# 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

2



### 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?

4

#### 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

1

# 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.

7

#### Discrete Mathematics is a **Gateway** Course

- discrete mathematics topics important in many courses ٠
  - 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

8