RNS INSTITUTE OF TECHNOLOGY

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
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Project Guide :

Accepted :

To Review :

Reviewer Initials & Signature

Rejected :

Synopsis on

MORPHOLOGICAL TAXONOMY OF GALAXIES USING CONVOLUTIONAL NEURAL NETWORKS

Place of Project Work : RNS Institute of Technology

By,

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MORPHOLOGICAL TAXONOMY OF GALAXIES USING CONVOLUTIONAL NEURAL NETWORKS

STUDY AREA :

Deep Learning, Image Processing

INTRODUCTION :

There are millions of huge collections of stars, gas, dust and stellar remnants all held together by gravity in our vast Universe. These collections, called galaxies, play a crucial part in understanding the large scale structure of the universe. The classification of these galaxies based on morphological parameters is a relevant requirement to understand their formation and evolution. Manual identification of the categories to which each belongs to can be tiresome, time consuming and error prone. The objective of our project is to automate the classification process using convolutional neural networks, a cardinal concept in the image data space, whilst comparing the accuracy of the classification with and without prior processing of the image dataset.

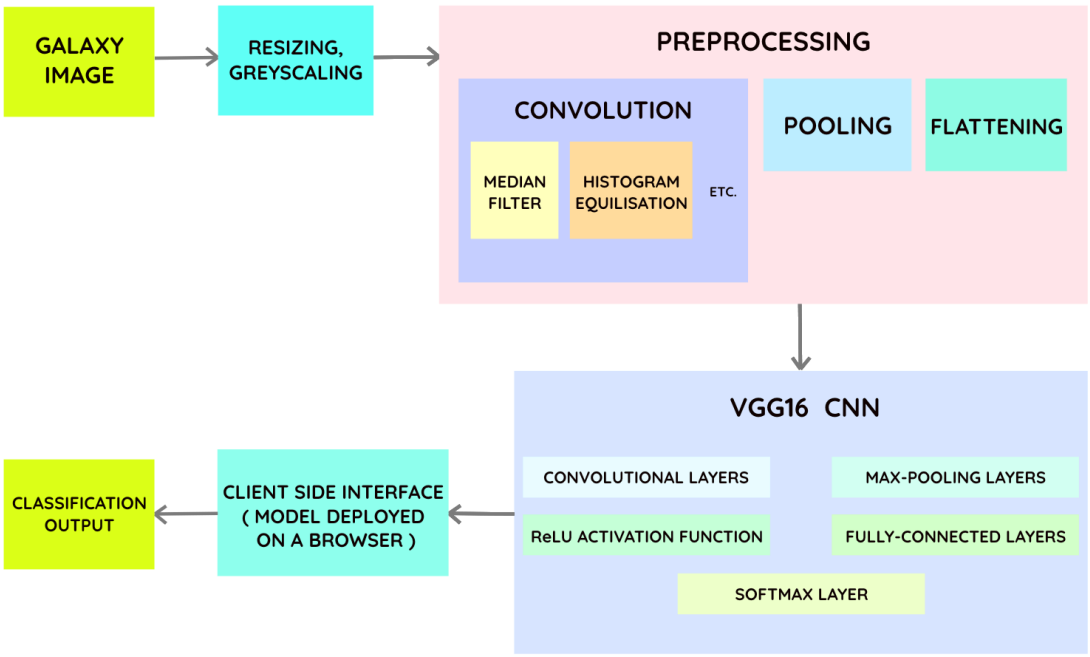
DATA :

- The dataset that will be used in the project is from the Galaxy Zoo Challenge produced by Kaggle, teamed up with Galaxy Zoo and Winton Capital. Link - https://www.kaggle.com/c/galaxy-zoo-the-galaxy-challenge/overview/description . There are around 60,000 images in the training set, a part of which will be used for validation, and around 80,000 images in the test set.

METHODOLOGY :

- The images are first resized to 224*224 and preprocessed. The steps for preprocessing include convolution, pooling, flattening.
- In convolution, the input image is matrix convoluted with various filters to obtain the feature map.
- Some of the filters used to process the images are median filtering and histogram equilisation for noise reduction and contrast adjustment.
- Pooling involves reducing the spacial size of the image to reduce the amount of parameters and computation in the network.
- Then the pooled image will be flattened and that is converted into a vector.
- Padding which is a process of adding layers of zeros to the input layer can be done to prevent shrinking of the images as the convolution or pooling layer increases.
- The CNN architecture that we are using to classify the images is Vgg16.
- Vgg16 has a total of 16 layers of which there are 12 convolutional layers, several max-pooling layers, ReLU(Rectified Linear Unit) activation function, fully-connected layer and softmax layer.
- The images will be passed through multiple convolutional layers with filters which have a receptive field of 3*3. This network has approximately 138 million parameters.
- The stride size is fixed to 1 pixel. The hidden layers have ReLU functions as activation function to prevent forwarding negative values.
- The data is then flattened and sent to dense layer. ReLU function will be added again to prevent passing negative values in the network.
- The softmax layer will output in the range 0 to 1.
- The model will then be deployed on a browser. The deployment process will be done by using tensorflow.js or flask based on the volume of the model.
- On the client side interface, the user can submit an image of a galaxy. This image will be fed as the input to the model and the model classifies the image and returns the output. The output is then rendered on the client side interface.

BLOCK DIAGRAM



SOFTWARE REQUIREMENTS :

- Jupyter Notebook / Google Collab
- Keras
- Open CV
- Tensorflow.js / Flask

OBJECTIVE OF THE PROPOSED PROJECT :

- Given an image, the model should be able to predict the type of the galaxy based on morphology, from the following three categories - Elliptical, Spiral and Irregular, with a good accuracy.
- We should be able to identify which model turns out to be the most accurate - the one without preprocessed images as the inputs or the one with the inputs having gone through image preprocessing.
- We aim to have a client side interface where the user can upload an image of a galaxy and get to know which type the galaxy falls under.

APPLICATIONS :

- Galaxy morphological classification on a large-scale database is important to help astronomers reduce classification errors and to help them produce information of statistical and observational importance as well as discovering the mystery of the universe at large.
- Classification of galaxies on morphological parameters helps in deducing some information about the formation and evolution of galaxies.
- Modern astronomical data on galaxy classification has revealed powerfully the existence of certain dark sectors of fundamental physics, that is the existence of particles and fields outside the standard models.

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[3] Fernando Caro, Marc Huertas-Company and Guillermo Cabrera, "Morphology and Interaction of Galaxies using Deep Learning", Published online by Cambridge University Press: 30 May 2017.