OOP in Arcade

Videogames Technology
Asignatura transversal

Departamento de Automática

Objectives

1. Understand the OO API in Arcade
2. Use sprites and sprites sheets with Arcade
3. Handle user input
4. Understand some multimedia file formats
5. Introduce the `Window`, `View` and `Sprite` classes

Bibliography

1. Paul Craven. The Arcade Book. Chapter 18: Using the Window class. (link).
2. Paul Craven. The Arcade Book. Chapter 19: User control. (link).
3. Paul Craven. The Arcade Book. Chapter 21: Spriters and collisions. (link).
4. Paul Craven. Using Views for Start/End Screens. (link).

Table of Contents

The `Window` class

Introduction

Arcade has an OOP API

- More features than structured API
- Easy to use API

Remember: use the reference documentation

- (`arcade.Window` reference)

The `Window` class

Introduction (II)

```
1  class MyGame(arcade.Window):
2      def __init__(self, width, height, title):
3          """ Initialize everything """
4
5          # Initialize the parent class
6          super().__init__(width, height, title)
7
8          arcade.set_background_color(arcade.color.AMAZON)
9
10     def setup(self):
11         """ Create the sprites and set up the game """
12         pass
13
14     def on_draw(self):
15         """ Render the screen. """
16
17         arcade.start_render()
18         # TODO: Drawing code goes here
```

The Window class

Introduction (III)

```
1  def main():
2      """ Main method """
3      game = MyGame(SCREEN_WIDTH, SCREEN_HEIGHT, "My Game Title")
4      game.setup()
5      arcade.run()
6
7
8  if __name__ == "__main__":
9      main()
```

The `Window` class

Constructor

Constructor

```
class arcade.Window(
        width: int = 800,
        height: int = 600,
        title: Optional[str] = 'Arcade Window',
        fullscreen: bool = False,
        resizable: bool = False,
        update_rate: Optional[float] = 0.016666666666666666,
        antialiasing: bool = True)
```

The `Window` class

Main methods and attributes

`arcade.Window`

Methods

- `setup()`.
  Initialization
- `on_draw()`.
  Drawing
- `on_update(delta_time: float)`.
  Move everything. Perform collision checks. Do all the game logic here

Attributes

- `background_color`.

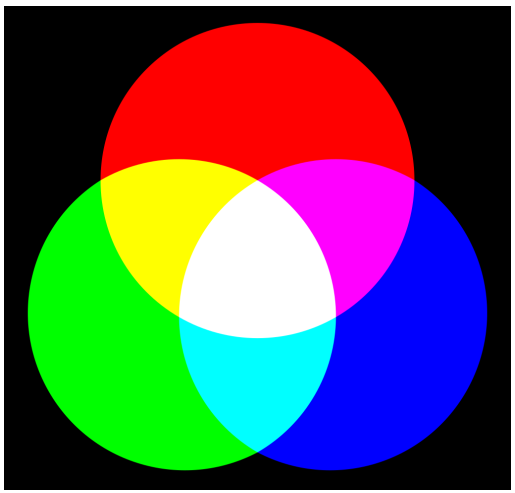
The `Window` class

Background (I)

```
# Use Arcade's built in color values
window.background_color = arcade.color.AMAZON
```

(List of colors)

```
# Specify RGB value directly (red)
window.background_color = 255, 0, 0
```



The `Window` class

Background (II)

Color	Color name	(R,G,B)	Hex
	Black	(0,0,0)	#000000
	White	(255,255,255)	#FFFFFF
	Red	(255,0,0)	#FF0000
	Lime	(0,255,0)	#00FF00
	Blue	(0,0,255)	#0000FF
	Yellow	(255,255,0)	#FFFF00
	Cyan	(0,255,255)	#00FFFF
	Magenta	(255,0,255)	#FF00FF
	Silver	(192,192,192)	#C0C0C0
	Gray	(128,128,128)	#808080
	Maroon	(128,0,0)	#800000
	Olive	(128,128,0)	#808000
	Green	(0,128,0)	#008000
	Purple	(128,0,128)	#800080
	Teal	(0,128,128)	#008080
	Navy	(0,0,128)	#000080

(Source)

The `Window` class

User control methods (I)

User control methods

- `on_key_press(key)` Called when the user presses key.
- `on_key_release(symbol: int, modifiers: int)`. Called when the user presses key.
- `on_mouse_press(x: float, y: float, button: int, modifiers: int)`. Called when the user presses a mouse button.
- `on_mouse_release(x: float, y: float, button: int, modifiers: int)`. Called when the user releases a mouse button.
- `on_mouse_motion(x, y, delta_x, delta_y)`. Called whenever the mouse moves.

The `Window` class

User control methods: Examples

Capturing a mouse click

```
def on_mouse_press(self, x, y, button, modifiers):
    """ Called when the user presses a mouse button. """

    if button == arcade.MOUSE_BUTTON_LEFT:
        print("Left mouse button pressed at", x, y)
    elif button == arcade.MOUSE_BUTTON_RIGHT:
        print("Right mouse button pressed at", x, y)
```

Capturing a key

```
def on_key_press(self, key, modifiers):
    if key == arcade.key.LEFT:
        print("Left key hit")
    elif key == arcade.key.A:
        print("The 'a' key was hit")
```

(More info about keys)

The `Window` class

Other methods

Other methods

- `activate()`.
- `center_window()`.
- `close()`.
- `get_location()`.
- `maximize()` and `minimize()`.
- `set_fullscreen(fullscreen: bool = True, screen: Optional[arcade.application.Window] = None, mode: Optional[pyglet.canvas.base.ScreenMode] = None, width: Optional[float] = None, height: Optional[float] = None)`.
- `set_location(x, y)`.
- `set_viewport(left: float, right: float, bottom: float, top: float)`.
  Set the coordinates we can see

The `Window` class

Using a game controller (I)

First, get the controllers with `arcade.get_joysticks()`

Get game controllers

```
joysticks = arcade.get_joysticks()

if joysticks:
    self.joystick = joysticks[0]
    self.joystick.open()
else:
    print("There are no joysticks.")
    self.joystick = None
```

Read game controller value

```
def update(self, delta_time):
    # Update the position according to the game controller
    if self.joystick:
        print(self.joystick.x, self.joystick.y)
```

The `Window` class

Using a game controller (II)

Read game controller value

```
def update(self, delta_time):
    # Update the position according to the game controller
    if self.joystick:
        print(self.joystick.x, self.joystick.y)
```

Centered $(0, 0)$

Down $(0, 1)$

Down-left $(-1, 1)$

Up $(0, -1)$

(Source)

(Interesting example)

Life-cycle management

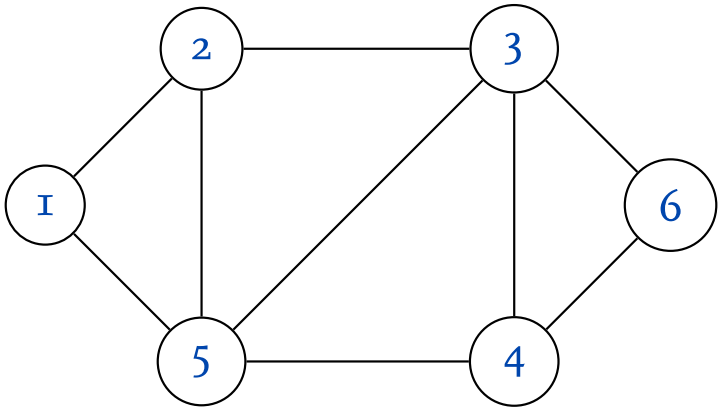
Graphs

Graph: Data structure with **nodes** and **edges**

- Widely used in programming, AI and videogames
- Huge number of applications

Central role in path planning

- (Video)
- Navigation mesh

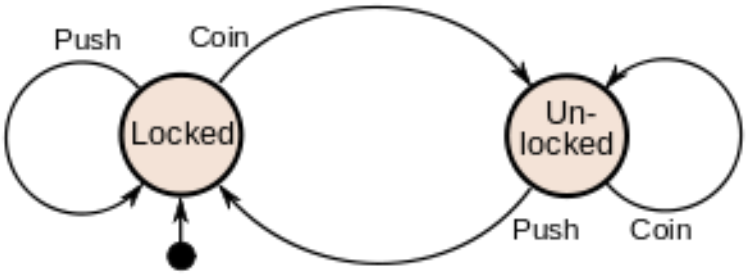


Life-cycle management

Finite States Machines (I)

Finite-State Machine (FSM)

A graph whose nodes represent states, usually associated with behaviours



(Source)

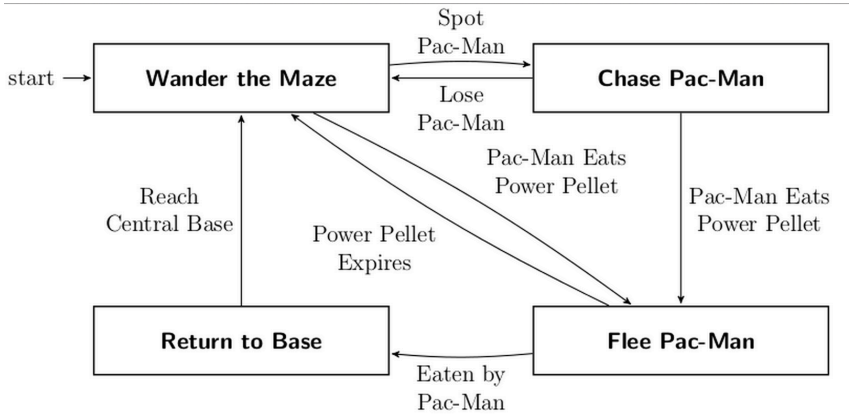
Life-cycle management

Finite States Machines (II)

FSMs have many applications

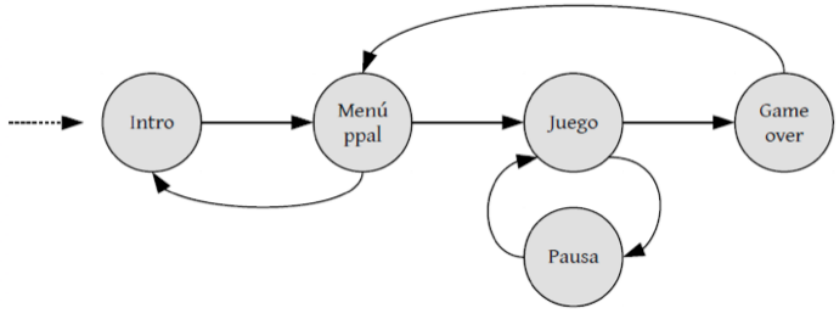
- Central role in Theory of Computation
- Good to model behaviours ... such as a NPC or an entire videogame

NPC behaviour



(Source)

Game life-cycle (also state)

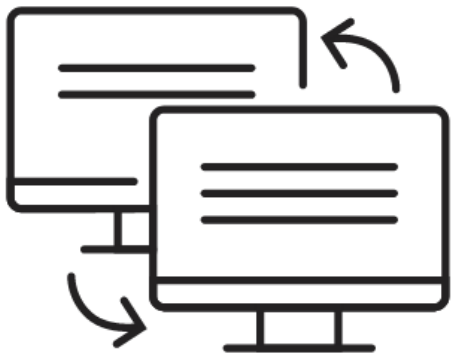


Life-cycle management

The `View` class (I)

Videogames use several screens, or states

- Start screens
- Instruction screens
- Game over screens
- Pause screens



(Source)

Arcade provides the `View` class

- Very much like the Window class
- It has the `on_draw()` and `on_update()` methods

Life-cycle management

The `View` class (II)

Our class must derive from `arcade.View`

```
class MyGame(arcade.Window):
```

⇒

```
class MyGame(arcade.View):
```

The view does not control the window size, so

```
super().__init__(SCREEN_WIDTH,
SCREEN_HEIGHT, SCREEN_TITLE)
```

⇒

```
super().__init__()
```

Life-cycle management

The `View` class (III)

Finally, we need to create a window, a view and show that view

```
def main():
    """ Main function """

    window = arcade.Window(SCREEN_WIDTH, SCREEN_HEIGHT,
        SCREEN_TITLE)
    start_view = GameView()
    window.show_view(start_view)
    start_view.setup()
    arcade.run()
```

Life-cycle management

The `View` class: Example (I)

GameOverView view

```
1  class GameOverView(arcade.View):
2      """ View to show when game is over """
3
4      [...]
5
6      def on_draw(self):
7          """ Draw this view """
8          self.clear()
9          self.texture.draw_sized(SCREEN_WIDTH / 2, SCREEN_HEIGHT
               / 2, SCREEN_WIDTH, SCREEN_HEIGHT)
10
11     def on_mouse_press(self, _x, _y, _button, _modifiers):
12         """ If the user presses the mouse button, re-start the
               game. """
13         game_view = GameView()
14         game_view.setup()
15         self.window.show_view(game_view)
```

Life-cycle management

The `View` class: Example (II)

Game view

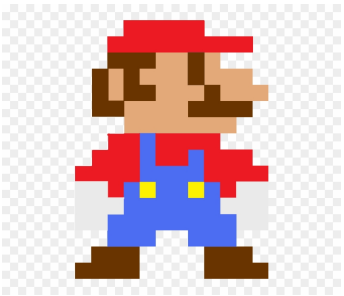
```
1  def on_update(self, delta_time):
2          """ Movement and game logic """
3
4          [ ... ]
5
6          # Check length of coin list. If it is zero, flip to the
7          # game over view.
8          if len(self.coin_list) == 0:
9              view = GameOverView()
10             self.window.show_view(view)
```

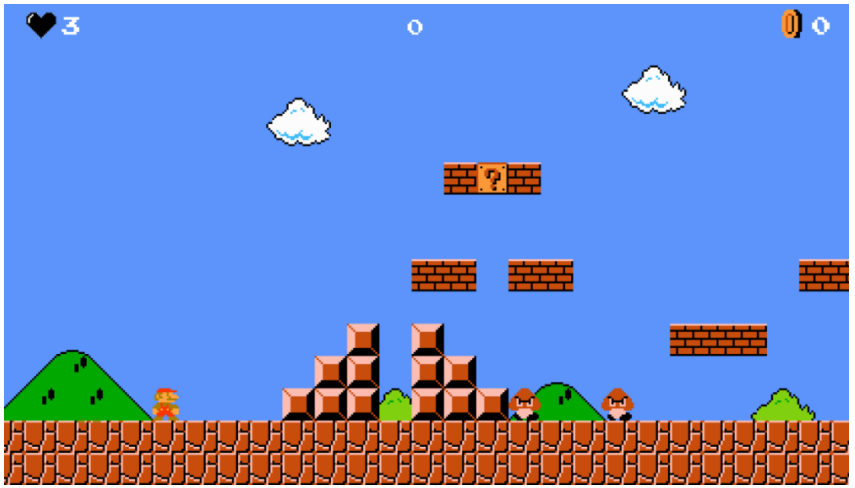
Sprites

Introduction

Sprite

A sprite is a 2D image used in videogames



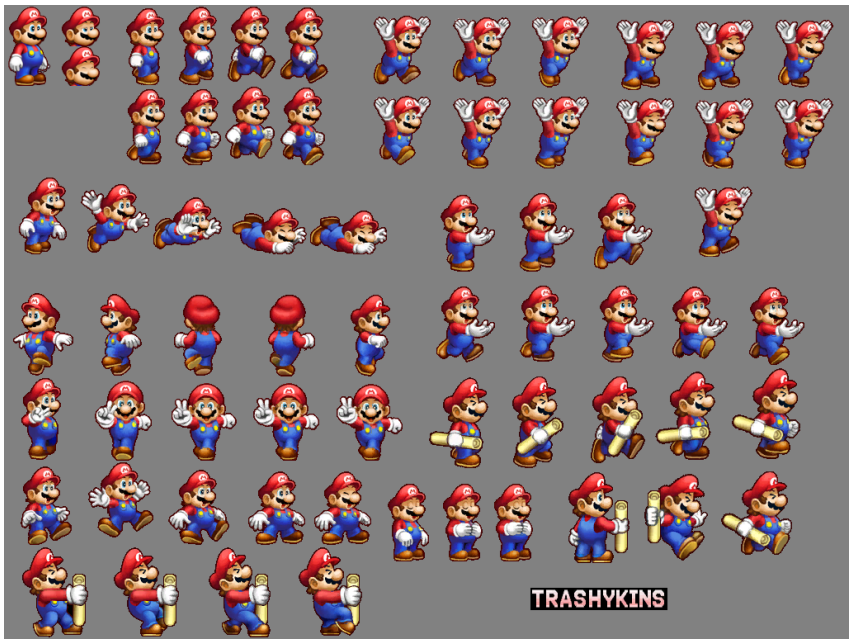


Sprites

Spritesheets

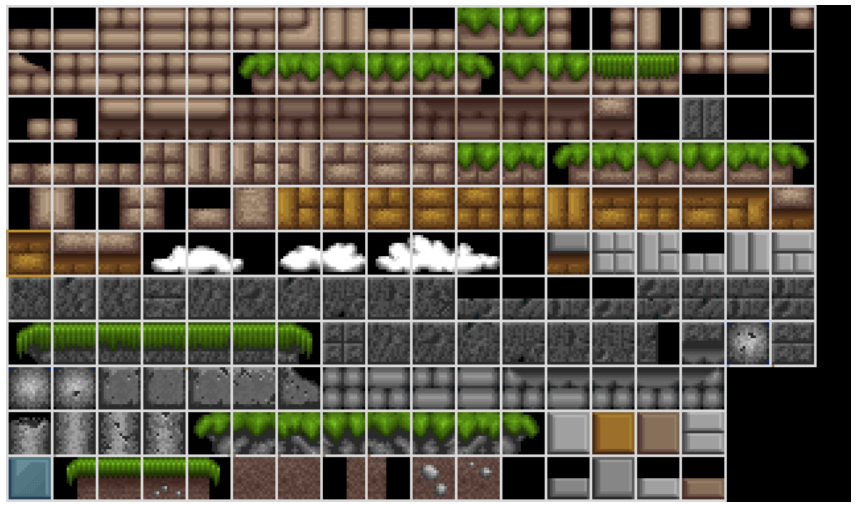
A videogame contains many sprites

- Difficult maintenance
- Solution: Spritesheets



Advantages

- One file contains many sprites
- Less I/O operations $\Rightarrow$ Better performance
- Less memory consumption



Sprites

Data formats (I)

In genenal, any data can be stored in three forms

- Not compressed
- Compressed with loss
- Compressed without loss

	Image format	Sound format	Binary data
Not compressed	BMP	WAV	
Compressed with loss	JPG	MP3	
Compressed without loss	PNG, GIF	-	ZIP, bzip, rar, ...

Sprites

Data formats (II)

Attending to what information is stored in image format, there are two types of image formats:

- Bitmap: stores each pixel
  - Scales bad
  - Formats: JPG, PNG, BMP, GIF
- Vectorial: stores coordinates
  - Scales well
  - Not supported by Arcade
  - Formats: SVG, EPS

Many open assets for your games!

- (Kenney)

Sprites

The `Sprite` class (I)

You will need to provide a path to the file

- *Absolute path*: Starts from the root directory
  - Example (Windows): `c:\\Users\atreides\Desktop\mygame\assets\sprites\mario.png`
  - Example (Linux): `/home/atreides/mygame/assets/sprites/mario.png`
- *Relative path*: Relative to the project's directory
  - Example (Windows): `assets\sprites\mario.png`
  - Example (linux): `assets/sprites/mario.png`

Always use relative paths in your projects!!!

Sprites

The `Sprite` class (II)

Sprites are a fundamental concept in Arcade

Creating a sprite

```
character = arcade.Sprite('images/character.png')
```

Placing a sprite

```
character.center_x = 300
character.center_y = 200
```

Sprite

The `Sprite` class (III)

(Reference documentation)

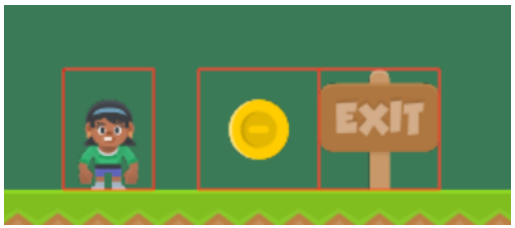
Constructor

```
class arcade.Sprite(
        filename: Optional[str] = None,
        scale: float = 1,
        image_x: float = 0, # offset within sprite sheet
        image_y: float = 0, # offset within sprite sheet
        image_width: float = 0,
        image_height: float = 0,
        center_x: float = 0,
        center_y: float = 0,
        repeat_count_x: int = 1,
        repeat_count_y: int = 1,
        flipped_horizontally: bool = False,
        flipped_vertically: bool = False,
        flipped_diagonally: bool = False,
        hit_box_algorithm: Optional[str] = 'Simple',
        angle: float = 0)
```

Sprite

The `Sprite` class (IV)

Sprites in Arcade implement collision detection and handling



hit_box_algorithm = 'None'

hit_box_algorithm = 'Simple'

hit_box_algorithm = 'Detailed'

Sprite

The `Sprite` class (V)

`arcade.Sprite`

Methods

- `on_update()`.
- `on_update(delta_time: float = 0.016)`.
- `draw()`.
- `append_texture(Texture: arcade.texture.Texture.`
  Appends a new texture (image)
- `set_position(center_x: float, center_y: float)`.
- `set_texture(texture_no: int))`.
- `stop()`
- `turn_left(theta: float = 90.0)`
- `turn_right(theta: float = 90.0)`
- `stop()`

Attributes

- alpha: int.
- angle: float.
- bottom: float and bottom: float.
- center_x: float and center_y: float.
  Center of the sprite
- change_x: float and change_y: float.
  Velocity in X and Y
- height: float.
- visible: bool.

(Reference documentation)

Sprite

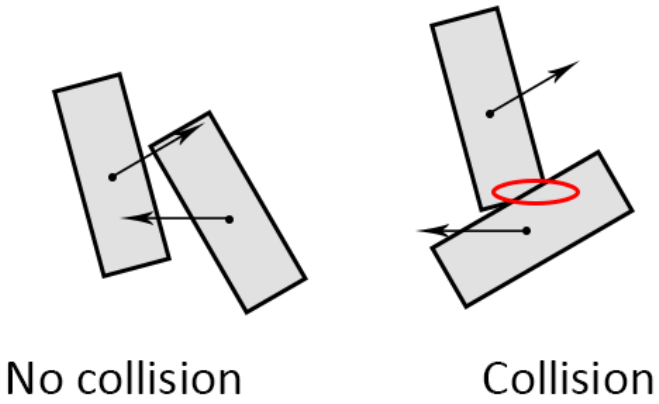
The `Sprite` class: Examples

```
# Make the sprite invisible
sprite.visible = False

# Change back to visible
sprite.visible = True

# Toggle visible
sprite.visible = not sprite.visible
```

The `Window` class

Collision detection

Collision detection is a key concept in game programming



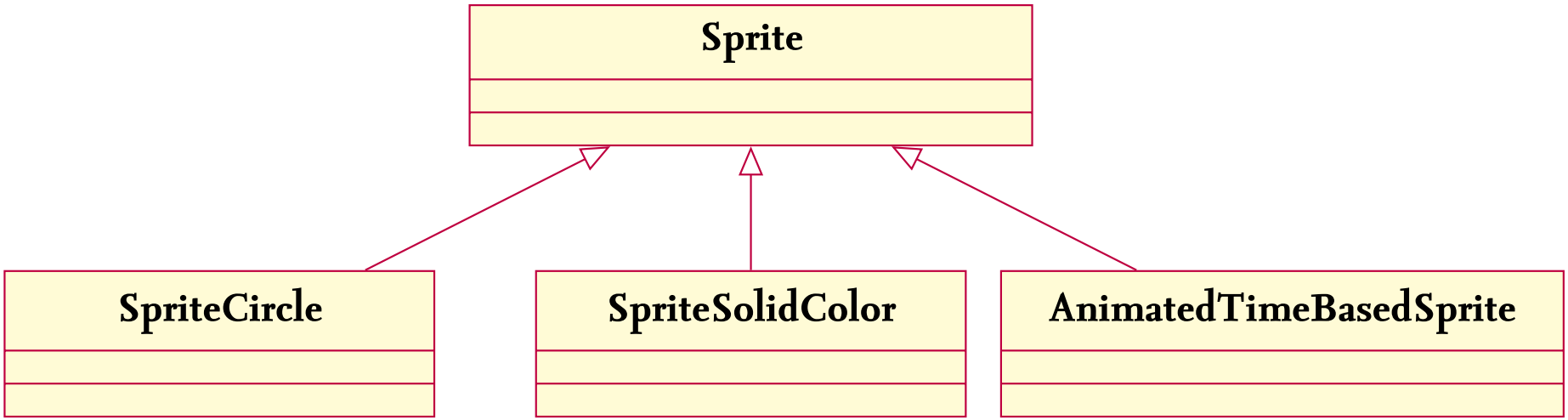
(Source)

Collision detection methods

- `collides_with_list(sprite_list: SpriteList)` → `bool`
- `collides_with_point(point: Union[Tuple[float, float], List[float]])` → `bool`
- `draw_hit_box()`.

Sprite

Other classes



- (SpriteCircle documentation)
- (SpriteSolidColor documentation)
- (SpriteAnimatedTimeBasedSprite documentation)

Sprites

Sprite lists (I)

Arcade stores sprites in lists

```
wall = arcade.Sprite('images/boxCrate.png')
wall.center_x = 300
wall.center_y = 300
wall_list = arcade.SpriteList()
wall_list.append(wall)
```

Lists can be manipulated as a whole

```
wall_list.draw()
```

And sprites can be removed from a list

```
wall.remove_from_sprite_lists()
```

Sprites

Sprite lists (II)

Lists in Arcade also implement collision detection

```
 hit_list =
arcade.check_for_collision_with_list(player_sprite,
coin_list)
```

Functional example in (example)

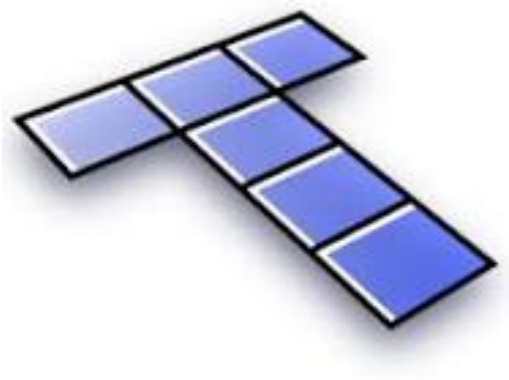
Sprites

Locating sprites

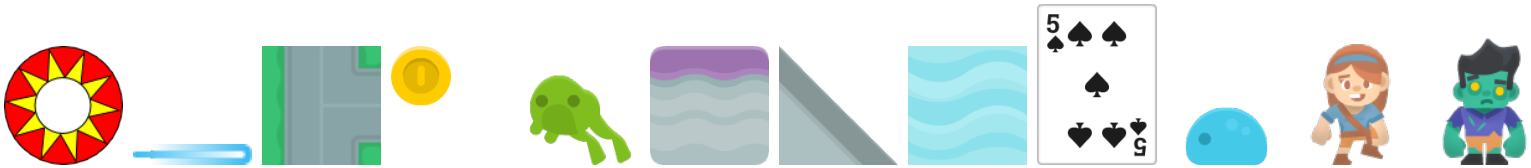
Locating sprites in the game is a tought work

- Closely related to level design
- There are tools that ease this task

(Tiled Map Editor)



Resources management (I)



Arcade comes along a collection of built-in resources

- Good for testing
- No need of files in disk
- Images, music, sounds, tiled maps and video

The path is something like ':resources:/path/to/resource'

```
arcade.Sprite(":resources:images/items/coinGold.png")
```

(List of resources)
(Arcade source code)

Resources management (II)

Adding new resources handlers

```
1 arcade.resources.add_resource_handle("characters", "resources/
      characters")
2 arcade.resources.add_resource_handle("maps", "resources/maps")
3 arcade.resources.add_resource_handle("data", "resources/data")
4 arcade.resources.add_resource_handle("sounds", "resources/sounds
      ")
5 arcade.resources.add_resource_handle("misc", "resources/misc")
```

Using resources handlers

```
1 self.player_sprite = PlayerSprite(":characters:Female/Female
      18-4.png")
```