What is Computer Science?

Is Computer Science the study of computers (Building computers, and writing computer programs)?

✓ Computer Science is no more about computers than astronomy is about telescopes, or biology is about microscopes. Science is not about tools. It is about how we use them, and what we find out we can do.

✓ The solution of many computer science problems may not even require the use of computers.

✓ That said, the design and implementation of computing system hardware and software are part of the fundamental problems of computer science.
What is Computer Science?

Is Computer Science the study of the uses of computers and software?

- Learning to use software packages is no more a part of CS than driver’s education is part of automotive engineering.
- Computer Science is responsible for building and designing software.

What is Computer Science? (definition)

Computer Science is the systematic study of the feasibility, structure, expression, and mechanics of the methodical processes (or algorithms) that underlie the acquisition, representation, processing, storage, communication of, and access to information.

- CS is the study of “algorithms”
The study of algorithms

- **Design**
  - solving problems by designing algorithms
- **formal properties**
  - correctness, limits
  - efficiency/cost
- **mechanics**
  - Computer hardware and software
- **representation and expression**
  - programming languages
- **their applications**
  - network design, ocean modeling, bioinformatics, CAD/CAM, simulation, web.

What is an algorithm?

A well-defined procedure that allows an agent (computer) to solve a problem.

Algorithms must:
1. Be well-ordered and unambiguous
2. Be executable
3. Solve the problem, and
4. Terminate.
Types of Operations in an algorithm

- Basic operations
  - variable assignment, arithmetic operations
- Conditional operations
  - If ..., Then ..., Else ....
- Repeat/looping operations
  - Repeat step 1 and 2 three times
  - Repeat steps 2,3,4,...10 until .......

Fundamental Question of CS

- What and how computational processes can be efficiently automated and implemented?:
  - We study the very nature of computing to determine which problems are (or are not) computable.
  - We design algorithms to solve computable problems
  - We compare various algorithms to determine if they provide a correct and efficient solution to a concrete problem.
  - We design programming languages to enable the specification and expression of such algorithms.
  - We design, evaluate, and build computer systems that can efficiently execute such specifications.
  - We apply such algorithms to important application domains.
Computer science vs. computer engineering

- Computer engineering concerns itself with assembling hardware and software components to erect computing engines with the best cost-performance characteristics.
- Computer scientists worry about the feasibility and efficiency of solutions to problems in a manner that is less dependent on current technologies. As such, computer scientists work on abstractions that hide details of underlying implementations to enable the construction and comprehension of yet more complex systems.
  - For example, Web is a direct result of our ability to free Internet application developers from the lower-level implementation details of moving bits and bytes over wires from one point to another.

Computer Science vs. Informatics and Computer Technology

- Informatics focuses domain specific computing applications (hence, bioinformatics, health informatics, etc.), as well as the human use of and interaction with computer systems (e.g. HCI, digital media).
- Computer Technology emphasizes the application side of computer systems, i.e. the use and understanding of current technologies and computing products.
- Computer Science is more concerned about the principles of computing and the creation and development of new software and computing methods that apply to a broad range of applications.
- Applied Computer Science emphasize more on the application side of computer science.
What can a CS graduate do

- Software application developer
- Software systems developer
- Computer system analyst
- Web application developer
- Network systems administrator
- Database administrator
- Computer Scientist / Researcher
- Game developer
- Network security specialist

Computer Science Career Outlook

  Nearly 70% job growth in STEM through 2026 will be in computing.

- U.S. News best jobs (2019):
  #1 Software Developer
  255,400 Projected Jobs; $101,790 Median Salary
Computer Science Sub-Areas

- Theoretical computer science
- Software engineering
- Databases and data mining
- Artificial intelligence and Machine learning
- Information security
- Networking
- Graphics, Vision, and imaging
- Programming languages and compiler
- High performance computing
- Computer architecture
- Bioinformatics,
- Social computing, etc.
**DATA MINING AND MACHINE LEARNING (DMML) RESEARCH GROUP**

We develop algorithms for machine learning, i.e., automatically learning models, patterns, and skills from essentially big data. We then use these algorithms to discover new approaches to designing artificial intelligence systems, as well as to find novel computational solutions to biological, medical and other complex real-world scientific/technological problems.

- Prof. Mohammad Al Hasan
- Prof. Murat Dundar
- Prof. George Mohler
- Prof. Snehasis Mukhopadhyay
- Prof. Yuni Xia

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**SOFTWARE ENGINEERING AND HIGH PERFORMANCE COMPUTING RESEARCH GROUP**

Our research investigates and exploits the distributed and parallel models of computation to create innovative high-performance, secure, and quality-aware software systems for various real-world applications. We conceive, design, and develop innovative tools, system environments, and concrete prototypes to demonstrate the impact of our research.

- Prof. James Hill
- Prof. Rajeev Raje
- Prof. Fengguang Song
IMAGING AND VISUALIZATION RESEARCH GROUP

We conduct theoretical and applied research in the areas of Computer Vision, Computational Biology and Neuroscience, Medical Image Computing, Machine Learning and Imaging for Forensics. Our goal is to develop novel, automated and user guided computational methods that can provide robustness, accuracy and computational efficiency in the analysis of visual data. We work toward solutions to existing problems, as well as explore different scientific disciplines, where our research can contribute with useful interpretation, quantification and modeling.

- Prof. Shiaofen Fang
- Prof. Gavriil Tsechpenakis
- Prof. Mihran Tuceryan
- Prof. Jiangyu Zheng

NETWORKING AND NETWORK SECURITY RESEARCH GROUP

Our research includes Internet architecture, cyber infrastructure for sciences and engineering, wireless sensor networks (WSNs) and Internet of Things, ad hoc mobile networks, Software Defined Networking (SDN), networking and communication security, and various IoT, security and privacy issues in real life applications such as health care, personal genomics, social networking and electronic voting.

- Prof. Arjan Durresi
- Prof. Yao Liang
- Prof. Xukai Zou
- Prof. Qin Hu
Who is a Computer Scientist?

A computer science person likes to:
✓ solve problems
✓ create new things
✓ stay atop of technology

Code Stars (Video)