Grenze International Journal of Engineering and Technology, January Issue

A Review on the Artificial Intelligence-based Acne Detection Diseases

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***Abstract*—Acne disease which is considered to be the most common skin condition consumes time and money by taking doctor's appointments for most of the acne targeted people. To solve this problem Image analysis becomes an attractive part as it is an integration of both medical field and technology for human's betterment. It includes taking advantage of advanced technologies like Artificial Intelligence (AI), Convolutional Neural Networks (CNN), Deep Learning (DL) and Machine Learning (ML). By conducting literature surveys, the main aim is to explore acne type, the datasets, data processing techniques, data augmentation techniques, model image recognition, deep learning frameworks and evaluation indicators. Overall the paper focuses on a comprehensive summary of all Artificial Intelligence architecture and standard sequence which shows good and efficient results for the dermatological images.**

***Index Terms*— Acne, Convolutional Neural Network, Deep Learning, Dermoscopic Images, Image Classification.**

I. INTRODUCTION

Due to drastic chemical and digital revolutionary changes in the world the first term which comes in contact affects the skin which is considered to be the largest organ of the human body. The radiation coming from the Sun, daily work out, eating habits, smoking, drinking, other sports activities, viruses and working patterns affects body and then skin area and that's why we face skin disease which is common in today's date. As it falls under dermatological conditions, this acne disease directly affects patients emotionally as well as psychologically by seeing their daily skin problems. We all are surrounded by social media and we all want to have a perfect balance in life along with a clear skin to look beautiful but due to daily changing factors like the presence of bacteria, fungi, parasites, microorganisms and viruses on the skin that's why we face acne problems. Acne basically has different names based on stages in medical terms like comedones, papules, and pustules to more serious stages such as nodules, cysts found on the face, shoulders and back side [16]. When the situation worsens, patients visit the doctor for the treatment, which consumes most of the patient time as well as it is cost consuming. The manual methods used by all dermatologists are detection of acne by observing the acne for at least a few months. Recently it has been found that AI is playing an important role in medical image processing specifically in terms of Convolutional Neural Networks (CNNs). So, automated classification of acne disease and other medical issues have been a blessing for the medical section as it is giving good results where both

Grenze ID: 01.GIJET.11.1.8

medical care and these deep learning models are complimenting each other.
In the healthcare sector, accuracy and efficiency of identifying acne disease by using convolutional neural networks (CNNs) works well on a large number of acne image datasets [17]. Further this article will helps us to learn how the different type of acne datasets is used for training purpose and how AI plays role in healthcare sector by using methods like Gray Level Co-occurrence Matrix (GLCM), Support Vector Machine (SVM), ResNet-50, Inception-v3, DenseNet121, Xception, VGG-16, CNN and Inception-ResNet-v2 architectures. The main focus is to look into the effectiveness of deep learning models for classifying different types of acne disease. The steps from start to end involve data collection, pre-processing, model architecture design, their training, and evaluation metrics. Furthermore, the new improvement, the ethical considerations, and the impact of using AI in healthcare.

Figure 1. Different types of Acne

In dermatological terms acne is the most common disease and these acne lesions can be harmful and non-harmful means cancerous or non-cancerous where non-cancerous skin growth is referred to as benign lesion. As in today's world we can see how drastically skin is getting affected due to various factors like eating habits, chemical changes, regular routine and it directly affects the outer layer of the body i.e. skin.
Once daily routine is ignored we face acne lesions, hereditary transfers can also be the reason. As being a part of a fast running world we want instant solutions to solve problems. There are so many treatments available for acne but for proper treatment and results we need to book appointments with a dermatologist, need to go through a number of skin tests as some patients have sensitive skin and all these are time consuming. Today the demand is more for AI based technology as it gives rapid and precise results. This overall paper classifies face acne types using deep neural networks. The goal of using AI is to consume patient's fewer amounts of time and precision in results. Developing and testing a deep neural network to identify different phases of acne lesion from pictures is part of the project review. The main focus is to consume patients less amount of time for solving their acne problem and giving best results based on acne type. The neural networks are structured in such a way that it can identify acne severity cases and classify them based on types. Computerized detection and categorization solves so many problems and moreover helps to get good results.
An automated detection method, which helps in classification mechanisms for acne type and showing reliable and more accurate results, is the whole goal. Developing an interface which should be user-friendly with proper interaction for patients and by maintaining existing dermatological workflows. The automated methods reduce human interpretative errors and, crucially, enable to check the acne severity of patients to prevent severe stages using proper recommended medications. At the end of the survey readers will gain knowledge of deep neural networks architecture flow in acne detection and various challenges and responsibilities associated with AI systems in the medical term.

A. Stages of Acne in Grading system

Pimple is the daily used term for acne and a common skin condition which formed due to overproduction of inflamed oil glands which constantly hold a sticky sebum substance which protects the skin from moisture loss present on skin. Generally pimples are called acne [14] lesions in medical terms which are small growths on the skin surface. For more understanding we can say acne is a disease and pimples are a symptom of acne. When this substance sebum, dead skin cells, outer dust particles, bacteria, etc. get trapped together an inflammation leads to redness on face. Papules, whiteheads, blackheads, cysts, nodules and pustules are all different types of pimples. Whiteheads which are also called closed comedones and blackheads which are black in texture because of oxidation of dust present in the pores by air both are less severe. Whereas cysts and nodules can affect skin's deepest layer with scars. The following are the grades of acne.

1. **Grade 1 (Mild Acne)** – This is the start stage of acne formation mostly found on the nose in the form of blackheads, a few papules which are small in size and can be seen red in colour on the cheeks.
2. **Grade 2 (Moderate Acne)** – The skin gets more blemishes with whiteheads i.e. closed comedones which are raised white or a yellowish dot. It is surrounded by redness and there is some swelling near that area. Here the term pimple can be used, a small bump or a blister formation filled with yellowish material.
3. **Grade 3 (Severe Acne)** – In severe acne a lot of papules and pustules are formed with inflammation. As the lesions are near to each other they can merge with each other. More redness and mild swelling is there on the face area. Even scars get formed once it gets healed.
4. **Grade 4 (Cystic Acne)** – This is a very severe stage. The blemishes get large in size. It gets deep in the layer of skin, contains pus inside and causes pain. The size of the cyst may be half a centimetre, which is considered a big blister type.

II. Review of Various used Acne detection Technique

A. Convolutional Neural Networks

CNNs are considered to be one of the best algorithm types in deep learning for image recognition. Images are considered to be unstructured data. They are in the form of pixels, the smallest element of the image in squared form. It is said that a pixel is the building block of an image which has length and width in numerical form. In AI terms we store images in the form of numpy arrays. The image can be of two types: grayscale images and RGB images. Grayscale is black and white image and in CNN channel 1 is reserved whereas RGB has 3 channels. When a certain amount of pixels get formed with each pixel having a certain value ranges from 0 to 255, 0 means black colour and 255 means white colour and in between the colour can vary. For example: if the image pixel is 0 it means it is black in colour, 255 means white in colour, in between 0 to 255 for grayscale it will be shade of grey and for RGB from 0 to 255 it will be some coloured format. As the technology is getting evolved day by day we can see parameters changing in every neural network and based on that algorithm are called by different names. Just like in a dark room we use a torch to search some things and with the help of it we easily reach the target in the same way considers the Figure 2. where in CNN we are having image dataset, in the input layer we are passing RGB i.e. colour image. The image can be collected directly from the medical area, internet and many more and they have complex patterns, so when the filter convolves from that image it extracts the important information from images based on the structure of the algorithm. Filter size should always be in odd number like 3*3, 5*5, 7*7 and so on.

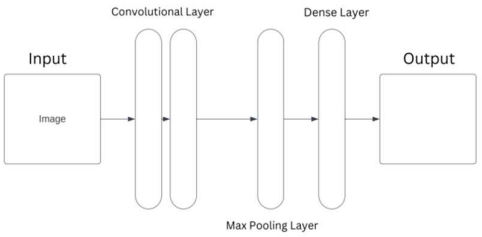

Figure 2. Basic CNN Architecture

Basically a CNN architecture consist of an input layer, more than one hidden neural layer with a combination of convolutional layers to convolve over images we provide, ReLU layers, pooling layers – to extract the information from dataset, and fully connected layers, and an output layer which categorize images accordingly. The input layer consists of acne images in the article and the 1st stage is pre-process the entire images before performing any neural model architecture on it. As some kind of noise or imbalanced data can be there which affect the results. The dataset used in this article for applying CNN are new collected images from sites like Internet, DermNet and ISIC Challenge Datasets with 2022 image count having Acne as well as Benign skin lesions as a raw dataset. Cross-validation method is used in it to avoid overfitting problem and 4 epochs gives accuracy of 87% and 10 epochs gives 96.4% accuracy. So, as the number of epochs increases accuracy has improved [1]. So in this way we can conclude from this article that what sequential steps need to follow to implement the architecture of CNN on a dataset, important measures need to be kept in mind while working on accuracy metrics. After that the classification is done on real-time data based on collected dataset. For another article on CNN architecture used for mobile application, we know there are so many skin layers and as the

technology is getting advanced day by day we can also take help of mobile phones to detect the acne severity. This work uses CNN, based on TensorFlow Lite. The steps include CRISP-DM methodology, which include stages like Understanding for overall idea of Business, Understanding data which has any null values check, Data Preparation, Modelling, Evaluation, and Deployments.

a. Business Understanding - The main role is always Business Understanding where we need to understand the exact problem, for that need to set research design objectives, need to determine the requirements for making proper application systems. Even if we are dealing with acne severity like mild, moderate or severe acne type, convolutional neural network (CNN) used as AI model [2] and an application is created to detect acne on face.

b. Data Understanding - In this article, the dataset's collection is the important part and considered to be needful in the model training process. The data collection is done from the site kaggle.com, acne grading dataset. The dataset consists of 999 data images divided into three folders namely Level0, Level1, and Level2, in the form of 500x555 images.

c. *Data Preparation* - When we talk about supervised data it means we need to label the data which is with seven classes of the problem we are going to solve and divided into two categories like the severity of acne and the type of acne in this article. Using LabelImg software object labelling is done. The training process of models becomes easy with labeling.

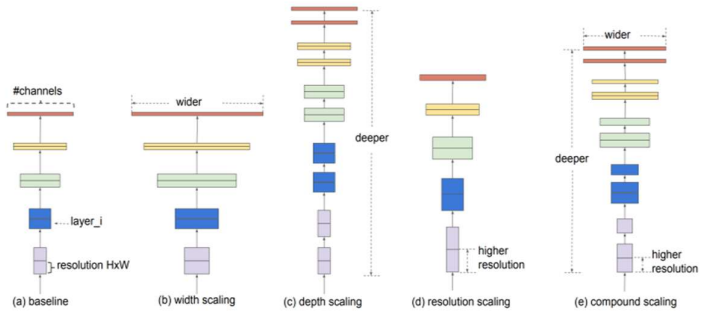

Figure 3: Efficient Det-Lite

Now this dataset is split into 80% training and 20% validation. A train set is for training data so that it can learn, while validation is for testing how properly it learns from model and needed data and again to prevent overfitting problems for testing dataset. It is an error that is too focused on the balance of the dataset as we do classification and important factors to avoid for any of the data set. In this study, using EfficientDet-Lite0 as shown in Figure 3, they tested the model performance and focused on Precision metrics. The results for architecture for seven classes are in values of 0.0690, 0.0052, 0.1646, 0.0389, 0.0166, 0.0085, and 0.0210. Kotlin language is used for mobile interface and it detects the face acne type and level from any supportive mobile devices. So in this way from this article we come to know after modelling we can even go with android interface application which helps in acne detection. This paper [13] used CNN demonstration to check on patient's data whether having the risk of acne scars and technology like only on image analysis. This initial approach for the binary classification with risk or no-risk shows a 0.93 AUC.

B. VGG16

VGG16 is a type of CNN architecture which focuses on some specific parameters and is famous for computer vision. It is generally used for object detection and a classification algorithm, VGG is easy to use for transfer learning. Some special focuses of VGG 16 are as follows:

- *a.* The 16 in this VGG16 [3] means 16 layers that have some weights. The overall architecture has 13 convolutional neural layers, 5 pooling layers followed by dense layers. So basically the sums up layers are 21 with 16 weight layers in it as shown in Figure 4.
- *b.* Tensor size of input images are 224*224 with 3 RGB channels.
- *c.* Hyper-parameters focused on 3*3 filters, stride is 1, same padding followed by maxpool layer of 2*2 filter of stride 2.
- *d.* *Conv*-1 layer with 64 filters, Conv-2 with 128 filters, Conv-3 with 256 filters, and Conv-4 and 5 with 512 filters.
- *e.* Fully connected layers with a final layer called as soft-max.

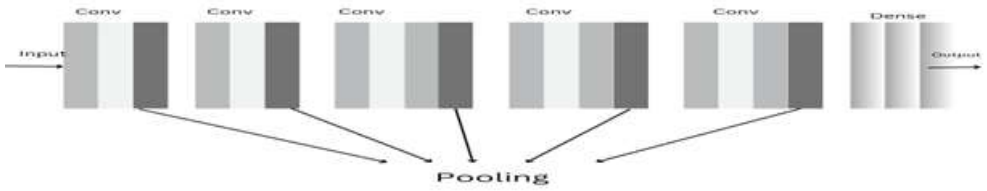

Figure 4. VGG 16 Architecture

In the article to grade acne type from comedo, papule, cyst, pustule by keeping in mind whether it is mild, moderate or severe. Prior Knowledge is used for enhancement and every image is considered. Random rotation, flipping images, translation, resizes and cropping is used for enriching the data quality. In the image augmentation some other transformations were added including addition of random gaussian noise, median blur, optical distortion, sharpening, brightness contrast, etc. Further by using ground truth and extraction they focused on Precision, Sensitivity, Specificity, Accuracy and Youden Index matrices on the dataset. In another article using VGG-16 model train and spilt ratio is compared to get a good accuracy of 88% for 12000 images data and classification of the facial skin images done [6].

C. U-Net

U-Net is a type of deep learning architecture which is mostly used in the medical field for segmentation [10] purposes. The architecture consists of a contracting path and an expansion path. Contracting path means the encoder layers and its work is to capture contextual information and to reduce the special resolution of input image. Typically it consists of multiple convolutional and max pooling layers. Whereas the expansion path contains decoder layers which decode the encoded data. The responsibility of the decoder is generating the segmentation map with the same resolution as the original input images have. U-Net architecture is shown in Figure 4.

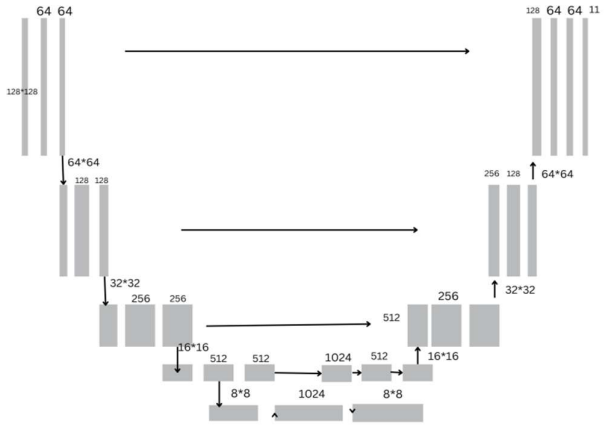

Figure 4. U-Net architecture

In the article semantic segmentation is used. Firstly for the dataset, they used central point ground truth (CGPT) [4] to fix the problem of U-Net's largest number of channels and the spatial dimension of the last encoder which is small in size. The mean for each axis of the pixel coordinates is calculated and marked as a single point on CPGT. After this U-net model is used keeping some important parameters in mind. For training the acne segmentation model, we used two losses: semantic segmentation loss and centre point loss. Segmentation model has been calculated between the final prediction acne segmentation model (ASM) and the acne ground truth (AGT). To verify the performance IoU is being compared which is 37.2% for lambda.

D. Pre-trained Model

In this paper, experiment is done on five types of CNN that have been pre trained on ImageNet. These five models are ResNet-50 – residual network, Inception-v3, DenseNet121, Xception and Inception-ResNet-v2. Pre-processing of all collected images include reverse and cropping. To avoid the problem of data imbalance, different weights in the cost function for different diseases is added. ResNet stands for Residual Network; it uses residual blocks which is so helpful for residual mapping. Here in this paper connections between the shallow and

deep layers of the network have been added. Such connections directly transmit the information of the shallow layer to the deep layer to avoid vanishing gradient problems. In the case of Inception structure the main focus is the inception block. Different kernels are present in a block and each kernel has a different shape, the output of the block is the result of combination from different kernel's output. DenseNet stands for Dense Convolutional Network which takes all preceding layers which means the entire network gets reused boosting the performance with few parameters. The Xception model is an inspiration version of the Inception model. Xception comes up with a depthwise separable convolution which helps in decoupling spatial correlations and cross-channel correlations change. Inception-ResNet is considered to be a combination of both Inception and ResNet model structure and architecture. When a residual connection is mixed or aligned to the Inception network, it becomes helpful to train deeper networks. For all the architecture Refer Figure 5.

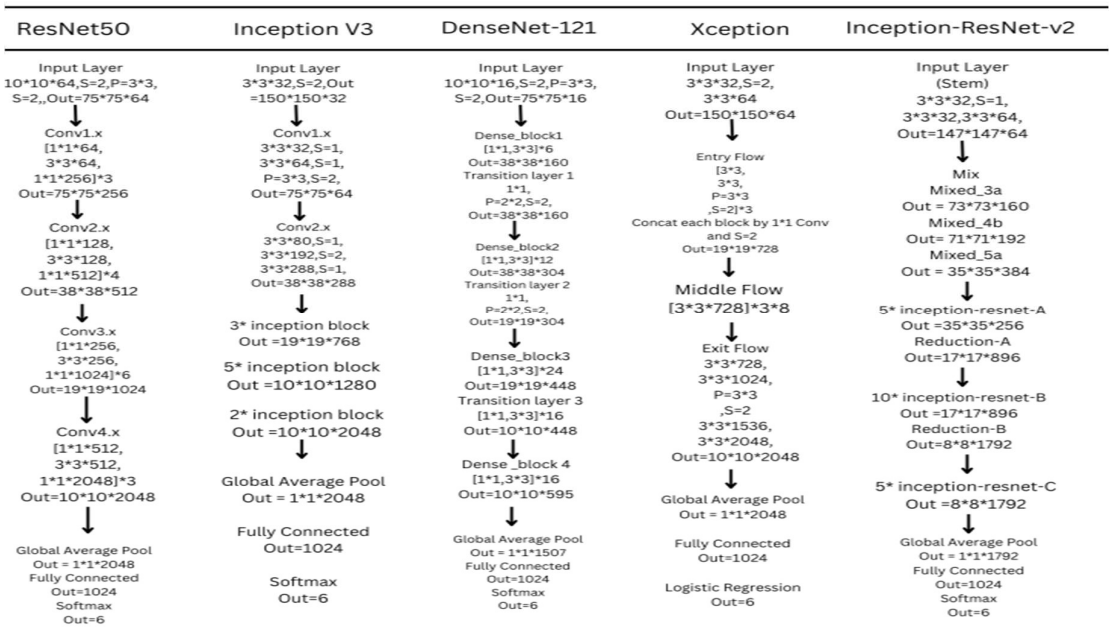

Figure 5. Pre-trained architecture

After training dataset on facial images and then on other body parts they came to know that Inception-ResNet-v2 achieved better results like for recall it's 77% and for precision it's 70.8%. In this way by performing step by step pre-processing steps and after learning each of the architecture the comparison becomes easy between all those different architecture. In the article for multi-class classification as the emergence of generative adversarial network (GAN) [7] which generates synthetic images using discriminator and generator from that one can easily get stability over image dataset and get good performance. The generator work is production of fake samples of image dataset but the generated images should be realistic samples which will be fed to training samples. The discriminator focus is to find differences between the true or real ones from the generator's collected fake samples, in this way this generator and discriminator play an important role for pre-training. CNN models which are based on the ResNet50 and VGG16 algorithms are used on partly unlabelled datasets. For multi-class classification performance has reached 92.3%.In the [12] article, a comparison of various pre-trained models on datasets including VGG16, Xception, Inception-V3, FastAi etc. was performed. The observation is that the training accuracy metrics and testing accuracies remained stable to some extent. The variations of Inception V3 model accuracies in the range of 89% to 99.7%. Thus, Inception V3, a pre-trained model on the ImageNet weights shows the highest accuracy among all.

E. Machine learning (ML)

We can say that nothing in this world is totally magic. When we talk about trending technologies like Deep Learning which is based on neural network and inspired from human brain cell, Machine learning algorithm which is best suited for dataset like tabular data, RDBMS data, unstructured data and by using such kind of algorithm one can either classify the datasets or cluster it using beneficiary tools like matplotlib and many more. Machine learning plays an important role in image detection in the medical field as well.

Each and every algorithm like Linear Regression, Decision Tree, K-means, SVM, etc. have its own specialty which has some statistical support and that's why after the model gets ready it performs best on unseen data. Machine Learning algorithm always start with data collection, pre-processing it like deleting null values, checking mean, mode and median of data, imbalance dataset so that whenever a ML model[15] get trained it should learn the data properly considering all the standard parameter of ML upto the accuracy and other metrics. For the flow consider Figure 6. The sequential flow of overall ML is so easy to understand as well as for implementation.

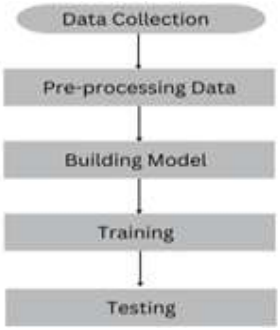

Figure 6. Basic ML Architecture

Algorithm like SVM [8] i.e. support vector machine is a type of Machine Learning algorithm which is used for both classification and regression depending on the requirement. When the data is linearly separable, the SVM model gives good accuracy. In the article it is said that doctor used to study acne manually, but to solve this using Computer technology like the Gray Level Co-occurrence Matrix (GLCM), automatic detection of face acne and classification becomes possible into categories like papules, pustules, and nodules or cysts. The basic understanding of SVM classification from Figure 7. is like hyper plane and best margin play an important role.

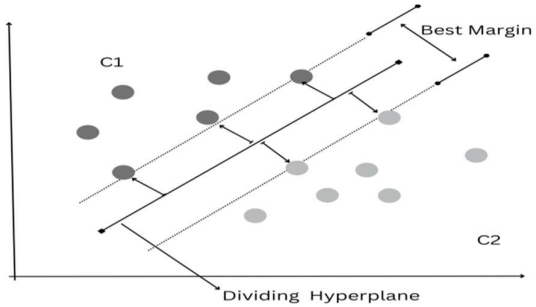

Figure 7. SVM architecture

The GLCM method is also known for texture analysis basically used on the dataset we have. This technique uses distance measure and direction for calculation. A square matrix which describes certain properties spatially and uses texture calculations in the second order. Statistical calculation is used for the first-order texture measurement based on the original values of images.The steps for SVM include collection of images, resizing, image pre-processing, calculating GLCM value based on calculation, making group of acne and GLCM value. For the identification of acne image with size 192*192 and by using GLCM characteristic extraction as well as algorithm accuracy count are 100%, 50%, 50% for papular means mild acne, pustular means moderate type and nodule type respectively. For overall acne the accuracy achieved is 66.7% less than 10 sec. When pixel size of 18 samples of acne image with 256*256 image size, the accuracy is 83.3%, 100%, 83.3% for papular acne pustules and nodules. The overall identification of the accuracy is 89% less than 10 sec. So the conclusion is as we take proper pixel size the accuracy is getting improved. Based on the research conducted for acne types like mild, moderate and severe, it can be concluded that the identification and classification of the types of skin diseases using such advanced technology which used only informative data and valid models to achieve good accuracy to solve real world problems[9].In the article every segmented image [11] is concluded using metrics like sensitivity, specificity, positive predictive value and negative predictive value. Sensitivity is the condition where the probability that a test will be positive for a patient facing acne. Specificity is considered to

be the probability that a test will be negative given a patient without acne condition. So for the Severity, Mild, Moderate, Severe, Very Severe category the Sensitivity is 0.9216, 0.8838, 0.9626, 0.9461 the Specificity is 0.9889, 0.9597, 0.973, 0.9114, the Positive Predictive Value is 0.9101, 0.8168, 0.9473, 0.9334, and for the Negative Predictive Value it is 0.9904, 0.976,0 0.9814, 0.9279 respectively.

III. CONCLUSION

So from a literature survey we can conclude that trending technologies like machine learning, deep learning play an important and crucial role in the medical sector for acne detection which is a real problem. There are a number of stable tools and libraries available which make the detection process so easy. The accuracy and efficiency also get improved if proper pre-processed dataset gets fed to the model architecture of deep learning and machine learning algorithms. This kind of human interruption free technology totally changes the world from manual efforts. All the architecture needs to be considered properly right from collection of data, maintaining the data privacy of collected data and preprocessing it before training it on any special model.
Hence we can conclude that from overall trending algorithm like Support Vector Machine (SVM), ResNet-50 famous for residual network, Inception-v3, DenseNet121, Xception, VGG-16, CNN and Inception-ResNet-v2 performs well considering specific evaluation metrics.

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