In [1]:
```
import pandas as pd
import numpy as np
import tensorflow as tf
import keras
import matplotlib.pyplot as plt
import seaborn as sns
import scipy
from sklearn.model_selection import train_test_split
```

In [2]:
```
(xtrain,ytrain),(xtest,ytest) = keras.datasets.cifar10.load_data()
classes = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'horse', 'ship', 'truck']
```

In [3]:
```
plt.imshow(xtrain[0])
plt.title(classes[ytrain[0][0]],)
plt.axis(False)
plt.show()
```

In [4]:
```
#  selecting 50% less data from xtrain
(xtrain_new_50,xtest_new_50,ytrain_new_50,ytest_new_50) =train_test_split(xtrain,ytrain,test_size=0.5,random_state=
xtrain_1,xtest_1,ytrain_1,ytest_1 = train_test_split(xtrain_new_50,ytrain_new_50,test_size=0.3,random_state=0)
print("Xtrain orignal :- ",xtrain.shape)
print("Xtrain 50% selected from xtrain:-",xtrain_new_50.shape)
print("70% selected from that 50% training :- ",xtrain_1.shape)
```

```
Xtrain orignal :-  (50000, 32, 32, 3)
Xtrain 50% selected from xtrain:- (25000, 32, 32, 3)
70% selected from that 50% training :-  (17500, 32, 32, 3)
```

In [5]:
```
from keras.models import Sequential
from keras.layers import Conv2D,Activation,BatchNormalization,MaxPooling2D,Dense,Flatten,Dropout
```

In [6]:
```
from keras.utils import to_categorical

ytrain = to_categorical(ytrain,10)
ytrain_new_50 = to_categorical(ytrain_new_50,10)
ytrain_1 = to_categorical(ytrain_1,10)

ytest = to_categorical(ytest,10)
ytest_new_50 = to_categorical(ytest_new_50,10)
ytest_1 = to_categorical(ytest_1,10)
```

In [7]:
```
xtrain_1[0].shape
```

Out[7]: (32, 32, 3)

In [8]:

```
AlexNet = Sequential()

#1st Convolutional Layer
AlexNet.add(Conv2D(filters=96, input_shape=xtrain_1[0].shape, kernel_size=(11,11), strides=(4,4), padding='same'))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))

# 1st Maxpooling Layer
AlexNet.add(MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same'))

#2nd Convolutional Layer
AlexNet.add(Conv2D(filters=256, kernel_size=(5, 5), strides=(1,1), padding='same'))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))

# 2nd Maxpooling Layer
AlexNet.add(MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same'))

#3rd Convolutional Layer
AlexNet.add(Conv2D(filters=384, kernel_size=(3,3), strides=(1,1), padding='same'))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))

#4th Convolutional Layer
AlexNet.add(Conv2D(filters=384, kernel_size=(3,3), strides=(1,1), padding='same'))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))

#5th Convolutional Layer
AlexNet.add(Conv2D(filters=256, kernel_size=(3,3), strides=(1,1), padding='same'))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))

# 3rd Maxpooling Layer
AlexNet.add(MaxPooling2D(pool_size=(2,2), strides=(2,2), padding='same'))

#Passing it to a Fully Connected layer
AlexNet.add(Flatten())

# 1st Fully Connected Layer
AlexNet.add(Dense(4096, input_shape=(32,32,3,)))
AlexNet.add(BatchNormalization())
```

```
AlexNet.add(Activation('relu'))

# Add Dropout to prevent overfitting
AlexNet.add(Dropout(0.4))

#2nd Fully Connected Layer
AlexNet.add(Dense(4096))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))
#Add Dropout
AlexNet.add(Dropout(0.4))

#3rd Fully Connected Layer
# AlexNet.add(Dense(1000))                    # this is being removed to perform ConvNet as fixed feature extra
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('relu'))
#Add Dropout
AlexNet.add(Dropout(0.4))

#Output Layer
AlexNet.add(Dense(10))
AlexNet.add(BatchNormalization())
AlexNet.add(Activation('softmax'))

#Model Summary
AlexNet.summary()
# https://cs231n.github.io/transfer-learning/
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 8, 8, 96)          34944
_________________________________________________________________
batch_normalization (BatchNo (None, 8, 8, 96)          384
_________________________________________________________________
activation (Activation)      (None, 8, 8, 96)          0
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 4, 4, 96)          0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 4, 4, 256)         614656
_________________________________________________________________
batch_normalization_1 (Batch (None, 4, 4, 256)         1024
```

| | | |
|---|---|---|
| activation_1 (Activation) | (None, 4, 4, 256) | 0 |
| max_pooling2d_1 (MaxPooling2 | (None, 2, 2, 256) | 0 |
| conv2d_2 (Conv2D) | (None, 2, 2, 384) | 885120 |
| batch_normalization_2 (Batch | (None, 2, 2, 384) | 1536 |
| activation_2 (Activation) | (None, 2, 2, 384) | 0 |
| conv2d_3 (Conv2D) | (None, 2, 2, 384) | 1327488 |
| batch_normalization_3 (Batch | (None, 2, 2, 384) | 1536 |
| activation_3 (Activation) | (None, 2, 2, 384) | 0 |
| conv2d_4 (Conv2D) | (None, 2, 2, 256) | 884992 |
| batch_normalization_4 (Batch | (None, 2, 2, 256) | 1024 |
| activation_4 (Activation) | (None, 2, 2, 256) | 0 |
| max_pooling2d_2 (MaxPooling2 | (None, 1, 1, 256) | 0 |
| flatten (Flatten) | (None, 256) | 0 |
| dense (Dense) | (None, 4096) | 1052672 |
| batch_normalization_5 (Batch | (None, 4096) | 16384 |
| activation_5 (Activation) | (None, 4096) | 0 |
| dropout (Dropout) | (None, 4096) | 0 |
| dense_1 (Dense) | (None, 4096) | 16781312 |
| batch_normalization_6 (Batch | (None, 4096) | 16384 |
| activation_6 (Activation) | (None, 4096) | 0 |
| dropout_1 (Dropout) | (None, 4096) | 0 |

```
batch_normalization_7 (Batch (None, 4096)              16384
_________________________________________________________________
activation_7 (Activation)    (None, 4096)              0
_________________________________________________________________
dropout_2 (Dropout)          (None, 4096)              0
_________________________________________________________________
dense_2 (Dense)              (None, 10)                40970
_________________________________________________________________
batch_normalization_8 (Batch (None, 10)                40
_________________________________________________________________
activation_8 (Activation)    (None, 10)                0
=================================================================
Total params: 21,676,850
Trainable params: 21,649,502
Non-trainable params: 27,348
_________________________________________________________________
```

In [9]:
```
AlexNet.compile(loss = 'categorical_crossentropy', optimizer= 'adam', metrics=['accuracy'])
```

In [10]:
```
# checkpoint = ModelCheckpoint('AlexNet.h5',save_best_only=True, monitor='val_accuracy',mode='max')
history =AlexNet.fit(xtrain_1,ytrain_1,epochs=100,batch_size=32)
```

```
547/547 [==============================] - 7s 13ms/step - loss: 0.1324 - accuracy: 0.9609
Epoch 32/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1261 - accuracy: 0.9617
Epoch 33/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1211 - accuracy: 0.9665
Epoch 34/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1212 - accuracy: 0.9645
Epoch 35/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1023 - accuracy: 0.9682
Epoch 36/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1170 - accuracy: 0.9663
Epoch 37/100
547/547 [==============================] - 7s 13ms/step - loss: 0.0979 - accuracy: 0.9706
Epoch 38/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1012 - accuracy: 0.9693
Epoch 39/100
547/547 [==============================] - 7s 13ms/step - loss: 0.0876 - accuracy: 0.9740
Epoch 40/100
547/547 [==============================] - 7s 13ms/step - loss: 0.1026 - accuracy: 0.9692
Epoch 41/100
```

In [11]:
```
history = pd.DataFrame(history.history)
```

In [12]:
```
history
```

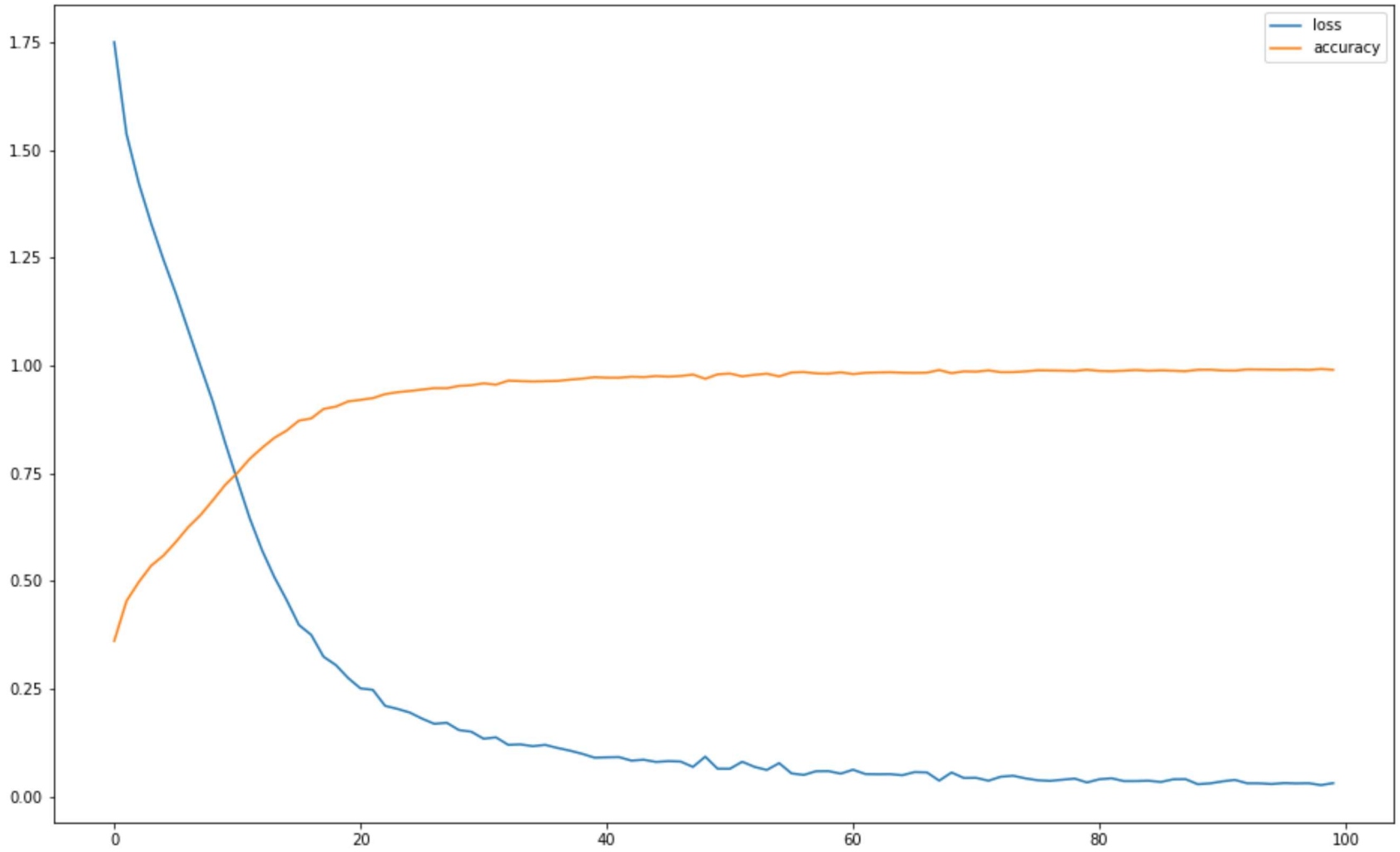
Out[12]:

| | loss | accuracy |
|---|---|---|
| **0** | 1.749619 | 0.361543 |
| **1** | 1.536217 | 0.454286 |
| **2** | 1.422057 | 0.498286 |
| **3** | 1.329333 | 0.536057 |
| **4** | 1.245421 | 0.559543 |
| **...** | ... | ... |
| **95** | 0.032239 | 0.990114 |
| **96** | 0.031350 | 0.990800 |
| **97** | 0.031872 | 0.989829 |
| **98** | 0.027423 | 0.992000 |
| **99** | 0.032049 | 0.990057 |

100 rows × 2 columns

In [13]:
```
1 history.plot.line(figsize=(16,10),)
```

Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x7f539a459250>



In [14]:
```
ypred = np.argmax(AlexNet.predict(xtest_1),axis=1)

ytrain = np.argmax(ytrain,axis=1)
ytrain_new_50 = np.argmax(ytrain_new_50,axis=1)
ytrain_1 = np.argmax(ytrain_1,axis=1)

ytest = np.argmax(ytest,axis=1)
ytest_new_50 = np.argmax(ytest_new_50,axis=1)
ytest_1 = np.argmax(ytest_1,axis=1)
```

In [15]:
```
from sklearn.metrics import confusion_matrix,classification_report,accuracy_score
accuracy_score(ypred,ytest_1)
```

Out[15]: 0.5650666666666667

In [16]:
```
ytrain = to_categorical(ytrain,10)
ytrain_new_50 = to_categorical(ytrain_new_50,10)
ytrain_1 = to_categorical(ytrain_1,10)

ytest = to_categorical(ytest,10)
ytest_new_50 = to_categorical(ytest_new_50,10)
ytest_1 = to_categorical(ytest_1,10)
```

In [17]:
```
history =AlexNet.fit(xtrain,ytrain,epochs=100,batch_size=32)
```

```
Epoch 1/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.8553 - accuracy: 0.7369
Epoch 2/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.6615 - accuracy: 0.7933
Epoch 3/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.5335 - accuracy: 0.8344
Epoch 4/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.4304 - accuracy: 0.8664
Epoch 5/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.3458 - accuracy: 0.8939
Epoch 6/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.2831 - accuracy: 0.9126
Epoch 7/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.2330 - accuracy: 0.9264
Epoch 8/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.1898 - accuracy: 0.9396
Epoch 9/100
1563/1563 [==============================] - 20s 13ms/step - loss: 0.1634 - accuracy: 0.9495
Epoch 10/100
```

In [18]:
```
history = pd.DataFrame(history.history)
```

In [19]:
```
1 history
```

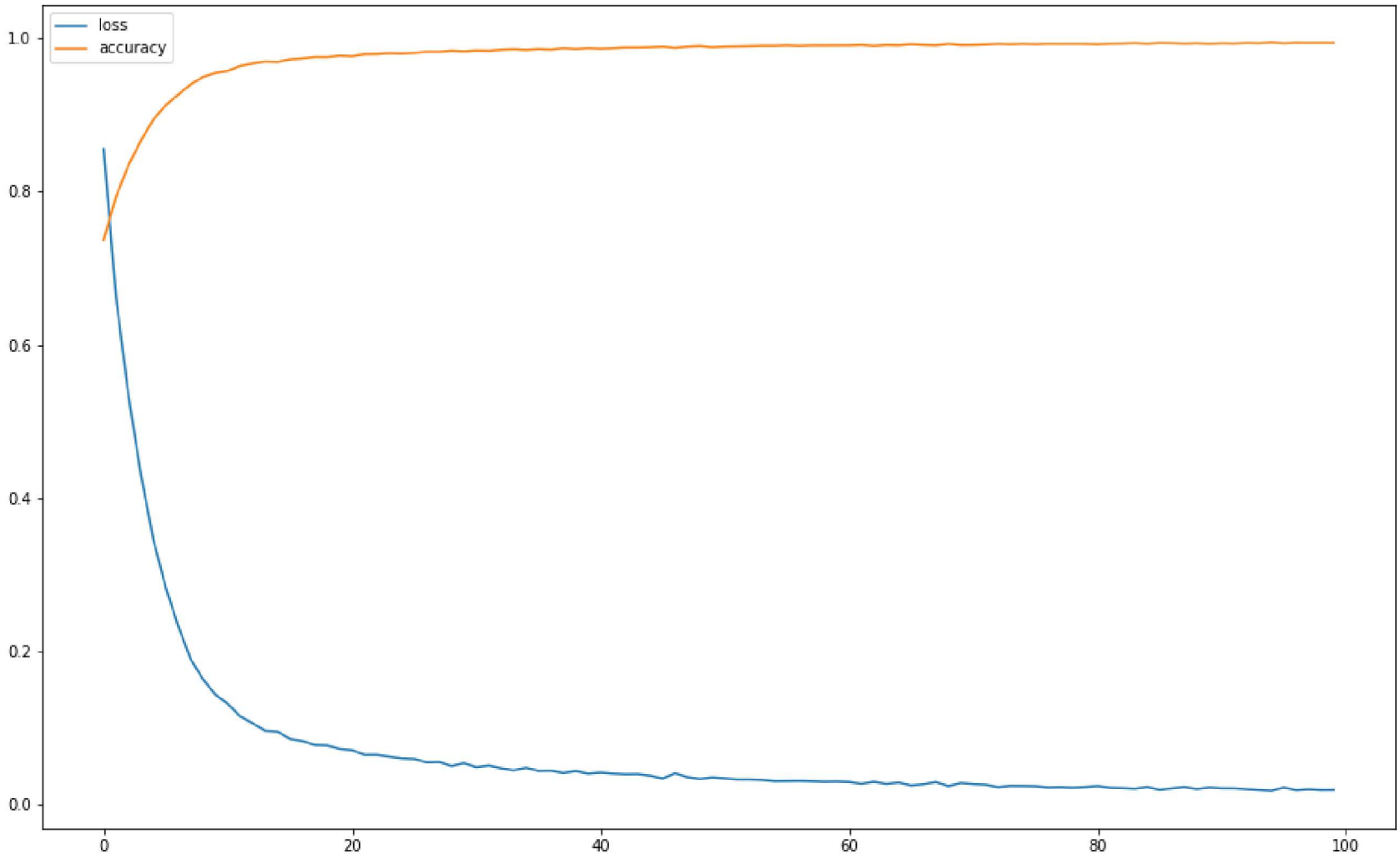
Out[19]:

| | loss | accuracy |
|---|---|---|
| **0** | 0.855332 | 0.73690 |
| **1** | 0.661502 | 0.79328 |
| **2** | 0.533495 | 0.83442 |
| **3** | 0.430364 | 0.86640 |
| **4** | 0.345819 | 0.89390 |
| **...** | ... | ... |
| **95** | 0.022198 | 0.99338 |
| **96** | 0.018639 | 0.99414 |
| **97** | 0.019822 | 0.99392 |
| **98** | 0.018850 | 0.99404 |
| **99** | 0.018977 | 0.99400 |

100 rows × 2 columns

In [20]:
```
1 history.plot.line(figsize=(16,10))
```

Out[20]: <matplotlib.axes._subplots.AxesSubplot at 0x7f53d01a0a90>



In [21]:
```
ypred = np.argmax(AlexNet.predict(xtest),axis=1)

ytrain = np.argmax(ytrain,axis=1)
ytrain_new_50 = np.argmax(ytrain_new_50,axis=1)
ytrain_1 = np.argmax(ytrain_1,axis=1)

ytest = np.argmax(ytest,axis=1)
ytest_new_50 = np.argmax(ytest_new_50,axis=1)
ytest_1 = np.argmax(ytest_1,axis=1)
```

In [22]:
```
from sklearn.metrics import confusion_matrix,classification_report,accuracy_score
accuracy_score(ypred,ytest)
```

Out[22]: 0.6501