Journal of Applied Biomedicine xxx (2016) xxx–xxx

Contents lists available at ScienceDirect

Journal of Applied Biomedicine

journal homepage: www.elsevier.com/locate/jab

Original Research Article

Prediction of post-operative survival expectancy in thoracic lung cancer surgery with soft computing

Mohammad Saber Iraji[1]

Faculty Member of Department of Computer Engineering and Information Technology, Payame Noor University, Iran

ARTICLE INFO

Article history:
Received 14 May 2016
Accepted 21 December 2016
Available online xxx

Keywords:
Thoracic surgery
Lung cancer
Adaptive fuzzy neural network
ELM
Neural networks

ABSTRACT

Prediction of survival expectancy after surgery is so important. Soft computing approaches using training data are good approximations to model the different systems.

We present many solutions to predict 1-year the post-operative survival expectancy in thoracic lung cancer surgery base on artificial intelligence. We implement multi-layer architecture of SUB- Adaptive neuro fuzzy inference system (MLA-ANFIS) approach with various combinations of multiple input features, neural networks, regression and ELM (extreme learning machine) based on the used thoracic surgery data set with sixteen input features. Our results contribute to the ELM (wave kernel) based on 16 features is more accurate than different proposed methods for predict the post-operative survival expectancy in thoracic lung cancer surgery purpose.

Introduction

It's very important for a person to know how long he survives. People encounter different diseases throughout life and they may survive from the death of vital organ disease, by surgery or organ transplants, in some cases. Medical decision making is a serious challenge, about the risks of survival after the surgery.

Analytical data are the basis for modelling systems and computational formulae. In fact, by modelling a system and designing it, we gain a relationship between its inputs and outputs. The black box is connected between the input-output system, it can be a regression, neural network, fuzzy system, or a different equation using empirical data.

Past researches prove that artificial intelligence techniques such as an artificial neural network (ANN) (Abraham, 2005; Mazurowski et al., 2008; Bajpai et al., 2011; Altan et al., 2016; Vyas et al., 2016; Zhang et al., 2016; Markou and Singh, 2003), support vector machine (SVM) (Vyas et al., 2016), decision support (Lisboa and Taktak, 2006) and regression has good performance in predicting from experimental data.

Zięba et al. (2014) extracted 9 decision rules from the boosted SVM for medical usage of expecting postoperative survival expectancy in the lung cancer patients. They used thoracic surgery data set containing 470 instances and 17 attributes, they applied boosted SVM classifier to classify the patients into two categories: class 1 – death within one year after surgery, class 2–survival.

Matsopoulos et al. (2005) have presented an automatic three-dimensional inflexible registration layout using self-organizing maps and radial basis functions. They modeled, approximations of lung tumor masses during radiotherapy by the feature points from thoracic computed tomography (CT) data.

Delen et al. (2010) suggested a machine learning method to select the prognosticator variables which, is more powerful in the risk category of thoracic patients. They applied multilayer perceptron (MLP), M5 algorithm-based regression tree and the support vector machine with a radial basis kernel function, making the best result R^2, in the prediction of survival time after lung transplantations and prognosis analysis.

Clark (1996) tries to calculate medical risk by using different methods such as uni-variate analysis, additive method, logistic regression, Bayes' theorem and neural network via the society of thoracic surgeons database.

Bhuvaneswari et al. (2014) offered one solution to classify lung CT images based on the extracted features using gabor filter and Walsh Hadamard transform. They implemented genetic algorithm

[1] Current address: Golestan province, Gorgn City, Shalikubi Ave, Edalate 2 Alley, Movahhed Apartment, West Second Floor, No 4916654739, Iran.

http://dx.doi.org/10.1016/j.jab.2016.12.001
1214-021X/

to select best features and they used K nearest neighbour (KNN), decision tree and multilayer perceptron to perform the classification of the lung diseases, the accuracy of neural network was higher.

In (Kuruvilla and Gunavathi, 2014) tomography (CT) images of the lungs are as the inputs and an approach is proposed to use feed forward back propagation neural networks method with the statistical features such as mean, standard deviation, skewness, kurtosis, fifth central moment and sixth central moment for the classification.

In the article (Paulpandi and Prasath, 2014) the ANFIS method is used to categorize lung tissue on CT scan images. (Mahersia et al., 2015) have reviewed the article to determine lung cancer by using different methods in three steps: pre-processing, segmentation of the lung and classification of the tumour patients.

Hashemi et al. (2013) have expressed the region, growing segmentation for feature extraction as input, they have applied Fuzzy Inference System (FIS) and artificial neural networks (ANNs) methods for mass detection in lung CT images, and the sensitivity of their results was 95%.

Polat and Güneş (2008) declared an approach for lung cancer detection by fuzzy weighting pre-processing and the artificial immune recognition system (AIRS) classifier. They selected four features from among 54 features using principles component analysis (PCA) and the classification accuracy of their proposed system was obtained 100%.

Esteva et al. (2007) developed neural networks and artificial intelligence to predict the thoracic surgery after lung resections. Their results had reported that naive bayes method achieved good results in terms of surgical risk classifying for lung separation candidates.

The up survey discussed the use of different existing methods for lung and thoracic surgery using artificial intelligence.

The number of patients who survive after surgery in comparison to patients who die is higher, in a one year period. The proper patient choice for surgery, taking risk and advantages.

So this need of system seems essential, which helps doctors to correct the classification of survival expectancy for treating patients after surgery accurately.

The motivation of undertaken study is design an intelligent system with different artificial intelligence methods to assist clinicians in predicting postoperative thoracic survival with high accuracy.

In this paper, a new intelligent method in the clinical diagnosis of thoracic lung cancer surgery is proposed, that helps doctors in patient selection and identifies the risk of death in patients after surgery.

Methodology and model

Neural network

Neural networks are like the human brain's ability to predict and category. The structure of the neural network is made of activation functions and cells called neurons (Abraham, 2005). The neural network training aim is, projected output training in order to make it so close to the actual output and have a low error (Mazurowski et al., 2008). Types of education, are supervised and unsupervised training. Input data and output are applied to the system in the training supervisor, but only the input data are applied to an education system without an observer and target categories. The purpose of learning is changing the parameters of the neural network in a way that they will be appropriate for the data network performance. A variety of activation functions and different learning rules are used for this purpose (Bajpai et al., 2011).The multi layer perceptron (MLP) (Altan et al., 2016), support vector machine (SVM) (Vyas et al., 2016), radial base function (RBF) (Zhang et al., 2016), self organize map (SOM), hopfid (Markou and Singh, 2003) are some types of neural networks.

Neural networks are made of neurons and they are used for predicting the relationship between inputs and output. The relationship between input and output neurons is done by middle (hidden) layer. Neural network output is measured from the Eq. (1).

$$y_j^h = f_j^h\left(\sum_i^n w_{ij}^h p_i + b_j^h\right) \tag{1}$$

y_j^h = output of neuron j of hidden neuron

p_i = input i to hidden neuron

w_{ij}^h = weight connection among input and hidden neuron from input i to neuron j

b_j^h = bias of hidden neuron j

f_j^h = transfer function for hidden neuron j

The transfer function is computed by following equation:

$$tansig(n) = \frac{2}{1+\exp(-2n)} - 1 \tag{2}$$

We utilized feed forward neural network and back propagation (BP) learning method in this research (Fig. 1). More information about neural networks is available in (Houška et al., 2014).

Neural networks deploy a model of the system by using such a data that 70% of it is randomly selected for training data and 15% for validation and 15% for testing.

ANFIS topology

Fuzzy system

Fuzzy logic is versus binary logic, which a member belongs to all categories, but with a different membership function. Fuzzy system is composed of a set of rules and membership functions. Rules created by the system designer are responsible for the inference system. The type of membership functions are influenced by the behaviour of input variables. Minimum and maximum fuzzy operators apply the rules (Zadeh, 1965).

The fuzzy system design process is as follows:

1. Converting numeric values to linguistic variables (fuzzifying of inputs).
2. Designing rules.
3. De-fuzzification of output.

Fuzzy systems are divided to two categories: type1-Mamdani and type2-takagi-sugeno model (Sugeno, 1985). Learnability of the neural network, using training input data and making calibration membership functions and accurate the fuzzy rules (Buckley and Hayashi, 1994). Ann and fuzzy system can be used together, the so-

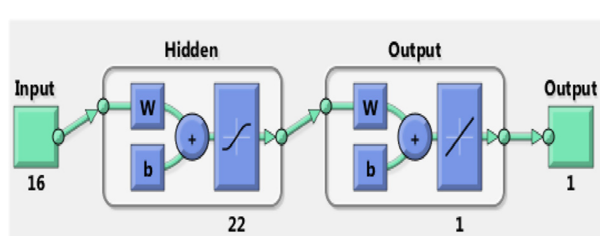

Fig. 1. Neural network structure.