In [1]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
from keras.datasets import fashion_mnist,cifar10
from keras.models import Sequential
from keras.layers import Dense, Activation, Dropout, Flatten, Conv2D, MaxPooling2D
from keras.layers.normalization import BatchNormalization
warnings.filterwarnings("ignore")
```

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

In [3]:
```
print("Total Number of images :- ",xtrain.shape[0]+ytrain.shape[0])
```

```
Total Number of images :-  100000
```

In [4]:
```
print("No of classes present in the data :-",len(np.unique(ytrain)))
```

```
No of classes present in the data :- 10
```

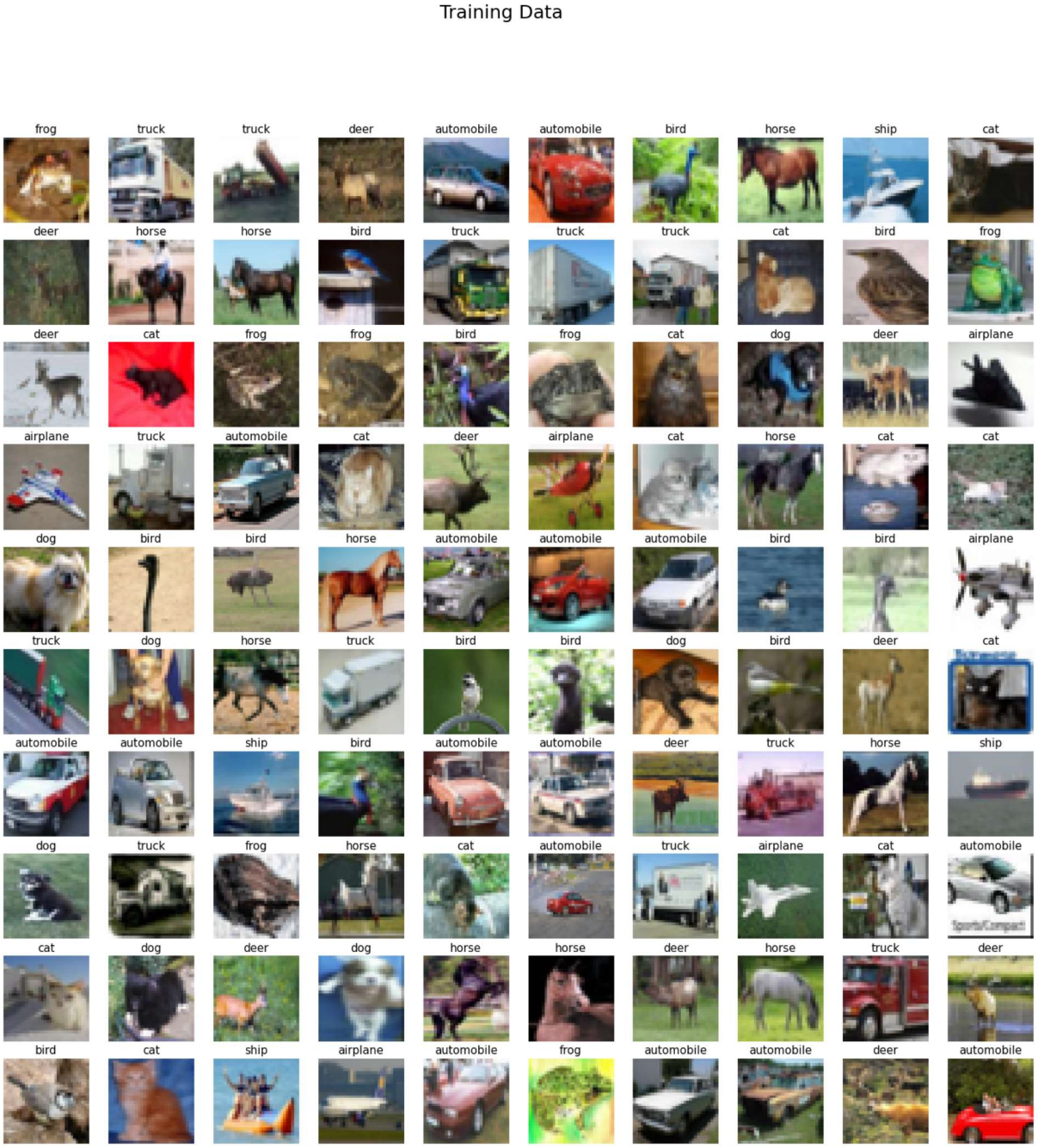
In [5]:
```
print("shape of images :- ",xtrain[0].shape)
```

```
shape of images :-  (32, 32, 3)
```

In [6]:

```
fig = plt.figure()
_, axs = plt.subplots(10,10, figsize=(25,25))
axs = axs.flatten()
for img, ax,k in zip(xtrain, axs,ytrain):
    ax.axis("off")
    ax.set_title(class_names[k[0]],fontsize=15)
    ax.imshow(img)
plt.suptitle('Training Data',fontsize=25)
plt.show()
```

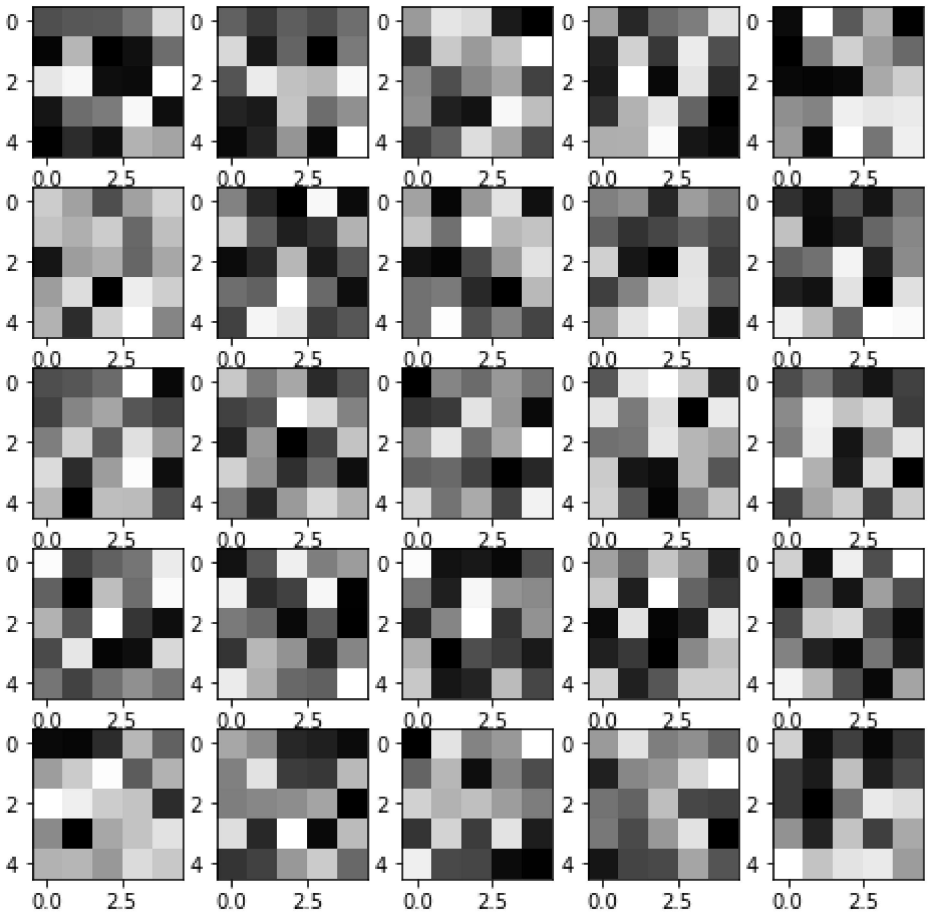
<Figure size 432x288 with 0 Axes>



In [7]:
```
from keras.utils import to_categorical
ytrain=to_categorical(ytrain)
ytest=to_categorical(ytest)
```

In [8]:

```
plt.figure(figsize=(8,8))
layers = Sequential()
x = Conv2D(filters=64,kernel_size=(5,5),input_shape=(32,32,3))
layers.add(x)
x1w = x.get_weights()[0][:,:,0,:]
for i in range(1,26):
    plt.subplot(5,5,i)
    plt.imshow(x1w[:,:,i],interpolation="nearest",cmap="gray")
plt.show()
```



In [9]:

```
AlexNet = Sequential()

#1st Convolutional Layer
AlexNet.add(Conv2D(filters=96, input_shape=(32,32,3), kernel_size=(11,11), strides=(4
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))
```

```
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()
```

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (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_2 (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_3 (Conv2D)            (None, 2, 2, 384)         885120
_________________________________________________________________
batch_normalization_2 (Batch (None, 2, 2, 384)         1536
_________________________________________________________________
activation_2 (Activation)    (None, 2, 2, 384)         0
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 2, 2, 384)         1327488
_________________________________________________________________
batch_normalization_3 (Batch (None, 2, 2, 384)         1536
_________________________________________________________________
activation_3 (Activation)    (None, 2, 2, 384)         0
_________________________________________________________________
conv2d_5 (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
_________________________________________________________________
dense_2 (Dense)              (None, 1000)              4097000
_________________________________________________________________
batch_normalization_7 (Batch (None, 1000)              4000
_________________________________________________________________
activation_7 (Activation)    (None, 1000)              0
_________________________________________________________________
dropout_2 (Dropout)          (None, 1000)              0
_________________________________________________________________
dense_3 (Dense)              (None, 10)                10010
_________________________________________________________________
batch_normalization_8 (Batch (None, 10)                40
_________________________________________________________________
activation_8 (Activation)    (None, 10)                0
=================================================================
Total params: 25,730,506
Trainable params: 25,709,350
Non-trainable params: 21,156
_________________________________________________________________
```

In [10]:
```
1 AlexNet.compile(loss = 'categorical_crossentropy', optimizer= 'adam', metrics=['accurc
```

In [11]:
```
1 batch_size= 256
2 epochs=250
```

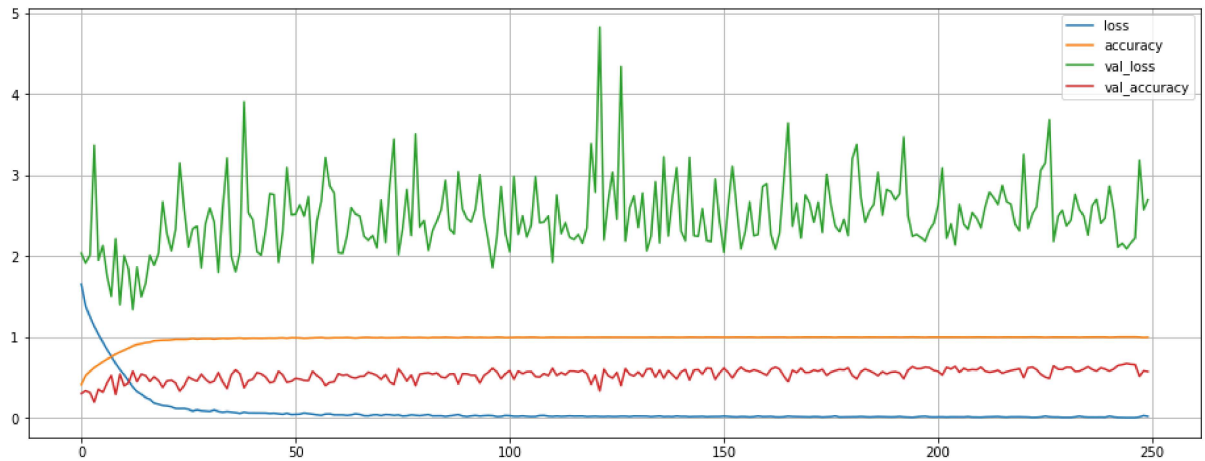
In [12]:
```
1 from sklearn.model_selection import train_test_split
2 xtrain,xval,ytrain,yval=train_test_split(xtrain,ytrain,test_size=0.3,random_state=0)
```

In [13]:
```
history = AlexNet.fit(xtrain,ytrain,validation_data=(xval,yval),batch_size=batch_size,e
```

```
137/137 [==============================] - 6s 43ms/step - loss: 0.0551 - accuracy: 0.9
829 - val_loss: 2.7593 - val_accuracy: 0.4448
Epoch 47/250
137/137 [==============================] - 6s 42ms/step - loss: 0.0512 - accuracy: 0.9
844 - val_loss: 1.9196 - val_accuracy: 0.5747
Epoch 48/250
137/137 [==============================] - 6s 43ms/step - loss: 0.0367 - accuracy: 0.9
888 - val_loss: 2.2962 - val_accuracy: 0.5295
Epoch 49/250
137/137 [==============================] - 6s 43ms/step - loss: 0.0527 - accuracy: 0.9
836 - val_loss: 3.0946 - val_accuracy: 0.4366
Epoch 50/250
137/137 [==============================] - 6s 43ms/step - loss: 0.0350 - accuracy: 0.9
893 - val_loss: 2.5101 - val_accuracy: 0.4505
Epoch 51/250
137/137 [==============================] - 6s 42ms/step - loss: 0.0402 - accuracy: 0.9
874 - val_loss: 2.5161 - val_accuracy: 0.4858
Epoch 52/250
137/137 [==============================] - 6s 42ms/step - loss: 0.0417 - accuracy: 0.9
870 - val_loss: 2.6322 - val_accuracy: 0.4776
```

In [14]:
```
history = pd.DataFrame(history.history)
```

In [15]:
```
plt.figure(figsize=(16,6))
plt.plot(history["loss"],label='loss')
plt.plot(history["accuracy"],label='accuracy')
plt.plot(history["val_loss"],label='val_loss')
plt.plot(history["val_accuracy"],label='val_accuracy')
plt.legend()
plt.grid("whitegrid")
plt.show()
```



In [16]:
```
ypredict = np.argmax(AlexNet.predict(xtest),axis=1)
```

In [17]:
```
ytest = np.argmax(ytest,axis=1)
```

In [18]:
```
1 ypredict
```

Out[18]: array([3, 8, 8, ..., 5, 1, 7])

In [19]:
```
1 from sklearn.metrics import confusion_matrix,plot_confusion_matrix,accuracy_score
2 print(confusion_matrix(ypredict,ytest))
```

```
[[534   8  45  21  12   6   2  14  16  21]
 [ 40 841  21  38  20  15  23  36  30 442]
 [112  17 689 164 256 146  97 155  16  46]
 [  3   9  24 331  39 101  29  31   7   9]
 [ 14   5  26  40 437  28  13  66   5   7]
 [  8   6  64 187  69 576  29 115   8  30]
 [ 22  12  65 113  91  65 766  26   4  30]
 [  9   6  10   9  22  20   6 513   1  15]
 [257  92  56  94  54  43  35  42 913 234]
 [  1   4   0   3   0   0   0   2   0 166]]
```

In [20]:
```
1 accuracy_score(ypredict,ytest)
```

Out[20]: 0.5766