Introduction to Computer Engineering

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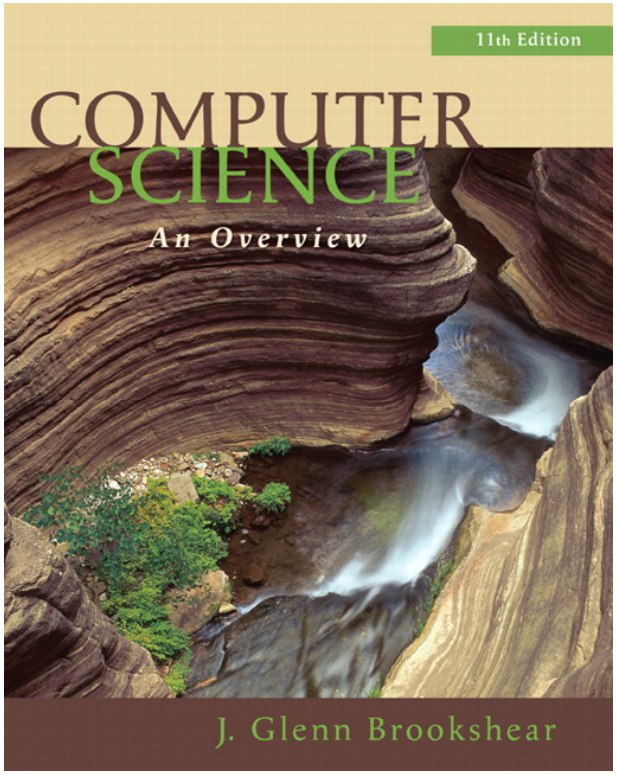
Textbook

- *Computer Science an Overview*

J.Glenn Brooksher, 11th Edition

Pearson 2011



Contents

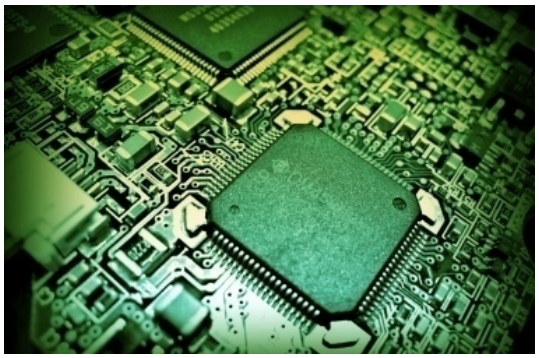
1. Computer science vs computer engineering
2. List of computer science fields defined by ACM and IEEE
3. Applied and theoretical computer science
4. A brief overview of computer science fields

Let’s start with a question!

Computer Science

vs

Computer Engineering



Science Definition

- The intellectual and practical activity encompassing the systematic study of the structure and behavior of the physical and natural world through observation and experiment [Dictionary]

- A systematic enterprise that builds and organizes knowledge in the form of testable explanations and predictions about the universe [Wikipedia]

Engineering Definition

- The branch of science and technology concerned with the design, building, and use of engines, machines, and structures. [Dictionary]

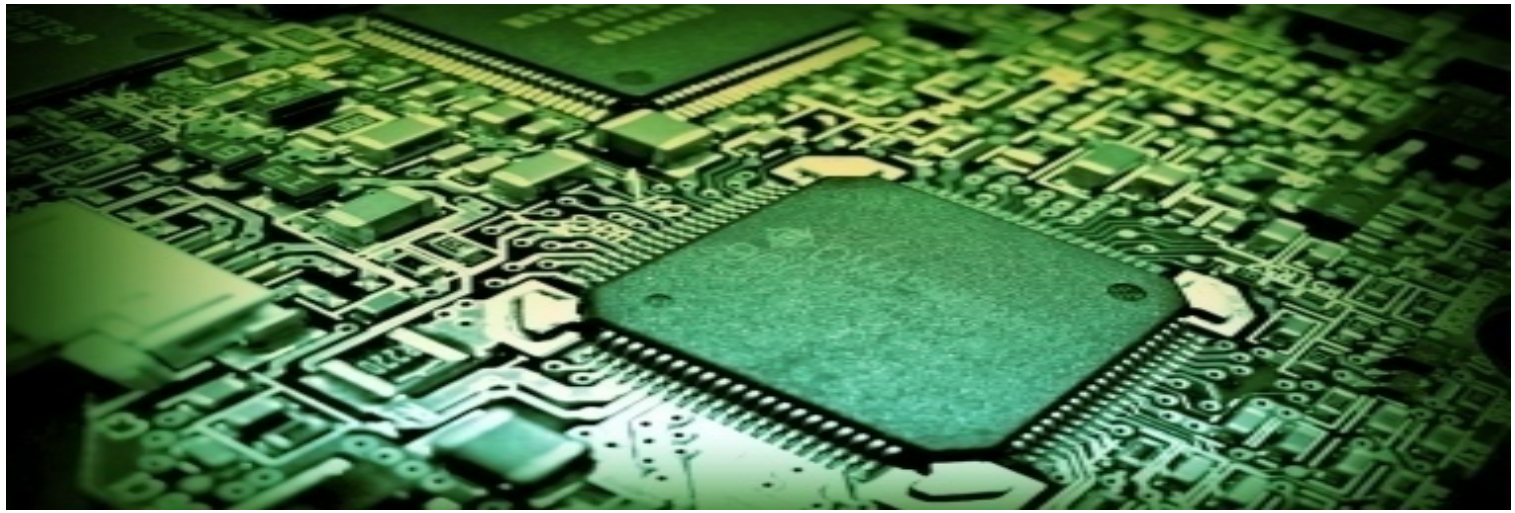
- The discipline, art, skill and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge, in order to design and build structures, machines, devices, systems, materials and processes that safely realize improvements to the lives of people. [Wikipedia]

Computer Science

- *Computer science* (abbreviated CS) is the study of the theoretical foundations of information and computation and of practical techniques for their implementation and application in computer systems

Computer Engineering

A discipline that integrates several fields of electrical engineering and computer science required to develop computer systems



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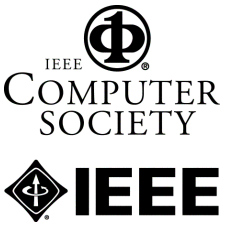
List of Computer Science Fields

CSAB Definition

- Computing Sciences Accreditation Board (CSAB)

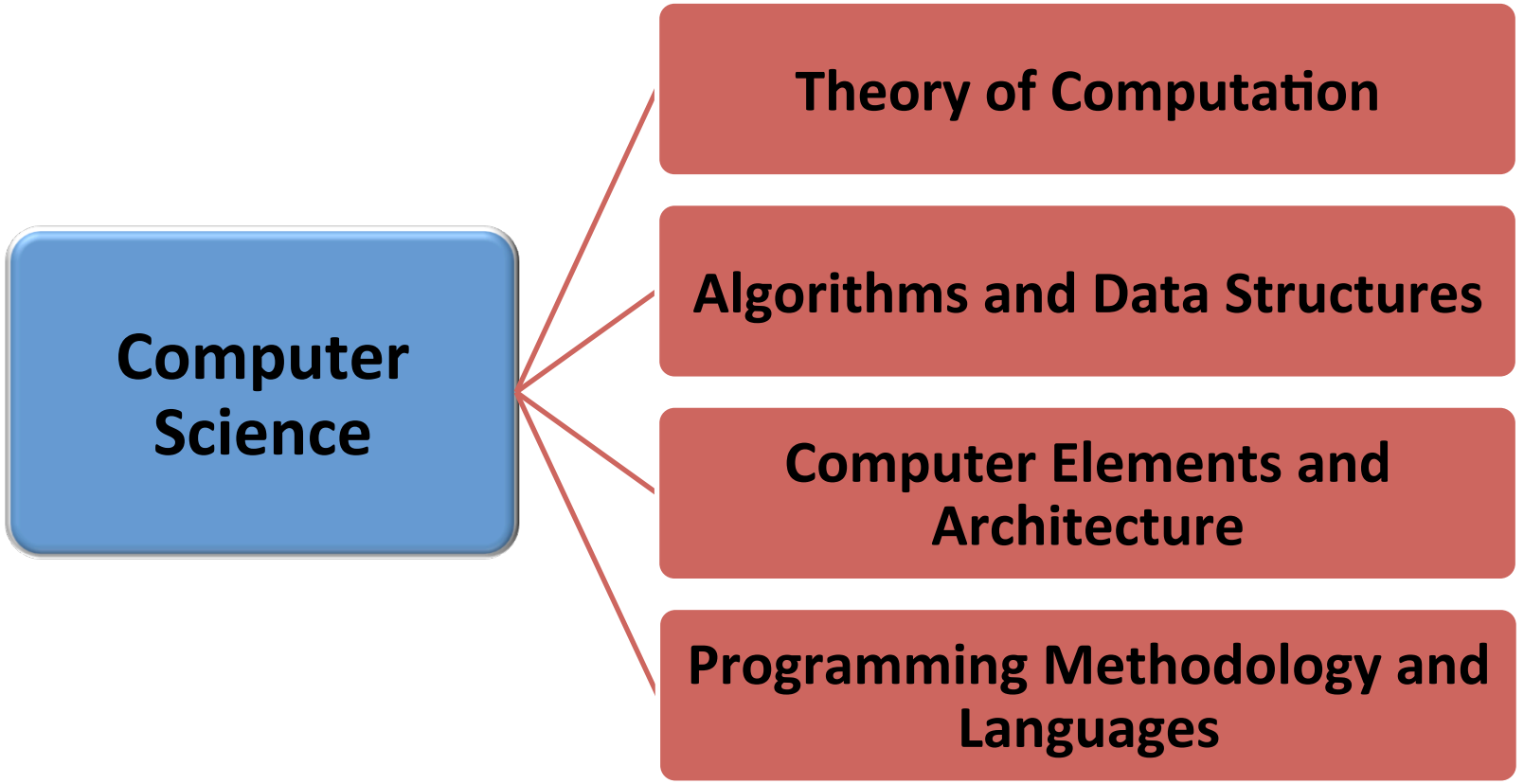
  - Association for Computing Machinery (ACM)

  - IEEE Computer Society (IEEE-CS)



List of Computer Science Fields

CSAB Definition



Other Related Fields: software engineering, artificial intelligence, computer networking and communication, database systems, parallel computation, distributed computation, computer-human interaction, computer graphics, operating systems, and numerical and symbolic computation

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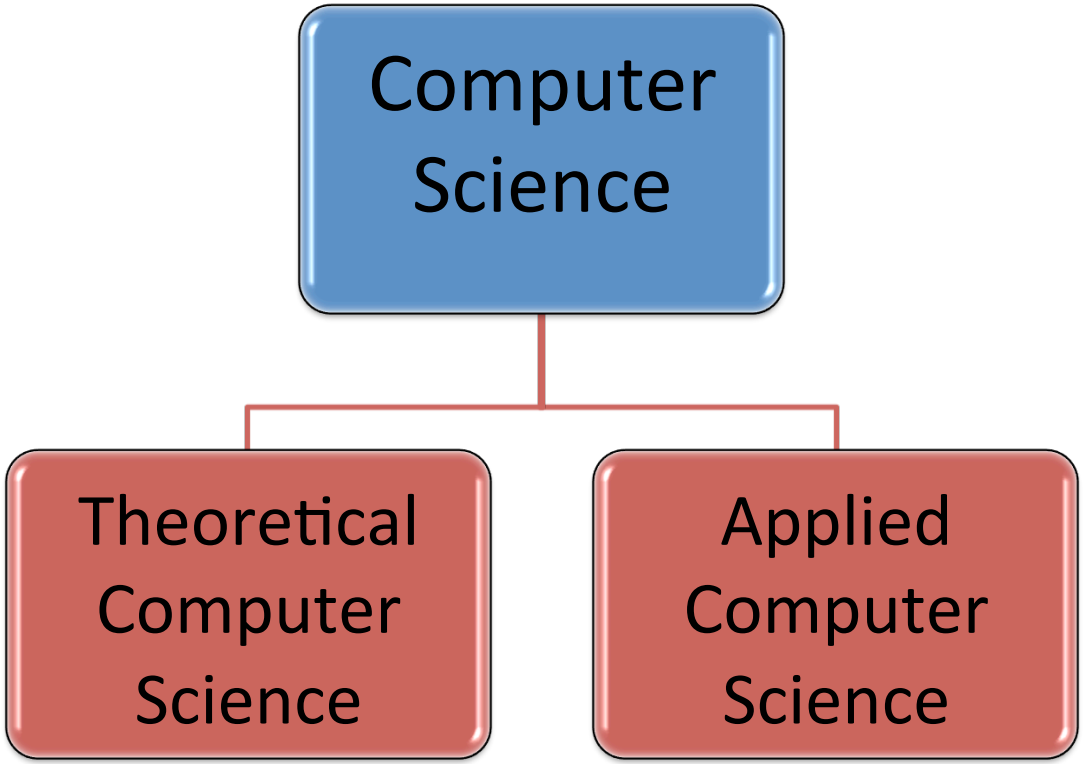
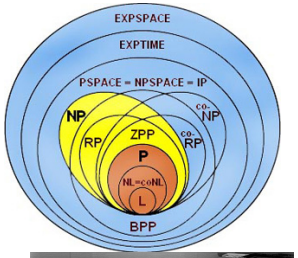
Computer Science Fields



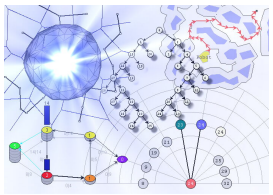
Theoretical Computer Science

- Theory of Computation



- Information and Coding Theory

- Algorithms and Data Structures



- Programming Language Theory

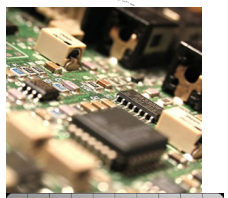
- Formal Methods

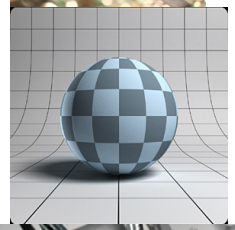
- Concurrent, Parallel and Distributed Systems

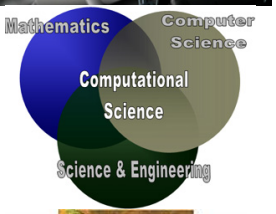
- Databases and Information Retrieval

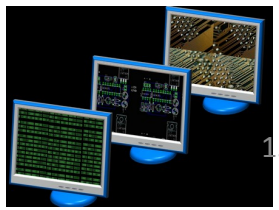
Applied Computer Science

- Artificial Intelligence
- Computer Architecture and Engineering
- Computer Graphics and Visualization
- Computer Security and Cryptography
- Computational Science
- Information Science
- Software Engineering









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Theoretical Computer Science

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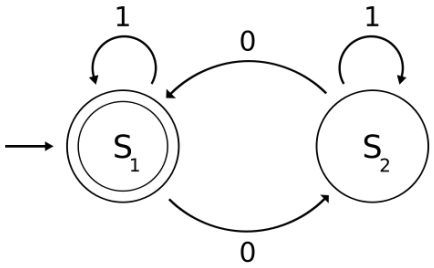
2. Information and coding theory
3. Algorithms and data structures
4. Programming language theory
5. Formal methods
6. Concurrent, parallel and distributed systems
7. Databases and information retrieval

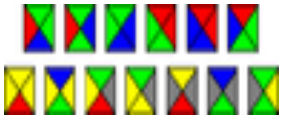
1. Theory of Computation

What can be computed?

What amount of resources are required to perform those computations?



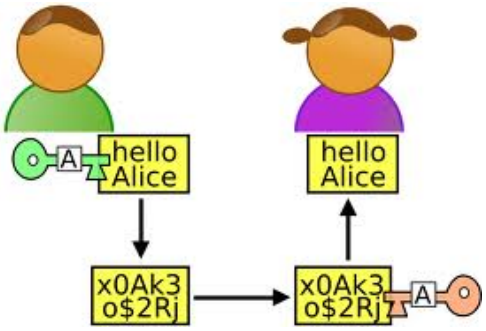
Automata Theory



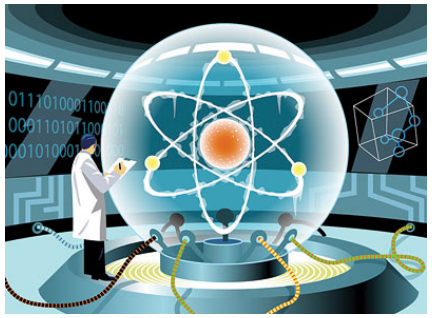
Computability Theory

P=NP ?

Computational Complexity Theory



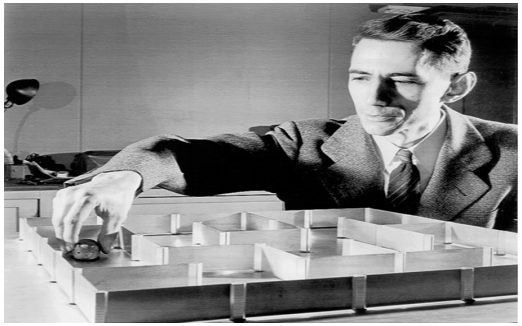
Cryptography



Quantum Computing Theory

1.2 Information Theory

How to quantify information?



Claude E. Shannon

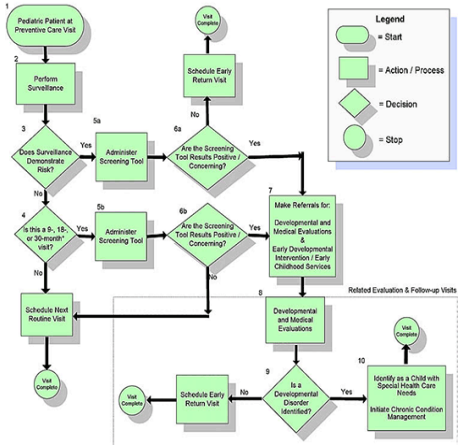
Shannon found

fundamental limits on signal processing operations such as compressing data and on reliably storing and communicating data.

1.2 Coding Theory

- Study of the properties of codes and their fitness for a specific application.
- Codes are used for:
  - Data compression
  - Cryptography
  - Error-correction
  - Network coding
- Codes are studied for the purpose of designing efficient and reliable data transmission methods.

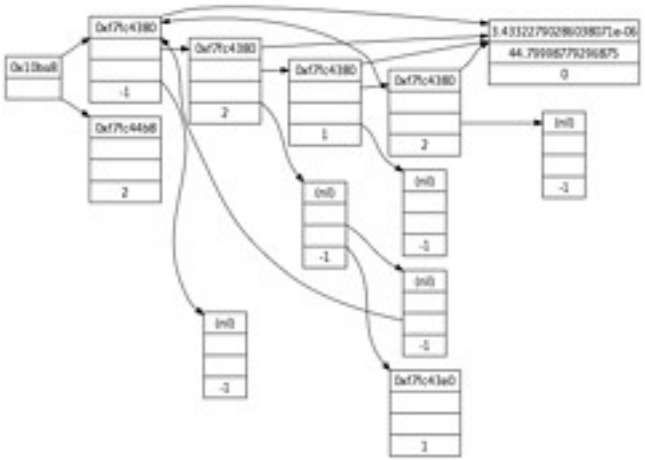
1.3 Algorithms and Data Structures



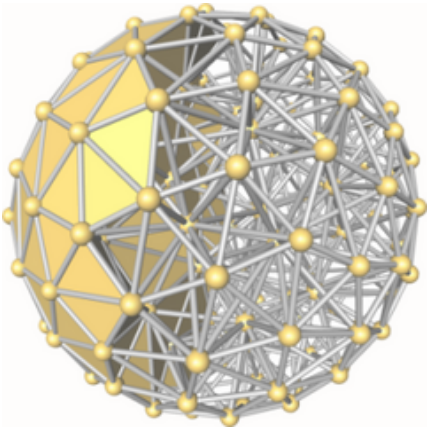
Algorithms

$O(n^2)$

Analysis of Algorithms



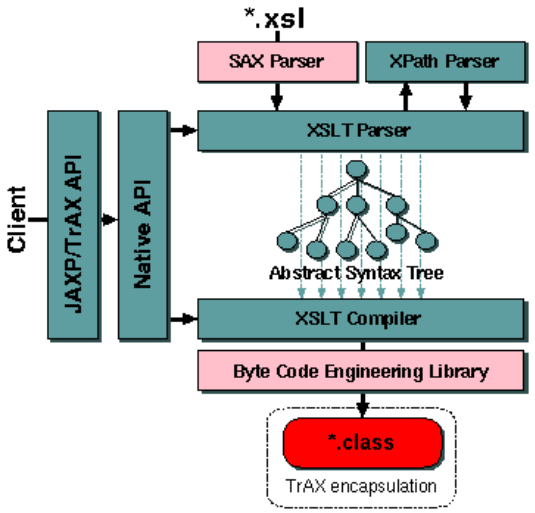
Data Structure



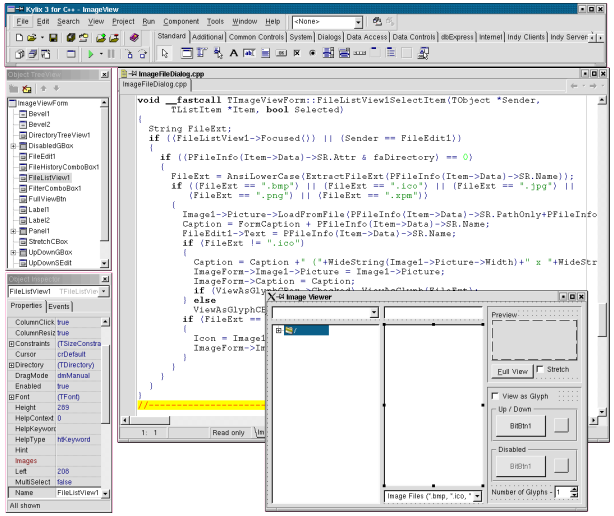
Computational Geometry

1.4 Programming Language Theory

Deals with the design, implementation, analysis, characterization, and classification of programming languages and their individual features



Compiler Design



Programming Language Theory

$$\Gamma \vdash x : \mathrm{Int}$$

Type theory

1.5 Formal methods

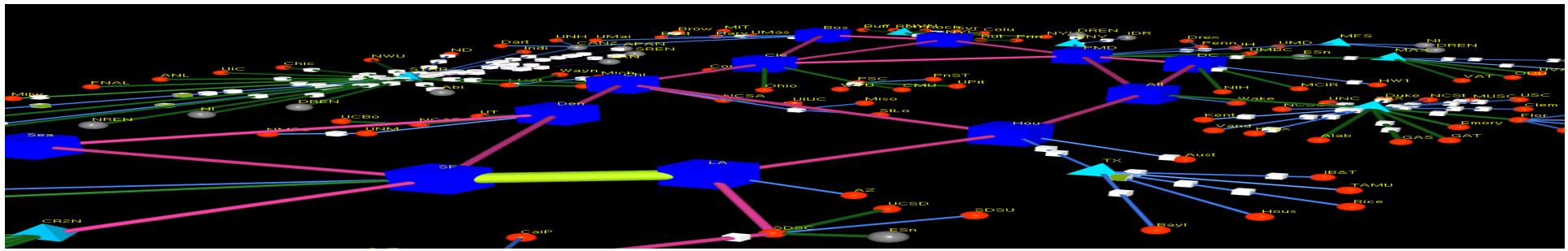
A particular kind of mathematically-based techniques for the specification, development and verification of software and hardware systems

The high cost of using formal methods means that they are usually only used in the development of high-integrity systems, where safety or security is of utmost importance

1.6 Concurrent, parallel and distributed systems

Several computations are executing simultaneously, and potentially interacting with each other

Distributed system extends the idea of concurrency onto multiple computers connected through a network



1.7 Databases and information retrieval

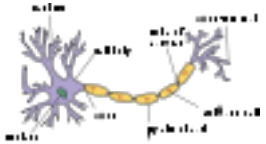
A database is intended to organize, store, and retrieve large amounts of data easily

Applied computer science

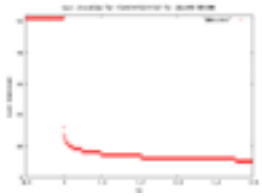
1. Artificial intelligence
2. Computer architecture and engineering
3. Computer graphics and visualization
4. Computer security and cryptography
5. Computational science
6. Information science
7. Software engineering

2.1 Artificial Intelligence

study and design of intelligent agents

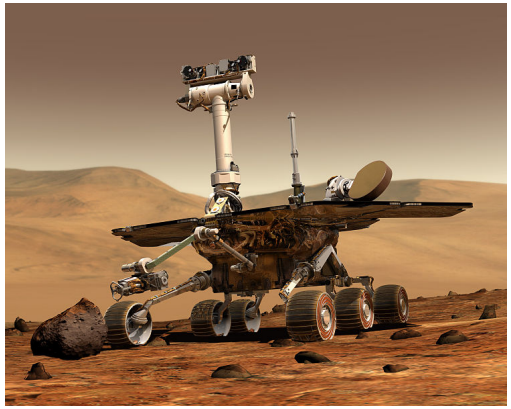


Knowledge Representation

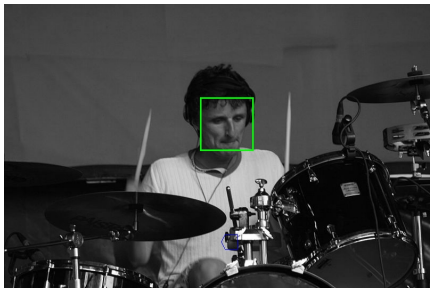


Data Mining

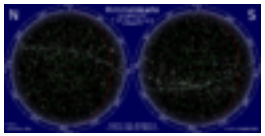
Robotics



Computer vision



Pattern Recognition



Evolutionary Computation

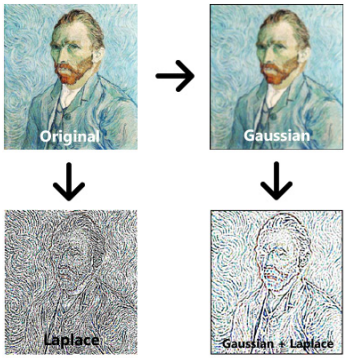
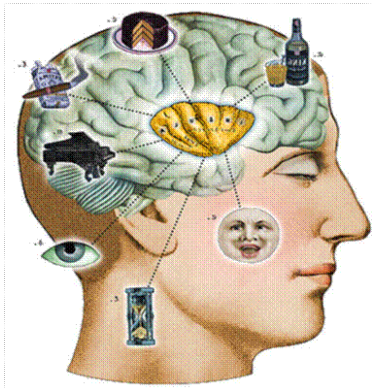
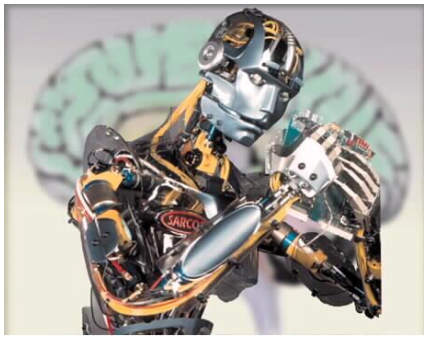


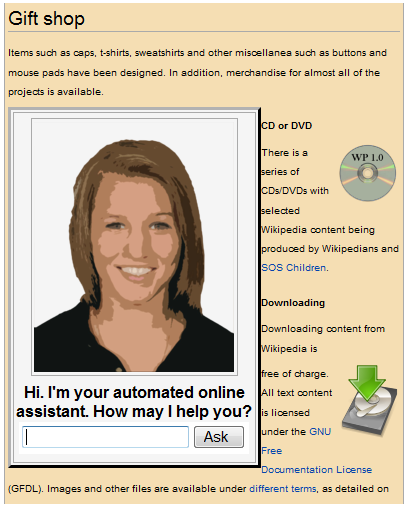
Image Processing



Cognitive Science

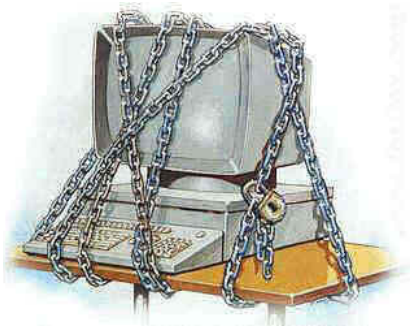


Machine Learning

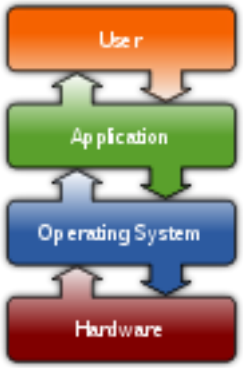


Natural Language Processing

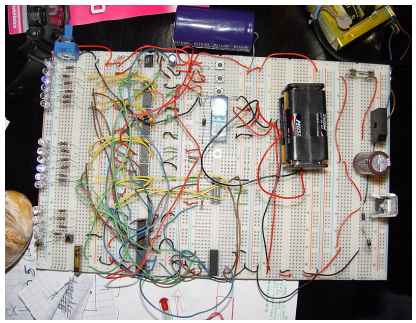
2.2 Computer Architecture and Engineering



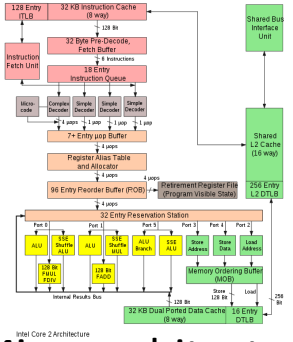
Computer Security



Operating Systems



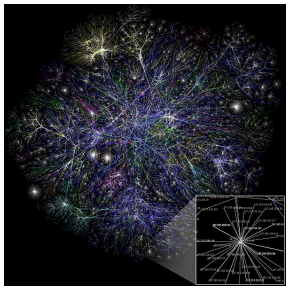
Digital Logic



Microarchitecture

Programming Language

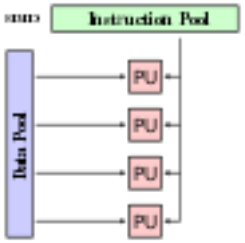
System Architecture



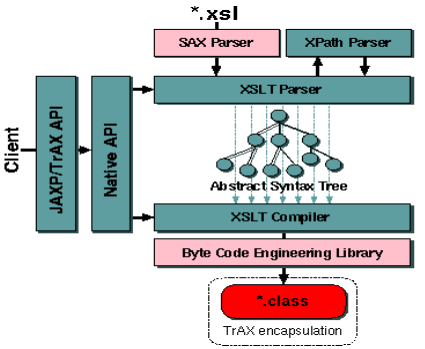
Computer Networks

Data Base

Ubiquitous Computing



Multiprocessing



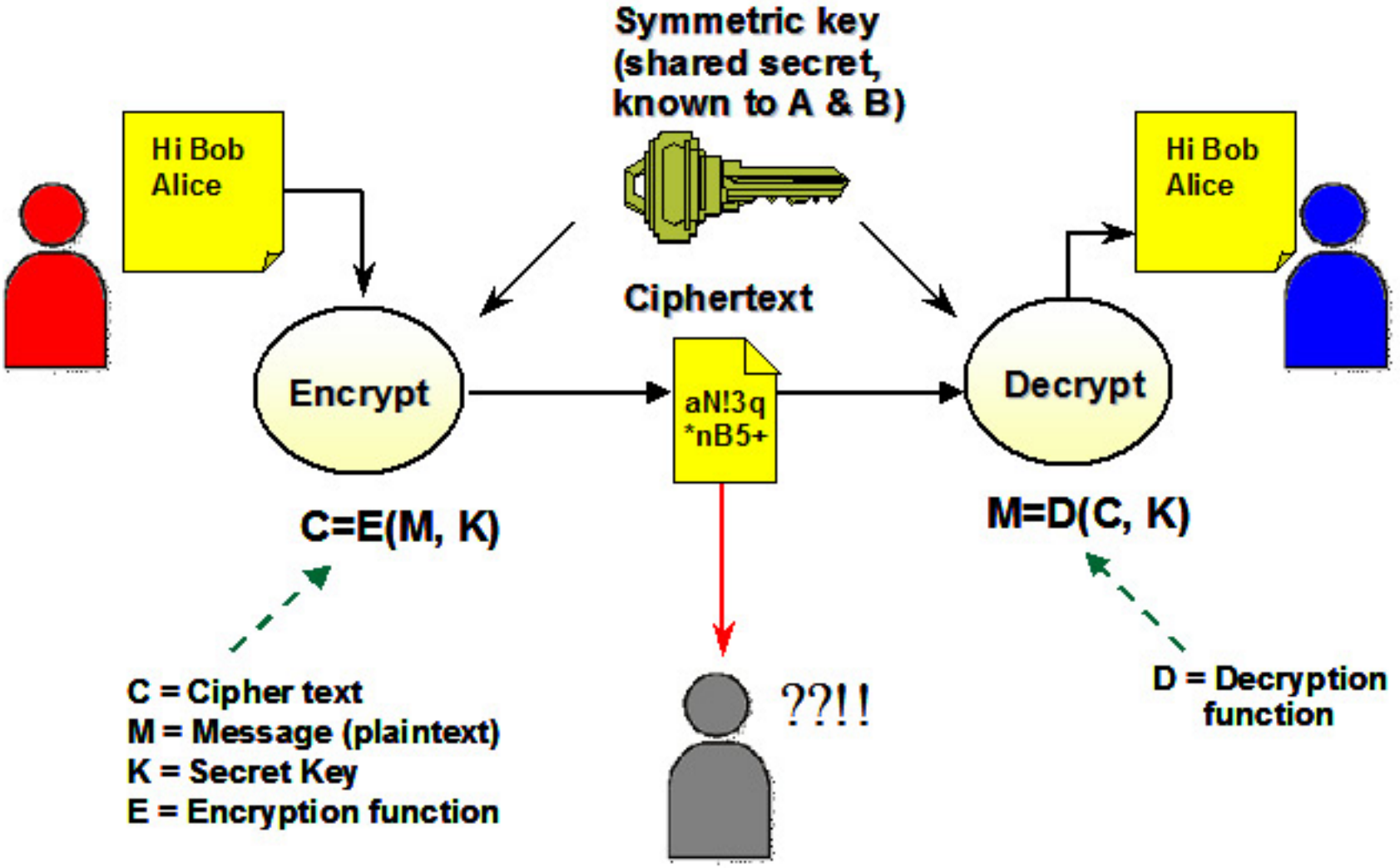
Compiler Design

2.3 Computer graphics and visualization

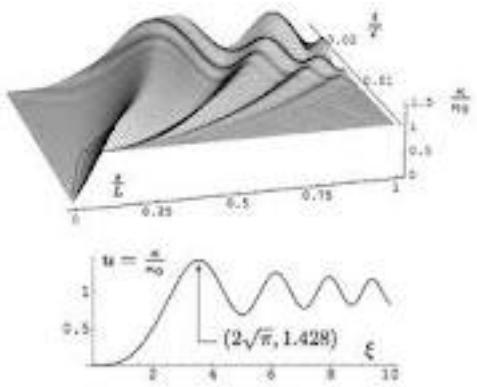
Subfields in computer graphics

1. Geometry: studies ways to represent and process surfaces
2. Animation: studies with ways to represent and manipulate motion
3. Rendering: studies algorithms to reproduce light transport
4. Imaging: studies image acquisition or image editing

2.4 Computer Security and Cryptography

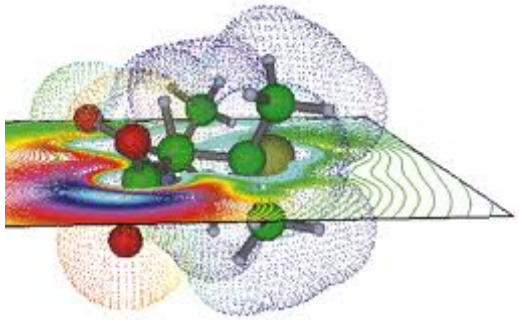


2.5 Computational science

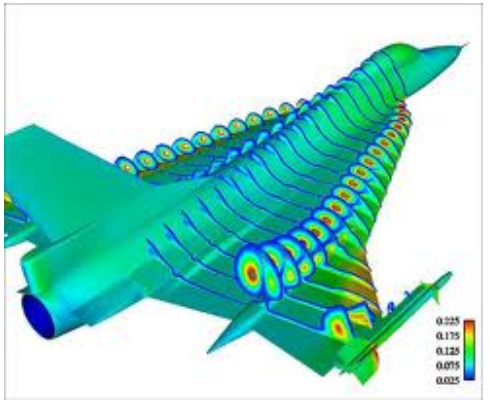


Numerical Analysis

Bioinformatics

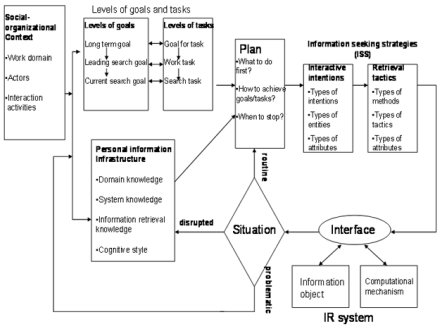


Computational Chemistry

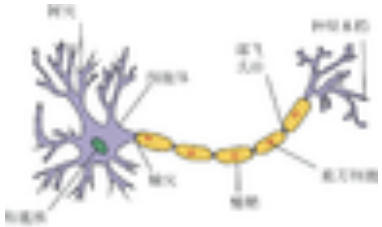


Computational Physics

2.6 Information science



Information Retrieval



Knowledge Representation

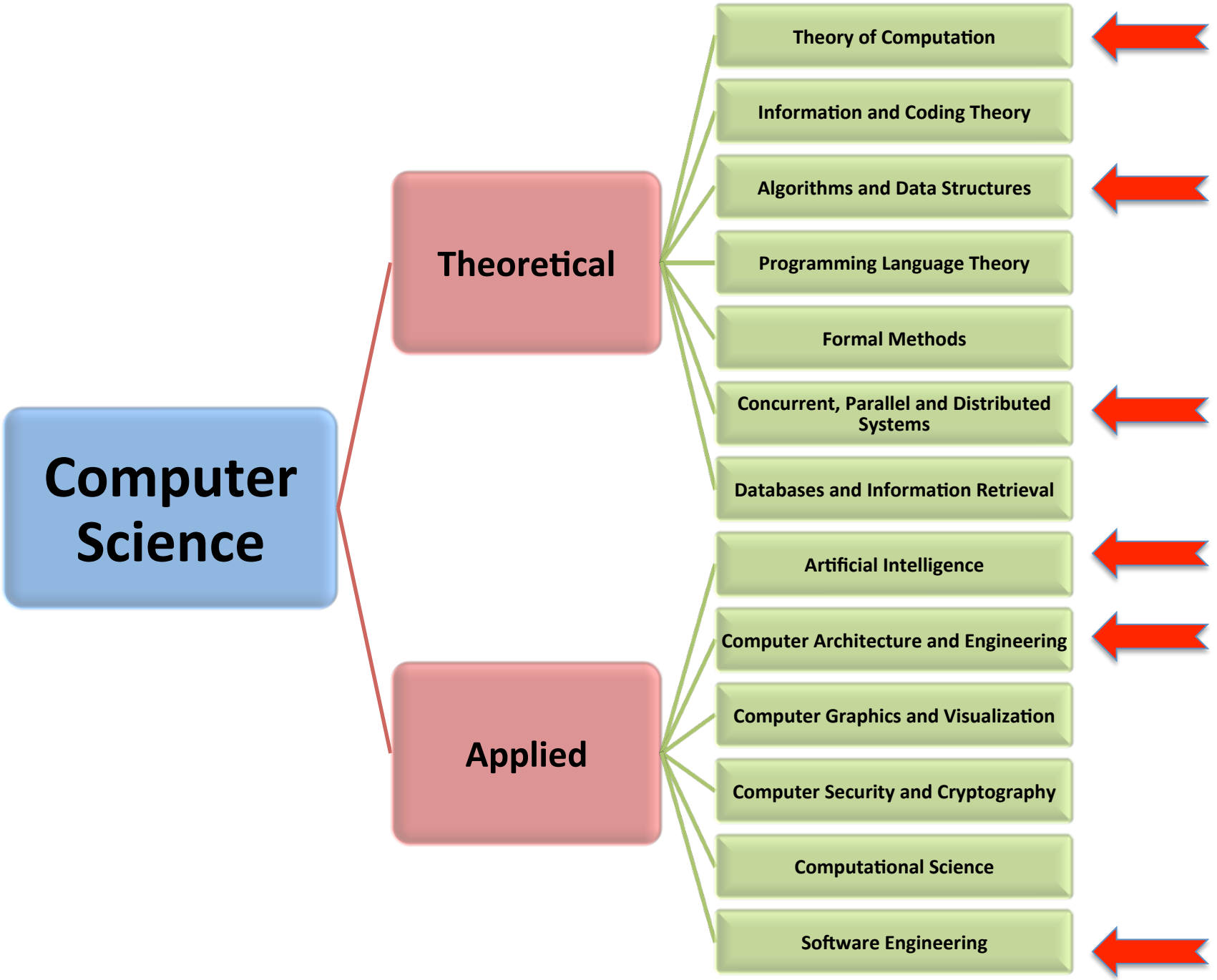
Human Computer Interaction

2.7 Software engineering

Software engineering is the study of designing, implementing, and modifying software in order to ensure it is of high quality, affordable, maintainable, and fast to build.

Computer Science

Computer science is the study of the theoretical foundations of information and computation and of practical techniques for their implementation and application in computer systems


Computer Science
Theoretical
Applied
Theory of Computation
Information and Coding Theory
Algorithms and Data Structures
Programming Language Theory
Formal Methods
Concurrent, Parallel and Distributed Systems
Databases and Information Retrieval
Artificial Intelligence
Computer Architecture and Engineering
Computer Graphics and Visualization
Computer Security and Cryptography
Computational Science
Software Engineering