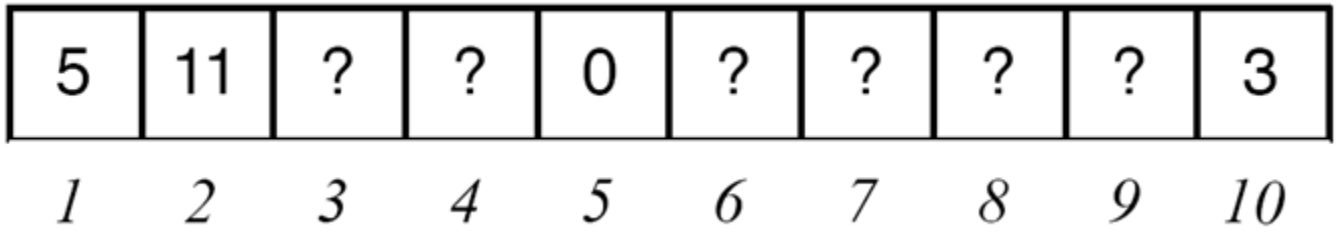
Programming Fundamentals

Lecture 07 – Arrays, Matrices, Animations and World Representations

Edirlei Soares de Lima
<edirlei.lima@universidadeeuropeia.pt>

Arrays

- Arrays are sequences of items (like variables) of the same type.
  - Each item is identified by an index (integer).



- With arrays we can store in memory sequences of values (numbers, text, imagens, etc.), which are all associated with a single variable (the array).

Arrays in Lua

- In Lua, are implemented through tables indexed by **integer numbers**.

- Different from many other programming languages, in Lua **we don't need to define the maximum size** of an array.

- **Creating a new array:**

```
my_array = {}
```

Arrays in Lua

- **Initializing some positions of the array:**

```
my_array[1] = 5
my_array[2] = 11
my_array[5] = 0
my_array[10] = 3
```

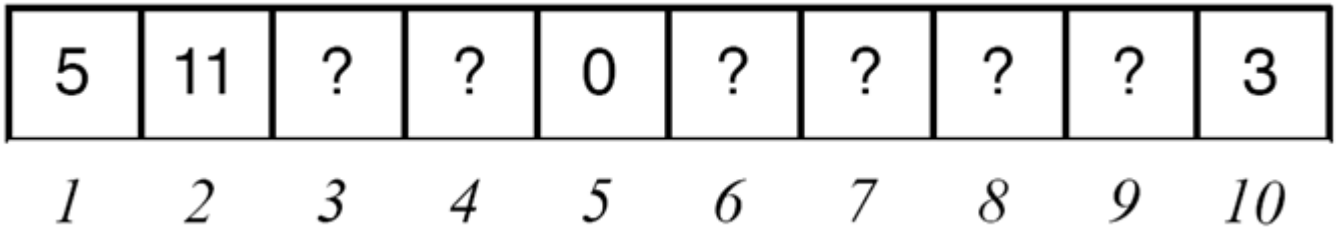


Table Functions

- Size of an array:

```
arr = {1, 2, 1, 6}
size = table.getn(arr)
```

- Add elements:

```
arr = {1, 2, 1, 6}
table.insert(arr, 8)
table.insert(arr, 1, 10)
```

- Remove elements:

```
arr = {1, 2, 1, 6}
table.remove(arr, 4)
table.remove(arr, 1)
```

Example 1: Platforms, Arrays and Camera

world.lua

```
require "vector2"

function CreateObject(x, y, w, h)
  return {position = vector2.new(x, y), size = vector2.new(w, h)}
end

function DrawWorld(world)
  for i = 1, table.getn(world), 1 do
    love.graphics.rectangle("fill", world[i].position.x,
                world[i].position.y, world[i].size.x, world[i].size.y)
  end
end
```

collision.lua

```
function GetBoxCollisionDirection(x1,y1,w1,h1,x2,y2,w2,h2)
  local xdist = math.abs((x1 + (w1 / 2)) - (x2 + (w2 / 2)))
  local ydist = math.abs((y1 + (h1 / 2)) - (y2 + (h2 / 2)))

  local combinedwidth = (w1 / 2) + (w2 / 2)
  local combinedheight = (h1 / 2) + (h2 / 2)

  ...
```

Example 1: Platforms, Arrays and Camera

collision.lua

```
  if(xdist > combinedwidth) then
    return vector2.new(0, 0)
  end
  if(ydist > combinedheight) then
    return vector2.new(0, 0)
  end
  local overlapx = math.abs(xdist - combinedwidth)
  local overlapy = math.abs(ydist - combinedheight)
  local playerdir = vector2.normalize(vector2.sub(vector2.new(x1,y1),
                                                  vector2.new(x2,y2)))
  local collisiondir
  if overlapx > overlapy then
    collisiondir = vector2.normalize(vector2.new(0, playerdir.y *
                                                 overlapy))
  elseif overlapx < overlapy then
    collisiondir = vector2.normalize(vector2.new(playerdir.x *
                                                 overlapx, 0))
  else
    collisiondir = vector2.normalize(vector2.new(playerdir.x *
                                    overlapx, playerdir.y * overlapy))
  end
  return collisiondir
end
```

Example 1: Platforms, Arrays and Camera

player.lua

```
require "vector2"
require "collision"

local player = {
  position = vector2.new(400, 100),
  velocity = vector2.new(0, 0),
  size = vector2.new(30, 60),
  maxspeed = 400,
  mass = 1,
  frictioncoefficient = 300,
  onGround = false
}

function UpdatePlayer(dt, world)
  local acceleration = vector2.new(0, 0)
  local gravity = vector2.new(0, 500)
  acceleration = vector2.applyForce(gravity, player.mass,
                                    acceleration)

  ...
```

Example 1: Platforms, Arrays and Camera

player.lua

```
local friction = vector2.mult(player.velocity, -1)
friction = vector2.normalize(friction)
friction = vector2.mult(friction, player.frictioncoefficient)
acceleration = vector2.applyForce(friction, player.mass,
                                  acceleration)
local movedirection = vector2.new(0, -1)
if love.keyboard.isDown("right") then
  local move = vector2.new(500, 0)
  acceleration = vector2.applyForce(move, player.mass, acceleration)
  movedirection.x = 1
end
if love.keyboard.isDown("left") then
  local move = vector2.new(-500, 0)
  acceleration = vector2.applyForce(move, player.mass, acceleration)
  movedirection.x = -1
end
if love.keyboard.isDown("up") and (player.onGround) then
  local jump = vector2.new(0, -50000)
  acceleration = vector2.applyForce(jump, player.mass, acceleration)
  movedirection.y = 1
  player.onGround = false
end
```

Example 1: Platforms, Arrays and Camera

player.lua

```
  local futurevelocity = vector2.add(player.velocity,
                                     vector2.mult(acceleration, dt))
  futurevelocity = vector2.limit(futurevelocity, player.maxspeed)
  local futureposition = vector2.add(player.position,
                                     vector2.mult(futurevelocity, dt))

  acceleration = CheckCollision(world, futureposition,
                                movedirection, acceleration)

  player.velocity = vector2.add(player.velocity,
                                vector2.mult(acceleration, dt))
  player.velocity = vector2.limit(player.velocity, player.maxspeed)
  player.position = vector2.add(player.position,
                                vector2.mult(player.velocity, dt))
end

function DrawPlayer()
  love.graphics.setColor(0.2, 0.2, 0.9)
  love.graphics.rectangle("fill", 380, player.position.y,
                          player.size.x, player.size.y)
end
```

Example 1: Platforms, Arrays and Camera

player.lua

```
function CheckCollision(world, futureposition, movedirection,
                        acceleration)
  for i = 1, table.getn(world), 1 do
    local collisiondir = GetBoxCollisionDirection(futureposition.x,
                    futureposition.y, player.size.x, player.size.y,
                    world[i].position.x, world[i].position.y,
                    world[i].size.x, world[i].size.y)
    if not (collisiondir.x == 0 and collisiondir.y == 0) then
      if collisiondir.y == movedirection.y then --down collision
        player.velocity.y = 0
        acceleration.y = 0
        player.onGround = true
      elseif collisiondir.y == 1 then --up collision
        player.velocity.y = 0
        acceleration.y = 0
      elseif movedirection.x ~= collisiondir.x then --side collision
        player.velocity.x = 0
        acceleration.x = 0
      end
    end
  end
  return acceleration
end
```

Example 1: Platforms, Arrays and Camera

player.lua

```
function GetPlayerPosition()
  return player.position
end
```

main.lua

```
require "vector2"
require "world"
require "player"

local world = {}

function love.load()
  world[1] = CreateObject(50, 550, 1200, 50)
  world[2] = CreateObject(500, 450, 50, 50)
  world[3] = CreateObject(750, 500, 100, 50)
  world[4] = CreateObject(1000, 420, 150, 50)
end

function love.update(dt)
  UpdatePlayer(dt, world)
end
```

Example 1: Platforms, Arrays and Camera

main.lua

```
function love.draw()
  love.graphics.setColor(0.2, 0.2, 0.9)
  DrawPlayer()
  love.graphics.setColor(0.2, 0.8, 0.2)
  local playerpos = GetPlayerPosition()
  love.graphics.translate(-(playerpos.x - 380), 0)
  DrawWorld(world)
end
```

Example 2: Arrays and Enemies

enemy.lua

```
require "vector2"

function CreateEnemy(x, y, r, t)
  local mdir, vdir
  if t == 1 then
    mdir = vector2.new(1, 0)
    vdir = vector2.new(-100, 0)
  elseif t == 2 then
    mdir = vector2.new(0, -1)
    vdir = vector2.new(0, 100)
  end
  return {position = vector2.new(x, y),
          velocity = vdir,
          radius = r,
          etype = t,
          mass = 1,
          movedirection = mdir,
          movechangetime = 2,
          movetimer = 0}
end
```

Example 2: Arrays and Enemies

enemy.lua

```
function UpdateEnemies(dt, enemies)
  for i = 1, table.getn(enemies), 1 do
    local acceleration = vector2.new(0, 0)
    if enemies[i].etype == 1 or enemies[i].etype == 2 then
      local moveForce = vector2.mult(enemies[i].movedirection, 100)
      acceleration = vector2.applyForce(moveForce, enemies[i].mass,
                                        acceleration)
      enemies[i].velocity = vector2.add(enemies[i].velocity,
                                        vector2.mult(acceleration, dt))
      enemies[i].velocity = vector2.limit(enemies[i].velocity, 100)
      enemies[i].position = vector2.add(enemies[i].position,
                                vector2.mult(enemies[i].velocity, dt))
      enemies[i].movetimer = enemies[i].movetimer + dt
      if enemies[i].movetimer > enemies[i].movechangetime then
        enemies[i].movetimer = 0
        enemies[i].movedirection =
                            vector2.mult(enemies[i].movedirection, -1)
      end
    end
  end
end
```

Example 2: Arrays and Enemies

enemy.lua

```
function DrawEnemies(enemies)
  for i = 1, table.getn(enemies), 1 do
    if enemies[i].etype == 1 then
      love.graphics.setColor(0.8, 0.0, 0.0)
    elseif enemies[i].etype == 2 then
      love.graphics.setColor(0.8, 0.8, 0.0)
    end
    love.graphics.circle("fill", enemies[i].position.x,
                         enemies[i].position.y, enemies[i].radius, 30)
  end
end
```

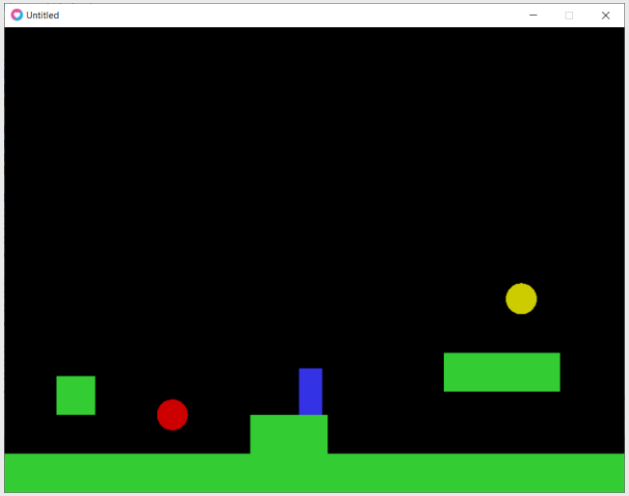
main.lua

```
require "vector2"
require "world"
require "player"
require "enemy"

local world = {}
local enemies = {}
```

Example 2: Arrays and Enemies

enemy.lua

```
function love.load()
  world[1] = CreateObject(50, 550, 1200, 50)
  world[2] = CreateObject(500, 450, 50, 50)
  world[3] = CreateObject(750, 500, 100, 50)
  world[4] = CreateObject(1000, 420, 150, 50)
  enemies[1] = CreateEnemy(650, 500, 20, 1)
  enemies[2] = CreateEnemy(1100, 350, 20, 2)
end

function love.update(dt)
  UpdatePlayer(dt, world)
  UpdateEnemies(dt, enemies)
End

function love.draw()
  love.graphics.setColor(0.2, 0.2, 0.9)
  DrawPlayer()
  love.graphics.setColor(0.2, 0.8, 0.2)
  local playerpos = GetPlayerPosition()
  love.graphics.translate(-(playerpos.x - 380), 0)
  DrawWorld(world)
  DrawEnemies(enemies)
end
```



Arrays and Animations

- Animations are created by **sequences of images**.
  - **Example:**

- We can store animations as arrays of images!

Images: http://www.inf.puc-rio.br/~elima/intro-eng/imagens_hero.zip

```
local hero_walk = {}  -- array of images
local hero_anim_frame = 1
local hero_pos_x = 100
local hero_pos_y = 225

function love.load()
  for x = 1, 4, 1 do  -- load the animation frames
    hero_walk[x] = love.graphics.newImage("Hero_Walk_0" .. x .. ".png")
  end
end

function love.update(dt)
  if love.keyboard.isDown("right") then

    hero_pos_x = hero_pos_x + (100 * dt)     -- moves the character
    hero_anim_frame = hero_anim_frame + 1    -- increases the anim. index
    if hero_anim_frame > 4 then              -- animation loop
      hero_anim_frame = 1
    end
  end
end

function love.draw() -- draw the character using the animation index
  love.graphics.draw(hero_walk[hero_anim_frame], hero_pos_x, hero_pos_y)
end
```

Example of Animation

- **Problem:** we didn't control the speed of the animation!
  - The faster the computer, the faster the animation will be played.

```
local hero_walk = {}
local hero_anim_frame = 1
local hero_pos_x = 100
local hero_pos_y = 225
local hero_anim_time = 0  -- variable to control the animation time

function love.load()
  for x = 1, 4, 1 do
    hero_walk[x] = love.graphics.newImage("Hero_Walk_0" .. x .. ".png")
  end
end

function love.update(dt)
  if love.keyboard.isDown("right") then
    hero_pos_x = hero_pos_x + (100 * dt)
    hero_anim_time = hero_anim_time + dt    -- increases the time with dt
    if hero_anim_time > 0.1 then            -- when time gets to 0.1
      hero_anim_frame = hero_anim_frame + 1 -- go to the next frame
      if hero_anim_frame > 4 then
        hero_anim_frame = 1
      end
      hero_anim_time = 0                -- reset the time counter
    end
  end
end

function love.draw()
  love.graphics.draw(hero_walk[hero_anim_frame], hero_pos_x, hero_pos_y)
end
```

Tables in Lua

- Lua tables allow us to associate names to its elements.

- With this feature, we can create structures to store related data:

```
player1 = {
  name   = "John",
  image  = love.graphics.newImage("John.png"),
  score  = 1000,
  lives  = 3,
  power  = 50,
  px     = 300,
  py     = 300
}
```

Tables in Lua

- We can access the elements of a table by its name:

```
io.write(player1.score)
```

```
.
.

love.graphics.draw(player1.image, player1.px,
                                  player1.py)
.
.
```

Exercise 1

1) Modify the code of the animation example in order to organize and store the variables that are related with the character in a table:

```
local hero_walk = {}
local hero_anim_frame = 1
local hero_pos_x = 100
local hero_pos_y = 225
local hero_anim_time = 0
```

   – Also change the code in order to use the new table. At the end, everything must be working the same way as before the introduction of the table.

Exercise 2

2) Continue the implementation of the last exercise by adding the animations and movement of the character to all other directions. Use the following images:

Images: http://www.inf.puc-rio.br/~elima/intro-eng/imagens_hero.zip

Matrices

- Matrices are two-dimensional arrays.
- A matrix stores data in an organized form with rows and columns.

3	1	8	6	1
7	2	5	4	9
1	9	3	1	2
5	8	6	7	3
6	4	9	2	1

Matrices in Lua

- **Declaring and initializing a matrix:**

```
my_matrix = {}          -- new matrix

for i=1, 10, 1 do
  my_matrix[i] = {}     -- new row
  for j=1, 10, 1 do
    my_matrix[i][j] = 0
  end
end
```

  - We are defining and initializing a matrix with 10 columns e 10 rows.

Matrices in Lua

- We can access the values **stored in the matrix** using their two-dimensional **indexes**.

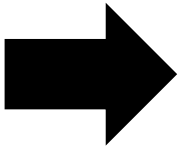
	0	1	2
0	5	?	1
1	?	?	?
2	?	8	?

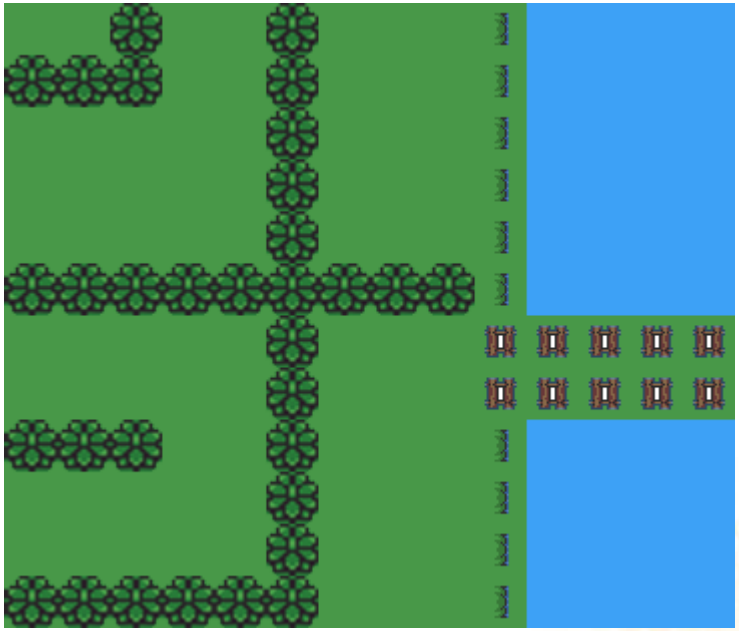
```
my_matrix[0][0] = 5;
my_matrix[1][2] = 8;
my_matrix[2][0] = 1;
```

Matrices and Game Worlds

- We can use matrices to represent 2D game worlds.
  - **Example:**

```
XXGXXGXXXEAAAA
GGGXXGXXXEAAAA
XXXXXGXXXEAAAA
XXXXXGXXXEAAAA
XXXXXGXXXEAAAA
GGGGGGGGGEAAAA
XXXXXGXXXPPPPP
XXXXXGXXXPPPPP
GGGXXGXXXEAAAA
XXXXXGXXXEAAAA
XXXXXGXXXEAAAA
GGGGGGXXXEAAAA
```





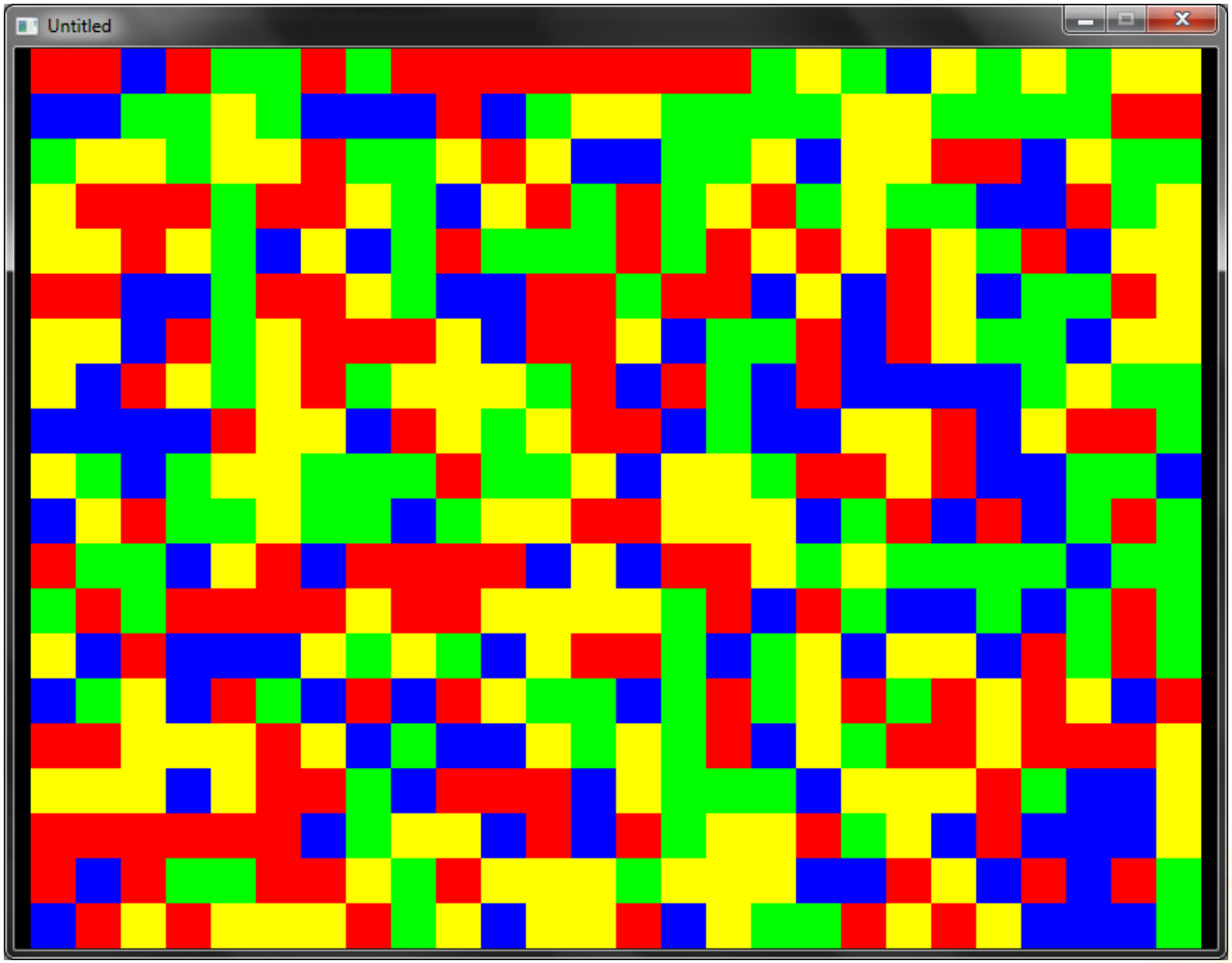
Matrices and Game Worlds – Example 1

- Generating a random matrix and drawing its elements on screen using colors.

```
1312103010112210
2113021120130132
1203201321012021
2113013023120231
3120312031031201
2010311103013130
0310312130310321
1010101203102031
3210321013210130
3203132031201110
```

```
local world = {}

function love.load()
  for i=1, 26, 1 do   -- initializes a random matrix (26 x 20)
    world[i] = {}
    for j=1, 20, 1 do
      world[i][j] = love.math.random(0, 3)
    end
  end
end

function love.draw()
  for i=1, 26, 1 do -- iterates through the matrix and draw the elements
    for j=1, 20, 1 do
      if (world[i][j] == 0) then
        love.graphics.setColor(1, 0, 0)
      elseif (world[i][j] == 1) then
        love.graphics.setColor(0, 1, 0)
      elseif (world[i][j] == 2) then
        love.graphics.setColor(0, 0, 1)
      elseif (world[i][j] == 3) then
        love.graphics.setColor(1, 1, 0)
      end
      love.graphics.rectangle("fill", (i * 30)-20, (j * 30)-30, 30, 30)
    end
  end
end
```

Matrices and Game Worlds – Example 1



Matrices and Game Worlds – Example 2

- Reading a matrix from a file and drawing its elements on screen using colors.

World1.txt

```
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAAAGGGGG
GGGGGGGGAGGGGG
GGGGGGGGAGGGGG
PPPPPPPPAPPPPP
AAAAAAAAAAAAAA
AAAAAAAAAAAAAA
```

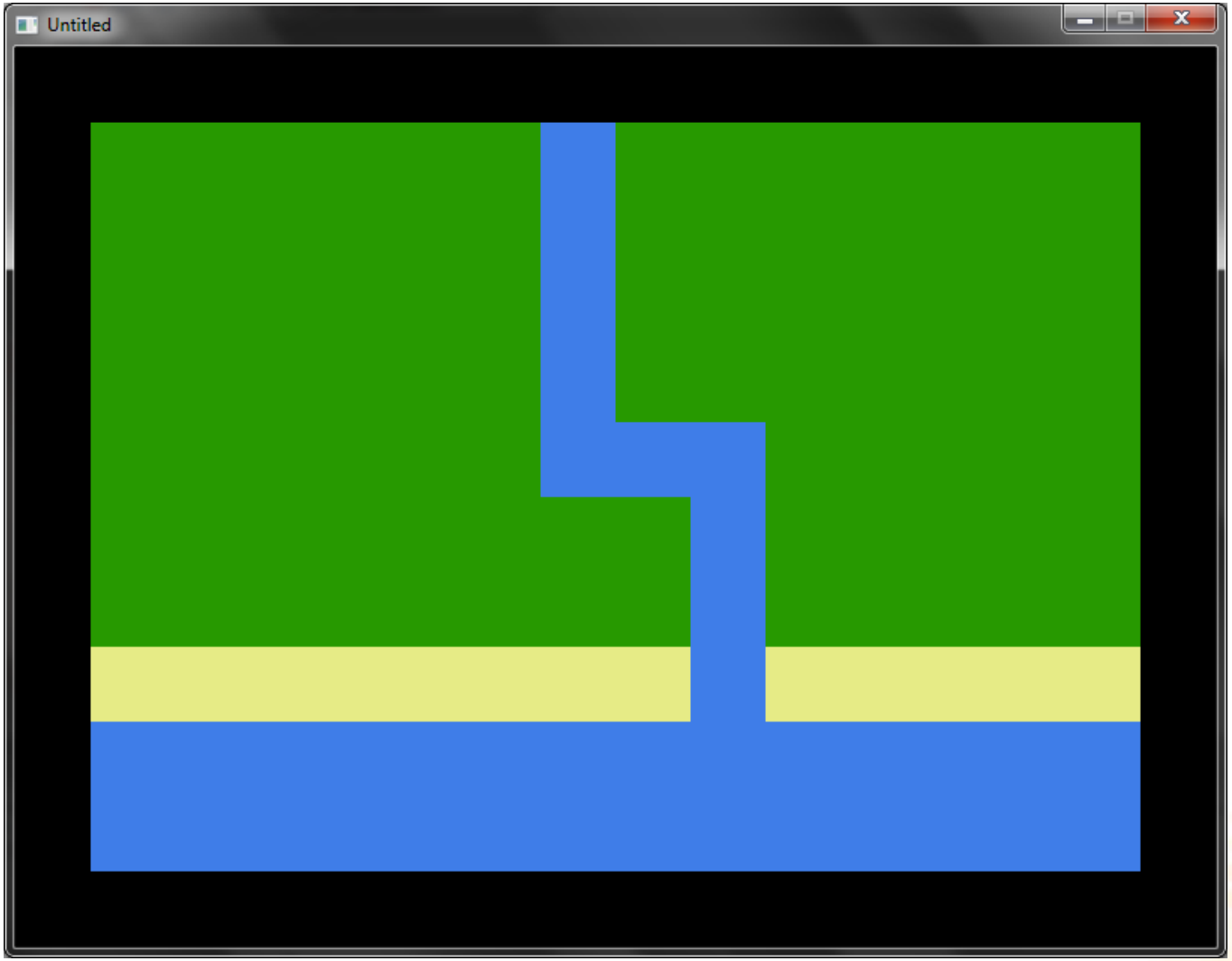
Matrices and Game Worlds – Example 2

```
local world = {}

function LoadMap(filename)     -- reads the content of the file
  local file = io.open(filename)
  local i = 1
  for line in file:lines() do
    world[i] = {}
    for j=1, #line, 1 do
      world[i][j] = line:sub(j,j)
    end
    i = i + 1
  end
  file:close()
end

function love.load()
  LoadMap("World1.txt")
end
.
.
.
```

Matrices and Game Worlds – Example 2

```
.
.
.

function love.draw()
  for i=1, 10, 1 do -- iterates through the matrix and draw the elements
    for j=1, 14, 1 do
      if (world[i][j] == "P") then
        love.graphics.setColor(0.901, 0.921, 0.525)
      elseif (world[i][j] == "G") then
        love.graphics.setColor(0.149, 0.6, 0)
      elseif (world[i][j] == "A") then
        love.graphics.setColor(0.250, 0.490, 0.909)
      end
      love.graphics.rectangle("fill", (j * 50), (i * 50), 50, 50)
    end
  end
end
```

Matrices and Game Worlds – Example 2



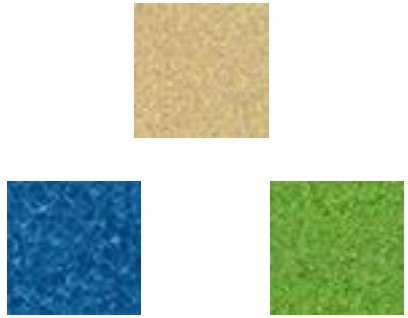
Matrices and Game Worlds – Example 3

- Reading a matrix from a file and drawing its elements on screen using images.

World1.txt

```
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAGGGGGGG
GGGGGGAAAGGGGG
GGGGGGGGAGGGGG
GGGGGGGGAGGGGG
PPPPPPPPAPPPPP
AAAAAAAAAAAAAA
AAAAAAAAAAAAAA
```

Images:



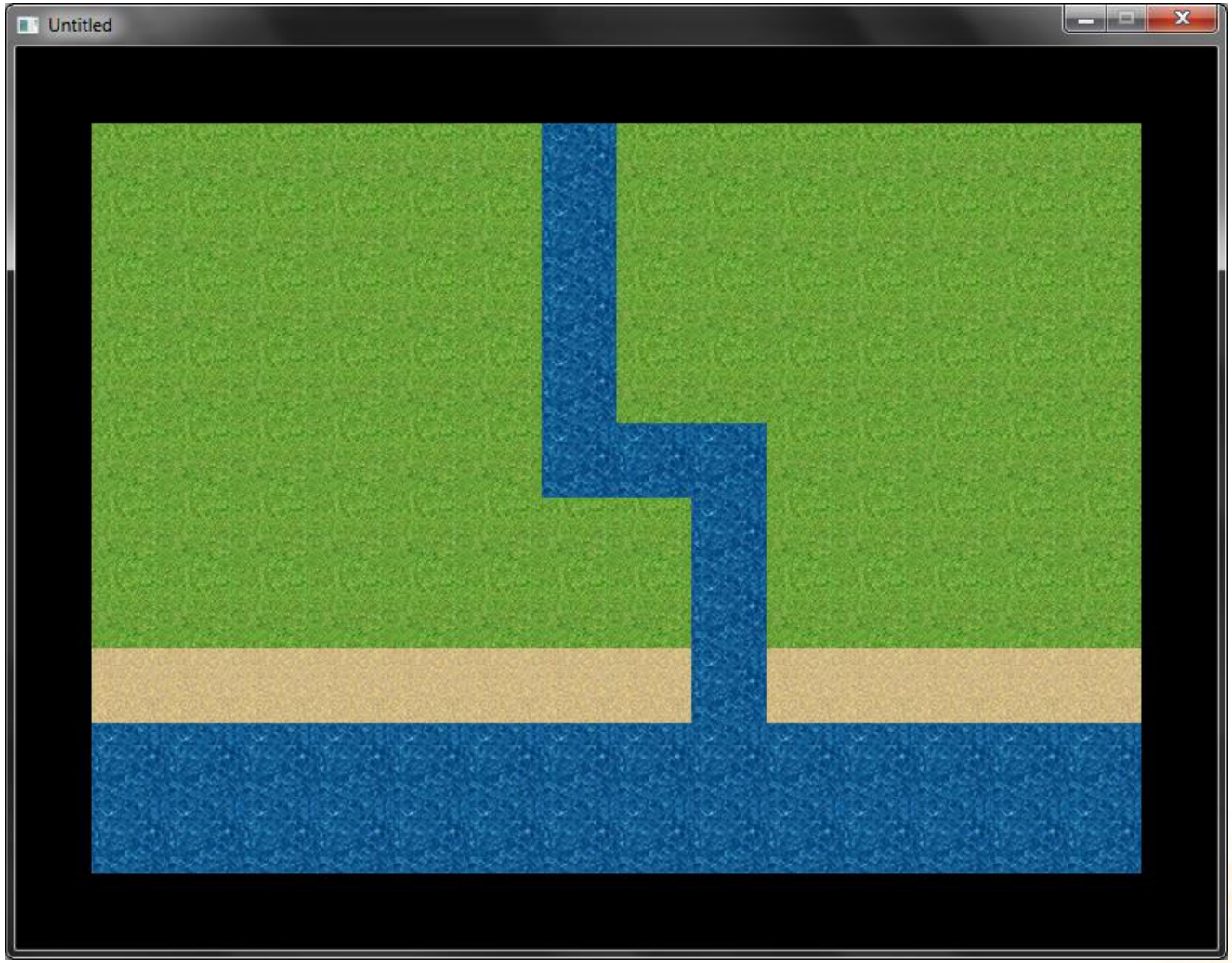
http://www.inf.puc-rio.br/~elima/intro-eng/tiles_exemplo.zip

Matrices and Game Worlds – Example 3

```
local world = {}
local tile_grass
local tile_water
local tile_sand

function LoadMap(filename) -- reads the content of the file
  local file = io.open(filename)
  local i = 1
  for line in file:lines() do
    world[i] = {}
    for j=1, #line, 1 do
      world[i][j] = line:sub(j,j)
    end
    i = i + 1
  end
  file:close()
end
.
.
.
```

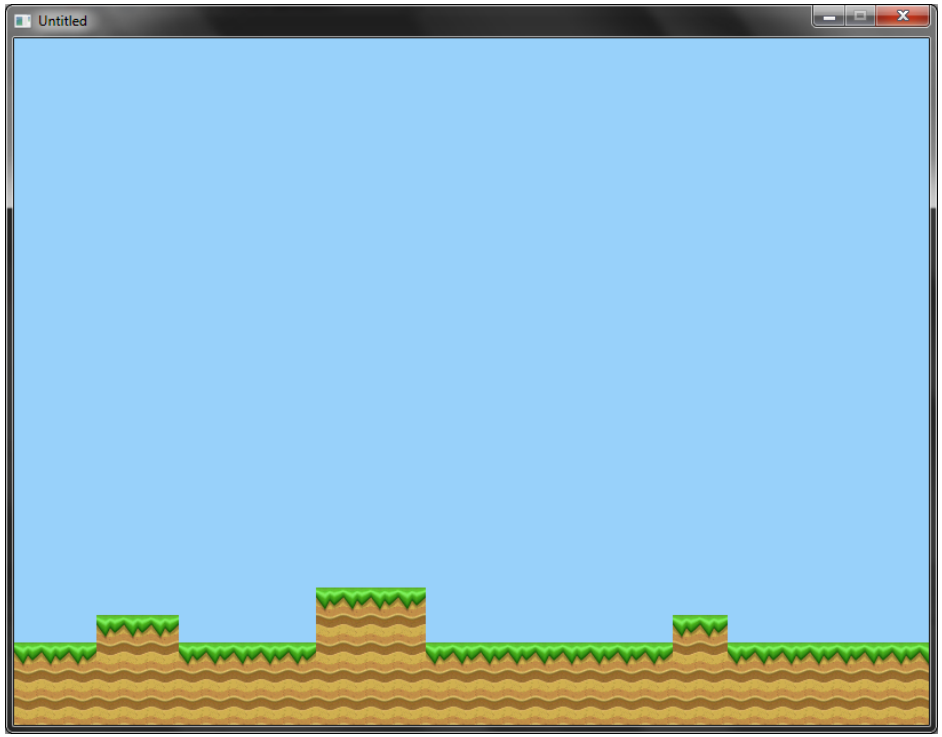
```
.
.
.

function love.load()
  LoadMap("World1.txt")
  tile_grass = love.graphics.newImage("grass.png")
  tile_water = love.graphics.newImage("water.png")
  tile_sand = love.graphics.newImage("sand.png")
end

function love.draw()
  for i=1, 10, 1 do -- iterates through the matrix and draw the elements
    for j=1, 14, 1 do
      if (world[i][j] == "P") then
        love.graphics.draw(tile_sand, (j * 50), (i * 50))
      elseif (world[i][j] == "G") then
        love.graphics.draw(tile_grass, (j * 50), (i * 50))
      elseif (world[i][j] == "A") then
        love.graphics.draw(tile_water, (j * 50), (i * 50))
      end
    end
  end
end
```

Matrices and Game Worlds – Example 3



Exercise 3

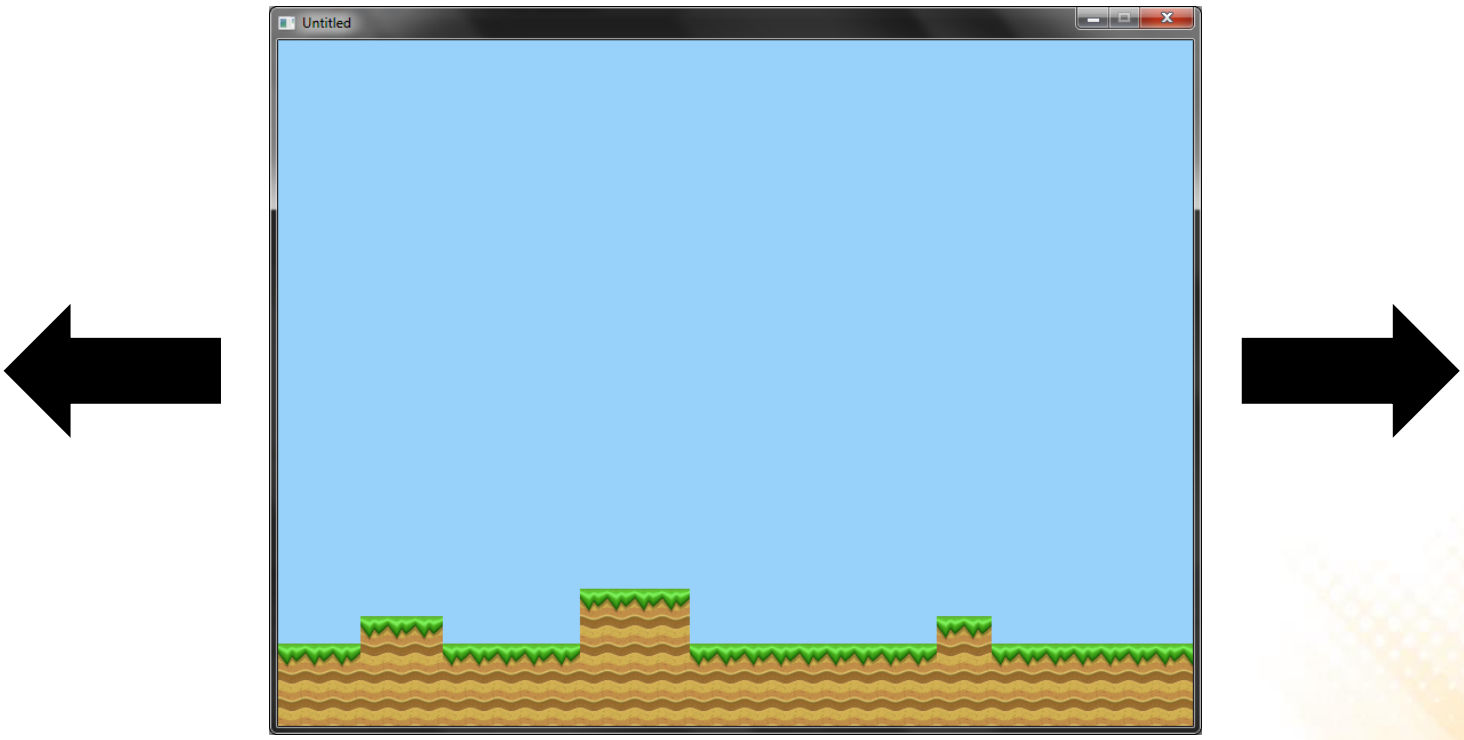
3) Implement a program to display the world of a platform game, which is stored in a text file.



Images: http://www.inf.puc-rio.br/~elima/intro-eng/mapa_exercicio3.zip

Exercise 4

4) Continue the implementation of the last exercise and code a virtual camera to allow the player to move and see the entire environment.
   - **Important**: don't draw parts of world that are not visible in the screen.



Texture Atlas

- A texture atlas (also called a sprite sheet or an image sprite) is an image containing a collection of smaller images, usually packed together to reduce the atlas size.

- It is often more efficient to store the textures in a texture atlas which is treated as a single unit by the graphics hardware.

Texture Atlas – Example

World

```
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX
XXXXXXXXXXXXXXX
XXXBXXXXXXXXXXX
XXBBBXXXXXXXXXX
GGGGGGGAAGGGGG
TTTTTTTPPTTTTT
TTTTTTTPPTTTTT
```

Tileset

http://www.inf.puc-rio.br/~elima/intro-eng/plataform_map1.zip

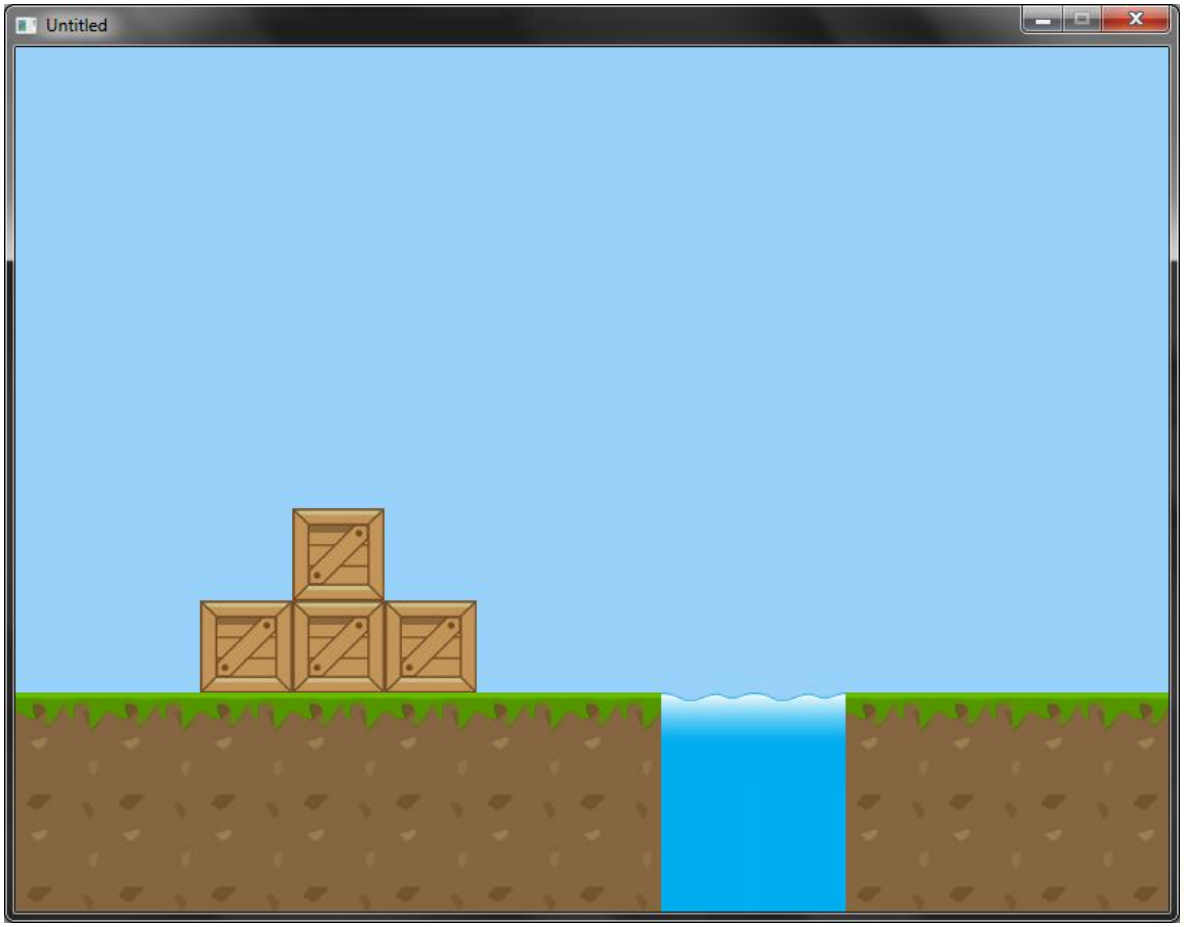
Texture Atlas – Example

```
local world = {}
local tilesetImage
local tileQuads = {}
local tileSize = 64

function LoadTiles(filename, nx, ny)
  tilesetImage = love.graphics.newImage(filename)
  local count = 1
  for i = 0, nx, 1 do
    for j = 0, ny, 1 do
      tileQuads[count] = love.graphics.newQuad(i * tileSize ,
                                        j * tileSize, tileSize, tileSize,
                                        tilesetImage:getWidth(),
                                        tilesetImage:getHeight())
      count = count + 1
    end
  end
end
.
.
.
```

```
.
.
.
function LoadMap(filename)
  local file = io.open(filename)
  local i = 1
  for line in file:lines() do
    world[i] = {}
    for j=1, #line, 1 do
      world[i][j] = line:sub(j,j)
    end
    i = i + 1
  end
  file:close()
end

function love.load()
  LoadMap("plataform_map.txt")
  LoadTiles("plataform_tileset.png", 2, 2)
  love.graphics.setBackgroundColor(0.6, 0.819, 0.980)
end
.
.
.
```

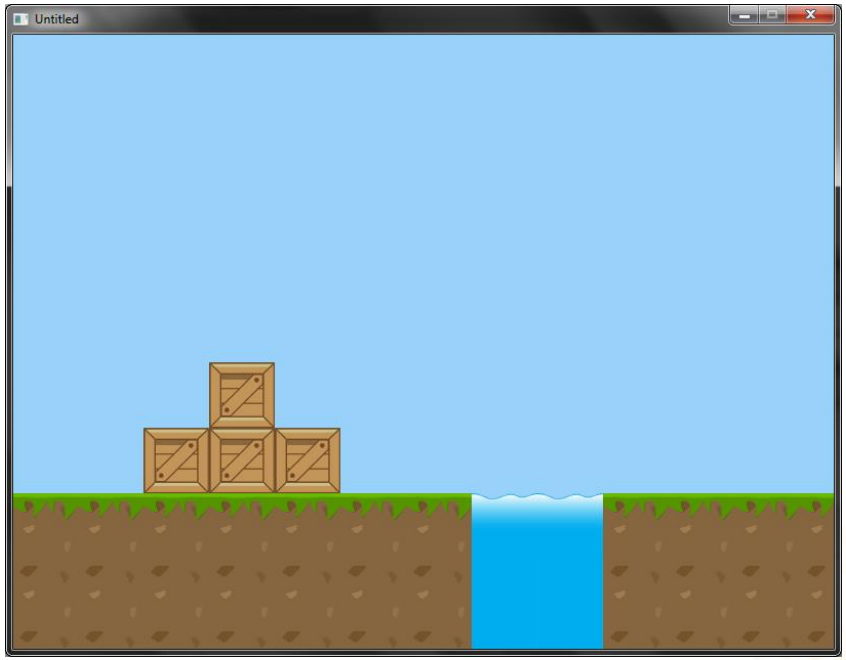
```
.
.
.
function love.draw()
  for i=1, 10, 1 do
    for j=1, 14, 1 do
      if (world[i][j] == "G") then
        love.graphics.draw(tilesetImage, tileQuads[1],
                    (j * tileSize) - tileSize, (i * tileSize) - tileSize)
      elseif (world[i][j] == "T") then
        love.graphics.draw(tilesetImage, tileQuads[4],
                    (j * tileSize) - tileSize, (i * tileSize) - tileSize)
      elseif (world[i][j] == "A") then
        love.graphics.draw(tilesetImage, tileQuads[7],
                    (j * tileSize) - tileSize, (i * tileSize) - tileSize)
      elseif (world[i][j] == "P") then
        love.graphics.draw(tilesetImage, tileQuads[8],
                    (j * tileSize) - tileSize, (i * tileSize) - tileSize)
      elseif (world[i][j] == "B") then
        love.graphics.draw(tilesetImage, tileQuads[6],
                    (j * tileSize) - tileSize, (i * tileSize) - tileSize)
      end
    end
  end
end
```

Texture Atlas – Example



Tile-Based Scrolling – Example

```
XXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXBXXXXXXXXXXXXBXXXXXXXXXX
XXBBBXXXXXXXXXXXBBBXXXXXXXX
GGGGGGGAAGGGGGGGGGGGAAGGGGG
TTTTTTTPPTTTTTTTTTTTPPTTTTT
TTTTTTTPPTTTTTTTTTTTPPTTTTT
```



http://www.inf.puc-rio.br/~elima/intro-eng/plataform_map2.zip

Tile-Based Scrolling – Example

```
local world = {}
local tilesetImage
local tileQuads = {}
local tileSize = 64

local world_config = {
  worldSize_x = 28,
  worldSize_y = 10,
  worldDisplay_x = 14,
  worldDisplay_y = 10
}

local camera = {
  pos_x = 1,
  pos_y = 1,
  speed = 120
}
```

```
function LoadTiles(filename, nx, ny)
  tilesetImage = love.graphics.newImage(filename)
  local count = 1
  for i = 0, nx, 1 do
    for j = 0, ny, 1 do
      tileQuads[count] = love.graphics.newQuad(i * tileSize, j *
                                        tileSize, tileSize, tileSize,
                                        tilesetImage:getWidth(),
                                        tilesetImage:getHeight())
      count = count + 1
    end
  end
end

function LoadMap(filename)
  local file = io.open(filename)
  local i = 1
  for line in file:lines() do
    world[i] = {}
    for j=1, #line, 1 do
      world[i][j] = line:sub(j,j)
    end
    i = i + 1
  end
  file:close()
end
```

```
function love.load()
  LoadMap("plataform_map.txt")
  LoadTiles("plataform_tileset.png", 2, 2)
  love.graphics.setBackgroundColor(0.6, 0.819, 0.980)
end

function love.update(dt)
  if love.keyboard.isDown("right") then
    camera.pos_x = camera.pos_x + (camera.speed * dt)
  elseif love.keyboard.isDown("left") then
    camera.pos_x = camera.pos_x - (camera.speed * dt)
  end

  if camera.pos_x < 0 then
    camera.pos_x = 0
  elseif camera.pos_x > world_config.worldSize_x * tileSize -
                        world_config.worldDisplay_x * tileSize - 1 then
    camera.pos_x = world_config.worldSize_x * tileSize -
                        world_config.worldDisplay_x * tileSize - 1
  end
end
```

```
function love.draw()
    offset_x = math.floor(camera.pos_x % tileSize)
    first_tile_x = math.floor(camera.pos_x / tileSize)
    for y=1, world_config.worldDisplay_y, 1 do
        for x=1, world_config.worldDisplay_x, 1 do
          if (world[y][first_tile_x + x] == "G") then
            love.graphics.draw(tilesetImage, tileQuads[1],
                        ((x -1)*tileSize) - offset_x ,((y-1)*tileSize))
          elseif (world[y][first_tile_x + x] == "T") then
            love.graphics.draw(tilesetImage, tileQuads[4],
                        ((x-1)*tileSize) - offset_x ,((y-1)*tileSize))
          elseif (world[y][first_tile_x + x] == "A") then
            love.graphics.draw(tilesetImage, tileQuads[7],
                        ((x-1)*tileSize) - offset_x ,((y-1)*tileSize))
          elseif (world[y][first_tile_x + x] == "P") then
            love.graphics.draw(tilesetImage, tileQuads[8],
                        ((x-1)*tileSize) - offset_x ,((y-1)*tileSize))
          elseif (world[y][first_tile_x + x] == "B") then
            love.graphics.draw(tilesetImage, tileQuads[6],
                        ((x-1)*tileSize) - offset_x ,((y-1)*tileSize))
          end
        end
    end
end
```

Tile-Based Scrolling – Example