

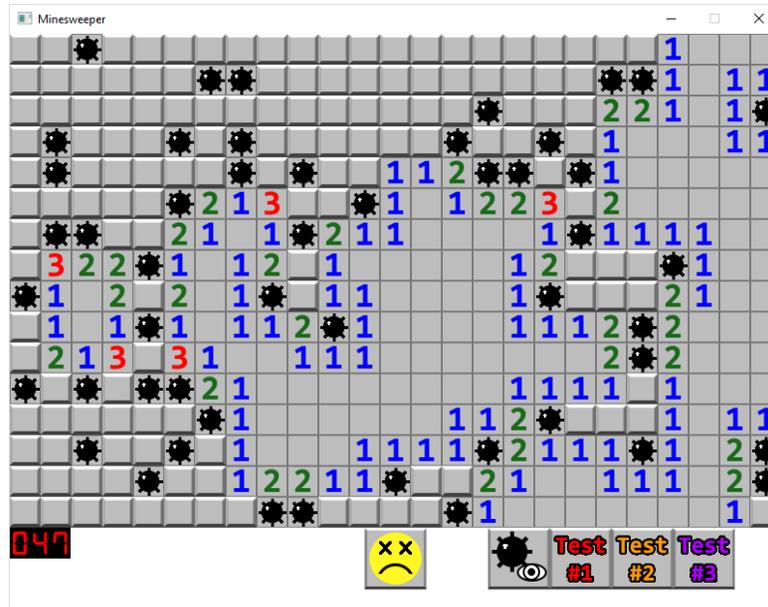
Project 3 – Minesweeper

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Overview

For this project you are going to create a version of the classic game, Minesweeper. Your final version will look something like this:



If you've never played the game before, you can find a number of playable versions of this online:

<http://minesweeperonline.com/>

<http://www.freeminesweeper.org/minecore.html>

To create this project you are going to use SFML (the Simple and Fast Multimedia Library) to do the work of drawing images to the screen and getting mouse input, while you will be responsible for everything else.

Description

Rules Overview

The rules of the game are as follows:

There exists a board, which contains a grid of spaces. A space could be a mine, or not. The player clicks on a space, and it gets revealed. The goal of the game is to reveal all the spaces that are not mines, while avoiding the spaces that are.

When a space is revealed:

If it's a mine, the game ends

If it's not a mine, it shows the number of mines **adjacent to** that space (anywhere from 0 to 8, with 0 just showing as an empty space)

- If a space has no adjacent mines, all non-mine spaces adjacent to it are also revealed

The player uses the numbers as clues to figure out where other mines may be located.

When all of the non-mine spaces have been revealed, the player wins!

Other features:

Flags: Right-clicking a **hidden** space puts a flag on that space, marking it as a possible mine. Flagged spaces cannot be revealed (with left-clicks or as a result of adjacent spaces being revealed), but another right-click will remove the flag.

Mine Counter: to track the number of mines that are on the board. Every time the player places a flag, the counter goes down by one. Every time they remove a flag, the counter goes up by one. The mine counter CAN go negative!

Restart Button: The smiley face centered at the top or bottom of the window lets you restart a new board with everything reset and mines randomized

Non-standard features for your version of this project

Debug Button: Clicking this button will toggle the visibility of the mines on the board. Use this to help you test/debug various features of the game. Having to play the game properly each time you want to test something is very time-consuming. Creating these developer shortcuts helps speed up the development process

Test Buttons #1-3: Another development shortcut, clicking on these loads a file with a specific board layout, details on this later.

Those are the features that your game will need to have. The rules are pretty simple, but even simple games like this can be challenging to implement.

Window / Board Setup

Most implementations of this game allow for variability in difficulty, board size, etc, but for this project you are going to use these dimensions and values:

Window Size	800 x 600
Mine count	50 on randomly generated maps, determined by file in other cases (more on this later)
Tile count	25 x 16 (400 tiles total)

SFML

The library that you will be using in this project is SFML—Simple Fast Multimedia Library. The first thing you would need to do is compile an application using this. Building an application using an external library can be a difficult thing, but it's something that you typically only have to do once at the start of a project, and then you're good to go until that project is finished.

To get started with SFML, visit this site:

<https://www.sfml-dev.org/download/sfml/2.5.1/>

You want to download the appropriate version for the IDE/compiler that you are using. If you are using something that isn't listed there, it is HIGHLY RECOMMENDED that you install and use one of the recommended tools. On Windows that would be Visual Studio, XCode on MacOS, etc. The links on that page are for already-compiled versions of the library which will work "out of the box" with the appropriate compiler.

Installing and compiling your first “Hello World” program can be a bit tricky, especially if you’ve never done it before. There are guides here: <https://www.sfml-dev.org/tutorials/2.5/>, and certainly elsewhere online, but often the best source is from the developer’s themselves.

SFML Basics

There are many guides and tutorials on how to use SFML, but the key features that you will be utilizing for this project are:

sf::Sprite	These objects will let you draw some or all of a texture to the screen, the primary object that you will use to represent all aspects of the game
sf::Texture	These store external images that your program needs
sf::Vector2f/i/u	A 2-dimensional vector (an X and Y position), a location on the screen; the f/i/u at the end indicates the type of data used for storage (float, int, unsigned int)
sf::Mouse	The mouse class, giving you information about where the cursor is located, and whether or not a mouse button is pressed

SFML Tutorials

This document will not replicate the wealth of information already out there about this library. The primary list of examples/tutorials can be found here: <https://www.sfml-dev.org/tutorials/2.5/>

From that page, a few in particular you will find useful for this project:

<https://www.sfml-dev.org/tutorials/2.5/window-window.php>

<https://www.sfml-dev.org/tutorials/2.5/window-events.php>

<https://www.sfml-dev.org/tutorials/2.5/graphics-sprite.php>

Anything beyond that will not be applicable for this project (networking, audio, etc will NOT be used). Everything you see on the screen (each space, numbers, buttons, etc) will all be created and drawn the same way: load a texture, create one or more sprites from that texture, and then draw them to the screen.

You will have to load and store the images listed in the next section in sf::Texture objects.

SF::Texture Objects and Global Variables

In this project you should not, under any circumstances, attempt to use sf::Texture objects in global space. Globals in general should be avoided, but if you try to load a sf::Texture in global space it may be initialized before other parts of SFML are initialized, causing it to crash before main() even starts.

To make matters worse, this problem might not occur on your machine, but it could on someone else’s (i.e. the person grading your project).

Images

For this project you will have a folder, creatively called **images**, where all of the images for this project will be stored. These images will all be loaded as sf::Texture objects to be used in the creation of sf::Sprite objects.

The images are as follows:

Game Images		
	mine.png	The star of the game (although if you play properly, you'll never see one!)
	tile_hidden.png	What all tiles look like before they are clicked/revealed
	tile_revealed.png	A revealed tile with no adjacent tiles
	number_#.png	Tiles with the numbers 1-8 on them (replace # with the appropriate number. Used for tiles that have 1-8 adjacent mines
	flag.png	Draw this on top of hidden tiles when they are flagged by the player as possible mines.
UI Images		
	face_happy.png	Click this button to reset the map. New mines, everything hidden, it's like you restarted the program.
	face_win.png	Victory!
	face_lose.png	The opposite of victory! (It's cool, no smiley faces were harmed during the creation of this project)
	digits.png	Used for the digits on the "remaining mines" display. You can use this one texture for all the numbers, and change the "texture rect" of a sprite to draw a different portion of the image. The size of each digit (and the size of the texture rect you should use) is 21 x 32 pixels, and each digit would be offset by 21 (the width) times the digit you wanted. See https://www.sfml-dev.org/tutorials/2.5/graphics-sprite.php for more information
	debug.png	Used to toggle debug mode
	test_1/2/3.png	Used to load test files from which the board will be set

Other Features

Buttons

A button is really just an image that you can click on to make something happen. A more complex UI system would use an event/messaging system, but on a basic level you just need a `sf::Sprite` to represent the button, and every time the player clicks on something, you need to check if that mouse click occurred inside the boundaries of the `sf::Sprite` you're using as the button.

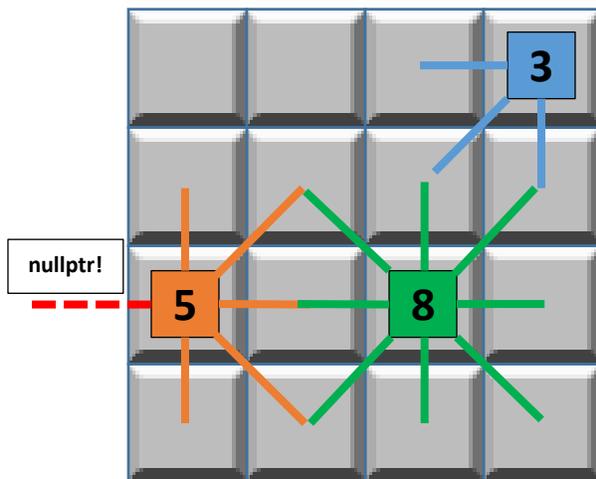
If you're drawing a sprite somewhere, you know its position (it's 0, 0 by default, or whatever you set it to). You can get the width/height of the sprite through its `textureRect`, and then it's just a matter of checking if the mouse position is inside that box.

Adjacent Mines and Tiles

In order to calculate the number of nearby mines, as well as when revealing tiles, each tile should store a list of neighboring tiles. A tile could have **UP TO 8** neighbors. An easy way to do this is with pointers. Since the number is a variable, a dynamically sized container would be perfect for this. You could also use a fixed-length array, since no tile will ever have more than 8 neighbors.

```
vector<Tile*> adjacentTiles; // Store each tile near us, the size() of each vector will vary
Tile* neighbors[8]; // Always 8 pointers, some of which might be nullptr
```

Adjacent Mines



In this example, tiles on the corners have 3 adjacent neighbors. The tiles on the edges of the board have 5 neighbors, while tiles not on the corner or the edges have 8 neighbors.

If you were to create an array of 8 pointers, some of them might not be valid, depending on where that particular tile is located

How you determine which tiles are nearby depends on how you set up the original board. 2D array? Each index will have neighbors that are ± 1 in the x/y axes.

Using a single array/vector? The calculations will be a bit different.

Code Structure

With larger programs, you can accomplish the goal in any number of ways. There isn't a single way to write this that works better above all others. From the outside perspective (i.e. that of a player), your application needs to DO various things:

- When the player clicks a space, reveal it.
 - When the player clicks the restart button, reset the board.
 - If a mine is revealed, end the game.
- And so on.

HOW you choose to accomplish those things is up to you. If you want to write a single, gigantic main() function, you are free to do so—that approach is not recommended, however. A few suggestions:

A class to represent the board. This represents the core data object in the game.

A class for tiles/spaces. The board is made up of a whole lot of these things. Each one of these can be a mine, have a flag, some number of adjacent tiles/mines, etc.

Many programs (games or otherwise) do the same things over and over again while the application is running. The ability to easily (in code) reset everything is critical. Think about what sorts of helper functions you might want to make that happen. Things like:

Restarting the board

Setting or clearing tiles of flags

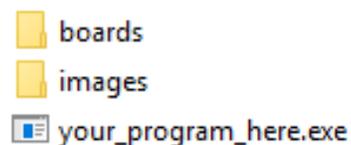
Setting or clearing mines (singly or in large quantities)

Recalculating the number of adjacent mines

Etc...

Paths

In this project, any operations involving files (loading textures and boards) should use RELATIVE paths, NOT absolute paths. Your code should be based around a folder structure like that the image on the right. When you load a texture, it should be from the images folder, like "images/mine.png", and when you load a board file it should be from the boards folder, such as "boards/testboard2.brd"



Mouse Interactions

The application can really do “nothing” until the user clicks their mouse. Typically games and many other applications are clearing/redrawing the screen on a regular basis (often dozens of times a second). Until the player clicks the mouse somewhere in the window, the program will appear to just sit there, idle.

Once the player has clicked, however (you can check for this in the event loop), you then need to do some checks about that click.

Where did they click?

Is that a valid space on the board anywhere? If so, should you do anything in response to this?

Did the player just click a mine?

Boom, game over!

If not a mine, reveal the tile (and possibly reveal adjacent tiles, which could reveal more tiles...)

Revealing a tile

If the number of adjacent mines is 0, reveal any neighboring tiles as well (as long as they aren't mines) In revealing those, do the same sort of check for any neighbors to that tile... (sounds a bit like recursion here!)

Storing Resources

While a program is running, it needs RESOURCES to get the job done—things like icons, textures, sound files, etc. Many of the resources need to be stored for long-term use, as they may be called upon time and time again... but you don't always know when they'll be needed when you compile your code.

A great storage container for assets that you want to reference by name is the `map<>`. Storing something that you can access by its name with `container["NameOfAsset"]` is vastly preferable to that of dealing with arrays—was “GameOver.png” stored in `array[25]`, or `array[26]`?

You may find it helpful to create a single storage container for all of the `sf::Texture` objects, and then pass that around to any class which might need those files.

Using Documentation

Reading through documentation, help files, guides, tutorials, etc is an absolutely critical skill that you must develop. The problem you are currently trying to solve, the exact combination of variables for your scenario might not have existed before now.

The One True Answer to your problem might not be out there on the Internet, in a StackOverflow.com question, or in a video on YouTube. However, the information to help you figure out PARTS of your problem are almost certainly out there. You will have to figure out how to make sense of those smaller bits of information and decide on a proper course of action.

For example, the data referenced `sf::Texture` objects disappears when the object is deleted, or falls out of scope. You can't create a `sf::Texture` inside a function, create a `sf::Sprite` from that texture, and then use the sprite outside the function. An example of this (and what not to do) in the documentation:

<https://www.sfml-dev.org/tutorials/2.5/graphics-sprite.php#the-white-square-problem>

Tips

Any libraries or APIs that you work with will have some sort of documentation. READ IT! You absolutely MUST get used to being able to sift through information to find the answers that you are looking for.

Don't be afraid to experiment! When getting access to new code, you have to figure out how it works. Documentation is all fine and good, but at some point you have to actually DO IT yourself. Learning by doing is the most effective way. Write some code, screw it up, fix that code, do it all over again.

Don't try to write the entire program all at once. Hard-code test values if you need to. Try to get one single tile working on a basic level (position, responding to mouse clicks, etc) before creating dozens/hundreds of them.

Think about what types of classes or functions you might want to have for this project. There is a board, a board has tiles, tiles have various properties or states... How do you want to store that data? An array? A vector<>? A 2-dimensional array?

You're the one writing the code! Write it in a way that makes sense to you. Everyone tackles problems a bit differently, find an approach that works for you.

Submissions

You are going to turn in your source code, and your source code only. No images, no SFML libraries, only the .h and .cpp files you wrote to complete the project. Zip up **JUST YOUR SOURCE CODE** and name it **LastName.FirstName.Project3.zip**.

Partial Credit for Features that Partially Work

The features you need to implement for this project are listed in the rubric on the next page, along with point values. For each feature you can get full points, half points, or no points.

1. Full points – Feature works perfectly, no bugs of any kind
2. Half points – Feature has any bugs at all, or is partially implemented
3. No points – Feature not implemented at all, or so minimally implemented that no functionality exists (for example: drawing a button to the screen that you can't click on at all doesn't count as partial implementation)

Point deductions:

-10 for using global variables (sf::Texture objects or otherwise). Seriously, globals are bad.

-10 for not using relative paths, or submitting anything other than your source code

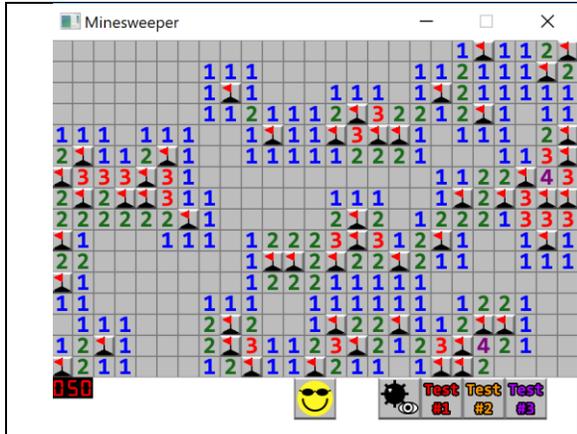
Rubric

Tile Revealing	Clicking on a tile reveals it. If it is a mine, game over. If it has 0 adjacent mines, reveal all neighboring tiles which are not currently revealed, not mines and not flagged , and then each of those neighbors go through this process as well. Depending on the board layout, a single click could reveal nearly the entire board!	20
Tile Display	Tiles display depending on their state: <ul style="list-style-type: none"> - Unrevealed (the default state) - Revealed, and empty (no adjacent mines) - Revealed, and near 1-8 mines (showing the appropriate number) - Revealed, and showing a mine 	10
Flags	Right-clicking on a hidden tile sets a flag on it. Right-clicking a flagged tile removes the flag. Left-clicking a tile with a flag has no effect. Flagged tiles cannot be revealed in any way (by the player, or by a revealing algorithm). The flag must be removed first. The number of flags on the board affects the counter (see below).	20
Mines Remaining	A counter of how many mines are on the board, minus the number of flags placed. Adding/removing flags from tiles affects this. Remaining flags CAN go negative!	20
End Conditions - Victory	Revealing all non-mine tiles ends the game, and marks all remaining tiles (i.e. the mines) with flags. Flagging mines will affect the counter, so the final counter will be a 0 after you win. Smiley face changes to sunglasses version.	10
End Conditions - Defeat	Clicking on a mine ends the game. What should happen: <ul style="list-style-type: none"> - All tiles with mines are revealed (and display on top of any flags you may have place) - The smiley face changes to the dead face (he's just acting, don't worry!) - No further interactions with the game board are possible. - The player CAN click the dead smiley face to start a new game, or use any of the testing/debug buttons. 	10
Random Mine Placement	When the game starts and when the board is reset (by clicking the smiley face button), 50 mines are randomly placed on the map--no more, no less	10
Test Buttons (1, 2 and 3)	3 test buttons to load testBoard1.brd, testBoard2.brd, etc. Each button updates all board spaces according to the data in the file, resets all flags and the counter – it's like you just started the program, with a specific set of data instead of random tiles. Your code will be tested with DIFFERENT BOARD FILES than the samples provided. (Same file format, just different 1s and 0s.)	20
Debug Button	Clicking the debug button toggles whether or not to show the mines on the map. Since the intent of this feature is to help YOU, the programmer, see the mines, draw the mines OVER anything else. Don't stop drawing anything else. These are in addition to whatever is normally being displayed.	10
	Total	130

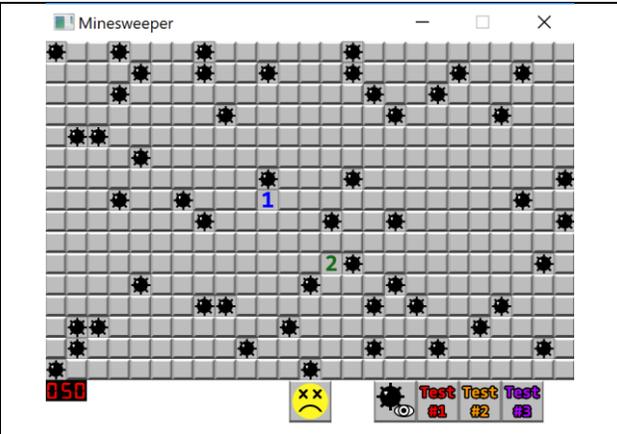
Sample Images

Victory

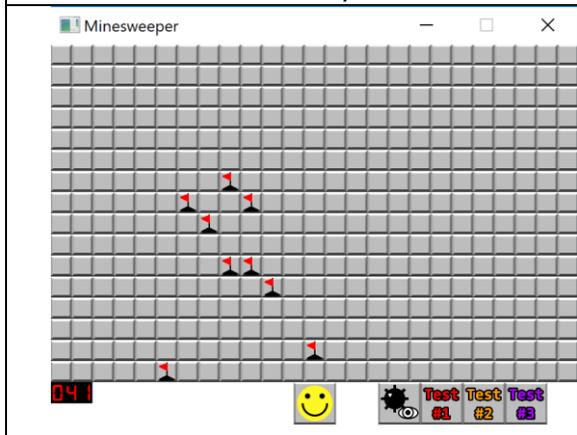
Defeat



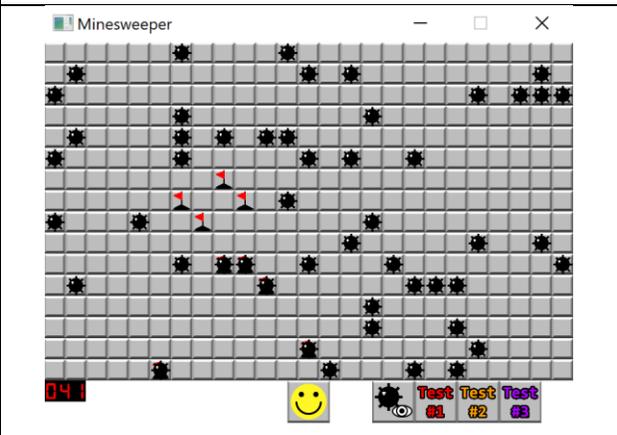
Victory!



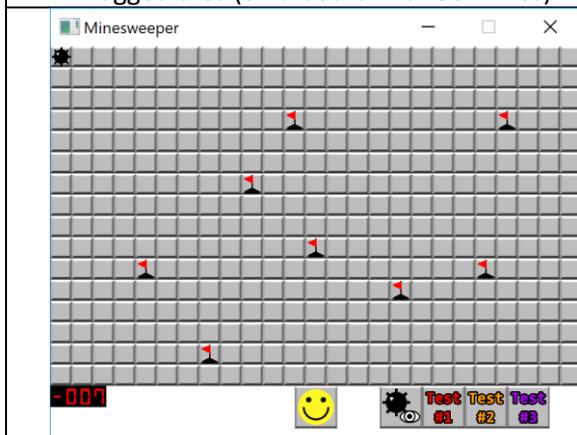
Defeat...



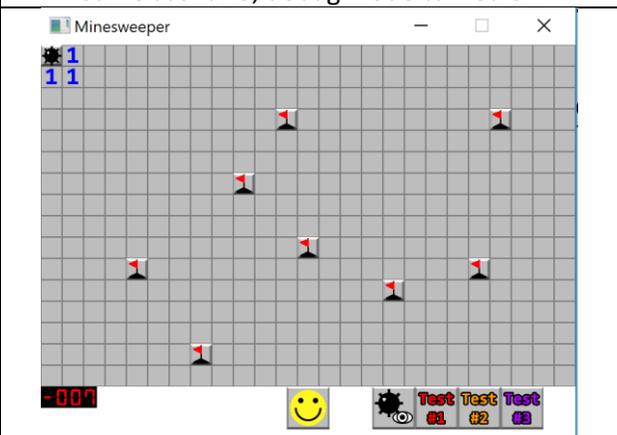
Flagged tiles (on a board with 50 mines)



Same scenario, debug mode turned on



Negative counter (Flags on a board with only 1 mine)



Same board, after just one click