Training a decision tree

`sklearn.datasets.load_digits` is a dataset of 8 by 8 images of numbers. In this assignment, you will train a decision tree classifier with sklearn and tune the parameter to get better accuracy.

```
# Run the following code to get your training data and test data
seed = 20190327
import sklearn.datasets
from sklearn.model_selection import train_test_split
Load_digits = sklearn.datasets.load_digits()
X_train, X_test, y_train, y_test = train_test_split(Load_digits.data, 

Load_digits.target,
                                                    test_size=0.2,
                                                    random_state=seed)
```

In this assignment, you are required to:

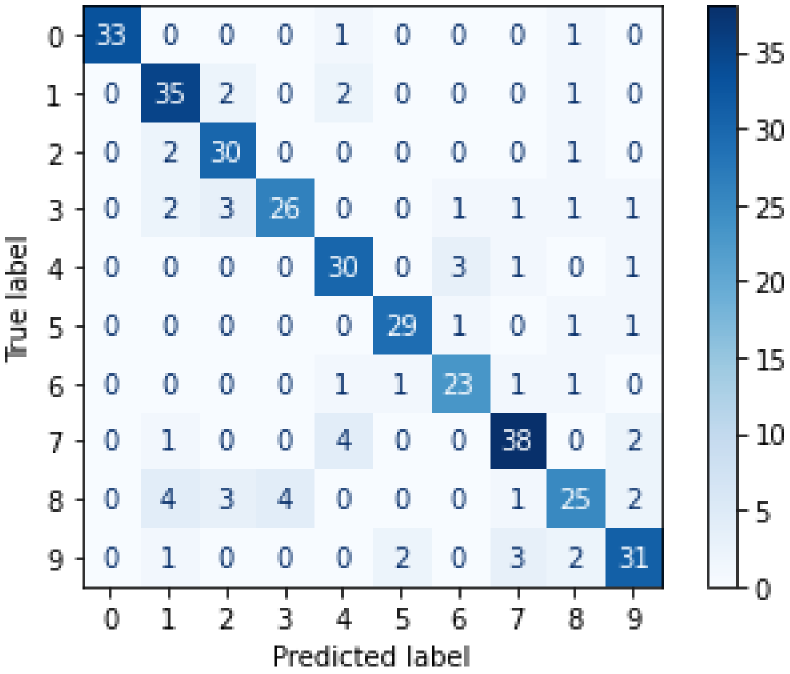
1. Train a model and test its accuracy

   Note: Use `random_state=seed` as an argument of the model so as to get consistent results.

2. Tune the parameter to get better performance

Note: In order to get full marks, you need to show your work how you choose the best perameters, rather than just showing what the best parameter is.

```
# 1. import model from sklearn

from sklearn import tree
clf = tree.DecisionTreeClassifier()

# 2. train you model with X_train and y_train

clf = clf.fit(X_train, y_train)

# 3. test your performance on X_test and y_test

from sklearn.metrics import accuracy_score, plot_confusion_matrix

# You can use accuracy_score to get accuracy of you model. You may 
also compute the score manually.
import matplotlib.pyplot as plt

def performance(clf):
    y_pred = clf.predict(X_test)
    disp = plot_confusion_matrix(clf, X_test, y_test, 
cmap=plt.cm.Blues)
    plt.show()
    print('Accuracy of the model:', accuracy_score(y_test, y_pred))

performance(clf)
```

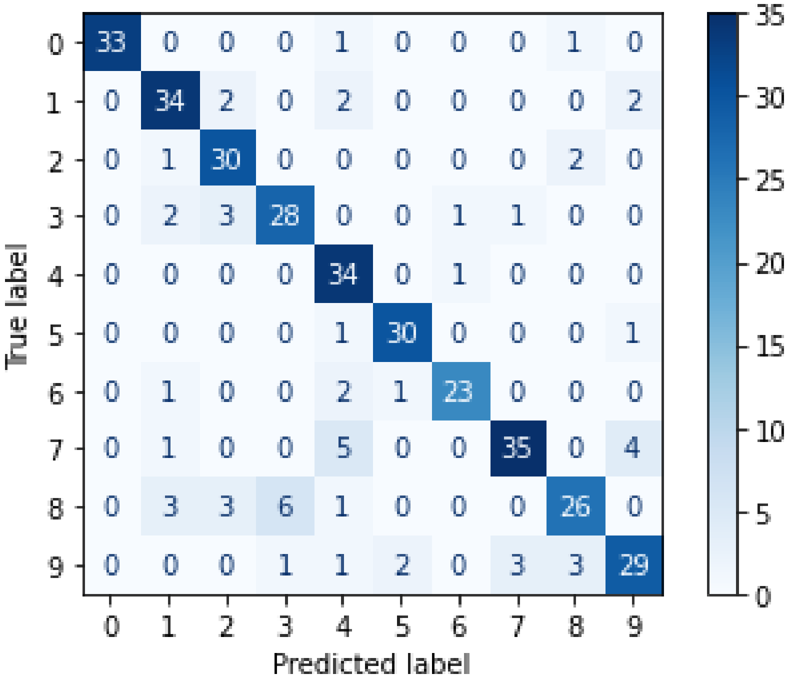


True label \ Predicted label	0	1	2	3	4	5	6	7	8	9
0	33	0	0	0	1	0	0	0	1	0
1	0	35	2	0	2	0	0	0	1	0
2	0	2	30	0	0	0	0	0	1	0
3	0	2	3	26	0	0	1	1	1	1
4	0	0	0	0	30	0	3	1	0	1
5	0	0	0	0	0	29	1	0	1	1
6	0	0	0	0	1	1	23	1	1	0
7	0	1	0	0	4	0	0	38	0	2
8	0	4	3	4	0	0	0	1	25	2
9	0	1	0	0	0	2	0	3	2	31

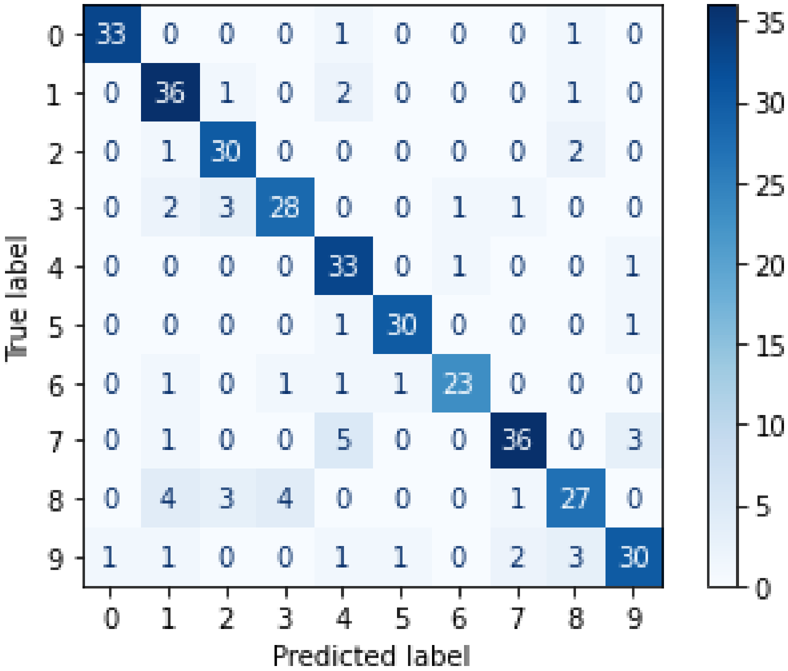
```
Accuracy of the model: 0.8333333333333334
```

There are several parameters to tune in a decision tree model, (e.g., `max_depth`, `max_features`, `max_leaf_nodes`, `min_samples_leaf`, `min_samples_split`). Try to tune your model by choosing the values for 1 ~ 3 parameters using cross validation. For example:

```
# 4. Try different max_depth and pick the best one

from ipywidgets import interactive

#max_depth = 10
model10 = tree.DecisionTreeClassifier(max_depth=10, random_state=seed)
# change the number of the max_depth and run this cell recurrently to
find the best max_depth
model10 = model10.fit(X_train, y_train)
performance(model10)
```



```
Accuracy of the model: 0.8388888888888889

#max_depth = 11
model11 = tree.DecisionTreeClassifier(max_depth=11, random_state=seed)
# change the number of the max_depth and run this cell recurrently to
find the best max_depth
model11 = model11.fit(X_train, y_train)
performance(model11)
```

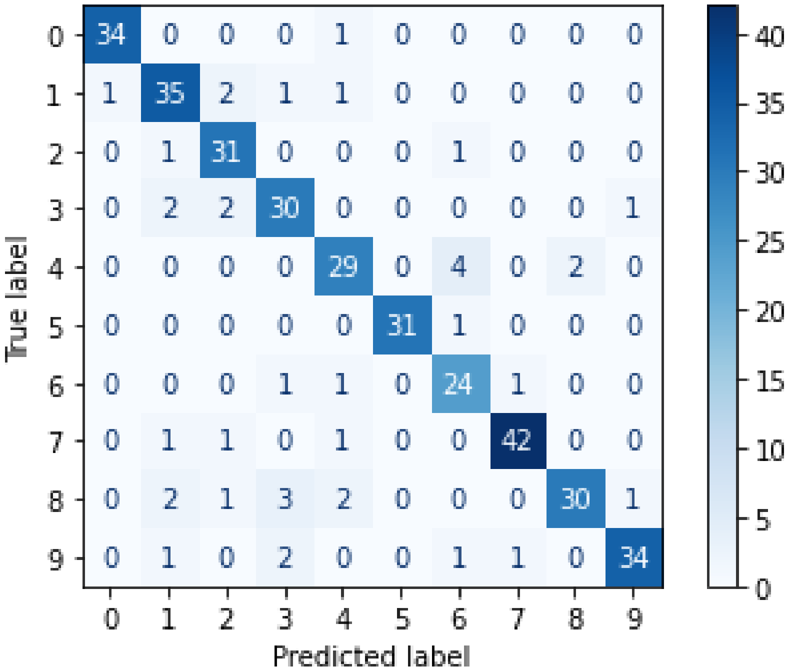


```
Accuracy of the model: 0.85
```

```
# 4.1 You may choose more parameters to tune
from IPython.display import SVG
from graphviz import Source
from IPython.display import display

def plot_tree(features, nodes, min_split, min_leaf):
  estimator = tree.DecisionTreeClassifier(random_state = seed
      , max_depth = best_depth
      , max_features = features
      , max_leaf_nodes = nodes
      , min_samples_split=min_split
      , min_samples_leaf=min_leaf)
  estimator.fit(X_train, y_train)
  performance(estimator)
  graph = Source(tree.export_graphviz(estimator
      , out_file=None
      , feature_names=Load_digits.feature_names
      , class_names=['0', '1', '2', '3', '4', '5', '6', '7', '8', '9',
'10', '11']
      , filled = True))

  display(SVG(graph.pipe(format='svg')))
  return estimator

inter=interactive(plot_tree
   , features = (40, 60)
   , nodes = [None, 10, 20, 30, 40, 50, 60]
   , min_split=[0.001, 0.01, 0.1]
   , min_leaf= [0.0001, 0.001, 0.01])

display(inter)
```

```
{"version_major":2,"version_minor":0,"model_id":"c6917cfabfd14d7c9cd39
99583d7c548"}
```

```
# 5. Show your best result
best_features = 51
best_nodes = None
best_min_split = 0.001
best_min_leaf = 0.0001
best_model = tree.DecisionTreeClassifier(
        max_depth = best_depth
      , max_features = best_features
      , max_leaf_nodes = best_nodes
      , min_samples_split= best_min_split
      , min_samples_leaf= best_min_leaf
      , random_state = seed)
best_model = best_model.fit(X_train, y_train)
performance(best_model)
```



	0	1	2	3	4	5	6	7	8	9
0	34	0	0	0	1	0	0	0	0	0
1	1	35	2	1	1	0	0	0	0	0
2	0	1	31	0	0	0	1	0	0	0
3	0	2	2	30	0	0	0	0	0	1
4	0	0	0	0	29	0	4	0	2	0
5	0	0	0	0	0	31	1	0	0	0
6	0	0	0	1	1	0	24	1	0	0
7	0	1	1	0	1	0	0	42	0	0
8	0	2	1	3	2	0	0	0	30	1
9	0	1	0	2	0	0	1	1	0	34

```
Accuracy of the model: 0.8888888888888888
```