Pole Position

Written By:

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Introduction:

I chose to write a pole-position game for a few reasons. Firstly, games are fun, and I have always loved wondering how video games were made and trying to make them for myself. Secondly, one of my interests in terms of a career path is to work on autonomous cars as a computer engineer. One of the main ways current autonomous cars determine what is the road and what is not is through various image processing techniques. The CPU for my pole-position game also uses image processing to drive itself autonomously.

Function Descriptions / Descriptions of Different Project Modules and Algorithms

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Graphics Engine (Pygame):

I wrote this project on the pygame graphics engine to establish a base to work on. Pygame allows me to transform images and display them to the screen in a timely manner.

The deformation problem:

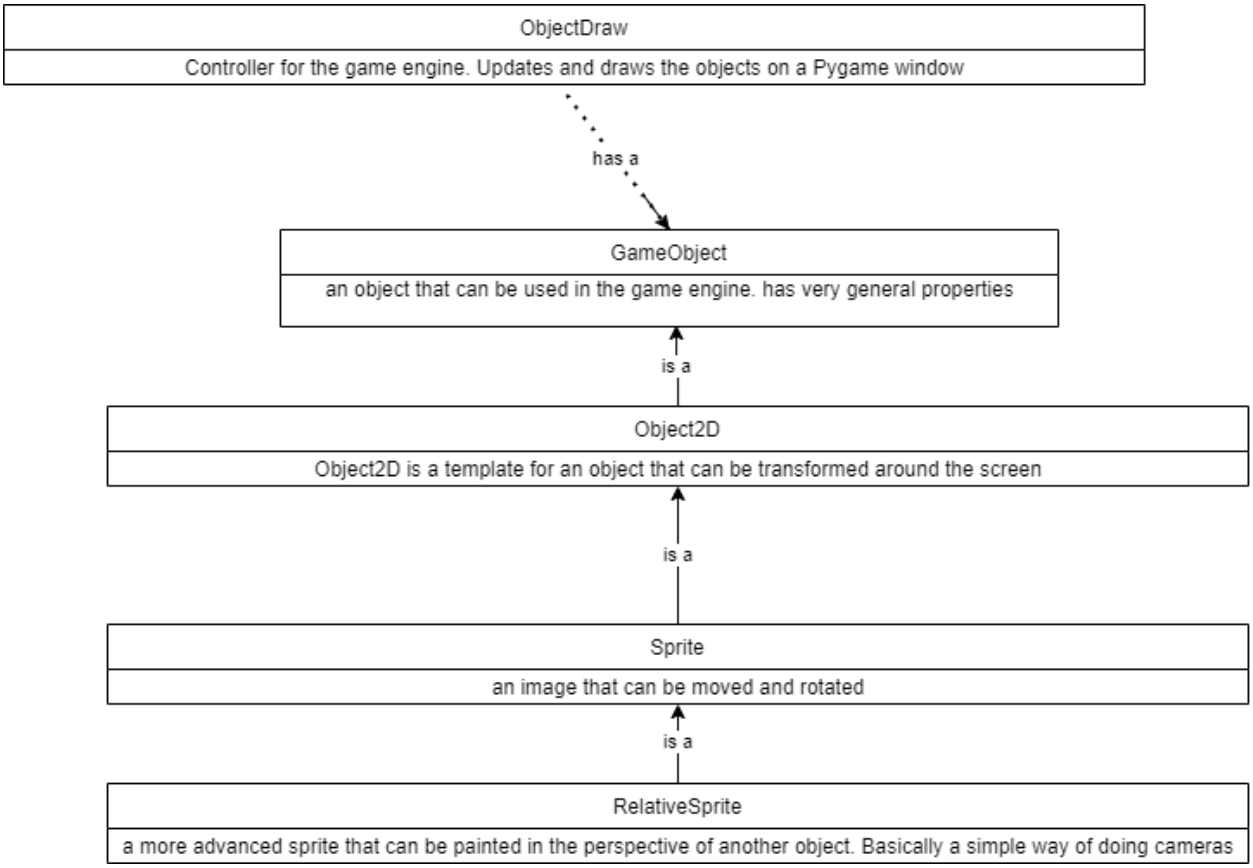
When I first started working with pygame I found that there is a problem with pygame's scale and rotation transformations. When an image is scaled down, it is shrunk down to fit inside a rectangular bounding box of the target scaling dimensions. This works great until the image is scaled *and* rotated *and* you want the picture to rotate about its center. The reasons that this problem originates is a bit long winded for this report but essentially what ended up happening is as the image rotated its corners stuck out from the bounding box, which meant that pygame further shrunk the image past the desired scale. What I did to solve this problem is manually calculate how far the corners will stick out and compensate by scaling the image to be that much bigger. The implementation of this is in Sprite.updateDisplayImage(self)

The Coordinate System problem:

Another issue I ran into with pygame is the way that it managed its coordinate system, although it stems from the computer graphics convention of the positive y direction being towards the bottom of the screen rather that the top of the screen, consistent with most math and physics axis. This means that sine and cosine will dictate that positive rotation is *clockwise* rather than counterclockwise, which is the physics and math convention. Despite this, pygame made the design decision to make positive rotation still *counterclockwise*, meaning that pygame rotation and sine and cosine calculations disagree. I fixed this issue by popping a negative in front of the rotation of my game objects before using pygame's rotation method, but it sure was confusing before I discovered the discrepancy and got everything straightened out.

Game Engine:

Since I was trying to program a game, I figured a good place to start would be to write a game engine. This, (surprisingly enough) is in the folder “game_engine”. The game engine class hierarchy is as follows:



To work with the game engine, a game developer would create a child classes of GameObject or any of its children (most likely Sprites and RelativeSprites) and an instance of the ObjectDraw class. They would then use ObjectDraw’s add() method to add the child classes of GameObject to the ObjectDraw instance. They then would create a loop at the end of their code like this:

```
while(not objectDraw.done):
    objectDraw.run(); # run the game engine stuff
```

Which will run all the game engine processes. This is implemented in PolePositionRunner.py

Anything game-specific processes that the game designer wants done will likely be put in the update method of child classes which follow the following template:

```
# updates the object values. is call repetively by the update loop
    def update(self):
        super(<classname>,self).update();
        # do class-specific stuff here
```

First-person mode:

I wanted to do first-person mode right. Not by just rotating a picture around the center point and calling it a day but by actually implementing a system of cameras, where Sprites could be shown from the perspective of another Object2D. I did this with the RelativeSprite class. If a RelativeSprite does not have a camera assigned it will be shown at the exact position and rotation that its *xPosition, yPosition,* and *rotation* class members reflect (Exactly as if it was a normal Sprite instance). However, if the setCamera() method is called with another Object2D, then the RelativeSprite will be displayed onscreen from the perspective of that Object2D. This is done such that if a RelativeSprite has itself as its camera, it will be shown unrotated and at the center of the screen. The bulk of this algorithm is in RelativeSprite.update() and RelativeSprite.paint().

Pole Position:

Pole position is essentially all the .py files outside of other folders.

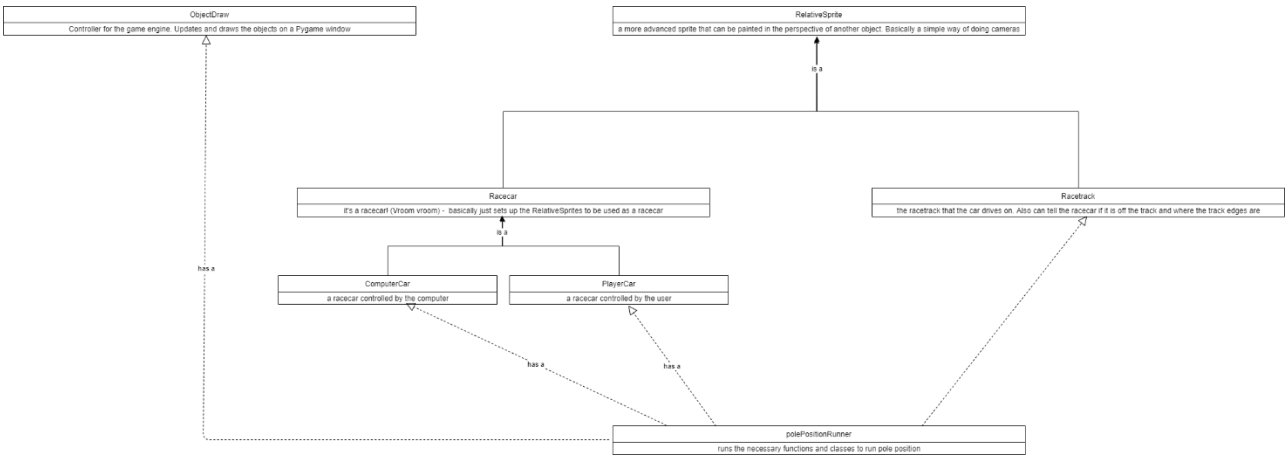
polePositionRunner.py

Racetrack.py

Racecar.py

Playercar.py

Computercar.py



Computercar Driving:

First. I passed the track image thorough my team's edge-detection program from our team project. The Computercar then uses my raytracing function (raytracing.raytrace()) in conjunction with Racetrack.isTrackEdge() function to figure out where it is on the track. Racetrack's isTrackEdge looks at

the edge-detection output and if the point it is given is a bright pixel on the edges map it will return True. Then, the CPU algorithm compares the lengths of rays straight sideways and at 45-degree angles forward from sideways to come up with a value representing where it is on the track. This value is fed into a PD calculation as the error which determines the corrective steering output.

Additional descriptions of functions

Every user defined function has a description commented on the line above the function declaration in the code summarizing it. Additionally, every class has a description at the top of the file that class is declared in underneath the imports, and detailed descriptions of its class members and their types are listed directly below that.

User manual

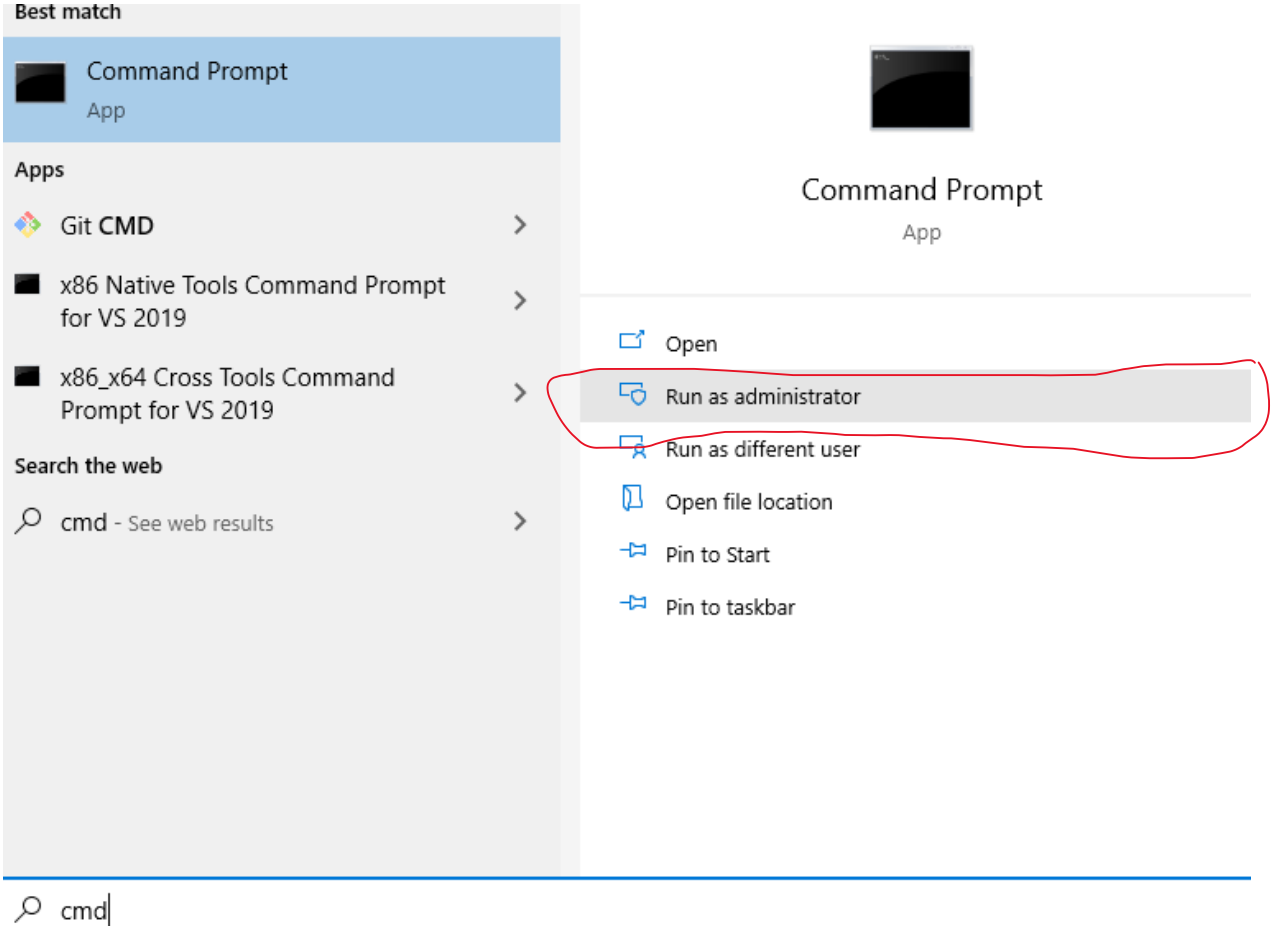
To get pole position running on your computer, you must first install the Python 3.9 IDLE on your computer. Make sure that you also get the Python functions for the command line, since you will need them to get Pygame. *Note: Pole Position will not run on anaconda without modification.* Then, you must open your command line. (On windows, press the windows key, type "cmd" and hit enter) Type the following commands in your command line:

```
pip install numpy

pip install pygame

pip install matplotlib
```

If this doesn't work try running the command line as an administrator, and check that you have the correct Python version.



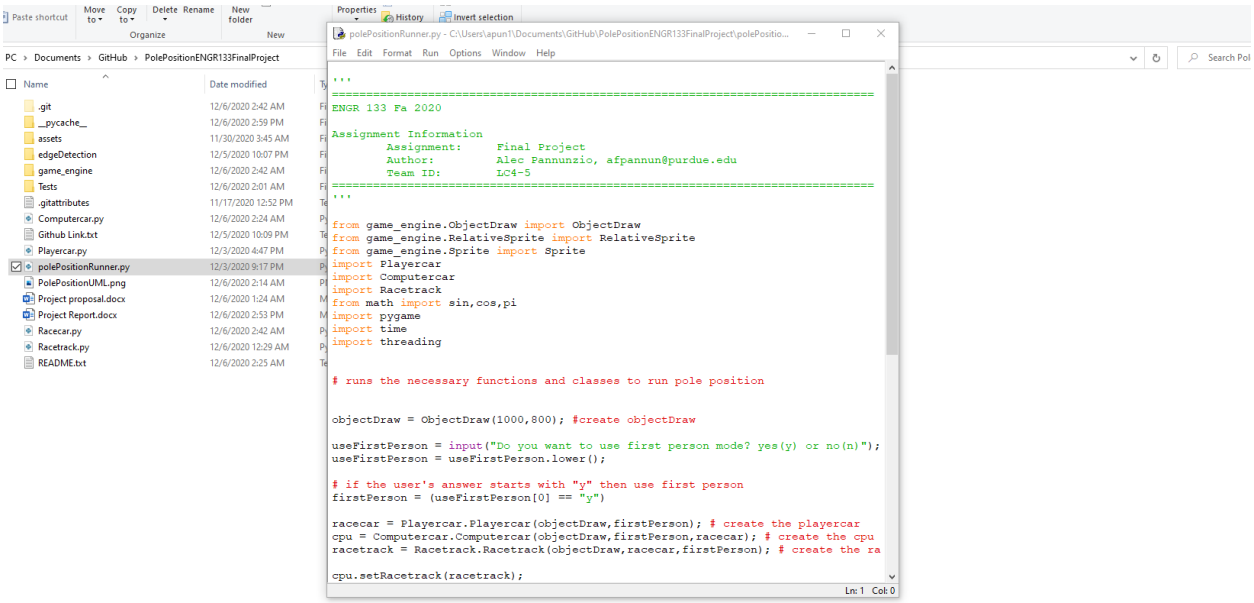
If you have additional problems installing pygame, consult this guide.

Now that you have installed all the libraries, you can run the program!

Now go into the project files and find polePositionRunner. Should be in the top level of the file structure. Right click on it and select “Edit with IDLE”. Alternatively, you could try double-clicking it, but this does not always run the correct version of Python.

If the “Edit with IDLE” option doesn’t work, try opening Python IDLE 3.9 fist and either opening it directly from the IDLE or try right-clicking again.

It should look like this when you are all done.

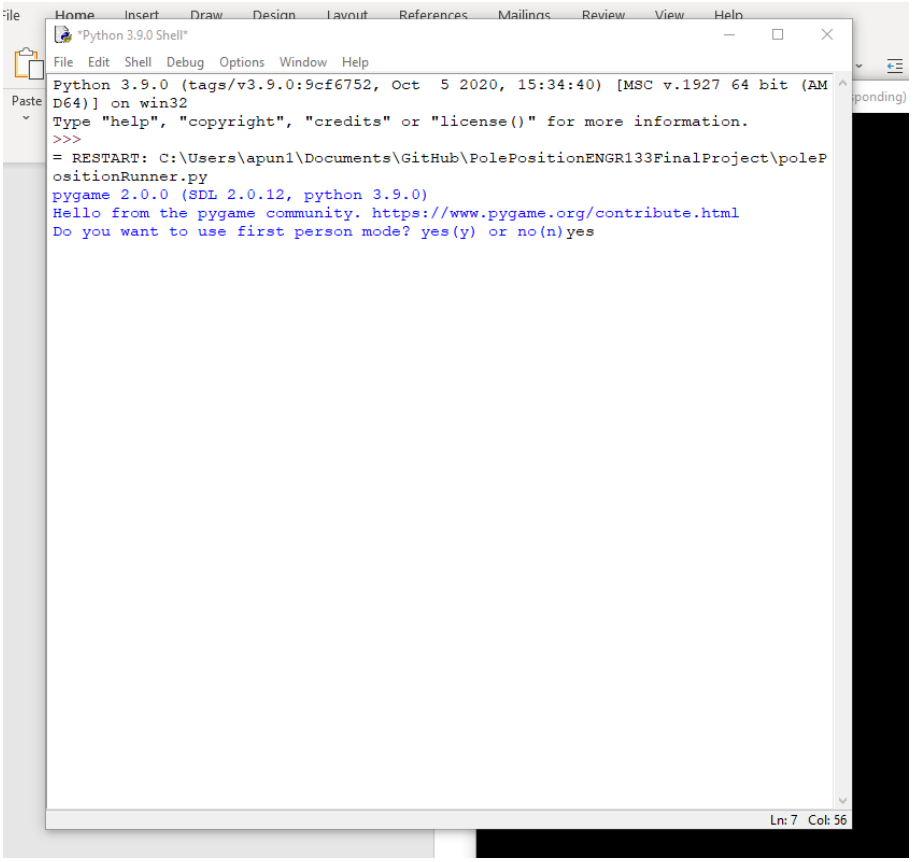


Once your screen looks like that, you just have to press F5 to run the program! (Or alternatively go to Run->open module)

Note: The files must be in the correct folder structure to work properly. Download the project as it is supposed to be here. (Github repo)

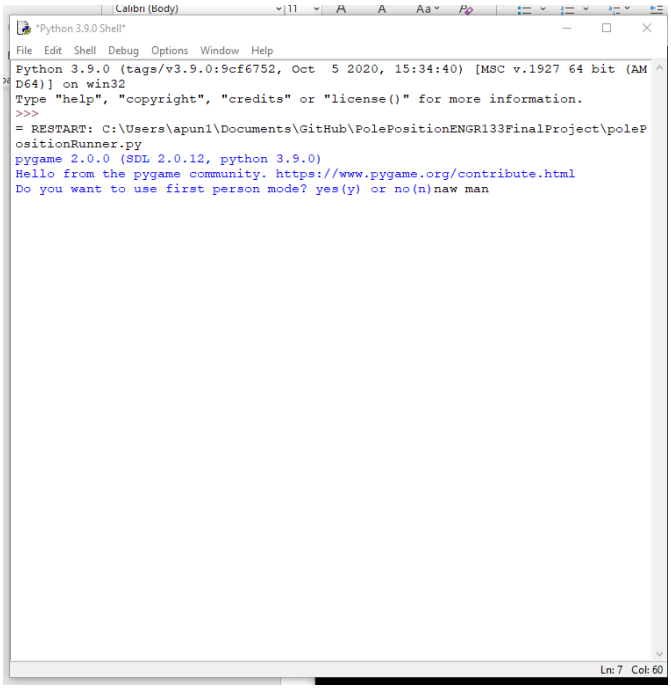
Once you run the program, the python shell will pop up along with a pygame window. On the shell you will be prompted, “Do you want to use first person mode? yes(y) or no(n)”. I would *highly* recommend trying both, but it doesn’t really matter which one you chose first. Type either y for first person mode or n for third person mode. Alternatively, if you type *anything* that starts with y it will run first person mode, and anything that doesn’t start with y will run third person mode.

Typing yes:

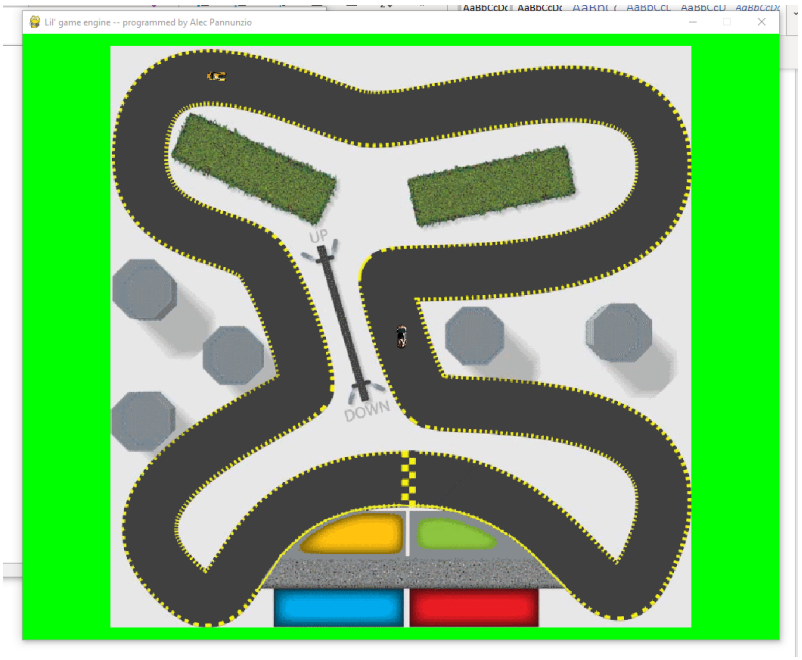


Will get you here \/

Typing no:



Will get you here:



At this point, press w to accelerate, s to slow down, a to turn left, and d to turn right. The shell will notify you if you go off the track. Have fun!

I made the CPU in first-person mode beatable, but if you can beat the CPU in third-person mode I would be very impressed, then I would promptly make the CPU drive faster and beat you 😊.

Code

Game Engine:

GameEngineToolbox:

```
'''
================================================================================
ENGR 133 Fa 2020

Assignment Information
    Assignment:     Final Project
    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================
'''
# a toolbox full of useful functions for the game engine



#checks that the passed variable is of the passed required type or types. Returns
 True if it is, false otherwise
def checkType(variable, requiredTypes, errorMessage = "Incorrect type", raiseErro
r = True):
    rightType = False;

    if type(requiredTypes) is tuple:
        for requiredType in requiredTypes:
            if (type(variable) is requiredType):
                rightType = True;

        if (raiseError):
            if not rightType:
                raise TypeError(errorMessage);
```

```
        return rightType;
    else:
        if not (type(variable) is requiredTypes):
            if (raiseError):
                raise TypeError(errorMessage);
            return False;
        else:
            return True;

# will make all objects bounce off the borders of the screen
def border_bounce(objectDraw):
    for current_object in objectDraw.objects:

        if (current_object.getPosition()[0] > objectDraw.screenSizeX-
current_object.xSize/2):
            current_object.setSpeed((-
1 * abs(current_object.getSpeed()[0]),current_object.getSpeed()[1]));

        if (current_object.getPosition()[1] < current_object.ySize/2):
            current_object.setSpeed((current_object.getSpeed()[0],abs(current_obj
ect.getSpeed()[1])));

        if (current_object.getPosition()[0] < current_object.xSize/2):
            current_object.setSpeed((abs(current_object.getSpeed()[0]),current_ob
ject.getSpeed()[1]));

        if (current_object.getPosition()[1] > objectDraw.screenSizeY-
current_object.ySize/2):
            current_object.setSpeed((current_object.getSpeed()[0],-
1 * abs(current_object.getSpeed()[1])));




'''
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ACADEMIC INTEGRITY STATEMENT
    I have not used source code obtained from any other unauthorized
    source, either modified or unmodified. Neither have I provided
    access to my code to another. The project I am submitting
    is my own original work.
================================================================================
'''
```

GameObject:

```
'''
================================================================================
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Assignment Information
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    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================
'''

# an object that can be used in the game engine. has very general properties

'''
class members
name - string - the name of the GameObject
'''
from game_engine.GameEngineToolbox import checkType;

class GameObject():
    #initialize the GameObject
    def __init__(self,name):
        self.name = str(name); #store the name as one of our class members

    # returns the gameObject's name
    def getName(self):
        return self.name;

    # this is called by the engine thread and child classes will override this
    def update(self):
        pass;

    # this is called by the engine thread and child classes will override this
    def paint(self):
        pass;


# tests this class
def testGameObject():
    bob = GameObject("bob");
    print(bob.getName());
```

```
    badboi = GameObject(69);
    print(badboi.getName());



'''
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================================================================================
'''
```

Object2D:

```
'''
================================================================================
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Assignment Information
    Assignment:     Final Project
    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================

'''
from game_engine.GameObject import GameObject
from game_engine.GameEngineToolbox import checkType



# Object2D is a template for an object that can be transformed around the screen
'''
class members:
xPosition - float - the position of the center of this object on the x axis
yPosition - float - the position of the center of this object the y axis
xSpeed - float - the speed of the object in the x direction
ySpeed - float - the speed of the object in the y direction
xAcceleration - float - the acceleration of the object in the x direction
yAcceleration - float - the acceleration of the object in the y direction
rotation - float - the rotation of this object (in radians)
angularVelocity - float - the speed at which the object is rotating
xSize - int - the size of this object in the x dimension
```

```
ySize - int - the size of this object in the y dimension
'''

class Object2D(GameObject):
    # initialize the object
    def __init__(self,name,xPosition,yPosition,xSize,ySize):
        super(Object2D,self).__init__(name);

        #check types
        checkType(xPosition,(int,float),"xPosition must be an number");
        checkType(yPosition,(int,float),"yPosition must be an number");
        checkType(xSize,(int,float),"xSize must be an number");
        checkType(ySize,(int,float),"ySize must be an number");

        # set the passed parameters to their respective class members
        self.xPosition = xPosition;
        self.yPosition = yPosition;
        self.xSize = xSize;
        self.ySize = ySize;

        # initialize the rest of the class members to zero
        self.xSpeed = 0;
        self.ySpeed = 0;
        self.xAcceleration = 0;
        self.yAcceleration = 0;
        self.rotation = 0.0;
        self.angularVelocity = 0;



    # updates the object values. is call repetively by the update loop
    def update(self):
        super(Object2D,self).update();
        self.xPosition += self.xSpeed;
        self.yPosition += self.ySpeed;

        self.xSpeed += self.xAcceleration;
        self.ySpeed += self.yAcceleration;

        self.rotation += self.angularVelocity;


    # sets the position of the object
    def setPosition(self,xPos, yPos):
        checkType(xPos,(int,float),"xPosition must be an int");
```

```
        checkType(yPos,(int,float),"yPosition must be an int");
        self.xPosition = xPos;
        self.yPosition = yPos;

    # sets the position of the object
    def setPosition(self, position):
        checkType(position,tuple,"position must be a tuple");
        self.xPosition = position[0];
        self.yPosition = position[1];


    # sets the speed of the object
    def setSpeed(self,xSpeed,ySpeed):
        checkType(xSpeed,(int,float),"xSpeed must be a number");
        checkType(ySpeed,(int,float),"ySpeed must be a number");
        self.xSpeed = xSpeed;
        self.ySpeed = ySpeed;

    # sets the speed of the object
    def setSpeed(self,speed):
        checkType(speed,tuple,"speed must be an tuple");
        self.xSpeed = speed[0];
        self.ySpeed = speed[1];


    # sets the acceleration of the object
    def setAcceleration(self,xAccel,yAccel):
        checkType(xAccel,(int,float),"xAcceleration must be a number");
        checkType(yAccel,(int,float),"yAcceleration must be a number");
        self.xAcceleration = xAccel;
        self.yAcceleration = yAccel;

    # sets the acceleration of the object
    def setAcceleration(self,acceleration):
        checkType(acceleration,tuple,"acceleration must be an tuple");
        self.xAcceleration = acceleration[0];
        self.yAcceleration = acceleration[1];

    #sets the rotation of the object
    def setRotation(self,rot):
        checkType(rot,(int,float),"rotation must be a number");
        self.rotation = rot;

    # sets the angular velocity of the object
    def setAngularVelocity(self,angV):
```

```
        checkType(angV,(int,float),"angularVelocity must be a number");
        self.angularVelocity = angV;

    # returns a list containing the [xPosition, yPosition]
    def getPosition(self):
        return (self.xPosition,self.yPosition);

    # returns a list containing the [xSpeed, ySpeed]
    def getSpeed(self):
        return (self.xSpeed, self.ySpeed);

    # returns a list containing the [xAcceleration, yAcceleration]
    def getAcceleration(self):
        return (self.xAcceleration, self.yAcceleration);

    # returns the rotation
    def getRotation(self):
        return self.rotation;

    # returns the angular velocity
    def getAngularVelocity(self):
        return self.angularVelocity;


# tests this class
def testObject2D():
    bob = Object2D("bob",0,0,10,10);
    print(bob.getName());
    bob.setSpeed(1,2);
    bob.setAcceleration(2,1);
    bob.update();
    bob.update();
    print(bob.getPosition());
    print(bob.getSpeed());



'''
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ObjectDraw:

```
'''
================================================================================
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Assignment Information
    Assignment:     Final Project
    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================
'''
import pygame
import sys
from threading import Thread
from game_engine.Sprite import Sprite;
from game_engine.GameEngineToolbox import checkType;
from game_engine.GameObject import GameObject;

# Controller for the game engine. Updates and draws the objects on a Pygame windo
w
'''
Class members:
screenSizeX - int - x size of the screen
screenSizeY - int - y size of the screeb
WHITE - tuple - represents the color white
BLACK - tuple - represents the color black
screen - pygame.surface - the screen we are using to put objects on
clock - Clock - the pygame clock. We will use this to set delays
done - boolean - whether the engine is done running yet. Setting this to false wi
ll stop the engine
objects - list[GameObject] (manually enforced) - a list of object for the engine
to
tickSpeed - int - analogous to frames per second. (1/wait time inbetween frames)
keysPressed - list[boolean] - the keys that are currently pressed down as fetched
 by pygame.key.get_pressed()
backgroundColor - tuple - the background color for the screen. Painted before all
 other objects
'''
```

```
class ObjectDraw():

    #initializes the objectdraw
    def __init__(self,screenSizeX, screenSizeY):

        #make sure types check out and assign screen size class members
        checkType(screenSizeX,int,"screenSizeX must be an int");
        checkType(screenSizeY,int,"screenSizeY must be an int");
        self.screenSizeX = screenSizeX;
        self.screenSizeY = screenSizeY;

        #define colors
        self.WHITE = (255,255,255)
        self.BLACK = (0,0,0)

        #initialize pygame
        pygame.init();

        self.screen = pygame.display.set_mode([screenSizeX, screenSizeY]) # get t
he screen

        pygame.display.set_caption("Lil' game engine -
- programmed by Alec Pannunzio"); #set the title of our display

        self.clock = pygame.time.Clock(); # get the clock


        #set up variables

        self.objects = []; # create the objects list

        self.done = True;

        self.tickSpeed = 60;

        self.keysPressed = [];

        self.backgroundColor = self.WHITE;

    # sets tickSpeed
    def setTickSpeed(self,newTick):
        checkType(newTick,int,"tickSpeed must be an integer");
        self.tickSpeed = newTick;

    #sets the background color
```

```
    def setBackgroundColor(self,newColor):
        checkType(newColor,tuple,"backgroundColor must be a tuple");
        self.backgroundColor = newColor;

    # will start the game engine
    def start(self):
        if (self.done): #make sure we aren't already running
            self.done = False;
        else:
            print("engine already running");


    # will pause the game engine
    def pause(self):
        self.done = True;

    #will stop the game engine
    def stop(self):
        print("stopping");
        self.done = True;
        pygame.quit();

    #should only be called by start(), runs the game engine loop
    def run(self):
        if (True):
            #set keysPressed
            self.keysPressed = pygame.key.get_pressed();

            # handle pygame events
            for event in pygame.event.get():
                if event.type == pygame.QUIT:
                    print("shutting down");
                    #shut 'er down
                    done = True;
                    pygame.display.quit();
                    pygame.quit();
                    sys.exit();
                    return;
                elif event.type == pygame.MOUSEBUTTONDOWN: # when the mouse is cl
icked
                    pass;



            #update the objects
```

```
            for current_object in self.objects:
                current_object.update();

            # draw background
            self.screen.fill(self.backgroundColor)

            #paint the objects
            for current_object in self.objects:
                current_object.paint(self.screen);


            pygame.display.flip(); #push the updates to the display

            self.clock.tick(self.tickSpeed); # delay for a bit inbetween frames

    # will add the gameObject to the game engine to be run
    def add(self,gameObject):
        assert issubclass(gameObject.__class__, GameObject); # make sure the obje
ct we are adding is a child of GameObject
        self.objects.append(gameObject);

    #returns the keys that the user has pressed
    def getKeysPressed(self):
        return self.keysPressed;

'''
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================================================================================
'''
```

Raytrace:

```
'''
================================================================================
ENGR 133 Fa 2020

Assignment Information
    Assignment:     Final Project
    Author:         Alec Pannunzio, afpannun@purdue.edu
```

```
    Team ID:        LC4-5
================================================================================
'''
from game_engine.GameEngineToolbox import checkType
from math import pi,sin,cos


'''
sends a ray starting from the given position and at the given angle and returns t
he distance when the passed function is true or the max length is exeeded

params:
startpos - tuple[float] - the position to start the ray at
angle - float - the angle (in degrees)
length - float - the maximum length to probe
function - function - stop when this function returns functionOutput
functionOutput - boolean - stop when the function output equals this
increment - float - how much to increment the probing length each time
'''
def raytrace(startpos,angle,length,function,functionOutput,increment = 1.3):
    checkType(startpos,(tuple),"starting position must be a tuple");
    checkType(startpos[0],(float,int),"start pos must contain numbers");
    checkType(angle,(float,int),"angle must be a number");
    checkType(length,(int,float),"ray length must be a number");
   # checkType(function,(type(raytrace)),"function must be of type function");
    checkType(increment,(float,int),"increment must be a number");

    angle = pi*angle/180; # convert angle to radians

    cLength = 0; # the current probe-length for the ray

    # set the position of the ray to the startposition
    x = startpos[0];
    y = startpos[1];

    # while we have not exceeded the length and the function did not return true
    while ( (not (function(x,y) == functionOutput) ) and (cLength < length) ):
        cLength += increment; # increment the length of the ray

        # calculate the pos of the endpoint of the ray
        x = startpos[0] + cLength * cos(angle);
        y = startpos[1] + cLength * sin(angle);

    return cLength
```

```
'''
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'''
```

Sprite:

```
'''
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ENGR 133 Fa 2020

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    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================
'''
from game_engine.Object2D import Object2D
from game_engine.GameEngineToolbox import checkType;
from math import sin, cos, pi, atan, tan
import pygame



# an image that can be moved and rotated
'''
class members:
imgSource - string - the source of the image
img - pygame.Surface - the image object
displayImg - pygame.Surface - the transformed image object ready to be displayed
showSizeX - int - the size the image is transformed to in the x dimension. (when
the image rotates the corners would stick out so we have to allow a bigger box fo
r the picture to fit in in the transformation)
showSizeY - int - the size the image is transformed to in the y dimension. (when
the image rotates the corners would stick out so we have to allow a bigger box fo
r the picture to fit in in the transformation)
imgScale - float - how many times bigger this surface is than the original image
```

```
'''

class Sprite(Object2D):
    def __init__(self,name,xPosition,yPosition,scaling,imgSource):
        checkType(scaling,(int,float),"the scaling factor must be a int or float"
);



        #calculate the size of the image
        self.img = pygame.image.load(imgSource).convert(); # load the image from
the imgSource
        self.xSize = scaling * self.img.get_width();
        self.ySize = scaling * self.img.get_height();

        super(Sprite,self).__init__(name,xPosition,yPosition,self.xSize,self.ySiz
e);

        self.img.set_colorkey((0,0,0)); # set the colorkey of the image to black

        self.displayImg = self.img; #initialize displayImg

        # initialize some class members
        self.showSizeX = self.xSize;
        self.showSizeY = self.ySize;
        self.imgScale = scaling;




    # updates the sprite and readies it for rendering
    def updateDisplayImage(self):
        # rotate the image to the correct rotation
        self.displayImg = pygame.transform.rotate(self.img,-self.rotation);


        '''
        scale the image
        (compensate for the corners sticking out from the bounding box by scaling
 the image that much larger)
        '''

        # calculate how far away from the center the corners would be
        cornerAngle = atan(self.ySize/self.xSize);
```

```
        cornerDist = ((self.ySize/2)**2 + (self.xSize/2)**2)**0.5; #the length fr
om the center of the rectangle to the corner. Serves as the "hypotenuse"

        # X dimension
        showSizeX1Multi = abs(cos(cornerAngle + pi*(self.rotation)/180)); #corner
 @ 45 degrees if unrotated
        showSizeX2Multi = abs(cos(-
cornerAngle + pi*(self.rotation)/180)); #corner @ -45 degrees if unrotated

        #use the larger of the two
        if (showSizeX1Multi > showSizeX2Multi):
            showSizeXMulti = showSizeX1Multi;
        else:
             showSizeXMulti = showSizeX2Multi;

        # Y dimension
        showSizeY1Multi = abs(sin(cornerAngle + pi*(self.rotation)/180)); #corner
 @ 45 degrees if unrotated
        showSizeY2Multi = abs(sin(-
cornerAngle + pi*(self.rotation)/180)); #corner @ -45 degrees if unrotated

        #use the larger of the two
        if (showSizeY1Multi > showSizeY2Multi):
            showSizeYMulti = showSizeY1Multi;
        else:
            showSizeYMulti = showSizeY2Multi;


        #calculate the size we should scale the picture to
        self.showSizeX = int(2*cornerDist*showSizeXMulti);
        self.showSizeY = int(2*cornerDist*showSizeYMulti);


        self.displayImg = pygame.transform.scale(self.displayImg, (self.showSizeX
,self.showSizeY));

    #updates this Sprite
    def update(self):
        super(Sprite,self).update(); # call the update of the parent class
        self.updateDisplayImage();


    #rotates the picture, but not the actual sprite object
    def rotatePicture(self,angle):
        self.img = pygame.transform.rotate(self.img,angle);
```

```
        self.xSize = self.imgScale * self.img.get_width();
        self.ySize = self.imgScale * self.img.get_height();

    def paint(self,screen):
        # paint the Sprite, adjusting so that the xPosition,yPosition are the coo
rdinates of the center
        screen.blit(self.displayImg,[self.xPosition-
self.showSizeX/2, self.yPosition-self.showSizeY/2]);




'''
================================================================================
ACADEMIC INTEGRITY STATEMENT
    I have not used source code obtained from any other unauthorized
    source, either modified or unmodified. Neither have I provided
    access to my code to another. The project I am submitting
    is my own original work.
================================================================================
'''
```

RelativeSprite

```
'''
================================================================================
ENGR 133 Fa 2020

Assignment Information
    Assignment:     Final Project
    Author:         Alec Pannunzio, afpannun@purdue.edu
    Team ID:        LC4-5
================================================================================
'''
from game_engine.Object2D import Object2D
from game_engine.ObjectDraw import ObjectDraw
from game_engine.GameEngineToolbox import checkType
from game_engine.Sprite import Sprite
from math import atan2, sqrt, sin, cos, pi

# a more advanced sprite that can be painted in the perspective of another object
. Basically a simple way of doing cameras
```

```
# NOTE: this object will act as a normal Sprite unless you set the camera with se
tCamera().
# NOTE: if it is a first person game it is customary to set all of the gameobject
s' cameras to the RelativeSprite representing the character, INCLUDING setting th
e camera of the character to itself.
'''
class members:
hasCamera - bool - whether the RelativeSprite has a camera assigned to it. If thi
s is false this object will be painted the same as a normal Sprite.
camera - Object2D - the object that we will paint relative to
zeroXPosition - float - offSets the sprites x position by this amount
zeroYPosition - float - offSets the sprites y position by this amount
zeroRotation - float - offsets the sprites rotation by this amount
displayXPosition - float - the x position that we will display (relative to the c
amera)
displayYPosition - float - the y position that we will display (relative to the c
amera)
displayRotation - float - the rotation that we will display (relative to the came
ra)
'''

class RelativeSprite(Sprite):
    def __init__(self,name,xPosition,yPosition,scaling,imgSource,objectDraw):
        super(RelativeSprite,self).__init__(name,xPosition,yPosition,scaling,imgS
ource);
        checkType(objectDraw,ObjectDraw,"objectDraw must be an ObjectDraw");

        self.hasCamera = False;
        self.objectDraw = objectDraw;
        self.camera = None;
        self.zeroXPosition = self.objectDraw.screenSizeX/2;
        self.zeroYPosition = self.objectDraw.screenSizeY/2;
        self.zeroRotation = 0;
        self.displayXPosition = xPosition;
        self.displayYPosition = yPosition;
        self.displayRotation = 0;

    # sets the camera of this object to the passed Object2D
    def setCamera(self,camera):
        assert issubclass(camera.__class__, Object2D); # make sure the object we
are adding is a child of Object2D
        self.camera = camera;
        self.hasCamera = True;

    # removes the camera from the object so it paints like a normal Sprite
```

```
    def removeCamera(self):
        self.camera = None;
        self.hasCamera = False;


    # calls the update method of superclasses and updates the displayimage to be
in the perspective of the camera
    def update(self):
        if not self.hasCamera:
            super(RelativeSprite,self).update(); # update like a normal Sprite
            self.displayXPosition = self.xPosition;
            self.displayYPosition = self.yPosition;
        else:
            super(Sprite,self).update(); # call the update method of Object2D, NO
T Sprite
            #save current position
            prevRotation = self.rotation;
            self.displayXPosition = self.xPosition;
            self.displayYPosition = self.yPosition;

            cameraPosition = self.camera.getPosition();


            #translate relative to the camera
            self.displayXPosition -= cameraPosition[0];
            self.displayYPosition -= cameraPosition[1];



            '''
            rotate around camera
            '''

            #convert to polar

            angle = atan2(self.displayYPosition,self.displayXPosition); # the ang
le of this object relative to the camera

            radius = sqrt(self.displayXPosition**2 + self.displayYPosition**2) #
thie distance this object is away from the camera

            # rotate the object around the camera <the camera's rotation>
            angle -= pi*self.camera.getRotation()/180;

            # convert back to rectangular and assign to displayPosition
```

```
            self.displayXPosition = radius * cos(angle);
            self.displayYPosition = radius * sin(angle);


            self.rotation -
= self.camera.getRotation(); # add internal rotation to match camera


            #add zero offsets
            self.rotation += self.zeroRotation;
            self.displayXPosition += self.zeroXPosition;
            self.displayYPosition += self.zeroYPosition;

            #set displayRotation
            self.displayRotation = self.rotation;


            '''
            update the display image with the relative values
            '''
            super(RelativeSprite,self).updateDisplayImage(); # update the display
 image with the relative values


            '''
            reset rotation back to where it was before
            '''
            self.rotation = prevRotation;
            # we don't have to reset position since we used displayPosition rathe
r than directly changing the object's position


    #paint relative to the camera
    def paint(self,screen):
        if self.hasCamera:
            # if we have a camera paint using the relative values
            screen.blit(self.displayImg,[self.displayXPosition-
self.showSizeX/2, self.displayYPosition-self.showSizeY/2]);
        else:
            # otherwise just use Sprite's paint method
            super(RelativeSprite,self).paint(screen);

    # set the zero position of the relativeSprite
    def setZeroPosition(self,zeroX,zeroY):
        checkType(zeroX,(int,float),"zero position must be a number");
        checkType(zeroY,(int,float),"zero position must be a number");
```

```
        self.zeroXPosition = zeroX;
        self.zeroYPosiiton = zeroY;

    #set the zero rotation of the relativeSprite
    def setZeroRotation(self,zeroRot):
        checkType(zeroRot,(int,float),"zeroRotation must be a number");
        self.zeroRotation = zeroRot;


'''
================================================================================
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================================================================================
'''
```