

Needleman-Wunsch : Sequence Alignment, String Edit Distance

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m = |x|, n = |y|
For i = 0 to m; M[i,0] =  $\delta$ i
For j = 0 to n; M[0,j] =  $\delta$ j

For i = 1 to m
  For j = 1 to n
    M[i,j] = min(match= $\alpha[x_i, y_j] + M[i-1, j-1]$ ,
                 skipi= $\delta + M[i-1, j]$ ,
                 skipj= $\delta + M[i, j-1]$ )
return M[m,n]
  
```

Each cell has three possible return values: (match, skipi, skipj).

Calculate again to trace back or store the value selected

 match
 skip i
 skip j

$\delta=1, \alpha_{\text{match}} = 0, \alpha_{\text{mismatch}} = 2$

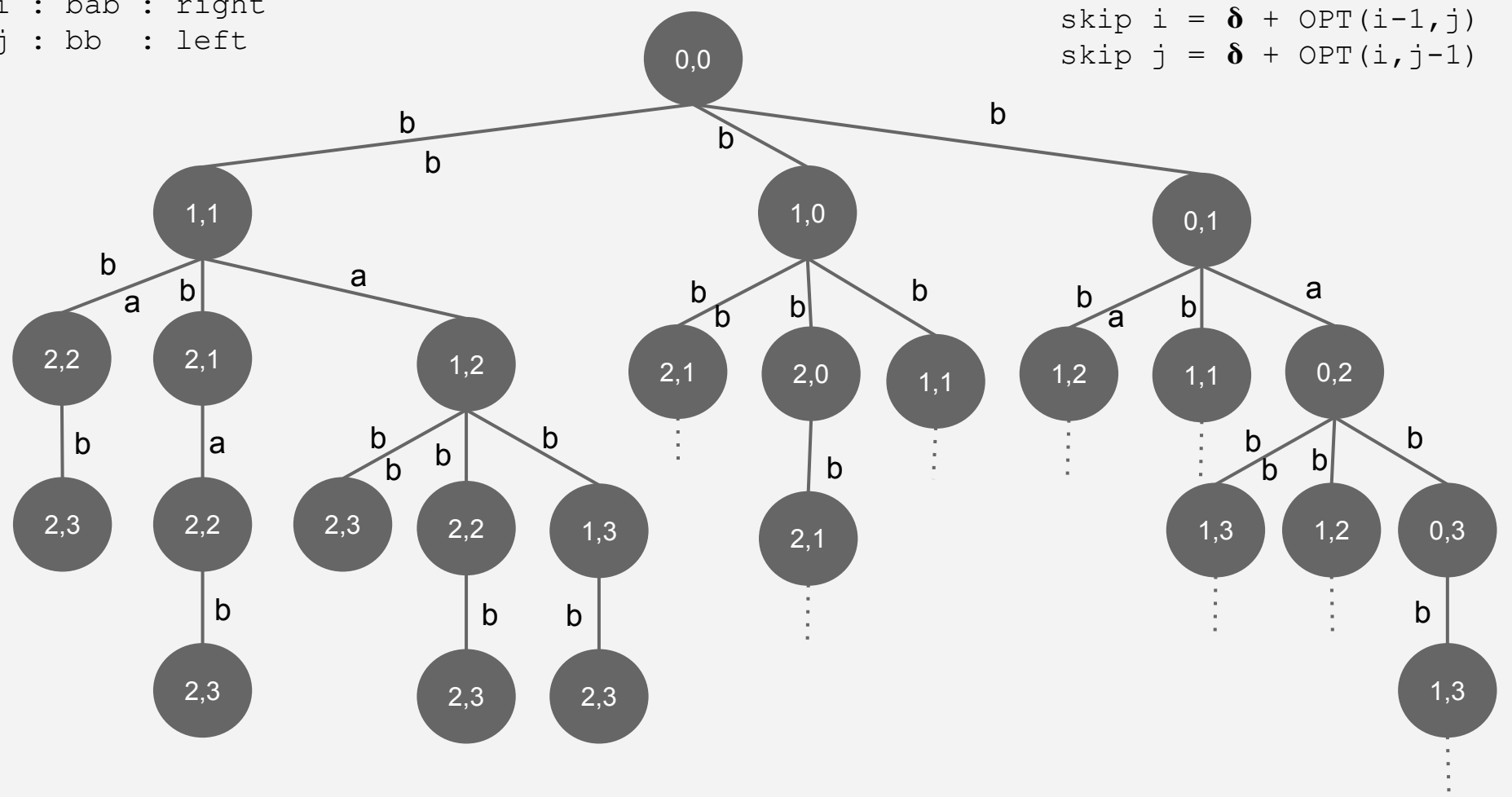
M	x_i	b	a	b	a
y_j	0	1	2	3	4
b	1	0, 2, 2	3, 1, 3	2, 2, 4	5, 3, 5
b	2	1, 3, 1	2, 2, 2	1, 3, 3	3, 2, 4

$\delta=3, \alpha_{\text{match}} = 0, \alpha_{\text{mismatch}} = 2$

M	x_i	b	a	b	a
y_j	0	3	6	9	12
b	3	0, 6, 6	5, 3, 9	6, 6, 12	11, 9, 15
b	6	3, 9, 3	2, 6, 6	3, 5, 9	8, 6, 12

i : bab : right
j : bb : left

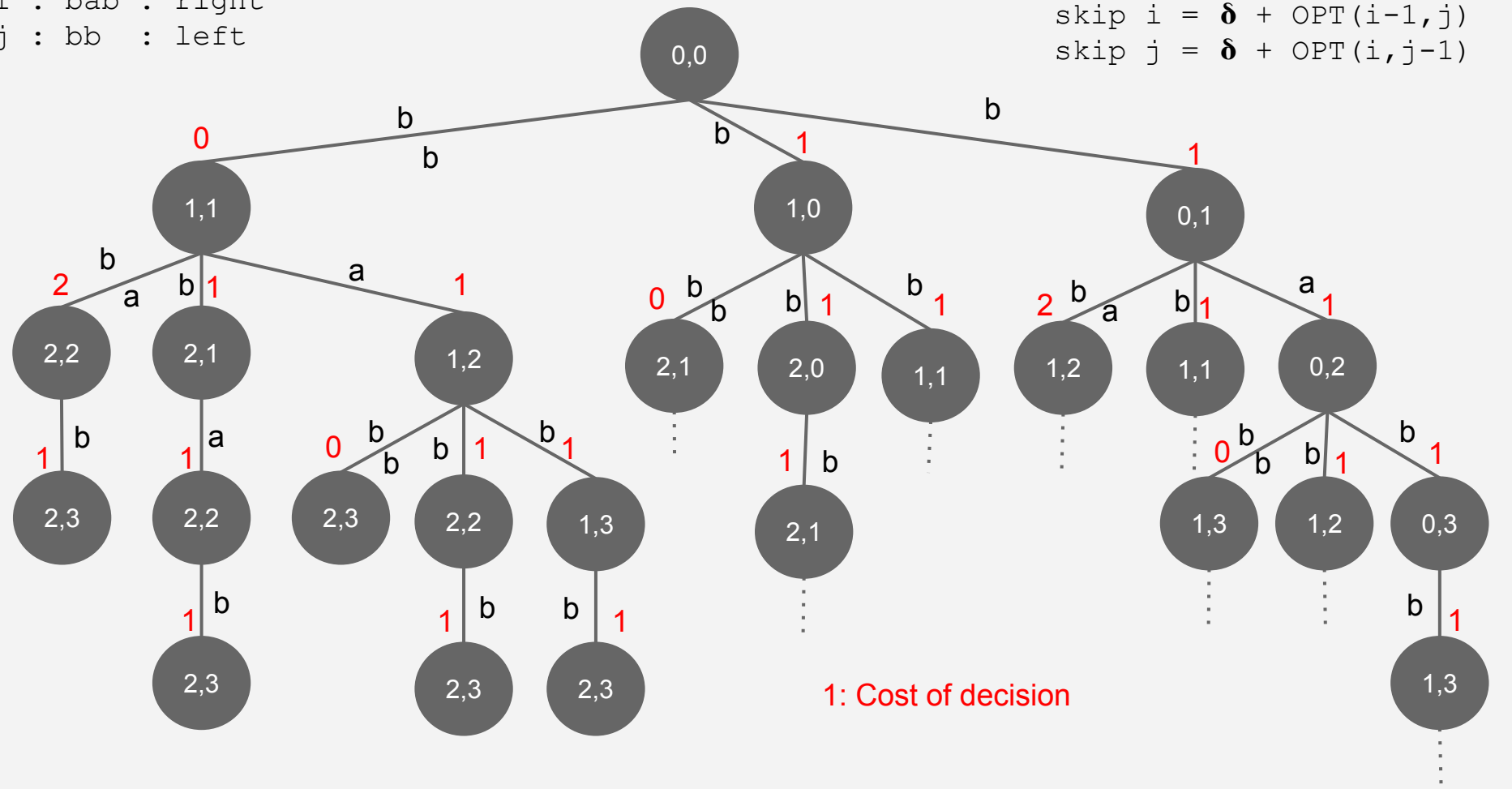
match = $\alpha + \text{OPT}(i-1, j-1)$
skip i = $\delta + \text{OPT}(i-1, j)$
skip j = $\delta + \text{OPT}(i, j-1)$



i : bab : right
 j : bb : left

$\delta=1, \alpha_{\text{match}}=0, \alpha_{\text{mismatch}}=2$

match = $\alpha + \text{OPT}(i-1, j-1)$
 skip i = $\delta + \text{OPT}(i-1, j)$
 skip j = $\delta + \text{OPT}(i, j-1)$



i : bab : right
 j : bb : left

$$\delta=1, \alpha_{\text{match}}=0, \alpha_{\text{mismatch}}=2$$

$$\begin{aligned} \text{match} &= \alpha + \text{OPT}(i-1, j-1) \\ \text{skip } i &= \delta + \text{OPT}(i-1, j) \\ \text{skip } j &= \delta + \text{OPT}(i, j-1) \end{aligned}$$

