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# 1.0 Analysis

## 1.1 Introduction

### 1.11 Background

UNO is a card game created in 1971 by Merle Robbins. Since the game’s introduction, it has sold increasingly well and has become one of the most popular card games played around the world. Since it’s inexpensive to buy and easy to learn, Uno appeals to a wide age range and continues to be enjoyed by both children and adults.

Although it is popular, there is still a large number of people who are unaware of the rules and do not know how to play. Therefore, I will be creating my own version of an UNO Card Game to allow users to practice and learn the rules through playing the game repeatedly.

### 1.12 Product Description

My version of the game will stick to the original rules and there will be a selection of options such as two, three and four-player modes. The user has a choice of playing against another real player, or against an AI. Through the implementation of client-server architecture, other users will be able to connect to the game and play against you. Additionally, I will be making an AI player that you can play against or use to fill in the slots if there aren’t enough real players available.

Your wins and losses in each game mode will be recorded. Therefore, a login system will be imperative so that users must create an account and log in before playing the game. This is necessary so the system can store data for multiple users.

**Rules of UNO**

Each player is dealt 7 cards initially and the remaining cards are placed facedown to form a draw pile. The top card of the draw pile is placed down to form the discard pile.

The rules are fairly simple: players take turns matching a card in their hand with the current card in the discard pile, either by colour or number. For instance, if a Yellow 2 is placed in the discard pile, the next player must place any yellow card or any coloured 2 from their hand. If a player cannot match the card, they must draw from the draw pile.

In addition to the normal cards, there are 5 special cards:

* Draw 2 Card – When you play this card, the next person to play must draw 2 cards and their turn is skipped.
* Reverse Card – This card reverses the direction of play.
* Skip Card – This card causes the next person to lose their turn.
* Wild Card – Placing this card down allows you to select and change the colour being played to any colour.
* Draw 4 Wild Card – This card allows you to change the colour being played and requires the next player to pick 4 cards from the draw pile, and their turn is skipped. However, this can only be placed when you have no cards that match the colour of the card previously played.

The aim of the game is to be the first player to get rid of all of your cards. However, you must remember to say “UNO” before your second-to-last card touches the discard pile, or if a player notices and calls you out, you must draw 4 cards. After getting rid of your cards, you gain points for the cards remaining in other player’s hands. Number cards are worth their face value but Draw 2, Reverse, and Skip cards are worth 20 points, and Wild and Draw 4 Wild Cards are worth 50 points. The first player to reach 500 points is the final winner.

## 1.2 Investigation

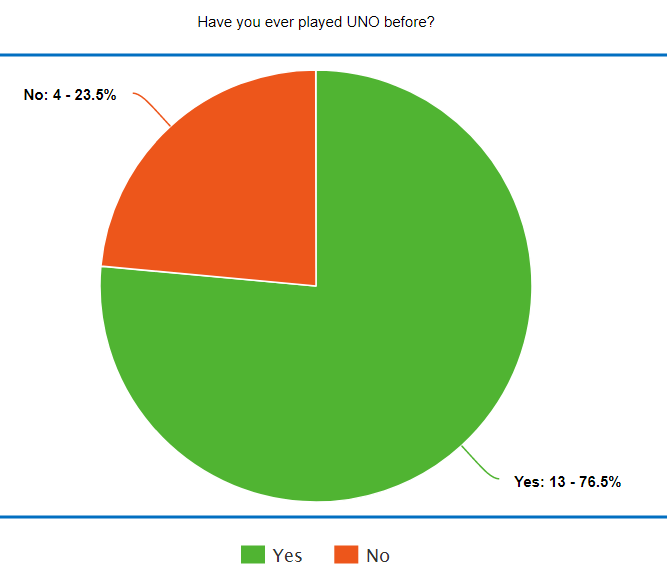
### 1.21 Prospective Users

As mentioned earlier, Uno is reasonably simple and hence it can be played by children and adults. However, I need to consider the fact that young children are unlikely to have the ability to perform actions such as creating an account and retrieving a verification code from their email.

Therefore, my target audience will be people aged around 8 or above and thus I have chosen my friends and family as my end users who will be playing my game. They are all computer literate so their skills shouldn’t limit the complexity of my game but I will attempt to keep things like navigating through options simple nonetheless.

### 1.22 Questionnaire

Through verbal feedback and the use of a poll I sent to friends I gained multiple responses. As seen on the chart, 76.6% of people have played UNO before, whereas 23.5% have not. This emphasises my earlier statement of UNO being an extremely popular card game but of course, a small minority have not played so I’ll need to make sure my game is easy to play and understand for first time players.



Furthermore, I asked the people who responded to inform me about any aspects or features of the game that they enjoyed and did not enjoy, or any possible improvements. The majority of people stated that they enjoyed how simple the game was and how easy it was to learn how to play. I hope to inherit this aspect into my game, making it user-friendly for all.  
One of my friends who have played the mobile version of UNO frequently in the past provided me with some useful knowledge of the cons of the game. For instance: the time limit, which can be frustrating. Players who do not perform any actions during their turn and run out of time will have a card picked out for them automatically. This means that many players can leave their devices unattended without having to manually pick a card, thus wasting the time of the other players. Although the time limit shortens over time, perhaps I can eliminate this from my game completely by skipping a player’s turn if they do not pick a card in time.

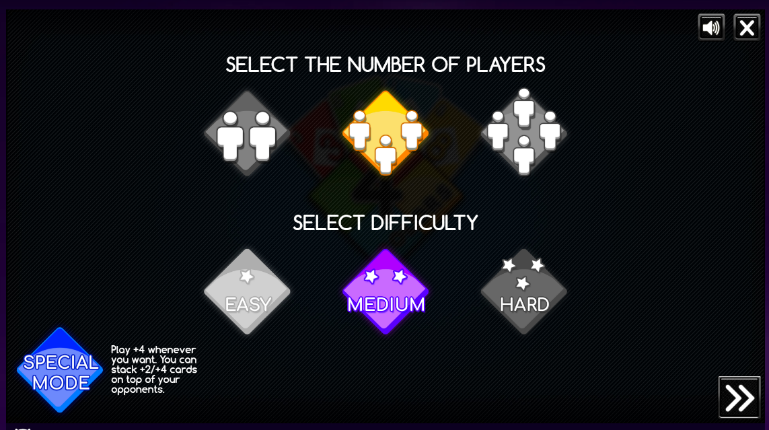
### 1.23 Existing Systems

I have looked at existing versions of Uno games to gain a deeper insight into what my game will look like and to see if I can improve on existing functionalities.

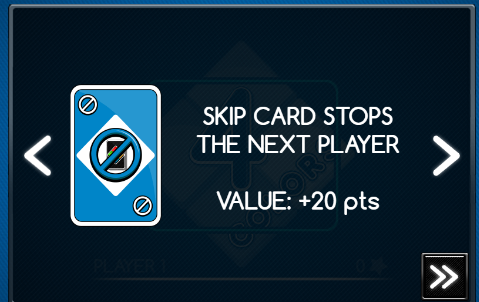


This is an online version of UNO, which is accessible via any web browser using the link <https://www.crazygames.com/game/uno-online>.

This version of the game had no login system meaning that players could not keep track of the number of wins and losses that they had.



After clicking play, you are directed to a screen that allows you to choose the number of players and the difficulty. There is also a special game mode where the rules are changed slightly. In this game mode, +4 can be played at any time and +2/+4 cards can be stacked. Although I will not include an option for the difficulty, I will allow the user to select the number of players.



Following this, the screen changes to display the rules. This is a useful feature because it allows the users to attain knowledge of the rules and the effect of the special cards before playing. However, new players may forget the effects of the special cards during the game, so I will implement a button that opens up a webpage of the rules. Users can look at this webpage as they play to aid them.



The game functions extremely well, with no errors regarding the actual gameplay. Users can select a card to place down, and the AI does the same when it is their turn.

There is background music that can be muted, as well as sound effects when a player uses a special card.

Once a player places their final card down, their score is calculated using the value of their opposing player’s cards and subsequently, the game restarts. This continues until a player reaches 250 points, in contrast to the usual 500 points. However, my game will not restart after it ends as an excessive number of rounds may need to be played.



I have noticed some possible improvements that I can implement into my game. For example, this system doesn’t display the current direction of play so it can be confusing as to whose turn it currently is if the reverse card is used continually. Also, there is no time limit during your turn, so perhaps I could include one to develop a sense of urgency and improve one’s decision-making skills.

This is the official Uno mobile game.

Likewise, there are no major issues with the gameplay. Although I noticed that the opponent’s cards aren’t placed down flat making it hard to determine how many cards your opponent has left, such as with the user on the right. The background of the game is also bright with various colours and objects but I find this slightly distracting so I am likely to use a simpler background.

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### 1.24 Constraints

**Hardware Constraints**

My game will be able to run on Microsoft Windows Devices such as PCs and laptops but not mobile devices. I’m using a Windows 10 laptop so I’m uncertain about the performance of my game on a MacBook device, but these devices should be able to run my game as Python is available on MacOS, as well as the Pygame module.

**Software Constraints**

Devices that run on iOS and Android will be unable to run this game on their devices. Users will require an internet connection to download my game, along with the necessary files, before they can play it. My game will also make use of a client server network to allow another user to join the game, thus requiring an internet connection. Furthermore, Python and a set of python modules named Pygame will need to be downloaded beforehand, in order to run my code.

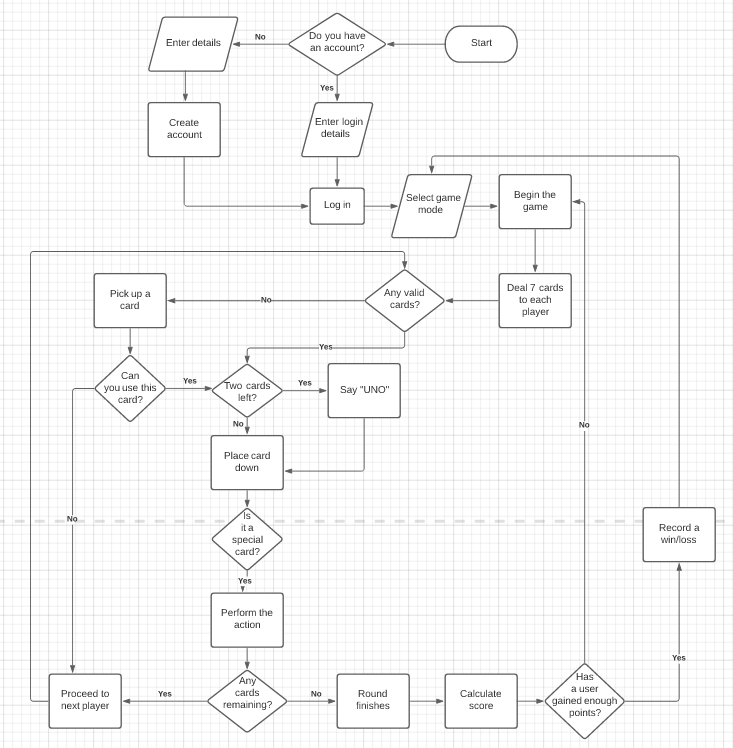
**User’s Knowledge of information technology**

The user will require a basic understanding of using computers since various actions need to be performed before they can access the game. For example, they will need to log into their email to obtain their verification code. Python also need to be installed beforehand, and the game itself needs to be downloaded from GitHub.

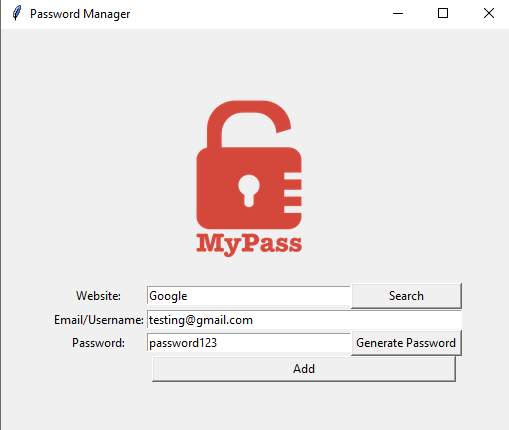
However, the system itself will be user-friendly and the necessary actions such as entering their login details and navigating through the various options should be fairly simple to complete.

### 1.25 Flow Diagram

This diagram represents the basic processes and decisions that will be made when logging in and selecting the classic game mode.



### 1.26 Prototypes

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To develop a prototype for my login screen, I have created a graphical user interface using Tkinter in Python. I made a password manager that lets users create accounts for websites and store these details inside a file. Users can use their own passwords, or the program can generate a password for you, as seen in the images. I experimented by storing the details in various formats, such as JSON, CSV and text files.

However, this is simply a prototype I used to develop the skills needed to produce a login system and some components of this prototype will not be used in my game. Such as the Search function that allows you to search for your login details for a specific website.

In the final version of my game, there must be additional options such as a button to log in and an entry box to enter your verification code.

## 1.3 Objectives

* New users must create an account to use the system.
* The new user should enter their new username, password and email
* The username and password must be unique and not already used
* The user should be able to generate a password if needed
* The user must answer a question to verify they are human
* The user should be able to log in to an existing account.
* The user must enter their username, password and email.
* The system must notify the user if fields are missing.
* The system must store the login details inside a database and allow new users to add their login details when creating an account.
* The system should track the number of wins and losses in each game mode by updating the database
* The system should display this information to the user when they are selecting game modes
* The tables in the database should be interlinked.
* For example, one table containing the user details will link to a table containing the wins and losses. This allows you to extract the data from the tables easily.
* The user should be able to navigate through the menu using the arrow keys.
* The user must be able to pick between two/three/four-player modes.
* The user should be able to read the rules when needed, by clicking on a button and being redirected to a webpage.
* There should be an option to adjust the volume or completely mute the sound.
* The client and server should be able to send data back and forth between each other.
  + The server should receive the action from the client and then execute the action.
  + All clients must receive the updated game after a player has made a move so that all players can see which card was just placed down.
* The system should shuffle the deck and deal 7 cards to each player.
* The remaining cards should form a draw pile and the top card of the draw pile should be placed down when starting the game
* The user should see all of his cards and how many cards his opponents have
* The user should be able to select one of their cards to place down.
* They will be notified if they choose a card that cannot be used.
* If they have no valid cards, they should be able to draw a card from the deck. If this card is valid, the player must be asked whether they want to place that card down.
* If they chose a wild card, they must be given the option to select a colour to change to.
* A button labelled “Uno” will be displayed on the screen during gameplay
* If the user forgets to click it before placing his second-to-last card down, the system should notify them and the user will draw four cards.
* The system should display the direction of play during gameplay so the user knows whose turn it is next.
* The system should explain the effect of the wildcard placed down.
* For instance, if Player 1 uses a Skip Card, the system will display a message, explaining that Player 2’s turn will be skipped.
* The round should finish once a player places down their final card.
* The system should direct the user back to the game mode selection screen once the game has finished.

## 

## 1.4 Language/Platform

There are a range of options for me to choose from regarding the platform and libraries used. Each have their own advantages and disadvantages.

Python

* **Tkinter** – This will enable me to create a GUI easily through the use of labels, buttons and more, plus I have a basic understanding of using it.
* **Pygame** – This library is designed for creating games, and will allow me to control the movements of the cards more easily. Although, it will be exceedingly more difficult to create a GUI and widgets such as buttons, which I may need to rely on heavily.
* There are many other modules for me to choose from to aid me in creating the game, such as PyQT or PySimpleGUI.

C#

* **Windows Form** – This allows me to drag and drop forms onto the screen to create a GUI easily. A variety of controls can be added to the forms, such as buttons.

### 1.41 Proposed Solution

My UNO card game will be created in Python using the Pygame module as opposed to Tkinter as it will make my solution considerably more complex and provide extra functionalities that Tkinter is incapable of. For instance, the entry boxes and buttons used will be created myself by taking into account attributes such as the x and y coordinates of the mouse’s current position. In regards to the programming language used to implement the game, I have chosen Python because I have a considerable amount of experience in contrast to C#.

The game will make use of networking so another player can join the game and play against you. All inputs by clients will be processed by the server and the server will send data back to the players so they receive updates in real-time. The delay between moves should be minimal to allow for smoother gameplay.

The game will be connected to a database on the server and I will use SQL queries to create the tables in the database, store data and retrieve it. For example, a table containing their login details and another table that records their wins and losses will be created. Their login details will need to be retrieved and compared against their inputted details to verify the players before allowing access into the game. Their wins and losses will be retrieved in order to display this information to the user when selecting game modes.

# 2.0 Design

## 2.1 Libraries

**pygame** – This library will be used to create most of the features in my GUI, including the buttons. I will also need this module to display my card images onto the screen, which I will be downloading from the internet to ensure they are of the same size and font.

**socket** – The socket library is essential for creating servers and clients and I will be using this to bind IP addresses to ports, to allow the clients to connect to the server.

**pickle –** This module implements binary protocols which enables the clients and server to send and receive data. The pickle module is useful for converting any type of data, including strings and objects, into a byte stream which can be sent. When the data is received, it is converted back into the original data.

**threading –** This module allows me to use multithreading so that multiple games can run at the same time. Every game will run in its own thread so that they do not interfere with each other.

**time –** My code will make use of the time.sleep() function from this module to add short delays in between sending and retrieving data to synchronise the clients. Without delays, I am likely to run into issues as the server may send data to the client before it is ready to receive it.

## 2.2 Description of Data Items (Data Types and Structures)

### 2.21 - User Information stored inside the Database

This is the information entered by the user when logging in or registering. I will validate the user input to ensure that they do not crash or break my program. These are examples of the data inputted by the user.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Field Name** | **Purpose** | **Field Type** | **Field Size** | **Example** | **Validation** |
| Username | Stores the player’s username | String | 15 | Bob03 | No special characters.  Must be between 3 and 15 characters long. |
| Password | Stores the encrypted version of the user’s password | String | 30 | Xykgfd23 | Not null.  Must be under 30 characters in length. |
| Email | Store’s the user’s email | String | 30 | bob@gmail.com | Not null Must be in the correct format. |

### 2.22 - Gameplay Data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Field Name** | **Purpose** | **Field Type** | **Field Size** | **Example** |
| Win | Stores the number of times the user has won in that game mode | Integer | 5 | 15 |
| Loss | Stores the number of times the user has lost in that game mode | Integer | 5 | 23 |
| Number Of Games Played | Stores the number of times the user has played in that game mode | Integer | 5 | 8 |
| Game Mode | Stores the ID of the game mode that has been played | Integer | 1 | 2 (For 2 players) |

### 2.23 - IPSO Diagram

|  |  |
| --- | --- |
| Inputs  -User data (Username, passwords…)  -Mouse clicks  -Keyboard Presses | Process  -Validation check  -Encrypt password using Caesar cipher  -Create SQL queries to insert user data  -Create SQL query to retrieve/update the number of wins, losses and games played.  -Get position of mouse and compare it to the position of the buttons  - Check which key was pressed and perform the necessary action |
| Outputs  -Display the user stats (Wins, losses, number of games played, game mode)  -Output the cards onto screen  -Update the new position of the cursor onto screen | Storage  -User’s personal data  -Number of wins, losses and games played |

## 2.3 Data Types and Structures

Throughout my program I will be using various data types and data structures.

* Boolean – This will be used throughout the code as variables will often need to be checked if they are set to True or False so that another process can occur.
* Floats – To store data such as the volume of the sounds.
* Tuples – This will be used often to store RBG values to specify the colours, as well as the coordinates of various objects.
* Strings – The user ID’s will be converted from an integer to a string so that it can be displayed onto the screen using pygame. String data such as messages will also be sent back and forth between the clients and servers occasionally.

Data Structures:

* Dictionaries - They will be essential on my server when creating multiple games. Every game has its own ID number and these will be linked together via key-value pairs.
* Lists - Objects such as buttons may be stored in lists to allow me to loop through the list and find the required button. Player decks will be a list since any card in the deck can be selected and these will need to be accessed via their indices.
* Stack – The main deck will be a stack since the top cards will need to be popped off when dealing the cards or when a player draws a card. It is unlikely that the players will use all cards in the deck so adding them to the back of the deck may not be necessary, hence a stack may be more useful here rather than a queue.

## 2.4 – Database Design

### 2.41 - Entity-Relationship Diagram

My database will be a simple one-to-one database as very little data will be stored. The Player table will contain the username, password and email of every single player that has registered. Each game mode has its own table which also contains the Username, along with the number of wins and losses that user has in that game mode. The username is a primary key in every table which allows me to retrieve the data easily.

### 2.42 Example Queries

**Inserting a new user into the database:**

INSERT INTO Players  
VALUES (“John03”, “qwerty123”, “john@gmail.com”)

**Incrementing the number of wins in a table:**

UPDATE Two\_P  
SET Wins = Wins + 1   
WHERE Username == “John03”

**Incrementing the number of losses in a table:**

UPDATE Three\_P  
SET Losses = Losses + 1   
WHERE Username == “John03”

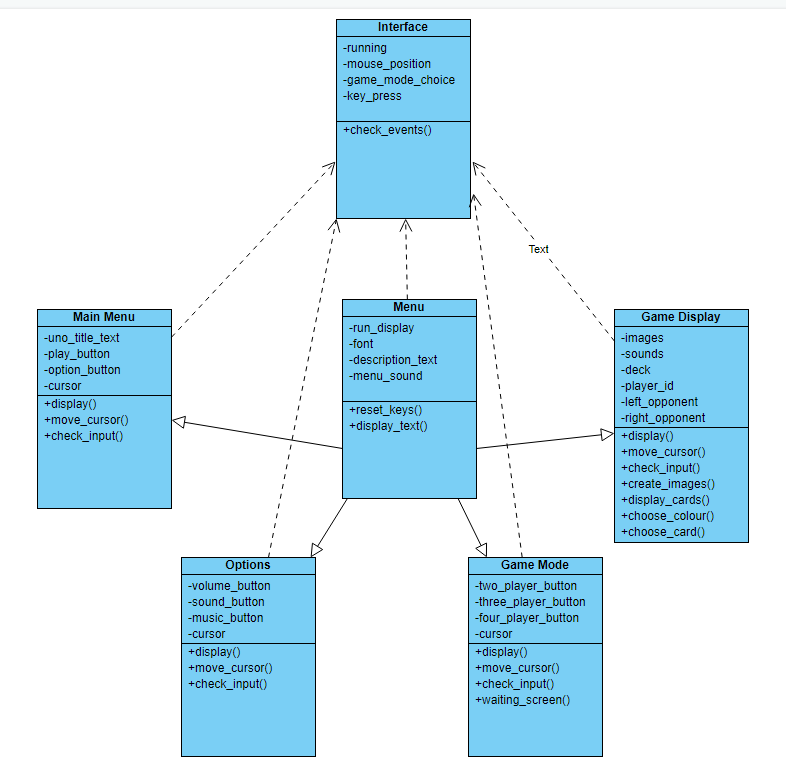
**Incrementing number of games played:**

UPDATE Players  
SET Games\_Played = Games\_Played + 1   
WHERE Username == “John03”

## 2.5 Class Diagram

This is a diagram of my Menu, Options, Game Mode and Game Display screens. As indicated by the normal arrows, these four classes will all inherit from one Menu class. This grants the four classes access to the attributes and methods in the Menu class. A benefit of this would be that the two methods inside the Menu class can be called from anywhere inside the other classes, without it needing to be rewritten. Every screen having its own class also makes debugging simpler and helps me break down the task. The font will be inherited to keep it consistent throughout all screens.

Every class has their own display, move\_cursor and check\_input method because the classes each contain different attributes and buttons, so different objects would be displayed on the screen. This is the reason that I chose not to have each class inherit the three methods from the Menu class.

Furthermore, the dashed arrows show that all 5 classes are dependent on the Interface class. This is due to the class objects being created and contained inside of the Interface class. All 5 classes will take the Interface as a parameter, enabling each screen to check for key presses on the same Interface and to move the cursor and display the necessary items onto the same screen. Any changes to the Interface object will affect all the other classes, thus they are all dependent on the Interface.

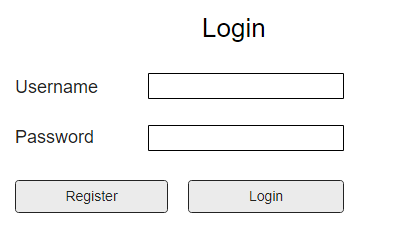
## 2.6 – UI Design / HCI Rationale

My aim is to optimise the ease of navigation to allow all users to select the menus and options easily, so I will ensure that all elements are positioned and sized appropriately. As the cards will be of various colours I have chosen to use a darker colour scheme to allow the cards to stand out during gameplay and to minimise confusion. The colour of the text must not overlap with the background colour either.

For my login and register screens, there will be several input boxes/buttons to input data such as their usernames and passwords. These elements will light up when the user clicks on them to indicate that they have been selected.

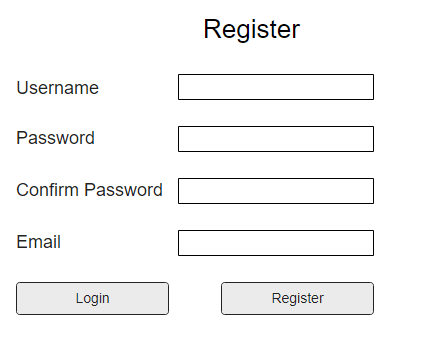
### 2.61 -Login Screen

The login screen is where the user can login to the system. There will be two input boxes to allow the user to enter their username and password, as well as two buttons labelled “Login” and “Register”. If the user has entered their details they can click the login button where they will be sent to the main menu. However, if the user wishes to register then they can click the register button to access the register screen.

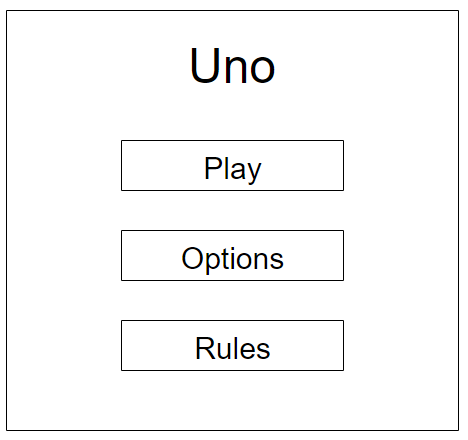


### 2.62 - Register Screen

The register screen allows the user to register a new account. It will have four input boxes for the username, password, email and an additional one to confirm your password. The text in the two boxes must match or an error will be displayed on the screen. If the user inputs are valid then a request will be sent to the server, after clicking register, and the account will be registered with the system. In addition to the register button, the login button allows you to return to the login screen in case you accidently clicked on register.



### 2.63 - Main Menu



The main menu screen will be displayed once the user has successfully logged in. It will consist of multiple buttons which allow the user to navigate through different screens such as the Game Mode selection screen and the Options screen.

The user will be able to highlight a button using the arrow keys, and pressing Enter will select that button. To return to the previous screen, the user can press the Back button. I will add some text at the bottom of the screen to tell the user about this.

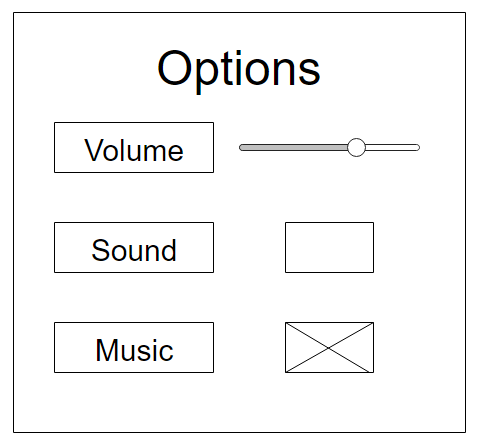
Selecting the Rules button will open up a website that explains the rules for new users.

### 2.64 – Game Mode Selection Screen

## 

This screen allows the user to select the game mode that they would like to play. This information will be sent to the server to be processed and the game will begin once enough players have joined.

### 2.65 – Options Screen



The purpose of this screen is to let the user adjust the volume for the sounds and music as it may be too loud/quiet for the user. They may also completely mute the sound and music if they wish to by selecting the corresponding box and pressing enter. A cross will be displayed inside the box if they have chosen to disable it.

### 2.66 – Game Play Screen

## 

## 

This is how I intend the two player mode to look. There will be no cards on the right and left sides compared to the other game modes since there are only two players.

The card at the top of the discard pile will be placed in the centre of the screen and a draw button will be placed directly under it, to give the user the choice of drawing a card.

Additionally, the player numbers will be placed alongside the player’s cards to differentiate between players.

## 

The three player mode will look slightly different as there is no player at the top of the screen. The opponent’s cards will be placed on either side of the screen.

To select a card, the users will use their arrow keys and press enter to select the card. I will add a cursor around the cards to let you see which one you are selecting.

## 

This is the layout of the four player mode. The opponent’s cards will be placed at the top, left and right sides of the window.

As there are more cards on the screen, any text that I display during the game will likely be adjusted slightly. For instance, the text that I will include to inform the players of the current player.

When you place down a card, the position of your remaining cards will shift along and remain centered to ensure they never display outside of the window.

### 2.7 – Description Of Measures Planned For System Security

My project makes use of sockets which allows clients to connect to my server over the internet. My server is hosted on my laptop at home, so I need to distribute my public IP address to anyone who wishes to play my game. This is a risk since someone who gains access to my public IP address may want to use it for malicious purposes. For instance, a hacker may attempt to brute-force a connection by trying all the possible ports associated with my IP address to gain access to my device. Or, they may attempt a DDoS attack to flood my device with traffic.

To prevent this from happening, I will only be distributing my public IP address to people that I know and trust. This is not a major issue as my game was designed for friends and family. Furthermore, I will minimise the chances of any attacks by running the server only when someone requests to play my game.

If someone gains access to my server they will be able to view data such as usernames, passwords and emails. To make this more secure, I can use hashing algorithms and encryption such as Caesar Cypher when storing the data.

To prevent SQL injection, user inputs on the login screen will also be validated. This will prevent people from accessing the database without authorisation and prevent my program from crashing. If I have enough time, I may attempt to use parameterized queries too.

## 2.6 – Pseudocode and Algorithms

### 2.61 - Get Text

This algorithm obtains the unicode of the key pressed by the user and adds it to a text variable so that it can stored and displayed onto the screen. This is vital for the login and register screen so the user can input their data.

Get\_text():  
 if user pressed a key:  
 for button in buttonlist: # Loops through the buttons on the screen  
 if button is active: # Finds the button that the user selected  
 if key = backspace:  
 Remove the character from the end of the text  
 else:  
 text += key.unicode

### 2.62 - Change The Volume

This is how the player will be able to adjust the volume on the options screen

Change\_volume():  
 if user pressed left\_arrow\_key:  
 move slider to left  
 decrease volume  
 else if user pressed right\_arrow\_key:  
 move slider to right  
 decrease increase  
 else if user pressed the up or down arrow key:  
 move cursor up or down  
 else if user pressed Enter and sound button is active:  
 mute or enable the sound  
 else if user pressed Enter and music button is active:  
 mute or enable the music

### 2.63 - Create The Deck

This will create the card objects by assigning them a colour and a value, such as red and 7.

Create\_deck():  
 colours = list containing red, blue, green and yellow

For number in range(2): # There are 2 of the same cards so it loops twice  
 for number in range(13):  
 # 1-9 will be the normal numbers and 10-12 are the special cards

for colour in colours: # create a card of this number for each colour  
 if number = 10:  
 create draw 2 card and give it the current colour  
 else if number = 11:  
 create reverse card and give it the current colour  
 else if number = 10:  
 create skip card and give it the current colour  
 else: # Any normal numbered card  
 create the card and give it the current colour  
 next colour

for number in range(4):  
 create wild card and wild 4 card

### 2.64 - Check if the card placed down is a special card

This function will perform the necessary action if a special card was placed down. For instance, the next player will be skipped if a skipped card is placed down.

Check\_card():

If card at top of discard pile is a draw 2 card:  
 the next player draws 2 cards  
 skip the next player  
else if card at top of discard pile is a skip card:  
 skip the next player  
else if card at top of discard pile is a reverse card:  
 skip the next player  
 change the direction  
else if card at top of discard pile is a wild 4 card:  
 the next player draws 4 cards  
 skip the next player  
else: # It is a normal card  
 move onto next player

### 2.65 - When the player chooses to draw a card

A DrawCard object will be sent to the server by the client and the server will execute the method inside the object which will deal a card to the player and then checks if that card can be placed down. If it is valid, the server will send data back to the client to inform the client that they should decide whether they want to place the drawn card down.

Similarly, if they want to place a card down, the action method would simply place their card down, by removing it from their deck and adding it to the discard pile. Then it would move onto the next turn.

Class DrawCard:

action():  
 give the player a card  
 if the card’s colour or value matches the card at the top of the discard pile:  
 send data to the client to ask the user if they want to place it down  
 else: # Doesn’t match  
 move onto the next player

2.66 - Client SideWhen a person runs the client code they will connect to the server and then a window will pop up on their screen allowing them to navigate through the Menus and choose a game mode. Once they chose a game mode, they will be asked to wait until enough players have joined so that the game can begin. This is a simplified version of the processes.

Connect to the server via it’s IP address and port

While loop:  
 display menu

if a game mode was selected:  
 send the selected game mode to the server  
 display the waiting screen  
 if data is received from the server: # This means the game has begun   
 stop displaying the waiting screen

else:   
 continue displaying the menu

While loop:  
 receive your player ID from the server  
 receive the game from the server

if your player ID = the current player’s ID: # It is your turn  
 display the game screen   
 action = choose or draw a card  
 send action to server

else: # Not your turn  
 display the game screen

wait to receive data from server  
 continue the loop to receive the updated game

# 4.0 Evaluation

Overall, I believe that my project was fairly successful. The game functions well and the game play proceeds smoothly with delays being barely perceptible. All clients are able to connect to the server without any issues and data is successfully sent between both clients and server. Unfortunately, I did not have enough time to create my database and login system and therefore I could not implement SQL into my technical solution.

To evaluate how successful my code was, I have analysed my initial objectives to determine whether I met them and to list potential improvements. Additionally, I have mentioned the objectives that I have not met.

**Navigating through the menus**

This was achieved successfully through the use of pygame’s event queue. After getting an event from the queue, the type of event is determined and the type would be the key that was pressed. For instance, if a user pressed the down key, the event’s type is equal to the down key. This allowed me to set a variable representing the down key to True, to inform the menu that the down key was pressed. The cursor rectangle would now adjust it’s coordinates so that it moved downwards onto the button below.

Once it moved, the variable was reset to False to allow the user to press the down key once again. This prevents the user from holding down a key and only allows them to tap the keys, thus preventing miss clicks. Additionally, text was displayed at the bottom of the screen to inform the users of which keys should be used to navigate through the menus.

**Multiple game modes**

This was successful and my game allowed you to pick between two, three and four player mode. Once a player picked their game mode, it was immediately sent to the server and the server would record the number of players that joined that game mode. Once enough players have chosen that game mode, the game would begin. If I had more time, I could have potentially included a 5 or 6 player mode.

**Reading the rules**

Players were able to access the rules by pressing the Rules button on the option screen. This directed them to a webpage as stated in my initial objective. However, I could have included a button during the game to allow users to view the rules while playing, in case they needed to recap the effect of a card.

**Adjust the volume**

This was successful through the user of a slider and buttons. When a user selected the slider, which is indicated by it being highlighted, they were able to change the volume by moving the slider left and right. There was also an option to completely mute the sound effects if they wished, by pressing the button. When disabled, a cross was displayed inside the box to make it clearly visible that the sound was disabled.

Although I intended to add music into my game, alongside the sound effects, I did not include any and this would be an improvement as it would make the game more enjoyable to play. I did not manage to find a suitable sound effect for the special cards so the sound effects only played when you placed a card down or pressed a button. A different sound was heard when an invalid card was chosen, to alert the user.

**Sending data back and forth**

This was also successful, as clients and the server had no issues with sending and receiving data. This was possible through libraries such as socket and pickle as mentioned in the design section.

Initially, the client and server only worked on my local network meaning that players from online with different IP addresses could not play my game. This was due to my router not knowing which device to send the packets to. However, through the use of port forwarding on my router, I managed to direct the traffic to the local IP address of my laptop, which allowed users from anywhere to connect to the server hosted on my laptop. I tested this with my friend in another location and we managed to play the game successfully.

Furthermore, on the server I added time delays in between sending data and this helped to synchronise my clients and prevented the client from shutting down. If the server sent data to the client milliseconds before the client was ready to receive the data, an error occurred, so this was fixed simply by adding a short delay of less than half a second. This did not seem to have a noticeable impact on the game as data was sent and received extremely quickly as seen in the tests.

**Shuffle the deck and deal 7 cards**

This was achieved and the deck was shuffled using the random module’s random.shuffle method. The deck was shuffled multiple times to reduce the chance of you getting multiple cards of the same colour.

The remaining cards after 7 cards were dealt to each player did form the draw pile, which can be seen when a player successfully drew a card in the testing section. The top of the discard pile was also placed in the centre when beginning the game.

**Viewing your cards and the opponent’s cards**

As intended, all of the cards in your deck are on display at the bottom of the screen. The opponent’s cards will be placed at the left, right or top of the screen, depending on the game mode chosen. When an opponent places a card down, you are able to see that a card has been removed. Additionally, when you place a card down, the cards shuffle along to ensure that there are never any gaps in between the cards in your hand. This keeps the cards centred and prevents them from displaying outside of the window. An improvement that could be made would be to animate the cards when they are selected, so you can see them moving towards the discard pile in the centre of the screen.

**Placing a card down or drawing a card**

This objective was also met successfully. Using your arrow keys you are able to move the cursor rectangle left and right to choose a card, and then pressing enter will select it. If the card is valid, it is sent to the server where it is placed in the discard pile and removed from your deck. If the card is not valid, text appears on the screen informing you of this, and a different sound will play. You are then allowed to select another card.  
When a wild card is chosen, you are able to choose the next colour as expected.

If you wish to draw a card, you simply hover over the draw card button and it will become highlighted. Once selected, similarly a DrawCard object is sent to the server and the execute method will be called, causing you to draw a card from the draw pile. If the card is valid, the server sends data back to you and waits to receive your decision on whether you would like to place the card down. Through the use of flags and if statements, I stopped the server from requesting the other players to choose a card until you have sent your decision back to the server.

**Uno functionality**