Image Classification

Convolutional Neural Network

Introduction

- Malaria is a mosquito-borne infectious disease that affects humans and other animals.
- Malaria kills one child every 30 seconds, about 3000 children every day.
- An estimated 300-600 million people suffer from malaria each year.
- More than 40 percent of the world's population lives in malaria-risk areas.

Factors

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- High poverty levels
- Political instability
- Presence of disease transmission vectors (ex. mosquitos)
- Densely populated areas

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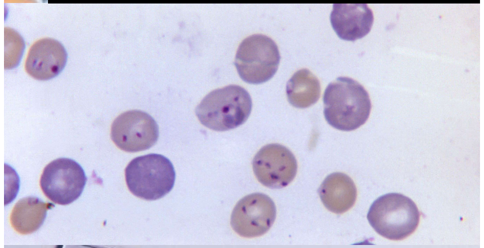

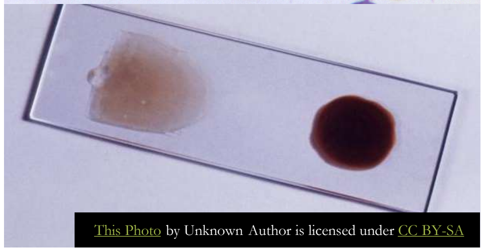

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Diagnosis

Most widely used method :

- Examining patients thin blood smears under a microscope
- The patients’ blood is smeared on a glass slide and stained with contrasting agents
- Clinician manually counts the number of parasitic red blood cells—sometimes up to 5,000 cells

Objective

- To reduce the burden for microscopists in resource-constrained regions and improve diagnostic accuracy
- Build an Image Classification model to obtain highest level of accuracy
- we must also consider making the model as small and computationally efficient as possible

Factors to consider

- Some of the factors to consider while building our model
  - Reliable power source
  - Battery-powered devices
  - Internet connection

Convolutional Neural Network

- CNNs use a variation of multilayer perceptron's designed to require minimal preprocessing.
- CNNs can be thought of automatic feature extractors from the image.
- While if I use a algorithm with pixel vector I lose a lot of spatial interaction between pixels, a CNN effectively uses adjacent pixel information to effectively downsample the image first by convolution and then uses a prediction layer at the end.

Overview

- The dataset contains 2 folders - Infected - Uninfected and it has total of 27,558 images.
- An instance of how the patient-ID is encoded into the cell name is shown herewith: "P1" denotes the patient-ID for the cell labeled "C33P1thinF_IMG_20150619_114756a_cell_179.png"
- **Source**:
  - This Dataset is taken from the official NIH Website: https://ceb.nlm.nih.gov/repositories/malaria-datasets/

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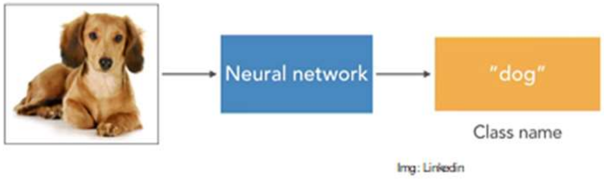
Tools

- Python -3
- Jupyter Notebook
- TensorFlow
- Keras



Img: Linkedin

How it works?

- Image recognition is the ability for computers to look at a photograph and understand what's in the photograph.
- Here we're passing in a picture to the neural network, and the neural network is generating a label, dog, because that's the main object that appears in the picture.
- A neural network is made up of separate nodes called neurons. These neurons are arranged into a series of groups called layers. Nodes in each layer are connected to the nodes in the following layer. Data flows from the input to the output along these connections.

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Technical Approach

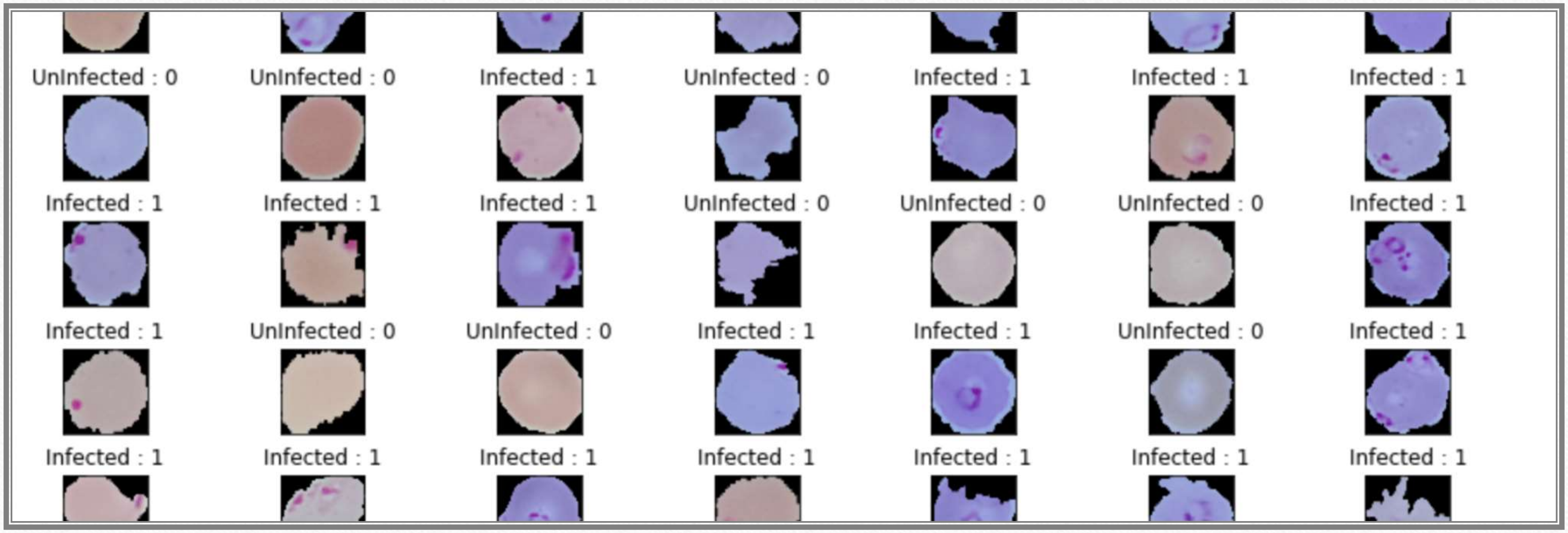
- Import required libraries
- Pre-processing image data
- Train and test data
- Building Model
- Compile & Training Model
- Transfer Learning

Import required libraries

- Keras
  - Conv2D, Max pooling, Dense, Flatten, Dropout, Load Img, Activation
- Scikit-Learn
- Matplotlib
- NumPy
- Pandas

Pre-processing image data

- Read and Image files
- Load image file
- Resize image file (50 x 50)
- Apply the same process for Parasitized & Uninfected
- Store and shuffle the data in array



Data Visualization

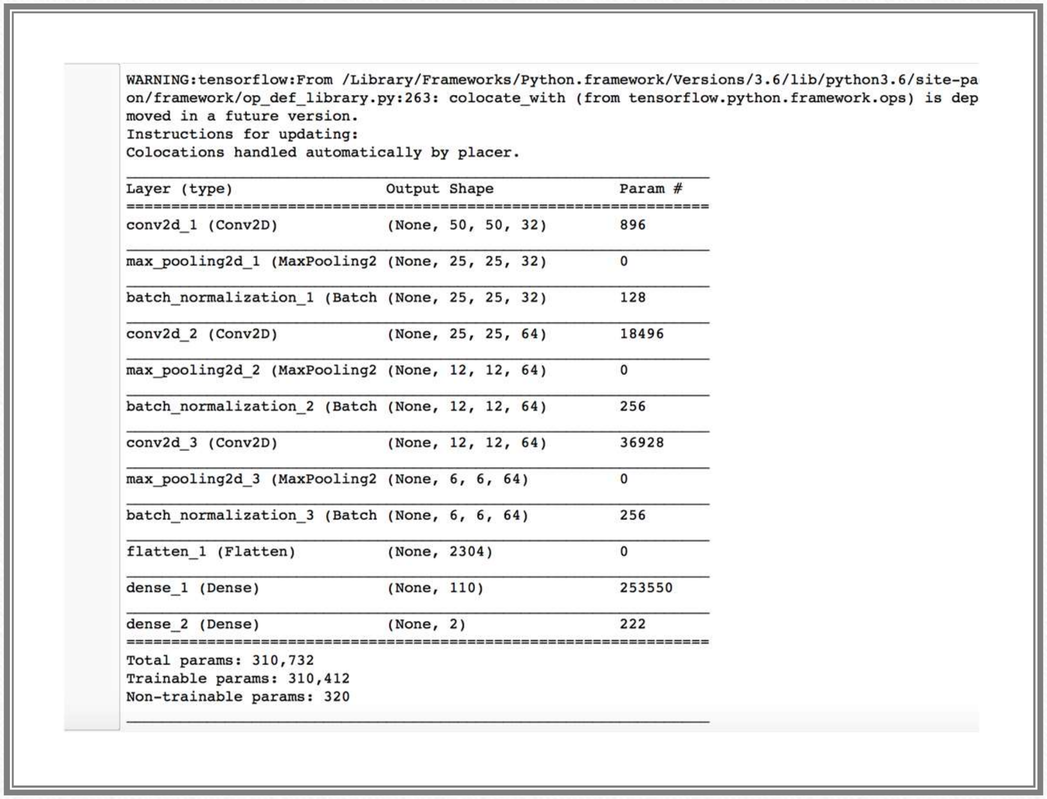
Normalize data

- Neural network best when the values are floating point values in between 0 and one.
- Normally images are stored as integer values for each pixel, this values is between 0 and 255, so convert the data to float and divide by 255.

Building Model

- Sequential
- Con2D :
- Maxpooling
- Batch Normalization
- Dropout

Model Summary



```
WARNING:tensorflow:From /Library/Frameworks/Python.framework/Versions/3.6/lib/python3.6/site-pa
on/framework/op_def_library.py:263: colocate_with (from tensorflow.python.framework.ops) is dep
moved in a future version.
Instructions for updating:
Colocations handled automatically by placer.
_________________________________________________________________
Layer (type)                 Output Shape              Param #   
=================================================================
conv2d_1 (Conv2D)            (None, 50, 50, 32)        896       
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 25, 25, 32)        0         
_________________________________________________________________
batch_normalization_1 (Batch (None, 25, 25, 32)        128       
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 25, 25, 64)        18496     
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 12, 12, 64)        0         
_________________________________________________________________
batch_normalization_2 (Batch (None, 12, 12, 64)        256       
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 12, 12, 64)        36928     
_________________________________________________________________
max_pooling2d_3 (MaxPooling2 (None, 6, 6, 64)          0         
_________________________________________________________________
batch_normalization_3 (Batch (None, 6, 6, 64)          256       
_________________________________________________________________
flatten_1 (Flatten)          (None, 2304)              0         
_________________________________________________________________
dense_1 (Dense)              (None, 110)               253550    
_________________________________________________________________
dense_2 (Dense)              (None, 2)                 222       
=================================================================
Total params: 310,732
Trainable params: 310,412
Non-trainable params: 320
_________________________________________________________________
```

- Total params: 310,732
- Trainable params: 310,412
- Non-trainable params: 320

Model Compile

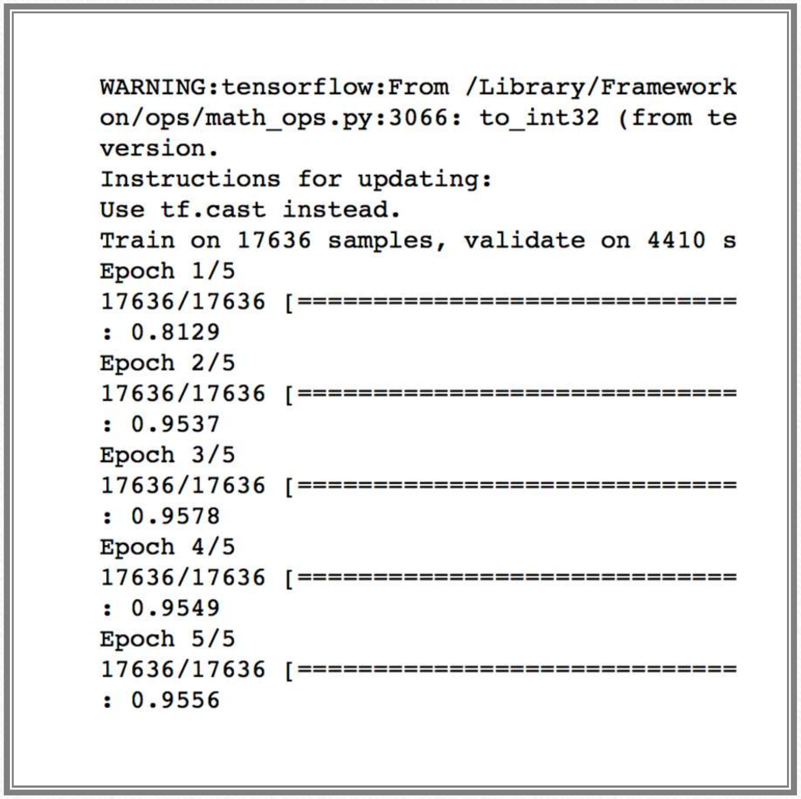
- Compile the model
- Params:
  - Loss
  - Optimizer
  - Metrics

Model Training

- Fit the data to Model
- Specify
  - Batch Size
  - Epochs
  - validation data

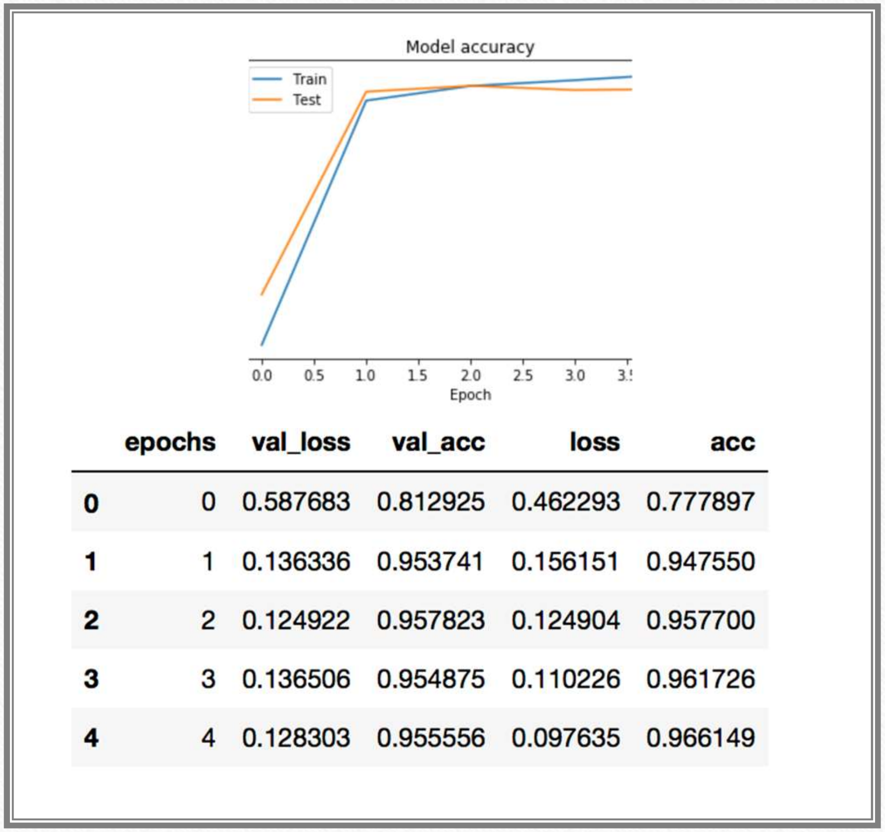
Training Results

- Epoch : 5



```
WARNING:tensorflow:From /Library/Framework
on/ops/math_ops.py:3066: to_int32 (from te
version.
Instructions for updating:
Use tf.cast instead.
Train on 17636 samples, validate on 4410 s
Epoch 1/5
17636/17636 [==============================
: 0.8129
Epoch 2/5
17636/17636 [==============================
: 0.9537
Epoch 3/5
17636/17636 [==============================
: 0.9578
Epoch 4/5
17636/17636 [==============================
: 0.9549
Epoch 5/5
17636/17636 [==============================
: 0.9556
```

Model Accuracy



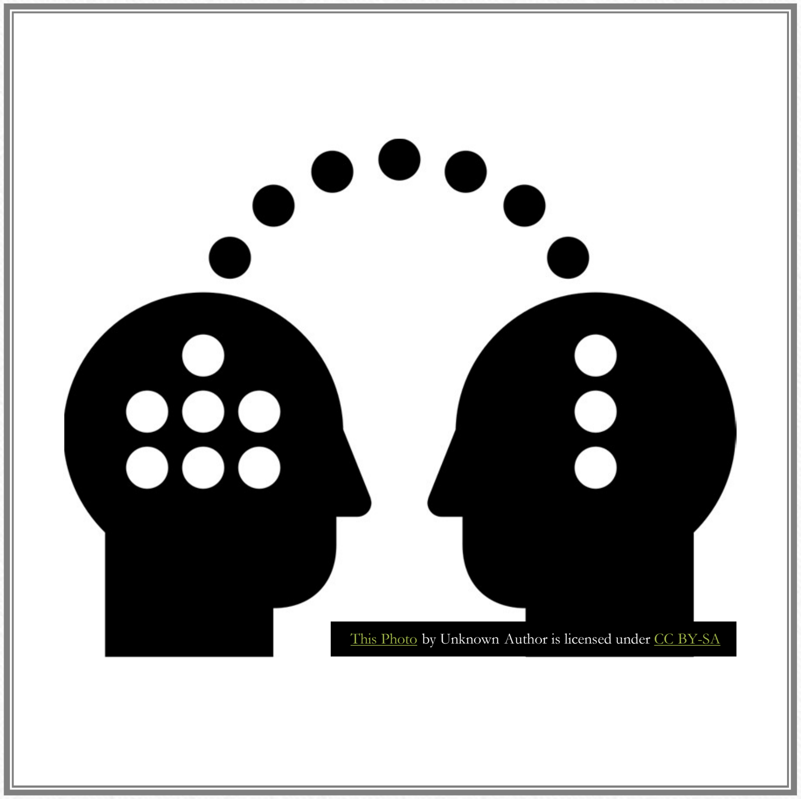
	epochs	val_loss	val_acc	loss	acc
0	0	0.587683	0.812925	0.462293	0.777897
1	1	0.136336	0.953741	0.156151	0.947550
2	2	0.124922	0.957823	0.124904	0.957700
3	3	0.136506	0.954875	0.110226	0.961726
4	4	0.128303	0.955556	0.097635	0.966149

Saving model weights

- Model structure
- Model Weights

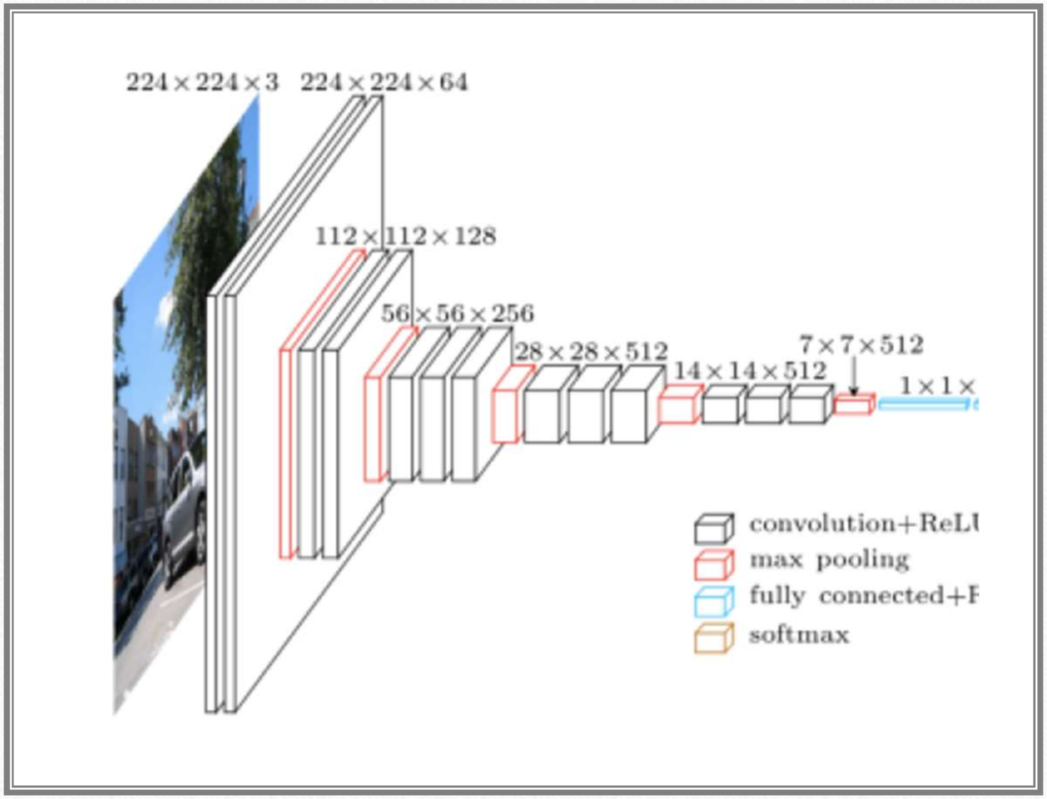
Model Testing with weights

- Import required libraries
- Load Model structure
- Load Model weights
- Load Image with target size
- Predict the image



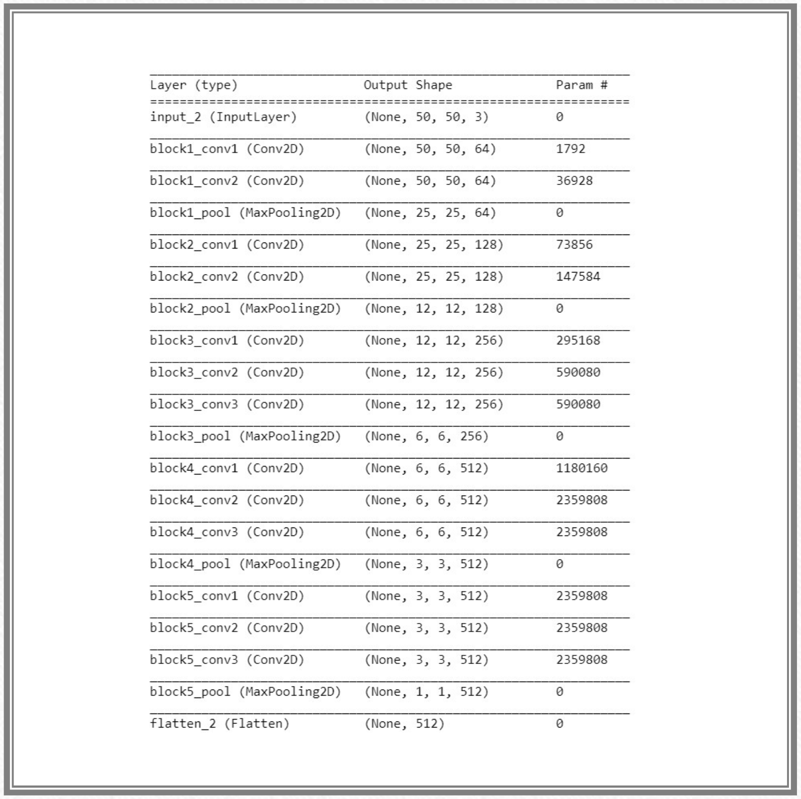
Transfer Learning (VGG16)

- ConvNet as fixed feature extractor.
- Fine-tuning the ConvNet
- Pretrained models



Load VGG16 model

- Total params: 14,714,688
- Trainable params: 14,714,688
- Non-trainable params: 0



```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
input_2 (InputLayer)         (None, 50, 50, 3)         0
_________________________________________________________________
block1_conv1 (Conv2D)        (None, 50, 50, 64)        1792
_________________________________________________________________
block1_conv2 (Conv2D)        (None, 50, 50, 64)        36928
_________________________________________________________________
block1_pool (MaxPooling2D)   (None, 25, 25, 64)        0
_________________________________________________________________
block2_conv1 (Conv2D)        (None, 25, 25, 128)       73856
_________________________________________________________________
block2_conv2 (Conv2D)        (None, 25, 25, 128)       147584
_________________________________________________________________
block2_pool (MaxPooling2D)   (None, 12, 12, 128)       0
_________________________________________________________________
block3_conv1 (Conv2D)        (None, 12, 12, 256)       295168
_________________________________________________________________
block3_conv2 (Conv2D)        (None, 12, 12, 256)       590080
_________________________________________________________________
block3_conv3 (Conv2D)        (None, 12, 12, 256)       590080
_________________________________________________________________
block3_pool (MaxPooling2D)   (None, 6, 6, 256)         0
_________________________________________________________________
block4_conv1 (Conv2D)        (None, 6, 6, 512)         1180160
_________________________________________________________________
block4_conv2 (Conv2D)        (None, 6, 6, 512)         2359808
_________________________________________________________________
block4_conv3 (Conv2D)        (None, 6, 6, 512)         2359808
_________________________________________________________________
block4_pool (MaxPooling2D)   (None, 3, 3, 512)         0
_________________________________________________________________
block5_conv1 (Conv2D)        (None, 3, 3, 512)         2359808
_________________________________________________________________
block5_conv2 (Conv2D)        (None, 3, 3, 512)         2359808
_________________________________________________________________
block5_conv3 (Conv2D)        (None, 3, 3, 512)         2359808
_________________________________________________________________
block5_pool (MaxPooling2D)   (None, 1, 1, 512)         0
_________________________________________________________________
flatten_2 (Flatten)          (None, 512)               0
```

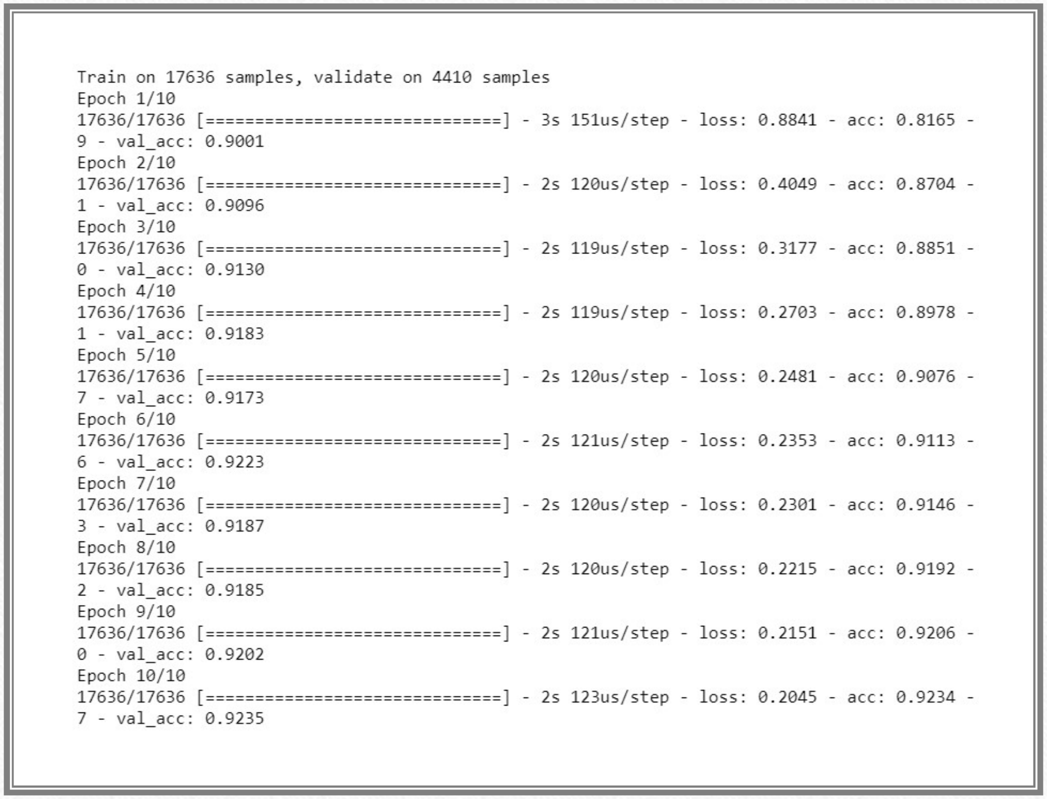
Flatten & Set the layer training to False

- Total params: 14,714,688
- Trainable params: 14,714,688
- Non-trainable params: 0

Features Extraction

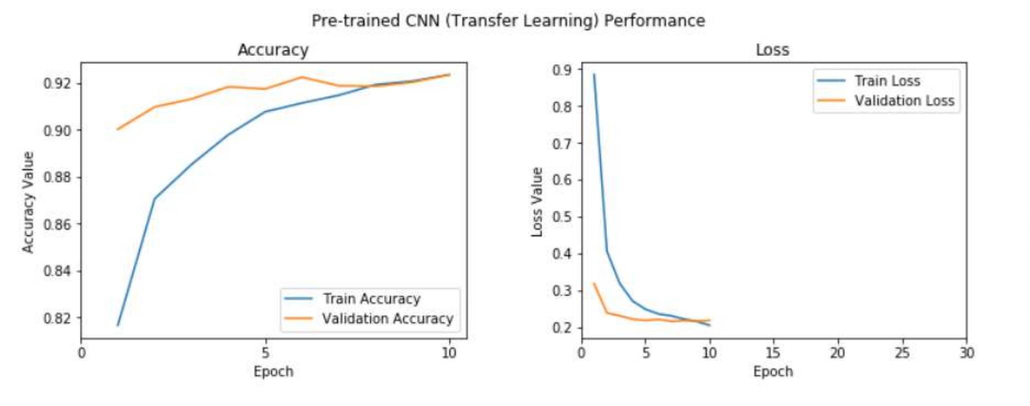
Train VGG Features: (17636, 512)
Validation VGG Features: (4410, 512)

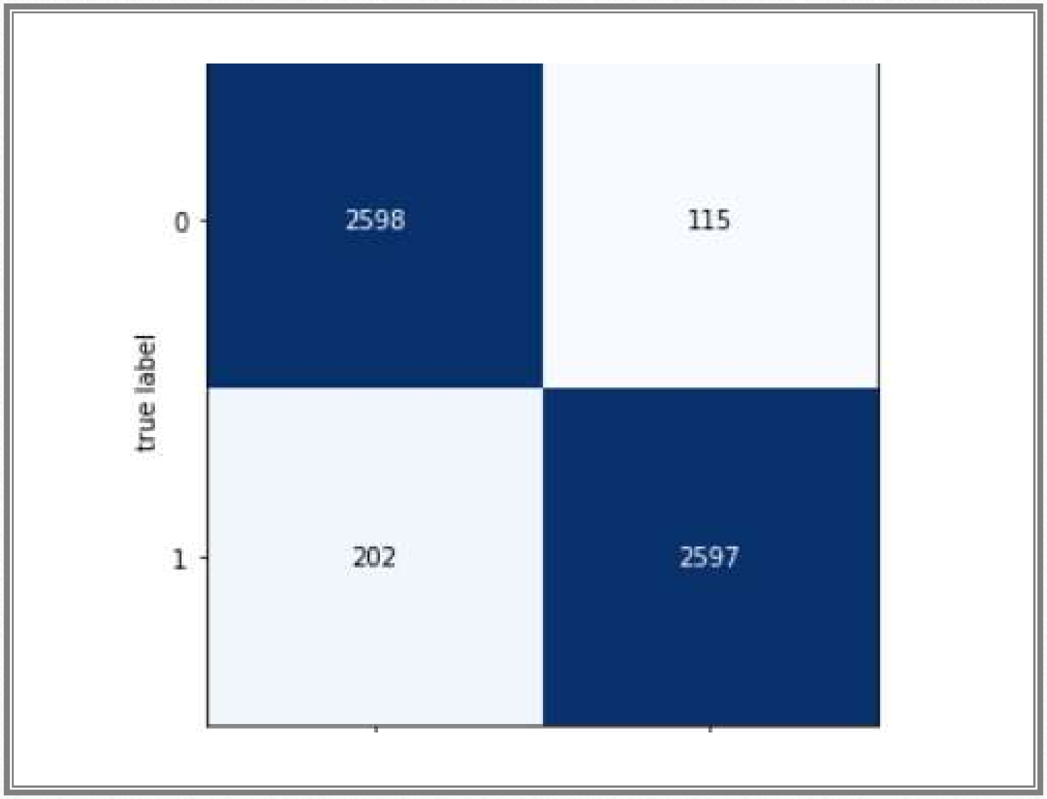
Train Model



```
Train on 17636 samples, validate on 4410 samples
Epoch 1/10
17636/17636 [==============================] - 3s 151us/step - loss: 0.8841 - acc: 0.8165 -
9 - val_acc: 0.9001
Epoch 2/10
17636/17636 [==============================] - 2s 120us/step - loss: 0.4049 - acc: 0.8704 -
1 - val_acc: 0.9096
Epoch 3/10
17636/17636 [==============================] - 2s 119us/step - loss: 0.3177 - acc: 0.8851 -
0 - val_acc: 0.9130
Epoch 4/10
17636/17636 [==============================] - 2s 119us/step - loss: 0.2703 - acc: 0.8978 -
1 - val_acc: 0.9183
Epoch 5/10
17636/17636 [==============================] - 2s 120us/step - loss: 0.2481 - acc: 0.9076 -
7 - val_acc: 0.9173
Epoch 6/10
17636/17636 [==============================] - 2s 121us/step - loss: 0.2353 - acc: 0.9113 -
6 - val_acc: 0.9223
Epoch 7/10
17636/17636 [==============================] - 2s 120us/step - loss: 0.2301 - acc: 0.9146 -
3 - val_acc: 0.9187
Epoch 8/10
17636/17636 [==============================] - 2s 120us/step - loss: 0.2215 - acc: 0.9192 -
2 - val_acc: 0.9185
Epoch 9/10
17636/17636 [==============================] - 2s 121us/step - loss: 0.2151 - acc: 0.9206 -
0 - val_acc: 0.9202
Epoch 10/10
17636/17636 [==============================] - 2s 123us/step - loss: 0.2045 - acc: 0.9234 -
7 - val_acc: 0.9235
```

Plot Accuracy and Loss





0	2598	115
1	202	2597

Model Performance

- Test Data:
  - Accuracy : 94.24 %
  - Precision: 95.76 %
  - Recall : 92.78 %
  - F-Measure: 94.2 %

Thank You