An Introduction to Algorithms

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Topics

ALGORITHMS

CHARACTERISTICS OF AN ALGORITHM

ALGORITHMS FOR BASIC PROBLEMS

Algorithms:

An algorithm is a set of step-by-step instructions for solving a problem or accomplishing a specific task.

They are used in many fields, such as computer science, mathematics, engineering, and more.

Algorithms are like a recipe, which tells you what to do and in what order to achieve a specific outcome.

They are designed to be executed by machines, such as computers, and humans can also execute them if needed.

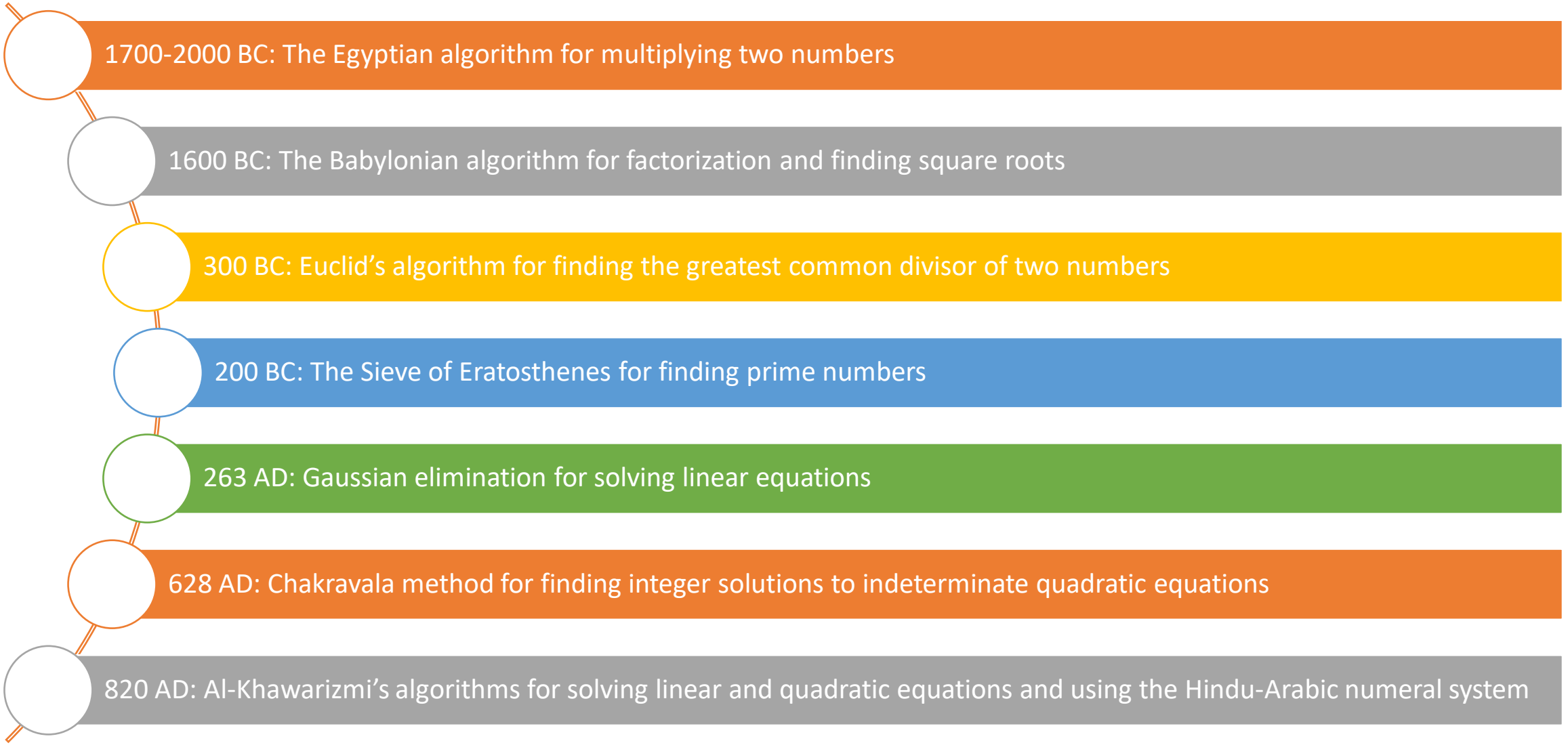
The use of algorithms is not a new concept, and people have been using them for centuries to solve problems.

With the advent of computers and the growth of technology, the use of algorithms has become more prevalent in various applications today.

The importance of algorithms cannot be overstated as they are crucial in solving problems and accomplishing tasks in many fields.

As we move further into the digital age, understanding algorithms and being able to design and implement them is becoming a fundamental skill.

Famous but oldest Algorithms:



Recent Algorithms with Huge Impact:

Generative adversarial networks (GANs), a type of neural network that can create realistic images, videos, and sounds from scratch or by manipulating existing data

AlphaFold, a deep-learning system that can predict the 3D structure of proteins, which is crucial for understanding many biological processes and diseases

GPT-3, a large natural-language computer model that can generate realistic and coherent text on almost any topic

TikTok's recommendation algorithms, which power the "For You" feed and create viral sensations and new forms of online expression

The algorithm for mRNA vaccines, which enabled the rapid development and deployment of effective vaccines against covid-19

Characteristics of an Algorithm:

Input: An algorithm requires some input values to start with. For example, an algorithm that multiplies two numbers needs two numbers as input.

Output: An algorithm produces one or more output values as a result of its execution. For example, an algorithm that multiplies two numbers returns one number as output.

Unambiguity: An algorithm should be clear and precise, without any room for confusion or interpretation. Each instruction in an algorithm should have only one meaning and effect.

Finiteness: An algorithm should have a limited number of instructions and steps that can be counted. It should also terminate after a finite amount of time or iterations.

Effectiveness: An algorithm should be efficient and feasible to execute. Each instruction in an algorithm should be simple enough to be carried out by a computer or a human.

Language independence: An algorithm should be independent of any programming language or platform. It can be expressed in any language or notation that is understandable by humans or computers.

Algorithms for Basic Problems:

There are many basic problems that can be solved using algorithms, such as sorting, searching, and calculating.

- Sorting
- Searching
- Calculating

Sorting Algorithms:

Sorting algorithms are used to arrange data in a specific order, such as alphabetical, numerical, or chronological order.

There are various sorting algorithms that differ in their complexity, stability, and performance.

Some common sorting algorithms are bubble sort, insertion sort, selection sort, merge sort, quick sort, and heap sort.

Live Demo of Sorting Algorithms:

- Sorting (Bubble, Selection, Insertion, Merge, Quick, Counting, Radix) - VisuAlgo
- Interactive animations (ide.sk)

Searching Algorithms:

Searching: Searching is the process of finding an item (such as a number, word, or record) in a collection of items (such as an array, list, or database).

There are many search algorithms that differ in their complexity, efficiency, and applicability.

Some common searching algorithms are linear search, binary search, interpolation search, and hashing.

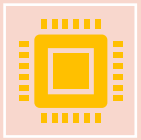
Live Demo of Sorting Algorithms:

- Sorting (Bubble, Selection, Insertion, Merge, Quick, Counting, Radix) - VisuAlgo

Calculating Algorithms:

Calculating algorithms are used to perform calculations, such as addition, subtraction, multiplication, division, and more.

There are various calculating algorithms, including the simple, long, and multi-digit arithmetic algorithms, among others.



These algorithms are essential in computer science and mathematics and have numerous applications in real-world scenarios.

The efficiency of these algorithms is critical, as the time and space complexity can significantly affect their performance.

Examples of Calculating Algorithms:

- An algorithm to calculate the area of a circle given its radius:

  Start

  Declare a constant PI with value 3.14

  Input radius

  *Compute area = PI * radius * radius*

  Output area

  End

Examples of Calculating Algorithms:

- An algorithm to calculate the factorial of a positive integer n:

Start
Input n
Initialize result = 1
For i = 1 to n:
    Multiply result by i
End for
Output result
End

Examples of Calculating Algorithms:

- An algorithm to calculate the sum of the first n natural numbers:

Start
Input n
Initialize sum = 0
For i = 1 to n:
    Add i to sum
End for
Output sum
End

Examples of Calculating Algorithms:

- An algorithm to calculate the average of an array of numbers:

Start
Declare an array A of size N and fill it with numbers
Initialize sum = 0 and count = 0
For each element x in A:
    Add x to sum
    Increment count by 1
End for
Compute average = sum / count
Output average
End


Questions?