In [ ]:
```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call
drive.mount("/content/drive", force_remount=True).
```

In [ ]:
```
import zipfile
import os

zip_path = "/content/drive/MyDrive/Deep_Learning_Projects /archive (15).zip"  #
extract_path = "/content/drive/My Drive/satellite_extracted_files"  # Change if

# Create the extraction directory if it doesn't exist
os.makedirs(extract_path, exist_ok=True)

# Extract the ZIP file
with zipfile.ZipFile(zip_path, 'r') as zip_ref:
    zip_ref.extractall(extract_path)

print(f"Files extracted to: {extract_path}")
```

In [ ]:
```
!pip install split-folders
```

```
Requirement already satisfied: split-folders in /usr/local/lib/python3.11/dist
-packages (0.5.1)
```

In [ ]:

```
import os
import cv2
import tensorflow
import numpy as np
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.applications import VGG16, Xception, InceptionResNetV2, R
from tensorflow.keras.models import Model
from tensorflow.keras.layers import Dense, GlobalAveragePooling2D
from tensorflow.keras.callbacks import EarlyStopping, ModelCheckpoint, ReduceLR
from tensorflow.keras.optimizers import Adam
from sklearn.utils.class_weight import compute_class_weight
from sklearn.metrics import classification_report, confusion_matrix
```

In [ ]:

```
import splitfolders  # Install using: pip install splitfolders
import os

# Path to your dataset (Change this to your actual path)
input_folder = "/content/drive/MyDrive/satellite_extracted_files/data"  # Main 

# Output folder for split dataset
output_folder = "/content/drive/My Drive/satellite_dataset_split"

# Create train and test sets (80% train, 20% test)
splitfolders.ratio(input_folder, output=output_folder, seed=42, ratio=(0.8, 0.2

print("Dataset split complete! Check:", output_folder)
```

```
Copying files: 5631 files [39:21,  2.38 files/s]

Dataset split complete! Check: /content/drive/My Drive/satellite_dataset_split
```

In [ ]:

```python
import os
import pandas as pd  # Install using: pip install pandas

# Paths to train and test directories
train_path = "/content/drive/MyDrive/satellite_dataset_split/train"
test_path = "/content/drive/MyDrive/satellite_dataset_split/val"

# Function to count images in each category
def count_images(data_path):
    category_counts = {}
    for category in os.listdir(data_path):
        category_folder = os.path.join(data_path, category)
        if os.path.isdir(category_folder):
            num_images = len([img for img in os.listdir(category_folder) if img
            category_counts[category] = num_images
    return category_counts

# Count images in train and test datasets
train_counts = count_images(train_path)
test_counts = count_images(test_path)

# Create a DataFrame for better visualization
df = pd.DataFrame({"Category": train_counts.keys(), "Train Images": train_count

# Print the table
print(df)

# Display in Colab as a proper table
from IPython.display import display
display(df)
```

```
    Category  Train Images  Test Images
0     cloudy          1200          300
1     desert           904          227
2  green_area         1200          300
3      water          1200          300
```


	Category	Train Images	Test Images
0	cloudy	1200	300
1	desert	904	227
2	green_area	1200	300
3	water	1200	300

In [ ]:
```
import os
import cv2
import numpy as np
from tensorflow.keras.utils import to_categorical
from sklearn.model_selection import train_test_split

# Define paths
dataset_path = "/content/drive/MyDrive/satellite_dataset_split/train"  # Change

# Define image size and categories
IMG_SIZE = (128, 128)  # Resize all images to 128x128
categories = ["cloudy", "desert", "green_area", "water"]  # Class labels

# Create empty lists for images and labels
X = []  # Image data
y = []  # Labels

# Load and preprocess images
for label, category in enumerate(categories):
    category_path = os.path.join(dataset_path, category)

    if os.path.isdir(category_path):  # Ensure it's a folder
        for img_name in os.listdir(category_path):
            img_path = os.path.join(category_path, img_name)

            if img_name.lower().endswith((".jpg", ".png", ".jpeg")):  # Process
                img = cv2.imread(img_path)  # Read image

                if img is not None:  # Ensure image is loaded correctly
                    img = cv2.resize(img, IMG_SIZE)  # Resize
```

```
                img = img / 255.0  # Normalize pixel values to [0,1]

                X.append(img)
                y.append(label)  # Convert category name to a number
            else:
                print(f"Skipping invalid image: {img_path}")  # Debugging me

# Convert to numpy arrays
X = np.array(X)
y = np.array(y)

# **Important**: Stratify using raw labels before one-hot encoding
X_train, X_val, y_train, y_val = train_test_split(X, y, test_size=0.2, random_s

# One-hot encode labels AFTER splitting
y_train = to_categorical(y_train, num_classes=len(categories))
y_val = to_categorical(y_val, num_classes=len(categories))

# Print dataset shapes
print(f"Training set: {X_train.shape}, Labels: {y_train.shape}")
print(f"Validation set: {X_val.shape}, Labels: {y_val.shape}")
```

```
Skipping invalid image: /content/drive/MyDrive/satellite_dataset_split/train/c
loudy/train_717.jpg
Skipping invalid image: /content/drive/MyDrive/satellite_dataset_split/train/d
esert/desert(453).jpg
Training set: (3601, 128, 128, 3), Labels: (3601, 4)
Validation set: (901, 128, 128, 3), Labels: (901, 4)
```

In [ ]:

```
import tensorflow as tf
from tensorflow.keras import layers, models

# Define CNN Model
model = models.Sequential([
    layers.Conv2D(32, (3, 3), activation='relu', input_shape=(128, 128, 3)),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(64, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Conv2D(128, (3, 3), activation='relu'),
    layers.MaxPooling2D((2, 2)),

    layers.Flatten(),
    layers.Dense(128, activation='relu'),
    layers.Dropout(0.5),  # Prevent overfitting
    layers.Dense(4, activation='softmax')  # 4 classes: cloudy, desert, green_ai
])

# Compile Model
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Show Model Summary
model.summary()
```

Model: "sequential_1"

Layer (type)	Output Shape	
conv2d_3 (Conv2D)	(None, 126, 126, 32)	
max_pooling2d_3 (MaxPooling2D)	(None, 63, 63, 32)	
conv2d_4 (Conv2D)	(None, 61, 61, 64)	
max_pooling2d_4 (MaxPooling2D)	(None, 30, 30, 64)	
conv2d_5 (Conv2D)	(None, 28, 28, 128)	
max_pooling2d_5 (MaxPooling2D)	(None, 14, 14, 128)	
flatten_1 (Flatten)	(None, 25088)	
dense_2 (Dense)	(None, 128)	3,
dropout_1 (Dropout)	(None, 128)	
dense_3 (Dense)	(None, 4)	

Total params: 3,305,156 (12.61 MB)

Trainable params: 3,305,156 (12.61 MB)

Non-trainable params: 0 (0.00 B)

Train the model

In [ ]:

```
# Train the model
history = model.fit(X_train, y_train,
                    epochs=20,
                    batch_size=32,
                    validation_data=(X_val, y_val))
```

```
Epoch 1/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 14s 65ms/step - accuracy: 0.5720 - loss: 0.8627 -
val_accuracy: 0.6848 - val_loss: 0.6221
Epoch 2/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 21ms/step - accuracy: 0.7058 - loss: 0.5588 -
val_accuracy: 0.7836 - val_loss: 0.4672
Epoch 3/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 21ms/step - accuracy: 0.7295 - loss: 0.5282 -
val_accuracy: 0.7503 - val_loss: 0.4677
Epoch 4/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.7486 - loss: 0.4913 -
val_accuracy: 0.7347 - val_loss: 0.4943
Epoch 5/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.7242 - loss: 0.4922 -
val_accuracy: 0.8224 - val_loss: 0.3881
Epoch 6/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 19ms/step - accuracy: 0.8474 - loss: 0.3864 -
val_accuracy: 0.8657 - val_loss: 0.3433
Epoch 7/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.8445 - loss: 0.3856 -
val_accuracy: 0.8191 - val_loss: 0.4815
Epoch 8/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 21ms/step - accuracy: 0.8546 - loss: 0.3829 -
val_accuracy: 0.8535 - val_loss: 0.3594
Epoch 9/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.8644 - loss: 0.3393 -
val_accuracy: 0.8468 - val_loss: 0.4632
Epoch 10/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.8757 - loss: 0.3173 -
val_accuracy: 0.8613 - val_loss: 0.3208
```

```
Epoch 11/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 20ms/step - accuracy: 0.8551 - loss: 0.3345 -
val_accuracy: 0.8224 - val_loss: 0.4162
Epoch 12/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.8111 - loss: 0.4107 -
val_accuracy: 0.8269 - val_loss: 0.4086
Epoch 13/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 21ms/step - accuracy: 0.8754 - loss: 0.3102 -
val_accuracy: 0.8901 - val_loss: 0.2771
Epoch 14/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 21ms/step - accuracy: 0.8888 - loss: 0.2785 -
val_accuracy: 0.7925 - val_loss: 0.5090
Epoch 15/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 20ms/step - accuracy: 0.8599 - loss: 0.3491 -
val_accuracy: 0.8824 - val_loss: 0.2885
Epoch 16/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 20ms/step - accuracy: 0.8957 - loss: 0.2630 -
val_accuracy: 0.8835 - val_loss: 0.3048
Epoch 17/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 19ms/step - accuracy: 0.8591 - loss: 0.3287 -
val_accuracy: 0.8302 - val_loss: 0.4399
Epoch 18/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 2s 20ms/step - accuracy: 0.8919 - loss: 0.2522 -
val_accuracy: 0.8690 - val_loss: 0.3315
Epoch 19/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 21ms/step - accuracy: 0.8664 - loss: 0.3431 -
val_accuracy: 0.8912 - val_loss: 0.2485
Epoch 20/20
113/113 ━━━━━━━━━━━━━━━━━━━━ 3s 21ms/step - accuracy: 0.9080 - loss: 0.2384 -
val_accuracy: 0.8868 - val_loss: 0.2730
```

#Evaluate Model Accuracy

In [ ]:
```
# Evaluate performance
loss, accuracy = model.evaluate(X_val, y_val)
print(f"Validation Accuracy: {accuracy*100:.2f}%")
```

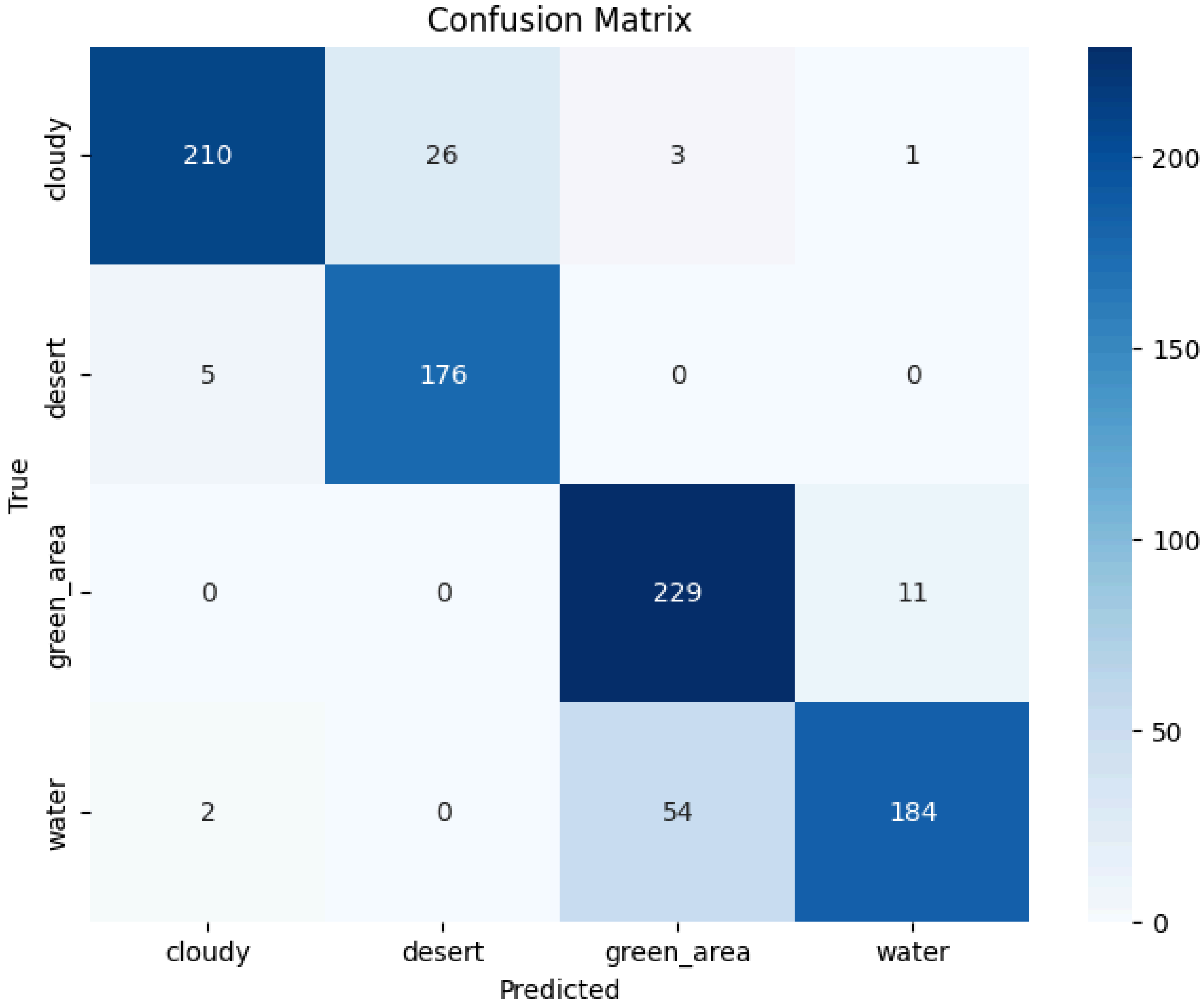
```
29/29 ━━━━━━━━━━━━━━━━━━━━ 0s 9ms/step - accuracy: 0.8864 - loss: 0.3006
Validation Accuracy: 88.68%
```

In [ ]:
```
model.save("/content/drive/MyDrive/satellite_dataset_split/model/satellite_clas
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `
keras.saving.save_model(model)`. This file format is considered legacy. We rec
ommend using instead the native Keras format, e.g. `model.save('my_model.kera
s')` or `keras.saving.save_model(model, 'my_model.keras')`.
```

```
In [ ]: from sklearn.metrics import confusion_matrix, classification_report

        # Predict the classes on validation set
        y_pred = model.predict(X_val)
        y_pred_classes = np.argmax(y_pred, axis=1)  # Convert probabilities to class lal
        y_true_classes = np.argmax(y_val, axis=1)   # True class labels

        # Compute Confusion Matrix
        conf_matrix = confusion_matrix(y_true_classes, y_pred_classes)

        # Print the confusion matrix
        print("Confusion Matrix:")
        print(conf_matrix)

        # Plot confusion matrix
        plt.figure(figsize=(8, 6))
        sns.heatmap(conf_matrix, annot=True, fmt='d', cmap='Blues', xticklabels=categor
        plt.title("Confusion Matrix")
        plt.xlabel("Predicted")
        plt.ylabel("True")
        plt.show()

        # Compute and print classification report (includes F1 Score)
        class_report = classification_report(y_true_classes, y_pred_classes, target_nam
        print("\nClassification Report:")
        print(class_report)
```

```
29/29 ━━━━━━━━━━━━━━━━━━━━ 2s 47ms/step
Confusion Matrix:
[[210  26   3   1]
 [  5 176   0   0]
 [  0   0 229  11]
 [  2   0  54 184]]
```



Confusion Matrix
True
cloudy
desert
green_area
water
210
26
3
1
5
176
0
0
0
0
229
11
2
0
54
184
Predicted
cloudy
desert
green_area
water
200
150
100
50
0

```
Classification Report:
              precision    recall  f1-score   support

      cloudy       0.97      0.88      0.92       240
      desert       0.87      0.97      0.92       181
  green_area       0.80      0.95      0.87       240
       water       0.94      0.77      0.84       240

    accuracy                           0.89       901
   macro avg       0.89      0.89      0.89       901
weighted avg       0.90      0.89      0.89       901
```

In [ ]: