Medicare-Clustering

January 27, 2020

1 Medicare Clustering

[1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import matplotlib.cm as cm
from scipy import stats
import seaborn as sns
import string
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import silhouette_score, silhouette_samples
from sklearn.cluster import KMeans
pd.options.display.max_rows = 1000
```

1.1 Data Cleaning

1.1.1 Loading Only Necessary Columns

[2]:
```
# Renaming column names & grabbing relevant columns
columns = ['npi', 'last_name', 'first_name', 'middle_initial', 'credentials',
           'gender', 'entity_code', 'street_1,', 'street_2', 'city', 'zip',
           'state', 'country', 'provider_type',␣
 ↪'medicare_participation_indicator',
           'place_of_service', 'hcpcs_code', 'hcpcs_desc', 'hcps_drug',␣
 ↪'services_count',
           'unique_patients_count', 'unique_patients_day_count',␣
 ↪'average_allowed_amount',
           'average_submitted_charge', 'average_medicare_payment',
           'average_medicare_payment_standardized']

relevant_columns = ['gender', 'credentials', 'entity_code', 'city', 'state',␣
 ↪'country', 'provider_type',
                    'medicare_participation_indicator', 'services_count',␣
 ↪'unique_patients_count',
                    'unique_patients_day_count','average_allowed_amount',␣
 ↪'average_submitted_charge',
```

```
                    'average_medicare_payment',␣
 ↪'average_medicare_payment_standardized']

relevant_numerical_columns = relevant_columns[8:]

df = pd.read_csv('CY2017.txt', sep="\t", header=0, skiprows=1, names=columns,
                 usecols=relevant_columns)

df['pocket'] = df['average_allowed_amount'] - df['average_medicare_payment']
```

1.1.2 Removing Outliers from Numerical Data

[3]:
```
def drop_numerical_outliers(df, z_thresh=4):
    # Constrains will contain `True` or `False` depending on if it is a value␣
 ↪below the threshold.
    constrains = df.select_dtypes(include=[np.number]) \
        .apply(lambda x: np.abs(stats.zscore(x)) < z_thresh,␣
 ↪result_type='reduce') \
        .all(axis=1)
    df.drop(df.index[~constrains], inplace=True)
rows = df.shape[0]
drop_numerical_outliers(df)
```

[4]:
```
# Percentage of samples removed by dropping outliers
percent_removed = round((rows - df.shape[0])/rows * 100, 2)
print(f'{percent_removed}% of data points have been removed')
```

```
1.1% of data points have been removed
```

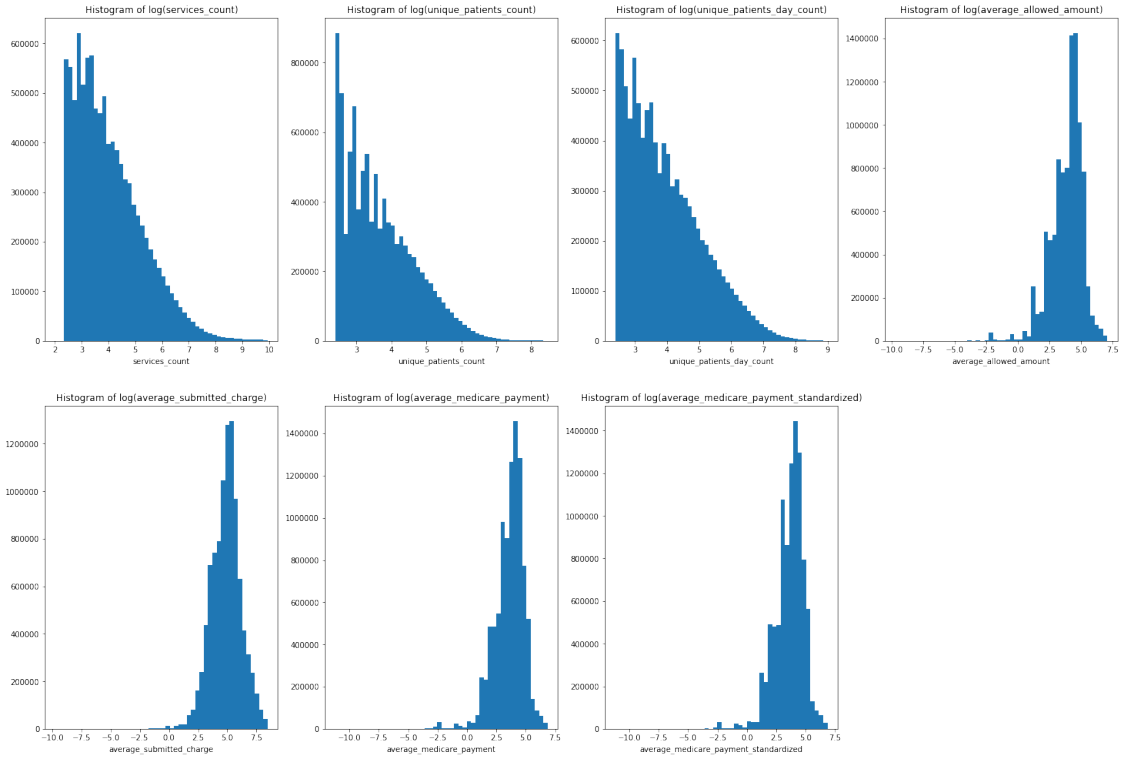
1.1.3 Addressing 0-values for Log Transformations

[5]:
```
# Function to replace 0-values with adjusted means for log graphing
def zero_fixer(df, col):
    avg = df[col][df[col] > 0].mean()
    df.loc[df[col] == 0, col] = avg

# Apply function to these two columns
zero_fixer(df, 'average_medicare_payment')
zero_fixer(df, 'average_medicare_payment_standardized')
```

1.2 Exploratory Data Analysis

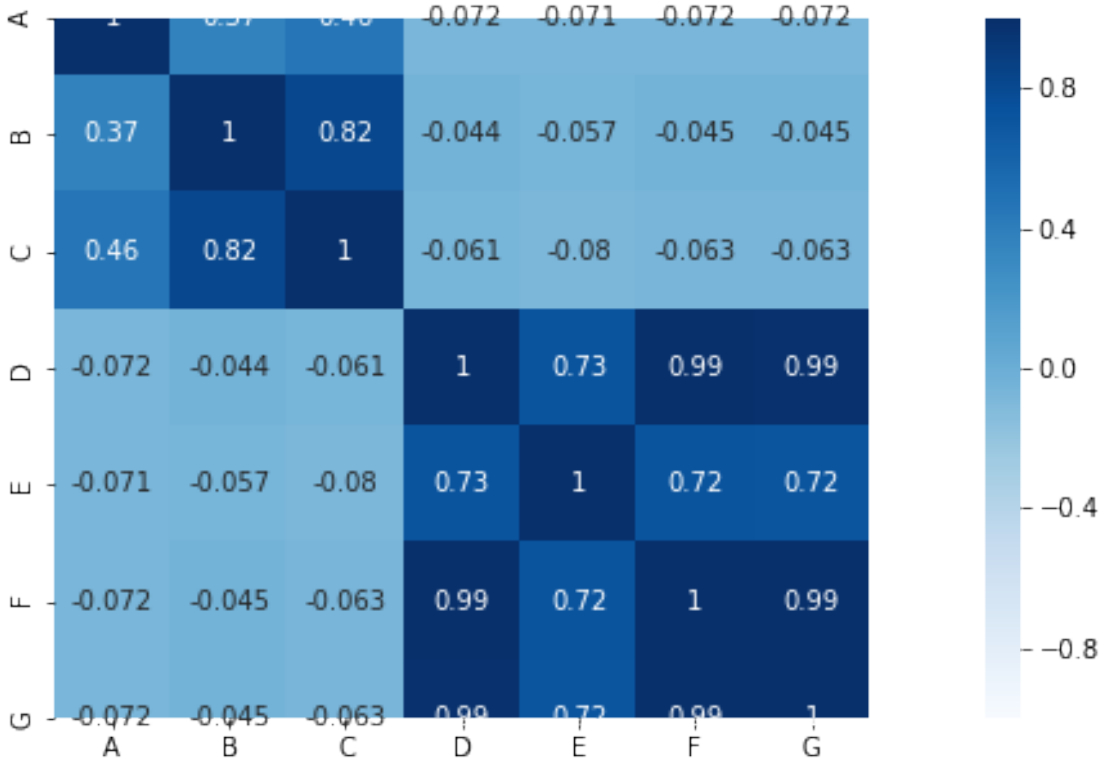
1.2.1 Histograms

[6]:
```
# Function to plot histograms for columns
def plotter(x, df):
    plt.hist(np.log(df[x]), bins=50)
    plt.xlabel(x)
    plt.title('Histogram of log(' + x + ')')


# Plot each column
j = 1
plt.figure(figsize=(25,17))
for i in relevant_numerical_columns:
    plt.subplot(2, 4, j)
    plotter(i, df)
    j = j + 1
```



1.2.2 Correllation Heatmap

[7]:
```
# Create a correlation heatmap for numerical columns
corr = df[relevant_numerical_columns].corr()
tick = list(string.ascii_uppercase[0:7])
plt.figure(figsize=(16, 5))
sns.heatmap(corr, xticklabels=tick, yticklabels=tick, square=True, vmin=-1,␣
 ↪vmax=1, annot=corr, cmap ='Blues')
plt.show()
```



1.3 Data Segmentation

1.3.1 Data Fixing

[8]:
```
# Converting categorical variables to numerical
df = pd.concat([df, pd.get_dummies(df['gender'],prefix='gender')],axis=1)
df.drop(['gender'],axis=1, inplace=True)
```

[9]:
```
# Using transformed values for columns
normal = ['average_allowed_amount', 'average_submitted_charge',␣
 ↪'average_medicare_payment',
          'average_medicare_payment_standardized']
```

```
for i in normal:
    df[i] = np.log(df[i])
```

1.3.2 Data Trimming

[10]:
```
# Looking only at medicare participants
df = df.loc[df['medicare_participation_indicator'] == 'Y', :]
```

[11]:
```
# Remove unncessary provider_types
def provider_dropper(df, provider):
    df = df[df.provider_type != provider]
    return df
df = provider_dropper(df, 'All Other Suppliers')
df = provider_dropper(df, 'Unknown Supplier/Provider Specialty')
```

1.3.3 Gathering *Training* and *Testing* Data

[12]:
```
# Reset index
df = df.reset_index(drop=True)
```

[13]:
```
# Sampling data from each provider type to keep representation consistent
def data_sampler(df, factor, it):
    keep = []
    for provider in it:
        sub_df = df[df.provider_type == provider]
        sample = sub_df.sample(frac = 1/factor, random_state = 0, axis = 0).index
        keep.append(sample)
    keep = [item for sublist in keep for item in sublist]
    return keep
it = set(df['provider_type'])
train = data_sampler(df, 100, it)
```

[14]:
```
# Randomly selecting from unused data for testing
df_less_train = df[~df.index.isin(train)]
test = df_less_train.sample(n = len(train), random_state = 1).index
```

1.4 Clustering

1.4.1 Standardize Data of Interest

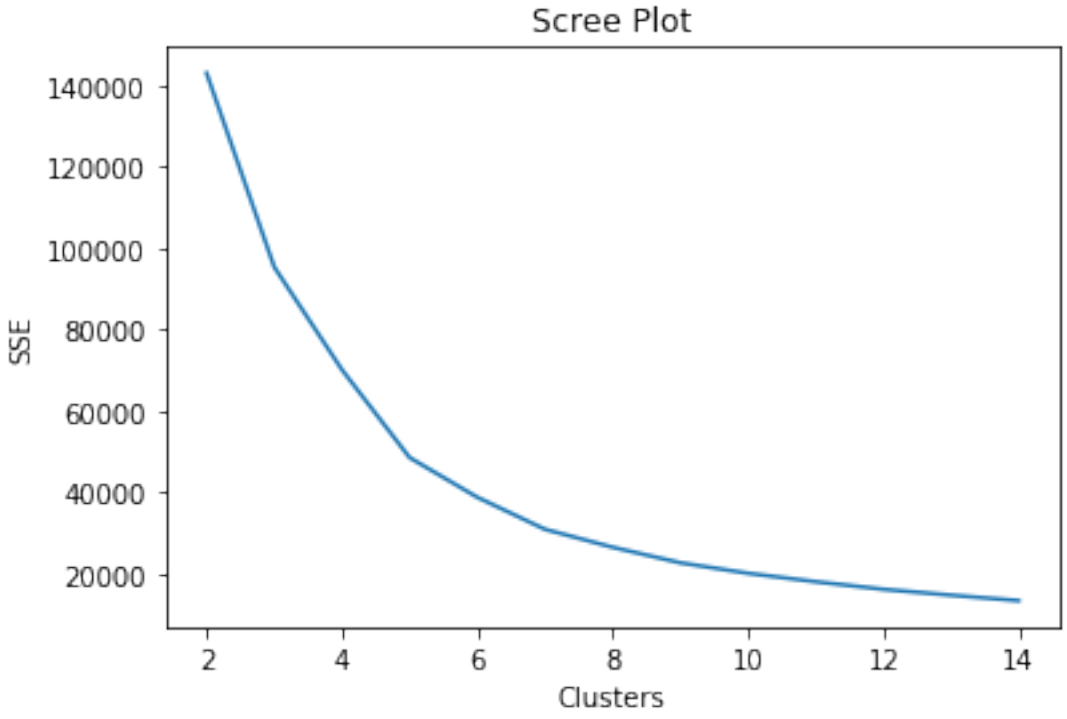
[15]:
```
cur_col = ['pocket', 'unique_patients_count']
scaler = StandardScaler()
std_df = df.loc[train, cur_col]
std_df = scaler.fit_transform(std_df)
```

1.4.2 Scree Plot

[16]:
```
# Finding SSE Values for various cluster sizes
maxClusters = 15
sse = []
for nClusters in range(2,maxClusters):
    kmeans = KMeans(n_clusters=nClusters, random_state=0).fit(std_df)
    sse.append(kmeans.inertia_)
```

[17]:
```
# Plotting SSE
print(sse)
plt.xlabel('Clusters')
plt.ylabel('SSE')
plt.title('Scree Plot')
plt.plot(range(2,maxClusters),sse)
plt.show()
```

```
[143099.77132873161, 95366.50767892331, 70107.5766921308, 48471.07485808471,
38713.55450175242, 30829.17918307367, 26410.32842881865, 22583.097770713266,
20002.3751636648, 17929.755583398495, 16061.782617128261, 14613.959243092377,
13270.330681806578]
```



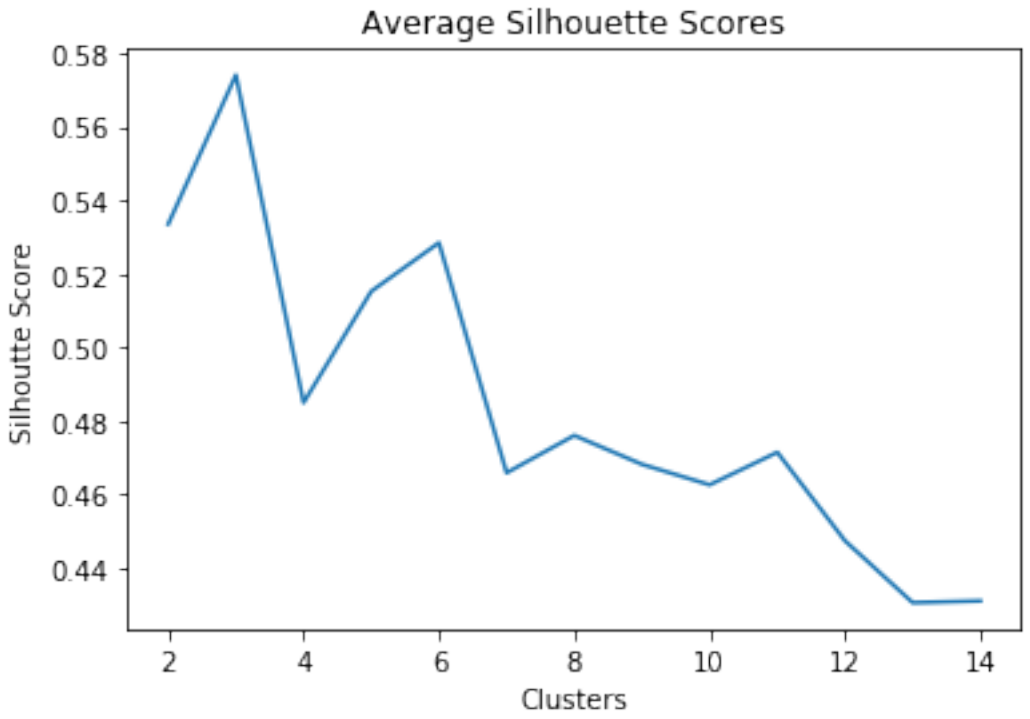
1.4.3 Silhouette Scores

[18]:
```
# Finding average silhouette score for various cluster sizes
silh = []
for nClusters in range(2,maxClusters):
    kmeans = KMeans(n_clusters=nClusters, random_state=0).fit(std_df)
    silhouette_avg = silhouette_score(std_df, kmeans.labels_, sample_size=10000)
    silh.append(silhouette_avg)
```

[19]:
```
# Plotting average silhouette scores
print(silh)
plt.xlabel("Clusters")
plt.ylabel("Silhoutte Score")
plt.title("Average Silhouette Scores")
plt.plot(range(2,maxClusters),silh)
```

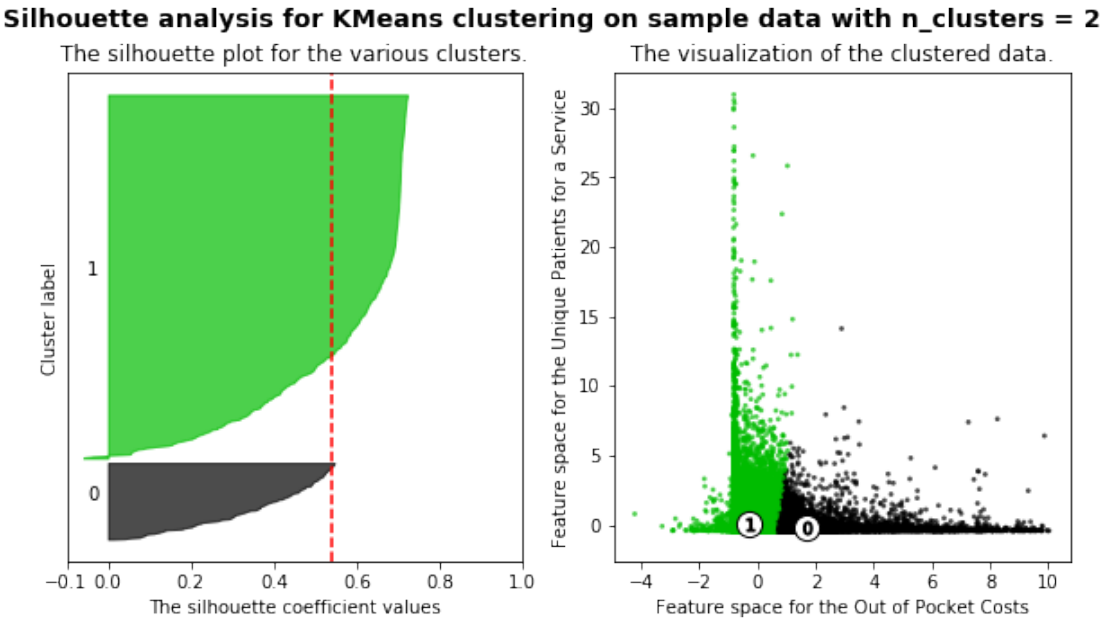
```
[0.5335226974955858, 0.5740921667319664, 0.4849282151718604, 0.5152271285524869,
0.5284519754504048, 0.4658320112123405, 0.4759991218399064, 0.46813062977151915,
0.46255799571808004, 0.47141513145215086, 0.44732548809892303,
0.43048353423955976, 0.4309532582984006]
```

[19]:
```
[<matplotlib.lines.Line2D at 0x1a1927bd90>]
```

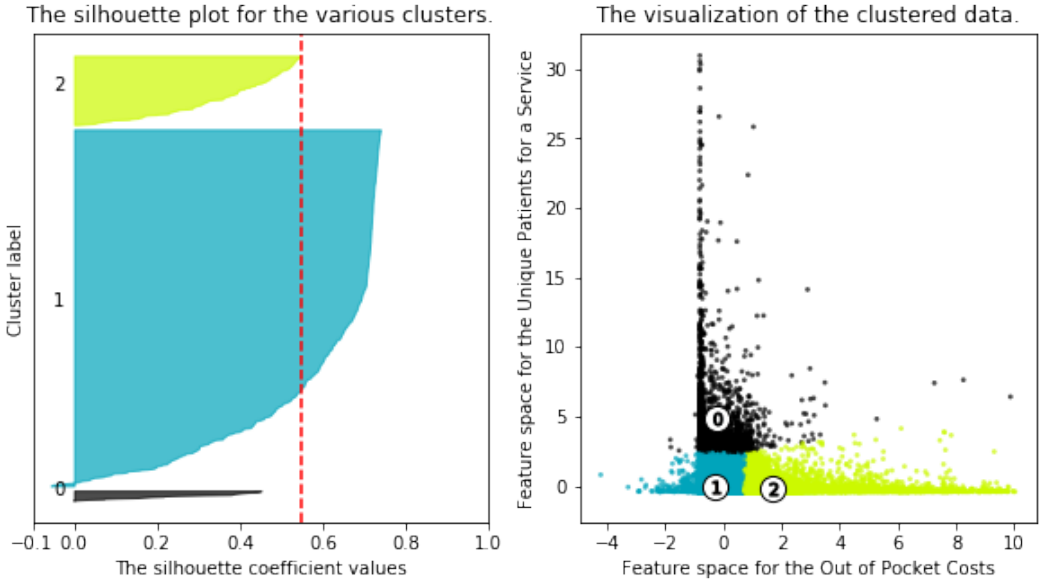


[20]:
```
# Creating silhouette plots for a sample of values
rel = [2,3,4,5,6]

for nClusters in rel:
    kmeans = KMeans(n_clusters=nClusters, random_state=0).fit(std_df)
    indices = np.random.choice(std_df.shape[0], 1000, replace=False)
    sample_silhouette_values = silhouette_samples(std_df[indices], kmeans.
 ↪labels_[indices])

    # Lower bound for plot
    y_lower = 10
    fig, (ax1, ax2) = plt.subplots(1, 2)
    fig.set_size_inches(10, 5)

    # Creating
    for i in range(nClusters):
        ith_values = sample_silhouette_values[kmeans.labels_[indices] == i]
        ith_values.sort()

        size_cluster_i = ith_values.shape[0]
        y_upper = y_lower + size_cluster_i

        color = cm.nipy_spectral(float(i) / nClusters)

        ax1.fill_betweenx(np.arange(y_lower, y_upper),0, ith_values,␣
 ↪facecolor=color, edgecolor=color, alpha=0.7)

        # Label the silhouette plots with their cluster numbers at the middle
        ax1.text(-0.05, y_lower + 0.5 * size_cluster_i, str(i))

        # Compute the new y_lower for next plot
        y_lower = y_upper + 10  # 10 for the 0 samples

    ax1.set_title("The silhouette plot for the various clusters.")
    ax1.set_xlabel("The silhouette coefficient values")
    ax1.set_ylabel("Cluster label")

    # The vertical line for average silhouette score of all the values
    ax1.axvline(x=sample_silhouette_values.mean(), color="red", linestyle="--")

    ax1.set_yticks([])  # Clear the yaxis labels / ticks
    ax1.set_xticks([-0.1, 0, 0.2, 0.4, 0.6, 0.8, 1])

    # 2nd Plot showing the actual clusters formed
    colors = cm.nipy_spectral(kmeans.labels_.astype(float) / nClusters)
    ax2.scatter(std_df[:, 0], std_df[:, 1], marker='.', s=30, lw=0, alpha=0.7,
                c=colors, edgecolor='k')
```

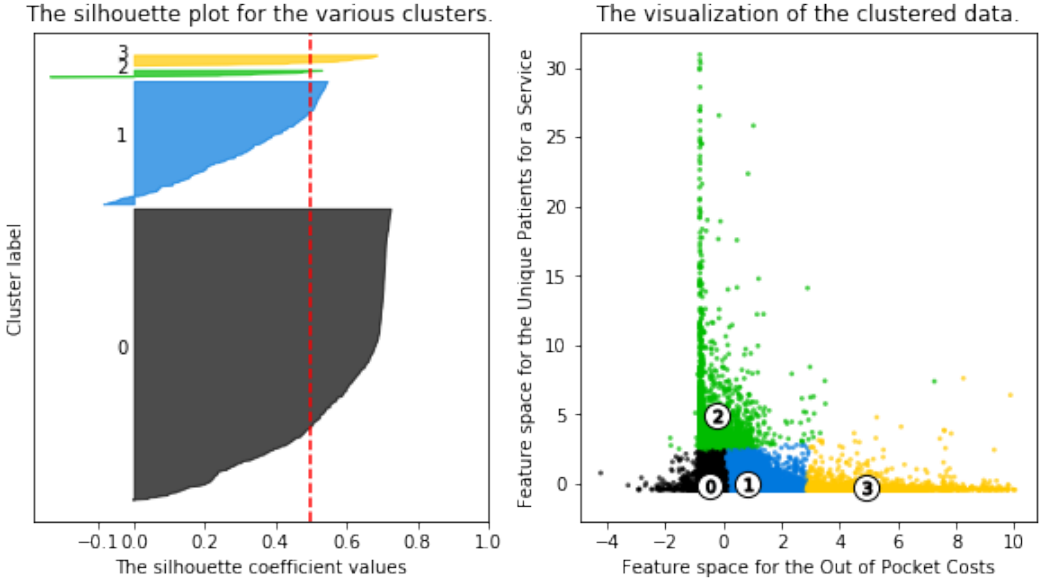
```
    # Labeling the clusters
    centers = kmeans.cluster_centers_
    # Draw white circles at cluster centers
    ax2.scatter(centers[:, 0], centers[:, 1], marker='o',
                c="white", alpha=1, s=200, edgecolor='k')

    for i, c in enumerate(centers):
        ax2.scatter(c[0], c[1], marker='$%d$' % i, alpha=1,
                    s=50, edgecolor='k')

    ax2.set_title("The visualization of the clustered data.")
    ax2.set_xlabel("Feature space for the Out of Pocket Costs")
    ax2.set_ylabel("Feature space for the Unique Patients for a Service")

    plt.suptitle(("Silhouette analysis for KMeans clustering on sample data "
                  "with n_clusters = %d" % nClusters),
                 fontsize=14, fontweight='bold')

plt.show()
```

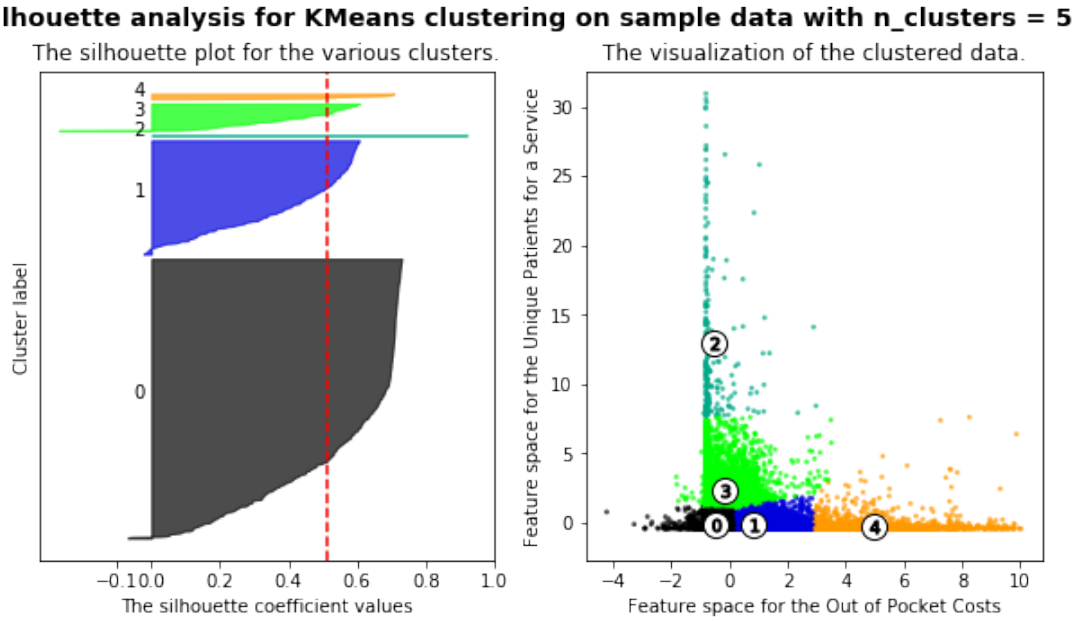


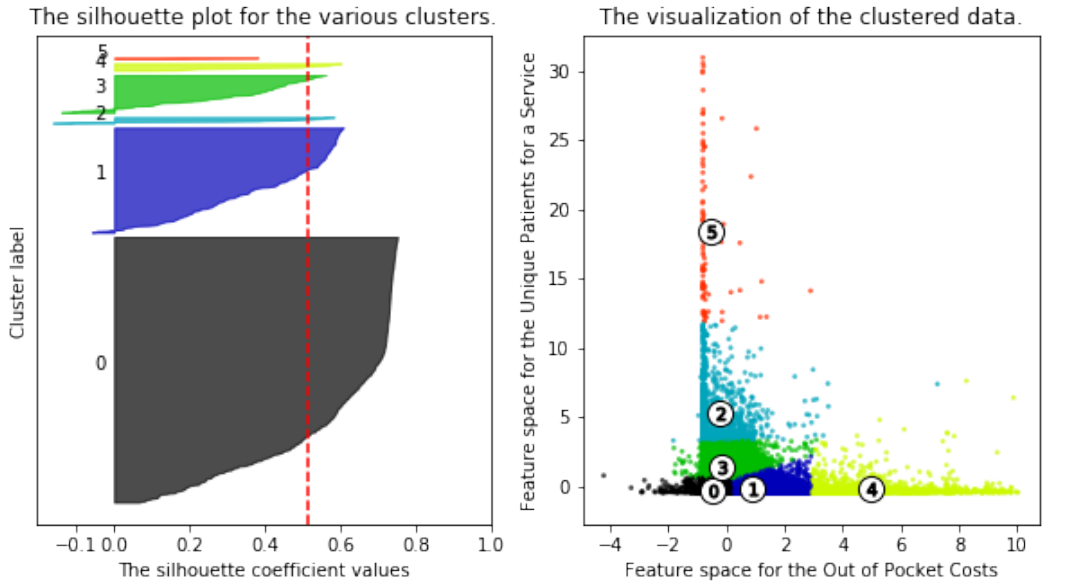
Silhouette analysis for KMeans clustering on sample data with n_clusters = 3



Silhouette analysis for KMeans clustering on sample data with n_clusters = 4







1.5 Analysis

[21]:
```
# Pulling Data again for clarity
cur_col = ['pocket', 'unique_patients_count']
scaler = StandardScaler()
```

```
std_df = df.loc[train, cur_col]
std_df = scaler.fit_transform(std_df)
```

[22]:
```
# Grabbing labels when K = 3 Clusters
labels = KMeans(n_clusters=3, random_state=0).fit_predict(std_df)
```

[23]:
```
# Creating df that has clusters and non-clustered information as well
data = df.loc[train, :]
data['Cluster'] = labels
```

[24]:
```
# Looking at cluster frequencies
print(data['Cluster'].value_counts(normalize = True))
```

```
1    0.827477
2    0.151974
0    0.020549
Name: Cluster, dtype: float64
```

[25]:
```
# Finding
for i in range(3):
    print(data.loc[data.Cluster == i]['provider_type'].value_counts(normalize =␣
 ↪True))
```

```
Diagnostic Radiology                    0.1580
Clinical Laboratory                     0.1165
Cardiology                              0.0980
Ophthalmology                           0.0845
Internal Medicine                       0.0820
Dermatology                             0.0595
Urology                                 0.0425
Family Practice                         0.0415
Emergency Medicine                      0.0380
Pathology                               0.0320
Ambulance Service Provider              0.0185
Orthopedic Surgery                      0.0170
Podiatry                                0.0170
Optometry                               0.0160
Nurse Practitioner                      0.0150
Endocrinology                           0.0135
Physician Assistant                     0.0135
Interventional Cardiology               0.0110
Anesthesiology                          0.0095
Pulmonary Disease                       0.0095
Hematology-Oncology                     0.0090
Centralized Flu                         0.0065
Portable X-Ray Supplier                 0.0065
Ambulatory Surgical Center              0.0060
```

```
Physical Medicine and Rehabilitation              0.0060
Neurology                                         0.0060
Gastroenterology                                  0.0060
Nephrology                                        0.0055
Clinical Cardiac Electrophysiology                0.0055
Rheumatology                                      0.0055
Otolaryngology                                    0.0050
Medical Oncology                                  0.0050
Mass Immunizer Roster Biller                      0.0035
Independent Diagnostic Testing Facility (IDTF)    0.0035
Interventional Pain Management                    0.0025
Psychiatry                                        0.0020
Infectious Disease                                0.0020
Physical Therapist in Private Practice            0.0020
Audiologist                                       0.0020
General Practice                                  0.0015
Certified Registered Nurse Anesthetist (CRNA)     0.0015
Pain Management                                   0.0015
Vascular Surgery                                  0.0015
Interventional Radiology                          0.0015
Sleep Medicine                                    0.0010
Allergy/ Immunology                               0.0010
General Surgery                                   0.0010
Sports Medicine                                   0.0010
Certified Clinical Nurse Specialist               0.0005
Radiation Therapy Center                          0.0005
Occupational Therapist in Private Practice        0.0005
Psychologist, Clinical                            0.0005
Radiation Oncology                                0.0005
Critical Care (Intensivists)                      0.0005
Nuclear Medicine                                  0.0005
Undefined Physician type                          0.0005
Hand Surgery                                      0.0005
Neuropsychiatry                                   0.0005
Clinic or Group Practice                          0.0005
Name: provider_type, dtype: float64
Diagnostic Radiology                              0.139393
Internal Medicine                                 0.116521
Family Practice                                   0.107916
Nurse Practitioner                                0.064407
Physician Assistant                               0.042106
Cardiology                                        0.041013
Physical Therapist in Private Practice            0.033873
Orthopedic Surgery                                0.028609
Anesthesiology                                    0.021419
Podiatry                                          0.021009
Emergency Medicine                                0.019867
Hematology-Oncology                               0.018265
```

Ophthalmology	0.018067
Pathology	0.017843
Dermatology	0.016937
Urology	0.016142
Gastroenterology	0.015472
Mass Immunizer Roster Biller	0.015447
Optometry	0.015335
Pulmonary Disease	0.014366
General Surgery	0.013646
Certified Registered Nurse Anesthetist (CRNA)	0.011374
Obstetrics & Gynecology	0.011051
Clinical Laboratory	0.010964
Neurology	0.010443
Nephrology	0.009487
Otolaryngology	0.009002
Physical Medicine and Rehabilitation	0.008568
Psychiatry	0.008530
Rheumatology	0.007562
Interventional Cardiology	0.006755
Radiation Oncology	0.006233
Centralized Flu	0.006097
Chiropractic	0.005786
Medical Oncology	0.005662
Clinical Cardiac Electrophysiology	0.005612
Endocrinology	0.005414
Vascular Surgery	0.005066
Interventional Radiology	0.004756
General Practice	0.004259
Psychologist, Clinical	0.003924
Infectious Disease	0.003849
Licensed Clinical Social Worker	0.003775
Pain Management	0.003638
Allergy/ Immunology	0.003253
Interventional Pain Management	0.003154
Hospitalist	0.003079
Occupational Therapist in Private Practice	0.002868
Neurosurgery	0.002781
Audiologist	0.002459
Critical Care (Intensivists)	0.002396
Independent Diagnostic Testing Facility (IDTF)	0.002359
Hand Surgery	0.002111
Geriatric Medicine	0.002036
Plastic and Reconstructive Surgery	0.001974
Sports Medicine	0.001242
Thoracic Surgery	0.001229
Colorectal Surgery (Proctology)	0.001180
Pediatric Medicine	0.001006
Ambulatory Surgical Center	0.000969

```
Nuclear Medicine                                    0.000919
Portable X-Ray Supplier                             0.000857
Certified Clinical Nurse Specialist                 0.000844
Hematology                                          0.000795
Cardiac Surgery                                     0.000782
Gynecological Oncology                              0.000745
Ambulance Service Provider                          0.000720
Hospice and Palliative Care                         0.000559
Surgical Oncology                                   0.000509
Anesthesiology Assistant                            0.000484
Osteopathic Manipulative Medicine                   0.000484
Registered Dietitian or Nutrition Professional      0.000410
Undefined Physician type                            0.000385
Oral Surgery (Dentist only)                         0.000310
Sleep Medicine                                      0.000273
Speech Language Pathologist                         0.000224
Preventive Medicine                                 0.000186
Maxillofacial Surgery                               0.000174
Certified Nurse Midwife                             0.000137
Public Health or Welfare Agency                     0.000112
Geriatric Psychiatry                                0.000112
Peripheral Vascular Disease                         0.000112
Addiction Medicine                                  0.000075
Neuropsychiatry                                     0.000075
Clinic or Group Practice                            0.000062
Radiation Therapy Center                            0.000050
Advanced Heart Failure and Transplant Cardiology    0.000025
Mammography Center                                  0.000012
Pharmacy                                            0.000012
Name: provider_type, dtype: float64
Internal Medicine                                 0.109661
Cardiology                                        0.062335
Family Practice                                   0.061659
Diagnostic Radiology                              0.056318
Ophthalmology                                     0.050909
Emergency Medicine                                0.042729
Gastroenterology                                  0.038131
Anesthesiology                                    0.037320
Dermatology                                       0.037117
Neurology                                         0.032385
General Surgery                                   0.029545
Orthopedic Surgery                                0.029207
Urology                                           0.028666
Optometry                                         0.026029
Nurse Practitioner                                0.025691
Nephrology                                        0.021500
Physician Assistant                               0.020823
Ambulatory Surgical Center                        0.019945
```

Radiation Oncology	0.018457
Pulmonary Disease	0.017511
Certified Registered Nurse Anesthetist (CRNA)	0.016091
Otolaryngology	0.015212
Ambulance Service Provider	0.014401
Interventional Cardiology	0.013454
Vascular Surgery	0.012305
Hematology-Oncology	0.011832
Podiatry	0.011020
Neurosurgery	0.010344
Clinical Cardiac Electrophysiology	0.010074
Independent Diagnostic Testing Facility (IDTF)	0.009398
Physical Medicine and Rehabilitation	0.009398
Psychiatry	0.008924
Obstetrics & Gynecology	0.007978
Endocrinology	0.006152
Hospitalist	0.005206
Interventional Pain Management	0.005003
Plastic and Reconstructive Surgery	0.004868
Pain Management	0.004868
Infectious Disease	0.004868
Rheumatology	0.004665
Medical Oncology	0.004462
General Practice	0.004192
Thoracic Surgery	0.003921
Interventional Radiology	0.003516
Hand Surgery	0.003516
Critical Care (Intensivists)	0.003245
Cardiac Surgery	0.003245
Colorectal Surgery (Proctology)	0.002637
Allergy/ Immunology	0.002231
Pathology	0.002028
Geriatric Medicine	0.001893
Psychologist, Clinical	0.001623
Surgical Oncology	0.001149
Gynecological Oncology	0.001149
Sports Medicine	0.000947
Hospice and Palliative Care	0.000811
Undefined Physician type	0.000811
Hematology	0.000676
Clinical Laboratory	0.000608
Osteopathic Manipulative Medicine	0.000608
Sleep Medicine	0.000541
Physical Therapist in Private Practice	0.000473
Nuclear Medicine	0.000473
Anesthesiology Assistant	0.000406
Licensed Clinical Social Worker	0.000406
Pediatric Medicine	0.000406

```
Certified Clinical Nurse Specialist                0.000338
Speech Language Pathologist                        0.000270
Oral Surgery (Dentist only)                        0.000270
Maxillofacial Surgery                              0.000203
Peripheral Vascular Disease                        0.000135
Addiction Medicine                                 0.000135
Preventive Medicine                                0.000135
Geriatric Psychiatry                               0.000135
Audiologist                                        0.000135
Portable X-Ray Supplier                            0.000068
Clinic or Group Practice                           0.000068
Neuropsychiatry                                    0.000068
Dentist                                            0.000068
Name: provider_type, dtype: float64
```

[26]:
```
for i in normal:
    data[i] = np.exp(data[i])
```

[27]:
```
data[['Cluster', 'unique_patients_count', 'pocket', 'services_count',␣
 ↪'average_submitted_charge']].groupby('Cluster').mean()
```

[27]:
```
         unique_patients_count     pocket  services_count  \
Cluster
0                   789.684000  15.366059     1357.885950
1                    60.659080  13.047823      153.621036
2                    55.939355  63.910223       74.633703

         average_submitted_charge
Cluster
0                      175.516889
1                      187.129310
2                      813.542266
```

1.6 Testing

[28]:
```
cur_col = ['pocket', 'unique_patients_count']
scaler = StandardScaler()
std_df = df.loc[train, cur_col]
std_df = scaler.fit_transform(std_df)
```

[29]:
```
# Standardize Testing Data
scaler = StandardScaler()
std_df = df.loc[test, cur_col]
std_df = scaler.fit_transform(std_df)
```

[30]:
```
test_labels = kmeans.predict(std_df)

data = df.loc[test, :]
data['Cluster'] = test_labels
```

[31]:
```
print(data['Cluster'].value_counts())
```

```
0    61458
1    24171
3     8714
4     1760
2     1124
5       99
Name: Cluster, dtype: int64
```

[32]:
```
for i in normal:
    data[i] = np.exp(data[i])
```

[33]:
```
data[['Cluster', 'unique_patients_count', 'pocket', 'services_count',␣
 ↪'average_submitted_charge']].groupby('Cluster').mean()
```

[33]:

Cluster	unique_patients_count	pocket	services_count	average_submitted_charge
0	41.420922	9.319727	128.573789	149.989181
1	46.511026	42.936072	64.370775	547.929749
2	830.127224	15.189287	1465.446441	166.831007
3	273.446179	16.726345	527.080250	186.916208
4	46.575568	145.372606	70.391477	1888.200571
5	2531.929293	13.391315	3967.636364	230.999075

[34]:
```
for i in range(3):
    print(data.loc[data.Cluster == i]['provider_type'].value_counts())
```

```
Diagnostic Radiology                          9787
Internal Medicine                             7178
Family Practice                               7041
Nurse Practitioner                            3994
Physician Assistant                           2536
Physical Therapist in Private Practice        2514
```

Cardiology	2400
Orthopedic Surgery	1759
Pathology	1246
Podiatry	1191
Hematology-Oncology	1148
Mass Immunizer Roster Biller	1138
Anesthesiology	1110
Emergency Medicine	1036
Ophthalmology	976
Urology	955
Optometry	844
General Surgery	775
Pulmonary Disease	765
Clinical Laboratory	716
Gastroenterology	695
Obstetrics & Gynecology	693
Dermatology	674
Certified Registered Nurse Anesthetist (CRNA)	537
Neurology	521
Nephrology	503
Chiropractic	461
Otolaryngology	443
Rheumatology	439
Physical Medicine and Rehabilitation	434
Interventional Cardiology	433
Psychiatry	418
Centralized Flu	383
Radiation Oncology	382
Medical Oncology	378
Clinical Cardiac Electrophysiology	342
Interventional Radiology	304
Endocrinology	298
Vascular Surgery	294
General Practice	259
Licensed Clinical Social Worker	255
Infectious Disease	234
Occupational Therapist in Private Practice	218
Allergy/ Immunology	210
Psychologist, Clinical	192
Audiologist	185
Hospitalist	170
Pain Management	164
Interventional Pain Management	164
Hand Surgery	145
Neurosurgery	139
Independent Diagnostic Testing Facility (IDTF)	133
Geriatric Medicine	123
Critical Care (Intensivists)	122

```
Plastic and Reconstructive Surgery                    104
Thoracic Surgery                                       72
Portable X-Ray Supplier                                64
Colorectal Surgery (Proctology)                        62
Sports Medicine                                        61
Pediatric Medicine                                     60
Hematology                                             52
Nuclear Medicine                                       52
Certified Clinical Nurse Specialist                    50
Ambulance Service Provider                             48
Ambulatory Surgical Center                             47
Gynecological Oncology                                 38
Hospice and Palliative Care                            35
Cardiac Surgery                                        35
Registered Dietitian or Nutrition Professional         26
Undefined Physician type                               26
Anesthesiology Assistant                               26
Osteopathic Manipulative Medicine                      24
Surgical Oncology                                      20
Oral Surgery (Dentist only)                            16
Sleep Medicine                                         12
Speech Language Pathologist                            10
Maxillofacial Surgery                                  10
Certified Nurse Midwife                                 9
Preventive Medicine                                     9
Addiction Medicine                                      8
Public Health or Welfare Agency                         7
Peripheral Vascular Disease                             7
Neuropsychiatry                                         5
Geriatric Psychiatry                                    4
Clinic or Group Practice                                3
Advanced Heart Failure and Transplant Cardiology        1
Pharmacy                                                1
Name: provider_type, dtype: int64
Internal Medicine                                    2715
Family Practice                                      1755
Diagnostic Radiology                                 1556
Cardiology                                           1154
Nurse Practitioner                                   1100
Anesthesiology                                        944
Physician Assistant                                   889
Gastroenterology                                      887
Emergency Medicine                                    872
Dermatology                                           867
General Surgery                                       685
Urology                                               659
Neurology                                             651
Ophthalmology                                         633
```

Optometry	628
Orthopedic Surgery	624
Certified Registered Nurse Anesthetist (CRNA)	603
Pulmonary Disease	463
Nephrology	450
Podiatry	427
Otolaryngology	394
Psychiatry	340
Hematology-Oncology	333
Radiation Oncology	305
Physical Medicine and Rehabilitation	293
Interventional Cardiology	252
Obstetrics & Gynecology	238
Vascular Surgery	227
Neurosurgery	181
Psychologist, Clinical	176
Endocrinology	172
Independent Diagnostic Testing Facility (IDTF)	163
Ambulatory Surgical Center	158
Clinical Cardiac Electrophysiology	152
Physical Therapist in Private Practice	142
Interventional Pain Management	140
Infectious Disease	136
Pain Management	123
Rheumatology	119
Hospitalist	114
Critical Care (Intensivists)	113
Ambulance Service Provider	112
Medical Oncology	111
General Practice	102
Interventional Radiology	88
Colorectal Surgery (Proctology)	82
Pathology	81
Plastic and Reconstructive Surgery	80
Allergy/ Immunology	66
Thoracic Surgery	66
Licensed Clinical Social Worker	64
Geriatric Medicine	62
Hand Surgery	57
Cardiac Surgery	52
Sports Medicine	39
Surgical Oncology	31
Hematology	24
Gynecological Oncology	23
Certified Clinical Nurse Specialist	22
Anesthesiology Assistant	20
Undefined Physician type	17
Hospice and Palliative Care	17

```
Pediatric Medicine                              16
Sleep Medicine                                  15
Osteopathic Manipulative Medicine               14
Nuclear Medicine                                11
Clinical Laboratory                             10
Oral Surgery (Dentist only)                      8
Preventive Medicine                              7
Audiologist                                      7
Occupational Therapist in Private Practice       5
Peripheral Vascular Disease                      5
Geriatric Psychiatry                             4
Neuropsychiatry                                  4
Maxillofacial Surgery                            3
Certified Nurse Midwife                          3
Speech Language Pathologist                      3
Radiation Therapy Center                         2
Clinic or Group Practice                         2
Addiction Medicine                               2
Chiropractic                                     1
Name: provider_type, dtype: int64
Diagnostic Radiology                           202
Clinical Laboratory                            138
Cardiology                                     138
Ophthalmology                                   95
Internal Medicine                               71
Dermatology                                     70
Urology                                         41
Ambulance Service Provider                      35
Pathology                                       35
Emergency Medicine                              33
Family Practice                                 26
Hematology-Oncology                             20
Orthopedic Surgery                              16
Interventional Cardiology                       15
Nurse Practitioner                              14
Podiatry                                        13
Endocrinology                                   13
Ambulatory Surgical Center                      10
Mass Immunizer Roster Biller                    10
Optometry                                        9
Centralized Flu                                  9
Anesthesiology                                   9
Portable X-Ray Supplier                          9
Physician Assistant                              8
Rheumatology                                     6
Medical Oncology                                 6
Clinical Cardiac Electrophysiology               6
Physical Medicine and Rehabilitation             6
```

```
Pulmonary Disease                                   4
Independent Diagnostic Testing Facility (IDTF)      4
Interventional Pain Management                      4
Gastroenterology                                    4
Otolaryngology                                      4
Audiologist                                         4
Pain Management                                     4
Interventional Radiology                            4
Psychiatry                                          3
General Practice                                    2
Vascular Surgery                                    2
Nephrology                                          2
Nuclear Medicine                                    2
Neurology                                           2
Infectious Disease                                  2
General Surgery                                     2
Chiropractic                                        1
Geriatric Psychiatry                                1
Pediatric Medicine                                  1
Allergy/ Immunology                                 1
Hand Surgery                                        1
Certified Registered Nurse Anesthetist (CRNA)       1
Occupational Therapist in Private Practice          1
Certified Clinical Nurse Specialist                 1
Cardiac Surgery                                     1
Plastic and Reconstructive Surgery                  1
Geriatric Medicine                                  1
Hematology                                          1
Name: provider_type, dtype: int64
```