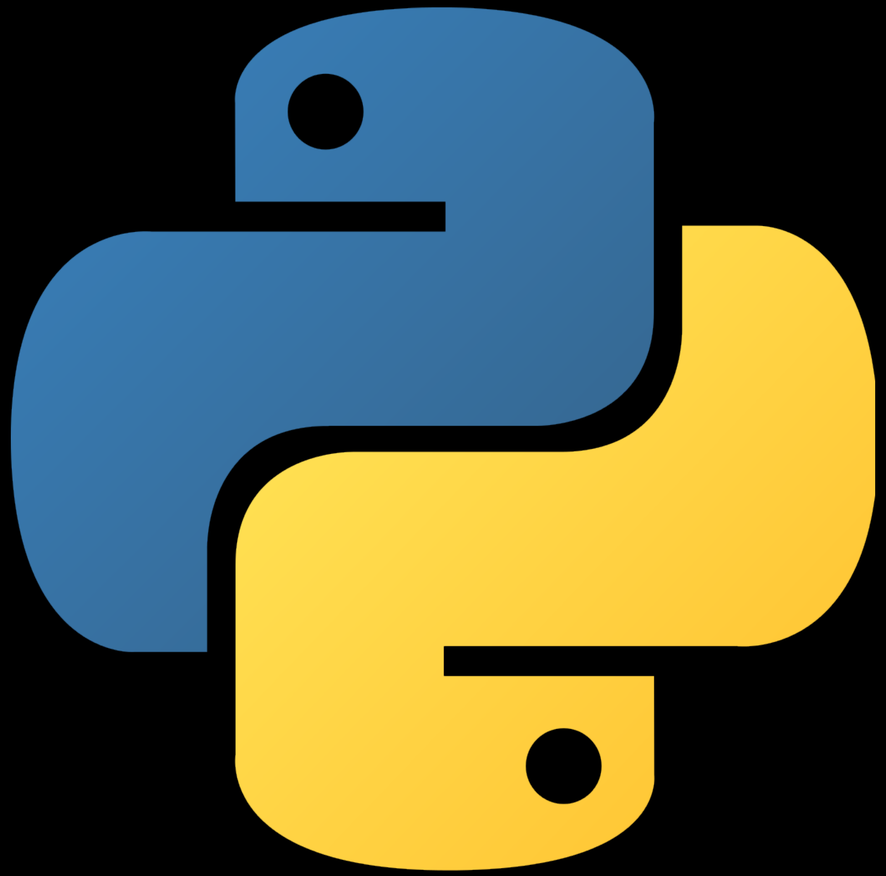
Welcome to Python!

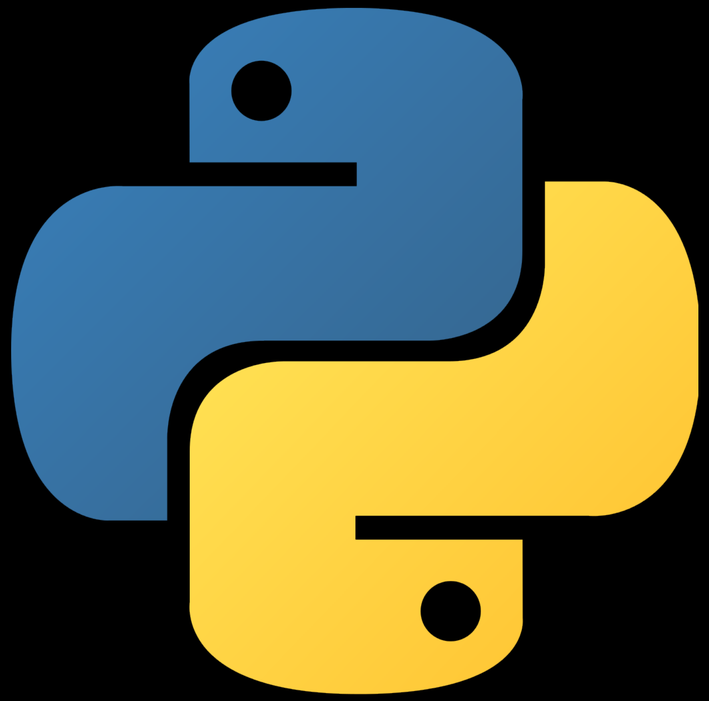
CS 41: hap.py code

The Python Programming Language



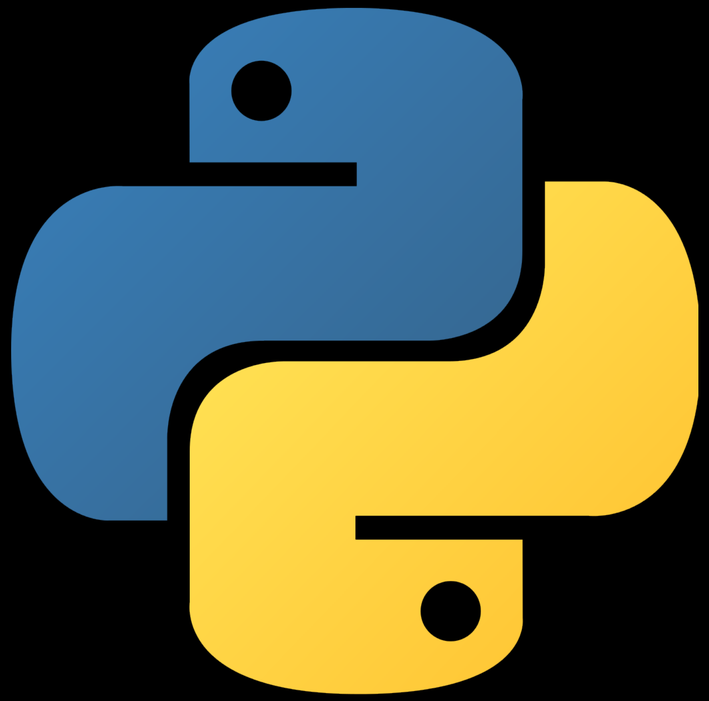
Agenda

Agenda



Welcome

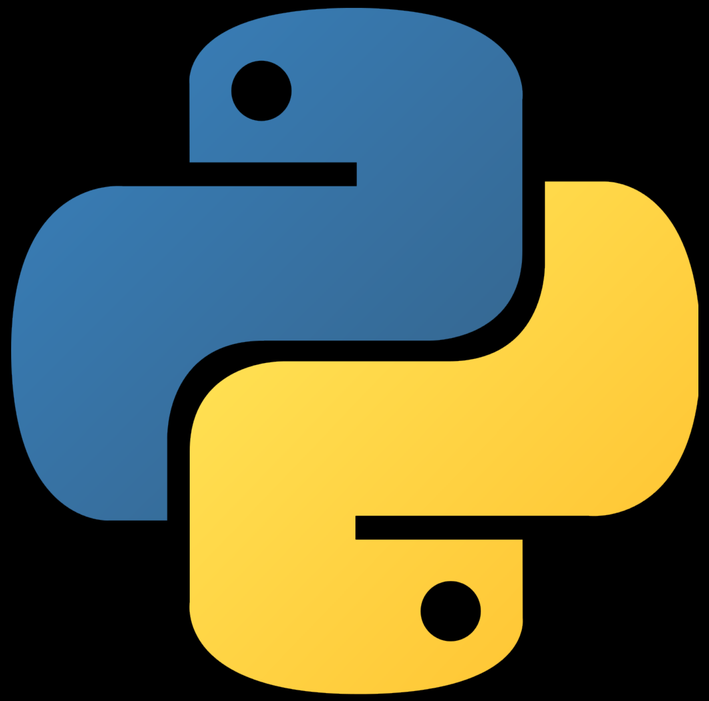
Agenda



Welcome

Why Take CS41?

Agenda



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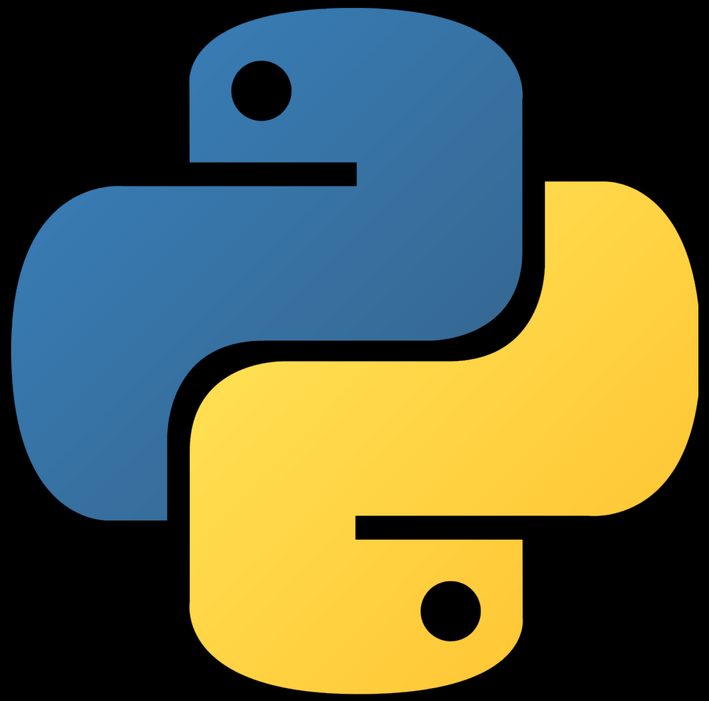
Why Take CS41?

What is Python?

Agenda



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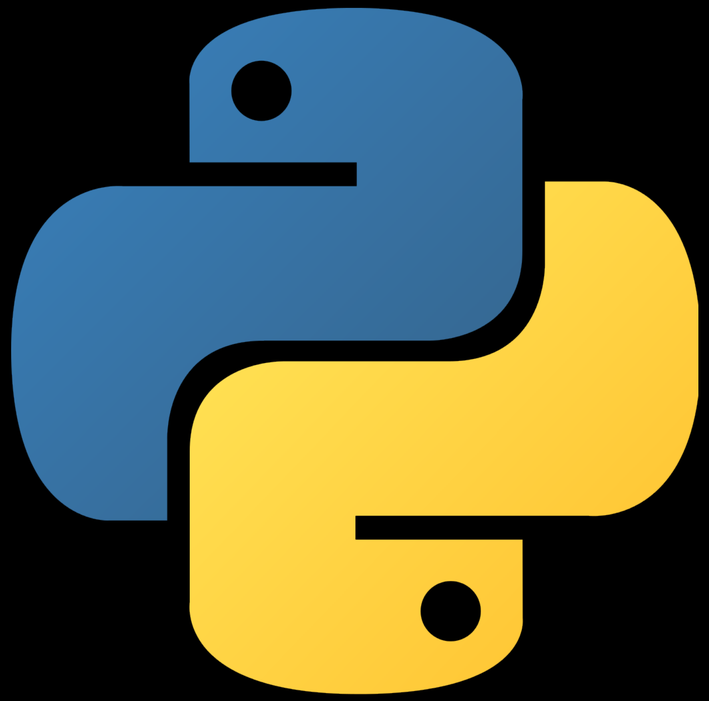

Welcome

Why Take CS41?

What is Python?

Logistics

Some Python Basics

Instructor

Sam Redmond

sredmond@stanford.edu

Course Helpers

Course Helpers

Brexton Pham

Meena Chetty

Gracie Young

David Slater

Christina Ramsey

Divya Saini

Matt Mahowald

Melissa Du

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Melissa Du

staff@stanfordpython.com

You

You

International Relations

Business

Computer Science

Chinese

Education

Biomedical Computation

Psychology

Environmental Engineering

Math

Medicine

Management Science & Engineering

History

Mechanical Engineering

Economics

Neuroscience

Aero/Astro

Symbolic Systems

Finance

English

Mathematical & Computational Science

Philosophy

Linguistics

Music

Electrical Engineering

Biomedical Informatics

Statistics

Bioengineering

East Asian Studies

Science, Technology and Society

Product Design

Why CS41?

Course Goals

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2. Learn to recognize and write "good" Python

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Questions

Questions

Why Python?

Questions

Why Python?

What is Python?

Questions

Why Python?

What is Python?

Will Python help me get a job?

History of Python

History of Python

Guido van Rossum
BDFL

History of Python

Guido van Rossum
BDFL

Python 1: 1994

History of Python

Guido van Rossum
BDFL

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Python 2: 2000

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Python 3: 2008

History of Python

Guido van Rossum
BDFL

Python 1: 1994

Python 2: 2000

Python 3: 2008

Specifically, we're using Python 3.4.3

Philosophy of Python

```
>>> import this
```

```
>>> import this

The Zen of Python, by Tim Peters
```

```
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Beautiful is better than ugly.
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```

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The Zen of Python, by Tim Peters
Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
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Sparse is better than dense.
Readability counts.
```

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```
Special cases aren't special enough to break the rules.
```

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Although practicality beats purity.
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Namespaces are one honking great idea -- let's do more of those!
```

Programmers are more important than programs

“Hello World” in Java

```
public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello World!");
    }
}
```

“Hello World” in C++

```
#include <iostream>
using namespace std;

int main() {
    cout << "Hello World!" << endl;
}
```

Double Yuck

“Hello World” in Python

```
print("Hello world!")
```

Who Uses Python?

Python at Stanford

Python at Stanford

CEE 245: Network Analysis for Urban Systems

COMM 382: Big Data and Causal Inference

CS 231N: Convolutional Neural Networks for Visual Recognition

EASTASN 105: Digital China: Computational Methods to Illuminate Society, Politics, and History

GENE 211: Genomics

LINGUIST 276: Quantitative Methods in Linguistics

MI 245: Computational Modeling of Microbial Communities

MS&E 448: Big Financial Data and Algorithmic Trading

PHYSICS 368: Computational Cosmology and Astrophysics

POLISCI 452: Text as Data

STATS 155: Statistical Methods in Computational Genetics

Python in Business

Python in Business

Dropbox

Eventbrite

venmo

Quora

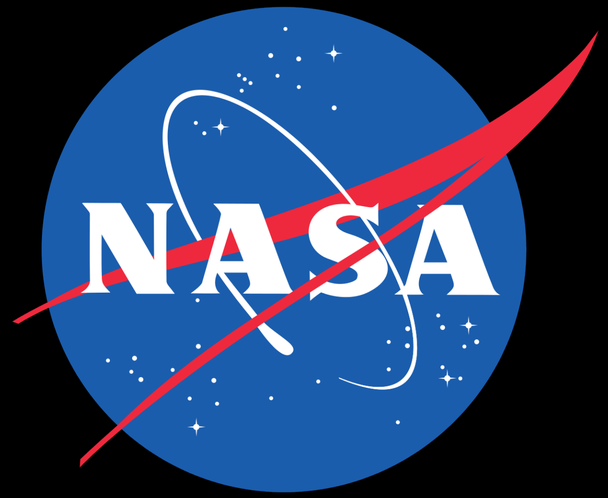
Google

Instagram

YouTube

Other Python Users

Other Python Users



5-Minute Break

Logistics

Logistics

Logistics

Lectures Tue / Thu, 3:00-4:20, 200-203

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Bookmark it! We'll post announcements, lecture slides, and handouts online.

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Prereqs CS106B/X

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Prereqs CS106B/X

Enrollment Cap 50

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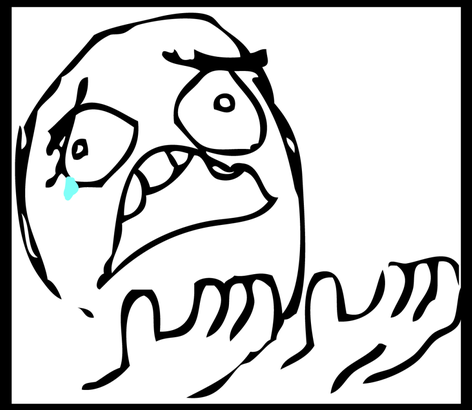

Logistics

Logistics

Attendance Required. At most 2 unexcused absences.

Logistics

iamhere.stanfordpython.com

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Auditing Encouraged

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Waitlist Rolling

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Piazza Sign up!

Logistics

Logistics

Assignments 4 in total

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Grading Functionality and style, on a checkmark scale

Logistics

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Credit For both functionality and style, average a check

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Late Days Two 24-hour extensions

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Honor Code Don’t cheat

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More specifics can be found on the Course Info handout

The Big Picture

The Road Ahead - The Python Language

The Road Ahead - The Python Language

Week 1 Python Fundamentals

Week 2 Data Structures

Week 3 Functions

Week 4 Functional Programming

Week 5 Object-Oriented Python

The Road Ahead - Python Tools

The Road Ahead - Python Tools

Week 6 Standard Library

Week 7 Third-Party Tools

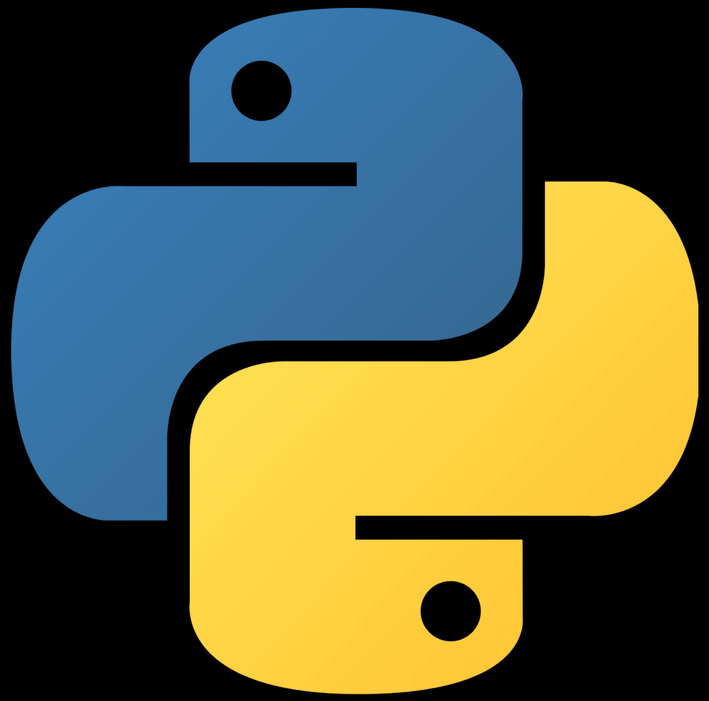
Week 8 Ecosystem

Week 9 Advanced Topics

Week 10 Projects!

Let’s Get Started!

Python Basics



- Interactive Interpreter
- Comments
- Variables and Types
- Numbers and Booleans
- Strings and Lists
- Console I/O
- Control Flow
- Loops
- Functions

Interactive Interpreter

```
sredmond$
```

Interactive Interpreter

```
sredmond$ python3
```

Interactive Interpreter

```
sredmond$ python3
Python 3.4.3 (v3.4.3:9b73f1c3e601, Feb 23 2015, 02:52:03)
[GCC 4.2.1 (Apple Inc. build 5666) (dot 3)] on darwin
Type "help", "copyright", "credits" or "license" for more information.
>>>
```

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sredmond$ python3
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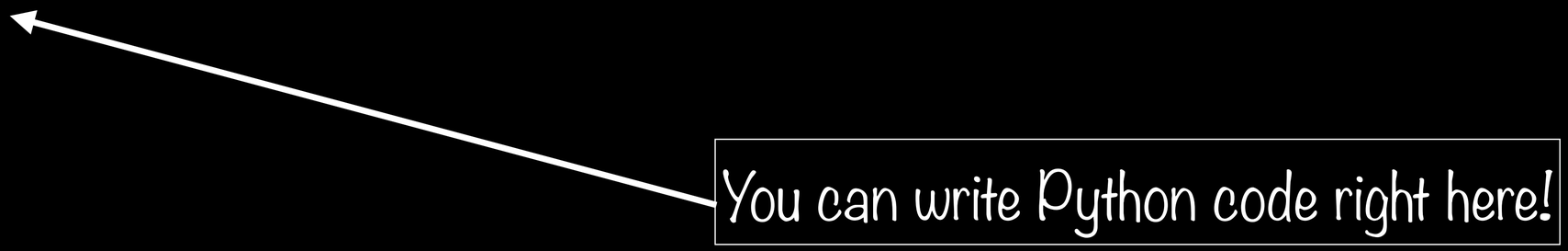

A Big Deal

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Immediate gratification!

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Sandboxed environment to experiment with Python

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Shortens code-test-debug cycle to seconds

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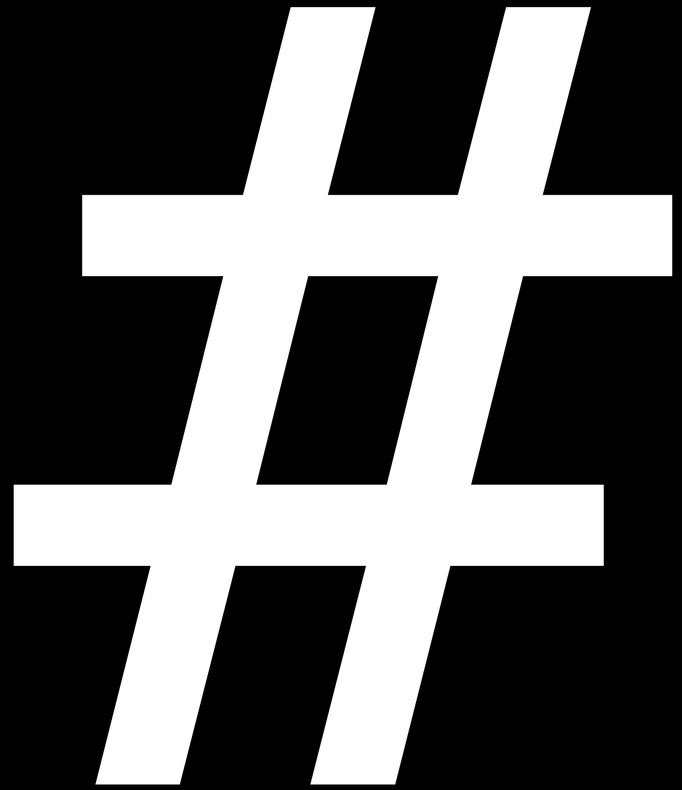
Immediate gratification!

Sandboxed environment to experiment with Python

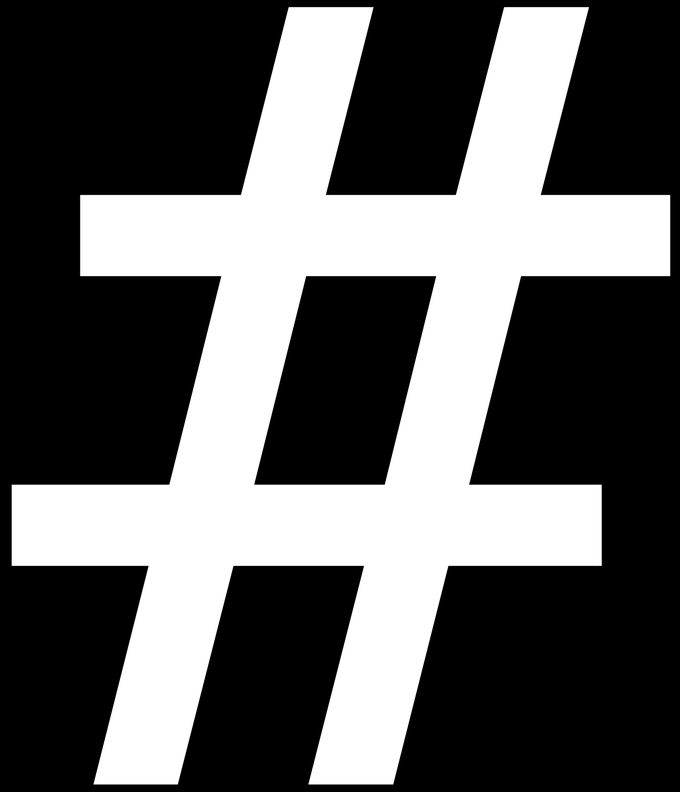
Shortens code-test-debug cycle to seconds

The interactive interpreter is your new best friend



Hashtag

Pound Sign



Sharp

Number Sign

Octothorpe

Comments

Comments

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

Comments

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

"""
    Multiline strings can be written
    using three "s, and are often used
    as function and module comments
"""
```

Variables

Variables

Variables

```
x = 2
```

No semicolon!

Variables

```
x = 2
x * 7
# => 14
```

No semicolon!

Variables

```
x = 2
x * 7
# => 14

x = "Hello, I'm "
```

No semicolon!

Variables

No semicolon!

```
x = 2
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x = "Hello, I'm "
x + "Python!"
# => "Hello, I'm Python"
```

Variables

```
x = 2
x * 7
# => 14
```

No semicolon!

```
x = "Hello, I'm "
x + "Python!"
# => "Hello, I'm Python"
```

What happened here?!

Where's My Type?

In Java or C++

```
int x = 0;
```

Where's My Type?

In Python

```
x = 0
```

Where's My Type?

Variables in Python are **dynamically-typed**: declared without an explicit type

However, **objects** have a type, so Python knows the type of a variable, even if you don't

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```
type(1)          # => <class 'int'>
type("Hello")    # => <class 'str'>
type(None)       # => <class 'NoneType'>
```

Where's My Type?

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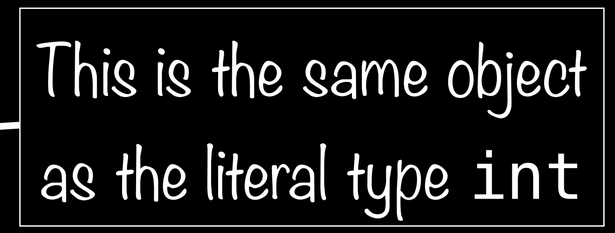


Where's My Type?

Variables in Python are **dynamically-typed**: declared without an explicit type

However, **objects** have a type, so Python knows the type of a variable, even if you don't

```
type(1)          # => <class 'int'>
type("Hello")    # => <class 'str'>
type(None)       # => <class 'NoneType'>
```

This is the same object as the literal type `int`

```
type(int)        # => <class 'type'>
type(type(int))# => <class 'type'>
```

Python's dynamic type system is fascinating! More on Wed.

Numbers and Math

Numbers and Math

Numbers and Math

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

Python has two numeric types
`int` and `float`

Numbers and Math

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

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

Python has two numeric types
`int` and `float`

Numbers and Math

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

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

Booleans

Booleans

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

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

Booleans

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

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

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

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
```

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

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`

Strings

Strings

Strings

No `char` in Python!

Both `'` and `"` create string literals

Strings

No `char` in Python!
Both ' and " create string literals

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

Strings

No `char` in Python!
Both `'` and `"` create string literals

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


greeting + ' ' + group + '!' # => 'Hello wørld!'
```

Indexing

```
  0 1 2 3 4 5 6
s='Arthur'
```

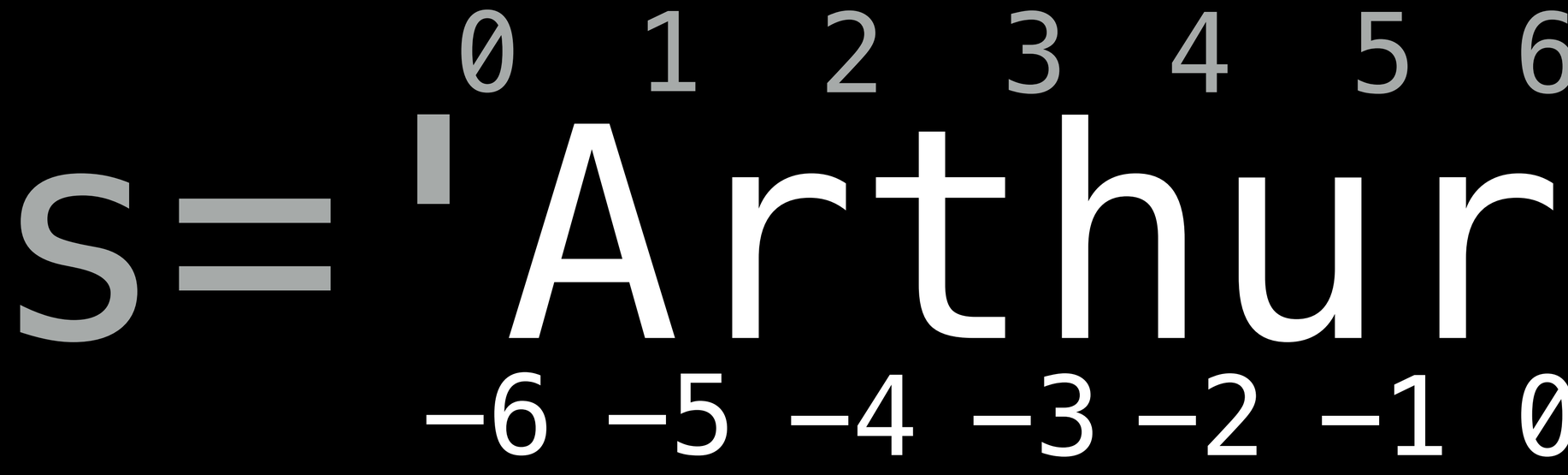
Indexing

```
  0 1 2 3 4 5 6
s='Arthur'
```

```
s[0] == 'A'
s[1] == 'r'
s[4] == 'u'
s[6] # Bad!
```

Negative Indexing

Negative Indexing

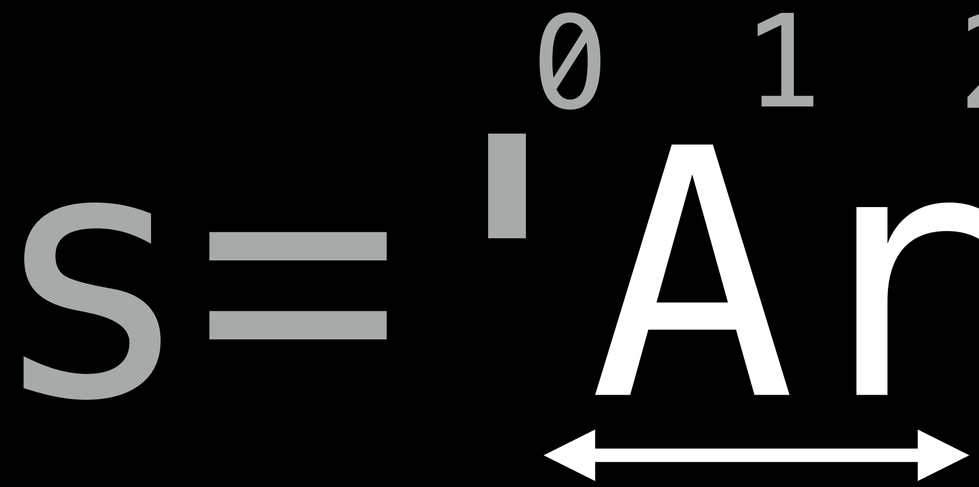



```
s[-1] == 'r'
s[-2] == 'u'
s[-4] == 't'
s[-6] == 'A'
```

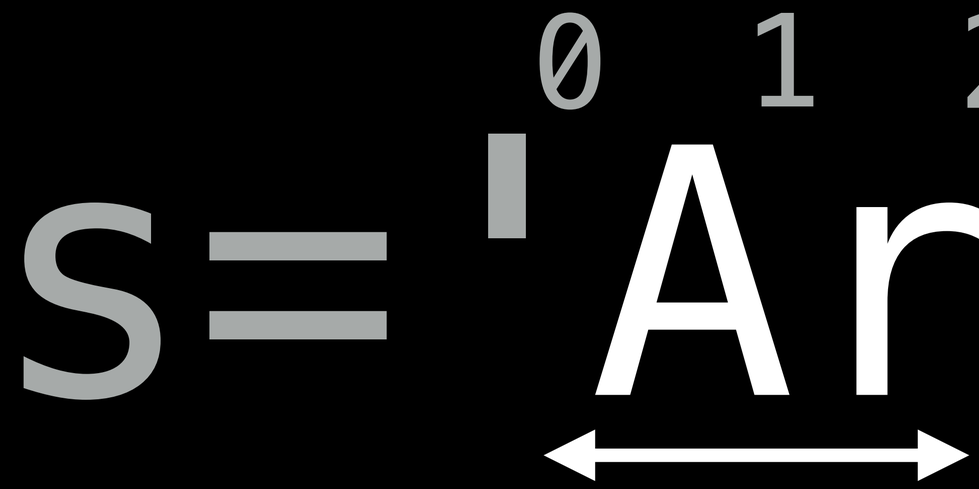
Slicing

```
      0 1 2 3 4 5 6
S='Arthur'
```

Slicing

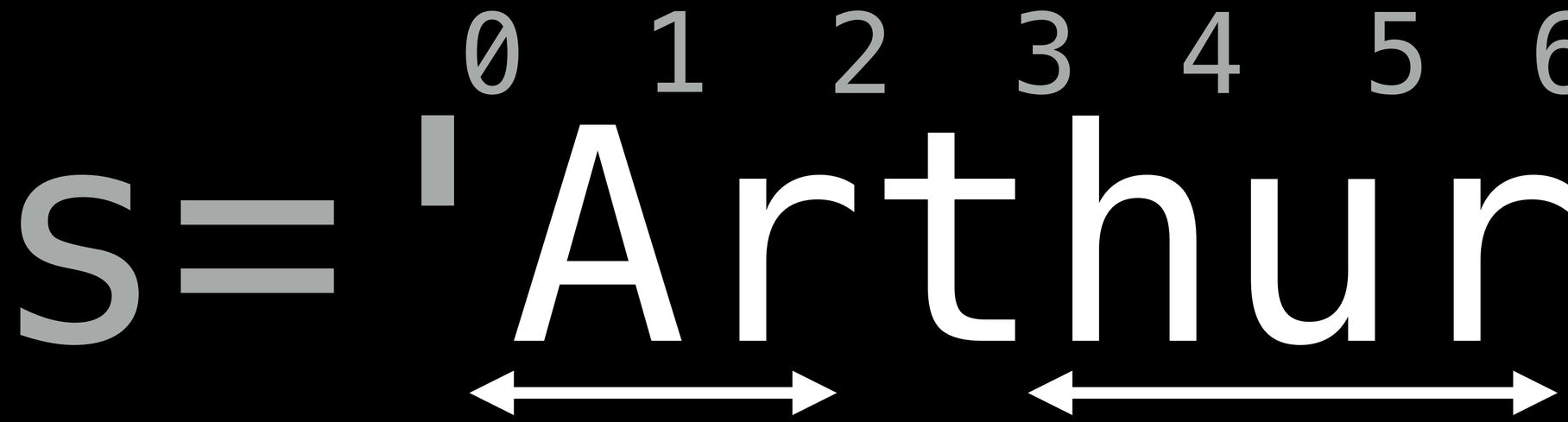


Slicing



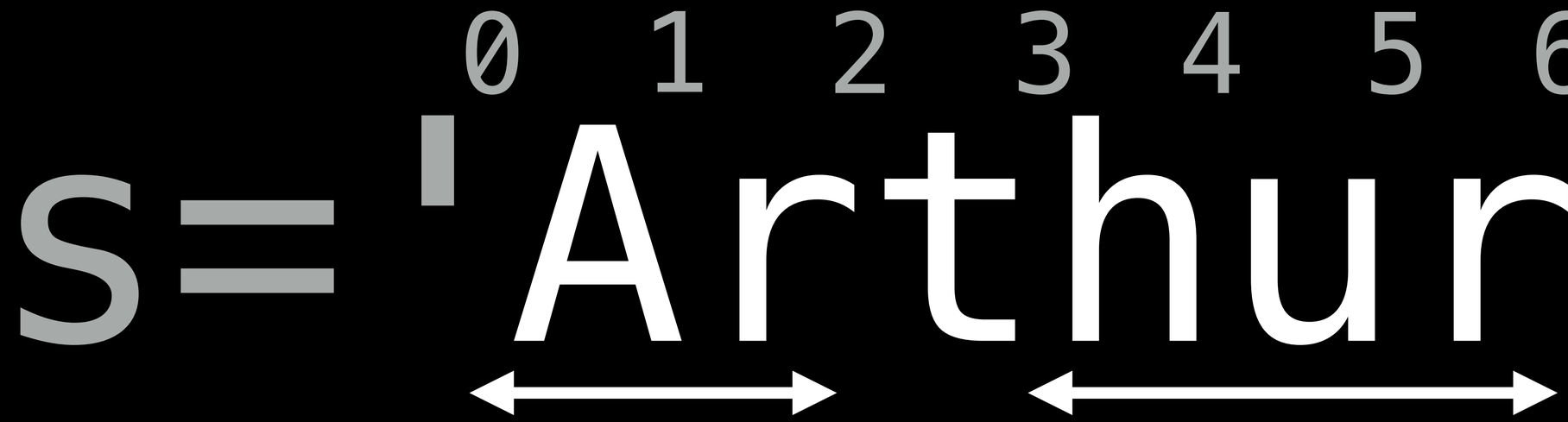

```
s[0:2] ==  'Ar'
```

Slicing



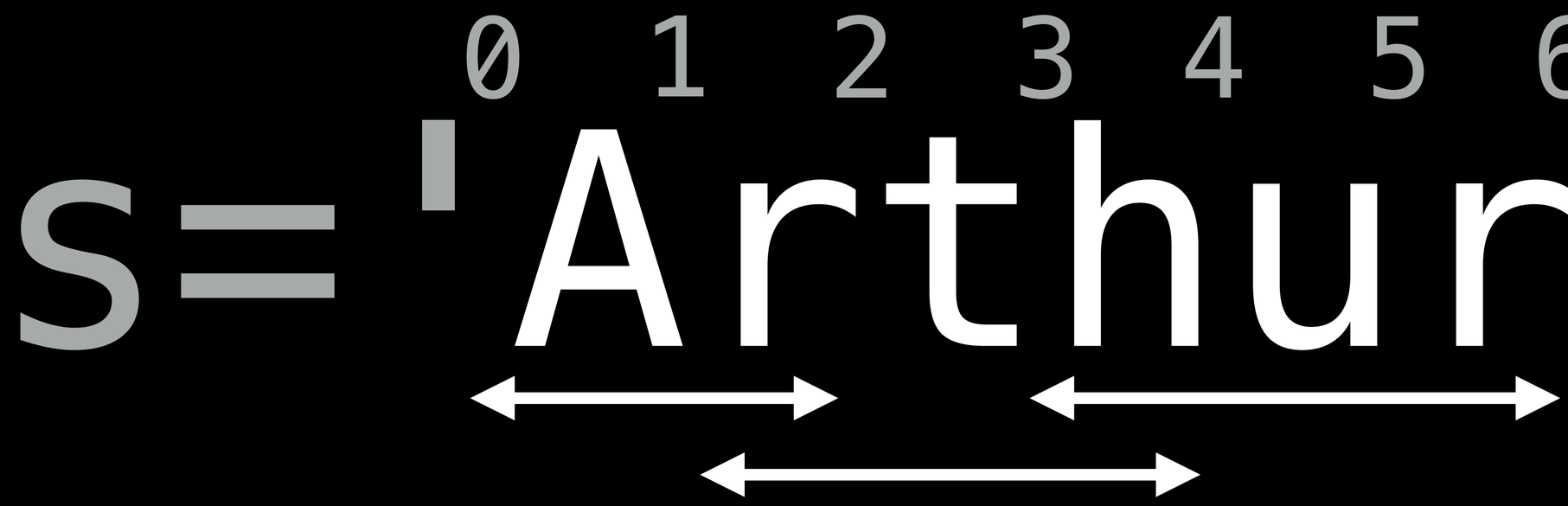

```
s[0:2] ==  'Ar'
```

Slicing



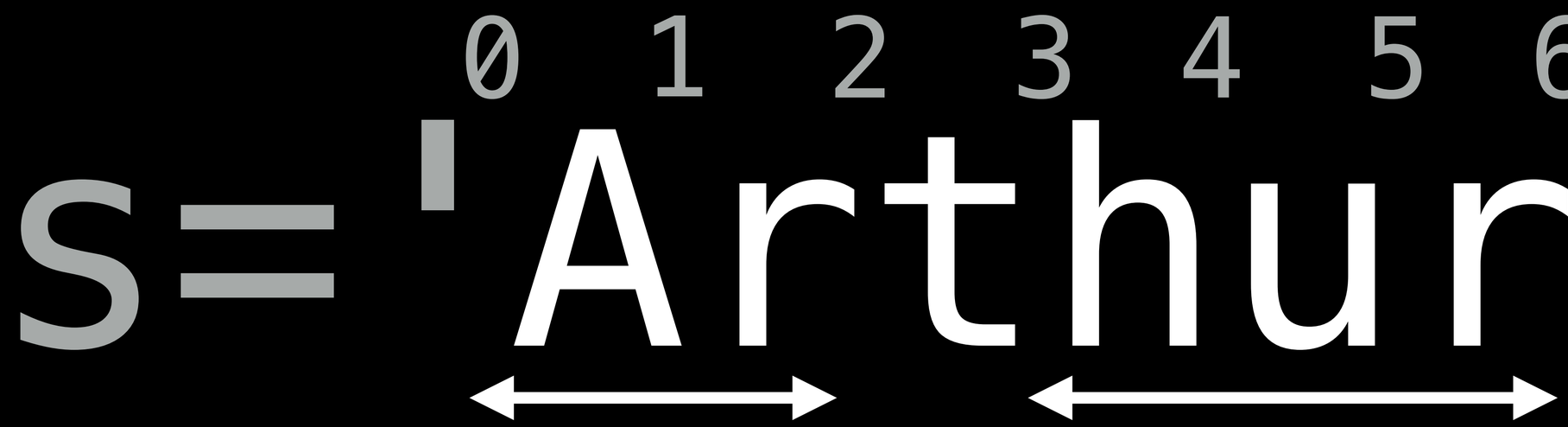

```
s[0:2] ==  'Ar'
s[3:6] == 'hur'
```

Slicing




```
s[0:2] ==  'Ar'
s[3:6] == 'hur'
s[1:4] == 'rth'
```

Strings



Implicitly starts at 0

```
s[:2] ==  'Ar'
s[3:] == 'hur'
```

Implicitly ends at the end

Strings

```
      0 1 2 3 4 5 6
S = 'A r t h u r'
```

Strings

```
  0 1 2 3 4 5 6
s='Arthur'
```

Can also pass a step size

```
s[1:5:2] == 'rh'
s[4::-2] == 'utA'
```

Strings

```
  0 1 2 3 4 5 6
s='Arthur'
```

Can also pass a step size

```
s[1:5:2] == 'rh'
s[4::-2] == 'utA'
```

Reversing a string

```
s[::-1] == 'ruhtrA'
```

Converting Values

Converting Values

```
str(42)          # => "42"
```

Converting Values

```
str(42)          # => "42"
int("42")        # => 42
```

Converting Values

```
str(42)          # => "42"
int("42")        # => 42
float("2.5")     # => 2.5
```

Converting Values

```
str(42)          # => "42"
int("42")        # => 42
float("2.5")     # => 2.5
float("1")       # => 1.0
```

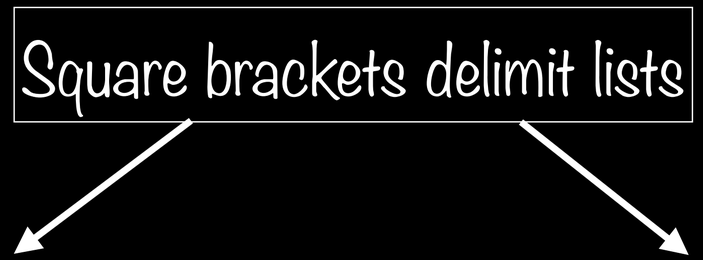
Lists

Dive into Python data structures Week 2!

Lists

```
easy_as = [1,2,3]
```

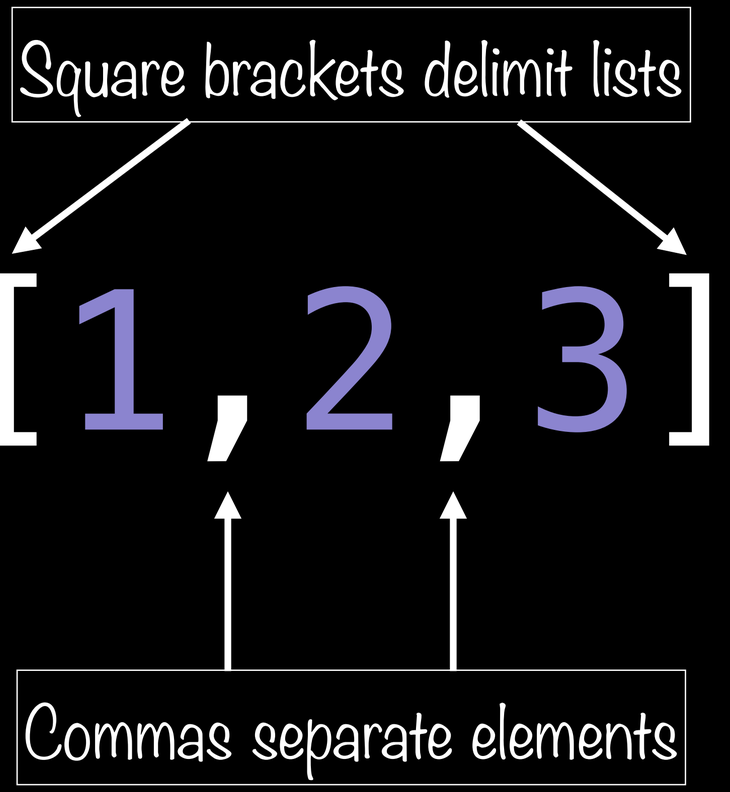
Lists



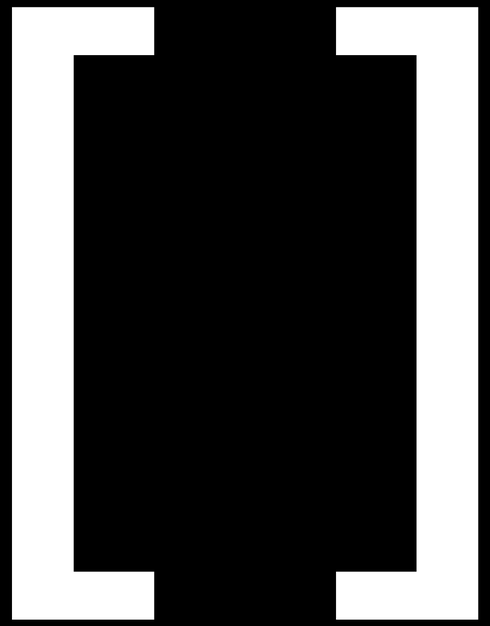

```
easy_as = [1,2,3]
```

Lists

```
easy_as = [1,2,3]
```



Lists



Versatile

Incredibly common

≈ ArrayList / Vector

Basic Lists

Basic Lists

```
# Create a new list
empty = []
letters = ['a', 'b', 'c', 'd']
numbers = [2, 3, 5]
```

Basic Lists

```
# Create a new list
empty = []
letters = ['a', 'b', 'c', 'd']
numbers = [2, 3, 5]

# Lists can contain elements of different types
mixed = [4, 5, "seconds"]
```

Basic Lists

```
# Create a new list
empty = []
letters = ['a', 'b', 'c', 'd']
numbers = [2, 3, 5]

# Lists can contain elements of different types
mixed = [4, 5, "seconds"]

# Append elements to the end of a list
numbers.append(7)   # numbers == [2, 3, 5, 7]
numbers.append(11)  # numbers == [2, 3, 5, 7, 11]
```

Inspecting List Elements

Inspecting List Elements

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

Inspecting List Elements

```
# 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[1:-1]  # => [3, 5, 7]
```

Nested Lists

Nested Lists

```
# Lists really can contain anything – even other lists!
x = [letters, numbers]
x  # => [['a', 'b', 'c', 'd'], [2, 3, 5, 7, 11]]
```

Nested Lists

```
# Lists really can contain anything – even other lists!
x = [letters, numbers]
x  # => [['a', 'b', 'c', 'd'], [2, 3, 5, 7, 11]]
x[0]  # => ['a', 'b', 'c', 'd']
```

Nested Lists

```
# Lists really can contain anything – even other lists!
x = [letters, numbers]
x  # => [['a', 'b', 'c', 'd'], [2, 3, 5, 7, 11]]
x[0]  # => ['a', 'b', 'c', 'd']
x[0][1]  # => 'b'
```

Nested Lists

```
# Lists really can contain anything – even other lists!
x = [letters, numbers]
x  # => [['a', 'b', 'c', 'd'], [2, 3, 5, 7, 11]]
x[0]  # => ['a', 'b', 'c', 'd']
x[0][1]  # => 'b'
x[1][2:]  # => [5, 7, 11]
```

General Queries

General Queries

```
# Length (len)
len([])  # => 0
len("python")  # => 6
len([4,5,"seconds"])  # => 3
```

General Queries

```
# Length (len)
len([])  # => 0
len("python")  # => 6
len([4,5,"seconds"])  # => 3


# Membership (in)
0 in []  # => False
'y' in 'python'  # => True
'minutes' in [4, 5, 'seconds']  # => False
```

Console I/O

Console I/O

Console I/O

`input` prompts the user for input

```
# Read a string from the user
>>> name = input("What is your name? ")
```

Console I/O

`input` prompts the user for input

```
# Read a string from the user
>>> name = input("What is your name? ")
What is your name?
```

Console I/O

`input` prompts the user for input

```
# Read a string from the user
>>> name = input("What is your name? ")
What is your name? Sam
```

Console I/O

`input` prompts the user for input

```
# Read a string from the user
>>> name = input("What is your name? ")
What is your name? Sam

>>> print("I'm Python. Nice to meet you,", name)
I'm Python. Nice to meet you, Sam
```

Control Flow

If Statements

No parentheses

Colon

No curly braces!

```
if the_world_is_flat:
    print("Don't fall off!")
```

Use 4 spaces to indent

4 Spaces?!

Readability counts

Removes visually-cluttering punctuation

Editor Settings

```
{
  "tab_size": 4,
  "translate_tabs_to_spaces": true,
}
```

If Statements

```
if some_condition:
    print('Some condition holds')
elif other_condition:
    print('Other condition holds')
else:
    print('Neither condition holds')
```

zero or more `elif`s

`else` is optional

An Aside

Python has no `switch` statement, opting for `if/elif/else` chains

Palindrome?

Palindrome?

```
# Palindrome Check
word = input("Please enter a word: ")
```

Palindrome?

```
# Palindrome Check
word = input("Please enter a word: ")
reversed_word = word[::-1]
```

Palindrome?

```
# Palindrome Check
word = input("Please enter a word: ")
reversed_word = word[::-1]
if word == reversed_word:
    print("Hooray! You entered a palindrome")
```

Palindrome?

```
# Palindrome Check
word = input("Please enter a word: ")
reversed_word = word[::-1]
if word == reversed_word:
    print("Hooray! You entered a palindrome")
else:
    print("You did not enter a palindrome")
```

Truthy and Falsy

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')
```

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')

# Empty data structures are 'falsy'
bool([])  # => False
```

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')

# Empty data structures are 'falsy'
bool([])  # => False

# Everything else is 'truthy'
```

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')

# Empty data structures are 'falsy'
bool([])  # => False

# Everything else is 'truthy'

# How should we check for an empty list?
```

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')

# Empty data structures are 'falsy'
bool([])  # => False

# Everything else is 'truthy'

# How should we check for an empty list?
data = []
if data:
    process(data):
else:
    print("There's no data!")
```

Truthy and Falsy

```
# 'Falsy'
bool(None)
bool(False)
bool(0)
bool(0.0)
bool('')

# Empty data structures are 'falsy'
bool([])  # => False

# Everything else is 'truthy'

# How should we check for an empty list?
data = []
if data:
    process(data):
else:
    print("There's no data!")
```

You should almost never test
`if expr == True`

Loops

For Loops

Loop explicitly over data

Strings, lists, etc.

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

No loop counter!

range

Used to iterate over a sequence of numbers

range

```
range(3)
# generates 0, 1, 2
```

Used to iterate over a sequence of numbers

range

```
range(3)
# generates 0, 1, 2

range(5, 10)
# generates 5, 6, 7, 8, 9
```

Used to iterate over a sequence of numbers

range

```
range(3)
# generates 0, 1, 2

range(5, 10)
# generates 5, 6, 7, 8, 9

range(2, 12, 3)
# generates 2, 5, 8, 11
```

Used to iterate over a sequence of numbers

range

```
range(3)
# generates 0, 1, 2

range(5, 10)
# generates 5, 6, 7, 8, 9

range(2, 12, 3)
# generates 2, 5, 8, 11

range(-7, -30, -5)
# generates -7, -12, -17, -22, -27
```

Used to iterate over a sequence of numbers

range

```
range(3)
# generates 0, 1, 2

range(5, 10)
# generates 5, 6, 7, 8, 9

range(2, 12, 3)
# generates 2, 5, 8, 11

range(-7, -30, -5)
# generates -7, -12, -17, -22, -27
```

Used to iterate over a sequence of numbers

`range(stop)` or `range(start, stop[, step])`

`break` and `continue`

break and continue

```
for n in range(10):
    if n == 6:
        break
    print(n, end=',')
# => 0, 1, 2, 3, 4, 5,
```

`break` and `continue`

```
for n in range(10):
    if n == 6:
        break
    print(n, end=',')
# => 0, 1, 2, 3, 4, 5,
```

`break` breaks out of the smallest enclosing `for` or `while` loop

`break` and `continue`

```
for n in range(10):
    if n == 6:
        break
    print(n, end=',')
# => 0, 1, 2, 3, 4, 5,

for n in range(10):
    if n % 2 == 0:
        print("Even", n)
        continue
    print("Odd", n)
```

`break` breaks out of the smallest enclosing `for` or `while` loop

`break` and `continue`

```
for n in range(10):
    if n == 6:
        break
    print(n, end=',')
# => 0, 1, 2, 3, 4, 5,

for n in range(10):
    if n % 2 == 0:
        print("Even", n)
        continue
    print("Odd", n)
```

`break` breaks out of the smallest enclosing `for` or `while` loop

`continue` continues with the next iteration of the loop

Functions

Dive into Python functions Week 3

Writing Functions

The `def` keyword defines a function

Parameters have no explicit types

```
def fn_name(param1, param2):
    value = do_something()
    return value
```

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

Prime Number Generator

Prime Number Generator

Prime Number Generator

```
def is_prime(n):
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
            return False
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
            return False
    return True
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
            return False
    return True

n = input("Enter a number: ")
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
            return False
    return True

n = input("Enter a number: ")
for x in range(2, int(n)):
```

Prime Number Generator

```
def is_prime(n):
    for i in range(2, n):
        if n % i == 0:
            return False
    return True

n = input("Enter a number: ")
for x in range(2, int(n)):
    if is_prime(x):
        print(x, " is prime")
    else:
        print(x, " is not prime")
```

More to Come

Default Argument Values

Keyword Arguments

Variadic Argument Lists

Unpacking Arguments

Anonymous Functions

First-Class Functions

Functional Programming

Next Time

More Python Fundamentals!

Types and Objects

String Formatting

File I/O

Using Scripts

Configuring Python 3

Lab!

Appendix

Citations

Examples in slides and interactive activities in this course are drawn, with or without modification, from:

http://learnpythonthehardway.org/

http://learnxinyminutes.com/docs/python3/

https://docs.python.org/3.4/tutorial/index.html