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Bio-Inspired Algorithms in Healthcare

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Abstract – Exploring hidden patterns in medical data sets is made possible by the huge potential of medical data mining. A clinical diagnosis can be made with the help of these patterns. Research on bio-inspired algorithms is a recent development. Its primary benefit is its ability to weave together social behavior, emergence, and connectionism subfields. In a nutshell, it involves modeling live phenomena using computers while studying life to make better computer applications. This chapter describes the application of five bio-inspired algorithms, including metaheuristics, to classify seven distinct real health-related information sets. While the other two of these methods rely on random population creation to create classification rules, the other two rely on the computation of similarity between the data used for training and testing. The outcomes demonstrated that bio-inspired supervised medical data classification methods were incredibly effective.

Keywords – orthogonal the local preserving projection, colony, medical the information classification, training data, testing data
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I. INTRODUCTION

These days, cloud computing serves as the backbone of our modern economy by providing cloud clients with on-demand services via the Internet. New technologies, such as big data and Internet of Things (IoT) activities, are emerging (healthcare services, smart cities, etc.) [1], which further requires excellent data processing to process data to increase the performance and efficacy of cloud computing systems. Nevertheless, there are two issues with current big data processing methods that impair computer system performance. These issues include lengthy response times and delays brought on by the repeated movement of data from computers to the cloud and from the cloud to Internet of Things applications. IoT devices currently gather a vast variety and volume of data (known as big data), and the resulting networks are expanding at a rapid pace [2].

Data transfer is utilized in IoT-based smart cities to provide efficient big data and analytics decision-making. After data from connected gadgets on IoT networks is gathered and aggregated, it is processed and stored on cloud servers. Additionally, automatic, highly scalable internet connectivity is required to handle the massive volume of data, which can enhance system performance even more. Research has shown that when short response times as well as latency are required, current cloud-based processing platforms cannot meet the performance requirements of Internet of Things applications. Furthermore, regional data dispersion and communication breakdowns during data transfer are additional causes of a high response time and latency. Raw data from IoT devices is continuously being received by cloud computing platforms, which causes bottlenecks [3]. Thus, a new paradigm that offers a platform between computer systems and Internet of Things devices that processes user data efficiently is bioinspired technique-based big data analytics.

Artificial Neural Networks (ANNs) outperform data mining on every measure, including performance, computational speed, and complexity level [4]. Networks of basic processing components (called "neurons") that use local data and communicate with one another makeup artificial neural networks (ANNs) [5]. Many problems in the real world have been handled with the help of ANN, including predicting future trends using a company's massive data archive. Successful applications of ANN have been made in every branch of engineering, including biology, medicine, health care, manufacturing, marketing, oceanography, and decision science, to name a few [6]. To aid in predicting cardiovascular illness, this research introduces a swarm intelligence approach called particle swarm optimization (PSO) combined with a feed-forward neural network.

As Bonbeau put it, "the emergent collective intelligence of groups of simple agents" [7]. is what we mean when we talk about "swarm intelligence." A swarm consists of many similar, basic agents that interact locally with one another and their surroundings, with no overarching leadership or guidance allowing for intriguing global behavior to arise.

In recent years, a new class of population-based algorithms called swarm-based algorithms has arisen [8]. that can efficiently solve a wide variety of complicated problems with minimal resources and time investment.

Therefore, swarm intelligence (SI) may be characterized as a relatively new branch of AI that is used to represent the collective behavior of social swarms found in nature. Examples of such swarms include ant colonies, honey bee hives, and bird flocks. Individually, these agents (insects or swarm members) are not very clever or capable, but they interact in predictable ways to accomplish tasks that are essential to their survival. Individuals in a swarm may have direct or indirect social interactions with one another [9]. The following is the outline for this paper. Work in this area is discussed in Section 2. In Section 4, we explore the theoretical foundations of our methodology and the theory-driven model we developed to identify dissatisfaction. Section 5 provides a conclusion and summary of this study.

II. RESEARCH METHODOLOGY

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A. Bio-Inspired ICT for Big Data Management in Healthcare

Bio-Inspired ICT for Big Data Management in Healthcare Decisions that affect life and death will in the future depend on having access to increasingly organized and data-rich knowledge. Because this data will transcend conventional scales and dimensions, we will need to consider new approaches, including technological innovations in communication and information. Compile, arrange, and calculate all the information that is necessary for patient survival and healthcare administration. We may connect Big Data and the problems associated with data-intensive computing to the future goal of smart healthcare by adopting a bioinspired method of approaching ICT. **As** shown in Figure 1, Finding correlations and causal relationships between symptoms and patients while also taking connectivity and interpersonal transmission processes into account is made possible by the multifaceted approach to disease and the addition of a social dimension of study [9].

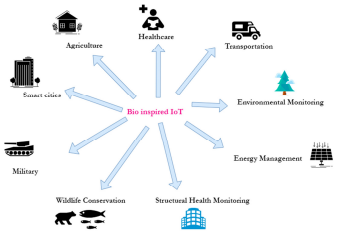

Figure. 1 Bio-inspired IoT applications.

B. Bio-Inspired Algorithms for Medical Data Analysis

Exploring the vast capabilities of mining medical data, the recent advancement in bio-inspired algorithm research has shown promising results in identifying patterns within medical datasets, crucial for clinical diagnosis. This interdisciplinary field merges elements of social behavior, emergent phenomena, and connectionist systems, essentially simulating living processes for enhanced computational applications. In their work, the authors illustrate the application of four distinct bio-inspired algorithms, including metaheuristics, to effectively classify various health-related data sets. Among these methods, two employ random population generation for rule creation, while the remaining focus is on analyzing similarities between test and training data. Their findings affirm the remarkable efficacy of bio-inspired algorithms in the systematic classification of medical data [44].

C. Medical data classification using bio-inspired algorithm

To help doctors with medical diagnosis, the clinical choice support structure (DSS) has become a significant field in the medical sciences in recent years. To increase the quality of DSS in healthcare, health record classifications are predicated on learning from diverse health datasets. This investigation's primary goal is to create a framework for successfully classifying health data. In medical data classification, the application of orthogonal local preservative projection (OLPP) has yielded encouraging results. This software is for high-dimensional data input. The functionality space is then shrunk without sacrificing calculation accuracy using a feature-reduction technique. The classifier that will be employed is an artificial neural network. An optimization algorithm was employed to increase productivity. A neural network employs a biobased optimization technique known as the "deliberately bee colony algorithm." The medical datasets show that the proposed system's current form has an average improvement in classification quality of 15% [18].

D. Bio-Inspired Computing: Algorithms Review, Deep Analysis, and the Scope of Applications.

The term "bio-inspired computing" refers to a broad range of recent computer science, mathematical information, and biology disciplines. A developing method called "bio-inspired computing optimization algorithms" draws inspiration and ideas from the biological evolution of nature to create innovative and resilient competing strategies. bio-inspired optimization methods have gained recognition in machine learning in recent years as the best ways to solve challenging problems in the fields of engineering and science. To identify the best solution, these issues are typically nonlinear and limited to several nonlinear constraints, which present several issues, including high dimensionality and time limitations. Recent trends have tended to utilize bio-inspired optimization algorithms, which offer a potential method for resolving complicated optimization issues, to address the shortcomings of classic optimization algorithms. the state-of-the-art nine recent bio-inspired computational methods, gap analysis, and their applications are presented in this paper. These include the following: The Artificial Algae Section (AAA), Gap Analysis, Chicken Swarm Optimization Method (CSOA), Moth The term flame Optimization (MFO), Fishes Swarm Algorithms (FSA), Cat Swarm Optimizing (the chief social officer), Algorithm (make), Genetic Beech Colony (GBC) Algorithm, Fish a Swarm Algorithm (FSA), Algae Algorithm (ESA), Moth Flame The optimization process (MFO), and the Grey Wolf Optimizing (GWO) Algorithm. The earlier, relevant works are gathered and shown from the Scopus databases. We also discuss several important problems in optimization as well as some uses for further study. We also examine in-depth talks on the fundamentals of these algorithms, their relationships to self-organization, and how they are applied in many fields of study. Consequently, certain important issues are raised by the suggested examination of these algorithms, which will need to be resolved in the future [36].

E. Bio-inspired Algorithms and Their Applications

For a very long time, scientists have looked to biology and nature to comprehend and model answers to difficult real-world issues. Numerous mathematical and algorithmic methods have been developed, along with a method of transferring knowledge from lifeforms to human technologies. The study of bionics bridges the biological structures and functions, organizational principles, and functions found in nature with our modern technologies. The results of bionics research encompass not just tangible goods but also a range of versatile optimization and

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computation techniques. 6 Four major categories of related algorithms can be distinguished: bio-inspired algorithms based on evolution, bio-inspired algorithms based on swarm intelligence, bio-inspired algorithms based on ecology, and multiple-purpose bio-inspired algorithms. With a sharp rise in the quantity of pertinent papers, bio-inspired algorithms, including neural networks, ant colony algorithms, optimization algorithms for particle swarms, and others, have been used in practically every field of research, engineering, and business management. The most recent advancements in ecology-based bioinspired algorithms, swarm intelligence-based bio-inspired algorithms, multi-objective bio-inspired algorithms, and evolutionary-based bio-inspired algorithms are reviewed in this work in a methodical, practical, and thorough manner.

Table 1. Convergence and difference between previous studies and current research

Research Title	**Bio-Inspired ICT for Big Data Management in Healthcare**	**Bio-Inspired Algorithms for Medical Data Analysis**	**MEDICAL DATA CLASSIFICATION USING BIO-INSPIRED ALGORITHM**	**Bio-Inspired Computing: Algorithms Review, Deep Analysis, and the Scope of Applications**	**Bio-inspired Algorithms and Their Applications**
Research Methodology	Descriptive analytical approach	Descriptive analytical approach	Descriptive analytical approach	Descriptive analytical approach	Descriptive analytical approach
Data used	Following a biologically inspired approach to ICT, we can weave big data and data-intensive computing issues into the future vision of smart healthcare.	Medical data has great potential for investigating hidden patterns in medical domain datasets. These patterns can be used for clinical diagnosis.	The classification of health records is based on learning from different health data sets to improve the better quality of DSS in health care. The main objective of this study is to establish a system for successful classification of health data	a, biologically inspired optimization algorithms in machine learning are known to solve optimal solutions to complex problems in science and engineering. However, these curves are usually nonlinear and constrained	The output of bionics research includes not only physical products, but also various computational methods of optimization that can be applied in different fields
data analysis	Tough a program spss	Tough a program spss	Tough a program spss	Tough a program Chart or table analaysisi	Tough a program spss
Results	Collecting, organizing, and calculating every aspect will be crucial for patient retention and for healthcare management. By following a biologically inspired approach to ICT, we can integrate big data and data-intensive computing issues into the future vision of smart healthcare.	The authors present the application of four biologically inspired algorithms and meta-heuristics to classify seven different real medical data sets. Two of these algorithms are based on calculating similarity between training and testing data while the other two are based on random generation of populations to construct classification rules.	In classifying medical information. This is a high-dimensional data input package. A feature reduction tool is then used to reduce the functional space without compromising the computational accuracy. Artificial neural networks be used as a classifier. We used an optimization algorithm to enhance performance.	use biologically inspired optimization algorithms that represent a promising approach to solving complex optimization problems. This paper presents the state of the art of nine of the recent bio-inspired algorithms, gap analysis, and its applications including; Bee Colony Genetic Algorithm (GBC), Fish Swarm Algorithm (FSA), Cat Swarm Optimization (CSO),	A systematic, pragmatic, and comprehensive review of the latest developments in evolutionary-based biologically inspired algorithms, swarm intelligence-based biologically inspired algorithms,
Similarities in research	descriptive and analytical approach	descriptive and analytical approach	descriptive and analytical approach	descriptive and analytical approach	descriptive and analytical approach
Differences in research	Time, place, sample Kuait	Time, place, sample Lebnce	Time, place, sample malysia	Time, place, sample gujrat	Time, place, sample Swayamsiddha
	Discover associations and causal relationships between	The results showed a very good performance of biologica	The “artificial bee colony algorithm” is a bio-based	We analyze in-depth discussions where the essence of these	It offers ecology-based biologically inspired algorithms and

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personal opinion	diseases and patients by considering the processes of communication and social infection. Thus, we achieve an evolution from data to multi-agent by introducing personalized medicine in a multi-layered architecture.	lly inspired algorithms for supervised classification of medical data.	optimization algorithm used by a neural network. The medical dataset represents an average improvement in the classification quality of the proposed system with the current form, about 15%.	algorithms and their relevance to customization and applications in various fields of research are presented. Consequently, the proposed analysis of these algorithms leads to some key problems that must be addressed in the future.	multi-objective biologically inspired algorithms.

III. BIO-INSPIRED ALGORITHMS HEALTHCARE

Suggested a data-aware family scheduling method for big data analytics based on genetic algorithms (GAs), with an emphasis on data dependencies, computational power, and bandwidth usage. Additionally, the GA algorithm separates data, and cloud-based computing services are offered. The outcomes show that because the method used by GA handles data using parallel processing, it produces effective results when speaking of turnaround periods. [10] presented a huge data mining method based on the multiobjective genetic modeling (GP) algorithm. This method is utilized to create the concrete creep model, which yields objective and precise predictions. The GP model operates at both standard and high strengths. suggested a large data analytics method based on the differential evolve (DE) algorithm that makes use of local search to boost the DE algorithm's exploitation potential. Although it takes a long time to compute, this method optimizes the huge amount of data from the 2015 benchmark challenges in both multi- и single-objective tasks. [11] presented a big data processing technique based on the adaptive approach (ES) algorithm that uses parallel scheduling utilizing cloud resources to handle data reliably and effectively. Additionally, the ES algorithm reduces the amount of time it takes to perform a set of jobs by dividing them into fragmented sets, each of which is executed by the same resources.

Suggested a huge data optimization technique based on the simulated annealing (SA) algorithm. This technique leverages a WOA to design several feature selections approaches, thereby reducing the modification by probing those that are most capable regions. The suggested method chooses the most beneficial elements for categorization tasks while also assisting in increasing classification accuracy. Additionally, [12] presented the SA algorithm-based selection of features (SAFS) method for computer vision and big data learning. The SAFS algorithm is primarily suitable for big data learning because it gradually reduces the issue size over iterations by eliminating variables and tightening a sparsity constraint based on a criterion. A big analysis of data based on the FSO and SA-based hybridized (FSOSAH) technique was developed by 8 Tayal and Singh [13] as an effective solution for a multiobjective issue based on stochastic dynamic facility layout. [14] suggested using the big data analytics crow search optimization (CO) method to cluster data. Additionally, many datasets through the Machine Learning Repository at the University of California, Irvine, are taken into consideration to validate the CO approach through research results, and these datasets exhibit superior convergence stability and computing efficiency.

A. Cellular Automata

Cellular automata (CA), an early example of bio-inspired computing, are mentioned as reference [40]. These are discrete systems, self-replicating in nature, composed of finitestate machines, or cells, arrayed in a network. Each cell is locally connected to others, leading to a complex global behavior emerging from these interactions [15]. The state of each cell synchronously alters based on its current state and the states of adjacent cells from the previous time step. A uniform local update rule is applied across all cells, establishing a homogeneous system [16]. The paper introduces Tumor-Cut [17], a method using a CA model that integrates gradient magnitude as the local transition rule, equating to the shortest path algorithm as indicated in [18]. Similarly, GTVCUT, a CAbased method for segmenting brain tumors in MRI images for neuro-radiosurgery planning, is cited as [19]. This semi-automatic technique involves adaptive initialization of foreground and background seeds through a simple draggable rectangle that encompasses the area of interest [20].

B. Membrane Computing Membrane Computing

Is an unconventional model of computation that assumes the functioning of the cells as an information processing system? In particular, this model formalizes the flow of metabolites among cells of a living tissue or the organelles in an eucaryotic cell. More specifically, the computational devices in membrane computing are called P systems [21]. This model can be effi-ciently implemented on parallel architectures [22] and has been applied to image segmentation [23]. P systems were efficiently applied to edge detection and multi-level thresholding in [24].

IV. SWARM-BASED ALGORITHMS

Suggested a massive data management strategy based on the synthetic colony of bees (ABC) algorithm, which finds the optimal cluster and optimizes it for varying dataset sizes. The implementation is done in a MapReduce-based Hadoop system, and the results show that, in terms of execution time, the ABC method produces a better result

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when compared to differential evolution with the particle swarm optimization approach (PSO). [27] presented a large data analytics technique called Firefly Swarm Optimization (FSO) for creating new connections on social media sites and determining whether a social network can survive. This method lowers the cost of handling large quantities of data by introducing a mathematical model to verify the social network's stability. To concentrate on six multiobjective issues [28]. suggested an FSO algorithm-based hybrid (FSOH) strategy for large data optimization. Although it has a high computational time complexity, it lowers execution costs. suggested a big data optimization strategy based on the PSO algorithm to enhance online lexicon learning and presented a dictionary-learning model that makes use of the auto updating stage. The PSO method increases accuracy while reducing computationally demanding tasks [29]. suggested a big data-driven program composition method based on the parallel clustered PSO method (PCPSO). Massive volumes of heterogeneous data are handled using the PCPSO algorithm, which uses MapReduce for parallel processing on the Hadoop platform [30]. presented a big data classification method based on the cat swarm optimization (social organizations) algorithm to choose features for text categorization in big data analytics

The phrase frequency-inverse document occurrence is used by the CSO algorithm to increase feature selection accuracy. For the economic carry dispatch problem [31]. suggested a big data analytics strategy based on the swarm intelligence (SI) algorithm. The SI algorithm processes high-dimensional data, which increases the accuracy of the data processing [32]. suggested utilizing rough sets to offer the ant colony optimum (ACO) algorithm-based strategy for mobile big data. Big data via social networks is managed more successfully when the ACO algorithm is used to choose the best feature for resolved judgments (tweets and posts). suggested the big data analytical technique for managing medical data, including patient and operation data, that is based on the improved ACO protocol (IACO) [33]. This approach aids physicians in promptly obtaining the necessary data. suggested using shuffled frog flying (SFL) to choose the characteristic for enhanced high-dimensional biological data. The SFL method maximizes the predicting accuracy for enhanced high-dimensional biomedical data by reducing irrelevant features and obtaining the group of characteristics by exploring the space containing probable subsets. The Fish Swarm Optimize (FSW) technique was proposed by [34]. for deciding on features in huge data. The FSO algorithm uses the behavior of fish swarming to simplify combinatorial problems, and it works well for a variety of applications. Fish movements in their quest for food have been used to construct social interactions among huge amounts of data. Effective outputs in terms of data correctness and fault tolerance are produced by this method. To efficiently manage large amounts of data [35]. suggested the intelligent droplets of water (IWD) method for workflow scheduling. The efficacy of the IWD-based strategy is tested using workflow simulation tools. The results demonstrate that, in comparison to the FCFS, Round-Round, and PSO algorithms, the IWD-based approach performs satisfactorily concerning cost and makespan.

V. ECOLOGICAL ALGORITHMS

Suggested a large data optimization strategy based on the invasive weed optimization (IWO) algorithm to handle the multiobjective portfolio allocation problem. Moreover, the multiobjective choice of the portfolio model is converted to the single-objective programming system using the uniform design and imprecise normalization technique. Big data is managed faster using the IWO method than PSO [36]. tackled the problem of huge data processing and analysis by presenting a hybrid biogeographybased optimum (BBO) methodology for multilayer perceptron training. According to experimental results, BBO outperforms GA and PSO algorithms in terms of velocity and is useful for training multilayer perceptrons [37]. suggested using the multispecies optimizer (PS2O) algorithm to choose characteristics for large data stream mining. The PS2O algorithm classifies the gathered data streams related to big data using an incremental classification technique, which improves the analytical accuracy with an acceptable amount of processing time [38].

VI. BIO-INSPIRED ALGORITHMS

Phonetic-based methods and large-vocabulary continuous speech recognition (LVCSR). To transliterate the audio's spoken content, LVCSR first indexes the data before looking for an index phrase. Phonetic indexing searching is handled via the phonetic-based approach, which works with phonemes or sounds. Video streams, such as CCTV footage and live streaming sports events, can have valuable information visualized, examined, and extracted through the use of video analytics. Video analytics can be run on centralized systems (servers) or end devices (edges) [39]. The study of social media analytics involves analyzing both structured and unstructured data from websites that facilitate user-to-user communication, such as Facebook, Twitter, and others. Two categories of online analytics exist: First, content-based (user-posted data) based on structure (combining the structural elements). Predictive analytics is a technique that makes use of both historical and present data to forecast future results. It can be applied to heterogeneity (data from multiple sources), spurious correlation (uncorrelated variables due to large dataset size), noise accumulation (an error of estimation during data interpretation), or incidental endogeneity (indications or variables that explain results that are independent of the leftovers term) [40].

The ability of an infrastructure to scale up or down its nodes in response to the volume of data being transferred for analytics is known as scalability. Large amounts of storage space are needed by big data analytics approaches to store all of the data needed to run the various analytics and extract the necessary information. The capacity of a system to process user data in the allotted amount of time is known as tolerance [41]. Agility-based big data analysis approaches are necessary to analyze user data in the necessary format since the type of information that needs

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analytics is always changing. To build virtual computers for remote user data processing, cloud-based systems need to apply the virtualization technique [42]. The big data analytics execution cost represents the amount of work needed to complete the task. The mechanism that indicates how simple it is to utilize the system to execute big data analytics is known as ease of use. The comparison of bio-inspired methods for large amounts of information analytics based on various parameters is covered in the section on data management [43].

VII. RESULTS

Enables the reader to select the best bio-inspired algorithm by comparing bioinspired big data analytics algorithms according to several criteria. As of right now, cloud computing has become the fifth computing utility and is attracting a lot of interest from academics and industry for the analysis of big data. With the ongoing advancement of virtualization technology, new models, procedures, and strategies for the efficient use of cloud infrastructure in big data management are appearing. Fog computing provides cloud services with the least amount of network latency and reaction time by utilizing mobile base stations, switches, routers, and gateways. As a result, big data analytics can also be carried out at the fog or edge device rather than at a distributed database or server.

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