Application of Probabilistic Techniques for the Development of a Prognosis Model of Stroke Using Epidemiological Studies

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ABSTRACT

Automated medical diagnosis systems based on knowledge-oriented descriptions have gained momentum with the emergence of recent artificial intelligence techniques. The objective of this paper is to propose a design of a probabilistic model for the prevention of stroke based on the most outstanding risk factors associated with this pathology. The authors gather probabilistic technologies to develop a new clinical support decision-making model. This development is part of a future system that aims to improve health-quality and prevent strokes. The Naïve Bayes model is proposed to calculate the probability of suffering a stroke in the future, based on epidemiological data. Due to a new design, the model is capable to determine the probability of suffering a stroke given some risk factors. The proposed model allows to calculate the final probability of suffering a specific disease for the preventive prognosis of the stroke based on risk factors. Our model enables query the probability of suffering a stroke giving as parameter the presence or absence of a specific indication, also setting if the indication can take several values with its presence, degree or value. With the obtained results the physician will be able to promote patients healthy living habits in order to prevent future stroke events.

Keywords: Epidemiology, Naïve Bayes Model, Probability, Prognosis, Stroke

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INTRODUCTION

Medical informatics is the discipline dedicated to the systematic processing of data, information and knowledge in medicine and healthcare (Shortliffe & Cimino, 2006). As has been mentioned previously (Haux, 2010), there is a need for introducing and exploring new theories, concepts or methods that significantly contribute to efficient, high-quality healthcare, improvements in quality of life and/or to the progress of biomedicine and the computer, health and information sciences. The growing rate of chronic diseases such as diabetes, hypertension, lower back pain, heart disease, and cardiovascular disease accounts for more than half of the overall growth of healthcare costs. For this reason, healthy living is an essential topic in the health field. In recent years, the Internet has been a mean to increase individual participation in disease prevention and health promotion. A study (Lemire, Paré, Sicotte, & Harvey, 2008) confirms the importance of the credibility of information on the frequency of Internet use, as a preferred source of information on personal health. It also shows the potentially influential role of the Internet in the development of personal knowledge of health issues. With the use of Internet, the development of Medical Differential Diagnosis and Therapy systems using computational intelligence, has gained momentum over the last years (Zhao, Yanxiang, & Hui, 2005). Sciences, biology and medicine are considered (Cohen, 2004) to have been among the most progressive scientific fields during the twentieth century, and such advancements are expected to have a tremendous impact on the information technology (IT) application domain landscape. However, leveraging the potential of knowledge-intensive applications in medical differential diagnosis is a critical issue to be tackled, in order to rely on the accuracy and efficiency of diagnosis or therapy systems.

This work presents the design of a prognosis model for the prevention of suffering stroke. Stroke is a cerebrovascular disease characterized by an abrupt interruption of blood supply to the brain, which triggers a set of symptoms that can be variable, depending on the brain area affected (80% of strokes are ischemic and the rest hemorrhagic). Stroke and heart attacks are the most common cardiovascular diseases and the leading cause of mortality in developed countries, there are many risk factors involved of suffering this pathology (i.e. such as overweight and smoking among other factors that can be decreased or even stopped with a correct approach). In this sense, the development of tools which can warn of the risk of suffering an illness like a stroke is crucial, where part of their risk factors are related with healthy living.

The paper is organized as follows: Methods section outlines relevant literature in the area and the core of the approach presenting a deep analysis of the epidemiology of the stroke risk factors and the proposed probabilistic model, based on the independance of the risk factors. Also a very deep explanation of the probabilistic calculus that had been done to estimate the final probability is presented. In Results’ section we present a specific example of use given the data provided by the epidemiological sources and it includes the evaluation (design and results) performed to assess the quality of the proposed model. Conclusions and future work are discussed in the Discussion section.

METHODS

In order to create an environment that helps the understanding of the method proposed in this paper, it is presented diverse literature based on medical diagnosis and prognosis to support decision-making. In the present context special attention is focused on healthy living and stroke prevention. Relative to healthy living, Gardner et al. (1999) reported two decades of work on the HELP system and the successful implementation of a knowledge-based decision-support as part of the information system at the LDS hospital at Salt Lake City. HELP was the first hospital information system to collect patient data needed for clinical decision-making, which incorporated a medical knowledge base and
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