# Analysis of Algorithm

Muhammad Athar email id: athar@northern.edu.pk WhatsApp# 0333-5077664

**(Week 01) Lectures 01 & 02**

**Objectives: Learning objectives of these lectures are**

- What is Algorithm
  - Why to Study Algorithm
- What do you mean by Design of Algorithm
  - What is a need to design of Algorithm
- What do you mean by Analysis of Algorithm
  - What is a need to analyze the designed algorithm
  - What is analyzed about algorithm
    - Execution time
    - Required Space

**Text Book & Resources:**

1. Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, The MIT Press; 3rdEdition (2009). ISBN-10: 0262033844
2. Introduction to the Design and Analysis of Algorithms by Anany Levitin, Addison Wesley; 2ndEdition (2006). ISBN-10: 0321358287
3. Algorithms in C++ by Robert Sedgewick (1999). ASIN: B006UR4BJS
4. Algorithms in Java by Robert Sedgewick, Addison-Wesley Professional; 3rd Edition(2002). ISBN-10: 0201361205

# Analysis of Algorithm

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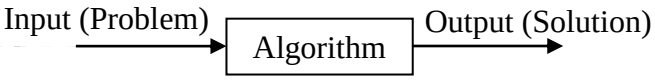
**What is Algorithm?**

- Algorithm is set of instructions to solve some problem.
  - Instructions must be in some sequence, because if
  - Instructions should be written in clear (unambiguous) form.
  - Must execute instructions in a finite amount of time.
  - Algorithm takes input (problem) and convert it into output (solution) by following the instructions in a finite time.




**Example**

Problem:

Multiply two numbers (99 and 999)

**Set of Instructions**

1. Pick first digit of first number (9)—from right most
2. Add second digit up to picked digit times (add 999 up to 9 times)
   a. Insert zero's at end of obtained result, no zero will be added if first digit is picked, 1 zero will be added for second digit, 2 zero's will be added for third digit; in this fashion no. of zero's will be increased.
   b. Store the obtained result
3. Repeat step 1-2 until digits of first number ends.
4. Add all result stored in step 2b

**Solution**

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**Definition**

An algorithm is any well-defined computational procedure that takes some values, or set of values, as input and produces some value, or set of values, as output. An algorithm is thus a sequence of computational steps that transform the input into output.

**Why to Study Algorithm?**

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"*Algorithmic is more than a branch of computer science. It is the core of computer science, and, in all fairness, can be said to be relevant to most of science, business, and technology" (David Harel)*

**Off course**: algorithm plays important role in the world of computer science.

- But we have to start its importance other than computer science. Come on and remind your life from childhood to now, amazingly you will find out that you are studying algorithm from childhood. As problem of multiplication have solved by you since childhood exactly as the above described fashion. So it's nothing new to study. Now question is about its importance. Make it clear that learning about algorithm is important more than anything in daily life. Just read the definition again, from definition you will be clear about the importance of algorithm because in daily life all of us have to solve problems. So learning the strategy to solve problems is necessary for everyone, hence we have to learn about algorithm.
- Learning algorithm also improve the analytical skill.
- A good understanding of algorithms is essential for a good understanding of the most basic element of computer science: programming. Unlike a program, an algorithm is a mathematical entity, which is independent of a specific programming language, machine, or compiler.

**Areas of Algorithms**

There are two following areas included in the study of algorithms

- Design of Algorithm
- Analysis of Algorithm

**Design of Algorithm**

Design of algorithm refers as instructions should be

- Unambiguous (should have clear meaning)
- In proper sequence (sequence matters a lot, in case of incorrect sequence algorithm may leads to incorrect solution)

**Why study algorithm design?**

# Analysis of Algorithm

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- Design of algorithms is core of algorithm, because finding correct solution is a basic goal to write an algorithm. Therefore algorithm should be designed in such a way that produces correct result otherwise there will be no use of that algorithm. So learning to design an algorithm is most important than algorithm.
- Second need to design of algorithm is to standardize the solution for generic problems.
- There are many facets to good program design. Good algorithm design is one of them (and an important one). To be really complete algorithm designer, it is important to be aware of programming and machine issues as well.

**Analysis of Algorithm:**

Analysis of algorithm mean finding out the required resources to execute a particular algorithm. This term also referred as "*efficiency of algorithm*".

**Why to Analyze Algorithm?**

Multiple algorithms can be design to solve a single problem. Required resources for each of them are different. Most suitable will be one for which minimum resources are required. So we have to calculate required resources for designed algorithm. To calculate required resources we have to analyze the design algorithm.

*Efficiency of algorithm* is measured in two dimensions

- Time (required time to perform instructions)
- Space (required space to store intermediate results)

**Example:**

- Problem: Multiply tow numbers (97 and 999)
- Algorithm 1: add 999, 97 times
- Algorithm 2: add 999, 7 times, and then add 999 , 9 times, and then add both result
- In algorithm 1 we need 97 operations of addition and in algorithm 2 we need 17 operations of addition. Algorithm 2 will be most suitable due to having fewer resources in term of time as compared to algorithm 1.
- In concluding remarks; in this course we will learn way to design algorithms to solve a problem and make analysis for designed algorithm.

# Analysis of Algorithm

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**Problem Development Steps**

The following steps are involved in solving computational problems.

- Problem definition
- Development of a model
- Specification of an Algorithm
- Designing an Algorithm
- Checking the correctness of an Algorithm
- Analysis of an Algorithm
- Implementation of an Algorithm
- Program testing
- Documentation

**Characteristics of Algorithms (Summery)**

The main characteristics of algorithms are as follows

- Algorithms must have a unique name
- Algorithms should have explicitly defined set of inputs and outputs
- Algorithms are well-ordered with unambiguous operations
- Algorithms halt in a finite amount of time. Algorithms should not run for infinity, i.e., an algorithm must end at some point.