

Discrete Mathematics and Its Applications

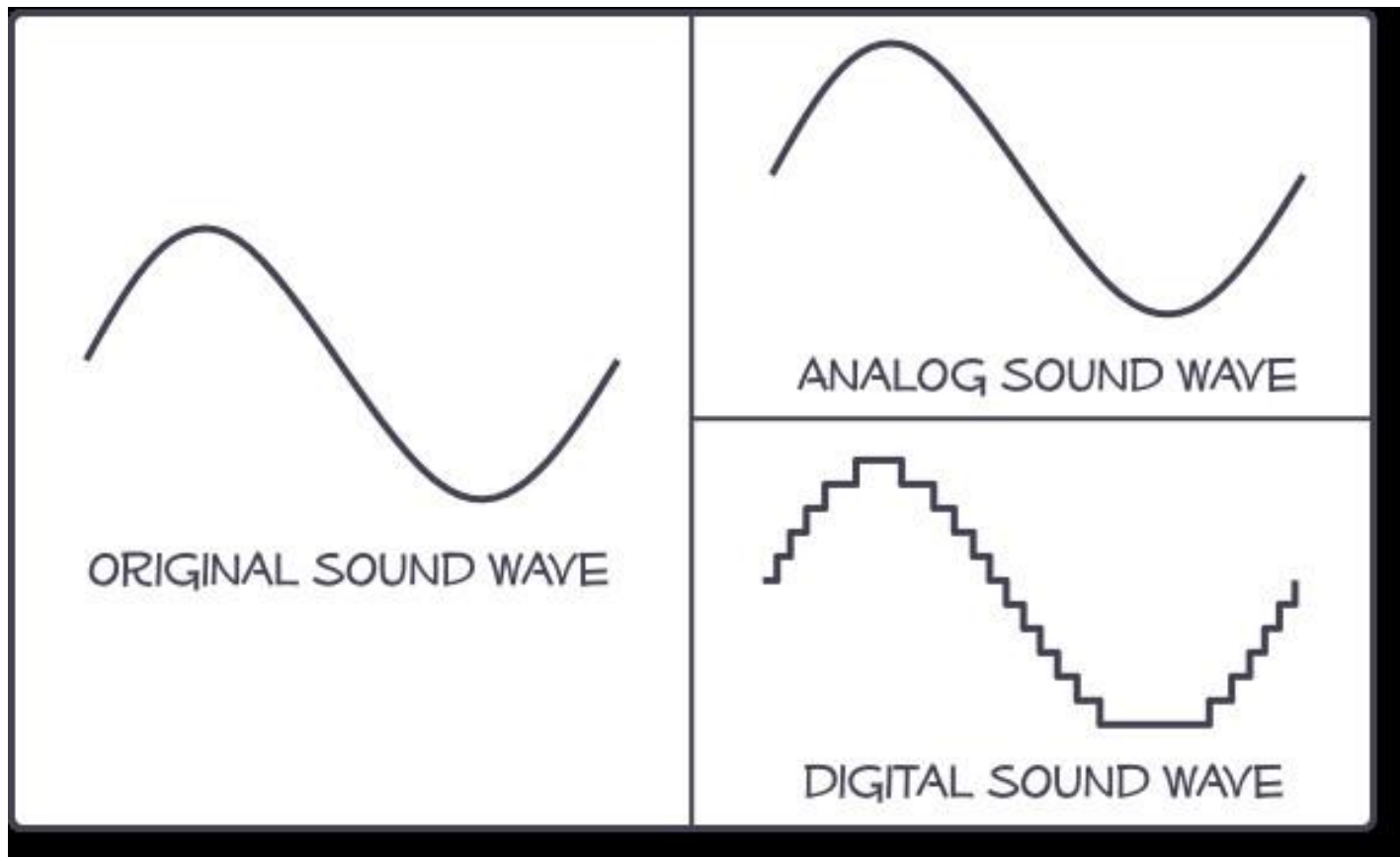
Introductory Lecture

What is Discrete Mathematics?

- study of discrete (as opposed to continuous) objects
- calculus deals with continuous objects and is not part of discrete mathematics
- examples of discrete objects
 - integers
 - steps taken by a computer program
 - distinct paths to travel from point A to point B on a map
 - ways to pick a winning set of numbers in a lottery
- mathematical background needed for all subsequent courses in computer science

Continuous vs. Discrete

- vinyl (continuous signal) vs. digital (discrete signal) music



Kinds of Problems Solved Using Discrete Mathematics

- how many ways can a password be chosen following specific rules?
- how many valid internet addresses are there?
- what is the probability of winning a particular lottery?
- is there a link between two computers in a network?
- how can I identify spam email messages?
- how can I encrypt a message so that no unintended recipient can read it?
- how can we build a circuit that adds two integers?

Kinds of Problems Solved Using Discrete Mathematics

- what is the shortest path between two cities using a transportation system?
- find the shortest tour that visits each of a group of cities only once and then ends in the starting city
- how can we represent English sentences so that a computer can reason with them?
- how can we prove that there are infinitely many prime numbers?
- how can a list of integers be sorted so that the integers are in increasing order?
- how many steps are required to do such a sorting?
- how to prove a sorting algorithm correctly sorts a list

Goals of a Course in Discrete Mathematics

- mathematical reasoning
 - ability to read, understand, and construct mathematical arguments and proofs
- combinatorial analysis
 - techniques for counting objects of different kinds.
- discrete structures
 - abstract mathematical structures that represent objects and the relationships between them
 - examples: sets, permutations, relations, graphs, trees, and finite state machines

Goals of a Course in Discrete Mathematics

- algorithmic thinking
 - solving problems with an algorithm: a sequence of steps that can be followed to solve any instance of a particular problem
 - specifying algorithms, analyzing memory and time required by an execution of the algorithm, and verifying that the algorithm will produce the correct answer
- applications and modeling
 - wide range of applications of the topics in discrete mathematics
 - problems in computing, chemistry, biology, linguistics, geography, business, etc.

Discrete Mathematics is a Gateway Course

- discrete mathematics topics important in many courses
 - Computer Science
 - 241 Data Structures
 - 304 Computer Organization
 - 420 Machine Learning
 - 423 Finite Automata
 - 427 Graphics
 - 437 Game Design
 - 303 Algorithms
 - 312 Programming Languages
 - 421 Databases
 - 424 Computer Architecture
 - 434 Networking
 - 454 Computer Security
 - Mathematics: Logic, Set Theory, Probability, Number Theory, Abstract Algebra, Combinatorics, Graph Theory, Game Theory, Network Optimization
 - other disciplines: Philosophy, Economics, Linguistics