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USING ARTIFICIAL IMMUNE AND CASE-BASED REASONING METHODS IN CLASSIFICATION OF TREATMENT EFFECTIVENESS

The article concerns the analysis of classification of medical data by use of selected method of artificial intelligence: case-based reasoning. The subject of the research is the assessment of effective treatment, being one of the most important medical problems. The basis work of the assessment system should be one of the classification methods. The aim of the attempted research is to study which of the enumerated method will be able to group data containing incomplete information in the best way. The classified data are descended from the patients with nephroblastoma and patients with backbone pain. The final aim of the research is to work out the functioning method of the learning system, assisting the doctor with making a decision during working out on patient's treatment therapy, and making analyses of the treatment effectiveness. On the basis of the medical tests, the system will classify the data assigning them to the appropriate therapy groups. Moreover, in the system will be used artificial immunology as the method of generalizing or extrapolating of the gathering and considering so far cases.

1. INTRODUCTION

1.1. THE CASE-BASED REASONING METHOD

The case-based reasoning technology assumes having by the problem solver a big set of situations descriptions and the manners of behaviours of those situations. Those descriptions we will call cases. The basic features of this method of solving problems are similarity of events, situations and actions. The way of the similarity measure isn't essential. The important thing is that some situations, phenomena and events are similar in the domain which we are concentrated on. So the data base of cases must be large. Since the size and quality of the data base depends whether the finding case will be more or less similar to the given problem.

1.2. THE DESCRIPTION OF THE REALIZED EXPERIMENTS.

The so far experiments were realized basis of data base, including information about patients with nephroblastoma and with backbone pain. The data base of patients with nephroblastoma, containing a great number of incomplete variables, which causes an increase of complexity of the problem. The data analysis gets more complicated, as during

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patients' examinations cytostatics are not usually applied, and while applying medicines, generally, patients are not examined.

After preparing data for analysis, there were carried out experiments using the neural networks.

In order to study dependences between morphological tests and applied cytostatics, there were chosen two networks, which task was to find the best solution with the smallest errors. The chosen networks are: Multilayer Perceptron) MLP) and Generalized Regression Neural Networks - GRNN. At least there was found a net with a vestigial error and using all of the impute variables, the approach in question failed to be effective, for cycles of the therapy were not taken into consideration. The detailed description of this research was shown in paper [1].

Furthermore, there was approached the different attempt towards to the problem. Namely, for data classification there was used a neural network type back-propagation. Where imputes data were morphological tests, that should respond a given output, pointing a number of the group. Studying behaviour of this network there can be affirmed that the network couldn't combine the input with the output correctly because the ratio of the number of outputs to the numbers of standards was too large. The detailed description of this research was shown in paper [2].

Considering rather small efficiency of the proposed method, being a result of data deficiency and a lack of data accuracy for the chosen method, fuzzy neural networks are proposed to be applied for further analysis.

In order to carry out this experiment was testing whether fuzzy neural networks were capable of learning to recognize more than two cytostatics or sets of cytostatics and than grouping patients according to their morphological tests and given drugs. These experiments also didn't bring the appropriate results.

Taking the prior experiments into consideration, that didn't bring appropriate results, there was decided on classify the data by using Case-Based Reasoning method. This experiment was carried out in two approaches:

1. For this analysis was taken 34 patients with backbone pain and with their 16 attributes (features), which are defined with their individual dimensions. In the experiment each patient was compared with all from the data base. Moreover, there was assumed that whole group of the patients must be divided into 9, 7 or 4 clusters. After finding the appropriate weights and comparing each patient with the group of all patients, it can be said that the CBR method was able to classify the objects into the right numbers of clusters.
2. The second approach was based on the same rules as the experiment described below. But the difference lies in the fact that the numbers of objects features was increased. Into 16 features given before there was added 8 features which presented a content of chemical compounds such as: calcium, magnesium, phosphorus and copper in hair and nails.

After caring out the tests using the case-based reasoning method, it can be said that the method classify all patients into appointed number of clusters. Those groups are very similar to the groups generated in the first approach. It's also possible to separate patients who both in the first approach and the second, have the same place in the group and have the same neighbours. Moreover, this method managed with lacks of data. It can be also observed that the patient numbered 27 is the one, who appears either at the end of the classification or is

assigned to different groups. The detailed description of this experiment was showed in paper [3].

2. ARTIFICIAL IMMUNE SYSTEM

Artificial immune system (AIS) is based upon models of the natural immune system. The natural immune system is an example of an evolutionary learning mechanism which contains a content addressable memory and the ability to remove rarely-used information. It is an example of an adaptive non-linear network in which control is decentralized and therefore the immune system has the potential to problem solving methods.

The AI system implements a learning technique inspired by the human immune system which is a remarkable natural defence mechanism that learns about foreign bodies. The immune system has not attracted but the implementation of computing field as the neural operation of the brain or the evolutionary process used in learning classifier systems.

The immune system is also a naturally occurring event–response system which can quickly adapt to changing situations. This system possesses a self organizing memory which is dynamically maintained and which allows items of information to be forgotten. It is thus adaptive to its external environment [4].

The immune system makes memory which content is addressable, thus allowing antigens to be identified by the same antibody.

2.1. IMMUNE CLASSIFICATION METHOD

The immune system generates two types of response: primary and secondary. The primary response occurs when the immune system experiences the antigen for the first time and reacts against it. The secondary response occurs when the same antigen is experienced again. It is characterized by a faster and more intensive production of antibody resulting from the priming of the B cells in the primary response. The secondary response can be triggered from an antigen which is similar, but not necessary identical, to the original one which established the cross-reactivity memory.

2.2. THE CONCEPT OF ARTIFICIAL IMMUNE SYSTEM

We develop an artificial immune system (AIS) which is inspired by the mammal immune system, and thus is composed of objects: a bone marrow, a network of B-cell – memory immune network (MIN) and an antigen population. The concepts such as B-cells, antibodies, antigen and bone marrow are implemented as instances of classes and that it is these classes which implement their functionality. B-cell network is realized as a set of B-cell objects and connects between these objects. The antigen corresponds to case of patient and treatment, and B-cell corresponds to case representation in classified system.

The bone marrow performs the following functions:

- generating a new B-cells,
- deciding which B cell objects die, and
- triggering the addition of cells to the immune network.

The memory immune network deciding where within the immune network to insert a given antigen. The MIN possess a main algorithm which initiates the immune response by presenting antigen to the B cell objects. The main algorithm for the immune system is illustrated bellow. At the end of every iteration of the main loop of the algorithm, the immune system node also generates completely new (random) B cell objects which can be considered for inclusion into the immune network.

The immune system algorithm for cluster antibody recognition.

Randomly initialise initial B cell population
Load antigen population
Until termination condition is satisfied do
Randomly select an antigen from the antigen population
Randomly select a point in the B cell network to insert the antigen
Select a percentage of the B cells local to the insertion point
For each B cell selected present the antigen to each B cell and request immune response
Order these B cells by stimulation level
Remove worst 3% of the B cell population
Generate n new B cells (where n equals 20% of the population)
Select m B cells to join the immune network (where m equals 3% of the population)
Identification of network connection and clusters based on the B-cells affinity

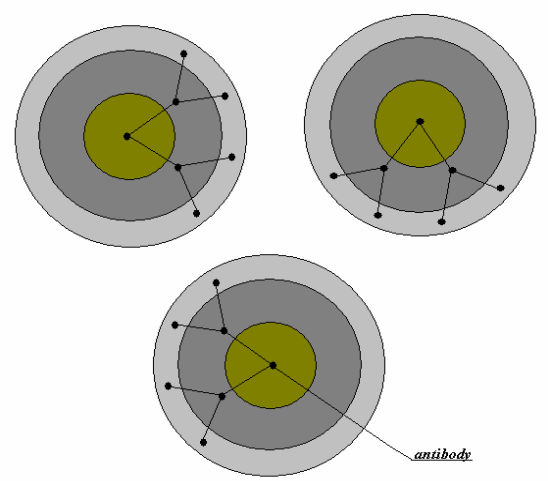

Fig.1. Schematic representation of the spreading influence of the antigen in the immune network.

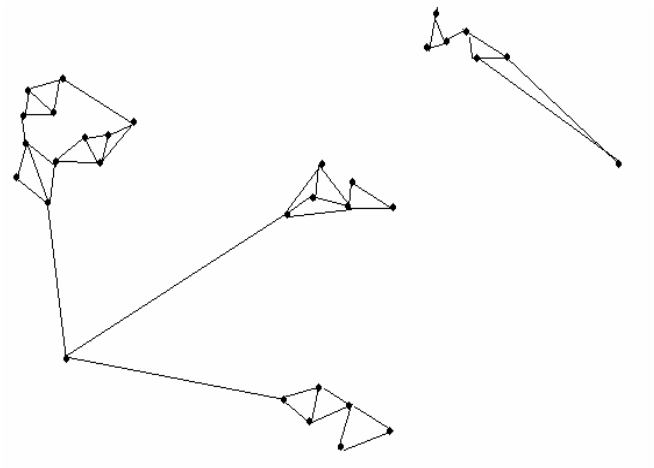

Fig.2. Exemplary network of antibodies concentrated in the clusters.

The first step in this algorithm is to randomly initialise the B cell object population. The B cell objects are generated by the immune system node. The antigen population is then generated in one step from case base files or dynamically from case base data set. When the antibody and antigen populations are initialised, the main loop of the immune system is executed. This loop first selects an antigen randomly from the antigen population.

Each antigen has an influence which spreads through the network, gradually decreasing in concentration as it goes. When the antigen is presented to a B cell, an immune response is initialised.

Each of the new B cell objects generated may be introduced into the immune network. This is accomplished by first finding the two B-cells with which the new B-cell object has the highest affinity. It is then connected to these two B-cell objects and to any other B-cell associated with them. Over time this leads to creating of regions (called clusters) containing similar B-cells within the network.

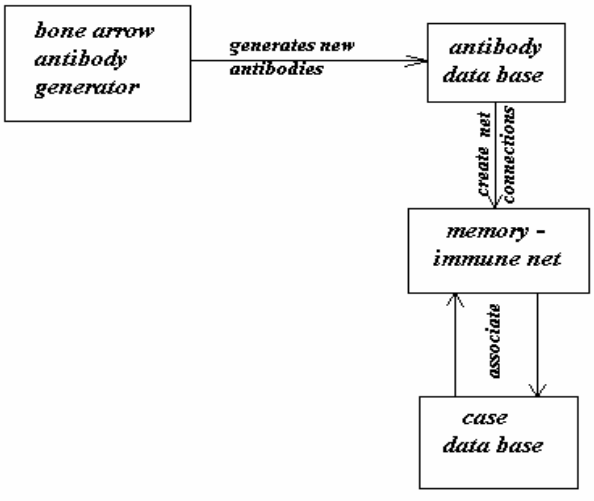

Fig.3. The schema of the system components.

In learning process each of patient treatment as antigen is connects with B-cell, which was most strongly stimulated by this antigen (Fig. 3). The value of the stimulation between B-cell and antigens will determine CBR method as a probability measure.

3. CONCLUSIONS.

Taking the prior experiments into consideration, it can be said that the neural networks are able to distinguish which medicine should be given on the basis of the morphological tests. One of the problems is that the network distinguished only two drugs while there are a dozen or so drugs. Another problem is lack of information that could even be to same extent changed the way of the carried out experiments. Those experiments allow to conclude that the more impute data the received answers were more diverse.

There was carried out the analysis using the Case-Based Reasoning method. These experiments showed that this method is able to manage with lack of information. Moreover, it can be affirmed that the Case-Based Reasoning method and the artificial immunology is able to manage with medical data that are real variables. Enriching the classification method by using the artificial immunology systems allows to receive a system that will be able simultaneously learn and classify the data.

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