Data preprocessing & aplly model of healthcare datasets

1.import dependencies & dataset

```
# pip install gender_guesser
```

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
```

```
df=pd.read_csv('Healthcare Providers.csv')
df
```

	index	National Provider Identifier	Last Name/Organization Name of the Provider	First Name of the Provider	Middle Initial of the Provider	Credentials of the Provider	C c Prc
0	8774979	1891106191	UPADHYAYULA	SATYASREE	NaN	M.D.	
1	3354385	1346202256	JONES	WENDY	P	M.D.	
2	3001884	1306820956	DUROCHER	RICHARD	W	DPM	
3	7594822	1770523540	FULLARD	JASPER	NaN	MD	
4	746159	1073627758	PERROTTI	ANTHONY	E	DO	
...	...	...	...	...	...	...	
99995	3837311	1386938868	PAPES	JOAN	NaN	PT	
99996	2079360	1215091327	HAYNER	MARGARET	S	ARNP	
99997	8927965	1902868185	VALENCIA	DANA	NaN	M.D.	
99998	8854571	1891941183	GONZALEZ-LAMOS	RAFAELA	NaN	NaN	
99999	3547535	1356772156	RAMEZANI	ELIIAN	NaN	NaN	

100000 rows × 27 columns

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 27 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   index                                                 100000 non-null  int64
 1   National Provider Identifier                          100000 non-null  int64
 2   Last Name/Organization Name of the Provider           100000 non-null  object
 3   First Name of the Provider                            95745 non-null   object
 4   Middle Initial of the Provider                        70669 non-null   object
 5   Credentials of the Provider                           92791 non-null   object
```

```
 6   Gender of the Provider                                    95746 non-null   object
 7   Entity Type of the Provider                               100000 non-null  object
 8   Street Address 1 of the Provider                          100000 non-null  object
 9   Street Address 2 of the Provider                          40637 non-null   object
 10  City of the Provider                                      100000 non-null  object
 11  Zip Code of the Provider                                  100000 non-null  float64
 12  State Code of the Provider                                100000 non-null  object
 13  Country Code of the Provider                              100000 non-null  object
 14  Provider Type                                             100000 non-null  object
 15  Medicare Participation Indicator                          100000 non-null  object
 16  Place of Service                                          100000 non-null  object
 17  HCPCS Code                                                100000 non-null  object
 18  HCPCS Description                                         100000 non-null  object
 19  HCPCS Drug Indicator                                      100000 non-null  object
 20  Number of Services                                        100000 non-null  object
 21  Number of Medicare Beneficiaries                          100000 non-null  object
 22  Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  object
 23  Average Medicare Allowed Amount                           100000 non-null  object
 24  Average Submitted Charge Amount                           100000 non-null  object
 25  Average Medicare Payment Amount                           100000 non-null  object
 26  Average Medicare Standardized Amount                      100000 non-null  object
dtypes: float64(1), int64(2), object(24)
memory usage: 20.6+ MB
```

2.check the missing values

```
df.isnull().sum()
```

```
index                                                       0
National Provider Identifier                                0
Last Name/Organization Name of the Provider                 0
First Name of the Provider                               4255
Middle Initial of the Provider                          29331
Credentials of the Provider                              7209
Gender of the Provider                                   4254
Entity Type of the Provider                                 0
Street Address 1 of the Provider                            0
Street Address 2 of the Provider                        59363
City of the Provider                                        0
Zip Code of the Provider                                    0
State Code of the Provider                                  0
Country Code of the Provider                                0
Provider Type                                               0
Medicare Participation Indicator                            0
Place of Service                                            0
HCPCS Code                                                  0
HCPCS Description                                           0
HCPCS Drug Indicator                                        0
Number of Services                                          0
Number of Medicare Beneficiaries                            0
Number of Distinct Medicare Beneficiary/Per Day Services    0
Average Medicare Allowed Amount                             0
Average Submitted Charge Amount                             0
Average Medicare Payment Amount                             0
Average Medicare Standardized Amount                        0
dtype: int64
```

3.filling missing value in neccassary features

- here in gender of the provider new category add unknown for gender
- In credentials of the provider new category add unknown_cred

```
# in gender & credentials missing value to unknown

df['Gender of the Provider'].fillna('Unknown', inplace=True)
df['Credentials of the Provider'].fillna('Unknown_cred', inplace=True)
df
```

	index	National Provider Identifier	Last Name/Organization Name of the Provider	First Name of the Provider	Middle Initial of the Provider	Credentials of the Provider	Pr
0	8774979	1891106191	UPADHYAYULA	SATYASREE	NaN	M.D.	
1	3354385	1346202256	JONES	WENDY	P	M.D.	
2	3001884	1306820956	DUROCHER	RICHARD	W	DPM	
3	7594822	1770523540	FULLARD	JASPER	NaN	MD	
4	746159	1073627758	PERROTTI	ANTHONY	E	DO	
...	...	...	...	...	...	...	
99995	3837311	1386938868	PAPES	JOAN	NaN	PT	
99996	2079360	1215091327	HAYNER	MARGARET	S	ARNP	
99997	8927965	1902868185	VALENCIA	DANA	NaN	M.D.	
99998	8854571	1891941183	GONZALEZ-LAMOS	RAFAELA	NaN	Unknown_cred	
99999	3547535	1356772156	RAMEZANI	ELIIAN	NaN	Unknown_cred	

100000 rows × 27 columns

```
df['Gender of the Provider'].value_counts()
```

```
Gender of the Provider
M          66641
F          29105
Unknown     4254
Name: count, dtype: int64
```

4.remove the unnecassary features & unique identifiers

- 'index', 'National Provider Identifier', 'Last Name/Organization Name of the Provider', 'First Name of the Provider', 'Middle Initial of the Provider','Street Address 1 of the Provider', 'Street Address 2 of the Provider','Zip Code of the Provider' above some colums are unique identifier and not depens reesults.

```
# drop down unneccesaries colums columns

df.drop(['index', 'National Provider Identifier',
       'Last Name/Organization Name of the Provider',
       'First Name of the Provider', 'Middle Initial of the Provider','Street Address 1 of the Provider',
       'Street Address 2 of the Provider','Zip Code of the Provider'], axis=1, inplace=True)
df
```

	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	City of the Provider	State Code of the Provider	Country Code of the Provider	Provider Type
0	M.D.	F	I	SAINT LOUIS	MO	US	Internal Medicine
1	M.D.	F	I	FAYETTEVILLE	NC	US	Obstetrics & Gynecology
2	DPM	M	I	NORTH HAVEN	CT	US	Podiatry
3	MD	M	I	KANSAS CITY	MO	US	Internal Medicine
4	DO	M	I	JUPITER	FL	US	Internal Medicine
...	...	...	...	...	...	...	...
99995	PT	F	I	WILMINGTON	IL	US	Physical Therapist in Private Practice
99996	ARNP	F	I	REDMOND	OR	US	Nurse Practitioner
99997	M.D.	M	I	SAINT LOUIS	MO	US	Cardiology
99998	Unknown_cred	F	I	LARCHMONT	NY	US	Internal Medicine
99999	Unknown_cred	F	I	GREAT NECK	NY	US	Physical Therapist in Private Practice

100000 rows × 19 columns

Next steps: Generate code with df View recommended plots

```
df.isnull().sum()
```

```
Credentials of the Provider                    0
Gender of the Provider                         0
Entity Type of the Provider                    0
City of the Provider                           0
State Code of the Provider                     0
Country Code of the Provider                   0
Provider Type                                  0
Medicare Participation Indicator               0
Place of Service                               0
```

```
HCPCS Code                                                0
HCPCS Description                                         0
HCPCS Drug Indicator                                      0
Number of Services                                        0
Number of Medicare Beneficiaries                          0
Number of Distinct Medicare Beneficiary/Per Day Services  0
Average Medicare Allowed Amount                           0
Average Submitted Charge Amount                           0
Average Medicare Payment Amount                           0
Average Medicare Standardized Amount                      0
dtype: int64
```

```
df['Gender of the Provider'].value_counts()
```

```
Gender of the Provider
M          66641
F          29105
Unknown     4254
Name: count, dtype: int64
```

6. Data type for numerical colums check & convert int & float for training propose

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 19 columns):
 #   Column                                                Non-Null Count   Dtype 
---  ------                                                --------------   ----- 
 0   Credentials of the Provider                           100000 non-null  object
 1   Gender of the Provider                                100000 non-null  object
 2   Entity Type of the Provider                           100000 non-null  object
 3   City of the Provider                                  100000 non-null  object
 4   State Code of the Provider                            100000 non-null  object
 5   Country Code of the Provider                          100000 non-null  object
 6   Provider Type                                         100000 non-null  object
 7   Medicare Participation Indicator                      100000 non-null  object
 8   Place of Service                                      100000 non-null  object
 9   HCPCS Code                                            100000 non-null  object
 10  HCPCS Description                                     100000 non-null  object
 11  HCPCS Drug Indicator                                  100000 non-null  object
 12  Number of Services                                    100000 non-null  object
 13  Number of Medicare Beneficiaries                      100000 non-null  object
 14  Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  object
 15  Average Medicare Allowed Amount                       100000 non-null  object
 16  Average Submitted Charge Amount                       100000 non-null  object
 17  Average Medicare Payment Amount                       100000 non-null  object
 18  Average Medicare Standardized Amount                  100000 non-null  object
dtypes: object(19)
memory usage: 14.5+ MB
```

```
def RemoveComma(x):
    return x.replace(",","")
df["Number of Services"] = pd.to_numeric(df["Number of Services"].apply(lambda x: RemoveComma(x)),
                                                    errors= "ignore")
df["Number of Medicare Beneficiaries"] = pd.to_numeric(df["Number of Medicare Beneficiaries"].apply(lambda x: Remo
                                                    errors= "ignore")
df["Number of Distinct Medicare Beneficiary/Per Day Services"] = pd.to_numeric(df["Number of Distinct Medicare Ben
                                                    errors= "ignore")
df["Average Medicare Allowed Amount"] = pd.to_numeric(df["Average Medicare Allowed Amount"].apply(lambda x: Remove
                                                    errors= "ignore")
df["Average Submitted Charge Amount"] = pd.to_numeric(df["Average Submitted Charge Amount"].apply(lambda x: Remove
                                                  errors = "ignore")
df["Average Medicare Payment Amount"] = pd.to_numeric(df["Average Medicare Payment Amount"].apply(lambda x: Remove
                                                  errors = "ignore")
df["Average Medicare Standardized Amount"] = pd.to_numeric(df["Average Medicare Standardized Amount"].apply(lambda
                                                    errors = "ignore")
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 19 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   Credentials of the Provider                           100000 non-null  object
 1   Gender of the Provider                                100000 non-null  object
 2   Entity Type of the Provider                           100000 non-null  object
 3   City of the Provider                                  100000 non-null  object
 4   State Code of the Provider                            100000 non-null  object
 5   Country Code of the Provider                          100000 non-null  object
 6   Provider Type                                         100000 non-null  object
 7   Medicare Participation Indicator                      100000 non-null  object
 8   Place of Service                                      100000 non-null  object
 9   HCPCS Code                                            100000 non-null  object
 10  HCPCS Description                                     100000 non-null  object
 11  HCPCS Drug Indicator                                  100000 non-null  object
 12  Number of Services                                    100000 non-null  float64
 13  Number of Medicare Beneficiaries                      100000 non-null  int64
 14  Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  int64
 15  Average Medicare Allowed Amount                       100000 non-null  float64
 16  Average Submitted Charge Amount                       100000 non-null  float64
 17  Average Medicare Payment Amount                       100000 non-null  float64
 18  Average Medicare Standardized Amount                  100000 non-null  float64
dtypes: float64(5), int64(2), object(12)
memory usage: 14.5+ MB
```

```
df['Number of Services']= df['Number of Services'].astype(np.int64)
df['Number of Medicare Beneficiaries']= df['Number of Medicare Beneficiaries'].astype(np.int64)
df['Number of Distinct Medicare Beneficiary/Per Day Services']= df['Number of Distinct Medicare Beneficiary/Per Da
df['Average Medicare Allowed Amount']=df['Average Medicare Allowed Amount'].astype(np.float64)
df['Average Submitted Charge Amount']=df['Average Submitted Charge Amount'].astype(np.float64)
df['Average Medicare Payment Amount']=df['Average Medicare Payment Amount'].astype(np.float64)
df['Average Medicare Standardized Amount'] = df['Average Medicare Standardized Amount'].astype(np.float64)
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 19 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   Credentials of the Provider                           100000 non-null  object
 1   Gender of the Provider                                100000 non-null  object
 2   Entity Type of the Provider                           100000 non-null  object
 3   City of the Provider                                  100000 non-null  object
 4   State Code of the Provider                            100000 non-null  object
 5   Country Code of the Provider                          100000 non-null  object
 6   Provider Type                                         100000 non-null  object
 7   Medicare Participation Indicator                      100000 non-null  object
```

```
 8   Place of Service                                        100000 non-null  object
 9   HCPCS Code                                              100000 non-null  object
 10  HCPCS Description                                       100000 non-null  object
 11  HCPCS Drug Indicator                                    100000 non-null  object
 12  Number of Services                                      100000 non-null  int64
 13  Number of Medicare Beneficiaries                        100000 non-null  int64
 14  Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  int64
 15  Average Medicare Allowed Amount                         100000 non-null  float64
 16  Average Submitted Charge Amount                         100000 non-null  float64
 17  Average Medicare Payment Amount                         100000 non-null  float64
 18  Average Medicare Standardized Amount                    100000 non-null  float64
dtypes: float64(4), int64(3), object(12)
memory usage: 14.5+ MB
```

7. creating new feature from existing features

```
# 1. Service Intensity
df['medicare Service Intensity'] =  df['Number of Medicare Beneficiaries']/df['Number of Services']

# 2. Price Differential
df['Price Differential'] = df['Average Submitted Charge Amount'] - df['Average Medicare Allowed Amount']

# 3. Standardization Factor
df['Standardization Factor'] = df['Average Medicare Standardized Amount'] / df['Average Medicare Payment Amount']
```

```
df.head()
```

	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	City of the Provider	State Code of the Provider	Country Code of the Provider	Provider Type	Par
0	M.D.	F	I	SAINT LOUIS	MO	US	Internal Medicine	
1	M.D.	F	I	FAYETTEVILLE	NC	US	Obstetrics & Gynecology	
2	DPM	M	I	NORTH HAVEN	CT	US	Podiatry	
3	MD	M	I	KANSAS CITY	MO	US	Internal Medicine	
4	DO	M	I	JUPITER	FL	US	Internal Medicine	

5 rows × 22 columns

8.checking the numbers of uniques value for encoding

- unique values>50 then used label encoding
- unique values>50 then used one hot encoding

```
print(len(df['Credentials of the Provider'].unique()))
print(len(df['Gender of the Provider'].unique()))
print(len(df['Entity Type of the Provider'].unique()))
print(len(df['City of the Provider'].unique()))
print(len(df['State Code of the Provider'].unique()))
print(len(df['Country Code of the Provider'].unique()))
print(len(df['Provider Type'].unique()))
print(len(df['Medicare Participation Indicator'].unique()))
print(len(df['Place of Service'].unique()))
print(len(df['HCPCS Code'].unique()))
print(len(df['HCPCS Description'].unique()))
print(len(df['HCPCS Drug Indicator'].unique()))
```

```
1855
3
2
5846
58
4
90
2
2
2631
2455
2
```

9.Apply the label encoding for categorical columns

```
# prompt: i have label encoding for Credentials of the Provider City of the Provider State Code of the Provider Pr

from sklearn.preprocessing import LabelEncoder
le = LabelEncoder()

df['Credentials of the Provider'] = le.fit_transform(df['Credentials of the Provider'])
df['City of the Provider'] = le.fit_transform(df['City of the Provider'])
df['State Code of the Provider'] = le.fit_transform(df['State Code of the Provider'])
df['Provider Type'] = le.fit_transform(df['Provider Type'])
df['HCPCS Code'] = le.fit_transform(df['HCPCS Code'])
df['HCPCS Description'] = le.fit_transform(df['HCPCS Description'])

df.head()
```

	Credentials of the Provider	Gender of the Provider	Entity Type of the Provider	City of the Provider	State Code of the Provider	Country Code of the Provider	Provider Type	Medi Participa Indic
0	667	F	I	4541	28	US	39	
1	667	F	I	1624	31	US	54	
2	438	M	I	3666	9	US	71	
3	956	M	I	2522	28	US	39	
4	410	M	I	2508	12	US	39	

5 rows × 22 columns

10.Apply the one hot encoding for categorical columns

```
# prompt: i have one hot encoding for Gender of the Provider Entity Type of the Provider Country Code of the Provi

df = pd.get_dummies(df, columns=['Gender of the Provider', 'Entity Type of the Provider', 'Country Code of the Prc
df.head()
```

	Credentials of the Provider	City of the Provider	State Code of the Provider	Provider Type	HCPCS Code	HCPCS Description	Number of Services	Numbe Medi Beneficia
0	667	4541	28	39	2251	967	27	
1	667	1624	31	54	2374	2054	175	
2	438	3666	9	71	2295	665	32	
3	956	2522	28	39	1329	2330	20	
4	410	2508	12	39	2163	973	33	

5 rows × 31 columns

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100000 entries, 0 to 99999
Data columns (total 31 columns):
 #   Column                                                Non-Null Count   Dtype
---  ------                                                --------------   -----
 0   Credentials of the Provider                           100000 non-null  int64
 1   City of the Provider                                  100000 non-null  int64
 2   State Code of the Provider                            100000 non-null  int64
 3   Provider Type                                         100000 non-null  int64
 4   HCPCS Code                                            100000 non-null  int64
 5   HCPCS Description                                     100000 non-null  int64
 6   Number of Services                                    100000 non-null  int64
 7   Number of Medicare Beneficiaries                      100000 non-null  int64
 8   Number of Distinct Medicare Beneficiary/Per Day Services  100000 non-null  int64
 9   Average Medicare Allowed Amount                       100000 non-null  float64
 10  Average Submitted Charge Amount                       100000 non-null  float64
 11  Average Medicare Payment Amount                       100000 non-null  float64
 12  Average Medicare Standardized Amount                  100000 non-null  float64
 13  medicare Service Intensity                            100000 non-null  float64
 14  Price Differential                                    100000 non-null  float64
 15  Standardization Factor                                100000 non-null  float64
 16  Gender of the Provider_F                              100000 non-null  int64
 17  Gender of the Provider_M                              100000 non-null  int64
 18  Gender of the Provider_Unknown                        100000 non-null  int64
 19  Entity Type of the Provider_I                         100000 non-null  int64
 20  Entity Type of the Provider_O                         100000 non-null  int64
 21  Country Code of the Provider_DE                       100000 non-null  int64
 22  Country Code of the Provider_JP                       100000 non-null  int64
 23  Country Code of the Provider_TR                       100000 non-null  int64
 24  Country Code of the Provider_US                       100000 non-null  int64
 25  Medicare Participation Indicator_N                    100000 non-null  int64
 26  Medicare Participation Indicator_Y                    100000 non-null  int64
 27  Place of Service_F                                    100000 non-null  int64
 28  Place of Service_O                                    100000 non-null  int64
 29  HCPCS Drug Indicator_N                                100000 non-null  int64
 30  HCPCS Drug Indicator_Y                                100000 non-null  int64
dtypes: float64(7), int64(24)
memory usage: 23.7 MB
```

11.Apply the standard scaler after succesfull encoding for all categorical colums as well as numerical columns

```
# prompt: all colums apply standard scaler

from sklearn.preprocessing import StandardScaler

scaler = StandardScaler()
df_scaled = scaler.fit_transform(df)

# Create a new DataFrame with the scaled data
df_scaled = pd.DataFrame(df_scaled, columns=df.columns)

# Print the first few rows of the scaled data
df_scaled.head()
```

	Credentials of the Provider	City of the Provider	State Code of the Provider	Provider Type	HCPCS Code	HCPCS Description	Number of Services	N Benef
0	-0.525655	0.998857	-0.021772	-0.037953	0.782766	-0.336239	-0.085301	-
1	-0.525655	-0.727201	0.175119	0.660735	0.958212	1.105866	-0.025939	
2	-1.092238	0.481099	-1.268747	1.452582	0.845527	-0.736897	-0.083296	-
3	0.189377	-0.195833	-0.021772	-0.037953	-0.532364	1.472031	-0.088109	-
4	-1.161514	-0.204118	-1.071857	-0.037953	0.657244	-0.328279	-0.082895	-

5 rows × 31 columns

12.apply the Principal Component Analysis

- 20 components converted

```
# prompt: pca 20 dimension

from sklearn.decomposition import PCA

pca = PCA(n_components=20)
pca_components = pca.fit_transform(df_scaled)

# Create a new DataFrame with the PCA components
pca_df = pd.DataFrame(pca_components, columns=[f"PC{i+1}" for i in range(20)])

# Print the first few rows of the PCA DataFrame
pca_df.head()
```

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	
0	0.500139	-0.730306	-0.082374	-0.428770	-0.360424	-0.109642	1.783237	-1.761939	(
1	-0.114045	0.137931	-0.250051	1.272301	-0.312189	-0.037351	1.972540	-0.129650	(
2	-0.844076	-0.504543	0.104084	1.447918	0.105589	-0.011592	-0.360755	1.352774	(
3	-0.856746	-0.215941	-0.082006	0.012066	0.183853	0.018137	-0.759451	0.923332	(
4	-0.995749	-0.508510	0.063426	0.591117	0.128362	-0.009369	-0.596144	1.089525	-(

Next steps: Generate code with pca_df View recommended plots

APPLY MACHINE LEARNING TECHNIQUES

1.Isolation forest

```
#apply isolation forest

from sklearn.ensemble import IsolationForest

# Define the model
model = IsolationForest(n_estimators=100, contamination=0.007)

# Fit the model
model.fit(df_scaled)

# Predict the outlier scores
outlier_scores = model.decision_function(df_scaled)

# Get the outlier predictions
outlier_predictions = model.predict(df_scaled)

# Create a new DataFrame with the outlier scores and predictions
df_outliers = pd.DataFrame({
    'Outlier Score': outlier_scores,
    'Outlier Prediction': outlier_predictions
})

# Merge the outlier information with the original data
df_with_outliers = pd.merge(df, df_outliers, left_index=True, right_index=True)

# Print the first few rows of the data with outlier information
df_with_outliers.head()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:439: UserWarning: X does not
  warnings.warn(
```

	Credentials of the Provider	City of the Provider	State Code of the Provider	Provider Type	HCPCS Code	HCPCS Description	Number of Services	Numbe Medi Beneficia
0	667	4541	28	39	2251	967	27	
1	667	1624	31	54	2374	2054	175	
2	438	3666	9	71	2295	665	32	
3	956	2522	28	39	1329	2330	20	
4	410	2508	12	39	2163	973	33	

5 rows × 33 columns

```
list(outlier_predictions).count(-1)
```

```
700
```

```
# diff graph of feature1 vs feature2 with outlier prediction

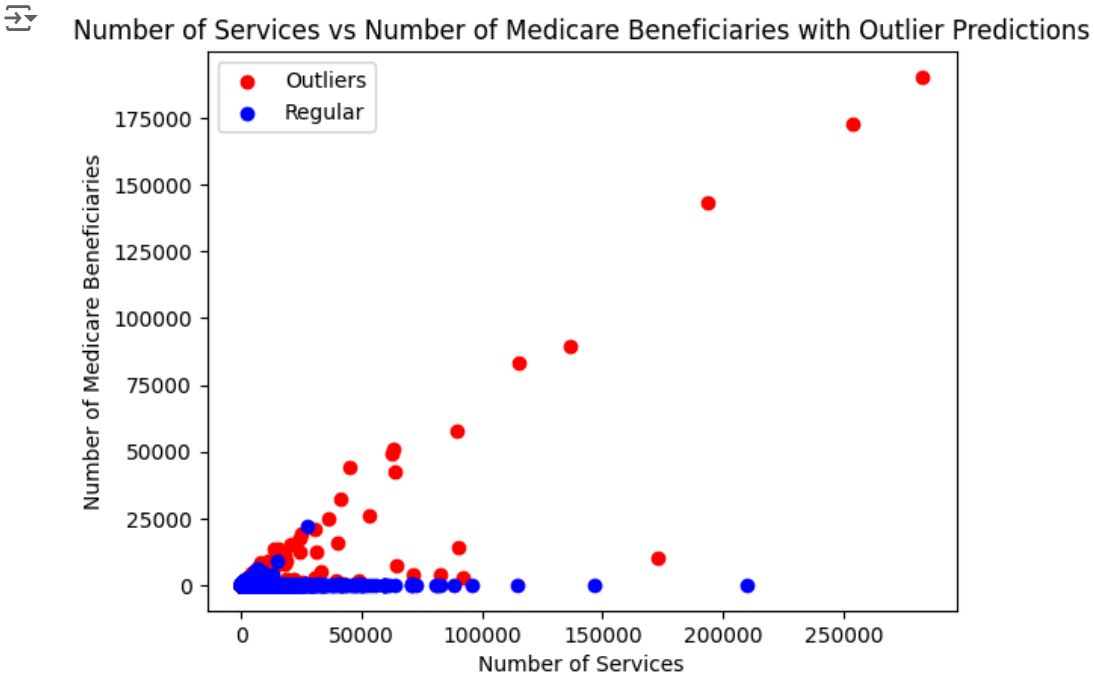
import matplotlib.pyplot as plt

# Separate the data by outlier prediction
outliers = df_with_outliers[df_with_outliers['Outlier Prediction'] == -1]
regular = df_with_outliers[df_with_outliers['Outlier Prediction'] == 1]

# Plot the data points
plt.scatter(outliers['Number of Services'], outliers['Number of Medicare Beneficiaries'], color='red', label='Outl
plt.scatter(regular['Number of Services'], regular['Number of Medicare Beneficiaries'], color='blue', label='Regul

# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Number of Medicare Beneficiaries')
plt.title('Number of Services vs Number of Medicare Beneficiaries with Outlier Predictions')

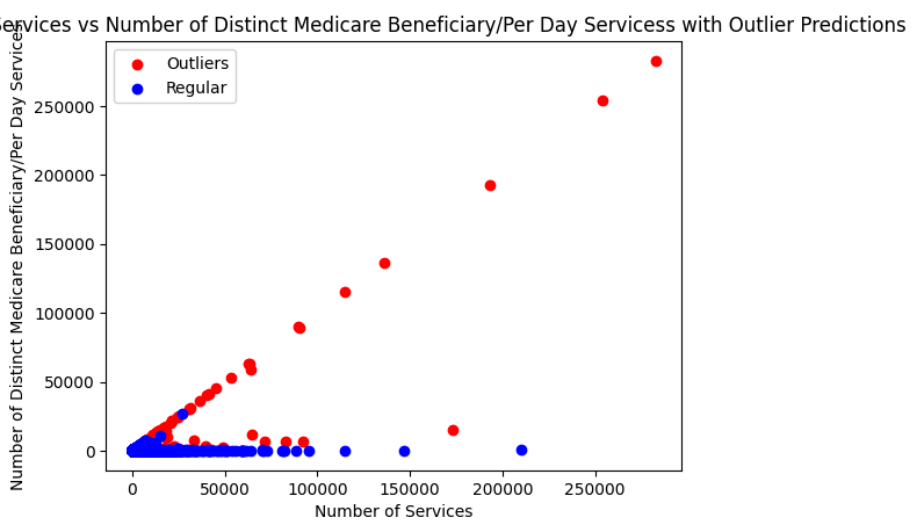
# Add legend and show plot
plt.legend()
plt.show()
```




```
plt.scatter(outliers['Number of Services'], outliers['Number of Distinct Medicare Beneficiary/Per Day Services'],
plt.scatter(regular['Number of Services'], regular['Number of Distinct Medicare Beneficiary/Per Day Services'], co

# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Number of Distinct Medicare Beneficiary/Per Day Services')
plt.title('Number of Services vs Number of Distinct Medicare Beneficiary/Per Day Servicess with Outlier Predictior

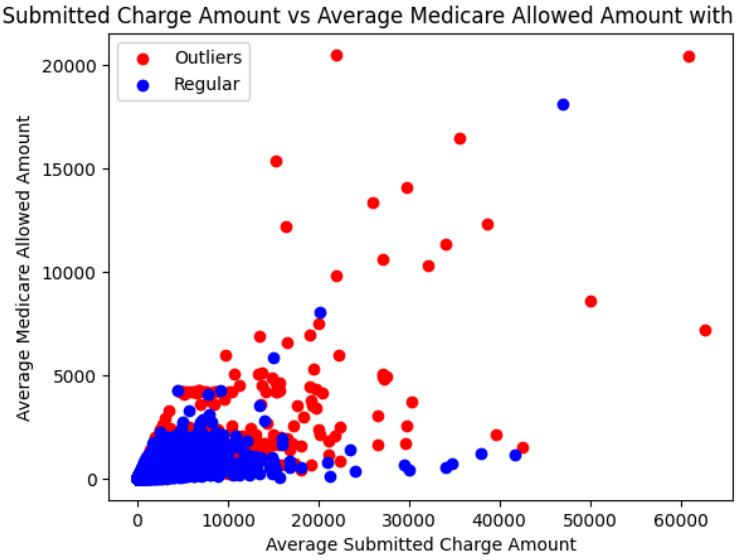
# Add legend and show plot
plt.legend()
plt.show()
```




```
plt.scatter(outliers['Average Submitted Charge Amount'], outliers['Average Medicare Allowed Amount'], color='red',
plt.scatter(regular['Average Submitted Charge Amount'], regular['Average Medicare Allowed Amount'], color='blue',

# Add labels and title
plt.xlabel('Average Submitted Charge Amount')
plt.ylabel('Average Medicare Allowed Amount')
plt.title('Average Submitted Charge Amount vs Average Medicare Allowed Amount with Outlier Predictions')

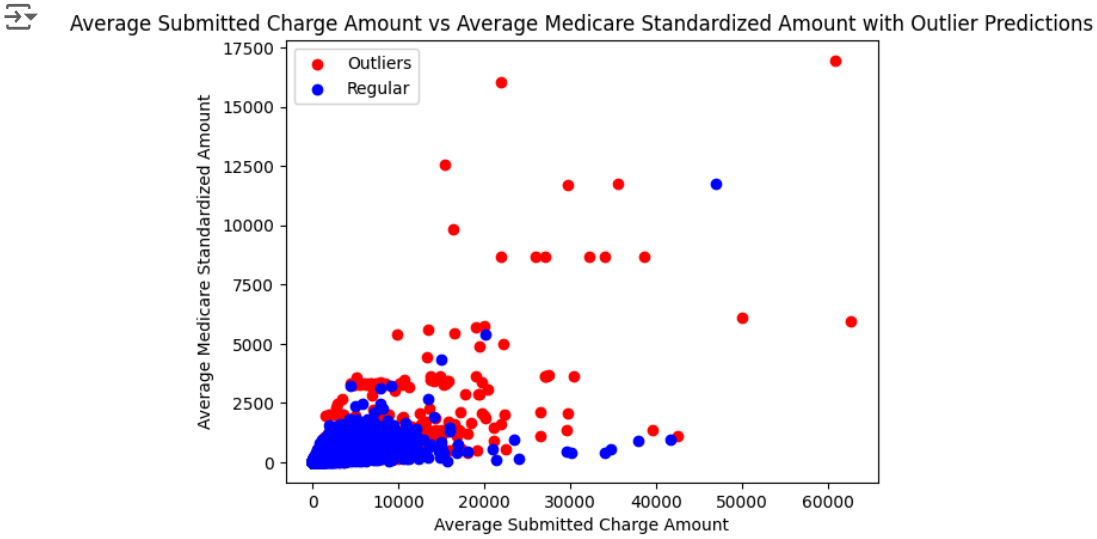
# Add legend and show plot
plt.legend()
plt.show()
```



```
plt.scatter(outliers['Average Submitted Charge Amount'], outliers['Average Medicare Standardized Amount'], color='
plt.scatter(regular['Average Submitted Charge Amount'], regular['Average Medicare Standardized Amount'], color='bl

# Add labels and title
plt.xlabel('Average Submitted Charge Amount')
plt.ylabel('Average Medicare Standardized Amount')
plt.title('Average Submitted Charge Amount vs Average Medicare Standardized Amount with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()
```



```
# prompt: ANOTHER  COLUMNS  SUGGEST ME TYPE  GRAPH WITH DETECTION MODEL OUTLIER PREDICTION

# Create a scatter plot of the 'Number of Services' and 'Average Medicare Payment Amount' columns, colored by outl
plt.scatter(outliers['Number of Services'], outliers['Average Medicare Payment Amount'], color='red', label='Outli
plt.scatter(regular['Number of Services'], regular['Average Medicare Payment Amount'], color='blue', label='Regula

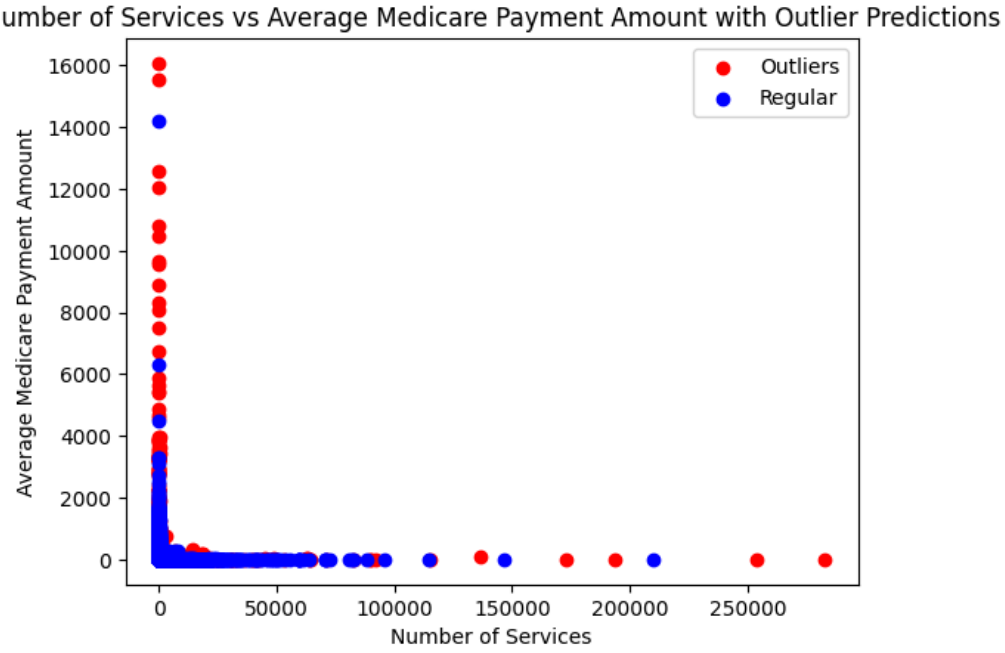
# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Average Medicare Payment Amount')
plt.title('Number of Services vs Average Medicare Payment Amount with Outlier Predictions')

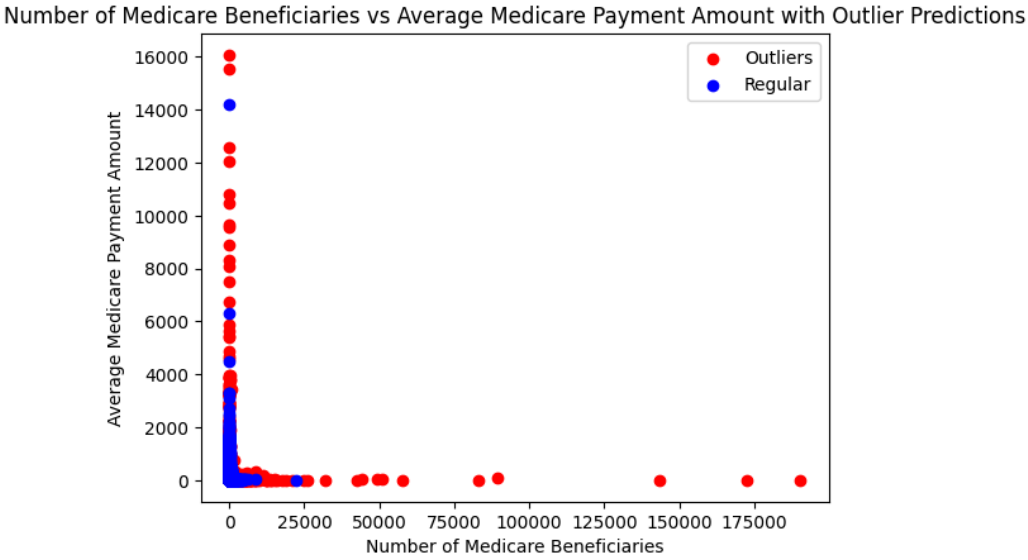
# Add legend and show plot
plt.legend()
plt.show()

# Create a scatter plot of the 'Number of Medicare Beneficiaries' and 'Average Medicare Payment Amount' columns, c
plt.scatter(outliers['Number of Medicare Beneficiaries'], outliers['Average Medicare Payment Amount'], color='red'
plt.scatter(regular['Number of Medicare Beneficiaries'], regular['Average Medicare Payment Amount'], color='blue',

# Add labels and title
plt.xlabel('Number of Medicare Beneficiaries')
plt.ylabel('Average Medicare Payment Amount')
plt.title('Number of Medicare Beneficiaries vs Average Medicare Payment Amount with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()
```

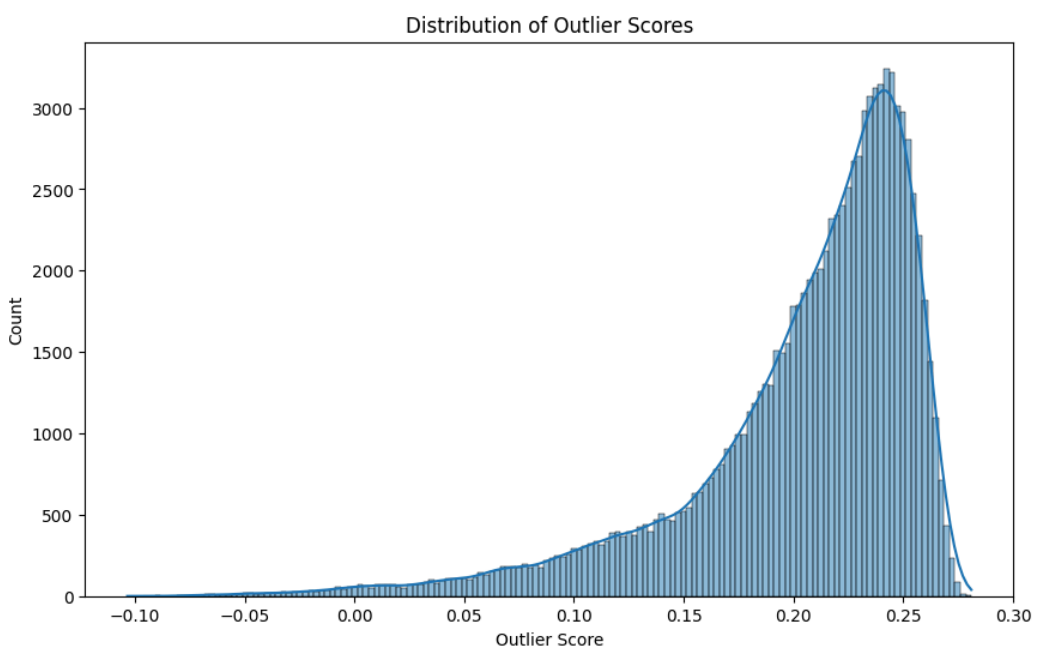

Number of Services vs Average Medicare Payment Amount with Outlier Predictions
Outliers
Regular
Average Medicare Payment Amount
Number of Services
0
2000
4000
6000
8000
10000
12000
14000
16000
0
50000
100000
150000
200000
250000

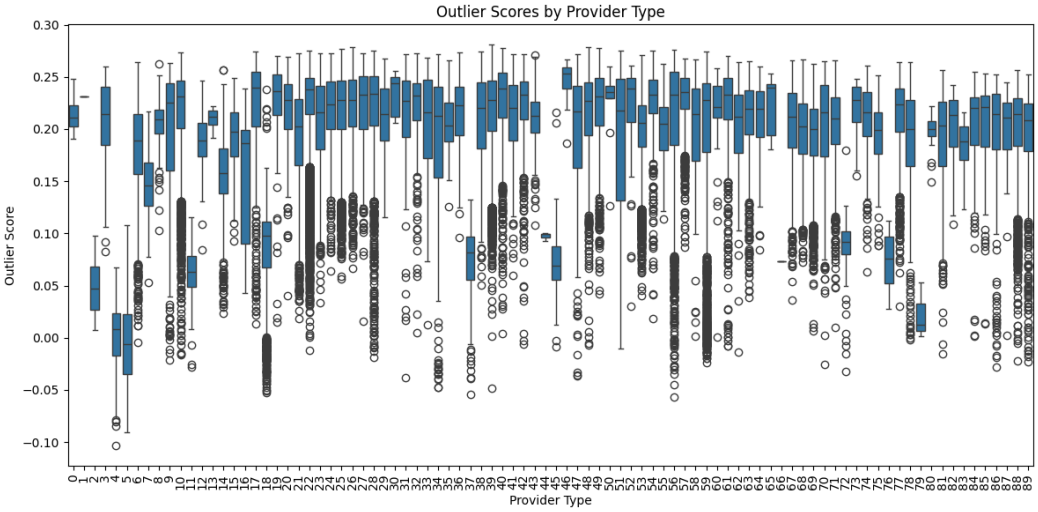

Number of Medicare Beneficiaries vs Average Medicare Payment Amount with Outlier Predictions
Outliers
Regular
Average Medicare Payment Amount
Number of Medicare Beneficiaries
0
2000
4000
6000
8000
10000
12000
14000
16000
0
25000
50000
75000
100000
125000
150000
175000

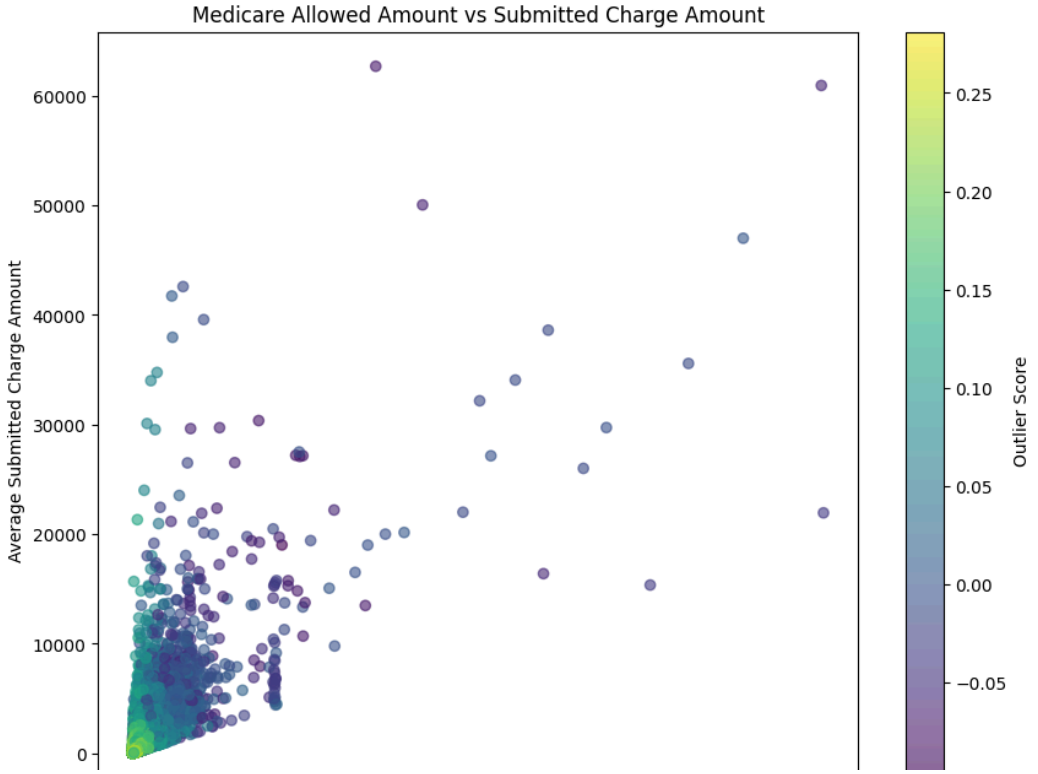
```
# 2. Histogram of Outlier Scores
plt.figure(figsize=(10, 6))
sns.histplot(df_with_outliers['Outlier Score'], kde=True)
plt.title('Distribution of Outlier Scores')
plt.xlabel('Outlier Score')
plt.ylabel('Count')
plt.show()

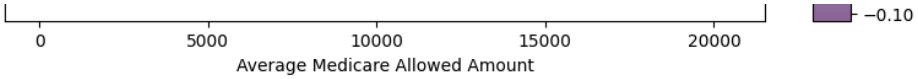
# 3. Box plot of Outlier Scores by Provider Type
plt.figure(figsize=(12, 6))
sns.boxplot(x='Provider Type', y='Outlier Score', data=df_with_outliers)
plt.xticks(rotation=90)
plt.title('Outlier Scores by Provider Type')
plt.tight_layout()
plt.show()

# 4. Scatter plot of Average Medicare Allowed Amount vs Average Submitted Charge Amount
plt.figure(figsize=(10, 8))
plt.scatter(df_with_outliers['Average Medicare Allowed Amount'].astype(float),
            df_with_outliers['Average Submitted Charge Amount'].astype(float),
            c=df_with_outliers['Outlier Score'],
            cmap='viridis',
            alpha=0.6)
plt.colorbar(label='Outlier Score')
plt.title('Medicare Allowed Amount vs Submitted Charge Amount')
plt.xlabel('Average Medicare Allowed Amount')
plt.ylabel('Average Submitted Charge Amount')
plt.show()
```


Distribution of Outlier Scores
Count
Outlier Score
3000
2500
2000
1500
1000
500
0
−0.10
−0.05
0.00
0.05
0.10
0.15
0.20
0.25
0.30

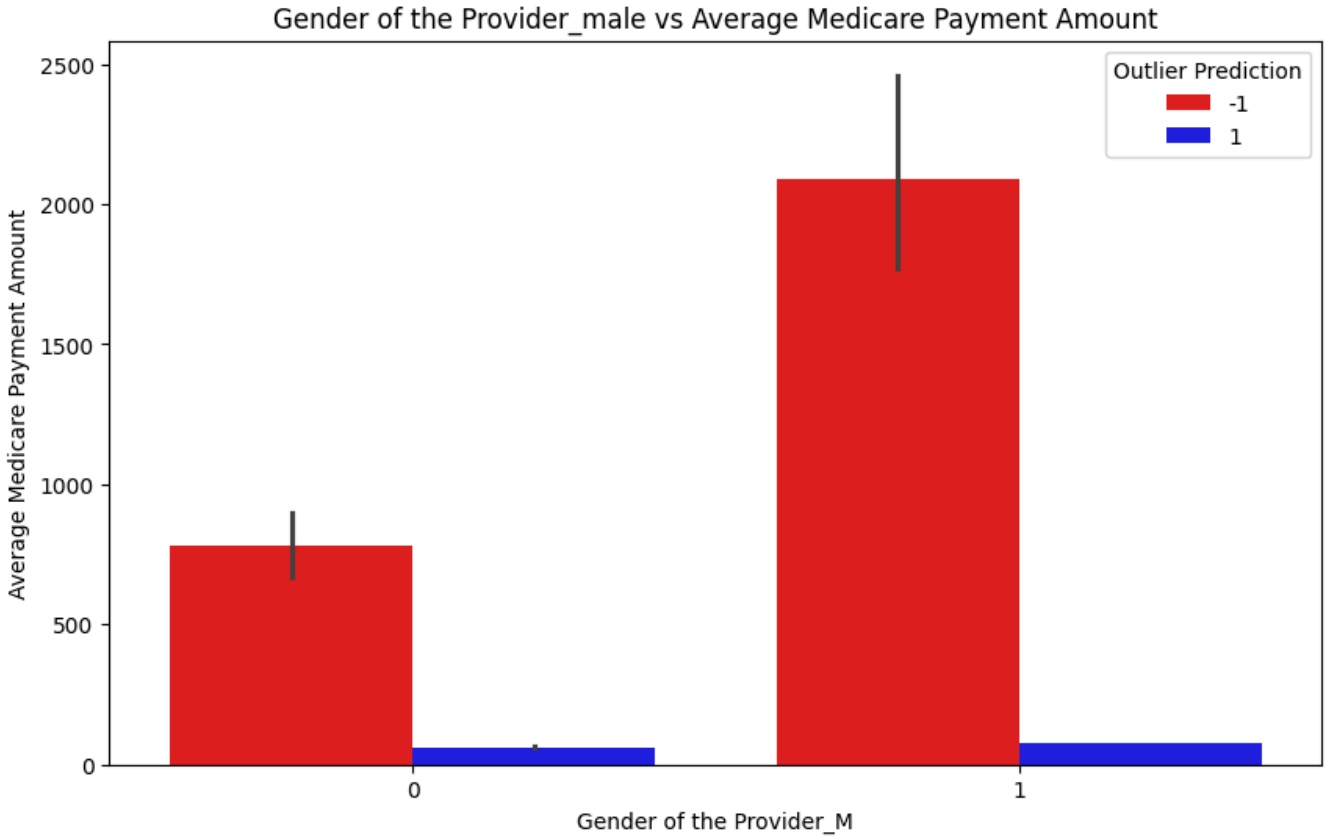

Outlier Scores by Provider Type
Outlier Score
Provider Type
0.30
0.25
0.20
0.15
0.10
0.05
0.00
−0.05
−0.10

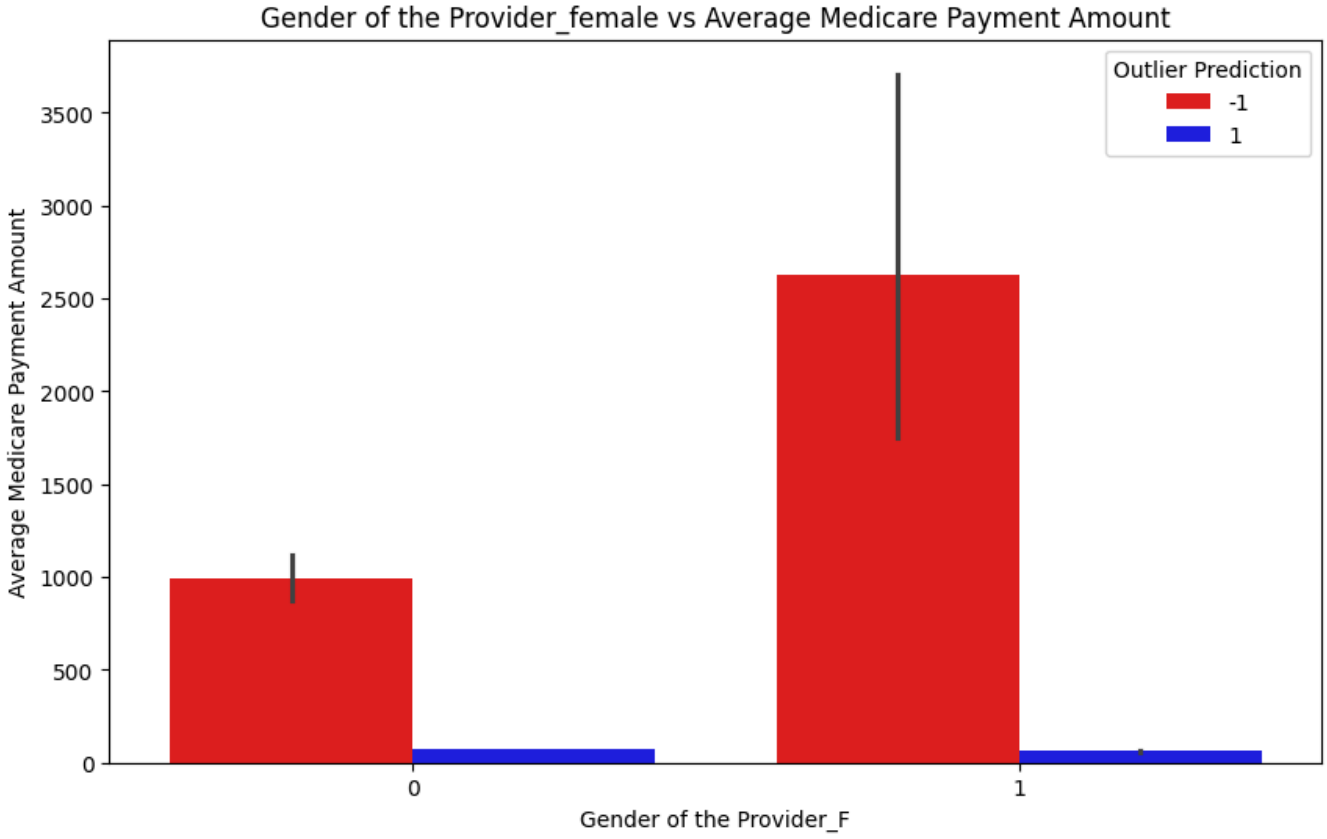

Medicare Allowed Amount vs Submitted Charge Amount
Average Submitted Charge Amount
Outlier Score
60000
50000
40000
30000
20000
10000
0
0.25
0.20
0.15
0.10
0.05
0.00
−0.05




```
plt.figure(figsize=(10, 6))
sns.barplot(x='Gender of the Provider_M', y='Average Medicare Payment Amount',
            hue='Outlier Prediction', data=df_with_outliers,
            palette={-1: 'red', 1: 'blue'})
plt.title('Gender of the Provider_male vs Average Medicare Payment Amount')
plt.show()

plt.figure(figsize=(10, 6))
sns.barplot(x='Gender of the Provider_F', y='Average Medicare Payment Amount',
            hue='Outlier Prediction', data=df_with_outliers,
            palette={-1: 'red', 1: 'blue'})
plt.title('Gender of the Provider_female vs Average Medicare Payment Amount')
plt.show()
```





2.Eliptical envelope

```
# eliptical enevelope technique apply

from sklearn.covariance import EllipticEnvelope
```

```
# Define the model
model = EllipticEnvelope(contamination=0.005)

# Fit the model
model.fit(df_scaled)

# Predict the outlier scores
outlier_scores = model.decision_function(df_scaled)

# Get the outlier predictions
outlier_predictions = model.predict(df_scaled)

# Create a new DataFrame with the outlier scores and predictions
df_outliers = pd.DataFrame({
    'Outlier Score': outlier_scores,
    'Outlier Prediction': outlier_predictions
})

# Merge the outlier information with the original data
df_with_outliers = pd.merge(df, df_outliers, left_index=True, right_index=True)

# Print the first few rows of the data with outlier information
df_with_outliers.head()



# Separate the data by outlier prediction
outliers = df_with_outliers[df_with_outliers['Outlier Prediction'] == -1]
regular = df_with_outliers[df_with_outliers['Outlier Prediction'] == 1]

# Plot the data points
plt.scatter(outliers['Number of Services'], outliers['Number of Medicare Beneficiaries'], color='red', label='Outli
plt.scatter(regular['Number of Services'], regular['Number of Medicare Beneficiaries'], color='blue', label='Regula

# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Number of Medicare Beneficiaries')
plt.title('Number of Services vs Number of Medicare Beneficiaries with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()

plt.scatter(outliers['Number of Services'], outliers['Number of Distinct Medicare Beneficiary/Per Day Services'], c
plt.scatter(regular['Number of Services'], regular['Number of Distinct Medicare Beneficiary/Per Day Services'], col

# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Number of Distinct Medicare Beneficiary/Per Day Services')
plt.title('Number of Services vs Number of Distinct Medicare Beneficiary/Per Day Servicess with Outlier Predictions

# Add legend and show plot
plt.legend()
plt.show()

plt.scatter(outliers['Average Submitted Charge Amount'], outliers['Average Medicare Allowed Amount'], color='red',
plt.scatter(regular['Average Submitted Charge Amount'], regular['Average Medicare Allowed Amount'], color='blue', l

# Add labels and title
plt.xlabel('Average Submitted Charge Amount')
plt.ylabel('Average Medicare Allowed Amount')
plt.title('Average Submitted Charge Amount vs Average Medicare Allowed Amount with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()
```

```
plt.show()

plt.scatter(outliers['Average Submitted Charge Amount'], outliers['Average Medicare Standardized Amount'], color='r
plt.scatter(regular['Average Submitted Charge Amount'], regular['Average Medicare Standardized Amount'], color='blu

# Add labels and title
plt.xlabel('Average Submitted Charge Amount')
plt.ylabel('Average Medicare Standardized Amount')
plt.title('Average Submitted Charge Amount vs Average Medicare Standardized Amount with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()
```

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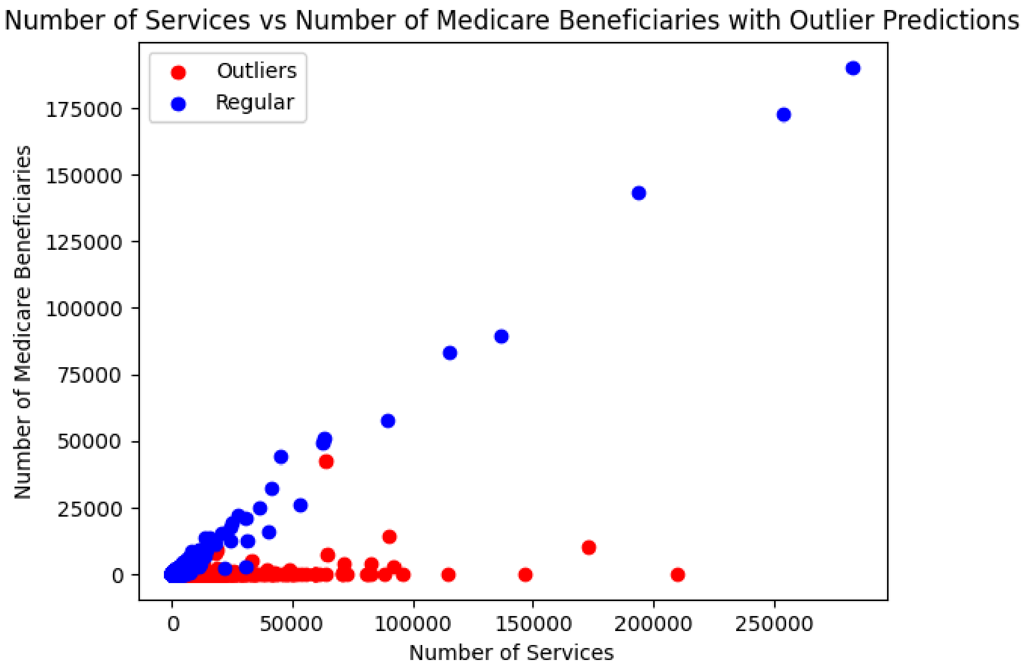
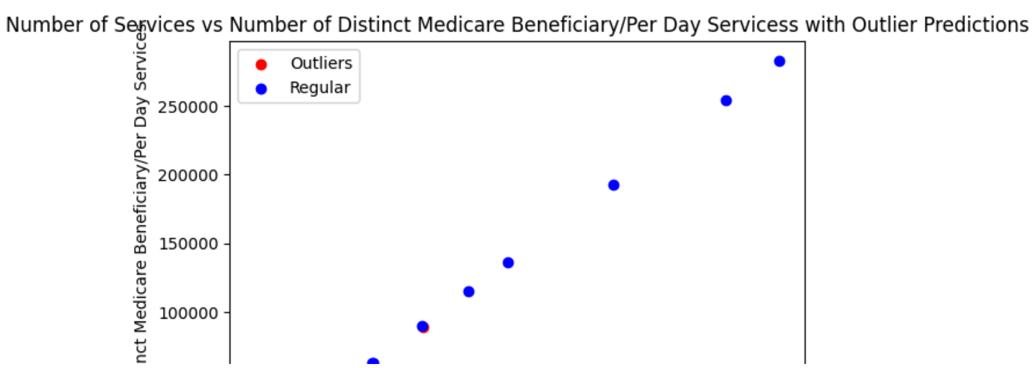
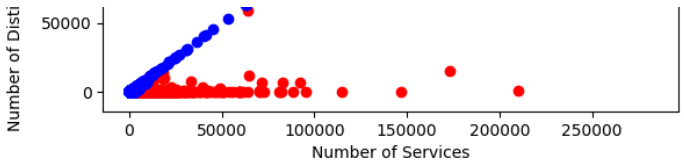
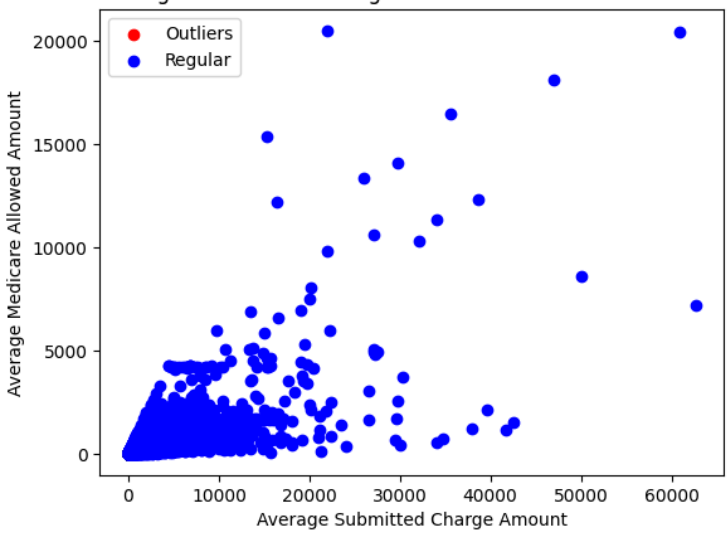


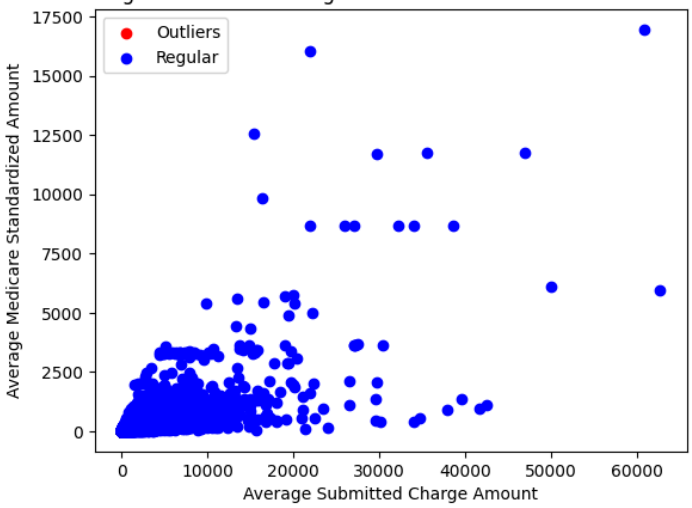




Average Submitted Charge Amount vs Average Medicare Allowed Amount with Outlier Predictions



Average Submitted Charge Amount vs Average Medicare Standardized Amount with Outlier Predictions



```
# Create a scatter plot of the 'Number of Services' and 'Average Medicare Payment Amount' columns, colored by outl
plt.scatter(outliers['Number of Services'], outliers['Average Medicare Payment Amount'], color='red', label='Outli
plt.scatter(regular['Number of Services'], regular['Average Medicare Payment Amount'], color='blue', label='Regula

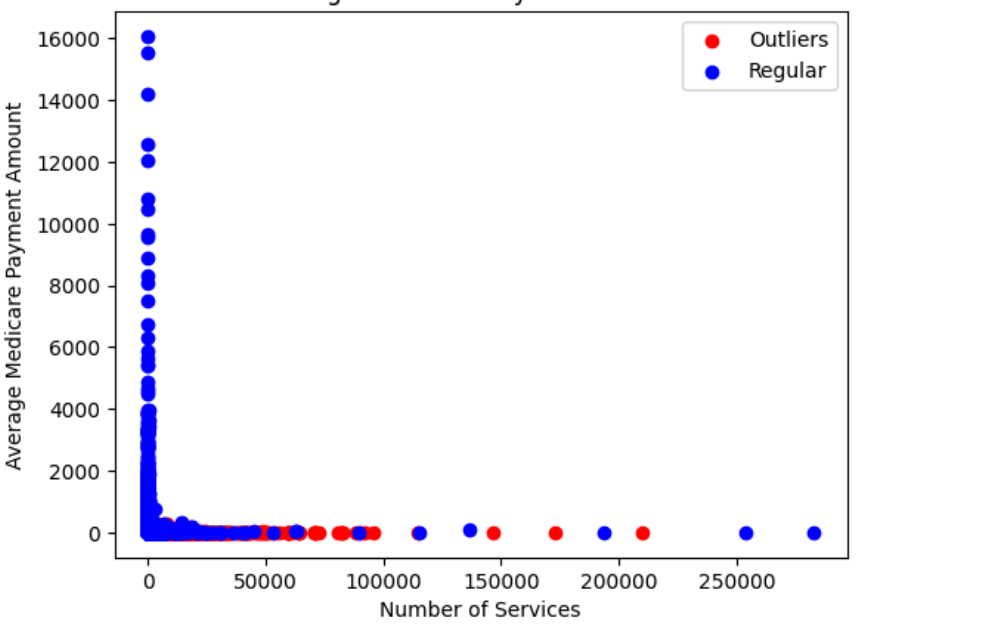
# Add labels and title
plt.xlabel('Number of Services')
plt.ylabel('Average Medicare Payment Amount')
plt.title('Number of Services vs Average Medicare Payment Amount with Outlier Predictions')

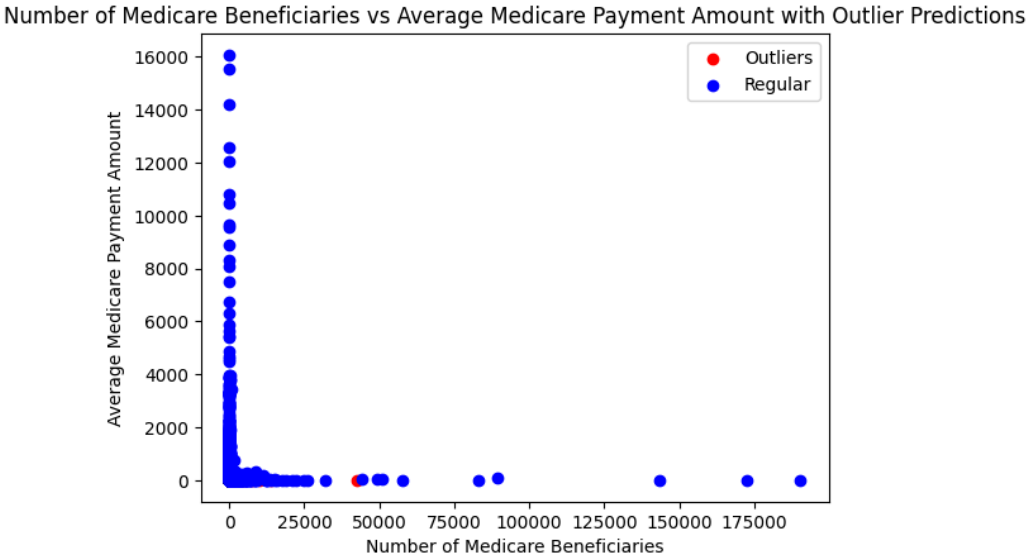
# Add legend and show plot
plt.legend()
plt.show()

# Create a scatter plot of the 'Number of Medicare Beneficiaries' and 'Average Medicare Payment Amount' columns, c
plt.scatter(outliers['Number of Medicare Beneficiaries'], outliers['Average Medicare Payment Amount'], color='red'
plt.scatter(regular['Number of Medicare Beneficiaries'], regular['Average Medicare Payment Amount'], color='blue',

# Add labels and title
plt.xlabel('Number of Medicare Beneficiaries')
plt.ylabel('Average Medicare Payment Amount')
plt.title('Number of Medicare Beneficiaries vs Average Medicare Payment Amount with Outlier Predictions')

# Add legend and show plot
plt.legend()
plt.show()
```



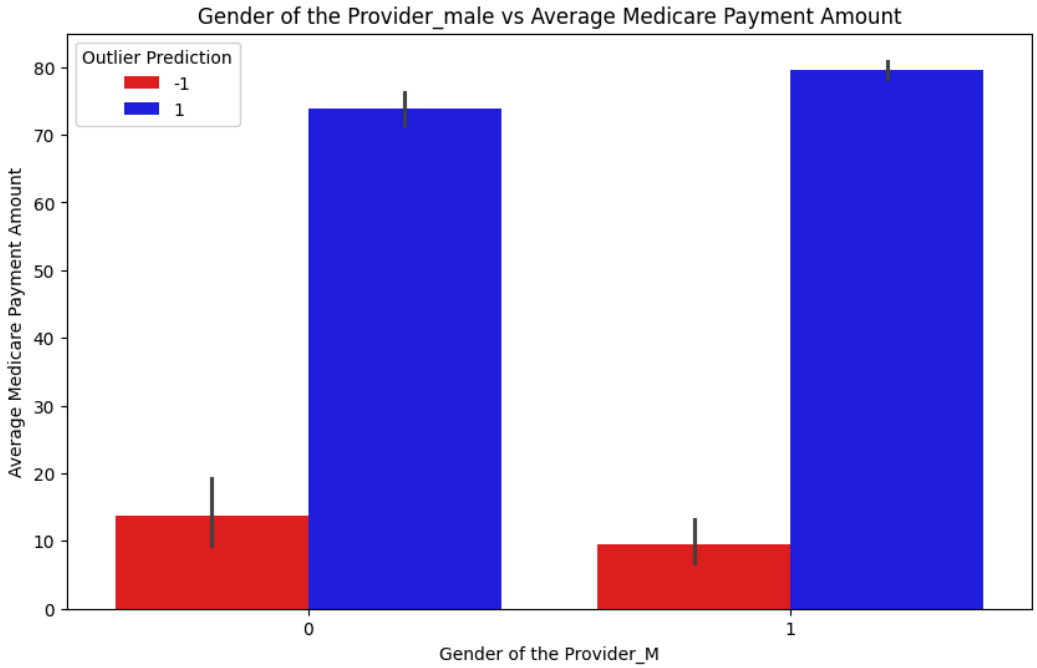


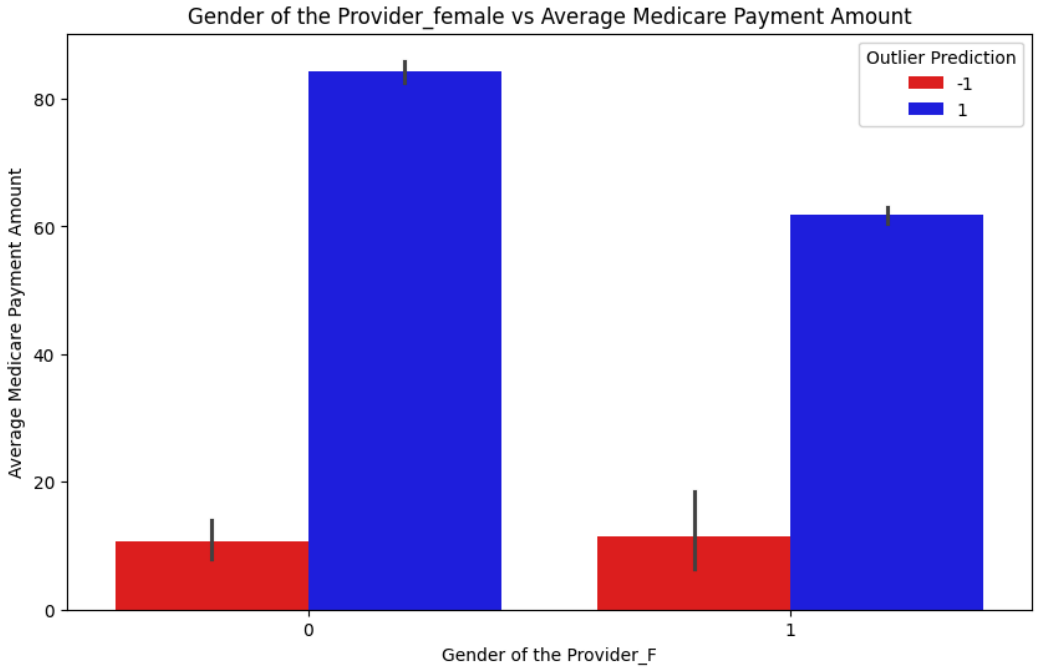

```
# # 2. Histogram of Outlier Scores
# plt.figure(figsize=(10, 6))
# sns.histplot(df_with_outliers['Outlier Score'], kde=True)
# plt.title('Distribution of Outlier Scores')
# plt.xlabel('Outlier Score')
# plt.ylabel('Count')
# plt.show()

# # 3. Box plot of Outlier Scores by Provider Type
# plt.figure(figsize=(12, 6))
# sns.boxplot(x='Provider Type', y='Outlier Score', data=df_with_outliers)
# # plt.xticks(rotation=90)
# plt.title('Outlier Scores by Provider Type')
# plt.tight_layout()
# plt.show()
```

```
plt.figure(figsize=(10, 6))
sns.barplot(x='Gender of the Provider_M', y='Average Medicare Payment Amount',
            hue='Outlier Prediction', data=df_with_outliers,
            palette={-1: 'red', 1: 'blue'})
plt.title('Gender of the Provider_male vs Average Medicare Payment Amount')
plt.show()

plt.figure(figsize=(10, 6))
sns.barplot(x='Gender of the Provider_F', y='Average Medicare Payment Amount',
            hue='Outlier Prediction', data=df_with_outliers,
            palette={-1: 'red', 1: 'blue'})
plt.title('Gender of the Provider_female vs Average Medicare Payment Amount')
plt.show()
```






```
list(outlier_predictions).count(-1)
```

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500
```

3.One class svm

```
# one class svm apply

from sklearn.svm import OneClassSVM

# Define the model
model = OneClassSVM(nu=0.007)

# Fit the model
```