

Project - 1 MA517M-Basic Programming Laboratory Last Date: 09 November 2025
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Rational Numbers (Fractions) using C++ Classes and Operator Overloading

Objective: To design a C++ program that implements fractions using classes, automatically simplifies them using GCD, and supports arithmetic operations, comparison, and display using operator overloading.

A rational number is of the form

$$\frac{p}{q}, \quad q \neq 0$$

where p and q are integers. Fractions are automatically reduced to simplest form using the greatest common divisor (GCD) of p and q .

Problem Description

Design a class `Rational` to represent fractions. The class should perform arithmetic operations, comparisons, and display in reduced form using operator overloading.

Class Specification

- **Class Name:** `Rational`
- **Private Data Members:**
 - `int numerator;`
 - `int denominator;`
 - `void simplify();`
- **Public Member Functions:**
 - `Rational(int p=0, int q=1);`
 - `void display() const;`
 - `int getNumerator() const;`
 - `int getDenominator() const;`

Operator Overloading

- `operator +(), -, *, /()` Performs addition, subtraction, multiplication, and division of fractions
- `operator ==((), !=(), <(), >())` Compares two fractions
- `operator <<()` Displays the fraction in simplest form

Tasks

1. Create fractions $f_1 = \frac{6}{8}$ and $f_2 = \frac{3}{4}$
2. Automatically simplify fractions using GCD
3. Compute $f_1 + f_2$, $f_1 - f_2$, $f_1 * f_2$, f_1 / f_2
4. Compare fractions using overloaded comparison operators
5. Display results using the overloaded $<<$ operator

Expected Output Example

```
f1 = 6/8 simplified = 3/4
f2 = 3/4
```

```
f1 + f2 = 3/2
f1 - f2 = 0/1
f1 * f2 = 9/16
f1 / f2 = 1/1
```

```
f1 == f2 : True
f1 < f2  : False
```

Project - 2: Conway's Game of Life Using C++ Classes

Problem Statement

Design and implement **Conway's Game of Life** using **C++ classes**. This is a zero-player game where the evolution of a 2D grid is determined by its initial state and simple rules. Each cell in the grid can be *alive* or *dead*, and the next generation of the grid is calculated based on the number of alive neighbors. The project should utilize object-oriented programming concepts such as classes, objects, encapsulation, and methods for handling game logic and grid updates.

Project Requirements

1. Create a **Cell** class to represent a single cell in the grid.
 - (a) Data member: current state (alive or dead)
 - (b) Methods: `setState()`, `getState()`
2. Create a **Grid** class to represent the game board (matrix).
 - (a) Initialize the grid with random alive and dead cells.
 - (b) Include a method to display the current state of the grid.
 - (c) Include a method to count alive neighbors for each cell.
 - (d) Include a method to update the grid according to the following rules:
 - Any live cell with fewer than two live neighbors dies (underpopulation).

- Any live cell with two or three live neighbors lives on.
 - Any live cell with more than three live neighbors dies (overpopulation).
 - Any dead cell with exactly three live neighbors becomes alive (reproduction).
3. Create a **Game** class to manage simulation.
 - (a) Display options for the user: **Start**, **Next Generation**, or **Quit**.
 - (b) Allow the user to advance the simulation one generation at a time.
 - (c) Allow the user to quit and confirm before exiting.
 - (d) Optionally, allow the user to specify the number of generations to simulate automatically.
 4. Ensure proper encapsulation of cell and grid operations within the respective classes.

Suggested Class Structure

1. Cell Class:

- Data member: `bool isAlive`
- Methods: `setState(bool state)`, `getState()`

2. Grid Class:

- Data member: 2D array of `Cell` objects
- Methods: `initializeGrid()`, `displayGrid()`, `countAliveNeighbors(int row, int col)`, `updateGrid()`

3. Game Class:

- Data member: `Grid` object, user choice, generation counter
- Methods: `startGame()`, `nextGeneration()`, `confirmQuit()`

Reference

For more details about Conway's Game of Life, visit: https://en.wikipedia.org/wiki/Conway's_Game_of_Life