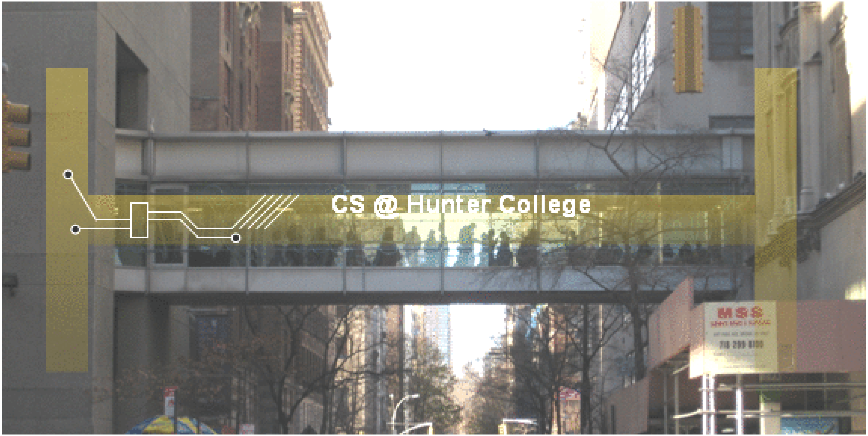
CSci 127: Introduction to Computer Science



hunter.cuny.edu/csci

Announcements

CSci 127 Lab Schedule, Spring 2019				
M	T	W	Th	F
				1/25 L1*
1/28 L1	1/29 L1 Lecture 1	1/30 L1	1/31 L1	2/1 L1
2/4 L2	2/5 L2 Lecture 2	2/6 L2	2/7 L2	2/8 L2
2/11 L3	No class	2/13 L3	2/14 L3	2/15 L3
No class	2/19 L3 Lecture 3	2/20 L4	2/21 L4	2/22 L4
2/25 L4	2/26 L4 Lecture 4	2/27 L5	2/28 L5	3/1 L5
3/4 L5	3/5 L5 Lecture 5	3/6 L6	3/7 L6	3/8 L6
3/11 L6	3/12 L6 Lecture 6	3/13 L7	3/14 L7	3/15 L7
3/18 L7	3/19 L7 Lecture 7	3/20 L8	3/21 L8	3/22 L8
3/25 L8	3/26 L8 Lecture 8	3/27 L9	3/28 L9	3/29 L9
4/1 L9	4/2 L9 Lecture 9	4/3 L10	4/4 L10	4/5 L10
4/8 L10	4/9 L10 Lecture 10	4/10 L11	4/11 L11	4/12 L11
4/15 L11	4/16 L11 Lecture 11	4/17 L12	4/18 L12	No class
No class	No class	No class	No class	No class
4/29 L12	4/30 L12 Lecture 12	5/1 L13	5/2 L13	5/3 L12
5/6 L13	5/7 L13 Lecture 13	5/8 L14	5/9 L14	5/10 L13/L14*
5/13 L14	5/14 L14 Lecture 14	Reading Day		

- Welcome Back!

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- Welcome Back!
- There's no more holidays until April.

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- There's no more holidays until April.
- Guest Lecturer: Katherine Howitt

Frequently Asked Questions

From lecture slips & recitation sections.

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- Could you explain more about arithmetic (especially modulo!) in Python?
  Yes, will do!
- One more time on all the `range()` options?
  We'll have some in group work and a quick review.

Today's Topics

- Arithmetic
- Indexing and Slicing Lists
- Colors & Hexadecimal Notation
- 2D Arrays & Image Files
- Design Challenge: Planes

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Arithmetic

Some arithmetic operators in Python:

- Addition:

Arithmetic

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- Addition: `sum = sum + 3`

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Arithmetic

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- Multiplication:

Arithmetic

Some arithmetic operators in Python:

- Addition: `sum = sum + 3`
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- Multiplication: `area = h * w`

Arithmetic

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- Division:

Arithmetic

Some arithmetic operators in Python:

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- Division: `ave = total / n`

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  `days = totalDays % 7`
- Exponentiaion:
  `pop = 2**time`

In Pairs or Triples...

What does this code do?

```
#Mystery code for lecture 3

startTime = int(input('Enter starting time: '))
duration = int(input('Enter how long: '))

print('Your event starts at', startTime, "o'clock.")

endTime = (startTime+duration)%12
print('Your event ends at', endTime, "o'clock.")
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- If the user enters, 9 and 2.
- If the user enters, 12 and 4.

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- If the user enters, 9 and 2.
- If the user enters, 12 and 4.
- If the user enters, 8 and 20.

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- If the user enters, 12 and 4.
- If the user enters, 8 and 20.
- If the user enters, 11 and 1.

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```
Enter starting time: 9
Enter how long: 2
Your event starts at 9 o'clock.
Your event ends at 11 o'clock.
```

In Pairs or Triples...

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In particular, what is printed...

- If the user enters, 12 and 4.

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Enter starting time: 12
Enter how long: 4
Your event starts at 12 o'clock.
Your event ends at 4 o'clock.
```

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  ```
  Enter starting time: 8
  Enter how long: 20
  Your event starts at 8 o'clock.
  Your event ends at 4 o'clock.
  ```

In Pairs or Triples...

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```

In particular, what is printed...

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```
Enter starting time: 11
Enter how long: 1
Your event starts at 11 o'clock.
Your event ends at 0 o'clock.
```

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- **Indexing and Slicing Lists**
- Colors & Hexadecimal Notation
- 2D Arrays & Image Files
- Design Challenge: Planes

In Pairs or Triples...

Mostly review:

```
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

Python Tutor

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(Demo with `pythonTutor`)

Review: `range()`

The three versions:

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- `range(stop)`

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- `range(stop)`
- `range(start, stop)`

Review: `range()`

The three versions:

- `range(stop)`
- `range(start, stop)`
- `range(start, stop, step)`

Slices

- Similar to `range()`, you can take portions or **slices** of lists and strings:

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print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

Slices

```
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

- Similar to `range()`, you can take portions or **slices** of lists and strings:

  `s[5:8]`

  gives: `"Uni"`

Slices

```
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

- Similar to `range()`, you can take portions or **slices** of lists and strings:

  `s[5:8]`

  gives: `"Uni"`
- Also works for lists:

Slices

```python
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

- Similar to `range()`, you can take portions or **slices** of lists and strings:

  `s[5:8]`

  gives: `"Uni"`
- Also works for lists:

  `names[1:3]`

Slices

```
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

- Similar to `range()`, you can take portions or **slices** of lists and strings:

  `s[5:8]`

  gives: `"Uni"`
- Also works for lists:

  `names[1:3]`

  gives: `["Anna", "Alice"]`

Slices

```
for d in range(10, 0, -1):
    print(d)
print("Blast off!")

for num in range(5,8):
    print(num, 2*num)

s = "City University of New York"
print(s[3], s[0:3], s[:3])
print(s[5:8], s[-1])

names = ["Eleanor", "Anna", "Alice", "Edith"]
for n in names:
    print(n)
```

- Similar to `range()`, you can take portions or **slices** of lists and strings:

  `s[5:8]`

  gives: `"Uni"`
- Also works for lists:

  `names[1:3]`

  gives: `["Anna", "Alice"]`
- Python also lets you “count backwards”: last element has index: `-1`.

Today's Topics

- Arithmetic
- Indexing and Slicing Lists
- **Colors & Hexadecimal Notation**
- 2D Arrays & Image Files
- Design Challenge: Planes

Colors

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

- Can specify by name.

Colors

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Colors

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

Colors

Color Name	HEX	Color
Black	#000000	
Navy	#000080	
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MediumBlue	#0000CD	
Blue	#0000FF	

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

Colors

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

- 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

Colors

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

- 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

Colors

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

- Can specify by numbers (RGB):

Colors

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

- Can specify by numbers (RGB):
  - Fractions of each:

Colors

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

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

Colors

Color Name	HEX	Color
Black	#000000	
Navy	#000080	
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MediumBlue	#0000CD	
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- 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:

Colors

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

- 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.

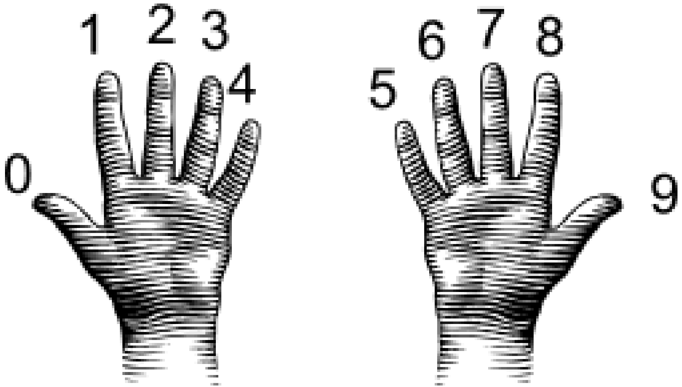
Colors

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

- 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)...

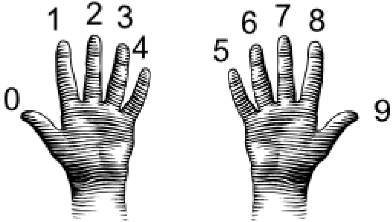
Decimal & Hexadecimal Numbers

Counting with 10 digits:



(from i-programmer.info)

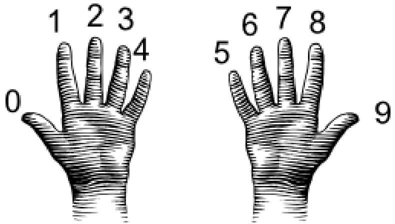
Decimal



(from i-programmer.info)

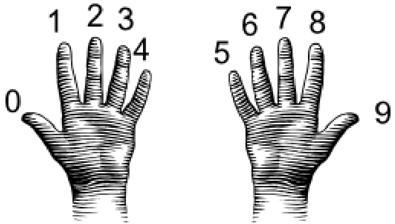
Decimal

00 01 02 03 04 05 06 07 08 09



(from i-programmer.info)

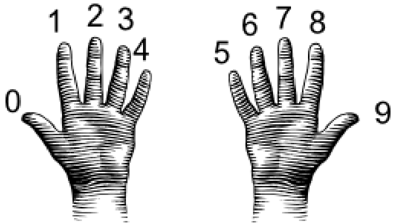
Decimal



(from i-programmer.info)

```
00 01 02 03 04 05 06 07 08 09
10 11 12 13 14 15 16 17 18 19
```

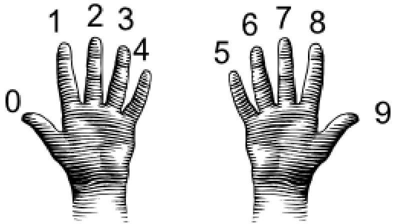
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29

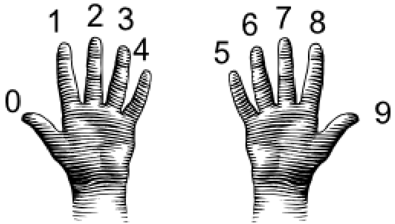
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39

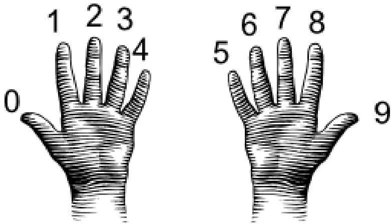
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49

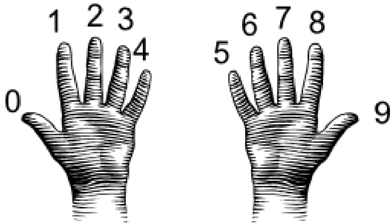
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59

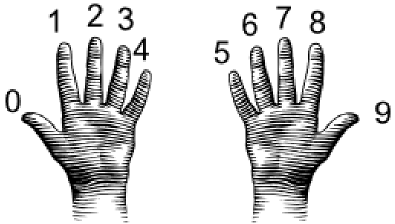
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69

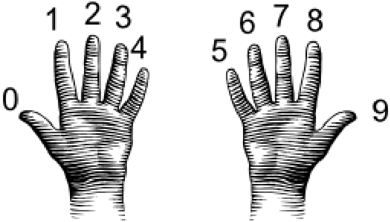
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79

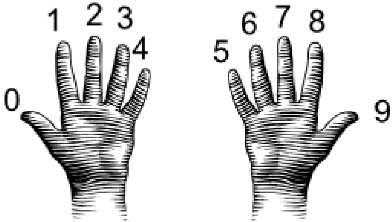
Decimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89

Decimal

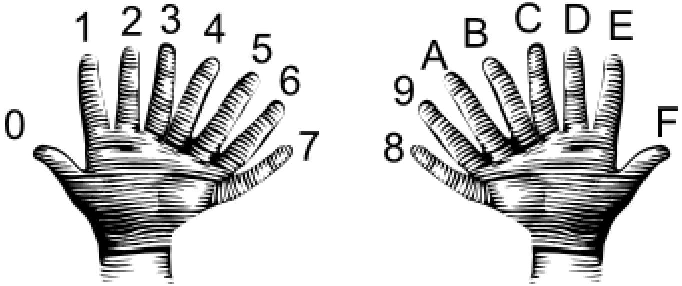


(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

Decimal & Hexadecimal Numbers

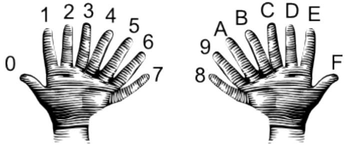
Counting with 16 digits:



(from i-programmer.info)

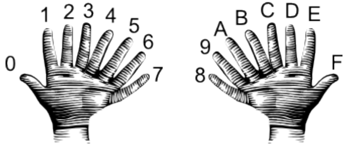
Hexadecimal

`00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F`



(from i-programmer.info)

Hexadecimal

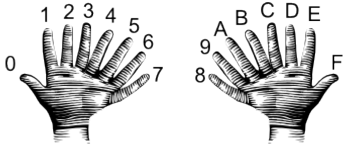


(from i-programmer.info)

```
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
```

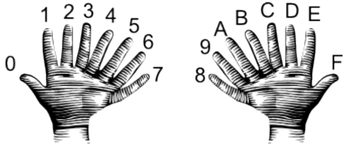
Hexadecimal

```
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
```



(from i-programmer.info)

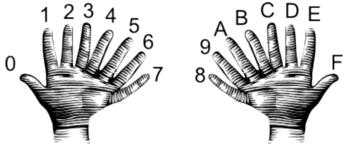
Hexadecimal



(from i-programmer.info)

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

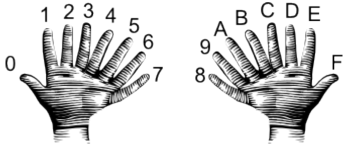
Hexadecimal



(from i-programmer.info)

```
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
```

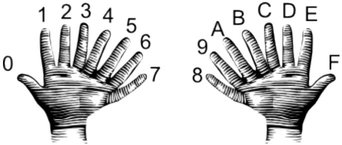
Hexadecimal



(from i-programmer.info)

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

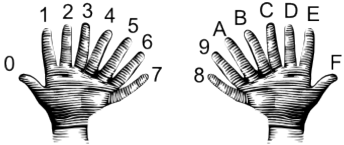
Hexadecimal



(from i-programmer.info)

```
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
```

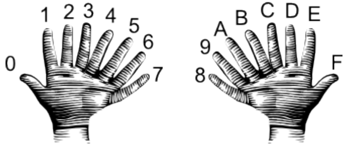
Hexadecimal



(from i-programmer.info)

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

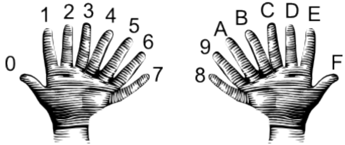
Hexadecimal



(from i-programmer.info)

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

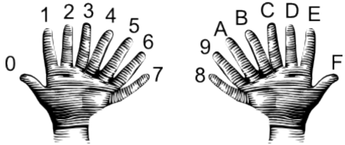
Hexadecimal



(from i-programmer.info)

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

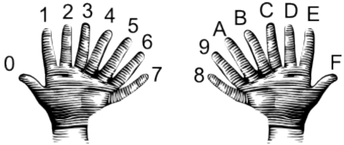
Hexadecimal



(from i-programmer.info)

```
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
```

Hexadecimal



(from i-programmer.info)

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
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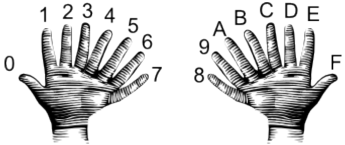
70	71	72	73	74	75	76	77	78	79	7A	7B	7C	7D	7E	7F
80	81	82	83	84	85	86	87	88	89	8A	8B	8C	8D	8E	8F
90	91	92	93	94	95	96	97	98	99	9A	9B	9C	9D	9E	9F
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF

Hexadecimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
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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
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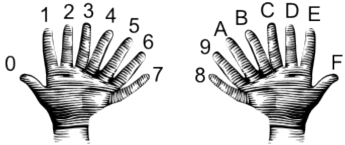
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF

Hexadecimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
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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
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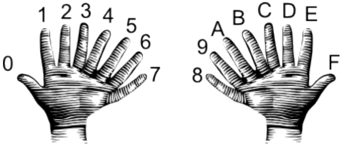
A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	AA	AB	AC	AD	AE	AF
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	BA	BB	BC	BD	BE	BF
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF

Hexadecimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
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20	21	22	23	24	25	26	27	28	29	2A	2B	2C	2D	2E	2F
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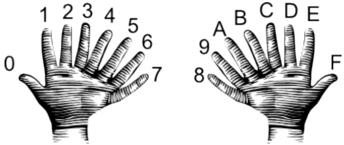
C0	C1	C2	C3	C4	C5	C6	C7	C8	C9	CA	CB	CC	CD	CE	CF
D0	D1	D2	D3	D4	D5	D6	D7	D8	D9	DA	DB	DC	DD	DE	DF
E0	E1	E2	E3	E4	E5	E6	E7	E8	E9	EA	EB	EC	ED	EE	EF

Hexadecimal



(from i-programmer.info)

00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
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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
Black	#000000	
Navy	#000080	
DarkBlue	#00008B	
MediumBlue	#0000CD	
Blue	#0000FF	

- 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):

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  - Hexcodes (base-16 numbers):
    e.g. `#0000FF` is no red, no green, and 100% blue.

In Pairs or Triples...

Some review and some novel challenges:

```python
import turtle
teddy = turtle.Turtle()

names = ["violet", "purple", "indigo", "lavender"]
for c in names:
  teddy.color(c)
  teddy.left(60)
  teddy.forward(40)
  teddy.dot(10)

teddy.penup()
teddy.forward(100)
teddy.pendown()

hexNames = ["#FF00FF", "#990099", "#550055", "#111111"]
for c in hexNames:
  teddy.color(c)
  teddy.left(60)
  teddy.forward(40)
  teddy.dot(10)
```

Trinkets

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

names = ["violet", "purple", "indigo", "lavender"]
for c in names:
  teddy.color(c)
  teddy.left(60)
  teddy.forward(40)
  teddy.dot(10)

teddy.penup()
teddy.forward(100)
teddy.pendown()

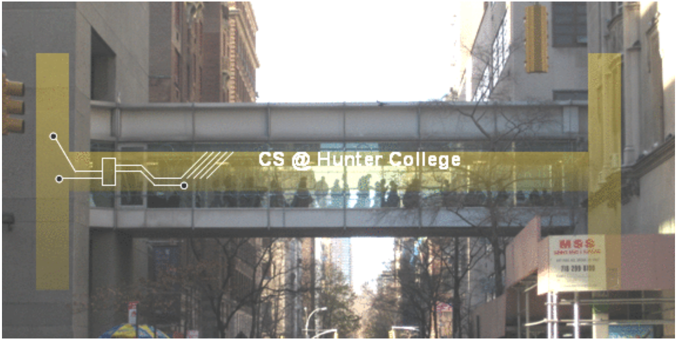
hexNames = ["#FF00FF", "#990099", "#550055", "#111111"]
for c in hexNames:
  teddy.color(c)
  teddy.left(60)
  teddy.forward(40)
  teddy.dot(10)
```

(Demo with `trinkets`)

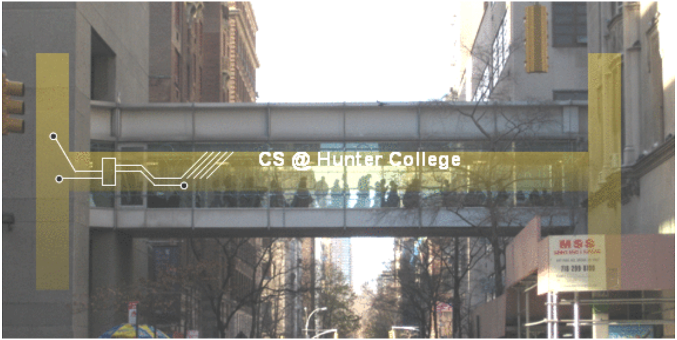
Today's Topics

- Arithmetic
- Indexing and Slicing Lists
- Colors & Hexadecimal Notation
- **2D Arrays & Image Files**
- Design Challenge: Planes

Images

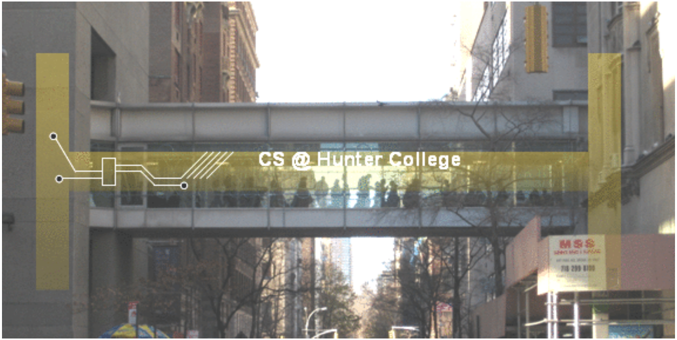


Images



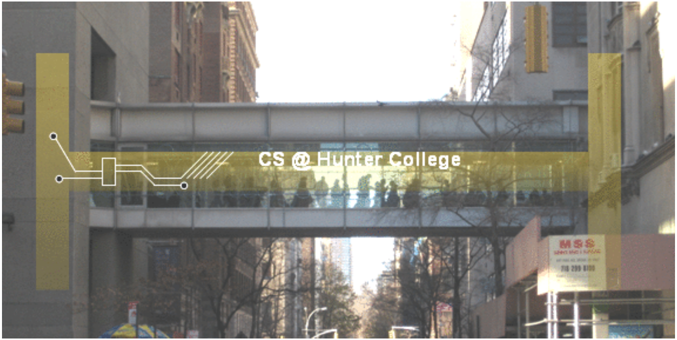
- We will use the standard portable network graphics (PNG) file format.

Images



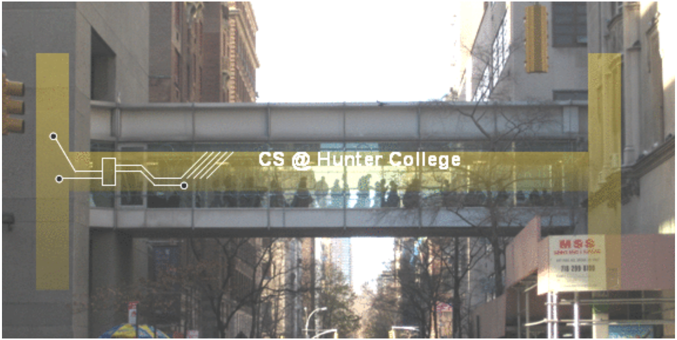
- We will use the standard portable network graphics (PNG) file format.
- Saves every picture element (or 'pixel')–

Images



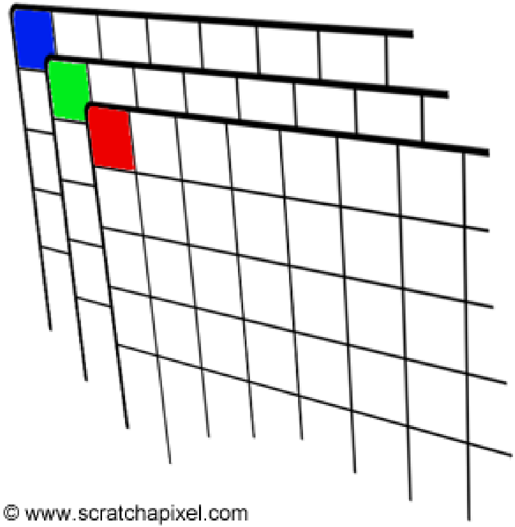
- We will use the standard portable network graphics (PNG) file format.
- Saves every picture element (or 'pixel')– often called a lossless format.

Images

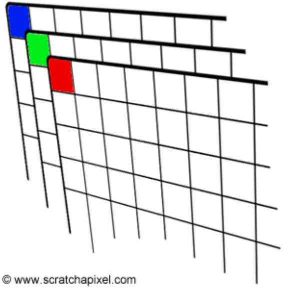


- We will use the standard portable network graphics (PNG) file format.
- Saves every picture element (or 'pixel')– often called a lossless format.
- Keeps track of the amount of red, blue, and green of each pixel.

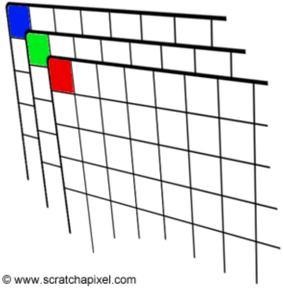
Images



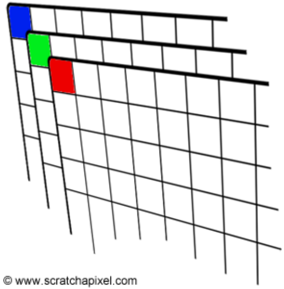
Images



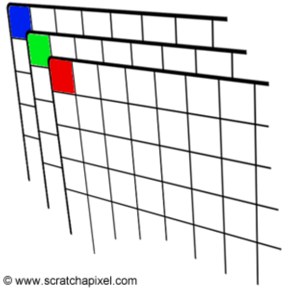
Images

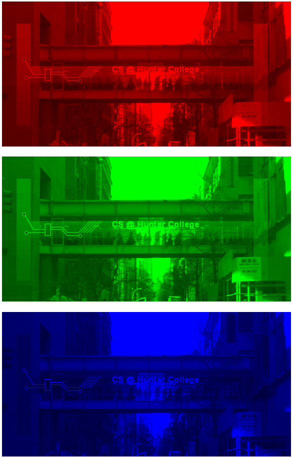


Images

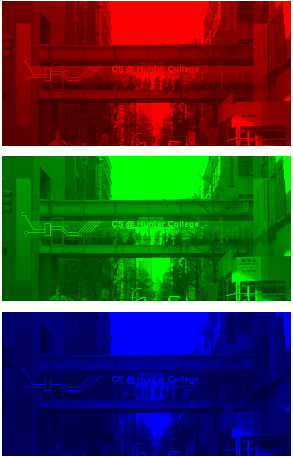


Images



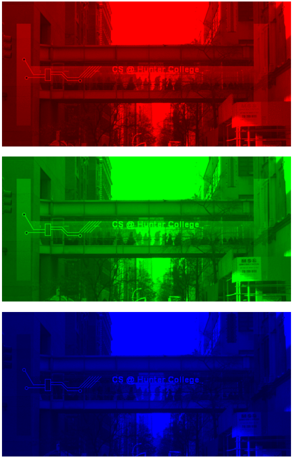


Useful Packages



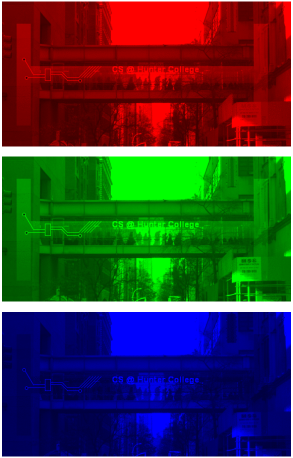
- We will use 2 useful packages for images:

Useful Packages



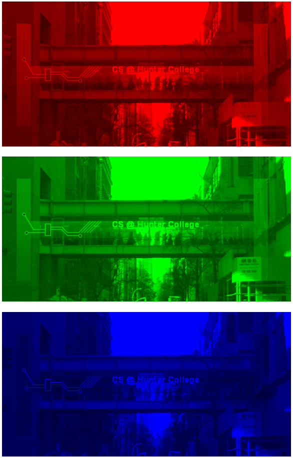
- We will use 2 useful packages for images:
  - `numpy`: numerical analysis package

Useful Packages



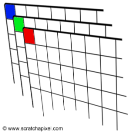
- We will use 2 useful packages for images:
  - `numpy`: numerical analysis package
  - `pyplot`: part of `matplotlib` for making graphs and plots

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')    #Read in image from csBridge.png
plt.imshow(img)                      #Load image into pyplot
plt.show()                           #Show the image (waits until close

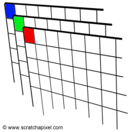
img2 = img.copy()          #make a copy of our image
img2[:,:,1] = 0            #Set the green channel to 0
img2[:,:,2] = 0            #Set the blue channel to 0

plt.imshow(img2)           #Load our new image into pyplot
plt.show()                 #Show the image (waits until closed to conti

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

Creating Images

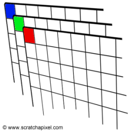
To create an image from scratch:



Creating Images

To create an image from scratch:

1. Import the libraries.



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To create an image from scratch:

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import matplotlib.pyplot as plt
import numpy as np
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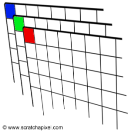

Creating Images

To create an image from scratch:

1. Import the libraries.

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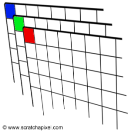
import matplotlib.pyplot as plt
import numpy as np
```

2. Create the image– easy to set all color



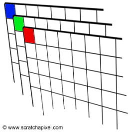
Creating Images

To create an image from scratch:

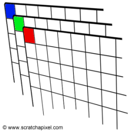
1. Import the libraries.

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

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



Creating Images



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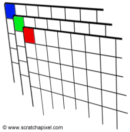
```

2. Create the image– easy to set all color
   1. to 0% (black):
      `img = np.zeros((num,num,3))`

Creating Images



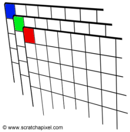
To create an image from scratch:

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):

Creating Images



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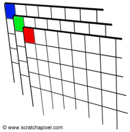
Creating Images



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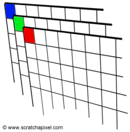

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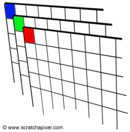

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   plt.imshow(img)
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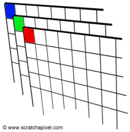

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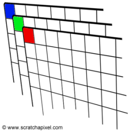

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plt.imshow(img)
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```

5. And save your image:

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

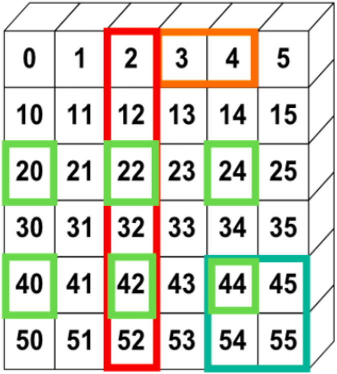
More on `numpy` arrays

```
>>> 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]])
```



numpy tutorial

Slicing & Image Examples

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

Slicing & Image Examples

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- Assuming the libraries are imported, what do the following code fragments produce:
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    img = np.zeros( (10,10,3) )
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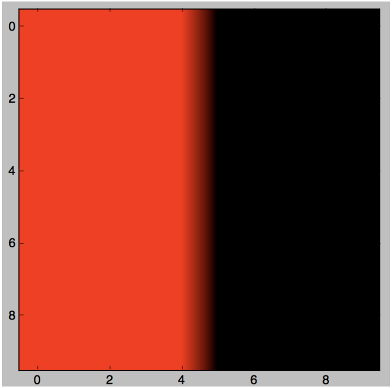
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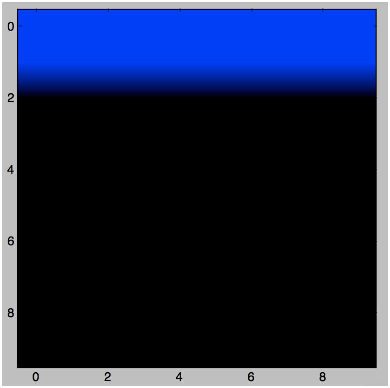
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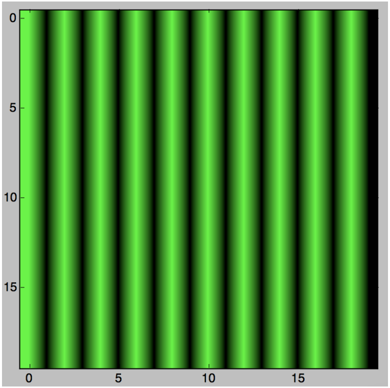
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  - ```
    img = np.zeros( (8,8,3) )
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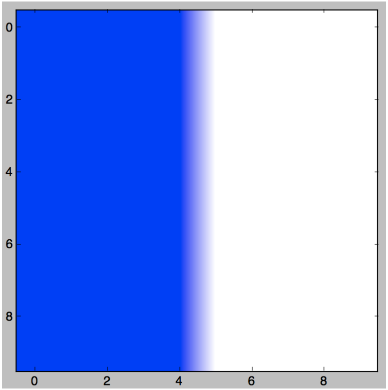
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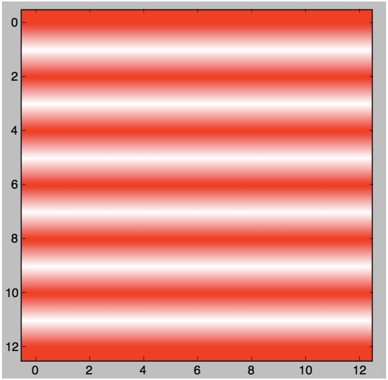
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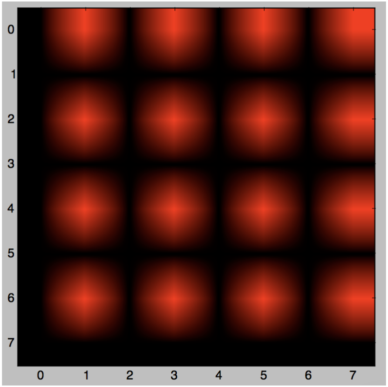
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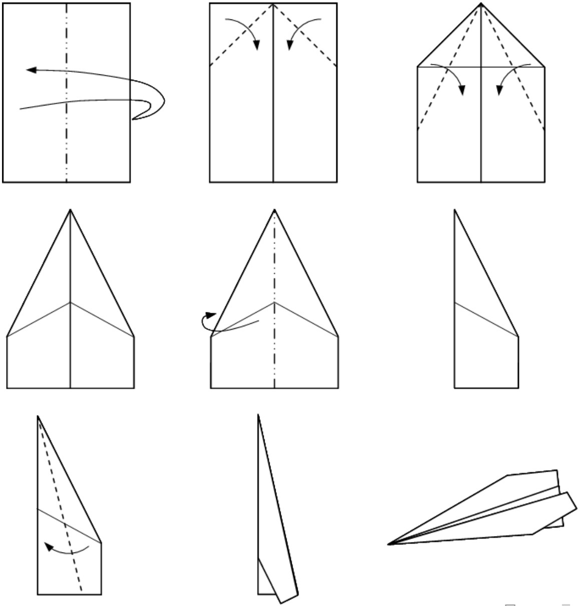
Today's Topics

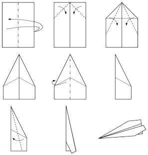
- Arithmetic
- Indexing and Slicing Lists
- Colors & Hexadecimal Notation
- 2D Arrays & Image Files
- **Design Challenge: Planes**

Design Challenge: Planes



Design Challenge: Planes

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



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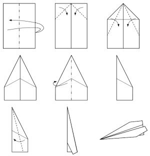

Design Challenge: Planes

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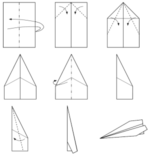
- With a slight twist: refining designs



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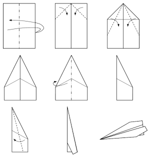

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  - As a team, write down your design.

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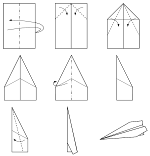

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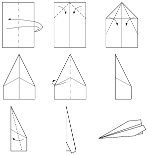

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  - They build an airplane to your design (test plane) **without consulting you**.

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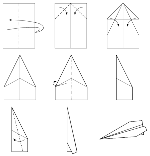

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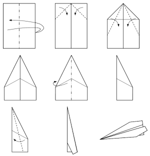

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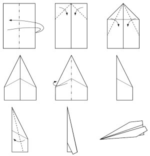

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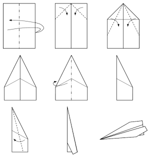

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  - Will be judged on closeness to the stage.

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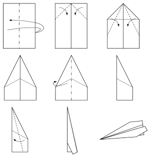

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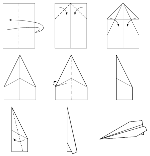

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  - Will be judged on closeness to the stage.
  - Winning design/build team gets chocolate.
- Remember to pick up all your airplanes!

Recap

- On lecture slip, write down a topic you wish we had spent more time (and why).

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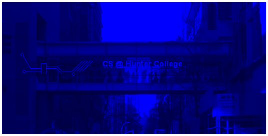
  - 2D Arrays & Image Files
- Pass your lecture slips to the end of the rows for the UTA's to collect.

Practice Quiz & Final Questions



- Since you must pass the final exam to pass the course, we end every lecture with final exam review.

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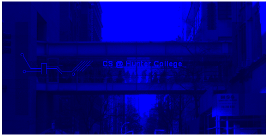

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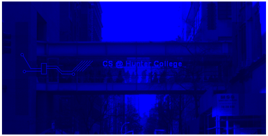

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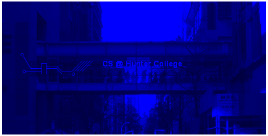

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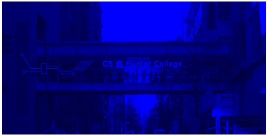

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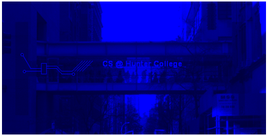

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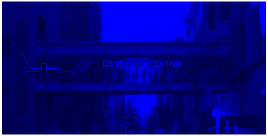

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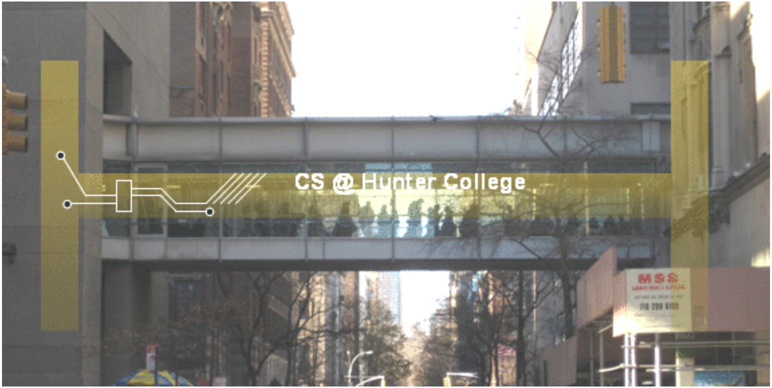
- We're starting with Fall 2017, Version 2.

Writing Boards



- Return writing boards as you leave...