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AN INTELLIGENT ASSISTANT FOR PREDICTION POST-COVID SKIN ALLERGIES DIAGNOSIS

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Symptoms, Skin, Itching, Machine learning, Classification, Diagnosis, Predict, Allergies, Precision, Measures, Intelligent, Covid-19

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ABSTRACT: The epidemic of COVID-19 provides various issues for healthcare professionals. Rapid assessment and treatment, vulnerability classification, efficient use of critical care facilities, adequate medications, surveillance, and prompt discharge, are crucial to protect as many casualties as possible. We described different classification techniques of ML (machine learning) to analyze skin-related issues. This research aims to provide adequate skin specialists with a strategic plan to understand that they may diagnose its prospects and problems. In this work, we use well-known ML methods, including DT (Decision Tree), LR (Logistic Regression), SVM (Support Vector Machines), KNN (K Nearest Neighbor), and multi-model (Gradient, gaussian nave bias, XGB, SGD), classification methods. Make an intelligent diagnostic assistant to correctly identify a certain kind of allergy condition.

INTRODUCTION: Skin diseases have increasingly captivated emergency care, progressing from preliminary clinical studies to a substantial scientific consensus [1]. Whereas the exact global incidence is unknown, it affects 1% to 2% of the population. Most people are currently suffering from various skin allergies after recovering from COVID-19. Recent researchers, with the help of dermatologists, have stated an association between skin problems and COVID-19. It's hard to tell what's going on with the skin without the help of a skin specialist and it's also hard to figure out how to treat this kind of disease.

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Allergies are a leading source of mortality, affecting many people worldwide. Due to a shortage of specialists, just 28% of cutaneous disorders are examined by a physician. Specialists are influential in determining epidermal infections and initiating therapeutic therapy. Nonspecialists' diagnosis efficiency is significantly less [2, 3]. Itchiness is increasingly becoming related to coronavirus infections. Like those associated with these other respiratory infections, including influenza and syphilis, such allergic reactions may develop in various forms.

A "maculopapular rash" is perhaps the most prevalent myriad. Such allergic reactions have few macules and minor, rising lesions. Quick bleeding is highly prevalent in anti-inflammatory patients and usually fades after the drug is discontinued. Allergic reactions and pain at the corners of the eyes may develop, triggering medication with lotions and nutritional supplements. Ringworm, a

fungal epidermis disease, is frequent in several patients. In some cases, combined with remedies, detergents and washes are adequate. Treatments may help very few patients with long-term melanomas. In post-COVID-19 patients, dermatitis or allergies are prevalent. It appears as an acoustic lesion with irritating, itching feelings that can continue for weeks or months. Antihistamines prescribed by a dermatologist and the use of calming lotion can reduce the disorder. "Post-infection immunity modifications are a possible cause [4]. While hypersensitivity needs emergency therapy, diagnosis depends mainly on diagnostic and therapeutic consequences. Older people and kids may exhibit the following manifestations: Generalized rashes, broad erythema, irritation, eye infections and inflammation of the eyes, lips, throat, teeth, face, or body parts.

Scope: Image analytics has increasingly become popular and is being employed in various domains. It can simplify human effort tasks like weeding, disease identification, plant growth stage identification, *etc*. The scope of our project is that it can be used to identify skin allergies, which is a side effect of the coronavirus. This algorithm can be a robust model to simplify the process and help doctors assess it. It can make the task even more straightforward to use, and it is also not as expensive as a diagnostic test to implement. This system can become more and more efficient with a large amount of image data.

Benefits:

- Early diagnosis of skin allergies reduces the negative impact of the allergies.
- Easy and flexible analysis to the user as it displays human-machine interaction.
- Faster prediction of the results
- low-cost application from users' point of view

The Remaining Work is Categorized as Follows: The second section discusses the background of the proposed method, and section 4 delves into the related work of post-COVID-19 skin allergies. In section 5, the proposed work methodology is elaborated. Section 6: experimental environments and examines the performance of the proposed method. This is followed by section 5's discussion about the theme of the proposed work, section 6's concluding remarks, and finally, section 7 suggests directions for future enhancement.

BACKGROUND: The outbreak has led to several behavioural modifications, such as using disinfectants or detergents frequently. As a consequence, several individuals develop hand eczema. Medical personnel who use PPE (Personal protective equipment) have reported that donning masks and lenses causes face epidermal rashes, erythema and worsening of pre-existing dermatitis [5].

Patients can develop severe eczema and extensive dermatitis with minor bumps and lesions resembling temperamental temperature. It can linger for days after COVID has cleared up. Skincare products and external antibiotic lotions can assist if something is affecting patients. An allergic reaction caused after recovery from the virus affects any portion of the body, typically the chest, although this can affect the extremities. Erythema is usually sensible but depends entirely on how much of the reaction there is, and lesions recover quickly, occurring in two or three days and fading in a week. Acral lesions resembling pseudo-chilblains, erythema multiforme-like eruptions, and various skin irritations are now the most commonly observed dermatitis signs. COVID-19-specific highly contagious living conditions might cause most such allergic reactions. SARS-CoV2 and immunological deregulatory actions 6 may cause some dermatitis symptoms.

The combination of its great transmissibility and protracted pathologic delay phase resulted in a worldwide pandemic that impacted millions of people and resulted in more deaths [7]. While it is most usually connected with inflammatory illness and pulmonary edema, scientific evidence suggests it may also cause dermatological symptoms worldwide. SARS-CoV-2 respiratory infection frequently leads to systemic complications. Such disorders are often divided into five main trends: erythematous dermatitis, cutaneous itchiness, quasi, live do or mortification, and antihistamine. A contagious spreading dermatitis is also found in pediatric inflammatory, multisystem syndrome, an uncommon and severe illness in adolescents. Such

patches are caused by cutaneous hemorrhage but do not alter colour when rubbed [8].

Related Works: In the U.S., inflammatory hypersensitivity to drugs, diets, or other nutrition items is growing more common [8]. One in every five of the sensitivities observed has irritation with unpredictable consequences, ranging from minor blemishes to fatal reactions. The highly customized interactions make people in the clinical context more vulnerable to allergic reactions [9].

The chest has been the most generally affected location. All dermatological signs, such as itchy reactions, pruritus, varioliform infections, and blemishes, were minimal or nonexistent in patients and typically resolved in days. Furthermore, specialists in Spain established that moderate irritation is associated with the eczematous redness associated with COVID-19 in certain minimum cases. It was expected that the COVID-19 contamination would manifest as hemorrhagic rashes [10, 11] identical to Dengue. It's essential to note that approximately one in five dengue patients develops itching. On the third day of hospitalization due to coronavirus, an elderly lady, [12] developed pruritus to purpuric, millimetric, aggregating macules in the flexural regions.

A slightly pruriginous irritation was reported. Thrombocytopenia is widespread, with influenza affecting 20% of COVID-19 patients with significant urticaria. Despite the insufficient evidence on itchiness, urticaria is a widely recognized dermal illness accompanied by severe itching. Chickenpox-like vesicles [13] were found in 6% of the study participants. Similarly, there seems to be a shortage of evidence about the itching in those people; nonetheless, few clinicians who treat COVID-19 patients note that the disease may be irritating.

Recent investigation underlines many aspects of autoimmune illness [14]. The most recent Italian study suggested that COVID-19 may affect skin-related issues. Similar to the clinical dermatology symptoms found in common viral infections. The most thorough explanation was that dermal symptoms did not correlate with disease severity. According to publicly available data, clinical symptoms may be present in 0.2 percent to 21% of COVID-19 patients. According to dermatologist insights, three investigations highlighted the incidence of irritation in afflicted individuals.

In an observational study of people with coronavirus [15], skin-related signs appeared 64% later or immediately with other severe infection symptoms, with a time complexity of 8 days in seniors from the commencement of infection of the pulmonary ailments to skin abnormalities [16]. After six months of follow-up, approximately 3% of respondents in the post-COVID-19 category reported skin irritation. The most prevalent ophthalmological complaint was hair fall, affecting about 20 percent of the cases. Hormonal changes in digestive fluids, which can happen as a side effect of viruses or anxiety, can cause serious side effects. The comprehensive study might give information on disorders with immune or autoimmune responses [17].

Methodology and Framework: An allergic response may not always indicate the presence of a specific illness. This term refers to any inflammation or redness that interferes with the usual skin texture. Post-Covid rash, itching, skin irritations, allergies, and athlete's foot are common lesions. Because medications might contribute to various skin infections, a physician must evaluate allergic reactions lasting more than three days without going away. Even though one progresses across the ML design process, one will probably find themselves iterating on a component till it fulfills the objectives, subsequently continuing on another task. In addition, once the first iteration is deployed, collect reviews from previous experiences and define goals for another deployment phase.

Data Set: Image data sets of skin rashes are collected from different resources that are publicly available. After collecting the data set, apply pre-processing techniques to eliminate redundant values and noisy elements. To train the model for effective diagnosis of skin-related issues.

Feature Extraction: The process of extracting features entails minimizing the resources necessary to explain several observations. Several decision-makers in ML consider that a well-adjusted feature extractor is the result of good model development.

Extraction of features is a broad term encompassing building parameter variations that avoid these issues while accurately representing the input.

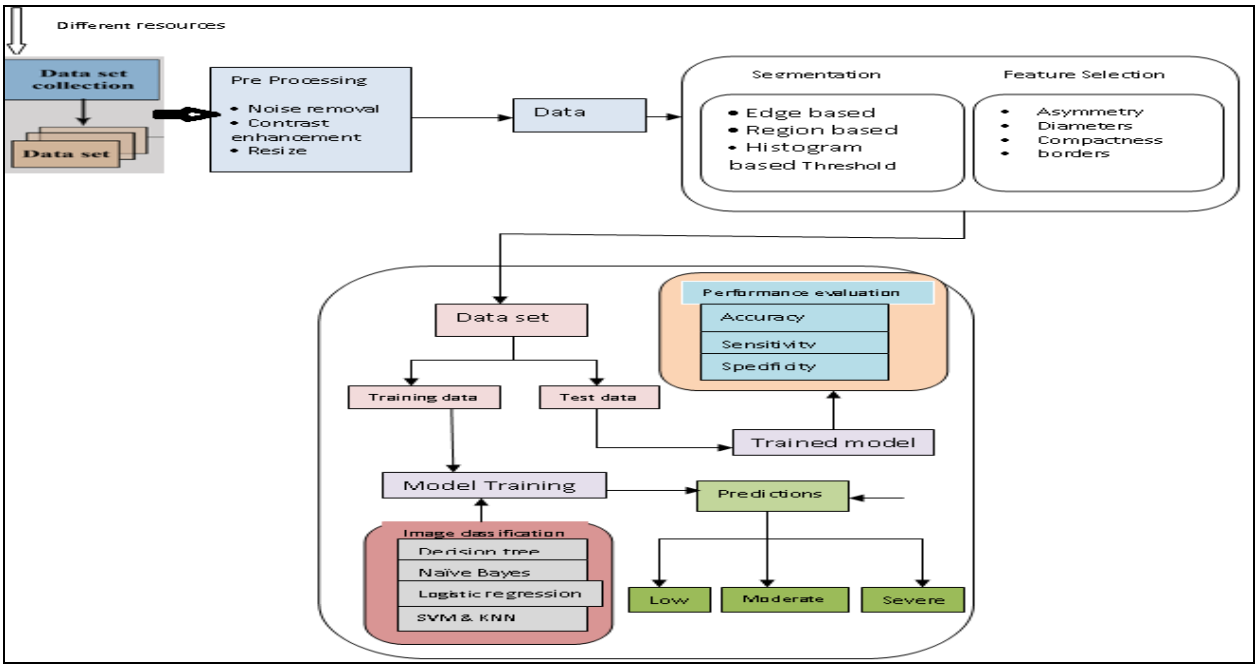

FIG. 1: FRAMEWORK OF THE PROPOSED SYSTEM

Logistic Regression: Regression uses the sigmoid activation function to forecast specific circumstances. It analyzes the dataset and assigns them values between zero and 1. The input parameters (X1, X2,...Xn) are progressively integrated and used the optimum values [18] to forecast the estimated value (Y).

$$Y = 1 / 2 \times e(mx1 + c) / 1 + e(mx1 + c) + e(mx2 + c) / 1 + e(mx2 + c)$$

In which 'c' is the interception and is the variable of the given variables X1 and X2 (in our case, X1, X2 are age and gender). The probability value must train each input value from the training examples (X1, X2). With formula, this work was done to categorize the dying and recovering patients of the post covid19.

Decision Tree (DT): The DT technique utilizes the effective forecasting method for supervised machine learning issues. The DT models are described in terms of a tree structure. The estimation in the DT is determined by identifying the root node of the tree structure and partitioning the training examples depending on a specific attribute (x**)** [19]. The DT classification technique estimates the tree structure's contamination percentage for forecasts. In this study, the post-COVID-19 skin rashes dataset has used the outcome that the patient's skin allergies are classified as low, moderate, and high.

$$G = n\sum i=1 \times xk(1-xk)$$

'x' is the percentage of the input image in the given classes 'k.' The dataset's binary logic tree structure is part of the process as simple as possible.

Support Vector Machines (SVM): The SVM is a supervised technique that uses boundary values to generate support vectors for every classifier in the subspace. The SVM attempts to optimize losses across categories by efficiently segregating feature space. If the provided sample is linearly restricted, conventional SVM can be used for classification methods; if the example is non-linear, which can be used [20].

This algorithm can classify both quantitative and non-linear data. It begins by mapping every piece of data into an n-dimensional training dataset, where n represents the number of features. It then finds the hyperplane that divides the data into different classes while maximizing the marginal proximity for both categories and reducing prediction error. Assuming the sample (A1, B1,....An, Bn), in which (A1,... An) is the number

of input variables, (B1,..., Bn) is the outcome variable, and 'C' is the interception; the Classification method [21] is defined as.

$$SVM = \sum n\ i=1\ \beta i - 1 / 2 \sum n\ i \times j=1\ bibjC(\alpha i \times \alpha j)\beta i\beta j$$

In the above equation, i=1,2,3,...n, and C=bii+ bjj. The SVM formula has been used to categorize post-COVID-19 skin irritation instances.

K-Nearest Neighbors (KNN): KNN is a multivariate method. The training and forecasting evaluation is based on the provided task or sample. The 'K' in KNN shows the number of k nearest data points. The KNN method categorizes the provided samples depending on 'K.' [22].

The KNN approach categorizes the learning sample automatically. It indicates that the forecasting of a new instance is developed by scanning the complete learning algorithm for comparative 'K' neighbor examples and categorizing depending on the category of maximum occurrences. The Distance measure method is used to find a comparable case.

$$Euclidean\ i \times j = \sqrt{n} \sum k=1\ (xik - yjk)^2$$

Gaussian Naïve Bias: It depends on the Bayesian hypothesis. This hypothesis can characterize the likelihood of an occurrence depending on background knowledge of aspects conducive to a particular outcome.

This classification implies that a specific characteristic in a category isn't strongly associated with other features, despite the reality that characteristics in that category may be interdependent.

Gradient Boosting: It is a regression analysis and classifiers ML approach that builds a performance of the classifier from a collection of inadequate estimate techniques, foremost typical of that is a tree structure. It integrates weak features to build a significant, robust good approximation accuracy rate. The error function is one and adapted to the task given.

XGB: In Supervised Learning, XGBoost [24] has become one of the types of boosting. A supervised method is a group of forecasters used to estimate the reliability of several models. In the boosting strategy, earlier models' errors are attempted to be corrected by classifiers by increasing parameters to the modeling techniques.

Stochastic Gradient Boosting: It is an integration of bagging and boosting techniques. SGB [25] is a supervised learning approach that combines boosting with decision trees to create a forecast by evaluating ensemble participants from all trees. The new classifier is trained iteratively following the steepest descent direction of the preceding tree's error function. By learning the classifier, SGB aims to minimize the prediction error between the classification algorithm and the actual function.

Performance Metrics: The CM (confusion matrix) and the ROC (receiver operating characteristic) curve have traditionally been used to assess classification diagnostic performance [23].

The CM is also defined as the loss or uncertainty matrices in the ML methods research arena. TP (True positives) are optimistic instances where the classification is accurately recognized. Likewise, TN (true negatives) are negative instances that were correctly detected by the classifier. False Positives (FP) and False Negatives (FN) are both situations in which the classifiers misinterpret the occurrences as positive or negative.

Implementation Analysis: Machine Learning techniques are more accurately predicted and quickly trained datasets. The image dataset is loaded and converted into labels used further for feature extraction. After extracting features from the images, classification algorithms are applied to classify different skin-related issues after corona recovery. Then the produced NumPy array is split and trained using Machine Learning algorithms, and the best fit model is selected for result analysis. It operates effectively with large amounts of input and practical uses. Aside from specific methods, we investigate how such a system recognizes illnesses using supervised learning, which resulted in a considerable gain in identifying skin reactions.

- The system allows the user to evaluate the hypersensitivity rapidly.
- After learning about the disorder, users will seek medical assistance. ML models are invented and created utilizing multiple methods.

FIG. 2: SAMPLE OF COLLECTED DATA SET IMAGES

Module for Pre-processing: algorithms get the dataset processes data. The data should always be well before eliminating and detecting biases before starting the fundamental analysis. When data is available due to an investigation, the following stage analyzes the results to retrieve meaningful data. Generally, the data output might be too much, less, or fragmented. Records pre-processing entails identifying data into three different types and analyzing it appropriately. As a result, data cleaning, organizing, formatting, and noisy modeling are critical components of any pre-processing data strategy.

Feature selection module is a programmatically selecting data factors contributing to the target variable or efficiency. The presence of hyperparameters in data reduces the accuracy. The advantages of performing the classification technique are as follows:

- Reduces overfitting
- Improves accuracy
- Reduces training time

```
[[ 41, 138, 131, ..., 123, 116,  38],
 [200, 119, 118, ..., 141, 150, 234],
 [224, 143, 126, ..., 173, 146, 240],
 ...,
 [224, 187, 171, ..., 165, 142, 213],
 [161,  97,  69, ..., 254, 253, 176],
 [136,  90,  92, ...,  91,  88, 123]]
```

FIG. 3: FEATURE MAP OF SKIN IMAGES

Classification Module: It is the methodology of categorizing a data set into categories; this can be done with different data types. The main objective is to determine what sort the observations will belong. The predictive assessment analysis process conceptualizes the non-linear mapping from distinct, independent factors to indicate other deterministic models. The key features are extracted from the images, and then an ML model is built to classify the severity classes of an infected skin image.

- ❖ The images are filtered using features like feature map max pooling.
- ❖ This image processing technique is used to process the images to extract valuable features to get the output.
- ❖ ML models are KNN, Ensemble Classifier, SVM, Logistic Regression, and Decision Tree. It can also be implemented with the help of Neural Networks using Grid-Dense layers.
- ❖ Finally, the output from these models is compiled to give effective results on skin allergy severity classification to get the desired output.

Logistic Regression:

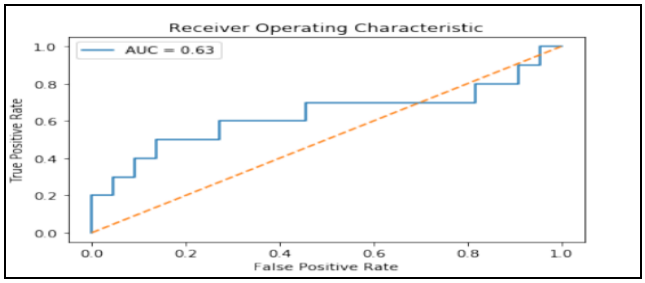

FIG. 4: ROC CURVE FOR LOGISTIC REGRESSION ACCURACY IS: 59%

Decision Tree:

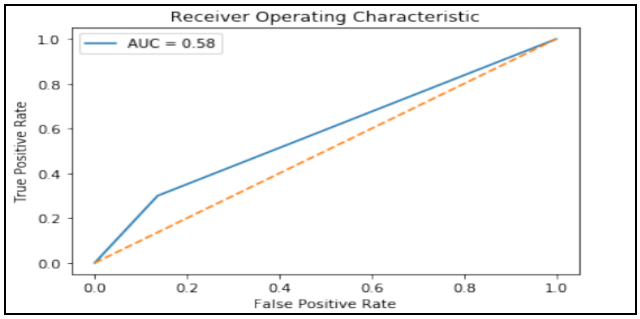

FIG. 5: ROC CURVE FOR DECISION TREE

Gaussian NB:

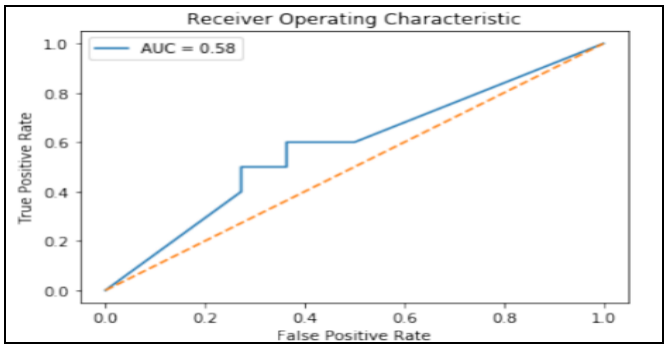

FIG. 6: ROC CURVE FOR GAUSSIAN NAIVE BAYES

K Neighbors Classifier accuracy is 35%

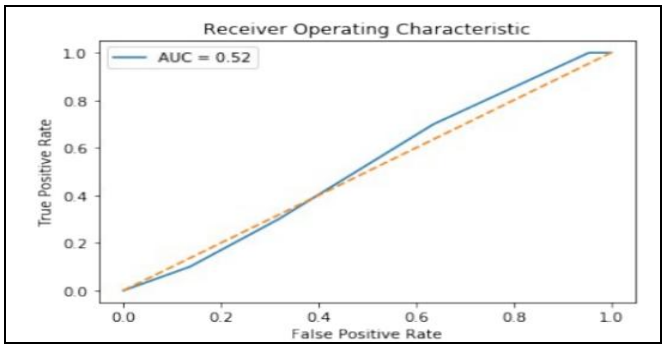

FIG. 7: ROC CURVE FOR KNN CLASSIFIER

Random Forest Classifier Accuracy is 44%:

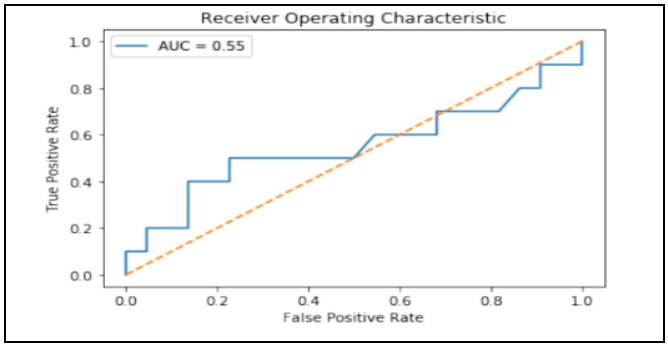

FIG. 8: ROC CURVE FOR RANDOM FOREST CLASSIFIER

SVM Accuracy 34%:

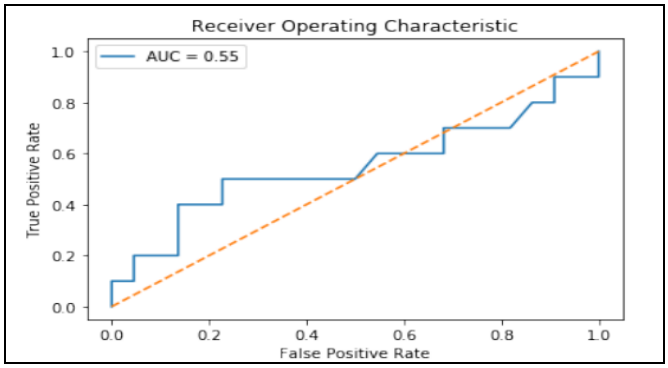

FIG. 9: ROC CURVE FOR SVM

Gradient Boosting Classifier Accuracy 47%

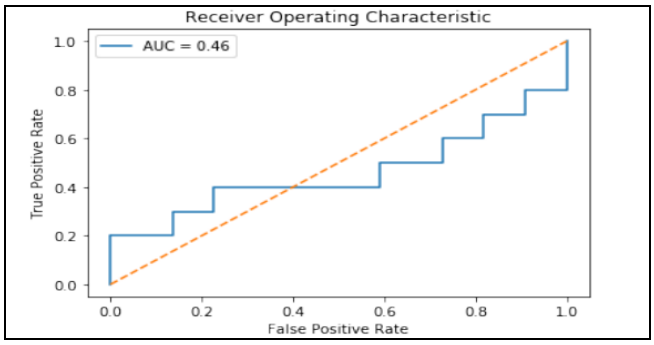

FIG. 10: ROC CURVE FOR GRADIENT BOOSTING

XGB Classifier Model accuracy is 47%

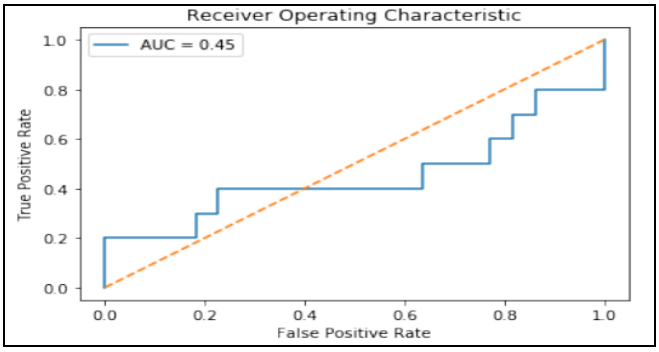

FIG. 11: ROC CURVE FOR XGB

SGD Classifier Model accuracy is 71%

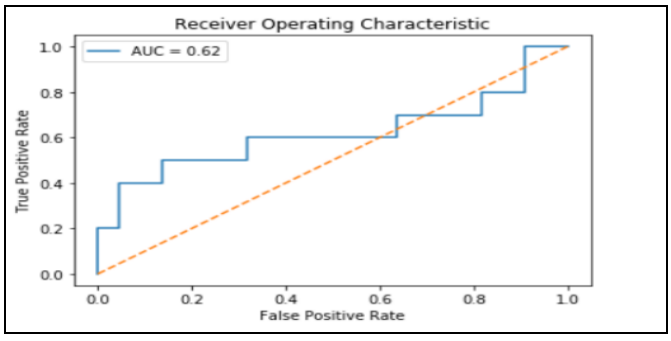

FIG. 12: ROC CURVE FOR SGD

TABLE 1: CLASSIFICATION REPORT

	Precision	Recell	F1-score	Support
1	0.60	0.60	0.60	10
0	0.80	0.73	0.76	11
Micro avg	0.70	0.67	0.68	21
Micro avg	0.70	0.66	0.68	21
Weighted avg	0.70	0.67	0.68	21

DISCUSSION: The SARS-CoV-2 epidemic has had far-reaching consequences, affecting millions of people clinically, economically, and morally. Furthermore, this critical virulence factor disease is challenging to handle because of its lengthy symptomless latent and pulmonary droplet transfer.

There are still no experiments relating to irritation in the COVID-19 global epidemic era, with most characteristic skin lesions in patients with SARSCoV2 inflammation.

Irritation information is insufficient in many files, or more records will be obtainable in the forthcoming. Irritation about various factors of the global epidemic (for example, relevant to the COVID-19 virus, increased frequency of preceding skin irritation disabilities, allergic events to Personal protection equipment, mental tension irritation) has been valued highly.

CONCLUSION: Dermal adverse reaction symptoms have become more common in the two years since the pandemic's spread. These dermatological issues must be treated as early as possible to prevent severe damage. The "Wait and see" strategy should not be adopted in these extreme conditions as there have been many new variants of diseases every day due to COVID-19. This model helps people identify skin allergies at earlier stages without any visual examination by a skin specialist. This work is developed to achieve its primary objective and help treat skin changes at different levels. As melanomas are not life-threatening, the main aim of this work is to provide patients with quality care and alleviate their frustration. People diagnosed with clinical signs of illness may receive support from an identified treatment modality that shortens the conditions and reduces irritation.

Limitations of the Proposed Study:

- Extensive data is needed to gain better accuracy, massive RAM and storage requirements
- Not flexible for the user who is not familiar with the computers
- They will be entirely online, leveraging virtualized storage. They will probably involve excellent information security procedures to secure servers in a data processing or server malfunction and access control methods to restrict access.
- Increased maintenance as the model needs to be updated frequently and for the cloud storage.

Future Enhancement: There is a chance of new variants of viruses with various skin diseases. It is essential to build a model that can train itself with all the existing skin allergies, making it easier to treat the skin changes caused by these viruses. The developed model should store all the predicted and trained diseases to optimize its performance using deep neural networks. In combination with Open CV, this can be transformed into a user-friendly and more efficient model that dermatologists can conveniently use as their intelligent assistants at hospitals.

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CONFLICTS OF INTEREST: Nil

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