Bilkent University

Department of Computer Engineering

CS 319 - Object-Oriented Software Engineering

Project Analysis Report

Iteration 1

Settlers of Catan

Group 1D

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1. Introduction

The Settlers of Catan, which is shortened to 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.

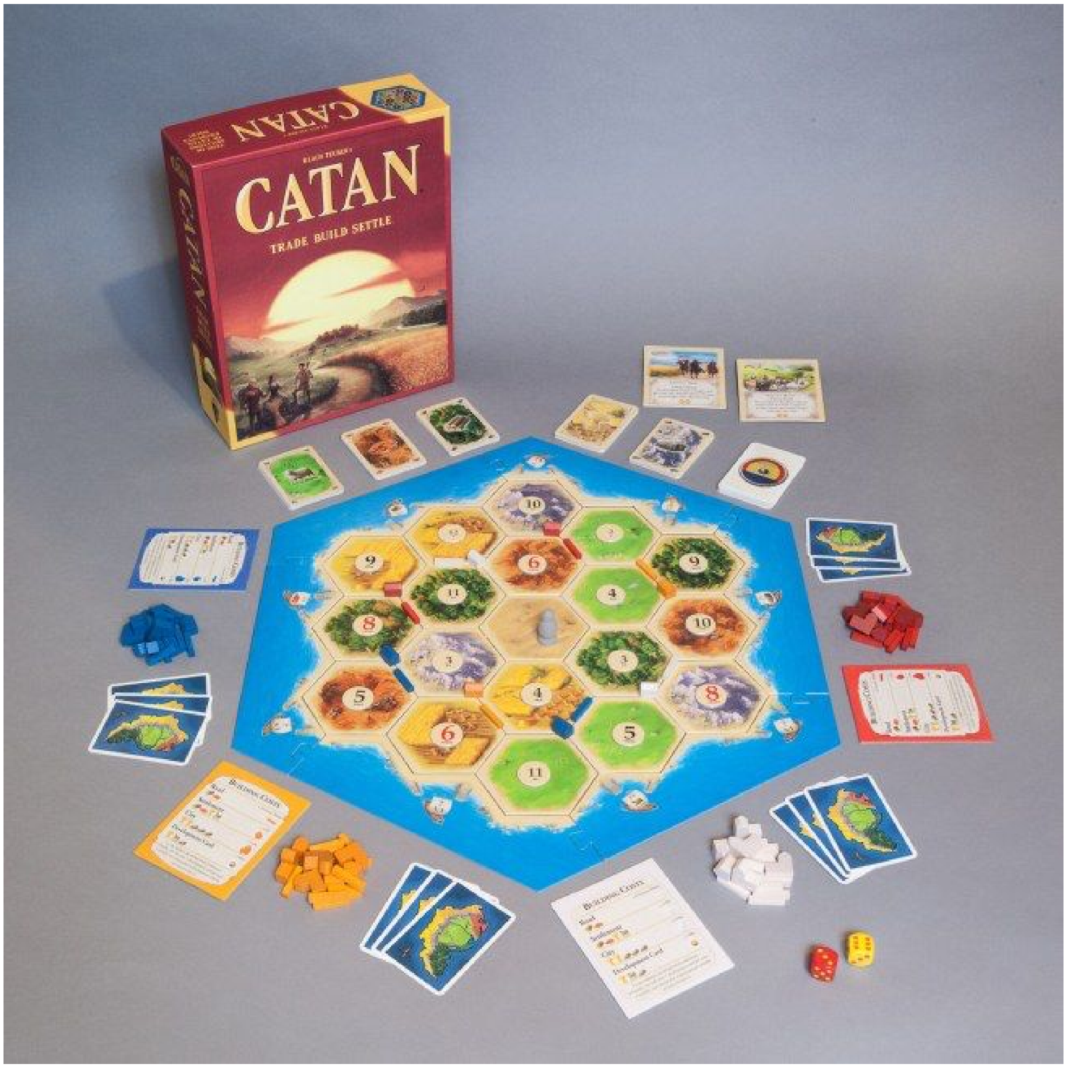


Fig. 1: Picture from game [2]

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 moving two dice. 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 new 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. If players roll a seven, 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 them. 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 the lands randomly.

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

Lands:

- Fields
- Hills
- Mountains
- Forest
- Pasture
- Desert

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 mostly operates in the same way 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 must be 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 next to them. Which means that all settlements built after the second turn should be connected. 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 other 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 of this 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.

3. Functional Requirements

Functional requirements will be discussed in this section.

3.1 Play Game

In the beginning of the game, there will be an initial page which is the menu. User can start game by clicking "Play Game" and they choose the number of opponents. The majority of the game capacities and screens that are important to play the game is included in "Play Game" section.

Our turn-based game has no time limit during each turn. Player can do trades, building settlements or roads, picking advancement cards, rolling dice etc. These actions can be done by mouse actions or keystrokes. Primary objective of the game is to reach 10 points with settlements, roads or other special cases like the longest roads.

3.2 How to Play

There is a "How to Play" option in the menu, which includes:

- Mouse and Keyboard Controls
- Game Rules

3.3 Settings

The player can access Settings Menu from the main menu with using the "Settings" button. Game settings can be changed by the user to make our game user-friendly. The settings are as follows:

- Music Volume
- Sound Volume
- Mute Music on/off
- Mute Sound on/off

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. We focus on simplifying the user interface so that there will not be any misunderstanding.

4.2 Reliability

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

Players can play our game only from one computer. As the rules say that every player should only see their own cards, players must look away if it is not their turn. This usually slows down the game, even though there is no need for any synchronization on network or simply between different computers.

4.4 Supportability

We designed our class model in a way that our game can be improved and bugs can be fixed later on the development.

4.5 Extendibility

We also designed our class model in a way that new features can be added after the first iteration.

5. System Models

5.1 Use Case Model

5.1.1 Use Case Diagram

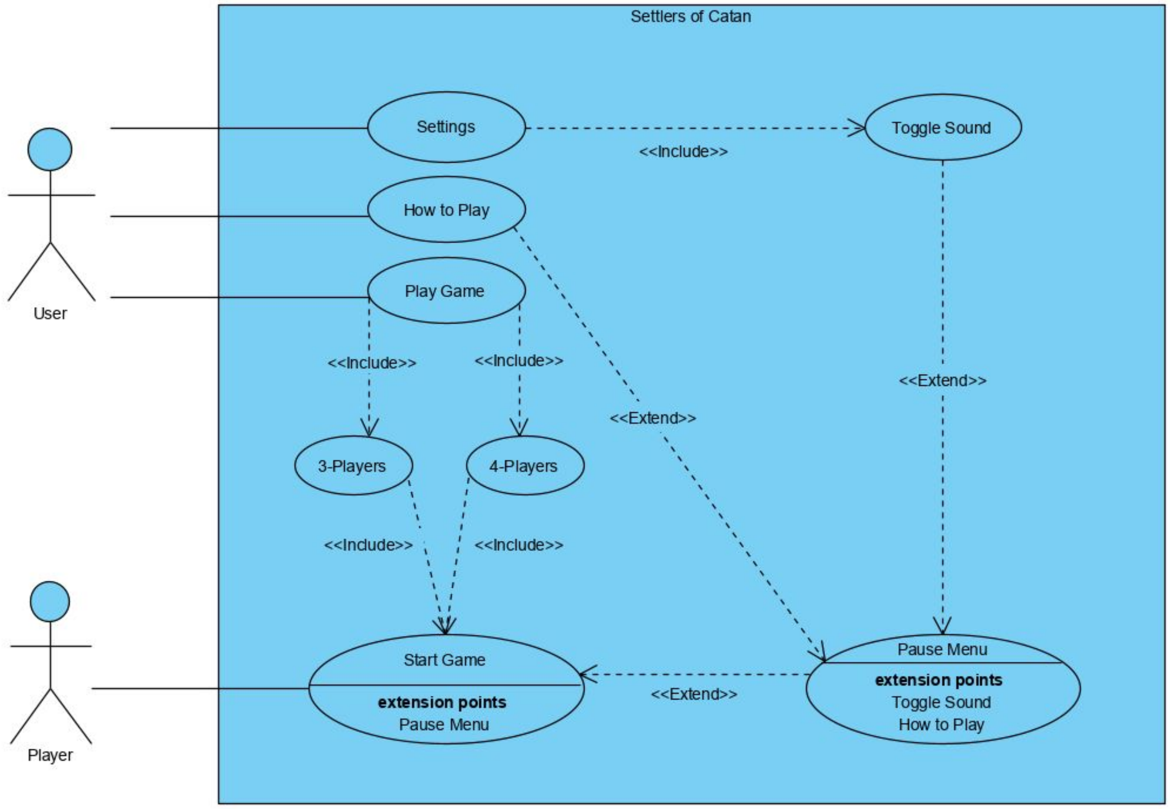


Fig. 2: Use Case Diagram

5.1.2 Use Case Descriptions

Use Case 1 - Play Game

Participating Actor: User

Stakeholders & Interests:

- User that wants to play the game.

Pre-Conditions:

- User must be in the main menu.

Post-Conditions:

- User selects whether there will be 3 or 4 players.

Entry Conditions:

- User selects “Play Game” from the main menu.

Exit Conditions:

- User selects “Quit Game” button from the pause menu or closes the program.

Success Scenario Event Flow:

1. User selects “Play Game” from the main menu.
2. System displays number of players screen.
3. User selects the number of players.
4. Game initializes.

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 escape button from keyboard to return to the main menu.

Use Case 2 - Start Game

Participating Actor: Player

Stakeholders & Interests:

- Players that want to start the game.

Pre-Conditions:

- There are at least 3, at most 4 players.

Post-Conditions:

- Each player has a name that is typed in the game.

Entry Conditions:

- Game is initialized from the “Play Game” button.
- User chose the number of players (3 or 4).

Exit Conditions:

- One of the players reach 10 points.
- User selects “Quit Game” button from the pause menu or closes the program.

Success Scenario Event Flow:

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

Alternative Event Flow:

1. Players decide that they do not want to play anymore.
2. Whoever’s turn it is, the player presses the “Quit” button or closes the program.

Use Case 3 - Settings

Participating Actor: User

Stakeholders & Interests:

- User that wants to mute/unmute the sound.

Pre-Conditions:

- User must be in the main menu.

Post-Conditions:

- Sound is toggled on or off.

Entry Conditions:

- User selects “Settings” from the main menu.

Exit Conditions:

- User 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. User selects “Settings” from the main menu.
2. User presses the “Mute” button to toggle on or off the sound.
3. System mutes or unmutes all the sound.
4. User 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, user decides that he/she does not want to mute/unmute the sound.
2. User selects the “Back” button from the screen or presses the escape button from keyboard to return to the main menu.

Use Case 4 - How to Play

Participating Actor: User/Player

Stakeholders & Interests:

- User that wants to learn how to play the game.
- Player that wants to remember some details about the game.

Pre-Conditions:

- User must be in the main menu.
- Player must be in the pause menu.

Post-Conditions:

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

Entry Conditions:

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

Exit Conditions:

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

Success Scenario Event Flows:

1. If user wants to learn the game
    A. User selects “How to Play” from the main menu.
    B. System displays the information about the game.
    C. User reads the information.
    D. User selects the “Back” button from the “How to Play” screen or presses the escape button from keyboard to return to the main menu.
2. If player wants to learn the game
    A. Player selects “How to Play” from the pause menu.
    B. System displays the information about the game.
    C. User reads the information.
    D. Player selects the “Back” button from the “Pause” screen or presses the escape button from keyboard and the game continues.

Use Case 5 - Pause Menu

Participating Actor: Player

Stakeholders & Interests:

- Players that want to pause the game.
- Players that want to mute/unmute the sound.
- Players that want to remember/learn how to play the game.

Pre-Conditions:

- The game is initialized.

Post-Conditions:

- The game is paused and unpaused.

Entry Conditions:

- Whoever’s turn it is, the player presses the escape button from the keyboard.

Exit Conditions:

- Player presses the “Back” button.
- Player presses the escape button from the keyboard.
- Player selects “Quit Game” button from the pause menu or closes the program.

Success Scenario Event Flows:

1. If the player wants to mute/unmute the sound.
   A. Player presses the escape button from the keyboard.
   B. The game pauses.
   C. System monitors the “Pause Menu” screen.
   D. Player mutes/unmutes the sound.
   E. Player presses “Back” button and the game continues.
2. If the player wants to remember/learn the game.
   A. Player presses the escape button from the keyboard.
   B. The game pauses.
   C. System monitors the “Pause Menu” screen.
   D. Player presses “How to Play” button.
   E. System monitors the “How to Play” screen.
   F. Player presses “Back” button to return to the “Pause Menu” screen.
   G. Player presses “Back” button again and the game continues.

Alternative Event Flow:

1. Player decides he/she does not want to play anymore and quits the game.

5.2 Dynamic Models

5.2.1 Sequence Model

Start the Game

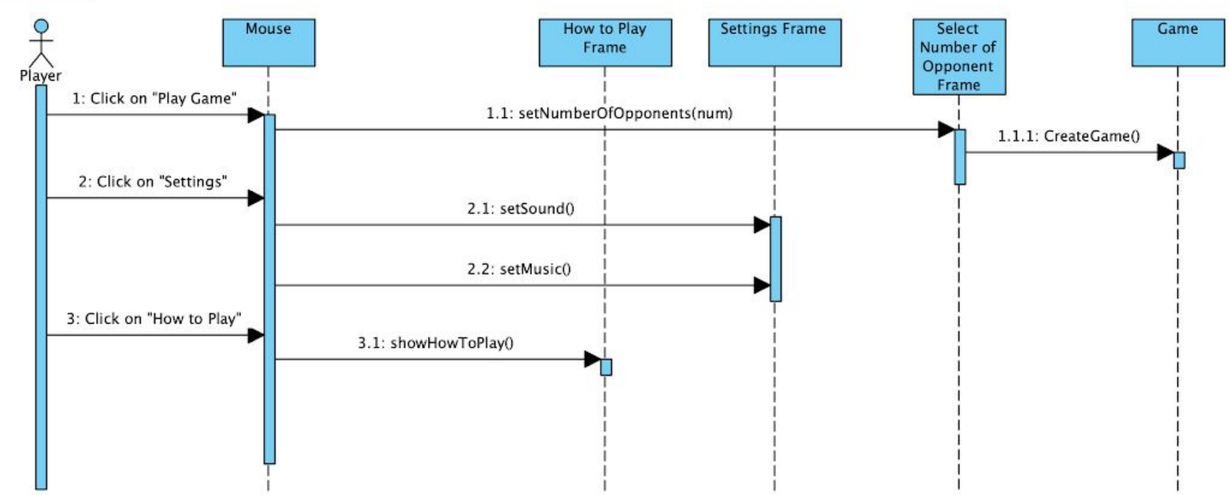
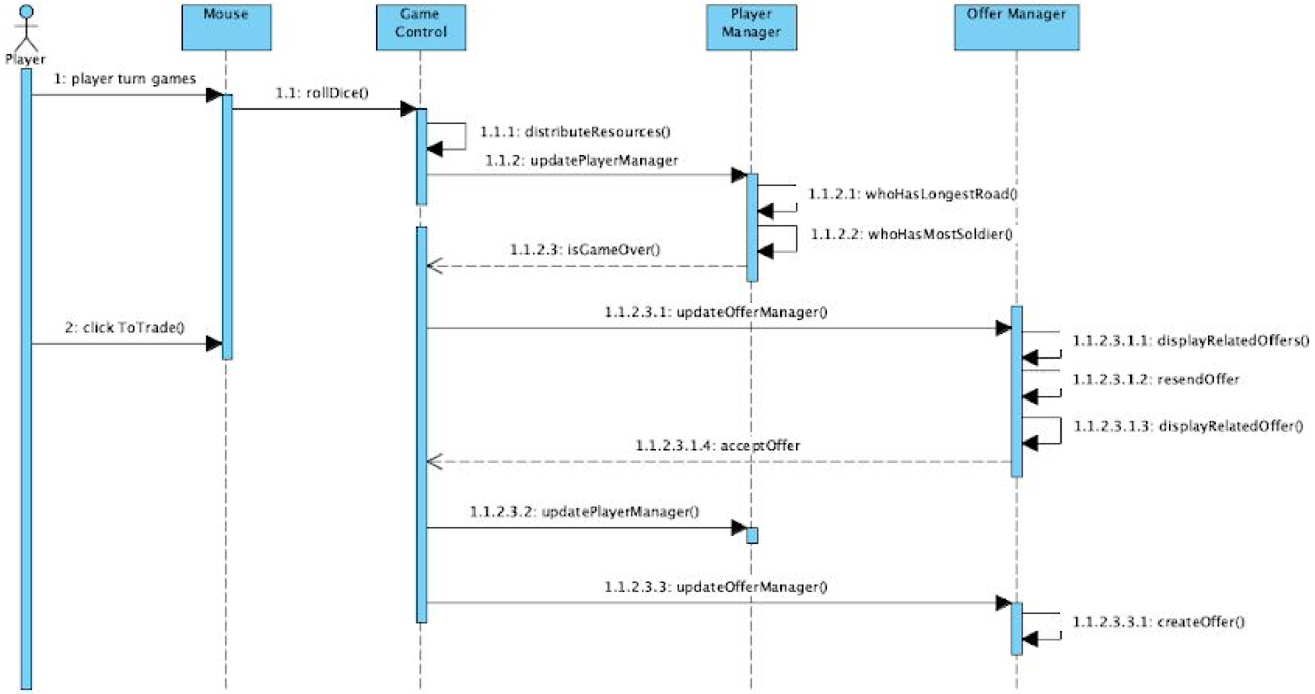


Fig. 3: Sequence Diagram for Play the Game.

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.

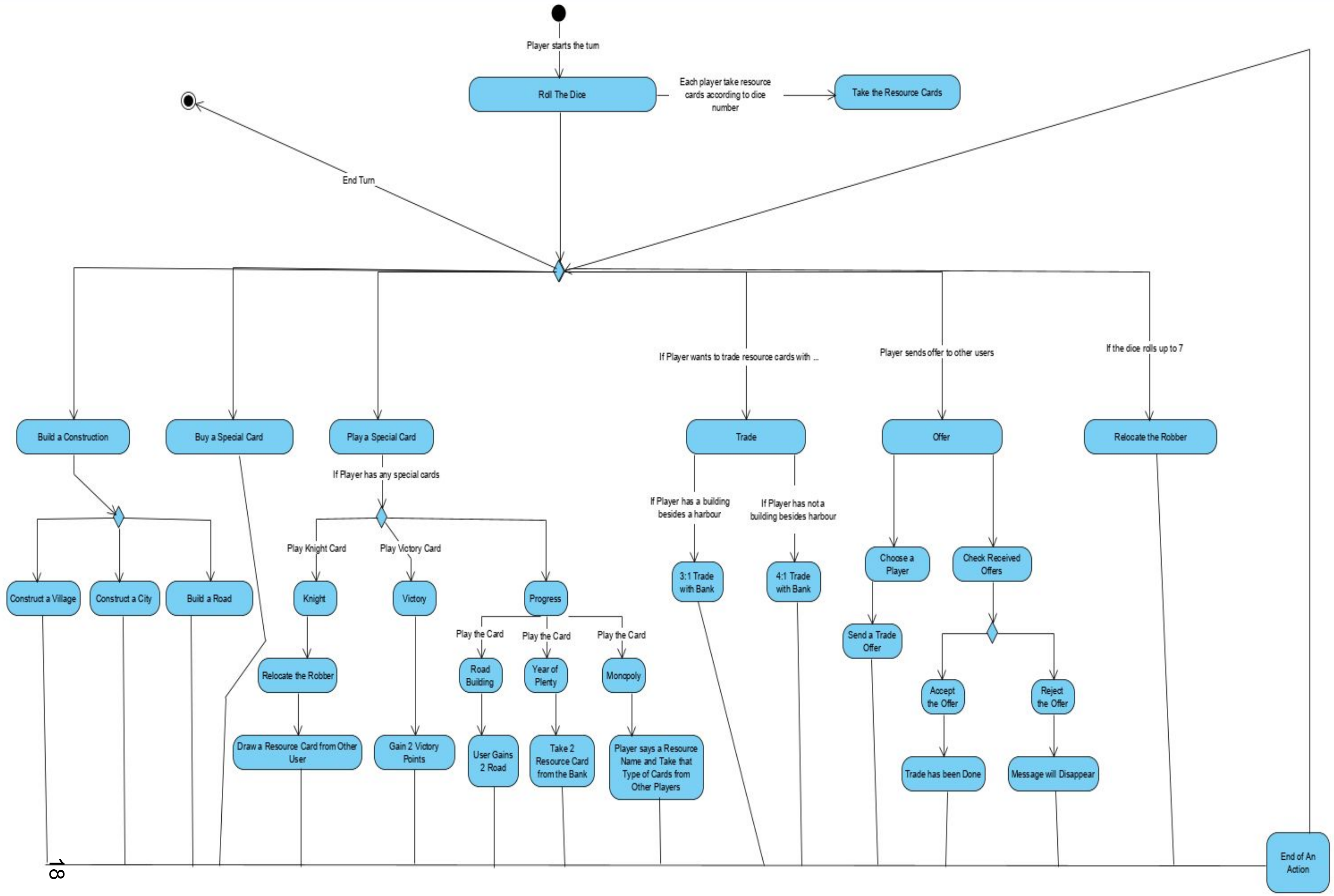
How to Play: showHowToPlay function hold the game instructions so that the user can learn how to play the game.


Player
Mouse
Game Control
Player Manager
Offer Manager
1: player turn games
1.1: rollDice()
1.1.1: distributeResources()
1.1.2: updatePlayerManager
1.1.2.1: whoHasLongestRoad()
1.1.2.2: whoHasMostSoldier()
1.1.2.3: isGameOver()
1.1.2.3.1: updateOfferManager()
2: click ToTrade()
1.1.2.3.1.1: displayRelatedOffers()
1.1.2.3.1.2: resendOffer
1.1.2.3.1.3: displayRelatedOffer()
1.1.2.3.1.4: acceptOffer
1.1.2.3.2: updatePlayerManager()
1.1.2.3.3: updateOfferManager()
1.1.2.3.3.1: createOffer()

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


Player starts the turn
Roll The Dice
Each player take resource cards according to dice number
Take the Resource Cards
End Turn
If Player wants to trade resource cards with ...
Player sends offer to other users
If the dice rolls up to 7
Build a Construction
Buy a Special Card
Play a Special Card
Trade
Offer
Relocate the Robber
If Player has any special cards
If Player has a building besides a harbour
If Player has not a building besides harbour
Play Knight Card
Play Victory Card
Construct a Village
Construct a City
Build a Road
Knight
Victory
Progress
3:1 Trade with Bank
4:1 Trade with Bank
Choose a Player
Check Received Offers
Play the Card
Play the Card
Play the Card
Send a Trade Offer
Relocate the Robber
Road Building
Year of Plenty
Monopoly
Accept the Offer
Reject the Offer
Draw a Resource Card from Other User
Gain 2 Victory Points
User Gains 2 Road
Take 2 Resource Card from the Bank
Player says a Resource Name and Take that Type of Cards from Other Players
Trade has been Done
Message will Disappear
End of An Action

The activity diagram above shows the actions of a player in one turn.

Explanation of the Activity Diagram:

After a player rolls the dice, appropriate resource cards are dealt to other players according to dice number. Then, player can do six of the actions as its shown in the diagram or directly end his/her turn.

First Action: Player can build constructions like road, village or city. However, in order to build these constructions, the player has to have sufficient number of resource cards.

Second Action: Player can buy a special card in his/her turn. Similarly, He/She has to pay proper number of resource cards to take any special card from the bank.

Third Action: Player can play one of his/her special cards in his/her turn, if he/she has

got any special card. In the diagram above, the purpose of the cards are shown when player plays them.

Knight Card: If player plays the knight card, he/she can change the location of the robber, moreover, he/she randomly draws one resource card from the other player that he/she has a construction in that area.

Victory Card: Player gains 2 victory points after plays this card.

Road Building Card: If the player play this card, he/she can place 2 extra free roads to the game map.

Year of Plenty Card: If player plays this card, he/she can take 2 resource cards that he/she wants from the bank.

Monopoly Card: If player use this card, choose a type of resource card and take all of the resource cards with this type from the other players.

Fourth Action: Player can trade with the bank. Normally, the player has to give four of the same type of resource cards to the bank to take one that he/she intended. However, if the player has a village or a city beside the harbour, he can give three of his cards to take one.

Fifth Action: Player can make offer to other players in his/her turn to trade their resource cards. Moreover, he/she can check their message box to see to offer comes from other players. Player can reject or accept the offer.

Sixth Action: Relocate the robber option is a special case. When player rolls the dice up to seven, he/she can relocate the robber. He decides to place the robber in case other players besides the robber cannot take resource card from that area.

Lastly, player can end his/her turn directly or after the actions and other player takes the turn. User can do many actions in a turn if he satisfies the conditions to do the action. Therefore, the end of an action turns back to the decision step in the diagram.

5.3 Class Model

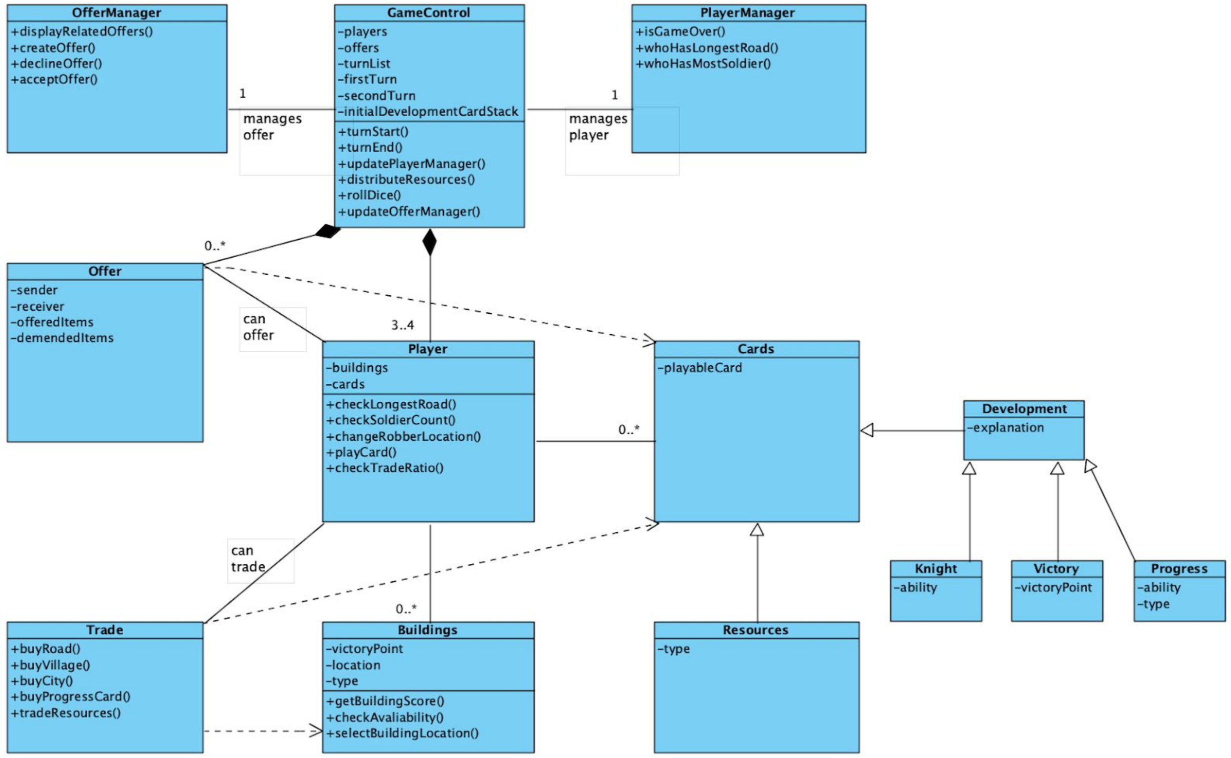


Fig. 5: Class Diagram

GameControl is the main class where all game is monitored and PlayerManager and OfferManager are the helper classes where manages the tasks for each player. Game consist of 3-4 players and multiple offers where when the game was finished, all the instances will be executed so composition relation is used. Also players have cards where they can offer or trade. Also GameControl have the control of the players and cards where an instance of a player can also affect the other players. For example, when a player plays a progress cards where all the selected resource card will be given to that player, all other players affected in that situation regard of that this is not occurred in their turn. Type attribute is determine the type of building or resource like the building is road or city, etc.

5.4 User Interface Mockup

5.4.1 Main Menu

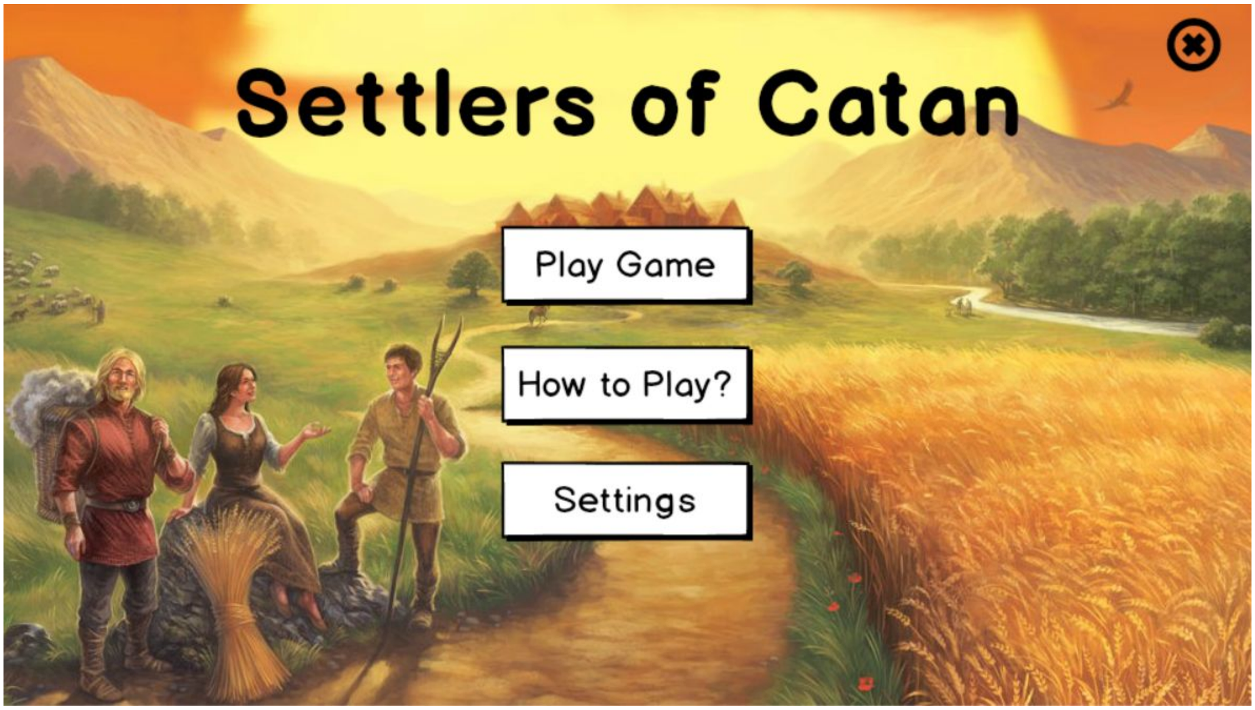


Fig. 6: Main Menu Screen [3]

This is the “Main Menu” screen. Here, the user 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 from the upper right button.

5.4.2 How to Play?

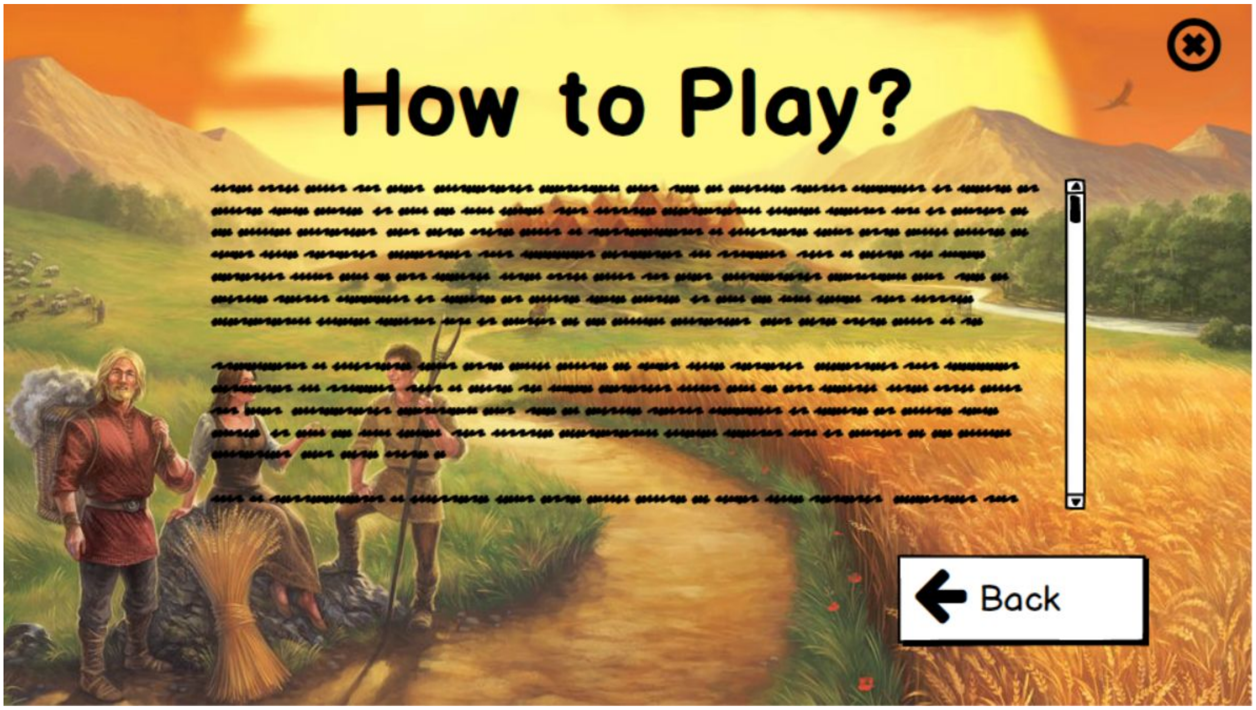


Fig. 7: How to Play Screen

In the “How to Play?” screen, user or player can remember or learn how to play the game by reading the instructions. The user can return to the main menu while the player can return to the pause screen by pressing the back button.

5.4.3 Settings

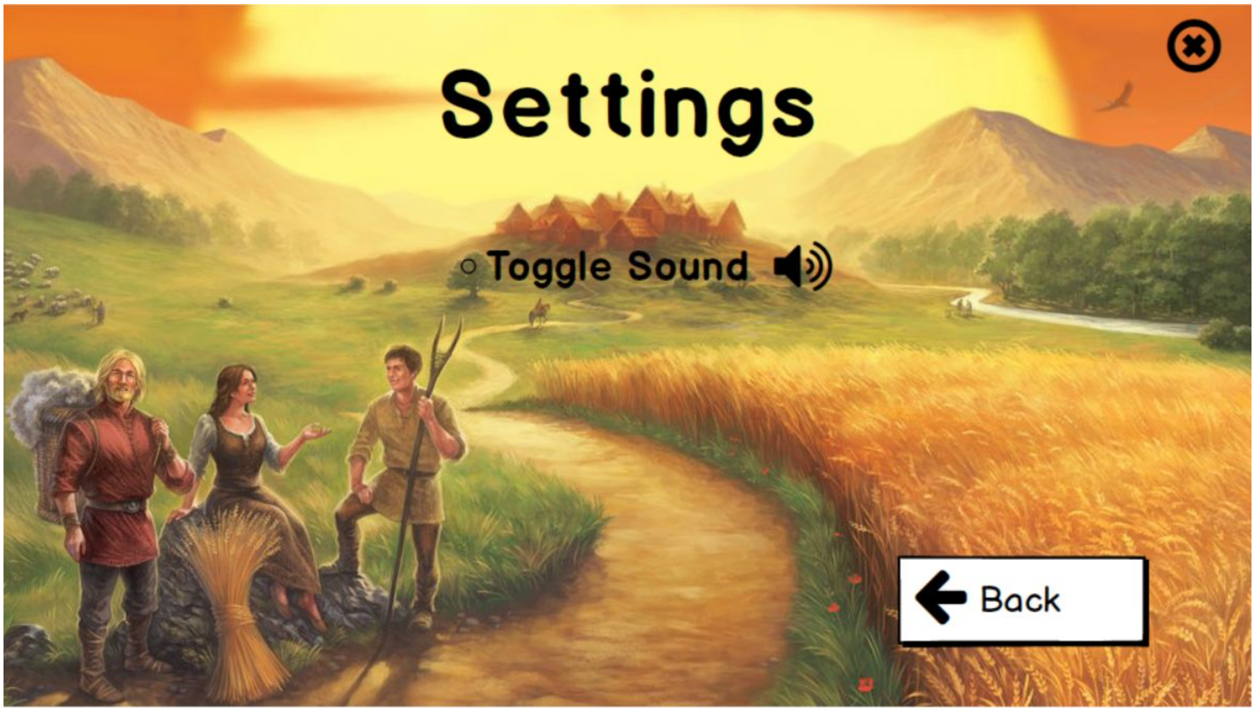


Fig. 8: Settings Screen

In the “Settings” screen, user can toggle the sound on or off by using the radio button. He/She can go back to the main menu using the back button.

5.4.4 Number of Players

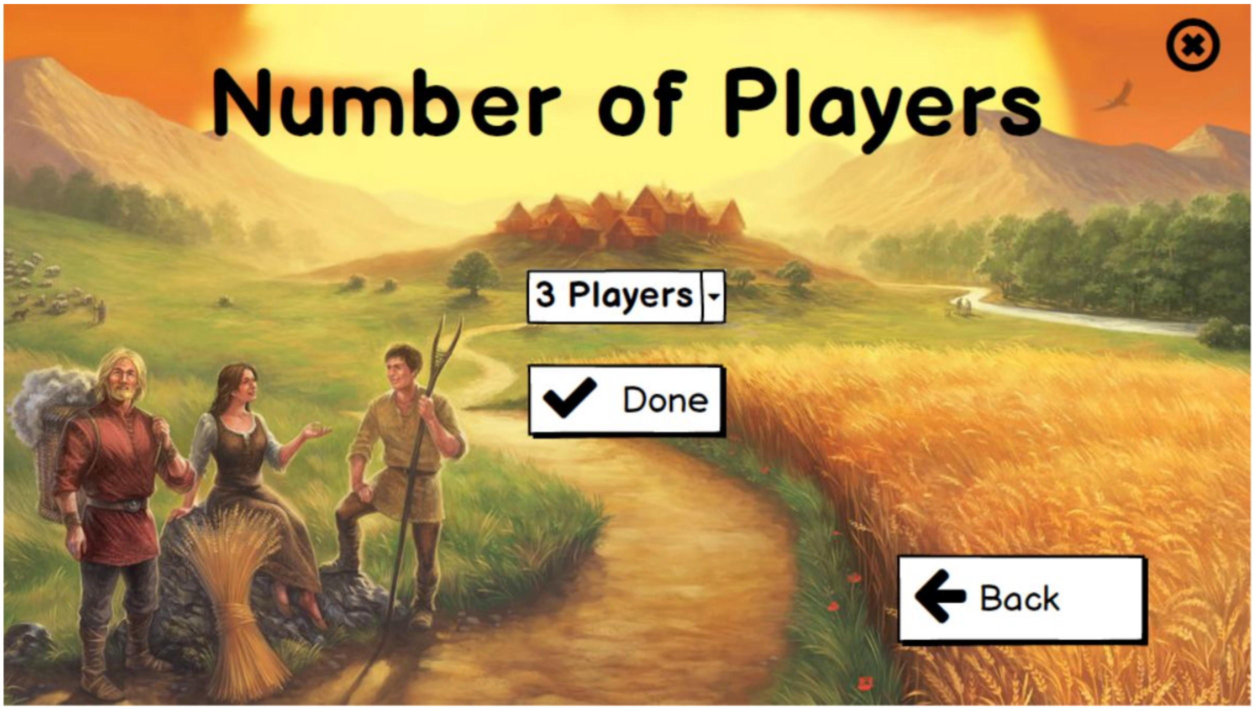


Fig. 9: Number of Players Screen

After pressing the “Play Game” button from the main menu, user is led to the “Number of Players” screen. He/She can choose how many people will be playing the game. In Catan, the number of players must be 3 or 4. After choosing the number of players, the user must press the “Done” button in order to progress into the name typing screen.

5.4.5 Name Type

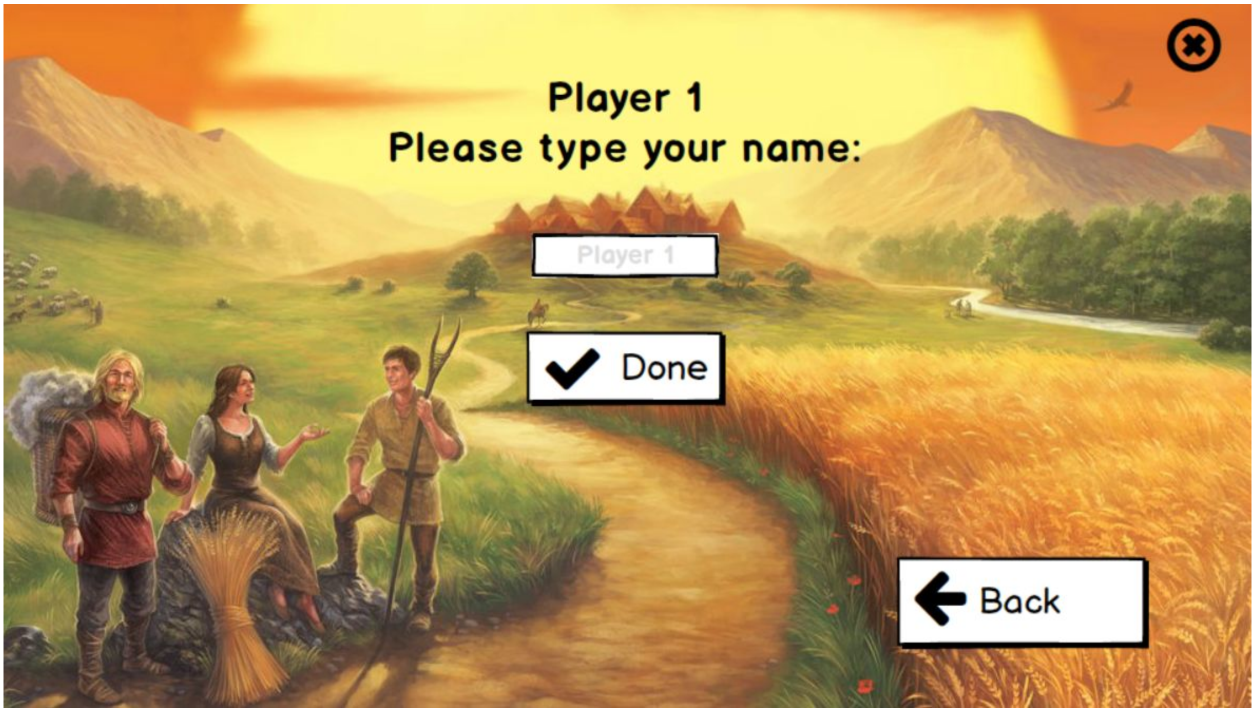
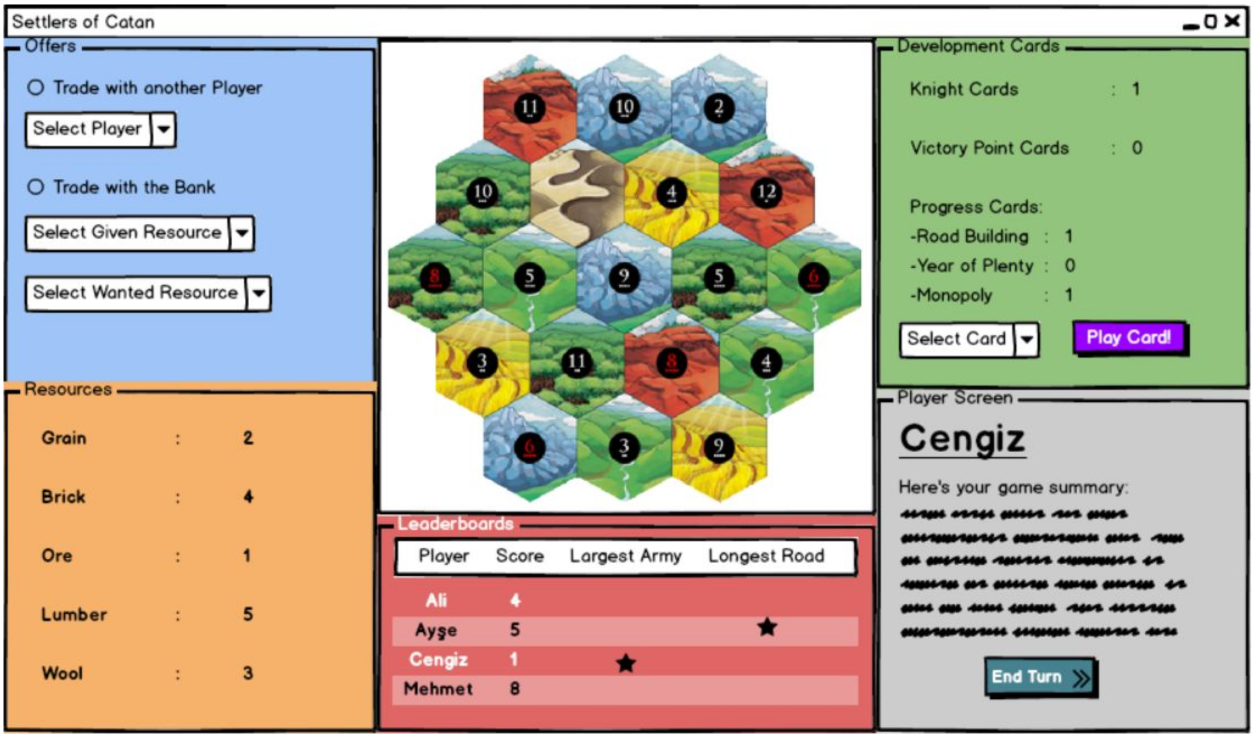


Fig. 10: Name Type Screen

After setting the number of players, the user is led to this screen where now, every player should type their name and press “Done” in order for the game to start.

5.4.6 Game



Grain	:	2
Brick	:	4
Ore	:	1
Lumber	:	5
Wool	:	3

Knight Cards : 1

Victory Point Cards : 0

Progress Cards:
-Road Building : 1
-Year of Plenty : 0
-Monopoly : 1

Player	Score	Largest Army	Longest Road
Ali	4		
Ayşe	5		★
Cengiz	1	★	
Mehmet	8		

Cengiz

Here's your game summary:

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

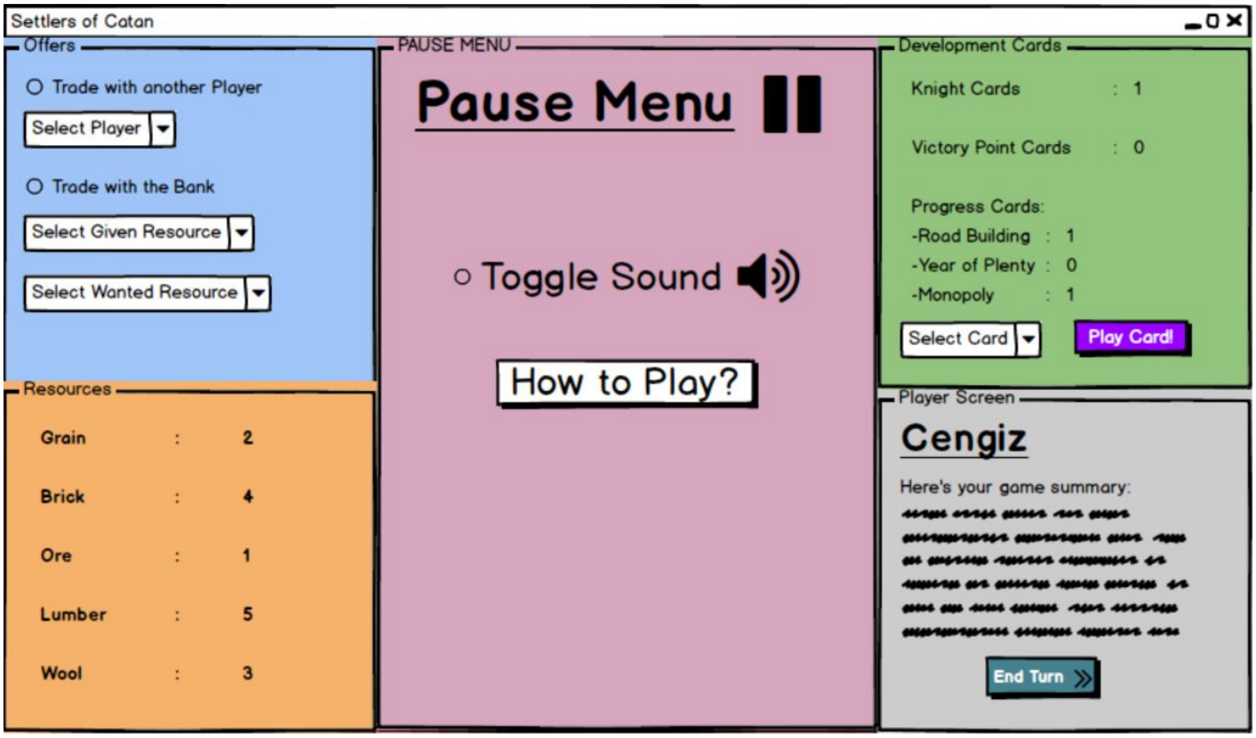
This is the “Game” screen where most of the game will take place in.

The upper left corner is the “Offers” tab where whoever’s turn it is (Cengiz, in our case) can trade with other players or trade with the bank choosing from a combo menu. 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. Lower right corner is the “Player Screen” tab. This is where whose turn it is written and the summary of that players game (info about the resource transactions, trades, offers etc. is written.). 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!

5.4.6 Pause Menu



Settlers of Catan

Offers

○ Trade with another Player

Select Player ▾

○ Trade with the Bank

Select Given Resource ▾

Select Wanted Resource ▾

Resources

Grain	:	2
Brick	:	4
Ore	:	1
Lumber	:	5
Wool	:	3

PAUSE MENU

Pause Menu

○ Toggle Sound

How to Play?

Development Cards

Knight Cards : 1

Victory Point Cards : 0

Progress Cards:
-Road Building : 1
-Year of Plenty : 0
-Monopoly : 1

Select Card ▾

Play Card!

Player Screen

Cengiz

Here's your game summary:

End Turn

Fig. 12: Pause Menu Screen

This is the “Pause Menu” screen where the user can press the escape button to pause the game. In this menu, he/she can toggle the sound on or off and access the “How to Play?” Screen.

6. References

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

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

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