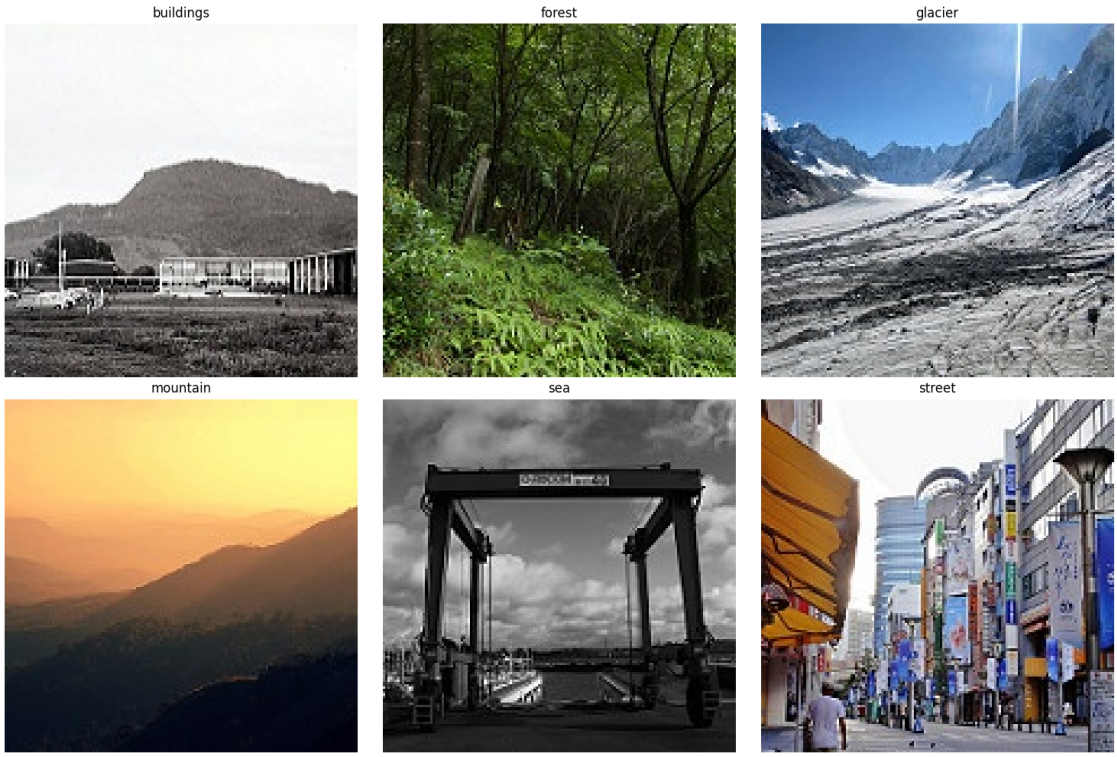
Oishi_136_Lab_5

October 24, 2024

1. Dataset Overview

[1]:
```
import matplotlib.pyplot as plt
import os
from tensorflow.keras.preprocessing.image import load_img, img_to_array

# Define the folder paths
train_dir = './seg_train'
categories = ['buildings', 'forest', 'glacier', 'mountain', 'sea', 'street']

# Display a few samples from each category
fig, axes = plt.subplots(nrows=2, ncols=3, figsize=(15, 10))

for i, category in enumerate(categories):
    category_path = os.path.join(train_dir, category)
    img_name = os.listdir(category_path)[0]  # Take the first image from each␣
 ↪category
    img = load_img(os.path.join(category_path, img_name), target_size=(150,␣
 ↪150))
    axes[i//3, i%3].imshow(img)
    axes[i//3, i%3].set_title(category)
    axes[i//3, i%3].axis('off')

plt.tight_layout()
plt.show()
```

```
WARNING:tensorflow:From
c:\Users\anura\AppData\Local\Programs\Python\Python311\Lib\site-
packages\keras\src\losses.py:2976: The name
tf.losses.sparse_softmax_cross_entropy is deprecated. Please use
tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```



2. Model Architecture

[2]:
```
import tensorflow as tf
from tensorflow.keras import layers, models

def create_cnn_model():
    model = models.Sequential()

    # First Convolutional Layer
    model.add(layers.Conv2D(32, (3, 3), activation='relu', input_shape=(150,␣
 ↪150, 3)))
    model.add(layers.MaxPooling2D((2, 2)))
    model.add(layers.BatchNormalization())

    # Second Convolutional Layer
    model.add(layers.Conv2D(64, (3, 3), activation='relu'))
    model.add(layers.MaxPooling2D((2, 2)))
    model.add(layers.BatchNormalization())

    # Third Convolutional Layer
    model.add(layers.Conv2D(128, (3, 3), activation='relu'))
    model.add(layers.MaxPooling2D((2, 2)))
    model.add(layers.BatchNormalization())
```

```
    # Flatten the output and add Dense layers
    model.add(layers.Flatten())
    model.add(layers.Dense(128, activation='relu'))
    model.add(layers.Dropout(0.5))  # Dropout for regularization
    model.add(layers.Dense(6, activation='softmax'))  # Output layer for 6␣
 ↪categories

    return model

model = create_cnn_model()
model.summary()
```

```
WARNING:tensorflow:From
c:\Users\anura\AppData\Local\Programs\Python\Python311\Lib\site-
packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated.
Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From
c:\Users\anura\AppData\Local\Programs\Python\Python311\Lib\site-
packages\keras\src\layers\pooling\max_pooling2d.py:161: The name tf.nn.max_pool
is deprecated. Please use tf.nn.max_pool2d instead.

Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 148, 148, 32)      896

 max_pooling2d (MaxPooling2  (None, 74, 74, 32)        0
 D)

 batch_normalization (Batch  (None, 74, 74, 32)        128
 Normalization)

 conv2d_1 (Conv2D)           (None, 72, 72, 64)        18496

 max_pooling2d_1 (MaxPoolin  (None, 36, 36, 64)        0
 g2D)

 batch_normalization_1 (Bat  (None, 36, 36, 64)        256
 chNormalization)

 conv2d_2 (Conv2D)           (None, 34, 34, 128)       73856

 max_pooling2d_2 (MaxPoolin  (None, 17, 17, 128)       0
 g2D)
```

```
 batch_normalization_2 (Bat  (None, 17, 17, 128)       512
 chNormalization)

 flatten (Flatten)           (None, 36992)             0

 dense (Dense)               (None, 128)               4735104

 dropout (Dropout)           (None, 128)               0

 dense_1 (Dense)             (None, 6)                 774

=================================================================
Total params: 4830022 (18.43 MB)
Trainable params: 4829574 (18.42 MB)
Non-trainable params: 448 (1.75 KB)
_________________________________________________________________
```

3. Model Training

[3]:
```python
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.preprocessing.image import ImageDataGenerator

# Compile the model
model.compile(optimizer=Adam(learning_rate=0.001),
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Data augmentation for training set
train_datagen = ImageDataGenerator(
    rescale=1./255,
    rotation_range=20,
    width_shift_range=0.2,
    height_shift_range=0.2,
    horizontal_flip=True,
    zoom_range=0.2
)

test_datagen = ImageDataGenerator(rescale=1./255)

# Load the training and validation data
train_generator = train_datagen.flow_from_directory(
    './seg_train',
    target_size=(150, 150),
    batch_size=32,
    class_mode='categorical'
)

validation_generator = test_datagen.flow_from_directory(
```

```
    './seg_test',
    target_size=(150, 150),
    batch_size=32,
    class_mode='categorical'
)

# Train the model
history = model.fit(
    train_generator,
    steps_per_epoch=train_generator.samples // train_generator.batch_size,
    epochs=20,
    validation_data=validation_generator,
    validation_steps=validation_generator.samples // validation_generator.
  ↪batch_size
)
```

```
Found 14034 images belonging to 6 classes.
Found 3000 images belonging to 6 classes.
Epoch 1/20
WARNING:tensorflow:From
c:\Users\anura\AppData\Local\Programs\Python\Python311\Lib\site-
packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue
is deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

WARNING:tensorflow:From
c:\Users\anura\AppData\Local\Programs\Python\Python311\Lib\site-
packages\keras\src\engine\base_layer_utils.py:384: The name
tf.executing_eagerly_outside_functions is deprecated. Please use
tf.compat.v1.executing_eagerly_outside_functions instead.

438/438 [==============================] - 569s 1s/step - loss: 3.6580 -
accuracy: 0.4124 - val_loss: 1.4408 - val_accuracy: 0.4822
Epoch 2/20
438/438 [==============================] - 381s 868ms/step - loss: 1.3358 -
accuracy: 0.4889 - val_loss: 1.2289 - val_accuracy: 0.6277
Epoch 3/20
438/438 [==============================] - 332s 759ms/step - loss: 1.1799 -
accuracy: 0.5394 - val_loss: 0.8405 - val_accuracy: 0.7144
Epoch 4/20
438/438 [==============================] - 105s 240ms/step - loss: 1.1375 -
accuracy: 0.5608 - val_loss: 0.8114 - val_accuracy: 0.7285
Epoch 5/20
438/438 [==============================] - 105s 240ms/step - loss: 1.0453 -
accuracy: 0.6030 - val_loss: 0.7938 - val_accuracy: 0.7201
Epoch 6/20
438/438 [==============================] - 107s 244ms/step - loss: 1.0326 -
accuracy: 0.6151 - val_loss: 0.7161 - val_accuracy: 0.7537
Epoch 7/20
```

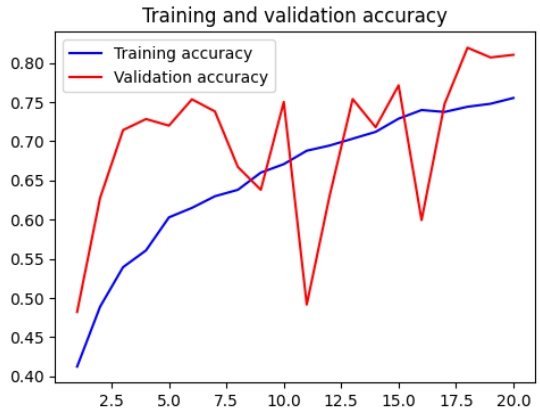
```
438/438 [==============================] - 195s 446ms/step - loss: 0.9968 -
accuracy: 0.6299 - val_loss: 0.7580 - val_accuracy: 0.7382
Epoch 8/20
438/438 [==============================] - 280s 634ms/step - loss: 0.9691 -
accuracy: 0.6381 - val_loss: 0.9313 - val_accuracy: 0.6673
Epoch 9/20
438/438 [==============================] - 104s 238ms/step - loss: 0.9182 -
accuracy: 0.6601 - val_loss: 1.0278 - val_accuracy: 0.6381
Epoch 10/20
438/438 [==============================] - 105s 238ms/step - loss: 0.8977 -
accuracy: 0.6709 - val_loss: 0.7706 - val_accuracy: 0.7503
Epoch 11/20
438/438 [==============================] - 106s 241ms/step - loss: 0.8528 -
accuracy: 0.6880 - val_loss: 1.7041 - val_accuracy: 0.4916
Epoch 12/20
438/438 [==============================] - 105s 240ms/step - loss: 0.8296 -
accuracy: 0.6947 - val_loss: 1.5638 - val_accuracy: 0.6310
Epoch 13/20
438/438 [==============================] - 103s 236ms/step - loss: 0.8271 -
accuracy: 0.7034 - val_loss: 0.7895 - val_accuracy: 0.7540
Epoch 14/20
438/438 [==============================] - 110s 250ms/step - loss: 0.7949 -
accuracy: 0.7121 - val_loss: 0.6870 - val_accuracy: 0.7181
Epoch 15/20
438/438 [==============================] - 123s 282ms/step - loss: 0.7563 -
accuracy: 0.7290 - val_loss: 0.7968 - val_accuracy: 0.7715
Epoch 16/20
438/438 [==============================] - 198s 452ms/step - loss: 0.7361 -
accuracy: 0.7400 - val_loss: 1.0260 - val_accuracy: 0.5995
Epoch 17/20
438/438 [==============================] - 122s 279ms/step - loss: 0.7431 -
accuracy: 0.7375 - val_loss: 0.7605 - val_accuracy: 0.7476
Epoch 18/20
438/438 [==============================] - 125s 285ms/step - loss: 0.7114 -
accuracy: 0.7442 - val_loss: 0.5808 - val_accuracy: 0.8196
Epoch 19/20
438/438 [==============================] - 122s 278ms/step - loss: 0.7068 -
accuracy: 0.7480 - val_loss: 0.5626 - val_accuracy: 0.8071
Epoch 20/20
438/438 [==============================] - 122s 277ms/step - loss: 0.6851 -
accuracy: 0.7554 - val_loss: 0.5964 - val_accuracy: 0.8105
```

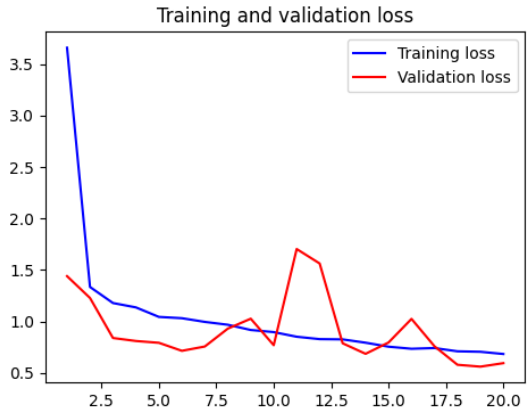
4. Evaluation

[4]:
```
# Evaluate the model
test_loss, test_acc = model.evaluate(validation_generator)
print(f'Test accuracy: {test_acc:.2f}')
```

```python
# Plot training and validation accuracy/loss
import matplotlib.pyplot as plt

def plot_accuracy_loss(history):
    acc = history.history['accuracy']
    val_acc = history.history['val_accuracy']
    loss = history.history['loss']
    val_loss = history.history['val_loss']

    epochs = range(1, len(acc) + 1)

    plt.figure(figsize=(12, 4))

    plt.subplot(1, 2, 1)
    plt.plot(epochs, acc, 'b', label='Training accuracy')
    plt.plot(epochs, val_acc, 'r', label='Validation accuracy')
    plt.title('Training and validation accuracy')
    plt.legend()

    plt.subplot(1, 2, 2)
    plt.plot(epochs, loss, 'b', label='Training loss')
    plt.plot(epochs, val_loss, 'r', label='Validation loss')
    plt.title('Training and validation loss')
    plt.legend()

    plt.show()

plot_accuracy_loss(history)

# Confusion matrix
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
import numpy as np

# Get predictions
Y_pred = model.predict(validation_generator)
y_pred = np.argmax(Y_pred, axis=1)

# Generate confusion matrix
cm = confusion_matrix(validation_generator.classes, y_pred)
disp = ConfusionMatrixDisplay(confusion_matrix=cm, display_labels=categories)
disp.plot(cmap=plt.cm.Blues)
plt.show()
```

```
94/94 [==============================] - 6s 60ms/step - loss: 0.5937 - accuracy:
0.8117
Test accuracy: 0.81
```






```
94/94 [==============================] - 5s 53ms/step
```