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उत्तिष्ठत जाग्रत प्राप्य वरान् निबोधत

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR

भारतीय अभियांत्रिकी विज्ञान एवं प्रौद्योगिकी संस्थान, शिबपुर

BTech Final Project

Handwriting Analysis

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Objective

- ❑ **Author recognition** from the **handwritten** text.
- ❑ Using **Convolutional Neural Network** and **train** using a **Softmax Classification** loss function .
- ❑ **Instead of traditional** way to establish **features** like **curvature** of **letters**, **spacing** between letters, and feed them into a strong **classifier** like **SVM** to distinguish between the **writers**.

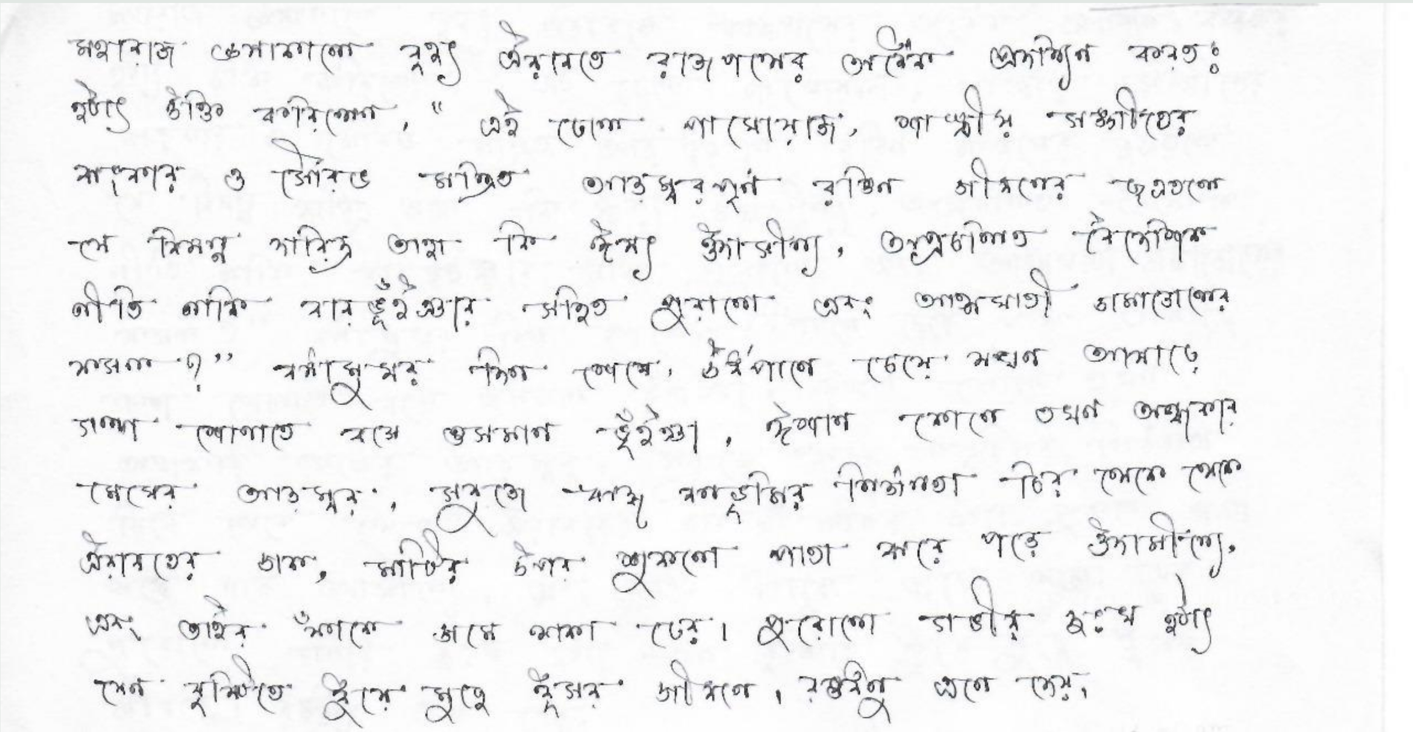
Solution

Previous Work…

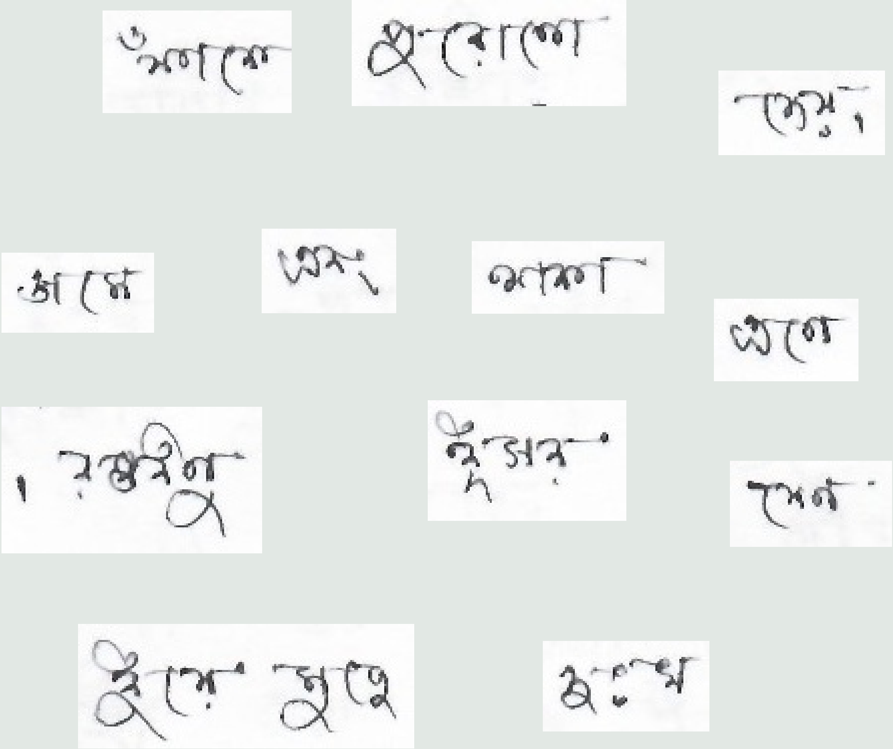
Preprocessing of the data set

- Segmented the handwritten image first line wise then word wise.
- **Grayscale Conversion**
- Thresholding (**Otsu's Method**)
- Dilation
- **Contour Detection**
- **Bounding Box Filtering**
- Bounding Box Visualization
- Word Extraction

Input image and the output (Bangla)



মহারাজ জগদানন্দ নৃত্য উদ্যানে রাজগণের অহংকার প্রত্যক্ষ করত:
স্বগত উক্তি করিলেন, " এই দেখ পাগোসাজি, আত্মীয় সঙ্গীদের
অহংকার ও জীবনে মাত্রিত অত্যধিকপূর্ণ রঙিন নাচনের জন্যতো
যে বিষয় খানিক তাহা কি ঈশ্বর উদাসীন্য, অত্যাচারী বৈদেশিক
নীতি নাকি বাহ্যিক উজ্জ্বলতার সহিত প্রকাশ এবং আত্মঘাতী চালাকোলের
সকল ?" বাস্তুমর কিন দেখে, উইপাতে ডেকে মগ্ন আসাতে
ডাকা খোলাতে বসে অসমান হইয়া, ঈশান কোণে তখন অন্ধকার
মেঘের আড়ম্বর, সূর্যে যায় বসুমতির নিস্তব্ধতা চিরে থেকে থেকে
বিশ্বাসের ডাক, নাটির উপর ঝুলানো পাতা ঝরে পড়ে উদাসীন্যে.
এবং তাহার ঝলকে আসে আলো দেয়। প্রবোধ রাতীর দুঃখ সূর্য
শেষ সুনিশ্চিতে ঈর্ষে দুঃখে দুঃসহ জীবনে। রক্তবিন্দু ঝরে দেয়।



ঝলকে

প্রবোধ

দেয়।

আসে

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। রক্তবিন্দু

দুঃসহ

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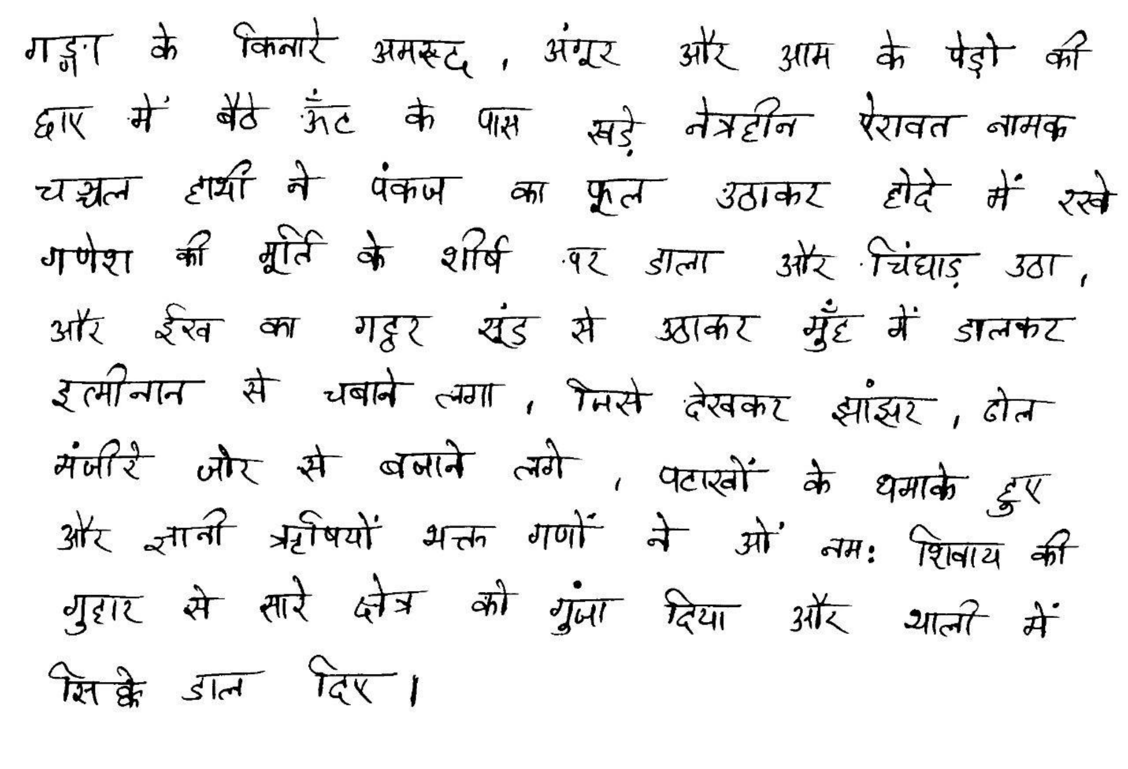
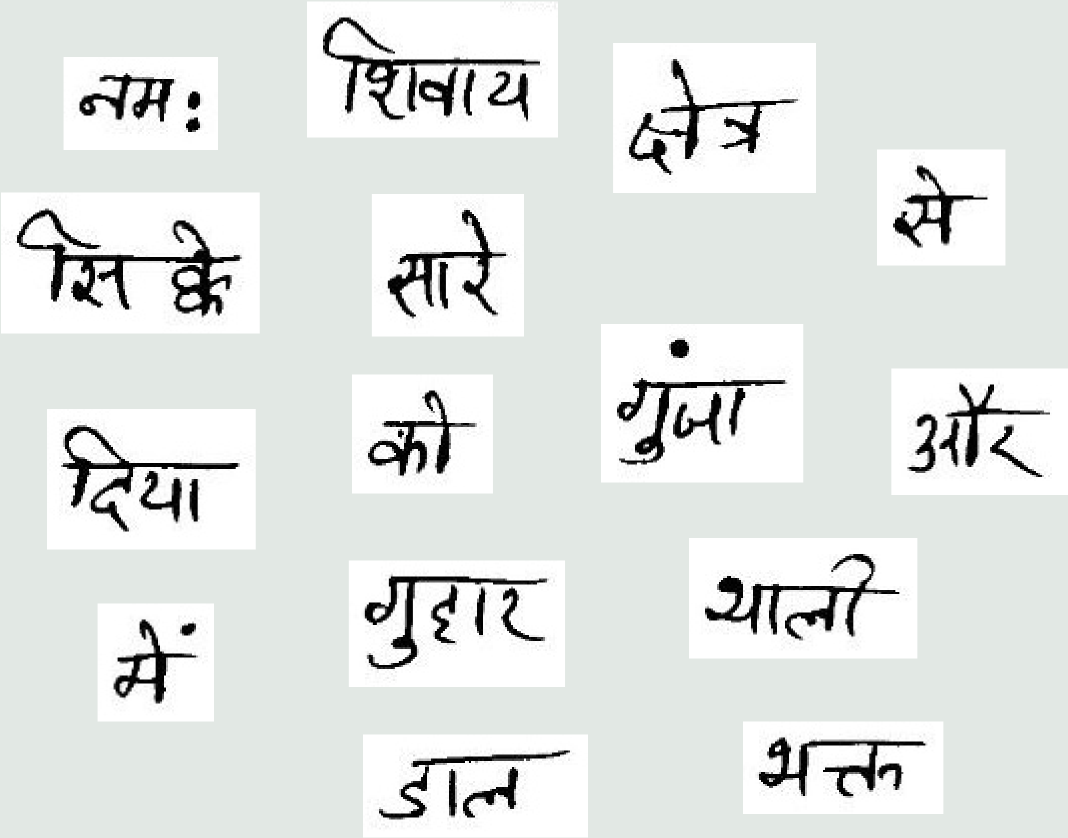
ঈর্ষে দুঃখে

দুঃখ

Input image and the output (Hindi)

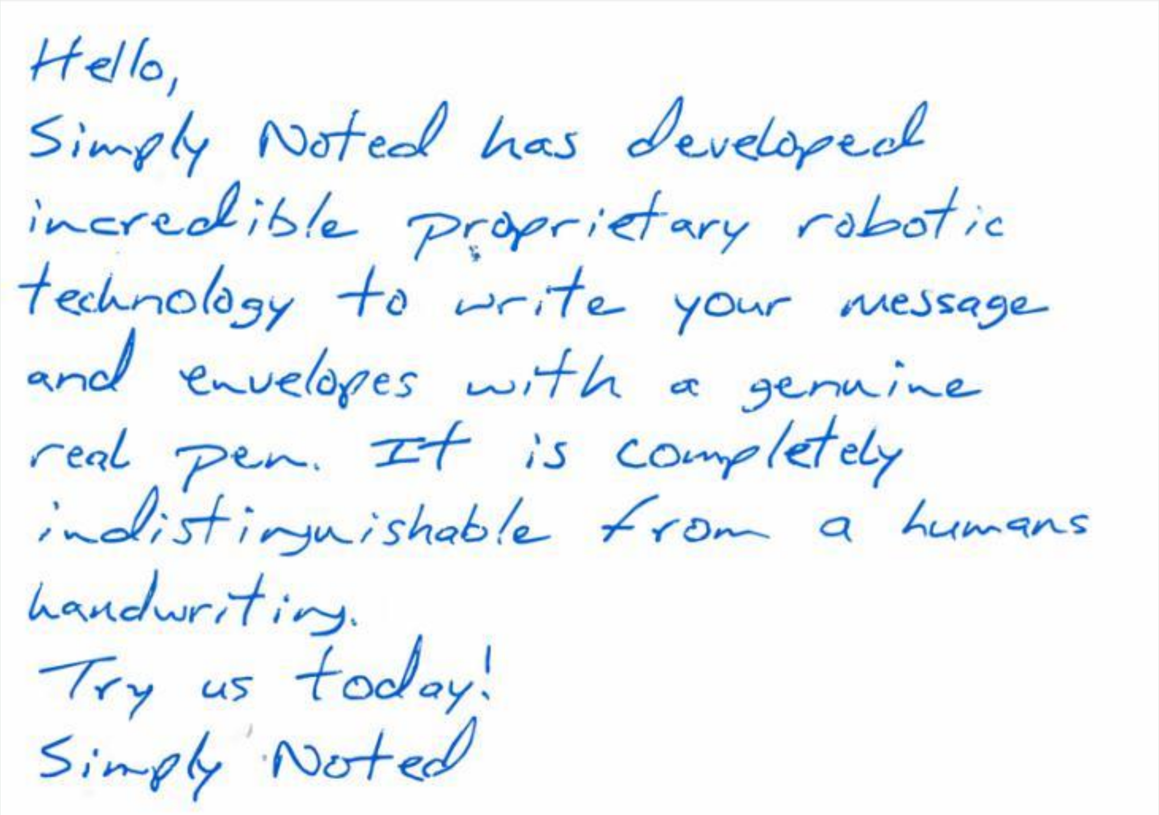


गङ्गा के किनारे अमरूद , अंगूर और आम के पेड़ो की
छाए में बैठे ऊँट के पास खड़े नेत्रहीन ऐरावत नामक
चञ्चल हाथी ने पंकज का फूल उठाकर होदे में रखे
गणेश की मूर्ति के शीर्ष पर डाला और चिंघाड़ उठा ,
और ईख का गट्ठर सूंड से उठाकर मुँह में डालकर
इत्मीनान से चबाने लगा , जिसे देखकर झांझर , ढोल
मंजीरे जोर से बजाने लगे , पटाखों के धमाके हुए
और ज्ञानी ऋषियों भक्त गणों ने ओं नमः शिवाय की
गुहार से सारे क्षेत्र को गुंजा दिया और थाली में
सिक्के डाल दिए ।

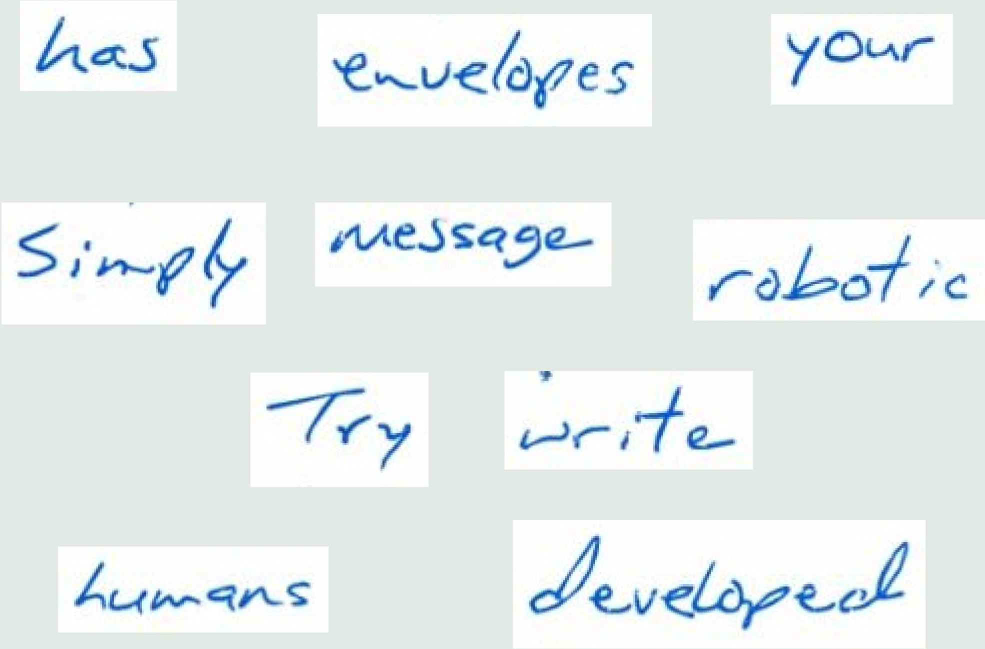


नमः
शिवाय
क्षेत्र
से
सिक्के
सारे
गुंजा
दिया
को
और
में
गुहार
थाली
डाल
भक्त

Input image and the output (English)



Hello,
Simply Noted has developed
incredible proprietary robotic
technology to write your message
and envelopes with a genuine
real pen. It is completely
indistinguishable from a humans
handwriting.
Try us today!
Simply Noted


has
envelopes
your
Simply
message
robotic
Try
write
humans
developed

Data Gathering (current work..)

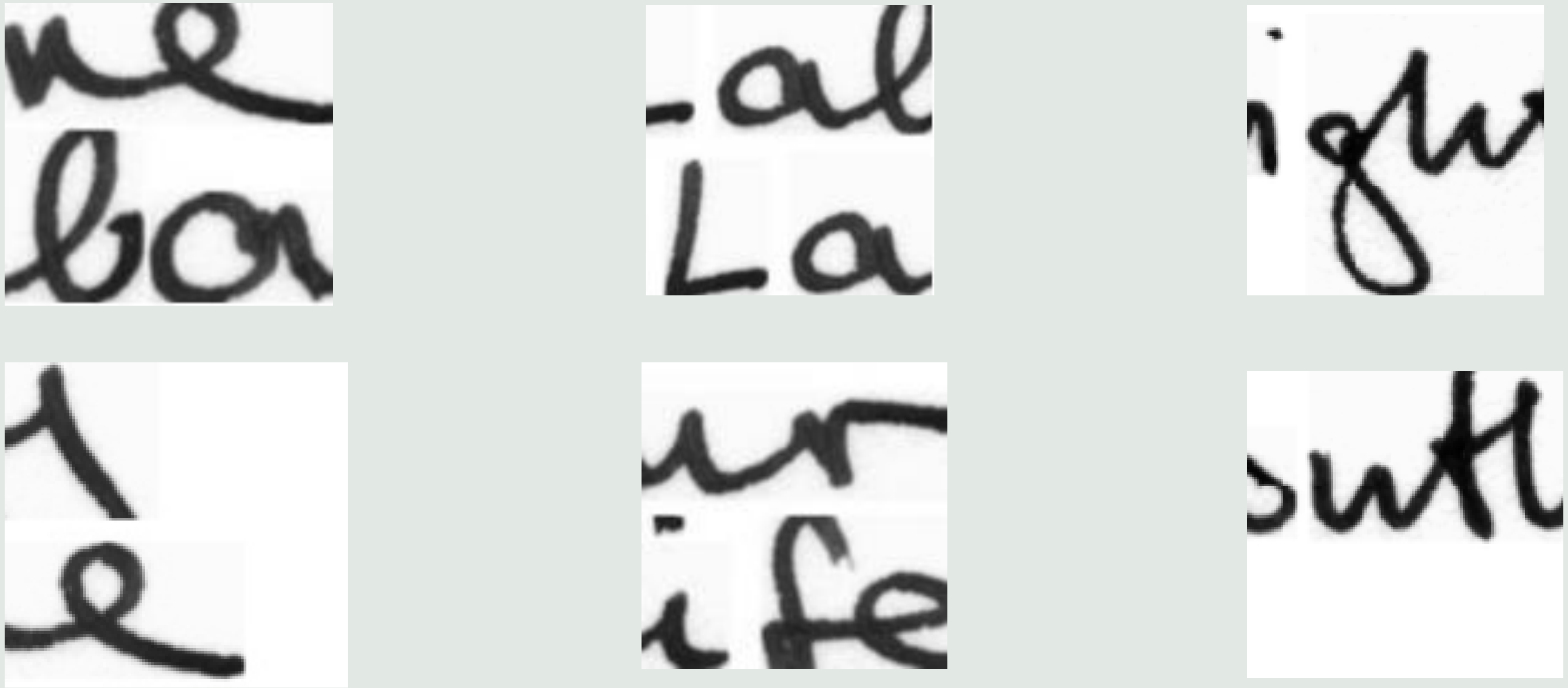
- The dataset used contains 1539 pages of scanned text sentences written by 600+ writers.

- This project uses the top 50 writers with most amount of data. Data is grouped by writers having written a collection of sentences

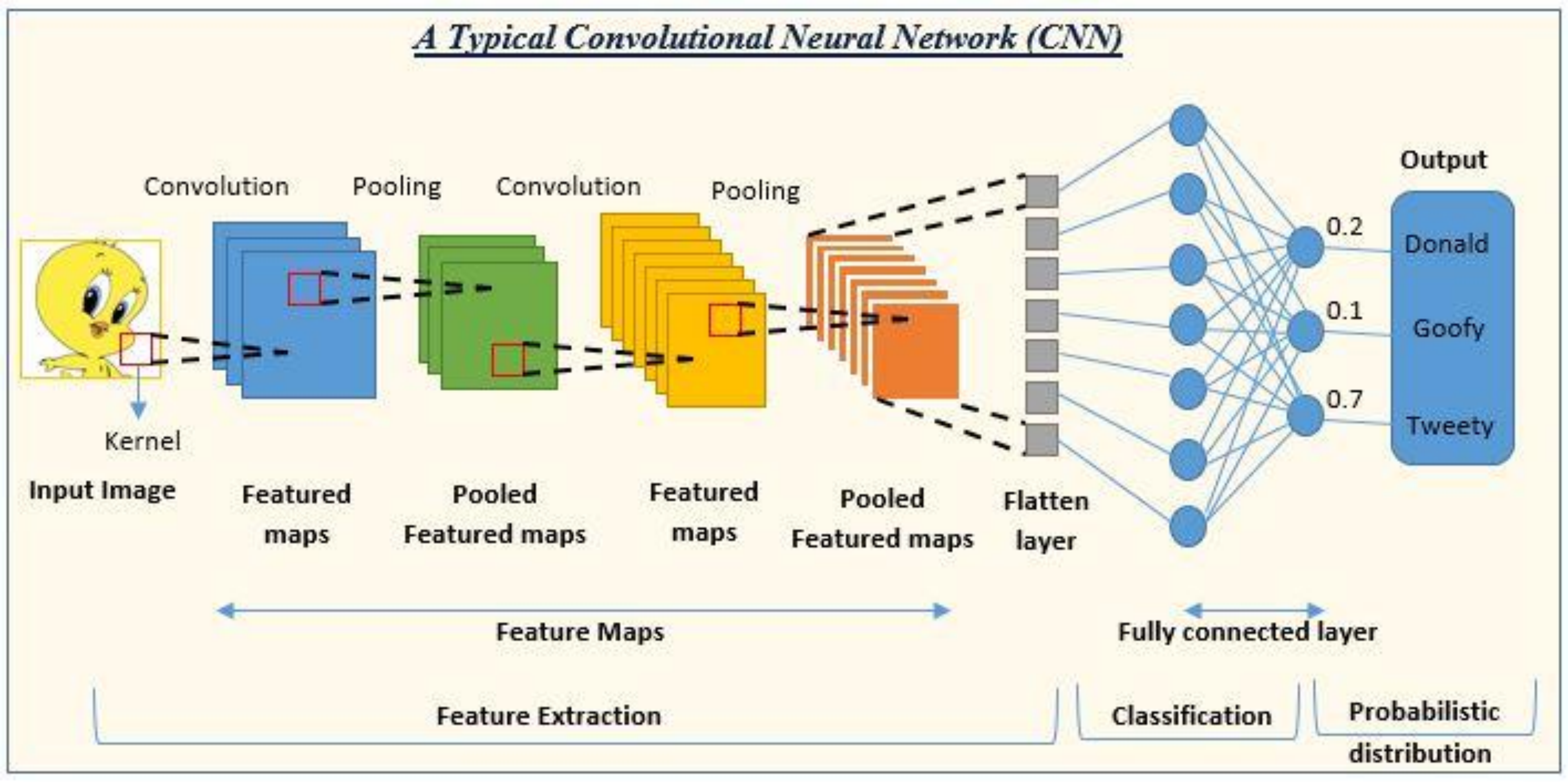
Preprocessing

- For our **CNN** to understand the writing style, language is not a restriction, so we pass patches of text having image size **113x113 pixels** from each sentence.
- We **didn't break** them **w.r.t. sentences** or **words**, but we **break** them down into **smaller image sets**.
- For serving the purpose, a **generator function** is implemented to **scan through each sentence** and **generate random** patches with same patch size.
- **Data-set** is shuffled.

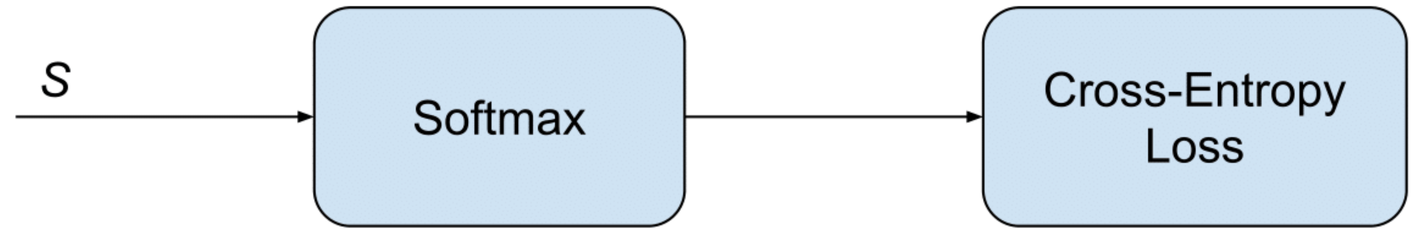
Input to the model



Convolutional Neural Network



Softmax Function



$$f(s)_i = \frac{e^{s_i}}{\sum_j^C e^{s_j}} \qquad CE = -\sum_i^C t_i log(f(s)_i)$$

Here, si: The *i*-th element of the input vector.
e: Euler's number (approximately 2.71828).

t: is the actual label (0 or 1 in binary classification, a one-hot vector in multi-class classification).

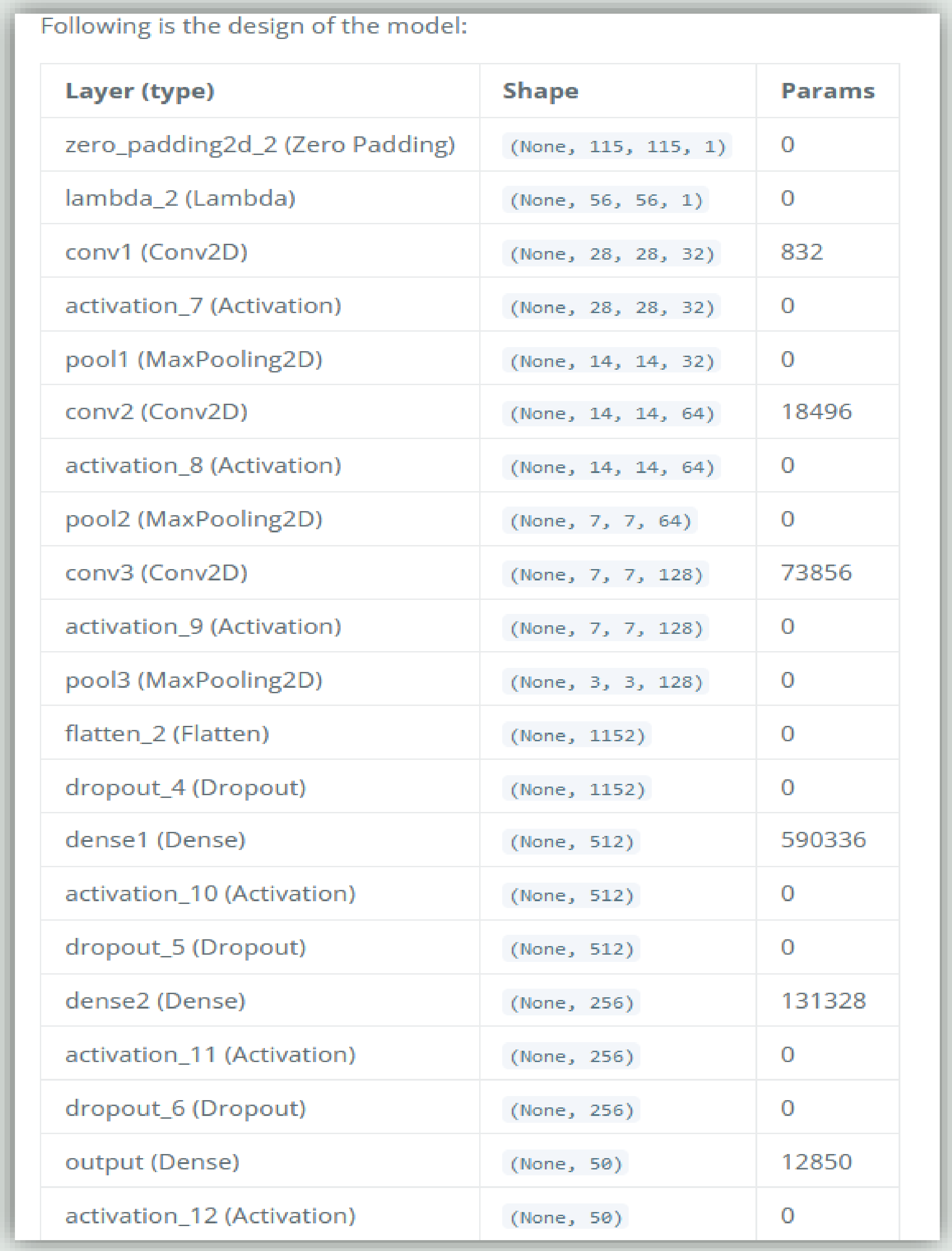
f(s)i: predicted probability

- **SoftMax function** is a mathematical function that **takes a vector** of real numbers as input and **transforms** it into a **probability distribution**.
- **Used** in machine learning, particularly in **multiclass classification** problems
- **Cross-Entropy Loss** is used for **classification tasks**.

Self-designed CNN Model

- We’ve used **Keras** with **TensorFlow** backend.
- A standard **CNN Model** is designed with **multiple convolution** and **maxpool layers**, a **few dense layers** and a **final output layer** is the **softmax activation**.
- **ReLU activation** was also used **between** the **convolution and dense layers**.
- The resultant model was **optimized using Adam Optimizer**.

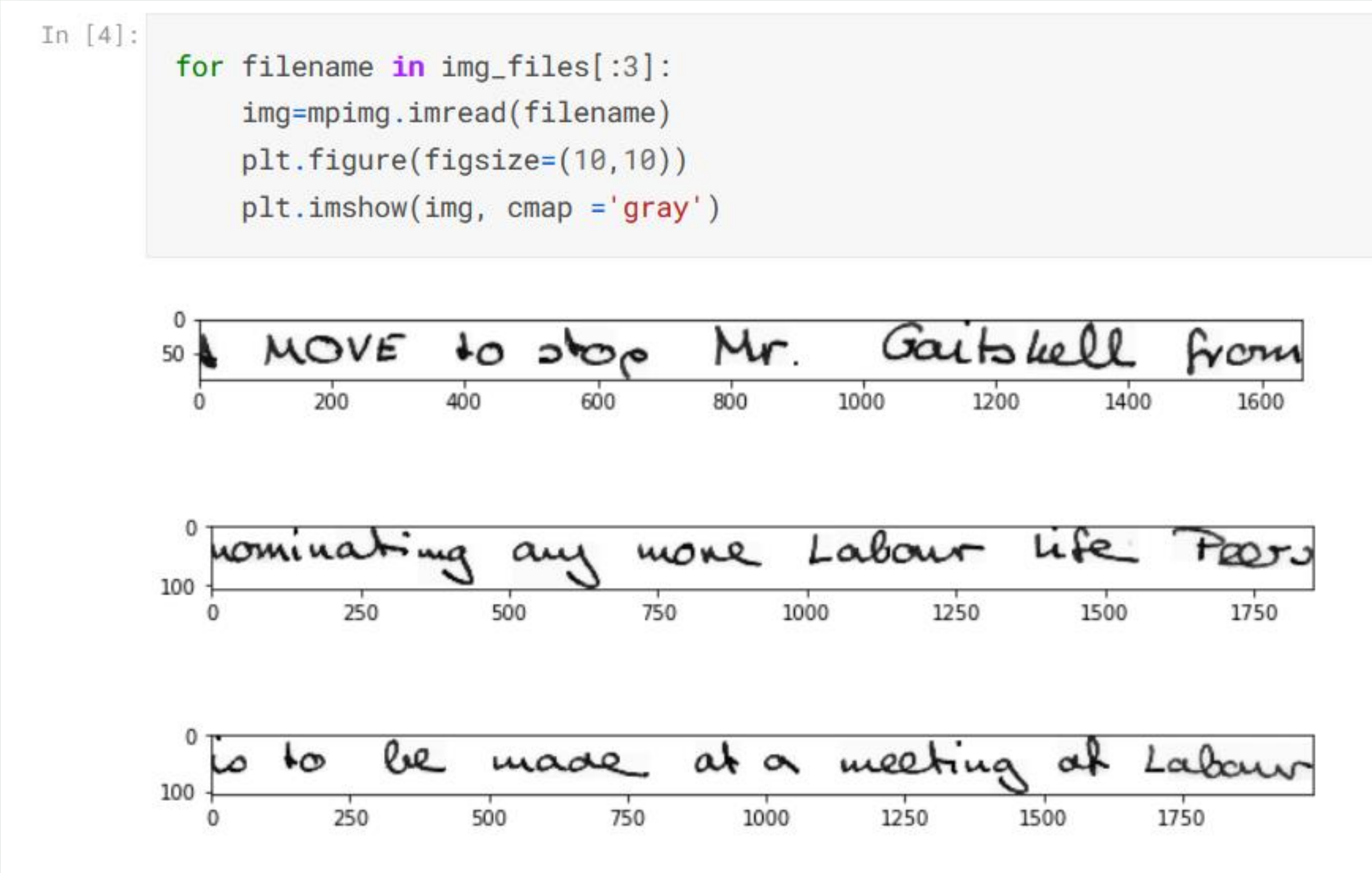
Design of the model



Following is the design of the model:

Layer (type)	Shape	Params
zero_padding2d_2 (Zero Padding)	`(None, 115, 115, 1)`	0
lambda_2 (Lambda)	`(None, 56, 56, 1)`	0
conv1 (Conv2D)	`(None, 28, 28, 32)`	832
activation_7 (Activation)	`(None, 28, 28, 32)`	0
pool1 (MaxPooling2D)	`(None, 14, 14, 32)`	0
conv2 (Conv2D)	`(None, 14, 14, 64)`	18496
activation_8 (Activation)	`(None, 14, 14, 64)`	0
pool2 (MaxPooling2D)	`(None, 7, 7, 64)`	0
conv3 (Conv2D)	`(None, 7, 7, 128)`	73856
activation_9 (Activation)	`(None, 7, 7, 128)`	0
pool3 (MaxPooling2D)	`(None, 3, 3, 128)`	0
flatten_2 (Flatten)	`(None, 1152)`	0
dropout_4 (Dropout)	`(None, 1152)`	0
dense1 (Dense)	`(None, 512)`	590336
activation_10 (Activation)	`(None, 512)`	0
dropout_5 (Dropout)	`(None, 512)`	0
dense2 (Dense)	`(None, 256)`	131328
activation_11 (Activation)	`(None, 256)`	0
dropout_6 (Dropout)	`(None, 256)`	0
output (Dense)	`(None, 50)`	12850
activation_12 (Activation)	`(None, 50)`	0

Visualize the image data.



```
In [4]:
for filename in img_files[:3]:
    img=mpimg.imread(filename)
    plt.figure(figsize=(10,10))
    plt.imshow(img, cmap ='gray')
```

A MOVE to stop Mr. Gaitskell from
0
50
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200
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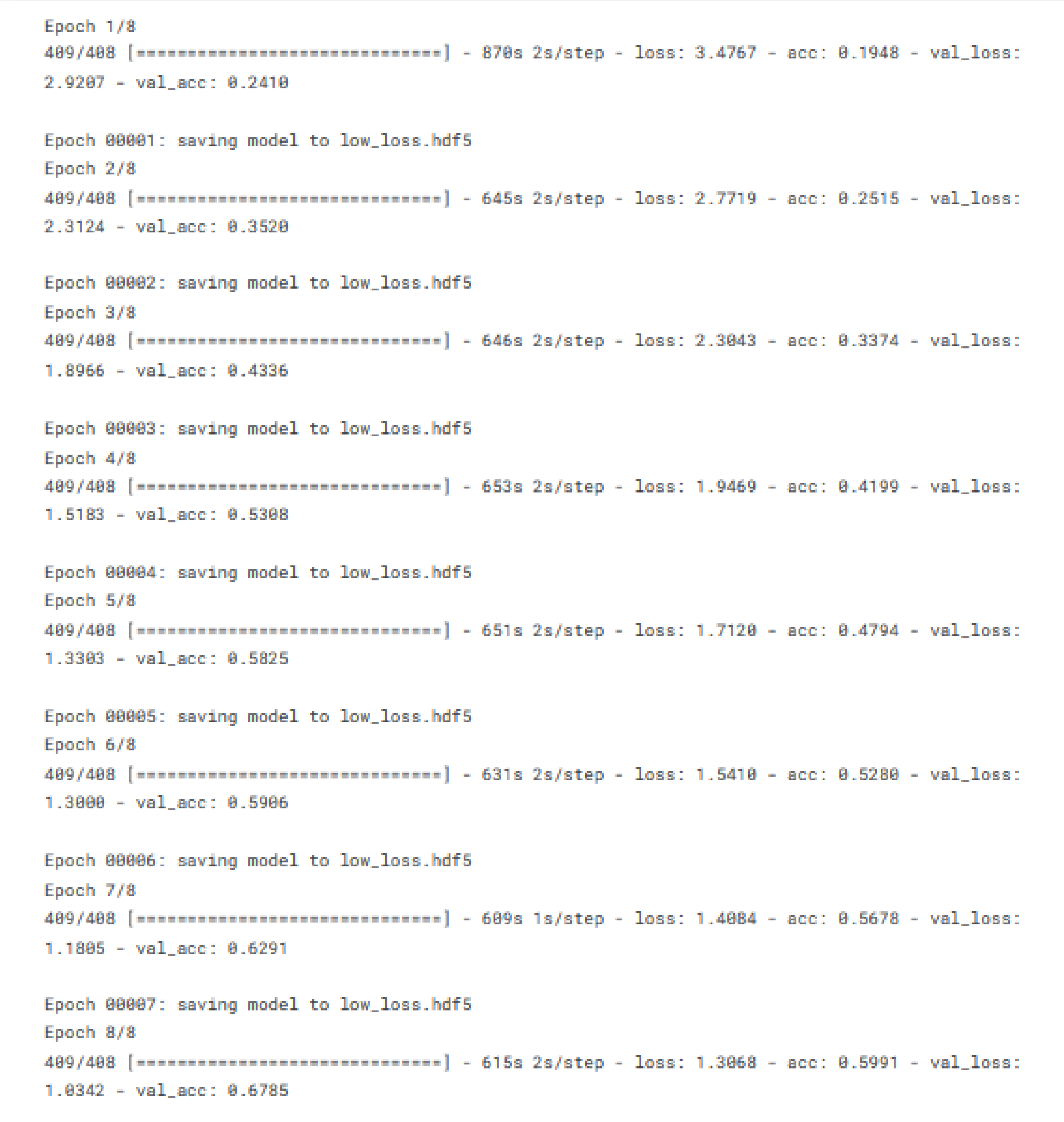
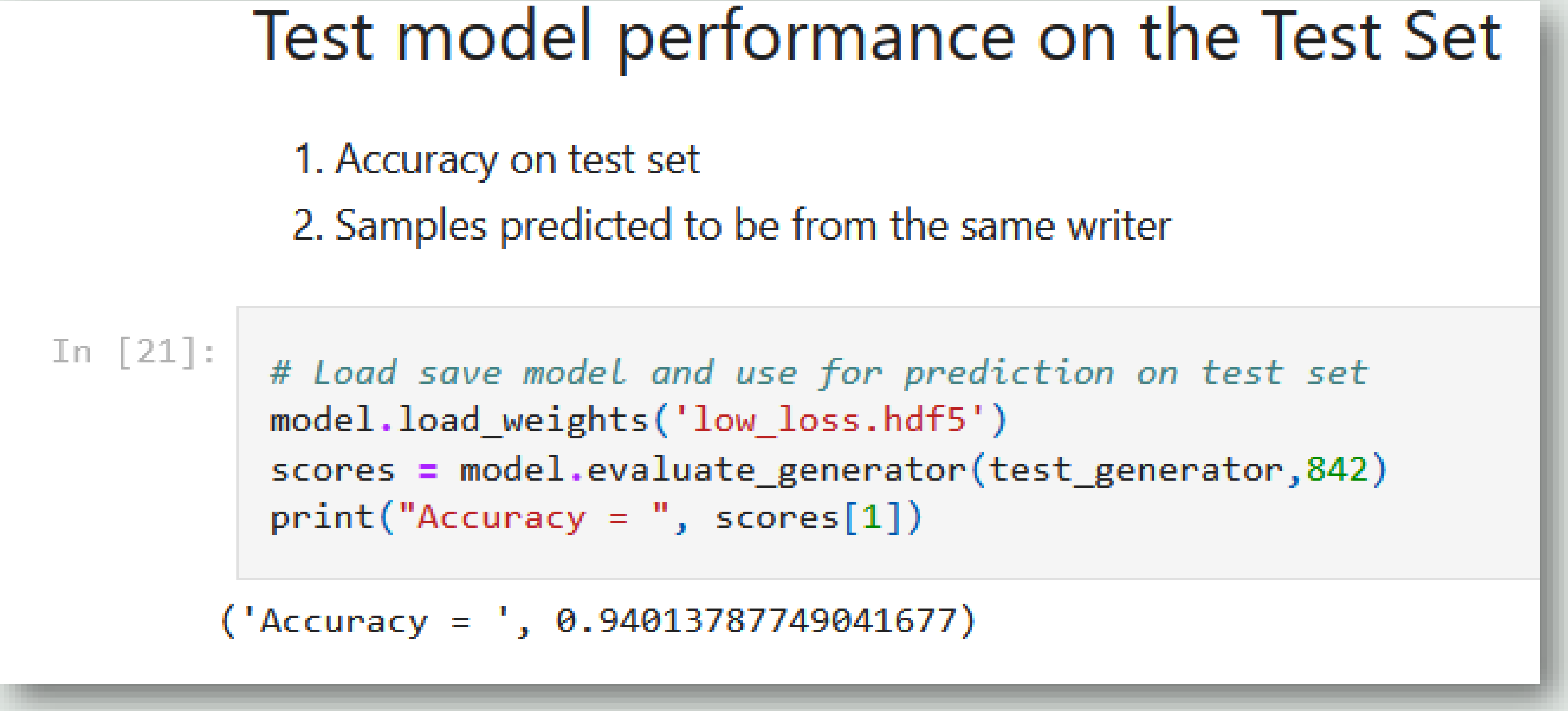
1250
1500
1750

Taking 8 epoch



```
Epoch 1/8
409/408 [==============================] - 870s 2s/step - loss: 3.4767 - acc: 0.1948 - val_loss:
2.9207 - val_acc: 0.2410

Epoch 00001: saving model to low_loss.hdf5
Epoch 2/8
409/408 [==============================] - 645s 2s/step - loss: 2.7719 - acc: 0.2515 - val_loss:
2.3124 - val_acc: 0.3520

Epoch 00002: saving model to low_loss.hdf5
Epoch 3/8
409/408 [==============================] - 646s 2s/step - loss: 2.3043 - acc: 0.3374 - val_loss:
1.8966 - val_acc: 0.4336

Epoch 00003: saving model to low_loss.hdf5
Epoch 4/8
409/408 [==============================] - 653s 2s/step - loss: 1.9469 - acc: 0.4199 - val_loss:
1.5183 - val_acc: 0.5308

Epoch 00004: saving model to low_loss.hdf5
Epoch 5/8
409/408 [==============================] - 651s 2s/step - loss: 1.7120 - acc: 0.4794 - val_loss:
1.3303 - val_acc: 0.5825

Epoch 00005: saving model to low_loss.hdf5
Epoch 6/8
409/408 [==============================] - 631s 2s/step - loss: 1.5410 - acc: 0.5280 - val_loss:
1.3000 - val_acc: 0.5906

Epoch 00006: saving model to low_loss.hdf5
Epoch 7/8
409/408 [==============================] - 609s 1s/step - loss: 1.4084 - acc: 0.5678 - val_loss:
1.1805 - val_acc: 0.6291

Epoch 00007: saving model to low_loss.hdf5
Epoch 8/8
409/408 [==============================] - 615s 2s/step - loss: 1.3068 - acc: 0.5991 - val_loss:
1.0342 - val_acc: 0.6785
```

Accuracy of the Model



Test model performance on the Test Set

1. Accuracy on test set
2. Samples predicted to be from the same writer

In [21]:

```python
# Load save model and use for prediction on test set
model.load_weights('low_loss.hdf5')
scores = model.evaluate_generator(test_generator,842)
print("Accuracy = ", scores[1])
```

```
('Accuracy = ', 0.94013787749041677)
```

Link to Code: https://www.kaggle.com/code/gkshaw/handwriting-recognition-cnn/edit

Future Work

Accuracy

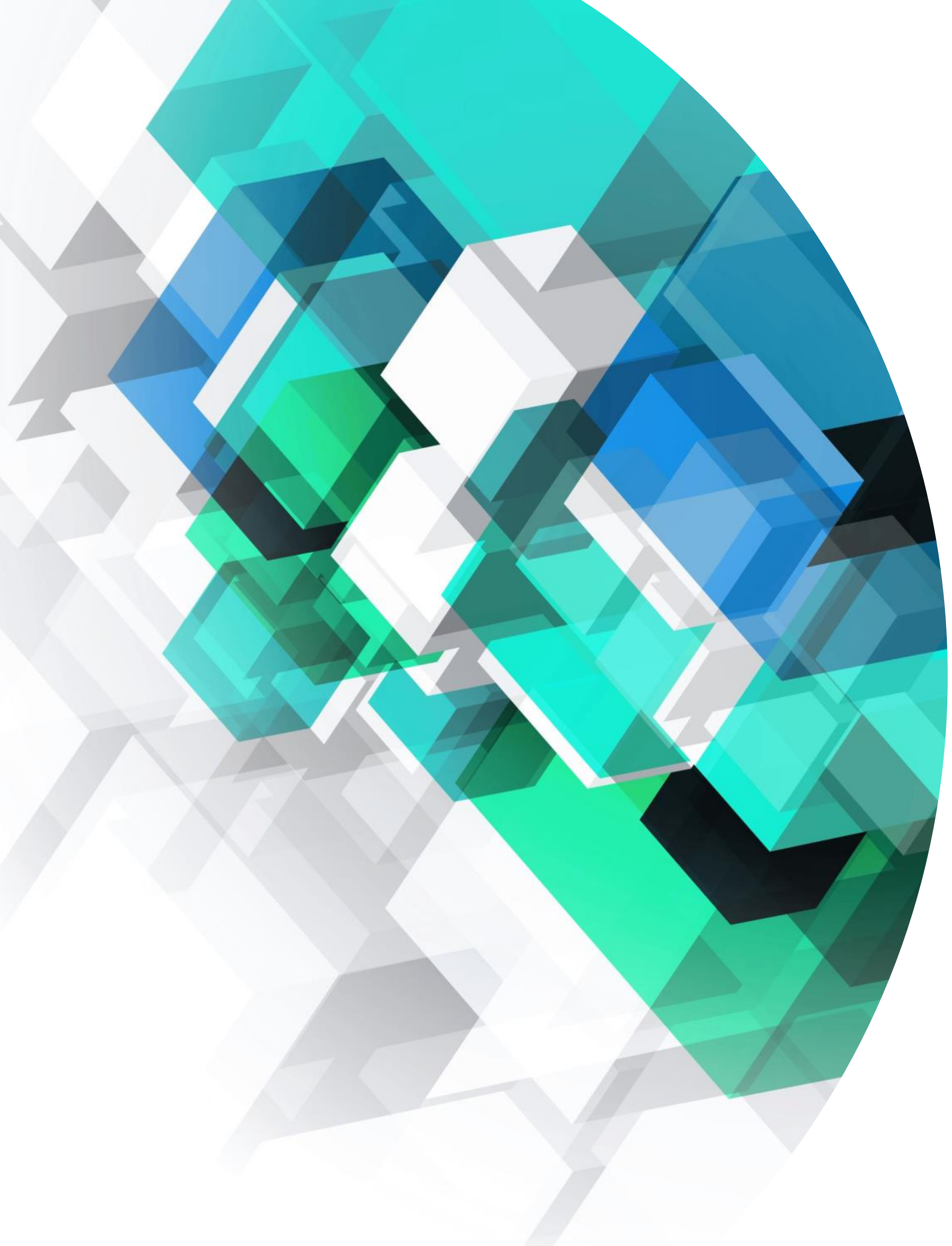
- **Accuracy can be improved** by applying other **advanced techniques** like **LSTM**.

Link to the Github repository code.

https://github.com/Gourav1695/BTech_Final_Project

References

- https://towardsdatascience.com/handwriting-recognition-using-tensorflow-and-keras-819b36148fe5
- https://www.tensorflow.org/api_docs
- https://keras.io/
- https://www.linkedin.com/pulse/handwritten-text-recognition-using-deep-learning-cnn-rnn-dikhit/



Thank You!

Feel free to ask any further questions. ☺