Artificial Intelligence in Medicine

Wiesław Wajs

AGH University of Science and Technology, Department of Automatics

Abstract: Medicine is a discipline that requires both judgment and action. Information science can help in several aspect. It can help the physician in collecting complete and relevant data. It can support the physician by providing access to the rapidly increasing sets of medical knowledge through different kinds of the data bases. It can facilitate the management of medical records which may be used for clinical follow-up of patients, clinical research, evaluation of medical action and education. In all these aspects, information science gives indirect help to medical decision.

Keywords: classification methods, correlation methods, expert systems, artificial immune network, statistics methods

1. Introduction

Medicine is a discipline that requires both judgment and action. Information science can help in several aspect. It can help the physician in collecting complete and relevant data. It can support the physician by providing access to the rapidly increasing sets of medical knowledge through different kinds of the data bases. It can facilitate the management of medical records which may be used for clinical follow-up of patients, clinical research, evaluation of medical action and education. In all these aspects, information science gives indirect help to medical decision. But there are many other practical uses designed to help the physician directly in what he considers as his personal privilege: the decision process itself. The physician considers diagnosis as both a science and an art. It is a science because it uses all the components of a scientific method of observation, generation and expression of hypothesis, experimentation and verification. It is an art because it frequently requires a large degree of intuition. Two types of medical approach can be distinguished. The first is related to the recognition of forms. The physician recognises the disease and identifies it, as he would recognise a well-know face, not analitycally but in an overall manner. This approach is intuitive, the analysis of the various factors involved in the diagnostic decision being reached unconsciously on not by a reasoning process. In a certain number of cases, however, the overall approach proves ineffective, and a sequential analysis of the parameters is required. In these cases diagnostic aid methods find their place, and the computer may become a useful tool, especially when the small ampunt of data that the human brain can process simultaneously is considered. Research an computer – aided diagnosis began an the 1960s. The objectives were resolve clinical problems by the use of mathematical formulations. Therefore, most of the work centred on the application of either logical or probabilistic methods.

2. Expert System Components

Expert Systems are built on three components. The Knowledge Base contains the granular elements of problem solving, descriptive knowledge, and the expression of the links that have to be applied between those elements, operation knowledge. The Inference Engine allows for selection of the appropriate elements of knowledge and application of the rules; interrogation of the use regarding questions which cannot be inferred or resolved by the system itself; management of the events' uncertainty; and explanation of the results. The Events Base describes the treated case, possibly enriched by the inferred events. Expert systems incorrectly became almost synonymous with the term "artificial intelligence" in the mind of most physicians and this was probably one of the reasons for their first success. Pioneering work was dane on rule-based systems, and was designed to deal with medical applications, but their greatest successes have occurred in fields other than medical ones. This not suprising because so much medical knowledge is difficult to grasp and to summarise with simple rules. Dissatisfaction with rule-based systems led investigators into new directions; they became aware that clinical findings must be linked with patho-physiological knowledge. Such knowledge is complex; its representation is done either by frames systems or by semantic networks, which many links and a hierarchical order. Before the development of Expert Systems, the clinical uses of medical decision-making programmers were very limited. The methodology used, in particular probabilistic procedures were too distant from the usual way of thinking of the physicians, and the programmers were applied to only a few limited clinical siotuations. The procedures used non-fuzzy data known with a high degree of certainty, asituation which is relatively rare in medicine, and these systems were unable to explain to the physician how they reached their conclusions. Expert system avoid these major pitfalls by using symbolic reasoning, being capable of handling fuzzy data, and explaining their proposed conclusions. Instead of procedural programming, Expert Systems are based on declarative programmingwhich allows for a large degree of flexibility.

3. Classification Medical Data Series by Artificial Immune Network

We are intent to demonstrate that immune system concept can be used as computational tools for data classification and prediction. The immune system has several useful ideas from viewpoint of data manipulation. The immune network theory hypothesizes the activities of the immune cells, the emergence of memory, and the discrimination between own cells, knows as self, and external invaders, knows as non-self.

The immune system has an internal image of all existing pathogens, infection non-self, to which it might be exposed during its lifetime. The artificial immune model consists of a set of cells, named antibodies, interconnected by links with associated connection strengths. There are several immune network models presented in the literature. The immune network models are based upon a set of differential equations to describe the dynamics of the network cells and molecules [10]. The interactions between different types of elements lead to the network connectivity pattern and dynamics. In the model proposed by Varela and Coutinho, it is possible to stress three characteristics of the immune network. The first one it is the structure. The structure describes the types of interactions among the network components, represented by matrices of connectivity. The second, it is dynamics that accounts for the variation in time of the concentrations and affinities of its cells. The third it is metadynamics, a property related to the continuous production of novel antibodies and death of non-stimulated or self-reactive cells. The main characteristic of the immune network theory is the definition of the individual's molecular identity, which emerges from the network organization followed by the learning of the molecular composition of the environment where the system develops.

4. Classification with Statistical Methods

Described classification method enables calculation of probability of disease incidence. A case of disease incidence is described with two parameters expressed in real numbers. The case can belong to a known set of cases there the disease occurred or to the set where the disease did not occur. There was presented a method for calculating probability with which a given case belongs to the set labeled as "1" or "0". Source data used in the paper come from medical databases and are original. The algorithm of the method was checked on clinical cases. Correlation method was used for generating respective statistics. The calculated correlation at a level of 0.8 is indicative of disease occurrence, whereas the correlation coefficient at a level of 0.0 is indicative of lack of disease. This property is used in the classification algorithm. It is frequent in the clinical practice that we have one test case and we try to determine whether or not that case describes symptoms of liability to the disease. Classification is related with the occurrence of disease Bronchopulmonary dysplasia, which is analyzed in a 3 to 4 week period preceding the disease incidence.

Bronchopulmonary dysplasia (BPD) is a chronic lung disease that develops in neonates treated with oxygen and positive pressure ventilation. The majority of BPD cases occur in pre-mature infants, usually those who have gestational age less than ge < 34 weeks and birth weight less than bw < 1500 g. These babies are more likely to be affected by a condition known as infant Respiratory Distress Syndrome, which occurs as a result of tissue damage to the lungs from being mechanical ventilator for a significant amount of time. Although mechanical ventilation is essential to their survival over time the pressure from the ventilation and excess oxygen intake can injure a newborn's delicate lungs. If symptoms of respiratory distress syndrome persist then the condition is considered Bronchopulmonary Displasia. Important factors in diagnosing BPD are prematurely, infection, mechanical ventilator dependence, and oxygen exposure.

The primary focus of all treatment associated with premature infants is on prevention of BPD. Surfactant replacement, invasive and noninvasive ventilation techniques, management of the patient ductus arteriosus, cautions management of oxygen therapy, caffeine, inhaled nitric oxide, and changes in delivery room practice have been studied to assess their effects on the development of the disease. Definition of BPD has many forms. Several factors found to have led to BPD in diverse populations of patients have made this difficult to accomplish. In 2001 the National Institute of Child Health and Human Development defined and classified BPD by gestational age and supplemental oxygen requirement.

Infants < 32 weeks postmenstrual age presenting with clinical manifestations of the disease, requiring supplemental oxygen at 28 days of life, and who were wanted to room air by 36 weeks or at discharge were considered to have mild BPD. Infants requiring < 30 % continuous oxygen at 36 weeks postmenstrual age or at discharge were considered to have moderate disease. Infants remaining on $>= 30$ % oxygen and on continuous positive airway pressure (CPAP) were considered to have a severe form of the disease. For infants > 32 weeks gestation, the identical oxygen requirement was implemented at day of life 56. The clinical definition of BPD determines the extent of the disease based on the level of oxygen administration. Walsh employed a psychologic test and response to room air for infants 36 weeks plus/minus 1 week. The test consisted of challenging patients by conducting a 30 min room – air trial if the patient was on < 30 % oxygen or was > 96 % saturated on > 30 %. Extreme prematurity in very-low birth-weigh infants and implementation of general patient care strategies such a ventilator management, oxygen administration, and their associated response have played a role in the prevalence of BPD.

In medical practice the problem of data classification is encountered. This issue is analyzed when a given case of disease is described with two parameters: birth weight (bw) and gestational age (ge). Classification lies in determining whether a given case of disease belongs to the set labeled "1" or "0".The proposed method enables calculation of probability that a given case belongs to the set labeled "1", and to the set labeled "0". In medical science the classification is especially important. Qualification of a case of disease as belonging to the set of recognized cases has practical significance. There are numerous known methods on the basis of which a given case can be qualified to a known set of data, e.g. Support Vector Machine, artificial neural network method, and also artificial immune network methods. These methods do not determine probability with which a given case belongs to the set of data. The proposed method employs a method correlating two parameters (bw, ge) of the same case of disease.

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Sztuczna inteligencja w medycynie

Streszczenie: Medycyna jest dyscypliną, która wymaga zarówno oceny jak też działania. Informatyka może być pomocna w wielu aspektach. Informatyka może pomóc lekarzowi w zbieraniu użytecznych danych. Techniki komputerowe mogą pomóc lekarzowi w dostępie do dużych zbiorów danych poprzez różnego rodzaju bazy danych. Informatyka dostarcza także licznych metod, które mogą mieć zastosowanie w systemach wspomagania decyzji oraz w procesach uczenia.

Słowa kluczowe: metody klasyfikacji, metody korelacji, systemy expertowe, sztuczne sieci immunologiczne, metody statystyczne

Prof. Wiesław Wajs, PhD

Hi received his MSc degree in 1969 and DSc and dr hab. Degrees in Computer Science in 1975 and 1985 respectively at AGH University of Science and Technology. Wiesław Wajs received his professor title in 2003. In the period 1991–1993 he worked as invited professor at TU Clausthal Zellerfeld, and in 1994 and 1996 worked as invited professor at Pomona State University. Wiesław Wajs is an author of 28 textbooks and books, and about 200 papers. He is a member of international working groups, journal editorial boards and programme committees of international conferences. He is a member of IFAC and WISAS Committee.

e-mail: wwa@ia.agh.edu.pl