Programming Fundamentals

Lecture 03 – Introduction to Löve 2D

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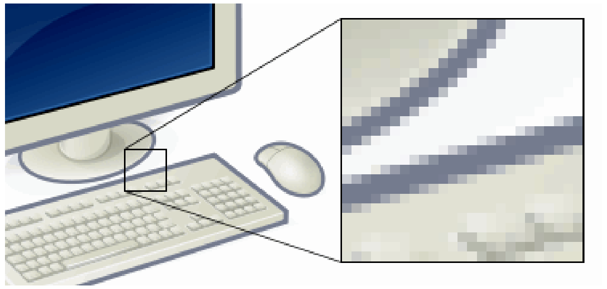
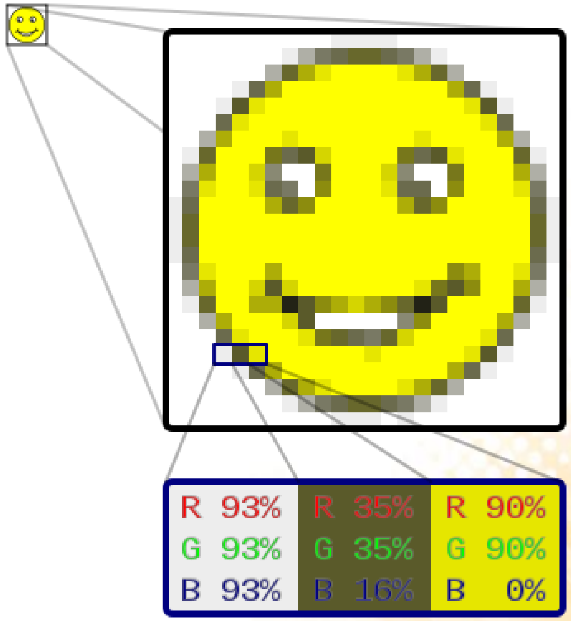
Computer Graphics Concepts

- **What is a pixel?**
  - In digital imaging, a pixel is a single square or rectangle point in a raster image (or the smallest addressable element in a display device).
  - Pixels are placed in a grid-like fashion and together they draw images on screen.
  - The location of a pixel is usually referred by its position x on the horizontal axis and y on the vertical axis of the grid (pixel coordinates).

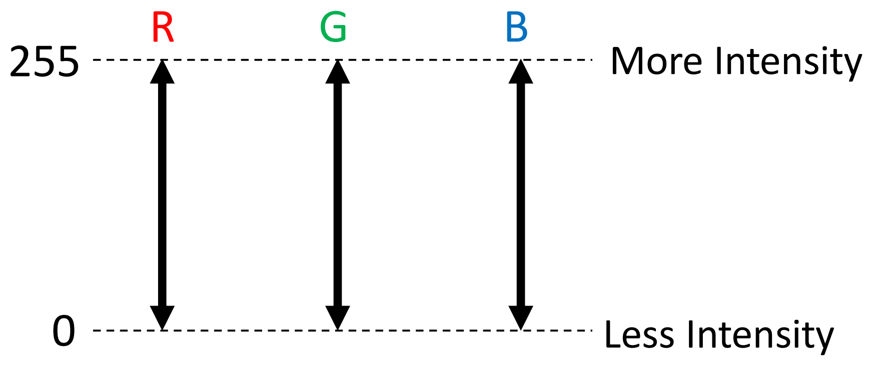


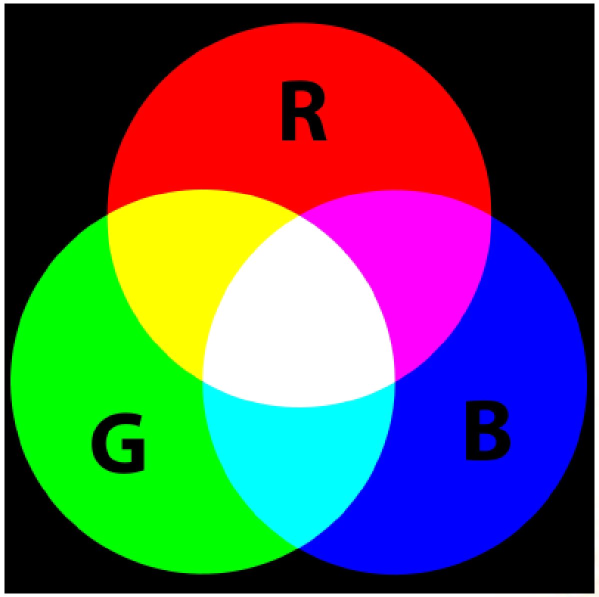


Computer Graphics Concepts

- In computer graphics, **colors** are generally defined by the intensity (chromaticity) of three additive primaries color (or channels): red, green, and blue.

- **RGB Scale:**





Important: the RBG scale used by Löve is between 0 and 1.

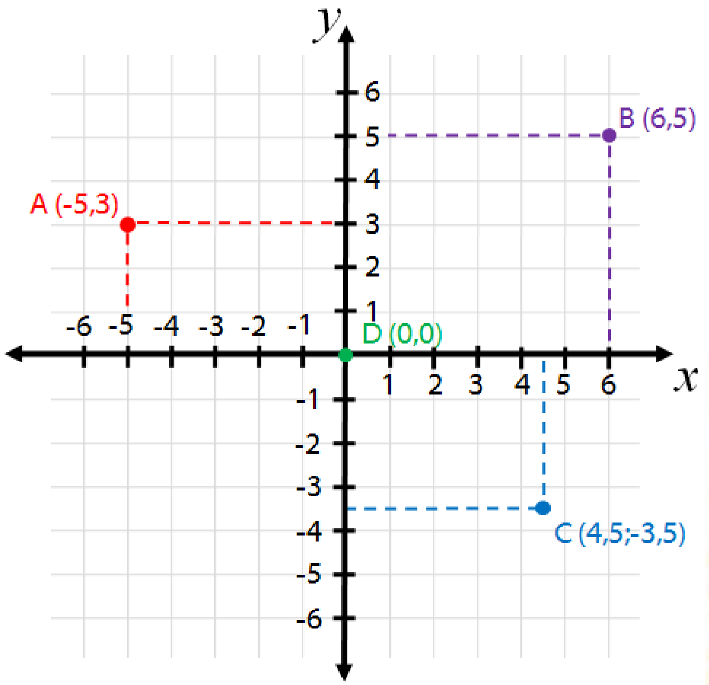
Don't know the RGB value of the color that you want?
http://doc.instantreality.org/tools/color_calculator/

Computer Graphics Concepts

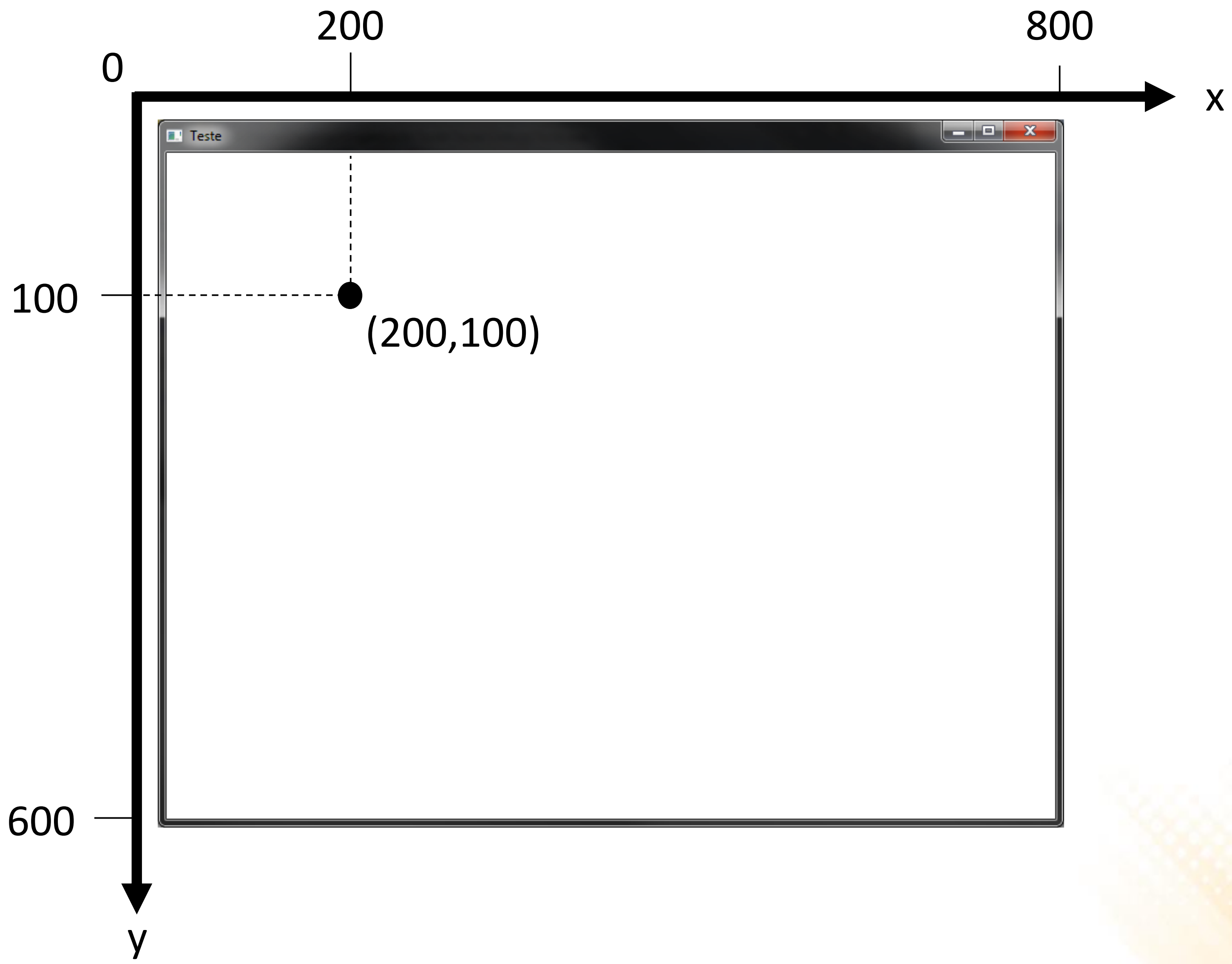
- Computer graphics uses **coordinate systems** to represent positions on a virtual scene.

- There are usually:
  - 2 axis to define a 2D space (x and y);
  - 3 axis to define a 3D space (x, y, and z);

- Warning: different tools/frameworks use different coordinate systems
  - 1 unit = 1 pixel / arbitrary scene units;
  - Origin at the top left / origin at the center / origin at the bottom left;
  - y goes up / y goes down;

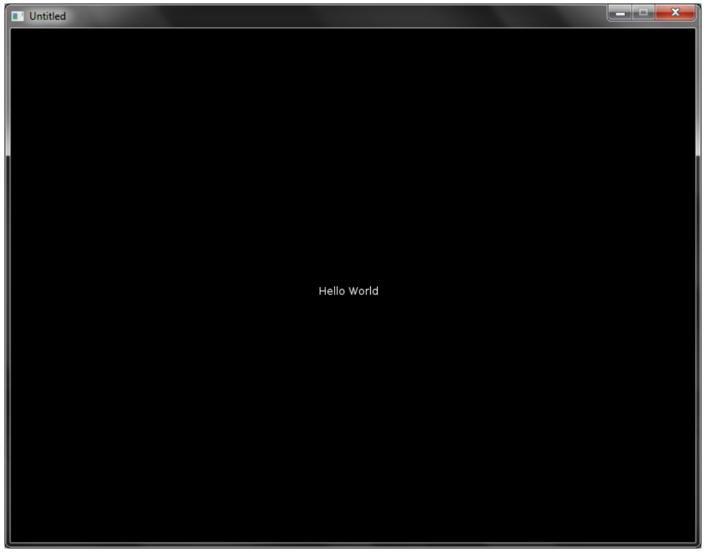


Löve 2D Coordinate System



“Hello World” in Löve

```
function love.draw()
  love.graphics.print("Hello World", 360, 300)
end
```



Hello World

The function `love.graphics.print` is used to draw a text on screen. The last two parameters represent the position (x and y) where the text will be drawn.

Programming in Löve

- Programming in Löve involves the implementation of **callback** functions. A callback is a function that you code and Löve automatically calls at certain times.

- **Example:**

```
love.draw()
```

  – The callback `love.draw` is called continuously to draw all the graphical elements (images, geometric shapes, text, etc.) on the screen every frame.

Löve Callbacks

- Löve has several callbacks to perform various tasks (all of them are optional):
  - Initialization, rendering, update, user input keyboard/mouse/joystick, ...
- A fully-featured game experience would probably utilize nearly all of Löve callbacks, so it's wise to know what they are.
  - List of Löve callbacks: https://www.love2d.org/wiki/Category:Callbacks
- More common callbacks:
  - love.load()
  - love.draw()
  - love.update(dt)

Callback `love.load()`

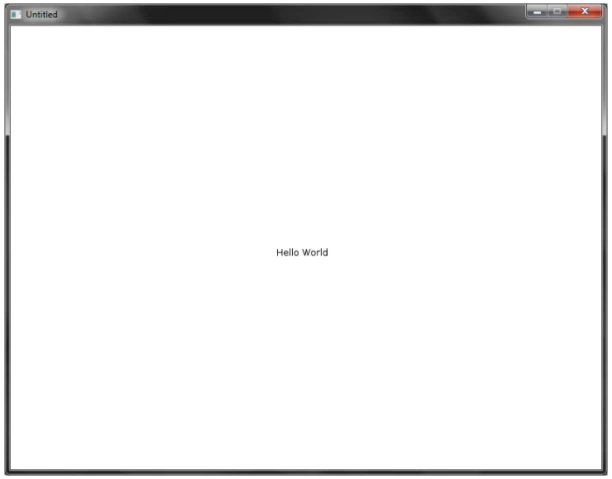
- The callback `love.load()` is called exactly once at the beginning of the game.

- Is usually used to:
  - Load resources (images, audio, etc.)
  - Initialize variables
  - Set specific settings

```
function love.load()
   image = love.graphics.newImage("cake.jpg")
   love.graphics.setColor(0, 0, 0)
   love.graphics.setNewFont(12)
   love.graphics.setBackgroundColor(255, 255, 255)
end
```

Back to the “Hello World”

```
function love.load()
   love.graphics.setColor(0, 0, 0)
   love.graphics.setBackgroundColor(1, 1, 1)
end

function love.draw()
    love.graphics.print("Hello World", 360, 300)
end
```



Hello World

The function `love.graphics.setColor` defines the color used to drawn things on screen (RGB model)

The function `love.graphics.setBackgroundColor` defines the background color (RGB model)

Callback `love.update(dt)`

- The callback `love.update(dt)` is called continuously while the game is running (<u>every frame</u>). The parameter 'dt' stands for "delta time" and it represents amount of seconds since the last time this function was called (usually a small value like 0.02571).

- Is usually used to:
  - Implementation of the game logic
  - Physics simulations
  - Artificial intelligence computations

Calculates the value of px at a constant rate (independently of the speed of the computer)

```
function love.update(dt)
  px = px + (100 * dt)
end
```

Back to the “Hello World”

```lua
local px    -- position of the text in the x axis

function love.load()
  love.graphics.setColor(0, 0, 0)
  love.graphics.setBackgroundColor(1, 1, 1)
  px = 0
end

function love.update(dt)
  px = px + (100 * dt)
end

function love.draw()
    love.graphics.print("Hello World", px, 300)
end
```

Löve Modules

- Löve comprises several **modules**:
  - Every module has a set of functions and data types that can be used for game programming.
  - All modules are contained in a global module called `love`.
- **Example of module:** `love.graphics`
  - In the previous examples we used some functions from the `love.graphics` module.
  - The function `love.graphics.print` is part of the `love.graphics` module.
- List of Löve modules: https://love2d.org/wiki/love

Module `love.graphics`

- The `love.graphics` module contain functions dedicated for graphical operations:
  - Draw lines, geometric shapes, text, images, etc.
  - Load external files (images, fonts, etc.) into memory.
  - Create special objects (particle system, canvas, etc.)
  - Manipulate the screen

- A complete list of functions of the `love.graphics` module is available at: https://love2d.org/wiki/love.graphics

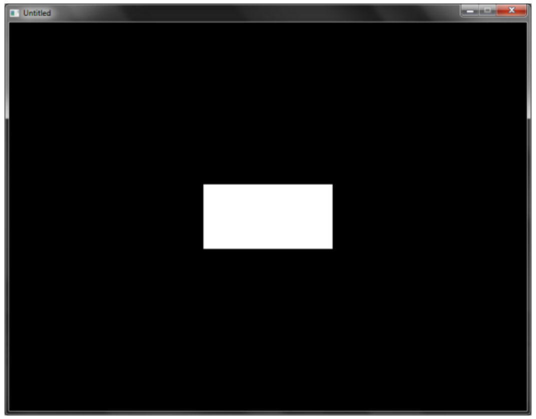
Module `love.graphics`

- Drawing basic **geometric shapes**:
  - **Rectangle:**

```
love.graphics.rectangle(mode, x, y, width, height)
```

Example:

```
love.graphics.rectangle("fill", 300, 250, 200, 100)
```



mode: “fill” to draw the shape filled or “line” to draw just an outline.

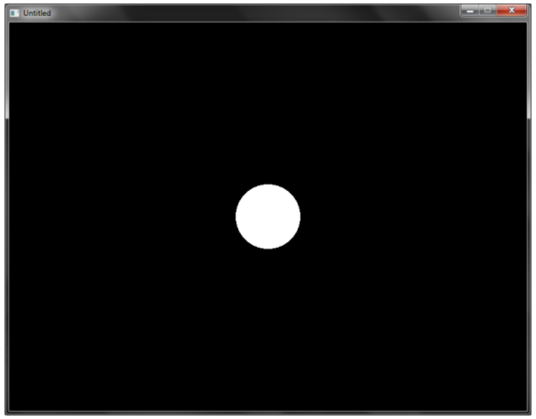
Module `love.graphics`

- Drawing basic **geometric shapes**:
  - **Circle:**

```
love.graphics.circle(mode, x, y, radius, segments)
```

Example:

```
love.graphics.circle("fill", 400, 300, 50, 100)
```



Number of segments used for drawing the circle

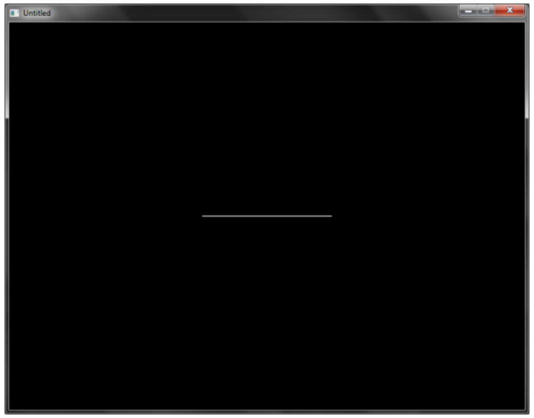
Module `love.graphics`

- Drawing basic **geometric shapes**:
  - **Line:**

```
love.graphics.line(x1, y1, x2, y2, ...)
```

Example:

```
love.graphics.line(300, 300, 500, 300)
```



More points are accepted as parameters.

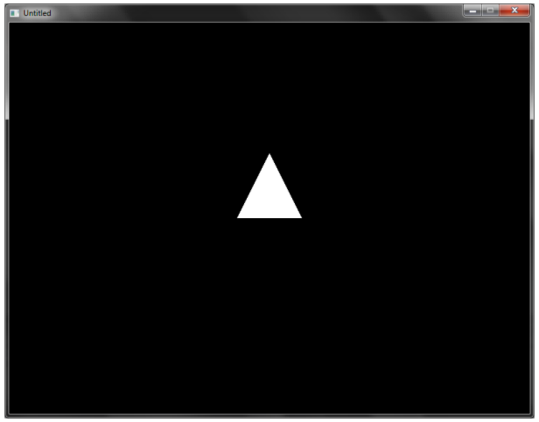
Module `love.graphics`

- Drawing basic **geometric shapes**:
  - **Polygon:**

```
love.graphics.polygon(mode, ...)
```

Example:

```
love.graphics.polygon("fill", 350, 300, 450, 300, 400, 200)
```



More points are accepted as parameters.

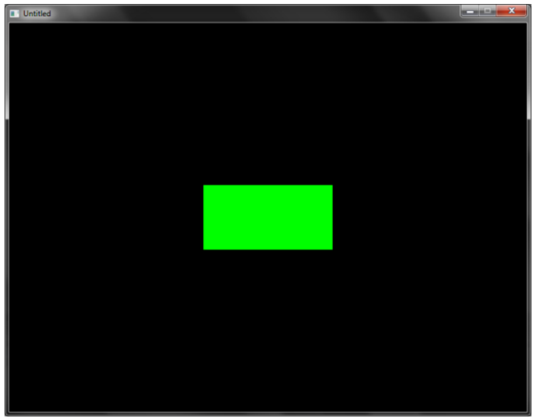
Module `love.graphics`

- Drawing basic **geometric shapes**:
  - **Changing the color of the geometric shapes:**

```
    love.graphics.setColor(red, green, blue, alpha)
```

Example:

```
love.graphics.setColor(0, 1, 0)
love.graphics.rectangle("fill", 300, 250, 200, 100)
```

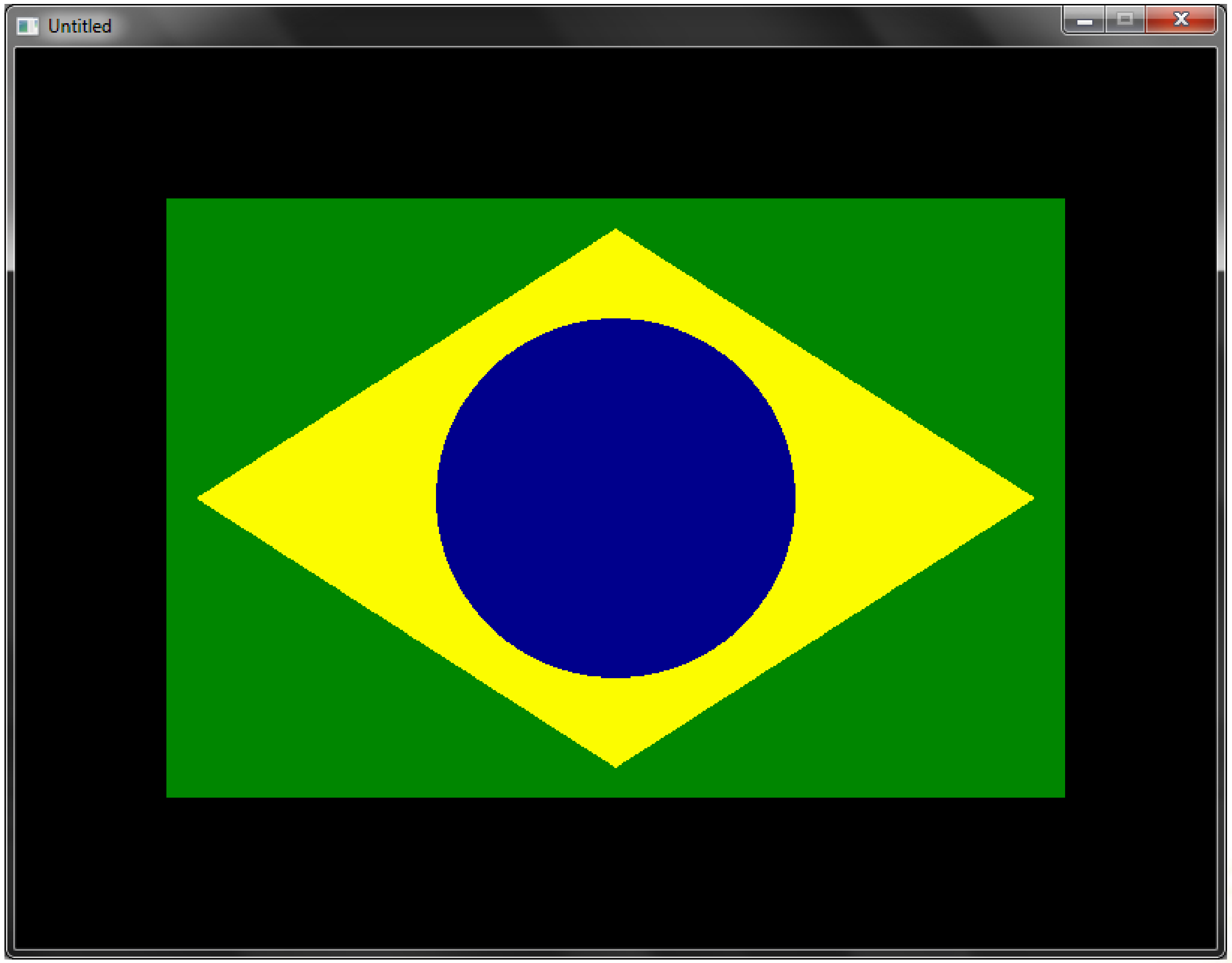


The alpha is optional and can be used to define colors with transparency.

Geometric Shapes - Example

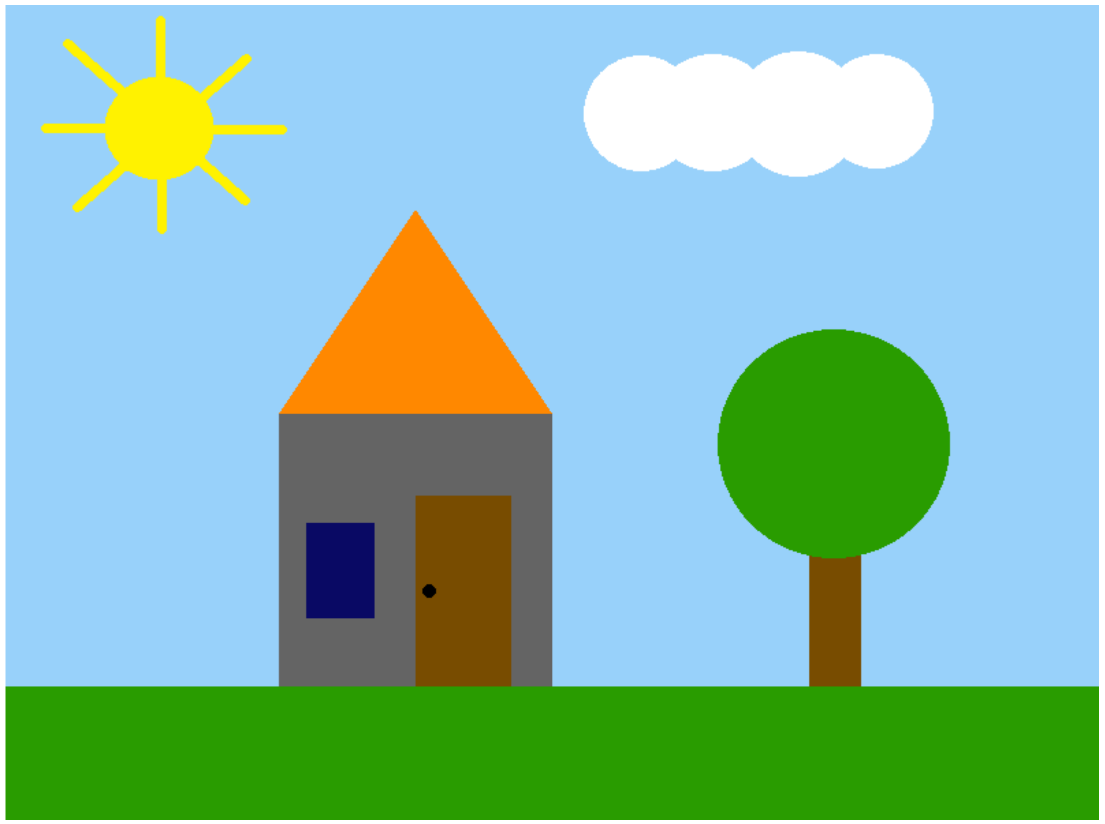
```lua
function love.draw()

    -- draw a rectangle
    love.graphics.setColor(0, 0.521, 0)
    love.graphics.rectangle("fill", 100, 100, 600, 400)

    -- draw a polygon
    love.graphics.setColor(0.988, 0.988, 0)
    love.graphics.polygon("fill", 120, 300, 400, 120,
                                   680, 300, 400, 480)

    -- draw a circle
    love.graphics.setColor(0, 0, 0.552)
    love.graphics.circle("fill", 400, 300, 120, 100)

end
```

Geometric Shapes - Example



Exercise 1

1) Using basic geometric shapes (lines, rectangles, circles, and polygons), implement a program to draw a scene similar to the one illustrated below:

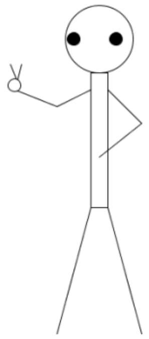


Hints:

- Start simple and add one element at a time.
- Test after adding each element.

Extra challenge:

- Draw a character in the scene using basic shapes:



Exercise 2

2) Rewrite the code of the last exercise using functions. Create one function for each of the elements of the scene and try to make them parameterized.
   – Example:

```
function DrawTree(x, y, height)
  love.graphics.setColor(0.5, 0.2, 0)
  love.graphics.rectangle("fill", x - 20, y - height, 40, height)
  love.graphics.setColor(0.2, 0.6, 0)
  love.graphics.circle("fill", x, y - height, 80)
end

function love.draw()
   DrawTree(200, 500, 200)
   DrawTree(400, 500, 300)
   DrawTree(600, 500, 250)
end
```