Session 1: Introduction and Orientation

Data Structures and Algorithm 1 - Lab

Yahya Tawil

Fri, 24 Sep 2021

Introduction

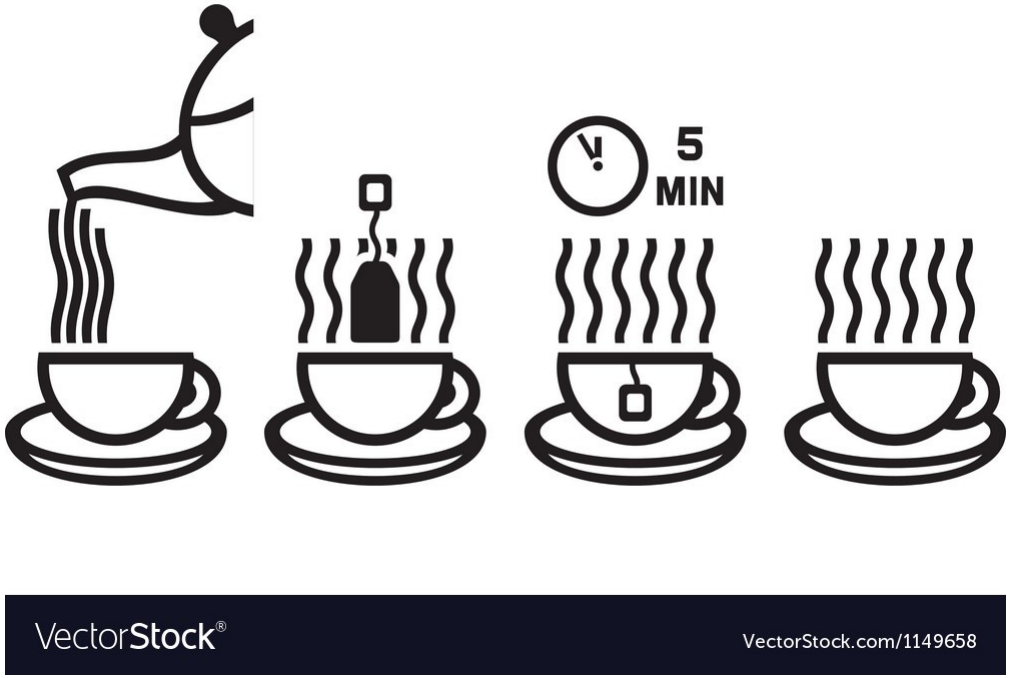
- How is me?
- Contact me: yahya.tawil@gmail.com (yahya.tawil@gmail.com) **or** yahya.tawil@std.hku.edu.tr (yahya.tawil@std.hku.edu.tr)

Introduce yourselfs: Name - Which year - Programming languages you know.

- This lecture is to make you exited about computer Algorithms

What is an algorithm?

Real Life Example (anaology):



More Complicated:

As a broad answer: "A set of steps to accomplish a task."

What if the problem is more complicated in real life?

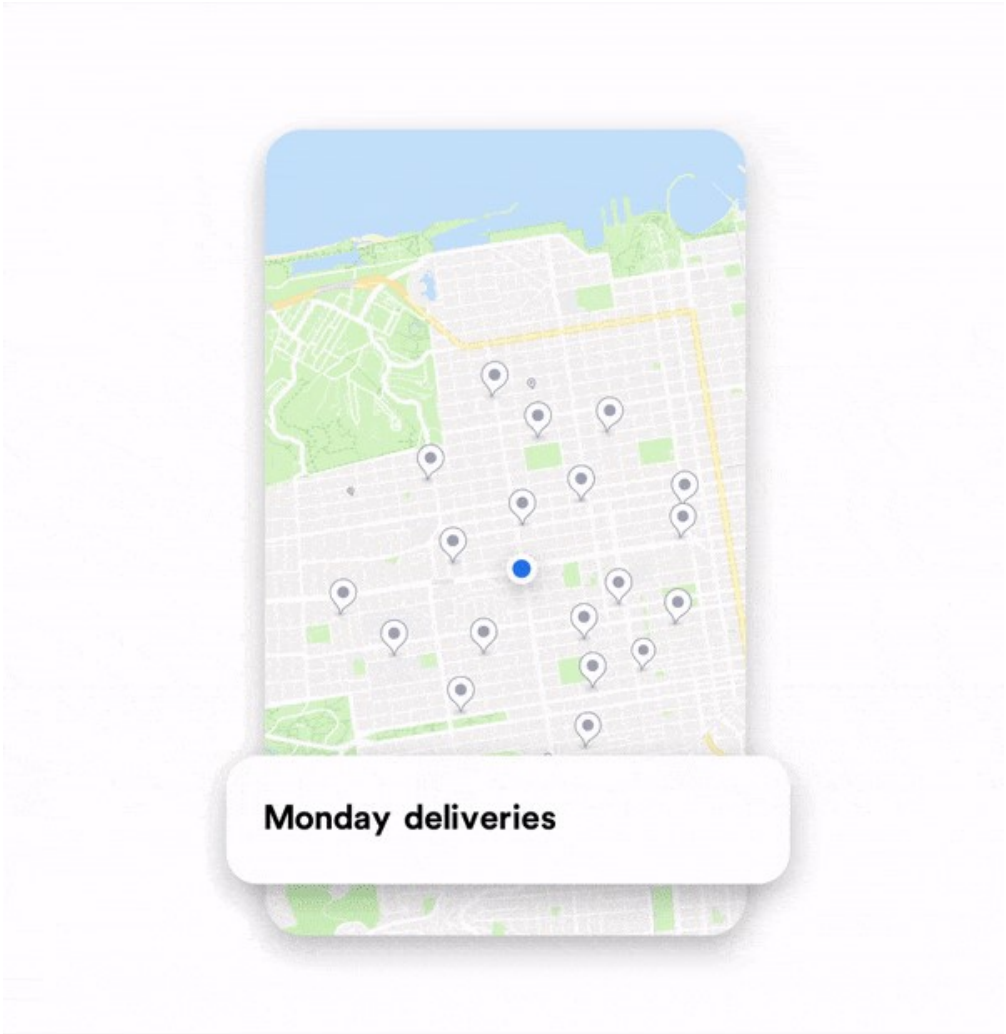
What is a computer algorithm?

A computer algorithm is any well-defined computational procedure that takes some value, or set of values, as input and produces some value, or set of values, as output.

Thus, an algorithm is a sequence of computational steps that transform the input into the output.

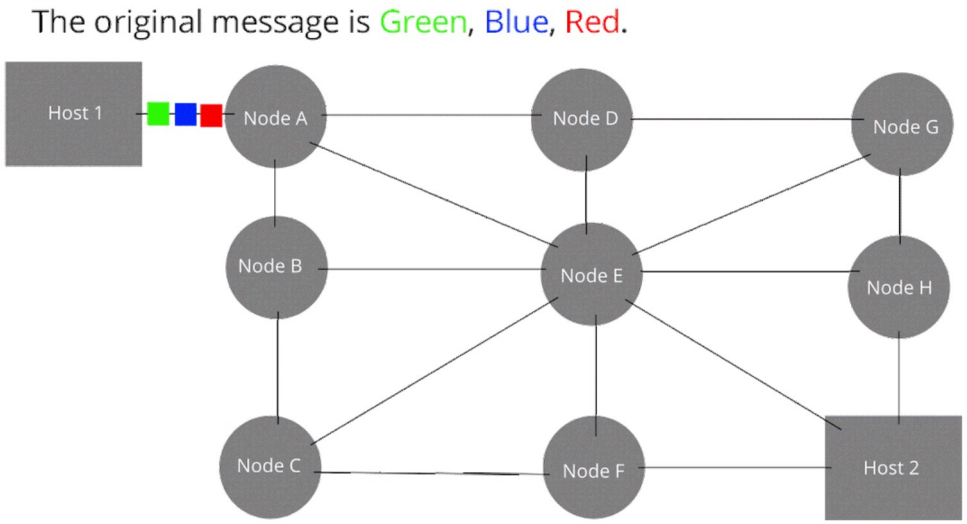
Applications of Algorithms in Many Branches in Computer Science

GPS Maps : Shortest Path (Graph Algorithms)



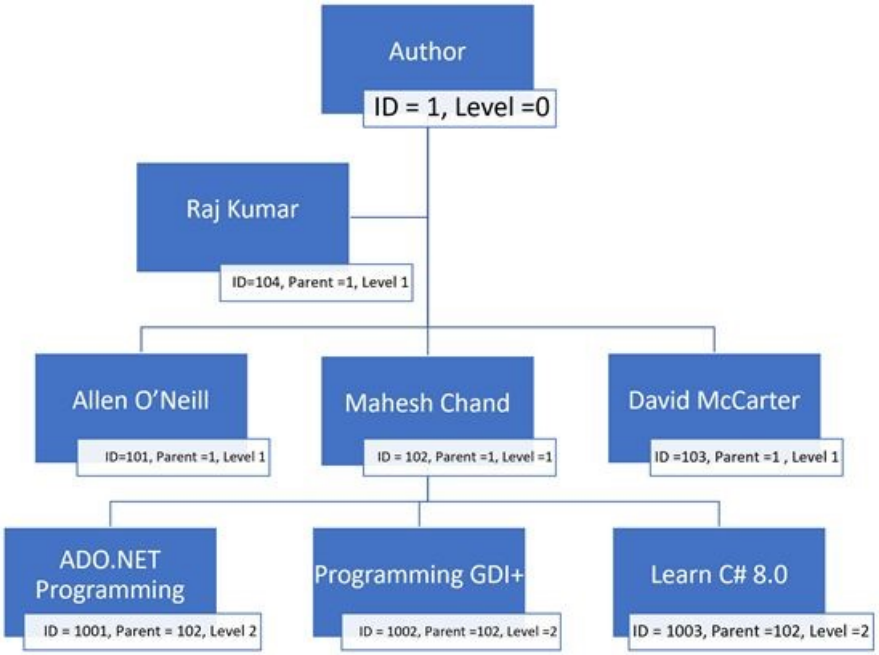
* source: getcircuit.com

Routing in Computers Networks : Shortest Path (Graph Algorithms)

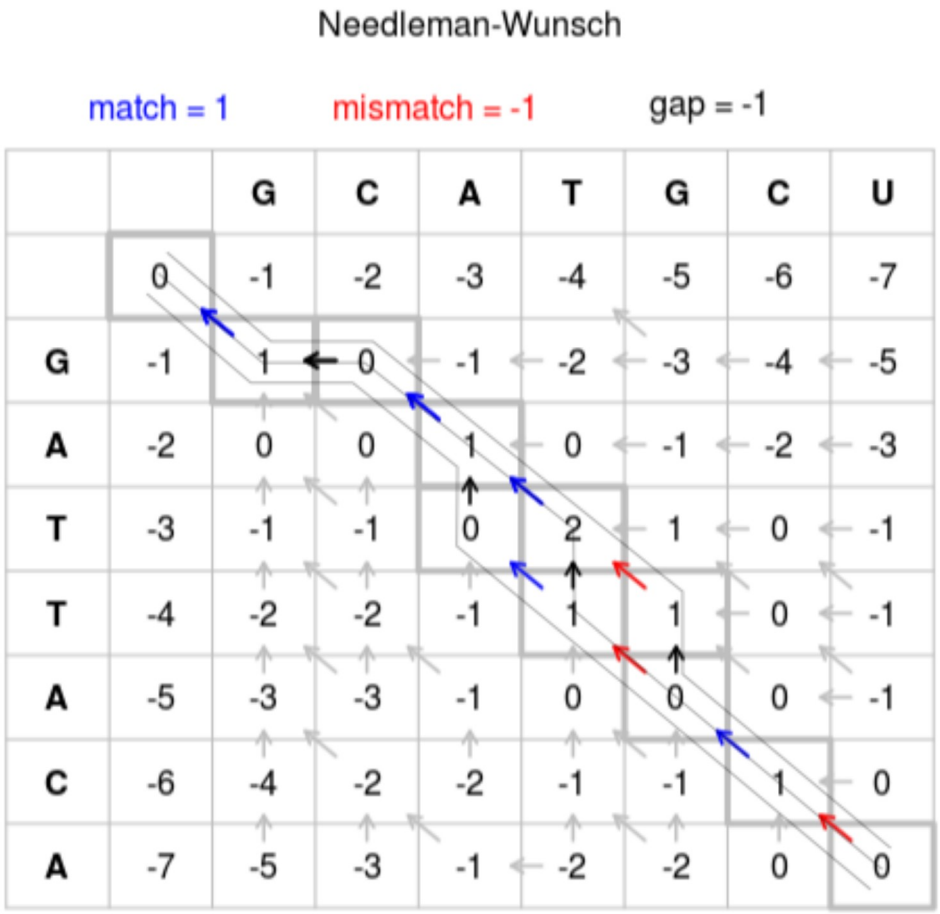


* sourse: Wikimedia

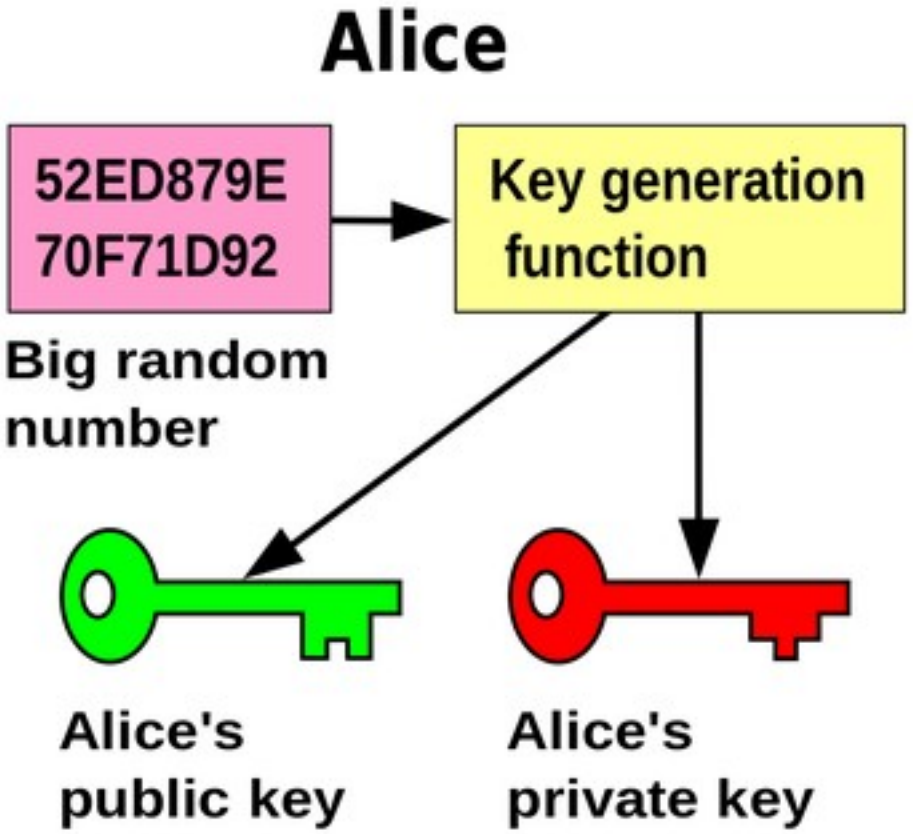
Databases : Tree Datastructure (Searching algorithms)



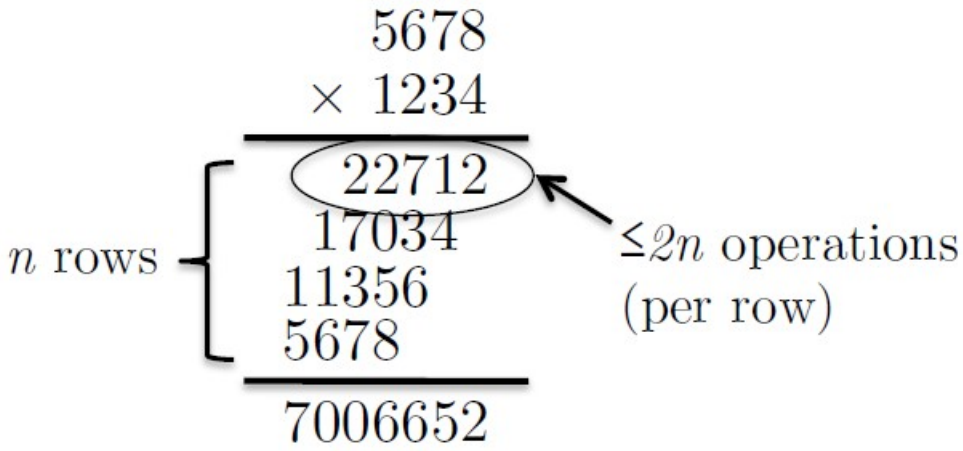
Biology : Compare Biological Sequences(Dynamic Programming)



Cryptography : Public Key(Prime Number Generation)



Example: Grade-school Algorithm (long multiplication algorithm)


5678
× 1234
22712
17034
11356
5678
7006652
n rows
≤2n operations
(per row)

For now, let's think of a primitive operation as any of the following:

1. adding two single-digit numbers.
2. multiplying two single-digit numbers.
3. adding a zero to the beginning or end of a number.

$$\text{total number of operations} \leq \underbrace{\text{constant}}_{=4} \cdot n^2$$

Take Grade-school Multiplication Algorithm to A Next Level

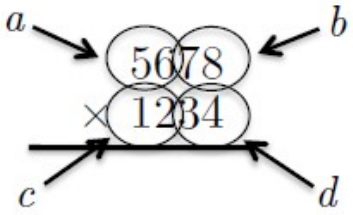
Karatsuba Algorithm

`Karatsuba`

Input: two n-digit positive integers x and y.
Output: the product $x \cdot y$.
Assumption: n is a power of 2.

---

if $n = 1$ **then** `// base case`
    compute $x \cdot y$ in one step and return the result
else `// recursive case`
    $a, b :=$ first and second halves of x
    $c, d :=$ first and second halves of y
    compute $p := a + b$ and $q := c + d$ using
     grade-school addition
    recursively compute $ac := a \cdot c$, $bd := b \cdot d$, and
     $pq := p \cdot q$
    compute $adbc := pq - ac - bd$ using grade-school
     addition
    compute $10^n \cdot ac + 10^{n/2} \cdot adbc + bd$ using
     grade-school addition and return the result



a b
56 78
x c 12 34 d

adbc = pq-ac-bd=6164-672-2652=2840

Result = 10^4 *672+10^2*2840 +2652 = 7006652

a b
5 6
x c 1 2 d

adbc = (5+6)*(1+2)-5*1-6*2=16

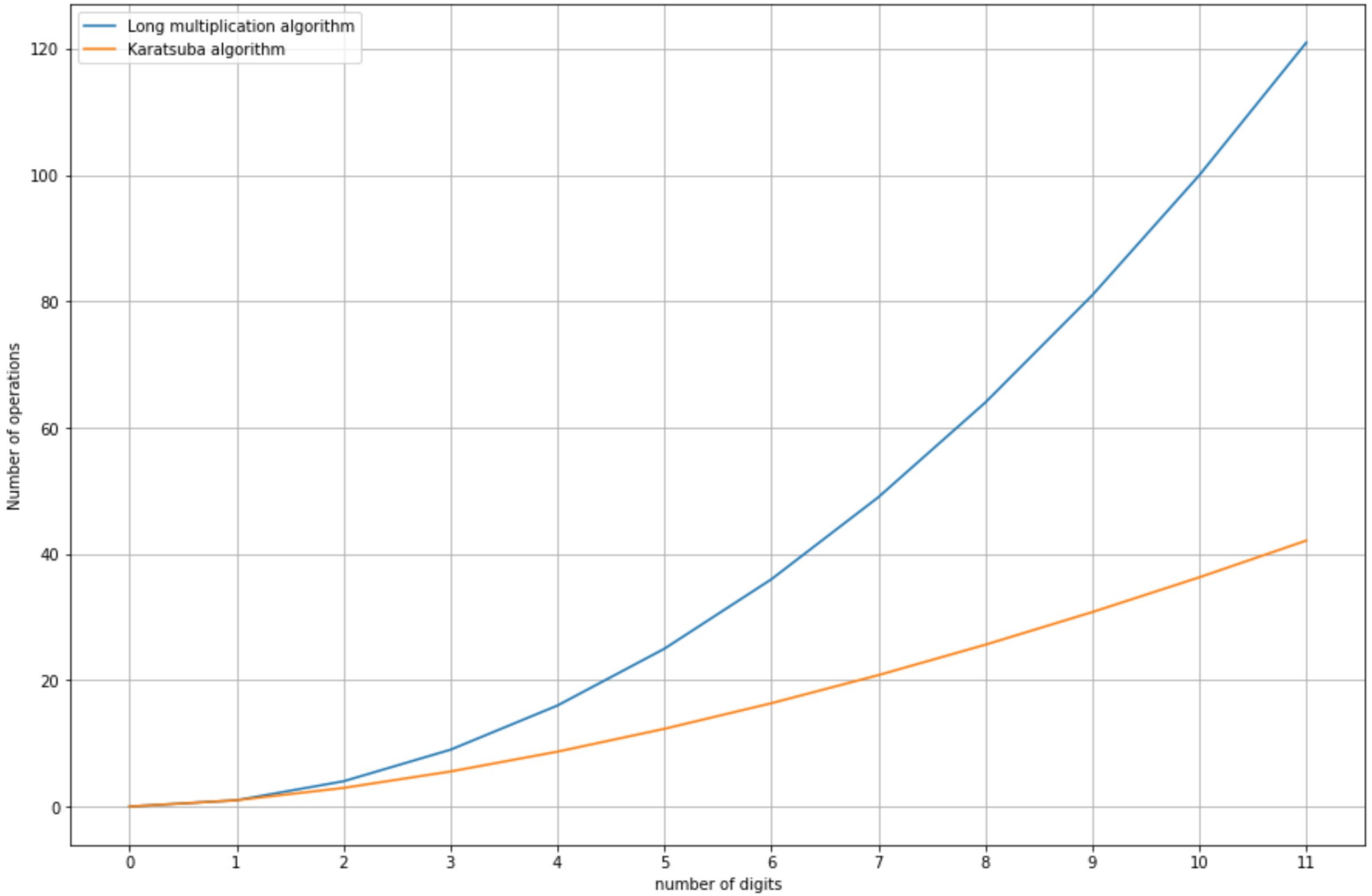
Result = 10^2 *5+10*16 +12 = 672

a b
7 8
x c 3 4 d

adbc = (7+8)*(3+4)-7*3-8*4=16

Result = 10^2 *21+10*52 +32 = 2652

Which one is better ?

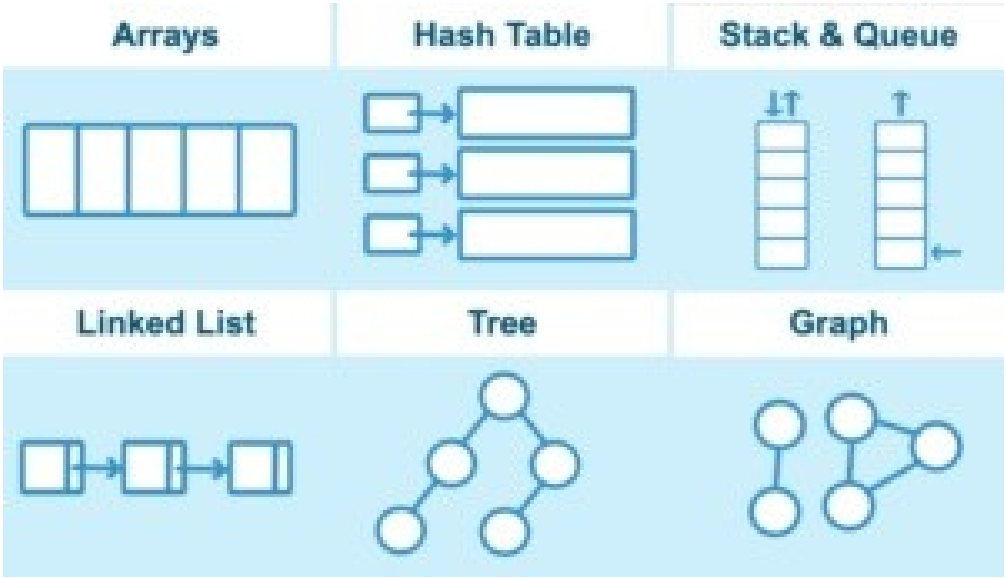

Long multiplication algorithm
Karatsuba algorithm
Number of operations
number of digits
0
20
40
60
80
100
120
0
1
2
3
4
5
6
7
8
9
10
11

"What do we want from a computer algorithm?"

1. Correctness and 2. Resource usage optimization (memory and time)

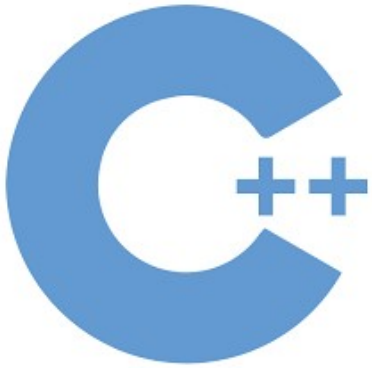
What Is A Data Structure?

”A data structure is a way to store and organize data in order to facilitate access and modifications. No single data structure works well for all purposes, and so it is important to know the strengths and limitations of several of them.”



* source: hellocodeclub.com

The Programming Language We Will Use In This Lab

Data Structure Part	Algorithms Part
	

Information About This Lab

- How many sessions? Check the lab repository at Github (https://github.com/yahyatawil/HKU-21-22-Data-Structures-Algorithm).

- Lab Material and Assignments? Manged using the lab repository at Github (https://github.com/yahyatawil/HKU-21-22-Data-Structures-Algorithm).

- Marks? Expected 30-40 marks.

Lab Rules

- Be positive, motivated and active, if you have any concern or question don't hesitat to contact me any time.

- Missing an assignment deadline (for no acceptable reason) penality is 50% deduction in the respective work mark.

- Plagiarism (https://www.hcii.cmu.edu/academics/plagiarism-policy) : cheating in any form is not permitted as ethical or educational behavior and will not be tolerated (seriously! first discovered plagiarism, a 10% deduction of your final lab mark. Second discovered plagiarism, 40%. third discovered plagiarism, you will get zero in the lab.)

- The official teaching language is english, thus only English is used and allowed for teaching, commnication, presentations, quizes and assignments.

Assignment 1

Setup you Git enviroment for the lab work. Instructions are found here (https://github.com/yahyatawil/HKU-21-22-Data-Structures-Algorithm/wiki/Assignment-1-(introduction)). Deadline: Mid-night of Thu 30 Sep 2021