Fuzzy-probabilistic multi agent system for breast cancer risk assessment and insurance premium assignment

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A B S T R A C T

In this paper, we present an agent-based system for distributed risk assessment of breast cancer development employing fuzzy and probabilistic computing. The proposed fuzzy multi agent system consists of multiple fuzzy agents that benefit from fuzzy set theory to demonstrate their soft information (linguistic information). Fuzzy risk assessment is quantified by two linguistic variables of high and low. Through fuzzy computations, the multi agent system computes the fuzzy probabilities of breast cancer development based on various risk factors. By such ranking of high risk and low risk fuzzy probabilities, the multi agent system (MAS) decides whether the risk of breast cancer development is high or low. This information is then fed into an insurance premium adjuster in order to provide preventive decision making as well as to make appropriate adjustment of insurance premium and risk. This final step of insurance analysis also provides a numeric measure to demonstrate the utility of the approach. Furthermore, actual data are gathered from two hospitals in Mashhad during 1 year. The results are then compared with a fuzzy distributed approach.

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1. Introduction

Risk assessment is one of the most important aspects in medical decision making. One of the risks that should be assessed is the risk of being affected by deadly diseases such as cancer where the risk is influenced by various variables. An appropriate paradigm for handling the effect of these variables can help insurance companies to better evaluate the risk of deadly diseases and provide the users suitable financial facilities for screening and preventive treatment circumstances based on a fair premium. In order confidential risk assessments can save so many lives and subsequently decrease the treatment costs and increase the social health.

Unfortunately, recognizing all of the effective variables and their precise amount of effectiveness in a risk assessment is nontrivial. In addition, the available information is highly imprecise and can lead to uncertain conclusions. With respect to the existing uncertainties in the available information, the first source of data for risk assessment is known as “soft” data[1] that can be represented in linguistic forms (linguistic data). This data is extracted from the expert opinions, their aggregated studies and experiences. Due to the linguistic form of this information and imprecision of data, fuzzy-logic based analysis offers a promising solution paradigm [2] to handle the existing uncertainty. In addition to soft data, the statistical data is another valid data source which can be helpful. This statistical data may be incomplete when the number of observed data is not considerably large. Hence the statistical data are also accompanied by uncertainty which is caused by sparsity and insufficiency of data. We have found fuzzy probability framework as a suitable approach which enables us to enhance the reliability of our risk assessment by employing both databases of soft data and statistical data at the same time. Furthermore fuzzy probabilities enable us to show the uncertainty of the assessed risk and compute the amount of uncertainties in these fuzzy probabilities.

Fuzzy probabilities were first introduced by Zadeh [3]. Fuzzy probability (FP) theory [4] is a fuzzy approach to probability theory and is a generalized form of probability theory. In fuzzy probabilities, probability theory is complemented with an extra dimension of uncertainty provided by fuzzy set theory [5]. We divide the applications of fuzzy probabilities to two different main areas [6]. The first is the area of reliability and risk assessment. In this area fuzzy probability has been widely applied in fuzzy fault trees to assess the fault risk [7–9], risk assessment of pedestrian collisions [6], reliability assessment for pressure piping [10], risk assessment of natural hazards [11] and reliability enhancement.