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H041

AI LAB 7

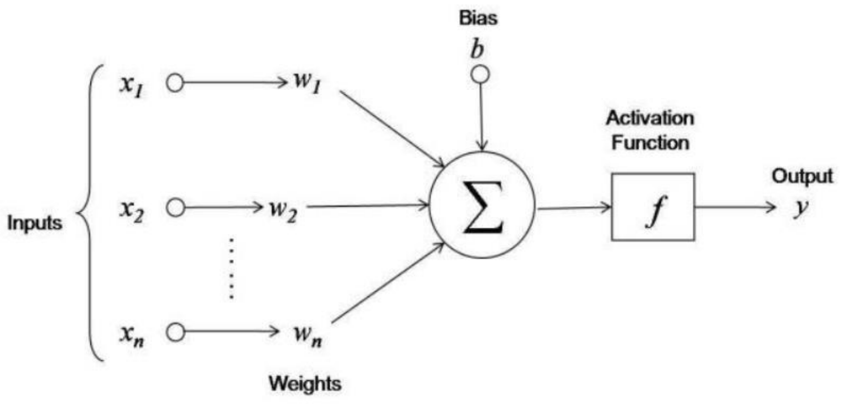
AIM: To study and implement Neural Network

a) Creating Multi neural network with Python

Module used: Tensorflow (Python)

Theory:

The first layer in a neural network is always the input layer where the data is fed. This data is later convoluted or spooled before reaching the final layer of output. The intermediate layers are known as hidden layers which is responsible for the efficiency of the model. Almost every layer has a +1 element which is responsible for reducing the bias.

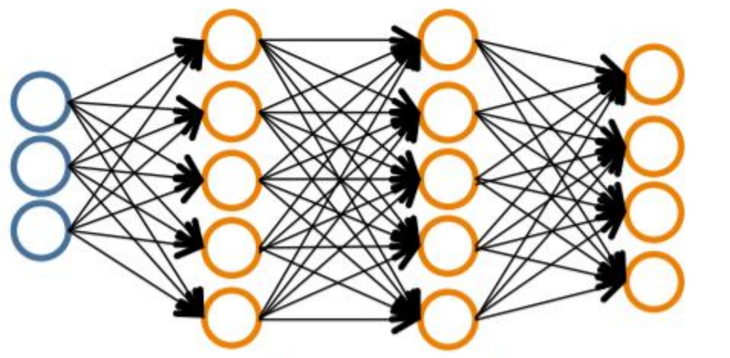


This flow chart shows the basic functioning of a neuron cell.

The neurons then apply an activation function like Sigmoid or ReLu. In a sigmoid activation function, the whole cost function calculated value between 0 and 1. This keeps on repeating in every hidden layer until it reaches the output layer.

The neuron keeps on learning with every iteration and we can’t get the best output on the first try itself. Forward propagation keeps on teaching the neuron the relationship between the dataset while back propagation is used to modify the weights which in turn helps in reducing the loss generated. Learning rate is a parameter that can be tweaked to control the rate at which the network learns. It cannot be too small or too large.

A multi-layer perceptron (MLP) has the same structure of a single layer perceptron with one or more hidden layers. These Neural networks contains an arbitrary number of neurons for each layer, that receives the inputs and elaborate them. Here the, hidden layers are equipped with ReLU activator. Finally, a sigmoid activator to the Output layer, so we squeeze each perceptron's output between 0 and 1.



The above given neural network is a Multi-layer Neural Network with two hidden layers.

General mathematic expressions used:

1. Cost function:

Neural network:

$$h_\Theta(x) \in \mathbb{R}^K \quad (h_\Theta(x))_i = i^{th} \text{ output}$$

$$J(\Theta) = -\frac{1}{m}\left[\sum_{i=1}^{m}\sum_{k=1}^{K} y_k^{(i)} \log(h_\Theta(x^{(i)}))_k + (1-y_k^{(i)})\log(1-(h_\Theta(x^{(i)}))_k)\right] + \frac{\lambda}{2m}\sum_{l=1}^{L-1}\sum_{i=1}^{s_l}\sum_{j=1}^{s_{l+1}}(\Theta_{ji}^{(l)})^2$$

where,

$$\{(x^{(1)},y^{(1)}),(x^{(2)},y^{(2)}),\ldots,(x^{(m)},y^{(m)})\}$$

$L =$ total no. of layers in network

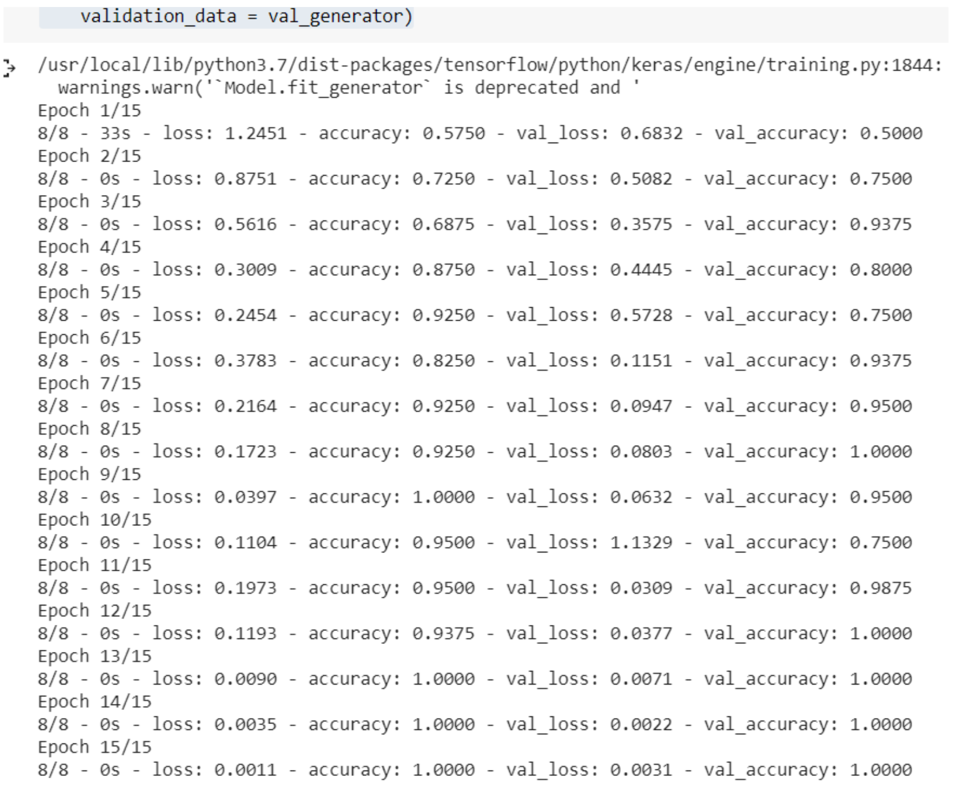
$s_l =$ no. of units (not counting bias unit) in layer l

Code:

```
import tensorflow as tf
import os
import zipfile

DESIRED_ACCURACY = 0.999

!wget --no-check-certificate \
    "https://storage.googleapis.com/laurencemoroney-
blog.appspot.com/happy-or-sad.zip" \
    -O "/tmp/happy-or-sad.zip"
```

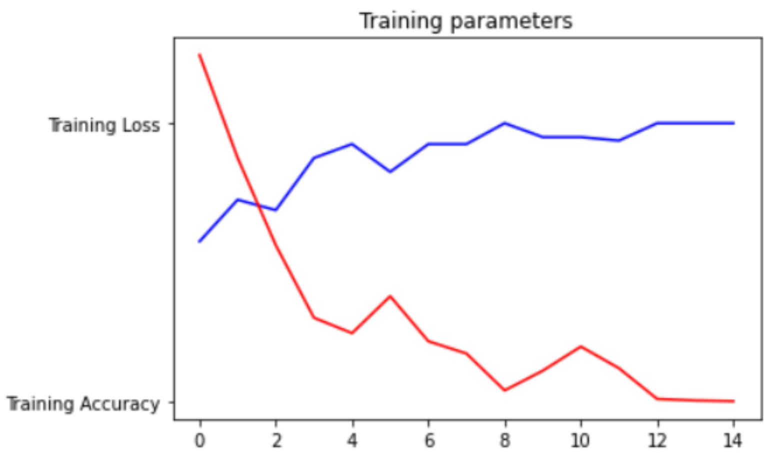
```
zip_ref = zipfile.ZipFile("/tmp/happy-or-sad.zip", 'r')
zip_ref.extractall("/tmp/h-or-s")
zip_ref.extractall("/tmp/h-or-s_test")
zip_ref.close()

class myCallback(tf.keras.callbacks.Callback):
        def on_epoch_end(self, epoch, logs={}):
            if(logs.get('acc') is not None and logs.get('acc')>DESIRED_
ACCURACY):
                print("\nReached 99.9% accuracy so cancelling training!
")
                self.model.stop_training = True

callbacks = myCallback()


model = tf.keras.models.Sequential([
        tf.keras.layers.Conv2D(16, (3,3), activation='relu', input_shap
e=(150, 150, 3)),
        tf.keras.layers.MaxPooling2D(2, 2),

        tf.keras.layers.Conv2D(32, (3,3), activation='relu'),
        tf.keras.layers.MaxPooling2D(2,2),

        tf.keras.layers.Conv2D(64, (3,3), activation='relu'),
        tf.keras.layers.MaxPooling2D(2,2),

        tf.keras.layers.Flatten(),
        tf.keras.layers.Dense(512, activation='relu'),
        tf.keras.layers.Dense(512, activation='relu'),
        tf.keras.layers.Dense(1, activation='sigmoid')
    ])

from tensorflow.keras.optimizers import RMSprop

model.compile(loss='binary_crossentropy',
              optimizer=RMSprop(lr=0.001),
              metrics=['accuracy'])


from tensorflow.keras.preprocessing.image import ImageDataGenerator

train_datagen = ImageDataGenerator(rescale=1/255)

train_generator = train_datagen.flow_from_directory(
            '/tmp/h-or-s',
            target_size=(150, 150),
            batch_size=10,
            class_mode='binary')

validation_datagen = ImageDataGenerator(rescale=1/255)

val_generator = validation_datagen.flow_from_directory(
            '/tmp/h-or-s_test',
            target_size=(150, 150),
            batch_size=10,
            class_mode='binary')


history = model.fit_generator(
    train_generator,
    steps_per_epoch = 8,
    epochs = 15,
    verbose = 2,
    validation_data = val_generator)


%matplotlib inline
import matplotlib.image as mpimg
import matplotlib.pyplot as plt

acc = history.history['accuracy']
loss = history.history['loss']
val_acc = history.history['val_accuracy']
val_loss = history.history['val_loss']

epochs = range(len(acc))

plt.plot(epochs, acc, 'b', "Training Accuracy")
plt.plot(epochs, loss, 'r', "Training Loss")
plt.title('Training parameters')
plt.figure()

plt.plot(epochs, val_acc, 'b', "Validation Accuracy")
plt.plot(epochs, val_loss, 'r', "Validation Loss")
plt.title('Validation parameters')
plt.figure()


model.summary()
```

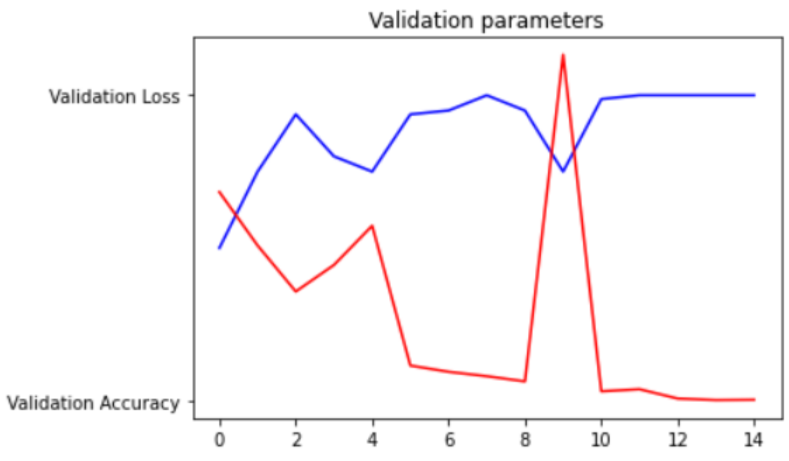
Output (Screenshots):

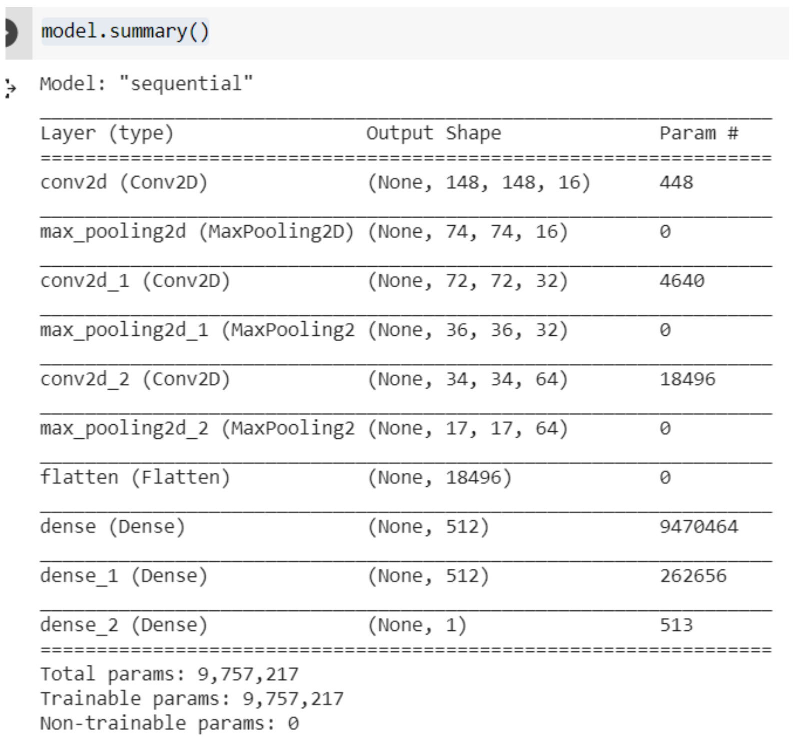


```
    validation_data = val_generator)
```

```
/usr/local/lib/python3.7/dist-packages/tensorflow/python/keras/engine/training.py:1844:
  warnings.warn('`Model.fit_generator` is deprecated and '
Epoch 1/15
8/8 - 33s - loss: 1.2451 - accuracy: 0.5750 - val_loss: 0.6832 - val_accuracy: 0.5000
Epoch 2/15
8/8 - 0s - loss: 0.8751 - accuracy: 0.7250 - val_loss: 0.5082 - val_accuracy: 0.7500
Epoch 3/15
8/8 - 0s - loss: 0.5616 - accuracy: 0.6875 - val_loss: 0.3575 - val_accuracy: 0.9375
Epoch 4/15
8/8 - 0s - loss: 0.3009 - accuracy: 0.8750 - val_loss: 0.4445 - val_accuracy: 0.8000
Epoch 5/15
8/8 - 0s - loss: 0.2454 - accuracy: 0.9250 - val_loss: 0.5728 - val_accuracy: 0.7500
Epoch 6/15
8/8 - 0s - loss: 0.3783 - accuracy: 0.8250 - val_loss: 0.1151 - val_accuracy: 0.9375
Epoch 7/15
8/8 - 0s - loss: 0.2164 - accuracy: 0.9250 - val_loss: 0.0947 - val_accuracy: 0.9500
Epoch 8/15
8/8 - 0s - loss: 0.1723 - accuracy: 0.9250 - val_loss: 0.0803 - val_accuracy: 1.0000
Epoch 9/15
8/8 - 0s - loss: 0.0397 - accuracy: 1.0000 - val_loss: 0.0632 - val_accuracy: 0.9500
Epoch 10/15
8/8 - 0s - loss: 0.1104 - accuracy: 0.9500 - val_loss: 1.1329 - val_accuracy: 0.7500
Epoch 11/15
8/8 - 0s - loss: 0.1973 - accuracy: 0.9500 - val_loss: 0.0309 - val_accuracy: 0.9875
Epoch 12/15
8/8 - 0s - loss: 0.1193 - accuracy: 0.9375 - val_loss: 0.0377 - val_accuracy: 1.0000
Epoch 13/15
8/8 - 0s - loss: 0.0090 - accuracy: 1.0000 - val_loss: 0.0071 - val_accuracy: 1.0000
Epoch 14/15
8/8 - 0s - loss: 0.0035 - accuracy: 1.0000 - val_loss: 0.0022 - val_accuracy: 1.0000
Epoch 15/15
8/8 - 0s - loss: 0.0011 - accuracy: 1.0000 - val_loss: 0.0031 - val_accuracy: 1.0000
```







```
model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d (Conv2D)              (None, 148, 148, 16)      448
_________________________________________________________________
max_pooling2d (MaxPooling2D) (None, 74, 74, 16)        0
_________________________________________________________________
conv2d_1 (Conv2D)            (None, 72, 72, 32)        4640
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 36, 36, 32)        0
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 34, 34, 64)        18496
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 17, 17, 64)        0
_________________________________________________________________
flatten (Flatten)            (None, 18496)             0
_________________________________________________________________
dense (Dense)                (None, 512)               9470464
_________________________________________________________________
dense_1 (Dense)              (None, 512)               262656
_________________________________________________________________
dense_2 (Dense)              (None, 1)                 513
=================================================================
Total params: 9,757,217
Trainable params: 9,757,217
Non-trainable params: 0
```

Conclusion: In this experiment, we have successfully created a neural network using the Tensorflow module. The dataset opted is a small chunk of a huge one thus, issues of overfitting are prominent. The Neural Network used here consists of 1 input layer, 2 hidden layers and 1 output layer and hence a multi layer neural network. The optimizer responsible for the backpropagation algorithm is the binary_crossentropy (due to classification of two categories) which has a learning rate set to 0.001. Finally, we trained the neural network and plotted its Accuracy-Loss Curves.

Reference Link:

- https://learnai1.home.blog/2019/12/18/multi-layer-neural-networks-python-implementation/\
- https://www.kaggle.com/androbomb/simple-nn-with-python-multi-layer-perceptron
- https://www.allaboutcircuits.com/technical-articles/how-to-create-a-multilayer-perceptron-neural-network-in-python/
- Machine Learning by Andrew Ng