

## **Code Club Challenge: Space Invaders**

## Setting up

One of the very first computer games was called “Space Invaders”<sup>1</sup> and we are going to try to recreate it in Python.

To get started, open LXTerminal and use the following command to download the start of the project:

Listing 1: Get the the starting point

```
$ git clone http://github.com/jrmhaig/space_invaders
```

This should create a new directory called `space_invaders` containing a Python program and some icons. Open the program with:

Listing 2: Opening the starting point

```
$ cd space_invaders
$ idle space_invaders.py
```

### Note

We need to use idle (for Python version 2) instead of idle3 (for Python version 3) because the PyGame module only works for Python version 2 on the Raspberry Pi at the moment. You could also launch Idle from the desktop icon and then browse to the correct directory to open the file.

## Controlling the ship

The first thing to do is to add the ship that you (the player) will control. This will move left and right along the bottom of the screen while the aliens, which you have to shoot, will go at the top. Look at the script below and see what you need to change.

### Note

Can you identify the parts that:

- Finds the picture file to use for the ship?
- Tells the computer where to put the ship?
- Finds out if you are pressing the left or right buttons?

Listing 3: Controlling the ship

```
import pygame

# Colours
WHITE = (255,255,255)

5 # Size of the screen
WIDTH = 400
```

---

<sup>1</sup>It was apparently originally created in 1978, which makes it almost as old as me!

```

HEIGHT = 300

10 pygame.init()
    clock = pygame.time.Clock()
    game_speed = 85
    screen = pygame.display.set_mode((WIDTH, HEIGHT), 0)

15 # Images # New
    ship_image = pygame.image.load('icons/ship.png') # New

    # Position of the ship # New
    ship = { # New
20         'x': 150, # New
         'y': 260, # New
        } # New

run = True

25 while run:
    screen.fill(WHITE)

    for event in pygame.event.get():
30         if event.type == pygame.QUIT:
            run = False
        elif event.type == pygame.KEYDOWN: # New
            # A key has been pressed # New
            if event.key == pygame.K_LEFT: # New
35                 # Move the ship left # New
                ship['x'] = ship['x'] - 1 # New
            elif event.key == pygame.K_RIGHT: # New
                # Move the ship right # New
40                 ship['x'] = ship['x'] + 1 # New

            # Put the ship on the screen # New
            screen.blit(ship_image, (ship['x'], ship['y'])) # New

            # Refresh the screen
45         pygame.display.update()
        clock.tick(game_speed)

```

## Make the movement easier

You have probably noticed that the movement of the ship is not very easy. You really want to be able to hold the key pressed rather than having to press it lots of times. The reason it is acting the way it is is because when it detects a keyboard *event* with `event.type == pygame.KEYDOWN` it sees the single action when you press the key and moves the ship once. What we really want is for it to tell when the key is pressed and then keep moving the ship until it is released, with `event.type == pygame.KEYUP`.

### Note

I have not printed all the code, indicating missing bits with '...', to save space.

Listing 4: Easier control of the ship

```

...

# Position of the ship
ship = {
5     'x': 150,
      'y': 260,
      }
ship_move_left = False           # New
ship_move_right = False         # New

10 run = True

while run:
    screen.fill(WHITE)

15     for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
        elif event.type == pygame.KEYDOWN:
20             # A key has been pressed
            if event.key == pygame.K_LEFT:
                # Start moving the ship left           # Changed
                ship_move_left = True                   # Changed
            elif event.key == pygame.K_RIGHT:
25                 # Start moving the ship right         # Changed
                ship_move_right = True                   # Changed
            elif event.type == pygame.KEYUP:              # New
                # A key has been released                # New
                if event.key == pygame.K_LEFT:           # New
                    # Stop moving the ship left          # New
                    ship_move_left = False              # New
                elif event.key == pygame.K_RIGHT:        # New
                    # Stop moving the ship right         # New
                    ship_move_right = False              # New
35
            if ship_move_left:                            # New
                ship['x'] = ship['x'] - 1                # New
            if ship_move_right:                            # New
                ship['x'] = ship['x'] + 1                # New
40
        # Put the ship on the screen
        screen.blit(ship_image, (ship['x'], ship['y']))

        # Refresh the screen
45     pygame.display.update()
    clock.tick(game_speed)

```

## Add a bit of *class*

Now we have managed to get the ship moving more easily but do you see what happens when you go to the edge of the window? We will solve this later. First, we are going to introduce a new programming idea;

*Classes and Objects.*

So far, we have just a single thing in our game – a ship that you can control with the arrow keys. Later we will also have a number of aliens as well as bullets, and all of these have very similar information about them and actions. For example, they all have a position (x and y) and they all need to move. With a Class we can write code for them all once and only once.

**Note**

Note, some of the lines marked “Changed” have very small changes, even just a single character, while others replace several lines with just one.

Can you see how I stopped the ship going off the side of the window?

Can you work out how to make it move faster or slower?

Listing 5: Adding classes

```

import pygame

# Colours
WHITE = (255,255,255)

5 # Size of the screen
WIDTH = 400
HEIGHT = 300

10 pygame.init()
clock = pygame.time.Clock()
game_speed=85
screen = pygame.display.set_mode((WIDTH, HEIGHT), 0)

15 class GamePiece:                                # New
    def __init__(self, x, y, image):                # New
        self.x = x                                  # New
        self.y = y                                  # New
        self.speed = 1                              # New
20     self.image = image                            # New
        self.move_left = False                      # New
        self.move_right = False                    # New
        self.min_x = 10                             # New
        self.max_x = 340                            # New

25     def move(self):                                # New
        if self.move_left:                          # New
            if self.x > self.min_x:                 # New
                self.x = self.x - self.speed        # New
30         if self.move_right:                      # New
            if self.x < self.max_x:                 # New
                self.x = self.x + self.speed        # New

        def draw(self):                              # New
35         screen.blit(self.image, (self.x, self.y)) # New

# Images
ship_image = pygame.image.load('icons/ship.png')
```

```
40 # Game objects # Changed
    ship = GamePiece(150, 260, ship_image) # Changed

    run = True

45 while run:
    screen.fill(WHITE)

    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
50         elif event.type == pygame.KEYDOWN:
            # A key has been pressed
            if event.key == pygame.K_LEFT:
                # Start moving the ship left
                ship.move_left = True # Changed
            elif event.key == pygame.K_RIGHT:
                # Start moving the ship right
                ship.move_right = True # Changed
60         elif event.type == pygame.KEYUP:
            # A key has been released
            if event.key == pygame.K_LEFT:
                # Stop moving the ship left
                ship.move_left = False # Changed
            elif event.key == pygame.K_RIGHT:
65                 # Stop moving the ship right
                ship.move_right = False # Changed

            # Move and draw the ship # Changed
            ship.move() # Changed
70            ship.draw() # Changed

            # Refresh the screen
            pygame.display.update()
            clock.tick(game_speed)
```

## Explanation

In the previous section we added a *Class* called `GamePiece`. By itself, this does not do anything to it provides a pattern from which we created an *Object* for the ship. Later, we will add another object for an alien and our code will contain:

Listing 6: Object creation example

```
ship = GamePiece(150, 260, ship_image)
alien = GamePiece(150, 30, alien_image)
```

Each of these is separate from the other and has its own x and y coordinates. They also both know how to move and draw themselves in the correct position in the window if we call the functions:

Listing 7: Function call example

```
ship.move()
alien.move()

ship.draw()
5 alien.draw()
```

and we can even set their speeds with:

Listing 8: Setting object variables

```
ship.speed = 0.6
alien.speed = 0.3
```

#### Note

This may be the answer to one of the questions in the last section!

As well as the move and draw functions you will see another function called `__init__` (that is a double ‘\_’ before and after the word ‘init’). This is a special function that is always run once when the object is created with `ship = GamePiece(150, 260, ship_image)`. This makes sure that all the variables have the correct values at the start.

## Add an alien

The real Space Invaders game has lots of aliens in rows but for the moment we will start with just one. As I said in the last section, a lot of the work is already done for us as we can use the `GamePiece` class. First, make some changes to the `GamePiece` class to let the alien “bounce” when it reaches the side of the screen.

Listing 9: Changes to the class

```
...

class GamePiece:
    def __init__(self, x, y, image):
5         self.x = x
           self.y = y
           self.speed = 1
           self.image = image
           self.move_left = False
10          self.move_right = False
           self.min_x = 10
           self.max_x = 340
           self.bounce = False                                     # New

15          def move(self):
              if self.move_left:
                  if self.x > self.min_x:
                      self.x = self.x - self.speed
                  elif self.bounce:                                # New
```

```

20         self.y = self.y + 5                # New
           self.move_left = False            # New
           self.move_right = True            # New
       if self.move_right:
           if self.x < self.max_x:
25               self.x = self.x + self.speed
           elif self.bounce:                  # New
               self.y = self.y + 5           # New
               self.move_left = True         # New
               self.move_right = False      # New
30
       def draw(self):
           screen.blit(self.image, (self.x, self.y))
...

```

Next, this is all that is needed to create the alien.

Listing 10: Create the alien object

```

...

# Images
ship_image = pygame.image.load('icons/ship.png')
5 alien_image = pygame.image.load('icons/alien1.png')    # New

ship = GamePiece(150, 260, ship_image)
alien = GamePiece(150, 30, alien_image)                  # New

10 # Make the alien move by itself                      # New
    alien.move_left = True                              # New
    # Make the alien bounce when it hits the edge       # New
    alien.bounce = True                                 # New
    alien.speed = 0.3                                   # New
15
...

```

Listing 11: Use the alien object

```

...

# Move and draw the ship
ship.move()
5 ship.draw()

# Move and draw the alien    # New
alien.move()                 # New
alien.draw()                  # New
10
...

```



## Shoot the alien

The next thing to do is to let you try to shoot the alien. For this, we need to load an image of a bullet with this line (try to find the correct place to put it):

Listing 12: Load the bullet image

```
bullet_image = pygame.image.load('icons/bullet.png')
```

Now the bullet needs to move up the screen, rather than left or right, and then disappear when it reaches the top. For this we need to add some new variables to the `__init__` function:

Listing 13: New variables

```
def __init__(self, x, y, image):
    self.x = x
    self.y = y
    self.speed = 1
5    self.image = image
    self.move_left = False
    self.move_right = False
    self.move_up = False           # New
    self.min_y = 20               # New
10    self.min_x = 10
    self.max_x = 340
    self.bounce = False
```

and add a new part to the move function:

Listing 14: New move function

```
def move(self):
    if self.move_left:
        if self.x > self.min_x:
            self.x = self.x - self.speed
5        elif self.bounce:
            self.y = self.y + 5
            self.move_left = False
            self.move_right = True
    if self.move_right:
10        if self.x < self.max_x:
            self.x = self.x + self.speed
        elif self.bounce:
            self.y = self.y + 5
            self.move_left = True
            self.move_right = False
15    if self.move_up:
        if self.y > self.min_y:
            self.y = self.y - self.speed
        # New
        # New
        # New
```

At the start of the game, the bullet doesn't exist and we can indicate this with:

Listing 15: Initialise bullet

```
# Game objects
bullet = None
ship = GamePiece(150, 260, ship_image)
alien = GamePiece(150, 30, alien_image)
```

And finally, the bullet should appear when we press the ‘SPACE’ bar.

Listing 16: Fire!

```
for event in pygame.event.get():
    ...
    elif event.type == pygame.KEYDOWN:
        # A key has been pressed
        ...
        elif event.key == pygame.K_SPACE and bullet == None:      # New
            # Fire the bullet from the mid-point of the ship      # New
            bullet = GamePiece(ship.x + 22, ship.y, bullet_image)  # New
            bullet.move_up = True                                   # New
        ...

    # Move and draw the alien
    alien.move()
    alien.draw()

    # Move and draw the bullet                                     # New
    if bullet != None:                                           # New
        bullet.move()                                           # New
        if bullet.y > bullet.min_y:                             # New
            bullet.draw()                                       # New
        else:                                                    # New
            bullet = None                                       # New
```

## Hit the alien

You may have noticed that the bullet currently just goes straight through the alien. This isn’t very good! In the GamePiece class we need a new function to detect if it has been hit.

Listing 17: Detect a hit

```
class GamePiece:
    def __init__(self, x, y, image):
        self.x = x
        self.y = y
        self.width = 0      # New
        self.height = 0     # New
        ...

    def draw(self):
        self.blit(self.image, (self.x, self.y))

    def detect_hit(self, other):      # New
```

```

        if other.x > self.x \                # New
            and other.x < self.x + self.width \ # New
        15         and other.y > self.y \        # New
            and other.y < self.y + self.height: # New
            return True                       # New
        else:                                # New
            return False                       # New
20     ...
    # Make the alien move by itself
    alien.move_left = True
    # Make the alien bounce when it hits the edge
    alien.bounce = True
25    alien.speed = 0.3
    # Set the height and width of the alien    # New
    alien.width = 47                           # New
    alien.height = 22                          # New

```

At the moment there is only one alien so when it is hit we will put it back at the top and make it move faster. Later, we can have several rows of aliens and try to keep a score.

Listing 18: Hit the alien

```

    # Move and draw the bullet
    if bullet != None:
        bullet.move()
        if bullet.y > bullet.min_y:
5         bullet.draw()
            if alien.detect_hit(bullet):        # New
                # Move the alien back to the top # New
                alien.x = 10                    # New
                alien.y = 10                    # New
10         # Move it a bit faster                # New
                alien.speed = alien.speed + 0.1 # New
                bullet = None                   # New
        else:
            bullet = None

```

## More aliens

Now we will make a line of 5 aliens and store them in an array.

Listing 19: Line of 5 aliens

```

...

bullet = None
ship = GamePiece(150, 260, ship_image)
5  aliens = []                                # Changed
    for i in range(5):                        # New
        alien = GamePiece(30 + i*50, 30, alien_image) # New
        # Keep aliens in line when they bounce        # New
        alien.min_x = 20 + i*50                # New

```

```

10     alien.max_x = 140 + i*50                                # New
    # Make the alien move by itself                            # Changed
    alien.move_left = True                                    # Changed
    # Make the alien bounce when it hits the edge              # Changed
    alien.bounce = True                                       # Changed
15     alien.speed = 0.3                                        # Changed
    # Set the height and width of the alien                   # Changed
    alien.width = 47                                           # Changed
    alien.height = 22                                          # Changed
    aliens.append(alien)                                       # New
20
run = True

...

```

And then get them all to move and get hit by bullets.

Listing 20: Line of 5 aliens

```

...

# Move and draw the ship
ship.move()
5 ship.draw()

# Move and draw the aliens                                # Changed
for alien in aliens:                                     # Changed
    alien.move()                                          # Changed
10    alien.draw()                                       # Changed

# Move and draw the bullet
if bullet != None:
    bullet.move()
15    if bullet.y > bullet.min_y:
        bullet.draw()
        for alien in aliens:                            # Changed
            if alien.detect_hit(bullet):                 # Changed
                aliens.remove(alien)                     # Changed
20                bullet = None                          # Changed
            break                                         # Changed
        else:
            bullet = None

25 # Refresh the screen
pygame.display.update()
clock.tick(game_speed)

```

and lose if aliens reach the bottom.

## To do

Keep score, alien bullets, more levels.