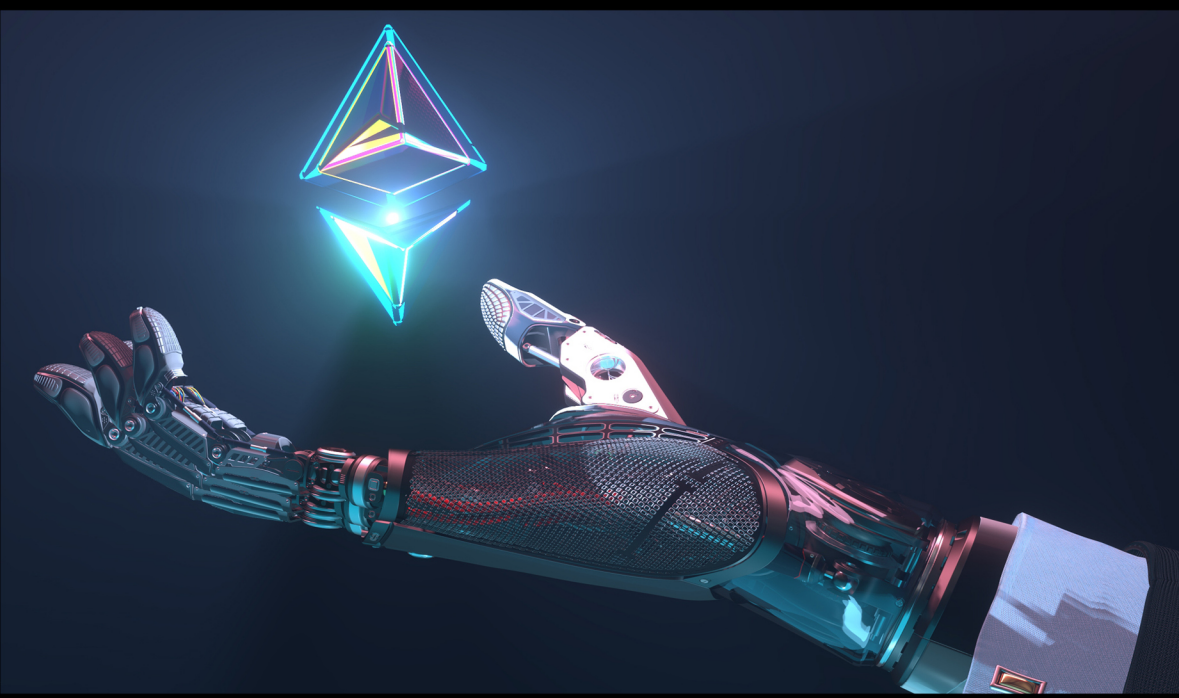
QUANTUM MACHINE INTELLIGENCE

# Hybrid Computational Intelligent Systems

## Modeling, Simulation and Optimization

EDITED BY
Siddhartha Bhattacharyya



CRC Press
Taylor & Francis Group

# Hybrid Computational Intelligent Systems

*Hybrid Computational Intelligent Systems – Modeling, Simulation and Optimization* unearths the latest advances in evolving hybrid intelligent modeling and simulation of human-centric data-intensive applications optimized for real-time use, thereby enabling researchers to come up with novel breakthroughs in this ever-growing field.

Salient features include the fundamentals of modeling and simulation with recourse to knowledge-based simulation, interaction paradigms, and human factors, along with the enhancement of the existing state of art in a high-performance computing setup. In addition, this book presents optimization strategies to evolve robust and failsafe intelligent system modeling and simulation.

The volume also highlights novel applications for different engineering problems including signal and data processing, speech, image, sensor data processing, innovative intelligent systems, and swarm intelligent manufacturing systems.

Features:

- A self-contained approach to integrating the principles of hybrid computational intelligence with system modeling and simulation.
- Well-versed foundation of computational intelligence and its application to real life engineering problems.
- Elucidates essential background, concepts, definitions, and theories thereby putting forward a complete treatment on the subject.
- Effective modeling of hybrid intelligent systems forms the backbone of almost every operative system in real-life.
- Proper simulation of real-time hybrid intelligent systems is a prerequisite for deriving any real-life system solution.
- Optimized system modeling and simulation enable real-time and failsafe operations of the existing hybrid intelligent system solutions.
- Information presented in an accessible way for researchers, engineers, developers, and practitioners from academia and industry working in all major areas and interdisciplinary areas of hybrid computational intelligence and communication systems to evolve human-centered modeling and simulations of real-time data-intensive intelligent systems.

**Quantum Machine Intelligence**
*Series Editors*
Siddhartha Bhattacharyya, Rajnagar Mahavidyalaya, Birbhum, India
Elizabeth C. Behrman, Wichita State University, USA

Quantum Machine Intelligence
*Siddhartha Bhattacharyya, Mario Koppen, Elizabeth Behrman, Ivan Cruz*

Hybrid Computational Intelligent Systems
Modeling, Simulation and Optimization
S*iddhartha Bhattacharyya*

For more information about this series, please visit: https://www.routledge.com/Quantum-Machine-Intelligence/book-series/QMI

# Hybrid Computational Intelligent Systems

## Modeling, Simulation and Optimization

Edited by

Siddhartha Bhattacharyya

CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

First edition published 2023
by CRC Press
6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press
4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

*CRC Press is an imprint of Taylor & Francis Group, LLC*



ISBN: 9781032393025 (hbk)
ISBN: 9781032463292 (pbk)
ISBN: 9781003381167 (ebk)

DOI: 10.1201/9781003381167

Typeset in Sabon
by codeMantra

The editor would like to dedicate this volume to all those who have inherited the unconscious habit of belittling almost every sincere effort, small or big.

# Contents

# Preface

Almost every technological innovation in the present times is being driven by intelligence in one form or the other with the advent of computational intelligence. Computational intelligence has made its presence felt in every nook and corner of the world, thanks to the rapid exploration of research in this direction. Computational intelligence is now not limited to only specific computational fields; it has made giant strides into several interdisciplinary fields of science, engineering, medical science, business, and finance including signal processing, smart manufacturing, predictive control, robot navigation, smart cities, sensor design to name a few. Latest advances in evolving soft computing concepts and algorithms toward enabling intelligent solutions to real-life problems have enriched this field of computational intelligence. To add to this, researchers have conjoined different intelligent tools and techniques to evolve hybrid intelligent systems, which results in more efficient alternatives to stand-alone intelligent systems.

Of late, human-centered computing has evolved rapidly to add human-centric components to the hybrid intelligent applications in vogue, thereby aiming at a more human-like realistic approach. Furthermore, in order to envisage efficient, robust, and failsafe applications for intelligent data processing, proper modeling of these data-intensive systems and applications has become a prerequisite. Effective modeling of these hybrid intelligent systems would entail knowledge-based simulation of the systems induced by human-centric factors, thereby making them interactive and responsive. In addition, intelligent agents can also help automate the objective. Although traditional modeling practices are already in vogue, the resultant models need to be optimized for enabling real-time and failsafe operations. Hence, optimization of the modeling and simulation process is also a much-needed affair.

This volume targets to unearth the latest advances in evolving hybrid intelligent modeling and simulation of data-intensive applications for real-time applications.

This volume comprises 23 well-versed contributory chapters entailing different facets of intelligent system modeling and their applications to a wide variety of data- and information-intensive frameworks.

Chapter 1 discusses the issues of generating ratings of the Russian agricultural universities, modeled using their passive, active, and semi-active digital footprints. The results of creating ratings show the areas for increasing the efficiency in implementing the instructions of the President of Russia back in 2012 on the achievement of the indicators for improving the activities of the Russian universities. The method for calculating the passive digital footprint is based on website metrics techniques. The active digital footprint includes information on scientific and educational resources posted on universities' websites in the form of developments, publications, consultations, legal and statutory materials, remote training, custom software, databases, and information about electronic employment agencies and digital marketplaces. The semi-active footprint includes information collected from subordinate educational institutions and processed by the Ministry of Science and Higher Education of the Russian Federation in the form of a self-examination report. The evaluated ratings are compared with an integrated metric, which serves as the indicator of a comprehensive evaluation of the effectiveness of agricultural universities' use of information resources.

Chapter 2 presents a hardware and software model for a mechatronic complex (MC) designed to automate technological processes for performing several technological operations (TO), which include actuating mechanisms (AM), detection, fixation, and storage of moving objects. The manual control mode of the MC implies that the human operator controls the TO using commands on the interactive touch panel (ITP) screen. The automatic control mode differs in that the human operator starts the MC using real and/or virtual buttons, and the rest of the actions occur due to the program embedded in the programmable logic controller (PLC). When performing a working cycle in this mode of operation of the MC, the most difficult technological operation is fixing a moving object. The successful implementation of this operation depends on the prediction and control of the trajectory of movement of the pneumatic AM with nonlinear characteristics. If, as a result of the movements, the central axes of the movable object and the pneumatic gripper are not aligned, then the object with a high degree of probability will not be fixed in the gripper jaws. In this case, the further course of the working cycle is disrupted, which affects the operability of the MC. Thus, for the automatic control mode of the MC, problems arise in finding a balance between the minimum time required for aligning the axes of the moving object and the pneumatic gripper which is controlled by the system timers. This chapter attempts to solve these associated problems by developing a program code for controlling the MC in automatic mode; creating a human-machine interface model and verification of its performance followed by an analysis of the kinematic model, comparison of the obtained experimental results for two control modes, and the assessment of forecasting the moment in time when the axes of the pneumatic gripper and the moving object are aligned.

Soil moisture monitoring is highly significant from the agricultural perspective. The efficient use of water plays an important role in cultivation. Proper water usage can be possible by soil moisture prediction. For better soil moisture content estimation, various parameters have to be considered such as soil moisture, turbidity, pH, temperature, and humidity. The objective of Chapter 3 is to monitor the soil moisture considering these parameters. To accomplish the objective, four different sensors are used in our work, and a comparative analysis between a few machine learning methods is performed for detecting the moisture content in the soil.

As a result of the universality of individual attacks and attacked phenomena in nature, the stability analysis of the predator-prey system has always been one of the research topics in the field of population dynamics. Time delay is a necessary factor to be considered when studying the population change law in the process of species evolution, which has a great impact on the stability of the system. Also, diffusion can represent the distribution state of the population living in the biological space. So, a diffusive ratio-dependent predator-prey system involving two delays is discussed in Chapter 4. The distribution of the eigenvalues corresponding to the linear system is analyzed by taking delay as a Hopf bifurcation parameter. By means of the representation of sets, the conditions for the stability of the system along with the further occurrence of Hopf bifurcation are taken into consideration. The theoretical results are supported by some particular systems and simulations. Besides, the spatial motion behavior of two populations in the food chain is discussed by taking diffusion as the object. Results indicate that the time delay and diffusion have significant effects on the system and spatial motion states of predator and prey populations.

College student health is a social issue and a key to national prosperity and development. Based on the grey GM (1,1) prediction model theory, Chapter 5 conducts a statistical analysis of the physical health test data of a certain grade of a college student, establishes a prediction model of the physical health test scores of the group of college students and the development trend of physical fitness, and discusses the relative residuals. Q test, variance ratio C test, and small error probability P test are used to test the accuracy of the model. Judging from the prediction results, with the strong support of the national labor education system, the overall physical fitness of students is on the rise, and there is room for improvement in the performance of some sports events. Studying college student fitness test data helps to monitor student health, improve fitness, and test the implementation effects of labor education, which has certain practical significance.

The University library is an important channel for students to solve problems and obtain knowledge. Due to different borrowing habits and interests, each student has obvious differences in book borrowing behavior and has a certain borrowing tendency. In order to respond to the call of "national reading" of the two sessions and help library managers carry out book

activities better and efficiently, taking university as an example, Chapter 6 adopts the Apriori algorithm of association rules, further discusses the factors affecting students' borrowing through the analysis of the factors affecting the borrowing volume of university libraries and finds out the correlation between book borrowing information. In addition, it also helps to understand students' reading preferences, improves reading literacy, and enables library administrators to make better decisions on book procurement and book recommendation.

The objective of Chapter 7 is to analyze the inspection systems for the recognition of materials by the dual-energy method. The focus of the study is the methods and algorithms to compare bremsstrahlung detectors in inspection systems operating in dual-energy mode. This chapter develops criteria and algorithms for comparing inspection systems with a material recognition option for various bremsstrahlung detectors and experimentally tests them for a betatron with maximum radiation energies of 4 and 7.5 MeV. Based on the analysis of the results of theoretical studies, a set of criteria and algorithms has been developed to compare inspection systems with a material recognition option. To evaluate the effectiveness of the developed criteria and algorithms, a series of experimental studies were conducted to compare the bremsstrahlung detectors manufactured by TSNK (Moscow, Russia) and Detection Technologies (Finland). The test objects consisted of fragments of organics, aluminum, steel, and lead with a mass thickness of 20–120 g/cm$^2$.

Computer-aided diagnosis and medical imaging systems have evolved in the past decade to a point where they can partially mimic radiologists and doctors. These systems can learn and differentiate the features and abnormalities in medical images and provide objective evidence with higher diagnostic confidence and faster inference. In Chapter 8, the authors focus on generating medical reports on chest X-ray images, which can be adapted later to work with other diagnostic tools such as ultrasounds and mammograms. The Indiana University dataset provides the CXR images corresponding to various lung and heart ailments, along with well-defined reports and findings. The generation of medical reports mainly consists of two broad tasks. The first task is to treat the problem as a multi-label classification task to obtain accurate tags for a particular image from the visual features. The second task is to generate the reports using these aforementioned tags, which require the use of recurrent neural networks such as hierarchical LSTMs, and improve the accuracy using a co-attention mechanism.

Presently, Internet of Things (IoT) is one of the ways of reducing manual intervention in different domains such as smart appliances and smart detection systems. Smart appliances are widely used technology that can be used in many areas such as in our home or office for providing comfort, energy consumption, security, etc. Such kind of system has become an important

and integral part of the modern home automation system. However, there exist some problems such as dedicated interfacing, user authentication, high security, and other related factors. To address these problems, the authors develop a low-power smart home automation system in Chapter 9, which not only controls the home appliances but also increases the security of the entire system. In this work, smart appliances can be easily controlled by using a smartphone. The proposed system and its hardware are based on Arduino with its interface and communication via Bluetooth with peripheral devices and the Android device system. The security and authentication of the system are done through RFID. The efficacy of the proposed system has been judged with respect to reduced time delay, power consumption, and security.

The COVID-19 outbreak has caused a sizable number of fatalities and poses an unprecedented threat to public health. Vaccination may be an effective weapon in halting the pandemic, delaying the spread of the disease, and reducing the severity of the sickness. Although most Indians have been fully vaccinated, a substantial number of Indians still have not received precautionary, even second doses of the COVID-19 vaccine. After huge income/job losses due to this pandemic, most Indians cannot afford the expensive COVID-19 vaccines from a private vaccination clinic. As a result, free Government vaccination center slots are always in great demand. It can be challenging for ordinary Indians to find free-of-cost slots at convenient places using the Indian government's vaccination web portal, 'CoWIN'. Chapter 10 presents an Android application that can check every 15 minutes for available vaccination slots at the user's desired location and send notifications to the user if slots match with user-preferred criteria. The novel feature of this app is that it may send SMS to several ordinary phone users according to their desired vaccination criteria from a single installed instance. The app collected users' feedback, and a usability study is included in this chapter.

Feature selection is a state-of-art research area for machine learning classification where extraneous attributes are removed to reduce the data processing load and increase classification accuracy. The search space for combinations of large dimensions of data becomes complex making the feature selection an optimization problem. Evolutionary algorithms are being increasingly applied to various optimization problems including feature selection as they have proven to be advantageous over traditional search due to their limited requirement of domain-specific information. A solution for the feature selection problem is binary in nature (selection or omission of a feature) and hence is represented as a binary vector of dimension n. Several binary variants of evolutionary algorithms have been proposed to deal with the available discrete solution space. Chapter 11 presents a binary variant of MMBAIS (Multi-Modal Bat Algorithm with Improved Search) which is an enhancement over the Bat algorithm. Each prospective solution

(feature subset), a bat, in Binary MMBAIS is represented as a binary vector rather than the traditional continuous solution space. The proposed algorithm is compared with some of the recent binary evolutionary algorithms; Binary Bat, BP-SOGSA, Binary Crow Search Algorithm, Binary Bat and Differential Evolution, and Binary Gray Wolf Optimization Algorithm over 15 benchmark datasets. Comparative studies illustrate the computational efficiency of Binary MMBAIS for feature selection with respect to the relative weighted consistency measure and classification accuracy over seven machine learning classifiers.

There are millions of people in this world, who have hearing disabilities due to various reasons. Sign languages (SLs) are used to communicate with these people. However, it is not easy to learn or use sign language. So, people face difficulty to interact with them properly. As hearing-impaired people are mostly familiar with SL, it is a visual language that is utilized by hard-of-hearing individuals to convey. Because of the extensive time needed in learning SL, individuals think that it is hard to speak with these specially-abled individuals, creating a communication gap. Chapter 12 attempts to resolve this issue by presenting "Audio to Indian Sign Language Interpreter (AISLI)", which translates English speech to Indian sign language (ISL) in form of Graphics Interchange Format (GIF) and yields letters as the output according to the phrase or word recognized. The Google Application Program Interface (API) is being utilized as the audio acknowledgment engine for the AISLI. The ISL structure is used for the interpretation of the results. It is expected that it will make the process for hearing-impaired individuals to comprehend simpler and speak with others, who do not know the language, using Natural Language Processing (NLP) and Machine Translation as the principal approach.

Pathological image reports are the primary basis of the diagnosis process and a little modification may mislead a doctor. Thus, tamper detection is essential for any medical image. In Chapter 13, a spatial domain-based fragile image watermarking scheme has been proposed for medical color images. This technique is not only useful for tamper detection but also allows to embed the electronic patient reports in the cover image without affecting the regions of interest. These personal reports are encrypted through an auto-generated key and watermark to provide immense privacy and reliability. The size of the watermark and the key are adaptive in nature and this adds a salient feature to this scheme. Moreover, the fragile watermarking process is performed in a reversible way. The proficiency of this proposed methodology is analyzed by means of imperceptibility, robustness, and hiding capacity and finally compared with some state-of-the-art techniques. Hereafter embedding, more than 60 dB average peak signal-to-noise ratio is obtained for applying 0.6 bits per pixel payload on an average. The overall assessment reflects that this scheme is able to provide enhanced hiding capacity, security, and reliability without affecting the region of medical interest of the images.

Worldwide climate change is significantly influenced by global warming as one of the important factors. The surface temperature of the earth has experienced a steady increase of 0.20 centigrade every decade of the last 30 years. Climate change is happening due to this. United Nations Framework Convention on Climate Change (UNFCCC) concurred in Paris that the earth's temperature increase needs to be limited below 20. The most common contributors or features to global warming need to be identified in order to find the reason behind this issue. Establishing a solution model for global warming and climate change as an act of urgency and working toward mitigation by limiting greenhouse gases emission is one of the primary concerns. Chapter 14 provides the trend and correlation of temperature rise and $CO_2$ emission and explains the different mechanisms driving optimal mitigation. Integrating the climate data and identifying the problem area is one of the objectives of this research. This will help to get a reliable control system that can deal with the global warming issue. This work suggests Green Machine Automation Model (GMAD) architecture and defines how global warming can be controlled using data engineering and analytics. Therefore, environment protection using machine learning (ML) and data engineering is the main contribution of this research work.

Chapter 15 presents an application-oriented methodology to estimate biological age (Abi) with the prediction of the life expectancy of an individual. Segregating collected data based on their different health parameters such as height, weight, blood pressure, body temperature, and Electromyogram (EMG) is the effective gateway to obtaining the biological age compared with the chronological age (Ach) after several trial-and-error methods. Estimation is performed to check the biological age of human beings of different chronological age groups from 21 to 50 years using a neural network algorithm. The decision-making of health status observation of different levels for biologically aged people is another important outcome of this research work. The error percentage for biological age varies from approximately 0.09% to 22.41%, and this estimation is the best fit for adults and middle-aged people. The mean error values of some particular predicted biological age compared to chronological age are 0.08, 0.32, 0.69, and 1.40.

Suicide risk assessment usually includes a conversation between a doctor and a patient. However, due to restricted access to mental health care facilities, clinician availability, absence of understanding, shame, abandonment, and discriminatory treatment associated with mental disorders, a substantial percentage of mentally ill people do not obtain medical help for their condition. Internet access and social media usage, on the other hand, have grown dramatically, allowing specialists and patients to communicate in ways that could contribute to the development of tools for detecting mental health disorders among people on social media. The primary purpose of Chapter 16 is to analyze online Twitter tweets and see what characteristics may indicate suicidal ideation in individuals. Machine learning and natural

language processing techniques are used to train our data and test the efficacy of the proposed technique. Several features including linguistic, topic, sentiment, temporal and statistical are retrieved and merged to obtain a high performance in classification. It is observed that there exist significant statistical differences in the datasets for suicidal ideation and non-suicidal users with respect to the different features. Results indicate that the combination of these different features outperforms the accuracy obtained by individual features separately.

Newspapers play a very significant role in society as it keeps the citizens informed about various events happening around them. The news might have a direct or indirect impact on the life of people, especially during a pandemic like COVID. India, in particular, saw a devastating second wave during March-May 2021 where there were concerns like oxygen and medicine shortages, more casualties, and maladministration. In this scenario, analysis of the news articles to mine the important topics becomes pertinent to understanding the role of media during the pandemic. In Chapter 17, 4,902 articles published from 15/3/2021 to 31/5/2021 in five prominent newspapers including *The Times of India, The Hindu, Hindustan Times, The Indian Express*, and *The Deccan Chronicle* are extracted and Latent Dirichlet Allocation (LDA) algorithm is applied to discover the important topics. Total nine topics are discovered focussing on resource constraints, bed scams, and various aspects of vaccination. This demonstrates that the media was only focused on presenting the ground reality prevailing during the period rather than discussing other important aspects like the well-being and mental health of the citizens. This was important as the second wave saw a lot more casualties and anxiety among the citizens of India.

In Chapter 18, a Fast Converging Flower Pollination Algorithm (FFPA) has been cast off to achieve optimized coefficients for implementing finite impulse response filters. Optimization is performed to minimize the fitness value that measures the weighted mean square error present in the passband and stopband of the designed filters. The hardware efficiency of the filter is calculated by approximating the number of structural adders and multiplier adders. Adder costs of the designed filters are obtained by computing the number of signed power two (SPT) terms present in filter coefficients after quantization stalked by common sub expression (CSE) elimination. Simulation results prove that the desired frequency response is achieved by lessening the word length of coefficients. The proposed algorithm outpaces the Parks McClellan Algorithm and traditional meta-heuristic algorithms like genetic algorithm, particle swarm optimization, differential evolution, cuckoo search algorithm, and flower pollination algorithm. Performance analysis of the designed filter has been shown by filtering a noisy phonocardiogram signal.

Deep learning has significantly helped better results for visual-based speech recognition. However, the majority of the research works focus on

improving only the training model's architecture. In Chapter 19, the authors identify that enhancing the pre-processing techniques also causes a surge in the model's accuracy. This chapter presents architecture-level suggestions to improve accuracy at every stage of the problem. First, the object recognition phase (for the lips) is improved by replacing the generic Haar cascade with BlazeFace. This process helps to cut down unnecessary information from being fed as input to the model. Since most real-time prediction demands the model to differentiate words of different lengths, enhancements to the window-size selection algorithm (pre-processing phase) are proposed. This algorithm dynamically calculates frames required for a specific word using silence detection techniques. In the final training phase, ResNets, GRUs, and LSTM models are employed to compare the results. The datasets obtained are from the Lombard-GRID corpus which consists of over 5,000 videos with 51 unique words. The proposed model improves the accuracy by around 15% more than standard techniques.

A modified Harris Hawks Optimization Algorithm is proposed in Chapter 20 that aims at determining the maximal levels of thresholding for grayscale images. In the recent past, the natural habits and mannerisms of a specific variety of hawks, namely, Harris Hawks, have been extensively observed with keen scientific interest, by researchers. This thorough observation has eventually led to the inception of a novel meta-heuristic algorithm regarded as the Harris Hawks Optimization Algorithm. The HHO algorithm has demonstrated capabilities of handling a wide array of optimization problems with startling efficiency. This chapter aims to suggest certain adaptive and intrinsic modifications that may accentuate and optimize the performance of the algorithm. A comparative analysis of the performance improvements based on real-world statistical benchmarks, such as the Kruskal-Wallis test, confirms the imminent superiority of the proposed algorithm in terms of performance and efficiency.

A precise and efficient technique for tumor segmentation in brain MRI is obligatory to acquire and analyze indispensable details for accurate diagnosis and required treatment planning. Deviations in tumor structure and size are fundamental challenges and choosing an appropriate segmentation technique shows considerable outcomes. Analyzing MRI images is a difficult and time-intensive process with human assessment of tumors in routine clinical applications. The accurate outcome of an automatic technique is crucial for the valuation of MRI images. The nonexistence of automatic tumor segmentation techniques presents a prime challenge since large amounts of MRI Image data are generated and consistently required for the segmentation process. Chapter 21 presents a unique framework for tumor detection with the EMGM model to rationalize the segmentation technique. Typically presented MRI sequences are used for experimental evaluation and obtained results with higher accuracy.

Industry 4.0 has highlighted remaining useful life (RUL) estimation as an important component for predictive maintenance. Prediction of remaining useful life (RUL) provides the estimate of residual time for system breakdown. By knowing the time estimate for upcoming failure, downtime caused due to unscheduled maintenance can be reduced. In real-time scenario, there is a dearth of training records for RUL estimation. Using advanced computer vision techniques, the time series data can be encoded into images to allow machines to visually recognize and classify and learn structures and patterns. The authors have proposed two novel techniques in Chapter 22 for data generation using Auxiliary Classifier Generative Adversarial Network (ACGAN)s for improving the RUL classification. Two ACGAN-based RUL techniques viz., time series-based ACGAN, and image-based ACGAN are generated using recurrence plots. Data generated with image ACGAN have disclosed higher similarity to original sensor data while compared to time ACGAN. Image data generated using ACGANs have revealed better generalization of features for improved RUL classification accuracy compared to that of the time series ACGAN. This chapter implements both the time and image-based ACGANs in RUL estimation and classification domain for the first time. The experimental results have showcased higher classification accuracy for RUL prediction using image ACGAN.

Computing algorithms have been developed for solving difficult optimization problems inspired by mimicking natural processes and the application of quantum theory. In the last two decades, Quantum Inspired Evolutionary Algorithms (QIEA) have shown promising results to solve hard problems using classical computers. In Chapter 23, the authors introduce the implementation algorithm of QIEA on a quantum computing machine that is a 5-qubit IBM Noisy Intermediate Scale Quantum (NISQ) system to solve a problem of 100 items knapsack. This chapter describes a practical implementation of the algorithm and compares the results obtained on a quantum machine vis-à-vis results on classical computers. Testing is done using four types of knapsack problems to prove the hypothesis that results on both the quantum and classical computers are comparable in fitness for the test cases.

This volume is a novel attempt to enrich the existing knowledge base on hybrid intelligent system modeling and simulation practices optimized for real-time applications. The editor would feel rewarded if the volume comes to the benefit of budding researchers in exploring the field further in order to unearth indigenous intelligent models and frameworks for the future.

**Siddhartha Bhattacharyya**
*Birbhum, India*

# Editors

**Dr. Siddhartha Bhattacharyya** did his Bachelors in Physics, Bachelors in Optics and Optoelectronics, and Masters in Optics and Optoelectronics from the University of Calcutta, India in 1995, 1998, and 2000 respectively. He completed his Ph.D. in Computer Science and Engineering from Jadavpur University, India in 2008. He is the recipient of the University Gold Medal from the University of Calcutta for his Masters. He is the recipient of several coveted awards including the Distinguished HoD Award and Distinguished Professor Award conferred by the Computer Society of India, Mumbai Chapter, India in 2017, the Honorary Doctorate Award (D. Litt.) from The University of South America, and the South East Asian Regional Computing Confederation (SEARCC) International Digital Award ICT Educator of the Year in 2017. He has been appointed as the ACM Distinguished Speaker for the tenure of 2018–2020. He has been inducted into the People of ACM hall of fame by ACM, the USA in 2020. He has been appointed as the IEEE Computer Society Distinguished Visitor for the tenure of 2021–2023. He has been elected as a full foreign member of the Russian Academy of Natural Sciences and the Russian Academy of Engineering. He has been elected a full fellow of The Royal Society for Arts, Manufacturers and Commerce (RSA), London, UK.

He is currently serving as the Principal of Rajnagar Mahavidyalaya, Rajnagar, Birbhum. He served as a Professor in the Department of Computer Science and Engineering of Christ University, Bangalore. He served as the Principal of RCC Institute of Information Technology, Kolkata, India during 2017–2019. He has also served as a Senior Research Scientist in the Faculty of Electrical Engineering and Computer Science of VSB Technical University of Ostrava, Czech Republic (2018–2019). Prior to this, he was the Professor of Information Technology at RCC Institute of Information

Technology, Kolkata, India. He served as the Head of the Department from March 2014 to December 2016. Prior to this, he was an Associate Professor of Information Technology at RCC Institute of Information Technology, Kolkata, India from 2011 to 2014. Before that, he served as an Assistant Professor in Computer Science and Information Technology at the University Institute of Technology, The University of Burdwan, India from 2005 to 2011. He was a Lecturer in Information Technology at Kalyani Government Engineering College, India during 2001–2005. He is a co-author of 6 books and the co-editor of 94 books and has more than 400 research publications in international journals and conference proceedings to his credit. He has got two PCTs and 19 patents to his credit. He has been a member of the organizing and technical program committees of several national and international conferences. He is the founding Chair of ICCICN 2014, ICRCICN (2015, 2016, 2017, 2018), and ISSIP (2017, 2018) (Kolkata, India). He was the General Chair of several international conferences like WCNSSP 2016 (Chiang Mai, Thailand), ICACCP (2017, 2019) (Sikkim, India) and (ICICC 2018 (New Delhi, India), and ICICC 2019 (Ostrava, Czech Republic).

He is the Associate Editor of several reputed journals including *Applied Soft Computing*, *IEEE Access*, *Evolutionary Intelligence*, and *IET Quantum Communications*. He is the editor of the *International Journal of Pattern Recognition Research* and the founding Editor in Chief of the *International Journal of Hybrid Intelligence, Inderscience*. He has guest-edited several issues with several international journals. He is serving as the Series Editor of IGI Global Book Series Advances in Information Quality and Management (AIQM), De Gruyter Book Series Frontiers in Computational Intelligence (FCI), CRC Press Book Series(s) Computational Intelligence and Applications & Quantum Machine Intelligence, Wiley Book Series Intelligent Signal and Data Processing, Elsevier Book Series Hybrid Computational Intelligence for Pattern Analysis and Understanding and Springer Tracts on Human Centered Computing.

His research interests include hybrid intelligence, pattern recognition, multimedia data processing, social networks, and quantum computing.

He is a life fellow of the Optical Society of India (OSI), India, a life fellow of the International Society of Research and Development (ISRD), UK, a fellow of the Institution of Engineering and Technology (IET), UK, a fellow of Institute of Electronics and Telecommunication Engineers (IETE), India and a fellow of Institution of Engineers (IEI), India. He is also a senior member of the Institute of Electrical and Electronics Engineers (IEEE), USA, the International Institute of Engineering and Technology (IETI), Hong Kong, and the Association for Computing Machinery (ACM), USA.

He is a life member of the Cryptology Research Society of India (CRSI), Computer Society of India (CSI), Indian Society for Technical Education (ISTE), Indian Unit for Pattern Recognition and Artificial Intelligence

(IUPRAI), Center for Education Growth and Research (CEGR), Integrated Chambers of Commerce and Industry (ICCI), and Association of Leaders and Industries (ALI). He is a member of the Institution of Engineering and Technology (IET), UK, International Rough Set Society, International Association for Engineers (IAENG), Hong Kong, Computer Science Teachers Association (CSTA), USA, International Association of Academicians, Scholars, Scientists and Engineers (IAASSE), USA, Institute of Doctors Engineers and Scientists (IDES), India, The International Society of Service Innovation Professionals (ISSIP) and The Society of Digital Information and Wireless Communications (SDIWC). He is also a certified Chartered Engineer of the Institution of Engineers (IEI), India. He is on the Board of Directors of the International Institute of Engineering and Technology (IETI), Hong Kong.

# Contributors

**Alexander E. Arkhipov**
Southwest State University
Russia

**Hema Banati**
Dyal Singh College, University of Delhi
New Delhi, India

**Rajib Banerjee**
Department of Electronics and Communication Engineering
DR. B. C. Roy Engineering College
Durgapur India

**Sharmila Banu K.**
School of Computer Science and Engineering
VIT Vellore
India

**Abhishek Basu**
Department of Electronics and Communication Engineering
RCC Institute of Information Technology
Kolkata, India

**Saikat Basu**
Department of Computer Science & Engineering
Maulana Abul Kalam Azad University of Technology
Kolkata, India

**Andrey Batranin**
School of Non-Destructive Testing
Tomsk Polytechnic University
Tomsk, Russia

**Rupal Bhargava**
Learning Experience
upGrad Education Pvt. Ltd.
Mumbai, India

**Siddhartha Bhattacharyya**
Rajnagar Mahavidyalaya
Birbhum, India

**K. Bhima**
Information Technology
B. V. Raju Institute of Technology
Narsapur, India

**Arindam Biswas**
Centre of IoT and AI Integration with Education-Industry-Agriculture and School of Mines and Metallurgy
Kazi Nazrul University Asansol
Asansol, India

**Maxim Bobyr**
Southwest State University
Russia

**Jaiyesh Chahar**
Solution Engineering
Siemens Technology Services Pvt. Ltd.
India

**Sergei Chakhlov**
School of Non-Destructive Testing
Tomsk Polytechnic University
Tomsk, Russia

**Debashish Chakravarty**
Department of Mining Engineering
Indian Institute of Technology
Kharagpur, India

**Anindya Chatterjee**
Solution Engineering
Siemens Technology Services Pvt. Ltd.
India

**Moumita Chatterjee**
Department of Computer Science & Engineering
Aliah University
Kolkata, India

**Avik Chattopadhyay**
Institute of Radio Physics and Electronics
University of Calcutta
Kolkata, India

**Fangfang Chen**
Department of Mathematics and Information Engineering
Chongqing University of Education
Chongqing, China

**Abhijit Das**
Department of IT
RCC Institute of Information Technology
Kolkata, India

**Poulami Das**
K. C. College of Engineering and Management Studies and Research
Thane, India

**Rik Das**
Solution Engineering
Program of Information Technology
Siemens Technology Services Pvt. Ltd.
India
Xavier Institute of Social Service
Ranchi, India

**Susmita Das**
Electronics and Instrumentation Engineering
Narula Institute of Technology
Kolkata, India

**Arghya Dasgupta**
Department of Computer Science Engineering
DR. B. C. Roy Engineering College Durgapur
India

**Debashis De**
Department of Computer Science & Engineering
Maulana Abul Kalam Azad University of Technology
Kolkata, India

**Sourav De**
Department of Computer Science and Engineering
Cooch Behar Govt. Engineering College
India

**Abhirup Deb**
Department of Computer Science and Engineering
Cooch Behar Government Engineering College
Cooch Behar, India

**Soumyaratna Debnath**
Department of Computer Science and Engineering
Cooch Behar Government Engineering College
Cooch Behar, India

**Sandip Dey**
Department of Computer Science
Sukanta Mahavidyalaya
Dhupguri, India

**Sayantani Ghosh**
Department of IT
University of Calcutta, Technology Campus
Kolkata, India

**Sergey Gorbachev**
Faculty of Innovative Technologies, National Research Tomsk State University
Tomsk State University
Tomsk, Russia

**Ayush Gupta**
Department of computer Science and Engineering
Cooch Behar Govt. Engineering College
India

**Lakshmi Shankar Iyer**
School of Business and Management
Christ University
Bangalore, India

**A. Jagan**
Computer Science and Engineering
B. V. Raju Institute of Technology
Narsapur, India

**Rui Jiang**
Department of Mathematics and Information Engineering
Chongqing University of Education
Chongqing, China

**Shuvam Kabiraj**
Department of Electronics and Communication Engineering
DR. B. C. Roy Engineering College Durgapur
India

**Indrajit Kar**
Solution Engineering
Siemens Technology Services Pvt. Ltd.
India

**Pravar Kulbhushan**
Solution Engineering
Siemens Technology Services Pvt. Ltd.
India

**Piyush Kumar**
Amity Institute of Information Technology
Amity University Kolkata
India

**Long Li**
School of Mathematics and Big Data, Chongqing University of Education
Chongqing, China

**Xiaoqing Li**
Department of Mathematics and Information Engineering
Chongqing University of Education
Chongqing, China

**Yan Ma**
Department of Mathematics and Information Engineering
Chongqing University of Education
Chongqing, China

**Tripti Mahara**
School of Business and Management
Christ University
Bangalore, India

**Koushik Majumder**
Department of Computer Science & Engineering
Maulana Abul Kalam Azad University of Technology
Kolkata, India

**Ashish Mani**
Amity Innovation & Design Centre
Amity University Noida
India

**Jitin Jain Mathew**
School of Business and Management
Christ University
Bangalore, India

**Victor Medennikov**
Federal Research Center, Computer Science and Control of the Russian Academy of Sciences
Russia

**Natalia Milostnaya**
Southwest State University
Russia

**Anwesha Mukherjee**
Department of Computer Science
Mahishadal Raj College
Mahishadal, India

**Sunetra Mukherjee**
Department of Electronics and Communication Engineering
DR. B. C. Roy Engineering College Durgapur
India

**Sudipta Mukhopadhyay**
Solution Engineering
Siemens Technology Services Pvt. Ltd.
India

**Ludmila Muratova**
VIAPI n.a. A.A. Nikonov - branch of the FSBSIFRC AESDRA VNIIESH
Russia

**Anchal N G**
School of Business and Management
Christ University
Bangalore, India

**Dalia Nandi**
Electronics and Communication Engineering
Indian Institute of Information Technology Kalyani
Kalyani, India

**Biswarup Neogi**
Electronics and Communication Engineering
JIS College of Engineering
Kalyani, India

**Nivedita**
School of Computer Science and Engineering
VIT Vellore
India

**Cristian Nolivos**
Southwest State University
Russia

**Sergey Osipov**
School of Non-Destructive Testing
Tomsk Polytechnic University
Tomsk, Russia

**M. S. Prasad**
Amity Institute of Space Science & Technology
Amity University Noida
India

**K. Dasaradh Ramaiah**
Information Technology
B. V. Raju Institute of Technology
Narsapur, India

**Avishek Ray**
K. C. College of Engineering and Management Studies and Research
Thane, India

**Pulakesh Roy**
Department of Mining Engineering
Kazi Nazrul University Asansol
Asansol, India

**Soumit Roy**
Analytics Presales and Solution Practice Lead, Jade Global
Chicago, USA

**Souvik Roy**
Department of Electronics and Communication Engineering
DR. B. C. Roy Engineering College Durgapur
India

**Subhrajit Sinha Roy**
Department of Electronics and Communication Engineering
RCC Institute of Information Technology
Kolkata, India

**Sudipta Saha**
Department of Computer Science & Engineering
Maulana Abul Kalam Azad University of Technology
Kolkata, India

**Rahul Sai R. S.**
School of Computer Science and Engineering
VIT Vellore
India

**Ravi Saini**
ASET
Amity University Noida
India

**Sergey Salnikov**
VIAPI n.a. A.A. Nikonov - branch of the FSBSIFRC AESDRA VNIIESH
Russia

**Poulomi Samanta**
Amity Institute of Information Technology
Amity University Kolkata
India

**Dhrubasish Sarkar**
Amity Institute of Information Technology
Amity University Kolkata
India

**Anirbit Sengupta**
Department of ECE
Dr. Sudhir Chandra Sur Institute of Technology and Sports Complex
Kolkata, India

**Chengxiang Shi**
Department of Mathematics and Information Engineering
Chongqing University of Education
Chongqing, China

**Sudershan Sridhar**
School of computer Science and Engineering
VIT Vellore
India

**Akshay Sriram**
School of Business and Management
Christ University
Bangalore, India

**B. K. Tripathy**
School of Information technology and Engineering
VIT Vellore
India

**Asha Yadav**
University of Delhi
New Delhi, India

**Alexander Zatsarinny**
Federal Research Center, Computer Science and Control of the Russian Academy of Sciences
Russia

**Yanxia Zhang**
School of Mathematics and Big Data, Chongqing University of Education
Chongqing, China

Chapter 1

# Creating ratings of agricultural universities based on their digital footprint

*Victor Medennikov*
Federal Research Center, Computer Science and Control of the Russian Academy of Sciences

*Ludmila Muratova and Sergey Salnikov*
VIAPI n.a. A.A. Nikonov - branch of the FSBSIFRC AESDRA VNIIESH

*Alexander Zatsarinny*
Federal Research Center, Computer Science and Control of the Russian Academy of Sciences

## CONTENTS



## 1.1 INTRODUCTION

The active development of digital technologies, as well as a number of serious restrictions associated with the COVID-19 pandemic, has become a driver for rethinking almost all aspects of both global and Russian educational activities. At the same time, the problem of the competitiveness of universities has become especially acute. To increase competitiveness, it was necessary to make significant investments in digital technologies for distance education, which was an obstacle to declining revenues due to lower

DOI: 10.1201/9781003381167-1 

incomes of consumers of university education as well as a decrease in the number of applicants from other countries. In the transition to self-isolation, the image of universities has become most influenced by their reasonable, effective representation in the Internet space, and not just the quality of educational services, which has become more difficult to control during the pandemic. The representation of universities in the Internet space is called the digital footprint.

As a rule, the concept of a digital footprint is understood as having two types: active and passive.

The active type includes information that is published in the Internet space directly by its owner or by a person authorized by him for this activity. A passive trace reflects information that is collected from his site without his participation and knowledge. In practice, this division is rather arbitrary, since the activities of universities can be displayed from many other sources, particularly those created by automated means. Such a digital trace will be called semi-active.

In our work, under the active digital footprint in relation to agricultural universities in Russia, we mean the amount of data that is posted on the website of each of them in the form of developments, publications, consultations, legal and regulatory materials, distance learning, application software, as well as databases and information about electronic employment agencies (EEAs) and digital marketplaces (DMPs) [1].

As the indicated digital footprints were not taken into consideration, the decree of Russian President was not implemented to achieve the following indicator of improving the activities of Russian universities by 2020: five should be included in the ranking of the 100 best universities in the world. The Accounts Chamber of the country issued a disappointing opinion on the unattainability of the target indicators of the decree, summing up at the end of its implementation period, having analyzed the institutional ratings QS [2] and THE [3] developed in the UK, as well as ARWU [4] used in China, since not a single Russian university participating in the program to implement the presidential decree could get into the first group of the hundred ratings considered above, although large sums were spent on the implementation of the program – over 80 billion rubles [5]. Note that such a result was evident long before the deadline for the completion of the specified program of state support for Russian universities in accordance with the presidential decree [6].

The analysis shows that the main reason for not implementing the decree is that the adopted program, focused on the implementation of the presidential decree, is based on the requirements for the information content of the educational environment in Russia in the field of university education. These requirements are enshrined in the relevant order No. 662 dated August 5, 2013, by the Ministry of Science and Higher Education of the Russian Federation "On Monitoring the Education System". In accordance

with the order, these requirements are focused on accounting only for educational activities. In developed countries, scientific research is essential. Such a digital divide could be eliminated by the presence of some integrated scientific and educational environment, the top of which is the formed single digital platform in the form of an information Internet space of scientific and educational resources [7]. In addition, in the context of active digitalization, the image of the university, which influences its ranking, is increasingly dependent on its comprehensive display in the Internet space. That is, the image in these conditions is most determined by the passive digital footprint.

The purpose of this study is to form and analyze the ratings of Russian universities using agricultural universities as an example, on the basis of their digital traces with the calculation of the integral rating. The resulting integral rating is an assessment of a complex indicator of the effectiveness of the use of information, scientific, and educational resources by agricultural universities. The methodology for forming these rankings based on calculated digital traces is the basis for harmonizing Russian and Western approaches to the development of university rankings in the context of the inevitability of the transition to a single digital platform of scientific and educational resources as the digital economy develops, smoothing out the shortcomings of the requirements of the Ministry of Science and Higher Education of the Russian Federation to the assessment of educational organizations.

## 1.2 METHODOLOGY FOR THE FORMATION OF UNIVERSITY RANKINGS BASED ON THE PASSIVE DIGITAL FOOTPRINT

For this technique, we use the so-called method of sitemetric assessment of universities, based on the analytical capabilities of the SiteAuditor site analysis and audit service program [8]. This program makes it possible to obtain the characteristics of the sites under study that are of interest to us (Table 1.1). The weighting factors in the last column are based on the results of expert judgments [9–11].

The values of indicators included in the "indexation" group were formed according to the metrics of search services included in Bing, Google, Yandex, and Seznam. The values of indicators included in the "directories" group are the result of a simple sum of indices (1-yes, 0-no) of the presence of university sites in the DMOZ, Mail.ru, Rambler TOP, and Yandex catalogs. The values of indicators included in the "problems" group are the result of a simple sum of indices (1-yes, 0-no) from the corresponding characteristics on the Spamhaus (IP) and Yandex.AGS sites. The values of indicators included in the "rating" group were formed on the basis of data from

*Table 1.1* Group indicators of the sitemetric method for calculating ratings

| *No.* | *Group indicators* | *Number in the group* | *Weight in %* |
|---|---|---|---|
| 1 | Indexation | 4 | 8,1 |
| 2 | Directories | 4 | 7,9 |
| 3 | Problems | 2 | 5,1 |
| 4 | Alexa rating (global) | 1 | 3,9 |
| 5 | Alexa rating (local) | 1 | 3,9 |
| 6 | Google rating PR | 1 | 8,1 |
| 7 | Yandex rating | 1 | 8,1 |
| 8 | Social services | 3 | 4,9 |
| 9 | Links on the website | 4 | 39,9 |
| 10 | Links from the site | 2 | 10,1 |
| | Total | 23 | 100,0 |

Alexa sites (both global and local), Google PR, and Yandex. The values of the "social services" group's indicators were the result of summing up the corresponding characteristics in social networks such as Facebook, Google Plus, and "My World" (Mail.ru). Site link group metrics were generated from relevant sections of Alexa, Google, Linkpad, and Majestic. The values of the indicators of the group of links from the site were determined as the average expression of the total number of corresponding indicators from the sites such as Bung and Linkpad. More detailed studies with detailed calculations can be found in [6,7]. The remaining indicators that can be obtained using the site-auditor program (another 17 indicators from various groups of indicators) were excluded from consideration in this chapter due to their low relevance and/or zero value for all the sites under study.

For the mathematical description of the methodology for evaluating universities on the basis of the considered passive digital footprint, we introduce the following expressions.

$P_2^m$ – the criterion for evaluating the $m$-th university, calculated on the basis of a passive digital footprint;
$d_{rm}^2$ – the size of the $r$-th indicator of site evaluation, calculated on the basis of a passive digital traces of the $m$-th university;
$q_{rm}^2$ – the size of the $r$-th indicator of the site assessment, calculated on the basis of a passive digital traces of the $m$-th university;
$\omega_r^2$ – weight of the size of the $r$-th indicator of site evaluation, calculated on the basis of a passive digital traces;

$$q_{rm}^2 = d_{rm}^2 / \max_m d_{rm}^2;$$

Then we get

$$P_2^m = \sum_k \omega_k^2 q_{km}^2 \tag{1.1}$$

In accordance with the abovementioned mathematical description of the methodology for evaluating universities, ten private ratings were formed based on sitemetry data. The obtained private ratings were further summed up with the weights given in Table 1.1. The results of calculations of assessments and ratings of universities obtained on the basis of their passive digital footprint are summarized in Table 1.10.

## 1.3 METHODOLOGY FOR GENERATING RATING BASED ON A SEMI-ACTIVE DIGITAL FOOTPRINT

The information required to generate ratings based on a semi-active digital footprint has been taken from self-examination reports according to [1]. Due to their large number, Table 1.2 shows only eight indicators as an example. The weights of all indicators in the final rating calculations have been determined by using mathematical statistics methods based on correlation analysis, the Kendall concordance factor, the probabilistic estimation model, and calculating the competency matrix. The calculation results show a high consistency of all ratings, which provide ample opportunities for using any of the abovementioned methods in further research, as well as their combination, such as average grades and ratings.

*Table 1.2* Groups of indicators for a semi-active digital footprint

| *No.* | *Indicators* | *Weight* |
|---|---|---|
| 1 | Specific weight of the number of RAS with an academic degree of candidate of sciences in the total RAS number at the university | 4.27 |
| 2 | Specific weight of the number of RAS with an academic degree of doctor of sciences in the total RAS number at the university | 4.59 |
| 3 | Total area of classrooms for training per student | 4.70 |
| 4 | Number of computers per student | 4.57 |
| 5 | University income for all types of activities per RAS member | 4.67 |
| 6 | University income generated by commercial activities per RAS member | 4.35 |
| 7 | Share of the RAS average income at a university, taking into account all types of activities, to the average salary in the region | 4.44 |
| 8 | Number of students studying under the federal budget funding program | 4.43 |

In Table 1.2, RAS stands for research academic staff. The mathematical description of the methodology for evaluating universities based on semi-active digital footprints is as follows:

$P_5^m$ – the evaluation criterion of the $m^{\text{th}}$ university, calculated on the basis of a semi-active digital footprints;
$d_{hm}^5$ – the size of the $h^{\text{th}}$ indicator, calculated on the basis of a semi-active digital footprints of the $m^{\text{th}}$ university;
$q_{hm}^5$ – the size of the $h^{\text{th}}$ indicator, calculated on the basis of a semi-active digital footprints of the $m^{\text{th}}$ university;
$\omega_{hm}^5$ – the size weight of the $h^{\text{th}}$ indicator, calculated on the basis of a semi-active digital footprints of the $m^{\text{th}}$ university;

$$q_{hm}^5 = d_{hm}^5 / \max_m d_{hm}^5$$

Then, we get:

$$P_5^m = \sum_h \omega_h^5 q_{hm}^5 \tag{1.2}$$

The resulting evaluation, with the corresponding ratings of universities based on their semi-active digital footprint, is comparatively given in Table 1.10.

## 1.4 METHODOLOGY FOR GENERATING RATINGS BASED ON AN ACTIVE DIGITAL FOOTPRINT

As already stated in the Introduction section, in addition to the traditional image role and the role of the university's business card, the role of the abovementioned digital footprint gains significantly greater importance in modern conditions because, with competent, scientifically grounded representation of universities on the Internet – in addition to providing faculty members with qualitatively new opportunities for an enhanced sharing of ideas with each other and their digital interaction with scientific and educational resources – it provides an effective system for introducing this knowledge into the economy and contributes to an increase in the intellectual level of society through the improvement of the education system [6]. Such a triunique role of scientifically grounded representation of universities on the Internet is most fully implemented when creating the above space of information scientific and educational resources (ISERs) on the Internet, integrating the following types of them posted on the websites of universities, scientific institutions, and various consulting centers of the agro-industrial complex: publications, development, consultations, legal and statutory

materials, training in a remote format, custom software, and databases. It is these scientific and educational resources that are most in demand in the agricultural economy [6,7,12].

In recent years, in addition to ISERs, these organizations on their websites have started developing, in one way or another, EEAs and DMPs, which reflect modern trends in rendering Internet services in the form of such digital services. Thus, we can consider seven types of ISERs, as well as EEAs and DMPs, as manifestations of an active digital footprint.

In view of the abovementioned reasons, we present the parameter values of this methodology:

Therefore, based on the above data, we present a mathematical description of the method:

$i$ – identifier defining the level of ISERs integration, $i \in I$ (Table 1.3);
$l$ – identifier specifying the storage form for ISERs, $l \in L$ (Table 1.4);
$n$ – identifier defining the kind of representation of ISERs, $n \in N$ (Table 1.5);

*Table 1.3* Indicators of the IR integration

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Unordered list | 10 |
| 2 | Ordered electronic presentation | 90 |
| Total | | 100 |

*Table 1.4* Indicators of the IR storage forms

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Catalog | 30 |
| 2 | Full-format electronic presentation | 70 |
| Total | | 100 |

*Table 1.5* Indicators of the ISER presentation types

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Developments | 30 |
| 2 | Publications | 20 |
| 3 | Databases | 5 |
| 4 | Application software packages | 5 |
| 5 | Remote learnings | 5 |
| 6 | Consultants | 30 |
| 7 | Regulatory information | 5 |
| Total | | 100 |

*Table 1.6* Particular criteria for evaluating an active digital footprint

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Evaluation criteria for ISER representation types | 70 |
| 2 | Private criterion for evaluating IRs based on the DMP's status | 15 |
| 3 | Private criterion for evaluating IRs based on the EEA's status | 15 |
| | Total | 100 |

*Table 1.7* Indicators of the IR evaluation criterion based on the DMP's status

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Unstructured message board | 5 |
| 2 | Structured message board | 10 |
| 3 | Automated search for a trading partner according to a given indicator | 20 |
| 4 | Automated information processes for all trading operations | 25 |
| 5 | Complete automation of e-commerce | 40 |
| | Total | 100 |

*Table 1.8* Indicators of the IR evaluation criterion based on the EEA's status

| *No.* | *Designation* | *Weight (%)* |
|---|---|---|
| 1 | Unstructured message board | 10 |
| 2 | Structured message board | 20 |
| 3 | Electronic employment agency (automated search) | 60 |
| 4 | Links to other employment agencies | 10 |
| | Total | 100 |

$m$ – university code, $m \in M$;

$P_j^m$ – the private criterion for evaluating, calculated on the basis of a active digital traces of the $m^{\text{th}}$ university based on the $j^{\text{th}}$ indicator, $j \in J$ (Table 1.6);

$P^m$ – the integral criterion for evaluating, calculated on the basis of a active digital traces of the $m^{\text{th}}$ university;

$\alpha_i^1$ – the value weight of the $i^{\text{th}}$ indicator of the scientific and educational IR integration;

$\alpha_l^2$ – weight of the $l^{\text{th}}$ storage form ISERs;

$\alpha_n^3$ – the value weight of the $n^{\text{th}}$ indicator of the scientific and educational IR presentation form;
$\beta_j$ – weight of the $j^{\text{th}}$ private criterion of assessment, calculated on the basis of a active digital traces (Table 1.6);
$v_{i\ln 0}^m$ – the size of ISERs of the $i^{\text{th}}$ integration level, the $l^{\text{th}}$ storage form, $n^{\text{th}}$ presentation kind of the $m^{\text{th}}$ university;
$\lambda_{i\ln}^m$ – the normalized value of the estimation of the size of the ISERs of the $i^{\text{th}}$ integration level, the $l^{\text{th}}$ storage form, $n^{\text{th}}$ presentation kind of the $m^{\text{th}}$ university;

$$\lambda_{i\ln}^m = v_{i\ln 0}^m / \max_m v_{i\ln 0}^m;$$

$d_{sm}^3$ – the size of the $s^{\text{th}}$ indicator of the website evaluation criterion based on the DMP's status of the $m^{\text{th}}$ university (Table 1.7);
$\omega_s^3$ – the value weight of the $s^{\text{th}}$ indicator of the website evaluation criterion based on the DMP's status (Table 1.7);
$d_{gm}^4$ – the size of the $g^{\text{th}}$ indicator of the website evaluation criterion based on the EEA's status of the $m^{\text{th}}$ university (Table 1.8);
$\omega_g^4$ – the value weight of the $g^{\text{th}}$ indicator of the website evaluation criterion based on the EEA's status (Table 1.8). Then:

$$P^m = \sum_j \beta_j \; P_j^m, \tag{1.3}$$

where $P_1^m = \sum_{i,l,n} \lambda_{i\ln}^m \alpha_i^1 \alpha_l^2 \alpha_n^3$, $P_3^m = \sum_s \omega_s^3 d_{gm}^3$,

$$P_4^m = \sum_g \omega_g^4 d_{gm}^4 \tag{1.4}$$

To demonstrate the underestimation of the active and passive digital footprints, Table 1.9 provides information about the low information content of ISERs on the universities' websites, where the column numbers mean the following indicators: C1 – percentage of websites having this type of ISER, C2 – unordered list, C3 – digital catalog, C4 – unordered full-format presentation, C5 – ordered full-format digital presentation, ASPs – application software packages, RL – remote learning, and RI – regulatory information.

*Table 1.9* Quality and quantity of ISERs on universities' websites

| *Types of ISERs* | *C1* | *C2* | *C3* | *C4* | *C5* |
|---|---|---|---|---|---|
| Developments | 85 | 3,684 | 391 | 337 | 248 |
| Publications | 89 | 18,649 | 408 | 344 | 0 |
| Databases | 11 | 530 | 45 | 0 | 0 |
| ASPs | 2 | 828 | 2 | 25 | 0 |
| RL | 12 | 1,195 | 0 | 0 | 3 |
| Consultants | 25 | 216 | 43 | 9 | 0 |
| RI | 89 | 18,649 | 408 | 344 | 0 |

*Table 1.10* Comparison of university ratings based on passive, semi-active, and active digital footprints

| *University* | *N1/N2/N3/N4* | *University* | *N1/N2/N3/N4* |
|---|---|---|---|
| Russian State Agrarian University – MTAA | 1/1/16/4 | Belgorod State Agrarian University | 6/43/10/7 |
| Orel State Agrarian University | 2/20/14/5 | Krasnoyarsk State Agrarian University | 7/22/32/2 |
| Novosibirsk State Agrarian University | 3/4/18/28 | Saint Petersburg State Agrarian University | 8/3/19/34 |
| Bryansk State Agrarian University | 4/21/2/20 | Saratov State Agrarian University | 9/6/11/9 |
| Kazan State Agrarian University | 5/28/15/8 | Bashkir State Agrarian University | 10/19/7/32 |

## 1.5 RATING CALCULATION RESULTS

Table 1.10 presents a comparison of the rankings of the first ten universities of the integral ranking (N1) based on the passive (N2), semi-active (N3), and active (N4) digital footprint.

Our analysis of the comparison results shows that the majority of universities virtually do not pay attention to their image. Thus, not a single university from the top-10 of the N1 rating has retained its leadership in the other three ratings. Only three institutions have been included in the leaders of three ratings out of four: Russian State Agrarian University – MTAA, Belgorod State Agrarian University, and Saratov State Agrarian University.

## 1.6 CONCLUSION

Our research has shown that universities are currently forced by the regulation to develop their websites, focusing only on those resources that are required by regulatory authorities and leaving a largely semi-active digital

footprint on the Internet. Therewith, they pay little attention to tools that enhance their active and passive digital footprints. Underestimation of these tools was the reason for not fulfilling the Russian President's instruction to achieve the goal; five Russian universities should be included in the ranking of the 100 best world universities by 2020. However, focusing only on indicators included in the calculations of the most famous university rankings, QS Rankings [2] and Times Higher Education (THE) [3], poses a great threat to the Russian economy. The indicators of these ratings are reflected in the self-survey report [1]. They are taken into account in the form of semi-active digital traces in this article. If in developed countries, thanks to market relations, the transfer of innovations to the economy is well established, in our country it was destroyed during the years of perestroika. Business in Russia is not interested in the indicators from the QS and THE ratings; they need the indicators included in the calculation of the active digital traces [6,13,14].

## REFERENCES


1. Order of the Ministry of Education and Science of the Russian Federation of June 14, 2013 N 462 "On approval of the procedure for conducting self-examination by an educational organization", https://base.garant.ru/70405358/, last accessed 2021/09/1.
2. QS World University & Business School Rankings, https://www.qs.com/rankings/, last accessed 2021/08/20.
3. World University Rankings, https://www.timeshighereducation.com/world-university-rankings, last accessed 2021/08/20.
4. Academic Ranking of World Universities, www.shanghairanking.com, last accessed 2021/08/20.
5. Universities from the project "5–100" did not enter the top 100 international rankings, https://www.rbc.ru/society/18/02/2021/602cbdff9a7947765cbb58e5?from=from_main_10, last accessed 2021/08/20.
6. Medennikov, V., Muratova, L., Salnikov, S. *Methodology for Assessing the Effectiveness of the Use of Information Scientific and Educational Resources*. Moscow, Analitik (2017).
7. Zatsarinny, A., Ereshko, F., Medennikov, V. Scientific and methodological approaches to the generation of the internet information space of scientific and educational resources. In: *IEEE Xplore Digital Library. Proceedings of the 1st International Conference of Information Systems and Design*, Moscow, Russia, December 5 (2019).
8. Site-Auditor, https://freesoft.ru/windows/siteauditor, last accessed 2021/08/20.
9. Sirotkin, G. System analysis of factors of quality of education in higher education institutions. *Caspian Journal: Management and High Technologies* 2(22), 109–118 (2013).
10. Guzaeva, M. The use of information resources of science and education to improve the effectiveness of the implementation of new forms of education, http://pedsovet.su/publ/164-1-0-1048/, last accessed 2021/08/20.

11. Antyukhov, A., Fomin, N. Development of the fund of evaluation funds in the context of the Federal State Educational Standard for Higher Education, https://cyberleninka.ru/article/n/razrabotka-fonda-otsenochnyh-sredstv-v-kontekste-fgos-vpo/viewer, last accessed 2021/08/20.
12. Medennikov, V., Raikov, A. Creating the requirements to the national platform "Digital Agriculture". In: *Proceedings of the 8th International Scientific Conference on Computing in Physics and Technology*, Moscow region, Russia, November 9–13, 2020, pp. 13–18. CEUR Workshop Proceedings, 2763 (2020).
13. Valero, A., Reenen, J. V. The economic impact of universities: Evidence from across the globe. *Economic of Education Review* 68, 53–67 (2019).
14. Hamdan, A., Sarea, A., Khamis, R., Anasweh, M. A causality analysis of the link between higher education and economic development: empirical evidence. *Heliyon* 6(6), Article 04046 (2020).

## Creating ratings of agricultural universities based on their digital footprint

Order of the Ministry of Education and Science of the Russian Federation of June 14, 2013 N 462 “On approval of the procedure for conducting self-examination by an educational organization”, https://base.garant.ru/70405358/, last accessed 2021/09/1 .

QS World University & Business School Rankings , https://www.qs.com/rankings/, last accessed 2021/08/20 .

World University Rankings , https://www.timeshighereducation.com/world-university-rankings, last accessed 2021/08/20 .

Academic Ranking of World Universities , www.shanghairanking.com, last accessed 2021/08/20 .

Universities from the project “5–100” did not enter the top 100 international rankings, https://www.rbc.ru/society/18/02/2021/602cbdff9a7947765cbb58e5?from=from_main_10, last accessed 2021/08/20 .

Medennikov, V. , Muratova, L. , Salnikov, S. Methodology for Assessing the Effectiveness of the Use of Information Scientific and Educational Resources. Moscow, Analitik (2017).

Zatsarinny, A. , Ereshko, F. , Medennikov, V. Scientific and methodological approaches to the generation of the internet information space of scientific and educational resources. In: IEEE Xplore Digital Library. Proceedings of the 1st International Conference of Information Systems and Design, Moscow, Russia, December 5 (2019).

Site-Auditor , https://freesoft.ru/windows/siteauditor, last accessed 2021/08/20 .

Sirotkin, G. System analysis of factors of quality of education in higher education institutions. Caspian Journal: Management and High Technologies 2(22), 109–118 (2013).

Guzaeva, M. The use of information resources of science and education to improve the effectiveness of the implementation of new forms of education, http://pedsovet.su/publ/164-1-0-1048/, last accessed 2021/08/20 .

Antyukhov, A. , Fomin, N. Development of the fund of evaluation funds in the context of the Federal State Educational Standard for Higher Education, https://cyberleninka.ru/article/n/razrabotka-fonda-otsenochnyh-sredstv-v-kontekste-fgos-vpo/viewer, last accessed 2021/08/20 .

Medennikov, V. , Raikov, A. Creating the requirements to the national platform “Digital Agriculture”. In: Proceedings of the 8th International Scientific Conference on Computing in Physics and Technology, Moscow region, Russia, November 9–13, 2020, pp. 13–18. CEUR Workshop Proceedings, 2763 (2020).

Valero, A. , Reenen, J. V. The economic impact of universities: Evidence from across the globe. Economic of Education Review 68, 53–67 (2019).

Hamdan, A. , Sarea, A. , Khamis, R. , Anasweh, M. A causality analysis of the link between higher education and economic development: empirical evidence. Heliyon 6(6), Article 04046 (2020).

## Mechatronic complex's fuzzy system for fixating moving objects

Bobyr, M.V. , Kulabukhov, S.A. Simulation of control of temperature mode in cutting area on the basis of fuzzy logic. Journal of Machinery Manufacture and Reliability, 2017, 46(3), 288–295.

Beater, P. Pneumatic Drives: System Design, Modelling and Control, Berlin Heidelberg, Springer-Verlag, 2007, p. 324.

Pfeffer, A. , Glück, T. , Schausberger, F. , Kugi, A. Control and estimation strategies for pneumatic drives with partial position information. Mechatronics, 2018, 50, 259–270. DOI: 10.1016/j.mechatronics.2017.09.01.01.

Wang, Y. , Ying, Y. , Xie, S. , Wang, H. , Feng, X. Mechatronics education at CDHAW of Tongji University: Laboratory guidelines, framework implementations aCnd improve-ments. Mechatronics, 2009, 19, 1346–1352. DOI: 10.1016/j.mechatronics.2009.09.001.

Saravanakumar, D. , Mohan, B. , Muthuramalingam, T. , Sakthivel, G. A review on recent research trends in servo pneumatic positioning systems. Precision Engineering, 2017, 49, 481–492.

Yuhimets, D.A. , Yudinkov, E.E. Development of an application software interface for controlling a Mitsubishi RV-2FB robotic arm. Programmnaya Ingeneria, 2018, 9(6), 253–261. DOI: 10.17587/prin.9.253-261 (in Russian).
Backe, W. The application of servo-pneumatic drives for flexible mechanical handling techniques. Robotics, 1986, 2(1), 45–56.
Östring, M. , Gunnarson, S. , Norrlöf, M. Closed-loop identification of an industrial robot containing flexibilities. Control Engineering Practice, 2003, 11(3), 291–300. DOI: 10.1016/S0967-0661(02)00114-4.
Arreguin, J.M.R. , Ortega, J.C.P. , Gorrostieta, E. , Troncoso, R.J.R. Artificial intelli-gence applied into pneumatic flexible manipulator. Proceedings of 7th Mexican Inter-national Conference on Artificial Intelligence 2008, 2008, pp. 339–345. DOI: 10.1109/MICAI.2008.76.
Elgeneidy, K. , Loshe, N. , Jackson, M. Bending angle prediction of control soft pneumatic actuators with embedded flex sensor – A data driven approach. Mechatronics, 2018, 50, 234–237.
Salamandra, B.L. Analysis of label position stabilization methods on automatic packaging machines. Journal of Machinery Manufacture and Reliability, 2017, 46(2), 181–186.
Shelekhov, V.I. , Tumurov, E.G. Applying automata-based software engineering for the lift control program. Programmnaya Ingeneria, 2017, 8(2), 99–111. DOI: 10.17587/prin.8.99-111 (in Russian).
Bobyr, M.V. , Yakushev, A.S. , Dorodnykh, A.A. Fuzzy devices for cooling the cutting tool of the CNC machine implemented on FPGA. Measurement, 2020. DOI: 10.1016/j.measurement.2019.107378.
Kruglova, T.N. Intellectual method of diagnosing and forecasting of a technical condition of the mechatronic complexes for extreme conditions. Mehatronika, avtomati-zatsiya, upravlenie, 2011, 3, 47–51 (in Russian).
Chunikhin, A. Yu Glazunov, V.A. Developing the mechanisms of parallel structure with five degrees of freedom designed for technological robots. Journal of Machinery Manufacture and Reliability, 2017, 46(4), 313–321.
Bobyr, M.V. , Emelyanov, S.G. A nonlinear method of learning neuro-fuzzy models for dynamic control systems. Applied Soft Computing, 2020, 88, 106030.
Loshitskiy, P.A. , Shehovcova, E.E. Calculation and simulation of an industrial manipulator on the power of the shell elements. Mekhatronika, avtomatizatsiya, upravlenie, 2015, 16(7), 470–475. DOI: 10.17587/mau.16.470-475 (in Russian).
Skvortsov, A.A. The use of finite state machines in the development of software for machines with complex structure. Programmnaya Ingeneria, 2018, 9(7), 332–336. DOI: 10.17587/prin.9.332-336 (in Russian).
Bobyr, M. , Titov, V. , Belyaev, A. Fuzzy system of distribution of braking forces on the engines of a mobile robot. MATEC Web of Conferences, 2016, 79, 01052.

## Quad sensor-based soil-moisture prediction using machine learning

Hemageetha, N. (2016). A survey on application of data mining techniques to analyze the soil for agricultural purpose. In 2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom) (pp. 3112–3117). IEEE.
Prakash, S. , Sharma, A. , & Sahu, S. S. (2018). Soil moisture prediction using machine learning. In 2018 Second International Conference on Inventive Communication and Computational Technologies (ICICCT) (pp. 1–6). IEEE.
Ouyang, W. , Wu, Y. , Hao, Z. , Zhang, Q. , Bu, Q. , & Gao, X. (2018). Combined impacts of land use and soil property changes on soil erosion in a mollisol area under long-term agricultural development. Science of the Total Environment, 613, 798–809.
Mishra, S. K. , Singh, V. P. , & Singh, P. K. (2018). Revisiting the soil conservation service curve number method. In V. P. Singh , S. Yadav , & R. N. Yadava (Eds.), Hydrologic Modeling (pp. 667–693). Springer, Singapore.
Katsanou, K. , & Lambrakis, N. (2017). Modeling the Hellenic karst catchments with the sacramento soil moisture accounting model. Hydrogeology Journal, 25(3), 757–769.

Zhang, K. , Chao, L. J. , Wang, Q. Q. , Huang, Y. C. , Liu, R. H. , Hong, Y. , Tu, Y. , Qu, W. , & Ye, J. Y. (2019). Using multi-satellite microwave remote sensing observations for retrieval of daily surface soil moisture across China. Water Science and Engineering, 12(2), 85–97.

Han, H. , Choi, C. , Kim, J. , Morrison, R. R. , Jung, J. , & Kim, H. S. (2021). Multiple-depth soil moisture estimates using artificial neural network and long short-term memory models. Water, 13(18), 2584.

Lu, Z. , Chai, L. , Liu, S. , Cui, H. , Zhang, Y. , Jiang, L. , Jin, R. , & Xu, Z. (2017). Estimating time series soil moisture by applying recurrent nonlinear autoregressive neural networks to passive microwave data over the Heihe River Basin, China. Remote Sensing, 9(6), 574.

Zhu, Q. , Wang, Y. , & Luo, Y. (2021). Improvement of multi-layer soil moisture prediction using support vector machines and ensemble Kalman filter coupled with remote sensing soil moisture datasets over an agriculture dominant basin in China. Hydrological Processes, 35(4), e14154.

Hong, Z. (2015). A Data-Driven Approach to Soil Moisture Collection and Prediction Using a Wireless Sensor Network and Machine Learning Techniques. Dissertation/thesis of Z. Hong, Electrical & Computer Engineering, University of Illinois at Urbana-Champaign.

Kodali, R. K. , & Sahu, A. (2016). An IoT based soil moisture monitoring on Losant platform. In 2016 2nd International Conference on Contemporary Computing and Informatics (IC3I) (pp. 764–768). IEEE.

Payero, J. O. , Mirzakhani-Nafchi, A. , Khalilian, A. , Qiao, X. , & Davis, R. (2017). Development of a low-cost Internet-of-Things (IoT) system for monitoring soil water potential using Watermark 200SS sensors. Advances in Internet of Things, 7(3), 71–86.

Payero, J. O. , Nafchi, A. M. , Davis, R. , & Khalilian, A. (2017). An arduino-based wireless sensor network for soil moisture monitoring using Decagon EC-5 sensors. Open Journal of Soil Science, 7(10), 288.

Mhaiskar, S. , Patil, C. , Wadhai, P. , Patil, A. , & Deshmukh, V. (2017). A survey on predicting suitable crops for cultivation using IoT. International Journal of Innovative Research in Computer and Communication Engineering, 5, 318–323.

Badhe, A. , Kharadkar, S. , Ware, R. , Kamble, P. , & Chavan, S. (2018). IOT based smart agriculture and soil nutrient detection system. International Journal on Future Revolution in Computer Science & Communication Engineering, 4(4), 774–777.

Mukherjee, A. , De, D. , Ghosh, S. K. , & Buyya, R. (2021). Mobile Edge Computing. Springer Nature, Switzerland AG.

Sengupta, A. , Debnath, B. , Das, A. , & De, D. (2021). FarmFox: A quad-sensor based IoT box for precision agriculture. IEEE Consumer Electronics Magazine, 10(4), 63–68.

Seber, G. A. , & Lee, A. J. (2012). Linear Regression Analysis (Vol. 329). John Wiley & Sons, Hoboken, NJ.

Awad, M. , & Khanna, R. (2015). Support vector regression. In M. Awad & R. Khanna (Eds.), Efficient Learning Machines (pp. 67–80). Apress, Berkeley, CA.

Xu, M. , Watanachaturaporn, P. , Varshney, P. K. , & Arora, M. K. (2005). Decision tree regression for soft classification of remote sensing data. Remote Sensing of Environment, 97(3), 322–336.

Pal, M. (2005). Random forest classifier for remote sensing classification. International journal of remote sensing, 26(1), 217–222.

Meyer, D. , Leisch, F. , & Hornik, K. (2003). The support vector machine under test. Neurocomputing, 55(1–2), 169–186.

Selvi, C. , & Sivasankar, E. (2019). A novel Adaptive Genetic Neural Network (AGNN) model for recommender systems using modified k-means clustering approach. Multimedia Tools and Applications, 78(11), 14303–14330.

Uyanık, G. K. , & Güler, N. (2013). A study on multiple linear regression analysis. Procedia-Social and Behavioral Sciences, 106, 234–240.

Medsker, L. R. , & Jain, L. C. (2001). Recurrent neural networks. Design and Applications, 5, 64–67.

## Stability analysis for a diffusive ratio-dependent predator-prey model involving two delays


Arditi, R. , Ginzburg, L. R. Coupling in predator prey dynamics: ratio-dependence. Journal of Theoretical Biology 139, 311–326 (1989).

He, X. Z. Stability and delays in a predator–prey system. Journal of Mathematical Analysis & Applications 198(2), 355–370 (1996).

Sun, C. , Han, M. , Lin, Y. , et al. Global qualitative analysis for a predator–prey system with delay. Chaos, Solitons & Fractals 32(4), 1582–1596 (2007).

Yan, X. P. , Chu, Y. D. Stability and bifurcation analysis for a delayed Lotka–Volterra predator–prey system. Journal of Computational and Applied Mathematics 196(1), 198–210 (2006).

Xu, R. Global stability and Hopf bifurcation of a predator-prey model with stage structure and delayed predator response. Nonlinear Dynamics 67(2), 1683–1693 (2012).

Kar, T. K. , Ghorai, A. Dynamic behaviour of a delayed predator-prey model with harvesting. Applied Mathematics and Computation 217(22), 9085–9104 (2011).

Deng, L. W. , Wang, X. D. et al. Hopf bifurcation analysis for a ratio-dependent predator-prey system with two delays and stage structure for the predator. Applied Mathematics and Computation 231(15), 214–230 (2014).

Karaoglu, E. , Merdan, H. Hopf bifurcation analysis for a ratio-dependent predator-prey system involving two delays. The ANZIAM journal: the Australian & New Zealand Industrial and Applied Mathematics Journal 55(3), 214–231 (2014).

Leslie, P. H. Some further notes on the use of matrices in population mathematics. Biometrika 35(3–4), 213–245 (1948).

Zhou, S. , Liu, Y. , Wang, G. The stability of predator–prey systems subject to the Allee effects. Theoretical Population Biology 67, 23–31 (2005).

Celik, C. The stability and Hopf bifurcation for a predator–prey system with time delay. Chaos Solitons and Fractals 37(1), 87–99 (2008).

Celik, C. Hopf bifurcation of a ratio-dependent predator-prey system with time delay. Chaos Solitons and Fractals 42(3), 1474–1484 (2009).

Liu, F. , Yang, R. , Tang, L. Hopf bifurcation in a diffusive predator-prey model with competitive interference. Chaos, Solitons and Fractals 120, 250–258 (2019).

Yang, R. Bifurcation analysis of a diffusive predator-prey system with Crowley-Martin function response and delay. Chaos, Solitons and Fractals 95, 131–139 (2017).

Rao, F , Castillo, C. , Kang, Y. Dynamics of a diffusion reaction prey–predator model with delay in prey: Effects of delay and spatial 95: components. Journal of Mathematical Analysis and Applications 461, 1177–1214 (2018).

Li, L. , Mei, Y. , Cao, J. Hopf bifurcation analysis and stability for a ratio-dependent predator-prey diffusive system with time delay. Chaos, Solitons and Fractals 30(3), 1–20 (2020).


## Analysis and prediction of physical fitness test data of college students based on grey model


Wang Wei . Research on the Status Quo of College Students' Physical Health and its Influencing Factors. Nanchang Hangkong University, Jiangxi, China, 2016.

Zhao Xinzhi . Research on the Development Trend and Grey Prediction of the Physical Health of College Students in Yunnan Province. Yunnan Normal University, Yunnan, China, 2018.

Qi Zhenyu . Research on the Correlation Between Physical Fitness Level of College Students and Sports Technique Learning. Shanxi Normal University, Shanxi, China, 2014.

Zhang Shengming , Cai Xiao, Guowei . Analysis of physical fitness indexes of college students' physical fitness test — Taking Guizhou medical university physical examination data as an example. Stationery and Sports Supplies and Technology 24: 109–110+141, 2020.

Xie Naiming , Liu Sifeng . Discrete GM (1,1) model and grey prediction model modeling mechanism. System Engineering Theory and Practice 1: 93–99, 2005.

Sun Ke . Forecast of the Labor Supply and Demand Relationship in Qinghai Province based on the GM (1,1) Gray Model: 20192030. Northwest University for Nationalities, Gansu, China,

2019.
Wu Chunguang . Improvement and Application of GM(1,1) Model and its MATLAB Implementation. East China Normal University, Shanghai, China, 2010.
Deng Julong . Basic Methods of Grey System (Second Edition). Wuhan: Huazhong University of Science and Technology Press, 2005.

## Analysis and research on book borrowing tendency based on Apriori algorithm

Melentieva, J. P. Reading among young Russians: Some modern tendencies. Slavic & East European Information Resources, 2009, 10(4): 304–321.
Dollinger, S. J. “You Are as You Read”: Do students’ reading interests contribute to their individuality? Reading Psychology, 2015, (ahead-of-print) 1(1): 1–26.
Yanbin, L. On reader studies. Research on Publishing and Distribution, 1987, 1(2): 35–38.
Yixiao, L. Zhiqiang, Z. Analysis of book publishing based on 2014 book ranking. Library Forum, 2015, 1(9): 89–94.
Hai, Z. Research on Job Risk Early Warning based on Association Rule Apriori Algorithm. Jilin University, Jilin, China, 2014.
Chengyong, W. Research and Application of Apriori Algorithm for Association Rules. North China Electric Power University (Beijing), Beijin, China, 2018.
Nan, Y. Research and Implementation of Web Log Mining based on Association Rule Apriori Algorithm. Chengdu University of Technology, Sichuan, China, 2012.
Weiguo, Y. Research and Application of Prediction Method based on Association Rules and Decision Tree. Dalian Maritime University, Shandong, China, 2012.
Zhixiu, D. Comparative Study on Readers’ Reading Tendency of Different Types of University Libraries in the Digital Age. Nanjing Agricultural University, Jiangsu, China, 2008.

## Performance evaluation of cargo inspection

Lee D. , Lee J. , Min J. , Lee B. , Lee B. , Oh K. , Kim J. , Cho S. Efficient material decomposition method for dual-energy X-ray cargo inspection system. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 2018, 884, 105–112.
Shikhaliev P. M. Megavoltage cargo radiography with dual energy material decomposition. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 2018, 882, 158–168.
Langeveld W.G.J. Comparison of dual-energy, Z-SCAN, and Z-SPEC material separation techniques for high-energy x-ray cargo inspection. AIP Conference Proceedings. AIP Publishing LLC, 2019, 2160(1), 050018.
Osipov S.P. , Usachev E.Y. , Chakhlov S.V. , et al. Limit capabilities of identifying materials by high dual-and multi-energy methods. Russian Journal of Nondestructive Testing, 2019, 55(9), 687–699.
Bairashewski D.A. , Drobychev G.Y. , Karas V.A. , Komarov V.V. , Protsko M.V. Development of the X-ray security screening systems at ADANI. International Conference on Engineering of Scintillation Materials and Radiation Technologies. Springer, Cham, 2018, 249–259.
Bendahan J. Vehicle and cargo scanning for contraband. Physics Procedia, 2017, 90, 242–255.
Cui Y. , Oztan B. Automated firearms detection in cargo x-ray images using RetinaNet. Anomaly Detection and Imaging with X-Rays (ADIX) IV. International Society for Optics and Photonics, 2019, 10999, 109990P.
Osipov S.P. , Chakhlov S.V. , Osipov O.S. , Li S. , Sun X. , Zheng J. , Hu X. , Zhang G. Physical and technical restrictions of materials recognition by the dual high energy X-ray imaging. International Journal of Applied Engineering Research, 2017, 12(23), 13127–13136.

Slavashevich I. , Pozdnyakov D. , Kasiuk D. , Linev V. Optimization of physico-topological parameters of dual energy X-ray. International Conference on Engineering of Scintillation Materials and Radiation Technologies, Springer, Cham, 2018, 261−269.
Chen Z. Q. , Zhao T. , Li L. A curve-based material recognition method in MeV dual-energy X-ray imaging system. Nuclear Science and Techniques, 2016, 27(1), 25.
Wang X.W. , Li J. , Tang C.X. , Chen Z.Q. , Zhong H.Q. Material discrimination by high-energy X-ray dual-energy imaging. High Energy Physics and Nuclear Physics, 2007, 31, (11), 1076−1081.
Ogorodnikov S. , Petrunin V. Processing of interlaced images in 4–10 MeV dual energy customs system for material recognition. Physical Review Special Topics-Accelerators and Beams, 2002, 5(10), 104701.
Nattress J. , Nolan T. , McGuinness S. , et al. High-contrast material identification by energetic multiparticle spectroscopic transmission radiography. Physical Review Applied, 2019, 11(4), 044085.
Harms J. , Maloney L. , Erickson A. Low-dose material-specific radiography using monoenergetic photons. Plos one, 2019, 14(9), 0222026.
http://scantronicsystems.com/en/products/idk_train_st2630t/.
http://www.nuctech.com/en/SitePages/ThDetailPage.aspx?nk=PAS&k=AIFEEF.
https://www.rapiscansystems.com/en/products/rapiscan-eagle-r60.
Osipov S.P. , Chakhlov S.V. , Osipov O.S. , Shtein A.M. , Strugovtsev D.V. About accuracy of the discrimination parameter estimation for the dual high-energy method. Materials Science and Engineering Conference Series, 2015, 81(1), 2082.
Yaffe M.J. , Rowlands J.A. X-ray detectors for digital radiography. Physics in Medicine & Biology, 1997, 42(1), 1−39.
Maddalena F. , Tjahjana L. , Xie A. , et al. Inorganic, organic, and perovskite halides with nanotechnology for high–light yield x-and γ-ray scintillators. Crystals, 2019, 9(2), 88.
Berger M.J. , Hubbell J.H. , Seltzer S.M. , Chang J. , Coursey J.S. , Sukumar R. , Zucker D.S. , Olsen K. XCOM: Photon Cross Sections Database, National Institute of Standards and Technology, 2010, http://www.nist.gov/pml/data/xcom/index.cfm/.
Chadwick M.B. , Obložinský P. , Herman M. , et al. ENDF/B–VII. 0: Next generation evaluated nuclear data library for nuclear science and technology. Nuclear Data Sheets, 2006, 107(12), 2931–3060.
Zhang G. , Zhang L. , Chen Z. An HL curve method for material discrimination of dual energy X-ray inspection systems. IEEE Nuclear Science Symposium Conference Record, 2005, IEEE, 2005, 326–328.
Osipov S.P. , Usachev E.Y. , Chakhlov S.V. , et al. Identification of materials in fragments of large-sized objects in containers by the dual-energy method. Russian Journal of Nondestructive Testing, 2019, 55(9), 672–686.
Scientific Educational Cargo Vehicle Inspection System .
http://portal.tpu.ru/departments/laboratory/rknl/eng/products/iDK.
Detection Technology Plc . https://www.deetee.com/x-scan-d-series.
American national standard for determination of the imaging performance of X-ray and gamma-ray systems for cargo and vehicle security screening, Standard ANSI N42.46, 2008.

## Automated medical report generation on chest X-ray

You, Q. , Jin, H. , Wang, Z. , Fang, C. , Luo, J. Image captioning with semantic attention. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 4651–4659. IEEE, Las Vegas, NV (2016).
Xu, K. , Ba, J. , Kiros, R. , Cho, K. , Courville, A. , Salakhudinov, R. , Zemel, R. , Bengio, Y. Show, attend and tell: Neural image caption generation with visual attention. In: International Conference on Machine Learning, pp. 2048–2057. PMLR, Lille (2015).
Syeda-Mahmood, T. , Wong, K. C. , Gur, Y. , Wu, J. T. , Jadhav, A. , Kashyap, S. , Karargyris, A. , Pillai, A. , Sharma, A. , Syed, A. B. Boyko, O. Chest x-ray report generation through fi- negrained label learning. In: International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 561–571. Springer, Cham (2020).

Demner-Fushman, D. , Kohli, M. D. , Rosenman, M. B. , Shooshan, S. E. , Rodriguez, L. , Antani, S. , Thoma, G. R. , McDonald, C. J. Preparing a collection of radiology examinations for distribution and retrieval. Journal of the American Medical Informatics Association 23(2), 304–310 (2016).

Bhattacharyya, S. , Snasel, V. , Hassanian, A. E. , Saha, S. , Tripathy, B. K. Deep Learning Research with Engineering Applications, De Gruyter Publications. Volume 7 in the series De Gruyter Frontiers in Computational Intelligence, Berlin (2020). DOI: 10.1515/9783110670905

Adate, A. , Tripathy, B. K. Deep learning techniques for image processing. In: S. Bhattacharyya , H. Bhaumik , A. Mukherjee & S. De (Eds.). Machine Learning for Big Data Analysis. Berlin, Boston: De Gruyter, 69–90 (2018).

Adate, A. , and Tripathy, B. K. A survey on deep learning methodologies of recent applications. In: D. P. Acharjya , A. Mitra & N. Zaman (Eds.). Deep Learning in Data Analytics- Recent Techniques, Practices and Applications. Springer Publications, 145–170. Springer Nature Switzerland AG (2021).

Kaul, D. , Raju, H. , Tripathy, B. K. Deep learning in healthcare, in: deep learning in data analytics. In: D. P. Acharjya , A. Mitra & N. Zaman (Eds). Deep Learning in Data Analytics- Recent Techniques, Practices and Applications. Springer Publications, 97–115 (2021).

Maheswari, K. , Shaha, A. , Arya, D. , Tripathy, B. K. , Rajkumar, R. Convolutional neural networks: A bottom-up approach. In: S. Bhattacharyya , A. E. Hassanian , S. Saha & B. K. Tripathy (Eds.). Deep Learning Research with Engineering Applications. De Gruyter Publications, Berlin 21–50 (2020).

Rajpurkar, P. , Irvin, J. , Zhu, K. , Yang, B. , Mehta, H. , Duan, T. , Ding, D. , Bagul, A. , Langlotz, C. , Shpanskaya, K. , Lungren, M. P. Chexnet: Radiologist-level pneumonia detection on chest x-rays with deep learning. arXiv preprint arXiv:1711.05225 (2017).

Tripathy, B.K. , Baktha, K. Investigation of recurrent neural networks in the field of sentiment analysis. In: The Proceedings of IEEE International Conference on Communication and Signal Processing (ICCSP17), Melmaruvathur (2017).

Bahdanau, D. , Cho, K. , Bengio, Y. Neural machine translation by jointly learning to align and translate. arXiv preprint arXiv:1409.0473 (2014).

Yu, Z. , Yu, J. , Cui, Y. , Tao, D. , Tian, Q. Deep modular co-attention networks for visual question answering. In: Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pp. 6281–6290. IEEE, Long Beach, CA (2019).

Gao, L. , Li, X. , Song, J. , Shen, H. T. Hierarchical LSTMs with adaptive attention for visual captioning. IEEE Transactions on Pattern Analysis and Machine Intelligence 42(5), 1112–1131 (2019).

Tanti, M. , Gatt, A. , Camilleri, K. P. Where to put the image in an image caption generator. Natural Language Engineering 24(3), 467–489 (2018).

Shin, H. C. , Roberts, K. , Lu, L. , Demner-Fushman, D. , Yao, J. , Summers, R. M. Learning to read chest x-rays: Recurrent neural cascade model for automated image annotation. In: Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 2497–2506. IEEE, Las Vegas, NV (2016).

Jing, B. , Xie, P. , Xing, E. On the automatic generation of medical imaging reports. In: Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics, vol. 1 (Long Papers), pp. 2577–2586. Melbourne Convention and Exhibition Centre, Melbourne (2018).

Yuan, J. , Liao, H. , Luo, R. Luo, J. Automatic radiology report generation based on multi- view image fusion and medical concept enrichment. In: International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 721–729. Springer, Cham (2019).

Xue, Y. , Xu, T. , Long, L. R. , Xue, Z. , Antani, S. , Thoma, G. R. , Huang, X. Multimodal recurrent model with attention for automated radiology report generation. In: International Conference on Medical Image Computing and Computer-Assisted Intervention, pp. 457–466. 21st International Conference on Medical Image Computing and Computer Assisted Intervention, Granada (2018).

Liu, G. , Hsu, T. M. H. , McDermott, M. , Boag, W. , Weng, W. H. , Szolovits, P. , Ghassemi, M. Clinically accurate chest x-ray report generation. In: Machine Learning for Healthcare Conference, pp. 249–269. PMLR, University of Michigan North Quadrangle Dining Hall, Ann Arbor, MI (2019).

Huang, X. , Yan, F. , Xu, W. , Li, M. Multi-attention and incorporating background information model for chest x-ray image report generation. IEEE Access 7, 154808–154817 (2019).

Tripathy, B. K. , Anuradha, J. Soft Computing- Advances and Applications. Cengage Learning Publications, New Delhi (2015).
Bhardwaj, P. , Guhan, T. , Tripathy, B. K. Computational Biology in the lens of CNN, (Chapter 5). In: S.S. Roy & Y.-H. Taguchi (Eds.). Handbook of Machine Learning Applications for Genomics, Studies in Big Data, vol. 103. Springer Nature Switzerland AG (2021). ISBN: 978-981-16-9157-7, 496166_1_En.
Gupta, P. , Bhachawat, S. , Dhyani, K. , Tripathy, B. K. A study of gene characteristics and their applications using Deep Learning, (Chapter 4). In: S.S. Roy & Y.-H. Taguchi (Eds.). Handbook of Machine Learning Applications for Genomics, Studies in Big Data, vol. 103. Springer Nature Switzerland AG (2021). ISBN: 978-981-16-9157-7, 496166_1_En.
Bose, A. , Tripathy, B. K. Deep learning for audio signal classification. In: S. Bhattacharyya , A. E. Hassanian , S. Saha and B. K. Tripathy (Eds.). Deep Learning Research and Applications. De Gruyter Publications, Berlin, pp. 105–136 (2020).

## An energy-efficient secured Arduino-based home automation using android interface

V. Vujoic and M. Makshimovic . “Raspberry Pi as a sensor web node for home automation”. Elsevier Transaction on Computer and Engineering 42, 153–171, 2015.
M. Marsan , G. Bucalo , A. Di Caro , M. Meo , and Y. Zhang . “Towards zero grid electricity networking: Powering BSs with renewable energy sources”. 2013 IEEE International Conference on Communications Workshops (ICC), Budapest, 2013, pp. 596–601.
A. Mishra , D. Irwin , P. Shenoy , J. Kurose , and T. Zhu . “Greencharge: Managing renewable energy in smart buildings”. IEEE Journal on Selected Areas in Communications 31(7), 1281–1293, 2013.
H. Nguyen , J. Song , and Z. Han . “Distributed demand side management with energy storage in smart grid”. IEEE Transactions on Parallel and Distributed Systems, 2014, doi: 10.1109/TPDS.2014.2372781.
I. Koutsopoulos and L. Tassiulas , “Optimal control policies for power demand scheduling in the smart grid”. IEEE Journal on Selected Areas in Communications 30(6), 1049–1060, 2012.
Smart Grid Working Group (2003–06) . Challenge and Opportunity: Charting a New Energy Future—Appendix A: Working Group Reports. Washington, DC: Energy Future Coalition, NW, 2008.
J. Zheng , D. Gao , and L. Lin . “Smart meters in smart grid: An overview”. 2013 IEEE Green Technologies Conference (GreenTech), Denver, CO, 2013, pp. 57–64.
Z. Li-Ming , L. Bao-Cheng , T. Qing-Hua , and W. Li-Ping . “The development and technological research of intelligent electrical building”. 2014 China International Conference on Electricity Distribution (CICED), Shenzhen, China, 2014, pp. 88–92.
X. Chen , T. Wei , and S. Hu . “Uncertainty-aware household appliance scheduling considering dynamic electricity pricing in smart home”. IEEE Transactions on Smart Grid 4(2), 932–941, 2013.
Y. Hadj-Said , S. Ploix , S. Galmiche , S. Bergeon , and X. Brunotte . “Canopea, an energy-smart home integrable into a smart-grid”. 2013 IEEE Grenoble Conference, Grenoble, 2013, pp. 1–7.
I. Horvat , N. Lukac , R. Pavlovic , and D. Starcevic . “Smart plug solution based on bluetooth low energy”. 2015 IEEE 5th International Conference on Consumer Electronics Berlin (ICCE-Berlin), Berlin, 2015, pp. 435–437.
C. Garrido , V. Lopez , T. Olivares , and M. Carmen Ruiz . “ Architecture proposal for heterogeneous, BLE-based sensor and actuator networks for easy management of smart homes”. 2016 15th ACM/IEEE International Conference on Information Processing in Sensor Networks (IPSN), Vienna, 2016, pp. 1–2.
J. Roux et al. “RadIoT: Radio communications intrusion detection for IoT - A protocol independent approach”. 2018 IEEE 17th International Symposium on Network Computing and Applications (NCA), Cambridge, MA, 2018, pp. 1–8.
T. Kim , H. Lee , and Y. Chung . “Advanced universal remote controller for home automation and security”. IEEE Transactions on Consumer Electronics 56(4), 2537–2542, 2010.

H. Kumar Singh , S. Verma , S. Pal , and K. Pandey . “A step towards home automation using IOT”. 2019 Twelfth International Conference on Contemporary Computing (IC3), Noida, 2019, pp. 1–5.
S.K. Vishwakarma , P. Upadhyaya , B. Kumari , A. Kumar Mishra . “Smart energy efficient home automation system using IoT”. 2019 4th International Conference on Internet of Things: Smart Innovation and Usages (IoT-SIU), Ghaziabad, 2019, pp. 1–4.
H. Bauer , M. Patel , and J. Veira . “The Internet of Things: Sizing up the opportunity.” 2014. Retrieved from: McKinsey at http://www.mckinsey.com/insights/high_tech_telecoms_internet/the_internet_of_things_sizing_up_the_opportunity.
C. Stolojescu-Crisan , C. Crisan , and B-P. Butunoi . “An IoT-based smart home automation system.” Sensors 21(11), 3784, 2021.
A. Singh , H. Mehta , A. Nawal , and O.V. Gnana Swathika . “Arduino based home automation control powered by photovoltaic cells”. Second International Conference on Computing Methodologies and Communication, IEEE, Erode, 2018.
Md. S. Mahamud , Md. S. Rahman Zishan , S. I. Ahmad , A. R. Rahman , M. Hasan , and Md. L. Rahman . “Domicile - An IoT based smart home automation”. IEEE 2019 International Conference on Robotics, Electrical and Signal Processing Techniques (ICREST), Dhaka, 2019, pp. 493–497.
N. Valov and I. Valova . “Home automation system with raspberry Pi”. 2020 7th International Conference on Energy Efficiency and Agricultural Engineering (EE&AE), IEEE, Ruse, 2020, pp. 1–5.
A. Eleyan and J. Fallon . “IoT-based home automation using android application”. 2020 International Symposium on Networks, Computers and Communications (ISNCC), IEEE, Montreal, QC, 2020, pp. 1–4.

## A multithreaded android app to notify available ‘CoWIN’ vaccination slots to multiple recipients

CoWIN Dashboard . “CoWIN dashboard”. Accessed July 13, 2022 . https://dashboard.cowin.gov.in/.
Co-WIN Public APIs . Accessed July 10, 2022 . https://apisetu.gov.in/api/cowin.
Co-WIN Slot Notifier . Accessed October 17, 2021 . http://getjab.in/.
CoWIN . “Search your nearest vaccination center”. Accessed January 16, 2021 . https://www.cowin.gov.in/.
Holder, J. “Covid world vaccination tracker - The New York Times”. Tracking coronavirus vaccinations around the world. Accessed July 11, 2022 . https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html.
Hussain, S. , and F. Suhel . “Why the private sector hasn’t been able to fulfil its 25% COVID vaccine quota – The wire science”. Why the private sector hasn’t been able to fulfil its 25% COVID vaccine quota – The wire science. Accessed September 14, 2021 . https://science.thewire.in/health/private-sector-not-able-fulfil-25-percent-covid-19-vaccine-quota/.
Mangla, S. “Impact of Covid-19 on Indian Economy.” Times of India Blog. Accessed July 11, 2021 . https://timesofindia.indiatimes.com/readersblog/shreyansh-mangla/impact-of-covid-19-on-indian-economy-2-35042/.
Sanyal, A. “Covishield at 780, Covaxin at 1,410: Maximum price for private hospitals”. Accessed June 8, 2021 . https://www.ndtv.com/india-news/covishield-at-780-covaxin-at-1-410-sputnik-v-at-1-145-maximum-price-that-can-be-charged-for-vaccines-by-private-hospitals-2459353.
Sharma, M. “Covishield, Covaxin to now cost private hospitals rs 225 per dose - Coronavirus outbreak news”. India Today. Accessed April 9, 2022 . https://www.indiatoday.in/coronavirus-outbreak/vaccine-updates/story/covishield-sii-covid-vaccine-price-dose-private-hospitals-1935466-2022-04-09.
Thakur, J. S. , and H. Kaur . “Vaccine distribution for COVID-19 and equity issues in India”. International Journal of Noncommunicable Diseases 6, no. 5 (2021): 98.

Coronaviridae Study Group of the International Committee on Taxonomy of Viruses . “The species severe acute respiratory syndrome-related coronavirus: Classifying 2019-nCoV and naming it SARS-CoV-2”. Nature Microbiology 5, no. 4 (2020): 536–544.
Worldometer . “Countries where coronavirus has spread”. Accessed July 12, 2022 . https://www.worldometers.info/coronavirus/countries-where-coronavirus-has-spread/?rel=outbound.
ZeeBusiness . “All 18+ citizens to get free covid-19 booster doses from July 15, say officials | Zee Business”. Zee Business. Accessed July 13, 2022 . https://www.zeebiz.com/india/news-all-18-citizens-to-get-free-covid-19-booster-doses-from-july-15-say-officials-189438.

## Binary MMBAIS for feature selection problem

Rao, Haidi , Xianzhang Shi , Ahoussou Kouassi Rodrigue , Juanjuan Feng , Yingchun Xia , Mohamed Elhoseny , Xiaohui Yuan , and Lichuan Gu . “Feature selection based on artificial bee colony and gradient boosting decision tree.” Applied Soft Computing 74 (2019): 634–642.
Jia, Zhen , Zhenbao Liu , Chi-Man Vong , and Michael Pecht . “A rotating machinery fault diagnosis method based on feature learning of thermal images.” IEEE Access 7 (2019): 12348–12359.
da Silva, Diogo L. , Leticia M. Seijas , and Carmelo J. A. Bastos-Filho . “Artificial bee colony optimization for feature selection of traffic sign recognition.” International Journal of Swarm Intelligence Research (IJSIR) 8, no. 2 (2017): 50–66.
Miao, Jianyu , and Lingfeng Niu . “A survey on feature selection.” Procedia Computer Science 91 (2016): 919–926.
Srivastava, Shweta , Nikita Joshi , and Madhvi Gaur . “A review paper on feature selection methodologies and their applications.” IJCSNS 14, no. 5 (2014): 78.
Bach, Francis R. “Bolasso: model consistent lasso estimation through the bootstrap.” In Proceedings of the 25th International Conference on Machine Learning, pp. 33–40. Helsinki, 2008.
Arora, Sankalap , and Priyanka Anand . “Binary butterfly optimization approaches for feature selection.” Expert Systems with Applications 116 (2019): 147–160.
Heidari, Ali Asghar , Seyedali Mirjalili , Hossam Faris , Ibrahim Aljarah , Majdi Mafarja , and Huiling Chen . “Harris hawks optimization: Algorithm and applications.” Future Generation Computer Systems 97 (2019): 849–872.
Wang, Zhichun , Minqiang Li , and Juanzi Li . “A multi-objective evolutionary algorithm for feature selection based on mutual information with a new redundancy measure.” Information Sciences 307 (2015): 73–88.
Banati, Hema , and Reshu Chaudhary . “Multi-modal bat algorithm with improved search (MMBAIS).” Journal of Computational Science 23 (2017): 130–144.
Yang, Xin-She . “A new metaheuristic bat-inspired algorithm.” In: Janusz Kacprzyk (ed.), Nature Inspired Cooperative Strategies for Optimization (NICSO 2010), pp. 65–74. Springer, Berlin, Heidelberg, 2010.
Ibrahim, Abdelmonem M. , and Mohamed A. Tawhid . “A new hybrid binary algorithm of bat algorithm and differential evolution for feature selection and classification.” In: Nilanjan Dey and V. Rajinikanth (eds.), Applications of Bat Algorithm and Its Variants, pp. 1–18. Springer, Singapore, 2021.
Dua, Dheeru , and Casey Graff . UCI Machine Learning Repository (2017).
https://rdrr.io/cran/zenplots/man/olive.html.
Somol, Petr , and Jana Novovičová . “Evaluating the stability of feature selectors that optimize feature subset cardinality.” In: Ronan Nugent (ed.), Joint IAPR International Workshops on Statistical Techniques in Pattern Recognition (SPR) and Structural and Syntactic Pattern Recognition (SSPR), pp. 956–966. Springer, Berlin, Heidelberg, 2008.
Eberhart, Russell , and James Kennedy . “A new optimizer using particle swarm theory.” In MHS’95. Proceedings of the Sixth International Symposium on Micro Machine and Human Science, pp. 39–43. IEEE, 1995.
Qasim, Omar Saber , and ZakariyaYahya Algamal . “Feature selection using particle swarm optimization-based logistic regression model.” Chemometrics and Intelligent Laboratory

Systems 182 (2018): 41–46.
Pashaei, Elnaz , Elham Pashaei , and Nizamettin Aydin . “Gene selection using hybrid binary black hole algorithm and modified binary particle swarm optimization.” Genomics 111, no. 4 (2019): 669–686.
Xue, Yu , Tao Tang , Wei Pang , and Alex X. Liu . “Self-adaptive parameter and strategy based particle swarm optimization for large-scale feature selection problems with multiple classifiers.” Applied Soft Computing 88 (2020): 106031.
Tawhid, Mohamed A. , and Kevin B. Dsouza . “Hybrid binary bat enhanced particle swarm optimization algorithm for solving feature selection problems.” Applied Computing and Informatics 16, no. 1/2 (2018): 117–136.
Liu, Feng , Xuehu Yan , and Yuliang Lu . “Feature selection for image steganalysis using binary bat algorithm.” IEEE Access 8 (2019): 4244–4249.
Al-Betar, MohammedAzmi , OsamaAhmad Alomari , and Saeid M. Abu-Romman . “A TRIZ-inspired bat algorithm for gene selection in cancer classification.” Genomics 112, no. 1 (2020): 114–126.
Emary, Eid , Hossam M. Zawbaa , and Aboul Ella Hassanien . “Binary grey wolf optimization approaches for feature selection.” Neurocomputing 172 (2016): 371–381.
Al-Tashi, Q. , S. J. A. Kadir , H. M. Rais , S. Mirjalili , and H. Alhussian . “Binary optimization using hybrid grey wolf optimization for feature selection.”IEEE Access 7 (2019): 39496–39508.
Al-Tashi, Qasem , Helmi Rais , and Said Jadid . “Feature selection method based on grey wolf optimization for coronary artery disease classification.” In International Conference of Reliable Information and Communication Technology, pp. 257–266. Springer, Cham, 2018

## Audio to Indian Sign Language Interpreter (AISLI) using machine translation and NLP techniques

Wikipedia Page . https://en.wikipedia.org/wiki/Indo-Pakistani_Sign_Language, last accessed 2021/09/24 .
Tripathy, B.K. , Sharma, A. , Natarajan, P. , Swarnalatha, P. , Lakkshmanan, A. , Krishnan, N. Image transformation using modified K-means clustering algorithm for parallel saliency map, IJET, 3(5), 347–353 (2013).
Tripathy, B.K. , Ghosh, A. , Panda, G. K. Adaptive K-means clustering to handle heterogeneous data using basic rough set theory. In: Meghanathan N. , Chaki N. , Nagamalai D. (eds.) Advances in Computer Science and Information Technology. Networks and Communications. CCSIT 2012. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol. 84, pp. 193–201. Springer, Berlin, Heidelberg (2012).
Tripathy, B. K. , Basu, A. , Govel, S. Image segmentation using spatial intuitionistic fuzzy C means clustering. In: 2014 IEEE International Conference on Computational Intelligence and Computing Research, pp. 1–5, Coimbatore (2014).
Tripathy, B.K. , Deepthi P.H. , Mittal, D. Hadoop with Intuitionistic Fuzzy C-means for clustering in Big Data, Advances in Intelligent Systems and Computing, vol. 438, pp.599–610. Springer, Singapore (2016).
Gupta, A. , Tripathy B. K. Implementing GloVe for context based k-means++ clustering. In: 2017 International Conference on Intelligent Sustainable Systems (ICISS), pp. 1041–1046 (2017), DOI: 10.1109/ISS1.2017.8389339.
Tripathy, B. K. , Mittal, D. Hadoop based uncertain possibilistic kernelized c-means algorithms for image segmentation and a comparative analysis. Applied Soft Computing, 46, 886–923 (2016).
Debgupta R. , Saha A. , Tripathy B.K. A faster fuzzy clustering approach for recommender systems. In: Bhateja V. , Satapathy S. , Zhang Y.D. , Aradhya V. (eds) Intelligent Computing and Communication, ICICC 2019, Advances in Intelligent Systems and Computing, vol. 1034, pp. 315–324. Springer, Singapore (2019), DOI: 10.1007/978-981-15-1084-7_30.
Tripathy, B.K. and Deepthi, P. H. Fuzzy set and rough set based Data Clustering Algorithms in Decision Making, IGI Edited volume: Fuzzy and Rough Set Theory in Organizational Decision Making. Arun Kumar, S. , Gao, X.-Z. , Abraham, A. (eds.), pp. 116–136, Chapter-6. IGI Global, Hershey, PA (2016).

Mariappan, H. M. , Gomathi, V. Real-time recognition of Indian sign language. In: IEEE International Conference on Computational Intelligence in Data Science (ICCIDS), pp. 1–6 (2019). DOI: 10.1109/ICCIDS.2019.8862125.
Ahmed, M. , Idrees, M. , Ul Abideen, Z. , Mumtaz, R. , Khalique, S. Deaf talk using 3D animated sign language: A sign language interpreter using Microsoft's kinect v2. SAI Computing Conference (SAI), pp. 330–335 (2016). DOI: 10.1109/SAI.2016.7556002.
Tripathy, B. K. , Baktha, K. Investigation of recurrent neural networks in the field of sentiment analysis. In: The Proceedings of IEEE International Conference on Communication and Signal Processing (ICCSP17), pp. 2047–2050, IEEE, Melmaruvathur (2017).
Tripathy, B. K. and Anuradha, J. Soft Computing Advances and Applications, Cengage Learning Publishers, New Delhi (2015).
Chowdhury, A. R. , Biswas, A. , Hasan, S. M. F. , Rahman, T. M. , Uddin, J. Bengali sign language to text conversion using artificial neural network and support vector machine. In: 2017 3rd International Conference on Electrical Information and Communication Technology (EICT), pp. 1–4 (2017). IEEE. DOI: 10.1109/EICT.2017.8275248.
Dutta, K. K. , Raju K. S. K. , Kumar, G. S. , Swamy, B.S.A. Double handed Indian Sign Language to speech and text. In: Third International Conference on Image Information Processing (ICIIP), pp. 374–377 (2015). DOI: 10.1109/ICIIP.2015.7414799.
Dutta, K. K. , Bellary, S. A. S. Machine learning techniques for Indian sign language recognition. In: International Conference on Current Trends in Computer, Electrical, Electronics and Communication (CTCEEC), pp. 333–336 (2017). DOI: 10.1109/CTCEEC.2017.8454988.
Grif, M. , Manueva, Y. Semantic analyses of text to translate to Russian sign language. In: 11th International Forum on Strategic Technology (IFOST), pp. 286–289 (2016). DOI: 10.1109/IFOST.2016.7884107.
Gupta, B. , Shukla, P. , Mittal, A. K-nearest correlated neighbor classification for Indian sign language gesture recognition using feature fusion. In: International Conference on Computer Communication and Informatics (ICCCI), pp. 1–5 (2016). DOI: 10.1109/ICCCI.2016.7479951.
Lin, X. , Yang, J. , Zhao, J. The text analysis and processing of Thai language text to speech conversion system. In: The 9th International Symposium on Chinese Spoken Language Processing, pp. 436–436 (2014). DOI: 10.1109/ISCSLP.2014.6936630.
Sai, V. S. V. , Champawat, Y. S. , Tripathy, B. K. Recommendation system based on text analysis. International Journal of Innovative Technology and Exploring Engineering (IJITEE), 8(9), 2351–2354 (2019).
Patel, U. , Ambekar, A. G. Moment based sign language recognition for Indian languages. In: International Conference on Computing, Communication, Control and Automation (ICCUBEA), pp. 1–6 (2017). DOI: 10.1109/ICCUBEA.2017.8463901.
Santa, U. , Tazreen, F. , Chowdhury, S. A. Bangladeshi hand sign language recognition from video. In: 20th International Conference of Computer and Information Technology (ICCIT), pp. 1–4 (2017). DOI: 10.1109/ICCITECHN.2017.8281818.
Sengupta, A. , Mallick, T. , Das, A. A cost effective design and implementation of arduino based sign language interpreter. In: IEEE 2019 Devices for Integrated Circuit (DevIC), pp. 12–15 (2019). DOI: 10.1109/DEVIC.2019.8783574.
Gunawan, H. , Thiracitta, N. , Nugroho, A. Sign language recognition using modified convolutional neural network model. In: Indonesian Association for Pattern Recognition International Conference (INAPR), pp. 1–5 (2018). DOI: 10.1109/INAPR.2018.8627014.
Golani, N. , Khandelwal, I. , Tripathy, B.K. Hybrid intelligent techniques in text mining and analysis of social networks and media data, Chapter-1. In: Banati, H. , Bhattacharyya, S. , Mani, A. , Köppen, M. (eds.) Hybrid Intelligence for Social Networks, pp. 1–24. Springer, Cham (2017).
Këpuska, V. , Bohouta, G. Comparing speech recognition systems (Microsoft API, Google API and CMU Sphinx). International Journal of Engineering Research and Application, 7(3), 20–24 (2017).
Google Cloud Speech to Text Website. https://cloud.google.com/speech-to-text, last accessed 2021/09/24 .

# Fragile medical image watermarking using auto-generated adaptive key-based encryption


Singh, A. K. , Kumar, B. , Singh, G. , and Mohan, A. (2017) Medical image watermarking techniques and applications. Multimedia Systems and Applications. Springer. DOI: 10.1007/978-3-319-57699-2.

Singh, A. K. , Sharma, N. , Dave, M. , and Mohan, A. (2012) A novel technique for digital image watermarking in spatial domain. 2012 2nd IEEE International Conference on Parallel, Distributed and Grid Computing, Waknaghat, pp. 497–501.

Sinha Roy, S. , Basu, A. , and Chattopadhyay, A. (2021) Secured diabetic retinopathy detection through hard exudates. In: Pan I. , Mukherjee A. , Piuri V. (eds.) Proceedings of Research and Applications in Artificial Intelligence. Advances in Intelligent Systems and Computing, vol. 1355, pp. 213–221. Springer, Singapore.

Liu, J. , Li, J. , Ma, J. , Naveed Sadiq, U.A.B. , and Yang, A. (2019) A robust multi-watermarking algorithm for medical images based on DTCWT-DCT and Henon map. Appl. Sci. 9(4): 1–23.

Kahlessenane, F. , Khaldi, A. , Kafi, R. , et al. (2021) A DWT based watermarking approach for medical image protection. J. Ambient Intell. Human Comput. 12: 2931–2938.

Kahlessenane, F. , Khaldi, A. , Kafi, R. , et al. (2021) A robust blind medical image watermarking approach for telemedicine applications. Cluster Comput. 24: 2069–2082.

Elbasi, E. and Kaya, V. (2018) Robust medical image watermarking using frequency domain and least significant bits algorithms. 2018 International Conference on Computing Sciences and Engineering (ICCSE), Kuwit, pp. 1–5.

Kavitha, V. , Palanisamy, C. , and Sureshkumar, T. (2020) perceptual masking based medical image watermarking using DTCWT and HVS. J. Crit. Rev. 7(2): 561–567.

Thakur, S. , Singh, A.K. , Kumar, B. , and Ghrera, S.P. (2020) Improved DWT-SVD-based medical image watermarking through hamming code and chaotic encryption. In: Dutta D. , Kar H. , Kumar C. , Bhadauria V. (eds.) Advances in VLSI, Communication, and Signal Processing. Lecture Notes in Electrical Engineering, vol. 587, pp. 897–906. Springer, Singapore.

Terzija, N. , Repges, M. , Luck, K. , and Geisselhardt, W. (2002) Digital image watermarking using discrete wavelet transform: Performance comparison of error correcting codes. In: J.J. Villanueva (ed.) Visualization, Imaging, and Image Processing. Acta Press, Marbella.

Priya, S. and Santhi, B. (2019) A novel visual medical image encryption for secure transmission of authenticated watermarked medical images. Mobile Networks Appl. 26: 2501–2508

Nayak, M.R. , Tudu, B. , Basu, A. , and Sarkar, S.K. (2015) On the implementation of a secured digital watermarking framework. Inf. Secur. J. A Glob. Perspect. 24(4–6): 118–126.

Nagm, A. and Safy Elwan, M. (2021) Protection of the patient data against intentional attacks using a hybrid robust watermarking code. Peer J Comput. Sci. 7: e400.

Madhu, B. and Holi, G (2021) CNN approach for medical image authentication. Indian J. Sci. Technol. 14(4): 351–360.

Phan, T.H.D. , Bui, V.H. , Nguyen, T.A. , and Hoang, T.M. (2020) A novel watermarking scheme based on the curvelet transformation method for medical images. 2020 7th NAFOSTED Conference on Information and Computer Science (NICS), Hochiminh, pp. 379–383.

Nawaz, S.A. , Li, J. , Liu, J. , Bhatti, U.A. , Zhou, J. , and Ahmad, R.M. (2020) A feature-based hybrid medical image watermarking algorithm based on SURF-DCT. In: Liu, Y. , Wang, L. , Zhao, L. , Yu, Z. (eds.) Advances in Natural Computation, Fuzzy Systems and Knowledge Discovery. ICNC-FSKD 2019. Advances in Intelligent Systems and Computing, vol. 1075, pp. 1080–1090. Springer, Cham.

Sinha Roy, S. , Basu, A. , and Chattopadhyay, A. (2019) Intelligent Copyright Protection for Images, 1st ed., CRC, Taylor and Francis, New York, NY.

Kutter, M. and Petitcolas, F.A.P. (1999) A fair benchmark for image watermarking systems. In: P. W. Wong and E. J. Delp III (eds.) Electronic Imaging ’99, Security and Watermarking of Multimedia Contents, vol. 3657, pp. 226–239. SPIE, San Jose, CA.

Alshanbari, H.S. (2021) Medical image watermarking for ownership & tamper detection. Multimed. Tools Appl. 80: 16549–16564.

Gull, S. , Loan, N.A. , Parah, S.A. et al. (2020) An efficient watermarking technique for tamper detection and localization of medical images. J. Ambient Intell. Human Comput. 11: 1799–1808.
Singh, A.K. (2019) Robust and distortion control dual watermarking in LWT domain using DCT and error correction code for color medical image. Multimed. Tools Appl. 78: 30523–30533.

## Designing of a solution model for global warming and climate change using machine learning and data engineering techniques

Cheshmehzangi, A. (2020) 'The analysis of global warming patterns from 1970s to 2010s', Atmospheric and Climate Sciences. doi: 10.4236/acs.2020.103022.
Hansen, J. , et al. (2006) 'Global temperature change',Proceedings of the National Academy of Sciences of the United States of America. doi: 10.1073/pnas.0606291103.
Intergovernmental Panel on Climate Change . (2007) Climate Change 2007 - The Physical Science Basis: Working Group I Contribution to the Fourth Assessment Report of the IPCC. Science.
Cheshmehzangi, A. and Dawodu, A. (2018) Sustainable Urban Development in the Age of Climate Change: People: The Cure or Curse. doi: 10.1007/978-981-13-1388-2.
Biskaborn, B. K. , et al. (2019) 'Permafrost is warming at a global scale', Nature Communications. doi: 10.1038/s41467-018-08240-4.
Kadam, M. , Kanoo, N. and Zheng, Y. (2017) 'Climate change: Relationships to CO2 emission and locations', in RIIT 2017- Proceedings of the 6th Annual Conference on Research in Information Technology. doi: 10.1145/3125649.3125-654.
Christensen, T. H. , et al. (2009) 'C balance, carbon dioxide emissions and global warming potentials in LCA-modelling of waste management systems', Waste Management and Research. doi: 10.1177/0734242X08096304.
Gentil, E. , Christensen, T. H. and Aoustin, E. (2009) 'Greenhouse gas accounting and waste management', Waste Management and Research. doi: 10.1177/0734242X09346702.
Paul, P. , et al. (2020) 'Environmental informatics vis-à-vis big data analytics: The geo-spatial & sustainable solutions', SSRN Electronic Journal. doi: 10.2139/ssrn.3670083.
Yang, C. , et al. (2019) 'Big earth data analytics: A survey', Big Earth Data. doi: 10.1080/20964471.2019.1611175.
Letrache, K. , El Beggar, O. and Ramdani, M. (2018) 'Green data warehouse design and exploitation', in ACM International Conference Proceeding Series. doi: 10.1145/3289402.3289529.
Kimball, R. , et al. (2008) The Data Warehouse Lifecycle Toolkit, Wiley.
Yener, F. and Yazgan, H. R. (2019) 'Optimal warehouse design: Literature review and case study application', Computers and Industrial Engineering. doi: 10.1016/j.cie.2019.01.006.
Herden, O. (2015) 'Data Warehouse', in Taschenbuch Datenbanken. doi: 10.3139/9783446440265.014.
Xu, Y. , Ramanathan, V. and Victor, D. G. (2018) 'Global warming will happen faster than we think', Nature. doi: 10.1038/d41586-018-07586-5.
Wang, C. , Zhang, Q. and Zhang, W. (2020) 'Corporate social responsibility, green supply chain management and firm performance: The moderating role of big-data analytics capability', Research in Transportation Business and Management. doi: 10.1016/j.rtbm.2020.100557.
Skytt, T. , Nielsen, S. N. and Jonsson, B. G. (2020) 'Global warming potential and absolute global temperature change potential from carbon dioxide and methane fluxes as indicators of regional sustainability – A case study of Jämtland, Sweden', Ecological Indicators. doi: 10.1016/j.ecolind.2019.105831.
Lotfalipour, M. R. , Falahi, M. A. and Bastam, M. (2013) 'Prediction of CO2 emissions in Iran using grey and ARIMA models', International Journal of Energy Economics and Policy, 3(3): 229–237.
Doreswamy, G. I. and Manjunatha, B. R. (2017) 'Hybrid data warehouse model for climate big data analysis', in Proceedings of IEEE International Conference on Circuit, Power and Computing Technologies, ICCPCT, 2017. doi: 10.1109/ICCPCT.2017.8074229.

Hassani, H. , Huang, X. and Silva, A. E. (2019) ‘Big data and climate change’, Big Data and Cognitive Computing. doi: 10.3390/bdcc3010012.
Hyndman, R. J. and Fan, S. (2010) ‘Density forecasting for long-term peak electricity demand’, IEEE Transactions on Power Systems. doi: 10.1109/TPWRS.2009.2036017.

## Human age estimation using sit-to-stand exercise data-driven decision-making by neural network

Brito L.B. , Ricardo D.R. , Araújo D.S. , Ramos P.S. , Myers J. , Araújo C.G. , Ability to sit and rise from the floor as a predictor of all-cause mortality. Eur J Prev Cardiol 21(7): 892–898 (2014).
Zhavoronkov A. , Mamoshina P. , Vanhaelen Q. , Scheibye-Knudsen M. , Moskalev A. , Aliper A. , Artificial intelligence for aging and longevity research: Recent advances and perspectives. Ageing Res Rev 49: 49–66 (2019). ISSN 1568-1637.
Pyrkov T.V. , Slipensky K. , Barg M. , et al., Extracting biological age from biomedical data via deep learning: too much of a good thing? Sci Rep 8: 5210 (2018).
Sahoo P.K. , Mohapatra S.K. , Wu S. Analyzing healthcare big data with prediction for future health condition. IEEE Access 4: 9786–9799 (2016).
Luo J. , Liu C. , Yang C. Estimation of EMG-based force using a neural-network-based approach. IEEE Access 7: 64856–64865 (2019).
Moore J.H. , Raghavachari N. Artificial intelligence based approaches to identify molecular determinants of exceptional health and life span-an interdisciplinary workshop at the national institute on aging. Front Artif Intell 2: 12 (2019).
Thomas R. , Michael P. , Michael B. , Barnes P. Life expectancy for people with disabilities. Neurorehabilitation 27(2): 201–209 (2010).
Pollock R.D. , Carter S. , Velloso C.P. , Duggal N.A. , Lord J.M. , Lazarus N.R. , Harridge S.D. An investigation into the relationship between age and physiological function in highly active older adults. J Physiol 593(3): 657–680 (2015).
Jin J. , Jin K.J. , Adibi K.S. , Adibi S. Systematic Predictive Analysis of Personalized Life Expectancy Using Smart Devices, Technologies. MDPI, Switzerland (2018).
Zhavoronko A. , Li R. , Ma C. , Mamoshina P. Deep biomarkers of aging and longevity: From research to applications. Aging 11(22): 10771–10780 (2019).
Rezaeian A. , Rezaeian M. , Khatami S.F. et al. Prediction of mortality of premature neonates using neural network and logistic regression. J Ambient Intell Human Comput 21: 1–14 (2020).
Kim J.C. , Chung K. Neural-network based adaptive context prediction model for ambient intelligence. J Ambient Intell Human Comput 11: 1451–1458 (2020).
De D. , Mukherjee A. , Sau A. , Bhakta I. Design of smart neonatal health monitoring system using SMCC. Healthcare Technol Lett 4(1): 13–19 (2017).
Banerjee A. , Chakraborty C. , Kumar A. , Biswas D. Chapter 5: Emerging trends in IoT and big data analytics for biomedical and health care technologies. In: Valentina Emilia Balas , Vijender Kumar Solanki , Raghvendra Kumar , Manju Khari (eds.), Handbook of Data Science Approaches for Biomedical Engineering. Academic Press, Cambridge, MA, 121–152 (2020). ISBN 9780128183182.
Lai D. , Chen Y. , Luo X. , et al. Age estimation with dynamic age range. Multimedia Tools Appl 76: 6551–6573 (2017).
Li X. , Makihara Y. , Xu C. , et al. Gait-based human age estimation using age group-dependent manifold learning and regression. Multimedia Tools Appl 77: 28333–28354 (2018).
Xia L. , Yang J. , Han T. , et al. A mobilized automatic human body measure system using neural network. Multimedia Tools Appl 78: 11291–11311 (2019).
Yao L. , Yang W. , Huang W. A fall detection method based on a joint motion map using double convolutional neural networks. Multimedia Tools Appl 81(4): 4551–4568 (2022). https://doi.org/10.1007/s11042-020-09181-1
Guo G. , Guowang M. , Fu Y. , Huang T.S. Human age estimation using bio-inspired features. 2009 IEEE Conference on Computer Vision and Pattern Recognition, Miami, FL, pp. 112–119 (2009).

Ashiqur R.S. Quantifying human biological age: A machine learning approach. Graduate Theses, Dissertations, and Problem Reports. 7376, West Virginia University (2019).
Nguyen D.T. , Cho S.R. , Shin K.Y. , Bang J.W. , Park K.R. Comparative study of human age estimation with or without preclassification of gender and facial expression. Sci World J 2014: 15 (2014).
Li X. , Makihara Y. , Xu C. , et al. Gait-based human age estimation using age group-dependent manifold learning and regression. Multimed Tools Appl 77: 28333–28354 (2018).
Cao D. , Lei Z. , Zhang Z. , Feng J. , Li S.Z. Human Age Estimation Using Ranking SVM. HoHai University, Center for Biometrics and Security Research & National Laboratory of Pattern Recognition, Institute of Automation, Chinese Academy of Sciences, China Research and Development Centre for Internet of Thing. 7th Chinese Conference, CCBR 2012, Guangzhou (2012).

## Feature-based suicide-ideation detection from Twitter data using machine learning techniques

World Health Organization . One in 100 deaths is by suicide, https://www.who.int/news/item/17-06-2021-one-in-100-deaths-is-by-suicide, last accessed 2021/10/18 .
Dholariya, P. Suicidal tendency in youth in relation to their gender (2017). doi: 10.13140/RG.2.2.23058.35523.
Pandey, A.R. , Bista, B. , Dhungana, R.R. , Aryal, K.K. , Chalise, B. , Dhimal, M. Factors associated with suicidal ideation and suicidal attempts among adolescent students in Nepal: Findings from global school-based students health survey. PLoS ONE 14(4): e0210383 (2019). doi: 10.1371/journal.pone.0210383.
Nock, M.K. , Borges, G. , Bromet, E.J. , Cha, C.B. , Kessler, R.C. , Lee, S. Suicide and suicidal behavior. Epidemiologic Reviews 30(10): 133–154 (2008). doi: 10.1093/epirev/mxn002.
Bilsen, J. Suicide and youth: Risk factors, 9: 540 (2018). doi: 10.3389/fpsyt.2018.00540. PMID: 30425663; PMCID: PMC6218408.
Klonsky, E.D. , May, A.M. , Saffer, B.Y. Suicide attempts, and suicidal ideation. Annu Rev Clin Psychol 12: 307–330 (2016). doi: 10.1146/annurev-clinpsy-021815-093204. Epub. PMID: 26772209.
Fernandes, A. , Dutta, R. , Velupillai, S. Identifying suicide ideation and suicidal attempts in a psychiatric clinical research database using natural language processing. Sci Rep 8: 7426 (2018). doi: 10.1038/s41598-018-25773-2.
Nock, M.K. , Borges, G. , Bromet, E.J. , Cha, C.B. , Kessler, R.C. , Sing, L. Suicide and suicidal behavior. Epidemiologic Reviews 30: 133–154 (2018). doi: 10.1093/epirev/mxn002.
Ji, S. , Pan, S. , Li, X. , Cambria, E. , Long, G. , Huang, Z. Suicidal ideation detection: A review of machine learning methods and applications. IEEE Transactions on Computational Social Systems 8(1): 214–226 (2020).
Cook, B.L. , Progovac, A.M. , Chen, P. , Mullin, B. , Hou, S. , Baca-Garcia, E. Novel use of natural language processing (NLP) to predict suicidal ideation and psychiatric symptoms in a text-based mental health intervention in Madrid. Computational and Mathematical Methods in Medicine 2016: 8708434 (2016). PMID: 27752278; PMCID: PMC5056245.
Mbarek, A. , Jamoussi, S. , Charfi, A. , Hamadou, A.B. Suicidal profiles detection in twitter. 289–296 (2019). doi: 10.5220/0008167602890296.
Ji, S. , Yu, C.P. , Fung, S. , Pan, S. , Long, G. Supervised learning for suicidal ideation detection in online user content. Complexity 1–10. doi: 10.1155/2018/6157249 (2018).
Ramírez-Cifuentes, D. , Freire, A. , Baeza-Yates, R. , Puntí, J. , Medina-Bravo P. , Velazquez D.A. , Gonfaus, J.M. , Gonzàlez, J. Detection of suicidal ideation on social media: Multimodal, relational, and behavioral analysis. Journal of Medical Internet Research 22(7): e17758 (2020). doi: 10.2196/17758.
O'Dea, B. , Batterham, P.J. , Calear, A.L. , Paris, C. , Chsistensen, H. Detecting suicidality on twitter. Internet Interventions 2(2): 183–188 (2015).
Shen, G. , Jia, J. , Nie, L. , Feng, F. , Zhang, C. , Hu, T. , Chua, T. , S., Zhu, W. Depression detection via harvesting social media: A multimodal dictionary learning solution. Proceedings of the Twenty-Sixth International Joint Conference on Artificial Intelligence (IJCAI-17), Melbourne,

(2017).
Kumar, A. , Sharma, A. , Arora, A. Anxious depression prediction in real-time social data. Proceeding of International Conference on Advanced Engineering, Science, Management and Technology – 2019 (ICAESMT19), Dehradun (2019).
Lora, S.K. , Sakib, N. , Antora, S.A. , Jahan, N. A comparative study to detect emotions from tweets analyzing machine learning and deep learning techniques. International Journal of Applied Information Systems 12(30): 6–12 (2020).
Rao, T.S.M. , Kompalli, V.S. , kompalli, U. A model to detect social network mental disorders using AI techniques. Journal of Critical Reviews 7(15): 2582–2587 (2020). ISSN-2394-5125.
Chatterjee, M. , Samanta, P. , Kumar, P. , Sarkar, D. Suicide ideation detection using multiple feature analysis from twitter data. 2022 IEEE Delhi Section Conference (DELCON) (pp. 1–6). New Delhi, IEEE (2022).
Kumar, P. , Samanta, P. , Dutta, S. , Chatterjee, M. , Sarkar, D. Feature based depression detection from twitter data using machine learning techniques. Journal of Scientific Research 66(2), 220–228 (2022).

## Analyzing the role of Indian media during the second wave of COVID using topic modeling

Ahlers, D. , (2006), News consumption and the new electronic media, The International Journal of Press/Politics, 11(1), 29–52, doi: 10.1177/1081180X05284317.
Amara, A. , Hadj Taieb, M.A. & Ben Aouicha, M. , (2021), Multilingual topic modeling for tracking COVID-19 trends based on Facebook data analysis. Applied Intelligence, 51, 3052–3073, doi: 10.1007/s10489-020-02033-3.
Aladia, L.L.M. , (2017). Role of legislature and judiciary in present Indian scenario, Journal of Emerging Technologies and Innovative Research, 4(1), 681–686.
Blei, D.M. , Ng, A. , & Jordan, M. , (2003), Latent dirichlet allocation, Journal of Machine Learning Research, 3, 993–1022.
Ghasiya, P. , & Okamura, K. , (2021), Investigating COVID-19 News Across Four Nations A Topic Modeling and Sentiment Analysis Approach, IEEE Access, Australia
Jang, H. , Rempel, E. , Roth, D. , Carenini, G. , & Janjua, N.Z. , (2021), Tracking COVID-19 discourse on twitter in North America infodemiology study using topic modeling and aspect-based sentiment analysis, Journal of Medical Internet Research, 23(2), 1–12.
Kumar, P. , & Singh, K. , (2019), Media, the fourth pillar of democracy a critical analysis,International Journal of Research and Analytical Reviews, 6(1).
Liu, Q. , Zheng, Z. , Zheng, J. , Chen, Q. , Liu, G. , Chen, S. , Chu, B. , Zhu, H. , Akinwunmi, B. , Huang, J. , Zhang, C.J.P. , & Ming, W. , (2020), Health communication through news media during the early stage of the covid-19 outbreak in china digital topic modeling approach, Journal of Medical Internet Research, 22(4), doi: 10.2196/19118.
Mudgal, R. , & Rana, P. , (2020), Future of print and e-newspaper in India a critique, International Journal of Multidisciplinary Research, 6(5).
NetDesk ., (2021), Coronavirus Updates. Hindu, May 2021. Accessed in July 2021 .
Ng, R. , Chow, T.Y.J. , & Yang, W. , (2021), News media narratives of COvid-19 across 20 countries early global convergence and later regional divergence, PLOS ONE, doi: 10.1371/journal.pone.0256358.
Panda, K.C. , & Swain, D. , (2011), E-newspapers and e-news services in the electronic age an appraisal,Annals of Library and Information Studies, 58, 55–62.
Patel, J. , Desai, H. , & Okhowat, A. , (2021), The role of the Canadian media during the initial response to the COVID-19 pandemic a topic modelling approach using Canadian broadcasting corporation news articles, JMIR Infodemiology, 1(1).
Ranjan, R. , Sharma, A. , & Verma, M.K. , (2021), Characterization of the second wave of COVID-19 in India, medRxiv, doi: 10.1101/2021.04.17.21255665.
Song, X. , Petrak, J. , Jiang Y. , Singh, I. , Maynard, D. , & Bontcheva, K. , (2021), Classification aware neural topic model for COVID-19 disinformation categorisation, PLOS ONE, doi:10.1371/journal.pone.0247086.

Wan, X. , Lucic, M.C. , Ghazzai, H. , & Massoud, Y. , (2021), Topic modeling and progression of American digital news media during the onset of the COVID-19 pandemic, IEEE Transactions on Technology and Society, doi: 10.1109/TTS.2021.3088800.

## Hardware-efficient FIR filter design using fast converging flower pollination algorithm – a case study of denoising PCG Signal

Aggarwal D. , Reddy K. S. & Sahoo S. K. (2013). FIR filter design approach for reduced hardware with order optimization and coefficient quantization. 2013 International Conference on Intelligent Systems and Signal Processing (ISSP), Gujrat, India.

Ausmed . (2018). Retreived from https://www.ausmed.com/articles/heart-murmur-sounds/ (last accessed on 27th July 2022 ).

Chandra A. & Chattopadhyay S. (2012). Role of mutation strategies of differential evolution algorithm in designing hardware efficient multiplier-less low-pass FIR filter. Journal of Multimedia, 7: 353–363.

Das P. , Naskar S. K. & Patra S. N. (2018). Hardware effiecient fir filter using global best steered quantum inspired cuckoo search algorithm. Applied Soft Computing, 71: 1–19.

Dhabal S. & Sengupta S. (2015). Efficient design of high pass FIR filter using quantum-behaved particle swarm optimization with weighted mean best position. Third International Conference on Computer, Communication, Control and Information Technology, Hooghly, IEEE, pp. 1–6.

Ganguly A. & Sharma M. (2017). Detection of pathological heart murmurs by feature extraction of phonocardiogram signals. Journal of Applied and Advanced Research, 2: 200–205.

Gold B. & Jordan K. (1969). A direct search procedure for designing finite duration impulse response filters. Transaction on Audio and Electroacoustics, 17: 33–36.

Hamza Cherif L. , Mostafi M. & Debbal S. M. (2014). Digital filters in heart sound analysis. International Journal of Clinical Medicine Research, 1(3): 97–108.

Harris, F. J. (1978). On the use of windows for harmonic analysis with the discrete fourier transform. Proceedings of the IEEE, 66(1): 51–83.

Kaiser, J. F. (1966). Digital filters. In Kuo, F. F. & Kaiser, J. F. (eds.), System Analysis by Digital Computer, chap. 7. New York, Wiley.

Karaboga N. & Cetinkaya B. (2006). Design of digital FIR filters using differential evolution algorithm. Circuits Systems Signal Processing, 25: 649–660.

McClellan J. H. & Parks T. W. (1973). A unified approach to tf»e design of optimum FIR linear phase digital filters. Transaction on Circuit Theory, 20: 697–701.

Mitra S. K. (2013). Digital Signal Processing - A Computer Based Approach (3rd ed.). Mc Graw Hill, India.

Reddy K. S. & Sahoo S. K. (2015). An approach for FIR filter coefficient optimization using differential evolution algorithm. International Journal of Electronics and Communications, 69, 101–108.

Reddy S. K. (2015). High performance VLSI architecture for digital FIR filter design. Birla Institute of Technology & Science, Electrical & Electronics Engineering, Pilani.

Sasahara T. & Suyama K. (2015). An ACO approach for design of CSD coefficient FIR filters. Asia-Pacific Signal and Information Processing Association Annual Summit and Conference (APSIPA), Hong Kong, IEEE, pp. 463–468.

Sharma S. (2009). Theory and Design of Finite Impulse Response (FIR) Filters in Digital Signal Processing (with Matlab Programs) (5th ed.). India: KATSON.

Singh T. , Josan H. S. (2014). Design of low pass digital FIR filter using cuckoo search algorithm. International Journal of Engineering Research and Applications, 4: 72–77.

Solank S. (2012). Design FIR filter with signed power of two terms using MATLAB. International Journal of Engineering & Technology 1: 1–6.

Thapar S. , Kaur P. & Aggarwal N. (2012). A low pass FIR filter design using genetic algorithm based artificial neural network. International Journal of Computer Technology and Electronics Engineering, 2: 99–103.

Tsutsumi S. & Suyama K. (2014). Design of FIR filters with discrete coefficients using ant colony optimization. Electronics and Communications in Japan, 132(7): 1066–1071.

Yang X-S . (2008). Nature Inspired Meta-Heuristics Algorithm. UK: Luniver Press.
Yang X-S . (2010). A New Metaheuristic Bat-Inspired Algorithm, https://arxiv.org/pdf/1004.4170.pdf (last accessed on 20 April 2018 ).
Yang X.-S. (2013). Flower Pollination Algorithm for Global Optimization, https://arxiv.org/pdf/1312.5673.pdf (last accessed on 22 April 2018 ).
Yang X-S . (2014). Nature Inspired Optimization Algorithms (1st ed.). London: Elsevier Insghits.
Yang X-S . (2011). Metaheuristic optimization: Algorithm analysis and open problems. In Pardalos, P. M. & Rebennack, S. (eds.). Experimental Algorithms. SEA 2011, Lecture Notes in Computer Science, Springer, Berlin, Heidelberg, vol. 6630, pp. 21–32.
Yang X-S. & Deb S. (2009). Cuckoo search via lévy flights. World Congress on Nature & Biologically Inspired Computing, Coimbatore, IEEE, pp. 210–214.
Yang X-S. , & Deb S. (2010). Engineering optimization by cuckoo search. International Journal of Mathematical Modeling and Numerical Optimization, 1(4): 330–343.

## Voice recognition system using deep learning

Chung, J. S. , Zisserman, A. Lip reading in the wild. In: Asian Conference on Computer Vision, pp.87–103, Springer, Cham (2016).
Tripathy, B. K. , Anuradha, J. Soft Computing- Advances and Applications. Cengage Learning publications, New Delhi (2015).
Bhattacharyya, S. , Snasel, V. , Hassanian, A. E. , Saha, S. , Tripathy, B. K. Deep Learning Research with Engineering Applications. De Gruyter Publications, Berlin (2020).
Adate, A. , Tripathy, B. K. , Arya, D. , Shaha, A. : Impact of deep neural learning on artificial intelligence research. In: S. Bhattacharyya , A. E. Hassanian , S. Saha and B. K. Tripathy (Eds.), Deep Learning Research and Applications. De Gruyter Publications, Berlin, pp.69–84 (2020).
Adate, A. , Tripathy, B. K. A survey on deep learning methodologies of recent applications. In: D.P. Acharjya , A. Mitra , and N. Zaman (Eds.), Deep Learning in Data Analytics- Recent Techniques, Practices and Applications, Springer Publications, Switzerland AG, pp.145–170 (2021). DOI: 10.1007/978-3-030-75855-4
Adate, A. , Tripathy, B. K. Deep learning techniques for image processing. In S. Bhattacharyya , H. Bhaumik , A. Mukherjee and S. De (Eds.), Machine Learning for Big Data Analysis, De Gruyter, Berlin, Boston, pp.69–90 (2018).
Bose, A. , Tripathy, B. K. Deep learning for audio signal classification. In: S. Bhattacharyya , A. E. Hassanian , S. Saha and B. K. Tripathy (Eds.), Deep Learning Research and Applications, De Gruyter Publications, Berlin, pp.105–136 (2020).
Kaul, D. , Raju, H. , Tripathy, B. K. Deep learning in healthcare. In: D.P. Acharjya , A. Mitra and N. Zaman (Eds.), Deep Learning in Data Analytics- Recent Techniques, Practices and Applications, Springer Publications, Switzerland, pp.97–115 (2021).
Maheswari, K. , Shaha, A. , Arya, D. , Tripathy, B. K. , Rajkumar, R. Convolutional neural networks: A bottom-up approach. In: S. Bhattacharyya , A. E. Hassanian , S. Saha and B. K. Tripathy (Eds.), Deep Learning Research with Engineering Applications, De Gruyter Publications, Berlin, pp.21–50 (2020).
Tripathy, B. K. , Baktha, K. Investigation of recurrent neural networks in the field of sentiment analysis. In: The Proceedings of IEEE International Conference on Communication and Signal Processing (ICCSP17), pp. 2047–2050, IEEE, Melmaruvathur (2017).
Adate, A. , Tripathy, B. K. Understanding single image super-resolution techniques with generative adversarial networks. In: J. Bansal , K. Das , A. Nagar , K. Deep and A. Ojha (Eds.), Soft Computing for Problem Solving, Advances in Intelligent Systems and Computing, vol. 816, pp. 833–840. Springer, Singapore (2017). DOI: 10.1007/978-981-13-1592-3_66.
Debgupta, R. , Chaudhuri, B.B. , Tripathy, B.K. A wide resnet-based approach for age and gender estimation in face images. In: A. Khanna , D. Gupta , S. Bhattacharyya , V. Snasel , J. Platos and A. Hassanien (Eds.), International Conference on Innovative Computing and Communications, Advances in Intelligent Systems and Computing, vol. 1087, pp. 517–530, Springer, Singapore (2020). DOI: 10.1007/978-981-15-1286-5_44.

Tripathy, B. K. , Parikh, S. , Ajay, P. , Magapu, C. Brain MRI segmentation techniques based on CNN and its variants, (Chapter-10). In: J. Chakki (Ed.), Brain Tumor MRI Image Segmentation Using Deep Learning Techniques, Elsevier publications (2022). DOI: 10.1016/B978-0-323-91171-9.00001-6.
Adate, A. , Tripathy, B. K. S-LSTM-GAN: Shared recurrent neural networks with adversarial training. In: A. Kulkarni , S. Satapathy , T. Kang , and A. Kashan (Eds.), Proceedings of the 2nd International Conference on Data Engineering and Communication Technology. Advances in Intelligent Systems and Computing, Vol. 828, Springer, Singapore, pp.107–115 (2019).
Wand, M. , Koutník, J. , Schmidhuber, J. Lipreading with long short-term memory. In: 2016 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp.6115–6119. IEEE, Shanghai (2016).
Gupta, P. , Bhachawat, S. , Dhyani, K. , Tripathy, B. K. A study of gene characteristics and their applications using deep learning, (Chapter 4). In: S.S. Roy and Y.-H. Taguchi (Eds.), Handbook of Machine Learning Applications for Genomics, Studies in Big Data, vol. 103, (2021). ISBN: 978-981-16-9157-7, 496166_1_En.
Bhardwaj, P. , Guhan, T. , Tripathy, B.K. Computational biology in the lens of CNN, (Chapter 5). In: S.S. Roy and Y.-H. Taguchi (Eds.), Handbook of Machine Learning Applica-tions for Genomics, Studies in Big Data, vol. 103 (2021). ISBN: 978-981-16-9157-7, 496166_1_En.
Afouras, T. , Chung, J. S. , Senior, A. , Vinyals, O. , Zisserman, A. Deep audio-visual speech recognition. IEEE Transactions on Pattern Analysis and Machine Intelligence 44(12), 8717–8727 (2018). DOI: 10.1109/TPAMI.2018.2889052
Afouras, T. , Owens, A. , Chung, J. S. , Zisserman, A. Self-supervised learning of audio-visual objects from video. In: Computer Vision–ECCV 2020: 16th European Conference, Glasgow, UK, August 23–28, 2020, Proceedings, Part XVIII 16, pp.208–224. Springer International Publishing, Glasgow (2020).
Zhou, B. , Khosla, A. , Lapedriza, A. , Oliva, A. , Torralba, A. Learning deep features for discriminative localization. In: Proceedings of The IEEE Conference on Computer Vision and Pattern Recognition, pp.2921–2929. IEEE, Las Vegas, NV (2016).
Petridis, S. , Stafylakis, T. , Ma, P. , Cai, F. , Tzimiropoulos, G. , Pantic, M. End-to-end audiovisual speech recognition. In: 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp.6548–6552. IEEE, Calgary (2018).
Petridis, S. , Li, Z. , Pantic, M. End-to-end visual speech recognition with LSTMs. In: 2017 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp.2592–2596. IEEE, New Orleans, LA (2017).
Bazarevsky, V. , Kartynnik, Y. , Vakunov, A. , Raveendran, K. , Grundmann, M. Blazeface: Sub-millisecond neural face detection on mobile gpus. arXiv preprint arXiv: 1907.05047 (2019).
Chiu, C. C. , Sainath, T. N. , Wu, Y. , Prabhavalkar, R. , Nguyen, P. , Chen, Z. , Kannan, A. , Weiss, R.J. , Rao, K. , Gonina, E. , Jaitly, N. , Li, B. , Chorowski, J. , Bacchiani, M. State-of-the-art speech recognition with sequence-to-sequence models. In: 2018 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp. 4774–4778. IEEE, Calgary (2018).
Alghamdi, N. , Maddock, S. , Marxer, R. , Barker, J. , Brown, G. J. A corpus of audio-visual Lombard speech with frontal and profile views. The Journal of the Acoustical Society of America, 143(6), EL523–EL529 (2018).
Zhang, K. , Zhang, Z. , Li, Z. , Qiao, Y. Joint face detection and alignment using multitask cascaded convolutional networks. IEEE Signal Processing Letters 23(10), 1499–1503 (2016).
Owens, A. , Efros, A. A. Audio-visual scene analysis with self-supervised multisensory features. In: Proceedings of the European Conference on Computer Vision (ECCV), Munich, pp.631–648 (2018).

## Modified Harris Hawk optimization algorithm for multilevel image thresholding

De, S. , Bhattacharyya, S. , Chakraborty, S. Color image segmentation using parallel OptiMUSIG activation function. Applied Soft Computing 12(10), 3228–3236 (2012).

Holland, J. Scientific American. Genetic Algorithms 267, 66–72 (1992).
Bansal, J.C. , Sharma, H. , Jadon, S.S. , Clerc, M. Spider monkey optimization algorithm for numerical optimization. Memetic Computing 6(1), 31–47 (2014).
De, S. , Bhattacharyya, S. , Dutta, P. Efficient grey-level image segmentation using an optimised musig (OptiMUSIG) activation function. International Journal of Parallel, Emergent and Distributed Systems 26(1), 1–39 (2011).
Dey, S. , Bhattacharyya, S. , Maulik, U. New quantum inspired meta-heuristic techniques for multi-level colour image thresholding. Applied Soft Computing 46, 677–702 (2016).
Dey, S. , Bhattacharyya, S. , Maulik, U. Efficient quantum inspired meta-heuristics for multi-level true colour image thresholding. Applied Soft Computing 56, 472–513 (2017).
Dey, S. , De, S. , Deb, A. , Debnath, S. Multilevel image segmentation using modified red deer algorithm pp. 362–368 (2021). https://doi.org/10.1109/Confluence51648.2021.9377112.
De, S. , Dey, S. , Debnath, S. , Deb, A. A new modified red deer algorithm for multi-level image thresholding. 2020 Fifth International Conference on Research in Computational Intelligence and Communication Networks (ICRCICN), India, pp. 105–111 (2020).
Ng, H. Pattern recognition letters. Automatic Thresholding for Defect Detection 27(14), 1644–1649 (2006).
Su, Y. , Dai, Y. , Liu, Y. A Hybrid Parallel Harris Hawks Optimization Algorithm for Reusable Launch Vehicle Reentry Trajectory Optimization with No-Fly Zones (2021). DOI:10.21203/rs.3.rs-554106/v1
Fan, Q. , Chen, Z. , Xia, Z. A novel quasi-reflected harris hawks optimization algorithm for global optimization problems. Soft Computing 24(19), 14825–14843 (2020).
Yıldız, A.R. , Yıldız, B.S. , Sait, S.M. , Bureerat, S. , Pholdee, N. A new hybrid harris hawks-nelder-mead optimization algorithm for solving design and manufacturing problems. Materials Testing 61(8), 735–743 (2019).
Heidari, A.A. , Mirjalili, S. , Faris, H. , Aljarah, I. , Mafarja, M. , Chen, H. Harris hawks optimization: Algorithm and applications. Future Generation Computer Systems 97, 849–872 (2019).
Liao, P.S. , Chen, T.S. , Chung, P.C. A fast algorithm for multilevel thresholding. Journal of Information Science and Engineering 17, 713–727 (2001).
De, S. , Bhattacharyya, S. , Dutta, P. A differential evolution algorithm based automatic determination of optimal number of clusters validated by fuzzy intercluster hostility index. In: 2009 First International Conference on Advanced Computing, Chennai, India, pp. 105–111 (2009).
Public-Domain Test Images for Homeworks and Projects . (2020) https://homepages.cae.wisc.edu/ece533/images/ (accessed September 3, 2020 ).
Yen, J.-C. , Chang, F.-J. , Chang, S. A new criterion for automatic multilevel thresholding. IEEE Transactions on Image Processing 4(3), 370–378 (1995).
Kruskal, W.H. , Wallis, W.A. Use of ranks in one-criterion variance analysis. Journal of the American Statistical Association 47(260), 583–621 (1952).
De, S. , Haque, F. Multilevel image segmentation using modified particle swarm optimization. In: Bhattacharyya, S. , Bhaumik, H. , De, S. , Klepac, G. (eds.) Intelligent Analysis of Multimedia Information, pp. 106–142. IGI Global (2016). DOI: 10.4018/978-1-5225-0498-6
Alabool, H. M. , et al. Harris hawks optimization: A comprehensive review of recent variants and applications. Neural Computing and Applications 33, 8939–8980 (2021).

## An automatic probabilistic framework for detection and segmentation of tumor in brain MRI images

Menze, B. H. , et al. The multimodal brain tumor image segmentation benchmark (BRATS). IEEE Transactions on Medical Imaging 34(10), 1993–2024, 2015.
Kalaiselvi, T , Sriramakrishnan, P. Rapid brain tissue segmentation process by modified FCM algorithm with CUDA enabled GPU machine. International Journal of Imaging Systems and Technology 28(3), 163–174, 2018.

Sharma, A. , Hamarneh, G. Missing MRI pulse sequence synthesis using multi-modal generative adversarial network. IEEE Transactions on Medical Imaging 39(4), 1170–1183, 2020.

Kalaiselvi, T. , Kumarashankar, P. , Sriramakrishnan, P. Three-phase automatic brain tumor diagnosis system using patches based updated run length region growing technique. Journal of Digital Imaging, Society for Imaging Informatics in Medicine, 2019. doi: 10.1007/s10278-019-00276-2.

Pravitasari, A. A. , Qanita, S. F. , Iriawan, N. , Fithriasari, K. , Irhamah , Purnami, S. W. , Ferriastuti, W. MRI-based brain tumor segmentation using Gaussian and hybrid Gaussian mixture model-spatially variant finite mixture model with expectation-maximization algorithm. Malaysian Journal of Mathematical Sciences 14(1), 77–93, 2020.

Song, Y , Ji, Z , Sun, Q. An extension Gaussian mixture model for brain MRI segmentation. 2014 36th Annual International Conference of the IEEE Engineering in Medicine and Biology Society, pp. 4711–4714, 2014. doi: 10.1109/EMBC.2014.6944676.PMID:25571044.

Nguyen, T. Gaussian mixture model based spatial information concept for image segmentation. Electronic Theses and Dissertation 438, 2011. https://scholar.uwindsor.ca/etd/438.

Kumar, N. S. , Satoor, S. , Buck, I. Fast parallel expectation maximization for Gaussian mixture model on GPUs using CUDA. 11th IEEE International Conference on High Performance Computing and Communications, 103–105, 2009. doi: 10.1109/HPCC.2009.45.

Khalil, M , Ayad, H , Adib, A. Performance evaluation of feature extraction techniques in MR-brain image classification system. Procedia Computer Science 127, 218–225, 2018.

Wang, G. , Li, W. , Ourselin, S. , Vercauteren, T. Automatic brain tumor segmentation using cascaded anisotropic convolutional neural networks. In International MICCAI Brain-lesion Workshop, pp. 178–190. Springer, Cham, 2017.

Sriramakrishnan, P , Kalaiselvi, T , Rajeswaran, R. Modified local ternary patterns technique for brain tumour segmentation and volume estimation from MRI multi-sequence scans with GPU CUDA machine. Biocybernetics and Biomedical Engineering 39(2), 470–487, 2019.

Bhima, K. , Jagan, A. Analysis of MRI based brain tumor identification using segmentation technique. 2016 International Conference on Communication and Signal Processing (ICCSP), pp. 2109–2113, Melmaruvathur, 2016. doi: 10.1109/ICCSP.2016.7754551.

Bhima, K. , Jagan, A. An improved method for automatic segmentation and accurate detection of brain tumor in multimodal MRI. International Journal of Image, Graphics and Signal Processing (IJIGSP) 9(5), 1–8, 2017. doi: 10.5815/ijigsp.2017.05.01.

Ryan, P. C. , David, H. Laidlaw: Bilateral Filtering of Multiple Fiber Orientations in Diffusion MRI. Springer-Verlag, 2015. http://link.springer.com/book/10.1007/978-3-319-11182-7.

Bhonsle, D. , Chandra, V. , Sinha, G.R. Medical image denoising using bilateral filter. I.J. Image, Graphics and Signal Processing 6, 36–43, 2012. doi: 10.5815/ijigsp.2012.06.06.

Hassen, O. A. , et al. Nature-inspired level set segmentation model for 3D-MRI brain tumor detection. Computers, Materials & Continua 68(1), 961–981, 2020. doi: 10.32604/cmc.2021.014404.

Menze, B. H. , Jakab, A. , Bauer, S. , et al. The multimodal brain tumor image segmentation benchmark (BRATS). IEEE Transactions on Medical Imaging 34(10), 1993–2024, 2015.

Muir, C. S. , Storm, H. H. , Polednak, A. Brain and other nervous system tumours. Cancer Surveys 19(20), 369–392, 1994.

Bauer, S. , Wiest, R. , Nolte, L. P. , Reyes, M. A survey of MRI-based medical image analysis for brain tumor studies. Physics in Medicine and Biology 58(13), R97–R129, 2013.

Jiang, Y. , Zhao, K. , Xia, K. , et al. A novel distributed multitask fuzzy clustering algorithm for automatic MR brain image segmentation. Journal of Medical Systems 43(5), 118:1–118:9, 2019.

Ranjbarzadeh, R. , Bagherian Kasgari, A. , Jafarzadeh Ghoushchi, S. , et al. Brain tumor segmentation based on deep learning and an attention mechanism using MRI multi-modalities brain images. Scientific Reports 11, 10930, 2021. doi: 10.1038/s41598-021-90428-8.

Tjahyaningtijas, H. P. A. Brain tumor image segmentation in MRI image. IOP Conference Series: Materials Science and Engineering 336, 012012, 2018.

Bakas, S. , Zeng, K. , Sotiras, A. , Rathore, S. , Akbari, H. , Gaonkar, B. , Rozycki, M. , Pati, S. , Davatzikos, C. GLISTRboost: Combining multimodal MRI segmentation, registration, and biophysical tumor growth modeling with gradient boosting machines for glioma segmentation. Lecture Notes in Computer Science 9556, 144–155, 2016. doi: 10.1007/978-3-319-30858-6_13.

Erasa, M. , Meena, K. A phenomenological survey on various types of brain diseases using soft computing techniques. International Journal of Civil Engineering and Technology 8, 1209–1220, 2017.
Nyo, M. , Mebarek-Oudina, F. , Hlaing, S. , Khan, N. Otsu's thresholding technique for MRI image brain tumor segmentation. Multimedia Tools and Applications, 2022. doi: 10.1007/s11042-022-13215-1.
Gordillo, N. , Montseny, E. , Sobrevilla, P. State of the art survey on MRI brain tumor segmentation. Magnetic Resonance Imaging 31(8), 1426–1438, 2013.

## Comparative study of generative adversarial networks for sensor data generation-based remaining useful life classification

J. Thilmany . "Multiphysics: All at once." Mechanical Engineering 132(2), 39–41, 2010. https://doi.org/10.1115/1.2010-Feb-5.
S. Hong , Z. Zhou , E. Zio , and B. Wang . "An adaptive method for health trend prediction of rotating bearings." Digital Signal Processing 35, 117–123, 2014.
Zeqi Zhao , Bin Liang , Xueqian Wang , and Weining Lu . "Remaining useful life prediction of aircraft engine based on degradation pattern learning. Reliability Engineering System Safety 164, 74–83, 2017.
Francesca Calabrese , et al. "Predictive maintenance: A novel framework for a data-driven, semi-supervised, and partially online prognostic health management application in industries." Applied Sciences 11(8), 3380, 2021.
Qi Li , Zhanbao Gao , Diyin Tang , and Baoan Li . "Remaining useful life estimation for deteriorating systems with timevarying operational conditions and condition-specific failure zones." Chinese Journal of Aeronautics 29(3), 662–674, 2016.
A. Saxena and K. Goebel . "Turbofan engine degradation simulation data set." NASA Ames Prognostics Data Repository. NASA Ames Research Center, Moffett Field, CA, 2008. http://ti.arc.nasa.gov/project/prognostic-data-repository.
Biggio, Luca , and Iason Kastanis . "Prognostics and health management of industrial assets: Current progress and road ahead." Frontiers in Artificial Intelligence 3 (2020): 578613.
Jay Lee , Hung-An Kao and Shanhu Yang . "Service innovation and smart analytics for industry 4.0 and big data environment." Procedia Cirp 16, 3–8, 2014.
LeCun, Yann , Bernhard Boser , John Denker , Donnie Henderson , Richard Howard , Wayne Hubbard , and Lawrence Jackel . "Handwritten digit recognition with a back-propagation network." Advances in Neural Information Processing Systems 2 (1989).
Yanming Guo , et al. "Deep learning for visual understanding: A review." Neurocomputing 187, 27–48, 2016.
Amgad Muneer , et al. "Deep-learning based prognosis approach for remaining useful life prediction of turbofan engine." Symmetry 13(10), 1861, 2021.
Sepp Hochreiter and Jürgen Schmidhuber . "Long short-term memory." Neural Computation 9(8), 1735–1780, 1997.
Zheng, Shuai , Kosta Ristovski , Ahmed Farahat , and Chetan Gupta . "Long short-term memory network for remaining useful life estimation." In 2017 IEEE International Conference on Prognostics and Health Management (ICPHM), pp. 88–95. IEEE, 2017.
Yuting Wu , et al. "Remaining useful life estimation of engineered systems using vanilla LSTM neural networks." Neurocomputing 275, 167–179, 2018.
AndréListou Ellefsen , et al. "Remaining useful life predictions for turbofan engine degradation using semi-supervised deep architecture." Reliability Engineering & System Safety 183, 240–251, 2019.
Andre S. Yoon , et al. "Semi-supervised learning with deep generative models for asset failure prediction." arXiv preprint arXiv:1709.00845, 2017.
Goodfellow, Ian , Jean Pouget-Abadie , Mehdi Mirza , Bing Xu , David Warde-Farley , Sherjil Ozair , Aaron Courville , and Yoshua Bengio . "Generative adversarial networks." Communications of the ACM 63, no. 11 (2020): 139–144.
Emily Denton , et al. "Deep generative image models using a laplacian pyramid of adversarial networks." arXiv preprint arXiv:1506.05751, 2015.

Alec Radford , Luke Metz , and Soumith Chintala . “Unsupervised representation learning with deep convolutional generative adversarial networks.” arXiv preprint arXiv:1511.06434, 2015.
Guisheng Hou , et al. “Remaining useful life estimation using deep convolutional generative adversarial networks based on an autoencoder scheme.” Computational Intelligence and Neuroscience 2020, 2020. https://www.hindawi.com/journals/cin/2020/9601389/.
Odena, Augustus , Christopher Olah , and Jonathon Shlens . “Conditional image synthesis with auxiliary classifier gans.” In International conference on machine learning, pp. 2642–2651. PMLR, 2017.
Wu, Lirong , Kejie Huang , and Haibin Shen . “A gan-based tunable image compression system.” In Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision, pp. 2334–2342, 2020.
Hyoung Suk Park , Jineon Baek , SunKyoung You , Jae Kyu Choi , and Jin Keun Seo . “Unpaired image denoising using a generative adversarial network in X-ray CT.” IEEE Access 7, 110414–110425, 2019.
Ledig, Christian , Lucas Theis , Ferenc Huszár , Jose Caballero , Andrew Cunningham , Alejandro Acosta , Andrew Aitken et al. “Photo-realistic single image super-resolution using a generative adversarial network.” In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, pp. 4681–4690, 2017.
Y. Le Cun , B. Boser , J. S. Denker , R. E. Howard , W. Habbard , L. D. Jackel , and D. Henderson . Handwritten Digit Recognition with a Back- Propagation Network, pp. 396–404. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 1990.
Kumar, Gaurav , and Pradeep Kumar Bhatia . “A detailed review of feature extraction in image processing systems.” In 2014 Fourth International Conference on Advanced Computing & Communication Technologies, pp. 5–12. IEEE, 2014.
Jinsung Yoon , Daniel Jarrett , and Mihaela van der Schaar . “Time- series generative adversarial networks.” In H. Wallach , H. Larochelle , A. Beygelzimer , F. d’Alch´ e-Buc , E. Fox , and R. Garnett , editors. Advances in Neural Information Processing Systems, vol. 32. Curran Associates, Inc., 2019.
TensorFlow . Large-scale machine learning on heterogeneous systems, 2015. Software available from tensorflow.org.
E. I. Obilor and E. C. Amadi . “Test for significance of Pearson’s correlation coefficient.” International Journal of Innovative Mathematics, Statistics & Energy Policies 6(1), 11–23, 2018.
K. Song , N. Wang , and H. Wang . “A metric learning-based Univariate time series classification method. Information 11(6), 288, 2020.
Y. Li , H. Chen , and Z. Wu . “Dynamic time warping distance method for similarity test of multipoint ground motion field.” Mathematical Problems in Engineering, 2010.

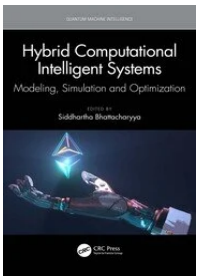
## Toward a framework for implementation of quantum-inspired evolutionary algorithm on noisy intermediate scale quantum devices (IBMQ) for solving knapsack problems

al, H. A. (n.d.). Qiskit. Retrieved July 17, 2022 , from Qiskit: https://qiskit.org/.
Assi, M. & Haraty, R. A. (2018). A survey of the knapsack problem. 2018 International Arab Conference on Information Technology (ACIT), Lebanon, pp. 1–6.
Bowen, J. P. (2016). Alan Turing: Founder of Computer Science. School on Engineering Trustworthy Software Systems. Cham: Springer.
Derrac, J. , Garcíab, S. , Molinac, D. , & Herrera, F. (2011). A practical tutorial on the use of nonparametric statistical tests as a methodology for comparing evolutionary and swarm intelligence algorithms. Swarm and Evolutionary Computation, 1(1), 3–18.
Deutsch, D. (1985). Quantum theory, the church-turing principle and the universal quantum computer. Proceedings of the Royal Society of London, 400(1818), 97–117. Royal Society.
Feynman, R. P. (1986). Quantum mechanical computers. Foundations of Physics, 16(6), 507–532.
Frank Arute, K. A. (2019). Quantum supremacy using a programmable superconducting processor. Nature, 574(7779), 505–510.

Grover, L. K. (1998). Quantum computers can search rapidly by using almost any transformation. Physical Review Letters, 80, 4329–4332.
Han, K. H. & Kim, J. H. (2002). Quantum-inspired evolutionary algorithm for a class of combinatorial optimization. IEEE Transactions on Evolutionary Computation, 6, 580–593.
Karp, R. (1974). Reducibility among combinatorial problems. In R. T. Miller , ed. Complexity of Computer Computations, pp. 85–103. Bostan: Springer.
Kellerer, H. , Pferschy, U. , & Pisinger, D. (2004). Exact solution of the knapsack problem. In Knapsack Problems, pp. 117–160. Amsterdam: Elsevier.
Mani, N. , Srivastava, G. , & Mani, A. (2016). Solving combinatorial optimization problems with quantum inspired evolutionary algorithm tuned using a novel heuristic method. CoRR.
Mani, N. , Srivastava, G. , Sinha, A. K. , & Mani, A. N. (2014). Effect of population structures on quantum-inspired evolutionary algorithm. Applied Computational Intelligence and Soft Computing 2014(24), 24.
Mohtasham, M. B. (2019). Quantum-evolutionary-algorithm-knapsack-python. Retrieved July 17, 2022, from Github: https://github.com/mjBM/Quantum-Evolutionary-Algorithm-Knapsack-Python-.
Narayanan, A. , Moore, M. (1996). Quantum-inspired genetic algorithms. Proceedings of IEEE International Conference on Evolutionary Computation, Nagoya, pp. 61–66.
Onoue, Y. (n.d.). likr/kplib. Retrieved July 17, 2022 , from github: https://github.com/likr/kplib.
Platel, M. D. , Schliebs, S. , & Kasabov, N. (2009). Quantum-inspired evolutionary algorithm: A multimodel EDA. IEEE Transactions on Evolutionary Computation, vol. 13, no. 6, pp. 1218–1232.
Preskill, J. (2018). Quantum computing in the NISQ era and beyond. Quantum 2, 79.
Ross, O. H. (2020). A review of quantum-inspired metaheuristics: Going from classical computers to real quantum computers. IEEE Access 8, 814–838.
Shor, P. W. (1994). Algorithms for quantum computation: Discrete logarithms and factoring. 35th Annual Symposium on Foundations of Computer Science, Santa Fe, pp. 124–134. IEEE.
Soloviev, V. P. & Bielza, C. (2021). Quantum-inspired estimation of distribution algorithm to solve the travelling salesman problem. 2021 IEEE Congress on Evolutionary Computation (CEC), Poland, pp. 416–425.
Vitiello, G. A. (2021). Implementing evolutionary optimization on actual quantum processors. Information Sciences 575, 542–562.
Zubairy, M. S. (2020). Quantum Mechanics for Beginners: With Applications to Quantum Communication and Quantum Computing. London: Oxford University Press.

Hybrid Computational Intelligent Systems (https://www.taylorfrancis.com/books/edit/10.1201/9781003381167/hybrid-computational-intelligent-systems-siddhartha-bhattacharyya) Show Path

Chapter




# An energy-efficient secured Arduino-based home automation using android interface

*By Arghya Dasgupta (/search?contributorName=Arghya Dasgupta&contributorRole=author&redirectFromPDP=true&context=ubx), Souvik Roy (/search?contributorName=Souvik Roy&contributorRole=author&redirectFromPDP=true&context=ubx), Sunetra Mukherjee (/search?contributorName=Sunetra Mukherjee&contributorRole=author&redirectFromPDP=true&context=ubx), Shuvam Kabiraj (/search?contributorName=Shuvam Kabiraj&contributorRole=author&redirectFromPDP=true&context=ubx), Rajib Banerjee (/search?contributorName=Rajib Banerjee&contributorRole=author&redirectFromPDP=true&context=ubx), Pulakesh Roy (/search?contributorName=Pulakesh Roy&contributorRole=author&redirectFromPDP=true&context=ubx), Arindam Biswas (/search?contributorName=Arindam Biswas&contributorRole=author&redirectFromPDP=true&context=ubx)*

Book Hybrid Computational Intelligent Systems (https://www.taylorfrancis.com/books/edit/10.1201/9781003381167/hybrid-computational-intelligent-systems-siddhartha-bhattacharyya)

| | |
|---|---|
| Edition | 1st Edition |
| First Published | 2023 |
| Imprint | CRC Press |
| Pages | 16 |
| eBook ISBN | 9781003381167 |



Previous Chapter (chapters/edit/10.1201/9781003381167-8/automated-medical-report-generation-chest-ray-tripathy-rahul-sai-sharmila-banu?context=ubx)
Next Chapter (chapters/edit/10.1201/9781003381167-10/multithreaded-android-app-notify-available-cowin-vaccination-slots-multiple-recipients-sudipta-saha-saikat-basu-koushik-majumder-debashish-chakravarty?context=ubx)

Journals

Corporate

Help & Contact

Connect with us


(https://www.linkedin.com/company/taylor-&-francis-group/)


(https://twitter.com/tandfnewsroom?lang=en)


(https://www.facebook.com/TaylorandFrancisGroup/)


(https://www.youtube.com/user/Taylorar