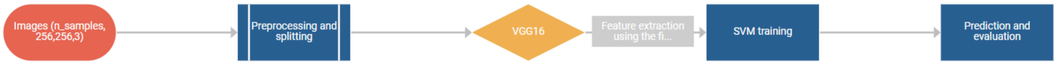
Image Classification Using Deep Features


Images (n_samples, 256,256,3)
Preprocessing and splitting
VGG16
Feature extraction using the fi...
SVM training
Prediction and evaluation

In [1]:

```
import cv2
import numpy as np
from sklearn.cluster import KMeans
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.preprocessing import normalize
from sklearn.metrics import accuracy_score, confusion_matrix
from sklearn.preprocessing import LabelEncoder
import os
import matplotlib.pyplot as plt
from sklearn.metrics import accuracy_score, confusion_matrix, ConfusionMatri
```

Dataset Import and preprocessiong

In [2]:

```
data_dir =  r"UCMerced_LandUse\UCMerced_LandUse\Images"

classes = sorted(os.listdir(data_dir))
image_size = (256, 256)
num_classes = len(classes)



images = []
labels = []

for idx, class_name in enumerate(classes):
    class_dir = os.path.join(data_dir, class_name)
    image_files = sorted(os.listdir(class_dir))

    for image_file in image_files:
        image_path = os.path.join(class_dir, image_file)
        img = cv2.imread(image_path)
        img = cv2.resize(img, image_size)
        images.append(img)
        labels.append(idx)
```

In [3]:

```
classes
```

Out[3]:

```
['agricultural',
 'airplane',
 'baseballdiamond',
 'beach',
 'buildings',
 'chaparral',
 'denseresidential',
 'forest',
 'freeway',
 'golfcourse',
 'harbor',
 'intersection',
 'mediumresidential',
 'mobilehomepark',
 'overpass',
 'parkinglot',
 'river',
 'runway',
 'sparseresidential',
 'storagetanks',
 'tenniscourt']
```

In [4]:

```
images = np.array(images)
labels = np.array(labels)
```

In [5]:

```
labels
```

Out[5]:

```
array([ 0,  0,  0, ..., 20, 20, 20])
```

Dataset Splitting: with ensurance that the split mainains a balance of images from different categories

In [6]:

```
def train_test_split(X, y, test_size=0.2, random_state=None):
    if random_state is not None:
        np.random.seed(random_state)

    indices = np.arange(len(X))
    np.random.shuffle(indices)


    test_size = int(len(X) * test_size)
    train_size = len(X) - test_size

    X_train = X[indices[:train_size]]
    X_test = X[indices[train_size:]]
    y_train = y[indices[:train_size]]
    y_test = y[indices[train_size:]]

    return X_train, X_test, y_train, y_test
```

In [7]:

```
X_train, X_test = [], []
y_train, y_test = [], []
for class_idx in range(num_classes):
    class_images = images[labels == class_idx]
    class_labels = labels[labels == class_idx]

    X_train_cls, X_test_cls, y_train_cls, y_test_cls = train_test_split(
        class_images, class_labels, test_size=0.2, random_state=42
    )

    X_train.extend(X_train_cls)
    y_train.extend(y_train_cls)
    X_test.extend(X_test_cls)
    y_test.extend(y_test_cls)

X_train, y_train = np.array(X_train), np.array(y_train)
X_test, y_test = np.array(X_test), np.array(y_test)

print(f"Training set: X={X_train.shape}, y={y_train.shape}")
print(f"Testing set: X={X_test.shape}, y={y_test.shape}")
```

```
Training set: X=(1680, 256, 256, 3), y=(1680,)
Testing set: X=(420, 256, 256, 3), y=(420,)
```

In [19]:

```
from keras.applications.vgg16 import preprocess_input
X_train, X_test, y_train, y_test = train_test_split(images, labels, test_siz
print(f"Train set size: {len(X_train)}, Test set size: {len(X_test)}")

def resize_images(images, target_size=(224, 224)):
    resized_images = np.array([cv2.resize(img, target_size) for img in image
    return resized_images

X_train_resized = resize_images(X_train)
X_test_resized = resize_images(X_test)

X_train_preprocessed = preprocess_input(X_train_resized)
X_test_preprocessed = preprocess_input(X_test_resized)

print("Images resized and preprocessed successfully.")
```

```
Train set size: 1680, Test set size: 420
Images resized and preprocessed successfully.
```

Deep feature extraction

1- Load VGG16 model without the final classification layer.

In [17]:

```
from keras.applications import VGG16
from keras.models import Model

vgg16_model = VGG16(weights='imagenet', include_top=True)

feature_extractor = Model(inputs=vgg16_model.input, outputs=vgg16_model.get_

print("VGG16 model loaded successfully. Using fc2 layer for feature extracti
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applic
ations/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels.h5
553467096/553467096 ━━━━━━━━━━━━━━━━━━━━ 2545s 5us/step
VGG16 model loaded successfully. Using fc2 layer for feature extraction.
```

In [20]:

```
X_train_features = feature_extractor.predict(X_train_preprocessed)
X_test_features = feature_extractor.predict(X_test_preprocessed)

print(f"Training features extracted: {X_train_features.shape}")
print(f"Testing features extracted: {X_test_features.shape}")
```

```
53/53 ━━━━━━━━━━━━━━━━━━━━ 88s 2s/step
14/14 ━━━━━━━━━━━━━━━━━━━━ 21s 1s/step
Training features extracted: (1680, 4096)
Testing features extracted: (420, 4096)
```

SVM classifier training

In [21]:

```
from sklearn.svm import SVC
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import make_pipeline

svm_classifier = make_pipeline(StandardScaler(), SVC(kernel='linear', random

svm_classifier.fit(X_train_features, y_train)

print("SVM Classifier trained successfully.")
```

```
SVM Classifier trained successfully.
```

In [22]:

```
y_pred = svm_classifier.predict(X_test_features)

print(f"Predicted labels: {y_pred}")
```

```
Predicted labels: [ 0  1 13 12  4  9  9  2  1 11  9  6 17  6  1  3  4 18 18
17 17  5 13 10
 20  1  4 11  0 15 10 20  5 15  6 18 10 17 15  9 20  2 16  7 17  2  0  2
  4 20 13  2  0 16  7 10 13  4 18 12 20 19  6 18 12 11 14 15 17 13 19  8
 16  1 17  9 17 11  8 17 18  8 16  1 19 19  5 11 12 17  1 14 14  2  5 19
 16 11  0  1  4 11  2 20 16 11 18  0 10 19 10  4 16  2 13  8 18  8 15 20
 12  3 20 17  2 16 13 14  1  4 18 15  8 20  5 19  9  4 17 19 11  1 18 13
  4  9 20  6 17 13  4 13  1 11 12  6  1  7 15  9  1 16  8  2  2 19  4  1
 12  2 14  8  2 14 17 18  7 17 20 11 16 14  3 18 17  8 15  2  4  0  1  6
 11  9  3 16  6 14 14 18 15 12 19  4 15 18 11 17 12 20  3 16 13 18  6 19
 12 18 19 17  3  6 14 14  7 13 12 17  9  6  6 13 14 14 12 20 12 14 13 15
 16 13 18 20 20 16 19  7  4 10 19  5  6  5 18 11 12 17 11 11  5 10  5 12
 16  7 20 14 11 17 18  0 10  5 12  7  8 15 17 14  8 15 18 10  2  3  7  8
  3  7 19 12 10 17 13 20  4  6 17  9 15  7 18  6  0  8 17 15  4  5 10 10
  9  7 18  2  1 10  0 10  2 15 17  3  2  4 16  3  5 15 11 10 14 13 11 13
  5 18 18  0  1  0 12 10 20  3  1  7  2 19  7 10  8  3 17  7 17  2 17 10
 12 17 14  4 20  8 18  2  9 19  2  1 15  7 15 11 10 15 19  0  7 14 13 13
 20  2 20  6 12 20 13 15 12  2  5 19 18  9 18 10  4  7  0  4 11  9 12 15
  7 16  1 14  3 12  4 16 10 20 12  8]
```

4. Performance Evaluation

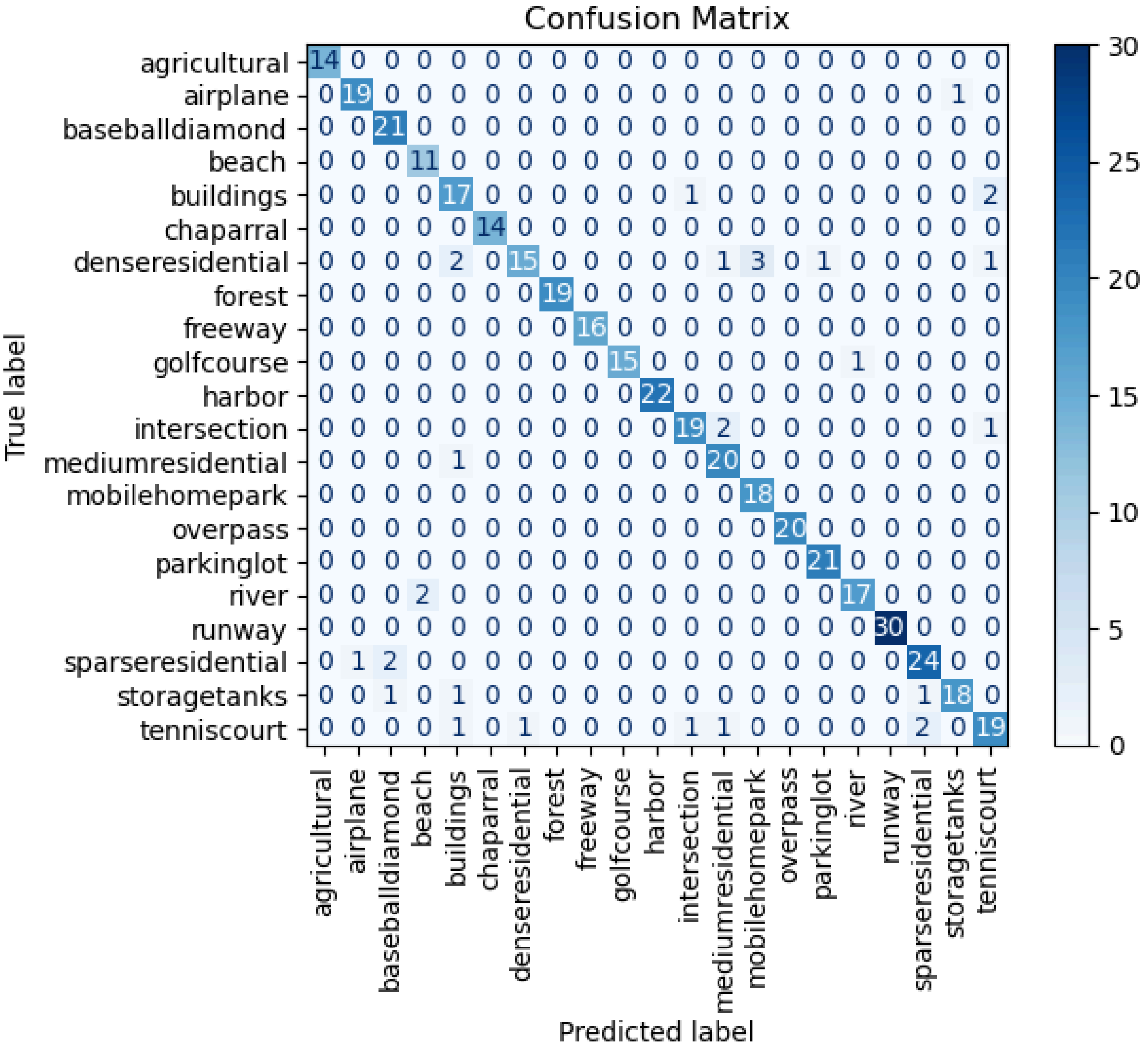
Compute Accuracy and Confusion Matrix

```
In [23]: from sklearn.metrics import accuracy_score, confusion_matrix, ConfusionMatri
         import matplotlib.pyplot as plt

         accuracy = accuracy_score(y_test, y_pred)
         print(f"Accuracy: {accuracy * 100:.2f}%")

         conf_matrix = confusion_matrix(y_test, y_pred)
         disp = ConfusionMatrixDisplay(confusion_matrix=conf_matrix, display_labels=c
         disp.plot(cmap=plt.cm.Blues, xticks_rotation='vertical')
         plt.title("Confusion Matrix")
         plt.show()
```

```
Accuracy: 92.62%
```



	agricultural	airplane	baseballdiamond	beach	buildings	chaparral	denseresidential	forest	freeway	golfcourse	harbor	intersection	mediumresidential	mobilehomepark	overpass	parkinglot	river	runway	sparseresidential	storagetanks	tenniscourt
agricultural	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
airplane	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
baseballdiamond	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
beach	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
buildings	0	0	0	0	17	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2
chaparral	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
denseresidential	0	0	0	0	2	0	15	0	0	0	0	0	1	3	0	1	0	0	0	0	1
forest	0	0	0	0	0	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0
freeway	0	0	0	0	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0
golfcourse	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	1	0	0	0	0
harbor	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0
intersection	0	0	0	0	0	0	0	0	0	0	0	19	2	0	0	0	0	0	0	0	1
mediumresidential	0	0	0	0	1	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0
mobilehomepark	0	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	0	0
overpass	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0
parkinglot	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0
river	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0
runway	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0
sparseresidential	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0
storagetanks	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	18	0
tenniscourt	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	2	0	19

```
In [ ]:
```

This notebook was converted with convert.ploomber.io