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Biometeorological Eczema Prediction: A Synthetic Environmental Stressors into a Pipeline with Machine Learning

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Abstract: ***The erratic course of Atopic Dermatitis (AD) is a major dilemma to preventive dermatology especially with regard to external fluctuations, which provoke exogenous flare-ups.***
Whereas the current diagnostic instruments are aimed at the severity at a single point in time, there is no combination of systems that can be used to model the longitudinal progression. In this work, an end-to-end machine learning model is suggested to forecast the changes in eczema severity (Mild, Moderate, Severe) through a synthesis of clinical patient data and the biometeorological variable.
The paper provides a methodological framework on how synthetic "digital twins"[11] can be used to test predictive architectures prior to clinical application with web framework.
Keywords: Machine Learning, Eczema, Atopic Dermatitis, XGBoost, Flask Web Application, Disease Progression Prediction.

I. INTRODUCTION

A simulated dataset was utilized with demographic, clinical, environmental, and lifestyle variables that represent patient variability in the real world in this study. With the help of this dataset, we created model that estimates the progression of eczema severity, which includes a mild, moderate, or severe category of patients.
In this manner, it can be emphasized that the integration of machine learning and open web platforms could facilitate personalized eczema management.

II. LITERATURE REVIEW

Early detection of patients treated with a high risk of experiencing severe symptoms is one of the advantages that allow clinicians to implement more effective treatment interventions that lead to improved long-term prognosis and contribute to the improvement of the quality of life of a patient.
Traditionally, traditional statistical models had been inadequate in this role because they typically do not effectively explain the nonlinear or non-additive causes of the development of eczema due to the numerous causes including demographics, environment, and lifestyle.

III.MATERIALS AND METHODOLOGY

A. Data Generation and Collection

Data were generated and collected through coding based on the study variables.
The target variable was the progression of eczema, and it was as follows:

- Mild (0)
- Moderate (1)
- Severe (2)

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B. Web Application Development.

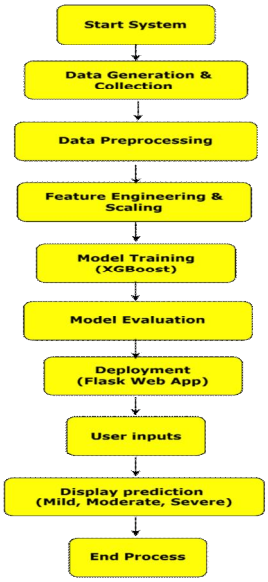


Fig. 1. Flow Diagram of System

IV. SYSTEM STRUCTURE & MODELS

A. System Structure

The system has an architecture where it consists of a machine learning pipeline, which is presented as a conglomerated end-to-end system that enables data preparation, model training, model evaluation, predicting in real-time through a web interface.

The multi-level structure ensures scalability, maintainability and reproducibility and hence it fits to the clinical decision-support environment.

B. System Models

1) Dataset Rationale

The selection of artificial data has been done to enable manipulation of the experiments and the introduction of other characteristics that cannot be easily obtained in the open data.

2) Results

- Accuracy: 85.5%
- Weighted Precision: 0.84
- Weighted Recall: 0.85
- Weighted F1-score: 0.84
- Log Loss: 0.46

Strategy in balancing techniques helped a great deal in recalling severe cases which were initially not well predicted.

V. DISCUSSION

The findings of the present research show that the Biometeorological Framework gives a tremendous improvement in predictive performance, over the conventional linear models.

This rate of performance is also to the fact that the model can offer the non-linear multi-hit hypothesis of the eczema flare-up that an individual factor can hardly solely cause a flare-up, but a complex interaction of low humidity, psychological stress, and adherence to medication, among other factors.

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VI. LIMITATIONS AND FUTURE WORK

The first weakness is the utilization of simulated data. Even though we had to model clinical parameters with Gaussian data, artificial data may not capture the infrequent clinical outliers, the idiosyncratic patients or long-tail of intricate co-morbidities of diverse real populations. As the model progresses to its clinical validation, the requirement to follow GDPR and HIPAA guidelines regarding privacy of clinical information in the Flask implementation will be enforced.

VII. CONCLUSION

The proposed AI-driven model is highly likely to predict the development of eczema using a multidimensional patient data.
It was deployed with the help of the Flask based web application, which explained its implementation as a strong clinical decision-support model.
The model is based on the multifactorial nature of eczema and allows medical workers to detect those patients against which there is an increased risk of developing an acute disease and take the preventive measures timely and design personal treatment programs.
Although the current study utilizes the synthetical data, interface of the web application is more intuitive, and less complicated framework that allows clinicians to input patient data and receive real-time predictions may help narrow the gap between extremely cumbersome machine learning models and applicability of AI in clinical settings to help improve patient outcomes even more.

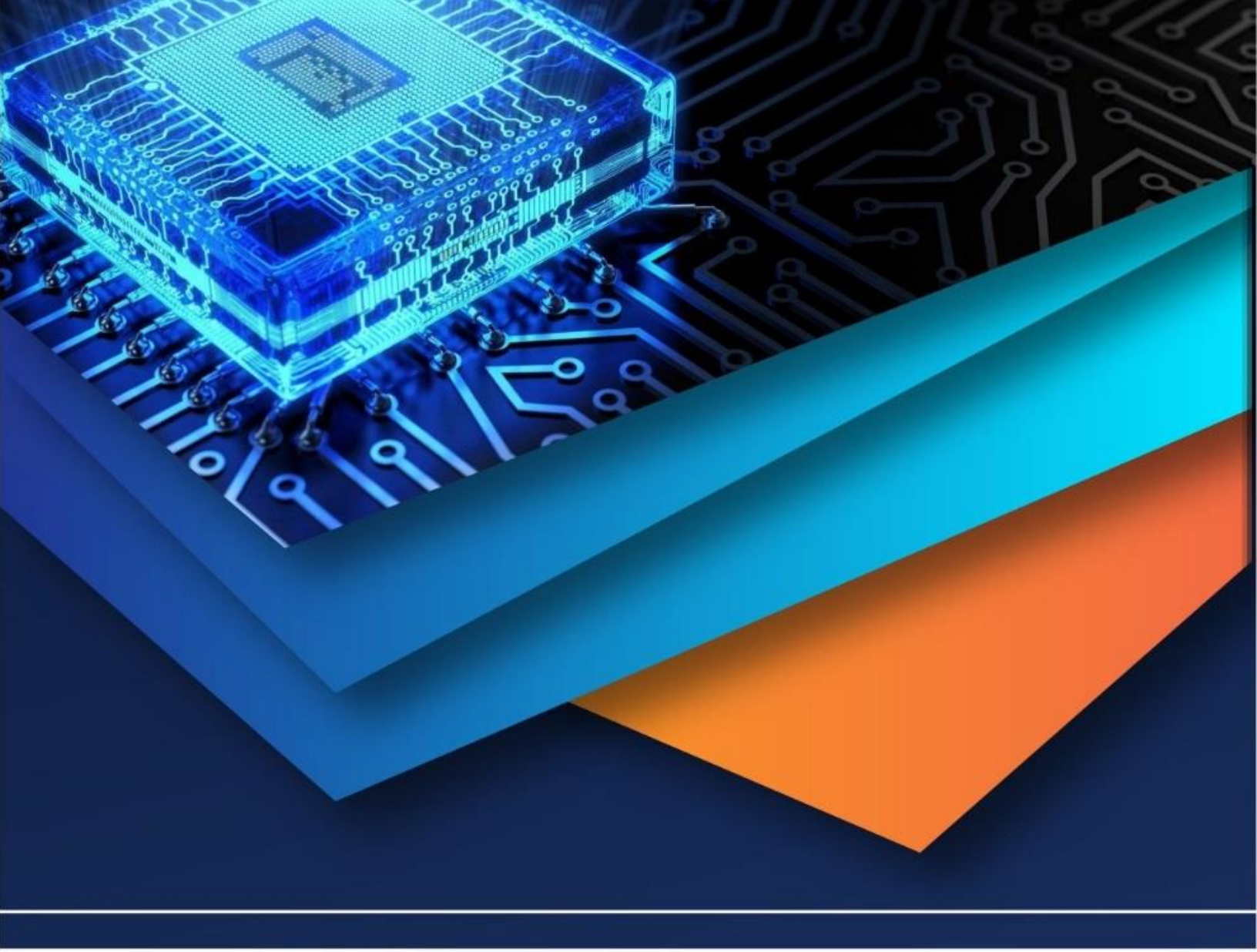
VIII. ACKNOWLEDGMENT

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