Bilkent University

Department of Computer Engineering

CS 319 - Object-Oriented Software Engineering

Project Analysis Report

Iteration 2

Settlers of Catan

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1. Introduction

The Settlers of Catan is a board game structured by Klaus Teuber and first distributed in 1995 in Germany by Franckh-Kosmos Verlag (Kosmos) as Die Siedler von Catan [1]. Each player has the role of settlers like as rulers and attempt to construct properties while doing exchange and getting resources. As each players properties grow, they gain points. The one who first to reach 10 points wins.

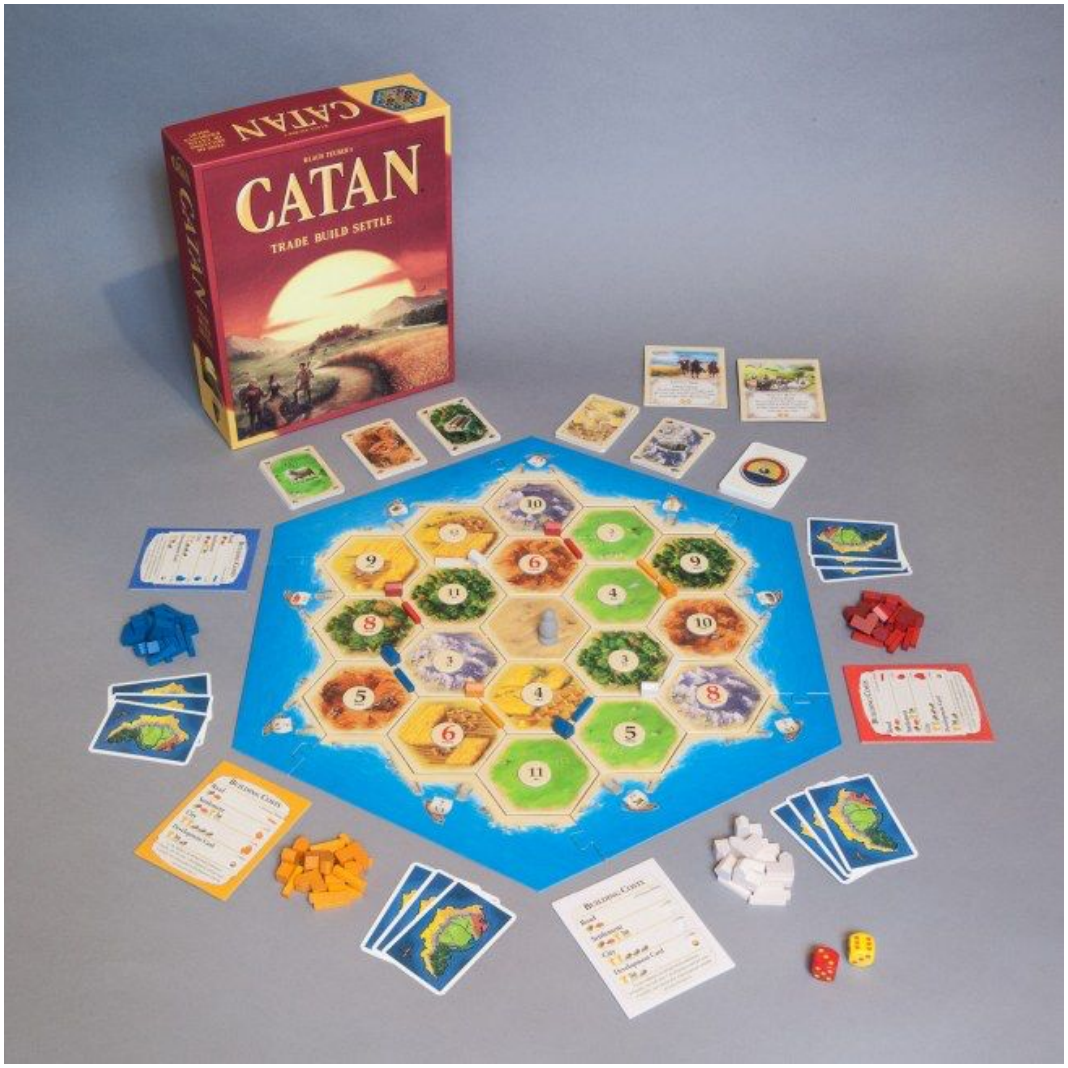

Fig. 1: Picture from game [2]

Terrain hexes and Tokens are randomly placed to make each game fairly interesting from the following. There will be no token in Desert hex, rather grey robber must be set to it. Each player gathers their colored settlements, cities, roads pieces. There are five different resource cards each with their own desk of cars and development cards which give advantages to players.

Every player starts the game with two settlements and two roads. Settlements can be put on hex corners if the three surrounding corners are unfilled. Roads can be put on hex edges. Roads and settlements should consistently be connected. Each kind of territory provides different resources. Hill terrain produces bricks, field terrain produces grain, pasture terrain

produces wool, wood produces lumber and mountain terrain makes ore. Every player takes the suitable resources by looking at their surrounding hexes. Every player begins their turn by rolling two dice. B In the event that players need resources, they can trade their resources by another player. If no one wants to trait, players can exchange four of similar resources by desired one. There is a building costs card that tells players what resources players need. Player can build roads, settlements or upgrade your settlements to cities which gather twice as many resources. Players can buy development cards for random advantages. Players can win the game by earning ten victory points. Each settlement is worth one victory points, each city is worth two. The player who has the longest road earns two victory points if it has length more or equal to five. Also player who has the biggest army earns two victory points where army size is calculated by the number of knight cards that can be obtainable through purchasing development cards. If players roll a seven or use a knight card, robber can move to another hex than player can choose anyone with a settlement bordering that hex and steal one resource card from there and also hex will not produce any resources until the robber is moved again.

2. Overview

2.1 Game Grid

Game grid consists of a lot of hexagons. Its general shape is a hexagon and it contains hexagon shaped territories. Those territories are called lands. Each land has paths on their edges and every three paths merge in intersections.

2.1.1 Lands

Every territory in the grid is a land and there are six different types of land. Each type has its own resource. At the start of the game each land is placed to the board randomly. There are also a number set which represents the numbers that can be rolled with two dice. Those numbers are placed to these lands randomly.

Each turn, players roll two dice. If a player in the game has settlements next to the land that contains the rolled number, then this player gets the resource of the land.

The type of the lands:

- Fields
- Hills
- Mountains
- Forest
- Pasture
- Desert (Not have resources, will be discussed in robber section(2.7))

2.1.2 Paths

Edges between the lands are called paths. They are the connections between the lands. Roads can be placed to these areas.

2.1.3 Intersections

Every three lands intersect at one point. Settlements and cities can be built in intersections.

2.2 Buildings

During the game, players can buy several different buildings using resources. Those can be settlements, cities and roads.

2.2.1 Settlements

Settlements are worth 1 victory point. Point system is detailed in Winning Conditions subsection. At the start of the game each player gets 2 settlements, and they get to place them according to Distance Rule. This rule specifies that a new settlement can be built to an open intersection only if none of the 3 adjacent intersections contains a settlement or a city.

Players get 1 resource card if they have a settlement on one of the intersections next to rolled number.

2.2.2 Cities

Cities are upgraded version of settlements. Two of the differences are, they are worth 2 victory points and they provide players with 2 resource cards instead of 1. They also can not be build in open intersections, they should built on top of a settlement.

2.2.3 Roads

Roads are the connections between settlements and cities. After the beginning turns, settlements can only be built if there are roads that is adjacent to them. Which means that all

settlements built after the second turn should be connected to a road. Additionally; if a player has the longest consecutive road path, he gets 2 victory points.

2.3 Trade

2.3.1 Trading with Other Players

Players can trade resources with other players in their turn. They can arrange any combination of cards in order to get their deal done. Offers are made during the turn of offer sender. Receiver player can answer the offer in his turn.

2.3.2 Trading with Bank

Players can trade with bank. In their turn, they can exchange four of the same resource cards with one desired resource. This trade can be done in any stage of the game and it doesn't require a specific land or harbor.

There are harbors in the outer space of the board. The game has two different harbor types. First of them is generic harbor. If players have settlements next to these harbors, they can exchange three of the same resources with one other resource. Other type is special harbor. These harbors are specified to sell only one resource and there is only one special harbor for each resource. Players can exchange two of the same resource cards with the resource that stated in the harbor.

2.4 Resource Cards

Game of Catan revolves around obtaining resources and using them on buildings and development cards. There are five resources in the game. They are grain (from fields), brick (from hills), ore (from mountains), lumber (from forest) and wool (from pasture). Players receive these cards if they have settlements next to relevant lands. Then these resource cards can be used to build buildings and to buy development cards.

2.5 Development Cards

There are three different types of development cards. These are Knights, Progress Cards and Victory Points. Players can buy these cards in their own turn. They draw the top card of the pile. Players are supposed to hide their cards and play them in appropriate positions.

2.5.1 Knight Cards

When a player plays this card, this player has the ability to move the robber. Then he can steal a resource card from a player who has a settlement or a city in robber's new land. If there are two or more players there, player may choose the victim.

2.5.2 Progress Cards

There are three types of progress cards

- Road Building: When this card is played, relevant player may immediately place two roads on the board.
- Year of Plenty: When this card is played, relevant player can take any two resource cards from the bank.
- Monopoly: When this card is played, relevant player picks a resource. Then every other player must hand all of their cards of chosen resource to the player.

2.5.3 Victory Point Cards

These cards represent cultural achievements and they grant 1 victory point to players. They can be played at the end of the game.

2.6 Extra Rewards

2.6.1 Largest Army

If a player plays three Knight Cards, he receives Largest Army Card which is worth 2 Victory Points. After this, if any other player plays more Knight Cards than him, Largest Army Card changes hands and new player gets the Victory Points

2.6.2 Longest Road

If a player has built five consecutive roads, he receives Longest Road Card which is worth 2 Victory Points. Similar to Largest Army, if any other player builds a longer road path, Longest Road Card changes hands and new player gets the Victory Points.

2.7 Robber

At the start he stands on desert. During the game if the number 7 is rolled, the player moves the robber to any land. Robber stands on the number and resources can not be collected from this land until the robber is moved again. If any of the players has more than 7 cards in their hands, they return half of their hands to the bank.

2.8 Turns

At the start of the turn, players will roll the dice. The players who own settlements or cities next to the rolled number will collect the resource of the land. After this, the player may offer trades to other players and to the bank. He also answers offers if he has any from other people. He can play development cards before buying new ones which means newly bought development cards can not be played in the same turn. Then the player may buy development

cards or build buildings with his resources. At the end of the turn, player checks his Victory Points.

2.9 Winning Conditions

Goal of this game is to collect Victory Points. Every settlement is equal to 1, and every city is equal to 2 Victory Points. Other than them having the largest army and longest road both gives players 2 Victory Points. Some development cards also give player 1 Victory Point. When one of the players reach 10 Victory Points, the game ends and he wins.

2.10 Game Settings

Players will be able to modify sound and music settings.

2.11 Additional Terms

In the second iteration, we introduce new specific of the game to vary from the other Settlers of Catan game variations.

2.11.1 Capital

Capitals are upgraded versions of the cities. Each player has only one privilege to build a capital. Capitals gain the resources as there is a city and settlement there. (Settlement(1) + City(2) = Capital(3)) This capital will increase the happiness of the player, which will provide players to not lost their cards. The keyword happiness will be described in more detail at 2.11.3.

2.11.2 Fishing

To increase the usage of scaffolding of the game grid, fishing keyword will be introduced to the game. Players who have any kind of settlement at the outside grid will have a chance to catch a fish at that turn which increases their happiness points. The keyword happiness will be described in more detail at 2.11.3.

2.11.3 Happiness

This new keyword “Happiness” will introduce a new mechanic for the game. Each player tries to stable their happiness point to not lose any card, which might be crucial. Players will lose happiness points when they have non-connected settlements to their capital. For each turn that their happiness is negative, the number of cards equal to their magnitude of happiness will be discarded.

3. Functional Requirements

3.1 Play Game

Player can create a game for four people and play the game of Catan. The player will play the game multiplayer but the game is offline hence they need to share the same play environment. The players are able to play individually and see their development, game panel and their resources and cards.

3.2 How to Play

Players can access to the information screen to understand the game and rules.

3.3 Settings

Players can access settings to open or close the game music.

3.4 Additional Functions

In the second iteration of the project, we are aiming to make some systemic changes that provides better usage for the application and create a diversity in the game that stands out the other variations of the Settlers of Catan.

3.4.1 Online Multiplayer Mode

Players can play the multiplayer game mode in online in online multiplayer mode. Player will only access their screen and game status and connect the other user through game play. Also players can use chat section to communicate with other players.

3.4.2 Offline Single Player Mode

Players can play the single player game against the computer. Although, there will be only one option about the game level.

4. Non-functional Requirements

In this section, we discuss the non-functional requirements of our project.

4.1 Usability

Catan has a complicated game board. Thus, players should be able to locate numbers and land types easily. All land types will be distinguishable from each other because we will use identifiable images for different lands. Numbers on the lands are going to be clearly visible.

Other than the visibility of game grid, general user interface is going to be simple. Trade/offer menu will be in one section of the screen, development card operations in another, scoreboard in another, number of resources in another and general info of the game and current player. Every section will have their own simplicities. Buying development cards will be done with only one click. For the usage of them, players will select one of the options from drop down list. After the players clicks to play button, the game itself will play the card if players has that card without needing additional process. Same is valid for trading mechanics. Player will only need to select resources and players in the case of offer. Listing, accepting and declining offers will also have a simple one click system. For trading, the game algorithms always calculate the best case in order to prevent players from doing wasteful trades.

Our game will have a soundtrack and players will be able to turn it on and off because they may like of dislike to play with music on.

4.2 Reliability

There are two ways the game can be played. First is that all players play the game in one computer. In this game style, players will need to look away from the computer if it is not their turn. Therefore there will be secrecy issues which makes the game less reliable as players can create strategies with the information they got. But this does not mean that there could be cheating. As our game will have a simple interface and as its algorithms will calculate everything, there will be no cheating. The algorithms will always check if wanted operation is valid or not.

In other game style, players play in different computers with connection. Therefore the game information will be needed to be stored in a server. This way, if any of the players disconnects the game info will not be lost. Also as the game algorithms are the same, there will be no cheating.

Our game does not store any personal information but a nickname. As any nickname can be given before starting the game and there is no need to give other information about players. Therefore, there will not be any security problems.

4.3 Performance

Our game will have sound which may decelerate the performance. If it is too much, players have the option to turn off the music. Our game also has high quality images in game grid. As the grid refreshes itself, some problems in performance may occur but there will not be other graphics on transitions and operations. Which means that operations done shouldn't affect the performance too much.

In multiplayer game mode, game information will be stored in a server and players will be connected to that. Players will have to synchronize with the server. Therefore there may be synchronization time issues. If there are connection problems, performance will be affected.

4.4 Supportability

Our game will be played on 64 bit computers which can be Windows and MacOS. Only additional requirement is that the computer needs to have Java installed. In the future, our game can be adapted to new systems.

4.5 Maintainability and Extendibility

The bugs that occured can be fixed later on the development. The model has the potential to be improved. New features, additional functions and mechanics can be added to the game.

5. System Models

5.1 Use Case Model

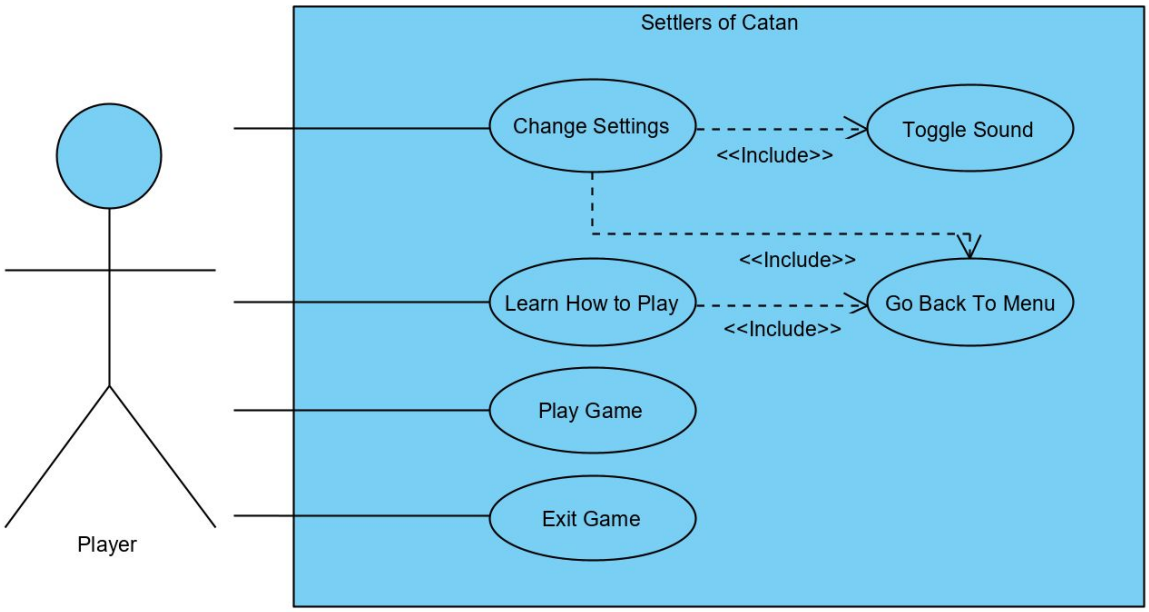

Fig. 2: Use Case Diagram

Use Case Descriptions

Use Case 1 - Play Game

Participating Actor: Player

Stakeholders & Interests:

- A player that wants to play the game.

Pre-Conditions:

- The player must be in the main menu.

Post-Conditions:

- A player has won the game.

Entry Conditions:

- The player selects “Play Game” from the main menu.

Exit Conditions:

- One of the players reach 10 points.
- The player closes the program.

Success Scenario Event Flow:

1. All players type their names and press the “Done” button.
2. Game starts.
3. Players play the game.
4. One of the players reach 10 points.
5. Game congratulates the player and ends.

Alternative Event Flow:

1. When in the number of players screen, user decides that he/she does not want to play the game.
2. User presses the “Go Back” button and returns to the main menu or simply closes the game.

Use Case 2 - Change Settings

Participating Actor: Player

Stakeholders & Interests:

- Player that wants to mute/unmute the sound.

Pre-Conditions:

- Player must be in the main menu.

Post-Conditions:

- Sound is toggled on or off.

Entry Conditions:

- Player selects “Settings” from the main menu.

Exit Conditions:

- Player selects the “Back” button from the screen or presses the escape button from keyboard to return to the main menu.

Success Scenario Event Flow:

1. Player selects “Settings” from the main menu.
2. Player presses the “Mute” button to toggle on or off the sound.
3. System mutes or unmutes all the sound.
4. Player selects the “Back” button from the screen or presses the escape button from keyboard to return to the main menu.

Alternative Event Flow:

1. When in the settings screen, player decides that he/she does not want to mute/unmute the sound.
2. Player selects the “Back” button from the screen or presses the escape button from keyboard to return to the main menu.

Use Case 3 - Learn How to Play

Participating Actor: Player

Stakeholders & Interests:

- A player that wants to learn how to play or remember some details about the game.

Pre-Conditions:

- Player must be in the main menu.

Post-Conditions:

- Player learned how to play the game/remembered the details.

Entry Conditions:

- Player selects “How to Play” from the main menu.

Exit Conditions:

- Player selects the “Back to Menu” button from the screen.

Success Scenario Event Flow:

1. Player selects “How to Play” from the main menu.
2. System displays the information about the game.
3. User reads the information.
4. User selects the “Back to Menu” button from the “How to Play” screen.

5.2 Dynamic Models

5.2.1 Sequence Model

Start the Game

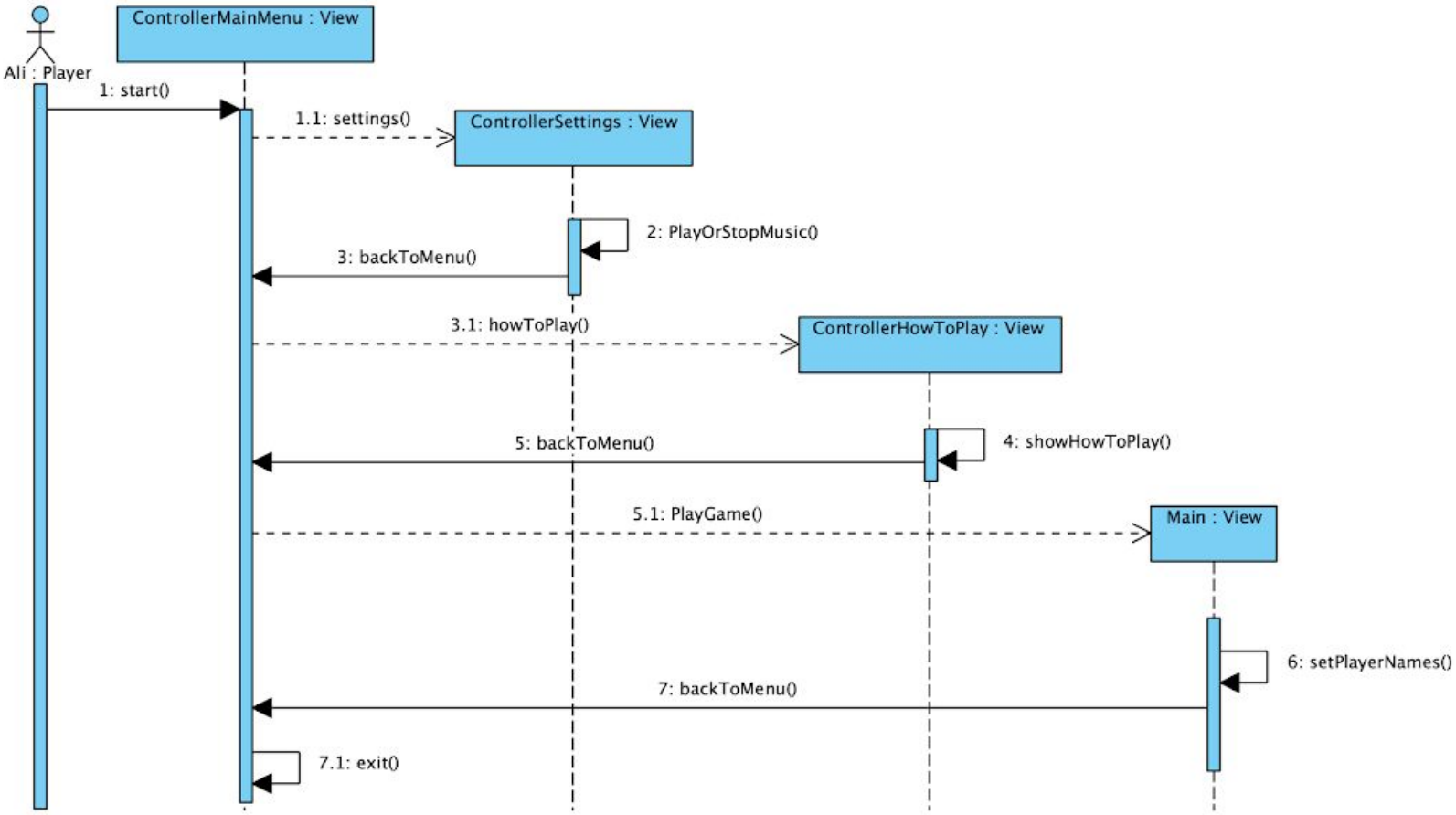

Fig. 3.1: Sequence Diagram for Starting the Game.

Play Game: Player has to enter opponents number in order to start the game. Then,CreateGame function direct player to game grid.

Settings: In setting option, player can configure the sound and music settings. setSound and setMusic functions will manage this functionality.

How to Play: showHowToPlay function hold the game instructions so that the user can learn how to play the game.

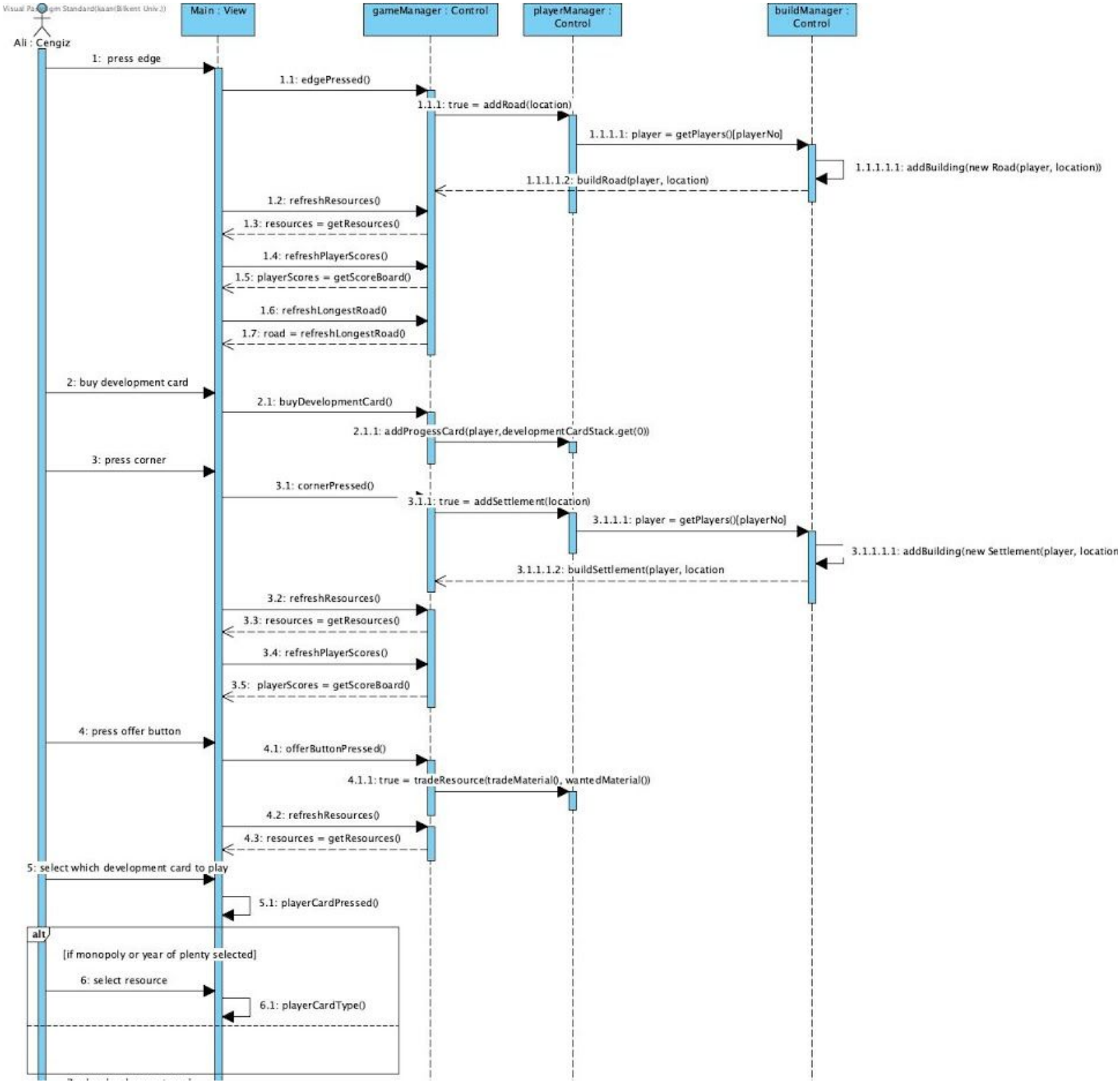

Fig. 3.2: Sequence Diagram for Playing the Game (Part 1) .

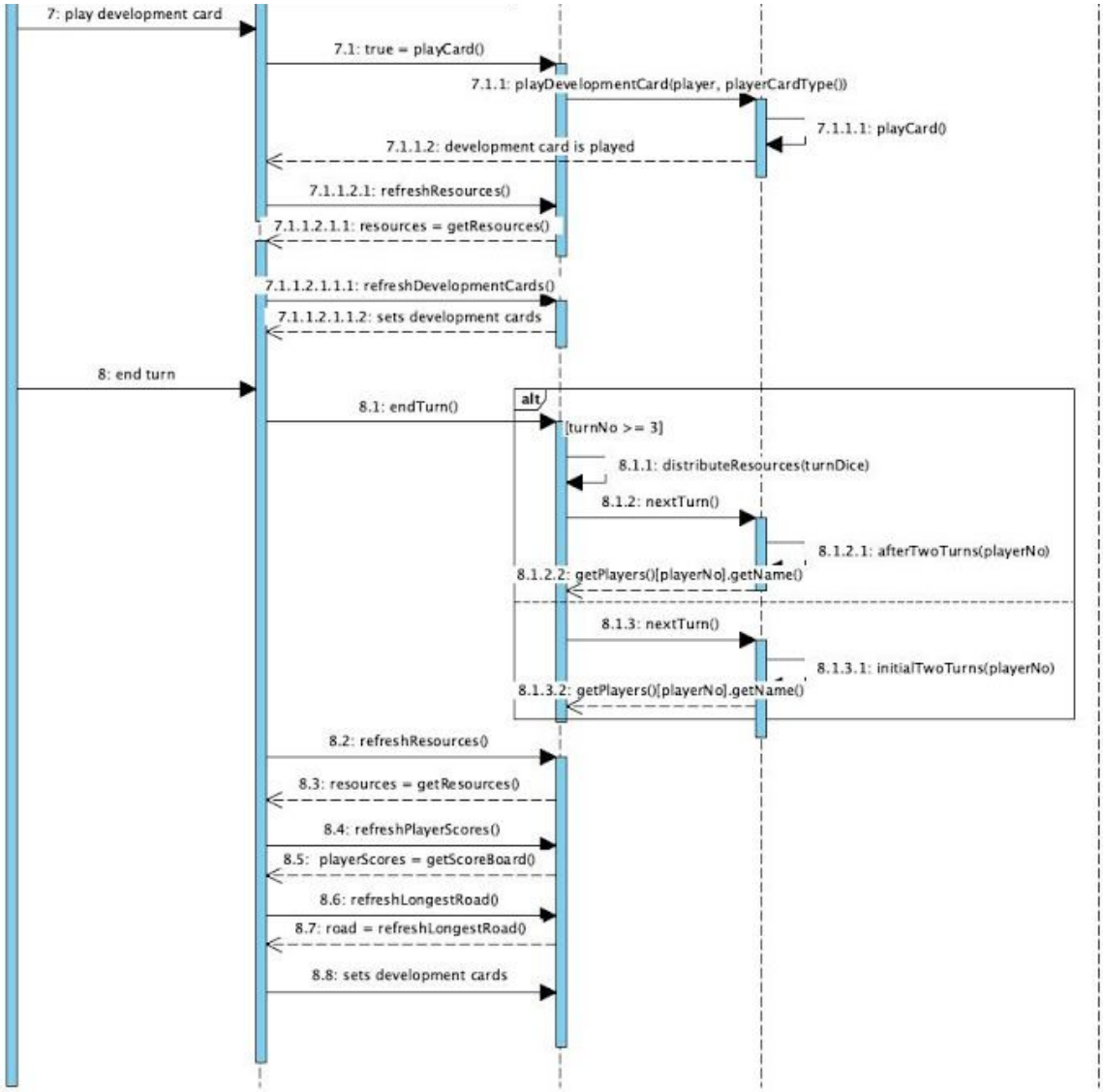

Fig. 3.3: Sequence Diagram for Playing the Game (Part 2).

When the player has the turn, he/she starts the turn with rolling the dice. Then, resources distribute to all players according to dice number. “distributeResources” function inside the game control class manage this functionality. Player manager above the diagram controls the victory points of the players, therefore, it can decide whether a player wins the game which means the game is over. Moreover, players can offer trade to other players. Offer manager manage these offers. Every player can see the offers that received to them. displayReletedOffers function holds this functionality. When user send an offer to other users, game control updates offer manager.

5.2.2 Activity Model

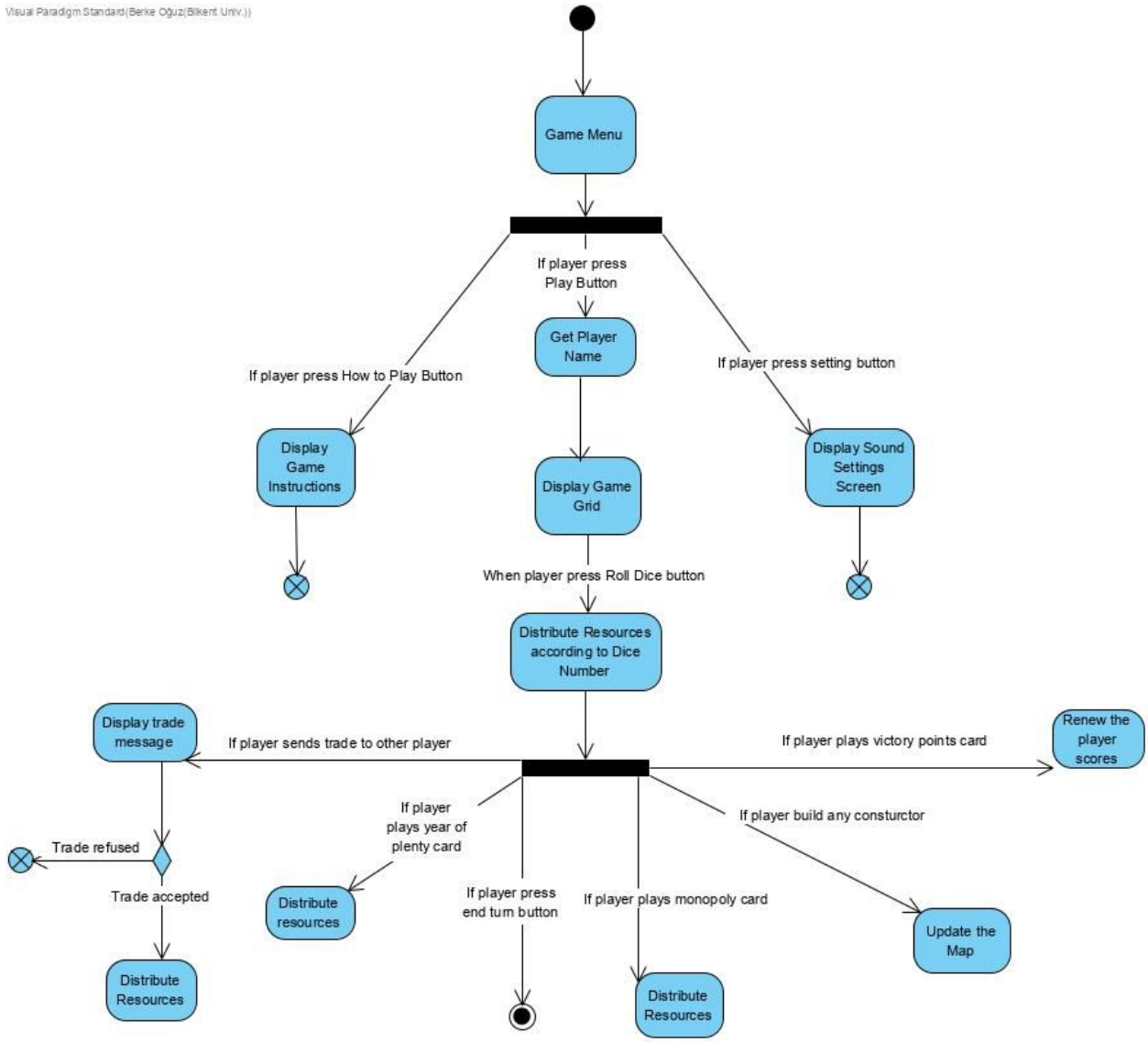

Fig. 4: Activity Diagram

The activity diagram above shows the system activities from the start of the menu and one turn of a player into the game.

If the user clicks the how to play button from the menu, system display a screen that shows the game instructors to the user.

If user wants to change the sound settings and press the settings button on the menu screen, the system displays sound settings screen.

If the player presses the play button, first system get the name of the players. Then, game starts and system displays the game grid to all players. If a player rolls a dice, system distribute the resources to all players according to dice number.

Then, the activities of the system continues simultaneously. A player can to many activities in his/her turn which makes the system activities simultaneously.

The activities of the system depends on the user activities in the game play. As an example, players can send trade messages to each other. If a player accepts the trade offer, system distributes the resources to that players according to deal of players, otherwise system does distribute resources, instead stops the process.

Moreover, players can play development cards in the turn. If monopoly and year of plenty cards plays by player, the duty of the system is distributing the resources to the players.

If player plays victory point card, system renews the score table of the player and adds 2 extra points to the player that plays that card.

If the player buy a building and construct it to the map, system has to update the map.

If player has nothing to do with his/her turn and press the end turn button, system stops the flow and the turn of a player ends.

5.3 Class Model

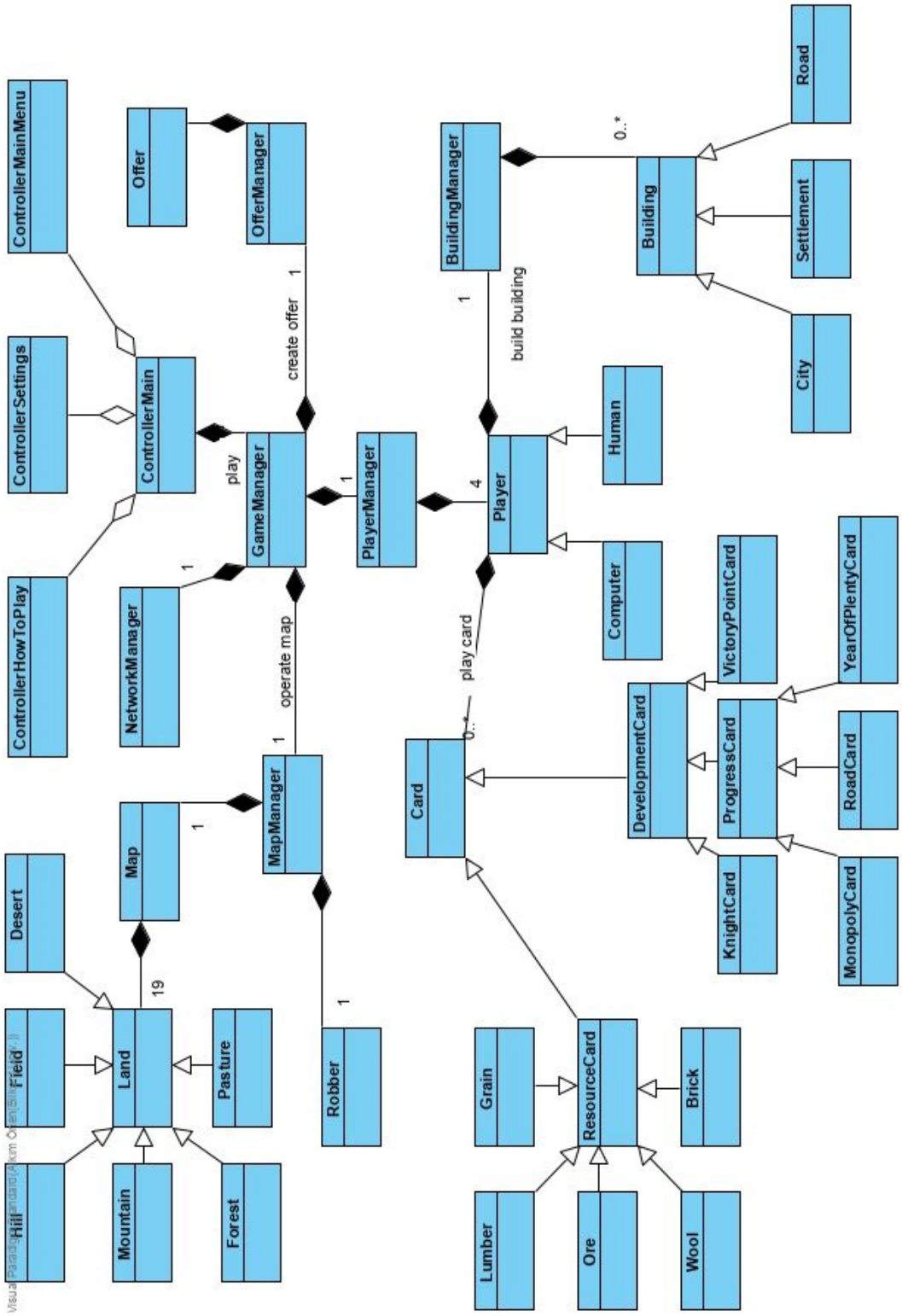

Fig. 5: Class Diagram

5.4 User Interface

5.4.1 Main Menu

Fig. 6: Main Menu Screen [3]

This is the “Main Menu” screen. Here, the player can either learn how to play the game, go into settings to toggle the sound on or off, or just simply play the game. If he/she decides not to play the game, he/she can quit the game by pressing the “Exit” button from the lower left part of the screen.

5.4.2 How to Play?

Fig. 7: How to Play Screen

In the “How to Play?” screen, the player can remember or learn how to play the game by reading the instructions. The player can return to the main menu by pressing the “Back to Menu” button from the lower right part of the screen.

5.4.3 Settings

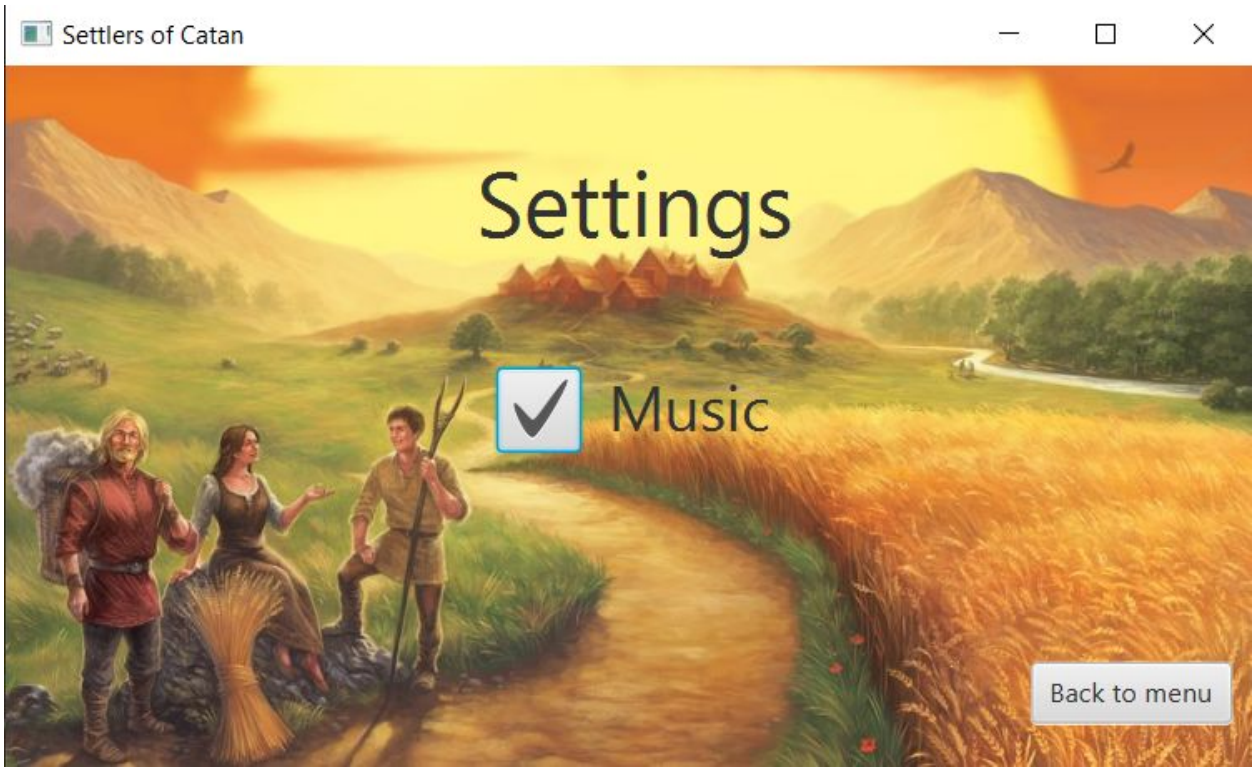

Fig. 8: Settings Screen

In the “Settings” screen, the player can toggle the sound on or off by using the checkbox. He/She can go back to the main menu using the “Back to Menu” button from the lower right part of the screen.

5.4.4 Player Names

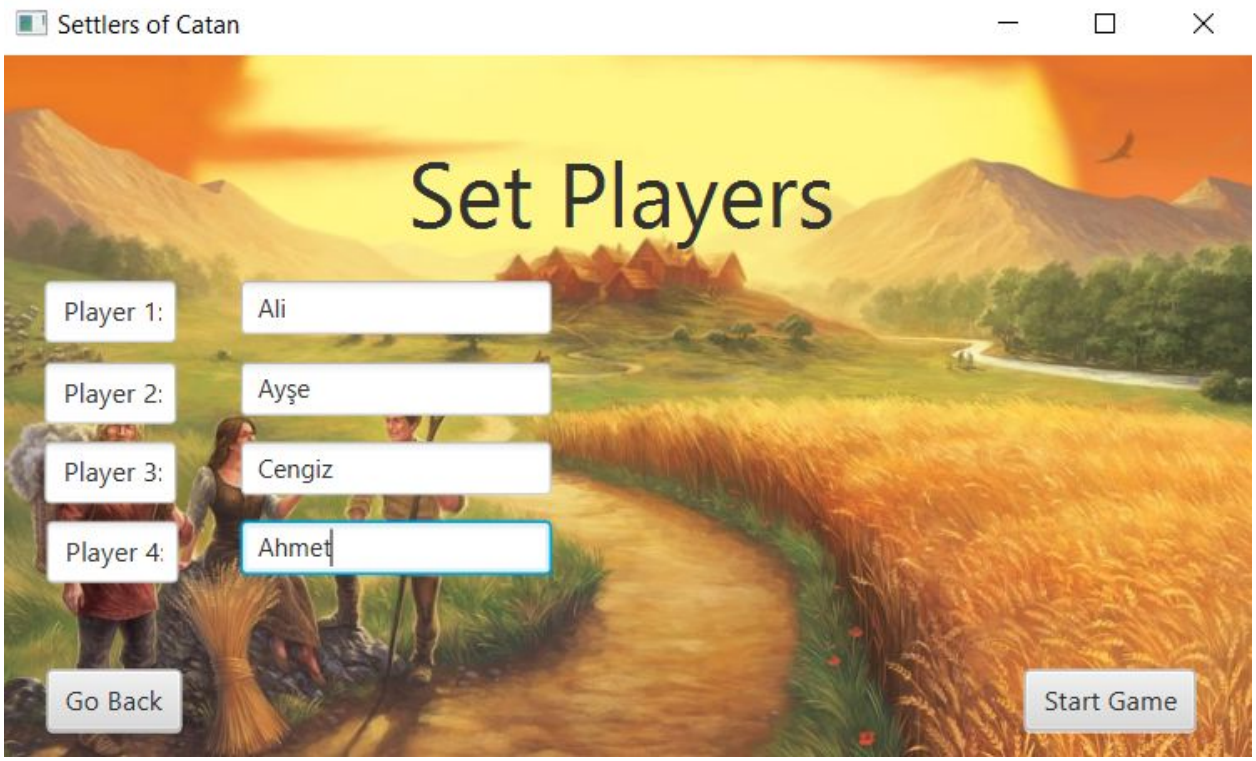

Fig. 9: Number of Players Screen

After pressing the “Play Game” button from the main menu, the player is led to the “Player Names” screen. Here, all the four players should type their names in their related spaces. If a name of a player is not specified, it is initialized as “Player X” where X denotes the number of the player (e.g. if Player 4 is left empty, Player 4 will be named so).

If there are not enough human players to play the game, the remaining players can be computer bots. This can be done by clicking the checkbox right next to the player name input bar. Since our mockup program trial is ended, we could not show it in the UI screen panel.

After choosing the players, bots and names, players can either start the game using “Start Game” button from the lower right part of the screen, or go back to the main menu using the “Go Back” button from the lower left part of the screen.

5.4.5 Game

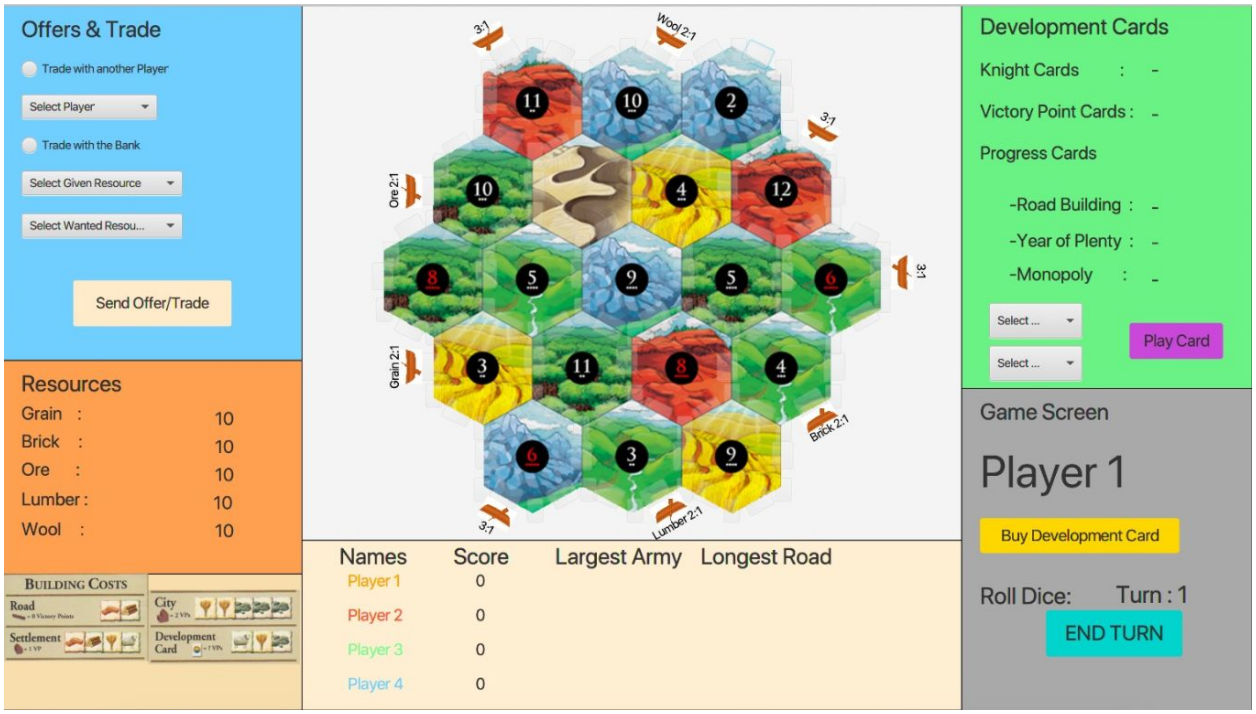

Fig. 11: Game Screen [4][5]

This is the “Game” screen where most of the game will take place in.

The upper left corner is the “Offers & Trade” tab where whoever’s turn it is, can trade with other players or trade with the bank choosing from a drop down list. The upper right corner is the “Development Cards” tab. This is where the user can see how many and which type of development cards he/she has and choose and play them.

Lower left corner is the “Resources” tab where the user can see how many resources of which type that he/she has. There is also the “Building Costs” tab where players can see which building costs how many resources of either type. Lower right corner is the “Player Screen” tab. This is where whose turn it is written and the rolled dice number is shown. The “End Turn” button is also here where the player presses in order to end his/her turn.

The center lower part is the “Leaderboards” tab where every player can see who has how many points and who has the largest army or longest road. The upper center part is the “Map” where every player is in an interaction with. They build settlements, cities and roads here. This is where the “game” is played!

6. References

[1] "Catan", https://en.wikipedia.org/wiki/Catan

[2] "Catan" https://www.catan.com/game/catan

[3] https://www.boardgamemechanics.com/blog/settlers-of-catan

[4] https://www.deviantart.com/avangion/art/Alternate-Catan-Hexes-318684622

[5] https://app.roll20.net/forum/post/1292382/settlers-of-catan