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Clinical Application of Neural Network for Cancer Detection Application

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Abstract

INTRODUCTION: The field of medical diagnostics is currently confronted with a significant obstacle in the shape of cancer, a disease that tragically results in the loss of millions of lives each year. Ensuring the administration of appropriate treatment to cancer patients is of paramount significance for medical practitioners.
OBJECTIVES: Hence, the accurate identification of cancer cells holds significant importance. The timely identification of a condition can facilitates prompt diagnosis and intervention. Numerous researchers have devised multiple methodologies for the early detection of cancer.
METHODS: The accurate anticipation of cancer has consistently posed a significant and formidable undertaking for medical professionals and researchers. This article examines various neural network technologies utilised in the diagnosis of cancer.
RESULTS: Neural networks have emerged as a prominent area of research within the medical science field, particularly in disciplines such as cardiology, radiology, and oncology, among others.
CONCLUSION: The findings of this survey indicate that neural network technologies demonstrate a high level of efficacy in the diagnosis of cancer. A significant proportion of neural networks exhibit exceptional precision when it comes to categorizing tumours cells.

Keywords: Cancer, Neural Network, Cells, ML

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1. Introduction

Cancer is a comprehensive term employed to designate a pathological condition arising from the unregulated proliferation and division of cells. The majority of cells within the human body exhibit distinct functionalities and have a predetermined lifespan [1]. However, it is important to note that cell death is an inherent biological phenomenon that transpires via a regulated mechanism referred to as apoptosis. Apoptosis is a biological process wherein a cell undergoes programmed cell death, thereby enabling the organism to replace it with a more functionally proficient counterpart [2]. Unfortunately, malignant cells exhibit mechanisms that would stop proliferation and die in programmed cell death and consequently these compounds grow settled in the organism, and generally relying on oxygen and nutrients supplied by neighbouring cells [3].

The proliferation of these malignant cells can promote neoplastic growth, compromise immune integrity, and induce pathological changes that disrupt normal bacterial physiological processes using DNA microarray technology plays a major role in cancer diagnosis and prognosis. The use of this technology offers significant advantages in analysing gene expression levels in cell hybrids simultaneously [5].

The use of gene expression data for detection at the molecular level provides a systematic and accurate approach to cancer classification. Accurate tumour classification is important for cancer treatment [6-8] . Using data mining techniques, statistical techniques and machine learning algorithms, researchers explored the challenges associated with cancer classification to accurately assess gene expression profiles that typically encompass a large number of genes.

The use of neural network techniques has proven to be very useful in the diagnosis and management of cancer. Recent studies have shown its effectiveness as a reliable tool for clustering or classifying gene expression data in artificial tissues [9] Clustering is an unsupervised learning task so that shows patterns or patterns in a data set without existing columns or descriptions Effective use has been demonstrated [10-12]. This has made them invaluable in the diagnosis and management of the neonatal stage of cancer.

This article uses deep learning as a key technique for identifying and classifying cancer cells. The classification process of an object involves assigning it to a predefined group or class, which is determined by a collection of observations about the object in question Using Convolutional Neural Networks (CNN), an internal learning love a technology and classify images.

Convolutional neural networks (CNNs) are artificial neural networks that are characterized by their multi-layered structure, which includes the co-organization of local subsets of receptive neurons connections to extend the whole of an image. Subsequently, feature maps are generated with equal weights and bias criteria [13]

The architectural design presented in this study effectively reduces the parameter estimation required for neural network training, thereby increasing the overall performance of the learning algorithm. The process of detecting cancer cells typically comprises two sequential stages: initial pre-processing of the dataset images, followed by subsequent classification of the images [14].

In order to categories the images, a Convolutional Neural Network (CNN) was employed, which had undergone training using the Invasive Ductal Carcinoma (IDC) dataset. As exemplified, Figure 1 depicts an image of a malignant cell.

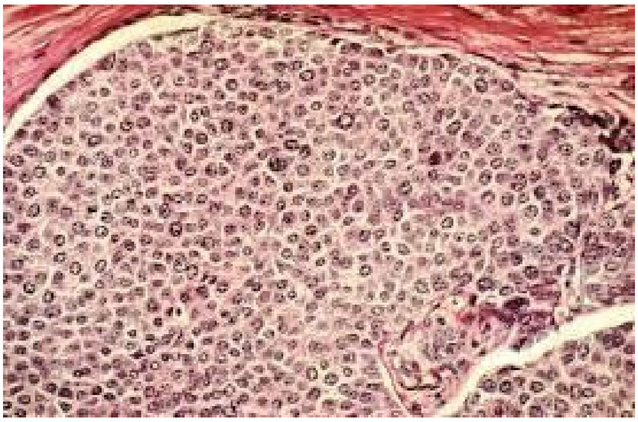

Figure 1 Cancer Cell

2. Neural Network

Neural networks are a mathematical model that takes inspiration from the biological processes seen in the human brain. Networks are constructed by joining numerous basic processing components via weighted paths [15]. In layman's terms, a neural network is formed of a collection of processing units known as neurons, which are coupled by synapses. A neural network contains a high degree of parallelism, therefore displaying the property of parallel distributed processing [16].
The learning techniques applied in neural networks may be generally divided into three major types:

2.1 Supervised learning

Supervised learning includes training a network by associating each input pattern with a matching output pattern, which acts as the desired or goal pattern. In the context of the learning process, it is commonly believed that a teacher is present to assist the assessment of the calculated output of a network and compare it with the predicted output in order to establish the level of inaccuracy [17]. The error may be exploited to adjust network settings, ultimately leading to an upgrade in performance. Several examples of supervised learning networks include the Backpropagation network, Tree neural network, and Time delay neural network, among others.

2.2 Unsupervised learning

Unsupervised learning refers to a form of machine learning where the network does not have access to the intended output [18]. The lack of a teacher to transmit desirable patterns leads in the system autonomously learning knowledge via the detection and modification of structural properties within the input patterns. Several examples of unsupervised learning networks.

2.3 Reinforcement learning

Reinforcement learning Within this strategy, a teacher, although present, refrains from supplying the expected response and instead just signals whether the calculated output is regarded right or wrong. The information supplied aids the network's learning process. A reward is supplied as a sort of encouragement for an answer that is regarded accurate, while a penalty is enforced for a response that is deemed erroneous. However, it should be mentioned that reinforcement learning does not rank among the commonly regarded ways of learning.

There are various benefits linked with the usage of neural networks.
Machine learning demonstrates the potential to gain information via experience, increase its performance, and alter its behavior in response to new and dynamic contexts.
• Owing to its computing strength, machine learning has the potential to perform numerous operations simultaneously.
• Machine learning does not place any constraints on the input variables it can process.
The usage of neural networks in numerous disciplines has received substantial interest in academic and industry contexts. Neural networks have found applications in many domains such as computer vision, natural language processing.
The subjects of interest include anticipating the behavior of complex systems, pattern recognition and image processing, control systems, forecasting and risk assessment, optimization and constraint fulfilment, signal processing, and data compression.

3. Literature Survey

An approach for cancer classification. This methodology integrates both supervised and unsupervised learning methodologies. In the context of supervised learning, it is common practice to employ a single layer of hidden neural networks (nns) with the objective of minimizing errors [19].

To determine the optimal network configuration, various activation functions are tested. The usage of unsupervised learning techniques encompasses the application of fuzzy, non-fuzzy, and c-means clustering algorithms. The network gets many metrics, such as cell size, average intensity, structure, form factor, and PGDNA, as input [20].

The assessment of the outcomes was undertaken using a dataset consisting of 467 photographs belonging to six different cancer classifications [21]. The classification rate attained by the application of neural network approaches was determined to be 96.9%. In contrast, the fuzzy c-means method gives only 76.50% success rate.

The methods proposed by Won et al. It involves the use of network classifiers to classify cancer based on negatively correlated criteria. The effectiveness of the proposed method is evaluated using three reference points [22].

The experimental findings indicate that classifiers with negatively correlated features exhibit higher levels of insight when applied to reference data.

A hybrid of particle swarm optimization (PSO) was suggested by Xu et al., where a mixture of probabilistic neural networks (PNN) and discrete binary versions was used the main application of PNN is to optimize gene selection and reduced dimensionality [23].

Furthermore, the use of Feed Forward Neural Network (FNN) is used to build neurons. The effectiveness of this approach has been demonstrated through rigorous testing in several cases including B-cell lymphoma patients, yielding an impressive accuracy rate of 80%.
A unique approach to cancer classification using artificial neural networks (ANN). Subjects are classified using the Wisconsin Breast Cancer Database, which has a total of 699 patients. There are two main types of white blood cell difference (WBCD) tumors, usually benign and malignant. Artificial neural networks (ANNs) are used with the objective of classifying the situation, while multi-objective genetic algorithms are used to reduce the search area and find optimal structures for ANN topologies [24].

A unique technique for cancer prediction, utilizing the perceptron network as a computational tool. The network was tested using the Diffuse large B-cell lymphoma (DLBCL) dataset, which included of 4026 genes. The genes were prioritized by calculating their signal-to-noise ratios, and afterwards, a threshold value was calculated [25]. The genes having signal-to-noise ratios below the stated threshold were eliminated from the study. Subsequently, a perceptron network was deployed to categories the patients, reaching an accuracy rate of 93%.

The aforementioned technique was employed for the purpose of categorizing microarray data pertaining to acute leukemia and brain tumors. Tumours exhibit a classification rate exceeding 90%. The researchers integrated both wrapper and filter methodologies to apply these techniques to genotypic microarray data pertaining to leukemia and central nervous system tumors [26].

The ensemble-based neural network approach proposed by Cho et al. Aims to efficiently detect cancer classes by utilizing multiple gene subsets that are deemed relevant. The efficacy of this methodology was evaluated using three distinct sets of cancer data, namely Leukemia, Colon, and Lymphoma datasets. The error back propagation algorithm was utilized to train the neural network on the specific gene subsets [27]. The perceptron model employed in this study was a multi-layer neural network with three layers.

Specifically, it consisted of 30 hidden nodes and two output nodes.

A novel hybrid methodology that integrates granular computing and fuzzy clustering techniques with statistical learning methods. Additionally, a Recursive Feature Elimination algorithm is employed to eliminate superfluous or noisy genes. The algorithm exclusively examines a large number of genes and selectively identifies those that are pertinent [28]. The task is accomplished with a level of precision amounting to 100%, utilizing three distinct open databases.

Procedure for detection and diagnosis of brain tumours. This study uses neural networks to analyse magnetic resonance imaging (MRI) images of a cohort of cancer patients. A new method for identifying tumour cells. The classification problem was solved using Support Vector Machine and Feedforward Neural Network. The proposed method was tested using established cases of liver cancer [29]. The empirical findings show that the proposed method shows remarkable improvement in cancer cell classification compared to conventional cancer segmentation methods. This paper provides an overview of various strategies for selecting among the discriminating genes for ranking applications. Fuzzy neural networks exhibit efficiency rates ranging from 92% to 96%. The importance of the feature selection process is magnified by the increased availability of cancer microarray data [30].

4. Architecture

The architecture used in this study differs from the traditional convolutional neural network in terms of the convolutional layer type and the number of pooling layers used the training system of the model includes the Convolutional Neural Network (CNN) architecture layers.

4.1 CNN

Computer vision is a subfield within the domain of Artificial Intelligence that pertains to the ability of a computer system to perceive and analyses images or visual data. The feature vector of CNN is initially inputted into the first layer and subsequently undergoes a transformation process, resulting in the generation of a high-level features vector as the layer advances. Neural networks are mathematical constructs consisting of neural units, commonly known as neurons. Biological neural networks bear resemblance to them in terms of their typical arrangement of neurons in layers and the establishment of connections solely between adjacent layers. The outputs of the neurons in the output layer are indicative of different classifications, with the number of output neurons being equal to the number of available classifications. The convolutional layers are comprised of a set of trainable transformations that perform dot product operations between the trainable transformations and the input of the layer in order to generate an activation map.

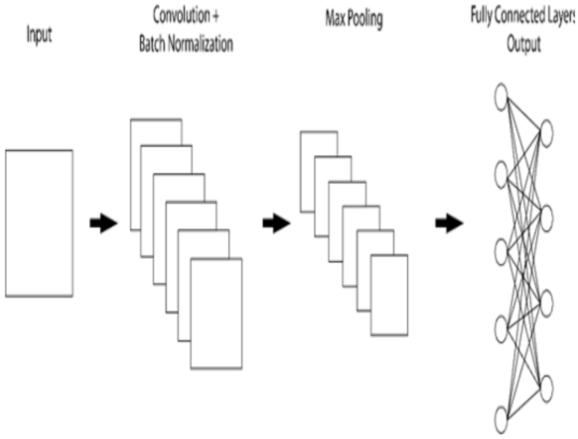

Figure2 CNN Model

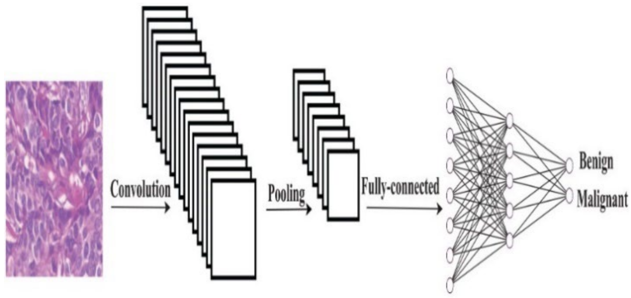

Figure 3 CNN Training Methodology

5. Result

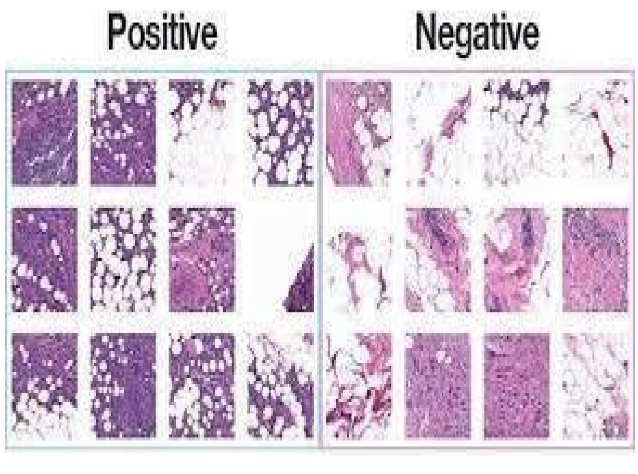

Figure 4 Cancer Cell Detection Result

This section presents a comprehensive summary of the experimental outcomes achieved through the utilization of Convolutional Neural Networks (Conv Nets) in the context of cancer cell detection. The analysis commences with a comprehensive examination of the dataset employed in the experimental study, subsequently followed by the presentation of the findings. The architectural design has been executed utilizing the Python programming language.

6. Conclusion

Cancer is an affliction of enormous magnitude, and timely detection plays an important role in the successful management of this disease. Cancer databases include a wide range of genes, determined by DNA microarray technology. The analysis of microarray gene expression data presents formidable challenges due to its limited scope and redundancy. Discovering informative genes from a large genome is a challenging task. By analyzing gene expression profiles, different types of cancer cells can be classified into subpopulations. In recent years, researchers have been increasingly interested in exploring the mechanisms of tumor cell division.

The findings of this study indicate that tissue-based technologies prove highly effective in cancer detection. A large proportion of neurons exhibit exceptional accuracy when it comes to tumor cell segmentation. The MLP algorithm exhibits high accuracy, in particular, yielding 97.1%. PNN follows closely with an accuracy of 96%, while the Perceptron algorithm achieves a slightly lower accuracy of 93%. Finally, the ART1 algorithm achieves an accuracy rate of 92%. After removing missing values from the data set, there is a noticeable improvement in the experimental results. Optimization of neural network systems can enhance performance by modifying network parameters. Adaptive classification rate is achieved using neural network techniques; However, training requires a lot of time.

For accuracy, many researchers have used neural network techniques with optimization algorithms such as particle swarm optimization (PSO). These algorithms are used to reduce dimensionality, limit the search space, and consequently reduce the time required to train the neurons. For example, the FLANN algorithm exhibits a classification accuracy of 63.4%, while the PSO-FLANN algorithm exhibits an adequate classification rate of 92.36%.

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