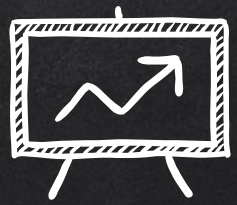


Dynamic Programming Dojo

What is Dynamic Programming?

- Method to solve complex problems by deliberately reducing to simple sub-problems;
- Only solve each problem once; Hold results of sub-problems in memory (memoization);
- Incrementally solve more complex problems from this simple foundations;
- **Provides exact, optimum solutions rather than approximations.**

Everything should be as simple as it can be,
but not simpler.

attrib. Albert Einstein

You must unlearn what you have learnt.

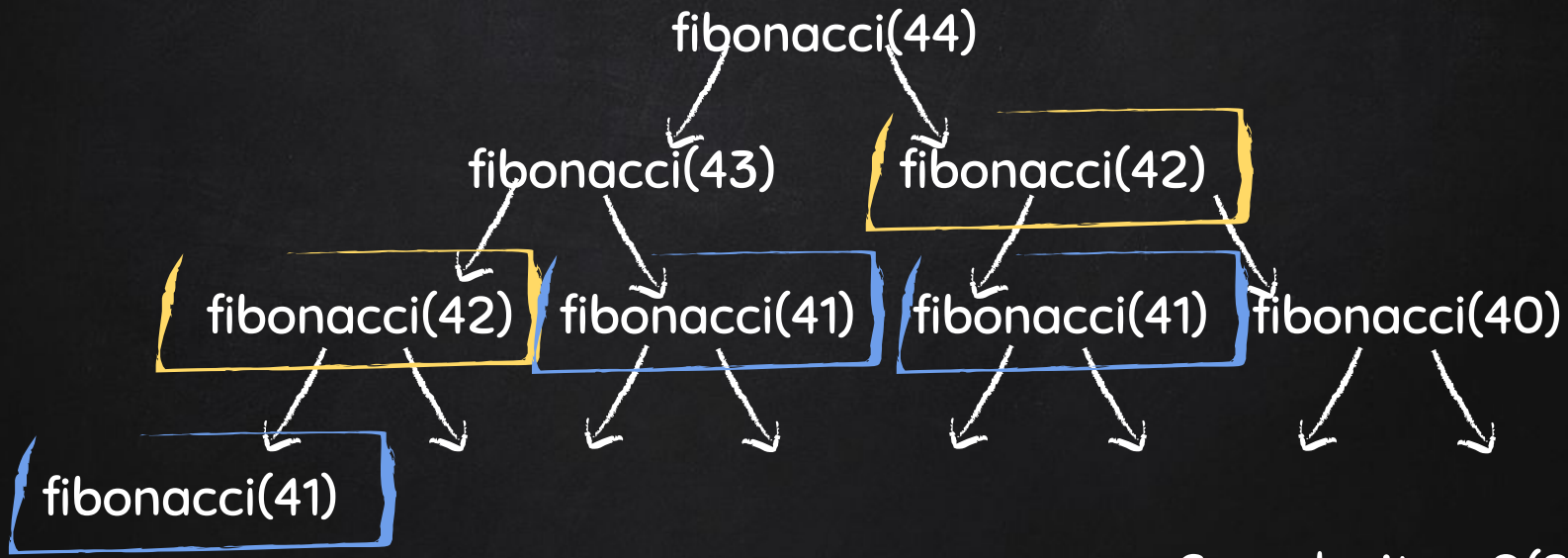
Yoda

When can I use Dynamic Programming?

If you can answer 'Yes' to both of these questions then Dynamic Programming can create a fast, optimal solution:

1. Optimal Substructure.
   Can a sub-problem be identified that produces an optimum solution?
2. Overlapping Subproblems.
   Would a 'naive' recursive solution repeatedly solve the same problem?

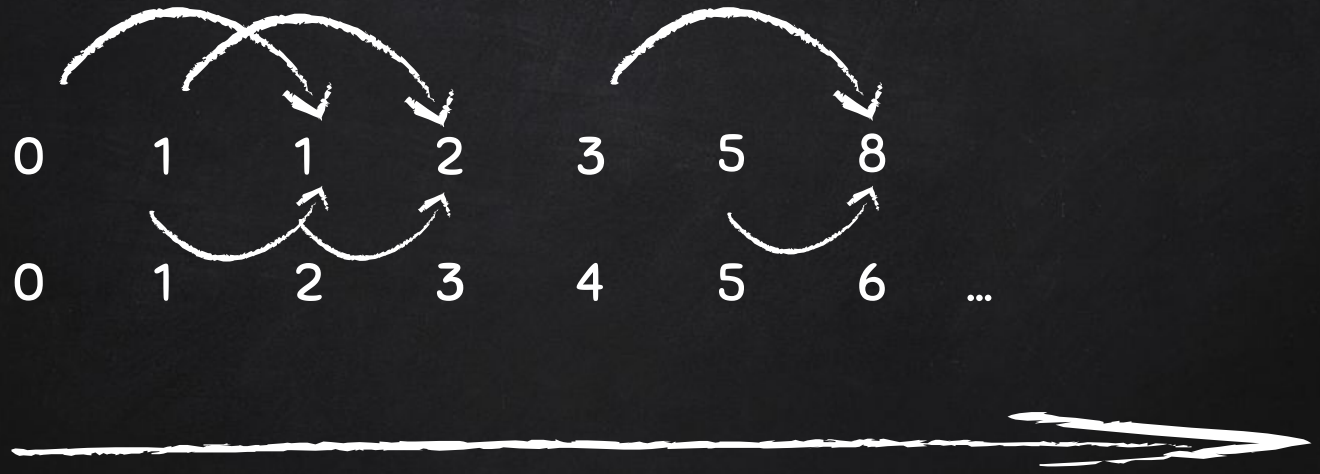
'Naive' Recursive Fibonacci Solution



Complexity = $O(2^n)$

Dynamic Fibonacci Solution

Bottom-up Approach



Complexity = O(n)

Problem 1 – Making Change

Given a set of coins, calculate the minimum number of coins required to sum up to a given value.

It's tempting to use a 'Greedy' algorithm which repeatedly subtracts the largest valued coin which does not exceed the remaining value.

This approach gives a good approximation but does not always produce the best result.
Try to make the value of 23 using the coins 1,4,15, & 20.

The 'Greedy' algorithm will give a solution of 4 coins (20, 1, 1, 1) but the optimal solution is 3 coins (15, 4, 4).

Making Change – Dynamic Method

Coins: 1, 2, 5, 10 Target Value: 8

Real World Examples

- Bioinformatics -DNA/RNA Sequence Alignmnent
  - Global - Needleman-Wunch Algorithm
  - Local - Smith-Waterman Alogorithm
- Hidden Markov Methods - Viterbi Algorithm
  - Speech Recognition
  - Particle Decay (Monte Carlo Method)
- Cricket
  - Duckworth - Lewis Method

Hands-on Problems

3 Problems to solve with Dynamic Programming

1. Minimum Coins Problem
2. Optimal Path Problem
3. Billboard Location Problem

Do. Or do not. There is no try.

Yoda

THANKS!

Any questions?

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Credits

Special thanks to all the people who made and released these awesome resources for free:

- Presentation template by SlidesCarnival
- Photographs by Unsplash

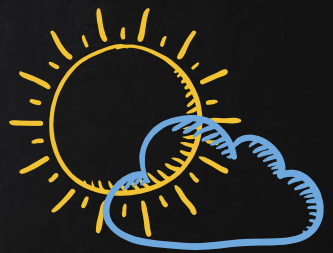
SlidesCarnival icons are editable shapes.

This means that you can:

- Resize them without losing quality.
- Change fill color and opacity.

Isn't that nice? :)

Examples:



Extra graphics