Chapter VI

Application of Bayesian Modeling to Management Information Systems: A Latent Scores Approach

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Abstract

This chapter deals with the application of Bayesian modeling as a management decision support tool for management information systems (MIS) managers. MIS managers have to deal with problems which require prediction and diagnosis for decision making. Lacking a proper tool for making informed decisions, MIS managers feel hard-pressed for a scenario analysis which can take into account the proper causal relationships existing in the real world. Bayesian modeling could be an appropriate support tool for such decision making. However, its application to decision support in MIS is different from application to other fields, as the variables in field of MIS are hypothetical. This brings in a need for Bayesian modeling at a hypothetical variable level rather than at the observed variable level. In this chapter we will study how Bayesian modeling can be used as a tool for managerial decision support in MIS. The conclusions of this chapter can also be extended to other social science researches where the variables are hypothetical in nature.
Structural equation modeling (SEM) is good for empirical validation but it is not suitable for prediction and diagnosis. Prediction and diagnosis are useful for managerial decision support and can be done using Bayesian networks. Bayesian networks, however, do not differentiate between causal and spurious relationships. The capability of SEM in empirical validation combined with the prediction and diagnosis capabilities of Bayesian modeling offers an excellent tool for managerial decision support. This study proposes the linkage of SEM to Bayesian testing, for prediction and diagnosis from an empirically validated model.

We apply the proposed approach to management decision support for customer retention in a virtual community. This research helps SEM researchers in extending their models for managerial prediction and diagnosis. It benefits Bayesian researchers by providing for the application of modeling causal relationships at a latent variable level. Modeling at the latent variable level, before Bayesian testing, would help in simplifying and uncovering the situation under study, and facilitating the identification of causal relationships.

Introduction

Structural equation modeling (SEM) is a causal modeling approach which combines cause-effect information with statistical data to provide a quantitative assessment of relationships among the studied variables. If the relationships are significant, the theoretical construction is considered valid and can be used to provide guidelines for the application of the model in practice. Although SEM is good for empirical validation of theoretically based causal relationships, and to some extent for prediction also, it is not suitable for diagnosis of the situation and thus has limitations in managerial decision making. Moreover, SEM primarily models linear relationships. In case the relationships are nonlinear, the potential effect of independent variables in explaining the variance in dependent variables would not be accurately known, resulting in poor prediction and diagnosis.

These limitations of SEM can be overcome by using Bayesian networks. Bayesian networks are especially suited for prediction and diagnosis and can be trained on the same structure with new data. Moreover, Bayesian networks are suitable for modeling nonlinear relationships. They are, therefore, useful for assessing the impact of changes in the modeled situation. Bayesian networks, however, have certain limitations in causal modeling from the viewpoint of social science research. To establish causality, three criteria, namely temporal order, association, and elimination of plausible alternatives must be fulfilled (Neuman, 2003). In Bayesian modeling, the relationships are based on association (conditional independence), and to some extent temporal order, but the third criterion of elimination of plausible alternatives is not fulfilled. The result is that Bayesian networks do not differentiate between a causal and a spurious relationship. Although, the theoretically valid structural model can be forced as a Bayesian net, the Bayesian networks are not as capable as SEM for theoretical explanation (Anderson, Mackoy, Thompson, & Harrell, 2004). Another limitation of Bayesian networks from MIS research perspective is that they do not differentiate between a latent construct and its measures (observed variables).

These limitations of Bayesian networks can be overcome by using a theoretically based and empirically validated model (which is possible by using SEM) and developing the
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