Python: Intro - Filip Schouwenaars
Note as of July 2019
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Chapters:

1. Python Basics
2. Python Lists
3. Functions and Packages
4. NumPy

Ch 1 - Python Basics

- Background:
  - Created by Guido Van Rossum
  - Text file - .py
- Variables and types
  - Case-sensative
  - `type():float, int, str, bool`

    Example:

    ```
    In [1]: type(bmi)
    Out[2]: float
    ```
  - Different types = different behavior

    Example:

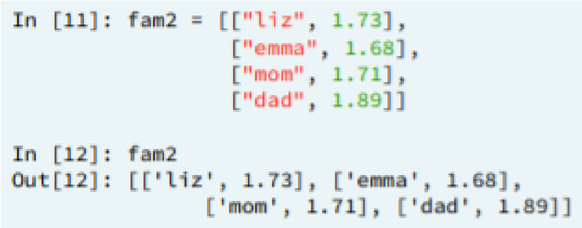
    ```
    In [3]: 2 + 3
    Out[4]: 5

    In [5]: 'ab' + 'cd'
    Out[6]: 'abcd'
    ```

Ch 2 - Python Lists

- List types: contains any type and different types

  Example:

  ```
  In [1]: fam = [1, 2, 3, 4]
  ```

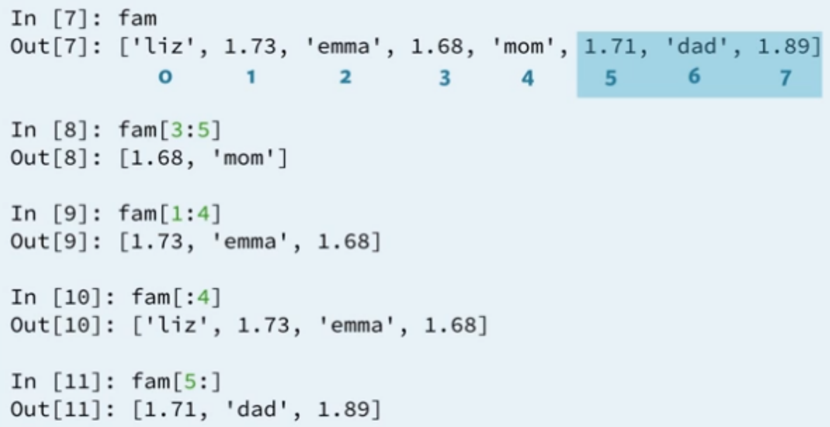


```
In [11]: fam2 = [["liz", 1.73],
                 ["emma", 1.68],
                 ["mom", 1.71],
                 ["dad", 1.89]]

In [12]: fam2
Out[12]: [['liz', 1.73], ['emma', 1.68],
          ['mom', 1.71], ['dad', 1.89]]
```

- Subsetting lists
  - Subset

    *zero-based indexing (index starts with 0)
    - `fam[0]` - first item
    - `fam[1]` - second item
    - `fam[-1]` - last item
  - Slicing

        - Syntax:
          `[start : end]` - start is inclusive, end is exclusive
          `fam[:4]`, `fam[5:]` - when leaving blank, means all.
          (1) `fam[:4]` = 1st (index 0) to 4th (index 3) elements;
          (2) `fam[5:]` = 6th (index 5) to the rest of elements;
          (3) `fam[:]` = select all elements;
          (4) `fam[-4:]` = last 4 elements
        - Example:

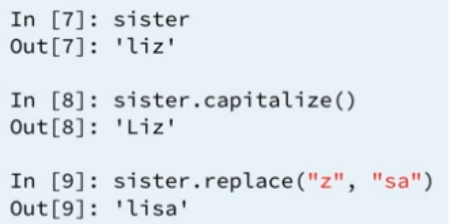


```
In [7]: fam
Out[7]: ['liz', 1.73, 'emma', 1.68, 'mom', 1.71, 'dad', 1.89]
           0      1      2      3      4     5      6     7

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]
```

- List manipulation
    - Replace list elements
      `In [5]: fam[0:2] = ["lisa", 1.74]`
    - Adding elements
      `fam + ["me", 1.79]`
    - Removing elements
      `del(fam[2])`
    - Inner working of lists (behind the scenes)
        - If `y = x`, the change of `y` also changes `x` since they represent a reference to the origian llist;
        - If `y = list(x)` or `y = x[:]`, then change of `y` doesn't affect `x`.

Ch 3 - Functions and Packages

- Functions
    - Basic functions
        - `max()`
        - `round(number, ndigits)` # decimal point is 0 by default
        - `help()` # open up documentation
- Methods: functions that belong to objects
    - String methods
      (`str`, `float`, `list` are called Python objects)
        - `str` - `capitalize(), replace()`



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

In [8]: sister.capitalize()
Out[8]: 'Liz'

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

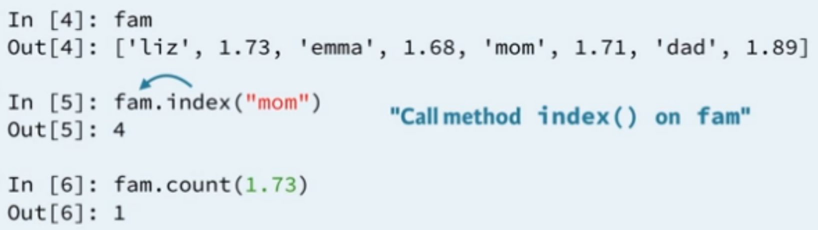
        - `float - bit_length(), conjugate()`
        - `list - index(), count()`

          `list - append(), remove(), reverse()` # will change the list they're called on.

    - List methods

      (To call the method, use ".")

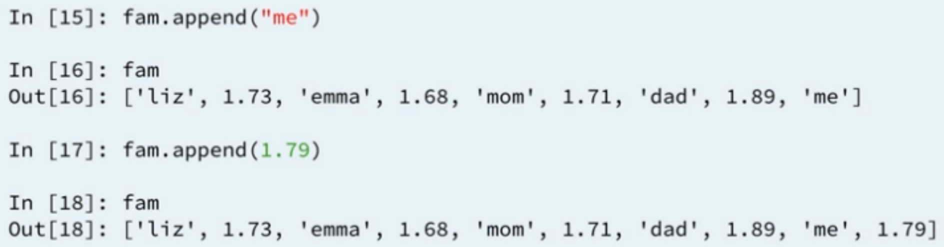
        - Examples



```
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

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

"Call method index() on fam"

        - More examples



```
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)`

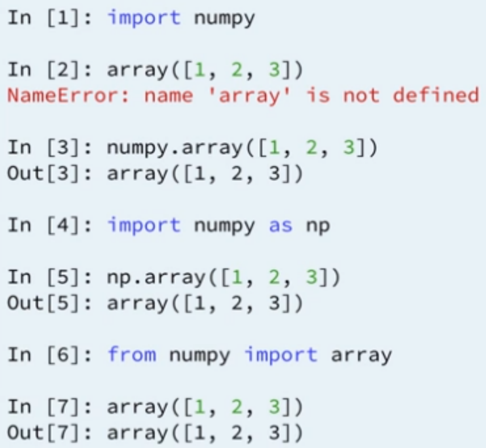
          `Out[11]: list`

        - Methods: call functions on objects

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

          `Out[12]: 6`

- Packages
    - Packages for data science
        - **NumPy** - to efficiently work with arrays
        - **Matplotlib** - for data visualization
        - **Scikit-learn** - for machine learning
    - Install package
        - Download `get-pip.py`
        - Terminal
            - `python3 get-pip.py`
            - `pip3 install numpy`
        - Example



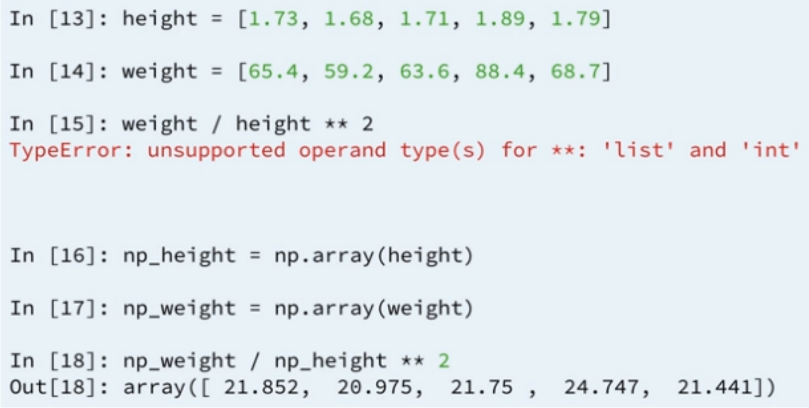
```
In [1]: import numpy

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])
```

Here, `from numpy import array` only imports the `array` function; this is called a selective import.
A courtsey note: it is a good practice to keep the standard way, i.e., using `numpy.array()` so that people reading the script can easily locate the package of a function.

- More example
  `from scipy.linalg import inv as my_inv`

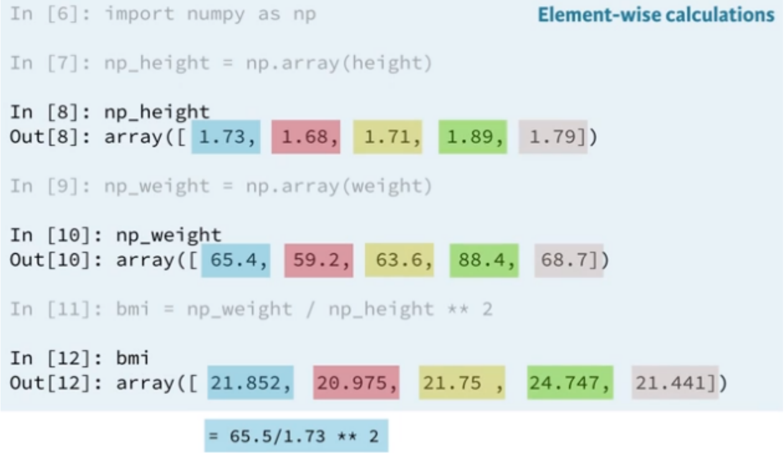
Ch 4 - **NumPy**

- Array calculation solution: NumPy arrays
  - Installation (terminal): `pip3 install numpy`
- 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])
```

- Example

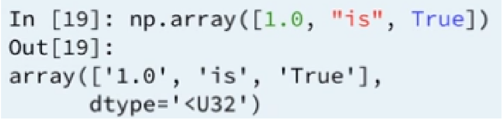


Element-wise calculations

```
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])
```

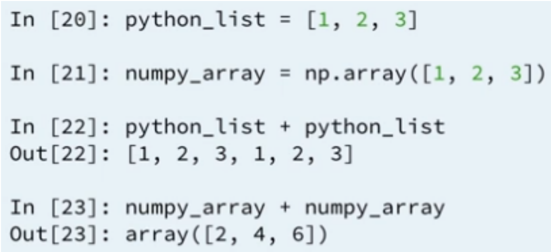
= 65.5/1.73 ** 2

- NumPy remarks
  - NumPy arrays contain only one type



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

- Typical arithmetic operators, such as +, -, *, and / have a different meaning for regular Python lists and `numpy` arrays.

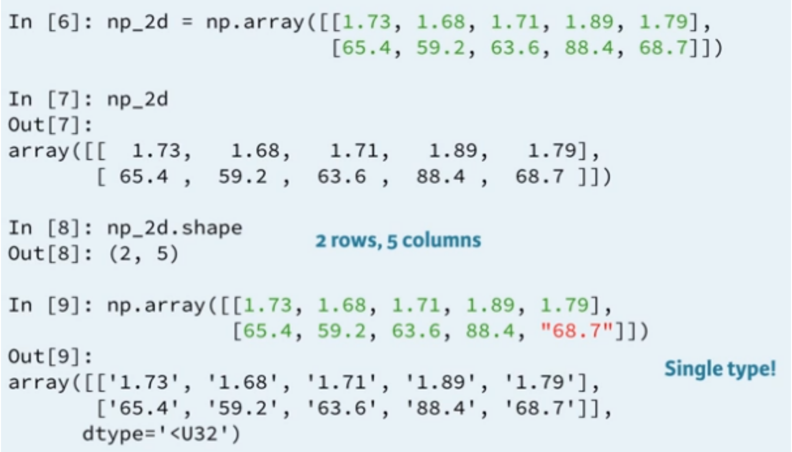


```
In [20]: python_list = [1, 2, 3]

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

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])
```

- 2D NumPy Arrays
  - Type of NumPy arrays

    `In [4]: type(np_height)`

    `Out[4]: numpy.ndarray` # ndarray = N-dimensional array
  - Shape of 2D NumPy arrays

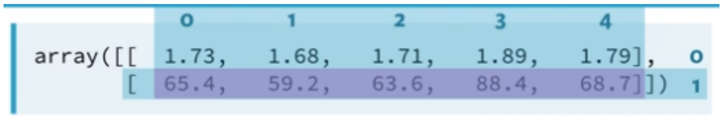


```
In [6]: np_2d = np.array([[1.73, 1.68, 1.71, 1.89, 1.79],
                          [65.4, 59.2, 63.6, 88.4, 68.7]])

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)

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')
```

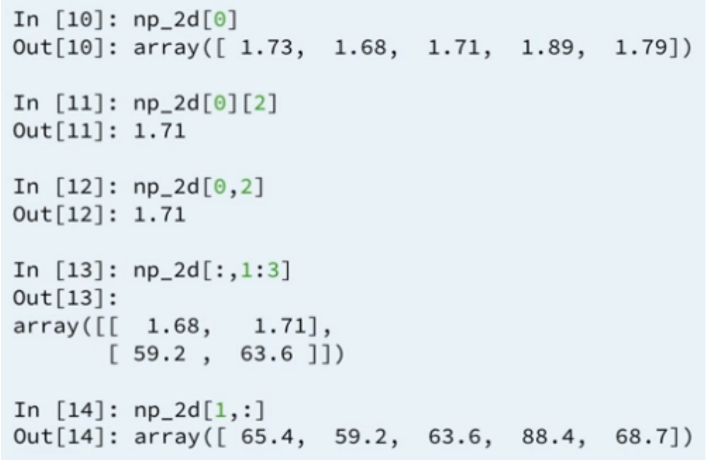
2 rows, 5 columns

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
```



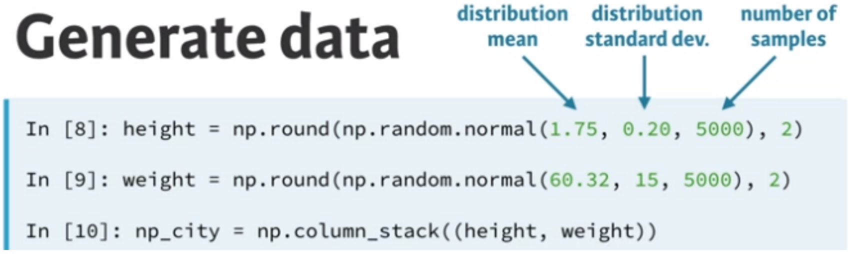
```
In [10]: np_2d[0]
Out[10]: array([ 1.73,  1.68,  1.71,  1.89,  1.79])

In [11]: np_2d[0][2]
Out[11]: 1.71

In [12]: np_2d[0,2]
Out[12]: 1.71

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])
```

  - Example: both syntax returns "a" and "c"

```
# regular list of lists
x = [["a", "b"], ["c", "d"]]
[x[0][0], x[1][0]]
```

```
# numpy
import numpy as np
np_x = np.array(x)
np_x[:,0]
```

- NumPy: basic statistics
    - `np.mean()`
    - `np.median()`
    - `np.corrcoef(np_city[:,0], np_city[:,1])`
    - `np.std()`
    - `np.sum()`
    - `np.sort()`
- Generate data



Generate data

```
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))
```