Assessment 3

Problem 2: Write a program to implement the new CNN model. The model should contains following things (use any grayscale dataset with the 10 classes).

In [1]:

```
import cv2
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns; sns.set()
from keras.datasets import cifar10
from sklearn.preprocessing import OneHotEncoder
from sklearn.metrics import confusion_matrix
from keras.layers import Conv2D, AveragePooling2D, Flatten, Dense, Dropout
from keras.models import Sequential, load_model
```

In [2]:

```
(X_train, y_train), (X_test, y_test) = cifar10.load_data()
labels = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship
', 'truck']
```

In [3]:

```
fig, axes = plt.subplots(ncols=5, nrows=2, figsize=(17, 8))
index = 0
for i in range(2):
    for j in range(5):
        axes[i,j].set_title(labels[y_train[index][0]])
        axes[i,j].imshow(X_train[index])
        axes[i,j].get_xaxis().set_visible(False)
        axes[i,j].get_yaxis().set_visible(False)
        index += 1
plt.show()
```

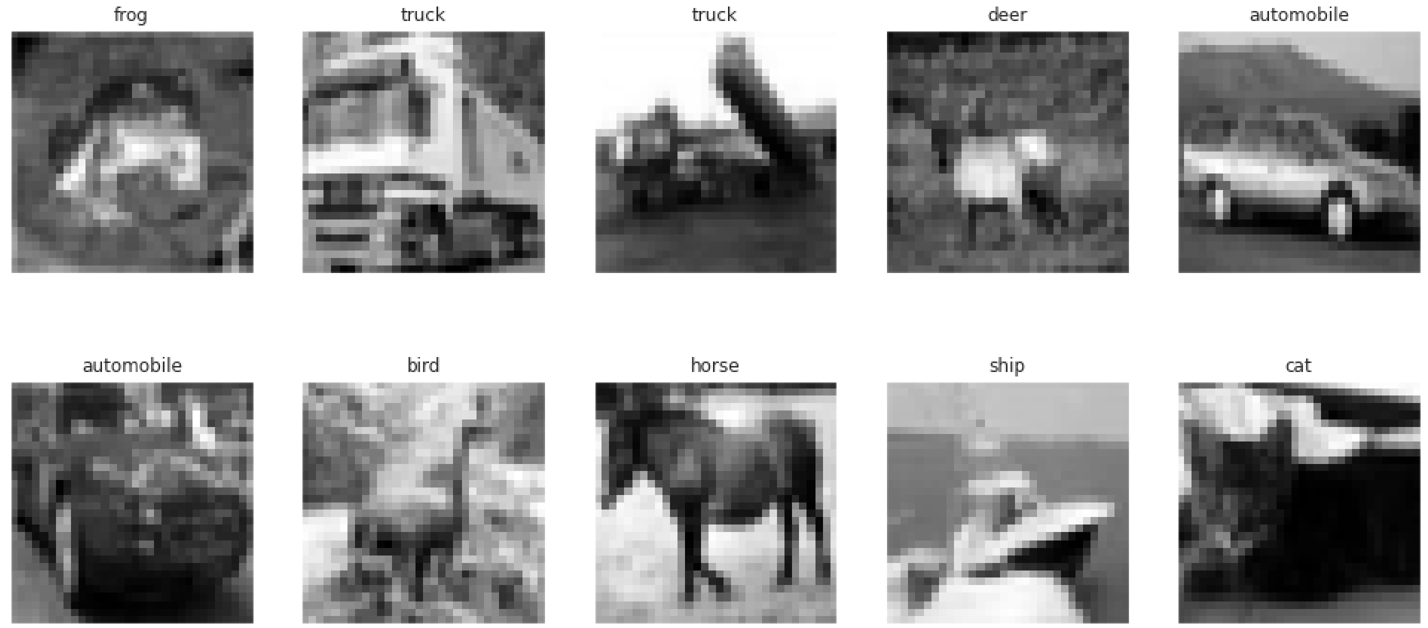
In [4]:

```
import cv2
X_train = np.array([cv2.cvtColor(image, cv2.COLOR_BGR2GRAY) for image in X_train])
X_test = np.array([cv2.cvtColor(image, cv2.COLOR_BGR2GRAY) for image in X_test])
```

In [5]:

```
fig, axes = plt.subplots(ncols=5, nrows=2, figsize=(17, 8))
```

```
fig, axes = plt.subplots(ncols=5, nrows=2, figsize=(17, 8))
index = 0
for i in range(2):
    for j in range(5):
        axes[i,j].set_title(labels[y_train[index][0]])
        axes[i,j].imshow(X_train[index], cmap='gray')
        axes[i,j].get_xaxis().set_visible(False)
        axes[i,j].get_yaxis().set_visible(False)
        index += 1
plt.show()
```



In [6]:

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

In [7]:

```
one_hot_encoder = OneHotEncoder(sparse=False)
one_hot_encoder.fit(y_train)
```

Out[7]:

```
OneHotEncoder(categories='auto', drop=None, dtype=<class 'numpy.float64'>,
              handle_unknown='error', sparse=False)
```

In [8]:

```
y_train = one_hot_encoder.transform(y_train)
y_test = one_hot_encoder.transform(y_test)
```

In [9]:

```
X_train = X_train.reshape(X_train.shape[0], X_train.shape[1], X_train.shape[2], 1)
X_test = X_test.reshape(X_test.shape[0], X_test.shape[1], X_test.shape[2], 1)
X_train.shape
```

Out[9]:

```
(50000, 32, 32, 1)
```

In [10]:

```
input_shape = (X_train.shape[1], X_train.shape[2], 1)
input_shape
```

Out[10]:

```
(32, 32, 1)
```

Model

Convolution 1 --->input(32, 32, 1) --->no. of filters = 6 ---> filter(5, 5) --->strides = 1 --->activation(relu) --->output(28, 28, 6)

SubSampling 1 Averagepooling2D --->input(28, 28, 6) ---> filter(2, 2) --->strides = 2 --->output(14, 14, 6)

Convolution 2 --->input(14, 14, 6) --->no. of filters = 16 ---> filter(5, 5) --->strides = 1 --->activation(relu) --->output(10, 10, 16)

SubSampling 2 Averagepooling2D --->input(10, 10, 16) ---> filter(2, 2) --->strides = 2 --->output(5, 5, 16)

FullyConnected 1 --->input(5, 5, 16) --->activation(relu) --->output(120)

FullyConnected 2 --->input(120) --->activation(relu) --->output(84)

Output --->input(84) --->activation(softmax) --->output(10)

In [11]:

```
model = Sequential()
model.add(Conv2D(6, kernel_size=(5, 5), padding='valid', activation='relu', input_shape=
input_shape))
model.add(AveragePooling2D(pool_size=(2, 2), strides = 2))
model.add(Conv2D(16, kernel_size=(5, 5), padding='valid', activation='relu'))
model.add(AveragePooling2D(pool_size=(2, 2), strides = 2))
model.add(Flatten())
model.add(Dense(120, activation='relu'))
model.add(Dense(84, activation='relu'))
model.add(Dense(10, activation='softmax'))
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d (Conv2D)              (None, 28, 28, 6)         156       
_________________________________________________________________
average_pooling2d (AveragePo (None, 14, 14, 6)         0         
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 10, 10, 16)        2416      
_________________________________________________________________
average_pooling2d_1 (Average (None, 5, 5, 16)          0         
_________________________________________________________________
flatten (Flatten)            (None, 400)               0         
_________________________________________________________________
dense (Dense)                (None, 120)               48120     
_________________________________________________________________
dense_1 (Dense)              (None, 84)                10164     
_________________________________________________________________
dense_2 (Dense)              (None, 10)                850       
=================================================================
Total params: 61,706
Trainable params: 61,706
Non-trainable params: 0
_________________________________________________________________
```

In [12]:

```
model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['acc'])
```

In [13]:

```
history = model.fit(X_train, y_train, epochs=20, batch_size=32, validation_data=(X_test,
y_test))
```

```
Epoch 1/20
1563/1563 [==============================] - 32s 20ms/step - loss: 1.9776 - acc: 0.2752 -
val_loss: 1.5926 - val_acc: 0.4180
```

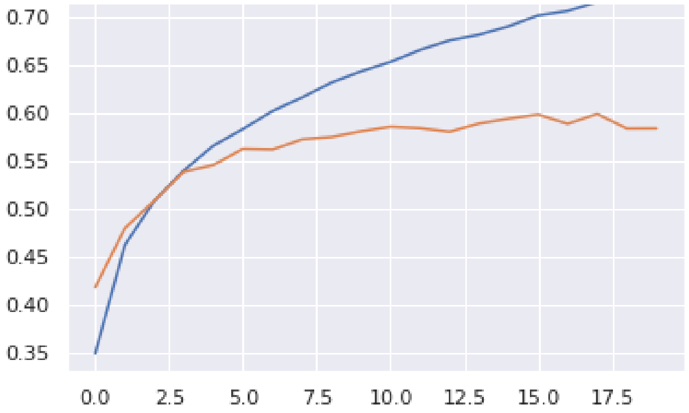
```
val_loss: 1.5920 - val_acc: 0.4100
Epoch 2/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.5403 - acc: 0.4458 -
val_loss: 1.4377 - val_acc: 0.4797
Epoch 3/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.3977 - acc: 0.5026 -
val_loss: 1.3832 - val_acc: 0.5085
Epoch 4/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.3016 - acc: 0.5407 -
val_loss: 1.3103 - val_acc: 0.5387
Epoch 5/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.2289 - acc: 0.5652 -
val_loss: 1.3023 - val_acc: 0.5457
Epoch 6/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.1711 - acc: 0.5858 -
val_loss: 1.2634 - val_acc: 0.5625
Epoch 7/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.1269 - acc: 0.6033 -
val_loss: 1.2593 - val_acc: 0.5618
Epoch 8/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.0876 - acc: 0.6161 -
val_loss: 1.2390 - val_acc: 0.5724
Epoch 9/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.0402 - acc: 0.6373 -
val_loss: 1.2409 - val_acc: 0.5749
Epoch 10/20
1563/1563 [==============================] - 31s 20ms/step - loss: 1.0142 - acc: 0.6441 -
val_loss: 1.2160 - val_acc: 0.5808
Epoch 11/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.9802 - acc: 0.6552 -
val_loss: 1.2194 - val_acc: 0.5856
Epoch 12/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.9436 - acc: 0.6692 -
val_loss: 1.2296 - val_acc: 0.5841
Epoch 13/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.9158 - acc: 0.6801 -
val_loss: 1.2512 - val_acc: 0.5803
Epoch 14/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.8887 - acc: 0.6871 -
val_loss: 1.2124 - val_acc: 0.5890
Epoch 15/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.8611 - acc: 0.6962 -
val_loss: 1.2370 - val_acc: 0.5941
Epoch 16/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.8278 - acc: 0.7094 -
val_loss: 1.2104 - val_acc: 0.5983
Epoch 17/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.8099 - acc: 0.7120 -
val_loss: 1.2405 - val_acc: 0.5887
Epoch 18/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.7849 - acc: 0.7225 -
val_loss: 1.2414 - val_acc: 0.5990
Epoch 19/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.7624 - acc: 0.7320 -
val_loss: 1.2979 - val_acc: 0.5837
Epoch 20/20
1563/1563 [==============================] - 31s 20ms/step - loss: 0.7524 - acc: 0.7348 -
val_loss: 1.3099 - val_acc: 0.5838
```

In [14]:

```
model.save('CustomCNNusingCIFAR_10.h5')
```

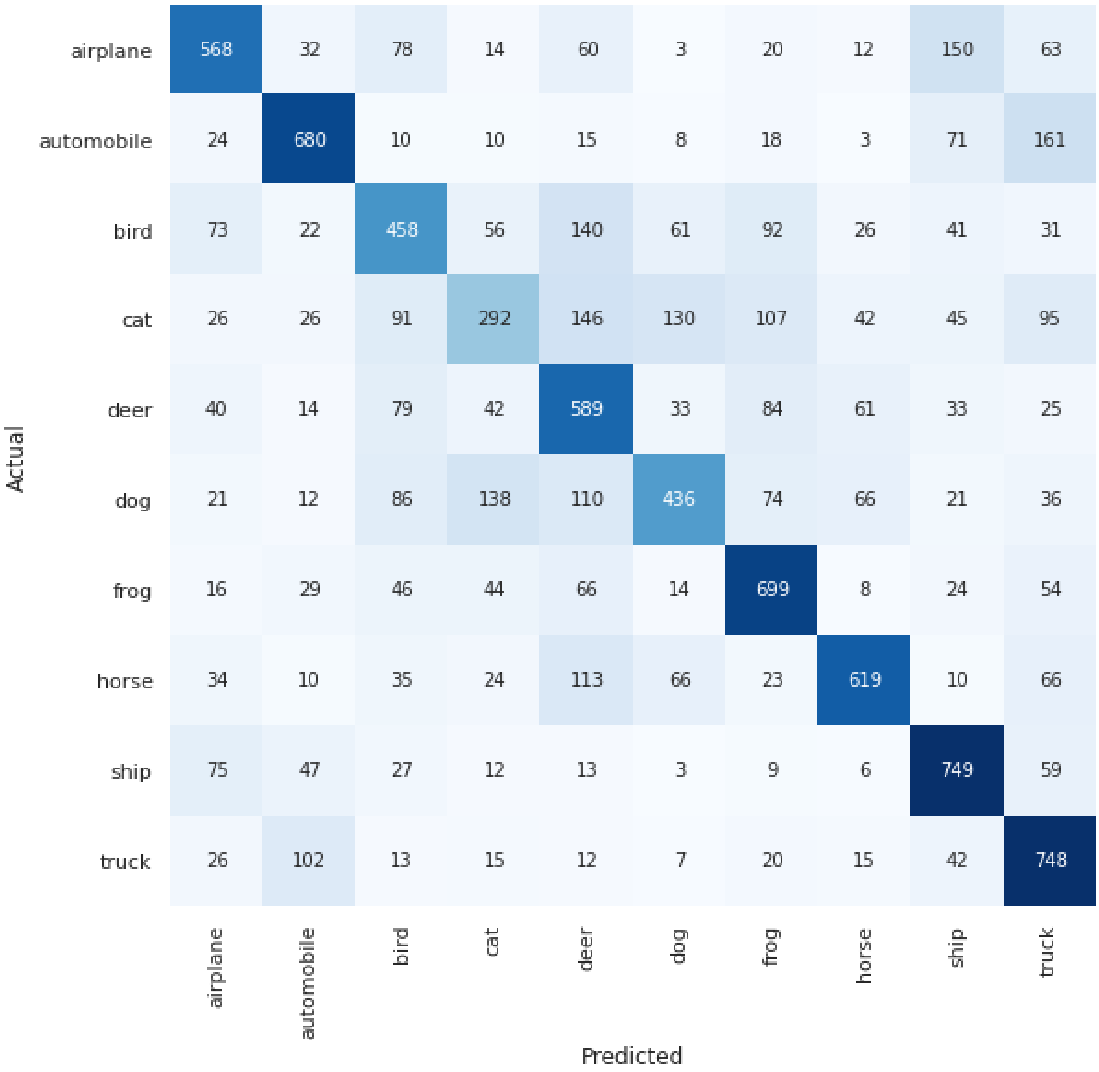
In [15]:

```
plt.title('Training Accuracy')
plt.plot(history.history['acc'])
plt.plot(history.history['val_acc'])
plt.show()
```



In [16]:

```
predictions = model.predict(X_test)
predictions = one_hot_encoder.inverse_transform(predictions)
y_test = one_hot_encoder.inverse_transform(y_test)
cm = confusion_matrix(y_test, predictions)
plt.figure(figsize=(9,9))
sns.heatmap(cm, cbar=False, xticklabels=labels, yticklabels=labels, fmt='d', annot=True,
cmap=plt.cm.Blues)
plt.xlabel('Predicted')
plt.ylabel('Actual')
plt.show()
```



	airplane	automobile	bird	cat	deer	dog	frog	horse	ship	truck
airplane	568	32	78	14	60	3	20	12	150	63
automobile	24	680	10	10	15	8	18	3	71	161
bird	73	22	458	56	140	61	92	26	41	31
cat	26	26	91	292	146	130	107	42	45	95
deer	40	14	79	42	589	33	84	61	33	25
dog	21	12	86	138	110	436	74	66	21	36
frog	16	29	46	44	66	14	699	8	24	54
horse	34	10	35	24	113	66	23	619	10	66
ship	75	47	27	12	13	3	9	6	749	59
truck	26	102	13	15	12	7	20	15	42	748