

Whatever the approach to development may be, the final program must satisfy some fundamental properties. Integrated development environments (IDEs) aim to integrate all such help. A study found that a few simple readability transformations made code shorter and drastically reduced the time to understand it. Many factors, having little or nothing to do with the ability of the computer to efficiently compile and execute the code, contribute to readability. 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. Auxiliary tasks accompanying and related to programming include analyzing requirements, testing, debugging (investigating and fixing problems), implementation of build systems, and management of derived artifacts, such as programs' machine code. Programs were mostly entered using punched cards or paper tape. Whatever the approach to development may be, the final program must satisfy some fundamental properties. Unreadable code often leads to bugs, inefficiencies, and duplicated code. These compiled languages allow the programmer to write programs in terms that are syntactically richer, and more capable of abstracting the code, making it easy to target varying machine instruction sets via compilation declarations and heuristics. 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*. Following a consistent programming style often helps readability. In 1801, the Jacquard loom could produce entirely different weaves by changing the "program" – a series of pasteboard cards with holes punched in them. For example, when a bug in a compiler can make it crash when parsing some large source file, a simplification of the test case that results in only few lines from the original source file can be sufficient to reproduce the same crash. Some languages are very popular for particular kinds of applications, while some languages are regularly used to write many different kinds of applications. Compilers harnessed the power of computers to make programming easier by allowing programmers to specify calculations by entering a formula using infix notation. Machine code was the language of early programs, written in the instruction set of the particular machine, often in binary notation. In the 9th century, the Arab mathematician Al-Kindi described a cryptographic algorithm for deciphering encrypted code, in *A Manuscript on Deciphering Cryptographic Messages*. High-level languages made the process of developing a program simpler and more understandable, and less bound to the underlying hardware. Text editors were also developed that allowed changes and corrections to be made much more easily than with punched cards. Expert programmers are familiar with a variety of well-established algorithms and their respective complexities and use this knowledge to choose algorithms that are best suited to the circumstances. This can be a non-trivial task, for example as with parallel processes or some unusual software bugs. Scripting and breakpointing is also part of this process. It affects the aspects of quality above, including portability, usability and most importantly maintainability.