

Introduction to Programming

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Outline

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What is Programming?

- Process of giving instructions to a computer
- Computers follow step-by-step instructions precisely
- A program is a sequence of instructions that accomplishes a task
- Algorithms (logic) vs Programs (implemented in code)

History & Evolution of Programming Languages

- 1940s: Machine code (binary)
- 1950s: Assembly language (mnemonics)
- 1960s–70s: Structured languages (C, Pascal)
- 1990s: Object-oriented (Java, C++)
- 2000s–Now: Multi-paradigm, scripting (Python, JavaScript)

Flow of Program Development

- ① Define the problem
- ② Design algorithm
- ③ Write pseudocode or flowchart
- ④ Translate into source code
- ⑤ Compile and run
- ⑥ Debug and test
- ⑦ Update and maintain

Pseudocode

- Informal description of a program's logic.
- Bridges the gap between human thought and actual code.
- Example:
 - Start
 - Input: integer a, integer b
 - Let $c = a + b$
 - Print c
 - End

Program Structure

- Typical structure of a program:
 - Input (data from user or file)
 - Processing (calculations, logic)
 - Output (display results)
- Uses variables, control flow (if/loops), and functions

Levels of Programming Languages

- Machine code (binary: 0s and 1s)
 - The lowest-level representation of a program
 - Directly executed by the CPU
- Assembly language (x86 assembly, ARM assembly)
 - Low-level language using mnemonics instead of binary
 - Easier for humans to read than machine code
- Higher-level languages (C, Python, Java etc.)
 - Abstract away hardware details
 - Easier to write, read, and maintain
- Domain-specific languages (DSL)
 - Designed for a particular purpose or domain
 - Examples: SQL for databases, HTML for web, R for data science

Compiled vs Interpreted

- **Compiled:** C, C++, Rust etc.
 - Source code compiled into machine code by a compiler producing an executable file
 - Faster execution
 - Platform-specific
- **Interpreted:** Python, Javascript etc.
 - Code executed line by line by an interpreter
 - No separate compilation step
 - Easier to test and debug, but slower

Why So Many Languages?

- Different goals:
 - Performance: C, C++
 - Safety and reliability: Go, Rust
 - Ease of use and productivity: Python
 - Domain focus: SQL, R
- No single language is best for all problems.

Programming Paradigms

- **Procedural:** Step-by-step instructions (C)
- **Object-Oriented:** Organize into classes/objects (Java, Python)
- **Functional:** Emphasis on *pure* functions, immutability (Haskell, Lisp)

Open Source vs Proprietary

- **Open Source:** Free to use, modify, share (Python, GCC)
- **Proprietary:** Owned, restricted licenses (MATLAB)
- Ecosystem and libraries often drive language adoption

Performance vs Productivity

- **Performance:** How fast a program runs (C, C++)
- **Productivity:** How quickly developers can write programs (Python, Ruby)
- Trade-off: High performance vs faster development

Portable Languages

- Code can run on multiple platforms with little/no modification
- Example: Java – Write Once, Run Anywhere
- Achieved via virtual machines or interpreters

Development Tools: Editors & IDEs

- **Text Editors:** lightweight coding (Notepad++, Sublime)
- **IDEs:** full-featured, include debugging, auto-completion (VS Code, PyCharm)

Development Tools: Debugging, Profiling, VCS

- **Debugger:** Step through code, inspect variables
- **Profiler:** Find performance bottlenecks
- **Version Control System, VCS:** Track changes, collaborate (Git)

Terminal and Command Line Interface (CLI)

- **Terminal:** Text-based interface to interact with the OS
- **CLI:** Execute commands directly by typing them
- Used for compiling, running, and managing projects
- Common tools: `gcc`, `gdb`, `python`, `git`