**What is Python?**

Python is a very popular general-purpose interpreted, interactive, object-oriented, and high-level programming language. Python is dynamically-typed and garbage-collected programming language. It was created by Guido van Rossum during 1985- 1990. Like Perl, Python source code is also available under the GNU General Public License (GPL).

Python supports multiple programming paradigms, including Procedural, Object Oriented and Functional programming language. Python design philosophy emphasizes code readability with the use of significant indentation.

This Python tutorial gives a complete understanding of Python programming language, starting from basic concepts to advanced concepts. This tutorial will take you through simple and practical approaches while learning Python Programming language.

**Python "Hello, World!"**

To start with Python programming, the very basic program is to print "Hello, World!" You can use the print() function. Below is an example of Python code to print

Hello, World!" −

Open Compiler

# Python code to print "Hello, World!"

print ("Hello, World!")

Characteristics of Python

Following are important characteristics of **Python Programming** −

* It supports functional and structured programming methods as well as [OOP](https://www.tutorialspoint.com/python/python_oops_concepts.htm).
* It can be used as a scripting language or can be compiled to byte-code for building large applications.
* It provides very high-level dynamic data types and supports dynamic type checking.
* It supports automatic garbage collection.
* It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java.

**Applications of Python**

[Python](https://www.tutorialspoint.com/python/python_overview.htm) is a general-purpose programming language. It is suitable for the development of a wide range of software applications. Over the last few years Python has been the preferred language of choice for developers in the following application areas –

**Data Science**

Python's recent meteoric rise in the popularity charts is largely due to its Data science libraries. Python has become an essential skill for data scientists. Today, real time web applications, mobile applications and other devices generate huge amount of data. Python's data science libraries help companies generate business insights from this data.

Libraries like [NumPy](https://www.tutorialspoint.com/numpy/index.htm), [Pandas](https://www.tutorialspoint.com/python_pandas/index.htm), and [Matplotlib](https://www.tutorialspoint.com/matplotlib/index.htm) are extensively used to apply mathematical algorithms to the data and generate [visualizations](https://www.tutorialspoint.com/python_pandas/python_pandas_visualization.htm). Commercial and community Python distributions like Anaconda and Active State bundle all the essential libraries required for data science.

**Machine Learning**

Python libraries such as [Scikit-learn](https://www.tutorialspoint.com/scikit_learn/index.htm) and [TensorFlow](https://www.tutorialspoint.com/tensorflow/index.htm) help in building models for prediction of trends like customer satisfaction, projected values of stocks etc. based upon the past data. [Machine learning](https://www.tutorialspoint.com/machine_learning/index.htm) applications include (but not restricted to) medical diagnosis, statistical arbitrage, basket analysis, sales prediction etc.

**Web Development**

Python's web frameworks facilitate rapid web application development. [Django](https://www.tutorialspoint.com/django/index.htm), [Pyramid](https://www.tutorialspoint.com/python_pyramid/index.htm), [Flask](https://www.tutorialspoint.com/flask/index.htm) are very popular among the web developer community. etc. make it very easy to develop and deploy simple as well as complex web applications.

Latest versions of Python provide asynchronous programming support. Modern web frameworks leverage this feature to develop fast and high performance web apps and APIs.

**Computer Vision and Image processing**

[OpenCV](https://www.tutorialspoint.com/opencv_python/index.htm) is a widely popular library for capturing and processing images. Image processing algorithms extract information from images, reconstruct image and video data. Computer Vision uses image processing for face detection and pattern recognition. OpenCV is a C++ library. Its Python port is extensively used because of its rapid development feature.

Some of the application areas of computer vision are [robotics](https://www.tutorialspoint.com/artificial_intelligence/artificial_intelligence_robotics.htm), industrial surveillance, automation, and [biometrics](https://www.tutorialspoint.com/biometrics/index.htm) etc.

**Embedded Systems and IoT**

Micropython (<https://micropython.org/>), a lightweight version especially for microcontrollers like [Arduino](https://www.tutorialspoint.com/arduino/index.htm). Many automation products, robotics, [IoT](https://www.tutorialspoint.com/internet_of_things/index.htm), and kiosk applications are built around Arduino and programmed with Micropython. [Raspberry Pi](https://www.tutorialspoint.com/raspberry_pi/index.htm) is also very popular alow cost single board computer used for these type of applications.

**Job Scheduling and Automation**

Python found one of its first applications in automating CRON (Command Run ON) jobs. Certain tasks like periodic data backups, can be written in Python scripts scheduled to be invoked automatically by operating system scheduler.

Many software products like Maya embed Python API for writing automation scripts (something similar to Excel micros).

**Desktop GUI Applications**

Python is a great option for building ergonomic, attractive, and user-friendly desktop GUI applications. Several graphics libraries, though built in C/C++, have been ported to Python. The popular Qt graphics toolkit is available as a [PyQt](https://www.tutorialspoint.com/pyqt/index.htm) package in Python. Similarly, WxWidgets has been ported to Python as [WxPython](https://www.tutorialspoint.com/wxpython/index.htm). Python's built-in GUI package, TKinter is a Python interface to the Tk Graphics toolkit.

Here is a select list of Python GUI libraries:

* Tkinter − Tkinter is the Python interface to the Tk GUI toolkit shipped with Python's standard library.
* wxPython − This is the Python interface for the wxWidgets GUI toolkit. BitTorrent Client application has been built with wxPython functionality.
* PyQt – Qt is one of the most popular GUI toolkits. It has been ported to Python as a PyQt5 package. Notable desktop GUI apps that use PyQt include QGIS, Spyder IDE, Calibre Ebook Manager, etc.
* PyGTK − PyGTK is a set of wrappers written in Python and C for GTK + GUI library. The complete PyGTK tutorial is available here.
* [PySimpleGUI](https://www.tutorialspoint.com/pysimplegui/index.htm) − PySimpleGui is an open-source, cross-platform GUI library for Python. It aims to provide a uniform API for creating desktop GUIs based on Python's Tkinter, PySide, and WxPython toolkits.
* Jython − Jython is a Python port for Java, which gives Python scripts seamless access to the Java GUI libraries on the local machine.

**Console-based Applications**

Python is often employed to build CLI (command-line interface) applications. Such scripts can be used to run scheduled CRON jobs such as taking database backups etc. There are many Python libraries that parse the command line arguments. The argparse library comes bundled with Pythons standard library. You can use Click (part of Flask framework) and Typer (included in FastAPI framework) to build console interfaces to the web-based applications built by the respective frameworks. Textual is a rapid development framework to build apps that run inside a terminal as well as browsers.

**CAD Applications**

CAD engineers can take advantage of Python's versatility to automate repetitive tasks such as drawing shapes and generating reports.

Autodesk Fusion 360 is a popular CAD software, which has a Python API that allows users to automate tasks and create custom tools. Similarly, SolidWorks has a built-in Python shell that allows users to run Python scripts inside the software.

CATIA is another very popular CAD software. Along with a VBScript, certain third-party Python libraries that can be used to control CATIA.

**Game Development**

Some popular gaming apps have been built with Python. Examples include BattleField2, The Sims 4, World of Tanks, Pirates of the Caribbean, and more. These apps are built with one of the following Python libraries.

Pygame is one of the most popular Python libraries used to build engaging computer games. Pygame is an open-source Python library for making multimedia applications like games built on top of the excellent SDL library. It is a cross-platform library, which means you can build a game that can run on any operating system platform.

Another library Kivy is also widely used to build desktop as well as mobile-based games. Kivy has a multi-touch interface. It is an open-source and cross-platform Python library for rapid development of game applications. Kivy runs on Linux, Windows, OS X, Android, iOS, and Raspberry Pi.

PyKyra library is based on both SDL (Software and Documentation Localisation) and the Kyra engine. It is one of the fastest game development frameworks. PyKyra supports MPEG , MP3, Ogg Vorbis, Wav, etc., multimedia formats.

**Features of Python**

The latest release of Python is 3.x. As mentioned before, Python is one of the most widely used languages on the web. I'm going to list a few of them here:

* **Easy-to-learn** − Python has few keywords, simple structure, and a clearly defined syntax. This allows the student to pick up the language quickly.
* **Easy-to-read** − Python code is more clearly defined and visible to the eyes.
* **Easy-to-maintain** − Python's source code is fairly easy-to-maintain.
* **A broad standard library** − Python's bulk of the library is very portable and cross-platform compatible on UNIX, Windows, and Macintosh.
* **Interactive Mode** − Python has support for an interactive mode that allows interactive testing and debugging of snippets of code.
* **Portable** − Python can run on a wide variety of hardware platforms and has the same interface on all platforms.
* **Extendable** − You can add low-level modules to the [Python interpreter](https://www.tutorialspoint.com/python/python_interpreter.htm). These modules enable programmers to add to or customize their tools to be more efficient.
* **Databases** − Python provides interfaces to all major commercial databases.
* **GUI Programming** − Python supports GUI applications that can be created and ported to many system calls, libraries, and Windows systems, such as Windows MFC, Macintosh, and the X Window system of Unix.
* **Scalable** − Python provides a better structure and support for large programs than shell scripting.

**Python Overview**

Python is a high-level, interpreted, interactive and object-oriented scripting language. Python is designed to be highly readable. It uses English keywords frequently where as other languages use punctuation, and it has fewer syntactical constructions than other languages.

* Python is Interpreted − Python is processed at runtime by the interpreter. You do not need to compile your program before executing it. This is similar to PERL and PHP.
* Python is Interactive − You can actually sit at a Python prompt and interact with the interpreter directly to write your programs.
* Python is Object-Oriented − Python supports Object-Oriented style or technique of programming that encapsulates code within objects.
* Python is a Beginner's Language − Python is a great language for the beginner-level programmers and supports the development of a wide range of applications from simple text processing to WWW browsers to games.

Python is an open-source and cross-platform programming language. It is available for use under Python Software Foundation License (compatible to GNU General Public License) on all the major operating system platforms Linux, Windows and Mac OS.

To facilitate new features and to maintain that readability, the Python Enhancement Proposal (PEP) process was developed. This process allows anyone to submit a PEP for a new feature, library, or other addition.

The design philosophy of Python emphasizes on simplicity, readability and unambiguity. Python is known for its batteries included approach as Python software is distributed with a comprehensive standard library of functions and modules.

Python's design philosophy is documented in the Zen of Python. It consists of nineteen aphorisms such as −

* Beautiful is better than ugly
* Explicit is better than implicit
* Simple is better than complex
* Complex is better than complicated

**Pythonic Code Style**

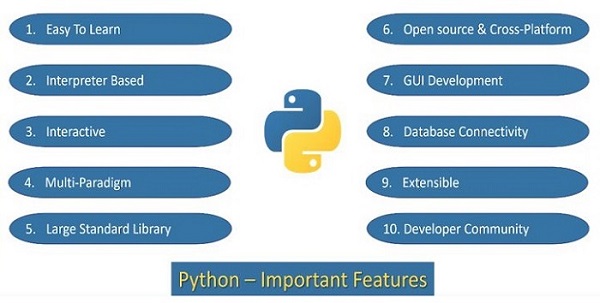
Python leaves you free to choose to program in an object-oriented, procedural, functional, aspect-oriented, or even logic-oriented way. These freedoms make Python a great language to write clean and beautiful code.

Pythonic Code Style is actually more of a design philosophy and suggests to write a code which is:

* Clean
* Simple
* Beautiful
* Explicit
* Readable

**Python – Features**

Python is a feature-rich, high-level, interpreted, interactive, and object-oriented scripting language. Python is a versatile and very popular programming language due to its features such as readability, simplicity, extensive libraries, and many more. In this tutorial, we will learn about the various features of Python that make it a powerful and versatile programming language.



Python's most important features are as follows:

**Easy to Learn**

This is one of the most important reasons for the popularity of Python. Python has a limited set of keywords. Its features such as simple [syntax](https://www.tutorialspoint.com/python/python_basic_syntax.htm), usage of indentation to avoid clutter of curly brackets and dynamic typing that doesn't necessitate prior declaration of variable help a beginner to learn Python quickly and easily.

**Dynamically Typed**

Python is a dynamically typed programming language. In Python, you don't need to specify the variable time at the time of the variable declaration. The types are specified at the runtime based on the assigned value due to its dynamically typed feature.

**Interpreter Based**

Instructions in any programming languages must be translated into machine code for the processor to execute them. Programming languages are either compiler based or interpreter based.

In case of a compiler, a [machine language](https://www.tutorialspoint.com/machine_learning/index.htm) version of the entire source program is generated. The conversion fails even if there is a single erroneous statement. Hence, the development process is tedious for the beginners. The C family languages (including [C](https://www.tutorialspoint.com/cprogramming/index.htm), [C++](https://www.tutorialspoint.com/cplusplus/index.htm), [Java](https://www.tutorialspoint.com/java/index.htm), [C#](https://www.tutorialspoint.com/csharp/index.htm) etc) are compiler based.

Python is an interpreter based language. The interpreter takes one instruction from the source code at a time, translates it into machine code and executes it. Instructions before the first occurrence of error are executed. With this feature, it is easier to debug the program and thus proves useful for the beginner level programmer to gain confidence gradually. Python therefore is a beginner-friendly language.

**Interactive**

Standard Python distribution comes with an interactive shell that works on the principle of REPL (Read Evaluate Print Loop). The shell presents a Python prompt >>>. You can type any valid Python expression and press Enter. Python interpreter immediately returns the response and the prompt comes back to read the next expression.

>>> 2\*3+1

7

>>> print ("Hello World")

Hello World

The interactive mode is especially useful to get familiar with a library and test out its functionality. You can try out small code snippets in interactive mode before writing a program.

**Multi-paradigm**

Python is a completely [object-oriented](https://www.tutorialspoint.com/python/python_oops_concepts.htm) language. Everything in a Python program is an [object](https://www.tutorialspoint.com/python/python_object_classes.htm). However, Python conveniently encapsulates its object orientation to be used as an imperative or procedural language such as C. Python also provides certain functionality that resembles functional programming. Moreover, certain third-party tools have been developed to support other programming paradigms such as aspect-oriented and logic programming.

Standard Library

Even though it has a very few keywords (only Thirty Five), Python software is distributed with a standard library made of large number of modules and packages. Thus Python has out of box support for programming needs such as serialization, data compression, internet data handling, and many more. Python is known for its batteries included approach.

Some of the Python's popular modules are:

* [NumPy](https://www.tutorialspoint.com/numpy/index.htm)
* [Pandas](https://www.tutorialspoint.com/python_pandas/index.htm)
* [Matplotlib](https://www.tutorialspoint.com/matplotlib/index.htm)
* Tkinter
* [Math](https://www.tutorialspoint.com/python/python_maths.htm)

**Open Source and Cross Platform**

Python's standard distribution can be downloaded from  <https://www.python.org/downloads/> without any restrictions. You can download pre-compiled binaries for various operating system platforms. In addition, the source code is also freely available, which is why it comes under open-source category.

Python software (along with the documentation) is distributed under Python Software Foundation License. It is a BSD style permissive software license and compatible to GNU GPL (General Public License).

Python is a cross-platform language. Pre-compiled binaries are available for use on various operating system platforms such as [Windows](https://www.tutorialspoint.com/windows10/index.htm), [Linux](https://www.tutorialspoint.com/unix/index.htm), Mac OS, [Android OS](https://www.tutorialspoint.com/android/index.htm). The reference implementation of Python is called CPython and is written in C. You can download the source code and compile it for your OS platform.

A Python program is first compiled to an intermediate platform independent byte code. The virtual machine inside the interpreter then executes the byte code. This behaviour makes Python a cross-platform language, and thus a Python program can be easily ported from one OS platform to other.

**GUI Applications**

Python's standard distribution has an excellent graphics library called TKinter. It is a Python port for the vastly popular GUI toolkit called TCL/Tk. You can build attractive user-friendly GUI applications in Python. GUI toolkits are generally written in C/C++. Many of them have been ported to Python. Examples are [PyQt](https://www.tutorialspoint.com/pyqt/index.htm), [WxWidgets](https://www.tutorialspoint.com/wxpython/index.htm), [PySimpleGUI](https://www.tutorialspoint.com/pysimplegui/index.htm) etc.

**Database Connectivity**

Almost any type of database can be used as a backend with the Python application. DB-API is a set of specifications for database driver software to let Python communicate with a relational database. With many third-party libraries, Python can also work with NoSQL databases such as [MongoDB](https://www.tutorialspoint.com/mongodb/index.htm).

**Extensible**

The term extensibility implies the ability to add new features or modify existing features. As stated earlier, CPython (which is Python's reference implementation) is written in C. Hence one can easily write modules/libraries in C and incorporate them in the standard library. There are other implementations of Python such as Jython (written in Java) and [IPython](https://www.tutorialspoint.com/jupyter/ipython_introduction.htm) (written in C#). Hence, it is possible to write and merge new functionality in these implementations with Java and C# respectively.

**Active Developer Community**

As a result of Python's popularity and open-source nature, a large number of Python developers often interact with online forums and conferences. Python Software Foundation also has a significant member base, involved in the organization's mission to "**Promote, Protect, and Advance the Python Programming Language**"

Python also enjoys a significant institutional support. Major IT companies Google, Microsoft, and Meta contribute immensely by preparing documentation and other resources.

Apart from the above-mentioned features, Python has another big list of good features, few are listed below −

* It supports functional and structured programming methods as well as OOP.
* It can be used as a scripting language or can be compiled to byte-code for building large applications.
* It provides very high-level dynamic [data types](https://www.tutorialspoint.com/python/python_data_types.htm) and supports dynamic type checking.
* It supports automatic garbage collection.
* It can be easily integrated with C, C++, COM, ActiveX, CORBA, and Java.

**Python - Syntax**

The Python syntax defines a set of rules that are used to create a Python Program. The Python Programming Language Syntax has many similarities to Perl, C, and Java Programming Languages. However, there are some definite differences between the languages.

**First Python Program**

Let us execute a [Python program to print "Hello, World!"](https://www.tutorialspoint.com/python/python_hello_world.htm) in two different modes of Python Programming. (a) Interactive Mode Programming (b) Script Mode Programming.

Python - Interactive Mode Programming

We can invoke a [Python interpreter](https://www.tutorialspoint.com/online_python_compiler.php) from command line by typing **python** at the command prompt as following –

$ python3

Python 3.10.6 (main, Mar 10 2023, 10:55:28) [GCC 11.3.0] on linux

Type "help", "copyright", "credits" or "license" for more information.

>>>

Here **>>>** denotes a Python Command Prompt where you can type your commands. Let's type the following text at the Python prompt and press the Enter −

>>> print ("Hello, World!")

If you are running older version of Python, like Python 2.4.x, then you would need to use print statement without parenthesis as in **print "Hello, World!"**. However in Python version 3.x, this produces the following result −

Hello, World!

**Python Identifiers**

A Python identifier is a name used to identify a [variable](https://www.tutorialspoint.com/python/python_variables.htm), [function](https://www.tutorialspoint.com/python/python_functions.htm), [class](https://www.tutorialspoint.com/python/python_object_classes.htm), [module](https://www.tutorialspoint.com/python/python_modules.htm) or other object. An identifier starts with a letter A to Z or a to z or an underscore (\_) followed by zero or more letters, underscores and digits (0 to 9).

Python does not allow punctuation characters such as &commat;, $, and % within identifiers.

*Python is a case sensitive programming language. Thus,****Manpower****and****manpower****are two different identifiers in Python.*

Here are naming conventions for Python identifiers −

* Python Class names start with an uppercase letter. All other identifiers start with a lowercase letter.
* Starting an identifier with a single leading underscore indicates that the identifier is **private** identifier.
* Starting an identifier with two leading underscores indicates a strongly **private** identifier.
* If the identifier also ends with two trailing underscores, the identifier is a **language-defined** special name.

**Python Reserved Words**

The following list shows the Python keywords. These are reserved words and you cannot use them as constant or variable or any other identifier names. All the Python keywords contain lowercase letters only.

|  |  |  |
| --- | --- | --- |
| and | as | assert |
| break | class | continue |
| def | del | elif |
| else | except | False |
| finally | for | from |
| global | if | import |
| in | is | lambda |
| None | nonlocal | not |
| or | pass | raise |
| return | True | try |
| while | with | yield |

**Python Lines and Indentation**

Python programming provides no braces to indicate blocks of code for class and function definitions or flow control. Blocks of code are denoted by **line indentation**, which is rigidly enforced.

The number of spaces in the indentation is variable, but all statements within the block must be indented the same amount. For example –

if True:

print ("True"

else:

print ("False")

**Python Multi-Line Statements**

Statements in Python typically end with a new line. Python does, however, allow the use of the line continuation character (\) to denote that the line should continue. For example −

total = item\_one + \

item\_two + \

item\_three

Statements contained within the [], {}, or () brackets do not need to use the line continuation character. For example, following statement works well in Python –

days = ['Monday', 'Tuesday', 'Wednesday',

'Thursday', 'Friday']

**Quotations in Python**

Python accepts single ('), double (") and triple (''' or """) quotes to denote string literals, as long as the same type of quote starts and ends the string.

The triple quotes are used to span the string across multiple lines. For example, all the following are legal –

word = 'word'

print (word)

sentence = "This is a sentence."

print (sentence)

paragraph = """This is a paragraph. It is

made up of multiple lines and sentences."""

print (paragraph)

**Comments in Python**

A comment is a programmer-readable explanation or annotation in the Python source code. They are added with the purpose of making the source code easier for humans to understand, and are ignored by Python interpreter

Just like most modern languages, Python supports single-line (or end-of-line) and multi-line (block) comments. Python comments are very much similar to the comments available in PHP, BASH and Perl Programming languages.

A hash sign (#) that is not inside a string literal begins a comment. All characters after the # and up to the end of the physical line are part of the comment and the Python interpreter ignores them.

# First comment

print ("Hello, World!") # Second comment

This produces the following result −

Hello, World!

You can type a comment on the same line after a statement or expression −

name = "Madisetti" # This is again comment

You can comment multiple lines as follows −

# This is a comment.

# This is a comment, too.

# This is a comment, too.

# I said that already.

Following triple-quoted string is also ignored by Python interpreter and can be used as a multiline comment:

''' This is a multiline

comment.

'''

**Using Blank Lines in Python Programs**

A line containing only whitespace, possibly with a comment, is known as a blank line and Python totally ignores it.

In an interactive interpreter session, you must enter an empty physical line to terminate a multiline statement.

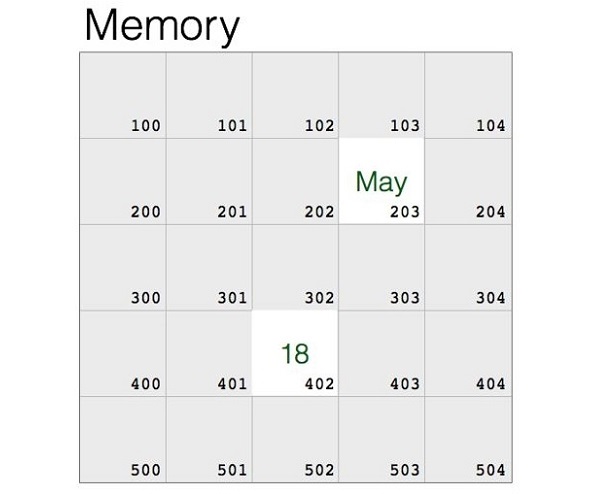
**Python Variables**

Python variables are the reserved memory locations used to store values with in a Python Program. This means that when you create a variable you reserve some space in the memory.

Based on the data type of a variable, memory space is allocated to it. Therefore, by assigning different data types to Python variables, you can store integers, decimals or characters in these variables.

**Memory Addresses**

Data items belonging to different data types are stored in computer's memory. Computer's memory locations are having a number or address, internally represented in binary form. Data is also stored in binary form as the computer works on the principle of binary representation. In the following diagram, a string **May** and a number **18** is shown as stored in memory locations.



If you know the assembly language, you will covert these data items and the memory address, and give a machine language instruction. However, it is not easy for everybody. Language translator such as Python interpreter performs this type of conversion. It stores the object in a randomly chosen memory location. Python's built-in **id()** function returns the address where the object is stored.

>>> "May"

May >>> id("May") 2167264641264 >>> 18 18 >>> id(18) 140714055169352

Once the data is stored in the memory, it should be accessed repeatedly for performing a certain process. Obviously, fetching the data from its ID is cumbersome. High level languages like Python make it possible to give a suitable alias or a label to refer to the memory location.

In the above example, let us label the location of May as month, and location in which 18 is stored as age. Python uses the assignment operator (=) to bind an object with the label.