EEEC10008(515169) S23: Object-Oriented Programming

Advanced Topics of Class

What you will learn from Lab 4

In this laboratory, you will learn the advance topics of object-oriented programming using class.

TASK 4-1 STATIC MEMBER

✓ `static` member can be taken as a global member for this class and all objects own the same copy (or value) of the member.

```
// lab4-1.cpp
#include <iostream>

class Point2D
{
private:
    int x;
    int y;
    static const int limit = 10;
    static double value;   // indicates that all object's value are the same

public:
    Point2D();
    void assignPoint2D(int x, int y);
    void displayPoint2D();
    static void setValue(double v);
                        // only static member function can access static member
};

Point2D::Point2D()
{
    x = 0;
    y = 0;
}

void Point2D::assignPoint2D(int n1, int n2)
{
    x = n1;
    y = n2;
}

void Point2D::displayPoint2D()
{
    std::cout << "(" << x << "," << y << ") = ";
    std::cout << value << std::endl;
}
void Point2D::setValue(double v)
```

```
{
    if (v < limit)
       value = v;
    else
       value = limit;
}

double Point2D::value = 0.0;   //  It needs to initialize static member

int main()
{
    Point2D ptArray[10];
    ptArray[0].setValue(1.1);
                    // modify the static member by static member fuction

    for (int i=0;i<10;i++)
    {
        ptArray[i].assignPoint2D(i,i+2);
        ptArray[i].displayPoint2D();
    }

    return 0;
}
```

- Comment the line `double Point2D::value = 0.0;` and compile the program again. Try to explain the error message.
- Remove `static` in `static const int limit = 10.0;` and compile the program again.
- Remove `const` in `static const int limit = 10.0;` and compile the program again.
- Try to modify `ptArray[0].setValue(1.1);` as `ptArray[0].setValue(30.1);` and execute the program again.
- Note: In C++11, you are not allowed to initialized non-integral type in class definition. You should only declare the variable and initialize it in the source code file.

TASK 4-2 CONST AND MUTABLE MEMBERS

✓ `const` member functions are not supposed to modify objects of a class. Please identify which member function should be `const` to make the program work successfully.

```
// lab4-2-1.cpp
#include <iostream>
/* class Point2D declares and defines in lab4-1*/

int main()
{
    const Point2D pt1;
    Point2D pt2;

    pt1.displayPoint2D();
    pt2.displayPoint2D();

    return 0;
}
```

```
// lab4-2-2.cpp
#include <iostream>
/* class Point2D declares and defines in lab4-2-1*/
/* add mutable (int) member named color to class Point2D */

void Point2D::displayPoint2D() const
{
    x = 5; y = 4;
    color = 10;
    std::cout << "(" << x << "," << y << ") = ";
    std::cout << value << std::endl;
}

int main()
{
    const Point2D pt1;
    Point2D pt2;

    pt1.displayPoint2D();
    pt2.displayPoint2D();

    return 0;
}
```

TASK 4-3 THIS POINTER

✓ `this` pointer is an implicit private member to store the address of the object for a class.

```
// original version in lab3-2.cpp
PointND::PointND(){
    value = 0.0;
    coord = new int [num];
    for (int i=0;i<num;i++) coord[i] = 0;
}
```

```
// modify version in lab4-3-1.cpp
PointND::PointND(){
    this->value = 0.0;
    this->coord = new int [num];
    for (int i=0;i<num;i++) this->coord[i] = 0;
}
```

✓ `this` pointer includes the address of the object, so it can be used to compare the addresses between different objects.

```
// lab4-3-2.cpp
#include <iostream>
/* class PointND declares and defines in lab 4-3-1 with copy constructor*/
/* add declaration of member function: copyPoint2D() to class PointND  */

void PointND::copyPointND(const PointND &pt){
    if (this != &pt){
        value = pt.value;
        coord = new int [num];
        for (int i=0;i<num;i++) coord[i] = pt.coord[i];
    }
}
int main(){
    int *vec = new int [num];
    for (int i=0;i<num;i++) vec[i] = i;

    PointND pt1;
    pt1.assignValue(4.3);
    pt1.assignCoord(vec,num);
    pt1.displayPointND();

    PointND pt2;
    pt2.copyPointND(pt1);
    pt2.displayPointND();

    PointND pt3;
    pt3.copyPointND(pt3);
    pt3.displayPointND();

    delete []vec;
    return 0;
}
```

EXERCISE 4-1 MINE SWEEPER

- ✓ In this exercise, you will create the famous and classic Windows game MineSweeper, by implementing classes named MineSweeper and Grid with member variables, static variables, member functions, and static functions to complete the game.
- ✓ You can get MineSweeper.h, Grid.h, and ex4-1.cpp from /home/share/lab4/, you should implement MineSweeper.cpp and Grid.cpp by yourself.
- ✓ Please run your program on our server, otherwise some characters might not display correctly.
- ✓ The icon might look dull on mobaxterm, if you want the icon to be more colorful, you can try using termius (https://termius.com/) to connect to our server.
- ✓ Introduction to Grid.h

```
class Grid {
    bool isMine = false;        // Indicate if the grid is a mine
    bool isOpen = false;        // Indicate if the grid is opened
    bool isExplode = false;     // Indicate if the mine is explode
    int mineCount = 0;          // The neighbor mine count

    static int gridOpenCount;  // The number of opened grid

  public:
    // Setters
    void setMine();                      // Set isMine to true
    void setExplode();                   // Set isExplode to true
    void setMineCount(int mineCount);  // Set mine count
    void open();                         // Set the grid to open

    // Getters
    bool getIsMine();                    // Get isMine
    bool getIsOpen();                    // Get isOpen
    int getMineCount();                  // Get mineCount

    // Static
    // Get gridOpenCount static variable.
    static int getGridOpenCount();

    // Reset gridOpenCount static variable.
    static void resetGridOpenCount();
```

```
    // Render
    // Render the grid by checking the grid status.
    // If the grid is not opened, render the blank icon.
    // If the grid is opened and the mineCount is 0, render 2 spaces
    // If the grid contains mine, is opened, and is exploded, render
    // the exploded icon.
    // If the grid contains mine, is opened, and is not exploded,
    // render the bomb icon.
    void render();
};
```

✓ Introduction to MineSweeper.h

```
class MineSweeper {
    int sizeX;       // The width of the grid map
    int sizeY;       // The height of the grid map
    int mineNum;     // The number of mine

    bool explode;    // If any mine explode, player lose
    bool win;        // If all the empty grid is opened, player win

    Grid** map = nullptr;  // The 2D grid map

  public:
    void run();      // The main logic process of the game

  private:
    // Prepare new grid map

    // Ask player for sizeX, sizeY and mineNum.
    // Then call createNewMap(), generateMines(), and countMine()
    void newGame();

    // Create new 2D grid map (2D Array)
    void createNewMap();

    // Randomly choose the grid to insert mines, provided by TA.
    // DO NOT MODIFY!
    void generateMines();
```

```
    // Count the number of neighbor grids that contains mine.
    void countMine();


    //In-game interaction

    // Open the selected grid, need to check for the validity of the
    // input.
    // If the opened grid is mine, explode!
    // If the opened grid's mineCount is 0,
    // call propagateWhiteSpace()
    void openGrid(int pressedPosY, int pressedPosX);

    // Propagate the white space recursively.
    // Stop the recursion when the grid contains mine, is already
    // opened, or its mineCount is not 0
    void propagateWhiteSpace(int pressedPosY, int pressedPosX);

    // After game setting
    void revealAllMines();
    void explodeAllMines();

    // Helper functions

    // Check if a game is won by comparing the gridOpenCount, grid
    // map size, and mine count
    void checkWin();

    //Check if a input pos is valid
    bool isPosValid(int posY, int posX);

    // Render
    // Render the grid map
    void render();
```

✓ How to print UTF-8 characters:

Code:

```
wcout << L"\U0001F4A5";
wcout << L"\U0001F4A3";
wcout << L"\u2B1C";
```

Result:

✓ Sample Output

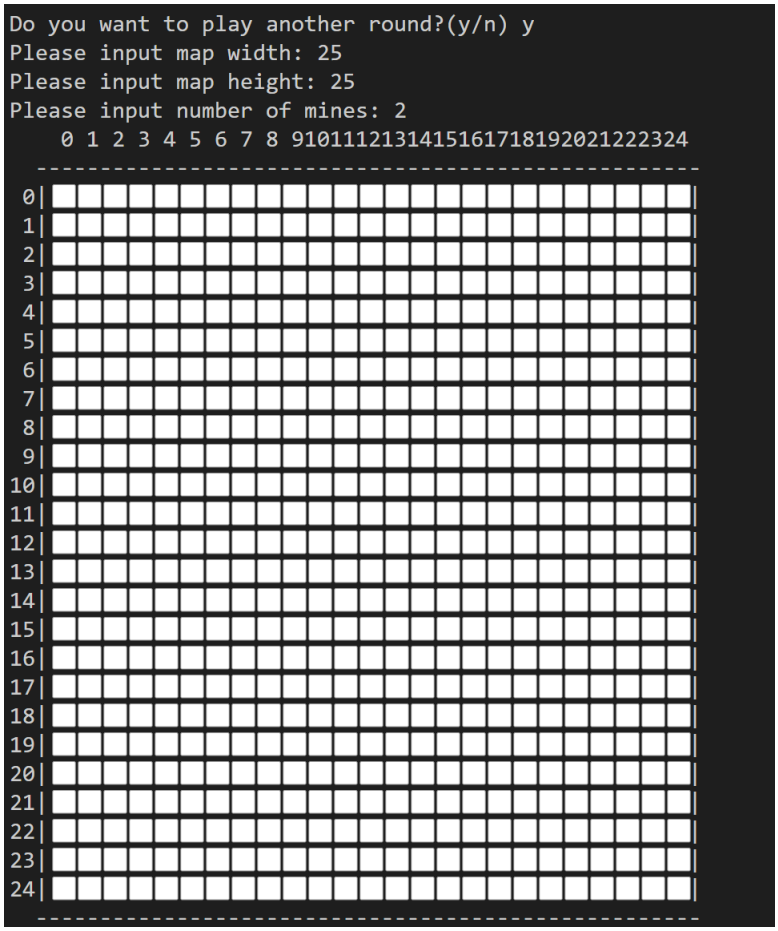
```
TA_Samuel@ICP:~/workspace/spring/lab4$ ./ex4-1
Please input map width: -1
Please input map height: -1
Input Error!
Please input map width: 0
Please input map height: 10
Input Error!
Please input map width: 10
Please input map height: 10
Please input number of mines: 0
Input Error!
Please input number of mines: 101
Input Error!
Please input number of mines: 5
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|■■■■■■■■■■|
 1|■■■■■■■■■■|
 2|■■■■■■■■■■|
 3|■■■■■■■■■■|
 4|■■■■■■■■■■|
 5|■■■■■■■■■■|
 6|■■■■■■■■■■|
 7|■■■■■■■■■■|
 8|■■■■■■■■■■|
 9|■■■■■■■■■■|
  ----------------------
Please enter the coordinate (x, y) you want to press: -1 9
Invalid coordinate!
Please enter the coordinate (x, y) you want to press: 10 10
Invalid coordinate!
Please enter the coordinate (x, y) you want to press: 0 0
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|         1 2 2 1    |
 3|         1■■ 1      |
 4|         1 2 2 1    |
 5|   1 1 1            |
 6|   1■■ 1 1 1        |
 7|   1■ 1■■ 1         |
 8| 1■ 1   1 1 1       |
 9|■■ 1                |
  ----------------------
```

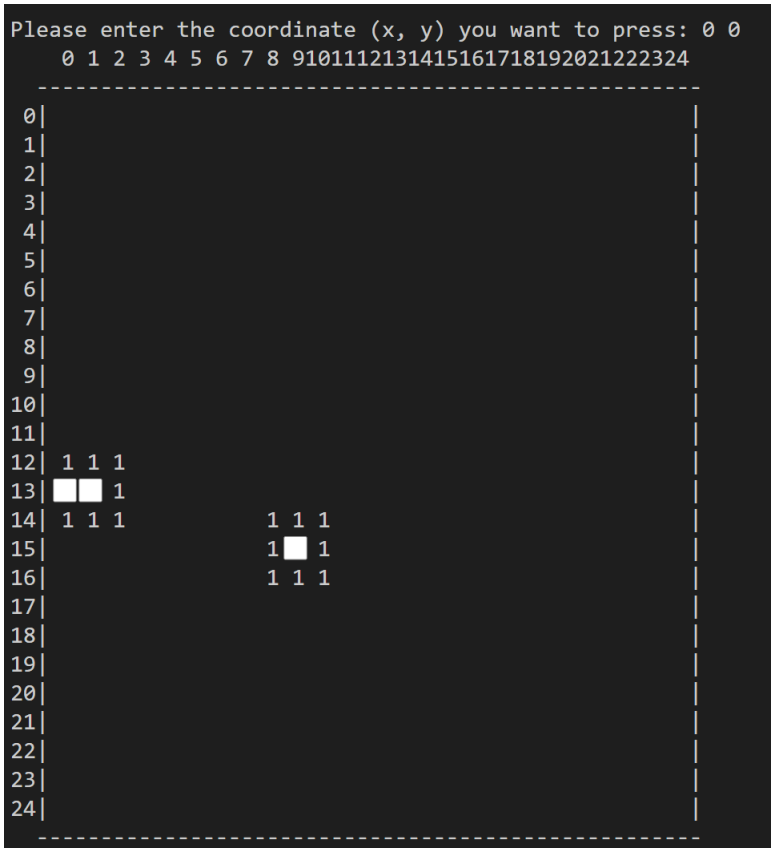
```
Please enter the coordinate (x, y) you want to press: 0 1
Grid (0, 1) is already pressed!
Please enter the coordinate (x, y) you want to press: 0 9
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|         1 2 2 1    |
 3|         1■■ 1      |
 4|         1 2 2 1    |
 5|   1 1 1            |
 6|   1■■ 1 1 1        |
 7|   1■ 1■■ 1         |
 8| 1■ 1   1 1 1       |
 9| 1■ 1               |
  ----------------------
Please enter the coordinate (x, y) you want to press: 2 7
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|         1 2 2 1    |
 3|         1■■ 1      |
 4|         1 2 2 1    |
 5|   1 1 1            |
 6|   1■■ 1 1 1        |
 7|   1 1 1■■ 1        |
 8| 1■ 1   1 1 1       |
 9| 1■ 1               |
  ----------------------
Please enter the coordinate (x, y) you want to press: 1 8
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|         1 2 2 1    |
 3|         1■■ 1      |
 4|         1 2 2 1    |
 5|   1 1 1            |
 6|   1■■ 1 1 1        |
 7|   1 1 1■■ 1        |
 8| 1 1 1   1 1 1      |
 9| 1■ 1               |
  ----------------------
```

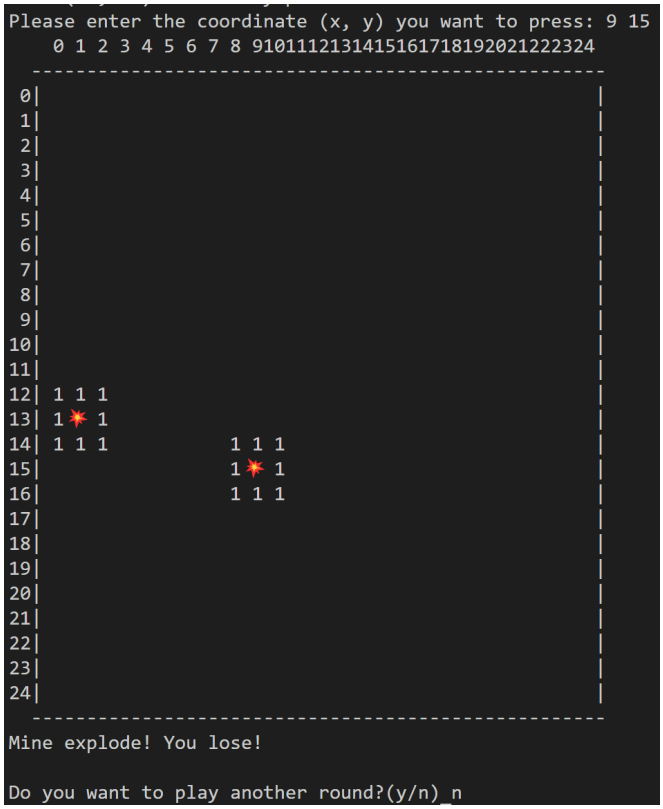
```
Please enter the coordinate (x, y) you want to press: 3 6
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|         1 2 2 1    |
 3|         1■■ 1      |
 4|         1 2 2 1    |
 5|   1 1 1            |
 6|   1■ 1 1 1 1       |
 7|   1 1 1■■ 1        |
 8| 1 1 1   1 1 1      |
 9| 1■ 1               |
  ----------------------
```

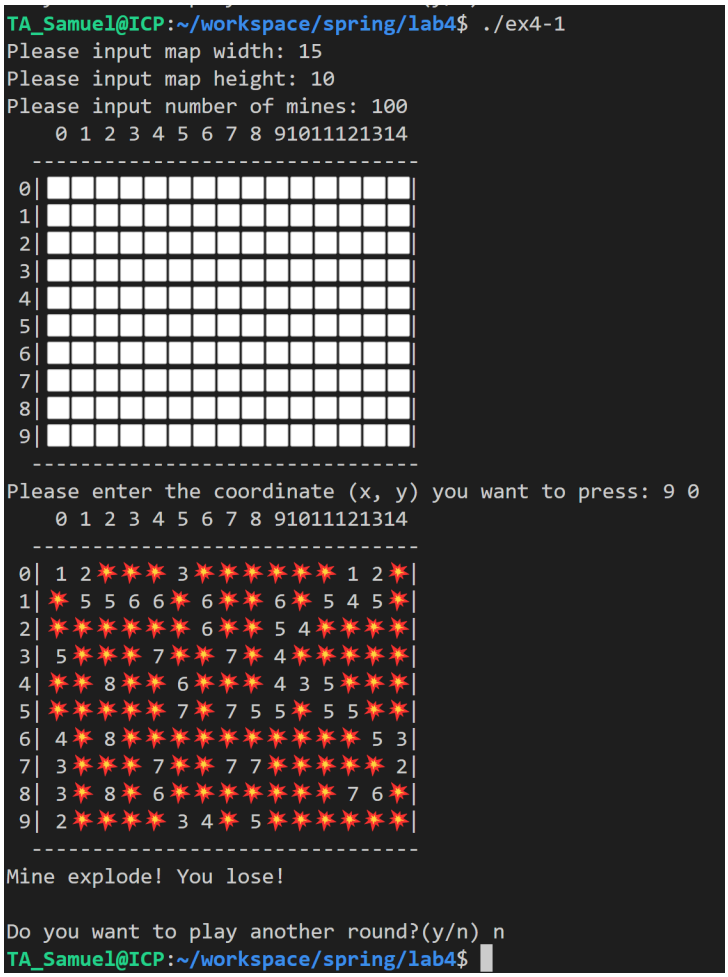
```
Please enter the coordinate (x, y) you want to press: 4 7
    0 1 2 3 4 5 6 7 8 9
  ----------------------
 0|                    |
 1|                    |
 2|        1 2 2 1     |
 3|        1 💣💣 1     |
 4|        1 2 2 1     |
 5|   1 1 1            |
 6|   1 💣 1 1 1 1      |
 7|   1 1 1 1 💣 1      |
 8| 1 1 1   1 1 1      |
 9| 1 💣 1              |
  ----------------------
You win!
```

```
Do you want to play another round?(y/n) y
Please input map width: 20
Please input map height: 20
Please input number of mines: 1
    0 1 2 3 4 5 6 7 8 910111213141516171819
  ----------------------------------------
 0|                                        |
 1|                                        |
 2|                                        |
 3|                                        |
 4|                                        |
 5|                                        |
 6|                                        |
 7|                                        |
 8|                                        |
 9|                                        |
10|                                        |
11|                                        |
12|                                        |
13|                                        |
14|                                        |
15|                                        |
16|                                        |
17|                                        |
18|                                        |
19|                                        |
  ----------------------------------------
Please enter the coordinate (x, y) you want to press: 0 0
    0 1 2 3 4 5 6 7 8 910111213141516171819
  ----------------------------------------
 0|                                        |
 1|            1 1 1                      |
 2|            1 💣 1                      |
 3|            1 1 1                      |
 4|                                        |
 5|                                        |
 6|                                        |
 7|                                        |
 8|                                        |
 9|                                        |
10|                                        |
11|                                        |
12|                                        |
13|                                        |
14|                                        |
15|                                        |
16|                                        |
17|                                        |
18|                                        |
19|                                        |
  ----------------------------------------
You win!
```


Do you want to play another round?(y/n) y
Please input map width: 25
Please input map height: 25
Please input number of mines: 2
0 1 2 3 4 5 6 7 8 910111213141516171819202122232 4


Please enter the coordinate (x, y) you want to press: 0 0
0 1 2 3 4 5 6 7 8 910111213141516171819202122232 4


Please enter the coordinate (x, y) you want to press: 9 15
0 1 2 3 4 5 6 7 8 9101112131415161718192021222324
Mine explode! You lose!
Do you want to play another round?(y/n) n


TA_Samuel@ICP:~/workspace/spring/lab4$ ./ex4-1
Please input map width: 15
Please input map height: 10
Please input number of mines: 100
0 1 2 3 4 5 6 7 8 91011121314
Please enter the coordinate (x, y) you want to press: 9 0
0 1 2 3 4 5 6 7 8 91011121314
Mine explode! You lose!
Do you want to play another round?(y/n) n
TA_Samuel@ICP:~/workspace/spring/lab4$