Code Club Challenge: Space Invaders

Setting up

One of the very first computer games was called "Space Invaders"[1] 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?

[1] It was apparently originally created in 1978, which makes it almost as old as me!

Listing 3: Controlling the ship

```
import pygame

# Colours
WHITE = (255,255,255)

# Size of the screen
WIDTH = 400
HEIGHT = 300

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

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

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

run = True

while run:
    screen.fill(WHITE)

    for event in pygame.event.get():
        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
                # Move the ship left                        # New
                ship['x'] = ship['x'] - 1                   # New
            elif event.key == pygame.K_RIGHT:               # New
                # Move the ship right                       # New
                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
    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 = {
        'x': 150,
        'y': 260,
        }
ship_move_left = False                                  # New
ship_move_right = False                                 # New

run = True

while run:
    screen.fill(WHITE)

    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
        elif event.type == pygame.KEYDOWN:
            # 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:
                # 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

    if ship_move_left:                                 # New
        ship['x'] = ship['x'] - 1                      # New
    if ship_move_right:                                # New
        ship['x'] = ship['x'] + 1                      # New

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

    # Refresh the screen
    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)

# Size of the screen
WIDTH = 400
HEIGHT = 300

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

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

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

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

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

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

run = True
```

```
while run:
    screen.fill(WHITE)

    for event in pygame.event.get():
        if event.type == pygame.QUIT:
            run = False
        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
        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:
                # Stop moving the ship right
                ship.move_right = False                  # Changed

    # Move and draw the ship                             # Changed
    ship.move()                                          # Changed
    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()
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):
        self.x = x
```

```
        self.y = y
        self.speed = 1
        self.image = image
        self.move_left = False
        self.move_right = False
        self.min_x = 10
        self.max_x = 340
        self.bounce = False                                    # New

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

    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')
alien_image = pygame.image.load('icons/alien1.png')      # New

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

# 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

...
```

Listing 11: Use the alien object

```
...

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

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

...
```

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
        self.image = image
        self.move_left = False
        self.move_right = False
        self.move_up = False                # New
```

```
        self.min_y = 20                    # New
        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
            elif self.bounce:
                self.y = self.y + 5
                self.move_left = False
                self.move_right = True
        if self.move_right:
            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
        if self.move_up:                           # New
            if self.y > self.min_y:                # New
                self.y = self.y - self.speed       # 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
            ...                                    # New (next 4 lines)
            elif event.key == pygame.K_SPACE and bullet == None:
                # Fire the bullet from the mid-point of the ship
                bullet = GamePiece(ship.x+22, ship.y, bullet_image)
                bullet.move_up = True
    ...

    # 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
                and other.y > self.y \             # New
```

```
                and other.y < self.y + self.height: # New
            return True                             # New
        else:                                       # New
            return False                            # New
...
# Make the alien move by itself
alien.move_left = True
# Make the alien bounce when it hits the edge
alien.bounce = True
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:
            bullet.draw()
            if alien.detect_hit(bullet):                # New
                # Move the alien back to the top        # New
                alien.x = 10                            # New
                alien.y = 10                            # New
                # 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)
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
    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
    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

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()
    ship.draw()

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

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

```
                    bullet = None                    # Changed
                    break                            # Changed
            else:
                bullet = None

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

and lose if aliens reach the bottom.

Score

It is about time we kept the score. For the moment, we will give 10 points for each hit. Make variable for the score and prepare the type font.

Listing 21: Score variable

```
import pygame

# Colours
WHITE = (255,255,255)
BLUE = (0, 0, 255)                                   # New

...

run = True
score = 0                                            # New
font = pygame.font.SysFont("monospace", 12)          # New

while run:
    screen.fill(WHITE)

...
```

Add 10 points for each alien hit and display the score.

Listing 22: Score a hit

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

```
            bullet.draw()
            for alien in aliens:
                if alien.detect_hit(bullet):
                    aliens.remove(alien)
                    bullet = None
                    score = score + 10                          # New
                    break
        else:
            bullet = None

    score_text = font.render("Score: " + str(score), 1, BLUE)  # New
    screen.blit(score_text, (10, 10))                           # New
```

To do

Keep score, alien bullets, more levels.