

# Project 2 Report

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## 1 Breaking Down Problems

We separate the transpositions from all other typo forms. By first keeping a record of where possible transpositions can occur (and each permutation of possible propagation lengths), we vastly simplify the recurrence. In the memoized solution, we also separate the initial table fill from backtracking.

## 2 Parameters for the recursion

The two arrays  $p$  and  $t$  (pattern and typo) and indexes  $i$  and  $j$  representing the positions in  $p$  and  $t$  currently being compared

## 3 What recurrence can you use

## 4 What are the base cases

Whenever  $i$  or  $j$  are equal to 1. If  $i = 1$ , the remaining characters in  $t[1..j - 1]$  were trivially all insertions at the beginning. If  $j = 1$ , the remaining characters in  $p[1..i - 1]$  were deleted. If both  $i = 1$  and  $j = 1$ , there are no further characters to compare.

## 5 What data structure would you use

A map from pairs of  $(i, j)$  to the cost of the recurrence for  $(i, j)$ , as well as a map from pairs of  $(i, j)$  to a set of numbers of transpositions  $k$  such that for each a chain of transpositions may have occurred in  $p[(i - k)..i]$  and  $t[(j - k)..j]$ .

We found that the best structure to use for memoizing would be 2D array with each cell containing the lowest cost typo, the overall cost of accumulated typos, and the index to the lowest cost next cell.

As well, a hash table is kept, indexed by the squashed coordinates of our 2D array to store possible transposition sites. This hash table contains arrays of size 12, where the distance into the table is the number of propagating transpositions, the contents of which is the cost to perform that chain of transpositions.

## 6 Pseudocode for a memoized dynamic programming solution

## 7 Worst case time complexity

The worst-case of our algorithm will encompass:

- $O(n * m)$  Transposition identification.
- $O(n * m)$  Fill table pass
- $O(n + m)$  Backtracking pass

So, as a whole, the algorithm takes  $O(n * m)$  time complexity.

**Input:** data: Table containing the memoized data

**Input:** transposes: Set of possible transpositions

**Input:** correct: The correct string

**Input:** actual: The actual string with typos

**Input:** i: Current position into the correct string

**Input:** j: Current position into the actual string

**Output:** Running cost of typos

```
1 def find_transposes ():
2     for i from 1 in length (correct):
3         for j from 1 in length (actual):
4 def Fill(i, j):
5     if data[i,j] has a value:
6         return the cost in data[i,j]
7     elif i == 1 and j == 1:
8         return 0
9     elif i == 1:
10        Let the cost be insert_cost(i,j) + Fill(i,j - 1)
11        Store the cost in data[i,j]
12        Set the typo of data[i,j] to Insert
13        Set the parent of data[i,j] to (i,j - 1)
14        return the cost
15    elif j == 1:
16        Let the cost be delete_cost(i,j) + Fill(i - 1,j)
17        Store the cost in data[i,j]
18        Set the typo of data[i,j] to Delete
19        Set the parent of data[i,j] to (i - 1,j)
20        return the cost
21    else:
22        Let options be a list of possible errors.
23        Add an Insert error to options with cost insert_cost(i,j) + Fill(i,j - 1) and parent (i,j - 1)
24        Add a Delete error to options with cost delete_cost(i,j) + Fill(i - 1,j) and parent (i - 1,j)
25        if correct[i] == actual[j]:
26            Add a None error with cost Fill(i - 1,j - 1) and parent (i - 1,j - 1)
27        else:
28            Add a Substitute error to options with cost substitute_cost(i,j) + Fill(i - 1,j - 1) and
                parent (i - 1,j - 1)
29        if There are transpositions in transposes[i,j]:
30            for t in transposes[i,j]:
31                Add a Transpose error with cost t.cost + Fill(i - t.length,j - t.length) and parent
                    (i - t.length,j - t.length)
32        Pick the minimum option in options
33        Store the cost, error type, and parent in in data[i,j]
34        return the cost
```

- 8 Pseudocode for nested loop
- 9 Can the space complexity of the iterative algorithm be improved relative to the memoized algorithm
- 10 Describe one advantage and disadvantage of the iterative algorithm