Computer science

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1 What is computer science?

Computer science can be defined as the study of computers -their design, capabilities, and limitations. Most of computer science falls into the domains of hardware or software. This one other domain, *theory*, that is primarily associated with software but can involve hardware. Theory addresses issues of complexity, *algorithms*(ways of doing things), efficiency, and limitations of algorithms and computers, among other things.

Operating systems provide a link between the user, the hardware, and the software. The operating system creates an environment with specialized commands that let the user perform various sophisticated actions. Exactly what this environment looks like and what actions are supported depend on the particular operating system. Some of these actions may include:

- displaying information on terminals or printing on printers
- sorting, searching, and restructuring information
- hiding or making available information to others using the same computer
- modifying or creating information
- getting instructions on using the operating system itself
- providing access to programs that perform a wide array of tasks
- accessing or sending information to other computers
- sending information to other people on the same or different computers.

Operating systems perform other actions. Computers have *keyboards*(or other input devices such as a *mouse* or *writing pad*) and *terminals* that allow people to send and receive information to and from the computer. There are other *peripheral devices*, such as *line* or *laser printers* that produce paper copies of information stored in the computer, and *disk drives* that give the computer access to large amounts of information. The operating system controls all these resources.

Larger computer systems allow more than one person to use the computer simultaneously. The operating system tries to give each person the illusion that he or she is the only one using the machine. This is termed *time-sharing*. This is done by having the computer split its attention among the different users, somewhat like a parent dealing with many children at the same time. The operating system allocates the computer's resources, such as line printers and disk drives, among the people using the computer.

Operating systems may provide support for network features such as elecronic mail or access to bulletin boards. Transmitting data across networks to and from other computers is sometimes handled by the operating system as well.

Hardware performs a limited number of simple functions.This is because hardware design makes a tradeoff between simple, fast *functions* (or instructions) and complex, slower instructions. Designers have opted for simple, fast instructions due to the performance improvements given to the computer. It is possible to write programs using only the instructions that the hardware can perform. This hardware language is called *machine language*. Writing large, sophisticated programs in machine language is a tedious and rather unexciting process. This due to the simple nature of machine languages. It is like trying to to discuss your feelings about something important to you and only using kindergarten-level words. To remedy this, *high level programming languages* were developed as a link between the hardware and programmers. Human or *natural languages* do not make good programming languages as they are very ambiguous and highly *context sensitive*.

High-level programming languages are somewhat of a compromise between human spoken languages and machine languages. *Compilers* (translators) and *interpreters* (simulators) enable the computer to understand programs written in a high-level programming language. Compilers translate programs in these new languages into the machine language that the computer understands. Interpreters do not produce translated programs like compilers, but instead simulate the execution of the programs as compared to a *compiled* program. Compilers and interpreters are programs that are written in a language that the machine already understands. Therefore, one can build languages on top of others existing languages. Look at mathematics for analogy. Once you know the language of addition, subtraction, and so forth, you can build up algebra, and then build calculus upon your knowledge of algebra and basic math operations.

Another subfield of computer science is *database management systems*. One of the major use of computers is in storing, retrieving and updating information (data). A collection of data is referred to as a *database*. Just as operating systems act as an environment for users, database management systems are programs that provide an environment that is tailored for the creation, modification, and access of data. This new environment is often less flexible than one that a compiler or interpreter creates with a new language. However, the database management environment has many specialized features that are unique to the problems that you encounter when dealing with large amounts of data. Using such a system, you can easily make complex queries of the data, add new information, or change existing information.

For example, you may have a database of all the friends that you have with information on each person indicating their adress, phone number, birth date, association to you, and other pertinent information. With a database management system you need not worry about how that information is represented in the machine. There are still somethings you must decide about the representation, but they are all on a very high level. You can easily make queries into such a database to print all your friends who have a birthday this moth, or print everyone who is who is between the ages of twenty and twenty-five, in the hiking club, and living in San Francisco or New York.

The most controversial field of computer science is *artifical intelligence*. Artificial intelligence deals with the simulation or modeling of “intelligence” on computers. It comprises many subfields that each address some aspect of intelligence. These include:

- Natural language processing;
  Understanding, translating, and paraphrasing spoken languages such as English or German
- Machine learning:
  Learning new information from existing or newly obtained knowledge
- Problem solving:
  Solving tasks within realworld environments
- Expert systems:
  Embodying the knowledge of experts in a particular domain
- Robotics:
  Creating robots that can move about and function in real environments
- Vision:
  Recognizing three-dimensional objects given two-dimensional images

Soft computing deals with noneexact or subsymbolic information. The field comprises various fields, of which *fuzzy logic, neural networks* and *genetic algorithms* are the most noteworthy.

Fuzzy logic extends familiar, two-value logic that supports only true or false values, and extends it to incorporate *multivalued logic*. Multivalued logic lets one specify degrees of belief such as fuzzy concepts like tall, heavy, and small can be expressed more naturally. Fuzzy logic is primarily used to build fuzzy expert systems that are in control devices like antilock car brakes, washing machines, and subways.

Neural networks are loose simulations of neurons in the brain. They offeran alternate way of representing information from that used in traditional artificial intelligence, which uses symbols to represent knowledge. Neural networks represent information sub-symbolically. Information is distributed throughout the network. This has advantages and disadvantages over symbolic, exact representations.

Genetic algorithms simulate the process of evolutionary change. Information is represented as chromosomes that can change through *crosslinking* (two chromosomes splitting to form two new chromosomes) and mutation (a piece of chromosome changing) The chromosomes that perform better are kept, and the system evolves over time to yield a good solution to the problem at hand. Genetic algorithms work by going through a series of evolutionary changes until the system performs at a certain level.

Computer graphics involves modeling and simulating two- and three-dimensional objects on the computer. Examples of objects that have been modeled in simulated environments include aircraft in flight, ships, automobile aerodynamics, stress mental fatigue, CAT (Computer Axial Tomography) and MRI (Magnetic Resonance Imaging) for medical examination of bones and tissues.

The field of computer-aided design (CAD), which helps people with the design of anything from buildings to bolts, depends on computer graphics. Architects use CAD tools to design buildings and show clients how the building will look once it is completed. In fact some of these tools even allow you to do a virtual walk-through of the building to get a feel for the space and the lighting.

Much work is done in graphics for the movie industry. This work may involve augmenting realworld scenes with lifelike, realistic special effects. Another avenue is creating fantastical special effects that would be impossible to created in the physical world, such as flying faster that the speed of light or descending into a black hole.

Oliver Grillmeyer, Exploring Computer Science with Scheme, Springer, 1999

VOCABULARY

Prepare a brief summary of the text above by underlining the most important technical issues concerning computers:

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1.1 Computer hardware

What do you know about computer hardware?

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1.2 Subfields within both Software and Hardware

The folowing passage is about the Greek-designed Antikythera mechanism, dating between 150 and 100 BC BC. Find the most important characteristics of this device.

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2 The history of computer science

Listen to the following documentary extract and tell how the development of computer technology has revolutionized science and society.

Compare the arguments presented in this extract and give your opinion.

- Introduction

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- Development

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- Conclusion
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Debate

Why has data become strategically so important with the rise of computer technology?