# General Notes

## What is an algorithm ?

An algorithm is a set of well defined rules or a recipe to solve a well defined problem . for example if we have a set of task that need to be completed according to their deadline , an algorithm would solve that problem.

Routing and Comunication depends on the shortest path algorithim

Algorithms are used in quantum mechanics and finance

## Pattern for Pseudocode

* Define a computation probelm
* Define Input
* Define outoput
* Solution that transform input to output

## The algorithm Designer's Mantra

"Perhaps the most important principle for the good algorithm designer is to refuse to be content" Aho , Hopcroft and Ullman (the Design and analysis of computer algorithm, 1974)

Simply Can we do better ?

## \*\* What is a mathematical proof?

A proof is verifying that a proposition is true thourgh a series of steps called "logical deductions" from a base set of axioms ( set of self evident truth) , they are the starting point of logical reasoning . poor axioms (shaky truth) can lead to unreliable mathematical reasoning. (paraphrased from Mathematics for Computer Science, Eric Lehman and Tom Leighton)

\*\*\* Propositions

In our logic system Propostions are binary statements that are true or false .however in other system a likelehood can be attached to the proposition ( completely true of completely false). a special case of propostion are called predicate whose truth depends on the value on one or more variable.

implications (==>) has the following truth tables

P Q P ==> Q

T T T

T F F

F T T ( accepted mathematical convention)

T T T

for if and only ( <==>)

P Q P==>Q Q ==> P P<==>Q

T T T T T

T F F T F

F T T F F

F F F F T

\*\* Axioms

an axioms is a proposition that you believe is true . Axioms should be consistent and complete

* Consistent , no proposition is self contradictory
* Complete, if every proposition can proved or disproved .

\*\* Logical deductions

Also called inference rules, combines axioms and true proposition to generate more true propositions

* **Modus Ponens ,**if P is true and P==> Q is true it means Q is true
  + **Tautology** is one true proposition and, each tautological proposition there is an associated inference rule

## \*\* Concepts

### \*\*\*loop invariant

a loop invariant is a property of an algorithm or functionality that satisfied the following conditions

Initialization: is true prio to the first iterations of the loop

Maintenance : is true before the loop iterations and before the next iterations

Termination: When the loop terminates, the invariant should help establish the correctness of the algorithm ( as an example, reduce (the inclusive sum of the array's element is a loop invariant)

## Guiding Principles of for the Analysis of Algorithms

In our quest in finding a fast algorithm “whose worst-case running time grows slowly with the input size”, according to Roughgarden, Linear time is the holly grail. Also, the Fast algorithm can be considered for free primitives, like merge sort, which are used in preprocessing the data.

## Principle 1: Worst Case Analysis

* Mathematically more Tractable than other kind of analysis
* Fewer assumptions
* Doesn’t require domain expertise compared to average case analysis.

## Principle 2: Ignoring Constants

* For mathematic tractability
* constants can vary from one platform to another.

## Principle 3 : Asymptotic Analysis

* Asymptotic analysis is studying the rate of growth of running time with input lengt