Load the MNIST dataset (introduced in Chapter 3) and split it into a training set and a test set (take the first 60,000 instances for training, and the remaining 10,000 for testing). Train a Random Forest classifier on the dataset and time how long it takes, then evaluate the resulting model on the test set.

Load the MNIST dataset

In [ ]:

```
from sklearn.datasets import fetch_openml
import time
```

Get the MNIST data using the below code

In [ ]:

```
mnist = fetch_openml('mnist_784', version=1, as_frame=False)
mnist.keys()
```

Out[ ]:

```
dict_keys(['data', 'target', 'frame', 'categories', 'feature_names', 'target_names',
'DESCR', 'details', 'url'])
```

define train and test data

In [ ]:

```
train, test = mnist["data"], mnist["target"]
```

Train Test data details

In [ ]:

```
print(train.shape)
print(test.shape)
```

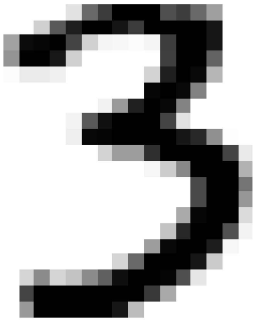
```
(70000, 784)
(70000,)
```

In [ ]:

```
%matplotlib inline
import matplotlib as mpl
import matplotlib.pyplot as plt

img = train[10000]
image_shape = img.reshape(28, 28)
plt.imshow(image_shape, cmap=mpl.cm.binary)
plt.axis("off")

plt.show()
```



```
In [ ]: test[10000]

Out[ ]: '3'
```

```
In [ ]: def plot_digits(instances, images_per_row=10, **options):
            size = 28
            images_per_row = min(len(instances), images_per_row)
            n_rows = (len(instances) - 1) // images_per_row + 1
            n_empty = n_rows * images_per_row - len(instances)
            padded_instances = np.concatenate([instances, np.zeros((n_empty, size * size))], a
            image_grid = padded_instances.reshape((n_rows, images_per_row, size, size))
            big_image = image_grid.transpose(0, 2, 1, 3).reshape(n_rows * size,images_per_row
            plt.imshow(big_image, cmap = mpl.cm.binary, **options)
            plt.axis("off")
```

```
In [ ]: import numpy as np
        plt.figure(figsize=(12,12))
        example_images = train[:100]
        plot_digits(example_images, images_per_row=10)
        plt.show()
```

split data into train(60000) and test (10000)

In [ ]:

```
X_train = mnist['data'][:60000]
y_train = mnist['target'][:60000]

X_test = mnist['data'][60000:]
y_test = mnist['target'][60000:]
```

Train a Random Forest classifier on the dataset and time how long it takes, then evaluate the resulting model on the test set.

In [ ]:

```
from sklearn.ensemble import RandomForestClassifier
```

In [ ]:

```
time_one_100 = time.time()
rnd_clf = RandomForestClassifier(n_estimators=100, max_leaf_nodes=16, random_state=42)
random_forest_clf=rnd_clf.fit(X_train, y_train)
time_two_100 = time.time()
```

Train a Random Forest classifier on the dataset

In [ ]:
```
print ( "Training time {:.2f}s ".format(time_two_100 - time_one_100))
```
```
Training time 22.05s
```

In [ ]:
```
from sklearn.metrics import accuracy_score
```

evaluate the resulting model on the test set.

In [ ]:
```
y_pred_one = rnd_clf.predict(X_test)
pred_score_100 = accuracy_score(y_test, y_pred_one)
print(pred_score_100)
```
```
0.8245
```

In [ ]:
```
rnd_clf = RandomForestClassifier(n_estimators=200, random_state=42)
```

In [ ]:
```
time_one_200 = time.time()
rnd_clf.fit(X_train, y_train)
time_two_200 = time.time()
```

In [ ]:
```
print("Training time {:.2f}s".format(time_two_200 - time_one_200))
```
```
Training time 116.56s
```

In [ ]:
```
y_pred_two = rnd_clf.predict(X_test)
pred_score_200 = accuracy_score(y_test, y_pred_two)
print(pred_score_200)
```
```
0.9707
```

In [ ]:
```
rnd_clf = RandomForestClassifier(n_estimators=400, random_state=42)
```

In [ ]:
```
time_one_400 = time.time()
rnd_clf.fit(X_train, y_train)
time_two_400 = time.time()
```

In [ ]:
```
print("Training time {:.2f}s".format(time_two_400 - time_one_400))
```
```
Training time 250.71s
```

In [ ]:
```
y_pred_three = rnd_clf.predict(X_test)
pred_score_400 = accuracy_score(y_test, y_pred_three)
print(pred_score_400)
```
```
0.9712
```

In [ ]:
```
rnd_clf7 = RandomForestClassifier(n_estimators=700, max_leaf_nodes=16, random_state=42
```

In [ ]:
```
time_one_700 = time.time()
rnd_clf.fit(X_train, y_train)
time_two_700 = time.time()
```

In [ ]:
```
print("Training time {:.2f}s".format(time_two_700 - time_one_700))
```
```
Training time 294.09s
```

In [ ]:

```
y_pred_four = rnd_clf.predict(X_test)
pred_score_700 = accuracy_score(y_test, y_pred_four)
print(pred_score_700)
```

```
0.9712
```

In [ ]:

```
print ( "Training time for 100 n_estimator {:.2f}s ".format(time_two_100 - time_one_1
print("Prediction Score for 100 n_estimator ", pred_score_100)
print ( "\n Training time for 200 n_estimator {:.2f}s ".format(time_two_200 - time_one
print("Prediction Score for 200 n_estimator ", pred_score_200)
print ( "\n Training time for 400 n_estimator {:.2f}s ".format(time_two_400 - time_one
print("Prediction Score for 400 n_estimator ", pred_score_400)
print ( "\n Training time for 700 n_estimator {:.2f}s ".format(time_two_700 - time_one
print("Prediction Score for 700 n_estimator ", pred_score_700)
```

```
Training time for 100 n_estimator 22.05s
Prediction Score for 100 n_estimator  0.8245

 Training time for 200 n_estimator 116.56s
Prediction Score for 200 n_estimator  0.9707

 Training time for 400 n_estimator 250.71s
Prediction Score for 400 n_estimator  0.9712

 Training time for 700 n_estimator 294.09s
Prediction Score for 700 n_estimator  0.9712
```

its look like increasing n_estimator value increase the run time. but other side its also increase the prediction score.

In [ ]: