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BEE COLONY OPTIMISATION FOR HEALTHCARE SERVICE OPTIMIZATION: A CASE STUDY IN HOSPITAL SCHEDULING

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Abstract
Aim: Some of the adverse health impacts that have been connected to air pollution include premature mortality, cardiovascular disease, bronchitis, asthma, and cancer.
Background: Air pollution has a detrimental effect on both the health and well-being of an individual, it raises significant concerns with regard to public health. Due to the expanding number of people living in these sorts of cities and the increased usage of fossil fuels, the infrastructure of these kinds of cities is experiencing an increasing amount of strain.
Contribution: Within the scope of this study, we examine the classification of lung scans obtained from paediatric respiratory patients by making use of healthcare management scheduling in order to identify possible instances of sickness.
Methodology: First, the images are subjected to pre-processing, which is accomplished by the application of a modified bee colony optimisation technique.
Findings: The architecture of the model enables it to perform more accurately than other methods compared to its existing methods.
Recommendation for Researchers: Furthermore, in terms of computing efficiency and accuracy of prediction, our method beat those of previous methods.
Future Research: In future research, this work can be enhanced using several deep learning algorithms for achieving better accuracy and performance.

Keywords: Lung Image, respiratory healthcare management, Bee Colony, Scheduling

1. INTRODUCTION

The air pollution on people's respiratory systems, which might make preexisting disorders worse, are most likely to have a negative impact on people (Bolaji et al., 2022; Saravanan et al., 2023; Saravanan et al., 2023; Uniyal et al., 2024). Asthma is one of the most prevalent illnesses that affect children and ranks high among paediatric illnesses, with an estimated frequency of 14% across the globe (Yadav et al., 2024a). Ongoing research is being conducted in the areas of investigating the complex mechanisms that are responsible for the interaction between these components. Nevertheless, there are a great number of factors that have the potential to bring on an asthma attack. These factors include contaminated air, specific surroundings, allergies, heredity, and even particular foods. The intensity of the association between elevated levels of air pollution and asthma in children is influenced by a variety of environmental factors, including geography, climate, and other environmental variables. It was the authors of the study that arrived at this conclusion. An underdeveloped immune system, higher breathing rates, and increased levels of physical activity are some of the variables that make children more susceptible to the adverse health impacts of air pollution than adults are. (Yadav et al., 2024b; Maguluri et al., 2023) These factors make children more susceptible to the adverse effects of air pollution.

Problem

According to the World Health Organisation, respiratory disorders are responsible for the deaths of millions of people every year. Within the parameters of this discussion, the diseases in question provide an especially high risk to youngsters. When it comes to children younger than five years old, respiratory infections are responsible for the vast majority of deaths that occur each year. In actuality, respiratory infections are responsible for over 6.6 million deaths over the course of each year (Shesayar et al., 2023). According to estimates, fourteen percent of the world's children and adolescents suffered with asthma in the year 2015. Asthma is the chronic respiratory disease that affects children more than any other condition that involves the respiratory system. A global estimate places the number of infants affected by cystic fibrosis at 130,000 and 140,000 (Devadason et al., 2024). This ailment is the second most frequent chronic respiratory condition in children.

Preterm newborns have seen a rise in their survival rate, and the prevalence of respiratory comorbidities has decreased as a result of innovations in prenatal and postnatal therapy (Abdalkareem et al., 2021). Additionally, there has been an increase in the proportion of people who are able to deliver their babies on the date that they were due. In spite of this, problems that are associated with lung immaturity, such as bronchopulmonary dysplasia (BPD), frequently continue into adolescence and, in extremely rare cases, even into adulthood (Behmanesh et al., 2020). It is because of the influence that these disorders have that this is the case. There are still some respiratory infections that cannot be cured in children, despite the fact that there have been significant advancements in medical science over the past few years. Adults are experiencing an increasing number of respiratory infections that are not contagious (Lo & Chiang, 2022).

As a result of the pleiotropic benefits that cellular-based therapies have on easing important diseases such as tissue regeneration, there has been an increase in the utilisation of these therapies pertaining to the treatment of lung sickness in recent years (Muniyan et al., 2022a). The reason for this is that these medicines are more effective at tackling the primary factors that lead to lung illness, which is what is pushing up their utilisation. The fact that these medications are effective in treating the primary symptoms of lung illness is one of the likely explanations for the rise in the use of these medications.

Objectives and Novelty

Recent studies looking at cellular therapies for respiratory diseases did not allow children to participate. Safety and ethical issues dictated this. Though these studies established the foundation for further studies into respiratory diseases in children, there is still an unequal distribution of clinical trials involving pediatric patients. Treatment of patients over their lifetimes can be expensive, but cellular therapies may make that task easier. Respiratory diseases can be healed by these therapies, which also stop them from becoming adult respiratory diseases. This goal must be achieved by developing strategies to stop childhood respiratory infections from developing into adult respiratory diseases. There is cause to assume that cellular therapies may not only alleviate respiratory issues but also remove the risk that these issues could worsen into more serious respiratory illnesses in adults. The possibility of cellular therapy to cure respiratory diseases and stop their progression is among its most promising features. The purpose of this research is to identify possible cases of disease by classifying lung images of paediatric respiratory patients on the basis of healthcare management schedule.

2. RELATED WORKS

It has been demonstrated through research that coughing can serve as a valid diagnostic tool for a wide range of respiratory ailments. These illnesses include asthma, pneumonia, croup, bronchiolitis, and infections of the lower respiratory tract. These results indicate that the specificity of this approach is approximately 80%, while the sensitivity is approximately 70% (Muniyan et al., 2022b). A recently developed technique for the diagnosis of COVID-19 that makes use of intelligence-based cough sound analysis has succeeded in achieving validity, as described in (Behnamian & Gharabaghli, 2023).

When it comes to the question of employing computers to evaluate lung auscultations and respiratory sounds, (Lopes et al., 2020) offers a comprehensive assessment of the existing literature on the subject. The number of articles on this subject has recently increased as a result of the growing demand for additional study into the

application of artificial intelligence (AI) in the treatment of lung diseases. The release of this research emerged as a direct result of the growing interest in the subject matter.
The authors of (Khalili et al., 2020) were able to diagnose ten different respiratory disorders by using cough audio analysis as their diagnostic resource. In addition to that, they provide a concise summary of the DL categorization techniques as they pertain to the various lung diseases. The focus of study has switched towards the use of intelligence and the advancements in ubiquitous computing in order to accomplish the goal of detecting and halting the propagation of the current COVID-19 epidemic for the purpose of preventing its further spread. When it came to this adjustment, the epidemic itself was the primary motivating factor.
In (Sharifi et al., 2021), the authors give a detailed and methodical evaluation of all ongoing research, with a particular emphasis on artificial intelligence and machine learning. Utilising audio, visual, and textual data for quick COVID-19 diagnosis, the authors report their findings. These publications are possible to find in the portion of the article that is devoted to references. In addition to these and other works, a wide variety of additional publications have made references to them. When it comes to the diagnosis of COVID-19, the authors of (Aladdin et al., 2023) have addressed all of your worries. They have made available a wide variety of open access materials, which include everything from respiratory sounds and text data to CT scans and X-ray images. This document contains all of the information that is required for an accurate diagnosis. A comprehensive study that focuses on six significant topics [48] explores a number of different aspects, including the classification of COVID-19 disorders, the generation of forecasts, the evaluation of risk, and the development of immunisations. Methods for putting these plans into action are the subject of consideration in the research as well.
The authors made only a brief reference to the substantial number of audio and voice datasets that are accessible to the public. By reading this article (Vijitha Ananthi & Subha Hency Jose, 2023), you will have the opportunity to find information on five of the most significant intelligence applications for COVID-19. Applications such as the diagnosis of COVID-19 data (images, audio, and text), the prediction of patient behaviour, the design of vaccines, and the development of diagnostic support apps are all examples of this type of use. Among these objectives are the identification of feelings, the fastening of the treatment of patients, and the monitoring of the propagation of diseases. Using these methods, it is also possible to monitor the progression of the disease over time. It is possible that these strategies could be useful in a wide variety of contexts. On the other hand, these researchers are making use of the material that is already available in order to zero in on the current outbreak, which is precisely COVID-19.
It is possible that even highly experienced medical professionals, even with access to diagnostic assistance technology, may find it difficult and time-consuming to discriminate between the numerous respiratory illnesses. Imaging studies, spirometry, bronchodilator response testing, clinical and auscultatory examinations, and investigations into bodily fluids are some of the diagnostic techniques that are likely to be required in order to arrive at an accurate diagnosis of respiratory disorders.
Considering the problems in getting clinical information and testing, it may be difficult to choose and deliver appropriate tests in a variety of settings, including community health care and remote places. This is because of the difficulty in acquiring clinical information. There could be a number of reasons for this, including the fact that it is difficult to get the requisite clinical data and diagnostic testing. Nevertheless, there is no answer to these issues at this time. Despite the fact that a hospital has access to imaging and laboratory facilities, diagnostic support tests still require a significant amount of time, clinical personnel, and financial resources. When it comes to the interpretation of radiographic images, researchers have observed that there are many instances of dispute taking place. It is possible for a misdiagnosis or a delayed diagnosis to have the opposite impact, in addition to the potential for harm to morbidity, mortality, and antibiotic stewardship. It is important that you give both of these items a lot of serious attention.

3. PROPOSED METHOD

Figure 1 illustrates the hypothetical model of the system. This method consists of four primary processes, which are as follows: pre-processing, feature extraction, feature vectorization, and classification. The subsequent stage consists of the construction of the framework. The next step is to examine the framed examples and determine the traits that they exhibit. Arranging the features into feature vectors is the next phase, which comes after the retrieval of the data.
It is now possible for a classifier to accept the feature vectors as input. Feature extraction makes it possible for the analysis algorithm, which is also known as a classifier, to deal with a significantly smaller amount of processed data in comparison to the enormous number of images that it must process.

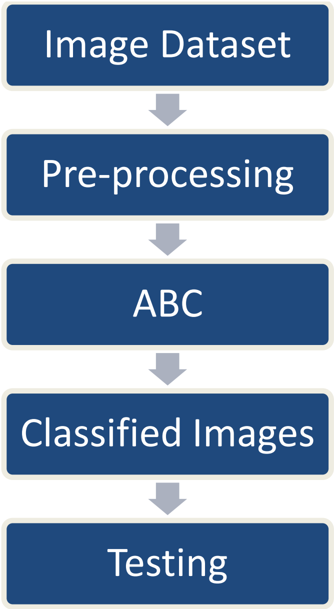

Figure 1: Proposed Model

This paper provides a cache optimisation issue that takes into account the discrete nature of the variables that are at the root of the problem. Convex techniques are unable to solve this problem, which is an example of an integer non-linear programming (INLP) problem that is NP-complete. When trying to identify the best solution to a problem, using a method that is extremely precise, such as the enumeration algorithm, becomes progressively more difficult with each repetition. The simulated annealing algorithm is an example of a heuristic algorithm. This algorithm has the potential to become stuck and still produce results that are less than optimal, regardless of the number of times it executes the procedure. As a result of this, the first algorithm for a bee colony, which we refer to as ABC, is presented in this research.

The caching strategy of the current frame and the channel circumstances are the only things that can make ABC technique more difficult to implement. The fact that this is the case leads us to think that the optimisation problem that is described in Equation (1) may be simplified to cache optimisation of a single feature sm, as demonstrated in Equation (2) respectively.

$$\max_{A} h_m(t)$$

The optimisation problem in terms of the cost function.

$$f_m(t) = h_m(t) - \lambda_{\max} - \mu_{\max}$$

Utilising the max() method is one approach to determining which of three values is the largest of the possibilities. Large regularisation coefficients (λ and μ) are responsible for ensuring the finding of profitable solutions, which is their primary function. The elimination of solutions that are theoretically impossible is an essential component of the operation, and as a result, it makes the operation accessible.

The DABCC believes that a honey pot is the most appropriate response from the perspective of the standard description of AI bee colony algorithms. It is possible to further subdivide the NBee bees into the Lbees, also known as leader bees, the Fbees, also known as follower bees, and the Sbees, also known as scout bees. NBee/2 is a popular representation of the ratio of leaders to followers in a group. It is possible to trace the genealogy of scout bees back to both leader and follower bees.

A unique position that is labelled on each honey comb in the bee colony is used to indicate the location of the jth leader bee in the colony. This coordinate is denoted by the notation Hbj(j=1,2,⋯4,Nbee/2). ABC makes it a daily priority to fulfil its mission of safeguarding the honey reserves. Honey sources are one alternative solution to the optimisation issue, which is described by an equation and given as a set of K-dimensional vectors. Honey sources are a type of honey. Mechanical bees are responsible for the collection process, and they are always looking for new honey plants to collect. When beekeepers use the profitability function, which is a tool that enables them to evaluate various honey sources in terms of their potential to generate a profit, they regularly reevaluate the results of what they have achieved. At time t=0, the locations of the honey sources are selected entirely at random because there is no precedent that has been established.

$$a_{m,k}(t)=\begin{cases}0 & rand(0,1)<0.5\\ 1 & otherwise\end{cases}$$

Increasing the number of honey source coordinates in a sequence that is completely random raises the level of computing complexity and the amount of time necessary for technique convergence. Through the utilisation of the caching technique from the preceding frame, the ABC algorithm is able to ascertain the location of the honey source that is not present in the initial frame.

$$a_{m,k}(t)=\begin{cases}1-a_{m,k}(t-1) & k=k'\\ a_{m,k}(t-1) & otherwise\end{cases}$$

The value of k_x can be any integer between 1 and K. To explore this phenomenon, the investigation in this instance selects two integers at random from the pool of possibilities. This assures that honey made from a variety of regions throughout the world will be available to consumers. In order to achieve a faster convergence of the DABCC, it is necessary to make use of honey sources that have a shorter Hamming distance to the optimal honey source.

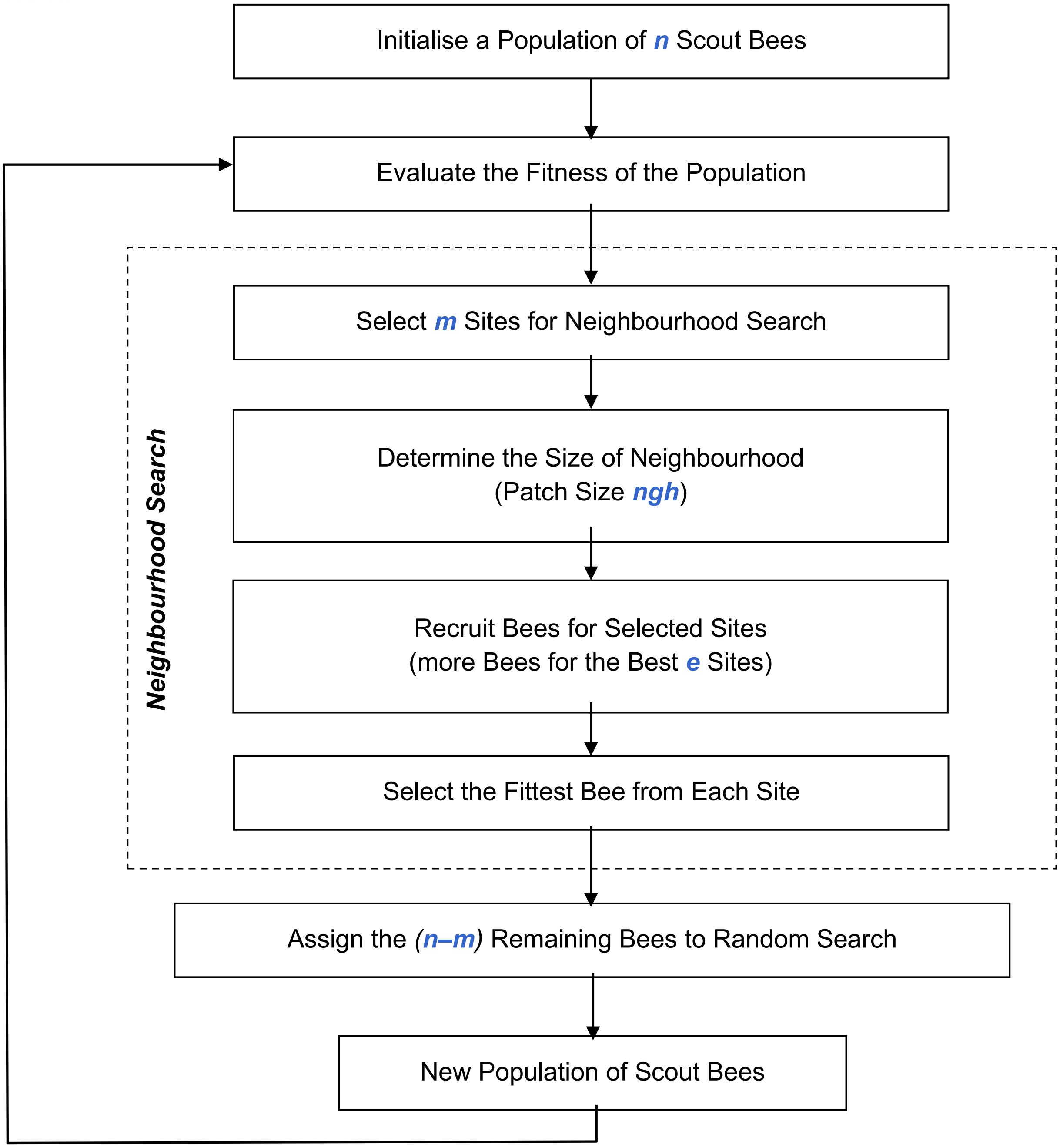

Figure 2: Bee Colony Optimization

When a leader bee encounters a source of honey as in Figure 2, it will immediately trigger the action function in order to locate further honey sources in the immediate vicinity. After that, it will evaluate the outcomes in relation to the ideal honey source coordinates that it has stored in its memory. A queen bee will refresh her memory and inform her subordinates about a new honey source that provides a higher return on investment. She will also let them know about the honey source. Following the conclusion of each cycle, the head bee evaluates the profitability of the honey supply in comparison to that of another head bee that has been chosen at random. In order to define the action function of the leader bee as φ(Hbj,Hbj′), where Hbj and Hbj′ represent the coordinates of the two paired bees, we can utilise a roulette system with the predicted probability and set the various components to 1. However, we must ensure that the components φ( ) of the two honey sources remain similar.
$P_r(k) = s_{m,k}(t)/\sum s_{m,k}(t)$
where
$s_{m,k}(t) = (D_{m,k}(t)/L_k)^Q$ and
There is a positive integer that represents the weighting factor, and its name is Q. Over the course of each passing interval, the popularity of the content cache, denoted by Q=1, sm,k(t), rises by one bit fk. Because the process of caching information becomes less complicated with a higher Q, it is possible to achieve a larger popularity boost for each cached data unit. Not only does the action function make it easier to make progress towards the goal of maximising profits, but it also serves to prevent the leader bee from engaging in useless expeditions.
An individual of the bee species that travels beside a forager bee as it seeks for honey. If the worker bee discovers a more beneficial site to gather honey than her boss, then she will successfully take over as the leader of the colony. With the help of the probabilities presented in Equation, the following bee is able to figure out what its next move will be. Whenever a bee that is following another bee makes a decision to travel somewhere, it will randomly alter its location.
$P_{mj}=f_j/f_{max}$.
In this particular instance, fj represents the wage that the jth leader bee earns, and fmax represents the highest possible wage that all leaders earn when taken together. A reduction in the amount of time and effort spent on computations results in an increase in the potential value of exploration.
After a predetermined number of rounds, the hive will transform one leader bee and one follower bee into scouter bees if the honey source that is most suitable for the two bees has not changed. It is because of this that the DABCC algorithm will be unable to locate a solution that is locally optimal. The optimal amount of honey that is available to both the leader bees and the following bees remains the same. During their visit to a honey source that has been chosen at random, the scout bees will bring honey to the bees that are in command as well as those that follow in their footsteps.
The initial content collection F at time t=0 consists of m people and n pieces of content. Collect information about these individuals and the content they hold. If you are aware of the channel conditions that exist between sm and um (nite, nlim, and nbee), then you will be able to figure out how to compute m and n successfully. To create a honey pit, fill out the formula Hb1HbNbee.
The default values of αm, n, θk, and γk are used by the DABCC method in order to establish the parameters for each and every piece of material that is included in the content set F. It is possible to determine the quality of the dataset by employing the sm metric in conjunction with Hm,n. In order to determine the initial point for the honey supply, the algorithm takes into account several parameters. These parameters include the initial bee count (NBee), the maximum number of bee iterations (Nlim), the dimension of the honey supply (K), the λ and μ punishment factors, and the total number of iterations. In situations where the current frame is not the first, the ABC algorithm is able to estimate the level of popularity of the material. After the completion of this forecast, it will check to see whether there has been any modification to the configuration of the network. After the action function of the bee has been carried out, the ABC algorithm is utilised in order to include the freshly generated content into the content that has been predetermined. Following the completion of the cache clearing process, the algorithm proceeds to the subsequent iteration.

4. RESULTS AND DISCUSSIONS

All of the X-ray data that was just added to the Kaggle repository is now available for viewing by anybody and everyone.
By conducting an analysis of a dataset on lung disease using the most recent version of the ABC algorithm, the purpose of this study is to improve our ability to forecast the risk that a specific patient would develop lung sickness. To this end, we intend to enhance our ability to precisely estimate the likelihood that a particular patient will develop a lung illness. The dataset's input feature—age, an X-ray image, gender, or a view position—is used to do a binary classification with the intention of detecting diseases and producing a Yes or No signal. Maybe the dataset contains items of this nature. The size and intricacy of this dataset make analysis of it extremely difficult.

Anticipating the possibility of disease outbreaks is quite challenging because of the extreme background noise and the total absence of data. In such situation, interpreting this dataset becomes considerably more challenging. There are many X-ray images in the entire collection that is on display. The dataset includes additional information along with the main data, such as a sample divided by gender and age. Moreover, the dataset can be expanded with more data. This section goes into considerable detail on the procedures used to start the inquiry.

By counting the total number of patients affected, for example, recall and accuracy can be gauged. Through this procedure, we can simultaneously eliminate the skewness from the data and evaluate the current state of health of a patient. Application of an average strategy makes this feasible. The percentage of purportedly ill persons who really become ill is one of the various methods to measure accuracy. Often stated, the recall is the proportion of patients out of all those whose illnesses were accurately detected. When trying to determine the likelihood that someone may get this lung illness, these might be the most crucial factors to take into account. There is a significant deal of potential for the combination of accuracy and recall to serve as a meaningful performance indicator.

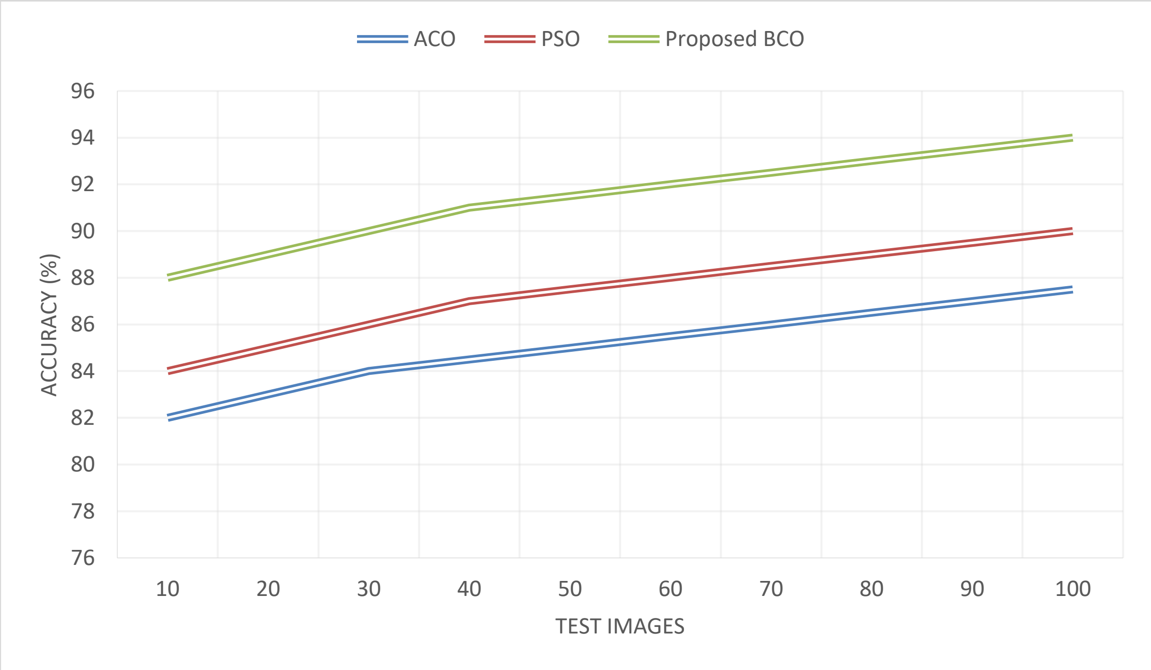

Figure 2: Accuracy

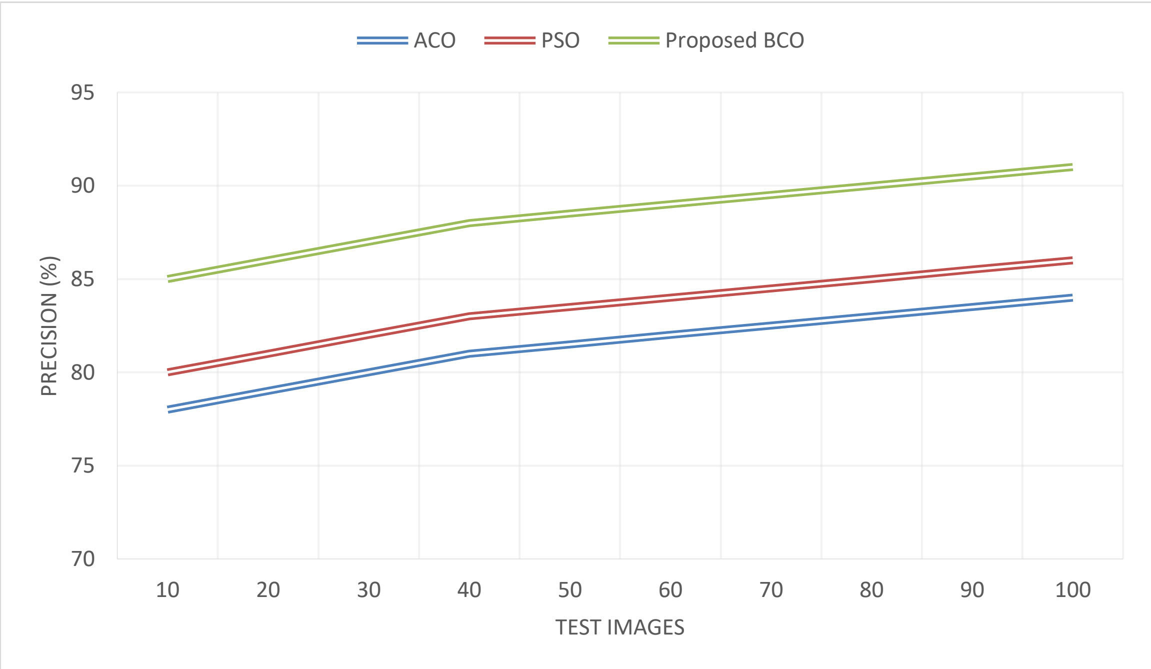

Figure 3: Precision

Figure 4: Recall

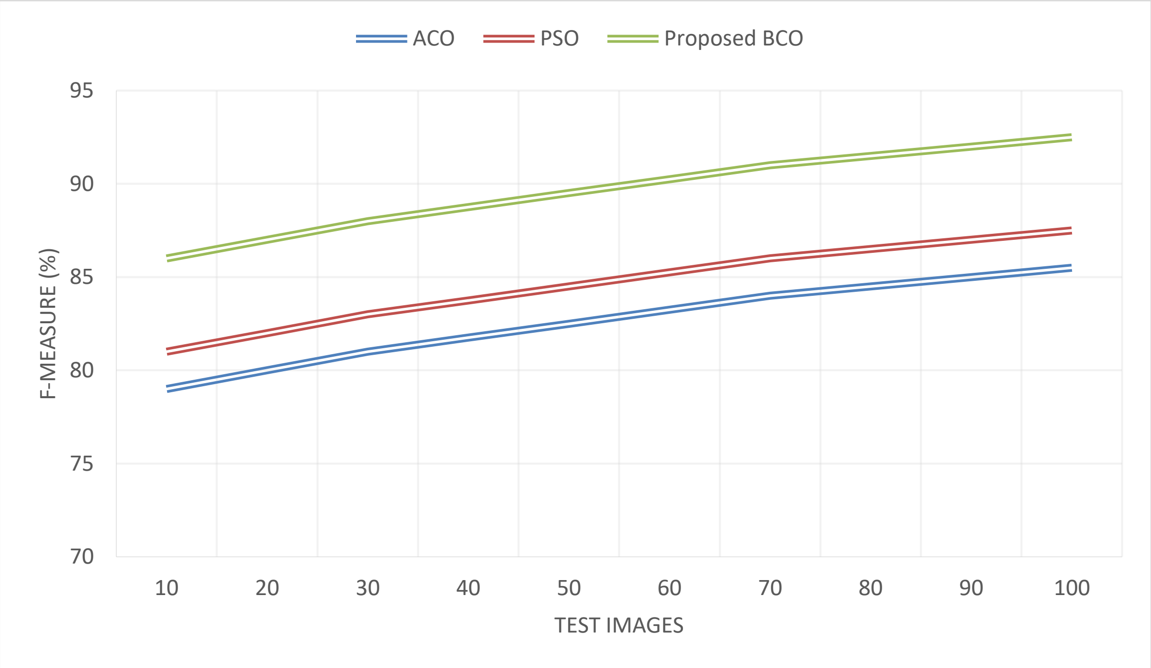

Figure 5: F-Measure

DISCUSSION AND INFERENCES

The provision of these services will enable medical practitioners to provide diagnoses in a more expedient manner, which is critical given the time-consuming nature of patient examinations as in Figure 2 - 5. This is something that will be attainable as a result of the well-planned effort. It may take a considerable amount of time for the patient to undergo more testing, during which time the patient will continue to have uneasy sensations.

Limitations

In order for the the model's performance be satisfactory, it will be possible to implement it for the purpose of diagnosing lung diseases in the actual world. The fact that it makes it easier for medical practitioners to carry out additional diagnostic procedures is one of the reasons why it is of extraordinary significance. In the same way that having a low recall and a high precision are both important, having a tiny mistake is also important.

5. CONCLUSIONS

The purpose of this research is to identify possible cases of disease by classifying lung images of paediatric respiratory patients on the basis of healthcare management schedule. First, the photographs are subjected to pre-processing, which is accomplished by the application of a modified bee colony optimisation technique. Due to the fact that binary classification is essential to the process of disease identification and diagnosis, the F score gets priority over accuracy in this situation. As a result of the findings, the proposed method is able to identify the optimal solution for detecting lung sickness in children with a higher degree of precision. In terms of accuracy, precision, recall, and f-measure, the simulation performs better than contemporary methods that are considered to be state-of-the-art.

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