Python & R

Introduction to Python

Programming Paradigms

There are many kinds of programming languages, with different purposes, styles, intended uses, etc. Professional programmers often spend large portions of their careers working with a single language, or perhaps a few similar ones. As a result, they are often unaware of the many ways and levels at which programming languages can differ. For educational and professional development purposes, it can be extremely valuable for programmers to encounter languages that are fundamentally different from the ones with which they are familiar.

Programming languages embody combinations of four paradigms. Some were designed with the intention of staying within the bounds of just one, or perhaps two. Others mix multiple paradigms, although in these cases one is usually dominant.

The paradigms are:

- *Procedural* - This is the traditional kind of programming language in which computation is described as a series of steps to be executed by the computer, along with a few mechanisms for branching, repetition, and subroutine calling. It dates back to the earliest days of computing and is still a core aspect of most modern languages, including those designed for other paradigms.
- *Declarative* - Declarative programming is based on statements of facts and logical deduction systems that derive further facts from those. The primary embodiment of the logic programming paradigm is Prolog, a language used fairly widely in Artificial Intelligence (AI) research and applications starting in the 1980s. As a purely logic-based language, Prolog expresses computation as a series of predicate calculus assertions, in effect creating a puzzle for the system to solve.
- *Functional* - In a purely functional language, all computation is expressed as function calls. In a truly pure language there aren't even any variable assignments, just function parameters. Lisp was the earliest functional programming language, dating back to 1958. Its name is an acronym for "LISt Processing language," a reference to the kind of data structure on which it is based.
  Lisp became the dominant language of AI in the 1960s and still plays a major role in AI research and applications.
- *Object-oriented* - Object-oriented programming was invented in the late 1960s, developed in the research community in the 1970s, and incorporated into languages that spread widely into both academic and commercial environments in the 1980s (primarily Smalltalk, Objective-C, and C++). In the 1990s this paradigm became a key part of modern software development approaches. Smalltalk and Lisp continued to be used, C++ became dominant, and Java was introduced. Mac OS X, though built on a Unix-like kernel, uses Objective-C for upper layers of the system, especially the user interface, as do applications built for Mac OS X. JavaScript, used primarily to program web browser actions, is another object-oriented

language. Once a radical innovation, object-oriented programming is today very much a mainstream paradigm.

Another dimension that distinguishes programming languages is their primary intended use. There have been languages focused on string matching, languages designed for embedded devices, languages meant to be easy to learn, languages built for efficient execution, languages designed for portability, languages that could be used interactively, languages based largely on list data structures, and many other kinds.

Language designers, whether consciously or not, make choices in these and other dimensions. Subsequent evolutions of their languages are subject to market forces, intellectual trends, hardware developments, and so on.

Python Language

Python is a beautiful language. It is effective for everything from teaching new programmers to advanced computer science study, from simple scripts to sophisticated advanced applications. It has always had some purchase in bioinformatics, and in recent years its popularity has been increasing rapidly.

Jun 2018	Jun 2017	Change	Programming Language	Ratings	Change
1	1		Java	15.368%	+0.88%
2	2		C	14.936%	+8.09%
3	3		C++	8.337%	+2.61%
4	4		Python	5.761%	+1.43%
5	5		C#	4.314%	+0.78%
6	6		Visual Basic .NET	3.762%	+0.65%
7	8	⌃	PHP	2.881%	+0.11%
8	7	⌄	JavaScript	2.495%	-0.53%
9	-	⌃⌃	SQL	2.339%	+2.34%
10	14	⌃⌃	R	1.452%	-0.70%
11	11		Ruby	1.253%	-0.97%
12	18	⌃⌃	Objective-C	1.181%	-0.78%
13	16	⌃	Visual Basic	1.154%	-0.86%
14	9	⌄⌄	Perl	1.147%	-1.16%
15	12	⌄	Swift	1.145%	-1.06%
16	10	⌄⌄	Assembly language	0.915%	-1.34%
17	17		MATLAB	0.894%	-1.10%
18	15	⌄	Go	0.879%	-1.17%
19	13	⌄⌄	Delphi/Object Pascal	0.875%	-1.28%
20	20		PL/SQL	0.848%	-0.72%

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Python features a syntax in which the ends of statements are marked only by the end of a line, and statements that form part of a compound statement are indented relative to the lines of code that introduce them. (It turns out that the semicolons, terminal keywords, and braces are primarily for the benefit of the compiler.)

Python is an interesting and powerful language with respect to computing paradigms. Its skeleton is procedural, and it has been significantly influenced by functional programming, but it has evolved into a fundamentally object-oriented language. Few, if any, other languages provide a blend like this as seamlessly and elegantly as does Python.

Installing Python

Python 3, the language's first non-backward-compatible release. Python 2.x older editions. Difference will be discussed. The major exception is that print was a statement in Python 2 but is now a function, allowing for more flexibility. Also, Python 3 reorganized and renamed some of its library modules and their contents, so using Python 2.x with examples that demonstrate the use of certain modules would involve more than a few minor changes.

Determine version of Python

```
$ python -V
```

Many of the Linux versions will show Python 2.7 or 2.8

The name of the executable for Python 3 may be python3 instead of just python.

```
$ python3 -V
```

If you are running Python in an integrated development environment—in particular IDLE, which is part of the Python installation—type the following at the prompt (>>>) of its interactive shell window to get information about its version:

```
>>> from sys import version
>>> version
```

The current release of Python can be downloaded from http://python.org/download/. Python with required libraries can be downloaded from - https://www.anaconda.com/download/

Running Python

Python can be run in many ways:

1. Type python3 on the command line
2. Run an IDE (Integreted Development Environment)
    a) IDLE
    b) Spyder
    c) Jupyter

The term command line refers to where you type commands to a "shell"—in particular, a Linux shell such as tcsh or bash or a Windows command window—as opposed to typing to the Python interpreter. The term interpreter may refer to either the interpreter running in a shell, the "Python

Shell” window in IDLE, or the corresponding window in whatever other development environment you might be using.

When Python starts interactively, it prints some information about its version. Then it repeats a cycle in which it:

1. Prints the prompt >>> to indicate that it is waiting for you to type something
2. Reads what you type
3. Interprets its meaning to obtain a value
4. Prints that value

Python interpreter won’t pay any attention to what you’ve typed until you press the Return (Enter) key.

When you want to quit a command-line Python interpreter, simply type Ctrl-D in Unix (including Linux and the Mac OS X Terminal application). In Windows, type Ctrl-Z. You exit an IDE with the usual Quit menu command.

Domain ambiguous terms

Term	Biology	Python
Sequence	Part of a DNA or RNA molecule; more often refers to the abstraction thereof, as represented with letters	A linear, and therefore numerically indexable, collection of values
String	A series of letters representing a DNA, RNA, or amino acid sequence	An immutable sequence type named str
Expression	The production of proteins under the control of cellular machinery influenced by life stage, the organ containing the cell, internal states (disease, hunger), and external conditions (dryness, heat)	A combination of primitive values, operators, and function calls A regular expression string
Translate	Convert DNA codons (base triples) to amino acids according to the genetic code of the organism	A method of str that uses a table to produce a new str with all the characters of the original replaced by the corresponding entries in the table
Class	One of the levels in the standard taxonomic classification of organisms	As in programming; more specifically, the type of an object, which itself is an object that defines the methods for its instances
Loop	A property of RNA secondary structures (among other meanings)	An action performed repeatedly until some condition is no longer true
Library	A collection of related sequences, most commonly used in the context of a library of expressed RNA in cDNA form	A collection of modules, each containing a collection of related definitions, as in “Python comes with an extensive library of optional tools and facilities”