x-ray-images-pneumonia-1

March 14, 2024

[2]:
```
#Importing libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import seaborn as sns
```

[3]:
```
import sklearn
import os
import shutil
import cv2
import random
```

[4]:
```
import tensorflow as tf
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.preprocessing import image_dataset_from_directory
```

```
2024-03-14 17:14:56.498801: E
external/local_xla/xla/stream_executor/cuda/cuda_dnn.cc:9261] Unable to register
cuDNN factory: Attempting to register factory for plugin cuDNN when one has
already been registered
2024-03-14 17:14:56.498918: E
external/local_xla/xla/stream_executor/cuda/cuda_fft.cc:607] Unable to register
cuFFT factory: Attempting to register factory for plugin cuFFT when one has
already been registered
2024-03-14 17:14:56.639292: E
external/local_xla/xla/stream_executor/cuda/cuda_blas.cc:1515] Unable to
register cuBLAS factory: Attempting to register factory for plugin cuBLAS when
one has already been registered
```

[5]:
```
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix, classification_report,␣
↪accuracy_score, precision_score, recall_score, f1_score
```

[6]:
```
import os
import cv2
import numpy as np
```

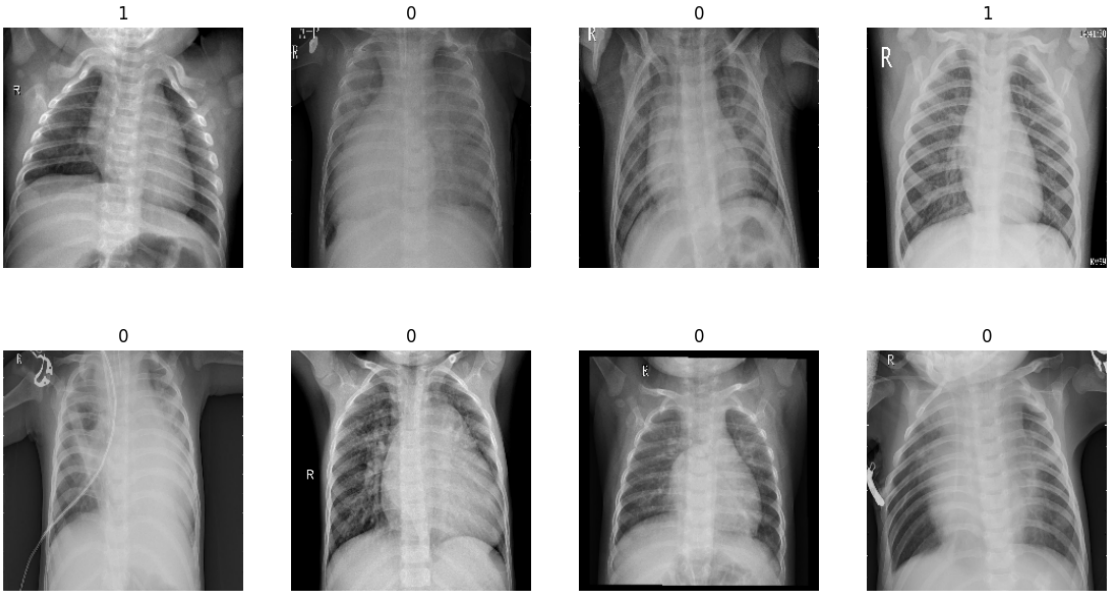
```
labels = ['PNEUMONIA', 'NORMAL']
img_size = 224

def get_training_data(data_dir):
    data = []
    for label in labels:
        path = os.path.join(data_dir, label)
        class_num = labels.index(label)
        data += [(cv2.cvtColor(cv2.resize(cv2.imread(os.path.join(path, img),␣
 ↪cv2.IMREAD_COLOR), (img_size, img_size)), cv2.COLOR_BGR2RGB), class_num) for␣
 ↪img in os.listdir(path)]
    return np.array(data, dtype=object)
```

[7]:
```
# Getting the image datasets from paths of the training, test and validation␣
 ↪dataset.
train = get_training_data('/kaggle/input/chest-xray-pneumonia/chest_xray/train')
test = get_training_data('/kaggle/input/chest-xray-pneumonia/chest_xray/test')
val = get_training_data('/kaggle/input/chest-xray-pneumonia/chest_xray/val')
```

[8]:
```
#Joining the datasets to enable splitting the dataset using the 80:20 ratio
dataset = np.concatenate((train, val, test), axis=0)
len(dataset)
print(dataset.shape)
```

```
(5856, 2)
```

[9]:
```
import random
import matplotlib.pyplot as plt

def plot_images_from_folder(dataset):
    random_indices = random.sample(range(len(dataset)), min(len(dataset), 8))
    plt.figure(figsize=(14, 24))
    for i, idx in enumerate(random_indices):
        plt.subplot(6, 4, i + 1)
        plt.imshow(dataset[idx][0], cmap='gray')
        plt.axis('off')
        plt.title(dataset[idx][1])
    plt.show()

plot_images_from_folder(dataset)
```



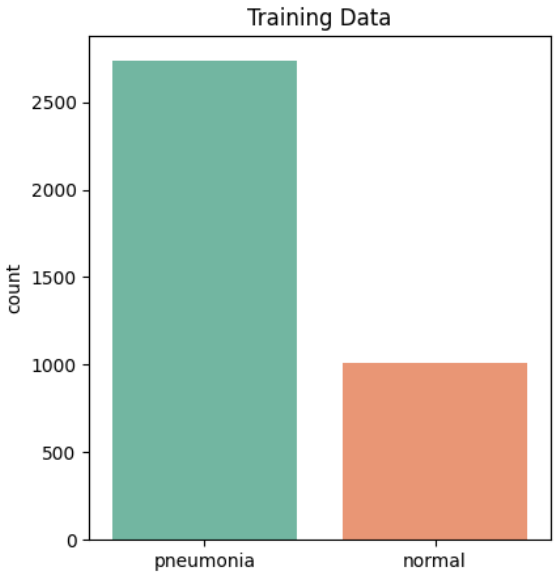
[10]:
```
#Split the dataset into the training and test dataset
initial_train_df, test_df = train_test_split(dataset, test_size = 0.20,␣
 ↪random_state = 30)
#Split the training dataset into the training and val dataset
train_df, val_df = train_test_split(initial_train_df, test_size = 0.20,␣
 ↪random_state = 30)
```

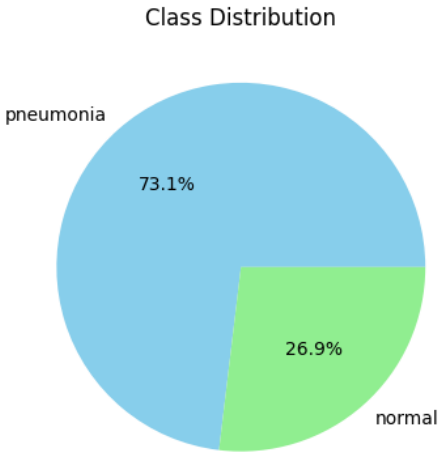
[11]:
```
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt

def count_labels(labels):
    # Extracting labels
    extracted_labels = [data[1] for data in labels]

    print("Number of labels:", len(extracted_labels))
    class_counts = np.bincount(extracted_labels)
    print("Count of 'pneumonia' (Class 0):", class_counts[0])
    print("Count of 'normal' (Class 1):", class_counts[1])

    # Plotting count distribution
    plt.figure(figsize=(10, 5))

    # Count plot
    plt.subplot(1, 2, 1)
    sns.countplot(x=extracted_labels, palette="Set2").set(title="Training␣
 ↪Data", xticklabels=['pneumonia', 'normal'])
```

```
    # Pie chart
    plt.subplot(1, 2, 2)
    labels = ['pneumonia', 'normal']
    plt.pie(class_counts, labels=labels, autopct='%1.1f%%', colors=['skyblue',␣
 ↪'lightgreen'])
    plt.title('Class Distribution')

    plt.show()

# Example usage
count_labels(train_df)
```

```
Number of labels: 3747
Count of 'pneumonia' (Class 0): 2739
Count of 'normal' (Class 1): 1008
```

```
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1765: FutureWarning:
unique with argument that is not not a Series, Index, ExtensionArray, or
np.ndarray is deprecated and will raise in a future version.
  order = pd.unique(vector)
```

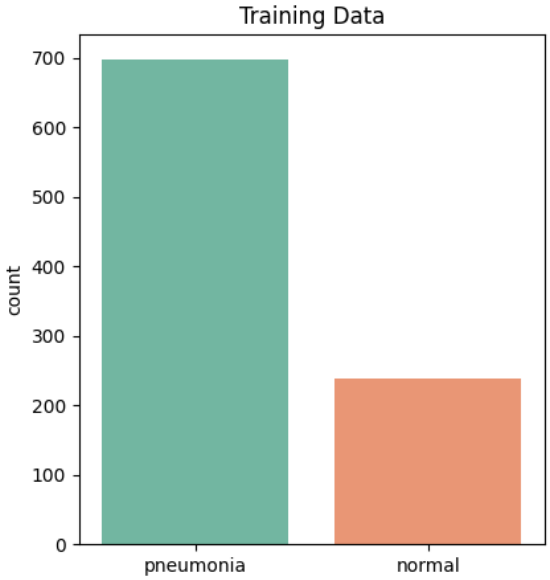


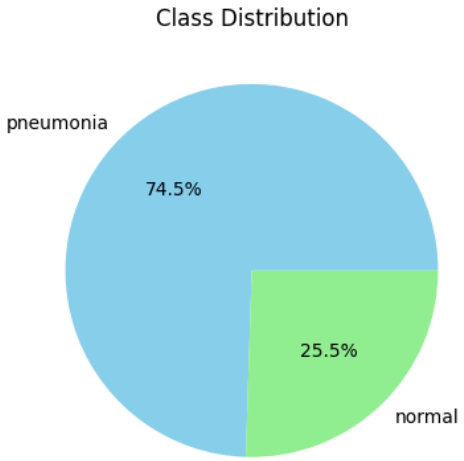


[12]:
```
#Class distribution for validation dataset
count_labels(val_df)
```

```
Number of labels: 937
Count of 'pneumonia' (Class 0): 698
Count of 'normal' (Class 1): 239
```

```
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1765: FutureWarning:
unique with argument that is not not a Series, Index, ExtensionArray, or
np.ndarray is deprecated and will raise in a future version.
  order = pd.unique(vector)
```

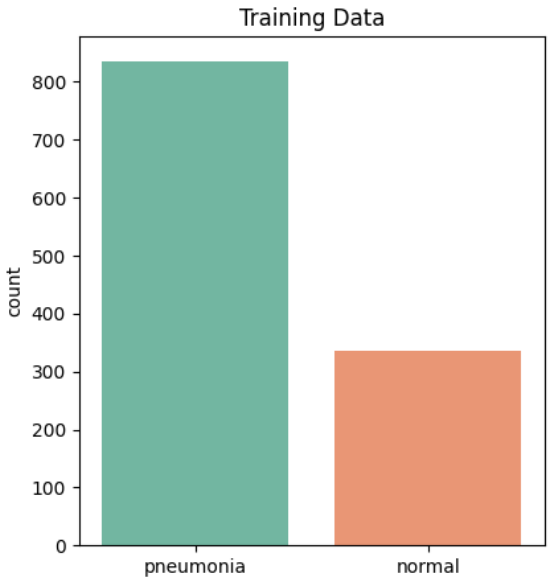


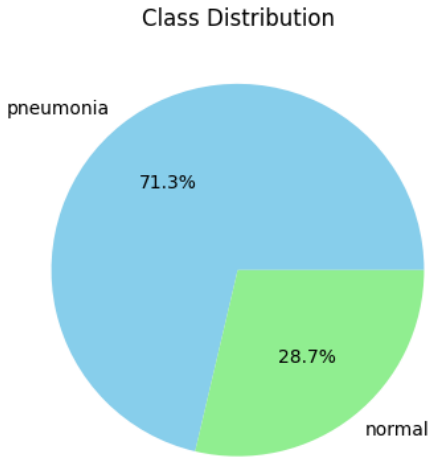


[13]:
```
#Class distribution for test dataset
count_labels(test_df)
```

```
Number of labels: 1172
Count of 'pneumonia' (Class 0): 836
Count of 'normal' (Class 1): 336
```

```
/opt/conda/lib/python3.10/site-packages/seaborn/_oldcore.py:1765: FutureWarning:
unique with argument that is not not a Series, Index, ExtensionArray, or
np.ndarray is deprecated and will raise in a future version.
  order = pd.unique(vector)
```





[14]:
```
#Shape of training dataset
train_df.shape
```

[14]: (3747, 2)

[15]:
```
#Shape of val dataset
val_df.shape
```

[15]: (937, 2)

[16]:
```
#Shape of test dataset
test_df.shape
```

[16]: (1172, 2)

0.0.1 Seperate the images and labels

[17]:
```
x_train, y_train = zip(*train_df)
x_test, y_test = zip(*test_df)
x_val, y_val = zip(*val_df)
```

[18]:
```
# Normalize the data
x_train = np.array(x_train) / 255
x_val = np.array(x_val) / 255
x_test = np.array(x_test) / 255
```

[19]:
```
# reshape data for deep learning
x_train = x_train.reshape(-1, img_size, img_size, 3)
y_train = np.array(y_train)

x_val = x_val.reshape(-1, img_size, img_size, 3)
y_val = np.array(y_val)

x_test = x_test.reshape(-1, img_size, img_size, 3)
y_test = np.array(y_test)
```

[20]:
```
# With data augmentation to prevent overfitting and handling the imbalance in␣
 ↪dataset
datagen = ImageDataGenerator(
        featurewise_center=False,  # set input mean to 0 over the dataset
        samplewise_center=False,  # set each sample mean to 0
        featurewise_std_normalization=False,  # divide inputs by std of the␣
 ↪dataset
        samplewise_std_normalization=False,  # divide each input by its std
        zca_whitening=False,  # apply ZCA whitening
        rotation_range=30,  # randomly rotate images in the range (degrees, 0␣
 ↪to 180)
        zoom_range=0.2, # Randomly zoom image
        width_shift_range=0.1,  # randomly shift images horizontally (fraction␣
 ↪of total width)
        height_shift_range=0.1,  # randomly shift images vertically (fraction␣
 ↪of total height)
        horizontal_flip=True,  # randomly flip images
        vertical_flip=False)  # randomly flip images

datagen.fit(x_train)
```

[21]:
```
# Define the early stopping and learning rate reduction callback
early_stopping = tf.keras.callbacks.EarlyStopping(monitor='val_loss',␣
 ↪patience=5, restore_best_weights=True)
learning_rate_reduction = tf.keras.callbacks.
 ↪ReduceLROnPlateau(monitor='val_loss', patience=3)
```

1 VGG 16 Model

[22]:
```
# VGG 16 Model
# Loading the model
from tensorflow.keras.applications.vgg16 import VGG16

vgg16_base_model = VGG16(
    include_top=False,
    weights="imagenet",
```

```
    input_shape=(224, 224, 3),
)

# Making sure the layers of the VGG16 model are not retrained
for layer in vgg16_base_model.layers:
    layer.trainable = False
```

[23]:
```
vgg16_model = tf.keras.models.Sequential()
vgg16_model.add(vgg16_base_model)
vgg16_model.add(tf.keras.layers.Flatten())
vgg16_model.add(tf.keras.layers.BatchNormalization())
vgg16_model.add(tf.keras.layers.Dense(128, activation='relu'))
vgg16_model.add(tf.keras.layers.Dropout(0.5))
vgg16_model.add(tf.keras.layers.Dense(1, activation='sigmoid'))

# Compile the model
vgg16_model.compile(
    loss='binary_crossentropy',
    optimizer=tf.keras.optimizers.Adam(),
    metrics=['accuracy']
)
```

[24]:
```
# Train the vgg16 model with early stopping
vgg16_model_history = vgg16_model.fit(
    datagen.flow(x_train,y_train, batch_size=32),
    epochs=5,
    validation_data=datagen.flow(x_val, y_val),
    callbacks=[early_stopping, learning_rate_reduction]
)
```

```
Epoch 1/5

/opt/conda/lib/python3.10/site-
packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:122:
UserWarning: Your `PyDataset` class should call `super().__init__(**kwargs)` in
its constructor. `**kwargs` can include `workers`, `use_multiprocessing`,
`max_queue_size`. Do not pass these arguments to `fit()`, as they will be
ignored.
  self._warn_if_super_not_called()
2024-03-14 17:17:10.922141: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 0:
4.63498, expected 3.85968
2024-03-14 17:17:10.922206: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 3:
6.55784, expected 5.78254
2024-03-14 17:17:10.922223: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 4:
6.61282, expected 5.83752
```

```
2024-03-14 17:17:10.922237: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 6:
6.34499, expected 5.56968
2024-03-14 17:17:10.922252: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 7:
6.25159, expected 5.47629
2024-03-14 17:17:10.922269: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 8:
5.43964, expected 4.66434
2024-03-14 17:17:10.922280: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 9:
6.54333, expected 5.76803
2024-03-14 17:17:10.922291: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 10:
5.76049, expected 4.98519
2024-03-14 17:17:10.922303: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 11:
5.33632, expected 4.56101
2024-03-14 17:17:10.922315: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 12:
4.04081, expected 3.2655
2024-03-14 17:17:10.969111: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[32,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[32,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:17:10.969174: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:17:10.969187: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:17:10.969198: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:17:10.969207: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:17:10.969228: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0
2024-03-14 17:17:12.206861: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 0:
```

```
4.63498, expected 3.85968
2024-03-14 17:17:12.206929: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 3:
6.55784, expected 5.78254
2024-03-14 17:17:12.206943: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 4:
6.61282, expected 5.83752
2024-03-14 17:17:12.206956: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 6:
6.34499, expected 5.56968
2024-03-14 17:17:12.206974: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 7:
6.25159, expected 5.47629
2024-03-14 17:17:12.206985: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 8:
5.43964, expected 4.66434
2024-03-14 17:17:12.206996: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 9:
6.54333, expected 5.76803
2024-03-14 17:17:12.207007: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 10:
5.76049, expected 4.98519
2024-03-14 17:17:12.207019: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 11:
5.33632, expected 4.56101
2024-03-14 17:17:12.207030: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 12:
4.04081, expected 3.2655
2024-03-14 17:17:12.252815: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[32,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[32,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:17:12.252883: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:17:12.252896: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:17:12.252908: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:17:12.252919: E
```

```
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:17:12.252941: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0

  2/118            8s 70ms/step - accuracy:
0.6172 - loss: 0.6967

WARNING: All log messages before absl::InitializeLog() is called are written to
STDERR
I0000 00:00:1710436647.540048     820 device_compiler.h:186] Compiled cluster
using XLA!  This line is logged at most once for the lifetime of the process.

  7/118            24s 219ms/step -
accuracy: 0.7160 - loss: 0.7747

2024-03-14 17:17:30.118987: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 0:
3.54907, expected 2.92871
2024-03-14 17:17:30.119045: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 2:
4.96556, expected 4.3452
2024-03-14 17:17:30.119065: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 4:
5.02093, expected 4.40057
2024-03-14 17:17:30.119081: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 5:
4.88945, expected 4.26909
2024-03-14 17:17:30.119093: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 6:
5.14523, expected 4.52487
2024-03-14 17:17:30.119104: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 7:
4.19105, expected 3.57069
2024-03-14 17:17:30.119116: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 8:
3.8535, expected 3.23314
2024-03-14 17:17:30.119127: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 9:
4.93508, expected 4.31472
2024-03-14 17:17:30.119139: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 10:
3.96824, expected 3.34788
2024-03-14 17:17:30.119150: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 11:
3.99737, expected 3.37701
2024-03-14 17:17:30.123410: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
```

```
bug/unexpected loss of precision in cudnn.
(f32[3,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[3,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:17:30.123453: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:17:30.123470: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:17:30.123484: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:17:30.123494: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:17:30.123516: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0
2024-03-14 17:17:30.236808: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 0:
3.54907, expected 2.92871
2024-03-14 17:17:30.236871: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 2:
4.96556, expected 4.3452
2024-03-14 17:17:30.236902: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 4:
5.02093, expected 4.40057
2024-03-14 17:17:30.236918: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 5:
4.88945, expected 4.26909
2024-03-14 17:17:30.236935: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 6:
5.14523, expected 4.52487
2024-03-14 17:17:30.236947: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 7:
4.19105, expected 3.57069
2024-03-14 17:17:30.236958: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 8:
3.8535, expected 3.23314
2024-03-14 17:17:30.236970: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 9:
4.93508, expected 4.31472
2024-03-14 17:17:30.236981: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 10:
```

```
3.96824, expected 3.34788
2024-03-14 17:17:30.236995: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 11:
3.99737, expected 3.37701
2024-03-14 17:17:30.241307: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[3,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[3,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:17:30.241348: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:17:30.241361: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:17:30.241372: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:17:30.241388: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:17:30.241409: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0

118/118            0s 314ms/step -
accuracy: 0.8409 - loss: 0.9836

2024-03-14 17:18:14.337871: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 12:
2.40131, expected 2.00221
2024-03-14 17:18:14.337943: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 63:
2.97198, expected 2.57289
2024-03-14 17:18:14.337957: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 223:
2.88224, expected 2.48315
2024-03-14 17:18:14.338007: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
5824: 2.95102, expected 2.55192
2024-03-14 17:18:14.338261: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50092: 2.95205, expected 2.55296
2024-03-14 17:18:14.338694: E
```

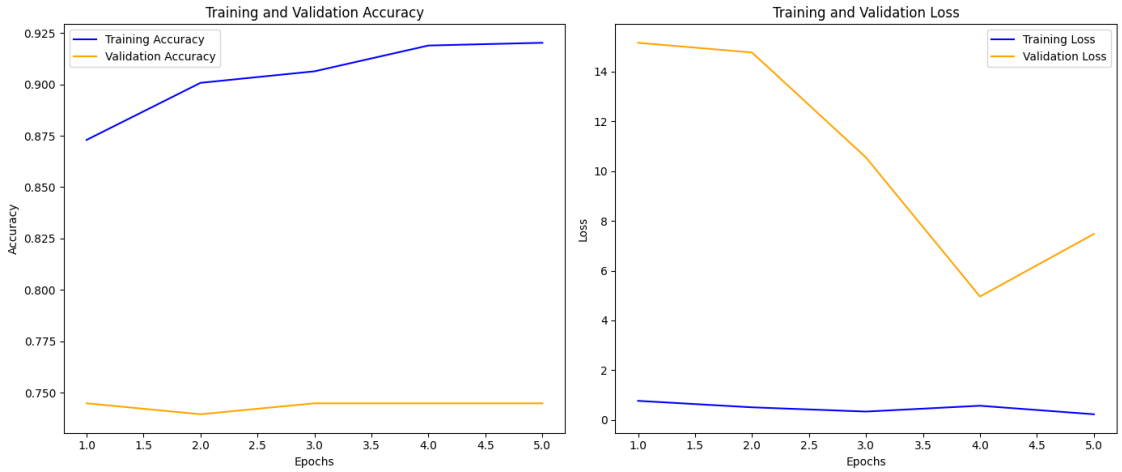
```
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100352: 4.55134, expected 3.66346
2024-03-14 17:18:14.338735: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100353: 6.08774, expected 5.19985
2024-03-14 17:18:14.338752: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100354: 6.46927, expected 5.58139
2024-03-14 17:18:14.338765: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100355: 6.10479, expected 5.21691
2024-03-14 17:18:14.338778: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100356: 5.41485, expected 4.52696
2024-03-14 17:18:14.352422: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[9,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[9,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:18:14.352461: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:18:14.352470: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:18:14.352477: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:18:14.352485: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:18:14.352503: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0
2024-03-14 17:18:14.653247: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 12:
2.40131, expected 2.00221
2024-03-14 17:18:14.653315: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 63:
2.97198, expected 2.57289
2024-03-14 17:18:14.653325: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at 223:
2.88224, expected 2.48315
```

```
2024-03-14 17:18:14.653356: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
5824: 2.95102, expected 2.55192
2024-03-14 17:18:14.653537: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50092: 2.95205, expected 2.55296
2024-03-14 17:18:14.653998: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100352: 4.55134, expected 3.66346
2024-03-14 17:18:14.654039: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100353: 6.08774, expected 5.19985
2024-03-14 17:18:14.654049: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100354: 6.46927, expected 5.58139
2024-03-14 17:18:14.654057: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100355: 6.10479, expected 5.21691
2024-03-14 17:18:14.654065: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
100356: 5.41485, expected 4.52696
2024-03-14 17:18:14.667429: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[9,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[9,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:18:14.667483: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:18:14.667499: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:18:14.667506: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:18:14.667514: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:18:14.667531: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0

118/118            76s 444ms/step -
```

```
accuracy: 0.8412 - loss: 0.9818 - val_accuracy: 0.7449 - val_loss: 15.1540 -
learning_rate: 0.0010
Epoch 2/5
118/118            44s 352ms/step -
accuracy: 0.9051 - loss: 0.4110 - val_accuracy: 0.7396 - val_loss: 14.7638 -
learning_rate: 0.0010
Epoch 3/5
118/118            44s 358ms/step -
accuracy: 0.8962 - loss: 0.3591 - val_accuracy: 0.7449 - val_loss: 10.5448 -
learning_rate: 0.0010
Epoch 4/5
118/118            44s 354ms/step -
accuracy: 0.9211 - loss: 0.6966 - val_accuracy: 0.7449 - val_loss: 4.9597 -
learning_rate: 0.0010
Epoch 5/5
118/118            44s 355ms/step -
accuracy: 0.9258 - loss: 0.2101 - val_accuracy: 0.7449 - val_loss: 7.4744 -
learning_rate: 0.0010
```

[25]:
```python
# Plotting the VGG16 model results

# Getting the accuracy
acc = vgg16_model_history.history['accuracy']
val_acc = vgg16_model_history.history['val_accuracy']

# Getting the losses
loss = vgg16_model_history.history['loss']
val_loss = vgg16_model_history.history['val_loss']

# Number of epochs it trained
epochs_range = range(1, len(acc) + 1)

# Plotting Training and Validation accuracy
plt.figure(figsize=(14, 6))
plt.subplot(1, 2, 1)
plt.plot(epochs_range, acc, label='Training Accuracy', color='blue')
plt.plot(epochs_range, val_acc, label='Validation Accuracy', color='orange')
plt.xlabel('Epochs')
plt.ylabel('Accuracy')
plt.title('Training and Validation Accuracy')
plt.legend()

# Plotting Training and Validation Loss
plt.subplot(1, 2, 2)
plt.plot(epochs_range, loss, label='Training Loss', color='blue')
plt.plot(epochs_range, val_loss, label='Validation Loss', color='orange')
plt.xlabel('Epochs')
```

```
plt.ylabel('Loss')
plt.title('Training and Validation Loss')
plt.legend()

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



1.1 Vgg16 Performance Evaluation

[26]:
```
evaluation_result=vgg16_model.evaluate(x_test,y_test)
```

```
36/37              0s 68ms/step -
accuracy: 0.7158 - loss: 4.1924

2024-03-14 17:21:21.134265: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50176: 3.79983, expected 3.15789
2024-03-14 17:21:21.134337: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50177: 5.13466, expected 4.49272
2024-03-14 17:21:21.134354: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50178: 4.78155, expected 4.13961
2024-03-14 17:21:21.134372: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50179: 4.88295, expected 4.24101
2024-03-14 17:21:21.134386: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50180: 4.73279, expected 4.09085
2024-03-14 17:21:21.134397: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
```

```
50181: 4.69943, expected 4.05749
2024-03-14 17:21:21.134408: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50182: 4.1975, expected 3.55556
2024-03-14 17:21:21.134421: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50183: 4.73806, expected 4.09612
2024-03-14 17:21:21.134431: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50184: 4.63452, expected 3.99258
2024-03-14 17:21:21.134443: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50185: 4.5168, expected 3.87486
2024-03-14 17:21:21.164311: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[20,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[20,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:21:21.164371: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:21:21.164386: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:21:21.164403: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:21:21.164414: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:21:21.164437: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0
2024-03-14 17:21:21.863936: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50176: 3.79983, expected 3.15789
2024-03-14 17:21:21.864016: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50177: 5.13466, expected 4.49272
2024-03-14 17:21:21.864033: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50178: 4.78155, expected 4.13961
2024-03-14 17:21:21.864049: E
```

```
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50179: 4.88295, expected 4.24101
2024-03-14 17:21:21.864063: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50180: 4.73279, expected 4.09085
2024-03-14 17:21:21.864073: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50181: 4.69943, expected 4.05749
2024-03-14 17:21:21.864083: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50182: 4.1975, expected 3.55556
2024-03-14 17:21:21.864096: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50183: 4.73806, expected 4.09612
2024-03-14 17:21:21.864106: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50184: 4.63452, expected 3.99258
2024-03-14 17:21:21.864117: E
external/local_xla/xla/service/gpu/buffer_comparator.cc:1137] Difference at
50185: 4.5168, expected 3.87486
2024-03-14 17:21:21.892855: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:705] Results
mismatch between different convolution algorithms. This is likely a
bug/unexpected loss of precision in cudnn.
(f32[20,64,224,224]{3,2,1,0}, u8[0]{0}) custom-call(f32[20,3,224,224]{3,2,1,0},
f32[64,3,3,3]{3,2,1,0}, f32[64]{0}), window={size=3x3 pad=1_1x1_1},
dim_labels=bf01_oi01->bf01,
custom_call_target="__cudnn$convBiasActivationForward", backend_config={"conv_re
sult_scale":1,"activation_mode":"kRelu","side_input_scale":0,"leakyrelu_alpha":0
} for eng20{k2=1,k4=1,k5=1,k6=0,k7=0} vs eng15{k5=1,k6=0,k7=1,k10=1}
2024-03-14 17:21:21.892912: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:270] Device: Tesla
P100-PCIE-16GB
2024-03-14 17:21:21.892926: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:271] Platform:
Compute Capability 6.0
2024-03-14 17:21:21.892943: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:272] Driver: 12020
(535.129.3)
2024-03-14 17:21:21.892954: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:273] Runtime:
<undefined>
2024-03-14 17:21:21.892979: E
external/local_xla/xla/service/gpu/conv_algorithm_picker.cc:280] cudnn version:
8.9.0
37/37            14s 379ms/step -
accuracy: 0.7157 - loss: 4.1932
```

[27]:
```
print("Loss of the model is - " , evaluation_result[0])
print("Accuracy of the model is - " , evaluation_result[1]*100 , "%")
```

```
Loss of the model is -  4.20750617980957
Accuracy of the model is -  71.33105993270874 %
```

[28]:
```
vgg16_predictions = vgg16_model.predict(x_test)
y_pred = (vgg16_predictions> 0.5).astype("int32").flatten()
y_pred
```

```
37/37              3s 75ms/step
```

[28]:
```
array([0, 0, 0, …, 0, 0, 0], dtype=int32)
```

[29]:
```
#Classification report
print(classification_report(y_test, y_pred, target_names = ['Pneumonia␣
 ↪(0)','Normal (1)']))
```

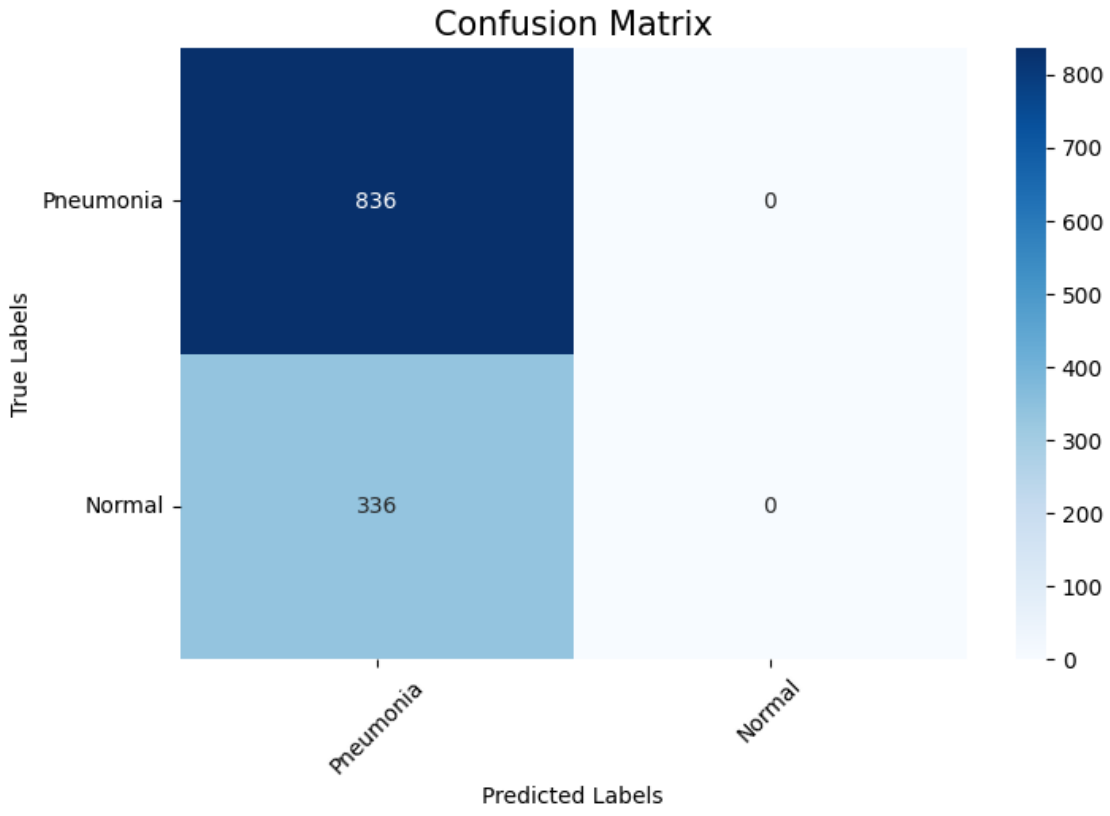
```
               precision    recall  f1-score   support

Pneumonia (0)       0.71      1.00      0.83       836
   Normal (1)       0.00      0.00      0.00       336

     accuracy                           0.71      1172
    macro avg       0.36      0.50      0.42      1172
 weighted avg       0.51      0.71      0.59      1172
```

```
/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/opt/conda/lib/python3.10/site-packages/sklearn/metrics/_classification.py:1344:
UndefinedMetricWarning: Precision and F-score are ill-defined and being set to
0.0 in labels with no predicted samples. Use `zero_division` parameter to
control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

[30]:
```
from sklearn.metrics import confusion_matrix
import seaborn as sns

# Confusion matrix
```

```
cm = confusion_matrix(y_test, y_pred)
print(cm)

# Setting the labels
labels = ['Pneumonia', 'Normal']

# Plotting the confusion matrix graph
plt.figure(figsize=(8, 5))
sns.heatmap(cm, annot=True, fmt='g', cmap='Blues', xticklabels=labels,␣
 ↪yticklabels=labels)
plt.xlabel('Predicted Labels', fontsize=10)
plt.ylabel('True Labels', fontsize=10)
plt.title('Confusion Matrix', fontsize=15)
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.show()
```

```
[[836   0]
 [336   0]]
```



1.2 If you find this notebook helpful, please upvote. Your support will be highly appreciated!.