Bilkent University

Department of Computer Engineering

CS319 Term Project

Analysis Report

Arnisa Fazla, Ege Türker, İbrahim Furkan Aygar, Hassam Abdullah, Oğulcan Pirim, Pınar Yücel

Instructor: Eray Tüzün

Teaching Assistant(s): Barış Ardıç, Elgun Jabrayilzade and Emre Sülün

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Analysis Report

Monopoly

1. Introduction

In this report, the Monopoly game will be analysed in detail and the proposed additions to the game in the to-be-designed software implementation will be presented.

Monopoly is a real-estate board game in which players engage in a simulated property and financial dealings using imitation money. The player's goal is to remain financially solvent while forcing opponents into bankruptcy by buying and developing pieces of property.

Proposed version of Monopoly will preserve the core gameplay functionalities of the original Monopoly game while introducing new breathtaking functionalities that can change the course of the game and make it more exciting.

One of the new features is the introduction of event cards. Event cards will be added to the chance card deck. Through event cards, players will be able to initiate an event on the property of their choice. The positive events will increase the property's value via organizing events such as festivals, while the negative events will decrease the property's value via natural disasters such as earthquakes. As another feature, players will be able to communicate with each other via general and private chat through which the players will be able to build alliances to eliminate other players. Moreover, players will be able choose whether or not they will collect rent and money exchange will be allowed among players. Assigning a player to be the banker is removed in this version of Monopoly since it will be a digital game. In our version of Monopoly, a 2D animation for the dice, an animation for pawn movements and sound effects for pawn movement, beginning of the turn and landing on an owned property will be implemented. Last but no least, our digital version of the Monopoly game provides connection over LAN for multiplayer 2 to 4 players.

The report starts with an overview in which the gameplay and the game entities are described in detail. The new features that will be added to the original game will also be described in detail. The report then continues with the description of functional, non-functional and pseudo requirements which are then followed by the presentation of system models.

2. Overview

2.1. Overall Flow of the Game

At the beginning of the game, each player is given $1500 and each player chooses a pawn to represent themselves on the board. The first player to choose a certain pawn gets to keep it. The player to start first is chosen randomly. Players play their turns until they go bankrupt and the last player to remain solvent wins the game.

2.2. Playing a Turn

Playing a turn starts with the player rolling the dice. Players' pawns move the number of tiles indicated by the sum of the dice clockwise. According to the tile on which the player's pawn currently is, the player can buy a property if the property does not currently have an owner, pay rent if the property is owned by another player, play a community chest card, play a chance card, go to jail, pay tax, do nothing or build a house if they own the property. If the player throws doubles, they play for another turn. If the player throws doubles three times in succession, they go to jail.

2.3. Bank

Bank holds an unlimited amount of money, the title deed cards and houses and hotels that are not owned by players. It pays players $200 whenever they pass the GO tile, escrows rent, auctions and sells properties, sells buildings, collects taxes and mortgages properties.

2.4. Gameboard

Gameboard contains a map in which there are 40 subsequent tiles of 8 types.

Figure 1: Monopoly Gameboard

2.5. Tiles

2.5.1. Property Tile

Property tiles are tiles on which there is a property. When players land on a property tile, they will be required to pay rent if the property is owned by another player or if not owned by anyone, they can buy the property if the player has sufficient money. Players who land on an owned property do not have to pay rent if the property is currently mortgaged or if the owner chooses not to collect rent. If players land on a property they own and if they own all the properties that are the same color as the property they landed, they can choose

to buy a building for the property they landed on. Buildings increase the rent of the properties.

2.5.2. GO

Each player's pawn is initially on the GO tile when the game starts. Whenever a player lands on the GO tile or passes it, the bank pays that player $200.
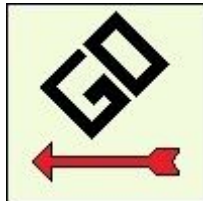
Figure 2: Go Tile

2.5.3. Go to Jail

Whenever players land on this tile, they directly go to jail.

Figure 3: Go to Jail Tile

2.5.4 Jail

If players are sent to jail their pawns stand on the "IN JAIL" part of the jail tile. There are three ways players can be sent to jail: Landing on the "Go to Jail" tile, drawing a card marked "Go to Jail" or by throwing doubles three times in a row. If players are in jail, they can exit by throwing a double on any of their next three turns, by using a "Get out of Jail" card, by buying a "Get out of Jail" card from another player and using it or by paying a $50 bail before rolling the dice. If a player who is in jail throws doubles, they play for only one turn and their pawns move forward the number of tiles according to the dice they rolled. If players fail to throw doubles at the end of their third turn, they have to pay the $50 bail and move forwards after their dice throw. Players who are in jail can buy and sell properties and buildings, participate in auctions and can collect rents. If players land on the jail tile normally, ie. after a dice throw, their pawns stand on the "JUST VISITING" part of the jail tile.

Figure 4: Jail Tile

2.5.5. Free Parking

When players land on the free parking tile, the turn moves to the next player.

Figure 5: Free Parking Tile

2.5.6. Super Tax and Income Tax

There is one Super Tax and one Income Tax tile. When players land on them they have to pay the specified tax or they can use a "Skip Tax" card to not pay the tax. Tax is paid to the bank.

2.5.7. Chance

When players land on a Chance tile, they have to draw a chance card.

Figure 6: Chance Tile

2.5.8. Community Chest

When players land on a Community Chest tile, they have to draw a community chest card.

Figure 7: Community Chest Tile

2.6. Properties

There are three types of properties which are colored properties, stations and utilities.

2.6.1. Colored Properties

There are 22 colored properties in total and they are grouped by the colors brown, light blue, pink, orange, red, yellow, green, dark blue that indicate their values from the least valuable to the most valuable. Buildings can be bought for colored properties.

2.6.2. Stations

There are 4 stations. Their rent is the number of stations the owner has times their base rent. Buildings can not be bought for stations.

2.6.3. Utilities

Utilities consist of Electric Company and Water Works. If the owner only has one utility property, the rent for that property is 4 times the dice roll of the player who lands on it. If the owner only has both of the utility properties, the rent for that property is 10 times the dice roll for the player who lands on it.

2.7. Cards

There are basically 3 groups of cards which are Community Chest Cards, Chance Cards and Title Deed Cards.

2.7.1. Community Chest Cards

Community Chest Cards can be found in the Community Chest Card deck. These cards may result in players paying or receiving money, going to jail or receiving a Get out of Jail Free card which can be kept until needed or can be traded with other players. Below is a list of all the unique community chest cards:

- Advance to Go (Collect $200)
- Bank error in your favor—Collect $200
- Doctor's fee—Pay $50
- From sale of stock you get $50
- Get Out of Jail Free
- Go to Jail–Go directly to jail–Do not pass Go–Do not collect $200
- Grand Opera Night—Collect $50 from every player for opening night seats
- Holiday Fund matures—Receive $100
- Income tax refund–Collect $20
- It is your birthday—Collect $10
- Life insurance matures–Collect $100
- Pay hospital fees of $100
- Pay school fees of $150
- Receive $25 consultancy fee
- You are assessed for street repairs–$40 per house–$115 per hotel

- You have won second prize in a beauty contest–Collect $10
- You inherit $100

Figure 8: A Community Chest Card

2.7.2. Chance Cards

Chance Cards can be found in the Chance Card deck. These cards may result in players paying or receiving money, going to jail, going to the specified tile or receiving a Get out of Jail Free card which can be kept until needed or can be traded with other players or can be an Event Card. Event Cards are specific to the proposed version of Monopoly. Through event cards, players will be able to initiate an event on the property of their choice. The positive events will increase the property's value via organizing events such as festivals, while the negative events will decrease the property's value via natural disasters such as earthquakes. The effects of the Event Cards will be permanent. Below is a list of all the unique chance cards:

- Advance to Go (Collect $200)
- Advance to Illinois Ave—If you pass Go, collect $200
- Advance to St. Charles Place – If you pass Go, collect $200
- Advance token to nearest Utility. If unowned, you may buy it from the Bank. If owned, throw dice and pay the owner a total ten times the amount thrown.
- Advance token to the nearest Railroad and pay the owner twice the rental to which he/she {he} is otherwise entitled. If Railroad is unowned, you may buy it from the Bank.
- Bank pays you dividend of $50
- Get Out of Jail Free
- Go Back 3 Spaces
- Go to Jail–Go directly to Jail–Do not pass Go, do not collect $200

- Make general repairs on all your property–For each house pay $25–For each hotel $100
- Pay poor tax of $15
- Take a trip to Reading Railroad–If you pass Go, collect $200
- Take a walk on the Boardwalk–Advance token to Boardwalk
- You have been elected Chairman of the Board–Pay each player $50
- Your building and loan matures—Collect $150
- You have won a crossword competition—Collect $100
- Organize a festival on the property of your choice—Property's rent and value are increased by 25%
- Organize this year Olympics on the property of your choice—Property's rent and value are increased by 50%
- Set a property on fire—Property's rent and value are decreased by 25% permanently
- Cause an earthquake to damage a property—Property's rent and value are decreased by 50% permanently
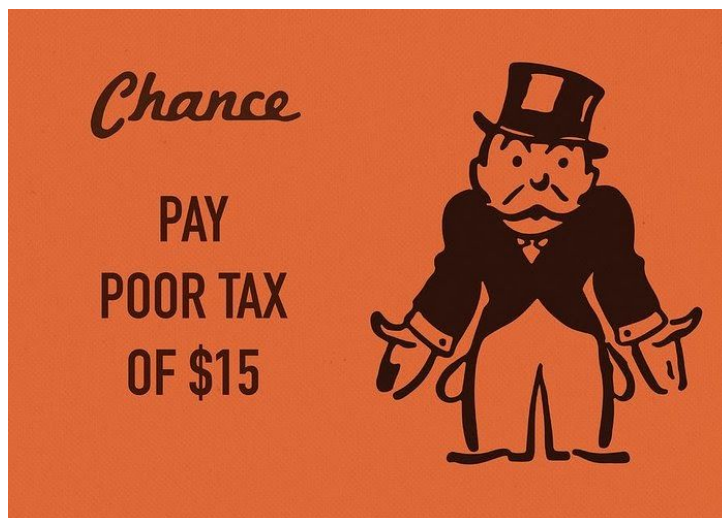
Figure 9: A Chance Card

2.8. Buildings

There are 2 types of buildings which are houses and hotels. Buildings can be sold back to the bank at half the original price.

2.8.1. Houses

There are 32 houses which can be bought from the bank. Houses increase the rent of a property when bought. When a player owns all of the properties in a certain color group, they may start purchasing houses for those properties. Houses have to be bought and sold evenly, meaning that the difference of number of houses on any two properties of the same color can be a maximum of 1.

2.8.2. Hotels

There are 12 hotels which can be bought from the bank. A player can change 4 houses with 1 hotel.

2.9. Rules

Below is the list of the rules of the proposed version of the Monopoly. All of the rules of the original version of Monopoly are inherited. However, there are some additions.

- If you land on a property that no player owns, you may buy it from the Bank at the price printed on the board. If you do not want to buy it, the Banker sells it at an auction to all players. You may join in this auction even though you originally said you didn't want to buy the property. The player who buys the property (or wins the auction) pays their money to the Bank and gets the card for the property from the Bank, which lists important information about the property.
- If you land on a property another player owns, you must pay them the rent that is listed on the property's card. There is no penalty if you land on a property you own - in this case, you don't have to do anything.
- If you land on Chance or Community Chest, you must draw the top card from the corresponding deck and follow its instructions. Chance cards usually cause you to move to different spaces on the board, and Community Chest cards usually give you bonus money or force you to pay money to the Bank. When you're done with a card, the card will be taken away and be put on the bottom of the deck it came from unless the card says you may keep it. Every card will be taken back and put on the bottom of the deck it was drawn from after they are used. However, event cards are an exception to this rule. The player who draws an event card may use it whenever they wish and then the card will be removed from the game utterly.
- If your token lands on GO or passes over it, you collect $200 from the Bank.
- If your token lands on Free Parking, nothing bad (or good) happens to you - it's just a "free" resting space.
- If you land on Income Tax or Luxury Tax, you must pay the amount of money shown on the space to the Bank.
- If you roll doubles (the same number on both dice), you get to take another turn after this one is over. However, if you roll doubles three times in a row, you don't get your third turn but you must go directly to Jail.
- While you are in Jail, you still roll the dice on your turn but you don't get to move your token. There are three ways to get out of Jail. If you roll a double for your turn, you get to leave Jail and move your token as normal. However, even though you rolled doubles, you don't get another turn. Use a "Get Out Of Jail, Free" card to leave Jail and move according to the roll of your dice. Pay a fine of $50 to the Bank to leave Jail and move forward according to your roll. If you don't roll doubles for three turns in a row, you must choose this option.

- Once you own all the colored properties of the same color, you can start to build houses on them. The more houses on your properties, the more you can charge for the rent when an opponent lands on one - the exact amounts are listed on each street's card. You can also sell houses back to the Bank for half the cost you paid for them.
- Once you have four houses on a property, you may buy a hotel to further increase the rent you can charge. Buying a hotel requires not only a cash payment but also requires you to return the four houses on the street back to the bank. There can only be one hotel on each property. If you sell a hotel, you get back the houses that you exchanged in order to build the hotel.
- When building and selling houses and hotels, you must build evenly. This means, for example, you have to have a house on each colored property in a color before you can build a second house on any colored property in that color, and you must have four houses on each colored property in a color in order to buy a hotel on any of the colored properties in that color.
- The game only comes with 32 houses and 12 hotels. If the Bank runs out of houses or hotels, no players may build any more of them until the Bank gets more of them (for example, if players sell them or exchange houses for a hotel). If there are only a few buildings left in the Bank and more than one player wants to buy them, the first one to buy them keeps them. This also means that if you're trying to sell a hotel and there aren't enough houses to put back on the colored property, you can't sell the hotel. An exception to this is that if all colored properties in a color have hotels on them, you may sell all the hotels at once and get back half the price you paid for the hotels plus half the total price of all the houses that you exchanged in order to build these hotels.
- You can sell any properties to another player for any price that you both agree on. But if you have houses or a hotel on the colored property, you must sell all of them back to the Bank before you can do so.
- You can take a loan from the Bank by mortgaging properties you own. Each property has a mortgage value listed on its card, which is how much money you get from the Bank if you mortgage the property. If a property is mortgaged, you do not collect rent when opponents land on it. To unmortgage a property, you have to pay the original mortgage value plus 10% interest back to the Bank. For example, if a property's mortgage value were $100, you would get $100 from the Bank if you choose to mortgage the property, but 10% of $100 is $10 so you would have to pay $110 to unmortgage the property. If there are houses or hotels on a property you want to mortgage, you must sell them all back to the Bank before you can do so.
- If you give a mortgaged property to another player as part of a trade, they may unmortgage the property right away by paying the normal cost (mortgage value plus 10% interest). If they choose not to unmortgage the property, they must still pay the

10% interest, and later they can unmortgage the property by paying the mortgage value plus another 10% interest.

- If you owe more money to another player or to the Bank than you can pay, you are allowed to sell your buildings, mortgage your properties and make trades with other players to try to get the money you owe. If you cannot get enough money after doing the above, you are bankrupt! This means you must hand everything you own to the player you owe money to (or back to the Bank, if you owe money to the Bank, and the Bank auctions each property to the other players) and you are eliminated from the game. When all but one player is eliminated from the game, that player wins.
- You can trade money and cards with other players whenever you want.
- A player may choose to not ask for rent.
- Once you own a monopoly of a color group of colored properties, you can make improvements on your colored properties with houses or hotels anytime during your turn or even between turns of your opponents.

3. Functional Requirements

3.1. Multiplayer Game

Since Monopoly is a game which is played with at least two people, the proposed digital version of Monopoly will inherit this functionality from the original game. Proposed digital version of Monopoly must be a multiplayer board game that can be played with 2-4 people.

3.1.1. Create a New Multiplayer Game

Users must be able to create a new multiplayer game. In order for the other players to join the game, the users should be connected to a network over which the session is shared.

3.1.2. Join a Game

Users must be able to join an already created game. They must be connected to a network over which the game is accessible to be able to join the game.

3.2. Pawn Selection

Players must be able to choose their pawns before the game starts. The first player to choose a certain pawn must be able to keep it.

3.3. Help

A help page in which there is information about the gameplay must be available to players and this page must be accessible to players both in the main menu and in-game.

3.4. Chat

Players must be able to chat both in general chat and private chat with each other.

3.5. Sound Effects

Sound effects for pawn movement, beginning of the turn and landing on an owned property must be implemented.

3.6. Trading System

Players must be able to trade money, properties, buildings and cards with each other at any time during the game. Players must also be able to give away their properties, buildings and cards for free.

3.7. Not Collecting Rent

Players must be able to choose not to collect rent.

3.8. Auctioning

Players must be able to auction their properties at any time they want. They also must be able to back out of a deal if they do not like the bids.

3.9. Buying and Selling Buildings

Players must be able to buy and sell buildings at any time they want. Players cannot buy buildings unless there are buildings available.

3.10. Viewing the Scoreboard

Players must be able to see how much money each player has, which properties each player owns and through the scoreboard at any time they want.

3.11. Animations

2D animation for rolling the dice and moving the pawns must be implemented.

4. Nonfunctional Requirements

4.1. Usability

Text colors and background colors must be contrasting to avoid unreadability.

4.2. Documentation

All of the classes, methods and algorithms must be explained in the documents and in the code.

4.3. Performance

The graphical user face of the game must respond to users within 1 ms. The system should support 4 concurrent players.

4.4. Supportability

The proposed digital version of Monopoly will be maintained by the group members whose names are written on the first page of this report in case of bugs.

4.5. Packaging

The game must be packaged as a jar file and must be loaded within 1s.

5. Pseudo Requirements

The system must be implemented using a version control system, GitHub.
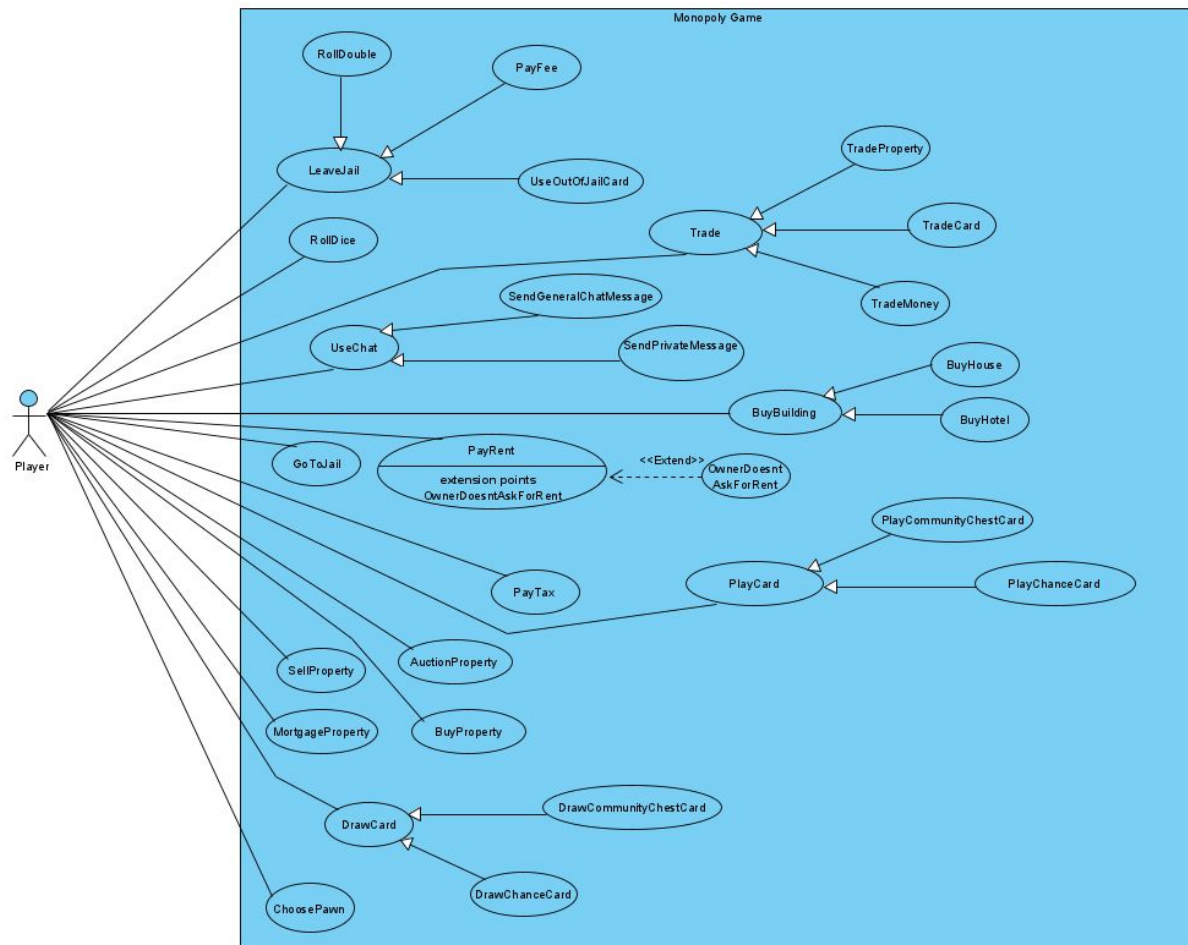
6. System Models

6.1. Use Case Model

Figure 10: User Case Diagram for gameplay

Use case name	RollDice
Participating actors	Initiated by Player Communicates with GameEngine
Flow of events	1. Player uses RollDice action in the game. 2. GameEngine responds by running the dice function and moves Player's pawn according to the dice result.
Entry condition	Player's turn has started.
Exit condition	Player has rolled the dice.

Use case name	PayRent
Participating actors	Initiated by Player Communicates with GameEngine Communicates with Owner
Flow of events	1.Player1 uses PayRent action. 2. GameEngine communicates with Owner to ask if the Owner will collect the rent or not. 3. Owner asks for rent. 4. GameEngine calculates the rent amount and transfers the money from Player to Owner. OR 1. Player1 uses PayRent action. 2.Owner doesn't ask for rent.
Entry condition	Player's pawn lands on an owned property.
Exit condition	Transaction has been made by GameEngine OR Owner doesn't ask for rent.

Use case name	SendPrivateMessage/UseChat
Participating actors	Initiated by Player1 Communicates with GameEngine Communicates with Player2
Flow of events	1. Player1 uses SendPrivateMessage function included in the UseChat function and types a message. 2. GameEngine delivers the message to Player2's client. 3. Player2 reads the message and decides to send a response using SendPrivateMessage function included in the UseChat function and types a message. 4. GameEngine delivers the message to Player1's client. 5. Player1 reads the message and decides not to respond.
Entry condition	Player1 and Player2 are playing the game.
Exit condition	Player1 and Player2 stop communicating.

Use case name	BuyHotel
Participating actors	Initiated by Player Communicates with GameEngine Communicates with Bank

Flow of events	1. Player use the BuyHotel function which is a part of the BuyBuilding function. BuyBuilding is included in UseBank. 2. GameEngine takes the cost of the hotel from the Player's balance. 3. GameEngine takes the houses from the selected property and gives it to the Bank. 4. GameEngine decreases the number of buyable hotels on the Bank. 5. GameEngine puts the hotel into the selected property.
Entry condition	Player has all of the properties of the same color. Player has four houses on each property of that same color. Player has enough money to buy a hotel. Bank has at least 1 hotel remaining.
Exit condition	Hotel has been built on the property.

Use case name	GoToJail
Participating actors	Initiated by Player Communicates with GameEngine
Flow of events	1. GameEngine puts the player into the Jail tile. 2. GameEngine ends Player's turn. 3. Player's pawn stays in Jail tile until the Player activates the LeaveJail use case.
Entry condition	Player's pawn lands on the Go to Jail tile. Player draws a Chance Card that prompts Player to go to Jail. Player draws a Community Chest Card that prompt Player to go to Jail. Player rolls three consecutive doubles.
Exit condition	Player's pawn has been put in Jail and Player's turn has ended.

Use case name	LeaveJail
Participating actors	Initiated by Player Communicates with GameEngine
Flow of events	1. Player leaves the jail tile. 2. Player's pawn proceeds to be moved by GameEngine according to the dice roll.
Entry condition	Player uses Get out of jail free card. Player pays fee to the bank to leave jail.

|	Player rolls a double. OR If Player spent 3 rounds in jail and didn't roll a double, GameEngine forces the player to pay the fee to leave jail. OR If Player spent 3 rounds in jail, didn't roll a double and can't pay the fee (includes not having any money or property to sell), Player gets bankrupt.
Exit condition	Player's pawn has been moved out of jail by GameEngine

6.2. Object and Class Model
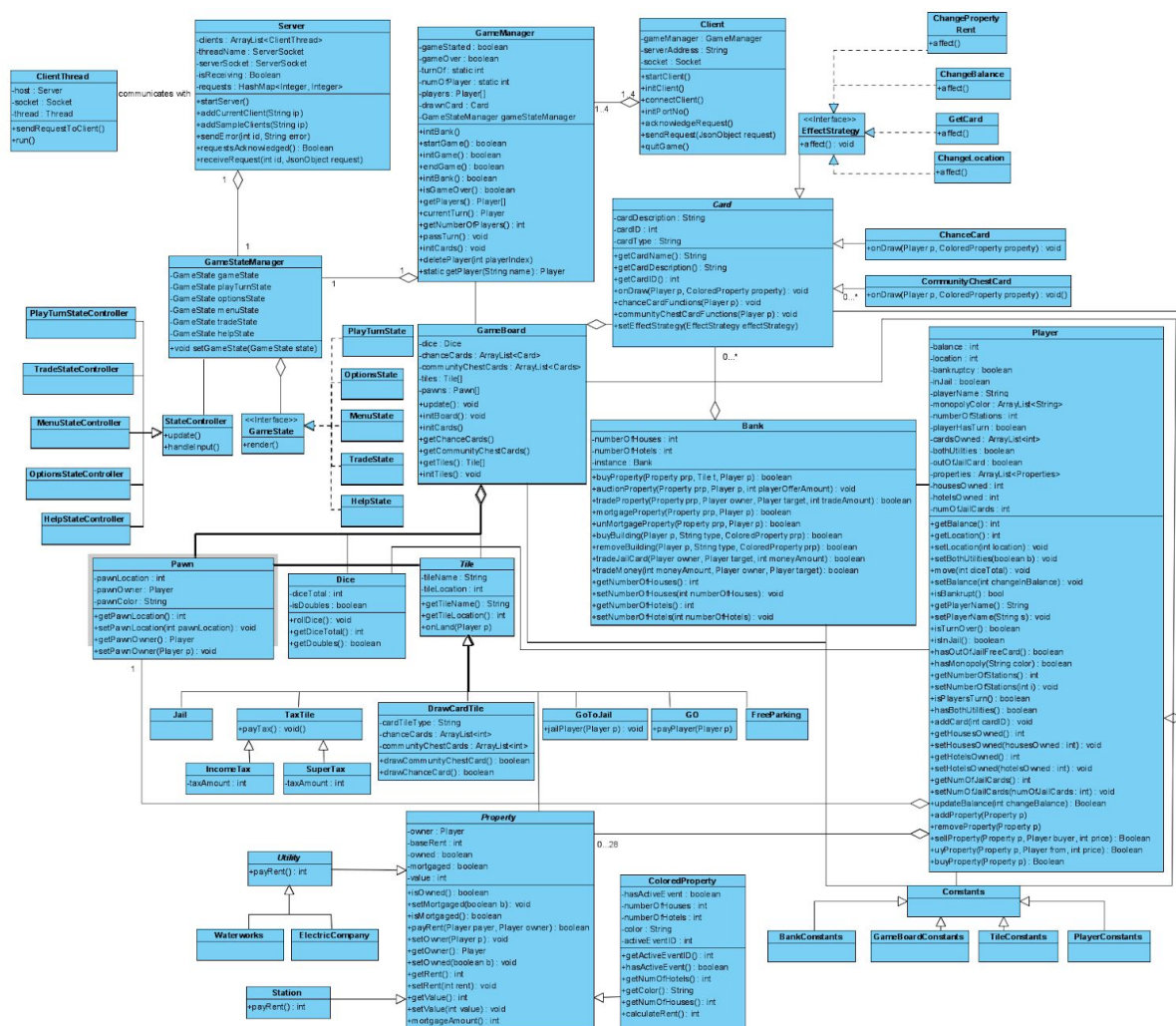
Figure 11: Object and Class model of the proposed system

6.3. Dynamic Models

6.3.1. State Diagrams
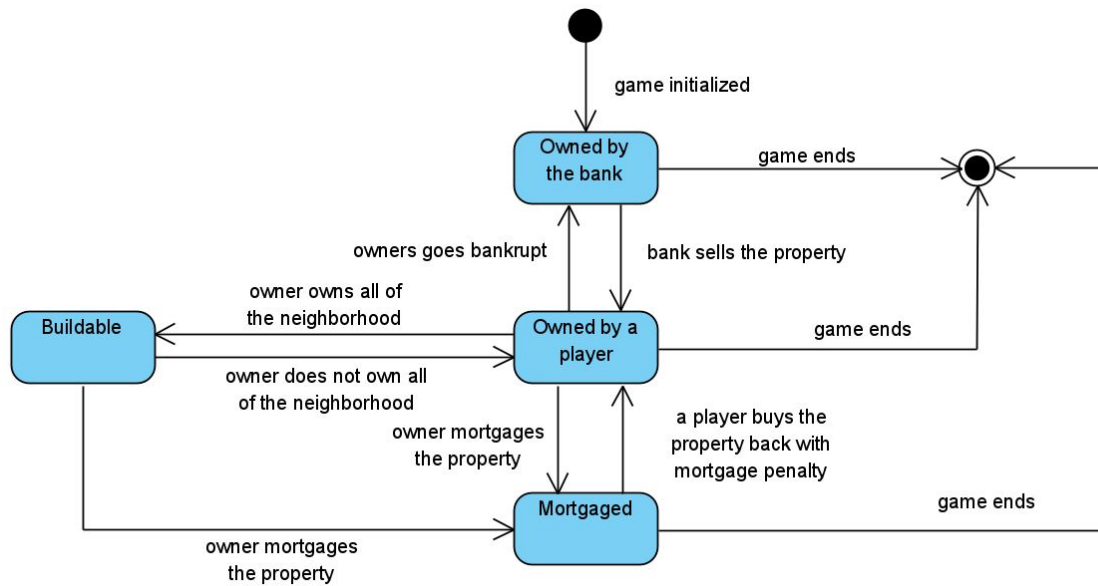
Figure 12: State Diagram of a Property
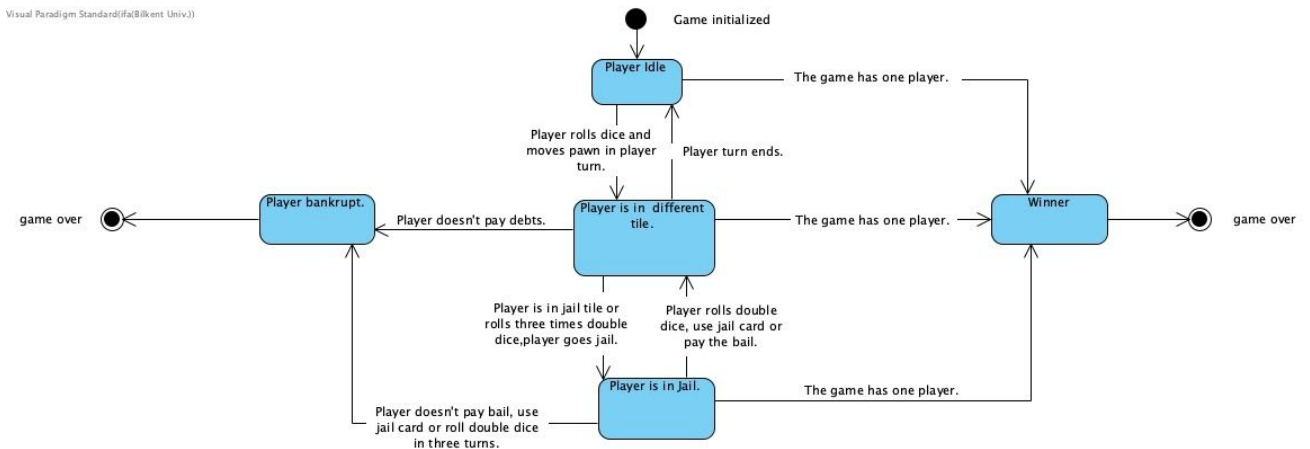
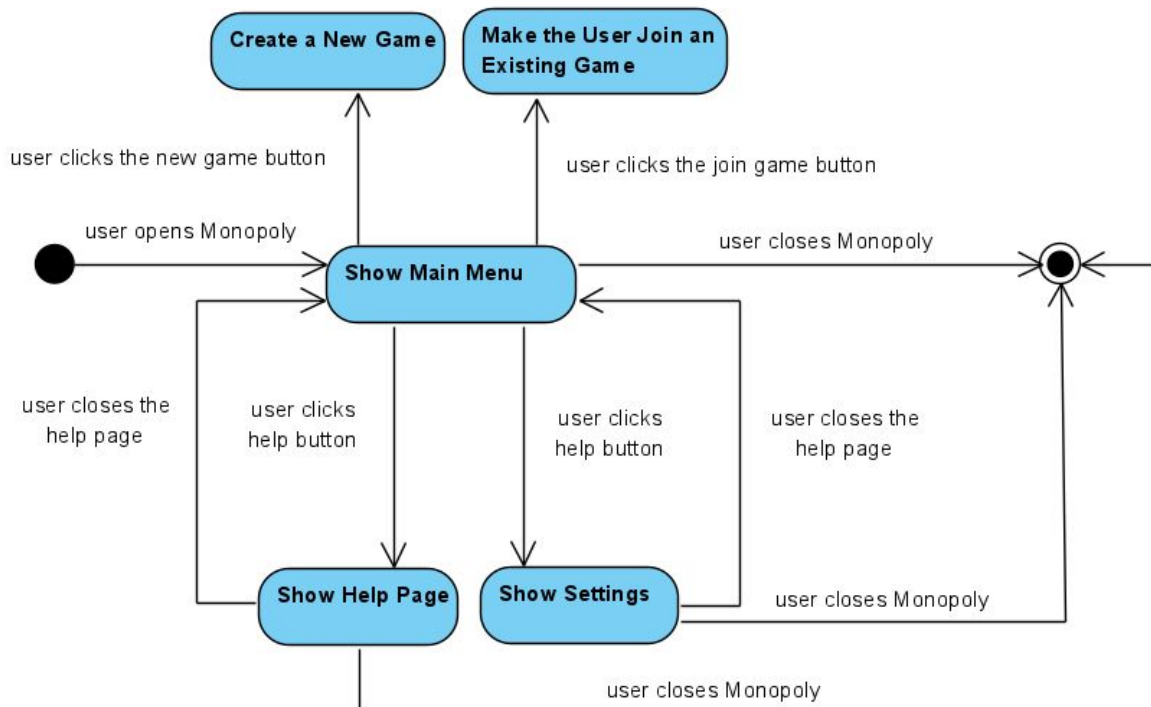Figure 13: State Diagram of a Player

6.3.2. Activity Diagrams
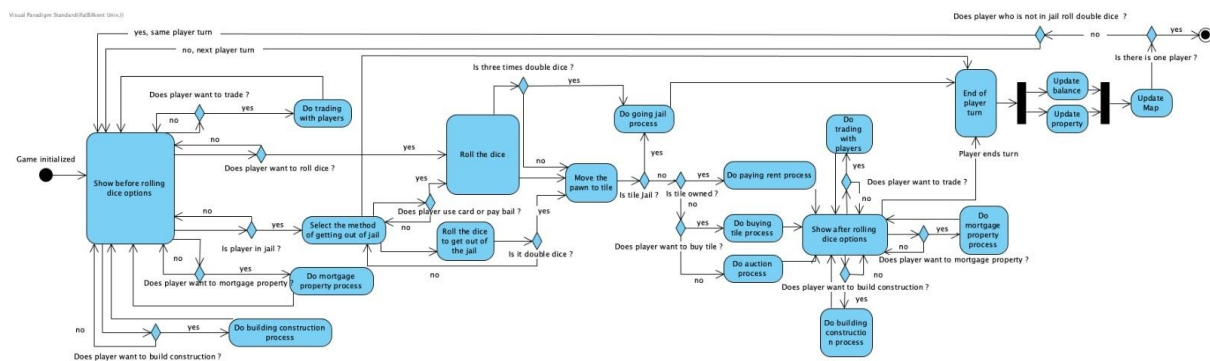

Figure 14: Activity Diagram for the Menu

Figure 15: Activity Diagram for How a Player Can Play Their Turn
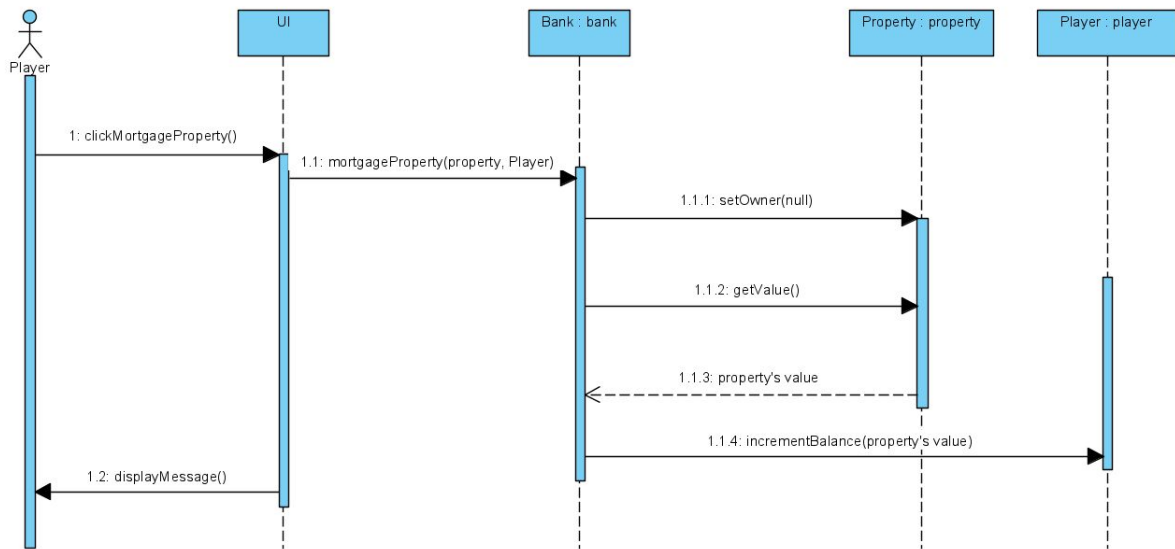
6.3.3. Sequence Diagrams

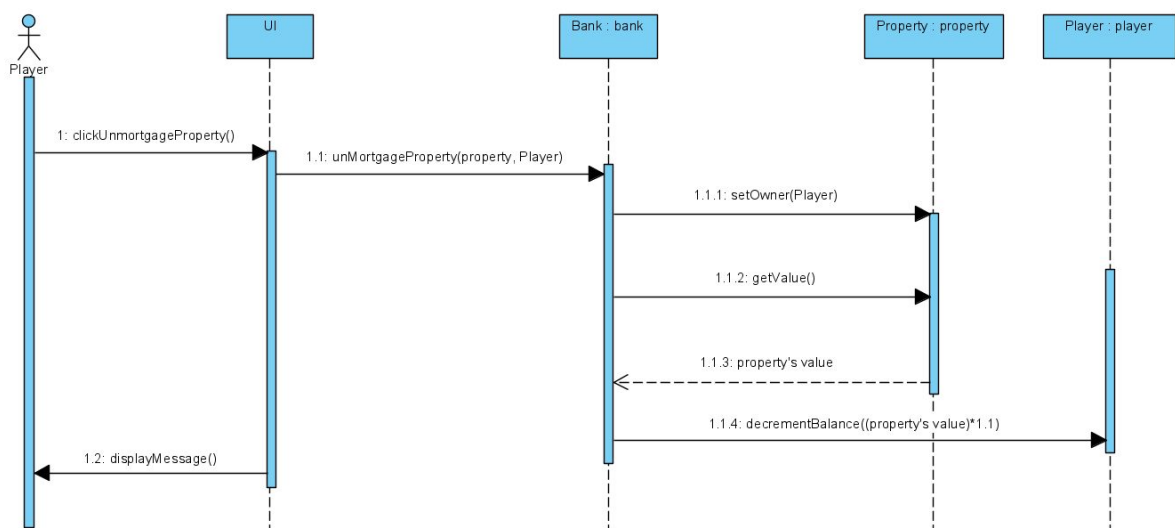
Figure 16: Sequence Diagram for Mortgaging a Property

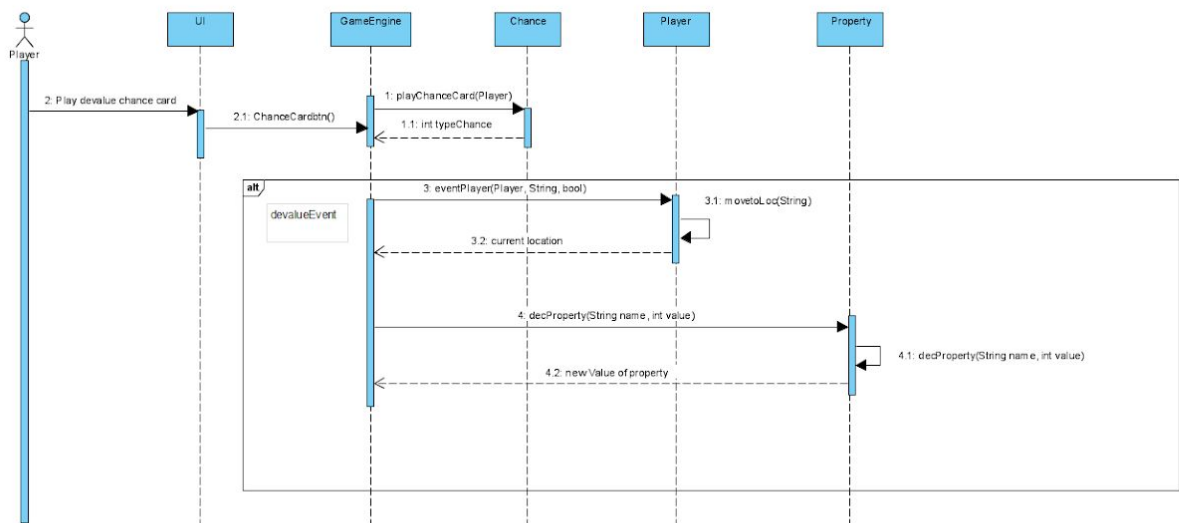

Figure 17: Sequence Diagram for Unmortgaging a Property

Figure 18: Sequence Diagram for Playing a Devalue Chance Card (Event Card)

7. User Interface

Users will be able to create a new game, join a game, view help and set the music volume in the main menu. The buttons on the right corner are for setting the volume and for seeing the help page from top to bottom (Figure 19). Below is a screenshot from the in game (Figure 20). Players will be able to view the scoreboard and access the help page any time they want during a game.
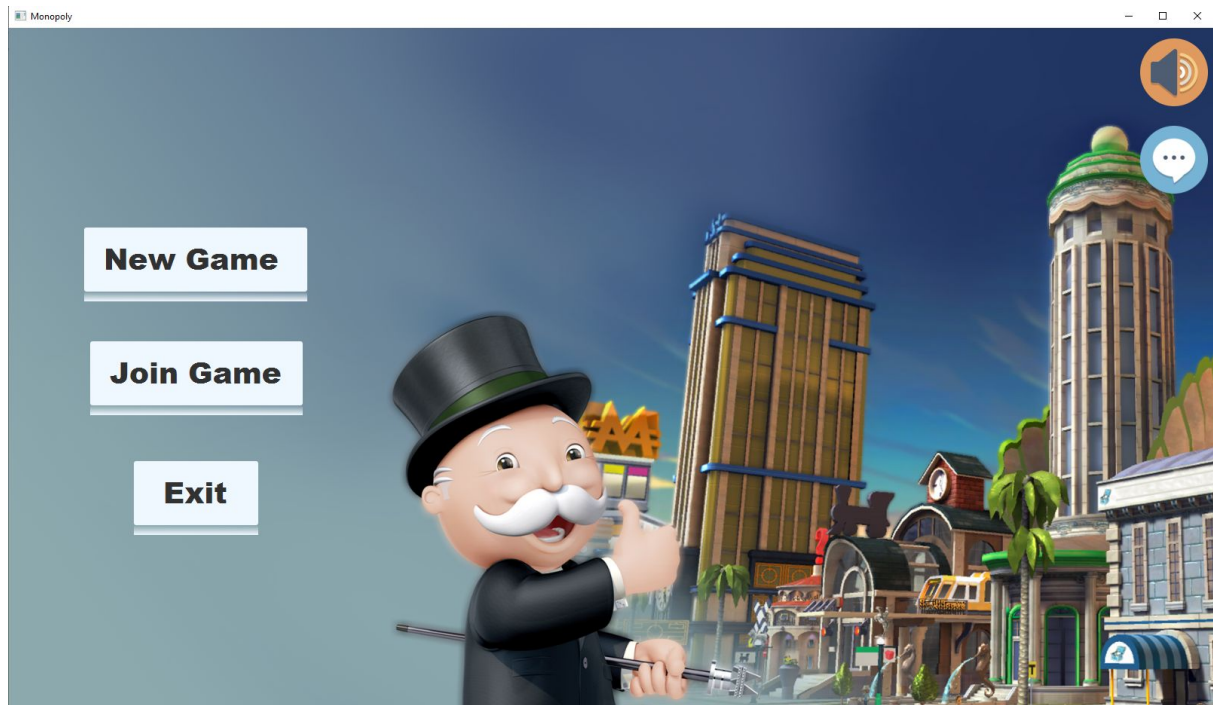

Figure 19: Main menu user interface

Figure 20: In game user interface

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