

## Assignment-2

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Course : CSE373

Section : 04

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Date : 17-6-2023

There are two problems:

(1) Polynomial (P) problems

(2) Non-polynomial (NP) problems

P problems can be solved in polynomial time, while NP problems can be verified in polynomial time but may not be solved in polynomial time.

Polynomial Problems:

Polynomial Problems can be solved in a time that is polynomial in the input size.

Examples of polynomial problems include:

Linear Search -  $n$

Binary Search -  $\log n$

Insertion sort -  $n^2$

Merge sort -  $n \log n$

Matrix Multiplication -  $n^3$

Non-Polynomial Problems:

Non-polynomial problems cannot be solved in

polynomial time. It can be solved in exponential time. Examples of non-polynomial problems include:

0/1 Knapsack -  $2^n$

Traveling Salesman Problem -  $2^n$

Sum of subsets -  $2^n$

Graph Coloring -  $2^n$

Hamiltonian Cycle -  $2^n$

Non-Deterministic Search:

Non-Deterministic search is a technique for solving NP problems. A non-deterministic algorithm is an algorithm that can make guesses about the input and then verify whether the guesses are correct. If the guesses are correct, the algorithm can solve the problem in polynomial time.



the Code of deterministic search algorithm with constant time:

Algorithm N search ( $A, n, \text{key}$ )

{

$j = \text{choice}()$ ;  $\rightarrow$  non-deterministic function

if ( $\text{key} = A[j]$ )

{

write ( $j$ );

success ();  $\rightarrow$  non-deterministic function

}

write(0);

Failure ();  $\rightarrow$  non-deterministic function.

}

Relationship between NP-Hard, NP Complement and P Problems:

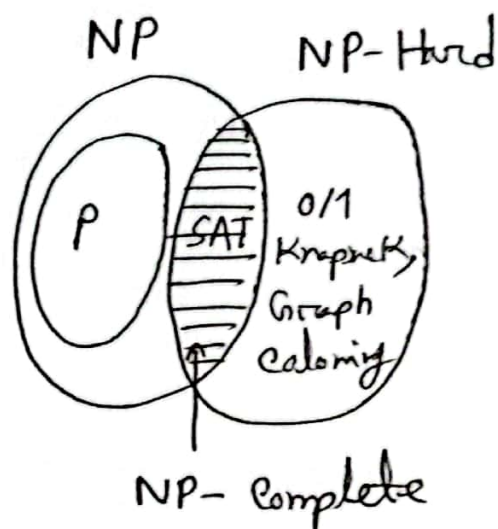
NP-hard problems are at least as hard as the Boolean satisfiability problem (SAT).

NP-complete problems are a subset of

NP-hard problems that can be solved in

polynomial time.

The following diagram shows the relationship between NP-hard, NP-complete and P problems.



NP-hard and NP-complete problems are challenging to solve but have critical applications in many areas, such as logistics, scheduling and artificial intelligence.

Moreover, P problems can also be solved in polynomial time.