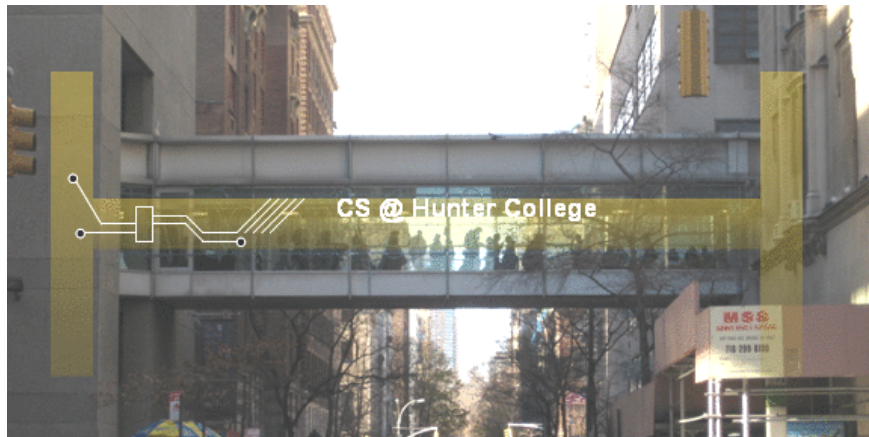


# CSci 127: Introduction to Computer Science



# Reminder

- Students often pose as expert even when they are not



# Reminder

- Students often pose as expert even when they are not
- Immediate, *easy* help is NOT REAL HELP



# Reminder



- Students often pose as expert even when they are not
- Immediate, *easy* help is NOT REAL HELP
- a.k.a. that student will not be there on your next interview
- **Please use class time to ask questions!**

# Reminder



- Students often pose as expert even when they are not
- Immediate, *easy* help is NOT REAL HELP
- a.k.a. that student will not be there on your next interview
- **Please use class time to ask questions!**
- Make an office hours appointment for further review!

# Tutoring is Fundamental



# Today's Topics



- Recap: Colors
- 2D Arrays & Image Files
- Decisions
- Design Challenge: Airplanes

# Today's Topics



- **Recap: Colors**
- 2D Arrays & Image Files
- Decisions
- Design Challenge: Airplanes



# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
```

```
thomasH = turtle.Turtle()
```

- i. #Change thomasH to be the color black:

```
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- ii. #Change thomasH to be the color white:

```
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- iii. #Change thomasH to be the brightest color blue:

```
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- iv. #Change thomasH to be the color purple:

```
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- v. #Change thomasH to be the color gray:

```
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

ii. #Change thomasH to be the color white:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iv. #Change thomasH to be the color purple:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

v. #Change thomasH to be the color gray:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- Need to fill in hexcodes (always start with #):

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("#       ")

ii. #Change thomasH to be the color white:
thomasH.color("#       ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("#       ")

iv. #Change thomasH to be the color purple:
thomasH.color("#       ")

v. #Change thomasH to be the color gray:
thomasH.color("#       ")
```

- Need to fill in hexcodes (always start with #): R R G G B B

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("#  ")

ii. #Change thomasH to be the color white:
thomasH.color("#  ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("#  ")

iv. #Change thomasH to be the color purple:
thomasH.color("#  ")

v. #Change thomasH to be the color gray:
thomasH.color("#  ")
```

- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("#  ")

ii. #Change thomasH to be the color white:
thomasH.color("#  ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("#  ")

iv. #Change thomasH to be the color purple:
thomasH.color("#  ")

v. #Change thomasH to be the color gray:
thomasH.color("#  ")
```

- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0
- White: F F F F F F

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

ii. #Change thomasH to be the color white:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

iv. #Change thomasH to be the color purple:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

v. #Change thomasH to be the color gray:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")
```

- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0
- White: F F F F F F
- Blue: 0 0 0 0 F F

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

ii. #Change thomasH to be the color white:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iv. #Change thomasH to be the color purple:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

v. #Change thomasH to be the color gray:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0
- White: F F F F F F
- Blue: 0 0 0 0 F F
- Purple: F F 0 0 F F

# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

ii. #Change thomasH to be the color white:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

iv. #Change thomasH to be the color purple:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")

v. #Change thomasH to be the color gray:
thomasH.color("# 

|  |  |  |  |  |  |
|--|--|--|--|--|--|
|  |  |  |  |  |  |
|--|--|--|--|--|--|

 ")
```

- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0
- White: F F F F F F
- Blue: 0 0 0 0 F F
- Purple: F F 0 0 F F
- Gray: 4 2 4 2 4 2



# Challenge

EmpID:

CSci 127 Mock Final, S19

2. (a) Fill in the boxes with the appropriate hexcode to change the color to match the comments:

```
import turtle
thomasH = turtle.Turtle()

i. #Change thomasH to be the color black:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

ii. #Change thomasH to be the color white:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

iii. #Change thomasH to be the brightest color blue:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")

iv. #Change thomasH to be the color purple:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")






v. #Change thomasH to be the color gray:
thomasH.color("# 

|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|

 ")
```






- Need to fill in hexcodes (always start with #): R R G G B B
- Black: 0 0 0 0 0 0
- White: F F F F F F
- Blue: 0 0 0 0 F F
- Purple: F F 0 0 F F
- Gray: 4 2 4 2 4 2 (any choice where RR = GG = BB).

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	






- Can specify by name.

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

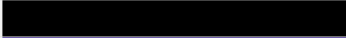




- Can specify by name.
- Can specify by numbers:

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	






- Can specify by name.
- Can specify by numbers:
  - ▶ Amount of Red, Green, and Blue (RGB).

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	






- Can specify by name.
- Can specify by numbers:
  - ▶ Amount of Red, Green, and Blue (RGB).
  - ▶ Adding light, not paint:

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

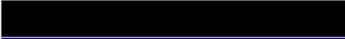




- Can specify by name.
- Can specify by numbers:
  - ▶ Amount of Red, Green, and Blue (RGB).
  - ▶ Adding light, not paint:
    - ★ Black: 0% red, 0% green, 0% blue

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

- Can specify by name.
- Can specify by numbers:
  - ▶ Amount of Red, Green, and Blue (RGB).
  - ▶ Adding light, not paint:
    - ★ Black: 0% red, 0% green, 0% blue
    - ★ White: 100% red, 100% green, 100% blue






# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

- Can specify by numbers (RGB):








# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	






- Can specify by numbers (RGB):
  - ▶ Fractions of each:  
e.g. (1.0, 0, 0) is 100% red, no green, and no blue.

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

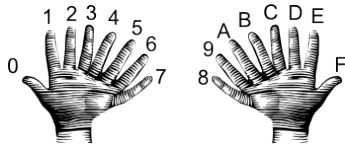
- Can specify by numbers (RGB):
  - ▶ Fractions of each:  
e.g. (1.0, 0, 0) is 100% red, no green, and no blue.
  - ▶ 8-bit colors: numbers from 0 to 255:  
e.g. (0, 255, 0) is no red, 100% green, and no blue.

# Recap: Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	






- Can specify by numbers (RGB):
  - ▶ Fractions of each:  
e.g. (1.0, 0, 0) is 100% red, no green, and no blue.
  - ▶ 8-bit colors: numbers from 0 to 255:  
e.g. (0, 255, 0) is no red, 100% green, and no blue.
  - ▶ Hexcodes (base-16 numbers)...

# Recap: Hexadecimal








00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
10	11	12	13	14	15	16	17	18	19	1A	1B	1C	1D	1E	1F
20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
30	31	32	33	34	35	36	37	38	39	3A	3B	3C	3D	3E	3F
40	41	42	43	44	45	46	47	48	49	4A	4B	4C	4D	4E	4F
50	51	52	53	54	55	56	57	58	59	5A	5B	5C	5D	5E	5F
60	61	62	63	64	65	66	67	68	69	6A	6B	6C	6D	6E	6F
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF
F0	F1	F2	F3	F4	F5	F6	F7	F8	F9	FA	FB	FC	FD	FE	FF

# Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

- Can specify by numbers (RGB):
  - ▶ Fractions of each:  
e.g. (1.0, 0, 0) is 100% red, no green, and no blue.
  - ▶ 8-bit colors: numbers from 0 to 255:  
e.g. (0, 255, 0) is no red, 100% green, and no blue.
  - ▶ Hexcodes (base-16 numbers):

# Colors

Color Name	HEX	Color
<u>Black</u>	<u>#000000</u>	
<u>Navy</u>	<u>#000080</u>	
<u>DarkBlue</u>	<u>#00008B</u>	
<u>MediumBlue</u>	<u>#0000CD</u>	
<u>Blue</u>	<u>#0000FF</u>	

- Can specify by numbers (RGB):
  - ▶ Fractions of each:  
e.g. (1.0, 0, 0) is 100% red, no green, and no blue.
  - ▶ 8-bit colors: numbers from 0 to 255:  
e.g. (0, 255, 0) is no red, 100% green, and no blue.
  - ▶ Hexcodes (base-16 numbers):  
e.g. #0000FF is no red, no green, and 100% blue.

# Today's Topics



- Recap: Colors
- **2D Arrays & Image Files**
- Decisions
- Design Challenge: Airplanes

# Arrays

- An **array** is a sequence of elements, much like a list.

1D array



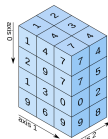
shape: (4,)

2D array



shape: (2, 3)

3D array



shape: (4, 3, 2)



# Arrays

1D array



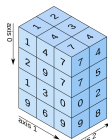
shape: (4,)

2D array



shape: (2, 3)

3D array

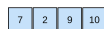


shape: (4, 3, 2)

- An **array** is a sequence of elements, much like a list.
- A **2D array** is like a grid of elements, think a list of lists.

# Arrays

1D array



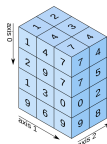
shape: (4,)

2D array



shape: (2, 3)

3D array

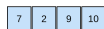


shape: (4, 3, 2)

- An **array** is a sequence of elements, much like a list.
- A **2D array** is like a grid of elements, think a list of lists.
- Can keep on adding dimensions (3D, etc.)

# Arrays

1D array



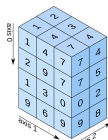
shape: (4,)

2D array



shape: (2, 3)

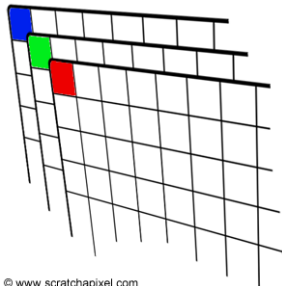
3D array



shape: (4, 3, 2)

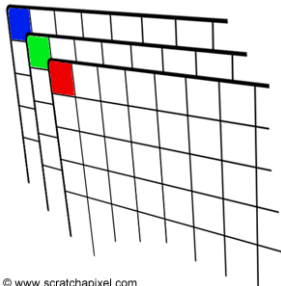
- An **array** is a sequence of elements, much like a list.
- A **2D array** is like a grid of elements, think a list of lists.
- Can keep on adding dimensions (3D, etc.)
- Can access pieces/slices as we do with strings and lists

# Images

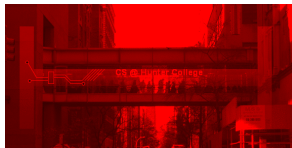


© www.scratchapixel.com

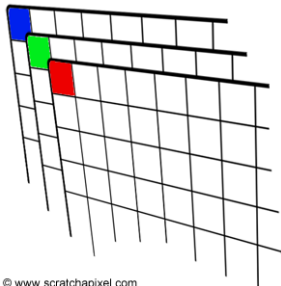
# Images



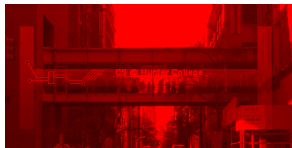
© www.scratchapixel.com



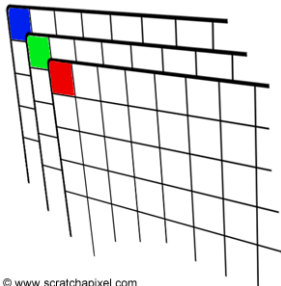
# Images



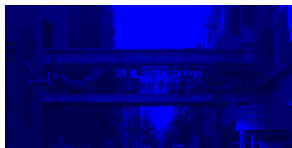
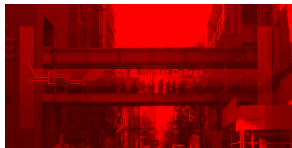
© www.scratchapixel.com



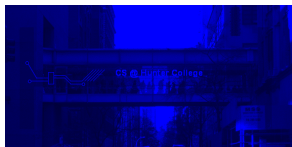
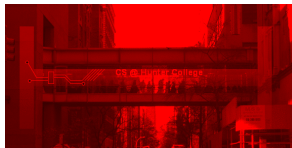
# Images



© www.scratchapixel.com



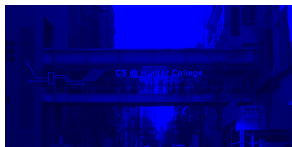
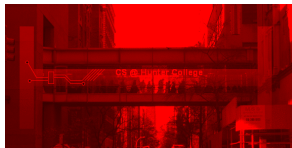
# Useful Packages



- We will use 2 useful packages for images:

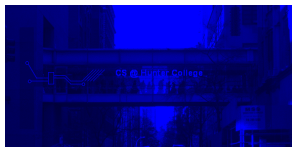
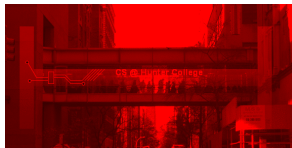


# Useful Packages



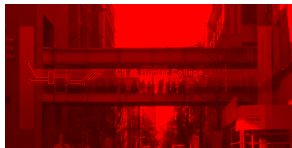
- We will use 2 useful packages for images:
  - ▶ `numpy`: numerical analysis package

# Useful Packages



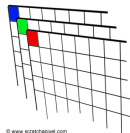
- We will use 2 useful packages for images:
  - ▶ `numpy`: numerical analysis package
  - ▶ `pyplot`: part of `matplotlib` for making graphs and plots

# Useful Packages



- We will use 2 useful packages for images:
  - ▶ `numpy`: numerical analysis package
  - ▶ `pyplot`: part of `matplotlib` for making graphs and plots
- See lab notes for installing on your home machine.

# Images with pyplot and numpy



#Import the packages for images and arrays:

```
import matplotlib.pyplot as plt
```

```
import numpy as np
```

```
img = plt.imread('csBridge.png')
```

```
plt.imshow(img)
```

```
plt.show()
```

#Read in image from csBridge.png

#Load image into pyplot

#Show the image (waits until close

```
img2 = img.copy()
```

```
img2[:, :, 1] = 0
```

```
img2[:, :, 2] = 0
```

#make a copy of our image

#Set the green channel to 0

#Set the blue channel to 0

```
plt.imshow(img2)
```

```
plt.show()
```

#Load our new image into pyplot

#Show the image (waits until closed to conti

```
plt.imsave('reds.png', img2) #Save the image we created to the file:
```

# Images with pyplot and numpy



#Import the packages for images and arrays:

```
import matplotlib.pyplot as plt
```

```
import numpy as np
```

```
img = plt.imread('csBridge.png')
```

```
plt.imshow(img)
```

```
plt.show()
```

#Read in image from csBridge.png

#Load image into pyplot

#Show the image (waits until close

```
img2 = img.copy()
```

```
img2[:, :, 1] = 0
```

```
img2[:, :, 2] = 0
```

#make a copy of our image

#Set the green channel to 0

#Set the blue channel to 0

```
plt.imshow(img2)
```

```
plt.show()
```

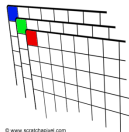
#Load our new image into pyplot

#Show the image (waits until closed to conti

```
plt.imsave('reds.png', img2) #Save the image we created to the file:
```

# Creating Images

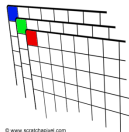
To create an image from scratch:



# Creating Images

To create an image from scratch:

- 1 Import the libraries.



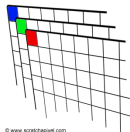
© www.scratchapixel.com

# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```



© www.scratchapixel.com



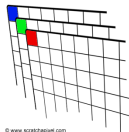
# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image— easy to set all color



© www.scratchapixel.com

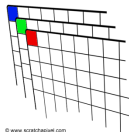
# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image— easy to set all color  
  - 1 to 0% (black):



© www.scratchapixel.com

# Creating Images

To create an image from scratch:

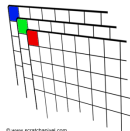
- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image– easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```



# Creating Images

To create an image from scratch:

- 1 Import the libraries.

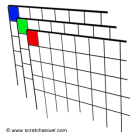
```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image– easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):



© www.scratchapixel.com

# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

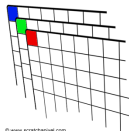
- 2 Create the image– easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):

```
img = np.ones( (num,num,3) )
```



© www.korshapost.com

# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image– easy to set all color

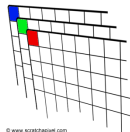
- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):

```
img = np.ones( (num,num,3) )
```

- 3 *Do stuff to the pixels to make your image*



# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image– easy to set all color

- 1 to 0% (black):

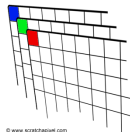
```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):

```
img = np.ones( (num,num,3) )
```

- 3 *Do stuff to the pixels to make your image*

- 4 You can display your image:



# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt
import numpy as np
```

- 2 Create the image– easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

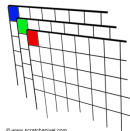
- 2 to 100% (white):

```
img = np.ones( (num,num,3) )
```

- 3 *Do stuff to the pixels to make your image*

- 4 You can display your image:

```
plt.imshow(img)
plt.show()
```



© www.korshapost.com



# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image— easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):

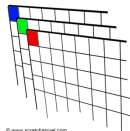
```
img = np.ones( (num,num,3) )
```

- 3 *Do stuff to the pixels to make your image*

- 4 You can display your image:

```
plt.imshow(img)  
plt.show()
```

- 5 And save your image:



# Creating Images

To create an image from scratch:

- 1 Import the libraries.

```
import matplotlib.pyplot as plt  
import numpy as np
```

- 2 Create the image— easy to set all color

- 1 to 0% (black):

```
img = np.zeros( (num,num,3) )
```

- 2 to 100% (white):

```
img = np.ones( (num,num,3) )
```

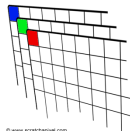
- 3 *Do stuff to the pixels to make your image*

- 4 You can display your image:

```
plt.imshow(img)  
plt.show()
```

- 5 And save your image:

```
plt.imsave('myImage.png', img)
```



© www.korshapost.com

# More on numpy arrays

```
>>> a[0,3:5]  
array([3,4])
```

```
>>> a[4:,4:]  
array([[44, 45],  
       [54, 55]])
```

```
>>> a[:,2]  
array([2,12,22,32,42,52])
```

```
>>> a[2::2,::2]  
array([[20,22,24],  
       [40,42,44]])
```

0	1	2	3	4	5
10	11	12	13	14	15
20	21	22	23	24	25
30	31	32	33	34	35
40	41	42	43	44	45
50	51	52	53	54	55

numpy tutorial

# Slicing & Image Examples

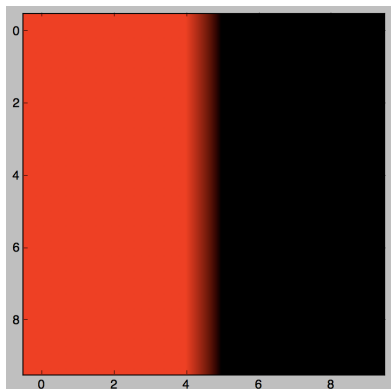
- Basic pattern: *img[rows, columns, channels]* with: *start:stop:step*.

# Slicing & Image Examples

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:
  - ▶ `img = np.zeros( (10,10,3) )`  
`img[0:10,0:5,0:1] = 1`

# Slicing & Image Examples

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:
  - ▶ `img = np.zeros( (10,10,3) )`  
`img[0:10,0:5,0:1] = 1`



# Slicing & Image Examples

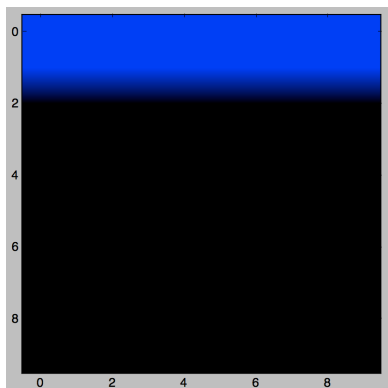
- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ num = 10  
  img = np.zeros( (num,num,3) )  
  img[0:2,:,2:3] = 1.0
```

# Slicing & Image Examples

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ num = 10  
  img = np.zeros( (num,num,3) )  
  img[0:2,:,2:3] = 1.0
```





# Slicing & Image Examples

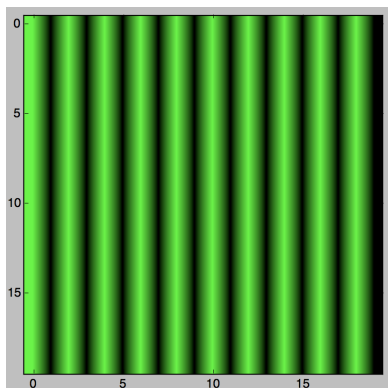
- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ num = int(input('Enter size'))  
  img = np.zeros( (num,num,3) )  
  img[:,::2,1] = 1.0
```

# Slicing & Image Examples

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ num = int(input('Enter size'))  
img = np.zeros( (num,num,3) )  
img[:,::2,1] = 1.0
```



# Challenge

- Basic pattern: *img[rows, columns, channels]* with: *start:stop:step*.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ img = np.ones( (10,10,3) )  
  img[0:10,0:5,0:2] = 0
```

# Challenge

- Basic pattern: *img[rows, columns, channels]* with: *start:stop:step*.
- Assuming the libraries are imported, what do the following code fragments produce:

- ▶ 

```
img = np.ones( (10,10,3) )  
img[0:10,0:5,0:2] = 0
```
- ▶ 

```
num = int(input('Enter size '))  
img = np.ones( (num,num,3) )  
img[::2,::,1:] = 0
```

# Challenge

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

- ▶ `img = np.ones( (10,10,3) )`  
`img[0:10,0:5,0:2] = 0`
- ▶ `num = int(input('Enter size '))`  
`img = np.ones( (num,num,3) )`  
`img[::2,::,1:] = 0`
- ▶ `img = np.zeros( (8,8,3) )`  
`img[::2,::2,0] = 1`

# Challenge

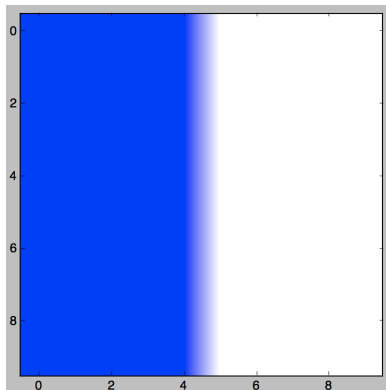
- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
► img = np.ones( (10,10,3) )  
  img[0:10,0:5,0:2] = 0
```

# Challenge

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
► img = np.ones( (10,10,3) )  
  img[0:10,0:5,0:2] = 0
```



# Challenge

- Basic pattern: *img[rows, columns, channels]* with: *start:stop:step*.
- Assuming the libraries are imported, what do the following code fragments produce:

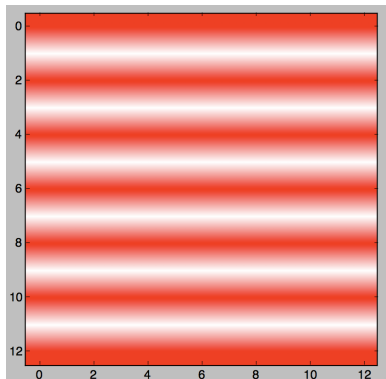
```
▶ num = int(input('Enter size '))  
  img = np.ones( (num,num,3) )  
  img[::2,:,1:] = 0
```



# Challenge

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
▶ num = int(input('Enter size '))  
img = np.ones( (num,num,3) )  
img[::2,:,1:] = 0
```



# Challenge

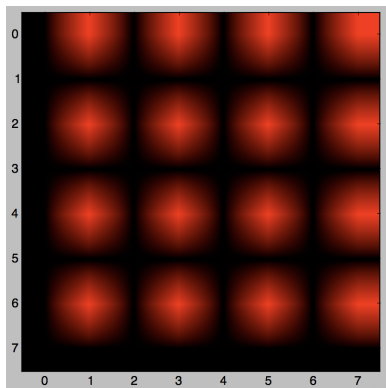
- Basic pattern: *img[rows, columns, channels]* with: *start:stop:step*.
- Assuming the libraries are imported, what do the following code fragments produce:

```
► img = np.zeros( (8,8,3) )  
  img[::2,1::2,0] = 1
```

# Challenge

- Basic pattern: `img[rows, columns, channels]` with: `start:stop:step`.
- Assuming the libraries are imported, what do the following code fragments produce:

```
► img = np.zeros( (8,8,3) )  
  img[::2,1::2,0] = 1
```



# Challenge

	0	1	2	3	4	5	6	7	8	9
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

- ① Design a 10 by 10 logo for Hunter College that contains a purple 'H'.

# Challenge

	0	1	2	3	4	5	6	7	8	9
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

- ① Design a 10 by 10 logo for Hunter College that contains a purple 'H'.
- ② Your logo should only contain the colors purple and white.

# Challenge

	0	1	2	3	4	5	6	7	8	9
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

- ① Design a 10 by 10 logo for Hunter College that contains a purple 'H'.
- ② Your logo should only contain the colors purple and white.
- ③ How can you make Python draw the logo?  
Write down a "To Do" list of things you need to do.

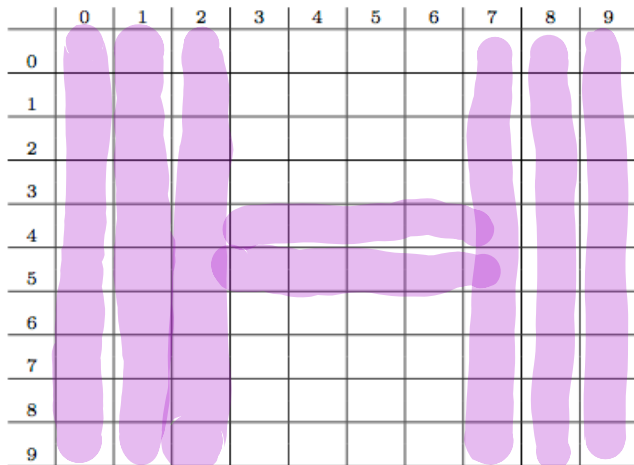
# Challenge

	0	1	2	3	4	5	6	7	8	9
0										
1										
2										
3										
4										
5										
6										
7										
8										
9										

- ① Design a 10 by 10 logo for Hunter College that contains a purple 'H'.
- ② Your logo should only contain the colors purple and white.
- ③ How can you make Python draw the logo?  
Write down a "To Do" list of things you need to do.
- ④ If time, refine your steps above into a Python program.

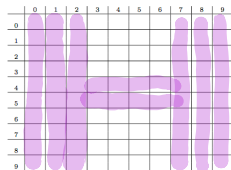
# Design a Hunter Logo

One possible solution:



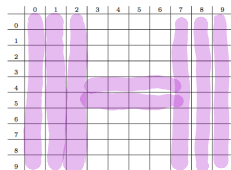


# Design a Hunter Logo



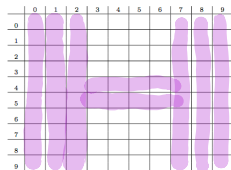
- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

# Design a Hunter Logo



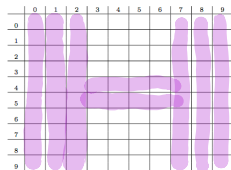
- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.
- 2 Set the 3 left columns to be purple.

# Design a Hunter Logo



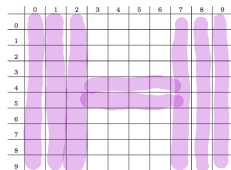
- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.
- 2 Set the 3 left columns to be purple.
- 3 Set the 3 right columns to be purple.

# Design a Hunter Logo



- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.
- 2 Set the 3 left columns to be purple.
- 3 Set the 3 right columns to be purple.
- 4 Set the middle 2 rows to be purple.

# Design a Hunter Logo



- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.
- 2 Set the 3 left columns to be purple.
- 3 Set the 3 right columns to be purple.
- 4 Set the middle 2 rows to be purple.
- 5 Save `logo` array to a file.

# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

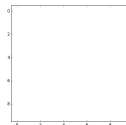
```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))  #10x10 array with 3 sheets of 1's
```



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```



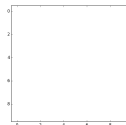


# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.



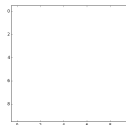
# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```



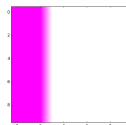
# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

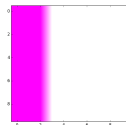
```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

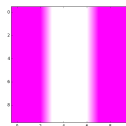
```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

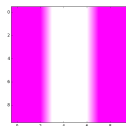
- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```

- 4 Set the middle 2 rows to be purple.



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

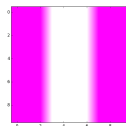
```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```

- 4 Set the middle 2 rows to be purple.

```
logoImg[4:6, :, 1] = 0 #Turn the green to 0 for middle rows
```



# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

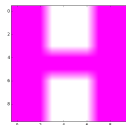
```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```

- 4 Set the middle 2 rows to be purple.

```
logoImg[4:6, :, 1] = 0 #Turn the green to 0 for middle rows
```





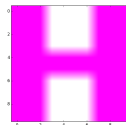
# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))  #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:, :3, 1] = 0 #Turn the green to 0 for first 3 columns
```



- 3 Set the 3 right columns to be purple.

```
logoImg[:, -3:, 1] = 0 #Turn the green to 0 for last 3 columns
```

- 4 Set the middle 2 rows to be purple.

```
logoImg[4:6, :, 1] = 0 #Turn the green to 0 for middle rows
```

- 5 Save `logo` array to file.

# Translating the Design to Code

- 1 Create a 10 by 10 array, `logo`, that starts out as all white pixels.

```
import matplotlib.pyplot as plt #import libraries for plotting
import numpy as np             #and for arrays (to hold images)
logoImg = np.ones((10,10,3))   #10x10 array with 3 sheets of 1's
```

- 2 Set the 3 left columns to be purple.

```
#To make purple, we'll keep red and blue at 100% and turn green to 0%
logoImg[:,0:3,1] = 0 #Turn the green to 0 for first 3 columns
```

- 3 Set the 3 right columns to be purple.

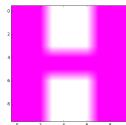
```
logoImg[:,7:10,1] = 0 #Turn the green to 0 for last 3 columns
```

- 4 Set the middle 2 rows to be purple.

```
logoImg[4:6,:,1] = 0 #Turn the green to 0 for middle rows
```

- 5 Save logo array to file.

```
plt.imsave("logo.png", logoImg) #Save the image to logo.png
```



# Today's Topics



- Recap: Colors
- 2D Arrays & Image Files
- **Decisions**
- Design Challenge: Airplanes

# Challenge

*Predict what these will do (novel concepts):*

```
yearBorn = int(input('Enter year born: '))
if yearBorn < 1946:
    print("Greatest Generation")
elif yearBorn <= 1964:
    print("Baby Boomer")
elif yearBorn <= 1984:
    print("Generation X")
elif yearBorn <= 2004:
    print("Millennial")
else:
    print("TBD")

x = int(input('Enter number: '))
if x % 2 == 0:
    print('Even number')
else:
    print('Odd number')
```

```
import turtle

tess = turtle.Turtle()
myWin = turtle.Screen()      #The graphics window
commands = input("Please enter a command string: ")

for ch in commands:
    #perform action indicated by the character
    if ch == 'F':              #move forward
        tess.forward(50)
    elif ch == 'L':            #turn left
        tess.left(90)
    elif ch == 'R':            #turn right
        tess.right(90)
    elif ch == 'A':            #lift pen
        tess.penup()
    elif ch == 'v':            #lower pen
        tess.pendown()
    elif ch == 'B':            #go backwards
        tess.backward(50)
    elif ch == 'r':            #turn red
        tess.color("red")
    elif ch == 'g':            #turn green
        tess.color("green")
    elif ch == 'b':            #turn blue
        tess.color("blue")
    else:                      #for any other character
        print("Error: do not know the command:", c)
```

# Python Tutor

```
yearBorn = int(input('Enter year born: '))
if yearBorn < 1946:
    print("Greatest Generation")
elif yearBorn <= 1964:
    print("Baby Boomer")
elif yearBorn <= 1984:
    print("Generation X")
elif yearBorn <= 2004:
    print("Millennial")
else:
    print("TBD")

x = int(input('Enter number: '))
if x % 2 == 0:
    print('Even number')
else:
    print('Odd number')
```

(Demo with pythonTutor)

# IDLE

```
import turtle

tess = turtle.Turtle()
myWin = turtle.Screen()    #The graphics window
commands = input("Please enter a command string: ")

for ch in commands:
    #perform action indicated by the character
    if ch == 'F':           #move forward
        tess.forward(50)
    elif ch == 'L':         #turn left
        tess.left(90)
    elif ch == 'R':         #turn right
        tess.right(90)
    elif ch == '^':         #lift pen
        tess.penup()
    elif ch == 'v':         #lower pen
        tess.pendown()
    elif ch == 'B':         #go backwards
        tess.backward(50)
    elif ch == 'r':         #turn red
        tess.color("red")
    elif ch == 'g':         #turn green
        tess.color("green")
    elif ch == 'b':         #turn blue
        tess.color("blue")
    else:                   #for any other character
        print("Error: do not know the command:", c)
```

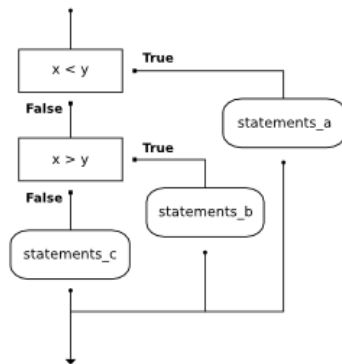
(Demo with IDLE)

# Decisions

```
if x < y:  
    print("x is less than y")  
elif x > y:  
    print("x is greater than y")  
else:  
    print("x and y must be equal")
```

# Decisions

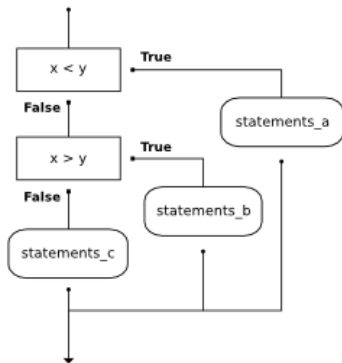
```
if x < y:  
    print("x is less than y")  
elif x > y:  
    print("x is greater than y")  
else:  
    print("x and y must be equal")
```





# Decisions

```
if x < y:  
    print("x is less than y")  
elif x > y:  
    print("x is greater than y")  
else:  
    print("x and y must be equal")
```



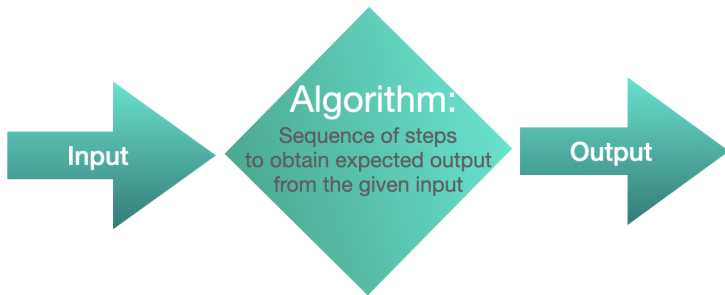
(This was just a first glance, will do much more on decisions over the next several weeks.)

# Today's Topics

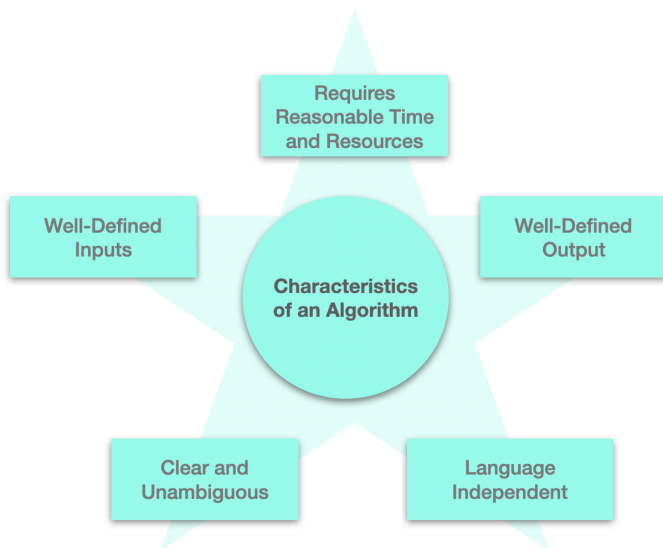


- Recap: Colors
- 2D Arrays & Image Files
- Decisions
- **Design Challenge: Airplanes**

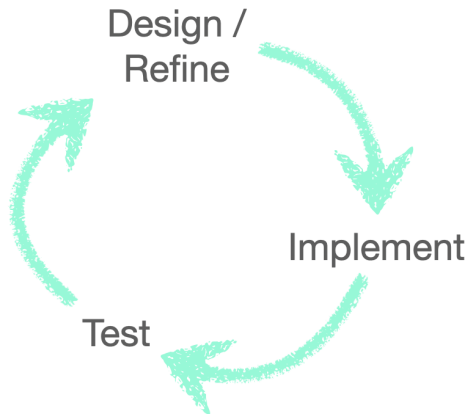
# What is an Algorithm?



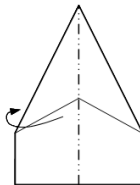
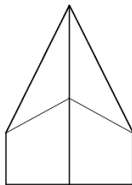
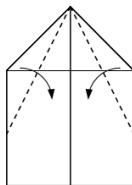
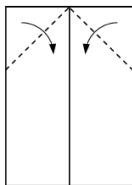
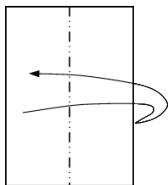
# Characteristics of an Algorithm



# Algorithm Design Cycle

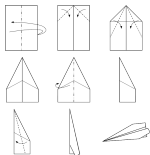


# Design Challenge: Planes



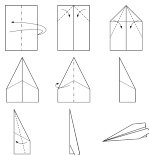
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.



# Design Challenge: Planes

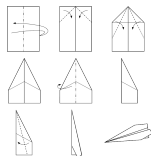
- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist:





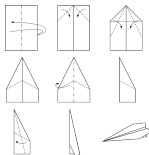
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs



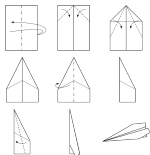
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:



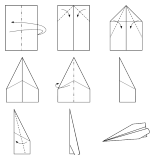
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:
  - ▶ Write down your design .



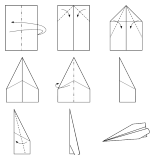
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:
  - ▶ Write down your design .
  - ▶ Exchange your design and a blank sheet of paper (**Input**) with a family member or friend.



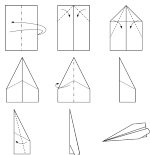
# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:
  - ▶ Write down your design .
  - ▶ Exchange your design and a blank sheet of paper (**Input**) with a family member or friend.
  - ▶ Ask them to follow your design to build an airplane **without consulting you**.



# Design Challenge: Planes

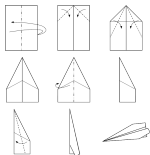
- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:



- ▶ Write down your design .
- ▶ Exchange your design and a blank sheet of paper (**Input**) with a family member or friend.
- ▶ Ask them to follow your design to build an airplane **without consulting you**.
- ▶ When they are done, observe the folded airplane (**Output**) and **revise your algorithm**.

# Design Challenge: Planes

- A classic write-an-algorithm challenge for introductory programming.
- With a slight twist: refining designs
- After class:



- ▶ Write down your design .
- ▶ Exchange your design and a blank sheet of paper (**Input**) with a family member or friend.
- ▶ Ask them to follow your design to build an airplane **without consulting you**.
- ▶ When they are done, observe the folded airplane (**Output**) and **revise your algorithm**.
- ▶ Repeat until you are satisfied with your airplane.

# Recap



- In Python, we introduced:



# Recap



- In Python, we introduced:
  - ▶ Recap: Colors
  - ▶ 2D Array & Image Files
  - ▶ Decisions

# Weekly Reminders!



Before next lecture, don't forget to:

- Review this week's Lecture and Lab

# Weekly Reminders!



Before next lecture, don't forget to:

- Review this week's Lecture and Lab
- Take the Lab Quiz on Gradescope by 9pm today

# Weekly Reminders!



Before next lecture, don't forget to:

- Review this week's Lecture and Lab
- Take the Lab Quiz on Gradescope by 9pm today
- Submit this class's 5 programming assignments (programs 16-20)