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Genetic Algorithms as a Tool for Assisting Medical Diagnosis in Oncology and Radiology

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ABSTRACT

Data on medical diagnoses might be complex and challenging to interpret with conventional statistical techniques. Metaheuristic algorithms, like genetic algorithms, have been created recently to offer almost ideal solutions to challenging medical issues. Natural selection is mimicked by genetic algorithms, which are nature- inspired methods for finding the best answers to challenging issues. Although genetic algorithms are widely employed in other industries, their potential in medicine is yet largely unexplored. This article examines possible medical applications for genetic algorithms and provides a synopsis of the related research.

Keywords : Conventional Statistical Techniques. Metaheuristic Algorithms

I. INTRODUCTION

The area of medicine has been altered by technological developments, which now make disease diagnosis, treatment, and management more effective and accurate. With the growth of big data in healthcare, the demand for sophisticated algorithms and computational techniques to analyze and extract useful information from these enormous datasets has increased. Genetic algorithms (GAs), a class of metaheuristic algorithm influenced by the concepts of natural selection and genetic variation, are one such algorithmic technique.

In a variety of disciplines, including engineering, economics, and computer science, GAs have demonstrated tremendous promise in resolving challenging optimization issues. Despite the potential advantages they may provide in a number of medical fields, including radiology, cancer, cardiology, neurology, and pharmacology, their use in medicine is yet largely unexplored. GAs can help medical practitioners analyse sizable datasets, find pertinent biomarkers, improve treatment regimens, and create personalized medicine strategies for specific patients.

In order to better understand how GAs could be used in medicine and healthcare, this paper will discuss some of these applications, including disease screening, diagnosis, treatment planning, pharmacovigilance, prognosis, and healthcare administration.

Further in this research, we will examine a segmentation technique used in radiology that uses both shape and textural information to distinguish a target object in an image.

II. GENETIC ALGORITHM

A GA is a metaheuristic approach that seeks to solve complicated issues by using rules of genetics as inspiration. This approach generates a set of random solutions (individuals), each with a variety of features (chromosomes). Chromosome cross- over and mutations result in a second generation of people with more varied traits, according to the laws of genetics.

The guiding principles of the genetic algorithm, which is based on natural selection, the fundamental rule of nature, are survival of the fittest and elimination of the inferior. The mechanism of natural selection is influenced by the diversity of individual features as well as the replication and selection of individuals, as well as their inheritance and recombination. Through these mechanisms, selection can continue from one generation to the next, assisting in the organism's evolution in the desired direction. This enables species to congregate and flourish in many directions, resulting in the diversity of creatures.

Holland first introduced the Genetic Algorithm in the early 1970s, basing it on Darwin's thesis of the survival of the fittest and natural selection. Genetic algorithms are now widely employed in the fields of engineering, business, and science. We can find a better remedy for the prior solution but can't find a new one. One of the most crucial search techniques is feature selection. The new, superior answer to the earlier outcome only stands in contrast to the others. The stop measure is therefore not always obvious in each issue. In general, genetic algorithms rely on biologically motivated operators like crossover, selection, and mutation to generate high-quality solutions to search and optimization problems [1].

Genetic algorithms are a good stochastic search technique with large applications in many fields since they are easy to implement, quick in target finding, and powerful in coding. This gives them a significant advantage over other search algorithms. A genetic algorithm's implementation and computation are primarily carried out through a number of crucial functions that are unique to genetic algorithms. The computation's direction is determined by setting the function and using the direction's adjustment to reach the desired result. Studying and establishing the algorithm's parameters is important to enhance the genetic algorithm and obtain the desired initial result.

III.ONCOLOGY

In cancer, genetic algorithms (GAs) have become effective methods for analyzing vast and intricate datasets. Finding the best chemotherapy drug combinations for the treatment of cancer is one area of application. Because traditional chemotherapy medications frequently have serious adverse effects and are not always effective, patients require customized therapies based on their unique genetic profiles.

In a study by Zhou et al.i, the best chemotherapeutic medication combination for the treatment of non-small cell lung cancer was determined using GAs. Based on the genetic profile of the patient and the features of the tumor, the study applied a GA-based algorithm to optimize the drug combination. In comparison to conventional chemotherapy regimens, the algorithm was able to select an ideal mix of chemotherapy medications that increased patient survival rates and decreased toxicity[2].

Predicting cancer recurrence and patient survival rates is another area of use. A GA-based predictive model for the recurrence of hepatocellular carcinoma was created in a study by Yang et al. This program which combined clinical and genetic data, was able to precisely forecast the likelihood of cancer recurrence and patient survival rates[3].

Natural selection serves as the inspiration for a particular kind of optimization technique known as genetic algorithms (GA). GA has been used in oncology to solve a variety of issues, including determining the best course of therapy and forecasting patient survival rates. Here, we will contrast various GA methods for estimating breast cancer patients' survival rates from tabular data.

Genetic algorithms (GA) are optimization techniques inspired by the principles of natural selection. In the field of oncology, GA has been applied to solve various problems, including determining the optimal course of therapy and predicting patient survival rates. In this section, we will compare different GA methods for estimating the survival rates of breast cancer patients using tabular data.

To predict the survival rates, three types of GA methods were employed: binary GA, real-valued GA, and integer GA. Each method represents the features differently. In binary GA, features are encoded as either 0 or 1, indicating their absence or presence, respectively. Integer GA represents each feature as an integer value. Real-valued GA, on the other hand, represents features as real numbers.

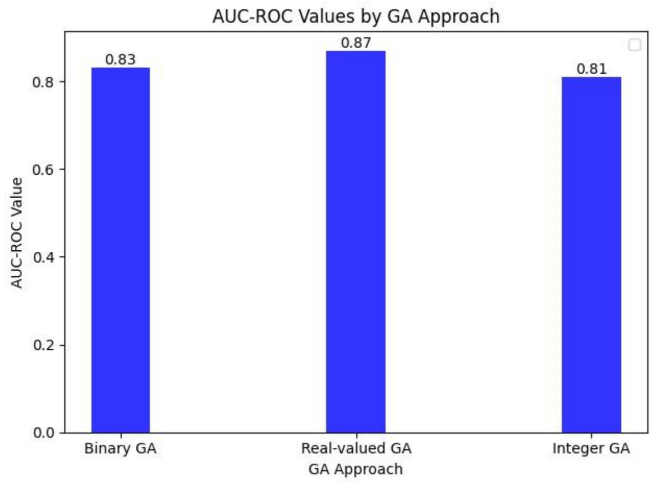
The performance of each method was assessed using the Area Under Receiver Operating Characteristic Curve (AUC-ROC), which measures the ability of a predictive model to distinguish between positive and negative outcomes.

For this investigation, we utilized the Cancer Genome Atlas (TCGA) breast cancer dataset. This dataset includes clinical data and gene expression information for 1,098 breast cancer patients. The clinical data comprises various factors such as patient age, tumor size, lymph node status, estrogen receptor status, progesterone receptor status, HER2 status, and survival status [4].

By employing these different GA methods on the TCGA breast cancer dataset, we aim to evaluate their effectiveness in predicting the survival rates of breast cancer patients. The comparison of these methods using the AUC-ROC metric will provide insights into the most suitable approach for survival rate estimation in this context.

Genetic Algorithm Approach	AUC-ROC Value
Binary GA	0.83
Real-valued GA	0.87
Integer GA	0.81

Table 1: shows the AUC-ROC values for each GA approach



The graph given below represents the data provided in Table 1.

Overall, the use of genetic algorithms to oncology holds out a lot of promise for enhancing the precision of cancer diagnosis, care, and prognosis. To completely comprehend the possible advantages and restrictions of these algorithms, more study is necessary.

IV.RADIOLOGY

Radiologists must quickly analyze and understand the massive volumes of data that are generated by radiology imaging techniques. Computer-aided detection and diagnosis are essential interdisciplinary technologies that can speed up and improve this procedure. Through the detection, segmentation, and classification of normal and abnormal patterns visible on many imaging modalities, including X-rays, MRI, CT scans, and ultrasound, these technologies aim to help radiologists analyze medical pictures more quickly and accurately.

The human body's organs in radiology scans are an example of a scene that is captured, analysed, and interpreted using machine vision. The borders (form) and sizes of the things inside the photographs must be determined in order to examine the objects more thoroughly. Edge detection hence becomes one of the key elements of automatic image processing techniques. Numerous studies have taken advantage of the GAs to identify the edges of images captured using various imaging modalities, including MRI, CT, and ultrasound.

Image enhancement and classification are vital components of digital and medical image analysis. These tasks can be categorized as supervised and unsupervised approaches. Supervised classification involves using specific tools to extract quantitative information from images with known labels, while unsupervised classification utilizes clustering techniques and algorithms to classify data without prior labeled information. Segmentation is a fundamental image processing task that aims to partition an image into homogeneous regions. It involves identifying and separating distinct objects or regions of interest within an image. The following table provides an overview of various studies that have utilized Genetic Algorithms (GAs) in different medical applications:

Author	Year	Technique	Invention
Anbarasi et al [5]	2010	Genetic Algo	Reduce the number of ECG test
Kiran et al	2011	Genetic Algo	Predict the Heart Attack
M. Jafari [6]	2012	Genetic Algo	Automatic Tumor Detection
A. Kaur[7]	2013	Genetic Algo	Identify the image areas with maximum chances of tumor
I. Bala	2014	Genetic Algo	Brain Tumor detection
G. R. Chandra [8]	2014	Genetic Algo	Extract the abnormal tumor portion in the brain

Table 2: Previous research analysis

A general-purpose image segmentation system called GENIE ("Genetic Imagery Exploration") uses a genetic approach to develop image- processing pipelines for a variety of image processing applications. These pipelines are made up of a series of basic image processing steps, such as filters, edge detectors, morphological, arithmetic, and point operators. Each person in the population is assessed for fitness by the genetic algorithm, which then chooses the fittest individuals to form the following generation and employs crossover and mutation to make children. By contrasting each pipeline's final classification output with a collection of training photos on which both good and bad examples of the desired feature have been manually marked, researchers may assess each pipeline's fitness within the population. In order to segregate the desired feature in new images by classifying each pixel as positive or negative, the fittest process is combined with a linear classifier. Harvey et al. ii specifically addressed GENIE to a medical feature-extraction problem using multi- spectral histopathology photos to distinguish between benign and malignant cells from a variety of samples. Their method was successful in identifying cancerous cells on images of breast cancer tissue[9].

A therapeutic robot for lower limb exercise was developed in a different publication. The system, which was made up of an ANN and a GA, could simulate a physiotherapist's behavior without one by learning how to respond for each patient[10].

In this paper, we outline a technique for segmenting images using high-level textural and shape information. The technique makes use of a collection of training images where a segmenting contour is manually made around a specific object (in this case, the prostate in a two-dimensional CT scan). A level set function in the system serves to represent a segmenting contour. Each segmenting contour has a different size, position, and direction, as well as a distinct shape.

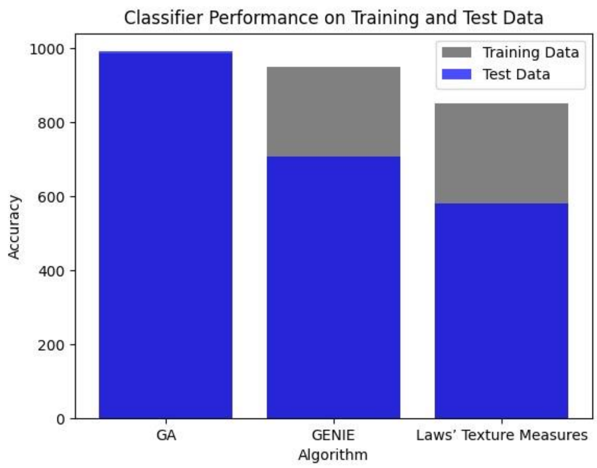
There is also a collection of "test images" that are not part of the training set and for which segmenting contours have been provided by a human. The objective of this task is to evolve a contour that segments an object of the desired class in a new image while adhering to shape constraints discovered in the training images and enclosing a region whose texture is a good match for textures discovered in the training images.

The steps in this process are, in brief, as follows:
1. Create a representation of the shape prior, or the average shape and variability of the n segmenting contours, from a set of n manually segmented training images.
2. Create a representation of the segmented objects' mean texture using the same training photos.
3. Apply the GA to generate a segmenting contour for identifying the desired object in a new image that is not part of the training set, as shown below:
(i) Begin with a base population of shapes that were generated randomly and were limited by the shape prior from step 1.
(ii) The similarity between the texture of a particular shape's contained region and the mean texture from step (2) serves as a measure of the shape's fitness.
(iii) create a new population by performing selection, crossover, and mutation as will be discussed later.
(iv) Continue until either a fitness score over a predetermined threshold is attained or more than 1000 iterations have been performed.
4. Calculate the "goodness of fit" of the fittest individual from the final generation [11].

The comparative study of the new approach and the previous approaches is as follows:

Algorithm	G: Training Data	G: Test Data
The GA Based Approach	985	991
GENIE	950	708
Laws' Texture Measures	850	580

Table 3: Goodness of fit of the final segmentation obtained.



The graph given below represents the data provided in Table 2

V. REFERENCES

[1]. Mitchell & Melanie, an Introduction to Genetic Algorithms, MIT press, Cambridge, 1996.

[2]. Zhou Y, Wang Z, Chen Y, Wei Y. Optimization of chemotherapy regimen using genetic algorithm for non-small cell lung cancer. Comput Biol Med. 2018.

[3]. Yang Z, Wu Y, Zhou Y, Jiang Y, Chen L, Wang C, et al. A genetic algorithm-based model for prediction of hepatocellular carcinoma recurrence. J Clin Lab Anal.

[4]. Ding, L., Ma, C., Xi, Y., Huang, J., Chen, M., & Hu, Y. (2018). A comparative study of genetic algorithms for predicting breast cancer survival. BMC medical genomics, 11(Suppl 5), 107.

[5]. Masilamani, Anbarasi & ANUPRIYA, & Iyenger, N Ch Sriman Narayana. (2010). Enhanced Prediction of Heart Disease with Feature Subset Selection using Genetic Algorithm. International Journal of Engineering Science and Technology.

[6]. Jafari, Mehdi, and Reza Shafaghi. "A hybrid approach for automatic tumor detection of brain MRI using support vector machine and genetic algorithm." Global journal of science, engineering and technology, vol. 3, 1-8, 2012.

[7]. Sharma, Pooja, Gurpreet Singh, and Amandeep Kaur. "Different Techniques Of Edge Detection In Digital Image Processing." International Journal of Engineering research and Applications 3.3, pp. 458-461, 2013.

[8]. R. Kumar, G., G. A. Ramachandra, and K. Nagamani. "An Efficient Feature Selection System to Integrating SVM with Genetic Algorithm for Large Medical Datasets." International Journal 4.2 (2014).

[9]. Harvey, N., Levenson, R. M., Rimm, D. L. Investigation of automated feature extraction techniques for applications in cancer detection from multi-spectral histopathology images. Proc. of SPIE 2003, 5032, 557-566.

[10]. Aminiazar W, Najafi F, Nekoui MA. Optimized intelligent control of a 2- degree of freedom robot for rehabilitation of lower limbs using neural network and genetic algorithm. J Neuroeng Rehabil 2013.

[11]. Ghosh, Payel & Mitchell, Melanie. (2006). Segmentation of medical images using a genetic algorithm. GECCO 2006 - Genetic and Evolutionary Computation Conference.

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