Why Are There So Many Programming Languages

Functional programming

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In computer science, functional programming is a programming paradigm where programs are constructed by applying and composing functions. It is a declarative programming paradigm in which function definitions are trees of expressions that map values to other values, rather than a sequence of imperative statements which update the running state of the program.

In functional programming, functions are treated as first-class citizens, meaning that they can be bound to names (including local identifiers), passed as arguments, and returned from other functions, just as any other data type can. This allows programs to be written in a declarative and composable style, where small functions are combined in a modular manner.

Functional programming is sometimes treated as synonymous with purely functional programming, a subset of functional programming that treats all functions as deterministic mathematical functions, or pure functions. When a pure function is called with some given arguments, it will always return the same result, and cannot be affected by any mutable state or other side effects. This is in contrast with impure procedures, common in imperative programming, which can have side effects (such as modifying the program's state or taking input from a user). Proponents of purely functional programming claim that by restricting side effects, programs can have fewer bugs, be easier to debug and test, and be more suited to formal verification.

Functional programming has its roots in academia, evolving from the lambda calculus, a formal system of computation based only on functions. Functional programming has historically been less popular than imperative programming, but many functional languages are seeing use today in industry and education, including Common Lisp, Scheme, Clojure, Wolfram Language, Racket, Erlang, Elixir, OCaml, Haskell, and F#. Lean is a functional programming language commonly used for verifying mathematical theorems. Functional programming is also key to some languages that have found success in specific domains, like JavaScript in the Web, R in statistics, J, K and Q in financial analysis, and XQuery/XSLT for XML. Domain-specific declarative languages like SQL and Lex/Yacc use some elements of functional programming, such as not allowing mutable values. In addition, many other programming languages support programming in a functional style or have implemented features from functional programming, such as C++11, C#, Kotlin, Perl, PHP, Python, Go, Rust, Raku, Scala, and Java (since Java 8).

Python (programming language)

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Python is a high-level, general-purpose programming language. Its design philosophy emphasizes code readability with the use of significant indentation.

Python is dynamically type-checked and garbage-collected. It supports multiple programming paradigms, including structured (particularly procedural), object-oriented and functional programming.

Guido van Rossum began working on Python in the late 1980s as a successor to the ABC programming language. Python 3.0, released in 2008, was a major revision not completely backward-compatible with earlier versions. Recent versions, such as Python 3.12, have added capabilites and keywords for typing (and

more; e.g. increasing speed); helping with (optional) static typing. Currently only versions in the 3.x series are supported.

Python consistently ranks as one of the most popular programming languages, and it has gained widespread use in the machine learning community. It is widely taught as an introductory programming language.

List of programming languages by type

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C (programming language)

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C is a general-purpose programming language. It was created in the 1970s by Dennis Ritchie and remains widely used and influential. By design, C gives the programmer relatively direct access to the features of the typical CPU architecture, customized for the target instruction set. It has been and continues to be used to implement operating systems (especially kernels), device drivers, and protocol stacks, but its use in application software has been decreasing. C is used on computers that range from the largest supercomputers to the smallest microcontrollers and embedded systems.

A successor to the programming language B, C was originally developed at Bell Labs by Ritchie between 1972 and 1973 to construct utilities running on Unix. It was applied to re-implementing the kernel of the Unix operating system. During the 1980s, C gradually gained popularity. It has become one of the most widely used programming languages, with C compilers available for practically all modern computer architectures and operating systems. The book The C Programming Language, co-authored by the original language designer, served for many years as the de facto standard for the language. C has been standardized since 1989 by the American National Standards Institute (ANSI) and, subsequently, jointly by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).

C is an imperative procedural language, supporting structured programming, lexical variable scope, and recursion, with a static type system. It was designed to be compiled to provide low-level access to memory and language constructs that map efficiently to machine instructions, all with minimal runtime support. Despite its low-level capabilities, the language was designed to encourage cross-platform programming. A standards-compliant C program written with portability in mind can be compiled for a wide variety of computer platforms and operating systems with few changes to its source code.

Although neither C nor its standard library provide some popular features found in other languages, it is flexible enough to support them. For example, object orientation and garbage collection are provided by external libraries GLib Object System and Boehm garbage collector, respectively.

Since 2000, C has consistently ranked among the top four languages in the TIOBE index, a measure of the popularity of programming languages.

Second-generation programming language

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The term was coined to provide a distinction from higher level machine independent third-generation programming languages (3GLs) (such as COBOL, C, or Java) and earlier first-generation programming languages (machine code)

Object-oriented programming

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Object-oriented programming (OOP) is a programming paradigm based on the object – a software entity that encapsulates data and function(s). An OOP computer program consists of objects that interact with one another. A programming language that provides OOP features is classified as an OOP language but as the set of features that contribute to OOP is contended, classifying a language as OOP and the degree to which it supports or is OOP, are debatable. As paradigms are not mutually exclusive, a language can be multi-paradigm; can be categorized as more than only OOP.

Sometimes, objects represent real-world things and processes in digital form. For example, a graphics program may have objects such as circle, square, and menu. An online shopping system might have objects such as shopping cart, customer, and product. Niklaus Wirth said, "This paradigm [OOP] closely reflects the structure of systems in the real world and is therefore well suited to model complex systems with complex behavior".

However, more often, objects represent abstract entities, like an open file or a unit converter. Not everyone agrees that OOP makes it easy to copy the real world exactly or that doing so is even necessary. Bob Martin suggests that because classes are software, their relationships don't match the real-world relationships they represent. Bertrand Meyer argues that a program is not a model of the world but a model of some part of the world; "Reality is a cousin twice removed". Steve Yegge noted that natural languages lack the OOP approach of naming a thing (object) before an action (method), as opposed to functional programming which does the reverse. This can make an OOP solution more complex than one written via procedural programming.

Notable languages with OOP support include Ada, ActionScript, C++, Common Lisp, C#, Dart, Eiffel, Fortran 2003, Haxe, Java, JavaScript, Kotlin, Logo, MATLAB, Objective-C, Object Pascal, Perl, PHP, Python, R, Raku, Ruby, Scala, SIMSCRIPT, Simula, Smalltalk, Swift, Vala and Visual Basic (.NET).

Lightweight programming language

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Lightweight programming languages are programming languages designed to have small memory footprint, are easy to implement (important when porting a language to different computer systems), and/or have minimalist syntax and features.

These programming languages have simple syntax and semantics, so one can learn them quickly and easily. Some lightweight languages (for example Lisp, Forth, and Tcl) are so simple to implement that they have many implementations (dialects).

Rust (programming language)

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Rust is a text-based general-purpose programming language emphasizing performance, type safety, and concurrency. It enforces memory safety, meaning that all references point to valid memory. It does so without a conventional garbage collector; instead, memory safety errors and data races are prevented by the "borrow checker", which tracks the object lifetime of references at compile time.

Rust supports multiple programming paradigms. It was influenced by ideas from functional programming, including immutability, higher-order functions, algebraic data types, and pattern matching. It also supports object-oriented programming via structs, enums, traits, and methods.

Software developer Graydon Hoare created Rust as a personal project while working at Mozilla Research in 2006. Mozilla officially sponsored the project in 2009. The first stable release of Rust, Rust 1.0, was published in May 2015. Following a large layoff of Mozilla employees in August 2020, multiple other companies joined Mozilla in sponsoring Rust through the creation of the Rust Foundation in February 2021. In December 2022, Rust became the first language other than C and assembly to be supported in the development of the Linux kernel.

Rust has been noted for its adoption in many software projects, especially web services and system software. It has been studied academically and has a growing community of developers.

Zig (programming language)

Zig are in contrast to those of many other languages designed in the same time period, like Rust, Carbon, and Nim. Generally, these languages are more

Zig is an imperative, general-purpose, statically typed, compiled system programming language designed by Andrew Kelley. It is free and open-source software, released under an MIT License.

A major goal of the language is to improve on the C language, with the intent of being even smaller and simpler to program in, while offering more functionality. The improvements in language simplicity relate to flow control, function calls, library imports, variable declaration and Unicode support. Further, the language makes no use of macros or preprocessor instructions. Features adopted from modern languages include the addition of compile time generic programming data types, allowing functions to work on a variety of data, along with a small set of new compiler directives to allow access to the information about those types using reflective programming (reflection). Like C, Zig omits garbage collection, and has manual memory management. To help eliminate the potential errors that arise in such systems, it includes option types, a simple syntax for using them, and a unit testing framework built into the language. Zig has many features for low-level programming, notably packed structs (structs without padding between fields), arbitrary-width integers and multiple pointer types.

The main drawback of the system is that, although Zig has a growing community, as of 2025, it remains a new language with areas for improvement in maturity, ecosystem and tooling. Also the learning curve for Zig can be steep, especially for those unfamiliar with low-level programming concepts. The availability of learning resources is limited for complex use cases, though this is gradually improving as interest and adoption increase. Other challenges mentioned by the reviewers are interoperability with other languages (extra effort to manage data marshaling and communication is required), as well as manual memory deallocation (disregarding proper memory management results directly in memory leaks).

The development is funded by the Zig Software Foundation (ZSF), a non-profit corporation with Andrew Kelley as president, which accepts donations and hires multiple full-time employees. Zig has very active contributor community, and is still in its early stages of development. Despite this, a Stack Overflow survey in 2024 found that Zig software developers earn salaries of $103,000 USD per year on average, making it one

of the best-paying programming languages. However, only 0.83% reported they were proficient in Zig.

Erlang (programming language)

in-process mechanism like exception handling used in many other programming languages. Crashes are reported like other messages, which is the only way

Erlang (UR-lang) is a general-purpose, concurrent, functional high-level programming language, and a garbage-collected runtime system. The term Erlang is used interchangeably with Erlang/OTP, or Open Telecom Platform (OTP), which consists of the Erlang runtime system, several ready-to-use components (OTP) mainly written in Erlang, and a set of design principles for Erlang programs.

The Erlang runtime system is designed for systems with these traits:

Distributed

Fault-tolerant

Soft real-time

Highly available, non-stop applications

Hot swapping, where code can be changed without stopping a system.

The Erlang programming language has data, pattern matching, and functional programming. The sequential subset of the Erlang language supports eager evaluation, single assignment, and dynamic typing.

A normal Erlang application is built out of hundreds of small Erlang processes.

It was originally proprietary software within Ericsson, developed by Joe Armstrong, Robert Virding, and Mike Williams in 1986, but was released as free and open-source software in 1998. Erlang/OTP is supported and maintained by the Open Telecom Platform (OTP) product unit at Ericsson.