AN OVERVIEW OF ARTIFICIAL NEURAL NETWORKS IN CANCER STUDIES

By

KEERTHANA T

Department of Biomedical Informatics

Rutgers University - School of Health Professions

Piscataway, NJ

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Professor: Dr. Dinesh P. Mital

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1. ABSTRACT

The second leading cause of death after cardiovascular disease is cancer worldwide, according to the world health organization (2018). Diagnosing cancer in the early stages can help in the early medical interventions for the better recovery and outcome. The studies were conducted to understand the of the various types of cancer and their stages. The artificial neural networks (ANN) are the multi-layer fully connected information processing paradigm inspired by the biological nervous system. The use of the ANN was highly significant in clinical and biological research over the past few years. These artificial neural networks are being trained and used while designing using publishing the experimental biomedical, clinical results worldwide to enhance the confidence of the quality and the reliability of the statistical data. The neural networks manipulate well-defined data. Nowadays, to monitor the aggressive activity of the cancers, artificial intelligence technology is used, and to predict the diagnosis and prognosis of the cancers numerous innovative methods were identified. They were also used in the formulating the potential guidelines and to determine the mode of treatment.

Finally, this paper explains how the artificial neural network works in an accurate diagnosis and prognosis of the various cancer studies and aids in a better treatment plan respective to the type of cancer in the patient.

2. OBJECTIVE

The artificial neural network has been used tremendously used as a nonlinear statistical data modeling. The main objective is to understand the application of ANN in cancer studies by

a. Prediction
b. Diagnosis
c. Prognosis

3. INTRODUCTION

The artificial neural network is a machine learning approach inspired by the way the thoughts and information are processed in the brain during a learning task. It is a massively parallel distributed algorithm in a computing system that has a property of natural propensity for storing and using the clinical and biological experimental data or knowledge. ANN is a knowledge acquired learning process, and the interneurons connection strength known as synaptic weights are helpful in the storage of data and knowledge, which is similar to the process in the brain. Using ANN in the for the medical diagnosis is a significant milestone in forecasting the data. ANN can subtly expand the boundaries of decision support systems (DSS). In healthcare organizations, the ANN enables the provision of predictive diagnosis biomedical imaging and monitor of the health standards in the patients.

4. BACKGROUND – ARTIFICIAL NEURAL NETWORK

In 1943, the first idea of the neural network was conceived by neurophysiologist Warren McCulloch and mathematician Walter Pitts and described the work of neurons and modeled the idea by creating a simple neural network with the help of electrical circuits [1].

According to Donald Herb in 1949, pointed out the fact that neural pathways are strengthened every time, similar to the fundamental learning in humans. He also stated that the connection is stronger and enhanced of the two neurons fire at the same time.

Over the period, this idea was merged with various testing systems and interphases, and the first multilayered unsupervised network was developed in 1975 [1].

The computational strategies are a more successful and effective method in analytical and biological studies. The biomedical systems must progressively analyze the nonlinear systems so that ANNs will be valuable computing methods for clinical studies. ANNs application to numerous aspects of cancer studies over decades. However, later research endeavors in this field have been merged with new information about the clinical aspects of malignant growth [2].

In cancer research, the prognostic analysis is made by the cancer biomarkers and the noninvasive diagnosis with the cytometric data an predicting the metastatically potential risk of cancer in the individuals [3]. The data should be input into the systems of artificial intelligence, and the algorithms are designed and coded.

ANN in cancer studies is skilled in generating the output with the combination of variables and input. There are multiple layers where the data is processed, and they include hidden layers which depict the neural connections. These hidden layers form the interconnected nodes typically have sensitive information, which is critical to the cancer research [4].

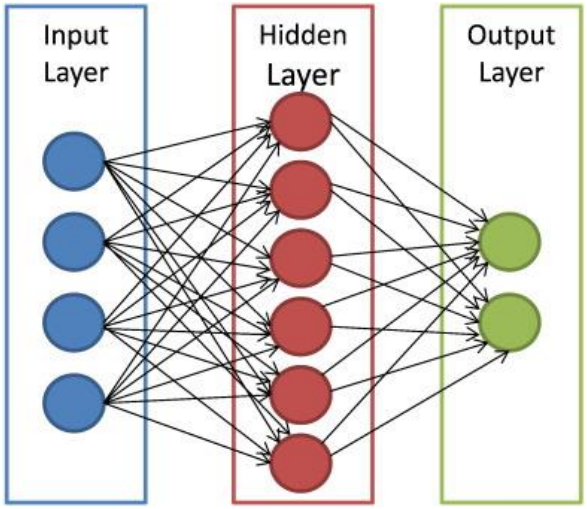

Figure 1: Represents the structure of an ANN with its interconnected group of nodes.

5. METHODLOGY

The prediction of the probability of breast cancer can be performed by the ANN. The screening and diagnostic mammograms were consolidated in the form of database which was interpreted by the radiologists. The demographic data was collected in case of negative mammogram with single entry and one image reported the finding were classified as false positives. The demographic risk factors were also included as input variables. The ANN was designed with various number of hidden nodes and output nodes with the probability of the malignant tumor in each individual finding.

The ANN was trained and tested in a tenfold cross validation for ensuring not to use the test samples. The supplementary analyses were performed to assess the robustness of the ANN. The first half of the database was skilled with ANN and tested on the second half of the database. Similarly, the second half of the data base is skilled, trained and tested on the first half of the data base.

The ability of the ANN model was evaluated and with group of radiologists. The ROC curve was generated for all the individual findings and from the ANN module and was compared to the ROC curve developed by the aggregate level of radiologists. The likelihood of the case was assessed and in the exact approach the sensitivity specificity and AUC were also obtained from the data findings [5].

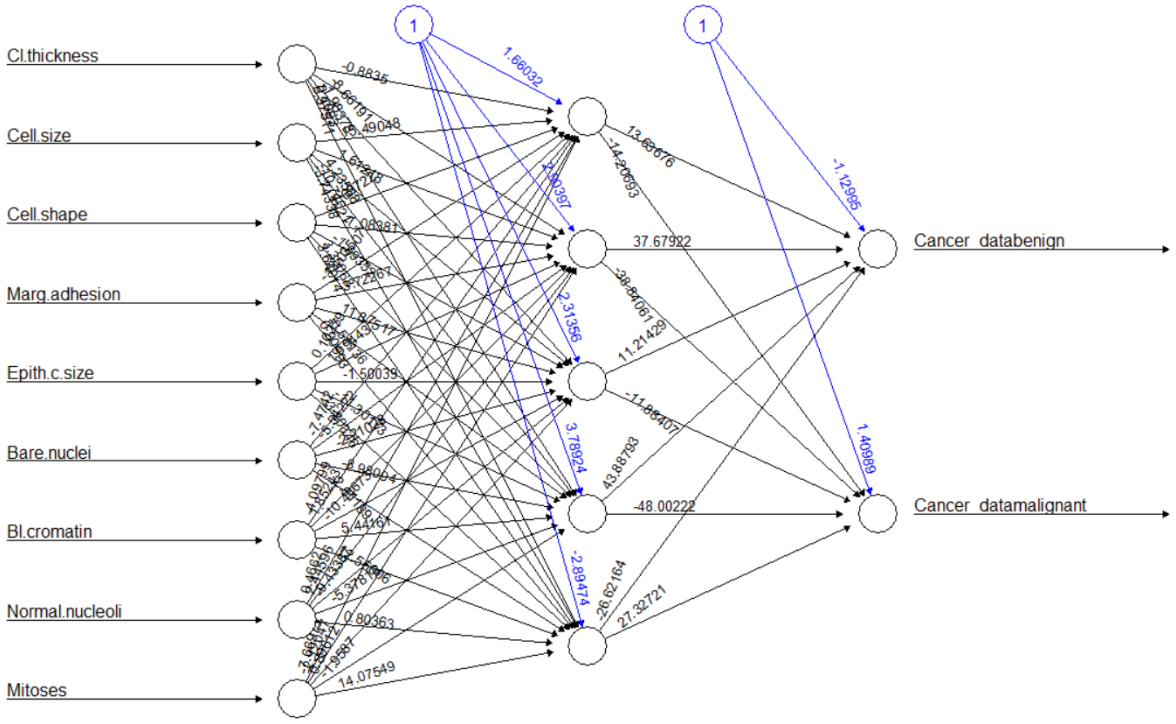

Figure 2: The typical structure of ANN with the interconnected nodes to predict the malignancy of the breast cancer is represented by the figure below.

The ANN can accurately predict the data of large collected data set and can differentiate the benign and malignant tumors in the individual patients with probability of breast cancers. The study has used the logical representation (LR) and Bayesian networking (BN) [5].

The significance of ANN in cancer diagnostics, the best example would be the study of colorectal neoplastic lesions. In this study, ANN was framed based on the principle of Feedforward secured with error propagation. The whole set was designed with two hidden layers, the input node and the output node. The ANN was skilled and tested for the data samples, and the data were evaluated using regression analysis. The data showed the analysis of human colonic neoplastic lesion combined with the cDNA microarrays, which differentiated the type of colon cancer based upon the lesions. Based on this case study, the ANN is an exceptional statistical approach to understand role of cancer biomarkers, their discovery, and manifestation along with medical diagnosis [7].

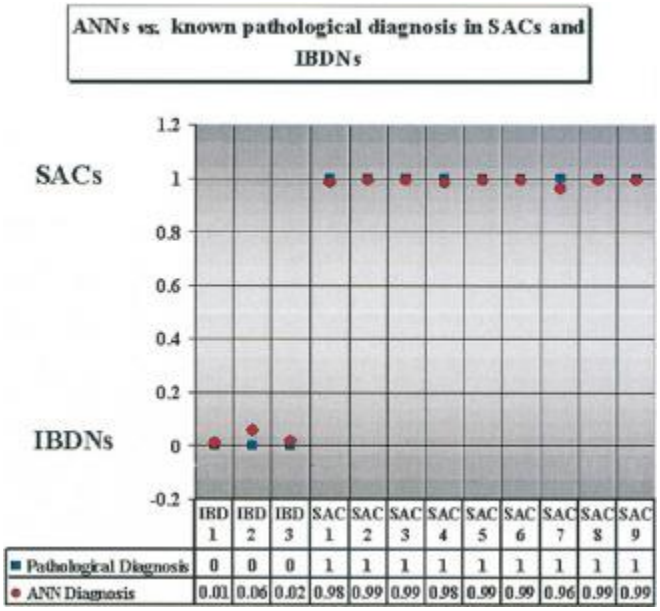

Figure 3 : The Graphical representation of diagnosis based on ANN. The Y-axis numerical representation if the diagnosis. The X-axis is the representation of test set (3 IBDNs, 9 SACs). This graph shows that the ANN accurately approximated the known pathologic diagnosis in all 12 cases.

To determine the prognostic evaluation of the patient with gastric cancer and to predict their survival rate the preope ANN model was established with 7:3 ratio. The input layer variables were defined in the training set. The models were compared to the existing cancer staging models from American joint commission on cancer with (cTNM) clinical TNM and (pTNM) pathological

TNM. The efficiency of the preope ANN model showed similarities with pTNM stage (TNM – tumor node metastasis) [7].

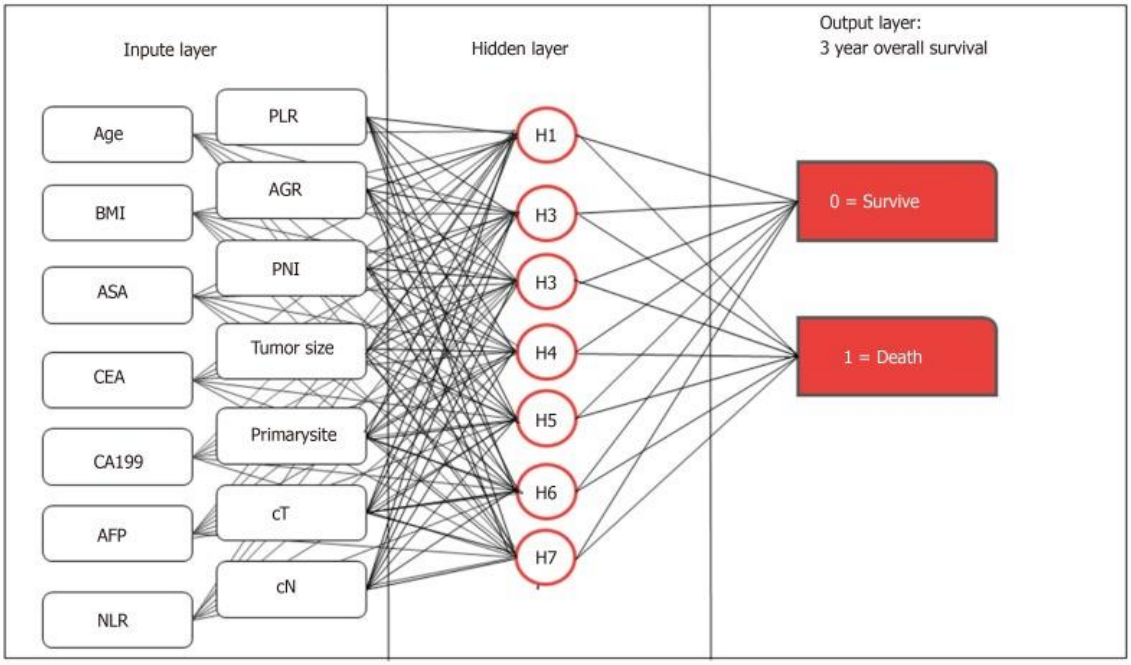

Figure 4: The artificial neural network model for the prognosis and survival rate after 3 years of the medical intervention with defined variable as input layer and the hidden layer and passed through output node through sigmoid function for the real result [7].

6. DISCUSSION

The artificial neural networks provide the exceptional statistical approach to understand the knowledge database. This is a most important part of artificial intelligence (AI). This interface must be trained with extremely large vigorous data and the results can be extracted based upon training the system. With multilayer progression including the input node, many hidden layers and output node, the critical data beyond human knowledge can be represented. This is a dynamic and substantial tool in the cancer prediction, diagnosis and prognosis. ANN model

predicted the breast cancer through the mammogram studies and elevated the presence of malignancy in the individuals. ANN also diagnosed the colonic lesion which differentiated in combination with cDNA microarray resulting in differential diagnosis. Finally, ANN were significantly accurate in the prognostic studies of gastric cancer and survival rate based on the TNM classification.

7. CONCLUSION

This study shows that the ANN models are precise and powerful tools in the cancer studies. The data output through this model is highly valid for the discovery of biomarker, prediction, diagnosis and prognosis in the cancer studies.

8. FIGURES

Figure 1*: Represents the structure of an ANN with its interconnected group of nodes.*

Figure 2*: The typical structure of ANN with the interconnected nodes to predict the malignancy of the breast cancer*

Figure 3*: The graphical representation of diagnosis based on ANN. The Y-axis numerical representation if the diagnosis. The X-axis is the representation of test set (3 IBDNs, 9 SACs). This graph shows that the ANN accurately approximated the known pathologic diagnosis in all 12 cases.*

Figure 4*: The artificial neural network model for the prognosis and survival rate after 3 years of the medical intervention with defined variable as input layer and the hidden layer and passed through output node through sigmoid function for the real result.*

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