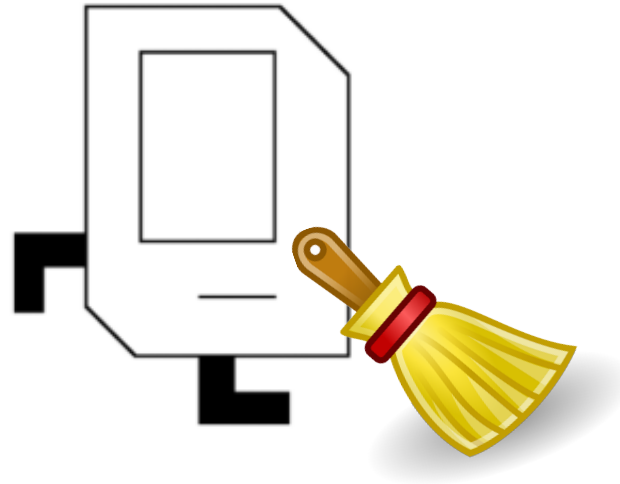




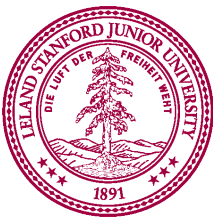
Nested Structures

Mehran Sahami and Chris Piech
CS106A, Stanford University

Housekeeping



- Assignment 5 goes out today!



Why is this so fast?



mantis shrimp colors



All

Videos

Shopping

Images

News

More

Settings

Tools

About 1,870,000 results (0.54 seconds)

Humans and many other primates have three; some birds and reptiles have four photoreceptors. Certain butterflies can even have six. But the mantis shrimp has **12** different types of photoreceptors in their eyes – and scientists haven't understood why until now. Jan 27, 2014



[Study Offers Insights into Unique Color Vision of Mantis Shrimp ...](#)

www.sci-news.com/biology/science-color-vision-mantis-shrimp-01719.html



Review

Core Datastructures

The standard is called “JSON”



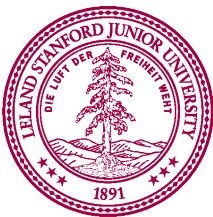
All datasets can be represented by:

Dictionaries,
Lists,
strings,
Floats,
Integers
Booleans,
None,
Blob



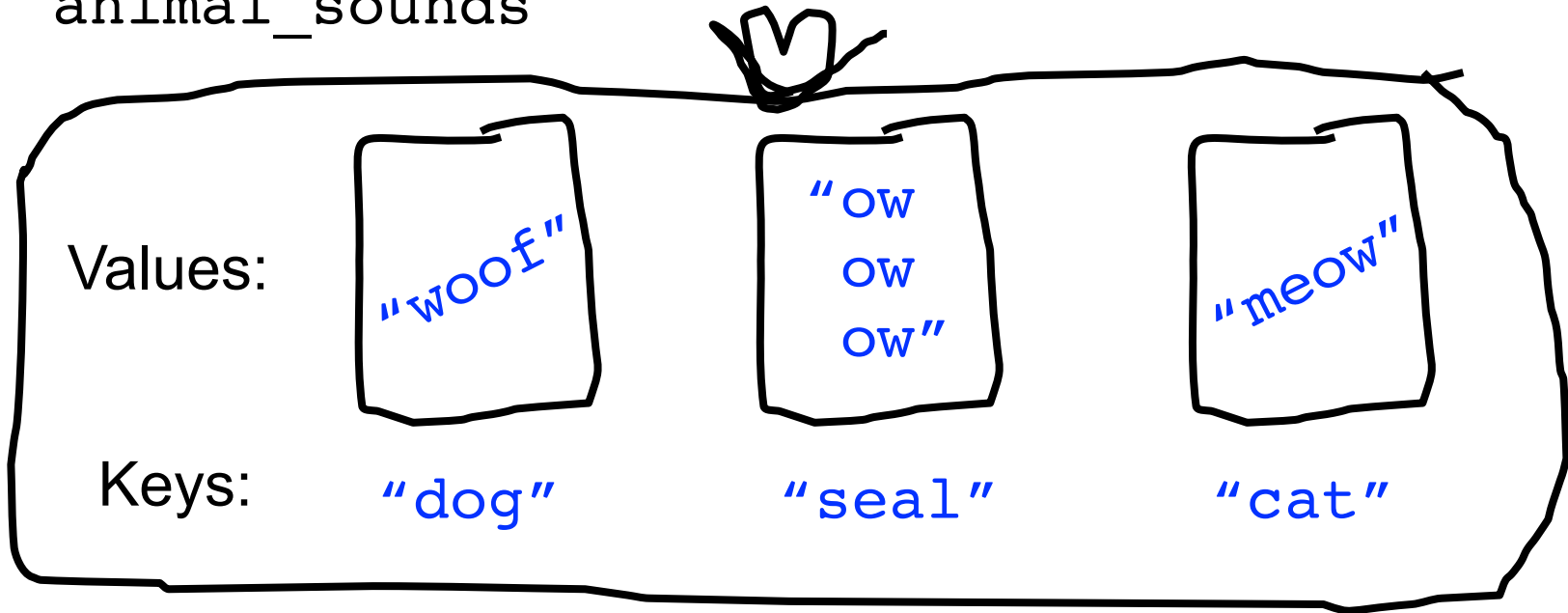
Example Google Dicts Query Result

```
{  
  "markers": [  
    {  
      "name": "Rixos The Palm Dubai",  
      "position": [25.1212, 55.1535],  
    },  
    {  
      "name": "Shangri-La Hotel",  
      "location": [25.2084, 55.2719]  
    },  
    {  
      "name": "Grand Hyatt",  
      "location": [25.2285, 55.3273]  
    }  
  ]  
}
```



Dict Review

animal_sounds



```
# 1. Make a new Dict  
animal_sounds = {}
```

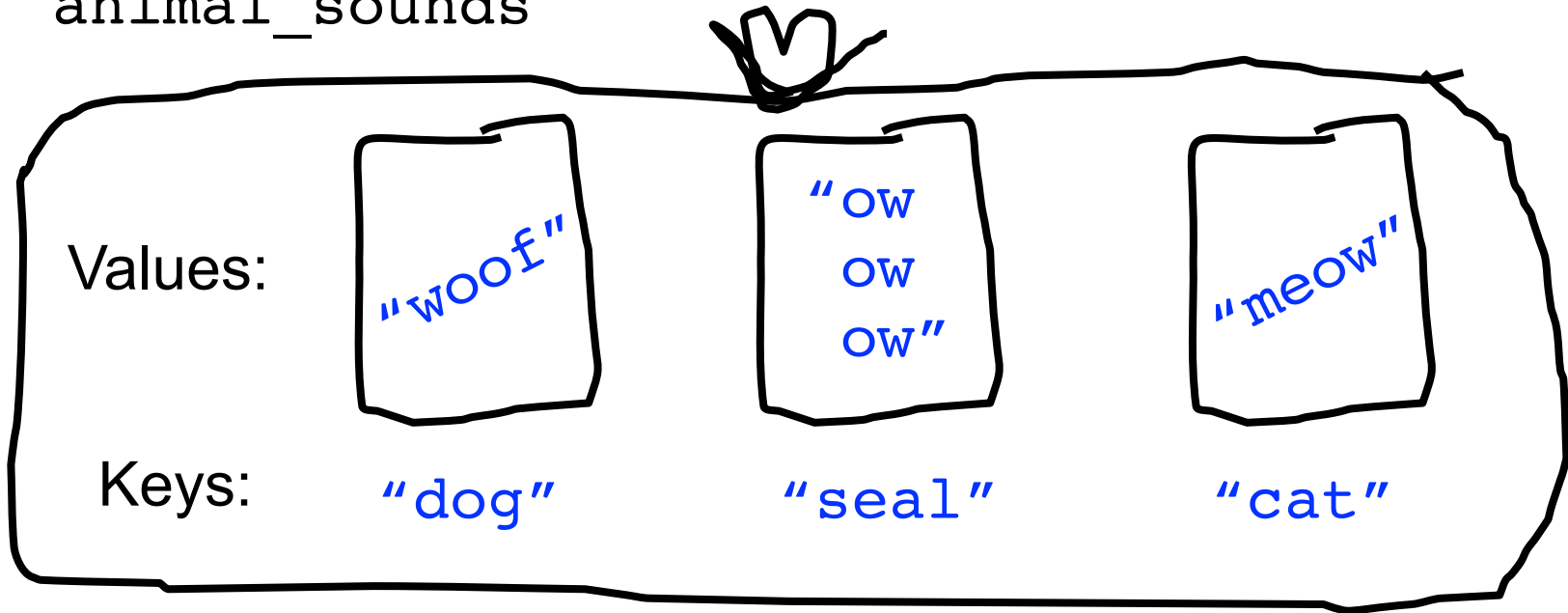
```
# 2. Put things into the Dict  
animal_sounds["dog"] = "woof"  
animal_sounds["cat"] = "meow"  
animal_sounds["seal"] = "ow ow ow"
```

```
# 3. Get things out of the Dict  
dog_sound = animal_sound["dog"] # "woof"
```



Dict Review

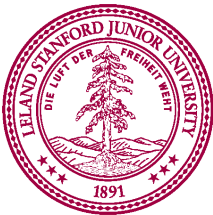
animal_sounds



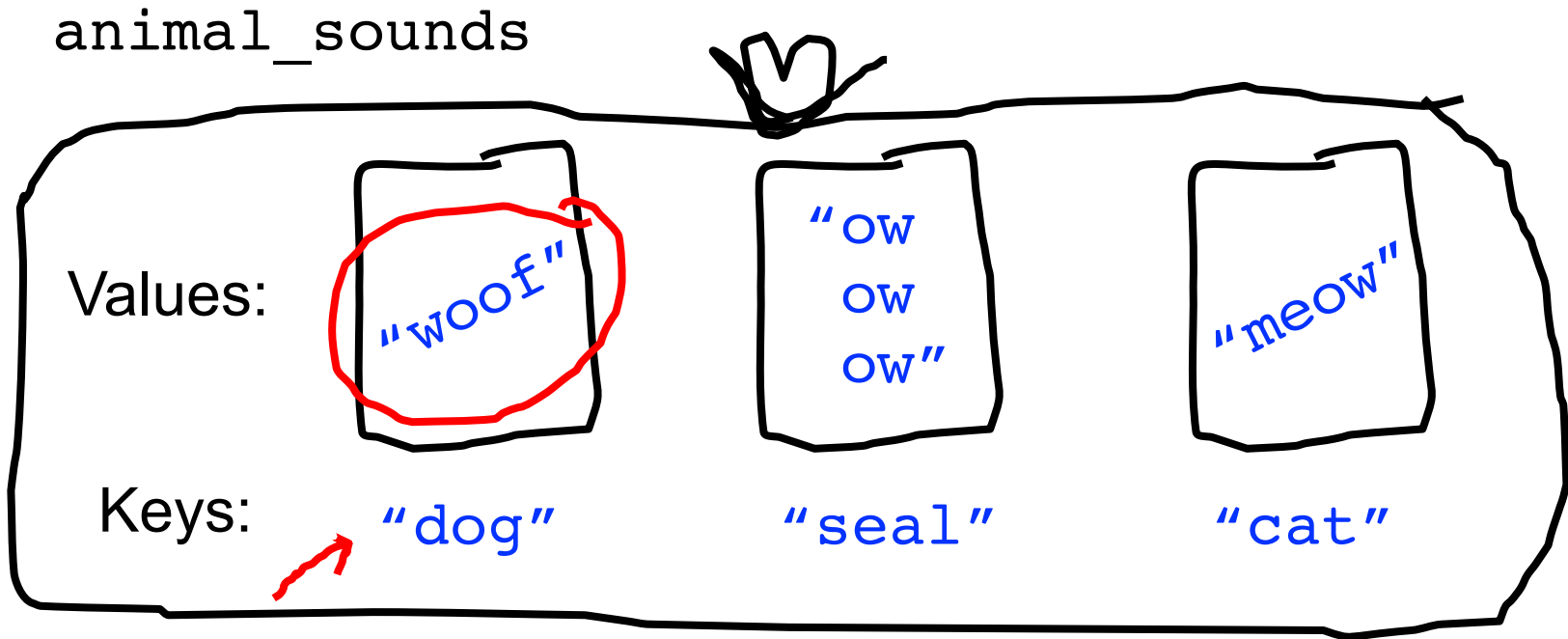
```
# 1. Make a new Dict  
animal_sounds = {}
```

```
# 2. Put things into the Dict  
animal_sounds["dog"] = "woof"  
animal_sounds["cat"] = "meow"  
animal_sounds["seal"] = "ow ow ow"
```

```
# 3. Get things out of the Dict  
dog_sound = animal_sound["dog"] # "woof"
```



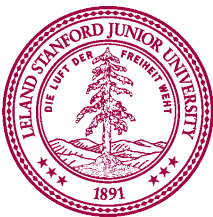
Dict Review



```
# 1. Make a new Dict  
animal_sounds = {}
```

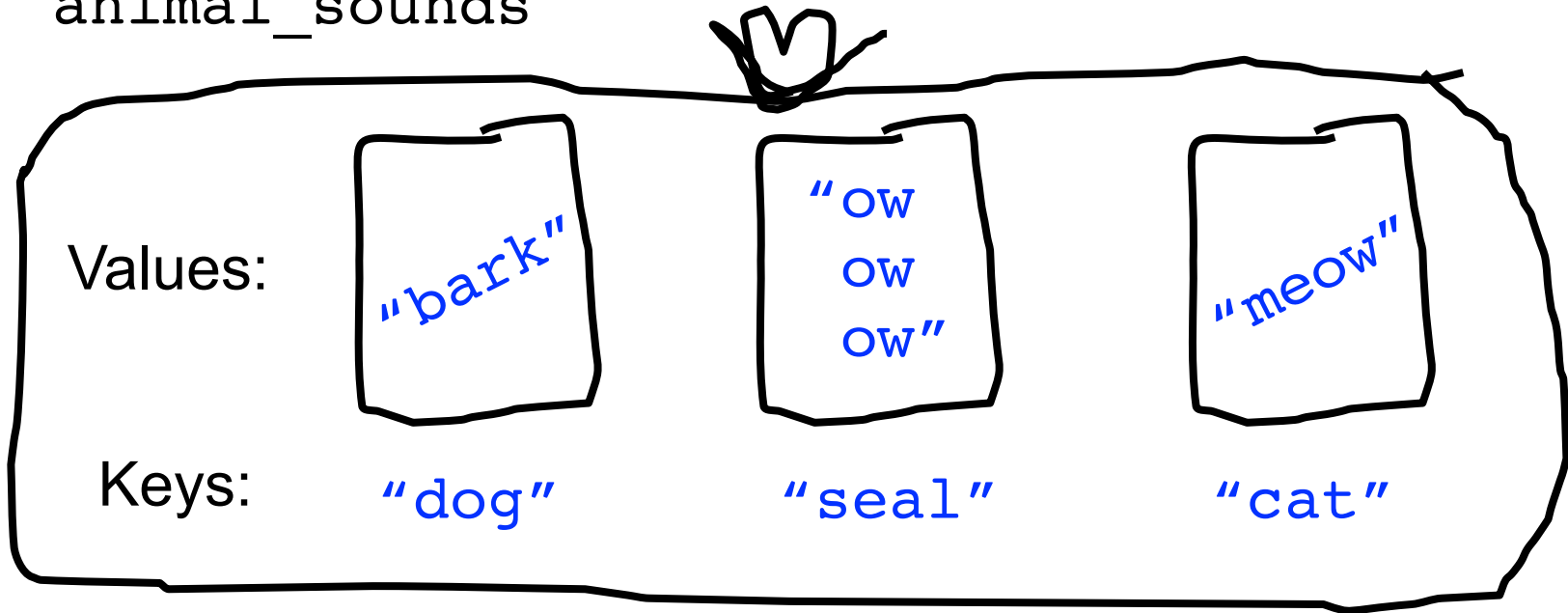
```
# 2. Put things into the Dict  
animal_sounds["dog"] = "woof"  
animal_sounds["cat"] = "meow"  
animal_sounds["seal"] = "ow ow ow"
```

```
# 3. Get things out of the Dict  
dog_sound = animal_sound["dog"] # "woof"
```



Dict Review

animal_sounds



```
# 1. Make a new Dict  
animal_sounds = {}
```

```
# 2. Put things into the Dict  
animal_sounds["dog"] = "woof"  
animal_sounds["cat"] = "meow"  
animal_sounds["seal"] = "ow ow ow"
```

```
# 3. Get things out of the Dict  
dog_sound = animal_sound["dog"] # "woof"  
fox_sound = animal_sound["fox"] # Error:not in Dict
```



brothers Vegard
and Bård Ylvisåker

Circa 2013



But there's one sound

Pi Ylvis – “The Fox”. Permission asked. Pending.

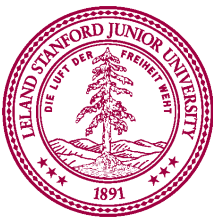


Dictionary Recap

key



value



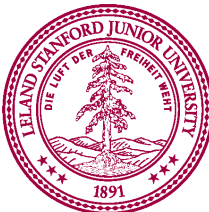
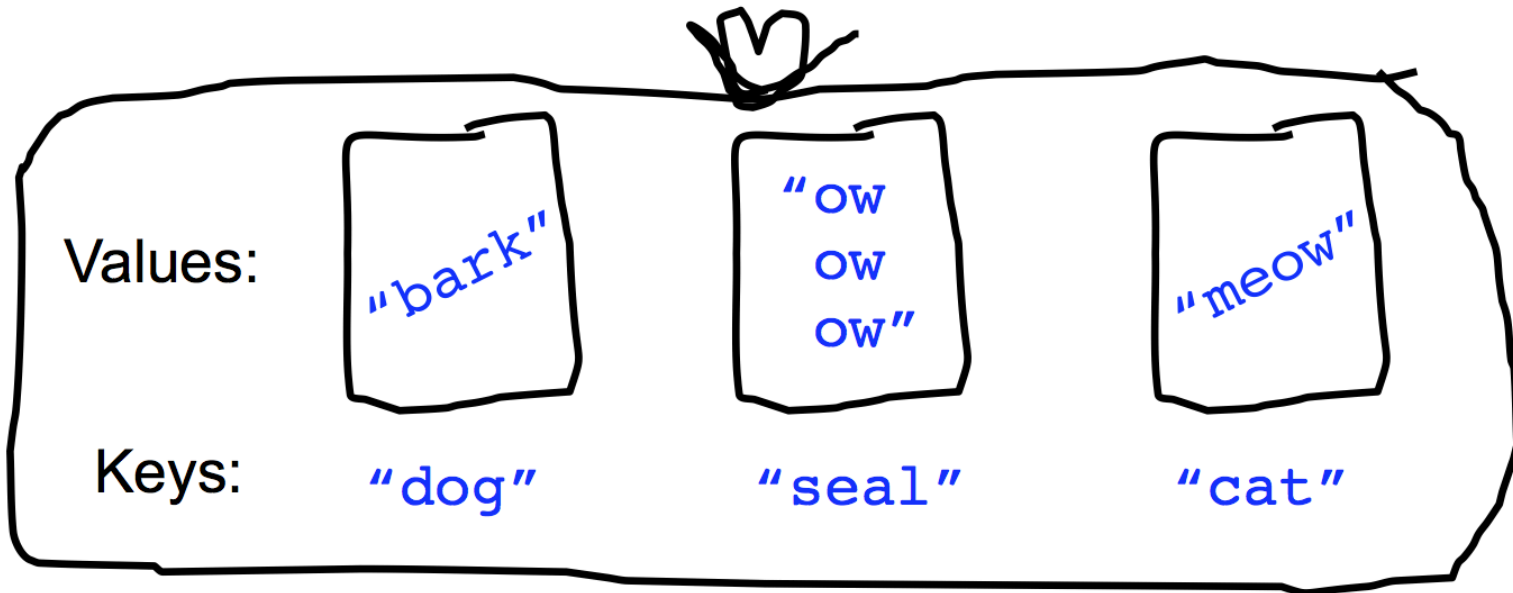
Dictionary Recap

key



value

(string) animal → (string) animal sound



Dictionary Recap

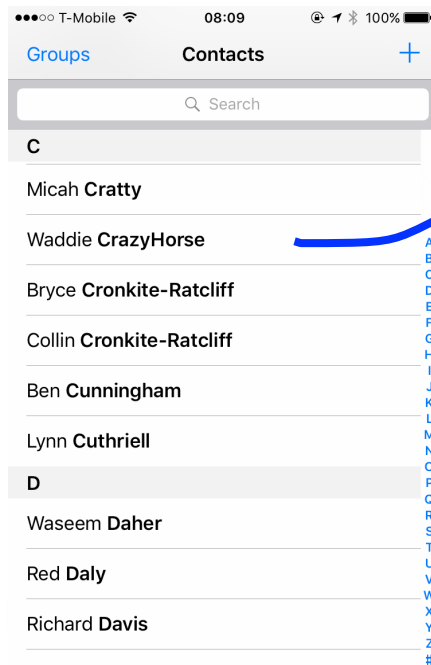
key



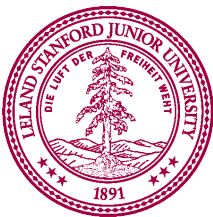
value

(string) animal → (string) animal sound

(string) name → (int) phone number



6701678



Dictionarys on one slide

1. Make a Dictionary

```
my_Dict = {}
```

2. Put and get values into a Dict

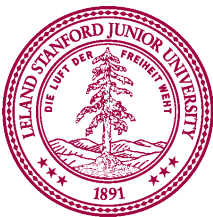
```
my_Dict[key] = new_value  
my_Dict[key] # returns the corresponding value
```

3. Some useful other methods

```
size = len(my_Dict)  
key in my_Dict # returns true or false if key is in Dict
```

4. Iterate using a foreach loop

```
for key in my_Dict:  
    value = my_Dict[key] # look up the corresponding value
```

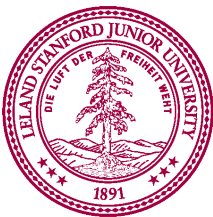




Dictionary are one way!

In dictionaries you can only look up values by keys. You can't look up keys by value.

`animal_sounds['meow']`  `KeyError: 'b'`





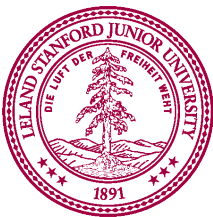
Each key gets has only one value!

If you put a key in the dictionary twice, it will overwrite

```
animal_sounds['dog'] = 'bark'  
animal_sounds['dog'] = 'woof'
```



```
animal_sounds = {'dog': 'woof'}
```



Learned about Collections



List

index -> value

Dictionary
key -> value

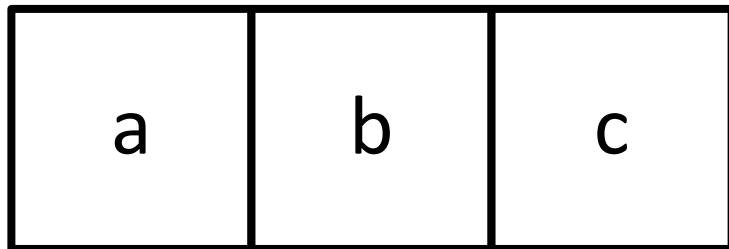
List

```
my_list = ['a', 'b', 'c']
```

```
print(my_list[1])
```

```
for i in range(len(my_list)):
    value = my_list[i]
    print(i, value)
```

my_list



0

1

2

indices

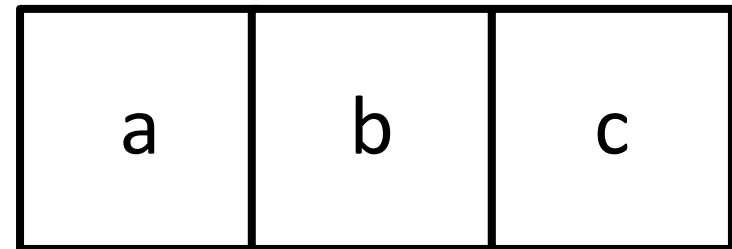
Dictionary

```
my_dict = {
    'x': 'a',
    'y': 'b',
    'c': 'c'
}
```

```
print(my_dict['y'])
```

```
for key in my_dict:
    value = my_dict[key]
    print(key, value)
```

my_dict



'x'

'y'

'z'

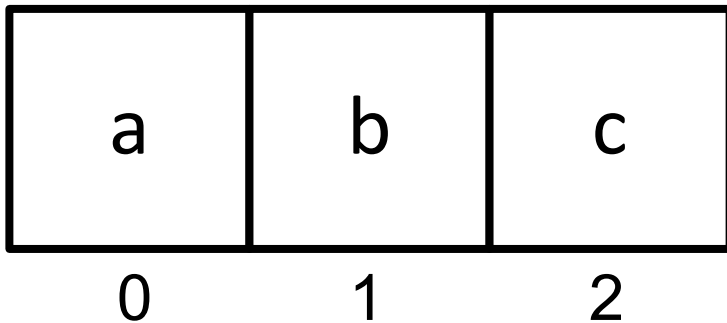
keys



List

```
my_list = [  
    'a',  
    'b',  
    'c'  
]  
  
print(my_list[1])  
  
for i in range(len(my_list)):  
    value = my_list[i]  
    print(i, value)
```

my_list

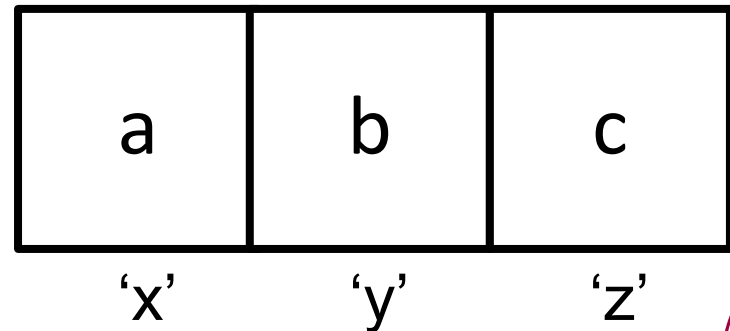


indices

Dictionary

```
my_dict = {  
    'x': 'a',  
    'y': 'b',  
    'c': 'c'  
}  
  
print(my_dict['y'])  
  
for key in my_dict:  
    value = my_dict[key]  
    print(key, value)
```

my_dict



keys



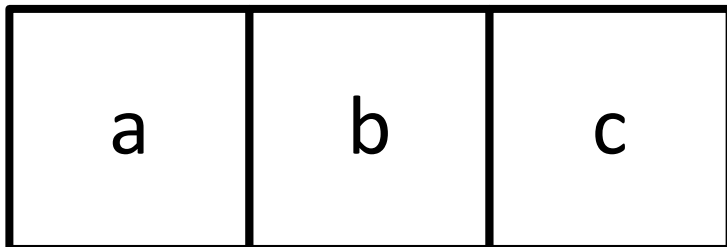
List

```
my_list = ['a', 'b', 'c']
```

```
print(my_list[1])
```

```
for i in range(len(my_list)):  
    value = my_list[i]  
    print(i, value)
```

my_list



0

1

2

indices

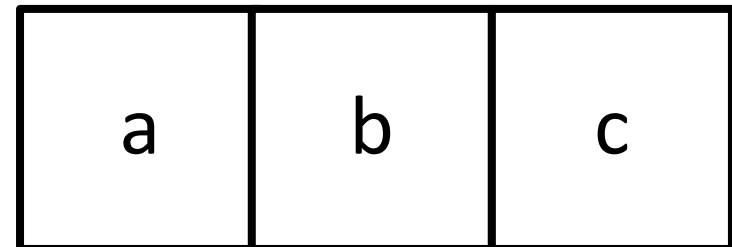
Dictionary

```
my_dict = {  
    'x': 'a',  
    'y': 'b',  
    'c': 'c'  
}
```

```
print(my_dict['y'])
```

```
for key in my_dict:  
    value = my_dict[key]  
    print(key, value)
```

my_dict



'x'

'y'

'z'

keys



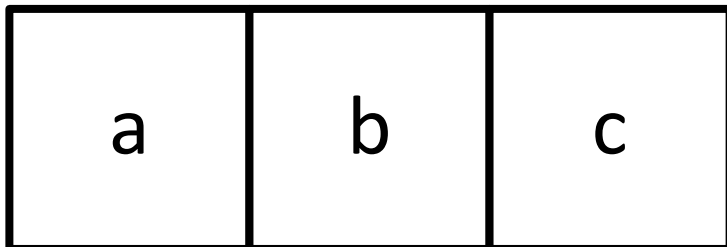
List

```
my_list = ['a', 'b', 'c']
```

```
print(my_list[1])
```

```
for i in range(len(my_list)):  
    value = my_list[i]  
    print(i, value)
```

my_list



0

1

2

indices

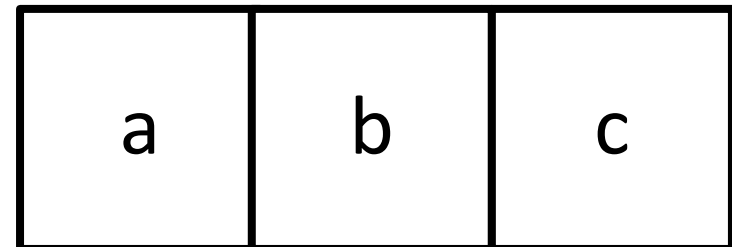
Dictionary

```
my_dict = {  
    'x': 'a',  
    'y': 'b',  
    'c': 'c'  
}
```

```
print(my_dict['y'])
```

```
for key in my_dict:  
    value = my_dict[key]  
    print(key, value)
```

my_dict



'x'

'y'

'z'

keys



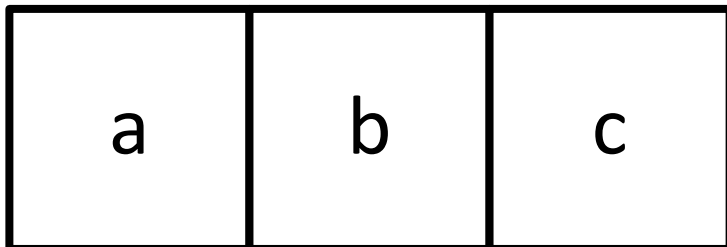
List

```
my_list = ['a', 'b', 'c']
```

```
print(my_list[1])
```

```
for i in range(len(my_list)):  
    value = my_list[i]  
    print(i, value)
```

my_list



0

1

2

indices

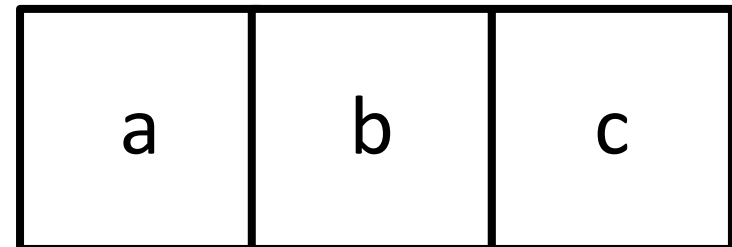
Dictionary

```
my_dict = {  
    'x': 'a',  
    'y': 'b',  
    'c': 'c'  
}
```

```
print(my_dict['y'])
```

```
for key in my_dict:  
    value = my_dict[key]  
    print(key, value)
```

my_dict



'x'

'y'

'z'

keys



End Review

Are you ready?

For...

The ULTIMATE cs106a question?

Ultimate CS106A: Reverse a Dict



Normal Dict:

Key -> Value

Reversed Dict:

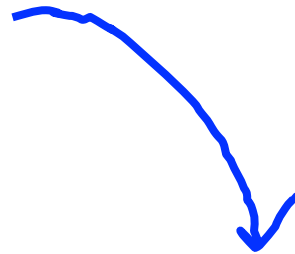
Value -> Keys



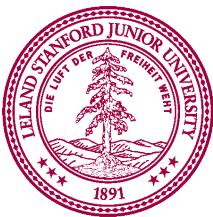
Claim: understanding this single example is most indicative of mastery in CS106A

Ultimate CS106A: Reverse a Dict

```
ages = {  
    'Mehran':50,  
    'Gary':70,  
    'Chris':32,  
    'Brahm':23,  
    'Adele':32,  
    'Lionel':32,  
    'Rihanna':32,  
    'Stephen':32  
}
```



```
reversed = {  
    50:['Mehran'],  
    70:['Gary'],  
    32:['Chris', 'Adele', 'Lionel', 'Rihanna', 'Stephen'],  
    23:['Brahm']  
}
```



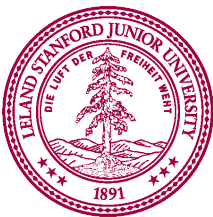
To the code!!!

Ultimate CS106A: Reverse a Dict

Gary -> 70

reversed = {

}



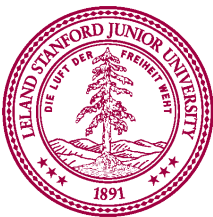
Ultimate CS106A: Reverse a Dict

Gary -> 70

reversed = {

70 : ['Gary'],

}



Ultimate CS106A: Reverse a Dict

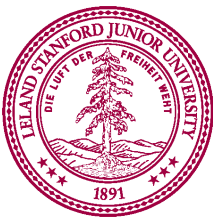
Chris -> 32

reversed = {

70 : ['Gary'],

32 : ['Chris'],

}



Ultimate CS106A: Reverse a Dict

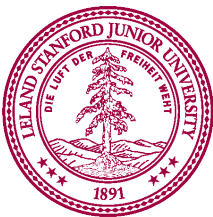
Mehran -> 50

reversed = {

70 : ['Gary'],

32 : ['Chris'],

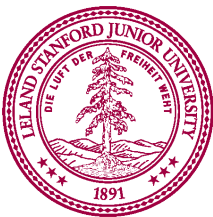
}



Ultimate CS106A: Reverse a Dict

Mehran -> 50

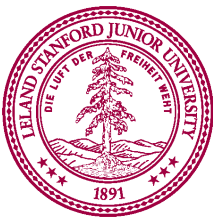
```
reversed = {  
    70 : ['Gary'],  
    50 : ['Mehran'],  
    32 : ['Chris'],  
}
```



Ultimate CS106A: Reverse a Dict

Rihanna -> 32

```
reversed = {  
    70 : ['Gary'],  
    50 : ['Mehran'],  
    32 : ['Chris'],  
}
```



Ultimate CS106A: Reverse a Dict

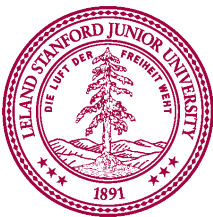
Rihanna -> 32

```
reversed = {  
    70 : ['Gary'],  
    50 : ['Mehran'],  
    32 : ['Chris', "Rihanna"],  
}
```



Ultimate CS106A: Reverse a Dict

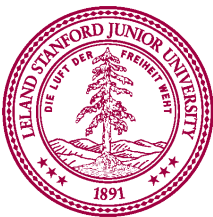
```
reversed = {  
    70 : ['Gary'],  
    50 : ['Mehran'],  
    32 : ['Chris', "Rihanna", 'Stephen', ... ]  
    23 : ['Brahm']  
}
```



something awesome

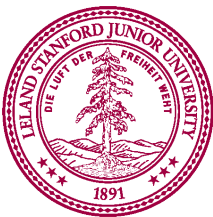
*idea credits to Keith

The XKCD Color Survey



The XKCD Color Survey

- Volunteers (online) were shown a randomly-chosen color and asked to name the color.
- The result is (after filtering) about 2.8 million RGB triplets and their names.
- What do people think the colors are?



The File Format

color-name, red, green, blue

navy blue,27,34,98
blue,41,201,234
lime green,99,212,32
red brown,160,89,66
orange,204,117,64
teal,12,208,219
blue,73,97,236
dark tan,209,202,95
moss green,77,147,83
magenta,136,30,75
blue,33,115,229
goldenrod,232,171,51
purplish blue,99,46,219
gray,212,209,208
green,56,188,125
mustard,197,164,25
red,242,9,26
pale green,221,240,210
cyan,199,254,247
carrot,240,80,16
purple,186,117,237
pale rose,197,68,63

fuchsia,210,13,137
pea green,198,247,15
forest green,17,106,39
tan,173,163,123
dark blue,27,7,117
teal,41,182,127
aqua,36,219,173
dark green,17,110,73
pale lime,189,244,125
light green,115,235,119
bright blue,17,155,238
hot pink,247,3,229
lighter green,98,253,147
brown,138,112,77
purple,116,50,76
red,245,42,54
green,7,173,31
bluish gray,82,110,127
blue,124,164,176
blue,120,158,209
sand,235,175,100
forest green,32,144,58

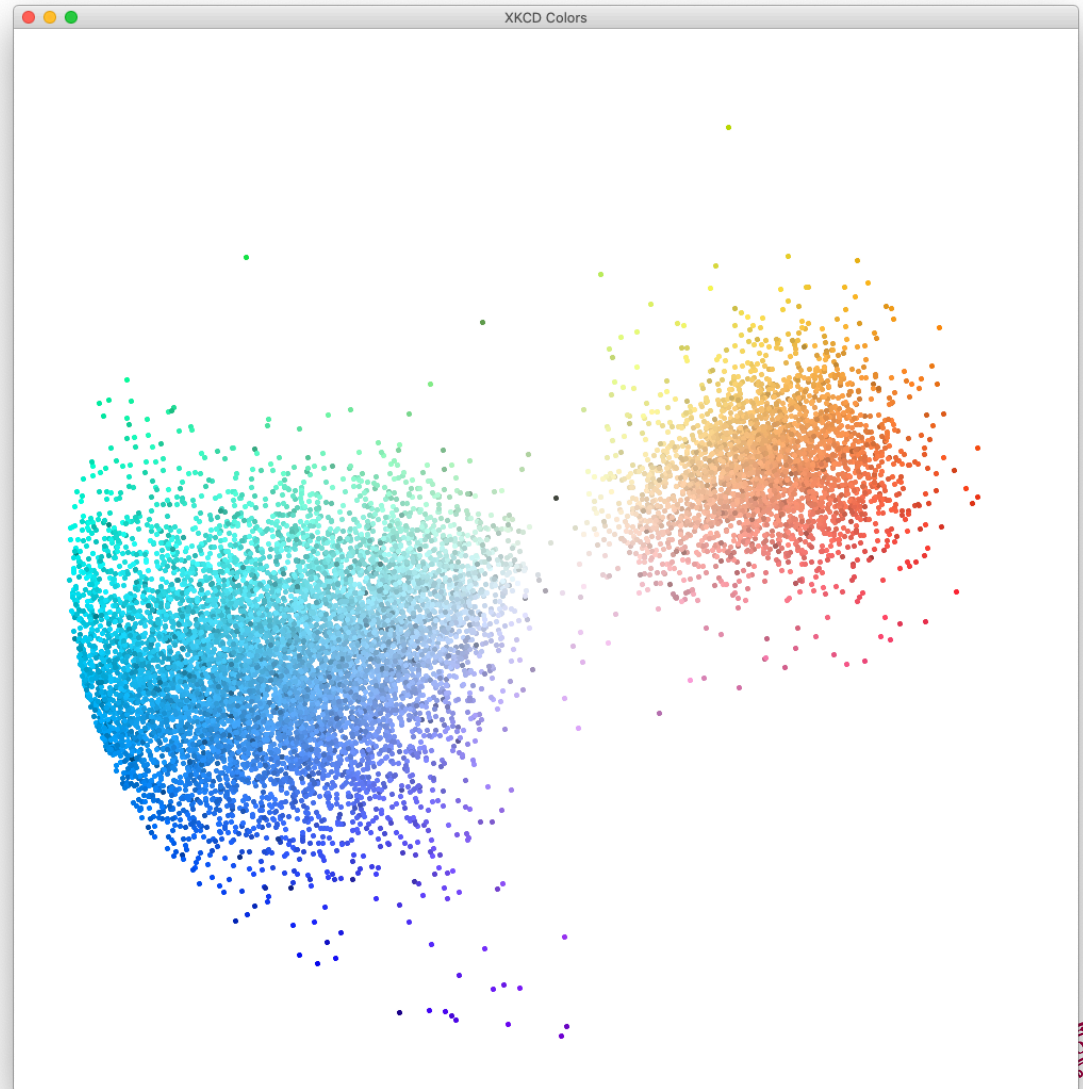
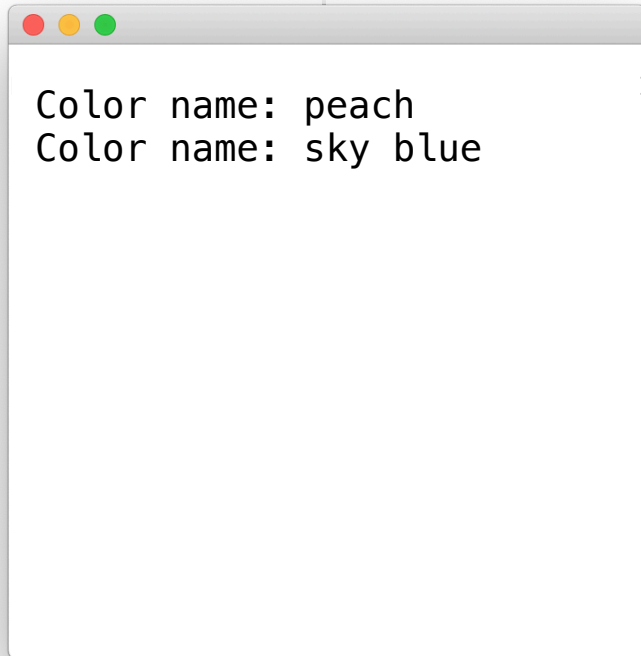
purple,145,37,226
dirty green,87,130,64
dirty green,125,136,42
brown,132,116,30
pink,252,68,255
blueberry,71,55,114
yellow brown,179,163,23
purple,199,64,183
deep purple,95,21,87
dirty yellow,221,198,107
light purple,185,110,194
sea blue,24,250,209
navy blue,16,32,75
bluish green,62,208,104
dark blue,2,0,50
blue,107,148,220
dark blue,101,68,175
sky blue,7,152,170
teal,81,166,152
green,19,246,59
green,20,252,59
aquamarine,65,206,163



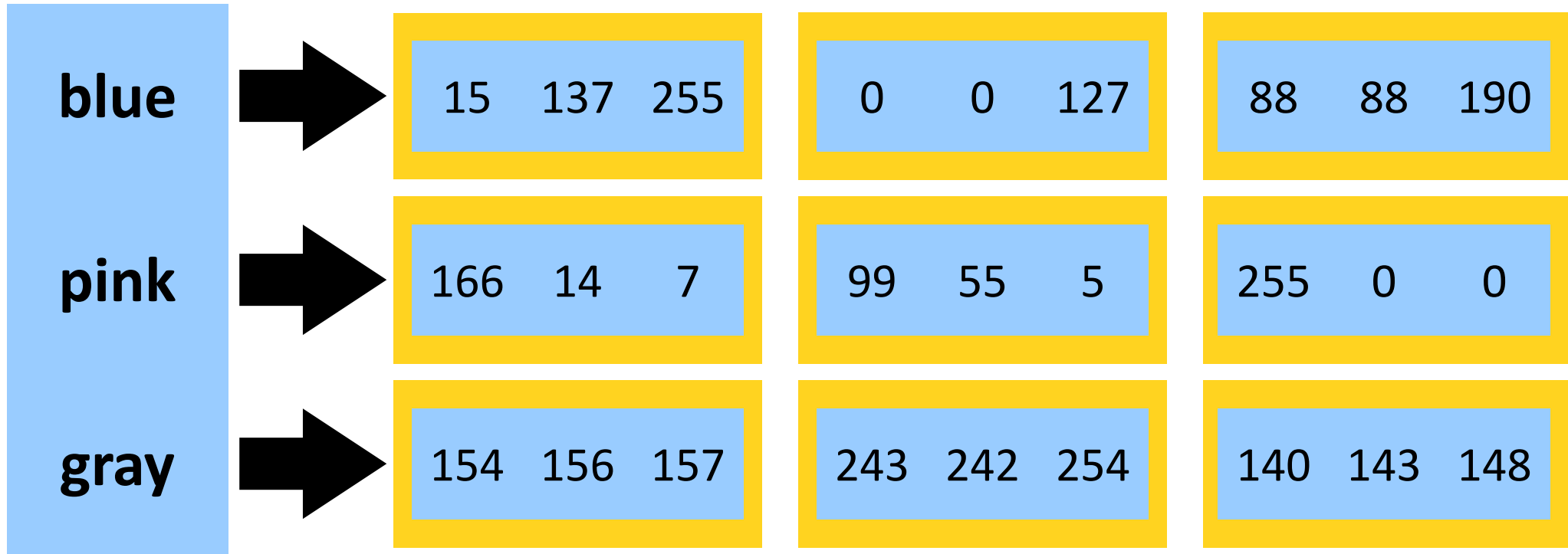
How to Structure Data?

I give this to
you so you can
focus on data

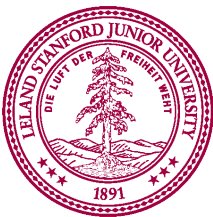
```
def plot_color(canvas, r, g, b):
```



How to Structure Data



***associate each color name
with a list of colors***



How to Structure Data

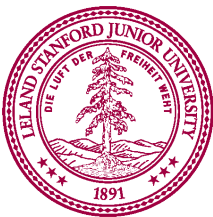
{

"clover green": `[[100, 216, 135], [72, 218, 111], [57, 109, 40], [9, 190, 78], [4, 217, 90], [36, 164, 33], [85, 195, 120], [137, 207, 101], [155, 213, 167], [41, 141, 12], [35, 195, 118], [63, 169, 115], [2, 184, 86], [49, 189, 100], [147, 200, 8], [63, 160, 43], [87, 121, 8], [49, 183, 44], [61, 190, 119]]`,

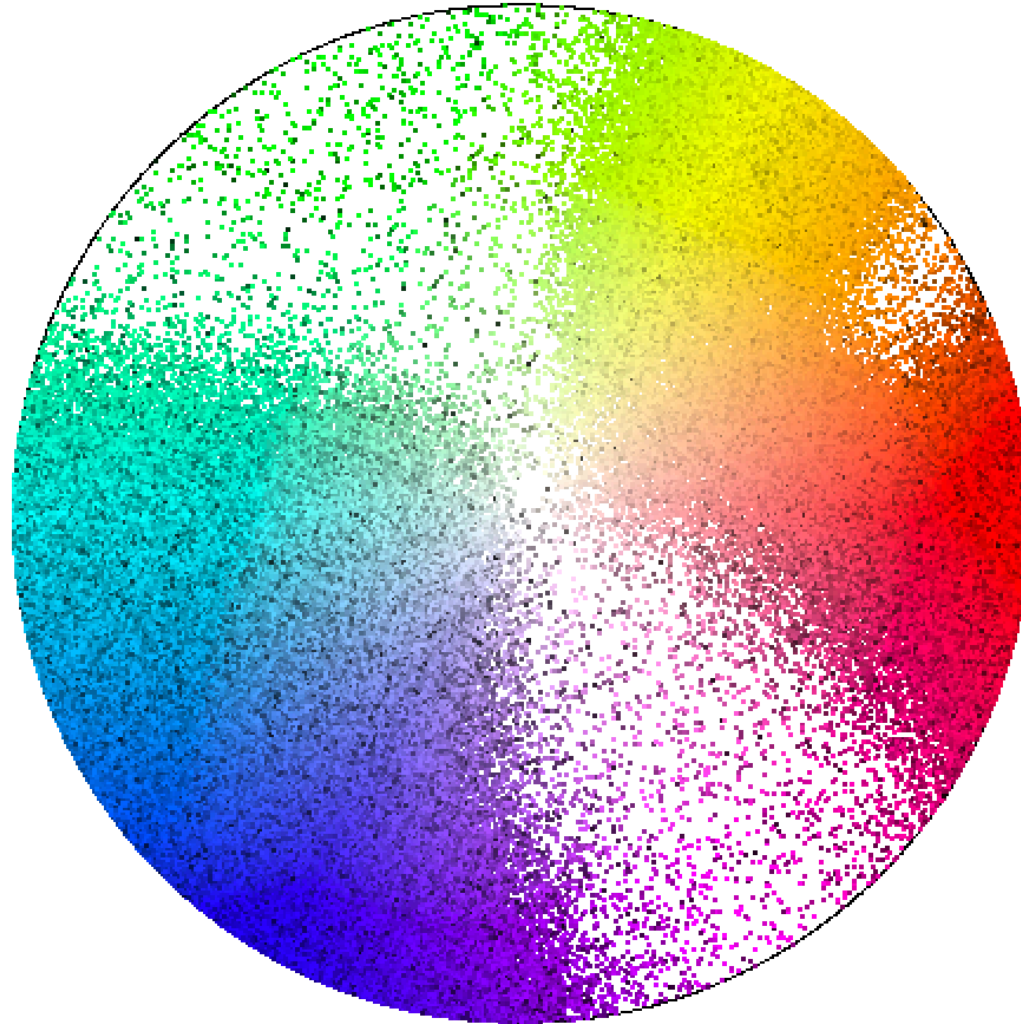
"sal": `[[184, 207, 244], [48, 199, 109], [247, 4, 25], [6, 101, 127], [196, 124, 36], [148, 30, 23], [106, 51, 249], [186, 63, 96], [209, 234, 226], [115, 18, 254], [59, 251, 10], [209, 84, 209], [254, 164, 39], [154, 165, 137], [82, 196, 178], [120, 250, 248], [175, 59, 33], [67, 52, 126], [224, 211, 50], [9, 255, 249], [138, 43, 154], [218, 158, 7], [213, 79, 90]]`,

"marzipan": `[[202, 197, 102], [34, 80, 112], [127, 162, 51], [90, 171, 24], [134, 198, 156], [163, 138, 126], [212, 248, 154], [133, 25, 118], [75, 143, 86], [46, 108, 0], [9, 242, 107], [29, 120, 25], [237, 209, 155], [215, 82, 187], [200, 79, 52], [12, 78, 60], [18, 52, 183], [186, 61, 232], [169, 201, 232], [173, 216, 142]]`

}

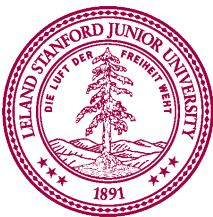


Displaying Colors



Further Reading

- <http:#blog.xkcd.com/2010/05/03/color-survey-results/>



Why is this so fast?



mantis shrimp colors



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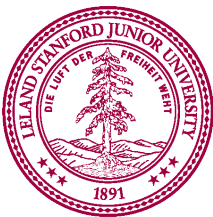
About 1,870,000 results (0.54 seconds)

Humans and many other primates have three; some birds and reptiles have four photoreceptors. Certain butterflies can even have six. But the mantis shrimp has **12** different types of photoreceptors in their eyes – and scientists haven't understood why until now. Jan 27, 2014



[Study Offers Insights into Unique Color Vision of Mantis Shrimp ...](#)

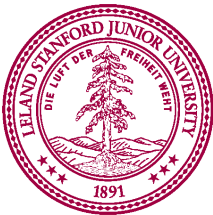
www.sci-news.com/biology/science-color-vision-mantis-shrimp-01719.html



Why is this so fast?



```
hash_int = hash(key);
```



Why is this so fast?



```
hash_int = hash(key);
```

(but we lose sortedness)

