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IMPLEMENTATION OF THE GREEDY ALGORITHM ON GRAPH COLORING USING PYTHON.

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Abstract-Map coloring is a classic problem in computer science and graph theory, where the objective is to assign colors to regions on a map such that no two adjacent regions share the same color. The greedy algorithm is a simple and efficient approach to solving this problem. The map that will be colored here is a map of Tamil Nadu, which consists of 38 districts. From the map, we get a dual graph with 38 vertices and 78 edges. Based on the greedy algorithm that has been applied, the minimum number of colors obtained is as many as four, with each district directly bordering having a different color. The results of map coloring by applying the greedy algorithm are also obtained with the help of the Python 3.7 programming language.

Keywords: Greedy algorithm, Dual graph, Vertex coloring.

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1INTRODUCTION

Graph coloring is a fundamental problem in computer science and mathematics, with applications in various fields such as scheduling, register allocation and map coloring. The objective of graph coloring is to assigncolors to the vertices of a graph in such a way that no two adjacent vertices share the same color. This problem has been extensively studied, and several algorithms have been developed to find valid colorings.

The greedy algorithm is a simple and intuitive approach that iteratively assigns colors to the vertices based on a specific ordering. At each step, the algorithm selects a vertex and assigns it the smallest available color that is not used by its adjacent vertices. This process continues until all vertices are assigned colors. We will explore the implementation of the greedy algorithm in graph coloring using python. Python is a versatile and widely-used programming language known for Simplicity and readability, making it an excellent choice for implementing algorithms.

The number of linkages occurring to the vertex determines the degrees of a node in a graph. Deg(u) describes the degree of a vertex u. A map $C: V \rightarrow \{C_1,\ C_2, \ldots,\ C_n\}$ is a coloring of G = (V,E). $C(v_i) \neq C(v_j)\ \forall\ v_i, v_j \in E$. Alternatively, the coloring of a graphG =(V,E) is a mapping $c:\ v\ \rightarrow s$, where s is a finite set a color, such that if $vw\ \in E$, $c(v) \neq c(w)$. The chromatic number of G, written $\chi(G)$is the lowest feasible number of colors used to solve the problem.

Graph coloring problems are widely used to solve computer-based applications and problems. Therefore, to find out the results of the implementation of the greedy algorithm, it is assisted by using the python programming language.

2OBJECTIVE

I- To implement the Greedy Algorithm for graph coloring in Python.

II- To efficiently and accurately color graphs with the minimum number of colors possible, while ensuring that no adjacent vertices share the same color.

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III- To demonstrate the practical application of the Greedy Algorithm in solving graph coloring problems.

IV- To provide a useful tool for practitioners in various fields, such as network optimization, scheduling, and resource allocation.

3 METHODOLOGY

This research method is a case study using a district map in Tamil Nadu which consists of 38 districts.

How the greedy algorithm works in the case of map coloring will be described as follow:

1. Begin by initializing an empty solution set.
2. Employ the node selection function to identify the node awaiting color assignment.
3. Use the color selection function to pick a color candidate from the set C, deducting it if already in use. Vertices are sorted in descending order based on their edge count.
4. Assess the suitability of the chosen color through the eligibility function. If deemed appropriate, include the color in the solution set; otherwise return to Step 2.
5. Verify if the coloring, thus far, covers all vertices optimally using an objective function. Cease the coloring process if an optimal solution is achieved; otherwise, revisit Step 2 for further refinement.

Before the greedy algorithm is applied, first every district in Tamil Nadu is labelled with a vertex. This can be seen in the below:

District name	Vertex	District name	Vertex
Kanyakumari	v_1	Coimbatore	v_{20}
Tirunelveli	v_2	Nilgiri	v_{21}
Thoothukudi	v_3	Erode	v_{22}
Tenkasi	v_4	Namakkal	v_{23}
Ramanadhapuram	v_5	Salem	v_{24}
Virudhunagar	v_6	Perambalure	v_{25}
Madurai	v_7	Cuddalore	v_{26}
Sivaganga	v_8	Kallakurichi	v_{27}
Pudukottai	v_9	Vilupuram	v_{28}
Theni	v_{10}	Tiruvannamalai	v_{29}
Dindugal	v_{11}	Dharmapuri	v_{30}
Thiruchirapalli	v_{12}	Krishnagiri	v_{31}
Thanjavur	v_{13}	Tirupattur	v_{32}
Tiruvarur	v_{14}	Vellore	v_{33}

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Nagapattinam	v_{15}	Ranipet	v_{34}
Mayiladuthurai	v_{16}	Chengalpattu	v_{35}
Ariyalur	v_{17}	Kanchipruram	v_{36}
Karur	v_{18}	Tiruvallur	v_{37}
Tiruppur	v_{19}	Chennai	v_{38}

The map of the districts in Tamil Nadu can be seen in figure 1. Each point represents a district. The points are connected by a line but specifically the area that is next to each other so that the graph model can be seen in figure 2.

Figure 1. Map of districts in Tamil Nadu

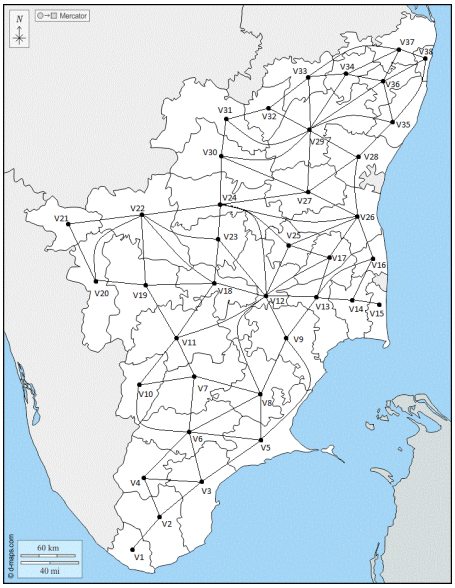

Figure 2. Graph model of district map in Tamil Nadu.

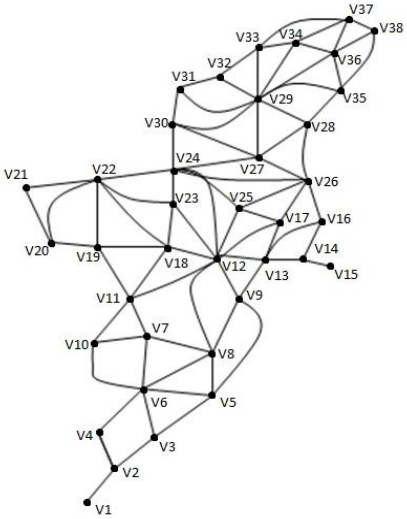

Figure 3. Dual graph of Tamil Nadu map

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Based on the graph model in figure 3, the degree of each point can be determined. The degrees of each point are arranged from the highest to the lowest level as shown in the following table:

Vertex	Degree	Vertex	Degree
v_{12}	9	v_{25}	4
v_{29}	9	v_{28}	4
v_{24}	7	v_{30}	4
v_{6}	6	v_{33}	4
v_{22}	6	v_{34}	4
v_{26}	6	v_{35}	4
v_{8}	5	v_{37}	4
v_{11}	5	v_{2}	3
v_{13}	5	v_{4}	3
v_{18}	5	v_{10}	3
v_{27}	5	v_{14}	3
v_{36}	5	v_{16}	3
v_{3}	4	v_{20}	3
v_{5}	4	v_{31}	3
v_{7}	4	v_{32}	3
v_{9}	4	v_{38}	3
v_{17}	4	v_{21}	2
v_{19}	4	v_{1}	1
v_{23}	4	v_{15}	1

4 RESULTS AND DISCUSSION

Through several things that have been done, the greedy algorithm is applied. The sequential stages of map coloring, executed using the greedy algorithm in python, represent a meticulous process that transition from input preparation to visualizing the output. These stages are delineatedto ensure a comprehensive understanding of the methodology.

The iteration of this map coloring journey begins with the fundamental step of organizing the vertex data of a graph. This data is systematically arranged in descending order, starting from the node with the highest degree and progressing to the one with the lowest. The greedy algorithm, renowned for its heuristic approach, becomes the linchpin of this process, aimed at producing a colored map as the final output.

Input: Vertex set of a graph which is arranged from node of highest degree to lowest.

Output: Colored Map.

The application of the greedy algorithm for coloring the districts in Tamil Nadu with python language requires 4 iterations, namely:

Iteration 1: Install the necessary packages.

Iteration 2: Initialize the graph and greedy algorithm for coloring function.

Iteration 3: Read map file and check the sample records.

Iteration 4: Visualize the coloring results using map data and the plotlib library.

The output of the implementation of the greedy algorithm with the python programming language is shown in figure 4.

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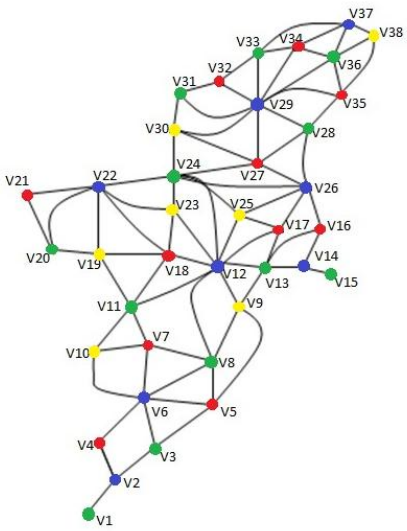

Figure 4. Coloring for the Tamil Nadu map dual graph.

The map of the districts in Tamil Nadu which is colored in four colors along with a description of each district is shown in figure 5 below.

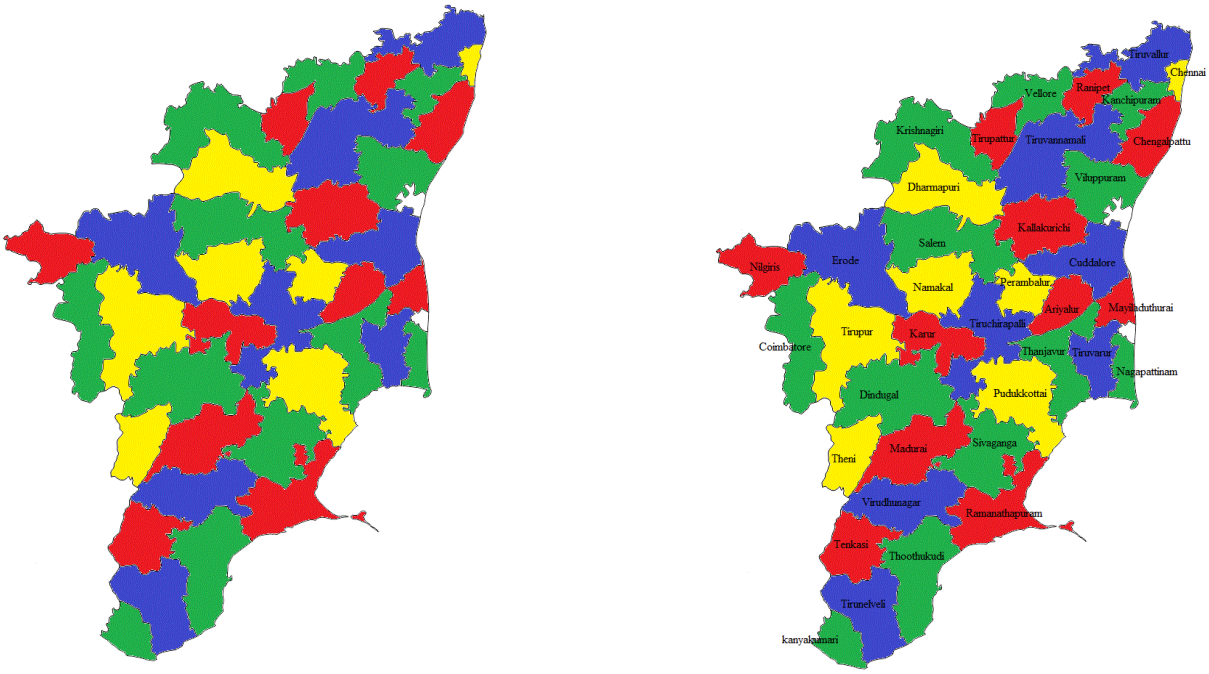

Figure 5.Colored map of the district in Tamil Nadu.

5 CONCLUSION

The application of the greedy algorithm to color the districts within the Tamil Nadu has yielded notable findings. Specifically, the map, representing 38 districts as vertices, translates into a graph model generating 78 edges. Employing a color set denoted as C, comprising eight distinct colors like Blue, Green, Red, Yellow, Purple, Pink, Orange, and Chocolate becomes a pivotal component of the algorithmic coloring process.

In the context of district characteristics, Tiruchirappalli and Tiruvannamalai districts emerges as a focal point due to its elevated number of point degrees. As per the greedy algorithm's principles, emphasizing local optimizations, Tiruchirappalli and Tiruvannamalai takes precedence and is initially colored in Blue. This strategic decision reflects the algorithm's consideration of the district's significance in the overall map representation. Based on the greedy algorithm with the help of python 3.7 programming language, four colors were obtained in coloring the district map in Tamil Nadu, namely Blue, Green, Red, and Yellow.

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