Chapter 3
Multivariate Analysis:
Factor and Discriminant Analyses

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ABSTRACT

Multivariate analysis is based on the statistical principle of multivariate statistics, which includes observation and analysis of statistical output variables in case of more than one output variable at a time. The technique is used to perform trade studies across multiple dimensions while taking into account the effects of all variables on the responses of interest in design and analysis. This chapter includes the theoretical concepts of multivariate analysis including factor and discriminant analyses. It is also gives examples to understand and apply them correctly.

1. INTRODUCTION

In the Multivariate Analysis, data that more than one variable is analyzed with any statistical techniques. This analysis is used as techniques to facilitate the analysis of complex data sets for many researchers. It also allows to analyze many dependent and independent variables. The multivariate analysis is needed in many different fields such as sociology, psychology, statistics, and medicine etc. In this chapter, factor and linear discriminant analyses which are techniques of multivariate analysis are introduced with examples.

Factor Analysis (FA) is one of the multivariate analysis techniques that are frequently used in the field especially in the social sciences. It aims to find a small

DOI: 10.4018/978-1-5225-3534-8.ch003

number of new unrelated variables by combining the variables associated with each other in varying p space. In other words, it is a method including the dimension reduction and the destruction of dependency structure. In factor analysis, researchers are primarily able to see what the underlying (fundamental) factors underlying the set of variables used in the research context are, and how each of these factors explains each of the variables. In this way, the researcher will have the ability to express and understand the set of many variable variables in his hand in a smaller number of reconstructed variables (factors). FA is similar to principal component analysis (PCA). The main difference between FA and PCA is that the components are expressed as a linear combination of variables in the analysis of the principal components, whereas in factor analysis the variables are not expressed as linear combinations of factors. The other difference is that while the principal component analysis is concerned with the amount of change in variables, factor analysis deals with covariance and correlation constructs.

Linear Discriminant Analysis (LDA) is a classification method developed by Fisher in 1936. It has a few assumptions. One of them is that variables have a multivariate normal distribution. The other is that there is no significant relationship among variables. The other assumption is that group variances are homogeneous. In the LDA, there are two purposes. They are *discrimination* and *classification*. Firtsly, a discrimination function is determined. Then, observations are divided into groups by using the discrimination function. The success of the method can be measured by how many observations in the dataset are correctly classified (assigned to their own group). Although this method is simple, it is a analysis technique that produces good results in complex problems. The fundamental difference between LDA and PCA is that PCA determines the best discriminating components without preliminary information about groups, whereas discriminant analysis calculates the best discriminating components for groups that are defined by the user.

In section 2, the multivariate analysis including factor and discriminant analyses is widely introduced with examples. The last part of the chapter includes references.

2. MULTIVARIATE ANALYSIS

2.1. Factor Analysis

Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. For example, it is possible that variations in six observed variables