



## Computer Science Overview

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### The Field

The rapid and widespread use of computers and information technology has generated a need for highly trained workers proficient in various job functions. These computer specialists include computer scientists, database administrators, and network systems and data communication analysts. Job tasks and occupational titles used to describe these workers evolve rapidly and continually, reflecting new areas of specialization or changes in technology, as well as the preferences and practices of employers.



Computer scientists work as theorists, researchers, or inventors. Their jobs are distinguished by the higher level of theoretical expertise and innovation they apply to complex problems and the creation or application of new technology. The areas of computer science research range from complex theory to hardware design to programming-language design. Some researchers work on multidisciplinary projects, such as developing and advancing uses of virtual reality, extending human-computer interaction, or designing robots. They may work on design teams with electrical engineers and other specialists.

Computer science researchers employed by academic institutions have job functions that are similar in many ways to those employed by other organizations. In general, researchers in academic settings have more flexibility to focus on pure theory, while those working in other organizations usually focus on projects that have the possibility of producing patents and profits. However, some researchers in non-academic settings have considerable latitude in determining the direction of their research.



With the Internet and electronic business generating large volumes of data, there is a growing need to be able to store, manage, and extract data effectively. Database administrators work with database management systems software and determine ways to organize and store data. They identify

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user needs and set up new computer databases. In many cases, database administrators must integrate data from outdated systems into a new system. They also test and coordinate modifications to the system when needed, and troubleshoot problems when they occur. An organization's database administrator ensures the performance of the system, understands the platform on which the database runs, and adds new users to the system. Because many databases are connected to the Internet, database administrators also must plan and coordinate security measures with network administrators. With the growing volume of sensitive data and the increasing interconnectedness of computer networks, data integrity, backup systems, and database security have become increasingly important aspects of the job of database administrators.

Network systems and data communications analysts, also referred to as network architects, design, test, and evaluate systems such as local area networks (LANs), wide area networks (WANs), the Internet, intranets, and other data communications systems. Systems are configured in many ways and can range from a connection between two offices in the same building to globally distributed networks, voice mail, and e-mail systems of a multinational organization. Network systems and data communications analysts perform network modeling, analysis, and planning, often requiring both hardware and software solutions. For example, a network may involve the installation of several pieces of hardware, such as routers and hubs, wireless adaptors, and cables, while also requiring the installation and configuration of software, such as network drivers. Analysts also may research related products and make necessary hardware and software recommendations.



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## Preparation

Computer scientists should be creative, inquisitive, analytical, and detail oriented. They must have a strong grasp of mathematics, including calculus, probability, and statistics, and computer systems. Preparation in one or more of the sciences, such as, physics, chemistry, biology, is also a requirement. Abilities to work as part of a team and to communicate well also will be important as computer science jobs frequently require interaction with specialists outside of computer science or engineering. To hone these skills, recommended coursework includes English, writing, social studies, and humanities.

Entry level positions in the field typically require a four year bachelor-of-science degree in computer science, information science, or computer engineering. State-of-the-art high technology research and development positions frequently require the M.S. or Ph.D. degree in either computer science or computer engineering. Tenure track professorial positions in a university require the Ph.D. degree.

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### ► Computer Science vs. Computer Engineering vs. Information Science

Most four year degree programs in computer science and computer engineering are accredited by the Accreditation Board for Engineering and Technology (ABET). Typically these degree programs reside in the university's College of Engineering. The computer engineering degree program resides in the Department of Computer Science and Engineering, or the Department of Electrical and Computer Engineering, or it may be a stand alone Department of Computer Engineering. In some cases, such as, MIT and University of California at Berkeley, these degrees are offered in the Department of Electrical Engineering and Computer Science.

Typically there is considerable overlap in the computer science and the computer engineering degree programs. The major difference between the two accredited degree programs is that an engineering design component is required in the accredited computer engineering degree program.

Information science degree programs are tailored to prepare students for careers in the application of computers in business. Therefore these degree programs typically reside in business colleges and are not accredited by ABET. Although there are a few ABET accredited programs offered in engineering colleges. In addition to computer science courses in programming, computer organization and operation, computer networks, databases, these degree programs require courses in business and management, and fewer courses are required in mathematics and the sciences than in computer science and engineering degree programs.

### ► Admission Requirements

Admissions requirements for undergraduate computer science programs include a solid background in mathematics (algebra, geometry, trigonometry, and calculus) and science (biology, chemistry, and physics), and courses in English, social studies, humanities, and computer and information technology. Bachelor's degree programs in computer science typically are designed to last 4 years.

### ► Co-ops

Internships and Coops provide students with a great opportunity to gain real-world experience while still in school. In addition, graduates can enhance their employment opportunities by participating in internship or co-op programs offered through their school.



### ► Courses of Study

In a typical four year 120 semester hour computer science degree program students studying computer science will complete 40 semester hours of study in computer science topics, along with at least 30 semester hours of study in mathematics (discrete mathematics, differential and integral calculus, and probability and statistics) and science topics, usually including a lab experience. Students will study topics such as algorithms, data structures, software design, concepts of programming languages, and computer organization and architecture. In addition, theoretical foundations, problem analysis, and solution design will be presented within the program of study. Students will also be exposed to a variety of programming languages and systems and should become proficient in at least one higher-level language. Good communication skills will be developed along with general studies in humanities, social sciences, and the arts.

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## ► Ongoing Study

Technological advances come so rapidly in the computer field that continuous study is necessary to keep one's skills up to date post graduation. Employers, hardware and software vendors, colleges and universities, and private training institutions offer continuing education. Additional training may come from professional development seminars offered by professional computing societies.

## ► Accredited Programs

Those interested in a career in Computer Science should consider reviewing programs that are accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET). ABET accreditation is based on an evaluation of a program's student achievement, program improvement, faculty, curricular content, facilities, and institutional commitment. The following is a current list of universities offering accredited degree programs in Computer Science.

<ul style="list-style-type: none"><li>• Alabama A&amp;M University</li><li>• University of Alabama at Birmingham</li><li>• The University of Alabama in Huntsville</li><li>• The University of Alabama</li><li>• University of Alaska Fairbanks</li><li>• Appalachian State University</li><li>• Arizona State University</li><li>• University of Arkansas at Little Rock</li><li>• University of Arkansas</li><li>• Armstrong Atlantic State University</li><li>• Auburn University</li><li>• Baylor University</li><li>• Bloomsburg University of Pennsylvania</li><li>• Boise State University</li><li>• Bowie State University</li><li>• Brigham Young University</li><li>• Bucknell University</li><li>• California Polytechnic State University, San Luis Obispo</li><li>• California State Polytechnic University, Pomona</li><li>• California State University, Chico</li><li>• California State University, Dominguez Hills</li><li>• California State University, Fullerton</li><li>• California State University, Long Beach</li><li>• California State University, Los Angeles</li><li>• California State University, Northridge</li><li>• California State University, Sacramento</li><li>• California State University, San Bernardino</li><li>• California University of Pennsylvania</li><li>• University of California, Berkeley</li><li>• University of California, Davis</li><li>• University of California, Los Angeles</li><li>• University of California, Riverside</li><li>• University of California, Santa Barbara</li><li>• Calvin College</li><li>• Case Western Reserve University</li><li>• Cedarville University</li><li>• Central Connecticut State University</li><li>• University of Central Florida</li><li>• College of Charleston</li><li>• University of Cincinnati</li></ul>	<ul style="list-style-type: none"><li>• University of Nebraska at Omaha</li><li>• University of Nebraska-Lincoln</li><li>• University of Nevada-Las Vegas</li><li>• University of Nevada-Reno</li><li>• University of New Hampshire</li><li>• University of New Haven</li><li>• New Jersey Institute of Technology</li><li>• College of New Jersey</li><li>• University of New Mexico</li><li>• University of New Orleans</li><li>• State University of New York at Binghamton</li><li>• State University of New York at Brockport</li><li>• State University of New York at New Paltz</li><li>• City University of New York, City College</li><li>• City University of New York, College of Staten Island</li><li>• Nicholls State University</li><li>• Norfolk State University</li><li>• North Carolina Agricultural and Technical State University</li><li>• University of North Carolina at Greensboro</li><li>• North Carolina State University at Raleigh</li><li>• North Dakota State University</li><li>• University of North Dakota</li><li>• University of North Florida</li><li>• University of North Texas</li><li>• Northeastern University</li><li>• Northern Arizona University</li><li>• University of Notre Dame</li><li>• Oakland University</li><li>• The Ohio State University</li><li>• Ohio University</li><li>• The University of Oklahoma</li><li>• Oregon State University</li><li>• Pace University</li><li>• Pacific Lutheran University</li><li>• University of the Pacific</li><li>• University of Pennsylvania</li><li>• Plymouth State University</li><li>• Polytechnic University</li><li>• Portland State University</li></ul>
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- Clemson University
- Coastal Carolina University
- University of Colorado at Colorado Springs
- University of Colorado at Denver and Health Sciences Center
- University of Connecticut
- Drexel University
- East Tennessee State University
- Eastern Kentucky University
- Eastern Washington University
- University of Evansville
- Fairleigh Dickinson University (Metropolitan Campus)
- Florida A & M University
- Florida Atlantic University
- Florida Institute of Technology
- Florida International University (University Park)
- Florida State University
- Gannon University
- George Mason University
- The George Washington University
- Georgia Institute of Technology
- Georgia Southern University
- Grambling State University
- Hampton University
- University of Houston
- University of Houston-Clear Lake
- Howard University
- Idaho State University
- University of Idaho
- University of Illinois at Chicago
- University of Illinois at Urbana-Champaign
- Illinois Institute of Technology
- Illinois State University
- Indiana University-Purdue University Fort Wayne
- Iona College
- Iowa State University
- Jackson State University
- Jacksonville State University
- The Johns Hopkins University
- Kansas State University
- The University of Kansas
- Kennesaw State University
- University of Kentucky
- Lafayette College
- Lamar University
- Lehigh University
- University of Louisiana at Lafayette
- University of Louisiana at Monroe
- Louisiana State University, Shreveport
- Louisiana Tech University
- University of Louisville
- Loyola College in Maryland
- University of Maine
- University of Maryland Baltimore County
- University of Massachusetts Boston
- University of Massachusetts Dartmouth

- University of Portland
- Prairie View A & M University
- Radford University
- Robert Morris University
- Rochester Institute of Technology
- Rose-Hulman Institute of Technology
- Rowan University
- Salem State College
- San Diego State University
- San Francisco State University
- San Jose State University
- University of Scranton
- Shippensburg University
- Slippery Rock University
- University of South Alabama
- South Carolina State University
- University of South Carolina Upstate
- University of South Carolina
- South Dakota School of Mines and Technology
- South Dakota State University
- University of South Florida
- Southeastern Louisiana University
- University of Southern California
- Southern Connecticut State University
- Southern Illinois University-Edwardsville
- University of Southern Maine
- Southern Methodist University
- University of Southern Mississippi
- Southern Polytechnic State University
- Southern University and Agricultural & Mechanical College
- St. Cloud State University
- Stephen F. Austin State University
- Stevens Institute of Technology
- Stony Brook University
- Syracuse University
- University of Tennessee at Chattanooga
- Tennessee Technological University
- Texas A & M University
- University of Texas at Arlington
- University of Texas at Dallas
- University of Texas at El Paso
- Texas Christian University
- Texas State University-San Marcos
- The University of Texas-Pan American
- The University of Toledo
- Towson University
- Tufts University
- Tulane University
- The University of Tulsa
- United States Air Force Academy
- United States Military Academy
- United States Naval Academy
- Utah State University
- Utah Valley State College
- Villanova University

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| <ul style="list-style-type: none"> <li>• Massachusetts Institute of Technology</li> <li>• University of Massachusetts Lowell</li> <li>• McNeese State University</li> <li>• The University of Memphis</li> <li>• Mercer University</li> <li>• Metropolitan State College of Denver</li> <li>• Miami University</li> <li>• University of Michigan</li> <li>• University of Michigan-Dearborn</li> <li>• Middle Tennessee State University</li> <li>• Millersville University of Pennsylvania</li> <li>• University of Minnesota Duluth</li> <li>• Mississippi State University</li> <li>• Mississippi Valley State University</li> <li>• University of Mississippi</li> <li>• Missouri State University</li> <li>• Missouri University of Science and Technology</li> <li>• Montana State University - Bozeman</li> <li>• Montana Tech of the University of Montana</li> <li>• University of Montana</li> <li>• Montclair State University</li> </ul> | <ul style="list-style-type: none"> <li>• Virginia Commonwealth University</li> <li>• Virginia Military Institute</li> <li>• Virginia Polytechnic Institute and State University</li> <li>• University of Virginia</li> <li>• Washington State University</li> <li>• University of West Georgia</li> <li>• West Virginia University</li> <li>• Western Kentucky University</li> <li>• Western Michigan University</li> <li>• Western Washington University</li> <li>• Westfield State College</li> <li>• Winston-Salem State University</li> <li>• Winthrop University</li> <li>• University of Wisconsin - Eau Claire</li> <li>• University of Wisconsin-Oshkosh</li> <li>• Worcester Polytechnic Institute</li> <li>• Wright State University</li> <li>• University of Wyoming</li> </ul> |
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## Specialty Areas

Most computer scientists are further classified by areas of focus. The following is a list of several major specialty areas within computer science:

- ▶ Algorithms and Theory
- ▶ Artificial Intelligence
- ▶ Architecture, Parallel Computing and Systems
- ▶ Bioinformatics and Computational Biology
- ▶ Database and Information Systems
- ▶ Graphics, Visualization and the Human Computer Interface
- ▶ Systems and Networking
- ▶ Programming Languages, Formal Systems, and Software Engineering
- ▶ Scientific Computing

### ▶ Algorithms and Theory

Research in this area focuses on the design and analysis of algorithms and data structures for problems arising in several areas of computer science, including automatic software verification, computational geometry, data mining, and machine learning.

### ▶ Artificial Intelligence

This specialty area focuses on a broad range of topics that include knowledge representation, learning, vision, reasoning, robotics, information systems, and planning. Application areas include molecular biology, manufacturing, control theory, and scheduling.

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## ► **Architecture, Parallel Computing and Systems**

Those focusing on the specialty area of architecture develop hardware designs, programming languages, and their compilers for next-generation computers and computing components. The specialty area of parallel computing area focuses on projects of varying size and investigates the software aspects of computation on computers composed of multiple processors.

## ► **Bioinformatics and Computational Biology**

Research in this area includes developing efficient and scalable algorithms for biomolecular simulation and applying data mining, statistical machine learning, natural language processing, and information retrieval to analyze and mine all kinds of biological data, including DNA sequences, protein sequences and structures, microarray data, and biology literature, for the purpose of facilitating biology discovery.

## ► **Database and Information Systems**

Individuals working in this area would conduct fundamental and cutting-edge research in databases, data mining, web mining, information retrieval, and natural language processing. Current areas of focus might include data integration, exploring and integrating the "Deep Web;" schema matching; security; mining data streams and sequential and semi-structured data; operating systems support for storage systems; text retrieval and mining; bio-informatics; database support for high performance computing; and top-k query processing.

## ► **Graphics, Visualization and the Human Computer Interface**

Graphics and visualization research includes modeling and animation of natural phenomena, computational topology, graphics hardware utilization, image based rendering, implicit surfaces, mesh processing and simplification, procedural modeling and texturing, shape modeling, surface parameterization, and visibility processing. Human-Computer Interface research involves user interface tools that better support early design tasks, systems and environments that help users maintain information awareness, tools for multimedia authoring and design, interfaces that foster social interaction, and, more generally, human-computer interaction.

## ► **Systems and Networking**

Networking and distributed systems group research includes a broad range of topics that include mobile systems, wireless protocols, ad-hoc networks, Quality of Service management, multimedia networking, peer-to-peer networking, routing, network simulations, active queue management, and sensor networks.

Operating system research focuses on distributed resource management, management of ubiquitous computing environments, reflective middleware, middleware "meta-operating systems," object-oriented operating system design, user interfaces that allow single users to interact with multi-computers, peer-to-peer operating system services, and context-sensitive distributed file systems, power management for data centers, file/storage systems, autonomic computing, system support for software robustness, and system support for databases. Security research includes dynamic security architectures; security for active networks; privacy, authentication, authorization, access control, and trust in ubiquitous computing environments that have mobile users; authentication in sensor networks; specification and

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validation of security access control policies; simulation of network security problems and solutions including denial of service; and next generation phone security. Real-time and embedded systems research areas include open real-time systems QoS driven real-time scheduling and communication protocols, integrated design of controllers and real-time schedulers, the integration between real-time, fault tolerant and security protocols, and robust dynamic real-time architecture for networked devices and smart spaces.

### ► **Programming Languages, Formal Systems, and Software Engineering**

Those working in this specialty area study the design and implementation of computer languages, with the goal of improving both programmer productivity and program quality. The topics of study range from abstract theories of computer languages to practical questions about the use and implementation of high-level languages.

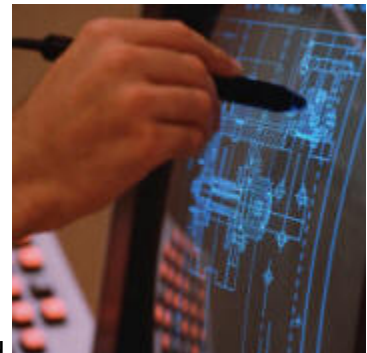
### ► **Scientific Computing**

Individuals working in the specialty area of scientific computing conduct research on the development and analysis of numerical techniques for approximating mathematical models of physical systems and on algorithms for solving the resulting equations on high performance computer systems. Specific scientific and engineering applications considered include biological molecular dynamics, materials science, semiconductor simulation, astrophysics, and the design of solid propellant rockets.

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## **Day in the Life**

The rapid spread of computers and information technology has generated a need for highly trained workers to design and develop new hardware and software systems and to incorporate new technologies. Job tasks and occupational titles used to describe these workers evolve rapidly, reflecting new areas of specialization or changes in technology, as well as the preferences and practices of employers.



### ► **Job Duties**

Computer scientists must be able to think logically and have good communication skills. Because they often deal with a number of tasks simultaneously, the ability to concentrate and pay close attention to detail is important. Computer scientists employed in private industry may advance into managerial or project leadership positions. Those employed in academic institutions can become heads of research departments or published authorities in their field. Database administrators may advance into managerial positions, such as chief technology officer, on the basis of their experience managing data and enforcing security. Computer specialists with work experience and considerable expertise in a particular subject or a certain application may find lucrative opportunities as independent consultants or may choose to start their own computer consulting firms.

### ► **The Workplace**

Computer scientists normally work in offices or laboratories in comfortable surroundings. They usually work about 40 hours a week -- the same as many other professional or office workers



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do. However, evening or weekend work may be necessary to meet deadlines or solve specific problems. Given the technology available today, telecommuting is common for computer professionals. As networks expand, more work can be done from remote locations through modems, laptops, electronic mail, and the Internet.

Like other workers who spend long periods in front of a computer terminal typing on a keyboard, computer systems analysts, database administrators, and computer scientists are susceptible to eyestrain, back discomfort, and hand and wrist problems such as carpal tunnel syndrome or cumulative trauma disorder. Through the adoption of good practices and modification of the workplace environment these problems can be mitigated.

### ► Teams and Coworkers

Although computer specialists sometimes work independently, they frequently work in teams on large projects. They must be able to communicate effectively with computer personnel, such as programmers and managers, as well as with users or other staff who may have no technical computer background.

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## Earnings

According to the US Department of Labor, Bureau of Labor Statistics, median annual earnings of computer and information scientists were \$93,950 in the most recent data. The middle 50 percent earned between \$71,930 and \$118,100. The lowest 10 percent earned less than \$53,590, and the highest 10 percent earned more than \$144,880. Median annual earnings of computer and information scientists employed in computer systems design and related services were \$95,340.

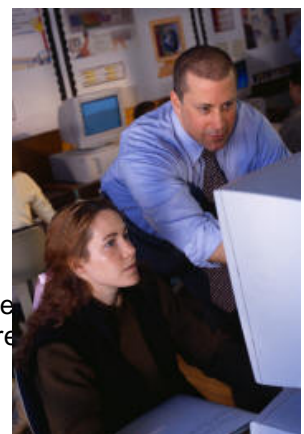


According to the National Association of Colleges and Employers, Summer 2008 Salary Survey Class computer science graduates were offered an average salary offer of \$60,416.

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## Employment

According to the US Department of Labor, Bureau of Labor Statistics, computer scientists and database administrators hold about 542,000 jobs in the U.S., including about 58,000 who were self-employed. Employment was distributed among the detailed occupations as follows:



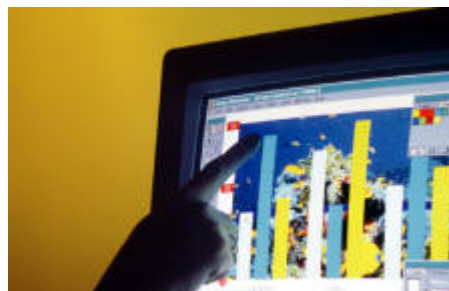
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Network systems and data communication analysts - 262,000  
 Database administrators - 119,000  
 Computer and information scientists, research - 25,000  
 Computer specialists, all other - 136,000

Although they are increasingly employed in every sector of the economy, the greatest concentration of these workers is in the computer systems design and related services industry. Firms in this industry provide services related to the commercial use of computers on a contract basis, including custom computer programming services; computer systems integration design services; computer facilities management services, including computer systems or data processing facilities support services for clients; and other computer-related services, such as disaster recovery services and software installation. Many computer scientists and database administrators are employed by Internet service providers; Web search portals; and data processing, hosting, and related services firms. Others work for government, manufacturers of computer and electronic products, insurance companies, financial institutions, and universities.



A growing number of computer specialists, such as network and data communications analysts, are employed on a temporary or contract basis; many of these individuals are self-employed, working independently as contractors or consultants. For example, a company installing a new computer system may need the services of several network systems and data communication analysts just to get the system running. Because not all of the analysts would be needed once the system is functioning, the company might contract for such employees with a temporary help agency or consulting firm, or with the network systems analysts themselves. Such jobs may last from several months to 2 years or more. This growing practice enables companies to bring in people with the exact skills they need to complete a particular project, rather than having to spend time or money training or retraining existing workers. Often, experienced consultants then train a company's in-house staff as a project develops.

The following is a partial list of employers of Computer Scientists:

Technology Intensive Firms	Other Firms
<ul style="list-style-type: none"> <li>▪ Apple Computer</li> <li>▪ AT&amp;T</li> <li>▪ Cisco Systems</li> <li>▪ Dell</li> <li>▪ Fujitsu Siemens Computers</li> </ul>	<ul style="list-style-type: none"> <li>▪ 3M Worldwide</li> <li>▪ Abbott Laboratories</li> <li>▪ Best Buy Corporation</li> <li>▪ Bristol-Myers Squibb Company</li> <li>▪ CNN</li> </ul>

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