

Algorithms and Data Structures

Dynamic Programming



Agenda

- Why do we need Dynamic Programming?
- How do we use Dynamic Programming?
- Interview Questions of Dynamic programming.



What Is Fibonacci Series

- A series of numbers: 0, 1, 1, 2, 3, 5, 8..., fib(n-2), fib(n-1), f(n) where:
 - $f(0) = 0$, $f(1) = 1$
 - $f(n) = f(n-1) + f(n-2)$ when $n \geq 2$
- So, what is $f(5)$?
- So, what is $f(50)$?



Perfect for Recursion

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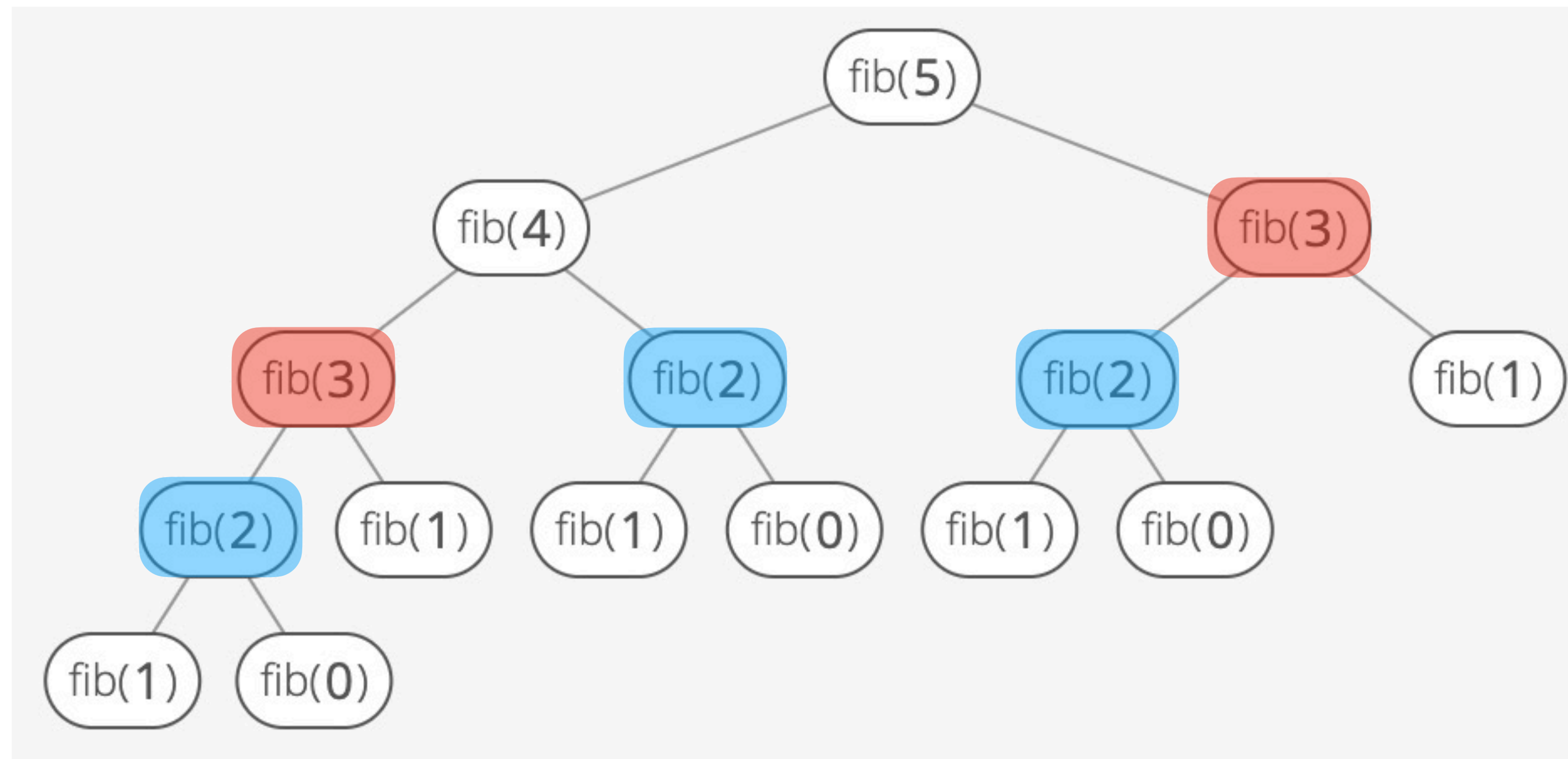
Let's Program It

- repl.it



Something Goes Wrong

- Look in to the problem tree of $\text{fib}(n)$:



How To Solve it?

- We did so many unnecessary computation during the process.
- Solution 1: How about we keep a record of solutions of sub-problems solved?

Dynamic Programming Solution

- Create a list to record result of sub-problems.
- Whenever we have a problem, we check the list first.
 - Only when we have not solve it, we compute the solution.
 - Otherwise, we use the result directly.



Let's Program It

- repl.it



Something Goes Wrong

- Remember recursion calls have a stack in memory.
- There will be a maximum recursive stack.
- Solution:
 - Bottom Up



Let's Program It

- repl.it



Is It Optimized?

- Now we finally achieved time complexity of $O(n)$.
- How about space? It is still $O(n)$.
- Can you do it use $O(1)$?



Sum of Subset Problem

- Given some integers, find how many possible subset that sum up to a given number.
- For example:
 - `sum_subset([1, 2, 3, 5, 8], 8)` will return 3 because:
 - [1, 2, 5]
 - [3, 5]
 - [8]
 - Are the valid subset that sum up to 8



Let's Program It

- repl.it



Sum of Subset Problem

- Greedy solution.
- Recursive solution.
- DP solution



Sum of Subset Problem - Follow Up

- Can you print all valid subset out?
- Can you return the smallest subset (with least number elements)?



Interview Questions for DP

- Max sum of subarray problem - we did recursion solution;
- How about a DP solution?
- Max Profit Trading Stock problem - a good practice.



Thank you!