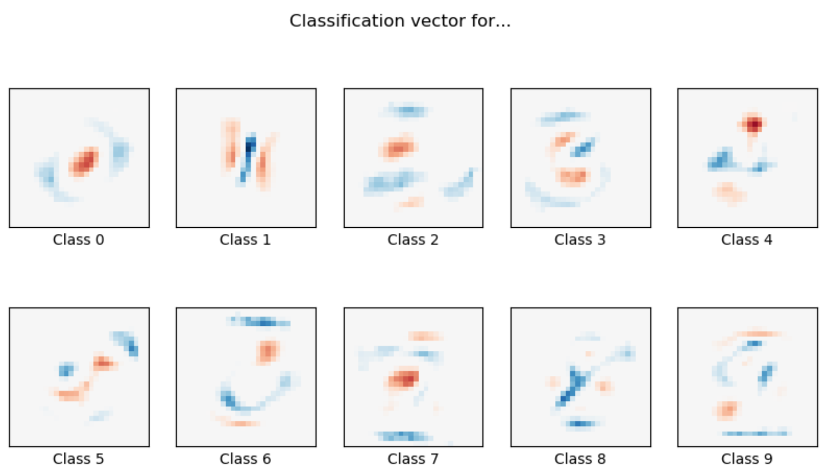
MNIST classfification using multinomial logistic + L1

Here we fit a multinomial logistic regression with L1 penalty on a subset of the MNIST digits classification task. We use the SAGA algorithm for this purpose: this a solver that is fast when the number of samples is significantly larger than the number of features and is able to finely optimize non-smooth objective functions which is the case with the l1-penalty. Test accuracy reaches > 0.8, while weight vectors remains *sparse* and therefore more easily *interpretable*.

Note that this accuracy of this l1-penalized linear model is significantly below what can be reached by an l2-penalized linear model or a non-linear multi-layer perceptron model on this dataset.



Out:

```
Sparsity with L1 penalty: 82.72%
Test score with L1 penalty: 0.8320
Example run in 2.909 s
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```
import time
import matplotlib.pyplot as plt
import numpy as np

from sklearn.datasets import fetch_mldata
from sklearn.linear_model import LogisticRegression
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import StandardScaler
from sklearn.utils import check_random_state

print(__doc__)

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# License: BSD 3 clause

# Turn down for faster convergence
t0 = time.time()
train_samples = 5000

mnist = fetch_mldata('MNIST original')
X = mnist.data.astype('float64')
y = mnist.target
random_state = check_random_state(0)
permutation = random_state.permutation(X.shape[0])
X = X[permutation]
y = y[permutation]
X = X.reshape((X.shape[0], -1))
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X_train, X_test, y_train, y_test = train_test_split(
    X, y, train_size=train_samples, test_size=10000)

scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)

# Turn up tolerance for faster convergence
clf = LogisticRegression(C=50. / train_samples,
                         multi_class='multinomial',
                         penalty='l1', solver='saga', tol=0.1)
clf.fit(X_train, y_train)
sparsity = np.mean(clf.coef_ == 0) * 100
score = clf.score(X_test, y_test)
# print('Best C % .4f' % clf.C_)
print("Sparsity with L1 penalty: %.2f%%" % sparsity)
print("Test score with L1 penalty: %.4f" % score)

coef = clf.coef_.copy()
plt.figure(figsize=(10, 5))
scale = np.abs(coef).max()
for i in range(10):
    l1_plot = plt.subplot(2, 5, i + 1)
    l1_plot.imshow(coef[i].reshape(28, 28), interpolation='nearest',
                   cmap=plt.cm.RdBu, vmin=-scale, vmax=scale)
    l1_plot.set_xticks(())
    l1_plot.set_yticks(())
    l1_plot.set_xlabel('Class %i' % i)
plt.suptitle('Classification vector for...')

run_time = time.time() - t0
print('Example run in %.3f s' % run_time)
plt.show()
```

Total running time of the script: (0 minutes 2.910 seconds)

Download Python source code: plot_sparse_logistic_regression_mnist.py

Download Jupyter notebook: plot_sparse_logistic_regression_mnist.ipynb

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