

Matter for Discussion

Artificial Intelligence and Primary Prevention of Health Hazards Related to Changes of Elements in the Environment

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Received: 9 May 2003

Accepted: 10 December 2003

Abstract

Some methods of artificial intelligence are evaluated in relation to development of medical elementology and primary prevention of health hazards related to antropogenic changes in the natural environment and the human food chain, diet, etc.

Searching for a new paradigm of the cross-disciplinary system approach to nutritional prevention of excess or deficiency of some elements is very time- and cost-consuming task. Using artificial intelligence methods we obtained interesting conclusions on the basis of apparently fully exploited experimental data.

Artificial intelligence (data mining and automatic knowledge discovering in particular) seems to be useful for developing interdisciplinary studies on medical elementology focused on application of scientific and technical progress for early detection of environmental health hazards related to excess or deficiency of selected elements in the natural environment, trophic chains and endoecological aspects (referring to possible inbalance of the basic homeostatic system).

This cooperation was initiated by the founding members of the International Union of Elementologists in New Delhi in 1983 and developed by a series of case studies, international conferences and monographs. Integration of studies in ecotoxicology, human ecology, environmental health with application of progress in informatics and environmental biotechnology is promising for more effective protection of health of consumers connected with changes of elements in the human diet and body (including primary prevention of some diseases of civilization).

Keywords: ecotoxicology, medical elementology, artificial intelligence, biotechnology

Introduction

According to the recommendation of the 1st International Conference of the International Union of Elementologists (IUE), the concept of interdisciplinary study on elements in health and diseases has been developed by a series of scientific Conferences and international monographs as team books like "Ekologizm w ochronie zdrowia" – Polish Academy of Sciences, 1989, J. W. Dobrowolski, S. B. Vohora, eds., and "New Horizons of

Health Aspects of Elements" Hamdard University, 1990, S.B.Vohora, J. W. Dobrowolski, eds., have been published. Some multidisciplinary meetings of experts, e.g. Intl. Conference EURO-ECO Anthropogenic Changes of the Content of Elements in the Environment and Human Food Chain; the Perspectives of Primary Prevention, at AGH University of Science and Technology in Krakow 1997 and, in particular, many International Workshops "Mengen- und Spuren-Elemente" at F. Schiller University in Jena, chaired by M. Anke series of the International Symposiums in the University of Athens, chaired by S. Ermidou-Pollet, S. Pollet (both including valuable

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proceedings) contributed to progress in knowledge in the new field of interdisciplinary knowledge in medical elementology [1, 2, 3, 4, 5, 6]. Important parts of this knowledge are results of long-term ecotoxicological surveys of various regions in linkage with human ecology and monitoring of trace elements in the natural environment, food chains and human body, including personal monitoring at cellular level [ibidem and 9, 10]. Application of new methods for early detection of environmental risk factors should be supplemented by applying new biotechnologies for more effective reduction contamination, e.g. with toxic elements of the air, soil, cultivated plants, animals and human food as contributions to primary prevention of incurable diseases of civilization, e.g. Minamata disease or Itai-itai disease related to intoxication of human trophic chain with mercury or cadmium, respectively.

Searching both for new possibilities of detection of the risk factors and better prevention based on great amount of scientific and technical information, the application of a new tool of data mining and management seems to be very useful.

New perspectives of proper use of already existing information is connected with the application of artificial intelligence. Let us start with a short reflection about the present situation in this field. The results of studies are not fully utilized because each experiment gives the answers to more questions than were actually posed. Accordingly, collecting, analyzing and processing the results of numerous experiments may lead to new observations (or even new discoveries) based only on thorough analysis of the gathered data. Such an analysis requires specialized intelligent tools, and that is the subject of the present study.

Study of elemental composition and their interactions with the living tissues under physiological and pathological conditions also answer questions that have not been explicitly asked. When one collects results of numerous tests and starts sorting through them to find the answers to unasked questions, one may come across new, useful and valuable information [7, 8].

Data mining brings the analogy to the mining sector, where mining operations are followed by extraction of useful material. Artificial intelligence seems to be a useful tool for uncovering hidden knowledge from seemingly fully utilized experimental data. Artificial intelligence is a branch of information science which may enrich our existing knowledge (e.g. in relation to change of elemental composition of human body) without any extra expenses on laboratory facilities [7].

Elements of Artificial Intelligence

The starting point is the definition of exploratory data analysis (also known as data mining). The term "information" is closely related to "data." The present study data will mean information that is recorded and processed to get a predetermined, symbolic form. The data ought to be treated as raw material and information will be worked out from the data by adding the indispensable element -

intelligence (be it human or artificial) linked with the awareness of the information process which allows for suitable selection, segregation and representation of data. The set of available, interrelated bits of information constitutes knowledge, which is generated mainly in the receiver's brain. By way of synergy with prior knowledge, new information becomes the sources of new knowledge- apparently not directly related to the delivered information, since a seemingly minor bit of information may decide global understanding of a process or phenomenon. When this understanding is achieved through a formalized system of references, we can speak about development of a theory or creation of a model. Sometimes it is necessary to laboriously gather a vast number of seemingly irrelevant bits of information, yet no build-up of real knowledge can be achieved for a long time when, quite unexpectedly after acquiring another seemingly unimportant bit of information, there comes a sudden revelation: all facts become clear and correlations obvious while the final effect - knowledge build-up - is rapid as a result of crystallization of information in a human brain well-supplied with information.

- Knowledge build-up through information acquired from data has a lot to statistics and related areas, where research has been involved for years in discovering and teaching others how to interpret data, how to present and analyze those data and how to describe the existing regularities.

Whatever the good translation of "data mining," the more important point is to characterize the formal methods and computer tools used for that purpose. These tools were defined in the work by Heidsieck and Ulm [11], who states that data mining is the description of a group of methods of broadly understood data analysis aimed to identify yet unknown regularities in large sets of data and the results are easy to interpret by researchers.

The methods of data mining are diverse and the group of methods is continually enriched. They are derived from statistics, information science, signal analysis, mathematics and graphics.

They are mostly induction methods. Conclusions are always based on the analysis of available data sources, not on the basis of abstract theories formulated a priori.

The results are easy to interpret - and hence can be used in practical applications.

The methods considered here are independent of semantic content of examined information, which ensures uniformity of methods used to examine even very diverse problems. The aim of these methods is providing the description of the examined fragment of reality or forecasting, as a key factor in primary prevention of environmentally-born health hazard. The methods are directed on practical applications, first of all supporting the decision-making processes related to common action of scientists, managers and knowledge-based society focused on system approach to prevention.

The choice of a suitable method of data analysis depends on the type of encountered problem. The main

types of tasks that can be solved using data mining are as follows:

- * Defining functional relationships. The main problem in this case is that we have data describing facts while we need to find the correlations between these facts.

Methods of Model Quality Measurements

Methods for verification of models obtained from analyses of large data sets using data mining techniques were presented in the previous paragraphs. Presentation of these techniques, however, did not provide the methods of model quality measurements. This issue is very important and will be addressed in this subsection.

Classified objects and the number (or percentage) of incorrectly classified ones are two basic values that can be further analyzed. For instance, they can be split for groups of objects. Furthermore, one can also analyze which types of errors are most frequent.

Evaluation of models used for solving non-pattern classification problems is much more difficult. The main difficulty involved in model quality evaluation is that one has to evaluate the adequacy of the set structure discovered with the help of the model when no information about the real correlations between the objects is available.

Evaluation of regressive models of time series may also use the obtained series of residues to check whether autocorrelation is present. These series can be also analyzed using spectral analysis techniques. Evaluation of adequacy of data mining results calls for a short explanation, too. Data mining techniques provide the assumptions for rational choice of the optimal (or sub-optimal) options [12]. For example, the optimal methods of analyses of elements in the environment and human body.

Presented methods of evaluation of models obtained as the result of data exploration are general and depend exclusively on the type of analyzed problems.

Interpretation of Results and Application of Results to Decision-Making Process

Positive verification of the created model justifies its application to real-life situations. The scope of applications is practically unlimited and covers:

- * studies of isolated fragment of reality - in this case the model should be treated as the description of investigated phenomena
- * forecasting - model may help to forecast how the given process will develop. It is worthwhile to mention that the term "forecasting" is given a broad meaning. In time-series analyses it means the determination of future values in the series, while in the case of cross-sectional data (relating to various objects, the time factor being neglected) forecasting might mean estimation of certain characteristics for new objects, unknown at the time when the model was created.
- * simulation - in these applications the model is uti-

lized to run substitute experiments in order to verify certain activities before they are commenced in real life. Using data mining results provides the answers to the question: "What will happen if...?" This group of applications is most useful in decision-making support as the model allows for checking the most likely outcomes of the decisions to be taken.

- * development of expert systems - knowledge acquired from data analysis may create (or supplement) the base of the expert systems, i.e. programs able to answer the users' questions by way of automatic reasoning.
- * development of decision-making systems - this application of data mining is brought down to an attempt to replace the decision-makers (i.e. humans) with artificial decision-making systems [13, 14]. Such attempts are made only in those areas where the time for decision-making is short (for example in real-time process control), while it is necessary to analyze huge amounts of information, as it has been recommended for efficient primary prevention at the International Symposiums on Trace Elements in Humans at the University of Athens.

Conclusions

Implementation of the model developed using data mining techniques requires further monitoring while in operation. Changes in reality may cause the model to become outdated or even useless after a while. If the discrepancies between the process and the model description become more frequent, the model ought to be updated. In some cases updating would involve the repetition of the whole procedure, in others- it would be sufficient to update model parameters only. There are perspectives of application of new environmental biotechnology (e.g. using laser photostimulation of plants) for primary prevention of some risk factors related to contamination of the natural environment and human food chain with trace elements and other xenobiotics [15].

Acknowledgements

This work was partly financially supported by the Polish Committee for Scientific Research within Wyzd.GGiS AGH Statute Grant.

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Pracownia Adsorpcji i Katalizy w Ochronie Środowiska
Wydziału Chemii Uniwersytetu im. Adama Mickiewicza w Poznaniu
organizuje w dniu 3 grudnia 2004 r.

X Ogólnopolskie Mikrosympozjum „Adsorpcja i Kataliza w Ochronie Środowiska”

dotyczące wykorzystywania materiałów naturalnych i odpadowych
w usuwaniu zanieczyszczeń chemicznych środowiska

Pisemne zgłoszenia uczestnictwa kierować do dnia 10 czerwca 2004 r. na adres:

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