SKIN DISEASE IDENTIFICATION PROJECT

(Approach:- Neural Network: Xception, MobileNet, DenseNet models, Ensemble model (majority voting))

Jaishruti Mahadevan, Nimmisha Gorakssakar, Saloni Agrawal, Adithya Narayanan Venkatesh Babu

Abstract

Dermatological disorders are one of the wide spread diseases in the world. Despite being common, its diagnosis is extremely difficult because of its complexities of skin tone, color, presence of hair, geographical variations, etc. For the past ten years these diseases have been the matter of concern as their sudden arrival and their complexities have increased the life risks. These Skin abnormalities are very infectious and need to be treated at earlier stages to avoid it from spreading. Total wellbeing including physical and mental health is also affected adversely. Affecting quality of life completely. A computer can efficiently and effortlessly interpret a lot of images where it is difficult for the human to interpret such a high amount of data and look into the details of the image inside. The system allows the users to upload the image of the affected area and provide correct diagnosis. Therefore Computer-Aided Detection and Computer-Based Diagnosis have become desirable and are under development by many research groups and proved to be very helpful.

Keywords: Machine Learning, Deep Learning, CNN, Xception, MobileNet, DenseNet201,transfer learning.

Introduction

Skin is the only exposed, biggest organ of the body. Exposed to all sorts of communications: dust, heat, water, air, micro-organisms like bacteria, viruses, etc. It is made up of various tissues like subcutaneous tissues, dermis and epidermis. Also it protects our internal organs from outer conditions. Moreover, it is also affected by chemical harm, adventitious viruses, immune system of an individual and genetic disorders that affects the skin. It's important to understand the skin disease than suggesting the cure to it. Initially, people ignore skin diseases and may try to cure by home remedies which may lead to severe the condition of disease. Skin diseases need to be diagnosed and cured on early stages or it may lead to severe disease or may lead to some other ailment. Moreover, most skin disorders are contagious. So, proper diagnosis and suggestions should be made by experts in time. If the judgement is wrong or treatment is delayed, it may affect the human health adversely. With advancement in technology efficient approaches could be made to detect and diagnose skin infections. Now a days through Image classification and pattern-based analysis of various skin diseases is possible through various Computer aided technologies. Machine Learning, deep learning and Artificial Neural Networks are areas which can play a very massive role in differentiating different classes of skin diseases. This can be done through different algorithms to classify and distinguish different skin disease images provided by the affected person. This research project will help us to gain more insight by using already existing different approaches, algorithms, models and therefore we can explore more in the fields of Machine Learning, Deep learning and transfer learning in distinguishing among 9 classes of skin diseases. So comparative analysis is done among four different CNN algorithms Xception, MobileNet, DenseNet201; followed by ensemble approach (majority voting) to achieve final predictions. Therefore we would be able to build a Best model with good accuracy level. Therefore, the main objective of this system is to achieve maximum accuracy of skin disease prediction. All these algorithms are implemented on 8 types of diseases (Melanoma, Melanocytic nevus, Basal cell carcinoma, Actinic keratosis, Benign keratosis, Dermatofibroma, Vascular lesion, Squamous cell carcinoma. More than 25,000 skin disease image samples have been compiled for developing and validating proposed framework.

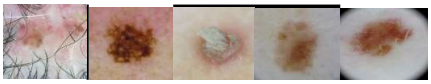


Fig.1: Images of various Skin Diseases

OVERVIEW OF SKIN DISEASES AND DEEP LEARNING AND NEURAL ALGORITHMS

Healthy skin is a sign of a healthy body. Skin protects body against infections and pollution in the environment and may get affected easily by the outer environment. Skin diseases are very common and differ incredibly in side effects and seriousness. Sometimes the skin diseases are temporary and sometimes permanent or even life-

threatening. The reason for skin disease may be external environmental factors, internal immune or genetic factors. They could be in the form of black/white heads, pimples, cysts or painful nodules. Their diagnosis and treatment should be started on early stages or may penetrate the skin and lead to bad scars or dark skin. It could be a chronic inflammatory and immune-mediated disease. It may affect the skin, nails, hair, and mucous membranes. Some of the potential causes of diseases are viral infections, allergens, stress, and genetics. These could or could not be contagious diseases. There is a brief description of all diseases which are predicted in this paper. ***Melanoma (MEL)***, also known as malignant melanoma is a type of skin cancer that develops from the pigment-producing cells known as melanocytes and can occur on any part of the body. It mainly occurs in the skin, but rarely occurs in the mouth, intestines, or eye (uveal melanoma). In women, they most commonly occur on the legs, while in men, they most commonly occur on the back. About 25% of melanomas develop from moles. Changes in a mole that can indicate melanoma include an increase in size, irregular edges, change in color, itchiness, or skin breakdown and are non-contagious. MEL size is approx. 2.5 cm (1 in) by 1.5 cm (0.6 in) and contains shades of brown, black, or tan, but some can be red or pink. ***Melanocytic nevus (NV)*** (also known as nevocytic nevus, nevus-cell nevus and commonly as a mole) is a type of melanocytic tumor (can be considered as mole) that contains nevus cells. The majority of moles appear during the first two decades of a person's life, with about one in every 100 babies being born with moles. Moles are a member of the family of skin lesions known as nevi and can occur in all mammalian species, but have been documented most extensively in humans, dogs, and horses. NVs are circular or oval and are usually small (commonly between 1–3 mm), though some can be larger than the size of a typical pencil eraser (>5 mm).They are brown, tan, pink or black (especially on dark-colored skin). They are not hereditary and there is no way to prevent a child from being born with moles. In some cases, they might have hair growing out of them. ***Basal cell carcinoma (BCC)*** is a type of skin cancer that most often develops on areas of skin exposed to the sun, such as the face. On brown and Black skin, it often looks like a bump that's brown or glossy black and has a rolled border. BCC occurs most often on areas of the skin that are exposed to the sun, such as your head and neck. The earliest lesions of BCC are generally seen as a small pink papule sometimes only 1 to 3 mm across. The tumour is larger than 2 cm and may have spread from the epidermis into the dermis. The color can vary from one BCC to the next. This cancer may be: Red or pink (most common), Brown, black, or show flecks of these colors, the same color as of the skin, Yellowish, White. They are not contagious. BCC may be derived from hair germ cells, including the outer hair sheath and hair follicular infundibulum. When severe, basal cell carcinoma becomes a full-blown skin cancer or penetrates below the surface of the skin. The tumours enlarge very slowly, sometimes so slowly that they go unnoticed as new growths. However, the growth rate varies greatly from tumour to tumour, with some growing as much as ½ inch (about 1 cm) in a year. ***Actinic keratosis (AK***), sometimes called solar keratosis or senile keratosis, is a pre-cancerous area of thick, scaly, or crusty skin. AK is a disorder (-osis) of epidermal keratinocytes that is induced by ultraviolet (UV) light exposure (actin-). These growths are more common in fair-skinned people and those who are frequently in the sun. It is often found on the face, lips, ears, forearms, scalp, neck or back of the hands. Range in size from 2 mm to 6 mm or larger (about the size of a small pea). Be surrounded by red, irritated skin. AKs are generally between 2-6mm in size but may grow larger. AKs can vary in color but often have a yellow or brown crust on top. AK are not contagious. Depending on the size and number of AKs, it can take up to three months for it to disappear after treatment ends. After the AKs go away, you will need to see your healthcare provider for a checkup once or twice a year. ***Benign keratosis*** (BK, also known as seborrheic keratosis) is a non-cancerous (benign) skin tumor that originates from cells in the outer layer of the skin. Like liver spots, BK are seen more often as people age. They are round or oval, feel flat or slightly elevated, like the scab from a healing wound. It is a common skin condition that mainly affects the scalp. It causes scaly patches, red skin and stubborn dandruff. BK can also affect oily areas of the body, such as the face, sides of the nose, eyebrows, ears, eyelids and chest. It ranges in size from very small to more than 2.5 cm (1 in) across. They are usually round or oval and range in color from light tan to black. They can develop as a single growth or in clusters. It is non-contagious. Infant: BK often completely disappears by 6 months to 1 year of age. Adolescent or adult: A few people see it clear without treatment. ***Dermatofibroma (DF)*** is a common benign fibrous nodule usually found on the skin of the lower legs. It is also called a cutaneous fibrous histiocytoma. They are hard solitary slow-growing papules (rounded bumps) that may appear in a variety of colors, usually brownish to tan; they are often elevated or pedunculated. It can be found anywhere on the body, but most often on the legs and arms. They occur most often in women; the male to female ratio is about 1:4. The age group in which they most commonly occur is 20 to 45 years. Its size varies from 0.5–1.5 cm diameter; most lesions are 7–10 mm diameter. It is tethered to the skin surface and mobile over subcutaneous tissue. They can vary in color but are typically pink to light brown in light skin and dark brown or black in dark skin. They may appear more pink or darker if a person accidentally irritates them. DF aren't bacterial, viral, or contagious and do not occur in the scalp area. ***Vascular lesions (VASC)*** are relatively common abnormalities of the skin and underlying tissues, more commonly known as

birthmarks. There are three major categories of vascular lesions: Haemangiomas, Vascular Malformations, and Pyogenic Granulomas. They each vary in terms of origin and necessary treatment. VASC have a varied appearance and can commonly occur in the head and neck. VASC range from very small to 2 cm. VASC may have the classical clinical appearance of a superficial soft tissue swelling with a bluish hue and an audible bruit, but may present as an unexplained mass without specific clinical feature. VASC are not contagious and are relatively common abnormalities of the skin and underlying tissues, affecting up to 50% of women aged 18 years and older. Spider veins, telangiectasia, and diffuse redness are often a result of ageing, sun damage or pregnancy and sometimes genetic. ***Squamous cell carcinoma (SCC)*** is the second most common form of skin cancer. It's usually found on areas of the body damaged by UV rays from the sun or tanning beds. Sun-exposed skin includes the head, neck, chest, upper back, ears, lips, arms, legs, and hands. SCC is a fairly slow-growing skin cancer. Stage 4 squamous cell carcinoma: The cancer can be any size and has spread (metastasized) to 1 or more lymph nodes which are larger than 3 cm and may have spread to bones or other organs in the body. It can occur anywhere on the body, including inside the mouth, the bottoms of feet and on genitals. This skin cancer tends to be one color, but the color can vary from one SCC to the next. This cancer may be: Red or pink (most common). It is not contagious.

The disease is commonly misdiagnosed and therefore treated with antibiotics. Deep learning is an implementation of Artificial Intelligence that empowers a structure to learn. These are self-learning PC programs that enter, bring in and enhance from their very own knowledge the data given to them. In many areas, ANN algorithms can be implemented, for example, medical diagnosis, image processing, prediction, classification, learning association, regression, and so on. Among these fields, in this paper we are implementing image recognition and classification techniques of neural network and deep learning. Image recognition technique helps computer applications to perceive the visual components inside an image and classification algorithm helps the system to learn the instance and distinguish it to one of the numerous classes. A big image database is used and learns emerging image characteristics and parameters for recognition. We are updating four deep learning and CNN algorithms for the classification of skin disease called Xception, MobileNet, DenseNet201 and Ensemble (majority voting). Below is a short explanation of the above algorithms. A convolutional neural network is a profound learning algorithm used to classify and recognize images. A neural network is a collection of neurons that take input and, in conjunction with information from other nodes, develop output without programmed rules. Neural network approach is used as it evaluates the problem through trial and error method.

The CNN follows a hierarchical model that operates on the construction of a network like a funnel. It provides a fully linked layer that connects all the neurons and processes the output. The algorithm requires an input picture and assigns weights in the picture to different elements and is able to distinguish between them. In order to learn particular patterns within the image, the convolution extracts the object's characteristics. It makes a network capable of recognizing the pattern in the image.

For selecting above models there are certain factors which are considered (explained further in the paper) like time taken to train the model, training accuracies, losses and test accuracies which decide the efficiency of model as per input dataset. Moreover, weights of ImageNet are used for pre-training all the models. Also we have fixed the pre-trained layers of the models and added a few layers to enhance are prediction and improve the performance of our models. Following are the models used to predict our evaluation regarding skin disease identification:

A. Pre-trained MobileNet model

MobileNet model is a network model which uses depthwise separable convolution as its basic unit. It has two layers: depthwise convolution and point convolution.

B. Pre-trained Xception model

Xception Model is proposed by Francois Chollet. It is a deep convolutional neural network architecture that involves Depth-wise Separable Convolutions. Xception is an extension of the inception Architecture which replaces the standard Inception modules with depth-wise Separable Convolutions. The architecture of Xception (Entry Flow>Middle Flow>Exit Flow).

C. Pre-trained DenseNet201 model

DenseNet-201 is a convolutional neural network that is 201 layers deep. A pre-trained version of the network could be loaded, trained on more than a million images from the ImageNet database. The pre-trained network can classify images into 1000 object categories, such as keyboard, mouse, pencil, and many animals.

D. Ensemble Model (Majority Voting)

A voting ensemble (or a "majority voting ensemble") is an ensemble machine learning model that combines the predictions from multiple other models. It is a technique that may be used to improve model performance, ideally achieving better performance than any single model used in the ensemble.

Dataset is fed into each model separately and their accuracies are noted at each run, furthermore, predictions are made to categorize the data into a class. Finally, the algorithm checks for the class with the highest probability. Highest probability class belongs to the given test input set. If unknown features appear or if a condition never appears before, it just gives a very general prediction which may not be accurate and that input data may fall under unknown class. Multiple samples from initial samples are obtained using the Data Augmentation technique. In all models algorithms Relu activation function is used. Relu layer operates to add non-linearity in pictures at the end of the convolution operation by

replacing all adverse values with zero. Next is the pooling layer that decreases the input image's dimensionality and decreases the complexity of the operating computation. This helps to avoid overfitting. In addition, a traditional neural network that links all neurons from the prior layer to the next layer is being built. At the end, the number on the input image is classified using a softmax activation function.

PROPOSED WORK AND RESULT ANALYSIS

In this paper, the use of 4 distinct deep learning classifiers could identify nine kinds of skin diseases called Melanoma, Melanocytic nevus, Basal cell carcinoma, Actinic keratosis, Benign keratosis, Dermatofibroma, Vascular lesion, Squamous cell carcinoma. For further classifications, the skin image dataset is originally augmented as the samples in the dataset are not evenly distributed in 8 classes. The dataset is split into the dataset of training, validation and testing: 60 percent for training, 30 percent for validation and 10 percent for testing. Afterwards, skin diseases are detected using four different classification algorithms called deep learning, CNN, Xception, MobileNet, DenseNet and Ensemble (majority voting). Each algorithm runs on the same dataset ten times and the training accuracy is calculated for each run. The parameters thus obtained are discussed and compared for all the four classification algorithms, also confusion matrix and graphical analysis is performed to check for the best precision which can be used for skin disease prediction. Objective of this paper, a brief overview of methodology and calculation formulas for different parameters are discussed below:

Stratified sampling will be done as this is a multi-class classification problem. Stratified sampling is done as all classes in the dataset are unevenly distributed so after using it all strata will have all class samples.
Evaluating approaches to be used are Deep Learning, Neural Network and Ensemble model with Epoch Early Stopping concept to improve accuracy with reduced losses.
Continuously observing Validation Loss and Training Accuracy graphs to estimate our approach.

Objective

TASK DEFINITION

To prepare a model with accuracy above 90% for diagnosing skin disease from these nine categories Melanoma, Melanocytic nevus, Basal cell carcinoma, Actinic keratosis, Benign keratosis, Dermatofibroma, Vascular lesion, Squamous cell carcinoma from image uploaded online by patients. This will be done in two phases with varied size of datasets.

Experimental Evaluation

METHODOLOGY

The dataset consists of 25,000 images of nine classes of skin diseases like Melanoma :'Mel', Melanocytic nevus: 'NV', Basal cell carcinoma: 'BCC', Actinic keratosis: 'AK', Benign keratosis: 'BKL', Dermatofibroma: 'DF', Vascular lesion: 'VASC', Squamous cell carcinoma: 'SCC' and Unknown: 'UNK' Format of images is .jpg and size of images is 1024*1024*3 but for evaluating purpose size of images taken is 224*224*3. In case the value is missing, all features for that property are zero.

Disease	Actual Count	After Augmentation
Mel	4522	8019
NV	12875	9746
BCC	3323	8004
AK	867	7416
BKL	2624	7449
DF	239	7327
VASC	253	7156
SCC	628	7302
Total	25331	62419

Table1: Number of instances of all classes of diseases

Exploratory Data Analysis

Data is available in two CSV data files consolidated into one by concatenating.
Data Augmentation: dataset is augmented as the image samples in the dataset are not evenly distributed in 9 classes as can be observed in the Table1. So augmentation is done by rotating images by 30 degree, horizontal and vertical shift, horizontal and vertical flip. These augmented images are separately stored into the separate folders of particular diseases.
Splitting dataset DataFrames into features: X and Y: CSV files are in the form of DataFrames i.e. table format. Dataframe ***Y*** is converted into a series of diseases format to be used further.
As the data is unevenly distributed into 8 classes, so data augmentation and stratified sampling is used to divide the dataset into 8 stratas of all diseases. X features of data will be used for the purpose of training the models. So it consists of columns like Images etc. Y feature is part of data which will be used for the purpose of testing the models. So it consists of 8 diseases data. Further for evaluation, DataFrames X and Y are splitting by the ratio as **train:validation:test :: 60:30:10** (X_train, y_train, X_valid, y_valid, X_test, y_test)

Converting data from DataFrames to tensor directories:

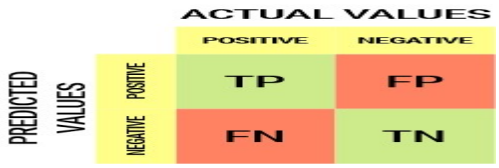
Data available is in the forms of DataFrames so to use the data in CNN models data needs to be converted into tensor format directories. All the DataFrames of train, test and validation are also converted into tensor directories and data is fed in models. Further these directories are saved so that they can be loaded whenever required.
Following are the important features which are related to Neural Network which help to analyse and improve models performance.

Confusion Matrix: A confusion matrix is a technique for summarizing the performance of a classification algorithm. Classification accuracy alone can be misleading if the dataset has an unequal number of observations in each class or if it has more than two classes. Calculating a confusion matrix will provide a better idea about predictions predicted and errors made by classification model.

The confusion matrix shows the ways in which the classification model is confused when it makes predictions.

A Confusion matrix is an N x N matrix (refer Fig.2) used for evaluating the performance of a classification model, where N is the number of target classes. The matrix compares the actual target values with those predicted by the machine learning model. The rows represent the predicted values of the target variable.

Fig.2 Confusion Matrix



Learning rate of model: In machine learning and statistics, the learning rate is a tuning parameter in an optimization algorithm that determines the step size at each iteration while moving towards a minimum of a loss function. Specifically, the learning rate is a configurable hyperparameter used in the training of neural networks that has a small positive value, often in the range between 0.0 and 1.0. The learning rate controls how quickly the model is adapted to the problem.

Smaller learning rates require more training epochs i.e. the smaller changes made to the weights on each update, whereas larger learning rates result in rapid changes and require fewer training epochs.

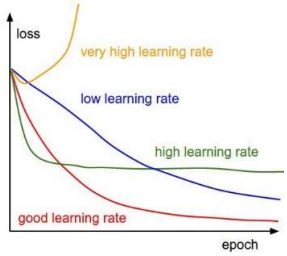
Optimizer: Optimizer is a function or algorithms or methods used to change the attributes of the neural network such as weights and learning rate to reduce the losses. Optimizers are used to solve optimization problems by minimizing the function. Thus, it helps in reducing the overall loss and improves the accuracy.

Learning Graphs: Accuracy and Loss

Loss curve: The most used graph to debug the Neural network is a Loss curve (refer Fig.3) during training. It explains the training process and direction in which the network learns.

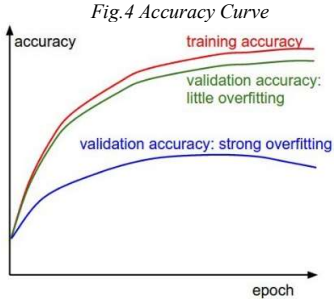
Through this example plot it is quite explanatory how the learning rate of the model differs. The log of loss can be evaluated in two forms; (1) After every Epoch, (2) After every Iteration. *It is ideal to plot loss across epochs rather than iterations.* During an epoch, the loss function is calculated across every data item and it is guaranteed to give the quantitative loss measure at the given epoch. But plotting a curve across iterations only gives the loss on a subset of the entire dataset. So validation loss and training loss curves are plotted.

Fig.3 Loss Curve



Accuracy curve: The accuracy graph is plotted to understand the training accuracy and validation accuracy (refer Fig.4).*The gap between training and validation accuracy is a clear indication of overfitting. The larger the gap, the higher the overfitting.*

Fig.4 Accuracy Curve



Regularization is a kind of regression where the learning algorithms are modified to reduce overfitting.

Precision, Recall and f1-score

Precision: Precision quantifies the number of positive class predictions that actually belong to the positive class.

$$Precision = \frac{True\ Positive}{(True\ Positive + False\ Positive)} = \frac{True\ Positive}{(Total\ Predicted\ Positive)}$$

Recall: Recall quantifies the number of positive class predictions made out of all positive examples in the dataset.

$$Recall = \frac{True\ Positive}{(True\ Positive + False\ Negative)} = \frac{True\ Positive}{(Total\ Actual\ Positive)}$$

F1-score: F-Measure provides a single score that balances both the concerns of precision and recall in one number and also, there is uneven class distribution (larger number of Actual Negatives).

$$f1 = \frac{2\ X\ (Precision\ X\ Recall)}{(Precision + Recall)}$$

Accuracy, also known as classification rate, can be described as right predictions of the overall results

proportion. If the precision is greater, the skin disease is predicted properly. It is possible to calculate accuracy as:

$A = (TP + TN) / ((TP + TN + FP + FN))$

Error rate can also be calculated by inverting the accuracy value as:

$Error\ Rate = (1 - A) * 100$

Fig5: Scatter Matrix and density plot:

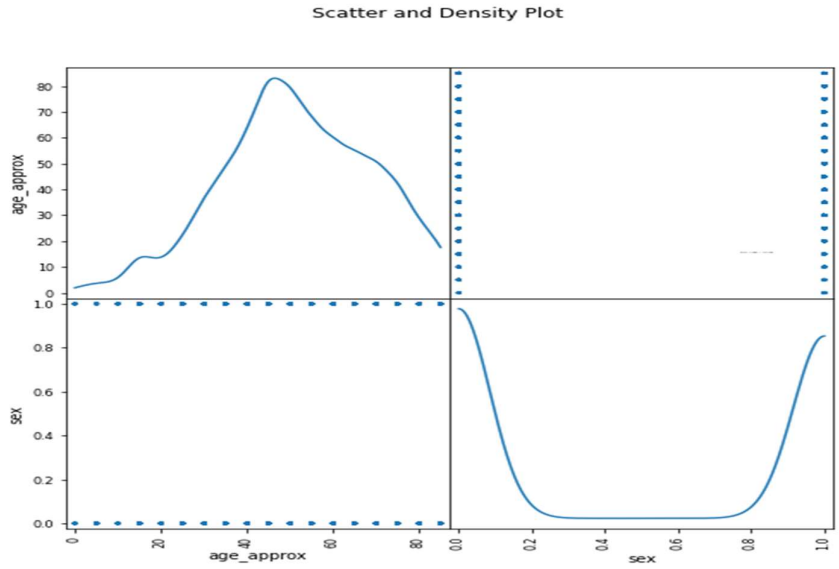
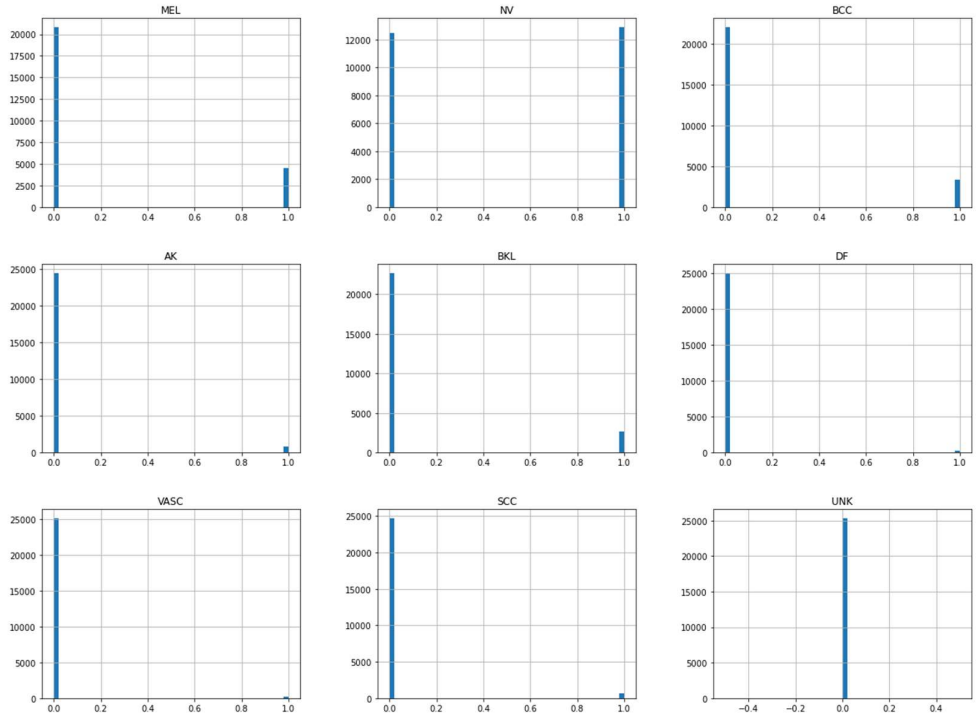


Fig 6: Histogram Plots of all 9 diseases:

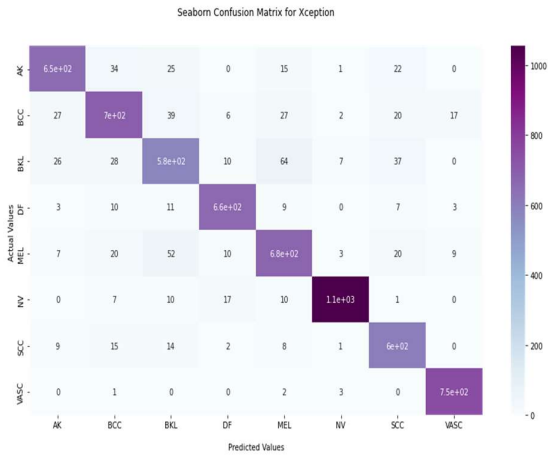


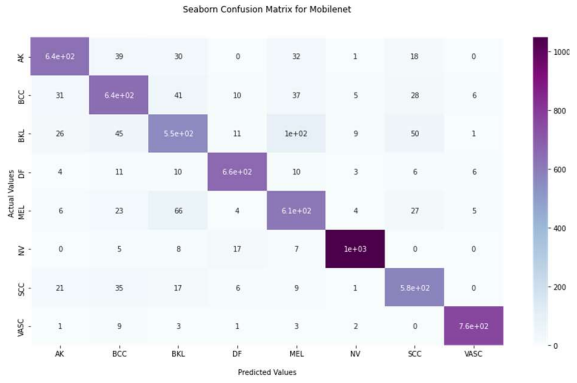
MODELS RESULTS

Models used for accurately predicting Skin disease considering all the aspects required like training accuracy, validation accuracy, testing accuracy and losses are Xception, MobileNet and DenseNet201. The predictions of these models are fed into the Ensemble model (majority voting). So a result of approx. 91.96% accuracy is achieved. The challenges faced while full assessment are missing values, uneven distributed classes in dataset, original size of images, training accuracy, learning rate, regularization, etc. lead to customization of the whole process. Table3 provides the confusion matrix (Fig 7) for all five algorithms for each class of named skin diseases,

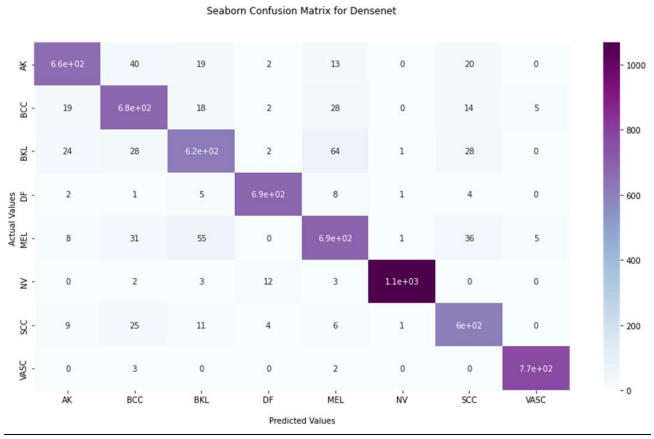
Melanoma:'Mel', Melanocytic nevus: 'NV', Basal cell carcinoma: 'BCC', Actinic keratosis: 'AK', Benign keratosis: 'BKL', Dermatofibroma: 'DF', Vascular lesion: 'VASC', Squamous cell carcinoma: 'SCC'. These matrices are also used to calculate the various parameters for each disease class such as precision (P), Recall'(R) and F1-score. Table2 summarizes the calculated parameters.

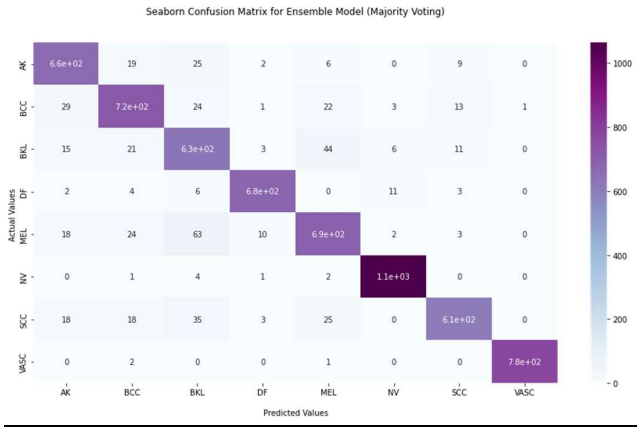
Fig 7: Confusion Matrix of all the models





The calculated values of various parameters such as accuracy of training are shown in Table 3. As shown in this table, we can conclude that ensemble is giving the best overall accuracy of 91.96% respectively picking up the best results from all algorithms. The analysis of learning graphs (Fig 8) depicts that all three models provide good training and validation accuracies with less losses i.e. training and validation losses. So ensemble model can provide the best accurate prediction of skin diseases among all the four algorithms which results in less possibility of misdiagnosis. A better treatment can be initiated if the class of disease is predicted correctly at an early stage.





Xception and DenseNet201 algorithms are very closely predicting with high training and testing accuracies which provides more precise classification outcomes, is the key behind this precision of ensemble overall.

CONCLUSION AND FUTURE SCOPE OF WORK

Performance of our neural network model is measured by accuracy achieved, i.e. 91.96% approximately, by ensemble model as single model was not performing well. So to achieve accurate results multiple techniques are used for data framing and also for our final model.

The proposed model's computational time is evaluated as a part of performance evaluation and compared against the existing approaches on performing the classification over similar data.

Model should perfectly diagnose the disease for which it is trained and also learn a new one by online learning. The correctness of diagnosis is directly proportional to the accuracy of the model.

Also, there is a need to continuously test the model based on the newly designed approach and try improving the accuracy by eliminating or improving certain parameters taken into consideration previously. In reference to existing models and approaches applied gradual learning and improved methods will be used. Diseases for which the model is not trained may be updated and learnt from time to time on a regular basis.
Model will diagnose skin disease from image uploaded by the patient.

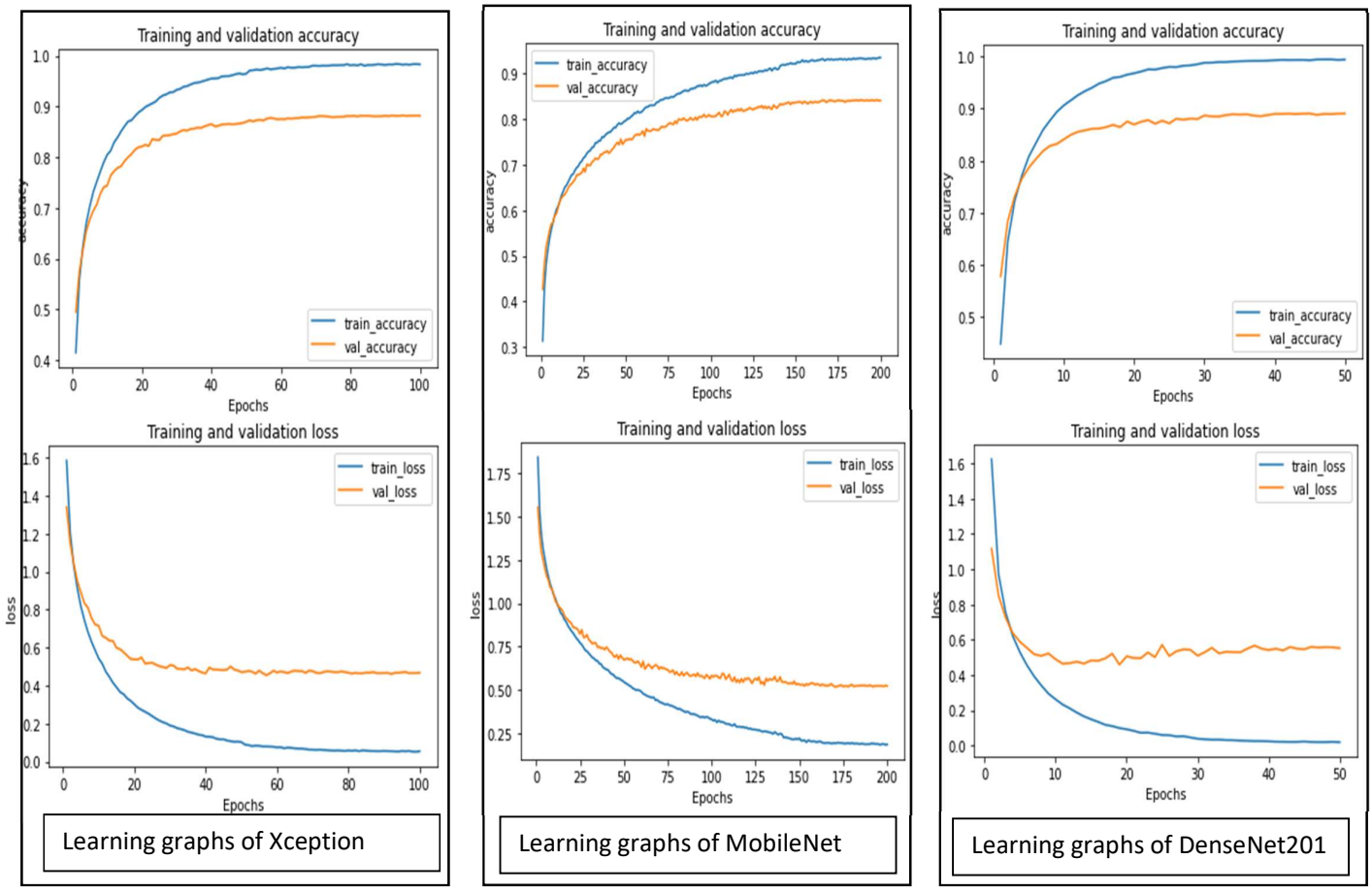
Table2: Precision, Recall and F-score table records of all diseases evaluated by all algorithms

	Xception			MobilNet			DenseNet201			Ensemble		
	P	R	F1	P	R	F1	P	R	F1	P	R	F1
Mel(4)	0.87	0.90	0.88	0.84	0.87	0.85	0.87	0.91	0.89	0.88	0.91	0.90
NV(5)	0.83	0.85	0.84	0.80	0.79	0.79	0.88	0.83	0.86	0.88	0.88	0.88
BCC(1)	0.77	0.79	0.78	0.69	0.75	0.72	0.80	0.84	0.82	0.80	0.86	0.83
AK(0)	0.93	0.93	0.93	0.92	0.93	0.93	0.97	0.96	0.96	0.97	0.96	0.96
BKL(2)	0.84	0.83	0.84	0.81	0.75	0.78	0.85	0.84	0.84	0.87	0.85	0.86
DF(3)	0.95	0.98	0.97	0.96	0.97	0.97	0.98	0.99	0.98	0.97	0.99	0.98
VASC(7)	0.92	0.84	0.88	0.86	0.81	0.84	0.91	0.85	0.88	0.93	0.85	0.89
SCC(6)	0.99	0.96	0.97	0.97	0.97	0.97	0.99	0.98	0.99	0.99	0.99	0.99

Table3: Testing And Training Accuracies of all four algorithms

S.No.	CNN Models	Testing Accuracies (%)	Training Accuracies (%)	Validation Accuracies (%)
1	Xception	89.43	98.3	88.19
2	MobileNet	86.57	93.49	84.08
3	DenseNet201	91.10	89.08	89.08
4	Ensemble	91.96	-	-

Fig8: Learning graphs



The major problems in the medical industry are to diagnose the skin disease precisely as any skin disease can be healed and retrieved if properly diagnosed at an early point. Nowadays study demonstrates that different computer aided techniques could be used for skin disease observations However, most important is to distinguish skin diseases at an early point. ANN and deep learning algorithms have the potential to have an impact on early detection of skin diseases. These neural network techniques can assist people make real-time adjustments to their skin. If these techniques are used properly, will certainly provide appropriate assistance and a unified approach to skin problems prevention. Moreover, these will assist physicians cure skin diseases in a timely manner as well. Limited medical information is easily accessible for research and analysis. If more real-time data are available in the future, the detection of skin disease and benefits in diagnosis can be explored with recent advances in artificial intelligence techniques. So in future, developing a Mobile App for detecting the skin disease from user input in real time environment. Recommending Ayurveda treatments and other naturopathy treatments to all patients for early stages and also for advance stages. Also, recommending preventions further for these nine classes as well changing scenarios in these as per time. Incorporating more advanced AI technology in doing further more precise research and finding results in this field. Furthermore, providing location specific recommendations of clinics/hospitals for treatment to patients will help them access easily and get best treatments.

REFERENCES

https://www.kaggle.com/andrewmvd/isic-2019
https://www.tutorialspoint.com/python_pillow/python_pillow_resizing_an_image.htm
https://www.tensorflow.org/tutorials/images/classification
https://github.com/anindox8/Ensemble-of-Multi-Scale-CNN-for-Dermatoscopy-Classification/blob/master/scripts/ensemble-val.ipynb
https://github.com/SwagatSBhuyan/Skin-Cancer-Classification-Using-CNN-Deep-Learning-Algorithm
https://androidkt.com/how-to-set-steps-per-epoch-validation-steps-and-validation-split-in-kerass-fit-method/
https://www.mathworks.com/help/deeplearning/ref/xception.html
https://vitalflux.com/machine-learning-training-validation-test-data-set/