

[Orbital] King's Gambit - Technical Design Documentation

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Project Overview

Team Name: King's Gambit

Members: Kishor Kumar(A0218445A), Jonathan Mui Koy Kit(A0217498N)

Project Name: King's Gambit

Proposed Level of Achievement: Apollo 11

Estimated time for gameplay: 1.5 - 2 hrs

Link to Software:

<https://github.com/KishorKumar11/KingsGambit/releases/tag/Beta>

Tech Stack:

- Version control : Github and Git
- Game Engine: Unreal Engine 4.26 (code in C++)

Motivation:

Due to the pandemic last year, the popularity of chess and other board games have skyrocketed. Many started playing this game of chess in order to fight boredom and learnt that there is more than what meets the eye in the 8x8 board of war.

There are many levels to chess and there are beginners who play for fun, intermediates who think deep and try to counterplay the opponent and lastly advanced players who study the theories vigorously.

After watching the famous Queen's Gambit show, many have taken interest in becoming a top player. However, they lack the instructions and practice to reach that level immediately. Infact, many get stuck at the same level for a long time as they are stuck to what they have tried out from the games they play. The key material required in transition from an intermediate to advanced is knowledge and tactics.

So the question arises from many intermediate players, what exactly should I do to get even better? That's when learning chess openings steps in. One may be a beginner who at least knows how the pieces work or an intermediate who thinks in the opponent's perspective.

Therefore, do you want to be in the world's top 5-10%? Hop on to this platform, learn the openings and get better.

Aim:

We aim to improve the skill level of beginners and intermediates who are struggling to get better. We also intend to make the game of chess more interesting by letting the users explore the theory behind openings.

User Profile/ Stories:

User Profile:

Target audience: People of all age groups interested in Chess who lack in depth knowledge and are stuck in a certain level for a long time. The game is established in English thus foreigners who don't speak the language will not be able to understand the instructions and options provided. Nonetheless, as the game of chess is universal, we believe everyone will be able to use the play mode. Chess instructors who need a tool to coach their students

Ideal user profile: Intermediate chess players who have a basic understanding of the rules of the game and want to improve on their skills.

User stories:

User story format: As a {user type/role} I can {function} so that {benefit}

High priority:

- As a beginner chess player, I want to be able to see where I can move each chess piece
- As a user who wants to learn the chess opening moves, I want to be able to go through the openings step by step
- As a user who wants to learn from the game, I want learning points to be delivered in a concise and memorable manner so that my time is spent efficiently
- As a user, I want to be able to resume a paused game from where i left off
- As a user, I want to be able to pause the game when necessary
- As a user, I want to be able to learn various opening moves
- As a stressed user, I want to relax while playing the game with the help of music and nice visuals
- As a user, I want to test what I have learnt from the teachings
- As a user, I need to understand the instructions of the game

Low Priority:

- As a user, I want to be able to adjust the screen resolution in game
- As a user, I want different types of visual effects for each round
- As a user, I want to be able to navigate easily through the various features of the game
- As a user, I want to be able to control the music volume
- As a user who wants to feel fulfilled, the game should not end too fast

Features:

Menu Overview

- a. Play Mode
 - i. Grid and piece Highlighting
 - ii. Display of error messages
 - iii. Display of player names
 - iv. In-game user manual
- b. Trainer Mode
 - i. 6 Different Openings
 - ii. Multiple Variations under each opening
 - iii. Free Room
- c. Guess Mode
 - i. Guess the square notation
 1. Music
 2. User input - Text
 3. 10 Levels (Increased Difficulty)
 - ii. Guess the next move
 1. Music
 2. User input - Drag Piece
 3. 5 Levels (Increased Difficulty)
 4. Free Room
 5. Pause
- d. Settings
 - i. Volume Bar
 - ii. Screen Resolution
- e. Credits
- f. Exit



Pause

Allows users to pause the game in any game menu. From the pause menu, users are able to either resume the game, return to the main menu to go to another game mode or quit the game directly.



Music

From lofi to gaming background songs to provide users a peaceful mindset and a surge to beat their opponent in the classic dual in Play Mode. Moreover, different background music is played in different game modes.

Free Room

Users are allowed to “fly” around the map with WASD controls. This allows users to have a better feel of the game and explore the map while playing the game.

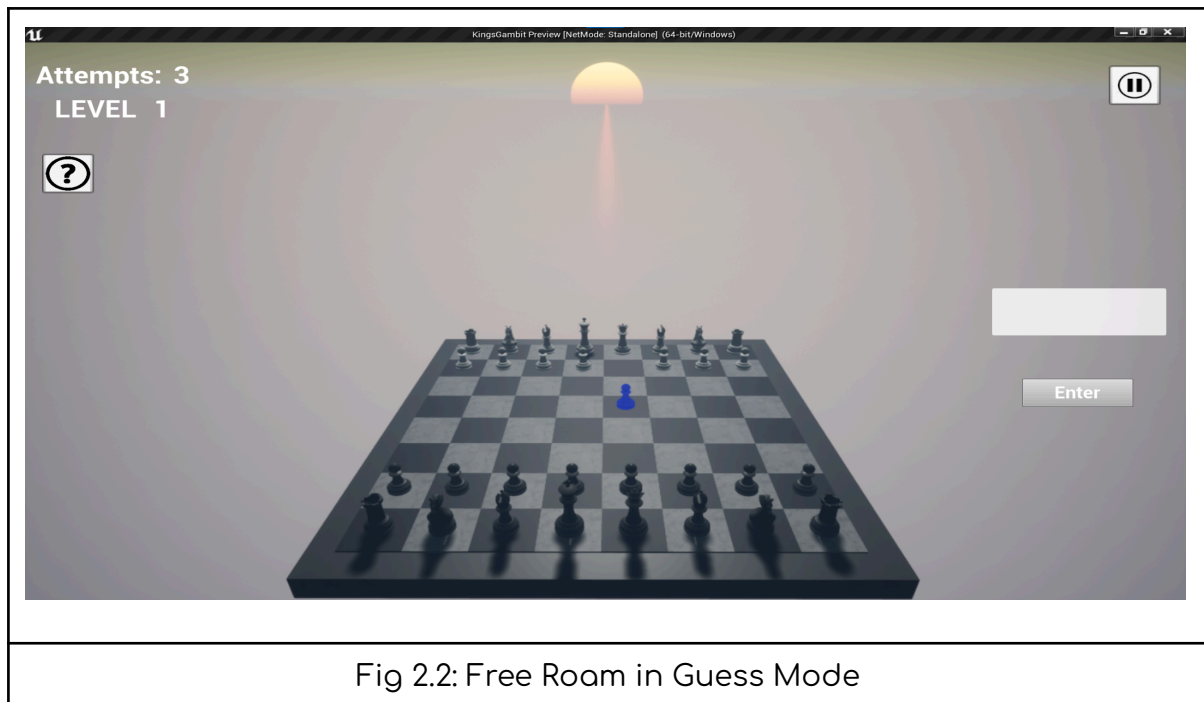


Fig 2.2: Free Room in Guess Mode

Play Mode

Basic 2 player chess game that allows 2 players to play a game of chess and practice their moves in the app. Can be used by chess teachers to practise against their students too.

Feature 1: Grid and Piece Highlighting

Upon selection of a chess piece by left clicking on it, the selected chess piece and the grids accessible by the selected chess piece will be highlighted. This not only helps beginner chess players with the rules of the game, it also helps experienced players easily see where they can move their pieces. In addition, opponent's chess pieces that can be eliminated by the selected chess piece will also be highlighted in a different colour.

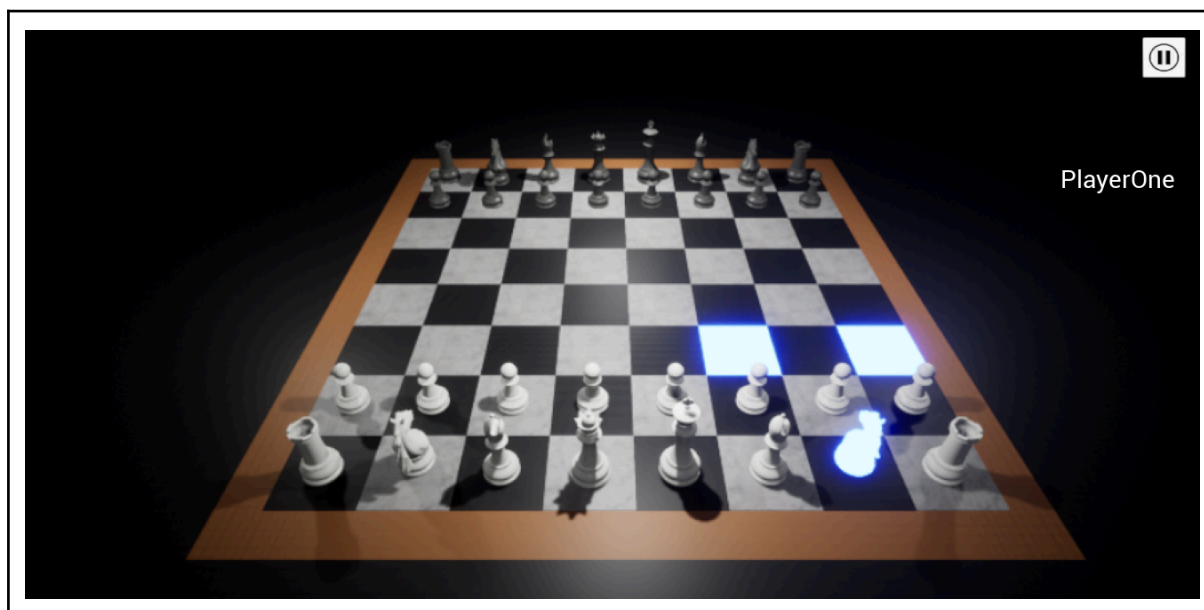


Fig 2.3: Grid and Piece Highlighting

Feature 2: Display of error messages

Error Messages will appear at the top left hand corner of the screen when the user tries to select pieces that don't belong to him or when the user tries to move the chess piece to an inaccessible grid.

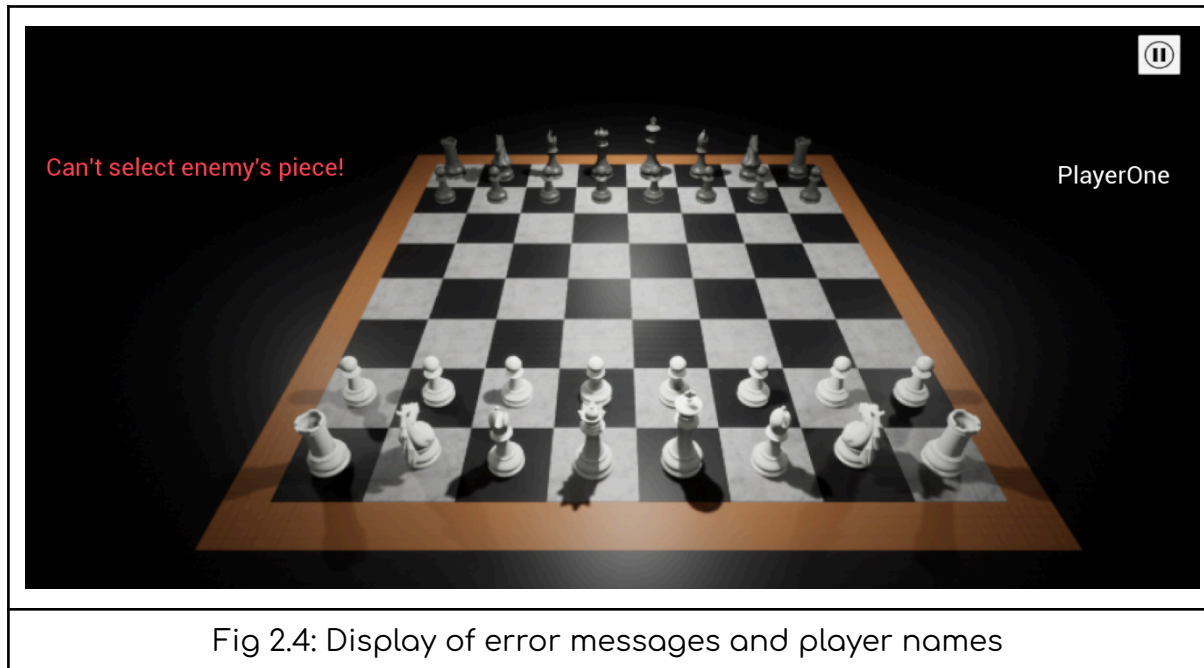


Fig 2.4: Display of error messages and player names

Feature 3: Display of player names

The identity of the current player will be displayed below the pause button, helping users easily identify who's turn it is.

Feature 4: In-game user manual

An in-game user manual appears whenever the play mode level starts to remind users of the controls of the game.

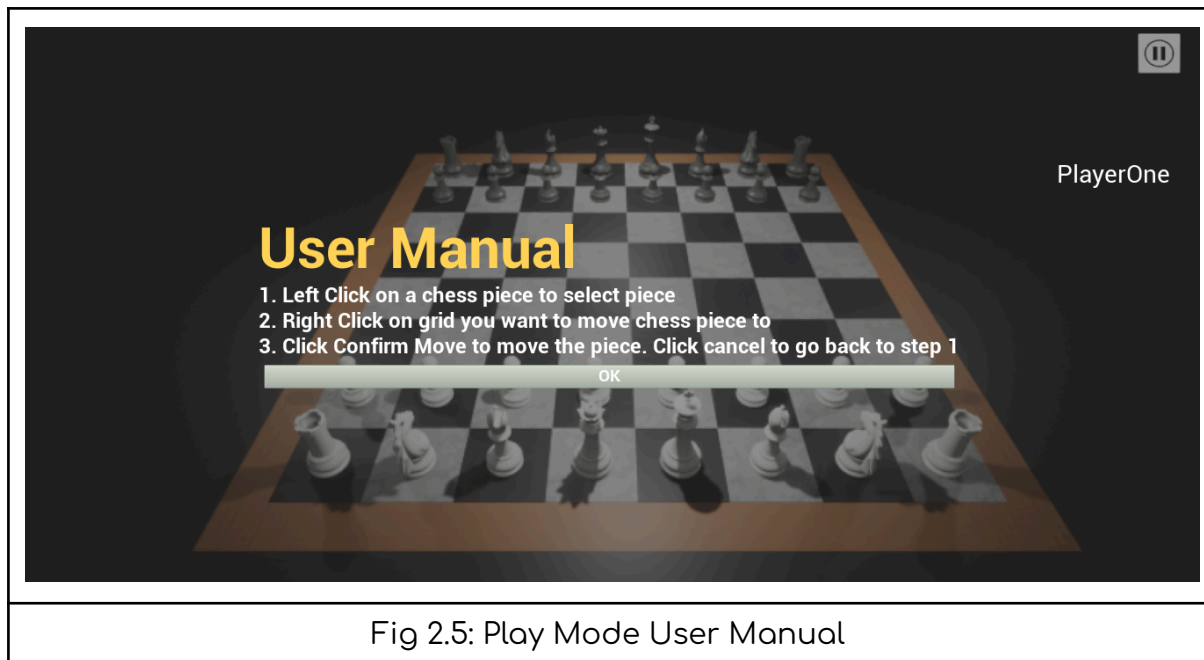


Fig 2.5: Play Mode User Manual

Trainer Mode

A mode that consists of famous opening methods/moves that defines the gap between beginners and intermediates. Descriptions on each move are provided for users to understand the logic behind the opening thus making it easier for them to use when playing.

Feature 1: 6 Different Openings

Descriptions and ability to pick which opening they want to learn are provided. Users are allowed to move back and forth screens to revisit and learn at their own pace.

Feature 2: Multiple Variations

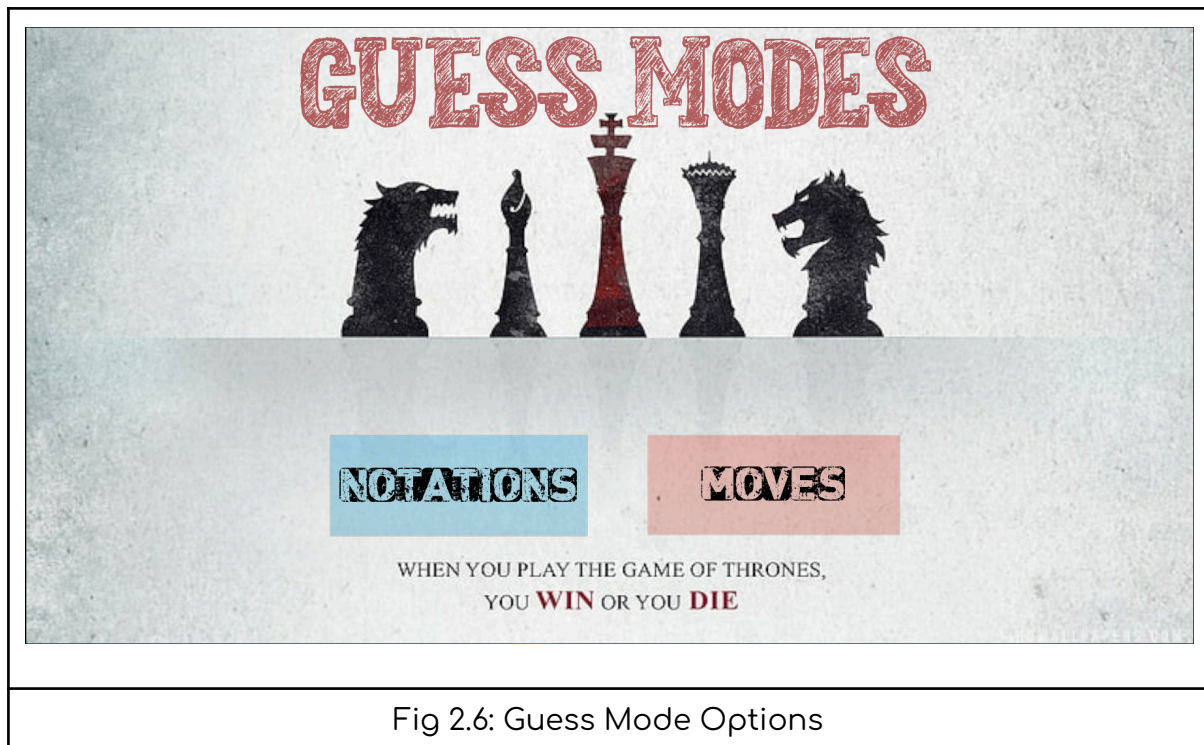
Under each opening choices are given to the user to pick which variation they would like to learn.

Feature 3: Free Room

Users are allowed to explore the world and have a better look at the board and its pieces.

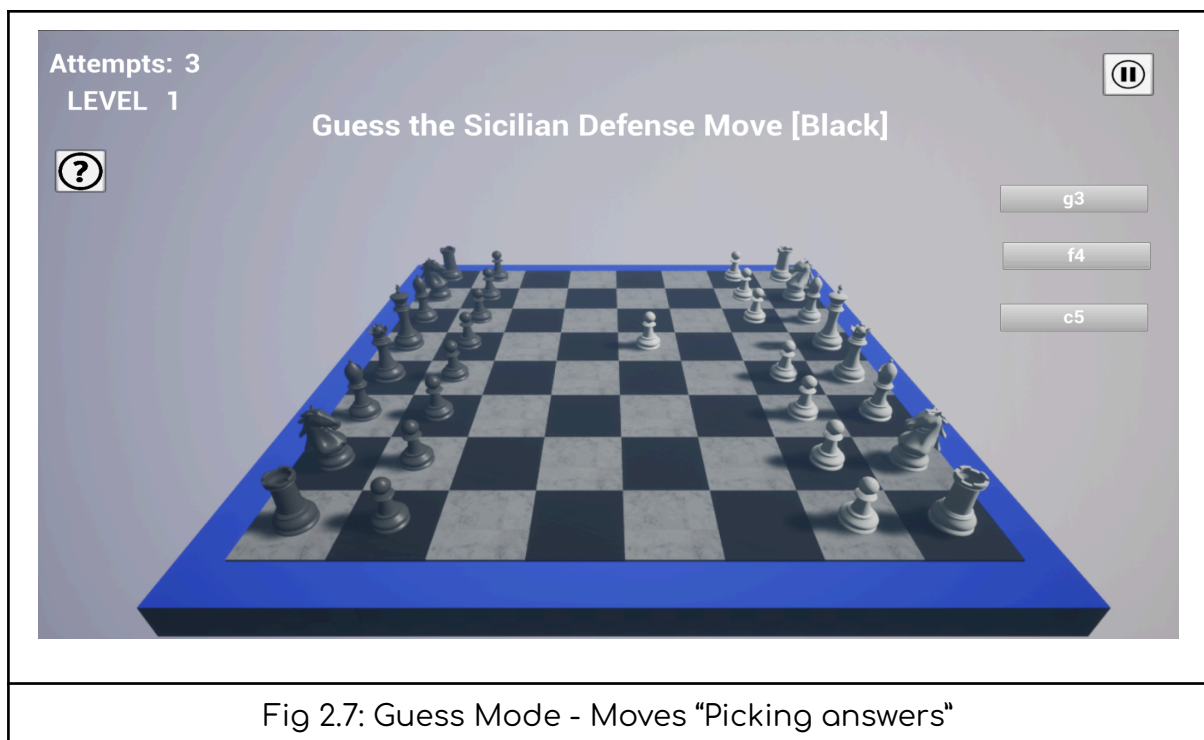
Guess Mode

A mode that gives users practice on learning more about chess notations and openings such as "complete the next move" and "pick the correct notation".



Feature 1: Pick and choose

An interactive platform where users have to pick the right options.



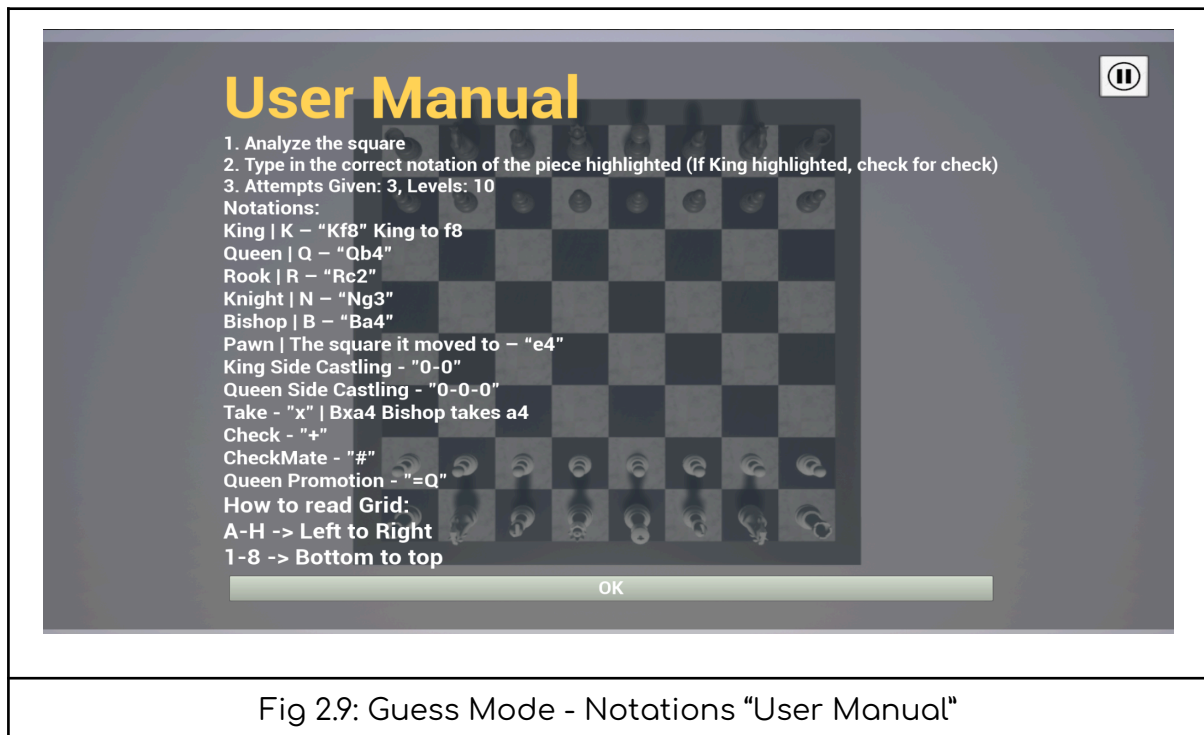
Feature 2: Fill in the box

Users are given a chance to type in the correct notation in the text box, giving them a chance to test themselves after going through the trainer mode.



Feature 3: User Manual

Instructions on how to use Guess Mode to optimize the user's experience.



Settings

Feature 1: Able to adjust the volume

Control over the volume of music is given to the user for best experience.

Feature 2: Able to adjust screen resolution

Depending on the user's device he/she is able to adjust the screen.

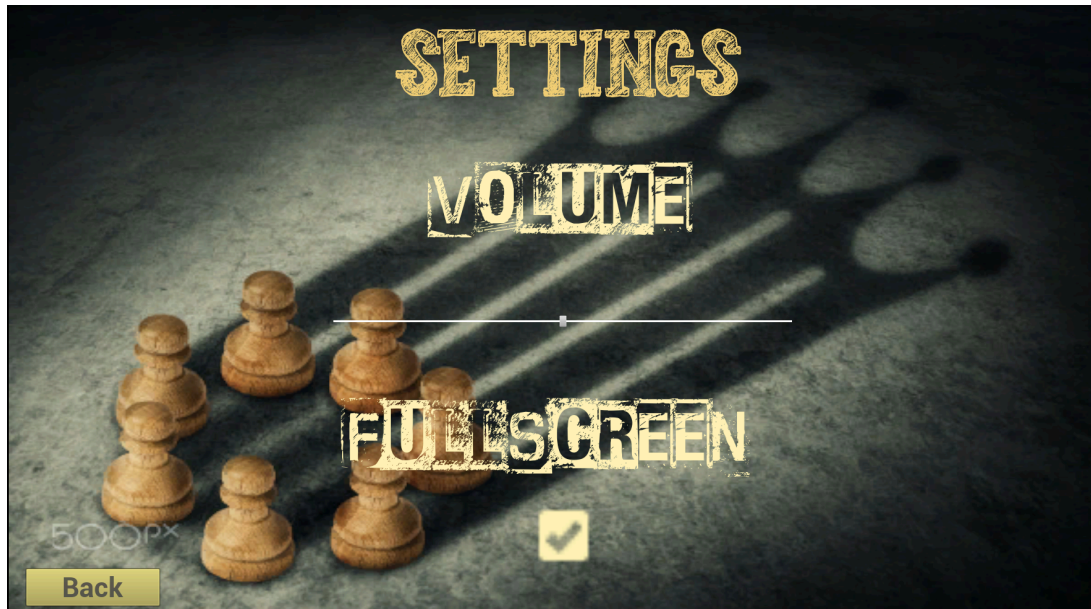
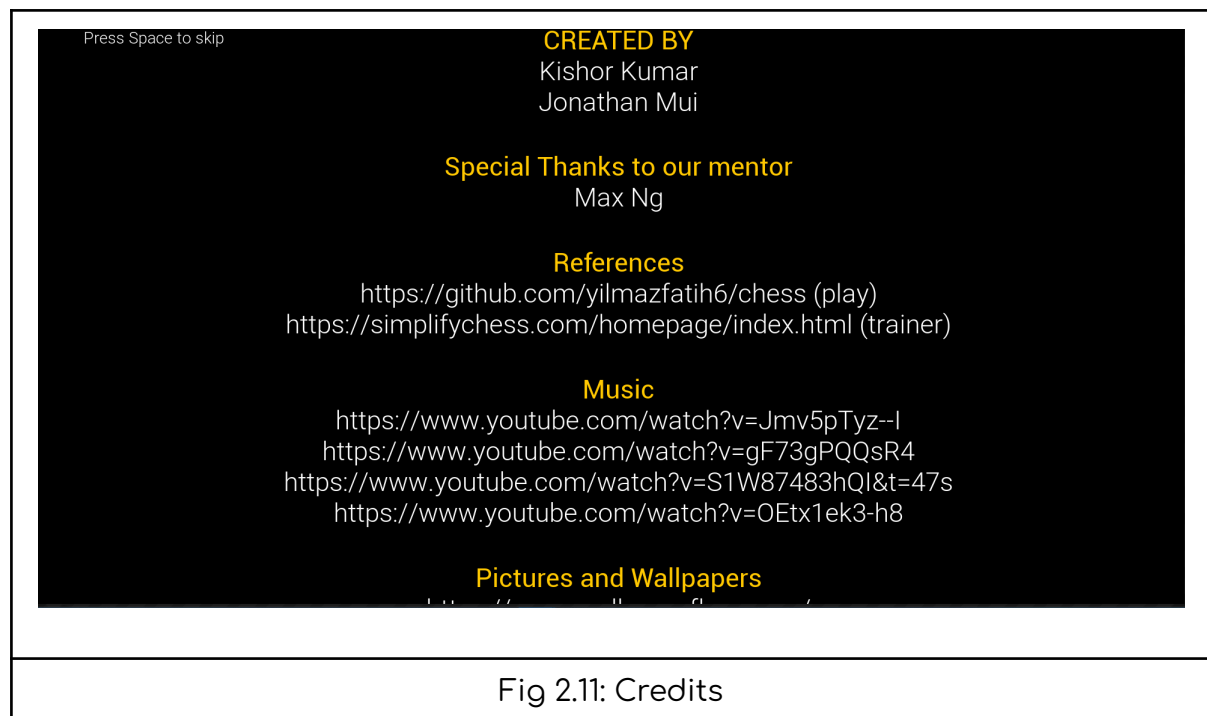


Fig 2.10: Settings Options

Credits

Feature 1: Scrolling credits

References are provided in this section to appreciate the knowledge and help gathered from multiple resources. This is also to help users gain information on working on a similar project in the future.



Exit

Feature 1: Quit the game

Allows users to exit the game.

Software Engineering (SWE):

SWE Principles

SOLID Practice

Single Responsibility Principle

The principle states that every class should only have 1 responsibility. In the design of the game, the chess board, player, controller and each individual chess piece are all classes with 1 specific role. (Details in class overview).

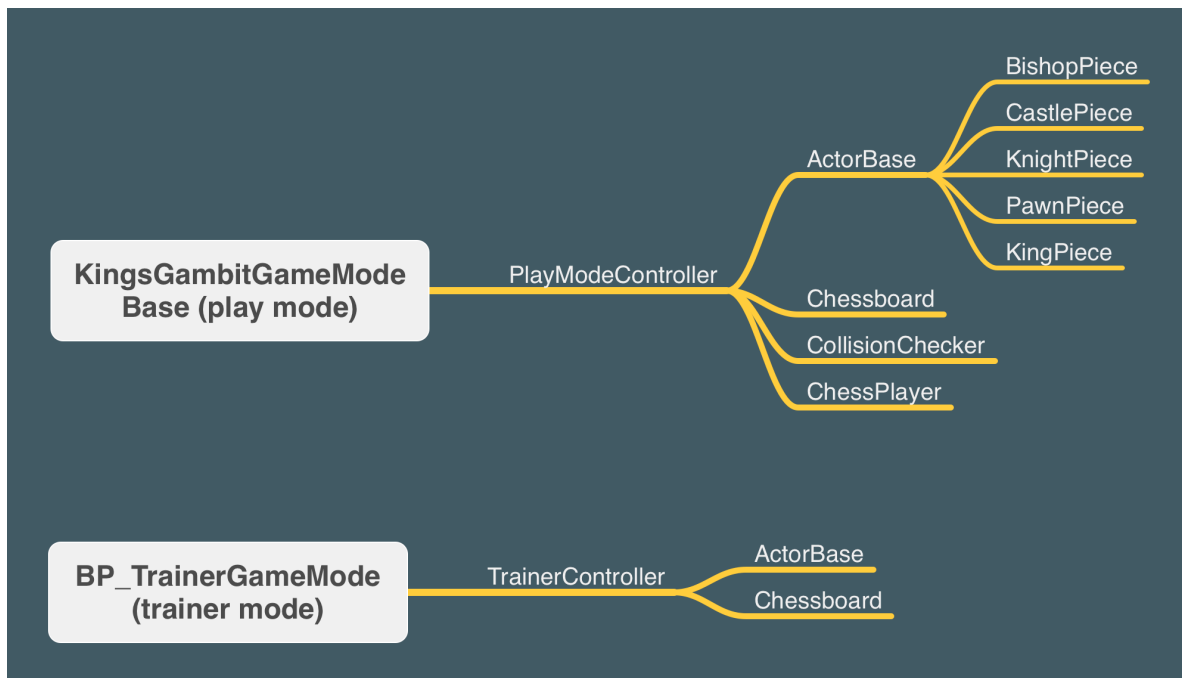
Liskov Substitution Principle

In the `SpawnWhiteActors` method in the `PlayModeController` class, while each actor is spawned as their own individual chess piece class, they are eventually added into the `SpawnedPieces` array which is an array of `AActor`.

DRY Principle

The Don't Repeat Yourself principle is used in our implementation of the pause feature of our game. Since the Pause Menu and button remains the same regardless of the game mode, each UI widget inherits from the `PauseMenuUserWidget` class. Thus, the code to implement the pause menu and button will not be repeated. At the same time, the functions that need to be implemented when the game is paused can be easily customised for different game modes.

Class Overview



GameModes

The Gamemode classes are inherited from Unreal Engine's `AGameModeBase` class. The GameMode classes manage the rules of the game and keep track of the game status in play mode. They also allow attachment of custom controller classes, thus the need for 2 separate Game Modes for play mode and trainer mode since both modes require different sets of controllers.

Controllers

The Controller classes are inherited from Unreal Engine's `APlayerController` class. They capture data from the user's device (mouse) and feed the input into the game. The input is then used to control the Actors in the game.

Actor

An actor is an object that can be placed or spawned in a level in Unreal Engine 4. The actors in our program are the chess board, chess pieces, Collision Checker (used in play mode) and ChessPlayer (player pawns used in play mode).

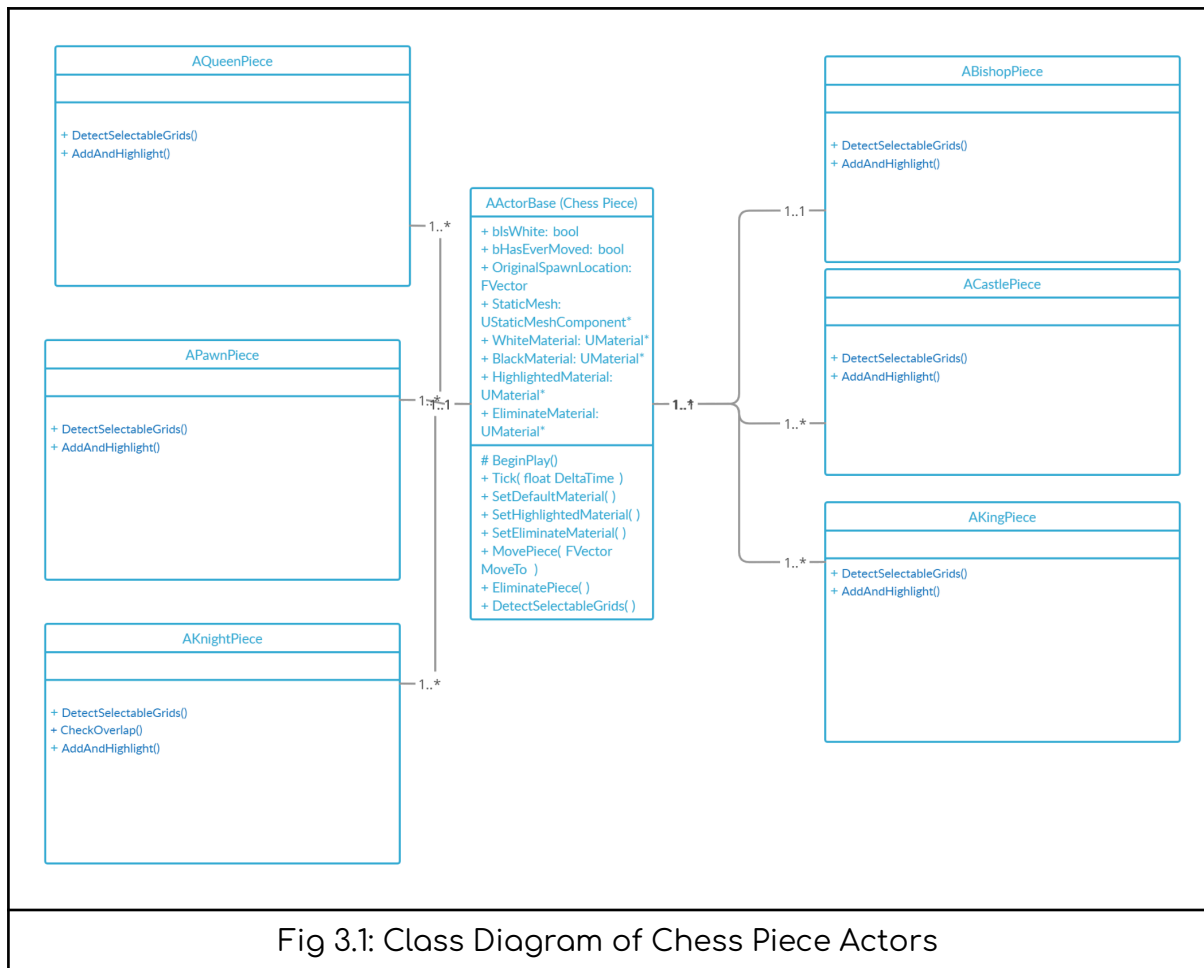


Fig 3.1: Class Diagram of Chess Piece Actors

Chess Pieces

The ActorBase class is the parent class for all the chess pieces. The **StaticMesh** variable which points to the 3D mesh of the respective chess pieces is inherited and set in each individual chess piece's respective class. The **DetectSelectableGrids()** function is also inherited in each individual chess piece's respective class since different chess pieces have different sets of moves

Collision Checker (used in play mode)

The Collision Checker is an invisible actor in the shape of a cuboid that is spawned on each grid on the chess board to check for potential overlaps/collisions of chess pieces. It is also used to detect the selectable grids of each chess piece

Chess Player (used in play mode)

The ChessPlayer actor is derived from UE4's APawn class. It sets the physical location of where the chess player is in play mode.

User Interfaces

All user interfaces are developed with the `UUserWidget` class in UE4 which allows our code to interact with the widgets we place on the screen (like buttons and text blocks). The widgets are then added to the viewport through the level class (`Playmode.cpp` for Trainer mode) and HUD class (`PlayModeHUD.cpp` for Play mode).

The `PauseMenuUserWidget` class is the parent class for all of our UIs as every UI besides the main menu has a pause button and the pause menu. The `UserWidgets` for playmode and each individual trainer are children of this parent class. Thus, they inherit the pause features and have additional widgets for their respective functionalities.

Testing

Our team mainly performed unit testing on using Unreal Engine 4's in-built play mode. In addition, our team performed a beta test and tried the app on other students.

Unit Testing Test Suite

Feature #1 - Pause Feature					
Test Scenario	Test Case	Test Data	Expected Result	Actual Result	Pass/Fail
Pause Button	On Click	Button click	Game Stops and Pause Menu Appears	Game Stops and Pause Menu Appears	Pass
Resume Button	On Click	Button click	Game resumes and pause menu disappears	Game resumes and pause menu disappears	Pass
Main Menu Button	On Click	Button click	Game exits to main menu	Game exits to main menu	Pass
Quit Button	On Click	Button click	Game exits and closes	Game exits and closes	Pass
Feature #2 - Play Mode					
Test Scenario	Test Case	Test Data	Expected Result	Actual Result	Pass/Fail
Grid and Piece	Clicking on a chess piece	Left Mouse Click	Chess Piece and selectable	Chess Piece and selectable	Pass in

Highlighting			grids of piece glows	grids glow in most cases. Not applicable to castling of Rook and Promotion of pawn to queen	most cases
Display of error messages	Left Clicking on opponent's chess piece or Right clicking on Non-selectable chess grids (Grids that are not glowing)	Left and Right Mouse Click dependent on scenario	Display of relevant error message in red on the top left of screen	Display of relevant error message in red on the top left of screen	Pass
Display of Current Player Name	Clicking on confirm move button to change Player's turn		Player Name displayed below pause button changes dynamically	Player Name displayed below pause button changes dynamically	Pass
User Manual	Upon entering play mode		User Manual is displayed		Pass
Feature #3 - Trainer Mode					
Test Scenario	Test Case	Test Data	Expected Result	Actual Result	Pass/Fail
6 different opening moves	Clicking on button of opening move in menu	On click	Tutorial for opening move clicked on loads Next Button proceeds to next step Previous Button reverts to previous step		Pass
Multiple Variations	Clicking on select variations at the end of the tutorial	On click	Leads to a menu of variations of that opening		Pass

			Tutorial of relevant variation shown when button is clicked		
Free Room	Using WASD and mouse wheel to move around the map	On click	Able to zoom into chess board and room around the map		Pass
Feature #4 - Guess Mode					
Test Scenario	Test Case	Test Data	Expected Result	Actual Result	Pass/Fail
Pick and choose (Guess next move)	If Button with correct answer is clicked, "Correct" is displayed and game moves on to next level. Else, "Wrong" is displayed and no of attempts is reduced by 1	Qn 1: Button Click - g3	Wrong	Wrong	Pass
Fill in the box (Notations)	Compares Text in textbox with Pre coded answers for question. If correct, "Correct is displayed" and game moves on to next level. If wrong, "Wrong" is displayed and no of attempts is reduced by 1	Qn 2: Input - Nf4	Correct	Correct	Pass
Pop up user manual	Upon loading of Guess Mode Upon Clicking of User manual button		Guess Mode UI disappears, game time pauses and user manual appears on screen	Guess Mode UI disappears, game time pauses and user manual appears on screen	Pass

Game Over Condition	No of attempts becomes 0	3 wrong answers in notations mode	Game over menu appears, game pauses	Game over menu appears, game pauses	Pass
Game Win Condition	10 correct answers in notations guess mode		Game won menu appears, game pauses	Game won menu appears, game pauses	Pass
Feature #5 - Settings					
Test Scenario	Test Case	Test Data	Expected Result	Actual Result	Pass/Fail
Adjust Volume	Volume of music gets increased when slider slides to the right and decreased when slider slides to the left	Volume bar slid left all the way	Music cuts	Music cuts	Pass
Toggle Fullscreen	When button is unchecked, game becomes windowed	Unchecked box	Game becomes windowed	Game becomes windowed	Pass

Beta Testing with other Orbital Groups

Fill this up (how the experience was, what was the other person's feedback? And did you choose to accept the feedback. If not, then why?)

Beta Testing by CalPal

Steps taken	Results	Remarks
Went through the Unit Testing Test Suite	All test cases passed, except Feature #2 Test Case 2.	
Feature #2 Test Case 2: - Entered the Game. - Entered Play Mode. - Pieces were highlighted when selected and could be moved, everything was working fine. - Exited Play Mode. - Played Credits and skipped the Credits.	Pieces were no longer highlighted upon selection. Upon attempting to right click a valid move, nothing occurs.	

6. Re-entered Play Mode.		
1. Enter Guess mode 2. Clicked on the pause button while still on the User Manual Page 3. Pressed 'OK' to close the user manual	The pause menu is still there but all options are unable to be clicked. Game can be continued even with the pause menu shown. To exit this pause menu, User has to first press the Help button, and then press the pause button again for the options to be selectable.	Consider disabling the pause button while the display menu is being shown.

Problems Encountered

- No endgame in play mode. The game is not able to tell when check/checkmate occurs
- Unable to implement castling in play mode
- Unable to implement pawn promotion in play mode

UI Feedback

- Thickness of the volume bar (Cannot be increased by a lot due to the unmodifiable handle placed on it)
- Make the fonts in the settings for the button to be clicked on the menu (Done)
- Guess mode: Include a title for the input box on the right (Done)
- For instructions, make the font size the same and section the instructions. (Done)
- Guess mode - include short instructions for each mode. (Done)