Notes on the ‘Introduction to interactive programming in python’ course.

Structural Programming: It is that which runs in a linear way from some point that would be the start and to the end, every bit of the program is looking for input from the user.

Event Driven Programming: It initializes and then it starts waiting, the program waits until there is some event that triggers action, it is based normally on the use of handlers.

These events sublclasify in:

-Timer events

Happen Periodically over time

-Input events

Buttons

Text Box

-Keyboard "

Key up

Key down

-Mouse "

Click

Drag

Ex.

Example of a simple event-driven program

CodeSkulptor GUI module, this module was created by the professors of the class for creating interactive applications in python

import simplegui

Event handler, this event handler as its name says will handle the main event in the program, which consists in just printing 'tick!' in form of a simple function with no input

def tick():

    print "tick!"

Register handler, Here the handler of the event is registered to occur in function of a function that comes with the simplegui which sets a timer for the event

timer = simplegui.create_timer(1000, tick)

Start timer

timer.start()

In this particular case, the program never stops printing tick!; which happens without the need of iterations, this is what event driven programming is about. The program keeps doing what it was told to do, and just waits until there is another event, which in this case, there is not.

Event Que.

The event queue is a list of events that are in the program that hen system runs with no particular order just depending on actions taken, in the moment all events are done running the system will keep waiting indefinitely. Every event runs from a handler, just one particular handler can be run at a time.

Local Variables & Global Variables.

Ex.

```
# global vs local examples


# num1 is a global variable


num1 = 1
print num1


# num2 is a local variable


def fun():
    num1 = 2
    num2 = num1 + 1
    print num2


fun()



# the scope of global num1 is the whole program, num 1 remains defined
print num1
```

```
# the scope of the variable num2 is fun(), num2 is now undefined
# print num2



# why use local variables?
# give a descriptive name to a quantity
# avoid computing something multiple times

def fahren_to_kelvin(fahren):
    celsius = (5.0 / 9) * (fahren - 32)
    print celsius
    zero_celsius_in_kelvin = 273.15
    return celsius + zero_celsius_in_kelvin

print fahren_to_kelvin(212)




# the risk/reward of using global variables
# risk - consider the software system for an airliner
#                 critical piece - flight control system
#                 non-critical piece - in-flight entertainment system

# both systems might use a variable called "dial"
# we don't want possibility that change the volume on your audio
# causes the plane's flaps to change!
```

```
# example
num = 4

def fun1():
    global num
    num = 5

def fun2():
    global num
    num = 6

# note that num changes, this is because of the use of the statement global inside
the function which enables to reference a variable  outside the function
print num
fun1()
print num
fun2()
print num

# global variables are an easy way for event handlers
# to communicate game information.

# safer method - but they required more sophisticated
# object-programming techniques
```

SimpleGUI: Explanation

SimpleGui is the module destined exclusively for the purpose of being able to run completely interactive aplications directly from the browser

Ej.

```
import simplegui

#We create a global variable containing the string that will print out on a message
message = "Welcome!"

# Handler for mouse click event
def click():
    global message
    message = "Good job!"

# Handler to draw on canvas that takes as one parameter the global variable message as well as the position, size of the font and color of it
def draw(canvas):
    canvas.draw_text(message, [50,112], 36, "Red")

# Create a frame and assign callbacks to event handlers
frame = simplegui.create_frame("Home", 300, 200)
frame.add_button("Click me", click)
```

```
frame.set_draw_handler(draw)

# Start the frame animation
frame.start()
```

Recommended Programming Structure.

Global variables
Helper Functions
Classes
Define event handlers
Create a frame
Register event handlers
Start Frame and Timers

Ej.

```
# SimpleGUI program template

# Import the module
import simplegui
```

```
# Define global variables (program state)

counter=0

# Define "helper" functions

def increment():

    global counter

    counter=counter+1


# Define event handler functions

# First function calls helper function increment and prints the global variable
counter

def tick():

    increment()

    print counter

# Second Function is for the secondary button that resets the counter

def button():

    global counter

    counter=0

# Third function is for besides printing in the console the output of the program,
printing in the canvas

def text(canvas):

    canvas.draw_text(str(counter),[150,112], 36, 'Blue')

# Create a frame with all its elements, the first button which is for executing the
handler function tick independant to the timer, and the first one for reseting the
counter

frame=simplegui.create_frame('simplegui test', 300, 200)

frame.add_button('Click me', tick)

frame.add_button('Reset', button)

# Register event handlers, the first is for the counter to be printed in the canvas,
the second is for the increments of the counter to occur every second

frame.set_draw_handler(text)

timer= simplegui.create_timer(1000, tick)
```

Start frame and timers

frame.start()

timer.start()

Frame Operations:

simplegui.create_frame frame.set_canvas_background frame.start frame.get_canvas_textwidth frame.add_label frame.add_button frame.add_input frame.set_keydown_handler

frame.set_keyup_handler frame.set_mouseclick_handler frame.set_mousedrag_handler frame.set_draw_handler

With the next example we get to know how to set an input on simplegui interactive frame

Simple Calculator Ex.

---

calculator with all buttons

import simplegui

initialize globals

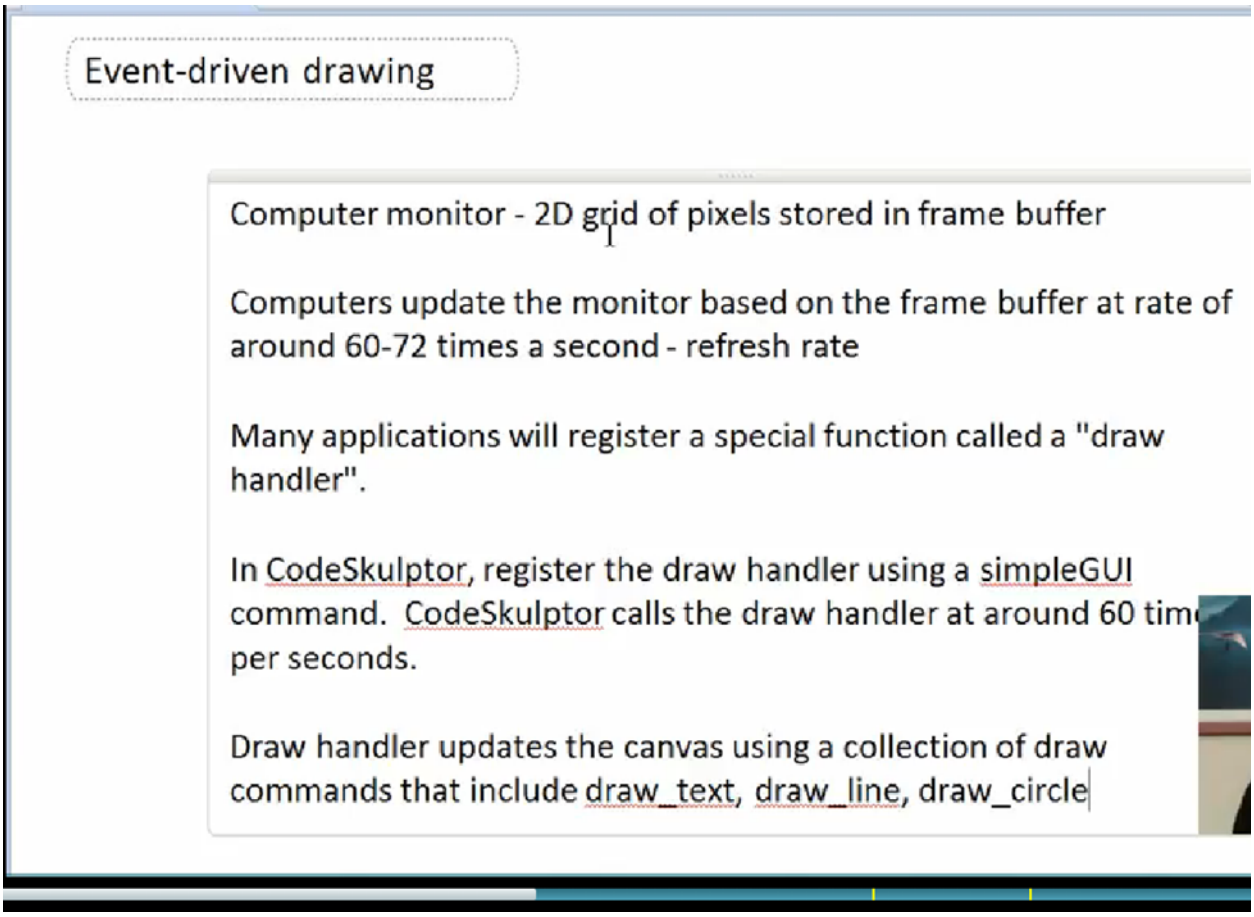
store = 0

operand = 0

```
# event handlers for calculator with a store and operand

def output():
    """prints contents of store and operand"""
    print "Store = ", store
    print "Operand = ", operand
    print ""

def swap():
    """ swap contents of store and operand"""
    global store, operand
    store, operand = operand, store
    output()

def add():
    """ add operand to store"""
    global store
    store = store + operand
    output()

def sub():
    """ subtract operand from store"""
    global store
    store = store - operand
    output()

def mult():
    """ multiply store by operand"""
```

```
    global store
    store = store * operand
    output()

def div():
    """ divide store by operand"""
    global store
    store = store / operand
    output()

def enter(t):
    """ enter a new operand"""
    global operand
    try:
        operand = int(t)
    except:
        operand=float(t)
    output()



# create frame
f = simplegui.create_frame("Calculator",300,300)

# register event handlers and create control elements
f.add_button("Print", output, 100)
f.add_button("Swap", swap, 100)
f.add_button("Add", add, 100)
f.add_button("Sub", sub, 100)
f.add_button("Mult", mult, 100)
f.add_button("Div", div, 100)
```

```
f.add_input("Enter", enter, 100)
f.set_canvas_background('White')


# get frame rolling
f.start()
```



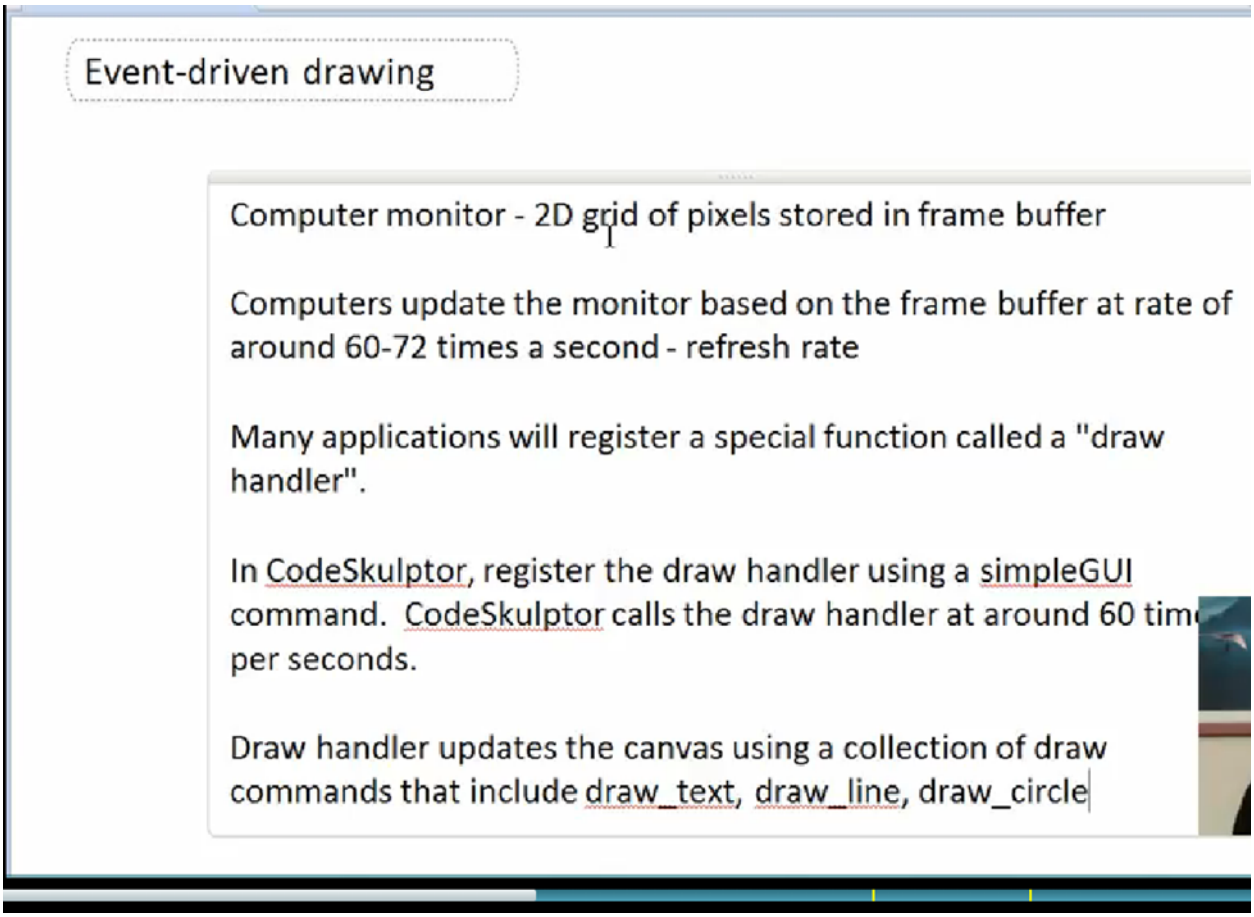
-Refresh rate is around 60 frames/sec

-Computer operating system requests that each application draw itself

-Each application has registered a special event handler called the "draw handler"

-In SimpleGUI, create and register a draw handler that draws on the canvas

-Use collection of draw operations defined in SimpleGUI



Example of a program that draws in simplegui a circle, a line, and a line of text:

```
# first example of drawing on the canvas

import simplegui

# define draw handler
def draw(canvas):
    canvas.draw_text("Hello!",[400, 325], 24, "White")
    canvas.draw_circle([400, 400], 30, 20, "Red")
    canvas.draw_line([400,500],[100,20],5,"Blue")
# create frame
frame = simplegui.create_frame("Text drawing", 800, 650)

# register draw handler
frame.set_draw_handler(draw)

# start frame
frame.start()
```

Another example of canvas

```
# example of drawing operations in simplegui
# standard HMTL color such as "Red" and "Green"
# note later drawing operations overwrite earlier drawing operations

import simplegui



# Handler to draw on canvas

def draw(canvas):
# for the circle the parameters are: coordinates of the center[x,y], radius,
```

```
#width of the outer line,"color of the outer line","color of the inner circle"
    canvas.draw_circle([100, 100], 50, 2, "Red", "Pink")
    canvas.draw_circle([300, 300], 50, 2, "Red", "Pink")
# Line parameters: coordinates of the initial point [x,y], coordinates of the ending
# point, width of the line, 'color'
    canvas.draw_line([100, 100],[300, 300], 2, "Black")
    canvas.draw_circle([100, 300], 50, 2, "Lime", "Green")
    canvas.draw_circle([300, 100], 50, 2, "Lime", "Green")
    canvas.draw_line([100, 300],[300, 100], 2, "Black")
# Polygon parameters: [A coordinates, B coordinates, C coordinates, D coordinates],
# width of the outer lines, "color of the outer lines", "color of the interior"
    canvas.draw_polygon([[150, 150], [250, 150], [250, 250], [150, 250]], 2,
        "Blue", "Aqua")
    canvas.draw_text("An example of drawing", [60, 385], 24, "Black")


# Create a frame and assign callbacks to event handlers
frame = simplegui.create_frame("Home", 400, 400)
frame.set_draw_handler(draw)
frame.set_canvas_background("Yellow")


# Start the frame animation
frame.start()
```

Interactive drawing

```
# interactive application to convert a float in dollars and cents

import simplegui

# define global value

value = 3.12

# Handle single quantity
def convert_units(val, name):
    result = str(val) + " " + name
    if val > 1:
        result = result + "s"
    return result

# convert xx.yy to xx dollars and yy cents
def convert(val):
    # Split into dollars and cents
    dollars = int(val)
    cents = int(round(100 * (val - dollars)))

    # Convert to strings
    dollars_string = convert_units(dollars, "dollar")
    cents_string = convert_units(cents, "cent")

    # return composite string
```

```
    if dollars == 0 and cents == 0:
        return "Broke!"
    elif dollars == 0:
        return cents_string
    elif cents == 0:
        return dollars_string
    else:
        return dollars_string + " and " + cents_string


# define draw handler
def draw(canvas):
    canvas.draw_text(convert(value), [60, 110], 24, "White")


# define an input field handler
def input_handler(text):
    global value
    value = float(text)


# create frame
frame = simplegui.create_frame("Converter", 400, 200)

# register event handlers
frame.set_draw_handler(draw)
frame.add_input("Enter value", input_handler, 100)


# start frame
```

```
frame.start()
```

Code for drawing a truck:

```
import simplegui
def draw(canvas):
    canvas.draw_circle([90,200], 20, 10, 'White', 'Blue')
    canvas.draw_circle([210,200], 20, 10, 'White', 'Blue')
    canvas.draw_line([50,180],[250,180], 40, 'Red')
    canvas.draw_line([55,170],[90,120], 5, 'Red')
    canvas.draw_line([90,120],[130,120],5, 'Red')
    canvas.draw_line([180,108],[180,160], 140, 'Red')



f=simplegui.create_frame('Draw',300,300)
f.set_draw_handler(draw)
f.set_canvas_background('Yellow')

f.start()



# Simple "screensaver" program.

# Import modules
import simplegui
import random

# Global state
message = "Python is Fun!"
position = [50, 50]
width = 500
```

```
height = 500
interval = 2000

# Handler for text box
def update(text):
    global message
    message = text

# Handler for timer
def tick():
    x = random.randrange(0, width)
    y = random.randrange(0, height)
    position[0] = x
    position[1] = y

# Handler to draw on canvas
def draw(canvas):
    canvas.draw_text(message, position, 36, "Red")

# Create a frame
frame = simplegui.create_frame("Home", width, height)

# Register event handlers
text = frame.add_input("Message:", update, 150)
frame.set_draw_handler(draw)
timer = simplegui.create_timer(interval, tick)

# Start the frame animation
frame.start()
timer.start()
```

The following is an example of changing labels in event driven programming

```
####################
# Example of event-driven code, buggy version

import simplegui

size = 10
radius = 10

# Define event handlers.

def incr_button_handler():
    """Increment the size."""
    global size
    size += 1
    label.set_text("Value: " + str(size))

def decr_button_handler():
    """Decrement the size."""
    global size
    # Insert check that size > 1, to make sure it stays positive
    size -= 1
    if size<0:
        size=size*(-1)
    elif size==0:
        size=size+1
    label.set_text("Value: " + str(size))
```

```
def change_circle_handler():
    """Change the circle radius."""
    global radius
    radius = size
    # Insert code to make radius label change.
    labelt.set_text("Radius: " + str(radius))


def draw(canvas):
    """Draw the circle."""
    canvas.draw_circle((100, 100), radius, 5, "Red", 'White')


# Create a frame and assign callbacks to event handlers.


frame = simplegui.create_frame("Home", 200, 200)
# If you want a label to change you need to insert name_of_label.set_text() function
in each of the event #handlers
label = frame.add_label("Value: " + str(size))
frame.add_button("Increase", incr_button_handler)
frame.add_button("Decrease", decr_button_handler)
labelt=frame.add_label("Radius: " + str(radius))
frame.add_button("Change circle", change_circle_handler)
frame.set_draw_handler(draw)


# Start the frame animation


frame.start()
```

Keyboard Events.

```
import simplegui


# initialize state
current_key = ' '


# event handlers, these event handlers serve the purpose of indicating in the status bar if a key is       #pressed of is not, the first handler handles the event of a key being pressed and changes the current #key value to a char with the chr() function just in case the key pressed is not a character which would #result in a traceback because the draw canvas can only get strings
def keydown(key):
    global current_key
    current_key = chr(key)
#the second event handler just changes back the value of current_key to an empty string, the status bar #will print any key that was pressed and that it is now up, or not pressed
def keyup(key):
    global current_key
    current_key = ' '
#This third event handler just draws on the canvas
def draw(c):
    # NOTE draw_text now throws an error on some non-printable characters
    # Since keydown event key codes do not all map directly to
    # the printable character via ord(), this example now restricts
    # keys to alphanumerics

    if current_key in "ABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789":
        c.draw_text(current_key, [10, 25], 20, "Red")


# create frame
f = simplegui.create_frame("Echo", 35, 35)
```

```
# register event handlers
f.set_keydown_handler(keydown)
f.set_keyup_handler(keyup)
f.set_draw_handler(draw)

# start frame
f.start()



# control the position of a ball using the arrow keys


import simplegui

# Initialize globals
WIDTH = 600
HEIGHT = 400
BALL_RADIUS = 20
#Ball position at the center of the screen
ball_pos = [WIDTH / 2, HEIGHT / 2]


# define event handlers
def draw(canvas):
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")
# event handler for keyboard events up, down, right, left. Each time the rate of movement of the ball is #4 pixels per key down, each movement specified by either +-x or +-y
def keydown(key):
    vel = 4
    if key == simplegui.KEY_MAP["left"]:
        ball_pos[0] -= vel
```

```
    elif key == simplegui.KEY_MAP["right"]:
        ball_pos[0] += vel
    elif key == simplegui.KEY_MAP["down"]:
        ball_pos[1] += vel
    elif key == simplegui.KEY_MAP["up"]:
        ball_pos[1] -= vel

# create frame
frame = simplegui.create_frame("Positional ball control", WIDTH, HEIGHT)

# register event handlers
frame.set_draw_handler(draw)
frame.set_keydown_handler(keydown)

# start frame
frame.start()
```

Motion in programs.

```
# Ball motion with an explicit timer

import simplegui



# Initialize globals
WIDTH = 600
HEIGHT = 400
BALL_RADIUS = 20
ball_pos = [0,0]

init_pos = [WIDTH / 2, HEIGHT / 2]
```

```
vel = [0, 3]  # pixels per tick
time = 0


# define event handlers
def tick():
    global time
    time = time + 1
#Function that represents the accereration
def cronos():
    vel[0]=vel[0]+1
    vel[1]=vel[1]+1


def draw(canvas):
    global time
    global init_pos
    # calculate ball position adding the acceleration factor of a unit to the velocity
vector per second
    ball_pos[0] = init_pos[0] + time * vel[0] + 0.5* (time**2)
    ball_pos[1] = init_pos[1] + time * vel[1] + 0.5* (time**2)
    #the position of the ball wraps around
    if ball_pos[0]>=600 or ball_pos[1]>=400:
        time=0
        ball_pos[0]=(ball_pos[0] + vel[0])%WIDTH
        ball_pos[1]=(ball_pos[1] +  vel[1])%HEIGHT
        init_pos=[ball_pos[0],ball_pos[1]]


    # draw ball
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")


# create frame
```

```
frame = simplegui.create_frame("Motion", WIDTH, HEIGHT)

# register event handlers
frame.set_draw_handler(draw)

timer = simplegui.create_timer(50, tick)
t= simplegui.create_timer(1000, cronos)

# start frame
frame.start()
timer.start()
t.start()

# Ball motion with an implicit timer

import simplegui

# Initialize globals
WIDTH = 600
HEIGHT = 400
BALL_RADIUS = 20

ball_pos = [WIDTH / 2, HEIGHT / 2]
vel = [0, 1] # pixels per update (1/60 seconds)

# define event handlers
def draw(canvas):
    # Update ball position
    ball_pos[0] += vel[0]
    ball_pos[1] += vel[1]
```

```
    # Draw ball
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")

# create frame
frame = simplegui.create_frame("Motion", WIDTH, HEIGHT)

# register event handlers
frame.set_draw_handler(draw)

# start frame
frame.start()
```

Collisions and reflections.

```
# Ball motion with an implicit timer

import simplegui

# Initialize globals
WIDTH = 600
HEIGHT = 400
BALL_RADIUS = 20


ball_pos = [WIDTH / 2, HEIGHT / 2]
vel = [2, 2] # pixels per update (1/60 seconds)

# define event handlers
def draw(canvas):
```

```
# Update ball position, this position updates include the collision and reflection
effect by modifying      # the vertical component and maintaining the horizontal
when the object collides with a horizontal #border of by modifying the horizontal
component and maintaining the vertical component when the #object collides with
a vertical border
    if ball_pos[0]>=WIDTH-BALL_RADIUS-1:
        vel[0]=vel[0]*-1
    elif ball_pos[1]>=HEIGHT-BALL_RADIUS-1:
        vel[1]= vel[1]*(-1)
    elif ball_pos[0]<=21:
        vel[0]= vel[0]*(-1)
    elif ball_pos[1]<=21:
        vel[1]= vel[1]*(-1)


    ball_pos[0] += vel[0]
    ball_pos[1] += vel[1]
    # Draw ball
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")


# create frame
frame = simplegui.create_frame("Motion", WIDTH, HEIGHT)


# register event handlers
frame.set_draw_handler(draw)


# start frame
frame.start()
```

Velocity Control

```
# control the velocity of a ball using the arrow keys
```

```
import simplegui
import random

# Initialize globals
WIDTH = 600
HEIGHT = 400
BALL_RADIUS = 20

ball_pos = [WIDTH / 2, HEIGHT / 2]
vel = [0, 0]

# define event handlers, the conditionals will make the ball bounce of the canvas
def draw(canvas):
    # Update ball position
    ball_pos[0] += vel[0]
    ball_pos[1] += vel[1]
    if ball_pos[0]>=WIDTH-BALL_RADIUS-1:
        vel[0]=-vel[0]
    elif ball_pos[1]>=HEIGHT-BALL_RADIUS-1:
        vel[1]=-vel[1]
    elif ball_pos[0]<=21:
        vel[0]=-vel[0]
    elif ball_pos[1]<=21:
        vel[1]=-vel[1]

    # Draw ball
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")
```

```
#each key stroke will modify the velocity vector to one direction, a little sound is added to make the ball #move more realistically and to make the control of the ball more chaotic
def keydown(key):
    acc = 1
    if key==simplegui.KEY_MAP["left"]:
        vel[0] -= acc-random.random()
    elif key==simplegui.KEY_MAP["right"]:
        vel[0] += acc+random.random()
    elif key==simplegui.KEY_MAP["down"]:
        vel[1] += acc+random.random()
    elif key==simplegui.KEY_MAP["up"]:
        vel[1] -= acc-random.random()


    print ball_pos


# create frame
frame = simplegui.create_frame("Velocity ball control", WIDTH, HEIGHT)


# register event handlers
frame.set_draw_handler(draw)
frame.set_keydown_handler(keydown)


# start frame
frame.start()
```

Mouse Input.

In order to put a mouse input that works with an interactive application say for example a simple program that indicates where in the canvas there was a click with a circle which moves (obviously) to the [x,y] coordinates where the click happened in the canvas and turning the ball green when the click was located within the radius of the circle, the appropriate mouse handler must be written, the example mentioned is as follows:

```
# Examples of mouse input


import simplegui

import math


# intialize globals

WIDTH = 450

HEIGHT = 300

ball_pos = [WIDTH / 2, HEIGHT / 2]

BALL_RADIUS = 15

ball_color = "Red"


# helper function for the event in which the click is located within the radius of the circle takes a vector between the

# position of the ball and the position of the click and takes the module of that vector

def distance(p, q):

    return math.sqrt( (p[0] - q[0]) ** 2 + (p[1] - q[1]) ** 2)


# define event handler for mouse click, if distance between position of the click and center of the circle is less than its       # radius modify color to green, else modify the position of the circle to be the position of the click.

#It is important to note that the mouse position is a TUPLE so for each mous click a new tuple is created

def click(pos):

    global ball_pos, ball_color

    if distance(pos, ball_pos) < BALL_RADIUS:
```

```
        ball_color = "Green"
    else:
        ball_pos = list(pos)
        ball_color = "Red"

def draw(canvas):
    canvas.draw_circle(ball_pos, BALL_RADIUS, 1, "Black", ball_color)

# create frame
frame = simplegui.create_frame("Mouse selection", WIDTH, HEIGHT)
frame.set_canvas_background("White")

# register event handler
frame.set_mouseclick_handler(click)
frame.set_draw_handler(draw)

# start frame
frame.start()
```

List Methods.

List methods include statements such as ‘in’ and the function ‘index()’.

The ‘in’ statement serves the purpose of determining if certain element is anywhere in the list, as well as for running through the list through iterations (for) and the index function serves the purpose of telling in which place of the list the element is found which can be very useful when modifying the list.

Others list methods like the functions append() and pop().

Append(), as we know adds another element to the list.

Pop() by default takes out the last place of the list, but it takes arguments as to which of the elements of the list will be removed, it takes the place on the list in which the element in this certain place will be removed.

Example:

```
#Simple task list


import simplegui


tasks = []


# Handler for button
def clear():
    global tasks
    tasks = []


# Handler for new task
def new(task):
    tasks.append(task)


# Handler for remove number
def remove_num(tasknum):
    n = int(tasknum)
    if n > 0 and n <= len(tasks):
        tasks.pop(n-1)


# Handler for remove name
def remove_name(taskname):
    if taskname in tasks:
        tasks.remove(taskname)
```

```
# Handler to draw on canvas, for loop to run through the list and making the draw text modify the y position through       # each iteration
def draw(canvas):
    n = 1
    for task in tasks:
        pos = 30 * n
        canvas.draw_text(str(n) + ": " + task, [5, pos], 24, "White")
        n += 1

# Create a frame and assign callbacks to event handlers
frame = simplegui.create_frame("Task List", 600, 400)
frame.add_input("New task:", new, 200)
frame.add_input("Remove task number:", remove_num, 200)
frame.add_input("Remove task:", remove_name, 200)
frame.add_button("Clear All", clear)
frame.set_draw_handler(draw)

# Start the frame animation
frame.start()
```

Example for creating in each click a circle in the position of the mouse

```
# Examples of mouse input

import simplegui
import math

# intialize globals
width = 450
height = 300
```

```
ball_list = []
ball_radius = 15
ball_color = "Red"

# helper function
def distance(p, q):
    return math.sqrt((p[0] - q[0]) ** 2 + (p[1] - q[1]) ** 2)

# define event handler for mouse click, draw
def click(pos):
    ball_list.append(pos)
#    if distance(ball_pos, pos) < ball_radius:
#            ball_color = "Green"
#    else:
#        ball_pos = [pos[0], pos[1]]
#        ball_color = "Red"

def draw(canvas):
    for ball_pos in ball_list:
        canvas.draw_circle(ball_pos, ball_radius, 1, "Black", ball_color)

# create frame
frame = simplegui.create_frame("Mouse selection", width, height)
frame.set_canvas_background("White")

# register event handler
frame.set_mouseclick_handler(click)
frame.set_draw_handler(draw)

# start frame
```

```
frame.start()
```

Modified versión of the previous program that changes the color of any previously drawn circle

```
# Examples of mouse input


import simplegui
import math


# intialize globals
width = 450
height = 300
ball_list = []
ball_radius = 15


# helper function
def distance(p, q):
    return math.sqrt((p[0] - q[0]) ** 2 + (p[1] - q[1]) ** 2)


# define event handler for mouse click, in each click there is going to be a
# run through each of the elements of the list that contains the ball positions
# if the distance between the click and the previous ball position is less than
# its radius it will mean that the ball has been clicked and will change color
# so the color on the main list is modified for that certain ball in some position
# if the flag isn't changed that will mean that their was a click outside the ball
# radius, so the new ball will be appended to the main list of balls
def click(pos):
    changed = False
```

```
    for ball in ball_list:
        if distance([ball[0], ball[1]], pos) < ball_radius:
            ball[2] = "Green"
            changed = True

    if not changed:
        ball_list.append([pos[0], pos[1], "Red"])

def draw(canvas):
    for ball in ball_list:
        canvas.draw_circle([ball[0], ball[1]], ball_radius, 1, "Black", ball[2])

# create frame
frame = simplegui.create_frame("Mouse selection", width, height)
frame.set_canvas_background("White")

# register event handler
frame.set_mouseclick_handler(click)
frame.set_draw_handler(draw)

# start frame
frame.start()
```

Modified version of the previous example but now removing each circle by clicking

```
# Examples of mouse input

import simplegui
import math
```

```
# intialize globals
width = 450
height = 300
ball_list = []
ball_radius = 15
ball_color = "Red"

# helper function
def distance(p, q):
    return math.sqrt((p[0] - q[0]) ** 2 + (p[1] - q[1]) ** 2)

# define event handler for mouse click, draw
def click(pos):
    remove = []
    n=0
    for ball in ball_list:
        if distance(ball, pos) < ball_radius:
            remove.append(ball)

    if remove == []:
        ball_list.append(pos)
    else:
        for ball in ball_list:
            if ball is remove[0]:
                ball_list.pop(n)
            n=n+1

def draw(canvas):
    for ball in ball_list:
```

```
        canvas.draw_circle([ball[0], ball[1]], ball_radius, 1, "Black", ball_color)

# create frame
frame = simplegui.create_frame("Mouse selection", width, height)
frame.set_canvas_background("White")

# register event handler
frame.set_mouseclick_handler(click)
frame.set_draw_handler(draw)

# start frame
frame.start()
```

Some other useful example functions for modifying lists bellow:

```
# Iterating over lists

def count_odd(numbers):
    count = 0
    for num in numbers:
        if num % 2 == 1:
            count += 1
    return count

def check_odd(numbers):
    for num in numbers:
        if num % 2 == 1:
            return True
    return False
```

```
def remove_odd(numbers):
    for num in numbers:
        if num % 2 == 1:
            numbers.remove(num)

def remove_odd2(numbers):
    remove = []
    for num in numbers:
        if num % 2 == 1:
            remove.append(numbers.index(num))

    for idx in remove:
        numbers.pop(idx)

def remove_odd3(numbers):
    remove = []
    for num in numbers:
        if num % 2 == 1:
            remove.append(num)

    for num in remove:
        numbers.remove(num)

def remove_odd4(numbers):
    newnums = []
    for num in numbers:
        if num % 2 == 0:
            newnums.append(num)
    return newnums
```

```
def remove_last_odd(numbers):
    n=0
    last_odd = 0
    for num in numbers:
        if num % 2 == 1:
            last_odd = num
    for num in numbers:
        if num==last_odd:
            ind=n
        n=n+1

    numbers=numbers.pop(ind)

def run():
    numbers = [1, 7, 2, 34, 8, 7, 2, 5, 14, 22, 93, 48, 76, 15, 7]
    print numbers
    remove_last_odd(numbers)
    print numbers

run()
```

Object Oriented Programming.

Each type of object has some methods to it, the built-in methods for a list object are for example methods like str_name.append(something), or str_name.sort() or any other method (previously called function) that is included within the type list.

As well as there are methods and types which are built-in the python language, there is the capability in the language for building your own types and methods within them.

A new type is declared in Python and in many other object oriented programming language as class, a new class will always begin with capital letter.

Example:

for this new class we name it Character, within this new class we define it’s methods, which are no # other than functions defined with double underscores, and with the fundamental difference that this #functions will only be able to operate in objects of the same class. As we can see, each method takes at #least one parameter which is self, in this parameter we can have , the functions with no underscores #are called behaviors.

```
class Character:
    def __init__(self, name, initial_health):
        self.name = name
        self.health = initial_health
        self.inventory = []

    def __str__(self):
        s  = "Name: " + self.name
        s += " Health: " + str(self.health)
        s += " Inventory: " + str(self.inventory)
        return s

    def grab(self, item):
        self.inventory.append(item)

    def get_health(self):
        return self.health

def example():
```

```
    me = Character("Bob", 20)
    print str(me)
    me.grab("pencil")
    me.grab("paper")
    print str(me)
    print "Health:", me.get_health()

example()
```

Example of OOP Program used to simulate the movement of particles.

```
# Particle class example used to simulate diffusion of molecules

import simplegui
import random

# global constants
WIDTH = 600
HEIGHT = 400
PARTICLE_RADIUS = 5
COLOR_LIST = ["Red", "Green", "Blue", "White"]
DIRECTION_LIST = [[1,0], [0, 1], [-1, 0], [0, -1]]


# definition of Particle class
class Particle:

    # initializer for particles
    def __init__(self, position, color):
```

```
        self.position = position
        self.color = color

    # method that updates position of a particle
    def move(self, offset):
        self.position[0] += offset[0]
        self.position[1] += offset[1]

    # draw method for particles
    def draw(self, canvas):
        canvas.draw_circle(self.position, PARTICLE_RADIUS, 1, self.color, self.color)

    # string method for particles
    def __str__(self):
        return "Particle with position = " + str(self.position) + " and color = " +
self.color



# draw handler
def draw(canvas):
    for p in particle_list:
        p.move(random.choice(DIRECTION_LIST))



    for p in particle_list:
        p.draw(canvas)



# create frame and register draw handler
frame = simplegui.create_frame("Particle simulator", WIDTH, HEIGHT)
```

```
frame.set_draw_handler(draw)


# create a list of particles
particle_list = []
for i in range(251):
    p = Particle([WIDTH / 2, HEIGHT / 2], random.choice(COLOR_LIST))
    particle_list.append(p)


# start frame
frame.start()
```

When you build an OOP you must always begin by constructing all the types that you'll need.

Example from quiz 6b (First working object type ever made by me!)

```
class BankAccount:
    def __init__(self, initial_balance):
#Creates an account with the given balance. Note that when you use a variable in a method that is going #to be used in other methods you'll need to place the self. In front of it
        self.balance=initial_balance
        self.cont=0
    def deposit(self, amount):
        """Deposits the amount into the account."""
        self.balance=amount+self.balance
    def withdraw(self, amount):
        """
        Withdraws the amount from the account.  Each withdrawal resulting in a
```

```
        negative balance also deducts a penalty fee of 5 dollars from the balance.
        """
        self.balance=self.balance-amount
        if self.balance<0:
            self.balance=self.balance-5
            self.cont=self.cont+5
    def get_balance(self):
        """Returns the current balance in the account."""
        return self.balance


    def get_fees(self):
        """Returns the total fees ever deducted from the account."""
        return self.cont
```

The power of OOP Relies on the fact that when you make any object a part of a class Python will keep track of any indefinite number of objects and its values, just as it would precisely do with the built in Types of objects such as lists or dictionaries and that is exactly how all new types of objects making code recycling much more easier.

- Class overload: in some OOP languages exists the capability of creating various __init__ methods which will respond to the class assignation in relation to the amount of parameters that the methods are capable of handling. In python this capability does not exist.

For example:

```
class Overload:
    def __init__(self, value1):
        pass
    def __init__(self, value1, value2):
        pass
```

value1=Overload(1)

value2=Overload(2,1)

In this previous example Python would give us a Type error it would only be able to take the first init value. But Python is flexible with methods, so if you need to use various parameters in a same method you would start the parameter in a predetermined value and if you wish you can use that parameter when needed. As in the following example.

```
class Overload:

    def __init__(self, one, two=0):

        """Example of method that takes one required argument and one optional argument."""

        pass



Overload(1)        # Implicitly, we leave the second argument as its default value, 0.

Overload(1,2)
```

This happens too in built in methods for types just like range() which can be used in this way: range(100) and creates a sequenced list of the numbers 0 to 99 or in this other way: range(50,100) which creates a list from 50 to 99, that first parameter of the method is set to zero.

Tiled Images.

To add tiled images and be able to use them:

demo for drawing using tiled images

import simplegui

import random

```
# define globals for cards
RANKS = ('A', '2', '3', '4', '5', '6', '7', '8', '9', '10', 'J', 'Q', 'K')
SUITS = ('C', 'S', 'H', 'D')
r=random.choice(RANKS)
s=random.choice(SUITS)
# card sprite - 950x392
CARD_CENTER = (36.5, 49)
CARD_SIZE = (73, 98)
#Load Image
card_image =
simplegui.load_image("http://commondatastorage.googleapis.com/codeskulptor-
assets/cards.jfitz.png")
#LOC is location in which the image will be drawn in the image
LOC= (155,90)
#Lists for defining the domain in which a mouse click which will be the area that
encloses the card
card_loc = list(LOC)
card_size = list(CARD_SIZE)
half_card_size= [card_size[0]/2 , card_size[1]/2]
#List to store the initial range of the card approximating ‘x’ and ‘y’ from the left
CARD_RANGE= [card_loc[0]-half_card_size[0], card_loc[1]-half_card_size[1]]
click=False
# define card class
class Card:
    def __init__(self, suit, rank):
        self.rank = rank
        self.suit = suit

    def draw(self, canvas, loc):
        i = RANKS.index(self.rank)
        j = SUITS.index(self.suit)
```

```
        card_pos = [CARD_CENTER[0] + i * CARD_SIZE[0],
                    CARD_CENTER[1] + j * CARD_SIZE[1]]
        canvas.draw_image(card_image, card_pos, CARD_SIZE, loc, CARD_SIZE)

# define draw handler
def draw(canvas):
    if click is True:
        one_card = Card(s,r)
        one_card.draw(canvas, LOC)


def click(pos):
    global r, s, click
    click= True
    position=pos
    if position[0]>=CARD_RANGE[0] and
position[0]<=CARD_RANGE[0]+card_size[0]:
        if position[1]>=CARD_RANGE[1] and
position[1]<=CARD_RANGE[1]+card_size[1]:
            r=random.choice(RANKS)
            s=random.choice(SUITS)
            one_card = Card(s,r)


# define frame and register draw handler
frame = simplegui.create_frame("Card draw", 300, 200)
frame.set_draw_handler(draw)
frame.set_mouseclick_handler(click)
# create a card


frame.start()
```

Visualizing objects.

##################

Object creation and use

Mutation with Aliasing

This particular example illustrates how aliasing also works with object instances in which an object p is # created within the type Point1 and then r is not created but instead entangled within the same #instance of the type p so basically r and p are the same object.

```
class Point1:
    def __init__(self, x, y):
        self.x = x
        self.y = y

    def set_x(self, newx):
        self.x = newx

    def get_x(self):
        return self.x

p = Point1(4, 5)
q = Point1(4, 5)
r = p

p.set_x(10)

print p.get_x()
print q.get_x()
print r.get_x()
```

```
##################

# Object shared state

# Mutation of shared state

# in this example a list is created, this same list will be modified in the class so the objects p and q which # are created with the coordinates list will be sharing the same instance of the class thus if the list #coordinates is changed within the class, which will happen, both objects will be changed because they #share the same list


class Point2:
    def __init__(self, coordinates):
        self.coords = coordinates


    def set_coord(self, index, value):
        self.coords[index] = value


    def get_coord(self, index):
        return self.coords[index]


coordinates = [4, 5]
p = Point2(coordinates)
q = Point2(coordinates)
r = Point2([4, 5])


p.set_coord(0, 10)


print p.get_coord(0)
print q.get_coord(0)
print r.get_coord(0)
```

```
##################
# Objects not sharing state
# By simply creating a copy of whatever list is passed to the class in order to create an object within the # class you avoid the previous situation from happening.


class Point3:
    def __init__(self, coordinates):
        self.coords = list(coordinates)

    def set_coord(self, index, value):
        self.coords[index] = value

    def get_coord(self, index):
        return self.coords[index]

coordinates = [4, 5]
p = Point3(coordinates)
q = Point3(coordinates)
r = Point3([4, 5])

p.set_coord(0, 10)

print p.get_coord(0)
print q.get_coord(0)
print r.get_coord(0)
```

Building Spaceship.

```
# Partial example code for Spaceship
# The following is an example for two of the classes that will be used for building spaceship

import simplegui



class ImageInfo:
    def __init__(self, center, size, radius = 0, lifespan = None, animated = False):
        self.center = center
        self.size = size
        self.radius = radius
        if lifespan:
            self.lifespan = lifespan
        else:
            self.lifespan = float('inf')
        self.animated = animated

    def get_center(self):
        return self.center

    def get_size(self):
        return self.size

    def get_radius(self):
```

```
        return self.radius

    def get_lifespan(self):
        return self.lifespan

    def get_animated(self):
        return self.animated



# art assets created by Kim Lathrop, may be freely re-used in non-commercial projects, please credit Kim


# ship image

ship_info = ImageInfo([45, 45], [90, 90], 35)

ship_image = simplegui.load_image("http://commondatastorage.googleapis.com/codeskulptor-assets/lathrop/double_ship.png")


# sound assets purchased from sounddogs.com, please do not redistribute

ship_thrust_sound = simplegui.load_sound("http://commondatastorage.googleapis.com/codeskulptor-assets/sounddogs/thrust.mp3")



# Ship class

class Ship:

    def __init__(self, pos, vel, angle, image, info):

        self.pos = [pos[0],pos[1]]

        self.vel = [vel[0],vel[1]]

        self.thrust = False

        self.angle = angle
```

```
        self.angle_vel = 0
        self.image = image
        self.image_center = info.get_center()
        self.image_size = info.get_size()
        self.radius = info.get_radius()

    def draw(self,canvas):
        canvas.draw_circle(self.pos, self.radius, 1, "White", "White")

    def update(self):
        pass
```

Set Sounds.

```
# simple music player, uses buttons and sounds
# note that .ogg sounds are not supported in Safari

import simplegui

# define callbacks
def play():
    """play some music, starts at last paused spot"""
    music.play()

def pause():
    """pause the music"""
    music.pause()

def rewind():
```

```
    """rewind the music to the beginning """
    music.rewind()

def laugh():
    """play an evil laugh
    will overlap since it is separate sound object"""
    laugh.play()

def vol_down():
    """turn the current volume down"""
    global vol
    if vol > 0:
        vol = vol - 1
    music.set_volume(vol / 10.0)
    volume_button.set_text("Volume = " + str(vol))

def vol_up():
    """turn the current volume up"""
    global vol
    if vol < 10:
        vol = vol + 1
    music.set_volume(vol / 10.0)
    volume_button.set_text("Volume = " + str(vol))



# create frame - canvas will be blank
frame = simplegui.create_frame("Music demo", 250, 250, 100)

# set up control elements
frame.add_button("play", play,100)
```

```
frame.add_button("pause", pause,100)
frame.add_button("rewind",rewind,100)
frame.add_button("laugh",laugh,100)
frame.add_button("Vol down", vol_down,100)
frame.add_button("Vol up", vol_up,100)

# initialize volume, create button whose label will display the volume
vol = 7
volume_button = frame.add_label("Volume = " + str(vol))



# load some sounds
music =
simplegui.load_sound("http://commondatastorage.googleapis.com/codeskulptor-
assets/Epoq-Lepidoptera.ogg")
laugh =
simplegui.load_sound("http://commondatastorage.googleapis.com/codeskulptor-
assets/Evillaugh.ogg")

# make the laugh quieter so my ears don't bleed
laugh.set_volume(.1)

frame.start()
```

Terminal Velocity model for the ship:

```
acc=10.0
fr=acc*.1
vel=0
t=1
while True:
    if t==1:
```

```
        vel=acc+vel
        t=t+1
        continue
    if acc>.000000000001:
        acc=acc-fr
        fr=acc*.1
        vel=acc+vel
    else:
        break
    print acc
    print vel
print 'terminal velocity is aprox: ' , vel
```

Modification of the bouncing ball that makes the ball appear in the other side of the frame via modular math.

```
def draw(canvas):
    # Update ball position
    ball_pos[0] += vel[0]
    ball_pos[1] += vel[1]


    if ball_pos[0]>WIDTH:
        ball_pos[0]=ball_pos[0]%WIDTH
    elif ball_pos[1]>HEIGHT:
        ball_pos[1]=ball_pos[1]%HEIGHT
    elif ball_pos[0]<0:
        ball_pos[0]=ball_pos[0]%WIDTH + WIDTH
```

```
    elif ball_pos[1]<0:
        ball_pos[1]=ball_pos[1]%HEIGHT + HEIGHT


    # Draw ball
    canvas.draw_circle(ball_pos, BALL_RADIUS, 2, "Red", "White")
```

Sprites.

Two dimensional image or animation integrated into a larger scene, usually treated as a graphical overlay

in 1970/1980's, doing 2D graphics was computationally expensive. Sprites were 2D images provided to

special hardware accelerators that overlaid the images onto the display.

Now, sprites are logical entities used to organize/represent images that add visual complexity to a game

Sprite sheets consisted a collection of sprites organized as a single image. Note that the individual sprites need not be regularly spaced on the sprite sheet.

We will prefer to load sprites as individual images to provide more flexibility in modifying the art assets for Spaceship and RiceRocks.

Color and Transparency

RGB model - three red, green, blue channels

Stored channel values as numerical intensities in the range 0-255

HTML string - "rgb(255, 0, 0)" - equivalent to "Red"

http://www.w3schools.com/html/html_colors.asp

Color - up to now, "White", "Black", "Red"

Challenge- would like to draw irregular shapes (like an asteroid or spaceship) that lie in

rectangular images

Add alpha channel to RGB model - channel stores transparency

HTML string - "rgba(255, 0, 0, 0.5)" - (1 is opaque, 0 is transparent)

Create image with transparent alpha channel in Photoshop, GIMP, paint.net, etc.

PNG image format is popular choice

Transparency - up to now, always opaque

Sprite Class.

Sprite class emo

```
import simplegui
import math

# helper class to organize image information
class ImageInfo:
    def __init__(self, center, size, radius = 0, lifespan = None, animated = False):
        self.center = center
        self.size = size
        self.radius = radius
        if lifespan:
            self.lifespan = lifespan
        else:
            self.lifespan = float('inf')
        self.animated = animated

    def get_center(self):
        return self.center

    def get_size(self):
        return self.size
```

```
    def get_radius(self):
        return self.radius

    def get_lifespan(self):
        return self.lifespan

    def get_animated(self):
        return self.animated

# load ship image
asteroid_info = ImageInfo([45, 45], [90, 90], 40)
asteroid_image = simplegui.load_image("http://commondatastorage.googleapis.com/codeskulptor-assets/lathrop/asteroid_blue.png")


# Sprite class
class Sprite():
    def __init__(self, pos, vel, ang, ang_vel, image, info, sound = None):
        self.pos = [pos[0],pos[1]]
        self.vel = [vel[0],vel[1]]
        self.angle = ang
        self.angle_vel = ang_vel
        self.image = image
        self.image_center = info.get_center()
        self.image_size = info.get_size()
        self.radius = info.get_radius()
        self.lifespan = info.get_lifespan()
        self.animated = info.get_animated()
```

```
        self.age = 0
        if sound:
            sound.rewind()
            sound.play()

    def draw(self, canvas):
        #canvas.draw_circle(self.pos, self.radius, 1, "Red", "Red")
        canvas.draw_image(self.image, self.image_center, self.image_size, self.pos,
self.image_size, self.angle)

    def update(self):
        self.angle += self.angle_vel
        self.pos[0] += self.vel[0]
        self.pos[1] += self.vel[1]



def draw(canvas):
    # draw ship and sprites
    a_rock.draw(canvas)

    # update ship and sprites
    a_rock.update()

# initialize frame
frame = simplegui.create_frame("Sprite demo", 800, 600)

# initialize ship and two sprites
a_rock = Sprite([400, 300], [0.3, 0.4], 0, 0.1, asteroid_image, asteroid_info)

# register handlers
```

```
frame.set_draw_handler(draw)

# get things rolling
frame.start()
```

Examples of Code repetition and ways to avoid it.

```
#########################
# Incomplete code from Pong
# Repeated code

def draw(c):
    global paddle1_pos, paddle2_pos

    paddle_width = 80

    if paddle_width/2 <= paddle1_pos + paddle1_vel <= width - paddle_width/2:
        paddle1_pos += paddle1_vel
    if paddle_width/2 <= paddle2_pos + paddle2_vel <= width - paddle_width/2:
        paddle2_pos += paddle2_vel

    c.draw_line([width/2, 0],[width/2, height], 1, "White")

    c.draw_line([4, paddle1_pos-paddle_width/2], [4, paddle1_pos+paddle_width/2],
4, "White")
    c.draw_line([width-4, paddle2_pos-paddle_width/2], [width-4,
paddle2_pos+paddle_width/2], 4, "White")

    ...
```

```
##########################

# Incomplete code from Pong

# Avoiding repetition with functions


paddle_width = 80


def paddle_move(paddle_num):

    if paddle_width/2 <= paddle_pos[paddle_num] + paddle_vel[paddle_num] <=
width - paddle_width/2:

        paddle_pos[paddle_num] += paddle_vel[paddle_num]


def paddle_draw(c, paddle_num):

    c.draw_line([paddle_loc[paddle_num], paddle_pos[paddle_num] -
paddle_width/2],

                PADDLE_THICKNESS, "White")



def draw(c):

    paddle_move(0)

    paddle_move(1)


    c.draw_line([width / 2, 0],[width / 2, height], 1, "White")


    paddle_draw(c,0)

    paddle_draw(c,1)


    ...
```

```
#########################
# Incomplete code from Pong
# Avoiding repetition with classes and methods

class Paddle:
    def __init__(self, loc, pos, vel):
        self.loc = loc
        self.pos = pos
        self.vel = vel
        self.width = 80

    def move(self):
        if self.width/2 <= self.pos + self.vel <= width - self.width/2:
            self.pos += self.vel

    def draw(c, self):
        c.draw_line([self.loc, self.pos-self.width / 2], PADDLE_THICKNESS, "White")

def draw(c):
    paddle1.move()
    paddle2.move()

    c.draw_line([width / 2, 0],[width / 2, height], 1, "White")

    paddle1.draw(c)
    paddle2.draw(c)

    ...
```

```
#########################
# Incomplete code from Pong
# Long if/elif chain

def keydown(key):
    global paddle1_vel, paddle2_vel
    if key == simplegui.KEY_MAP["up"]:
        paddle2_vel -= 2
    elif key == simplegui.KEY_MAP["down"]:
        paddle2_vel += 2
    elif key == simplegui.KEY_MAP["w"]:
        paddle1_vel -= 2
    elif key == simplegui.KEY_MAP["s"]:
        paddle1_vel += 2



#########################
# Incomplete code from Pong
# Avoiding long if/elif chain with dictionary mapping values to actions

def paddle1_faster():
    global paddle1_vel
    paddle1_vel += 2

def paddle1_slower():
    global paddle1_vel
    paddle1_vel -= 2

def paddle2_faster():
```

```
    global paddle2_vel
    paddle2_vel += 2

def paddle2_slower():
    global paddle2_vel
    paddle2_vel -= 2



inputs = {"up": paddle2_slower,
          "down": paddle2_faster,
          "w": paddle1_slower,
          "s": paddle1_faster}

def keydown(key):
    for i in inputs:
        if key == simplegui.KEY_MAP[i]:
            inputs[i]()



##########################
# Illustration of a dictionary mapping values to functions

def f():
    print "hi"

d = {0: f}

d[0]()
```

```
#########################
# Incomplete code from Pong
# Avoiding long if/elif chain with dictionary mapping values to action arguments

inputs = {"up": [1, -2],
          "down": [1, 2],
          "w": [0, -2],
          "s": [0, 2]}

def keydown(key):
    for i in inputs:
        if key == simplegui.KEY_MAP[i]:
            paddle_vel[inputs[i][0]] += inputs[i][1]



#########################
# Sample of using tiled image
# Has some uses of "magic" (unexplained) constants.

# demo for drawing using tiled images

import simplegui

# define globals for cards
RANKS = ['A', '2', '3', '4', '5', '6', '7', '8', '9', 'T', 'J', 'Q', 'K']
SUITS = ['C', 'S', 'H', 'D']

# card sprite - 950x392
CARD_CENTER = (36.5, 49)
CARD_SIZE = (73, 98)
```

```
card_image =
simplegui.load_image("http://commondatastorage.googleapis.com/codeskulptor-
assets/cards.jfitz.png")



# define card class
class Card:
    def __init__(self, suit, rank):
        self.rank = rank
        self.suit = suit

    def draw(self, canvas, pos):
        i = RANKS.index(self.rank)
        j = SUITS.index(self.suit)
        card_pos = [CARD_CENTER[0] + i * CARD_SIZE[0],
                    CARD_CENTER[1] + j * CARD_SIZE[1]]
        canvas.draw_image(card_image, card_pos, CARD_SIZE, pos, CARD_SIZE)

# define draw handler
def draw(canvas):
    one_card.draw(canvas, (155, 90))

# define frame and register draw handler
frame = simplegui.create_frame("Card draw", 300, 200)
frame.set_draw_handler(draw)

# createa card
one_card = Card('S', '6')

frame.start()
```

```
#########################
# Sample of using tiled image
# Naming constants and calculating other constants from those

# demo for drawing using tiled images

import simplegui

# define globals for cards
RANKS = ['A', '2', '3', '4', '5', '6', '7', '8', '9', 'T', 'J', 'Q', 'K']
SUITS = ['C', 'S', 'H', 'D']

# card sprite - 950x392
CARD_SIZE = (73, 98)
card_image =
simplegui.load_image("http://commondatastorage.googleapis.com/codeskulptor-
assets/cards.jfitz.png")

FRAME_SIZE = (300, 200)

# define card class
class Card:
    def __init__(self, suit, rank):
        self.rank = rank
        self.suit = suit

    def draw(self, canvas, pos):
        i = RANKS.index(self.rank)
```

```
        j = SUITS.index(self.suit)
        card_loc = [(.5 + i) * CARD_SIZE[0],
                    (.5 + j) * CARD_SIZE[1]]
        canvas.draw_image(card_image, card_loc, CARD_SIZE, pos, CARD_SIZE)

# define draw handler
def draw(canvas):
    one_card.draw(canvas, (FRAME_SIZE[0] / 2, FRAME_SIZE[1] / 2))

# define frame and register draw handler
frame = simplegui.create_frame("Card draw", FRAME_SIZE[0], FRAME_SIZE[1])
frame.set_draw_handler(draw)

# createa card
one_card = Card('S', '6')

frame.start()



##########################
# Incomplete code from Pong
# Magic unnamed constants, repeated code, long expressions

width = 600
height = 400



def ball_init():
    if random.randrange(0,2) == 0:
        return [300,200], [3 + 3 * random.random(), 8 * (random.random() - 0.5)]
```

```
    else:
        return [300,200], [-(3 + 3 * random.random()), 8 * (random.random() - 0.5)]



##########################
# Incomplete code from Pong
# Constants named and computed, repetition avoided, expressions broken into
# named pieces

width = 600
height = 400



def ball_init():
    pos = [width/2, height/2]

    vel_x = 3 + 3 * random.random()
    vel_y = 8 * (random.random() - 0.5)

    if random.randrange(0,2) == 1:
        vel_x = -vel_x

    return pos, [vel_x, vel_y]
```

Sets.

A set is a data type that stores mutliple values with no order and doesn’t allow duplicates but it does allow modifications.

```
# Examples of Sets
```

```
instructors = set(['Rixner', 'Warren', 'Greiner', 'Wong'])
print instructors

inst2 = set(['Rixner', 'Rixner', 'Warren', 'Warren', 'Greiner', 'Wong'])
print inst2

print instructors == inst2

for inst in instructors:
    print inst

instructors.add('Colbert')
print instructors
instructors.add('Rixner')
print instructors

instructors.remove('Wong')
print instructors
#instructors.remove('Wong')
#print instructors

print 'Rixner' in instructors
print 'Wong' in instructors
```

Output of the program.

```
set(['Rixner', 'Warren', 'Greiner', 'Wong'])
set(['Rixner', 'Warren', 'Greiner', 'Wong'])
True
Rixner
Warren
Greiner
Wong
```

```
set(['Rixner', 'Warren', 'Greiner', 'Wong', 'Colbert'])
set(['Rixner', 'Warren', 'Greiner', 'Wong', 'Colbert'])
set(['Rixner', 'Warren', 'Greiner', 'Colbert'])
True
False
```

Examples of Sets 2 using the set1.difference_update(set2) method for removing from the all elements # in set2 that belong to set1

instructors = set(['Rixner', 'Warren', 'Greiner', 'Wong'])

print instructors

def get_rid_of(inst_set, starting_letter):

    remove_set = set([])

    for inst in inst_set:

        if inst[0] == starting_letter:

            remove_set.add(inst)

    inst_set.difference_update(remove_set)

get_rid_of(instructors, 'W')

print instructors

Output of the function.

```
set(['Rixner', 'Warren', 'Greiner', 'Wong'])
set(['Rixner', 'Greiner'])
```