



INTRO TO PYTHON FOR DATA SCIENCE

Hello Python!

What you will learn

- Python
- Specifically for Data Science
- Store data
- Manipulate data
- Tools for data analysis


How you will learn

Python

- Guido Van Rossum
- General Purpose: build anything
- Open Source! Free!
- Python Packages, also for Data Science
 - Many applications and fields
- Version 3.x – <https://www.python.org/downloads/>

IPython Shell

Execute Python commands

 DataCamp

< Course Outline >

Calculations with variables 100xp


Remember how you calculated the money you ended up with after 7 years of investing \$100? You did something like this:

```
100 * 1.10 ** 7
```

Instead of calculating with the actual values, you can use variables instead. The `savings` variable you've created in the previous exercise represents the \$100 you started with. Up to you to create a new variable to represent `1.10` and then redo the calculations!


Instructions

- Create a variable `factor`, equal to `1.10`.
- Use `savings` and `factor` to calculate the amount of money you end up with after 7 years. Store the result in a new variable, `result`.
- Print out the value of `result`.

 [Take Hint \(-30xp\)](#)

script.py

```
1 # Create a variable savings
2 savings = 100
3
4 # Create a variable factor
5
6
7 # Calculate result
8
9
10 # Print out result
```

 Submit Answer

IPython Shell

```
In [1]: |
```


IPython Shell

Python Script

- Text Files - .py
- List of Python Commands
- Similar to typing in IPython Shell

Python Script

DataCamp Interface

 DataCamp

< Course Outline >

Calculations with variables

100xp


Remember how you calculated the money you ended up with after 7 years of investing \$100? You did something like this:

```
100 * 1.10 ** 7
```

Instead of calculating with the actual values, you can use variables instead. The `savings` variable you've created in the previous exercise represents the \$100 you started with. Up to you to create a new variable to represent `1.10` and then redo the calculations!


Instructions

- Create a variable `factor`, equal to `1.10`.
- Use `savings` and `factor` to calculate the amount of money you end up with after 7 years. Store the result in a new variable, `result`.
- Print out the value of `result`.

 [Take Hint \(-30xp\)](#)

script.py

```
1 # Create a variable savings
2 savings = 100
3
4 # Create a variable factor
5
6
7 # Calculate result
8
9
10 # Print out result
```

 [Submit Answer](#)

IPython Shell

```
In [1]: |
```

Shell



INTRO TO PYTHON FOR DATA SCIENCE

Variables and Types

Variable

- Specific, case-sensitive name
- Call up value through variable name
- 1.79 m – 68.7 kg

```
In [1]: height = 1.79
```

```
In [2]: weight = 68.7
```

```
In [3]: height
```

```
Out[3]: 1.79
```

Calculate BMI

```
In [1]: height = 1.79
```

```
In [2]: weight = 68.7
```

```
In [3]: height
```

```
Out[3]: 1.79
```

```
In [4]: 68.7 / 1.79 ** 2
```

```
Out[4]: 21.4413
```

```
In [5]: weight / height ** 2
```

```
Out[5]: 21.4413
```

```
In [6]: bmi = weight / height ** 2
```

```
In [7]: bmi
```

```
Out[7]: 21.4413
```

$$\text{BMI} = \frac{\text{weight}}{\text{height}^2}$$

Reproducibility

 my_script.py

```
height = 1.79
weight = 68.7
bmi = weight / height ** 2
print(bmi)
```

Output:
21.4413

Reproducibility

 my_script.py

```
height = 1.79
weight = 74.2 ←
bmi = weight / height ** 2
print(bmi)
```

Output:
23.1578

Python Types

```
In [8]: type(bmi)
Out[8]: float
```

```
In [9]: day_of_week = 5
```

```
In [10]: type(day_of_week)
Out[10]: int
```

Python Types (2)

```
In [11]: x = "body mass index"
```

```
In [12]: y = 'this works too'
```

```
In [13]: type(y)
```

```
Out[13]: str
```

```
In [14]: z = True
```

```
In [15]: type(z)
```

```
Out[15]: bool
```


Python Types (3)

```
In [16]: 2 + 3  
Out[16]: 5
```

Different type = different behavior!

```
In [17]: 'ab' + 'cd'  
Out[17]: 'abcd'
```



INTRO TO PYTHON FOR DATA SCIENCE

Python Lists



Python Data Types

- `float` – real numbers
- `int` – integer numbers
- `str` – string, text
- `bool` – `True`, `False`

```
In [1]: height = 1.73
```

```
In [2]: tall = True
```

- Each variable represents single value

Problem

- Data Science: many data points
- Height of entire family

```
In [3]: height1 = 1.73
```

```
In [4]: height2 = 1.68
```

```
In [5]: height3 = 1.71
```

```
In [6]: height4 = 1.89
```

- Inconvenient



Python List

[a, b, c]

```
In [7]: [1.73, 1.68, 1.71, 1.89]
```

```
Out[7]: [1.73, 1.68, 1.71, 1.89]
```

```
In [8]: fam = [1.73, 1.68, 1.71, 1.89]
```

```
In [9]: fam
```

```
Out[9]: [1.73, 1.68, 1.71, 1.89]
```

- Name a collection of values
- Contain any type
- Contain different types

Python List

[a, b, c]

```
In [10]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [11]: fam
```

```
Out[11]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

```
["liz", 1.73]  
["emma", 1.68]  
["mom", 1.71]  
["dad", 1.89]
```



Python List

[a, b, c]

```
In [10]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [11]: fam
```

```
Out[11]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

```
In [11]: fam2 = [{"liz", 1.73},  
                 {"emma", 1.68},  
                 {"mom", 1.71},  
                 {"dad", 1.89}]
```

```
In [12]: fam2
```

```
Out[12]: [['liz', 1.73], ['emma', 1.68],  
          ['mom', 1.71], ['dad', 1.89]]
```

List type

```
In [13]: type(fam)
Out[13]: list
```

```
In [14]: type(fam2)
Out[14]: list
```

- Specific functionality
- Specific behavior



INTRO TO PYTHON FOR DATA SCIENCE

Subsetting Lists

Subsetting lists

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

index:	0	1	2	3	4	5	6	7
--------	---	---	---	---	---	---	---	---

"zero-based indexing"

Subsetting lists

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

index:	0	1	2	3	4	5	6	7
	'liz'	1.73	'emma'	1.68	'mom'	1.71	'dad'	1.89

```
In [3]: fam[3]
```

```
Out[3]: 1.68
```

Subsetting lists

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

index:	0	1	2	3	4	5	6	7
	'liz'	1.73	'emma'	1.68	'mom'	1.71	'dad'	1.89

```
In [3]: fam[3]
```

```
Out[3]: 1.68
```

```
In [4]: fam[6]
```

```
Out[4]: 'dad'
```

Subsetting lists

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

index:	0	1	2	3	4	5	6	7
	-8	-7	-6	-5	-4	-3	-2	-1

```
In [3]: fam[3]
```

```
Out[3]: 1.68
```

```
In [4]: fam[6]
```

```
Out[4]: 'dad'
```

```
In [5]: fam[-1]
```

```
Out[5]: 1.89
```

Subsetting lists

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

index:	0	1	2	3	4	5	6	7
	-8	-7	-6	-5	-4	-3	-2	-1

```
In [3]: fam[3]
```

```
Out[3]: 1.68
```

```
In [4]: fam[6] ←
```

```
Out[4]: 'dad'
```

```
In [5]: fam[-1]
```

```
Out[5]: 1.89
```

```
In [6]: fam[-2] ←
```

```
Out[6]: 'dad'
```

List slicing

```
In [7]: fam
Out[7]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

0 1 2 3 4 5 6 7

```
In [8]: fam[3:5]
Out[8]: [1.68, 'mom']
```

[start : end]

inclusive

exclusive



List slicing

```
In [7]: fam
Out[7]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

0 1 2 3 4 5 6 7

```
In [8]: fam[3:5]
Out[8]: [1.68, 'mom']
```

```
In [9]: fam[1:4]
Out[9]: [1.73, 'emma', 1.68]
```

[**start** : **end**]

inclusive **exclusive**



List slicing

```
In [7]: fam
```

```
Out[7]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

0	1	2	3	4	5	6	7
liz	1.73	emma	1.68	mom	1.71	dad	1.89

```
In [8]: fam[3:5]
```

```
Out[8]: [1.68, 'mom']
```

```
In [9]: fam[1:4]
```

```
Out[9]: [1.73, 'emma', 1.68]
```

```
In [10]: fam[:4]
```

```
Out[10]: ['liz', 1.73, 'emma', 1.68]
```



List slicing

```
In [7]: fam
Out[7]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

0	1	2	3	4	5	6	7
---	---	---	---	---	---	---	---

```
In [8]: fam[3:5]
Out[8]: [1.68, 'mom']
```

```
In [9]: fam[1:4]
Out[9]: [1.73, 'emma', 1.68]
```

```
In [10]: fam[:4]
Out[10]: ['liz', 1.73, 'emma', 1.68]
```

```
In [11]: fam[5:]
Out[11]: [1.71, 'dad', 1.89]
```



INTRO TO PYTHON FOR DATA SCIENCE

Manipulating Lists

List Manipulation

- Change list elements
- Add list elements
- Remove list elements

Changing list elements

```
In [1]: fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]
```

```
In [2]: fam
```

```
Out[2]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

```
In [3]: fam[7] = 1.86
```

```
In [4]: fam
```

```
Out[4]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.86]
```

```
In [5]: fam[0:2] = ["lisa", 1.74]
```

```
In [6]: fam
```

```
Out[6]: ['lisa', 1.74, 'emma', 1.68, 'mom', 1.71, 'dad', 1.86]
```

Adding and removing elements

```
In [7]: fam + ["me", 1.79]
```

```
Out[7]: ['lisa', 1.74, 'emma', 1.68,  
        'mom', 1.71, 'dad', 1.86, 'me', 1.79]
```

```
In [8]: fam_ext = fam + ["me", 1.79]
```

```
In [9]: del(fam[2])
```

```
In [10]: fam
```

```
Out[10]: ['lisa', 1.74, 1.68, 'mom', 1.71, 'dad', 1.86]
```

```
In [11]: del(fam[2])
```

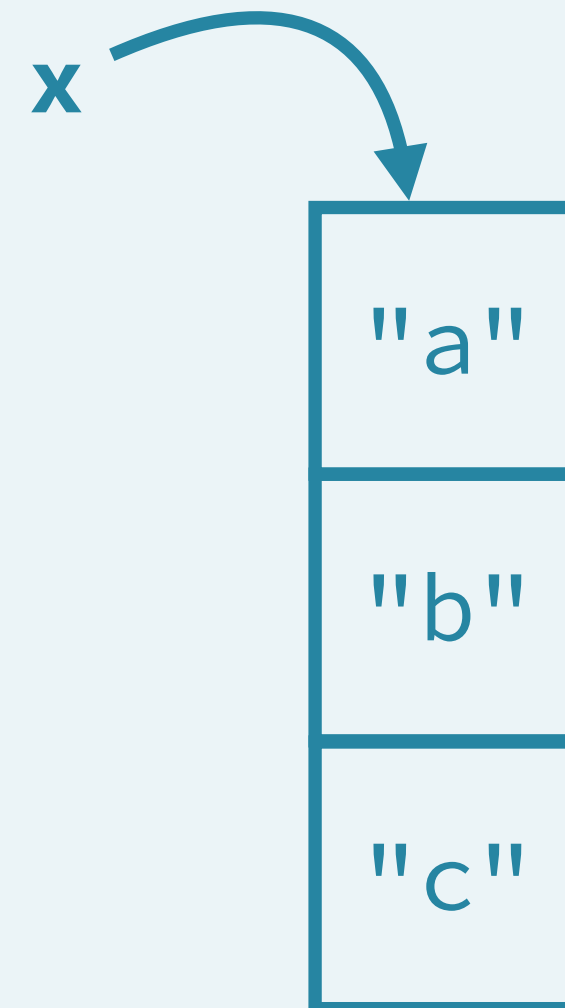
```
In [12]: fam
```

```
Out[12]: ['lisa', 1.74, 'mom', 1.71, 'dad', 1.86]
```

Behind the scenes (1)

```
In [13]: x = ["a", "b", "c"]
```

```
In [14]: y = x
```



Behind the scenes (1)

```
In [13]: x = ["a", "b", "c"]
```

```
In [14]: y = x
```

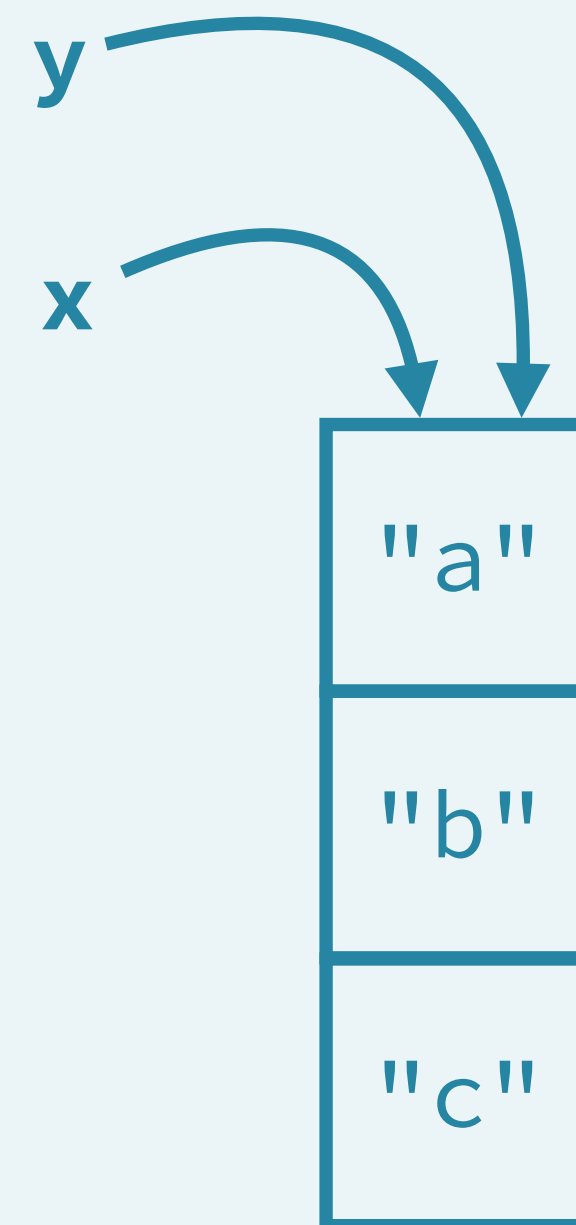
```
In [15]: y[1] = "z"
```

```
In [16]: y
```

```
Out[16]: ['a', 'z', 'c']
```

```
In [17]: x
```

```
Out[17]: ['a', 'z', 'c']
```



Behind the scenes (1)

```
In [13]: x = ["a", "b", "c"]
```

```
In [14]: y = x
```

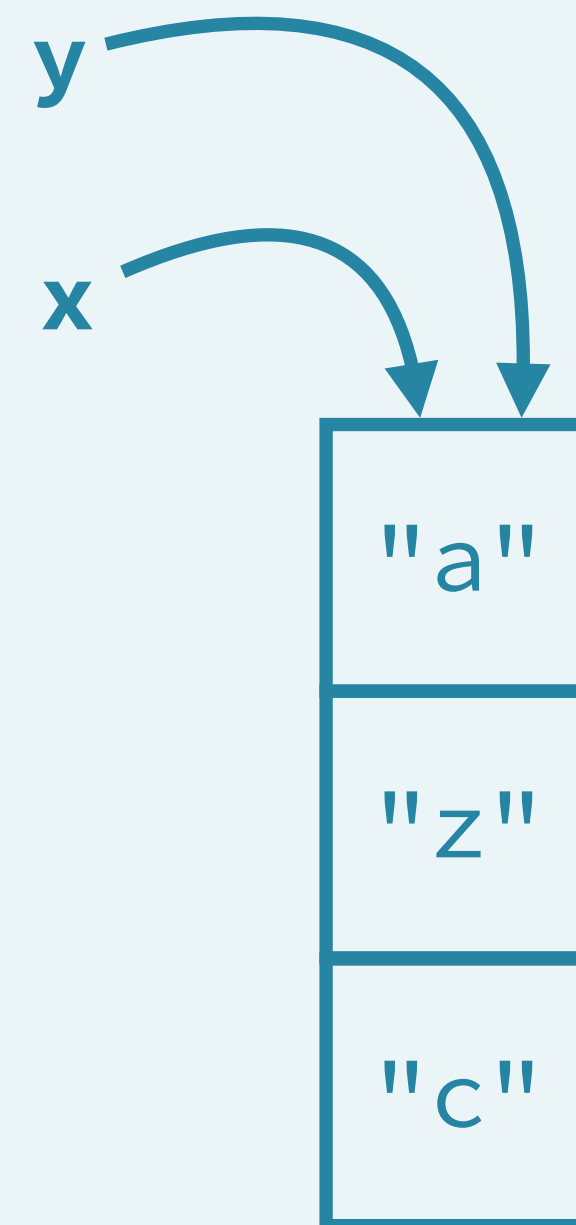
```
In [15]: y[1] = "z"
```

```
In [16]: y
```

```
Out[16]: ['a', 'z', 'c']
```

```
In [17]: x
```

```
Out[17]: ['a', 'z', 'c']
```



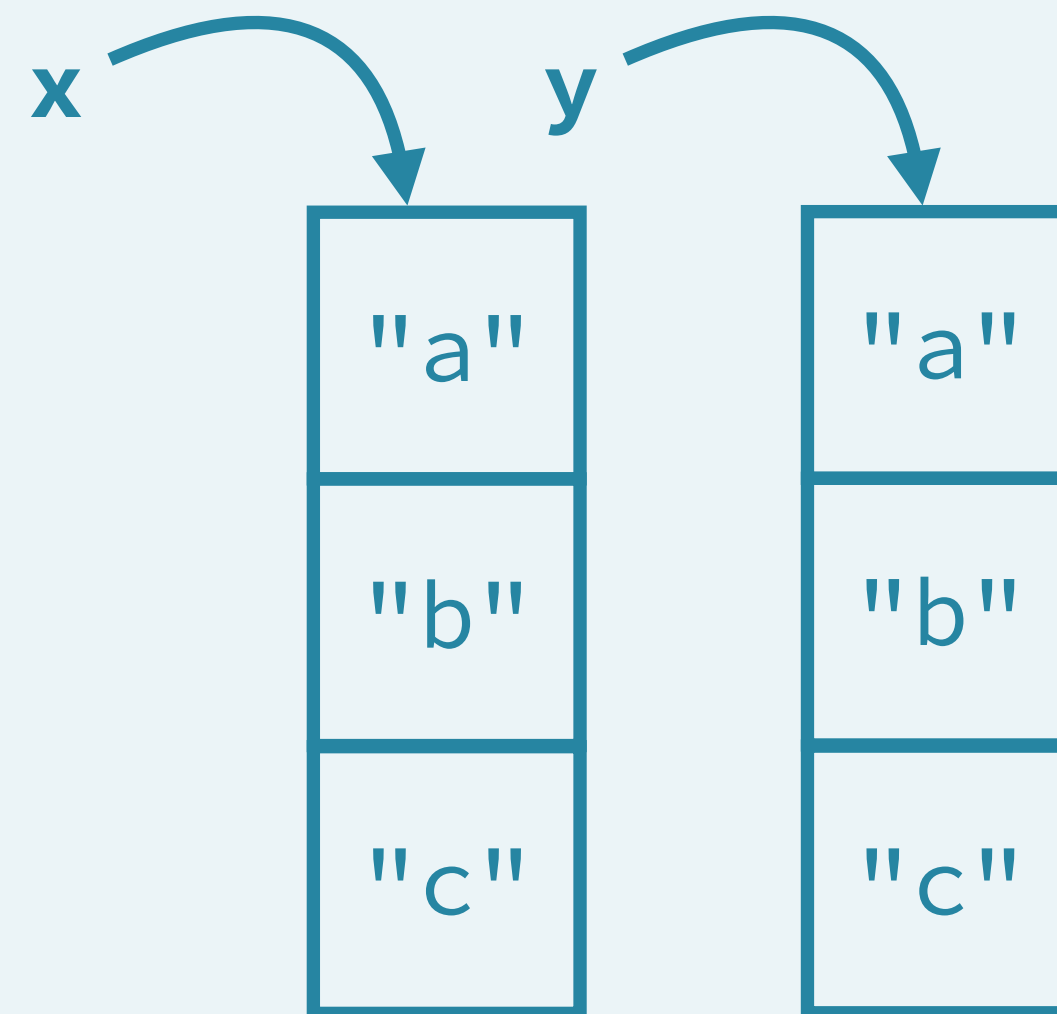
Behind the scenes (2)

```
In [18]: x = ["a", "b", "c"]
```

```
In [19]: y = list(x)
```

```
In [20]: y = x[:]
```

```
In [21]: y[1] = "z"
```



Behind the scenes (2)

```
In [18]: x = ["a", "b", "c"]
```

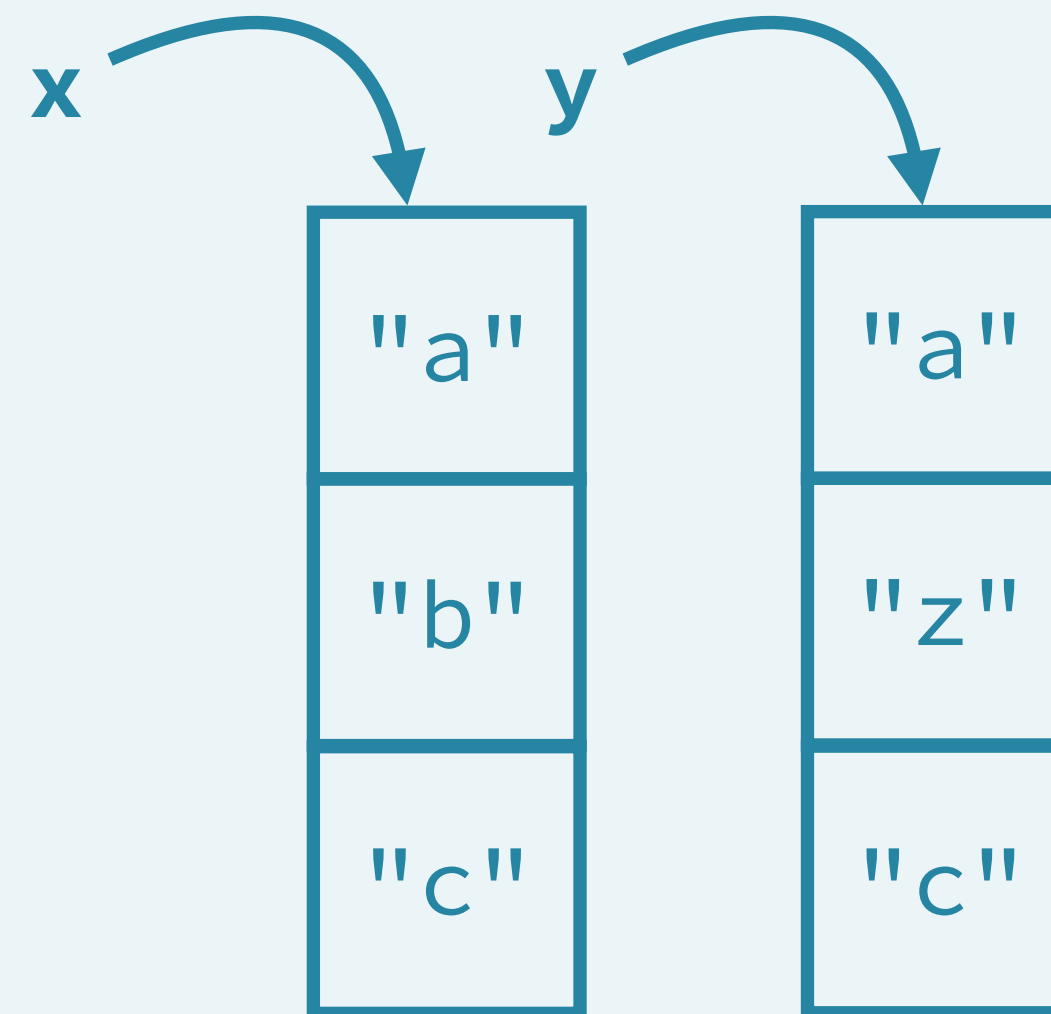
```
In [19]: y = list(x)
```

```
In [20]: y = x[:]
```

```
In [21]: y[1] = "z"
```

```
In [22]: x
```

```
Out[22]: ['a', 'b', 'c']
```





INTRO TO PYTHON FOR DATA SCIENCE

Functions

Functions

- Nothing new!
- `type()`
- Piece of reusable code
- Solves particular task
- Call function instead of writing code yourself

Example

```
In [1]: fam = [1.73, 1.68, 1.71, 1.89]
```

```
In [2]: fam
```

```
Out[2]: [1.73, 1.68, 1.71, 1.89]
```

```
In [3]: max(fam)
```

```
Out[3]: 1.89
```



Example

```
In [1]: fam = [1.73, 1.68, 1.71, 1.89]
```

```
In [2]: fam
```

```
Out[2]: [1.73, 1.68, 1.71, 1.89]
```

```
In [3]: max(fam)
```

```
Out[3]: 1.89
```

```
In [4]: tallest = max(fam)
```

```
In [5]: tallest
```

```
Out[5]: 1.89
```

round()

```
In [6]: round(1.68, 1)
Out[6]: 1.7
```

```
In [7]: round(1.68)
Out[7]: 2
```

```
In [8]: help(round)
```

[Open up documentation](#)

Help on built-in function round in module builtins:

```
round(...)
round(number[, ndigits]) -> number
```

Round a number to a given precision in decimal digits (default 0 digits). This returns an int when called with one argument, otherwise the same type as the number. ndigits may be negative.

round()

```
In [8]: help(round)
```

```
round(...)  
round(number[, ndigits]) -> number
```

Round a number to a given precision in decimal digits (default 0 digits). This returns an int when called with one argument, otherwise the same type as the number. ndigits may be negative.

```
round(1.68, 1)
```



round()

```
In [8]: help(round)
```

```
round(...)  
round(number[, ndigits]) -> number
```

Round a number to a given precision in decimal digits (default 0 digits). This returns an int when called with one argument, otherwise the same type as the number. ndigits may be negative.

`round(1.68)`





round()

```
In [8]: help(round)
```

```
round(...)  
    round(number[, ndigits]) -> number
```

Round a number to a given precision in decimal digits (default 0 digits). This returns an int when called with one argument, otherwise the same type as the number. ndigits may be negative.

```
round(number)
```

```
round(number, ndigits)
```

Find functions

- How to know?
- Standard task → probably function exists!
- The internet is your friend



INTRO TO PYTHON FOR DATA SCIENCE

Methods

Built-in Functions

- Maximum of list: `max()`
- Length of list or string: `len()`
- Get index in list: ?
- Reversing a list: ?

Back 2 Basics

		type	examples of methods
In [1]:	sister = "liz"	Object	str capitalize() replace()
In [2]:	height = 1.73	Object	float bit_length() conjugate()
In [3]:	fam = ["liz", 1.73, "emma", 1.68, "mom", 1.71, "dad", 1.89]	Object	list index() count()

Methods: Functions that belong to objects

list methods

```
In [4]: fam
Out[4]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```

```
In [5]: fam.index("mom")
Out[5]: 4
```

"Call method `index()` on `fam`"

```
In [6]: fam.count(1.73)
Out[6]: 1
```


str methods

```
In [7]: sister
```

```
Out[7]: 'liz'
```

```
In [8]: sister.capitalize()
```

```
Out[8]: 'Liz'
```

```
In [9]: sister.replace("z", "sa")
```

```
Out[9]: 'lisa'
```



Methods

- Everything = object
- Object have methods associated, depending on type

```
In [10]: sister.replace("z", "sa")  
Out[10]: 'lisa'
```

```
In [11]: fam.replace("mom", "mommy")  
AttributeError: 'list' object has no attribute 'replace'
```

```
In [12]: sister.index("z")  
Out[12]: 2
```

```
In [13]: fam.index("mom")  
Out[13]: 4
```

Methods (2)

```
In [14]: fam
Out[14]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
```



```
In [15]: fam.append("me")
```

```
In [16]: fam
Out[16]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89, 'me']
```

```
In [17]: fam.append(1.79)
```

```
In [18]: fam
Out[18]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89, 'me', 1.79]
```

Summary

- Functions

```
In [11]: type(fam)
Out[11]: list
```

- Methods: call functions *on* objects

```
In [12]: fam.index("dad")
Out[12]: 6
```



INTRO TO PYTHON FOR DATA SCIENCE

Packages

Motivation

- Functions and methods are powerful
- All code in Python distribution?
 - Huge code base: messy
 - Lots of code you won't use
 - Maintenance problem

Packages

- Directory of Python Scripts
- Each script = module
- Specify functions, methods, types
- Thousands of packages available
 - Numpy
 - Matplotlib
 - Scikit-learn

```
pkg/  
  mod1.py  
  mod2.py  
  ...
```

Install package

- <http://pip.readthedocs.org/en/stable/installing/>
- Download `get-pip.py`
- Terminal:
 - `python3 get-pip.py`
 - `pip3 install numpy`

Import package

```
In [1]: import numpy
```

```
In [2]: array([1, 2, 3])
```

```
NameError: name 'array' is not defined
```

```
In [3]: numpy.array([1, 2, 3])
```

```
Out[3]: array([1, 2, 3])
```

```
In [4]: import numpy as np
```

```
In [5]: np.array([1, 2, 3])
```

```
Out[5]: array([1, 2, 3])
```

```
In [6]: from numpy import array
```

```
In [7]: array([1, 2, 3])
```

```
Out[7]: array([1, 2, 3])
```

from numpy import array

 my_script.py

```
from numpy import array

fam = ["liz", 1.73, "emma", 1.68,
       "mom", 1.71, "dad", 1.89]

...

fam_ext = fam + ["me", 1.79]

...

print(str(len(fam_ext)) + " elements in fam_ext")

...

np_fam = array(fam_ext)
```

Using Numpy, but not very clear

import numpy

 my_script.py

```
import numpy

fam = ["liz", 1.73, "emma", 1.68,
       "mom", 1.71, "dad", 1.89]

...

fam_ext = fam + ["me", 1.79]

...

print(str(len(fam_ext)) + " elements in fam_ext")

...

np_fam = numpy.array(fam_ext)
```

Clearly using Numpy



INTRO TO PYTHON FOR DATA SCIENCE

NumPy



Lists Recap

- Powerful
- Collection of values
- Hold different types
- Change, add, remove
- Need for Data Science
 - Mathematical operations over collections
 - Speed



Illustration

```
In [1]: height = [1.73, 1.68, 1.71, 1.89, 1.79]
```

```
In [2]: height
```

```
Out[2]: [1.73, 1.68, 1.71, 1.89, 1.79]
```

```
In [3]: weight = [65.4, 59.2, 63.6, 88.4, 68.7]
```

```
In [4]: weight
```

```
Out[4]: [65.4, 59.2, 63.6, 88.4, 68.7]
```

```
In [5]: weight / height ** 2
```

```
TypeError: unsupported operand type(s) for **: 'list' and 'int'
```



Solution: NumPy

- Numeric Python
- Alternative to Python List: NumPy Array
- Calculations over entire arrays
- Easy and Fast
- Installation
 - In the terminal: `pip3 install numpy`



NumPy

```
In [6]: import numpy as np
```

```
In [7]: np_height = np.array(height)
```

```
In [8]: np_height
```

```
Out[8]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])
```

```
In [9]: np_weight = np.array(weight)
```

```
In [10]: np_weight
```

```
Out[10]: array([ 65.4,  59.2,  63.6,  88.4,  68.7])
```

```
In [11]: bmi = np_weight / np_height ** 2
```

```
In [12]: bmi
```

```
Out[12]: array([ 21.852,  20.975,  21.75 ,  24.747,  21.441])
```




NumPy

```
In [6]: import numpy as np
```

Element-wise calculations

```
In [7]: np_height = np.array(height)
```

```
In [8]: np_height
```

```
Out[8]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])
```

```
In [9]: np_weight = np.array(weight)
```

```
In [10]: np_weight
```

```
Out[10]: array([ 65.4,  59.2,  63.6,  88.4,  68.7])
```

```
In [11]: bmi = np_weight / np_height ** 2
```

```
In [12]: bmi
```

```
Out[12]: array([ 21.852,  20.975,  21.75 ,  24.747,  21.441])
```

```
= 65.5/1.73 ** 2
```



Comparison

```
In [13]: height = [1.73, 1.68, 1.71, 1.89, 1.79]
```

```
In [14]: weight = [65.4, 59.2, 63.6, 88.4, 68.7]
```

```
In [15]: weight / height ** 2
```

```
TypeError: unsupported operand type(s) for **: 'list' and 'int'
```

```
In [16]: np_height = np.array(height)
```

```
In [17]: np_weight = np.array(weight)
```

```
In [18]: np_weight / np_height ** 2
```

```
Out[18]: array([ 21.852,  20.975,  21.75 ,  24.747,  21.441])
```



NumPy: remarks

```
In [19]: np.array([1.0, "is", True])  
Out[19]:  
array(['1.0', 'is', 'True'],  
      dtype='<U32')
```

NumPy arrays: contain only one type

```
In [20]: python_list = [1, 2, 3]
```

```
In [21]: numpy_array = np.array([1, 2, 3])
```

Different types: different behavior!

```
In [22]: python_list + python_list  
Out[22]: [1, 2, 3, 1, 2, 3]
```

```
In [23]: numpy_array + numpy_array  
Out[23]: array([2, 4, 6])
```



NumPy Subsetting

```
In [24]: bmi  
Out[24]: array([ 21.852,  20.975,  21.75 ,  24.747,  21.441])
```

```
In [25]: bmi[1]  
Out[25]: 20.975
```

```
In [26]: bmi > 23  
Out[26]: array([False, False, False,  True, False], dtype=bool)
```

```
In [27]: bmi[bmi > 23]  
Out[27]: array([ 24.747])
```



INTRO TO PYTHON FOR DATA SCIENCE

2D NumPy Arrays



Type of NumPy Arrays

```
In [1]: import numpy as np
```

```
In [2]: np_height = np.array([1.73, 1.68, 1.71, 1.89, 1.79])
```

```
In [3]: np_weight = np.array([65.4, 59.2, 63.6, 88.4, 68.7])
```

```
In [4]: type(np_height)
```

```
Out[4]: numpy.ndarray
```

ndarray = N-dimensional array

```
In [5]: type(np_weight)
```

```
Out[5]: numpy.ndarray
```

2D NumPy Arrays

```
In [6]: np_2d = np.array([[1.73, 1.68, 1.71, 1.89, 1.79],  
                           [65.4, 59.2, 63.6, 88.4, 68.7]])
```

```
In [7]: np_2d  
Out[7]:  
array([[ 1.73,   1.68,   1.71,   1.89,   1.79],  
       [65.4 ,  59.2 ,  63.6 ,  88.4 ,  68.7 ]])
```

```
In [8]: np_2d.shape  
Out[8]: (2, 5) 2 rows, 5 columns
```

```
In [9]: np.array([[1.73, 1.68, 1.71, 1.89, 1.79],  
                  [65.4, 59.2, 63.6, 88.4, "68.7"]])
```

```
Out[9]:  
array([[ '1.73', '1.68', '1.71', '1.89', '1.79'],  
       [ '65.4', '59.2', '63.6', '88.4', '68.7']],  
      dtype='<U32')
```

Single type!



Subsetting

	0	1	2	3	4	
array([[	1.73,	1.68,	1.71,	1.89,	1.79],	0
	65.4,	59.2,	63.6,	88.4,	68.7]])	1

```
In [10]: np_2d[0]
```

```
Out[10]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])
```

```
In [11]: np_2d[0][2]
```

```
Out[11]: 1.71
```

```
In [12]: np_2d[0,2]
```

```
Out[12]: 1.71
```




Subsetting

	0	1	2	3	4	
array([[	1.73,	1.68,	1.71,	1.89,	1.79],	0
	65.4,	59.2,	63.6,	88.4,	68.7]])	1

```
In [10]: np_2d[0]
```

```
Out[10]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])
```

```
In [11]: np_2d[0][2]
```

```
Out[11]: 1.71
```

```
In [12]: np_2d[0,2]
```

```
Out[12]: 1.71
```

```
In [13]: np_2d[:,1:3]
```

```
Out[13]:
```

```
array([[ 1.68,  1.71],
       [ 59.2 ,  63.6 ]])
```



Subsetting

	0	1	2	3	4	
array([[	1.73,	1.68,	1.71,	1.89,	1.79],	0
[	65.4,	59.2,	63.6,	88.4,	68.7])	1

```
In [10]: np_2d[0]
```

```
Out[10]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])
```

```
In [11]: np_2d[0][2]
```

```
Out[11]: 1.71
```

```
In [12]: np_2d[0,2]
```

```
Out[12]: 1.71
```

```
In [13]: np_2d[:,1:3]
```

```
Out[13]:
```

```
array([[ 1.68,  1.71],
       [ 59.2 ,  63.6 ]])
```

```
In [14]: np_2d[1,:]
```

```
Out[14]: array([ 65.4,  59.2,  63.6,  88.4,  68.7])
```



INTRO TO PYTHON FOR DATA SCIENCE

NumPy: Basic Statistics



Data analysis

- Get to know your data
- Little data → simply look at it
- Big data → ?



City-wide survey

```
In [1]: import numpy as np
```

```
In [2]: np_city = ... # Implementation left out
```

```
In [3]: np_city
```

```
Out[3]:
```

```
array([[ 1.64,  71.78],  
       [ 1.37,  63.35],  
       [ 1.6 ,  55.09],  
       ...,  
       [ 2.04,  74.85],  
       [ 2.04,  68.72],  
       [ 2.01,  73.57]])
```



NumPy

```
In [4]: np.mean(np_city[:,0])  
Out[4]: 1.7472
```

```
In [5]: np.median(np_city[:,0])  
Out[5]: 1.75
```

```
In [6]: np.corrcoef(np_city[:,0], np_city[:,1])  
Out[6]:  
array([[ 1.          , -0.01802],  
       [-0.01803,  1.          ]])
```

```
In [7]: np.std(np_city[:,0])  
Out[7]: 0.1992
```

- `sum()`, `sort()`, ...
- Enforce single data type: speed!



Generate data

distribution
mean

distribution
standard dev.

number of
samples

```
In [8]: height = np.round(np.random.normal(1.75, 0.20, 5000), 2)
```

```
In [9]: weight = np.round(np.random.normal(60.32, 15, 5000), 2)
```

```
In [10]: np_city = np.column_stack((height, weight))
```