HW5

Bruno Morgado
RIN: 661995422

Question 1: Convolutional Neural Network

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, Conv2D, MaxPooling2D, Flatten
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
```

Splitting data

In [ ]:

```
(x_train, y_train), (x_test, y_test) = cifar10.load_data()

print("x shape:",x_train.shape)

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

```
x shape: (50000, 32, 32, 3)
```

Setting up model

In [ ]:

```
# CNN model
model = Sequential()
model.add(Conv2D(filters=64, kernel_size=(5, 5), activation='relu', input_shape=(32
model.add(MaxPooling2D(pool_size=(2, 2),  strides=(2,2)))
model.add(Conv2D(filters=32, kernel_size=(3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2),  strides=(2,2)))
model.add(Conv2D(filters=32, kernel_size=(3, 3), activation='relu'))
model.add(Flatten())
model.add(Dense(64, activation='relu'))
model.add(Dense(10, activation='softmax'))

# Compile model
model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

# Print model summary
model.summary()
```

```
WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\si
te-packages\keras\src\backend.py:873: The name tf.get_default_graph is deprecated. P
lease use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\si
te-packages\keras\src\layers\pooling\max_pooling2d.py:161: The name tf.nn.max_pool i
s deprecated. Please use tf.nn.max_pool2d instead.

WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\si
te-packages\keras\src\optimizers\__init__.py:309: The name tf.train.Optimizer is dep
recated. Please use tf.compat.v1.train.Optimizer instead.

Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #   
=================================================================
 conv2d (Conv2D)             (None, 28, 28, 64)        4864      
                                                                 
 max_pooling2d (MaxPooling2  (None, 14, 14, 64)        0         
 D)                                                              
                                                                 
 conv2d_1 (Conv2D)           (None, 12, 12, 32)        18464     
                                                                 
 max_pooling2d_1 (MaxPoolin  (None, 6, 6, 32)          0         
 g2D)                                                            
                                                                 
 conv2d_2 (Conv2D)           (None, 4, 4, 32)          9248      
                                                                 
 flatten (Flatten)           (None, 512)               0         
                                                                 
 dense (Dense)               (None, 64)                32832     
                                                                 
 dense_1 (Dense)             (None, 10)                650       
                                                                 
=================================================================
Total params: 66058 (258.04 KB)
Trainable params: 66058 (258.04 KB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
```

Training Model and plotting results

In [ ]:

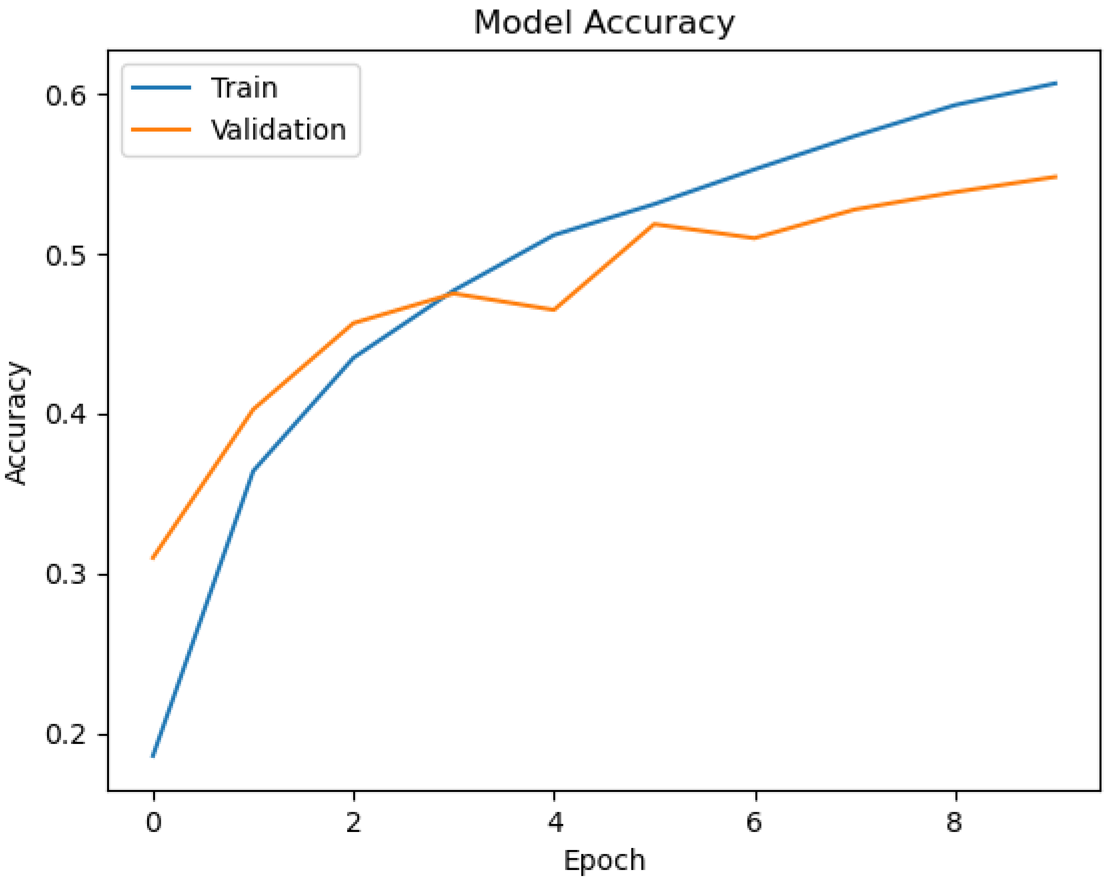
```
# Train model
history = model.fit(x_train, y_train, epochs=10, batch_size=64, validation_split=0.

plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(['Train', 'Validation'], loc='upper left')
plt.show()
```

```
Epoch 1/10
WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\si
te-packages\keras\src\utils\tf_utils.py:492: The name tf.ragged.RaggedTensorValue is
deprecated. Please use tf.compat.v1.ragged.RaggedTensorValue instead.

WARNING:tensorflow:From c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\si
te-packages\keras\src\engine\base_layer_utils.py:384: The name tf.executing_eagerly_
outside_functions is deprecated. Please use tf.compat.v1.executing_eagerly_outside_f
unctions instead.

547/547 [==============================] - 15s 24ms/step - loss: 2.2902 - accuracy:
0.1858 - val_loss: 1.8536 - val_accuracy: 0.3097
Epoch 2/10
547/547 [==============================] - 14s 25ms/step - loss: 1.7229 - accuracy:
0.3639 - val_loss: 1.6206 - val_accuracy: 0.4024
Epoch 3/10
547/547 [==============================] - 13s 24ms/step - loss: 1.5468 - accuracy:
0.4347 - val_loss: 1.4976 - val_accuracy: 0.4564
Epoch 4/10
547/547 [==============================] - 12s 23ms/step - loss: 1.4419 - accuracy:
0.4768 - val_loss: 1.4570 - val_accuracy: 0.4749
Epoch 5/10
547/547 [==============================] - 12s 22ms/step - loss: 1.3588 - accuracy:
0.5115 - val_loss: 1.5013 - val_accuracy: 0.4647
Epoch 6/10
547/547 [==============================] - 12s 23ms/step - loss: 1.3008 - accuracy:
0.5308 - val_loss: 1.3507 - val_accuracy: 0.5183
Epoch 7/10
547/547 [==============================] - 13s 23ms/step - loss: 1.2472 - accuracy:
0.5525 - val_loss: 1.4098 - val_accuracy: 0.5095
Epoch 8/10
547/547 [==============================] - 12s 22ms/step - loss: 1.1977 - accuracy:
0.5734 - val_loss: 1.3330 - val_accuracy: 0.5275
Epoch 9/10
547/547 [==============================] - 14s 25ms/step - loss: 1.1483 - accuracy:
0.5928 - val_loss: 1.3104 - val_accuracy: 0.5383
Epoch 10/10
547/547 [==============================] - 12s 21ms/step - loss: 1.1000 - accuracy:
0.6063 - val_loss: 1.3377 - val_accuracy: 0.5479
```



Question 2 SVM:

Importing and wrangling data

In [ ]:

```
from sklearn.datasets import load_breast_cancer
data = load_breast_cancer()
print(data['data'])
print(data['target'])

desired_features = ['worst area', 'worst compactness', 'worst concavity']
desired_feature_indeces = []
for feature in desired_features:
   bool = data['feature_names']==feature

   desired_feature_indeces.append([i for i, val in enumerate(bool) if val][0])

print(desired_feature_indeces)

X = np.array(data['data'][:,desired_feature_indeces])

print(X.shape)

y = np.array(data['target'])
print(y.shape)
```

```
[[1.799e+01 1.038e+01 1.228e+02 ... 2.654e-01 4.601e-01 1.189e-01]
 [2.057e+01 1.777e+01 1.329e+02 ... 1.860e-01 2.750e-01 8.902e-02]
 [1.969e+01 2.125e+01 1.300e+02 ... 2.430e-01 3.613e-01 8.758e-02]
 ...
 [1.660e+01 2.808e+01 1.083e+02 ... 1.418e-01 2.218e-01 7.820e-02]
 [2.060e+01 2.933e+01 1.401e+02 ... 2.650e-01 4.087e-01 1.240e-01]
 [7.760e+00 2.454e+01 4.792e+01 ... 0.000e+00 2.871e-01 7.039e-02]]
[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
 1 0 0 0 0 0 0 0 0 1 0 1 1 1 1 1 0 0 1 0 0 1 1 1 1 0 1 0 0 1 1 1 1 0 1 0 0
 1 0 1 0 0 1 1 1 0 0 1 0 0 0 1 1 1 0 1 1 0 0 1 1 1 0 0 1 1 1 1 0 1 1 0 1 1
 1 1 1 1 1 1 0 0 0 1 0 0 1 1 1 0 0 1 0 1 0 0 1 0 0 1 1 0 1 1 0 1 1 1 1 0 1
 1 1 1 1 1 1 1 1 0 1 1 1 1 0 0 1 0 1 1 0 0 1 1 0 0 1 1 1 1 0 1 1 0 0 0 1 0
 1 0 1 1 1 0 1 1 0 0 1 0 0 0 0 1 0 0 0 1 0 1 0 1 1 0 1 0 0 0 0 1 1 0 0 1 1
 1 0 1 1 1 1 1 0 0 1 1 0 1 1 0 0 1 0 1 1 1 1 0 1 1 1 1 1 0 1 0 0 0 0 0 0 0
 0 0 0 0 0 0 0 1 1 1 1 1 1 0 1 0 1 1 0 1 1 0 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1
 1 0 1 1 0 1 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0 1 1 1 0 1 0 1 1 1 1 0 0 0 1 1
 1 1 0 1 0 1 0 1 1 1 0 1 1 1 1 1 1 1 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0 0 1 0 0
 0 1 0 0 1 1 1 1 1 0 1 1 1 1 1 0 1 1 1 0 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 1 1
 1 0 1 1 1 1 1 0 1 1 0 1 1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 0 1 1 1 1 1 1 0 1 1
 0 1 0 1 1 0 1 0 1 1 1 1 1 1 1 1 0 0 1 1 1 1 1 1 0 1 1 1 1 1 1 1 1 1 1 0 1
 1 1 1 1 1 1 0 1 0 1 1 0 1 1 1 1 1 0 0 1 0 1 0 1 1 1 1 1 0 1 1 0 1 0 1 0 0
 1 1 1 0 1 1 1 1 1 1 1 1 1 1 1 0 1 0 0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 1 1 1 1 1 1 1 0 0 0 0 0 0 1]
[23, 25, 26]
(569, 3)
(569,)
```

Splitting data

```
In [ ]: from sklearn.model_selection import train_test_split

        X_train, X_test, y_train, y_test=train_test_split(
            X,y,
            test_size=0.30,
            train_size=0.70,
            random_state=420,
            shuffle=True,
            stratify=y)
```

```
accuracy score : 0.8830409356725146
```

Linear model

```
In [ ]: #Importing the SVM
        from sklearn.pipeline import Pipeline
        from sklearn.preprocessing import StandardScaler
        from sklearn.svm import LinearSVC
        from sklearn import svm

        #Training SVM
        svm_clf = Pipeline([ ("scaler", StandardScaler()),
                ("linear_svc", LinearSVC(C=1, loss="hinge"))])
        svm_clf.fit(X_train, y_train)

        #Extracting data from prodicted
        preds = svm_clf.predict(X_test)
```

```
#Evaluate
from sklearn.metrics import accuracy_score
acc = accuracy_score(y_test,preds)
print('accuracy score :', acc)
```

```
accuracy score : 0.9473684210526315
```

```
c:\Users\MorgadoBruno\AppData\Local\anaconda3\envs\ML\lib\site-packages\sklearn\svm
\_classes.py:32: FutureWarning: The default value of `dual` will change from `True`
to `'auto'` in 1.5. Set the value of `dual` explicitly to suppress the warning.
  warnings.warn(
```

Radial model

In [ ]:

```
from sklearn.svm import SVC
#Training SVM
svm_clf_radial = Pipeline([ ("scaler", StandardScaler()),
        ('svc', SVC(C=2, kernel='rbf'))])
svm_clf_radial.fit(X_train, y_train)

#Extracting data from prodicted
preds = svm_clf_radial.predict(X_test)

#Evaluate
from sklearn.metrics import accuracy_score
acc = accuracy_score(y_test,preds)
print('accuracy score :', acc)
```

```
accuracy score : 0.935672514619883
```

The linear model has a slightly higher accuracy score given these hyper parameters.