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KÜTAHYA DUMLUPINAR ÜNİVERSİTESİ
MÜHENDİSLİK FAKÜLTESİ

Bilgisayar Mühendisliği Bölümü


IEEE TRANSACTIONS ON
CONSUMER ELECTRONICS

MAY 2023 VOLUME 69 NUMBER 2 ITCEDA (ISSN 0098-3063)

A Publication by the IEEE Consumer Technology Society

REGULAR PAPERS

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IEEE

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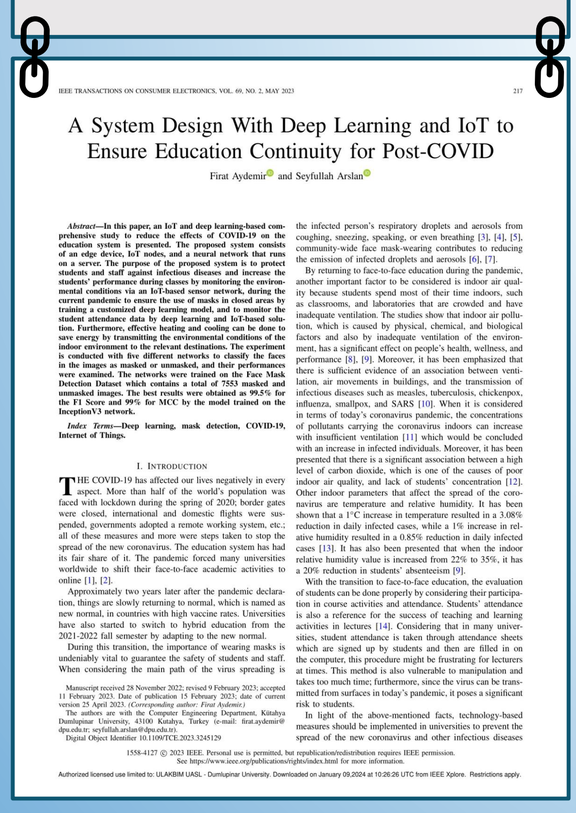
IEEE TRANSACTIONS ON CONSUMER ELECTRONICS, VOL. 69, NO. 2, MAY 2023 217

A System Design With Deep Learning and IoT to Ensure Education Continuity for Post-COVID

Firat Aydemir and Seyfullah Arslan

***Abstract*—In this paper, an IoT and deep learning-based comprehensive study to reduce the effects of COVID-19 on the education system is presented. The proposed system consists of an edge device, IoT nodes, and a neural network that runs on a server. The purpose of the proposed system is to protect students and staff against infectious diseases and increase the students' performance during classes by monitoring the environmental conditions via an IoT-based sensor network, during the current pandemic to ensure the use of masks in closed areas by training a customized deep learning model, and to monitor the student attendance data by deep learning and IoT-based solution. Furthermore, effective heating and cooling can be done to save energy by transmitting the environmental conditions of the indoor environment to the relevant destinations. The experiment is conducted with five different networks to classify the faces in the images as masked or unmasked, and their performances were examined. The networks were trained on the Face Mask Detection Dataset which contains a total of 7553 masked and unmasked images. The best results were obtained as 99.5% for the F1 Score and 99% for MCC by the model trained on the InceptionV3 network.**

***Index Terms*—Deep learning, mask detection, COVID-19, Internet of Things.**

I. Introduction

THE COVID-19 has affected our lives negatively in every aspect. More than half of the world's population was faced with lockdown during the spring of 2020; border gates were closed, international and domestic flights were suspended, governments adopted a remote working system, etc.; all of these measures and more were steps taken to stop the spread of the new coronavirus. The education system has had its fair share of it. The pandemic forced many universities worldwide to shift their face-to-face academic activities to online [1], [2].

Approximately two years later after the pandemic declaration, things are slowly returning to normal, which is named as new normal, in countries with high vaccine rates. Universities have also started to switch to hybrid education from the 2021-2022 fall semester by adapting to the new normal.

During this transition, the importance of wearing masks is undeniably vital to guarantee the safety of students and staff. When considering the main path of the virus spreading is the infected person's respiratory droplets and aerosols from coughing, sneezing, speaking, or even breathing [3], [4], [5], community-wide face mask-wearing contributes to reducing the emission of infected droplets and aerosols [6], [7].

By returning to face-to-face education during the pandemic, another important factor to be considered is indoor air quality because students spend most of their time indoors, such as classrooms, and laboratories that are crowded and have inadequate ventilation. The studies show that indoor air pollution, which is caused by physical, chemical, and biological factors and also by inadequate ventilation of the environment, has a significant effect on people's health, wellness, and performance [8], [9]. Moreover, it has been emphasized that there is sufficient evidence of an association between ventilation, air movements in buildings, and the transmission of infectious diseases such as measles, tuberculosis, chickenpox, influenza, smallpox, and SARS [10]. When it is considered in terms of today's coronavirus pandemic, the concentrations of pollutants carrying the coronavirus indoors can increase with insufficient ventilation [11] which would be concluded with an increase in infected individuals. Moreover, it has been presented that there is a significant association between a high level of carbon dioxide, which is one of the causes of poor indoor air quality, and lack of students' concentration [12]. Other indoor parameters that affect the spread of the coronavirus are temperature and relative humidity. It has been shown that a 1°C increase in temperature resulted in a 3.08% reduction in daily infected cases, while a 1% increase in relative humidity resulted in a 0.85% reduction in daily infected cases [13]. It has also been presented that when the indoor relative humidity value is increased from 22% to 35%, it has a 20% reduction in students' absenteeism [9].

With the transition to face-to-face education, the evaluation of students can be done properly by considering their participation in course activities and attendance. Students' attendance is also a reference for the success of teaching and learning activities in lectures [14]. Considering that in many universities, student attendance is taken through attendance sheets which are signed up by students and then are filled in on the computer, this procedure might be frustrating for lecturers at times. This method is also vulnerable to manipulation and takes too much time; furthermore, since the virus can be transmitted from surfaces in today's pandemic, it poses a significant risk to students.

In light of the above-mentioned facts, technology-based measures should be implemented in universities to prevent the spread of the new coronavirus and other infectious diseases

Manuscript received 28 November 2022; revised 9 February 2023; accepted 11 February 2023. Date of publication 15 February 2023; date of current version 25 April 2023. (*Corresponding author: Firat Aydemir*)

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Digital Object Identifier 10.1109/TCE.2023.3245129

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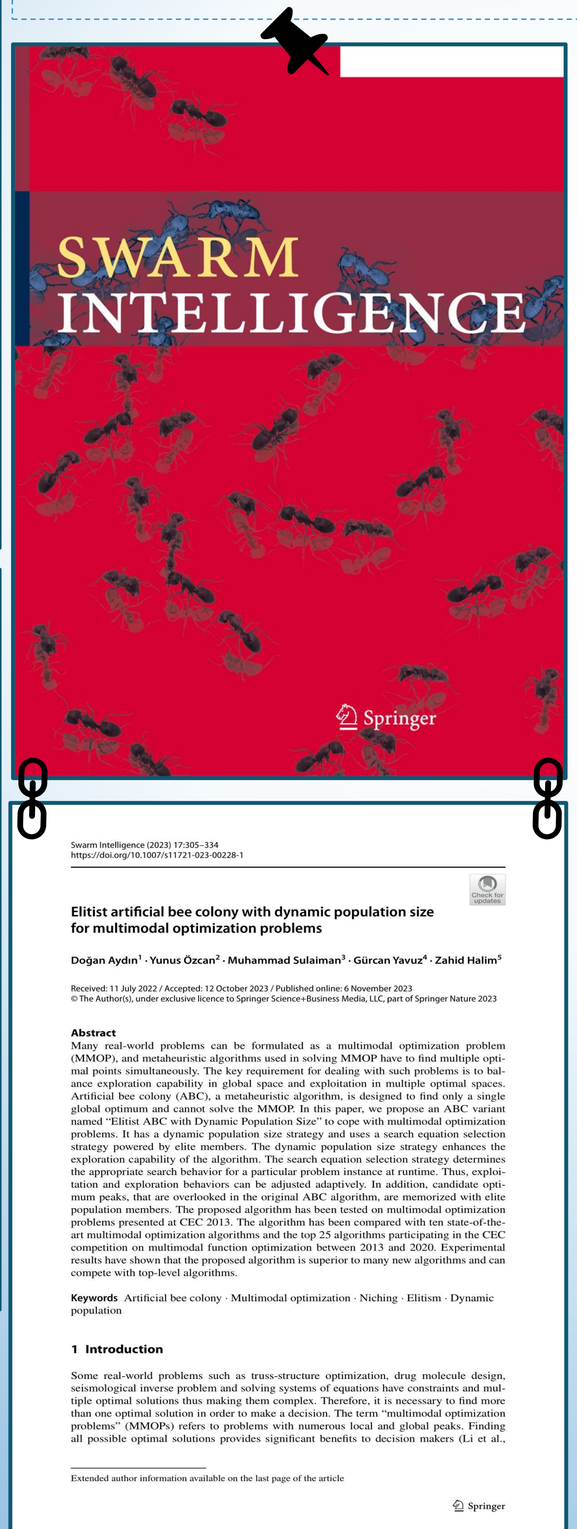
SWARM INTELLIGENCE

Springer

► https://link.springer.com/article/10.1007/s11721-023-00228-1

Swarm Intelligence (2023) 17:305–334
https://doi.org/10.1007/s11721-023-00228-1

Elitist artificial bee colony with dynamic population size for multimodal optimization problems

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Received: 11 July 2022 / Accepted: 12 October 2023 / Published online: 6 November 2023

Abstract

Many real-world problems can be formulated as a multimodal optimization problem (MMOP), and metaheuristic algorithms used in solving MMOP have to find multiple optimal points simultaneously. The key requirement for dealing with such problems is to balance exploration capability in global space and exploitation in multiple optimal spaces. Artificial bee colony (ABC), a metaheuristic algorithm, is designed to find only a single global optimum and cannot solve the MMOP. In this paper, we propose an ABC variant named "Elitist ABC with Dynamic Population Size" to cope with multimodal optimization problems. It has a dynamic population size strategy and uses a search equation selection strategy powered by elite members. The dynamic population size strategy enhances the exploration capability of the algorithm. The search equation selection strategy determines the appropriate search behavior for a particular problem instance at runtime. Thus, exploitation and exploration behaviors can be adjusted adaptively. In addition, candidate optimum peaks, that are overlooked in the original ABC algorithm, are memorized with elite population members. The proposed algorithm has been tested on multimodal optimization problems presented at CEC 2013. The algorithm has been compared with ten state-of-the-art multimodal optimization algorithms and the top 25 algorithms participating in the CEC competition on multimodal function optimization between 2013 and 2020. Experimental results have shown that the proposed algorithm is superior to many new algorithms and can compete with top-level algorithms.

Keywords Artificial bee colony · Multimodal optimization · Niching · Elitism · Dynamic population

1 Introduction

Some real-world problems such as truss-structure optimization, drug molecule design, seismological inverse problem and solving systems of equations have constraints and multiple optimal solutions thus making them complex. Therefore, it is necessary to find more than one optimal solution in order to make a decision. The term "multimodal optimization problems" (MMOPs) refers to problems with numerous local and global peaks. Finding all possible optimal solutions provides significant benefits to decision makers (Li et al.,

Extended author information available on the last page of the article

Springer

https://www.sciencedirect.com/science/article/pii/S2307187723001281 ◄


ISSN: 2307-1877

ELSEVIER

جامعة الكويت
KUWAIT UNIVERSITY

Journal of Engineering Research
Kuwait University

Volume : 11
Issue : 4

Journal of Engineering Research 11 (2023) 259–265

Contents lists available at ScienceDirect

Journal of Engineering Research

journal homepage: www.journals.elsevier.com/journal-of-engineering-research

Comparative analysis of metaheuristic algorithms for natural gas demand forecasting based on meteorological indicators

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ABSTRACT

Forecasting natural gas consumption is of great importance for the investments decisions made by decision-makers, the industrial sector, energy resources management, and especially for the economies of countries with high energy imports. In this study, we compared the performances of 4 different metaheuristic algorithms for estimating Turkey's natural gas demand. Normalized meteorological data (temperature, pressure, humidity, wind, and precipitation) were used as input parameters in the compared optimization models. Data between 2010 and 2017 (96 months) were used as training data, and data between 2018 and 2020 were used as test data (36 months). In the research, three mathematical models were developed as linear, exponential, and quadratic, respectively. The PSO-Quadratic model has the most successful prediction results for observed natural gas consumption in all three mathematical models among four different algorithms.

Introduction

Since natural gas is a low-carbon and clean energy source, it is preferred over polluting fuels such as coal and oil, and its importance is increasing daily [7]. Natural gas, used in electricity generation, industry, and especially for heating, has advantages [25,42]. These are high combustion efficiency, low waste material release, cost-effectiveness, easy storage, or no need for storage space [26]. Turkey, a peninsula that connects Asia and Europe, plays a geopolitical role in the intercontinental (from Asia to Europe, from the Middle East to Europe) transportation of energy resources such as oil and natural gas through pipelines [20]. Turkey strives to maximize its potential to become an essential international hub among producers in the Middle East, Central Asia, Russia and the Mediterranean [3]. Due to increasing energy demand and limited energy resources, Turkey is heavily dependent on energy imports. Through imports, Turkey meets almost all its natural gas needs (99.3 %).

Because energy production costs are high, a successful balance between energy production and consumption planning is critical [16,28]. Accurate energy demand forecasting is essential for decision-makers and country managers to achieve successful results.

When the studies on energy consumption estimation in the literature are examined, the focus is on the estimation of energy sources such as oil, coal, natural gas, transport energy, wind, solar, geothermal [1,4,10,11,20,21,28,33]. The energy policies deemed significant for the prognosis of future forecasts in each nation are determined by many variables [32]. In natural gas demand estimation, temperature, GDP (Gross National Product), population, season, date, import and export data are generally used as input parameters, respectively [19,8].

Studies in the literature show a need for studies in which meteorological data such as average temperature, pressure, humidity, wind and precipitation are used as parameters (Eis, Kalender Oksuz, and [9,18,37]). Researchers have used different estimation methods such as Artificial Neural Networks (ANN), Genetic algorithm (GA), ARIMA (Auto Regressive Integrated Moving Average), Regression analysis, ANFIS (Adaptive Neuro-Fuzzy Inference System), Gray algorithm, swarm intelligence algorithms to predict natural gas consumption demand [17,24,38,39,41,5,6]. Qiao et al. [30] used a whale optimization algorithm to predict short-term natural gas consumption by developing a new hybrid forecasting model in the light of the Volterra adaptive filter.

Deb et al. [15] compared the performances of DEA, PSO, and GA in their study and found that the best result was the PSO algorithm. Beskirli et al. [8] argue that the DEA algorithm for energy demand estimation is successful, and the lowest error values are in the quadratic model. Assareh et al. [2], tried to estimate the energy demand estimation with PSO and GA in their study. They used linear and exponential mathematical models. In the performance comparison, they saw that the exponential model of the PSO algorithm had the best result. When forecasting natural gas demand, meteorological parameters are essential. Although energy demand depends on many variable parameters in interaction, it is known that the impact of climate change

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https://doi.org/10.1016/j.jer.2023.100127
Received 10 June 2022; Received in revised form 20 February 2023; Accepted 27 April 2023

https://dergipark.org.tr/tr/pub/gazimmfd/issue/72928/1014788 ◄

https://mf.dpu.edu.tr


Gazi / Vol: 21 Sayı / No: 3 Eylül / September 2018 ANKARA

GAZİ ÜNİVERSİTESİ MÜHENDİSLİK - MİMARLIK FAKÜLTESİ DERGİSİ

Journal of The Faculty of Engineering and Architecture of Gazi University

Journal of the Faculty of Engineering and Architecture of Gazi University 38:2 (2023) 1153-1167

Mühendislik Mimarlık Fakültesi Dergisi
Journal of The Faculty of Engineering and Architecture of Gazi University

Publication / Online ISSN : 1304 - 4915
Basım / Printed ISSN : 1300 - 1884

Comparative analysis of metaheuristic optimization algorithms for natural gas demand forecast with meteorological parameters

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Highlights:

- Natural gas demand forecasting according to meteorological input parameters
- Energy estimation with metaheuristic algorithms
- Turkey's monthly natural gas consumption forecast

Keywords:

- Natural gas demand forecast
- Forecast according to meteorological parameters
- Metaheuristic algorithms

Article Info:
Research Article
Received: 25.10.2021
Accepted: 19.05.2022

DOI:
10.17341/gazimmfd.1014788

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Graphical/Tabular Abstract

Natural gas demand forecasting is critical, especially for decision-makers and the industrial sector. This study presents Turkey's monthly natural gas demand forecasting model according to meteorological parameters. Figure A shows the general structure of our suggested models and processes for natural gas demand forecasting.

Figure A. Block diagram of Natural Gas Demand Forecast with Meteorological Parameters

Purpose:
This study aims to present Turkey's monthly natural gas demand forecast model according to meteorological parameters with metaheuristic optimization algorithms.

Theory and Methods:
Meteorological data such as monthly average temperature, pressure, humidity, wind, precipitation were used as input parameters to estimate Turkey's natural gas demand. 2010-2017 data were used as training data and 2018-2020 data were used as test data. Four different metaheuristic algorithms (Artificial Bee Colony Algorithm (ABC), Charged System Search Algorithm (CSS), Crow Search Algorithm (CSA), and Harmony Search Algorithm (HSA)) and three different mathematical models (linear, exponential, quadratic) was used. Results were compared according to six different error metrics (AE, MAE, R^2, MAPE, RMS, MARNE).

Results:
Natural gas demand estimation results from the models we propose based on meteorological parameters are as follows. In the linear model, the CSA algorithm gave the best result for the training dataset, while the ABC algorithm produced the best result for the test dataset. In the exponential model, while the algorithm that gave the best result in the training dataset was the HSA algorithm, the algorithm that gave the best result for the test dataset was the CSA algorithm. In the Quadratic model, while CSS produces a nominal error value for the training dataset, the CSA algorithm gives the best results in the test dataset. In general, the CSA algorithm gave the best result for the test data among the three mathematical models.

Conclusion:
As a result, four different metaheuristic algorithms have been successfully applied with three different models for Turkey's natural gas consumption estimation. Policymakers can use the results of the models presented in this study as a guide for future natural gas energy plans in Turkey. The proposed model can be extended by applying datasets from different countries and with different input parameters