In [1]:
```
"""
ECGR 5105 - Intro to Machine Learning
Homework 2 - Part 1
Phillip Harmon
"""
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:
```
#Import Dataset
csvData = pd.read_csv('diabetes.csv')
csvData
```

Out[2]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctic
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 9 columns

In [3]:
```
#Sort Dataset
x = csvData.iloc[:,0:-1].values
y = csvData.iloc[:,-1].values
```

In [4]:
```
#Train-Test Split
from sklearn.model_selection import train_test_split
xt, xv, yt, yv = train_test_split(x, y, train_size = 0.8, test_size = 0.2, ran
```

In [5]:
```
#Clean the Dataset
from sklearn.preprocessing import MinMaxScaler, StandardScaler
 # scaler = StandardScaler() #MinMaxScaler gave better results here
scaler = MinMaxScaler()
xt = scaler.fit_transform(xt)
xv = scaler.fit_transform(xv)
```

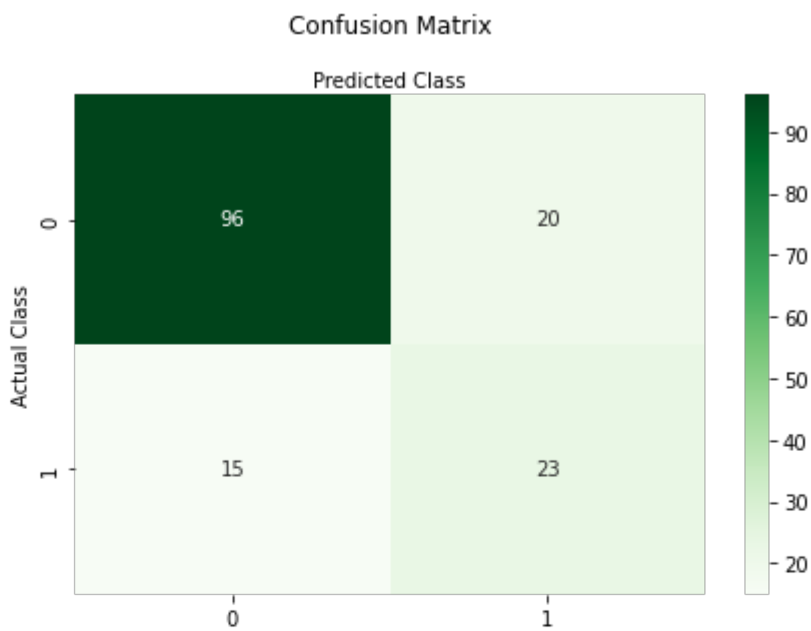
In [6]:
```
#Perform the Training
from sklearn.linear_model import LogisticRegression
training_montage = LogisticRegression(random_state=1337)
training_montage.fit(xt,yt);
```

In [7]:
```
#Test the Model
p = training_montage.predict(xv)
```

In [8]:
```
#Evaluate the model metrics
from sklearn import metrics
print("Model Accuracy:  {:.3f}%".format(metrics.accuracy_score(yv,p)*100))
print("Model Precision: {:.3f}%".format(metrics.precision_score(yv,p)*100))
print("Model Recall:    {:.3f}%".format(metrics.recall_score(yv,p)*100))
```

```
Model Accuracy:  77.273%
Model Precision: 53.488%
Model Recall:    60.526%
```

In [9]:
```
#Analyze using the Confusion Matrix
from sklearn.metrics import confusion_matrix
import seaborn as sns
classes = ['Not Diabetes','Diabetes']
figure, axis = plt.subplots()
ticks = np.arange(len(classes))
plt.xticks(ticks, classes)
plt.yticks(ticks, classes)
sns.heatmap(pd.DataFrame(confusion_matrix(yv, p)), annot=True, cmap="Greens",
axis.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion Matrix', y=1.1)
plt.ylabel('Actual Class')
plt.xlabel('Predicted Class');
```



In [ ]:

In [1]:
```
"""
ECGR 5105 - Intro to Machine Learning
Homework 2 - Part 2
Phillip Harmon
"""
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:
```
#Import Dataset
csvData = pd.read_csv('diabetes.csv')
csvData
```

Out[2]:

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunctic
0	6	148	72	35	0	33.6	0.62
1	1	85	66	29	0	26.6	0.35
2	8	183	64	0	0	23.3	0.67
3	1	89	66	23	94	28.1	0.16
4	0	137	40	35	168	43.1	2.28
...	...	...	...	...	...	...	
763	10	101	76	48	180	32.9	0.17
764	2	122	70	27	0	36.8	0.34
765	5	121	72	23	112	26.2	0.24
766	1	126	60	0	0	30.1	0.34
767	1	93	70	31	0	30.4	0.31

768 rows × 9 columns

In [3]:
```
#Sort Dataset
x = csvData.iloc[:,0:-1].values
y = csvData.iloc[:,-1].values
```

In [18]:
```
#Clean the Dataset
from sklearn.preprocessing import MinMaxScaler, StandardScaler
scaler = StandardScaler()
 # scaler = MinMaxScaler() #StandardScaler gave better results here
x = scaler.fit_transform(x)
```

In [19]:
```
#Perform the Training with K=5
from sklearn.model_selection import KFold
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score
kcup = KFold(n_splits=5, random_state=1337, shuffle=True)
model = LogisticRegression(random_state=1337)
results = cross_val_score(model,x,y,cv=kcup)
print("K=5 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.s
```

```
K=5 | Accuracy: 77.734% (2.167%)
```

In [17]:
```
#Perform the Training with K=10
kcup = KFold(n_splits=10, random_state=1337, shuffle=True)
model = LogisticRegression(random_state=1337)
results = cross_val_score(model,x,y,cv=kcup)
print("K=10 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.
```

```
K=10 | Accuracy: 76.811% (3.108%)
```

In [ ]:

In [1]:
```
"""
ECGR 5105 - Intro to Machine Learning
Homework 2 - Part 3
Phillip Harmon
"""
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:
```
#Load and Build the Dataset
from sklearn.datasets import load_breast_cancer
loaded  = load_breast_cancer()
labels  = np.reshape(loaded.target, (len(loaded.target),1))
inputs  = pd.DataFrame(loaded.data)
names   = np.append(loaded.feature_names, 'label')
dataset = pd.DataFrame(np.concatenate([inputs,labels],axis=1))
dataset.columns = names
dataset
```

Out[2]:

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points	mea symmetr
0	17.99	10.38	122.80	1001.0	0.11840	0.27760	0.30010	0.14710	0.241
1	20.57	17.77	132.90	1326.0	0.08474	0.07864	0.08690	0.07017	0.181
2	19.69	21.25	130.00	1203.0	0.10960	0.15990	0.19740	0.12790	0.206
3	11.42	20.38	77.58	386.1	0.14250	0.28390	0.24140	0.10520	0.259
4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	0.180
...	...	...	...	...	...	...	...	...	.
564	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890	0.172
565	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791	0.175
566	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302	0.159
567	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200	0.239
568	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	0.158

569 rows × 31 columns

In [3]:
```
#Sort Dataset
x = dataset.iloc[:,0:-1].values
y = dataset.iloc[:,-1].values
```

In [4]:
```
#Train-Test Split
from sklearn.model_selection import train_test_split
xt, xv, yt, yv = train_test_split(x, y, train_size = 0.8, test_size = 0.2, ran
```

In [5]:
```
#Clean the Dataset
from sklearn.preprocessing import MinMaxScaler, StandardScaler
scaler = StandardScaler()
 # scaler = MinMaxScaler() #StandardScaler gave better results here
xt = scaler.fit_transform(xt)
xv = scaler.fit_transform(xv)
```

In [6]:
```
#Perform the Training
from sklearn.linear_model import LogisticRegression
training_montage = LogisticRegression(random_state=1337)
training_montage.fit(xt,yt);
```

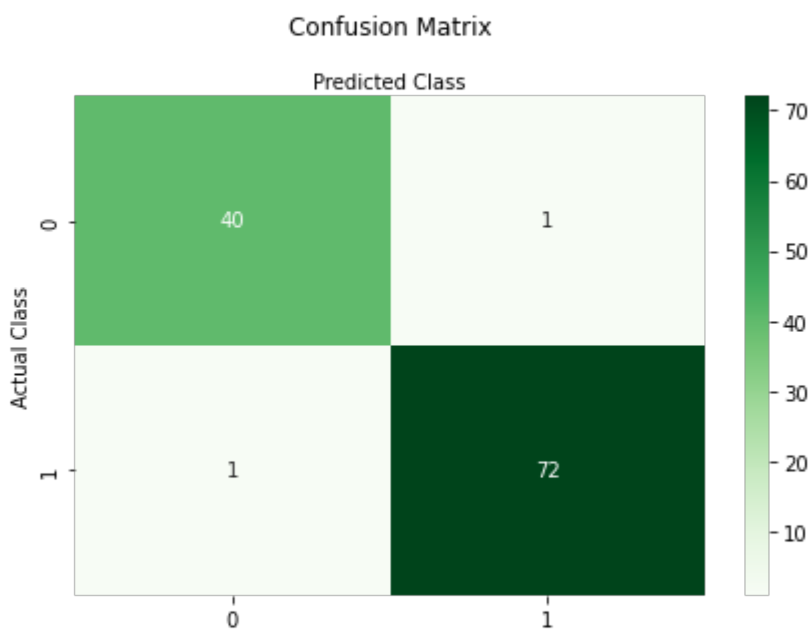
In [7]:
```
#Test the Model
p = training_montage.predict(xv)
```

In [8]:
```
#Evaluate the model metrics
from sklearn import metrics
print("Model Accuracy:  {:.3f}%".format(metrics.accuracy_score(yv,p)*100))
print("Model Precision: {:.3f}%".format(metrics.precision_score(yv,p)*100))
print("Model Recall:    {:.3f}%".format(metrics.recall_score(yv,p)*100))
```

```
Model Accuracy:  98.246%
Model Precision: 98.630%
Model Recall:    98.630%
```

In [9]:

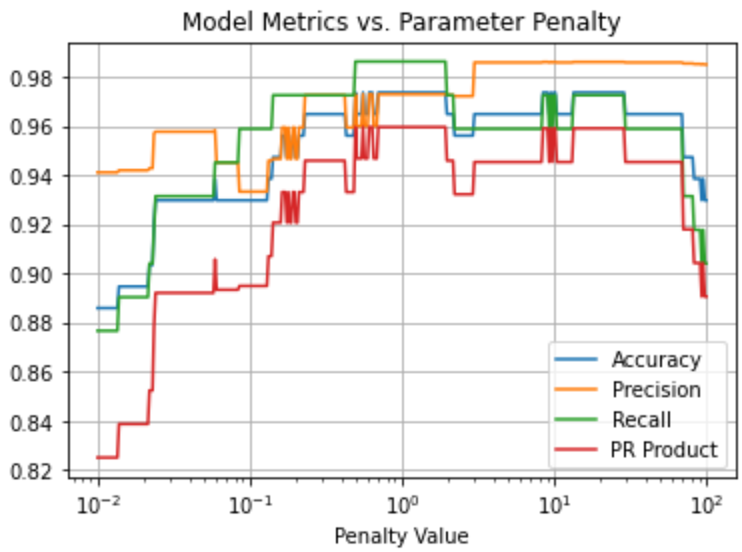
```
#Analyze using the Confusion Matrix
from sklearn.metrics import confusion_matrix
import seaborn as sns
classes = ['Not Diabetes','Diabetes']
figure, axis = plt.subplots()
ticks = np.arange(len(classes))
plt.xticks(ticks, classes)
plt.yticks(ticks, classes)
sns.heatmap(pd.DataFrame(confusion_matrix(yv, p)), annot=True, cmap="Greens",
axis.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion Matrix', y=1.1)
plt.ylabel('Actual Class')
plt.xlabel('Predicted Class');
```



In [10]:

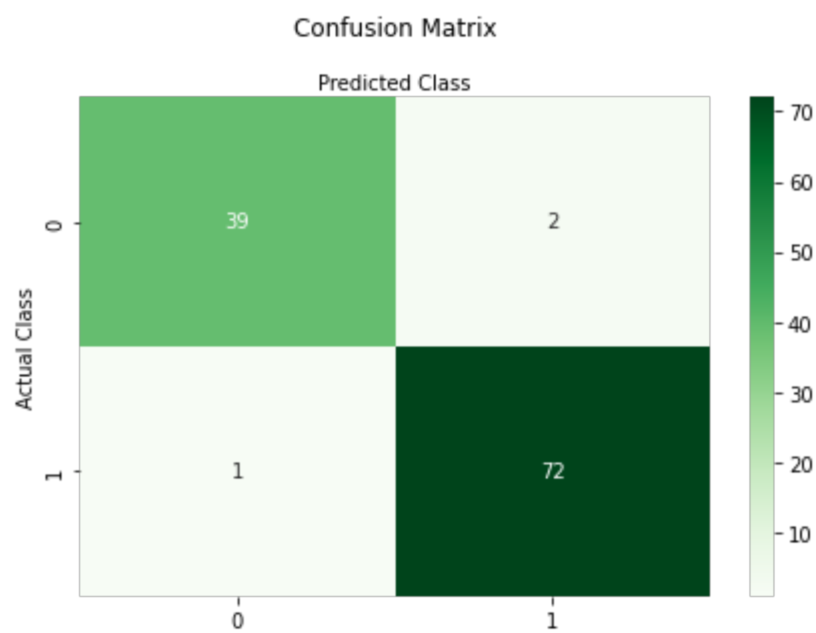
```
#Reevaluate using a variety of weight penalties
lambdas = np.logspace(-2,2,num=400)
acc_log = []
prc_log = []
rec_log = []
for lam in lambdas:
    model = LogisticRegression(penalty='l1',C=lam,solver='liblinear',random_st
    model.fit(xt,yt)
    p = model.predict(xv)
    rec_log.append(metrics.recall_score(yv,p))
    prc_log.append(metrics.precision_score(yv,p))
    acc_log.append(metrics.accuracy_score(yv,p))
```

In [11]:
```
#Plot the results
plt.semilogx(lambdas,acc_log,label='Accuracy')
plt.semilogx(lambdas,prc_log,label='Precision')
plt.semilogx(lambdas,rec_log,label='Recall')
PRval = np.multiply(prc_log,rec_log)
plt.semilogx(lambdas,PRval,label='PR Product')
plt.grid()
plt.xlabel('Penalty Value')
plt.title('Model Metrics vs. Parameter Penalty')
plt.legend();
```



In [12]:
```
#According to the plot, lambda = 1 is about the best it gets
model = LogisticRegression(penalty='l1',C=1,solver='liblinear',random_state=13
model.fit(xt,yt)
p = model.predict(xv)
print("Model Accuracy:  {:.3f}%".format(metrics.accuracy_score(yv,p)*100))
print("Model Precision: {:.3f}%".format(metrics.precision_score(yv,p)*100))
print("Model Recall:    {:.3f}%".format(metrics.recall_score(yv,p)*100))
classes = ['Not Diabetes','Diabetes']
figure, axis = plt.subplots()
ticks = np.arange(len(classes))
plt.xticks(ticks, classes)
plt.yticks(ticks, classes)
sns.heatmap(pd.DataFrame(confusion_matrix(yv, p)), annot=True, cmap="Greens",
axis.xaxis.set_label_position("top")
plt.tight_layout()
plt.title('Confusion Matrix', y=1.1)
plt.ylabel('Actual Class')
plt.xlabel('Predicted Class');
```

```
Model Accuracy:  97.368%
Model Precision: 97.297%
Model Recall:    98.630%
```



In [ ]:

In [1]:
```
"""
ECGR 5105 - Intro to Machine Learning
Homework 2 - Part 4
Phillip Harmon
"""
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

In [2]:
```
#Load and Build the Dataset
from sklearn.datasets import load_breast_cancer
loaded  = load_breast_cancer()
labels  = np.reshape(loaded.target, (len(loaded.target),1))
inputs  = pd.DataFrame(loaded.data)
names   = np.append(loaded.feature_names, 'label')
dataset = pd.DataFrame(np.concatenate([inputs,labels],axis=1))
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dataset
```

Out[2]:

	mean radius	mean texture	mean perimeter	mean area	mean smoothness	mean compactness	mean concavity	mean concave points	mea symmetr
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4	20.29	14.34	135.10	1297.0	0.10030	0.13280	0.19800	0.10430	0.180
...	...	...	...	...	...	...	...	...	.
564	21.56	22.39	142.00	1479.0	0.11100	0.11590	0.24390	0.13890	0.172
565	20.13	28.25	131.20	1261.0	0.09780	0.10340	0.14400	0.09791	0.175
566	16.60	28.08	108.30	858.1	0.08455	0.10230	0.09251	0.05302	0.159
567	20.60	29.33	140.10	1265.0	0.11780	0.27700	0.35140	0.15200	0.239
568	7.76	24.54	47.92	181.0	0.05263	0.04362	0.00000	0.00000	0.158

569 rows × 31 columns

In [3]:
```
#Sort Dataset
x = dataset.iloc[:,0:-1].values
y = dataset.iloc[:,-1].values
```

In [4]:
```
#Clean the Dataset
from sklearn.preprocessing import MinMaxScaler, StandardScaler
scaler = StandardScaler()
 # scaler = MinMaxScaler() #StandardScaler gave better results here
x = scaler.fit_transform(x)
```

In [5]:
```
#Perform the Training with K=5
from sklearn.model_selection import KFold
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import cross_val_score
kcup = KFold(n_splits=5, random_state=1337, shuffle=True)
model = LogisticRegression(random_state=1337)
results = cross_val_score(model,x,y,cv=kcup)
print("K=5 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.s
```

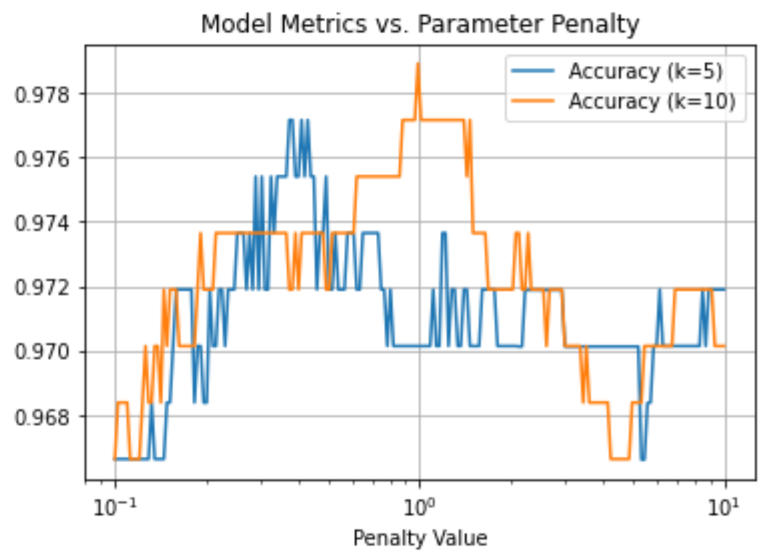
```
K=5 | Accuracy: 97.539% (1.290%)
```

In [6]:
```
#Perform the Training with K=10
kcup = KFold(n_splits=10, random_state=1337, shuffle=True)
model = LogisticRegression(random_state=1337)
results = cross_val_score(model,x,y,cv=kcup)
print("K=10 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.
```

```
K=10 | Accuracy: 97.716% (1.122%)
```

In [7]:
```
#Reevaluate using a variety of weight penalties
lambdas = np.logspace(-1,1,num=200)
k5_acc_log = []
kcup = KFold(n_splits=5, random_state=1337, shuffle=True)
for lam in lambdas:
    model = LogisticRegression(penalty='l1',C=lam,solver='liblinear',random_st
    results = cross_val_score(model,x,y,cv=kcup)
    k5_acc_log.append(results.mean())
k10_acc_log = []
kcup = KFold(n_splits=10, random_state=1337, shuffle=True)
for lam in lambdas:
    model = LogisticRegression(penalty='l1',C=lam,solver='liblinear',random_st
    results = cross_val_score(model,x,y,cv=kcup)
    k10_acc_log.append(results.mean())
```

In [8]:
```
#Plot the results
plt.semilogx(lambdas,k5_acc_log,label='Accuracy (k=5)')
plt.semilogx(lambdas,k10_acc_log,label='Accuracy (k=10)')
plt.grid()
plt.xlabel('Penalty Value')
plt.title('Model Metrics vs. Parameter Penalty')
plt.legend();
```



In [9]:
```
#Best k=5 weight is about 0.35
kcup = KFold(n_splits=5, random_state=1337, shuffle=True)
model = LogisticRegression(penalty='l1',C=0.35,solver='liblinear',random_state
results = cross_val_score(model,x,y,cv=kcup)
print("K=5 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.s
```

```
K=5 | Accuracy: 97.541% (0.653%)
```

In [10]:
```
#Best k=10 weight is about 1
kcup = KFold(n_splits=10, random_state=1337, shuffle=True)
model = LogisticRegression(penalty='l1',C=1,solver='liblinear',random_state=13
results = cross_val_score(model,x,y,cv=kcup)
print("K=10 | Accuracy: {:.3f}% ({:.3f}%)".format(results.mean()*100, results.
```

```
K=10 | Accuracy: 97.892% (1.312%)
```

In [ ]: