

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 *a/ 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.

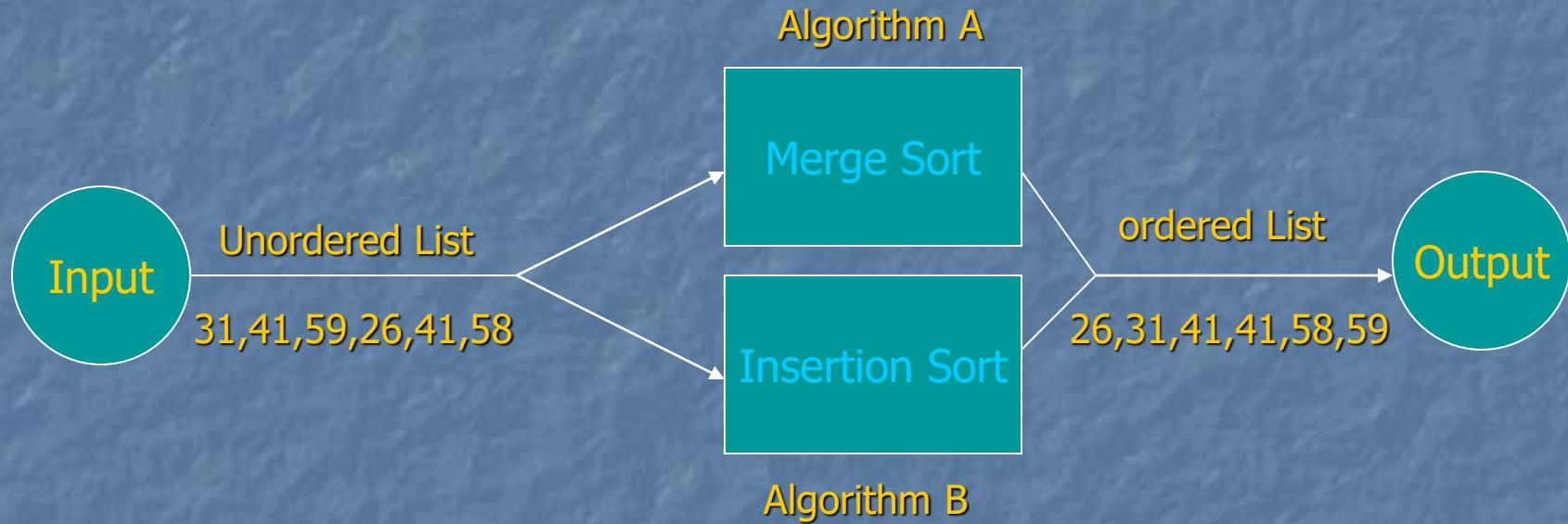
Grading

- 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 × 1234)

981

1234

3924

2943

1962

981

1210554

981

1234

981

1962

2943

3924

1210554

American

English

MULTIPLICATION (981 x 1234)

(*a la russe*)

$$\begin{array}{r} 981 & 1234 & 1234 \\ 490 & 2468 & \\ 245 & 4936 & 4936 \\ 122 & 9872 & \\ 61 & 19744 & 19744 \\ 30 & 39488 & \\ 15 & 78976 & 78976 \\ 7 & 157952 & 157952 \\ 3 & 315904 & 315904 \\ 1 & 631808 & \underline{631808} \\ & & \underline{1210554} \end{array}$$

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 ...