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Comparative Study of Greedy and Dynamic Programming Algorithms

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***Abstract*- There are problems have N inputs and require to find a feasible solution that either maximizes or minimizes a given objective function that satisfies some constraints. A feasible solution that does this is called an optimal solution. The Greedy method suggests that one can devise an algorithm which works in steps, taking one input at a time, at each step, a decision is made regarding whether or not a particular input is an optimal solution. In order to solve a given problem, using a Dynamic programming method, we need to solve different partitions of the problem, then combine the solutions of the sub problems to reach an overall solution. In this paper, we have discussed various Greedy and Dynamic programming algorithm and try to find out which one is the best under given circumstances.**

Keywords-Greedy; Dynamic; objective function

I. INTRODUCTION

The Greedy method suggests that one can devise an algorithm that works in steps, considering one input at a time. At each step, a decision is made regarding whether or not a given input is in an optimal solution. Decision is made by considering the inputs in an order determined by some selection procedure. If the addition of the next input into the partially constructed optimal solution results in an infeasible solution, then this input is not added to the partial solution. Dynamic Programming is an algorithm design method that can be used when the solution to a problem may be viewed as the result of a sequence of decisions.

Dynamic programming is a method for solving a complex problem by breaking it down into a collection of simpler sub problems. It is valid to problems exhibiting the properties of overlapping sub problems and optimal structure. When applicable, the method takes far less time than naive methods that don't take advantage of the sub problem overlap. In order to solve a given problem, using a dynamic programming method, we need to solve different partitions of the problem, and then combine the solutions of the sub problems to reach an overall solution. In this paper, the author have discussed various greedy algorithms (Greedy knapsack, Minimum Spanning Tree, Single Source Shortest Path) and Dynamic algorithms (Single Source Shortest Path, All Pair Shortest Path).

The paper is organised into four sections. Section I give brief introduction about greedy and dynamic algorithm. Section II discusses the related work. Section III gives a comparative study of Greedy and Dynamic Algorithms. Section IV gives the conclusion.

II. RELATED WORK

a)Greedy Algorithm

We have Greedy algorithm to implement greedy knapsack to maximize the profit, to obtain minimum spanning tree using Primes algorithm and to find single source shortest path using Dijkstra algorithm. All these algorithms work on greedy principle taking a single input at each stage and then try to obtain global optimal solution based upon local optimal solution. In these all problems are optimized solution is generated using a top-down approach. Greedy algorithm is best suited for problems like minimum spanning tree in which there is only one optimal solution. But algorithm exhibit no parallelism and not give best result for problems having more than one optimal solution .Greedy algorithms are less expensive and produce faster result.

b)Dynamic Algorithm

We have used Dynamic algorithm to implement Single Source Shortest Path using Bellman Ford algorithm and All Pair Shortest Path using Dynamic Programming Algorithm. These algorithm works on Dynamic algorithm choose all the input and try to find global optimal solution. . In these problems optimized solution is generated using a bottom-up approach.

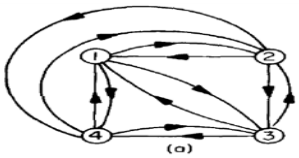
Algorithm exhibit the property of parallelism hence best suited for large problems having more than one optimal solution. Dynamic algorithms are usually slower than greedy algorithm and little more expensive.

Let us prove it with an example

EXAMPLE

Let us explain the above with the help of Travelling Salesman Problem

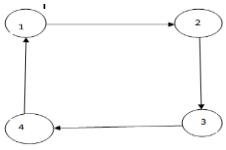
Consider a graph and corresponding Adjacency Matrix in fig. (a) and fig.(b)



(a)

$$\begin{bmatrix} 0 & 10 & 15 & 20 \\ 5 & 0 & 9 & 10 \\ 6 & 13 & 0 & 12 \\ 8 & 8 & 9 & 0 \end{bmatrix}$$
(b)

if we consider vertex=1 as source vertex



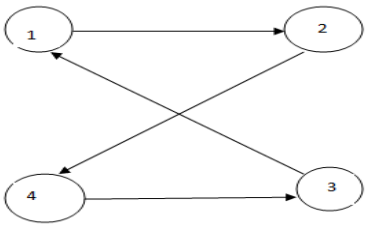
(c)

By using greedy algorithm the locally optimal choice is taken at each stage with the hope of finding a global optimum. Hence the path that is followed is shown in fig(c)

Total Cost: 10+9+12+8=39

By using Dynamic algorithm, we need to solve different parts of the problem, and then combine the solutions of the sub problems to reach an overall solution.

Hence the path that is followed is shown in fig. (d)



(d)

Total Cost: 10+10+9+6=35

Hence we can see that Dynamic algorithm guarantee to generate optimal solution whereas Greedy Method generates a very good solution which may or may not be optimal.

III. COMPARISON

In Greedy Method we don't want to try all intermediate places. We go to the nearest intermediate place. It means making the locally optimal choice at each stage with the hope of finding a global optimum. Dynamic programming approach, we need to solve different parts of the problem, and then combine the solutions of the sub problems to reach an overall solution.

Greedy Method use top-down approach whereas Dynamic method uses a bottom approach. Greedy Method does not guarantee to give best solution but almost a optimal solution whereas Dynamic programming always generate a best solution. Greedy algorithms are usually faster than Dynamic Algorithm.

Greedy algorithm lacks with parallelism property whereas Dynamic Algorithm are exposed to parallelism.

IV. CONCLUSION

Both Greedy and Dynamic programming algorithm try to find out the optimal solution. In both algorithm an optimal solution to the problem contains within it optimal solutions to sub-problems. Greedy method work efficiently for some problems like Minimum Spanning tree while it is not best suited for some problem like Travelling Sales man ,0/1 Knapsack. Dynamic method always generates optimal solution but they are less efficient than Greedy algorithm. As Greedy algorithm are generally fast. Greedy method is often not suited for large problem due to lack of parallelism, whereas Dynamic algorithm can work for these problem Greedy method lacks in parallelism while Dynamic method are expensive.

So In future we need to develop algorithm that trade-off between parallelism and expenses.

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