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Applications of Artificial Bee Colony Algorithms and its Variants in Health Care

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Abstract

Artificial Intelligence (AI) is always in various domain of science, literature, animation, medical filed and other real world applications. AI makes the system to store large amount of data in a systematic manner and translate the information into functional tools as per the requirement of application. AI is in use for specific applications such as defense, space exploration, and medical science. The implementation of AI in healthcare is experienced through AI-based systems for more accurate and precise diagnosis, cure and treatment of debilitating conditions. Artificial Bee Colony [ABC] algorithm is a metaheuristics algorithm has been applied in various fields of health care in recent time. There are various techniques available for image processing of MRI images, noise removal techniques for EEG, ECG, EMG signals, detection of tumor, detection of breast cancer cell, all these have merits along with limitation. When these techniques are embedded with ABC algorithm their use can be extended in such a way that, they overcome their limitation and can be used in a broad domain.

Keywords: Artificial bee colony algorithm; ECG signal analysis; EEG signal analysis; Liver image segmentation; Tumor detection; Ear recognition; Iris recognition; MRI images; Ultrasound imaging; Breast cancer detection

Introduction

The definition for the phrase Artificial Intelligence (AI) [1] calls for formalization of the term “intelligence”. Artificial Intelligence can be used to recognize objects like digital gadgets in ubiquitous computing environment. AI is in use, in the world of healthcare in different format, in different tools, and for different requirements which the traditional technology seems to have limited applications. For example medical imaging technology only provides images of brain, ECG provides electrical activities of heart, but these technologies are unable to provide detailed information or data about a specific element

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(or part), hence this requirement can be fulfilled by the use of AI. AI tools are used to improve the efficiency of medical diagnosis applications. Therefore decision making of diagnosis in medical field is possible with the use of artificial intelligence in medical equipment. Few of the notable contributions of AI in the field of health care are:

1. Diagnostic help: The use of artificial intelligence can improve the patient's health by interfacing the AI with health monitoring equipment. The reminders for drug orders, patient's health condition can be produced.
2. AI tools can be used for planning a therapy before it is performed over the patient. An Ai system aids a plan for a particular condition for therapy.
3. Information Retrieval, is a software agent used for searching a solution for a complex medical problem, this will helps in information retrieval up gradation of data about a specific situation.
4. Image interpretation can detect multiple images at a time and extensively used in clinical applications like X-rays, angiograms, CT, and MRI scans.

Artificial Intelligence in Medicine Field

AI is a computer oriented technology nowadays used by doctor for complex situation and management of patient's data [2] [3]:

1. It provides a laboratory platform for the representation, examination, and indexing of medical information.
2. By designing tools to support research applications and decision-making support system.
3. It integrates activities of cognitive sciences, medical sciences with application software.
4. It offers a discipline for scientific medical community for research and other applications.

Artificial Bee Colony Algorithm

Characteristics of a swarm intelligent algorithm

Intelligence level of swarm [4] varies from swarm to swarm. The interaction between the agents is possible with self-organization. ABC algorithm is a metaheuristic, works on the principle of honey bees functioning. This algorithm works in the same way like the honey bees works for food searching [i.e. food in the algorithm depicts solution for a specific problem], exploration of new food sources, mining of food from the sources, informing other bees about cost (i.e. length in the algorithm), amount (i.e. size in the algorithm), position, direction, and other parameters of food.

Foraging etiquettes of honey bees

Intelligence behaviour of honey bees is developed due to the foraging behaviour. The foraging etiquettes of honey bees depends on three main elements: the food source, the employed honey bees and the unemployed honey bees. The functioning and behaviour of honey bees depends on two parameters: the selection on size of food source and the termination of low food junction.

(i) Sources of food: The food source [5,6] contents depend on various factors which includes the richness (energy concentration), easiness of energy extraction, and proximity to the nest. In other words it's the profitability of food source.

(ii) Employed foragers: Employed foragers (bees) [6] are related to a food sources which are currently under mining process by them. The information carried by employed bee about the food source is distance, direction and size of food source present. They share this information through the waggle dance to onlooker members.

(iii) Unemployed foragers: These are always searching for food source, categorized as scouts foragers and onlooker foragers. The scouts are new volunteers for food search; around the surrounding of the nest, at the same time onlooker bees are waiting for food source exploration, based upon the information shared by employed foragers [6].

The total numbers of scouts are about 5–10% of other bees in the nest.The entire hive divided in number of section. The most important part of hive is the dancing area where the source of information regarding quality of food sources is shared with onlooker's bee through the dance. This dance is known as waggle dance. The onlookers are observing dance pattern, then they decides to work for a food source. The profitability of food source is directly proportional to the recruitment of onlooker bee [5,6].

Organization of ABC Algorithm

The province of artificial bees in ABC algorithm comprises three types of honey bees [6]: employed bees, constantly looking for specific food sources, onlooker bees, observing the waggle dance of employed bees in the hive for food source selection, and scout bees, food source searcher. Onlooker and scouts are also known as unemployed bees. The positions of all the food sources are discovered by scout bees. These food sources are milked by employed bees and onlooker bees, and this continuous process of exploration will lead to termination of food sources. Which results that, the employed bee becomes a scout bee and starts searching for a new food sources?

In ABC process, food source position is identified as the solution to problem and fitness (quality) is represents the amount of a food source of the associated solution. The algorithm in its basic form, represents the, number of employed bees are equal to the number of food sources available, as the employed bees are associated with one and only one food source at a time. The algorithmic structure of the ABC optimization algorithm [6] is given as below in FIG. 1:

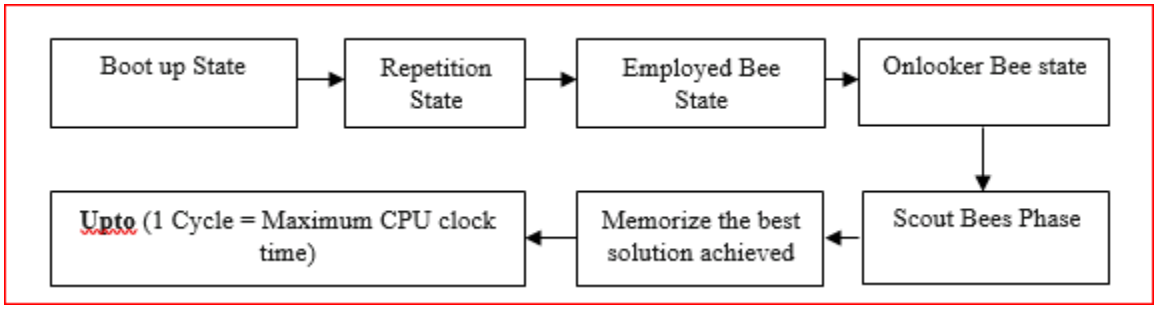

FIG. 1. **Step by step procedure diagram of ABC algorithm process [1].**

The scout bees initiate the control parameters setting as well as food source population. The employed bee starts looking for new food sources. The bedrock of new food source is first of all checked by its fitness value. Then, the information of food sources are shared by employed bee with onlooker bees through waggle dance at hive.

The onlooker bees select the food sources based on optimal probability value. For the evaluation of probability roulette wheel selection method is used.

Numbers of trials are used to find the optimal solution, if not found, then employed bees become scout bee, and the solutions of employed bee are terminated. Then scout bee searches for new solutions randomly. The food sources whose value becomes poor due to foraging process, or new food sources with little values, balances the aroused negative feedback behaviour to the positive feedback. These steps are recycled till a level of convergence is achieved.

Application of ABC in Health care

ABC algorithm is nowadays used in various fields [7] like image processing, signal processing, data mining, robot and navigation control, robust control system etc., followings are the few excerpts of use of ABC algorithm in medical science domain.

The biomedical signals are low amplitude, and low frequency signals affected by different noises, reason is interferences from different sources such as power line interference, movements of recording electrodes. The signal to noise ratio can be improved by designing the proper digital filters, can be applied to medical signals. An IIR filter for transcranial Doppler signal using ABC is proposed by Karaboga [8] to improve SNR value.

Biomedical sensors are used to collect human body signals, may contains the noise. This signal reflects the functioning of human body organ, improper functioning may results in deviation in these signals. Unfortunately there is no common filter to filter these noise signals, due to differences in the probability of distribution of noise. Transcranial Doppler signal are filtered by an adaptive IIR filter using ABC with window size of 1000 samples is proposed by Karaboga [9].

An Adaptive Noise Canceller (ANC) using Bounded Range ABC (BR-ABC) for filtering Electroencephalogram (EEG) / Event Related Potential (ERP) [10] is used. The performance of this algorithm is evaluated on scale such as, Signal to Noise Ratio in dB; correlation between templates ERP, difference between resultant, and mean values are used. The performance of ABC with noisy environment, in comparison with LMS, RLS shows the superiority. The adaptive noise cancellation techniques based on gradient methods such as LMS, and RLS and improved ANC based on Bounded Range ABC (BR-ABC) [10] algorithm is used for ERP filtering from an EEG signal affected by noise. The benefit of ANC based ABC technique is, its filtering capability and can be used in ERP filtering and artifact removal from the EEG signal.

Modified Artificial Bee Colony (MABC) algorithm [11] is used for classification of ElectroCardioGram signals, for diagnosis of arrhythmias signals. The output of MABC is compared with seventeen other outputs [11]. The classification rate of MABC is 99.30% (success rate), on balanced dataset it around 97.96%.

DNA microarray is a technology allows analysing gene level. The gene level indicates the synthesis of various messenger ribonucleic acid (mRNA) molecules [12]. The gene level expression is used in applications, such as diagnose diseases, tumor identification, selection of best therapy to avoid illness, detection of mutations within other processes. The classification suffers while identifying different classes of a particular disease.

The process of learning and recognition becomes difficult for any classification technique because of availability of few samples and large quantity of genes. The artificial neural network (ANN) is used for classification, prediction and

approximation. The methodology for classification of DNA microarray [12] involves a process based on swarm intelligence algorithm to classify the genes to identify the disease. To test the accuracy and evaluate the relevance of genes for correct classification of the samples of the disease of this method four different datasets are used. The fitness function of ABC algorithm with respect to Euclidean distance classifier is used to select the set of genes fit for the process.

ABC algorithm can be used for the segmentation of liver region for diagnosis purpose in Computer Tomographic images. In this centroid of cluster is calculated by ABC along with the region corresponding to each cluster [13]. It removes small and thin regions of liver covered by flesh regions, sharp edges of organs using morphological operations. A region growing method is used to enhance the process.

A multilevel segmentation approach using ABC is proposed by [14] for Iris detection. The multilevel thresholding may results as a time consuming process if number of threshold is not controlled. Two types of ABC algorithms, basic and G-best guided ABC along with Cuckoo Search (CS) and Particle Swarm Optimisation (PSO) algorithms are used to select the optimal thresholds distribution delimiting the components of the iris image for improving the process of iris detection.

The ABC algorithm is used for selection of various features in classification of EEG [15] signals. These features are band power, autoregressive model, coherence and phase locking values. The classification accuracy of EEG can be improved by considering features like artifact and background noise removal, feature extraction, feature selection, and feature classification elements. The artifacts and background noise are filtered by surface Laplacian filter, sub features are classified by support vector machine.

The effect of speckle noise can be reduced by using 2D FIR [16] filters in ultrasound images, which may affect the diagnostic decisions. The ABC can be used to optimize the filter coefficients with different window sizes. The different performance parameters such as mean square error (MSE), peak signal-to-noise ratio (PSNR) and signal-to-noise ratio (SNR), are used evaluate the effect of speckle noise degraded image.

The Enhanced Artificial Bee Colony Optimization (EABCO) is proposed by Sivakumar [17] is used to identify the nipple and breast border position to identify the suspicious regions on digital mammograms. This process involves bilateral subtraction between left and right breast image. The EABCO is used to detect the border and to find the nipple position. The performance parameters of algorithm are true positive and false positive detection are used to detect the asymmetry in images.

A better performance is achieved for diabetic diagnosis using ABC [18] using the mutation operator. The diversity of ABC is enhanced by using a blended crossover operator [18] of genetic algorithm. The various performance measures are classification rate, sensitivity and specificity are used by Beloufa [18].

A modified ABC (MABC) proposed by Dilmac et al. [19] is used for the classification of ECG heart beats for the diagnosis of arrhythmias in electrocardiographic signalsusing the clustering. A classifier based on MABC is developed, termed as MABCC. The heart beat signals are classified by distinctive features of ECG to achieve better success rate. The MABCC achieves the better classification rate (98.73%) in comparison with GA and PSO based classifiers.

Breast images affected by cancer, are captured through magnetic resonance imaging (MRI) technique. The performance of artificial bee colony (ABC) clustering algorithm is compared with the Enhanced SOM based K – means clustering algorithm to segment breast Dynamic Contrast Enhanced DCE- MR images [20]. Algorithm also provides a quantitative comparison of the performance of these image segmentation techniques with breast DCE-MR images. An ABC algorithm is used for clustering, every bee of the algorithm represents a clustering solution as a set of k cluster centres, and for clustering the breast DCE-MR images. ABC clustering algorithm based segmentation method provides good classifying results for the breast cancer data. Another clustering method known as the Enhanced Self-organizing features map based K-means clustering algorithm, is used to enhance the search of an optimized space to operate the clustering. Therefore clustering acquires more information as compared to other segmentation method. The misclassified pixels can be corrected partially by SOM based K-means clustering. Therefore better results are obtained by using ABC with clustering than hybrid method of K-means algorithm and SOM method.

The attributes of Artificial Bee Colony (ABC) and radial basis function networks (RBFNNs) are used to analyse the epileptic disorder in human brain through EEG signal. For classification [21] of EEG signals, the RBFNNs have been trained by a modified version of ABC algorithm. In thisvariant of ABC, the onlookers are selected based on binary tournament. Metrics such as Gaussian, Multi-quadric, and Inverse-multi-quadric are used for measuring the effectiveness of the method in numerous mixtures of healthy segments, seizure-free segments, and seizure segments. The test results shows that RBFNN with inverse-multi-quadric kernel trained with modified ABC is superior than RBFNNs with other kernels trained by ABC and modified ABC.

Conclusion

From the above discussion, ABC algorithm is widely used in the field of health care because of advantages offered like foraging behaviour of honey bees, fast convergence speed, good classification behaviours. Also the ABC algorithm can be embedded with other algorithm for efficiently for obtaining a certain type of result. Use of AI with ABC algorithm is a latest trend widely used by researchers nowadays.

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