

Data Science and Generative AI

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[**Python Programming**](#)

Python Programming Language

Python is a widely used programming language that offers several unique features and advantages compared to languages like **Java** and **C++**.

In the late 1980s, [**Guido van Rossum**](#) dreamed of developing Python. The first version of **Python 0.9.0 was released in 1991**. Since its release, Python started gaining popularity. According to reports, Python is now the most popular programming language among developers because of its high demands in the tech realm.

- Python laid its foundation in the late 1980s.
- The implementation of Python was started in December 1989 by **Guido Van Rossum** at CWI in Netherland.
- In February 1991, **Guido Van Rossum** published the code (labeled version 0.9.0) to alt.sources.
- In 1994, Python 1.0 was released with new features like lambda, map, filter, and reduce.
- Python 2.0 added new features such as list comprehensions, garbage collection systems.
- On December 3, 2008, Python 3.0 (also called "Py3K") was released. It was designed to rectify the fundamental flaw of the language.
- *ABC programming language* is said to be the predecessor of Python language, which was capable of Exception Handling and interfacing with the Amoeba Operating System.
- The following programming languages influence Python:
 - ABC language.
 - Modula-3

What is Python

Python is a general-purpose, dynamically typed, high-level, compiled and interpreted, garbage-collected, and purely object-oriented programming language that supports procedural, object-oriented, and functional programming.

Features of Python:

- **Easy to use and Read** - Python's syntax is clear and easy to read, making it an ideal language for both beginners and experienced programmers. This simplicity can lead to faster development and reduce the chances of errors.
- **Dynamically Typed** - The data types of variables are determined during run-time. We do not need to specify the data type of a variable during writing codes.
- **High-level** - High-level language means human readable code.
- **Compiled and Interpreted** - Python code first gets compiled into bytecode, and then interpreted line by line. When we download the Python in our system from org we download the default implement of Python known as CPython. CPython is considered to be Compiled and Interpreted both.
- **Garbage Collected** - Memory allocation and de-allocation are automatically managed. Programmers do not specifically need to manage the memory.
- **Purely Object-Oriented** - It refers to everything as an object, including numbers and strings.
- **Cross-platform Compatibility** - Python can be easily installed on Windows, macOS, and various Linux distributions, allowing developers to create software that runs across different operating systems.
- **Rich Standard Library** - Python comes with several standard libraries that provide ready-to-use modules and functions for various tasks, ranging from **web development** and **data manipulation** to **machine learning** and **networking**.
- **Open Source** - Python is an open-source, cost-free programming language. It is utilized in several sectors and disciplines as a result.

Python Features

Python provides many useful features which make it popular and valuable from the other programming languages. It supports object-oriented programming, procedural programming approaches and provides dynamic memory allocation. We have listed below a few essential features.

1) Easy to Learn and Use

Python is easy to learn as compared to other programming languages. Its syntax is straightforward and much the same as the English language. There is no use of the semicolon or curly-bracket, the indentation defines the code block. It is the recommended programming language for beginners.

2) Expressive Language

Python can perform complex tasks using a few lines of code. A simple example, the hello world program you simply type `print("Hello World")`. It will take only one line to execute, while Java or C takes multiple lines.

3) Interpreted Language

Python is an interpreted language; it means the Python program is executed one line at a time. The advantage of being interpreted language, it makes debugging easy and portable.

4) Cross-platform Language

Python can run equally on different platforms such as Windows, Linux, UNIX, and Macintosh, etc. So, we can say that Python is a portable language. It enables programmers to develop the software for several competing platforms by writing a program only once.

5) Free and Open Source

Python is freely available for everyone. It is freely available on its official website www.python.org. It has a large community across the world that is dedicatedly working towards make new python modules and functions. Anyone can contribute to the Python community. The open-source means, "Anyone can download its source code without paying any penny."

6) Object-Oriented Language

Python supports object-oriented language and concepts of classes and objects come into existence. It supports inheritance, polymorphism, and encapsulation, etc. The object-oriented procedure helps to programmer to write reusable code and develop applications in less code.

7) Extensible

It implies that other languages such as C/C++ can be used to compile the code and thus it can be used further in our Python code. It converts the program into byte code, and any platform can use that byte code.

8) Large Standard Library

It provides a vast range of libraries for the various fields such as machine learning, web developer, and also for the scripting. There are various machine learning libraries, such as Tensor flow, Pandas, Numpy, Keras, and Pytorch, etc. Django, flask, pyramids are the popular framework for Python web development.

9) GUI Programming Support

Graphical User Interface is used for the developing Desktop application. PyQt5, Tkinter, Kivy are the libraries which are used for developing the web application.

Java vs. Python

Python is an excellent choice for rapid development and scripting tasks. Whereas Java emphasizes a strong type system and object-oriented programming.

Python Code:

```
1. print("Hello World")
```

Java Code:

```
1. public class HelloWorld {  
2.     public static void main(String[] args) {  
3.         System.out.println("Hello, World!");  
4.     }  
5. }
```

In Java, we need to declare classes, method structures many other things.

While both programs give the same output, we can notice the syntax difference in the print statement.

- In Python, it is easy to learn and write code. While in Java, it requires more code to perform certain tasks.
- Python is dynamically typed, meaning we do not need to declare the variable. Whereas Java is statically typed, meaning we need to declare the variable type.
- Python is suitable for various domains such as Data Science, Machine Learning, Web development, and more. Whereas Java is suitable for web development, mobile app development (Android), and more.

Python Basic Syntax

There is no use of curly braces or semicolons in Python programming language. It is an English-like language. But Python uses indentation to define a block of code. Indentation is nothing but adding whitespace before the statement when it is needed.

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For example -

```
1. def func():
2.     statement 1
3.     statement 2
4.     .....
5.     .....
6.     statement N
```

Python Popular Frameworks and Libraries

Python has wide range of libraries and frameworks widely used in various fields such as machine learning, artificial intelligence, web applications, etc. We define some popular frameworks and libraries of Python as follows.

- **Web development (Server-side)** - Django, Flask, Pyramid, CherryPy
- **GUIs based applications** - Tkinter, PyGTK, PyQt, PyJs, etc.
- **Machine Learning** - TensorFlow, PyTorch, Scikit-learn, Matplotlib, Scipy, etc.
- **Mathematics** - NumPy, Pandas, etc.
- **BeautifulSoup**: a library for web scraping and parsing HTML and XML
- **Requests**: a library for making HTTP requests
- **SQLAlchemy**: a library for working with SQL databases
- **Kivy**: a framework for building multi-touch applications
- **Pygame**: a library for game development
- **Pytest**: a testing framework for Python Django
- **REST framework**: a toolkit for building RESTful APIs
- **FastAPI**: a modern, fast web framework for building APIs
- **Streamlit**: a library for building interactive web apps for machine learning and data science
- **NLTK**: a library for natural language processing

Python print() Function

Python print() function is used to display output to the console or terminal. It allows us to display text, variables and other data in a human readable format.

Syntax:

```
print(object(s), sep=separator, end=end, file=file, flush=flush)
```

It takes one or more arguments separated by comma(,) and adds a 'newline' at the end by default.

Parameters:

- *object(s)* - As many as you want data to display, will first converted into string and printed to the console.
- *sep* - Separates the objects by a separator passed, default value = " ".
- *end* - Ends a line with a newline character
- *file* - a file object with write method, default value = sys.stdout

Example:

```
1. # Displaying a string
2. print("Hello, World!")
3.
4. # Displaying multiple values
5. name = "Aman"
6. age = 21
7. print("Name:", name, "Age:", age)
8.
9. # Printing variables and literals
10.x = 5
11.y = 7
12.print("x =", x, "y =", y, "Sum =", x + y)
13.
14.# Printing with formatting
15.percentage = 85.75
16.print("Score: {:.2f}%".format(percentage))
```

Output:

```
Hello, World!
Name: Aman Age: 21
X = 5 y = 7 Sum = 12
Score: 85.75%
```

Python Conditional Statements

Conditional statements help us to execute a particular block for a particular condition. In this tutorial, we will learn how to use conditional expression to execute a different block of statements. Python provides if and else keywords to set up logical conditions. The elif keyword is also used as a conditional statement.

Example code for if..else statement

```
1. x = 10
2. y = 5
3.
4. if x > y:
5.     print("x is greater than y")
6. else:
7.     print("y is greater than or equal to x")
```

Output: x is greater than y

Python Loops

Sometimes we may need to alter the flow of the program. The execution of a specific code may need to be repeated several times. For this purpose, the programming languages provide various loops capable of repeating some specific code several times. Consider the following tutorial to understand the statements in detail.

Python For Loop

```
1. fruits = ["apple", "banana", "cherry"]
2. for x in fruits:
3.     print(x, end=" ")
```

Output:

apple banana cherry

Python While Loop

```
1. i = 1
2. while i<5:
3.     print(i, end=" ")
4.     i += 1
```

Output: 1 2 3 4

How to Install Python

Python is a popular high-level, general-use programming language. Python is a programming language that enables rapid development as well as more effective system integration. Python has two main different versions: Python 2 and Python 3. Both are really different.

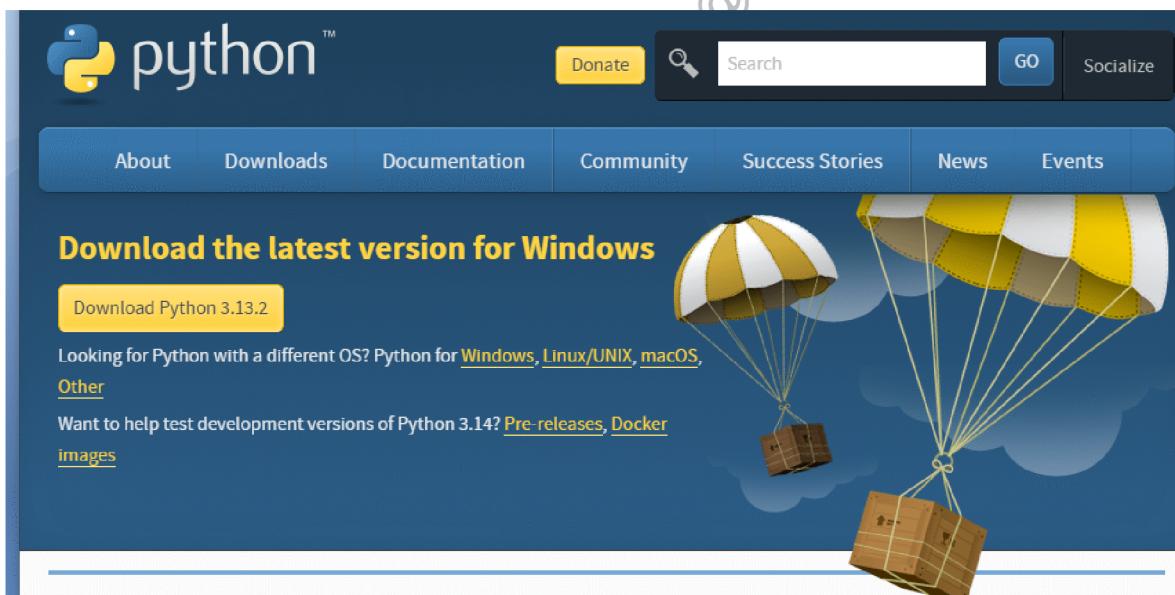
Python is much simpler to learn and programme in. Any plain text editor, such as notepad or notepad++, may be used to create Python programs. To make it easier to create these routines, one may also utilise an online IDE for Python or even install one on their machine. IDEs offer a variety of tools including a user-friendly code editor, the debugger, compiler, etc.

One has to have Python installed on their system in order to start creating Python code and carrying out many fascinating and helpful procedures. The first step in learning how to programming in Python is to install or update Python on your computer. There are several ways to install Python: you may use a package manager, get official versions from Python.org, or install specialised versions for embedded devices, scientific computing, and the Internet of Things.

In order to become Python developer, the first step is to learn how to install or update Python on a local machine or computer. In this tutorial, we will discuss the installation of Python on various operating systems.

Installation on Windows

Visit the link <https://www.python.org> to download the latest release of Python. In this process, we will install Python 3.13.2 on our Windows operating system. When we click on the above link, it will bring us the following page.



Step - 1: Select the Python's version to download.

Click on the download button to download the exe file of Python.

If in case you want to download the specific version of Python. Then, you can scroll down further below to see different versions from 2 and 3 respectively. Click on download button right next to the version number you want to download.

The screenshot shows the Python.org downloads page. At the top, there's a search bar and a sidebar with various icons. Below the header, there's a section titled "Looking for a specific release?" followed by "Python releases by version number:". A table lists the following releases:

Release version	Release date	Download	Release Notes
Python 3.10.11	April 5, 2023	Download	Release Notes
Python 3.11.3	April 5, 2023	Download	Release Notes
Python 3.10.10	Feb. 8, 2023	Download	Release Notes
Python 3.11.2	Feb. 8, 2023	Download	Release Notes
Python 3.11.1	Dec. 6, 2022	Download	Release Notes
Python 3.10.9	Dec. 6, 2022	Download	Release Notes
Python 3.9.16	Dec. 6, 2022	Download	Release Notes

At the bottom left, there's a link "View older releases". On the right side, there's a vertical sidebar with various icons.

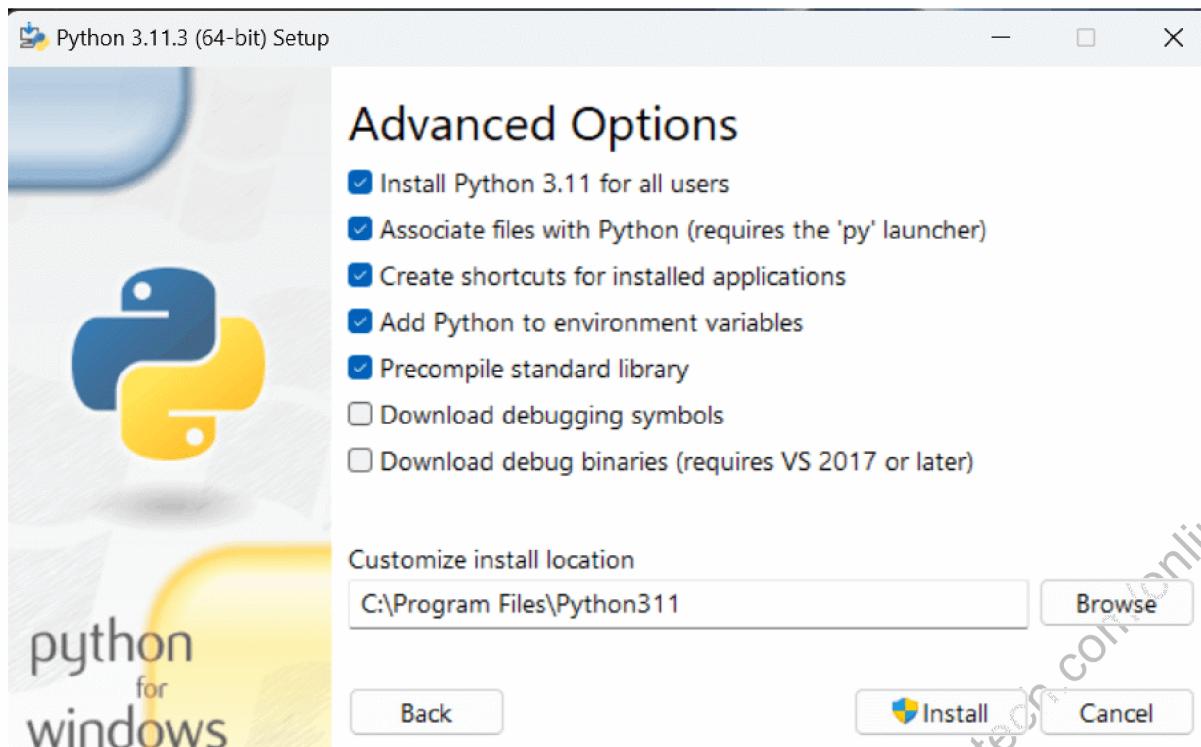
Step - 2: Click on the Install Now

Double-click the executable file, which is downloaded.

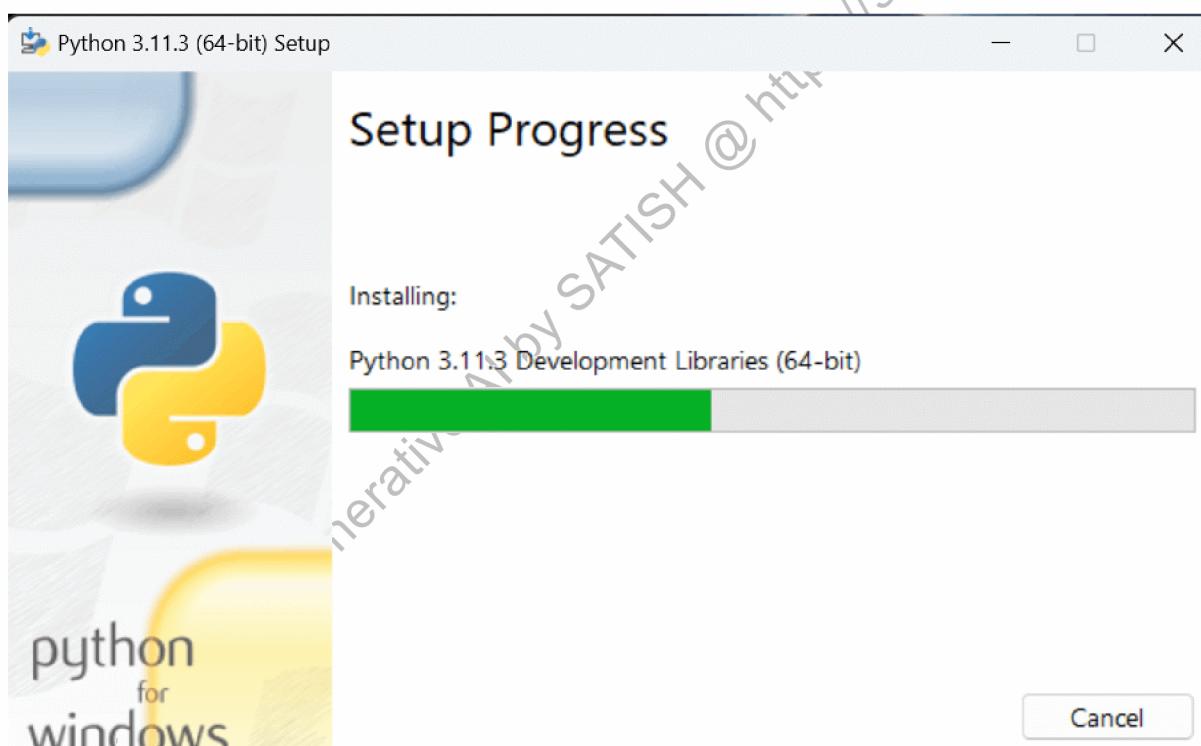


The following window will open. Click on the Add Path check box, it will set the Python path automatically.

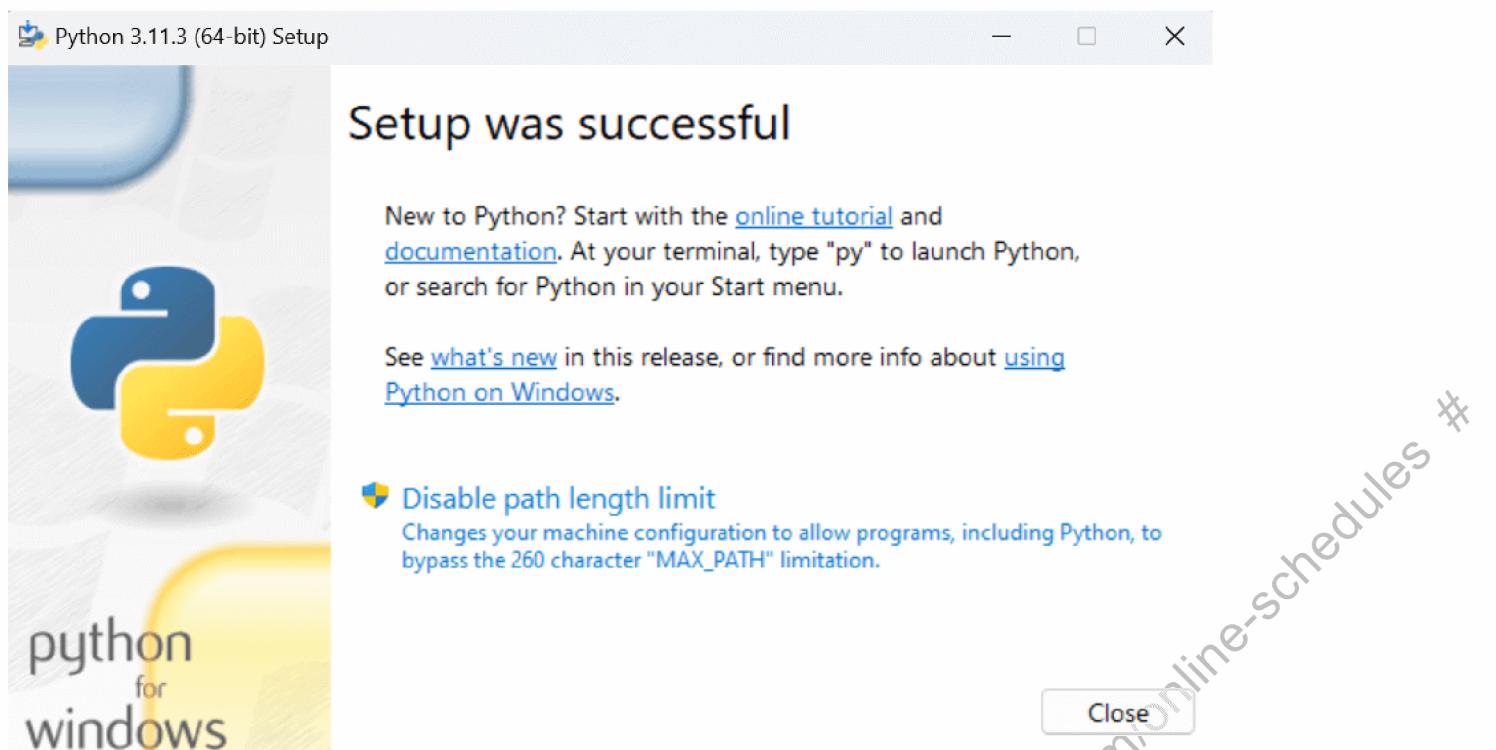
Now, Select Customize installation and proceed. We can also click on the customize installation to choose desired location and features. Other important thing is install launcher for the all user must be checked.



Step - 3 Installations in Process



The set up is in progress. All the python libraries, packages, and other python default files will be installed in our system. Once the installation is successful, the following page will appear saying " Setup was successful ".



Step - 4: Verifying the Python Installation

To verify whether the python is installed or not in our system, we have to do the following.

- Go to "Start" button, and search " cmd ".
- Then type, " **python -- version** ".
- If python is successfully installed, then we can see the version of the python installed.
- If not installed, then it will print the error as " **'python' is not recognized as an internal or external command, operable program or batch file.** ".

A screenshot of a Microsoft Windows Command Prompt window. The title bar says "Command Prompt". The window shows the following text:

```
Microsoft Windows [Version 10.0.22621.1485]
(c) Microsoft Corporation. All rights reserved.

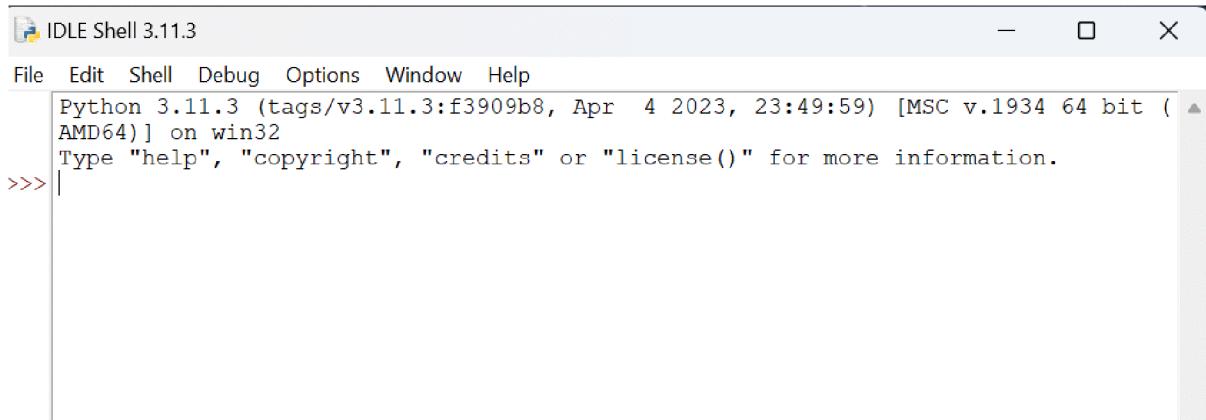
C:\Users\bharg>python --version
Python 3.11.3

C:\Users\bharg>
```

We are ready to work with the Python.

Step - 5: Opening idle

Now, to work on our first python program, we will go the interactive interpreter prompt(idle). To open this, go to "Start" and type idle. Then, click on open to start working on idle.



The screenshot shows the IDLE Shell 3.11.3 window. The title bar reads "IDLE Shell 3.11.3". The menu bar includes File, Edit, Shell, Debug, Options, Window, and Help. The main window displays the Python 3.11.3 startup message:
Python 3.11.3 (tags/v3.11.3:f3909b8, Apr 4 2023, 23:49:59) [MSC v.1934 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
A command prompt ">>>" is visible at the bottom left.

Jupyter Installation:



Free software, open standards, and web services for interactive computing across all programming languages

Step-1: Google → search for “Jupyter Notebook”

A screenshot of a Google search results page. The search bar at the top contains the query "jupyter notebook". Below the search bar, there are navigation links: All, Images, Videos, Shopping, Short videos, News, Forums, and More. The first result is a link to the Jupyter website, titled "Jupyter Notebook". The snippet below the title says: "JupyterLab is the latest web-based interactive development environment for notebooks, code, and data. Its flexible interface allows users to configure and ...". There are two additional links below: "Installing Jupyter" and "Try Jupyter".

Step-2: Install JupyterLab

A screenshot of the Jupyter.org/install page. The URL "jupyter.org/install" is visible in the browser's address bar. The page features a large header with the Jupyter logo and navigation links for Try, Install, Get Involved, Documentation, News, Social, and Governance. The main content area has a title "Installing Jupyter" and a subtitle "Get up and running on your computer".

Project Jupyter's tools are available for installation via the [Python Package Index](#), the leading repository of software created for the Python programming language.

This page uses instructions with [pip](#), the recommended installation tool for Python. If you require *environment management* as opposed to just installation, look into [conda](#), [mamba](#), [pipenv](#), and [Homebrew](#).

JupyterLab

Install JupyterLab with [pip](#):

```
pip install jupyterlab
```

Step-3: Start → run 'cmd' → open command prompt

```
# pip install jupyterlab
```

```
Microsoft Windows [Version 10.0.19045.4651]
(c) Microsoft Corporation. All rights reserved.

C:\Users\96035>pip install jupyterlab
DEPRECATION: Loading egg at c:\users\96035\appdata\local\programs\python\python312\lib\site-packages\jupyterlab-1.4.0-py3.12.egg is deprecated. pip 25.1 will enforce this behaviour change. A possible solution is to use pip for package installation. Discussion can be found at https://github.com/pypa/pip/pull/10591.
Requirement already satisfied: jupyterlab in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (4.2.5)
Requirement already satisfied: async-lru>=1.0.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from jupyterlab) (2.0.4)
Requirement already satisfied: httpx>=0.25.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from jupyterlab) (0.27.2)
Requirement already satisfied: ipykernel>=6.5.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from jupyterlab) (6.29.5)
Requirement already satisfied: jinja2>=3.0.3 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from jupyterlab) (3.1.4)
Requirement already satisfied: jupyter-core in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from jupyterlab) (4.2.5)
```

Step-4: install jupyter notebook

```
# pip install notebook
```

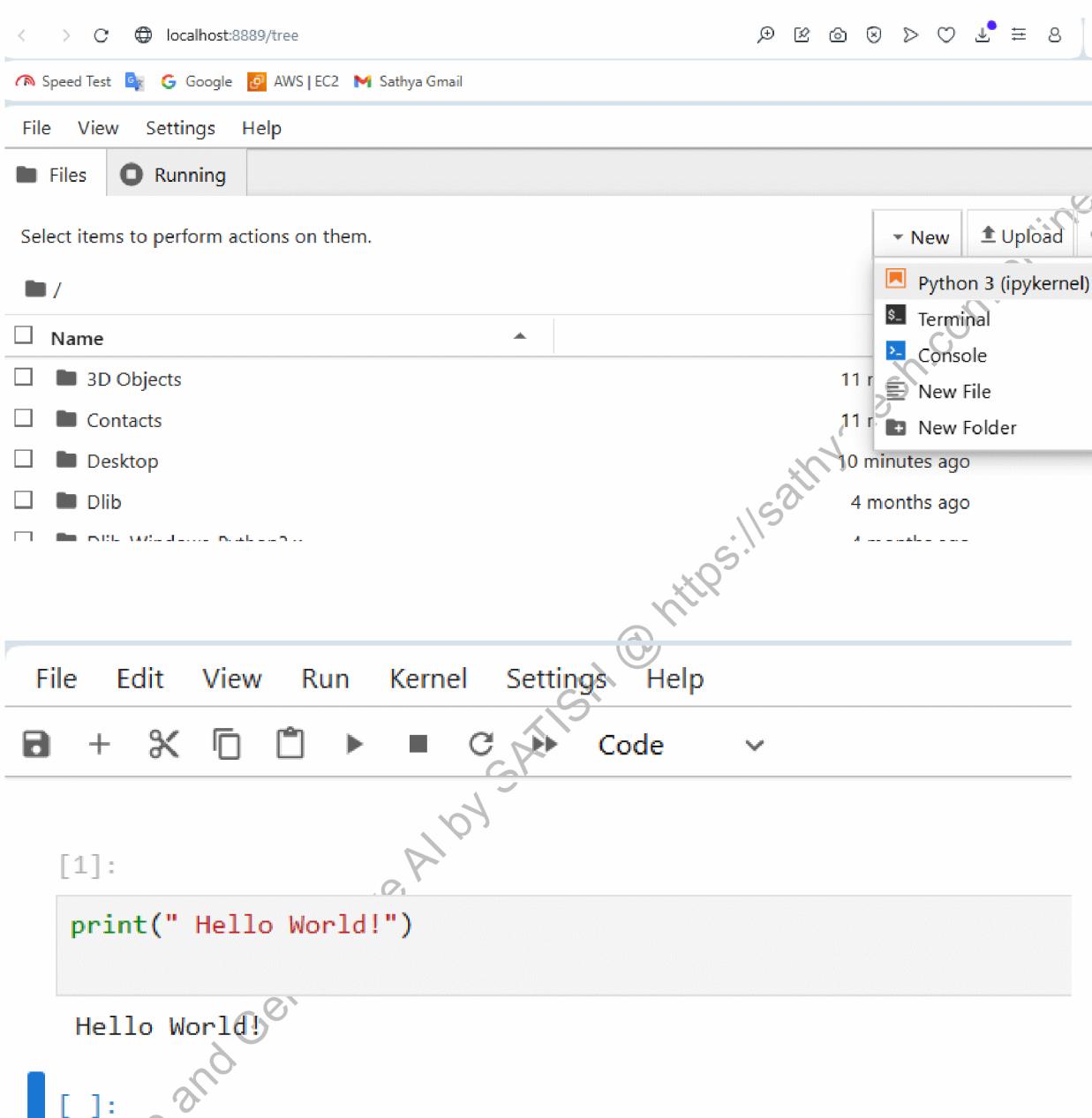
```
C:\Users\96035>
C:\Users\96035>pip install notebook
DEPRECATION: Loading egg at c:\users\96035\appdata\local\programs\python\python312\lib\site-packages\notebook-7.2.2-py3.12.egg is deprecated. pip 25.1 will enforce this behaviour change. A possible solution is to use pip for package installation. Discussion can be found at https://github.com/pypa/pip/pull/10591.
Requirement already satisfied: notebook in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (7.2.2)
Requirement already satisfied: jupyter-server<3,>=2.4.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (2.14.2)
Requirement already satisfied: jupyterlab-server<3,>=2.27.1 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (2.27.3)
Requirement already satisfied: jupyterlab<4.3,>=4.2.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (4.2.5)
Requirement already satisfied: notebook-shim<0.3,>=0.2 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (0.2.4)
Requirement already satisfied: tornado>=6.2.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (6.4.1)
Requirement already satisfied: anyio>=3.1.0 in c:\users\96035\appdata\local\programs\python\python312\lib\site-packages (from notebook) (3.2.0)
```

Step-5: Launch jupyter notebook

```
# jupyter notebook
```

```
\Users\96035>
\Users\96035>
\Users\96035>jupyter notebook
2025-04-09 12:30:53.771 ServerApp] Extension package jupyter_lsp took 0.6572s to import
2025-04-09 12:30:54.550 ServerApp] Extension package jupyter_server_terminals took 0.77
2025-04-09 12:30:57.314 ServerApp] jupyter_lsp | extension was successfully linked.
2025-04-09 12:30:57.323 ServerApp] jupyter_server_terminals | extension was successfull
2025-04-09 12:30:57.335 ServerApp] jupyterlab | extension was successfully linked.
2025-04-09 12:30:57.346 ServerApp] notebook | extension was successfully linked.
2025-04-09 12:31:03.104 ServerApp] notebook_shim | extension was successfully linked.
2025-04-09 12:31:03.388 ServerApp] notebook_shim | extension was successfully loaded.
2025-04-09 12:31:03.395 ServerApp] jupyter_lsp | extension was successfully loaded.
2025-04-09 12:31:03.397 ServerApp] jupyter_server_terminals | extension was successfull
2025-04-09 12:31:03.446 LabApp] JupyterLab extension loaded from C:\Users\96035\AppData
```

Step-6: Open Jupyter Editor → select “New” → “Python 3”



Multi-line Statements

Multi-line statements are written into the notepad like an editor and saved it with .py extension. In the following example, we have defined the execution of the multiple code lines using the Python script.

Code:

1. name = "Andrew Venis"
2. branch = "Computer Science"
3. age = "25"
4. print("My name is: ", name,)
5. print("My age is: ", age)

Script File:

Pros and Cons of Script Mode

The script mode has few advantages and disadvantages as well. Let's understand the following advantages of running code in script mode.

- We can run multiple lines of code.
- Debugging is easy in script mode.
- It is appropriate for beginners and also for experts.

Let's see the disadvantages of the script mode.

- We have to save the code every time if we make any change in the code.
- It can be tedious when we run a single or a few lines of code.

Get Started with PyCharm

In our first program, we have used gedit on our CentOS as an editor. On Windows, we have an alternative like notepad or notepad++ to edit the code. However, these editors are not used as IDE for python since they are unable to show the syntax related suggestions.

JetBrains provides the most popular and a widely used cross-platform IDE **PyCharm** to run the python programs.

PyCharm installation

As we have already stated, PyCharm is a cross-platform IDE, and hence it can be installed on a variety of the operating systems. In this section of the tutorial, we will cover the installation process of PyCharm on Windows, MacOS, CentOS, and Ubuntu.

Windows

Installing PyCharm on Windows is very simple. To install PyCharm on Windows operating system, visit the link <https://www.jetbrains.com/pycharm/download/download-thanks.html?platform=windows> to download the executable installer. **Double click** the installer (.exe) file and install PyCharm by clicking next at each step.

To create a first program to Pycharm follows the following step.

Step - 1. Open Pycharm editor. Click on "Create New Project" option to create new project.

Step - 2. Select a location to save the project.

1. We can save the newly created project at desired memory location or can keep file location as it is but atleast change the project default name **untitled** to "**FirstProject**" or something meaningful.
2. Pycharm automatically found the installed Python interpreter.
3. After change the name click on the "Create" Button.

Step - 3. Click on "File" menu and select "**New**". By clicking "New" option it will show various file formats. Select the "Python File".

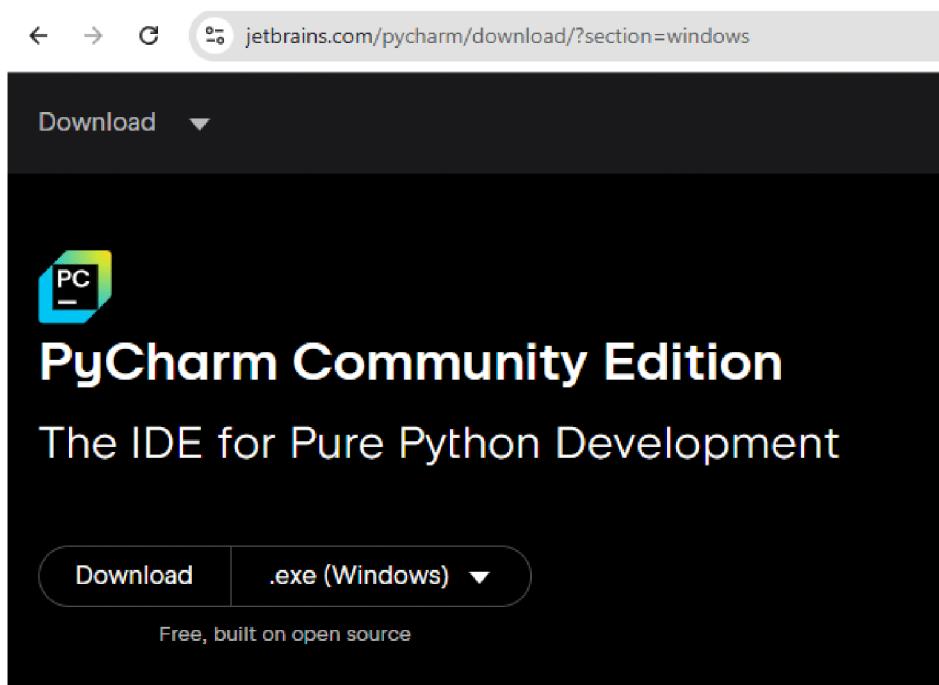
Step - 4. Now type the name of the Python file and click on "OK". We have written the "FirstProgram".

Step - 5. Now type the first program - `print("Hello World")` then click on the "Run" menu to run program.

Step - 6. The output will appear at the bottom of the screen.

PyCharm IDE Installation:

Download and install “PyCharm Community Edition”



Write a test “Hello World” script

A screenshot of the PyCharm IDE interface. The top navigation bar shows 'PP python...', 'Version co...', 'Current File', and other icons. The main editor window shows a file named 'DEMO.py' with the following code:

```
1
2
3
4
5
6     print(" Hello World! ")
7
8
9
10
11
```

The code editor has a dark theme with syntax highlighting. Below the editor is a 'Run' toolbar with a dropdown set to 'DEMO'. The bottom panel is a terminal window showing the output of the script:

```
C:\Users\96035\PycharmProjects\pythonProject\.venv\Scripts\python
Hello World!

Process finished with exit code 0
```