The Evolutionary Machine Learning Modelto Detect the COVID 19 Infections due in Medical Images.

Susheel George Joseph M.C.A., M.Tech, M.Phil, UGC-NET, (Ph.D)[1]
Associate Professor, Department of Computer Applications,
Kristu Jyoti College of Management and Technology,
Changanassery, Kerala, India
susheelgj@gmail.com, 9446189371

Dr. Jaibir Singh[2]
Associate Professor, Department of Computer science and Engineering,
O.P.J.S. University, Churu, Rajasthan.
jaibir729@gmail.com, 9467746029

Abstract. In processing Computer Tomography (CT) medical images, some of the image processing works use evolutionary algorithms. Evolutionary algorithms are the part of evolutionary computing and they are considered as metaheuristic optimization algorithm. Meta-heuristic is a heuristic designed to find, generate, or select a heuristic (partial search algorithm) or higher-level procedure which provides an adequate solution to an optimization problem, especially with incomplete or imperfect information or limited computation capacity. Metaheuristics can be used to a variety of problems especially matching or searching that may make relatively few assumptions about the optimization problem being solved. CT scan medical images can be examined to check whether the patient is infected due to COVID 19. Here three different evolutionary algorithms are used in various steps for the medical image processing. Initially the Cuckoo search algorithm is used to monitor a Kapur/Otsu image thresholding and then a segmentation algorithm to extract the pneumonia infection. An improved marine predator algorithm is used for X-Ray image segmentation.
Keywords. Machine Learning, COVID 19, Cuckoo Search, Segmentation Algorithm, Marine predator algorithm, image processing, evolutionary algorithms.

1. INTRODUCTION

Computational Intelligence means the ability of a computer to learn a specific task from data or experimental observation. It is a set of nature inspired methodologies and approaches to address complex real-world problems to which numerical or traditional modelling can be meaningless for some reasons: the processes may be more complex for numerical reasoning, it might contain a few uncertainties during the process, or the process may not be predicted precisely in nature.

Evolutionary computation is a family of algorithms for global optimization and the subfield of artificial intelligence and soft computing studying these algorithms. They are a family of population-based trial and error problem solvers with a meta heuristic or stochastic optimization character. An initial set of candidate solutions is generated and iteratively updated. Each new generation is produced by stochastically removing less desired solutions, and introducing small random changes. These techniques can produce highly optimized solutions in a wide range of problem settings, making them popular in computer science. Many variants and extensions exist, suited to more specific families of problems and data structures. evolutionary processes.

2. RELATED WORKS

Cuckoo search is an optimization algorithm. It was inspired by the obligate brood parasitism of some cuckoo species by laying their eggs in the nests of other host birds (of other species). Some host birds can engage direct conflict with the intruding cuckoos. For example, if a host bird discovers the eggs are not their own, it will either throw these alien eggs away or simply abandon its nest and build a new nest elsewhere. Some cuckoo species such as the New World brood-parasitic Tapera have evolved in such a way that female parasitic cuckoos are often very specialized in the mimicry in colours and pattern of the eggs of a few chosen host species. Cuckoo search idealized such breeding behaviour, and thus can be applied for various optimization problems.

Cuckoo Optimization Algorithm (COA) is inspired by the life of a bird family, called Cuckoo. Special lifestyle of these birds and their characteristics in egg laying and breeding has been the basic motivation for development of this new evolutionary optimization algorithm. Similar to other evolutionary methods, Cuckoo Optimization Algorithm (COA) starts with an initial population. The cuckoo population, in different societies, is in two types: mature cuckoos and eggs. The effort to survive among cuckoos constitutes the basis of Cuckoo Optimization Algorithm. During the survival competition some of the cuckoos or their eggs, demise. The survived cuckoo societies immigrate to a better environment and start reproducing and laying eggs. Cuckoos' survival effort hopefully converges to a state that there is only one cuckoo society, all with the same profit values[1].

An image can be divided or partitioned into various parts called segments. It's not a great idea to process the entire image at the same time as there will be regions in the image which do not contain any information. Image is divided into segments and can make use of the important segments for processing the image. This is the method of the working of image segmentation.An image is a collection or set of different pixels. The pixels are grouped together that have similar attributes using image segmentation.

Region-based Segmentation

One simple way to segment different objects could be to use their pixel values. An important point is that the pixel values will be different for the objects and the image's background if there's a sharp contrast between them. A threshold value can be set here. The pixel values falling below or above that threshold can be classified accordingly (as an object or the background). This technique is known as ***Threshold Segmentation***.

Edge Detection Segmentation

There is always an edge between two adjacent regions with different grayscale values (pixel values). The edges can be considered as the discontinuous local features of an image.The use of this discontinuity to detect edges can be make use and hence a boundary of the object is defined. This helps to detect the shapes of multiple objects present in a given image. By the use of filters and convolutions the edges can be detected.

Marine Predators algorithm (MPA) is an algorithm proposed under the nature-inspired metaheuristic algorithm. The main inspiration of this algorithm is based on the extensive foraging strategies of marine organisms, namely Lévy movement and Brownian movement, both of which are based on random strategies[2].

3. METHODOLOGY

People with COVID-19 have had a wide range of symptoms reported – ranging from mild symptoms to severe illness. Symptoms may appear 2-14 days after exposure to the virus.Older adults and people who have severe underlying medical conditions like heart or lung disease or diabetes seem to be at higher risk for developing more serious complications from COVID-19 illness.

Chest CT has an important significant role in the diagnosis, detection of complications, and prognostication of coronavirus disease 2019 (COVID-19). Implementation of appropriate safety and precautionary measures, chest CT protocol optimization, and a standardized reporting system based on the pulmonary observations and findings in this disease will improve the clinical utility of chest CT into a more accurate level. However, chest CT examinations may lead to both false-negative and false-positive results. Furthermore, the added value of chest CT in diagnostic decision making is dependent on several dynamic variables, most notably available resources (real-time reverse transcription–polymerase chain reaction [RT-PCR] tests, personal protective equipment, CT scanners, hospital and radiology personnel availability, and isolation room capacity) and the prevalence of both COVID-19 and other diseases with overlapping manifestations at chest CT.

Chest CT is valuable to detect both alternative diagnoses and complications of COVID-19 (acute respiratory distress syndrome, pulmonary embolism, and heart failure), while its role for prognostication requires further investigation. The proposed design is imaging and managing care of patients with COVID-19, with various algorithms and techniques including (a) chest CT protocol, (b) chest CT findings of COVID-19 and its complications, (c) the diagnostic accuracy of chest CT and its role in diagnostic decision making and prognostication, and (d) reporting and communicating chest CT findings.

Figure1. Flow Representation of the Model

a. Chest CT Protocol; Cuckoo Search Optimization Algorithm

Patients who are referred for CT Scanning should undergo a non–contrast material–enhanced chest CT unless CT pulmonary angiography is necessary to identify pulmonary embolism (PE). Patients from all ages can become affected or infected with this SARS-CoV-2 and have to undergo chest imaging. Low-radiation-dose CT images are generated by using lower kilovoltage settings. Denoising is done iteratively or deep learning–based reconstruction techniques or deep convolutional neural networks for noise reduction[3]. To reduce the low radiation component of the x-ray spectrum the spectral shaping of the x-ray beam is done. Then the classification is done by COA. COA uses a fractional order calculus(FoC) to classify the patients into normal patients, COVID 19infected patients and Pneumonia infected patients as shown in the figure2.

Low-radiation chest CT performed has been shown to be feasible for imaging patients with COVID-19, with non-inferior diagnostic quality and a radiation dose reduction of more than 92% compared among those of a standard radiation CT acquisition. Thus, performing low-radiation-dose CT instead of full-radiation-dose CT as standard for the estimation or

investigation of the lung parenchyma in COVID-19 can be defended on the basis of the ALARA (as low as reasonably achievable) principle.

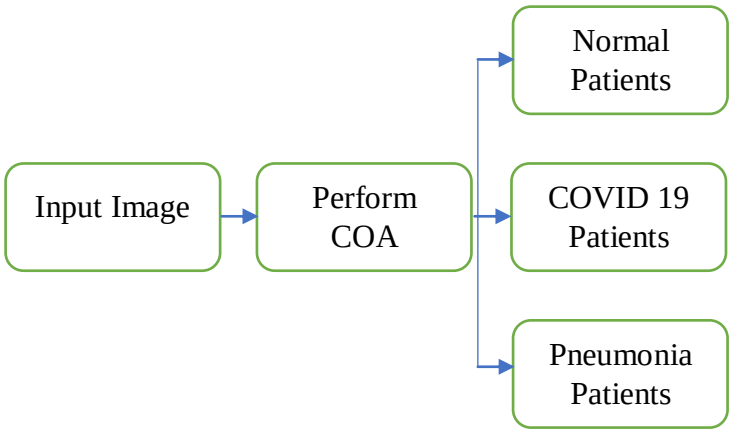

Figure 2. *Classification Process of Cuckoo-search Optimization Algorithm*

b. Chest CT findings of COVID-19 and its complications; Region based Segmentation or Threshold Segmentation.

The medical images of COVID 19 patients, Pneumonia Patients and Normal Patients can be directly analysed by region-based segmentation or threshold segmentation to point out certain elements in the image that permits the diagnosis. Moreover, it is a common practice to extract various features from all the images and create a dataset that contained the information of the objects contained in the images. In the current case, not all the features extracted could provide desired information about the disease that is going to be analysed; for this reason, it is important to use automated tools that remove the non-desired (irrelevant or duplicated) elements.

Image segmentation is one of the increasingly important tasks of research and clinical practice in radiology. The main objective of segmentation is to separate regions or objects of interest from each other by the parts of the body to make quantitative measurements. Clearly, identifying further diagnosis and its insights, including measuring the area and volume of segmented structures.Image segmentation is a commonly used technique in digital image processing and analysis to partition an image into multiple parts or regions. It is often based on the characteristics of the pixels in the image[4]. Image segmentation could involve separating foreground region from background region, or clustering regions of pixels based on similarities or dissimilarities in shape or colour.

Region based segmentation or threshold segmentation is an effective technique for image segmentation that have been developed using domain-specific knowledge to effectively solve segmentation problems in medical imaging, especially Pneumonia and COVID 19[5]. During medical diagnosis for COVID 19 or Pneumonia pulmonologists analyse lungs images either X-Ray or CT to distinguish between COVID 19 or Pneumonia types. They then use an image segmentation technique called clustering to identify those types in their images. Clustering is a method to separate groups of objects in a scene. The K-means clustering algorithm finds separations such that objects within each cluster are as close to each other as possible, and as far from other objects in other clusters as possible.

Image segmentation involves converting an image into a collection of regions of pixels that are represented by a mask or a labelled image. By dividing an image into segments, only the

important segments of the image is processed instead of processing the entire image. A common technique is to look for abrupt discontinuities in pixel values, which typically indicate edges that define a region[4].

The paper used an approach is to detect similarities in the regions of an image. Some techniques implemented in MATLAB that follow this approach are thresholding, clustering, and region growing.

Thresholding

Using Otsu's method, *imbinarize* performs thresholding on a 2D or 3D grayscale image to create a binary image.

Clustering

This technique lets you create a segmented labelled image using a specific clustering algorithm. Using K-means clustering–based segmentation, *imsegkmeans* segments an image into K number of clusters.

Region Growing

Region growing is a simple region-based image segmentation method. A popularly used algorithm is *activecontour*, which examines neighbouring pixels of initial seed points and determines iteratively whether the pixel neighbors should be added to the region[6].

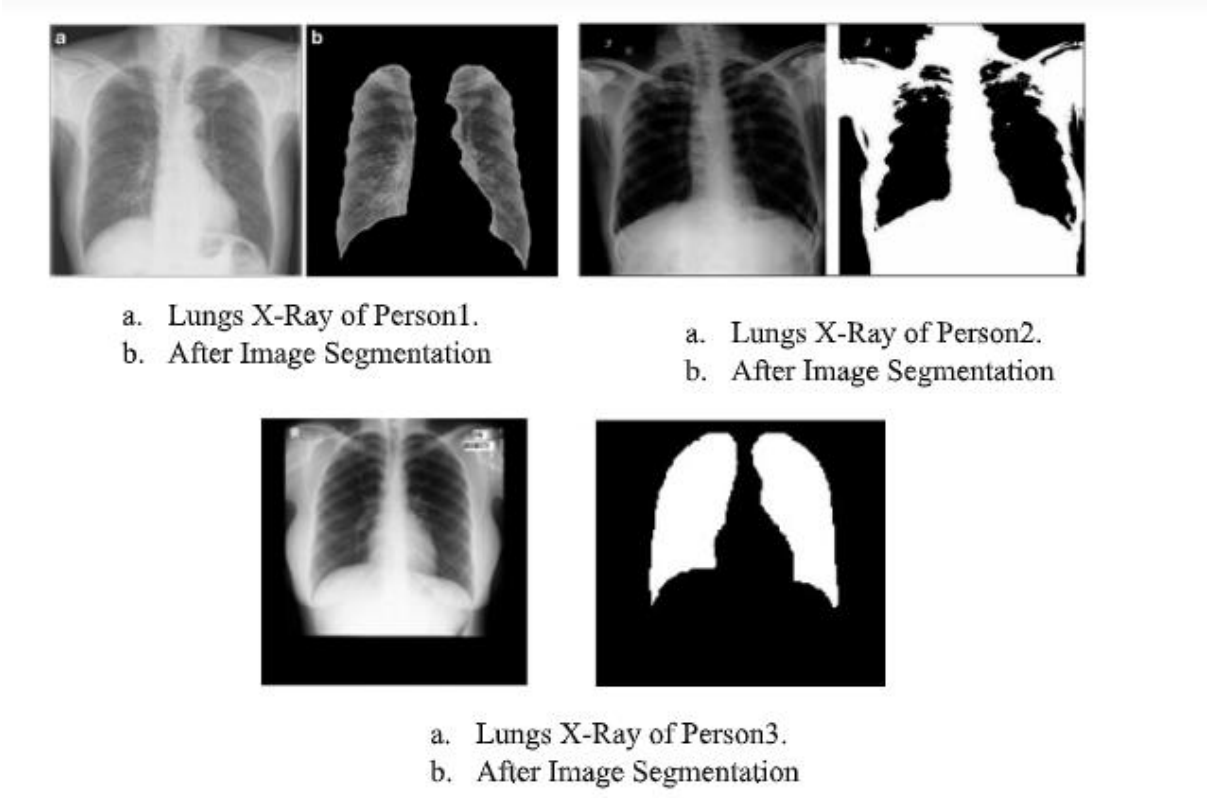

Figure 3. *Image Segmentation Process Applied on Three Medical Images*

c. The diagnostic accuracy of chest CT and its role in diagnostic decision making and prognostication. Marine Predators algorithm.

Marine Predators Algorithm (MPA) is a nature-inspired optimization method that follows the rules that naturally govern in optimal foraging strategy and encounters rate policy between predator and prey in marine ecosystems. The MPA optimization process is divided into three

main phases, considering different velocity ratios and at the same time mimicking the entire life of a predator and prey: (1) in high velocity ratio, or when prey is moving faster than predator, (2) in unit velocity ratio, or when both predator and prey are moving at almost same pace, and (3) in low velocity ratio, when predator is moving faster than prey. Besides the three phases defined for optimization, some natural and human-caused environmental issues such as eddy formation and FAD's effect are mathematically modelled to include in the MPA. This optimization method can be used for the accuracy of the chest CT and decision making in the diagnosis and prognostication.

4. DISCUSSION

In this paper, an effective method is proposed by combining three various popular and advanced techniques. Thus, it can be considered as a hybrid technique with different algorithms. Each phase is implemented in MATLAB code and inference is obtained for three various classes. The paper suggests to read medical images either obtained through X-Rays or CT Images, while during the testing dataset had images from both category of images. Here in this paper the results are not used in significant, instead paper focus on the technology that van be used to identify or classify patients who have the symptoms of COVID 19.

There may be patients with normal flue and cold, also wheezing may happen due to the pulmonological diseases or allergic conditions to various substances, climatic changes or weather conditions. Several factors may lead to a person to be a patient. When these patients come to diagnosis, the diagnostic centre proposes either a CT or X-Ray based on his or her health conditions and that image is subjected to examined electronically. These combined approaches will do a close observation and provides a better inference whether the patient is a normal patient or COVID 19 patient or Pneumonia Patient.

Since everyone have to follow COVID protocols and maintain social distancing, there is a risk factor in diagnosing COVID 19 patients. Especially close interaction is needed to get the inputs that needed for the observation. Both X-Rays and CT images, radiographers must have a close contact with patients. More over these machines also must be disinfected before the use of next scanning. So crucial care is needed while implementing this technology. During the study to develop this paper I have experienced such real situations.

5. CONCLUSION

In the paper I have focused to classify the persons based on their X-Rays or CT Scan Images. This is just and identification process whether the person is a normal patient or COVID 19 patient or Pneumonia patient. For implementing a chest protocol, COA is used and in the second stage segmentation is done for chest CT findings and complications. In the role of decision making MPA is used. Smart and accurate decision are made. Based on the studies, it is realized that more than 90% of the classification is accurate and precise.

This paper has a wide range of future scope such that the classified data can be further analysed for treatments or additional processes. For the enhancement of the image here de-noising of image using deep CNN is applied. Additional enhancement or filtering techniques also can be applied before classification.

6. REFERENCES

1. Keyu Zhong, Qifang Luo, Yongquan Zhou, Ming Jiang. TLMPA: Teaching-learning-based Marine Predators algorithm[J]. AIMS Mathematics, 2021, 6(2): 1395-1442. doi: 10.3934/math.2021087

2. Ramin Rajabioun (2021). Cuckoo Optimization Algorithm (https://www.Mathworks.com/matlabcentral/fileexchange/35635-cuckoo-optimization-algorithm),MATLAB Central File Exchange.
3. Susheel George Joseph, Dr. Vijay Pal Singh, **"Denoising of Images using Deep Convolutional Neural Networks (DCNN)"**, International Journal of Engineering Development and Research (IJEDR), ISSN:2321-9939, Volume.7, Issue 3, pp.826-832, September 2019, Available at :http://www.ijedr.org/papers/IJEDR1903143.pdf.
4. M. N. Saad, Z. Muda, N. S. Ashaari and H. A. Hamid, "Image segmentation for lung region in chest X-ray images using edge detection and morphology," 2014 IEEE International Conference on Control System, Computing and Engineering (ICCSCE 2014), Penang, Malaysia, 2014, pp. 46-51, doi: 10.1109/ICCSCE.2014.7072687.
5. Adel Oulefki, Sos Agaian, Thaweesak Trongtirakul, Azzeddine Kassah Laouar, "Automatic COVID-19 lung infected region segmentation and measurement using CT-scans images Pattern Recognit." 2021 Jun; 114: 107747. Published online 2020 Nov 2. doi: 10.1016/j.patcog.2020.107747.
6. https://au.mathworks.com/discovery/image-segmentation.html.
7. Susheel George Joseph,"A Machine Learning (ML) Modelling Approach in Monitoring and Controlling the Viral Pandemic- COVID 19", International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.7, Issue 6, page no.1709-1717, June 2020, Available:http://www.jetir.org/papers/JETIR2006575.pdf
8. JOUR;Claussen, Jens Christian;Wang, Jun;Zhou, Bihua;Zhou, Shudao, "An Improved Cuckoo Search Optimization Algorithm for the Problem of Chaotic Systems Parameter Estimation",Hindawi Publishing Corporation (ISSN 1687-5265), Volume 2016,https://doi.org/10.1155/2016/2959370
9. A. Bustamam, V. Y. Nurazmi, and D. Lestari "Applications of Cuckoo search optimization algorithm for analyzing protein-protein interaction through Markov clustering on HIV" AIP Conference Proceedings 2023, 020232 (2018); https://doi.org/10.1063/1.5064229 Published Online: 23 October 2018.
10. Susheel George Joseph, Dr.Vijay Pal Singh, Multimodal Medical Image Fusion by Combining Box Filtering and Guided Filtering Techniques using Bi-Linear Interpolation, International Journal of Emerging Technologies and Innovative Research (www.jetir.org), ISSN:2349-5162, Vol.6, Issue 6, page no.259-267, June 2019.
11. Mehta N, Budhiraja S. Multimodal Medical Image Fusion Using Guided Filter in NSCT Domain. Biomed Pharmacol J 2018;11(4). Available from: http://biomedpharmajour nal.org/?p=24550