Algorithms Design and Analysis [ETCS-301]

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Dynamic programming

- Solves problems by combining the solutions to sub-problems
- Sub-problems are overlapping
- Doesn't solve overlapping sub-problems again and again
- Behave like Divide and Conquer if sub-problems are not overlapping
- Used in optimization problems
- Can be used either top-down with memoization or bottom-up method

Four Steps of Dynamic programming

1. Characterize the structure of an optimal solution
2. Recursively define the value of an optimal solution
3. Compute the value of an optimal solution
4. Construct an optimal solution from computed information

Elements of dynamic programming

Two key ingredients that an optimization problem must have in order to apply dynamic programming:

1. Optimal substructure
2. Overlapping sub-problems

Memoization

- Memoization is mainly storing the value in the form of Memo or in some tabular method
- Whenever we need some calculation of the sub-problem then we first check the memo
- If solution of the sub-problems is already available in memo then we use that solution and not solve the sub-problem again
- If the solution of the sub-problem is not in memo then we solve the sub-problem and note the result in the form of the memo for next call

Difference between Dynamic Programming and Memoization I

- Memoization is a term describing an optimization technique where we cache previously computed results, and return the cached result when the same computation is needed again.
- Dynamic programming is a technique for solving problems of recursive nature, iteratively and is applicable when the computations of the subproblems overlap.
- Dynamic programming is typically implemented using tabulation, but can also be implemented using memoization. So as we can see, neither one is a "subset" of the other.
- When we solve a dynamic programming problem using tabulation we solve the problem bottom-up i.e. by solving all related sub-problems first, typically by filling up an n-dimensional table. Based on the results in the table, the solution to the top / original problem is then computed.

Difference between Dynamic Programming and Memoization II

- If we use memoization to solve the problem we do it by maintaining a map of already solved sub problems. We do it top-down in the sense that we solve the top problem first (which typically recurses down to solve the sub-problems).

Thank you

Please send your feedback or any queries to akyadav1@amity.edu, akyadav@akyadav.in or contact me on +91 9911375598