Devanagari Character Recognition using Deep Learning

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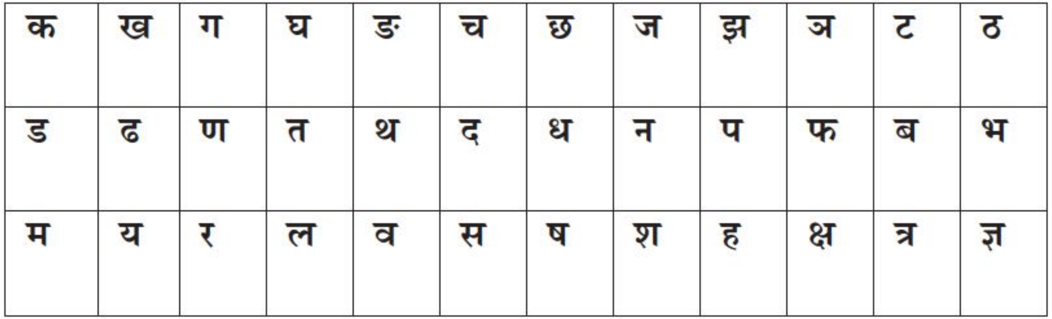
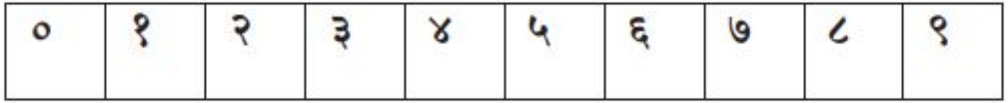
Devanagari Script

Devanagari is part of the Brahmic family of scripts of Nepal, India, Tibet, and South-East Asia. Devanagari script consists of 12 vowels, 36 base forms of consonant, 10 numeral characters.



क	ख	ग	घ	ङ	च	छ	ज	झ	ञ	ट	ठ
ड	ढ	ण	त	थ	द	ध	न	प	फ	ब	भ
म	य	र	ल	व	स	ष	श	ह	क्ष	त्र	ज्ञ



०	१	२	३	४	५	६	७	८	९

Problem Statement

To recognise Devanagari Characters from Images

Overview

The project proposes a model for Devanagari Character Recognition based on ConvNet.

Challenges

1. The complexity of the Devanagari Script.
2. There are total 46 classes for classification

Tools and Languages

Python

Keras

H5py & Numpy Library

Bottle

Process

Data Collection

Image Preprocessing

Training

Prediction

Dataset

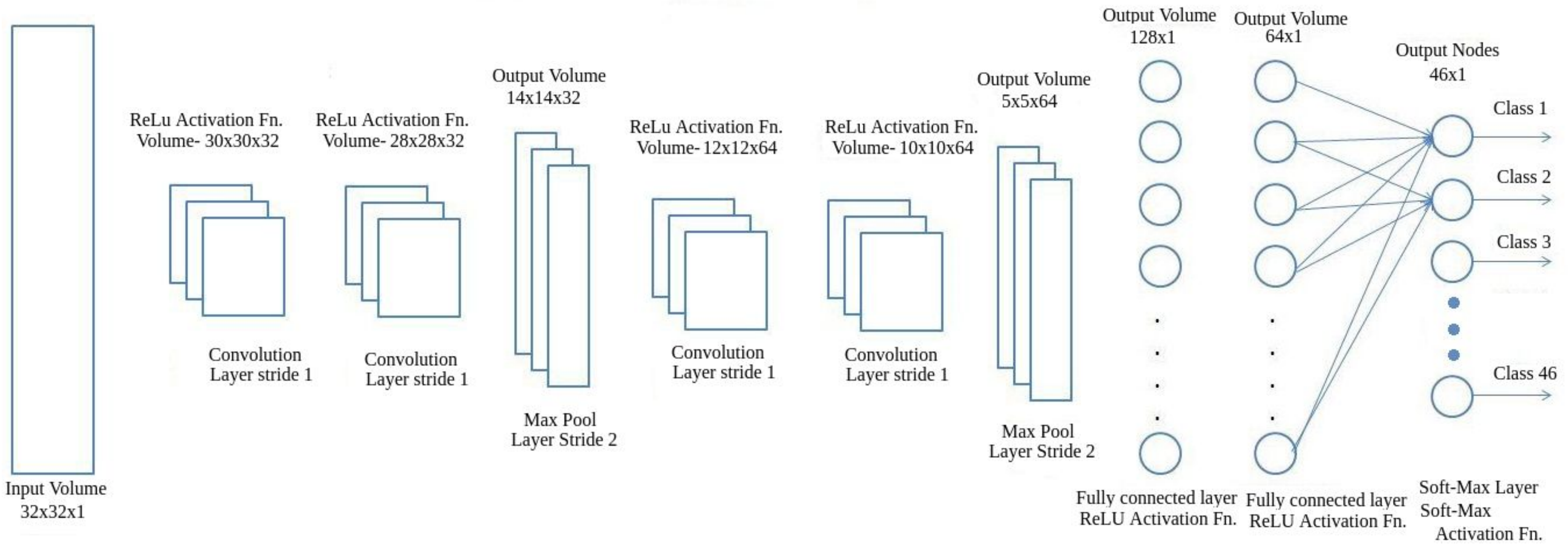
The dataset for the system is collected from the UCI machine learning repository. It contains **92000** grayscale images of **46** classes including the 10 digits class.

The image size is **32x32** pixels but the actual image size is **28x28** pixels with 2 pixel padding in each direction. The image background is black(0) and the character is written in white(255).

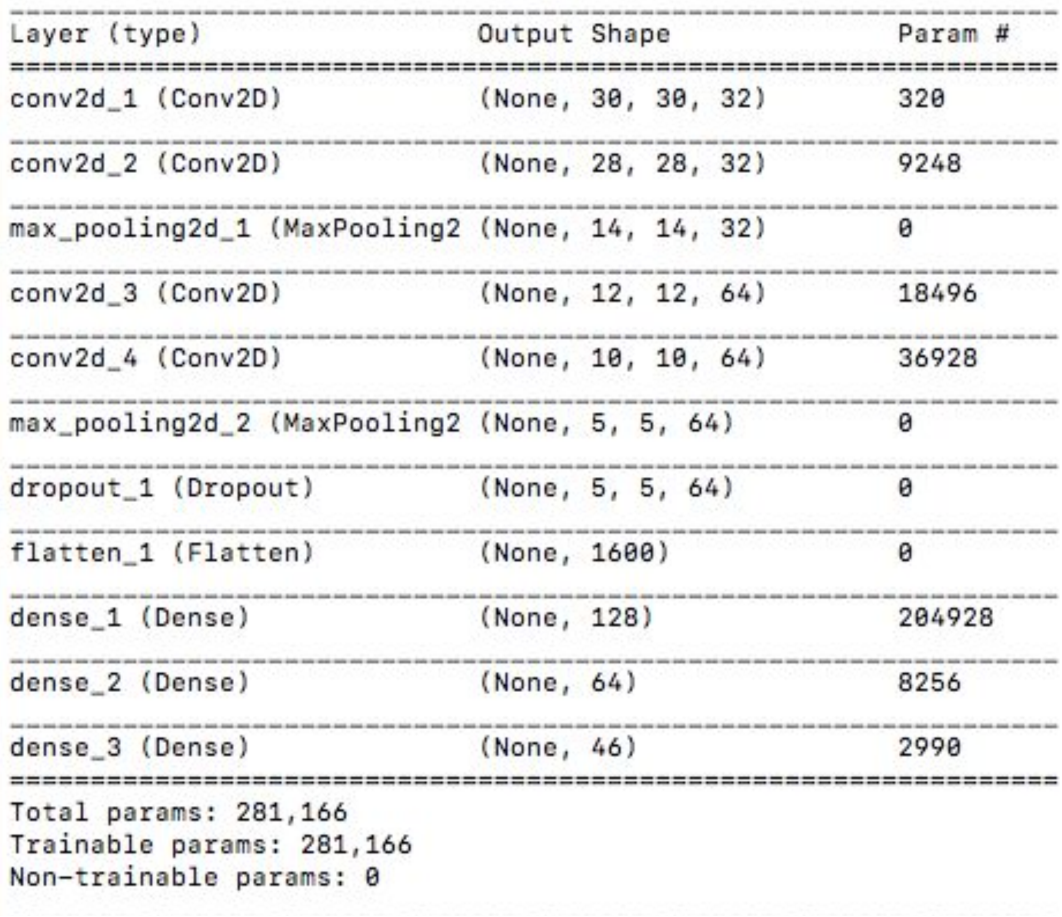
Image Preprocessing

As the preprocessing step in each iteration, few steps are carried out to evade the issue of overfitting. Common image augmentation steps are performed for preprocessing.

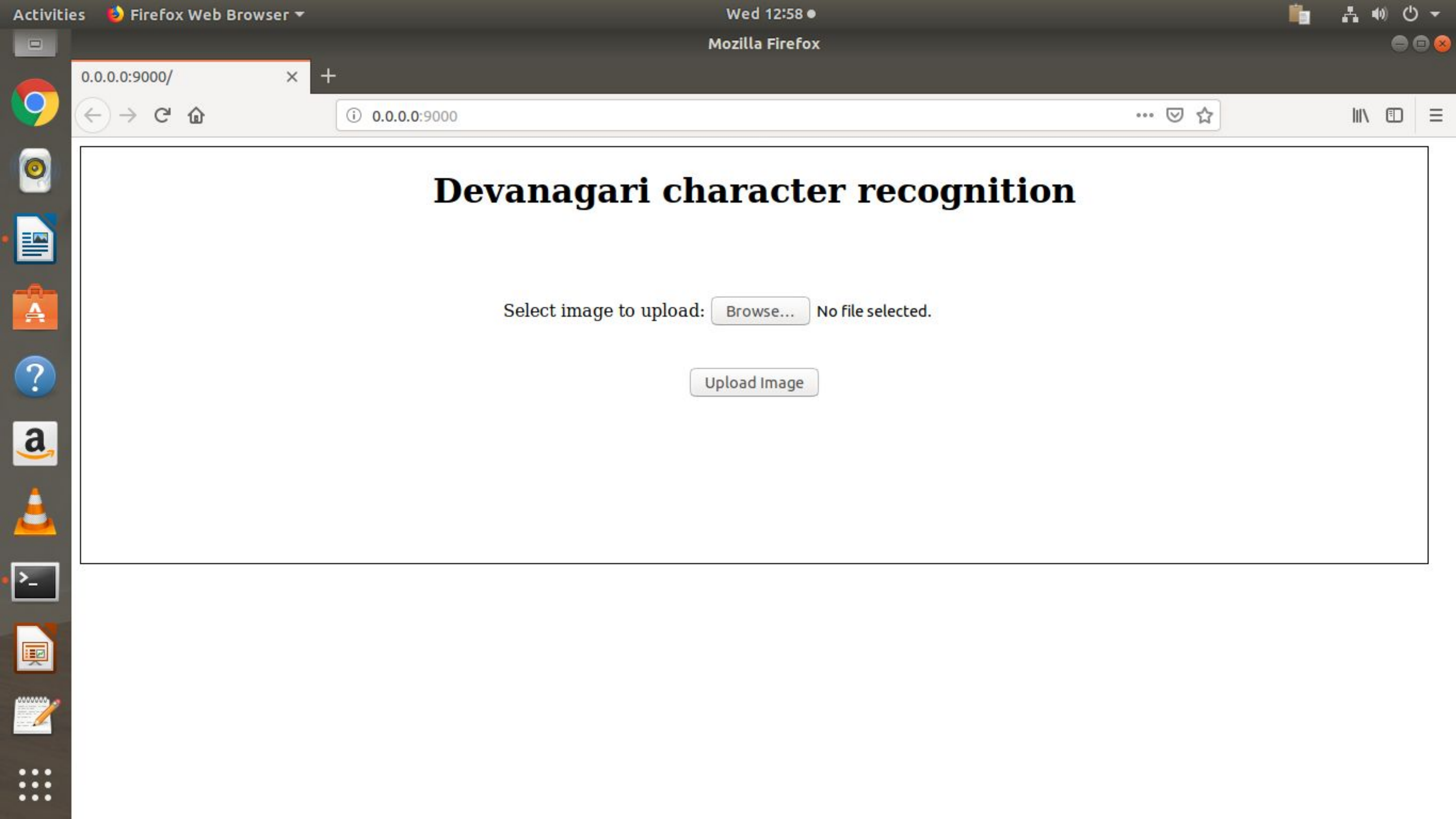
Architecture of the proposed model



Summary of the ConvNet Model used



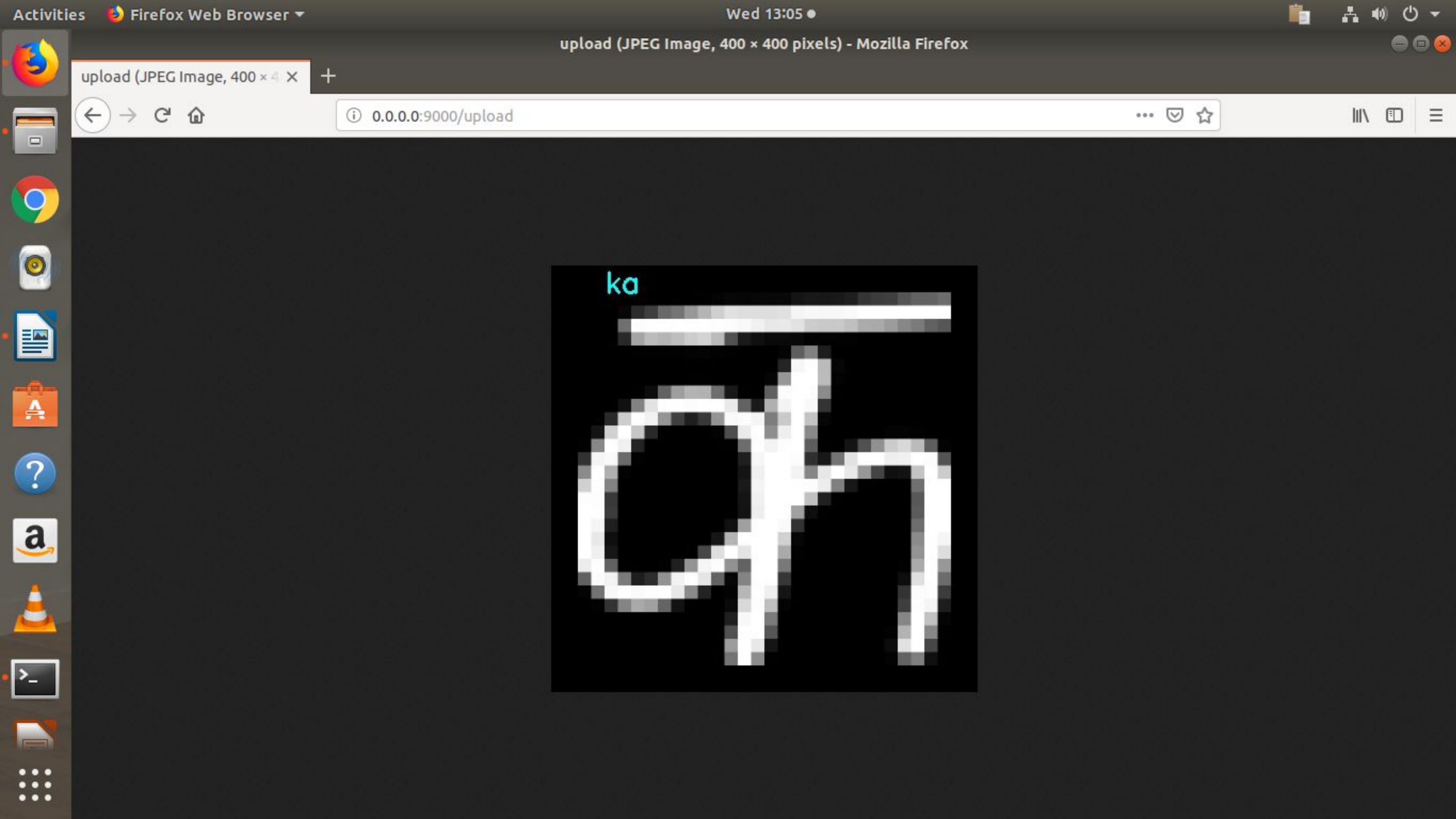
```
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_1 (Conv2D)            (None, 30, 30, 32)        320
_________________________________________________________________
conv2d_2 (Conv2D)            (None, 28, 28, 32)        9248
_________________________________________________________________
max_pooling2d_1 (MaxPooling2 (None, 14, 14, 32)        0
_________________________________________________________________
conv2d_3 (Conv2D)            (None, 12, 12, 64)        18496
_________________________________________________________________
conv2d_4 (Conv2D)            (None, 10, 10, 64)        36928
_________________________________________________________________
max_pooling2d_2 (MaxPooling2 (None, 5, 5, 64)          0
_________________________________________________________________
dropout_1 (Dropout)          (None, 5, 5, 64)          0
_________________________________________________________________
flatten_1 (Flatten)          (None, 1600)              0
_________________________________________________________________
dense_1 (Dense)              (None, 128)               204928
_________________________________________________________________
dense_2 (Dense)              (None, 64)                8256
_________________________________________________________________
dense_3 (Dense)              (None, 46)                2990
=================================================================
Total params: 281,166
Trainable params: 281,166
Non-trainable params: 0
```

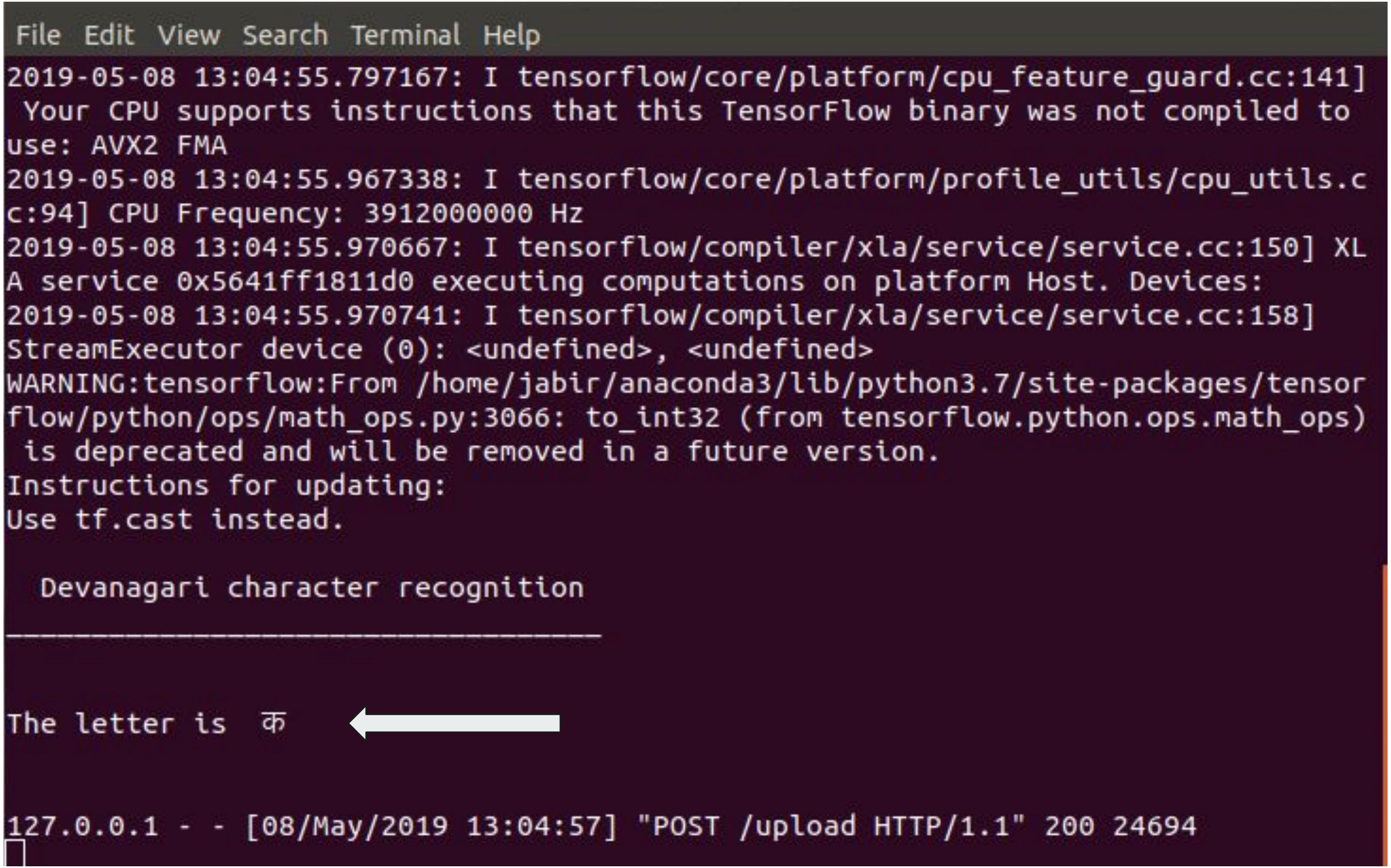


Devanagari character recognition

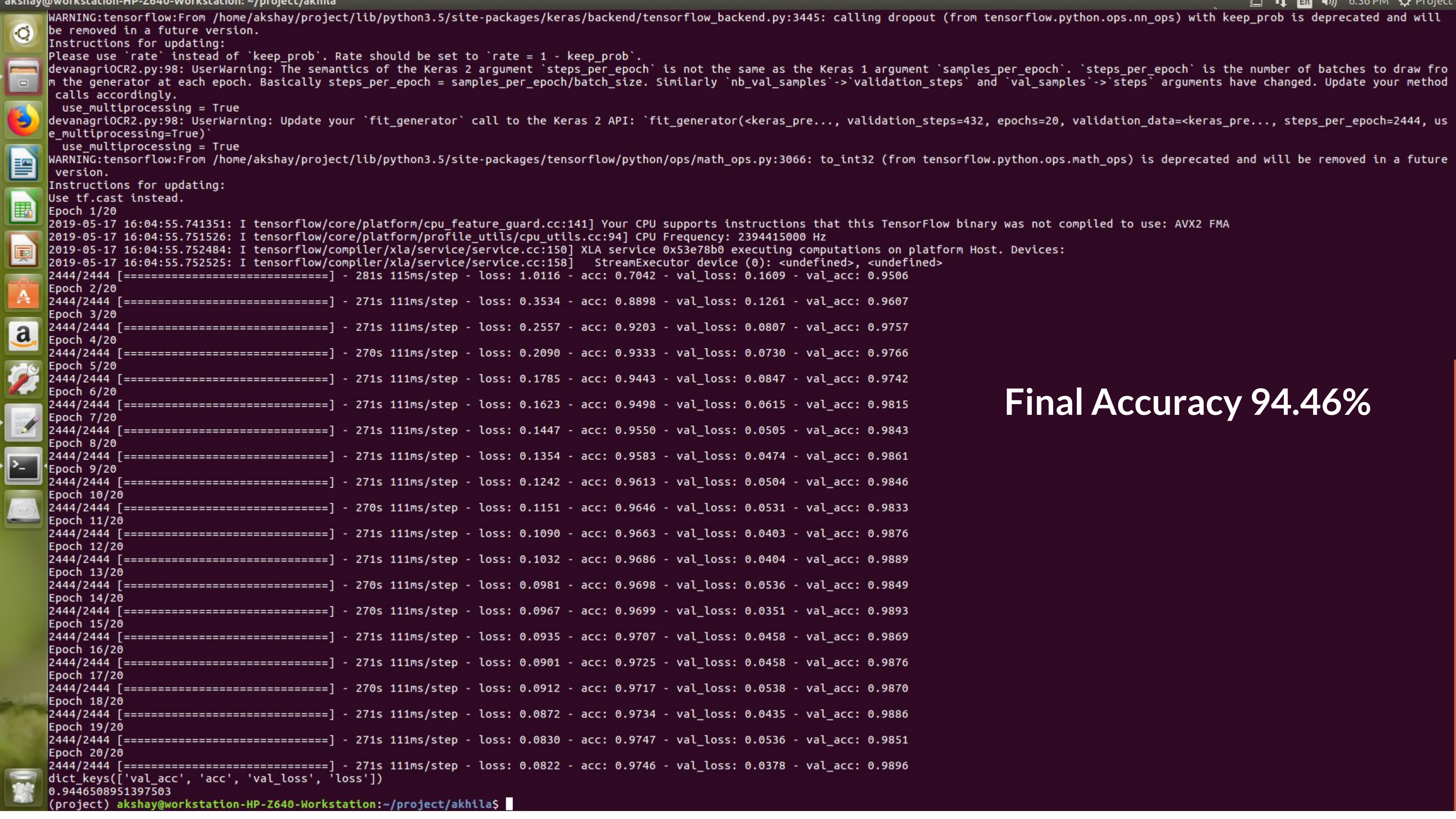
Select image to upload: Browse... No file selected.

Upload Image


Activities
Firefox Web Browser
Wed 13:05
upload (JPEG Image, 400 × 400 pixels) - Mozilla Firefox
upload (JPEG Image, 400 × 4
0.0.0.0:9000/upload
ka



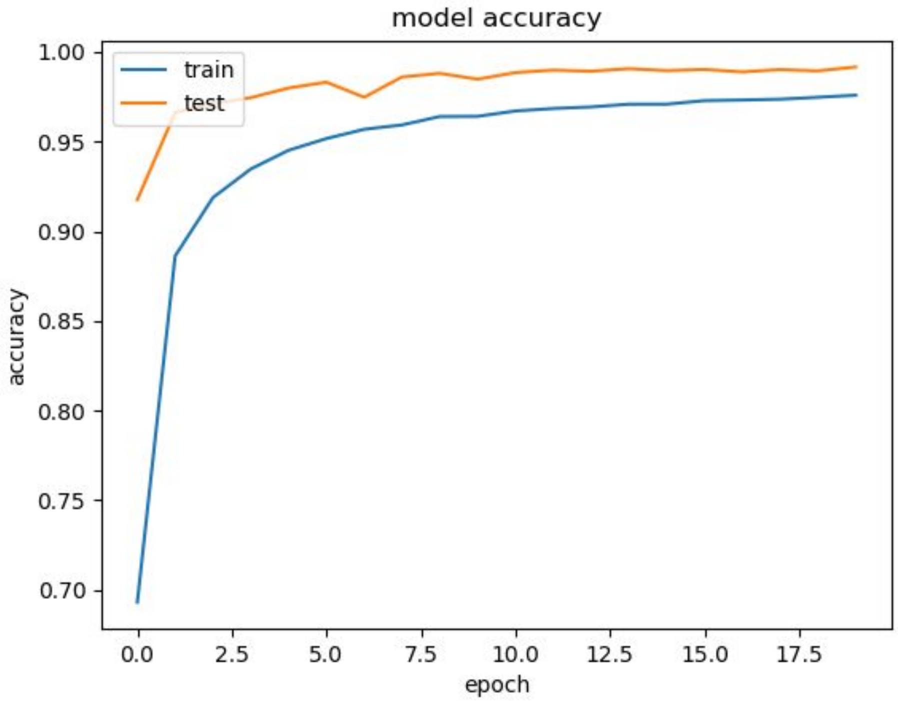
```
2019-05-08 13:04:55.797167: I tensorflow/core/platform/cpu_feature_guard.cc:141]
 Your CPU supports instructions that this TensorFlow binary was not compiled to
use: AVX2 FMA
2019-05-08 13:04:55.967338: I tensorflow/core/platform/profile_utils/cpu_utils.c
c:94] CPU Frequency: 3912000000 Hz
2019-05-08 13:04:55.970667: I tensorflow/compiler/xla/service/service.cc:150] XL
A service 0x5641ff1811d0 executing computations on platform Host. Devices:
2019-05-08 13:04:55.970741: I tensorflow/compiler/xla/service/service.cc:158]
StreamExecutor device (0): <undefined>, <undefined>
WARNING:tensorflow:From /home/jabir/anaconda3/lib/python3.7/site-packages/tensor
flow/python/ops/math_ops.py:3066: to_int32 (from tensorflow.python.ops.math_ops)
 is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.

  Devanagari character recognition

___________________________________


The letter is  क


127.0.0.1 - - [08/May/2019 13:04:57] "POST /upload HTTP/1.1" 200 24694
```



```
WARNING:tensorflow:From /home/akshay/project/lib/python3.5/site-packages/keras/backend/tensorflow_backend.py:3445: calling dropout (from tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will
be removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`.
devanagriOCR2.py:98: UserWarning: The semantics of the Keras 2 argument `steps_per_epoch` is not the same as the Keras 1 argument `samples_per_epoch`. `steps_per_epoch` is the number of batches to draw fro
m the generator at each epoch. Basically steps_per_epoch = samples_per_epoch/batch_size. Similarly `nb_val_samples`->`validation_steps` and `val_samples`->`steps` arguments have changed. Update your method
 calls accordingly.
  use_multiprocessing = True
devanagriOCR2.py:98: UserWarning: Update your `fit_generator` call to the Keras 2 API: `fit_generator(<keras_pre..., validation_steps=432, epochs=20, validation_data=<keras_pre..., steps_per_epoch=2444, us
e_multiprocessing=True)`
  use_multiprocessing = True
WARNING:tensorflow:From /home/akshay/project/lib/python3.5/site-packages/tensorflow/python/ops/math_ops.py:3066: to_int32 (from tensorflow.python.ops.math_ops) is deprecated and will be removed in a future
 version.
Instructions for updating:
Use tf.cast instead.
Epoch 1/20
2019-05-17 16:04:55.741351: I tensorflow/core/platform/cpu_feature_guard.cc:141] Your CPU supports instructions that this TensorFlow binary was not compiled to use: AVX2 FMA
2019-05-17 16:04:55.751526: I tensorflow/core/platform/profile_utils/cpu_utils.cc:94] CPU Frequency: 2394415000 Hz
2019-05-17 16:04:55.752484: I tensorflow/compiler/xla/service/service.cc:150] XLA service 0x53e78b0 executing computations on platform Host. Devices:
2019-05-17 16:04:55.752525: I tensorflow/compiler/xla/service/service.cc:158]   StreamExecutor device (0): <undefined>, <undefined>
2444/2444 [==============================] - 281s 115ms/step - loss: 1.0116 - acc: 0.7042 - val_loss: 0.1609 - val_acc: 0.9506
Epoch 2/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.3534 - acc: 0.8898 - val_loss: 0.1261 - val_acc: 0.9607
Epoch 3/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.2557 - acc: 0.9203 - val_loss: 0.0807 - val_acc: 0.9757
Epoch 4/20
2444/2444 [==============================] - 270s 111ms/step - loss: 0.2090 - acc: 0.9333 - val_loss: 0.0730 - val_acc: 0.9766
Epoch 5/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1785 - acc: 0.9443 - val_loss: 0.0847 - val_acc: 0.9742
Epoch 6/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1623 - acc: 0.9498 - val_loss: 0.0615 - val_acc: 0.9815
Epoch 7/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1447 - acc: 0.9550 - val_loss: 0.0505 - val_acc: 0.9843
Epoch 8/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1354 - acc: 0.9583 - val_loss: 0.0474 - val_acc: 0.9861
Epoch 9/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1242 - acc: 0.9613 - val_loss: 0.0504 - val_acc: 0.9846
Epoch 10/20
2444/2444 [==============================] - 270s 111ms/step - loss: 0.1151 - acc: 0.9646 - val_loss: 0.0531 - val_acc: 0.9833
Epoch 11/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1090 - acc: 0.9663 - val_loss: 0.0403 - val_acc: 0.9876
Epoch 12/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.1032 - acc: 0.9686 - val_loss: 0.0404 - val_acc: 0.9889
Epoch 13/20
2444/2444 [==============================] - 270s 111ms/step - loss: 0.0981 - acc: 0.9698 - val_loss: 0.0536 - val_acc: 0.9849
Epoch 14/20
2444/2444 [==============================] - 270s 111ms/step - loss: 0.0967 - acc: 0.9699 - val_loss: 0.0351 - val_acc: 0.9893
Epoch 15/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.0935 - acc: 0.9707 - val_loss: 0.0458 - val_acc: 0.9869
Epoch 16/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.0901 - acc: 0.9725 - val_loss: 0.0458 - val_acc: 0.9876
Epoch 17/20
2444/2444 [==============================] - 270s 111ms/step - loss: 0.0912 - acc: 0.9717 - val_loss: 0.0538 - val_acc: 0.9870
Epoch 18/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.0872 - acc: 0.9734 - val_loss: 0.0435 - val_acc: 0.9886
Epoch 19/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.0830 - acc: 0.9747 - val_loss: 0.0536 - val_acc: 0.9851
Epoch 20/20
2444/2444 [==============================] - 271s 111ms/step - loss: 0.0822 - acc: 0.9746 - val_loss: 0.0378 - val_acc: 0.9896
dict_keys(['val_acc', 'acc', 'val_loss', 'loss'])
0.9446508951397503
(project) akshay@workstation-HP-Z640-Workstation:~/project/akhila$
```

Final Accuracy 94.46%

Performance Evaluation



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**International Journal for Science and
Advance Research in Technology (IJSART)**

Devanagari Character Recognition using ConvNet

Authors: Akhila VU & Prof. Vinya Vijayan

Conclusion

An efficient model for Devanagari Character Recognition is designed in ConvNet which classifies almost all the script Images.

References

- Devanagari Script Character Recognition Using Machine Learning

  https://towardsdatascience.com/devanagari-script-character-recognition-using-machine-learning-6006b40fa6a9

- Devanagari Character Recognition Using Artificial Neural Network

  International Journal of Engineering and Technology 9(3):2161-2167
  DOI: 10.21817/ijet/2017/v9i3/1709030246

धन्यवाद