

Introduction to Pygame

Presented by:

ACM at University of Southern Indiana



Attendance



Requirements

Python

- Download python from
- <https://www.python.org/downloads/>
- Run the installer:
 - Windows: Ensure “Add Python to Path” is checked when installing

A plain text editor
and a shell
environment

-or-

An Integrated
Development
Environment (IDE)

- VS Code
- Etc..

Set Up

Download or clone repository from
<https://www.github.com/JakobieBrown/PygameIntro>
(link in discord)

Open the directory in a terminal or IDE

Install pygame.

In your terminal type:

```
pip install pygame
```

Initializing Pygame

```
import pygame
```

- Import the pygame module

```
pygame.init()
```

- Required before using pygame

```
pygame.display.set_mode((WIDTH,HEIGHT))
```

- Creates a window with a pygame.Surface of the desired size

```
while True:
```

- Loop forever

Handling Events

Without handling events, the program is unresponsive.

- Windows: press 'ctrl' + 'c' in the console to kill the program
- Mac: press '⌘' + '.'

Get a List of the events in the main loop:

```
events = pygame.event.get()
```

Iterate through the events:

```
for event in events:
```

```
    if event.type == pygame.<event type>:
```

Quitting Pygame

`pygame.quit()`

- The opposite of `pygame.init()`
- `quit()` safely uninitializes all pygame modules
- After calling `quit()`, pygame will no longer work

Quit Event

- The quit event is triggered when the user presses close on the window.
- Check for this event in the event loop
- if `event.type == pygame.QUIT`:
 `pygame.quit()` # quit pygame
 `exit()` # exit program

Setting FPS

`pygame.time.Clock`

Used to manage timing and the frame rate

Create a clock instance

```
clock = pygame.time.Clock()
```

In the main loop:

```
clock.tick(30) # sets the framerate to 30 fps
```


Rendering Images

Pygame renders images with `pygame.Surface`.

Surfaces are drawn on the main surface with `main_surface.blit()`

In the main loop call `pygame.display.update()` to re-render the surfaces

Pygame axis begins at the top left

+x is to the right

+y is downward

Pygame Surface

`pygame.Surface`

- Used to draw images on the pygame window

Four “types” of surfaces

- Basic surface
- Main surface
 - The base surface all other surfaces are drawn on top of
- Image surface
 - Used to display image data
- Text surface
 - Used to render text

`Surface.blit(surface, rect)`

- Used to draw any surface to any other surface

Pygame Surface

Main Surface

- `screen = pygame.display.set_mode((width,height))`
- Named screen by convention

Basic Surface

- `surface = pygame.Surface((width,height))`
- `surface.fill(color)` #fill surface with a color

Image Surface

- `image = pygame.image.load(path/to/image)`
- `.convert_alpha()` # converts the image to a usable format and preserves the alpha value.

Pygame Surface

Text Surface

- Rendered from a Font object
- `text_surface = font.render(txt, antialias, color, bg_color)`

Font

- `font = pygame.font.Font(path/to/font | None, size)`
- `font = pygame.font.SysFont("FontName", size, bold, italic)`

Example (drawing a surface to the main surface)

- `box = pygame.Surface((32,32)) #create 32x32 square`
- `box.fill("blue") #fill square with blue`
- `screen.blit(box,(x,y,w,h))#draw surface to screen`

Pygame Rect

Rectangles in pygame are very useful

They're used to:

- Accurately place and move surfaces
- Detect collisions

```
image = pygame.image.load(path).convert_alpha()
```

```
Image_rect = image.get_rect() # create rect from image
```

```
screen.blit(image,image_rect) # blit image to screen
```

Pygame Rect

Using rects enables us to place images accurately without using geometry

```
rect = surface.get_rect(point* = (x,y))
```

This enables you to set a point of the rect to a specific coordinate values.

topleft midtop topright

midleft center midright

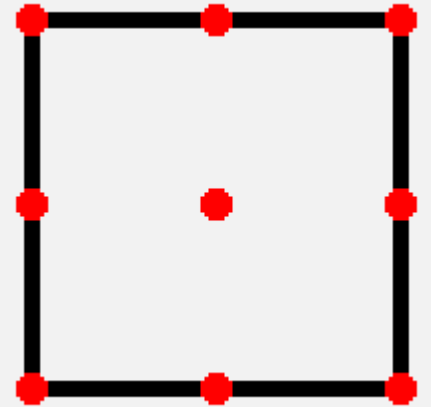
bottomleft midbottom bottomright

Example (draw text in top right corner)

```
txt = font.render(txt,True,'white', None)
```

```
rect = txt.get_rect(topright = (screen_width, 0))
```

```
screen.blit(txt,rect)
```



Animation (movement)

Motion in videos is caused by changing the position of an image over time.

The rects we set up for our images will make this very simple.

Example:

```
image = pygame.image.load(path)
```

```
rect = image.get_rect()
```

```
speed = c
```

```
while True:
```

```
    rect.x += speed
```

```
    screen.blit(image, rect)
```

Animation (movement): 2-Dimensional

For 2-dimensional movement:

- Deal with components separately
- Cos is for x
- Sin is for y

Example:

```
direction = (direction + delta_dir) % 360  
velocity.x += cos(direction)  
velocity.y += sin(direction)  
position.x += velocity.x  
position.y -= velocity.y # inverted y-axis
```


Collision Detection

Rects enable us to check for collisions between two rects

`rect.colliderect(other_rect)`

- Returns Boolean value to indicate if rects overlap
- Problem: Calling this for all possible colliding rects would be tedious and/or inefficient

Key Events

Pygame provides an interface that triggers events when keys are pressed

To respond to these events we listen for them in the event loop.

```
for event in pygame.event.get():  
    if event.type == pygame.KEYDOWN:  
        if event.key == pygame.K_<key>:  
            #do something  
    elif event.type == pygame.KEYUP:  
        if event.key == pygame.K_<key>:  
            #do something
```

Surface Transformation: Rotation

`pygame.transform.rotate(surface, angle)`

- Returns the transformed surface
- Angle is in degrees
- Keep an unaltered surface to transform to avoid issues
- Reset center after rotation
- +angle: counterclockwise
- -angle: clockwise

Example

```
image = pygame.image.load(path).convert_a...
```

```
rect = image.get_rect(center = (x,y))
```

```
rotated = pygame.tansform.rotate(image, angle)
```

```
rect = rotated.get_rect(center = rect.center)
```

Surface Transformation: Scale

`pygame.transform.scale(surface, 2d size)`

- Scales surface to the size provided
- Size is two values (w,h)

`pygame.transform.scale2x(surface)`

- Scales the surface by a factor of two

`pygame.transform.scale_by(surface, factor)`

- Scales the surface by the factor provided

Same tips for rotation apply to scale

Example:

```
image = pygames.image.load(path).convert_a...
```

```
rect = image.get_rect(center = (x,y))
```

```
scaled = pygame.tansform.scale(image, size)
```

```
rect = scaled.get_rect(center = rect.center)
```

Physics based movement: Acceleration & Velocity

So far, we have moved our surfaces by a constant amount

To emulate kinematic motion, we can move our surface by variable amount

To accomplish this, we'll use two values.
Acceleration and velocity.

In the main loop:

```
acceleration += c #constant
```

```
velocity += acceleration
```

```
position += velocity
```

This has the effect of “gaining speed” over time

It works great for a frictionless environment

Physics based movement: Drag

With the acceleration and velocity working together to move the surface, you've probably noticed it becomes too fast

To fix this we need to create a terminal velocity

Terminal velocity occurs when the friction force becomes large enough to oppose the accelerating force, making acceleration drop to zero and causing the velocity to become constant

Example:

```
friction_coeff = .04
```

```
acceleration += c
```

```
velocity += acceleration
```

```
friction = friction_coeff*velocity
```

```
velocity -= friction
```

As the velocity grows, so does the friction eventually reaching terminal velocity

Basic Game States

Creating a basic game state is simple

We change what happens in the main loop

Example:

```
active = boolean
```

```
while True:
```

```
    if active:
```

```
        # play game
```

```
    else:
```

```
        # show start screen
```

Mouse Events

Pygame provides an interface that triggers events from the mouse

- `event.pos` # position of mouse in a mouse event

Mouse Events

- `pygame.MOUSEBUTTONDOWN` #when mouse button is pressed
- `pygame.MOUSEUP` #when mouse button is released
 - `event.button` # represents which button was pressed/released
 - Left-click: 1 | Wheel-click: 2 | Right-click: 3
 - Wheel-scroll up: 4 | Wheel-scroll down: 5
- `Pygame.MOUSEMOTION`
 - `event.rel` # change in position
- `pygame.WHEEL`
 - `Event.y` # how much the wheel scrolled vertically
 - `Event.x` # how much the wheel scrolled horizontally

Shapes and lines

Pygame provides an interface for drawing shapes and lines on surface

Example

```
pygame.draw.line(surface, color, start, end, width)
```

Example

```
rect = (x,y,w,h)
```

```
pygame.draw.ellipse(surface,color,rect)
```

Colors

In graphic art we use additive colors Red, Blue, and Green

- Any color can be made by combining red, blue, and green at varying values
- Red, Blue, and Green can be values in range [0-255]
- Numbers can be represented with hexadecimal values [000000 – FFFFFFFF]

Pygame handles colors in 3 different ways

- By a 3 integer tuple: (R,G,B)
- By a hexadecimal string: '#RRGGBB'
- By the name of the color: 'color_name'

Colors

Examples

```
red = pygame.Color((255,0,0))
```

```
blue = pygame.Color('#0000FF')
```

```
green = pygame.Color('green')
```

Alpha Value

Colors also have an Alpha value in range [0-255] that determines the transparency of the color

Example

```
transparent_red = pygame.Color((255,0,0,128))
```

```
transparent_blue = pygame.Color('#0000FF80')
```

Sounds

Load sound:

```
sound = pygame.mixer.load('path/to/sound')
```

Adjust volume:

```
sound.set_volume(percentage)
```

Play Sound once:

```
sound.play()
```

Play Sound multiple times:

```
sound.play(n) #plays sound n times
```

Loop forever:

```
sound.play(-1)
```

Stop:

```
sound.stop()
```

Sprite class

The sprite class is used to unify the surface and the rect under one object

Example

```
class Player(pygame.sprite.Sprite):
```

```
    def __init__(self):
```

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

```
        self.image = pygame.Surface((w,h))
```

```
        self.rect = self.image.get_rect()
```

`self.image` and `self.rect` are required attributes in a pygame Sprite

This may seem no different than if you were to create a class, but the real advantage is when you put sprites into groups.

Sprite Groups

A group in pygame is a collection of sprites

Pygame has two types of sprite groups

Group for multiple sprites

GroupSingle for a single sprite

Group has a draw method that uses a sprites, image and rect to draw the sprites on a surface

Group has an update method that calls the update method of sprites in the group

Creating groups:

```
player_group = pygame.sprite.GroupSingle()
```

```
Projectile_group = pygame.sprite.Group()
```

Sprite Groups

Drawing sprites in a group to screen:

```
player_group.draw(screen)
```

Updating sprites:

```
class Player(pygame.sprite.Sprite):
```

```
    def __init__(self):...
```

```
    def update(self):
```

```
        #update player
```

```
player_group.update()
```

Referencing Sprites in groups:

```
player = player_group.sprite # for GroupSingle
```

```
projectile = projectile_group.sprites # List, for Group
```

Spawning Objects

Now that we have our groups and sprites drawing to the screen

We can spawn objects simply by adding them to their group.

```
player_group.add(Player())
```


Group Collision

One of the largest benefits of Sprite Groups is to efficiently handle collisions

To check for collisions between two sprite groups:

GroupSingle:

```
pygame.sprite.spritecollide(group.sprite,  
other_group, bool)
```

- If bool is true, the sprite from other_group is destroyed
- Returns a list of sprites in other_group detected in the collision

Group:

```
pygame.sprite.groupcollide(groupA, groupB,  
destroyA, destroyB)
```

- Returns a Dict of <spriteA, List<sprite>>

Group Collision

Examples:

Single collide with group

```
for sprite in pygame.sprite.spritecollide(a.sprite, b,  
False,):
```

```
    print(f'{a.sprite} collided with {sprite}')
```

Group collide with group

```
for sprite_a, list_b in  
pygame.sprite.groupcollide(a,b,False,False).items():
```

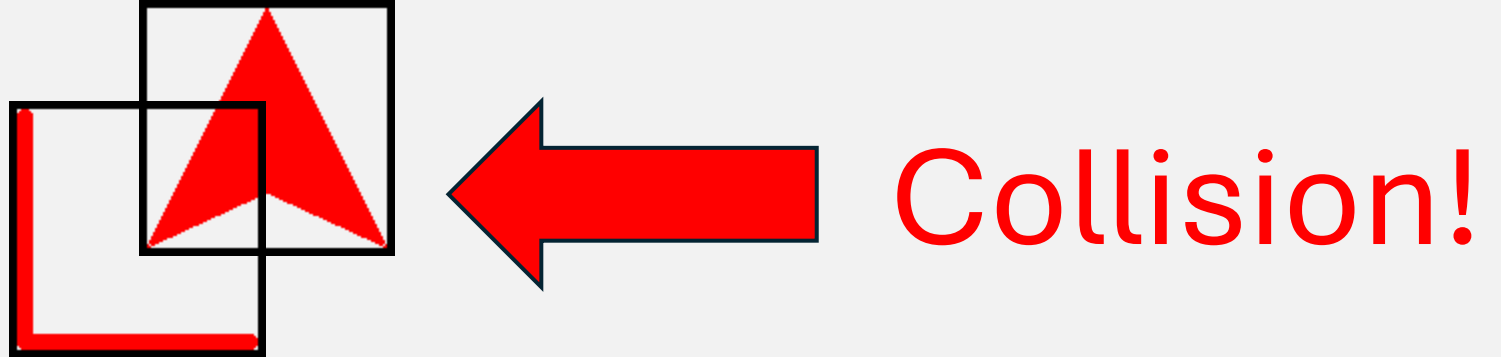
```
    for sprite_b in list_b:
```

```
        print(f'{sprite_a} collided with {sprite_b}')
```

Pixel-perfect Collisions

At this point you may have noticed the collisions look a bit strange.

This is caused by how `colliderect()` behaves
`colliderect` checks if the rects are overlapping and returns true if they are



Pixel-perfect Collisions

To fix this, we'll use masks.

Creating a mask:

```
image = pygame.image.load(path)...
```

```
mask = pygame.mask.from_surface(image)
```

Comparing masks:

```
a.mask.overlap(b.mask, offset) -> Boolean
```

The offset is the difference between the topleft coordinates of the two sprites

To correctly calculate this:

```
offset = (b.rect.left - a.rect.left,  
          b.rect.top - a.rect.top)
```



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