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Applications of Mathematical in Computer Science

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Abstract
Mathematics (The QUEEN's mother of all Sciences), is the foundation of Computer Science.
Mathematics can be perceived in our garden or park from symmetry of leaves, flowers, fruits etc. and by so many examples of Geometry and symmetry can be seen in nature. Scientists and researchers cannot ideally accomplish their work without the inclusion of mathematics. Mathematics is sociable for analytical skills needed in Computer Disciplines like; Concepts of binary number system, Boolean algebra, Calculus, Discrete mathematics, linear algebra, number theory, and graph theory are the most applicable to the subject of computer science with the accessional emergence of new concepts like machine learning, artificial intelligence, virtual reality and augmented reality make the future of mathematics grow endless.
Mathematics has been an important intellectual preoccupation of man for a long time. Computer Science as a formal discipline is about seven decades young. Is the almost spontaneous use of computing? In this article, this paper convey to the frontage the many close connections and parallels between the Mother and daughter sciences. The paper underscores the strong interplay and interactions by looking at some exciting contemporary results from number theory and combinatorial mathematics and algorithms of computer science.
Keywords*: Computational paradigm, Combinatorial mathematics, Binary Number System, Discrete Mathematics , Number Theory, Graph Theory, Virtual Reality, Augmented Reality, Artificial Intelligence and Machine Learning.*

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I. Introduction

Sometimes it becomes a matter of discussion about the significance of Mathematics in Computer Science most expectedly in the life of every First Year Computer Science students. Some see mathematics as of no important in the field of computer engineering because they think it is very difficult. But on the contrary mathematics increases the analysis thinking of every engineer.

Likewise some scholars argue that it contributes only little value in Computer Science while others (mostly in the majority) say that it is the foundation for Computer Science.

According to Donald Ervin Knuth, an American computer scientist, mathematician, and professor emeritus at Stanford University and the father of analysis of algorithms, mathematics is considered as the fundamental intellectual tool in computer engineering, but computing is also increasingly used as a key component in solving mathematical problems. For example let us focus on the study of algorithm, isn't this merely a branch of mathematics? After all, algorithm was primarily given birth by a mathematician, Al-Khwarizmi, before the days of computer science. He evolved the methods for solving problems which used step by step instructions. An algorithm includes a finite number of steps each of which may have a number of operations. Computer scientists use mathematics in their professional lives in one way or other. Mathematics delivers the theoretical basis for many branches of computer science, and important analytic tools for others. Mathematics is been described in this paper as the queen mother of wisdom for engineering most especially Computer Engineering.

"Mathematics is as old as humanity, while computer science is a young discipline" according to empiricist philosopher David Hume.

II. History Of Mathematics In Computer Science

The history of computer science began long before our modern discipline of computer science, usually appearing in forms like mathematics or physics. Developments in previous centuries alluded to the discipline that we now know as computer science. This progression, from mechanical inventions and mathematical theories towards modern computer concepts and machines led to the development of a major academic field, massive technological advancement across the Western world.

In 1702, Gottfried Wilhelm Leibniz developed logic in a formal, mathematical sense with his writings on the binary numeral system. In his system, the ones and zeroes also represent true and false values or on and off states. But it took more than a century before George Boole published his Boolean algebra in 1854 with a complete system that allowed computational processes to be mathematically modeled.

By this time, the first mechanical devices driven by a binary pattern had been invented. The industrial revolution had driven forward the mechanization of many tasks, and this included weaving. Punched cards controlled Joseph Marie Jacquard's loom in 1801, where a hole punched in the card indicated a binary one and an unquenched spot indicated a binary zero. Jacquard's loom was far from being a computer, but it did illustrate that machines could be driven by binary systems.

Before the modern age and the worldwide spread of knowledge, written examples of new mathematical developments have come to light only in a few locales. From 3000 BC the Mesopotamian states of Sumer, Akkad and Assyria, followed closely by Ancient Egypt and the Levantine state of Ebla began using arithmetic, algebra and geometry for purposes of taxation, commerce, trade and also in the patterns in nature, the field of astronomy and to record time and formulate calendars.

The evolution of the computer is based upon a strong mathematical concept and there is no field in today modern computer science that do not have the interplay of mathematics.

III. Objective Of The Study

This paper focuses on analyzing the application of mathematics in computer science in present scenario of multidisciplinary approach by careful study of workings of mathematics as well as computer science.
This paper also looked forward to discourage the mindset of many young computer engineering students who take mathematics as a public emery, which is not but a source of wisdom in solving problems in the world of computer Science.

IV. Significance Of The Study

Mathematics plays a very significant role in Computer Science and Engineering. This paper discusses the significance of various concepts of different branches of mathematics and their application in Computer Science and Engineering. These concepts are discussed as follows:

A. Binary Math

The binary number system is one of the most dominant developments in the history of technology. The formalization of the system and its additions and refinements over the course of 200+ years ultimately led to the creation of electronic circuitry constructed using logic gates. This creation ushered in the technological era and left the world forever changed. Important figures in the history of the binary number system and mathematical logic and less directly the history of computers and computer science include Gottfried Leibniz, George Boole, Augustus De Morgan and Claude Shannon. This paper focuses on Leibniz's formalization of the binary system and his work in mathematical logic and computing machines. It is the core of computer operation and among the utmost important type of math used in computer science. To symbolize every number within the computer, binary is used. Bits and binary.

Computers use binary - the digits 0 and 1 - to store data. A binary digit, or bit, is the smallest unit of data in computing. It is represented by a 0 or a 1. Binary numbers are made up of binary digits (bits), ex. the binary number 1001.
The circuits in a computer's processor are made up of billions of transistors. A transistor is a tiny switch that is activated by the electronic signals it receives. The digits 1 and 0 used in binary reflect the on and off states of a transistor.

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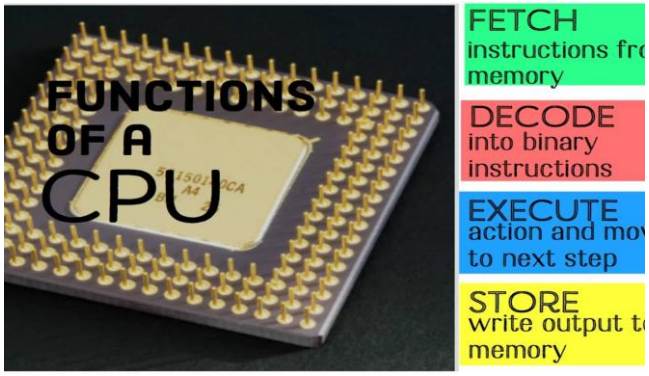
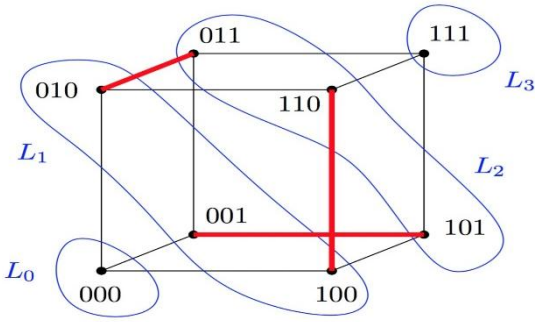


Computer programs are sets of instructions. Each instruction is translated into machine code - simple binary codes that activate the CPU. Programmers write computer code and this is converted by a translator into binary instructions that the processor can execute.
All software, music, documents, and any other information that is processed by a computer, is also stored using binary.

Discrete Mathematics provides an essential virtual foundation for every area of computer science, and its applications are correspondingly vast.
At the most fundamental level, all of a computer's data is represented as bits (zeroes and ones). Computers make calculations by modifying these bits in accordance with the laws of Booleanalgebra, which form the basis of all digital circuits (which are represented as graphs). Low-level programming languages rely directly on logical operators such as *and, not,* and *or.* Software developers using high-level languages will often work to optimize their code by minimizing the number of low-level operations, and may even operate directly on bits. Programmers also use Boolean logic to control program flow -- that is, which instructions are executed under certain conditions.



When programming, it is important to be confident that your code will achieve the desired results. Programs can be described precisely with mathematics, and the tools of propositionallogic can be used to reason about their correctness. This skill is critical to the design and analysis of algorithms, a core area of computer science. Iterative programming and functional programming are two major paradigms which rely upon the principle of mathematicalinduction to verify their loops (for and while) and recursive function calls, respectively. Logic is the language used for most formal specification languages, and is fundamental for understanding much of the literature in verification and in programming language foundations and design

B. BOOLEAN ALGEBRA

It is used to analyze and simplify the digital (logic) circuits. It uses only the binary numbers i.e. 0 and 1. It is also named as Binary Algebra or logical Algebra. The concept of Boolean algebra was first introduced by George Boole in 1854 in his book, "The Mathematical Analysis of Logic", and further extended in his book, An Investigation of the Laws of Thought. The significance of Boolean algebra exists in the theory of probability, geometry of sets, and information theory. Furthermore, it exists as the basis for the design of circuits used in electronic digital computers, computer programming, and mathematical logic, and is also used in other areas of mathematics such as set theory and statistics. A Boolean function is an algebraic expression formed with binary

variables, the logic operation, parenthesis, and equal sign. A Boolean function can be converted from an algebraic expression into a logic diagram possessed of AND, OR, NOT (inverter) gates.

✓ Boolean Addition The basic rules of Boolean addition are as follows

0 + 0 = 0
0 + 1 = 1
1 + 0 = 1
1 + 1 = 1

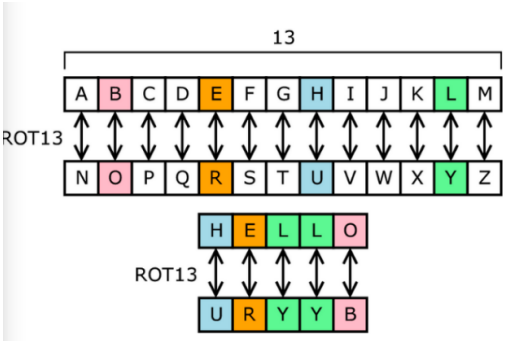
✓ Boolean Multiplication The rules of Boolean multiplication method are as follows: 0.0=0 0.1=0 1.0=0 1.1=1

✓ Properties of Boolean Algebra Boolean Algebra is a mathematical system consisting of a set of two or more distinct elements, two binary operations denoted by the symbol (+) and (.) , and one unary operator denoted by the symbol either bar(commutative, associative, distributive, absorption, consensus and idemotency properties of the Boolean algebra. Great mathematician De Morgan has contributed with two of the most important theorems of Boolean algebra .De Morgan's theorems are extremely useful in simplifying expression in which a product of sum of variables is complimented.

Boolean algebra has been applied in search engines such as Google and many other use Boolean algebra to facilitate the users to get data whenever they request or search.

C. CRYPTOLOGY

Cryptology is mathematics, such as number theory and the application of formulas and algorithms underpin cryptography and cryptanalysis. Cryptanalysis concepts are highly specialized and complex, so this discussion concentrates on some of the key mathematical concepts behind cryptography, as well as modern examples of its usage.



In order for data to be secured for storage or transmission, it must be transformed in such a manner that it would be difficult for an unauthorized individual to be able to discover its true meaning. To do this, security systems and software use certain mathematical equations that are very difficult to solve unless strict criteria are met. The level of difficulty of solving a given equation is known as its intractability. These equations form the basis of cryptography.

D. STATISTICS

It is a branch of mathematics involved in computer science to a greater extent. The knowledge in the field of statistics is necessary to understand algorithms and other statistical properties that are needed in computer science. Some related statistical measures are mean, mode, regression analysis, variance, and kurtosis. Probability and Statistics for Computer Science treats with the most common discrete and continuous distributions, disclosing how they find use in decision and estimation problems and devise computer algorithms to generate observations from the multifarious distributions. The knowledge of statistics is supportive for data mining, speech recognition, vision and image analysis, data compression, artificial intelligence, network and traffic modelling to varying extent as per requirement of researchers / scientists like as follows:

- Data Mining: It is an analysis of information in a database, using tools that look for trends or irregularities in large data sets. In other words "to find valuable information from the available data sets using statistical techniques". Data Compression: It is the coding of data by usage of compact formulas, called algorithms, and usefulness to save storage space or transmission time.
- Speech Recognition: It is an act of identifying spoken words by a machine. The spoken words are transformed into a sequence of numbers and matched against coded dictionaries.
- Vision and Image Analyses: Vision and image analysis also require statistics to solve contemporary and practical problems/ queries in computer vision, image processing, and artificial intelligence.

- Stochastic Algorithms: Stochastic algorithms follow a detailed sequence of actions to perform a task in the face of uncertainty.
- Artificial Intelligence: It is implicated with modelling aspects of human thought on computers.
- Machine Learning: It is the ability of a machine or a system to enhance or make progress in its performance based on previous results.
- Capacity Planning: Capacity planning finds out what equipment and software will be enough to face the needs of a situation or a proposed end while providing the most power for the least cost.
- Storage and Retrieval: Storage and retrieval techniques are dependent on statistics to make sure computerized data is kept and recovered efficiently and reliably.
- Quality Management: It uses statistics to make analysis the condition of manufactured parts (hardware, software, et.al...) using tools and sampling to make sure a minimum level of defects.
- Software Engineering: It is a systematic approach to the analysis, design, implementation, and maintenance of computer programs. 3.11 Calculus The study of continuous change of functions come under purview of calculus. If someone wants to work in these professions, he/she must have some knowledge of calculus. The subthemes of Computer Science such as machine learning, data mining, scientific computing, image processing, and creating the graphics and physics engines for video games, including the 3D visuals for simulations, the aforesaid subject is supportive. Both differential and integral calculus that are two major concepts of calculus contribute much in the area of computer graphics, scientific computing, and computer security. Computer scientists also take help of multivariate calculus.

E. DISCUSSION NO DOUBT

Computer Science is the subset of Mathematical Sciences. Discrete mathematics, linear algebra, number theory, and graph theory are the branches of mathematics, the most relevant to the computer science profession. Different fields of the profession, from machine learning to software engineering, apply concepts of these branches of mathematics in one way or other. Without getting familiar with these mathematical concepts, it may be difficult to manage data structures, databases, and algorithms.

V. Conclusion

This paper discussed the important and applications of mathematics in Computer Science and Engineering. It is clearly understood that mathematics in an essential tool to all computer application. The mathematical impact depends on the kind of job to be done in the field of computer engineering. Almost all computer based programs utilize mathematical skills and knowledge but there is still much more to be done with the emergence of new concepts of artificial intelligence and machine learning. Overall, the proficiency of computer in this generation is built on the mathematical knowledge which is a foundation for computer science. For a person to succeed in any discipline of Computer Science, he/she must inculcate acumen of mathematics.

Reference

[1]. Neugebauer, Otto (1969) [1957]. The Exact Sciences in Antiquity. Acta HistoricaScientiarumNaturalium ET Medicinalium. Vol. 9.
[2]. Heath (1931). "A Manual of Greek Mathematics". Nature. **128** (3235):
[3]. Tedre, Matti (2014). The Science of Computing: Shaping a Discipline. Chapman Hall.
[4]. "Al-Kindi, Cryptography, Codebreaking and Ciphers". Retrieved 2007-01-12.
[5]. "Charles Babbage". Encyclopædia Britannica Online Academic Edition. Encyclopædia Britannica In. Retrieved 2013-02-20.
[6]. INTERNATIONAL CONFERENCE ON APPLICABLE MATHEMATICS (ICAM-2016). Archived 2017-03-23 at the Wayback Machine The Department of Mathematics, Stell
[7]. Geddes, K. O., Czapor, S. R., &Labahn, G. (1992). Algorithms for computer algebra. Springer Science & Business Media.
[8]. Albrecht, R. (2012). Computer algebra: symbolic and algebraic computation (Vol. 4). Springer Science & Business Media.
[9]. Mignotte, M. (2012). Mathematics for computer algebra. Springer Science & Business Media.
[10]. 88385-570-6.
[11]. Greenberg, John L.; Goodstein, Judith R. (1983-12-23). "Theodore von Kármán and Applied Mathematics in America" (PDF). Science. **222** (4630): 1300–1304. Doi:10.1126/science.222.4630.1300. PMID 17773321. S2CID 19738034.
[12]. Santa Clara University Dept of Applied Mathematics, archived from the original on 2011-05-04, retrieved 2011-03-05
[13]. Today, numerical analysis includes numerical linear algebra, numerical integration, and validated numerics as subfields.
[14]. Hager, G., &Wellein, G. (2010). Introduction to high performance computing for scientists and engineers. CRC Press.
[15]. Geshi, M. (2019). The Art of High Performance Computing for Computational Science, Springer.
[16]. West, D. B. (2001). Introduction to graph theory (Vol. 2). Upper Saddle River: Prentice Hall.
[17]. Bondy, J. A., &Murty, U. S. R. (1976). Graph theory with applications (Vol. 290). London: Macmillan.
[18]. Winston, W. L., & Goldberg, J. B. (2004). Operations research: applications and algorithms (Vol. 3). Belmont: Thomson Brooks/Cole.
[19]. Boland, P. J. (2007). Statistical and probabilistic methods in actuarial science. CRC Press.
[20]. Wainwright, K. (2005). Fundamental methods of mathematical economics/Alpha C. Chiang, Kevin Wainwright. Boston, Mass.: McGraw-Hill/Irwin