CS 124 Python Tutorial

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www.tinyurl.com/
cs124python

Running Python

Interactive Interpreter

```
(cs124-env) kpatel$ python3
Python 3.5.2 (default, Nov 12 2018, 13:43:14)
[GCC 5.4.0 20160609] on linux
Type "help", "copyright", "credits" or "license" for more
information.
>>>
```

You can write Python code right here!

Based on a slide by Sam Redmond

Running Python Scripts

```
(cs124-env) kpatel$ python3 my_script.py
<output from the script>

(cs124-env) kpatel$ python3 hello.py
What is your name? Krishna
Hey Krishna, I'm Python!
```

Supply the filename of the Python script to run after the `python3` command

Based on a slide by Sam Redmond

Python Basics

Comments

```
# Single line comments start with a '#'

"""
Multiline comments can be written between
three "s and are often used as function
and module comments.
"""
```

Based on a slide by Sam Redmond

Numbers and Math

```
3               # => 3   (int)
3.0             # => 3.0 (float)

1 + 1           # => 2
8 - 1           # => 7
10 * 2          # => 20
5 / 2           # => 2.5
9 / 3           # => 3.0
7 / 1.4         # => 5.0

7 // 3          # => 2  (integer division)
7 % 3           # => 1  (integer modulus)
2 ** 4          # => 16 (exponentiation)
```

Python has two numeric types

`int` and `float`

Based on a slide by Sam Redmond

Strings

```
# Unicode by default
greeting = 'Hello'
group = "wørld"

# Concatenate
combo = greeting + ' ' + group + "!"

combo == "Hello wørld!"  # => True
```

No char in Python!
Both ' and " make string literals

Based on a slide by Sam Redmond

Booleans

```
True              # => True
False             # => False

not True          # => False
True and False    # => False
True or False     # => True (short-circuits)

1 == 1            # => True
2 * 3 == 5        # => False
1 != 1            # => False
2 * 3 != 5        # => True

1 < 10            # => True
2 >= 0            # => True
1 < 2 < 3         # => True  (1 < 2 and 2 < 3)
1 < 2 >= 3        # => False (1 < 2 and 2 >= 3)
```

`bool` is a subtype of `int`, where `True == 1` and `False == 0`

Based on a slide by Sam Redmond

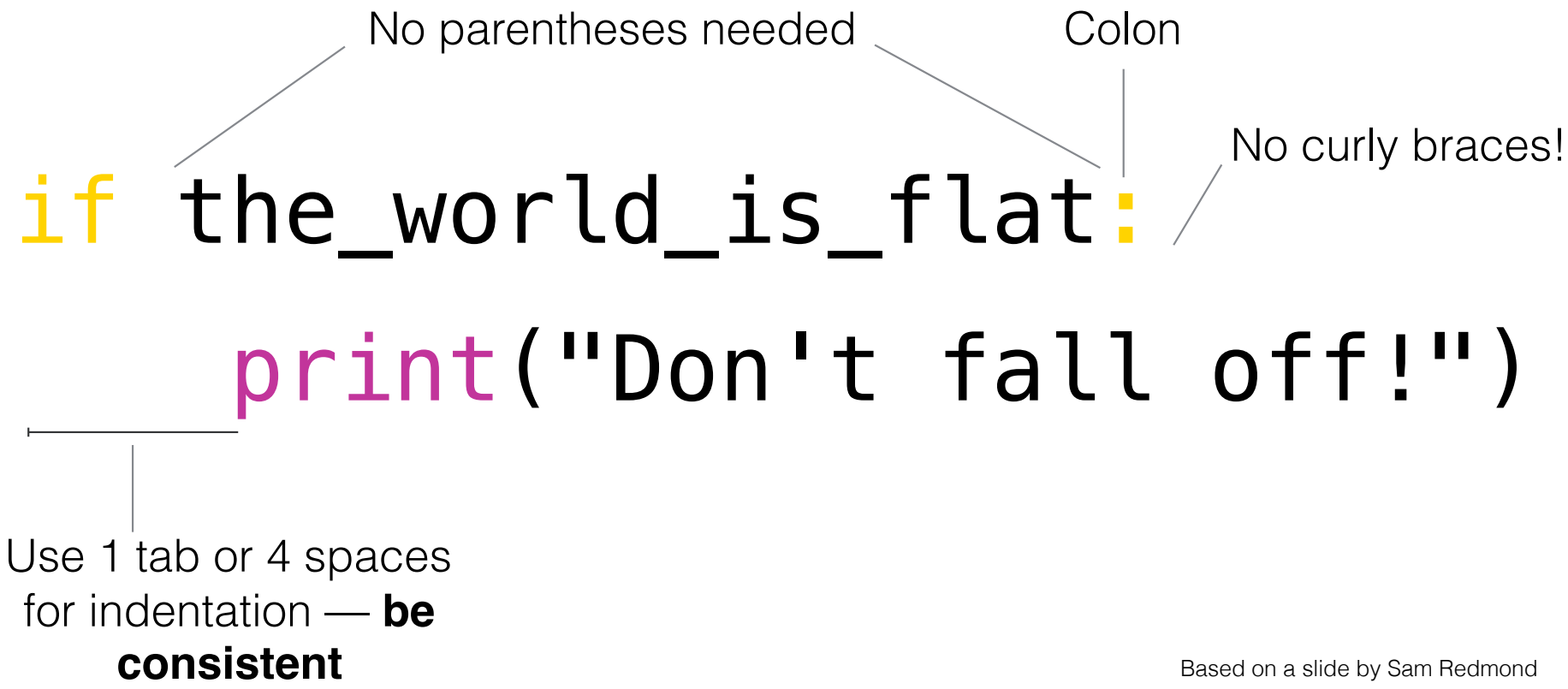
None

Similar to `null` in other languages

```
not None          # => True
bool(None)        # => False
```

`None` has an inherent value of "`False`"

If Statements



Based on a slide by Sam Redmond

Exercise 1

`elif` and `else`

```
if name == "jurafsky":
    print("dan is lecturing")
elif name == "kpatel":
    print("krishna is lecturing")
else:
    print("someone else is lecturing")
```

zero or more `elif`s

`else` is optional

Python has no `switch` statement,

opting for `if/elif/else` chains

Based on a slide by Sam Redmond

Variables

```
my_integer = 10          # => create an integer
my_string = ‘hello!’     # => create a string

my_integer = my_string # => set my_integer to my_string
print(my_integer)      # => prints ‘hello!’
```

There are no types in Python!

For Loops

Strings, lists, etc.

```
for item in iterable:
    process(item)
```

No loop counter!

Based on a slide by Sam Redmond

Looping over Collections

```
# Loop over words in a list.
for color in ["red", "green", "blue", "yellow"]:
    print(color)

# => "red"
# => "green"
# => "blue"
# => "yellow"
```

Based on a slide by Sam Redmond

Looping with an Index

```
for idx in range(3):
    print(idx)

# => 0
# => 1
# => 2
```

```
for idx in range(3, 6):
    print(idx)

# => 3
# => 4
# => 5
```

Exercise 2

While Loops

```
while condition:
    # do something
```

`break` and `continue`

```
i = 0
while True:
    print(i)
    if i == 2:
        break
    i += 1

# => 0
# => 1
# => 2
```

```
i = 0
while i <= 3:
    i += 1
    if i == 1:
        continue
    print(i)

# => 2
# => 3
# => 4
```

Writing Functions

The `def` keyword defines a function

Parameters have no explicit types

```
def fn_name(param1, param2):
    ...
    return value_1, value_2
```

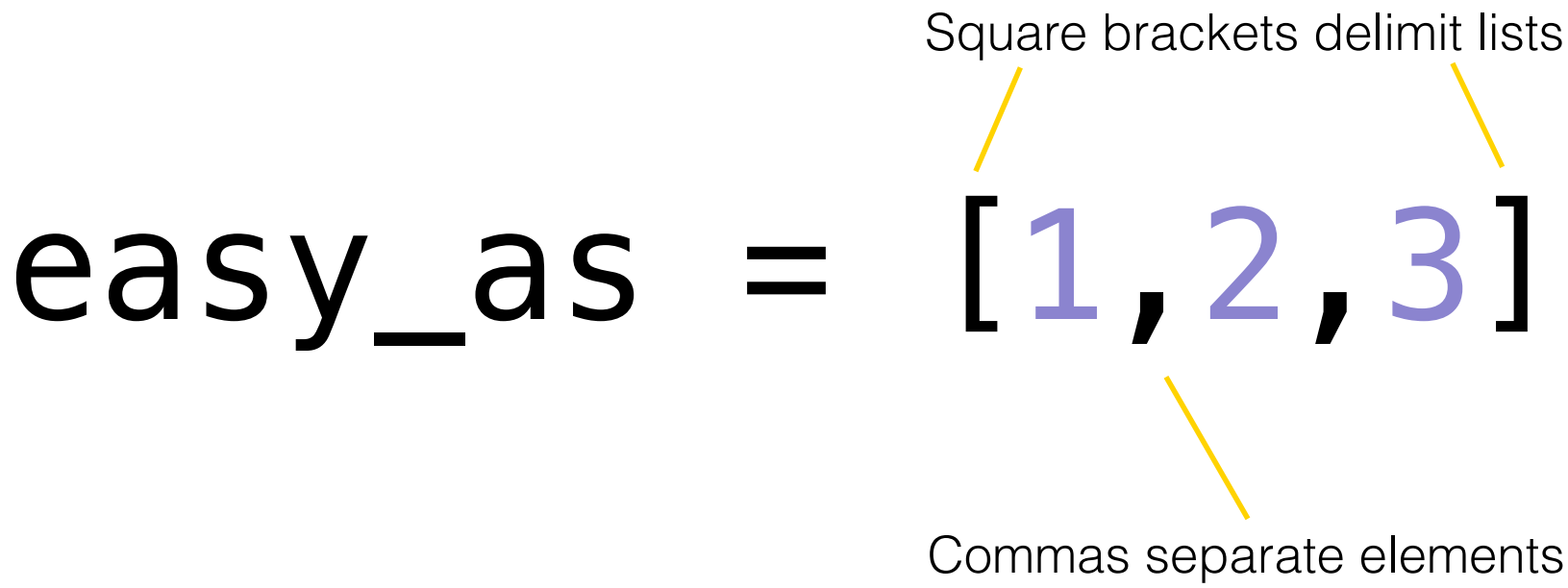
`return` is optional
if either return or its value are omitted, implicitly returns `None`

You can return multiple values

Based on a slide by Sam Redmond

Data Structures

List



Based on a slide by Sam Redmond

Inspecting List Elements

```
empty = []
also_empty = list()
letters = ['a', 'b', 'c', 'd']
numbers = [2, 3, 5, 7, 11]

# Access elements at a particular index
numbers[0]   # => 2
numbers[-1]  # => 11

# You can also slice lists - the same rules apply
letters[:3]    # => ['a', 'b', 'c']
numbers[2:-1]  # => [5, 7]
```

Based on a slide by Sam Redmond

Exercises 3, 4

Useful List Functions

```
# Add to end of list
lst.append(2)   # => [2]
lst.append(50)  # => [2, 50]

# Insert at position
lst.insert(0, ‘hi’)    # => ['hi', 2, 50]

# Remove from position
lst.pop(1)  # => [‘hi’, 50]
```

Find more functions here:
https://docs.python.org/3/tutorial/datastructures.html

Length

```
numbers = [2, 3, 5, 7, 11]
hello = “hi!”

# find the length
len(numbers)    # => 5
len(hello)      # => 3
```

Counting vs. Indexing

Index

```
          0    1    2    3
letters = ['a', 'b', 'c', ‘d’]

len(letters)  # => 4
```

Sets

```
empty = set()
letters = ['a', ‘b', ‘a’]
letters_set = set(letters)    # => set(‘a’, ‘b’)

# Add to a set
letters_set.add(‘c’)   # => set(‘a’, ‘b’, ‘c’)
letters_set.add(‘b’)   # => set(‘a’, ‘b’, ‘c’)

# Membership
‘b’ in letters_set   # => True
‘c’ in letters       # => False
```

Dictionaries

```
empty = {}
also_empty = dict()
d = {'one': 1, 'two': 2, 'three':3}

# Getting
d['one']    # => 1
d['four']   # => Raises KeyError

# Setting
d['one'] = 3 # => {'one': 3, 'two': 2, 'three':3}
d['six'] = 4 # => {'one': 3, 'two': 2, 'three':3,'six':4}

# Membership (looks at keys)
'one' in d   # => True
 2 in d    # => False
```

Keys must be unique

Exercise 5

Tuples

```
letters = ['a', 'b', 'c', 'd']
```

`tuples` are immutable

```
# Creating Tuples
letter_tup = tuple(letters)   # => (‘a’, ‘b’, ‘c’, ‘d’)
num_tup = (1, 2)

# Indexing
letter_tup[0] # => ’a’

# Cannot change contents once created
letter_tup[0] = 4 # => Raises Error

# Membership
‘a’ in letter_tup   # => True
```

Numpy

```
import numpy as np
```

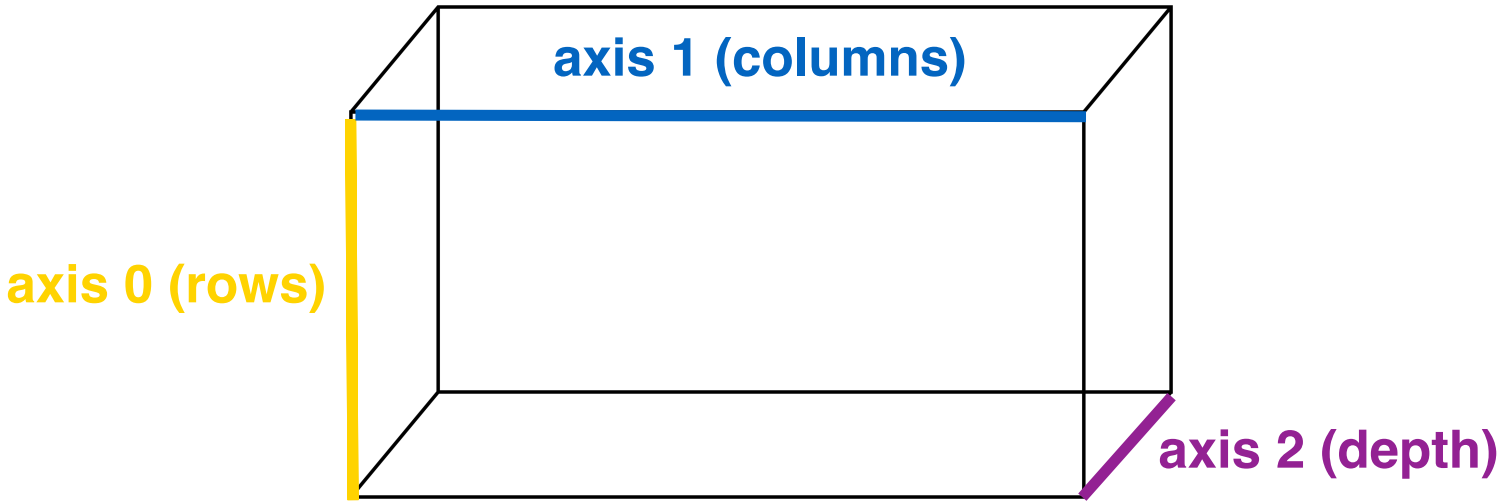
Arrays

```
# Array filled with zeros
zeros = np.zeros(4)     # => array([0., 0., 0., 0.])

# Array filled with ones
ones = np.ones((2, 1))     # => array([[1.],
                                    [1.]])

# Python List to Numpy Array
arr = np.array([1, 3, 4])   # => array([1., 3., 4.])
```

Axis




```
np.ones((1, 2, 3))
# array([[[1., 1., 1.],
#         [1., 1., 1.]]])
```

Arrays

```
ones = np.ones((2, 1))       # => array([[1.],
                                        [1.]])
arr = np.array([1, 3, 4])    # => array([1., 3., 4.])
cat = np.array([3, 2])          # => array([3., 2.])


# Useful Tricks
arr[1] = 9       # => array([1., 9., 4.])
len(ones)        # => 2
ones.shape       # => (2, 1)
ones.reshape(2) # => array([[1., 1.]])
np.concatenate((arr, cat)) => array([1, 3, 4, 3, 2])
```

Useful Math

```
# Natural log
np.log(10)                    # => 2.302

# Squareroot
np.sqrt(4)                    # => 2

# Dot Product
a = np.array([1, 0])
b = np.array([2, 3])
a.dot(b)                      # => 2

# L2 Norm / Euclidian Distance
np.linalg.norm(a)             # => 1.0
```

$$\|\mathbf{x}\|_2 = \left(\sum_{i=1}^{N} |x_i|^2\right)^{1/2} = \sqrt{x_1^2 + x_2^2 + \ldots + x_N^2}$$

Broadcasting

```
range = np.arange(4)    # => array([0, 1, 2, 3])

# Vector and a Scalar
range * 2               # => array([0, 2, 4, 6])

# Vector and a Vector
range / range           # => array([nan,  1.,  1.,  1.])

# Vector and a Matrix
matrix = np.ones((3, 4))
range + matrix        # => array([[ 1.,  2.,  3.,  4.],
                                [ 1.,  2.,  3.,  4.],
                                [ 1.,  2.,  3.,  4.]])
```

When you think of broadcasting,
think of element-wise operations

Exercise 6

Documentation

https://docs.scipy.org/doc/numpy/reference/routines.html

The best resource!

Regular Expressions

`re` — Regular expression operations

```
# Search for pattern match anywhere in string; return None if not found
m = re.search(r"(\w+) (\w+)", "Isaac Newton, Physicist")
m.group(0)  # "Isaac Newton" - the entire match
m.group(1)  # "Isaac" - first parenthesized subgroup
m.group(2)  # "Newton" - second parenthesized subgroup

# Match pattern against start of string; return None if not found
m = re.match(r"(?P<fname>\w+) (?P<lname>\w+)", "Malcolm Reynolds")
m.group('fname')  # => 'Malcolm'
m.group('lname')  # => 'Reynolds'
```

Based on a slide by Sam Redmond

`re` — Regular expression operations

```
# Substitute occurrences of one pattern with another
re.sub(r'@\w+\.com', '@stanford.edu', 'k@cal.com jurafsky@bears.com')
# => k@stanford.edu jurafsky@stanford.edu

pattern = re.compile(r'[a-z]+[0-9]{3}')  # compile pattern for fast ops
match = re.search(pattern, '@@@abc123')  # pattern is first argument
match.span()  # (3, 9)
```

Based on a slide by Sam Redmond

Exercise 7

https://www.learnpython.org/ on Chrome

Hello, World!
Variables and Types
Lists
Basic Operators
String Formatting
Basic String Operations
Conditions
Loops
Functions
Dictionaries

Modules and Packages
Numpy Arrays
Generators
List Comprehensions
Regular Expressions
Sets
Decorators

Unix Videos (follow along)

https://tinyurl.com/unix-videos

Videos 1, 4, 6-10, 14-19

Based on a slide by Sam Redmond

Sklearn

Documentation

https://scikit-learn.org/stable/user_guide.html

The best resource!

Linear Regression

```
from sklearn.linear_model import LinearRegression
x = np.array([1, 2, 3, 4])
y = np.array([4, 5, 6, 7])

# Fit your linear regression
reg = LinearRegression().fit(x, y)

# Predict
reg.predict(np.array([1, 2]))
```