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## 1 What are Algorithms?

The word algorithms comes from the Muslim scientist in the region of Iran, Khwarizmi. His date of birth is not known.

He published a book called '*Al Kitab Al Mukhtatar fi hisab al-jab wa'l-muqabalah*'

What is the algorithmic definition? It is as the following,

- 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

What is an algorithm - a formal definition,

- An algorithm is a sequence of unambiguous instructions for solving a problem, i.e, for obtaining a required output for an legitimate input in a finite amount of time

In the above, some keywords are,

- **Unnambiguity** - Must be very well defined
- **Finite amount of time** - should not be some estimated amount of time

Another definition is,

- Recipe, process, method, technique, procedure, routine ...

## 2 Why is the study of algorithms worthwhile?

To work on the time, and to demonstrate that our solution terminates, and with the correct answer,

- Suppose computers were infinitely fast and computer memory was free
- Would you have any reason to study algorithms?
- The answer is "YES"

- to demonstrate that your solution method terminates and does so with the correct answer

We study algorithms, because often we have limited resources, and we wish to complete the termination of the program with the correct answer, so that the fewest number of resources are used Putting in into summary,

- Processing time is a bounded resources
- Computers may be fast but they are not infinitely fast. And memory may be inexpensive, but it is not free.
- Use these resources wisely
- Insertion and Merge Sort

Let's take an example

- Suppose that computer A executes 10 billion instructions per second and computer B executes only 10 million instructions per seconds
- Insertion sort in machine language for computer A by world's crafftiest programmer resulting in  $2n^2$  time.
- Suppose an average programmer implements merge sort, using a high-level language with an inefficient compiler, taking  $50 * n * \log(n)$  Time
- To sort 10million numbers, computer A takes,

$$2 \cdot (10^7)^2 \text{instructions} \frac{1}{10^{10} \text{instructions/second}} = 20,000 \text{seconds (more than 5.5 hours)}.$$

While B takes,

$$50 * 10^7 * \log(10^7) \text{instructions} \frac{1}{10^7 \text{instructions/second}} = 1163 \text{seconds (less than 20 minutes)}$$