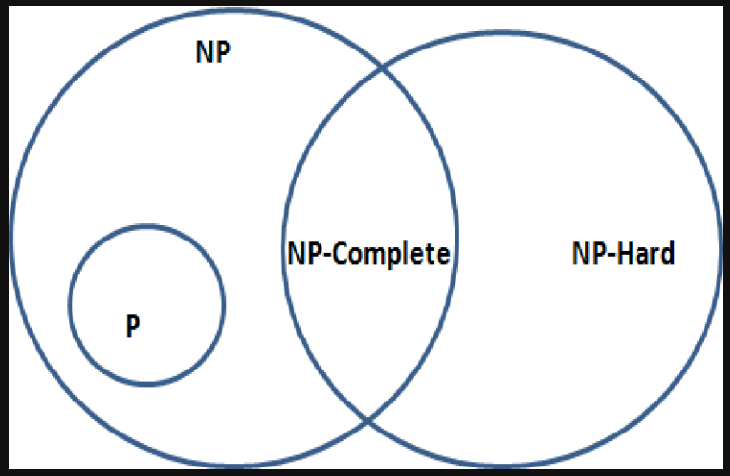
# Research Area: P, NP, NP-Hard, and NP-Complete Problems

# Class P




- class of problems that have polynomial-time deterministic algorithms.
- Examples: Linear and Binary Search, MergeSort, Insertion Sort, Matrix Multiplication

# Exponential Time Problems

- 0/1 Knapsack
- Travelling Salesman Problem
- Sum of subsets
- Graph Coloring
- and many more

# Class NP

- class of decision problems that are solvable in polynomial time on a non-deterministic machine.
- Psuedocode for non-determisitic:

```
NDSearch(arr, n, key):
    j = choice()
    if key == arr[j]:
        write(j)
        success()
    write(0)
    failure()
```

- The time complexity of the above non-deterministic search algorithm is - O(1)

# NP-Hard

- if all the problems in NP are polynomial time reducible to it, then it is called an NP-Hard problem.
- Example: Satisfiability

# NP-Complete

- The intersection of NP and NP-Hard is NP-Complete Problem