NEURAL NETWORKS CUM CLOUD COMPUTING APPROACH IN DIAGNOSIS OF CANCER

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ABSTRACT: It is proposed to have a study on the diagnosis of cancer using neural network approach engaging cloud computing. Cloud computing facilitates data protection, privacy and medical record access. The present paper focuses on cloud computing services extended to medical diagnosis of cancer as well as selection of therapeutic strategies. A neural network judged the possible recurrence rate of tumors correctly in 960 of 1008 cases by using data from lymphatic node positive patients (tumor size, number of palpable lymphatic nodules, tumor hormone receptor status, etc.). A new development framework for cloud computing called User Interface Medical Services (UIMS) is formulated. Cancer diagnosis is carried out using neural networks and the implementation of cloud computing enhance the efficiency and accuracy of diagnosis.

KEYWORDS: Neural Networks – Artificial Neural Networks - Cloud Computing – Cancer Diagnosis Strategies – UIMS – MLP – PCA - SOM.

I. INTRODUCTION

The term neural network traditionally refers to a network of biological neurons. The modern usage of the term refers to artificial neural networks, which are composed of artificial neurons. Thus the term has two distinct usages, Biological neural networks and Artificial Neural Networks. Biological neural networks are made up of real biological neurons that are connected in the peripheral nervous system or central nervous system. In the field of neuroscience, they are identified as a group of neurons that performs a specific physiological function in the laboratory analysis. Artificial neural networks are composed of interconnecting artificial neurons. This network may either be used to gain an understanding of biological neural networks, or for solving artificial intelligence problems.

Fig.1 Neural Networks

II. ARCHITECTURE OF NEURAL NETWORKS

1. Feed-forward networks:

Feed-forward ANNs allow signals to travel one way only; from input to output. There is no feedback (loops) i.e. the output of any layer does not affect that same layer. Feed-forward ANNs tend to be straight forward networks that associate inputs with outputs. They are extensively used in pattern recognition. This type of organization is also referred to as bottom-up or top-down.

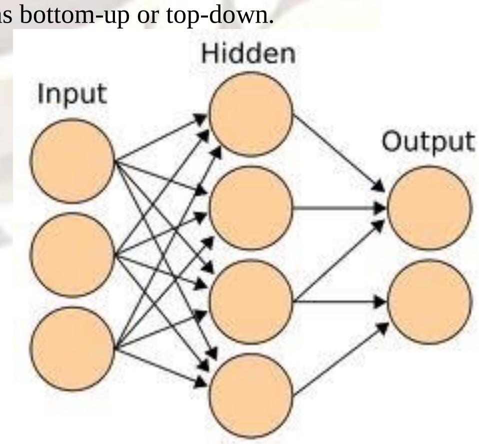

Fig.2 Feed-Forward Networks

2. Feedback networks:

Feedback networks can have signals travelling in both directions by introducing loops in the network. Feedback networks are very powerful and can get extremely complicated. Feedback networks are dynamic; their 'state' is changing continuously until they reach an equilibrium point. They remain at the equilibrium point until the input changes and a new equilibrium needs to be found. Feedback architectures are also referred to as interactive or recurrent, although the latter term is often used to denote feedback connections in single-layer organizations.

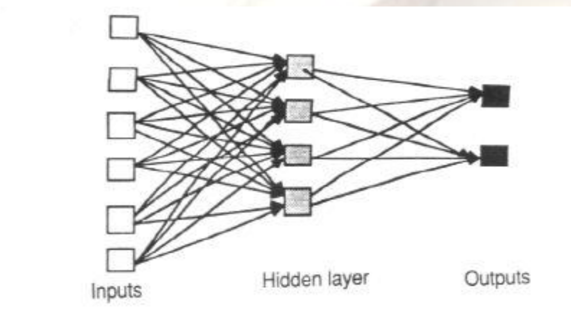

Fig.3 Feedback Networks

III. NEURAL NETWORKS LAYER

The common type of artificial neural network consists of three groups, or layers, of units: a layer of "input" units is connected to a layer of "hidden" units, which is connected to a layer of "output" units. The activity of the input units represents the raw information that is fed into the network. The activity of each hidden unit is determined by the activities of the input units and the weights on the connections between the input and the hidden units. The behavior of the output units depends on the activity of the hidden units and the weights between the hidden and output units.

This simple type of network is interesting because the hidden units are free to construct their own representations of the input. The weights between the input and hidden units determine when each hidden unit is active, and so by modifying these weights, a hidden unit can choose what it represents. We can also distinguish single-layer and multi-layer architectures. The single-layer organization, in which all units are connected to one another, constitutes the most general case and is of more potential computational power than hierarchically structured multi-layer organizations. In multi-layer networks, units are often numbered by layer, instead of following a global numbering.

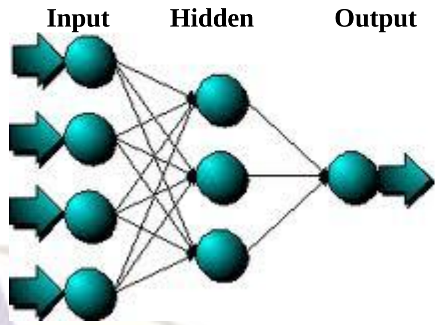

Fig.4 Neural Networks Layer

IV. APPLICATIONS OF NEURAL NETWORKS

Neural Networks have broad applications to the real world business problems. They have already been successfully applied in many industries. Since neural networks are best at identifying patterns or trends in data, they are well suited for prediction or forecasting. These include Sales forecasting, Industrial process control, Customer research, Data validation, Risk management and Target marketing.

V. NEURAL NETWORKS IN MEDICINE

The Artificial Neural Networks (ANN) receives extensive application to biomedical systems in the next few decades. The research is focusing on modeling parts of the human body and recognizing diseases from various scans (e.g. cardiograms, CAT scans, ultrasonic scans, etc).

Fig.5 Neural Networks in Medicine

Neural Networks are ideal in recognizing diseases using scans there is no need to provide a specific algorithm on how to identify the diseases. Neural Networks learn by example so the details of how to identify the diseases are not needed. What is needed is a set of examples that are reprehensive of all the variations of the diseases. The examples need to be selected very carefully if the system is to perform reliably and efficiently.

1. Modelling and Diagnosing the Cardiovascular System:

Neural Networks are used experimentally to model the human cardiovascular system. Diagnosis can be achieved by building a model of the cardiovascular system of an individual and comparing it with the real time physiological measurements taken from the patient. If this routine is carried out regularly, potential harmful medical conditions can be detected at an early stage and thus make the process of combating the disease much easier.

Fig.6 Cardio Vascular System

A model of an individual's cardiovascular system must mimic the relationship among physiological variables (i.e., heart rate, systolic and diastolic blood pressures, and breathing rate) at different physical activity levels. If a model is adapted to an individual, then it becomes a model of the physical condition of that individual. The simulator will have to be able to adapt to the features of any individual without the supervision of an expert. This calls for a neural network.

Another reason that justifies the use of ANN technology is the ability of ANNs to provide sensor fusion which is the combining of values from several different sensors. Sensor fusion enables the ANNs to learn complex relationships among the individual sensor values, which would otherwise be lost if the values were individually analyzed. In medical modeling and diagnosis, this implies that even though each sensor in a set may be sensitive only to a specific physiological variable, ANNs are capable of detecting complex medical conditions by fusing the data from the individual biomedical sensors.

2. Electronic Noses:

ANNs are used experimentally to implement electronic noses. Electronic noses have several potential applications in telemedicine. Telemedicine is the practice of medicine over long distances via a communication link. The electronic nose would identify odours in the remote surgical environment. These identified odours would then be electronically transmitted to another site where an door generation system would recreate them. Because the sense of smell can be an important sense to the surgeon, telesmell would enhance telepresent surgery.

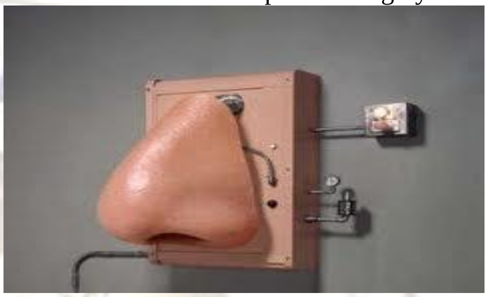

Fig.7 Electronic Nose

3. Instant Physician:

An application developed in the mid-1980s called the "instant physician" trained an auto associative memory neural network to store a large number of medical records, each of which includes information on symptoms, diagnosis, and treatment for a particular case. After training, the net can be presented with input consisting of a set of symptoms; it will then find the full stored pattern that represents the "best" diagnosis and treatment.

Fig.8 Instant Physician

4. Examine common characteristics in large volume of data:

Locating common characteristics in large amounts of data is a type of classification problem. Neural networks can be used to solve classification problems, typically through Multi-Layer Perceptron (MLP) and Support Vector Machines (SVM) type networks.

Examples of classification applications in medicine include dividing research populations or data into groups for further study. For example, data from studies of body movement could be classified into different patterns to aid with physical therapy.

5. Predicting results based on existing data:

Forecasting results based on existing data is a type of function approximation problem. Neural networks can be used to solve function approximation problems, typically through Multi-Layer Perception (MLP), Radial Basis Function (RBF) and CANFIS (Co-Active Neuro-Fuzzy Inference System) type networks.

Examples of function approximation applications in medicine include the prediction of patient recovery and automated changes to device settings. For example, data from studies of potential recovery level of patients can provide realistic estimates to patients while helping facilities cut costs by better allocating resources.

6. Predict the progression of medical data over time:

Predicting the progression of medical data over time is a type of time-series prediction problem. Neural networks can be used to solve time-series problems, typically through Time-Lagged Recurrent (TLRN) type network.

Examples of time-series predictions in medicine include the prediction of cell growth and disease dispersion. For example, data from studies of muscle stimulation patterns of arm movements can be used to control mouse movements on a computer screen.

7. Identify specific characteristics in medical imagery:

Identifying specific characteristics in medical imagery is a type of image processing problem. Neural networks can be used to solve image processing problems, typically through Principal Component Analysis (PCA) type network.

Examples of image processing in medicine include the detection of characteristics in ultrasound and x-ray features. For example, image data from studies of mammograms can be used for the detection of breast cancer.

8. Group medical data based on key characteristics:

Grouping of medical data based on key characteristics is a type of clustering problem. Neural networks can be used to solve clustering problems, typically through Self-Organizing Map (SOM) type network.

Examples of clustering in medicine include the detection of key characteristics in demographics or pre-existing conditions. For example, data from studies combined with sensitivity analysis can reverse engineer a biologically plausible relationship from real world data.

VI. CLOUD COMPUTING:

Cloud computing consists of hardware and software resources made available on the internet as managed third-party services. These services typically provide access to advanced software applications and high – end networks of server computers.

VII. TYPES OF CLOUD COMPUTING:

Service providers create cloud computing systems to serve common business or research needs. Examples of cloud computing services include:

1. Virtual IT: Configure and utilize remote, third-party servers as extensions to a company's local IT network
2. Software: Utilize commercial software applications or develop and remotely host custom built applications.
3. Network storage: Back up or archive data across the internet to a provider without needing to know the physical location of storage.

VIII. CHARACTERISTICS OF CLOUD COMPUTING:

1. Infrastructure as a Service (IaaS):

- Sharing hardware resources
- Extending the infrastructure on demand
- Networking capability
- Internet connection
- Cost effective cause it replace the need for buying, installing, configuration, customization, extending, support and upgrade.

2. Platform as a Service (PaaS):

- Developers build their applications over it
- The platform is extending, with other web services and with more features in the future
- The platform is hosted by the vendors
- The vendor is responsible for updating, upgrading, security and management of the platform.

3. **Software as a Service (SaaS):**
- Targeting the end users
- User has no need to worry about updating, upgrading , security
- Easy to extend with more features
- The vendor is hosting the services, storing the files, the customer information and data.

IX. CLOUD COMPUTING FOR MEDICAL FIELD

1. **Centralization:**

One of the most important features will be so beneficial for the medical field and health care area is Centralization, which means saving time, cost and data. as well as providing more easier approach to access , retrieve and processing data. Risk will increase in centralization, and that is risk covered by 2 elements, Centralization of security process is an important factor to relay on, and end-user privileges and access levels.

2. **Collaboration:**

Collaboration on certain projects, or tasks is also an important needed feature of cloud computing. Which also is an important feature to use, Doctors can collaborate together on cases, researches, through sharing resources, information and files.

3. **Virtualization:**

It is the core axis of IaaS (Infrastructure-as-a-Service): which refers to using virtual machine rather than the hardware, which will make a good sense if the vendor of medical devices (radiology) can make a use of the concept, it'll be cost effective.

X. CANCER

Cancer is primarily an environmental disease, though genetics influence the risk of some cancers. Common environmental factors leading to cancer include: tobacco use, poor diet and obesity, infection, radiation, lack of physical activity, and environmental pollutants. These environmental factors cause or enhance abnormalities in the genetic material of cells. Cell reproduction is an extremely complex process that is normally tightly regulated by several classes of genes, including oncogenes and tumor suppressor genes. Hereditary or acquired abnormalities in these regulatory genes can lead to the development of cancer. A small percentage of cancers, approximately five to ten percent, are entirely hereditary.

The presence of cancer can be suspected on the basis of clinical signs and symptoms, or findings after medical imaging. Definitive diagnosis of cancer, however, requires the microscopic examination of a biopsy specimen. Most cancers can be treated, with the most important modalities being chemotherapy, radiotherapy and surgery. The prognosis in cancer cases can be greatly influenced by the type and location of the cancer and the extent of disease. While cancer can affect people of all ages, and a few types of cancer are more common in children than in adults, the overall risk of developing cancer generally increases with age, at least up to age 80-85 yr. In 2007, cancer caused about 13% of all human deaths worldwide (7.9 million). Rates are rising as more people live to an old age and as mass lifestyles changes occur in the developing world.

1. Origin of Cancer:

The organs in our body are made up of cells. Cells divide and multiply as the body needs them. When these cells continue multiplying when the body doesn't need them, the result is a mass or growth, also called a tumor. These growths are considered either benign or malignant. Benign is considered non-cancerous and malignant is cancerous. Benign tumors rarely are life threatening and do not spread to other parts of the body. They can often be removed. Malignant tumors, however, often invade nearby tissue and organs, spreading the disease.

2. Spreading of Cancer:

The cells within malignant tumors have the ability to invade neighboring tissues and organs, thus spreading the disease. It is also possible for cancerous cells to break free from the tumor site and enter the bloodstream, spreading the disease to other organs. This process of spreading is called metastasis. When cancer has metastasized and has affected other areas of the body, the disease is still referred to the organ of origination. For example, if cervical cancer spreads to the lungs, it is still called cervical cancer, not lung cancer. Although most cancers develop and spread this way -- via an organ - blood cancer like leukemia do not. They affect the blood and the organs that form blood and then invade nearby tissues.

Fig.9 Spreading of Cancer Cells

XI. DIAGNOSING CANCER USING NEURAL NETWORKS

Artificial Neural Network model could perform "intelligent" tasks similar to those performed by the human brain. Artificial neural network models offer a completely different approach to problem solving and they are sometimes called the sixth generation of computing. In the network the input neuron values are the demographic data concerns information such as patient's age, sex etc. The hidden neuron values are based on heuristic diagnostic knowledge represents experience accumulated through years and concerns the way an expert uses the patient data to make diagnoses. The heuristic knowledge has been acquired interviewing experts in the field and constructed a diagnostic tree based on criteria. The output layer produces the outputs.

1. Training the model:

Once a network has been structured for a particular application, that network is ready to be trained. To start this process the initial weights are chosen randomly. Then, the training, or learning, begins. The ANN has been trained by exposing it to sets of existing data (based on the follow up history of cancer patients) where the outcome is known. Multi-layer networks use a variety of learning techniques; the most popular is back – propagation algorithm. It is one of the most effective approaches to machine learning algorithm Information flows from the direction of the input layer towards the output layer. A network is trained rather than programmed. Learning in ANN's is typically accomplished using examples. This is also called 'training' in ANN's because the learning is achieved by adjusting the connection weights in ANN's iteratively so that trained (or learned) .The number of iterations of the training algorithm and the convergence time will vary depending on the weight initialization. After repeating this process for a sufficiently large number of training cycles the network will usually converge to some state where the error of the calculations is small. In this case one says that the network has learned a certain target function. Learning techniques are often divided into supervised, unsupervised and reinforcement learning.

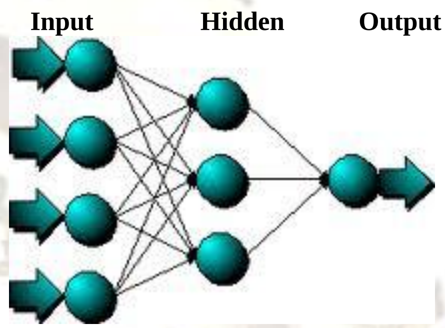

Fig.10 Neural Networks Layer

It is well known that the performance of learning systems on the training data often does not reflect the performance on unknown data. This is due to the fact that the system often adapts well on training to the particularities of the training data. Therefore, the training data should be randomly chosen from all available data. It should represent the typical data properties. If we have initially a bias in the training data you will encounter performance problems for the test data later. In order to test the real generalization abilities of a network to unknown data, it must be tested by classified, but yet unknown data, the test data that should not contain samples coming from patients of the training data. We have to face the fact that patient data is very individual and it is difficult to generalize from one patient to another. Ignoring this fact would pretend better results than a real system could practically achieve.

2. Method of study:

2.1 Cell culture and Tumor samples:

The source and other information for the cell lines and tumor samples used in this study are described for the training set and for the test set. All the original histological diagnoses were made at tertiary hospitals, which have reference diagnostic laboratories with extensive experience in the diagnosis of pediatric cancers.

2.2 Microarray experiments:

Improve knowledge for gene function. Focus basic research. Focus design of therapeutic strategies. Disease diagnosis. Sequencing and mutation detection.

XII. DIAGNOSING CANCER USING CLOUD COMPUTING

Medical applications and solutions as a service are not brand new idea , There are many companies providing medical solutions as a service , though there are many other web based solutions targeting medical and health care field as EMR " electronic medical record " , EHR " electronic health record " , PHR " personal health record " , also HIS " Hospital Information Systems " . Some large corporations also get into the market providing their services in health care area as Google and Microsoft . Most of those services and applications are classified under SaaS " Software as a Service " , there is no Platform built to target medical or health care area under the classification of PaaS , also even there is many Web based application and services , along with many open source web based medical and health care solutions , there is no application begin built on specific platform yet . Some fear buzzed up for security of medical and health care related data and information , also seems the developers not interested yet to move from their own web based services to someone else platform . especially with the portability issue . Somehow some already joined the cloud , i believe I should mention that some research centers and educational facilities already using some Cloud services and platform to provide the collaboration , sharing and increase the productivity to the team work . Cloud Computing model could perform "intelligent" tasks similar to those performed by the human brain.

XIII. USER INTERFACE MEDICAL SERVICES:

UIMS is an interactive decision support system (DSS) Computer Software, which is designed to assist physicians and other health professionals with decision making tasks, as determining diagnosis of patient data. An User Interface Medical Services has been coined as an active knowledge systems, which use two or more items of patient data to generate case-specific advice. This implies that a UIMS is simply a DSS that is focused on using knowledge management in such a way to achieve clinical advice for patient care based on some number of items of patient data. There are two types of UIMS, Knowledge-Based and Non Knowledge-Based.

1. Features of a Knowledge-Based UIMS:

Most UIMS consist of three parts, the knowledge base, interface engine, and mechanism to communicate. The knowledge base contains the rules and associations of compiled data which most often take the form of IF-THEN rules. If this was a system for determining drug interactions, then a rule might be that IF drug X is taken AND drug Y is taken THEN alert user. Using another interface, an advanced user could edit the knowledge base to keep it up to date with new drugs. The inference engine combines the rules from the knowledge base with the patient's data. The communication mechanism will allow the system to show the results to the user as well as have input into the system.

2. Features of a non-Knowledge-Based UIMS:

UIMS's that do not use a knowledge base use a form of artificial intelligence called machine learning, which allow computers to learn from past experiences and/or find patterns in clinical data. Two types of non-knowledge-based systems are artificial neural networks and genetic algorithms.

Artificial neural networks use nodes and weighted connections between them to analyze the patterns found in the patient data to derive the associations between the symptoms and a diagnosis. This eliminates the need for writing rules and for expert input. However since the system cannot explain the reason it uses the data the way it does, most clinicians don't use them for reliability and accountability reasons.

Genetic Algorithms are based on simplified evolutionary processes using directed selection to achieve optimal UIMS results. The selection algorithms evaluate components of random sets of solutions to a problem. The solutions that come out on top are then recombined and mutated and run through the process again. This happens over and over till the proper solution is discovered. They are the same as neural networks in that they derive their knowledge from patient data. Non-knowledge-based networks often focus on a narrow list of symptoms like ones for a single disease as opposed to the knowledge based approach which cover many different diseases to diagnosis.

CONCLUSION AND FURTHER ENHANCEMENT:

1. Neural Networks are effectively used in diagnosis of cancer
2. The applications of cloud computing enhances the efficiency of the diagnosis
3. UIMS is applied for decision support
4. Features of knowledge-based and non-knowledge based brings effectiveness
5. Further work will be carried out towards diagnosis of Swine Flu, Chicken Guinea, Brain Tumor and Brain Fever.

REFERENCES

Journal Papers:

[1] Neural Networks at Pacific Northwest National Laboratory http://www.emsl.pnl.gov:2080/docs/cie/neural/neural.homepage.html

[2] Artificial Neural Networks in Medicine http://www.emsl.pnl.gov:2080/docs/cie/techbrief/NN.techbrief.html

[3] Electronic Noses for Telemedicine http://www.emsl.pnl.gov:2080/docs/cie/neural/papers2/keller.ccc95.abs.html

[4] Pattern Recognition of Pathology Images http://kopernik-eth.npac.syr.edu:1200/Task4/pattern.html

[5] Ageing or cancer: a review on the role of caretakers and gatekeepers.
D Van Heemst, P M Den Reijer, R G J Westendorp in European journal of cancer Oxford England 1990 (2007)

[6] Tumor suppressor genes in breast cancer: the gatekeepers and the caretakers.
Andre M Oliveira, Jeffrey S Ross, Jonathan A Fletcher in American Journal of Clinical Pathology (2005)

Books:

[7] An introduction to neural computing. Aleksandra, I. and Morton, H. 2nd edition

[8] Neural Networks by Eric Davalo and Patrick Naim 2nd edition

[9] Learning internal representations by error propagation by Rumelhart, Hinton and Williams (1986). 1st edition

[10] Recessive human cancer susceptibility genes M Wada, J Yokota in Nippon Rinsho (1988) 1st edition

[11] Cloud-Based Solution for Healthcare IT by A.K. Soman, 3rd edition, Science Publishers

Theses:

[12] Industrial Applications of Neural Networks (research reports Esprit, I.F.Croall, J.P.Mason)

[13] Klimasauskas, CC. (1989). The 1989 Neuro Computing Bibliography. Hammerstrom, D. (1986). A Connectionist/Neural Network Bibliography.

[14] DARPA Neural Network Study (October, 1987-February, 1989). MIT Lincoln Lab. Neural Networks, Eric Davalo and Patrick Naim

[15] Assimov, I (1984, 1950), Robot, Ballatine, New York.

[16]Ageing or cancer: a review on the role of caretakers and gatekeepers.
D Van Heemst, P M Den Reijer, R G J Westendorp in European journal of cancer Oxford England 1990 (2007)