(1)

Parameterized Algo
Test-2

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2. ~~Let~~ CA.

a) Let the given strings be $s_1, s_2 \ldots s_k$.
Define matrix $A_{ij} = S_{ij}$.

- Now each column can be partitioned based on the letters occurring in it. Rows of the column in which same letter occur are grouped into the same partition. This partitioning is done on every column. So, we can define c_p has the number of columns having the same partition.

- If C is a class of the partioning P, then let $z_{p,c}$ be the number of columns where solution agrees with class C. ~~That is to say the corresponding column of the partition~~

Here, class refers to the partition in the partitioning of the column.

By the definition of Closest-String problem

$$\sum_{C \in P} z_{P,C} \le c_P \quad \forall P$$ {The number of columns of a particular partion}

$$\sum_{i \notin C, C \in P} z_{P,C} \le d \quad \forall 1 \le i \le K$$ {The number of times where the class doesn't agree with the solution should be less than d}

$$z_{P,C} \ge 0 \quad \forall P, C$$ {Trivial constraint}

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Thus, if closest string has a solution, the ILP also has a solution.

b) Similarly, if we have the ILP and we can find its solution,

we can choose $x_{p,c}$ columns that match in the solution, ~~.....~~ having the corresponding partition & the rest of the columns with that partition we can choose a solution string that disagrees.

Thus, if the ILP has a solution, then the closest string also has a solution.

c) We know that ILP can be solved in $O(p^{2.5p+o(p)} \cdot L)$ where p is the number of variables.

Here the number of variables is $|P|k$, where $|P|$ is the number of partitions of the instance.

So, time is $O((|P|k)^{O(|P|k)})$ and thus closest string is FPT.

(3)

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1. We will first try to reduce the given instance.

- Each vertex can have only atmost r edges of the same colour. This is because if we choose atmost r vertex neighboring to this in the matching set's vertices.
$$\Rightarrow \max_{v \in V(G)} deg(v) = r^2$$

- Now we just branch on the choice of edges. Assuming there is a edge in the solution from this vertex and the neighboring vertex, we choose that edge & remove all edges with that color and edges incident on those 2 vertex and decrease r by 1.

- If not then we branch on the choise of the edges in the solution from neighbor to neighbours' neighbor. Similarly remove the edges incident on those vertices and the edges of corresponding colours.

- Tree depth — r
  Number of branches — $r^2 + r^4 = O(r^4)$
  $\Rightarrow$ Total time $= O(r^{4r} \cdot n)$
  $\Rightarrow$ This is an FPT