1.9 Why programming

Computing careers

While careers in law, medicine, and engineering have existed for hundreds of years, computers are relatively new so careers in computing are new too. Today, computing jobs are often ranked among the best jobs, in terms of opportunity, salary, work-life balance, job security, job satisfaction, work conditions, etc. Nearly all computing jobs require some training in programming; some jobs then focus on programming, while others instead focus on related aspects.

In a 2019 ranking (below), the top job is software developer. In another ranking, 3 of the top 20 were computing jobs. Note: Rankings from different sources vary greatly; some have more engineers, human resources managers, data scientists, marketing, etc. Also, the specific ordering in a ranking is not usually substantial (like rank #2 vs. #5), and rankings change every year. However, note that most rankings consistently have several computing jobs in the top tier.

Table 1.9.1: Best jobs of 2019, per U.S. News and World Report.

The rankings are based off growth potential, work-life balance, and salary.

Ranking	Occupation	Description
1	Software developer	Designs computer programs, combining creativity and technical know-how, often working in teams.
2-4	Statistician, physician's assistant, dentist	
5 (tie)	Orthodontist, Nurse Anesthetist	
7-8	Nurse Practitioner, Pediatrician	
9 (tie)	Obstetrician and Gynecologist, Oral and Maxillofacial Surgeon, Prosthodontist, Physician	

Source: U.S. News and World Report (includes links to expanded descriptions), 2019.

Feedback?

PARTICIPATION ACTIVITY 1.9.1: Computing jobs are often ranked among the best jobs.

1) What factor was used to rank the best jobs?
   - Salary
   - Job security
   - Multiple factors were considered

Correct

Salary, job security, work conditions, opportunities, and many other factors are typically considered.

2) Software developers spend nearly all their time alone at a computer.
   - True
   - False

Correct

Software developers commonly work closely with team members, making joint decisions, helping each other, testing each others' software, etc. They also work closely with customers, sales teams, other engineers, etc.

3) Interestingly, the above list is dominated by jobs in what two general areas?
   - Computing, and health care
   - Computing, and manufacturing

Correct

Furthermore, many computing applications deal with health, and many health workers make extensive use of computers. NOTE: Different rankings exist, some of which have more computing jobs and more non-health jobs like human resource manager, marketing manager, various engineers, etc.

Feedback?

Types of computing jobs

Table 1.9.2: Computing jobs.

A wide variety of computing jobs exist.

Occupation	Job Summary	Entry-level education	2018 median pay
Computer and Information Research	Computer and information	Doctoral or professional degree	$111,370

Scientists	research scientists invent and design new approaches to computing technology and find innovative uses for existing technology. They study and solve complex problems in computing for business, medicine, science, and other fields.		
Computer Network Architects	Computer network architects design and build data communication networks, including local area networks (LANs), wide area networks (WANs), and intranets. These networks range from a small connection between two offices to a multinational series of globally distributed communications systems.	Bachelor's degree	$109,020
Computer Programmers	Computer programmers write code to	Bachelor's degree	$84,280

	create software programs. They turn the program designs created by software developers and engineers into instructions that a computer can follow.		
Computer Support Specialists	Computer support specialists provide help and advice to people and organizations using computer software or equipment. Some, called computer network support specialists, support information technology (IT) employees within their organization. Others, called computer user support specialists, assist non-IT users who are having computer problems.	Varies: High-school degree and higher	$53,470
Computer Systems Analysts	Computer systems analysts study an organization's current	Bachelor's degree	$88,740

	computer systems and procedures and design information systems solutions to help the organization operate more efficiently and effectively. They bring business and information technology (IT) together by understanding the needs and limitations of both.		
Database Administrators	Database administrators (DBAs) use specialized software to store and organize data, such as financial information and customer shipping records. They make sure that data are available to users and are secure from unauthorized access.	Bachelor's degree	$90,070
Information Security Analysts	Information security analysts plan and carry out security measures to	Bachelor's degree	$98,350

	protect an organization's computer networks and systems. Their responsibilities are continually expanding as the number of cyberattacks increase.		
Network and Computer Systems Administrators	Computer networks are critical parts of almost every organization. Network and computer systems administrators are responsible for the day-to-day operation of these networks.	Bachelor's degree	$82,050
Software Developers	Software developers are the creative minds behind computer programs. Some develop the applications that allow people to do specific tasks on a computer or other device. Others develop the underlying systems that run the devices or control networks.	Bachelor's degree	$105,590

Web Developers	Web developers design and create websites. They are responsible for the look of the site. They are also responsible for the site's technical aspects, such as performance and capacity, which are measures of a website's speed and how much traffic the site can handle. They also may create content for the site.	Associate's degree	$69,430

Source: bls.gov (includes links to detailed descriptions and outlooks for each occupation).

Feedback?

PARTICIPATION ACTIVITY 1.9.2: Computing jobs.

Refer to the above BLS table of computing jobs.

Computer support specialists

Likely requires both a strong knowledge of computer technology, and excellent interpersonal skills due to dealing with non-technical users.

Computer support specialists may

Correct

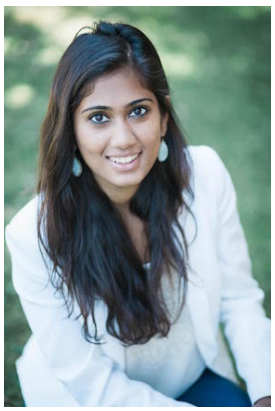
	share with software developers particular program features and interfaces that confuse users.	
Software developers	Create, design, and program software. Software developers often have a firm understanding of available technologies for building software.	**Correct**
Computer programmers	Help write programs created by software developers. Computer programmers may write code in multiple computer languages on a daily basis.	**Correct**
Computer systems analysts	Help organizations use computing technology to operate effectively. Requires strong combination of business and computing technology knowledge. Computer systems analysts also help organizations operate more efficiently.	**Correct**
Information security analysts	Focus on protecting an organization's computers and data. Increasingly important as "hackers" continue to steal huge amounts of data, as widely-publicized in recent years. Information security analysts learn the weaknesses of computers in order to protect the computers and data.	**Correct**
Web developers	Build websites, which may involve the look/feel, the content, the performance of the site, and more. Web development is a rapidly evolving field, with many technologies created to make web development more efficient.	**Correct**

Reset

Feedback?

For many non-computing jobs (dentist, attorney, nurse, business, etc.), computer usage is high, and thus knowledge of computing technology can yield strong advantages even for people not in a computing career.

Programming and non-computing jobs



Many people in non-computing jobs find that knowing some programming can benefit their careers. Some examples:

- *Kelly* majored in chemistry, and now works as a scientist in a pharmaceutical company. Kelly helps analyze clinical trials. Her company uses commercial statistical software, but she found that writing small custom programs yielded even better analyses. Her co-workers now come to her for help. She is glad she took a required programming class in college, though at the time she wasn't as happy about it.
- *Paul* majored in civil engineering, and now authors technical content for a large company. Paul noticed that several authoring tasks done in Google Docs by the in-house 25-person authoring team could be automated. Building on the programming he learned in a required college course, Paul spent several hours online learning about Google Docs "add on" programming, and wrote two small add-ons. His add-on programs have become part of the standard authoring process for the entire team, who frequently thanks Paul for saving them time and relieving them of tedious tasks.
- *Ethan* majored in business, and got a job in sales operations of a Silicon Valley startup company. Building on the C++ programming he learned from a college course, he started tinkering with writing database query programs using "SQL", and discovered he had a knack for it. His job duties have expanded to include running database reports, and he has automated dozens of reports via programming, helping people throughout the company be more productive.
- *Eva* (pictured above) majored in environmental science. She voluntarily took a programming course in college believing the knowledge/skills could be important to her. She took a job at a startup company doing various marketing tasks. She began to manage the company's website, and realized that a few small programs could make the web pages dynamic and interactive. She wrote the code herself, which was reviewed and approved by the engineering team and became part of the company's live website. She plans on getting a graduate degree in environmental science and expects programming will be useful in her research.

PARTICIPATION ACTIVITY 1.9.3: Programming in non-computing jobs.

Consider the examples above.

1) Kelly voluntarily took a programming course in college.
   - ○ True
   - ◉ False

Correct

Kelly was required to take a programming course, and wasn't happy about it, as she didn't see what programming had to do with chemistry. But now she is glad she did, because the relatively small amount of programming she does in her job has benefited her career.

2) Ethan learned SQL programming in a college course and now applies SQL programming in his job.
   - ○ True
   - ◉ False

Correct

Actually, Ethan learned C++, and the SQL he now programs in his job is quite different. But many core programming skills apply across different languages. Once a student learns to program in one language, learning to program in other languages can be much easier and less intimidating too.

3) Eva voluntarily took a programming class in college.
   - ◉ True
   - ○ False

Correct

Eva's major did not require programming. But, seeing how widespread computer usage is, she challenged herself to take introductory programming, even though she knew the course was hard. It was a lot of work, but she's glad she did it.

Feedback?

Precision, logic, and computational thinking

Many people find that programming encourages precise, logical thought that can lead to better writing and speaking, clearer processes, and more. The thought processes needed to build correct, precise, logical programs is sometimes called ***computational thinking*** and has benefits beyond programming.

PARTICIPATION ACTIVITY 1.9.4: Learning programming tends to aid in precise, logical thought, aspects of computational thinking.

1 2 3 4 ▶ 2x speed

Workers will be painting offices on Monday.
The painters will have ID tags.

They are white and brown.
Inform the contractors of special requests.

Common English usage may be vague. Are workers, painters, and contractors the same people or different? What exactly is white and brown?

Feedback?

New programmers often complain about how unforgiving programming is, but such attention to detail is one of the benefits of learning programming.

PARTICIPATION ACTIVITY 1.9.5: Computational thinking.

1) What's wrong with this survey question?

How many minutes did you spend?
__ Under 5
__ 6 or more

- Should say "More than 6" instead of "6 or more".
- (selected) Exactly 5 minutes is not a choice

Correct

The first choice covers 0 - 4. The second covers 6 - infinity. 5 is not covered. Programmers are trained to think precisely about such ranges. (Note: This is a common mistake on surveys).

2) An online shopping site allows setting up a recurring order. A person needs to determine the order frequency for laundry detergent. One bottle does 64 loads. He

Correct

Programmers become very good at analyzing processes over time, among other useful mental processes. Here, the person determines the rate is 1 + 1 + 0.5 per week, and 64 / 2.5 is 25.6, so every 24 weeks helps ensure the next bottle arrives before the previous one empties.

does a load a week. His wife does a load a week. His daughter does a load every two weeks. What's the best frequency?

- (●) Every 24 weeks
- ( ) Every 32 weeks
- ( ) Every 64 weeks

Feedback?

You've never done anything like this

Programming is different than nearly anything most students have done before. Most new programmers initially struggle. Just as a child learning to walk will stumble and fall, a student learning to program will stumble and fall many times as well.

Programs have literally transformed the world in the past few decades. But, *correct programs are hard to create*. Programs are among the most sophisticated of human creations. Even one wrong symbol in a program with thousands of characters can cause the program to entirely fail. And programs deal with doing long sequences of tasks over time. Such features are not common in other aspects of life.

Programming is a combination of concepts and skill. The skill part is not as common in other "academic" subjects. Learning to program thus requires practice. A student cannot watch a piano teacher play and then walk away playing piano. Writing correct expressions, properly formed if-else branches, correctly working loops, etc., requires repeated attempts, and, like the new piano player, lots of mistakes along the way.

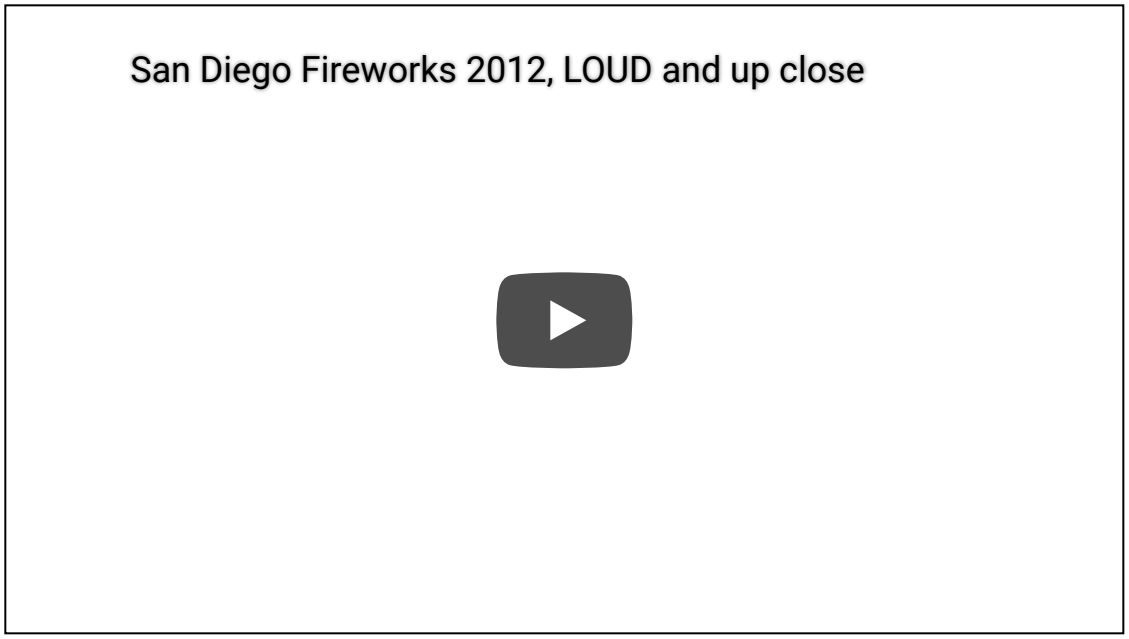
Programming also requires a lot of mental energy. No easy steps exist for how to solve a given problem by writing a program. Many students are not accustomed to having to think so hard to solve a problem, instead looking to follow standard steps or just trying to "look up the answer".

Students studying programming are about to embark on one of the most rewarding but also the most challenging of human endeavours. When stuck, students may wish to take solace that everyone struggles. Like the child learning to walk, each fall hurts, but know that each fall brings one closer to learning a powerful skill.

Even the best programmers make mistakes

Even the best programmers make mistakes. In San Diego 2012, a software bug caused 17-minutes of fireworks to launch nearly simultaneously.

Video 1.9.1: When software goes wrong...



PARTICIPATION ACTIVITY 1.9.6: Programming.

1) For most people, programming comes easy.
   - ○ True
   - ◉ False

Correct

Programming is different than anything most people have ever done, and is one of the most challenging things humans do. Learning programming takes practice and patience, but can be rewarding in many ways.

2) If a student has trouble converting a problem statement into a program, the teacher and/or learning content must have done a poor job.
   - ○ True
   - ◉ False

Correct

Teachers and learning content can only do so much. Programming does not just involve conceptual knowledge, but is also a skill. Like riding a bike, playing piano, driving a car, or shooting a basketball, everyone is weak initially. Lots of practice is essential to learning programming.

Feedback?