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1.1 What is the minimum amount of code needed to make a Pygame window appear?

The following snippet of code will create a window 800 pixels wide by 600 pixels tall. Note that the set\_mode function requires width and height be a tuple.

import pygame

pygame.init()

WIDTH = 800

HEIGHT = 600

screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

running = True

while running:

for event in pygame.event.get():

if event.type == pygame.QUIT:

running = False

# flip the display updates user screen with images

pygame.display.flip()

pygame.quit()

1.2 I want to make a full game project, what is a good main.py file startup?

import pygame

# these constants may be stored in a setting.py module

WIDTH = 800

HEIGHT = 600

FPS = 60

WHITE = (255, 255, 255)

###

class Application:

def \_\_init\_\_(self):

# create the screen

self.screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

# create a group for all sprites

self.sprites = pygame.sprite.Group()

# create a clock object to manage frame rate and ticks

self.clock = pygame.time.Clock()

# a bool value to end the game loop

self.running = True

def gameloop(self):

while self.running:

# maintain FPS rate and measure delta time

self.dt = self.clock.tick(FPS) / 1000

# handle all user events since last frame

self.update\_events()

# update sprite logic and positions

self.sprites.update()

# update the screen

self.update\_screen()

def update\_screen(self):

# fill with background image or color

self.screen.fill(WHITE)

# draw sprites on screen

self.sprites.draw(self.screen)

# flip screen from previous frame to new frame

pygame.display.flip()

def update\_events(self):

for event in pygame.event.get():

if event.type == pygame.QUIT:

self.running = False

# additional inputs can be handled here.

def main():

pygame.init()

app = Application()

app.gameloop()

pygame.quit()

if \_\_name\_\_ == '\_\_main\_\_':

main()

2.1 How do I draw a rectangle on my screen?

Use pygame.draw.rect function.

pygame.draw.rect(*surface*, *color*, *rect*, *width* = 0)

*surface* is surface you want to draw on. If you are drawing on your screen, then this is your screen variable.

color is a tuple represeing RGB values. This is often a constant you have made.

rect is either a Rect object of a tuple of 4 values (x, y, width, height)

The optional argument width defaults to 0. When 0, the shape is filled in. Otherwise it is hollow.

There are several ways to use this function.

Example: draw a filled red rectangle on screen at (x,y) = (100, 200), width = 50, height = 25

RED = (255, 0, 0)

pygame.draw.rect(screen, RED, (100, 200, 50, 25))

Example: draw a hollow blue rect at x= 500, y = 400, width =100, height = 20 with edge width size of 1

BLUE = (0, 0, 255)

pygame.draw.rect(screen, BLUE, (500, 400, 100, 20), width = 1)

Example: create a Rect object, then draw that object

GREEN = (0, 255, 0)

my\_rect = pygame.Rect(150, 550, 40, 40)

pygame.draw.rect(screen, GREEN, my\_rect)

2.2 How do I draw a polygon on my screen?

pygame.draw.rect(*surface*, *color*, *rect*, *width* = 0)

*surface* is surface you want to draw on.

*color* is a tuple represeing RGB values.

*points* is a list or tuple of points which are in tuple form.

*width* = 0 is default, making the polygon filled.

Example

GREEN = (0, 255, 0)

points = [(50, 100), (50, 200), (100, 150)]

pygame.draw.polygon(screen, GREEN, points) # filled

pygame.draw.polygon(screen, RED, points, width = 2) # hollow

The above example will make a green filled triangle that is outlined in red.

2.3 How do I draw a circle or an ellipse on my screen?

A circle can be drawin with either the circle or ellipse function.

pygame.draw.circle(surface, color, center, radius, width = 0)

*surface* is surface you want to draw on.

*color* is a tuple represeing RGB values.

*center* is a tuple for (x, y) or a vector.

*radius* is the radius of the circle.

*width* = 0 (optional) is used for line thickness. width = 0 is filled; width > 0 is hollow.

pygame.draw.ellipse(surface, color, rect, width = 0)

*surface* is surface you want to draw on.

*color* is a tuple represeing RGB values.

*rect* is either a Rect object or a tuple (x, y, width, height) for a bounding rectangle

*width* = 0 (optional) is used for line thickness. width = 0 is filled; width > 0 is hollow.

Examples

RED = (255, 0, 0)

BLUE = (0, 0, 255)

GREEN = (0, 255, 0)

# draw a blue circle at (400, 300) with radius 50

pygame.draw.circle(screen, BLUE, (400, 300), 50)

# draw a hollow circle with red outline

pygame.draw.circle(screen, RED, (100, 400), 25, width = 1)

# creating Rect object at (550, 200) with width = height = 75

rect1 = pygame.Rect(550, 200, 75, 75)

# drawing a circle that inscribes rect1

pygame.draw.ellipse(screen, GREEN, rect1)

# creating a Rect that is 100 pixels long but only 50 high

rect2 = pygame.Rect(200, 40, 100, 50)

# drawing the ellipse bound by the rect2 object.

pygame.draw.ellipse(screen, BLUE, rect2)

2.4 How do I draw a line on my screen?

Use the line function.

pygame.draw.line(surface, color, start, end, width = 1)

*surface* is surface you want to draw on.

*color* is a tuple represeing RGB values.

*start* is a tuple for (x, y) for one endpoint of the line

*end* is a tupe for the other endpoint of the line.

*width* = 1 (optional) is used for line thickness. width = 1 is default.

pygame.draw.line(screen, BLUE, (100, 200), (600, 50))

pygame.draw.line(screen, GREEN, (200, 300), (400, 400), width = 3)

2.5 How do I draw shapes to surface that is not my screen?

Shapes can be drawn onto any surface object in pygame.

You can create your own instances of the Surface class or, since an image is also a surface, load a surface with pygame.image.load.

In this example, we create an image object by making a surface, then drawing to the surface a circle.

RED = (255, 0, 0)

# create a screen surface

screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

# create an image surface

image = pygame.Surface( (100, 100) )

# calculate center of our image surface

x, y = image.get\_width() / 2, image.get\_height() / 2

# draw red circle in center of the image

pygame.draw.circle(image, RED, (x, y), 20)

# draw the circle image on the screen.

screen.blit(image, (400, 300))

2.6 I drew a shape on a surface, now how can I make the outside of my shape transparent?

Use the set\_colorkey(*color*) method that belongs to a Surface object to set the color you want to be transparent.

In this example, we make a red circle on an image surface and then make the part of the surface that is outside of the circle transparent (instead of the black color it is by default).

RED = (255, 0, 0)

BLACK = (0, 0, 0)

WHITE = (255, 255, 255)

# create a screen

screen = pygame.display.set\_mode((800, 600))

# make the screen a white background

screen.fill(WHITE)

# create a surface that will perfectly fit a circle with radius 50

radius = 50

image = pygame.Surface( (radius \* 2, radius \* 2) )

x, y = radius, radius

pygame.draw.circle(image, RED, (x, y), radius)

# make BLACK transparent

image.set\_colorkey(BLACK)

# draw the circle image on the screen.

screen.blit(image, (400, 300))

2.7 How do I load an image in pygame?

Use the pgyame.image.load(*image\_file*) function. Remember that you must also use *image*.convert() or *image*.convert\_alpha() to convert the pixel format of the image to match the pixel format of the screen you have created.

The following little program assumes there is a PNG image called game\_guy.png in the working directory.

import pygame

pygame.init()

WIDTH = 800

HEIGHT = 600

screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

image = pygame.image.load('game\_guy.png') # load image

image = image.convert\_alpha() # convert pixel format to match screen

screen.blit(image, (400, 300)) # paint image at location (400, 300)

running = True

while running:

for event in pygame.event.get():

if event.type == pygame.QUIT:

running = False

# flip the display

pygame.display.flip()

pygame.quit()

2.8 What does convert or convert\_alpha do? Do I really need to use them?

Images are a big rectangular arrangement of RGB color and Alpha transparency values. The format of these pixels must be converted to match the pixel format of the user's screen.

If you do not convert the image to match the pixel format of the screen then every frame where the image is drawn the conversion must occur as its drawn. This is very slow and will slow down frame rate. Therefore, pygame recommends converting it once and for all and storing the converted images back on itself.

Example

image = pygame.image.load('game\_guy.png') # load image

image = image.convert\_alpha() # convert pixel format to match screen

The above two lines of code are often combined to single line:

image = pygame.image.load('game\_guy.png').convert\_alpha()

Using convert\_alpha preserves the transparency properties of the PNG image.

2.9 Help! I have drawn a shape or blitted an image but I do not see it on my screen!

The most common cause of this problem is not calling the function pygame.dispaly.flip or pygame.display.update

The function pygame.display.flip will update the entire screen surface. The function pygame.dispaly.update allows you supply a list a Rect objects specifying the specific rectangle areas you wish to update. Since flip always updates the entire screen, it is typically a slower function.

3.1 How to I create a Sprite I can use in my game?

A sprite is an instance of a class that subclasses the built in pygame.sprite.Sprite class.

The following is an example of a very simply subclass of Sprite called Circle\_Sprite.

class Circle\_Sprite(pygame.sprite.Sprite): # subclass

def \_\_init\_\_(self, x, y): # an init that takes x, y position

super().\_\_init\_\_()

self.image = pygame.Surface( (50, 50) ) # an image

pygame.draw.circle(self.image, BLUE, (25, 25), 25)

self.image.set\_colorkey(BLACK)

self.rect = self.image.get\_rect() # a rect

self.rect.x = x

self.rect.y = y

def update(self):

self.rect.x += 1

All subclasses of Sprite should have a self.image and self.rect property. Usually, you will also want to include an update method as well.

3.2 How do I use a Sprite in a pygame program?

Sprites are best used in a pygame.sprite.Group or one of the other Group types.

The following code snippit is part of a program which creates an instance of the Circle\_Sprite class from FAQ 3.1.

# … some imports, screen, and color constants …

screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

sprites = pygame.sprite.Group()

sprite1 = Circle\_Sprite(100, 200) # create a Circle\_Sprite object

sprites.add(sprite1) # add sprite to our group

running = True

while running:

for event in pygame.event.get():

if event.type == pygame.QUIT:

running = False

# flip the display

screen.fill(WHITE)

sprites.update() # calls update method for each sprite in group

sprites.draw(screen) # see note below

pygame.display.flip()

pygame.quit()

A note on the draw method that belongs to Group objects:

sprites.draw(screen) works exactly the same as follows:

for sprite in sprites:

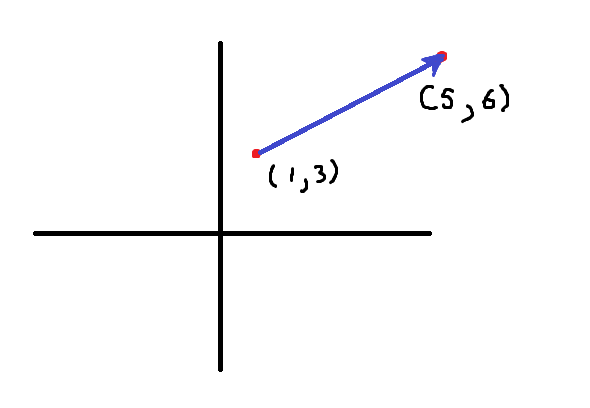
screen.blit(sprite.image, sprite.rect)

So as you can see, each sprite's image in the group Sprites is blitted onto the screen using the sprites rect object for position. Therefore, each sprite you desire to draw on the screen should have a self.image and a self.rect.

4.1 What is a vector?

A 2D vector is a set of instructions for how to move from one place to another.

Imagine you are at position (1, 3) and your lunch is at (5, 6). A vector tells you how far you must move and in which direction to reach your lunch.



The vector needed to travel from (1, 3) to (5, 6) can be described in two manners.

Method 1 Component Form

Method 2 Magnitude and Direction

Distance =

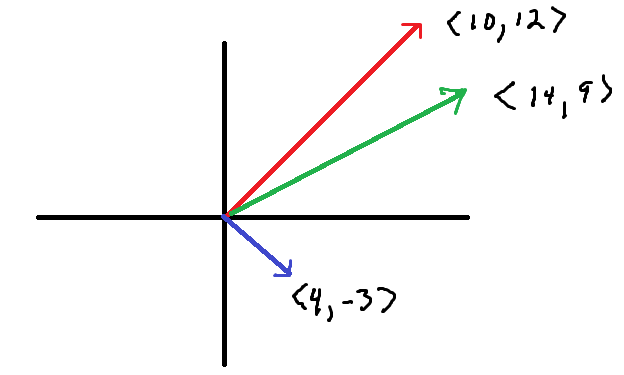
Direction =

Each method has advantages. While the component form tells how much to move right and how much to move up and down and is easier to perform math operations with, the magnitude and direction tells exactly how far to move and in which direction.

4.2 How do you add or subtract two vectors?

Suppose throw a ball on a path represented by the vector . While in the air, however, the force of the wind affects it blowing along a path represented by the vector . What is the result of the throw?

To find the resulting path vector of the ball, simply add



4.3 How do I create a vector in Pygame?

A vector is an instance of the pygame.math.Vector2 class.

To create a vector pass the constructor the x, y components of your vector.

v = pygame.math.Vector2(4, 5)

You can also create a copy of a vector from another vector.

w = pygame.math.Vector2(v)

4.4 What are some of the math operations I can do with vectors in pygame?

You can add and subtract vectors. You can also multiply a vector by a real number.

v = pygame.math.Vector2(4, 5)

w = pygame.math.Vector2(9, -1)

print(v + w)

print(v - w)

print(3 \* v)

Output:

[13, 4]

[-5, 6]

[12, 15]

We can also use the shortcut += and -= operators as well.

4.5 How do I get the x and y component of a vector in Pygame?

Simply access the x and y property as follows:

v = pygame.math.Vector2(3, 4)

print(v.x, v.y)

Output:

3.0 4.0

4.6 How do I find the magnitude (length) of vectors in Pygame?

Magnitude can be found with the magnitude or length methods.

v = pygame.math.Vector2(3, 4)

magnitude\_v = v.magnitude()

length\_v = v.length() # alias for magnitude

print(magnitude\_v, length\_v) # both 5.0

Note: Since the magnitude method uses the Pythagorean theorem it requires taking a square root. Square roots are very slow in computer science. Therefor, Pygame does not recommend using this method inside your game loop. It is better to use magnitude\_squared or length\_squared methods.

4.7 How do I find the direction angle of vectors in Pygame?

There is no specific method for the direction angle of a vector. Instead Pygame supplies us with the angle\_to method to measure angle of rotation to a given vector.

*vec1*.angle\_to(*vec2*) returns the degrees that vec1 must be rotated to match *vec2*. If *vec1* is on the positive x-axis then this angle is the direction angle for *vec2*.

v = pygame.math.Vector2(3, 4)

x\_vec = pygame.math.Vector2(1, 0) # a normal vector on x-axis

angle = x\_vec.angle\_to(v)

print('direction angle of v', angle)

Remember that the direction of a vector is measured from the positive x-axis in a clockwise-rotation. (In math class it is a counter-clockwise, but is backward in pygame because the positive y-axis goes downward in pygame.)

4.8 How do I use vectors to control the postion, velocity, and acceleration of a sprite projectile (like a tossed ball)?

Sir Isaac Newton developed his laws of motion many years ago. The laws of motion give us very useful equations for predicting the location of an object at different moments in time.

Assume that acceleration constant over a time interval – read 'delta t'. means "change in"

The change in a sprites velocity is its acceleration times change in time.

The change in position is dependent on acceleration and velocity.

To use these formulas we simply supply our sprites with an an acceleration, velocity, and position vector.

The should be the change in time between frames. We get this using the tick method from a pygame.time.Clock object.

The following program application demonstrates how to use position, velocity, and acceleration vectors to model the motion of a ball tossed at a 45 degree angle upwards (-45 degrees) with velocity of 50 pixels per millisecond. The ball is under constant downward acceleration of 20 pixels per millisecond squared due to gravity.

import pygame

WIDTH = 600

HEIGHT = 600

GRAVITY = 20

BLUE = (0, 0, 255)

WHITE = (255, 255, 255)

BLACK = (0, 0, 0)

class Circle\_Sprite(pygame.sprite.Sprite):

def \_\_init\_\_(self, app, x, y, speed, angle):

super().\_\_init\_\_()

self.game = app

self.image = pygame.Surface( (50, 50) )

pygame.draw.circle(self.image, BLUE, (25, 25), 25)

self.image.set\_colorkey(BLACK)

self.rect = self.image.get\_rect()

self.pos = pygame.math.Vector2(x, y)

self.vel = pygame.math.Vector2(speed, 0)

self.vel = self.vel.rotate(angle)

self.acc = pygame.math.Vector2(0, GRAVITY)

self.rect.center = self.pos

def update(self):

dt = self.game.dt

self.vel += self.acc \* dt

self.pos += 0.5 \* self.acc \* dt \*\* 2 + self.vel \* dt

self.rect.center = self.pos

class Application:

def \_\_init\_\_(self):

self.screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

self.sprites = pygame.sprite.Group()

circle = Circle\_Sprite(self, 100, 200, 50, -45)

self.sprites.add(circle)

self.running = True

self.clock = pygame.time.Clock()

def gameloop(self):

self.dt = self.clock.tick(60) / 1000

while self.running:

for event in pygame.event.get():

if event.type == pygame.QUIT:

self.running = False

# flip the display

self.screen.fill(WHITE)

self.sprites.update()

self.sprites.draw(self.screen)

pygame.display.flip()

def main():

pygame.init()

app = Application()

app.gameloop()

pygame.quit()

if \_\_name\_\_ == '\_\_main\_\_':

main()

4.9 How do I use vectors to control movement of a character controlled by a user?

The following example program allows the user to control the acceleration vector (green) for the sprite. The postion of the sprite and the direction and magnitude of the velocity vector (red) are caclculated using the equations of motion.

import pygame

WIDTH = 1000

HEIGHT = 800

BLUE = (0, 0, 255)

RED = (255, 0, 0)

GREEN = (0, 255, 0)

WHITE = (255, 255, 255)

BLACK = (0, 0, 0)

class Circle\_Sprite(pygame.sprite.Sprite):

def \_\_init\_\_(self, app, x, y):

super().\_\_init\_\_()

self.game = app

self.image = pygame.Surface( (50, 50) )

pygame.draw.circle(self.image, BLUE, (25, 25), 25)

self.image.set\_colorkey(BLACK)

self.rect = self.image.get\_rect()

self.pos = pygame.math.Vector2(x, y)

self.vel = pygame.math.Vector2(0, 0)

self.acc = pygame.math.Vector2(0, 0)

self.rect.center = self.pos

def update(self):

self.check\_keys()

dt = self.game.dt

self.vel += self.acc \* dt

self.pos += 0.5 \* self.acc \* dt \*\* 2 + self.vel \* dt

self.rect.center = self.pos

def check\_keys(self):

acc\_rate = 0.01

keys = pygame.key.get\_pressed()

if keys[pygame.K\_LEFT]:

self.acc += pygame.math.Vector2(-acc\_rate, 0)

if keys[pygame.K\_RIGHT]:

self.acc += pygame.math.Vector2(acc\_rate, 0)

if keys[pygame.K\_DOWN]:

self.acc += pygame.math.Vector2(0, acc\_rate)

if keys[pygame.K\_UP]:

self.acc += pygame.math.Vector2(0, -acc\_rate)

class Application:

def \_\_init\_\_(self):

self.screen = pygame.display.set\_mode( (WIDTH, HEIGHT) )

self.sprites = pygame.sprite.Group()

self.circle = Circle\_Sprite(self, 100, 200)

self.sprites.add(self.circle)

self.running = True

self.clock = pygame.time.Clock()

def gameloop(self):

self.dt = self.clock.tick(60) / 1000

while self.running:

for event in pygame.event.get():

if event.type == pygame.QUIT:

self.running = False

self.screen.fill(WHITE)

self.sprites.update()

self.sprites.draw(self.screen)

self.draw\_vectors()

pygame.display.flip()

def draw\_vectors(self):

# for visual effect vel vector is scaled by x 10 and acc vect by x 100

pygame.draw.line(self.screen, RED, self.circle.pos, self.circle.pos + self.circle.vel \* 10)

pygame.draw.line(self.screen, GREEN, self.circle.pos, self.circle.pos + self.circle.acc \* 100)

def main():

pygame.init()

app = Application()

app.gameloop()

pygame.quit()

if \_\_name\_\_ == '\_\_main\_\_':

main()