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HW4

RIN: 661995422

Question 1

In [ ]:
```
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras.datasets import cifar10
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense
from tensorflow.keras import Input
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.utils import to_categorical

import numpy as np
from skimage import io
from matplotlib import pyplot as plt
import copy

import ssl
ssl._create_default_https_context = ssl._create_unverified_context
```

```
WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\site-packages\keras\src\losses.py:2976: The name tf.losses.sparse_softmax_cross_entropy is deprecated. Please use tf.compat.v1.losses.sparse_softmax_cross_entropy instead.
```

Extracting data

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

Plotting an image from each category

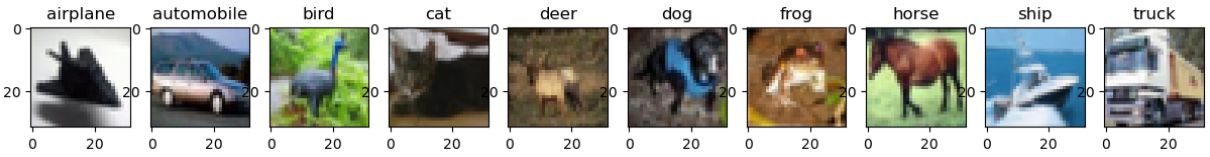
In [ ]:
```
"""This plot finds an index for each of the types of images """

indeces = []

for label in range(10):
    iter = 0
    while y_train[iter] != label and iter<(y_train.size-1):
        iter += 1
    indeces.append(iter)

print(indeces)
```

```
[29, 4, 6, 9, 3, 27, 0, 7, 8, 1]
```

Plotting images

In [ ]:
```
plt.figure()

label_names = ['airplane', 'automobile', 'bird', 'cat', 'deer', 'dog', 'frog', 'hor
fig, ax = plt.subplots(1,10, figsize=(15,10))

for label in range(10):
    ax[label].imshow(x_train[indeces[label]])
    ax[label].title.set_text(label_names[label])

plt.show()
```

```
<Figure size 640x480 with 0 Axes>
```



Reshaping the images for a fully connected NN

In [ ]:
```
print(x_train.shape)
print(x_train.shape[0])

x_train = x_train.reshape(50000, -1)
print(x_train.shape)
print(x_train)

# Convert the target data into one-hot encoding
y_train = to_categorical(y_train, 10)
```

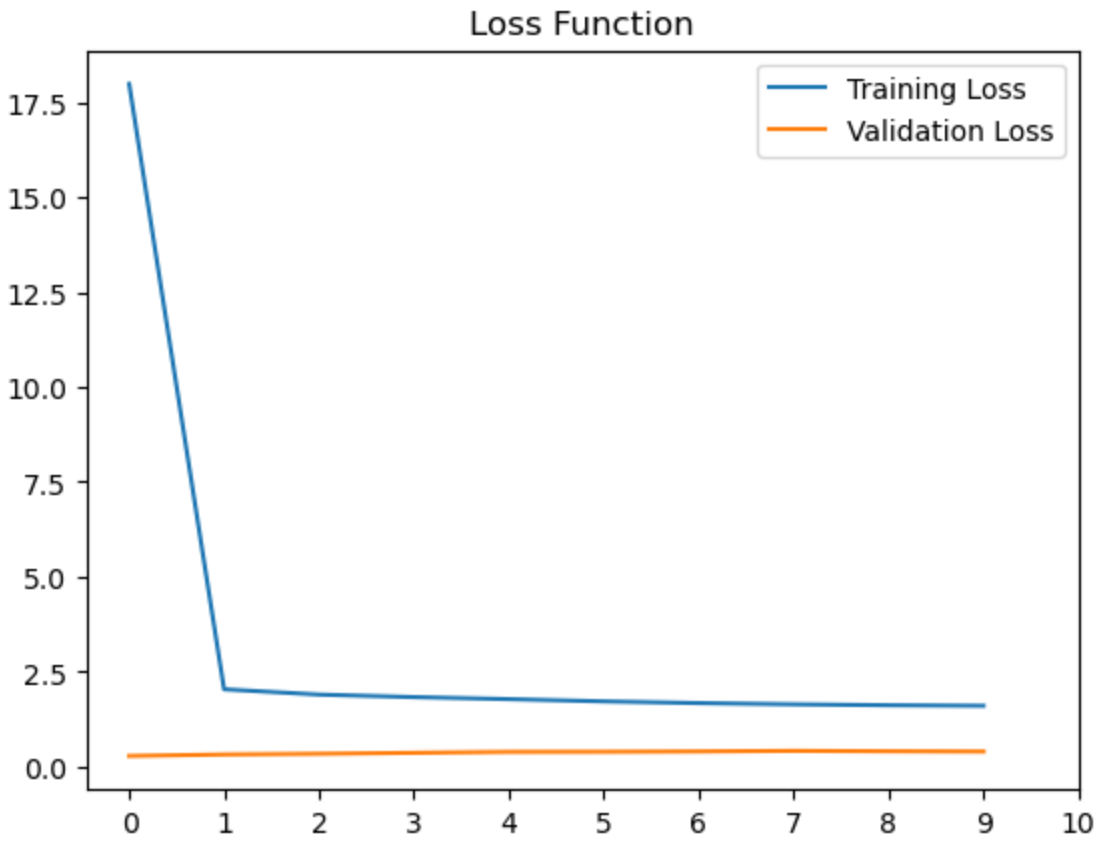
```
(50000, 32, 32, 3)
50000
(50000, 3072)
[[ 59  62  63 ... 123  92  72]
 [154 177 187 ... 143 133 144]
 [255 255 255 ...  80  86  84]
 ...
 [ 35 178 235 ...  12  31  50]
 [189 211 240 ... 195 190 171]
 [229 229 239 ... 163 163 161]]
```

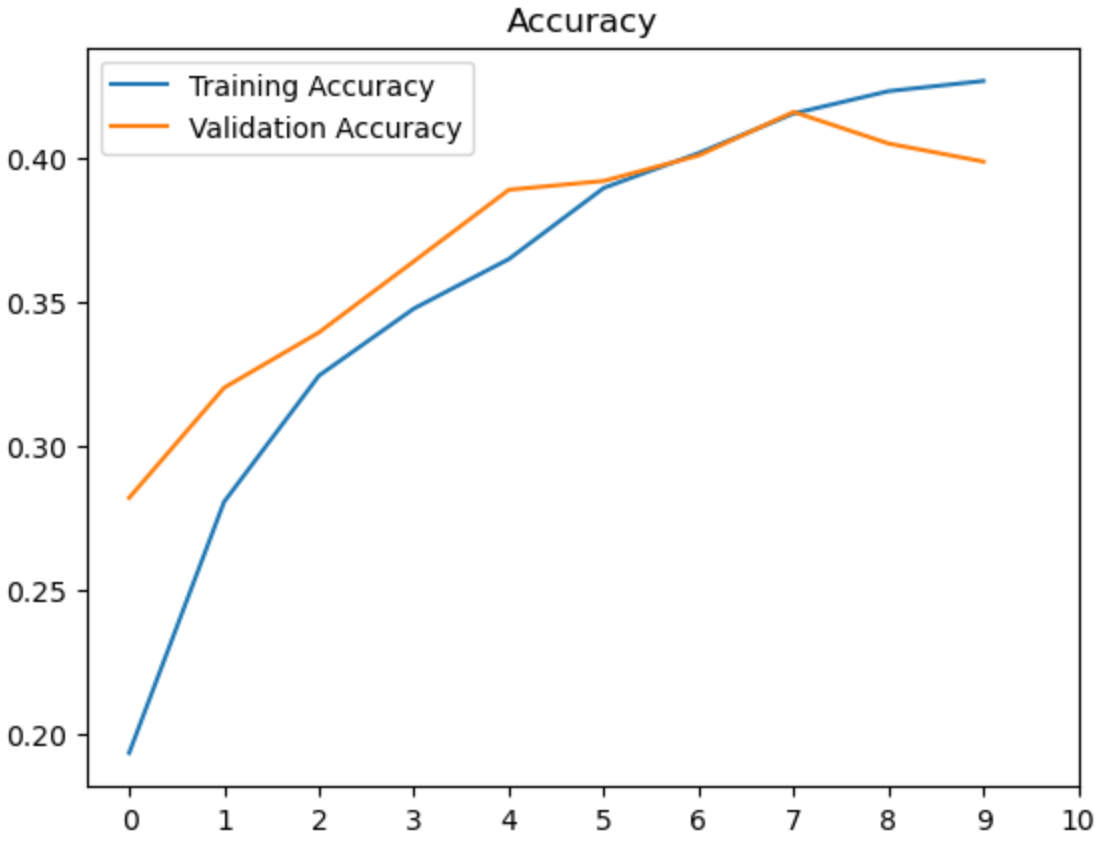
In [ ]:
```
def create_nn(n_layers, learn_rate):
    """ This function will be the function used for tuning the number of layers as

    Args:
        n_layers (_type_): _description_

    Returns:
        _type_: _description_
    """
    model = Sequential()
    model.add(Input(shape=(3072,)))
    for n in range(n_layers):
```

```
        model.add(Dense(2**(n_layers - n + 4), activation="relu")) #adds layers wit
                                                #with number of neurons in higher pow
                                                #the smallest layer has 2^5 or 32 neu

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

    optimizer = Adam(learning_rate=learn_rate)
    model.compile(optimizer=optimizer,
                  loss='categorical_crossentropy',
                  metrics=['accuracy'])
    model.summary()
    return model
```

In [ ]:
```
n_layers = [4, 5, 6]
learn_rates = [0.001, 0.0005]

accuracy = 0
opt_n = 0
opt_rate = 0
for n in n_layers:
    for rate in learn_rates:
        model = create_nn(n, rate)
        fit = model.fit(x_train, y_train, epochs=10,
                  batch_size=100, validation_split=0.3)
        if fit.history['accuracy'][-1] > accuracy:
            accuracy = fit.history['accuracy'][-1]
            opt_n = n
            opt_rate = rate
            opt_model = copy.deepcopy(model)
            opt_fit = copy.deepcopy(fit)

        del model
        del fit
```

In [ ]:
```
plt.figure()

plt.plot(opt_fit.history['loss'], label = "Training Loss")
plt.plot(opt_fit.history['val_accuracy'],label = "Validation Loss")
plt.legend()
plt.xticks(range(11))
plt.title("Loss Function")

plt.show()


plt.figure()

plt.plot(opt_fit.history['accuracy'], label = "Training Accuracy")
plt.plot(opt_fit.history['val_accuracy'],label = "Validation Accuracy")
plt.legend()
plt.xticks(range(11))
plt.title("Accuracy")

plt.show()
```





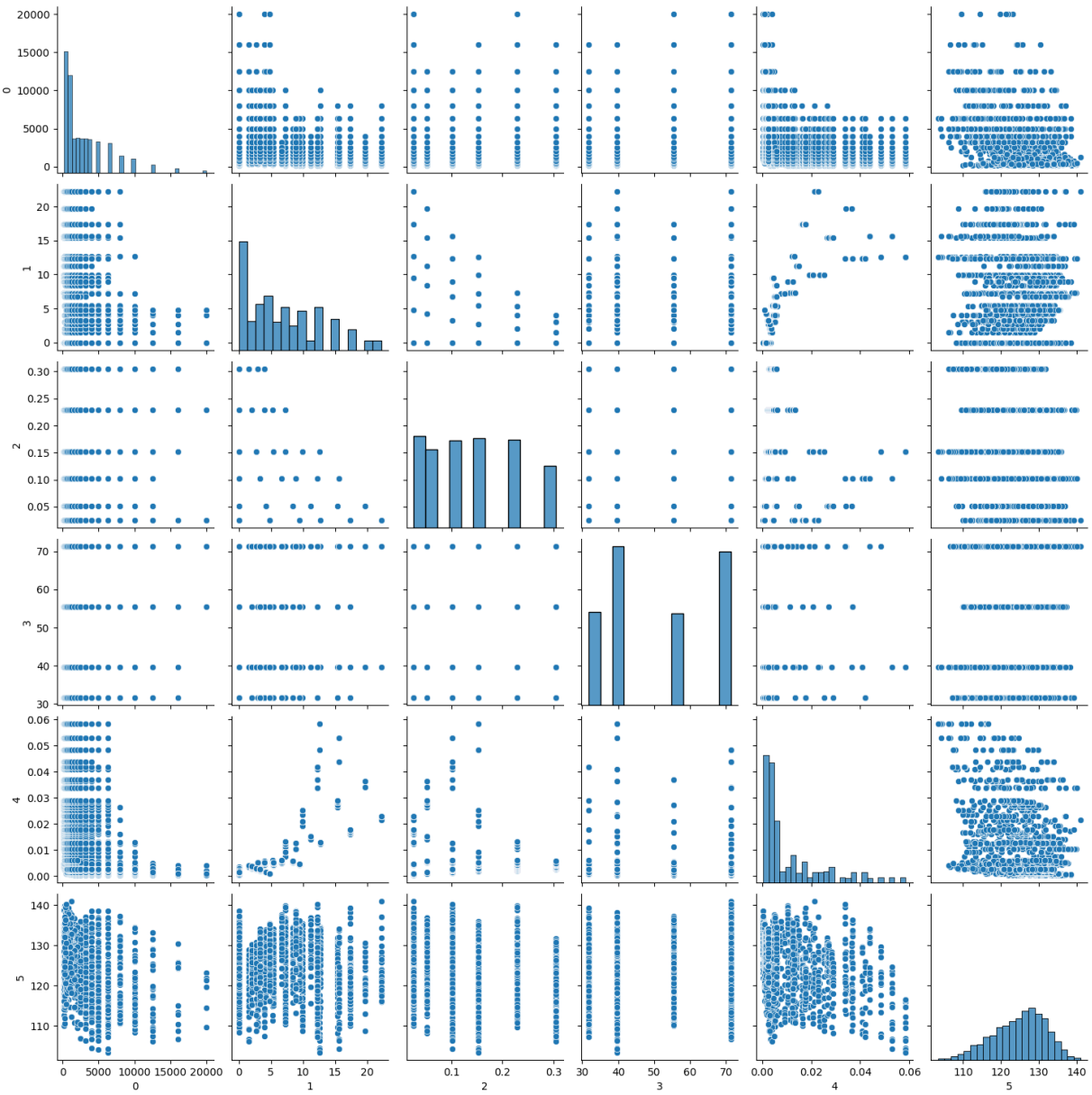
Question 2

In [ ]:

In [ ]:
```
from IPython.display import display
import numpy as np
import pandas as pd
import seaborn as sns
from sklearn.model_selection import train_test_split
from tensorflow.keras.layers import Rescaling
from tensorflow.keras.regularizers import L2
from sklearn.preprocessing import MinMaxScaler
```

In [ ]:
```
df = pd.read_csv('airfoil_self_noise.dat', sep="\t",header=None )
sns.pairplot(df)
```

Out[ ]: <seaborn.axisgrid.PairGrid at 0x1a58e804f40>



In [ ]:
```
# Data Preparation
df = pd.read_csv('airfoil_self_noise.dat', sep="\t",header=None )
display(df)

y = df.iloc[:, -1]
```

```
y = np.asmatrix(y)
y = y.T
print(y.shape)

minmax = MinMaxScaler()
X = df.iloc[:, :-1]
X = np.asarray(X)
X = minmax.fit_transform(X)
print(X)
print(X.shape)
```

	0	1	2	3	4	5
0	800	0.0	0.3048	71.3	0.002663	126.201
1	1000	0.0	0.3048	71.3	0.002663	125.201
2	1250	0.0	0.3048	71.3	0.002663	125.951
3	1600	0.0	0.3048	71.3	0.002663	127.591
4	2000	0.0	0.3048	71.3	0.002663	127.461
...	...	...	...	...	...	...
1498	2500	15.6	0.1016	39.6	0.052849	110.264
1499	3150	15.6	0.1016	39.6	0.052849	109.254
1500	4000	15.6	0.1016	39.6	0.052849	106.604
1501	5000	15.6	0.1016	39.6	0.052849	106.224
1502	6300	15.6	0.1016	39.6	0.052849	104.204

1503 rows × 6 columns

```
(1503, 1)
[[0.03030303 0.         1.         1.         0.03900472]
 [0.04040404 0.         1.         1.         0.03900472]
 [0.0530303  0.         1.         1.         0.03900472]
 ...
 [0.19191919 0.7027027  0.27272727 0.19949495 0.90411066]
 [0.24242424 0.7027027  0.27272727 0.19949495 0.90411066]
 [0.30808081 0.7027027  0.27272727 0.19949495 0.90411066]]
(1503, 5)
```

In [ ]:
```
model = Sequential()
model.add(Input(shape=(5,)))
model.add(Dense(14, activation="linear"))
model.add(Dense(1, activation="elu"))
# Add output layer
model.add(Dense(1, activation="linear"))

optimizer = Adam(learning_rate=0.01)
model.compile(optimizer=optimizer,
              loss='mean_squared_error',
```

```
                  metrics=[keras.metrics.R2Score()])
model.summary()
```

```
Model: "sequential_48"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_222 (Dense)           (None, 14)                84

 dense_223 (Dense)           (None, 1)                 15

 dense_224 (Dense)           (None, 1)                 2

_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense_222 (Dense)           (None, 14)                84

 dense_223 (Dense)           (None, 1)                 15

 dense_224 (Dense)           (None, 1)                 2

=================================================================
Total params: 101 (404.00 Byte)
Trainable params: 101 (404.00 Byte)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

In [ ]:
```
fit = model.fit(X, y, epochs=1500,
                    batch_size=1000, validation_split=0.3)
```

In [ ]:
```
print("train R2 Score: ", fit.history['r2_score'][-1])
print("test R2 Score: ", fit.history['val_r2_score'][-1])
```

```
train R2 Score:  0.5566079616546631
test R2 Score:  0.4110473394393921
```