Computer Programmers

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Significant Points

- Almost 8 out of 10 computer programmers held an associate's degree or higher in 2006; nearly half held a bachelor's degree, and 2 out of 10 held a graduate degree.

- Employment of computer programmers is expected to decline by four percent through 2016.

- Job prospects will be best for applicants with a bachelor's degree and experience with a variety of programming languages and tools.

Nature of the Work

Computer programmers write, test, and maintain the detailed instructions, called programs, that computers follow to perform their functions. Programmers also conceive, design, and test logical structures for solving problems by computer. With the help of other computer specialists, they figure out which instructions to use to make computers do specific tasks. Many technical innovations in programming—advanced computing technologies and sophisticated new languages and programming tools, for example—have redefined the role of a programmer and elevated much of the programming work done today.

Job titles and descriptions may vary, depending on the organization, but computer programmers are individuals whose main job function is programming. Programmers usually write programs according to the specifications given by computer software engineers and systems analysts. (Sections on computer software engineers and on computer systems analysts appear elsewhere in the *Handbook*.) After engineers and analysts design software—describing how it will work—the programmer converts that design into a logical series of instructions that the computer can follow. The programmer codes these instructions in a conventional programming language such as COBOL; an artificial intelligence language such as Prolog; or one of the more advanced object-oriented languages, such as Java, C++, or ACTOR.

Different programming languages are used depending on the purpose of the program. Programmers generally know more than one programming language, and because many languages are similar, they often can learn new languages relatively easily. In practice, programmers often are referred to by the language they know, such as Java programmers, or by the type of function they perform or environment in which they work—for example, database programmers, mainframe programmers, or Web programmers.

Programmers also update, repair, modify, and expand existing programs. Some, especially those working on large projects that involve many programmers, use computer-assisted software engineering (CASE) tools to automate much of the coding process. These tools enable a programmer to concentrate on writing the unique parts of a program. Programmers working on smaller projects often use "programmer environments," applications that increase productivity by combining compiling, code walk through, code generation, test data generation, and debugging functions. Programmers also use libraries of basic code that can be modified or customized for a specific application. This approach yields more reliable and consistent programs and increases programmers' productivity by eliminating some routine steps.

Programs vary widely depending on the type of information they will access or generate. For example, the instructions involved in updating financial records are very different from those required to simulate flight for pilot training. Simple programs can be written in a few hours, but some programs draw data from many existing systems or use complex mathematical formulas. These programs may take more than a year to create. In most cases, several programmers work together as a team under a senior programmer's supervision.

Programmers test a program by running it to ensure that the instructions are correct and that the program produces the desired outcome. If errors do occur, the programmer must make the appropriate change and recheck the program until it produces the correct results. This process is called testing and debugging. Programmers may continue to fix problems for as long as a program is used.

Programmers working on a mainframe, a large centralized computer, may prepare instructions for a computer operator who will run the program. (A section on computer operators appears elsewhere in the *Handbook*.) Programmers also may contribute to the instruction manual for a program.

Programmers in software development companies may work directly with experts from various fields to create specialized software—either programs designed for specific clients or packaged software for general use—ranging from games and educational software to programs for desktop publishing and financial planning. Programming of packaged software constitutes one of the most rapidly growing segments of the computer services industry.

Increasingly, advanced software platforms are bridging the gap between computer programmers and computer users. New platforms, such as spreadsheet, accounting, and enterprise resource planning applications, have created demand for computer specialists who have first-hand knowledge of a user-base. These workers use such platforms to develop programs that meet the specific needs of this base. Computer programmers often are responsible for creating the software platform, and then fine-tuning the final program after it has been made.

Computer programmers often are grouped into two broad types—applications programmers and systems programmers. *Applications programmers* write programs to handle a specific job, such as a program to track inventory within an organization. They also may revise existing packaged software or customize generic applications purchased from vendors. *Systems programmers*, in contrast, write programs to maintain and control computer systems software for operating systems, networked systems, and database systems. These workers make changes in the instructions that determine how the network, workstations, and central processing unit of a system handle the various jobs they have been given, and how they communicate with peripheral equipment such as terminals, printers, and disk drives. Because of their knowledge of the entire computer system, systems programmers often help applications programmers determine the source of problems that may occur with their programs.
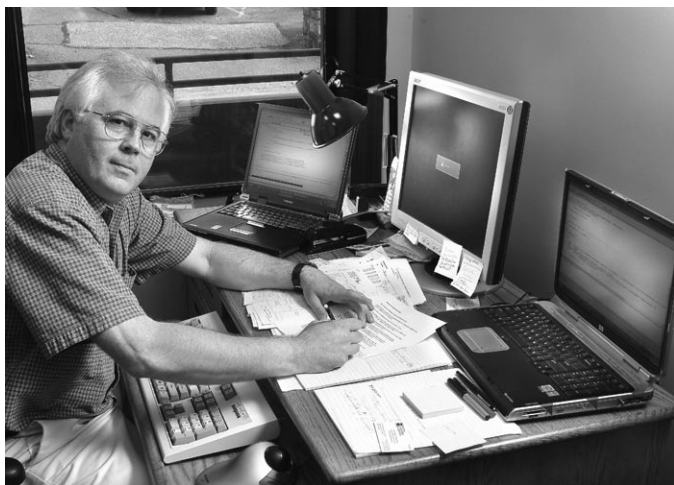
Computer programmers write, test, and maintain the detailed instructions that computers follow.

In some organizations, workers known as *programmer-analysts* are responsible for both the systems analysis and programming. (A more detailed description of the work of programmer-analysts is presented in the section on computer systems analysts elsewhere in the *Handbook*.)

Work environment. Programmers spend the majority of their time in front of a computer terminal, and work in clean, comfortable offices. Telecommuting is becoming more common, however, as technological advances allow more work to be done from remote locations.

Most computer programmers work about 40 hours per week. Long hours or weekend work may be required, however, to meet deadlines or fix unexpected technical problems. About four percent work part-time, compared with about 15 percent for all occupations.

Like other workers who spend long periods in front of a computer terminal typing at a keyboard, programmers are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome.

Training, Other Qualifications, and Advancement

A bachelor's degree commonly is required for computer programming jobs, although a two-year degree or certificate may be adequate for some positions. Employers favor applicants who already have relevant programming skills and experience. Skilled workers who keep up to date with the latest technology usually have good opportunities for advancement.

Education and training. Most programmers have a bachelor's degree, but a two-year degree or certificate may be adequate for some jobs. Some computer programmers hold a college degree in computer science, mathematics, or information systems, whereas others have taken special courses in computer programming to supplement their degree in a field such as accounting, finance, or another area of business. In 2006, more than 68 percent of computer programmers had a bachelor's degree or higher, but as the level of education and training required by employers continues to rise, this proportion is expected to increase.

Employers who use computers for scientific or engineering applications usually prefer college graduates who have a degree in computer or information science, mathematics, engineering, or the physical sciences. Employers who use computers for business applications prefer to hire people who have had college courses in management information systems and business, and who possess strong programming skills. A graduate degree in a related field is required for some jobs.

Most systems programmers hold a four-year degree in computer science. Extensive knowledge of a variety of operating systems is essential for such workers. This includes being able to configure an operating system to work with different types of hardware and being able to adapt the operating system to best meet the needs of a particular organization. Systems programmers also must be able to work with database systems, such as DB2, Oracle, or Sybase.

In addition to educational attainment, employers highly value relevant programming skills, as well as experience. Although knowledge of traditional programming languages still is important, employers are placing an emphasis on newer, object-oriented languages and tools such as C++ and Java. Additionally, employers seek people familiar with fourth- and fifth-generation languages that involve graphic user interface and systems programming. College graduates who are interested in changing careers or developing an area of expertise may return to a two-year community college or technical school for specialized training. In the absence of a degree, substantial specialized experience or expertise may be needed.

Entry-level or junior programmers may work alone on simple assignments after some initial instruction, or they may be assigned to work on a team with more experienced programmers. Either way, beginning programmers generally must work under close supervision.

Because technology changes so rapidly, programmers must continuously update their knowledge and skills by taking courses sponsored by their employer or by software vendors, or offered through local community colleges and universities.

Certification and other qualifications. When hiring programmers, employers look for people with the necessary programming skills who can think logically and pay close attention to detail. Programming calls for patience, persistence, and the ability to perform exacting analytical work, especially under pressure. Ingenuity and creativity are particularly important when programmers design solutions and test their work for potential failures. The ability to work with abstract concepts and to do technical analysis is especially important for systems programmers because they work with the software that controls the computer's operation.

Because programmers are expected to work in teams and interact directly with users, employers want programmers who are able to communicate with non-technical personnel. Business skills are also important, especially for those wishing to advance to managerial positions.

Certification is a way to demonstrate a level of competence and may provide a jobseeker with a competitive advantage. In addition to language-specific certificates, product vendors or software firms also offer certification and may require professionals who work with their products to be certified. Voluntary certification also is available through various other organizations.

Advancement. For skilled workers who keep up to date with the latest technology, prospects for advancement are good. In large organizations, programmers may be promoted to lead programmer and be given supervisory responsibilities. Some applications programmers may move into systems programming after they gain experience and take courses in systems software. With general business experience, programmers may become programmer-analysts or systems analysts, or may be promoted to managerial positions. Programmers with specialized knowledge and experience with a language or operating system may work in research and development and may even become computer software engineers. As employers increasingly contract with outside firms to do programming jobs, more opportunities should arise for experienced programmers with expertise in a specific area to work as consultants.

Employment

Computer programmers held about 435,000 jobs in 2006. Programmers are employed in almost every industry, but the largest concentration is in computer systems design and related services. Large numbers of programmers also work for software publishers, financial institutions, insurance carriers, educational institutions, government agencies, and management of companies and enterprises. Many computer programmers work independently as consultants on a temporary or contract basis, some of whom are self-employed. About 17,000 computer programmers were self-employed in 2006.

Job Outlook

Employment of computer programmers is expected to decline slowly. Job prospects should be best for those with a bachelor's degree and experience with a variety of programming languages and tools.

Employment change. Employment of computer programmers is expected to decline slowly, decreasing by 4 percent from 2006 to 2016. The consolidation and centralization of systems and applications, developments in packaged software, advances in programming languages and tools, and the growing ability of users to design, write, and implement more of their own programs mean that more programming functions can be performed by other types of information workers, such as computer software engineers.

Another factor contributing to employment decline will be the offshore outsourcing of programming jobs. Because they can transmit their programs digitally, computer programmers can perform their job function from anywhere in the world, allowing companies to employ workers in countries that have lower prevailing wages. Computer programmers are at a much higher risk of having their jobs outsourced abroad than are workers involved in more complex and sophisticated information technology functions, such as software engineering. Much of the work of computer programmers requires little localized or specialized knowledge and can be made routine once knowledge of a particular programming language is mastered—and computer programming languages have become known internationally.

Nevertheless, employers will continue to need some local programmers, especially those who have strong technical skills and who understand an employer's business and its programming requirements. This means that programmers will have to keep abreast of changing programming languages and techniques. Given the importance of networking and the expansion of client/server, Web-based, and wireless environments, organizations will look for programmers who can support data communications and help implement business and intranet strategies. Demand for programmers with strong object-oriented programming capabilities and technical specialization in areas such as client/server programming, wireless applications, multimedia technology, and graphic user interface likely will stem from the expansion of intranets, extranets, and Internet applications. Programmers also will be needed to create and maintain expert systems and embed these technologies in more products. Finally, a growing emphasis on cybersecurity will lead to increased demand for programmers who are familiar with digital security issues, and are skilled in using appropriate security technology.

Job prospects. Although employment is projected to decline, numerous job openings will result from the need to replace programmers who leave the labor force or transfer to other occupations. Prospects for these openings should be best for applicants with a bachelor's degree and experience with a variety of programming languages and tools. The languages that are in demand today include C++, Java, and other object-oriented languages, as well as newer, domain-specific languages that apply to computer networking, database management, and Internet application development. As technology evolves, however, and newer, more sophisticated tools emerge, programmers will need to update their skills in order to remain competitive. Obtaining vendor-specific or language-specific certification also can provide a competitive edge.

Jobs for both systems and applications programmers should be most plentiful in computer consulting businesses. These establishments are part of the computer systems design and related services industry, which is projected to be among the fastest growing industries in the economy over the 2006 to 2016 period.

Earnings

Median annual earnings of wage-and-salary computer programmers were $65,510 in May 2006. The middle 50 percent earned between $49,580 and $85,080 a year. The lowest 10 percent earned less than $38,460, and the highest 10 percent earned more than $106,610. Median annual earnings in the industries

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-2016	
				Number	Percent
Computer programmers	15-1021	435,000	417,000	-18,000	-4

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

employing the largest numbers of computer programmers in May 2006 are shown below:

Software publishers..$79,270
Computer systems design and related services.....................67,880
Management of companies and enterprises 67,170
Insurance carriers..65,650

According to the National Association of Colleges and Employers, starting salary offers for computer programmers averaged $49,928 per year in 2007.

According to Robert Half Technology, a firm providing specialized staffing services, average annual starting salaries in 2007 ranged from $55,250 to $90,250 for applications development programmers/analysts, and from $60,250 to $94,750 for software developers. Average starting salaries for mainframe systems programmers ranged from $52,250 to $70,750.

Related Occupations

Other professional workers who deal extensively with data include computer software engineers, computer scientists and database administrators, computer systems analysts, statisticians, mathematicians, engineers, commercial and industrial designers, and operations research analysts.

Sources of Additional Information

State employment service offices can provide information about job openings for computer programmers. Municipal chambers of commerce are an additional source of information on an area's largest employers.

Further information about computer careers is available from:

➤ Association for Computing Machinery, 2 Penn Plaza, Suite 701, New York, NY 10121-0701.

Internet: **http://www.acm.org**

➤ Institute of Electrical and Electronics Engineers Computer Society, Headquarters Office, 1730 Massachusetts Ave. NW., Washington, DC 20036-1992.

Internet: **http://www.computer.org**

➤ National Workforce Center for Emerging Technologies, 3000 Landerholm Circle SE., Bellevue, WA 98007.

Internet: **http://www.nwcet.org**

➤ University of Washington Computer Science and Engineering Department, AC101 Paul G. Allen Center, Box 352350, 185 Stevens Way, Seattle, WA 98195-2350.

Internet: **http://www.cs.washington.edu/WhyCSE**