Chapter 7.14
Predicting Voluntary Participation in a Public Health Program Using a Neural Network

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ABSTRACT

Researchers increasingly use Artificial Neural Networks (ANNs) to predict outcomes across a broad range of applications. They frequently find the predictive power of ANNs to be as good as or better than conventional discrete choice models. This article demonstrates the use of an ANN to model a consumer's choice to participate in North Carolina's Maternity Care Coordination (MCC) program, a state sponsored voluntary public health service initiative. Maternal and infant Medicaid claims data and birth certificate data were collected for 59,999 births in North Carolina during the years 2000-2002. Part of this sample was used to train and test an ANN that predicts voluntary enrollment in MCC. When tested against a hold-out production sample, the ANN model correctly predicted 99.69% of those choosing to participate and 100% of those choosing not to participate in the MCC program.

INTRODUCTION

Information technology (IT) plays a pervasive role throughout the health care industry. In addition to providing the data storage and data processing capabilities needed to support the business management, customer relations management, human resource management and office automations requirements of health care organizations, IT also is used increasingly to support decision making functions.

Most decision support methodologies rely on the mathematical modeling of historical data. Many of these systems, such as the widely accepted Acute Physiology and Chronic Health Evaluation (APACHE) system, are based on binary LOGIT regression estimations or other statistical analysis techniques. This type of modeling requires the specification of *a priori* functional relationships between dependent and independent variables based on assumptions such as correct model specification, error-free measurement of independent variables, and normally distributed, heteroscedastistic, independent, zero-mean residuals. It is more likely, however, that health care decisions will depend on a variety of factors involving complex, hidden interrelationships of both socio-demographic and health related characteristics.

To address issues of nonlinearity and complex relationships in study data, many modelers have turned to other methods of analysis that fall under the broader categorization of "artificial intelligence" (AI). AI, which attempts to give computers human-like reasoning capabilities, includes techniques such at expert systems, fuzzy systems, genetic algorithms, case-based reasoning and a variety of classifier systems like the Artificial Neural Network (ANN) used in this study.

Because of advantages like ease of optimization, prediction accuracy, easy knowledge dissemination, workload reduction and decision support, Artificial Neural Networks have been widely accepted and used for more than a decade in the health care arena (Lisboa & Taktak, 2006). When used in medical applications, ANNs are known to provide decision support assistance that can produce highly accurate results (Kaur & Wasan, 2006). Several studies show ANNs offering better predictive performance than other modeling alternatives (Alkan, Koklukaya, & Subasi, 2005; Alpsan, Towsey, Ozdamar, Tsoi, & Ghista, 1995; Goss & Vozikis, 2002). Examples of medical applications of an ANN include the analysis of trauma data (Chesney et al., 2006; Eftekhar et

al., 2005) and the diagnoses of cancer (Lisboa & Taktak, 2006), diabetes (Kuar & Wasan, 2006), gastrointestinal hemorrhage (Das et al., 2003), and myocardial infarction (Baxt, 1991; Baxt, Shofer, Sites, & Hllander, 2002).

While medical diagnosis is probably the most common health care application for Artificial Neural Networks, they also have been used successfully in other health care service areas. Examples include identifying individuals at risk for high medical costs (Crawford, Fuhr, Clarke, Hubbs, 2005), identifying sources of future high cost treatments within a given health plan population (Kudyba, Hamar, & Gandy, 2006), evaluating if patient debt is likely to be repaid (Zurada & Lonial, 2005), and predicting nursing staff levels (Seomun, Chang, Lee, Kim, & Park, 2006).

ANNs are generally well accepted and frequently used in the health care industry, but one sector that does not seem to have taken advantage of this technology is public health care services. While facing the expected pressures for professionalism and quality service, public health care also faces the additional burdens of budgetary restrictions and legislative oversight. As a result, public health care, like other sectors of health care, is intensifying its focus on the enhancement of operating efficiency through effective resource allocation. One way to enhance efficiency is to more accurately identify resource demands. Because Artificial Neural Networks excel at identifying relationships in historical data for purposes of classification and prediction, it follows that using an ANN to predict participation in a public health program should improve predictive capability, reduce inefficient resource allocation, and decrease variability in treatment processes (Kudyba et al., 2006). North Carolina's Maternity Care Coordination (MCC) program represents one such public health care initiative.

The Maternity Care Coordination program attempts to coordinate prenatal care for eligible Medicaid clients. MCC provides counseling, referrals, and resource assistance for women considered

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