Utilitas Mathematica

ISSN 0315-3681 Volume 122, 2025

Air Quality Index Forecasting via Genetic Algorithm - Based Improved Extreme Learning Machine

[1] Pranaja Mothe

PG Scholar, Department of Computer Science & Engineering, Siddhartha Institute of Technology and Sciences, Hyderabad, India.

[2] Mr. B Ravindar Reddy

Assistant Professor, Department of Computer Science & Engineering, Siddhartha Institute of Technology and Sciences,

ABSTRACT

Air quality has always been one of the most important environmental concerns for the general public and society. Using machine learning algorithms for Air Quality Index (AQI) prediction is helpful for the analysis of future air quality trends from a macro perspective. When conventionally using a single machine learning model to predict air quality, it is challenging to achieve a good prediction outcome under various AQI fluctuation trends. In order to effectively address this problem, a genetic algorithm-based improved extreme learning machine (GA-KELM) prediction method is enhanced. First, a kernel method is introduced to produce the kernel matrix which replaces the output matrix of the hidden layer. To address the issue of the conventional limit learning machine where the number of hidden nodes and the random generation of thresholds and weights lead to the degradation of the network learning ability, a genetic algorithm is then used to optimize the number of hidden nodes and layers of the kernel limit learning machine.

1. INTRODUCTION

Air pollution is a prevalent environmental problem in the twenty-first century. In light of the rapid industrialization and urbanization, air pollution is getting worse, which greatly affects our living environment and health. Li et al. came to the conclusion that outdoor physical activity poses numerous health risks due to ambient air pollution in China. According to the Chinese Ambient Air Quality Standards (GB3095-2012), there are six conventional air pollutants used to measure air quality: sulfur dioxide (SO2), nitrogen dioxide (NO2), particulate matter with a particle size less than 10 microns (PM10), particulate matter with a particle size less than 2.5 microns (PM2.5), ozone (O3), and carbon monoxide (CO). These pollutants have adverse effects on human health. The International Energy Agency estimates that air pollution causes 6.5 million premature

deaths per year, while long-term exposure to pollutants, such as fine particles (e.g.,PM2.5) or traffic-related pollutants, is linked to higher rates of lung cancer, coronary heart disease, and other illnesses.

2. LITERATURE SURVEY

2.1 Variational Bayesian Network with Information Interpretability Filtering for Air Quality Forecasting:

Air quality plays a vital role in people's health, and air quality forecasting can assist in decision making for government planning and sustainable development. In contrast, it is challenging to multi-step forecast accurately due to its complex and nonlinear caused by both temporal and spatial dimensions. Deep models, with their ability to model strong nonlinearities, have become the primary methods for air quality forecasting. However, because of the lack of mechanism-based analysis, uninterpretability forecasting makes decisions risky, especially when the government makes decisions.

2.2 Spatiotemporal air quality forecasting and health risk assessment over smart city of NEOM:

Modeling and predicting air pollution concentrations is important to provide early warnings about harmful atmospheric substances. However, uncertainty in the dynamic process and limited information about chemical constituents and emissions sources make air-quality predictions very difficult. This study proposed a novel deep-learning method to extract high levels of abstraction in data and capture spatiotemporal features at hourly and daily time intervals in NEOM City, Saudi Arabia. The proposed method integrated a residual network (ResNet) with the convolutional long short-term memory (ConvLSTM).

3. SYSTEM ANALYSIS

3.1 EXISTING SYSTEM:

The existing systems for air quality prediction have long grappled with the challenge of delivering precise forecasts, a crucial requirement in safeguarding human health amidst escalating pollution levels. Many traditional deep and machine learning algorithms have fallen short due to inaccuracies in their weight training processes, resulting in suboptimal predictive performance characterized by higher mean square error (MSE) and root mean square error (RMSE).

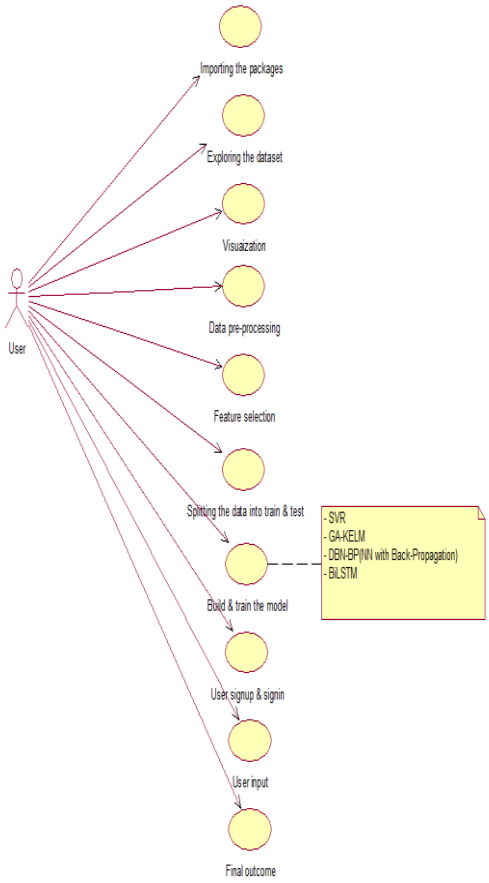
3.2 PROPOSED SYSTEM:

In this study, we propose an innovative approach to address the pressing issue of accurate air quality prediction, a fundamental requirement for human well-being in the face of increasing pollution levels. Existing machine learning and deep

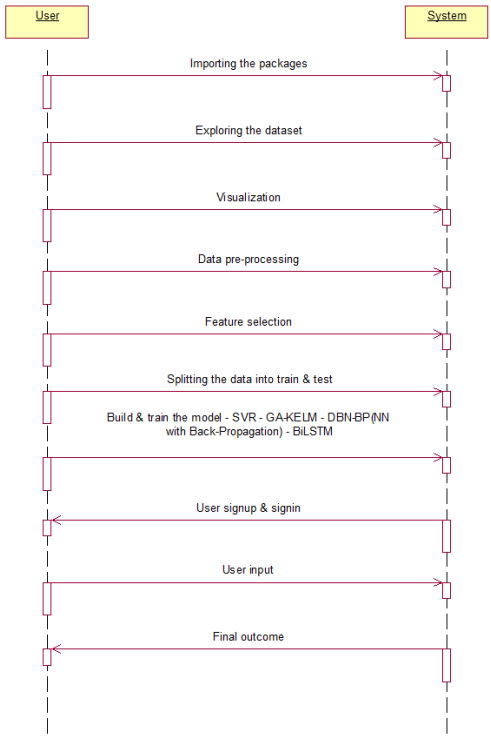
learning algorithms have struggled to provide precise predictions due to inaccurate weight training. To overcome this challenge, we introduce an enhanced model combining Extreme Learning Machine (ELM) with Genetic Algorithm (GA), referred to as GA-KLEM. This novel approach optimizes not only the number of hidden layer nodes but also thresholds and weights within the ELM framework.

4. SYSTEM DESIGN

4.1 USE CASE DIAGRAM



4.2 SEQUENCE DIAGRAM



5. IMPLEMENTATION

Data loading: using this module we are going to import the dataset.

Data Processing: Using the module we will explore the data.

Splitting data into train & test: using this module data will be divided into train & test

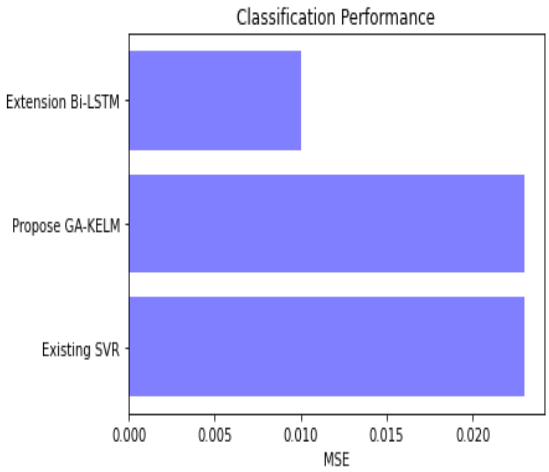
Model generation: Model building - SVR - GA-KELM - DBN-BP(NN with Back-Propagation) - BiLSTM. Algorithms accuracy calculated

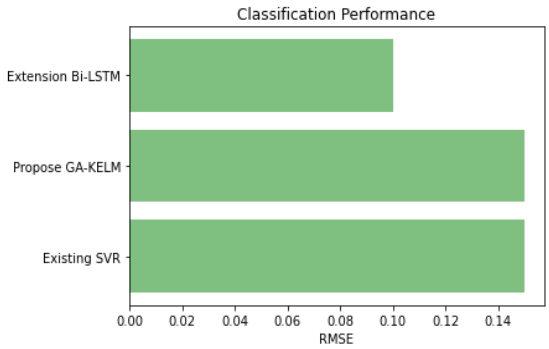
User signup & login: Using this module will get registration and login

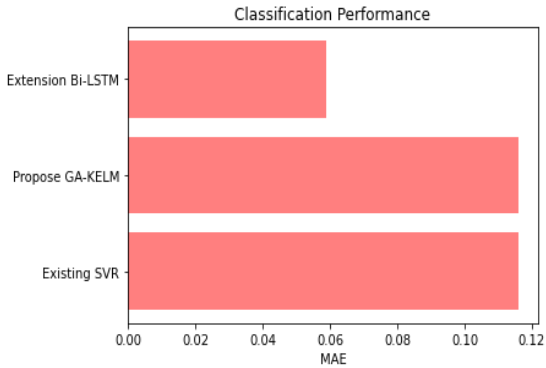
User input: Using this module will give input for prediction

Prediction: final predicted displayed

6. OUTPUT SCREENS







7. CONCLUSION

The economic development achieved by the country through rapid urbanization is polluting the environment in an alarming way and putting people's lives in danger. Therefore, a correct analysis and accurate prediction of air quality remains a primary condition to achieve the objective of sustainable development. This paper focuses on the problem of prediction model design, and investigates the problems related to the optimization of the model parameters. A GA-KELM model is designed, implemented, and tested. It is experimentally proven to be more efficient than the classical shallow learning and can effectively explore and learn the interdependence of multivariate air quality correlation time series such as temperature, humidity, wind speed, SO2, and PM10. Therefore, the GA-KELM model developed in this study can be used to provide valuable support to vulnerable groups and trigger early warning of adverse air quality events. However, there are still areas for further investigation and improvement. In recent years, numerous advanced algorithms and optimization methods based on genetic algorithms and population intelligence have emerged.

8. REFERENCES

I. Y. Han, J. C. K. Lam, and V. O. K. Li, ‘‘A Bayesian LSTM model to evaluate the effects of air pollution control regulations in China,’’ in Proc. IEEE Big Data Workshop

(Big Data), Dec. 2018, pp. 4465–4468.

II. L. Bai, J. Wang, X. Ma, and H. Lu, ‘‘Air pollution forecasts: An overview,’’ Int. J. Environ. Res. Public Health, vol. 15, no. 4, p. 780, 2018.

III. Y. Ding and Y. Xue, ‘‘A deep learning approach to writer identification using inertial sensor data of air-handwriting,’’ IEICE Trans. Inf. Syst., vol. E102-D, no. 10, pp. 2059–2063, 2019.

IV. S.-Q. Dotse, M. I. Petra, L. Dagar, and L. C. De Silva, ‘‘Application of computational intelligence techniques to forecast daily PM10 exceedances in Brunei Darussalam,’’ Atmos. Pollut. Res., vol. 9, no. 2, pp. 358–368, Mar. 2018.

V. M. Jia, A. Komeily, Y. Wang, and R. S. Srinivasan, ‘‘Adopting Internet of Things for the development of smart buildings: A review of enabling technologies and applications,’’ Automat. Construct., vol. 101, pp. 111–126, May 2019.