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", 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

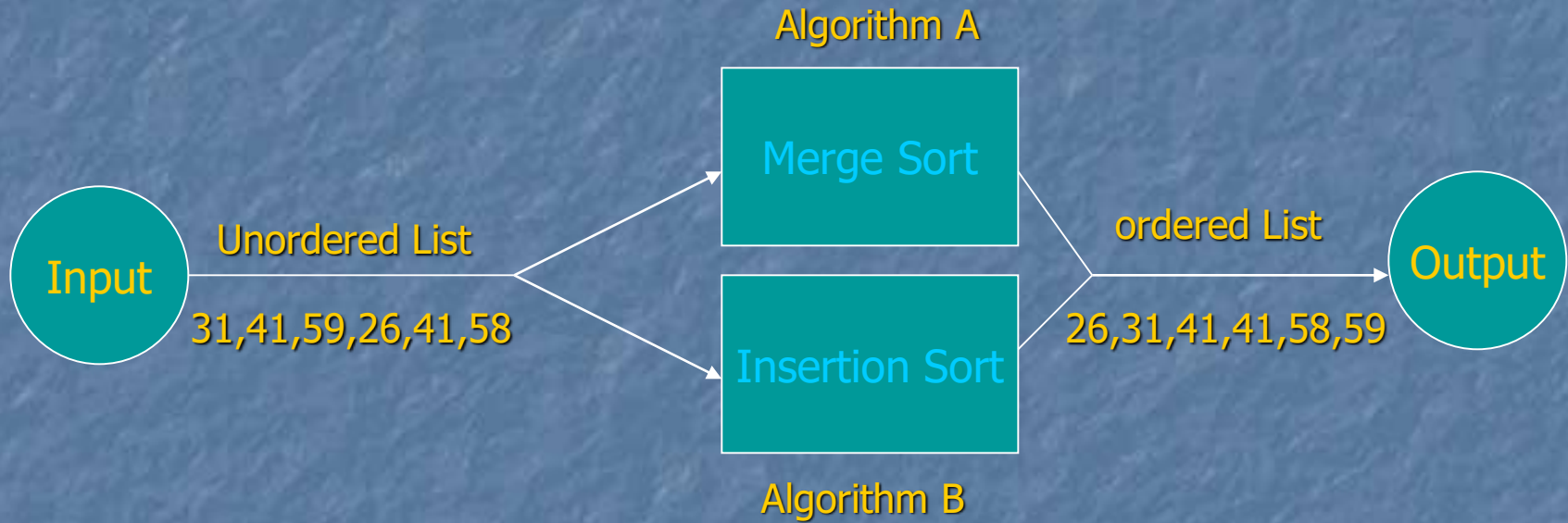- We can also view an algorithm as a tool for solving a well specified computational problem.

  or

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

Example: *Algorithms* to sort numbers in ascending order

Algorithm A

Merge Sort

Input

Unordered List

31,41,59,26,41,58

Insertion Sort

Algorithm B

ordered List

26,31,41,41,58,59

Output

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 <u>later in the course</u>, 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	
	2943	1962	
	1962	2943	
	981	3924	
	1210554	1210554	

American

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
				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 …