

Python programming : basic grammar

ECE30007 Intro to AI Project

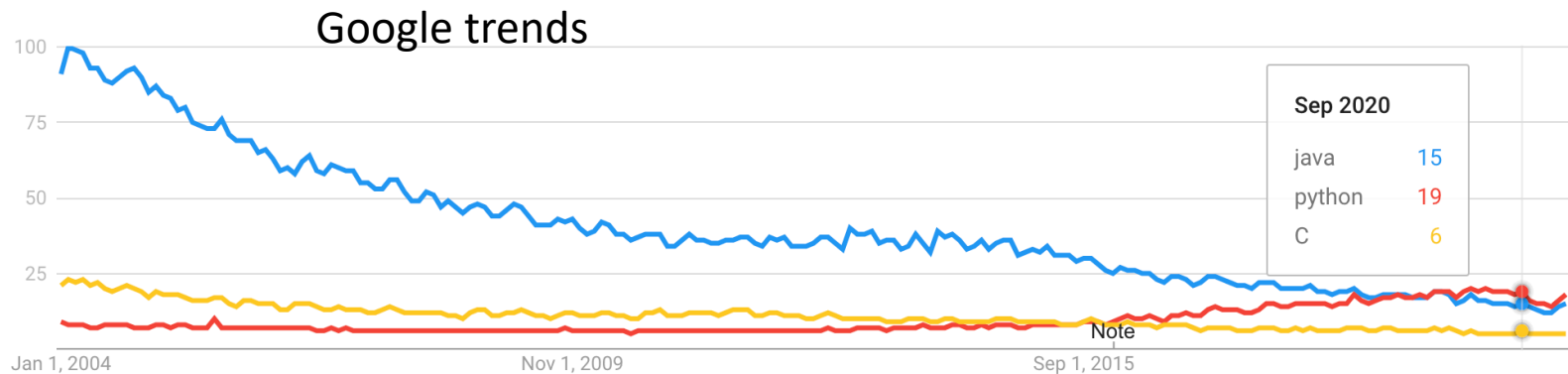
outline

- getting started
 - install, jupyter
- basics
 - variable, control, function, file I/O
- modules
 - numpy
 - matplotlib
- object oriented programming
 - class

IEEE Top 10 Programming languages of 2019

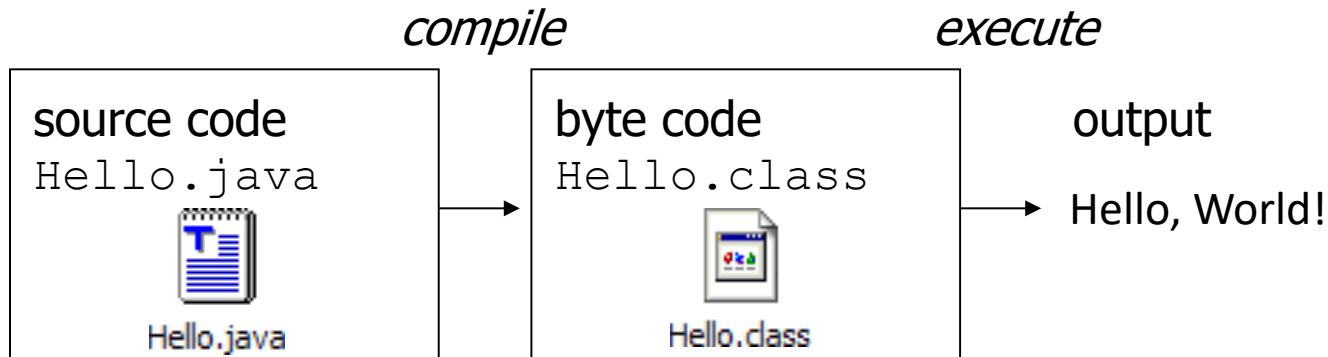
Rank	Language	Type	Score
1	Python	🌐 🖥️ ⚙️	100.0
2	Java	🌐 📱 🖥️	96.3
3	C	📱 🖥️ ⚙️	94.4
4	C++	📱 🖥️ ⚙️	87.5
5	R	🖥️	81.5
6	JavaScript	🌐	79.4
7	C#	🌐 📱 🖥️ ⚙️	74.5
8	Matlab	🖥️	70.6

<https://learnworthy.net/ieee-ranked-the-top-programming-languages-of-2019/>

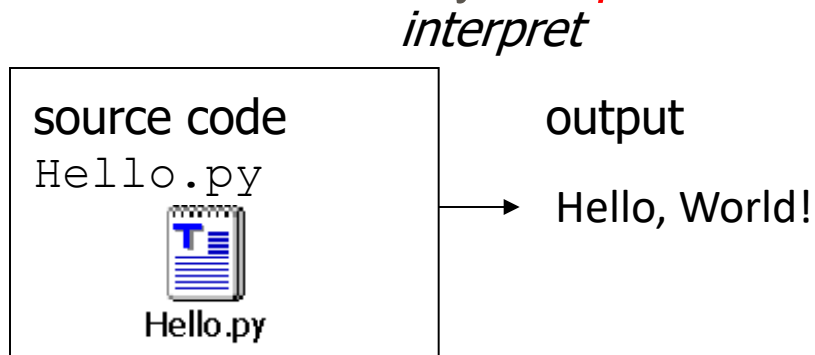


compiling and interpreting

- Many languages require you to *compile* (translate) your program into a form that the machine understands.



- Python is instead directly *interpreted* into machine instructions.



Python

- An interpreted, high-level, general-purpose programming language
 - Supports multiple programming paradigms, including procedural, object-oriented, and functional programming
 - Dynamically typed and garbage-collected
 - Emphasizes code readability
(with its notable use of significant whitespace)
 - Written in C

why Python?

- Clear syntax
 - *"Executable pseudo-code"*
- Easiness in data manipulation
 - Packages like NumPy, SciPy, Matplotlib, Pandas, ...
- Popularity — a large number of users and user groups
 - There is ample development and documentation
- Drawbacks
 - Not as fast as C or Java

Python history

- Late 80s - Conceptualization and initial implementation
 - Led by Guido van Rossum (National Research Institute of Mathematics and Computer Science)
- 1991 - Python (version 0.9.0) was first released
 - classes, lists, strings, and exception handling
 - supports for functional programming (lambda, map, filter, and reduce)
- 2000 - Python 2.0 was released
 - Included list comprehensions and a fully-functional garbage collector
 - Started to support Unicode
- 2008 - Python 3.0 was released
 - Improved the internal mechanisms, grammar and expressions
 - Broke backward compatibility; *c.f.*, a tool called "2to3"
- Current versions
 - Python 3.9 (Feb 2021)

Python Philosophy

- Python strives for a simpler, less-cluttered syntax and grammar
- Python embraces a *"there should be one — and preferably only one — obvious way to do it"* design philosophy
 - Beautiful is better than ugly
 - Explicit is better than implicit
 - Simple is better than complex
 - Complex is better than complicated
 - Readability counts
- Key features
 - Open source language
 - Extensive library support
 - Cross-platform

"import this"

install

<https://www.python.org/downloads/>



Looking for a specific release?

python3.x is quite different from python2.x

hello world!

in Terminal

```
Henrys-MacBook-Pro:~ henry$ ipython
Python 3.7.2 (v3.7.2:9a3ffc0492, Dec 24 2018, 02:44:43)
Type 'copyright', 'credits' or 'license' for more information
IPython 7.5.0 -- An enhanced Interactive Python. Type '?' for help.

In [1]: print('Hello World!')
Hello World!

In [2]: exit()
```

if on Windows

- open a Python IDE like IDLE, and do the same thing above

or IDE

- edit a python file (e.g., my_code.py), and run it (e.g., python my_code.py)

or jupyter

jupyter

install in Terminal

```
$ pip install jupyter
```

move to your working directory

```
$ cd ~/my_dir/
```

run jupyter

```
$ jupyter notebook
```

```
Henrys-MacBook-Pro:~ henry$ jupyter notebook --ip=127.0.0.1  
[I 01:07:20.256 NotebookApp] Loading IPython parallel extension  
(... )
```

To access the notebook, open this file in a browser:

`file:///Users/henry/Library/Jupyter/runtime/nbserver-63283-open.html`

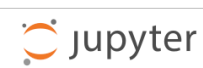
Or copy and paste one of these URLs:

<http://127.0.0.1:8888/?token=47691093547ac0acf85af893e6417c6b6726d576>

open a web browser like Chrome and copy and paste the url

<http://127.0.0.1:8888/?token=47691093547ac0acf85af893e6417c6b6726d576>

jupyter

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jupyter **Untitled1** Last Checkpoint: a few seconds ago (unsaved changes)

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Code



In [1]: `print('hello world!')`

hello world!

In []:

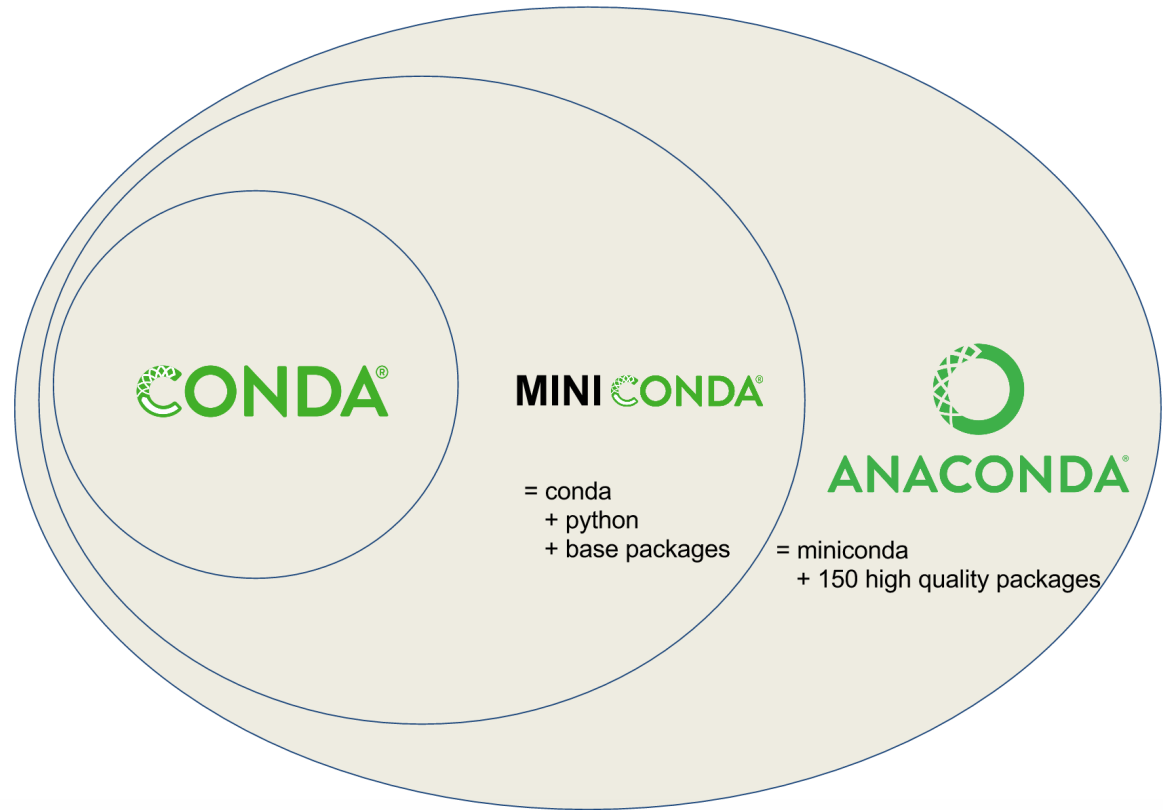


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Conda <https://docs.conda.io/>

An open source package and environment management system that runs on Windows, Mac OS and Linux.

- Conda provides prebuilt packages or binaries.
- Conda is cross platform.
- Packages can be easily installed (through pip) in conda environment.



Google colaboratory

https://colab.research.google.com



Welcome To Colaboratory

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What is Colaboratory?

Colaboratory, or "Colab" for short, allows you to write and execute Python in your browser, with

- Zero configuration required
- Free access to GPUs
- Easy sharing

Whether you're a **student**, a **data scientist** or an **AI researcher**, Colab can make your work easier. Watch [Introduction to Colab](#) to learn more, or just get started below!

▼ Getting started

The document you are reading is not a static web page, but an interactive environment called a **Colab notebook** that lets you write and execute code.

For example, here is a **code cell** with a short Python script that computes a value, stores it in a variable, and prints the result:

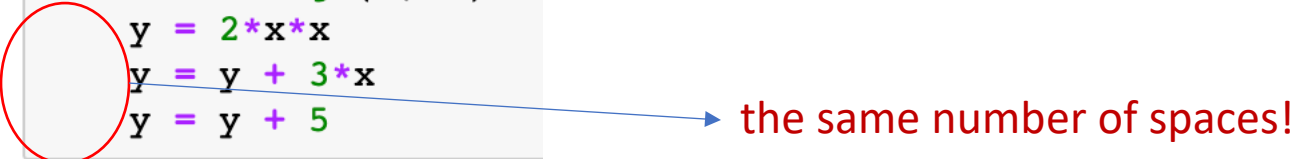
```
[ ] seconds_in_a_day = 24 * 60 * 60
    seconds_in_a_day
```

86400

indentation

- **indentation** instead of braces for the scope of expressions
- All lines must be indented the same amount to be part of the scope
 - or indented more if part of an inner scope
- use proper indentation
 - since the indenting is part of program.

```
In [2]: for x in range(1,10):  
        y = 2*x*x  
        y = y + 3*x  
        y = y + 5
```



```
In [3]: print(y)
```

194

comment

- compiler will ignore any thing after '#'

```
In [1]: print('comment') # this is comment  
        # this line is comment
```

comment

variables

- no declaration
- the variable is created when you assign it a value
- everything is an object
 - variable, class, function, etc

integer

- integer

```
In [2]: x = 3
```

```
In [3]: x
```

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

- int(x) and float(x)

```
In [10]: int(3.5)
```

```
Out[10]: 3
```

```
In [11]: float(3)
```

```
Out[11]: 3.0
```

integer

- the type of variable can change with the value

```
In [13]: x = 3.5  
         y = 2
```

type(x) is float

```
In [14]: x = y + 2
```

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

```
Out[15]: int
```

string

- '+' is overloaded as in C++

```
In [16]: x = 'hello'
         y = 'world'
         z = x + ' ' + y
```

```
In [17]: z
```

```
Out[17]: 'hello world'
```

- some methods

```
In [23]: len(z), str(3.5), z[2], z[6:8]
```

from index 6 to index 7
index starts from 0.

```
Out[23]: (11, '3.5', 'l', 'wo')
```

- immutable (e.g., `x[3] = 'X'` # illegal)

string

`len(string)` - number of characters in a string
(including spaces)

`str.lower(string)` - lowercase version of a string

`str.upper(string)` - uppercase version of a string

```
In [8]: len('HGU')
```

```
Out[8]: 3
```

```
In [9]: str.lower('HGU')
```

```
Out[9]: 'hgu'
```

```
In [10]: str.upper('Handong')
```

```
Out[10]: 'HANDONG'
```

list

- ordered collection of data
- data can be of different types
- same subset operations as strings

```
In [100]: x = [2, 1, 4, 6]
          y = [1, 3.5, 'HGU']
          y[0:2]          # from index 0 to index 1
```

```
Out[100]: [1, 3.5]
```

```
In [101]: y[1:]          # from index 1 to the end
```

```
Out[101]: [3.5, 'HGU']
```

slice operator

```
1 # Slice Operator
2 a = [1,2,3,4,5]
3
4 print(a[0:2]) # Choose elements [0-2), upper-bound noninclusive
5
6 print(a[0:-1]) # Choose all but the last
7
8 print(a[::-1]) # Reverse the list
9
10 print(a[::2]) # Skip by 2
11
12 print(a[::-2]) # Skip by -2 from the back
13
```

[1, 2]

[1, 2, 3, 4]

[5, 4, 3, 2, 1]

[1, 3, 5]

[5, 3, 1]

a

[0]	[1]	[2]	[3]	[4]
1	2	3	4	5

a[0:2]

[0]	[1]	[2]	[3]	[4]
1	2	3	4	5

list: reassign (mutable)

- reassigns the ith element

```
In [74]: x = ['i', 'love', 'you']
```

```
In [75]: x
```

```
Out[75]: ['i', 'love', 'you']
```

```
In [76]: x[2] = 'hgu'
```

```
In [77]: x
```

```
Out[77]: ['i', 'love', 'hgu']
```


list: reference and copy

- y points x (they refer to the same object)
- if x changes, so does y

```
In [67]: x = ['i', 'love', 'you']
```

```
In [69]: y = x
```

```
In [72]: x[2] = 'hgu'
```

```
In [73]: y
```

```
Out[73]: ['i', 'love', 'hgu']
```

or, we can copy

```
In [111]: x = [1, 2, 3]
```

```
In [112]: y = x.copy()
```

```
In [113]: x[1] = 20
```

```
In [114]: y
```

```
Out[114]: [1, 2, 3]
```

```
In [115]: x
```

```
Out[115]: [1, 20, 3]
```

list: append

- append

```
In [84]: x = [1, 2, 3, 4, 5]
```

```
In [85]: x.append(6)
```

```
In [86]: x
```

```
Out[86]: [1, 2, 3, 4, 5, 6]
```

```
In [87]: x = x + [7]
```

```
In [88]: x
```

```
Out[88]: [1, 2, 3, 4, 5, 6, 7]
```

list: extend

- extend

```
In [90]: x = [1, 2, 3, 4, 5]
```

```
In [92]: x.extend([6, 7])
```

```
In [93]: x
```

```
Out[93]: [1, 2, 3, 4, 5, 6, 7]
```

```
In [94]: x = x + [8, 9]
```

```
In [95]: x
```

```
Out[95]: [1, 2, 3, 4, 5, 6, 7, 8, 9]
```

list: append

- append one more element

```
In [96]: x = [1, 2, 3, 4, 5]
```

```
In [97]: x.append([6, 7])
```

```
In [98]: x
```

```
Out[98]: [1, 2, 3, 4, 5, [6, 7]]
```

```
In [99]: x[5]
```

```
Out[99]: [6, 7] # [6, 7] is one element
```

```
In [14]: a = [1, 2, 3, 4]
```

```
In [15]: 1 in a
```

```
Out[15]: True
```

tuples

A tuple is a collection which is ordered and unchangeable

```
In [102]: x = (1, 2, 3)
```

```
In [103]: x
```

```
Out[103]: (1, 2, 3)
```

```
In [104]: x[1] = 10          # immutable: cannot change the element
```

```
-----  
TypeError                                Traceback (most recent call last)  
<ipython-input-104-b88844ced749> in <module>  
----> 1 x[1] = 10  
  
TypeError: 'tuple' object does not support item assignment
```

```
In [105]: y = (2,)          # type is tuple
```

```
In [106]: y
```

```
Out[106]: (2,)
```

```
In [107]: y = (2)          # type is int
```

```
In [108]: y
```

```
Out[108]: 2
```

```
1 y = (2,)  
2 print(type(y))  
3  
4 y = (2)  
5 print(type(y))
```

```
<class 'tuple'>  
<class 'int'>
```

why do we need tuple (immutable)?
because it is faster than list (mutable).

dictionary

- a set of key-value pairs
- mutable.

```
In [133]: x = {1:'paul', 2:'peter', 3:'john'}
```

```
In [134]: x[2]          # x.get(2)
```

```
Out[134]: 'peter'
```

```
In [135]: x[3]='james'
```

```
In [136]: x
```

```
Out[136]: {1: 'paul', 2: 'peter', 3: 'james'}
```

```
In [137]: x[5] = 'andy'
```

```
In [138]: del(x[3])
```

```
In [139]: x          # x.items()
```

```
Out[139]: {1: 'paul', 2: 'peter', 5: 'andy'}
```

output

- print text output on the console

```
In [150]: print(x)
```

```
{1: 'paul', 2: 'peter', 5: 'andy'}
```

```
In [151]: print (x, y)      # y = [1, 2, 3]
```

```
{1: 'paul', 2: 'peter', 5: 'andy'} [1, 2, 3]
```

```
In [153]: age = 25  
print ('I am ', age, ' years old')
```

```
I am  25  years old
```

output

- Print without newline

```
1 print("Hello there!")
2 print("It is a great day.")
3
4
5 print("Hello there!", end = '')
6 print("It is a great day.")
```

Hello there!

It is a great day.

Hello there!It is a great day.

- With format specifier

```
1 print('I am %d years old.' % 24)
2 print('I am %s.' % 'Handong')
3 print('Your score is %f' % 2.3)
4 print('%10s' % 'abcde')
5 print('Today is %d %s.' % (9, 'March'))
```

I am 24 years old.

I am Handong.

Your score is 2.300000

abcde

Today is 9 March.

input

- reads a string value from user input

```
In [*]: age = input('how old are you?')
```

how old are you?

string

```
In [164]: age = input('how old are you?')
```

how old are you?19 # after typing '19' in the blue box above

```
In [165]: print(age)
```

19

```
In [167]: int(age)+6
```

```
Out[167]: 25
```

for loop

- with list, range

`range(start, stop)`

`range(start, stop, step)`

```
In [2]: for x in [1,3,5,9]:  
        print(x)
```

1
3
5
9

```
In [3]: for x in range(5):  
        print(x)
```

0
1
2
3
4

```
In [4]: for x in range(3,7):  
        print(x)
```

3
4
5
6

for loop: enumerate

- One can easily find the index (iteration number) inside a "for" loop
 - Wrap an iterable with 'enumerate'
 - it will yield the item along with its index

```
1 # Know the index faster
2 vowels=['a','e','i','o','u']
3 for i, letter in enumerate(vowels):
4     print (i, letter)
5
```

```
0 a
1 e
2 i
3 o
4 u
```

while loop

- while with a condition

```
In [6]: x = 1  
        while x < 5:  
            print(x)  
            x = x + 1
```

1
2
3
4

break, continue

- the same as in C

if, elif, else

- **elif** means “else if”

```
In [7]: x = 10
        if x <= 5 :
            y = x + 5
        elif x <= 10 :
            y = x + 10
        else :
            y = x
        print (y)
```

20

no switch statement in Python
→ instead, we can implement it.

logic

- Many logical expressions use *relational operators*:

Operator	Meaning	Example	Result
==	equals	<code>1 + 1 == 2</code>	True
!=	does not equal	<code>3.2 != 2.5</code>	True
<	less than	<code>10 < 5</code>	False
>	greater than	<code>10 > 5</code>	True
<=	less than or equal to	<code>126 <= 100</code>	False
>=	greater than or equal to	<code>5.0 >= 5.0</code>	True

- Logical expressions can be combined with *logical operators*:

Operator	Example	Result
and	<code>9 != 6 and 2 < 3</code>	True
or	<code>2 == 3 or -1 < 5</code>	True
not	<code>not 7 > 0</code>	False

exercise 1

- Write a program to print out a right triangle of '*', whose width is given as an input.
- ex) when input is 5, the output should be as follows.

```
*****
```

```
****
```

```
***
```

```
**
```

```
*
```

exercise 2

- implement a program to print out a month

```
Enter the start day (0~6)>> 3
Enter the number of days (0~6)>> 31
Sun Mon Tue Wed Thu Fri Sat
      1   2   3   4
  5   6   7   8   9  10  11
 12  13  14  15  16  17  18
 19  20  21  22  23  24  25
 26  27  28  29  30  31
```

```
Enter the start day (0~6)>> 6
Enter the number of days (0~6)>> 29
Sun Mon Tue Wed Thu Fri Sat
                        1
      2   3   4   5   6   7   8
     9  10  11  12  13  14  15
    16  17  18  19  20  21  22
    23  24  25  26  27  28  29
```