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Mathematical Applications in Computer Science

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Abstract

Everybody must learn mathematics in some capacity, whether it is in the kitchen or on the voyage from Earth to the Moon or Mars. Everywhere we look, mathematics is present. The symmetry of the leaves, flowers, fruits, etc., in our garden or park can be used to observe it. There are several instances of geometry and symmetry in nature. In one way or another, God created the universe through the application of mathematics. Likewise, among all the sciences, mathematics is the queen. Researchers and scientists cannot complete their task without using mathematics. The cornerstone of computer science is mathematics. To be interested in any area of computer science, a person must first develop a passion for mathematics, which will help them master the topic more thoroughly. Analytical thinking is supported by mathematics. Capabilities needed for computer science. When new ideas like machine learning, artificial intelligence, virtual reality, and augmented reality emerge, the concepts that are most applicable to the field of computer science are those found in the binary number system, Boolean algebra, calculus, discrete mathematics, linear algebra, number theory, and graph theory.

Key words

Number Theory, Graph Theory, Discrete Mathematics, Calculus, Binary Number System, Computer Science, Machine Learning, Artificial Intelligence.

Preface

It is common knowledge that mathematics is the most illustrious star in this universe's Galaxy of Sciences. The development of mathematical knowledge and skill requires an interface with the outside world. Many branches of science and engineering rely heavily on mathematics. Setting clear boundaries between disciplines is seldom easy (see, for instance, the distinction between the fields of chemical physics and physical chemistry, etc.). Although many mathematicians have been studying computer science covertly, many computer scientists have been doing mathematics. Various sciences are interdependent in the current day. The many social sciences are interdependent and cannot exist separately. These are connected one topic is a complementing part of another. Despite their differences, many scientific subjects share many characteristics. The July 2020 New Education Policy has also endorsed this multidisciplinary approach.

At times, the importance of mathematics in computer science becomes a topic of debate. While the majority of experts claim that it is the cornerstone of computer science, some contend that it adds very little to the field.

Although mathematics is an essential cognitive tool in computers, computing is also becoming a more important part of solving mathematical problems. Isn't studying algorithms just a subfield of mathematics if we concentrate on it? After all, Al-Khwarizmi, a mathematician, was the main creator of algorithms before computer science existed. He developed problem-solving techniques that included detailed instructions. A finite number of stages make up an algorithm, and each step may involve a number of operations.

In one way or another, computer scientists employ mathematics in their work. For many areas of computer science, mathematics provides the theoretical underpinnings, and for others, it

provides crucial analytical tools. As a result, computer scientists apply certain mathematical concepts to particular computing issues. The analytical abilities required for data analysis and problem-solving are facilitated by mathematics. A careful examination reveals that computer science first appeared as a subfield of mathematics before evolving into a distinct and autonomous field.

The aim of the research

By carefully examining both computer science and mathematics literature, this study aims to investigate how mathematics is applied in computer science in the current multidisciplinary approach.

The Importance of Mathematics

In the fields of computer science and engineering, mathematics is crucial. The importance of certain ideas from several areas of mathematics and how they are used in computer science and engineering are covered in this essay.

1.*Math in Binary*

It is the fundamental component of computer operation and one of the most significant mathematical concepts in computer science. Binary is utilized in computers to represent each and every number. Only the numbers 0 and 1 are present in the binary number system. Any information that a computer executes is represented by a series of zeros and ones. All data that we need a computer to process must therefore be translated to binary. Computers store data using binary numbers. There are billions of transistors that make up a computer processor's circuitry. The binary numbers 1 and 0 represent a transistor's on and off positions. There are several uses for standard arithmetic in computer programming. The majority of written programs involve arithmetic operations, including addition, subtraction, multiplication, and division.

2.*The concept of discrete mathematics*

It is a discrete element branch of mathematics that makes use of arithmetic and algebra. To work in many computers science related professions, a student must be proficient in discrete mathematics, which is the mathematical language of computer science. The study and description of objects and issues in various computer science fields, such as computer architecture, algorithms, programming languages, cryptography, automated theorem proving, software development, machine learning, operating systems, computer security, and networks, are aided by concepts and notations from said branch of mathematics.

3.*Algebra in Boolean*

It is employed to simplify and evaluate digital circuits, often known as logic circuits. Only the binary integers 0 and 1 are used. It is also known as logical algebra or binary algebra. In his 1854 book "The Mathematical Analysis of Logic," George Boole originally proposed the idea of Boolean algebra. He then expanded on it in his book An Investigation of the Laws of Thought. Information theory, geometry of sets, and probability theory all benefit from the use of Boolean algebra. Along with being utilized in other branches of mathematics like set theory and statistics, it also serves as the foundation for the design of circuits used in electronic digital computers, computer programming, and mathematical logic.

An algebraic expression made up of binary variables, the logic operation, parentheses, and equal sign is called a Boolean function. It is possible to transform a Boolean function from an algebraic expression into a logic diagram with AND, OR, and NOT (inverter) gates.

4. *Addition in Boolean*

The following are the fundamentals of Boolean addition.

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

Logical OR addition is equivalent to Boolean addition.

5. *Multiplication in Boolean*

The following are the Boolean multiplication method's rules.

0.0 = 0, 0.1= 0, 1.0 = 0, 1.1 = 1.

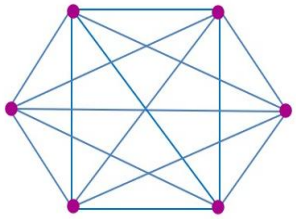
6. *Boolean algebraic properties*

A collection of two or more distinct elements, two binary operations represented by the symbols (+) and (.) and one unary operator represented by the symbol eighter bar (-), makes up the mathematical system known as Boolean algebra. The Boolean algebra's commutative, associative, distributive, absorption, consensus, and idempotency qualities are all satisfied by this. Two of Boolean algebra's most significant theorems were made by the renowned mathematician De Morgan. Expressions where a product of the sum of the variables is complemented can be greatly simplified with the help of De Morgan's theorems.

Google and DuckDuckGo are two examples of search engines that use Boolean algebra to help users obtain info anytime they ask for it or search for it. Microprocessors, embedded systems, electronic and electrical project circuits, and microcontrollers all use logic gates. These digital devices are based on the Boolean function and are classified as AND, OR, XOR, NAND, NOR, XNOR, and NOT.

7. *Graph Theory*

This hypothesis was first presented in the 18th century by Swiss mathematician Leonhard Euler. Graphs are typically structures with vertices. These days, life graphs are utilized to tackle a wide range of issues in fields such as communication, engineering science, and computers. It is possible to ascertain whether two computers are connected by a communication link by using the graph models of computer networks. In a transportation network, graphs are also employed to tackle the challenge of determining the quickest route between two cities.



8. *Trees*

When Arthur Cayley, an English mathematician, utilized trees to count specific kinds of chemical compounds, he introduced the idea. These are especially helpful in computer science because they are used in many different algorithms. Trees, for example, are used to create effective algorithms for finding objects in lists.

9.*Cryptology*

Everyone is aware that hidden messages have been transmitted from the prehistoric era to the current scientific and technological era. Traditionally, these transmissions are used for diplomatic, electronic banking, and military secret communications. It's a clever method that renders communications incomprehensible to everybody but the intended recipient. Cryptology is the study of secret systems and is based on the field of mathematics known as number theory.

10. *Statistics*

As a branch of mathematics, it plays a significant role in computer science. To comprehend algorithms and other statistical features required in computer science, one must have a solid understanding of statistics. A few statistical metrics have to do with variance, kurtosis, regression analysis, mean, mode, and skewness. Computer science's Probability and Statistics course covers the most popular discrete and continuous distributions, explains how they are used in estimate and decision-making tasks, and develops computer algorithms to produce observations from the various distributions.

According to the needs of researchers and scientists, statistical knowledge is helpful to varied degrees for data mining, speech recognition, vision

and image analysis, data compression, artificial intelligence, networks, and traffic modelling.

- ***Data Mining:*** Information in a database is analysed using techniques that search for patterns or anomalies in huge data sets. To put it another way, "to use statistical techniques to extract useful information from the available data packages."
- ***Data Compression:*** It involves the use of concise formulas, known as algorithms, to code data in order to save transmission time or storage space.
- ***Speech Recognition:*** In computer vision, image processing, and artificial intelligence, statistics are also required for vision and image analysis in order to answer current and practical problems and queries.
- ***Vision and Image Analyses:*** To address current and useful issues/questions in computer vision, image processing, and artificial intelligence, statistics are also necessary for vision and image analysis.
- ***Stochastic Algorithms:*** Stochastic algorithms execute a task in the presence of uncertainty by following a precise set of steps.
- ***Artificial Intelligence:*** It is linked to computer modelling of some facets of human cognition.
- ***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:*** In order to provide the most power at the lowest possible cost, capacity planning determines what hardware and software will be sufficient to meet the demands of a circumstance or a proposed purpose.
- ***Storage and Retrieval:*** Statistics are used in storage and retrieval methods to ensure that computerized data is stored and recovered effectively and consistently.
- ***Quality Management:*** Using tools and samples to ensure a minimum level of flaws, it analyses the state of manufactured items (hardware, software, etc.) using statistics.
- ***Software Engineering:*** It is a systematic approach to the analysis, design, implementation, and maintenance of computer programs.

11. *Calculus*

Calculus is the field that studies continuous changes in functions. Someone needs to know a little math if they wish to work in these fields. Computer science subthemes like image processing, data mining, machine learning, scientific computing, and developing the physics and graphics engines for video games—including 3D visuals for simulations—are supportive of the aforementioned subject. Two of calculus's main ideas, differential and integral calculus, are very helpful in computer security, scientific computing, and computer graphics. Multivariate calculus also helps computer scientists.

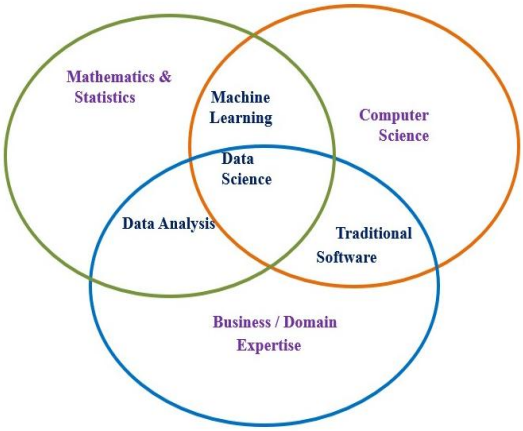
Talk About

It is unquestionably true that computer science is a subset of mathematics. Among mathematics, discrete mathematics, linear algebra, number theory, and graph theory are the area's most pertinent to the field of computer science. The ideas of these schools of mathematics are applied in several professional domains, such as software engineering and machine learning. Those who are unfamiliar with these mathematical ideas may find it difficult to handle databases, algorithms, and data structures.

In summary

Does the field of computer science actually need mathematics? The question is not closed-ended. It can be said that it depends on the type of work. Creating a food blog, for example, does not require a mathematical background. But in order to create a successful blog, attention must be paid to

audience preferences, topic popularity, article ratings, etc. Computer engineering uses mathematical skills in practically all of its programs, but with the introduction of new ideas in machine learning, artificial intelligence, etc., there is still a lot to learn. Overall, the foundation of computer science requires mathematical proficiency, either directly or indirectly. In order to advance in any computer science field, a person must develop mathematical acumen.



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