
# PYTHON FOR COMPUTATIONAL PROBLEM SOLVING

## Introduction to Programming Languages

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## Programming

- Giving **instructions to a computer** to perform specific tasks
- **Translates human logic** to a form computers can understand

## Programming Languages (PLs)

- **Tools used to write programs** that computers can execute
- Instructions communicated effectively. Thanks to **syntax (set of rules) provided by PLs**
- **Why:** Computers only understand binary (0s and 1s). PLs act as a bridge between humans and computers
- **Eg:** Python, C, C++, JavaScript, Golang, R etc.

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## Why so many programming languages?

- **Different Needs:** Each language is **designed to solve specific types of problems** or target different applications (e.g., web development, system programming, data analysis)

- **Evolving Technology:** As technology changes, **new languages emerge** to meet modern requirements, offer better performance, or provide new features.

- **Efficiency and Flexibility:** Some languages are **better suited for certain tasks**. For example, Python is great for rapid development, while C is ideal for performance-critical systems.


## The TIOBE Index

- Measure of popularity of programming languages, updated once a month
- Uses online search engine results to track language trends over time
- Not about which programming language is “the best”

https://www.tiobe.com/tiobe-index/

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## The TIOBE Index (as of September 2024)

| Sep 2024 | Sep 2023 | Change | Programming Language | Ratings | Change |
|---|---|---|---|---|---|
| 1 | 1 | | Python | 20.17% | +6.01% |
| 2 | 3 | ↑ | C++ | 10.75% | +0.09% |
| 3 | 4 | ↑ | Java | 9.45% | -0.04% |
| 4 | 2 | ↓ | C | 8.89% | -2.38% |
| 5 | 5 | | C# | 6.08% | -1.22% |
| 6 | 6 | | JavaScript | 3.92% | +0.62% |
| 7 | 7 | | Visual Basic | 2.70% | +0.48% |
| 8 | 12 | ⇈ | Go | 2.35% | +1.16% |
| 9 | 10 | ↑ | SQL | 1.94% | +0.50% |
| 10 | 11 | ↑ | Fortran | 1.78% | +0.49% |

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## Types of Programming Languages

- **Low Level:** Directly understood by machine. Much harder to code with, but has the fastest performance.
**Eg:** Machine language

- **Middle Level:** Provides some basic data structures and definitions while still maintaining direct interaction with the machine. Still somewhat hard to code with, but has fast performance.
**Eg:** C, C++

- **High Level:** Focuses on ease of use and provides many programming structures by default. Worse performance but very easy to code and develop with.
**Eg:** Python, JavaScript

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## Python: An Introduction

- First published in Feb 1991 by Guido van Rossum
- **Multi–paradigm** programming language
- Highly **simple and readable**
- As of Sept 2024, Python Package Index contains **more than 565,000 packages**
- **Versatile uses:** GUIs, test frameworks, automation and web scraping, scientific computing, text processing, image processing, graph generation etc.
- **Extremely popular:** used for YouTube, Dropbox, Spotify, Instagram, Pinterest, Uber, Reddit etc.

## Applications of Python

- **Data Science:** Libraries like NumPy, Pandas, Matplotlib etc. are used for predictive analysis, data processing and data visualisation
- **AI & Machine Learning:** Python is used to develop neural networks and NLP systems using libraries like Tensorflow and Pytorch
- **Web Development:** Frameworks like Django and Flask power large scale web applications like Instagram
- **Drug Discovery:** Python is used in molecular modelling and simulations using libraries like Open Babel and PyMOL


## Applications of Python

- **IoT and Embedded Systems:** Integrations with platforms like Raspberry Pi and Arduino to control hardware devices
- **Circuit Design and Simulation:** Tools like PySpice, SKiDL are used for circuit simulation and PCB design
- **Computational Fluid Dynamics (CFD):** Libraries such as OpenFOAM are used for simulating fluid flow
- **Structural Analysis:** Frameworks like OpenSeesPy are used for structural modelling and earthquake engineering


# THANK YOU

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