Introduction

Monday, September 26, 2022 5:33 PM

Mathematics (from Ancient Greek μάθημα; *máthēma:* 'knowledge, study, learning') is an area of knowledge that includes such topics as numbers (arithmetic and number theory),[1] formulas and related structures (algebra),[2] shapes and the spaces in which they are contained (geometry),[1] and quantities and their changes (calculus and analysis).[3][4][5] Most mathematical activity involves the use of pure reason to discover or prove the properties of abstract objects, which consist of either abstractions from nature or—in modern mathematics—entities that are stipulated with certain properties, called axioms. A mathematical proof consists of a succession of applications of some deductive rules to already known results, including previously proved theorems, axioms and (in case of abstraction from nature) some basic properties that are considered as true starting points of the theory under consideration.

Mathematics is used in science for modeling phenomena, which then allows predictions to be made from experimental laws. The independence of mathematical truth from any experimentation implies that the accuracy of such predictions depends only on the adequacy of the model. Inaccurate predictions, rather than being caused by incorrect mathematics, imply the need to change the mathematical model used. For example, the perihelion precession of Mercury could only be explained after the emergence of Einstein's general relativity, which replaced Newton's law of gravitation as a better mathematical model.

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The word *mathematics* comes from Ancient Greek *máthēma* (*μάθημα*), meaning "that which is learnt,"[9] "what one gets to know," hence also "study" and "science". The word for "mathematics" came to have the narrower and more technical meaning "mathematical study" even in Classical times.[10] Its adjective is *mathēmatikós* (μαθηματικός), meaning "related to learning" or "studious," which likewise further came to mean "mathematical." In particular, *mathēmatikḗ tékhnē* (μαθηματικὴ τέχνη; Latin: *ars mathematica*) meant "the mathematical art."

Similarly, one of the two main schools of thought in Pythagoreanism was known as the *mathēmatikoi* (μαθηματικοί)—which at the time meant "learners" rather than "mathematicians" in the modern sense.

Discrete mathematics is the study of mathematical structures that can be considered "discrete" (in a way analogous to discrete variables, having a bijection with the set of natural numbers) rather than "continuous" (analogously to continuous functions). Objects studied in discrete mathematics include integers, graphs, and statements in logic.[1][2][3][4] By contrast, discrete mathematics excludes topics in "continuous mathematics" such as real numbers, calculus or Euclidean geometry. Discrete objects can often be enumerated by integers; more formally, discrete mathematics has been characterized as the branch of mathematics dealing with countable sets[5] (finite sets or sets with the same cardinality as the natural numbers). However, there is no exact definition of the term "discrete mathematics".[6]

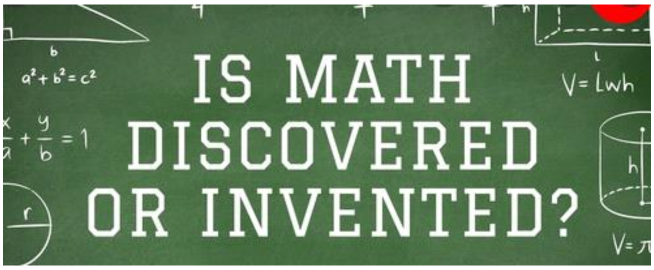
Topics in discrete mathematics

- Theoretical computer science.
- Information theory.
- Logic.
- Set theory.
- Combinatorics.
- Graph theory.
- Number theory.
- Algebraic structures.

1. Computer Science:
   - Algorithms and data structures
   - Cryptography
   - Computer networking
   - Artificial intelligence and machine learning
   - Database theory
2. Operations Research:
   - Optimization problems
   - Decision-making
   - Project management
   - Scheduling and resource allocation
3. Electrical Engineering:
   - Digital circuit design
   - Signal processing
   - Communication systems
   - Coding theory
4. Bioinformatics:
   - Sequence analysis
   - Phylogenetic tree construction
   - Protein structure prediction

5. Economics and Finance:
    - Game theory
    - Auction design
    - Portfolio optimization
    - Risk management
6. Social Sciences:
    - Network analysis
    - Voting systems
    - Social network modeling
    - Behavioral economics
7. Logistics and Transportation:
    - Routing and scheduling problems
    - Network design
    - Traffic flow analysis
8. Cybersecurity:
    - Cryptography and cryptanalysis
    - Access control and authentication
    - Network security protocols

1. Algorithms and Data Structures:
    - Discrete mathematics provides the foundational concepts for designing and analyzing efficient algorithms, such as graph theory, combinatorics, and recurrence relations.
    - Understanding discrete structures like sets, graphs, trees, and graphs is essential for implementing data structures in computer programs.
2. Cryptography:
    - Discrete mathematics, particularly number theory and abstract algebra, forms the mathematical basis for modern cryptographic systems, such as public-key cryptography and elliptic curve cryptography.
3. Computer Networks:
    - Graph theory is used to model and analyze the topological structure of computer networks, enabling the design of efficient routing algorithms and communication protocols.
    - Combinatorics and probability theory are used to study network traffic patterns and optimize network performance.
4. Artificial Intelligence and Machine Learning:
    - Discrete structures like graphs and trees are used to represent knowledge and solve complex problems in areas like natural language processing, computer vision, and decision-making.
    - Combinatorial optimization techniques, such as constraint programming and integer programming, are used in AI systems for planning, scheduling, and resource allocation.
5. Database Theory:
    - Relational database theory is built on the foundations of discrete mathematics, including sets, relations, and formal logic.
    - Concepts from graph theory and combinatorics are used in the design and optimization of database systems, such as indexing and query processing.
6. Computational Complexity:
    - Discrete mathematics, particularly the theory of computation and computational complexity, provides the tools to analyze the inherent difficulty of computational problems and the limitations of algorithms.



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