CMPE230 Project 3 - Minesweeper

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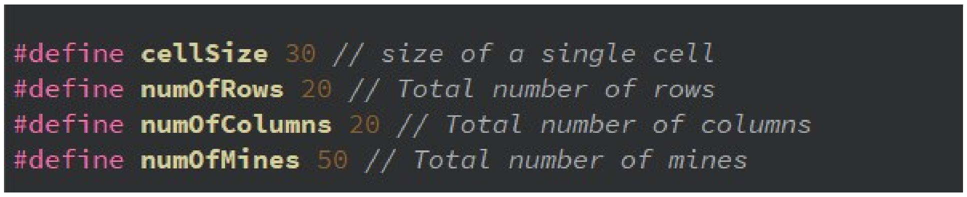
1) Introduction

The Minesweeper game is a classic puzzle game where the objective is to clear a grid containing hidden mines without detonating any of them. The grid presents numbers indicating how many mines are adjacent to each cell, allowing the player to strategically deduce safe cells to uncover. This document provides an in-depth look at the problem definition, solution, user interface, execution, program structure, examples, improvements, difficulties encountered, and conclusion of the Minesweeper game project.

2) Program Interface and Execution

Game Initialization:

- You can change the number of mines, rows and columns by changing respective variables in main.cpp:



```
#define cellSize 30 // size of a single cell
#define numOfRows 20 // Total number of rows
#define numOfColumns 20 // Total number of columns
#define numOfMines 50 // Total number of mines
```

- To execute the program first ensure QT is installed and working. Then you will need to open minesweeper.pro in QT Creator. After making sure that you set the row, column and mine counts you need to build the project in QT Creator by choosing “ Build Project “minesweeper” ” in the Build menu. After that the program is compiled and ready to run in QT Creator.

Gameplay:

- The user clicks on cells to reveal them.
- If a mine is clicked, the game ends.
- If a number is revealed, it indicates how many mines are adjacent to that cell.
- If there is no adjacent mine no number will pop up and all the adjacent cells will be revealed
- The user can flag cells suspected of containing mines.
- The number of revealed cells will be the score.
- User can get hints by clicking hint button and clicking second time will result in revealing the cell if the hinted cell isn't already revealed.

Winning the Game:

- The user wins by revealing all non-mine cells.

User Interface:

- The GUI includes a grid of buttons for revealing cells and flagging mines.
- There are menu options for restarting the game and taking a hint from system at the top.
- A score that keeps track of the total number of revealed cells is displayed at the top left corner.

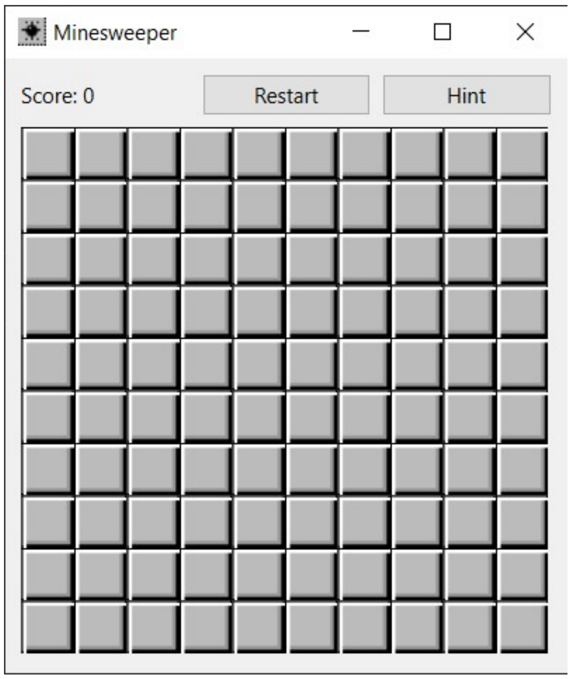
3) Input and Output

User can open cells by simply left clicking them. Similarly to restart to game left clicking restart button and to get a hint left clicking hint button will be sufficient.

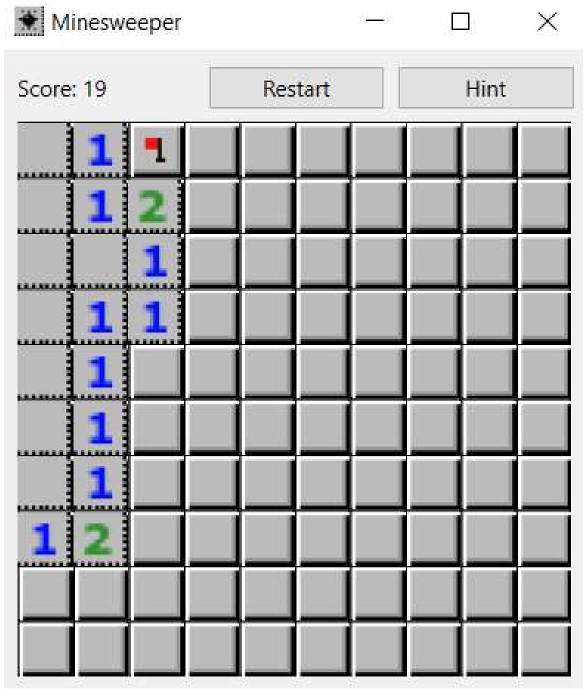
Right clicking will result with a flag. If there already is a flag it is possible to remove it with a second right click.

Some Examples:

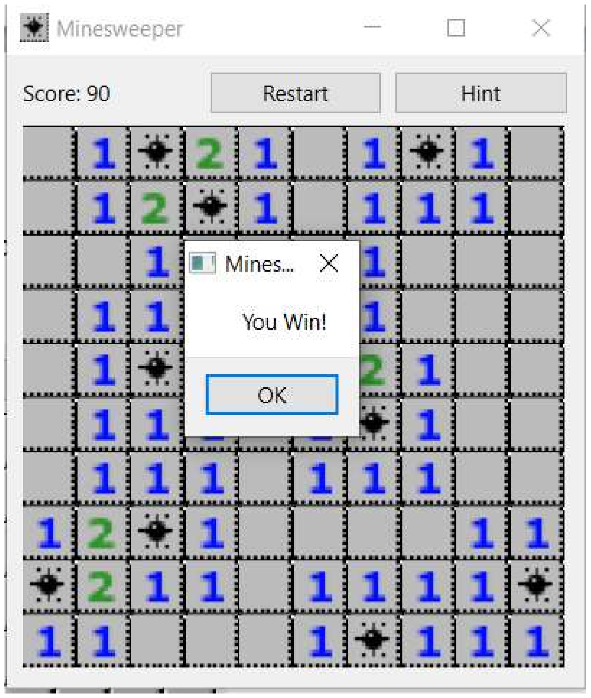
- Initial situation:

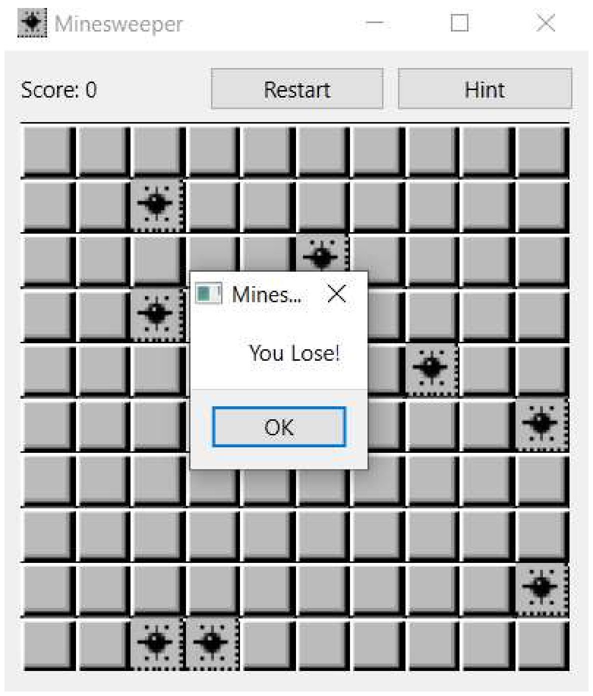


- After left click top left most cell and putting a flag:

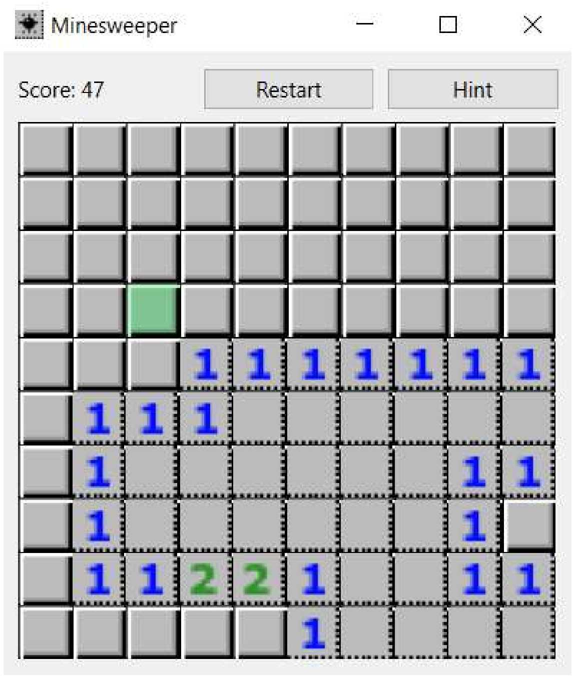


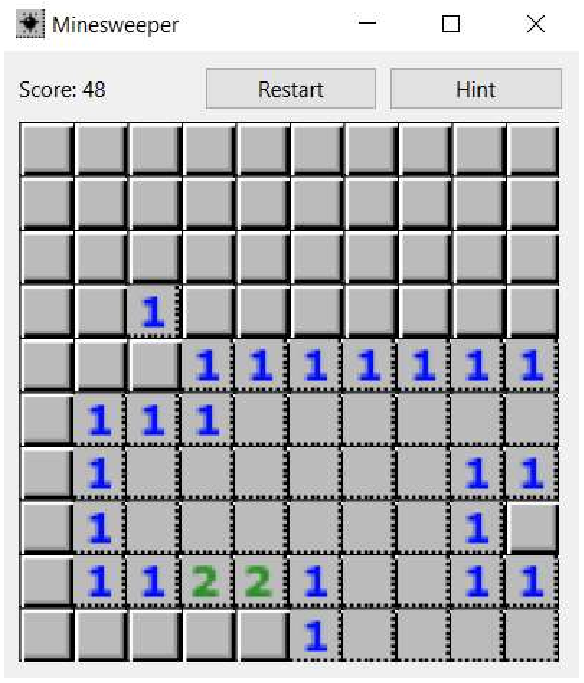
- Game lose and game win screens:





- Using hint button twice:





4) Program Structure

The Minesweeper game is structured into several modules:

1. **main.cpp:**
   - Initializes the game and handles the main game loop.
   - Manages the graphical user interface, including drawing the grid and handling user interactions.
2. **MineField.cpp:**
   - Contains the logic for grid generation, mine placement, cell revealing, hint finding and checking the game end conditions.
3. **Cell.cpp:**
   - Stores data for each cell

5) Improvements and Extensions

Possible Improvements:

- **Enhanced Graphics:** Improving the visual appeal of the game.
- **Leaderboard:** Implementing a leaderboard to track high scores.
- **Advanced Commands:** The game can include more advanced commands. For example left clicking an opened cell with a status equals to the amount of flags adjacent to it may open all non-flagged cells.

- **Multiplayer Mode:** Allowing multiple players to play cooperatively or competitively.
- **Improved Hints:** Finding hints that are hard to deduce by using advanced patterns or utilizing the remaining mine count.

6) Difficulties Encountered

Challenges:

- **GUI Implementation:** Handling user interactions and drawing the grid were initially challenging. There were problems like having changes in cell sizes and having non-square cells. However those problems got eventually solved by fixing sizes or using similar approaches.
- **Hint Option:** Implementing a perfect algorithm for the hint button that utilizes all the information on the board proved to be challenging and somewhat excessive for our needs. Instead, we implemented a sufficient algorithm that uses a partial set of information. The algorithm works as follows:

1. **Initial Comparison:**
    - The algorithm first compares the status of all opened cells with the number of closed cells adjacent to each opened cell.
    - If the number of adjacent closed cells equals the number indicated by the opened cell, virtual flags are placed on each of these closed cells.
2. **Virtual Flag Check:**
    - The algorithm then scans all the opened cells again.
    - It compares the number of virtual flags with the number indicated by the opened cell.
3. **Safe Cell Identification:**
    - If the number of virtual flags around an opened cell equals the number on the cell, and there is an additional closed cell without a virtual flag, this closed cell is considered safe.
    - This safe cell is then provided as a hint to the player.

This approach provides a practical balance, offering useful hints without the complexity of a perfect algorithm.

7) Conclusion

The Minesweeper game project provided valuable experience in GUI programming, algorithm design, QT implementation and project documentation. The final product is a functional game with potential for future enhancements. This project highlighted the importance of planning, problem-solving, and continuous improvement in software development.

8) Appendices

All the source codes (.cpp and .h files), all the required .png files (in “assets” folder), and the .qrc and .pro files that are required by QT Creator to compile and run the project are provided in the .zip file.