

Python Classes

- you can use the `class` keyword to create your own classes
- here is a tiny example of a class

Python Classes

tinyclass.py

```
#!/usr/bin/env python3

import math

class vector:
    def __init__ (self, pair):
        self.pair = pair
    def get_x (self):
        return self.pair[0]
    def get_y (self):
        return self.pair[1]
    def get_pair (self):
        return self.pair
    def get_length (self):
        return math.sqrt(sqr(self.pair[0]) + sqr(self.pair[1]))
```

Python Classes



```
def sqr (x):  
    return x*x  
  
v = vector ([3, 4])  
print ("using the Pythagorean theory the hypotenuse", end=' ')  
print ("(or magnitude) of the vector", end=' ')  
print (v.get_pair(), "=", v.get_length())
```

Extending last weeks tutorial to use classes

- create a ball class with a constructor which has an initial position and a velocity vector

Extending last weeks tutorial to use classes

```
#!/usr/bin/env python3

import sys, pygame, random

class ball:
    def __init__ (self, initial_position, velocity):
        self.curpos = initial_position
        self.velocity = velocity
        self.ball = pygame.image.load("ball.png").convert ()
        self.ballrect = self.ball.get_rect ()
        self.ballrect = self.ballrect.move (initial_position)

    def update (self, surface):
        self.ballrect = self.ballrect.move (self.velocity)
        if self.ballrect.left < 0 or self.ballrect.right > width:
            self.velocity[0] = -self.velocity[0]
        if self.ballrect.top < 0 or self.ballrect.bottom > height:
            self.velocity[1] = -self.velocity[1]
        surface.blit (self.ball, self.ballrect)
```

Extending last weeks tutorial to use classes

```
width = 1900
height= 1000
black = (0, 0, 0)

pygame.init ()
screen = pygame.display.set_mode([width, height])

bl = []
for i in range (80):
    bl += [ball ([random.randint (0, width-1),
                        random.randint (0, height-1)],
                [random.randint (-2, 2),
                 random.randint (-2, 2)])]
```

Extending last weeks tutorial to use classes



```
while True:
    for event in pygame.event.get ():
        if event.type == pygame.QUIT:
            sys.exit(0)

    screen.fill (black)
    for b in bl:
        b.update (screen)
    pygame.display.flip()
```

PyGame Sprites

- these notes show how sprites can be created
 - without object orientation
 - and also with object orientation
- they re-implement the bouncing ball demo which we covered in earlier weeks
 - using sprites rather than images

PyGame Sprites

- sprites are quite complicated
 - in my experience this is due to their close association with object orientation
 - you can use sprites without object orientation
 - for a small number of sprites this is easy enough and the code is smaller than its object orientated counterpart (and much simpler)
 - for any reasonable number of sprites ≥ 3 then should use OO as the reduction in code probably offsets the OO complication
- use object orientated sprites when implementing Missile Command

When to use sprites in PyGame

- when you have:
 - many instances of an object on the screen at a time
 - some objects that you need to track closely (e.g. collision detection)
 - sprites have a `self.rect` attribute, which can be passed to the function `colliderect` so Pygame will handle all collisions
 - a sprite's `update()` method, with a time argument, makes it easy to deal with a dynamic environment
- you can easily kill sprites if collisions occur (or create sounds)
 - sprites can be thought of as semi autonomous

When not to use sprites

- when your:
 - objects don't share much (if any) code
 - and if you rarely have more than one copy of each object instantiated at a time
 - game entities (images) never move *by themselves* (eg. card decks)
- simple user interfaces are often easier to do with surfaces than with sprites

Creating a simple sprite

```
#!/usr/bin/python3

import pygame
from pygame.locals import KEYDOWN

width  = 320
height = 240
size   = [width, height]
pygame.init()
screen = pygame.display.set_mode(size)
background = pygame.Surface(screen.get_size())

b = pygame.sprite.Sprite() # create sprite
b.image = pygame.image.load("ball.png").convert() # load ball image
b.rect = b.image.get_rect() # use image extent values
b.rect.topleft = [0, 0] # put the ball in the top left corner
screen.blit(b.image, b.rect)

pygame.display.update()
while pygame.event.poll().type != KEYDOWN:
    pygame.time.delay(100)
```

The sprite in PyGame

- is an object that contains both:
 - an image (a surface)
 - and a location at which to draw that image (a Rect)

- term *sprite* is actually a holdover from older display systems that did such manipulations directly in hardware
 - Commodore 64, Commodore Amiga used this technique in early 1980s to early 1990s
 - other manufactures did exactly the same, Atari etc

The sprite in PyGame

- sprites work well in object-oriented languages like Python
 - you have a standard sprite interface `pygame.sprite.Sprite`, and extend those classes as specific sprites
- see the `BallSprite` class in the example later on

The sprite in PyGame

- sprites have two important instance variables
 - `self.image` and `self.rect`
 - `self.image` is a surface, which is the current image that will be displayed. `self.rect` is the location at which this image will be displayed when the sprite is drawn to the screen
- sprites also have one important instance method, `self.update`.

Creating a simple sprite using an extra Class

```
#!/usr/bin/env python3

import pygame
from pygame.locals import KEYDOWN

class BallSprite(pygame.sprite.Sprite):
    image = None

    def __init__(self, location):
        pygame.sprite.Sprite.__init__(self)

        if BallSprite.image is None:
            # This is the first time this class has been
            # instantiated. So, load the image for this and
            # all subsequence instances.
            BallSprite.image = pygame.image.load("ball.png")
        self.image = BallSprite.image

        # Make our top-left corner the passed-in location.
        self.rect = self.image.get_rect()
        self.rect.topleft = location
```


Creating a simple sprite using an extra Class



```
pygame.init()
screen = pygame.display.set_mode([320, 320])
b = BallSprite([0, 0]) # put the ball in the top left corner
screen.blit(b.image, b.rect)
pygame.display.update()
while pygame.event.poll().type != KEYDOWN:
    pygame.time.delay(10)
```

Bouncing ball using sprites and no user defined classes

```
#!/usr/bin/env python3

import pygame
from pygame.locals import KEYDOWN

width  = 320
height = 240
size   = [width, height]
ydir = 1
xdir = 1
xpos = 0
ypos = 0
pygame.init()
screen = pygame.display.set_mode(size)
background = pygame.Surface(screen.get_size())

b = pygame.sprite.Sprite() # create sprite
b.image = pygame.image.load("ball.png").convert() # load image
b.rect = b.image.get_rect() # use image extent values
b.rect.topleft = [xpos, ypos] # put the ball in the top left corner
screen.blit(b.image, b.rect)
slow = 0
```

Bouncing ball using sprites and no user defined classes

```
def gravity(y):  
    global height  
    return int (((height+height/20) * 3) / y)  
  
pygame.display.update()  
while pygame.event.poll().type != KEYDOWN:  
    pygame.time.delay(gravity(ypos))  
    # If we're at the top or bottom of the screen,  
    # switch directions.  
  
    if b.rect.bottom>=height:  
        ydir = -1  
    elif ypos == 0:  
        ydir = 1  
    if xpos == 0:  
        xdir = 1  
    elif b.rect.right>=width:  
        xdir = -1
```

Bouncing ball using sprites and no user defined classes

```
if slow:
    screen.fill([0, 0, 0]) # blank the screen
else:
    rectlist = [screen.blit(background, b.rect)]

# Move our position up or down by one pixel
xpos += xdir
ypos += ydir
b.rect.topleft = [xpos, ypos]

if slow:
    screen.blit(b.image, b.rect)
    pygame.display.update()
else:
    rectlist += [screen.blit(b.image, b.rect)]
    pygame.display.update(rectlist)
```

Bouncing ball using sprites and no user defined classes

```
#!/usr/bin/env python3

import pygame
from pygame.locals import KEYDOWN

class BallSprite(pygame.sprite.Sprite):
    image = None

    def __init__(self, initial_position):
        pygame.sprite.Sprite.__init__(self)
        if BallSprite.image is None:
            BallSprite.image = pygame.image.load("ball.png")
        self.image = BallSprite.image

        self.rect = self.image.get_rect()
        self.rect.topleft = initial_position
        self.going_down = True # Start going downwards
        self.next_update_time = 0 # update() hasn't been called yet.
```

Bouncing ball using sprites and no user defined classes

```
def update(self, current_time, bottom):
    # Update every 10 milliseconds = 1/100th of a second.
    if self.next_update_time < current_time:

        # If we're at the top or bottom of the screen, switch directions.
        if self.rect.bottom == bottom - 1: self.going_down = False
        elif self.rect.top == 0: self.going_down = True

        # Move our position up or down by one pixel
        if self.going_down: self.rect.top += 1
        else: self.rect.top -= 1

    self.next_update_time = current_time + 10
```

Bouncing ball using sprites and no user defined classes

```
pygame.init()
boxes = []
for location in [[0, 0],
                 [60, 60],
                 [120, 120]]:
    boxes.append(BallSprite(location))

screen = pygame.display.set_mode([150, 150])
while pygame.event.poll().type != KEYDOWN:
    screen.fill([0, 0, 0]) # blank the screen.

    time = pygame.time.get_ticks()
    for b in boxes:
        b.update(time, 150)
        screen.blit(b.image, b.rect)
    pygame.display.update()
```

Bouncing ball using sprites and no user defined classes

- it is worth noting that the OO solution uses processor resources efficiently

The event loop

```
while True:
    event = pygame.event.wait()
    if event.type == pygame.QUIT:
        sys.exit(0)
    if event.type == KEYDOWN:
        if event.key == K_ESCAPE:
            sys.exit(0)
```

- consider the above section of code

- it waits for an event to occur and then acts upon the event
- an event will be mouse movement, mouse click, key up/down etc

- what happens if there is no event present?

The event loop

- various event retrieval mechanisms in Pygame
 - read the documentation for ideas
- how do we handle the problem of no events occurring?

USEREVENTS

- one mechanism is to poll the event queue
 - this is a lazy programming mechanism and cpu intensive
- a better solution is to introduce USEREVENTS

USEREVENT example code (snippet)



```
def updateAll ():  
    if allExplosions != []:  
        for e in allExplosions:  
            e.update ()  
        pygame.display.flip ()  
        pygame.time.set_timer (USEREVENT+1, delay)
```

USEREVENT example code (snippet)

```
def wait_for_event ():
    global screen
    while True:
        event = pygame.event.wait ()
        if event.type == pygame.QUIT:
            sys.exit(0)
        if event.type == KEYDOWN and event.key == K_ESCAPE:
            sys.exit (0)
        if event.type == pygame.MOUSEBUTTONDOWN and event.button == 1:
            createExplosion (pygame.mouse.get_pos ())
        if event.type == USEREVENT+1:
            updateAll ()
```

Tutorial

- try out the example code given in the lecture
- make sure you completed last weeks tutorial and adapt this code and
 - without using sprites, implement an explosion class
 - which is activated at the cursor position on the screen
- an explosion can be visually generated by drawing expanding circles
 - and then by reversing the size (remembering to blank out the larger ones)

explosions.py

```
#!/usr/bin/env python3

import pygame, sys, time, random
from pygame.locals import *

ramp_one, ramp_two, ramp_three = None, None, None

wood_light = (166, 124, 54)
wood_dark = (76, 47, 0)
blue = (0, 100, 255)
dark_red = (166, 25, 50)
dark_green = (25, 100, 50)
dark_blue = (25, 50, 150)
black = (0, 0, 0)
white = (255, 255, 255)
```

explosions.py

```
width, height = 1024, 768
screen = None

maxRadius = 60
allExplosions = []
delay = 100    # number of milliseconds delay before generating a USEREVENT

class explosion:
    def __init__ (self, pos):
        self._radius = 1
        self._maxRadius = maxRadius
        self._increasing = True
        self._pos = pos
```


explosions.py

```
def update (self):
    if self._increasing:
        pygame.draw.circle (screen, white, self._pos, self._radius, 0)
        self._radius += 1
        if self._radius == self._maxRadius:
            self._increasing = False
    else:
        pygame.draw.circle (screen, black, self._pos, self._radius, 0)
        self._radius -= 1
        if self._radius > 0:
            pygame.draw.circle (screen, white, self._pos, self._radius, 0)
        else:
            globalRemove (self)
```

explosions.py



```
def createExplosion (pos):  
    global allExplosions  
    allExplosions += [explosion (pos)]  
    pygame.time.set_timer (USEREVENT+1, delay)  
  
def globalRemove (e):  
    global allExplosions  
    allExplosions.remove (e)
```

explosions.py



```
def updateAll ():
    if allExplosions != []:
        for e in allExplosions:
            e.update ()
        pygame.display.flip ()
        pygame.time.set_timer (USEREVENT+1, delay)
```

explosions.py

```
def wait_for_event ():
    global screen
    while True:
        event = pygame.event.wait ()
        if event.type == pygame.QUIT:
            sys.exit(0)
        if event.type == KEYDOWN and event.key == K_ESCAPE:
            sys.exit (0)
        if event.type == pygame.MOUSEBUTTONDOWN and event.button == 1:
            createExplosion (pygame.mouse.get_pos ())
        if event.type == USEREVENT+1:
            updateAll ()
```

explosions.py



```
def main ():  
    global screen  
    pygame.init ()  
    screen = pygame.display.set_mode ([width, height])  
    wait_for_event ()  
  
main ()
```

Homework

- firstly get the `explosions.py` to work
- now comment each function
- comment each class and its use
- familiarise yourself with the game missile command
- see if you can extend this code to place six cities and 3 missile silos statically at the bottom of the screen

Homework 2

- write a Python program to print out all permutations of a string

- for example ab



```
ab  
ba
```

- for example abc



```
abc  
acd  
bac  
bca  
cab  
cba
```

slide 40
gais

Homework 2

- your program should be able to take any size string with unique characters and print out all permutations