COMPARING THE PERFORMANCE OF ORDINAL LOGISTIC REGRESSION AND ARTIFICIAL NEURAL NETWORK WHEN ANALYZING ORDINAL DATA

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CHAPTER I

INTRODUCTION

1.1 Background

Service industries measure their performance with respect to customer satisfaction using multiple techniques, including customer surveys (Allen & Seaman, 2007). Surveys are also used to measure employee satisfaction, job performance and other facets of the internal service quality of an organization. Typically, the types of information collected from surveys are related to descriptive, behavioral and attitudinal attributes of the respondents (Rea & Parker, 2005). Socioeconomic data of the respondents (such as income, age, and ethnicity) is an example of descriptive information collected from a survey. Survey questions about respondent behavior, such as utilization of various resources and facilities, are designed to document the respondents' patterns of behavior while they are using the facilities. The respondents' stated attitudes about various conditions related to the services they used are also commonly found in survey studies.

Organizations use this descriptive, behavioral, and attitudinal information from surveys to determine what types of services should be offered or withdrawn, which factors most strongly govern respondents' satisfaction with the provided services, how various work environments influence productivity, and many other essential decisions. Thus, survey research has become of critical importance for business decision-making (Allen & Seaman, 2007; Rea & Parker, 2005).

Stevens' classification of measurement scale (Stevens, 1946) classifies data collected from surveys into four types of scales: nominal, ordinal, interval and ratio. Nominal scale refers to categories without ordering the preferences, such as gender (male and female), favorite colors (blue, white, and black), and seasons (fall, spring, summer and winter). Ordinal scale preserves rank ordering in the categories but no measures of distance between categories are possible because the distance between categories are not necessary equal. Some examples of ordinal data are variables describing stages of cancer (I, II, II), the quality of waiting service (poor, acceptable, excellent), and customer satisfaction with a service delivery (very dissatisfied, dissatisfied, neutral, satisfied, and very satisfied). The distance between "neutral" and "satisfied" may not be the same as the distance between "satisfied" and "very satisfied." An interval scale has the same characteristics as an ordinal scale, but the distances between any points are consistent. However, an interval scale does not have an absolute zero. An example of interval data is temperature in Fahrenheit (F) degrees since 0^o F is arbitrary and negative values can be used. Ratio data has all the characteristics of interval data except that it has an absolute zero. Examples of ratio data are a person's weight and height.

In summary, a nominal scale allows differentiation between responses by categorizing only, while an ordinal scale enables the researcher to determine the rank-order of preferences without using the distance between any points in the scale. In contrast, an interval scale is able to measure the distance between responses. A ratio scale is the highest level of measurement since it has an absolute (as opposed to an arbitrary) zero point.

Stevens (1946) also outlines the statistical procedures that are permissible for each type of scale, in which each permissible statistics for each type of scale includes all of its predecessors. The permissible statistics for nominal data should be limited to the mode, the number of cases, and the contingency correlation. The permissible statistics for ordinal data include all statistics for nominal data plus the median and percentiles, while that for interval data include all the statistics for ordinal data and also allows calculation of the mean, standard deviation, and product moment correlation. A ratio scale preserves all of the permissible statistics in the other scales while also allowing coefficient of variation. According to Stevens (1946), performing data analysis without considering the type of measurement scale can lead to meaningless results. Table 1.1 shows Stevens' classification of measurement scale.

The vast majority of surveys use Likert scales as the rating format (Allen & Seaman, 2007). The Likert scale is used to measure respondents' attitudes toward a given statement. Although the Likert scale is commonly constructed as a five-point scale, some researchers recommend the use of the seven-point scale in order to achieve higher reliability results (Allen & Seaman, 2007; Jamieson, 2004). Sometimes the scale is set to a four-point scale or other even numbers in order to force a respondent to make a choice by eliminating the "neutral" option.

Table 1.1 Classification of measurement scale (Stevens, 1946)

Scale	Basic empirical operation	Permissible statistics
Nominal	Determination of equality	Number of cases Mode Contingency correlation
Ordinal	Determination of greater than or less than	Median Percentiles Rank-order correlation
Interval	Determination of equality of intervals or differences	Mean Standard deviation Product-moment correlation
Ratio	Determination of equality of ratios	Coefficient of variation

The Likert scale often ranges from least to most in order to capture a respondent's feeling of intensity toward a given item (Turk, Uysal, Hammit, & Vaske, 2011). For example, respondents are asked to indicate their degree of agreement with a particular statement, and they may express their agreement as "strongly disagree," "disagree," "neither disagree nor agree," "agree," and "strongly agree." The response categories in the Likert scale have a rank-order. Although the numbers 1, 2, 3, 4, and 5 may be assigned to the respective response categories, the distance between each category is not equal. For example, the distance between "1=strongly disagree" and "2=disagree" may not be assumed to be the same as the distance between "2=disagree" and "3=neither disagree nor agree." Thus, the Likert scale should be categorized as an ordinal scale (Allen & Seaman, 2007; Jamieson, 2004).

Ordinal data has been widely utilized in education, health, behavioral and social studies. In the social and behavioral sciences, an ordinal scale is often used to measure attitudes and opinions. For example, employees could be asked to rate their overall job satisfaction using ordered categories such as “strongly dissatisfied,” “dissatisfied,” “neutral,” “satisfied,” and “strongly satisfied.” This measure of overall job satisfaction is ordinal because employees who choose “satisfied” experience more positive feeling toward their job than if they choose “neutral.” The rank-order is clear even though the difference between “satisfied” and “neutral” can not be measured numerically and certainly can not be assumed to be equal to other intervals.

Ordinal data is different from interval data because the absolute distances between each level in ordinal data are unknown even though the rank-order of the level is clearly defined. Nominal and ordinal data are categorical data but nominal data does not involve a rank-order. In general, data analyses for nominal, interval, and ratio data are clearly defined but this is not the case with data analysis for ordinal data. Many studies treat ordinal data as interval data (Knapp, 1990; Mayer, 1971; Velleman & Leland, 1993). Underlying this might be the fact that parametric tests with interval data are considered easier to interpret and provide more meaningful information than non-parametric tests (Allen & Seaman, 2007; Chimka & Wolfe, 2009). However, treating ordinal data as interval data may result in a misrepresentation of the results and lead to poor decision making since such treatment causes substantial bias by assuming equal intervals between points of the ordinal data and other assumptions related to the data distribution that are rarely fulfilled by ordinal data.

A study conducted by Hastie, Botha, and Schnitzler (1989) shows that treating ordinal output data as interval data results in statistically significant interaction between independent variables. However, when this ordinal output data is analyzed as ordinal data, the interaction is not statistically significant. Therefore, many researchers recommend not analyzing ordinal data as interval data in order to achieve a higher capability of detecting meaningful trends of input variables on the response variable. Thus, analyzing ordinal data using methods that are able to maintain the rank-order of ordinal data without assuming equal distances between categories provide more valuable and useful results for further investigation and decision-making (Gregoire & Driver, 1987; Jamieson, 2004; Mayer, 1971).

Multiple analytical statistical methods are available to analyze ordinal data. These methods can be a model-based approach, such as models for cumulative response probabilities or a non-model based approach, such as a nonparametric method based on ranking. A model-based approach is commonly used to test causal relationships, while a non-model based approach tends to be used for making inferences related to association/correlation measures. A common model-based method used to analyze ordinal data is an Ordinal Logistic Regression (OLR) model (further explanation of the OLR model is presented in sub-section 2.2.1). Several approaches are available to build the OLR model, such as the cumulative link model, the adjacent categories model, and the continuation ratio model. The most commonly used among these three approaches is the cumulative OLR model (Agresti, 2010; Tutz, 2012).

In addition to statistical models, several machine-learning algorithms are also available to analyze ordinal data, such as an Artificial Neural Network (ANN) model, a decision tree model, and a Support Vector Machine (SVM) model. An ANN model is a computational model that is inspired by the properties of biological neurons. The ANN model term used in this study refers to a multilayer perceptron (MLP) ANN, an artificial neural network that is comprised of input, hidden and output layers. The hidden layer is the key of an ANN model since it contains the summation and transfer function of each node (further explanation of ANN is presented in sub-section 2.2.2). A decision tree model presents a classification rule as a tree in which different subsets of variables are used at different levels of the tree. The classification rule in the tree defines the decision boundary. A SVM model functions as a pattern classification method by finding the optimal separating hyper-plane for either linear or non-linear data. The optimization process in an SVM model relies on the kernel function used in the model

Among these three techniques (ANN, decision tree and SVM), the ANN model has more similarities with the regression model than the other models. The comparisons between the ANN model and the logistic regression model for classification or prediction problems of binary response data have been conducted extensively (Deng, Chen, & Pei, 2008; Karlaftis & Vlahogianni, 2011; Paliwal & Kumar, 2009). However, none of the previous studies have compared the performance of OLR and ANN models to analyze ordinal data.

1.2 Problem Statement

The benefits of analyzing ordinal data using methods that maintain the rank-order of ordinal data and do not assume equal distances between categories promise meaningful and useful results in decision-making. Although some previous studies have applied the

OLR or ANN models to analyze ordinal data, the existing research focuses on comparing the performance of the logistic regression and ANN models for classification of binary responses. None of the existing studies compares the performance of the ANN and OLR models to analyze ordinal data under different marginal probability distributions and correlation coefficients. Understanding the impact of different combinations of marginal probability distributions and correlation coefficients on the ANN and OLR performance could help providing a guide for selecting an appropriate model and parameters in order to build a better model to analyze ordinal data. This can, in turn, lead to more efficient and value-added decision-making.

1.3 Purpose

The purpose of this study is to compare the application of the OLR and ANN models to analyze ordinal data using different scenarios by varying the combinations of the marginal probability distribution and correlation coefficients. This study attempts to provide the best guidance for model selection for various combinations of marginal distribution and correlation coefficient to analyze ordinal data. The specific objectives of this study are to:

1. Develop the OLR and ANN models to represent a relationship between one predictor and one response variable with various combinations of marginal probability and correlation coefficients.
2. Develop the OLR and ANN models to represent a relationship between three predictors and one response variable with different combinations of marginal probabilities and correlation coefficients.

3. Compare the models' accuracy.
4. Evaluate the models and summarize the results for use in model selection for each scenario.

1.4 Test Case: The Service Profit Chain in Training Restaurants

In order to compare the performance of the Artificial Neural Network (ANN) and Ordinal Logistic Regression (OLR) model to analyze ordinal data, data is collected from two training restaurants by using student satisfaction surveys and instructor evaluations of student job performance. Collected data is used as the source to determine marginal probabilities and correlation coefficients for simulations. Two groups of data are generated in the simulations. The first group of data consists of two variables (one input and one outcome variable). The input variable is the instructor evaluations of student job performance, while the output variable is the student overall satisfaction based on student attitudes and perceptions. The second group of data consists of four variables (three input and one outcome variable), which refers to three determinants of student satisfaction and the student overall satisfaction. Both the OLR and ANN models are built using each data set generated from the simulation and each data set collected from the survey. Finally, this study compares the misclassification rate (the proportion of disagreement between the predicted-outcome and the actual outcome) resulting from the OLR and ANN models.

The service sector has been growing rapidly in the past two decades. One of the largest private-sector employers in the United States is the restaurant industry. This industry provides many career opportunities for college students pursuing degrees in hospitality, restaurant management, as well as in the culinary arts. Currently, there are approximately 261 schools that offer degrees in the culinary arts and culinary management in the United States (Hertzman & Ackerman, 2010). As of June 2011, the Accreditation Commission for Programs in Hospitality Administration (ACPHA) has granted accreditation for 55 hospitality programs in the US (chrie.org, 2012). One of the most important facilities in those programs is the training restaurant, since the learning process in the training restaurant improves the skill and critical thinking required for the restaurant industry (Gustafson, Love, & Montgomery, 2005).

The case study for this research uses the service-profit chain framework as a platform to build OLR and ANN models. The Service Profit Chain (SPC) is a comprehensive framework of the relationships between employee, customer, and profitability introduced by Heskett, Jones, Loveman, Sasser Jr, and Schlesinger (1994). The framework links employee satisfaction with the value of the product and service delivered to create customer satisfaction, and then assess the effect on profitability.

The information gained from examining the internal links of the SPC concept in a training restaurant, which involves student satisfaction and job performance during the learning process in the training restaurant, can provide valuable input to improve restaurant performance and customer satisfaction. Although the training restaurant has an important role in the effectiveness of hospitality and culinary programs in preparing students to enter the restaurant industry, this type of training facility has received less attention in the literature (Alexander, Lynch, & Murray, 2009; Nies, 1993). Thus, this exploratory study may help add to the body of knowledge governing the utilization of training restaurants in education.

1.5 Summary of the Research Gaps

Ordinal data is rank-ordered data commonly used in social and behavioral studies as well as in educational and health studies. This type of data is different from interval data because the distance between each category is not necessarily equal. Ordinal data is also different from nominal data because of its rank-ordered property. Despite the distinctive properties of ordinal data, many studies continue analyzing ordinal data using methods that only work properly with interval or nominal data (Agresti, 2010; Hastie et al., 1989; Mayer, 1971).

In recent years, regression and ANN models have been considered competing model-building techniques in the literature. Many studies have been conducted to compare and contrast the use of regression and ANN models in the area of prediction and classification problems (Deng et al., 2008; Karlaftis & Vlahogianni, 2011; Luengo, García, & Herrera, 2009; Paliwal & Kumar, 2009). However, none of those studies focus on the use of the OLR and ANN models as a model-building technique for ordinal data.

This study compares the performance of the OLR and ANN models by using survey data collected from two training restaurants and artificial data generated through simulation. Artificial data is randomly generated based on marginal probabilities and correlation coefficients. Although some studies that compare regression and ANN models also use simulation to generate data, none of them generates data as correlated ordinal data. Instead, a random uniform distribution is utilized (Cardoso & Da Costa, 2007; Jianlin, Zheng, & Pollastri, 2008).

This study builds the OLR and ANN models to explore two relationships in the internal link as explained in the Service Profit Chain (SPC) concept. The case study uses the internal link of the SPC because this link reflects the effectiveness of the learning process in the training restaurant. Also, the number of previous studies that explore the internal link of the SPC is much smaller than that of studies which explore the external link. The internal links are comprised of 1) the relationship between employee satisfaction and employee performance and 2) the relationship between employee satisfaction and the determinant factors of employee satisfaction, such as clarity of job descriptions, self-motivation, reward, recognition, and many others. Currently, no study has been conducted to compare the OLR and ANN by testing the internal links of the SPC in a training restaurant setting.

1.6 Organization of the Study

Chapter I delivers an overview of the main topic under study, and the rationale for the need of such a study. The problem statement, purpose, test case for the study and the research gaps that the study aims to fulfill are also stated. Chapter II provides a review of literature relevant to the development of the study. The methodology and procedures used in the study, including the process for developing the instruments used to collect data are presented in Chapter III.

Chapter IV provides the process used to compare the OLR and ANN models with one independent variable and presents the results gained from the comparison. The chapter also explains the simulation process used to generate data with specific marginal probabilities and correlation structure. The results of comparing OLR and ANN models with three independent variables are presented in Chapter V. The last chapter, Chapter VI, contains a summary, conclusions and recommendations for future research.

CHAPTER II

REVIEW OF LITERATURE

2.1 Introduction

The first part of this chapter explains the two methods used to analyze ordinal data: the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models. The next part of this chapter presents the methods used in the study to perform simulations needed to generate artificial data. It also includes the relevant correlation setups, including detailed algorithms used to generate random marginal probabilities, correlation matrices, and correlated ordinal data. The performance metrics and hypothesis testing used to compare the OLR and ANN models are also explained. The last section provides a review of relevant literature about the structure and function of training restaurants, the service-profit chain (SPC), and employee satisfaction, which provide the research framework for the case study.

2.2 Methods for Analyzing Ordinal Data

An ordinal scale is commonly used to gather data about subjective responses in many behavioral studies. For example, some studies explore employee and customer satisfaction and their determinants. Although the variables are measured in ordinal scales, some researchers tend to treat them as continuous variables and to analyze them using linear regression models. For instance, Eskildsen and Nussler (2000) built a linear regression model to predict employee satisfaction in several companies in Denmark, whilst Gustafsson and Johnson (2004) applied a linear regression model to determine attribute importance in a service satisfaction model. Analyzing ordinal data using any model that assumes equal distances between categories of such data may produce meaningless results (Agresti, 2010; Mayer, 1971; Tutz, 2012).

The Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models are two analytical methods which are appropriate for analyzing ordinal data. Compared to the ANN model, the OLR is easier to interpret and can be statistically tested. On the other hand, the ANN has a higher capability to deal with any non-linear functions and any data distribution as well as multi-collinearity within input variables (Lin, 2007). Many studies that compare statistical methods and the ANN model to predict overall customer or employee satisfaction show that the ANN model results in a lower standard deviation and misclassification rate than statistical methods (West, Brockett, & Golden, 1997; Gronholdt & Martensen, 2005). However, all of those studies treat the respondents' responses either as interval or nominal data, although the responses are measured with the Likert-type scales. Ignoring the rank order of ordinal data by treating such data as nominal scale or assuming equal distances between categories of ordinal data in order to analyze such data as interval data may lead to meaningless findings (Ananth & Kleinbaum, 1997; Jamieson, 2004; Tutz, 2012).

2.2.1 Ordinal Logistic Regression (OLR) Model

Regression modeling is a model-based approach that is useful to investigate the relationship between multiple independent variables and a dependent variable, as well as to examine the effect of independent variables on a dependent variable (Chen & Hughes, 2004). Linear regression and logistic regression are two common regression models used in many previous studies. The decision to choose either linear regression or logistic regression depends on the measurement scale of the dependent variable. When a dependent variable is on a continuous scale, a linear regression is more appropriate. On the other hand, a logistic regression performs better with binary variables. However, a logistic regression model should not be used to analyze ordinal data since this model attains only 50%-75% of the asymptotic relative efficiency (the limit of the ratio of the sample size required) compared to an ordinal logistic regression (with a cumulative-logit link) for a five level category dependent variable (Armstrong & Sloan, 1989).

An Ordinal Logistic Regression (OLR) model is an extension of a logistic regression that is capable of handling data on ordinal scales. Basically, a logistic regression is used to investigate the relationship between independent and dependent variables, in which the dependent variable is a binary/dichotomous variable. However, a logistic regression can be modified to analyze nominal or ordinal data by changing the link function from simple logistic to cumulative logits (Lawson & Montgomery, 2006). Thus, when a dependent variable is on an ordinal scale, the use of an ordinal regression is more appropriate than a multiple regression (Lundahl, Vegholm, & Silver, 2009; McCullagh, 1980)

Other than the OLR, Clogg and Shihadeh (1994) explain that the log-linear model and measures of association are also appropriate methods to analyze ordinal data. These three methods produce similar results, since all of these methods maintain the rank order of the ordinal data and do not assume equal distances between categories of such data. However, when ordinal data is analyzed by using a method that does not consider the rank order of the data, such as a logistic regression model, differences in the results may occur (Clogg & Shihadeh, 1994; Tutz, 2012).

Several cumulative link functions are available to build an OLR model, such as the cumulative logits, probit, cauchit, complementary log-log, and the related log-log link (Agresti, 2010). The decision to choose one link over the others depends upon the distribution of the dependent variable. The most commonly used link function in the OLR model is the cumulative logit model (Clogg & Shihadeh, 1994; Fullerton, 2009). The cumulative logit link function is used when an OLR model is applied to the *k* levels of a dependent variable, the model incorporates *k-1* logits into a single model. Thus, the function can be written as:

$$logit\ [P(Y_i \leq j)] = \propto_j + \beta' x_i = \propto_j + \beta_1 x_{i1} + \beta_2 x_{i2} + \cdots \qquad (2.1)$$

where $j=1,\ldots,k-1$, and β indicates the effect of the independent variables, x_i denotes the column vector of the value of the independent variable, y_i denotes the response levels of the dependent variable. Based on Equation 2.1, the effect of β is the same for each cumulative logit.

If $\pi_{1,}\ \pi_{2,\ldots\ldots}\pi_k$ denote marginal probabilities of each *k* level of a dependent variable, then the cumulative logit can be determined as:

$$logit[P(Y \leq j)] = log\frac{P(Y\leq j)}{1-P(Y\leq j)} = log\frac{\pi_1+\cdots+\pi_j}{\pi_{j+1}+\cdots+\pi_k}\ . \tag{2.2}$$

The cumulative logit link is a symmetric function, thus this link is preferred when the ordinal data of the response variable is evenly distributed among all category levels. If the ordinal data being analyzed tend to be distributed on the higher response levels, such as 'very satisfied' on a satisfaction rating, the complementary log-log link function is generally used to build the OLR model (Chen & Hughes, 2004). The complementary log-log link function can be written as:

$$log\{-log[1 - logP(Y \leq j)]\} = \propto_j + \beta' x. \tag{2.3}$$

With the complementary log-log link function (shown in Equation 2.3), $P(Y\leq\ j)$ moves toward 1.0 at a higher rate than it moves toward 0.0 (Chen & Hughes, 2004). Therefore, this link function is more suitable when the outcome data is dominantly distributed on the higher level.

To interpret OLR results, a researcher should consider the signs and coefficients used in the model. The signs represent the existence of negative or positive effects of the independent variables on the ordinal outcome. The intercept parameter, α, refers to the estimated ordered logits for the adjacent levels of the dependent variable. The coefficient, β, indicates that a one unit change in the independent variable results in a change of the odds of the event occurring by a factor of e^{β}, holding other independent variables as constant (Fullerton, 2009).

2.2.2 Artificial Neural Network (ANN) Model

An Artificial Neural Network (ANN) is an information-processing model that is inspired by the brain function. The key characteristics of the ANN are its capability to model complexity and uncertainty. The ANN model often performs better than traditional statistical techniques, since this technique does not require the assumptions of traditional statistical techniques, such as linearity, absence of multi-collinearity, and normally distributed data (Garver, 2002; Lin, 2007; Nisbet, Elder, & Miner, 2009). ANN models are built through an iterative process in which the model learns the pattern of complex relationships between input and output.

The simplest form of a neural network consists of three layers: input, hidden and output. The first layer is comprised of one or more processing elements (PE) that represent independent (predictor) variables, while the output layer contains one or more PEs that are referred as dependent (outcome) variables. The output layer consists of several PEs that represent the model's classification decisions. Each PE represents one class of output. The hidden layer in the model connects the input and output layers. In general, there can be one or more hidden layers between the input and output layer.

The key element in the ANN is the connection weights (Turban, Sharda, & Delen, 2011). The connection weights represent the relative weight of each input to the next processing element in the hidden layer and output layer. The weights also express how the processing element learns the pattern of information given to the networks. Other important elements in the ANN are the summation and transfer functions. The summation function calculates the weighted sum of all processing elements in the input layer that enters each processing element in the hidden layer. The summation function multiplies each input value by its weight and sums the values to get the weighted sum. This function is also referred as an activation function of each processing element in the input layer. Based on this summation function, an ANN model may or may not use a PE in the input when determining a PE in the sequence layer. In addition, the transfer function determines how the network combines input from each PE in the hidden layer that enters into the PEs in the output layer.

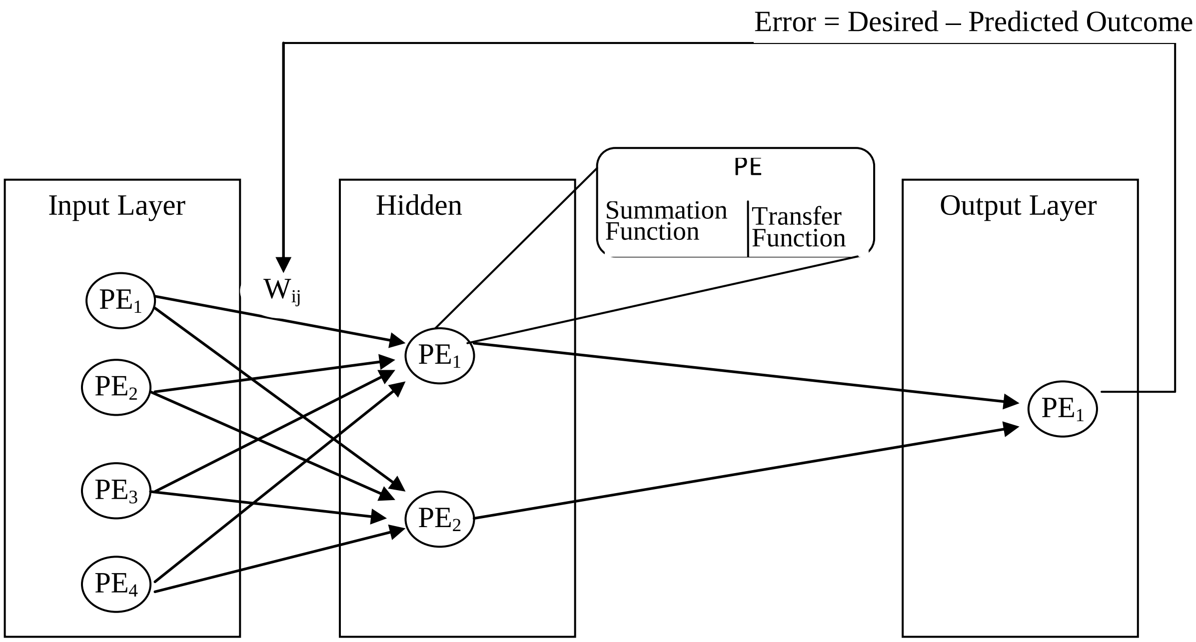

Figure 2.1 Information processing in MLP ANN with back-propagation algorithm (Mehrotra, Mohan, & Ranka, 1997)

The focus of this study is on multilayer perceptrons (MLP) ANN or feed-forward neural networks with a back-propagation algorithm, the most commonly used neural networks for classification problems (Mehrotra et al., 1997; Perlovsky, 2001). The back-propagation MLP ANN, as shown in Figure 2.1, is a type of ANN that adjusts the connection weight by minimizing the error between the desired output and the predicted outcome produced by the network. An ANN with this algorithm is trained by giving input and output data to the network. During the training period, the network learns the data patterns between the input and output and adjusts its connection weights to minimize error. Once trained, the connection weights are retained and remain available to determine output values for any new input fed to the network.

Each PE in the hidden layer transfers several PEs from the input layer to the sequence layers by using summation and transfer functions. Thus, the connection weight in the ANN model is difficult to explaine (Dreiseitl & Ohno-Machado, 2002; Turban et al., 2011). More hidden layers used in an ANN model results in more complex connection weights and interdependencies (West, Brockett, & Golden, 1997). Another potential drawback of an ANN model is the possibility of the model reaching the local minimum error rate since the iteration process depends on the sample used to learn the pattern when the network is trained. Thus, a validation data set is needed to decrease this potential weakness (West et al., 1997).

2.2.3 Performance Metrics

The performance metrics of a predictive model are frequently measured in terms of an error (Mehrotra et al., 1997). The nature of the problem determines the choice of the error measure. In classification problems, such as the application of a predictive model for nominal and ordinal outcome variables, one of the common measures of error is misclassification rate (Mehrotra et al., 1997; Webb & Copsey, 2011). A smaller misclassification rate indicates better model performance. A misclassification rate can be calculated as:

$$Misclassification\ rate = \frac{number\ of\ misclassified\ samples}{total\ number\ of\ samples}\ . \qquad (2.4)$$

For an ordinal outcome variable with many categories, the misclassification rate refers to the total number of misclassified samples of the outcome categories predicted by a model versus the actual categories for all classes.

Some analytical packages such as IBM SPSS Modeler and SAS Enterprise Miner present a confusion matrix to express the performance of a model being used for analysis. A confusion matrix has an appearance similar to that of a contingency table. Each column of this matrix represents the number of cases in an outcome category predicted by a model, while each row represents the number of cases in an actual category. Figure 2.2 shows the confusion matrix resulting from a seven-class classification problem (the outcome variable is a seven-point Likert scale). Thus, the confusion matrix has a dimension of 7x7. Each cell in the confusion matrix indicates number of misclassified/true-classified samples. When the outcome category of a sample predicted by a model is not the same as the actual category, the sample is counted as misclassified. Otherwise, the sample is counted as true-classified.

		Outcome Category (Class) Predicted by a Model						
		1	**2**	**3**	**4**	**5**	**6**	**7**
Actual Category (Class)	**1**	**True**	Misclass	Misclass	Misclass	Misclass	Misclass	Misclass
	2	Misclass	**True**	Misclass	Misclass	Misclass	Misclass	Misclass
	3	Misclass	Misclass	**True**	Misclass	Misclass	Misclass	Misclass
	4	Misclass	Misclass	Misclass	**True**	Misclass	Misclass	Misclass
	5	Misclass	Misclass	Misclass	Misclass	**True**	Misclass	Misclass
	6	Misclass	Misclass	Misclass	Misclass	Misclass	**True**	Misclass
	7	Misclass	Misclass	Misclass	Misclass	Misclass	Misclass	**True**

Figure 2.2 A confusion matrix representation for seven-class classification problem

2.2.4 Statistical Test to Compare the OLR and ANN models

Determining which type of statistical test to use to compare two or more models is one of the critical problems in this study. Many studies that compare machine learning algorithms and statistical models use different types of statistical tests, such as McNemar's test, the Wilcoxon signed-rank test, the Quasi F test and hypothesis testing on the average performance, to determine which model (algorithm) performs better for the problem that is being investigated (Dietterich, 1998). A taxonomy that helps to determine the statistical test to be used to compare different models (algorithms) is shown in Figure 2.3.

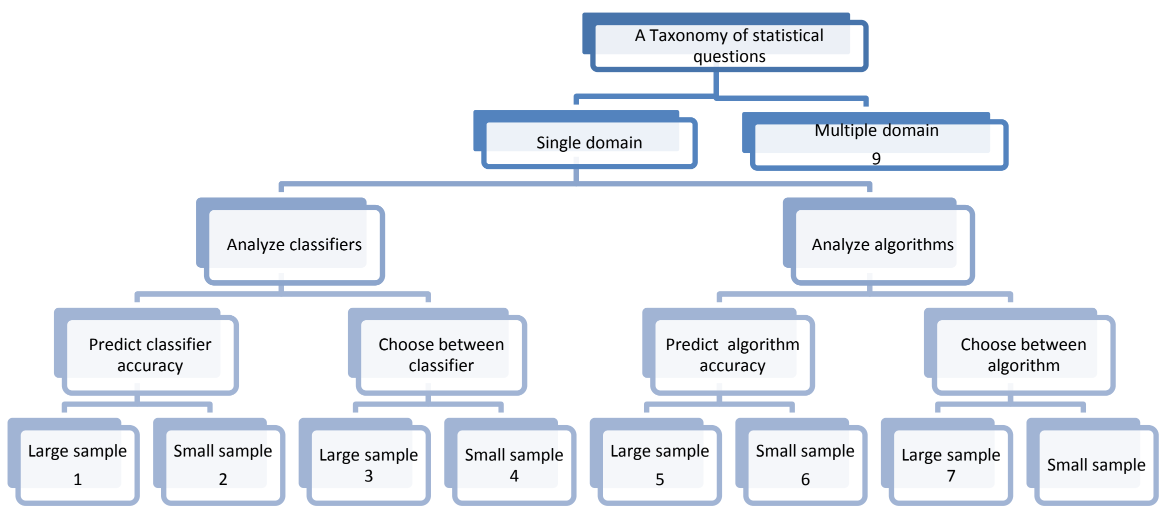

Figure 2.3 A taxonomy of statistical tests in comparing algorithms (Dietterich, 1998)

This study follows condition number 5, which suggests 1) to build algorithm on each training data sets of size *m*, 2) to test the resulting frozen model (classifier) on the testing data set and 3) compare the algorithms' accuracy based on the average performance (Dietterich, 1998). These suggestions are similar to the procedure undertaken in this study, which builds the ANN and OLR models using *n* training data sets of size *m*. In this study, each model is trained on each training data set and the resulting classifiers are tested on *n* testing data sets. The average accuracy or misclassification on test data sets predicts the performance of ANN and OLR models. Then, a hypothesis test on the mean is used to compare the average accuracy or misclassification obtained from the testing data sets.

One test procedure for investigating the difference between population means μ_1 and μ_2 is based on the assumption that the population distributions are normal and the value of the population variance is known to the investigator. However, both of these assumptions are unnecessary if the test procedure is performed on large sample sizes (Devore, 2008). When this test procedure is applied to compare the average misclassification rate from two algorithms, i.e. model 1 and model 2, the hypothesis testing can be expressed as the following:

$H_0: \mu_1 - \mu_2 = 0,$

$H_0: \mu_1 - \mu_2 \neq 0,$

$$Z = \frac{\bar{X} - \bar{Y} - 0}{\sqrt{\frac{S_1^2}{m} + \frac{S_2^2}{n}}}, \tag{2.5}$$

where μ_1 = the true mean misclassification rate for model 1

μ_2 = the true mean misclassification rate for model 2

$\bar{X}$ = the sample average of misclassification rate for model 1

$\bar{Y}$ = the sample average of misclassification rate for model 2

S_1^2 = sample variance for model 1

S_2^2 = sample variance for model 2

m = number of sample for model 1

n = number of sample for model 2

These tests are usually appropriate if both *m* and *n* are more than 40. H_0 is rejected if *p*-value is smaller than the desired type I error. If H_0 is rejected, the result confirms that there is a statistically significant difference between the mean misclassification rate resulting from model 1 and model 2. Otherwise, H_0 fails to be rejected, which means the misclassification rate resulting from model 1 is not statistically significant different from the one resulting from model 2.

2.3 Generating Correlated Ordinal Data

In order to evaluate and compare the performance of two models with a small data size, simulation is used to generate artificial data (Ibrahim & Suliadi, 2011). Additionally, if the artificial data is generated based on a particular data set in which the responses within a specific subject (respondent) are correlated and the responses between subjects are independent, then the artificial data are classified as correlated ordinal data and commonly generated based on the marginal probabilities and the correlation coefficient (Demirtas, 2006; Ibrahim & Suliadi, 2011; Lee, 1997).

Many studies discuss procedures to generate correlated binomial data based on the marginal probabilities and correlation coefficient, but only a few algorithms are available to generate correlated ordinal data. Some methods to generate ordinal data are developed from methods to generate binomial data (Lee, 1997; Sebastian, Dominik, & Friedrich, 2011). Several algorithms have been proposed to generate correlated ordinal data. A technique proposed by Gange (1995) uses the iterative proportional fitting algorithm for generating correlated ordinal data. This method determines the marginal joint distribution based on the log-linear model. However, this method requires intensive computation, even for a small number of variables (Demirtas, 2006; Ibrahim & Suliadi, 2011). Another method proposed by Lee (1997) simulates correlated ordinal data using a convex combination and archimedian copulas approach and computes the correlation coefficient using Goodman Kruskal's Γ coefficient. This approach does not require the same intensive level of calculation as the one suggested by Gange (1995), so that any number of categories and variables can be handled easily using this method. Unfortunately, this method cannot handle a negative correlation coefficient.

Biswas (2004) generates correlated ordinal data for a specific type of correlation (Autoregressive type correlation). This method requires the variables to be independent and identically distributed. Thus, this method is very restrictive. Another algorithm that has relatively high flexibility is suggested by Demirtas (2006). This algorithm uses the generation of binary data as the intermediate step and computes correlation using Pearson's product-moment correlation coefficient. Ordinal values of the original data are collapsed into binary values. Then, iterative calculations are conducted to compute the binary correlation and convert the binary data into ordinal data based on the original marginal distribution. A shortcoming of this method is its incapability to handle negative correlations. Based on the pros and cons of the available algorithms to generate correlated ordinal data, the decision to choose one algorithm over to the other depends on the type of correlation coefficient.

If the simulated variables could have a negative correlation coefficient, then the method proposed by Gange (1995) is the preferred algorithm. In circumstances when simulated variables have an autoregressive type correlation, the algorithm introduced by Biswas (2004) is the preferred choice. Alternatively, when simulated variables have positive correlation coefficients, either the algorithm proposed by Demirtas (2006) or Lee (1997) can be used. The difference between each algorithm is the type of correlation used in the simulation. Demirtas (2006) applies Pearson's product-moment correlation coefficient and Lee (1997) applies the Gamma correlation coefficient. This study uses the convex combination algorithm proposed by Lee since this algorithm requires a simple calculation and Gamma correlation coefficient, a type of correlation that is suitable for ordinal data.

Three main steps to generate correlated ordinal data using the convex combination algorithm proposed by Lee (1997) are 1) finding the extreme table, 2) finding the joint distribution, and 3) applying the inversion algorithm. The extreme table is used to check if the preferred Gamma correlation is achievable with the given marginal probabilities. The joint distribution is determined by applying linear programming to the convex combination of the extreme table. The last step is to generate the ordinal correlated data by applying the inversion algorithm, which aims to generate correlated ordinal observations.

2.4 Generating Correlation Coefficients

A simulation to generate correlated ordinal data requires marginal probabilities and correlation coefficients. The correlation coefficients for correlated ordinal data are commonly presented in a correlation matrix. Since a correlation matrix has to be symmetric and positive semi-definite, then a certain algorithm is needed to ensure the fulfillment of this requirement when correlation coefficients are generated.

Let r_{ij} be the correlation coefficient between x_i and x_j where $x_1, x_{2,\ldots,} x_n$ are random variables. A correlation matrix is a symmetric and positive semi-definite matrix form of r_{ij}. All entries in a correlation matrix have a value between [-1, 1], and the diagonal entries are equal to one. One method to generate correlation matrices is by randomly generating correlation matrices without considering particular settings (Budden, Hadavas, Hoffman, & Pretz, 2007; Joe, 2006; Olkin, 1981). In this method, correlation matrices are randomly generated based on the upper and lower bound set in each entry, which is not consistently [-1,1] in order to guarantee that the matrices are positive semi-definite matrices and their diagonal entries are equal to one. The application of this approach to generate a *p*-dimensional correlation matrix *R* enables $\binom{p}{2}$ entries to be independently generated in the interval [-1, 1] and the remaining entries (except the diagonal entries) to be constrained on a specific interval. This specific interval depends upon the value of the first $\binom{p}{2}$ entries and the sequence of the partial correlation being generated.

Consider 4x4 correlation matrices. The correlation matrix is in the form of

$$C = \begin{bmatrix} 1 & r_{12} & r_{13} & r_{14} \\ r_{21} & 1 & r_{23} & r_{24} \\ r_{31} & r_{32} & 1 & r_{34} \\ r_{41} & r_{42} & r_{43} & 1 \end{bmatrix}$$

The following procedure is the detailed formula to randomly generate 4 x 4 correlation matrices without considering particular settings as suggested by Budden et al. (2007). The first step in generating correlation matrices is to generate the correlation coefficient of r_{12}, r_{13}, and r_{14} which can be randomly generated ~ *U* (-1, 1). The second step is to determine the lower and upper limit of the other correlation coefficients in order to ensure generated matrices are symmetric and positive semi-definite.

A matrix can be a positive semi-definite matrix if and only if the matrix and all of its symmetric sub-matrices have a nonnegative determinant. It means that if C is a correlation matrix, det $C \geq 0$ and all its sub-matrices are in the form of

$$C_{ijk} = \begin{bmatrix} 1 & r_{ij} & r_{ik} \\ r_{ij} & 1 & r_{jk} \\ r_{ik} & r_{jk} & 1 \end{bmatrix}$$

is also a correlation matrix for $i, j, k \in \{1,2,3,4\}$; with no two of *i, j,* and *k* equal.

Three limits on the possible range of the other correlation coefficients (r_{23}, r_{24}, r_{34}) are determined to ensure the symmetric and positive semi-definite requirement in addition to the symmetric boundary of a correlation matrix, $r_{ij} = r_{ji}$.

Another method is to randomly generate correlation matrices with particular settings, such as eigen-values or expected values, and distribution of entries (Marsaglia & Olkin, 1984). Compared to other available methods that are generating correlation matrices based on the distribution of the entries, the Wishart distribution is the most commonly used distribution for generating a correlation matrix (Gentle, 2003). Although the Wishart distribution is initially known as the probability distribution of the covariance matrix, many studies have applied the Wishart distribution to generate correlation matrices since a correlation matrix can be calculated from a covariance matrix. The elements of a correlation matrix can be obtained by dividing the (i,j) element of the covariance matrix by the square root of the product of the ith diagonal element and the jth diagonal element of the covariance matrix (Gentle, 2003). In addition, the p dimension of the correlation matrices and the mean of the randomly generated matrices should be known a priori in order to generate correlation matrices based on the Wishart distribution.

This study compares the performance of the OLR and ANN models to analyze ordinal data by fitting ordinal data collected from two training restaurants to both models. The OLR and ANN models are built to analyze the internal link of the Service Profit Chain (SPC). The concept of the SPC and training restaurant is used as the framework and research basis for the case study. The following subsection presents the review of some relevant literature about the concept of training restaurants, the service profit chain, and employee satisfaction.

2.5 Training Restaurant

Training restaurants, production kitchens and industrial training placements provide practical elements and vocational settings in food and beverage management curricula. Training restaurants function as learning environments to deliver a mix of practical leadership and management skills to students. In this type of restaurant, students not only learn food production and service, but they also learn managerial skills and techniques (Alexander, 2007). Therefore, students are required to fulfill different responsibilities (either in the kitchen area or in the service area) during their practical activities in training restaurants. For instance, a student who makes salad on one particular day may become a team captain or a waiter on another day.

Although the main purpose of training restaurants is not to generate profit, training restaurants are required to generate revenue to cover their operational costs (Alexander et al., 2009). Hospitality departments that operate training restaurants expect the training restaurants to become more cost-effective so that the department is able to reduce its subsidy, and the restaurant can gradually achieve financial autonomy. Achieving a condition without any subsidy means that a training restaurant has been successful in creating a realistic learning condition, effectively mixing training and profit making. Therefore, training restaurants should not only be treated and managed as laboratories, but also as business entities. The summary of training restaurant characteristics and a comparison to profit-oriented restaurants is presented in Table 2.1.

Table 2.1 Comparisons of training restaurants and profit-oriented restaurants

	Profit-oriented Restaurant	Training Restaurant
Main Purpose	Profit Generating	Learning Media & Revenue Generating
Employee	Regular-Paid Employee	Students
	Relatively Fixed Position	Rolling Position/Responsibility
	Unpredictable Turnover	Periodic Turnover rate

The unique characteristics of training restaurants may present obstacles to these restaurants gaining profit. According to Nies (1993), more than half of the training restaurants owned by various schools in the US are located inside the school area and operated within limited hours during the school's instructional period. These characteristics may create limited access for the public to dine in training restaurants. In addition, training restaurants experience frequent and predictable turnover because different groups of students operate the restaurants for each instructional period (semester/quarter). A high turnover rate requires the restaurants to find creative ways to maintain good relationships with their customers, since the familiarity that commonly supports good relationships between front-line employees and customer is diminished.

2.6 The Service Profit Chain

Heskett et al. (1994) introduce the Service Profit Chain (SPC) as a comprehensive framework of relationships between employee, customer, and profitability. In a service industry, the theory posits that internal service quality influences employee satisfaction. Internal service quality refers to employees' perceptions of their working environment, various aspects of their job and their relationships with peers and supervisors. A satisfied employee tends to deliver better service and product value to the customer. A higher perceived service and product value leads to higher customer satisfaction. In turn, a satisfied customer tends to be a loyal customer. By having a loyal customer, an organization experiences higher growth and profit level. This proposition is supported by empirical studies from various service companies, such as Southwest Airlines and Taco Bell. Figure 2.4 illustrates the proposition of this concept.

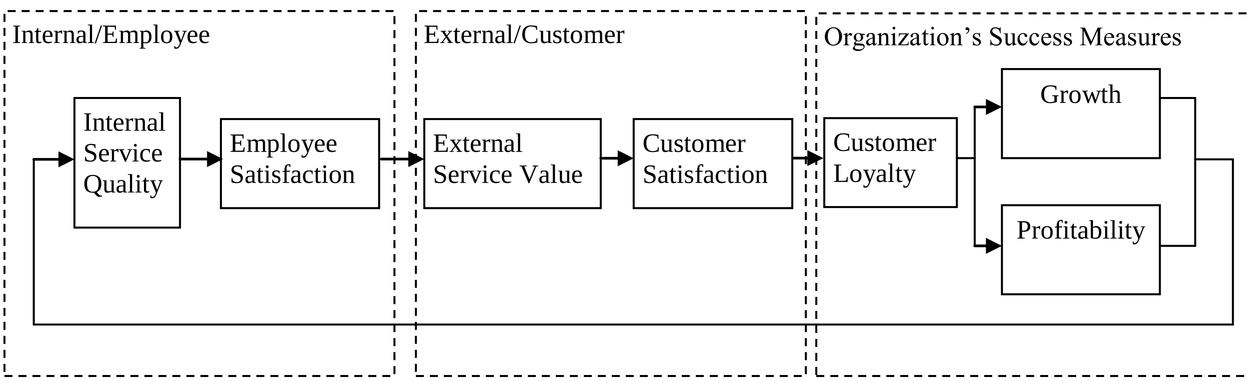

Figure 2.4 The links in the Service Profit Chain (Heskett et al., 1994)

The SPC is recognized by many researchers as the best model to guide service organizations in achieving higher organizational performance (Herington & Johnson, 2010). Many empirical studies test some of the linkages and their results strengthen specific aspects of this framework. For example, Maritz and Nieman (2008) examine the relationships between the service profit chain initiatives (represented by retention and sales volume) and service quality dimensions, whereas Gelade and Young (2005) find that customer satisfaction mediates the relationship between employee attitudes and organizational performance.

2.6.1 Link between Employee and Customer Satisfaction

Many studies demonstrate a positive correlation between customer satisfaction and employee satisfaction (Chi & Gursoy, 2009; Koys, 2003). Other studies show that the relationship between customer satisfaction and employee satisfaction gets stronger if the employees have higher loyalty (Gelade & Young, 2005; Schlesinger & Zornitsky, 1991). Furthermore, Gelade and Young (2005) suggest that positive employee experience, as demonstrated by positive attitudes such as satisfaction and commitment and by positive evaluations of organizational climate, are closely related to high levels of customer satisfaction. Thus, employees that have positive feelings about their workplace deliver positive effects when they carry out their work. This emotion is perceived and absorbed by the customer. As a result, customers experience pleasant service encounters.

2.6.2 Link between Customer Satisfaction and Organizational Success Measures

The Service Profit Chain (SPC) suggests that profit and other measures of success used in an organization, are positively correlated with customer satisfaction (Heskett & Sasser, 2010). This SPC proposition is supported by other studies which find that customer satisfaction is positively correlated with non-financial performance (Schneider, 1991; Tornow & Wiley, 1991) and with financial performance as well (Anderson, Fornell, & Lehmann, 1994; Rust & Zaborik, 1993). Types of financial and non-financial measures chosen in a study depend on a company's operation. For example, Tornow and Wiley (1991) use two non-financial indicators (right first time, on time) and three financial indicators (contract retention, revenue retention and service gross profit) to test the relationship between customer satisfaction and organizational performance in a computer service company.

In another perspective, Anderson and Mittal (2000) suggest that the relationship between satisfaction and repurchase in retail industry is non-linear. In that case, dissatisfaction has a greater impact on repurchase intent than satisfaction and the impact of satisfaction on repurchase intent is greater at the extremes. In addition, they also show that at a certain point, the increased cost to improve customer satisfaction is likely to outweigh the beneficial effects of further customer satisfaction. Therefore, diminishing returns are applied when relating customer satisfaction to profitability.

2.6.3 Link between Employee Satisfaction and Organization's Success Measures

Some studies find that sales and profitability as a measure of business performance have a significant relationship with employee satisfaction and employee retention. Reichheld (1993) explains that a loyal employee tends to establish good relationships with customers. In turn, these relationships will increase customer loyalty, and as a result, increase profitability. Thus, in service industries, employee retention has a significant role because it has a positive relationship with customer retention (Reichheld, 1993). Similarly, Koys (2001) studied this relationship in some outlets of a restaurant chain and found that there was a significant relationship between employee satisfaction and financial performance.

In contrast, Bernhardt et al. (2000) and Chi and Gursoy (2009) found that there is no significant relationship between employee satisfaction and financial performance. Similarly, a study of employee perception and business performance using a meta-analysis finds that there is only a small relationship between business unit productivity and profitability, and employee engagement (Harter, Schmidt, & Hayes, 2002). This study explains that customer satisfaction mediates the relationship between employee satisfaction and profitability; thus, there is only either a small relationship or even a non-significant relationship between employee satisfaction and profitability (Harter, Schmidt, & Hayes, 2002).

2.7 Employee Satisfaction

Disposition (temperament), work environment and culture are key determinants of employee satisfaction according to Saari and Judge (2004). Disposition includes employee personality traits, core self-evaluation, the perception of the job itself, extraversion and conscientiousness. Even though organizations cannot directly influence employee personalities, the use of appropriate selection methods and good alignment between employees and job tasks help to ensure that people are selected for, and placed into, jobs most appropriate for them. In addition, job variation, job range/scope and autonomy of the job are required to ensure the work environment remains interesting and challenging (Love & O'Hara, 1987). Four areas of cross-cultural differences among the employees are individualism versus collectivism, uncertainty avoidance versus risk taking, power distance or the extent to which power is unequally distributed, and achievement oriented or non-achievement oriented. Because of the potential for cross-cultural misinterpretation, managers should be aware and adjust cultural factors that influence employee attitude and satisfaction (Saari & Judge, 2004).

Another study conducted by Gostick and Elton (2007) explores the relationship between employee satisfaction and employee engagement or employee involvement in an organization. The study measures employee engagement based on employee perception toward the opportunity to do satisfying work, acceptance of opinion by the manager, feeling accepted as a team member by peers and supervisors, and the manager's recognition (Gostick & Elton, 2007). Internal service quality is also suggested as a determinant factor of employee satisfaction (Fitzsimmons & Fitzsimmons, 2008). According to these authors, internal service quality is related to employee perceived value toward selection and development programs, rewards and recognition, access to information to serve the customers, workplace technology, and job design.

Previous studies explore the determinants of employee satisfaction in dining services by using the same constructs as employee satisfaction studies in other areas (Gazzoli, Hancer, & Park, 2010; Salanova, Agut, & Peiro, 2005; Susskind, Kacmar, & Borchgrevink, 2007; Tepeci & Bartlett, 2002). Salanova et.al (2005) uses autonomy, organizational resources, such as technology and training offered, engagement, and service climate as employee satisfaction drivers. In addition, other factors such as role conflict, physical work environment, relationship with peer workers, relationship with superior, and dispositional influence are used as employee satisfaction drivers (Gelade & Young, 2005; Martensen & Granholdt, 2001; Matzler, Fuchs, & Schubert, 2004;

Maxham, Netemeyer, & Lichtenstein, 2008; Salanova et al., 2005; Timothy & Chester, 2004). Based on the previous research, this study uses the constructs shown in Table 2.2 to develop the student questionnaires used in the survey.

Table 2.2 Constructs of employee satisfaction

Dimensions	**Constructs/Dimension**
Internal Determinants	- Dispositional influence/self-motivation (Gelade & Young, 2005; Saari & Judge, 2004)
External Determinants	- Development of competencies, engagement (Salanova et al., 2005) - Superior relationships, working condition, peer relations (Martensen & Granholdt, 2001) - Job clarity, recognition, reward (Saari & Judge, 2004)

Based on all of these perspectives, the determinants of employee satisfaction can be classified into two groups: internal and external. The internal determinants come from within the employees themselves, while the external determinants are triggered by the work and organizational conditions. The internal determinants come from the subjective characteristics of employees, which can be either created before they work in the company or after they join the company. On the other hand, the external determinants come from the work environment, which can be influenced by the internal service quality, work conditions, co-workers, leaders and subordinates.

The SPC concept posits that satisfied employees tend to have a better performance when they serve a customer. In the training restaurant setting, the employees are the students, who work in the restaurant during a particular semester/quarter as part of a course. The students, who work in training restaurants, are required to do a rolling position, such as serving customers, greeting and directing, and managing the operation of the day. Thus, the students are expected to understand the entire products offered and procedures during the operation as well as and to become skilled at delivering service and managing a restaurant (Maxham et al., 2008; Alexander et al., 2009). Based on the previous research, this study uses the constructs shown in Table 2.3 to develop the instructor questionnaires used in the survey.

Table 2.3 Constructs of student performance

Dimensions	**Constructs/Dimension**
Students In-Role Performance	- Knowledge of product, knowledge of procedure (Maxham et al., 2008) - Production skill, service skill, managerial skill (Alexander et al., 2009)
Employee Extra-Role Performance	- Intention to satisfy customer, intention to go beyond duty (Maxham et al., 2008)

CHAPTER III

RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the research procedures designed to compare performance of the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models when analyzing ordinal data. In this study, the OLR and ANN models are used to test two relationships in the Service Profit Chain (SPC), the relationship between employee perceived value of the internal and external determinants of employee satisfaction and employee overall satisfaction and the relationship between employee overall satisfaction and job performance. Before building the OLR and ANN models, the study undertakes some preparatory steps, such as checking for missing values and outliers as well as examining data distributions. Since the total number of students who work at the sampled training restaurants is relatively small ($n < 30$), this study generates additional correlated ordinal data using simulations to build the OLR and ANN models. The preferred model is the one with the lowest averaged misclassification rate, which is calculated as the

the proportion of disagreement between the predicted-outcome from a model and the actual outcome from a testing data set.

The first step in this research is to create a conceptual framework in order to analyze possible relationships between student overall satisfaction and job performance in a training restaurant by applying the internal link of the Service Profit Chain (SPC) model. This step includes exploring factors that may affect student overall satisfaction and job performance. The second step is to design a data collection plan for use in two different training restaurants, Taylors' Dining Room at Oklahoma State University – USA and Fajar Teaching Restaurant at Universitas Negeri Malang - Indonesia.

The next step is to generate simulated data that have marginal probability distributions and correlation coefficients similar to data collected from the surveys at both training restaurants. Additional sets of data are also generated using random marginal probabilities and correlation coefficients. Two groups of data are generated in the simulation. The first group consists of two variables (one input and one outcome variable) and refers to the effect of employee overall satisfaction on job performance. The second group consists of four variables (three input variables and one outcome variable) and refers to the effect of student perceived value of three determinants of employee satisfaction on student overall satisfaction.

Data that is generated using simulations is split into two data sets, training and testing data sets. Each training or testing data set consists of 50 pair data points (predictor and outcome). Both the OLR and ANN models are fitted to training data sets and used as classifiers (frozen models). The models resulting from this step are used to predict the outcome category of all predictor data points in the testing data sets. The performance of the OLR and ANN models are measured from the misclassification rates, the proportion of disagreement between the predicted-outcome from a model and the actual outcome from a testing data set. The last step in this research is to compare the mean misclassification rate resulting from the constructed OLR and ANN models. The framework of the overall methodology used in this research is presented in Figure 3.1.

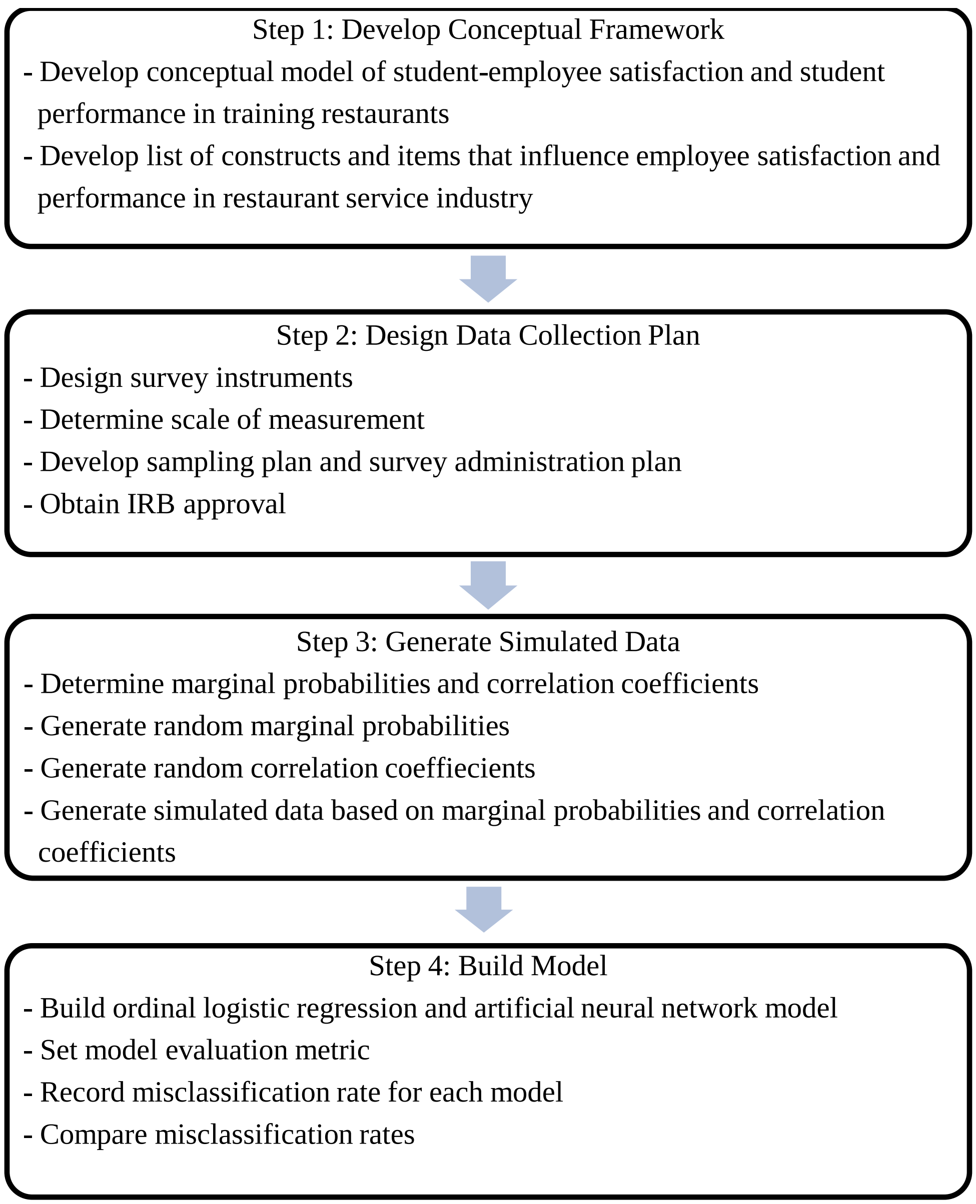

Figure 3.1 The framework of the research methodology

3.2 Research Step 1: Conceptual Frameworks

This study follows the proposition from previous literature regarding the effect of employee perceived value of the internal and external determinants of employee satisfaction on employee overall satisfaction and the effect of employee overall satisfaction on job performance. The conceptual framework of this study is illustrated in Figure 3.2.

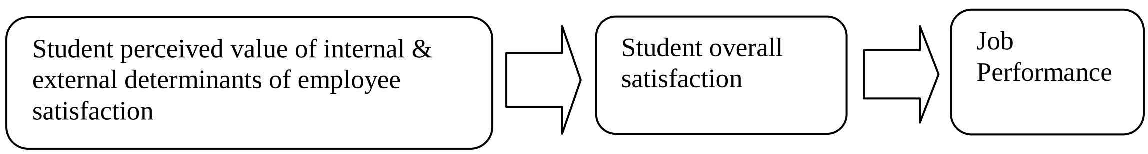

Figure 3.2 The conceptual framework of the study

The propositions are:

1: Student perceived value of employee satisfaction determinants affect overall satisfaction.

2: Student overall satisfaction affects job performance.

3.3 Research Step 2: Data Collection Plan

This study conducted surveys to collect data. Based on the two categories of respondents who filled out the questionnaires, two types of instruments were used in this study: a student-employee instrument and an instructor instrument. The questions used in these instruments were based on previous studies in order to ensure the questions had both validity and reliability. The student-employee instrument contained nine constructs/ dimensions identified by Salanova et al. (2005), Martensen and Granholdt (2001), and Saari and Judge (2004), while the instructor instrument contained questions identified by

Maxham et al. (2008) and Alexander et al. (2009). Both instruments only contained close-ended questions. A list of constructs used in the student instrument is shown in Table 2.2.

3.3.1 Initial Instrument and Pretest

Before applying for Institutional Review Board (IRB) permission, the initial instruments were finalized. The initial instruments contained the following sections: 1) Brief explanation of the research project, including the title and the objective; 2) Confidentiality of the participants, procedure and risks, contact information and the expected length of time to take the survey; 3) Questionnaires. After the development of the initial instruments, a comprehensive discussion with faculty members was conducted to receive any feedback related to the order of the questions, language, general structure of questionnaire items, and the appearance of the instruments. The constructs and items used in the student and instructor questionnaires are listed in the sub-sections 3.3.4 and 3.3.5 respectively. The IRB approval to conduct surveys at FTR and Taylors' Dining can be found in Appendices 2a and 2b. Additionally, the questionnaires used in the survey at Taylors' Dining and FTR can be found in Appendices 3a, 3b, 3c, 3d, 3e and 3f.

3.3.2 Pilot Test

A pilot test of the student instrument was administered to ten students that were taking Managing Café class in the Culinary Program at the Universitas Negeri Malang. The purpose of the pilot test was to assess the length of time needed to complete the survey as well as to conduct face validity and initial reliability analyses. The study examined reliability based on internal consistency measures using Cronbach's Alpha test. Data collected from the pilot test is shown in Appendix 2. The obtained alpha for each construct shown in Table 3.1 was higher than 0.7, the recommended value of alpha for a reliable scale (Turk et al., 2011). Thus, the alphas obtained indicated that the constructs in the instrument had acceptable inter-item reliability.

Table 3.1 Reliability Alpha on pilot data

Construct	Number of items	Cronbach's Alpha
Development of competencies	6 items	0.816
Recognition	3 items	0.714
Working condition	4 items	0.721
Reward	6 items	0.790
Engagement	5 items	0.850
Peer relationship	4 items	0.777
Superior relationship	6 items	0.855
Job clarity	5 items	0.741
Dispositional influence/self-motivation	3 items	0.738

3.3.3 Instrument Validity

Validity indicates the ability of an instrument to measure the intended concepts (Turk et al., 2011). The study evaluated the validity of the instrument by investigating the face validity of the instrument. Face validity, a basic index of content validity, indicates the degree to which the items in the instrument appear that they will measure the intended concept (Turk et al., 2011). To ensure the face validity of the instruments, the research advisor and the outside committee member provided feedback on the initial instrument. This repetitive process resulted in rewording some questions.

The manager of each training restaurant also provided some comments on the instruments. These comments created differences between the student instruments used in the Fajar Teaching Restaurant and Taylors' Dining Room. For example, there are no questions related to compensation for students at Taylors' Dining since students work in this restaurant as part of a class. However, there are two questions related to compensation for students at the other training restaurant since they are paid for their work. The manager in Taylors' Dining also recommended deleting some questions in the student instrument because of the repetitiveness of the questions. For example, the FTR survey contains four questions related to how the students were rewarded, while the Taylors' Dining survey contains only two. As a result, the student instrument used in FTR has more questions (42 questions) than the one used in Taylors' Dining (29 questions). The other difference is related to the preferred terminology for the student employee. FTR's and Taylors' Dining's manager recommended using "employee" and "student lab" as the term that refers to student employees in the questionnaire. The pilot test revealed that the instrument did not cause problems in terms of the clarity of the questions and language.

3.3.4 Student Instrument

The student instrument measures the students' perceived value of some factors that influence their overall satisfaction as student-employees in the training restaurant. The student instrument consists of two sections. The first section contains 42 items identified by Salanova et al. (2005), Martensen and Granholdt (2001), and Saari and Judge (2004) and uses a seven-point Likert scale. In this part, '1' indicates that the student “strongly disagrees” with the statement on the instrument, while ‘7’ represents strong agreement with the statement being asked. The statements in this section evaluate the student perceived value of internal service factors as well as external factors that may influence his/her satisfaction.

The second section intends to measure student overall satisfaction. This section has two questions and uses a seven-point Likert scale. In this section, ‘1’ indicates that the student is “very dissatisfied” with his/her working experience during the lab session at the restaurant, while ‘7’ indicates that the student is “very satisfied.” At the end, the student is asked to write down his/her name so that his/her responses can be paired up with the instructor’s responses related to his/her job performance. Table 3.2 presents the constructs and items used in the student questionnaire. See Appendix 3a and 3c for the student instrument used in Taylors’ Dining and FTR.

Target Population. The target population for this instrument was student-employees in the training restaurants. The study employed convenience sampling to collect data. The samples were all students who worked in the Taylors’ Dining and FTR during the survey period.

Sample size. There were 28 student-employees at Taylors’ Dining Room and 24 student-employees at Fajar Teaching Restaurant.

Survey Administration. This study administered the surveys by distributing the instrument to all student-employees before the morning briefing. After filling out the instrument, student-employees returned the instrument to the front-desk.

Table 3.2 Student questionnaire items

Constructs and items*
Reward (6 items)
Q1a. I am fairly rewarded for the experience I have; Q1b. *I am fairly rewarded for the stresses of my job* Q1c. I am fairly rewarded for the effort I put forth; Q1d. I am fairly rewarded for the work I have performed well Q22. *The pay system is based on achievement*; Q23. *The pay system is transparent*
Engagement (5 items)
Q2a. *When decisions about employee are made at FTR, complete information is collected for making those decisions* Q2b. When decisions about employee are made at FTR, all sides affected by the decisions are presented Q2c. *When decisions about employee are made at FTR, the decisions are made in timely fashion* Q2d. When decisions about employee are made at FTR, useful feedback about the decision and their implementation are provided Q20. My manager involves me in planning the work of my team
Superior relationship (7 items)
Q2e. *My supervisor/manager treat me with respect and dignity* Q2f. My supervisor/manager works very hard to be fair Q2g. My supervisor/manager shows concern for my rights as a student employee Q10. I know how the instructor evaluates my performance. Q13. My superior is trustworthy; Q24. My supervisor gives me feedback when I perform poorly
Development of competencies (6 items)
Q4. My job provides me the opportunity to develop a wide range of my skills Q6. *My job allows me to utilize the full range of my educational training* Q7. *The training I have received has prepared me well for the work I do* Q8. I believe I have the opportunity for personal development at FTR Q30. Employees in our organization have knowledge of the job to deliver superior quality product and service Q31. Employees in our organization have the skill to deliver superior quality work and service
Recognition (2 items)
Q5. My job is important to the success of this restaurant Q32. Employees receive recognition for delivery of superior product and service Q25. My supervisor gives me feedback when I do a better job than average
Working condition (4 items)
Q14. *I have sufficient authority to do my job well* ; Q21. Work environment is pleasant Q26. I have autonomy to decide the order of tasks I perform Q33. Employees are provided with tools, technology and other resources to support the delivery of quality product and service
Peer relationship (4 items)
Q15. Most employees that I worked with are likeable ; Q16. Employees are team oriented Q18. *People are treated with respect in my team, regardless of their job* Q19. The people in my teams are willing to help each other, even if it means doing something outside their usual duties
Job clarity (5 items)
Q3. I understand what I have to do on my job. Q9. I am able to satisfy the conflicting demands of various people I work with. Q11. I know what the people I work with expect of me. Q12. *I feel that I can get information needed to carry out on my job.* Q17. I have a clear understanding of the goals and objectives of this restaurant as a whole
Dispositional influence/self-motivation (3 items)
Q27. I am enthusiastic about my job Q28. *I am proud of the work I do*; Q29. *I feel happy when I am working hard*

*Items written in Italic were removed for Taylors'

3.3.5 Instructor Instrument

Another type of instrument used in this study is the instructor evaluation. This questionnaire has three parts. The first section has seven questions identified by Maxham et al. (2008) and Alexander et al. (2009). This section aims to measure student performance during the working period at the training restaurant, which includes knowledge of product, knowledge of procedure, production skill, service skill, and managerial skill. This section uses a seven-point Likert scale, in which '1' indicates that a student has a poor performance and '7' indicates that a student has an excellent performance. The second section has two questions and aims to measure the student's intent to go beyond the minimum requirement. This second section used a seven-point Likert scale, in which '1' indicates student has very low intent to go beyond the minimum requirement and '7' indicates very high intent. The third section, which contains two questions, measures student effort level to satisfy customers based on how often this attribute is observed in the student's daily work. This section used a seven-point Likert scale, in which '1' indicates that the student never puts effort to satisfy customers and '7' indicates that the student always tries to satisfy customers. Table 3.3 presents the constructs and items used in the instructor instrument. See Appendices 3b and 3d for the complete instructor instrument used in Taylors' Dining and FTR. The items listed in the instructor instrument were the same for both training restaurants.

Target Population. The target population for this type of instrument was the instructors who were responsible for supervising all students who operated each restaurant. The instructors evaluated the job performance of each student based on his/her production and service skill during the lab session at the training restaurant. The study conducted convenience sampling to collect instructor evaluations. The samples were all instructors who supervised the students in Taylors' Dining and FTR during the survey period.

Sample size. Only one instructor supervised each training restaurant.

Survey Administration. The study administered the survey by distributing a list of performance measurement items to the instructors during the last week of the survey period. The instructors then assessed each student's performance.

Table 3.3 Instructor questionnaire items

Constructs and items
Students In-Role Performance (8 items)
Q1a. How do you rate this student in terms of performance with regard to knowledge of the restaurant products? Q1b. How do you rate this student in terms of performance with regard to knowledge of opening procedures? Q1c. How do you rate this student in terms of performance with regard to knowledge of closing procedures? Q1d. How do you rate this student in terms of performance with regard to all required tasks specified in his/her role as a student in a laboratory?
Q3a. How do you rate this student in terms of performance with regard to production skill? Q3b. How do you rate this student in terms of performance with regard to service skill? Q3c. How do you rate this student in terms of performance with regard to managerial skill?
Q2. How do you rate this student in terms of overall performance?
Students Extra-Role Performance (3 items)
Q4. How do you rate this student's intention to go above and beyond "the call of duty"?
Q5. How do you rate this student's intention to voluntarily do extra or non-required work in order to help customer?
Q6. How often did the student willingly go out of his/her way to make a customer satisfied?

3.4 Research Step 3: Generating Simulated Data

A common method to test the performance of statistical and/or machine learning models with a small sample size is by performing a simulation study on generated artificial data. In this study, a student's responses within the student-employee questionnaire were assumed to be correlated, while the responses between any two student surveys were assumed to be independent. Additionally, responses within an instructor's questionnaire for any given student were also assumed to be correlated, while the instructor's evaluations for different students were assumed to be independent. The simulated data was generated to mimic the students' responses and the instructors' evaluation that were collected from the surveys. Therefore, this study generated ordinal correlated data to test the performance of the OLR and ANN models in order to mimic the assumption of data collected from the survey, which were correlated within subjects and independent between subjects.

There were two groups of data sets generated in this study. The first one consisted of one predictor variable and one outcome variable, while the second one consisted of three predictor variables and one outcome variable. The first data set referred to the link between student-employee perceived value of employee satisfaction determinants and overall satisfaction, while the second data set referred to the link between student-employee overall satisfaction and job performance. Since there were only 24 and 28 students responses collected from Fajar Teaching Restaurant and Taylors' Dining, this study only used 3 out of 42 items listed as employee satisfaction determinants as the predictor variables in the first data set. The purpose of using only three items is to follow the rule of thumb suggested by Peng, Lee, and Ingersoll (2002) and Churchill and Brown

(2007) regarding to the ratio between an outcome variable and its predictors, which is 1:10.

The study selected the input variables based on the gamma correlation coefficient as suggested by Guyon and Elisseeff (2003). The top three employee satisfaction determinants that had the highest Goodman Kruskal's gamma correlation coefficient with the student-employee overall satisfaction were chosen as the predictor variables in the first data set. The study uses the Goodman Kruskal's gamma to express the correlation coefficient because this coefficient is a common method to measure correlation between ordinal variables if there is a large number of ties in the data set, as in this case study (Lee, 1997). The three-predictor variables for the first data set from Taylors' Dining were "understanding what to do," "enthusiastic feeling" and "opportunity to develop skill." The predictor variables for data set from FTR were "understanding what to do," "proud to be a worker" and "opportunity to develop skill."

Three scenarios were carried out to generate each group of data sets: 1) Using marginal probabilities and correlation coefficients obtained from the Taylors' Dining Room data set; 2) Using marginal probabilities and correlation coefficients obtained from the Fajar Teaching Restaurant data set; and 3) Using randomly generated marginal probabilities and correlation coefficients to simulate a more general case. For each scenario, 1,000 runs of simulation, which was the same as the number of simulations suggested by Dietterich (1998), were performed in order to account for training and testing data variation and internal randomness. Each run of simulation generated 100 data points, which consisted of 50 training data points and 50 testing data points. By using training data generated from each run of the simulation, both the Ordinal Logistic

Regression (OLR) and Artificial Neural Network (ANN) models were built. Then, these two models were used to predict the outcome using the predictor variables in the testing data sets. The last step was to calculate the misclassification rate as the proportion of disagreement between the predicted-outcome resulted from the model and the actual outcome from the testing data set. Smaller misclassification rates were preferred.

3.4.1 Procedure to Generate Ordinal Correlated Data

This study applied the convex combination method suggested by Lee (1997) to generate correlated ordinal data based on the marginal probabilities and correlation coefficient. The simulations to generate the data were carried out using SAS 9.3. The correlation coefficient used in the simulation was expressed as the Goodman Kruskal's Gamma correlation. According to Ibrahim and Suliadi (2011), the convex combination method required less computation than the iterative proportional fitting method proposed by Gange (1995) and provided more flexibility than the method provided by Biswas (2004). The convex combination method was carried out in two stages. The first one was finding the joint distribution based on the marginal distribution and gamma correlation coefficient, and the next stage was generating ordinal random values by using the inversion algorithm. To validate the results generated from the convex combination method, this study conducted a mean rank test to compare the results and the desired marginal probabilities and correlation coefficients.

The procedure to find the joint distribution can be summarized as follows:

1. Identify two extreme tables, the maximal table (π_{max}, corresponds to $\gamma = 1$)and the minimal table (π_{min}, corresponds to $\gamma = -1$).

2. Find λ by considering the joint distribution table of $\pi(\lambda) = \lambda\pi_{min} + (1-\lambda)\pi_{max}$ and $0 \le \lambda \le 1$. As long as λ can be identified, then $-1 \le \gamma \le 1$ exists.
3. Find joint distributions that meet the univariate and bivariate margins using linear programming.

3.4.2 Procedure to Generate Random Marginal Probabilities

Random marginal probabilities were generated following the uniform distribution provided in IBM SPSS Statistics. Since data collected from the training restaurants were on a seven-point Likert scale, the study generated the marginal probability for each category response based on the following distribution (see Table 3.4):

Table 3.4 The distribution of random marginal probabilities

Category response level	Rules to generate marginal probabilities
Category level 7, p_7	$p_7 \sim$ U (0,1)
Category level 6, p_6	$p_6 \sim$ U (0,1-p_7)
Category level 5, p_5	$p_5 \sim$ U(0,1-(p_6+p_7)
Category level 4, p_4	$p_4 \sim$U(0, 1- (p_5+p_6+p_7))
Category level 3, p_3	$p_3\sim$U(0, 1- (p_4+ p_5+p_6+p_7))
Category level 2, p_2	$p_2 \sim$U(0, 1- (p_3+p_4+p_5+p_6+p_7))
Category level 1, p_1	$p_1 = 1 - (p_2+p_3+p_4+p_5+p_6+p_7)$

where p_i denote the proportion of response in the *i* category.

The study started generating the marginal probabilities with the highest category response in order to give the higher category responses more flexibility to vary since survey data was commonly negatively-skewed distributed. The study generated the marginal probabilities following the rules presented in Table 3.4 that were developed after the discussion with the committee member to ensure random and reasonable marginal distributions on the simulated data.

3.4.3 Procedure to Generate the Correlation Coefficient and Correlation Matrices

A single correlation coefficient used to correlate student-employee overall satisfaction and job performance was generated following the uniform distribution provided in the IBM SPSS Statistics. The lower limit of the correlation coefficient was set at 0.27 based on the lower 95% bound of the correlation coefficient between employee satisfaction and job performance in previous research conducted by Judge, Thoresen, Bono, and Patton (2001). The upper limit used to generate the correlation coefficient was set at 0.96, the highest correlation coefficient between employee satisfaction and job performance found in the literature (Judge et al., 2001). After establishing the lower and upper limit, the correlation coefficient was generated as $\gamma \sim \mathrm{U}(0.27, 0.96)$.

Random correlation matrices were needed to generate data sets with three predictor variables and one outcome variable, which represented the relationship between three student employee satisfaction determinants and overall satisfaction. To ensure that the generated random matrices conformed to the characteristics of correlation matrices (symmetric and positive semi-definite), this study generated 4 x 4 correlation matrices following the algorithm suggested by Budden et al. (2007). Based on this algorithm, if r_{ij} is the correlation coefficient between x_i and x_j, and $x_1, x_{2, \ldots,} x_n$ are random variables where n = total number of random variables, for $j=2,3,4$, and i=1, three correlation coefficients

(r_{12}, r_{13}, and r_{14}) could be randomly generated using a uniform (-1,1) distribution. The other correlation coefficients ($r_{23,}$ r_{24} and r_{34}) should be randomly chosen from the intervals provided by the algorithm to ensure the symmetric and positive semi-definiteness of the matrices. Since this study found that all variables were positively correlated to each other, then $r_{1j} \sim U(0,1)$, where $j=2,3,4$. Additionally, the minimum $r_{23,}$ r_{24} and r_{34} were set at 0 and the maximum followed the upper limit given by the algorithm.

3.4.4 Procedure to Validate Generated Data

The study performed a mean rank test, a nonparametric rank-based test for ordered categorical responses, to determine whether the generated data had an identical distribution to the original data. This test was performed to ensure that the algorithm used to generate correlated ordinal data worked properly. The study conducted the Wilcoxon test and the Mann-Whitney test to validate generated data since both of these tests were the most commonly used rank tests for ordered categorical data (Agresti, 2010; Leech, C.Barrett, & Morgan, 2011).

3.5 Research Step 4: Build Model

This study used two model-building techniques, the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN), to test two relationships in the service-profit chain. Before constructing the OLR and ANN models, the study carried out some preparation steps, such as checking for missing values and outliers as well as calculating skewness and kurtosis. Since the total numbers of students who worked at the training restaurants were relatively small, this study also used data generated from a simulation to build the OLR and ANN models. The performance of OLR and ANN models were measured based on the misclassification rate. A model with the lowest misclassification rate was preferred.

3.5.1 Artificial Neural Network

Within the ANN model, a specific activation function is used to connect two layers (input and output layer) in the model. The number of nodes in the input and output layers is used to determine the number of nodes in the hidden layer. The type of activation function used in the model depends on the outcome range in the output layer. Other aspects to be considered during the building process are the network architecture and topology, and learning algorithm.

This study built the ANN models using IBM SPSS Modeler 14.2. Based on the option available in this software package, steps carried out to build the ANN model can be explained as follows:

1. Determine the objective: build a new model.
2. Determine the type of network architecture: a multilayer perceptron (MLP).
3. Determine the number of nodes in the hidden layer.
4. Determine stopping rules.
5. Determine a percentage of records used for an overfit prevention set

3.5.2 Ordinal Logistic Regression

The OLR model is an extension of a logistic regression used to analyze ordinal data. The OLR method is the most appropriate and practical technique to analyze the effect of independent variables on a rank-ordered dependent variable because the dependent variable cannot be assumed as normally distributed or as interval data (Lawson & Montgomery, 2006). The OLR model fit depends on the number of independent variables and the selected link function determined during the model-building phase. This study built the OLR models using IBM SPSS Modeler 14.2.

Based on the options available in IBM SPSS Modeler 14.2, the steps to build the OLR models can be explained as follows:

1. Determine whether the intercept is included in the model or not.
2. Specify the link function.
3. Specify the parameter estimation method.
4. Determine the scale parameter estimation method.
5. Specify the iteration rule to control the parameters for model convergence.

3.5.3 Comparing Model Performance

This study used misclassification rate to measure the performance of the constructed OLR and ANN models. The misclassification rate was measured as the aggregate ratio of total wrong classifications for all classes to the total number of data used in the model. For example, since the variables used in this study were a seven-point Likert scale, then the misclassification rate was calculated as the total number of wrong classifications for response category one to seven. A wrong misclassification occurred when the predicted categories from the model were not the same as the actual categories presented in the testing data. The lower misclassification rate indicates better model performance.

In IBM SPSS Modeler 14.2, the misclassification rate is presented along with the confusion matrix. This matrix has an appearance similar to a contingency table and contains information related to the actual and predicted classification done by the specified model. The dimension of this matrix depends on number of the actual and predicted category responses.

By using data generated from the simulation, this study built 1,000 OLR and ANN models to compare the misclassification rates obtained from each model. There were 1,000 $\hat{p}_1$ and $\hat{p}_2$ values calculated from each model, where $\hat{p}_1$ and $\hat{p}_2$ referred to misclassification rates resulting from the OLR and ANN models respectively. The number of misclassification rates collected from each model was large enough (n > 30) to apply the central limit theorem to test the difference between the average misclassification rates resulting from the OLR and ANN models. Based on the central limit theorem, the assumption of normally distributed population were unnecessary since the test was performed on large sample sizes (Devore, 2008). Since the population variance was unknown, the test used the sample variance.

The hypothesis test was as follows:

$H_0: \mu_1 - \mu_2 = 0,$

$H_1: \mu_1 - \mu_2 \neq 0,$

and

$$Z = \frac{\bar{\hat{p}}_1 - \bar{\hat{p}}_2 - (\mu_1 - \mu_2)}{\sqrt{\frac{S_{\hat{p}1}^2}{1000} + \frac{S_{\hat{p}2}^2}{1000}}} \, . \tag{3.1}$$

where μ_1 = the true mean misclassification rate for the ordinal logistic regression model

μ_2 = the true mean misclassification rate for the artificial neural network model

$\bar{\hat{p}}_1$ = the sample average of misclassification rate resulting from the OLR model

$\bar{\hat{p}}_2$ = the sample average of misclassification rate resulting from the ANN model

$S_{\hat{p}1}^2$ = sample variance of $\bar{\hat{p}}_1$ resulting from the OLR model

$S_{\hat{p}2}^2$ = sample variance $\bar{\hat{p}}_2$ resulting from the ANN model

For $\alpha = 0.05$, $\alpha/2 = 0.025$, and $Z_{\alpha/2} = -1.96$ and $Z_{1-\alpha/2} = 1.96$ (two-sided test). H_0 is rejected if *p* value is smaller than the desired type I error (α).

If H_0 is rejected, then the study concludes that there is a statistically significant difference on the mean of misclassification rate resulting from the OLR and ANN models. Otherwise, H_0 is fail to be rejected, which means the mean of the misclassification rates resulting from the OLR is not statistically significant different from the one resulting from the ANN.

3.6 Summary

This chapter presents detailed procedures used to compare the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models to analyze ordinal data. These procedures can be grouped into 4 steps. The first step is to develop the framework model. The study uses the internal link of the Service Profit Chain (SPC) as the framework to compare the OLR and ANN models. The internal links used in this study consists of two causal links: the link between employee perceived value of the internal and external determinants of employee satisfaction and employee overall satisfaction and the link between employee overall satisfaction and job performance.

Based on the framework outlined in the previous step, the second step is to design a data collection plan. The study conducts surveys in two training restaurants, Taylors' Dining Room at Oklahoma State University-USA and Fajar Teaching Restaurant (FTR) at Universitas Negeri Malang-Indonesia. Students and instructors are the respondents for the surveys.

The third step is to generate correlated ordinal data using simulation proposed by Lee (1997). The simulated data is generated based upon the marginal probabilities and correlation coefficients that are similar to that of data collected from Taylors' Dining (scenario 1) and FTR (scenario 2), while the last simulated data have random marginal probabilities and random correlation coefficients (scenario 3). The simulated data in this study can be grouped into two sets. The first one is needed to test the relationship between student overall satisfaction and job performance. This data set consists of one input variable and one output variable. The other one is used to test the relationship between three determinants of student overall satisfaction and the student overall satisfaction. This data set consists of four variables which refers to three determinants of student overall satisfaction (input) and student overall satisfaction (output). For each set, the correlated ordinal data are generated from 1,000 run of simulations with 100 observations (50 training data 50 testing data) on each run.

The last step is to build the OLR and ANN models using each training data set generated from the simulations as explained previously. The performance of the OLR and

ANN models is compared based on the mean of the misclassification rates from the testing data set. The mean of the misclassification rates is calculated as the average of the proportion of disagreement between the predicted-outcome from the model and the actual outcome from the testing data. Hypothesis test on the mean of the misclassification rates is used to identify conditions in which the OLR outperforms the ANN model and vice versa.

CHAPTER IV

THE ORDINAL LOGISTIC REGRESSION AND ARTIFICIAL NEURAL NETWORK WITH ONE INPUT VARIABLE

4.1 Introduction

This chapter presents the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models that were built using one input variable. The input variable in this case was the student overall satisfaction and the output variable was the student performance. The input variable was obtained from the student instrument, while the output variable was obtained from the instructor instrument. To compare the performance of the OLR and ANN models, three scenarios were designed. The first scenario was to build both models using simulated data that has similar marginal probability distributions and correlation coefficient to collected data from survey at Taylors' Dining. The second scenario was to construct both models using simulated data that has similar marginal probability distributions and correlation coefficients to collected data from surveys at

Fajar Teaching Restaurant (FTR), while the last scenario was to build both models using randomly generated correlated ordinal data based on the random marginal probabilities and correlation coefficients.

4.2 Preparation Steps

Before constructing the models, a review was performed to determine if there were any missing values in any data set. The initial check showed that there were no missing values found in the data collected from both restaurants, Taylors' Dining and FTR, respectively. There were 24 and 28 student responses from FTR and Taylors' Dining. In addition, there were 24 and 28 responses received from the instructors who evaluated the student performance in each restaurant.

The study also explored the marginal probabilities of each collected data set. As shown in Figures 4.1 and 4.2, the distributions of the student overall satisfaction and student performance data from both restaurants were negatively skewed. This meant that most students rated their overall satisfaction as student lab as "neutral" or higher, and most students were assessed as having good performance or higher by the instructor.

The skewness values of student overall satisfaction data collected from Taylors' Dining and FTR were -1.447 and -0.566, respectively. Additionally, the skewness values of student performance data collected from Taylors' and FTR were -0.955 and -0.208, respectively. The skewness indicated that the student overall satisfaction and performance data collected from Taylors' Dining was more negatively skewed than the one collected from FTR. The kurtosis values of student overall satisfaction data collected from Taylors' Dining and FTR were 1.993 and -0.507 respectively. The kurtosis values indicated the "peakedness" (positive kurtosis) and flatness (negative kurtosis) of student overall satisfaction data collected from Taylors' and FTR.

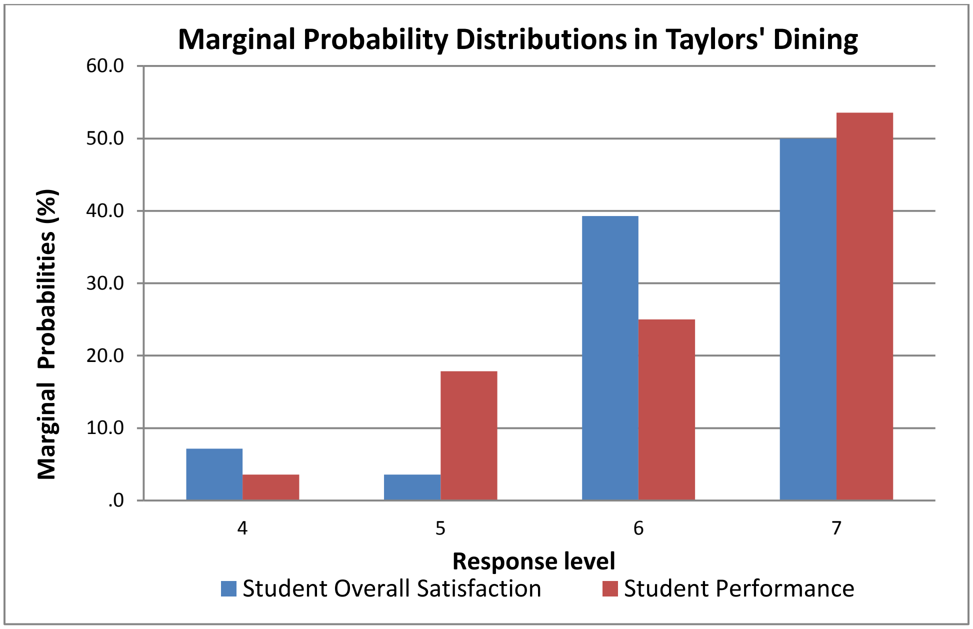

Figure 4.1 Marginal probability distributions of input and output data in Taylors' dining (one input variable)

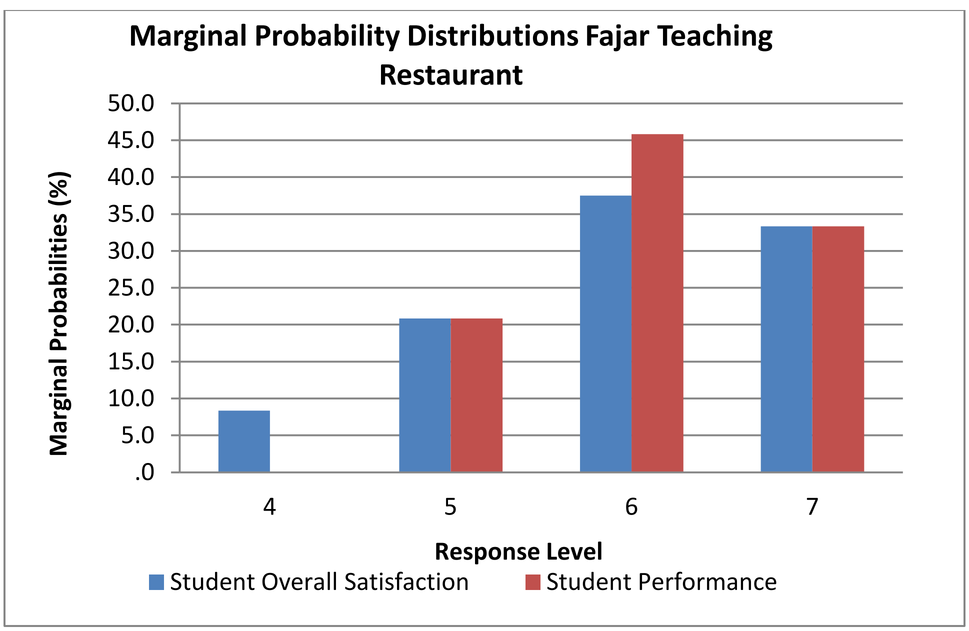

Figure 4.2 Marginal probability distributions of input and output data in FTR (one input variable)

To be able to construct OLR and ANN models, each student's response on the overall satisfaction statement was paired with the student performance assessment by the instructor. All students in FTR put their names on the questionnaire, while seven out of twenty-eight students in Taylors' Dining did not put their names on the surveys. Thus, the study was not able to calculate the correlation coefficient for data collected from Taylors' Dining. Instead, the correlation coefficient between student overall satisfaction and student performance in Taylors' Dining was assumed to be similar to the correlation coefficient obtained from FTR. The gamma correlation coefficient between student overall satisfaction and performance based on data collected from FTR and based on data collected from Taylors' (excluding students' responses without name) are 0.57 and 0.63, respectively. Thus, the correlation coefficients collected from both training restaurant were assumed to be comparable.

The correlation coefficient between student overall satisfaction and performance based on data collected from FTR is shown in Table 4.1. The results in Table 4.1 show the obtained Gamma (a correlation coefficient for ordinal scale) is .57 with a significance level of 0.008, which means student overall satisfaction is positively correlated with student performance, assuming α=.01. On the other hand, the obtained Pearson (a correlation coefficient for interval scale) is .438 with a significance level of .032, which means that the correlation is not statistically significant at α=.01. These results indicate that treating ordinal data as different scales, either interval or ordinal, may result in a different correlation coefficient and significance level. The study uses the obtained Gamma correlation coefficient, $\Gamma = 0.57$ to generate correlated ordinal data for scenario

1 (Taylors' Dining Room's scenario) and 2 (Fajar Teaching Restaurant's scenario) in order to treat the ordinal data with a relevant ordinal analysis.

Table 4.1 Correlation coefficient between student overall satisfaction and performance

		Value	Approx. Sig.
Ordinal by Ordinal	Gamma	.570	.008
Interval by Interval	Pearson's R	.438	.032
N of Valid Cases		24	

4.3 Validating Algorithm to Generate Correlated Ordinal Data

As explained in section 4.2, some students in Taylors' Dining did not put their names on the questionnaire, so it could not be paired with instructor responses. This study used data collected from FTR to validate the algorithm applied to generate correlated ordinal data.

Cross tabulated data from FTR and its initial simulated data set are shown in Tables 4.2 and 4.3. The results in Tables 4.2 and 4.3 show by inspection that the difference between marginal probabilities for each response category in data obtained from FTR and from the simulation ranges from 0.7% - 9.5%.

Table 4.2 Cross tabulated data from Fajar Teaching Restaurant

			Instructor perception toward student performance			Total
			5	6	7	
Student overall satisfaction	4.00	Count	1	1	0	2
		% of Total	4.2%	4.2%	.0%	8.3%
	5.00	Count	1	4	0	5
		% of Total	4.2%	16.7%	.0%	20.8%
	6.00	Count	2	4	3	9
		% of Total	8.3%	16.7%	12.5%	37.5%
	7.00	Count	1	2	5	8
		% of Total	4.2%	8.3%	20.8%	33.3%
Total		Count	5	11	8	24
		% of Total	20.8%	45.8%	33.3%	100.0%

Table 4.3 Cross tabulated data of the first generated correlated ordinal data set

			Instructor Perception toward Student Performance			
			5.00	6.00	7.00	Total
Student overall satisfaction	4.00	Count	5	2	2	9
		% of Total	5.0%	2.0%	2.0%	9.0%
	5.00	Count	8	4	1	13
		% of Total	8.0%	4.0%	1.0%	13.0%
	6.00	Count	5	35	7	47
		% of Total	5.0%	35.0%	7.0%	47.0%
	7.00	Count	4	10	17	31
		% of Total	4.0%	10.0%	17.0%	31.0%
Total		Count	22	51	27	100
		% of Total	22.0%	51.0%	27.0%	100.0%

To determine whether the mean rank between the survey data and the simulated data was statistically different or not, a mean rank test was also carried out. The mean ranks for the survey data (data collected from FTR) and the simulated data are shown in Table 4.4, while the Wilcoxon test and Mann-Whitney test results are shown in Table 4.5.

Table 4.4 Mean rank for student overall satisfaction and performance

	group	N	Mean Rank	Sum of Ranks
Student overall satisfaction	Survey data	24	61.27	1470.50
	Simulated data	100	62.80	6279.50
	Total	124		
Instructor evaluation on student performance	Survey data	24	65.40	1569.50
	Simulated data	100	61.81	6180.50
	Total	124		

Table 4.4 shows that the mean rank of the student overall satisfaction variable from the survey data is lower than the one from the simulated data, while the mean rank

of the student performance variable from the survey data is higher than the one from the simulated data. Assuming α=0.01, the asymptotic significance values for the student overall satisfaction and student performance, as shown in Table 4.5, are 0.842 and 0.632, respectively. Both of these significance values are greater than the specified α. Thus, there is no significant difference between mean ranks on FTR's student overall satisfaction and student performance data and the simulated data. These results suggest that the algorithm used to generate these correlated ordinal data is valid and can be used for further analyses.

Table 4.5 Mean rank test statistics

	Student overall satisfaction	Student performance
Mann-Whitney U	1170.500	1130.500
Wilcoxon W	1470.500	6180.500
Z	-.199	-.479
Asymp. Sig. (2-tailed)	.842	.632

4.4 Scenario 1

This scenario generated data with similar marginal probabilities to data collected from Taylors' Dining. As mentioned in section 4.2, the correlation coefficient used in this scenario was assumed to be similar to data collected from Fajar Teaching Restaurant. The study performed 1,000 runs of the simulation to generate 1,000 data sets with 100 observations in each data set. The 100 observations were then split into two sets: 50 observations were used as a training data set and the others were used as a testing data set.

The marginal probabilities of student overall satisfaction and student performance, as shown in Figure 4.1, were negatively skewed, which meant that data was likely to be distributed among the higher response levels. Therefore, a cumulative log-log function is more appropriate for use in the OLR link function than the other available cumulative functions such as cumulative logit or probit (Agresti, 2010; Chen & Hughes, 2004).

The study used the multilayer perceptron (MLP) as the network architecture in the ANN model since this architecture is more appropriate for predictive classification problems (Turban, Sharda, & Delen, 2011). The automatic option available in IBM SPSS Modeler was chosen to set the hidden layer since the automated neural networks in IBM SPSS were very powerful (Nisbet et al., 2009). This option let the software determine the number of nodes in the hidden layer that make the model fit best with the data set. The biggest benefit of using the automatic option was that the software automatically searched over the decision surface with different initial learning rates, different momentum, and different numbers of hidden layers in order to get the best parameters for the model (Nisbet et al., 2009). The study allocated 30% of the data set as an overfit prevention data set, which was used to track errors during the training process in order to prevent an over fitted model. The descriptive statistics of the misclassification rates for the OLR and ANN models for scenario 1 are shown in Table 4.6.

Table 4.6 Descriptive Statistics of Misclassification Rates from Scenario 1 (one input variable)

	N	Range	Min	Max	Mean	Std. Deviation
OLR misclassification rate	1000	.44	.22	.66	.4536	.07539
ANN misclassification rate	1000	.42	.24	.66	.4556	.07420
Valid N (listwise)	1000					

Table 4.6 indicates that the mean and maximum values of the misclassification rates obtained from the OLR and ANN models were not significantly different. Additionally, there were only small differences between the range and standard deviation resulting from both models.

4.5 Scenario 2

This scenario generated data with similar probabilities and a correlation coefficient to data collected from Fajar Teaching Restaurant. The study also performed similar simulations to those explained in Scenario 1.

The marginal probabilities of the student overall satisfaction and the student performance, as shown in Figure 4.2, were negatively skewed. This meant that data was likely to be distributed on the higher response levels. Thus, the cumulative log-log function was more appropriate for use in the OLR link function than the other available cumulative functions such as cumulative logit or probit (Agresti, 2010; Chen & Hughes, 2004). The ANN models for scenario 2 were built using the same approach as scenario 1. This scenario also applied the multilayer perceptron (MLP) network architecture and the automatic option in the hidden layer setting because the automated neural networks provided by IBM SPSS Modeler was very powerful according to Nisbet et al. (2009). To prevent obtaining an overfit model, the study also allocated 30% of the data set as an overfit prevention data set.

The descriptive statistics of misclassification rates for the OLR and ANN models for scenario 2 are shown in Table 4.7. This table shows that the range, minimum, and maximum values of the misclassification rates obtained from the OLR and ANN models were exactly the same. The mean misclassification rate from the OLR models was slightly lower than the one from the ANN models. Additionally, small differences were found between the standard deviation of misclassification rates that resulted from both models.

Table 4.7 Descriptive Statistics of Misclassification Rates from Scenario 2 (one input variable)

	N	Range	Min.	Max.	Mean	Std. Deviation
OLR misclassification rate	1000	.44	.20	.64	.4033	.07595
ANN misclassification rate	1000	.44	.20	.64	.4065	.07500
Valid N (listwise)	1000					

4.6 Scenario 3

Scenario 3 generated ordinal correlated data based on random marginal probabilities and correlation coefficients using the uniform random generator available in IBM SPSS Statistics 19.0. The random number generator in IBM SPSS has a period of 2^{32}, which means that the software can generate 2^{32} random numbers with a uniform distribution before it begins to repeat itself (McCullough, 1999). A previous study suggested that a random number generator with a period of 2^{31} is acceptable to generate 1,000 data points (L'Ecuyer & Hellekalek, 1998). Another study conducted by Knuth (1997) suggested that a more modest period of 2^{31} could be used to generate one million random numbers. Therefore, the use of the random number generator provided by IBM SPSS Statistics 19.0 is acceptable to generate random numbers needed in 1,000 runs of the simulation.

As explained in section 3.4.3, the lower limit of the correlation coefficient was set at 0.27 and the upper limit was set at 0.96. These limits were determined based upon the lower 95% bound of the correlation coefficient between employee satisfaction and job performance in the previous research conducted by Judge et al. (2001). By having the lower and upper limit, the correlation coefficient was generated following $U(0.27, 0.96)$.

The distribution of the generated correlation coefficients used in this scenario is shown in Figure 4.3. This figure shows that the generated correlation coefficients are fairly evenly distributed among all intervals. The first and the last intervals were the two intervals in which the generated correlation coefficients were most highly concentrated.

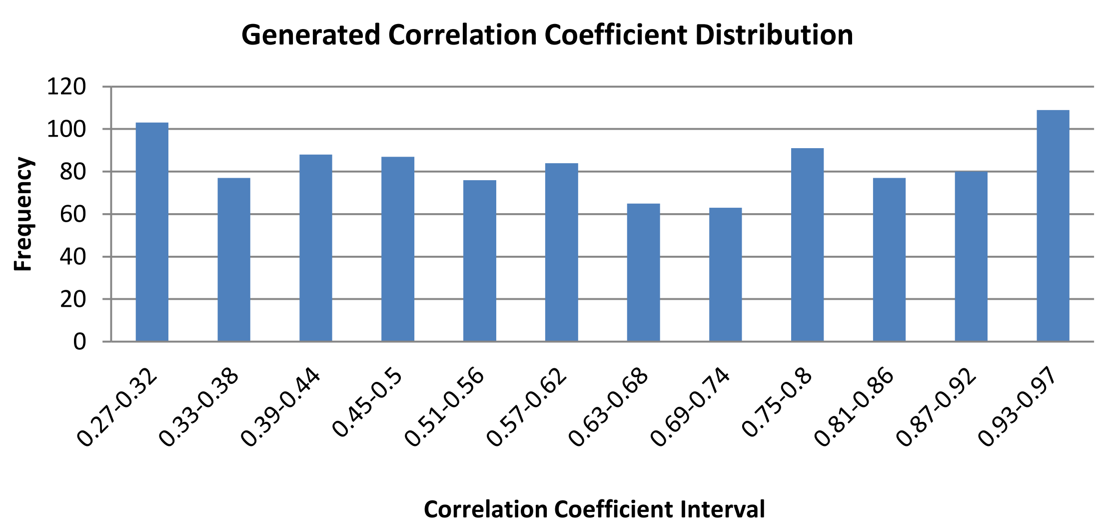

Figure 4.3 The distribution of the generated correlation coefficients

The rules shown in Table 4.8 were used to generate marginal probabilities for both the student overall satisfaction and the student performance variables and were developed following the discussion with the committee member to ensure of the production of random and reasonable marginal distributions on the simulated data (negatively skewed distribution).

The marginal probabilities were generated using the following rules:

Table 4.8 The rules to generate marginal probabilities

Category response level	Rules to generate marginal probabilities
Category level 7, p_7	$p_7 \sim$ U (0,1)
Category level 6, p_6	$p_6 \sim$ U (0,1-p_7)
Category level 5, p_5	$p_5 \sim$ U(0,1-(p_6+p_7))
Category level 4, p_4	$p_4 \sim$U(0, 1- (p_5+p_6+p_7))
Category level 3, p_3	$p_3\sim$U(0, 1- (p_4+ p_5+p_6+p_7))
Category level 2, p_2	$p_2 \sim$U(0, 1- (p_3+p_4+p_5+p_6+p_7))
Category level 1, p_1	$p_1 = 1 - (p_2+p_3+p_4+p_5+p_6+p_7)$

where p_i denote the proportion of response in the i category and i = 1, 2, 3, 4, 5, 6, 7.

The marginal probabilities generated for the student performance and student overall satisfaction variables are shown in Table 4.9 and Table 4.10. The results in Table 4.9 show that the random marginal probabilities generated for the student performance variable for category level “1=poor” to “6=very good” were positively skewed and for category “7=excellent” were almost evenly distributed.

Table 4.9 Student performance marginal probability distributions

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	967	981	901	807	624	325	101
0.1001-0.2	25	17	76	120	154	202	108
0.2001-0.3	6	2	12	45	101	113	97
0.3001-0.4	2		9	12	58	108	102
0.4001-0.5			2	9	30	81	88
0.5001-0.6				5	24	69	106
0.6001-0.7				2	6	38	87
0.7001-0.8					2	39	106
0.8001-0.9					1	16	103
0.9001-1.00						9	102

Table 4.10 Student overall satisfaction marginal probability distributions

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	965	972	910	788	608	334	88
0.1001-0.2	30	22	68	126	188	214	94
0.2001-0.3	2	6	13	53	79	159	75
0.3001-0.4	3		4	20	54	99	95
0.4001-0.5			5	6	41	69	98
0.5001-0.6				6	16	52	127
0.6001-0.7				1	11	35	112
0.7001-0.8					2	20	102
0.8001-0.9					1	15	95
0.9001-1.00						3	114

Table 4.10 shows that the random marginal probabilities generated for the student overall satisfaction variable for category level “1=very dissatisfied” to “6= satisfied” were positively skewed and for category “7=very satisfied” were almost evenly distributed. These results indicate that the rules used to generate random marginal probabilities are more likely to generate low marginal probabilities for lower category level data. In contrast, the rules generate uniformly distributed marginal probabilities for the highest category level data.

The distributions of the marginal probabilities of the simulated data used in the scenario 3 were varied because the marginal probabilities were randomly generated. Thus, the simulated data had a chance to be negatively skewed, positively skewed, normally distributed or distributed in some other patterns. Having varied distributions of the marginal probabilities, the OLR model for each simulated data set was built by running several model-building processes with a different cumulative link function available in IBM SPSS Modeler in order to obtain the OLR model that fitted best with the data set. The “best” model was chosen based on misclassification rates (lowest was preferred).

Similar to scenario 1 and 2, the study used the automatic option available in IBM SPSS Modeler to build ANN models in scenario 3. This option let the software choose the network architecture that fitted best with the data set. In this scenario, the study also allocated 30% of the data set as an overfit prevention data set in order to prevent an over fitted model.

The descriptive statistics of misclassification rates for the OLR and ANN models for scenario 3 are shown in Table 4.11. This table shows that the mean values of the misclassification rates obtained from the OLR and ANN models were very similar. Only small differences were found between the range and standard deviation resulting from both models and one extremely high misclassification rate was obtained from an OLR model.

Table 4.11 Descriptive statistics of misclassification rates from scenario 3 (one input variable)

	N	Range	Min.	Max.	Mean	Std. Deviation
OLR misclassification rates	1000	.90	.00	.90	.3467	.19044
ANN misclassification rates	1000	.78	.00	.78	.3488	.18241
Valid N (listwise)	1000					

4.7 Misclassification Rates Comparison

The misclassification rates were calculated based on the disagreement proportion between the predicted-category from either the OLR or ANN models and the actual outcome from the testing data set. Based on the mean and standard deviation of the misclassification rates obtained from the OLR and ANN models built in each scenario, the study performed a hypothesis test to determine whether the performance of the OLR and ANN models were different when the models were used to analyze a relationship link between one output variable and one input variable.

The hypothesis test was:

$H_0: \mu_1 - \mu_2 = 0,$

$H_1: \mu_1 - \mu_2 \neq 0,$

where μ_1 = mean of the misclassification rate for the OLR model

μ_2 = mean misclassification rate for the ANN model

Scenario 1: $$Z=\frac{(\bar{\hat{p}}_1-\bar{\hat{p}}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{S_{\hat{p}1}^2}{1000}+\frac{S_{\hat{p}2}^2}{1000}}}=\frac{(0.4536-0.4556)-0}{\sqrt{\frac{(0.07539)^2}{1000}+\frac{(0.07420)^2}{1000}}}=-0.5979$$

p-value = 0.275

Scenario 2: $$Z=\frac{(\bar{\hat{p}}_1-\bar{\hat{p}}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{S_{\hat{p}1}^2}{1000}+\frac{S_{\hat{p}2}^2}{1000}}}=\frac{(0.4033-0.4065)-0}{\sqrt{\frac{(0.07595)^2}{1000}+\frac{(0.075)^2}{1000}}}=-0.9609$$

p-value = 0.1683

Scenario 3: $$Z=\frac{(\bar{\hat{p}}_1-\bar{\hat{p}}_2)-(\mu_1-\mu_2)}{\sqrt{\frac{S_{\hat{p}1}^2}{1000}+\frac{S_{\hat{p}2}^2}{1000}}}=\frac{(0.3467-0.3488)-0}{\sqrt{\frac{(0.19044)^2}{1000}+\frac{(0.18241)^2}{1000}}}=-0.2518$$

p-value = 0.4006

where $\bar{\hat{p}}_1$ = the sample average of misclassification rate resulting from the OLR model

$\bar{\hat{p}}_2$ = the sample average of misclassification rate resulting from the ANN model

$S_{\hat{p}1}^2$ = sample variance of $\bar{\hat{p}}_1$ resulting from the OLR model

$S_{\hat{p}2}^2$ = sample variance of $\bar{\hat{p}}_2$ resulting from the ANN model

Assuming a type I error α = 0.05 and α/2 = 0.025, H_0 was rejected if *p*-value < 0.025 (two-tailed test).

The *p*-value obtained for scenario 1, 2, and 3 were 0.275, 0.1683, and 0.4006 respectively. Since *p*-value > 0.025, then the study fails to reject H_0. Thus, the results indicate that there are no statistically significant differences between the mean of the misclassification rates resulting from the OLR and ANN models and there is no reason that the OLR and ANN models have different performance level when analyzing a relationship between one input and one output ordinal variable.

4.8 Summary

This chapter discusses the comparison of the OLR and ANN models when both models are used in a classification problem for ordinal data with one input and one output variable. Both models are used to analyze the link between student overall satisfaction and student performance in a training restaurant. In addition to data collected from the surveys, the study also generates correlated ordinal data by performing simulations. The simulations are carried out in three steps: 1) generate random marginal probabilities; 2) generate random correlation coefficients; and 3) generate correlated ordinal data based on the marginal probability and correlation coefficients generated on the previous steps.

Three scenarios are developed to compare the performance of OLR and ANN models in term of misclassification rates (the proportion of disagreement between the predicted outcome and the actual outcome). The first two scenarios generate data based on the marginal probabilities and correlation coefficient resulting from the surveys in Taylors' Dining at Oklahoma State University – USA and Fajar Teaching Restaurant at Universitas Negeri Malang – Indonesia. The last scenario (scenario 3) generates data based on random marginal probabilities and correlation coefficients.

The results of the hypothesis test on the mean of the misclassification rates resulting from both models, the OLR and ANN models, show that the *p*-values obtained for scenarios 1, 2, and 3 were 0.275, 0.1683, and 0.4006 respectively. Assuming $\alpha = 0.05$, and $\alpha/2 = 0.025$., the *p*-values from all scenarios are less than 0.025, so the results of hypothesis testing confirm that there is no significant statistically differences between the mean of the misclassification rates resulting from the OLR and ANN models for all scenarios. In other words, when analyzing a causal relationship between one input and one output variable using ordinal data that has similar marginal probabilities and correlation coefficients to the data collected from either Taylors' Dining or FTR, or even randomly distributed marginal probabilities and correlation coefficients, both the OLR and ANN models result in similar means of misclassification rates. So, either the OLR or ANN model could be used to analyze the relationship.

CHAPTER V

THE ORDINAL LOGISTIC REGRESSION AND ARTIFICIAL NEURAL NETWORK WITH THREE INPUT VARIABLES

5.1 Introduction

This chapter presents the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models that were constructed from the causal relationship of the student perceived value of one internal determinant and two external determinants of student satisfaction on the student overall satisfaction at the training restaurants. The input and output variables were obtained from the student instrument. Three scenarios were designed to compare the performance of the OLR and ANN models. These scenario were built based on data collected in Taylors' Dining (scenario 1), Fajar Teaching Restaurant (scenario 2), and simulated correlated-ordinal data sets that were generated from the random marginal probabilities and correlation coefficients (scenario 3). A hypothesis test was carried out on the mean of the misclassification rates resulting from both models for each scenario.

5.2 Preparation Steps

The preparatory step in the model building process was to check for any missing values in the data set. The initial check showed that there were no missing values in data collected from both restaurants. There were 24 and 28 student responses from FTR and Taylors' Dining respectively, which were related to their perceived value of the internal and external determinants of employee satisfaction and their overall satisfaction as student lab/workers in the training restaurants.

Because there were only 24 and 28 students responses collected from Fajar Teaching Restaurant and Taylors' Dining and more than 25 employee satisfaction determinants listed in the student instrument, not all the determinants listed in the instrument were used as the input variables in the models. The study only selected three employee satisfaction determinants listed in the student instrument as the input variables in order to follow the rule of thumb of the ratio between outcome variable and its input variables at 1:10 (Peng et al., 2002). The three employee satisfaction determinants were selected based on the gamma correlation coefficient. As suggested by Guyon and Elisseeff (2003), a variable ranking based on the correlation coefficient can be used to determine input variables used in prediction/classification problems. Thus, the three determinants that had the highest gamma coefficient with the student-employee overall satisfaction were chosen as the input variables in the data set.

Based on the correlation coefficients obtained from the Taylors' data set, as presented in Table 5.1, the three determinants used as the input variables in the models were "understand what to do" ($\Gamma = 0.947$), "enthusiastic feeling to do job" ($\Gamma = 0.901$) and "opportunity to develop skill" ($\Gamma = 0.841$). In addition, based on the correlation coefficients obtained from Fajar Teaching Restaurant's data set, as presented in Table 5.2, the three determinants used in the models in scenario 2 were "understand what to do" ($\Gamma = 0.829$), "proud to be worker" ($\Gamma = 0.697$), and "opportunity to develop skill" ($\Gamma = 0.682$).

Table 5.1 Gamma correlation coefficient from Taylors' data

Determinants	**Correlation with satisfaction as a student employee (Gamma Correlation)**
Understand what to do	**0.947**
Enthusiastic feeling to do job	**0.901**
Opportunity to develop skill	**0.841**
Sufficient job direction	0.834
Friendly peer worker	0.831
Recognition on good performance	0.82
Sufficient equipment and technology	0.82
Comprehend objective and goal	0.806
Comment on good performance	0.799
Team oriented	0.784
Sufficient skill to deliver good food and service	0.783
The importance of the job	0.779
Sufficient knowledge about food and service delivered	0.761
Self-development opportunity	0.697
Pleasant work environment	0.68
Fair superior	0.656
Reward for good performance	0.63
Sufficient autonomy to determine job order	0.62
Helpful peer worker	0.612
Trustworthiness of instructor	0.5
Reward for effort	0.48
Manager shows concern about student's right	0.465
Involvement in planning	0.434
Feedback about decision and its implementation	0.429
All sides effect-presented as consequence of decision	0.413
Satisfying conflicting demand	0.338
Peer expectation	0.279
Performance evaluation from instructor	0.134
Feedback on poor performance	0.118

Table 5.2 Gamma correlation coefficient from Fajar Teaching Restaurant data

Determinants	**Correlation with satisfaction as a student employee (Gamma Correlation)**
Understand what to do	**0.829**
Proud to be a worker	**0.697**
Opportunity to develop skill	**0.682**
Happy to work	0.65
Enthusiastic feeling to do job	0.634
Comprehend objective and goal	0.605
The importance of the job	0.536
Sufficient training for work	0.534
Equality right in the team	0.531
Sufficient skill to deliver good food and service	0.517
Self-development opportunity	0.514
Sufficient knowledge about food and service delivered	0.512
Peer expectation	0.497
Reward for effort	0.494
Sufficient autonomy to determine job order	0.478
Reward for experience	0.475
Sufficient job direction	0.455
Satisfying conflicting demand	0.445
Reward for good performance	0.423
Pleasant work environment	0.39
Helpful peer worker	0.383
Comment for good performance	0.351
Respectful supervisor	0.325
Sufficient authority to run the job	0.324
Friendly peer worker	0.316
Work challenge to implement all knowledge	0.299
Team work oriented	0.294
Involvement in planning	0.28
Recognition on good performance	0.247
Trustworthiness superior	0.234
Sufficient equipment and technology	0.224
Pay based on achievement	0.175
Performance evaluation from instructor	0.173
Right time decision	0.167
Feedback on poor performance	0.125
Manager shows concern about student's right	0.088
Transparency payment	0.085
All sides effect-presented as consequence of decision	-0.02
Complete information when decision is made	-0.054
Fair superior	-0.184
Feedback about decision and its implementation	-0.291
Reward for stress from work	-0.45

Two of the three top correlation coefficients obtained from Taylors' and FTR data, as shown in Table 5.1 and 5.2 were the same. The first and the third determinants of student overall satisfaction in both training restaurants were "understand what to do" and "opportunity to develop skill". Although the second determinant was different, both items listed as the second determinants in both restaurants were related to self-motivation. Thus, the results of the top three determinants of student overall satisfaction used in scenario 1 (Taylors') and scenario 2 (FTR) were assumed to be consistent with each other.

The study also explored the marginal probabilities of all variables used in the models from each collected data set. As shown in Figures 5.1 and 5.2, the marginal distributions of all the variables from both restaurants were skewed into the high category levels. This meant that most students rated their overall satisfaction at "neutral" or higher, and most students responded with "agree" or higher to statements that were related to the internal and external determinants of employee satisfaction.

The skewness values of the variables "understand what to do," "enthusiastic feeling to do job," "opportunity to develop skill," and "student overall satisfaction" for data collected from Taylors' are -1.367, -1.457, -1.074, and -1.447. Additionally, the skewness values of the variables "understand what to do," "proud to be a worker," "opportunity to develop skill," and "student overall satisfaction" for data collected from FTR are -1.067, -0.816, -0.402 and -0.566. The skewness values indicated that data collected from Taylors' was more negatively skewed than that from FTR for all four variables.

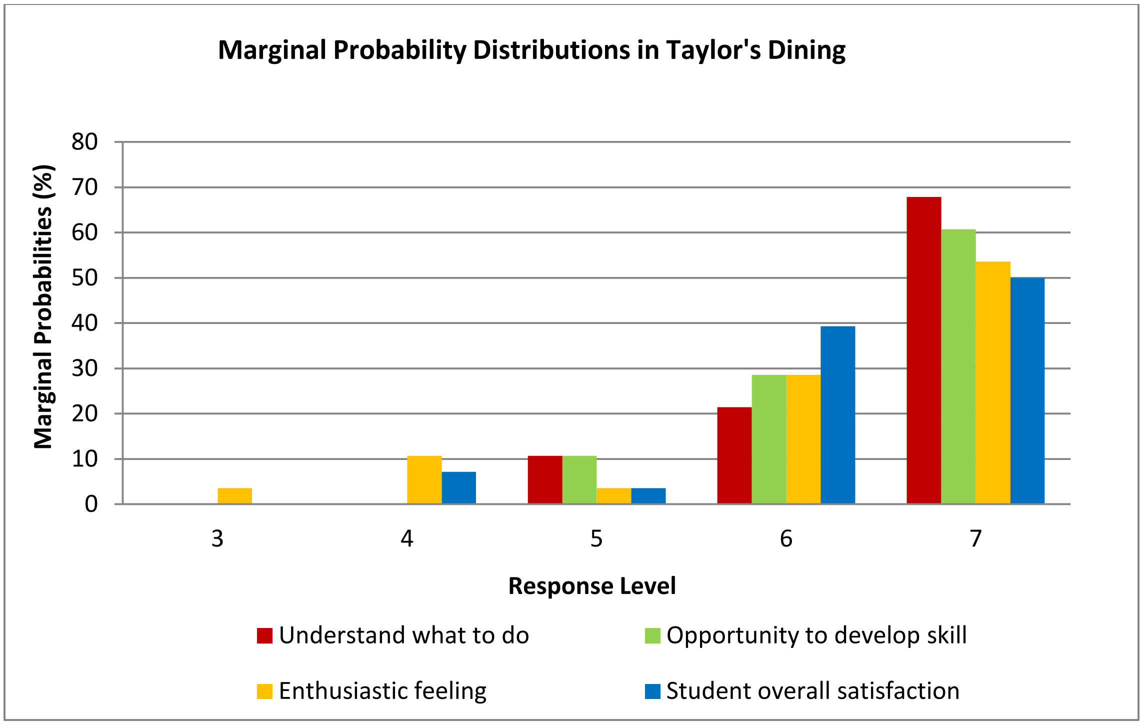

Figure 5.1 Marginal probability distributions from Taylors' data

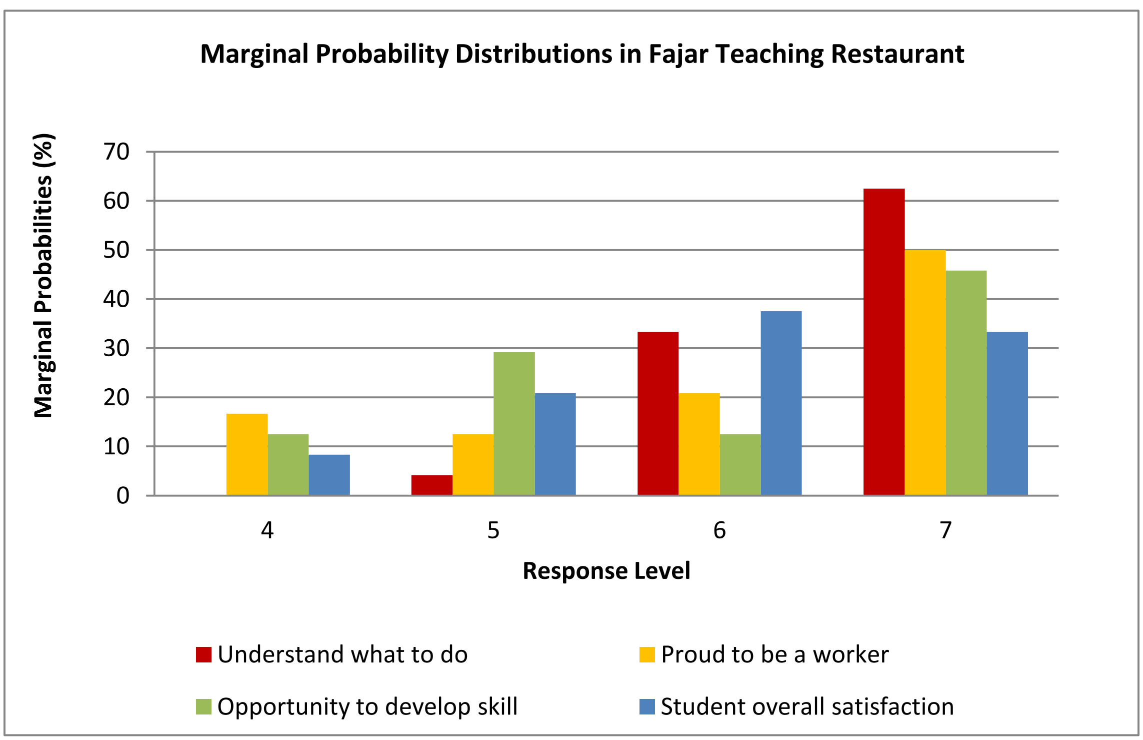

Figure 5.2 Marginal probability distributions from FTR data

Figure 5.1 shows that approximately 50% of student-employees in Taylors' felt "strongly satisfied" and almost 40% felt "very satisfied" with their lab session in the training restaurant. In contrast, as shown in Figure 5.2, the marginal probabilities of students who felt "strongly satisfied" and "very satisfied" at FTR were approximately 33% and 38%. Furthermore, the differences between the marginal probabilities of response categories 5 and 6 were approximately more than 30% for the Taylors' Dining data set and less than 20% for the FTR data set. The results shown in Figures 5.1 and 5.2 indicate that more students in FTR rated their overall satisfaction on category level 3, 4, and 5 than the students in Taylors'.

The kurtosis values of the variables "understand what to do," "enthusiastic feeling to do job," "opportunity to develop skill," and "student overall satisfaction" for data collected from Taylors' are .629, 1.251, -0.022, and 1.993. Additionally, the kurtosis values of the variables "understand what to do," "proud to be a worker," "opportunity to develop skill," and "student overall satisfaction" for data collected from FTR are .295, -0.843, -1.402, -0.507. The kurtosis indicated that data collected from Taylors' was more "peaked" than that from FTR for all four variables, indicating the data collected from FTR was more widely spread than that of Taylors'.

5.3 Validating Algorithm to Generate Correlated Ordinal Data

After finishing the preparatory step, the study continued by validating the algorithm applied to generate correlated ordinal data. The validation process was carried out in order to compare the original data collected from the surveys with the simulated data. This process began by comparing the marginal probabilities for each category response in data obtained from the survey and the simulation. This was followed by execution of the mean rank test.

The study used data collected from Taylors' Dining to validate the algorithm to generate correlated ordinal data with three input variables and one output variable. The other data set, data collected from FTR, had been used for validating the algorithm to generate correlated ordinal data with one input and one output variable. Tables 5.3, 5.4, and 5.5 present the cross tabulated data from Taylors' Dining and the initial simulated data set. These tables show the difference between marginal probabilities for each response category in data obtained from FTR and the simulation ranges from 0% - 7%.

Table 5.3 Cross tabulated data of "understanding what to do"

			Student overall satisfaction (survey)				Total	Student overall satisfaction (simulated)				Total
			4	5	6	7		4	5	6	7	
Understanding what to do	5	Count	1	0	2	0	3	9	3	1	1	14
		% of Total	3.6%	.0%	7.1%	.0%	10.7%	9.0%	3.0%	1.0%	1.0%	14.0%
	6	Count	1	1	4	0	6	0	0	22	0	22
		% of Total	3.6%	3.6%	14.3%	.0%	21.4%	.0%	.0%	22.0%	.0%	22.0%
	7	Count	0	0	5	14	19	2	1	18	43	64
		% of Total	.0%	.0%	17.9%	50.0%	67.9%	2.0%	1.0%	18.0%	43.0%	64.0%
Total		Count	2	1	11	14	28	11	4	41	44	100
		% of Total	7.1%	3.6%	39.3%	50.0%	100.0%	11.0%	4.0%	41.0%	44.0%	100.0%

Table 5.4 Cross tabulated data of "opportunity to develop skill"

			Student overall satisfaction (survey)				Total	Student overall satisfaction (simulated)				Total
			4	5	6	7		4	5	6	7	
Opportunity to develop skill	5	Count	1	1	1	0	3	9	3	2	2	16
		% of	3.6%	3.6%	3.6%	.0%	10.7%	9.0%	3.0%	2.0%	2.0%	16.0%
	6	Count	1	0	5	2	8	1	0	27	2	30
		% of	3.6%	.0%	17.9%	7.1%	28.6%	1.0%	.0%	27.0%	2.0%	30.0%
	7	Count	0	0	5	12	17	1	1	12	40	54
		% of	.0%	.0%	17.9%	42.9%	60.7%	1.0%	1.0%	12.0%	40.0%	54.0%
Total		Count	2	1	11	14	28	11	4	41	44	100
		% of	7.1%	3.6%	39.3%	50.0%	100.0%	11.0%	4.0%	41.0%	44.0%	100.0%

Table 5.5 Cross tabulated data of "enthusiastic feeling"

			Student overall satisfaction (survey)				Total	Student overall satisfaction (Simulated)				Total
			4	5	6	7		4	5	6	7	
Enthusiastic feeling	3	Count	0	0	1	0	1	5	1	1	1	8
		% of Total	.0%	.0%	3.6%	.0%	3.6%	5.0%	1.0%	1.0%	1.0%	8.0%
	4	Count	2	1	0	0	3	5	2	5	0	12
		% of Total	7.1%	3.6%	.0%	.0%	10.7%	5.0%	2.0%	5.0%	.0%	12.0%
	5	Count	0	0	1	0	1	0	0	5	0	5
		% of Total	.0%	.0%	3.6%	.0%	3.6%	.0%	.0%	5.0%	.0%	5.0%
	6	Count	0	0	6	2	8	0	0	23	2	25
		% of Total	.0%	.0%	21.4%	7.1%	28.6%	.0%	.0%	23.0%	2.0%	25.0%
	7	Count	0	0	3	12	15	1	1	7	41	50
		% of Total	.0%	.0%	10.7%	42.9%	53.6%	1.0%	1.0%	7.0%	41.0%	50.0%
Total		Count	2	1	11	14	28	11	4	41	44	100
		% of Total	7.1%	3.6%	39.3%	50.0%	100.0%	11.0%	4.0%	41.0%	44.0%	100.0%

After exploring the marginal probabilities for each category in all four variables, the study performed a mean rank test to determine whether the mean rank between the survey data and the simulated data was statistically different or not. The mean ranks for the survey data (data collected from Taylors') and the simulated data are shown in Table 5.6, while Mann-Whitney test results are shown in Table 5.7.

Table 5.6 Mean rank for student overall satisfaction and its three determinants

	Group	N	Mean Rank	Sum of Ranks
Understanding what to do	Survey data	28	66.75	1869.00
	Simulated	100	63.87	6387.00
	Total	128		
Opportunity to develop skill	Survey data	28	68.54	1919.00
	Simulated	100	63.37	6337.00
	Total	128		
Enthusiastic feeling	Survey data	28	67.84	1899.50
	Simulated	100	63.57	6356.50
	Total	128		
Overall Satisfaction as a student lab	Survey data	28	68.30	1912.50
	Simulated	100	63.44	6343.50
	Total	128		

Table 5.7 Mean rank test statistics

	Understanding what to do	Opportunity to develop skill	Enthusiastic Feeling	Student overall satisfaction
Mann-Whitney U	1337.000	1287.000	1306.500	1293.500
Z	-.430	-.728	-.585	-.670
Asymp. Sig. (2-tailed)	.668	.466	.559	.503

Table 5.6 shows that the mean ranks of the survey data are higher than the simulated data for all of the four variables. Assuming α=0.01, the asymptotic significance values for “understand what to do,” “opportunity to develop skill,” “enthusiastic feeling,” and “student overall satisfaction” as presented in Table 5.7 are 0.668, 0.466, 0559, and 0.503 respectively. All four asymptotic significance values are greater than the specified α. Thus, there is no significant difference between the mean ranks on all of the four tested variables from Taylors’ and the simulated data. As with the previous mean rank test carried out in section 4.3, these results confirm that the algorithm used to generate the correlated ordinal data is valid and can be used for further analyses.

5.4 Scenario 1

This scenario generated data that has similar marginal probabilities to data collected from Taylors’ Dining. As shown in Table 5.1, the three determinants used as the input variables in the models were “understand what to do” (Γ = 0.947), “enthusiastic feeling to do job” (Γ = 0.901) and “opportunity to develop skill” (Γ = 0.841). The gamma correlations obtained from Taylors’ data set show that the three determinants have a high correlation with the student overall satisfaction.

The total amount of collected data was relatively small for use in comparing the performance of the OLR and ANN models. Therefore, the study performed 1,000 runs of simulation to generate 1,000 data sets with 100 observations in each set. The 100 observations were then split into two sets; 50 observations were used as a training data set and the others were used as a testing data set.

The correlated ordinal data used in this scenario were generated based on the marginal probabilities of "understanding what to do," "opportunity to develop skill," "enthusiastic feeling," and "student overall satisfaction" variables as shown in Figure 5.1 and the correlation coefficient as shown in Table 5.8. The correlation coefficients presented in Table 5.8 show that all input variables are highly correlated with the output variables (all correlation coefficients > 0.8). This means that the higher the students rate their understanding about what to do, opportunity to develop skill, and enthusiastic feeling toward the work in the training restaurant, the higher the students rate their overall satisfaction. In addition, the correlations among the input variables ("understanding what to do," "opportunity to develop skill," and "enthusiastic feeling") are also high, which means that the higher the students rate any one of the three input variables, the higher they rate the other two input variables.

Table 5.8 Gamma correlation coefficients between variables used in Scenario 1 (three input variables)

	Understanding what to do	Opportunity to develop skill	Enthusiastic Feeling	Student overall Satisfaction
Understanding what to do	1	0.855	0.897	0.947
Opportunity to develop skill	0.855	1	0.909	0.841
Enthusiastic Feeling	0.897	0.909	1	0.901
Student overall satisfaction	0.947	0.841	0.901	1

The marginal probability distributions as shown in Figure 5.1 indicated that the output data were negatively skewed; thus, the cumulative complementary log-log function was used in the OLR link function as suggested by Chen and Hughes (2004) and Agresti (2010). The study used the multilayer perceptron (MLP) as the network architecture in the ANN models because Turban et al. (2011) and Garver (2002) suggest that his architecture works best with classification problems. This study applied the automatic option available in IBM SPSS Modeler to set the hidden layer in the ANN model. The study allocated 30% of the data set as an overfit prevention data set during the training process to prevent achieving an over-fitted model. The descriptive statistics of misclassification rates for the OLR and ANN models for scenario 1 is shown in Table 5.9.

Table 5.9 The descriptive statistics of misclassification rates for Scenario 1 (three input variables)

	N	Range	Min.	Max.	Mean	Std. Deviation
OLR misclassification rates	1000	.58	.02	.60	.1827	.06516
ANN misclassification rates	1000	.56	.02	.58	.1922	.07503
Valid N (listwise)	1000					

Table 5.9 shows that the range and maximum values of the misclassification rates obtained from the ANN models were lower than the one obtained from the OLR models. However, the mean and standard deviation of the misclassification from the ANN models were higher than that of the OLR models. The minimum value of the misclassication rates obtained from the OLR and ANN models are the same.

5.5 Scenario 2

This scenario generated data that has similar marginal probabilities and correlation coefficients to data collected from Fajar Teaching Restaurant (FTR). As shown in Table 5.2, the three determinants used as the input variables in the models were “understand what to do” ($\Gamma = 0.829$), “proud to be a worker” ($\Gamma = 0.697$) and “opportunity to develop skill” ($\Gamma = 0.682$). The gamma correlation obtained from the FTR data set shows that “understand what to do” has a high correlation with the student overall satisfaction ($\Gamma > 0.8$). The other two determinants, “proud to be a worker” and “opportunity to develop skill” have medium correlation with the student overall satisfaction ($0.6 \leq \Gamma \leq 0.8$).

The total number of collected data was relatively small for use in comparing the performance of the OLR and ANN models. Thus, the study performed 1,000 runs of simulation to generate 1,000 data sets with 100 observations in each set. The 100 observations were then split into two sets; 50 observations were used as a training data set and the others were used as a testing data set.

The correlated ordinal data used in this scenario was generated based on the marginal probabilities of “understanding what to do,” “proud to be a worker,” “opportunity to develop skill,” and “student overall satisfaction” variables as shown in Figure 5.2 and the correlation coefficients as shown in Table 5.10. The correlation coefficients presented in Table 5.10 show that “understand what to do” was highly correlated with “proud to be worker” and “student overall satisfaction” ($\Gamma > 0.8$), and poorly correlated with “opportunity to develop skill” ($\Gamma < 0.6$). Additionally, “proud to be a worker” was moderately correlated with “student overall satisfaction” ($0.6 \leq \Gamma \leq 0.8$) and poorly correlated with “opportunity to develop skill” ($\Gamma < 0.6$).

Table 5.10 Gamma correlation coefficients between variables used in scenario 2 (three input variables)

	understand what to do	proud to be a worker	opportunity to develop skill	student overall satisfaction
understand what to do	1	0.835	0.573	0.829
proud to be a worker	0.835	1	0.52	0.697
opportunity to develop skill	0.573	0.52	1	0.682
student overall satisfaction	0.829	0.697	0.682	1

The marginal probability distributions of the output variable, as shown in Table 5.2, were negatively skewed, thus the cumulative complementary log-log function was used in the OLR link function. The study used the multilayer perceptron (MLP) as the network architecture and applied the automatic option available in IBM SPSS Modeler to set the hidden layer. To prevent an over-fitted model, the study allocated 30% of the data set as an overfit prevention data set during the training process. All the settings on this scenario were similar to the ones used in scenario 1 because both scenarios had negatively skewed output variables. The descriptive statistics of misclassification rates for the OLR and ANN models for scenario 1 are shown in Table 5.11.

Table 5.11 The descriptive statistics of misclassification rates for Scenario 2 (three input variables)

	N	Range	Min.	Max.	Mean	Std. Deviation
OLR misclassification rates	1000	.58	.16	.74	.3920	.09362
ANN misclassification rates	1000	.52	.10	.62	.3278	.07627
Valid N (listwise)	1000					

Table 5.11 shows that all the descriptive statistical values (range, minimum, maximum, mean and standard deviation) of the misclassification rates obtained from the ANN models were lower than the ones from the OLR models.

5.6 Scenario 3

Scenario 3 generated ordinal correlated data, which consisted of three input variables and one output variable, based on random marginal probabilities and correlation coefficients. The marginal probabilities were generated using the uniform random generator available in IBM SPSS 19.0 for four times in order to obtain the independent marginal probabilities for the four variables (three input and one output) that were used in the models. The use of the random number generator (RNG) provided by IBM SPSS for this case study can be justified since the RNG in IBM SPSS has a period of 2^{32}. This means that the software can generate 2^{32} random number with a uniform distribution before it begins to repeat itself (McCullough, 1999). Any RNG software with a period of 2^{32} is acceptable to generate one million of random numbers according to Knuth (1997).

The marginal probabilities for each variable were generated using the rules presented in Table 5.12. These rules were used to generate marginal probabilities for three input variables and one output variable, and were developed after discussion with the committee member to ensure production of random and reasonable marginal distributions on the generated data.

Table 5.12 The rules to generate marginal probabilities

Category response level	Rules to generate marginal probabilities
Category level 7, p_7	$p_7 \sim U(0,1)$
Category level 6, p_6	$p_6 \sim U(0,1-p_7)$
Category level 5, p_5	$p_5 \sim U(0,1-(p_6+p_7)$
Category level 4, p_4	$p_4 \sim U(0, 1- (p_5+p_6+p_7))$
Category level 3, p_3	$p_3 \sim U(0, 1- (p_4+ p_5+p_6+p_7))$
Category level 2, p_2	$p_2 \sim U(0, 1- (p_3+p_4+p_5+p_6+p_7))$
Category level 1, p_1	$p_1 = 1 - (p_2+p_3+p_4+p_5+p_6+p_7)$

where p_i denote the proportion of response in the i category and i = 1, 2, 3, 4, 5, 6, 7.

The generated marginal probabilities for variable 1, 2, 3 (the variables used as the input variables) and 4 (the variable used as the output variable) are shown in Table 5.12, 5.13, 5.14, and 5.15 respectively. These tables show that the random marginal probabilities generated for all of the four variables were positively skewed for response categories 1 - 6 and were almost evenly distributed for response category 7. These results indicate that the rules used to generate random marginal probabilities are more likely to generate more data sets with low marginal probabilities for lower category level data and are more likely to generate uniform distributed marginal probabilities for the highest category level data.

Table 5.13 Marginal probability distributions input variable 1

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	966	964	903	794	596	319	103
0.1001-0.2	23	27	69	110	178	213	107
0.2001-0.3	10	4	20	51	97	139	94
0.3001-0.4	1	4	4	29	67	112	95
0.4001-0.5		1	2	12	28	87	99
0.5001-0.6			1	2	13	40	103
0.6001-0.7			1	1	11	43	108
0.7001-0.8				1	8	27	98
0.8001-0.9					2	17	97
0.9001-1.00						3	96

Table 5.14 Marginal probability distributions input variable 2

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	981	966	914	815	585	319	93
0.1001-0.2	16	27	62	107	186	189	110
0.2001-0.3	3	4	12	46	108	128	95
0.3001-0.4		3	9	18	48	114	127
0.4001-0.5			2	10	31	84	95
0.5001-0.6			1	3	23	71	107
0.6001-0.7					11	47	85
0.7001-0.8				1	6	34	101
0.8001-0.9					2	13	88
0.9001-1.00						1	99

Table 5.15 Marginal probability distributions input variable 3

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	977	968	914	820	605	351	94
0.1001-0.2	18	23	54	123	154	193	92
0.2001-0.3	4	7	24	33	106	125	94
0.3001-0.4	1	2	6	11	59	101	93
0.4001-0.5			1	7	40	93	114
0.5001-0.6			1	3	17	57	88
0.6001-0.7				3	8	39	117
0.7001-0.8					7	26	101
0.8001-0.9					3	10	119
0.9001-1.00					1	5	88

Table 5.16 Marginal probability distributions output variable

Marginal Probabilities Interval.	Frequency of Each Category Level of Generated Student Performance						
	1	2	3	4	5	6	7
0 – 0.1	967	971	918	808	605	325	95
0.1001-0.2	29	19	53	114	178	207	118
0.2001-0.3	3	8	20	51	92	125	107
0.3001-0.4		1	4	14	59	93	85
0.4001-0.5	1	1	4	7	29	93	92
0.5001-0.6				6	20	64	97
0.6001-0.7					8	44	102
0.7001-0.8			1		6	34	101
0.8001-0.9					1	12	105
0.9001-1.00					2	3	98

Scenario 3 used three input variables and one output variable, thus the simulation to generate correlated ordinal data required 4 x 4 random correlation matrices. The generated matrices should be symmetric and positive semi-definite in order to ensure that the generated random matrices conform to the characteristics of correlation matrices. As explained in section 3.4.3, this study generated 4 x 4 correlation matrices following the algorithm proposed by Budden et al. (2007).

Based on this algorithm, if r_{ij} denotes the correlation coefficient between x_i and x_j, and $x_1, x_{2,\ldots,} x_4$ are random variables where j=2 (input variable 1), 3 (input variable 2), 4 (input variable 3), three correlation coefficients (r_{12}, r_{13}, and r_{14}) can be randomly generated using a uniform (-1,1) distribution. In this case study, x_1 is the output variable, and x_2, x_3, and x_4 are the input variables. This setting allows each input variable to independently correlate with the output variable. The correlation coefficient obtained from Taylors' and FTR data show that the three determinants used in the model are positively correlated with student overall satisfaction, thus this scenario set r_{12}, r_{13}, and $r_{14} \sim$ U(0,1).

The other correlation coefficients, which referred to correlation among input variables (r_{23}, r_{24} and r_{34}), should be randomly chosen from the intervals provided by the algorithm to ensure the symmetric and positive semi-definiteness of the matrices. Since this study found that all input variables used in scenarios 1 and 2 were positively correlated to each other, then the minimum values of r_{23}, r_{24} and r_{34} were set at minimum (0, the lower limit) and the maximum follows the upper limit given by the algorithm.

Table 5.16 presents the generated correlation coefficient intervals resulting from the simulation. This table shows by inspection that the correlation coefficients between input and output variables and the correlation coefficients among input variables are almost uniformly distributed among all intervals, with the lowest frequency occurring at the interval between 0.8 – 1.0. These results fulfill the scenario 3 setting, randomly generating correlation coefficients.

Table 5.17 Generated correlation coefficient intervals

Correlation Coefficient Interval	Frequency					
	Correlation between Input and Output Variables			Correlation among Input Variables		
	r_{12}	r_{13}	r_{14}	r_{23}	r_{24}	r_{34}
0.0 – 0.2	195	221	216	264	190	220
0.2 – 0.4	218	206	237	252	264	263
0.4 – 0.6	200	214	207	233	260	238
0.6 – 0.8	242	226	209	172	183	196
0.8 – 1.0	145	133	131	79	103	83

Table 5.18 The descriptive statistics of misclassification rates for scenario 1 (three input variables)

	N	Range	Min.	Max.	Mean	Std. Deviation
OLR misclassification rates	1000	.96	.02	.98	.3685	.18840
ANN misclassification rates	1000	.80	.00	.80	.3364	.16090
Valid N (listwise)	1000					

The distributions of the marginal probabilities and the correlation coefficients of the simulated data used in the scenario 3 were varied because the marginal probabilities and correlation coefficient were randomly generated. Thus, the simulated data had a chance to be negatively skewed, positively skewed, normally distributed or other pattern with various correlation coefficient levels. Having varied distributions of the marginal probabilities, the OLR model for each simulated data set was built by running several model-building processes with a different cumulative link function in order to obtain the OLR model that fitted best with the data set.

The automatic option available in IBM SPSS Modeler was chosen to set the hidden layer since the automated neural networks in IBM SPSS were very powerful (Nisbet et al., 2009). This option let the software determine the number of nodes in the hidden layer that make the model fit best with the data set. The biggest benefit of using the automatic option was that the software automatically searched over the decision surface with different initial learning rates, different momentum, and different numbers of hidden layers in order to get the best parameter for the model (Nisbet et al., 2009).

Table 5.17 presents the descriptive statistics of the misclassification rates obtained from the OLR and ANN models in scenario 3. This table shows that all the descriptive statistics values (range, minimum, maximum, mean and standard deviation) obtained from the ANN models were lower than those from the OLR models, indicating the ANN models performs better than the OLR models.

5.7 Misclassification Rates Comparison

Based on the mean and standard deviation of the misclassification rates obtained from the OLR and ANN models built in each scenario, the study performed a hypothesis testing to determine whether the performance of the OLR and ANN models were different when the models were used to analyze a relationship link between three output variables and one input variable.

The hypothesis test was:

$H_0: \mu_1 - \mu_2 = 0,$

$H_1: \mu_1 - \mu_2 \neq 0,$

where μ_1 = mean misclassification rate for the ordinal logistic regression (OLR) model

μ_2 = mean misclassification rate for the artificial neural network (ANN) model

Scenario 1: $$Z = \frac{(\bar{\hat{p}}_1 - \bar{\hat{p}}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{S^2_{\hat{p}1}}{1000} + \frac{S^2_{\hat{p}2}}{1000}}} = \frac{(0.1827 - 0.1922) - 0}{\sqrt{\frac{(0.06516)^2}{1000} + \frac{(0.07503)^2}{1000}}} = -3.0231,$$

p-value = 0.0013,

Scenario 2: $$Z = \frac{(\bar{\hat{p}}_1 - \bar{\hat{p}}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{S^2_{\hat{p}1}}{1000} + \frac{S^2_{\hat{p}2}}{1000}}} = \frac{(0.392 - 0.3278) - 0}{\sqrt{\frac{(0.09362)^2}{1000} + \frac{(0.07627)^2}{1000}}} = 16.8124,$$

p-value = less than 0.0001,

Scenario 3: $$Z = \frac{(\bar{\hat{p}}_1 - \bar{\hat{p}}_2) - (\mu_1 - \mu_2)}{\sqrt{\frac{S^2_{\hat{p}1}}{1000} + \frac{S^2_{\hat{p}2}}{1000}}} = \frac{(0.3467 - 0.3488) - 0}{\sqrt{\frac{(0.19044)^2}{1000} + \frac{(0.18241)^2}{1000}}} = 4.0971,$$

p-value = less than 0.0001,

where $\bar{\hat{p}}_1$ = the estimated mean of the misclassification rate obtained from the OLR models

$\bar{\hat{p}}_2$ = the estimated mean of the misclassification rate obtained from the ANN models

$S^2_{\hat{p}1}$ = sample variance of $\bar{\hat{p}}_1$ obtained from the OLR models

$S^2_{\hat{p}2}$ = sample variance of $\bar{\hat{p}}_2$ obtained from the ANN models

Assuming a type I error α = 0.05 and α/2 = 0.025, H_0 was rejected if p-value< 0.025 (two tailed test).

The Z-value obtained for scenarios 1, 2, and 3 were -3.0231, 16.8124, and 4.0971 respectively, while the p-values for scenario 1 was 0.0013 and for scenarios 2 and 3 were smaller than 0.0001. Since all of obtained p-values for scenarios 1, 2, and 3 are less than 0.025, then H_0 is rejected. These results indicated that there were statically significant differences between the mean of the misclassification rates resulting from the OLR and ANN models. Thus, the results indicate that the OLR outperforms ANN model when analyzing data that has similar marginal probabilities and correlation coefficient to Taylors' data. On the other hand, the results indicate that the ANN performs better than the OLR when analyzing data that has either similar marginal probabilities and correlation coefficients to FTR data or randomly marginal probabilities and correlation coefficients.

5.8 Choosing a Model

The results from the hypothesis testing show that if we plan to analyze ordinal data which have three input variables and one output variable and the marginal probabilities and correlation coefficient are similar to data set collected from Taylors', the OLR models perform better than the ANN models in term of misclassification rates. In contrast, if the ordinal data have marginal probability distributions and correlation coefficients that are similar to data sets collected from FTR, the ANN performs better than the OLR. Additionally, if a data set consists of three input variables and the marginal probability distribution and correlation coefficients are unknown, the ANN outperforms the OLR models.

The results obtained from scenario 3 can be a useful source to analyze in more detail when the ANN outperforms the OLR model and vice versa. Based on the misclassification rates shown in Appendix 6c, there are 484 observations in which the ANN outperforms the OLR, 205 observations in which both model results in the same misclassification rates and 311 observations in which the OLR outperforms the ANN. When the marginal probabilities are highly distributed on the higher categories (4 and above) for all input and output variables and the correlation coefficients are randomly distributed, the OLR model has a chance to achieve a slightly lower, higher, or even similar misclassification rates to the ANN models. However, when the marginal probabilities are highly distributed distributions on the higher categories (4 and above) for all variables and the correlation between input and output variables is also relatively high, the OLR tends to outperforms the ANN.

The ANN tends to outperform the OLR when the marginal distribution on the higher categories (4 and above) is relatively low (positively skewed) or data is widely spread into all categories (evenly distributed) for one or more variables, especially when the correlation coefficients between input and output variables are also low. The correlation coefficients among input variables seem not to have an influence on the misclassification rates resulting from both models.

5.9 Summary

As explained earlier, the cumulative link function used in the OLR is determined from the output data distribution. The results show that the output data collected from Taylors' and FTR are negatively skewed. Therefore, both scenarios apply the same cumulative function to build the OLR models in scenario 1 (based on Taylors' data) and scenario 2 (based on FTR data). There is also no difference in the procedure when the study builds the ANN models and performs analyses in scenario 1 and 2.

The descriptive statistics resulting from scenario 1 and scenario 2, as presented in Table 5.9 and 5.11, show that the mean of misclassification rate obtained from the OLR and ANN models fitted to Taylors' data is lower than that obtained from models fitted to FTR data. Two factors that may cause the mean of misclassification rate obtained from Taylors' data to be lower than that from FTR data are the marginal probability distributions and correlation coefficients. Although Taylors' and FTR output data are negatively skewed, Taylors' data set is more concentrated on response categories 6 and 7 (approximately 90%) than FTR' data set (approximately 70%). The rest of the output data is distributed among response categories 4 and 5. The kurtosis value calculated from

Taylors' data supports that data collected from Taylors' is more peaked than that of the FTR data. Having more peaked distributed responses means less complexity, which may result in a better fitting model. In addition, all the input variables from Taylors' data are highly correlated to the output ($\Gamma > 0.8$), while only one input variable from FTR is highly correlated to the output ($\Gamma > 0.8$). The other two are moderately correlated ($0.6 \leq \Gamma \leq 0.8$). Higher correlation coefficients may increase the prediction performance of a model.

The hypothesis test on the mean of misclassification rates obtained from scenarios 1, 2, and 3 results in the conclusions to reject H_0 for scenario 1, 2, and 3. This means that the mean classification rates obtained from the OLR and ANN models are statistically different for all scenarios. Scenario 2 and 3, result in positive Z values, which means that the ANN models perform better than the OLR models. In contrast, scenario 1 results in a negative value, which means the OLR models perform better than the ANN models. The possible reason for this is that data used in scenario 1 is better-structured than that in scenarios 2 and 3. As explained before, data used in scenario 1 has higher correlations between all the input variables and the output variables than that in scenarios 2 and 3. High correlation means that the input variables have a higher capability to predict the output. Therefore, the OLR models works better in scenario 1.

On the other hand, the ANN models work better than the OLR models when the complexity, in term of data structure, is relatively high such as that found in scenarios 2 and 3. As suggested by Henery (1994), two possible reasons why a certain algorithm performs better than others are the complexity of the problem and data set structure. Some measures of the complexity of a problem are number of observations, number of attributes/variables and number of classes, while several measures of the complexity of data structures are commonly expressed as statistical measures such as skewness, kurtosis and correlation coefficient (Henery 1994).

Because scenario 3 used randomly simulated data, this data used in scenario 3 has more variability than that in scenarios 1 and 2. Additionally, in scenario 2, the survey data show that only one input variable has high correlation ($\Gamma = 0.829$) with the output variable. The other two have medium correlation ($\Gamma = 0.697$ and 0.682) with the output variable. The simulated data in scenario 2 also have a similar correlation level to its survey data. The marginal probabilities in the FTR data (scenario 2) are also more widely spread than that of the Taylors' data (scenario 1). Therefore, FTR data is more complex in its data structures than the Taylors' data. As a result, the misclassification rates obtained from the ANN models are lower than those from the OLR models for the FTR data and randomly generated data.

CHAPTER VI

SUMMARY, CONCLUSIONS AND FUTURE WORK

6.1 Summary

Survey research is a widely used method for collecting information used in decision-making throughout service industries. An ordinal scale is one of the common measurement scales used in survey research. Analysis of ordinal data must be conducted by using appropriate methods that maintain the rank-ordering of data and do not assume equal intervals between categories in order to produce more meaningful results. The Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models are two of many available models which can be used to analyze ordinal data, and which maintain the rank-order of the ordinal data without assuming equal intervals between categories. This study focuses on comparing the performance of the OLR and ANN models when analyzing ordinal data.

An OLR model is an extension of a logistic regression model modified for ordinal output data, while the ANN model is a machine learning algorithm capable of analyzing highly complex data. This study evaluates three scenarios to compare the performance of the OLR and ANN models when analyzing ordinal data. The first scenario is to fit both models to simulated data that has similar marginal probabilities and correlation coefficients to the survey data collected from Taylors' Dining Room at Oklahoma State University - USA. The second scenario is to fit the OLR and ANN models to simulated data that has similar marginal probability distributions and correlation coefficients to the survey data collected from Fajar Teaching Restaurant (FTR) at Universitas Negeri Malang – Indonesia. The last scenario is to fit the OLR and ANN models to simulated data in which the marginal probabilities and correlation coefficients are randomly generated.

The application of the OLR and ANN models to analyze a causal relationship between one input variable and one output variable results in no statistically significant difference between the means of the misclassification rates resulting from both models for all three scenarios tested. Therefore, the performance of the OLR and ANN models, in terms of the misclassification rates, is the same when analyzing ordinal data that has similar marginal probabilities and correlation coefficient to Taylors' data, FTR, or randomly distributed marginal probabilities and correlation coefficients. In other word, similar results can be achieved using either the OLR or ANN model when analyzing a causal relationship between one input and output variable.

The application of the OLR and ANN models to analyze a causal relationship between three input variables and one output variable results in a significant difference between the means of the misclassification rates resulting from both models for all three scenarios tested. The OLR model outperforms the ANN model when it is used to analyze ordinal data that has similar marginal probabilities and correlation coefficients to Taylors' data. In contrast, the ANN model outperforms the OLR model when it is used to analyze ordinal data that has similar marginal probabilities and correlation coefficients to FTR's data, as well as when the marginal probabilities and correlation coefficients are randomly distributed.

The finding of this study as presented in the previous chapter provides guidance for model selection for each scenario. The guidance may help a decision-maker to choose a model that produces a lower misclassification rates when analyzing ordinal data, the type of data that is commonly used in surveys. The summary of the guidance for model selection for each scenario is presented in Table 6.1. The check mark in Table 6.1 indicates that a particular model performs better than the other under certain correlation coefficient and marginal probability distributions. This table shows that the complexity of the problem, which is represented by the number of input variables (attributes), and the complexity of the data structures, which is represented by the correlation coefficient and marginal probability distribution including the kurtosis, should be considered before fitting data sets to either the OLR or ANN models. When the OLR and ANN models are used to analyze the simplest problem, a problem with one input variable, either model results in the same mean misclassification rate. When the OLR and ANN models are used to analyze a more complex problem, i.e., a problem with three input variables, the complexity of the data structure affects the decision to choose either the OLR or ANN model in order to get a lower misclassification rate. The OLR model performs better than the ANN model when analyzing a classification problem with three input variables with a simpler data structure (more peaked data distribution and high correlation between input and output variables). On the other hand, the ANN model performs better than the OLR model when analyzing a classification problem with three input variables with a more complex data structure (more flat data distribution and low-medium correlation between input and output variables).

Table 6.1 Summary of the best guess-estimate models

	One input variable	Three input variables			
		High correlation between input and output variables		Low correlation between input and output variables	
		Left skewed marginal probabilities (peaked kurtosis)	Widely spread marginal probabilities (flat kurtosis)	Left skewed marginal probabilities (peaked kurtosis)	Widely spread marginal probabilities (flat kurtosis)
OLR	√	√			
ANN	√		√	√	√

The guidance for model selection for each scenario shown in Table 6.1 can be used by a decision maker when choosing an analytical model to explore the relationship between input and output variables. For example, the training restaurant manager of Taylors' Dining and FTR may apply either the OLR or ANN model when testing the relationship between student overall satisfaction and performance. When a decision-maker plans to analyze a relationship between three input variables and one output variables, and the preliminary analysis shows that the correlation between input and output variable is low/medium, the decision-maker should consider using the ANN model since it results in lower misclassification rates, and thus, produces more meaningful results. In contrast, if the preliminary test shows that the correlations between input and output variables are high, then an exploration of the marginal distribution is needed before the decision-maker builds a model. If the marginal distribution is left skewed and peaked kurtosis, the decision maker should consider using the OLR model. However, if the marginal distribution shows a flat kurtosis, the ANN model is preferred.

Although the interpretation of the importance weight of predictor variables in the ANN model is easier that the OLR model, restaurant managers are more familiar with the use of the OLR than ANN models. The reason of the familiarity is the fact that the OLR analysis package is available in commonly used statistical software such as SAS and IBM SPSS Statistics. The other reason that makes the ANN model has not been frequently used to analyze survey data in the restaurant industry is the fact that the building process of the ANN model is more complicated than the OLR. Therefore, the guidance for model selection for each scenario resulting from this study can be a useful source to the restaurant manager when trying to find an alternative model to analyze survey data.

Besides the model selection process, the other important step to compare the performance of the OLR and ANN models in this research is the simulation process. Because of the limited amount of data collected from the survey, this research performs simulations to generate ordinal correlated data. The simulation helps providing the quantity data needed to evaluate the impact of different marginal probabilities and correlation coefficients on the performance of both models. The simulation used to generate random correlation matrices provides lower and upper bounds of some correlation coefficients to ensure the symmetry and positive-semidefiniteness of the matrices applied to generate correlated ordinal data. As long as the elements of the matrix are generated within the lower and upper bound, then the matrix produced by the simulation can be considered a correlation matrix.

In addition to the results of comparing the performance of the OLR and ANN models when analyzing ordinal data, the results from the case studies used in this research show similarity in the top three determinant factors of student overall satisfaction that have the highest gamma coefficient with the student-employee overall satisfaction in Taylors' Dining and FTR. The students' responses in Taylors' show that "understand what to do," "enthusiastic feeling to do job," and "opportunity to develop skill" are the top three determinant factors of students overall satisfaction; while in FTR, the top three determinant factors are "understand what to do," "proud to be worker," and "opportunity to develop skill." These results confirms that student overall satisfaction are highly correlated with job description and job clarity, students' opportunity to develop service and managerial skill as well as self motivation for both training restaurants.

6.2 Conclusions

This study demonstrates that the performance of the OLR and ANN models is the same when both models are used to analyze a causal relationship with one input and one output variable. Different marginal probability distributions and correlation coefficients used in different scenarios do not produce different mean misclassification rates when both models are fitted to data sets that consist of one input and one output variable. However, when the number of input variables is changed to three, the OLR outperforms the ANN if both models are used to analyze ordinal data that is negatively skewed with peaked kurtosis and high correlation between input and output variables. In contrast, the ANN outperforms the OLR model when the ordinal data is more widely spread (flat kurtosis), particularly when the correlation coefficient is not high. Correlation coefficients between the input variables and the output variable have a significant influence on the misclassification rates resulting from the ANN and OLR models. However, the correlation coefficient among the input variables seems not to have an impact on the misclassification rates resulting from both models.

6.3 Future Work

Several opportunities are available to extend this study. The following are some suggestions for further research on analyzing ordinal data.

1. A study may compare the performance of the OLR and ANN models with more than three input variables to discover any trends in the models' performance due to number of input variables used in the models.
2. A study may compare the performance of the OLR and ANN models when all input variables have negative correlation coefficients with the output variable to investigate whether the conclusion is affected by the altered correlation coefficient.
3. A study may compare the performance of the OLR and ANN models when some input variables have negative correlation coefficients and the other variables have positive correlation coefficients with the output variable to investigate whether the conclusion is changed by the altered correlation coefficient.

4. A study may compare the performance of the OLR and ANN models using ordinal variables that have fewer categories to find out whether there is a trend in each models' performance due to number of categories in the variables used in the models.
5. A study may use different algorithms to generate correlation matrices to test whether the pattern of the correlation matrices influences the performance of the models. For example: a study may generate correlation matrices following Wishart distribution or other particular setting.
6. A study may repeat the methodology with different models/algorithms, such as a Support Vector Machine model and a decision tree model, to provide broader perspective of other available algorithms to analyze ordinal data.
7. A study may use the external link (customer sides) of the Service Profit Chain (SPC) as the framework to compare the same models so that the results may provide a comprehensive link of the SPC.

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APPENDICES

Appendix 1a. IRB Approval to Conduct Survey in Fajar Teaching Restaurant (FTR) at Universitas Negeri Malang – Indonesia

Oklahoma State University Institutional Review Board

Date:	Friday, May 15, 2009
IRB Application No	EG093
Proposal Title:	Exploring the Service Profit Chain in a Student Operated Restaurant
Reviewed and Processed as:	Expedited

Status Recommended by Reviewer(s): Approved   Protocol Expires: 5/14/2010

Principal Investigator(s):

Aisyah Larasati	Camille F DeYong
37 S. Univ. Place, Apt. 2	322 Eng N
Stillwater, OK 74075	Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

✓ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia Kennison, Chair
Institutional Review Board

Appendix 1b. IRB Approval to conduct survey in Taylors' Dining Room at Oklahoma State University – USA

Oklahoma State University Institutional Review Board

Date:	Monday, March 21, 2011
IRB Application No	EG112
Proposal Title:	Exploring the Service Profit Chain Using a Combination of Statistical methods and the Neural Network Models
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 3/20/2012

Principal Investigator(s):

Aisyah Larasati
37 S. Univ. Place, Apt. 2
Stillwater, OK 74075

Camille F DeYong
322 Eng N
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Shelia M. Kennison

Shelia Kennison, Chair
Institutional Review Board

Appendix 2. Pilot Testing Data

	Students' Responses - Respondents #									
Question Item	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Item 1a	5	5	4	3	7	6	4	5	6	3
Item 1b	6	4	3	4	5	6	5	3	5	4
Item 1c	7	3	5	3	7	5	5	5	6	5
Item 1d	5	4	4	3	7	7	5	6	5	5
Item 2a	3	6	6	5	7	7	6	5	6	5
Item 2b	2	6	4	6	6	6	6	6	6	5
Item 2c	2	5	5	5	6	6	5	6	5	5
Item 2d	4	6	7	6	5	6	5	5	4	4
Item 2e	3	6	4	7	7	7	5	7	6	4
Item 2f	2	5	6	7	7	7	6	7	6	6
Item 2g	4	5	6	6	7	7	7	7	6	6
Item 3	5	6	5	4	7	7	6	7	6	5
Item 4	6	5	6	5	7	7	6	7	7	6
Item 5	5	6	7	6	3	7	6	5	7	5
Item 6	6	4	7	6	4	7	6	5	7	5
Item 7	6	4	7	4	7	7	6	6	7	6
Item 8	7	5	7	6	7	7	6	6	7	5
Item 9	4	7	4	4	7	6	6	6	5	4
Item 10	2	2	6	5	7	6	6	6	4	4
Item 11	6	6	6	5	7	6	6	5	4	6
Item 12	5	7	5	5	7	7	5	7	5	5
Item 13	5	6	6	6	7	7	5	7	7	6
Item 14	7	6	6	5	7	5	7	6	5	5
Item 15	7	6	6	4	3	7	6	5	6	7
Item 16	4	5	4	5	3	6	7	6	6	6
Item 17	7	7	5	5	5	7	6	5	7	6
Item 18	7	6	6	4	4	7	5	7	6	6
Item 19	7	6	6	5	5	5	7	7	6	7
Item 20	5	6	5	6	7	7	6	5	6	6

Appendix 2. (con't)

	Students' Responses - Respondents #									
Question Item	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
Item 21	6	6	4	5	6	7	5	6	4	5
Item 22	5	4	7	3	5	6	5	5	4	4
Item 23	6	7	7	4	5	7	6	6	6	5
Item 24	6	6	7	5	7	7	7	7	4	7
Item 25	5	6	6	5	4	7	5	6	6	4
Item 26	7	5	6	5	5	5	6	5	3	6
Item 27	7	6	4	5	7	7	6	6	6	7
Item 28	7	5	5	4	7	7	4	7	6	6
Item 29	7	7	7	6	7	7	6	7	6	7
Item 30	5	4	7	5	7	6	7	7	7	7
Item 31	4	5	7	6	6	7	6	7	5	6
Item 32	7	4	5	5	4	7	6	7	7	6
Item 33	6	7	4	5	6	5	6	5	4	5
Item 34	2	2	2	2	2	2	2	2	2	2
Item 35	7	6	5	4	7	6	5	6	6	6
Item 36	7	5	6	5	7	6	5	7	6	6

Appendix 3a. Student Instrument used in Taylors' Dining Room

TAYLOR'S DINING

Dear lab student,

I am conducting this survey as part of the requirements to complete my study at OSU. I appreciate your effort to provide valuable information about your learning experience in Taylor's Dining by taking a few moments to answer the following questions and leave the completed questionnaire in the provided box.

This survey will take approximately 5-10 minutes. Data will keep in a confidential storage until December 2012.

There will be no risk anticipated from participating in the survey. Your response will completely confidential, and your participation in this study is strictly voluntary.

If you have questions about the study, please feel free to contact Aisyah by phone in 405-744-2030, or by email at aisyah.larasati@okstate.edu.

If you have any questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or by email at irb@okstate.edu

Yours truly,

Aisyah Larasati

aisyah.larasati@okstate.edu

School of Industrial Engineering & Management

Oklahoma State University

Please indicate your attitude toward the the following statement by circling the appropriate number from 1 – Strongly Disagree to 7 Strongly Agree.

1 : Strongly disagree → 7: Strongly agree

Statement							
1. I am fairly rewarded for:							
a. the effort I put forth	1	2	3	4	5	6	7
b. the work I have performed well	1	2	3	4	5	6	7
1 : Strongly disagree → 7: Strongly agree							
2. When decisions about lab students are made at Taylor 's Dining							
a. all sides affected by the decisions are presented	1	2	3	4	5	6	7
b. useful feedback about the decision and their implementation are provided	1	2	3	4	5	6	7
c. my supervisor/manager works very hard to be fair	1	2	3	4	5	6	7
d. my supervisor/manager shows concern for my rights as a student in a laboratory setting	1	2	3	4	5	6	7
1 : Strongly disagree → 7: Strongly agree							
3. I understand what I have to do during my lab.	1	2	3	4	5	6	7
4. My work in the lab provides me the opportunity to develop a wide range of my skills	1	2	3	4	5	6	7
5. My work in the lab is important to the success of this restaurant	1	2	3	4	5	6	7

1 : Strongly disagree → 7: Strongly agree

Statement							
6. I believe I have the opportunity for personal development at the restaurant	1	2	3	4	5	6	7
7. I am able to satisfy the conflicting demands of various people I am in lab with.	1	2	3	4	5	6	7
8. I know how the instructor evaluates my performance.	1	2	3	4	5	6	7
9. I know what the people I am in lab with expect of me.	1	2	3	4	5	6	7
10. I feel that I can get information needed to carry out on my work in the lab.	1	2	3	4	5	6	7
11. My instructor is trustworthy	1	2	3	4	5	6	7
12. Most students that I worked with are likeable	1	2	3	4	5	6	7
13. Students are team oriented	1	2	3	4	5	6	7
14. I have a clear understanding of the goals and objectives of this laboratory as a whole	1	2	3	4	5	6	7
15. The people in my lab are willing to help each other, even if it means doing something outside their usual	1	2	3	4	5	6	7

16. My manager/instructor involves me in planning the work of my lab	1	2	3	4	5	6	7

1 : Strongly disagree → 7: Strongly agree

17. The lab environment is pleasant	1	2	3	4	5	6	7
18. My supervisor/ instructor gives me feedback when I perform poorly	1	2	3	4	5	6	7
19. My supervisor/ instructor commends me when I do a better than average job	1	2	3	4	5	6	7
20. I have freedom to decide the order of tasks I perform	1	2	3	4	5	6	7
21. I am enthusiastic about my lab experience	1	2	3	4	5	6	7
22. Students in our laboratory have knowledge of the job to deliver superior quality product and service	1	2	3	4	5	6	7
23. Students in our laboratory have the skill to deliver superior quality work and service	1	2	3	4	5	6	7
24. Students receive recognition for delivery of superior product and service	1	2	3	4	5	6	7
25. Students are provided with tools, technology and other resources to support the delivery of	1	2	3	4	5	6	7

PLEASE CIRCLE THE NUMBER OF YOUR ANSWER FOR THE FOLLOWING QUESTIONS

26. How would you rate your overall satisfaction toward your experience as a student in lab at Taylors' Dining?
    1: very dissatisfied → 7: very satisfied

    1 2 3 4 5 6 7

27. How would you rate your overall satisfaction toward your experience as a student at Oklahoma State University?
    1: very dissatisfied → 7: very satisfied

    1 2 3 4 5 6 7

Name: ______________________________

THANKS FOR YOUR COOPERATION

Appendix 3b. Instructor Instrument in Taylors' Dining Room

Dear Instructor,

I am conducting this survey as part of the requirements to complete my study at OSU. I appreciate your effort to provide valuable information about your students' performance during their learning experience in Taylors' dining.

Please take a few moments to answer the following questions and leave the completed questionnaire in the provided box.
This survey will take approximately 5 minutes. Data will keep in a confidential storage until December 2012.

There will be no risk anticipated from participating in the survey. Your response will completely confidential, and your participation in this study is strictly voluntary.

If you have questions about the study, please feel free to contact Aisyah by phone in 405-744-2030, or by email at aisyah.larasati@okstate.edu.

If you have any questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or by email at irb@okstate.edu

Yours truly,

Aisyah Larasati
aisyah.larasati@okstate.edu
School of Industrial Engineering & Management
Oklahoma State University

Name of student being evaluated:

____

Please indicate your evaluation toward the the following statement by circling the appropriate number from 1 – Poor to 7 Excellent or n/a for not applicable. Please evaluate these aspects for each of restaurant employees

1: Poor → 7: excellent

1. How do you rate this student in terms of performance with regard to

a.	knowledge of the restaurant products?	1	2	3	4	5	6	7	n/a
b.	knowledge of opening procedures?	1	2	3	4	5	6	7	n/a
c.	knowledge of closing procedures?	1	2	3	4	5	6	7	n/a
d.	all required tasks specified in his/her role as a student in a laboratory?	1	2	3	4	5	6	7	n/a
2.	How do you rate this student in terms of overall performance?	1	2	3	4	5	6	7	n/a

Please indicate your evaluation toward the following statement by circling the appropriate number from 1 – Poor to 7 Excellent or n/a for not applicable. Please evaluate these aspects for each of lab student

1: Poor → 7: excellent

3. How do you rate this student in terms of performance with regard to

a.	production skill?	1	2	3	4	5	6	7	n/a
b.	service skill?	1	2	3	4	5	6	7	n/a
c.	managerial skill?	1	2	3	4	5	6	7	n/a

PLEASE CIRCLE THE NUMBER OF YOUR ANSWER FOR THE FOLLOWING QUESTIONS

4. How do you rate this student intention to go above and beyond "the call of duty"?
   1: Very low → 7: Very high

   1 2 3 4 5 6 7

5. How do you rate this student's intention to voluntarily do extra or non-required work in order to help customer?
   1: Very low → 7: Very high

   1 2 3 4 5 6 7

6. How often did the student willingly go out of his/her way to make a customer satisfied?
   1: Never → 7: Always

Appendix 3c. Student Instrument used in FTR (English version)

PLEASE CIRCLE THE NUMBER OF YOUR ANSWER FOR THE FOLLOWING QUESTIONS

34. What is your last educational background:
    a. General Senior High School
    b. Vocational High School with major in culinary
    c. Vocational High School with major other than culinary
    d. Associate Degree in culinary
    e. Associate Degree other than culinary
35. How would you rate your overall satisfaction toward your experience as a student employee at FTR?

1: very dissatisfied → 7: very satisfied

1	2	3	4	5	6	7

36. How would you rate your overall satisfaction toward your experience as a student at Universitas Negeri Malang?

1: very dissatisfied → 7: very satisfied

1	2	3	4	5	6	7

37. Name:

THANKS FOR YOUR COOPERATION

FAJAR TEACHING RESTAURANT

(FTR)

Dear FTR Employee,

In an effort to increase your satisfaction during your learning experience in Fajar Teaching Restaurant-Universitas Negeri Malang, please take a few moments to answer the following questions and leave the completed questionnaire with us.

This survey will take approximately 15 minutes. We will provide you the finding of this research at the end of December 2009. Data will keep in a confidential storage until December 2011.

We appreciate your effort to help us improve FTR by completing the questionnaire. Your opinion and comments will be a great value for us to provide you better experience.

There will be no risk anticipated from participating in the survey. Your response will completely confidential, and your participation in this study is strictly voluntary.

If you have questions about the study, please feel free to contact Aisyah Larasati by phone in 0341 7790567 or by email at aisyah.larasati@okstate.edu.

Yours truly,

Aisyah Larasati

aisyah.larasati@okstate.edu
School of Industrial Engineering & Management
Oklahoma State University

Please indicate your attitude toward the the following statement by circling the appropriate number from 1 – Strongly Disagree to 7 Strongly Agree.

		1 : Strongly disagree → 7: Strongly agree							
1.	I am fairly rewarded for:								
	a.	the experience I have	1	2	3	4	5	6	7
	b.	the stresses of my job	1	2	3	4	5	6	7
	c.	the effort I put forth	1	2	3	4	5	6	7
	d.	the work I have performed well	1	2	3	4	5	6	7
2.	When decisions about employee are made at FTR,								
	a.	complete information is collected for making those decision	1	2	3	4	5	6	7
	b.	all sides affected by the decisions are presented	1	2	3	4	5	6	7
	c.	the decisions are made in timely fashion	1	2	3	4	5	6	7
	d.	useful feedback about the decision and their implementation are provided	1	2	3	4	5	6	7
	e.	my supervisor/manager treat me with respect and dignity	1	2	3	4	5	6	7
	f.	my supervisor/manager works very hard to be fair	1	2	3	4	5	6	7
	g.	my supervisor/manager shows concern for my rights as a student employee	1	2	3	4	5	6	7
3.	I understand what I have to do on my job.		1	2	3	4	5	6	7
4.	My job provides me the opportunity to develop a wide range of my skills		1	2	3	4	5	6	7
5.	My job is important to the success of this restaurant		1	2	3	4	5	6	7
6.	My job allows me to utilize the full range of my educational training		1	2	3	4	5	6	7
7.	The training I have received has prepared me well for the work I do		1	2	3	4	5	6	7
8.	I believe I have the opportunity for personal development at FTR		1	2	3	4	5	6	7
9.	I am able to satisfy the conflicting demands of various people I work with.		1	2	3	4	5	6	7
10.	I know how the instructor evaluates my performance.		1	2	3	4	5	6	7
11.	I know what the people I work with expect of me.		1	2	3	4	5	6	7
12.	I feel that I can get information needed to carry out on my job.		1	2	3	4	5	6	7

13.	My superior is trustworthy	1	2	3	4	5	6	7
14.	I have sufficient authority to do my job well	1	2	3	4	5	6	7
15.	Most employees that I worked with are likeable	1	2	3	4	5	6	7
16.	Employees are team oriented	1	2	3	4	5	6	7
17.	I have a clear understanding of the goals and objectives of this company as a whole	1	2	3	4	5	6	7
18.	People are treated with respect in my team, regardless of their job	1	2	3	4	5	6	7
19.	The people in my teams are willing to help each other, even if it means doing something outside their usual duties	1	2	3	4	5	6	7
20.	My manager involves me in planning the work of my team	1	2	3	4	5	6	7
21.	Work environment is pleasant	1	2	3	4	5	6	7
22.	The pay system is based on achievement	1	2	3	4	5	6	7
23.	The pay system is transparent	1	2	3	4	5	6	7
24.	My supervisor gives me feedback when I perform poorly	1	2	3	4	5	6	7
25.	My supervisor commends me when I do a better than average job	1	2	3	4	5	6	7
26.	I have autonomy to decide the order of tasks I perform	1	2	3	4	5	6	7
27.	I am enthusiastic about my job	1	2	3	4	5	6	7
28.	I am proud of the work I do	1	2	3	4	5	6	7
29.	I feel happy when I am working hard	1	2	3	4	5	6	7
30.	Employees in our organization have knowledge of the job to deliver superior quality product and service	1	2	3	4	5	6	7
31.	Employees in our organization have the skill to deliver superior quality work and service	1	2	3	4	5	6	7
32.	Employees receive recognition for delivery of superior product and service	1	2	3	4	5	6	7
33.	Employees are provided with tools, technology and other resources to support the delivery of quality product and service	1	2	3	4	5	6	7

Appendix 3d. Instructor Instrument used in FTR (English version)

FAJAR TEACHING RESTAURANT

(FTR)

Dear Instructor,

In an effort to increase student satisfaction as FTR employee during their learning experience, please take a few moments to answer the following questions and leave the completed questionnaire with us.

This survey will take approximately 10 minutes. We will provide you the finding of this research at the end of December 2009. Data will keep in a confidential storage until December 2011.

We appreciate your effort to help us improve FTR by completing the questionnaire. Your opinion and comments will be a great value for achieving purposes of this teaching restaurant.

There will be no risk anticipated from participating in the survey. Your response will completely confidential, and your participation in this study is strictly voluntary.

If you have questions about the study, please feel free to contact Aisyah Larasati by phone in 0341 7790567 or by email at aisyah.larasati@okstate.edu.

Yours truly,

Aisyah Larasati

aisyah.larasati@okstate.edu
School of Industrial Engineering & Management
Oklahoma State University

Name of student being evaluated:

Please indicate your evaluation toward the the following statement by circling the appropriate number from 1 – Poor to 7 Excellent. Please evaluate these aspects for each of FTR employees

	1: Poor → 7: excellent						
1. How do you rate this employee in terms of performance with regard to							
a. knowledge of the FTR product?	1	2	3	4	5	6	7
b. knowledge of opening procedure?	1	2	3	4	5	6	7
c. knowledge of closing procedure?	1	2	3	4	5	6	7
d. all required tasks specified in his/her job description?	1	2	3	4	5	6	7
2. How do you rate this employee in terms of overall performance?	1	2	3	4	5	6	7

Please indicate your evaluation toward the the following statement by circling the appropriate number from 1 – Poor to 7 Excellent or n/a for not applicable. Please evaluate these aspects for each of FTR employee

	1: Poor → 7: excellent							
3. How do you rate this employee in terms of performance with regard to								
a. production skill?	1	2	3	4	5	6	7	n/a
b. service skill?	1	2	3	4	5	6	7	n/a
c. managerial skill?	1	2	3	4	5	6	7	n/a

PLEASE CIRCLE THE NUMBER OF YOUR ANSWER FOR THE FOLLOWING QUESTIONS

4. How do you rate this student intention to go above and beyond "the call of duty"?

1: Very low → 7: Very high

1	2	3	4	5	6	7

5. How do you rate this employee intention voluntarily do extra or non-required work in order to help customer?

1: Very low → 7: Very high

1	2	3	4	5	6	7

6. How often did the employee willingly go out of his/her way to make a customer satisfied?

1: Never → 7: Always

1	2	3	4	5	6	7

Appendix 3e. Student Instrument used in FTR (Indonesian version)

Lingkarilah angka yang menunjukkan jawaban Anda terhadap pertanyaan berikut.

34. Apakah pendidikan terakhir Anda?
a. SMU
b. SMK keahlian Tata Boga
c. SMK selain keahlian Tata Boga
d. D3 keahlian Tata Boga
e. D3 selain keahlian Tata Boga

35. Secara keseluruhan, bagaimanakah tingkat kepuasan Anda sebagai mahasiswa yang bekerja di FTR?

1: Sangat tidak puas → 7: sangat puas

1	2	3	4	5	6	7

36. Secara keseluruhan, bagaimanakah tingkat kepuasan Anda sebagai mahasiswa Universitas Negeri Malang?

1: Sangat tidak puas → 7: sangat puas

1	2	3	4	5	6	7

37. Nama:

TERIMA KASIH ATAS PARTISIPASI ANDA

FAJAR TEACHING RESTAURANT

(FTR)

Karyawan FTR yang saya hormati,

Untuk meningkatkan kepuasan Anda selama proses belajar Anda di Fajar Teaching Restaurant – Universitas Negeri Malang, saya mohon Anda meluangkan waktu untuk menjawab pertanyaan berikut dan mengembalikan kuisioner yang telah diisi kepada kami.

Survey ini akan membutuhkan waktu kurang lebih 15 menit. Kami akan memberitahukan hasil penelitian ini pada akhir bulan Desember 2009. Data yang diperoleh akan disimpan dan dijaga kerahasiaannya hingga akhir Desember 2011.

Kami sangat menghargai kesediaan Anda untuk membantu kami untuk memajukan FTR dengan mengisi kuisioner ini. Pendapat dan komentar anda sangat berarti untuk melayani Anda lebih baik lagi.

Tidak ada resiko yang berarti dengan berpartisipasi di survey ini. Respon yang Anda berikan sepenuhnya dijamin kerahasiaannya, dan partisipasi Anda di survey ini sepenuhnya sukarela.

Jika Anda memiliki pertanyaan tentang penelitian ini, silahkan menghubungi Aisyah Larasati by phone idi nomr telefon 0341 7790567 atau melaui email aisyah.larasati@okstate.edu.

Salam hormat,

Aisyah Larasati

aisyah.larasati@okstate.edu
School of Industrial Engineering & Management
Oklahoma State University

Lingkarilah angka yang sesuai dengan penilaian Anda terhadap pernyataan berikut. Angka 1 menunjukkan sangat tidak setuju dan Angka 5 menunjukkan sangat setuju.

		1 : Sangat tidak setuju → 7: Sangat setuju							
1.	Saya diberikan reward yang sesuai atas:								
	a.	Pengalaman yang saya miliki	1	2	3	4	5	6	7
	b.	Stress yang saya dapat dari pekerjaan saya	1	2	3	4	5	6	7
	c.	Usaha yang saya lakukan	1	2	3	4	5	6	7
	d.	Pekerjaan yang mampu saya selesaikan dengan baik	1	2	3	4	5	6	7
2.	Saat keputusan tentang karyawan di FTR diambil,								
	a.	Informasi yang lengkap telah dikumpulkan untuk mebuat keputusan tersebut	1	2	3	4	5	6	7
	b.	Semua dampak yang bakal terjadi dari keputusan tersebut telah dipertimbangkan	1	2	3	4	5	6	7
	c.	Keputusan diambil pada waktu yang tepat	1	2	3	4	5	6	7
	d.	Masukan tentang keputusan tersebut beserta implementasinya telah tersedia	1	2	3	4	5	6	7
	e.	Atasan saya memperlakukan saya dengan hormat	1	2	3	4	5	6	7
	f.	Atasan saya berusaha keras untuk bertindak adil	1	2	3	4	5	6	7
	g.	Atasan saya memperhatikan hak saya sebagai mahasiswa dan karyawan	1	2	3	4	5	6	7
3.	Saya memahami hal yang harus saya lakukan di pekerjaan saya		1	2	3	4	5	6	7
4.	Pekerjaan saya meberikan peluang pada saya untuk mengembangkan berbagai ketrampilan saya		1	2	3	4	5	6	7
5.	Pekerjaan saya sangat penting untuk kesuksesan restaurant ini		1	2	3	4	5	6	7
6.	Pekerjaan saya memungkinkan saya untuk menggunakan semua pengetahuan yang saya peroleh selama training.		1	2	3	4	5	6	7
7.	Training yang saya peroleh mampu mempersiapkan saya untuk bekerja dengan baik		1	2	3	4	5	6	7
8.	Saya yakin bahwa saya memiliki kesempatan untuk mengembangkan diri saya di FTR		1	2	3	4	5	6	7
9.	Saya mampu memenuhi konflik kepentingan dari berbagai pihak yang bekerja bersama saya.		1	2	3	4	5	6	7
10.	Saya memahami bagaimana dosen pembiming mengevaluasi performansi saya.		1	2	3	4	5	6	7
11.	Saya memahami harapan yang dimiliki karyawan lain yang bekerja bersama saya terhadap pekerjaan yang saya lakukan.		1	2	3	4	5	6	7

12.	Saya merasa saya memiliki petunjuk yang lengkap mengenai bagaimana saya harus melakukan pekerjaan saya.	1	2	3	4	5	6	7
13.	Atasan saya dapat dipercaya	1	2	3	4	5	6	7
14.	Saya memiliki kewenangan yang memadai untuk melakukan pekerjaan saya dengan baik	1	2	3	4	5	6	7
15.	Pada umumnya karyawan yang bekerja bersama saya menyenangkan	1	2	3	4	5	6	7
16.	Karyawan berrientasi untuk bekerja secara tim.	1	2	3	4	5	6	7
17.	Saya memahami tujuan dari restaurant ini secara utuh.	1	2	3	4	5	6	7
18.	Setiap Karyawan diperlakukan secara terhormat di tim saya, tanpa membedakan perannya.	1	2	3	4	5	6	7
19.	Karyawan di tim saya selalu bersedia saling tolong menolong, meskipun harus melakukan sesuatu diluar tanggungjawabnya	1	2	3	4	5	6	7
20.	Atasan saya melibatkan saya dalam perencaan kerja tim saya.	1	2	3	4	5	6	7
21.	Lingkungan kerja disini menyenangkan.	1	2	3	4	5	6	7
22.	Sistem pengupahan disini berdasar atas prestasi yang dicapai.	1	2	3	4	5	6	7
23.	Sistem pengupahan yang diterapkan transparent.	1	2	3	4	5	6	7
24.	Atasan saya akan memberikan masukan bila performansi saya buruk.	1	2	3	4	5	6	7
25.	Atasan saya My supervisor menghargai prestasi saya bila saya mampu bekerja diatas rata-rata	1	2	3	4	5	6	7
26.	Saya memiliki kewenangan untuk menentukan urutan kerja yang harus saya lakukan.	1	2	3	4	5	6	7
27.	Saya merasa antusia terhadap pekerjaan yang saya lakukan.	1	2	3	4	5	6	7
28.	Saya merasa bangga terhadap apa yanga saya lakukan.	1	2	3	4	5	6	7
29.	Saya senang saat saya mampu bekerja keras	1	2	3	4	5	6	7
30.	Karyawan di restaurant ini memiliki pengetahuan yang memadai untuk mampu memberikan produk dan layanan prima.	1	2	3	4	5	6	7
31.	Karyawan di restaurant ini memiliki ketrampilan yang memadai untuk mampu memberikan produk dan layanan prima.	1	2	3	4	5	6	7
32.	Karyawan menerima penghargaan yang sesuai saat mampu memberikan produk dan layanan prima.	1	2	3	4	5	6	7
33.	Karyawan dilengkapi dengan peralatan, teknlogi, dan sumber daya lainnya untuk menunjang penyampaian produk dan layanan prima.	1	2	3	4	5	6	7

Appendix 3f. Instructor Instrument used in FTR (Indonesian version)

FAJAR TEACHING RESTAURANT

(FTR)

Dosen Pembimbing yang saya hormati,

Untuk meningkatkan kepuasan mahasiswa sebagai karyawan FTR selama proses belajar di Fajar Teaching Restaurant – Universitas Negeri Malang, saya mohon kesediaannya untuk meluangkan waktu menjawab pertanyaan berikut dan mengembalikan kuisioner yang telah diisi kepada kami.

Survey ini akan membutuhkan waktu kurang lebih 10 menit. Kami akan memberitahukan hasil penelitian ini pada akhir bulan Desember 2009. Data yang diperoleh akan disimpan dan dijaga kerahasiaannya hingga akhir Desember 2011.

Kami sangat menghargai kesediaan Anda untuk membantu kami untuk memajukan FTR dengan mengisi kuisioner ini. Pendapat dan komentar anda sangat berarti untuk pencapaian tujuan restaurant pembelajaran ini.

Tidak ada resiko yang berarti dengan berpartisipasi di survey ini. Respon yang Anda berikan sepenuhnya dijamin kerahasiaannya, dan partisipasi Anda di survey ini sepenuhnya sukarela.

Jika Anda memiliki pertanyaan tentang penelitian ini, silahkan menghubungi Aisyah Larasati by phone idi nomr telefon 0341 7790567 atau melaui email aisyah.larasati@okstate.edu.

Hormat saya,

Aisyah Larasati

aisyah.larasati@okstate.edu
School of Industrial Engineering & Management
Oklahoma State University

Nama mahasiswa yang dinilai:

Lingkarilah angka yang mewakili evaluasi Anda terhadap pernyataan berikut ini. Angka 1 menunjukkan performansi yang sangat buruk dan angka 7 menunjukkan performansi yang sangat baik. Evaluasilah aspek berikut untuk setiap mahasiswa yang terlibat sebagai karyawan FTR.

		1: sangat buruk → 7: sangat baik						
1.	Bagaimanakah penilaian Anda terhadap performansi karyawan tersebut menyakut hal-hal berikut ini:							
a.	Pengetahuan tentang produk-produk FTR?	1	2	3	4	5	6	7
b.	Pengetahuan tentang opening procedure?	1	2	3	4	5	6	7
c.	Pengetahuan tentang closing procedure?	1	2	3	4	5	6	7
d.	Semua tanggung jawab yang tertulis di job deskripsi?	1	2	3	4	5	6	7
2.	Bagaimanakah penilaian Anda tentang performansi karyawan tersebut secara keseluruhan?	1	2	3	4	5	6	7

Lingkarilah angka yang mewakili evaluasi Anda terhadap pernyataan berikut ini. Angka 1 menunjukkan performansi yang sangat buruk dan angka 7 menunjukkan performansi yang sangat baik atau n/a bila tidak applicable. Evaluasilah aspek berikut untuk setiap mahasiswa yang terlibat sebagai karyawan FTR.

		1: sangat buruk → 7: sangat baik							
3.	Bagaimanakah penilaian Anda terhadap performansi karyawan tersebut terkait dengan:								
a.	production skill?	1	2	3	4	5	6	7	n/a
b.	service skill?	1	2	3	4	5	6	7	n/a
c.	managerial skill?	1	2	3	4	5	6	7	n/a

LINGKARILAH ANGKA YANG SESUAI DENGAN JAWABAN ANDA TERHADAP PERTANYAAN BERIKUT INI:

4. Bagaimanakah penilaian Anda terhadap kecenderungan karyawan ini untuk bekerja diluar tanggung jawabnya?

1: Sangat rendah → 7: sangat tinggi

1	2	3	4	5	6	7

5. Bagaimanakah penilaian Anda terhadap kecenderungan karyawan ini untuk secara sukarela melakukan pekerjaan tambahan yang dapat membantu konsumen?

1: Sangat rendah → 7: sangat tinggi

1	2	3	4	5	6	7

6. Seberapa seringkah karyawan ini bersedia bekerja dengan kemampuan maksimalnya untuk memuaskan konsumen?

1: Tidak Pernah → 7: selalu

1	2	3	4	5	6	7

TERIMA KASIH ATAS BANTUAN ANDA

Appendix 4a. Students' Responses collected from Taylors' Dining

	Students' Responses																
Respondent #	Item 1a	Item 1b	Item 2a	Item 2b	Item 2c	Item 2d	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14
1	6	5	4	4	6	7	6	6	6	5	5	6	6	5	7	5	6	4
2	6	6	4	4	6	6	6	5	5	5	5	6	6	5	7	6	5	4
3	7	7	6	6	7	7	7	6	7	6	7	7	7	7	7	6	6	6
4	6	6	5	5	6	6	7	7	6	6	6	6	6	5	6	6	6	6
5	7	6	5	7	7	7	7	7	7	7	7	6	7	7	7	7	7	7
6	7	6	5	6	7	7	7	7	7	7	5	5	7	7	7	7	7	7
7	5	5	4	5	7	6	7	7	6	6	6	6	6	6	6	7	7	7
8	7	7	5	5	6	6	7	7	7	7	7	7	7	7	7	7	7	7
9	7	7	4	4	7	7	7	7	7	7	5	7	7	7	7	7	6	7
10	6	7	4	5	7	7	7	7	6	5	6	5	6	7	7	7	7	6
11	5	5	4	4	4	4	5	5	5	5	5	6	5	5	6	5	5	4
12	7	7	6	6	7	7	7	7	7	7	6	7	6	7	7	7	7	7
13	6	7	5	5	7	7	7	7	7	6	6	6	6	7	7	7	7	7
14	5	7	4	5	7	7	7	6	6	7	7	7	6	7	6	7	7	7
15	6	7	4	4	7	7	7	7	6	6	5	6	5	7	7	7	7	7
16	5	7	5	4	7	7	7	7	6	6	6	6	6	6	6	7	7	7
17	6	6	4	4	6	6	6	5	6	6	6	5	7	6	7	6	6	5
18	5	5	5	6	6	6	7	7	6	6	5	6	7	5	7	7	6	7

Appendix 4a. (cont'd)

	Students' Responses																	
Respondent #	Item 1a	Item 1b	Item 2a	Item 2b	Item 2c	Item 2d	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10	Item 11	Item 12	Item 13	Item 14
19	4	4	4	4	5	6	6	6	6	5	5	6	6	6	6	6	6	6
20	5	5	5	5	6	6	7	7	7	6	6	6	7	7	7	7	7	6
21	5	5	3	4	5	5	7	6	6	7	4	6	4	6	7	6	6	6
22	7	7	7	7	6	7	7	7	7	7	7	7	7	7	7	7	7	7
23	6	6	6	5	6	7	6	6	6	6	5	6	6	6	7	6	6	6
24	5	5	5	6	7	7	7	7	7	7	6	7	7	7	7	7	7	7
25	4	5	4	4	5	5	6	6	6	5	5	5	5	5	5	6	6	6
26	7	7	5	5	7	7	7	7	7	7	7	7	7	7	7	7	7	7
27	5	5	5	4	6	6	6	6	5	5	6	6	6	6	7	7	7	6
28	6	6	4	7	7	7	7	7	7	5	7	7	7	7	6	7	7	6

Appendix 4a. (cont'd)

	Students' Responses												
Respondent #	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25	Item 26	Item 27
1	6	5	5	5	5	5	4	4	4	5	5	4	5
2	7	4	5	5	5	5	4	4	4	5	5	5	5
3	5	6	6	7	7	5	6	6	6	7	6	7	6
4	6	6	6	5	5	5	6	5	6	5	6	6	6
5	7	6	7	5	7	5	7	7	7	7	7	7	7
6	7	7	7	6	7	6	7	7	7	7	7	7	7
7	7	6	7	5	6	6	7	5	6	6	6	7	7
8	7	5	7	5	6	6	7	7	7	7	6	7	7
9	7	4	7	5	7	7	7	7	7	7	7	7	7
10	7	7	6	4	6	6	7	6	6	7	7	7	7
11	5	5	5	5	5	5	4	4	4	5	5	4	4
12	7	7	7	6	7	6	7	6	7	7	7	7	7
13	7	7	7	6	5	5	7	7	7	7	7	7	7
14	7	6	7	7	6	6	6	6	6	6	6	6	7
15	7	6	7	6	6	6	7	5	6	7	7	7	7
16	7	6	7	5	7	6	7	6	6	6	7	7	7
17	5	6	7	6	6	6	6	5	6	6	5	6	6
18	7	7	7	6	6	6	6	6	7	6	7	6	6

Appendix 4a. (cont'd)

	Students' Responses												
Respondent #	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25	Item 26	Item 27
19	6	6	6	6	5	5	6	6	6	6	6	6	5
20	6	6	6	6	7	6	7	7	7	7	7	7	7
21	7	7	6	6	6	6	6	6	6	6	7	7	7
22	7	7	7	7	7	7	7	7	7	7	7	7	7
23	7	4	6	5	6	3	5	5	5	7	6	6	6
24	7	4	7	7	7	7	7	7	7	7	7	6	7
25	6	5	5	5	5	5	3	4	4	4	4	6	4
26	7	7	7	7	7	4	7	7	7	7	7	6	7
27	7	7	7	5	6	5	7	5	6	6	6	6	6
28	6	7	6	6	5	6	6	6	6	7	7	6	6

Appendix 4b. Students' Responses collected from FTR

	Students' Responses																		
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2a	Item 2b	Item 2c	Item 2d	Item 2e	Item 2f	Item 2g	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
1	2	4	2	4	6	7	6	5	6	7	6	6	5	6	7	7	6	6	6
2	4	1	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3	7	1	7	7	3	2	2	4	3	2	4	7	7	7	7	7	7	4	2
4	3	4	3	4	6	6	5	6	6	5	7	7	5	6	6	6	6	7	2
5	1	3	6	7	3	4	5	5	6	5	6	7	5	7	5	5	5	6	4
6	3	1	7	7	5	6	6	5	6	6	5	7	7	7	5	5	6	6	6
7	4	4	6	6	4	6	4	5	5	3	4	6	4	5	6	5	7	5	5
8	4	1	5	4	6	4	5	7	4	6	6	6	4	7	7	7	7	4	6
9	3	4	2	3	5	6	5	6	7	7	6	5	5	6	6	4	6	3	5
10	5	1	7	7	7	7	2	7	4	7	7	7	5	5	5	7	6	4	4
11	7	1	7	7	7	7	7	1	7	7	7	7	7	7	1	7	7	7	7
12	1	1	6	7	5	7	7	6	6	7	6	7	4	7	6	6	6	7	5
13	6	6	5	7	7	6	6	6	7	7	7	7	7	7	7	7	7	6	6
14	3	3	3	3	3	3	3	5	7	6	7	7	7	7	7	7	7	6	5
15	4	2	6	6	4	5	6	5	6	6	6	6	5	4	6	5	5	5	5
16	7	3	5	3	5	6	5	4	6	6	6	7	7	7	7	7	7	6	6
17	4	5	5	5	6	6	5	5	5	6	7	6	6	6	6	6	6	6	6
18	7	4	7	7	7	7	5	6	4	4	4	7	7	7	6	7	7	6	7

Appendix 4b. (cont'd)

	Students' Responses																		
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2a	Item 2b	Item 2c	Item 2d	Item 2e	Item 2f	Item 2g	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
19	5	2	5	6	5	6	6	5	7	7	7	7	7	5	5	6	6	6	6
20	5	5	5	5	6	6	5	4	6	6	6	6	7	7	7	7	7	5	4
21	3	3	5	6	5	5	5	4	4	6	6	6	6	5	5	6	5	3	4
22	7	1	7	7	7	7	7	7	7	5	6	7	7	7	7	7	7	5	5
23	3	4	4	4	5	5	6	6	5	6	6	7	5	6	5	6	6	6	7
24	3	5	5	4	6	6	7	6	5	5	5	6	6	6	3	5	3	4	5

Appendix 4b. (cont'd)

	Students' Responses																		
Respondent #	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25	Item 26	Item 27	Item 28	Item 29
1	4	6	6	6	6	7	5	5	5	6	5	3	5	5	4	6	6	4	6
2	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
3	6	6	5	7	7	7	7	7	7	5	3	1	1	6	7	7	7	7	7
4	6	7	6	6	6	5	7	6	6	6	6	4	7	6	6	7	6	5	7
5	6	5	6	6	5	7	6	6	7	5	6	2	7	7	3	4	6	7	7
6	4	7	4	7	7	7	7	7	5	7	7	6	7	7	7	7	7	7	7
7	6	6	6	7	3	5	6	4	2	2	5	2	4	6	7	7	7	7	7
8	6	6	6	6	7	4	5	6	6	5	4	7	7	7	6	6	4	5	7
9	5	6	6	5	4	5	5	4	5	6	5	1	2	5	5	5	5	4	6
10	4	4	5	4	4	7	6	5	4	7	6	1	1	7	4	5	7	7	7
11	7	7	7	1	1	1	1	7	7	7	7	1	1	7	1	7	7	7	7
12	7	7	7	7	5	6	6	6	7	7	5	7	7	7	7	7	6	6	6
13	6	7	7	5	7	6	7	7	5	7	7	6	7	7	7	7	7	7	7
14	5	7	6	7	5	7	6	5	6	6	7	2	1	6	5	6	7	7	7
15	5	6	6	5	6	7	6	5	5	4	6	3	6	6	6	6	7	6	6
16	7	6	6	6	7	5	7	5	6	6	5	7	6	4	5	5	7	6	7
17	6	5	5	6	6	7	6	5	7	6	6	5	6	7	5	5	6	4	6

Appendix 4b. (cont'd)

	Students' Responses																		
Respondent #	Item 11	Item 12	Item 13	Item 14	Item 15	Item 16	Item 17	Item 18	Item 19	Item 20	Item 21	Item 22	Item 23	Item 24	Item 25	Item 26	Item 27	Item 28	Item 29
18	7	7	6	6	7	7	7	6	5	6	5	7	7	7	7	7	7	7	7
19	5	7	7	7	7	7	5	7	7	5	7	5	6	7	7	7	6	7	7
20	4	5	7	7	6	6	7	6	6	6	6	4	6	4	4	6	6	6	6
21	6	5	6	5	7	7	6	7	7	6	7	4	6	7	7	6	7	6	7
22	7	6	6	7	5	6	7	6	6	7	6	5	5	7	7	7	7	7	7
23	6	6	7	6	7	7	7	6	7	5	5	3	5	6	7	6	5	5	6
24	6	6	6	5	5	4	5	3	5	3	4	4	5	6	5	6	7	4	5

Appendix 4b. (con't)

	Students' Responses						
Respondent #	Item 30	Item 31	Item 32	Item 33	Item 34	Item 35	Item 36
1	6	6	4	4	2	5	6
2	7	7	7	7	2	7	7
3	2	3	7	1	2	7	7
4	6	6	4	3	2	6	5
5	7	7	5	2	2	6	6
6	5	6	7	4	2	6	6
7	6	6	4	3	2	5	6
8	7	7	3	4	2	5	6
9	5	6	5	3	2	4	5
10	7	7	7	6	2	5	4
11	7	7	7	7	2	7	7
12	7	7	7	5	2	6	7
13	6	7	7	5	2	6	6
14	7	7	3	2	2	7	7
15	7	7	6	5	2	7	6
16	7	7	5	5	2	7	6
17	7	7	6	7	2	5	5

Appendix 4b. (con't)

	Students' Responses						
Respondent #	Item 30	Item 31	Item 32	Item 33	Item 34	Item 35	Item 36
18	7	7	7	5	2	7	7
19	7	7	7	5	2	6	7
20	7	7	7	4	2	6	6
21	7	6	7	5	2	6	6
22	7	7	6	5	2	7	5
23	6	6	7	3	2	6	7
24	4	5	4	3	2	4	6

Appendix 4c. Instructor's evaluation collected from Taylors' Dining

	Instructor's evaluation										
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2	Item 3a	Item 3b	Item 3d	Item 4	Item 5	Item 6
1	5	6	3	4	5	4	3	5	5	4	5
2	4	5	5	6	5	6	5	5	5	6	5
3	7	7	7	7	7	7	7	7	7	7	7
4	6	4	4	5	4	4	3	2	4	3	3
5	5	7	7	7	7	6	7	7	6	6	6
6	6	5	5	5	6	6	5	5	5	5	5
7	6	6	6	6	6	5	5	6	6	6	6
8	7	6	6	7	7	6	6	6	6	6	6
9	6	7	7	7	7	7	7	6	5	4	4
10	7	7	7	7	7	7	7	7	7	7	7
11	7	7	7	7	7	7	7	7	7	7	7
12	7	6	6	6	6	7	6	6	5	5	5
13	7	7	7	7	7	7	7	7	7	7	7
14	6	6	6	6	5	6	6	6	6	6	6
15	4	5	5	6	5	5	3	2	3	2	4
16	6	5	7	6	6	6	7	7	5	5	6
17	7	7	7	7	7	6	7	5	7	7	7

Appendix 4c. (con't)

	Instructor's evaluation										
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2	Item 3a	Item 3b	Item 3d	Item 4	Item 5	Item 6
18	7	7	7	7	7	7	7	7	7	7	7
19	7	7	7	7	7	7	7	7	7	7	7
20	7	7	7	7	7	7	7	7	7	7	7
21	7	7	7	7	7	7	7	7	7	7	7
22	7	7	7	7	7	7	7	7	7	7	7
23	6	7	7	5	6	6	5	7	6	6	6
24	7	5	5	6	6	6	7	7	6	6	6
25	7	7	7	7	7	7	7	7	7	7	7
26	5	5	5	4	5	5	5	4	2	2	2
27	6	7	7	6	6	6	6	6	6	6	6
28	7	7	7	7	7	7	7	7	7	7	7

Appendix 4d. Instructor's evaluation collected from FTR

	Instructor's evaluation										
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2	Item 3a	Item 3b	Item 3d	Item 4	Item 5	Item 6
1	7	7	7	7	6	6	6	6	5	5	5
2	7	7	7	7	7	6	7	6	7	7	7
3	7	7	7	7	6	6	6	5	6	6	6
4	7	7	7	7	7	7	7	6	7	6	7
5	7	7	7	7	6	7	6	6	7	6	7
6	7	7	7	7	7	7	7	6	7	7	7
7	7	7	7	7	6	7	7	6	5	5	7
8	7	7	7	6	5	6	5	5	6	5	5
9	6	7	7	6	6	7	7	5	7	7	7
10	7	7	7	7	6	6	5	6	6	6	6
11	5	6	6	6	6	5	5	5	6	6	6
12	5	5	5	5	5	5	5	5	5	5	5
13	7	7	7	7	6	6	5	6	6	6	7
14	7	7	7	7	7	7	7	6	6	6	7
15	7	6	6	5	5	5	5	5	7	7	6
16	7	7	7	7	7	7	7	6	7	7	7
17	7	6	6	6	6	6	6	6	7	6	6

Appendix 4d. (con't)

	Instructor's evaluation										
Respondent #	Item 1a	Item 1b	Item 1c	Item 1d	Item 2	Item 3a	Item 3b	Item 3d	Item 4	Item 5	Item 6
18	7	7	7	7	7	7	7	6	6	5	5
19	7	7	7	7	5	5	5	5	5	5	5
20	6	6	6	6	6	5	6	6	5	5	5
21	7	7	7	7	6	6	6	5	6	5	5
22	7	6	6	7	7	6	6	7	7	6	6
23	7	7	7	7	7	7	7	6	7	6	7
24	7	7	7	7	5	6	6	5	6	6	6

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.46	0.46	33	0.54	0.56	65	0.32	0.36	97	0.4	0.44	129	0.5	0.44	161	0.52	0.56
2	0.42	0.42	34	0.34	0.34	66	0.4	0.48	98	0.42	0.42	130	0.38	0.4	162	0.52	0.56
3	0.46	0.48	35	0.48	0.44	67	0.42	0.44	99	0.38	0.44	131	0.48	0.46	163	0.42	0.44
4	0.48	0.38	36	0.5	0.54	68	0.5	0.48	100	0.5	0.44	132	0.46	0.4	164	0.44	0.42
5	0.46	0.56	37	0.36	0.36	69	0.42	0.42	101	0.3	0.4	133	0.5	0.32	165	0.46	0.5
6	0.38	0.44	38	0.42	0.46	70	0.52	0.54	102	0.42	0.44	134	0.46	0.48	166	0.56	0.58
7	0.52	0.46	39	0.46	0.46	71	0.5	0.44	103	0.24	0.24	135	0.46	0.46	167	0.58	0.58
8	0.5	0.46	40	0.34	0.36	72	0.56	0.58	104	0.42	0.4	136	0.4	0.4	168	0.32	0.44
9	0.5	0.52	41	0.5	0.52	73	0.42	0.58	105	0.5	0.5	137	0.38	0.36	169	0.4	0.34
10	0.52	0.54	42	0.48	0.42	74	0.56	0.56	106	0.42	0.46	138	0.5	0.4	170	0.22	0.78
11	0.52	0.5	43	0.48	0.56	75	0.52	0.44	107	0.54	0.56	139	0.52	0.3	171	0.42	0.46
12	0.5	0.4	44	0.38	0.44	76	0.38	0.4	108	0.44	0.44	140	0.34	0.36	172	0.54	0.54
13	0.46	0.6	45	0.38	0.4	77	0.36	0.38	109	0.46	0.46	141	0.4	0.38	173	0.58	0.56
14	0.52	0.5	46	0.3	0.32	78	0.6	0.48	110	0.38	0.38	142	0.42	0.42	174	0.32	0.34
15	0.44	0.46	47	0.66	0.42	79	0.44	0.44	111	0.46	0.46	143	0.46	0.46	175	0.4	0.42
16	0.42	0.5	48	0.44	0.4	80	0.48	0.46	112	0.5	0.54	144	0.5	0.5	176	0.52	0.44
17	0.44	0.46	49	0.54	0.6	81	0.56	0.54	113	0.32	0.32	145	0.42	0.42	177	0.54	0.54
18	0.34	0.48	50	0.5	0.5	82	0.44	0.48	114	0.38	0.48	146	0.32	0.32	178	0.38	0.44
19	0.48	0.42	51	0.56	0.58	83	0.48	0.5	115	0.72	0.54	147	0.44	0.42	179	0.36	0.36
20	0.34	0.34	52	0.44	0.44	84	0.36	0.36	116	0.5	0.5	148	0.4	0.44	180	0.56	0.56
21	0.42	0.54	53	0.48	0.48	85	0.34	0.42	117	0.48	0.52	149	0.48	0.48	181	0.6	0.62
22	0.38	0.4	54	0.5	0.52	86	0.46	0.44	118	0.44	0.46	150	0.48	0.48	182	0.46	0.56
23	0.5	0.5	55	0.46	0.58	87	0.4	0.48	119	0.46	0.44	151	0.52	0.52	183	0.46	0.46
24	0.36	0.32	56	0.54	0.5	88	0.46	0.44	120	0.36	0.36	152	0.44	0.44	184	0.36	0.26
25	0.48	0.48	57	0.52	0.4	89	0.5	0.5	121	0.24	0.3	153	0.38	0.42	185	0.56	0.54
26	0.44	0.4	58	0.36	0.46	90	0.42	0.42	122	0.64	0.42	154	0.36	0.36	186	0.46	0.46
27	0.36	0.46	59	0.6	0.42	91	0.48	0.4	123	0.44	0.4	155	0.46	0.42	187	0.48	0.48
28	0.46	0.36	60	0.56	0.58	92	0.54	0.56	124	0.46	0.38	156	0.6	0.48	188	0.4	0.34
29	0.46	0.46	61	0.44	0.5	93	0.34	0.44	125	0.48	0.52	157	0.58	0.54	189	0.4	0.6
30	0.5	0.5	62	0.34	0.32	94	0.56	0.5	126	0.46	0.4	158	0.46	0.4	190	0.4	0.42
31	0.54	0.6	63	0.32	0.32	95	0.5	0.44	127	0.58	0.36	159	0.44	0.44	191	0.5	0.5
32	0.5	0.5	64	0.38	0.4	96	0.5	0.5	128	0.52	0.44	160	0.52	0.54	192	0.38	0.36

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor (con't)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
193	0.42	0.52	225	0.48	0.42	257	0.4	0.46	289	0.38	0.4	321	0.52	0.5	353	0.38	0.42
194	0.42	0.42	226	0.44	0.44	258	0.46	0.44	290	0.42	0.42	322	0.6	0.6	354	0.48	0.52
195	0.56	0.52	227	0.38	0.4	259	0.46	0.5	291	0.52	0.46	323	0.62	0.6	355	0.44	0.48
196	0.46	0.46	228	0.5	0.4	260	0.62	0.34	292	0.54	0.48	324	0.36	0.42	356	0.36	0.42
197	0.54	0.44	229	0.4	0.44	261	0.5	0.4	293	0.48	0.46	325	0.48	0.42	357	0.38	0.4
198	0.36	0.38	230	0.44	0.48	262	0.54	0.48	294	0.38	0.34	326	0.58	0.62	358	0.4	0.44
199	0.48	0.5	231	0.52	0.66	263	0.44	0.48	295	0.44	0.48	327	0.52	0.5	359	0.5	0.46
200	0.46	0.48	232	0.52	0.52	264	0.34	0.5	296	0.44	0.44	328	0.46	0.46	360	0.54	0.44
201	0.5	0.52	233	0.44	0.42	265	0.4	0.3	297	0.38	0.4	329	0.42	0.42	361	0.34	0.5
202	0.44	0.44	234	0.48	0.5	266	0.46	0.5	298	0.44	0.44	330	0.32	0.4	362	0.44	0.46
203	0.48	0.5	235	0.54	0.5	267	0.36	0.46	299	0.28	0.32	331	0.56	0.5	363	0.44	0.44
204	0.62	0.6	236	0.58	0.36	268	0.42	0.42	300	0.5	0.54	332	0.52	0.54	364	0.48	0.5
205	0.6	0.56	237	0.34	0.28	269	0.44	0.38	301	0.46	0.38	333	0.44	0.56	365	0.56	0.5
206	0.46	0.46	238	0.5	0.36	270	0.34	0.34	302	0.62	0.56	334	0.36	0.34	366	0.42	0.6
207	0.48	0.48	239	0.42	0.54	271	0.5	0.38	303	0.32	0.32	335	0.48	0.38	367	0.6	0.6
208	0.26	0.3	240	0.4	0.5	272	0.36	0.48	304	0.48	0.48	336	0.58	0.38	368	0.48	0.48
209	0.46	0.42	241	0.5	0.54	273	0.48	0.44	305	0.54	0.46	337	0.42	0.4	369	0.46	0.46
210	0.42	0.42	242	0.56	0.38	274	0.48	0.48	306	0.48	0.5	338	0.44	0.4	370	0.54	0.54
211	0.4	0.4	243	0.46	0.34	275	0.56	0.36	307	0.34	0.34	339	0.4	0.36	371	0.38	0.28
212	0.36	0.44	244	0.38	0.44	276	0.3	0.4	308	0.34	0.34	340	0.44	0.5	372	0.38	0.42
213	0.58	0.5	245	0.42	0.44	277	0.5	0.46	309	0.48	0.48	341	0.64	0.52	373	0.38	0.4
214	0.44	0.44	246	0.58	0.38	278	0.4	0.52	310	0.44	0.42	342	0.5	0.5	374	0.46	0.48
215	0.5	0.44	247	0.5	0.46	279	0.44	0.32	311	0.58	0.58	343	0.46	0.46	375	0.38	0.4
216	0.46	0.54	248	0.32	0.44	280	0.58	0.34	312	0.44	0.46	344	0.44	0.44	376	0.36	0.36
217	0.48	0.48	249	0.48	0.48	281	0.42	0.48	313	0.4	0.44	345	0.5	0.52	377	0.42	0.44
218	0.26	0.26	250	0.58	0.36	282	0.54	0.52	314	0.4	0.42	346	0.48	0.46	378	0.56	0.56
219	0.46	0.46	251	0.48	0.4	283	0.36	0.38	315	0.42	0.46	347	0.44	0.46	379	0.36	0.46
220	0.38	0.38	252	0.44	0.42	284	0.54	0.38	316	0.4	0.56	348	0.62	0.42	380	0.34	0.34
221	0.4	0.4	253	0.34	0.36	285	0.38	0.38	317	0.38	0.42	349	0.38	0.38	381	0.52	0.52
222	0.54	0.48	254	0.34	0.5	286	0.36	0.56	318	0.44	0.48	350	0.4	0.38	382	0.5	0.54
223	0.42	0.58	255	0.28	0.44	287	0.56	0.54	319	0.3	0.46	351	0.42	0.36	383	0.48	0.5
224	0.54	0.46	256	0.38	0.28	288	0.42	0.46	320	0.48	0.48	352	0.52	0.46	384	0.52	0.5

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor (con't)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
385	0.44	0.38	417	0.54	0.48	449	0.48	0.34	481	0.46	0.52	513	0.34	0.34	545	0.44	0.46
386	0.44	0.38	418	0.48	0.48	450	0.48	0.46	482	0.46	0.52	514	0.46	0.48	546	0.6	0.6
387	0.44	0.42	419	0.44	0.38	451	0.32	0.32	483	0.46	0.5	515	0.34	0.38	547	0.38	0.4
388	0.44	0.44	420	0.42	0.44	452	0.38	0.38	484	0.4	0.4	516	0.38	0.42	548	0.44	0.54
389	0.32	0.32	421	0.56	0.58	453	0.38	0.44	485	0.5	0.48	517	0.5	0.52	549	0.52	0.44
390	0.52	0.54	422	0.54	0.4	454	0.4	0.4	486	0.52	0.52	518	0.56	0.56	550	0.52	0.58
391	0.3	0.34	423	0.4	0.48	455	0.5	0.54	487	0.52	0.52	519	0.28	0.28	551	0.56	0.5
392	0.34	0.34	424	0.4	0.54	456	0.52	0.4	488	0.4	0.4	520	0.36	0.34	552	0.52	0.52
393	0.32	0.32	425	0.48	0.48	457	0.42	0.42	489	0.3	0.38	521	0.52	0.56	553	0.46	0.52
394	0.42	0.44	426	0.36	0.38	458	0.46	0.52	490	0.4	0.34	522	0.5	0.5	554	0.54	0.5
395	0.38	0.36	427	0.52	0.44	459	0.36	0.4	491	0.34	0.4	523	0.42	0.42	555	0.46	0.44
396	0.4	0.52	428	0.4	0.4	460	0.44	0.5	492	0.46	0.46	524	0.5	0.54	556	0.6	0.6
397	0.6	0.6	429	0.4	0.4	461	0.52	0.44	493	0.42	0.42	525	0.44	0.38	557	0.54	0.56
398	0.42	0.42	430	0.42	0.36	462	0.48	0.54	494	0.52	0.52	526	0.42	0.46	558	0.52	0.54
399	0.52	0.5	431	0.48	0.46	463	0.38	0.6	495	0.5	0.46	527	0.4	0.5	559	0.42	0.4
400	0.36	0.28	432	0.48	0.54	464	0.46	0.42	496	0.5	0.5	528	0.44	0.52	560	0.48	0.48
401	0.42	0.44	433	0.46	0.46	465	0.48	0.48	497	0.42	0.44	529	0.46	0.46	561	0.5	0.52
402	0.44	0.5	434	0.36	0.5	466	0.44	0.5	498	0.5	0.52	530	0.5	0.46	562	0.6	0.6
403	0.56	0.56	435	0.56	0.56	467	0.36	0.36	499	0.48	0.48	531	0.5	0.46	563	0.48	0.42
404	0.38	0.36	436	0.44	0.44	468	0.44	0.46	500	0.54	0.58	532	0.34	0.34	564	0.48	0.48
405	0.46	0.46	437	0.38	0.38	469	0.5	0.48	501	0.52	0.54	533	0.48	0.48	565	0.34	0.32
406	0.52	0.54	438	0.46	0.48	470	0.4	0.4	502	0.48	0.46	534	0.42	0.42	566	0.5	0.5
407	0.4	0.4	439	0.24	0.38	471	0.5	0.56	503	0.32	0.34	535	0.36	0.38	567	0.34	0.38
408	0.54	0.54	440	0.52	0.56	472	0.54	0.54	504	0.46	0.46	536	0.42	0.46	568	0.5	0.5
409	0.44	0.52	441	0.38	0.38	473	0.48	0.48	505	0.6	0.56	537	0.44	0.44	569	0.52	0.52
410	0.52	0.4	442	0.62	0.58	474	0.48	0.36	506	0.52	0.56	538	0.4	0.4	570	0.44	0.44
411	0.54	0.56	443	0.32	0.32	475	0.48	0.5	507	0.58	0.6	539	0.52	0.52	571	0.48	0.5
412	0.42	0.42	444	0.5	0.46	476	0.4	0.4	508	0.46	0.5	540	0.24	0.26	572	0.42	0.32
413	0.44	0.48	445	0.56	0.54	477	0.46	0.5	509	0.44	0.46	541	0.5	0.48	573	0.4	0.36
414	0.46	0.5	446	0.52	0.54	478	0.42	0.42	510	0.5	0.5	542	0.4	0.44	574	0.38	0.38
415	0.44	0.4	447	0.44	0.44	479	0.44	0.44	511	0.26	0.24	543	0.6	0.6	575	0.4	0.38
416	0.62	0.46	448	0.48	0.46	480	0.5	0.48	512	0.38	0.26	544	0.42	0.38	576	0.52	0.54

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor (con't)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
577	0.54	0.54	609	0.44	0.52	641	0.58	0.36	673	0.5	0.48	705	0.58	0.58	737	0.36	0.42
578	0.52	0.52	610	0.52	0.5	642	0.46	0.46	674	0.5	0.52	706	0.48	0.5	738	0.6	0.62
579	0.56	0.52	611	0.44	0.5	643	0.54	0.56	675	0.48	0.44	707	0.46	0.46	739	0.4	0.46
580	0.48	0.5	612	0.4	0.44	644	0.54	0.42	676	0.5	0.5	708	0.6	0.48	740	0.46	0.48
581	0.38	0.4	613	0.44	0.56	645	0.36	0.36	677	0.4	0.5	709	0.48	0.46	741	0.44	0.48
582	0.42	0.42	614	0.66	0.48	646	0.56	0.58	678	0.48	0.42	710	0.42	0.32	742	0.32	0.42
583	0.4	0.4	615	0.42	0.4	647	0.52	0.5	679	0.56	0.64	711	0.4	0.38	743	0.44	0.44
584	0.62	0.54	616	0.42	0.42	648	0.54	0.54	680	0.5	0.62	712	0.4	0.44	744	0.36	0.42
585	0.38	0.4	617	0.48	0.48	649	0.42	0.42	681	0.48	0.48	713	0.48	0.48	745	0.56	0.6
586	0.34	0.4	618	0.46	0.46	650	0.42	0.5	682	0.46	0.5	714	0.52	0.52	746	0.52	0.54
587	0.48	0.54	619	0.5	0.48	651	0.42	0.44	683	0.46	0.44	715	0.4	0.54	747	0.44	0.48
588	0.32	0.3	620	0.52	0.5	652	0.52	0.54	684	0.46	0.44	716	0.56	0.4	748	0.38	0.32
589	0.34	0.32	621	0.34	0.34	653	0.58	0.56	685	0.56	0.56	717	0.48	0.44	749	0.44	0.46
590	0.48	0.5	622	0.52	0.36	654	0.48	0.46	686	0.56	0.54	718	0.38	0.38	750	0.3	0.3
591	0.5	0.5	623	0.38	0.4	655	0.48	0.44	687	0.34	0.34	719	0.56	0.52	751	0.52	0.52
592	0.52	0.56	624	0.44	0.44	656	0.36	0.36	688	0.42	0.42	720	0.56	0.46	752	0.52	0.52
593	0.52	0.52	625	0.42	0.44	657	0.48	0.5	689	0.46	0.46	721	0.5	0.52	753	0.36	0.38
594	0.38	0.46	626	0.52	0.52	658	0.48	0.52	690	0.36	0.36	722	0.44	0.46	754	0.38	0.38
595	0.52	0.56	627	0.54	0.52	659	0.5	0.4	691	0.5	0.5	723	0.56	0.56	755	0.52	0.5
596	0.48	0.48	628	0.58	0.58	660	0.54	0.4	692	0.52	0.48	724	0.44	0.38	756	0.36	0.36
597	0.44	0.44	629	0.56	0.56	661	0.52	0.52	693	0.4	0.38	725	0.56	0.56	757	0.48	0.42
598	0.42	0.5	630	0.48	0.5	662	0.5	0.42	694	0.44	0.44	726	0.48	0.5	758	0.66	0.66
599	0.52	0.52	631	0.42	0.4	663	0.54	0.56	695	0.36	0.38	727	0.46	0.52	759	0.48	0.46
600	0.32	0.32	632	0.5	0.48	664	0.66	0.6	696	0.52	0.52	728	0.56	0.32	760	0.4	0.4
601	0.42	0.42	633	0.42	0.42	665	0.38	0.38	697	0.44	0.42	729	0.46	0.48	761	0.52	0.52
602	0.52	0.48	634	0.48	0.48	666	0.5	0.56	698	0.38	0.38	730	0.28	0.36	762	0.48	0.48
603	0.46	0.42	635	0.54	0.56	667	0.54	0.52	699	0.36	0.4	731	0.44	0.42	763	0.56	0.58
604	0.36	0.36	636	0.38	0.4	668	0.5	0.5	700	0.44	0.52	732	0.46	0.48	764	0.54	0.48
605	0.52	0.48	637	0.5	0.48	669	0.46	0.5	701	0.5	0.46	733	0.5	0.5	765	0.38	0.38
606	0.48	0.38	638	0.46	0.5	670	0.42	0.42	702	0.38	0.44	734	0.5	0.54	766	0.46	0.44
607	0.46	0.46	639	0.52	0.48	671	0.5	0.48	703	0.44	0.46	735	0.48	0.5	767	0.5	0.54
608	0.6	0.6	640	0.42	0.46	672	0.5	0.5	704	0.42	0.38	736	0.52	0.5	768	0.38	0.42

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor (con't)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
769	0.38	0.38	801	0.44	0.44	833	0.36	0.44	865	0.52	0.52	897	0.36	0.36	929	0.46	0.4
770	0.46	0.48	802	0.52	0.58	834	0.6	0.64	866	0.34	0.46	898	0.42	0.4	930	0.36	0.32
771	0.4	0.42	803	0.38	0.38	835	0.42	0.42	867	0.46	0.44	899	0.5	0.48	931	0.5	0.5
772	0.56	0.56	804	0.52	0.5	836	0.48	0.48	868	0.48	0.44	900	0.26	0.26	932	0.44	0.48
773	0.58	0.58	805	0.44	0.48	837	0.4	0.4	869	0.44	0.44	901	0.38	0.4	933	0.36	0.36
774	0.48	0.36	806	0.38	0.38	838	0.34	0.46	870	0.3	0.32	902	0.4	0.64	934	0.56	0.54
775	0.52	0.52	807	0.46	0.5	839	0.58	0.56	871	0.54	0.64	903	0.6	0.52	935	0.3	0.32
776	0.5	0.5	808	0.38	0.38	840	0.46	0.42	872	0.4	0.4	904	0.4	0.36	936	0.56	0.5
777	0.4	0.4	809	0.42	0.36	841	0.4	0.4	873	0.38	0.38	905	0.56	0.56	937	0.52	0.48
778	0.5	0.56	810	0.5	0.5	842	0.44	0.44	874	0.48	0.48	906	0.44	0.4	938	0.44	0.46
779	0.44	0.48	811	0.54	0.54	843	0.46	0.48	875	0.38	0.38	907	0.5	0.5	939	0.36	0.32
780	0.54	0.62	812	0.44	0.44	844	0.5	0.5	876	0.32	0.24	908	0.52	0.6	940	0.4	0.46
781	0.42	0.42	813	0.34	0.36	845	0.42	0.42	877	0.42	0.42	909	0.28	0.34	941	0.56	0.58
782	0.38	0.36	814	0.34	0.36	846	0.34	0.34	878	0.34	0.38	910	0.38	0.4	942	0.44	0.44
783	0.34	0.58	815	0.46	0.5	847	0.36	0.36	879	0.48	0.48	911	0.52	0.54	943	0.5	0.5
784	0.48	0.48	816	0.5	0.5	848	0.44	0.46	880	0.38	0.38	912	0.36	0.38	944	0.58	0.56
785	0.52	0.32	817	0.44	0.42	849	0.38	0.38	881	0.56	0.56	913	0.38	0.5	945	0.44	0.44
786	0.52	0.52	818	0.46	0.48	850	0.4	0.4	882	0.52	0.5	914	0.4	0.4	946	0.4	0.32
787	0.4	0.44	819	0.44	0.42	851	0.38	0.4	883	0.46	0.44	915	0.48	0.48	947	0.52	0.54
788	0.38	0.5	820	0.32	0.5	852	0.58	0.4	884	0.42	0.46	916	0.38	0.38	948	0.46	0.48
789	0.46	0.46	821	0.5	0.5	853	0.58	0.56	885	0.3	0.32	917	0.52	0.46	949	0.48	0.48
790	0.42	0.42	822	0.44	0.7	854	0.4	0.44	886	0.42	0.42	918	0.62	0.64	950	0.32	0.5
791	0.4	0.44	823	0.28	0.28	855	0.48	0.52	887	0.46	0.48	919	0.64	0.62	951	0.4	0.76
792	0.44	0.46	824	0.42	0.42	856	0.48	0.52	888	0.4	0.3	920	0.48	0.4	952	0.48	0.48
793	0.46	0.46	825	0.62	0.5	857	0.54	0.54	889	0.44	0.52	921	0.36	0.38	953	0.52	0.58
794	0.4	0.4	826	0.48	0.52	858	0.5	0.5	890	0.38	0.4	922	0.5	0.5	954	0.34	0.34
795	0.38	0.44	827	0.34	0.38	859	0.46	0.44	891	0.36	0.72	923	0.46	0.44	955	0.6	0.58
796	0.44	0.4	828	0.48	0.5	860	0.46	0.54	892	0.42	0.4	924	0.5	0.54	956	0.46	0.54
797	0.32	0.54	829	0.3	0.3	861	0.44	0.44	893	0.54	0.42	925	0.34	0.36	957	0.4	0.4
798	0.42	0.42	830	0.48	0.44	862	0.54	0.58	894	0.56	0.52	926	0.52	0.44	958	0.56	0.52
799	0.52	0.52	831	0.36	0.46	863	0.38	0.4	895	0.44	0.44	927	0.48	0.5	959	0.42	0.44
800	0.46	0.48	832	0.4	0.38	864	0.46	0.46	896	0.44	0.44	928	0.46	0.46	960	0.52	0.46

Appendix 5a. Misclassification Rates for Scenario 1 with one predictor (Taylors' Data)

Misclassification Rates with one predictor variable					
Run#	OLR	ANN	Run#	OLR	ANN
961	0.5	0.5	993	0.36	0.38
962	0.42	0.4	994	0.28	0.28
963	0.42	0.44	995	0.48	0.48
964	0.44	0.44	996	0.36	0.38
965	0.48	0.42	997	0.32	0.42
966	0.44	0.44	998	0.48	0.54
967	0.32	0.3	999	0.46	0.5
968	0.54	0.6	1000	0.36	0.4
969	0.56	0.6			
970	0.44	0.5			
971	0.56	0.46			
972	0.48	0.52			
973	0.46	0.46			
974	0.4	0.48			
975	0.6	0.48			
976	0.52	0.56			
977	0.48	0.56			
978	0.46	0.5			
979	0.38	0.44			
980	0.68	0.6			
981	0.46	0.5			
982	0.48	0.48			
983	0.5	0.44			
984	0.44	0.5			
985	0.44	0.44			
986	0.36	0.38			
987	0.38	0.44			
988	0.3	0.34			
989	0.44	0.4			
990	0.44	0.46			
991	0.46	0.46			
992	0.5	0.5			

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.38	0.38	33	0.58	0.42	65	0.5	0.5	97	0.3	0.3	129	0.46	0.36	161	0.32	0.3
2	0.52	0.54	34	0.32	0.32	66	0.38	0.4	98	0.32	0.26	130	0.54	0.42	162	0.46	0.4
3	0.46	0.44	35	0.48	0.56	67	0.38	0.32	99	0.24	0.24	131	0.44	0.36	163	0.38	0.38
4	0.26	0.36	36	0.34	0.46	68	0.32	0.32	100	0.46	0.5	132	0.5	0.4	164	0.4	0.4
5	0.4	0.44	37	0.34	0.38	69	0.34	0.38	101	0.42	0.4	133	0.32	0.3	165	0.34	0.38
6	0.4	0.3	38	0.38	0.46	70	0.32	0.28	102	0.32	0.32	134	0.36	0.44	166	0.32	0.38
7	0.46	0.42	39	0.4	0.44	71	0.5	0.42	103	0.36	0.6	135	0.48	0.28	167	0.42	0.34
8	0.38	0.38	40	0.46	0.46	72	0.42	0.42	104	0.36	0.36	136	0.5	0.52	168	0.34	0.4
9	0.38	0.44	41	0.44	0.42	73	0.4	0.4	105	0.34	0.36	137	0.36	0.3	169	0.34	0.34
10	0.44	0.44	42	0.34	0.36	74	0.3	0.32	106	0.46	0.46	138	0.48	0.38	170	0.34	0.4
11	0.48	0.48	43	0.36	0.36	75	0.38	0.38	107	0.46	0.4	139	0.38	0.38	171	0.42	0.26
12	0.44	0.44	44	0.34	0.36	76	0.42	0.44	108	0.34	0.34	140	0.38	0.38	172	0.46	0.34
13	0.28	0.28	45	0.36	0.38	77	0.32	0.4	109	0.4	0.4	141	0.36	0.34	173	0.4	0.46
14	0.38	0.36	46	0.4	0.42	78	0.32	0.42	110	0.38	0.44	142	0.42	0.44	174	0.38	0.36
15	0.28	0.3	47	0.26	0.26	79	0.52	0.46	111	0.34	0.36	143	0.38	0.28	175	0.28	0.38
16	0.32	0.42	48	0.46	0.48	80	0.36	0.32	112	0.4	0.38	144	0.4	0.32	176	0.46	0.38
17	0.32	0.32	49	0.32	0.34	81	0.44	0.5	113	0.42	0.4	145	0.38	0.46	177	0.5	0.42
18	0.44	0.38	50	0.5	0.5	82	0.54	0.54	114	0.44	0.4	146	0.36	0.34	178	0.32	0.34
19	0.36	0.32	51	0.32	0.32	83	0.42	0.42	115	0.34	0.34	147	0.38	0.34	179	0.46	0.4
20	0.3	0.3	52	0.42	0.42	84	0.26	0.26	116	0.52	0.5	148	0.44	0.3	180	0.56	0.34
21	0.56	0.54	53	0.34	0.34	85	0.32	0.32	117	0.36	0.36	149	0.38	0.36	181	0.34	0.34
22	0.36	0.44	54	0.28	0.28	86	0.42	0.4	118	0.42	0.42	150	0.5	0.42	182	0.42	0.44
23	0.42	0.4	55	0.34	0.34	87	0.32	0.34	119	0.36	0.42	151	0.34	0.4	183	0.34	0.34
24	0.46	0.46	56	0.42	0.42	88	0.24	0.24	120	0.28	0.22	152	0.34	0.34	184	0.58	0.52
25	0.38	0.38	57	0.5	0.52	89	0.38	0.38	121	0.4	0.28	153	0.54	0.28	185	0.48	0.3
26	0.42	0.42	58	0.54	0.54	90	0.46	0.46	122	0.44	0.44	154	0.52	0.52	186	0.42	0.44
27	0.42	0.42	59	0.34	0.34	91	0.38	0.42	123	0.4	0.26	155	0.4	0.3	187	0.4	0.42
28	0.52	0.52	60	0.28	0.32	92	0.44	0.48	124	0.58	0.28	156	0.34	0.34	188	0.38	0.4
29	0.48	0.54	61	0.46	0.4	93	0.44	0.44	125	0.32	0.36	157	0.42	0.44	189	0.52	0.52
30	0.36	0.36	62	0.46	0.46	94	0.56	0.46	126	0.58	0.4	158	0.46	0.28	190	0.36	0.36
31	0.52	0.52	63	0.42	0.5	95	0.38	0.38	127	0.32	0.4	159	0.38	0.44	191	0.34	0.34
32	0.28	0.28	64	0.56	0.56	96	0.6	0.52	128	0.3	0.38	160	0.4	0.36	192	0.4	0.46

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
193	0.34	0.34	225	0.38	0.38	257	0.42	0.42	289	0.36	0.36	321	0.4	0.38	353	0.38	0.36
194	0.4	0.4	226	0.4	0.4	258	0.48	0.42	290	0.34	0.32	322	0.42	0.48	354	0.46	0.4
195	0.5	0.42	227	0.36	0.38	259	0.54	0.54	291	0.28	0.28	323	0.48	0.48	355	0.46	0.46
196	0.44	0.44	228	0.42	0.5	260	0.44	0.46	292	0.46	0.5	324	0.34	0.34	356	0.44	0.44
197	0.3	0.3	229	0.38	0.38	261	0.3	0.32	293	0.4	0.48	325	0.4	0.38	357	0.38	0.56
198	0.38	0.38	230	0.34	0.42	262	0.44	0.42	294	0.48	0.54	326	0.42	0.34	358	0.32	0.34
199	0.4	0.4	231	0.28	0.26	263	0.38	0.46	295	0.58	0.62	327	0.5	0.48	359	0.3	0.3
200	0.46	0.52	232	0.28	0.26	264	0.46	0.56	296	0.36	0.36	328	0.34	0.34	360	0.32	0.32
201	0.36	0.38	233	0.56	0.58	265	0.34	0.44	297	0.46	0.46	329	0.52	0.52	361	0.44	0.44
202	0.48	0.48	234	0.34	0.4	266	0.4	0.4	298	0.36	0.36	330	0.4	0.4	362	0.48	0.46
203	0.36	0.4	235	0.46	0.44	267	0.4	0.4	299	0.32	0.3	331	0.42	0.48	363	0.26	0.22
204	0.28	0.34	236	0.3	0.36	268	0.36	0.36	300	0.4	0.42	332	0.38	0.38	364	0.42	0.42
205	0.36	0.36	237	0.32	0.32	269	0.42	0.42	301	0.32	0.32	333	0.36	0.36	365	0.3	0.36
206	0.4	0.4	238	0.4	0.34	270	0.36	0.36	302	0.42	0.32	334	0.34	0.28	366	0.46	0.46
207	0.48	0.48	239	0.46	0.46	271	0.32	0.42	303	0.4	0.4	335	0.48	0.48	367	0.36	0.38
208	0.24	0.24	240	0.36	0.36	272	0.48	0.46	304	0.42	0.48	336	0.54	0.34	368	0.36	0.36
209	0.54	0.36	241	0.36	0.36	273	0.42	0.38	305	0.42	0.46	337	0.38	0.38	369	0.28	0.32
210	0.5	0.38	242	0.46	0.42	274	0.42	0.42	306	0.28	0.28	338	0.44	0.44	370	0.32	0.32
211	0.38	0.44	243	0.28	0.28	275	0.4	0.4	307	0.44	0.44	339	0.4	0.42	371	0.4	0.36
212	0.4	0.4	244	0.44	0.4	276	0.46	0.46	308	0.44	0.44	340	0.4	0.4	372	0.44	0.44
213	0.32	0.36	245	0.38	0.38	277	0.28	0.28	309	0.34	0.34	341	0.48	0.52	373	0.52	0.48
214	0.36	0.36	246	0.34	0.28	278	0.38	0.32	310	0.34	0.4	342	0.4	0.38	374	0.4	0.44
215	0.38	0.38	247	0.48	0.42	279	0.48	0.48	311	0.46	0.44	343	0.32	0.34	375	0.5	0.5
216	0.32	0.36	248	0.36	0.46	280	0.36	0.44	312	0.36	0.38	344	0.46	0.46	376	0.36	0.4
217	0.36	0.36	249	0.4	0.4	281	0.52	0.52	313	0.38	0.38	345	0.32	0.34	377	0.24	0.28
218	0.44	0.38	250	0.46	0.44	282	0.38	0.44	314	0.44	0.46	346	0.36	0.36	378	0.42	0.42
219	0.5	0.5	251	0.38	0.38	283	0.38	0.38	315	0.36	0.36	347	0.4	0.4	379	0.4	0.4
220	0.36	0.36	252	0.28	0.34	284	0.4	0.58	316	0.5	0.52	348	0.56	0.56	380	0.42	0.5
221	0.38	0.38	253	0.56	0.46	285	0.46	0.42	317	0.4	0.42	349	0.42	0.48	381	0.5	0.44
222	0.48	0.5	254	0.39	0.36	286	0.46	0.4	318	0.5	0.58	350	0.34	0.36	382	0.32	0.28
223	0.38	0.32	255	0.44	0.52	287	0.3	0.3	319	0.36	0.36	351	0.46	0.42	383	0.42	0.48
224	0.58	0.4	256	0.34	0.44	288	0.44	0.54	320	0.58	0.44	352	0.5	0.5	384	0.4	0.38

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
385	0.44	0.44	417	0.26	0.38	449	0.44	0.46	481	0.5	0.48	513	0.34	0.34	545	0.34	0.38
386	0.42	0.42	418	0.44	0.42	450	0.34	0.4	482	0.4	0.4	514	0.46	0.64	546	0.32	0.32
387	0.46	0.4	419	0.6	0.6	451	0.36	0.36	483	0.4	0.4	515	0.38	0.46	547	0.54	0.48
388	0.32	0.28	420	0.36	0.36	452	0.22	0.28	484	0.46	0.46	516	0.42	0.42	548	0.28	0.3
389	0.26	0.34	421	0.46	0.52	453	0.36	0.38	485	0.4	0.48	517	0.26	0.26	549	0.32	0.36
390	0.36	0.36	422	0.28	0.28	454	0.42	0.42	486	0.42	0.3	518	0.44	0.44	550	0.52	0.52
391	0.3	0.22	423	0.4	0.4	455	0.36	0.38	487	0.52	0.54	519	0.4	0.46	551	0.44	0.54
392	0.32	0.28	424	0.52	0.46	456	0.4	0.4	488	0.4	0.4	520	0.38	0.44	552	0.34	0.34
393	0.5	0.5	425	0.48	0.48	457	0.54	0.42	489	0.36	0.36	521	0.38	0.42	553	0.26	0.26
394	0.48	0.4	426	0.38	0.36	458	0.52	0.36	490	0.5	0.5	522	0.56	0.4	554	0.42	0.5
395	0.34	0.36	427	0.54	0.54	459	0.36	0.38	491	0.38	0.44	523	0.42	0.42	555	0.4	0.4
396	0.34	0.38	428	0.38	0.4	460	0.36	0.52	492	0.44	0.44	524	0.46	0.52	556	0.38	0.38
397	0.46	0.48	429	0.32	0.4	461	0.3	0.32	493	0.38	0.46	525	0.3	0.36	557	0.42	0.36
398	0.52	0.38	430	0.38	0.38	462	0.38	0.38	494	0.48	0.48	526	0.42	0.38	558	0.48	0.44
399	0.36	0.36	431	0.34	0.32	463	0.34	0.38	495	0.3	0.34	527	0.4	0.38	559	0.32	0.32
400	0.5	0.5	432	0.34	0.38	464	0.42	0.46	496	0.38	0.38	528	0.4	0.4	560	0.34	0.34
401	0.4	0.38	433	0.52	0.52	465	0.28	0.36	497	0.38	0.38	529	0.44	0.48	561	0.4	0.4
402	0.56	0.52	434	0.42	0.38	466	0.36	0.36	498	0.32	0.32	530	0.54	0.54	562	0.36	0.32
403	0.36	0.46	435	0.36	0.36	467	0.46	0.46	499	0.34	0.34	531	0.34	0.3	563	0.38	0.4
404	0.32	0.4	436	0.4	0.4	468	0.46	0.48	500	0.52	0.56	532	0.3	0.3	564	0.38	0.4
405	0.36	0.36	437	0.42	0.36	469	0.38	0.38	501	0.4	0.4	533	0.36	0.36	565	0.48	0.4
406	0.56	0.56	438	0.48	0.48	470	0.42	0.44	502	0.42	0.44	534	0.46	0.46	566	0.4	0.4
407	0.34	0.36	439	0.4	0.42	471	0.4	0.4	503	0.28	0.26	535	0.38	0.38	567	0.4	0.44
408	0.56	0.42	440	0.42	0.46	472	0.44	0.44	504	0.4	0.46	536	0.46	0.42	568	0.36	0.44
409	0.48	0.48	441	0.58	0.44	473	0.58	0.54	505	0.44	0.44	537	0.38	0.46	569	0.46	0.46
410	0.32	0.38	442	0.3	0.32	474	0.46	0.46	506	0.38	0.3	538	0.42	0.44	570	0.28	0.32
411	0.44	0.44	443	0.34	0.34	475	0.42	0.38	507	0.54	0.48	539	0.36	0.34	571	0.44	0.44
412	0.42	0.48	444	0.48	0.44	476	0.38	0.4	508	0.3	0.3	540	0.48	0.4	572	0.38	0.38
413	0.46	0.5	445	0.36	0.38	477	0.38	0.32	509	0.52	0.28	541	0.38	0.38	573	0.44	0.46
414	0.56	0.54	446	0.32	0.36	478	0.44	0.36	510	0.44	0.5	542	0.4	0.4	574	0.32	0.36
415	0.34	0.38	447	0.5	0.44	479	0.4	0.42	511	0.38	0.36	543	0.36	0.36	575	0.38	0.38
416	0.44	0.4	448	0.34	0.34	480	0.42	0.32	512	0.38	0.4	544	0.46	0.42	576	0.38	0.38

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
577	0.38	0.38	609	0.48	0.42	641	0.46	0.38	673	0.42	0.42	705	0.38	0.38	737	0.44	0.38
578	0.4	0.4	610	0.48	0.4	642	0.38	0.38	674	0.46	0.46	706	0.32	0.3	738	0.44	0.44
579	0.42	0.46	611	0.32	0.32	643	0.36	0.34	675	0.36	0.36	707	0.34	0.34	739	0.46	0.5
580	0.32	0.34	612	0.4	0.4	644	0.34	0.34	676	0.44	0.46	708	0.54	0.54	740	0.4	0.42
581	0.34	0.38	613	0.4	0.4	645	0.46	0.48	677	0.38	0.36	709	0.38	0.4	741	0.54	0.46
582	0.34	0.4	614	0.46	0.46	646	0.4	0.4	678	0.3	0.28	710	0.44	0.52	742	0.36	0.36
583	0.36	0.42	615	0.3	0.3	647	0.28	0.28	679	0.34	0.44	711	0.42	0.48	743	0.4	0.42
584	0.46	0.46	616	0.48	0.46	648	0.32	0.34	680	0.4	0.42	712	0.48	0.44	744	0.42	0.32
585	0.48	0.46	617	0.4	0.46	649	0.42	0.46	681	0.48	0.48	713	0.58	0.54	745	0.32	0.36
586	0.52	0.54	618	0.26	0.26	650	0.4	0.32	682	0.44	0.38	714	0.52	0.5	746	0.28	0.33
587	0.3	0.3	619	0.4	0.44	651	0.44	0.44	683	0.38	0.38	715	0.36	0.36	747	0.42	0.3
588	0.36	0.3	620	0.54	0.54	652	0.36	0.3	684	0.5	0.44	716	0.44	0.44	748	0.3	0.36
589	0.42	0.42	621	0.36	0.36	653	0.34	0.4	685	0.36	0.42	717	0.4	0.4	749	0.26	0.32
590	0.26	0.3	622	0.36	0.36	654	0.36	0.36	686	0.36	0.36	718	0.38	0.34	750	0.44	0.46
591	0.5	0.4	623	0.36	0.36	655	0.44	0.44	687	0.3	0.34	719	0.56	0.56	751	0.32	0.34
592	0.36	0.36	624	0.52	0.52	656	0.5	0.5	688	0.36	0.36	720	0.36	0.4	752	0.32	0.38
593	0.36	0.36	625	0.44	0.42	657	0.44	0.44	689	0.36	0.36	721	0.44	0.46	753	0.38	0.36
594	0.38	0.38	626	0.46	0.54	658	0.46	0.46	690	0.46	0.54	722	0.44	0.44	754	0.38	0.38
595	0.48	0.48	627	0.38	0.38	659	0.5	0.54	691	0.4	0.42	723	0.5	0.5	755	0.36	0.36
596	0.58	0.6	628	0.42	0.42	660	0.58	0.4	692	0.5	0.46	724	0.28	0.28	756	0.48	0.52
597	0.2	0.2	629	0.4	0.4	661	0.36	0.36	693	0.28	0.3	725	0.32	0.32	757	0.38	0.3
598	0.34	0.38	630	0.44	0.4	662	0.34	0.34	694	0.56	0.52	726	0.46	0.46	758	0.42	0.5
599	0.52	0.56	631	0.3	0.3	663	0.28	0.24	695	0.44	0.44	727	0.38	0.38	759	0.34	0.44
600	0.44	0.46	632	0.5	0.48	664	0.38	0.42	696	0.46	0.46	728	0.28	0.38	760	0.38	0.36
601	0.52	0.58	633	0.38	0.42	665	0.32	0.3	697	0.32	0.38	729	0.44	0.44	761	0.52	0.48
602	0.42	0.42	634	0.36	0.36	666	0.4	0.38	698	0.46	0.48	730	0.54	0.54	762	0.44	0.44
603	0.32	0.36	635	0.38	0.38	667	0.38	0.38	699	0.46	0.46	731	0.44	0.44	763	0.36	0.36
604	0.38	0.4	636	0.48	0.52	668	0.24	0.24	700	0.52	0.52	732	0.58	0.56	764	0.34	0.38
605	0.4	0.4	637	0.32	0.32	669	0.28	0.28	701	0.26	0.3	733	0.36	0.38	765	0.38	0.3
606	0.32	0.32	638	0.6	0.6	670	0.4	0.44	702	0.58	0.52	734	0.32	0.36	766	0.4	0.38
607	0.34	0.38	639	0.42	0.5	671	0.28	0.28	703	0.38	0.42	735	0.5	0.5	767	0.34	0.38
608	0.32	0.32	640	0.3	0.34	672	0.28	0.28	704	0.32	0.46	736	0.32	0.32	768	0.44	0.44

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
769	0.44	0.44	801	0.5	0.46	833	0.3	0.36	865	0.26	0.36	897	0.34	0.4	929	0.56	0.56
770	0.4	0.4	802	0.32	0.28	834	0.4	0.56	866	0.52	0.52	898	0.4	0.4	930	0.38	0.42
771	0.42	0.42	803	0.44	0.46	835	0.38	0.38	867	0.34	0.38	899	0.34	0.48	931	0.42	0.56
772	0.42	0.5	804	0.42	0.42	836	0.46	0.46	868	0.36	0.4	900	0.34	0.5	932	0.42	0.4
773	0.36	0.36	805	0.46	0.46	837	0.52	0.54	869	0.26	0.26	901	0.42	0.42	933	0.4	0.46
774	0.34	0.34	806	0.3	0.3	838	0.34	0.38	870	0.44	0.38	902	0.44	0.46	934	0.3	0.3
775	0.36	0.42	807	0.5	0.5	839	0.36	0.4	871	0.4	0.4	903	0.46	0.5	935	0.4	0.54
776	0.42	0.5	808	0.48	0.48	840	0.58	0.58	872	0.34	0.34	904	0.44	0.46	936	0.4	0.4
777	0.4	0.4	809	0.5	0.48	841	0.4	0.46	873	0.6	0.32	905	0.46	0.44	937	0.34	0.32
778	0.36	0.36	810	0.4	0.4	842	0.52	0.44	874	0.44	0.44	906	0.44	0.44	938	0.34	0.34
779	0.44	0.44	811	0.42	0.46	843	0.34	0.42	875	0.42	0.42	907	0.42	0.42	939	0.26	0.32
780	0.44	0.46	812	0.36	0.38	844	0.52	0.52	876	0.32	0.48	908	0.28	0.42	940	0.4	0.4
781	0.44	0.44	813	0.52	0.36	845	0.56	0.56	877	0.58	0.58	909	0.48	0.48	941	0.46	0.44
782	0.42	0.3	814	0.32	0.34	846	0.32	0.38	878	0.38	0.36	910	0.52	0.52	942	0.36	0.36
783	0.44	0.44	815	0.36	0.3	847	0.36	0.36	879	0.42	0.42	911	0.32	0.24	943	0.28	0.26
784	0.4	0.34	816	0.44	0.42	848	0.4	0.34	880	0.42	0.42	912	0.36	0.36	944	0.44	0.54
785	0.4	0.4	817	0.36	0.36	849	0.44	0.44	881	0.36	0.38	913	0.48	0.54	945	0.42	0.42
786	0.4	0.4	818	0.44	0.44	850	0.3	0.38	882	0.24	0.28	914	0.36	0.36	946	0.44	0.42
787	0.38	0.38	819	0.36	0.42	851	0.34	0.34	883	0.44	0.46	915	0.28	0.28	947	0.36	0.38
788	0.4	0.36	820	0.48	0.48	852	0.38	0.38	884	0.42	0.4	916	0.46	0.46	948	0.42	0.36
789	0.4	0.48	821	0.4	0.36	853	0.42	0.38	885	0.44	0.52	917	0.32	0.3	949	0.46	0.52
790	0.42	0.42	822	0.34	0.32	854	0.34	0.4	886	0.3	0.32	918	0.48	0.44	950	0.4	0.4
791	0.54	0.54	823	0.46	0.46	855	0.58	0.58	887	0.26	0.22	919	0.42	0.42	951	0.46	0.48
792	0.48	0.48	824	0.48	0.48	856	0.36	0.36	888	0.34	0.34	920	0.3	0.34	952	0.52	0.54
793	0.58	0.54	825	0.44	0.46	857	0.38	0.4	889	0.5	0.48	921	0.36	0.4	953	0.44	0.54
794	0.3	0.36	826	0.24	0.3	858	0.42	0.36	890	0.48	0.36	922	0.34	0.34	954	0.5	0.5
795	0.5	0.36	827	0.58	0.56	859	0.54	0.54	891	0.28	0.28	923	0.48	0.48	955	0.42	0.42
796	0.24	0.34	828	0.3	0.28	860	0.44	0.48	892	0.32	0.44	924	0.44	0.38	956	0.28	0.38
797	0.34	0.54	829	0.48	0.48	861	0.42	0.42	893	0.42	0.54	925	0.42	0.42	957	0.38	0.46
798	0.4	0.4	830	0.28	0.36	862	0.42	0.42	894	0.42	0.42	926	0.44	0.5	958	0.52	0.52
799	0.36	0.36	831	0.34	0.44	863	0.36	0.46	895	0.46	0.46	927	0.4	0.6	959	0.36	0.48
800	0.5	0.5	832	0.34	0.34	864	0.54	0.5	896	0.4	0.4	928	0.3	0.3	960	0.38	0.38

Appendix 5b. Misclassification Rates for Scenario 2 with one predictor (FTR Data)

Misclassification Rates with one predictor variable					
Run#	OLR	ANN	Run#	OLR	ANN
961	0.44	0.50	993	0.44	0.46
962	0.38	0.42	994	0.64	0.64
963	0.48	0.38	995	0.44	0.44
964	0.44	0.42	996	0.46	0.50
965	0.48	0.50	997	0.46	0.46
966	0.48	0.48	998	0.42	0.48
967	0.44	0.44	999	0.28	0.28
968	0.44	0.44	1000	0.48	0.54
969	0.38	0.52			
970	0.42	0.42			
971	0.54	0.54			
972	0.44	0.42			
973	0.42	0.40			
974	0.38	0.44			
975	0.46	0.52			
976	0.4	0.46			
977	0.38	0.38			
978	0.24	0.36			
979	0.44	0.42			
980	0.24	0.24			
981	0.60	0.40			
982	0.30	0.34			
983	0.50	0.34			
984	0.44	0.50			
985	0.28	0.40			
986	0.36	0.38			
987	0.42	0.48			
988	0.32	0.32			
989	0.36	0.36			
990	0.52	0.56			
991	0.34	0.34			
992	0.42	0.42			

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.44	0.44	33	0.26	0.26	65	0.4	0.38	97	0.08	0.14	129	0.58	0.54	161	0.36	0.36
2	0.36	0.36	34	0.46	0.44	66	0.26	0.26	98	0.56	0.56	130	0.66	0.6	162	0.52	0.42
3	0.28	0.28	35	0.68	0.66	67	0.44	0.44	99	0.04	0.04	131	0.68	0.66	163	0.18	0.18
4	0.08	0.08	36	0.18	0.18	68	0.26	0.24	100	0.32	0.3	132	0.38	0.34	164	0.02	0.02
5	0.74	0.76	37	0.38	0.38	69	0.3	0.3	101	0.4	0.4	133	0.62	0.62	165	0.26	0.3
6	0.5	0.48	38	0.7	0.64	70	0.36	0.36	102	0.22	0.32	134	0.46	0.46	166	0.46	0.46
7	0.26	0.12	39	0.22	0.22	71	0.02	0.14	103	0.16	0.16	135	0.24	0.24	167	0.38	0.36
8	0.46	0.46	40	0.32	0.32	72	0.32	0.32	104	0.62	0.64	136	0.08	0.08	168	0.42	0.42
9	0.12	0.12	41	0.5	0.48	73	0.26	0.26	105	0.06	0.04	137	0.42	0.42	169	0.72	0.38
10	0.52	0.52	42	0.58	0.58	74	0.26	0.28	106	0.38	0.38	138	0.28	0.36	170	0.42	0.4
11	0.46	0.44	43	0.46	0.46	75	0.2	0.2	107	0.08	0.08	139	0.72	0.72	171	0.64	0.58
12	0.3	0.3	44	0.56	0.56	76	0.58	0.6	108	0.34	0.34	140	0.68	0.68	172	0.54	0.54
13	0.58	0.58	45	0.24	0.28	77	0.12	0.16	109	0.48	0.48	141	0.62	0.62	173	0.36	0.36
14	0.1	0.1	46	0.44	0.44	78	0.56	0.56	110	0.22	0.3	142	0.22	0.26	174	0.44	0.44
15	0.26	0.26	47	0.26	0.3	79	0.64	0.46	111	0.52	0.52	143	0.64	0.64	175	0.4	0.4
16	0.44	0.44	48	0.36	0.36	80	0.22	0.22	112	0.32	0.32	144	0.06	0.12	176	0.28	0.36
17	0.62	0.6	49	0.34	0.34	81	0.5	0.5	113	0.42	0.4	145	0.22	0.24	177	0.2	0.2
18	0.3	0.3	50	0.06	0.06	82	0.26	0.26	114	0.28	0.28	146	0.16	0.22	178	0.38	0.38
19	0.08	0.08	51	0.26	0.26	83	0.56	0.6	115	0.2	0.2	147	0.16	0.14	179	0.14	0.14
20	0.46	0.44	52	0	0.36	84	0.28	0.28	116	0.14	0.14	148	0.44	0.44	180	0.04	0.04
21	0.26	0.26	53	0.7	0.7	85	0.14	0.14	117	0.54	0.48	149	0.44	0.46	181	0.06	0.06
22	0.4	0.4	54	0.64	0.58	86	0.26	0.26	118	0.44	0.44	150	0.32	0.34	182	0.42	0.42
23	0.32	0.32	55	0.14	0.18	87	0.18	0.28	119	0.54	0.54	151	0.36	0.46	183	0.64	0.68
24	0	0	56	0.54	0.54	88	0.28	0.3	120	0.02	0.02	152	0.2	0.2	184	0.56	0.64
25	0.14	0.14	57	0.66	0.66	89	0.12	0.12	121	0.36	0.34	153	0.2	0.2	185	0.34	0.24
26	0.4	0.42	58	0.12	0.12	90	0.4	0.34	122	0.38	0.44	154	0.18	0.18	186	0.4	0.42
27	0.24	0.24	59	0.06	0.06	91	0.34	0.32	123	0.48	0.48	155	0.24	0.24	187	0.12	0.16
28	0.48	0.5	60	0.58	0.56	92	0.44	0.46	124	0.3	0.38	156	0.58	0.58	188	0.12	0.12
29	0.56	0.54	61	0.46	0.44	93	0.5	0.5	125	0.56	0.56	157	0.1	0.1	189	0.02	0.06
30	0.16	0.16	62	0.3	0.3	94	0.3	0.3	126	0.28	0.28	158	0.6	0.6	190	0.22	0.2
31	0.38	0.38	63	0.52	0.52	95	0.4	0.4	127	0.14	0.14	159	0.16	0.14	191	0	0.04
32	0.32	0.32	64	0.32	0.32	96	0.26	0.26	128	0.1	0.1	160	0.26	0.32	192	0.2	0.24

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
193	0.4	0.4	225	0.16	0.16	257	0.28	0.28	289	0.54	0.54	321	0.2	0.2	353	0.08	0.08
194	0.06	0.08	226	0.8	0.78	258	0.5	0.52	290	0.4	0.4	322	0.12	0.12	354	0.36	0.42
195	0.42	0.44	227	0.22	0.22	259	0.42	0.44	291	0.58	0.62	323	0.84	0.74	355	0.04	0.04
196	0.5	0.5	228	0.22	0.22	260	0.42	0.42	292	0	0.1	324	0.52	0.48	356	0.62	0.56
197	0.14	0.14	229	0.46	0.38	261	0.7	0.7	293	0.1	0.1	325	0.18	0.18	357	0.4	0.4
198	0.9	0.76	230	0.32	0.32	262	0.14	0.14	294	0.42	0.42	326	0.6	0.64	358	0.12	0.12
199	0.4	0.4	231	0.42	0.36	263	0.38	0.38	295	0.34	0.34	327	0.26	0.26	359	0.7	0.66
200	0.34	0.34	232	0.34	0.34	264	0.38	0.38	296	0.02	0.04	328	0.48	0.48	360	0.32	0.32
201	0.26	0.26	233	0.74	0.74	265	0.12	0.12	297	0.38	0.38	329	0.54	0.54	361	0.16	0.16
202	0.3	0.36	234	0.2	0.04	266	0.38	0.38	298	0.1	0.1	330	0.42	0.4	362	0.48	0.54
203	0.2	0.2	235	0.48	0.48	267	0.2	0.2	299	0.26	0.26	331	0.48	0.48	363	0.36	0.38
204	0.26	0.26	236	0.06	0.04	268	0.36	0.36	300	0.58	0.64	332	0.38	0.4	364	0.46	0.46
205	0.38	0.38	237	0.44	0.44	269	0.16	0.16	301	0.16	0.16	333	0.24	0.24	365	0.46	0.36
206	0.16	0.16	238	0.16	0.16	270	0.22	0.22	302	0.4	0.4	334	0.42	0.42	366	0.54	0.64
207	0.42	0.52	239	0.3	0.3	271	0.48	0.48	303	0.52	0.66	335	0.54	0.54	367	0.2	0.2
208	0.16	0.14	240	0.3	0.32	272	0.1	0.1	304	0.24	0.24	336	0.64	0.74	368	0.52	0.52
209	0.58	0.52	241	0.44	0.44	273	0.42	0.42	305	0.14	0.22	337	0.66	0.64	369	0.56	0.58
210	0.18	0.18	242	0.44	0.44	274	0.2	0.16	306	0.14	0.14	338	0.28	0.28	370	0.54	0.52
211	0.5	0.5	243	0.04	0.06	275	0.1	0.1	307	0.4	0.38	339	0.14	0.14	371	0.2	0.16
212	0.58	0.58	244	0.44	0.44	276	0.18	0.18	308	0.32	0.32	340	0.48	0.48	372	0.36	0.42
213	0.58	0.54	245	0.12	0.12	277	0.34	0.3	309	0.3	0.3	341	0.36	0.34	373	0.34	0.34
214	0.32	0.4	246	0.4	0.36	278	0.32	0.26	310	0.54	0.54	342	0.36	0.36	374	0.56	0.56
215	0.1	0.12	247	0.38	0.38	279	0	0	311	0.54	0.4	343	0.48	0.52	375	0.52	0.54
216	0.56	0.56	248	0.64	0.66	280	0.36	0.36	312	0.38	0.58	344	0.18	0.2	376	0.18	0.2
217	0.12	0.1	249	0.24	0.24	281	0.56	0.58	313	0.1	0.1	345	0.44	0.44	377	0.52	0.52
218	0.42	0.42	250	0.46	0.54	282	0.24	0.26	314	0.5	0.5	346	0.48	0.46	378	0.28	0.28
219	0.36	0.38	251	0.26	0.26	283	0.08	0.06	315	0.38	0.38	347	0.5	0.5	379	0.18	0.18
220	0.5	0.5	252	0.54	0.54	284	0.36	0.36	316	0.36	0.36	348	0.48	0.48	380	0.06	0.04
221	0.6	0.6	253	0.56	0.62	285	0	0	317	0.7	0.36	349	0.38	0.38	381	0	0.4
222	0.3	0.36	254	0.42	0.46	286	0.14	0.14	318	0.56	0.52	350	0.4	0.38	382	0.14	0.14
223	0.28	0.22	255	0.4	0.4	287	0.32	0.32	319	0.22	0.22	351	0.42	0.42	383	0.58	0.58
224	0.06	0.06	256	0.24	0.24	288	0.26	0.28	320	0.22	0.22	352	0.66	0.68	384	0.76	0.74

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
385	0.62	0.62	417	0.74	0.72	449	0.3	0.3	481	0.18	0.18	513	0.2	0.34	545	0.26	0.26
386	0.2	0.36	418	0.38	0.36	450	0.68	0.68	482	0.52	0.52	514	0.04	0.08	546	0.42	0.42
387	0.68	0.68	419	0.32	0.32	451	0.54	0.52	483	0.1	0.1	515	0.4	0.4	547	0.24	0.24
388	0.38	0.38	420	0.44	0.44	452	0.16	0.16	484	0.36	0.36	516	0.52	0.36	548	0.14	0.14
389	0.4	0.36	421	0.56	0.6	453	0.3	0.3	485	0.24	0.34	517	0.5	0.44	549	0.14	0.14
390	0.28	0.48	422	0.66	0.64	454	0.64	0.64	486	0.2	0.22	518	0.16	0.18	550	0.04	0.04
391	0.72	0.72	423	0.28	0.26	455	0.06	0.24	487	0.6	0.6	519	0.26	0.24	551	0.5	0.5
392	0.08	0.08	424	0.48	0.48	456	0.44	0.42	488	0.28	0.28	520	0.12	0.12	552	0.42	0.42
393	0.48	0.48	425	0.14	0.18	457	0.26	0.26	489	0.04	0.1	521	0.2	0.2	553	0.1	0.1
394	0.62	0.6	426	0.18	0.2	458	0.14	0.2	490	0.16	0.16	522	0.02	0.62	554	0.48	0.48
395	0.18	0.32	427	0.58	0.56	459	0.4	0.42	491	0.06	0.12	523	0.5	0.56	555	0.32	0.34
396	0.54	0.54	428	0.18	0.2	460	0.3	0.42	492	0.44	0.44	524	0.08	0.08	556	0.1	0.1
397	0.7	0.7	429	0.22	0.22	461	0.64	0.64	493	0.16	0.16	525	0.02	0.34	557	0.66	0.66
398	0.3	0.3	430	0.1	0.1	462	0.14	0.14	494	0.12	0.12	526	0.24	0.24	558	0.52	0.52
399	0.44	0.5	431	0.26	0.26	463	0.06	0.08	495	0.12	0.16	527	0.18	0.18	559	0.26	0.26
400	0	0.14	432	0.12	0.1	464	0.36	0.36	496	0.5	0.5	528	0.2	0.2	560	0.24	0.32
401	0.32	0.42	433	0.72	0.68	465	0.1	0.1	497	0.3	0.38	529	0.12	0.12	561	0.48	0.52
402	0.4	0.4	434	0.4	0.44	466	0.26	0.26	498	0.56	0.56	530	0.12	0.12	562	0.08	0.08
403	0.12	0.28	435	0.4	0.4	467	0.1	0.1	499	0.38	0.38	531	0.42	0.42	563	0.26	0.26
404	0.34	0.34	436	0.28	0.28	468	0.44	0.3	500	0.14	0.14	532	0.2	0.2	564	0.56	0.6
405	0.38	0.44	437	0.66	0.66	469	0.22	0.22	501	0.52	0.36	533	0.34	0.34	565	0.2	0.24
406	0.12	0.14	438	0.44	0.44	470	0.5	0.56	502	0.02	0.04	534	0.2	0.16	566	0.76	0.76
407	0.56	0.56	439	0.18	0.18	471	0.48	0.48	503	0.18	0.22	535	0.4	0.4	567	0.48	0.5
408	0.52	0.52	440	0.24	0.24	472	0.58	0.56	504	0.18	0.18	536	0.78	0.78	568	0.12	0.12
409	0.38	0.38	441	0.1	0.1	473	0.36	0.36	505	0.44	0.44	537	0.44	0.44	569	0.58	0.66
410	0.32	0.32	442	0.5	0.5	474	0.18	0.18	506	0.28	0.32	538	0.32	0.32	570	0.08	0.08
411	0.46	0.46	443	0.32	0.34	475	0.46	0.66	507	0.58	0.5	539	0.48	0.52	571	0.32	0.32
412	0.78	0.62	444	0.38	0.38	476	0.24	0.24	508	0.12	0.12	540	0.16	0.1	572	0.6	0.6
413	0.12	0.16	445	0.12	0.12	477	0.52	0.52	509	0.58	0.6	541	0.62	0.68	573	0.02	0.02
414	0.4	0.4	446	0.14	0.46	478	0.64	0.64	510	0.24	0.24	542	0.08	0.08	574	0.34	0.34
415	0.12	0.34	447	0.28	0.28	479	0.14	0.12	511	0.58	0.58	543	0.32	0.26	575	0.12	0.18
416	0.48	0.68	448	0.1	0.08	480	0.02	0.04	512	0.5	0.5	544	0.08	0.08	576	0.32	0.46

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
577	0.24	0.24	609	0.14	0.12	641	0.22	0.18	673	0.04	0.04	705	0.02	0.02	737	0.24	0.24
578	0.36	0.38	610	0.5	0.54	642	0.08	0.08	674	0.26	0.26	706	0.2	0.28	738	0.36	0.4
579	0.34	0.36	611	0.36	0.36	643	0.02	0	675	0.26	0.2	707	0.38	0.38	739	0.4	0.4
580	0.42	0.42	612	0.12	0.12	644	0	0	676	0.26	0.26	708	0.42	0.42	740	0.06	0.14
581	0.32	0.28	613	0.34	0.34	645	0.64	0.66	677	0.32	0.34	709	0.6	0.62	741	0.52	0.52
582	0.04	0.04	614	0.36	0.4	646	0.46	0.46	678	0.42	0.46	710	0.26	0.26	742	0.44	0.42
583	0.64	0.6	615	0.22	0.22	647	0.42	0.42	679	0.4	0.36	711	0.44	0.48	743	0.16	0.14
584	0.52	0.52	616	0.1	0.1	648	0.08	0.08	680	0.26	0.26	712	0.08	0.08	744	0.16	0.16
585	0.2	0.2	617	0.4	0.4	649	0.44	0.4	681	0.1	0.16	713	0.26	0.24	745	0.1	0.1
586	0.38	0.52	618	0.2	0.2	650	0.16	0.16	682	0.24	0.28	714	0.38	0.38	746	0.1	0.44
587	0.08	0.08	619	0.08	0.08	651	0.1	0.16	683	0.62	0.62	715	0.04	0.04	747	0.24	0.26
588	0.34	0.34	620	0.16	0.16	652	0.42	0.5	684	0.22	0.22	716	0.04	0.04	748	0.38	0.46
589	0.54	0.62	621	0.38	0.38	653	0.74	0.7	685	0.24	0.24	717	0.38	0.38	749	0.14	0.14
590	0.14	0.14	622	0.52	0.52	654	0.54	0.54	686	0.64	0.58	718	0.26	0.26	750	0.34	0.3
591	0.68	0.68	623	0.52	0.52	655	0.3	0.36	687	0.4	0.46	719	0.48	0.48	751	0.6	0.38
592	0.18	0.18	624	0.4	0.4	656	0.12	0.12	688	0.56	0.56	720	0.48	0.5	752	0.82	0.7
593	0.1	0.1	625	0.08	0.08	657	0.42	0.42	689	0.42	0.42	721	0	0	753	0.68	0.62
594	0.16	0.16	626	0.1	0.1	658	0.5	0.62	690	0.52	0.52	722	0.08	0.08	754	0.44	0.44
595	0.3	0.3	627	0.44	0.44	659	0.32	0.32	691	0.04	0.04	723	0.8	0.78	755	0.6	0.6
596	0.62	0.56	628	0.08	0.08	660	0.5	0.48	692	0.26	0.26	724	0.3	0.3	756	0.6	0.46
597	0.42	0.42	629	0.04	0.04	661	0.14	0.14	693	0.18	0.18	725	0.38	0.34	757	0.84	0.66
598	0.02	0.02	630	0.44	0.58	662	0.56	0.56	694	0.06	0.04	726	0.42	0.46	758	0.36	0.36
599	0.04	0.44	631	0.46	0.46	663	0.1	0.1	695	0.04	0.04	727	0.14	0.14	759	0.56	0.56
600	0.36	0.38	632	0.3	0.3	664	0.62	0.62	696	0.1	0.1	728	0.46	0.44	760	0.8	0.04
601	0.26	0.26	633	0.46	0.46	665	0.58	0.52	697	0.38	0.38	729	0.28	0.28	761	0.42	0.44
602	0.02	0.46	634	0.54	0.52	666	0.26	0.26	698	0.38	0.38	730	0.74	0.72	762	0.1	0.04
603	0.22	0.22	635	0	0	667	0.4	0.38	699	0.18	0.18	731	0.2	0.2	763	0.68	0.68
604	0.28	0.34	636	0.5	0.58	668	0.24	0.24	700	0.82	0.64	732	0.18	0.18	764	0.16	0.16
605	0.64	0.66	637	0.12	0.12	669	0.06	0.12	701	0.46	0.46	733	0.28	0.28	765	0.24	0.18
606	0	0	638	0.4	0.4	670	0.24	0.24	702	0.36	0.38	734	0.34	0.32	766	0.54	0.24
607	0.28	0.28	639	0.3	0.3	671	0.44	0.44	703	0.52	0.66	735	0.04	0.04	767	0.28	0.1
608	0.4	0.4	640	0.34	0.34	672	0.5	0.5	704	0.38	0.48	736	0.42	0.42	768	0.48	0.5

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
769	0.64	0.66	801	0.2	0.2	833	0.04	0.12	865	0.62	0.6	897	0.42	0.44	929	0.4	0.42
770	0.58	0.58	802	0.16	0.16	834	0.32	0.32	866	0.54	0.6	898	0.18	0.2	930	0.26	0.26
771	0.54	0.54	803	0.5	0.32	835	0.44	0.46	867	0.46	0.46	899	0.7	0.56	931	0.44	0.46
772	0.48	0.48	804	0.2	0.04	836	0.56	0.46	868	0.6	0.62	900	0.12	0.12	932	0.32	0.34
773	0.74	0.6	805	0.38	0.38	837	0.78	0.7	869	0.2	0.2	901	0.16	0.16	933	0.2	0.22
774	0.52	0.52	806	0.62	0.62	838	0.64	0.52	870	0.56	0.56	902	0.48	0.5	934	0.4	0.42
775	0.52	0.56	807	0.66	0.44	839	0.24	0.24	871	0.4	0.44	903	0.2	0.2	935	0.26	0.26
776	0.54	0.54	808	0.46	0.38	840	0.3	0.3	872	0.32	0.26	904	0.24	0.32	936	0.54	0.54
777	0.64	0.64	809	0.56	0.48	841	0.56	0.56	873	0.42	0.4	905	0.46	0.46	937	0.28	0.3
778	0.46	0.34	810	0.64	0.56	842	0.4	0.4	874	0.3	0.3	906	0.24	0.24	938	0.54	0.54
779	0.56	0.14	811	0.68	0.3	843	0.1	0.1	875	0.08	0.08	907	0.28	0.38	939	0.08	0.08
780	0.5	0.5	812	0.34	0.28	844	0.56	0.56	876	0.48	0.52	908	0.36	0.36	940	0.3	0.26
781	0.16	0.28	813	0.18	0.12	845	0.54	0.58	877	0.16	0.16	909	0.2	0.22	941	0.26	0.34
782	0.24	0.16	814	0.34	0.48	846	0.1	0.1	878	0.32	0.28	910	0.54	0.54	942	0.2	0.3
783	0.28	0.26	815	0.42	0.42	847	0.14	0.48	879	0.24	0.26	911	0.26	0.26	943	0.12	0.14
784	0.78	0.74	816	0.64	0.64	848	0.08	0.08	880	0.22	0.22	912	0.54	0.54	944	0.46	0.44
785	0.68	0.68	817	0.34	0.32	849	0.6	0.62	881	0.48	0.48	913	0.4	0.24	945	0.58	0.6
786	0.4	0.42	818	0.24	0.04	850	0.76	0.76	882	0.4	0.4	914	0.8	0.78	946	0.26	0.24
787	0.66	0.68	819	0.34	0.34	851	0.42	0.34	883	0.3	0.42	915	0.58	0.58	947	0.38	0.4
788	0.26	0.24	820	0.48	0.34	852	0.58	0.6	884	0.6	0.6	916	0.4	0.4	948	0.42	0.5
789	0.66	0.66	821	0.12	0.1	853	0.28	0.3	885	0.48	0.5	917	0.3	0.3	949	0.34	0.34
790	0.2	0.2	822	0.28	0.28	854	0.34	0.34	886	0.34	0.34	918	0.3	0.44	950	0.58	0.54
791	0.28	0.44	823	0.54	0.42	855	0.58	0.64	887	0.24	0.24	919	0.34	0.34	951	0.62	0.54
792	0.38	0.42	824	0.34	0.36	856	0.06	0.06	888	0.48	0.48	920	0.18	0.18	952	0.04	0.04
793	0.5	0.2	825	0.58	0.6	857	0.32	0.32	889	0.52	0.58	921	0.5	0.32	953	0.84	0.78
794	0.18	0.14	826	0.2	0.12	858	0.2	0.16	890	0.4	0.4	922	0.3	0.3	954	0.08	0.08
795	0.54	0.5	827	0.24	0.24	859	0.4	0.38	891	0.2	0.16	923	0.2	0.3	955	0.04	0.06
796	0.4	0.18	828	0.62	0.62	860	0.6	0.6	892	0.54	0.56	924	0.04	0.04	956	0.54	0.48
797	0.62	0.6	829	0.38	0.38	861	0.18	0.22	893	0.22	0.22	925	0.36	0.36	957	0.42	0.42
798	0.22	0.16	830	0.3	0.22	862	0.52	0.54	894	0.38	0.38	926	0.06	0.14	958	0.4	0.4
799	0.6	0.58	831	0.06	0.06	863	0.24	0.24	895	0.62	0.62	927	0.16	0.22	959	0.28	0.26
800	0.42	0.42	832	0.06	0.06	864	0.08	0.08	896	0.42	0.44	928	0.28	0.28	960	0.3	0.3

Appendix 5c. Misclassification Rates for Scenario 3 with one predictor (Random Data)

Misclassification Rates with one predictor variable					
Run#	OLR	ANN	Run#	OLR	ANN
961	0.22	0.22	993	0.34	0.32
962	0.14	0.38	994	0.08	0.08
963	0.56	0.58	995	0.46	0.46
964	0.38	0.36	996	0.24	0.24
965	0.5	0.38	997	0.48	0.48
966	0.08	0.1	998	0.28	0.28
967	0.42	0.42	999	0.4	0.4
968	0.58	0.58	1000	0.32	0.32
969	0.34	0.32			
970	0.42	0.42			
971	0.36	0.38			
972	0.54	0.54			
973	0.06	0.06			
974	0.14	0.14			
975	0.44	0.44			
976	0.16	0.18			
977	0.16	0.16			
978	0	0			
979	0.36	0.32			
980	0.34	0.32			
981	0.48	0.48			
982	0.42	0.32			
983	0.44	0.44			
984	0.64	0.58			
985	0.36	0.36			
986	0.26	0.28			
987	0.62	0.64			
988	0.08	0.08			
989	0.78	0.58			
990	0.3	0.3			
991	0.3	0.34			
992	0.6	0.4			

Appendix 6a. Misclassification Rates for Scenario 1 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.34	0.4	31	0.18	0.1	61	0.14	0.16	91	0.22	0.18	121	0.14	0.2	151	0.16	0.14
2	0.14	0.18	32	0.26	0.28	62	0.28	0.4	92	0.12	0.04	122	0.1	0.12	152	0.16	0.04
3	0.16	0.16	33	0.1	0.12	63	0.18	0.12	93	0.3	0.26	123	0.6	0.18	153	0.16	0.2
4	0.24	0.16	34	0.1	0.1	64	0.26	0.3	94	0.14	0.2	124	0.26	0.26	154	0.22	0.12
5	0.12	0.14	35	0.16	0.16	65	0.18	0.58	95	0.22	0.22	125	0.14	0.26	155	0.24	0.14
6	0.14	0.18	36	0.12	0.12	66	0.26	0.16	96	0.14	0.2	126	0.2	0.2	156	0.26	0.24
7	0.12	0.12	37	0.04	0.12	67	0.1	0.12	97	0.18	0.2	127	0.22	0.22	157	0.1	0.1
8	0.2	0.2	38	0.46	0.26	68	0.16	0.2	98	0.2	0.22	128	0.1	0.14	158	0.16	0.16
9	0.26	0.28	39	0.2	0.08	69	0.18	0.16	99	0.18	0.16	129	0.26	0.26	159	0.24	0.24
10	0.12	0.12	40	0.12	0.14	70	0.24	0.08	100	0.08	0.1	130	0.12	0.1	160	0.16	0.18
11	0.24	0.22	41	0.2	0.1	71	0.16	0.2	101	0.08	0.1	131	0.18	0.24	161	0.2	0.16
12	0.24	0.28	42	0.16	0.2	72	0.16	0.24	102	0.16	0.26	132	0.12	0.14	162	0.14	0.16
13	0.14	0.12	43	0.24	0.28	73	0.36	0.4	103	0.18	0.18	133	0.16	0.14	163	0.28	0.22
14	0.16	0.24	44	0.16	0.16	74	0.22	0.18	104	0.28	0.18	134	0.14	0.12	164	0.22	0.24
15	0.26	0.24	45	0.2	0.2	75	0.28	0.32	105	0.3	0.22	135	0.18	0.18	165	0.18	0.2
16	0.1	0.08	46	0.18	0.14	76	0.24	0.2	106	0.22	0.12	136	0.12	0.22	166	0.1	0.18
17	0.06	0.06	47	0.1	0.14	77	0.18	0.22	107	0.2	0.24	137	0.08	0.08	167	0.14	0.14
18	0.3	0.24	48	0.32	0.18	78	0.1	0.1	108	0.14	0.24	138	0.26	0.3	168	0.14	0.14
19	0.22	0.26	49	0.2	0.18	79	0.24	0.18	109	0.16	0.16	139	0.22	0.58	169	0.1	0.06
20	0.36	0.34	50	0.14	0.18	80	0.28	0.22	110	0.24	0.26	140	0.26	0.34	170	0.3	0.34
21	0.14	0.16	51	0.26	0.26	81	0.16	0.24	111	0.22	0.22	141	0.14	0.22	171	0.08	0.12
22	0.2	0.18	52	0.26	0.14	82	0.12	0.14	112	0.22	0.16	142	0.2	0.2	172	0.24	0.2
23	0.24	0.18	53	0.12	0.12	83	0.28	0.26	113	0.16	0.18	143	0.24	0.22	173	0.16	0.16
24	0.24	0.34	54	0.28	0.26	84	0.3	0.24	114	0.14	0.18	144	0.2	0.2	174	0.16	0.22
25	0.18	0.18	55	0.18	0.18	85	0.28	0.32	115	0.18	0.16	145	0.16	0.16	175	0.22	0.26
26	0.22	0.24	56	0.3	0.16	86	0.08	0.06	116	0.22	0.2	146	0.24	0.22	176	0.36	0.32
27	0.12	0.08	57	0.12	0.14	87	0.18	0.12	117	0.2	0.16	147	0.28	0.26	177	0.28	0.2
28	0.26	0.22	58	0.24	0.18	88	0.18	0.24	118	0.18	0.16	148	0.22	0.22	178	0.24	0.18
29	0.26	0.22	59	0.16	0.14	89	0.2	0.2	119	0.14	0.14	149	0.24	0.24	179	0.18	0.18
30	0.1	0.1	60	0.24	0.32	90	0.16	0.26	120	0.2	0.24	150	0.24	0.2	180	0.1	0.12

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Appendix 6a. Misclassification Rates for Scenario 1 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
181	0.18	0.22	211	0.24	0.42	241	0.08	0.16	271	0.3	0.3	301	0.18	0.24	331	0.24	0.24
182	0.18	0.08	212	0.24	0.2	242	0.24	0.24	272	0.18	0.18	302	0.14	0.26	332	0.12	0.12
183	0.08	0.12	213	0.16	0.12	243	0.2	0.18	273	0.18	0.14	303	0.22	0.22	333	0.26	0.2
184	0.24	0.2	214	0.24	0.22	244	0.14	0.14	274	0.18	0.12	304	0.16	0.2	334	0.28	0.1
185	0.1	0.12	215	0.24	0.22	245	0.18	0.16	275	0.2	0.2	305	0.3	0.34	335	0.18	0.18
186	0.1	0.14	216	0.12	0.2	246	0.16	0.18	276	0.18	0.24	306	0.18	0.26	336	0.1	0.1
187	0.08	0.08	217	0.02	0.02	247	0.18	0.16	277	0.14	0.24	307	0.14	0.2	337	0.2	0.24
188	0.16	0.22	218	0.16	0.22	248	0.14	0.22	278	0.16	0.16	308	0.12	0.14	338	0.12	0.16
189	0.2	0.22	219	0.26	0.3	249	0.16	0.16	279	0.12	0.1	309	0.2	0.26	339	0.24	0.28
190	0.22	0.24	220	0.14	0.08	250	0.16	0.14	280	0.22	0.12	310	0.18	0.12	340	0.24	0.32
191	0.3	0.2	221	0.16	0.14	251	0.14	0.12	281	0.24	0.2	311	0.14	0.22	341	0.14	0.14
192	0.18	0.2	222	0.26	0.18	252	0.14	0.16	282	0.22	0.2	312	0.24	0.3	342	0.22	0.14
193	0.1	0.1	223	0.1	0.18	253	0.14	0.12	283	0.26	0.2	313	0.34	0.26	343	0.14	0.12
194	0.24	0.24	224	0.22	0.24	254	0.18	0.12	284	0.24	0.2	314	0.16	0.2	344	0.16	0.26
195	0.22	0.1	225	0.14	0.1	255	0.14	0.14	285	0.26	0.24	315	0.2	0.24	345	0.16	0.14
196	0.26	0.28	226	0.1	0.08	256	0.08	0.1	286	0.24	0.26	316	0.28	0.12	346	0.18	0.12
197	0.14	0.14	227	0.32	0.34	257	0.14	0.22	287	0.24	0.18	317	0.24	0.26	347	0.1	0.1
198	0.16	0.24	228	0.2	0.18	258	0.2	0.1	288	0.14	0.14	318	0.1	0.1	348	0.14	0.16
199	0.14	0.06	229	0.14	0.12	259	0.12	0.2	289	0.24	0.18	319	0.32	0.26	349	0.16	0.16
200	0.14	0.12	230	0.24	0.32	260	0.2	0.16	290	0.12	0.14	320	0.22	0.3	350	0.12	0.14
201	0.18	0.18	231	0.12	0.22	261	0.12	0.12	291	0.16	0.14	321	0.22	0.14	351	0.18	0.26
202	0.2	0.22	232	0.26	0.24	262	0.22	0.22	292	0.14	0.18	322	0.24	0.24	352	0.18	0.14
203	0.2	0.32	233	0.16	0.16	263	0.14	0.18	293	0.08	0.06	323	0.2	0.24	353	0.14	0.14
204	0.16	0.24	234	0.16	0.16	264	0.12	0.14	294	0.12	0.12	324	0.18	0.18	354	0.28	0.34
205	0.16	0.12	235	0.12	0.14	265	0.12	0.22	295	0.2	0.22	325	0.22	0.16	355	0.22	0.26
206	0.26	0.26	236	0.3	0.26	266	0.18	0.32	296	0.28	0.3	326	0.06	0.06	356	0.16	0.14
207	0.14	0.16	237	0.12	0.14	267	0.16	0.18	297	0.22	0.26	327	0.16	0.22	357	0.3	0.24
208	0.12	0.2	238	0.1	0.12	268	0.2	0.22	298	0.08	0.08	328	0.34	0.2	358	0.2	0.22
209	0.3	0.1	239	0.14	0.14	269	0.08	0.08	299	0.32	0.4	329	0.1	0.08	359	0.26	0.28
210	0.2	0.26	240	0.12	0.22	270	0.1	0.12	300	0.16	0.2	330	0.16	0.1	360	0.12	0.08

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Appendix 6a. Misclassification Rates for Scenario 1 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
361	0.18	0.18	391	0.22	0.2	421	0.22	0.24	451	0.18	0.28	481	0.14	0.24	511	0.16	0.22
362	0.12	0.12	392	0.16	0.14	422	0.2	0.2	452	0.1	0.18	482	0.22	0.22	512	0.1	0.06
363	0.24	0.18	393	0.1	0.18	423	0.12	0.08	453	0.12	0.12	483	0.2	0.2	513	0.14	0.14
364	0.08	0.08	394	0.14	0.22	424	0.22	0.22	454	0.2	0.2	484	0.3	0.48	514	0.16	0.1
365	0.22	0.26	395	0.14	0.18	425	0.14	0.3	455	0.18	0.16	485	0.26	0.26	515	0.18	0.12
366	0.26	0.2	396	0.16	0.16	426	0.16	0.14	456	0.14	0.14	486	0.14	0.12	516	0.2	0.12
367	0.22	0.22	397	0.28	0.34	427	0.12	0.16	457	0.36	0.22	487	0.26	0.26	517	0.22	0.22
368	0.22	0.24	398	0.14	0.2	428	0.14	0.18	458	0.16	0.2	488	0.12	0.1	518	0.16	0.3
369	0.22	0.14	399	0.08	0.14	429	0.14	0.2	459	0.14	0.14	489	0.22	0.2	519	0.14	0.24
370	0.2	0.2	400	0.18	0.14	430	0.26	0.26	460	0.22	0.2	490	0.06	0.06	520	0.28	0.34
371	0.22	0.26	401	0.32	0.36	431	0.12	0.12	461	0.14	0.08	491	0.3	0.18	521	0.14	0.42
372	0.12	0.14	402	0.12	0.18	432	0.14	0.16	462	0.12	0.08	492	0.2	0.28	522	0.18	0.2
373	0.16	0.18	403	0.24	0.18	433	0.18	0.16	463	0.22	0.18	493	0.18	0.18	523	0.18	0.16
374	0.22	0.22	404	0.28	0.28	434	0.2	0.22	464	0.14	0.04	494	0.14	0.12	524	0.14	0.14
375	0.2	0.22	405	0.12	0.1	435	0.12	0.12	465	0.2	0.2	495	0.12	0.24	525	0.18	0.2
376	0.2	0.14	406	0.18	0.24	436	0.12	0.12	466	0.16	0.2	496	0.1	0.12	526	0.32	0.3
377	0.14	0.16	407	0.1	0.12	437	0.26	0.18	467	0.22	0.2	497	0.16	0.24	527	0.24	0.2
378	0.14	0.14	408	0.18	0.2	438	0.08	0.12	468	0.26	0.26	498	0.06	0.08	528	0.14	0.16
379	0.14	0.14	409	0.04	0.08	439	0.12	0.12	469	0.2	0.18	499	0.16	0.2	529	0.26	0.32
380	0.22	0.22	410	0.22	0.2	440	0.1	0.18	470	0.14	0.14	500	0.04	0.04	530	0.2	0.22
381	0.18	0.12	411	0.16	0.12	441	0.14	0.44	471	0.14	0.18	501	0.12	0.12	531	0.18	0.2
382	0.22	0.24	412	0.22	0.3	442	0.08	0.08	472	0.16	0.12	502	0.18	0.2	532	0.18	0.28
383	0.2	0.14	413	0.08	0.1	443	0.12	0.1	473	0.14	0.16	503	0.1	0.44	533	0.18	0.14
384	0.22	0.18	414	0.24	0.26	444	0.18	0.18	474	0.14	0.12	504	0.22	0.22	534	0.16	0.16
385	0.24	0.3	415	0.22	0.24	445	0.18	0.1	475	0.26	0.26	505	0.08	0.08	535	0.16	0.16
386	0.14	0.36	416	0.18	0.22	446	0.2	0.22	476	0.12	0.1	506	0.22	0.18	536	0.2	0.16
387	0.12	0.12	417	0.1	0.12	447	0.22	0.22	477	0.16	0.16	507	0.12	0.1	537	0.1	0.1
388	0.26	0.3	418	0.16	0.14	448	0.06	0.02	478	0.2	0.22	508	0.06	0.12	538	0.2	0.16
389	0.26	0.24	419	0.14	0.14	449	0.24	0.42	479	0.22	0.22	509	0.2	0.46	539	0.16	0.2
390	0.16	0.24	420	0.08	0.12	450	0.14	0.16	480	0.18	0.24	510	0.22	0.22	540	0.2	0.18

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Appendix 6a. Misclassification Rates for Scenario 1 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
541	0.22	0.26	571	0.16	0.2	601	0.24	0.24	631	0.16	0.18	661	0.14	0.28	691	0.2	0.26
542	0.24	0.26	572	0.18	0.14	602	0.12	0.14	632	0.2	0.1	662	0.26	0.26	692	0.22	0.22
543	0.12	0.12	573	0.14	0.22	603	0.3	0.22	633	0.18	0.14	663	0.18	0.22	693	0.14	0.14
544	0.18	0.24	574	0.08	0.04	604	0.18	0.18	634	0.26	0.34	664	0.22	0.22	694	0.26	0.28
545	0.16	0.12	575	0.18	0.16	605	0.3	0.22	635	0.24	0.12	665	0.26	0.32	695	0.2	0.14
546	0.18	0.1	576	0.12	0.2	606	0.14	0.34	636	0.14	0.14	666	0.12	0.16	696	0.06	0.06
547	0.18	0.14	577	0.14	0.16	607	0.14	0.18	637	0.22	0.22	667	0.18	0.16	697	0.26	0.28
548	0.18	0.16	578	0.22	0.26	608	0.16	0.16	638	0.3	0.24	668	0.14	0.18	698	0.14	0.12
549	0.18	0.22	579	0.28	0.28	609	0.18	0.24	639	0.18	0.18	669	0.22	0.26	699	0.12	0.12
550	0.08	0.12	580	0.22	0.32	610	0.28	0.36	640	0.16	0.22	670	0.24	0.24	700	0.24	0.18
551	0.26	0.28	581	0.14	0.12	611	0.12	0.18	641	0.24	0.24	671	0.28	0.26	701	0.26	0.24
552	0.18	0.22	582	0.1	0.14	612	0.14	0.14	642	0.2	0.18	672	0.22	0.22	702	0.18	0.2
553	0.2	0.18	583	0.16	0.16	613	0.3	0.28	643	0.12	0.14	673	0.26	0.22	703	0.12	0.16
554	0.08	0.08	584	0.12	0.12	614	0.2	0.2	644	0.12	0.12	674	0.16	0.1	704	0.12	0.12
555	0.2	0.24	585	0.2	0.22	615	0.16	0.12	645	0.18	0.2	675	0.2	0.2	705	0.12	0.12
556	0.18	0.14	586	0.2	0.22	616	0.1	0.12	646	0.08	0.06	676	0.2	0.2	706	0.08	0.1
557	0.18	0.22	587	0.3	0.26	617	0.14	0.1	647	0.16	0.26	677	0.2	0.18	707	0.16	0.2
558	0.22	0.22	588	0.2	0.18	618	0.28	0.34	648	0.1	0.12	678	0.26	0.22	708	0.28	0.36
559	0.12	0.14	589	0.12	0.12	619	0.18	0.14	649	0.34	0.36	679	0.16	0.22	709	0.26	0.22
560	0.06	0.14	590	0.1	0.16	620	0.26	0.24	650	0.2	0.24	680	0.22	0.26	710	0.08	0.04
561	0.16	0.2	591	0.18	0.18	621	0.24	0.46	651	0.16	0.22	681	0.14	0.26	711	0.2	0.2
562	0.14	0.2	592	0.36	0.28	622	0.14	0.26	652	0.1	0.28	682	0.12	0.2	712	0.12	0.14
563	0.2	0.36	593	0.2	0.22	623	0.12	0.1	653	0.26	0.32	683	0.2	0.2	713	0.24	0.14
564	0.16	0.18	594	0.14	0.18	624	0.2	0.24	654	0.1	0.12	684	0.14	0.14	714	0.2	0.24
565	0.22	0.22	595	0.26	0.22	625	0.12	0.16	655	0.18	0.12	685	0.12	0.22	715	0.14	0.34
566	0.2	0.2	596	0.1	0.16	626	0.2	0.18	656	0.18	0.16	686	0.24	0.22	716	0.1	0.14
567	0.14	0.14	597	0.16	0.18	627	0.2	0.18	657	0.24	0.24	687	0.2	0.18	717	0.14	0.22
568	0.18	0.2	598	0.26	0.22	628	0.16	0.16	658	0.22	0.18	688	0.12	0.14	718	0.12	0.12
569	0.14	0.12	599	0.2	0.18	629	0.22	0.2	659	0.18	0.2	689	0.22	0.14	719	0.26	0.26
570	0.14	0.14	600	0.18	0.2	630	0.18	0.2	660	0.16	0.18	690	0.06	0.06	720	0.12	0.14

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Appendix 6a. Misclassification Rates for Scenario 1 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
721	0.3	0.28	751	0.14	0.14	781	0.2	0.14	811	0.16	0.24	841	0.36	0.32	871	0.18	0.18
722	0.2	0.22	752	0.26	0.26	782	0.12	0.22	812	0.18	0.2	842	0.48	0.5	872	0.2	0.18
723	0.08	0.26	753	0.2	0.28	783	0.2	0.18	813	0.14	0.18	843	0.18	0.2	873	0.1	0.1
724	0.3	0.14	754	0.3	0.3	784	0.08	0.1	814	0.12	0.16	844	0.26	0.22	874	0.1	0.08
725	0.12	0.16	755	0.16	0.16	785	0.3	0.28	815	0.18	0.14	845	0.1	0.16	875	0.22	0.14
726	0.08	0.12	756	0.24	0.22	786	0.24	0.28	816	0.2	0.24	846	0.32	0.32	876	0.2	0.24
727	0.26	0.28	757	0.16	0.2	787	0.22	0.22	817	0.22	0.18	847	0.2	0.12	877	0.16	0.14
728	0.26	0.22	758	0.1	0.14	788	0.2	0.26	818	0.1	0.14	848	0.24	0.24	878	0.08	0.1
729	0.08	0.1	759	0.14	0.1	789	0.14	0.22	819	0.18	0.12	849	0.16	0.18	879	0.38	0.34
730	0.16	0.2	760	0.24	0.16	790	0.22	0.26	820	0.2	0.16	850	0.24	0.18	880	0.2	0.22
731	0.2	0.18	761	0.16	0.22	791	0.06	0.08	821	0.4	0.36	851	0.12	0.16	881	0.22	0.24
732	0.22	0.26	762	0.22	0.32	792	0.16	0.14	822	0.16	0.16	852	0.16	0.16	882	0.2	0.12
733	0.16	0.18	763	0.08	0.08	793	0.14	0.14	823	0.16	0.22	853	0.16	0.16	883	0.14	0.12
734	0.14	0.12	764	0.2	0.38	794	0.12	0.1	824	0.22	0.2	854	0.12	0.12	884	0.12	0.14
735	0.16	0.28	765	0.16	0.14	795	0.16	0.24	825	0.18	0.3	855	0.24	0.24	885	0.12	0.18
736	0.08	0.08	766	0.26	0.18	796	0.14	0.16	826	0.26	0.14	856	0.24	0.24	886	0.14	0.38
737	0.26	0.24	767	0.3	0.34	797	0.14	0.2	827	0.2	0.22	857	0.18	0.22	887	0.16	0.16
738	0.16	0.18	768	0.14	0.14	798	0.16	0.2	828	0.22	0.24	858	0.14	0.2	888	0.04	0.14
739	0.14	0.16	769	0.12	0.14	799	0.08	0.12	829	0.26	0.28	859	0.12	0.08	889	0.1	0.12
740	0.2	0.18	770	0.14	0.06	800	0.28	0.2	830	0.2	0.24	860	0.16	0.2	890	0.22	0.22
741	0.08	0.08	771	0.06	0.16	801	0.12	0.16	831	0.2	0.22	861	0.16	0.2	891	0.12	0.12
742	0.12	0.1	772	0.18	0.18	802	0.14	0.12	832	0.24	0.22	862	0.28	0.2	892	0.28	0.18
743	0.26	0.24	773	0.22	0.22	803	0.18	0.22	833	0.16	0.16	863	0.22	0.24	893	0.18	0.1
744	0.26	0.22	774	0.2	0.18	804	0.2	0.18	834	0.34	0.38	864	0.16	0.12	894	0.12	0.24
745	0.12	0.12	775	0.36	0.3	805	0.18	0.1	835	0.22	0.16	865	0.24	0.2	895	0.22	0.22
746	0.18	0.2	776	0.1	0.14	806	0.12	0.14	836	0.22	0.2	866	0.18	0.16	896	0.18	0.2
747	0.18	0.22	777	0.18	0.18	807	0.22	0.2	837	0.14	0.14	867	0.14	0.14	897	0.2	0.2
748	0.24	0.28	778	0.38	0.38	808	0.08	0.08	838	0.12	0.1	868	0.1	0.1	898	0.12	0.04
749	0.06	0.06	779	0.12	0.1	809	0.14	0.14	839	0.2	0.18	869	0.06	0.22	899	0.22	0.2
750	0.2	0.16	780	0.1	0.1	810	0.3	0.22	840	0.24	0.36	870	0.1	0.06	900	0.26	0.28

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Appendix 6a. Misclassification Rates for Scenario 2 with three predictor variables (Taylors' Data)

Misclassification Rates with three predictor variables											
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
901	0.14	0.24	931	0.34	0.26	961	0.2	0.2	991	0.2	0.2
902	0.16	0.24	932	0.26	0.28	962	0.14	0.1	992	0.2	0.2
903	0.18	0.18	933	0.14	0.12	963	0.22	0.2	993	0.12	0.08
904	0.18	0.22	934	0.1	0.12	964	0.14	0.22	994	0.26	0.26
905	0.12	0.16	935	0.22	0.22	965	0.24	0.24	995	0.14	0.26
906	0.04	0.04	936	0.16	0.18	966	0.2	0.18	996	0.22	0.32
907	0.06	0.16	937	0.16	0.18	967	0.18	0.16	997	0.16	0.22
908	0.1	0.18	938	0.26	0.28	968	0.16	0.2	998	0.18	0.26
909	0.2	0.18	939	0.2	0.24	969	0.24	0.18	999	0.14	0.16
910	0.3	0.32	940	0.22	0.28	970	0.16	0.16	1000	0.14	0.22
911	0.14	0.08	941	0.18	0.06	971	0.26	0.24			
912	0.16	0.18	942	0.1	0.14	972	0.16	0.1			
913	0.2	0.28	943	0.24	0.18	973	0.32	0.18			
914	0.12	0.14	944	0.14	0.12	974	0.14	0.26			
915	0.28	0.32	945	0.22	0.2	975	0.2	0.3			
916	0.12	0.14	946	0.18	0.22	976	0.2	0.2			
917	0.12	0.22	947	0.22	0.26	977	0.16	0.22			
918	0.16	0.18	948	0.1	0.12	978	0.24	0.38			
919	0.18	0.32	949	0.16	0.26	979	0.24	0.14			
920	0.16	0.2	950	0.28	0.26	980	0.32	0.32			
921	0.16	0.14	951	0.24	0.24	981	0.14	0.2			
922	0.16	0.12	952	0.18	0.56	982	0.2	0.14			
923	0.18	0.24	953	0.16	0.22	983	0.2	0.2			
924	0.18	0.24	954	0.18	0.14	984	0.1	0.1			
925	0.14	0.34	955	0.18	0.22	985	0.36	0.36			
926	0.22	0.16	956	0.14	0.18	986	0.08	0.08			
927	0.2	0.26	957	0.24	0.22	987	0.34	0.18			
928	0.22	0.24	958	0.12	0.14	988	0.14	0.16			
929	0.16	0.2	959	0.26	0.34	989	0.22	0.3			
930	0.22	0.1	960	0.14	0.16	990	0.2	0.18			

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.36	0.26	31	0.4	0.38	61	0.38	0.24	91	0.4	0.42	121	0.5	0.48	151	0.32	0.3
2	0.28	0.26	32	0.34	0.38	62	0.5	0.26	92	0.44	0.44	122	0.44	0.38	152	0.38	0.28
3	0.42	0.36	33	0.44	0.48	63	0.4	0.32	93	0.3	0.22	123	0.3	0.28	153	0.42	0.38
4	0.36	0.26	34	0.38	0.18	64	0.5	0.24	94	0.3	0.26	124	0.58	0.42	154	0.3	0.26
5	0.46	0.32	35	0.3	0.38	65	0.4	0.4	95	0.24	0.24	125	0.26	0.26	155	0.22	0.32
6	0.48	0.4	36	0.3	0.38	66	0.28	0.28	96	0.38	0.4	126	0.5	0.62	156	0.5	0.32
7	0.34	0.4	37	0.4	0.24	67	0.4	0.44	97	0.34	0.28	127	0.4	0.28	157	0.3	0.28
8	0.44	0.44	38	0.48	0.36	68	0.34	0.3	98	0.36	0.2	128	0.38	0.36	158	0.54	0.5
9	0.36	0.3	39	0.38	0.26	69	0.34	0.36	99	0.42	0.38	129	0.32	0.22	159	0.48	0.28
10	0.26	0.26	40	0.36	0.36	70	0.48	0.34	100	0.32	0.16	130	0.38	0.16	160	0.3	0.36
11	0.4	0.32	41	0.44	0.42	71	0.38	0.32	101	0.4	0.26	131	0.5	0.42	161	0.4	0.48
12	0.36	0.24	42	0.18	0.24	72	0.34	0.32	102	0.38	0.36	132	0.24	0.3	162	0.36	0.28
13	0.34	0.2	43	0.24	0.16	73	0.46	0.44	103	0.38	0.32	133	0.44	0.44	163	0.4	0.28
14	0.34	0.34	44	0.48	0.4	74	0.42	0.4	104	0.34	0.18	134	0.3	0.24	164	0.4	0.26
15	0.38	0.28	45	0.34	0.18	75	0.42	0.38	105	0.38	0.3	135	0.32	0.3	165	0.22	0.22
16	0.36	0.4	46	0.5	0.36	76	0.46	0.3	106	0.3	0.32	136	0.46	0.42	166	0.48	0.42
17	0.44	0.26	47	0.34	0.3	77	0.42	0.22	107	0.36	0.34	137	0.34	0.3	167	0.36	0.34
18	0.28	0.34	48	0.44	0.4	78	0.46	0.42	108	0.44	0.32	138	0.38	0.26	168	0.32	0.36
19	0.34	0.28	49	0.26	0.32	79	0.54	0.4	109	0.46	0.36	139	0.46	0.36	169	0.42	0.4
20	0.34	0.4	50	0.22	0.34	80	0.48	0.3	110	0.48	0.46	140	0.44	0.36	170	0.42	0.34
21	0.34	0.4	51	0.46	0.36	81	0.56	0.28	111	0.44	0.42	141	0.4	0.24	171	0.38	0.32
22	0.46	0.36	52	0.24	0.24	82	0.4	0.38	112	0.36	0.32	142	0.38	0.4	172	0.32	0.32
23	0.36	0.2	53	0.34	0.3	83	0.4	0.42	113	0.34	0.28	143	0.42	0.28	173	0.42	0.3
24	0.28	0.34	54	0.34	0.52	84	0.22	0.42	114	0.66	0.54	144	0.34	0.22	174	0.38	0.28
25	0.48	0.32	55	0.54	0.32	85	0.38	0.14	115	0.42	0.42	145	0.34	0.42	175	0.36	0.3
26	0.48	0.34	56	0.44	0.38	86	0.28	0.18	116	0.4	0.34	146	0.38	0.34	176	0.38	0.32
27	0.28	0.3	57	0.52	0.42	87	0.32	0.28	117	0.46	0.3	147	0.44	0.34	177	0.46	0.36
28	0.36	0.36	58	0.58	0.46	88	0.36	0.34	118	0.58	0.5	148	0.22	0.16	178	0.42	0.26
29	0.44	0.34	59	0.48	0.26	89	0.5	0.34	119	0.28	0.28	149	0.32	0.26	179	0.22	0.22
30	0.42	0.3	60	0.24	0.28	90	0.3	0.28	120	0.54	0.32	150	0.3	0.42	180	0.5	0.3

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
181	0.42	0.28	211	0.42	0.36	241	0.48	0.4	271	0.5	0.32	301	0.34	0.26	331	0.34	0.3
182	0.38	0.4	212	0.32	0.34	242	0.36	0.36	272	0.4	0.36	302	0.38	0.22	332	0.5	0.4
183	0.5	0.32	213	0.3	0.18	243	0.46	0.32	273	0.36	0.3	303	0.4	0.4	333	0.54	0.24
184	0.36	0.28	214	0.22	0.12	244	0.5	0.44	274	0.46	0.32	304	0.24	0.24	334	0.38	0.4
185	0.34	0.34	215	0.16	0.1	245	0.34	0.28	275	0.42	0.26	305	0.26	0.26	335	0.52	0.46
186	0.56	0.42	216	0.4	0.36	246	0.52	0.42	276	0.2	0.22	306	0.42	0.36	336	0.52	0.48
187	0.34	0.34	217	0.32	0.34	247	0.34	0.38	277	0.44	0.26	307	0.42	0.3	337	0.44	0.32
188	0.4	0.28	218	0.4	0.38	248	0.64	0.32	278	0.28	0.28	308	0.42	0.4	338	0.34	0.24
189	0.38	0.42	219	0.46	0.38	249	0.52	0.32	279	0.4	0.4	309	0.44	0.34	339	0.5	0.4
190	0.5	0.34	220	0.4	0.24	250	0.42	0.24	280	0.48	0.26	310	0.44	0.4	340	0.6	0.28
191	0.42	0.26	221	0.5	0.3	251	0.5	0.38	281	0.22	0.3	311	0.34	0.3	341	0.56	0.4
192	0.5	0.42	222	0.4	0.34	252	0.46	0.4	282	0.32	0.26	312	0.4	0.44	342	0.48	0.38
193	0.38	0.32	223	0.38	0.36	253	0.58	0.46	283	0.42	0.3	313	0.48	0.28	343	0.6	0.32
194	0.44	0.26	224	0.52	0.38	254	0.28	0.34	284	0.56	0.3	314	0.32	0.26	344	0.42	0.26
195	0.42	0.24	225	0.38	0.4	255	0.32	0.28	285	0.28	0.24	315	0.2	0.24	345	0.66	0.32
196	0.28	0.36	226	0.48	0.32	256	0.32	0.34	286	0.54	0.46	316	0.4	0.24	346	0.6	0.26
197	0.28	0.24	227	0.24	0.24	257	0.34	0.42	287	0.46	0.36	317	0.4	0.26	347	0.5	0.46
198	0.44	0.46	228	0.4	0.3	258	0.34	0.3	288	0.28	0.18	318	0.6	0.34	348	0.56	0.36
199	0.4	0.34	229	0.32	0.34	259	0.4	0.38	289	0.32	0.38	319	0.42	0.3	349	0.38	0.26
200	0.22	0.3	230	0.28	0.2	260	0.42	0.34	290	0.38	0.32	320	0.42	0.38	350	0.62	0.3
201	0.34	0.3	231	0.36	0.32	261	0.3	0.32	291	0.32	0.26	321	0.26	0.22	351	0.46	0.38
202	0.44	0.32	232	0.46	0.44	262	0.46	0.42	292	0.34	0.26	322	0.54	0.36	352	0.52	0.38
203	0.44	0.34	233	0.38	0.3	263	0.22	0.26	293	0.3	0.34	323	0.38	0.32	353	0.56	0.34
204	0.32	0.26	234	0.44	0.36	264	0.22	0.22	294	0.3	0.16	324	0.54	0.28	354	0.72	0.3
205	0.52	0.34	235	0.54	0.24	265	0.3	0.24	295	0.52	0.44	325	0.44	0.36	355	0.42	0.28
206	0.26	0.3	236	0.36	0.3	266	0.3	0.36	296	0.44	0.3	326	0.6	0.34	356	0.56	0.34
207	0.46	0.24	237	0.3	0.28	267	0.42	0.38	297	0.5	0.38	327	0.4	0.26	357	0.44	0.32
208	0.36	0.4	238	0.44	0.24	268	0.5	0.5	298	0.46	0.24	328	0.56	0.38	358	0.58	0.2
209	0.52	0.34	239	0.42	0.36	269	0.3	0.26	299	0.44	0.18	329	0.42	0.38	359	0.52	0.28
210	0.32	0.3	240	0.44	0.42	270	0.34	0.26	300	0.34	0.2	330	0.5	0.2	360	0.56	0.34

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
361	0.54	0.2	391	0.42	0.38	421	0.26	0.36	451	0.46	0.34	481	0.28	0.24	511	0.58	0.28
362	0.48	0.38	392	0.3	0.26	422	0.4	0.44	452	0.52	0.42	482	0.46	0.34	512	0.54	0.3
363	0.56	0.56	393	0.3	0.28	423	0.32	0.3	453	0.36	0.42	483	0.3	0.32	513	0.48	0.42
364	0.4	0.32	394	0.34	0.26	424	0.34	0.2	454	0.52	0.54	484	0.4	0.42	514	0.52	0.36
365	0.56	0.2	395	0.52	0.44	425	0.28	0.3	455	0.42	0.24	485	0.24	0.26	515	0.38	0.28
366	0.54	0.3	396	0.56	0.26	426	0.34	0.28	456	0.28	0.18	486	0.38	0.36	516	0.3	0.28
367	0.52	0.22	397	0.44	0.4	427	0.32	0.36	457	0.34	0.26	487	0.36	0.36	517	0.52	0.36
368	0.6	0.28	398	0.4	0.36	428	0.42	0.28	458	0.42	0.28	488	0.46	0.42	518	0.3	0.36
369	0.64	0.22	399	0.48	0.4	429	0.36	0.3	459	0.38	0.26	489	0.3	0.22	519	0.32	0.36
370	0.64	0.4	400	0.38	0.28	430	0.34	0.28	460	0.32	0.3	490	0.34	0.36	520	0.42	0.38
371	0.4	0.28	401	0.54	0.38	431	0.48	0.3	461	0.54	0.48	491	0.42	0.42	521	0.32	0.3
372	0.5	0.3	402	0.44	0.36	432	0.38	0.28	462	0.44	0.3	492	0.42	0.34	522	0.42	0.34
373	0.44	0.26	403	0.32	0.38	433	0.5	0.3	463	0.4	0.38	493	0.3	0.4	523	0.38	0.3
374	0.42	0.44	404	0.24	0.24	434	0.36	0.34	464	0.42	0.42	494	0.34	0.2	524	0.48	0.3
375	0.66	0.36	405	0.42	0.28	435	0.22	0.28	465	0.32	0.36	495	0.28	0.3	525	0.5	0.42
376	0.38	0.36	406	0.5	0.24	436	0.52	0.32	466	0.26	0.28	496	0.48	0.4	526	0.44	0.46
377	0.26	0.26	407	0.4	0.28	437	0.2	0.24	467	0.42	0.4	497	0.52	0.34	527	0.44	0.42
378	0.46	0.42	408	0.62	0.42	438	0.5	0.46	468	0.36	0.22	498	0.32	0.26	528	0.46	0.42
379	0.52	0.26	409	0.36	0.32	439	0.36	0.4	469	0.62	0.38	499	0.44	0.42	529	0.52	0.36
380	0.4	0.3	410	0.42	0.44	440	0.44	0.34	470	0.52	0.34	500	0.44	0.28	530	0.46	0.46
381	0.42	0.44	411	0.36	0.36	441	0.46	0.42	471	0.56	0.32	501	0.48	0.44	531	0.32	0.3
382	0.52	0.44	412	0.36	0.28	442	0.4	0.3	472	0.4	0.22	502	0.38	0.3	532	0.42	0.34
383	0.58	0.42	413	0.52	0.34	443	0.34	0.34	473	0.32	0.22	503	0.38	0.34	533	0.32	0.26
384	0.5	0.38	414	0.56	0.44	444	0.32	0.36	474	0.36	0.3	504	0.42	0.32	534	0.24	0.24
385	0.5	0.42	415	0.28	0.24	445	0.52	0.36	475	0.28	0.24	505	0.38	0.22	535	0.3	0.34
386	0.32	0.3	416	0.38	0.38	446	0.34	0.3	476	0.54	0.36	506	0.32	0.3	536	0.5	0.46
387	0.38	0.36	417	0.44	0.3	447	0.24	0.2	477	0.26	0.28	507	0.32	0.32	537	0.4	0.42
388	0.3	0.26	418	0.34	0.28	448	0.34	0.3	478	0.4	0.38	508	0.48	0.46	538	0.42	0.32
389	0.36	0.32	419	0.4	0.44	449	0.32	0.38	479	0.42	0.42	509	0.34	0.3	539	0.28	0.36
390	0.6	0.42	420	0.34	0.38	450	0.36	0.22	480	0.5	0.42	510	0.46	0.32	540	0.46	0.4

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
541	0.4	0.36	571	0.44	0.38	601	0.42	0.4	631	0.44	0.46	661	0.52	0.4	691	0.28	0.22
542	0.4	0.38	572	0.38	0.36	602	0.48	0.38	632	0.64	0.34	662	0.6	0.4	692	0.42	0.32
543	0.42	0.38	573	0.44	0.32	603	0.34	0.36	633	0.34	0.36	663	0.32	0.3	693	0.24	0.2
544	0.48	0.48	574	0.26	0.32	604	0.3	0.32	634	0.52	0.48	664	0.34	0.26	694	0.34	0.3
545	0.5	0.42	575	0.3	0.32	605	0.3	0.34	635	0.36	0.36	665	0.26	0.3	695	0.28	0.28
546	0.36	0.32	576	0.26	0.32	606	0.48	0.46	636	0.36	0.28	666	0.4	0.24	696	0.3	0.36
547	0.3	0.32	577	0.48	0.3	607	0.36	0.3	637	0.56	0.42	667	0.22	0.24	697	0.38	0.32
548	0.38	0.28	578	0.42	0.4	608	0.6	0.38	638	0.36	0.6	668	0.44	0.46	698	0.34	0.34
549	0.36	0.24	579	0.36	0.42	609	0.36	0.26	639	0.32	0.28	669	0.46	0.32	699	0.36	0.4
550	0.36	0.32	580	0.24	0.18	610	0.34	0.32	640	0.28	0.28	670	0.26	0.24	700	0.42	0.24
551	0.46	0.4	581	0.3	0.34	611	0.34	0.22	641	0.36	0.34	671	0.28	0.26	701	0.56	0.46
552	0.26	0.3	582	0.44	0.46	612	0.36	0.3	642	0.2	0.22	672	0.32	0.34	702	0.38	0.38
553	0.18	0.18	583	0.44	0.24	613	0.46	0.38	643	0.4	0.5	673	0.5	0.44	703	0.32	0.48
554	0.6	0.44	584	0.42	0.28	614	0.42	0.34	644	0.34	0.36	674	0.3	0.22	704	0.5	0.32
555	0.46	0.38	585	0.4	0.26	615	0.46	0.3	645	0.4	0.36	675	0.44	0.4	705	0.5	0.48
556	0.32	0.2	586	0.3	0.3	616	0.32	0.34	646	0.4	0.32	676	0.34	0.16	706	0.24	0.28
557	0.42	0.3	587	0.2	0.22	617	0.44	0.46	647	0.38	0.3	677	0.46	0.32	707	0.24	0.3
558	0.36	0.36	588	0.42	0.3	618	0.36	0.42	648	0.48	0.4	678	0.34	0.26	708	0.34	0.38
559	0.3	0.34	589	0.32	0.3	619	0.28	0.3	649	0.42	0.36	679	0.52	0.32	709	0.44	0.36
560	0.3	0.4	590	0.34	0.2	620	0.5	0.5	650	0.26	0.26	680	0.46	0.24	710	0.24	0.32
561	0.4	0.34	591	0.38	0.36	621	0.34	0.34	651	0.58	0.34	681	0.42	0.36	711	0.4	0.28
562	0.5	0.22	592	0.54	0.34	622	0.48	0.46	652	0.4	0.5	682	0.4	0.38	712	0.38	0.36
563	0.3	0.26	593	0.4	0.36	623	0.3	0.22	653	0.38	0.26	683	0.22	0.3	713	0.34	0.3
564	0.3	0.32	594	0.36	0.34	624	0.34	0.32	654	0.44	0.46	684	0.48	0.44	714	0.32	0.24
565	0.38	0.28	595	0.38	0.28	625	0.32	0.26	655	0.46	0.42	685	0.5	0.34	715	0.24	0.3
566	0.36	0.26	596	0.26	0.14	626	0.38	0.28	656	0.34	0.32	686	0.3	0.34	716	0.48	0.42
567	0.48	0.42	597	0.5	0.38	627	0.36	0.3	657	0.48	0.46	687	0.56	0.36	717	0.46	0.48
568	0.34	0.26	598	0.34	0.36	628	0.34	0.3	658	0.32	0.3	688	0.44	0.38	718	0.32	0.3
569	0.28	0.32	599	0.34	0.38	629	0.4	0.26	659	0.42	0.36	689	0.34	0.42	719	0.32	0.18
570	0.56	0.38	600	0.34	0.36	630	0.38	0.28	660	0.36	0.3	690	0.4	0.28	720	0.26	0.28

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
721	0.38	0.32	751	0.36	0.34	781	0.32	0.18	811	0.28	0.28	841	0.36	0.3	871	0.34	0.36
722	0.44	0.32	752	0.46	0.34	782	0.32	0.34	812	0.38	0.4	842	0.44	0.44	872	0.3	0.38
723	0.36	0.28	753	0.44	0.42	783	0.42	0.3	813	0.34	0.28	843	0.34	0.22	873	0.24	0.24
724	0.38	0.28	754	0.48	0.42	784	0.32	0.32	814	0.38	0.28	844	0.38	0.22	874	0.42	0.32
725	0.36	0.36	755	0.42	0.32	785	0.28	0.34	815	0.4	0.26	845	0.36	0.36	875	0.2	0.16
726	0.42	0.36	756	0.3	0.28	786	0.5	0.46	816	0.38	0.3	846	0.38	0.36	876	0.42	0.4
727	0.5	0.38	757	0.32	0.28	787	0.38	0.38	817	0.3	0.32	847	0.34	0.36	877	0.42	0.32
728	0.42	0.3	758	0.4	0.36	788	0.26	0.24	818	0.38	0.26	848	0.34	0.26	878	0.32	0.36
729	0.2	0.2	759	0.5	0.4	789	0.4	0.32	819	0.44	0.3	849	0.44	0.36	879	0.32	0.36
730	0.24	0.34	760	0.44	0.44	790	0.56	0.38	820	0.28	0.24	850	0.36	0.34	880	0.42	0.38
731	0.38	0.34	761	0.34	0.3	791	0.42	0.34	821	0.32	0.38	851	0.34	0.26	881	0.42	0.34
732	0.4	0.28	762	0.46	0.32	792	0.26	0.16	822	0.54	0.38	852	0.36	0.34	882	0.32	0.28
733	0.46	0.2	763	0.32	0.32	793	0.28	0.26	823	0.42	0.24	853	0.36	0.16	883	0.32	0.2
734	0.34	0.28	764	0.42	0.48	794	0.28	0.34	824	0.3	0.36	854	0.42	0.24	884	0.44	0.46
735	0.36	0.2	765	0.36	0.34	795	0.24	0.24	825	0.36	0.3	855	0.34	0.24	885	0.32	0.26
736	0.34	0.3	766	0.38	0.32	796	0.36	0.36	826	0.36	0.36	856	0.48	0.36	886	0.34	0.3
737	0.32	0.3	767	0.38	0.36	797	0.38	0.32	827	0.38	0.24	857	0.28	0.34	887	0.3	0.22
738	0.44	0.22	768	0.34	0.4	798	0.28	0.28	828	0.24	0.2	858	0.38	0.42	888	0.5	0.24
739	0.26	0.22	769	0.36	0.42	799	0.46	0.38	829	0.36	0.3	859	0.34	0.26	889	0.44	0.24
740	0.32	0.36	770	0.46	0.34	800	0.28	0.2	830	0.32	0.26	860	0.44	0.4	890	0.4	0.26
741	0.26	0.26	771	0.36	0.32	801	0.44	0.42	831	0.28	0.22	861	0.48	0.44	891	0.24	0.2
742	0.46	0.42	772	0.44	0.3	802	0.42	0.26	832	0.44	0.38	862	0.26	0.24	892	0.34	0.38
743	0.2	0.26	773	0.3	0.26	803	0.44	0.28	833	0.66	0.46	863	0.3	0.32	893	0.48	0.34
744	0.54	0.38	774	0.44	0.44	804	0.5	0.58	834	0.38	0.34	864	0.32	0.3	894	0.4	0.32
745	0.74	0.42	775	0.36	0.38	805	0.44	0.42	835	0.48	0.3	865	0.56	0.46	895	0.34	0.34
746	0.3	0.22	776	0.52	0.4	806	0.44	0.4	836	0.42	0.32	866	0.26	0.28	896	0.36	0.4
747	0.34	0.28	777	0.32	0.24	807	0.28	0.24	837	0.38	0.32	867	0.32	0.28	897	0.24	0.24
748	0.3	0.32	778	0.26	0.28	808	0.24	0.24	838	0.42	0.4	868	0.48	0.26	898	0.48	0.3
749	0.3	0.24	779	0.38	0.28	809	0.4	0.26	839	0.28	0.28	869	0.32	0.36	899	0.54	0.24
750	0.4	0.38	780	0.38	0.38	810	0.46	0.34	840	0.38	0.34	870	0.46	0.36	900	0.38	0.28

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Appendix 6b. Misclassification Rates for Scenario 2 with three predictor variables (FTR Data)

Misclassification Rates with three predictor variables											
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
901	0.18	0.2	931	0.32	0.26	961	0.26	0.18	991	0.4	0.44
902	0.4	0.34	932	0.28	0.26	962	0.52	0.52	992	0.24	0.36
903	0.42	0.34	933	0.38	0.42	963	0.32	0.42	993	0.4	0.24
904	0.46	0.38	934	0.44	0.36	964	0.44	0.34	994	0.28	0.26
905	0.36	0.36	935	0.5	0.38	965	0.34	0.38	995	0.46	0.28
906	0.38	0.42	936	0.32	0.3	966	0.44	0.32	996	0.28	0.36
907	0.2	0.28	937	0.36	0.32	967	0.42	0.4	997	0.72	0.38
908	0.4	0.4	938	0.38	0.26	968	0.44	0.4	998	0.52	0.38
909	0.4	0.38	939	0.5	0.34	969	0.32	0.42	999	0.58	0.52
910	0.34	0.36	940	0.44	0.46	970	0.36	0.36	1000	0.22	0.22
911	0.42	0.28	941	0.44	0.38	971	0.42	0.44			
912	0.28	0.28	942	0.38	0.34	972	0.42	0.42			
913	0.32	0.26	943	0.26	0.22	973	0.42	0.3			
914	0.58	0.34	944	0.4	0.3	974	0.28	0.5			
915	0.3	0.34	945	0.26	0.18	975	0.46	0.36			
916	0.26	0.2	946	0.66	0.46	976	0.26	0.4			
917	0.42	0.3	947	0.4	0.32	977	0.36	0.3			
918	0.54	0.36	948	0.36	0.4	978	0.3	0.5			
919	0.3	0.36	949	0.32	0.34	979	0.46	0.3			
920	0.24	0.22	950	0.32	0.3	980	0.36	0.36			
921	0.26	0.22	951	0.28	0.24	981	0.22	0.32			
922	0.42	0.38	952	0.3	0.22	982	0.34	0.26			
923	0.28	0.26	953	0.42	0.4	983	0.46	0.36			
924	0.38	0.42	954	0.36	0.34	984	0.24	0.16			
925	0.54	0.4	955	0.44	0.36	985	0.5	0.62			
926	0.4	0.26	956	0.46	0.28	986	0.3	0.24			
927	0.44	0.42	957	0.32	0.22	987	0.42	0.48			
928	0.28	0.3	958	0.28	0.3	988	0.5	0.28			
929	0.3	0.36	959	0.36	0.3	989	0.36	0.4			
930	0.48	0.38	960	0.46	0.42	990	0.32	0.36			

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
1	0.48	0.5	31	0.54	0.68	61	0.64	0.68	91	0.12	0.12	121	0.16	0.14	151	0.44	0.28
2	0.5	0.38	32	0.1	0.08	62	0.32	0.36	92	0.58	0.34	122	0.32	0.32	152	0.5	0.4
3	0.28	0.3	33	0.26	0.24	63	0.26	0.3	93	0.58	0.58	123	0.54	0.52	153	0.58	0.58
4	0.34	0.38	34	0.58	0.64	64	0.24	0.36	94	0.42	0.28	124	0.38	0.4	154	0.22	0.24
5	0.38	0.38	35	0.38	0.26	65	0.5	0.48	95	0.36	0.38	125	0.46	0.46	155	0.56	0.44
6	0.46	0.28	36	0.22	0.24	66	0.22	0.22	96	0.18	0.2	126	0.36	0.38	156	0.66	0.62
7	0.68	0.58	37	0.2	0.12	67	0.3	0.26	97	0.56	0.56	127	0.24	0.3	157	0.32	0.26
8	0.28	0.26	38	0.42	0.52	68	0.26	0.26	98	0.32	0.36	128	0.54	0.48	158	0.36	0.36
9	0.14	0.08	39	0.34	0.36	69	0.22	0.22	99	0.4	0.32	129	0.44	0.44	159	0.56	0.56
10	0.36	0.36	40	0.4	0.36	70	0.5	0.44	100	0.12	0.14	130	0.2	0.22	160	0.18	0.16
11	0.38	0.24	41	0.24	0.2	71	0.24	0.22	101	0.28	0.28	131	0.46	0.42	161	0.5	0.32
12	0.22	0.2	42	0.2	0.2	72	0.16	0.3	102	0.46	0.42	132	0.22	0.22	162	0.54	0.5
13	0.34	0.32	43	0.36	0.38	73	0.58	0.46	103	0.2	0.2	133	0.3	0.36	163	0.02	0.02
14	0.6	0.56	44	0.2	0.2	74	0.34	0.56	104	0.16	0.14	134	0.08	0.08	164	0.28	0.28
15	0.26	0.26	45	0.42	0.42	75	0.36	0.34	105	0.52	0.52	135	0.46	0.42	165	0.24	0.4
16	0.18	0.14	46	0.16	0.16	76	0.26	0.28	106	0.42	0.28	136	0.34	0.34	166	0.44	0.4
17	0.42	0.38	47	0.56	0.46	77	0.16	0.18	107	0.54	0.42	137	0.38	0.22	167	0.5	0.4
18	0.38	0.34	48	0.42	0.4	78	0.2	0.2	108	0.38	0.4	138	0.56	0.52	168	0.58	0.64
19	0.42	0.28	49	0.28	0.26	79	0.34	0.28	109	0.12	0.14	139	0.46	0.44	169	0.38	0.34
20	0.44	0.42	50	0.62	0.34	80	0.56	0.36	110	0.32	0.3	140	0.18	0.22	170	0.52	0.52
21	0.9	0.8	51	0.34	0.4	81	0.56	0.52	111	0.24	0.1	141	0.48	0.42	171	0.56	0.46
22	0.3	0.28	52	0.04	0.1	82	0.22	0.16	112	0.62	0.48	142	0.08	0.06	172	0.42	0.4
23	0.62	0.6	53	0.44	0.2	83	0.18	0.16	113	0.32	0.22	143	0.38	0.3	173	0.34	0.34
24	0.46	0.46	54	0.62	0.58	84	0.1	0.18	114	0.24	0.32	144	0.26	0.3	174	0.54	0.46
25	0.42	0.38	55	0.64	0.62	85	0.42	0.36	115	0.42	0.46	145	0.18	0.22	175	0.52	0.54
26	0.06	0.06	56	0.42	0.42	86	0.34	0.34	116	0.5	0.48	146	0.18	0.22	176	0.22	0.2
27	0.74	0.6	57	0.42	0.42	87	0.2	0.22	117	0.6	0.5	147	0.2	0.2	177	0.32	0.34
28	0.3	0.26	58	0.04	0.06	88	0.1	0.1	118	0.56	0.54	148	0.16	0.24	178	0.12	0.08
29	0.4	0.36	59	0.42	0.44	89	0.38	0.26	119	0.42	0.42	149	0.42	0.26	179	0.36	0.42
30	0.36	0.34	60	0.68	0.72	90	0.68	0.7	120	0.08	0.18	150	0.38	0.36	180	0.14	0.14

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
181	0.4	0.36	211	0.1	0.1	241	0.44	0.44	271	0.24	0.22	301	0.34	0.34	331	0.56	0.58
182	0.28	0.28	212	0.3	0.22	242	0.04	0.04	272	0.56	0.24	302	0.16	0.24	332	0.56	0.58
183	0.42	0.38	213	0.2	0.18	243	0.36	0.3	273	0.04	0.06	303	0.52	0.5	333	0.5	0.48
184	0.04	0.04	214	0.46	0.48	244	0.12	0.14	274	0.2	0.26	304	0.22	0.16	334	0.38	0.42
185	0.32	0.34	215	0.16	0.18	245	0.68	0.6	275	0.06	0.08	305	0.12	0.12	335	0.62	0.56
186	0.4	0.42	216	0.56	0.6	246	0.38	0.36	276	0.38	0.36	306	0.58	0.46	336	0.48	0.44
187	0.44	0.44	217	0.18	0.26	247	0.58	0.5	277	0.38	0.4	307	0.42	0.38	337	0.28	0.24
188	0.56	0.54	218	0.2	0.2	248	0.38	0.34	278	0.42	0.4	308	0.22	0.24	338	0.34	0.38
189	0.88	0.76	219	0.46	0.46	249	0.72	0.48	279	0.52	0.48	309	0.26	0.3	339	0.12	0.08
190	0.22	0.22	220	0.34	0.2	250	0.18	0.18	280	0.3	0.5	310	0.38	0.44	340	0.5	0.46
191	0.12	0.14	221	0.68	0.32	251	0.4	0.34	281	0.58	0.54	311	0.32	0.4	341	0.18	0.22
192	0.14	0.1	222	0.26	0.26	252	0.38	0.36	282	0.16	0.16	312	0.36	0.36	342	0.14	0.14
193	0.38	0.38	223	0.56	0	253	0.4	0.36	283	0.4	0.38	313	0.1	0.1	343	0.5	0.4
194	0.36	0.26	224	0.02	0	254	0.28	0.36	284	0.2	0.16	314	0.02	0.02	344	0.2	0.22
195	0.12	0.14	225	0.06	0.04	255	0.4	0.42	285	0.34	0.34	315	0.2	0.12	345	0.22	0.18
196	0.44	0.48	226	0.24	0.3	256	0.56	0.52	286	0.68	0.68	316	0.44	0.44	346	0.26	0.26
197	0.2	0.22	227	0.36	0.34	257	0.34	0.3	287	0.44	0.44	317	0.22	0.2	347	0.36	0.34
198	0.36	0.46	228	0.08	0.08	258	0.16	0.2	288	0.16	0.16	318	0.58	0.54	348	0.42	0.34
199	0.36	0.36	229	0.44	0.44	259	0.68	0.74	289	0.14	0.16	319	0.68	0.62	349	0.68	0.6
200	0.46	0.34	230	0.48	0.36	260	0.68	0.5	290	0.66	0.68	320	0.1	0.08	350	0.76	0.7
201	0.18	0.16	231	0.1	0.1	261	0.3	0.28	291	0.3	0.34	321	0.18	0.24	351	0.18	0.22
202	0.5	0.44	232	0.26	0.3	262	0.56	0.5	292	0.44	0.38	322	0.76	0.68	352	0.14	0.1
203	0.32	0.32	233	0.16	0.12	263	0.2	0.18	293	0.24	0.24	323	0.52	0.36	353	0.36	0.44
204	0.14	0.14	234	0.08	0.06	264	0.3	0.22	294	0.16	0.3	324	0.32	0.34	354	0.36	0.24
205	0.66	0.6	235	0.16	0.08	265	0.2	0.22	295	0.4	0.28	325	0.08	0.08	355	0.34	0.2
206	0.58	0.48	236	0.34	0.4	266	0.14	0.14	296	0.34	0.34	326	0.48	0.48	356	0.1	0.1
207	0.3	0.42	237	0.5	0.48	267	0.26	0.34	297	0.66	0.72	327	0.38	0.38	357	0.48	0.36
208	0.12	0.1	238	0.42	0.4	268	0.54	0.44	298	0.18	0.16	328	0.14	0.26	358	0.56	0.62
209	0.28	0.28	239	0.2	0.18	269	0.44	0.42	299	0.52	0.5	329	0.32	0.34	359	0.56	0.58
210	0.42	0.34	240	0.46	0.46	270	0.08	0.08	300	0.36	0.26	330	0.5	0.46	360	0.46	0.4

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
361	0.36	0.36	391	0.12	0.14	421	0.04	0.04	451	0.34	0.32	481	0.2	0.14	511	0.68	0.74
362	0.4	0.46	392	0.64	0.62	422	0.4	0.34	452	0.28	0.26	482	0.26	0.3	512	0.08	0.08
363	0.38	0.38	393	0.36	0.36	423	0.54	0.54	453	0.44	0.48	483	0.18	0.14	513	0.28	0.26
364	0.64	0.6	394	0.18	0.26	424	0.44	0.42	454	0.34	0.34	484	0.46	0.42	514	0.16	0.1
365	0.12	0.12	395	0.4	0.44	425	0.32	0.36	455	0.38	0.3	485	0.4	0.34	515	0.2	0.22
366	0.38	0.38	396	0.24	0.26	426	0.1	0.14	456	0.08	0.1	486	0.6	0.58	516	0.24	0.28
367	0.58	0.36	397	0.42	0.38	427	0.28	0.28	457	0.38	0.38	487	0.5	0.5	517	0.38	0.4
368	0.28	0.28	398	0.14	0.1	428	0.62	0.56	458	0.5	0.36	488	0.18	0.14	518	0.34	0.26
369	0.26	0.24	399	0.62	0.66	429	0.42	0.4	459	0.56	0.56	489	0.04	0.04	519	0.46	0.46
370	0.08	0.08	400	0.32	0.36	430	0.44	0.36	460	0.24	0.22	490	0.36	0.36	520	0.48	0.44
371	0.52	0.52	401	0.84	0.76	431	0.44	0.48	461	0.02	0.04	491	0.42	0.36	521	0.02	0.02
372	0.36	0.32	402	0.78	0.64	432	0.34	0.28	462	0.18	0.18	492	0.38	0.4	522	0.52	0.5
373	0.24	0.14	403	0.6	0.3	433	0.12	0.08	463	0.16	0.14	493	0.2	0.22	523	0.5	0.52
374	0.5	0.44	404	0.6	0.64	434	0.6	0.58	464	0.8	0.68	494	0.34	0.22	524	0.44	0.32
375	0.16	0.08	405	0.36	0.36	435	0.6	0.62	465	0.4	0.42	495	0.52	0.4	525	0.28	0.28
376	0.24	0.16	406	0.16	0.2	436	0.5	0.52	466	0.36	0.26	496	0.1	0.24	526	0.36	0.32
377	0.18	0.16	407	0.44	0.44	437	0.2	0.22	467	0.28	0.22	497	0.52	0.48	527	0.36	0.42
378	0.16	0.12	408	0.56	0.54	438	0.06	0.08	468	0.08	0.08	498	0.18	0.16	528	0.22	0.26
379	0.52	0.42	409	0.12	0.14	439	0.24	0.22	469	0.5	0.5	499	0.74	0.62	529	0.2	0.16
380	0.42	0.4	410	0.6	0.62	440	0.02	0.04	470	0.52	0.52	500	0.16	0.22	530	0.44	0.46
381	0.34	0.42	411	0.32	0.22	441	0.38	0.36	471	0.36	0.32	501	0.32	0.3	531	0.5	0.6
382	0.12	0.22	412	0.38	0.48	442	0.16	0.18	472	0.56	0.48	502	0.52	0.7	532	0.48	0.5
383	0.32	0.36	413	0.5	0.4	443	0.3	0.3	473	0.1	0.08	503	0.1	0.1	533	0.3	0.3
384	0.12	0.12	414	0.46	0.44	444	0.28	0.3	474	0.14	0.06	504	0.3	0.3	534	0.4	0.36
385	0.14	0.1	415	0.3	0.26	445	0.64	0.24	475	0.38	0.4	505	0.2	0.22	535	0.12	0.2
386	0.28	0.3	416	0.18	0.1	446	0.2	0.3	476	0.16	0.14	506	0.12	0.06	536	0.4	0.3
387	0.32	0.38	417	0.34	0.32	447	0.36	0.34	477	0.24	0.24	507	0.4	0.26	537	0.3	0.28
388	0.44	0.38	418	0.28	0.18	448	0.3	0.3	478	0.28	0.24	508	0.28	0.32	538	0.02	0.06
389	0.54	0.5	419	0.2	0.22	449	0.16	0.22	479	0.26	0.14	509	0.26	0.28	539	0.02	0.02
390	0.1	0.1	420	0.22	0.3	450	0.46	0.42	480	0.32	0.24	510	0.2	0.16	540	0.48	0.5

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
541	0.06	0.08	571	0.6	0.5	601	0.3	0.3	631	0.36	0.4	661	0.82	0.12	691	0.7	0.44
542	0.5	0.48	572	0.48	0.38	602	0.12	0.1	632	0.14	0.12	662	0.86	0.48	692	0.52	0.18
543	0.26	0.32	573	0.18	0.18	603	0.28	0.24	633	0.46	0.46	663	0.52	0.12	693	0.96	0.4
544	0.74	0.66	574	0.16	0.18	604	0.54	0.5	634	0.18	0.18	664	0.84	0.5	694	0.82	0.18
545	0.14	0.16	575	0.62	0.62	605	0.56	0.56	635	0.22	0.22	665	0.62	0.16	695	0.28	0.16
546	0.32	0.34	576	0.1	0.1	606	0.36	0.38	636	0.14	0.18	666	0.74	0.48	696	0.94	0.5
547	0.46	0.36	577	0.18	0.14	607	0.42	0.46	637	0.46	0.48	667	0.54	0.12	697	0.46	0.32
548	0.08	0.08	578	0.28	0.32	608	0.6	0.58	638	0.64	0.64	668	0.86	0.58	698	0.98	0.32
549	0.72	0.68	579	0.22	0.22	609	0.3	0.32	639	0.08	0.08	669	0.46	0.2	699	0.52	0.48
550	0.62	0.5	580	0.8	0.48	610	0.24	0.22	640	0.34	0.5	670	0.88	0.44	700	0.92	0.28
551	0.78	0.68	581	0.36	0.42	611	0.22	0.34	641	0.2	0.22	671	0.7	0.32	701	0.24	0.28
552	0.2	0.24	582	0.52	0.54	612	0.6	0.54	642	0.26	0.28	672	0.76	0.32	702	0.26	0.24
553	0.14	0.2	583	0.54	0.48	613	0.32	0.34	643	0.2	0.18	673	0.84	0.66	703	0.26	0.28
554	0.18	0.2	584	0.14	0.28	614	0.68	0.64	644	0.34	0.18	674	0.68	0.44	704	0.34	0.36
555	0.38	0.4	585	0.18	0.12	615	0.58	0.5	645	0.34	0.34	675	0.44	0.3	705	0.28	0.28
556	0.06	0.06	586	0.24	0.26	616	0.56	0.5	646	0.46	0.5	676	0.44	0.38	706	0.58	0.68
557	0.48	0.32	587	0.64	0.64	617	0.22	0.22	647	0.46	0.46	677	0.64	0.36	707	0.18	0.18
558	0.18	0.18	588	0.12	0.12	618	0.06	0.04	648	0.76	0.56	678	0.9	0.22	708	0.54	0.62
559	0.66	0.58	589	0.52	0.56	619	0.68	0.34	649	0.6	0.46	679	0.64	0.22	709	0.38	0.36
560	0.26	0.26	590	0.48	0.48	620	0.64	0.6	650	0.42	0.4	680	0.9	0.18	710	0.36	0.36
561	0.38	0.36	591	0.42	0.2	621	0.48	0.54	651	0.42	0.44	681	0.88	0.38	711	0.56	0.4
562	0.54	0.6	592	0.18	0.22	622	0.42	0.34	652	0.44	0.38	682	0.24	0.08	712	0.54	0.5
563	0.24	0.16	593	0.24	0.2	623	0.1	0.1	653	0.34	0.44	683	0.4	0.48	713	0.52	0.52
564	0.16	0.18	594	0.54	0.52	624	0.4	0.34	654	0.18	0.14	684	0.48	0.24	714	0.64	0.6
565	0.26	0.38	595	0.26	0.28	625	0.32	0.4	655	0.54	0.5	685	0.88	0.5	715	0.08	0.12
566	0.34	0.3	596	0.1	0.18	626	0.34	0.32	656	0.76	0.42	686	0.6	0.2	716	0.54	0.42
567	0.4	0.38	597	0.2	0.26	627	0.5	0.52	657	0.82	0.4	687	0.28	0.14	717	0.46	0.32
568	0.48	0.4	598	0.08	0	628	0.68	0.64	658	0.74	0.34	688	0.72	0.36	718	0.28	0.34
569	0.56	0.46	599	0.36	0.36	629	0.22	0.22	659	0.92	0.06	689	0.74	0.44	719	0.28	0.28
570	0.4	0.44	600	0.2	0.22	630	0.3	0.44	660	0.84	0.48	690	0.42	0.46	720	0.56	0.56

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables																	
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
721	0.3	0.36	751	0.28	0.28	781	0.16	0.28	811	0.14	0.1	841	0.34	0.22	871	0.46	0.32
722	0.4	0.34	752	0.5	0.42	782	0.4	0.38	812	0.38	0.38	842	0.46	0.4	872	0.36	0.2
723	0.34	0.46	753	0.32	0.4	783	0.22	0.4	813	0.5	0.48	843	0.28	0.22	873	0.7	0.68
724	0.52	0.46	754	0.32	0.28	784	0.32	0.32	814	0.52	0.58	844	0.28	0.28	874	0.34	0.38
725	0.32	0.38	755	0.4	0.34	785	0.46	0.46	815	0.4	0.42	845	0.64	0.66	875	0.3	0.36
726	0.44	0.42	756	0.34	0.36	786	0.64	0.52	816	0.18	0.18	846	0.22	0.24	876	0.64	0.46
727	0.2	0.28	757	0.16	0.18	787	0.18	0.2	817	0.42	0.44	847	0.1	0.04	877	0.08	0.08
728	0.5	0.54	758	0.14	0.14	788	0.22	0.2	818	0.52	0.46	848	0.12	0.1	878	0.48	0.44
729	0.22	0.22	759	0.12	0.1	789	0.32	0.32	819	0.64	0.72	849	0.38	0.36	879	0.3	0.32
730	0.36	0.38	760	0.38	0.46	790	0.5	0.44	820	0.32	0.34	850	0.7	0.62	880	0.56	0.58
731	0.32	0.28	761	0.42	0.38	791	0.2	0.08	821	0.44	0.38	851	0.16	0.2	881	0.5	0.34
732	0.3	0.24	762	0.32	0.36	792	0.34	0.32	822	0.54	0.54	852	0.28	0.3	882	0.22	0.28
733	0.44	0.42	763	0.2	0.2	793	0.42	0.4	823	0.28	0.3	853	0.64	0.44	883	0.24	0.24
734	0.38	0.34	764	0.14	0.18	794	0.66	0.48	824	0.2	0.32	854	0.24	0.2	884	0.68	0.62
735	0.2	0.24	765	0.2	0.22	795	0.2	0.2	825	0.12	0.18	855	0.66	0.68	885	0.34	0.3
736	0.22	0.24	766	0.54	0.5	796	0.38	0.4	826	0.12	0.14	856	0.32	0.34	886	0.48	0.5
737	0.56	0.48	767	0.48	0.48	797	0.62	0.56	827	0.46	0.5	857	0.28	0.3	887	0.38	0.32
738	0.56	0.46	768	0.44	0.28	798	0.2	0.14	828	0.5	0.44	858	0.7	0.68	888	0.56	0.46
739	0.2	0.22	769	0.38	0.34	799	0.3	0.32	829	0.36	0.36	859	0.54	0.54	889	0.16	0.1
740	0.38	0.38	770	0.44	0.34	800	0.16	0.16	830	0.26	0.48	860	0.44	0.3	890	0.36	0.3
741	0.1	0.16	771	0.3	0.32	801	0.58	0.42	831	0.44	0.42	861	0.56	0.48	891	0.2	0.18
742	0.44	0.5	772	0.42	0.42	802	0.06	0.06	832	0.72	0.72	862	0.44	0.48	892	0.32	0.38
743	0.28	0.4	773	0.74	0.5	803	0.1	0.14	833	0.66	0.66	863	0.42	0.46	893	0.32	0.34
744	0.04	0.06	774	0.16	0.16	804	0.66	0.64	834	0.6	0.58	864	0.6	0.62	894	0.48	0.46
745	0.26	0.22	775	0.32	0.38	805	0.76	0.44	835	0.42	0.44	865	0.58	0.42	895	0.6	0.7
746	0.26	0.28	776	0.08	0.08	806	0.46	0.46	836	0.48	0.48	866	0.34	0.46	896	0.44	0.36
747	0.38	0.38	777	0.5	0.5	807	0.12	0.18	837	0.3	0.32	867	0.22	0.16	897	0.14	0.1
748	0.5	0.5	778	0.1	0.1	808	0.56	0.56	838	0.12	0.14	868	0.14	0.1	898	0.6	0.74
749	0.44	0.44	779	0.12	0.12	809	0.14	0.2	839	0.48	0.38	869	0.46	0.44	899	0.08	0.14
750	0.54	0.54	780	0.24	0.24	810	0.46	0.4	840	0.26	0.26	870	0.48	0.42	900	0.06	0.06

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Appendix 6c. Misclassification Rates for Scenario 3 with three predictor variables (Random Data)

Misclassification Rates with three predictor variables											
Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN	Run#	OLR	ANN
901	0.4	0.36	931	0.1	0.1	961	0.06	0.18	991	0.42	0.42
902	0.06	0.06	932	0.44	0.44	962	0.48	0.46	992	0.1	0.12
903	0.34	0.36	933	0.48	0.46	963	0.52	0.42	993	0.54	0.48
904	0.04	0.04	934	0.46	0.5	964	0.7	0.62	994	0.08	0.08
905	0.4	0.34	935	0.6	0.58	965	0.2	0.12	995	0.28	0.38
906	0.22	0.24	936	0.4	0.46	966	0.58	0.54	996	0.32	0.34
907	0.42	0.38	937	0.5	0.42	967	0.3	0.3	997	0.28	0.22
908	0.04	0.02	938	0.26	0.3	968	0.34	0.38	998	0.2	0.2
909	0.1	0.14	939	0.4	0.4	969	0.42	0.48	999	0.16	0.18
910	0.16	0.2	940	0.46	0.48	970	0.64	0.6	1000	0.3	0.32
911	0.52	0.46	941	0.38	0.4	971	0.26	0.18			
912	0.7	0.64	942	0.1	0.1	972	0.62	0.7			
913	0.2	0.2	943	0.36	0.3	973	0.28	0.28			
914	0.5	0.34	944	0.32	0.28	974	0.14	0.14			
915	0.46	0.4	945	0.32	0.36	975	0.54	0.44			
916	0.44	0.4	946	0.46	0.26	976	0.58	0.64			
917	0.56	0.64	947	0.08	0.12	977	0.36	0.38			
918	0.48	0.34	948	0.5	0.5	978	0.18	0.18			
919	0.36	0.26	949	0.56	0.56	979	0.32	0.18			
920	0.26	0.3	950	0.14	0.12	980	0.3	0.26			
921	0.32	0.3	951	0.24	0.28	981	0.4	0.44			
922	0.34	0.34	952	0.16	0.16	982	0.24	0.3			
923	0.62	0.52	953	0.24	0.22	983	0.46	0.48			
924	0.22	0.22	954	0.08	0.12	984	0.08	0.06			
925	0.46	0.46	955	0.16	0.14	985	0.28	0.26			
926	0.4	0.42	956	0.46	0.42	986	0.34	0.36			
927	0.44	0.56	957	0.28	0.22	987	0.26	0.28			
928	0.24	0.22	958	0.54	0.52	988	0.42	0.34			
929	0.24	0.1	959	0.32	0.32	989	0.42	0.38			
930	0.32	0.36	960	0.12	0.1	990	0.38	0.3			

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Scope and Method of Study: The purpose of this study is to compare the performance of the Ordinal Logistic Regression (OLR) and Artificial Neural Network (ANN) models when analyzing ordinal data using different scenarios by varying the combinations of the marginal probability distributions and correlation coefficients. Two internal links in the Service Profit Chain (SPC), the relationship between employee perceived value of the internal and external determinants of employee satisfaction and employee overall satisfaction and the relationship between employee overall satisfaction and job performance are used as a framework to build the OLR and ANN models. Ordinal data collected from surveys at two trainining restaurants (Taylors' Dining at Oklahoma State University, USA and Fajar Teaching Restaurant at Universitas Negeri Malang, Indonesia) and simulated correlated ordinal data are fitted to the OLR and ANN models in order to compare the mean of misclassification rates from each model. A model with a lower misclassification rate is preferred.

Findings and Conclusions: The application of the OLR and ANN models to analyze a causal relationship between one input variable and one output variable results in no statistically significant difference between the means of the misclassification rates resulting from both models for all three scenarios tested. On the other hand, the application of the OLR and ANN models to analyze a causal relationship between three input variables and one output variable results in a statistically significant difference between the means of the misclassification rates resulting from both models for all three scenarios tested. The OLR model outperforms the ANN model when it is used to analyze ordinal data that has similar marginal probabilities and correlation coefficients to Taylors' data. In contrast, the ANN model outperforms the OLR model when it is used to analyze ordinal data that has marginal probabilities and correlation coefficients either similar to FTR's data or randomly distributed. These results suggest that the complexity of the problem, which is represented by the number of input variables (attributes), and the complexity of the data structures, which is represented by the correlation coefficient and marginal probability distribution including the kurtosis, should be considered before fitting data sets to either the OLR or ANN models.

ADVISER'S APPROVAL: Dr.Camille DeYong