In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt

import pickle
from sklearn.model_selection import train_test_split

from sklearn.model_selection import cross_val_score
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import KFold

from sklearn.linear_model import LogisticRegression
from sklearn.svm import LinearSVC
from sklearn.neighbors import NearestCentroid
from time import time
from sklearn.model_selection import GridSearchCV
```

In [2]:
```
with open('names.txt') as f:
    words = f.read().split()
```

In [3]:
```
soils = []
for i in range(40):
    soils.append('soil'+str(i))
```

In [4]:
```
wild_area = []
for i in range(4):
    wild_area.append('wild_area'+str(i))
```

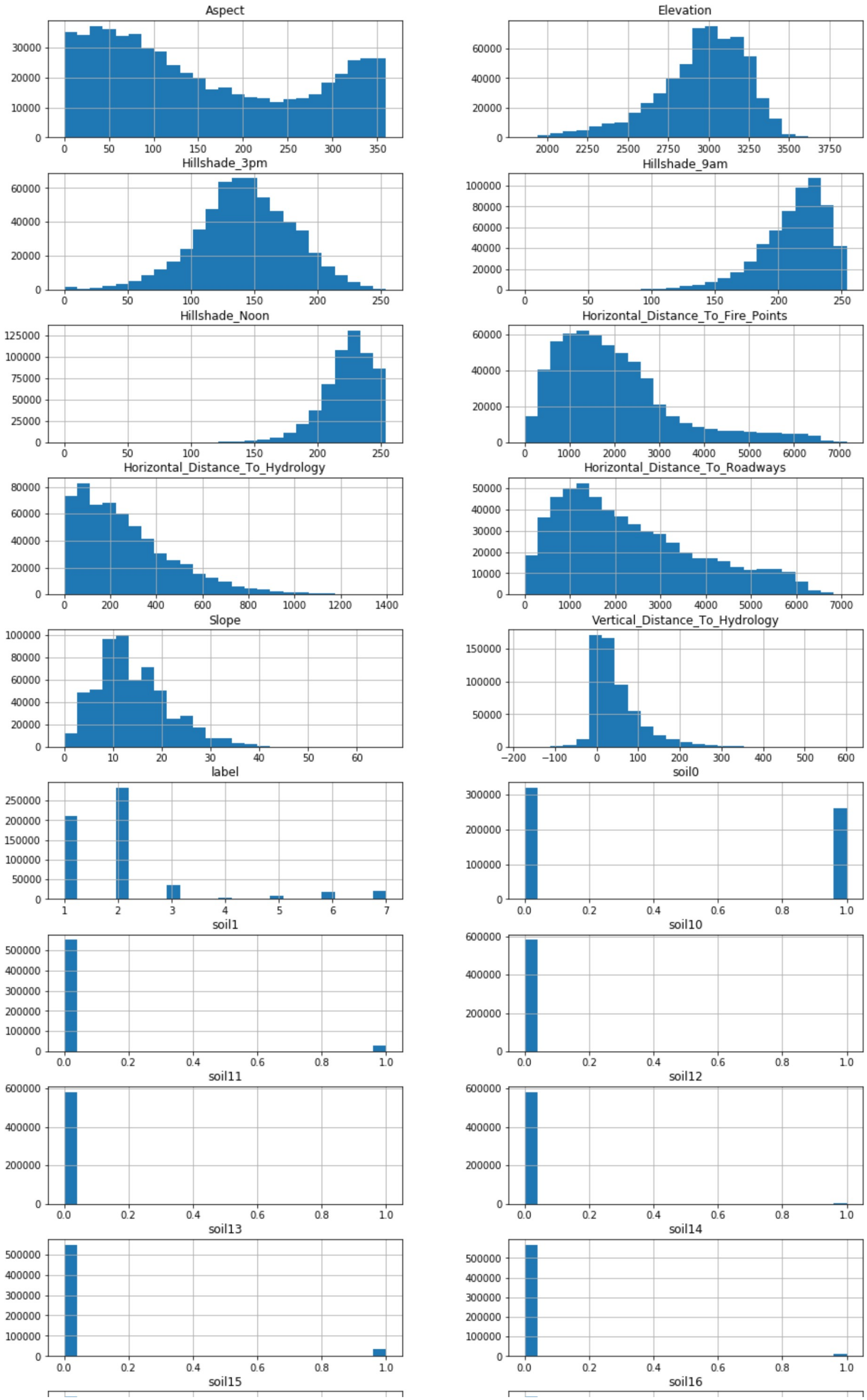
In [5]:
```
names = words[1:] + soils + wild_area + ['label']
```

In [6]:
```
df = pd.read_csv('covtype.data', names=names)
```

In [7]:

```
fig = plt.figure(figsize = (15,80))
ax = fig.gca()
df.hist(ax = ax, bins = 25, layout=(-1, 2))
plt.show()
```

```
C:\Users\grech\Anaconda3\lib\site-packages\IPython\core\interactiveshell.py:2961
: UserWarning: To output multiple subplots, the figure containing the passed axe
s is being cleared
  exec(code_obj, self.user_global_ns, self.user_ns)
```


Aspect
0
10000
20000
30000
0 50 100 150 200 250 300 350
Elevation
0
20000
40000
60000
2000 2250 2500 2750 3000 3250 3500 3750
Hillshade_3pm
0
20000
40000
60000
0 50 100 150 200 250
Hillshade_9am
0
20000
40000
60000
80000
100000
0 50 100 150 200 250
Hillshade_Noon
0
25000
50000
75000
100000
125000
0 50 100 150 200 250
Horizontal_Distance_To_Fire_Points
0
20000
40000
60000
0 1000 2000 3000 4000 5000 6000 7000
Horizontal_Distance_To_Hydrology
0
20000
40000
60000
80000
0 200 400 600 800 1000 1200 1400
Horizontal_Distance_To_Roadways
0
10000
20000
30000
40000
50000
0 1000 2000 3000 4000 5000 6000 7000
Slope
0
20000
40000
60000
80000
100000
0 10 20 30 40 50 60
Vertical_Distance_To_Hydrology
0
50000
100000
150000
−200 −100 0 100 200 300 400 500 600
label
0
50000
100000
150000
200000
250000
1 2 3 4 5 6 7
soil0
0
100000
200000
300000
0.0 0.2 0.4 0.6 0.8 1.0
soil1
0
100000
200000
300000
400000
500000
0.0 0.2 0.4 0.6 0.8 1.0
soil10
0
200000
400000
600000
0.0 0.2 0.4 0.6 0.8 1.0
soil11
0
200000
400000
600000
0.0 0.2 0.4 0.6 0.8 1.0
soil12
0
200000
400000
600000
0.0 0.2 0.4 0.6 0.8 1.0
soil13
0
100000
200000
300000
400000
500000
0.0 0.2 0.4 0.6 0.8 1.0
soil14
0
100000
200000
300000
400000
500000
0.0 0.2 0.4 0.6 0.8 1.0
soil15
soil16

In [8]:
```
y_all = df.pop('label').values
X_all = df.values
```

In [9]:
```
X_train, X_test, y_train, y_test = train_test_split(X_all, y_all, test_size = 0.33,
                                                    random_state = 5, stratify = y_
all)
```

In [10]:
```

```

In [11]:
```
models = [LogisticRegression(), LinearSVC(), NearestCentroid()]
```

In [12]:
```
def perform_cross_validation(X, y, strat = True, scaled = False):

    scaler = StandardScaler()

    if scaled == True:
        X = scaler.fit_transform(X)

    for model in models:
        start = time()

        if strat == True:
            scores = cross_val_score(model, X, y, cv=5)
        else:
            scores = cross_val_score(model, X, y, cv=KFold(n_splits=5))

        end = time()
        print(str(model).split('(')[0] + ' Mean Accuracy', abs(scores).mean(), 'tim
e =', str(end-start))
```

In [13]:
```
# Stratified and not scaled
perform_cross_validation(X_train_, y_train_, strat = True, scaled = False)
```

```
LogisticRegression Mean Accuracy 0.7177930929478986 time = 4.396827220916748
LinearSVC Mean Accuracy 0.45334156099445977 time = 17.462740659713745
NearestCentroid Mean Accuracy 0.20557159113246537 time = 0.04794478416442871
```

In [14]:
```
# Stratified and scaled
perform_cross_validation(X_train_, y_train_, strat = True, scaled = True)
```

```
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: Data
ConversionWarning: Data with input dtype int64 was converted to float64 by Stand
ardScaler.
  warnings.warn(msg, DataConversionWarning)

LogisticRegression Mean Accuracy 0.7191919005503472 time = 4.681137323379517
LinearSVC Mean Accuracy 0.7159908895408809 time = 21.561322927474976
NearestCentroid Mean Accuracy 0.5539955593259217 time = 0.0334625244140625
```

In [15]:
```
# Not stratified and not scaled
perform_cross_validation(X_train_, y_train_, strat = False, scaled = False)
```

```
LogisticRegression Mean Accuracy 0.715 time = 4.612468719482422
LinearSVC Mean Accuracy 0.4266 time = 17.65973997116089
NearestCentroid Mean Accuracy 0.20380000000000004 time = 0.03232526779174805
```

In [16]:

```
def run_grid_search(model, params, X, y, scaled = True):
    if scaled:
        scaler = StandardScaler()
        X_train_ = scaler.fit_transform(X)

    grid = GridSearchCV(model, params, cv=5)
    grid.fit(X_train_, y)
    results = grid.grid_scores_


    params = []
    scores = []
    for score in results:
        mean = score[1]
        try:
            param = score[0]['C']
        except:
            param = score[0]['shrink_threshold']

        scores.append(abs(mean))
        params.append(param)


    ax = plt.subplot(111)
    ax.scatter(params, scores)
    ax.set_title('Grid Search Results for ' + str(model).split('(')[0])
    ax.set_xlabel('Parameter Tuned')
    ax.set_ylabel('Average Accuracy')
    plt.show()
```

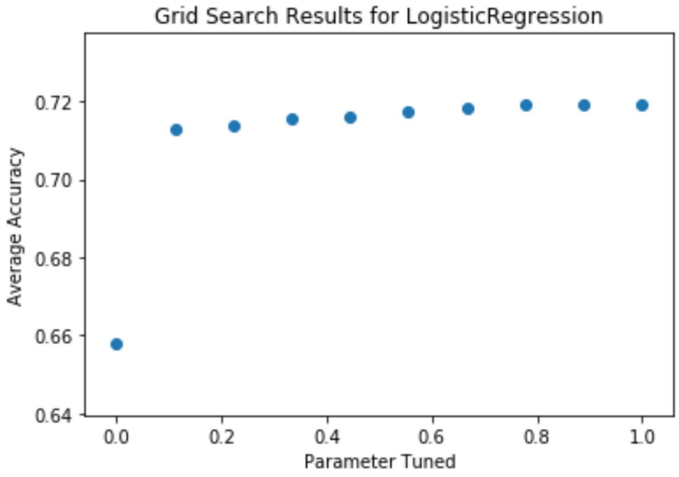
In [17]:

```
param = {'C' : np.linspace(1e-8, 1, 10)}
paramSVC = {'C' : np.linspace(1e-8, 1, 10)}
neighbor_param = {'shrink_threshold' : np.linspace(0.1, 10, 10)}
```

In [18]:

```
run_grid_search(LogisticRegression(), param, X_train_, y_train_)
```

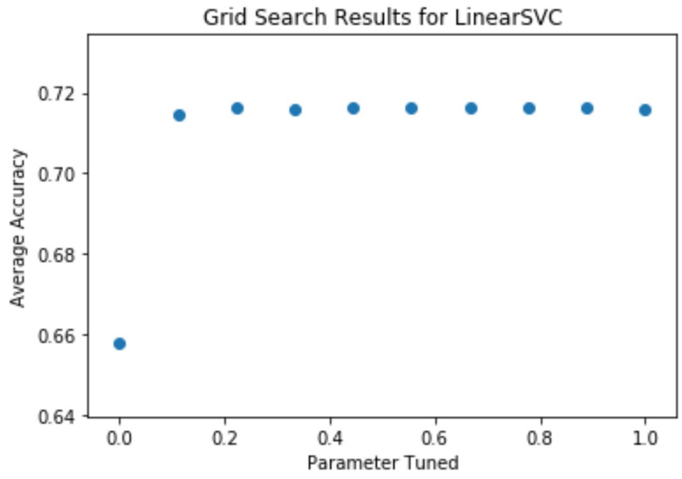
```
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: Data
ConversionWarning: Data with input dtype int64 was converted to float64 by Stand
ardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:76
2: DeprecationWarning: The grid_scores_ attribute was deprecated in version 0.18
in favor of the more elaborate cv_results_ attribute. The grid_scores_ attribute
will not be available from 0.20
  DeprecationWarning)
```



In [19]:

```
run_grid_search(LinearSVC(), paramSVC, X_train_, y_train_)
```

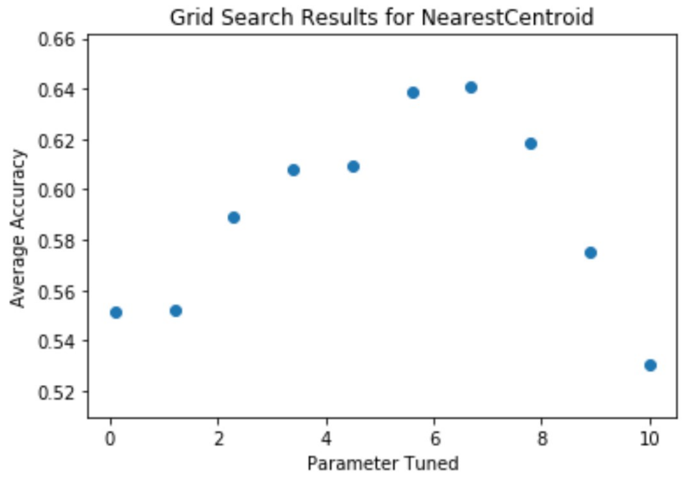
```
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: Data
ConversionWarning: Data with input dtype int64 was converted to float64 by Stand
ardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:76
2: DeprecationWarning: The grid_scores_ attribute was deprecated in version 0.18
in favor of the more elaborate cv_results_ attribute. The grid_scores_ attribute
will not be available from 0.20
  DeprecationWarning)
```



In [20]:

```
run_grid_search(NearestCentroid(), neighbor_param, X_train_, y_train_)
```

```
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\utils\validation.py:475: Data
ConversionWarning: Data with input dtype int64 was converted to float64 by Stand
ardScaler.
  warnings.warn(msg, DataConversionWarning)
C:\Users\grech\Anaconda3\lib\site-packages\sklearn\model_selection\_search.py:76
2: DeprecationWarning: The grid_scores_ attribute was deprecated in version 0.18
in favor of the more elaborate cv_results_ attribute. The grid_scores_ attribute
will not be available from 0.20
  DeprecationWarning)
```



Chaging the random seed does not change the best value by much. The LogisticRegression model is fairly good without optimization along with the Support Vector Machine. Changing the cross validation strategy so that it is not stratified sampling hurts the performance of the models, and does not provide the optimum values.

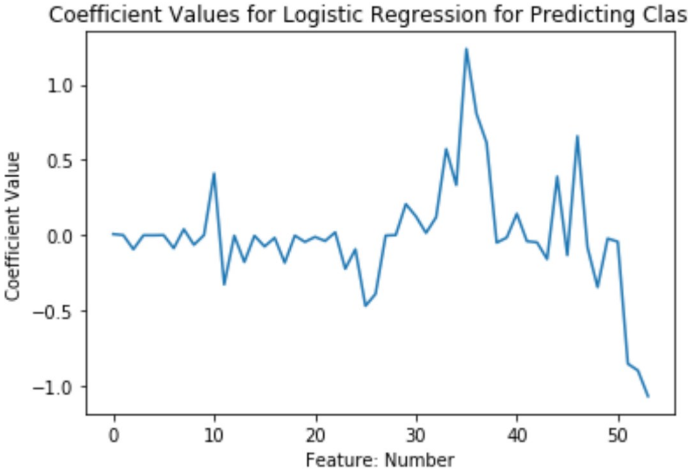
```
In [21]: imps = []
         for model in models[:-1]:
             model.fit(X_train_, y_train_)
             feature_imp = model.coef_
             imps.append(feature_imp)
             print(str(model))
```

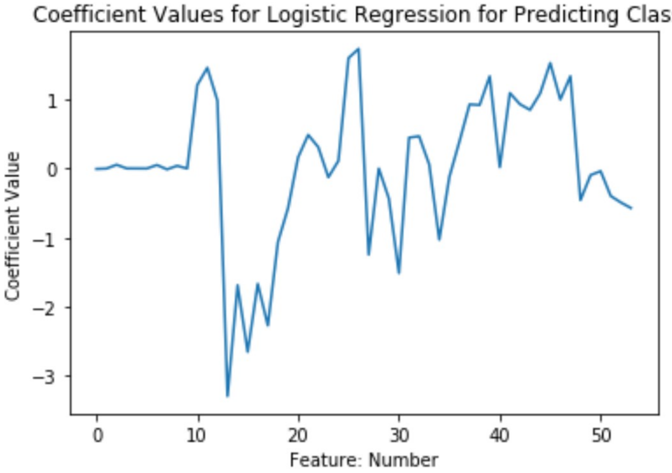
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=True,
          intercept_scaling=1, max_iter=100, multi_class='ovr', n_jobs=1,
          penalty='l2', random_state=None, solver='liblinear', tol=0.0001,
          verbose=0, warm_start=False)
LinearSVC(C=1.0, class_weight=None, dual=True, fit_intercept=True,
     intercept_scaling=1, loss='squared_hinge', max_iter=1000,
     multi_class='ovr', penalty='l2', random_state=None, tol=0.0001,
     verbose=0)
```

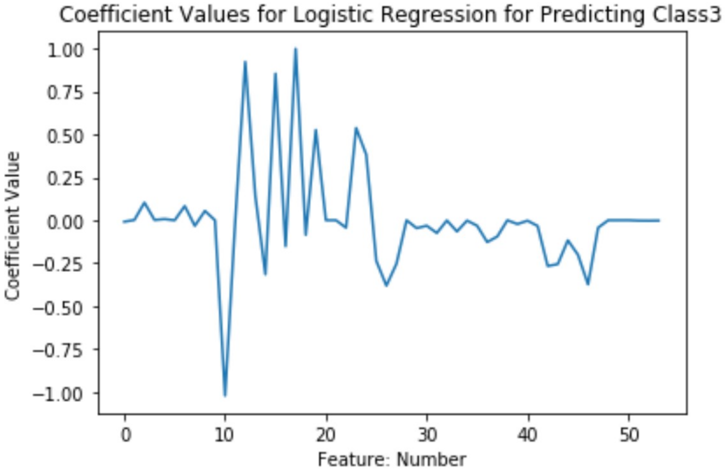
```
In [22]: imp1 = imps[0]
         imp2 = imps[1]
```

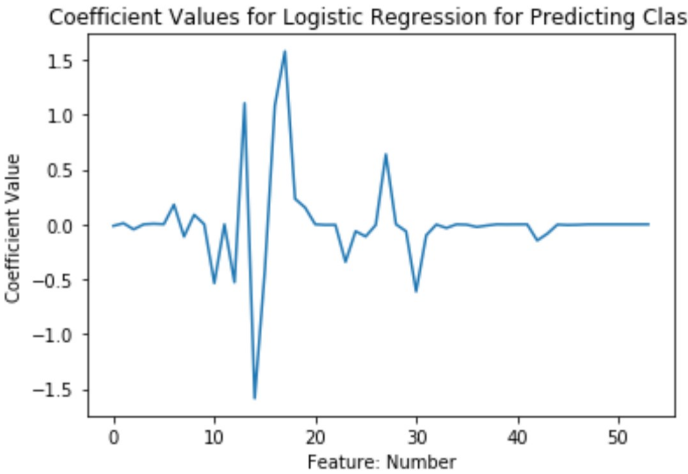
In [26]:

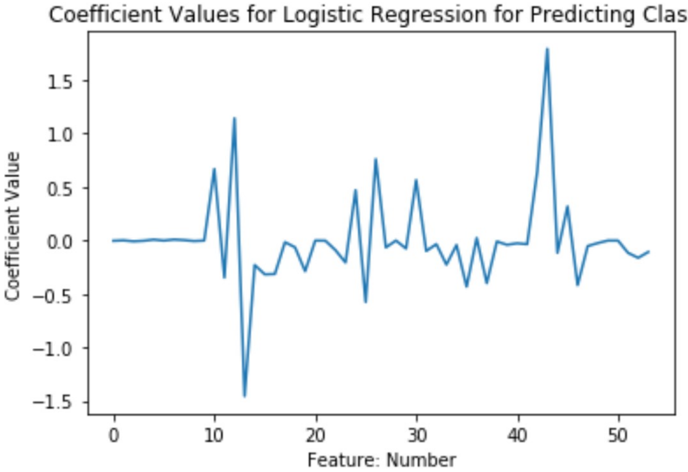
```
for i, imp in enumerate(imp1):
    ax = plt.subplot(111)
    ax.plot(imp)
    ax.set_title('Coefficient Values for Logistic Regression for Predicting Class'
+ str(i+1))
    ax.set_xlabel('Feature: Number')
    ax.set_ylabel('Coefficient Value')
    plt.show()
```

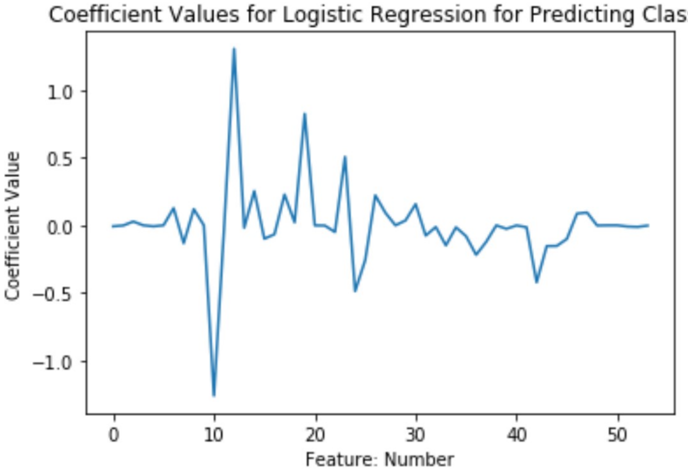

Coefficient Values for Logistic Regression for Predicting Class1
Coefficient Value
1.0
0.5
0.0
−0.5
−1.0
0
10
20
30
40
50
Feature: Number

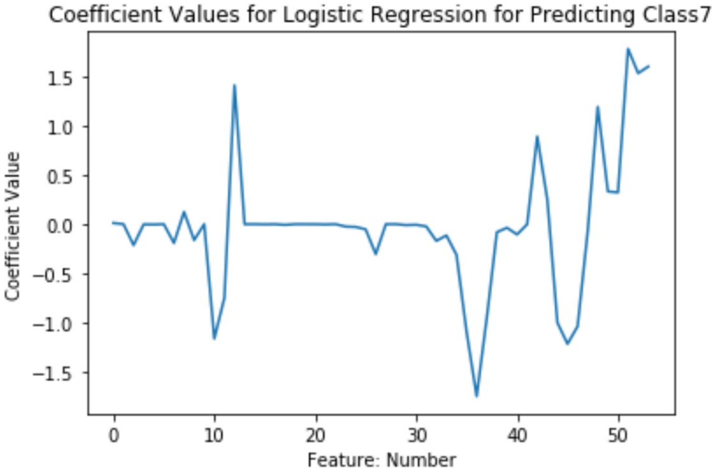

Coefficient Values for Logistic Regression for Predicting Class2
Coefficient Value
1
0
−1
−2
−3
0
10
20
30
40
50
Feature: Number


Coefficient Values for Logistic Regression for Predicting Class3
Coefficient Value
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
10
20
30
40
50
Feature: Number


Coefficient Values for Logistic Regression for Predicting Class4
Coefficient Value
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
10
20
30
40
50
Feature: Number

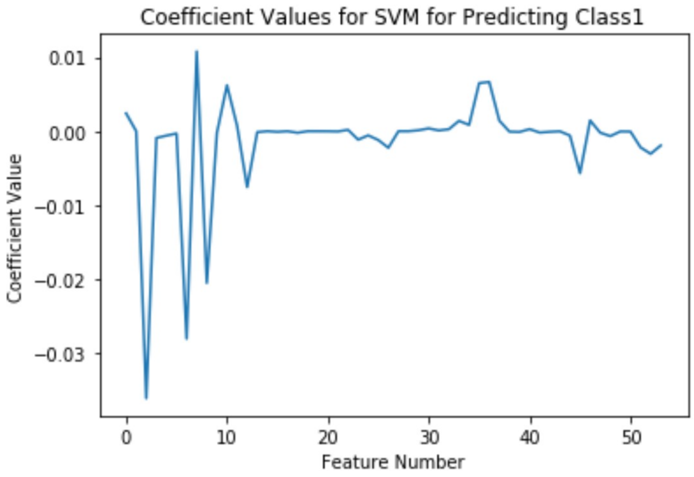

Coefficient Values for Logistic Regression for Predicting Class5
Coefficient Value
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
10
20
30
40
50
Feature: Number

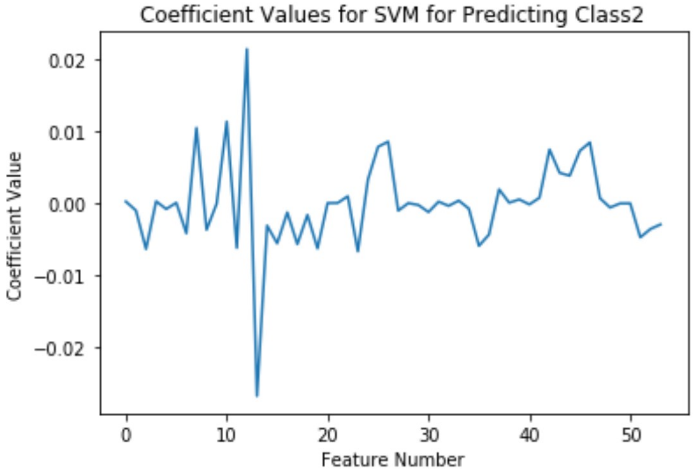

Coefficient Values for Logistic Regression for Predicting Class6
Coefficient Value
1.0
0.5
0.0
−0.5
−1.0
0
10
20
30
40
50
Feature: Number

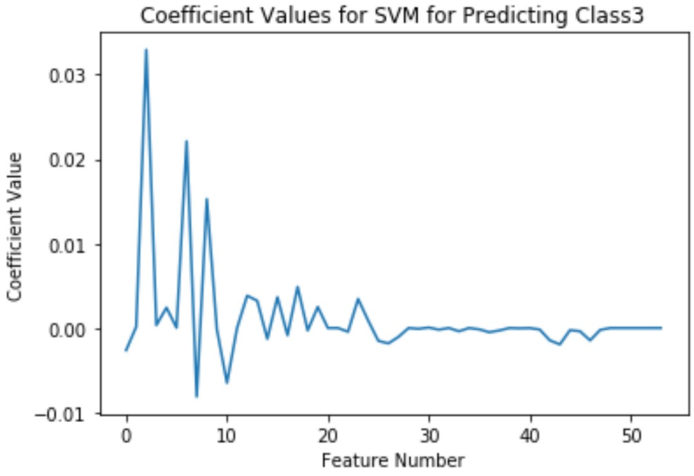

Coefficient Values for Logistic Regression for Predicting Class7
Coefficient Value
1.5
1.0
0.5
0.0
−0.5
−1.0
−1.5
0
10
20
30
40
50
Feature: Number

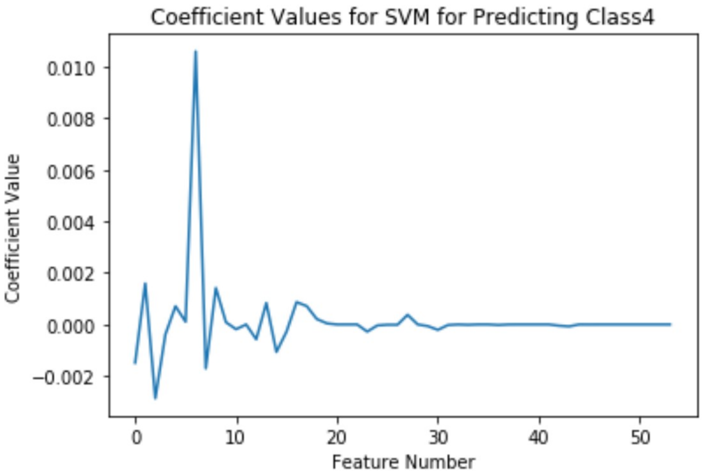
In [27]:

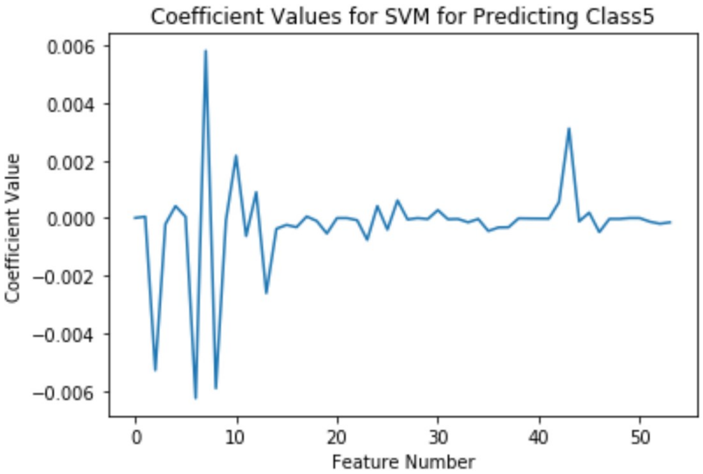
```
for i, imp in enumerate(imp2):
    ax = plt.subplot(111)
    ax.plot(imp)
    ax.set_title('Coefficient Values for SVM for Predicting Class' + str(i+1))
    ax.set_xlabel('Feature Number')
    ax.set_ylabel('Coefficient Value')
    plt.show()
```

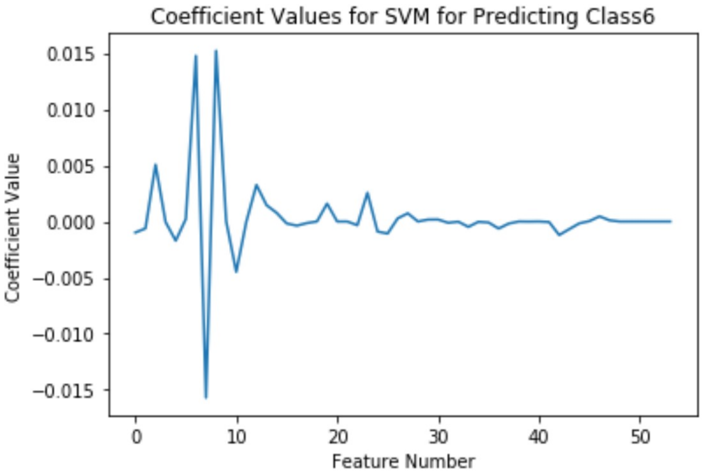

Coefficient Values for SVM for Predicting Class1
Coefficient Value
0.01
0.00
−0.01
−0.02
−0.03
0
10
20
30
40
50
Feature Number

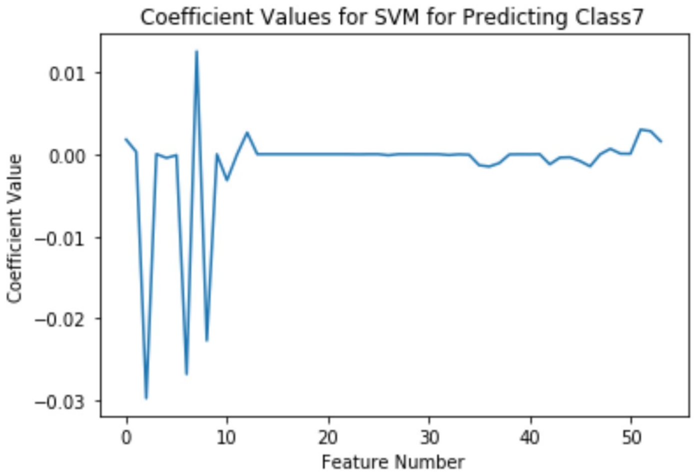

Coefficient Values for SVM for Predicting Class2
Coefficient Value
0.02
0.01
0.00
−0.01
−0.02
0
10
20
30
40
50
Feature Number


Coefficient Values for SVM for Predicting Class3
Coefficient Value
0.03
0.02
0.01
0.00
−0.01
0
10
20
30
40
50
Feature Number


Coefficient Values for SVM for Predicting Class4
Coefficient Value
0.010
0.008
0.006
0.004
0.002
0.000
−0.002
0
10
20
30
40
50
Feature Number


Coefficient Values for SVM for Predicting Class5
Coefficient Value
0.006
0.004
0.002
0.000
−0.002
−0.004
−0.006
0
10
20
30
40
50
Feature Number


Coefficient Values for SVM for Predicting Class6
Coefficient Value
0.015
0.010
0.005
0.000
−0.005
−0.010
−0.015
0
10
20
30
40
50
Feature Number


Coefficient Values for SVM for Predicting Class7
Coefficient Value
0.01
0.00
−0.01
−0.02
−0.03
0
10
20
30
40
50
Feature Number

```
In [ ]:
```