CS5700 Programming Assignment 2

Constraint Satisfaction Problems

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Github link:

https://github.com/Pavan7947/assignment1/tree/master/project_assignment_2

Code:

```
# Graph - adjacency list representation
class Graph:
    def __init__(self, vertices):
        self.vertices = vertices
        self.graph = [[] for _ in range(vertices)]

    def add_edge(self, u, v):
        self.graph[u].append(v)
        self.graph[v].append(u)

    def is_safe(self, v, c, color, result):
        for neighbor in self.graph[v]:
            if color[neighbor] == c:
                return False
        return True

    def graph_coloring_util(self, m, color, v, result):
        if v == self.vertices:
            result.append(color[:])
            return True

        for c in range(1, m + 1):
            if self.is_safe(v, c, color, result):
                color[v] = c
                if self.graph_coloring_util(m, color, v + 1, result):
                    return True
                color[v] = 0

    def graph_coloring(self, m):
        color = [0] * self.vertices
        result = []
        if not self.graph_coloring_util(m, color, 0, result):
            print("Solution does not exist")
            return
        return result

    def print_graph(self):
        for i, neighbors in enumerate(self.graph):
            print("Vertex {} -> {}".format(i, neighbours))
    # Backtrack
    path.pop()
    visited[start] = False
```

```
import geopandas as gpd
import matplotlib.pyplot as plt
from random import randint
from matplotlib.colors import to_hex
```

```
shape_path =
"/Users/Pavan/MO_2009_County_Boundaries_shp/MO_2009_County_Boundaries_shp.shp"
map = gpd.read_file(shape_path)
map.head()

# Create a graph from the map
num_states = len(map)
state_graph = Graph(num_states)

# Assume that neighboring states are connected in the graph
for i in range(num_states):
    for j in range(i + 1, num_states):
        if map.geometry[i].touches(map.geometry[j]):
            state_graph.add_edge(i, j)

# Uncomment below to see the adjacency list representation of graph
# state_graph.print_graph()

# Choose the number of colors for the map
num_colors = 4

# Get the coloring result
coloring_result = state_graph.graph_coloring(num_colors)

for i, colors in enumerate(coloring_result):
    print("Coloring solution {} -> {}".format((i+1), colors))
    print('Max colors used: {}'.format(max(colors)))

# Assign colors to states
state_colors = {i: to_hex(plt.cm.tab10.colors[color]) for i, color in enumerate(coloring_result[0])}
```

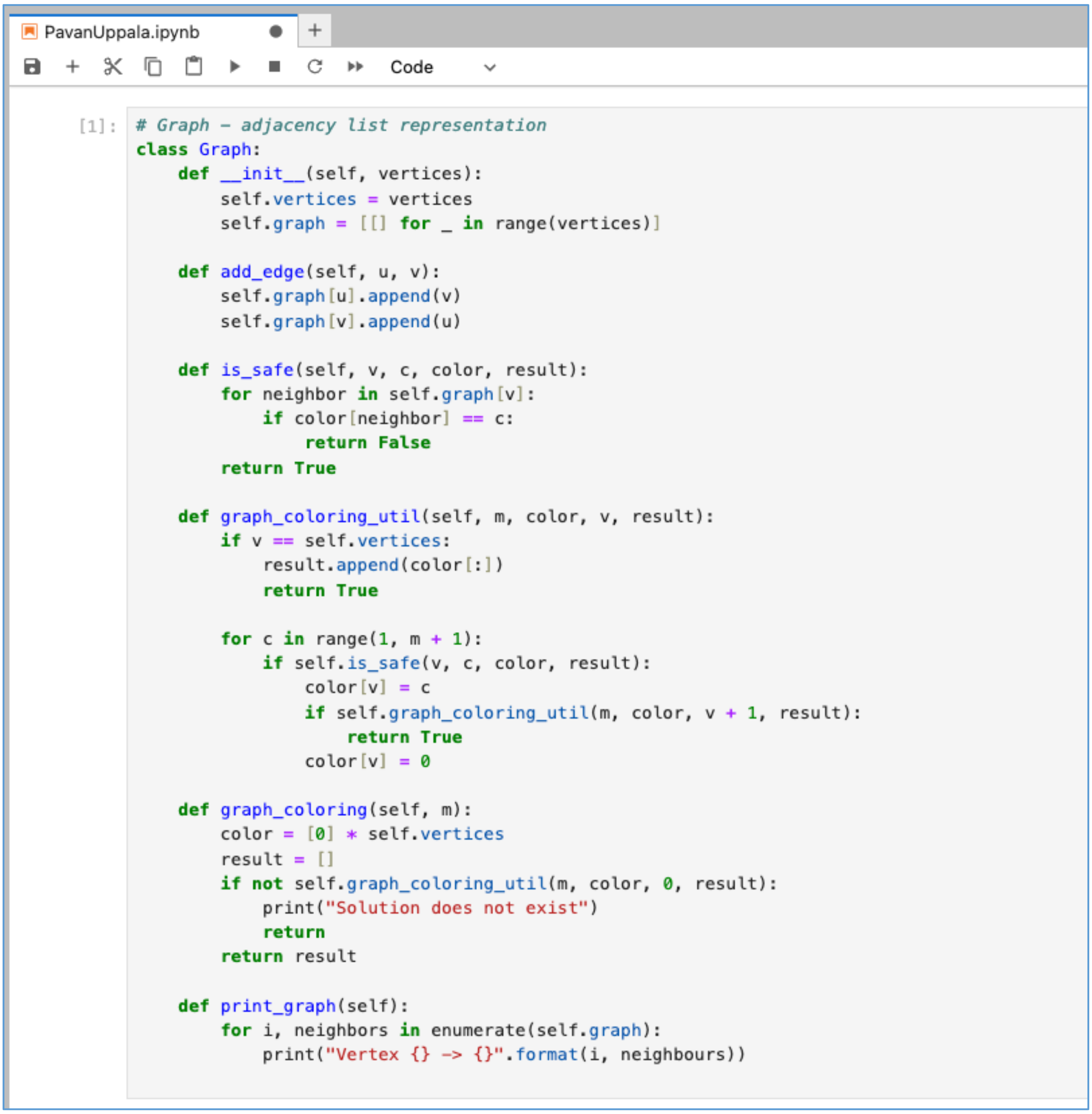
```
# Plot the USA map with colors
fig, ax = plt.subplots(1, 1, figsize=(15, 10))
map.plot(ax=ax, color=[state_colors[i] for i in range(num_states)])

# Plot county shapes
map.boundary.plot(ax=ax, color='black', linewidth=0.5)

# Plot county names
for x, y, label in zip(map.geometry.centroid.x, map.geometry.centroid.y, map['COUNTYNAME']):
    ax.text(x, y, label, fontsize=8, ha='center', va='center')

ax.set_title('Missouri Map with Colors and County Names')
plt.show()
```

# Screenshots



```
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    def is_safe(self, v, c, color, result):
        for neighbor in self.graph[v]:
            if color[neighbor] == c:
                return False
        return True

    def graph_coloring_util(self, m, color, v, result):
        if v == self.vertices:
            result.append(color[:])
            return True

        for c in range(1, m + 1):
            if self.is_safe(v, c, color, result):
                color[v] = c
                if self.graph_coloring_util(m, color, v + 1, result):
                    return True
                color[v] = 0

    def graph_coloring(self, m):
        color = [0] * self.vertices
        result = []
        if not self.graph_coloring_util(m, color, 0, result):
            print("Solution does not exist")
            return
        return result

    def print_graph(self):
        for i, neighbors in enumerate(self.graph):
            print("Vertex {} -> {}".format(i, neighbours))
```

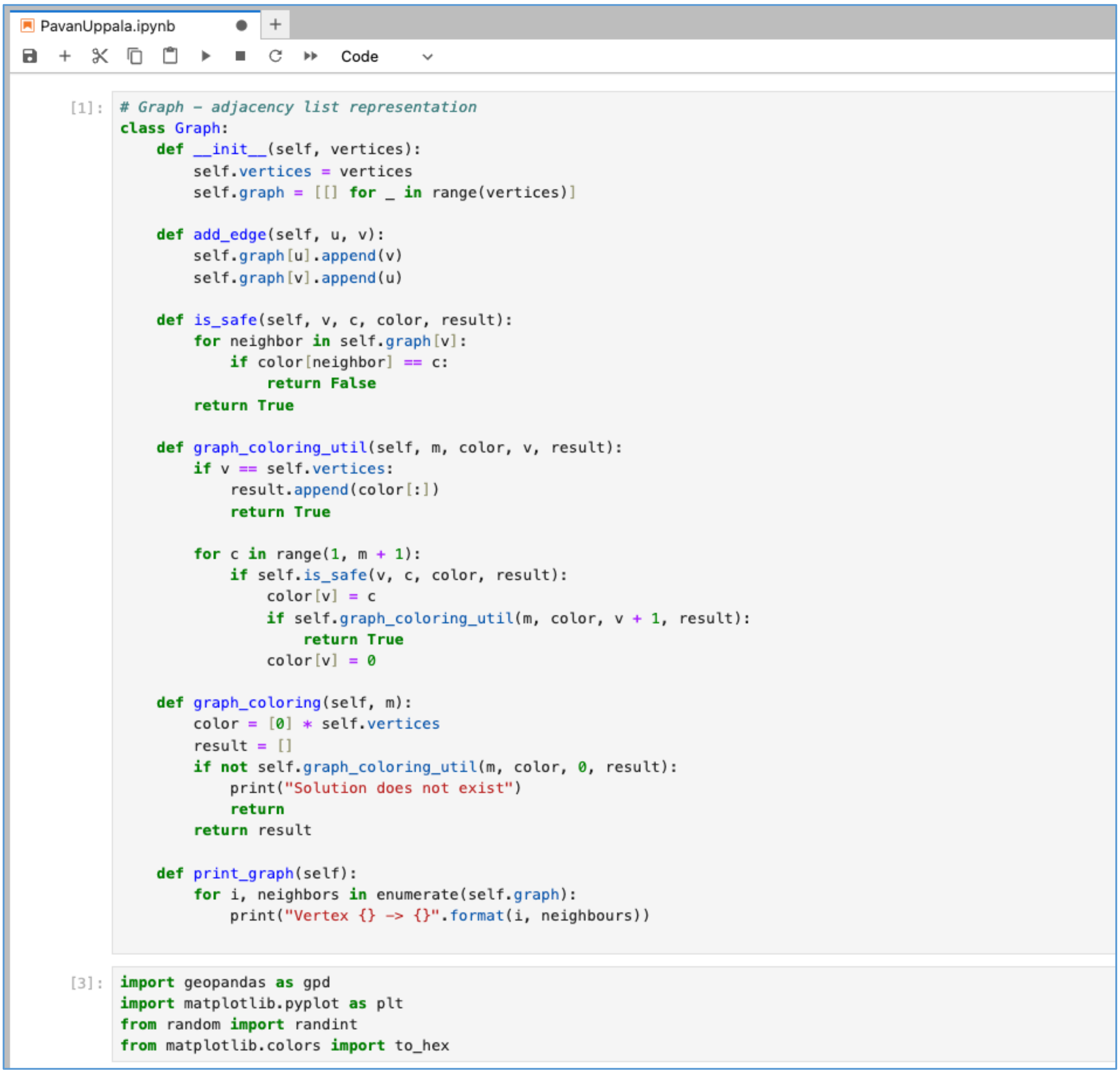

[1]:

```python
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class Graph:
    def __init__(self, vertices):
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        self.graph = [[] for _ in range(vertices)]

    def add_edge(self, u, v):
        self.graph[u].append(v)
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    def is_safe(self, v, c, color, result):
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    def graph_coloring_util(self, m, color, v, result):
        if v == self.vertices:
            result.append(color[:])
            return True

        for c in range(1, m + 1):
            if self.is_safe(v, c, color, result):
                color[v] = c
                if self.graph_coloring_util(m, color, v + 1, result):
                    return True
                color[v] = 0

    def graph_coloring(self, m):
        color = [0] * self.vertices
        result = []
        if not self.graph_coloring_util(m, color, 0, result):
            print("Solution does not exist")
            return
        return result

    def print_graph(self):
        for i, neighbors in enumerate(self.graph):
            print("Vertex {} -> {}".format(i, neighbours))
```
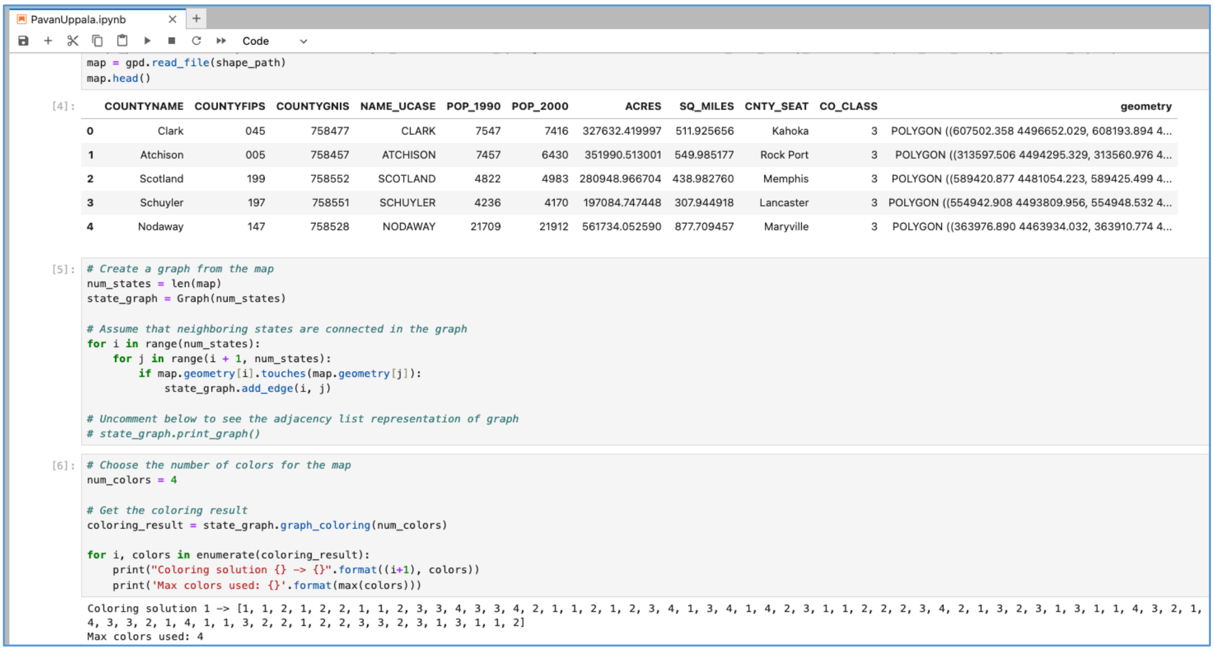

[3]:

```python
import geopandas as gpd
import matplotlib.pyplot as plt
from random import randint
from matplotlib.colors import to_hex
```



```
map = gpd.read_file(shape_path)
map.head()
```

[4]:

	COUNTYNAME	COUNTYFIPS	COUNTYGNIS	NAME_UCASE	POP_1990	POP_2000	ACRES	SQ_MILES	CNTY_SEAT	CO_CLASS	geometry
0	Clark	045	758477	CLARK	7547	7416	327632.419997	511.925656	Kahoka	3	POLYGON ((607502.358 4496652.029, 608193.894 4...
1	Atchison	005	758457	ATCHISON	7457	6430	351990.513001	549.985177	Rock Port	3	POLYGON ((313597.506 4494295.329, 313560.976 4...
2	Scotland	199	758552	SCOTLAND	4822	4983	280948.966704	438.982760	Memphis	3	POLYGON ((589420.877 4481054.223, 589425.499 4...
3	Schuyler	197	758551	SCHUYLER	4236	4170	197084.747448	307.944918	Lancaster	3	POLYGON ((554942.908 4493809.956, 554948.532 4...
4	Nodaway	147	758528	NODAWAY	21709	21912	561734.052590	877.709457	Maryville	3	POLYGON ((363976.890 4463934.032, 363910.774 4...

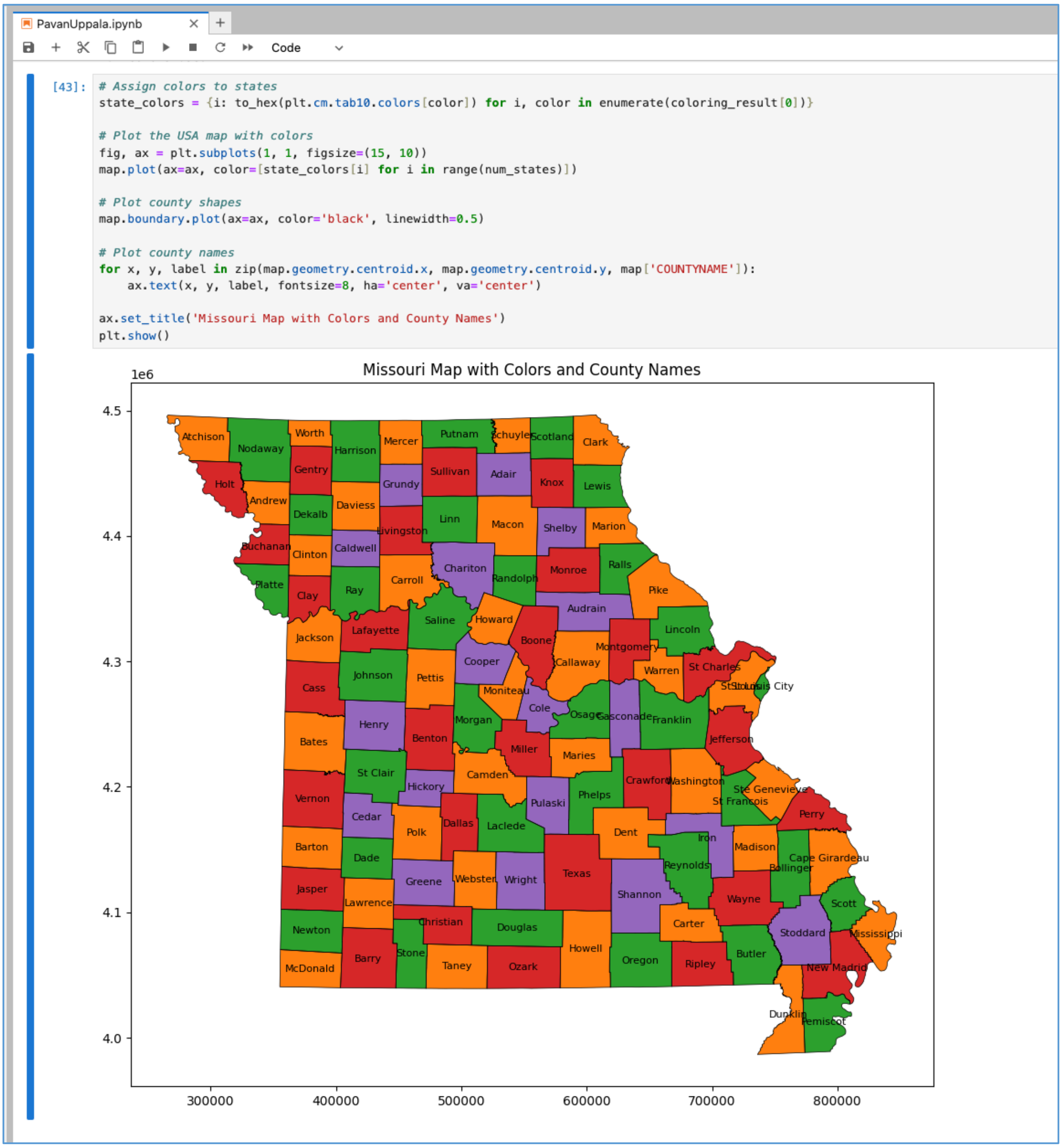
[5]:

```
# Create a graph from the map
num_states = len(map)
state_graph = Graph(num_states)

# Assume that neighboring states are connected in the graph
for i in range(num_states):
    for j in range(i + 1, num_states):
        if map.geometry[i].touches(map.geometry[j]):
            state_graph.add_edge(i, j)

# Uncomment below to see the adjacency list representation of graph
# state_graph.print_graph()
```

[6]:

```
# Choose the number of colors for the map
num_colors = 4

# Get the coloring result
coloring_result = state_graph.graph_coloring(num_colors)

for i, colors in enumerate(coloring_result):
    print("Coloring solution {} -> {}".format((i+1), colors))
    print('Max colors used: {}'.format(max(colors)))
```

```
Coloring solution 1 -> [1, 1, 2, 1, 2, 2, 1, 1, 2, 3, 3, 4, 3, 3, 4, 2, 1, 1, 2, 1, 2, 3, 4, 1, 3, 4, 1, 4, 2, 3, 1, 1, 2, 2, 2, 3, 4, 2, 1, 3, 2, 3, 1, 3, 1, 1, 4, 3, 2, 1,
4, 3, 3, 2, 1, 4, 1, 1, 3, 2, 2, 1, 2, 2, 3, 3, 2, 3, 1, 3, 1, 1, 2]
Max colors used: 4
```



```
[43]: # Assign colors to states
      state_colors = {i: to_hex(plt.cm.tab10.colors[color]) for i, color in enumerate(coloring_result[0])}

      # Plot the USA map with colors
      fig, ax = plt.subplots(1, 1, figsize=(15, 10))
      map.plot(ax=ax, color=[state_colors[i] for i in range(num_states)])

      # Plot county shapes
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      # Plot county names
      for x, y, label in zip(map.geometry.centroid.x, map.geometry.centroid.y, map['COUNTYNAME']):
          ax.text(x, y, label, fontsize=8, ha='center', va='center')

      ax.set_title('Missouri Map with Colors and County Names')
      plt.show()
```