KLE Society's

KLE Technological University

A Course Project

On

HackerEarth's Deep Learning Challenge: 'Tis STILL the Season to be Jolly

submitted in partial fulfillment of the course

Machine Learning (17ECSC306)

in

School of Computer Science and Engineering

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Academic year 2020-21

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Acknowledgement

We would like to express our sincere gratitude to all those people who have assisted us in the completion of this project, without whose help it could not have been possible. All their contributions are deeply appreciated and acknowledged.

We would also like to thank Dr. Meena S M, Professor, and Head of Department, School of Computer Science and Engineering for having provided the opportunity to extend our skills in the direction of this project.

We express our heartfelt gratitude to both our guides and course teachers, Prof. Uday Nagaraj Kulkarni, and Prof. Sunil V. Gurlahosur, whose valuable insights proved to be vital in contributing to the success of this course project.

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Abstract

This project is the solution of a problem statement on the online competing platform HackerEarth. The problem "HackerEarth Deep Learning Challenge: 'Tis STILL the season to be jolly" focuses on Multi-Label Classification using Deep Learning. The platform wants the participants to build a model that would be able to tell if a post on a social media platform is holiday related or not. To accomplish this task the platform has given the task of classifying the images into 6 classes

- Airplane
- Jacket
- Snowman
- Christmas Tree
- Candle
- Miscellaneous

Our model however can classify between 2 extra classes.

- Durga Puja
- Eid

The approach used in the project is that of Transfer Learning. The project uses pretrained InceptionV3 model with a few final layers added to suit our needs. The final accuracy that we achieved with our model with the aforementioned 8 classes was 92.93% on the training data and 87.35% on the validation data.

1 Introduction

1.1 Overview

Deep Learning is an application of Artificial Intelligence (AI) that provides systems with the ability to automatically learn and improve from experience without being explicitly programmed. Deep Learning is a science that determines patterns in data. These patterns are then used to better describe a problem and to provide a solution to it. As a subset of artificial intelligence, deep learning lies at the heart of various innovations: self-driving cars, natural language processing, image recognition, and so on.

Image recognition is one of the tasks in which deep neural networks (DNNs) excel. Neural network architecture is inspired by the human brain structure, hence the name. Although powerful, Deep convolution neural networks may take days or months to build. Hence emerged the intuition behind Transfer Learning, that if a model is trained on a large and general enough data set, this model will effectively serve as a generic model of the visual world. The knowledge of the pre-trained models is then transferred and used to solve other problems.

1.2 Problem Statement

The goal is to use Deep Learning to develop a model that classifies images based on elements within the picture.

Specifically, the elements in the pictures are related to holiday decor or holiday season vacations, such as a snowman, a Christmas tree and so on. These elements are essentially the classes in which the images have to be classified.

Hence, the task is to classify the images into the following eight classes: (i) Miscellaneous, (ii) Christmas Tree, (iii) Jacket, (iv) Candle, (v) Airplane (vi) Snowman (vii) Durga Puja and (viii) Eid

1.3 Objectives of the Project

A product recommendation system is a software tool designed to generate and provide suggestions for items or content a specific user would like to purchase or engage with. Utilizing machine learning techniques and various data about both individual products and individual users, the system creates an advanced net of complex connections between those products and those people.

The products on an e-commerce platform can be classified into categories during the holiday season sales using their images. This categorization will help monetizing the

platform. Hence, the objective is to built a model that will improve the product recommendation system for the e-commerce platform by using image classification.

1.4 Data Description

The dataset consists of two directories namely, train and test. The train data contains 6469 images belonging to 6 classes. An additional train.csv file is provided that lists the labels of all 6469 images in the train directory. The test data contains 3489 images.

Figure 1 and Table 1 describe the distribution of images in each of the 6 classes.

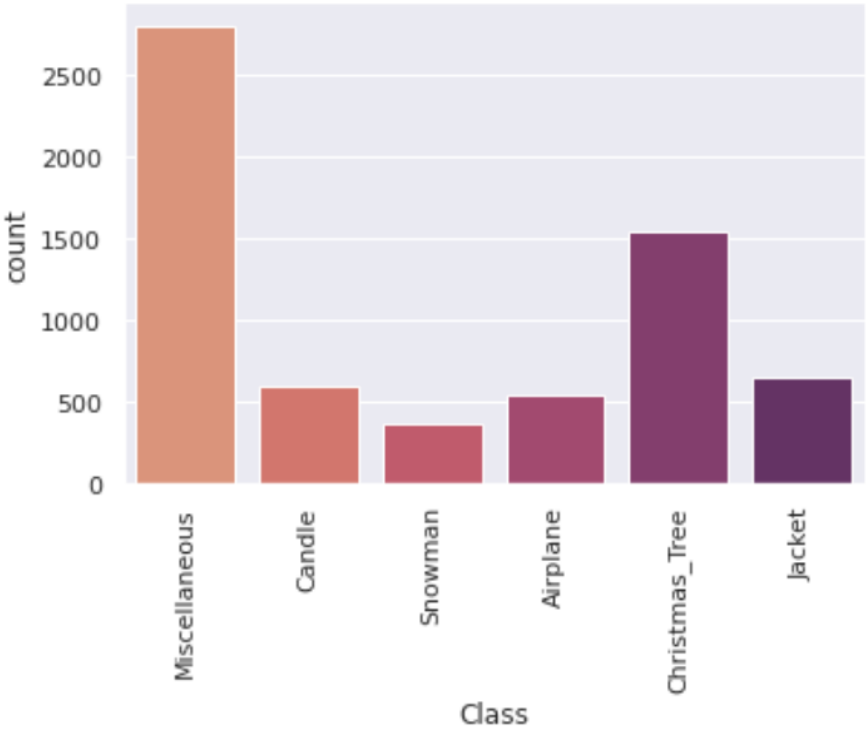


Figure 1: Bar plot showing distribution of data into 6 classes.

Class	Count
Miscellaneous	2801
Christmas Tree	1539
Jacket	640
Candle	593
Airplanes	535
Snowman	361

Table 1: Table showing count of images in each class

In addition to the data already available, 837 images belonging to 2 more classes namely,

Durga Puja and Eid have been added. Figure 2 shows the distribution after the addition of these images.

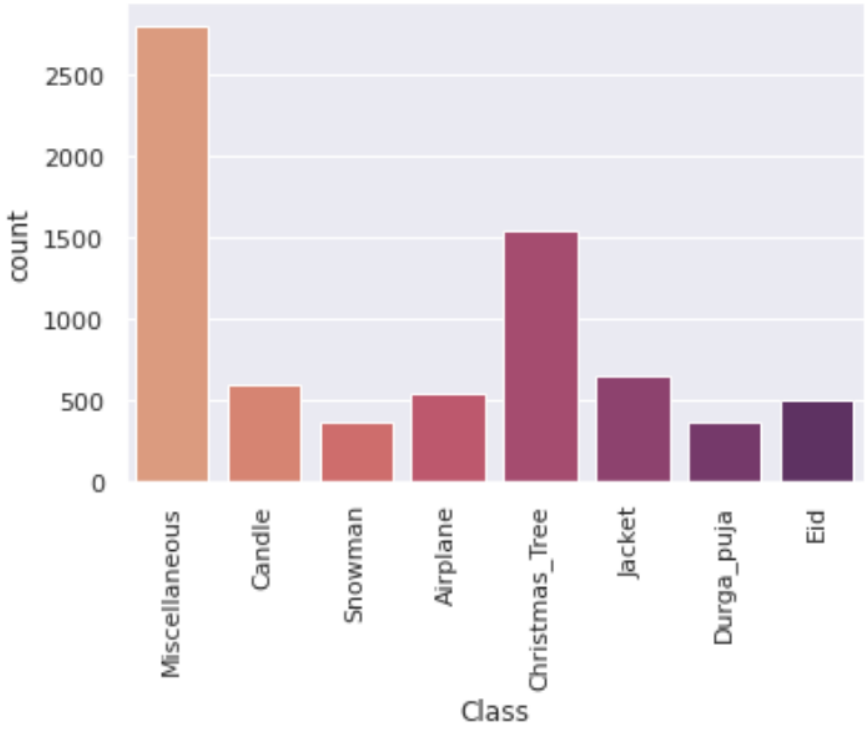


Figure 2: Bar plot showing distribution of data into 8 classes.

1.5 Literature Survey

The paper "Multi-class Image Classification Using Deep Learning Algorithm" [1], talks about Classifying images as a complex problem in the field of computer vision.Deep learning algorithms are computerized models that simulate the human brain functions and operations. Training a deep learning model is a costly process in machine resources and time. In this paper a convolutional neural network model pre-trained on Image-Net is used for classification of images on the PASCAL VOC 2007 data-set. The transfer learning approach is used to improve the performance of the deep learning CNN model where classification works fairly well with the smallest amount of computation time and fewer machine resources. The behavior of the Deep learning CNN model is studied and the performance has been measured. The obtained results are compared with the obtained test results from the Super-vector coding of local image descriptors method, SVM method, and Region Ranking SVM method, which tested with the PASCAL VOC 2007 data-set. The final results evaluate the deep learning algorithm as a state-of-the-art method for an image classification task.

2 Requirement Specification

The requirements specifications for the project are :

1. The deep learning model should be able to look at images and classify them between 8 given labels,
    - Airplane
    - Jacket
    - Snowman
    - Christmas Tree
    - Candle
    - Miscellaneous
    - Durga Puja
    - Eid
2. The deep learning model should be deployed on an edge device.
3. The mobile application that the model is deployed on should be able to tell the confidence percentage it has when displaying the class a certain image belongs to.
4. The mobile application should be able to make inference within a maximum of 3 seconds.

3 Proposed Methodology

Transfer learning, is a research problem in machine learning that focuses on storing knowledge gained while solving one problem and applying it to a different but related problem. In this method, pre-trained models are used as the starting point on computer vision tasks instead of developing models from the very beginning.

3.1 Pre-Processing

Pre-processing the dataset for image classification includes resizing images, removing noise, flipping the images horizontally or vertically, and adjusting brightness, hue, contrast, saturation and so on of the image. Pre-processing is carried out so as to bring variation in the images in the dataset.

Furthermore, the ability of a deep learning model to generalise can be improved by image augmentation. Image augmentation is technique to artificially expand the size of training dataset using the data that is available. Augmentation includes a range of operations from the field of image manipulation, such as shifts, flips, zooms, and much more.

In Keras, ImageDataGenerator is used to emply real-time image augmentation. ImageDataGenerator provides preprocessing_function is a function that will be applied to all inputs. A preprocess_input() function adequate all the inputs to the format the model, Inception V3, requires. The training images are loaded in batches and resized to have the shape (299,299,3) which is the default input shape for the model.

3.2 Model Design

Inception V3 is a 42 layer deep neural network proposed in the paper Rethinking the Inception Architecture for Computer Vision, published in 2015. In an Inception V3 model, several techniques for optimizing the network are included like, factorized convolutions, regularization, dimension reduction, and parallelized computations.

The layers in the Inception V3 model are non-trainable. But a few of the layers marked as 'final part' in figure 3, can be trained specifically for the output we require. A Global Average Pooling layer, Dense layers with activation function as ReLu and the final Dense layer with activation function Softmax are added. The final layer will have 8 outputs for the 8 classes given.

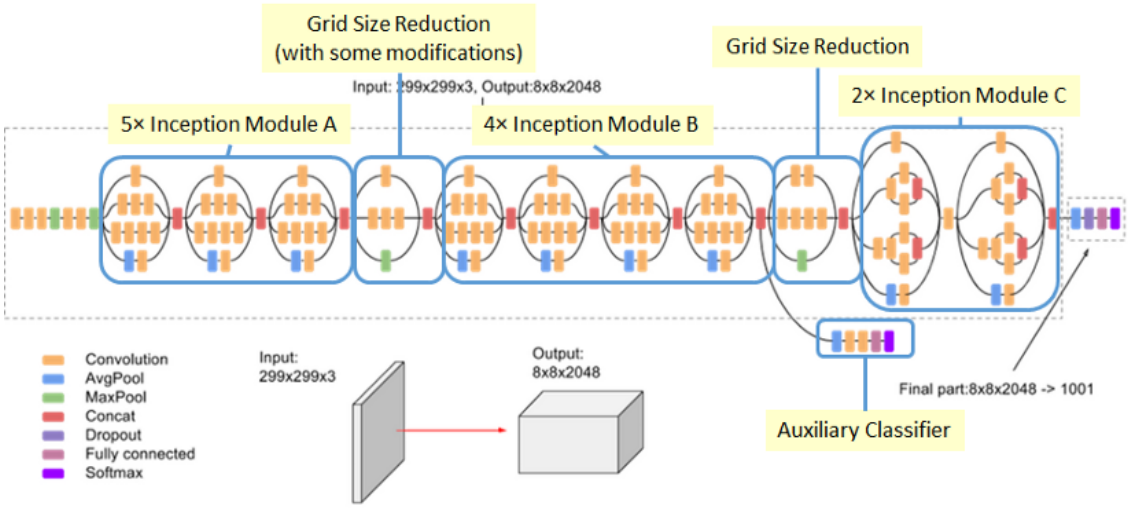


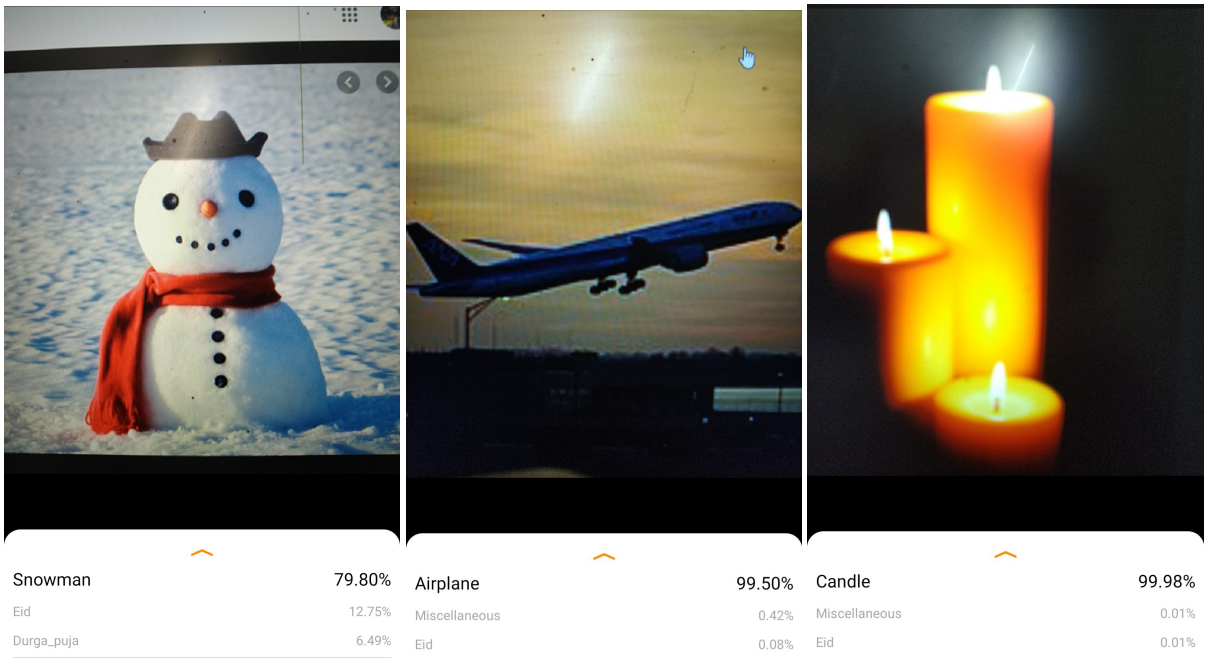
Figure 3: Inception V3 Architecture

4 Results

After training the Inception V3 for 12 epochs, the training accuracy and validation accuracy stood at 92.93% and 87.35% respectively. Figure 4 shows the evolution of both training and validation accuracies with the each epoch. Moreover, the test accuracy for the test images provided was found to be 91.008%.

In addition to the testing the model on given data, the model was deployed on an android application using which we can make prediction in real-time for the any image the model has not encountered beforehand. Figure 5 shows the predictions made by the application.

Figure 4: Learning Curve showing Accuracy vs Epoch for Training and Validation Data



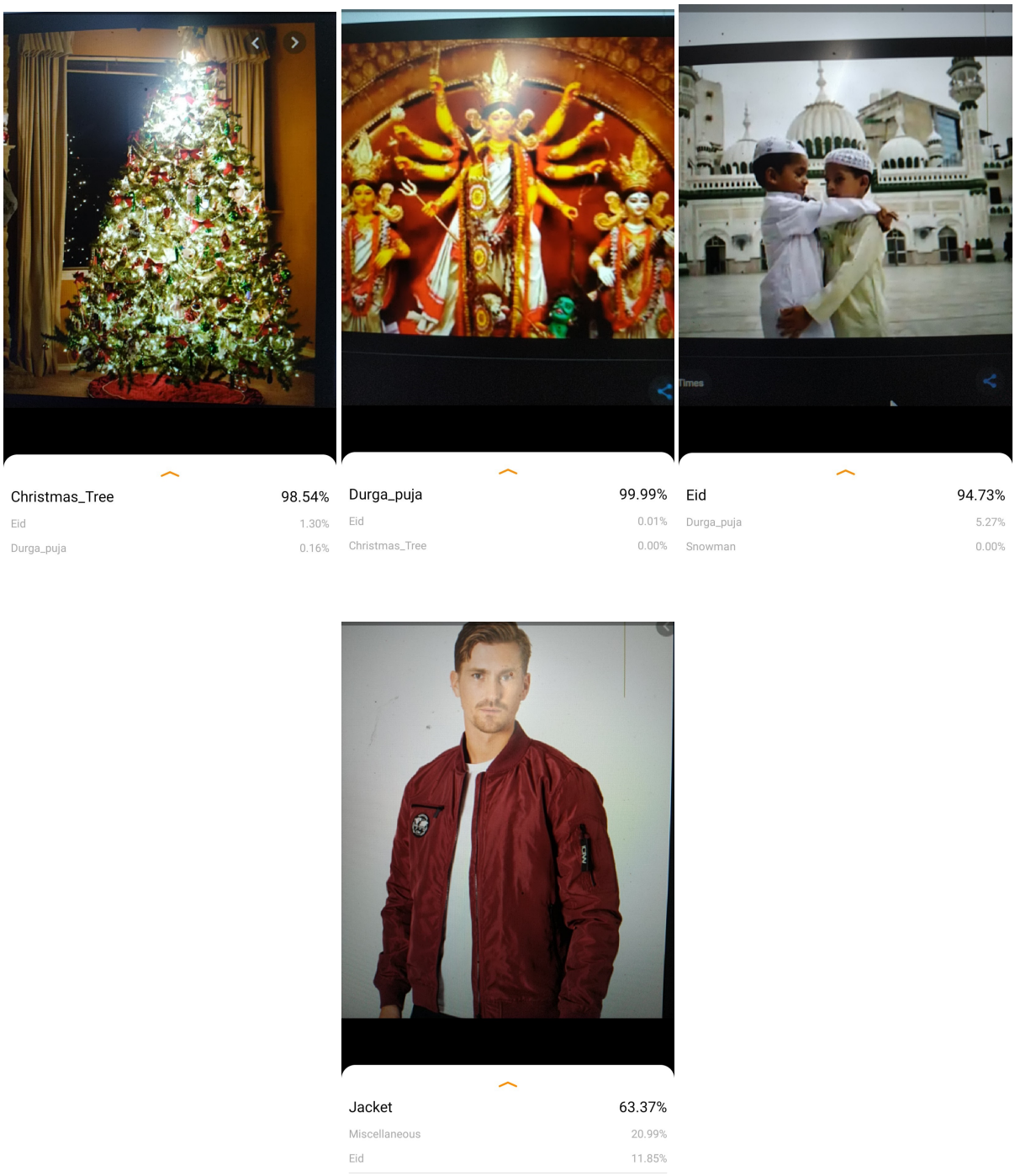


Figure 5: Predictions made by the application for each class

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[1] W A Ezat, M M Dessouky, and N A Ismail. "Multi-class Image Classification Using Deep Learning Algorithm". In: *Journal of Physics: Conference Series* 1447 (Jan. 2020), p. 012021. DOI: 10.1088/1742-6596/1447/1/012021. URL: https://doi.org/10.1088/1742-6596/1447/1/012021.