In [1]:
```
import pandas as pd
import numpy as np
import seaborn as sns
import matplotlib.pyplot as plt
%matplotlib inline
```

In [3]:
```
from tensorflow.keras.datasets import cifar10
```

In [4]:
```
(x_train, y_train),(x_test,y_test) = cifar10.load_data()
```

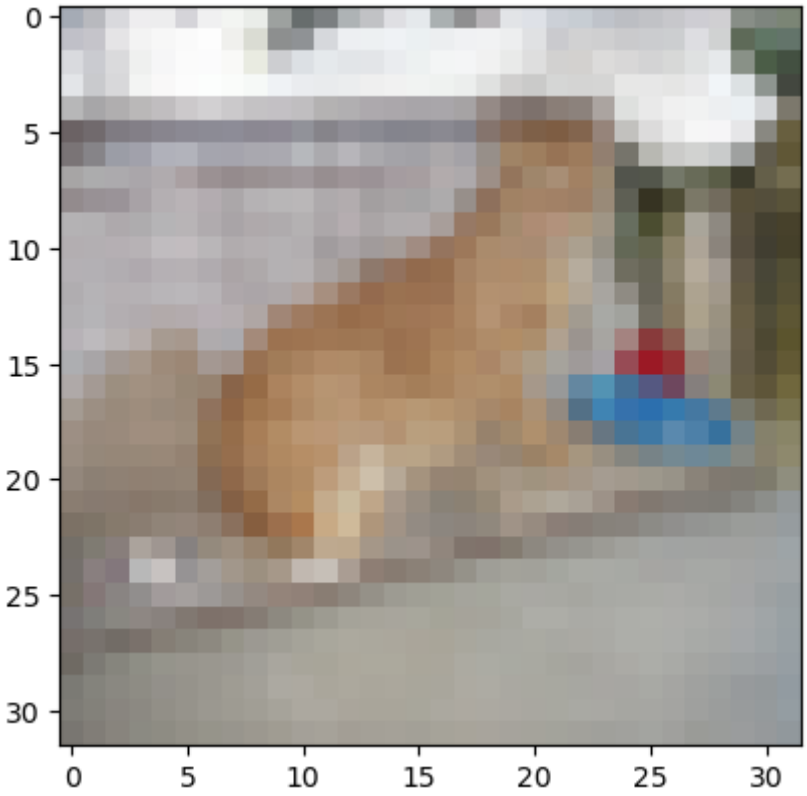
```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 119s 1us/step
```

In [5]:
```
x_train.shape
```

Out[5]:
```
(50000, 32, 32, 3)
```

In [12]:
```
plt.imshow(x_train[1030])
```

Out[12]:
```
<matplotlib.image.AxesImage at 0x1e42efb1be0>
```



In [13]:
```
x_train[0].max()
```

Out[13]:
```
255
```

In [14]:
```
x_train = x_train/255
```

In [15]:
```
x_test = x_test/255
```

In [17]:
```
from tensorflow.keras.utils import to_categorical
```

In [18]:
```
y_cat_train = to_categorical(y_train, 10)
```

In [19]:
```
y_cat_test = to_categorical(y_test, 10)
```

In [20]:
```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, Dense, MaxPool2D, Flatten
```

In [22]:
```
model = Sequential()

model.add(Conv2D(filters=32, kernel_size=(4,4), input_shape=(32,32,3), activation=

model.add(MaxPool2D(pool_size=(2,2)))

model.add(Conv2D(filters=32, kernel_size=(4,4), input_shape=(32,32,3), activation=

model.add(MaxPool2D(pool_size=(2,2)))

model.add(Flatten())

model.add(Dense(256, activation='relu'))

model.add(Dense(10,activation='softmax'))

model.compile(loss='categorical_crossentropy', optimizer='adam', metrics=['accuracy
```

In [23]:
```
model.summary()
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 29, 29, 32)        1568

 max_pooling2d (MaxPooling2D  (None, 14, 14, 32)       0
 )

 conv2d_1 (Conv2D)           (None, 11, 11, 32)        16416

 max_pooling2d_1 (MaxPooling  (None, 5, 5, 32)         0
 2D)

 flatten (Flatten)           (None, 800)               0

 dense (Dense)               (None, 256)               205056

 dense_1 (Dense)             (None, 10)                2570

=================================================================
Total params: 225,610
Trainable params: 225,610
Non-trainable params: 0
_________________________________________________________________
```

In [24]:
```
from tensorflow.keras.callbacks import EarlyStopping
```

In [25]:
```
early_stop = EarlyStopping(monitor='val_loss', patience=2)
```

In [26]:
```
model.fit(x_train, y_cat_train, epochs=15, validation_data=(x_test, y_cat_test), ca
```

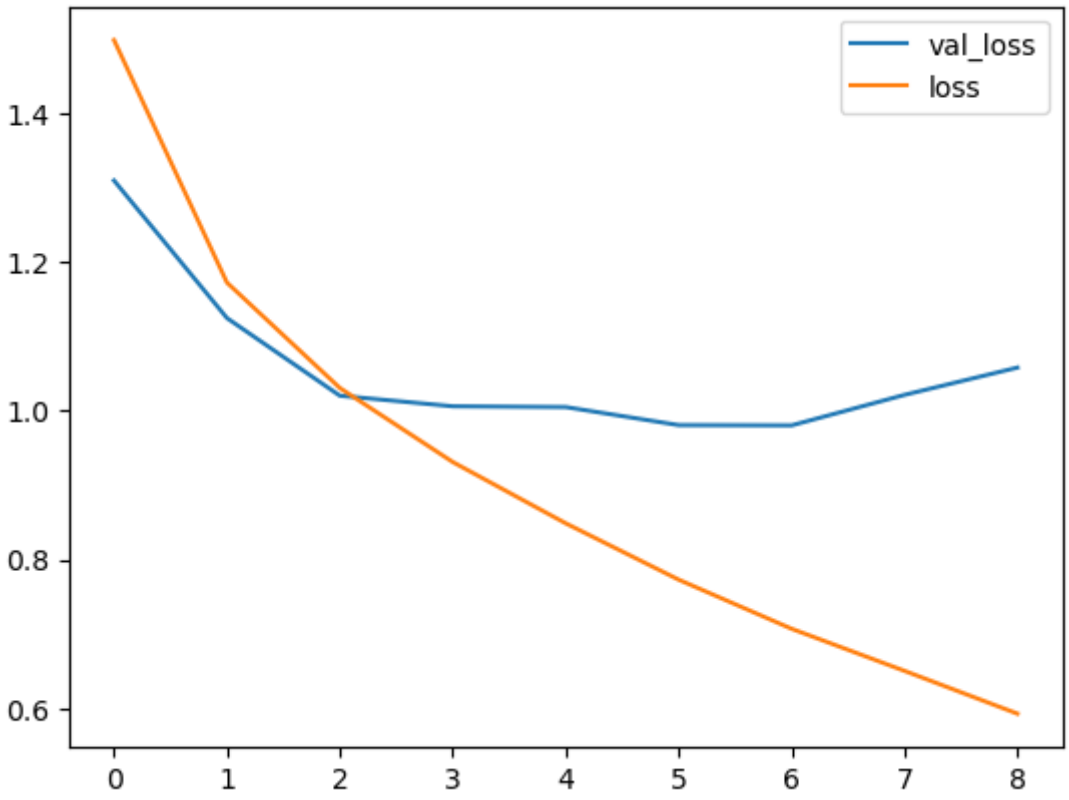
```
Epoch 1/15
1563/1563 [==============================] - 17s 11ms/step - loss: 1.4979 - accura
cy: 0.4560 - val_loss: 1.3093 - val_accuracy: 0.5371
Epoch 2/15
1563/1563 [==============================] - 16s 10ms/step - loss: 1.1721 - accura
cy: 0.5858 - val_loss: 1.1244 - val_accuracy: 0.6054
Epoch 3/15
1563/1563 [==============================] - 16s 10ms/step - loss: 1.0305 - accura
cy: 0.6373 - val_loss: 1.0201 - val_accuracy: 0.6520
Epoch 4/15
1563/1563 [==============================] - 15s 10ms/step - loss: 0.9310 - accura
cy: 0.6759 - val_loss: 1.0059 - val_accuracy: 0.6509
Epoch 5/15
1563/1563 [==============================] - 15s 10ms/step - loss: 0.8487 - accura
cy: 0.7042 - val_loss: 1.0048 - val_accuracy: 0.6568
Epoch 6/15
1563/1563 [==============================] - 15s 10ms/step - loss: 0.7730 - accura
cy: 0.7319 - val_loss: 0.9806 - val_accuracy: 0.6714
Epoch 7/15
1563/1563 [==============================] - 15s 9ms/step - loss: 0.7070 - accurac
y: 0.7531 - val_loss: 0.9803 - val_accuracy: 0.6725
Epoch 8/15
1563/1563 [==============================] - 15s 9ms/step - loss: 0.6504 - accurac
y: 0.7725 - val_loss: 1.0212 - val_accuracy: 0.6739
Epoch 9/15
1563/1563 [==============================] - 15s 9ms/step - loss: 0.5929 - accurac
y: 0.7916 - val_loss: 1.0579 - val_accuracy: 0.6663
```

Out[26]:
```
<keras.callbacks.History at 0x1e423867610>
```

In [27]:
```
model_loss = pd.DataFrame(model.history.history)
```

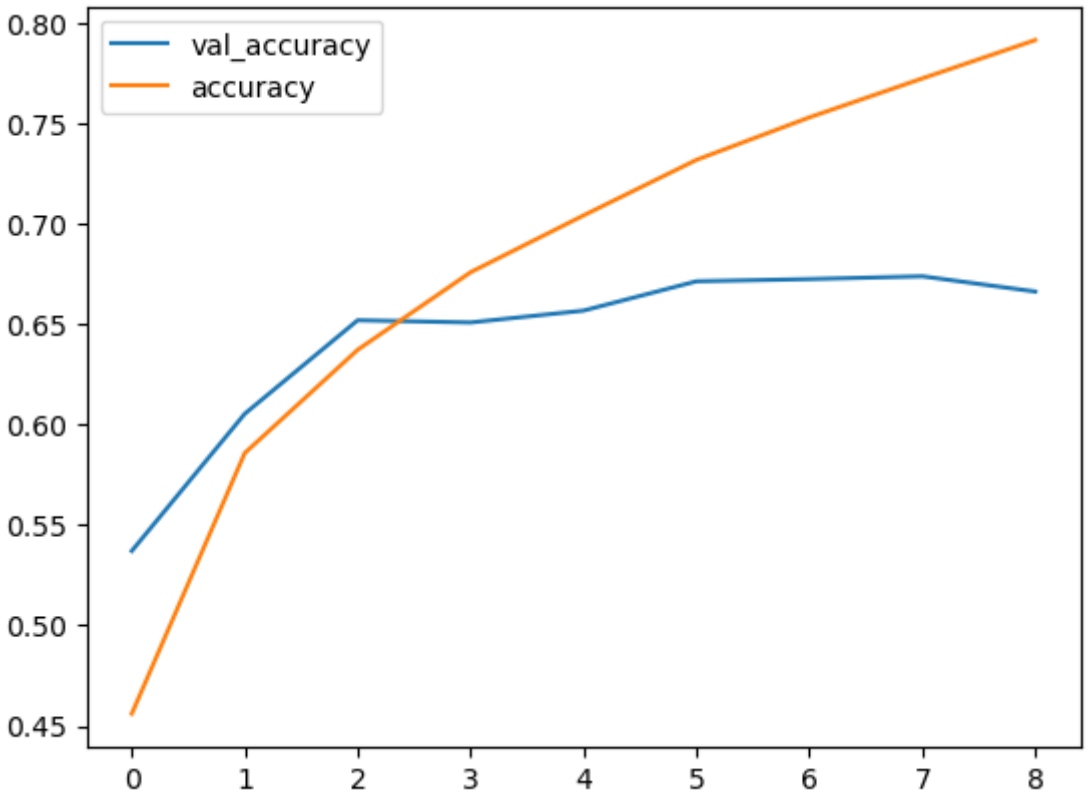
In [30]:
```
model_loss[['val_loss', 'loss']].plot()
```

Out[30]:
```
<AxesSubplot:>
```



In [31]:
```
model_loss[['val_accuracy', 'accuracy']].plot()
```

Out[31]: <AxesSubplot:>



In [32]:
```
model.evaluate(x_test, y_cat_test, verbose=0)
```

Out[32]:
```
[1.0579068660736084, 0.6662999987602234]
```

In [33]:
```
from sklearn.metrics import classification_report, confusion_matrix
```

In [34]:
```
predictions = model.predict(x_test)
```

```
313/313 [==============================] - 1s 3ms/step
```

In [37]:
```
prediction = np.argmax(predictions,axis=1)
```

In [38]:
```
print(classification_report(y_test, prediction))
```

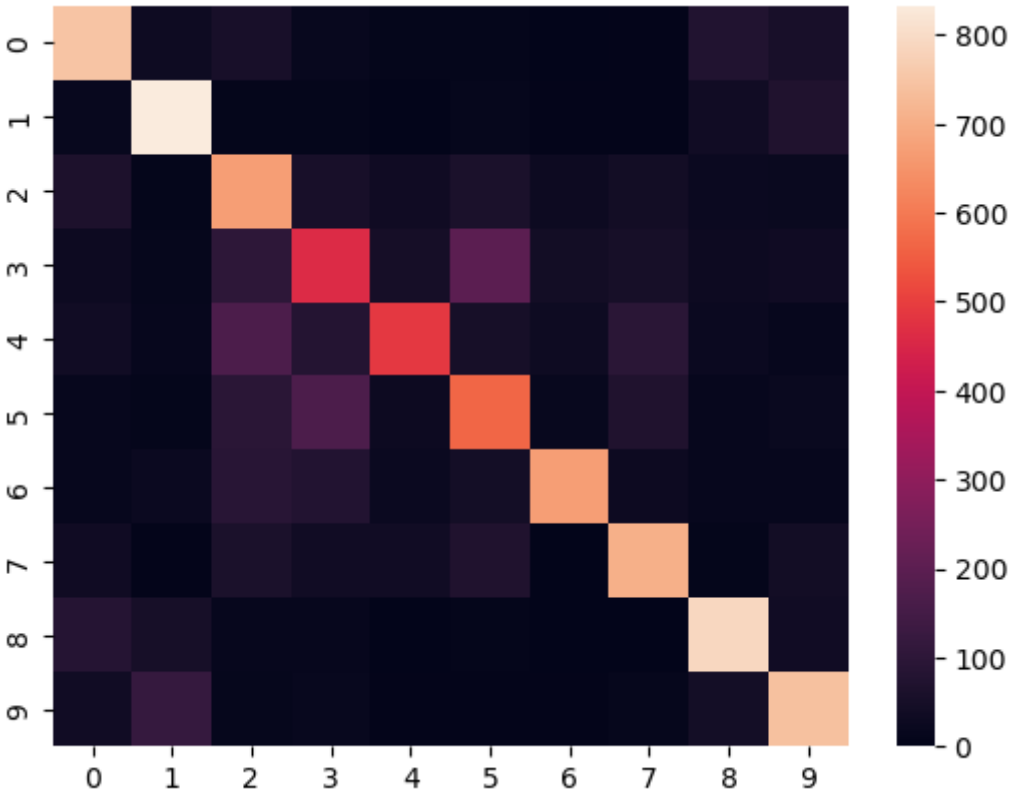
```
              precision    recall  f1-score   support

           0       0.69      0.75      0.72      1000
           1       0.75      0.83      0.79      1000
           2       0.53      0.67      0.59      1000
           3       0.49      0.46      0.48      1000
           4       0.72      0.49      0.58      1000
           5       0.56      0.56      0.56      1000
           6       0.84      0.67      0.74      1000
           7       0.69      0.70      0.70      1000
           8       0.74      0.79      0.77      1000
           9       0.71      0.74      0.72      1000

    accuracy                           0.67     10000
   macro avg       0.67      0.67      0.66     10000
weighted avg       0.67      0.67      0.66     10000
```

In [39]:
```
confusion_matrix(y_test, prediction)
```

Out[39]:
```
array([[747,  31,  54,  19,   7,   8,   3,   5,  73,  53],
       [ 18, 833,   9,   7,   2,  12,   5,   5,  39,  70],
       [ 65,   7, 668,  53,  33,  60,  28,  42,  24,  20],
       [ 29,  13, 100, 462,  48, 196,  40,  52,  27,  33],
       [ 39,  15, 168,  79, 486,  49,  30,  94,  25,  15],
       [ 16,   9,  93, 166,  28, 565,  17,  70,  15,  21],
       [ 14,  26,  91,  75,  23,  45, 670,  27,  14,  15],
       [ 35,   5,  59,  38,  39,  69,   3, 703,   9,  40],
       [ 82,  49,  14,  16,   3,   7,   0,   3, 790,  36],
       [ 36, 120,  13,  19,   5,   5,   5,  13,  45, 739]], dtype=int64)
```

In [40]:
```
sns.heatmap(confusion_matrix(y_test, prediction))
```

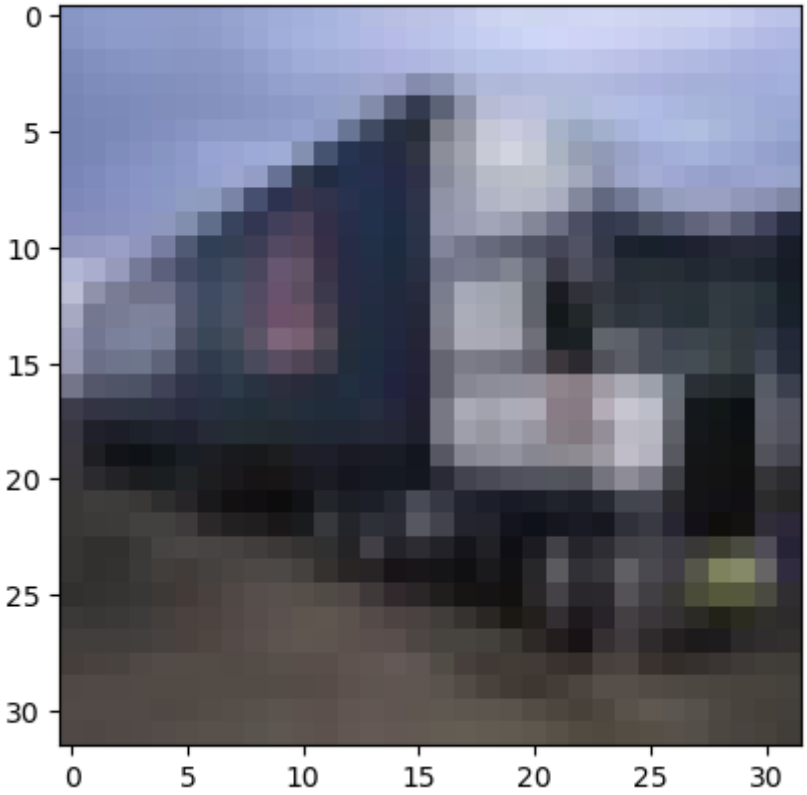
Out[40]:
```
<AxesSubplot:>
```



In [46]:
```
my_image = x_test[34]
```

In [47]:
```
plt.imshow(my_image)
```

Out[47]:
```
<matplotlib.image.AxesImage at 0x1e425b59dc0>
```



In [48]:
```
np.argmax(model.predict(my_image.reshape(1,32,32,3)) ,axis=1)
```

```
1/1 [==============================] - 0s 14ms/step
```

Out[48]:
```
array([9], dtype=int64)
```

In [ ]:
```

```