Week 2

Game Loop Programming

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Objectives

- Explore an example game loop
- Review and apply the concepts of frames, frame rates and fixed time steps
- Create and display sprites to the game window

Default Constructor

- Class myClass {}
- the compiler provides you a default zero argument constructor, along with a destructor, a copy constructor, and a copy assignment operator.

Implicit Conversion

```
#include <iostream>
using namespace std;
class complexNumbers {
  double real, img;
public:
//default constructor
  complexNumbers() : real(0), img(0) { }

//copy constructor
complexNumbers(const complexNumbers& c) { real = c.real; img = c.img; }

 //implicit conversion
complexNumbers( double r, double i = 0.0) { real = r; img = i; }


 //friend function
 friend void display(complexNumbers cx);
};
void display(complexNumbers cx){
  cout<<"Real Part: "<<cx.real<<" Imag Part: "<<cx.img<<endl;
}
int main() {
  complexNumbers one(1);
  complexNumbers five = 5;  //copy assignment operator
  display(one);
  display(five);
display(300);  //➔ Implicit conversion
  return 0;
}
```

Explicit constructor

- The explicit function specifier controls unwanted implicit type conversions. It can only be used in declarations of constructors within a class declaration.

- explicit complexNumbers2(double r, double i = 0.0) { real = r; img = i; }
  complexNumbers2 one(1);
  //complexNumbers2 five = 5; //not allowed using explicit constructor
  display2(one);
  //display2(five);
  //display2(300); // Implicit conversion not allowed

How to set an Icon for the window

- sf::Image mIcon;
- mIcon.loadFromFile("Media/Textures/icon.png");
- mWindow.setIcon(mIcon.getSize().x, mIcon.getSize().y, mIcon.getPixelsPtr());
- sf::Image also provides functions to load, read, write pixels
- mIcon.create(20, 20, sf::Color::Yellow);
- sf::Color color = mIcon.getPixel(0, 0);
- color.a = 0; //make the top-left pixel transparent
- color.r = 0; //set the r = 0 (rgb) from the color
- mIcon.setPixel(0, 0, color);

Font and Text

- Create a graphical text to display

```
sf::Font mFont;
sf::Text mText;
if (!mFont.loadFromFile("Media/Sansation.ttf"))
return;


mText.setString("Hello SFML");
mText.setFont(mFont);
mText.setPosition(5.f, 5.f);
mText.setCharacterSize(50);
mText.setFillColor(sf::Color::Black);
```

Play the Music

- Streamed music played from an audio file
- Musics are sounds that are streamed rather than completely loaded in memory
- A music is played in its own thread in order not block the rest of the program
- Supported audio formats: ogg, wav, flac, aiff, au, raw, paf, svx, nist, voc, ircam, w64, mat4, mat5, pvf, htk, sds, avr, sd2, caf, wve, mpc2k, rf64

Music Parameters

- #include <SFML/Audio.hpp>
- sf::Music mMusic;
- mMusic.openFromFile("Media/Textures/nice_music.ogg");
- //change some parameters
- mMusic.setPosition(0, 1, 10); //change its 3D position
- mMusic.setPitch(2); //increase the pitch
- mMusic.setVolume(50); //reduce the volume
- mMusic.setLoop(true); //make it loop
- mMusic.setAttenuation(100);
- mMusic.play();

Game Loop

- The run() function you saw in the example from last week, and below, is known as the main loop or game loop

```
void Game::run()
{
   while (mWindow.isOpen())
   {
      processEvents();
      update();
      render();
   }
}
```

Game Loop (cont'd.)

- It processes all the components in the game and continues to do so until the application is terminated
- The processing of events, updating of all game assets and then rendering them to the destination output is a standard loop for games

Game Loop (cont'd.)

- It processes all the components in the game and continues to do so until the application is terminated
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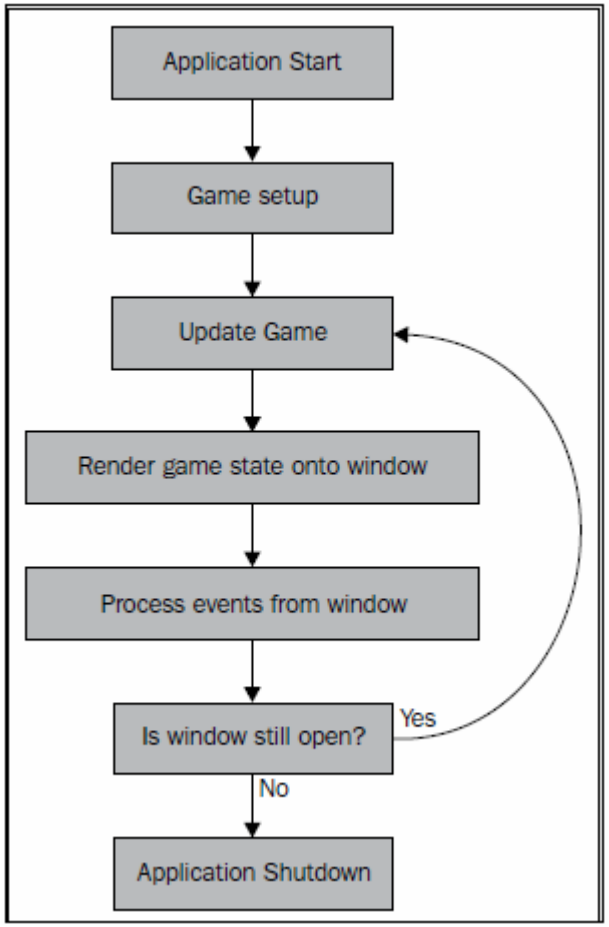
- You've heard the term **frame** or **tick** before, and that is what we call an iteration of the loop

Game Loop (cont'd.)

- The flowchart to the right illustrates the logic and different processes of the game, including the main loop



Events

- Events can be user-generated such as mouse clicks or movement or keyboard presses
- They can also be generated by the assets in the game, such as when an enemy spots the player
- We don't have any events in our example yet, so let's create some!

- How 'bout moving that circle with the keyboard?

Events (cont'd.)

- For events in SFML, we use the `sf::Event` object
- We're going to use two events for this example:

  `sf::Event::KeyPressed` and `sf::Event::KeyReleased`

processEvents()

```
void Game::processEvents()
{
    sf::Event event;
    while (mWindow.pollEvent(event))
    {
        switch (event.type)
        {
            case sf::Event::KeyPressed:
              handlePlayerInput(event.key.code, true);
              break;
            case sf::Event::KeyReleased:
              handlePlayerInput(event.key.code, false);
              break;
            case sf::Event::Closed:
              mWindow.close();
              break;
        }
    }
}
```

handlePlayerInput()

```
void Game::handlePlayerInput(sf::Keyboard::Key key, bool isPressed)
{
	if (key == sf::Keyboard::W)
	  mIsMovingUp = isPressed;
	else if (key == sf::Keyboard::S)
	  mIsMovingDown = isPressed;
	else if (key == sf::Keyboard::A)
	  mIsMovingLeft = isPressed;
	else if (key == sf::Keyboard::D)
	  mIsMovingRight = isPressed;
}
```

New update()

```
void Game::update()
{
   sf::Vector2f movement(0.f, 0.f);
   if (mIsMovingUp)
     movement.y -= 1.f;
   if (mIsMovingDown)
     movement.y += 1.f;
   if (mIsMovingLeft)
     movement.x -= 1.f;
   if (mIsMovingRight)
     movement.x += 1.f;

   mPlayer.move(movement);
}
```

How about mouse?

```
if (sf::Mouse::isButtonPressed(sf::Mouse::Left))
{
sf::Vector2i mousePosition =
sf::Mouse::getPosition(mWindow);
mPlayer.setPosition((float)mousePosition.x,
(float)mousePosition.y);
}
```

Vector Object

- SFML's Vector object is instantiated as:

```
sf::Vector2<float>
```

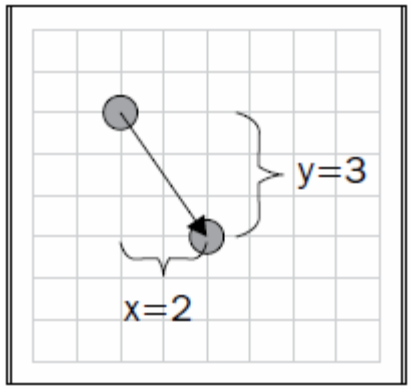
- We use the typedef for variable declarations, which is as follows:

```
sf::Vector2f myVector(0.f, 0.f);
```

- As you would expect, there are many common operations in the Vector class that we can access through a Vector object

Vector Object (cont'd.)

- In games, vectors can represent coordinates or a direction to move
- The diagram below represents a vector(2,3) and it could be a translation of 2 units to the right and 3 down:



Frame-Independence

- You might remember from Unity that we were able to move an object a certain number of units per second
  - We multiplied the speed by Time.deltaTime
- We can do this in SFML too, so that the player's movement isn't dependent on the framerate – or number of times the update runs per second

Frame-Independence (cont'd.)

- Well, we're still relying on the framerate, but the movement is spread out evenly over the frames
- So let's have a look at our new update function and see what's new…

New update()

```
void Game::update(sf::Time deltaTime)
{
   sf::Vector2f movement(0.f, 0.f);
   if (mIsMovingUp)
     movement.y -= PlayerSpeed;
   if (mIsMovingDown)
     movement.y += PlayerSpeed;
   if (mIsMovingLeft)
     movement.x -= PlayerSpeed;
   if (mIsMovingRight)
     movement.x += PlayerSpeed;

   mPlayer.move(movement * deltaTime.asSeconds());
}
```

Measuring Frames

- We can measure the time each frame takes in order to figure out `deltaTime`
- We use the `sf::Clock` class
- Sf::Clock has only two methods: getElapsedTime() and restart(). Both returns the elapsed time since the clock was started and then it resets the clock to zero. getElapsedTime() can be called without calling restart()

```
sf::Clock clock;
sf::Time time = clock.getElapsedTime();
float seconds = time.asSeconds();
sf::Int32 milliseconds = time.asMilliseconds();
sf::Int64 microseconds = time.asMicroseconds();
time = clock.restart();
```

Measuring Frames (cont'd.)

```
void Game::run()
{
   sf::Clock clock;
   while (mWindow.isOpen())
   {
      sf::Time deltaTime = clock.restart();
      processEvents();
      update(deltaTime);
      render();
   }
}
```

Fixed Time Step

- Time based on a system function such as a while loop will never be constant
  - We saw this way back with HTML5 and its highly-varying frame rate
  - Unity too!
- Fortunately we can create fixed time execution using a counter and a check
  - The while loop is definitely going to execute fast enough to serve as very small time increments added to our counter variable

Fixed Time Step (cont'd.)

```
void Game::run()
{
   sf::Clock clock;
   sf::Time timeSinceLastUpdate = sf::Time::Zero;
   while (mWindow.isOpen())
   {
      processEvents();
      timeSinceLastUpdate += clock.restart();
      while (timeSinceLastUpdate > TimePerFrame)
      {
         timeSinceLastUpdate -= TimePerFrame;
         processEvents();
         update(TimePerFrame);
      }
      render();
   }
}
```

Fixed Time Step (cont'd.)

- If you want to read more on this topic, you can read the article at the following address:
  - http://gafferongames.com/game-physics/fix-your-timestep

Displaying Sprites

```
sf::Texture texture;
if (!texture.loadFromFile("path/to/file.png"))
{
  // Handle loading error
}
sf::Sprite sprite(texture);
sprite.setPosition(100.f, 100.f);
window.clear();
window.draw(sprite);
window.display();
```

Rendering

- Rendering is the process of drawing your assets to the screen
- Ideally, we'd only want our assets being drawn if they were updated somehow in the program
  - Would save on performance
- However, *real-time rendering* just draws to the screen as fast as possible

Rendering (cont'd.)

- Have you ever wondered why there is an FPS count in games? Like 30 or 60
- It's because the end user can't see blindingly-fast updates so the frame rate is limited to allow the processor to perform other tasks

Rendering (cont'd.)

- *Double buffering* is a technique of rendering that uses two virtual windows or screens, called buffers
  - Front and back buffers
- The front buffer is what the user sees
- The back buffer is what's going to be drawn next frame – will become the front buffer

Adding the Sprite

```
// Game.hpp
class Game
{
  public:
    Game();
    ...
  private:
    sf::Texture mTexture;
    sf::Sprite mPlayer;
    ...
};
```

Adding the Sprite (cont'd.)

```
// Game.cpp
Game::Game()
: ...
, mTexture()
, mPlayer()
{
   if (!mTexture.loadFromFile("Media/Textures/Eagle.png"))
   {
      // Handle loading error
   }
   mPlayer.setTexture(mTexture);
   mPlayer.setPosition(100.f, 100.f);
}
```

Appendix B – Code Editor Tips

- Zoom
  - Press **Ctrl+Mouse** wheel to increase and decrease the font size
- Box Selector
  - Select rectangular region, type a line, and have that line repeated for every line part of the region
    - Hold **Alt** while using mouse to make vertical section
    - Start typing…typed line appears on every line in region
- Generate from Usage
  - Type method invocation without first creating method
    - **Ctrl** + dot (.) automatically generates heading

Appendix C – Visual Studio Configuration

- When Visual Studio is launched, Start Page is displayed
  - Checkbox in extreme left corner – **Show page at startup**
    - Check/uncheck **Close page after project load** to add/remove Start page tab from development environment
- Pin a project so it is always there
  - Pushpin is revealed when you move mouse over Recent projects area

Customizing

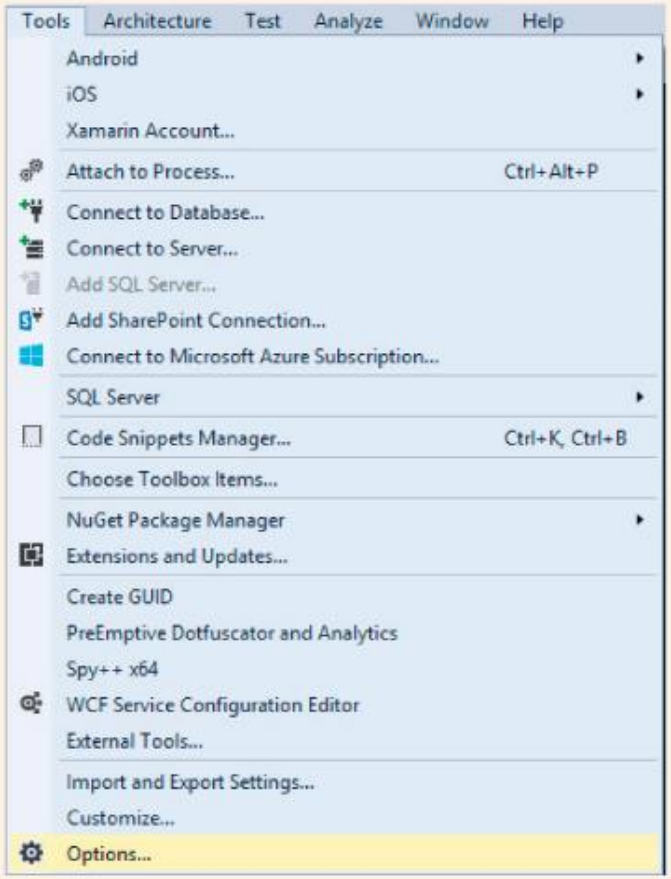


FIGURE A-2 Using Tools, Options to configure Visual Studio

Environment

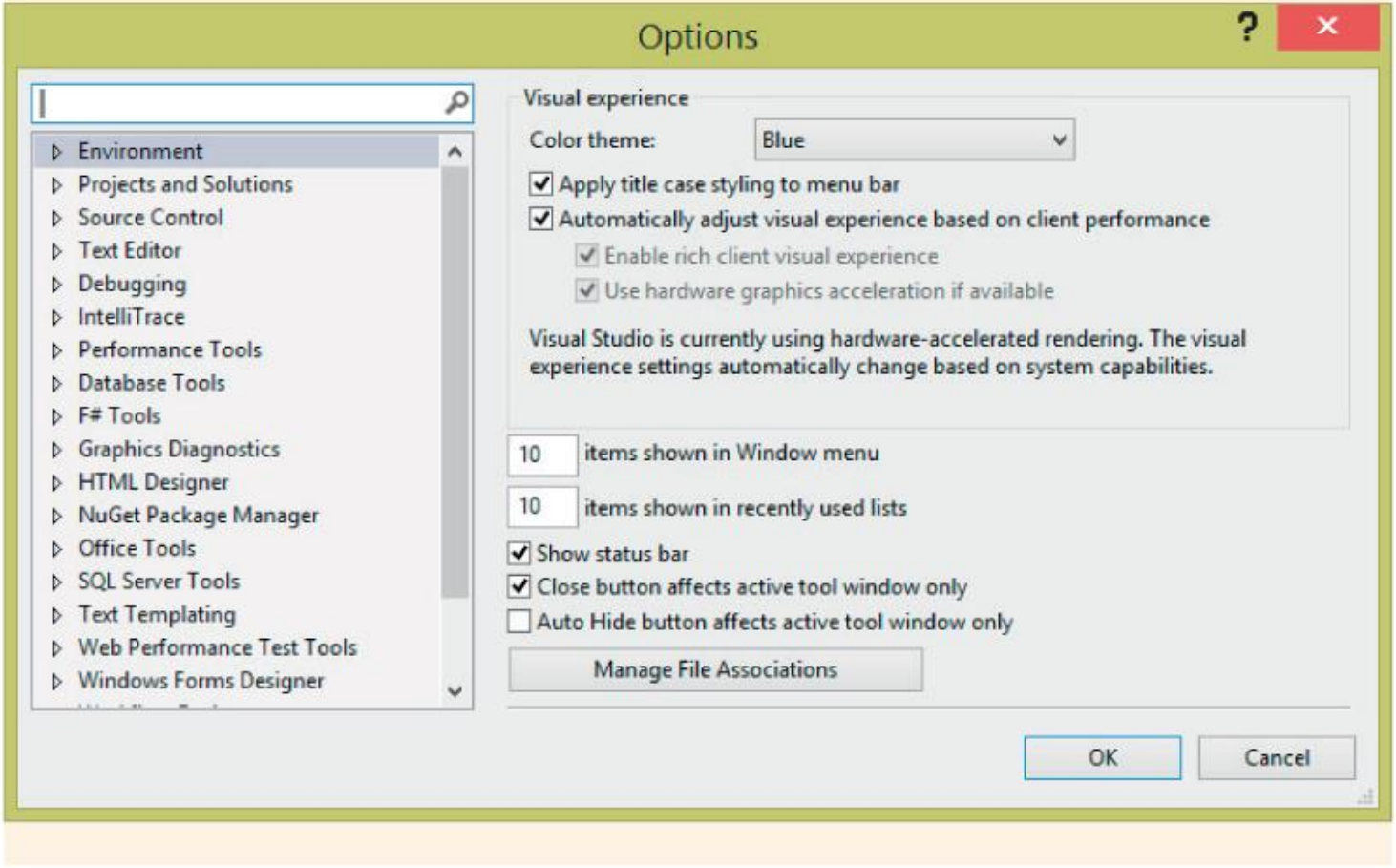


FIGURE A-3 Environment General options

Environment

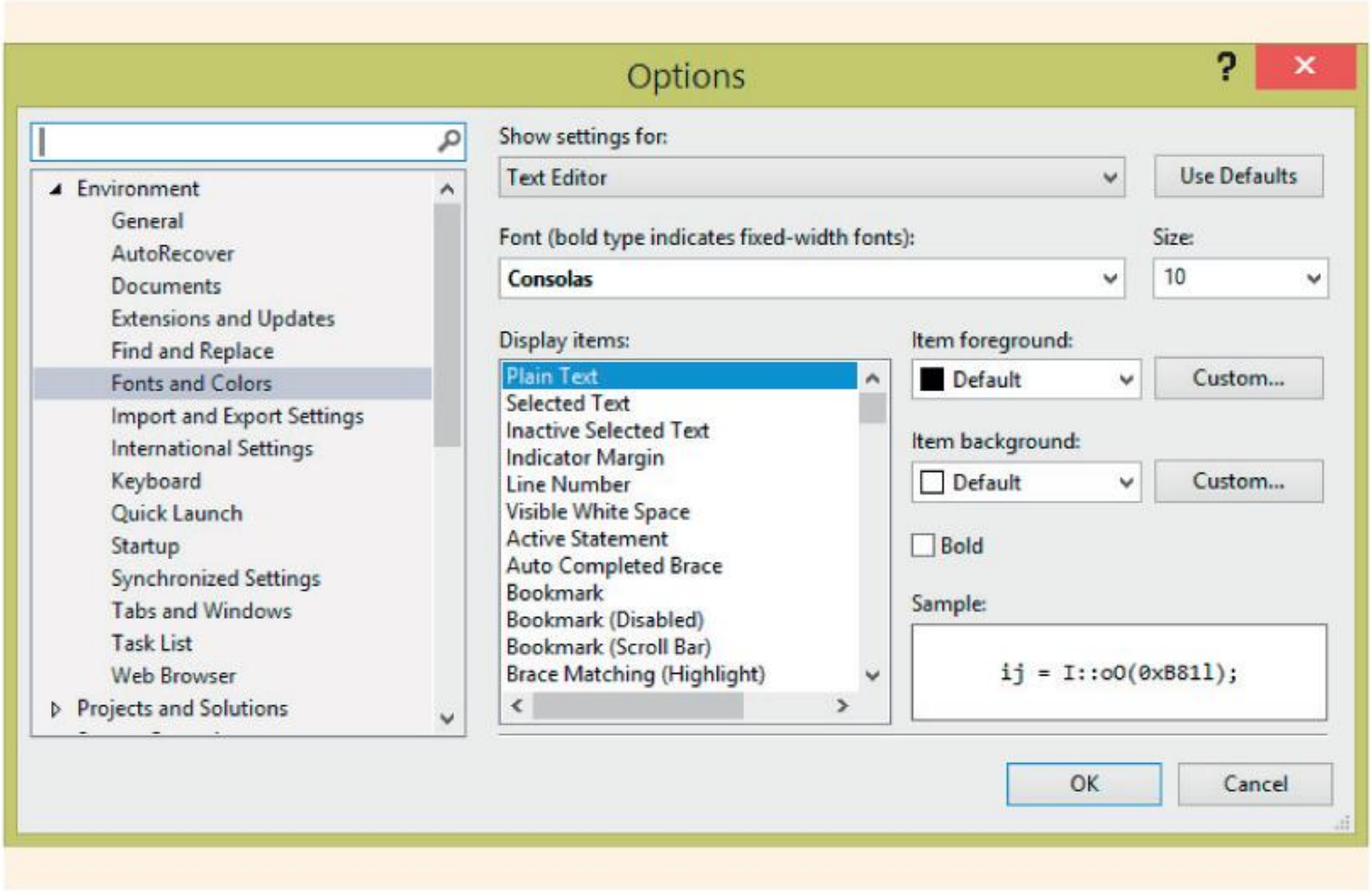


FIGURE A-4 Setting the fonts and colors

Environment

- **Environment**, **Startup** node lets you determine what is opened when you first start Visual Studio
  - **Show Start Page**, **Open Home Page**, **Load last loaded solution**, **Show Open Project** dialog box, **Show New Project** dialog box, or **Show empty environment**
- Set the URL for your Home page and Search page from **Environment**, **Web Browser** node