In [1]:

```
# https://github.com/vrinda1309/DL-task-4.git

# Task 1:Implementation of VGG-16 model
```

In [2]:

```
#importing other required libraries
import numpy as np
import pandas as pd
from sklearn.utils.multiclass import unique_labels
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import seaborn as sns
import itertools
from sklearn.model_selection import train_test_split
from sklearn.metrics import confusion_matrix
from keras import Sequential
from keras.applications import VGG19, VGG16, ResNet50
from keras.preprocessing.image import ImageDataGenerator
from keras.optimizers import SGD,Adam
from keras.callbacks import ReduceLROnPlateau
from keras.layers import Flatten, Dense, BatchNormalization, Activation,Dropout
from keras.utils import to_categorical
import tensorflow as tf
import random
```

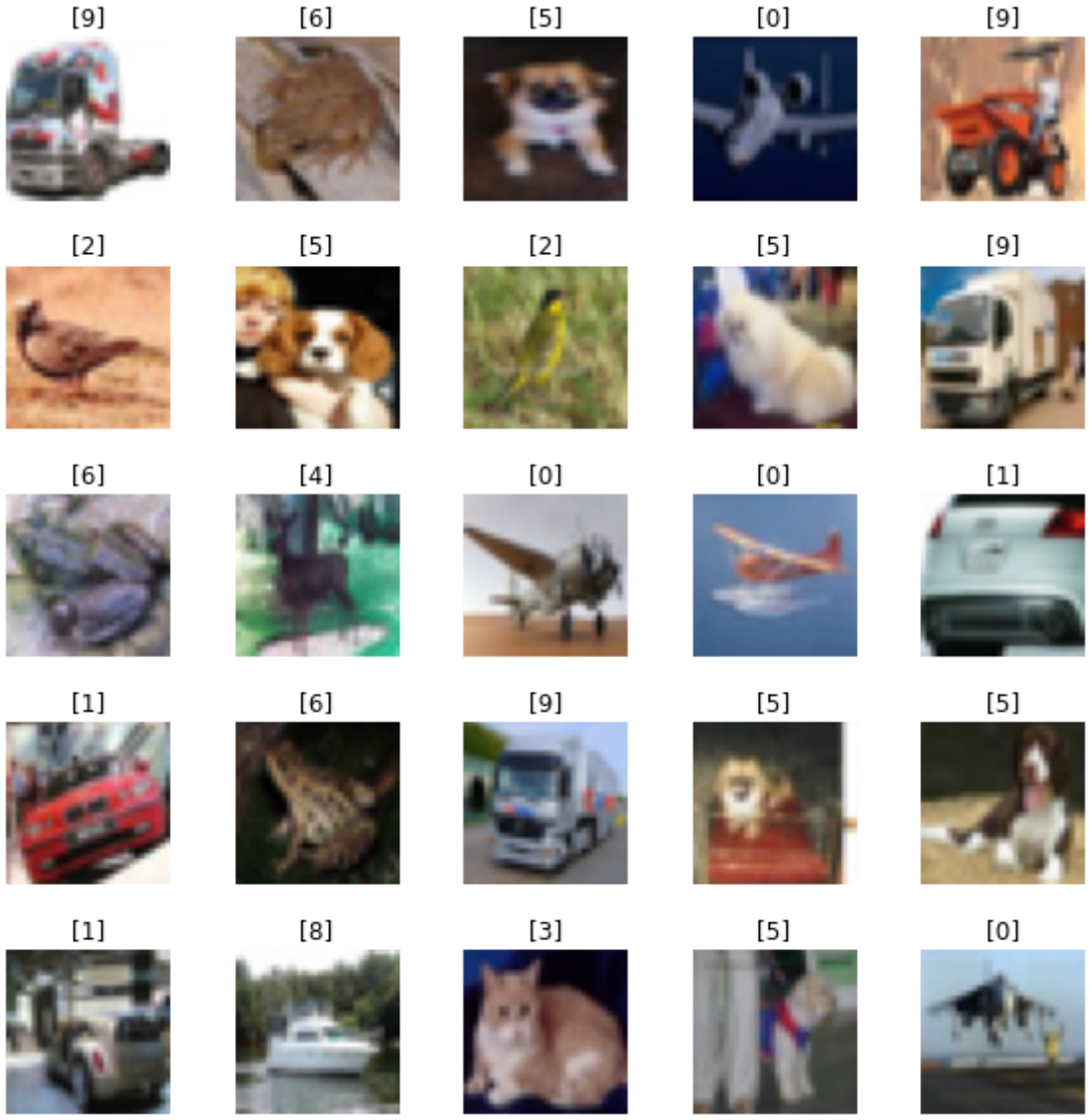
In [3]:

```
#Keras library for CIFAR dataset
from keras.datasets import cifar10
(x_train, y_train),(x_test, y_test)=cifar10.load_data()
```

In [4]:

```
W_grid=5
L_grid=5
fig,axes = plt.subplots(L_grid,W_grid,figsize=(10,10))
axes=axes.ravel()
n_training=len(x_train)
for i in np.arange(0,L_grid * W_grid):
    index=np.random.randint(0,n_training)
    axes[i].imshow(x_train[index])
    axes[i].set_title(y_train[index])
    axes[i].axis('off')
plt.subplots_adjust(hspace=0.4)
```

```
C:\Users\VRINDA\anaconda3\lib\site-packages\matplotlib\text.py:1163: FutureW
arning: elementwise comparison failed; returning scalar instead, but in the
future will perform elementwise comparison
  if s != self._text:
```



In [5]:

```
#Train-validation-test split
x_train,x_val,y_train,y_val=train_test_split(x_train,y_train,test_size=.3)
```

In [6]:

```
#Dimension of the CIFAR10 dataset
print((x_train.shape,y_train.shape))
print((x_val.shape,y_val.shape))
print((x_test.shape,y_test.shape))
```

```
((35000, 32, 32, 3), (35000, 1))
((15000, 32, 32, 3), (15000, 1))
((10000, 32, 32, 3), (10000, 1))
```

In [7]:

```
#Onehot Encoding the labels.
#Since we have 10 classes we should expect the shape[1] of y_train,y_val and y_test to chan
y_train=to_categorical(y_train)
y_val=to_categorical(y_val)
y_test=to_categorical(y_test)

#Verifying the dimension after one hot encoding
print((x_train.shape,y_train.shape))
print((x_val.shape,y_val.shape))
print((x_test.shape,y_test.shape))
```

```
((35000, 32, 32, 3), (35000, 10))
((15000, 32, 32, 3), (15000, 10))
((10000, 32, 32, 3), (10000, 10))
```

In [8]:

```
#Image Data Augmentation
train_generator = ImageDataGenerator(rotation_range=2, horizontal_flip=True, zoom_range=.1

val_generator = ImageDataGenerator(rotation_range=2, horizontal_flip=True,zoom_range=.1)

test_generator = ImageDataGenerator(rotation_range=2,  horizontal_flip= True, zoom_range=.1

#Fitting the augmentation defined above to the data
train_generator.fit(x_train)
val_generator.fit(x_val)
test_generator.fit(x_test)
```

In [9]:

```
#Learning Rate Annealer
lrr= ReduceLROnPlateau(monitor='val_acc', factor=.01,  patience=3, min_lr=1e-5)
```

In [10]:

```
#VGG16 Model
base_model_vgg16 = VGG16(include_top = False, weights= 'imagenet', input_shape = (32,32,3),

#Adding the final layers to the above base models where the actual classification is done i
model_vgg16= Sequential()
model_vgg16.add(base_model_vgg16)
model_vgg16.add(Flatten())
#Adding the Dense layers along with activation and batch normalization
model_vgg16.add(Dense(1024,activation=('relu'),input_dim=512))
model_vgg16.add(Dense(512,activation=('relu')))
model_vgg16.add(Dense(256,activation=('relu')))
#model.add(Dropout(.3))
model_vgg16.add(Dense(128,activation=('relu')))
#model.add(Dropout(.2))
model_vgg16.add(Dense(10,activation=('softmax')))

#Checking the final VGG16 model summary
model_vgg16.summary()
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applic
ations/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5 (https://stor
age.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_
ordering_tf_kernels_notop.h5)
58892288/58889256 [==============================] - 9s 0us/step
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
vgg16 (Functional)           (None, 1, 1, 512)         14714688
_________________________________________________________________
flatten (Flatten)            (None, 512)               0
_________________________________________________________________
dense (Dense)                (None, 1024)              525312
_________________________________________________________________
dense_1 (Dense)              (None, 512)               524800
_________________________________________________________________
dense_2 (Dense)              (None, 256)               131328
_________________________________________________________________
dense_3 (Dense)              (None, 128)               32896
_________________________________________________________________
dense_4 (Dense)              (None, 10)                1290
=================================================================
Total params: 15,930,314
Trainable params: 15,930,314
Non-trainable params: 0
_________________________________________________________________
```

In [*]:

```
0]//5, validation_data = val_generator.flow(x_val, y_val, batch_size = 5), validation_steps=
```

```
C:\Users\VRINDA\anaconda3\lib\site-packages\tensorflow\python\keras\engine\t
raining.py:1844: UserWarning: `Model.fit_generator` is deprecated and will b
e removed in a future version. Please use `Model.fit`, which supports genera
tors.
  warnings.warn('`Model.fit_generator` is deprecated and '

Epoch 1/20
7000/7000 [==============================] - 5512s 780ms/step - loss: 200.33
52 - accuracy: 0.1261 - val_loss: 1.9843 - val_accuracy: 0.1704
WARNING:tensorflow:Learning rate reduction is conditioned on metric `val_acc
` which is not available. Available metrics are: loss,accuracy,val_loss,val_
accuracy,lr
Epoch 2/20
5810/7000 [=======================>......] - ETA: 14:13 - loss: 2.0916 - acc
uracy: 0.1908
```

In [ ]:

```
#Making prediction
y_pred2=model_vgg16.predict_classes(x_test)
y_true=np.argmax(y_test,axis=1)

#Plotting the confusion matrix
confusion_mtx=confusion_matrix(y_true,y_pred2)

#Plotting non-normalized confusion matrix
plot_confusion_matrix(y_true, y_pred2, classes = class_names,title = 'Non-Normalized VGG16


#Plotting normalized confusion matrix
plot_confusion_matrix(y_true, y_pred2, classes = class_names, normalize = True, title= 'Nor


#Accuracy of VGG16
from sklearn.metrics import accuracy_score
```

In [ ]:

```
# Task 2- Linear classifier on Alexnet

import numpy as np
import tensorflow as tf
from tensorflow import keras

layer = keras.layers.Dense(3)
layer.build((None, 4))  # Create the weights

print("weights:", len(layer.weights))
print("trainable_weights:", len(layer.trainable_weights))
print("non_trainable_weights:", len(layer.non_trainable_weights))

layer = keras.layers.BatchNormalization()
layer.build((None, 4))  # Create the weights

print("weights:", len(layer.weights))
print("trainable_weights:", len(layer.trainable_weights))
print("non_trainable_weights:", len(layer.non_trainable_weights))

layer = keras.layers.Dense(3)
layer.build((None, 4))  # Create the weights
layer.trainable = False  # Freeze the layer

print("weights:", len(layer.weights))
print("trainable_weights:", len(layer.trainable_weights))
print("non_trainable_weights:", len(layer.non_trainable_weights))


# Make a model with 2 layers
layer1 = keras.layers.Dense(3, activation="relu")
layer2 = keras.layers.Dense(3, activation="sigmoid")
model = keras.Sequential([keras.Input(shape=(3,)), layer1, layer2])

# Freeze the first layer
layer1.trainable = False

# Keep a copy of the weights of layer1 for later reference
initial_layer1_weights_values = layer1.get_weights()

# Train the model
model.compile(optimizer="adam", loss="mse")
model.fit(np.random.random((2, 3)), np.random.random((2, 3)))

# Check that the weights of layer1 have not changed during training
final_layer1_weights_values = layer1.get_weights()
np.testing.assert_allclose(
    initial_layer1_weights_values[0], final_layer1_weights_values[0]
)
np.testing.assert_allclose(
    initial_layer1_weights_values[1], final_layer1_weights_values[1]
)



inner_model = keras.Sequential(
    [
        keras.Input(shape=(3,)),
        keras.layers.Dense(3, activation="relu"),
```

```
        keras.layers.Dense(3, activation="relu"),
    ]
)

model = keras.Sequential(
    [keras.Input(shape=(3,)), inner_model, keras.layers.Dense(3, activation="sigmoid"),]
)

model.trainable = False  # Freeze the outer model

assert inner_model.trainable == False  # All layers in `model` are now frozen
assert inner_model.layers[0].trainable == False  # `trainable` is propagated recursively


base_model = keras.applications.Xception(
    weights='imagenet',  # Load weights pre-trained on ImageNet.
    input_shape=(150, 150, 3),
    include_top=False)  # Do not include the ImageNet classifier at the top.

base_model.trainable = False

inputs = keras.Input(shape=(150, 150, 3))
# We make sure that the base_model is running in inference mode here,
# by passing `training=False`. This is important for fine-tuning, as you will
# learn in a few paragraphs.
x = base_model(inputs, training=False)
# Convert features of shape `base_model.output_shape[1:]` to vectors
x = keras.layers.GlobalAveragePooling2D()(x)
# A Dense classifier with a single unit (binary classification)
outputs = keras.layers.Dense(1)(x)
model = keras.Model(inputs, outputs)


model.compile(optimizer=keras.optimizers.Adam(),
              loss=keras.losses.BinaryCrossentropy(from_logits=True),
              metrics=[keras.metrics.BinaryAccuracy()])
model.fit(new_dataset, epochs=20, callbacks=..., validation_data=...)


# Unfreeze the base model
base_model.trainable = True

# It's important to recompile your model after you make any changes
# to the `trainable` attribute of any inner layer, so that your changes
# are take into account
model.compile(optimizer=keras.optimizers.Adam(1e-5),  # Very low learning rate
              loss=keras.losses.BinaryCrossentropy(from_logits=True),
              metrics=[keras.metrics.BinaryAccuracy()])

# Train end-to-end. Be careful to stop before you overfit!
model.fit(new_dataset, epochs=10, callbacks=..., validation_data=...)


# Create base model
base_model = keras.applications.Xception(
    weights='imagenet',
    input_shape=(150, 150, 3),
    include_top=False)
# Freeze base model
base_model.trainable = False
```

```
# Create new model on top.
inputs = keras.Input(shape=(150, 150, 3))
x = base_model(inputs, training=False)
x = keras.layers.GlobalAveragePooling2D()(x)
outputs = keras.layers.Dense(1)(x)
model = keras.Model(inputs, outputs)

loss_fn = keras.losses.BinaryCrossentropy(from_logits=True)
optimizer = keras.optimizers.Adam()

# Iterate over the batches of a dataset.
for inputs, targets in new_dataset:
    # Open a GradientTape.
    with tf.GradientTape() as tape:
        # Forward pass.
        predictions = model(inputs)
        # Compute the loss value for this batch.
        loss_value = loss_fn(targets, predictions)

    # Get gradients of loss wrt the *trainable* weights.
    gradients = tape.gradient(loss_value, model.trainable_weights)
    # Update the weights of the model.
    optimizer.apply_gradients(zip(gradients, model.trainable_weights))


    import tensorflow_datasets as tfds

tfds.disable_progress_bar()

train_ds, validation_ds, test_ds = tfds.load(
    "cats_vs_dogs",
    # Reserve 10% for validation and 10% for test
    split=["train[:40%]", "train[40%:50%]", "train[50%:60%]"],
    as_supervised=True,  # Include labels
)

print("Number of training samples: %d" % tf.data.experimental.cardinality(train_ds))
print(
    "Number of validation samples: %d" % tf.data.experimental.cardinality(validation_ds)
)
print("Number of test samples: %d" % tf.data.experimental.cardinality(test_ds))


import matplotlib.pyplot as plt

plt.figure(figsize=(10, 10))
for i, (image, label) in enumerate(train_ds.take(9)):
    ax = plt.subplot(3, 3, i + 1)
    plt.imshow(image)
    plt.title(int(label))
    plt.axis("off")
```