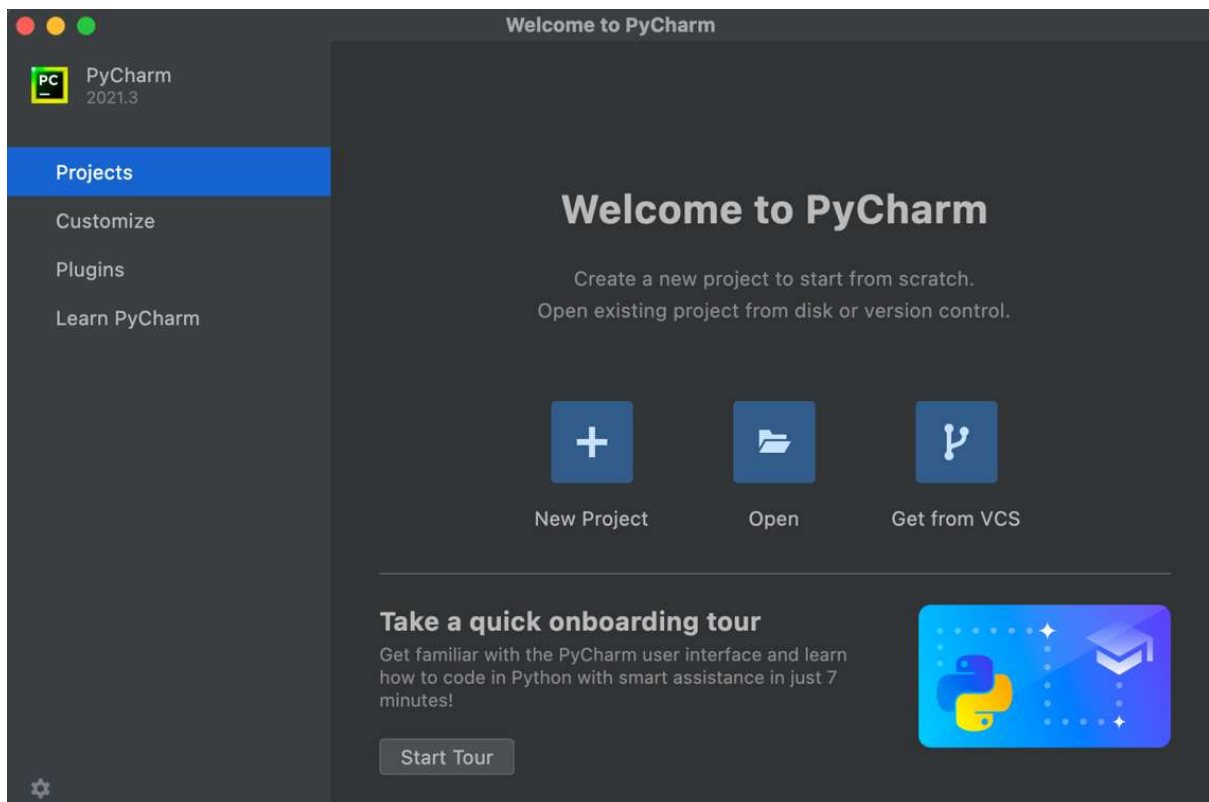
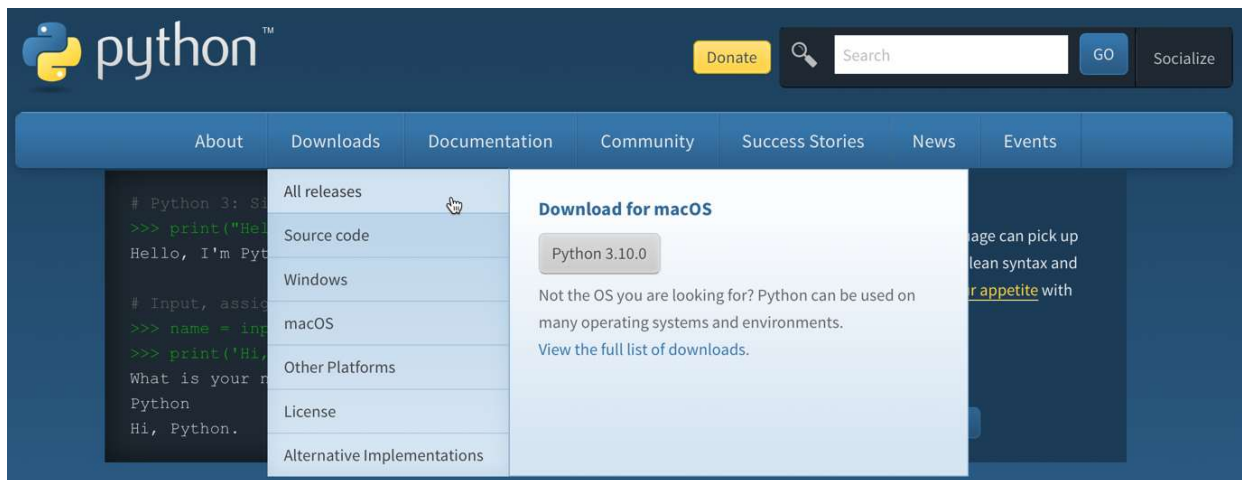
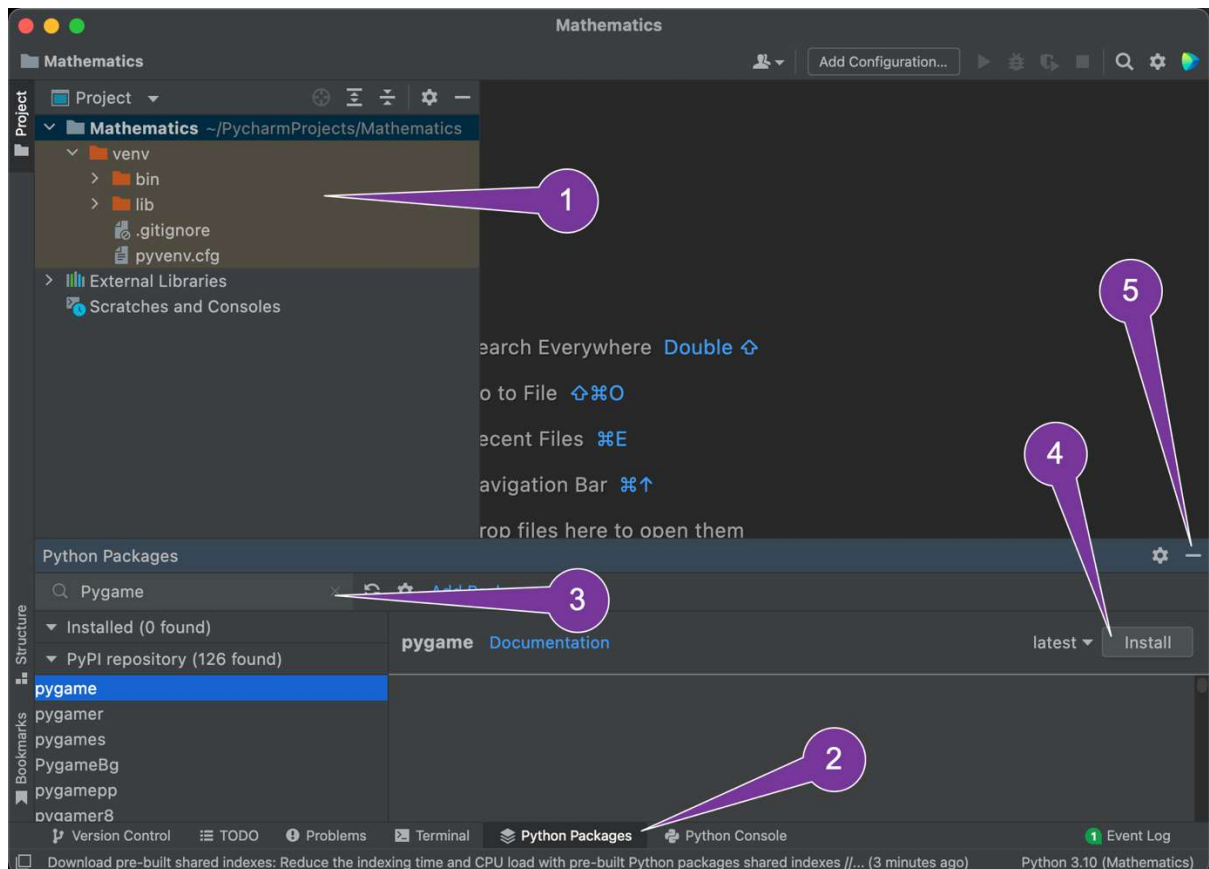
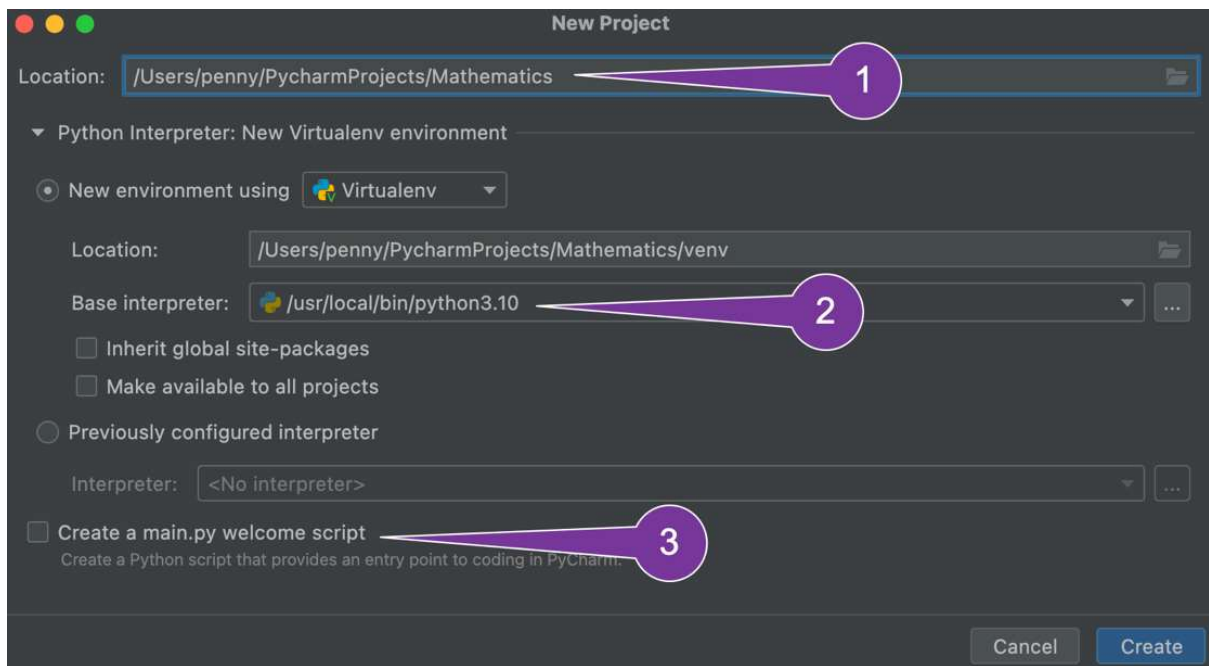
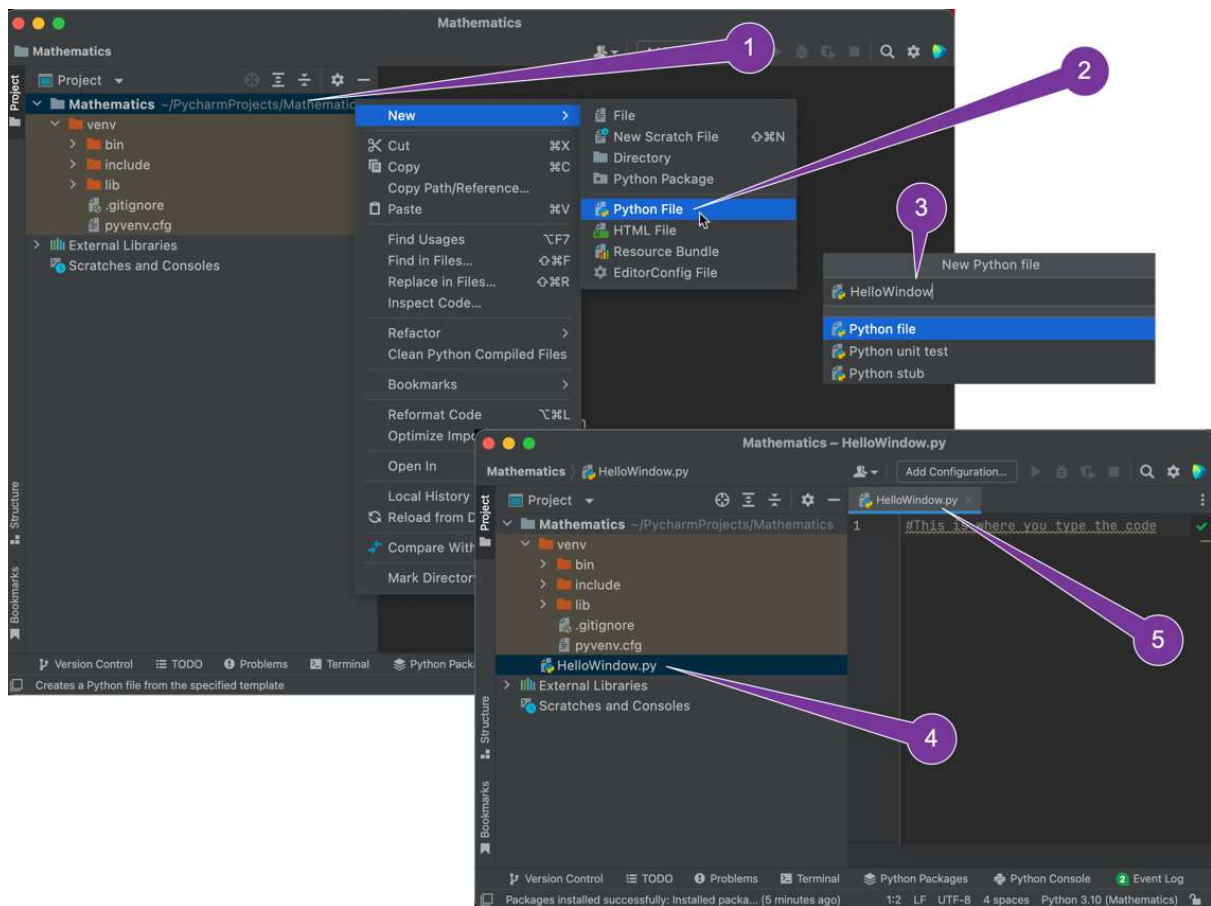


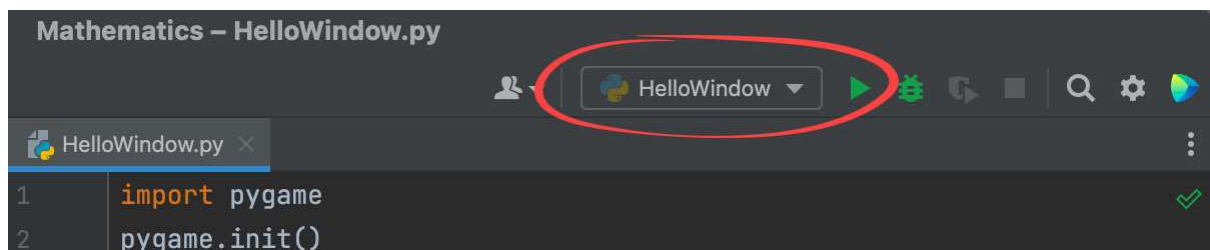
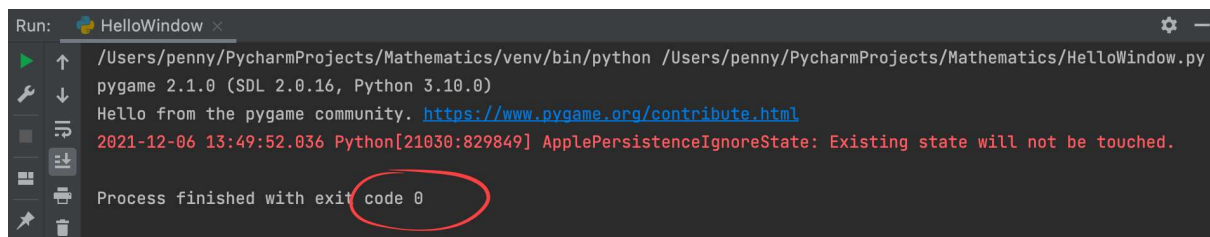
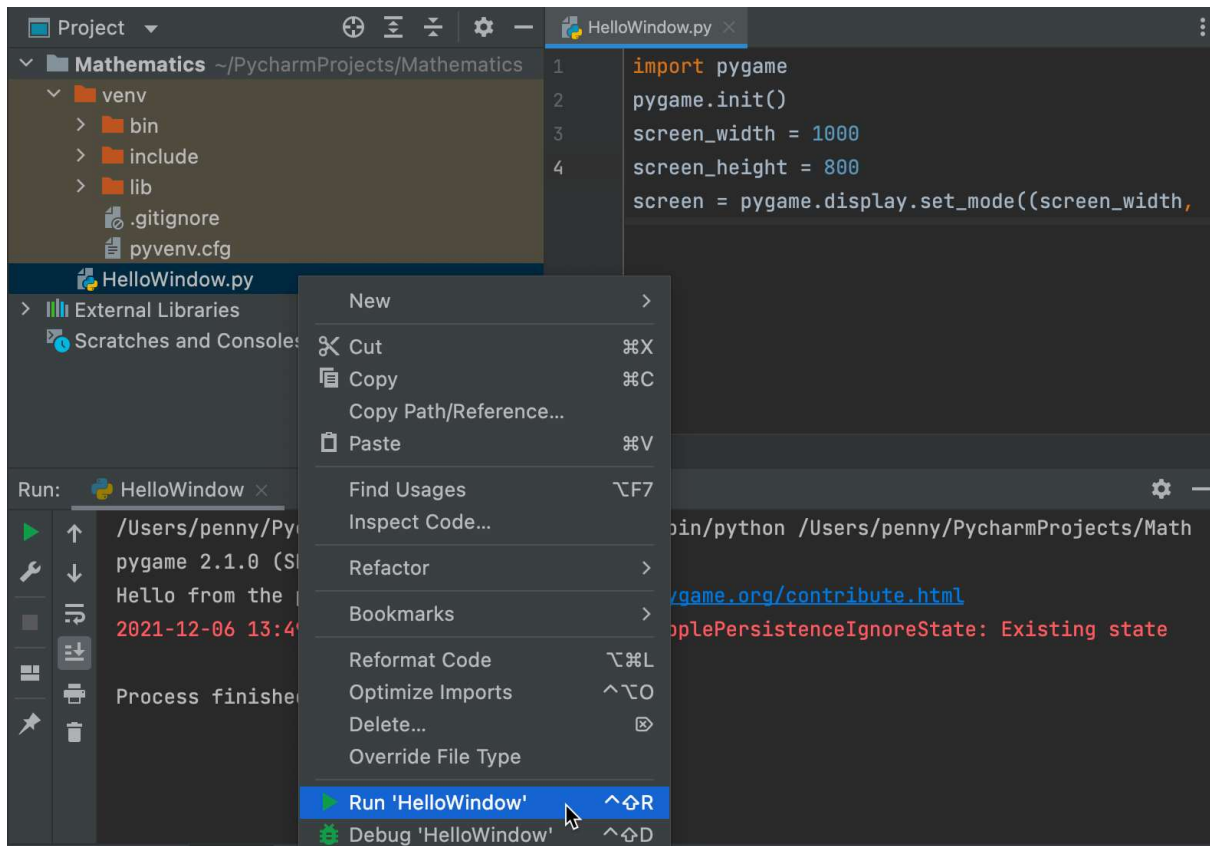
## Chapter 1: Hello Graphics Window: You're on your way



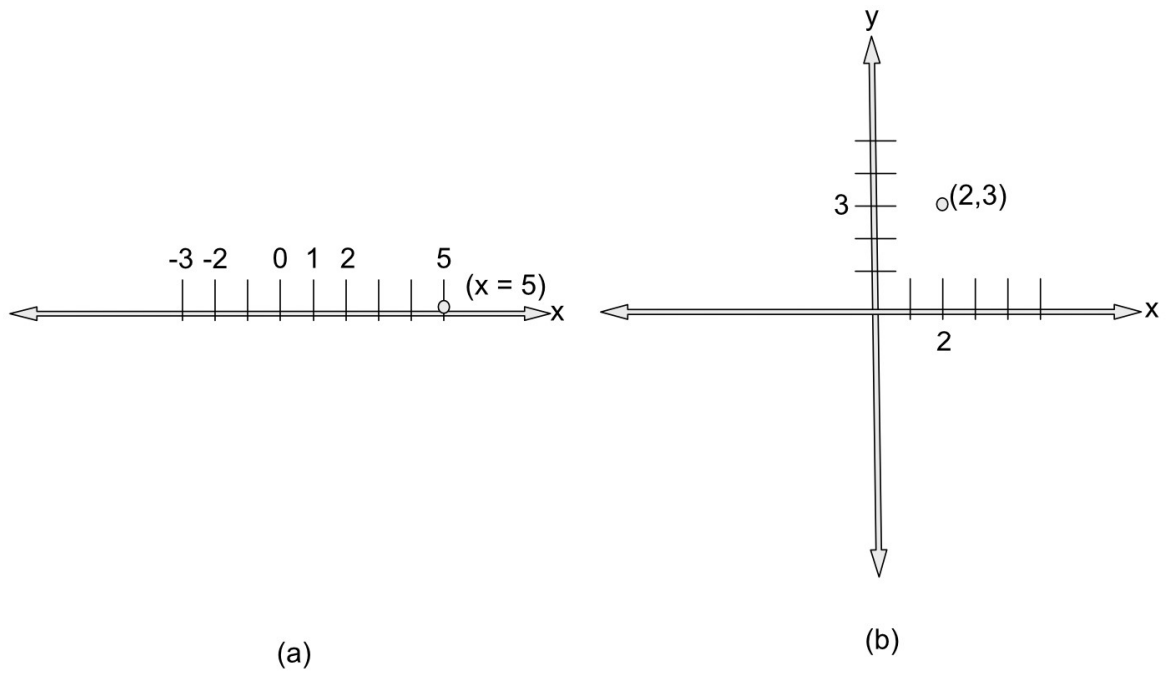
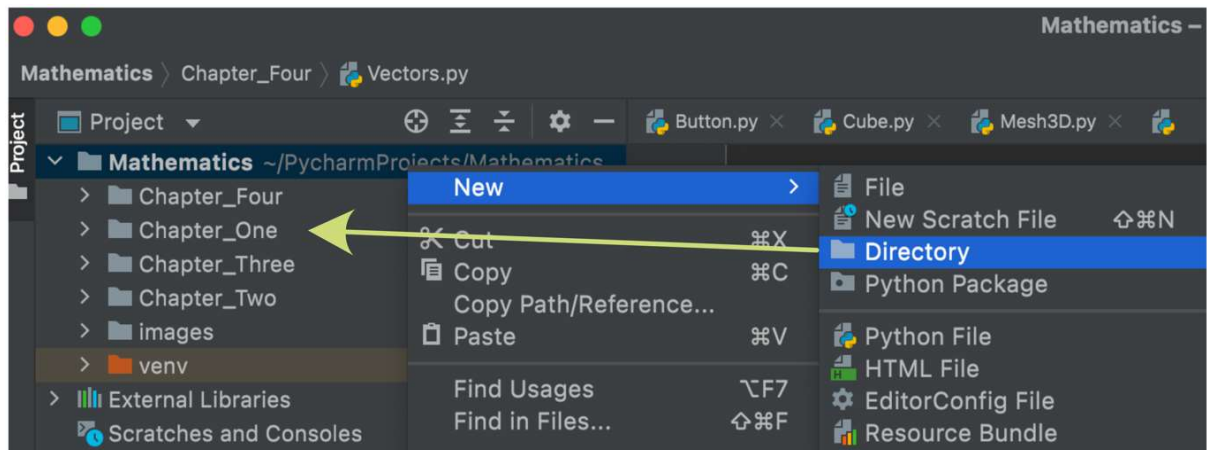


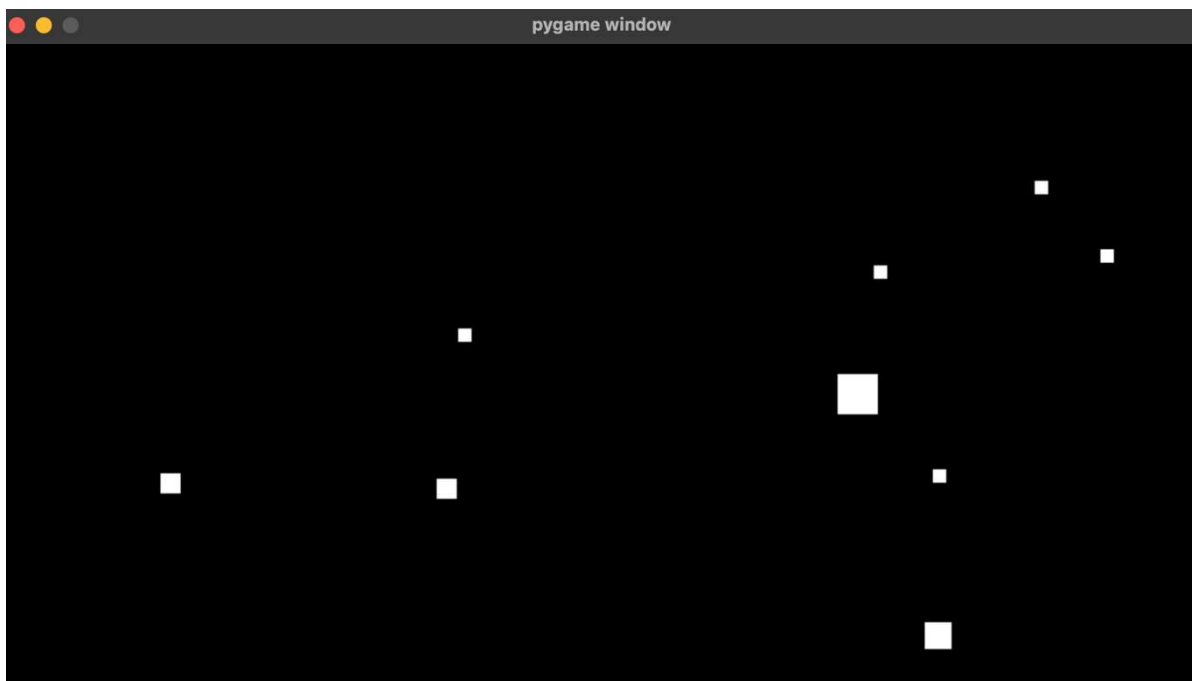
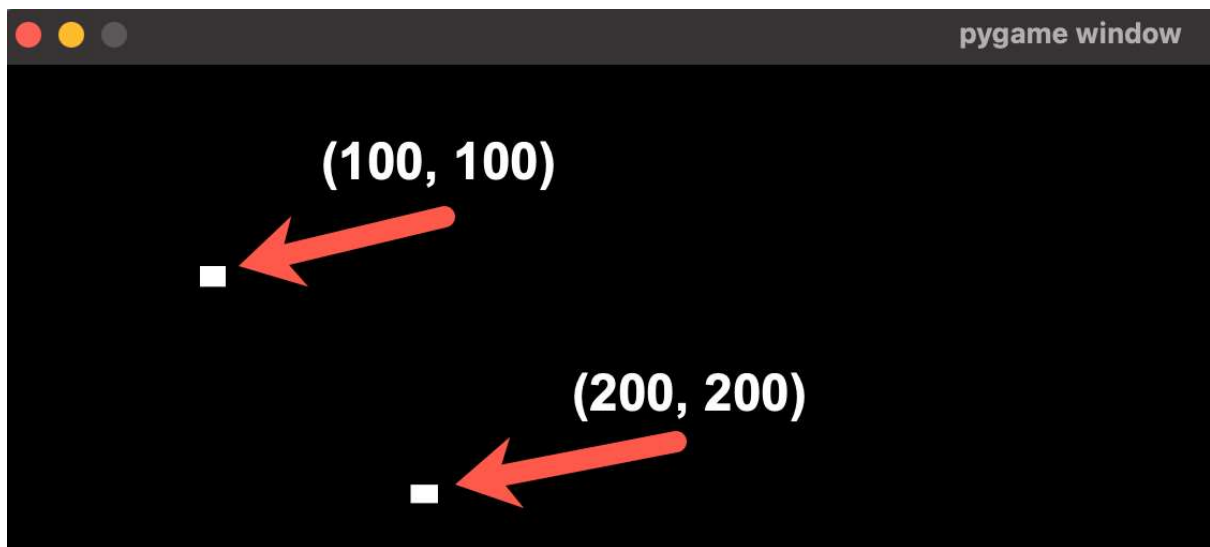


```
1 import pygame
2 pygame.init()
3 screen_width = 1000
4 screen_height = 800
5 screen = pygame.display.set_mode((screen_width, screen_height))
```

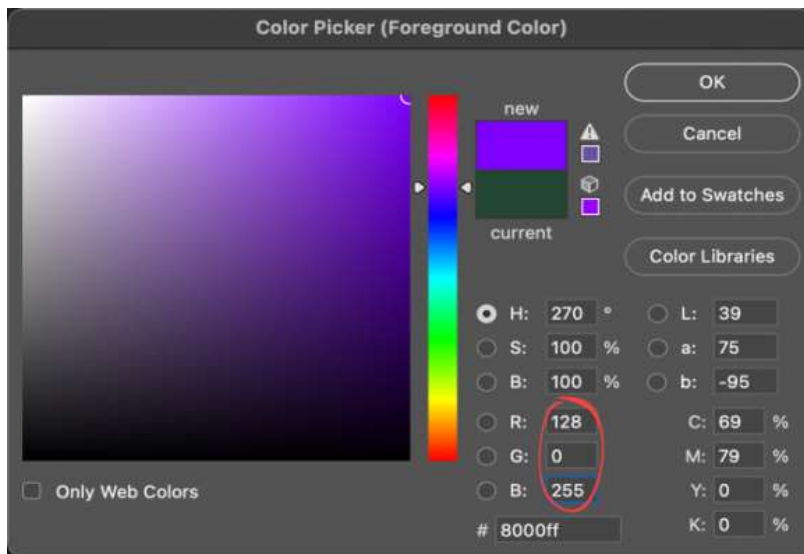




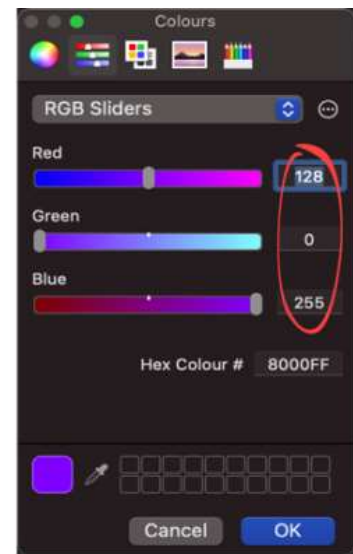




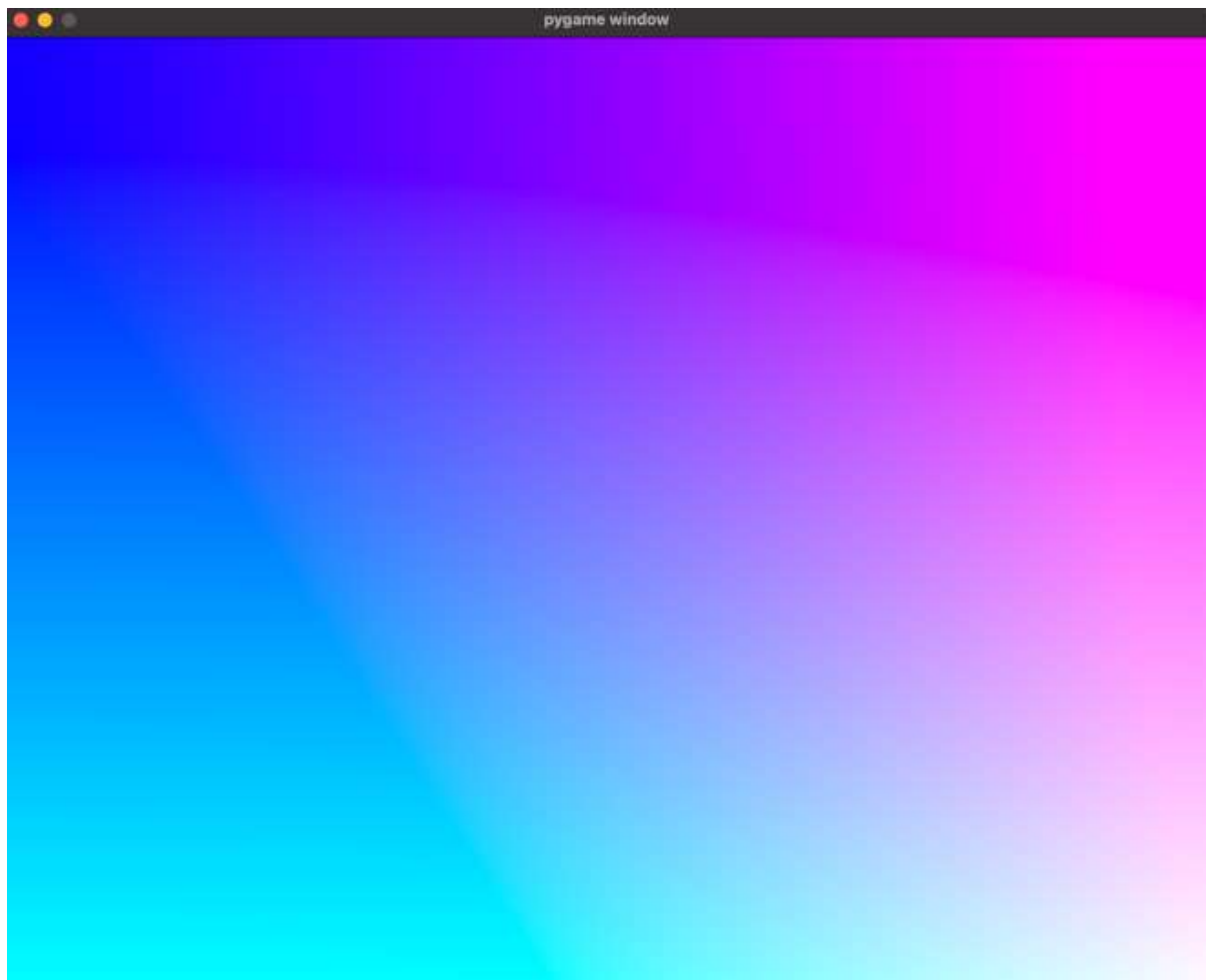
## Chapter 2: Let's Start Drawing

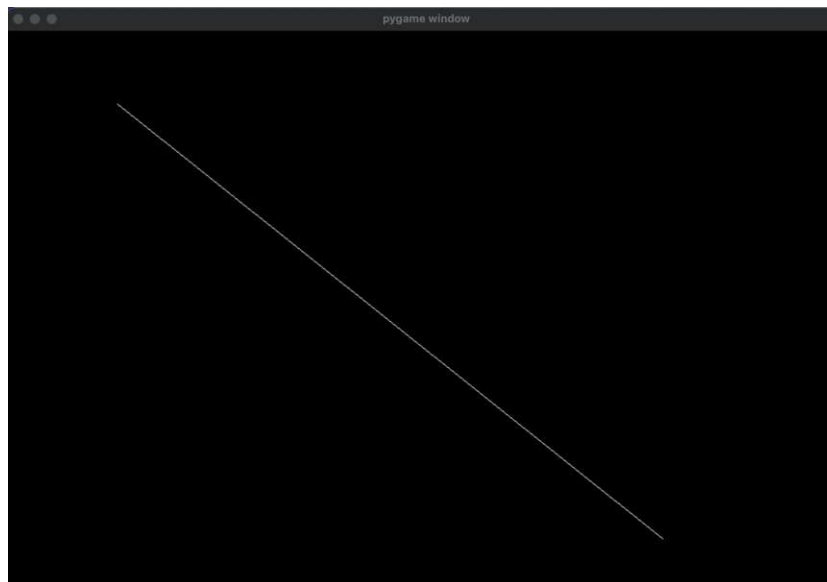
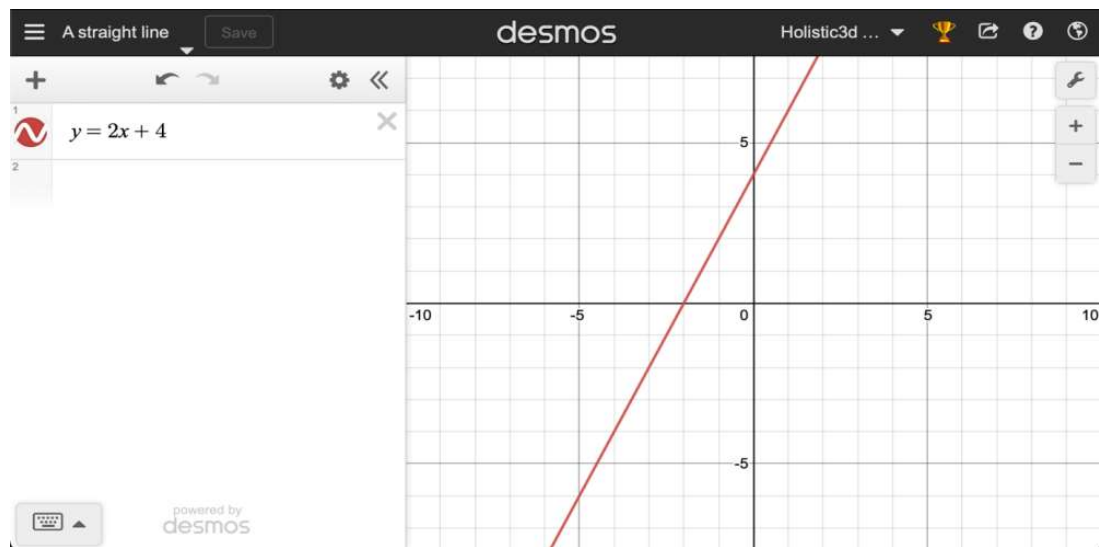


(a)



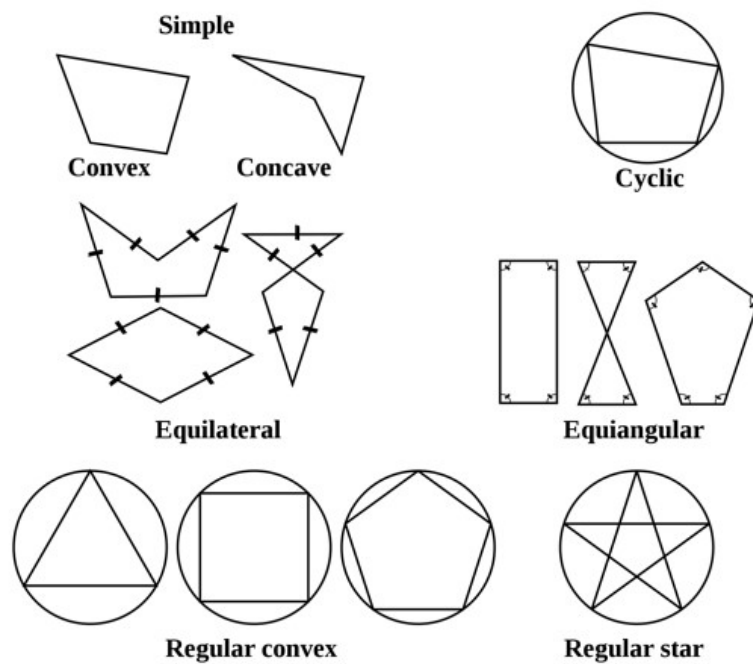
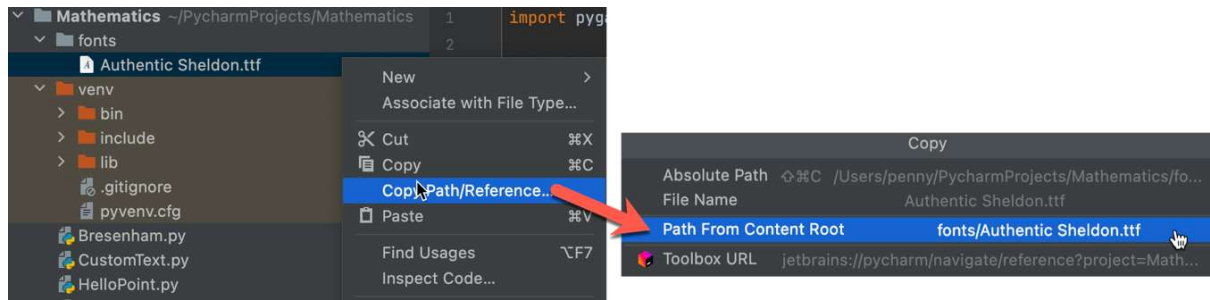
(b)

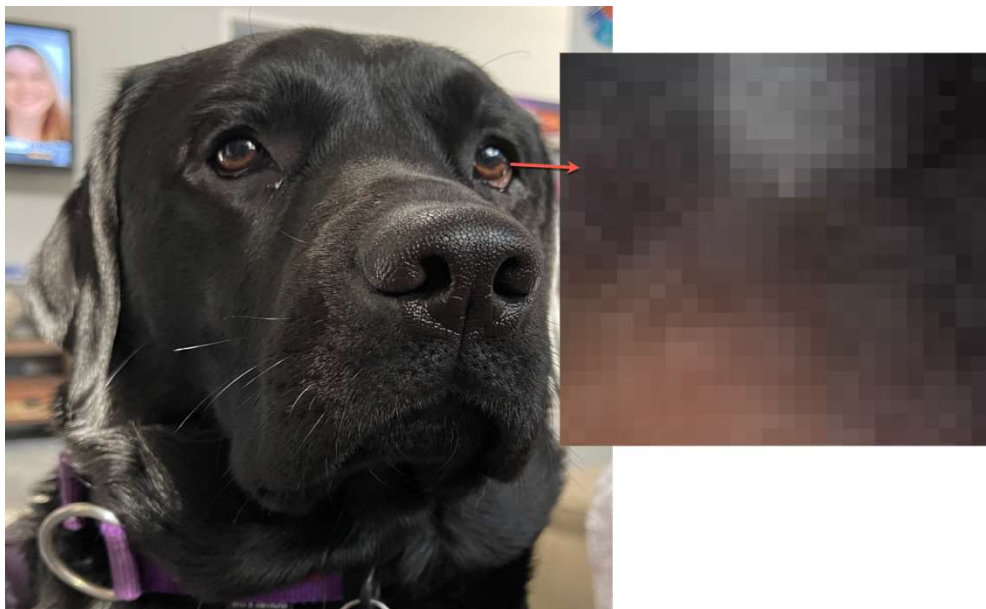
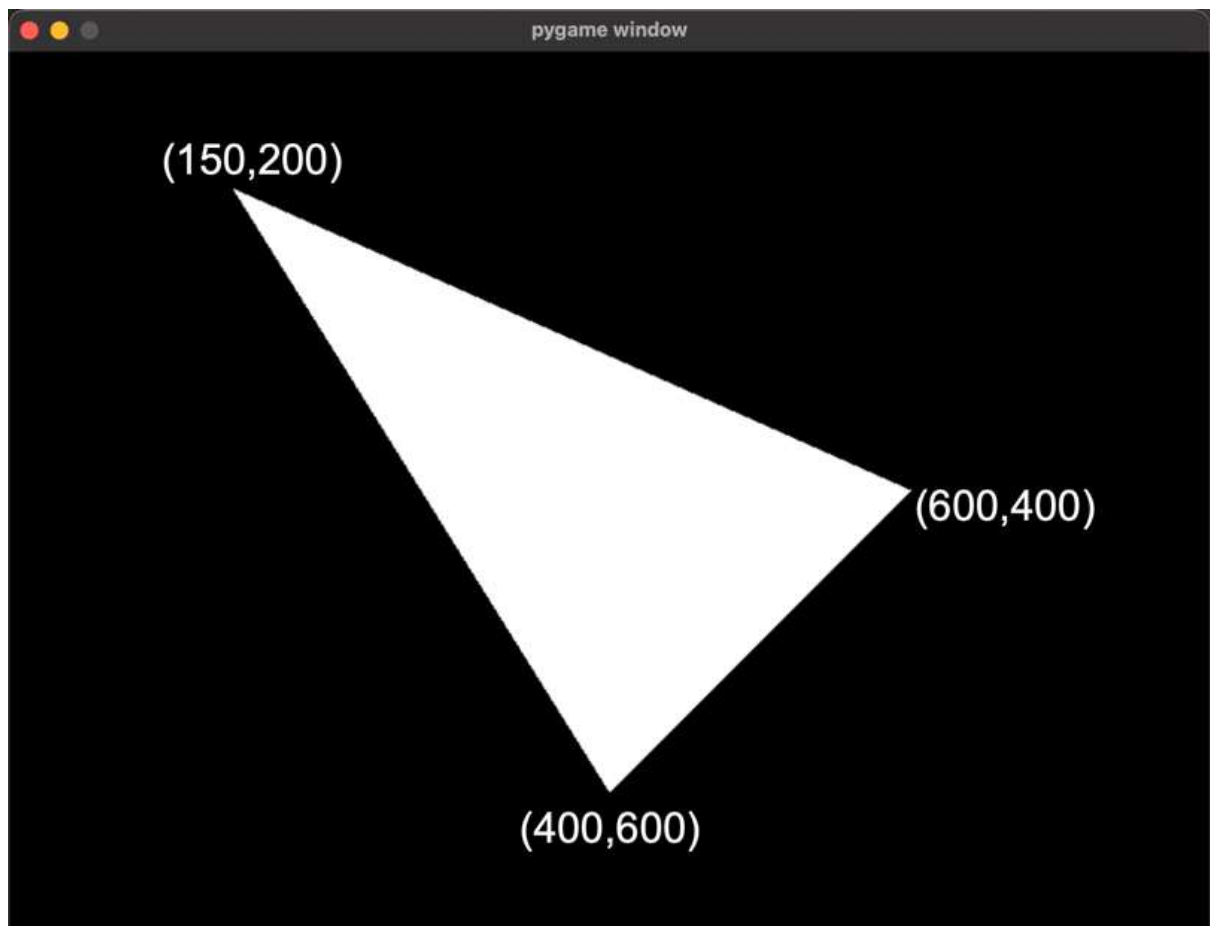




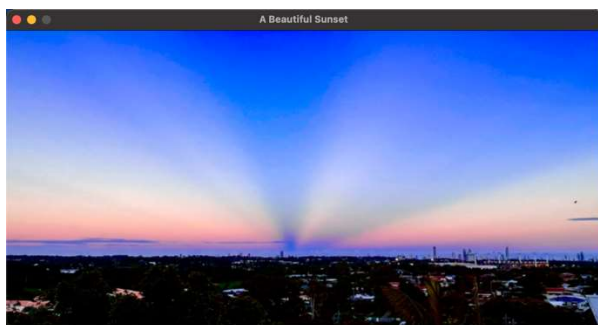
**A** Times New Roman  
is a serif font.

**A** Arial  
is a sans-serif font.

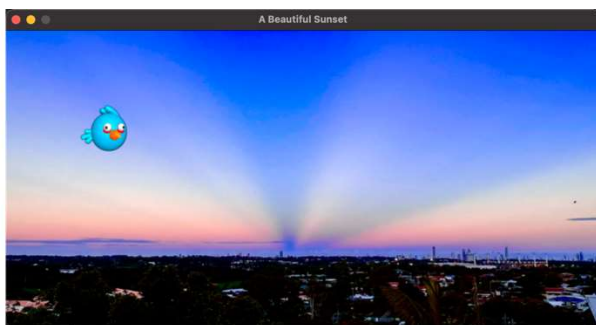






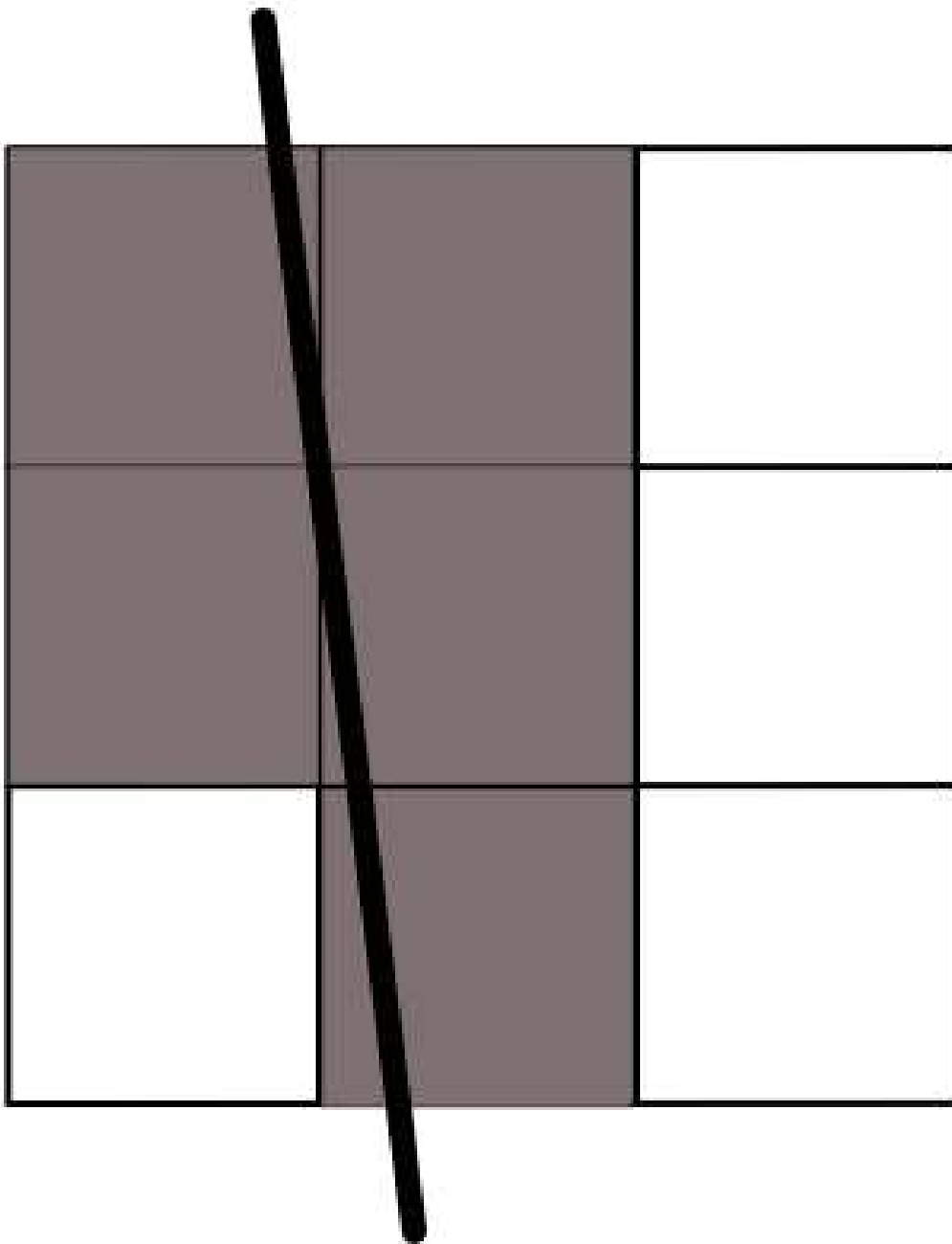


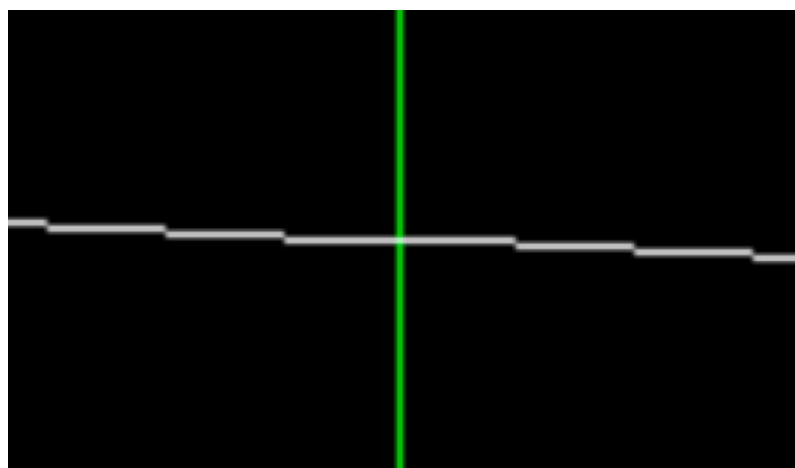
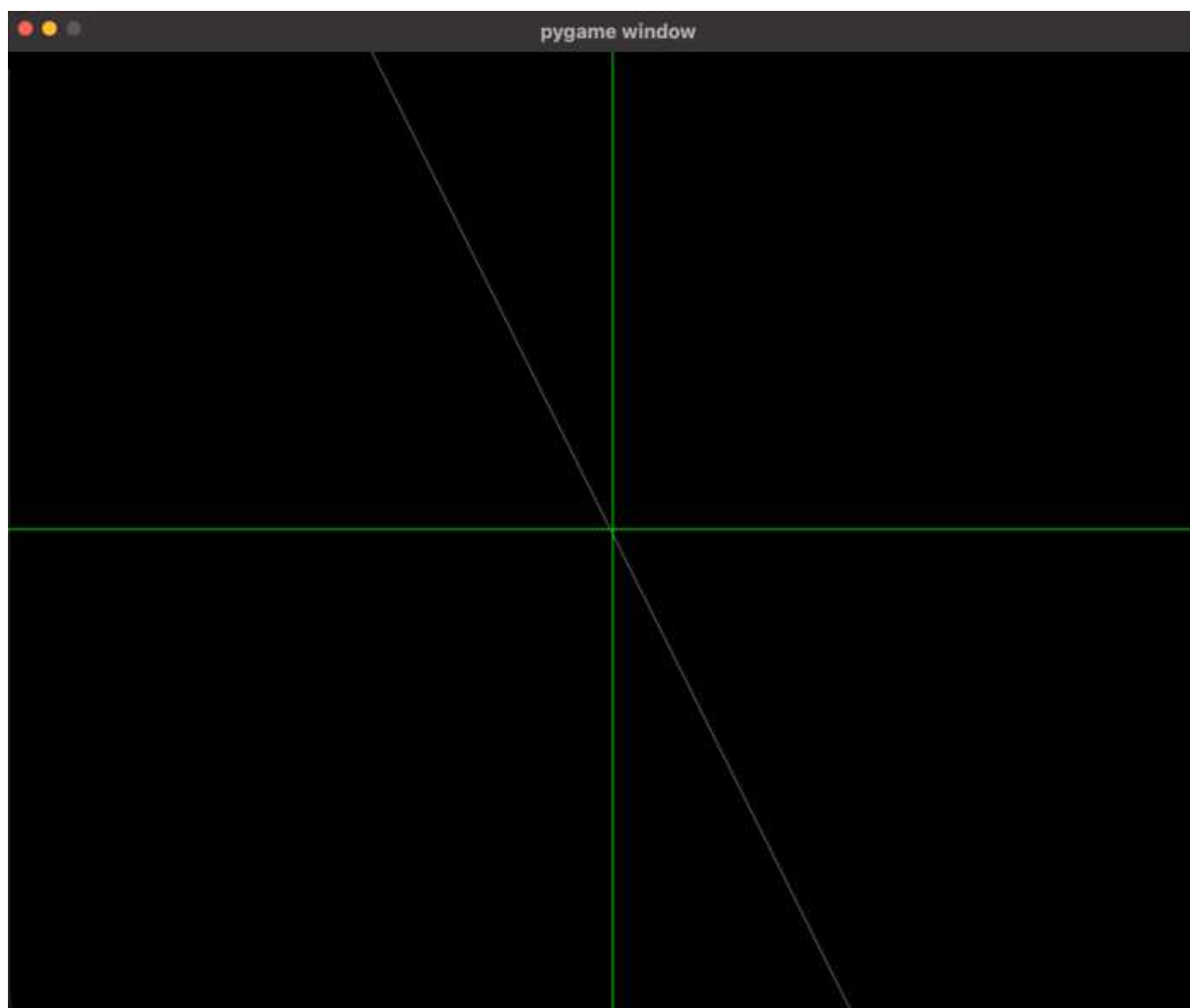
(a)



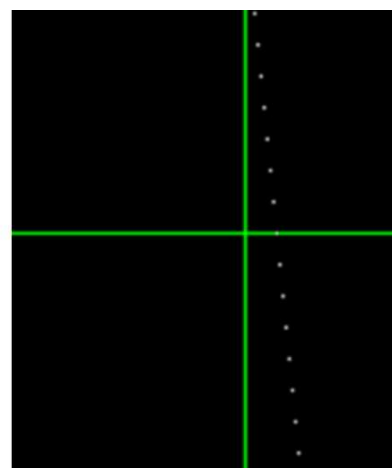
(b)

## Chapter 3: Line Plotting Pixel by Pixel

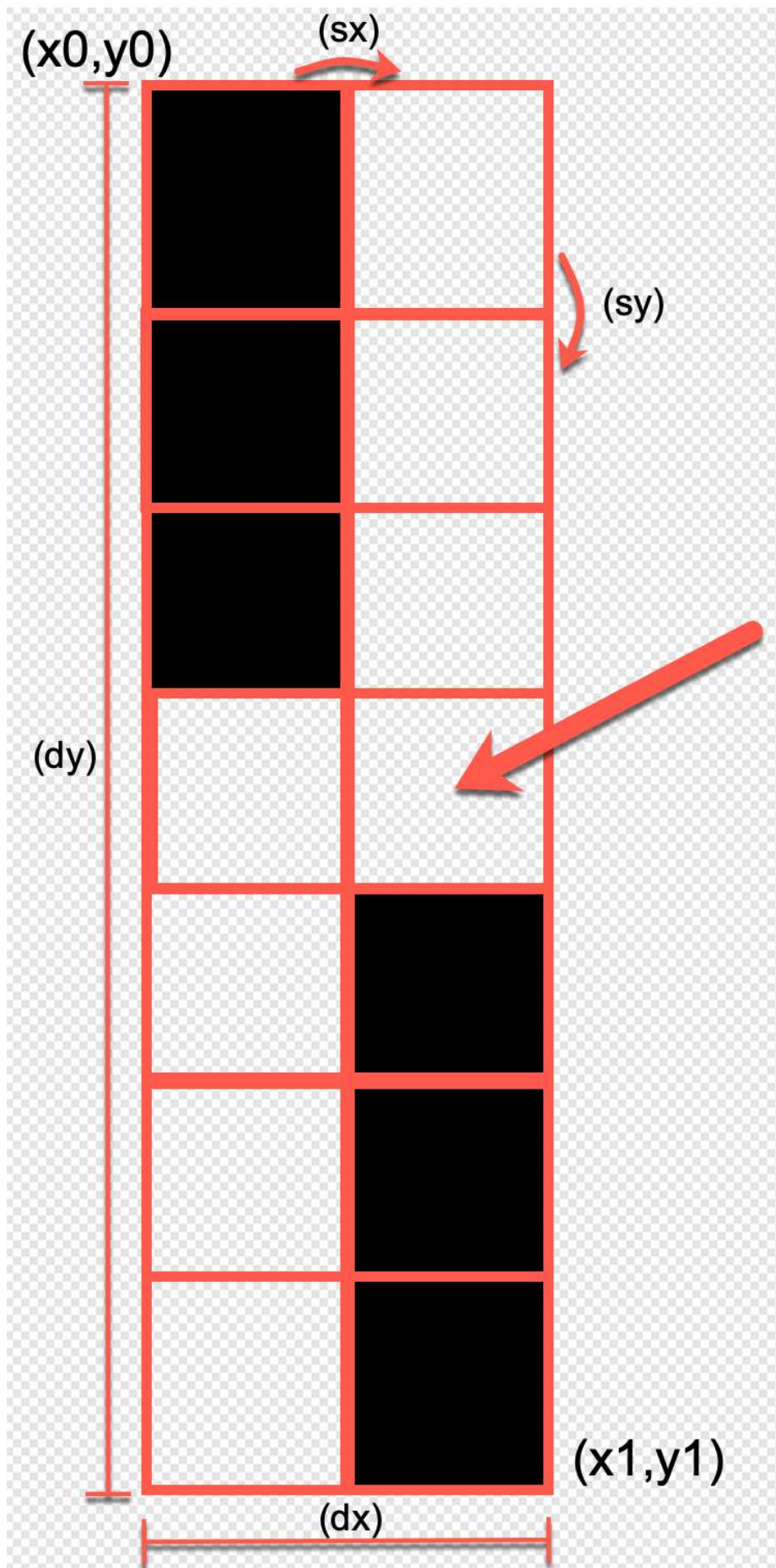


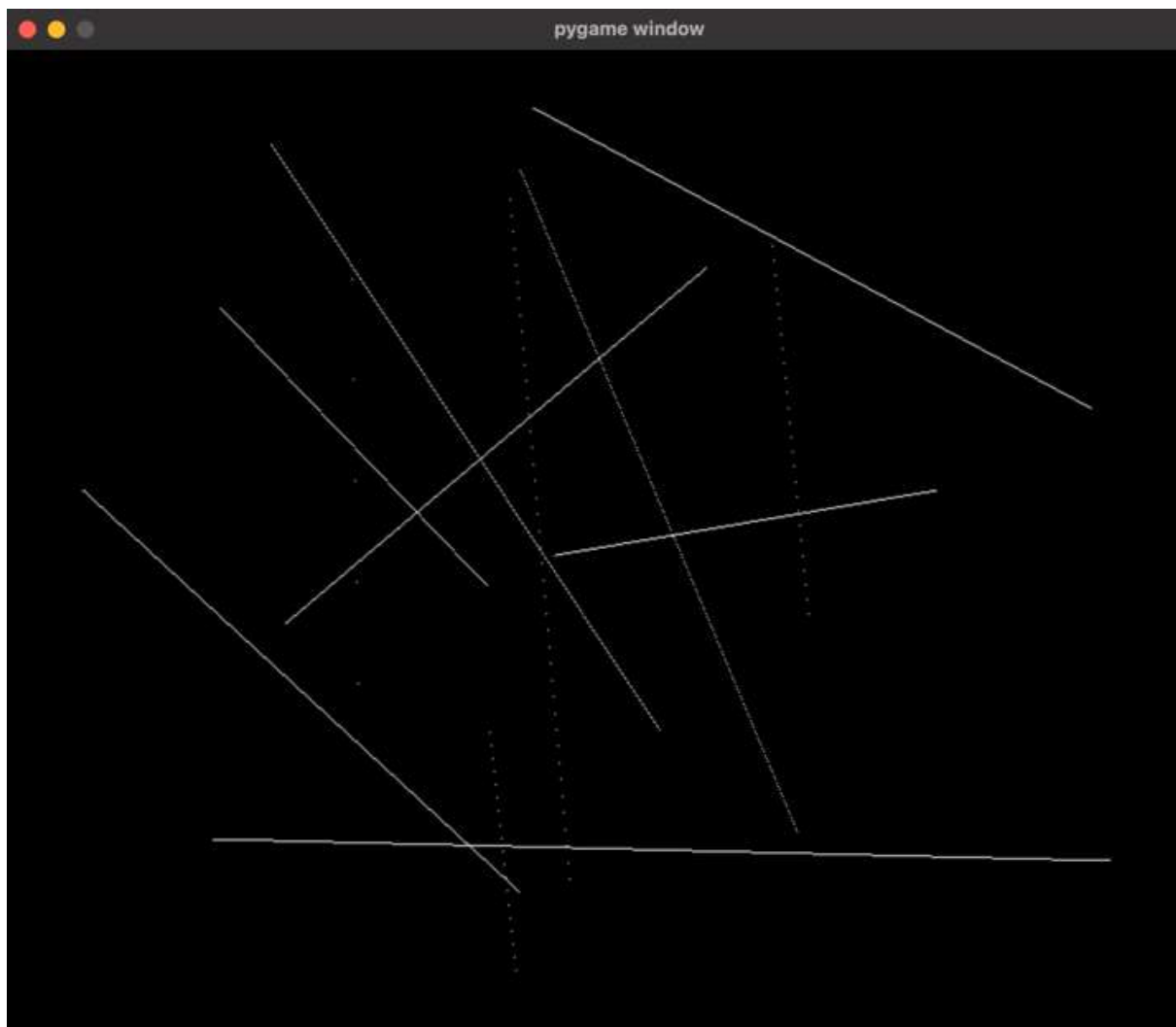


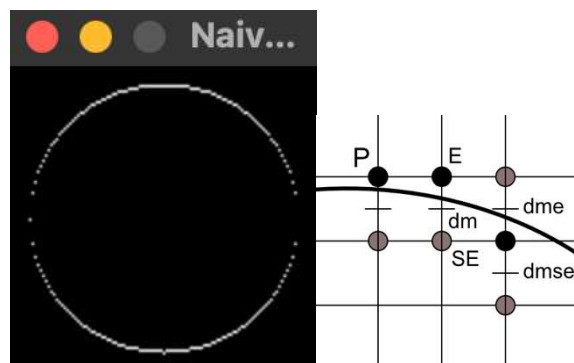
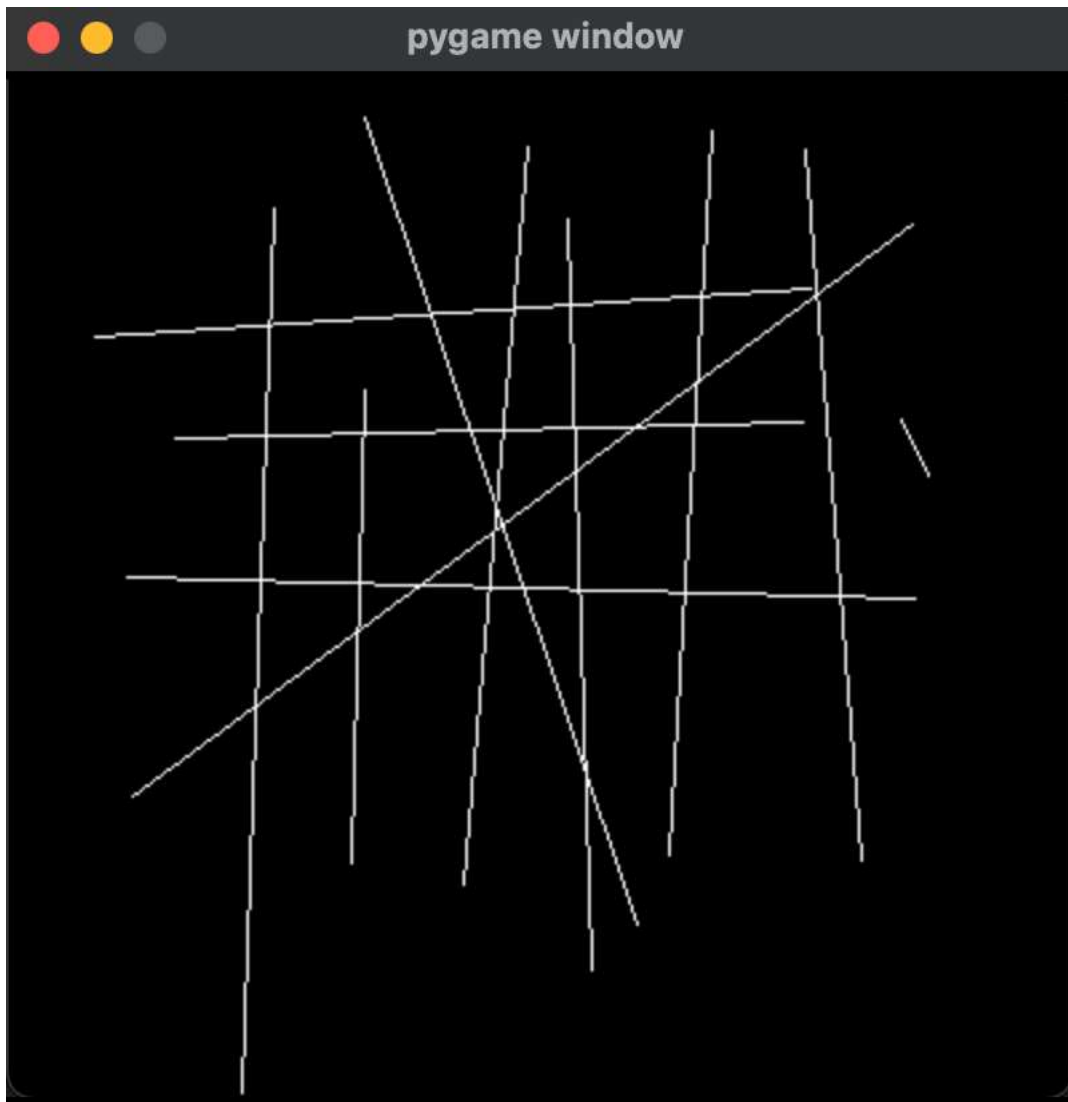
(a)



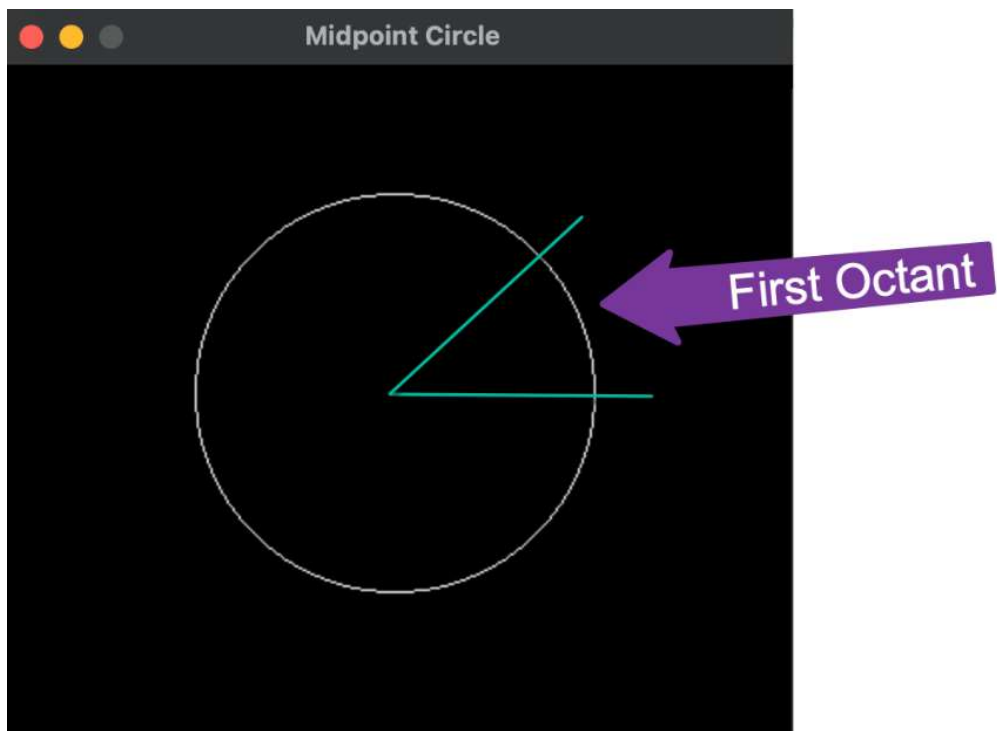
(b)

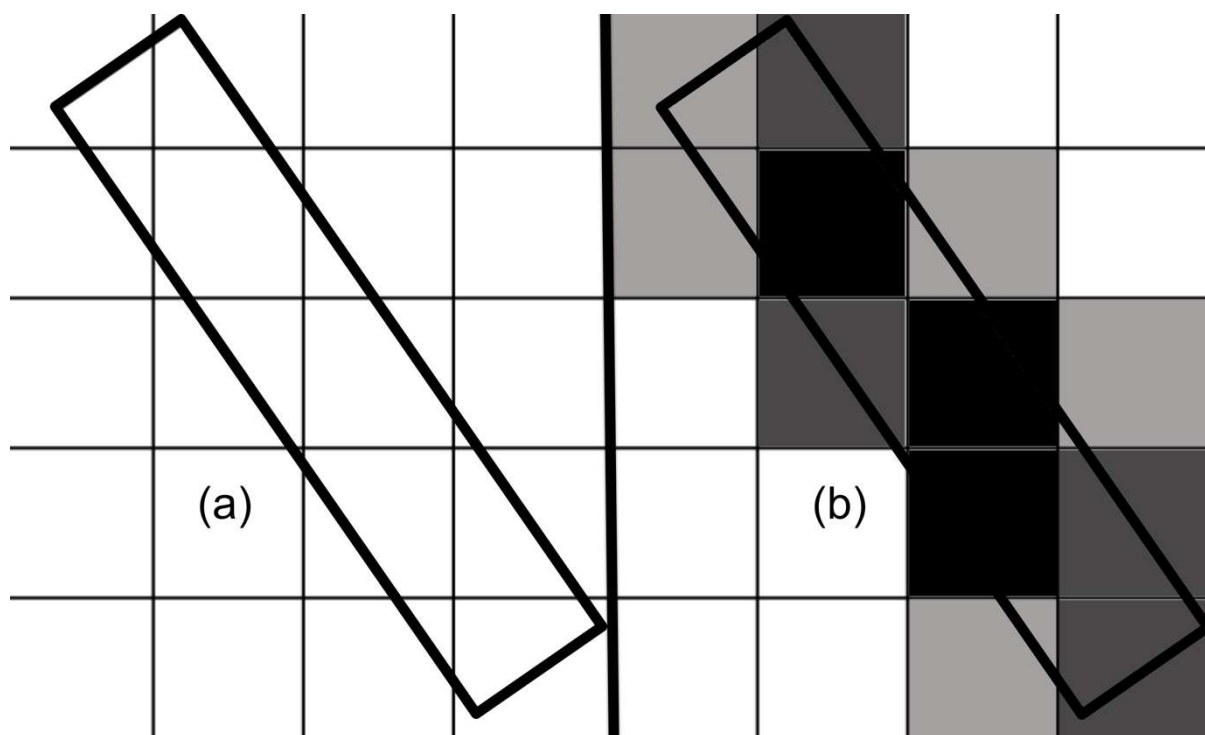
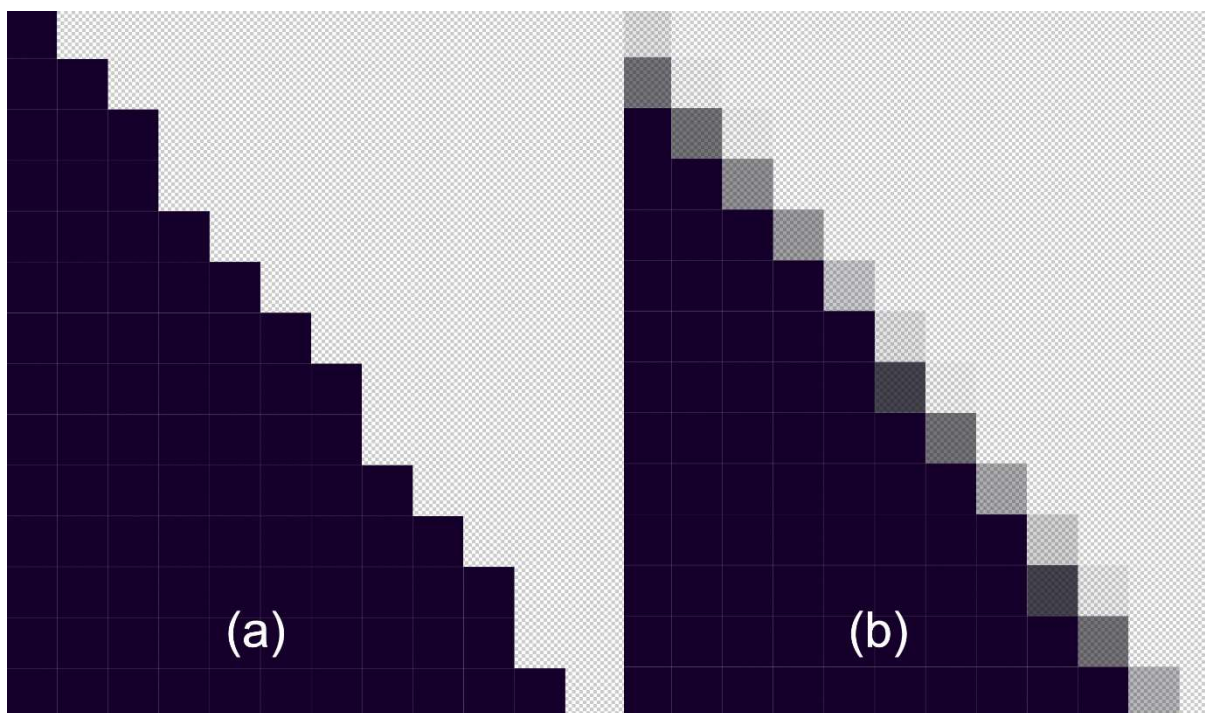




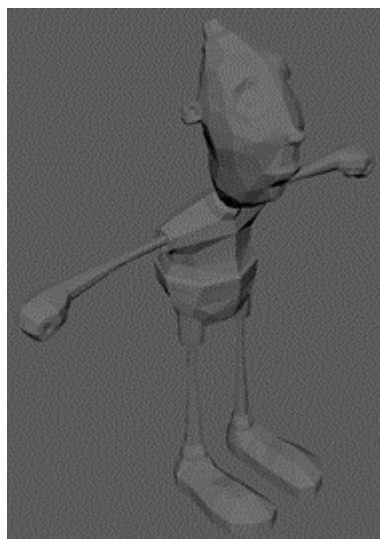
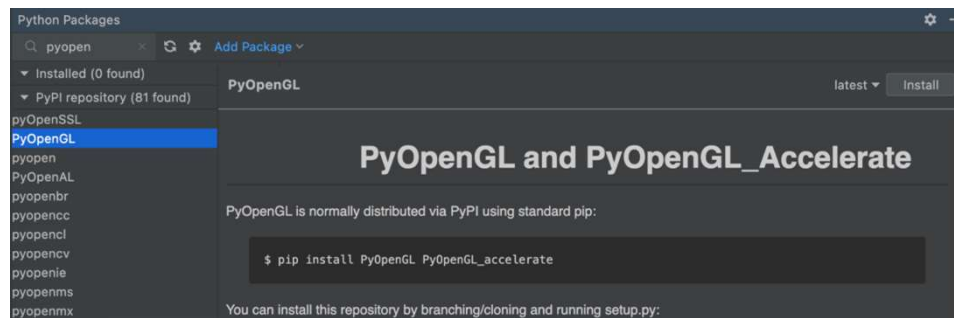
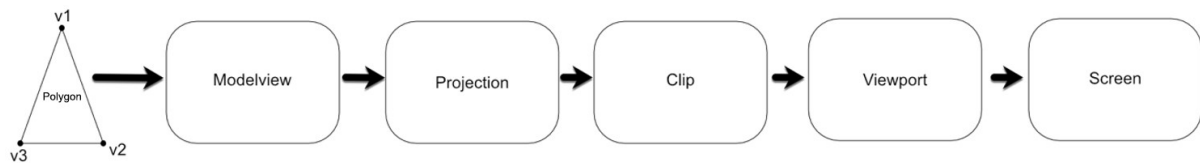
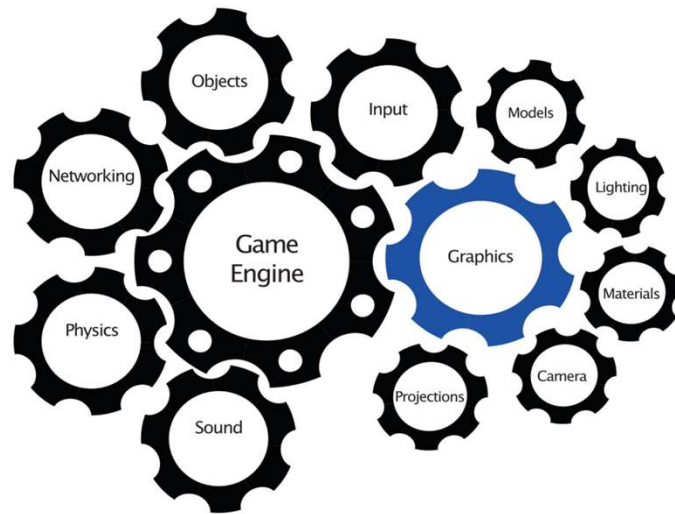


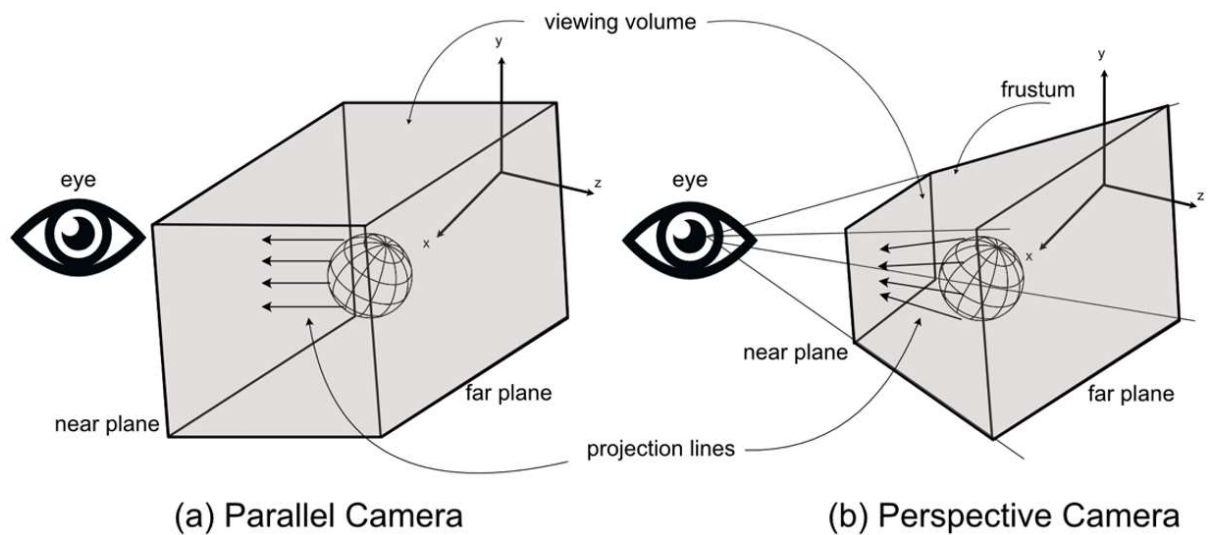
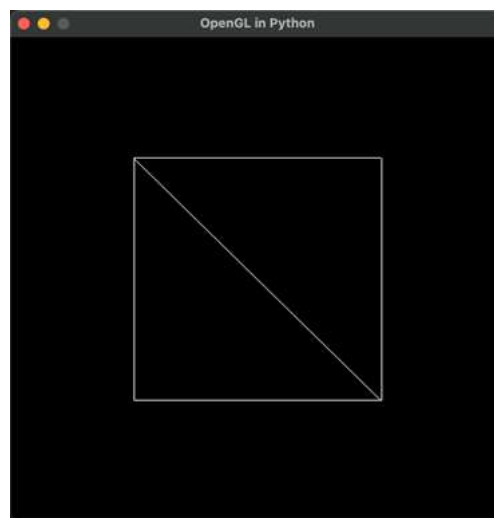
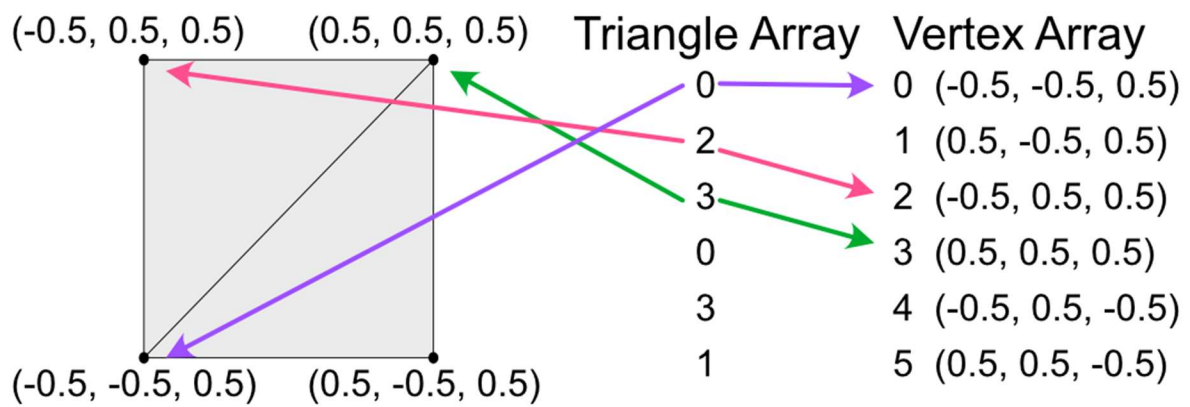


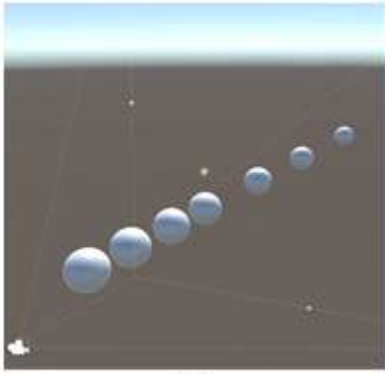




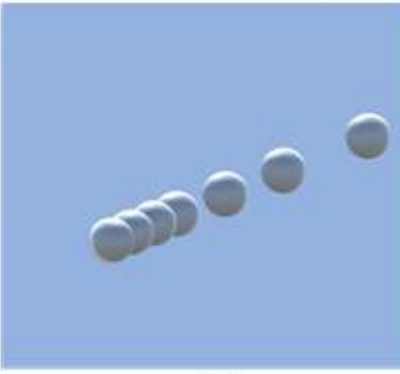
## Chapter 4: Graphics and Game Engine Components



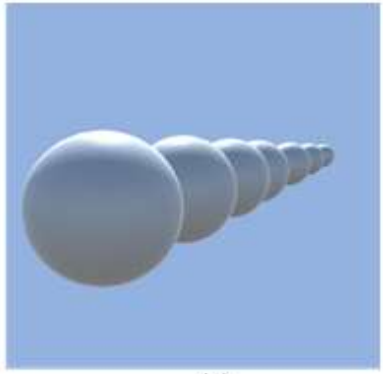




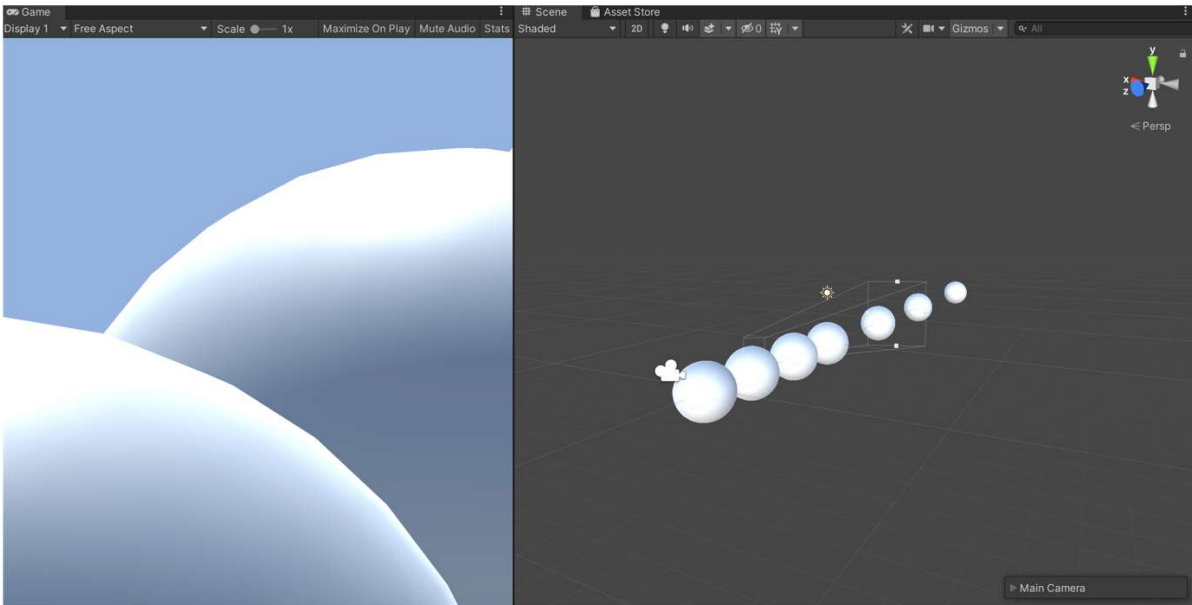
(a)



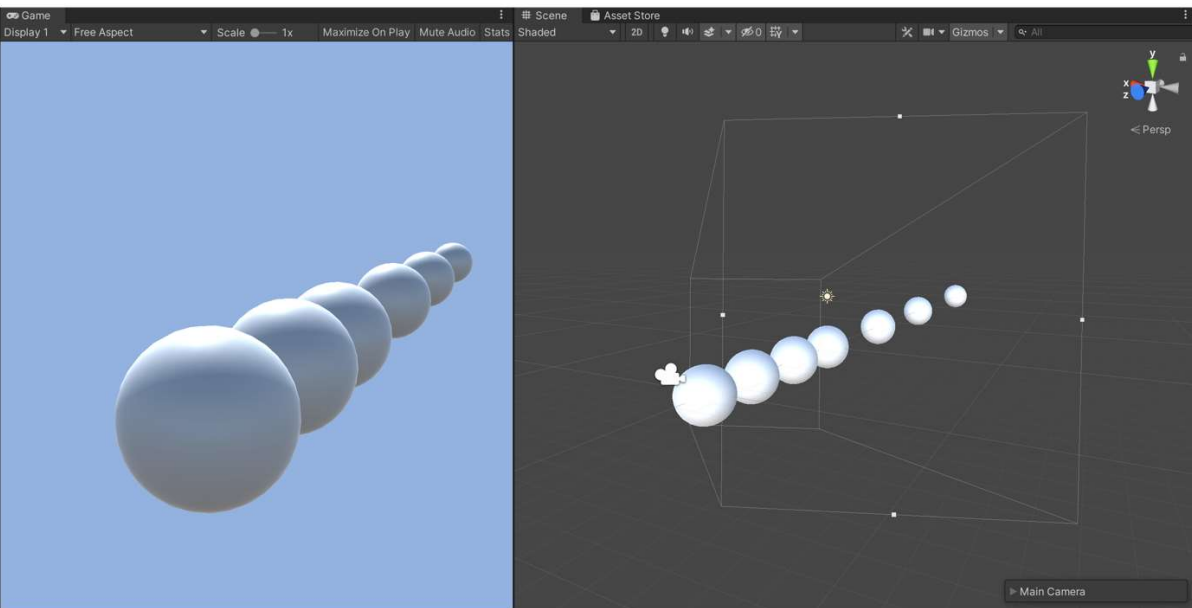
(b)



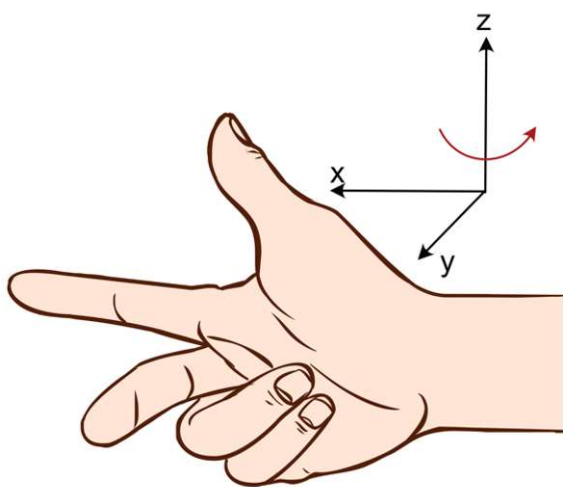
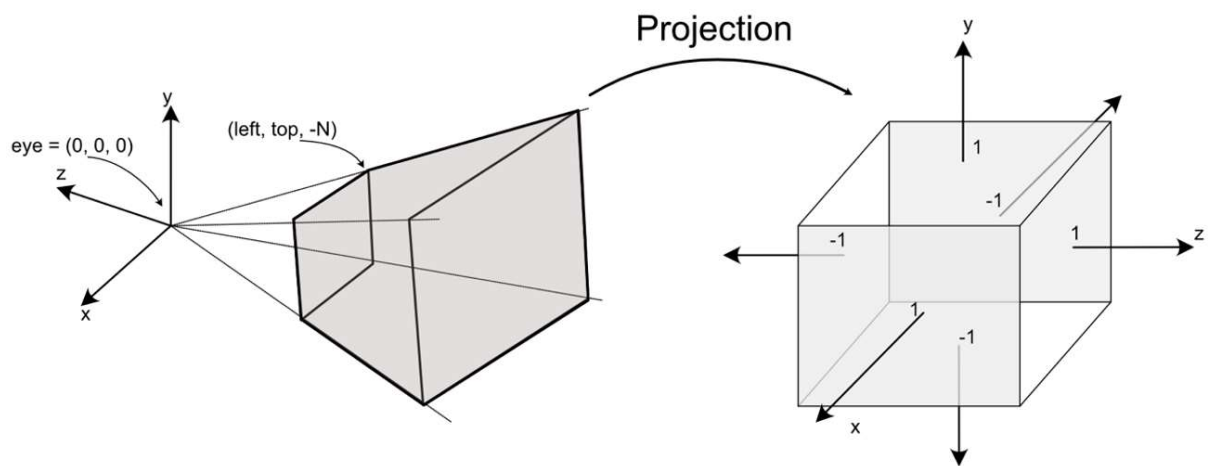
(c)



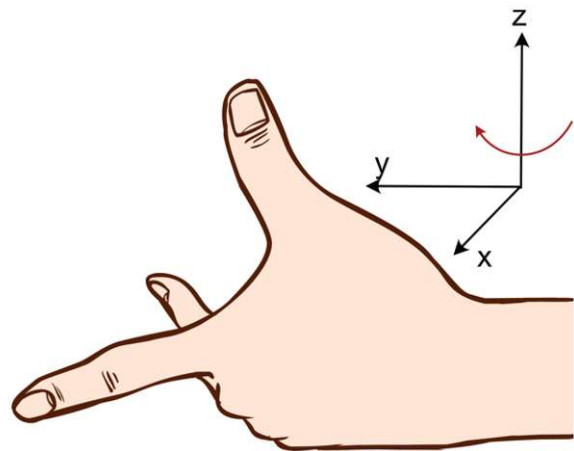
(a) Narrow Field of View



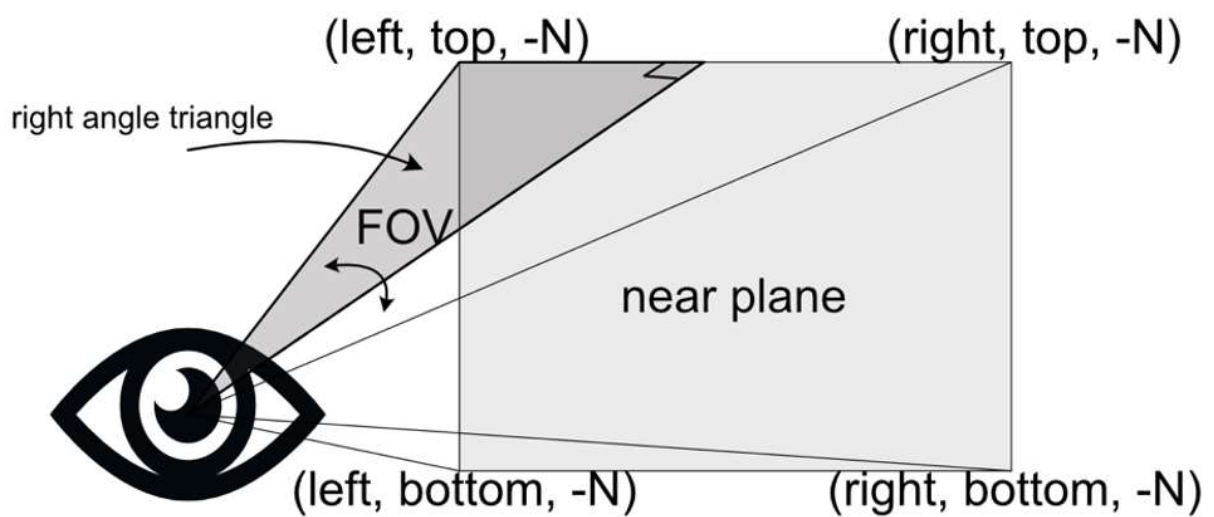
(b) Wide Field of View



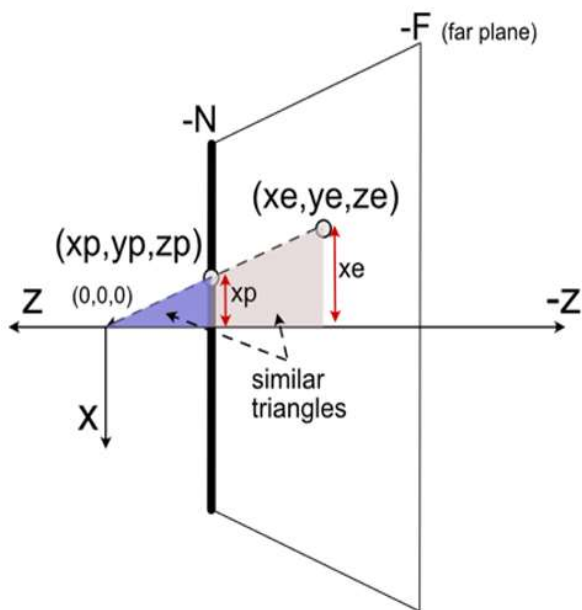
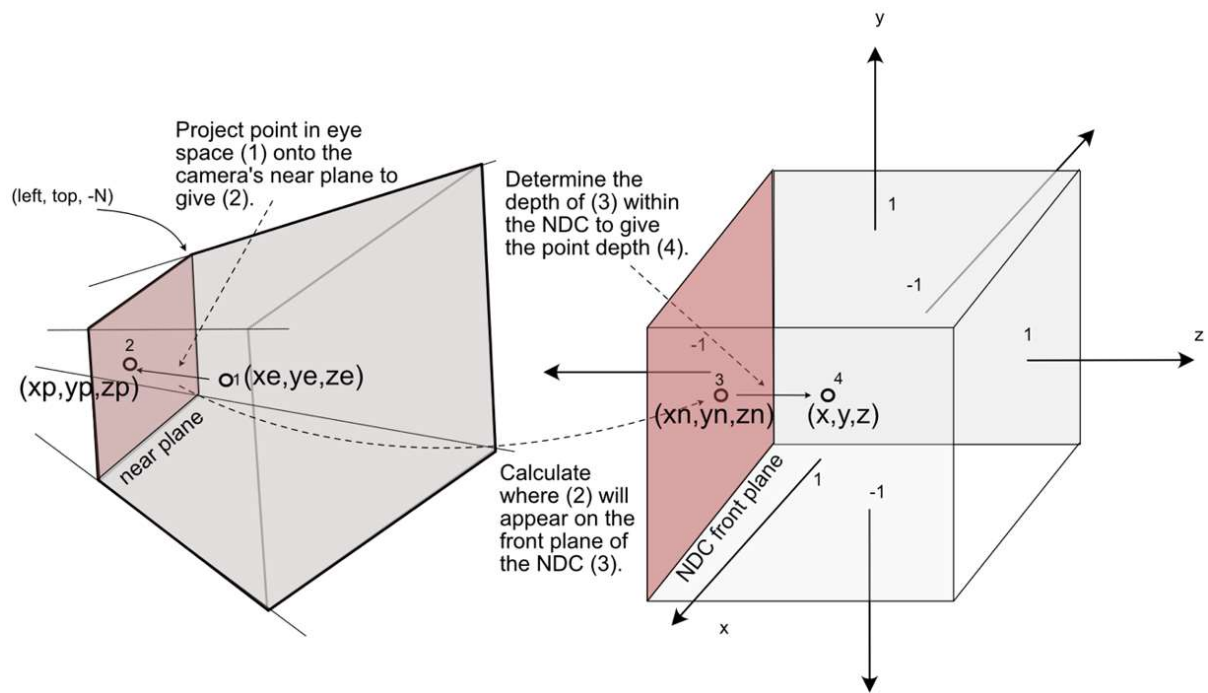
Right-Hand Rule



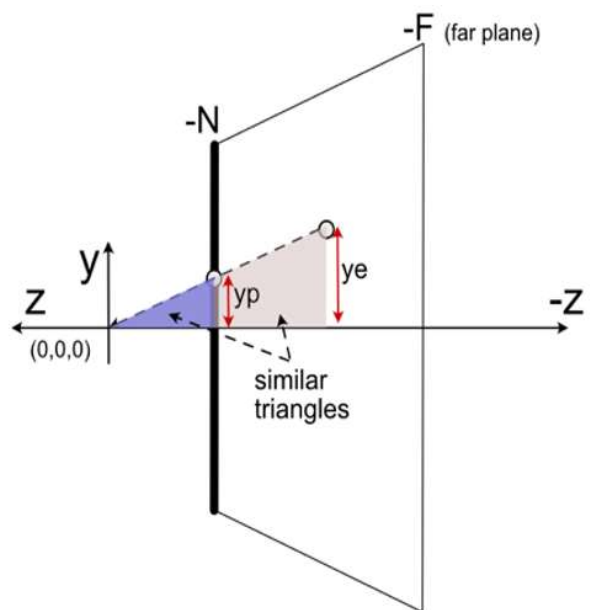
Left-Hand Rule



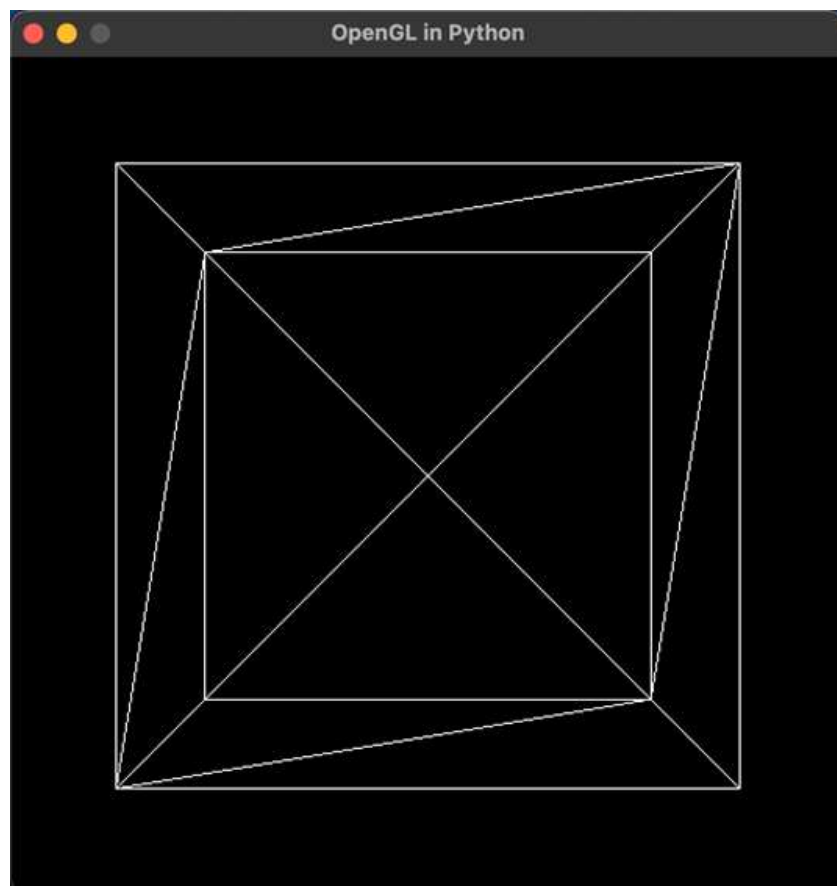
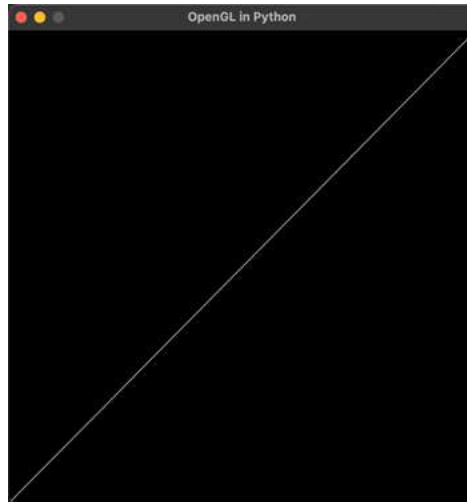
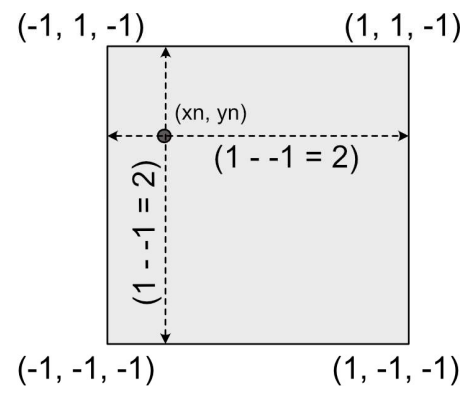
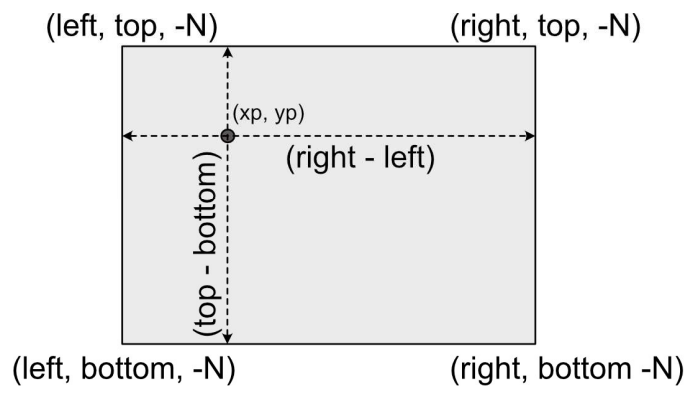


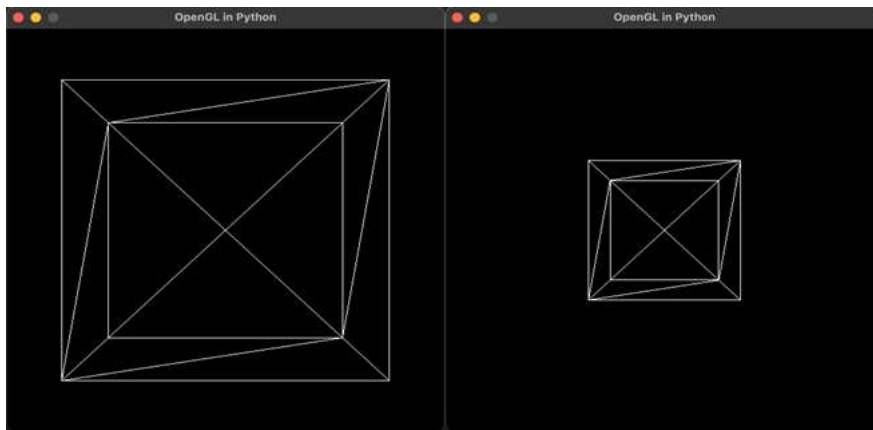


Top View



Side View

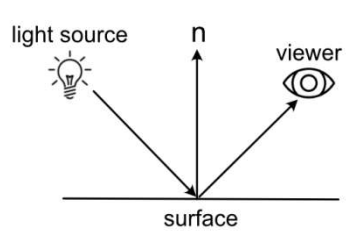




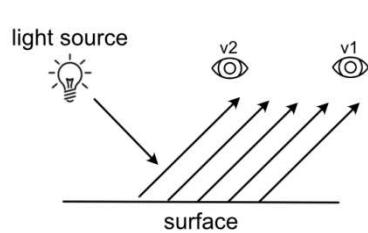
FOV = 30

FOV = 60

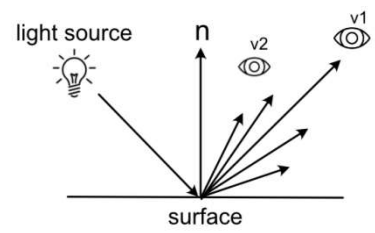
## Chapter 5: Let's Light it Up!



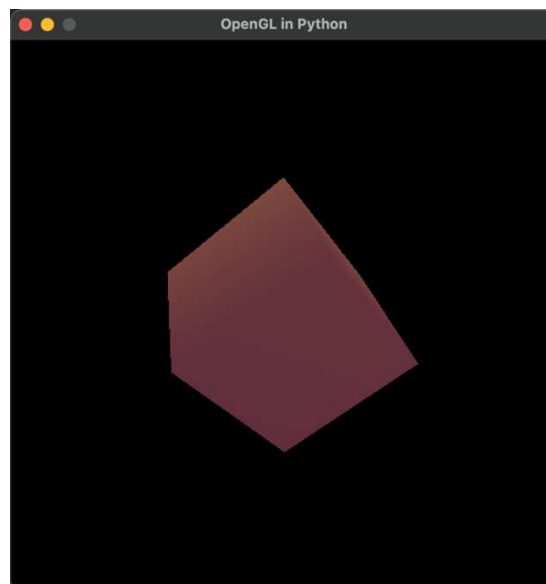
(a) Directions Involved Light Calculations

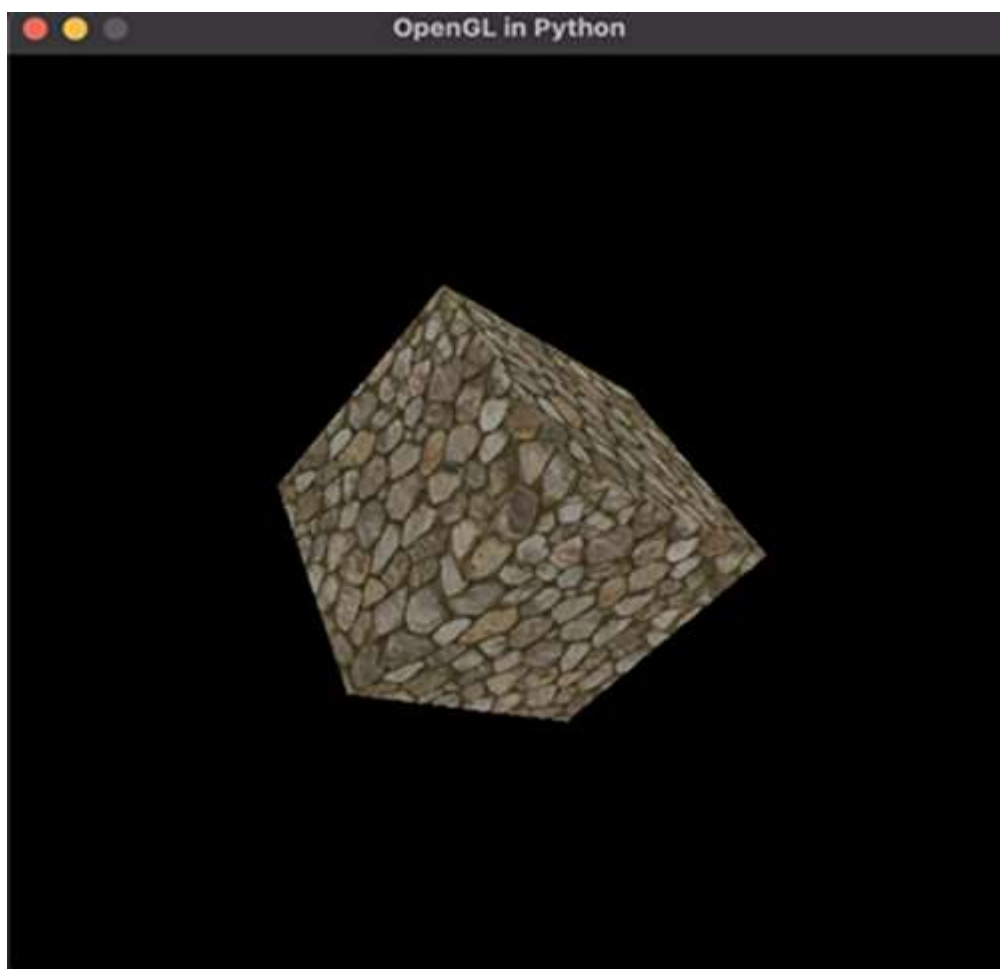
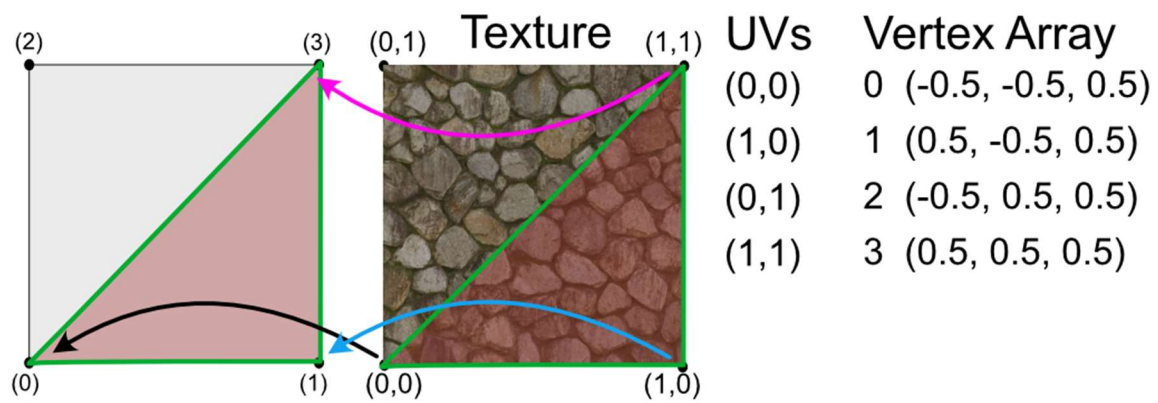


(b) Diffuse Scattering

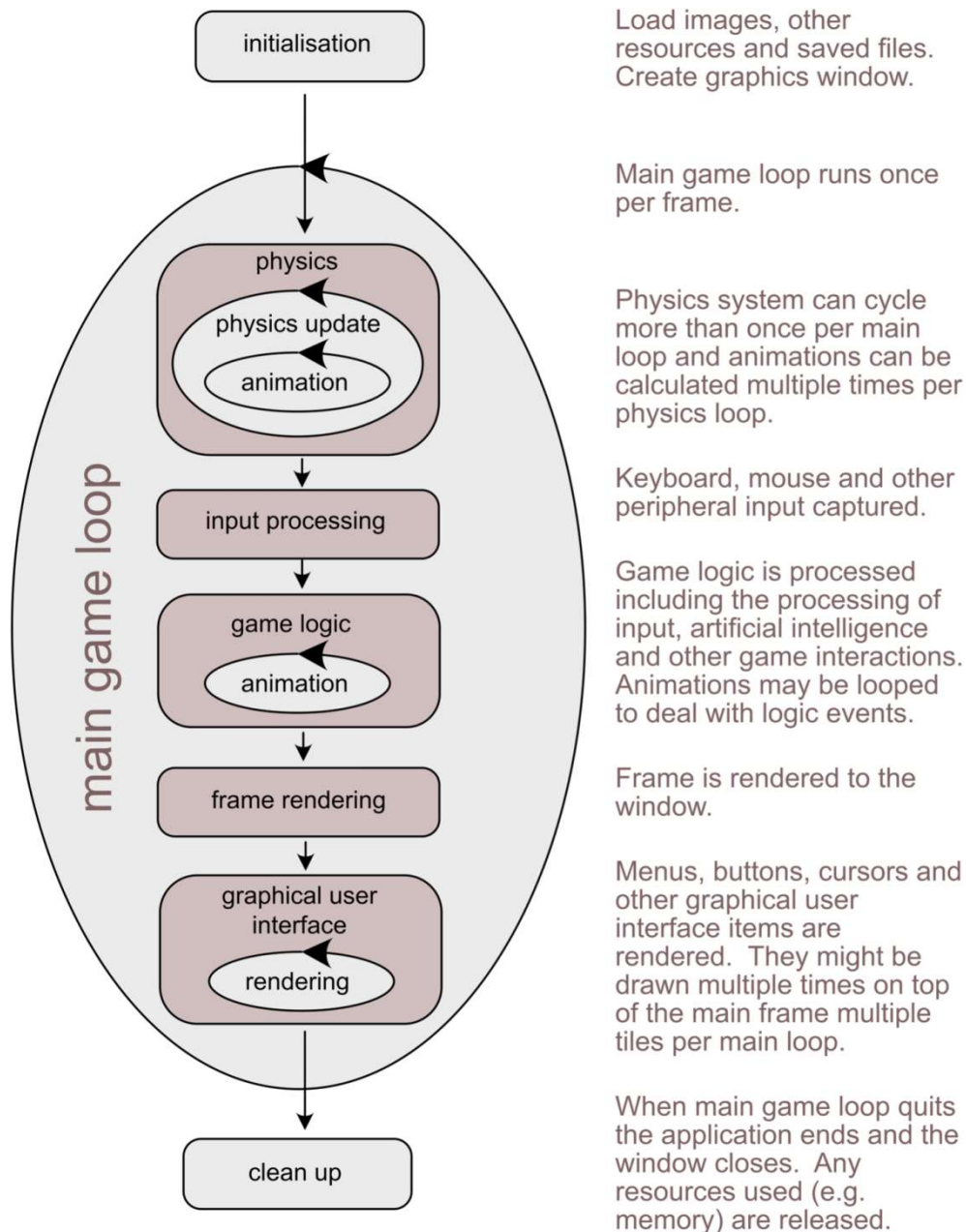


(c) Specular Reflection

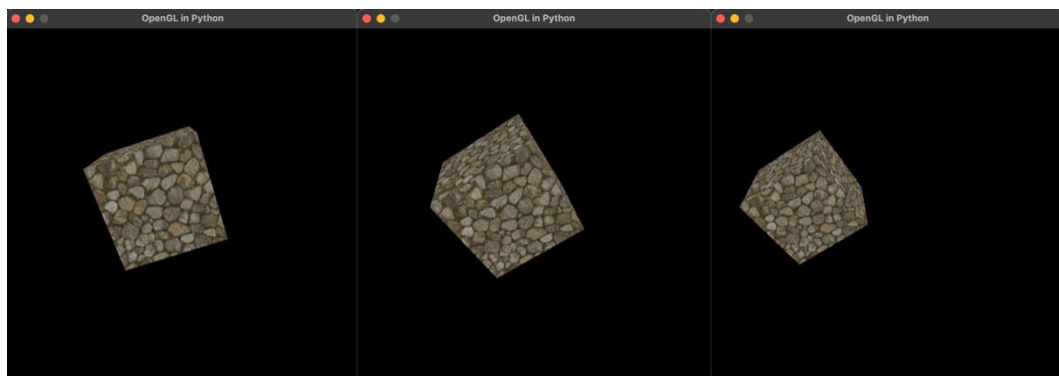
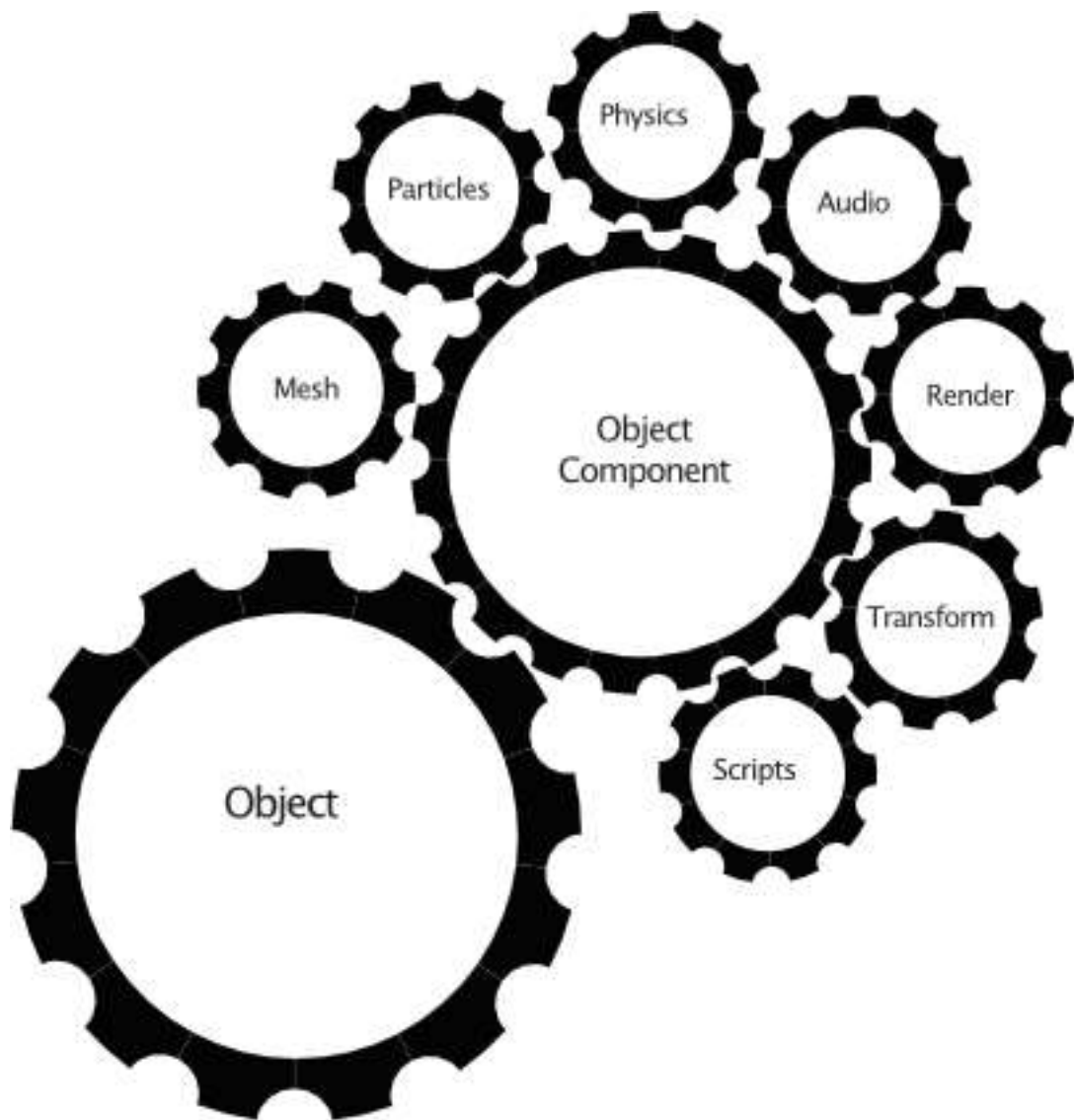


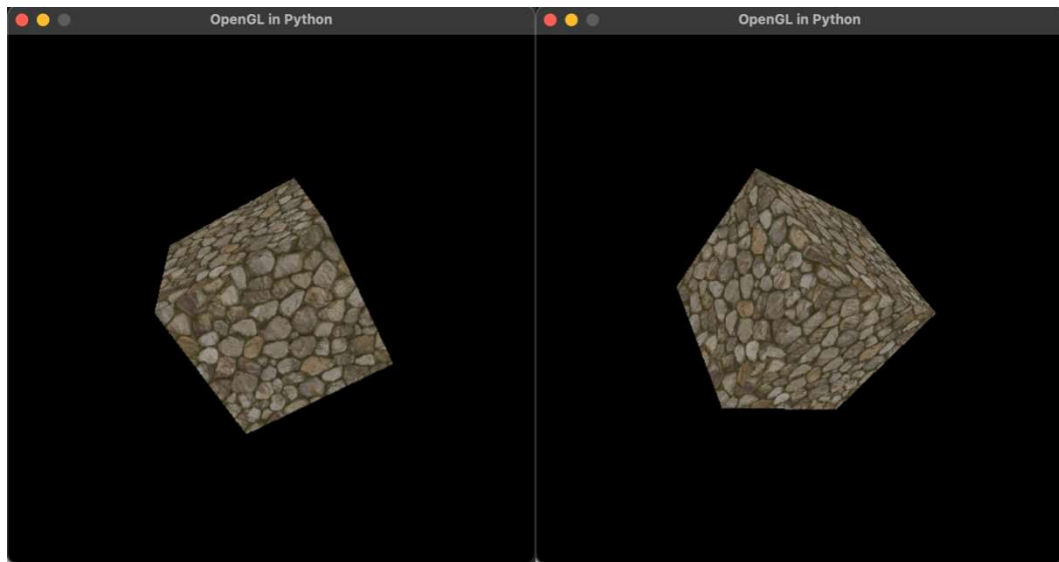


## Chapter 6: Updating and Drawing the Graphics Environment



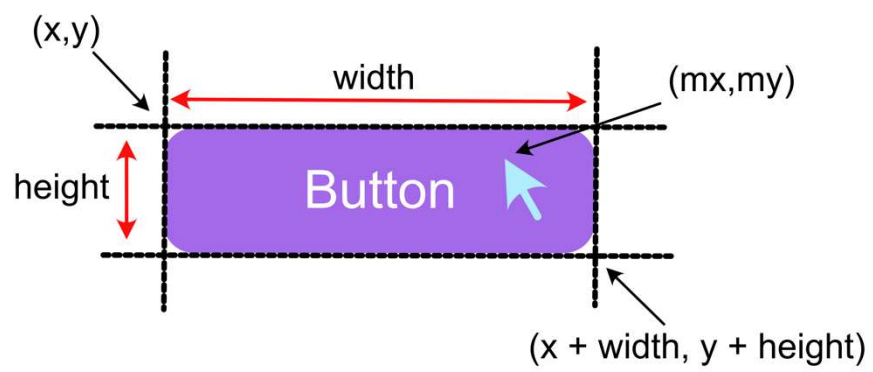
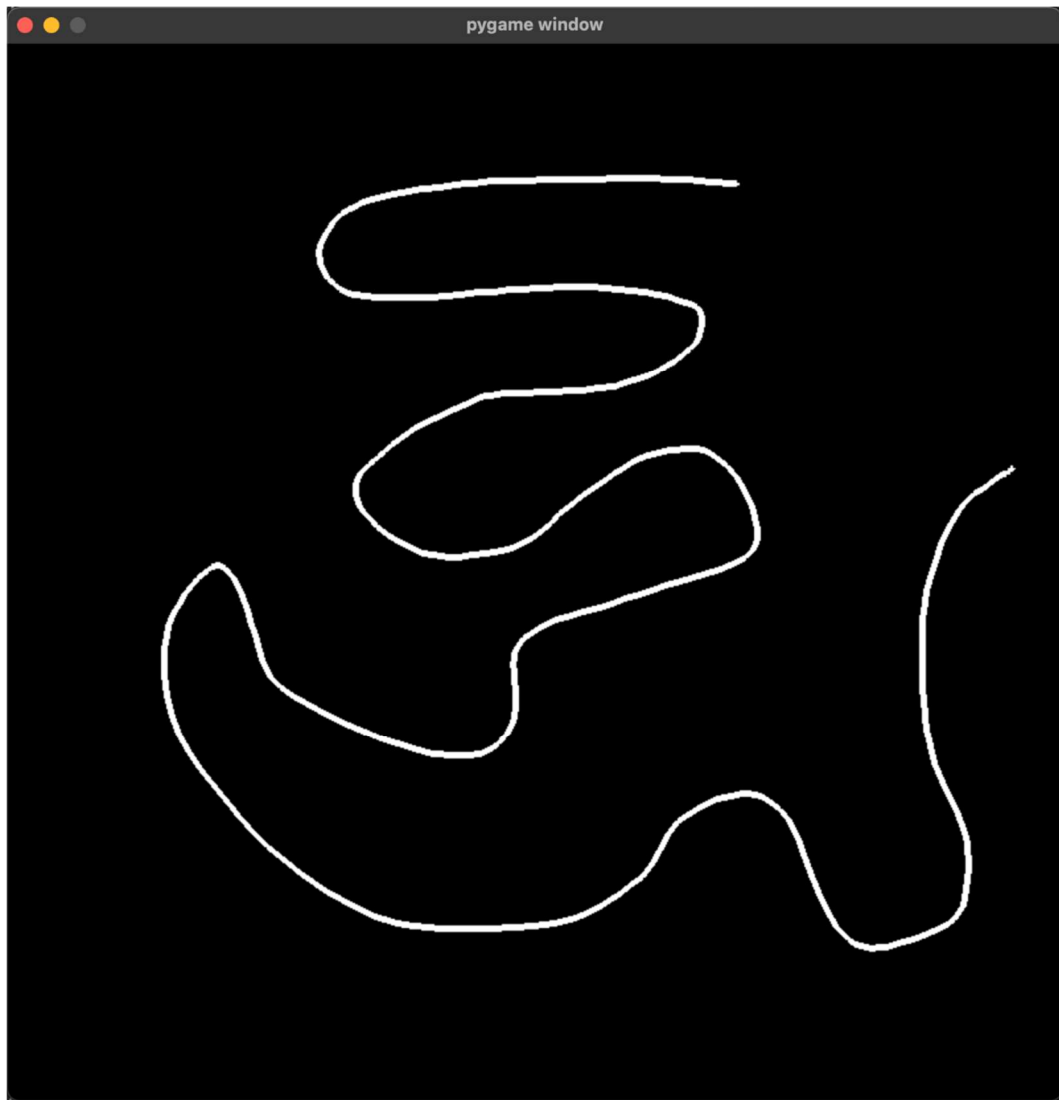


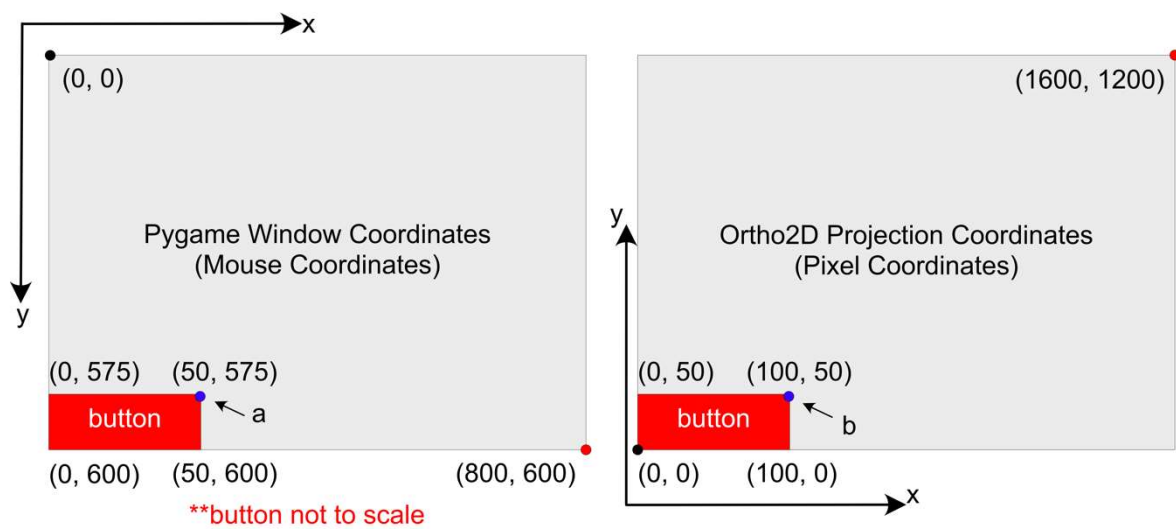
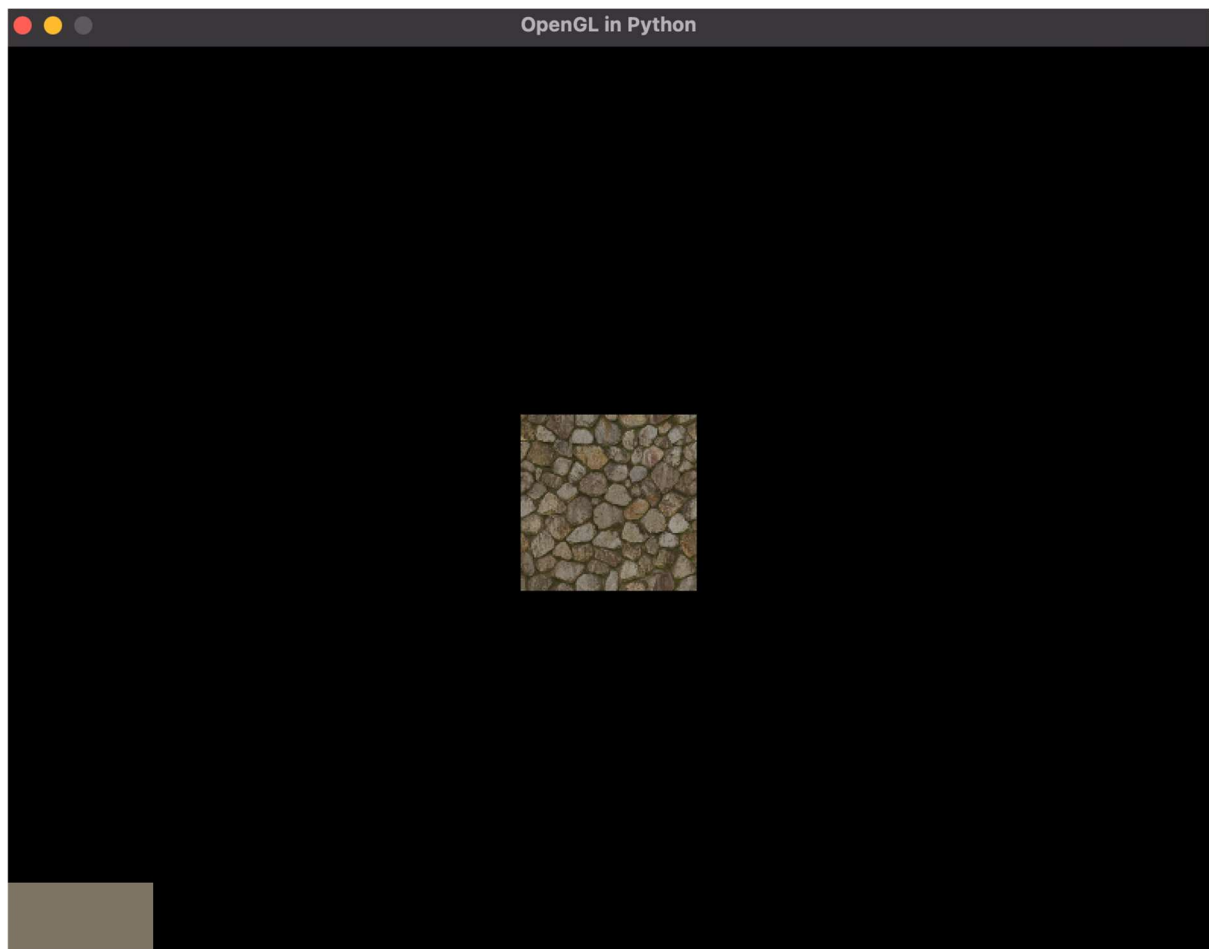




## Chapter 7: Interactions with the Keyboard and Mouse for Dynamic Graphics Programs



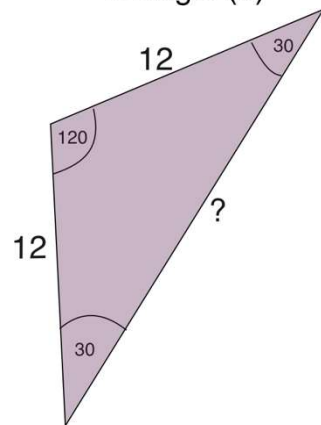
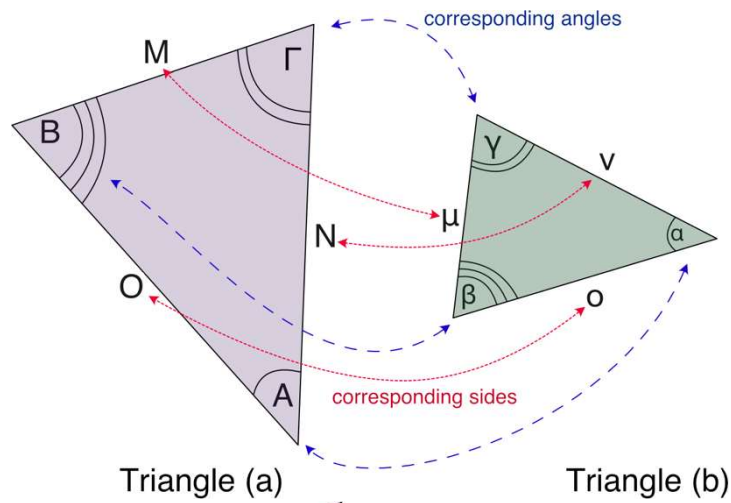




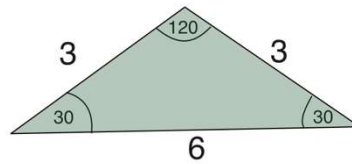
$$\frac{a.x}{\text{mouse window width}} = \frac{b.x}{\text{ortho2d window width}}$$

$$\frac{a.y}{\text{mouse window height}} = \frac{b.y}{\text{ortho2d window height}}$$

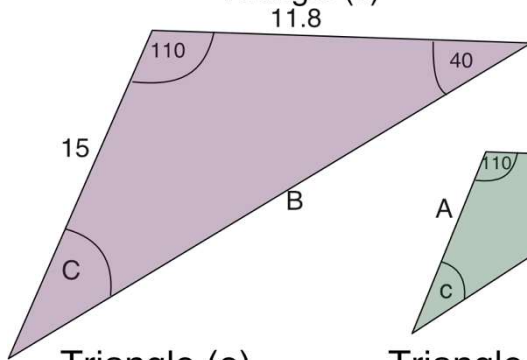
## Chapter 8: Reviewing Our Knowledge of Triangles



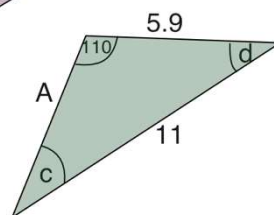
Triangle (c)



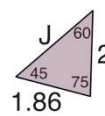
Triangle (d)



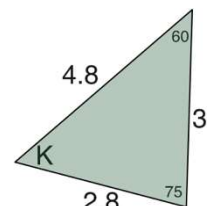
Triangle (e)



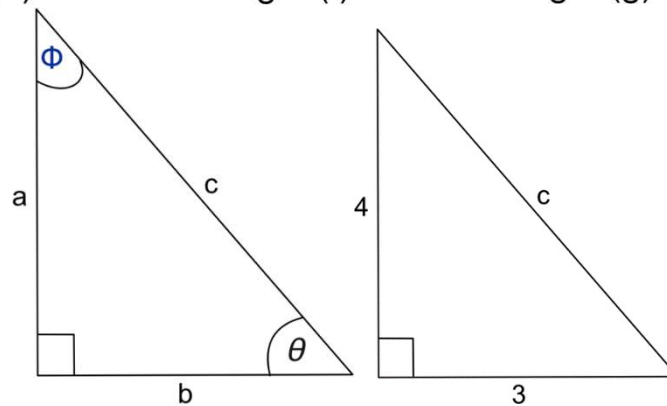
Triangle (f)

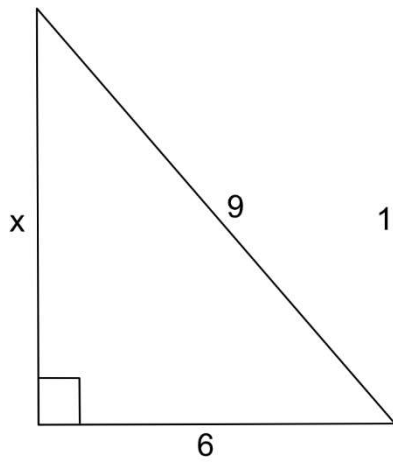


Triangle (g)

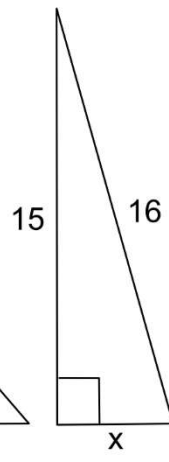


Triangle (h)

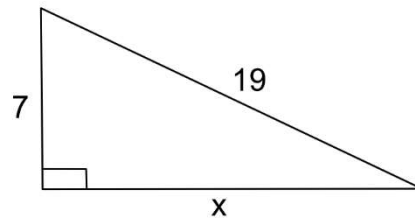




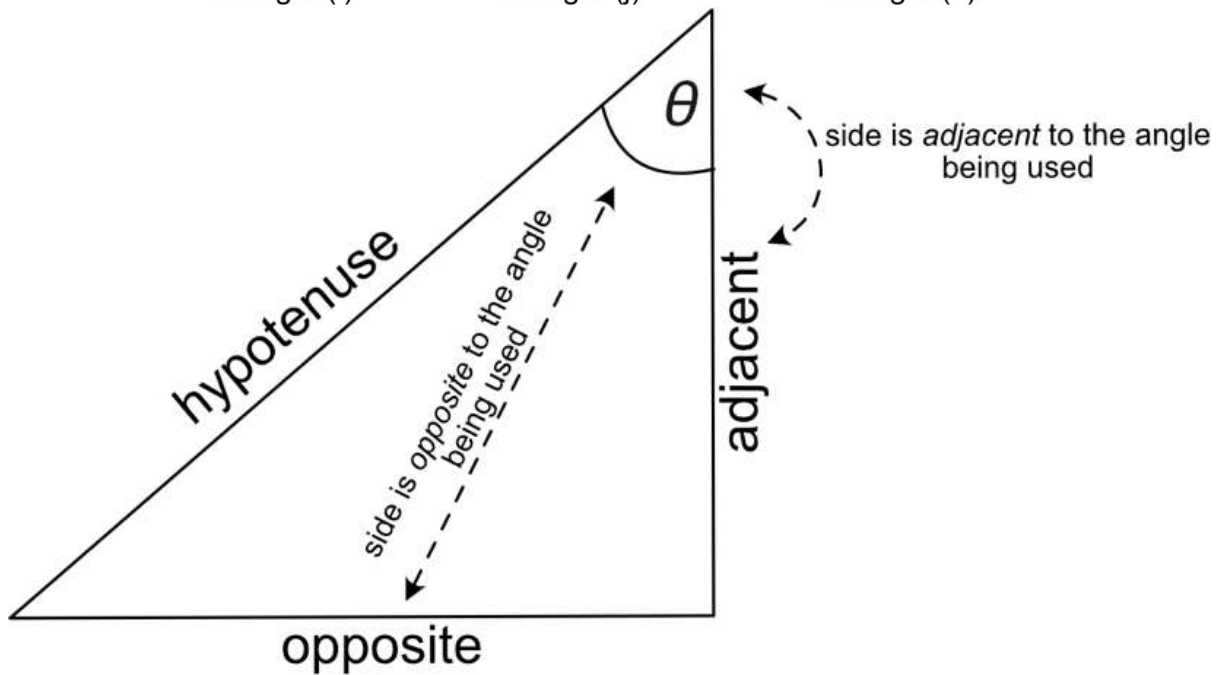
Triangle (i)



Triangle (j)



Triangle (k)



Google

arctan(0.75) in degrees



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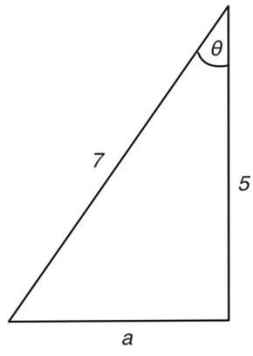
Tools

About 108,000 results (0.32 seconds)

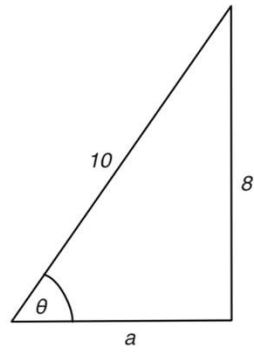
arctan(0.75) =

36.8698976 degrees

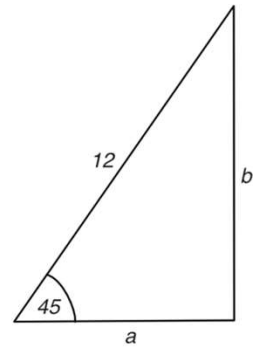
More info



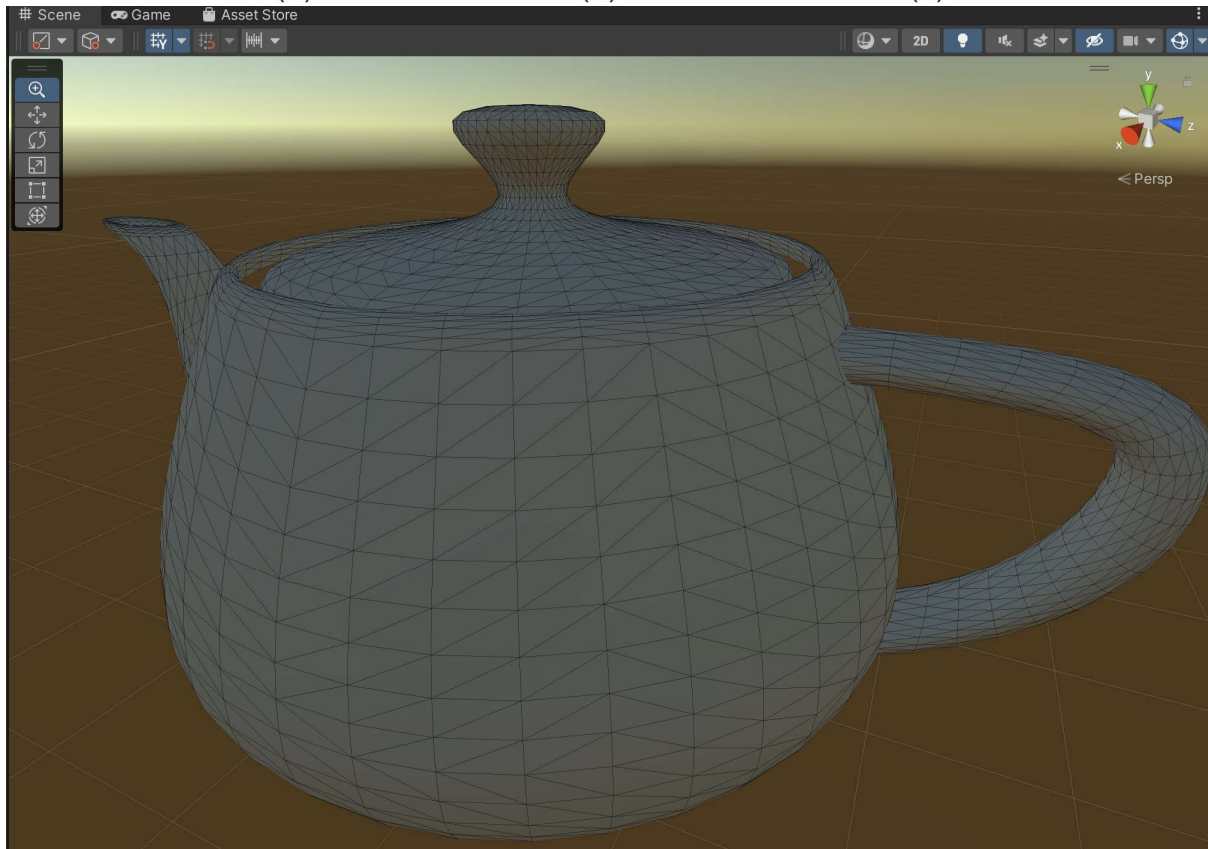
(X)



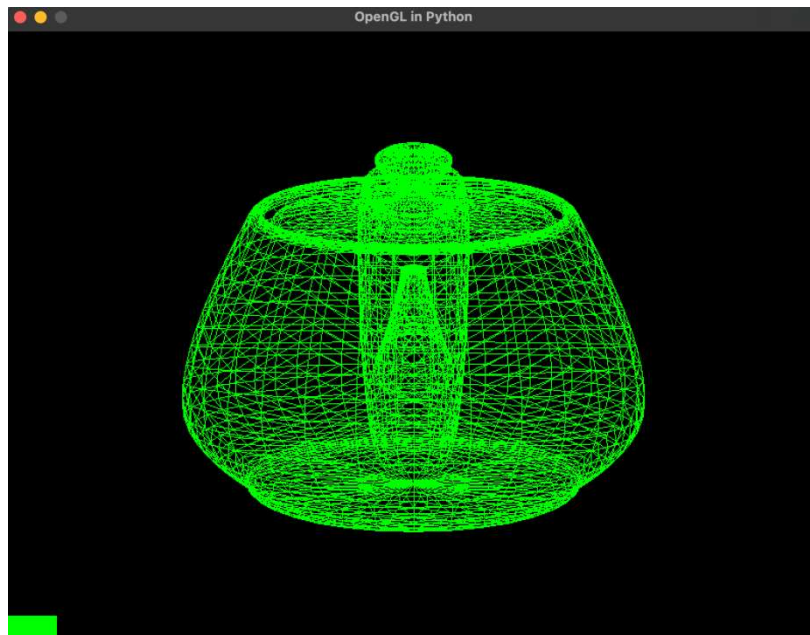
(Y)



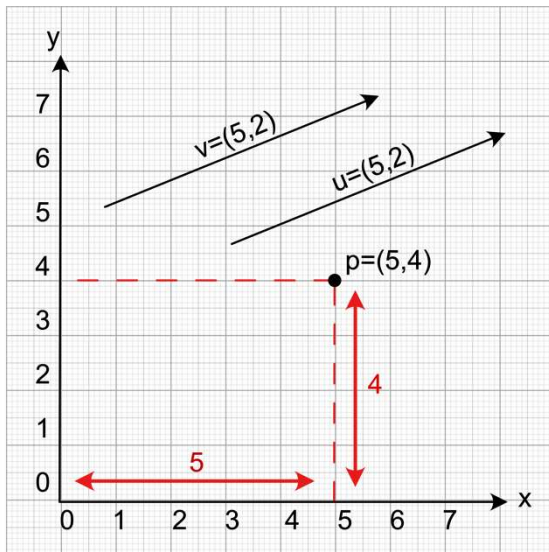
(Z)



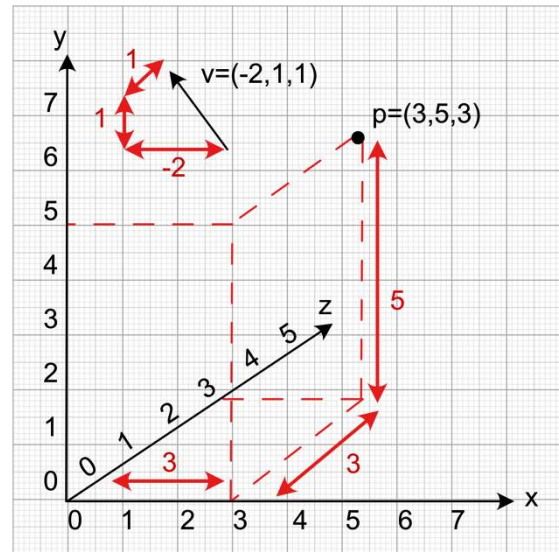




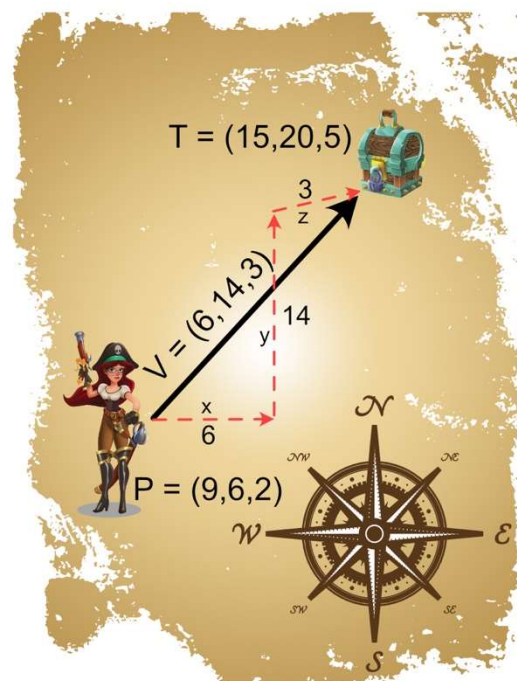
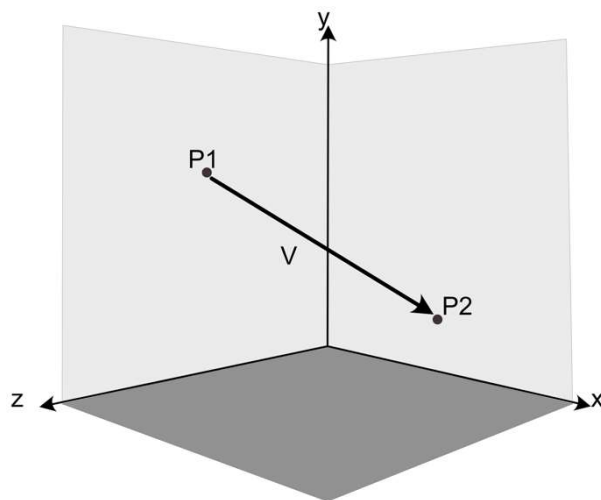
## Chapter 9: Practicing Vector Essentials

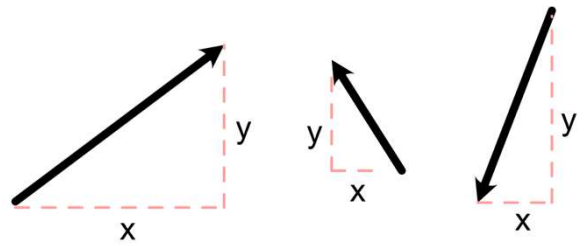
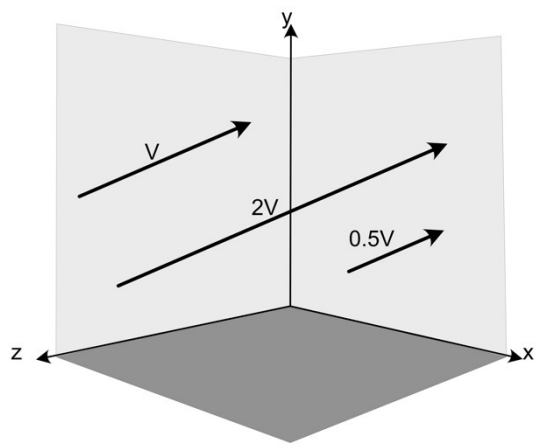
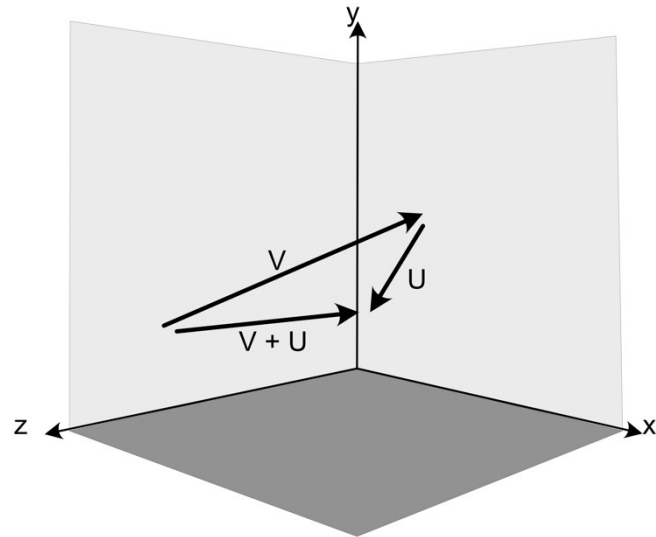


(a) 2D

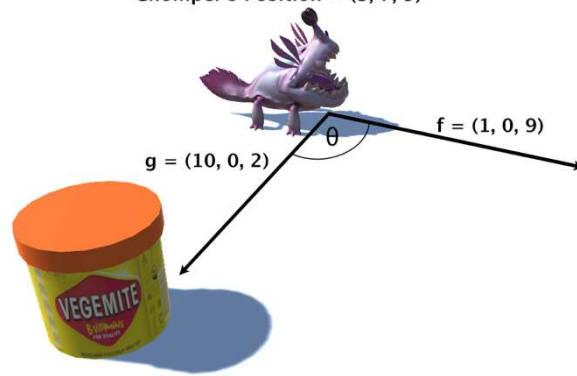


(b) 3D

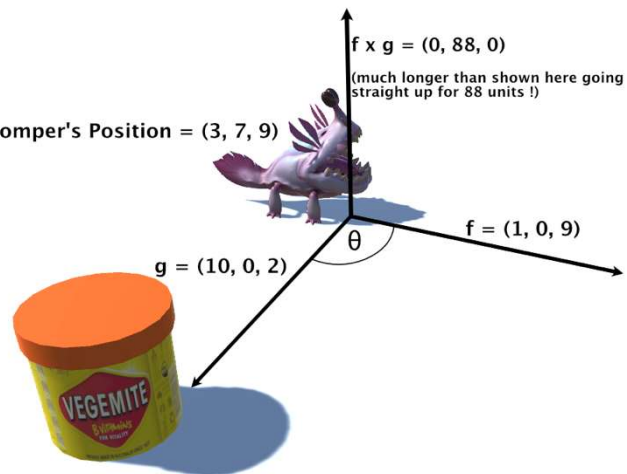




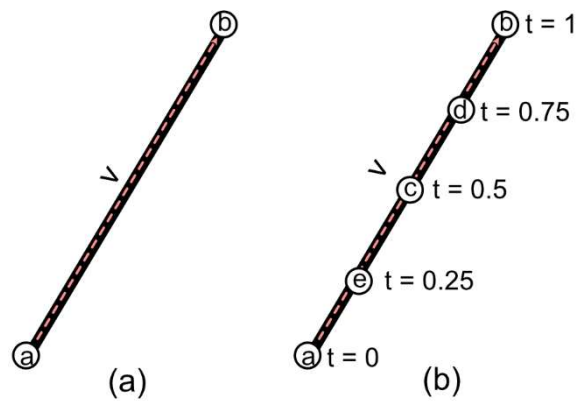
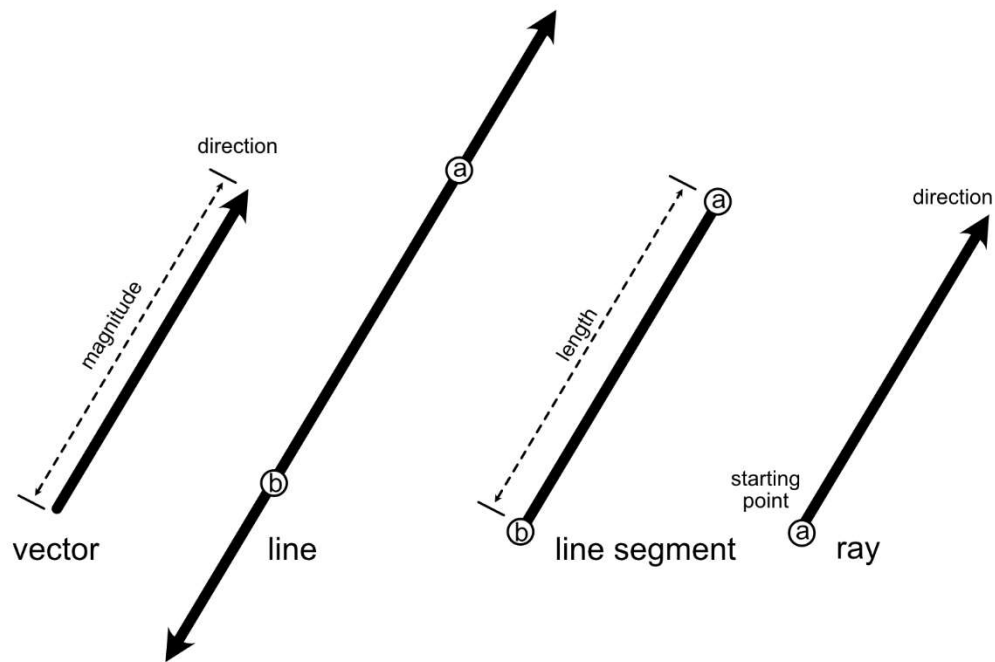
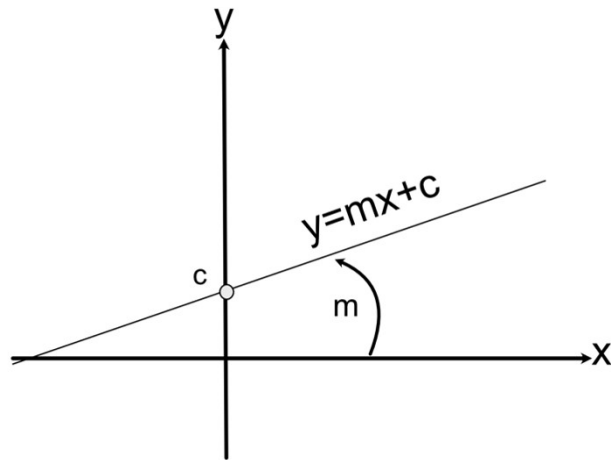
Chomper's Position = (3, 7, 9)

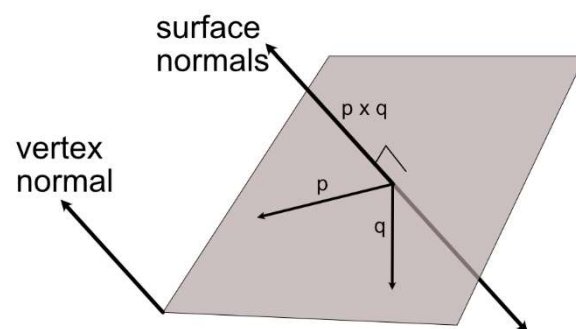
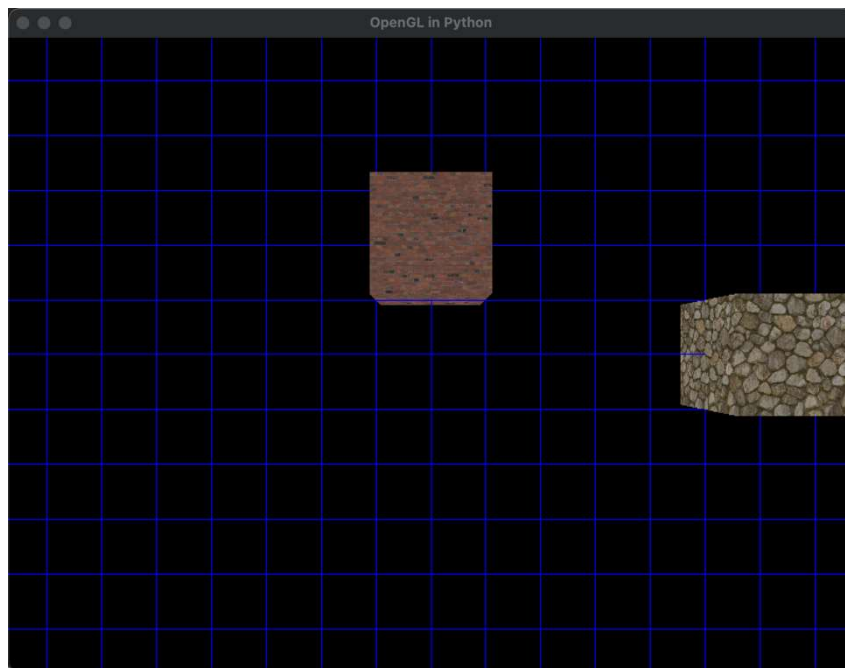
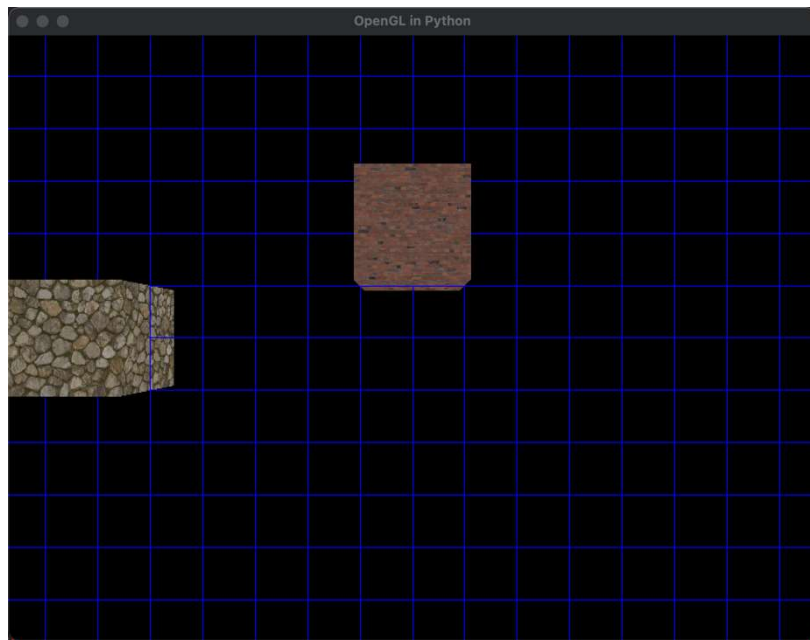


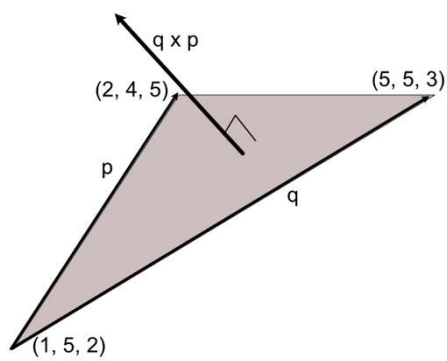
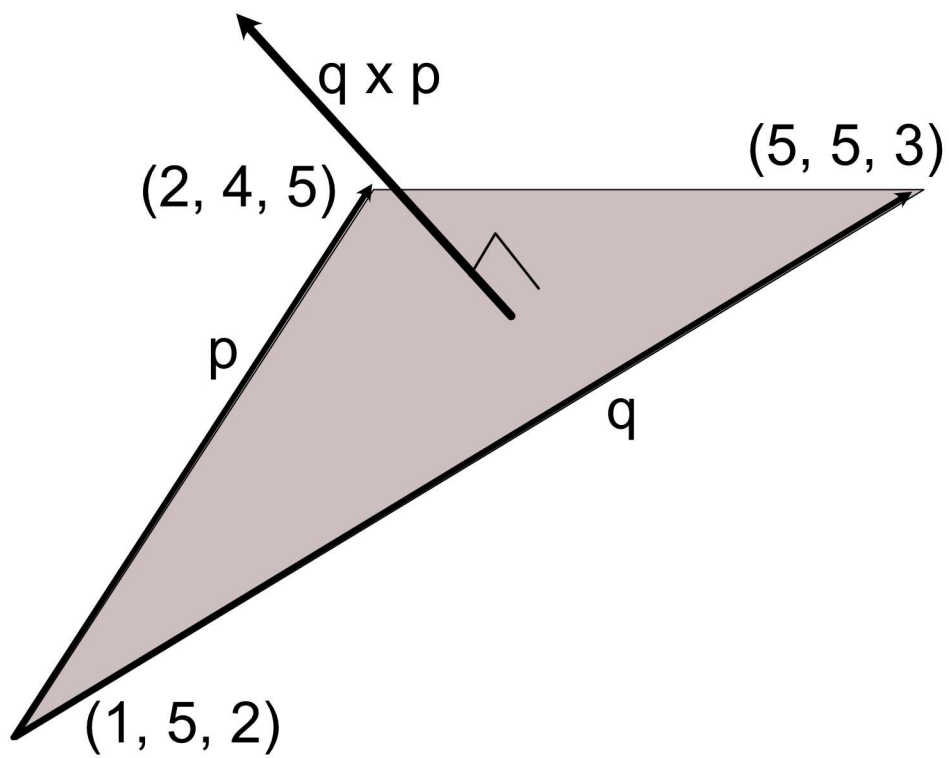
Chomper's Position = (3, 7, 9)

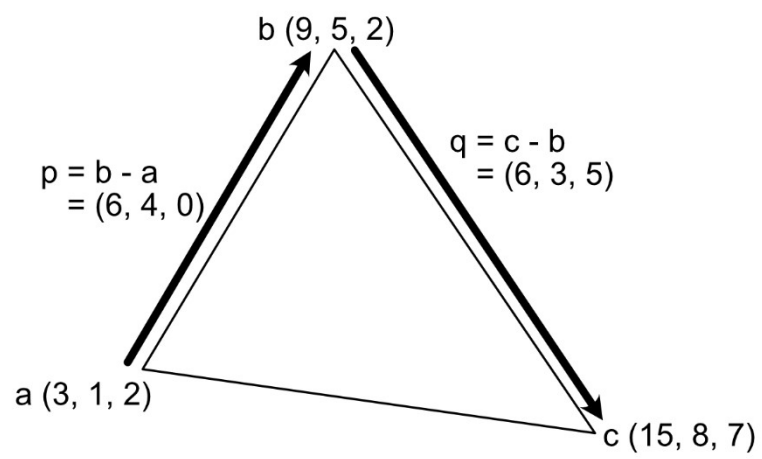
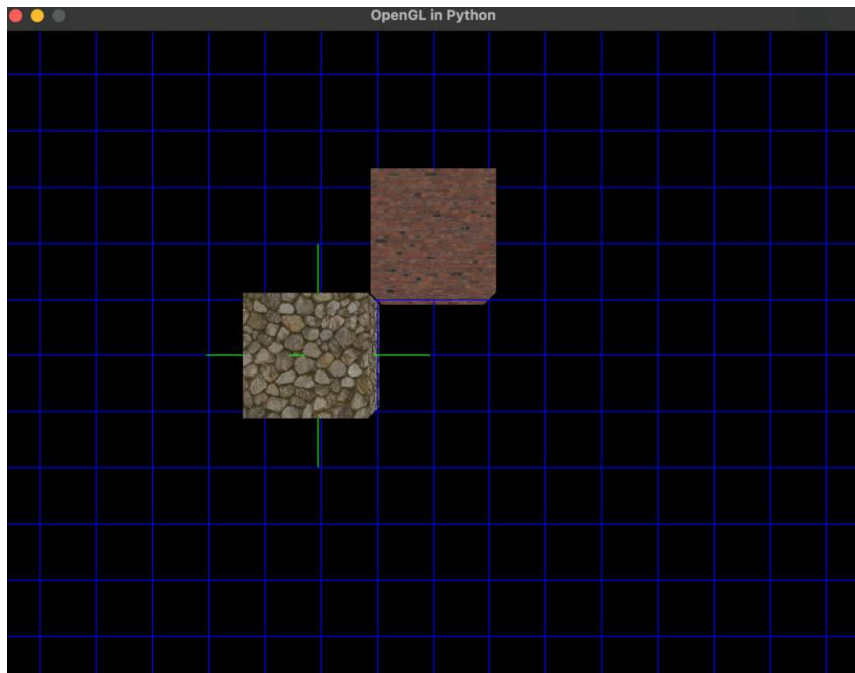


## Chapter 10: Getting acquainted with Lines, Rays and Normals



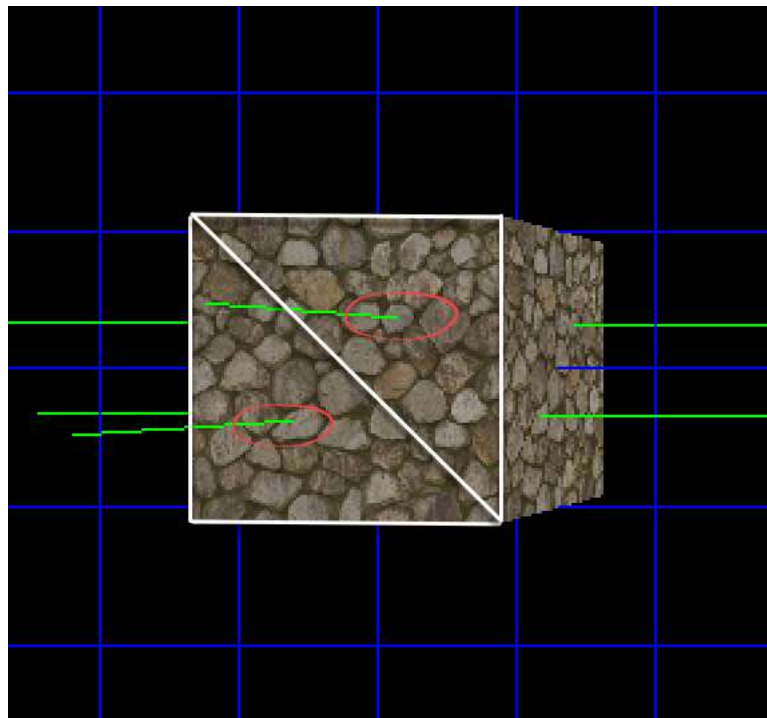
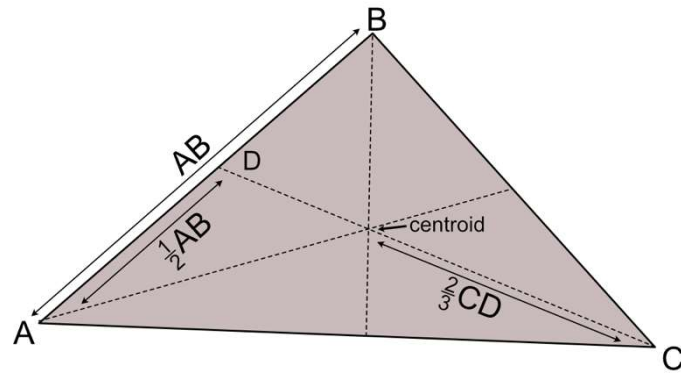


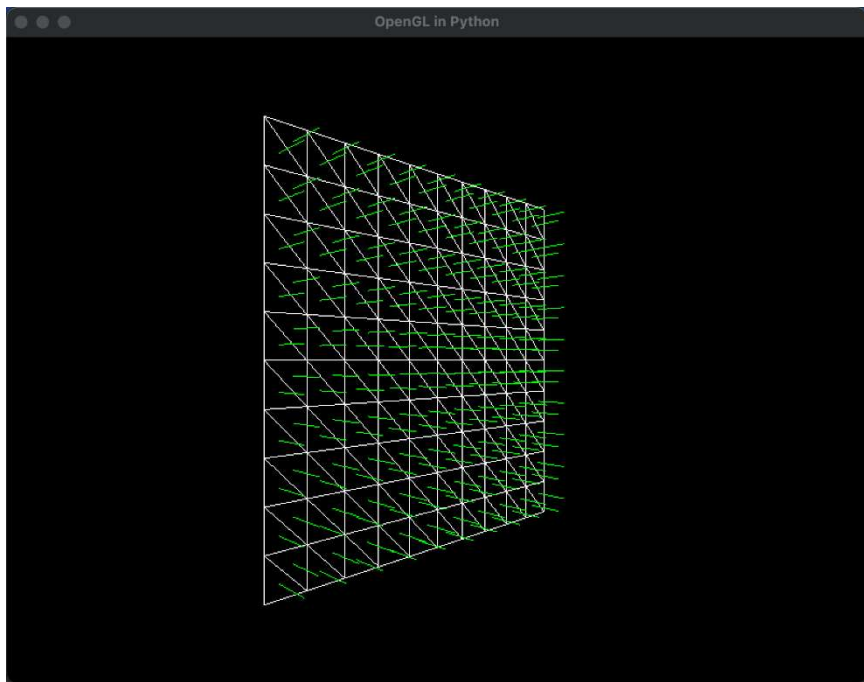


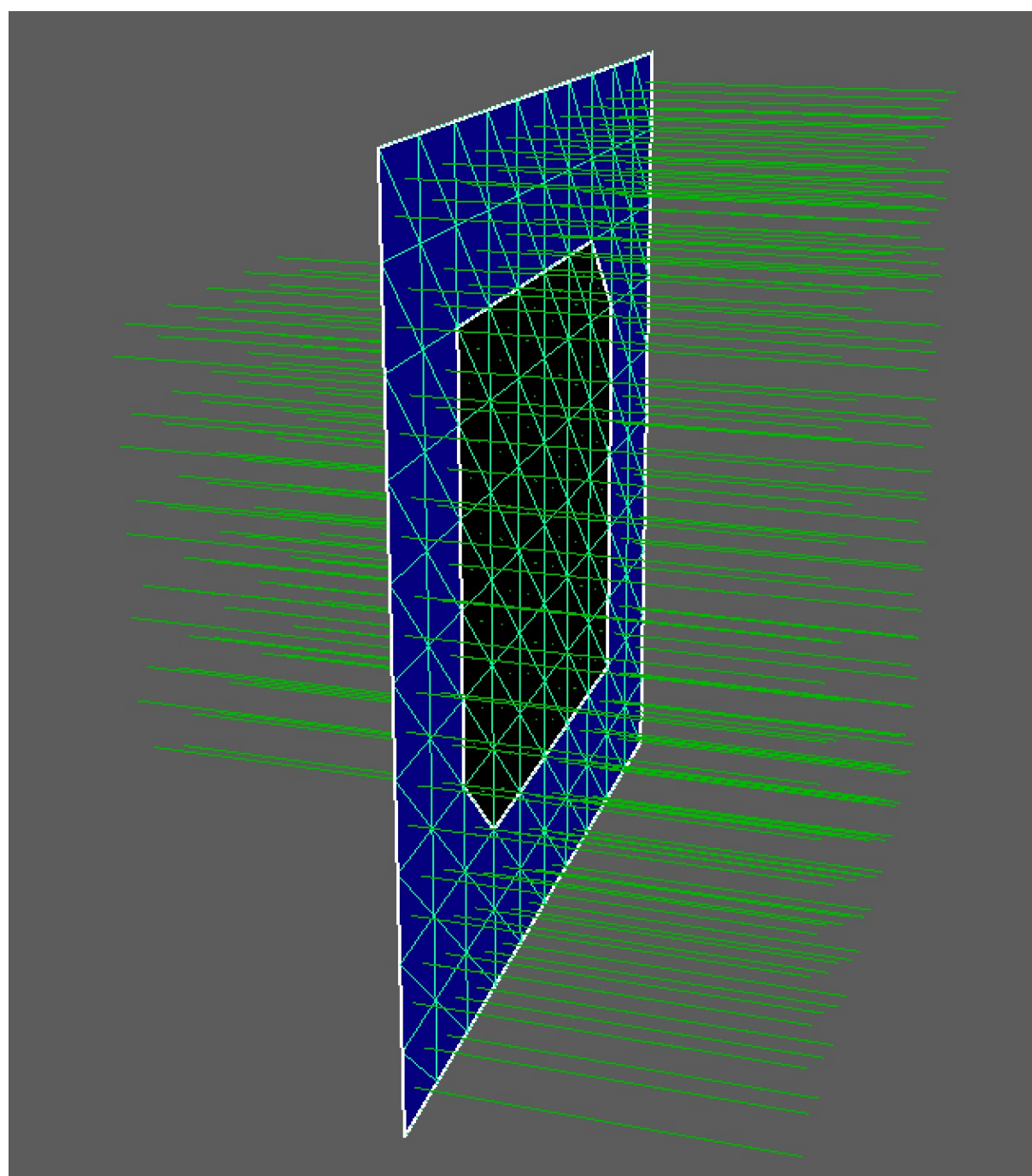


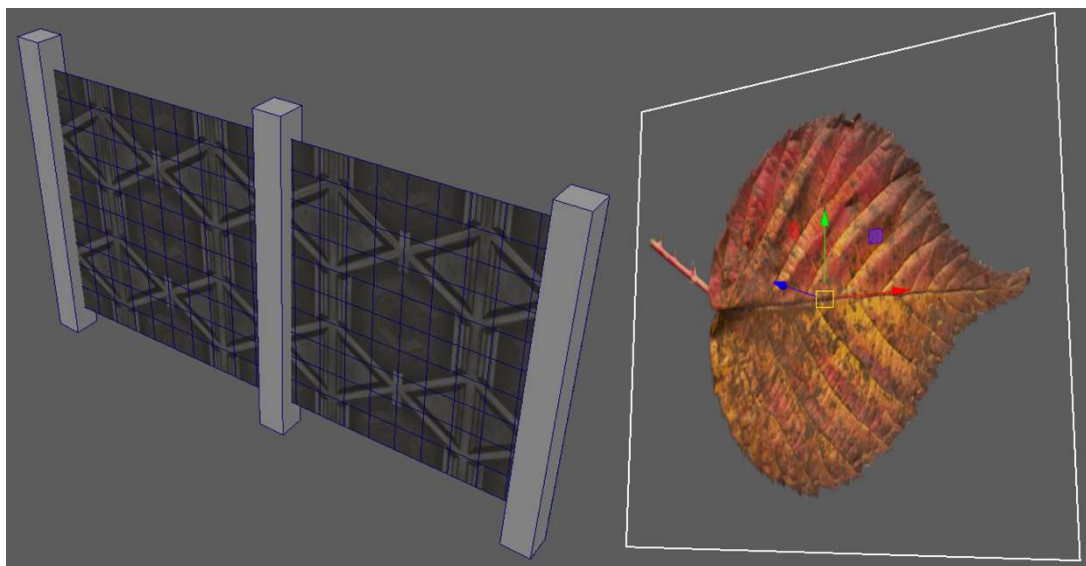
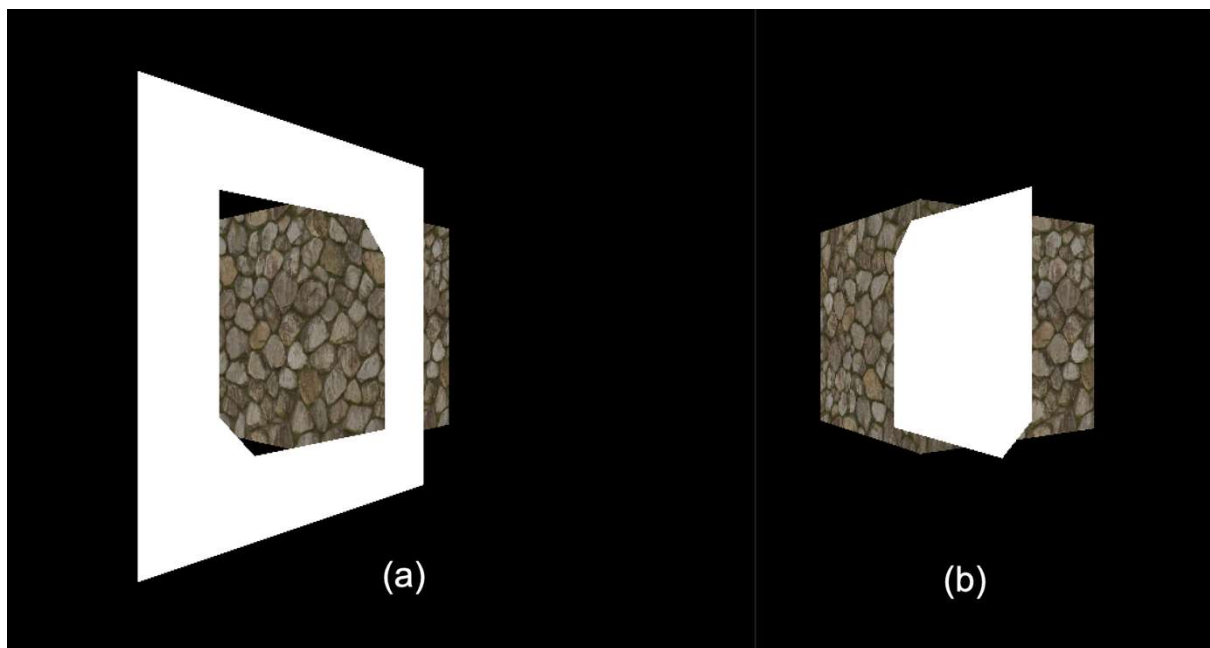


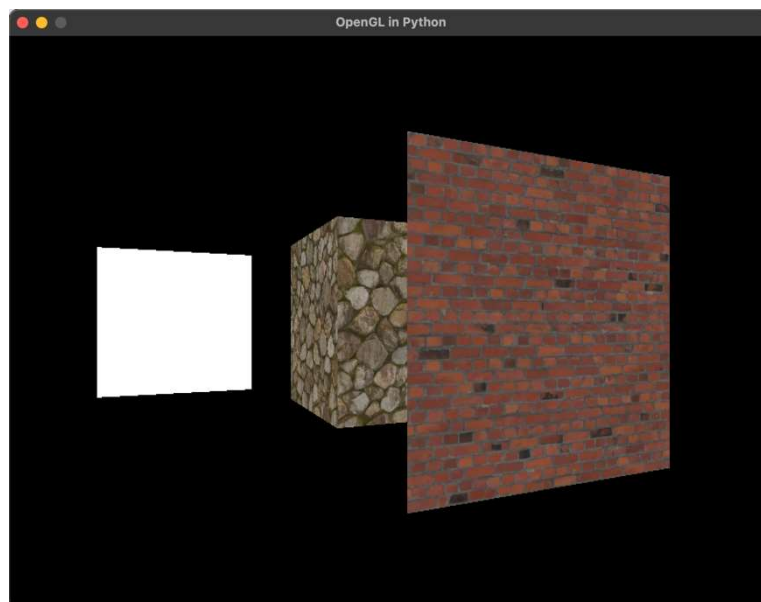
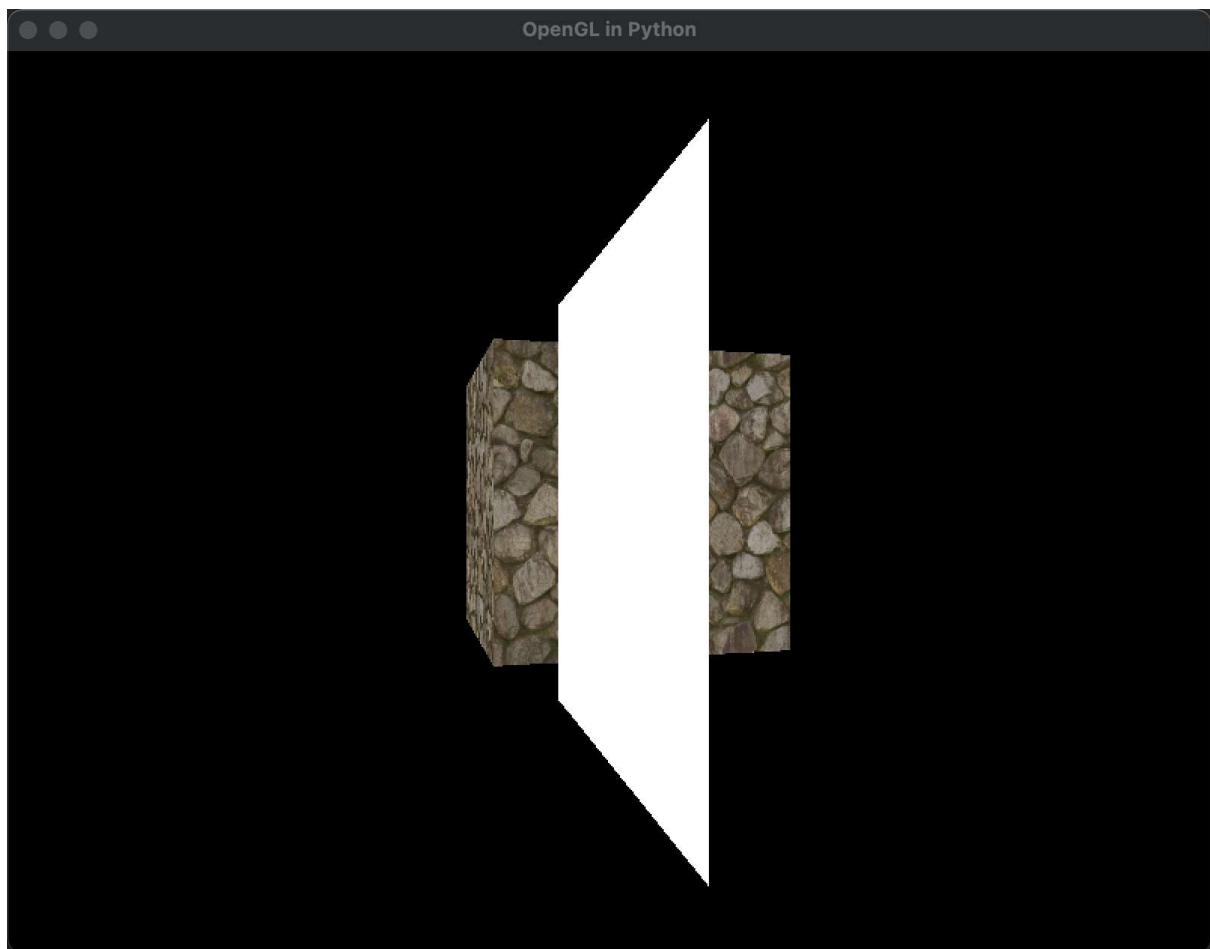
## Chapter 11: Manipulating the Light and Texture of Triangles

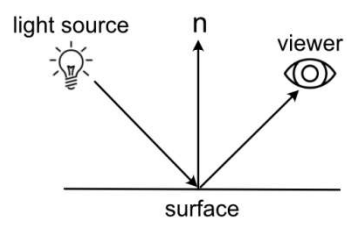
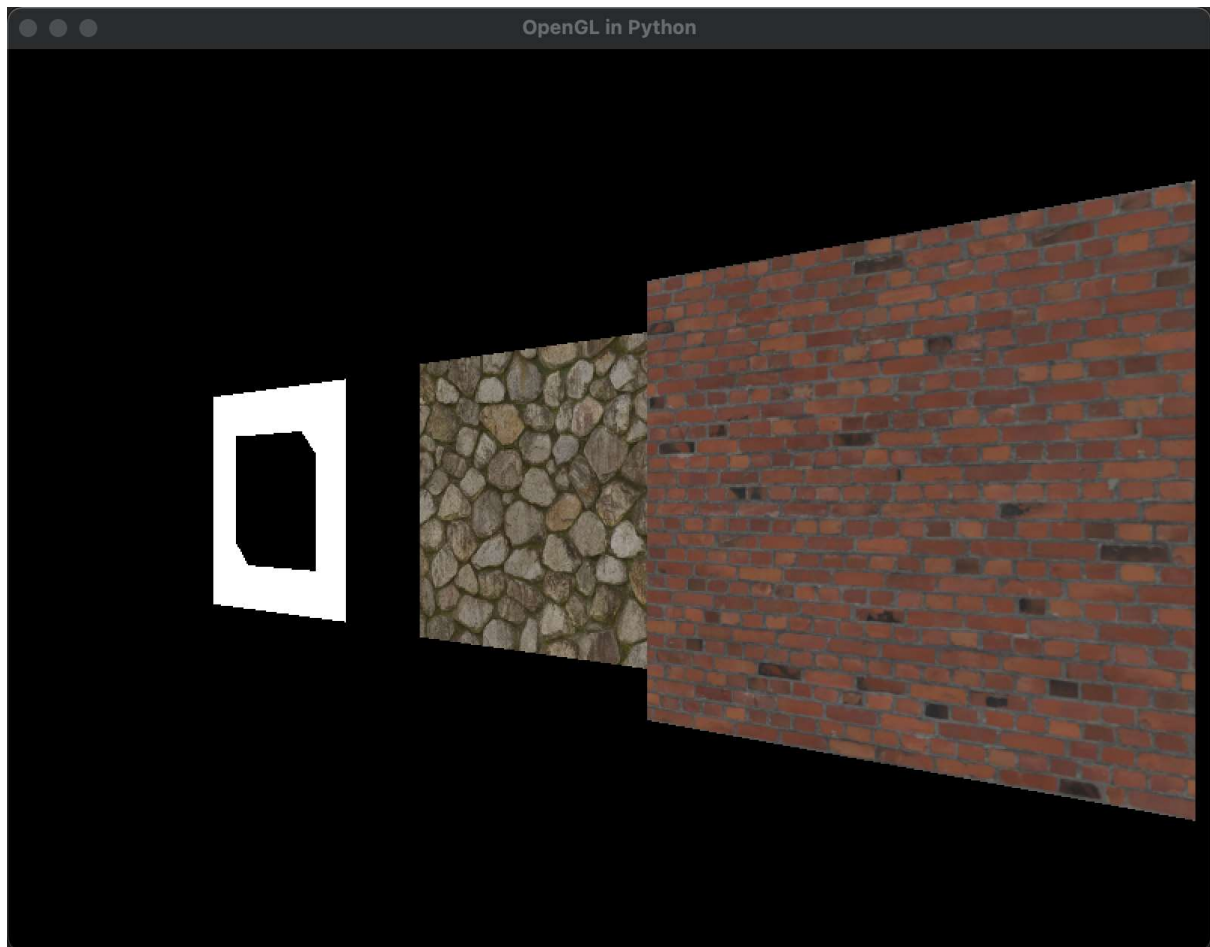




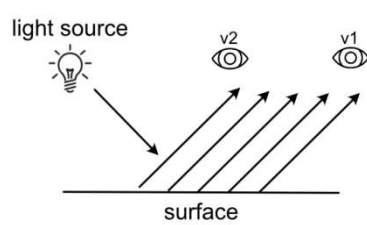




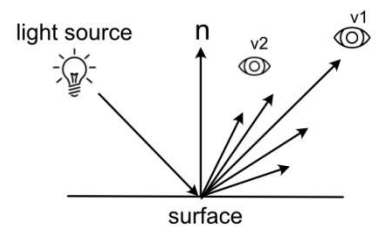




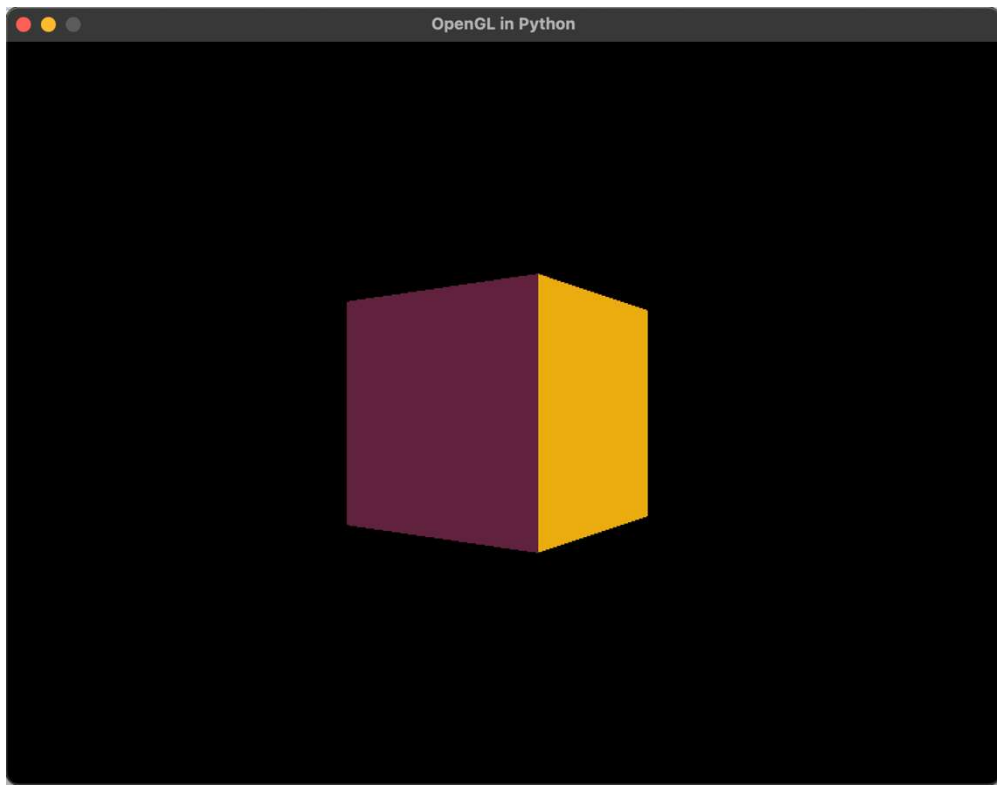
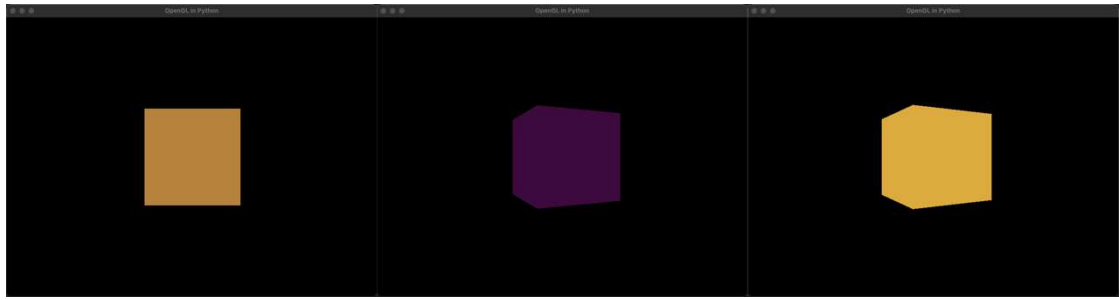
(a) Directions Involved Light Calculations



(b) Diffuse Scattering

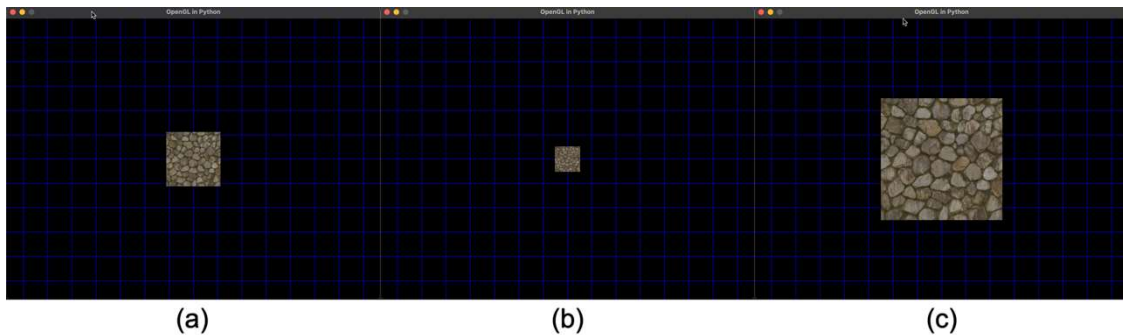
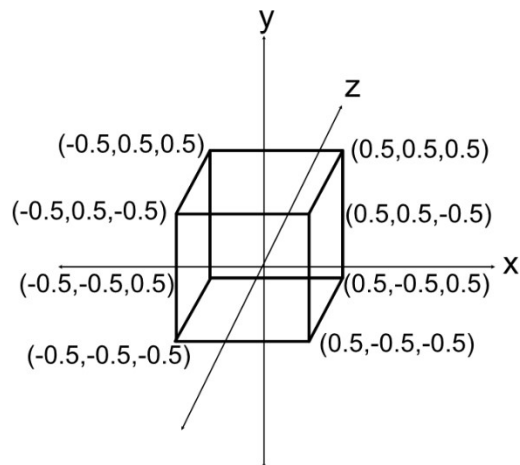
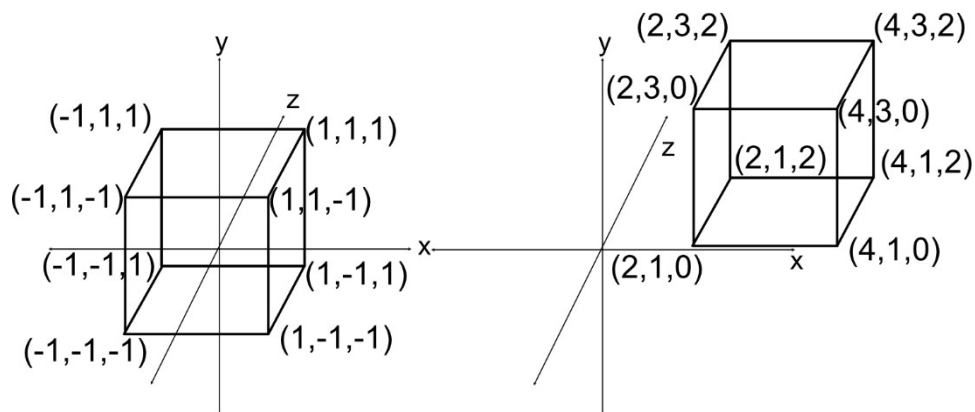
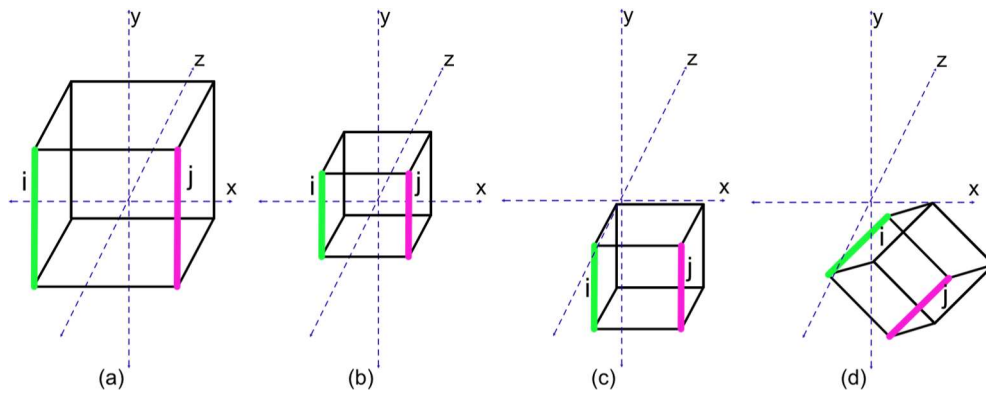


(c) Specular Reflection

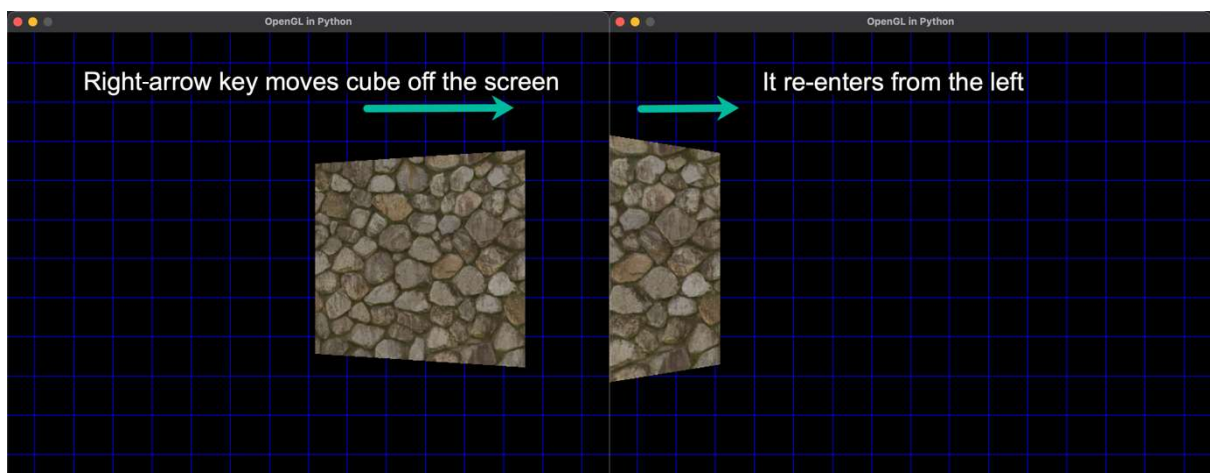
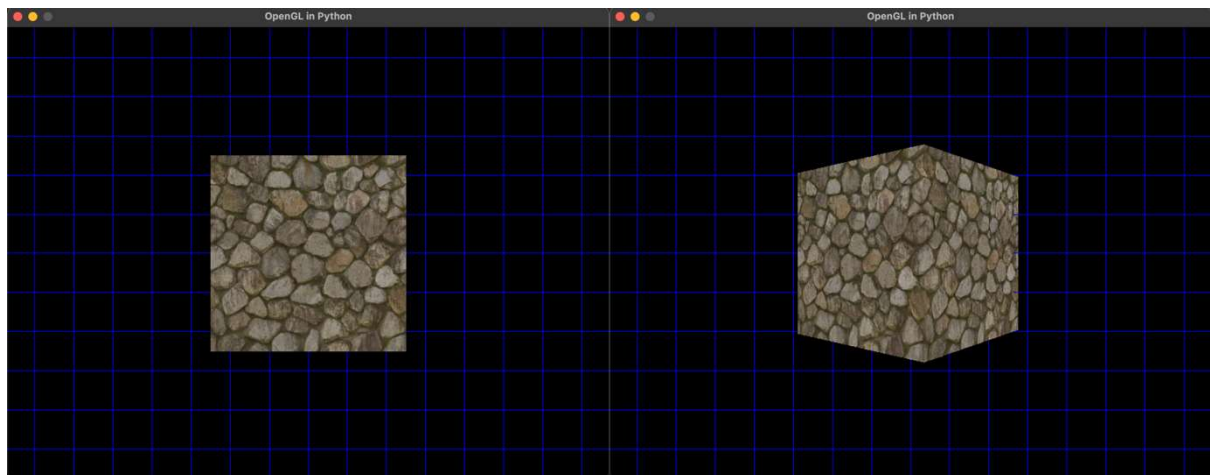
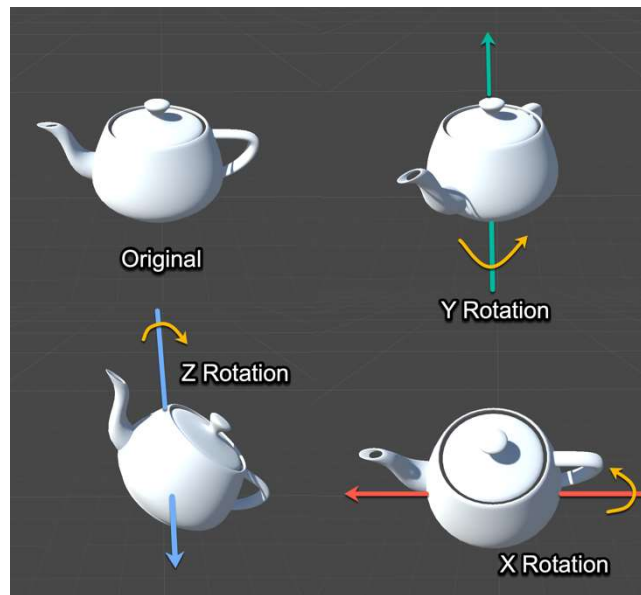


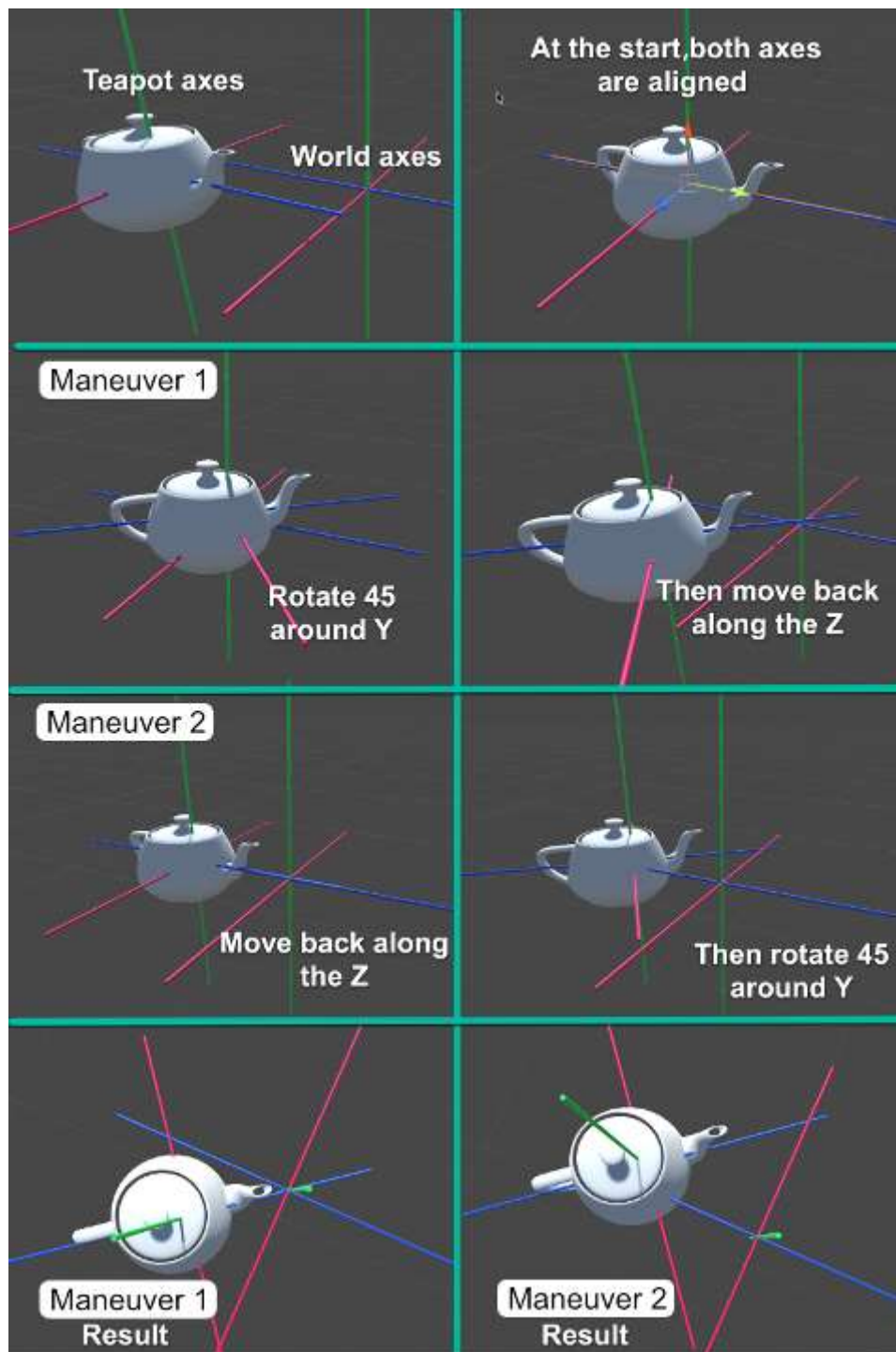


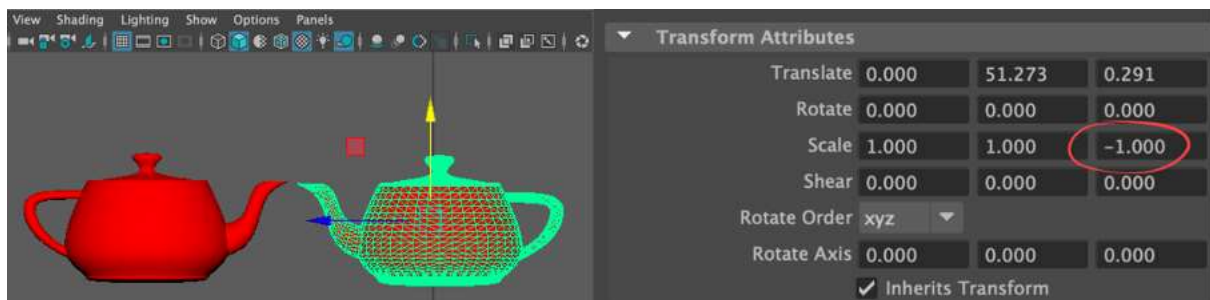
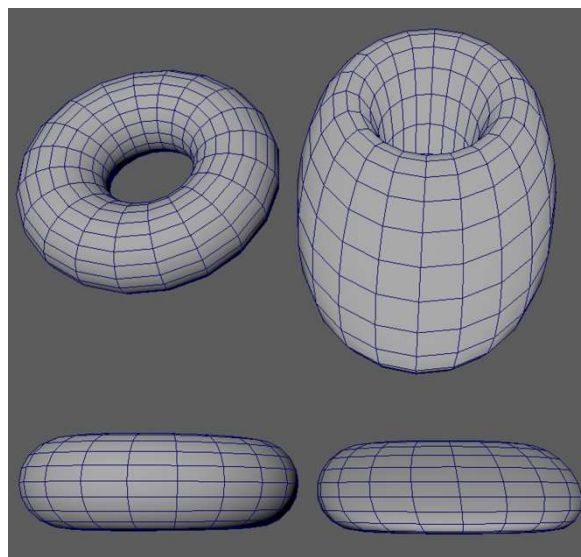
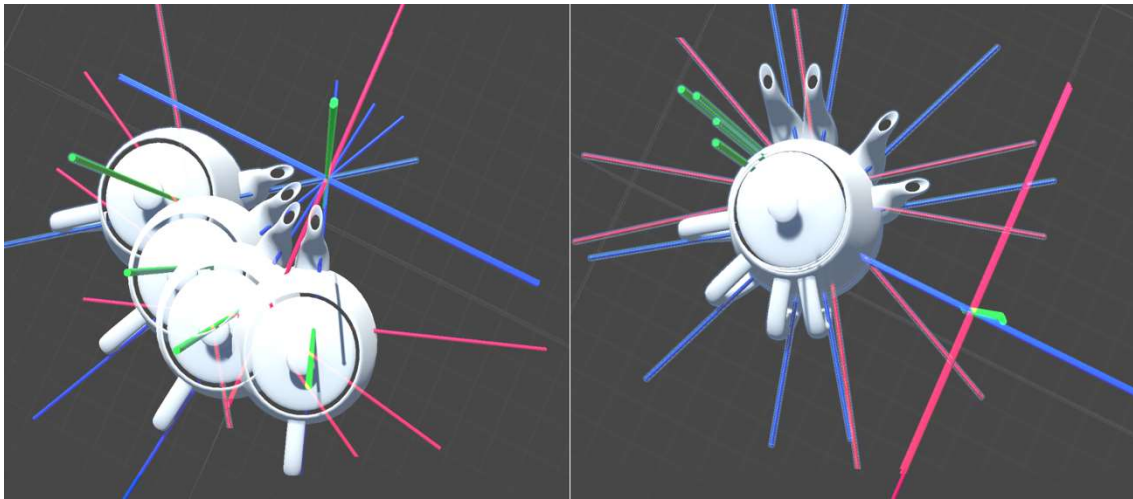
## Chapter 12: Mastering Affine Transformations



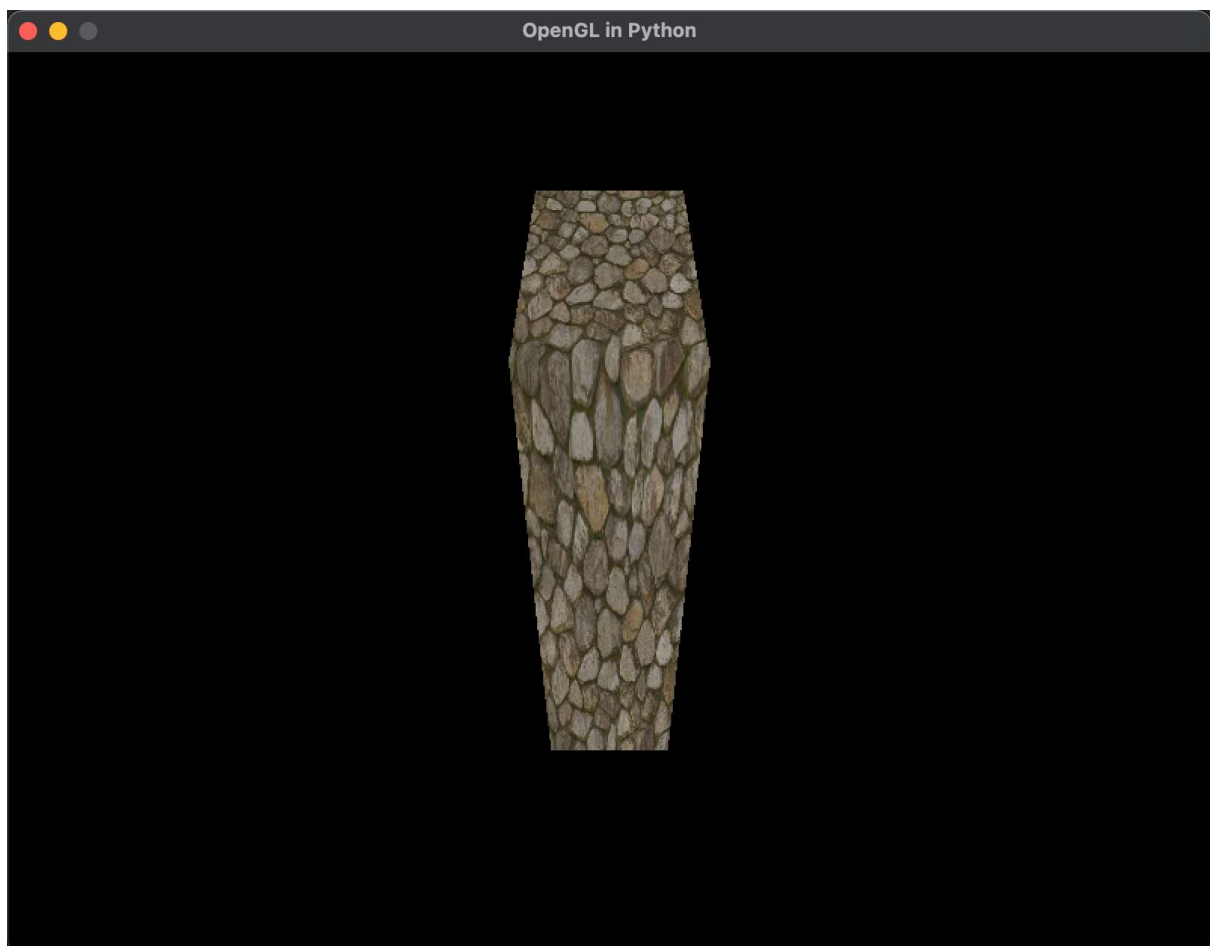
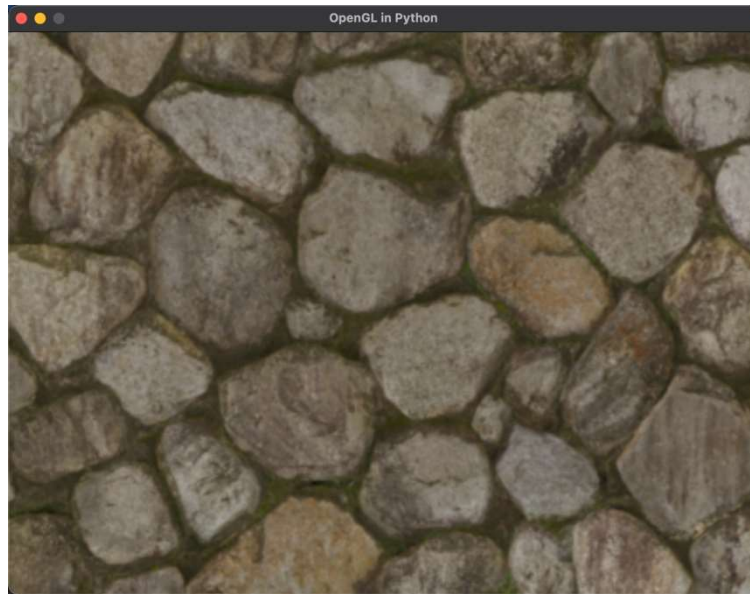








## Chapter 13: Understanding the Importance of Matrices



## Matrix Multiplication Calculator

### Matrix A input

Insert matrix
Restore matrix

	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>4</sub>
1	1	0	0	0
2	0	0.707	0.707	0
3	0	-0.707	0.707	0
4	0	0	0	1

Clear
Fill empty cells with zero

### Matrix B input

Insert matrix
Restore matrix

☐ Complex numbers (more)

Decimal

	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>
1	0.5	0	0	0
2	0	2	0	0
3	0	0	1	0
4	0	0	0	1

Clear
Fill empty cells with zero

Calculate

Matrix A dimension: 4 X 4

Matrix B dimension: 4 X 4

## Result of matrix multiplication

### Matrix A input

Insert matrix
Restore matrix

	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	A <sub>4</sub>
1	1	0	0	0
2	0	1	0	0
3	0	0	1	-3
4	0	0	0	1

Clear
Fill empty cells with zero

### Matrix B input

Insert matrix
Restore matrix

☐ Complex numbers (more)

Decimal

	B <sub>1</sub>	B <sub>2</sub>	B <sub>3</sub>	B <sub>4</sub>
1	0.5	0	0	0
2	0	1.414	0.707	0
3	0	-1.414	0.707	0
4	0	0	0	1

Clear
Fill empty cells with zero

Calculate

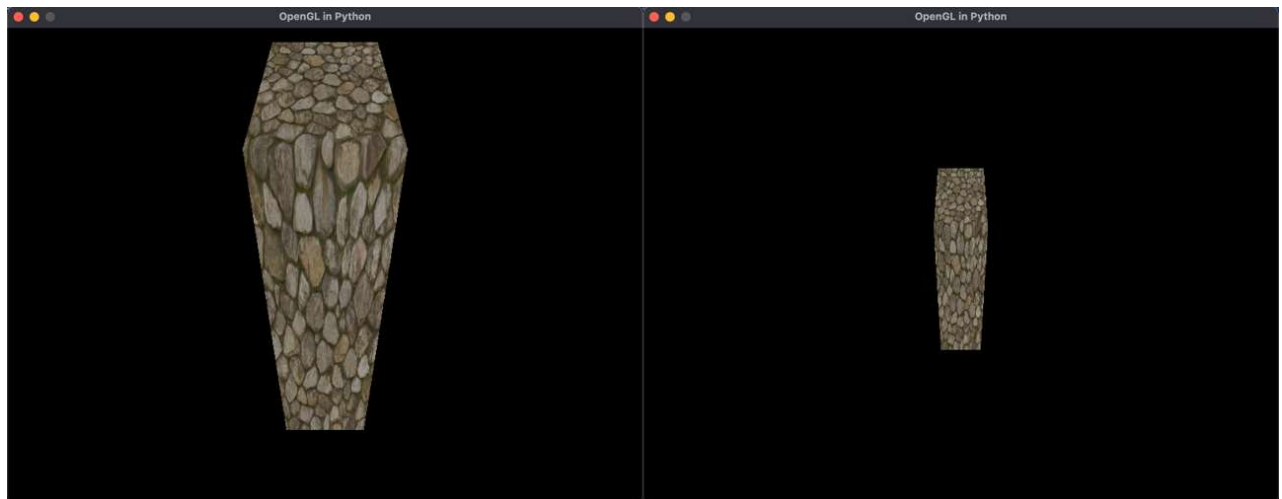
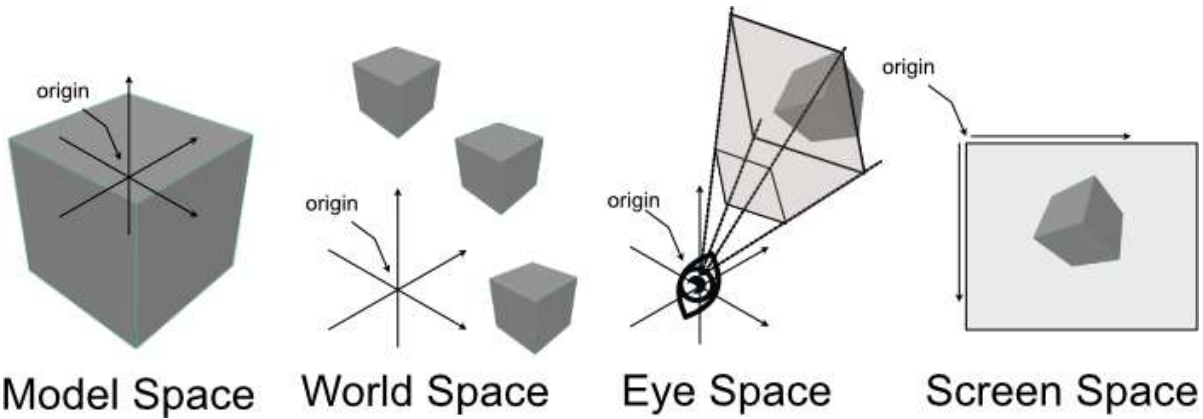
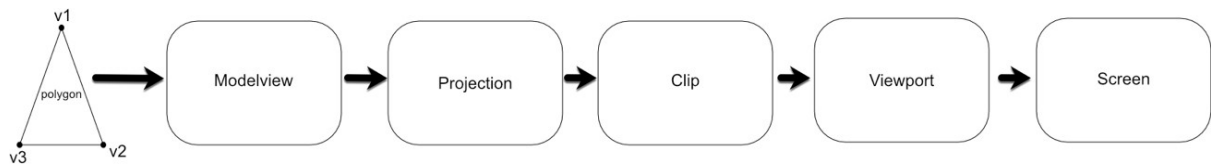
Result:

	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>
1	0.5	0	0	0
2	0	1.414	0.707	0
3	0	-1.414	0.707	0
4	0	0	0	1

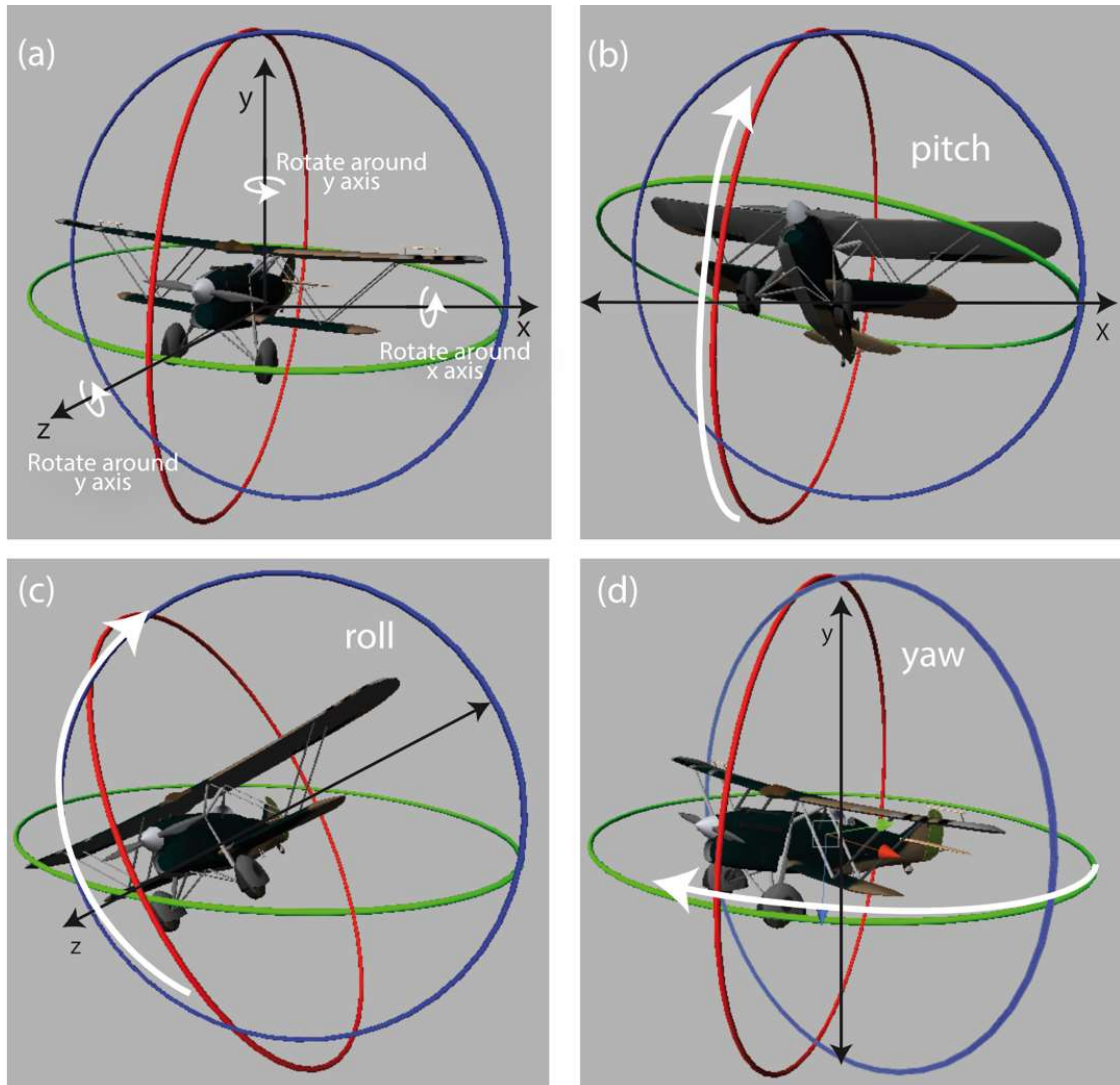
	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>4</sub>
1	0.5	0	0	0
2	0	1.414	0.707	0
3	0	-1.414	0.707	-3
4	0	0	0	1

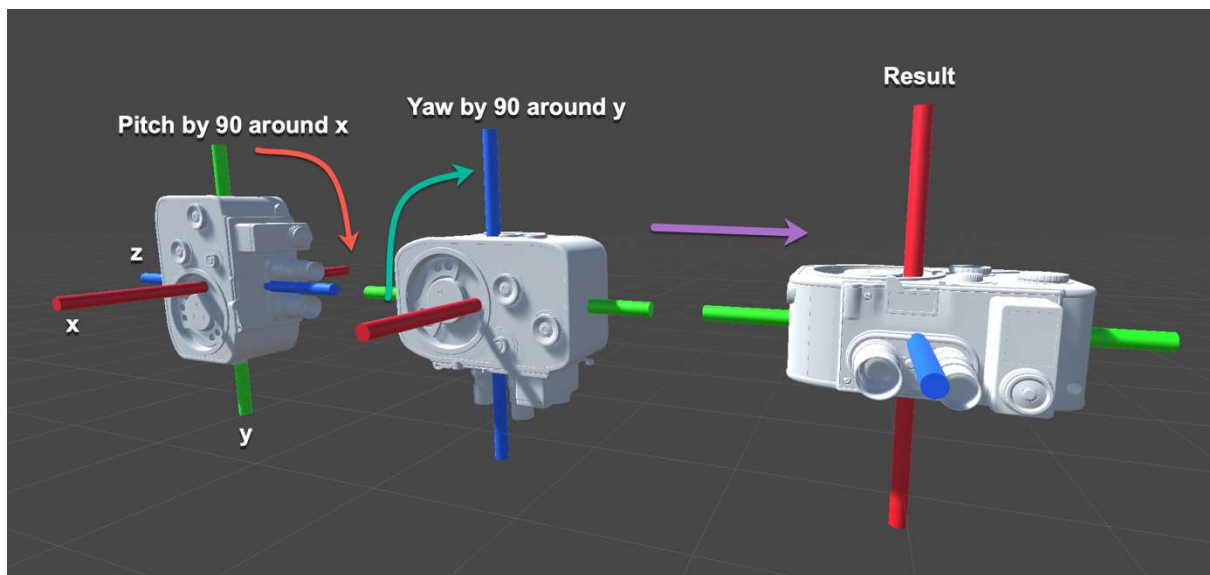
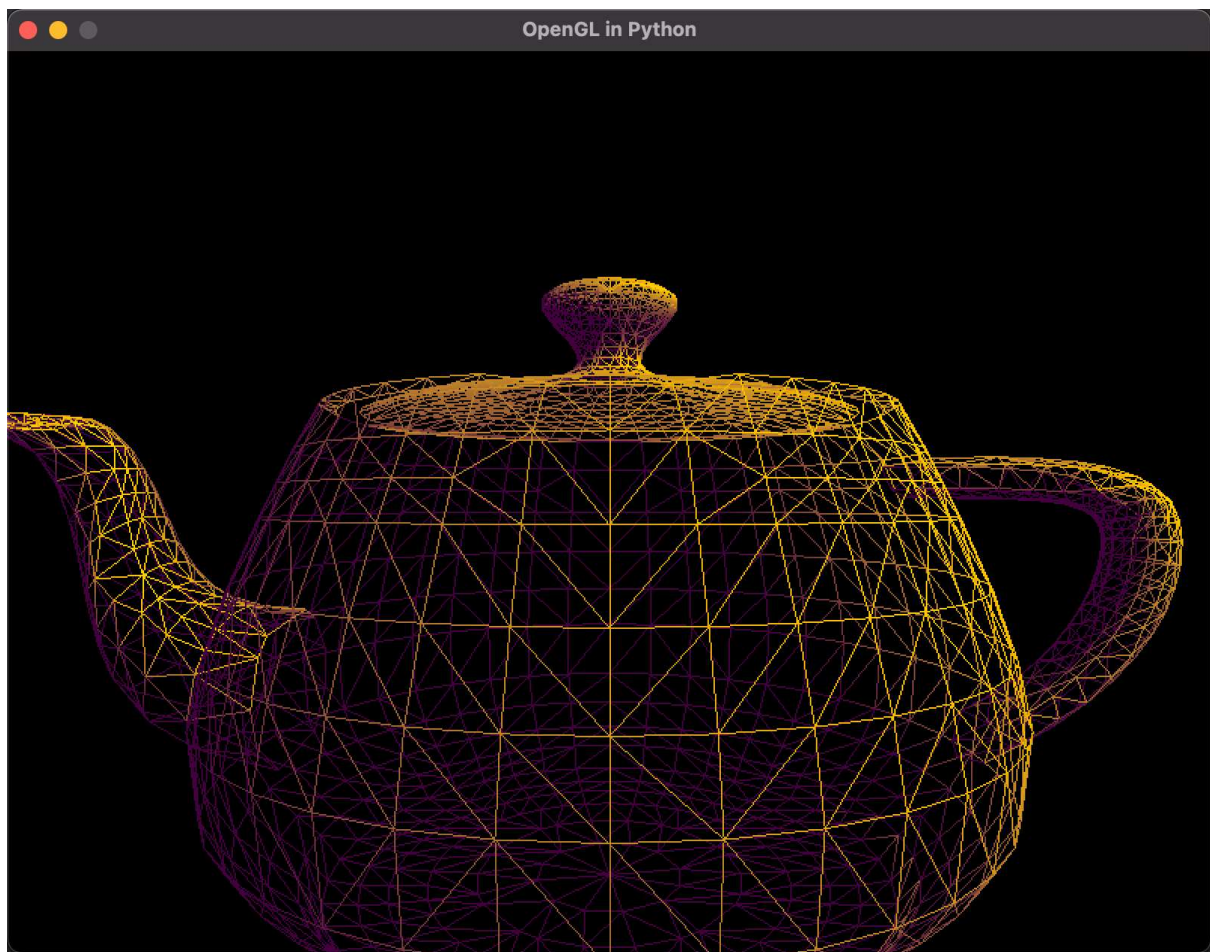


## Chapter 14: Working with coordinate Spaces

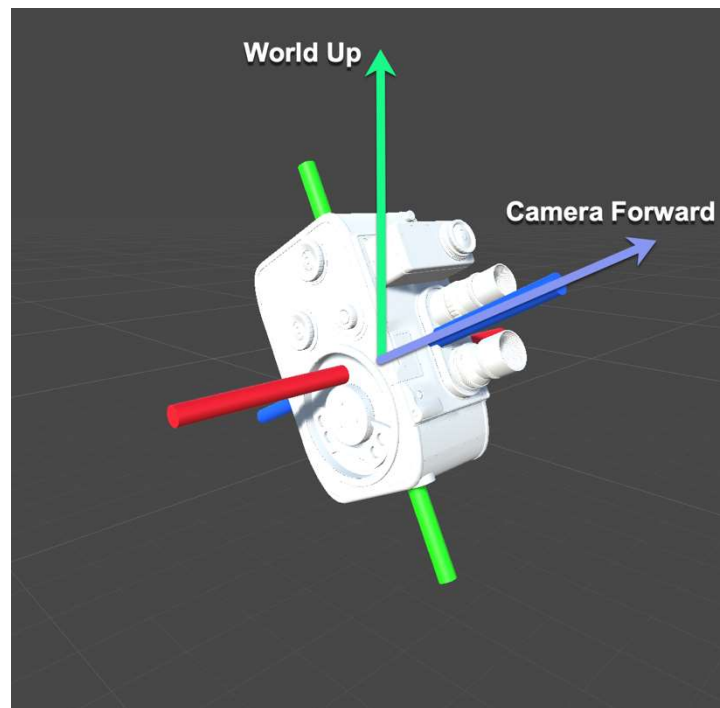
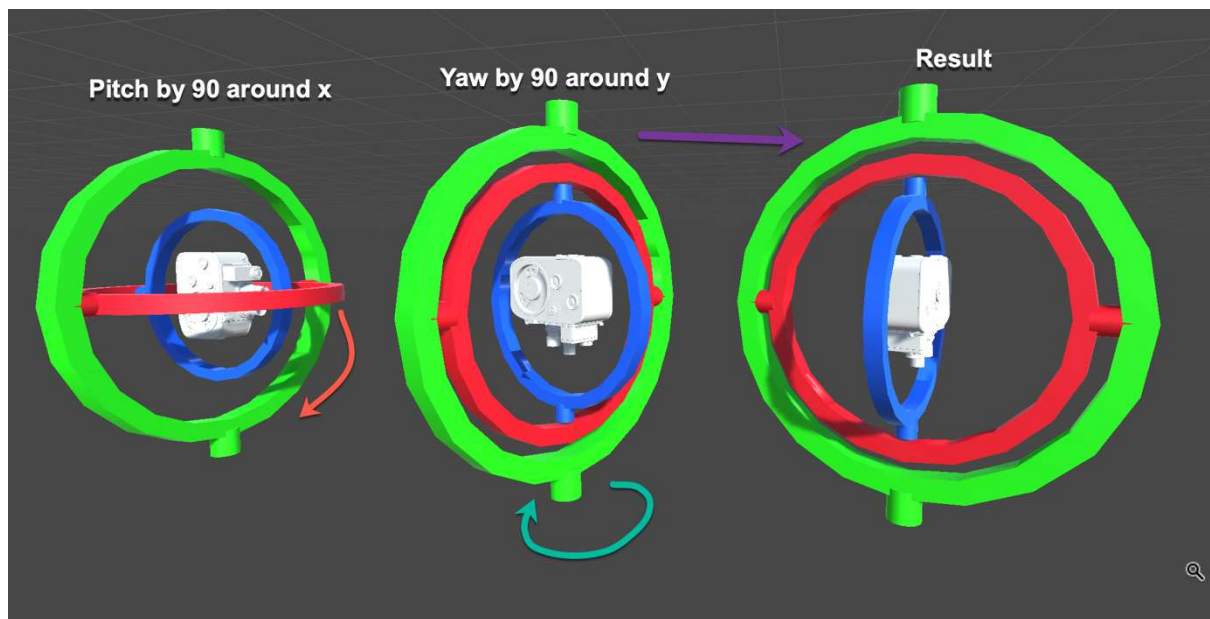


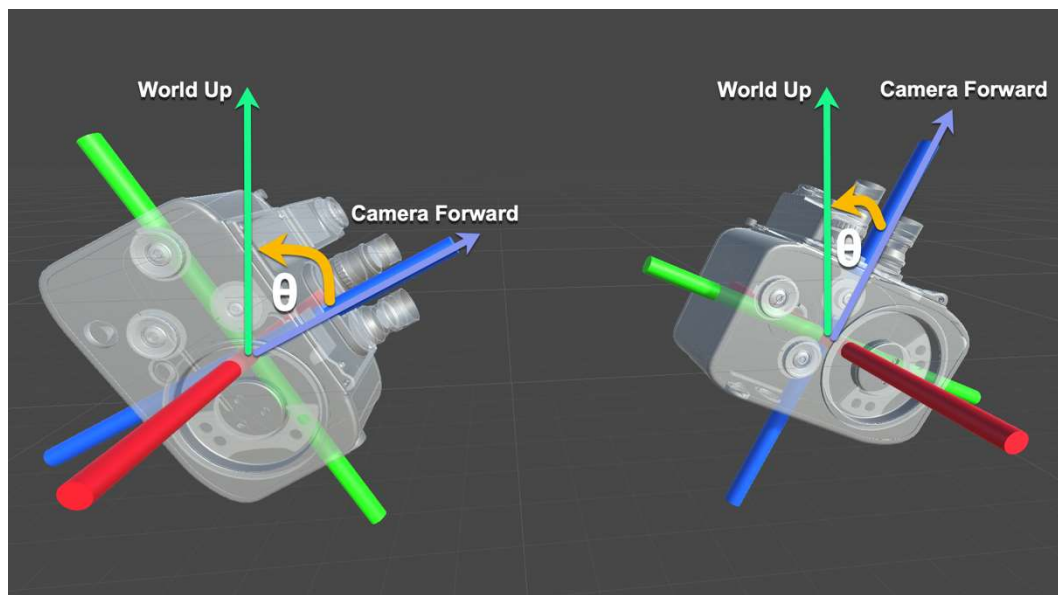
## Chapter 15: Navigating the view space



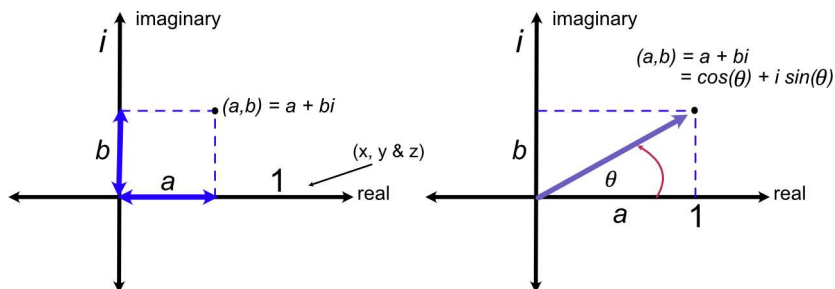
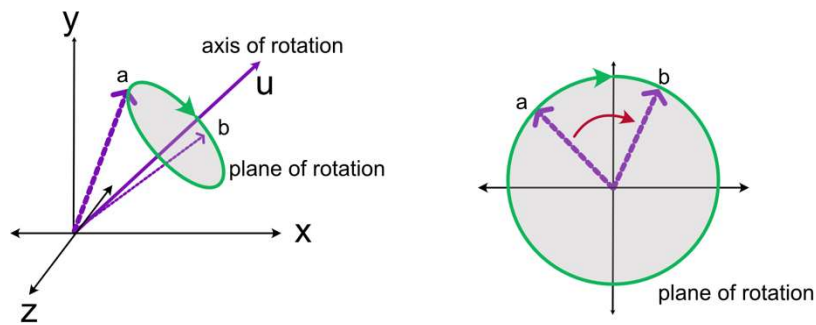
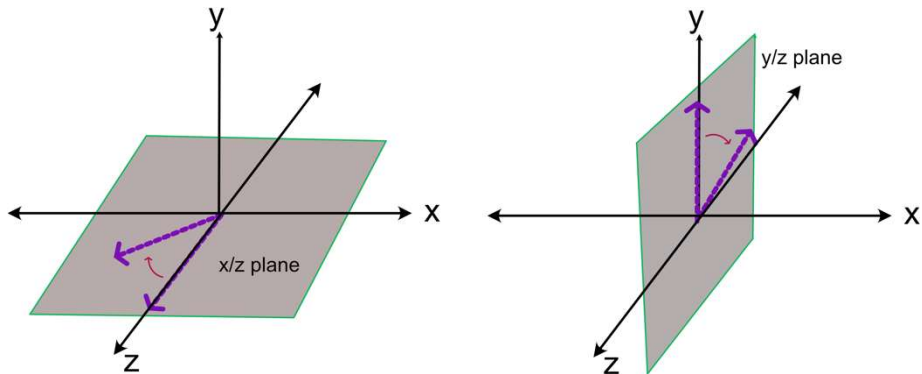
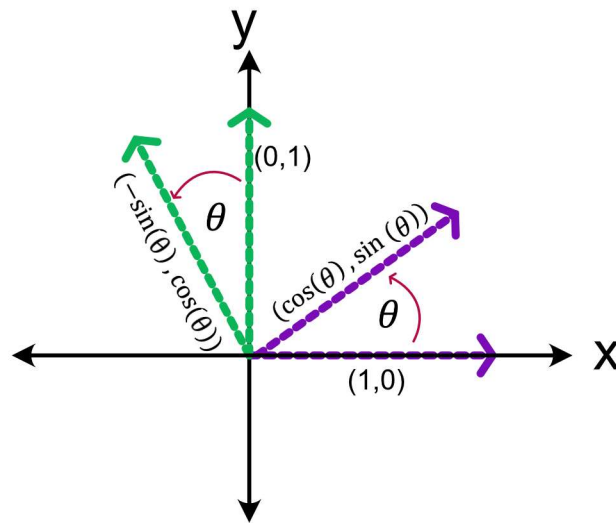


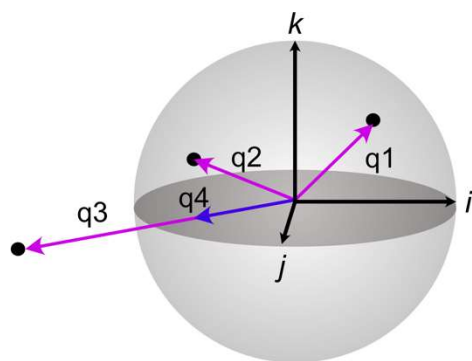
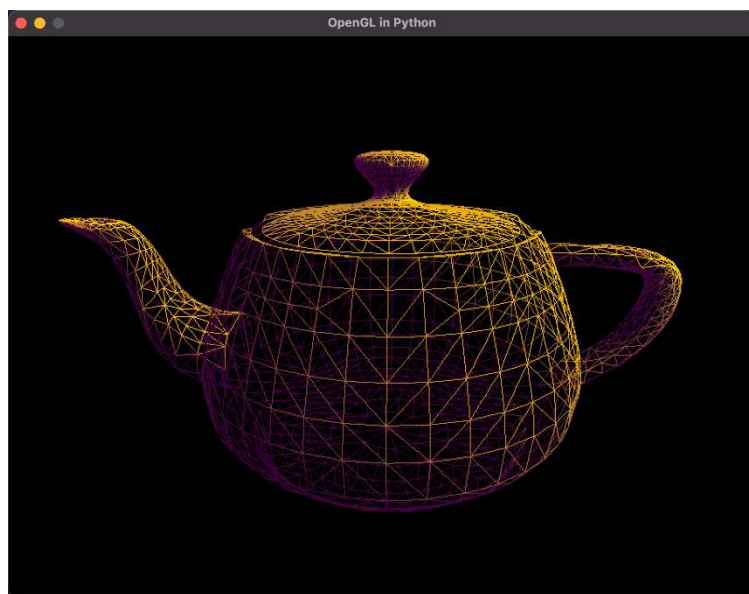
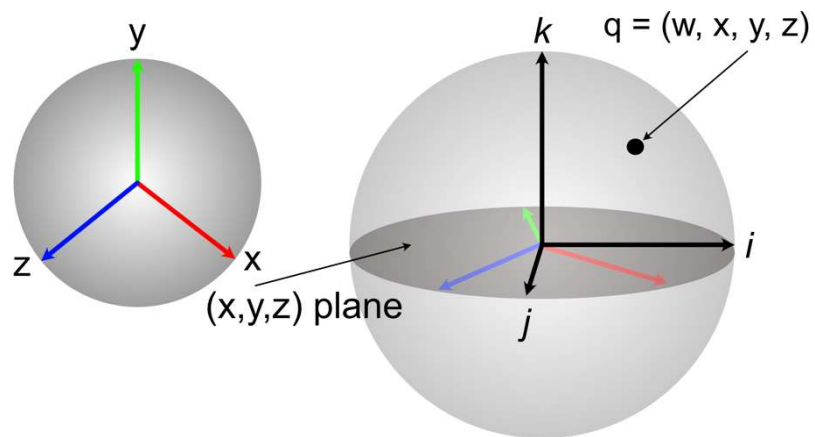


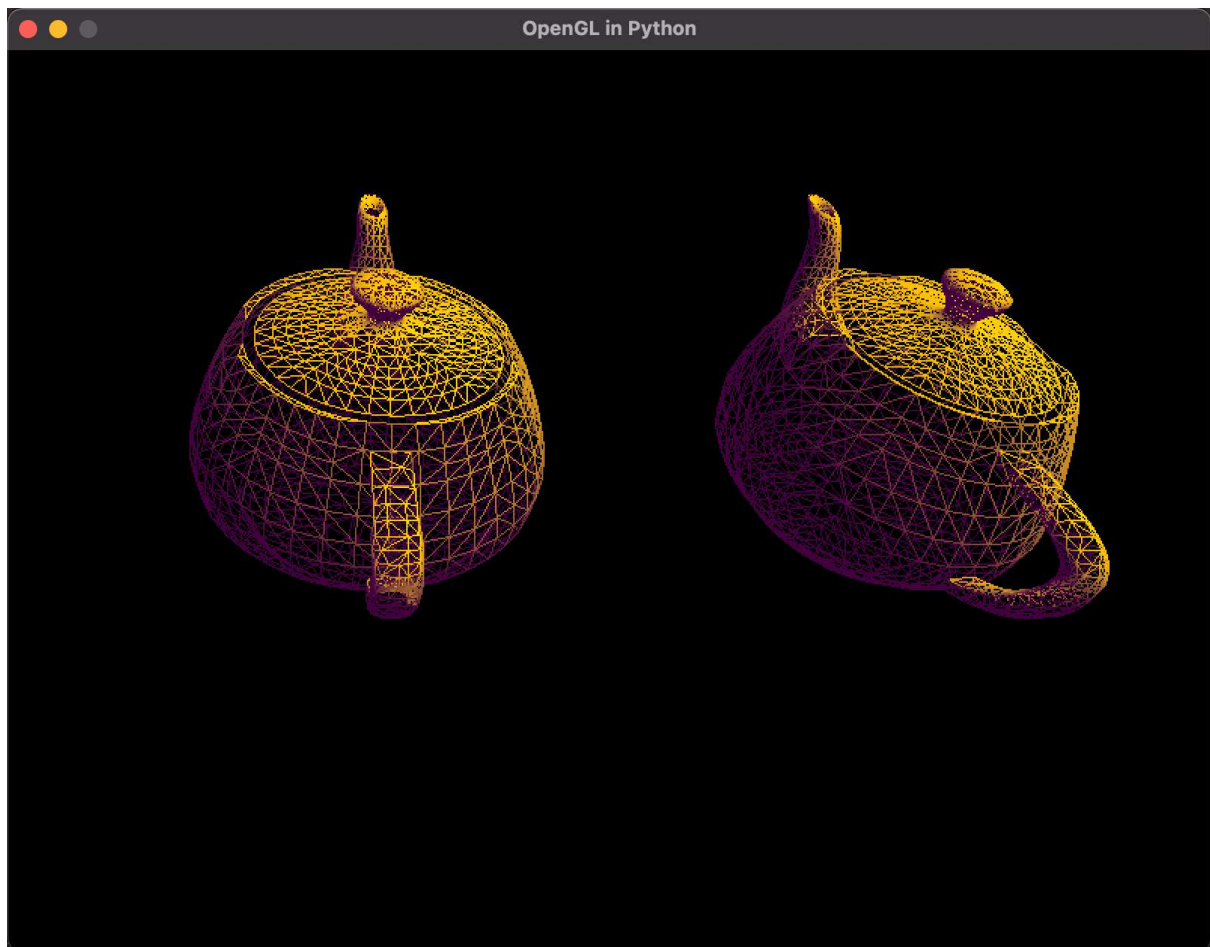
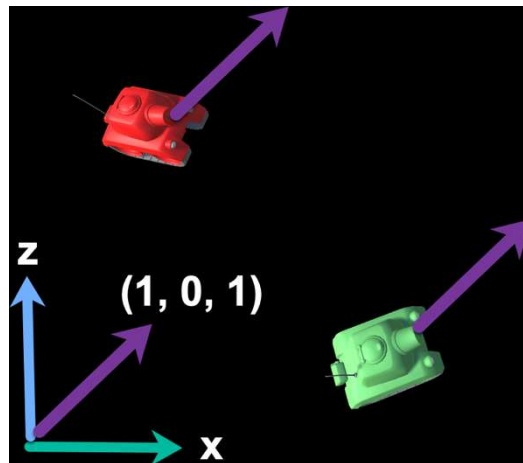
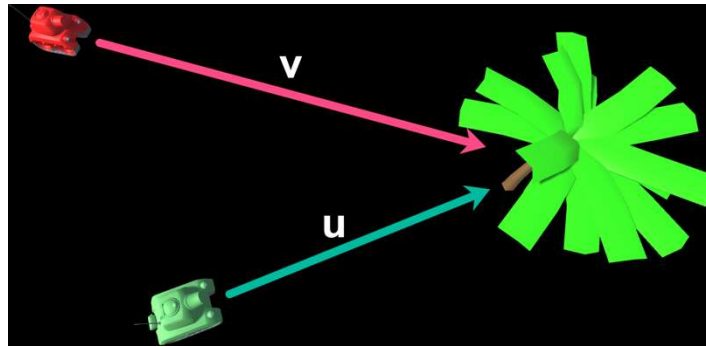




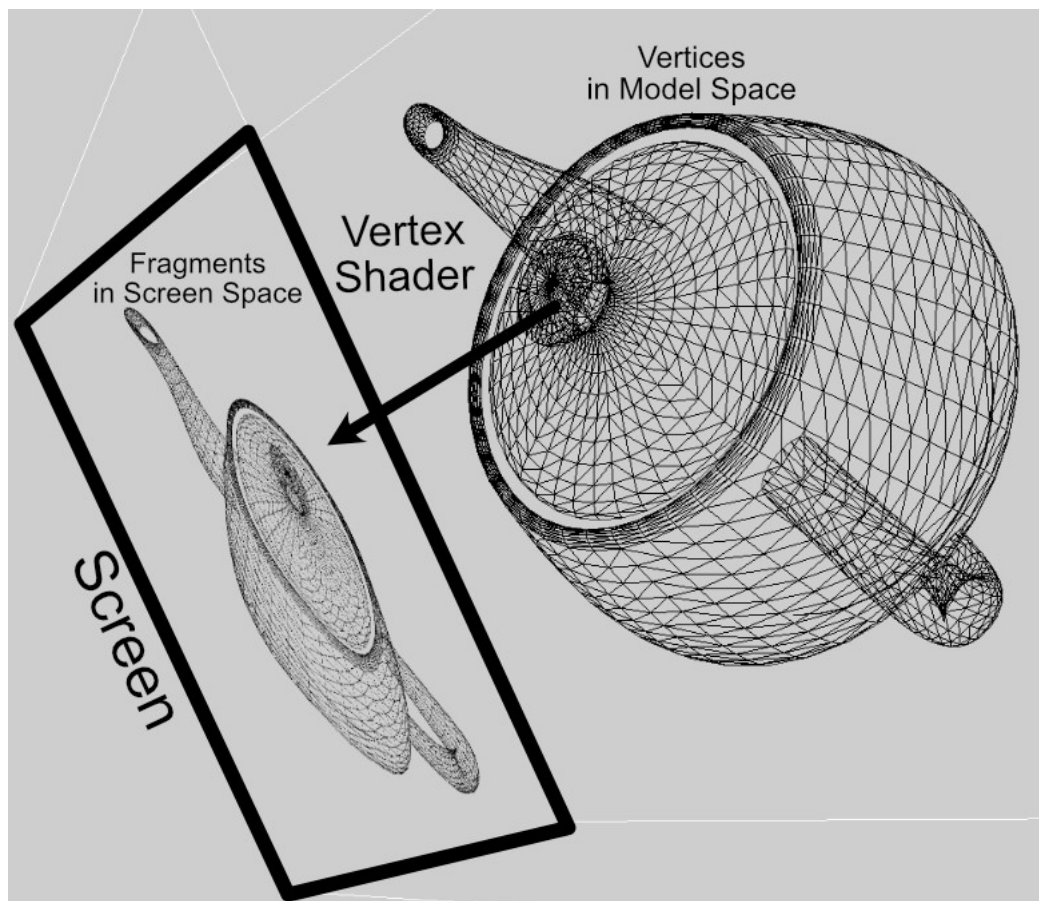
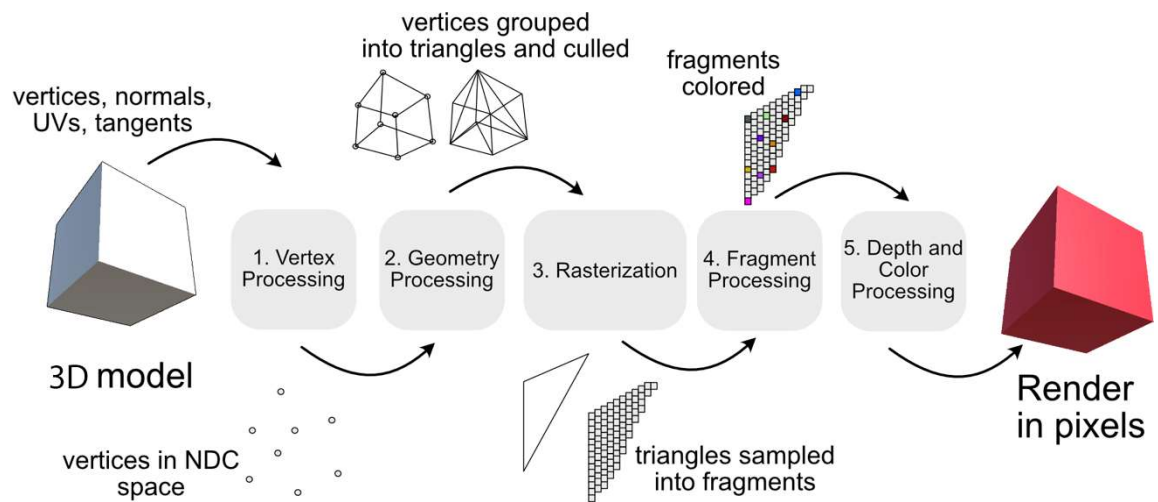
## Chapter 16: Rotating with Quaternions



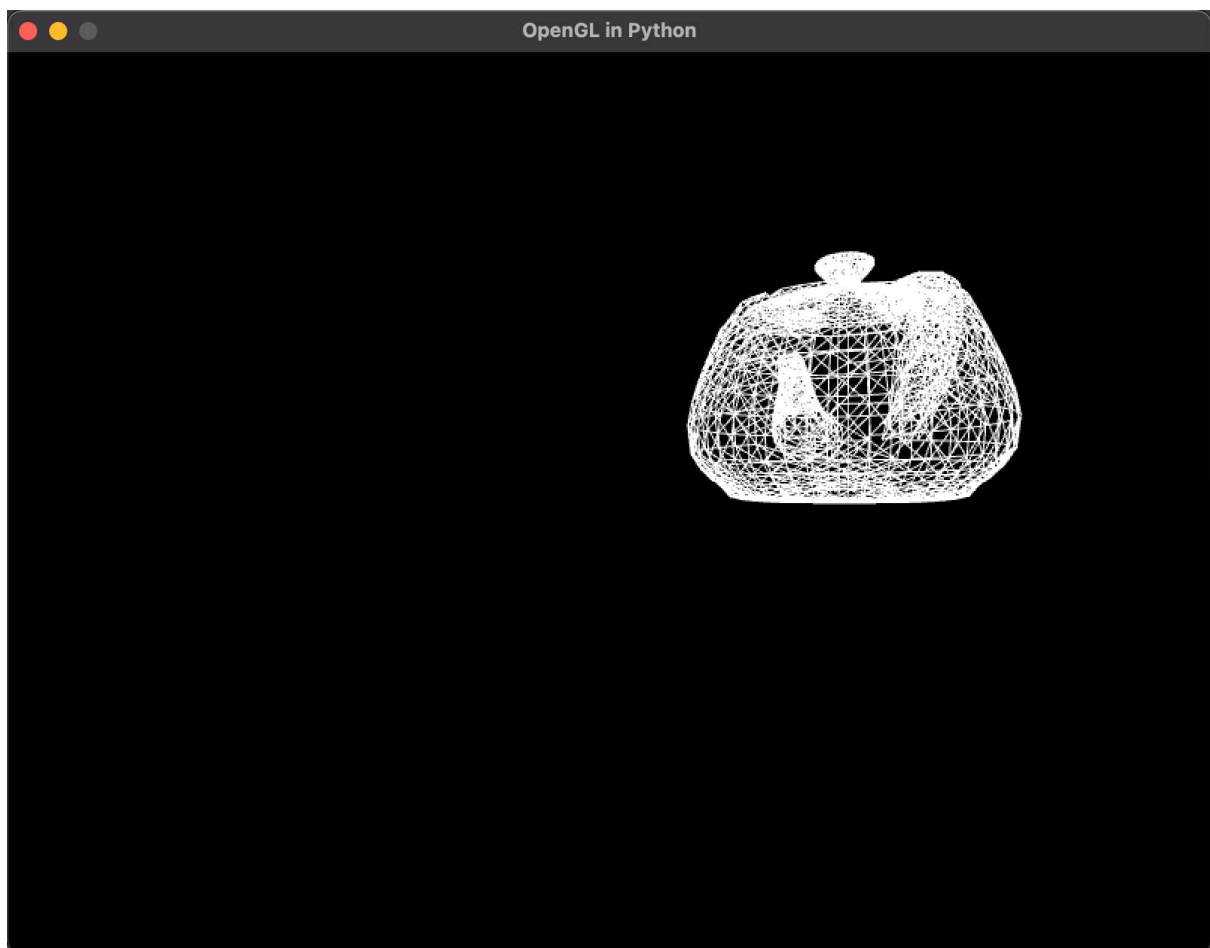
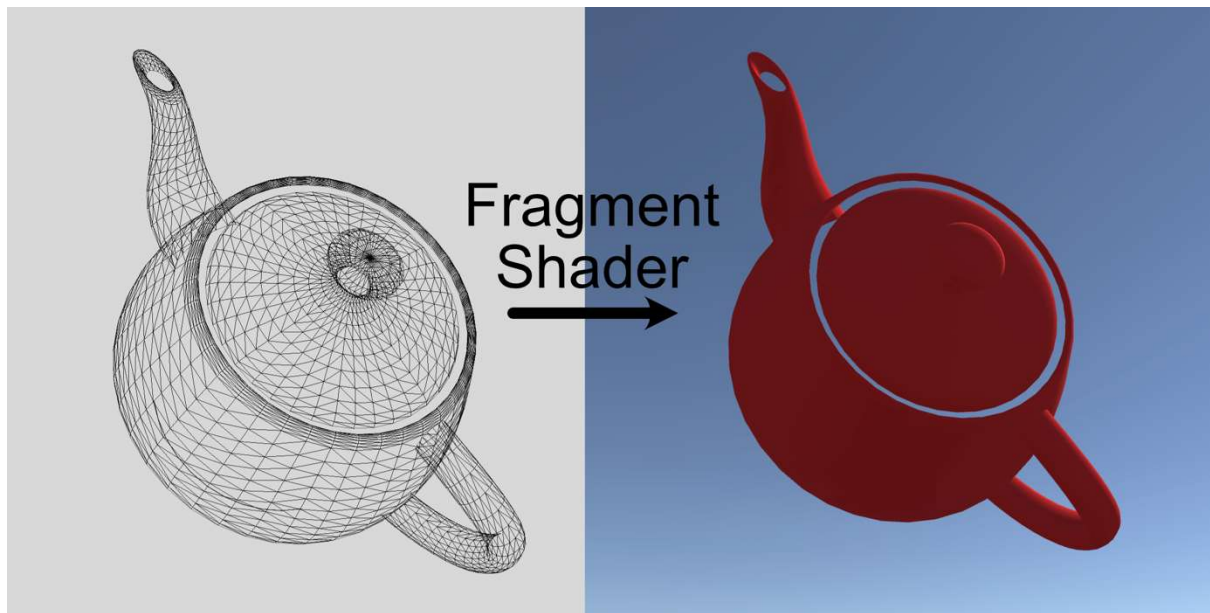




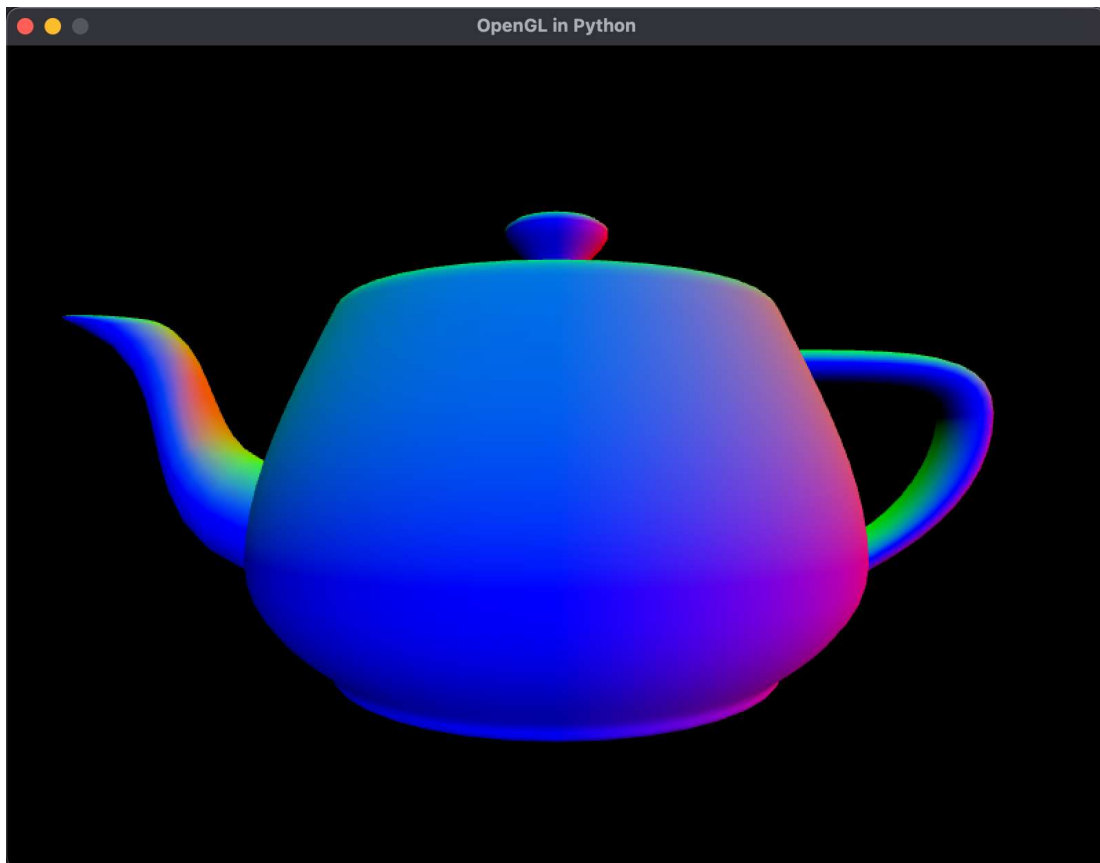
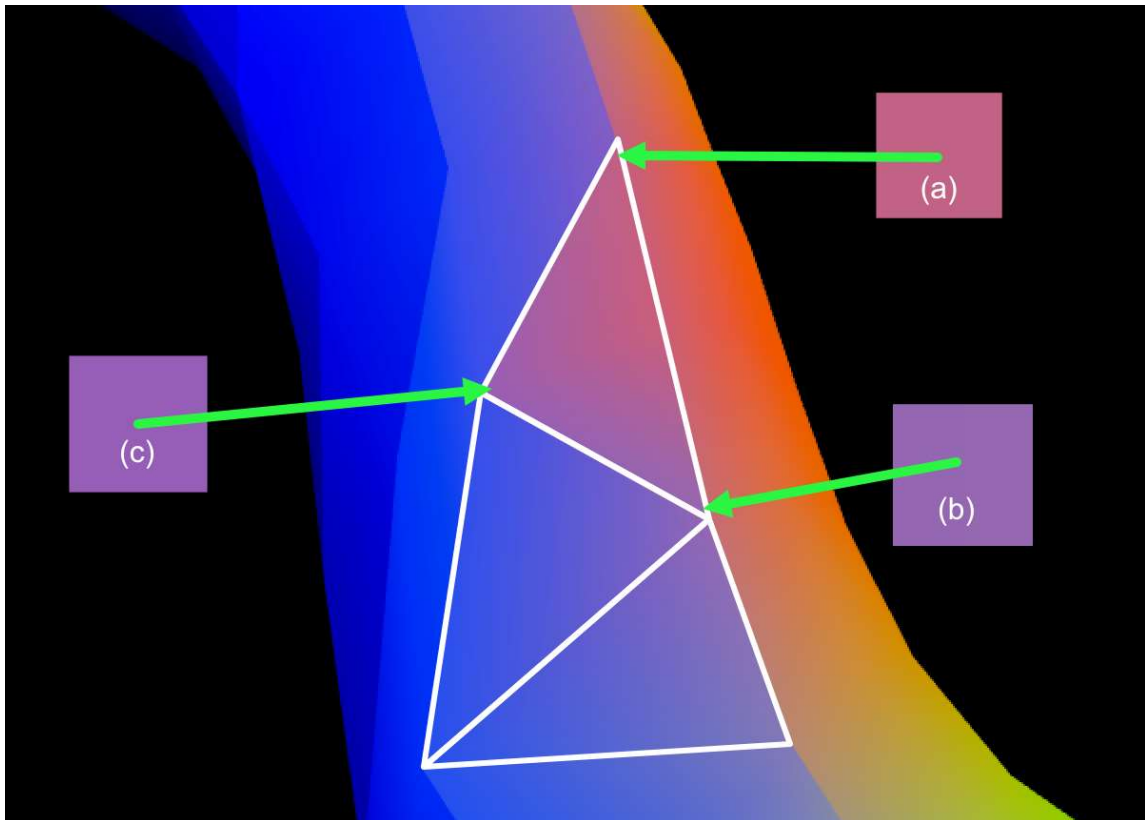
## Chapter 17: Vertex and fragment shading



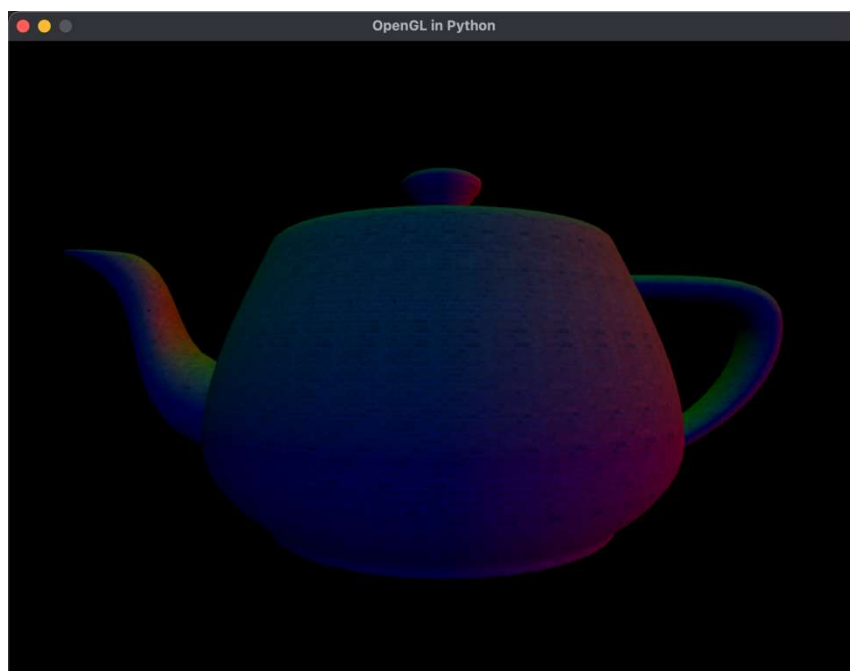
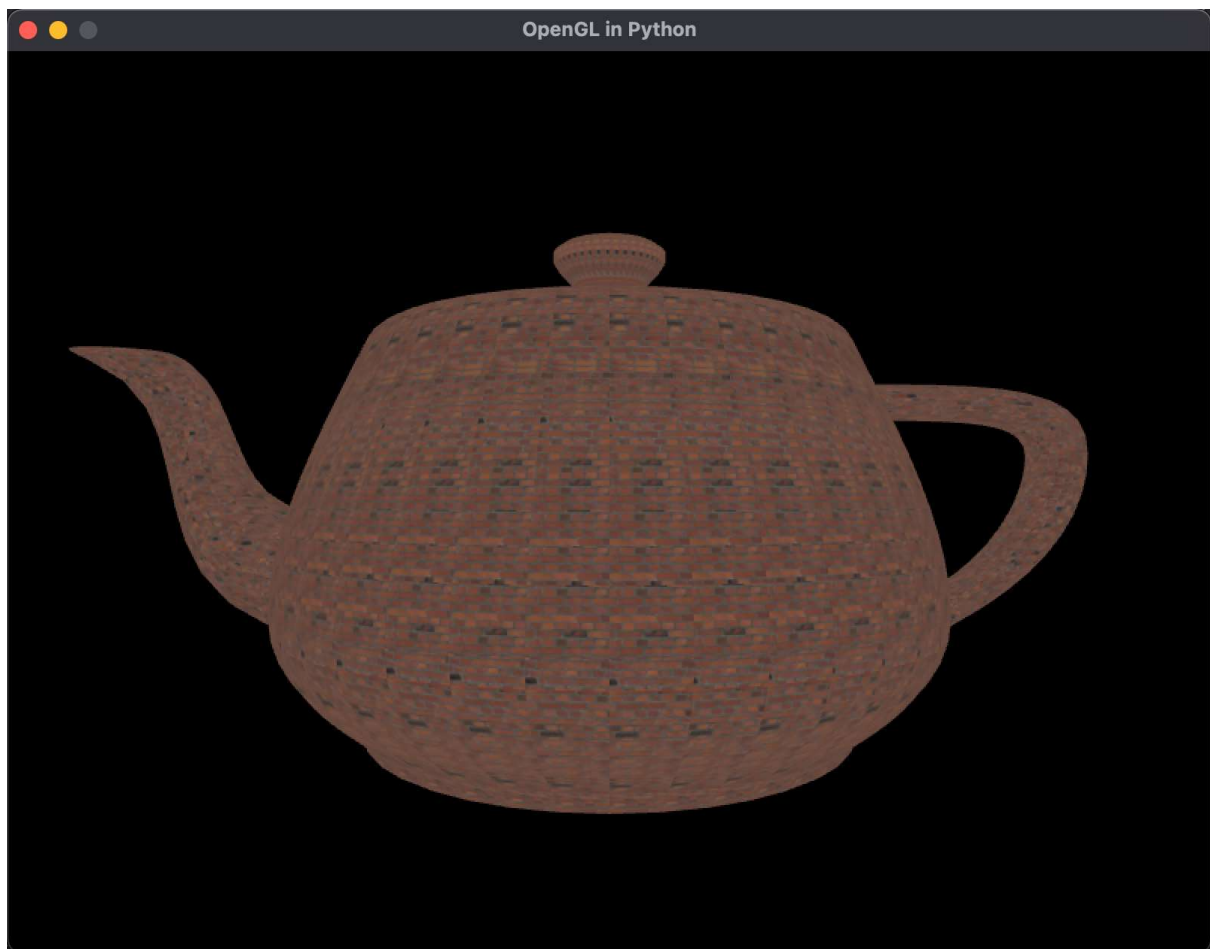


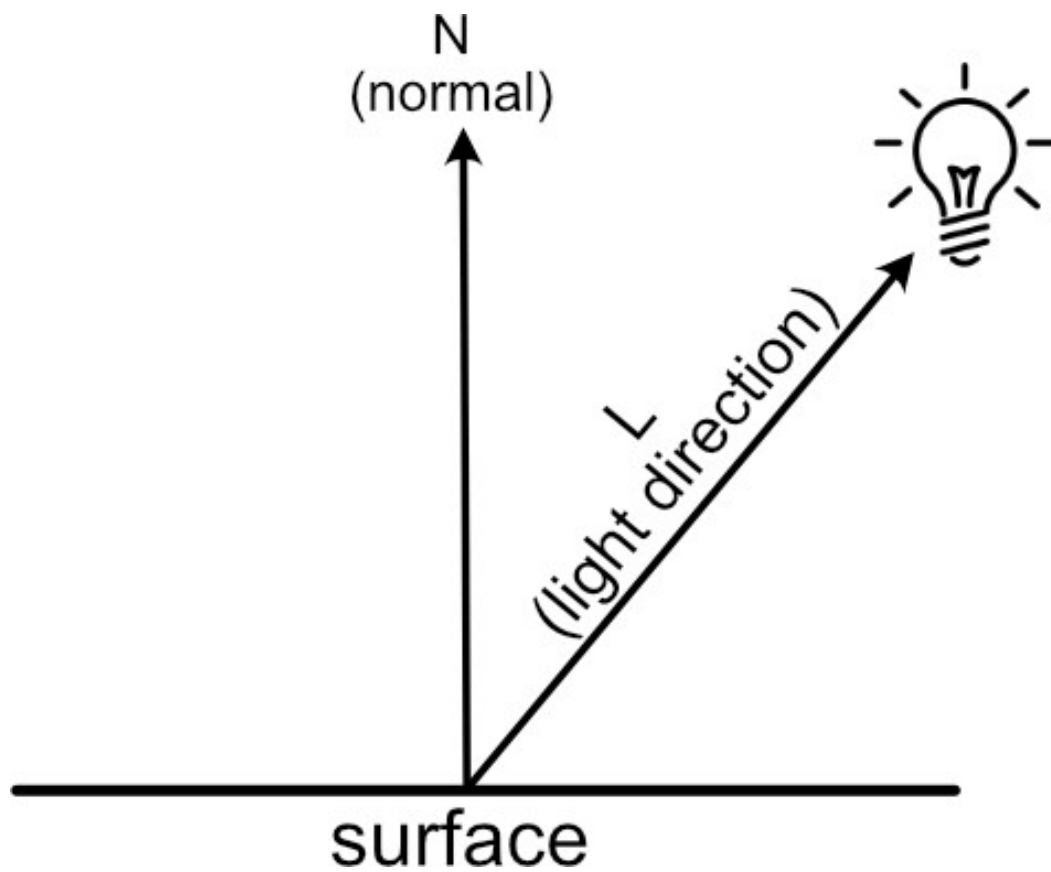
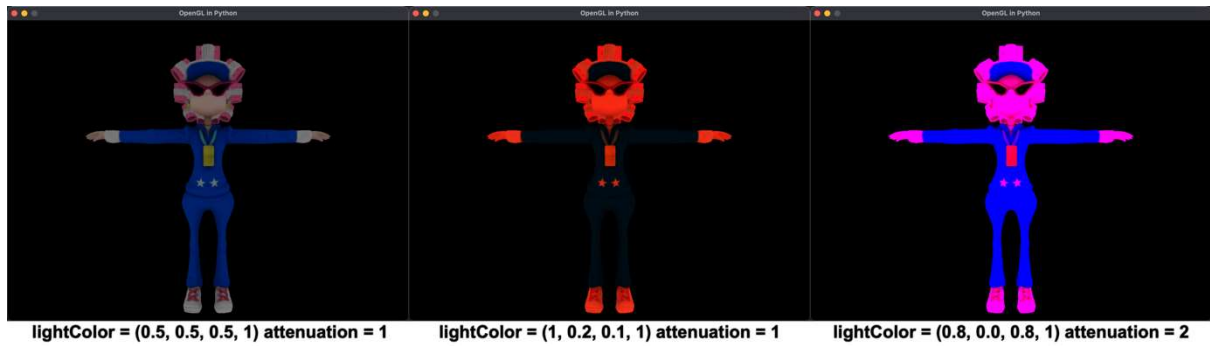
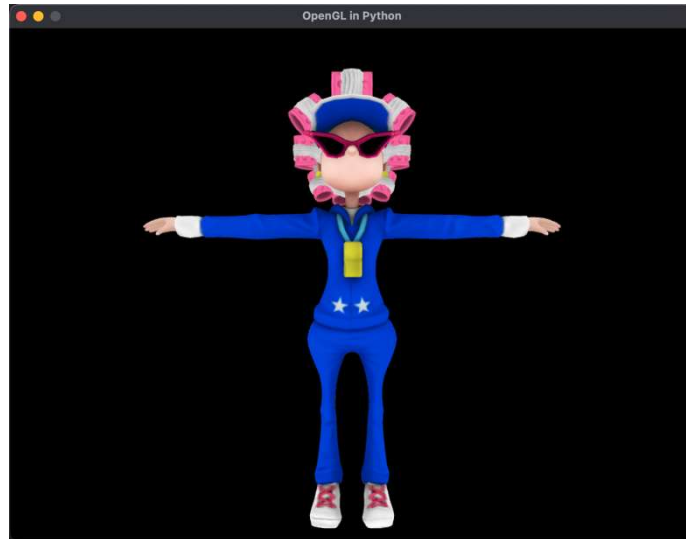


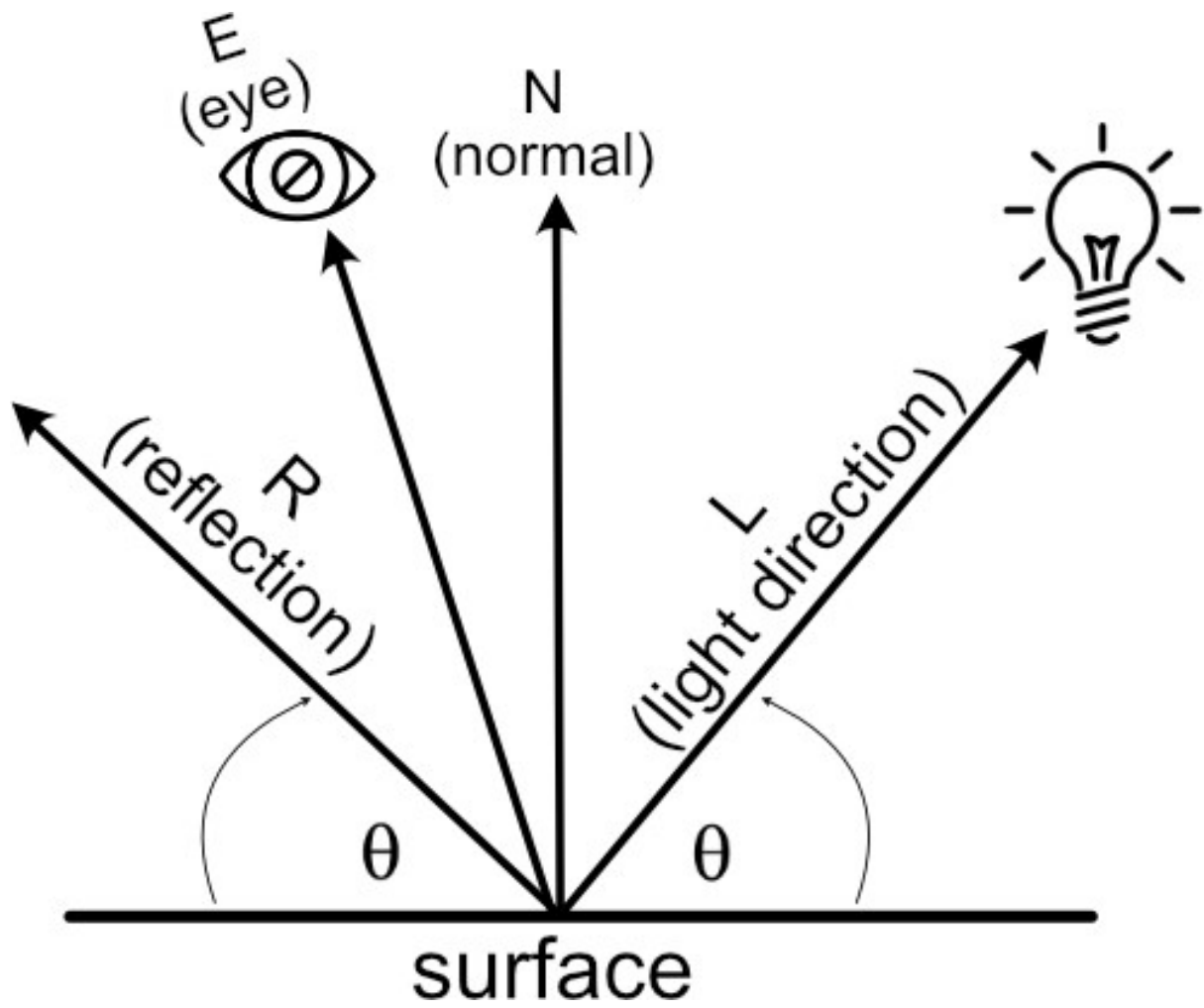
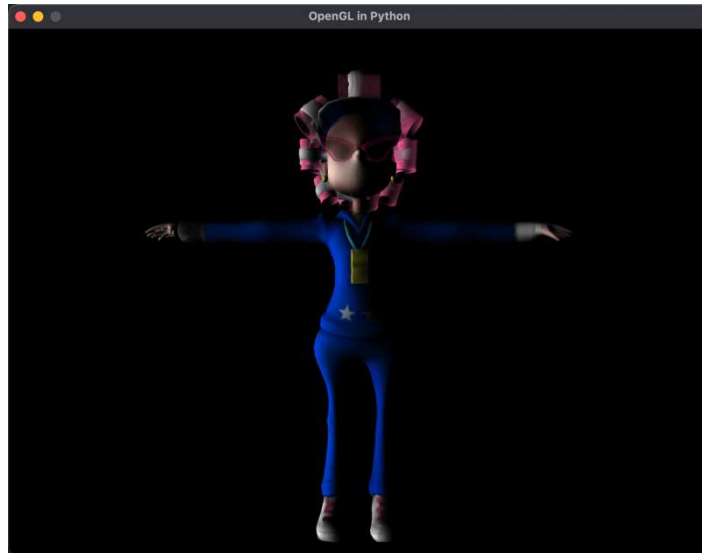
## Chapter 18: Customizing the Render Pipeline

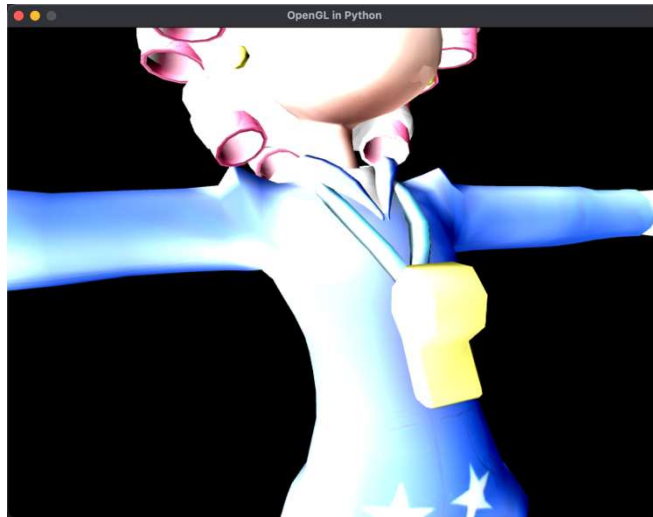




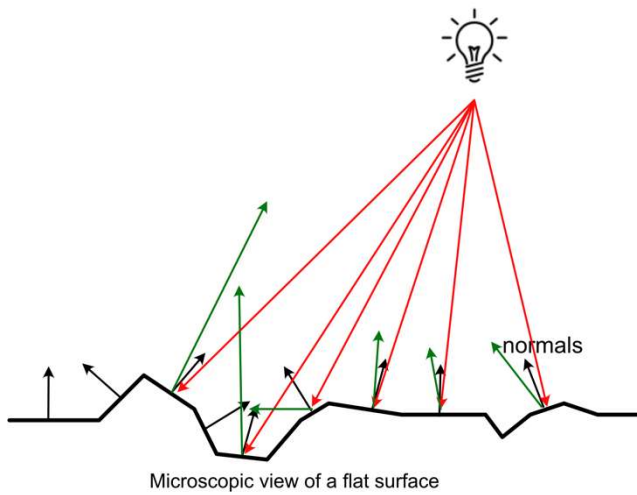
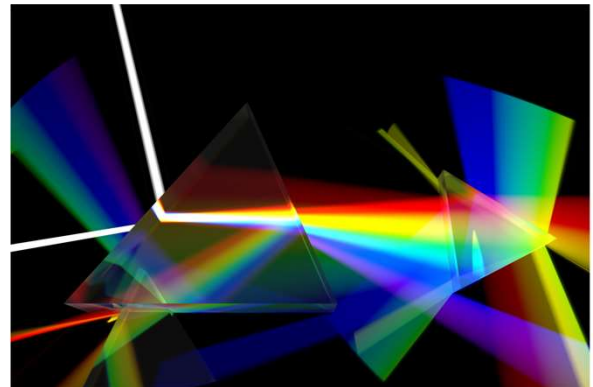
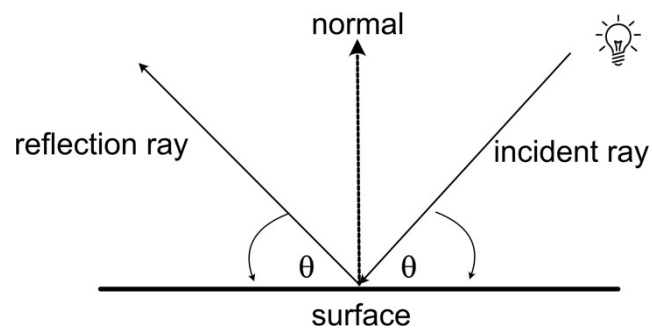








## Chapter 19: Rendering Visual Realism Like a Pro



Micro-faceted surface



Polished surface

