities in collaboration with the customer.

The project also underwent thorough testing to verify reliability and functionality of the web-based game application.

## *Limitations*

### **N-Queens Puzzle**

- The Chessboard size is limited to 10 Queen pieces due to computation complexities emerging with higher size boards as heavy resources are consumed when computing the solutions.

### **Polyspere Puzzle – 2D**

- The user cannot perform combinations of rotation and flips due to logical constraints.

### **Polysphere Puzzle – 3D**

- Placement of the shapes can only be done unidirectional relative to the initial placement of the first sphere.
- Users cannot place the pieces diagonally as the shape of pieces cannot be skewed from its original shape.

- The user cannot drag and drop the pieces on the pyramid. The game relies on the User's understanding of the 3-d structures and visual knowledge of the shapes. The limitation is caused due to heavy reliance on libraries such as Three.js and Orbit Controls that are used to generate the 3-D elements of the Game.

## *Future Improvements*

To improve the puzzle-solving capabilities, the optimization of time complexity and the enhancement of algorithmic efficiency in the computation of solutions for each puzzle will be required in the project. The primary goal is to guarantee the time required for solving puzzles is minimized, and the implemented algorithms show efficiency in delivering accurate solutions. By improving the time complexity, the overall performance of the puzzle-solving mechanisms will be enhanced, providing users with a smoother experience in navigating through complex problems.

Furthermore, enhancement in both the user experience and the visual features of the system can also be implemented. This improvement can elevate the overall usability and aesthetics of the application. Enhancing the user experience requires improving the interface, navigation flow, and overall interaction design for a more intuitive, efficient, and satisfying engagement for the users.