1
```
#import libraries
import numpy as np
import pandas as pd
import statsmodels.api as sm
import matplotlib.pyplot as plt
import seaborn as sea
import numpy as np
from sklearn.discriminant_analysis import LinearDiscriminantAnalysis
from sklearn.discriminant_analysis import QuadraticDiscriminantAnalysis
from sklearn.linear_model import LogisticRegression
from sklearn import metrics
from sklearn.model_selection import train_test_split as split
from sklearn.model_selection import KFold
from statsmodels.stats.outliers_influence import variance_inflation_factor as vif
from sklearn.decomposition import PCA
```

2
```
#data preprocessing, cleaning and a little sorting
health_data_raw=pd.read_stata('Data Sets_Other/sect3_health.dta')
health_data=pd.read_stata('Data Sets_Other/sect3_health.dta',convert_categoricals=False,preserve_dtypes=F
health_data=health_data.fillna(0)
health_data
#health_data.describe()
#health_data_raw
#health_data_raw.describe()
#sea.pairplot(health_data)
```

2

	zone	state	lga	sector	ea	hhid	indiv	s03q01	s03q02	s03q03
0	2	2	204	2	10001	2040001	1	1.0	0.0	2.0
1	2	2	204	2	10001	2040001	2	1.0	0.0	2.0
2	2	2	204	2	10001	2040001	3	1.0	0.0	1.0
3	2	2	204	2	10001	2040001	4	2.0	2.0	2.0
4	2	2	204	2	10001	2040001	5	2.0	2.0	2.0
...	...	...	...	...	...	...	...	...	...	...
16406	2	34	3413	2	10245	34130179	3	1.0	0.0	1.0
16407	2	34	3413	2	10245	34130180	1	1.0	0.0	1.0
16408	2	34	3413	2	10245	34130180	2	2.0	1.0	2.0
16409	2	34	3413	2	10245	34130180	3	1.0	0.0	1.0
16410	2	34	3413	2	10245	34130180	4	2.0	1.0	2.0

16411 rows × 55 columns

3
```
health_data.columns
```

3
```
Index(['zone', 'state', 'lga', 'sector', 'ea', 'hhid', 'indiv', 's03q01',
       's03q02', 's03q03', 's03q04_1', 's03q04_2', 's03q05', 's03q06_1',
```

```
       's03q06_2', 's03q06_os', 's03q07a', 's03q08', 's03q09', 's03q10_1',
       's03q10_2', 's03q10_os', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q12_os', 's03q13', 's03q13_os',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b',
       's03q18b_os', 's03q19', 's03q20', 's03q21', 's03q22', 's03q23',
       's03q24', 's03q25', 's03q26', 's03q27', 's03q28', 's03q29', 's03q30',
       's03q31', 's03q32', 's03q32_os', 's03q33'],
      dtype='object')
```

4
```
#data for the south west for past 30 days
southwest_total_data=health_data.loc[health_data['zone']==6,['state','sector','s03q03','s03q04_1','s03q04
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]
#state_zone=health_data.loc[health_data['zone']<=6,['state','zone']]
#state_zone=state_zone.loc[state_zone['state']==24,:]
#sea.pairplot(southwest_total_data)
southwest_total_data
```

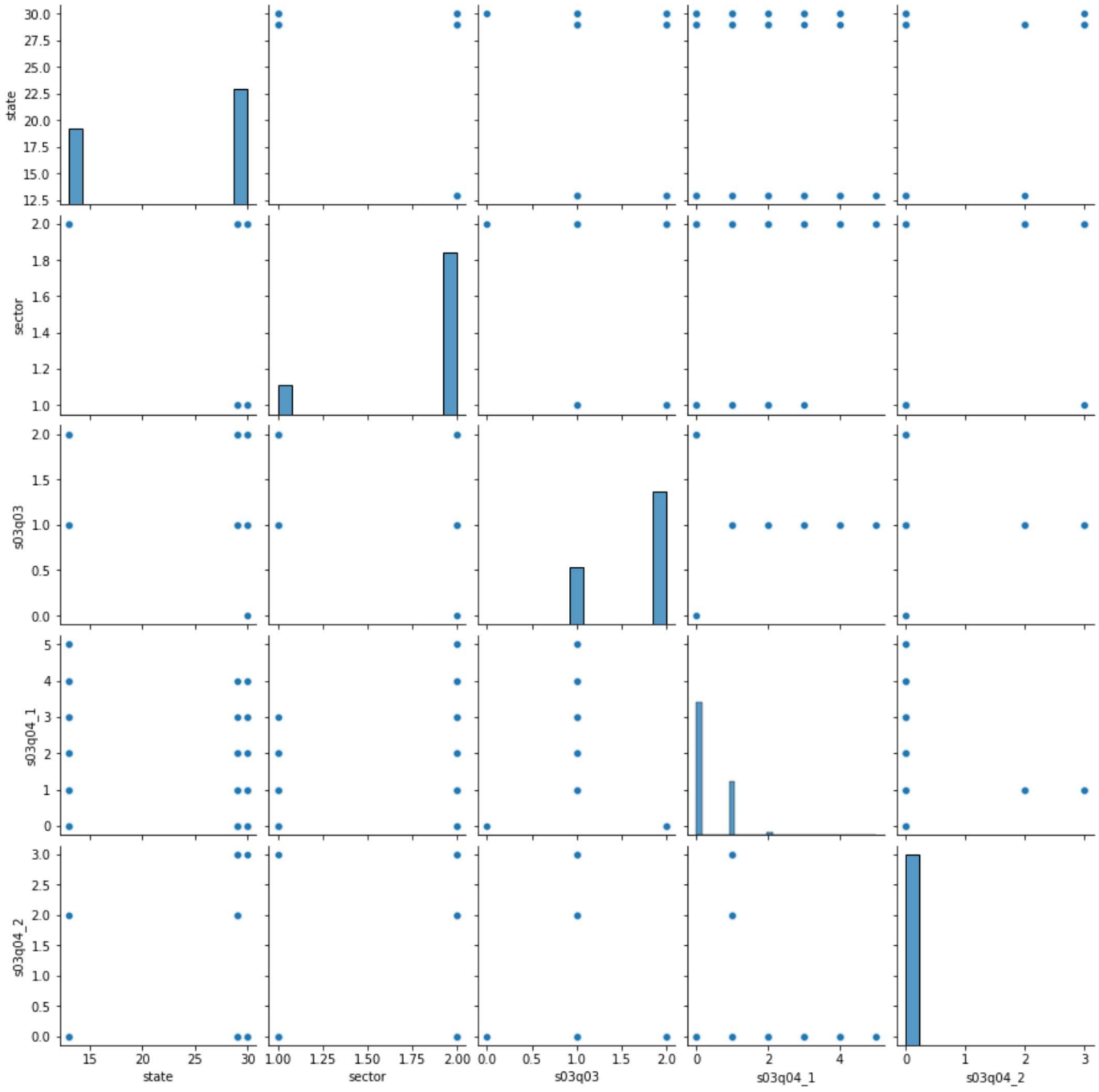
4

	state	sector	s03q03	s03q04_1	s03q04_2	s03q05	s03q06_1	s03q06_2	s03q07
2109	13	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0
2110	13	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0
2111	13	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0
2112	13	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0
2113	13	2	1.0	1.0	0.0	0.0	2.0	26.0	4.0
...	...	...	...	...	...	...	...	...	...
14149	30	2	2.0	0.0	0.0	1.0	2.0	0.0	4.0
14150	30	2	2.0	0.0	0.0	1.0	2.0	0.0	1.0
14151	30	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0
14152	30	2	2.0	0.0	0.0	1.0	2.0	8.0	3.0
14153	30	2	2.0	0.0	0.0	2.0	0.0	0.0	0.0

2114 rows × 27 columns

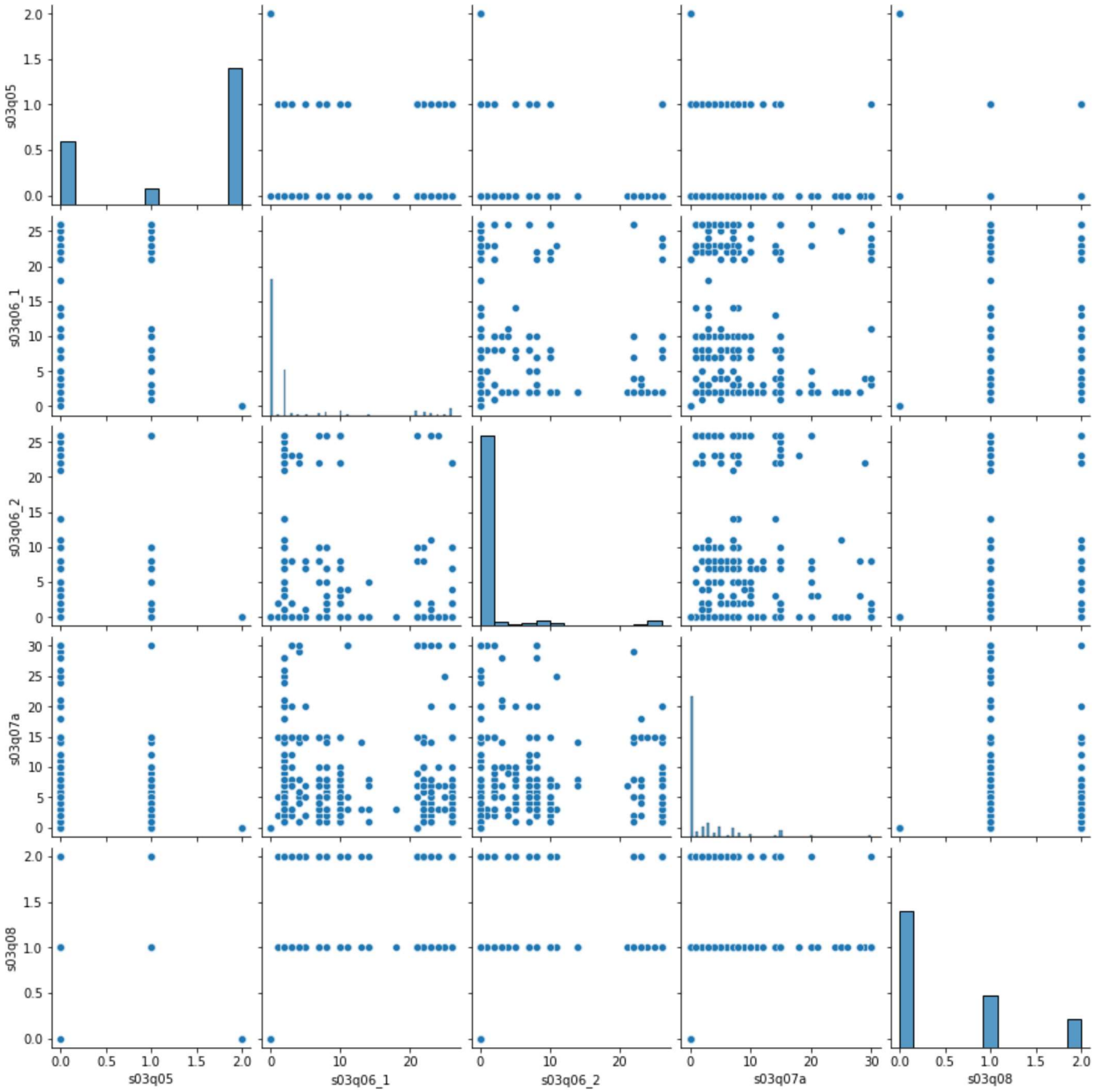
5
```
#data plotting
sw_plot_1=southwest_total_data.loc[:,['state','sector','s03q03','s03q04_1','s03q04_2']]
sea.pairplot(sw_plot_1)
```

5
```
<seaborn.axisgrid.PairGrid at 0x29dbaabc100>
```



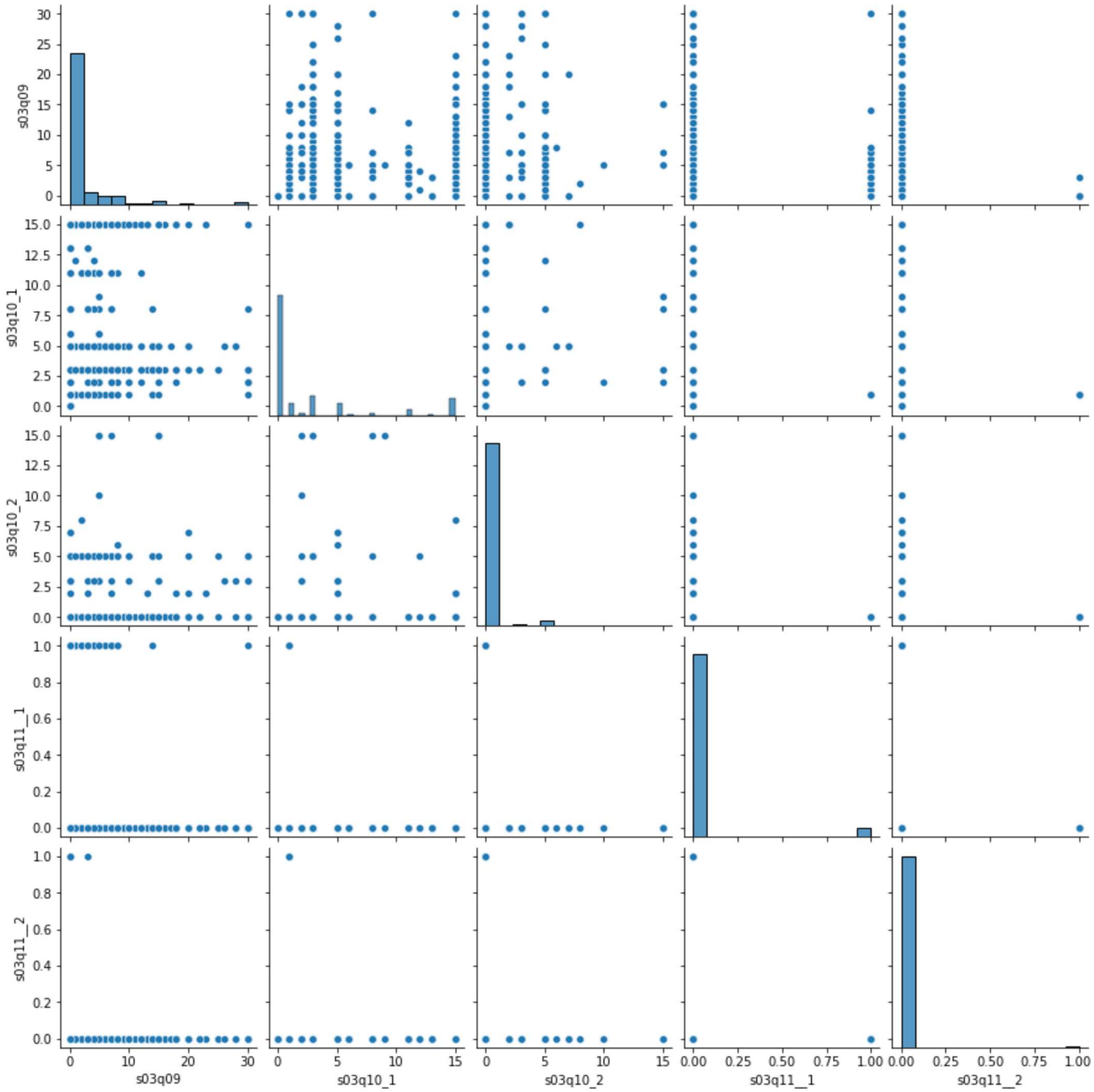

```
#data plotting
sw_plot_2=southwest_total_data.loc[:,['s03q05','s03q06_1','s03q06_2','s03q07a','s03q08']]
sea.pairplot(sw_plot_2)
```

```
<seaborn.axisgrid.PairGrid at 0x29dbd55e280>
```



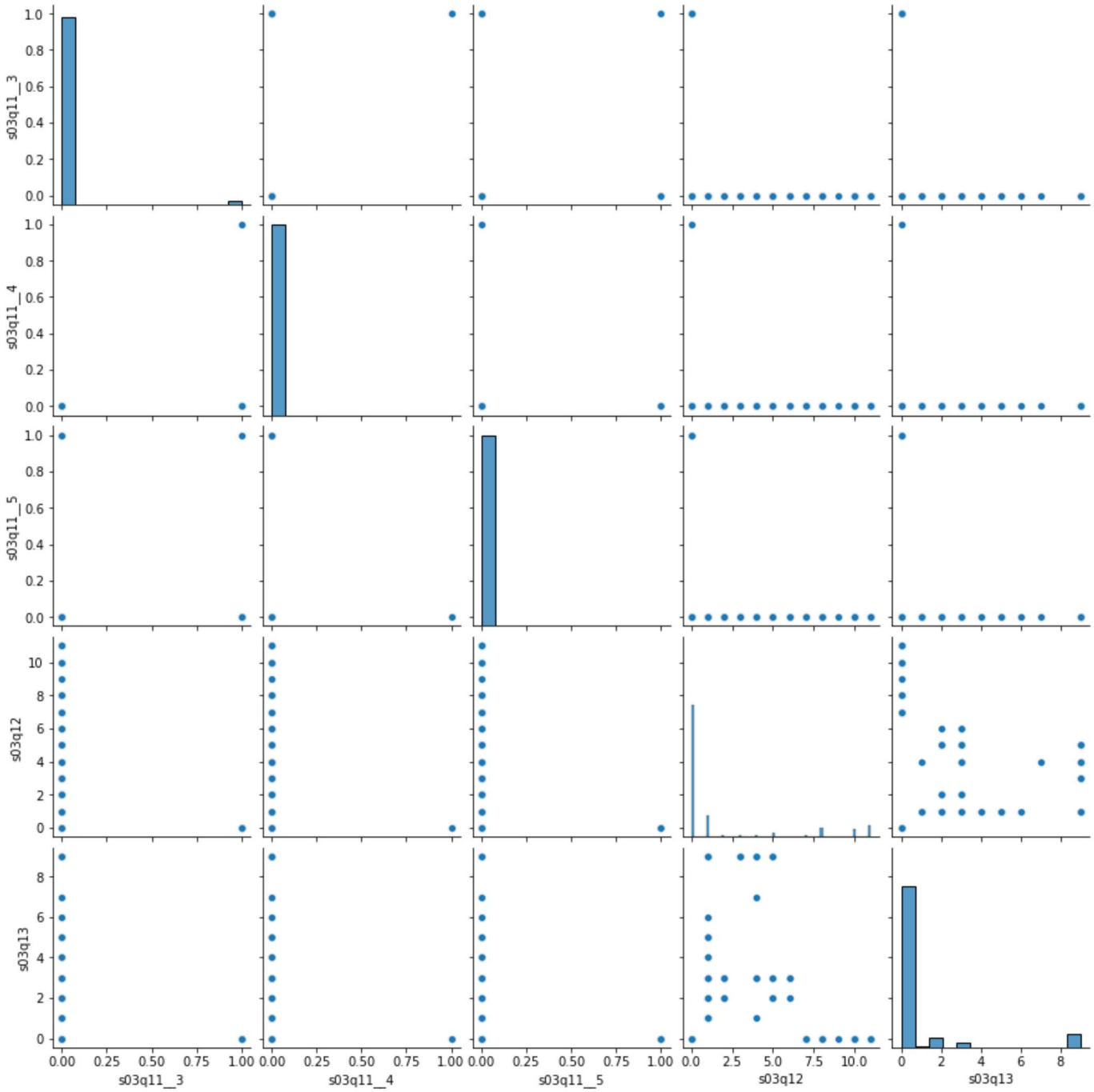

```
7  #data plotting
   sw_plot_3=southwest_total_data.loc[:,['s03q09', 's03q10_1','s03q10_2', 's03q11__1', 's03q11__2']]
   sea.pairplot(sw_plot_3)
```

```
7  <seaborn.axisgrid.PairGrid at 0x29dbe7bbfd0>
```



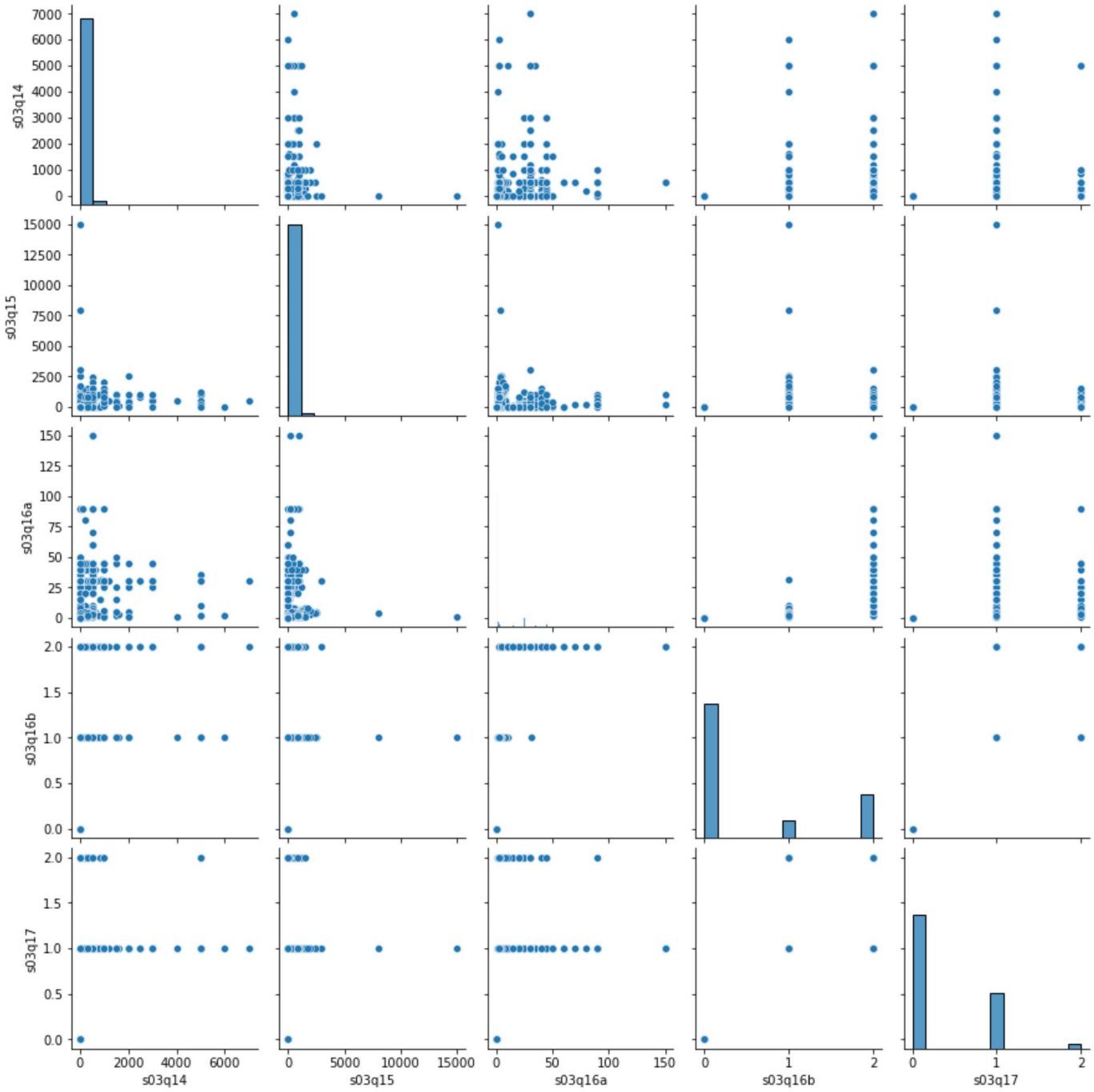
8
```
#data plotting
sw_plot_4=southwest_total_data.loc[:,['s03q11__3','s03q11__4', 's03q11__5', 's03q12', 's03q13']]
sea.pairplot(sw_plot_4)
```

8
```
<seaborn.axisgrid.PairGrid at 0x29dbf454e50>
```

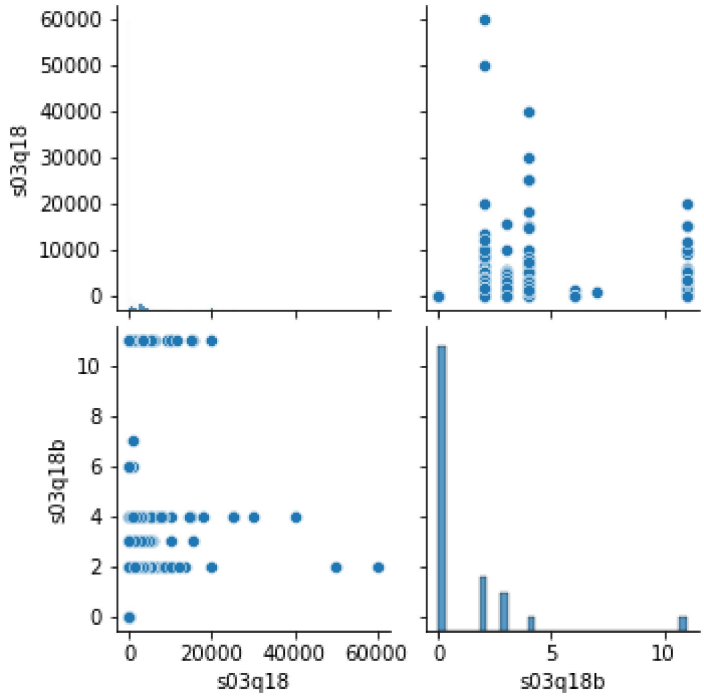



```
[9] #data plotting
    sw_plot_5=southwest_total_data.loc[:,['s03q14', 's03q15', 's03q16a', 's03q16b', 's03q17']]
    sea.pairplot(sw_plot_5)
```

```
[9] <seaborn.axisgrid.PairGrid at 0x29dc142b130>
```




```
10  #data plotting
    sw_plot_6=southwest_total_data.loc[:,[ 's03q18', 's03q18b']]
    plot6=sea.pairplot(sw_plot_6)
```



11
```
#test for colinearity if needed (vif)
vifdatax=health_data.loc[health_data['zone']==6,['zone','state','sector','s03q04_1','s03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]


vif_data=pd.DataFrame()
vif_data['feature']=vifdatax.columns

vif_data['VIF']=[vif(vifdatax.values,i) for i in range(len(vifdatax.columns))]
print(vif_data)
```

```
      feature         VIF
0        zone  126.379359
1       state    1.283020
2      sector    1.155342
3    s03q04_1    2.411468
4    s03q04_2    1.071587
5      s03q05   15.748960
6    s03q06_1    1.710809
7    s03q06_2    1.260246
8     s03q07a    3.671035
9      s03q08    8.521257
10     s03q09    3.909443
11   s03q10_1   11.165224
12   s03q10_2    1.208677
13  s03q11__1    3.129934
14  s03q11__2    1.283692
15  s03q11__3    1.641351
16  s03q11__4    1.169566
17  s03q11__5    1.055591
18     s03q12   13.549558
19     s03q13    2.960139
20     s03q14    1.327161
21     s03q15    1.554728
22    s03q16a    3.966910
23    s03q16b   24.194978
```

```
24     s03q17    9.254953
25     s03q18    1.852098
26    s03q18b    2.136655
```

```
12 #dropping zone
vifdatax2=health_data.loc[health_data['zone']==6,['state','sector','s03q04_1','s03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]

vif2=pd.DataFrame()
vif2['features']=vifdatax2.columns

vif2['vif without zone']=[vif(vifdatax2.values,i) for i in range(len(vifdatax2.columns))]
print(vif2)
```

```
     features  vif without zone
0       state          9.676173
1      sector         21.228903
2    s03q04_1          2.945476
3    s03q04_2          1.075971
4      s03q05         21.573383
5    s03q06_1          2.047939
6    s03q06_2          1.366675
7     s03q07a          4.568601
8      s03q08         12.087358
9      s03q09          4.456681
10   s03q10_1         14.247174
11   s03q10_2          1.253104
12  s03q11__1          3.030307
13  s03q11__2          1.287912
14  s03q11__3          1.570109
15  s03q11__4          1.168333
16  s03q11__5          1.042877
17     s03q12         16.930420
18     s03q13          3.327298
19     s03q14          1.387409
20     s03q15          1.607263
21    s03q16a          4.786470
22    s03q16b         31.389877
23     s03q17         12.708499
24     s03q18          1.970719
25    s03q18b          2.619985
```

```
13 #dropping s03q16b
vifdatax3=health_data.loc[health_data['zone']==6,['state','sector','s03q04_1','s03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q17', 's03q18', 's03q18b']]

vif3=pd.DataFrame()
vif3['features']=vifdatax3.columns

vif3['vif without zone']=[vif(vifdatax3.values,i) for i in range(len(vifdatax3.columns))]
print(vif3)
```

```
     features  vif without zone
0       state          9.631939
1      sector         20.843857
2    s03q04_1          2.870477
3    s03q04_2          1.075722
4      s03q05         21.139569
```

```
5    s03q06_1          2.046588
6    s03q06_2          1.365672
7     s03q07a          4.547949
8      s03q08         11.620837
9      s03q09          4.378667
10   s03q10_1         13.743133
11   s03q10_2          1.253074
12  s03q11__1          2.827063
13  s03q11__2          1.278112
14  s03q11__3          1.516592
15  s03q11__4          1.167528
16  s03q11__5          1.039716
17     s03q12         16.076017
18     s03q13          3.208642
19     s03q14          1.387347
20     s03q15          1.596120
21    s03q16a          2.415898
22     s03q17         11.175194
23     s03q18          1.969782
24    s03q18b          2.562827
```

14
```
#dropping s03q05
vifdatax4=health_data.loc[health_data['zone']==6,['state','sector','s03q04_1','s03q04_2',
       's03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q17', 's03q18', 's03q18b']]

vif4=pd.DataFrame()
vif4['features']=vifdatax4.columns

vif4['vif without zone']=[vif(vifdatax4.values,i) for i in range(len(vifdatax4.columns))]
print(vif4)
```

```
     features  vif without zone
0       state          6.097718
1      sector          6.330041
2    s03q04_1          2.740638
3    s03q04_2          1.074633
4    s03q06_1          2.042511
5    s03q06_2          1.365662
6     s03q07a          4.543688
7      s03q08         10.714032
8      s03q09          4.317878
9    s03q10_1         13.708924
10   s03q10_2          1.251383
11  s03q11__1          2.711825
12  s03q11__2          1.274130
13  s03q11__3          1.470535
14  s03q11__4          1.166591
15  s03q11__5          1.034808
16     s03q12         15.951323
17     s03q13          3.111595
18     s03q14          1.387162
19     s03q15          1.592676
20    s03q16a          2.385899
21     s03q17         10.748048
22     s03q18          1.968390
23    s03q18b          2.535864
```

15
```
#dropping s03q12
vifdatax5=health_data.loc[health_data['zone']==6,['state','sector','s03q04_1','s03q04_2',
       's03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
```

```
       's03q11__4', 's03q11__5', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q17', 's03q18', 's03q18b']]

vif5=pd.DataFrame()
vif5['features']=vifdatax5.columns

vif5['vif without zone']=[vif(vifdatax5.values,i) for i in range(len(vifdatax5.columns))]
print(vif5)
```

```
     features  vif without zone
0       state          6.096657
1      sector          6.326565
2    s03q04_1          2.730057
3    s03q04_2          1.072848
4    s03q06_1          2.041564
5    s03q06_2          1.365661
6     s03q07a          4.516364
7      s03q08         10.664574
8      s03q09          4.298487
9    s03q10_1          4.224135
10   s03q10_2          1.245882
11  s03q11__1          2.679302
12  s03q11__2          1.272134
13  s03q11__3          1.463381
14  s03q11__4          1.166484
15  s03q11__5          1.034655
16     s03q13          2.183749
17     s03q14          1.378289
18     s03q15          1.585710
19    s03q16a          2.384502
20     s03q17          9.520753
21     s03q18          1.949016
22    s03q18b          2.535808
```

16

```
#changing the values of 1 and 2 to yes and no respectively.
val2str=southwest_total_data.loc[:,'s03q03']

for i in southwest_total_data.index:
    if val2str[i]==1.0:
        southwest_total_data['s03q03'][i]='YES'
    else:
        southwest_total_data['s03q03'][i]='NO'



southwest_total_data.head(30)
```

```
<ipython-input-16-232bc1bf4345>:8: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.ht
  southwest_total_data['s03q03'][i]='NO'
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\pandas\core\indexing.py:1637: SettingWithCopyWarning
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.ht
  self._setitem_single_block(indexer, value, name)
<ipython-input-16-232bc1bf4345>:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.ht
  southwest_total_data['s03q03'][i]='YES'
```

16

	state	sector	s03q03	s03q04_1	s03q04_2	s03q05	s03q06_1	s03q06_2	s03q07a

	state	sector	s03q03	s03q04_1	s03q04_2	s03q05	s03q06_1	s03q06_2	s03q07a
2109	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2110	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2111	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2112	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2113	13	2	YES	1.0	0.0	0.0	2.0	26.0	4.0
2114	13	2	YES	1.0	0.0	0.0	2.0	0.0	4.0
2115	13	2	YES	1.0	0.0	0.0	2.0	10.0	3.0
2116	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2117	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2118	13	2	YES	1.0	0.0	0.0	8.0	7.0	8.0
2119	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2120	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2121	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2122	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2123	13	2	NO	0.0	0.0	1.0	21.0	0.0	0.0
2124	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2125	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2126	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2127	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2128	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2129	13	2	YES	1.0	0.0	0.0	2.0	0.0	4.0
2130	13	2	YES	1.0	0.0	0.0	2.0	0.0	5.0
2131	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2132	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2133	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2134	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2135	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2136	13	2	YES	1.0	0.0	0.0	2.0	0.0	3.0
2137	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2138	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0

30 rows × 27 columns

17
```
#split data using 80/20 method and train and test
southwest_train, southwest_test= split(southwest_total_data,test_size=0.2)
southwest_train
southwest_test
```

17

	state	sector	s03q03	s03q04_1	s03q04_2	s03q05	s03q06_1	s03q06_2	s03q07
2673	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
13004	29	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
12887	29	1	NO	0.0	0.0	2.0	0.0	0.0	0.0
13825	30	2	NO	0.0	0.0	1.0	23.0	0.0	1.0
2497	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
...	...	...	...	...	...	...	...	...	...
2841	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
12938	29	1	NO	0.0	0.0	2.0	0.0	0.0	0.0
2629	13	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
13073	29	2	NO	0.0	0.0	2.0	0.0	0.0	0.0
2405	13	2	YES	1.0	0.0	0.0	2.0	0.0	7.0

423 rows × 27 columns

18
```
#logisitc regression
'''
visit_doc=health_data.loc[health_data['zone']==6,['state','sector','s03q03','s03q04_1','s03q04_2']]
val2str=visit_doc.loc[:,'s03q03']
for i in visit_doc.index:
    if val2str[i]==1.0:
        visit_doc['s03q03'][i]='YES'
    else:
        visit_doc['s03q03'][i]='NO'
        '''
visit_doc_model = LogisticRegression()
swtrainx= southwest_train.loc[:, ['sector', 's03q04_1', 's03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]
swtrainy= southwest_train.loc[:, ['s03q03']]
visit_doc_model.fit(swtrainx, swtrainy)
print(visit_doc_model.coef_)
#visit_doc_model.n_features_in_
#visit_doc_model
```

```
[[-1.05897890e+00  3.85292611e-01  6.74875148e-03 -1.43940484e+00
  -1.12861486e-02  8.12972848e-02  1.47209351e-01  7.03239731e-02
```

```
   6.56942975e-02  1.76331546e-01  2.57102684e-02  9.57989922e-03
  -4.04863766e-03  4.26900448e-03  0.00000000e+00  6.17059104e-03
   1.88232408e-02  1.36323039e-01  1.11134783e-03 -5.12971426e-04
   4.20091121e-02  6.81180452e-02  4.83811193e-02  2.08996754e-04
   6.15052994e-02]]
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

19
```
#predition and summary
swtesttrue= southwest_test.loc[:, ['s03q03']]
swtestx= southwest_test.loc[:, ['sector', 's03q04_1', 's03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]
logmodel_pred=visit_doc_model.predict(swtestx)
print(metrics.classification_report(swtesttrue, logmodel_pred))
metrics.confusion_matrix(swtesttrue, logmodel_pred)
#metrics.f1_score(swtesttrue,logmodel_pred)
```

```
              precision    recall  f1-score   support

          NO       0.94      0.98      0.96       292
         YES       0.96      0.86      0.91       131

    accuracy                           0.95       423
   macro avg       0.95      0.92      0.93       423
weighted avg       0.95      0.95      0.94       423
```

19
```
array([[287,   5],
       [ 18, 113]], dtype=int64)
```

20
```
#lda
visitdoc_ldamodel=LinearDiscriminantAnalysis()
visitdoc_ldamodel.fit(swtrainx, swtrainy)
visitdoc_ldamodel
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
```

20
```
LinearDiscriminantAnalysis()
```

21
```
#prediction and summary
ldamodel_pred=visitdoc_ldamodel.predict(swtestx)
print(metrics.classification_report(swtesttrue, ldamodel_pred))
metrics.confusion_matrix(swtesttrue, ldamodel_pred)
```

```
              precision    recall  f1-score   support

          NO       1.00      1.00      1.00       292
         YES       1.00      1.00      1.00       131

    accuracy                           1.00       423
   macro avg       1.00      1.00      1.00       423
```

```
weighted avg       1.00      1.00      1.00       423
```

21
```
array([[292,   0],
       [  0, 131]], dtype=int64)
```

22
```
#qda
visitdoc_qdamodel=QuadraticDiscriminantAnalysis()
visitdoc_qdamodel.fit(swtrainx, swtrainy)
visitdoc_qdamodel
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\discriminant_analysis.py:808: UserWarning: V
  warnings.warn("Variables are collinear")
```

22
```
QuadraticDiscriminantAnalysis()
```

23
```
#prediction and summary
qdamodel_pred=visitdoc_qdamodel.predict(swtestx)
print(metrics.classification_report(swtesttrue, qdamodel_pred))
metrics.confusion_matrix(swtesttrue, qdamodel_pred)
```

```
              precision    recall  f1-score   support

          NO       1.00      0.92      0.96       292
         YES       0.86      1.00      0.92       131

    accuracy                           0.95       423
   macro avg       0.93      0.96      0.94       423
weighted avg       0.96      0.95      0.95       423
```

23
```
array([[270,  22],
       [  0, 131]], dtype=int64)
```

24
```
#sorting data x and y
kcvx=southwest_total_data.loc[:,['sector','s03q04_1','s03q04_2',
       's03q05','s03q06_1','s03q06_2','s03q07a','s03q08','s03q09', 's03q10_1',
       's03q10_2', 's03q11__1', 's03q11__2', 's03q11__3',
       's03q11__4', 's03q11__5', 's03q12', 's03q13',
       's03q14', 's03q15', 's03q16a', 's03q16b', 's03q17', 's03q18', 's03q18b']]

kcvy=southwest_total_data.loc[:,['s03q03']]
kcvymae=health_data.loc[:,['s03q03']]
```

25
```
#cross validation with 7 folds for log regression
k=7
folds=KFold(n_splits=k)
accuracy=[]
metrep=[]

for train_index,test_index in folds.split(kcvx):
    #x_train=[],x_test=[],y_train=[],y_test=[]
    x_train,x_test= kcvx.iloc[train_index,:],kcvx.iloc[test_index,:]
    y_train,y_test= kcvy.iloc[train_index,:],kcvy.iloc[test_index,]

    #print(train_index,test_index)
    visit_doc_model.fit(x_train,y_train)
    y_pred=visit_doc_model.predict(x_test)
    metrep.append(metrics.classification_report(y_test,y_pred))
    accuracy.append(metrics.accuracy_score(y_test,y_pred))
    #mae.append(metrics.mean_absolute_error(y_test,y_pred))
```

```
#print(accuracy)
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

26

```
#to collect mae data

#cross validation with 7 folds for log regression
k=7
folds=KFold(n_splits=k)


mae=[]
for train_index,test_index in folds.split(kcvx):
    #x_train=[],x_test=[],y_train=[],y_test=[]
    x_train,x_test= kcvx.iloc[train_index,:],kcvx.iloc[test_index,:]
    y_train,y_test= kcvymae.iloc[train_index,:],kcvymae.iloc[test_index,]

    #print(train_index,test_index)
    visit_doc_model.fit(x_train,y_train)
    y_pred=visit_doc_model.predict(x_test)
    #metrep.append(metrics.classification_report(y_test,y_pred))
    #accuracy.append(metrics.accuracy_score(y_test,y_pred))
    mae.append(metrics.mean_absolute_error(y_test,y_pred))
```

```
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.
```

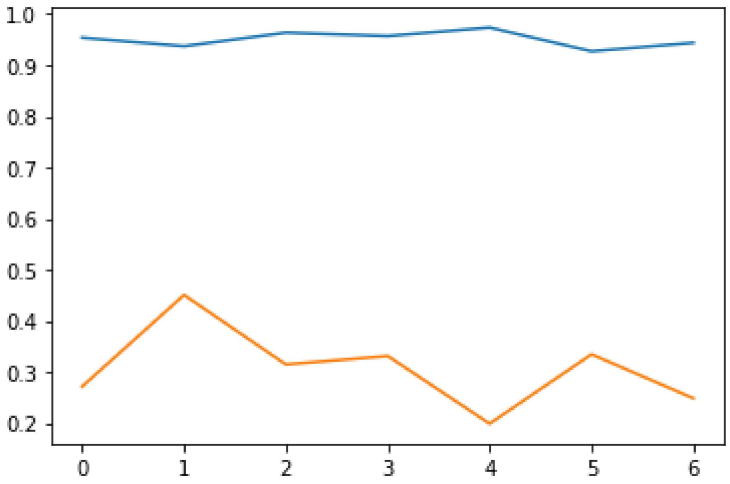
```
Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\utils\validation.py:63: DataConversionWarnin
  return f(*args, **kwargs)
C:\Users\Elisha Komolafe\anaconda3\lib\site-packages\sklearn\linear_model\_logistic.py:763: ConvergenceWa
STOP: TOTAL NO. of ITERATIONS REACHED LIMIT.

Increase the number of iterations (max_iter) or scale the data as shown in:
    https://scikit-learn.org/stable/modules/preprocessing.html
Please also refer to the documentation for alternative solver options:
    https://scikit-learn.org/stable/modules/linear_model.html#logistic-regression
  n_iter_i = _check_optimize_result(
```

27
```
print(metrep[0])
print(mae[0])
```

```
              precision    recall  f1-score   support

          NO       0.95      0.97      0.96       180
         YES       0.96      0.93      0.94       122

    accuracy                           0.95       302
   macro avg       0.95      0.95      0.95       302
weighted avg       0.95      0.95      0.95       302

0.271523178807947
```

28
```
plt.plot(accuracy)
plt.plot(mae)
```

28
```
[<matplotlib.lines.Line2D at 0x29dc4ba45e0>]
```




```
29  #pca method on single 80/20 data used originally using 85% variance retained
    pca=PCA(0.85)
    pca.fit(swtrainx)
    #pca.n_components_
    pcatrainx=pca.transform(swtrainx)
    pcatestx=pca.transform(swtestx)
    pcatrainx
    #pcatestx
    pca.explained_variance_ratio_
```

```
29  array([0.96094318])
```

```
30  #pca method on single 80/20 data used originally using 95% variance retained
    pca=PCA(0.90)
    pca.fit(swtrainx)
    #pca.n_components_
    pcatrainx=pca.transform(swtrainx)
    pcatestx=pca.transform(swtestx)
    pcatrainx
    #pcatestx
    pca.explained_variance_ratio_
```

```
30  array([0.96094318])
```

```
31  #pca method on single 80/20 data used originally using 95% variance retained
    pca=PCA(0.95)
    pca.fit(swtrainx)
    #pca.n_components_
    pcatrainx=pca.transform(swtrainx)
    pcatestx=pca.transform(swtestx)
    pcatrainx
    #pcatestx
    pca.explained_variance_ratio_
```

```
31  array([0.96094318])
```

```
32  #pca method on single 80/20 data used originally using 95% variance retained
    pca=PCA(0.97)
    pca.fit(swtrainx)
    #pca.n_components_
    pcatrainx=pca.transform(swtrainx)
    pcatestx=pca.transform(swtestx)
    pcatrainx
```

```
#pcatestx
pca.explained_variance_ratio_
```

```
array([0.96094318, 0.0209545 ])
```

```
#pca method on single 80/20 data used originally using 95% variance retained
pca=PCA(0.99)
pca.fit(swtrainx)
#pca.n_components_
pcatrainx=pca.transform(swtrainx)
pcatestx=pca.transform(swtestx)
pcatrainx
pca.n_components_
pca.explained_variance_ratio_
#pcatestx
```

```
array([0.96094318, 0.0209545 , 0.01805902])
```

```
#pca method on single 80/20 data used originally using 95% variance retained
pca=PCA(n_components=5)
pca.fit(swtrainx)
#pca.n_components_
pcatrainx=pca.transform(swtrainx)
pcatestx=pca.transform(swtestx)
pcatrainx
pca.n_components_
pca.explained_variance_ratio_
#pcatestx
```

```
array([9.60943179e-01, 2.09545000e-02, 1.80590151e-02, 2.68076314e-05,
       5.91560832e-06])
```

```
#pca method on single 80/20 data used originally using 95% variance retained
pca=PCA(n_components=10)
pca.fit(swtrainx)
#pca.n_components_
pcatrainx=pca.fit_transform(swtrainx)
pcatestx=pca.transform(swtestx)
pca.n_components_
pca.explained_variance_ratio_
#pcatestx
```

```
array([9.60943179e-01, 2.09545000e-02, 1.80590151e-02, 2.68076314e-05,
       5.91560832e-06, 3.81611754e-06, 2.63692975e-06, 2.22269441e-06,
       6.62598672e-07, 5.80356999e-07])
```