Session 1: Introduction to Discrete Structures

1.1 Definition: Discrete Structures

Discrete Structures or Mathematics is the part of mathematics devoted to the study of discrete objects. (Here *discrete* means consisting of distinct or unconnected elements.)

Discrete Structures is the study of mathematical structures that are fundamentally discrete rather than continuous.

A course in discrete mathematics should teach students how to work with discrete structures, which are the abstract mathematical structures used to represent discrete objects and relationships between these objects.

These discrete structures, in contrast to real numbers that have the property of varying "smoothly", the objects studied in discrete mathematics – such as integers, graphs, and statements in logic – do not vary smoothly in this way, but have distinct, separate values.
Discrete mathematics therefore excludes topics in "continuous mathematics" such as 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* (*finite sets* or sets with the same cardinality as the natural numbers). However, there is no exact definition of the term "discrete mathematics.

Although the main objects of study in discrete mathematics are discrete objects, analytic methods from continuous mathematics are often employed as well.

1.2 Target audience

Students taking BTIT, BSIT, BSCS who want to learn computer programming

1.3 Why study Discrete Structures

a) It develops your:

mathematical thinking/ reasoning - Students must understand mathematical reasoning in order to read, comprehend, and construct mathematical arguments.

Algorithmic Thinking: Certain classes of problems are solved by the specification of an algorithm. After an algorithm has been described, a computer program can be constructed implementing it.

Combinatorial Analysis: An important problem-solving skill is the ability to count or enumerate

objects. The stress is on performing combinatorial analysis to solve counting problems and analyze algorithms, not on applying formulae.

Applications and Modeling: Discrete mathematics has applications to almost every conceivable area of study. There are many applications to computer science and data networking, as well as applications to such diverse areas as chemistry, biology, linguistics, geography, business, and the Internet. These applications are natural and important uses of discrete mathematics and are not contrived. Modeling with discrete mathematics is an extremely important problem-solving skill, which students have the opportunity to develop by constructing their own models in some of the exercises.

b) It improves your problem-solving stability

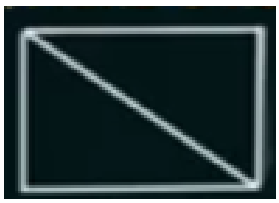
c) If you are computer science student, then Discrete Structures is for you – Discrete Structures as a Unit is important to survive in subjects such as Compiler Design. Databases, Computer Security, Operating Systems, Automata Theory, etc.

d) Many problems can be solved using Discrete Structure:

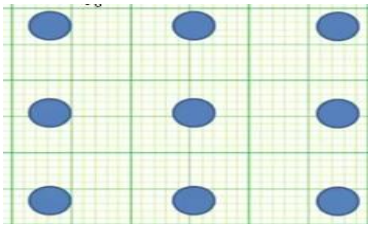
Examples

1) Sorting list of integers
2) Finding the shortest path from your home to your friend's home
3) How ways different combinations of passwords are possible with just 8 alphanumeric characters?
4) Encrypt a message and deliver it to your friend and you don't want anybody to read that message except your friend
5) Drawing a graph with two conditions:
    a) You are not allowed to lift your pen
    b) You are not allowed to repeat edges e.g. try drawing these graphs

i)

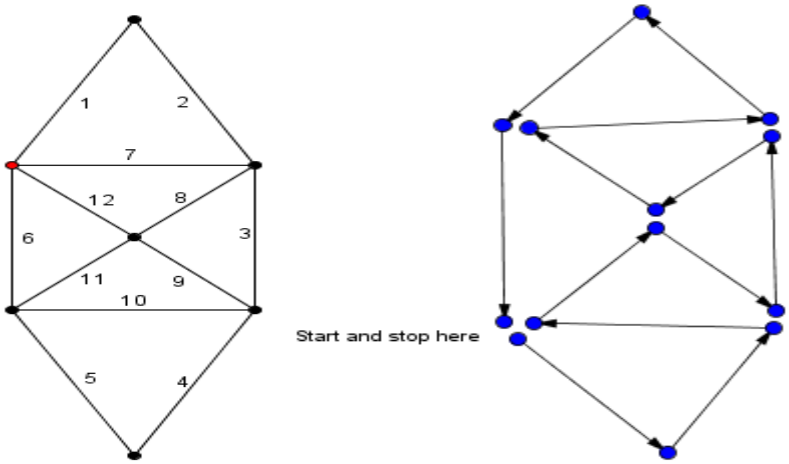


ii)



iii) Connect 9 Dots with 4 Lines

Solution



Other kinds of problems solved using discrete mathematics include:

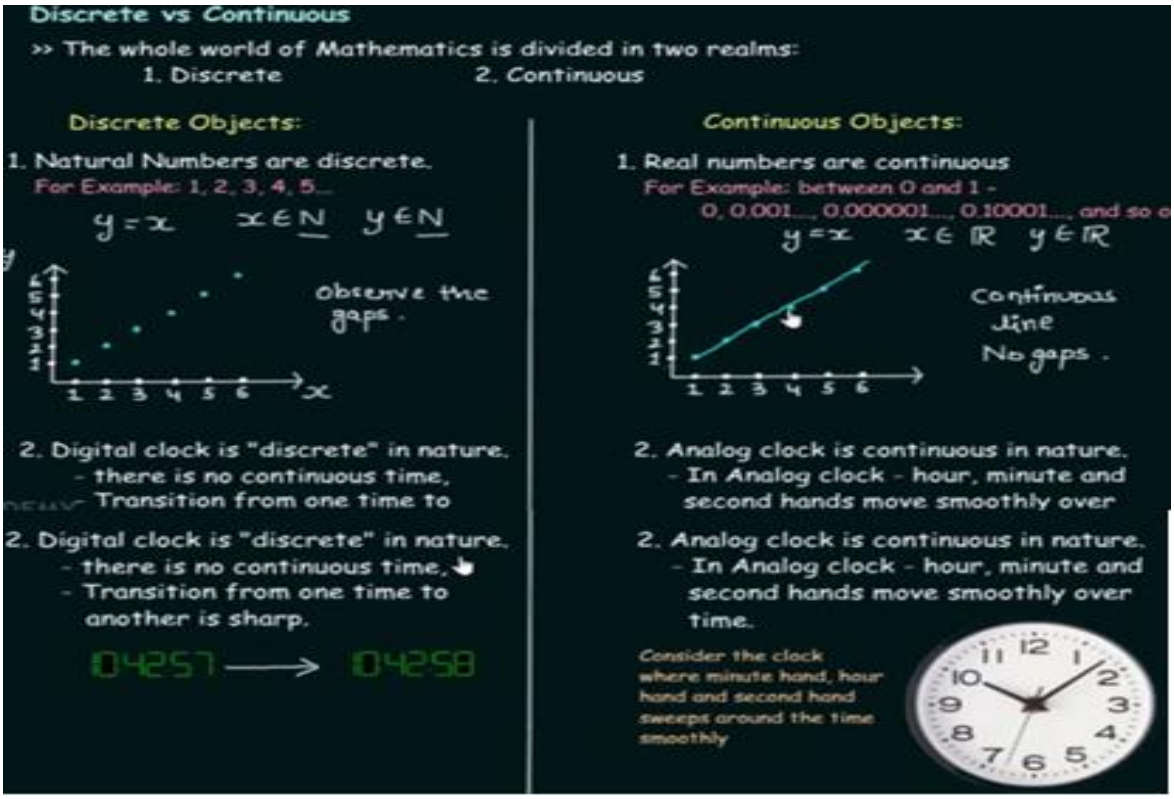
- How many ways are there to choose a valid password on a computer system?
- What is the probability of winning a lottery?
- Is there a link between two computers in a network?
- How can I identify spam e-mail messages?
- How can I encrypt a message so that no unintended recipient can read it?
- What is the shortest path between two cities using a transportation system?
- 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 can it be proved that a sorting algorithm correctly sorts a list?
- How can a circuit that adds two integers be designed?
- How many valid Internet addresses are there?

1.4 Discrete versus continuous

Discrete means Distinct or Not connected or not continuous. The whole world of mathematics is divided in two realms:

a) Discrete

b) Continuous



Remark

You will learn the discrete structures and techniques needed to solve problems such as these. More generally, discrete mathematics is used whenever objects are counted, when relationships between finite (or countable) sets are studied, and when processes involving a finite number of steps are analyzed. A key reason for the growth in the importance of discrete mathematics is that information is stored and manipulated by computing machines in a discrete fashion.

1.5 Student Activity

Identifies five other kinds of problems you can solve using discrete mathematics