Importing libraries

In [1]:
```
import os                        # for working with files
import numpy as np               # for numerical computationss
import pandas as pd              # for working with dataframes
import seaborn as sns
import torch                     # Pytorch module
import matplotlib.pyplot as plt # for plotting informations on graph and images using t
import torch.nn as nn            # for creating  neural networks
from torch.utils.data import DataLoader # for dataloaders
from PIL import Image            # for checking images
import torch.nn.functional as F # for functions for calculating loss
import torchvision.transforms as transforms   # for transforming images into tensors
from torchvision.utils import make_grid       # for data checking
from torchvision.datasets import ImageFolder  # for working with classes and images
# from torchsummary import summary              # for getting the summary of our model
import tensorflow as tf
from  tensorflow import keras
import itertools
from sklearn.metrics import precision_score, accuracy_score, recall_score, confusion_ma

%matplotlib inline

import cv2
from tensorflow.keras.preprocessing import image

from glob import glob
import shutil

from mlxtend.plotting import plot_confusion_matrix
```

Data loading and exploring

In [2]:
```
os.makedirs('/kaggle/working/lung_aca')
os.makedirs('/kaggle/working/lung_scc')
os.makedirs('/kaggle/working/lung_n')
```

In [3]:
```
lung_dir1 = "/kaggle/working/"
lungs1 = os.listdir(lung_dir1)
lungs1
```

Out[3]:
```
['lung_scc', 'lung_aca', 'lung_n']
```

In [4]:
```
if '__notebook_source__.ipynb' in lungs1:
    os.remove('/kaggle/working/__notebook_source__.ipynb')

if '.virtual_documents' in lungs1:
    shutil.rmtree('/kaggle/working/.virtual_documents')
```

In [5]:
```
```

```
lung_dir2 = "/kaggle/working/"
lungs2 = os.listdir(lung_dir2)
lungs2
```

Out[5]:
```
['lung_scc', 'lung_aca', 'lung_n']
```

In [6]:
```
folders = glob('/kaggle/input/lung-and-colon-cancer-histopathological-images/lung_colon
print('New Paths: ', folders)
```

```
New Paths:  ['/kaggle/input/lung-and-colon-cancer-histopathological-images/lung_colon_im
age_set/lung_image_sets/lung_aca', '/kaggle/input/lung-and-colon-cancer-histopathologica
l-images/lung_colon_image_set/lung_image_sets/lung_scc', '/kaggle/input/lung-and-colon-c
ancer-histopathological-images/lung_colon_image_set/lung_image_sets/lung_n']
```

In [7]:
```
for i in folders:
    IMAGE_FILES = glob(i + '/*.jpeg')
    train_imgs = IMAGE_FILES
    num_show = len(IMAGE_FILES)
    columns = 5

    plt.figure(figsize=(25,12))
    for idx, train_img in enumerate(train_imgs):
        if idx >= num_show:
            break

        t = train_img.split('/')
        # Original:
        bgrimg = cv2.imread(train_img)
        # Grayscle:
        grayimg = cv2.cvtColor(bgrimg, cv2.COLOR_BGR2GRAY)
        # Sobel Edge Detaction:
        sobelx = cv2.Sobel(grayimg,int(cv2.CV_64F),1,0,ksize=3) #ksize=3 means we'll be
        sobely = cv2.Sobel(grayimg,int(cv2.CV_64F),0,1,ksize=3)
        sobel = np.sqrt(np.square(sobelx) + np.square(sobely))

        cv2.imwrite('/kaggle/working/' + t[6] + '/' + t[7], sobel)
```

```
<Figure size 1800x864 with 0 Axes>
<Figure size 1800x864 with 0 Axes>
<Figure size 1800x864 with 0 Axes>
```

Show some example for lung cancer

In [8]:
```
lung_dir = "/kaggle/working/"
lungs = os.listdir(lung_dir)
lungs
```

Out[8]:
```
['lung_scc', 'lung_aca', 'lung_n']
```

In [9]:
```
# Number of images for each disease
nums_train = {}
nums_val = {}
for lung in lungs:
    nums_train[lung] = len(os.listdir(lung_dir + '/' + lung))
```

```
img_per_class_train = pd.DataFrame(nums_train.values(), index=nums_train.keys(), column
print('Train data distribution :')
img_per_class_train
```

```
Train data distribution :
```

Out[9]:

	no. of images
lung_scc	5000
lung_aca	5000
lung_n	5000

In [10]:

```
# Function to show image
train = ImageFolder(lung_dir, transform=transforms.ToTensor())
def show_image(image, label):
    print("Label :" + train.classes[label] + "(" + str(label) + ")")
    return image.permute(1, 2, 0)
```

Lung_aca

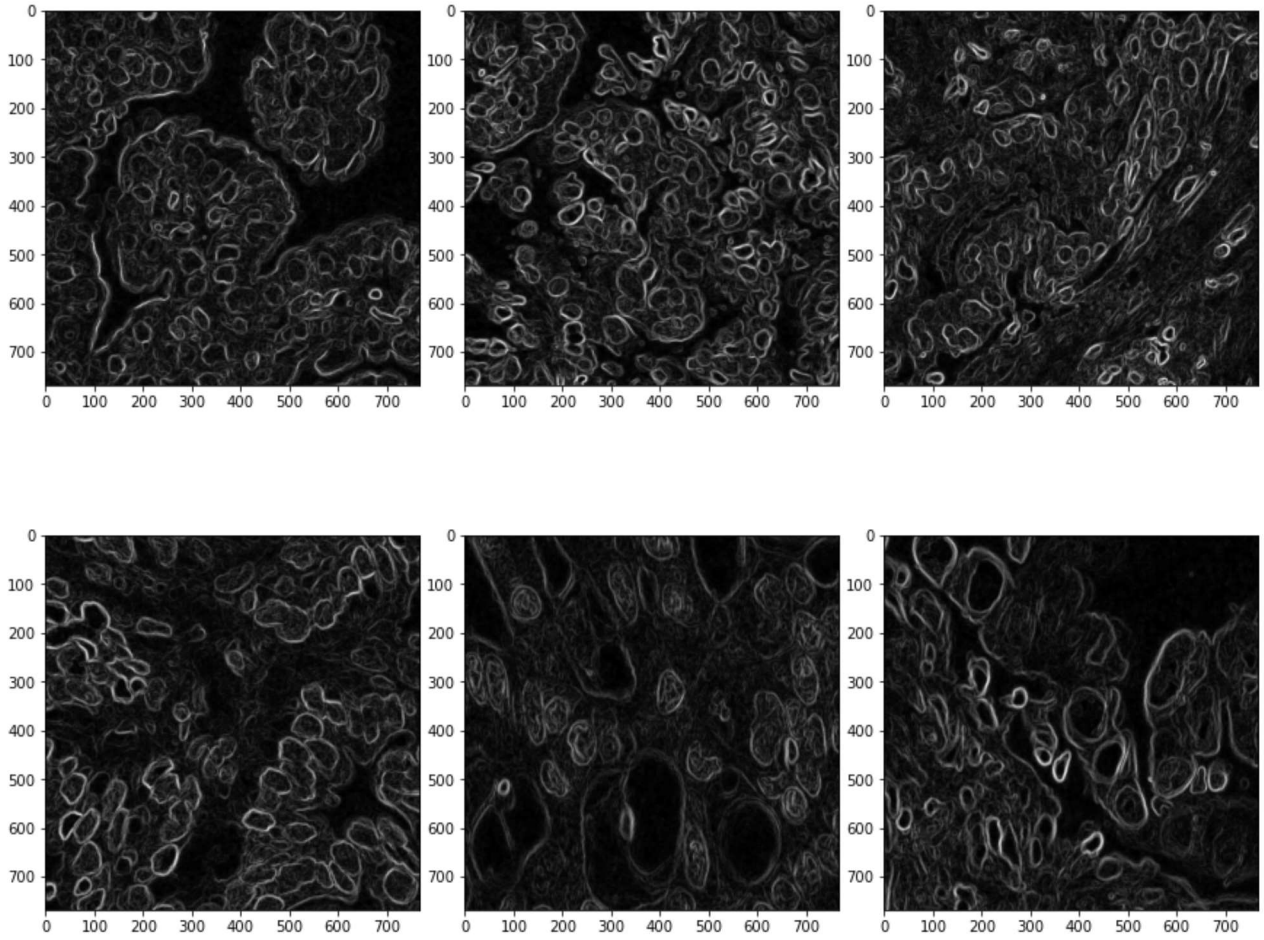
In [11]:

```
fig, axs = plt.subplots(2, 3,figsize=(12,10))
fig.tight_layout(pad=0)
axs[0,0].imshow(show_image(*train[1]))
axs[0,1].imshow(show_image(*train[1100]))
axs[1, 0].imshow(show_image(*train[2010]))
axs[1,1].imshow(show_image(*train[3500]))
axs[0,2].imshow(show_image(*train[4120]))
axs[1,2].imshow(show_image(*train[4860]))
```

```
Label :lung_aca(0)
Label :lung_aca(0)
Label :lung_aca(0)
Label :lung_aca(0)
Label :lung_aca(0)
Label :lung_aca(0)
```

Out[11]:

```
<matplotlib.image.AxesImage at 0x7ffac4c4b450>
```

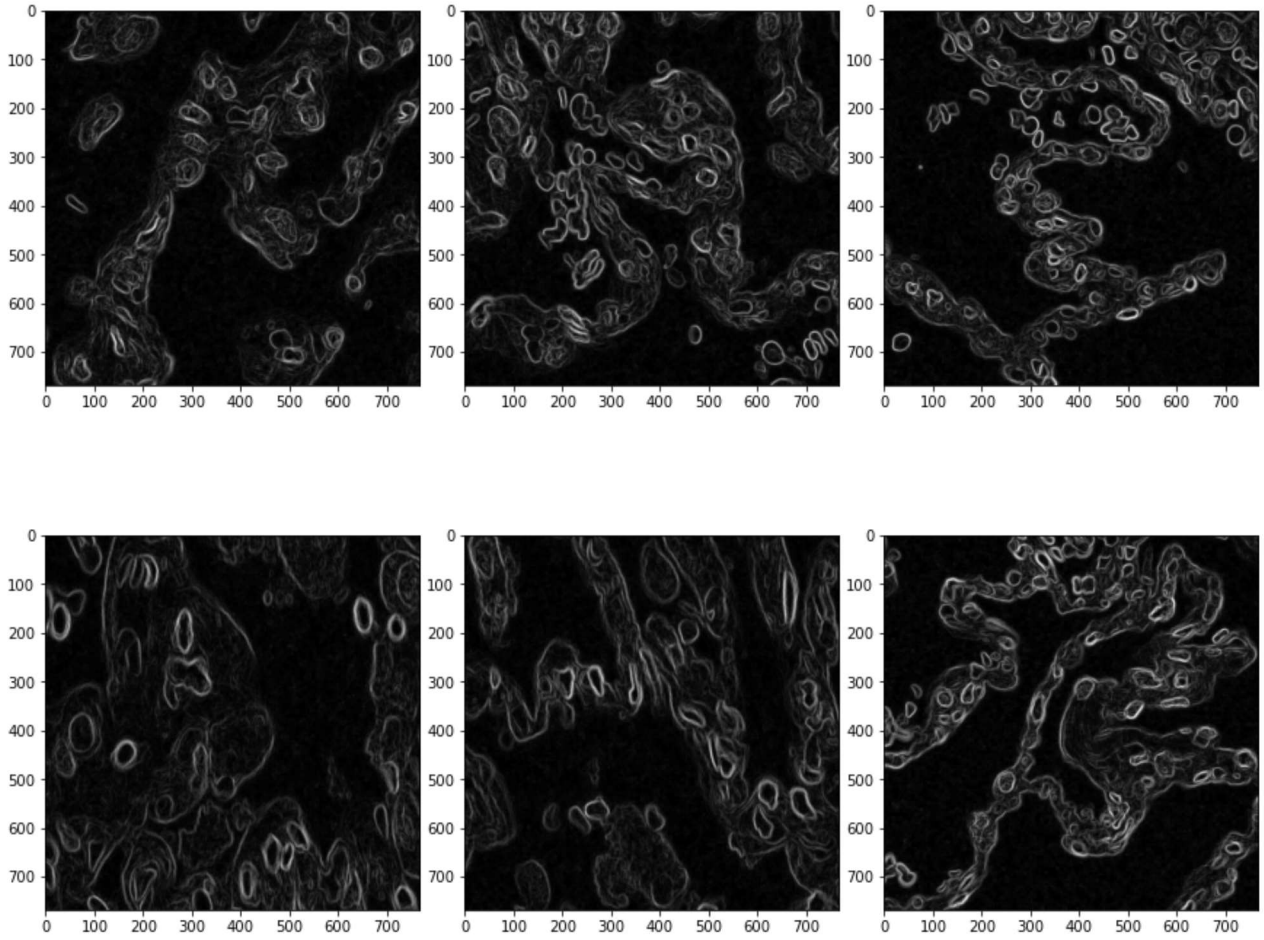


Lung_n

In [12]:
```
fig, axs = plt.subplots(2, 3,figsize=(12,10))
fig.tight_layout(pad=0)
axs[0,0].imshow(show_image(*train[5010]))
axs[0,1].imshow(show_image(*train[6050]))
axs[1, 0].imshow(show_image(*train[7000]))
axs[1,1].imshow(show_image(*train[7500]))
axs[0,2].imshow(show_image(*train[8000]))
axs[1,2].imshow(show_image(*train[8620]))
```

```
Label :lung_n(1)
Label :lung_n(1)
Label :lung_n(1)
Label :lung_n(1)
Label :lung_n(1)
Label :lung_n(1)
```

Out[12]:
```
<matplotlib.image.AxesImage at 0x7ffac4219d50>
```

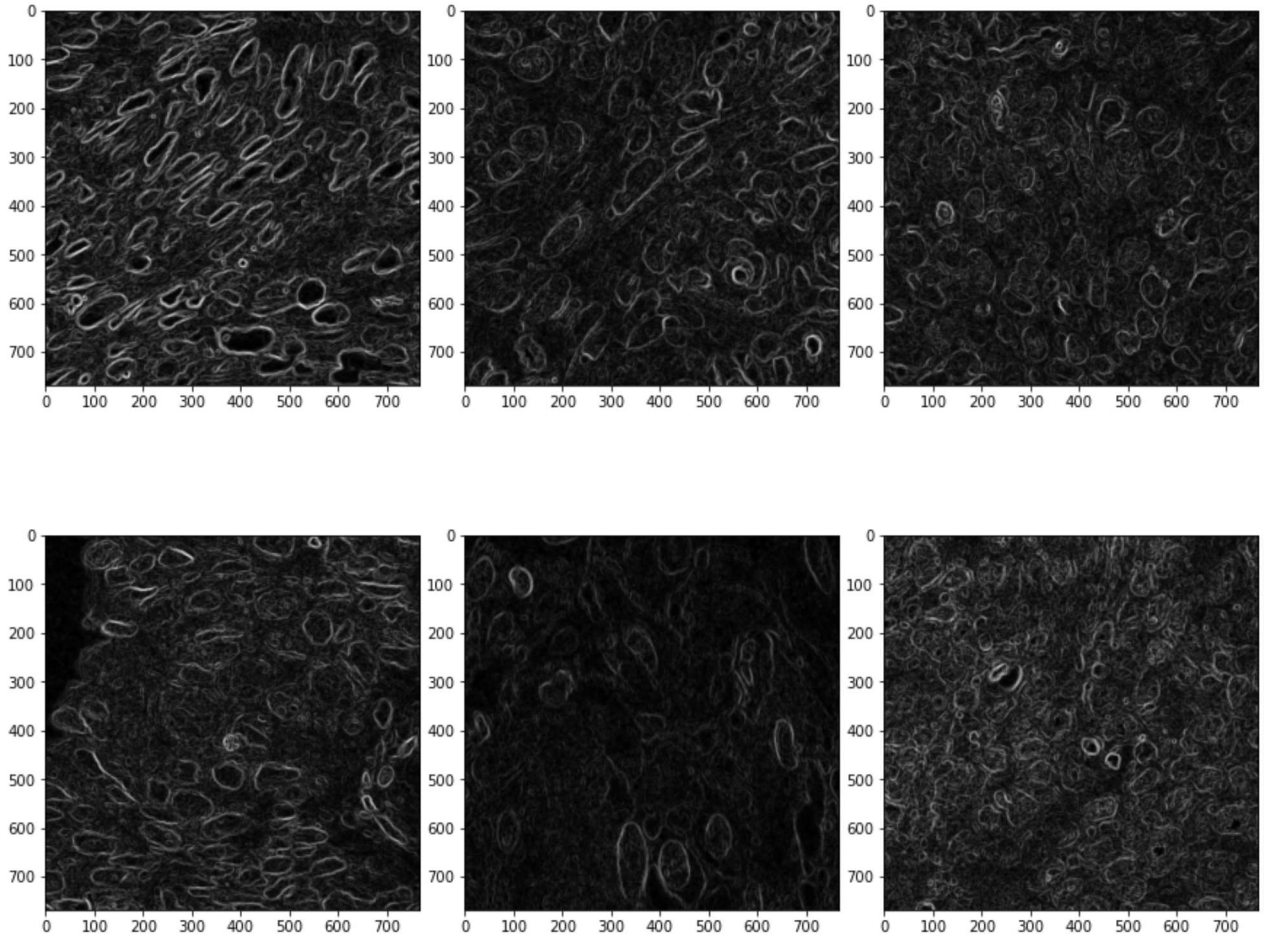


Lung_scc

In [13]:
```
fig, axs = plt.subplots(2, 3,figsize=(12,10))
fig.tight_layout(pad=0)
axs[0,0].imshow(show_image(*train[11001]))
axs[0,1].imshow(show_image(*train[12000]))
axs[1, 0].imshow(show_image(*train[13050]))
axs[1,1].imshow(show_image(*train[14000]))
axs[0,2].imshow(show_image(*train[14200]))
axs[1,2].imshow(show_image(*train[14800]))
```

```
Label :lung_scc(2)
Label :lung_scc(2)
Label :lung_scc(2)
Label :lung_scc(2)
Label :lung_scc(2)
Label :lung_scc(2)
```

Out[13]:
```
<matplotlib.image.AxesImage at 0x7ffabee75950>
```



Modeling

In [14]:
```
train_gen = keras.preprocessing.image.ImageDataGenerator(rescale=1./255,
                                                         rotation_range = 20 ,
                                                         horizontal_flip = True ,
                                                         validation_split = 0.2
                                                         )
valid_gen =  keras.preprocessing.image.ImageDataGenerator(rescale=1./255,validation_spl
train_data = train_gen.flow_from_directory(lung_dir, subset='training', target_size=(22
                                           class_mode='categorical', shuffle=True)

val_data = valid_gen.flow_from_directory(lung_dir, subset='validation', target_size=(22
                                           class_mode='categorical', shuffle=False)
```

```
Found 12000 images belonging to 3 classes.
Found 3000 images belonging to 3 classes.
```

In [15]:
```
unique, counts = np.unique(val_data.classes, return_counts=True)
dict(zip(unique, counts))
```

Out[15]:
```
{0: 1000, 1: 1000, 2: 1000}
```

model_1

In [16]:
```
model_1 = keras.models.Sequential()
model_1.add(keras.layers.Conv2D(8, 3, activation='relu', input_shape=(224, 224, 3)))

model_1.add(keras.layers.Dropout(0.05))
model_1.add(keras.layers.MaxPooling2D())

model_1.add(keras.layers.Conv2D(16, 3, activation='relu', input_shape=(224, 224, 3)))

model_1.add(keras.layers.Dropout(0.1))
model_1.add(keras.layers.MaxPooling2D())

model_1.add(keras.layers.Conv2D(32, 3, activation='relu', input_shape=(224, 224, 3)))

model_1.add(keras.layers.Dropout(0.1))
model_1.add(keras.layers.MaxPooling2D())

model_1.add(keras.layers.Conv2D(64, 3, activation='relu'))
model_1.add(keras.layers.Dropout(0.15))
model_1.add(keras.layers.MaxPooling2D())

model_1.add(keras.layers.Conv2D(128, 3, activation='relu'))
model_1.add(keras.layers.Dropout(0.2))
model_1.add(keras.layers.MaxPooling2D())

model_1.add(keras.layers.Flatten())
model_1.add(keras.layers.Dense(256, activation='relu'))
model_1.add(keras.layers.Dense(3, activation='softmax'))

model_1.compile(optimizer='adam',loss='categorical_crossentropy', metrics=['accuracy'])
model_1.summary()
```

```
2023-02-03 16:22:49.109345: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:49.110525: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:49.111358: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:49.113196: I tensorflow/core/platform/cpu_feature_guard.cc:142] This Te
nsorFlow binary is optimized with oneAPI Deep Neural Network Library (oneDNN) to use the
following CPU instructions in performance-critical operations:  AVX2 AVX512F FMA
To enable them in other operations, rebuild TensorFlow with the appropriate compiler fla
gs.
2023-02-03 16:22:49.113495: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:49.114404: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:49.115225: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:54.044896: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:54.045850: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937]
successful NUMA node read from SysFS had negative value (-1), but there must be at least
```

```
one NUMA node, so returning NUMA node zero
2023-02-03 16:22:54.046649: I tensorflow/stream_executor/cuda/cuda_gpu_executor.cc:937] successful NUMA node read from SysFS had negative value (-1), but there must be at least one NUMA node, so returning NUMA node zero
2023-02-03 16:22:54.047329: I tensorflow/core/common_runtime/gpu/gpu_device.cc:1510] Created device /job:localhost/replica:0/task:0/device:GPU:0 with 15043 MB memory:  -> device: 0, name: Tesla P100-PCIE-16GB, pci bus id: 0000:00:04.0, compute capability: 6.0
Model: "sequential"
```

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 222, 222, 8)	224
dropout (Dropout)	(None, 222, 222, 8)	0
max_pooling2d (MaxPooling2D)	(None, 111, 111, 8)	0
conv2d_1 (Conv2D)	(None, 109, 109, 16)	1168
dropout_1 (Dropout)	(None, 109, 109, 16)	0
max_pooling2d_1 (MaxPooling2	(None, 54, 54, 16)	0
conv2d_2 (Conv2D)	(None, 52, 52, 32)	4640
dropout_2 (Dropout)	(None, 52, 52, 32)	0
max_pooling2d_2 (MaxPooling2	(None, 26, 26, 32)	0
conv2d_3 (Conv2D)	(None, 24, 24, 64)	18496
dropout_3 (Dropout)	(None, 24, 24, 64)	0
max_pooling2d_3 (MaxPooling2	(None, 12, 12, 64)	0
conv2d_4 (Conv2D)	(None, 10, 10, 128)	73856
dropout_4 (Dropout)	(None, 10, 10, 128)	0
max_pooling2d_4 (MaxPooling2	(None, 5, 5, 128)	0
flatten (Flatten)	(None, 3200)	0
dense (Dense)	(None, 256)	819456
dense_1 (Dense)	(None, 3)	771

```
Total params: 918,611
Trainable params: 918,611
Non-trainable params: 0
```

In [17]:

```
history = model_1.fit(train_data,
          validation_data=val_data,
          epochs = 5)
```

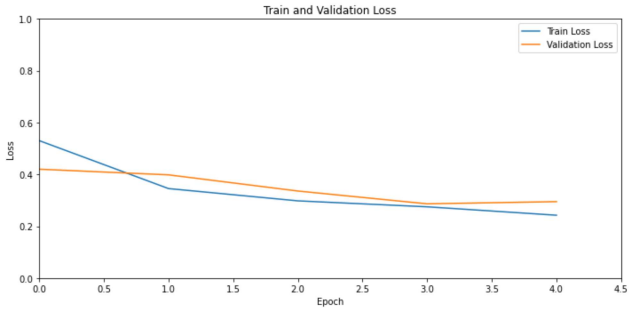
```
2023-02-03 16:22:55.805833: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Allocation of 38535168 exceeds 10% of free system memory.
```

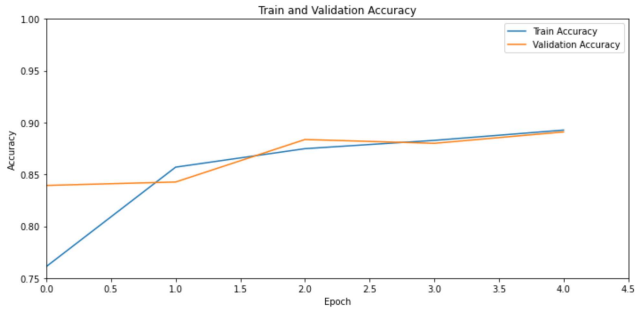
```
2023-02-03 16:22:55.926870: I tensorflow/compiler/mlir/mlir_graph_optimization_pass.cc:1
85] None of the MLIR Optimization Passes are enabled (registered 2)
Epoch 1/5
2023-02-03 16:22:57.754710: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Alloca
tion of 38535168 exceeds 10% of free system memory.
2023-02-03 16:22:58.785462: I tensorflow/stream_executor/cuda/cuda_dnn.cc:369] Loaded cu
DNN version 8005
2023-02-03 16:22:59.316112: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Alloca
tion of 38535168 exceeds 10% of free system memory.
  3/188 [..............................] - ETA: 2:07 - loss: 1.1295 - accuracy: 0.2865
2023-02-03 16:23:06.052524: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Alloca
tion of 38535168 exceeds 10% of free system memory.
  4/188 [..............................] - ETA: 2:40 - loss: 1.1207 - accuracy: 0.2930
2023-02-03 16:23:07.346767: W tensorflow/core/framework/cpu_allocator_impl.cc:80] Alloca
tion of 38535168 exceeds 10% of free system memory.
188/188 [==============================] - 270s 1s/step - loss: 0.5304 - accuracy: 0.761
1 - val_loss: 0.4200 - val_accuracy: 0.8393
Epoch 2/5
188/188 [==============================] - 253s 1s/step - loss: 0.3453 - accuracy: 0.857
0 - val_loss: 0.3983 - val_accuracy: 0.8427
Epoch 3/5
188/188 [==============================] - 247s 1s/step - loss: 0.2979 - accuracy: 0.874
8 - val_loss: 0.3359 - val_accuracy: 0.8837
Epoch 4/5
188/188 [==============================] - 245s 1s/step - loss: 0.2749 - accuracy: 0.882
8 - val_loss: 0.2864 - val_accuracy: 0.8800
Epoch 5/5
188/188 [==============================] - 246s 1s/step - loss: 0.2425 - accuracy: 0.892
8 - val_loss: 0.2949 - val_accuracy: 0.8910
```

In [18]:

```
plt.figure(figsize = (20,5))
plt.subplot(1,2,1)
plt.title("Train and Validation Loss")
plt.xlabel("Epoch")
plt.ylabel("Loss")
plt.plot(history.history['loss'],label="Train Loss")
plt.plot(history.history['val_loss'], label="Validation Loss")
plt.xlim(0, 4.5)
plt.ylim(0.0,1.0)
plt.legend()

plt.subplot(1,2,2)
plt.title("Train and Validation Accuracy")
plt.xlabel("Epoch")
plt.ylabel("Accuracy")
plt.plot(history.history['accuracy'], label="Train Accuracy")
plt.plot(history.history['val_accuracy'], label="Validation Accuracy")
plt.xlim(0, 4.5)
plt.ylim(0.75,1.0)
plt.legend()
plt.tight_layout()
```





In [19]:

```
Y_pred = model_1.predict(val_data)
y_pred = np.argmax(Y_pred, axis=1)

print(classification_report(val_data.classes, y_pred))
```

```
              precision    recall  f1-score   support

           0       0.91      0.75      0.82      1000
           1       0.94      0.97      0.96      1000
           2       0.83      0.95      0.89      1000

    accuracy                           0.89      3000
   macro avg       0.89      0.89      0.89      3000
weighted avg       0.89      0.89      0.89      3000
```

In [20]:

```
# calculating and plotting the confusion matrix
cm1 = confusion_matrix(val_data.classes, y_pred)
plot_confusion_matrix(conf_mat=cm1,show_absolute=True,
                                show_normed=True,
                                colorbar=True)
plt.show()
```