

However, readability is more than just programming style. By the late 1960s, data storage devices and computer terminals became inexpensive enough that programs could be created by typing directly into the computers. In the 1880s, Herman Hollerith invented the concept of storing data in machine-readable form. Proficient programming usually requires expertise in several different subjects, including knowledge of the application domain, details of programming languages and generic code libraries, specialized algorithms, and formal logic. Popular modeling techniques include Object-Oriented Analysis and Design (OOAD) and Model-Driven Architecture (MDA). Their jobs usually involve: Although programming has been presented in the media as a somewhat mathematical subject, some research shows that good programmers have strong skills in natural human languages, and that learning to code is similar to learning a foreign language. They are the building blocks for all software, from the simplest applications to the most sophisticated ones. Methods of measuring programming language popularity include: counting the number of job advertisements that mention the language, the number of books sold and courses teaching the language (this overestimates the importance of newer languages), and estimates of the number of existing lines of code written in the language (this underestimates the number of users of business languages such as COBOL). As early as the 9th century, a programmable music sequencer was invented by the Persian Banu Musa brothers, who described an automated mechanical flute player in the Book of Ingenious Devices. Techniques like Code refactoring can enhance readability. Normally the first step in debugging is to attempt to reproduce the problem. Allen Downey, in his book *How To Think Like A Computer Scientist*, writes: Many computer languages provide a mechanism to call functions provided by shared libraries. Techniques like Code refactoring can enhance readability. Some text editors such as Emacs allow GDB to be invoked through them, to provide a visual environment. Unreadable code often leads to bugs, inefficiencies, and duplicated code. By the late 1960s, data storage devices and computer terminals became inexpensive enough that programs could be created by typing directly into the computers. New languages are generally designed around the syntax of a prior language with new functionality added, (for example C++ adds object-orientation to C, and Java adds memory management and bytecode to C++, but as a result, loses efficiency and the ability for low-level manipulation). A study found that a few simple readability transformations made code shorter and drastically reduced the time to understand it. For example, COBOL is still strong in corporate data centers often on large mainframe computers, Fortran in engineering applications, scripting languages in Web development, and C in embedded software. In 1206, the Arab engineer Al-Jazari invented a programmable drum machine where a musical mechanical automaton could be made to play different rhythms and drum patterns, via pegs and cams. Programmers typically use high-level programming languages that are more easily intelligible to humans than machine code, which is directly executed by the central processing unit. Debugging is often done with IDEs. Standalone debuggers like GDB are also used, and these often provide less of a visual environment, usually using a command line. A study found that a few simple readability transformations made code shorter and drastically reduced the time to understand it. Some languages are more prone to some kinds of faults because their specification does not require compilers to perform as much checking as other languages. Implementation techniques include imperative languages (object-oriented or procedural), functional languages, and logic languages.