Querying Zip Codes from U.S. Census

To run the data, you can also add the 1000 zipcodes and 26000 zip codes CSV manually. They're included in the Actual Dataset folder in the Google Drive! There are preloadded cells below to load in the precleaned CSVs.

Importing State Data by Zip Code

```
df_zip_states = pd.read_csv("uszips.csv")
df_zip_states["zip"] = df_zip_states["zip"].astype(str).str.zfill(5)
df_zip_states
```

	zip	lat	lng	city	state_id	state_name	zcta	parent_zcta	population	density	county_fips	county_name	county_weights	county_names_all	county_fips_all	imprecise	mi
0	00601	18.18027	-66.75266	Adjuntas	PR	Puerto Rico	True	NaN	16721.0	100.2	72001	Adjuntas	{"72001": 98.74, "72141": 1.26}	Adjuntas|Utuado	72001|72141	False	
1	00602	18.36075	-67.17541	Aguada	PR	Puerto Rico	True	NaN	37510.0	477.6	72003	Aguada	{"72003": 100}	Aguada	72003	False	
2	00603	18.45744	-67.12225	Aguadilla	PR	Puerto Rico	True	NaN	48317.0	543.1	72005	Aguadilla	{"72005": 99.76, "72099": 0.24}	Aguadilla|Moca	72005|72099	False	
3	00606	18.16585	-66.93716	Maricao	PR	Puerto Rico	True	NaN	5435.0	47.3	72093	Maricao	{"72093": 82.27, "72153": 11.66, "72121": 6.06}	Maricao|Yauco|Sabana Grande	72093|72153|72121	False	
4	00610	18.29110	-67.12243	Anasco	PR	Puerto Rico	True	NaN	25413.0	264.4	72011	Añasco	{"72011": 96.71, "72099": 2.82, "72083": 0.37,...	Añasco|Moca|Las Marías|Aguada	72011|72099|72083|72003	False	
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
33778	99923	55.98043	-130.03803	Hyder	AK	Alaska	True	NaN	25.0	0.6	2198	Prince of Wales-Hyder	{"02198": 100}	Prince of Wales-Hyder	02198	False	
33779	99925	55.55398	-132.96276	Klawock	AK	Alaska	True	NaN	854.0	6.1	2198	Prince of Wales-Hyder	{"02198": 100}	Prince of Wales-Hyder	02198	False	
33780	99926	55.12617	-131.48928	Metlakatla	AK	Alaska	True	NaN	1385.0	4.0	2198	Prince of Wales-Hyder	{"02198": 100}	Prince of Wales-Hyder	02198	False	
33781	99927	56.33305	-133.60044	Point Baker	AK	Alaska	True	NaN	18.0	1.5	2198	Prince of Wales-Hyder	{"02198": 100}	Prince of Wales-Hyder	02198	False	
33782	99929	56.36089	-132.00635	Wrangell	AK	Alaska	True	NaN	2105.0	0.3	2275	Wrangell	{"02275": 100}	Wrangell	02275	False	

33783 rows × 18 columns

Merging State Data to Zip Codes

```
df_zips_and_states = top_1000_zips.merge(right=df_zip_states[["zip", "state_id", "lat", "lng", "city", "density", "county_fips", "county_name"]], left_on="Zip Code", right_on="zip")

df_zips_and_states = df_zips_and_states[df_zips_and_states["Population Size"] != 0]
df_zips_and_states = df_zips_and_states[["Population Size", "Zip Code", "state_id", "lat", "lng", "city", "density", "county_fips", "county_name"]]

df_zips_and_states.columns = ['Population Size', 'Zip Code', 'State', 'Latitude', 'Longitude', 'City', 'Population Density', 'County FIPS', 'County Name']

df_zips_and_states
```

	Population Size	Zip Code	State	Latitude	Longitude	City	Population Density	County FIPS	County Name
0	137213	77494	TX	29.74566	-95.82302	Katy	1398.4	48157	Fort Bend
1	136784	08701	NJ	40.07635	-74.20311	Lakewood	2135.0	34029	Ocean
2	123042	77449	TX	29.83674	-95.73547	Katy	1756.9	48201	Harris
3	118437	78660	TX	30.44361	-97.59558	Pflugerville	1025.1	48453	Travis
4	112211	77433	TX	29.94920	-95.73979	Cypress	734.7	48201	Harris
...	...	...	...	...	...	...	...	...	...
33171	2	72636	AR	35.99121	-92.71651	Gilbert	4.9	5129	Searcy
33172	1	99638	AK	53.01329	-168.75359	Nikolski	0.0	2016	Aleutians West
33173	1	57439	SD	45.33464	-98.10007	Ferney	1.0	46013	Brown
33174	1	82224	WY	42.93677	-104.88811	Lost Springs	0.0	56009	Converse
33175	1	99903	AK	55.73414	-132.10669	Meyers Chuck	0.0	2275	Wrangell

33176 rows × 9 columns

Convert Zip Codes to List for Subsequent API Querying

```
zip_codes = df_zips_and_states["Zip Code"].tolist()
zip_codes = zip_codes[:1000]
zip_codes
```

```
        '93727',
        '11377',
        '96706',
        '92804',
        '95823',
        '60804',
        '77379',
        '92154',
        '79928',
        '11233',
        '34953',
        '95076',
        '11235',
        '27587',
        '84043',
        '76063',
        '60608',
        '77407',
        '11204',
        '77459',
        '92592',
        '93033',
        '93535',
        '92704',
        '28269',
        '91710',
        '27610',
        '92509',
```

Query Federal Government GSA API for Per Diem Rates

```
import requests
import pandas as pd
import time

headers = {
    "x-api-key": "QMVs4H9JiK1KF23lDzesf1GNbHIJ3IhaSraQxU5r",
}

# Year for which to retrieve per diem rates
year = "2024"

# Initialize an empty list to store DataFrames
dataframes = []

# Loop through each zip code
for zip_code in zip_codes:
    url = f"https://api.gsa.gov/travel/perdiem/v2/rates/zip/{zip_code}/year/{year}"

    try:
        # Send GET request
        response = requests.get(url, headers=headers)

        # Check if the request was successful
        if response.status_code == 200:
            # Parse JSON response
            data = response.json()

            # Extract relevant data for DataFrame
            rates = data.get('rates', [])
            if rates:  # Ensure rates exist
                for rate in rates:
                    for rate_detail in rate.get('rate', []):
                        months = rate_detail.get('months', {}).get('month', [])
                        for month in months:
                            # Create a DataFrame row for each month
                            row = {
                                'Zip Code': rate_detail.get('zip'),
                                'City': rate_detail.get('city'),
                                'County': rate_detail.get('county'),
                                'State': rate.get('state'),
                                'Year': rate.get('year'),
                                'Month': month.get('long'),
                                'Rate': month.get('value'),
                                'Meals': rate_detail.get('meals')
                            }
                            # Append the row to a DataFrame
                            dataframes.append(pd.DataFrame([row]))
            time.sleep(0.1)  # Add a delay of 0.1 seconds between requests
        else:
            print(f"Failed to retrieve data for {zip_code}. Status code: {response.status_code}")
    except Exception as e:
        print(f"An error occurred for {zip_code}: {e}")

# Combine all DataFrames into a single DataFrame
if dataframes:  # Ensure there are DataFrames to concatenate
    final_dataframe = pd.concat(dataframes, ignore_index=True)
    # Display the combined DataFrame
    print(final_dataframe.head())
else:
    print("No data available to concatenate.")
```

Show hidden output

Zip Codes and Per Diem Rates for Each Month

```
final_dataframe
```

	Zip Code	City	County	State	Year	Month	Rate	Meals
0	77494	Standard Rate	None	TX	2024	January	107	59
1	77494	Standard Rate	None	TX	2024	February	107	59
2	77494	Standard Rate	None	TX	2024	March	107	59
3	77494	Standard Rate	None	TX	2024	April	107	59
4	77494	Standard Rate	None	TX	2024	May	107	59
...	...	...	...	...	...	...	...	...
13231	27265	Greensboro	Guilford	NC	2024	August	116	64
13232	27265	Greensboro	Guilford	NC	2024	September	116	64
13233	27265	Greensboro	Guilford	NC	2024	October	120	64
13234	27265	Greensboro	Guilford	NC	2024	November	120	64
13235	27265	Greensboro	Guilford	NC	2024	December	120	64

13236 rows × 8 columns

Zip Codes and Averaged Per Diem Rates

```
# calculate average per diem rate for each zip code
per_diem = final_dataframe.groupby('Zip Code')['Rate'].mean()
per_diem = pd.DataFrame(per_diem)

# Extract unique city names associated with each zip code
unique_cities = final_dataframe[['Zip Code', 'City']].drop_duplicates()

# If there are multiple cities per zip code, take the first one
city_by_zip = unique_cities.groupby('Zip Code')['City'].first()

# Add the City column to the per_diem DataFrame
per_diem['isStandard'] = per_diem.index.map(city_by_zip)

per_diem
```

Zip Code	Rate	isStandard
10002	256.666667	New York City
10003	256.666667	New York City
10009	256.666667	New York City
10016	256.666667	New York City
10023	256.666667	New York City
...	...	...
98661	164.500000	Vancouver
98682	164.500000	Vancouver
99208	127.000000	Spokane
99301	118.000000	Richland / Pasco
99336	118.000000	Richland / Pasco

978 rows × 2 columns

Zip Codes and Averaged Meal Rates

```
meals = final_dataframe.groupby('Zip Code')['Meals'].mean()

meals = pd.DataFrame(meals)

meals
```

Zip Code	Meals
10002	79.0
10003	79.0
10009	79.0
10016	79.0
10023	79.0
...	...
98661	74.0
98682	74.0
99208	74.0
99301	69.0
99336	69.0

978 rows × 1 columns

Import House Prices by Zip Code Nationwide

```
df_house_prices=pd.read_csv("zillow.csv")

df_house_prices['Zip Code'] = df_house_prices['RegionName'].astype(str).str.zfill(5)

df_house_prices
```

	RegionID	SizeRank	RegionName	RegionType	StateName	State	City	Metro	CountyName	2000-01-31	...	2024-05-31	2024-06-30	2024-07-31	2024-08-31	2024-09-30	2024-10-3
0	91982	1	77494	zip	TX	TX	Katy	Houston-The Woodlands-Sugar Land, TX	Fort Bend County	209050.476760	...	495075.413843	495380.402566	495002.983332	495408.561941	496096.305465	497215.16189
1	61148	2	8701	zip	NJ	NJ	Lakewood	New York-Newark-Jersey City, NY-NJ-PA	Ocean County	129618.780605	...	574111.688523	579228.585853	583825.798950	588765.877710	594583.485735	599788.27507
2	91940	3	77449	zip	TX	TX	Katy	Houston-The Woodlands-Sugar Land, TX	Harris County	103655.528341	...	282147.022097	282107.280779	281872.890421	281691.186379	281502.991848	281086.41027
3	62080	4	11368	zip	NY	NY	New York	New York-Newark-Jersey City, NY-NJ-PA	Queens County	146323.411563	...	452805.954270	453500.452732	452997.379756	452371.998659	453320.495788	453075.34377
4	91733	5	77084	zip	TX	TX	Houston	Houston-The Woodlands-Sugar Land, TX	Harris County	102106.861831	...	274613.196678	274446.918170	274155.370186	273883.459171	273631.254558	273125.76564
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..
26318	63527	39992	14441	zip	NY	NY	Dresden	Rochester, NY	Yates County	95200.506993	...	212859.345739	217705.207088	220747.040461	223033.160778	225156.691276	227314.26863
26319	99927	39992	98628	zip	WA	WA	Klickitat	NaN	Klickitat County	NaN	...	183691.428602	184378.493108	182270.098233	179856.661697	177621.288376	176436.41050
26320	80861	39992	52163	zip	IA	IA	Protivin	NaN	Howard County	NaN	...	110531.058676	112546.786601	114074.312787	114923.348472	114988.321750	115144.24507
26321	93941	39992	82515	zip	WY	WY	Hudson	Riverton, WY	Fremont County	NaN	...	173795.269429	174129.180796	173601.285437	173438.172525	173265.888713	173444.63429
26322	80190	39992	50160	zip	IA	IA	Martensdale	Des Moines-West Des Moines, IA	Warren County	NaN	...	197239.571536	197434.125142	197622.447782	197875.013913	198489.179930	199001.79533

26323 rows × 311 columns

Merge Zip Codes, Census Data, Per Diem Data, and House Price Data

```
# merge house prices with per diem rates on the zip code
diem_and_house_price = per_diem.merge(right=df_house_prices[["2020-06-30", "Zip Code"]], left_on="Zip Code", right_on="Zip Code")

# rename columns
diem_and_house_price.columns = ["Zip Code", "Per Diem Daily Rate", "isStandard", "House Price"]

# merge and add additional info from U.S. Census Bureau for each zip code
diem_and_house_and_info = diem_and_house_price.merge(right=df_zips_and_states[["Zip Code", "City", "State", "Population Size", "Population Density", "County FIPS", "County Name"]], left_on="Zip Code",

# rename columns
diem_and_house_and_info.columns = ["Zip Code", "Per Diem Daily Rate", "Rate Zone", "House Price", "City", "State", "Population Size", "Population Density", "County FIPS", "County Name"]

# create column to track if the rate is designated as a "Standard Rate" by the GSA
diem_and_house_and_info["isStandard"] = diem_and_house_and_info["Rate Zone"] == "Standard Rate"

diem_and_house_and_info.to_csv("diem_and_house_and_info.csv", index=False)
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-8-5dd9b6171b88> in <cell line: 0>()
      1 # merge house prices with per diem rates on the zip code
----> 2 diem_and_house_price = per_diem.merge(right=df_house_prices[["2020-06-30", "Zip Code"]], left_on="Zip Code", right_on="Zip Code")
      3 
      4 # rename columns
      5 diem_and_house_price.columns = ["Zip Code", "Per Diem Daily Rate", "isStandard", "House Price"]

NameError: name 'per_diem' is not defined
```

Load in precollected CSV with 1000 zip codes

```
import pandas as pd

diem_and_house_and_info = pd.read_csv("https://raw.githubusercontent.com/AlexanderCalafiura/DataScience112FinalProject/refs/heads/main/AC_ML_dataset_1000.csv")
diem_and_house_and_info
```

	Zip Code	Per Diem Daily Rate	Rate Zone	House Price	City	State	Population Size	Population Density	County FIPS	County Name	isStandard	Cluster	Price_to_PerDiem_Ratio
0	10002	256.666667	New York City	1.007951e+06	New York	NY	75517	35458.5	36061	New York	False	2	3927.083523
1	10003	256.666667	New York City	1.396697e+06	New York	NY	53825	36357.3	36061	New York	False	2	5441.678039
2	10009	256.666667	New York City	8.344787e+05	New York	NY	58341	36524.7	36061	New York	False	2	3251.215762
3	10016	256.666667	New York City	9.288574e+05	New York	NY	54297	38131.6	36061	New York	False	2	3618.924930
4	10023	256.666667	New York City	1.337869e+06	New York	NY	67468	26875.1	36061	New York	False	2	5212.475343
...	...	...	...	...	...	...	...	...	...	...	...	...	...
931	98661	164.500000	Vancouver	3.321296e+05	Vancouver	WA	52027	1842.8	53011	Clark	False	0	2019.024970
932	98682	164.500000	Vancouver	3.498594e+05	Vancouver	WA	67297	911.2	53011	Clark	False	0	2126.804651
933	99208	127.000000	Spokane	3.130112e+05	Spokane	WA	58834	466.1	53063	Spokane	False	0	2464.654825
934	99301	118.000000	Richland / Pasco	2.813411e+05	Pasco	WA	86467	68.7	53021	Franklin	False	1	2384.246692
935	99336	118.000000	Richland / Pasco	2.628567e+05	Kennewick	WA	51180	1475.2	53005	Benton	False	0	2227.599373

936 rows × 13 columns

Load in precollected CSV with all 26000 zip codes

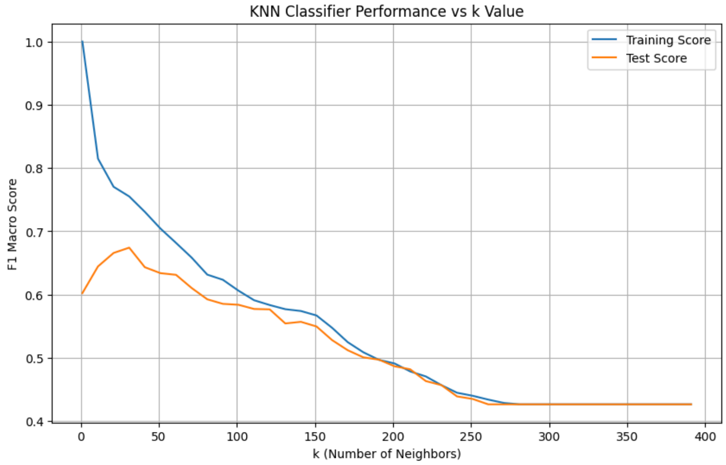
```
import pandas as pd

diem_and_house_and_info = pd.read_csv("https://raw.githubusercontent.com/AlexanderCalafiura/DataScience112FinalProject/refs/heads/main/AC_ML_dataset_26000.csv")
diem_and_house_and_info
```

	Zip Code	Per Diem Daily Rate	Rate Zone	House Price	City	State	Population Size	Population Density	County FIPS	County Name	isStandard
0	1001	122.0	Springfield	219508.964752	Agawam	MA	16136	551.7	25013	Hampden	False
1	1002	146.0	Northampton	339812.737345	Amherst	MA	24726	179.3	25015	Hampshire	False
2	1005	130.0	Worcester	244509.442046	Barre	MA	4786	42.8	25027	Worcester	False
3	1007	146.0	Northampton	295540.622491	Belchertown	MA	15406	108.4	25015	Hampshire	False
4	1008	122.0	Springfield	232702.865612	Blandford	MA	1324	8.4	25013	Hampden	False
...	...	...	...	...	...	...	...	...	...	...	...
26176	99360	107.0	Standard Rate	348803.942100	Touchet	WA	1299	3.1	53071	Walla Walla	True
26177	99361	107.0	Standard Rate	249922.063928	Waitsburg	WA	1800	3.1	53071	Walla Walla	True
26178	99362	107.0	Standard Rate	270400.509440	Walla Walla	WA	42794	54.5	53071	Walla Walla	True
26179	99402	107.0	Standard Rate	283674.534416	Asotin	WA	1628	1.9	53003	Asotin	True
26180	99403	107.0	Standard Rate	254236.175503	Clarkston	WA	20483	55.1	53003	Asotin	True

26181 rows × 11 columns

K Neighbors Classifer

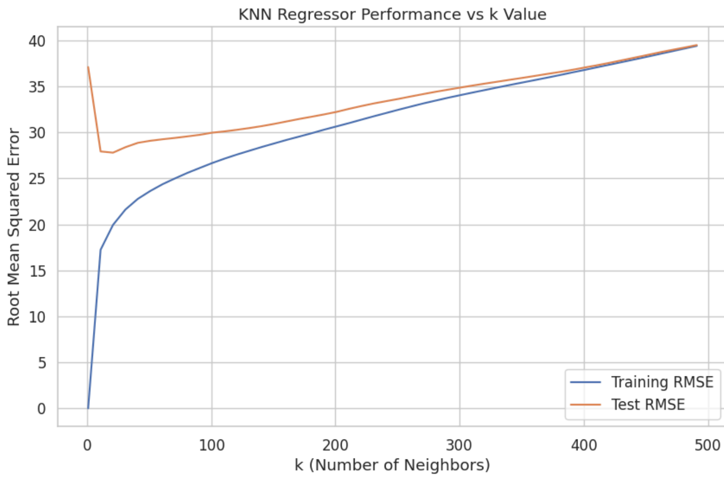
```
import matplotlib.pyplot as plt
from sklearn.model_selection import GridSearchCV
from sklearn.pipeline import make_pipeline
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import make_column_transformer
from sklearn.impute import SimpleImputer
from sklearn.metrics import classification_report
import pandas as pd

df = diem_and_house_and_info

X = df[["House Price", "Population Size", "Population Density", "County Name"]]
y = df["isStandard"]

num_cols = ["House Price", "Population Size", "Population Density"]
cat_cols = ["County Name"]

# Add imputation steps for both numerical and categorical columns
col_transformer = make_column_transformer(
    (make_pipeline(SimpleImputer(strategy="median"), StandardScaler()), num_cols),
    (make_pipeline(SimpleImputer(strategy="most_frequent"), OneHotEncoder(handle_unknown="ignore")), cat_cols),
    remainder="drop"
)

pipeline = make_pipeline(col_transformer, KNeighborsClassifier())

grid_cv = GridSearchCV(
    estimator=pipeline,
    param_grid={"kneighborsclassifier__n_neighbors": range(1, 400, 10)},
    scoring="f1_macro",
    cv=5,
    return_train_score=True
)

grid_cv.fit(X, y)

results = pd.DataFrame(grid_cv.cv_results_)

plt.figure(figsize=(10, 6))
plt.plot(results["param_kneighborsclassifier__n_neighbors"], results["mean_train_score"], label="Training Score")
plt.plot(results["param_kneighborsclassifier__n_neighbors"], results["mean_test_score"], label="Test Score")
plt.xlabel("k (Number of Neighbors)")
plt.ylabel("F1 Macro Score")
plt.title("KNN Classifier Performance vs k Value")
plt.legend()
plt.grid(True)
plt.show()

# Get the best model and refit on all data
best_model = grid_cv.best_estimator_

# Make predictions on the same data to get the classification report
y_pred = best_model.predict(X)

# Generate and print classification report
report = classification_report(y, y_pred)
print("\nClassification Report:")
print(report)
print("Best parameters:", grid_cv.best_params_)
print("Best F1 macro score:", grid_cv.best_score_)
```




```
Classification Report:
              precision    recall  f1-score   support

       False       0.85      0.93      0.89       696
        True       0.72      0.53      0.61       240

    accuracy                           0.83       936
   macro avg       0.79      0.73      0.75       936
weighted avg       0.82      0.83      0.82       936

Best parameters: {'kneighborsclassifier__n_neighbors': 31}
Best F1 macro score: 0.6741562538013064
```

K Neighbors Regressor

```
import matplotlib.pyplot as plt
from sklearn.model_selection import GridSearchCV
from sklearn.pipeline import make_pipeline
from sklearn.neighbors import KNeighborsRegressor
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import make_column_transformer
from sklearn.impute import SimpleImputer
from sklearn.metrics import mean_squared_error, r2_score
import pandas as pd
import numpy as np

df = diem_and_house_and_info

X = df[["House Price", "Population Size", "Population Density", "County Name", "isStandard"]]
y = df["Per Diem Daily Rate"]

num_cols = ["House Price", "Population Size", "Population Density"]
cat_cols = ["County Name", "isStandard"]

# Add imputation steps for both numerical and categorical columns
col_transformer = make_column_transformer(
    (make_pipeline(SimpleImputer(strategy="median"), StandardScaler()), num_cols),
    (make_pipeline(SimpleImputer(strategy="most_frequent"), OneHotEncoder(handle_unknown="ignore")), cat_cols),
    remainder="drop"
)

pipeline = make_pipeline(col_transformer, KNeighborsRegressor())

grid_cv = GridSearchCV(
    estimator=pipeline,
    param_grid={"kneighborsregressor__n_neighbors": range(1, 500, 10)},
    scoring="neg_root_mean_squared_error",
    cv=5,
    return_train_score=True
)

grid_cv.fit(X, y)

results = pd.DataFrame(grid_cv.cv_results_)

plt.figure(figsize=(10, 6))
plt.plot(results["param_kneighborsregressor__n_neighbors"], -results["mean_train_score"], label="Training RMSE")
plt.plot(results["param_kneighborsregressor__n_neighbors"], -results["mean_test_score"], label="Test RMSE")
plt.xlabel("k (Number of Neighbors)")
plt.ylabel("Root Mean Squared Error")
plt.title("KNN Regressor Performance vs k Value")
plt.legend()
plt.grid(True)
plt.show()

# Get the best model and refit on all data
best_model = grid_cv.best_estimator_

# Make predictions on the same data to evaluate regression performance
y_pred = best_model.predict(X)

# Generate and print regression metrics
rmse = np.sqrt(mean_squared_error(y, y_pred))
r2 = r2_score(y, y_pred)
print("\nRegression Metrics:")
print(f"RMSE: {rmse:.4f}")
print(f"R² Score: {r2:.4f}")
print("Best parameters:", grid_cv.best_params_)
print("Best neg RMSE score:", grid_cv.best_score_)
print("Best RMSE score:", -grid_cv.best_score_)
```



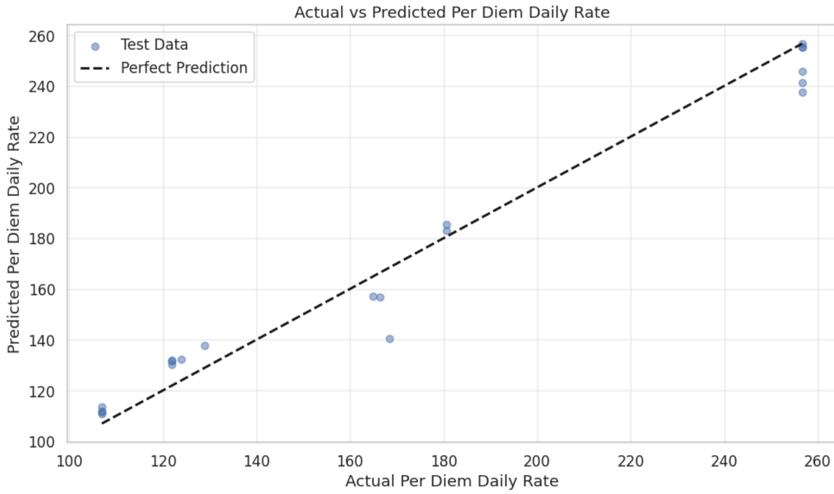

```
Regression Metrics:
RMSE: 19.7652
R² Score: 0.8203
Best parameters: {'kneighborsregressor__n_neighbors': 21}
Best neg RMSE score: -27.796335882362815
Best RMSE score: 27.796335882362815
```

Random Forest Regressor

```
import matplotlib.pyplot as plt
from sklearn.model_selection import GridSearchCV, train_test_split
from sklearn.pipeline import make_pipeline
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import StandardScaler, OneHotEncoder
from sklearn.compose import make_column_transformer
from sklearn.impute import SimpleImputer
from sklearn.metrics import mean_squared_error, r2_score
import pandas as pd
import numpy as np

df = diem_and_house_and_info

X = df[["House Price", "Population Size", "Population Density", "County Name", "isStandard"]]
y = df["Per Diem Daily Rate"]

# Split data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2, random_state=42)

num_cols = ["House Price", "Population Size", "Population Density"]
cat_cols = ["County Name", "isStandard"]

# Add imputation steps for both numerical and categorical columns
col_transformer = make_column_transformer(
    (make_pipeline(SimpleImputer(strategy="median"), StandardScaler()), num_cols),
    (make_pipeline(SimpleImputer(strategy="most_frequent"), OneHotEncoder(handle_unknown="ignore")), cat_cols),
    remainder="drop"
)

pipeline = make_pipeline(col_transformer, RandomForestRegressor(random_state=42))

param_grid = {
    "randomforestregressor__n_estimators": [20, 100, 200],
    "randomforestregressor__max_features": ["sqrt", "log2"],
    "randomforestregressor__min_samples_split": [2, 5, 10],
    "randomforestregressor__max_depth": [None, 20, 50]
}

grid_cv = GridSearchCV(
    estimator=pipeline,
    param_grid=param_grid,
    scoring="neg_root_mean_squared_error",
    cv=5,
    return_train_score=True
)

# Fit on training data only
grid_cv.fit(X_train, y_train)

# Get the best model
best_model = grid_cv.best_estimator_

# Make predictions on test data
y_train_pred = best_model.predict(X_train)
y_test_pred = best_model.predict(X_test)

# Calculate metrics on both training and test sets
train_rmse = np.sqrt(mean_squared_error(y_train, y_train_pred))
test_rmse = np.sqrt(mean_squared_error(y_test, y_test_pred))
train_r2 = r2_score(y_train, y_train_pred)
test_r2 = r2_score(y_test, y_test_pred)

print("\nRegression Metrics:")
print(f"Training RMSE: {train_rmse:.4f}")
print(f"Test RMSE: {test_rmse:.4f}")
print(f"Training R² Score: {train_r2:.4f}")
print(f"Test R² Score: {test_r2:.4f}")
print("Best parameters:", grid_cv.best_params_)
print("CV Best RMSE score:", -grid_cv.best_score_)

# Create a scatterplot of actual vs predicted rates
plt.figure(figsize=(10, 6))
plt.scatter(y_test, y_test_pred, alpha=0.5, label='Test Data')
plt.plot([y_test.min(), y_test.max()], [y_test.min(), y_test.max()], 'k--', lw=2, label='Perfect Prediction')
plt.xlabel('Actual Per Diem Daily Rate')
plt.ylabel('Predicted Per Diem Daily Rate')
plt.title('Actual vs Predicted Per Diem Daily Rate')
plt.legend()
```

```
plt.grid(True, alpha=0.3)
plt.tight_layout()
plt.show()
```

```
Regression Metrics:
Training RMSE: 7.9703
Test RMSE: 10.4568
Training R² Score: 0.9782
Test R² Score: 0.9695
Best parameters: {'randomforestregressor__max_depth': 20, 'randomforestregressor__max_features': 'sqrt', 'randomforestregressor__min_samples_split': 2, 'randomforestregressor__n_estimators': 100}
CV Best RMSE score: 20.599490350298964
```

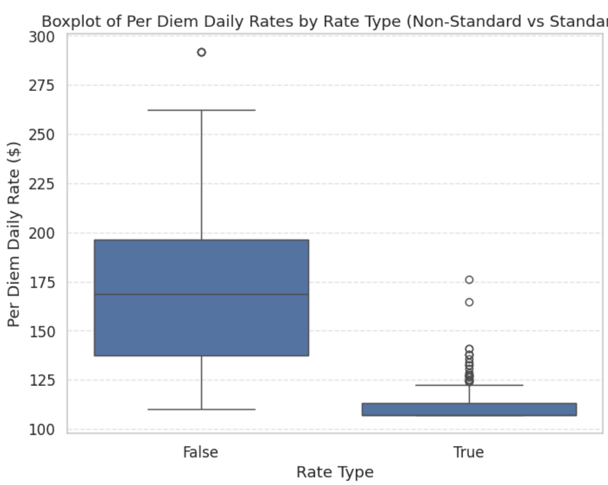


Data Analysis

Plot Experimentation

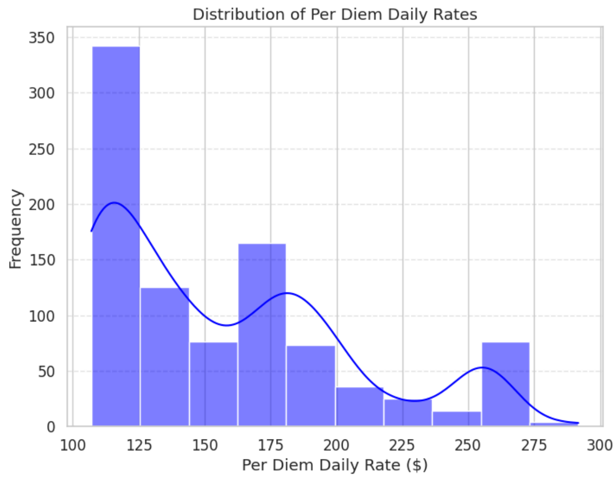
Box plot to help us visualize the spread of data: where are the standard rates concentrated? Non standard rates?

```
import matplotlib.pyplot as plt
import seaborn as sns

# create the boxplot
plt.figure(figsize=(8, 6))
sns.boxplot(data=df, x="isStandard", y="Per Diem Daily Rate")
plt.title("Boxplot of Per Diem Daily Rates by Rate Type (Non-Standard vs Standard)")
plt.xlabel("Rate Type")
plt.ylabel("Per Diem Daily Rate ($)")
plt.grid(axis="y", linestyle="--", alpha=0.5)
plt.show()
```



Histogram to help us visualize the spread of per-diem rates. Where do we see standard per diem rates concentrated? What per diem rates are in the highest range?

```
# create the histrogram
plt.figure(figsize=(8, 6))
sns.histplot(df["Per Diem Daily Rate"], bins=10, kde=True, color="blue")
plt.title("Distribution of Per Diem Daily Rates")
plt.xlabel("Per Diem Daily Rate ($)")
plt.ylabel("Frequency")
plt.grid(axis="y", linestyle="--", alpha=0.5)
plt.show()
```



Check the number of standard and non-standard rates.

```
# count the number of rows where isStandard is True and False
is_standard_counts = df["isStandard"].value_counts()
print("Standard rate:")
print(is_standard_counts)
```

```
Standard rate:
isStandard
False    696
True     240
Name: count, dtype: int64
```

Check summary statistics for all per diem rates.

```
# Calculate summary statistics for Per Diem Daily Rate
per_diem_summary = df["Per Diem Daily Rate"].describe()
print("\nSummary Statistics for Per Diem Daily Rate:")
print(per_diem_summary)
```

```
Summary Statistics for Per Diem Daily Rate:
count    936.000000
mean     157.332591
std       46.645857
min      107.000000
25%      118.000000
50%      144.666667
75%      180.666667
max      291.750000
Name: Per Diem Daily Rate, dtype: float64
```

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler

df = diem_and_house_and_info
df = df.dropna()

plt.figure(figsize=(15, 10))

# 1. Per Diem Rate vs House Price
plt.subplot(2, 3, 1)
plt.scatter(df['Per Diem Daily Rate'], df['House Price'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Per Diem Rate vs House Price')
plt.xlabel('Per Diem Daily Rate ($)')
plt.ylabel('House Price ($)')
plt.grid(True)

# 2. Per Diem Rate vs Population Density
plt.subplot(2, 3, 2)
plt.scatter(df['Per Diem Daily Rate'], df['Population Density'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Per Diem Rate vs Population Density')
plt.xlabel('Per Diem Daily Rate ($)')
plt.ylabel('Population Density')
plt.grid(True)

# 3. House Price vs Population Size
plt.subplot(2, 3, 3)
plt.scatter(df['House Price'], df['Population Size'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('House Price vs Population Size')
plt.xlabel('House Price ($)')
plt.ylabel('Population Size')
plt.grid(True)

# 4. Log-transformed House Price vs Log-transformed Population Density
plt.subplot(2, 3, 4)
plt.scatter(np.log1p(df['House Price']), np.log1p(df['Population Density']), alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Log House Price vs Log Population Density')
plt.xlabel('Log House Price')
plt.ylabel('Log Population Density')
plt.grid(True)

# 5. Population Size vs Population Density
plt.subplot(2, 3, 5)
plt.scatter(df['Population Size'], df['Population Density'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Population Size vs Population Density')
plt.xlabel('Population Size')
plt.ylabel('Population Density')
plt.grid(True)
```

```
# 6. House Price to Per Diem Ratio vs Population Density
df['Price_to_Diem_Ratio'] = df['House Price'] / df['Per Diem Daily Rate']
plt.subplot(2, 3, 6)
plt.scatter(df['Price_to_Diem_Ratio'], df['Population Density'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Price-to-Diem Ratio vs Population Density')
plt.xlabel('House Price / Per Diem Rate')
plt.ylabel('Population Density')
plt.grid(True)

plt.tight_layout()
plt.savefig('scatterplots_set1.png')
plt.close()

# Create a second set of plots
plt.figure(figsize=(15, 10))

# 7. Per Diem Rate vs Population Size
plt.subplot(2, 3, 1)
plt.scatter(df['Per Diem Daily Rate'], df['Population Size'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Per Diem Rate vs Population Size')
plt.xlabel('Per Diem Daily Rate ($)')
plt.ylabel('Population Size')
plt.grid(True)

# 8. Create Urban Index (Pop Density * Pop Size / 10000)
df['Urban_Index'] = df['Population Density'] * df['Population Size'] / 10000
plt.subplot(2, 3, 2)
plt.scatter(df['Urban_Index'], df['Per Diem Daily Rate'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Urban Index vs Per Diem Rate')
plt.xlabel('Urban Index')
plt.ylabel('Per Diem Daily Rate ($)')
plt.grid(True)

# 9. House Price vs Per Diem Rate by State
plt.subplot(2, 3, 3)
for state in df['State'].unique()[:5]:  # Limit to 5 states for clarity
    state_data = df[df['State'] == state]
    plt.scatter(state_data['Per Diem Daily Rate'], state_data['House Price'], alpha=0.7, label=state)
plt.title('House Price vs Per Diem Rate by State')
plt.xlabel('Per Diem Daily Rate ($)')
plt.ylabel('House Price ($)')
plt.legend()
plt.grid(True)

# 10. Standardized House Price vs Standardized Per Diem Rate
scaler = StandardScaler()
df_scaled = pd.DataFrame(scaler.fit_transform(df[['House Price', 'Per Diem Daily Rate']]),
                         columns=['Standardized House Price', 'Standardized Per Diem Daily Rate'])
df_scaled['isStandard'] = df['isStandard'].values

plt.subplot(2, 3, 4)
plt.scatter(df_scaled['Standardized Per Diem Daily Rate'], df_scaled['Standardized House Price'],
            alpha=0.5, c=df_scaled['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Standardized House Price vs Standardized Per Diem Rate')
plt.xlabel('Standardized Per Diem Daily Rate')
plt.ylabel('Standardized House Price')
plt.grid(True)

# 11. House Price vs Population Density by Standard Rate
plt.subplot(2, 3, 5)
standard_rate = df[df['isStandard'] == True]
non_standard_rate = df[df['isStandard'] == False]
plt.scatter(standard_rate['Population Density'], standard_rate['House Price'], alpha=0.5, label='Standard Rate', color='green')
plt.scatter(non_standard_rate['Population Density'], non_standard_rate['House Price'], alpha=0.5, label='Non-Standard Rate', color='blue')
plt.title('House Price vs Population Density by Rate Type')
plt.xlabel('Population Density')
plt.ylabel('House Price ($)')
plt.legend()
plt.grid(True)

# 12. Per Diem Rate vs State (boxplot)
plt.subplot(2, 3, 6)
top_states = df.groupby('State').size().nlargest(10).index
state_data = df[df['State'].isin(top_states)]
sns.boxplot(x='State', y='Per Diem Daily Rate', data=state_data)
plt.title('Per Diem Rate Distribution by State')
plt.xlabel('State')
plt.ylabel('Per Diem Daily Rate ($)')
plt.xticks(rotation=45)

plt.tight_layout()
plt.savefig('scatterplots_set2.png')
plt.close()

# Create a third set of plots
plt.figure(figsize=(15, 10))

# 13. Per Diem Rate vs isStandard (boxplot)
plt.subplot(2, 2, 1)
sns.boxplot(x='isStandard', y='Per Diem Daily Rate', data=df)
plt.title('Per Diem Rate by Standard Status')
plt.xlabel('Is Standard Rate')
plt.ylabel('Per Diem Daily Rate ($)')
plt.grid(True)

# 14. House Price vs County FIPS (for top counties)
top_counties = df.groupby('County Name').size().nlargest(10).index
county_data = df[df['County Name'].isin(top_counties)]
plt.subplot(2, 2, 2)
for county in top_counties:
    county_subset = county_data[county_data['County Name'] == county]
    plt.scatter(county_subset['Per Diem Daily Rate'], county_subset['House Price'], alpha=0.7, label=county)
plt.title('House Price vs Per Diem Rate by County')
plt.xlabel('Per Diem Daily Rate ($)')
plt.ylabel('House Price ($)')
plt.legend(loc='upper left', bbox_to_anchor=(1, 1))
plt.grid(True)

# 15. Create Cost of Living Index (House Price / National Median)
national_median = df['House Price'].median()
df['Cost_of_Living_Index'] = df['House Price'] / national_median
plt.subplot(2, 2, 3)
plt.scatter(df['Cost_of_Living_Index'], df['Per Diem Daily Rate'], alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}))
plt.title('Cost of Living Index vs Per Diem Rate')
plt.xlabel('Cost of Living Index')
plt.ylabel('Per Diem Daily Rate ($)')
plt.grid(True)

# 16. Per Diem Rate vs House Price with Population Size as marker size
```

```
plt.subplot(2, 2, 4)
plt.scatter(df['Per Diem Daily Rate'], df['House Price'],
            alpha=0.5, c=df['isStandard'].map({True: 'green', False: 'blue'}),
            s=df['Population Size']/1000)  # Scale down for visibility
plt.title('Per Diem Rate vs House Price (Size = Population)')
plt.xlabel('Per Diem Daily Rate ($)')

plt.ylabel('House Price ($)')
plt.grid(True)

plt.tight_layout()
plt.savefig('scatterplots_set3.png')
plt.close()
```

```
<ipython-input-141-9ee18c86c6a1>:52: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

<ipython-input-141-9ee18c86c6a1>:76: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

<ipython-input-141-9ee18c86c6a1>:161: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```

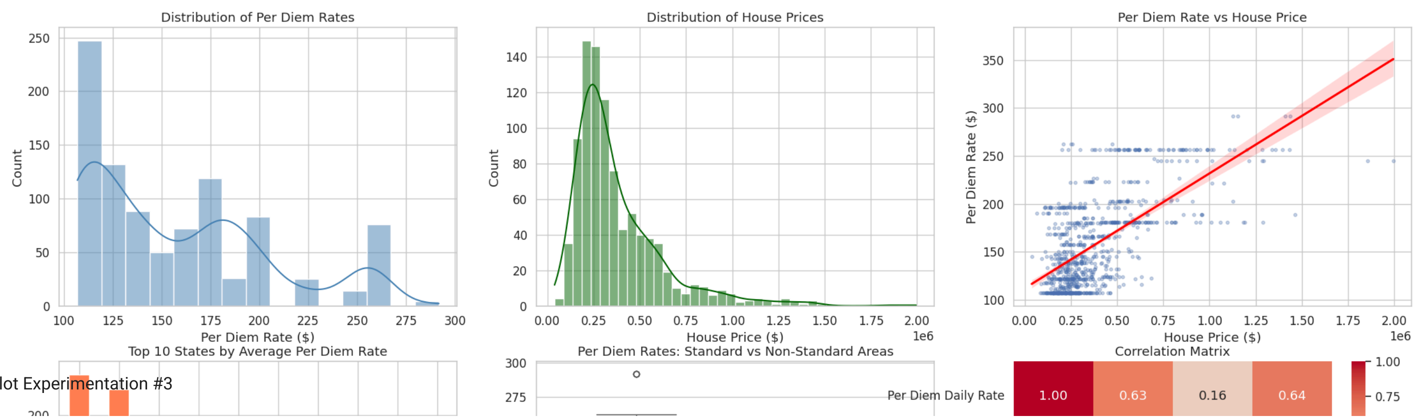
Plot Experimentation #2

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from scipy import stats
import plotly.express as px
import plotly.graph_objects as go
from matplotlib.colors import LinearSegmentedColormap

df = diem_and_house_and_info

plt.style.use('ggplot')
sns.set(style="whitegrid", font_scale=1.1)
plt.rcParams['figure.figsize'] = [12, 8]
plt.rcParams['figure.dpi'] = 100

fig = plt.figure(figsize=(25, 30))

# 1. Per Diem Rate Distribution
ax1 = fig.add_subplot(5, 3, 1)
sns.histplot(df['Per Diem Daily Rate'], kde=True, ax=ax1, color='steelblue')
ax1.set_title('Distribution of Per Diem Rates')
ax1.set_xlabel('Per Diem Rate ($)')
ax1.set_ylabel('Count')

# 2. House Price Distribution
ax2 = fig.add_subplot(5, 3, 2)
sns.histplot(df['House Price'], kde=True, ax=ax2, color='darkgreen')
ax2.set_title('Distribution of House Prices')
ax2.set_xlabel('House Price ($)')
ax2.set_ylabel('Count')

# 3. Scatter plot: Per Diem vs House Price
ax3 = fig.add_subplot(5, 3, 3)
sns.regplot(x='House Price', y='Per Diem Daily Rate', data=df, scatter_kws={'alpha':0.3, 's':10},
            line_kws={'color':'red'}, ax=ax3)
ax3.set_title('Per Diem Rate vs House Price')
ax3.set_xlabel('House Price ($)')
ax3.set_ylabel('Per Diem Rate ($)')

# 4. Top 10 states by average Per Diem Rate
ax4 = fig.add_subplot(5, 3, 4)
state_avg = df.groupby('State')['Per Diem Daily Rate'].mean().sort_values(ascending=False).head(10)
state_avg.plot(kind='bar', ax=ax4, color='coral')
ax4.set_title('Top 10 States by Average Per Diem Rate')
ax4.set_xlabel('State')
ax4.set_ylabel('Average Per Diem Rate ($)')
plt.setp(ax4.xaxis.get_majorticklabels(), rotation=45)

# 5. Box plot: Per Diem by Standard vs Non-Standard
ax5 = fig.add_subplot(5, 3, 5)
sns.boxplot(x='isStandard', y='Per Diem Daily Rate', data=df, ax=ax5, palette='Set2')
ax5.set_title('Per Diem Rates: Standard vs Non-Standard Areas')
ax5.set_xlabel('Is Standard Rate Area')
ax5.set_ylabel('Per Diem Rate ($)')

# 6. Correlation Heatmap
ax6 = fig.add_subplot(5, 3, 6)
numeric_cols = ['Per Diem Daily Rate', 'House Price', 'Population Size', 'Population Density']
corr = df[numeric_cols].corr()
sns.heatmap(corr, annot=True, cmap='coolwarm', vmin=-1, vmax=1, ax=ax6, fmt='.2f')
ax6.set_title('Correlation Matrix')

# 7. Population Size vs Per Diem Rate
ax7 = fig.add_subplot(5, 3, 7)
sns.scatterplot(x='Population Size', y='Per Diem Daily Rate', data=df, alpha=0.5, ax=ax7, hue='isStandard', palette='Set1')
ax7.set_title('Population Size vs Per Diem Rate')
ax7.set_xlabel('Population Size')
ax7.set_ylabel('Per Diem Rate ($)')
ax7.set_xscale('log')  # Log scale for better visualization

# 8. Population Density vs Per Diem Rate
ax8 = fig.add_subplot(5, 3, 8)
scatter = sns.scatterplot(
    x='Population Density',
    y='Per Diem Daily Rate',
    data=df,
```

```
    alpha=0.5,
    ax=ax8,
    hue='isStandard',
    palette='Set1',
    hue_order=[True, False]  # Adjust based on your actual values
)
ax8.set_title('Population Density vs Per Diem Rate')
ax8.set_xlabel('Population Density (people per sq mile)')
ax8.set_ylabel('Per Diem Rate ($)')
ax8.set_xscale('log')  # Log scale for better visualization

# Create custom legend with explicit mapping
custom_labels = {"True": "Standard Rate", "False": "Non-Standard Rate"}  # Adjust based on your values
handles, labels = ax8.get_legend_handles_labels()
ax8.legend(handles, [custom_labels[label] for label in labels])

# 9. Per Diem Rate by Rate Zone (Top 10)
ax9 = fig.add_subplot(5, 3, 9)
zone_avg = df.groupby('Rate Zone')['Per Diem Daily Rate'].mean().sort_values(ascending=False).head(10)
zone_avg.plot(kind='bar', ax=ax9, color='purple')
ax9.set_title('Top 10 Rate Zones by Average Per Diem')
ax9.set_xlabel('Rate Zone')
ax9.set_ylabel('Average Per Diem Rate ($)')
plt.setp(ax9.xaxis.get_majorticklabels(), rotation=45)

# 10. House Price by Rate Zone (Top 10)
ax10 = fig.add_subplot(5, 3, 10)
zone_house = df.groupby('Rate Zone')['House Price'].mean().sort_values(ascending=False).head(10)
zone_house.plot(kind='bar', ax=ax10, color='teal')
ax10.set_title('Top 10 Rate Zones by Average House Price')
ax10.set_xlabel('Rate Zone')
ax10.set_ylabel('Average House Price ($)')
plt.setp(ax10.xaxis.get_majorticklabels(), rotation=45)

# 11. K-means clustering
ax11 = fig.add_subplot(5, 3, 11)
# Select features for clustering
features = ['Per Diem Daily Rate', 'House Price', 'Population Size', 'Population Density']
X = df[features].copy()
# Handle missing values
X = X.fillna(X.mean())
# Standardize the data
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)
# Apply K-means clustering
kmeans = KMeans(n_clusters=4, random_state=42)
df['Cluster'] = kmeans.fit_predict(X_scaled)
# Visualize clusters
sns.scatterplot(x='House Price', y='Per Diem Daily Rate', hue='Cluster', data=df, palette='viridis',
                alpha=0.6, s=50, ax=ax11)
ax11.set_title('K-means Clustering of ZIP Codes')
ax11.set_xlabel('House Price ($)')
ax11.set_ylabel('Per Diem Rate ($)')

# 12. Per Diem Rate Distribution by State (Violin Plot)
ax12 = fig.add_subplot(5, 3, 12)
# Select top 5 states by count
top_states = df['State'].value_counts().head(5).index.tolist()
state_subset = df[df['State'].isin(top_states)]
sns.violinplot(x='State', y='Per Diem Daily Rate', data=state_subset, ax=ax12, palette='pastel')
ax12.set_title('Per Diem Rate Distribution by State (Top 5)')
ax12.set_xlabel('State')
ax12.set_ylabel('Per Diem Rate ($)')

# 13. House Price to Per Diem Ratio by State
ax13 = fig.add_subplot(5, 3, 13)
# Calculate ratio
df['Price_to_PerDiem_Ratio'] = df['House Price'] / df['Per Diem Daily Rate']
ratio_by_state = df.groupby('State')['Price_to_PerDiem_Ratio'].mean().sort_values(ascending=False).head(10)
ratio_by_state.plot(kind='bar', ax=ax13, color='darkred')
ax13.set_title('Top 10 States by House Price to Per Diem Ratio')
ax13.set_xlabel('State')
ax13.set_ylabel('Average Ratio (House Price / Per Diem)')
plt.setp(ax13.xaxis.get_majorticklabels(), rotation=45)

# 14. Joint Distribution Plot
ax14 = fig.add_subplot(5, 3, 14)
# Create a custom colormap
cmap = LinearSegmentedColormap.from_list('custom_cmap', ['#f7fbff', '#08306b'])
# Create a 2D histogram
h = ax14.hist2d(df['House Price'], df['Per Diem Daily Rate'], bins=50, cmap=cmap)
fig.colorbar(h[3], ax=ax14, label='Count')
ax14.set_title('Joint Distribution of House Prices and Per Diem Rates')
ax14.set_xlabel('House Price ($)')
ax14.set_ylabel('Per Diem Rate ($)')

# 15. Per Diem Rate by Population Size Categories
ax15 = fig.add_subplot(5, 3, 15)
# Create population size categories
df['Population_Category'] = pd.cut(df['Population Size'],
                                  bins=[0, 1000, 5000, 10000, 50000, 100000],
                                  labels=['Very Small', 'Small', 'Medium', 'Large', 'Very Large'])
sns.boxplot(x='Population_Category', y='Per Diem Daily Rate', data=df, ax=ax15, palette='Blues')
ax15.set_title('Per Diem Rates by Population Size Category')
ax15.set_xlabel('Population Size Category')
ax15.set_ylabel('Per Diem Rate ($)')

# Adjust layout
plt.tight_layout(pad=3.0)
plt.savefig('per_diem_analysis.png', dpi=300, bbox_inches='tight')
plt.show()

# Additional interactive visualizations with Plotly
# Create a choropleth map of average per diem rates by state
state_data = df.groupby('State').agg({
    'Per Diem Daily Rate': 'mean',
    'House Price': 'mean',
    'Population Size': 'sum'
}).reset_index()

fig_map = px.choropleth(state_data,
                      locations='State',
                      locationmode='USA-states',
                      color='Per Diem Daily Rate',
                      scope='usa',
                      color_continuous_scale='Viridis',
                      title='Average Per Diem Rate by State')
fig_map.show()
```

```
# Create a bubble chart of per diem rates, house prices, and population
fig_bubble = px.scatter(state_data,
                       x='House Price',
                       y='Per Diem Daily Rate',
                       size='Population Size',
                       color='State',
                       hover_name='State',
                       size_max=60,
                       title='Per Diem Rate vs House Price by State (Bubble Size = Population)')
fig_bubble.show()

# Create a sunburst chart of per diem rates by state and rate zone
sunburst_data = df.groupby(['State', 'Rate Zone']).agg({
    'Per Diem Daily Rate': 'mean',
    'Zip Code': 'count'
}).reset_index()
sunburst_data = sunburst_data.rename(columns={'Zip Code': 'Count'})

fig_sunburst = px.sunburst(sunburst_data,
                          path=['State', 'Rate Zone'],
                          values='Count',
                          color='Per Diem Daily Rate',
                          color_continuous_scale='RdBu',
                          title='Per Diem Rates by State and Rate Zone')
fig_sunburst.show()
```

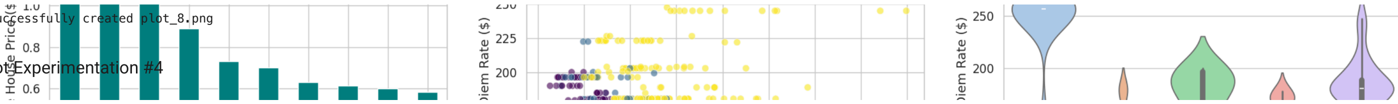
```
<ipython-input-142-ac1e7d67b317>:53: FutureWarning:



Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effect.


<ipython-input-142-ac1e7d67b317>:138: FutureWarning:



Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0. Assign the `x` variable to `hue` and set `legend=False` for the same effect.


---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-142-ac1e7d67b317> in <cell line: 0>()
    157 cmap = LinearSegmentedColormap.from_list('custom_cmap', ['#f7fbff', '#08306b'])
    158 # Create a 2D histogram
--> 159 h = ax14.hist2d(df['House Price'], df['Per Diem Daily Rate'], bins=50, cmap=cmap)
    160 fig.colorbar(h[3], ax=ax14, label='Count')
    161 ax14.set_title('Joint Distribution of House Prices and Per Diem Rates')

                                  5 frames
/usr/local/lib/python3.11/dist-packages/numpy/lib/_histograms_impl.py in _get_outer_edges(a, range)
    321         first_edge, last_edge = a.min(), a.max()
    322         if not (np.isfinite(first_edge) and np.isfinite(last_edge)):
--> 323             raise ValueError(
    324                 "autodetected range of [{}, {}] is not finite".format(first_edge, last_edge))
    325 

ValueError: autodetected range of [nan, nan] is not finite
```



Plot Experimentation #3

```
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from sklearn.cluster import KMeans
from scipy import stats
import plotly.express as px
import plotly.graph_objects as go
from matplotlib.colors import LinearSegmentedColormap
import traceback

df = diem_and_house_and_info

# Set up the visualization environment
plt.style.use('ggplot')
sns.set(style="whitegrid", font_scale=1.1)
plt.rcParams['figure.dpi'] = 100

# Function to save plot
def create_and_save_plot(plot_num, plot_function):
    try:
        plt.figure(figsize=(12, 8))
        plot_function()
        plt.tight_layout()
        plt.savefig(f'plot_{plot_num}.png', dpi=300, bbox_inches='tight')
        plt.close()
        print(f"Successfully created plot_{plot_num}.png")
    except Exception as e:
        print(f"Error creating plot_{plot_num}: {str(e)}")
        traceback.print_exc()
        plt.close()  # Close the figure even if there was an error

# 8. Population Density vs Per Diem Rate
create_and_save_plot(8, lambda: sns.scatterplot(x='Population Density', y='Per Diem Daily Rate',
                                             data=df, alpha=0.5, hue='isStandard', palette='Set1')
                    and plt.title('Population Density vs Per Diem Rate')
                    and plt.xlabel('Population Density (people per sq mile)')
```

```
                    and plt.ylabel('Per Diem Rate ($)')
                    and plt.xscale('log'))
```



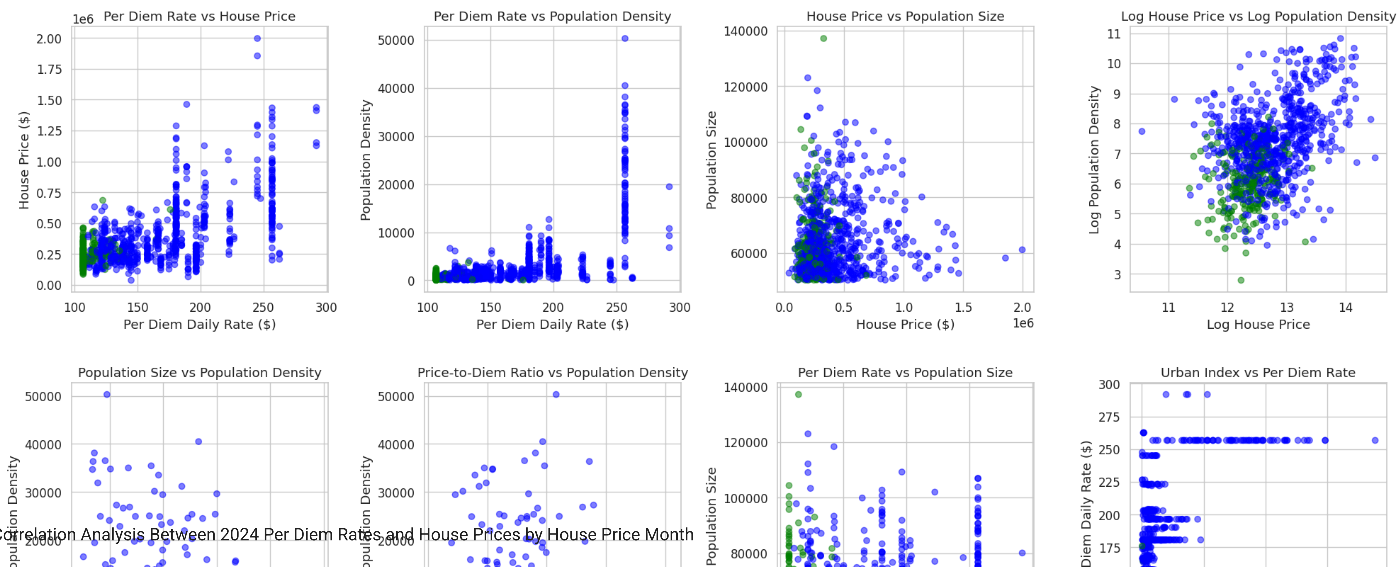
```
Successfully created plot_8.png
```

Plot Experimentation #4

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.preprocessing import StandardScaler
from matplotlib.colors import LinearSegmentedColormap

df = diem_and_house_and_info

df = df.dropna(subset=['House Price', 'Per Diem Daily Rate', 'Population Size', 'Population Density'])

# Create a figure with multiple subplots
fig, axes = plt.subplots(4, 4, figsize=(20, 20))
axes = axes.flatten()

# 1. Per Diem Rate vs House Price
axes[0].scatter(df['Per Diem Daily Rate'], df['House Price'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[0].set_title('Per Diem Rate vs House Price')
axes[0].set_xlabel('Per Diem Daily Rate ($)')
axes[0].set_ylabel('House Price ($)')
axes[0].grid(True)

# 2. Per Diem Rate vs Population Density
axes[1].scatter(df['Per Diem Daily Rate'], df['Population Density'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[1].set_title('Per Diem Rate vs Population Density')
axes[1].set_xlabel('Per Diem Daily Rate ($)')
axes[1].set_ylabel('Population Density')
axes[1].grid(True)

# 3. House Price vs Population Size
axes[2].scatter(df['House Price'], df['Population Size'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[2].set_title('House Price vs Population Size')
axes[2].set_xlabel('House Price ($)')
axes[2].set_ylabel('Population Size')
axes[2].grid(True)

# 4. Log-transformed House Price vs Log-transformed Population Density
# Add small value to avoid log(0)
axes[3].scatter(np.log1p(df['House Price']), np.log1p(df['Population Density']), alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[3].set_title('Log House Price vs Log Population Density')
axes[3].set_xlabel('Log House Price')
axes[3].set_ylabel('Log Population Density')
axes[3].grid(True)

# 5. Population Size vs Population Density
axes[4].scatter(df['Population Size'], df['Population Density'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[4].set_title('Population Size vs Population Density')
axes[4].set_xlabel('Population Size')
axes[4].set_ylabel('Population Density')
axes[4].grid(True)

# 6. House Price to Per Diem Ratio vs Population Density
df['Price_to_Diem_Ratio'] = df['House Price'] / df['Per Diem Daily Rate']
axes[5].scatter(df['Price_to_Diem_Ratio'], df['Population Density'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[5].set_title('Price-to-Diem Ratio vs Population Density')
axes[5].set_xlabel('House Price / Per Diem Rate')
axes[5].set_ylabel('Population Density')
axes[5].grid(True)

# 7. Per Diem Rate vs Population Size
axes[6].scatter(df['Per Diem Daily Rate'], df['Population Size'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[6].set_title('Per Diem Rate vs Population Size')
axes[6].set_xlabel('Per Diem Daily Rate ($)')
axes[6].set_ylabel('Population Size')
axes[6].grid(True)

# 8. Create Urban Index (Pop Density * Pop Size / 10000)
df['Urban_Index'] = df['Population Density'] * df['Population Size'] / 10000
axes[7].scatter(df['Urban_Index'], df['Per Diem Daily Rate'], alpha=0.5,
               c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[7].set_title('Urban Index vs Per Diem Rate')
axes[7].set_xlabel('Urban Index')
axes[7].set_ylabel('Per Diem Daily Rate ($)')
axes[7].grid(True)

# 9. House Price vs Per Diem Rate by State (top 5 states)
top_states = df['State'].value_counts().nlargest(5).index
for state in top_states:
    state_data = df[df['State'] == state]
    axes[8].scatter(state_data['Per Diem Daily Rate'], state_data['House Price'], alpha=0.7, label=state)
axes[8].set_title('House Price vs Per Diem Rate by State')
axes[8].set_xlabel('Per Diem Daily Rate ($)')
axes[8].set_ylabel('House Price ($)')
axes[8].legend()
axes[8].grid(True)

# 10. Standardized House Price vs Standardized Per Diem Rate
scaler = StandardScaler()
numeric_cols = ['House Price', 'Per Diem Daily Rate']
df_scaled = pd.DataFrame(
    scaler.fit_transform(df[numeric_cols]),
    columns=['Standardized House Price', 'Standardized Per Diem Daily Rate']
)
df_scaled['isStandard'] = df['isStandard'].values

axes[9].scatter(df_scaled['Standardized Per Diem Daily Rate'],
                df_scaled['Standardized House Price'],
                alpha=0.5,
                c=df_scaled['isStandard'].map({True: 'green', False: 'blue'}))
axes[9].set_title('Standardized House Price vs Per Diem Rate')
axes[9].set_xlabel('Standardized Per Diem Daily Rate')
axes[9].set_ylabel('Standardized House Price')
```

```
axes[9].grid(True)

# 11. House Price vs Population Density by Standard Rate
standard_rate = df[df['isStandard'] == True]
non_standard_rate = df[df['isStandard'] == False]
axes[10].scatter(standard_rate['Population Density'], standard_rate['House Price'],
                alpha=0.5, label='Standard Rate', color='green')
axes[10].scatter(non_standard_rate['Population Density'], non_standard_rate['House Price'],
                alpha=0.5, label='Non-Standard Rate', color='blue')
axes[10].set_title('House Price vs Population Density by Rate Type')
axes[10].set_xlabel('Population Density')
axes[10].set_ylabel('House Price ($)')
axes[10].legend()
axes[10].grid(True)

# 12. Per Diem Rate vs State (boxplot)
top_states = df['State'].value_counts().nlargest(5).index
state_data = df[df['State'].isin(top_states)]
sns.boxplot(x='State', y='Per Diem Daily Rate', data=state_data, ax=axes[11], hue='State', legend=False)
axes[11].set_title('Per Diem Rate Distribution by State')
axes[11].set_xlabel('State')
axes[11].set_ylabel('Per Diem Daily Rate ($)')
axes[11].tick_params(axis='x', rotation=45)

# 13. Per Diem Rate vs isStandard (boxplot)
sns.boxplot(x='isStandard', y='Per Diem Daily Rate', data=df, ax=axes[12], hue='isStandard', legend=False)
axes[12].set_title('Per Diem Rate by Standard Status')
axes[12].set_xlabel('Is Standard Rate')
axes[12].set_ylabel('Per Diem Daily Rate ($)')
axes[12].grid(True)

# 14. House Price vs County Name (for top counties)
top_counties = df['County Name'].value_counts().nlargest(5).index
county_data = df[df['County Name'].isin(top_counties)]
for county in top_counties:
    county_subset = county_data[county_data['County Name'] == county]
    axes[13].scatter(county_subset['Per Diem Daily Rate'], county_subset['House Price'],
                    alpha=0.7, label=county)
axes[13].set_title('House Price vs Per Diem Rate by County')
axes[13].set_xlabel('Per Diem Daily Rate ($)')
axes[13].set_ylabel('House Price ($)')
axes[13].legend()
axes[13].grid(True)

# 15. Create Cost of Living Index (House Price / National Median)
national_median = df['House Price'].median()
df['Cost_of_Living_Index'] = df['House Price'] / national_median
axes[14].scatter(df['Cost_of_Living_Index'], df['Per Diem Daily Rate'], alpha=0.5,
                c=df['isStandard'].map({True: 'green', False: 'blue'}))
axes[14].set_title('Cost of Living Index vs Per Diem Rate')
axes[14].set_xlabel('Cost of Living Index')
axes[14].set_ylabel('Per Diem Daily Rate ($)')
axes[14].grid(True)

# 16. Per Diem Rate vs House Price with Population Size as marker size
# Normalize population size for better visualization
pop_size_normalized = df['Population Size'] / df['Population Size'].max() * 100
axes[15].scatter(df['Per Diem Daily Rate'], df['House Price'],
                alpha=0.5,
                c=df['isStandard'].map({True: 'green', False: 'blue'}),
                s=pop_size_normalized)
axes[15].set_title('Per Diem Rate vs House Price (Size = Population)')
axes[15].set_xlabel('Per Diem Daily Rate ($)')
axes[15].set_ylabel('House Price ($)')
axes[15].grid(True)

plt.tight_layout()
plt.savefig('scatterplots_all.png', dpi=300)
plt.show()
```

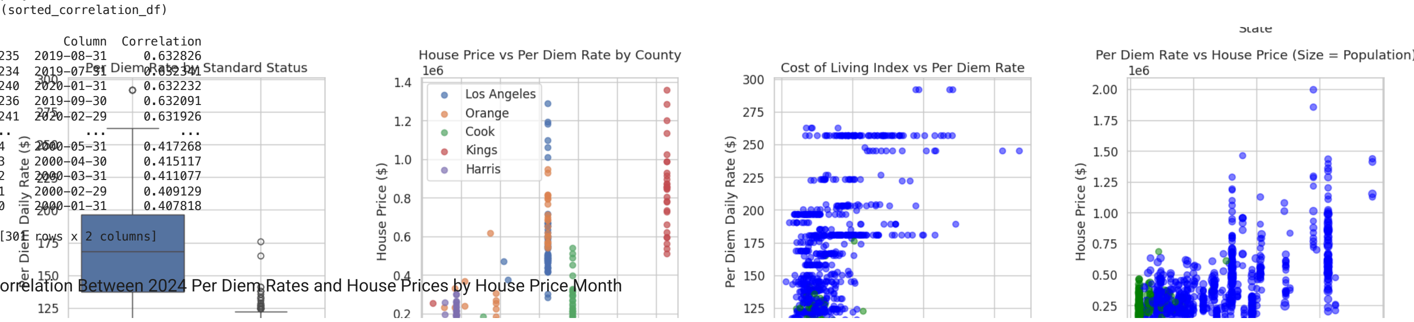
```
<ipython-input-144-a9711a30a838>:58: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

<ipython-input-144-a9711a30a838>:75: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy

<ipython-input-144-a9711a30a838>:156: SettingWithCopyWarning:


A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
```



Correlation Analysis Between 2024 Per Diem Rates and House Prices by House Price Month

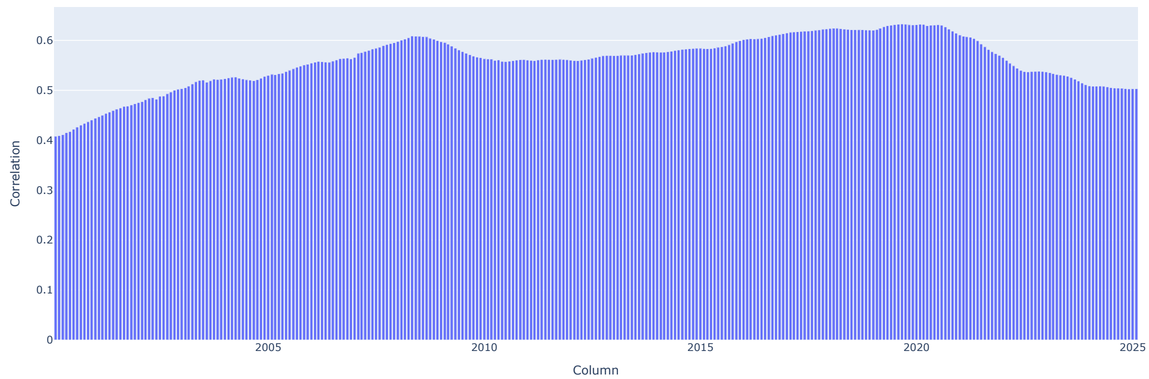
```
correlations = []

# Loop over every column in df_house_prices
for col in df_house_prices.columns:
    # Skip 'Zip Code' as it's used for merging and not a numerical value for correlation
    if col in "Zip Code RegionID    SizeRank    RegionName  RegionType  StateName   State   City    Metro   CountyName":
        continue

    # Merge per_diem with df_house_prices on the current column
    merged_df = per_diem.merge(right=df_house_prices[["Zip Code", col]], left_on="Zip Code", right_on="Zip Code")

    # Rename columns for clarity
    merged_df.columns = ["Zip Code", "Per Diem Daily Rate", "isStandrd", col]

    # Calculate correlation
    corr = merged_df[col].corr(merged_df["Per Diem Daily Rate"])

    # Store the correlation in the list
    correlations.append({"Column": col, "Correlation": corr})

# Create a DataFrame from the correlations list
correlation_df = pd.DataFrame(correlations)

# Sort the DataFrame by correlation in descending order
sorted_correlation_df = correlation_df.sort_values(by="Correlation", ascending=False)

# Display the sorted correlations
print(sorted_correlation_df)
```

```
         Column  Correlation
235  2019-08-31     0.632826
234  2019-07-31     0.632341
240  2020-01-31     0.632232
236  2019-09-30     0.632091
241  2020-02-29     0.631926
..          ...          ...
4    2000-05-31     0.417268
3    2000-04-30     0.415117
2    2000-03-31     0.411077
1    2000-02-29     0.409129
0    2000-01-31     0.407818

[301 rows x 2 columns]
```



Correlation Between 2024 Per Diem Rates and House Prices by House Price Month

```
sorted_correlation_df.sort_values(by="Column", ascending=True)
sorted_correlation_df = sorted_correlation_df.sort_values(by="Column", ascending=True)

px.bar(data_frame=sorted_correlation_df, x="Column", y="Correlation")
```



Relationship Between House Prices and Per Diem Rates by Zip Code

```
import plotly.express as px

px.scatter(data_frame=diem_and_house_and_info, x="House Price", y="Per Diem Daily Rate", hover_name="Zip Code", color="isStandard")
```


```
correlation = diem_and_house_and_info["House Price"].corr(diem_and_house_and_info["Per Diem Daily Rate"])
correlation
```

```
np.float64(0.6311908691904375)
```

Experimentation That Was Not Used in Final Analysis

Google Hotels Web Scraping

```
import requests
from bs4 import BeautifulSoup
import pandas as pd
import re
import time

def scrape_hotel_prices(zip_code):
    url = f"https://www.google.com/travel/search?q={zip_code}%20hotels&qs=CAEgACgAOA1IAA&ved=0CAAQ5JsGahgKEwjwpqmvnZWMAxUAAAAAHQAAAAAQ8wE&ts=CAESBgoCCAMQARpQCjISLjIlMHg4OGRlZWEzYTRjY2JlNDlkOjB4ZDkwNz

    headers = {
        'User-Agent': 'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/91.0.4472.124 Safari/537.36',
        'Accept-Language': 'en-US,en;q=0.9',
        'Referer': 'https://www.google.com/'
    }

        # Fetch the webpage
    response = requests.get(url, headers=headers)

    if response.status_code != 200:
        print(f"Failed to fetch data for zip code {zip_code}: {response.status_code}")
        return []

    # Parse the HTML content
    soup = BeautifulSoup(response.text, 'html.parser')

    # Find all price spans with the specific jsaction attribute
    price_spans = soup.find_all('span', attrs={'jsaction': 'mouseenter:JttVIc;mouseleave:VqIRre;'})

    # Extract prices
    prices = []

    for span in price_spans:
        # Extract price text
        price_text = span.text.strip()

        # Extract numeric value from price text (removing currency symbol)
        price_match = re.search(r'[\$£€¥](\d+(?:\.\d+)?)', price_text)
        if price_match:
            price = float(price_match.group(1))
            prices.append(price)
```

```
    return prices

# List of top 1000 zip codes
top_1000_zips = top_1000_zips[:10] # for example purposes

# Create a list to store results
results = []

# Loop through each zip code
for zip_code in top_1000_zips:
    print(f"Scraping data for zip code: {zip_code}")

    # Get prices for the current zip code
    prices = scrape_hotel_prices(zip_code)

    # Calculate average price if prices were found
    if prices:
        avg_price = sum(prices) / len(prices)
        results.append({
            'Zip_Code': zip_code,
            'Average_Price': round(avg_price, 2),
            'Number_of_Hotels': len(prices)
        })
    else:
        results.append({
            'Zip_Code': zip_code,
            'Average_Price': None,
            'Number_of_Hotels': 0
        })

    # Add a delay to avoid being blocked
    time.sleep(0.1)

# Create a DataFrame from the results
avg_prices_df = pd.DataFrame(results)

print(avg_prices_df)
```