importing all required library

```
import numpy as np
import cv2
import matplotlib.pyplot as plt
import tensorflow as tf
from tensorflow import keras
from sklearn.metrics import accuracy_score
from tensorflow.keras import layers
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Input, Conv2D, Dense, Flatten, Dropout, LSTI
from tensorflow.keras.layers import GlobalMaxPooling2D, MaxPooling2D
from tensorflow.keras.models import Model
from tensorflow.keras import regularizers, optimizers
from tensorflow.keras.utils import to_categorical
#import visualkeras
```

Importing the cifar-10 dataset from Keras

```
from tensorflow.keras.datasets import cifar10
(X_train, Y_train), (X_test, Y_test) = cifar10.load_data()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 13s 0us/step
```

```
print('x_train Shape: {}'.format(X_train.shape))
print('x_test Shape: {}'.format(X_test.shape))
print('y_train Shape: {}'.format(Y_train.shape))
print('y_test Shape: {}'.format(Y_test.shape))
```

```
x_train Shape: (50000, 32, 32, 3)
x_test Shape: (10000, 32, 32, 3)
y_train Shape: (50000, 1)
y_test Shape: (10000, 1)
```

```
plt.figure()
plt.imshow(X_train[1000])
plt.colorbar()
```

```
<matplotlib.colorbar.Colorbar at 0x7f89f70c8ad0>
```

```
X_train = X_train/255
X_test = X_test/255

# One-Hot-Encoding
Y_train_en = to_categorical(Y_train,10)
Y_test_en = to_categorical(Y_test,10)
```

```
Y_train_en
```

```
array([[0., 0., 0., ..., 0., 0., 0.],
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 0., 0., ..., 0., 0., 1.],
       ...,
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 1., 0., ..., 0., 0., 0.],
       [0., 1., 0., ..., 0., 0., 0.]], dtype=float32)
```

Visualization of Dataset

```
for i in range(1,31):
  plt.subplot(2, 15, i)
  plt.imshow(X_train[i])
```

0
25
0 250 250 250 250 250 250 250 250 250 250 250 250 250 250 25
0
25
0 250 250 250 250 250 250 250 250 250 250 250 250 250 250 25

Base Model

```
model = Sequential()
model.add(Conv2D(1024,(4,4),input_shape=(32,32,3),activation='relu'))
model.add(Conv2D(512,(4,4),input_shape=(32,32,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.4))
model.add(Conv2D(256,(4,4),input_shape=(32,32,3),activation='relu'))
model.add(Conv2D(128,(4,4),input_shape=(32,32,3),activation='relu'))
model.add(MaxPooling2D(pool_size=(2,2)))
model.add(Dropout(0.4))
model.add(Flatten())
model.add(Dense(64,activation='relu'))
model.add(Dense(32,activation='relu'))
model.add(Dense(units =10  , activation = 'softmax'))
model.compile(loss='categorical_crossentropy',optimizer='SGD',metrics=['accurac
```

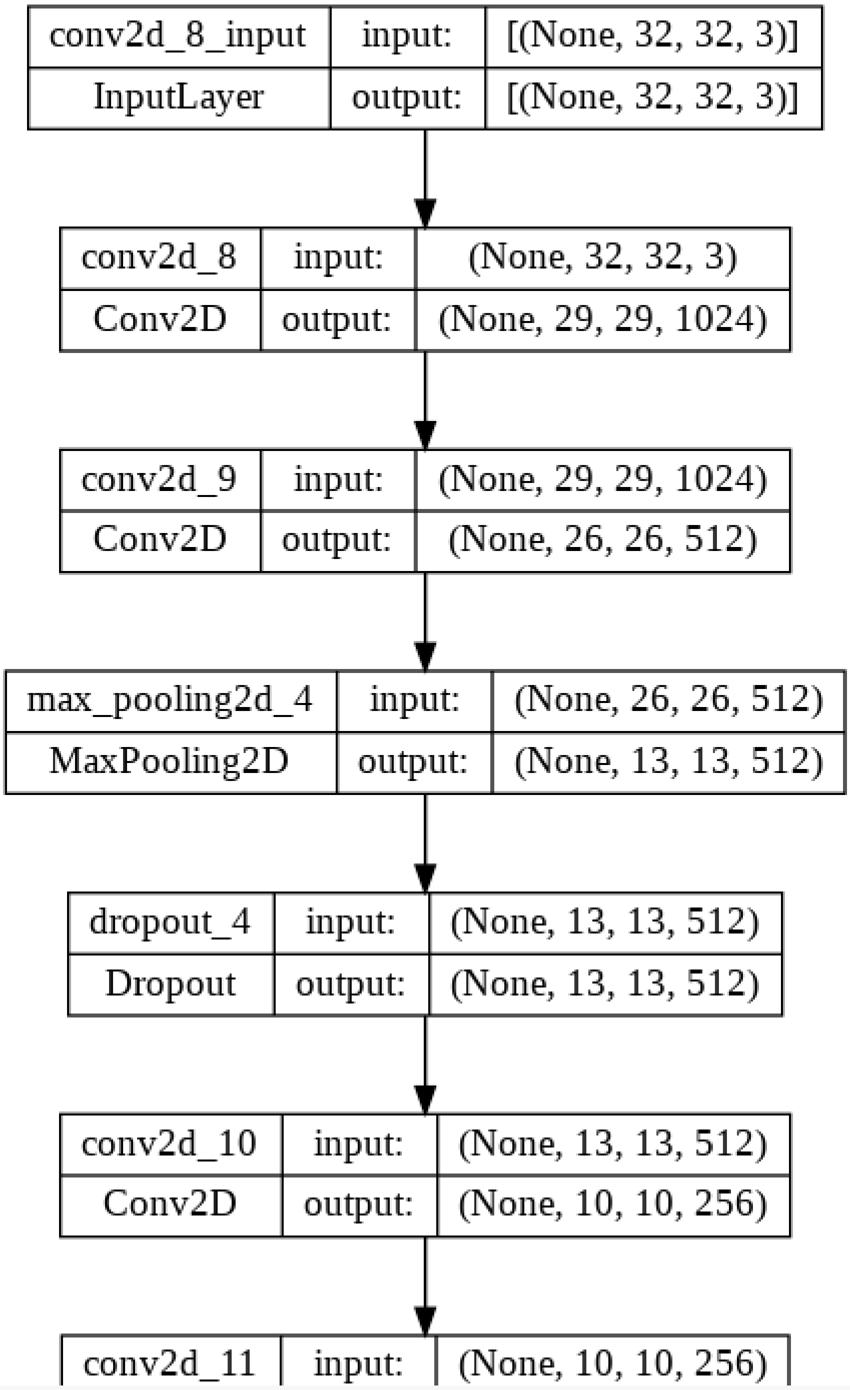
```
model.summary()
history = model.fit(X_train, Y_train_en, epochs = 10, verbose=1,validation_data
```

```
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 conv2d_8 (Conv2D)           (None, 29, 29, 1024)      50176     
                                                                 
 conv2d_9 (Conv2D)           (None, 26, 26, 512)       8389120   
                                                                 
 max_pooling2d_4 (MaxPooling  (None, 13, 13, 512)      0         
 2D)                                                             
                                                                 
 dropout_4 (Dropout)         (None, 13, 13, 512)       0         
                                                                 
 conv2d_10 (Conv2D)          (None, 10, 10, 256)       2097408   
                                                                 
 conv2d_11 (Conv2D)          (None, 7, 7, 128)         524416    
                                                                 
 max_pooling2d_5 (MaxPooling  (None, 3, 3, 128)        0         
 2D)                                                             
                                                                 
 dropout_5 (Dropout)         (None, 3, 3, 128)         0         
                                                                 
 flatten_2 (Flatten)         (None, 1152)              0         
                                                                 
 dense_6 (Dense)             (None, 64)                73792     
                                                                 
 dense_7 (Dense)             (None, 32)                2080      
                                                                 
 dense_8 (Dense)             (None, 10)                330       
                                                                 
=================================================================
Total params: 11,137,322
Trainable params: 11,137,322
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
1563/1563 [==============================] - 304s 194ms/step - loss: 2.1383 -
Epoch 2/10
1563/1563 [==============================] - 302s 193ms/step - loss: 1.8051 -
Epoch 3/10
1563/1563 [==============================] - 302s 193ms/step - loss: 1.5863 -
Epoch 4/10
1563/1563 [==============================] - 302s 193ms/step - loss: 1.4382 -
Epoch 5/10
1563/1563 [==============================] - 301s 193ms/step - loss: 1.3297 -
Epoch 6/10
1563/1563 [==============================] - 308s 197ms/step - loss: 1.2391 -
```

```
Epoch 7/10
1563/1563 [==============================] - 302s 193ms/step - loss: 1.1596 -
Epoch 8/10
1563/1563 [==============================] - 301s 193ms/step - loss: 1.0873 -
Epoch 9/10
1563/1563 [==============================] - 300s 192ms/step - loss: 1.0215 -
Epoch 10/10
1563/1563 [==============================] - 301s 192ms/step - loss: 0.9591 -
```

Architecture of Model

```
from tensorflow.keras.utils import plot_model
plot_model(model, to_file='cnn_plot.png', show_shapes=True, show_layer_names=Tru
```

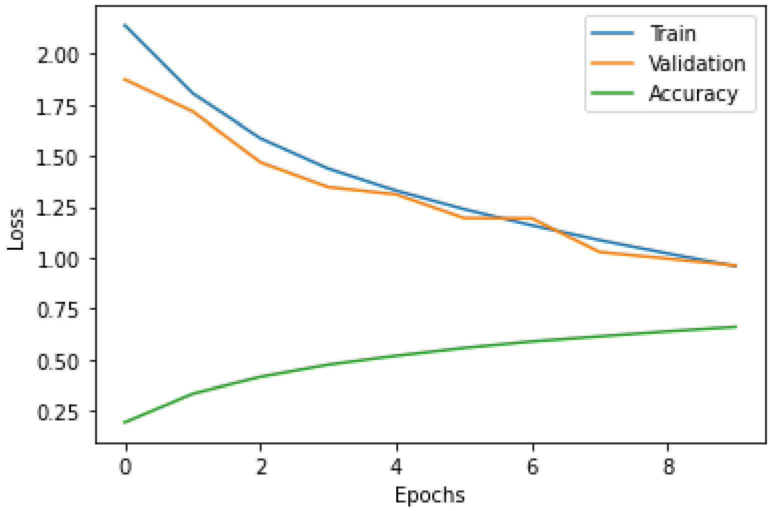

conv2d_8_input | input: | [(None, 32, 32, 3)]
InputLayer | output: | [(None, 32, 32, 3)]
conv2d_8 | input: | (None, 32, 32, 3)
Conv2D | output: | (None, 29, 29, 1024)
conv2d_9 | input: | (None, 29, 29, 1024)
Conv2D | output: | (None, 26, 26, 512)
max_pooling2d_4 | input: | (None, 26, 26, 512)
MaxPooling2D | output: | (None, 13, 13, 512)
dropout_4 | input: | (None, 13, 13, 512)
Dropout | output: | (None, 13, 13, 512)
conv2d_10 | input: | (None, 13, 13, 512)
Conv2D | output: | (None, 10, 10, 256)
conv2d_11 | input: | (None, 10, 10, 256)

```
evaluation = model.evaluate(X_test, Y_test_en)
print('Test Accuracy of Model_1(with Dropouts): {}'.format(evaluation[1]))
```

```
313/313 [==============================] - 15s 47ms/step - loss: 0.9340 - acc
Test Accuracy of Model_1(with Dropouts): 0.670199990272522
```

```
|   MaxPooling2D   | output: | (None, 3, 3, 128) |
```

```
def plotloss(history_1):
    plt.plot(history_1.history['loss'])
    plt.plot(history_1.history['val_loss'])
    plt.plot(history_1.history['accuracy'])
    plt.xlabel('Epochs')
    plt.ylabel('Loss')
    plt.legend(['Train', 'Validation', 'Accuracy'])
    plt.show()
plotloss(history)
```



Data Preprocessing for RNN

```
img = np.float32(X_train[0])
k1=(img[:,:,0]+img[:,:,1]+img[:,:,2])/3;
k1
```

```
array([[0.24052288, 0.1751634 , 0.18431373, ..., 0.52026147, 0.49542484,
        0.4901961 ],
       [0.07320262, 0.        , 0.03398693, ..., 0.34771243, 0.32941177,
        0.34771243],
       [0.09150327, 0.03006536, 0.10980392, ..., 0.32941177, 0.33202615,
        0.29281047],
       ...,
       [0.61960787, 0.5071896 , 0.50326794, ..., 0.47450984, 0.12287582,
        0.13986929],
       [0.5424836 , 0.44183007, 0.47058824, ..., 0.5568628 , 0.2522876 ,
        0.22222222],
       [0.57124186, 0.51111114, 0.53333336, ..., 0.7058824 , 0.4614379 ,
        0.3751634 ]], dtype=float32)
```

```
img_float32
```

```
array([[[0.8980392 , 0.8980392 , 0.9372549 ],
        [0.9254902 , 0.92941177, 0.96862745],
        [0.91764706, 0.9254902 , 0.96862745],
        ...,
        [0.8509804 , 0.85882354, 0.9137255 ],
        [0.8666667 , 0.8745098 , 0.91764706],
        [0.87058824, 0.8745098 , 0.9137255 ]],

       [[0.87058824, 0.8666667 , 0.8980392 ],
        [0.9372549 , 0.9372549 , 0.9764706 ],
        [0.9137255 , 0.91764706, 0.9647059 ],
        ...,
        [0.8745098 , 0.8745098 , 0.9254902 ],
        [0.8901961 , 0.89411765, 0.93333334],
        [0.8235294 , 0.827451  , 0.8627451 ]],

       [[0.8352941 , 0.80784315, 0.827451  ],
        [0.91764706, 0.9098039 , 0.9372549 ],
        [0.90588236, 0.9137255 , 0.95686275],
        ...,
        [0.8627451 , 0.8627451 , 0.9098039 ],
        [0.8627451 , 0.85882354, 0.9098039 ],
        [0.7921569 , 0.79607844, 0.84313726]],

       ...,

       [[0.5882353 , 0.56078434, 0.5294118 ],
        [0.54901963, 0.5294118 , 0.49803922],
        [0.5176471 , 0.49803922, 0.47058824],
        ...,
        [0.8784314 , 0.87058824, 0.85490197],
        [0.9019608 , 0.89411765, 0.88235295],
        [0.94509804, 0.94509804, 0.93333334]],

       [[0.5372549 , 0.5176471 , 0.49411765],
        [0.50980395, 0.49803922, 0.47058824],
        [0.49019608, 0.4745098 , 0.4509804 ],
        ...,
        [0.70980394, 0.7058824 , 0.69803923],
        [0.7921569 , 0.7882353 , 0.7764706 ],
        [0.83137256, 0.827451  , 0.8117647 ]],

       [[0.47843137, 0.46666667, 0.44705883],
        [0.4627451 , 0.45490196, 0.43137255],
        [0.47058824, 0.45490196, 0.43529412],
        ...,
        [0.7019608 , 0.69411767, 0.6784314 ],
        [0.6431373 , 0.6431373 , 0.63529414],
        [0.6392157 , 0.6392157 , 0.6313726 ]]], dtype=float32)
```

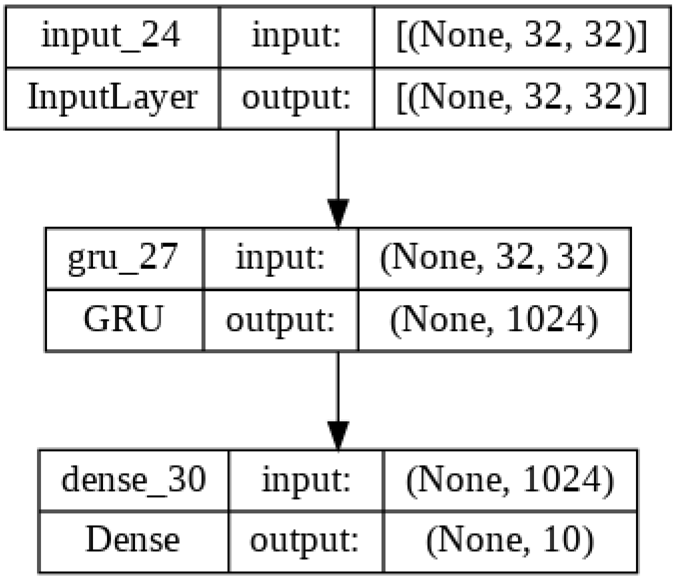
```
X_train_grayscale = np.zeros(X_train.shape[:-1])
X_test_grayscale = np.zeros(X_test.shape[:-1])
for i in range(X_train.shape[0]):
    img = np.float32(X_train[0])
    k1=(img[:,:,0]+img[:,:,1]+img[:,:,2])/3;
    X_train_grayscale[i] = k1
for i in range(X_test.shape[0]):
    img = np.float32(X_train[0])
    k1=(img[:,:,0]+img[:,:,1]+img[:,:,2])/3;
    X_test_grayscale[i] = k1
```

Creation of RNN Model

```
model1 = keras.Sequential()
model1.add(Input(shape=(32,32)),)
model1.add(layers.GRU(1024))
model1.add(layers.Dense(10))
model1.compile(loss='categorical_crossentropy',optimizer='SGD',metrics=['accura
```

Architecture of Model

```
plot_model(model1, to_file='rnn_plot.png', show_shapes=True, show_layer_names=T
```


input_24 input: [(None, 32, 32)]
InputLayer output: [(None, 32, 32)]
gru_27 input: (None, 32, 32)
GRU output: (None, 1024)
dense_30 input: (None, 1024)
Dense output: (None, 10)

```
np.shape(X_train_grayscale)
np.shape(Y_train_en)
```

```
(50000, 10)
```

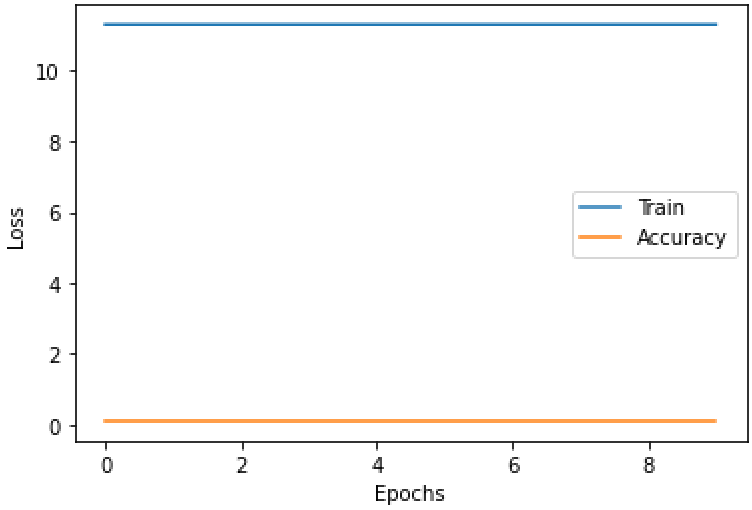
```
model1.summary()
history1= model1.fit(np.array(X_train_grayscale), np.array(Y_train_en), epochs =
```

```
Model: "sequential_44"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 gru_27 (GRU)                (None, 1024)              3250176

 dense_30 (Dense)            (None, 10)                10250

=================================================================
Total params: 3,260,426
Trainable params: 3,260,426
Non-trainable params: 0
_________________________________________________________________
Epoch 1/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 2/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2827 -
Epoch 3/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 4/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 5/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 6/10
```

```
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 7/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
Epoch 8/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2827 -
Epoch 9/10
1563/1563 [==============================] - 18s 11ms/step - loss: 11.2827 -
Epoch 10/10
1563/1563 [==============================] - 17s 11ms/step - loss: 11.2826 -
```

Loss and Accuracy

```
def plotloss(history_1):
    plt.plot(history_1.history['loss'])
    plt.plot(history_1.history['accuracy'])
    plt.xlabel('Epochs')
    plt.ylabel('Loss')
    plt.legend(['Train', 'Accuracy'])
    plt.show()
plotloss(history1)
```



✓ 0s completed at 00:37 ● ×