A Survey on CAT System for Locally Advanced Breast Cancer

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Abstract : A noninvasive computer-aided-theragnosis (CAT) system was developed for the early therapeutic cancer response assessment in patients with locally advanced breast cancer (LABC) treated with neoadjuvant chemotherapy. The proposed CAT system was based on multi-parametric quantitative ultrasound (QUS) spectroscopic methods in conjunction with advanced machine learning techniques. Specifically, a kernel-based metric named maximum mean discrepancy (MMD), a technique for learning from imbalanced data based on random undersampling, and supervised learning were investigated with response-monitoring data from LABC patients. The CAT system was tested on 56 patients using statistical significance tests and leave-one-subject-out classification techniques. Textural features using state-of-the-art local binary patterns (LBP), and gray-scale intensity features were extracted from the spectral parametric maps in the proposed CAT system. The system indicated significant differences in changes between the responding and non-responding patient populations as well as high accuracy, sensitivity, and specificity in discriminating between the two patient groups early after the start of treatment, i.e., on weeks 1 and 4 of several months of treatment. The proposed CAT system achieved an accuracy of 85%, 87%, and 90% on weeks 1, 4 and 8, respectively. The sensitivity and specificity of developed CAT system for the same times was 85%, 95%, 90% and 85%, 85%, 91%, respectively. The proposed CAT system thus establishes a noninvasive framework for monitoring cancer treatment response in tumors using clinical ultrasound imaging in conjunction with machine learning techniques. Such a framework can potentially facilitate the detection of refractory responses in patients to treatment early on during a course of therapy to enable possibly switching to more efficacious treatments.

***IndexTerms* - Cancer treatment, computer aided theragnosis, kernel methods, maximum mean discrepancy, personalized medicine, quantitative ultrasound, supervised learning.**

I. INTRODUCTION

Personalized cancer therapy is a rapid developing area of research that has attracted the attention of researchers from various fields such as biology, biomedical engineering, biophysics, and medicine. The rationale behind personalized cancer therapy is that patients respond to treatment differently depending on many factors such as stage of disease, tumour grade, immune response, and their genetic profile. The goal is to avoid needless and/or harmful continuation of an ineffective treatment, and to transform cancer therapy early on during a course of treatment by predicting who will effectively respond to a particular treatment, and to find the best treatment for a specific tumour.

According to data from the World Health Organization, breast cancer is one of the most prevalent cancers, accounting for 29% of all cancer cases worldwide. Despite recent advances in the early detection of breast cancer, it still is often not be discovered until it is fairly large or locally advanced. Locally advanced breast cancer (LABC) includes breast tumours greater than 5 cm in diameter, which are often at an advanced stage locally and inoperable, but have not yet spread outside the breast and/or regional lymph nodes. Women with LABC are often recommended "up-front" chemotherapy before their surgery (neoadjuvant chemotherapy) in order to shrink the tumour, a technique which was pioneered in the setting of LABC. An early detection of patient response to chemotherapy is potentially crucial in such cases in order to avoid continuation of an ineffective treatment and increase survival rates.

Assessing the efficacy of cancer treatments on subjects in clinical applications is typically conducted late during treatment. This is mainly because monitoring cancer therapy effects is currently performed at macroscopic levels, which relies on clinical practice to measure the size of a tumour. Although this approach is well established for research, clinical screening, and treatment, changes in size can take weeks to months after the completion of treatment to become apparent, and do not always occur even when the treatment is effective due to scar tissue formation. To overcome this problem, cancer response monitoring at microscopic level has recently been suggested. This can be done with recent advances in medical imaging and by the understanding that cancer therapy-induced cell death can be detected early after the start of treatment, non-invasively, through different functional imaging modalities. These include functional methods which probe changes in cell structure associated with tumour cell death or tumour vasculature. Currently, the most established methods for cell death detection are those focussed on the detection of apoptosis (programmed cell death) . These methods could potentially be used in a clinical setting and are based on imaging modalities such as positron emission tomography (PET) , single photon emission computed tomography (SPECT), and magnetic resonance imaging (MRI). However, these methods have two main limitations: they are presently expensive, and require contrast agents to be administered in order to enhance the contrast from soft tissue. The potential for side effects from allergic reactions and the radioactivity of some agents are also limiting factors.

II. LITERATURE SURVEY

Abien Fred M. Agarap [1] has done a comparison of six machine learning (ML) algorithms: GRU-SVM[4], Linear Regression, Multilayer Perceptron (MLP), Nearest Neighbor (NN) search, Softmax Regression, and Support Vector Machine (SVM) on the Wisconsin Diagnostic Breast Cancer (WDBC) dataset by measuring their classification test accuracy, and their sensitivity and specificity values. The said dataset consists of features which were computed from digitized images of FNA tests on a breast mass. For the implementation of the ML algorithms, the dataset was partitioned in the following fashion: 70% for training phase, and 30% for the testing phase. The hyper-parameters used for all the classifiers were manually assigned. Results show that all the presented ML algorithms performed well (all exceeded 90% test accuracy) on the classification task. The MLP algorithm stands out among the implemented algorithms with a test accuracy of ≈99.04%.

Prannoy Giri [2], Breast Cancer is one of the significant reasons for death among ladies. Many researches have been done on the diagnosis and detection of breast cancer using various image processing and classification techniques. Nonetheless, the disease remains as one of the deadliest disease. Having conceive one out of six women in her lifetime. Since the cause of breast cancer stays obscure, prevention becomes impossible. Thus, early detection of tumour in breast is the only way to cure breast cancer. Using CAD (Computer Aided Diagnosis) on mammographic image is the most efficient and easiest way to diagnosis for breast cancer. Accurate discovery can effectively reduce the mortality rate brought about by using mamma cancer. Masses and microcalcifications clusters are an important early symptoms of possible breast cancers. They can help predict breast cancer at it's infant state. The image for this work is being used from the DDSM Database (Digital Database for Screening Mammography) which contains approximately 3000 cases and is being used worldwide for cancer research. This paper quantitatively depicts the analysis methods used for texture features for detection of cancer. These texture featuresare extracted from the ROI of the mammogram to characterize the microcalcifications into harmless, ordinary or threatening. These features are further decreased using Principle Component Analysis(PCA) for better identification of Masses. These features are further compared and passed through Back Propagation algorithm (Neural Network) for better understanding of the cancer pattern in the mammography image.

Tuba kiyan [3] et al. 2004 has discussed that statistical neural networks can be used to perform breast cancer diagnosis effectively. The scholar has compared statistical neural network with Multi Layer Perceptron on WBCD database. Radial basis function(RBF), General Regression Neural Network(GRNN),Probabilistic Neural Network(PNN) were used for classification and their overall performance were 96.18% for Radial Basis Function (RBF), 97% PNN, 98.8% for GRNN and 95.74% for MLP. Hence it is proved that these statistical neural network structures can be applied to diagnose breast cancer.

Xin Yao [4] et al. 1999 has attempted to implement neural network for breast cancer diagnosis. Negative correlation training algorithm was used to decompose a problem automatically and solve them. In this article the author has discussed two approaches such as evolutionary approach and ensemble approach, in which evolutionary approach can be used to design compact neural network automatically. The ensemble approach was aimed to tackle large problems but it was in progress.

III. MACHINE LEARNING

Machine learning, a branch of artificial intelligence, is a scientific discipline concerned with the design and development of algorithms that allow computers to evolve behaviours based on empirical data, such as from sensor data or databases.

3.1 TYPES OF MACHINE LEARNING ALGORITHMS

- Supervised learning.
- Unsupervised learning.
- Semi-supervised learning.
- Reinforcement learning.
- Transduction.

3.2 SVM

A support vector machine (SVM) is a concept in statistics and computer science for a set of related supervised learning methods that analyze data and recognize patterns, used for classification and regression analysis. The standard SVM takes a set of input data and predicts, for each given input, which of two possible classes forms the input, making the SVM a non-probabilistic binary linear classifier.

Table 1: List Performance of breast cancer diagnosis using SVM.

S.no	Year	Author	Algorithms	Results Obtained
1	2012	J R Marsilin	SVM	78%
2	2011	Li Rong	SVM-KNN	98.06%
3	2011	F Eddaoudi	SVM	95%
4	2011	S. Arun	SVM	98.24%

3.3 RVM

Relevance vector machine (RVM) is a machine learning technique that uses Bayesian inference to obtain parsimonious solutions for regression and classification. The RVM has an identical functional form to the support vector machine, but provides probabilistic classification.

3.4NEURAL NETWORKS

Neural Network (NN) is one of the best machine learning techniques for classification, regression and pattern recognition. NN have discovered numerous applications in capacity guess and signal processing. A lot of research work on detection of cancerous cells shows that the number of false positive cases have decreased drastically. However, there are several limitations to the machine learning techniques. First of all the few parameters to be configured for the training process through Artificial Neural Network (ANN). The process is to find the number of hidden layer, hidden nodes and learning rates. Second it takes long time to train the system through complex architecture and parameters updates in each iteration. Third, it can be caught to neighbour minima so that the optimal performance cannot be guaranteed. Most popular Neural Network (NN) algorithms used in classification is feed forward with back propagation algorithm. After choosing the weights of the network randomly, the back-propagation algorithm computes the necessary evaluations.

IV CONCLUSION

In this survey , the performance of different machine learning algorithms such as Support Vector Machine(SVM) is assessed. Many researchers have applied the algorithm of neural networks and also RVM for predicting cancers, especially the breast cancer. By going through various articles, RVM is applied for detecting optical cancer, ovarian cancer etc. Overall, if studies on SVM continues, then it is likely that the use of SVM will become much more useful in diagnosing breast cancer.

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