Chapter 4
Optimizing and Managing Digital Telecommunication Systems Using Data Mining and Knowledge Discovery Approaches

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ABSTRACT

This chapter is interested in discussing and reporting how one can be benefited by using Data Mining and Knowledge Discovery techniques in achieving an acceptable level of quality of service of telecommunication systems. The quality of service is defined as the metrics which is predicated by using the data mining techniques, decision tree, association rules and neural networks. Digital telecommunication networks are highly complex systems and thus their planning, management and optimization are challenging tasks. The user expectations constitute the Quality of Service (QoS). To gain a competitive edge on other operators, the operating personnel have to measure the network in terms of QoS. In current times, there are three data mining methods applied to actual GSM network performance measurements, in which the methods were chosen to help the operating staff to find the essential information in network quality performance measurements. The results of Pekko (2004) show that the analyst can make good use of Rough Sets and Classification and Regression Trees (CART), because their information can be expressed in plain language rules that preserve the variable names of the original measurement. In addition, the CART and the Self-Organizing Map (SOM) provide effective visual means for interpreting the data set.

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INTRODUCTION

In response to human communication needs, telecommunications have developed into cellular radio networks, which enable subscribers to connect and communicate regardless of their location and even movement. The first generation networks were analogue, but the benefits of digital transmission, such as fewer transmission errors and more efficient use of radio frequencies, have paved the way for second-generation networks (2G) digital mobile telecommunication networks, whose most widely spread realizations are based on the Global System for Mobile communications standard (GSM World, 2003). The next generation, 3G networks are now being built, and the GSM successor is based on the Universal Mobile Telecommunications System (UMTS) standard. The UMTS network extends user connectivity on a global scale and provides more bandwidth for the user, enabling even multimedia transmissions. Digital mobile telecommunication networks are highly complex systems and thus their planning, management and optimization are not trivial tasks. The systems' complexity arises from elements such as switches, controllers, transceiver stations, to name just a few, which jointly form the radio interface of a network for mobile stations. The basic units of this complex network are base transceiver stations with antennas pointed to a radio coverage area, called the cell.

The subscribers, connected to the network via their mobile stations, expect network availability, connection throughput, and affordability. Moreover, the connection should not degrade or be lost abruptly as the user moves within the network area. These user expectations constitute Quality of Service (QoS), specified as "the collective effect of service performances, which determine the degree of satisfaction of a user of a service" (ITU-T E.800). To gain a competitive edge over other operators, the operating personnel have to measure the network in terms of QoS. By analyzing the information of their measurements, they can manage and improve the quality of their services. With the information, they can also optimize the parameters and the configuration of the network.

However, because the operating staff is easily overwhelmed by hundreds of measurements, the measurements are aggregated into performance indicators, the most important of which are the Key Performance Indicators (KPI), which again can be divided into cost efficiency and QoS indicators (Lempiläinen & Manninen, 2001). Personnel expertise with the KPIs and the problems occurring in the cells of the network vary widely, but each personnel know the desirable KPI value range at least. Furthermore, the operators have their individual ways to judge if the KPIs in the cell indicate that the cell is performing as expected and if the cell is in its normal state. Their judgment may be based on simple rules such as "if any of the KPIs is unacceptable, then the state of a cell is unacceptable". The acceptance limits of the KPIs and the labeling rules are part of the a priori knowledge for analysis. When the operating personnel improve the QoS on the basis of their a priori knowledge, they face a lot of questions given below:

- What is the most common combination of KPI values when the state of a cell is unacceptable?
- Which KPIs is the most useful one for detecting problems?
- Which cells have the best QoS and how does KPI data manifest this?
- Whether all the KPIs relevant for analysis?

In finding the answers for QoS related questions, the personnel's main goal is to locate the problem areas in the network. Also, to support QoS improvement, one should know the best areas in the network. Should there be any; the configurations of well performing areas could be used to configure the problem areas of the network. Finally, even if most cells in the network perform as expected, it is useful to find cell groups that differ from