CLOUD AND DISTRIBUTED SYSTEMS

Journal

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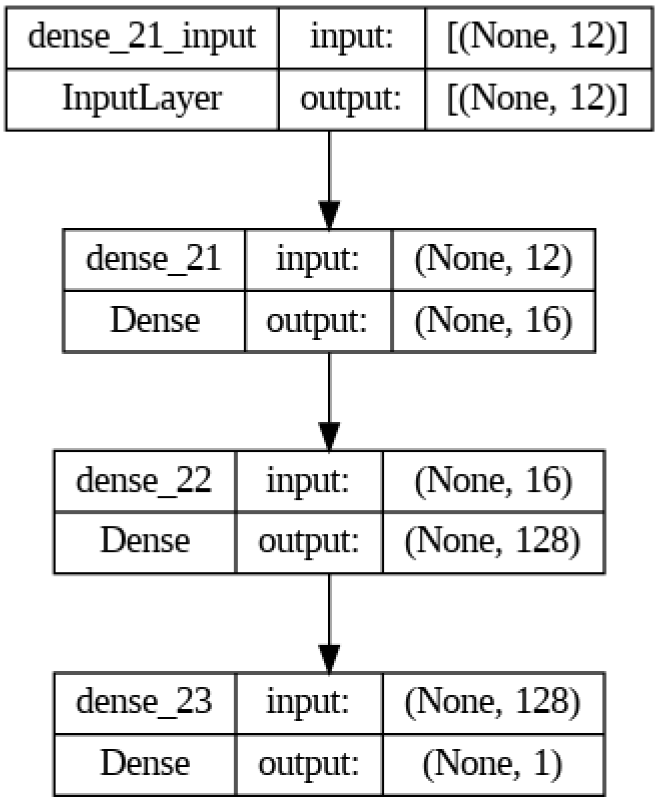


Task 1

Aim:

To test for the best quality wine in a competition through a classification model. The classification model will be used to identify and state if the wine would be successful or likely to win in the competition. This will be done one input category that will be classified based on the average of the scored. This will then be display through a GUI or a visualisation graph.

Data Overview:

The assumed data that is being provided is 14872 pieces of data which is segregated into 13 columns. Each wine entry in this dataset will be given a binary classification. If the wine meets the standards, a 'good quality wine' (score = average +) will classify the win. Otherwise, any wine that does not fit this standard will be registered as a 'bad quality wine' (score = 0), a 'decent quality wine will be ranked as having a score of 1.

Model Initialisation:

The initialisation of the model will be conducted by linking the dataset to the Google Colab file, this means that the Google Drive must be mounted (to establish a connection) then the file must be taken from it.

The splitting of the data was conducted through the '.drop' function. The split data would be all data split into two (train and test) but for only the columns that contained data that was relevant to the model (excluding: ID, yet through this section I faced problem regarding the setup. The first section when I dropped a column, I used the code structure (' X = wine_dataset.drop('fixed acidity')') as a result, I presumed that to drop more columns, more commas would be added with inverted text, yet this was false and lead to compiler issues. This led me to look at official documentation that stated that for more than one, listed item, the use of square brackets with circular brackets was required. From this information, I changed the code to look like this ('wine_dataset.drop(['fixed acidity', 'citric acid', 'chlorides', 'free sulphur dioxide', 'total sulphur dioxide', 'density', 'Id', 'pH', 'sulphates', 'quality'], axis = 1)'). The data was then printed. Although all of this later changed and removed.

After the binary classification of the data, I chose to drop two only columns that I didn't require such as "Id", "test_good_wine" (a column which I had created for binary classification but was incorrect). Alongside this I deicide to split my training data by 0.4 with a random_state of 47. But later on, this changed (reported upon below) due to an issue with overfitting.

Data cleaning for model dataset:

This section was to check if there were any null values within the dataset. To check this countless test were conducted to ensure this including checking correlated data and null values. This showed to have a negative result, meaning different techniques to remove dirty data was not required. Through this process, I struggled with the correct way to implement the heatmap, due to the inclusion of two graphing libraries. This caused the figure size of the heatmap to differ on every run.

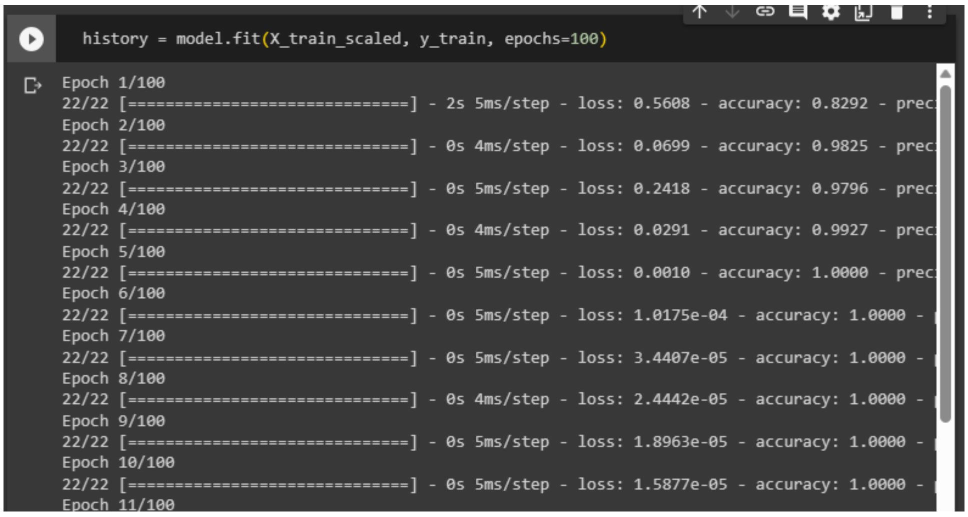
Model Binary Classification

This section was focused on creating an output column that showed all the output against the input column. To initiate this, the data was first checked to see the range of quality in the wines. This showed to have a range of 3-8, this therefore meant that to differentiate between a good quality wine and a bad quality wine 5 would be the average. With this information, two different methods were used to classify the data into binary format. The first format used the pd.qcut function but yet this failed to register in in the database as binary, as a result the second format that was formed was using an if statement to check if the quality was higher or lower than 5, then register the column as 1 or 0. This second turned out to be successful, through a value count check. Here the expected result was a relatively even differentiation between both positive and negative values, which occurred.

Model fitting:

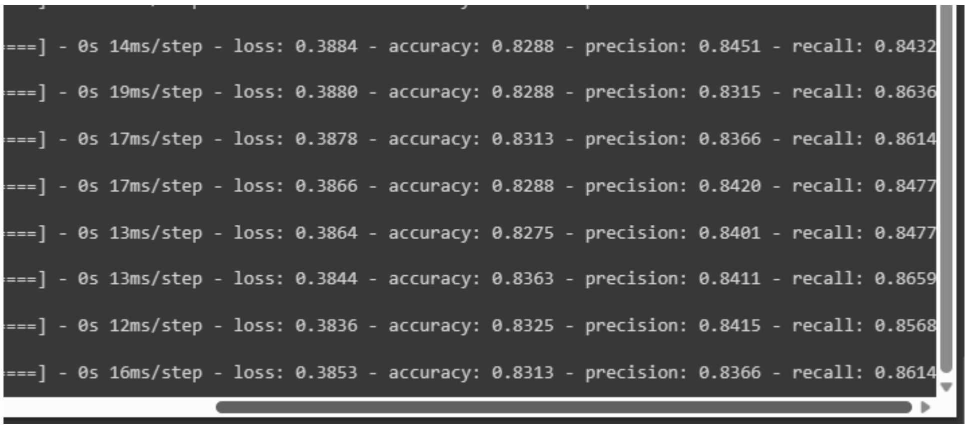
For the initialisation before the fitting of the model, 3 different deep learning layers were used. Initially, 2 deep learning layers were used, but after iteratively training, I decided to add another layer to make it stronger. These were an output layer, and 2 others. The output layer had a sigmoid activation function.

For the fitting of the model, overfitting occurred several times, leading to the normalisation section being edited several times. Through the image seen below, the initial accuracy was 100%, which is incredibly unlikely after the first couple epochs



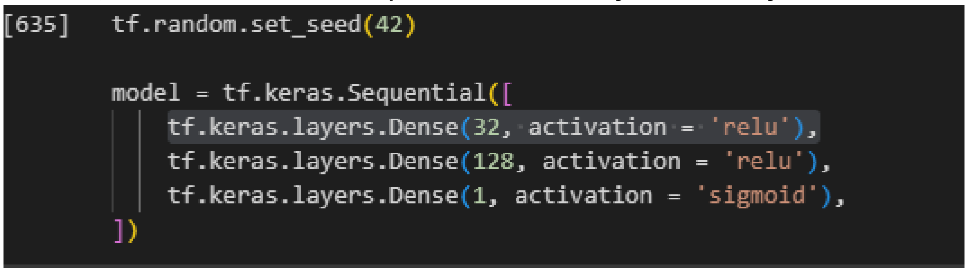
```
history = model.fit(X_train_scaled, y_train, epochs=100)

Epoch 1/100
22/22 [==============================] - 2s 5ms/step - loss: 0.5608 - accuracy: 0.8292 - prec
Epoch 2/100
22/22 [==============================] - 0s 4ms/step - loss: 0.0699 - accuracy: 0.9825 - prec
Epoch 3/100
22/22 [==============================] - 0s 5ms/step - loss: 0.2418 - accuracy: 0.9796 - prec
Epoch 4/100
22/22 [==============================] - 0s 4ms/step - loss: 0.0291 - accuracy: 0.9927 - prec
Epoch 5/100
22/22 [==============================] - 0s 5ms/step - loss: 0.0010 - accuracy: 1.0000 - prec
Epoch 6/100
22/22 [==============================] - 0s 5ms/step - loss: 1.0175e-04 - accuracy: 1.0000 -
Epoch 7/100
22/22 [==============================] - 0s 5ms/step - loss: 3.4407e-05 - accuracy: 1.0000 -
Epoch 8/100
22/22 [==============================] - 0s 4ms/step - loss: 2.4442e-05 - accuracy: 1.0000 -
Epoch 9/100
22/22 [==============================] - 0s 5ms/step - loss: 1.8963e-05 - accuracy: 1.0000 -
Epoch 10/100
22/22 [==============================] - 0s 5ms/step - loss: 1.5877e-05 - accuracy: 1.0000 -
Epoch 11/100
```

This result was not correct. This was due to overfitting in the splitting of the data. Initially I had the train_size variable as 0.4, hence resulting in an extremely high accuracy. To mitigate this issue, I decrease the test size to 0.7, changed the random_state from 47 to 34 and this resulted in a more favourable accuracy of 0.8313.



```
===] - 0s 14ms/step - loss: 0.3884 - accuracy: 0.8288 - precision: 0.8451 - recall: 0.8432
===] - 0s 19ms/step - loss: 0.3880 - accuracy: 0.8288 - precision: 0.8315 - recall: 0.8636
===] - 0s 17ms/step - loss: 0.3878 - accuracy: 0.8313 - precision: 0.8366 - recall: 0.8614
===] - 0s 17ms/step - loss: 0.3866 - accuracy: 0.8288 - precision: 0.8420 - recall: 0.8477
===] - 0s 13ms/step - loss: 0.3864 - accuracy: 0.8275 - precision: 0.8401 - recall: 0.8477
===] - 0s 13ms/step - loss: 0.3844 - accuracy: 0.8363 - precision: 0.8411 - recall: 0.8659
===] - 0s 12ms/step - loss: 0.3836 - accuracy: 0.8325 - precision: 0.8415 - recall: 0.8568
===] - 0s 16ms/step - loss: 0.3853 - accuracy: 0.8313 - precision: 0.8366 - recall: 0.8614
```

With the intention of improving the model whilst also being accurate, I chose to add another layer (third layer) to the model. Through this, I tested several different numbers of neurons. This being 128, resulted in a 100% accuracy, 64, resulted in 98%, 16, resulted in 91 %, which is the one I kept. As a result, my models layers look like this.



```
[635]   tf.random.set_seed(42)

        model = tf.keras.Sequential([
            tf.keras.layers.Dense(32, activation = 'relu'),
            tf.keras.layers.Dense(128, activation = 'relu'),
            tf.keras.layers.Dense(1, activation = 'sigmoid'),
        ])
```

Test for overfitting:

To test for overfitting a class that predicted the scaled data was created. This was then displayed within an array to show the first initial prediction and the accuracy of the model. The first 20 arrays were then displayed in binary format. This was beneficial later o as it helped to reduce the overfitting of 100% to 80% and later the approximate accuracy of 93

Model Evaluation:

Model evaluation was conducted through a confusion matric that showed the correct/false positive/negatives. This showed a relatively low score for false positive and negatives which is what is required. Alongside this, the accuracy, precision and recall of the model during fitting was also portrayed. These helped to portray the integrity of data from the model fitting process.

Evaluating on the model itself:

Through the development of this model, I struggled with developing a model that fit my expectations and was aligned with my current knowledge on neural networks. My goals were extremely high compared to what my knowledge was, therefore leading to a developed yet not extraordinary model. If I had more time, I would have used several models to evaluate the accuracy and iteratively adapt the model to suite the desired outcome of a high and precise accuracy. I also would have liked to use more deep learning layers to boost the accuracy. I think this current model, suites the desired goal of creating a wine dataset that is accurate and uses training and testing to increase the efficiency and accuracy.

Task 2

Aim:

To develop an ASIR (Animal Species image recognition) system that can differentiate and identify images of cats and dogs. The system will learn the distinctive features between both animals and be able to implement this upon any species. This will be developed by the model analysing an inputted image then labelling/predicting the output.

Data Overview:

The assumed data which is provided is that there is a 10, 000-image dataset provided with 80% being training and 20% being used as the test set. For both training and test sets, half are cat images whilst the other half are dogs. For this ASIR system, 200 will be selected and halved for each dataset. The sample size determination methodology for this system will be segregated into physical, resolution and image size to increase the time of the model's analysation process and decrease the risk of eccentric data.

- Physical features: not contain, text, human bodies, extreme close shots (that do not show the full body) or conceal the animal.
- Resolution: 250-500, to test non-blurry images.
- Image size: does not need to be upscaled nor downscaled, to increase time of training and reduce image blurredness.

This will be split into a folder… named with the subfolders of cat and dog images within them.

Network Architecture:

The architecture of the CNN will be a ResNet architecture. The reasoning for this choice is due to 'fast training speed', reduced effect of the 'vanishing gradient' phenomenon and most importantly obtain 'a high accuracy in network performance in Image Classification'[1].

[1] Medium, 2016. “Microsoft Presents: Deep Residual Networks”. Located at: (Microsoft Presents : Deep Residual Networks | by Baki Er | Medium)

This has now been changed to Inception V3 as it is considered more "computationally efficient, both in terms of the numbers of parameter generated by the network and the economic cost (regarding the memory and other resources)"[2] .

Similarly, to ResNet, this architecture is made for image classification. It is designed with 48 layers and can increase training time by using a previously trained network which may or may not contain images that align to what is being trained in an individual's model. Alongside this it also has many different optimisations such as 'Factorisation into Smaller Convolutions', 'Spatial Factorisation into Asymmetric Convolutions', Utility of Auxiliary Classifiers' and 'Efficient Grid Size Reduction'[3]. These help to improve the models training, implementing and testing phases.

This also means that numerous other images are indirectly used due to the model's architecture of implementing different layers to increase the accuracy.

Model Initialisation:

The setup of the model is based around the linking of the dataset to the 'Google Colab' file and adding all the required modules/libraries which need to be run. The chosen ones are mainly based around the TensorFlow Keras package (due to its links to Inception V3). But there are several others as well to assist with computation of numbers, image processing and graphing.

Despite the simplicity of this step, there were several errors with the workspace not recognising or being able to correct allocate the right libraries to each other (particurly for the TensorFlow modules). To debug this, I found the version of TensorFlow being used and searched up the modules which it included. This led to the surprise that this version (2.12.0) does support this module functions. Whilst the reasoning behind the slight error was unknown, this was left alone.

Model Building:

The building of the model is created by selecting the different layers and allocating different functions to it. These were the 'Flatten' function (to remove and flatten the inception layer of the model), 'Dense' (send outputs from previous layer to all the neurons, hence providing each neuron with an output), and 'Dropout' (applies the sent outputs from previous layer and send it to subsequent layer). Alongside these layers, the model object is created to initialise the model and then it is compiled. The inclusion of a model summary has been included to assist in viewing the current model.

Within this section, the layer. {function}, failed to work. Whilst this was included, it didn't run or failed to compile the code. As a result, I removed the 'layer.' section and it was successful in compiling.

Model Data Augmentation:

[2] A Guide to ResNet, Inception v3, and SqueezeNet | Paperspace Blog
[3] Inception V3 Model Architecture (opengenus.org)

Data Augmentation being defined as the "process of artificially increasing the amount of data by generating new data points from existing data"[4] . As a result, this is what has been implemented into the model. These datapoints has been initialised through the 'ImageDataGenerator' where the images have been resized and rescaled depending on the dataset (training or testing). I also made dataset binary to make it easier to classify.

By chance, a major error was avoided by reading documentation upon Data augmentation for Inception V3. This being that data augmentation techniques cannot be used for testing data.

Model Fitting:

The training of the model was created through a 'model.fit' function. This resulted in a successful outcome of approximately 90 % accuracy after 5 epochs. This took about 30 minutes, with 5-6 mins per epochs (depending on the speed of Wi-Fi). This was later viewed through two charts, one for accuracy and one for loss.

The creation of the chart showed to be difficult due to the use of the wrong library for the majority of the implementation. This was later solved after using the 'matlibplot' module and the right terminology.

Model Evaluation:

The evaluation of the model showed to further support the claim that the accuracy is approximately 90%.

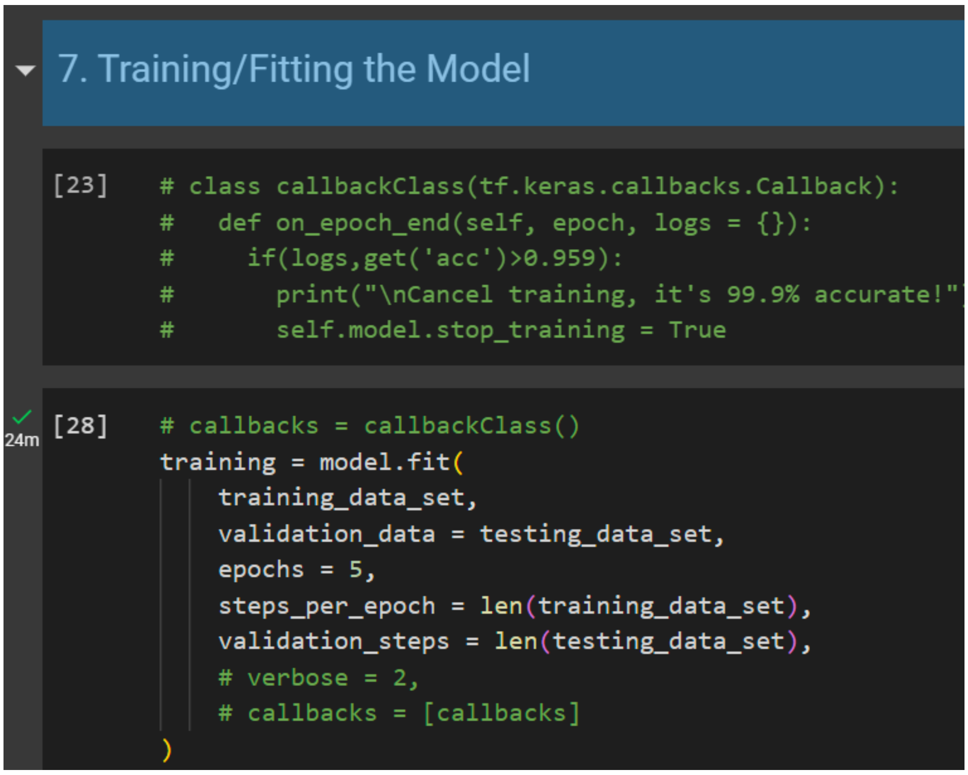
Example Prediction

The introduction tasks within this section were to read the current binary classification and labelling the data. This allowed for the prediction model for the dog and the cat to occur. This was done through the predict folder.

Problems faced:

- Problems with trying to include callback, failed to work in the end, but accuracy was still high
- Problems with training data because epoch was placed at 100 and it took too long steps per epoch and validation step were too low and didn't match up with the files as well, caused issues
- Problem with batch size, it took too long, due to low ram in colab. This was changed to 16, the normal number of RAM in Google Colab
- Layers.Flatten and other functions failed to work

[4] The Essential Guide to Data Augmentation in Deep Learning (v7labs.com)


7. Training/Fitting the Model

```
[23]  # class callbackClass(tf.keras.callbacks.Callback):
      #   def on_epoch_end(self, epoch, logs = {}):
      #     if(logs,get('acc')>0.959):
      #       print("\nCancel training, it's 99.9% accurate!"
      #       self.model.stop_training = True
```

```
24m [28]  # callbacks = callbackClass()
      training = model.fit(
          training_data_set,
          validation_data = testing_data_set,
          epochs = 5,
          steps_per_epoch = len(training_data_set),
          validation_steps = len(testing_data_set),
          # verbose = 2,
          # callbacks = [callbacks]
      )
```

- the prediction model because wrong libraries kept being used or things that didn't align to the architecture
  - Led to cats and dogs being mistaken for the other class
  - Not understanding the numbers of scientific notation
  - Unable to
- Finding an architecture that would be useful to do and was strongly beneficial
- Finding the particular structure of dealing with a classification problem

Reflecting:

This process showed the relationship between the training images and the accuracy of the training data was one that increased. Originally in the training data and the fitting of the model, the accuracy was 0.92 % accurate, yet when the two images from the dogs and cats 'predict' folder was used, the accuracy increased to 99 %. This meant that through the prediction, these images were classified easily through the model due to possible similarities with the training data. If this model was to be redesigned, it would need to accost for a larger range of training images, or the images used for prediction would be more diverse and unique by having different lighting, background or angles that the animal is captured at. By doing so, the relationship between the training images and accuracy of predictions would be more diverse and be able to accost more input images.

Personal Reflection:

This model could have been improved through many ways such as deeper learning layers, a more diverse range of images used for prediction, addressing the issues that lay about the large time span that running the model would take, improving the accuracy and links that the accuracy had with other elements. I also would have liked to create a more diverse dataset with both cats and dogs within one folder so that the model could try and differentiate between these (more unique manner than 1 image of a dog and a cat as these images were limited in scope and biased in that they were stereotypical images of a dog or a cat). In doing so, this may allow the model to perform better in different types of datasets (relating to animal classification))

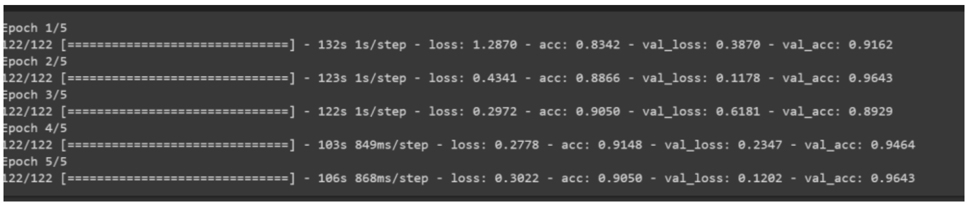
MAJOR DISCOVERY

Due to time restrictions and stress, a major which I forgot to include was the splitting of the dataset into 200 images. This meant the whole process revolved around the testing of all images.

As a result, the path will be changed but the model will not be. This will be documented through a success of fail. To ensure that there is data even if this causes the error to function or create layers or anything, a copy will be created for this file. This will allow me to manipulate the data that I have within the dataset for the new dataset, if need be.

Failure at first step:

Splitting the dataset, this meant the data had to split up 50 per folder for training and testing. Yet here I already made another mistake. I read that there had to be 50 in cat and dogs training but 100 in testing. As a result, I will show the epoch accuracy training data, but this will not be the final dataset nor model.

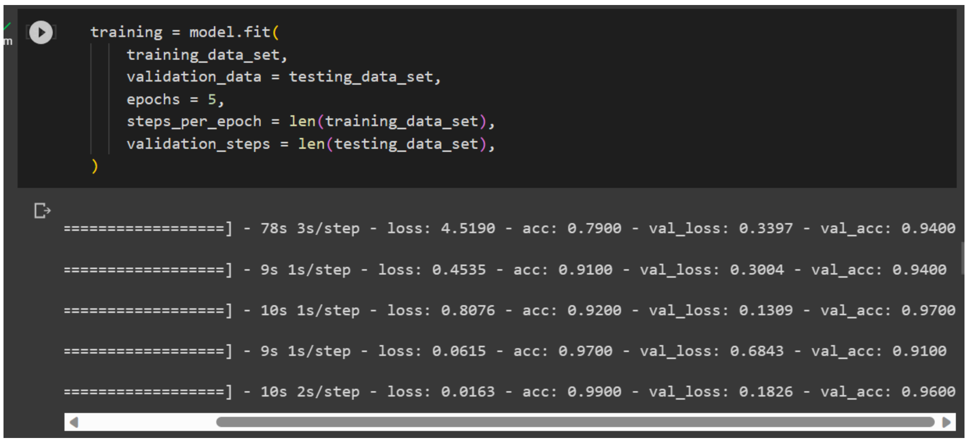


```
poch 1/5
122/122 [==============================] - 132s 1s/step - loss: 1.2870 - acc: 0.8342 - val_loss: 0.3870 - val_acc: 0.9162
poch 2/5
122/122 [==============================] - 123s 1s/step - loss: 0.4341 - acc: 0.8866 - val_loss: 0.1178 - val_acc: 0.9643
poch 3/5
122/122 [==============================] - 122s 1s/step - loss: 0.2972 - acc: 0.9050 - val_loss: 0.6181 - val_acc: 0.8929
poch 4/5
122/122 [==============================] - 103s 849ms/step - loss: 0.2778 - acc: 0.9148 - val_loss: 0.2347 - val_acc: 0.9464
poch 5/5
122/122 [==============================] - 106s 868ms/step - loss: 0.3022 - acc: 0.9050 - val_loss: 0.1202 - val_acc: 0.9643
```

Yet despite, this mistake, the model showed a pretty good accuracy. With a decently high validation accuracy.

Implementation:

The implementation of the model showed to extremely accurate and did not have overfitting occurring either. To understand if a model is overfitting, two categories should be analysed. These categories are comparing the metric between the accuracy and validation accuracy. If there is a high correlation that is with the accuracy being above about the validation accuracy, there is a likelihood that the model is overfitting, whilst if both categories are aligned in a lower score, it would be overfitting.



```
training = model.fit(
    training_data_set,
    validation_data = testing_data_set,
    epochs = 5,
    steps_per_epoch = len(training_data_set),
    validation_steps = len(testing_data_set),
)
```

```
=================] - 78s 3s/step - loss: 4.5190 - acc: 0.7900 - val_loss: 0.3397 - val_acc: 0.9400

=================] - 9s 1s/step - loss: 0.4535 - acc: 0.9100 - val_loss: 0.3004 - val_acc: 0.9400

=================] - 10s 1s/step - loss: 0.8076 - acc: 0.9200 - val_loss: 0.1309 - val_acc: 0.9700

=================] - 9s 1s/step - loss: 0.0615 - acc: 0.9700 - val_loss: 0.6843 - val_acc: 0.9100

=================] - 10s 2s/step - loss: 0.0163 - acc: 0.9900 - val_loss: 0.1826 - val_acc: 0.9600
```

Through this result, we can gain an understanding, that this model is overfitting slightly but it also underfitting to a certain degree. This could be a result of using a transfer learning model.

Reflection:

Overall, the development of this model was varied in complexity depending on the individuals needs and want to develop the model. This allowed this task to be interesting, whilst engaging. The use of Inception V3 was a transfer learning technique which assisted in engaging me and allowing me to understand the CNN architecture model much better.

Task 3

Goal: The aim of this task is to evaluate if an AI that passed the Turing test would be considered sentient.

To evaluate this several aspects, need to be researched these being:

- What is a sentient AI?
- What does it mean for an AI machine to pass the Turing test?
- How is a sentient AI and an AI that passed the Turing test interlinked?

The task paragraph is written below:

With the development of Artificial Intelligence (AI) becoming ever prevalent in modern times, the recent news of an AI passing the Turing test has created questions of what this means for society. It raises concerns about the ethicality, sentience, proliferation of inaccurate information. Alongside this, it raises concerns about future development of what the current AGI (Artificial General Intelligence) is capable of or what it may become.

AI being defined as "a branch of computer science involved in building smart machines capable of performing human-like tasks" [5] is broad umbrella term for the three levels of

[5] My Great Learning, 2022. "What is Artificial General Intelligence (AGI)? (mygreatlearning.com)". Located at: (https://www.mygreatlearning.com/blog/artificial-general-intelligence/)

logical and emotional intelligence that machines are capable. These being ANI (Artificial Narrow Intelligence): AI's that have a narrow range of abilities, AGI (Artificial General Intelligence): machines that are on par with human capabilities and ASI (Artificial Superintelligence): machines that surpass human capabilities. These subcategories correlate to the Turing test through the how AI classified into each of these categories. The Turing test differentiates ANI and AGI AI's. Since this new AI has passed the Turing Test, the model has become gone from an ANI to and AGI. This means that this model can emulate human intelligence and behaviour. As a result, this AI has the possibility to register or feel emotions. Yet, this does not mean that it can be classified as a Sentient AI as it must also meet three standards. According to Stuart Russel, an influential novelist in AI, these standards are to have an AI with 'a perfect Unity of an external body and internal mind', 'a defining original language for the AI to access' and ' a defining culture to wire with other sentient beings'[6]. Consequently, from lack of information, the AI cannot be presumed to be sentient. Yet it will be able to mimic human intelligence, think, understand, learn and apply its knowledge similarly to a human.

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