In [1]:
```
pip install tensorflow
```

```
Collecting tensorflow
  Using cached tensorflow-2.8.0-cp38-cp38-macosx_10_14_x86_64.whl (217.4
MB)
Requirement already satisfied: flatbuffers>=1.12 in /opt/anaconda3/lib/py
thon3.8/site-packages (from tensorflow) (2.0)
Requirement already satisfied: protobuf>=3.9.2 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from tensorflow) (3.19.4)
Requirement already satisfied: tf-estimator-nightly==2.8.0.dev2021122109
 in /opt/anaconda3/lib/python3.8/site-packages (from tensorflow) (2.8.0.de
v2021122109)
Requirement already satisfied: setuptools in /opt/anaconda3/lib/python3.8
/site-packages (from tensorflow) (49.2.0.post20200714)
Requirement already satisfied: astunparse>=1.6.0 in /opt/anaconda3/lib/py
thon3.8/site-packages (from tensorflow) (1.6.3)
Requirement already satisfied: typing-extensions>=3.6.6 in /opt/anaconda3
/lib/python3.8/site-packages (from tensorflow) (3.7.4.2)
Requirement already satisfied: gast>=0.2.1 in /opt/anaconda3/lib/python3.
8/site-packages (from tensorflow) (0.5.3)
Requirement already satisfied: google-pasta>=0.1.1 in /opt/anaconda3/lib/
python3.8/site-packages (from tensorflow) (0.2.0)
Requirement already satisfied: tensorboard<2.9,>=2.8 in /opt/anaconda3/li
b/python3.8/site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: libclang>=9.0.1 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from tensorflow) (13.0.0)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in /o
pt/anaconda3/lib/python3.8/site-packages (from tensorflow) (0.24.0)
Requirement already satisfied: opt-einsum>=2.3.2 in /opt/anaconda3/lib/py
thon3.8/site-packages (from tensorflow) (3.3.0)
Requirement already satisfied: absl-py>=0.4.0 in /opt/anaconda3/lib/pytho
n3.8/site-packages (from tensorflow) (1.0.0)
Requirement already satisfied: h5py>=2.9.0 in /opt/anaconda3/lib/python3.
8/site-packages (from tensorflow) (2.10.0)
Requirement already satisfied: keras-preprocessing>=1.1.1 in /opt/anacond
a3/lib/python3.8/site-packages (from tensorflow) (1.1.2)
Requirement already satisfied: keras<2.9,>=2.8.0rc0 in /opt/anaconda3/lib
/python3.8/site-packages (from tensorflow) (2.8.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in /opt/anaconda3/lib/
python3.8/site-packages (from tensorflow) (1.44.0)
Requirement already satisfied: six>=1.12.0 in /opt/anaconda3/lib/python3.
8/site-packages (from tensorflow) (1.15.0)
Requirement already satisfied: numpy>=1.20 in /opt/anaconda3/lib/python3.
8/site-packages (from tensorflow) (1.22.2)
Requirement already satisfied: wrapt>=1.11.0 in /opt/anaconda3/lib/python
3.8/site-packages (from tensorflow) (1.11.2)
Requirement already satisfied: termcolor>=1.1.0 in /opt/anaconda3/lib/pyt
hon3.8/site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: wheel<1.0,>=0.23.0 in /opt/anaconda3/lib/p
ython3.8/site-packages (from astunparse>=1.6.0->tensorflow) (0.34.2)
Requirement already satisfied: requests<3,>=2.21.0 in /opt/anaconda3/lib/
python3.8/site-packages (from tensorboard<2.9,>=2.8->tensorflow) (2.24.0)
Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /opt/anac
onda3/lib/python3.8/site-packages (from tensorboard<2.9,>=2.8->tensorflow
) (1.8.1)
Requirement already satisfied: markdown>=2.6.8 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from tensorboard<2.9,>=2.8->tensorflow) (3.3.6)
Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /opt/a
naconda3/lib/python3.8/site-packages (from tensorboard<2.9,>=2.8->tensorf
low) (0.4.6)
Requirement already satisfied: tensorboard-data-server<0.7.0,>=0.6.0 in /
opt/anaconda3/lib/python3.8/site-packages (from tensorboard<2.9,>=2.8->te
nsorflow) (0.6.1)
Requirement already satisfied: werkzeug>=0.11.15 in /opt/anaconda3/lib/py
thon3.8/site-packages (from tensorboard<2.9,>=2.8->tensorflow) (1.0.1)
Requirement already satisfied: google-auth<3,>=1.6.3 in /opt/anaconda3/li
b/python3.8/site-packages (from tensorboard<2.9,>=2.8->tensorflow) (2.6.0
)
Requirement already satisfied: idna<3,>=2.5 in /opt/anaconda3/lib/python3
.8/site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->tensor
flow) (2.10)
Requirement already satisfied: urllib3!=1.25.0,!=1.25.1,<1.26,>=1.21.1 in
 /opt/anaconda3/lib/python3.8/site-packages (from requests<3,>=2.21.0->ten
sorboard<2.9,>=2.8->tensorflow) (1.25.3)
Requirement already satisfied: chardet<4,>=3.0.2 in /opt/anaconda3/lib/py
thon3.8/site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->t
ensorflow) (3.0.4)
Requirement already satisfied: certifi>=2017.4.17 in /opt/anaconda3/lib/p
ython3.8/site-packages (from requests<3,>=2.21.0->tensorboard<2.9,>=2.8->
tensorflow) (2020.6.20)
Requirement already satisfied: requests-oauthlib>=0.7.0 in /opt/anaconda3
/lib/python3.8/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tens
orboard<2.9,>=2.8->tensorflow) (1.3.1)
Requirement already satisfied: cachetools<6.0,>=2.0.0 in /opt/anaconda3/l
ib/python3.8/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>
=2.8->tensorflow) (5.0.0)
Requirement already satisfied: pyasn1-modules>=0.2.1 in /opt/anaconda3/li
b/python3.8/site-packages (from google-auth<3,>=1.6.3->tensorboard<2.9,>=
2.8->tensorflow) (0.2.8)
Requirement already satisfied: rsa<5,>=3.1.4; python_version >= "3.6" in
/opt/anaconda3/lib/python3.8/site-packages (from google-auth<3,>=1.6.3->t
ensorboard<2.9,>=2.8->tensorflow) (4.8)
Requirement already satisfied: zipp>=0.5 in /opt/anaconda3/lib/python3.8/
site-packages (from importlib-metadata>=4.4; python_version < "3.10"->mar
kdown>=2.6.8->tensorboard<2.9,>=2.8->tensorflow) (3.1.0)
Requirement already satisfied: oauthlib>=3.0.0 in /opt/anaconda3/lib/pyth
on3.8/site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<
0.5,>=0.4.1->tensorboard<2.9,>=2.8->tensorflow) (3.2.0)
Requirement already satisfied: pyasn1<0.5.0,>=0.4.6 in /opt/anaconda3/lib
/python3.8/site-packages (from pyasn1-modules>=0.2.1->google-auth<3,>=1.6
.3->tensorboard<2.9,>=2.8->tensorflow) (0.4.8)
Installing collected packages: tensorflow
Successfully installed tensorflow-2.8.0
WARNING: You are using pip version 20.2.4; however, version 22.0.3 is ava
ilable.
You should consider upgrading via the '/opt/anaconda3/bin/python -m pip i
nstall --upgrade pip' command.
Note: you may need to restart the kernel to use updated packages.
```

In [78]:
```
import tensorflow as tf
from tensorflow.keras import datasets, layers, models
import matplotlib.pyplot as plt
import numpy as np
from sklearn.metrics import confusion_matrix,classification_report
```

In [4]:
```
(X_train, Y_train), (X_test, y_test) =datasets.cifar10.load_data()
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.ta
r.gz
170500096/170498071 [==============================] - 41s 0us/step
170508288/170498071 [==============================] - 41s 0us/step
```

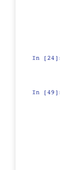
In [8]:
```
#lets check training samples
plt.figure(figsize = (15,2)) #make image smaller
plt.imshow(X_train[1])
```

Out[8]:
```
<matplotlib.image.AxesImage at 0x7fcb19c90a40>
```


In [16]:
```
#lets help label our images
Y_train = Y_train.reshape(-1,)
classes = ["airplane", "automobile", "bird", "cat","deer","dog", "frog", "
horse","ship","truck"]
```

In [17]:
```
#lets create a quick function to plot these images
def plot_image(X,y,index):
    plt.figure(figsize = (15,2))
    plt.imshow(X_train[index])
    plt.xlabel(classes[y[index]])
```

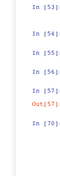
In [20]:
```
plot_image(X_train,Y_train,3)
```



In [21]:
```
#we are now able to classify many images
```

In [22]:
```
plot_image(X_train,Y_train,1)
```


In [23]:
```
plot_image(X_train,Y_train,6)
```



In [24]:
```
#lets try to make our image a bit clearer by normalizing data
X_train = X_train /255
X_test = X_test/255
```

In [49]:
```
#lets build a neural network
#since our data is not categorical we use sparse cross entropy
cnn = models.Sequential([
    #cnn
    layers.ConvZD(filters=32,kernel_size=(3,3),activation="relu",input_sha
pe=(32,32,3)),
    layers.MaxPooling2D((2,2)),

    layers.ConvZD(filters=64,kernel_size=(3,3),activation="relu"),
    layers.MaxPooling2D((2,2)),
    #dense
    layers.Flatten(),
    layers.Dense(64,activation="relu"),
    layers.Dense(10,activation="softmax")

])
```

In [50]:
```
cnn.compile(optimizer = "adam",loss="sparse_categorical_crossentropy",
            metrics=["accuracy"])
```

In [51]:
```
cnn.fit(X_train,Y_train,epochs=10)
```

```
Epoch 1/10
1563/1563 [==============================] - 21s 13ms/step - loss: 1.4405
- accuracy: 0.4814
Epoch 2/10
1563/1563 [==============================] - 21s 13ms/step - loss: 1.0986
- accuracy: 0.6158
Epoch 3/10
1563/1563 [==============================] - 21s 14ms/step - loss: 0.9674
- accuracy: 0.6637
Epoch 4/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.8802
- accuracy: 0.6933
Epoch 5/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.8111
- accuracy: 0.7182
Epoch 6/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.7524
- accuracy: 0.7384
Epoch 7/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.7059
- accuracy: 0.7544
Epoch 8/10
1563/1563 [==============================] - 21s 14ms/step - loss: 0.6594
- accuracy: 0.7686
Epoch 9/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.6164
- accuracy: 0.7831
Epoch 10/10
1563/1563 [==============================] - 22s 14ms/step - loss: 0.5779
- accuracy: 0.7963
```

Out[51]:
```
<keras.callbacks.History at 0x7fcb19feecd0>
```

In [52]:
```
#time to test our test set
cnn.evaluate(X_test,y_test)
```

```
313/313 [==============================] - 1s 3ms/step - loss: 0.9089 - a
ccuracy: 0.7086
```

Out[52]:
```
[0.9088751077651978, 0.7085999846458435]
```

In [53]:
```
#we have a 70% accuracy, with more epochs we can increase this accuracy
#however for now we will stick with 10 epochs
```

In [54]:
```
y_test = y_test.reshape(-1)
```

In [55]:
```
y_pred = cnn.predict(X_test)
```

In [56]:
```
y_classes = [np.argmax(element) for element in y_pred]
```

In [57]:
```
y_test[:5]
```

Out[57]:
```
array([3, 8, 8, 0, 6], dtype=uint8)
```

In [70]:
```
plot_image(X_test,y_test,20)
```


In [74]:
```
plot_image(X_test,y_test,19)
```

In [69]:
```
#we see that the images are only 70% accurate
```

In [79]:
```
print("Classification Report: \n", classification_report(y_test,y_classes)
)
```

```
Classification Report:
              precision    recall  f1-score   support

           0       0.75      0.73      0.74      1000
           1       0.81      0.81      0.81      1000
           2       0.65      0.58      0.61      1000
           3       0.54      0.46      0.49      1000
           4       0.67      0.66      0.67      1000
           5       0.56      0.70      0.62      1000
           6       0.79      0.75      0.77      1000
           7       0.77      0.73      0.75      1000
           8       0.82      0.82      0.82      1000
           9       0.73      0.84      0.78      1000

    accuracy                           0.71     10000
   macro avg       0.71      0.71      0.71     10000
weighted avg       0.71      0.71      0.71     10000
```

In [ ]:
```

```

In [ ]:
```

```