# Lecture 1

(Analysis of Algorithm )

# Online Course Presence

- My Channel:

  https://www.youtube.com/@universitycomputerscience

- Subscribe & Listen to all relevant Playlists.
- Non-Monetized channel, made for only local students in Urdu language.
- Publicize it to all your Urdu speaking fellows/colleagues & friends

# Today's Agenda

- Objective of the course & Course outline.
- Origin of word: *Algorithm*
- Teaching Procedure, Material/Resources, Grading.
- Algorithm?
- Data Structure? Algorithmics?
- How do we Analyze?
- Aim of Analysis of Algorithm.
- Hard Problems.
- Examples of some Multiplication Algorithms

# Objective of the course

- Understanding the foundations of algorithms and use of Data Structures in the development of application-oriented algorithms.
- Inculcate skills to understand mathematical notations in algorithms and their simple mathematical proofs.
- Develop expertise needed for analyzing the algorithms.
- Gain familiarity with a number of classical problems that occur frequently in real-world applications.

# Origin of word: *Algorithm*

- The word *Algorithm* comes from the name of the muslim author *Abu Ja'far Mohammad ibn Musa-al-Khowarizmi*. He was born in the eighth century at Khwarizm (Kheva), a town south of river Oxus in present Uzbekistan. Uzbekistan, a Muslim country for over a thousand years, was taken over by the Russians in 1873.
- Much of al-Khwarizmi's work was written in a book titled *al Kitab al-mukhatasar fi hisab al-jabrwa'l-muqabalah* (The Compendious Book on Calculation by Completion and Balancing). It is from the titles of these writings and his name that the words *algebra* and *algorithm* are derived. As a result of his work, al-Khwarizmi is regarded as the most outstanding mathematician of his time

# Teaching Procedure

- Lectures
- Discussions
- Assignments ( Important )
- Sudden Quizzes
- Mid Term
- Final Exam

# Material / Resources

- Text Book
  - "Introductions to Algorithms", 2nd Edition

    by

    Thomas H. Cormen

    Charles E. Leiserson

    Ronald L. Rivest

    Clifford Stein

- For other books, view course outline
- WWW
- Any other good book on Algorithm Analysis.

# Grading

- Assignments..... 05 %
- Quizzes/class participation..... 10 %
- Project + Presentation ..... 05 %
- Mid Exam ..... 30 %
- Final Exam ..... 50 %

# What is Algorithm?

- Informally, an algorithm is any well-defined computational procedure that takes some value or set of values as input and produce some value or set of values as output.

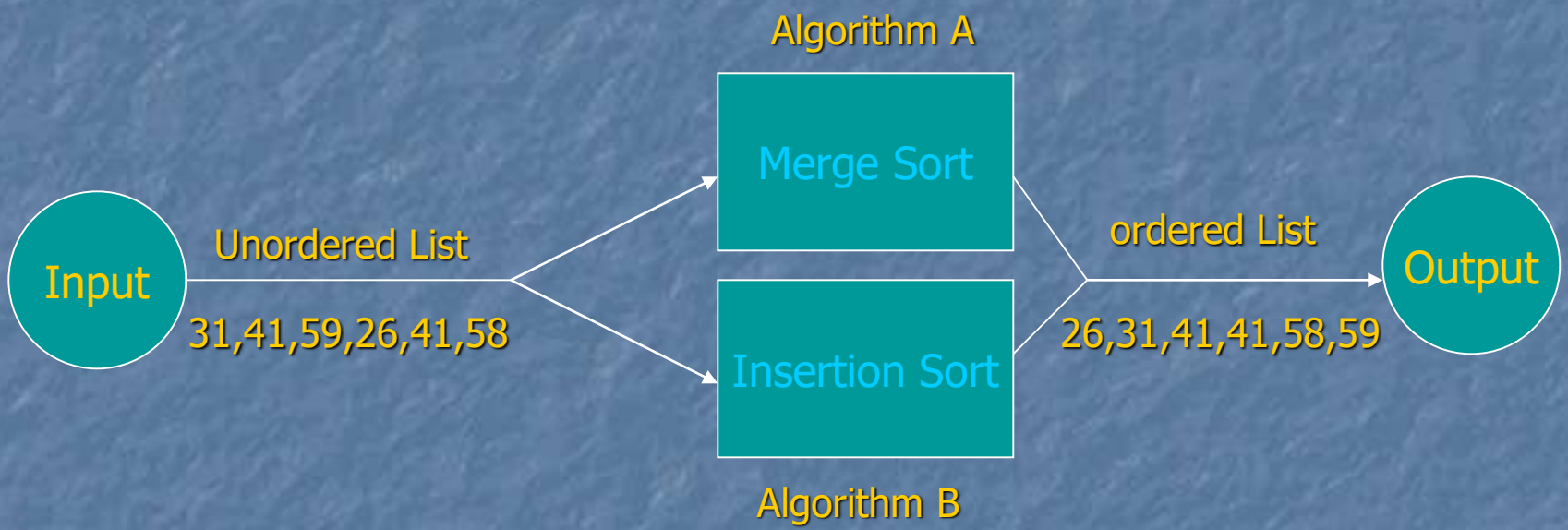
or

- We can also view an algorithm as a tool for solving a well specified computational problem.

or

- We can say algorithm is a sequence of operations to solve problems correctly.

# Example: *Algorithms* to sort numbers in ascending order




In above figure the whole set of input numbers are known as instance of the sorting problem.

# Data Structure

- A Data Structure is a systematic way of organizing and accessing data with a specific relationship between the elements, in order to facilitate access and modifications.

- No single data structure works well for all purposes, so it is important to be familiar with pros and cons of several Data Structures.

# Algorithmics

- It is the science that lets designers study and evaluate the effect of algorithms based on various factors so that the best algorithm is selected to meet a particular task in given circumstances.

- It is also the science that tells how to design a new algorithm for a particular job.

# How do we Analyze?

- Every Algorithm has a parameter N or n that effects its running time.
- For example, for sorting different numbers the parameter N is the number of input numbers to be sorted.

- So for analyzing algorithms our starting point is to have n or N

N or n ⟶ shows size of the Input.

# Aim of Analysis of Algorithm

- Primary Concern:
  - Time ( i.e. less number of time taken by Algo)
  - Space ( i.e. less memory space to be taken)

- Secondary issues:
  - Size of instances to be handled
  - Type of language to be used for programming
  - Type of machine for implementation

# Hard Problems

- Most of the contents of this course are about to address/discuss algorithms and their efficiency. Our usual measure of efficiency is speed.
- There are some problems, however, for which no efficient solution is known.
- We will study few of these kind of problems later in the course, which are known as NP-Complete problems.

# PARAMETERS FOR SELECTION OF AN ALGORITHM

- Priority of Task
- Type of Available Computing Equipment
- Nature of Problem
- Speed of Execution
- Storage Requirement
- Programming Effort

A good choice can save both money and time, and can successfully solve the problem.

# MULTIPLICATION
# (981 x 1234)

| American | English |
|---|---|
| 981 | 981 |
| 1234 | 1234 |
| 3924 | 981**1** |
| 2943 | 196**2** |
| 1962 | 294**3** |
| 981 | 392**4** |
| 1210554 | 1210554 |

# MULTIPLICATION (981 x 1234)

## (*a la russe*)

| | | |
|---|---|---|
| 981 | 1234 | 1234 |
| 490 | 2468 | |
| 245 | 4936 | 4936 |
| 122 | 9872 | |
| 61 | 19744 | 19744 |
| 30 | 39488 | |
| 15 | 78976 | 78976 |
| 7 | 157952 | 157952 |
| 3 | 315904 | 315904 |
| 1 | 631808 | 631808 |
| | | 1210554 |

# MULTIPLICATION (981 x 1234)
## (*DIVIDE & CONQUER*)

| | Multiply | | Shift | Result |
|---|---|---|---|---|
| i) | 09 | 12 | 4 | 108 . . . . |
| ii) | 09 | 34 | 2 | 306 . . |
| iii) | 81 | 12 | 2 | 972 . . |
| iv) | 81 | 34 | 0 | 2754 |
| | | | | **1210554** |

# MULTIPLICATION (9 x 12)
# (*DIVIDE & CONQUER*)

| | Multiply | | Shift | Result |
|---|---|---|---|---|
| i) | 0 | 1 | 2 | 0 . . |
| ii) | 0 | 2 | 1 | 0 . |
| iii) | 9 | 1 | 1 | 9 . |
| iv) | 9 | 2 | 0 | 18 |
| | | | | **108** |

# Assignment No 1

- Implement Multiplication algorithm using *Divide and Conquer* approach to multiply any two integer numbers.
- Use any language or visual language (tool) of your choice. Due Coming Monday
- Copying assignment is strictly prohibited. If found, will lead to cancellation of assignment.

# Thank You ...