MetaChess: Close to reality chess in metaverse

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Session 2019-2023

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September, 2022

Student's Declaration

We declare that this project titled "*MetaChess: Close to reality chess in metaverse*", submitted as requirement for the award of degree of Bachelors in Computer Science, does not contain any material previously submitted for a degree in any university; and that to the best of our knowledge, it does not contain any materials previously published or written by another person except where due reference is made in the text.

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The Department of Computer Science, National University of Computer and Emerging Sciences, accepts this thesis titled *MetaChess: Close to reality chess in metaverse*, submitted by Muhammad Abdullah (p19-0036), Nauman Tasawar (p19-0067), and Abdullah Tahir (p19-0073), in its current form, and it is satisfying the dissertation requirements for the award of Bachelors Degree in Computer Science.

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Muhammad Abdullah

Nauman Tasawar

Abdullah Tahir

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Abstract

A fully immersive, hyper-spatiotemporal, self-sustaining virtual shared space for humans to play, work, and socialize is the goal of Metaverse, an evolving Internet paradigm.The metaverse is moving from science fiction to a future reality thanks to recent developments in emerging technologies like extended reality, artificial intelligence, and blockchain.This project is about making chess game in Metaverse. The users will be able to play the game using Oculus VR gear and can interact with the chess board and chess pieces using the said VR set. This will enable the users to play the game with each other from comfort of their liking. The gameplay would simulate the experience as if the user is playing the game in real-time. The player will have an option to choose from different rooms to play in. In each room user will have different themes to enhance user experience e.g. There will be a room in which user can select medieval style structure.

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Chapter 1

Introduction

The Metaverse represents a highly interactive three-dimensional virtual world. Like the real world, users can trade land, buildings, and other digital assets in the Metaverse and explore the space using their personalized avatars. These avatars are replicas of the user that can do everything a human can do in the real world[15].

This project is about making chess game in Metaverse. The users will be able to play the game using Oculus VR gear and can interact with the chess board and chess pieces using the said VR set. This will enable the users to play the game with each other from comfort of their liking. The gameplay would simulate the experience as if the user is playing the game in real-time. The player will have an option to choose from different rooms to play in. In each room user will have different themes to enhance user experience e.g. There will be a room in which user can select medieval style structure.

The game of chess has been around for hundreds of years. It has played a prominent role in Western culture since the Middle Ages (Adams 2) [10]. Every day it is played by millions of people around the world. The game takes strategy, patience, and above all, problem solving. Chess is quite complex yet the objective is beautifully simple.

1.1   Chess Logic

The game is played on a square board made up of 64 smaller squares. Half of these small squares are black and the other half are white, making a checkerboard pattern. At the

beginning of the game, there are 32 pieces, 16 black and 16 white. Each player has eight pawns, two castles, two knights, two bishops, one queen, and one king.

The pawn is often viewed as the weakest piece on the board. The pawn may move forward two squares on its first move, but may only move forward one square on all subsequent moves. The pawn can only move straight forward unless it is attacking an opposing piece. To attack, it must move to a square to its immediate forward diagonal. The pawn does have one very important characteristic. If a pawn makes it to the opposite end of the board, it is immediately "promoted" to become any other piece, except a king. It is also unable to remain a pawn (Let's Play 2). Therefore, the weakest piece in the game can potentially become the most powerful piece.

The castle is a piece that can move forward, backward, right, or left. It can move as many squares as possible until it meets a square already occupied by another piece. The castle can attack from far away. Another name for the castle is the rook. For the purposes of this paper, we will refer to castles as rooks from now on.

The knight is an interesting piece. It may move two spaces forward or backward, then one space to the left or right. It can also move two spaces left or right, then one space forward or backward. The knight is the only piece that can "jump" over other pieces to reach its destination.

The bishop may move any number of spaces diagonally. Therefore, the bishop that begins on a black square will never be on a white square for the duration of the game.

The queen is widely regarded as the most powerful piece on the board. It is essentially a combination of the rook and the bishop. The queen may move forward, backward, left, right, or diagonally as many squares as desired, until it meets a square already occupied by another piece. Finally, the king is the most important piece in the game.

The king may move one square in any direction. Although the king is not overly powerful, it is vital because losing your king means losing the game. The goal of chess is to capture the opposing player's king. When a king is in danger of being captured by an opposing piece, that king is in "check". If black makes a move to put the white king in check, white must, in its subsequent turn, move so that the king is no longer in check. This can be done

by moving the king out of check, moving another piece to block the check, or capturing the piece that threatens the king. When a king is in check and no move can be made to get the king out of check, "checkmate" is declared and the game is over. Whichever player forces checkmate wins the game. Notations are often used when writing about chess. Each piece is represented by a letter and each square on the board is represented by a combination of one letter and one number. These notations are demonstrated in the following table and image [18].

Piece	Notation	Symbol
King	K	♔
Queen	Q	♕
Rook	R	♖
Knight	N	♘
Bishop	B	♗
Pawn	P	♙

Table 1.1: Notations

Chapter 2

Review of Literature

Interest in the idea of the metaverse leaped in 2021-2022, prompted in part by Facebook's decision to rebrand itself as "Meta." The word was coined by sci-fi author Neal Stephenson in 1992 in his novel "Snow Crash[19]." In today's terms, the metaverse is the realm of computer-generated, networked extended reality, or XR, an acronym that embraces all aspects of augmented reality, mixed reality and virtual reality (AR, MR and VR). At this point in time, the metaverse is generally made up of somewhat- immersive XR spaces in which interactions take place among humans and automated entities. Some are daily interactions with augmented-reality apps that people have on their computers and phones. Some are interactions taking place in more-immersive domains in gaming or fantasy worlds. Some occur in "mirror worlds" that duplicate real-life environments.

2.1 Chess.com

The purpose of this literature review is to examine whether the body of research on chess interventions shows that chess has an impact on student outcomes. In order for a study to measure the impact of chess, the study must show that outcomes for individuals in the chess intervention were a result of participating in the program. The eligible studies varied in the quality of their research design and in turn, their ability to link findings with participation in the chess intervention. A majority of the studies used research designs that did not control for group equivalence when comparing chess participants and non-participants. As a result, the findings from these studies should be examined cautiously

because the differences in outcomes between chess participants and the comparison group could be a result of differences in individual student characteristics, rather than the impact of the chess intervention [4].

2.2   A survey on metaverse

Metaverse is a new type of Internet application and social form that integrates avariety of new technologies. It provides an immersive experience based on augmentedreality technology, creates a mirror image of the real world based on digital twintechnology, builds an economic system based on blockchain technology, and tightlyintegrates the virtual world and the real world into the economic system, the socialsystem, and the identity system, allowing each user to produce content and edit theworld. Metaverse is still a concept that is constantly evolving, and differentparticipants are enriching its meaning in their own ways. [16]

2.3   3D virtual world in metaverse

This article surveys the current status of computing as it applies to 3D virtual spaces and outlines what is needed to move from a set of independent virtual worlds to an integrated network of 3D virtual worlds or Metaverse that constitutes a compelling alternative realm for human sociocultural interaction. In presenting this status report and roadmap for advancement, attention will be specifically directed to the following four features that are considered central components of a viable Metaverse.

(1) Realism. Is the virtual space sufficiently realistic to enable users to feel psychologically and emotionally immersed in the alternative realm? (2) Ubiquity. Are the virtual spaces that comprise the Metaverse accessible through all existing digital devices (from desktops to tablets to mobile devices), and do the user's virtual identities or collective persona remain intact throughout transitions within the Metaverse? (3) Interoperability. Do the virtual spaces employ standards such that (a) digital assets used in the reconstruction or rendering of virtual environments remain interchangeable across specific implementations and (b) users can move seamlessly between locations without interruption in their immersive experience? (4) Scalability. Does the server architecture deliver sufficient

power to enable massive numbers of users to occupy the Metaverse without compromising the efficiency of the system and the experience of the users?

In order to provide context for considering the present state and potential future of 3D virtual spaces, the article begins by presenting the historical development of virtual worlds and conceptions of the Metaverse. This history incorporates literary and gaming precursors to virtual world development as well as direct advances in virtual world technology, because these literary and gaming developments often preceded and significantly influenced later achievements in virtual world technology. [11]

2.4 Cloud gaming on vr headset

Cloud Gaming to achieve the improvement in need. Cloud Gaming is an emerging gaming service that provides million users with novel and highly accessible gaming experience. By leveraging elastic and high-performance computing resources, Cloud Gaming offloads the intensive workloads of game processing from client's device to powerful Cloud Server. As shown in Fig. 1, the interactive gaming application is stored at the Cloud Server and gets executed once requested. The rendered game scenes are then delivered back to the client as a sequence of encoded video over a broadband network. At the client's side, the inputs from devices such as mouse, keyboard, joystick are recorded and sent back to the Cloud Server for the manipulation of game logics. Therefore, cloud gaming frees game players from buying expensive gaming machines and allows them to play high-quality game with any device.

We consider that Cloud Gaming is a prospective option for improving the accessibility of VR gaming, but multiple difficulties need to be carefully addressed before making it viable for practical usage. Since this is still a work in progress and without any evaluations yet. [8]

Year	Title	Achievement	Limitation
2020	Decentraland [13]	Decentraland is a **3D virtual world** browser-based platform. Users can buy/sell virtual plots of land in the platform.	Not accessible on VR headset. Users have to **create** their own virtual worlds which are quite expensive too.
2015	Virtual sandbox [17]	The Sandbox is a virtual world where players can **build, own, and monetize** their gaming experiences in the Ethereum blockchain.	Not available on VR headset.
2018	Axie Infinity [14]	Axie Infinity is a non-fungible token-based online video game. Players of Axie Infinity **collect and mint NFTs**	User can't create their own maps, **exploring** the maps are really limited
2020	Chain of Alliance [1]	Is a role-playing fantasy game involving **customizable monsters** with NFT value.	Only available on android.
2020	Population:One [2]	Population: One is a multiplayer, **First Person Shooter**, Battle Royale.	Not free. Can't **digitally** trade assets.
2019	Beat Saber [20]	Beat Saber is a virtual reality rhythm game. It takes place in a surrealistic neon environment and features the player **slicing blocks representing musical beats** with a pair of contrasting-colored sabers.	N/A
2009	Chess.com [4]	Chess.com is an internet **online chess server game**, news website and social networking website.	Not available on any VR headset. Doesn't provide and **immersive** close to reality feel.
2022	A Survey on Metaverse: Fundamentals, Security, and Privacy [21]	A comprehensive survey of the fundamentals, security, and privacy of metaverse. This also present the critical **challenges** of metaverse systems.	N/A
2022	The Metaverse in 2040 [7]	Conducted **survey** to gather expert views about metaverse's future.	N/A
2013	3D Virtual worlds and the metaverse: Current status and future possibilities [12]	Achievements surveys the **current status** of computing as it applies to 3D virtual spaces and outlines what is needed to move from a set of independent virtual worlds to an integrated network of 3D virtual worlds or Metaverse	N/A
2022	Opportunities in the metaverse . How businesses can explore the metaverse and navigate the hype vs. reality [3]	**Success** of metaverse lies on a robust and **flexible financial** ecosystem that will allow users to seamlessly connect between the physical and virtual worlds.	N/A
2017	Cloud-Based VR Gaming: Our Vision on Improving the Accessibility of VR Gaming [9]	Cloud Gaming for **improving** the accessibility of **VR gaming** which is based on the more compact and affordable HMDs.	N/A
2016	Tilt Brush [5]	A 3D virtual-reality **drawing experience** for Oculus that lets you paint in the air simply by waving your hands.	N/A

Table 2.1: Literature review summary

Chapter 3

Project Vision

3.1 Metachess

To solve the problem of currently available chess games not been able to provide an immersive chess environment where users can interact with each other whilst experiencing close to reality game. Hence we thought to introduce a chess game in metaverse. Here users will interact with our game through Oculus headset.In metachess users will have an option to explore different maps, rooms where they can play chess with their friends and family members whilst having a close to reality feel.

3.1.1 Motivation

The motivation behind choosing this project is the scope of the metaverse industry as it continues to grow every year and the power of VR gaming. It is interesting how technology can impact our lives, so we can explore, interact with virtual worlds from the comfort of our liking. Metaverse will surely paved the way how humans will socially interact with each others.As well as how they do their daily business because metaverse will not only revolutionize the gaming industry it will have a major impact on banking, education, tourism.

3.1.2 Problem Statement

- The current problem while playing chess is all the available chess games lack the feel of 3D chess environment, hence they also lack the interactivity between the

players and the environment.

- We purposed a solution by building a chess game in Metaverse. So the players can have close to reality experience, and allow the players to interact with the environment.

- This will also ensures that the players are sitting close to each other in virtual space where as in real world they may be miles apart.

3.2 Business Opportunity
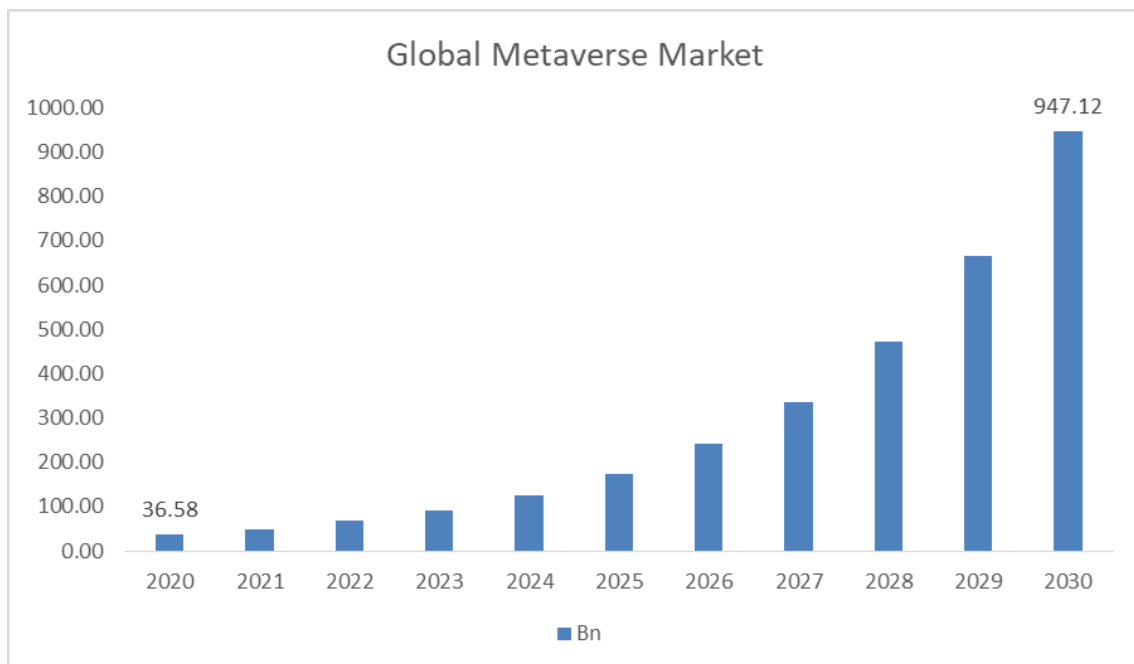
Figure 3.1: Global Metaverse market. [6]

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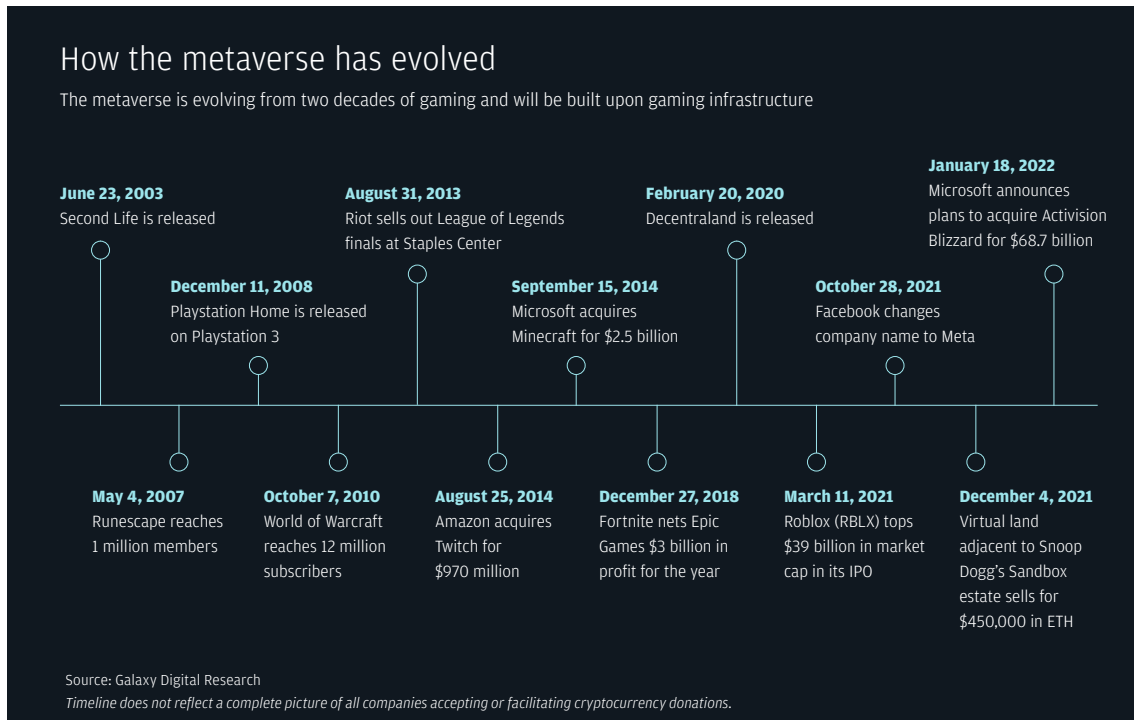
Figure 3.2: Metaverse Evolvement

3.3 Objectives

1. Provide users the most authentic or close to reality chess game-play experience in Metaverse from the comfort of their liking.

2. Providing a night city themed verse where users can explore the environment and interact with it. So they can experience something surreal, yet imaginative.

3. Players can invite their social media friends, interact with other players inside the Metaverse, and collaborate to enjoy the games together.

3.4 Project Scope

MetaChess is a cross-platform application that allows two players to engage in a real-time game of chess in metaverse. The primary goal is to provide a chess game that is intuitive and entertaining for players of all skill levels. The game also provides some useful features, such as the ability to explore the environment and interact with it. In general, it focuses on providing a simple, streamlined playing experience.

3.5 Stakeholders Description

1. Virtual reality and metaverse is a high emerging field. In recent times there have been a lot of development happening in this field. MetaChess main target group are the users who play games in VR. We focus on providing users the most authentic or close to reality chess game-play experience in Metaverse from the comfort of their liking.

2. As chess is played by millions of users everyday throughout the world we have a future plan where companies like chess.com can hold their virtual game events/matches in our game we would like to facilitate them.

Chapter 4

Software Requirements Specifications

4.1 List of Features

The game is played on a square board made up of 64 smaller squares. Half of these small squares are black and the other half are white, making a checkerboard pattern. At the beginning of the game, there are 32 pieces, 16 black and 16 white. Each player has eight pawns, two castles, two knights, two bishops, one queen, and one king.

- The pawn is often viewed as the weakest piece on the board. The pawn may move forward two squares on its first move, but may only move forward one square on all subsequent moves. The pawn can only move straight forward unless it is attacking an opposing piece. To attack, it must move to a square to its immediate forward diagonal. The pawn does have one very important characteristic. If a pawn makes it to the opposite end of the board, it is immediately "promoted" to become any other piece, except a king. It is also unable to remain a pawn (Let's Play 2). Therefore, the weakest piece in the game can potentially become the most powerful piece.

- The castle is a piece that can move forward, backward, right, or left. It can move as many squares as possible until it meets a square already occupied by another piece. The castle can attack from far away. Another name for the castle is the rook. For the purposes of this paper, we will refer to castles as rooks from now on.

- The knight is an interesting piece. It may move two spaces forward or backward,

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then one space to the left or right. It can also move two spaces left or right, then one space forward or backward. The knight is the only piece that can "jump" over other pieces to reach its destination.

- The bishop may move any number of spaces diagonally. Therefore, the bishop that begins on a black square will never be on a white square for the duration of the game.

- The queen is widely regarded as the most powerful piece on the board. It is essentially a combination of the rook and the bishop. The queen may move forward, backward, left, right, or diagonally as many squares as desired, until it meets a square already occupied by another piece. Finally, the king is the most important piece in the game.

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Piece	Notation	Symbol
King	K	♔
Queen	Q	♕
Rook	R	♖
Knight	N	♘
Bishop	B	♗
Pawn	P	♙

Table 4.1: Notations

4.2 Functional Requirements

Priority	Description
Level 1	The highest priority level; all requirements of this level must be fully satisfied and verified in order for the software to be released.
Level 2	Requirements of this level do not need to be implemented in order for the software to still be viable.
Level 3	Lowest priority and not expected to be implemented in the current release.

Table 4.2: Priority

4.2.1 Movement

0100 Pawn Pawns shall move one space forward, optionally two spaces forward on their opening move. **Priority 1**

0110 Rook Rooks shall move vertically or horizontally any number of spaces unless impeded by another piece. **Priority 1**

0120 Knight Knights shall move two spaces either vertically or horizontally followed by one space perpendicularly. **Priority 1**

0130 Bishop Bishops shall move diagonally any number of spaces unless impeded by another piece. **Priority 1**

0140 Queen Queens shall move vertically, horizontally, or diagonally any number of spaces unless impeded by another piece. **Priority 1**

0150 King Kings shall move one space in any direction. **Priority 1**

0160 Castling When requirements are met for castling (see definition), kings may move two spaces towards a rook, with the rook moving onto the space crossed over by the king. **Priority 1**

0170 When a piece is selected, all legal moves for that piece are highlighted. **Priority 2**

0180 The active player shall select a piece by clicking it. **Priority 1**

0190 The player playing white is first to move.**Priority 1**

0200 When a piece is selected, the active player may select another piece by clicking it. **Priority 1**

0210 The active player shall capture a piece by moving onto a legal square containing an opposing piece. **Priority 1**

0220 Captured pieces shall be displayed in the side of the chessboard. **Priority 2**

4.2.2 Capturing

0250 General Capture If a piece other than a pawn, moving in its normal fashion, may move into a square occupied by an opposing piece, the friendly piece may capture the opposing piece. **Priority 1**

0260 Pawn Pawns shall capture by moving forward one space diagonally into an opposing piece. **Priority 1**

0270 En Passant When requirements are met for en passant capture, a pawn may capture as above into a space crossed, but no longer occupied by an opposing piece. **Priority 1**

4.2.3 Promotion

0300 Promotion A pawn, having entered the rank opposite where it started, shall be promoted to a piece of its controller's choosing. **Priority 1**

4.2.4 Move Legality

0400 Legality A move shall be deemed illegal if it does not follow the above rules or would cause the moving player's king to become in check. **Priority 1 0410** Users shall be given the choice of who plays black and white. **Priority 1**

0420 Each user is to have their pieces start at the bottom of the board on their display.

Priority 1

4.2.5   Game Saving/Loading

0500 A player shall be able to save his game to a .sav file. **Priority 2**

0510 He shall be able to load his game from a .sav file, even if he is on a different computer than the one where the game was originally saved. **Priority 2**

0520 The .sav format shall be plain text, unencrypted. **Priority 2**

0530 A .sav file shall contain the following information: **0535** the positions of each player's pieces **Priority 2**

0540 whose turn it is. **Priority 2**

0550 the most recent move made. **Priority 2**

4.2.6   Network

0600 Connection **Priority 1**

0610 Establishing Connection shall be between two computers, each with the MetaChess program. **Priority 1**

0620 IP Addresses Connections shall be determined by IP(v4) addresses. **Priority 1**

0630 Game Start When two games have connected, they shall send a ready message to signal the start of the game. **Priority 1**

4.2.7   Message

0700 Messages **Priority 1**

0710 Protocol Messages shall be passed using algebraic chess notation.**Priority 1**

4.3   Non-Functional Requirements

4.3.1   Network

0800 Bandwidth There shall be sufficient bandwidth to handle game messages.**Priority 1**

0810 The network shall be available. **Priority 1**

4.4 Use Cases/ Use Case Diagram

A use case diagram represents the main use case activities and the interaction of actors and the system that is under development process. It helps to identify all the main processes of the system which are then visualized in ovals, known as a use case. A use case diagram is drawn from a scenario that explains the working of the system.
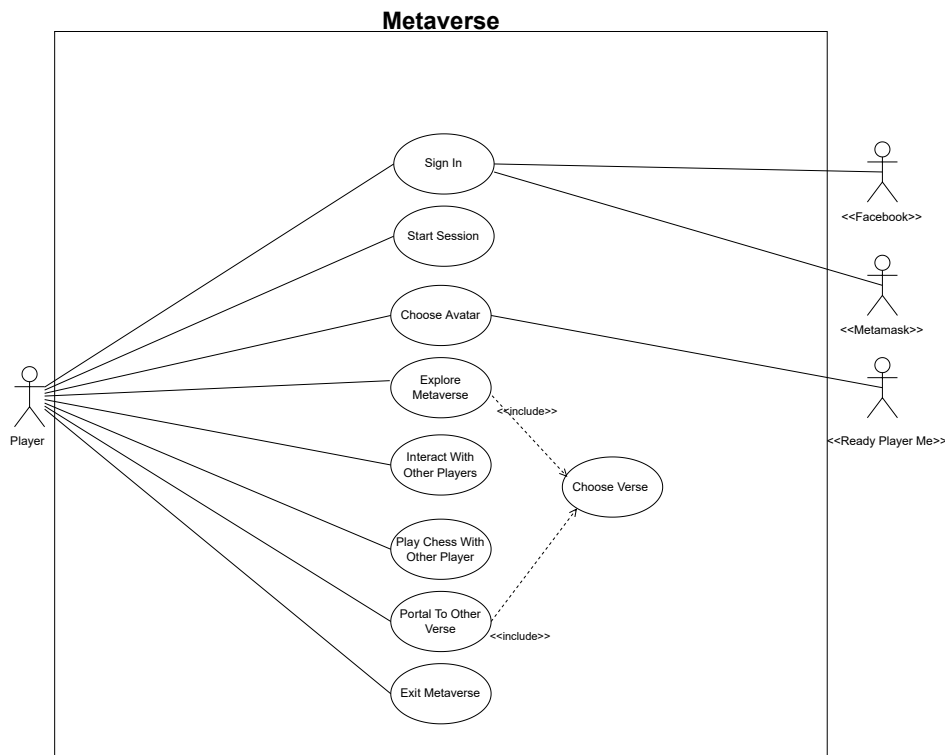
Figure 4.1: Use Case Diagram

4.5 Swimlane

The Swimlane diagram is shown in 4.2, it represents the flow of the activities in a specific order and it explains the details and conditions at every step. This UML diagram helps in understanding the flow of activities and it can help to identify those activities that can be run parallel to make an efficient system. The given diagram represents the flow of activities in Metaverse, it also explains which activity is initiated by which actor, since

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the activities are separated by swim lanes.
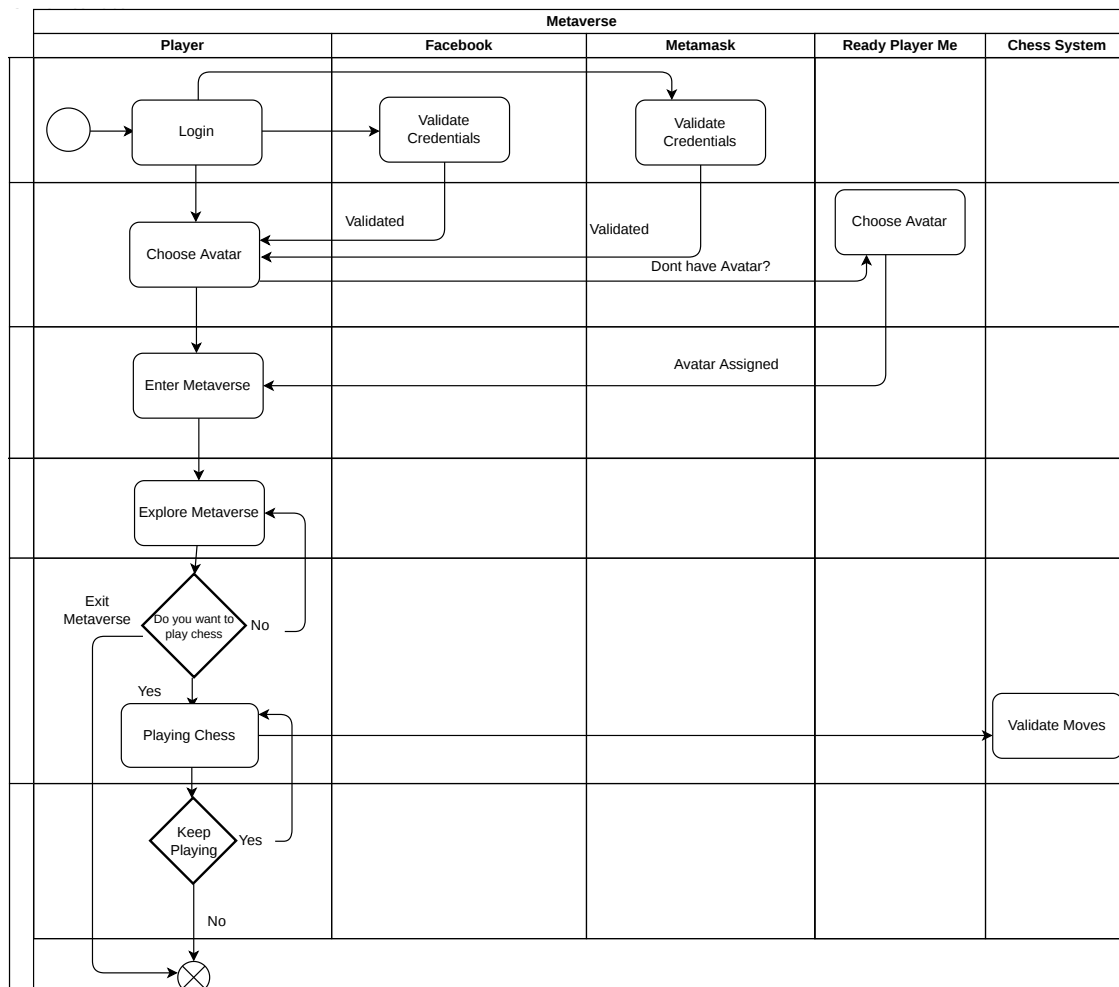
Figure 4.2: Swimlane Diagram

4.6 Flowchart

```
                    ┌─────────┐
                    │  start  │
                    └────┬────┘
                         │
                    ┌────▼────┐
                    │  login  │
                    └────┬────┘
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                   ┌─────▼─────┐        No    ┌──────────────────┐
                   │ are you   ├──────────────►│ Facebook/Metamask│
                   │ logged in?│               └────────┬─────────┘
                   └─────┬─────┘                         │
                         │ Yes              Login        │
                         │               successful      │
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                   │Chosse avatar│
                   └─────┬──────┘
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   │   Ready    │ No│ Do you have│
   │ Player Me  │◄──┤ an Avatar? │
   └─────┬──────┘   └────┬──────┘
         │               │ Yes
         │          ┌────▼────────┐
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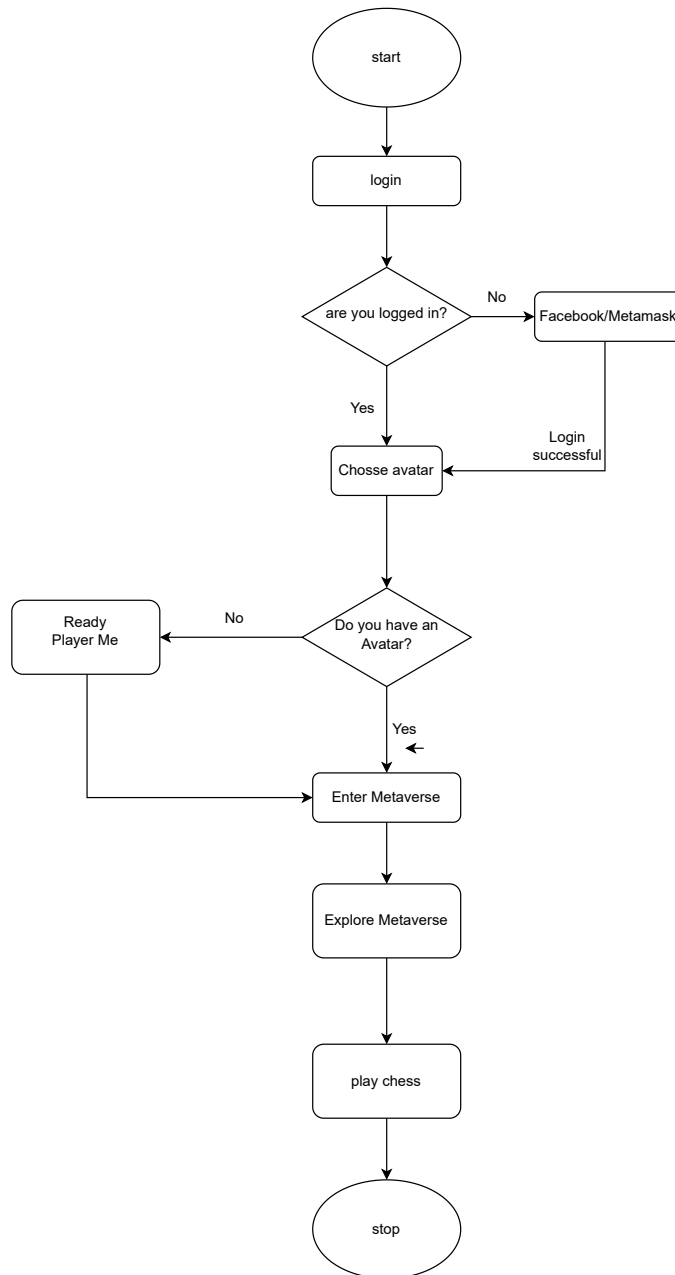
Figure 4.3: flowchart

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4.7 Software Development Plan

- Sketch of a scenario:

Figure 4.4: Sketch of chess

- Flow chart of the sequence:

    - Starting the game

    - Spawing the avatar

    - Moving of the avatar

    - Exploring metaverse.

    - Initiating chess game

- Starting of chess game

    - Set up game pieces

- Playing the game

    - Completing a move

    - Validating the move.

    - Removing pieces

    - Replacing pieces

- Ending the game

    - Relocating pieces to initial positions

- Back to exploring metaverse

    - Enter the portal to different map.

- Resources

    - VR Headset

    - PC

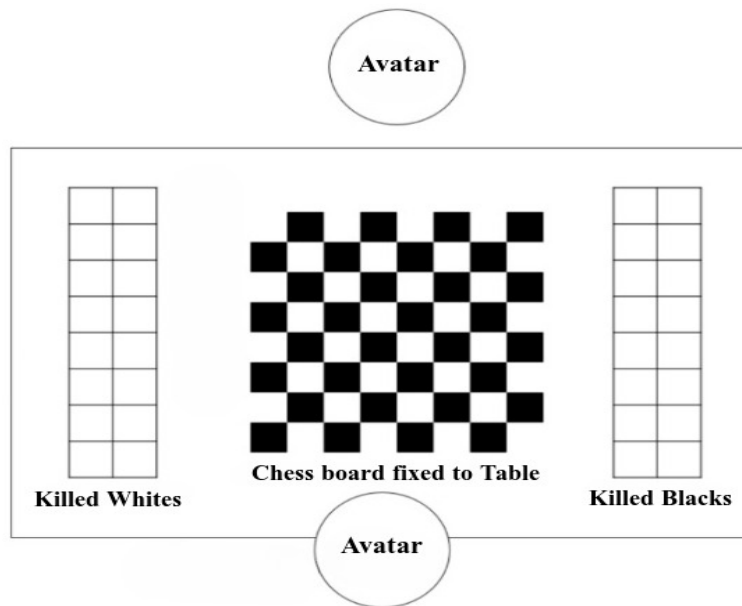- Work Breakdown Structure

    - Each person's key areas of interest and work division and summarized in the table below

Task Name	Duration	Start	Finish	complete	Assigned To
Start of FYP 1	1d	08/22/22	08/22/22		
Project Proposal	5d	09/01/22	09/07/22	100%	M.Abdullah, Nauman Tasawar, Abullah Tahir
Project Defence	6d	09/05/22	09/12/22	100%	M.Abdullah, Nauman Tasawar, Abullah Tahir
Literature review	46d	09/01/22	11/03/22	80%	M.Abdullah, Abullah Tahir
3D model of environment and chess	46d	09/09/22	11/11/22	60%	Nauman Tasawar, Abullah Tahir
Developing basic animations.	36d	10/01/22	11/18/22	40%	M.Abdullah, Nauman Tasawar, Abullah Tahir
Prototype of chess game environment in oculus.	24d	10/25/22	11/25/22	0%	M.Abdullah, Nauman Tasawar, Abullah Tahir
Setting up game server	11d	11/15/22	11/29/22	0%	M.Abdullah, Abullah Tahir
Allow multiple user to login	13d	11/23/22	12/09/22	0%	Nauman Tasawar
Testing all functionalities	40d	10/21/22	12/15/22	10%	M.Abdullah, Nauman Tasawar
Documentation	56d	10/01/22	12/16/22	25%	M.Abdullah
End of FYP 1	1d	12/20/22	12/20/22		

Figure 4.5: Teamwork Distribution

- Gantt chart
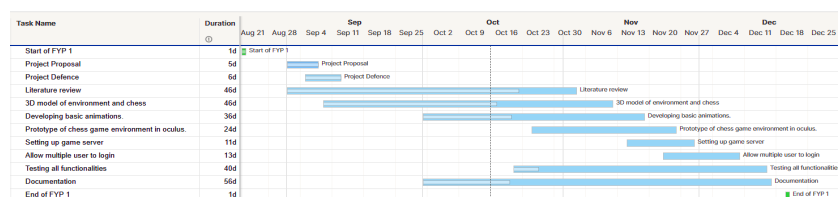
Figure 4.6: FYP-1 Gantt Chart
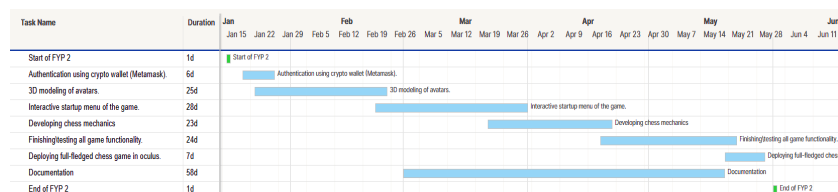
Figure 4.7: FYP-2 Gantt Chart

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- Expected Difficulties

Difficulty	Mitigation strategy
Accurate use of VR Headset	Provide a user manual for basic instructions.
Integrating the chess mechanics	Implementing standardized chess moves.
Quality of 3D environment Assets	Making assets with high quality on a high-end rig.
Server performance	Using optimized settings for the server for smooth operation.
Avatar functionality	Adding general animations for an avatar.

Table 4.3: Expected Difficulties

Chapter 5

Iteration Plan

This chapter is used to describe the iteration plan of the project. How will try project proceeds to complete all the requirements. The chapter will guide about the modules of the project and development of those modules. In this chapter students are required to discuss the plan of execution of the project in terms of phases:

- Midterm FYP 1

    - Delivered first demo of our environment and showed chess asset we made in blender.

    - Designing the environment in blender.

    - Literature review related metaverse, and chess.

    - Designing Use-case, swimlane, flow diagrams.

- Final FYP 1

    - Delivered improved demo of our environment.

    - Working chess machines, were players can grab chess pieces and preform logical moves.Except special moves.

- Midterm FYP 2

    - Avatar integration with which users can explore the verse, and interact with the environment.

- **-** User authentication before joining the game.

- Final FYP 2

  - **-** Multiplayer chess game with improved UI screens.

Chapter 6

Iteration 1

6.1   Use Cases/ Use Case Diagram

A use case diagram represents the main use case activities and the interaction of actors and the system that is under development process. It helps to identify all the main processes of the system which are then visualized in ovals, known as a use case. A use case diagram is drawn from a scenario that explains the working of the system.

Figure 6.1: Use Case Diagram

6.2 Swimlane

The Swimlane diagram is shown in 4.2, it represents the flow of the activities in a specific order and it explains the details and conditions at every step. This UML diagram helps in understanding the flow of activities and it can help to identify those activities that can be run parallel to make an efficient system. The given diagram represents the flow of activities in Metaverse, it also explains which activity is initiated by which actor, since the activities are separated by swim lanes.
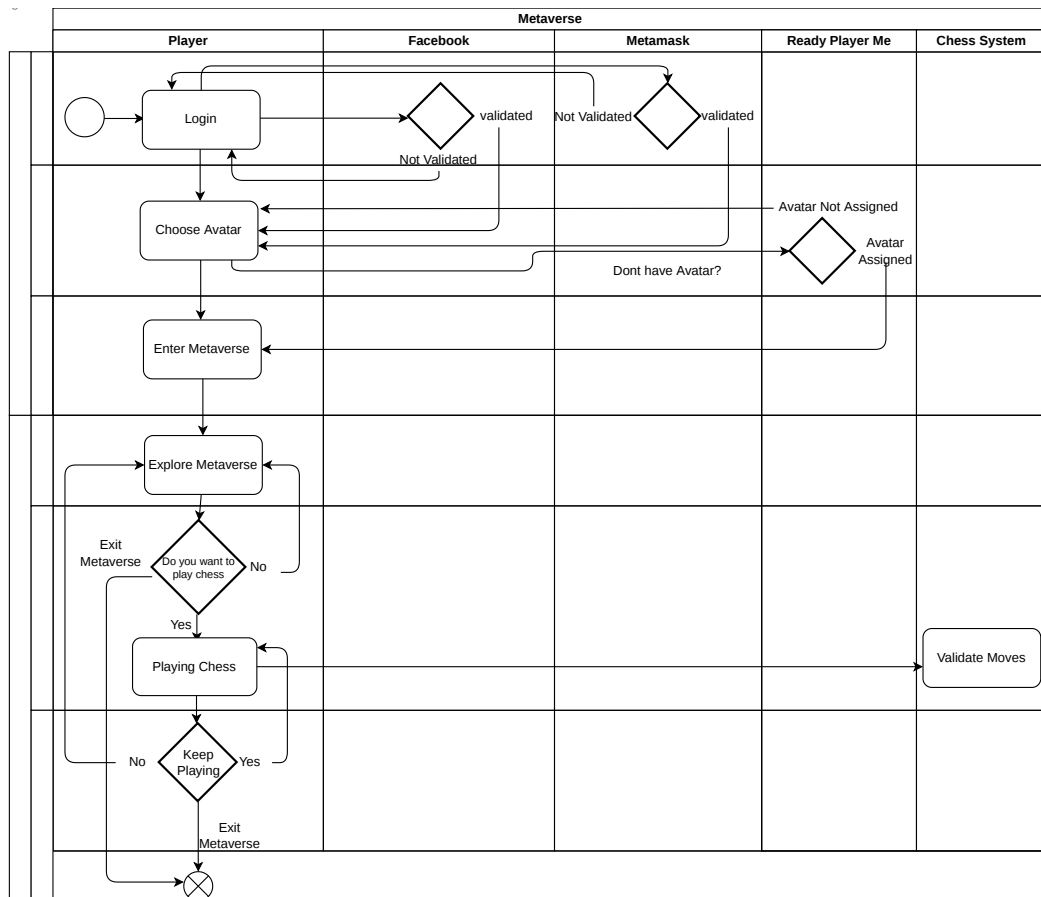
Figure 6.2: Swimlane Diagram

6.3 Flowchart

start

login

are you logged in? — No → Facebook/Metamask

Yes

Login successful

Chosse avatar

Do you have an Avatar? — No → Ready Player Me

Yes

Enter Metaverse

Explore Metaverse

play chess

stop
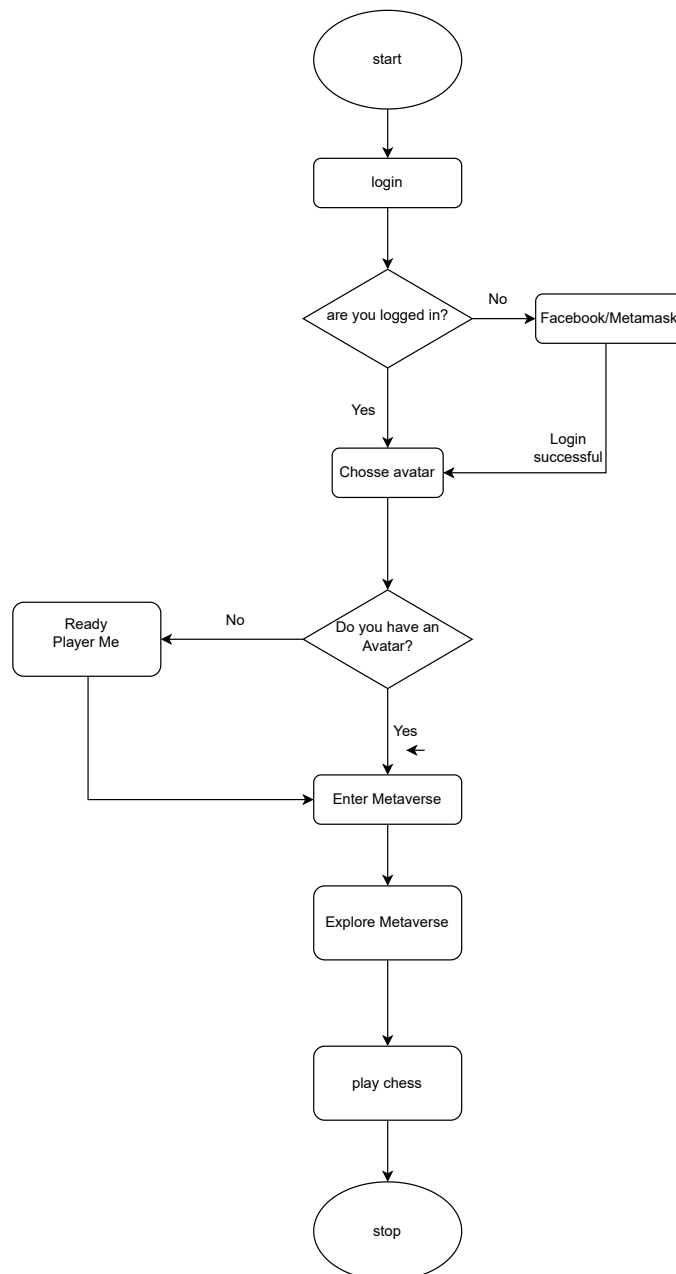
Figure 6.3: flowchart

6.4 Activity diagrams

6.4.1 Activity diagram for the movement of chess piece

Precondition: During the Play Game state

Main Flow: The active player clicks a piece to select it. The game displays the positions it can move to. The player selects the new destination by clicking. The piece is moved there if it is a valid move. Their opponent becomes the active player.

Alternate Flow: The active player may decide to select a different piece by clicking one of their own. If there are no valid moves and the active player is not in check the game ends as a stalemate. If there are no valid moves and the active player is in check the inactive player wins

Figure 6.4: Activity diagram for the movement of chess piece

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Chapter 7

Iteration 2

7.1 Use Cases/ Use Case Diagram

A use case diagram represents the main use case activities and the interaction of actors and the system that is under development process. It helps to identify all the main processes of the system which are then visualized in ovals, known as a use case. A use case diagram is drawn from a scenario that explains the working of the system.
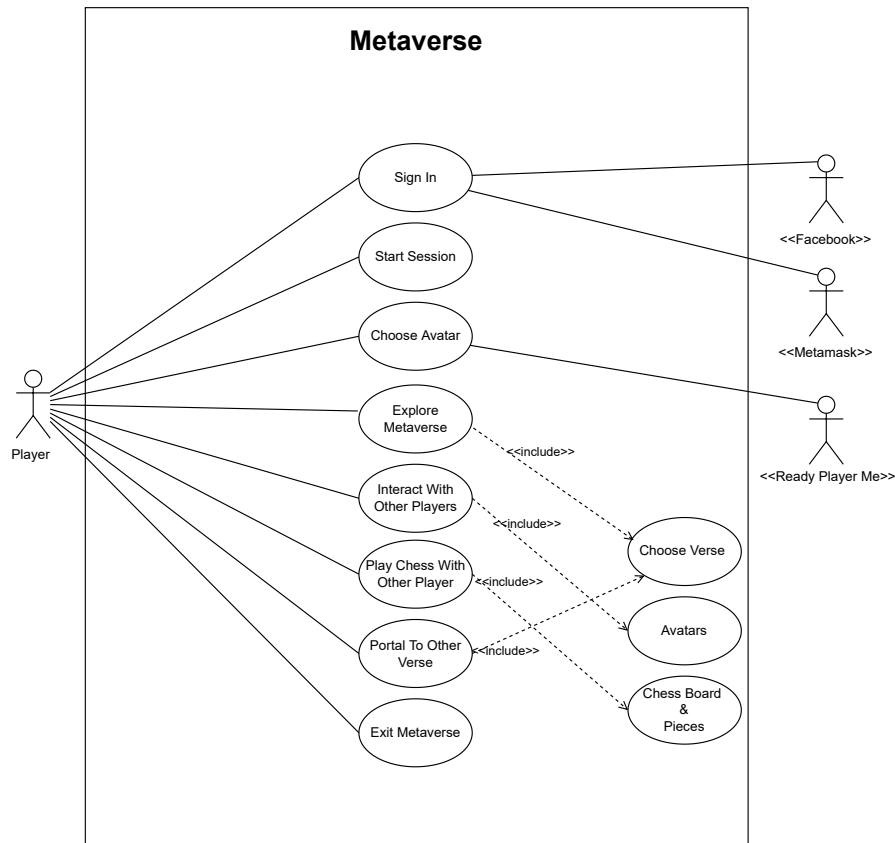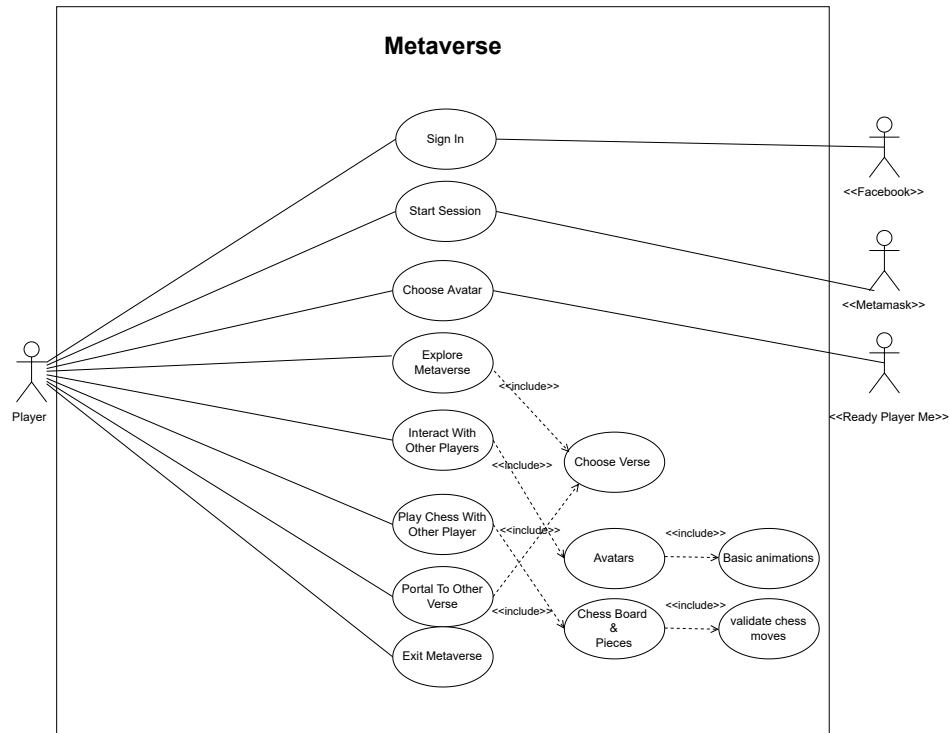
Figure 7.1: Use Case Diagram

7.2 Swimlane

The Swimlane diagram is shown in 4.2, it represents the flow of the activities in a specific order and it explains the details and conditions at every step. This UML diagram helps in understanding the flow of activities and it can help to identify those activities that can be run parallel to make an efficient system. The given diagram represents the flow of activities in Metaverse, it also explains which activity is initiated by which actor, since the activities are separated by swim lanes.
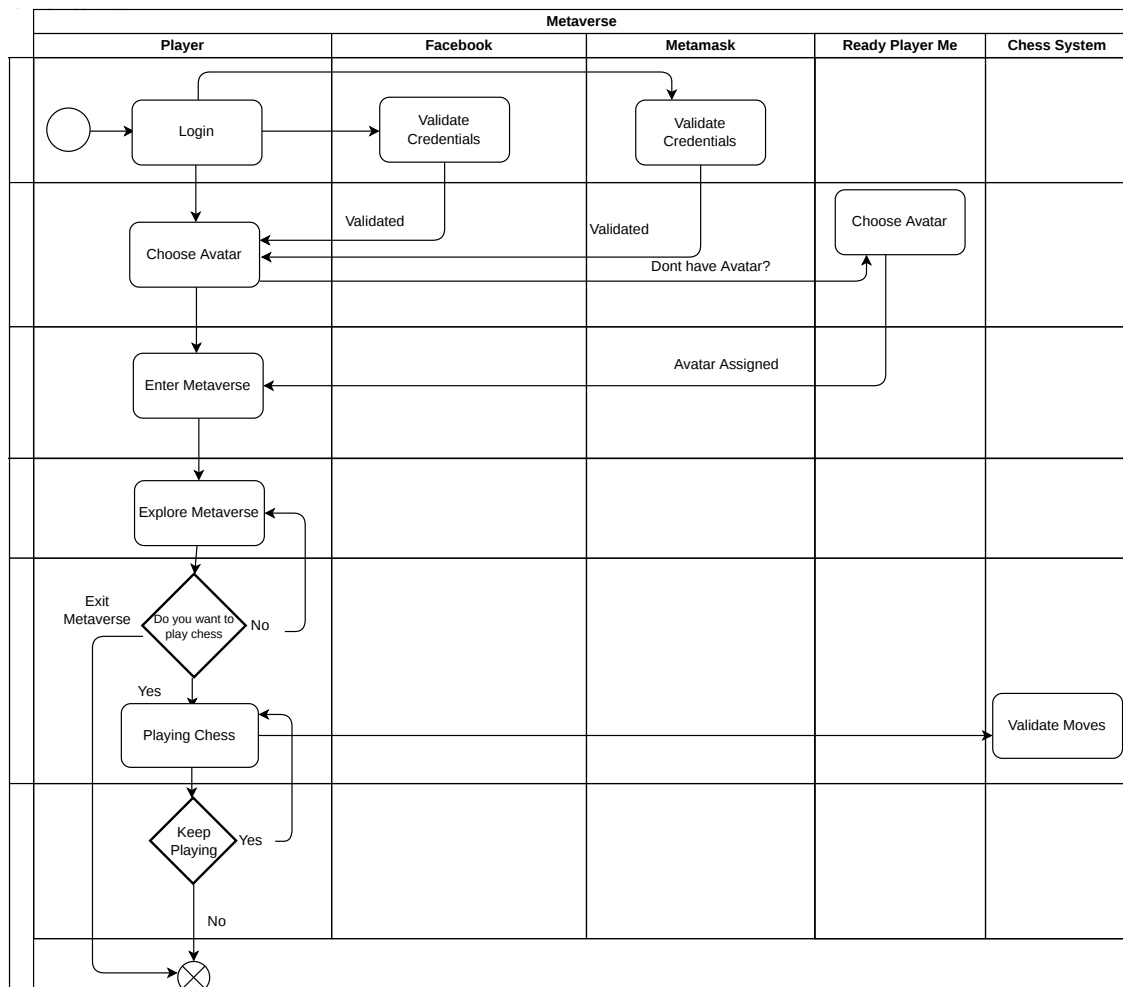
Figure 7.2: Swimlane Diagram

7.3 Flowchart
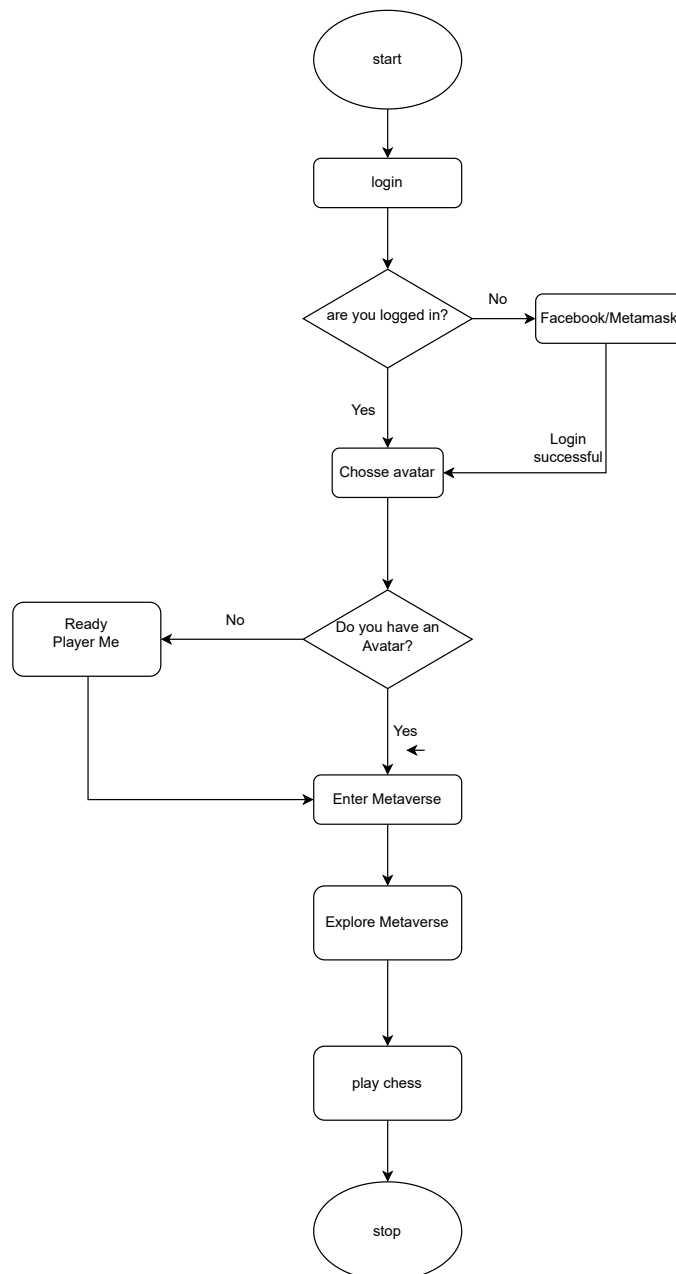
Figure 7.3: flowchart

7.4 Activity diagrams

7.4.1 Activity diagram for the movement of chess piece

Precondition: During the Play Game state

Main Flow: The active player clicks a piece to select it. The game displays the positions it can move to. The player selects the new destination by clicking. The piece is moved there if it is a valid move. Their opponent becomes the active player.

Alternate Flow: The active player may decide to select a different piece by clicking one of their own. If there are no valid moves and the active player is not in check the game ends as a stalemate. If there are no valid moves and the active player is in check the inactive player wins
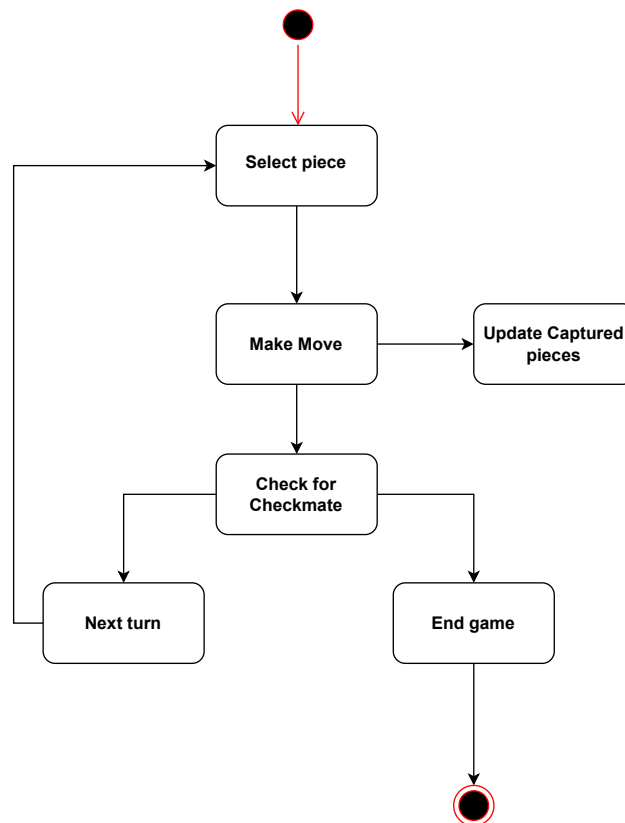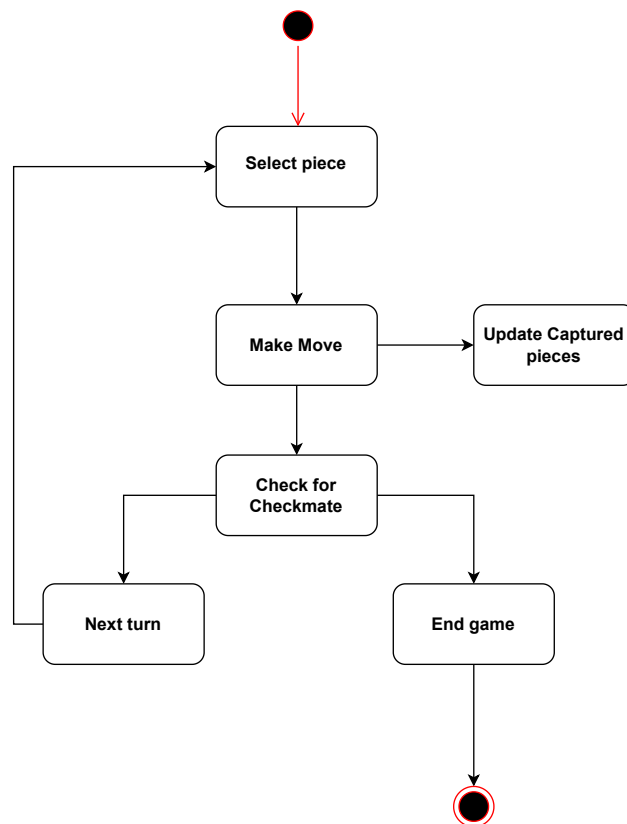
Figure 7.4: Activity diagram for the movement of chess piece

7.4.2   Activity diagram for ready player me

```
                        ●

                 ┌──────────────────┐
                 │ choose avatar with │◄──────────────┐
                 │ ready player one   │               │
                 └──────────────────┘                │
                          │                           │
                          ▼                           │
                      ◇ Is this the              ┌──────────────┐
                        avatar you    ──no──►    │ Chosse different │
                        want? ◇                  └──────────────┘
                          │
                         yes
                          ▼
                 ┌──────────────────┐
                 │ Enter Metaverse  │
                 └──────────────────┘
                          │
                          ▼
                      ◇ do you want to     no      ┌──────────────────┐
                        stay in current ──────►    │ go to different map │
                        map? ◇                     └──────────────────┘
                          │                                 │
                         yes                                │
                          ▼                                 │
                 ┌──────────────────┐                       │
                 │ explore metaverse │◄─────────────────────┘
                 └──────────────────┘
                          │
                          ▼
                        ◉
```

38
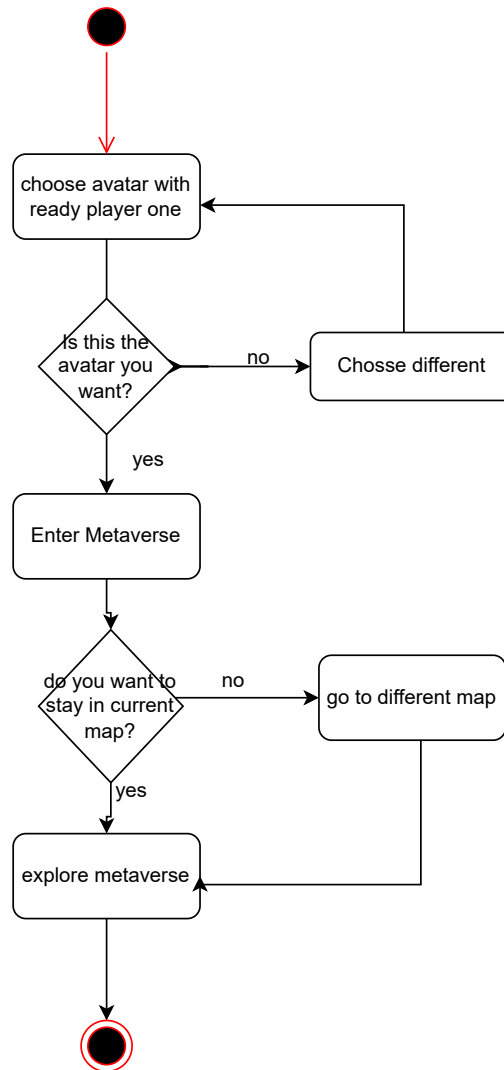
7.4.3 Activity diagram for login
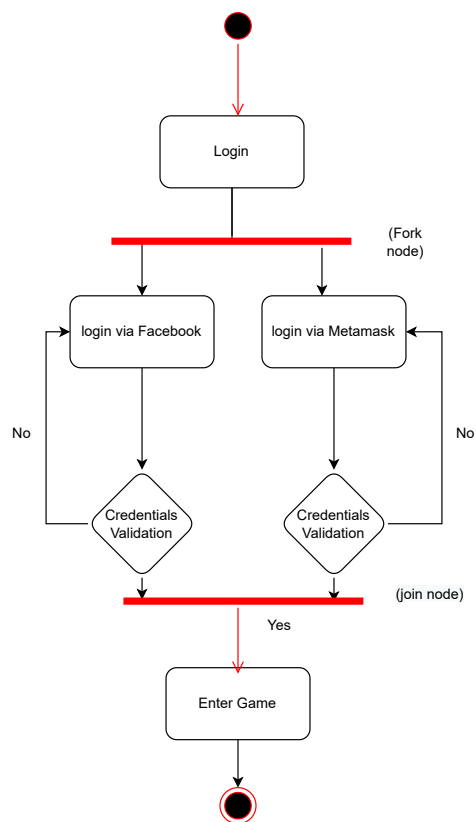
Figure 7.6: Activity diagram for login

7.5 Class Diagram

Chessboard
-Chesspeice[]:Chesspeices
-Awake() : void -Update():void -GenerateAllTiles():void -GenerateSingleTitle() -SpawnAllPeice():void -SpawnSinglePeice() -PositionAllPeice():void -PostionSinglePeice():void -GetTileCenter() -HighLightTile():void -RemoveHighlightTiles():void -Containvalidmoves():void -move():void -lookuptitlesIndex():void

Chesspiece
-Update():void +GetAvailableMoves() +SetPosition() +SetScale()

Pawn
GetAvailavleMoves():

Knight
GetAvailavleMoves():

Rook
GetAvailavleMoves():

Bishop
GetAvailavleMoves():

Queen
GetAvailavleMoves():

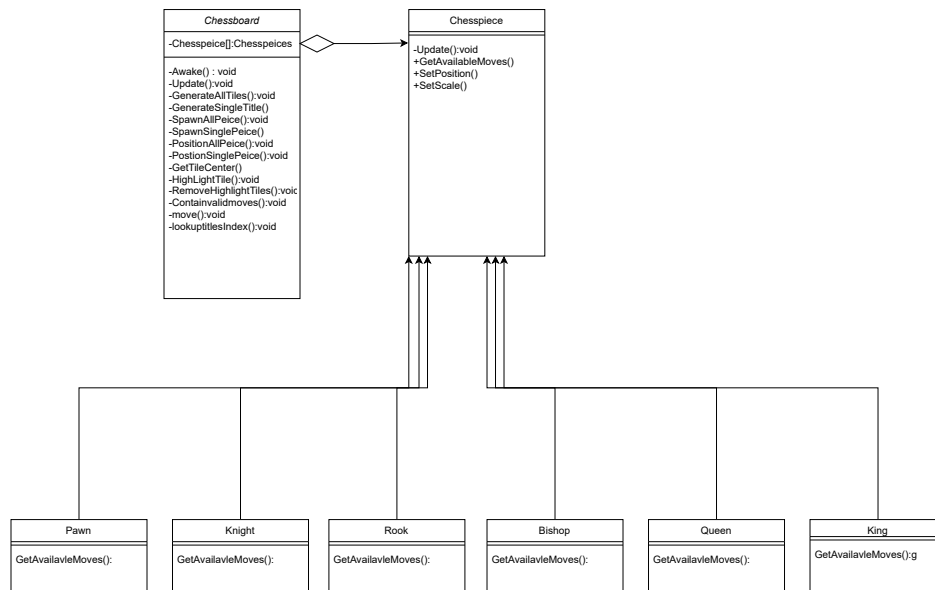| King |
| --- |
| GetAvailavleMoves():g |

Figure 7.7: Partial class Diagram of chess system
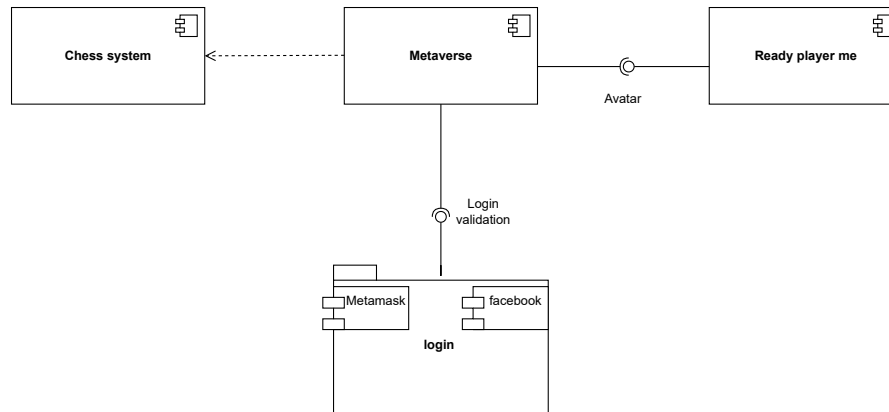
40

7.6 Component diagram

Figure 7.8: Component diagram of the game

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Appendix A

Definitions

Bishop: one of two pieces of the same color that may be moved any number squares diagonally, as long as no other piece blocks its way. One piece always remains on White squares and the other always on Black.

Castling: to move the king two squares horizontally and bring the appropriate rook to the square the king has passed over.

Check: To make a move that puts the opponents King under direct attack.

Checkmate: a situation in which an opponent's king is in check and it cannot avoid being captured. This then brings the game to a victorious result.

Chess Board: A board you need to play Chess. Have 64 black and white square.

Chess: A game played by 2 people on a chessboard with 16 pieces each.

En Passant: a method by which a pawn that is moved two squares can be captured by an opponent's pawn commanding the square that was passed.

En Passant: The main piece of the game, checkmating this piece is the object of the game. It can move 1 space in any direction.

Knight: This piece can move 1 space vertically and 2 spaces horizontally or 2 spaces vertically and 1 space horizontally. This piece looks like a horse. This piece can also jump over other pieces.

Pawn: One of eight men of one color and of the lowest value usually moved one square at a time vertically and capturing diagonally.

Player or user: A user or a player will be the person that is playing the chess game.

Queen: This piece can move in any number of spaces in any direction as long as no other piece is in its way.

Rook: one of two pieces of the same color that may be moved any number squares horizontally or vertically, as long as no other piece blocks its way.

Stalemate: A situation in which a player's king is not in check, but that player can make no move. This then results is a stalemate, which is a draw.

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