Discrete Structures

INTRODUCTION TO DISCRETE MATHEMATICS

Mathematics

▶ Math expresses the mechanisms of the universe and is the underlying tool used to make many astonishing engineering achievements.

▶ Math has many branches:

  ▶ Continuous Math:

      ▶ Deals with real numbers, and the infinite numbers between them.

      ▶ Reflects the world around us, smooth and continues.

      ▶ E.g.: Progression of time, rotation and revolution of planets, circles, etc.

  ▶ Discrete Math:

      ▶ Integers

      ▶ Countable items

What is Discrete Mathematics?

- Deals with set of items that can only contain distinct values that cannot be further subdivided.

- Part of mathematics devoted to the study of discrete objects.

- Used for counting objects, studying countable sets and analyzing process steps.

- Examples of discrete objects:

  - Name of colors

  - Ideas like gender

  - No of siblings

  - Integers

  - Steps taken by a computer program

What is Discrete Mathematics?

- Provides the math background needed for many courses in computer science

- Computer operates in discrete steps and stores data in discrete bits.

- The continuous nature of the world translates into discrete steps by digitalizing it.

- Concepts and notations from discrete math are useful in studying and describing objects in branches of computer science.

- Discrete math is a tool, to help understand and solve interesting problems.

Simple problems DM deals with:

1. Consider 4 people and 4 chairs. How many different ways can these 4 people be seated on the 4 chairs.

1. Shortest path between two locations?

2. Lets say you have an 8x8 checker board with the corner squares missing. Can we fill up every space with 31 domino pieces. Only place tile vertically or horizontally and should cover the entire board.
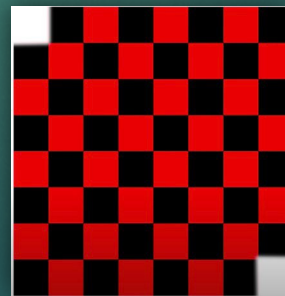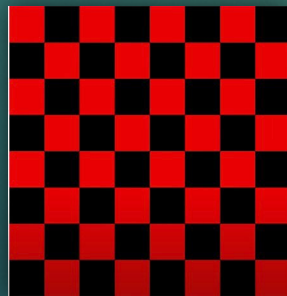
Some other interesting problems:

➢ How many ways can a password be chosen following specific rules?

➢ What is the shortest path between two cities using transportation system?

➢ How many valid Internet addresses are there?

➢ What is the probability of winning a lottery?

➢ Is there a link between two computers in a network?

➢ How can I encrypt a message so that an unintended recipient can read it?

➢ How can a circuit that adds two integers be designed?

Goals of Discrete Mathematics

➤ Students should learn a particular set of mathematical facts and apply them

➤ Students should learn to think logically and mathematically.

➤ To achieve these goals, this course stresses the use of Python programming and mathematical reasoning to discover different ways problems are solved.

Goals of Discrete Mathematics

➢ **Mathematical Reasoning**

- ▪ Ability to read, comprehend, and construct mathematical arguments and proof

➢ **Combinatorial Analysis**

- ▪ Ability and techniques for counting, or enumerate objects e.g., objects of different kinds.

- ▪ Stress is on combinational analysis to solve counting problems or analyze algorithms and not on applying formulas.

➢ **Algorithmic Thinking**

- ▪ **Mathematical portion that includes specification of algorithms, working verifications, analysis of computer memory and time required to perform the task.**

Goals of Discrete Mathematics

➤ **Discrete Structures**

- ▪ Abstract mathematical structures that represent discrete objects and the relationships between them, e.g., sets, permutations, relations, and graphs.

➤ **Applications and Modeling**

- ▪ Concepts from discrete mathematics have been used to address problems in many areas of study; such as computer science, chemistry, biology, geography, business and more.

- ▪ Students can construct their own models through the knowledge of discrete mathematics.

Why study Discrete Mathematics

➤ Develops mathematical maturity: understand and create mathematical arguments

➤ Attack problems and helps develop problem solving skills.

➤ Discrete mathematics will be important in many advance courses in all parts of mathematical sciences.

- **Computer Science**: Data structures, algorithms, database, programming languages, computer security, databases, networking, game design, theory of computation, AI and more.

- **Mathematics**: logic, set theory, number theory, linear and abstract algebra, combinatorics, graph theory and probability theory.

- Used in other fields of operational research, biology, chemistry, engineering and more.

➤ You may find this course significantly more challenging than any course previousl taken.

➤ Science is full of proofs, and you might just learn to read and write proofs.