In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.patches as mpatches
import us
import re
```

Read in and Clean Data

Spending Data

In [ ]:
```
# source: Prof. Fulton
spending = pd.read_excel('data/IIJA FUNDING AS OF MARCH 2023.xlsx', engine = 'openp

spending.columns = ['state', 'spending']
spending.state = spending.state.str.lower()
spending.loc[spending.state == 'deleware', 'state'] = 'delaware'

display(spending.head(), spending.tail())
```

	state	spending
0	alabama	3.0000
1	alaska	3.7000
2	american samoa	0.0686
3	arizona	3.5000
4	arkansas	2.8000

	state	spending
52	virginia	4.5
53	washington	4.0
54	west virginia	2.0
55	wisconsin	2.8
56	wyoming	2.3

Population Data

In [ ]:
```
# Source: Census.gov
population = pd.read_excel(
    'https://www2.census.gov/programs-surveys/popest/tables/2020-2023/state/totals/
    engine='openpyxl', header=3
)
```

```
population.columns = ['state', 'pop_base', 'pop2020', 'pop2021', 'pop2022', 'pop202
population.state = population.state.str.replace('.', '', regex=False)
population.state = population.state.str.lower()
population = population.dropna(axis=0, how='any')

display(population.head(7), population.tail())
```

	state	pop_base	pop2020	pop2021	pop2022	pop2023
0	united states	331464948.0	331526933.0	332048977.0	333271411.0	334914895.0
1	northeast	57614141.0	57430477.0	57243423.0	57026847.0	56983517.0
2	midwest	68987296.0	68969794.0	68850246.0	68783028.0	68909283.0
3	south	126268529.0	126465281.0	127353282.0	128702030.0	130125290.0
4	west	78594982.0	78661381.0	78602026.0	78759506.0	78896805.0
5	alabama	5024294.0	5031864.0	5050380.0	5073903.0	5108468.0
6	alaska	733374.0	732964.0	734923.0	733276.0	733406.0

	state	pop_base	pop2020	pop2021	pop2022	pop2023
52	washington	7705267.0	7724566.0	7741433.0	7784477.0	7812880.0
53	west virginia	1793713.0	1791562.0	1785249.0	1774035.0	1770071.0
54	wisconsin	5893713.0	5896700.0	5879978.0	5890543.0	5910955.0
55	wyoming	576850.0	577664.0	579548.0	581629.0	584057.0
57	puerto rico	3285874.0	3281557.0	3262693.0	3220113.0	3205691.0

Party Data

In [ ]:
```
# source: https://electionlab.mit.edu/data
election_results = pd.read_csv('data/1976-2020-president.csv')
election_results = election_results.loc[election_results.year == 2020]

idx = election_results.groupby('state')['candidatevotes'].idxmax()
state_by_winner = election_results.loc[idx]
state_by_winner = state_by_winner[['state', 'candidate']]
state_by_winner['party'] = np.where(state_by_winner['candidate'] == 'BIDEN, JOSEPH
state_by_winner['state'] = state_by_winner['state'].str.lower()

display(state_by_winner.head(), state_by_winner.tail())
```

	state	candidate	party
3741	alabama	TRUMP, DONALD J.	rep
3745	alaska	TRUMP, DONALD J.	rep
3752	arizona	BIDEN, JOSEPH R. JR	dem
3771	arkansas	TRUMP, DONALD J.	rep
3773	california	BIDEN, JOSEPH R. JR	dem

	state	candidate	party
4252	virginia	BIDEN, JOSEPH R. JR	dem
4256	washington	BIDEN, JOSEPH R. JR	dem
4264	west virginia	TRUMP, DONALD J.	rep
4267	wisconsin	BIDEN, JOSEPH R. JR	dem
4281	wyoming	TRUMP, DONALD J.	rep

In [ ]:
```
# according to https://www.newsweek.com/expanding-map-swing-states-that-will-decide
# https://amac.us/newsline/elections/swing-states-2024/
swing_states = [
    'arizona', 'florida', 'georgia', 'indiana', 'iowa', 'michigan',
    'north carolina', 'ohio', 'pennsylvania', 'wisconsin'
]
```

GDP Data

In [ ]:
```
# source: Bureau of Economic Analysis
gdp = pd.read_excel('https://www.bea.gov/sites/default/files/2023-12/stgdppi3q23.xl

gdp = gdp.loc[:, ['Unnamed: 0','2022.1']]
gdp.columns = ['state', 'real_gdp']
gdp = gdp.dropna(axis=0, how='any')
gdp.state = gdp.state.str.strip().str.lower()

display(gdp.head(), gdp.tail())
```

	state	real_gdp
2	united states	21822037
3	new england	1140308
4	connecticut	276669
5	maine	72414
6	massachusetts	604358

	state	real_gdp
58	hawaii	85211
59	nevada	187226
60	oregon	254708
61	washington	641144
62	overseas activity2	...

Debt & Infrastructure Spending Data

In [ ]:
```
# Source: Census.gov
finances = pd.read_excel(
    'https://www2.census.gov/programs-surveys/gov-finances/tables/2021/21slsstab1.x
    engine='openpyxl', header=10, index_col=1
)

states = []
current_state = None

for col in finances.columns:
    current_state = col.lower() if 'Unnamed' not in col else current_state
    states.append(current_state)

finances.iloc[1,:] = states

finances.columns = states

# finances = finances.loc[:, (finances.iloc[0, :] == 'State & local') & (finances.i
finances = finances.loc[:, finances.iloc[0, :] == ' State']

finances.index = finances.index.str.strip()

finances = pd.DataFrame({
    'state' : finances.T.index, # loc['Debt outstanding'].
    'revenue' : finances.loc['Revenue1'].T,
    'debt' : finances.loc['Debt outstanding'].T,
    'infrastructure' : (
        finances.loc['Expenditure1':].loc['Highways'].T +
        finances.loc['Expenditure1':].loc['Air transportation (airports)'].T +
        finances.loc['Expenditure1':].loc['Parking facilities'].T +
        finances.loc['Expenditure1':].loc['Sea and inland port facilities'].T +
        finances.loc['Expenditure1':].loc['Utility expenditure'].T
    )
})
finances = finances.reset_index(drop=True)

display(finances.head(), finances.tail())
```

	state	revenue	debt	infrastructure
0	united states total	3975040333	1208170688	164442737
1	alabama	43769959	9118128	1720709
2	alaska	14186218	5652311	1482688
3	arizona	68592195	8969733	1336701
4	arkansas	42968905	7868953	1589453

	state	revenue	debt	infrastructure
47	virginia	97747751	31041855	5554361
48	washington	102871984	30206602	2450061
49	west virginia	22371082	13368743	1663989
50	wisconsin	65795068	21978336	2185640
51	wyoming	8179668	924246	620168

Road Miles Data

In [ ]:
```
# source: https://www.fhwa.dot.gov/policyinformation/statistics/2021/hm60.cfm
roads = pd.read_csv('data/hm60.csv')

roads.index = roads.iloc[:,0]
roads.index.name = 'State'
roads.index = roads.index.str.lower()

roads.columns = roads.iloc[0,:] + ' ' + roads.iloc[1,:] + ' ' + roads.iloc[2,:]

roads = roads['TOTAL LANE MILES']
roads = roads.dropna()
roads = roads.iloc[4:]
roads.name = 'road_miles'

roads = pd.to_numeric(roads.str.replace(',', ''))

roads = roads.rename(index={'maine  (3)':'maine'})

print(roads.head(), roads.tail())
```

```
State
alaska          35927
arizona        162428
arkansas       204358
california     400218
colorado       186199
Name: road_miles, dtype: int64 State
wisconsin       239518
wyoming          62588
u.s. total     8823515
puerto rico      41587
grand total    8865103
Name: road_miles, dtype: int64
```

Land Area Data

In [ ]:
```
# source: https://www.census.gov/geographies/reference-files/2010/geo/state-area.ht
land_area = pd.read_csv('data/landArea_census.csv')

land_area = land_area.loc[:, [x for x in land_area.columns if 'Unnamed' not in x an
land_area.columns = ['state', 'total_area', 'land_area', 'water_area']

land_area = land_area.dropna(axis=0, how='any')

land_area.state = land_area.state.str.lower()
land_area.state = land_area.state.str.replace('[0-9:]', '', regex=True)

for col in land_area.columns[1:]:
    land_area[col] = pd.to_numeric(land_area[col].str.replace(',', ''))

display(land_area.head(), land_area.tail())
```

	state	total_area	land_area	water_area
2	total	3805927	3535932	269995
4	united states	3796742	3531905	264837
5	alabama	52420	50645	1775
6	alaska	665384	570641	94743
7	arizona	113990	113594	396

	state	total_area	land_area	water_area
59	island areas	3860	603	3257
60	american samoa	581	76	505
61	guam	571	210	361
62	northern mariana islands	1976	182	1793
63	u.s. virgin islands	733	134	599

In [ ]:

Merge Datasets

In [ ]:
```
display(population.state[~population.state.isin(spending.state)], spending.state[~s
```

```
0    united states
1        northeast
2          midwest
3            south
4             west
Name: state, dtype: object
2               american samoa
12                        guam
37    northern mariana islands
48          tribal communities
49           us virgin islands
Name: state, dtype: object
```

In [ ]:
```
data = pd.merge(population, spending, on='state', how='inner')
data = pd.merge(data, state_by_winner, on='state', how='inner')
data = pd.merge(data, finances, on='state', how='inner') ## FIX TO KEEP PR
data = pd.merge(data, gdp, on='state', how='inner')
data = pd.merge(data, land_area, on='state', how='inner')
data = pd.merge(data, roads, left_on='state', right_index=True, how='inner')

# data = data.drop([x for x in data.columns if 'state' in x], axis=1)

data['spending_per_capita'] = (data['spending'] * 10**9) / data['pop2023']
data['debt_per_capita'] = (data['debt'] * 1000) / data['pop2023']
data['party_alt'] = np.where(data['state'].isin(swing_states), 'swing', data['party

mapping = us.states.mapping('name', 'abbr')
mapping = {key.lower(): value for key, value in mapping.items()}

data['area_abbr'] = data['state'].map(mapping)
data.loc[data.area_abbr.isnull(), 'area_abbr'] = 'DC'

print(f'Shape: {data.shape}\n\n')
display(data.head(), data.tail())
```

```
Shape: (50, 21)
```

	state	pop_base	pop2020	pop2021	pop2022	pop2023	spending	candidat
1	alaska	733374.0	732964.0	734923.0	733276.0	733406.0	3.7	TRUMF DONALI
2	arizona	7157902.0	7186683.0	7272487.0	7365684.0	7431344.0	3.5	BIDEN JOSEPH R JI
3	arkansas	3011490.0	3014348.0	3028443.0	3046404.0	3067732.0	2.8	TRUMF DONALI
4	california	39538212.0	39503200.0	39145060.0	39040616.0	38965193.0	18.4	BIDEN JOSEPH R JI
5	colorado	5773707.0	5785219.0	5811596.0	5841039.0	5877610.0	3.2	BIDEN JOSEPH R JI

5 rows × 21 columns

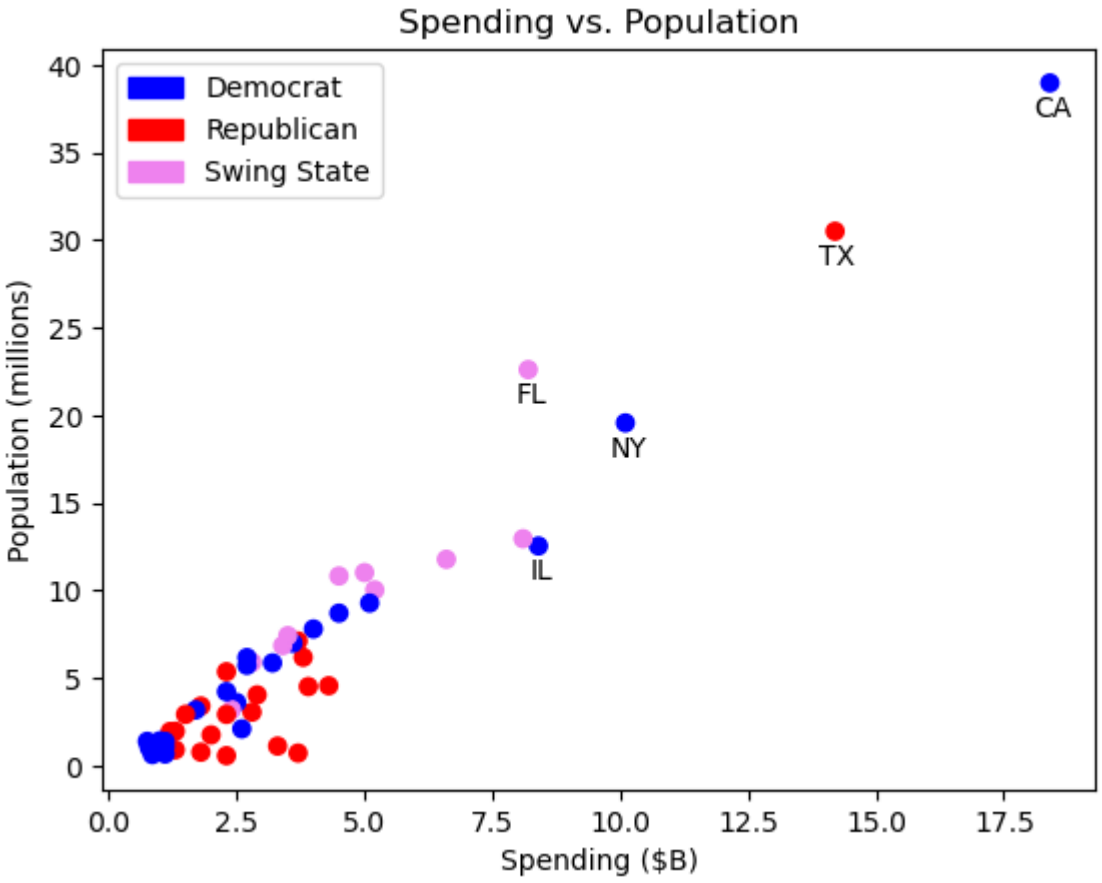
	state	pop_base	pop2020	pop2021	pop2022	pop2023	spending	candidate
46	virginia	8631373.0	8637193.0	8657348.0	8679099.0	8715698.0	4.5	BIDEN, JOSEPH R. JR
47	washington	7705267.0	7724566.0	7741433.0	7784477.0	7812880.0	4.0	BIDEN, JOSEPH R. JR
48	west virginia	1793713.0	1791562.0	1785249.0	1774035.0	1770071.0	2.0	TRUMP, DONALD J.
49	wisconsin	5893713.0	5896700.0	5879978.0	5890543.0	5910955.0	2.8	BIDEN, JOSEPH R. JR
50	wyoming	576850.0	577664.0	579548.0	581629.0	584057.0	2.3	TRUMP, DONALD J.

5 rows × 21 columns

Plots

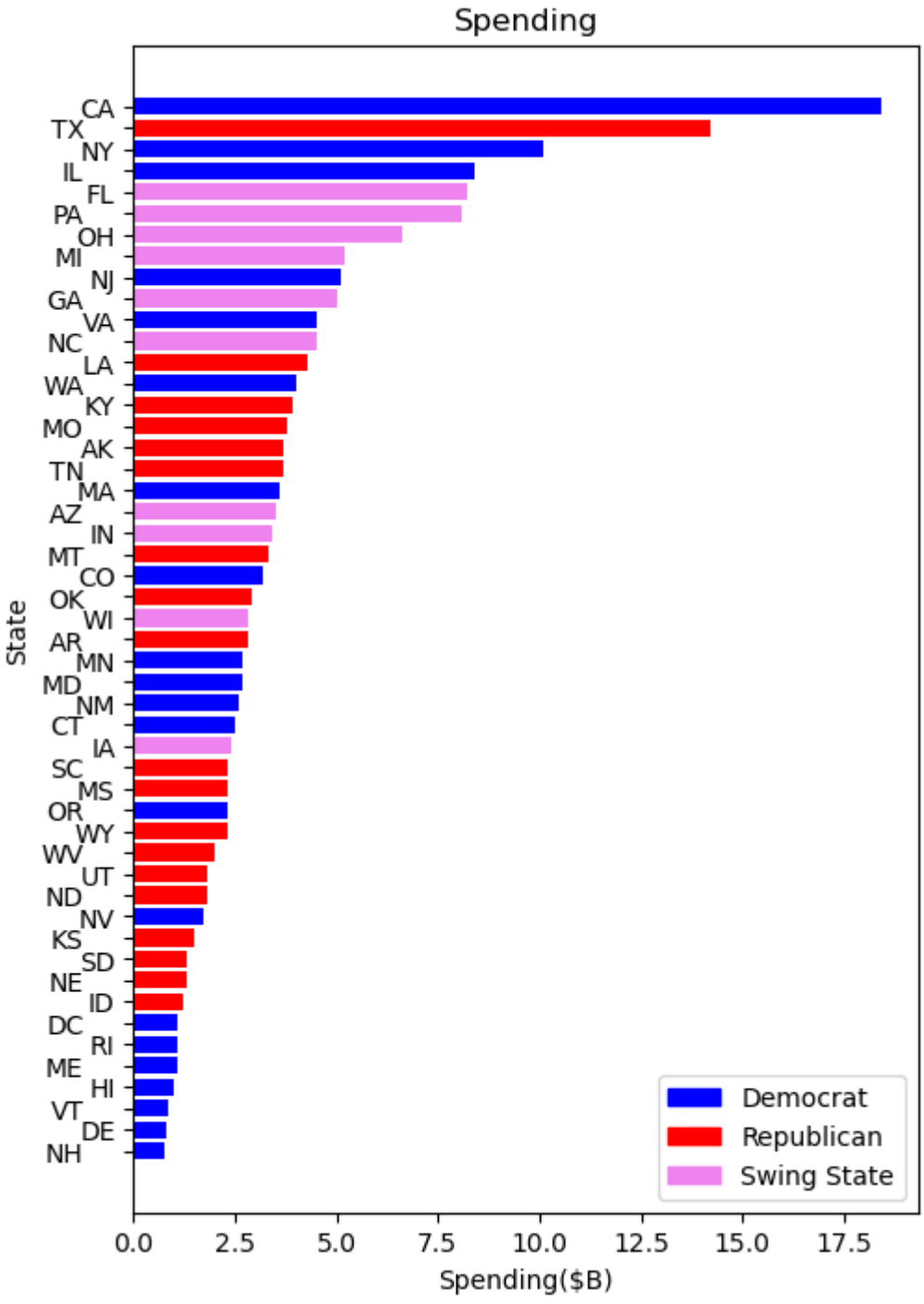
In [ ]:
```
data = data.sort_values(by='spending', ascending=False, ignore_index=True)
```

```
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}
colors = [color_map[party] for party in data.party_alt]

fig, ax = plt.subplots()

ax.scatter(data.spending, data.pop2023 / 10**6, color=colors)
ax.set_xlabel('Spending ($B)')
ax.set_ylabel('Population (millions)')
ax.set_title('Spending vs. Population')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(data[:5].area_abbr):
    plt.annotate(
        label, (data.spending[i], data.pop2023[i] / 10**6),
        textcoords="offset points", xytext=(1,-12), ha='center',
    )

plt.show()
```



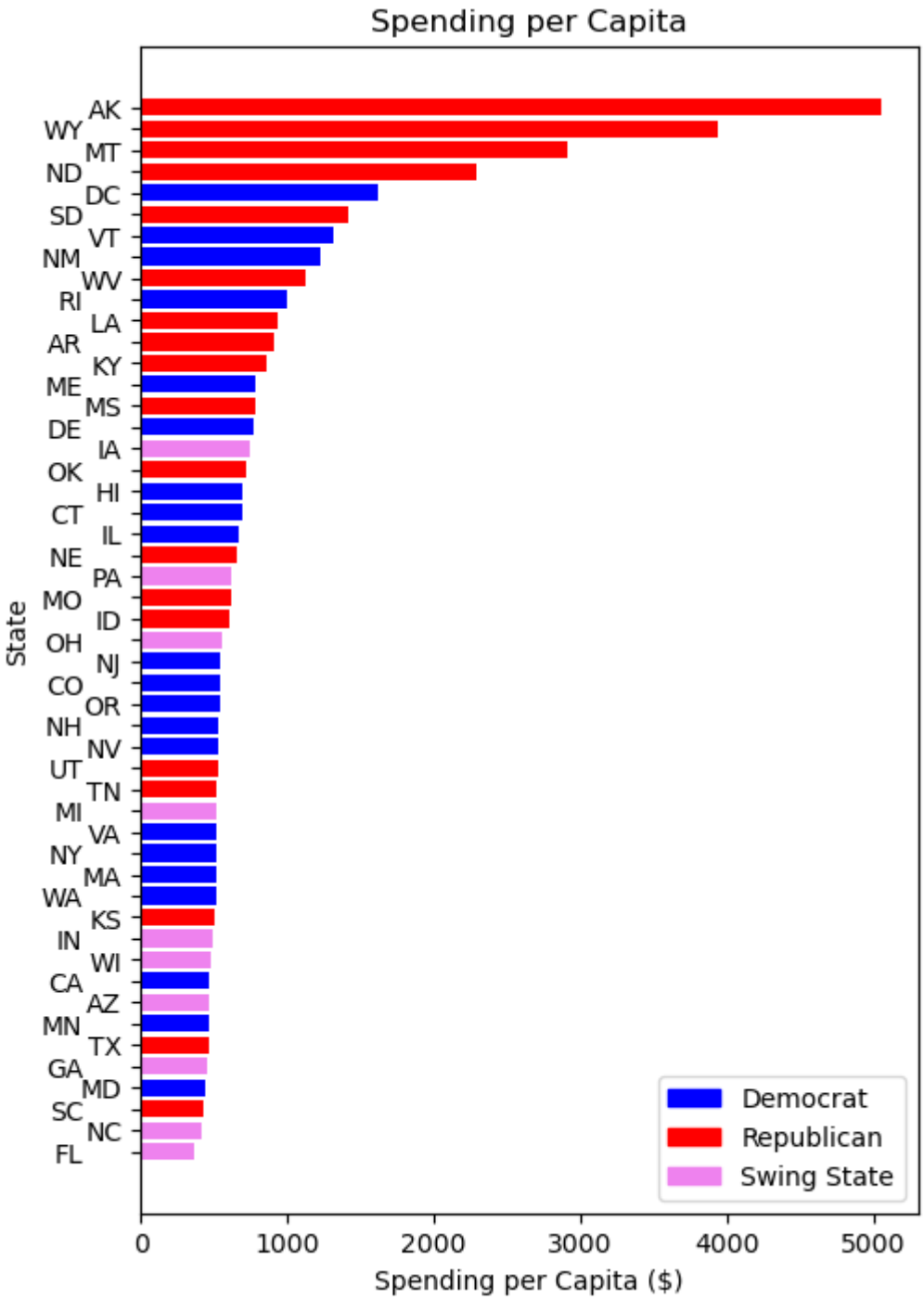
In [ ]:
```
data = data.sort_values(by='spending', ascending=True, ignore_index=True)
colors = [color_map[party] for party in data.party_alt]

fig, ax = plt.subplots(layout='constrained', figsize=(5, 7))
ax.barh(data.area_abbr, data.spending, color=colors)
ax.set_title('Spending')
```

```
ax.set_xlabel('Spending($B)')
ax.set_ylabel('State')

for i, label in enumerate(ax.get_yticklabels()):
    if i % 2 == 0:
        label.set_position((-0.04, 0))

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

plt.show()
```



In [ ]:

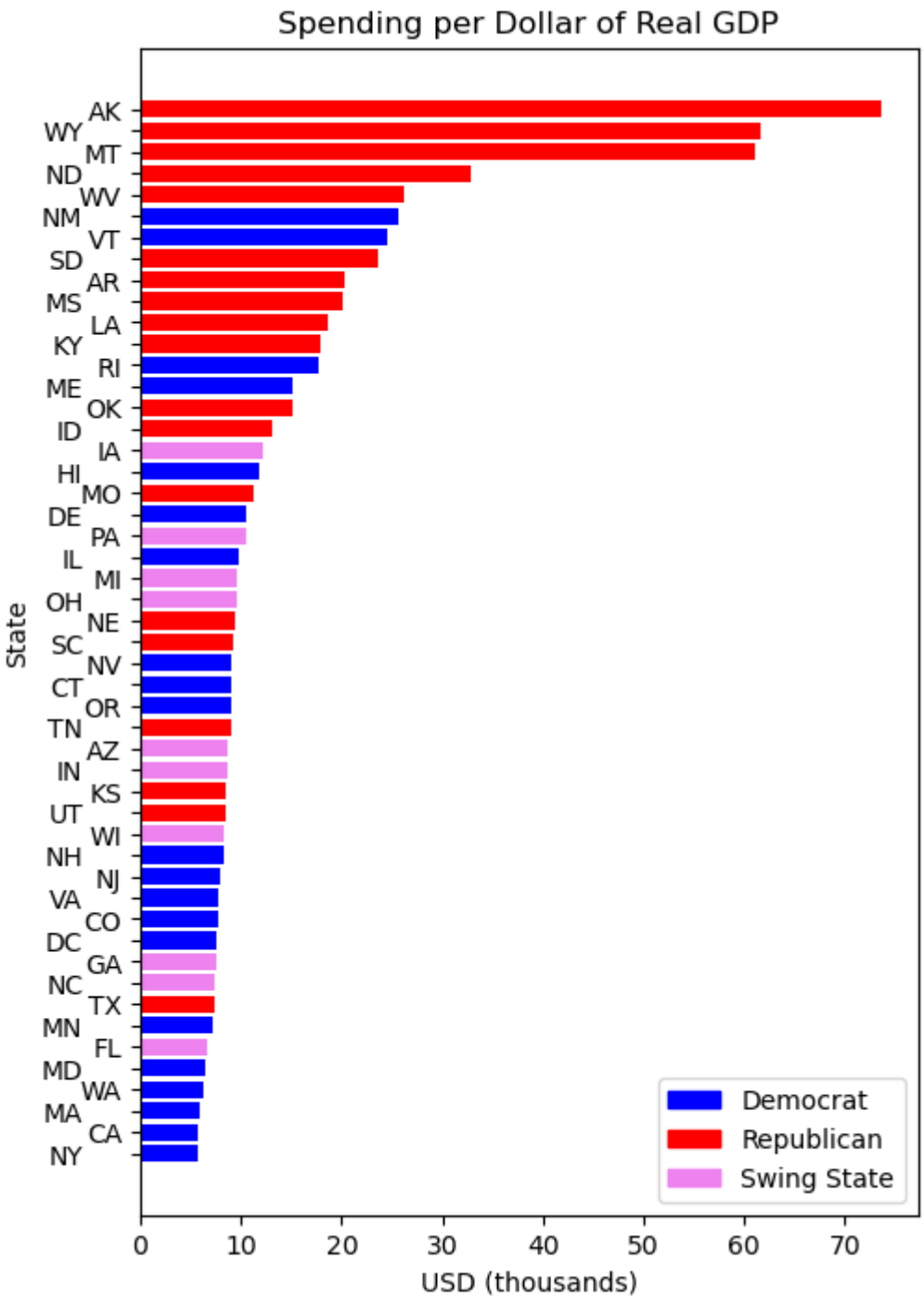
```
data = data.sort_values(by = 'spending_per_capita')

fig, ax = plt.subplots(layout='constrained', figsize=(5, 7))
for i in range(len(data)):
    row = data.iloc[i]
    bar = ax.barh(
        row['area_abbr'], row['spending_per_capita'],
        color = color_map[row['party_alt']],
    )
ax.set_title('Spending per Capita')
ax.set_xlabel('Spending per Capita ($)')
ax.set_ylabel('State')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_yticklabels()):
    if i % 2 == 0:
        label.set_position((-0.05, 0))

plt.show()
```



In [ ]:
```
denominators = {
    'pop2023':'Spending per Capita',
    'real_gdp':'Spending per Dollar of Real GDP',
    'debt':'Spending per Dollar of State Debt',
    'infrastructure':'Spending per Dollar of Annual Infrastructure Spending',
    'road_miles':'Spending per Mile of Road',
    'land_area':'Spending per Square Mile of Land Area',
}
```

In [ ]:
```
denominator = 'real_gdp'

data['new_col'] = data['spending'] * 10**9 / data[denominator] / 1000
data = data.sort_values(by='new_col')
```

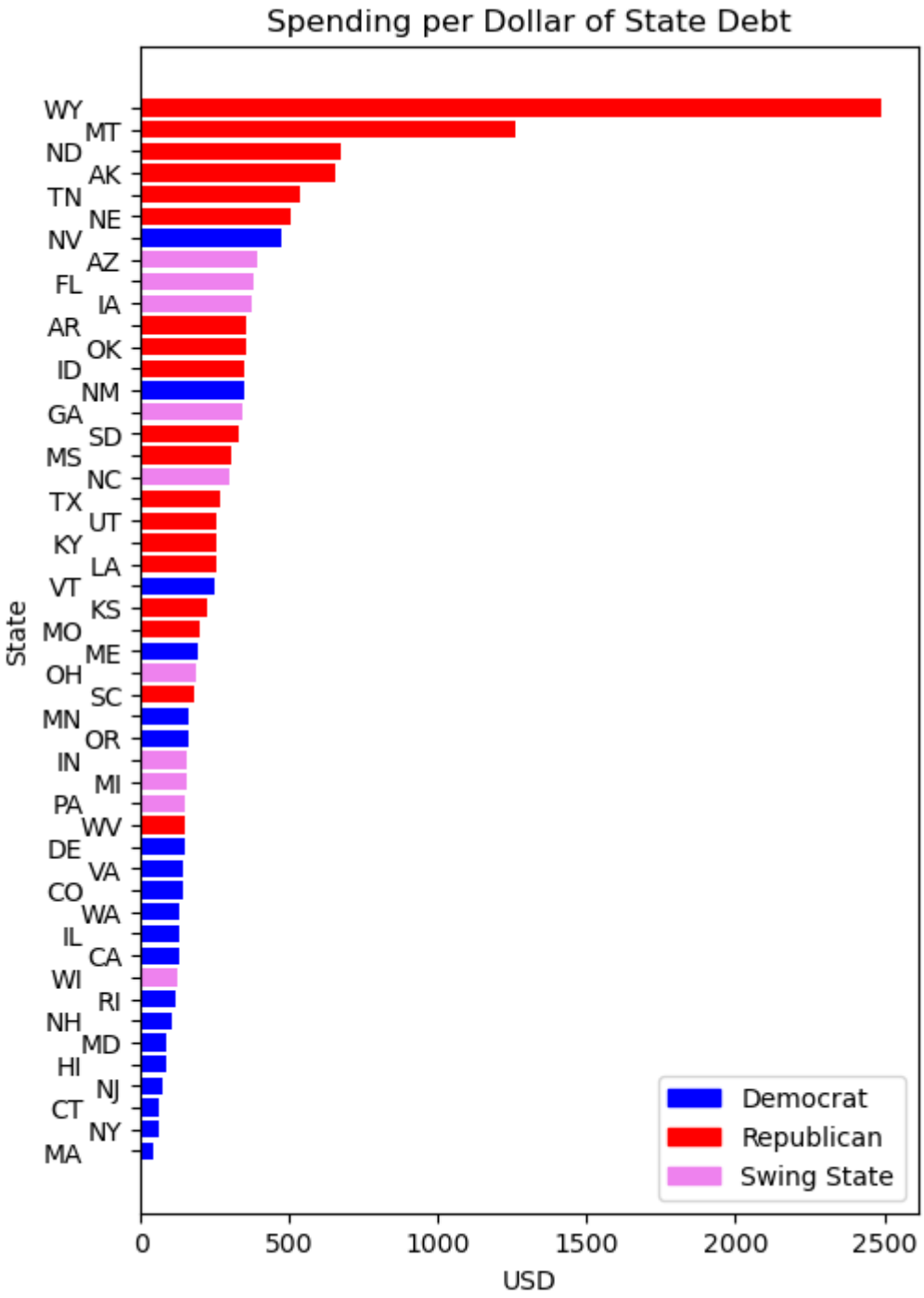
```
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}

fig, ax = plt.subplots(layout='constrained', figsize=(5, 7))
for i in range(len(data)):
    row = data.iloc[i]
    bar = ax.barh(
        row['area_abbr'], row['new_col'],
        color = color_map[row['party_alt']],
    )
ax.set_title(denominators[denominator])
ax.set_xlabel('USD (thousands)')
ax.set_ylabel('State')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_yticklabels()):
    if i % 2 == 0:
        label.set_position((-0.05, 0))

data.drop('new_col', axis = 1, inplace = True)

plt.show()
```



In [ ]:

```
denominator = 'debt'

data_no_zero = data.loc[data[denominator] != 0, :].copy()

data_no_zero['new_col'] = data_no_zero['spending'] * 10**9 / data_no_zero[denominat
data_no_zero = data_no_zero.sort_values(by='new_col')
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}

fig, ax = plt.subplots(layout='constrained', figsize=(5, 7))
for i in range(len(data_no_zero)):
    row = data_no_zero.iloc[i]
    bar = ax.barh(
        row['area_abbr'], row['new_col'],
```

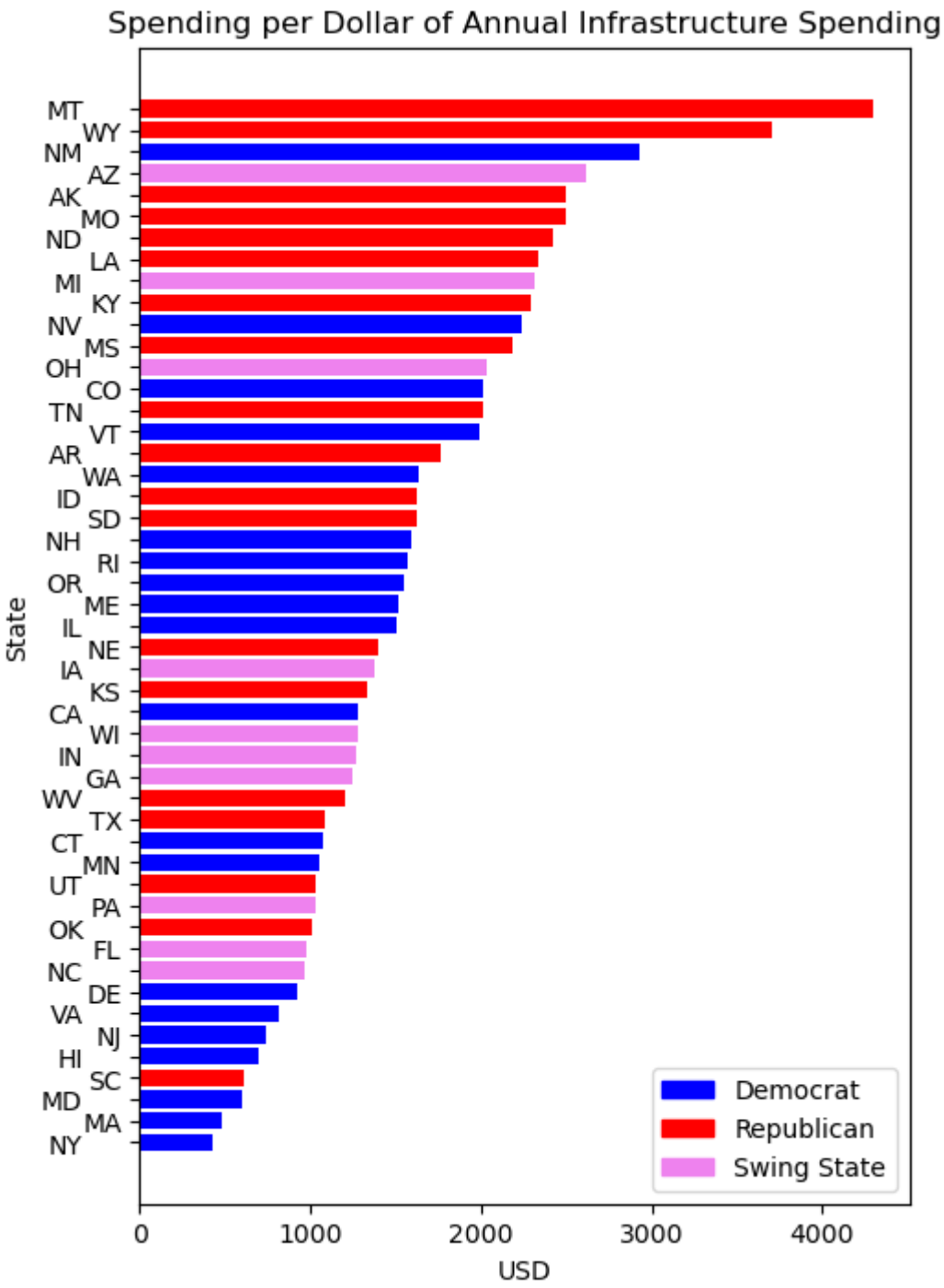
```
        color = color_map[row['party_alt']],
    )
ax.set_title(denominators[denominator])
ax.set_xlabel('USD')
ax.set_ylabel('State')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_yticklabels()):
    if i % 2 == 0:
        label.set_position((-0.05, 0))

data_no_zero.drop('new_col', axis = 1, inplace = True)

plt.show()
```



In [ ]:

```
denominator = 'infrastructure'

data_no_zero = data.loc[data[denominator] != 0, :].copy()

data_no_zero['new_col'] = data_no_zero['spending'] * 10**9 / data_no_zero[denominat
data_no_zero = data_no_zero.sort_values(by='new_col')
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}

fig, ax = plt.subplots(layout='constrained', figsize=(5, 7))
for i in range(len(data_no_zero)):
    row = data_no_zero.iloc[i]
    bar = ax.barh(
        row['area_abbr'], row['new_col'],
```

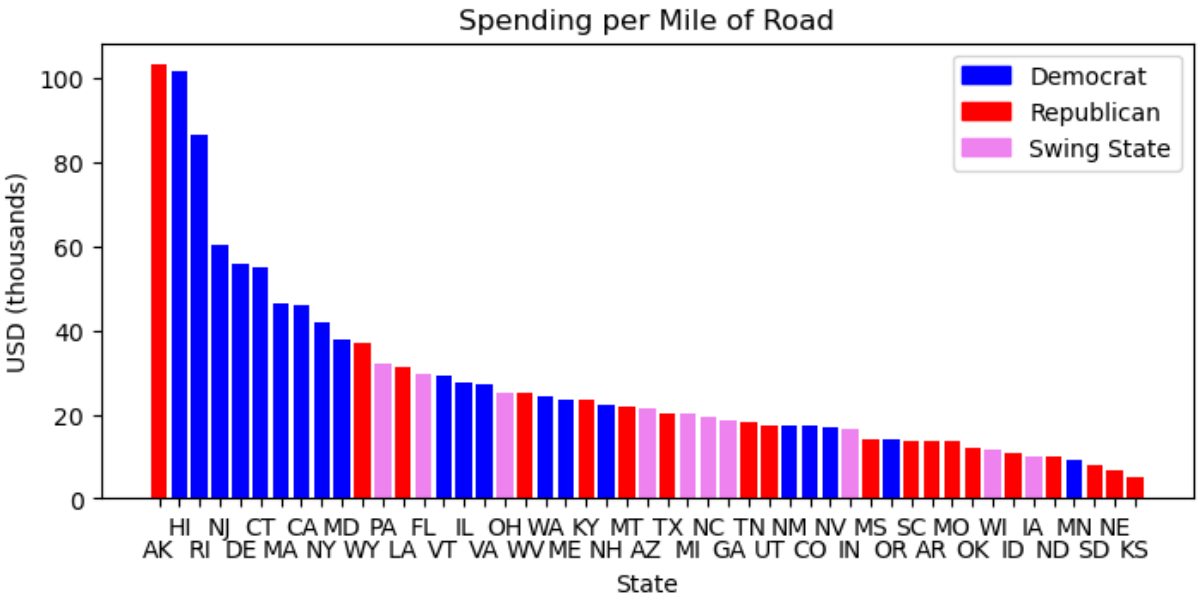
```
        color = color_map[row['party_alt']],
    )
ax.set_title(denominators[denominator])
ax.set_xlabel('USD')
ax.set_ylabel('State')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_yticklabels()):
    if i % 2 == 0:
        label.set_position((-0.05, 0))

data_no_zero.drop('new_col', axis = 1, inplace = True)

plt.show()
```



In [ ]:

```
denominator = 'road_miles'

data_no_zero = data.loc[data.area_abbr != 'DC', :].copy()

data_no_zero['new_col'] = data_no_zero['spending'] * 10**9 / data_no_zero[denominat
data_no_zero = data_no_zero.sort_values(by='new_col', ascending=False)
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}

fig, ax = plt.subplots(layout='constrained', figsize=(7, 3.5))
for i in range(len(data_no_zero)):
    row = data_no_zero.iloc[i]
    bar = ax.bar(
        row['area_abbr'], row['new_col'],
```

```
        color = color_map[row['party_alt']],
    )
ax.set_title(denominators[denominator])
ax.set_ylabel('USD (thousands)')
ax.set_xlabel('State')

blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_xticklabels()):
    if i % 2 == 0:
        label.set_position((0, -0.05))

data_no_zero.drop('new_col', axis = 1, inplace = True)

plt.show()
```



In [ ]:

```
denominator = 'land_area'

data_no_zero = data.loc[data.area_abbr != 'DC', :].copy()

data_no_zero['new_col'] = data_no_zero['spending'] * 10**9 / data_no_zero[denominat
data_no_zero = data_no_zero.sort_values(by='new_col', ascending=False)
color_map = {'dem':'blue', 'rep':'red', 'swing':'violet'}

fig, ax = plt.subplots(layout='constrained', figsize=(7, 3.5))
for i in range(len(data_no_zero)):
    row = data_no_zero.iloc[i]
    bar = ax.bar(
        row['area_abbr'], row['new_col'],
        color = color_map[row['party_alt']],
    )
ax.set_title(denominators[denominator])
ax.set_ylabel('USD (thousands)')
ax.set_xlabel('State')
```

```
blue_patch = mpatches.Patch(color = 'blue', label = 'Democrat')
red_patch = mpatches.Patch(color = 'red', label = 'Republican')
purple_patch = mpatches.Patch(color = 'violet', label = 'Swing State')
ax.legend(handles = [blue_patch, red_patch, purple_patch])

for i, label in enumerate(ax.get_xticklabels()):
    if i % 2 == 0:
        label.set_position((0, -0.05))

data_no_zero.drop('new_col', axis = 1, inplace = True)

plt.show()
```