

# Lecture 1

(Analysis of Algorithm )

# 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”, 2<sup>nd</sup> 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

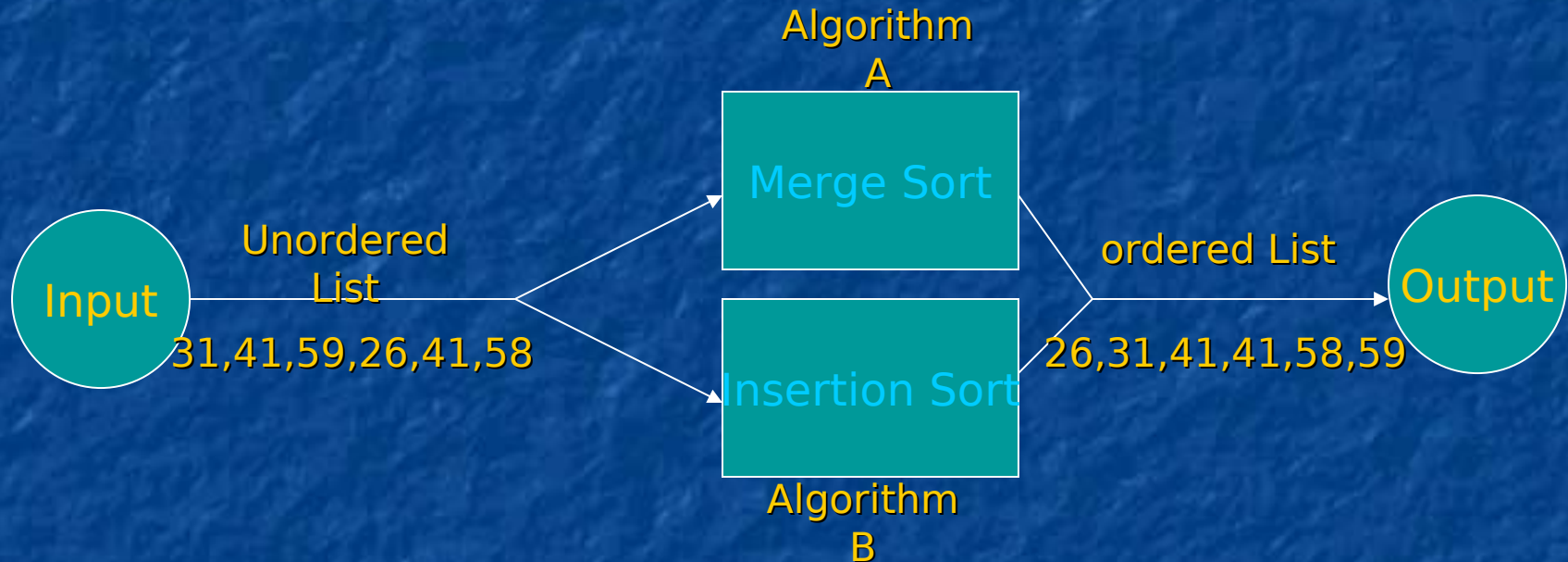
- We can also view an **algorithm** as a tool for solving a well specified **computational problem**.

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)\_

$$\begin{array}{r} 981 \\ 1234 \\ \hline 3924 \\ 2943 \\ 1962 \\ 981 \\ \hline 1210554 \\ \hline \end{array}$$

American

$$\begin{array}{r} 981 \\ 1234 \\ \hline 981 \\ 1962 \\ 2943 \\ 3924 \\ \hline 1210554 \\ \hline \end{array}$$

English

# 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	<u>631808</u>
		<u>1210554</u>



# 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
				<b>1210554</b>

# 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
				<b>108</b>

# 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 ...