**PROJECT REPORT** (Updated Version)

# "MEMORY MATCHING GAME USING SFML"

**FALL 2024**

**CSE208L OBJECT ORIENTED PROGRAMMING LAB**


**SUBMITTED BY :**

SYED MUHAMMAD AHSAN JAN (**23PWCSE2309**)

MIAN SAEED AHMAD (**23PWCSE2319**)

MUHAMMAD HUSSAIN (**23PWCSE2272**)


**SECTION : A**

**SUBMITTED TO :**

Engr. Sumayyea Salahuddin

(January 27, 2025)


Department of Computer Systems Engineering

University of Engineering and Technology, Peshawar

# Memory Matching Game using SFML

## Objective

The objective of this lab was to develop a memory matching game using the Simple and Fast Multimedia Library (SFML) in C++. The game challenges players to match cards based on their colors, testing their memory and cognitive skills. The game progresses through multiple levels, with increased difficulty based on the number of mistakes and time limitations.

## Tools and Technologies

- **SFML (Simple and Fast Multimedia Library)**: A multimedia library used for creating games and interactive applications.
- **C++**: Programming language used for developing the game logic.
- **Font**: The "arial.ttf" font was used to display text in the game.
- **C++ Standard Library**: Utilized for random number generation, vector manipulation, and time handling.

## About Game (Levels , Cards Grid and Color Randomization)

1. **Levels and Progression**
    - The game progresses through multiple levels, starting from level 1.
    - Completing a level involves matching all pairs of cards correctly.
    - Levels become more challenging due to reduced card display times and increased hardship levels.
    - If the player reaches level 10 successfully, a special message, "YOUR MEMORY IS A MIRACLE," is displayed, marking the end of the game.
2. **Color Assignment and Randomization**
    - Each level's grid contains paired cards with random colors.
    - The initializeCards function creates a list of random colors for card pairs, ensures there are two cards of each color, and then shuffles the color list to randomize card placement.
    - Random colors are generated using rand(), creating variability in card colors every game.
3. **Hardship Levels**
    - The hardship increases after every three levels.
    - Hardship is primarily reflected in the reduced time cards remain face-up for the player to memorize their positions.

- At the beginning of the game, cards are visible for 5 seconds. This time decreases incrementally with advancing levels.

4. **Total Levels and Game Over**
    - The maximum level is 10. Completing it successfully ends the game with a congratulatory message.
    - The game ends prematurely if the player accumulates 10 mistakes or their score falls below -20.
5. **Cards Grid**
    - The game uses a 4x4 grid with 16 cards, calculated based on the GRID_SIZE constant (set to 4).
    - Each card is 80x80 pixels in size.
    - The cards are initially placed face down and shuffled randomly.
    - Cards are created using SFML RectangleShape objects, with their positions calculated according to their index in the grid.
    - The grid's total width and height depend on the GRID_SIZE and card dimensions.
    - The card grid remains the same throughout the game, with the layout being consistent in every level.
6. **Comments**
    - The game displays dynamic comments based on player performance.
    - Positive comments like "You're on fire!" and "Keep it up!" are shown when the player performs well.
    - Negative comments such as "Oops, focus harder!" are shown when the player makes mistakes.
    - The comment displayed is determined by the player's score and mistakes.
    - Comments are displayed in cyan-colored text below the gameplay information (score, level, etc.).
    - Comments are intended to motivate and provide feedback, adding a fun and interactive element to the game.

**Game Overview**

1. **Game Mechanics**:
    - The game consists of a grid of cards, initially faced down.
    - Players click on cards to flip them over, trying to find matching pairs.
    - After a certain time, the cards are flipped back to their original state.
    - If the player makes a correct match, the score increases; if the player makes a mistake, the score decreases.
    - The game progresses through levels with increasing difficulty, which is determined by the number of mistakes and the time left.
2. **Hardship Levels**:
    - As the player advances through levels, the hardship level increases, which affects the duration the cards are displayed before being flipped back over. Initially, the cards are displayed for 5 seconds, but the time decreases to 4, 3, and so on with each new level.
3. **Game Over Condition**:
    - The game ends if the player runs out of time, makes too many mistakes, or reaches level 10.
    - If the player completes level 10, the game displays a message stating "YOUR MEMORY IS A MIRACLE" and ends.
4. **User Interface**:
    - The game provides feedback such as the score, level, mistakes, and other relevant information on the screen.
    - Encouraging or humorous comments are displayed based on the player's score and mistakes.

**Object-Oriented Programming (OOP) Connection**

The game design incorporates several key **Object-Oriented Programming (OOP)** concepts to structure and organize the code effectively. Here’s a breakdown of how these principles are used in the game:

1. **Encapsulation**:
    - The Card class encapsulates all the properties and behaviors related to a card. It stores the card's shape, color, flipped state, and its corresponding border. The behavior of flipping the card and drawing it to the screen is also encapsulated in the class through methods like flip() and draw(). This allows the Card class to maintain its internal state while exposing only the necessary functionality to other parts of the game.

Example:

```cpp
class Card {
public:
    sf::RectangleShape shape, border;
    sf::Color originalColor;
    bool flipped;

    // Constructor, flip method, and draw method to manage card's behavior
};
```

2. **Abstraction**:

- The game code abstracts complex card behaviors into simple operations like flip() and draw(). For instance, when the player clicks on a card, the game doesn't need to worry about how the card's internal shape is rendered or how it flips—those details are handled by the Card class itself. The abstraction simplifies the gameplay logic and allows the developer to focus on higher-level features.

Example:

```cpp
card.flip();  // Flips the card without needing to know its internal workings
```

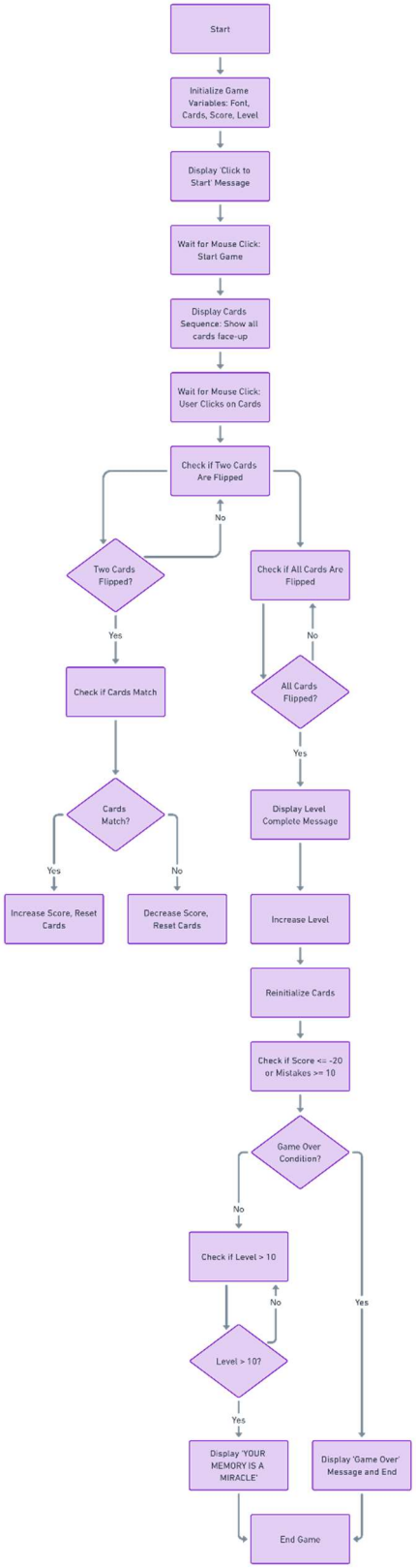
**Code Explanation**

The code is divided into several sections, each focusing on a specific aspect of the game.

1. **Card Class**:
    - The Card class is used to represent each individual card in the grid. It includes properties like the card's shape, color, and whether it has been flipped.
    - The flip method is used to change the card's state from face-down to face-up and vice versa.
2. **Game Initialization**:
    - The initializeCards function generates a shuffled set of cards with random colors, ensuring that there are pairs of matching colors.
    - This function sets up the initial grid layout of cards based on the predefined grid size.

3. **Display Functions**:
    - The displayMessage function shows messages like "Game Over" or "Well Done" to the player.
    - The displayCardSequence function shows the sequence of cards for a specified amount of time before flipping them back over.
4. **Game Loop**:
    - The game runs within a loop that checks for user input (mouse clicks) to flip the cards.
    - If two cards are flipped, the game checks if they match, updating the score and making the appropriate changes to the game state.
    - The game tracks the player's progress through levels and displays relevant information such as score, time remaining, and the number of mistakes.

## Flowchart


Start
Initialize Game Variables: Font, Cards, Score, Level
Display 'Click to Start' Message
Wait for Mouse Click: Start Game
Display Cards Sequence: Show all cards face-up
Wait for Mouse Click: User Clicks on Cards
Check if Two Cards Are Flipped
No
Two Cards Flipped?
Yes
Check if Cards Match
Cards Match?
Yes
Increase Score, Reset Cards
No
Decrease Score, Reset Cards
Check if All Cards Are Flipped
No
All Cards Flipped?
Yes
Display Level Complete Message
Increase Level
Reinitialize Cards
Check if Score <= -20 or Mistakes >= 10
Game Over Condition?
No
Check if Level > 10
No
Level > 10?
Yes
Display 'YOUR MEMORY IS A MIRACLE'
Yes
Display 'Game Over' Message and End
End Game

## Code Listing

```
#include <SFML/Graphics.hpp>
#include <vector>
#include <ctime>
#include <cstdlib>
#include <iostream>
#include <sstream>
#include <random>

const int GRID_SIZE = 4;
const int CARD_WIDTH = 80;
const int CARD_HEIGHT = 80;
int WINDOW_WIDTH = GRID_SIZE * CARD_WIDTH + 200;
int WINDOW_HEIGHT = GRID_SIZE * CARD_HEIGHT;

class Card {
public:
    sf::RectangleShape shape, border;
    sf::Color originalColor;
    bool flipped;

    Card(int x, int y, sf::Color color) {
        shape.setSize(sf::Vector2f(CARD_WIDTH, CARD_HEIGHT));
        shape.setPosition(x, y);
        shape.setFillColor(sf::Color(169, 169, 169));

        border.setSize(sf::Vector2f(CARD_WIDTH, CARD_HEIGHT));
        border.setPosition(x, y);
        border.setFillColor(sf::Color::Transparent);
        border.setOutlineThickness(4);
        border.setOutlineColor(sf::Color::Black);

        flipped = false;
        originalColor = color;
    }


    void flip() {
        flipped = !flipped;
        shape.setFillColor(flipped ? originalColor : sf::Color(169, 169, 169));
    }

    void draw(sf::RenderWindow &window) {
        window.draw(shape);
        window.draw(border);
    }
};

void initializeCards(std::vector<Card> &cards, std::vector<sf::Color> &colors) {
    cards.clear();
    int numPairs = (GRID_SIZE * GRID_SIZE) / 2;
    colors.clear();

    for (int i = 0; i < numPairs; ++i) {
        colors.push_back(sf::Color(rand() % 256, rand() % 256, rand() % 256));
    }
    colors.insert(colors.end(), colors.begin(), colors.end());
    std::random_shuffle(colors.begin(), colors.end());

    int index = 0;
    for (int i = 0; i < GRID_SIZE; ++i) {
        for (int j = 0; j < GRID_SIZE; ++j) {
            cards.emplace_back(j * CARD_WIDTH, i * CARD_HEIGHT, colors[index]);
            index++;
        }
    }
}
```

```cpp
void displayMessage(sf::RenderWindow &window, const std::string &message, sf::Font &font) {
    sf::Text text(message, font, 30);
    text.setFillColor(sf::Color::White);
    text.setPosition(WINDOW_WIDTH / 2 - text.getLocalBounds().width / 2, WINDOW_HEIGHT / 2 - 30);
    window.clear();
    window.draw(text);
    window.display();
}

void displayCardSequence(sf::RenderWindow &window, std::vector<Card> &cards, int viewTime) {
    for (auto &card : cards) {
        card.flip();
    }
    window.clear(sf::Color::Black);
    for (auto &card : cards) {
        card.draw(window);
    }
    window.display();
    sf::sleep(sf::seconds(viewTime));
    for (auto &card : cards) {
        card.flip();
    }
}

void displayLevelComplete(sf::RenderWindow &window, sf::Font &font) {
    displayMessage(window, "Well done!", font);
    sf::sleep(sf::seconds(2));
    displayMessage(window, "Prepare for next level!", font);
    sf::sleep(sf::seconds(2));
}

void displayGameOver(sf::RenderWindow &window, sf::Font &font) {
    displayMessage(window, "Game Over! Try again!", font);
    sf::sleep(sf::seconds(2));
}
```

```cpp
std::string getRandomComment(int score, int mistakes) {
    std::vector<std::string> positive = {"You're on fire!", "Amazing memory!", "Keep it up!"};
    std::vector<std::string> negative = {"Oops, focus harder!", "Don't give up!", "You can do this!"};
    return mistakes > score / 10 ? negative[rand() % negative.size()] : positive[rand() % positive.size()];
}

int main() {
    int level = 1, score = 0, mistakes = 0, hardshipLevel = 1;
    int cardShowTime = 5;

    sf::RenderWindow window(sf::VideoMode(WINDOW_WIDTH, WINDOW_HEIGHT), "Memory Matching Game");
    sf::Font font;
    if (!font.loadFromFile("C:\\Windows\\Fonts\\arial.ttf")) {
        std::cerr << "Failed to load font!\n";
        return -1;
    }

    std::vector<Card> cards;
    std::vector<sf::Color> colors;

    initializeCards(cards, colors);
    bool firstCardFlipped = false, secondCardFlipped = false;
    int firstCardIndex = -1, secondCardIndex = -1;
    bool gameStarted = false;

    displayMessage(window, "Click to Start!", font);
    while (window.isOpen() && !gameStarted) {
        sf::Event event;
        while (window.pollEvent(event)) {
            if (event.type == sf::Event::Closed) window.close();
            if (event.type == sf::Event::MouseButtonPressed && event.mouseButton.button == sf::Mouse::Left) {
                gameStarted = true;
            }
        }
    }
```

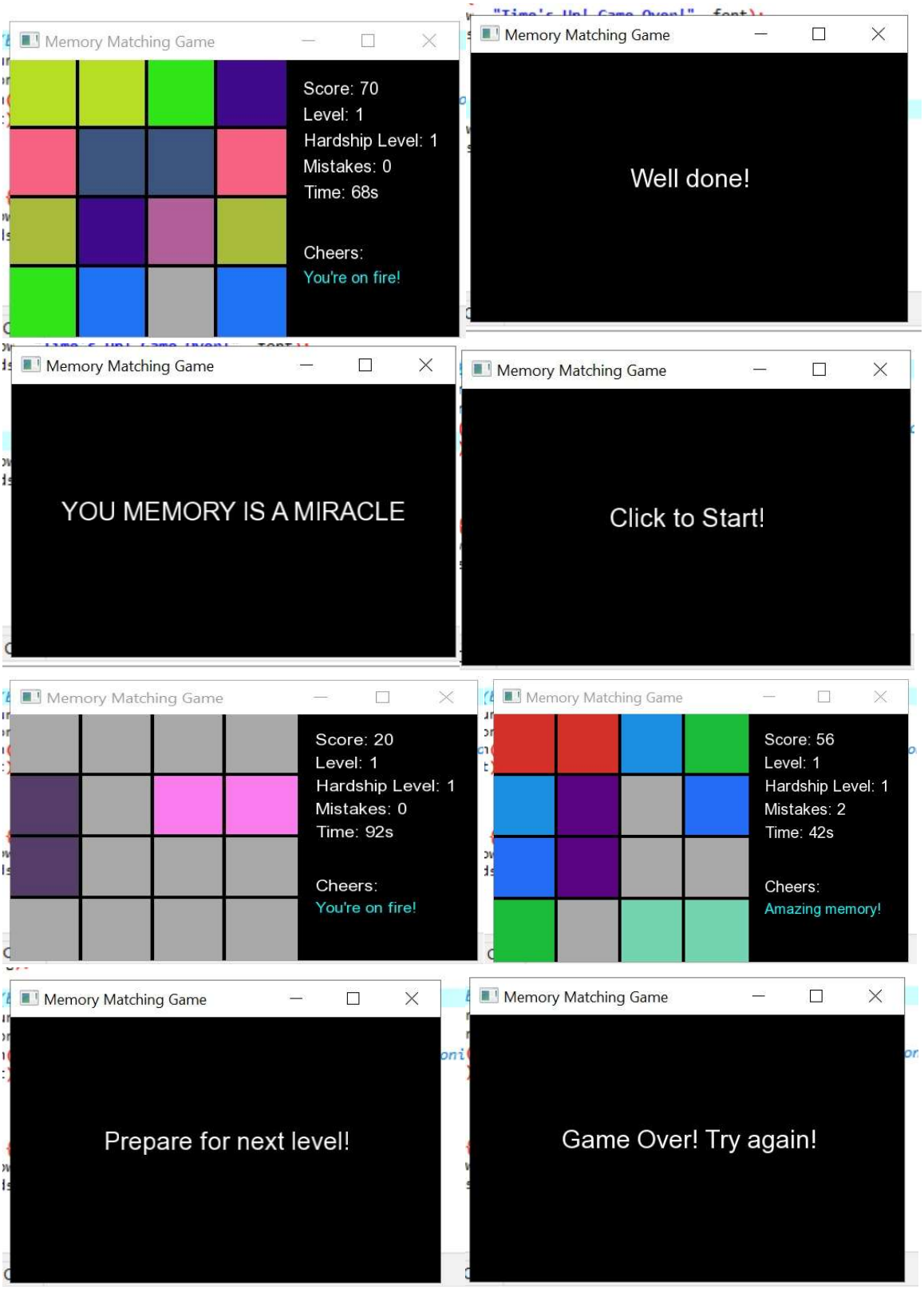
```
std::string currentComment = "Get ready!";  // Initial comment
while (window.isOpen()) {
    int viewTime = std::max(3, 6 - hardshipLevel);

    displayCardSequence(window, cards, viewTime);

    sf::Clock levelClock;

    while (window.isOpen()) {
        sf::Event event;
        while (window.pollEvent(event)) {
            if (event.type == sf::Event::Closed) window.close();

            if (event.type == sf::Event::MouseButtonPressed && event.mouseButton.button == sf::Mouse::Left) {
                sf::Vector2i mousePos = sf::Mouse::getPosition(window);
                int x = mousePos.x / CARD_WIDTH;
                int y = mousePos.y / CARD_HEIGHT;

                if (x < GRID_SIZE && y < GRID_SIZE) {
                    int cardIndex = y * GRID_SIZE + x;

                    if (!cards[cardIndex].flipped && gameStarted) {
                        cards[cardIndex].flip();
                        if (!firstCardFlipped) {
                            firstCardFlipped = true;
                            firstCardIndex = cardIndex;
                        } else if (!secondCardFlipped) {
                            secondCardFlipped = true;
                            secondCardIndex = cardIndex;
                        }
                    }
                }
            }
        }
```

```
        if (firstCardFlipped && secondCardFlipped) {
            if (cards[firstCardIndex].originalColor == cards[secondCardIndex].originalColor) {
                score += 10 * level;
                currentComment = getRandomComment(score, mistakes);  // Update comment after a correct match
                firstCardFlipped = secondCardFlipped = false;

                bool allFlipped = true;
                for (auto &card : cards) {
                    if (!card.flipped) {
                        allFlipped = false;
                        break;
                    }
                }

                if (allFlipped) {
                    displayLevelComplete(window, font);
                    level++;
                    if (level % 3 == 0) hardshipLevel++;

                    initializeCards(cards, colors);
                    levelClock.restart();
                    break;
                }
            } else {
                sf::sleep(sf::seconds(0.5));
                cards[firstCardIndex].flip();
                cards[secondCardIndex].flip();
                score -= 2 * level;
                mistakes++;
                currentComment = getRandomComment(score, mistakes);  // Update comment after a mistake
                firstCardFlipped = secondCardFlipped = false;
```

```
            if (score <= -20 || mistakes >= 10) {
                displayGameOver(window, font);
                return 0;
            }
        }
    }

    window.clear(sf::Color::Black);
    for (auto &card : cards) card.draw(window);

    sf::Text scoreText("Score: " + std::to_string(score), font, 20);
    scoreText.setPosition(WINDOW_WIDTH - 180, 20);
    window.draw(scoreText);

    sf::Text levelText("Level: " + std::to_string(level), font, 20);
    levelText.setPosition(WINDOW_WIDTH - 180, 50);
    window.draw(levelText);

    sf::Text hardshipText("Hardship Level: " + std::to_string(hardshipLevel), font, 20);
    hardshipText.setPosition(WINDOW_WIDTH - 180, 80);
    window.draw(hardshipText);

    sf::Text mistakeText("Mistakes: " + std::to_string(mistakes), font, 20);
    mistakeText.setPosition(WINDOW_WIDTH - 180, 110);
    window.draw(mistakeText);

    int remainingTime = 105 - levelClock.getElapsedTime().asSeconds();
    std::stringstream timeStream;
    timeStream << "Time: " << remainingTime << "s";
    sf::Text timerText(timeStream.str(), font, 20);
    timerText.setPosition(WINDOW_WIDTH - 180, 140);
    window.draw(timerText);
```

```
    // Add a two-line gap before the "Cheers:" heading
    sf::Text cheersHeading("Cheers:", font, 20);
    cheersHeading.setPosition(WINDOW_WIDTH - 180, 170 + 40); // Adjusted gap (two-line gap)
    cheersHeading.setFillColor(sf::Color::White); // White for heading
    window.draw(cheersHeading);

    // Display the comment (below "Cheers:" heading)
    sf::Text funnyComment(currentComment, font, 18);
    funnyComment.setFillColor(sf::Color::Cyan);
    funnyComment.setPosition(WINDOW_WIDTH - 180, 200 + 40); // Adjusted positioning
    window.draw(funnyComment);

    window.display();

    if (remainingTime <= 0) {
        displayMessage(window, "Time's Up! Game Over!", font);
        sf::sleep(sf::seconds(2));
        return 0;
    }

    if (level > 10) {
        displayMessage(window, "YOUR MEMORY IS A MIRACLE", font);
        sf::sleep(sf::seconds(2));
        return 0;
    }
  }
 }

 return 0;
}
```

**Output Screenshots (Taken randomly during gameplay)**



**Testing and Results**

1. **Functionality Testing**:
    - The game logic was tested to ensure that the cards flip correctly, matches are detected, and the score updates appropriately.
    - The game was also tested for the display of messages such as "Game Over," "Level Complete," and other feedback messages.
2. **Performance Testing**:
    - The game was tested to ensure smooth performance without any lag or crashes. It performed well even with a higher number of cards or increased difficulty.
3. **Usability Testing**:
    - The user interface was tested for clarity, and the instructions were easy to follow. Players found the game intuitive and engaging.

**Conclusion**

The memory matching game was successfully developed using SFML and C++. The game meets the requirements by offering engaging gameplay, a clear user interface, and challenging levels. The random card pairing, coupled with dynamic difficulty levels, ensures that the game remains interesting as players progress. The inclusion of feedback messages, such as random comments based on performance, adds a fun and motivational element to the game. The use of **Object-Oriented Programming (OOP)** principles like **Encapsulation** and **Abstraction** has helped organize the game code and make it easier to maintain and extend.