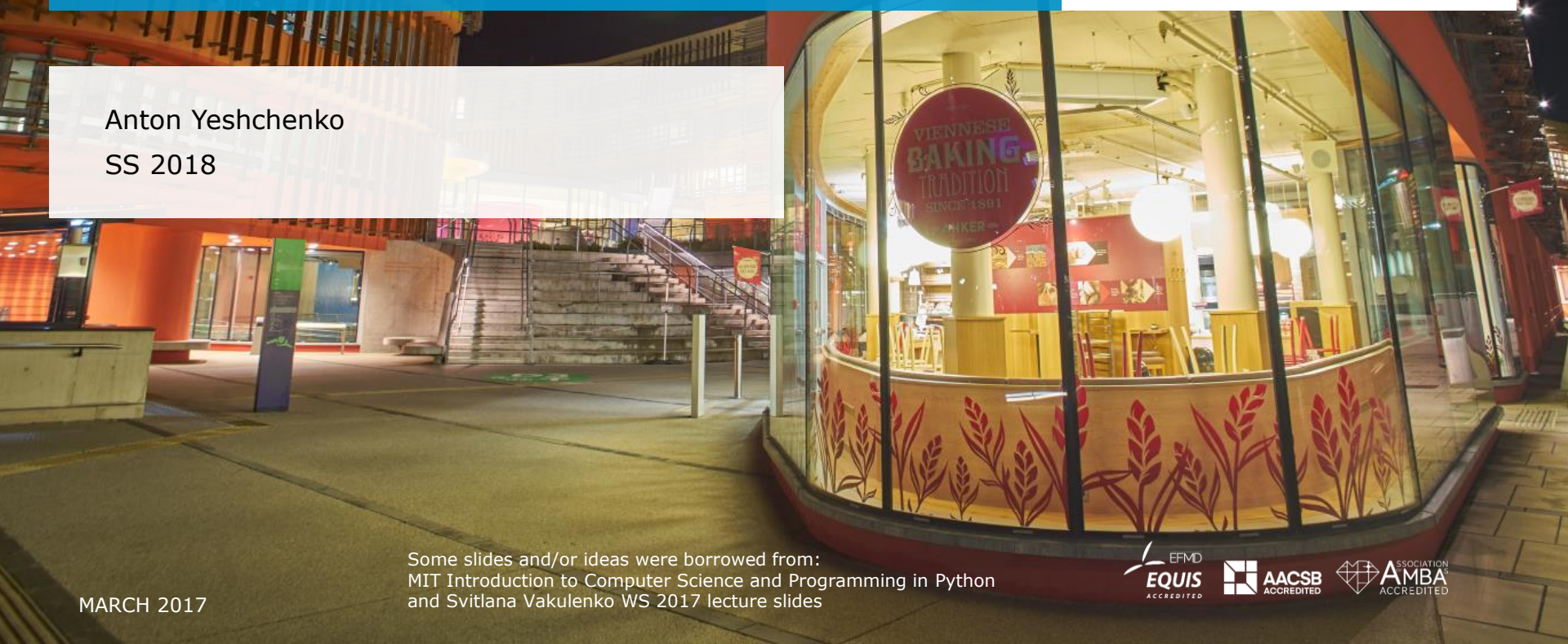
Principles of Software Programming

Basics of programming and intro to Python

WU WIRTSCHAFTS UNIVERSITÄT WIEN VIENNA UNIVERSITY OF ECONOMICS AND BUSINESS

Anton Yeshchenko

SS 2018

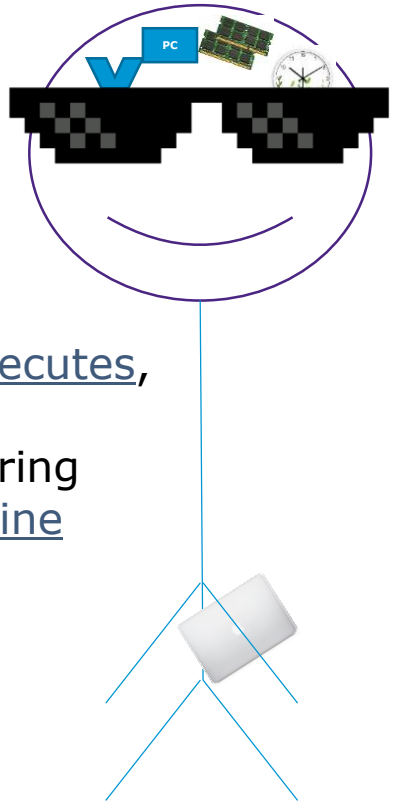


Some slides and/or ideas were borrowed from:
MIT Introduction to Computer Science and Programming in Python
and Svitlana Vakulenko WS 2017 lecture slides

MARCH 2017

Recap!

- Programming - the process of writing computer programs
- Algorithm
- ALU + RAM + PC + Clock ≈ Turing machine
- Assembler
- Low-level languages (C++,C)
- High-level languages (python, java)
- Interpreter is a computer program that directly executes, i.e. *performs*, instructions written in a programming or scripting language, without requiring them previously to have been compiled into a machine language program
- Compiler

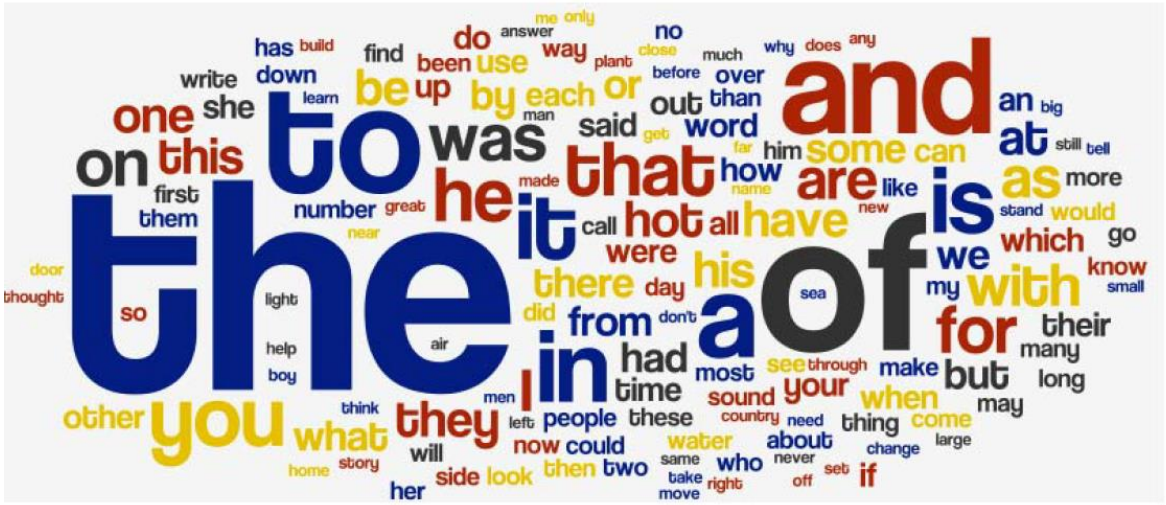


Today!

1. Syntax, semantic
2. Data, data types
3. Operators
4. Variables
5. Functions
6. Packages

Aspect of languages

- **primitive constructs**
  - English: words
  - programming language: numbers, strings, simple operators



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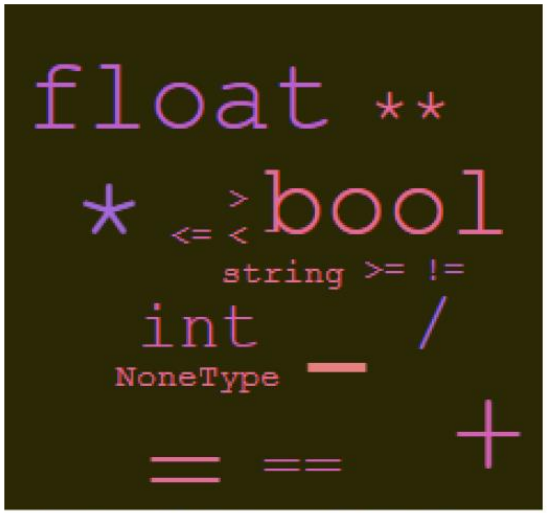

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Aspect of languages

- **syntax**
  - English: "cat dog boy" → not syntactically valid
    "cat hugs boy" → syntactically valid
  - programming language: "hi"5 → not syntactically valid
    3.2*5 → syntactically valid

Aspect of languages

- **syntax**
  - English: "cat dog boy" → not syntactically valid
    "cat hugs boy" → syntactically valid
  - programming language: "hi"5 → not syntactically valid
    3.2*5 → syntactically valid

Syntactic errors?

- Common and easily caught

Aspect of languages

- **Semantic** is the meaning associated with a **syntactically correct** string of symbols

- English: can have many meanings "*We saw her duck*"
  - We looked at a duck that belonged to her.
  - We looked at her quickly squat down to avoid something.
  - We use a saw to cut her duck.

- Programming languages: have only one meaning but may not be what programmer intended

Aspect of languages

- **Semantic** is the meaning associated with a **syntactically correct** string of symbols

- English: can have many meanings "*We saw her duck*"
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- Programming languages: have only one meaning but may not be what programmer intended

- **Semantic errors?**
  - Program crash
  - Program runs forever
  - There is an answer but different than expected

Python programs

- a **program** is a sequence of definitions and commands

- **Commands** (statements) instruct *interpreter* to do something

- can be typed directly in a **shell (terminal)** or stored in a **file** that is read into the shell and evaluated
  - We use jupyter notebooks, that we will see in the first excercise!

Objects

Program can manipulate so called **Data objects**

objects have a **type** that defines the kinds of things programs can do to them

- **Ana** is a **human** so she can walk, speak English, etc.
- **Chewbacca** is a **wookieso** he can walk, “mwaaarhrhh”, etc
- **Integer** are the numbers, you can count, add, multiply..

Simple data types

EINSPANNER

Coffee:

- 60 ml (2 shots) espresso
- cocoa powder to top
- brown sugar as preferred

Whipped cream:

- 100 to 120 ml heavy/whipping cream (aka 35% cream)
- 1.5 tsp powdered sugar
- 1/2 tsp vanilla extract (optional)

Instructions:

Whip the heavy cream until stiff with peaks by hand or using a mixer with the whisk attachment. Add freshly brewed espresso into a cup and top with whipped cream. The ratio of cream to espresso for an Einspanner is 1:1 so not all the cream will be used up—although I certainly won't discourage you from adding all the of the whipped cream into the drink! To finish, sift on cocoa powder and add brown sugar to your liking.

http://2.bp.blogspot.com/-bPE0E6zEHkg/T4bGyQaMSlI/AAAAAAAAoA0/cPDOpjpt9AY/s1600/20120402_Demel-Coffee-Einsp%25C3%25A4nner-Copyright-Merisi-Vienna_0218.jpg
https://www.epicurious.com/recipes/food/views/einspanner-200826

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- **1/2** tsp vanilla extract (optional)

60, 2, 100, 120	integer
1.5, 0.5	floating point
“cocoa powder”, “brown sugar”	String
True, False	Boolean
None	Special type that has one value “None”

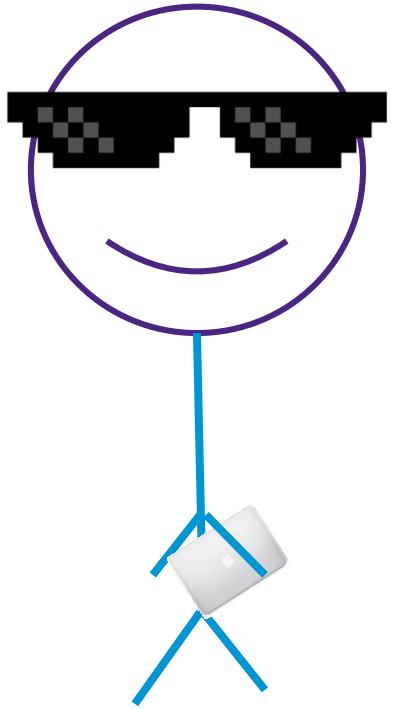
http://2.bp.blogspot.com/-bPE0E6zEHkg/T4bGyQaMSlI/AAAAAAAAoA0/cPDOpjpt9AY/s1600/20120402_Demel-Coffee-Einsp%25C3%25A4nner-Copyright-Merisi-Vienna_0218.jpg
https://www.epicurious.com/recipes/food/views/einspanner-200826

Built-in functions and parameters

- abs(x)
- pow(x, y)
- **print**(x)
- input()
- type(x)

- Parameters
- Return

High level languages
University student



Quiz 1!

Expressions

- **combine objects and operators** to form expressions
- an expression has a **value**, which has a type
- syntax for a simple expression

```
<object> <operator> <object>
```

Operators

- `i+j` → the **sum**
- `i-j` → the **difference**
- `i*j` → the **product**

if both are ints, result is int
if either or both are floats, result is float

- `i/j` → **division**

result is float

- `i%j` → the **remainder** when `i` is divided by `j`
- `i**j` → `i` to the **power** of `j`

Operator precedence

parentheses used to tell Python to do these operations first

Or without parenthesis

1. **
2. *
3. /
4. + and –

- 2 + 2 * 5 = 12
- (2 + 2) * 5 = 20

Strings

- Letters, special characters, spaces, digits
- Enclose in **quotation marks or single quotes**
  - "hello there"
- **Concatenate** strings
  - “ana” + “ “ + “hello there”
  - Result will be new string:
    - “Ana hello there”

- Do some **operations** on a string:
  - “hello there” + “ana” * 3

Jupiter notebook! Let's put our hands to actually do something here

- Integrated Development Environment (**IDE**)
- **web** application
- **easy**-to-use, interactive
- show **results** in the same document with code
- **presentation**: add description, plots, images & videos

Login to your own battlefield!

https://programming.ai.wu.ac.at/6088/notebooks/$STUDENTID

Exercise 1. Einspanner

Coffee:
- **60** ml (**2** shots) espresso
- **cocoa powder** to top
- **brown sugar** as preferred

Whipped cream:
- **120** ml heavy/whipping cream (aka 35% cream)
- **1.5** tsp powdered sugar
- **1/2** tsp vanilla extract**(optional)**

How much calories in the drink?

1. Show on the screen the name of the drink
2. Show number of calories

Hints:
Use function print()
Write one **expression** for the calculation of number of calories

	Number of	**Calories**
Espresso	1 (shot)	0
Cocoa powder	1 (portion)	20
Brown sugar	1 (portion)	40
Whipped cream	100	450
Powdered suar	1 (spoon)	20
Vanilla	1 (spoon)	30

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Exercise 1. WHAT HAVE WE DONE?

What's the use of that **piece of** code?

HTTPS://PXHERE.COM/EN/PHOTO/720036

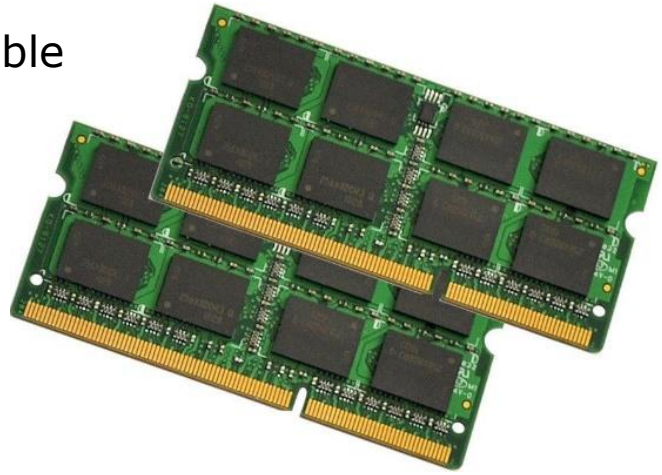
Variables

- a **variable** is a value that can change, depending on conditions or on information passed to the program

- Equal sign is an **assignment** of a value to a variable name

variable value

```
pi = 3.14159
pi_approx = 22/7
```



- Value stored in computer memory
- An assignment binds name to value
- Retrieve value associated with name or variable by invoking the name, by typing `pi`

Static vs dynamic typing

Static typing	Dynamic typing
Java, C++, C ..	Python, Ruby ..
int a = 10	a = 10 (will be integer)
float b = 20.33	b = 20.33 (will be float implicitly)
String s2 = "hello Java"	c = “Hello guys”

Built-in type conversion (cast)

can **convert object of one type to another**

Explicit:

- float(3)converts integer 3 to float 3.0
- int(3.9) truncates float 3.9 to integer 3
- str(x)

Implicit

- 1 + 0.4

Implicit conversion miracle!

Ariane 5

- 4 June 1996
- European Space Agency 10 years and $7 billion
- takeoff in French Guiana

HTTP://WWW.MILITARY.COM/VIDEO/SPACE-TECHNOLOGY/LAUNCH-VEHICLES/ARIANE-5-ROCKET-LAUNCH-FAILURE/2096157730001
HTTPS://WWW.LINKEDIN.COM/PULSE/ARIANE-5-ROCKET-LAUNCH-FAILURE-DO-ONE-LINE-COMPUTER-CODE-DAHLBERG/
HTTPS://UPLOAD.WIKIMEDIA.ORG/WIKIPEDIA/COMMONS/THUMB/3/3C/ARIANE_5ES_WITH_ATV_4_ON_ITS_WAY_TO_ELA-3.JPG/1200PX-ARIANE_5ES_WITH_ATV_4_ON_ITS_WAY_TO_ELA-3.JPG

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HTTPS://WWW.LINKEDIN.COM/PULSE/ARIANE-5-ROCKET-LAUNCH-FAILURE-DO-ONE-LINE-COMPUTER-CODE-DAHLBERG/

Programming vs Math

- in programming, you do not “solve for x”

```
pi = 3.14159
radius = 2.2
# area of circle
area = pi*(radius**2)
radius = radius+1
```

an assignment
* expression on the right, evaluated to a value
* variable name on the left
* equivalent expression to `radius = radius + 1` is `radius += 1`

Operators

- **Assignment**:
  - =, +=, -=,*=,/=, %=, **=, //= (floor division)

A = 10

A += 10

A -= 10

A *= 10

A /= 10

etc.

Exercise 2.

1. Define variables
2. **Assign value** of how much of the ingredient is needed for the recipe

Variables
Espresso
Cocoa powder
Brown sugar
Whipped cream
Powdered suar
Vanilla

Coffee:

- **60** ml (**2** shots) espresso
- **cocoa powder (1 portion)** to top
- **brown sugar (1 portion)** as preferred

Whipped cream:

- **120** g heavy/whipping cream
  1.5 spoon powdered sugar
- **1/2** spoon vanilla extract**(optional)**

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Exercise 2.

1. Define variables
2. **Assign value** of how much of the ingredient is needed for the recipe
3. **Use table and variables to calculate the total calories**

Variables	Number of	Calories
Espresso	1 (shot)	0
Cocoa powder	1 (portion)	20
Brown sugar	1 (portion)	40
Whipped cream	100	450
Powdered suar	1 (spoon)	20
Vanilla	1 (spoon)	30

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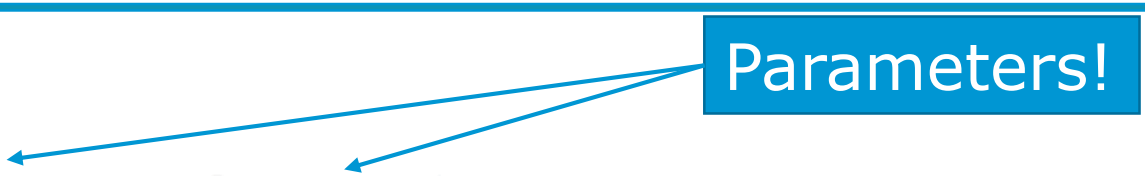
Functions




```
def lastFirst(firstName, lastName):
    separator = ', '
    result = lastName + separator + firstName
    return result
```

Functions

Parameters!

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def lastFirst(firstName, lastName):
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We get something back!

Functions

Parameters!

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def lastFirst(firstName, lastName):
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```

We get something back!

Now we can use it many times!

```
print(lastFirst('Benjamin', 'Franklin'))
print(lastFirst('Andrew', 'Harrington'))
```

Functions

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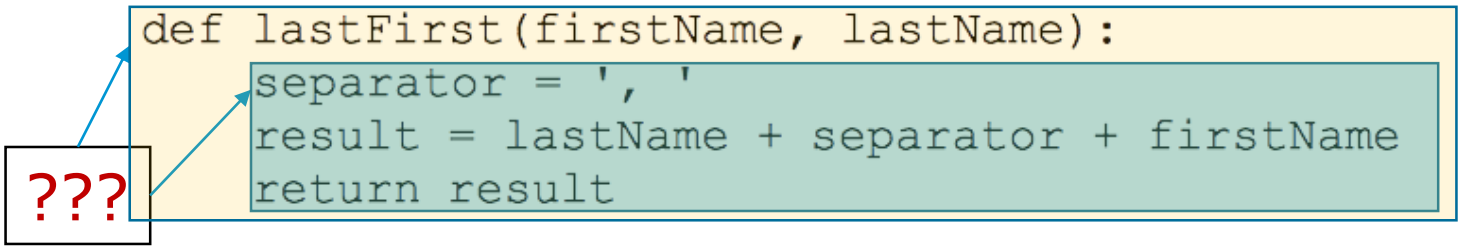
Pythonic style

- PEP 8 -- Style Guide for Python Code



- Indentation: **4 spaces**

https://www.python.org/dev/peps/pep-0008/

http://www.voidspace.org.uk/python/articles/python_style_guide.shtml

https://stackoverflow.com/questions/2357230/what-is-the-proper-way-to-comment-functions-in-python

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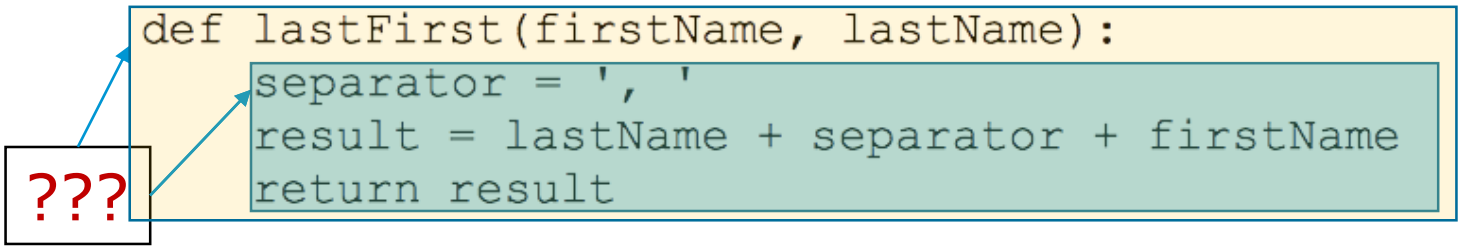

- Indentation: **4 spaces**
- Naming convention: no CamelFont, rather lower_case_with_underscores

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Pythonic style

- PEP 8 -- Style Guide for Python Code

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    separator = ', '
    result = lastName + separator + firstName
    return result
```

???

- Indentation: 4 spaces
- Naming convention: no CamelFont, rather lower_case_with_underscores
- Comments:

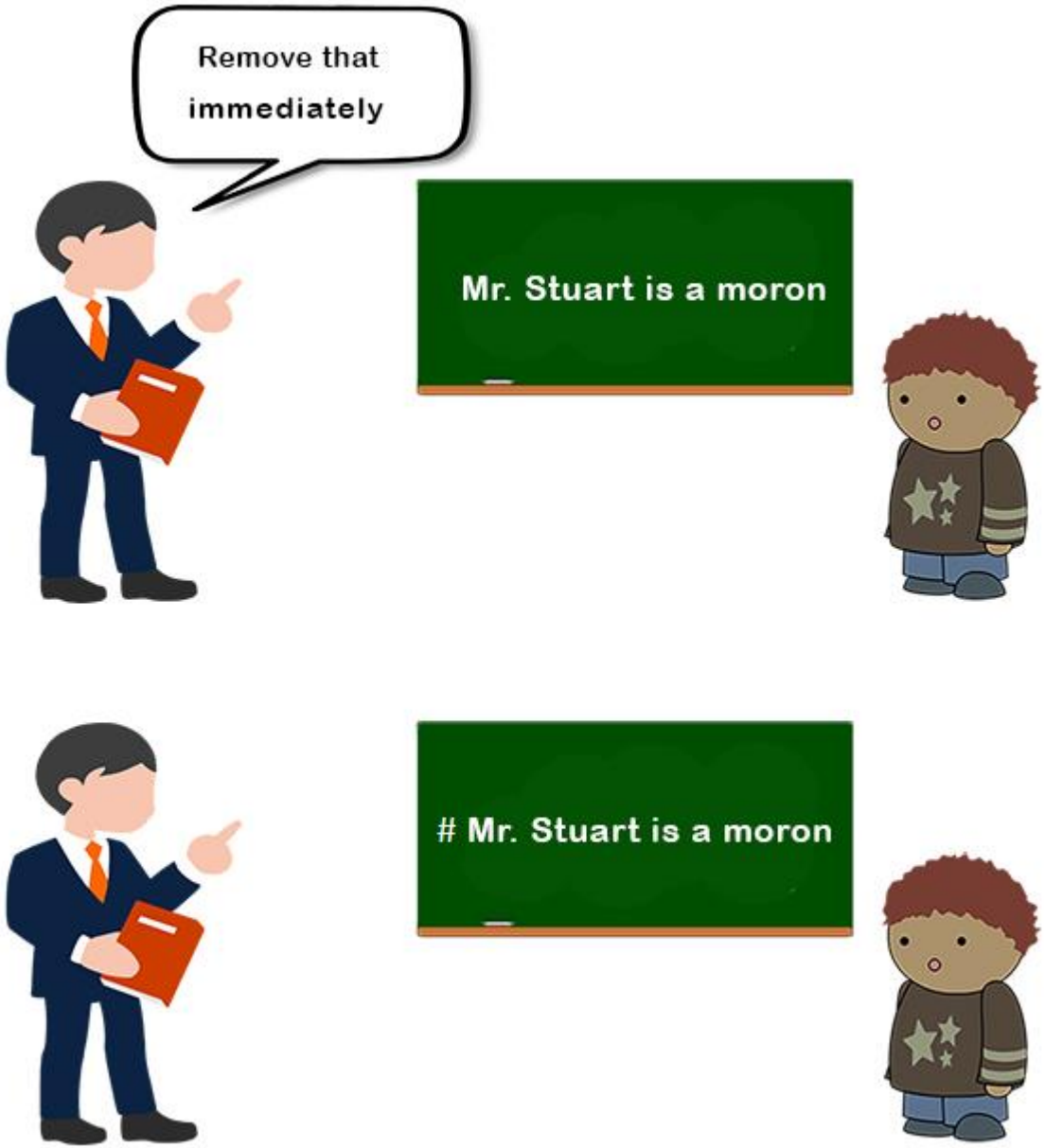
```
# ??? Why is this here?

"""Create a new user.
Line 2 of comment...
And so on... """
```

https://www.python.org/dev/peps/pep-0008/

http://www.voidspace.org.uk/python/articles/python_style_guide.shtml

https://stackoverflow.com/questions/2357230/what-is-the-proper-way-to-comment-functions-in-python



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Variable scope

- function scope and global scope
- no access to local variables outside the function

```
globalVar = "This is global"


def myFunction():

    localVar = "This is local"
```

http://gettingstartedwithpython.blogspot.co.at/2012/05/variable-scope.html

Exercise 3: Write a function calculate calories and say something nice.

1. **Write function** to calculate the calories
2. **Add 1 argument**, that will say **how many spoons of sugar** you put in the coffee
3. All other variables create inside of the function

Solution

Import

- **Example: math functions**

```
import math
print (math.sqrt(10))

from math import pi
r = 5
area = pi*r*r
```

https://commons.wikimedia.org/wiki/File:Artillery-spoked_wheel.jpg

http://ubuntuforums.org/showthread.php?t=879970

https://en.wikibooks.org/wiki/Python_Programming/Modules

Packages

modules, libraries, extensions

PyPI - Python Package Index is a repository of software

There are currently **120396** packages

https://pypi.python.org/pypi

To use a package from this index: "pip install *package*"

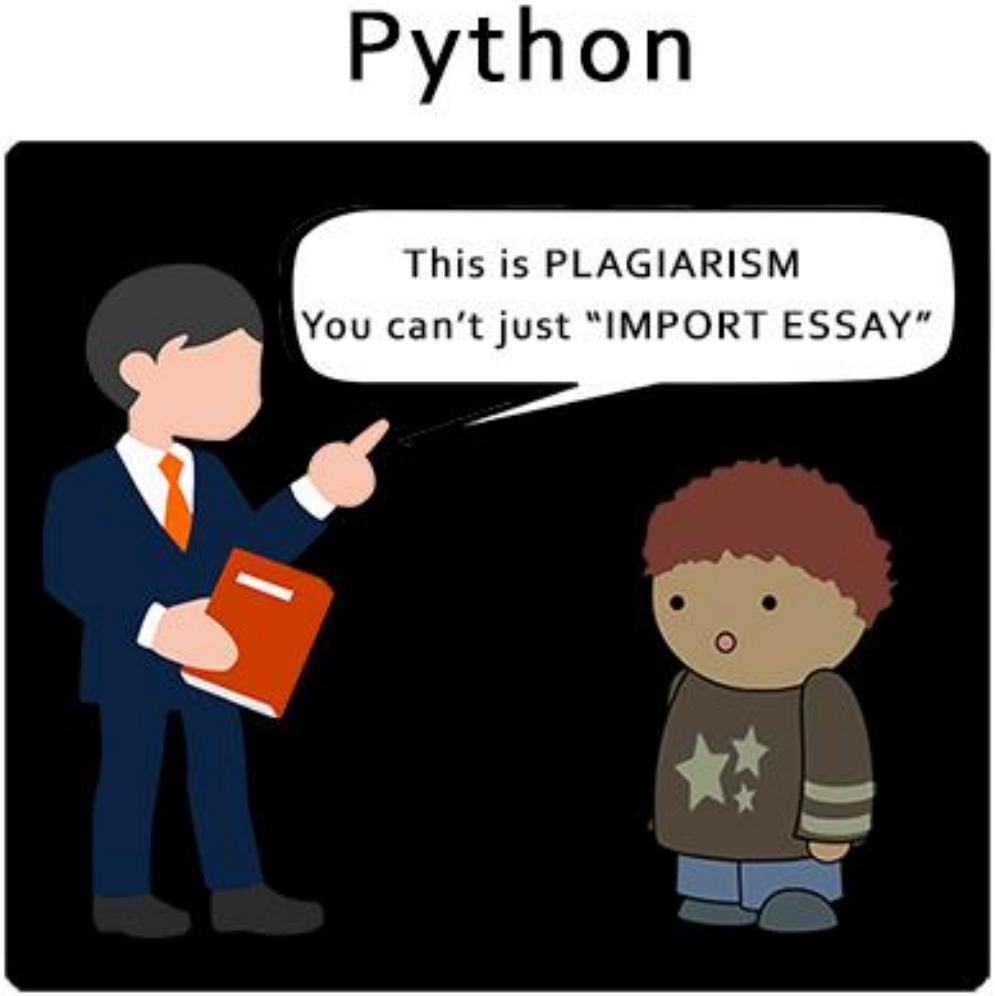
- **Web data**: requests, scrapy, BeautifulSoup, nltk
- **Data science**: NumPy, SciPy, matplotlib, tensorflow
- **Web development**: django, flask, SQLAlchemy

https://www.tensorflow.org/install/install_linux#InstallingNativePip

https://docs.python.org/3/library/index.html

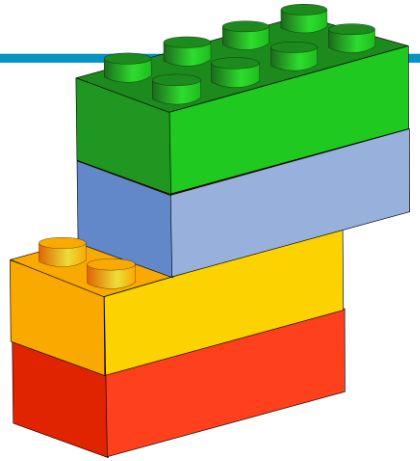
https://pythontips.com/2013/07/30/20-python-libraries-you-cant-live-without/

Import



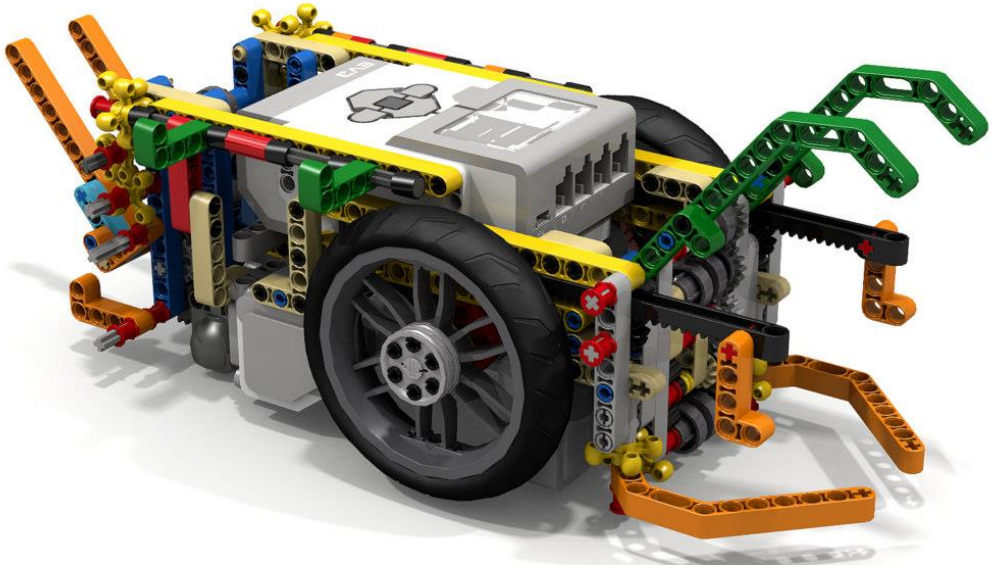
LEGO®

- building blocks
- iterative development
- Reduce, Reuse, Recycle principle



https://www.goodfreephotos.com/vector-images/lego-blocks-vector-clipart.png.php

https://www.flickr.com/photos/keykalou/11931885745



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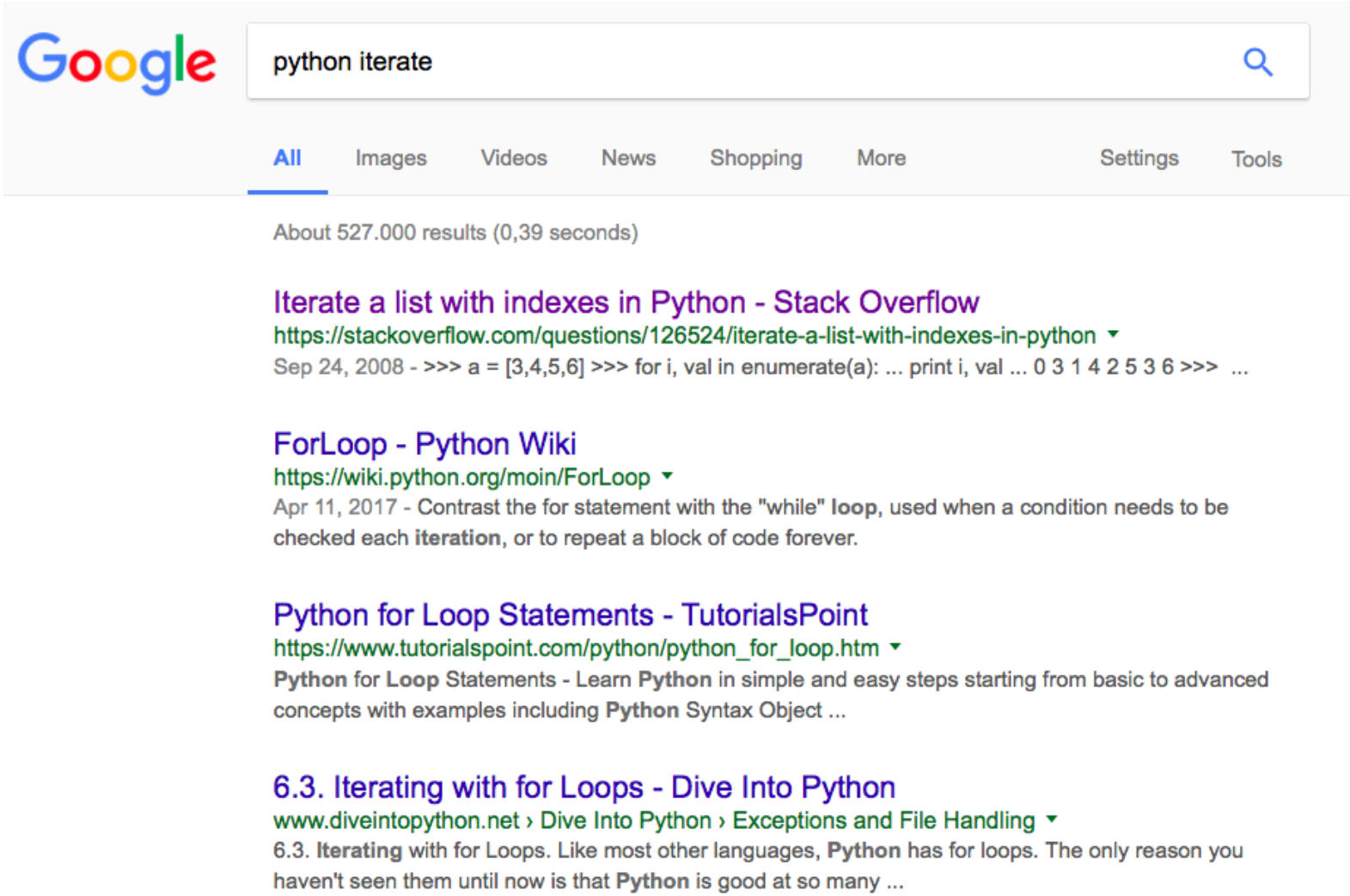
Questions?


Google
python iterate
All
Images
Videos
News
Shopping
More
Settings
Tools
About 527.000 results (0,39 seconds)
Iterate a list with indexes in Python - Stack Overflow
https://stackoverflow.com/questions/126524/iterate-a-list-with-indexes-in-python
Sep 24, 2008 - >>> a = [3,4,5,6] >>> for i, val in enumerate(a): ... print i, val ... 0 3 1 4 2 5 3 6 >>> ...
ForLoop - Python Wiki
https://wiki.python.org/moin/ForLoop
Apr 11, 2017 - Contrast the for statement with the "while" loop, used when a condition needs to be checked each iteration, or to repeat a block of code forever.
Python for Loop Statements - TutorialsPoint
https://www.tutorialspoint.com/python/python_for_loop.htm
Python for Loop Statements - Learn Python in simple and easy steps starting from basic to advanced concepts with examples including Python Syntax Object ...
6.3. Iterating with for Loops - Dive Into Python
www.diveintopython.net › Dive Into Python › Exceptions and File Handling
6.3. Iterating with for Loops. Like most other languages, Python has for loops. The only reason you haven't seen them until now is that Python is good at so many ...

Stack overflow

- Specialized Q/A forum

6 Answers

active oldest votes

293

```
>>> a = [3,4,5,6]
>>> for i, val in enumerate(a):
...     print i, val
...
0 3
1 4
2 5
3 6
>>>
```

Quiz 2!

Homework 2!

Exercise 1.

- Bart Simpson chalkboard.
- Write one phrase 10 times and output it to the screen

Exercise 2.

- Write a function outputs the age of the person
  - that has 2 arguments (parameters). **First** is a **name (string)**, **second** is a **number**

print(persons_age("Harry Potter", 25))

Will print:

"Harry Potter is 25 years old"

HTTP://SIMPSONS.WIKIA.COM/WIKI/BART_THE_GENIUS

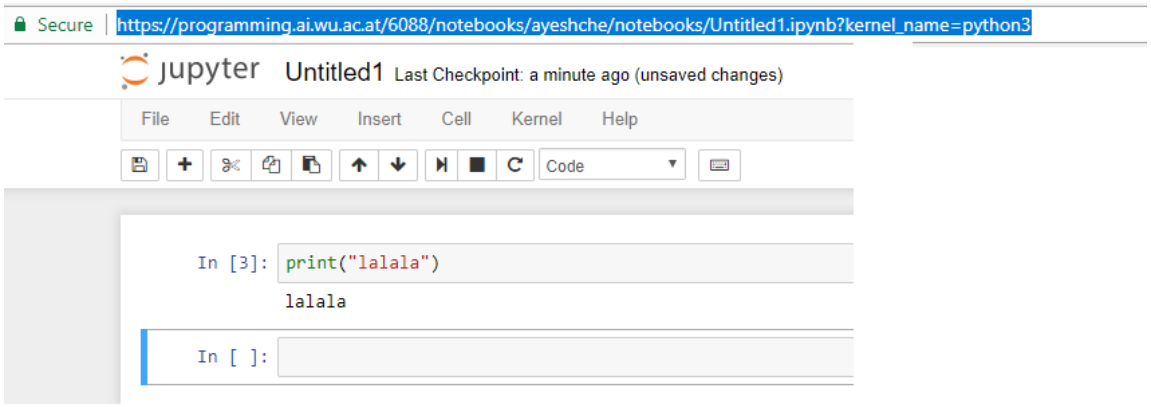
Submission rule

- **Deadline, 19 of March 2pm.**

Algorithm to submission:

1. Go to Jupiter Notebook created for you
2. Create file "homework 2"
3. Complete assignment
4. Login to the course page https://learn.wu.ac.at/dotlrn/classes/pool/6088.18s
5. Find homework's page, and for homework2, submit the link to your notebook.

Welcome to ask me anything!



See you next time!

- **Programming:** algorithms, syntax and semantics, programming, compiler, interpreter
- **Basics and types:** variables, operations, primitive data types, Strings, static vs dynamic typing, explicit vs implicit type casting
- **Control flow and functions:** if-else branches, loops, functions (parameters, return values)
- **Lists:** Arrays (lists), create and fill Arrays, multidimensional Arrays
- **Classes:** Class vs Instance of class, objects, create objects, instance variable, constructor, method overloading
- **Inheritance:** inherit classes, method overriding, problems and solutions for multiple inheritance
- **Information hiding:** variable access, access modifier (Java) and naming conventions, get- and set-methods
- **Object oriented programming:** why OOP, inheritance ("is-a"- and "is-part-of"-relations), information hiding/encapsulation, abstract classes, Super-constructor, polymorphism

Additional topics if you plan to take the exam as "Wahlfach" course (5 ECTS):

Wahlfach:

- **Exceptions**
- **Dynamic data structures:** Stacks, Queues, Maps (Dictionaries), Trees

My boss gave me 30 days (not working days) to learn Python to transfer to the Data Science team. What is the best approach to learn as much as possible?

Al Klein, 45 years of earning a living developing systems.

Answered Oct 9, 2016

Show him this - after 43 years of using and teaching programming, learning it in 30 days will, AT BEST, let you know what basics you need to learn. It takes the average left-brained individual (one most suited to learning programming) at least 6 months to learn programming, and a few years to become somewhat competent at it.

30 days? Does he also want you standing on the tip of your nose the entire month? That's how silly "learn programming in 30 days" sounds to someone who's been there. (If you're already an accomplished programmer, just look at a language manual and start porting a program you've written into Python. That's about an hour of work, plus the time it takes to port it.)

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