



# DP Concepts

video  
26✓

&

## Questions



हाथ  
(Motivation)

”

HARDWORK

HAS

NO

SUBSTITUTE...

”

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Done

• 1-D based DP

• 2-D based DP

Progress

• String based DP

• Grid based DP

• Game Strategy

We'll do:-

(i) RECURSION  
+  
MEMOIZATION  
(Top Down)

(ii) Bottom UP

(iii) Time & Space

## DP on Strings :-

→ Longest Common Subsequence (LCS)

→ Print LCS

→ Edit Distance

→ Shortest common Supersequence (SCS)

→ Print SCS

⇒ Palindrome related DP problems :-



Palindromic Substrings + Blueprint



Longest Palindromic Substring

# Longest Palindromic Subsequence

(1) Recursion + Memoization

(2) Bottom UP → Blue Print

## 1312. Minimum Insertion Steps to Make a String Palindrome

Hard

Topics

Companies

Hint

Given a string s. In one step you can insert any character at any index of the string.

Return the minimum number of steps to make s palindrome.

A **Palindrome String** is one that reads the same backward as well as forward.

Example :-  $S = \text{"m d b a b d m"}$

Output = 2

# Why DP??

## Recursion + Memoization

DP

IT'S NO MORE A HARD QN

STORY -> CODE LIKHO

TRUST ME, STORY TO CODE IS MAGIC.....

amazon

RECURSION + MEMO

HARD → EASY

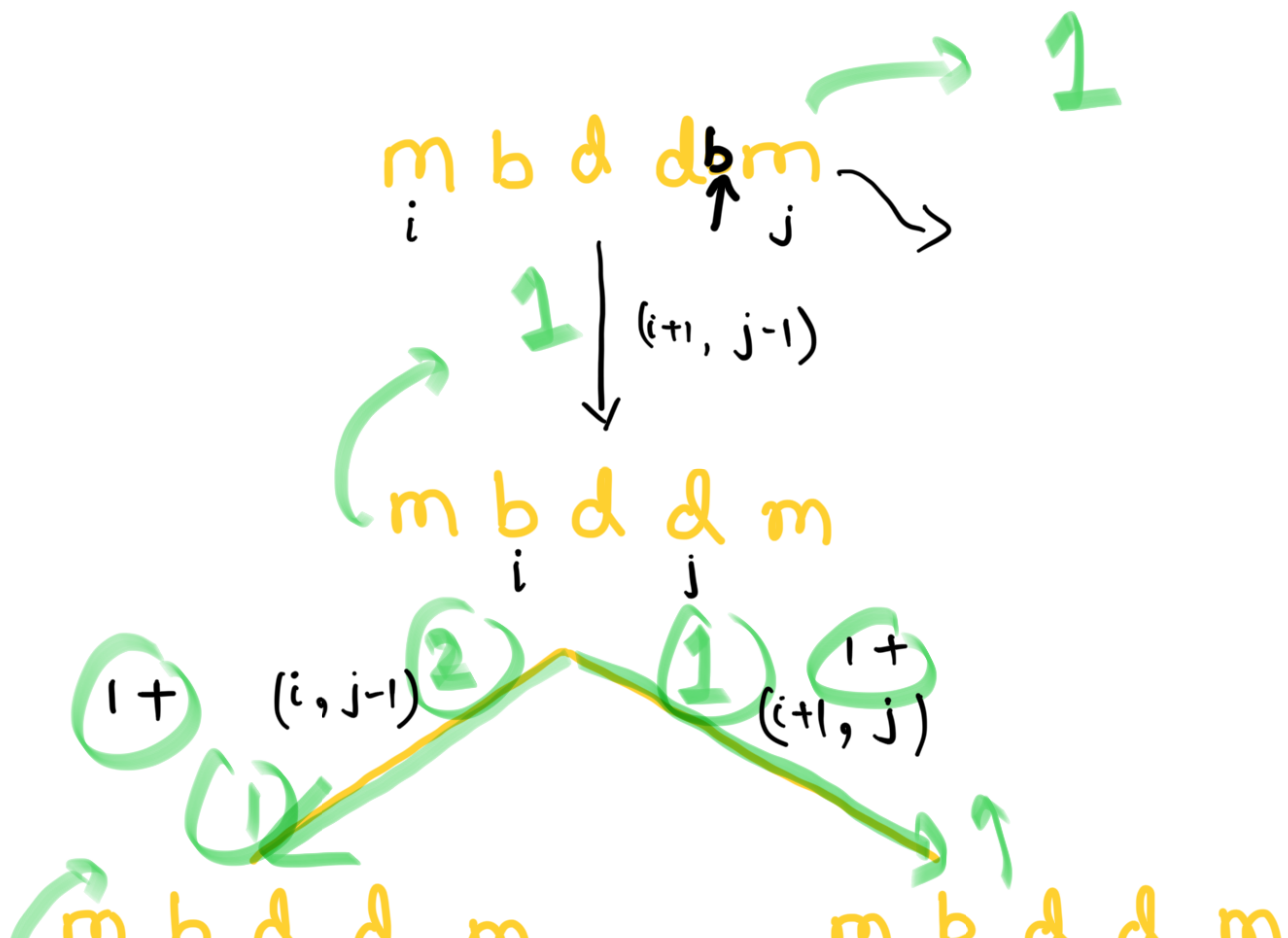
Microsoft

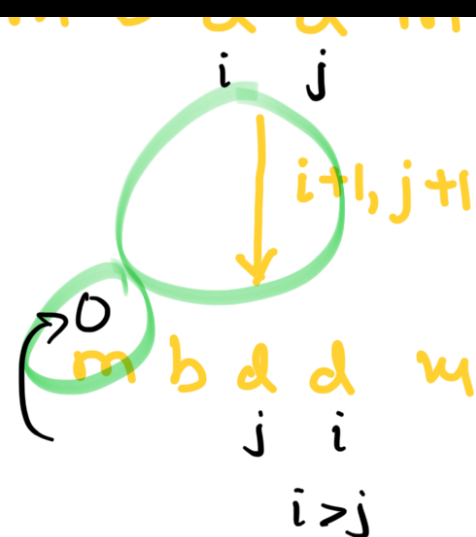
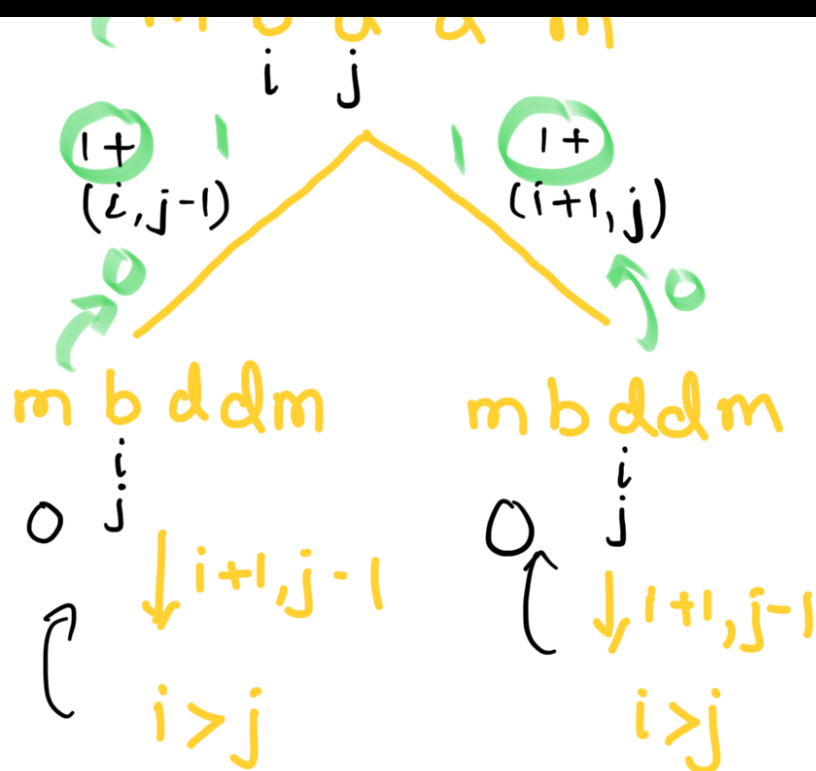
LEETCODE-1312

MINIMUM INSERTION STEPS TO MAKE A STRING PALINDROME

16:36

Minimum Insertion Steps to Make a String Palindrome - (GOOGLE) | Recur+Memo | Leetcode-1312





# Using Bottom Up (Blueprint)

```
class Solution {
public:
    int t[501][501];
    int solve(int i, int j, string &s) {

        if(i >= j)
            return 0;

        if(t[i][j] != -1)
            return t[i][j];

        if(s[i] == s[j])
            return t[i][j] = solve(i+1, j-1, s);

        return t[i][j] = 1 + min(solve(i, j-1, s), solve(i+1, j, s));
    }
}
```

$S \rightarrow 0$   $n \rightarrow 1$

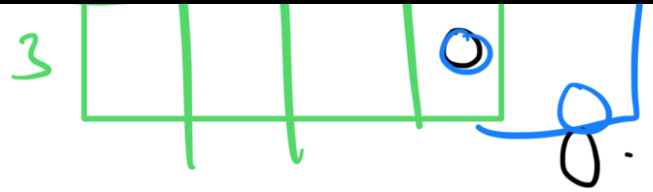
$t[i][j]$  = min insertion to make  $s[i...j]$  a palindrome.

m b d d m

0 1 2 3 4

[0...0]

	m	b	d	d	m
0	0				
1		0			
2			0		
3				0	
4					0



Blue print code:-

$f[i][j]$

"  $\frac{a}{i} \frac{b}{j} c d$  "  $i + j = 0 + 2 = 2 - 1 = 1$

```
for (int L = 2; L <= n; L++) {
    for (i = 0; i < n - L + 1; i++) {
```

$j = i + L - 1;$

$\text{if } (s[i] == s[j]) \{ // \text{no insertion}$

$f[i][j] = f[i+1][j-1];$

$\} \text{ else } \{$

$f[i][j] = 1 + \min(f[i][j-1], f[i+1][j]);$

$\}$

$\}$

$\}$

return  $f[0][n-1];$

$T.C = O(n^2)$

$S(0..n-1)$   $S.C = O(n^2)$





the 1990s, the number of people in the UK who are employed in the public sector has increased by 1.5 million (1990–1999) (Department of Health 2000).

There is a growing emphasis on the importance of the public sector in the provision of health care services. The public sector is seen as the main provider of health care services in the UK, and it is expected that the public sector will continue to play a major role in the provision of health care services in the future (Department of Health 2000).

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