Intelligent Decision Support System for Osteoporosis Prediction

Walid Moudani, Lebanese University, Lebanon
Ahmad Shahin, Lebanese University, Lebanon
Fadi Chakik, Lebanese University, Lebanon
Dima Rajab, Lebanese University, Lebanon

ABSTRACT

The healthcare environment is generally perceived as being information rich yet knowledge poor. The healthcare industry collects huge amounts of healthcare data which, unfortunately, are not “mined” to discover hidden information. However, there is a lack of effective analysis tools to discover hidden relationships and trends in data. The information technology may provide alternative approaches to Osteoporosis disease diagnosis. This study examines the potential use of classification techniques on a massive volume of healthcare data, particularly in prediction of patients that may have Osteoporosis Disease (OD) through its risk factors. The paper proposes to develop a dynamic rough sets solution approach in order to generate dynamic reduced subsets of features associated with a classification model using Random Forest (RF) decision tree to identify the osteoporosis cases. There has been no research in using the afore-mentioned algorithm for Osteoporosis patients’ prediction. The reduction of the attributes consists of enumerating dynamically the optimal subsets of the most relevant attributes by reducing the degree of complexity. An intelligent decision support system is developed for this purpose. The study population consisted of 2845 adults. The performance of the proposed model is analyzed and evaluated based on a set of benchmark techniques applied in this classification problem.

Keywords: Dynamic Programming, Features Reduction, Multi-Classifier Decisions Tree, Osteoporosis, Predictive Models, Rough Sets

1. INTRODUCTION

Medical diagnosis is an important but complicated task that should be performed accurately and efficiently and its automation would be very useful and advantageous. Unfortunately, not all doctors possess expertise in every sub specialty and moreover they are in many places a scarce resource. Therefore, an automatic medical diagnosis system would enhance medical care and reduce costs. Moreover, appropriate computer-based information and/or decision support systems can aid in achieving clinical tests at a reduced cost. Or, efficient and accurate
implementation of automated system needs a comparative study of various techniques available. However, most hospitals today employ some sort of hospital information systems to manage their healthcare or patient data (Oben- shain, 2004). These systems typically generate huge amounts of data which take the form of numbers, text, charts and images. Unfortunately, these data are rarely used to support clinical decision making. There is a wealth of hidden information in these data that is largely untapped. The main motivation of our research is to process data in order to get useful information that can enable healthcare practitioners to make intelligent clinical decisions. In this paper, we deal with the diagnosis of one of the real health problem, called osteoporosis disease, because of its increasing frequency over the countries.

The social economic burden of osteoporosis is so large that its etiology, prevention and treatment have become an urgent issue that needs to be coped with worldwide. This disease is a chronic complex health problem for millions of women worldwide, 80% of whom are post-menopausal. Unless prevented or treated, this silent disease will continue to limit both the quality and the quantity of many older women and significantly add to health care cost for this group (Taylor, Schreiner, & Stone, 2004; Arling, Doebbeling, & Fox, 2011). Osteoporosis prevention is complicated but it holds promise as the best way to decrease future fractures (Kanis, Johansson, & Johnell, 2005). Looking around the world, we see that osteoporosis, like other diseases such as cancer, heart disease, and diabetes; occurs in some areas much more than in others and varies from one culture to another. This clarifies that the development of weak bones is not a natural artifact of aging. While the United States has one of the highest osteoporosis rates in the world, there are other areas where this disorder is relatively rare, even among the older segments of the population (Dawson-Hughes, Tosteson, & Melton, 2008; Koh, Sendrine, & Torralba, 2001; Sen, Rives, & Messina, 2005; De Laet, Kanis, & Oden, 2005; Taylor, Schreiner, & Stone, 2004). For example, the inhabitants of Singapore, Hong Kong, and certain sectors of former Yugoslavia, as well as the Bantu of South Africa have traditionally held extremely low rates of osteoporotic fracture. In Japan, vertebral compression fractures among women between ages 50 and 65 were so rare that many physicians doubt their existence, and the incidence of hip fractures among the elderly Japanese historically has been much less than half that of Western countries (Koh, Sendrine, & Torralba, 2001; Sen, Rives, & Messina, 2005). Africans and native peoples living traditional lifestyles have been classified as “almost immune” to osteoporosis (De Laet, Kanis, & Oden, 2005). Interestingly enough, as these less technologically advanced countries become more Westernized, their rates of osteoporotic fracture are steadily increasing (Taylor, Schreiner, & Stone, 2004). We note that some Lebanese studies have showed that the mean BMD for the Lebanese female is lower than that of the European woman. Another Lebanese study showed that the hip fractures occur at a younger age in Lebanon (between 65 and 75) compared to western population (above 75) and that 60% of patients with hip fractures have osteopenia rather than osteoporosis (Taylor, Schreiner, & Stone, 2004).

Osteoporosis is a bone disease that commonly occurs among postmenopausal women. Recognizing population with high risks of osteoporosis remains a difficult challenge. Early detection and diagnosis is the key for prevention but are very difficult, without using costly diagnosing devices, due to complex factors involved and its gradual bone loss process with no obvious warning symptoms. Building an Osteoporosis prediction system using data mining techniques based on analyzing postmenopausal risk factors is the aim of this study. By discovering the osteoporosis disease warehouses for Osteoporosis, significant patterns can be extracted in order to build a robust disease prediction models that aim to guide medical decision making (Harold, 2008) and provide an easier way to detect if a person can have the risk of an osteoporosis. The aim of this study is to examine the potential use of classification on a massive volume of healthcare data, particularly in prediction of