**Dynamic Programming**

What is Dynamic Programming?

Dynamic programming is mainly optimization over plain recursion. It is a technique where an algorithmic problem is first broken down into sub-problems, the results are saved, and then the sub-problems are optimized to find the overall solution – which usually has to do with finding the maximum and minimum range of the algorithmic query.

Dynamic Programming

* Greedy Algorithm
  + A greedy algorithm builds a solution incrementally, making choices that seem best now. It picks the option that offers the most immediate benefit or profit at each step. With the hope that these local optima will lead to a global optimum solution.
  + Example: Coin Change Problem
    - Imagine you have to give N for an amount of N using the fewest coins. But you only have these coins: 1, 5, 10, 25. You must give back 63, and now we can use a greedy algorithm to use the shortest steps to give the change. We start with the highest denomination less than N.
      * Two 25-cent coins (50 cents)
      * One 10-cent coin (10 cents)
      * Three 1-cent coins (3 cents)
      * Equal 63 cents.
* Divide-and-Conquer.
  + Divides a problem into smaller, more manageable subproblems, each of which is solved independently. The solutions to these subproblems are then combined to solve the original problem.
  + Example: Merge Sort Algorithm
    - It's used for sorting an array or a list of elements.
    - If we are going to sort an array of n elements, we split it into two halves and then split again if we need to, until the list is sorted.
    - Time complexity of O(n log n).
* Dynamic Programming
  + Dynamic programming (DP) is a method for solving complex problems by breaking them down into simpler subproblems. It’s applicable when a problem can be divided into overlapping subproblems, which can be solved independently. The key idea behind dynamic programming is to store solutions of these subproblems so that when the same subproblem arises, its solution can be reused, significantly improving efficiency.
  + Example: Fibonacci Sequence
    - The Fibonacci sequence is a classic example that illustrates the concept of dynamic programming. In this sequence, each number is the sum of the two preceding ones, usually starting with 0 and 1.
  + Memoization (Top Down)
  + Tabulation (Bottom-Up)
* Weighted Interval Scheduling
  + Weighted Interval Scheduling is a classic problem in dynamic programming that deals with selecting a subset of non-overlapping intervals from a set of intervals, each with its own weight (or value), in such a way that the total weight of the selected intervals is maximized.