Chapter 4.21
Decision Support Systems for Cardiovascular Diseases Based on Data Mining and Fuzzy Modelling

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INTRODUCTION

The widespread availability of new computational methods and tools for data analysis and predictive modelling requires medical informatics researchers and practitioners to systematically select the most appropriate strategy to cope with clinical prediction problems. In particular, data mining techniques offer methodological and technical solutions to deal with the analysis of medical data and construction of decision support systems. Furthermore, fuzzy modelling deals with the ambiguity inherent in all medical problems. These methods can be used to design and develop
clinical decision support systems (CDSSs), which, 
after evaluated from the experts, can be integrated 
into clinical environments.

Cardiovascular diseases (CVDs) are the lead-
ing cause of death in many countries worldwide. 
According to the World Health Organization, 
CVDs are the cause of death of 16.6 million people 
around the globe each year. The multifaceted 
nature of these diseases, combined with a wide 
variety of treatments and outcomes, and complex 
relationships with other diseases, for example, 
diabetes, have made diagnosis and optimal treat-
ment of cardiovascular diseases a problem for all 
but experienced cardiologists.

This article addresses the decision sup-
port regarding cardiovascular diseases, using 
computer-based methods, focusing on the 
coronary artery disease (CAD) diagnosis and on 
the prediction of clinical restenosis in patients 
undergoing angioplasty. Methods reported in 
the literature are reviewed with respect to (i) the 
medical information that are employing in order 
to reach the diagnosis and (ii) the data analysis 
techniques used for the creation of the CDSSs. 
In what concerns medical information, easily 
and noninvasively-obtained data present several 
advantages compared to other types of data, while 
data analysis techniques that are characterized by 
transparency regarding their decisions are more 
suitable for medical decision making. A recently 
developed approach that complies with the above 
requirements is presented. The approach is based 
on data mining and fuzzy modelling. Using this 
approach, one CDSS has been developed for each 
of the two cardiovascular problems mentioned 
above. These CDSSs are extensively evaluated 
and comments about the discovered knowledge 
are provided by medical experts. The later is of 
great importance in designing and evaluating 
CDSSs, since it allows them to be integrated into 
real clinical environments.

BACKGROUND

Data Mining is the process of discovering patterns 
and correlations from large amounts of data, using 
artificial intelligence, statistical, and mathematical 
techniques (Tan, Steinbach, & Kumar, 2005). 
Fuzzy logic is the extension of the classical crisp 
(binary) logic into a multivariate form. Fuzzy 
logic is closer to the human logic, thus being able 
to deal with real world noisy and imprecise data 
(Wang, 1986). CDSSs are computerized tools 
developed to assist physicians through the pro-
cess of decision making. A known approach for 
the development of CDSSs is the use of experts’ 
knowledge combined with an inference engine. 
However, recent advances in designing CDSSs 
employ automated knowledge extraction from 
data, using data mining techniques, while fuzzy 
logic provides several advantages in designing 
inference engines, compared to the classical crisp 
logic. The combination of data mining and fuzzy 
modelling provides a powerful tool for fully au-
tomated creation of CDSSs, experiencing several 
advantages: (i) transparency in decision making, 
(ii) addressing the ambiguity inherent in clinical 
data, and (iii) ability to interpret all decisions 
in a medical manner. All the above are of great 
importance for physicians, when performing 
decision making.

Coronary artery disease (CAD) is the devel-
opment of atherosclerotic plaques in coronary 
arteries, resulting in coronary luminal narrowing 
and subsequently occlusion, and thus leading to 
myocardial infarction or sudden cardiac death. 
Coronary angiography (CA) is considered to be 
the “gold standard” method for the diagnosis of 
CAD and it is widely used. However, CA is an 
invasive and costly procedure that needs high level 
technical experience and technology and cannot 
be used for screening of large populations or close 
follow-up of treatment (Escolar, Weigold, Fuisz, & 
Weissman, 2006). Computer aided methodologies 
for CAD diagnosis have also been proposed in the 
literature; in this case the data obtained by some