

Database Programming With C

Object database

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An object database or object-oriented database is a database management system in which information is represented in the form of objects as used in object-oriented programming. Object databases are different from relational databases which are table-oriented. A third type, object–relational databases, is a hybrid of both approaches.

Object databases have been considered since the early 1980s.

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.

Program database

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Program database (PDB) is a file format (developed by Microsoft) for storing debugging information about a program (or, commonly, program modules such as a DLL or EXE). PDB files commonly have a .pdb extension. A PDB file is typically created from source files during compilation. It stores a list of all symbols in a module with their addresses and possibly the name of the file and the line on which the symbol was declared. This symbol information is not stored in the module itself, because it takes up a lot of space.

C++

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C++ is a high-level, general-purpose programming language created by Danish computer scientist Bjarne Stroustrup. First released in 1985 as an extension of the C programming language, adding object-oriented (OOP) features, it has since expanded significantly over time adding more OOP and other features; as of 1997/C++98 standardization, C++ has added functional features, in addition to facilities for low-level memory manipulation for systems like microcomputers or to make operating systems like Linux or Windows, and even later came features like generic programming (through the use of templates). C++ is usually implemented as a compiled language, and many vendors provide C++ compilers, including the Free Software Foundation, LLVM, Microsoft, Intel, Embarcadero, Oracle, and IBM.

C++ was designed with systems programming and embedded, resource-constrained software and large systems in mind, with performance, efficiency, and flexibility of use as its design highlights. C++ has also been found useful in many other contexts, with key strengths being software infrastructure and resource-constrained applications, including desktop applications, video games, servers (e.g., e-commerce, web search, or databases), and performance-critical applications (e.g., telephone switches or space probes).

C++ is standardized by the International Organization for Standardization (ISO), with the latest standard version ratified and published by ISO in October 2024 as ISO/IEC 14882:2024 (informally known as C++23). The C++ programming language was initially standardized in 1998 as ISO/IEC 14882:1998, which was then amended by the C++03, C++11, C++14, C++17, and C++20 standards. The current C++23 standard supersedes these with new features and an enlarged standard library. Before the initial standardization in 1998, C++ was developed by Stroustrup at Bell Labs since 1979 as an extension of the C language; he wanted an efficient and flexible language similar to C that also provided high-level features for program organization. Since 2012, C++ has been on a three-year release schedule with C++26 as the next planned standard.

Despite its widespread adoption, some notable programmers have criticized the C++ language, including Linus Torvalds, Richard Stallman, Joshua Bloch, Ken Thompson, and Donald Knuth.

Object–relational database

store for software written in an object-oriented programming language, with an application programming interface API for storing and retrieving objects

An object–relational database (ORD), or object–relational database management system (ORDBMS), is a database management system (DBMS) similar to a relational database, but with an object-oriented database model: objects, classes and inheritance are directly supported in database schemas and in the query language. Also, as with pure relational systems, it supports extension of the data model with custom data types and methods.

An object–relational database can be said to provide a middle ground between relational databases and object-oriented databases. In object–relational databases, the approach is essentially that of relational databases: the data resides in the database and is manipulated collectively with queries in a query language; at the other extreme are OODBMSes in which the database is essentially a persistent object store for software written in an object-oriented programming language, with an application programming interface API for storing and retrieving objects, and little or no specific support for querying.

C Sharp (programming language)

C# (/ˈsi? ʔʔʔʔrp/ see SHARP) is a general-purpose high-level programming language supporting multiple paradigms. C# encompasses static typing, strong typing

C# (see SHARP) is a general-purpose high-level programming language supporting multiple paradigms. C# encompasses static typing, strong typing, lexically scoped, imperative, declarative, functional, generic, object-oriented (class-based), and component-oriented programming disciplines.

The principal inventors of the C# programming language were Anders Hejlsberg, Scott Wiltamuth, and Peter Golde from Microsoft. It was first widely distributed in July 2000 and was later approved as an international standard by Ecma (ECMA-334) in 2002 and ISO/IEC (ISO/IEC 23270 and 20619) in 2003. Microsoft introduced C# along with .NET Framework and Microsoft Visual Studio, both of which are technically speaking, closed-source. At the time, Microsoft had no open-source products. Four years later, in 2004, a free and open-source project called Microsoft Mono began, providing a cross-platform compiler and runtime environment for the C# programming language. A decade later, Microsoft released Visual Studio Code (code editor), Roslyn (compiler), and the unified .NET platform (software framework), all of which support C# and are free, open-source, and cross-platform. Mono also joined Microsoft but was not merged into .NET.

As of January 2025, the most recent stable version of the language is C# 13.0, which was released in 2024 in .NET 9.0

Fourth-generation programming language

A fourth-generation programming language (4GL) is a high-level computer programming language that belongs to a class of languages envisioned as an advancement

A fourth-generation programming language (4GL) is a high-level computer programming language that belongs to a class of languages envisioned as an advancement upon third-generation programming languages (3GL). Each of the programming language generations aims to provide a higher level of abstraction of the internal computer hardware details, making the language more programmer-friendly, powerful, and versatile. While the definition of 4GL has changed over time, it can be typified by operating more with large collections of information at once rather than focusing on just bits and bytes. Languages claimed to be 4GL may include support for database management, report generation, mathematical optimization, graphical user interface (GUI) development, or web development. Some researchers state that 4GLs are a subset of domain-specific languages.

The concept of 4GL was developed from the 1970s through the 1990s, overlapping most of the development of 3GL, with 4GLs identified as "non-procedural" or "program-generating" languages, contrasted with 3GLs being algorithmic or procedural languages. While 3GLs like C, C++, C#, Java, and JavaScript remain popular for a wide variety of uses, 4GLs as originally defined found uses focused on databases, reports, and websites. Some advanced 3GLs like Python, Ruby, and Perl combine some 4GL abilities within a general-purpose 3GL environment, and libraries with 4GL-like features have been developed as add-ons for most popular 3GLs, producing languages that are a mix of 3GL and 4GL, blurring the distinction.

In the 1980s and 1990s, there were efforts to develop fifth-generation programming languages (5GL).

Database

hooks for database design, application programming, application program maintenance, database performance analysis and monitoring, database configuration

In computing, a database is an organized collection of data or a type of data store based on the use of a database management system (DBMS), the software that interacts with end users, applications, and the database itself to capture and analyze the data. The DBMS additionally encompasses the core facilities provided to administer the database. The sum total of the database, the DBMS and the associated applications can be referred to as a database system. Often the term "database" is also used loosely to refer to any of the DBMS, the database system or an application associated with the database.

Before digital storage and retrieval of data have become widespread, index cards were used for data storage in a wide range of applications and environments: in the home to record and store recipes, shopping lists, contact information and other organizational data; in business to record presentation notes, project research and notes, and contact information; in schools as flash cards or other visual aids; and in academic research to hold data such as bibliographical citations or notes in a card file. Professional book indexers used index cards in the creation of book indexes until they were replaced by indexing software in the 1980s and 1990s.

Small databases can be stored on a file system, while large databases are hosted on computer clusters or cloud storage. The design of databases spans formal techniques and practical considerations, including data modeling, efficient data representation and storage, query languages, security and privacy of sensitive data, and distributed computing issues, including supporting concurrent access and fault tolerance.

Computer scientists may classify database management systems according to the database models that they support. Relational databases became dominant in the 1980s. These model data as rows and columns in a series of tables, and the vast majority use SQL for writing and querying data. In the 2000s, non-relational databases became popular, collectively referred to as NoSQL, because they use different query languages.

Objective-C

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Objective-C is a high-level general-purpose, object-oriented programming language that adds Smalltalk-style message passing (messaging) to the C programming language. Originally developed by Brad Cox and Tom Love in the early 1980s, it was selected by NeXT for its NeXTSTEP operating system. Due to Apple macOS's direct lineage from NeXTSTEP, Objective-C was the standard language used, supported, and promoted by Apple for developing macOS and iOS applications (via their respective application programming interfaces (APIs), Cocoa and Cocoa Touch) from 1997, when Apple purchased NeXT, until the introduction of the Swift language in 2014.

Objective-C programs developed for non-Apple operating systems or that are not dependent on Apple's APIs may also be compiled for any platform supported by GNU Compiler Collection (GCC) or LLVM/Clang.

Objective-C source code 'messaging/implementation' program files usually have .m filename extensions, while Objective-C 'header/interface' files have .h extensions, the same as C header files. Objective-C++ files are denoted with a .mm filename extension.

Berkeley DB

an embedded database software library for key/value data, historically significant in open-source software. Berkeley DB is written in C with API bindings

Berkeley DB (BDB) is an embedded database software library for key/value data, historically significant in open-source software. Berkeley DB is written in C with API bindings for many other programming languages. BDB stores arbitrary key/data pairs as byte arrays and supports multiple data items for a single key. Berkeley DB is not a relational database, although it has database features including database transactions, multiversion concurrency control and write-ahead logging. BDB runs on a wide variety of operating systems, including most Unix-like and Windows systems, and real-time operating systems.

BDB was commercially supported and developed by Sleepycat Software from 1996 to 2006. Sleepycat Software was acquired by Oracle Corporation in February 2006, who continued to develop and sell the C Berkeley DB library. In 2013 Oracle re-licensed BDB under the AGPL license and released new versions until May 2020. Bloomberg L.P. continues to develop a fork of the 2013 version of BDB within their Comdb2 database, under the original Sleepycat permissive license.

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