Chapter 3

Fuzzy Clustering: An Analysis of Service Quality in the Mobile Phone Industry

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ABSTRACT

This chapter presents a study of the development of the clustering methodology to data analysis, with particular attention to the analysis from a crisp environment to a fuzzy environment. An applied problem concerning service quality (using SERVQUAL) of mobile phone users, and subsequent loyalty and satisfaction forms the data set to demonstrate the clustering issue. Following details on both the crisp k-means and fuzzy c-means clustering techniques, comparable results from their analysis are shown, on a subset of data, to enable both graphical and statistical elucidation. Fuzzy c-means is then employed on the full SERVQUAL dimensions, and the established results interpreted before tested on external variables, namely the level of loyalty and satisfaction across the different clusters established.

INTRODUCTION

This chapter presents a study of the development of the clustering methodology to data analysis (Punj and Stewart, 1983). In particular, the development of a clustering technique from its original crisp environment to working within a fuzzy environment is described. From the introduction of fuzzy set theory in Zadeh (1965), as an extension of the classical notion of a set, it has grown and itself advanced to offer novel dimensions to traditional (crisp) analysis approaches (see for example, Bonarini et al., 2000; Estrada et al., 2008; Gader, 1995; Zarandi et al., 2002). Related to the context of this chapter,
Tokushige et al. (2007) undertook the consideration of multivariate functional data, using clustering, in crisp and fuzzy environments. Pertinent to the analysis reported in this chapter, Beynon et al. (2012) consider clustering, importantly moving from the consideration of data within a crisp environment to an ambiguous (fuzzy) environment. In their discussing of this crisp to fuzzy understanding, and important for the type of data considered in this chapter, they state (p. 7):

… it is important to acknowledge that there may not be distinct clusters of objects … Instead, objects may be ambiguously associated with established clusters … This may be particularly evident in the analysis of perceptual data, which is inherently ambiguous. As a result, technical developments which acknowledge the ambiguous association of objects to clusters may be particularly valuable …

This statement acknowledges the practicalities of the data being considered, namely that it is, or may be, perceptual (fuzzy), and it cannot simply be argued as simply black or white (Cheng et al., 1998).

The applied problem considered in this chapter is in respect to the consumer-based issue of service quality (Powell, 1995). Underpinned by consumers’ evaluations of expectations and/or performance, service quality is demonstrated to be a powerful predictor of consumers’ positive and negative evaluations of service. Service quality is also shown to drive customer loyalty and thus ultimately impacts the firm’s bottom line and the development and expansion of business (Parasuraman et al., 1985; 1988; Cronin and Taylor, 1992). Typically, in this area of research, emphasis is on both technical and applied understanding. Zeithaml (1987) states (in Najjar & Bishu, 2006, p. 36):

… service quality is a consumer judgment about an entity’s overall excellence or superiority. It is a form of attitude, and results from a comparison and expectations to perceptions of performance received.

In technical terms, two clustering techniques will be exposited. These techniques demonstrate the development of clustering across the traditional crisp environment, with the employment of crisp k-means clustering (MacQueen, 1967; Johnson and Wichern, 2002), through to the more nascent fuzzy environment, with the employment of fuzzy c-means clustering (Bezdek, 1980, 1981). The fuzzy c-means technique becomes the main focus of the technical analysis, after its comparison with the more traditional k-means approach.

In applied terms, the main consideration is the elucidation of SERVQUAL (Parasuraman et al., 1985; 1988), a scale which assesses the expectations-performance gap to measure customers’ perceptions of service quality with service provider firms. The five SERVQUAL based dimensions, Tangibles, Reliability, Responsiveness, Assurance and Empathy will be considered in depth. Using survey data, the variables will be clustered using fuzzy c-means clustering (and compared with crisp k-means clustering on a smaller subset of these). The combination of the consideration of SERVQUAL and fuzzy c-means clustering places this chapter directly in the area of marketing analytics (Hauser, 2007).

This chapter will consider consumers’ perceived quality of service with their mobile phone provider, and how the SERVQUAL dimensions may link with consumer loyalty and satisfaction (Gaudet, 2004). Previous findings in this area have suggested that there is a positive relationship between high levels of perceived service quality and consumer satisfaction and loyalty (Fournier & Mick, 1999; Keiningham et al., 1999). These constructs will be tested here (bringing also the inclusion of graphical and statistical analysis with the fuzzy c-means clustering undertaken).