A Comparison of Membership Function Types for Fuzzy-based Quality of Web Service Evaluation Model

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INTRODUCTION

A Fuzzy Inference System (FIS) is a soft computing model that uses fuzzy set theory to map inputs into outputs. As shown in Figure 1, FIS comprises four components, namely fuzzifier, inference engine, rule base and defuzzifier. Fuzzifier converts crisp inputs into membership degrees, which used in a fuzzy set. Then the membership degrees are used by an inference engine to generate results. The inference engine carries out the work by referring to the rules set by the rule base. The results generated by the inference engine may contain many values depending on the number of rules. Hence, defuzzifier will use these result values in its process to produce a single crisp value [1]-[2]. This defuzzification process involves a special algorithm, such as Karnik-Mendel (KM) algorithms [1]-[2].

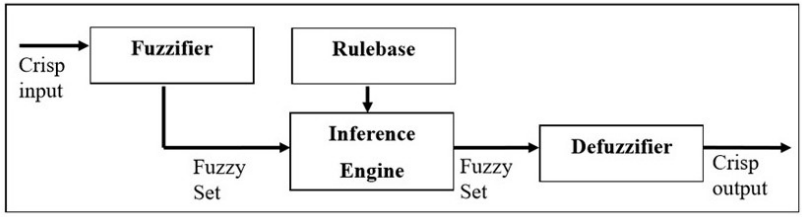

Figure 1 Fuzzy inference system's components

In this work, we focused on the fuzzifier component, specifically on membership functions that are used by fuzzifier to convert crisp inputs into membership degrees. There are several types of membership functions that can be applied in the FIS, but the most commonly used are triangular, trapezoidal and Gaussian membership functions. Although these three types of membership function serve the same purpose, their performances are different. For example, when they were implemented in fuzzy-based sign language applications, trapezoidal membership function outperformed the other two membership functions by producing the highest accuracy in gesture identification [5].

Another work applied the three types of membership function in the Fuzzy Logic controller and compared their performances [6]. The work found out that triangular and trapezoidal were better than Gaussian membership function. Triangular membership function, however, became better than trapezoidal when the condition was in steady-state. A different result was obtained when the three membership functions were implemented in adaptive neuro-fuzzy FIS for classification problems [7]. In this work, the Gaussian membership function had demonstrated a higher degree of accuracy with lesser computational complexity, as compared to the other two membership functions. From the three membership function types, none of them can perform the best in all conditions. As discussed above, each membership function can outperform the others depending on the type of application. Therefore it motivates us to propose a FIS-based model to evaluate the Quality of Web Service (QoWS). An investigation must be carried out to determine which membership function type produces the most accurate evaluation results.

QoWS evaluation is one of the critical procedures in a web service environment because it determines the performance aspects of web service. This means that it determines the excellent service in delivering its tasks. Existing QoWS evaluation models are based on hard computation, which means the decision is using the computation of exact values. In contrast, our work proposed a QoWS evaluation model using Fuzzy Logic due to the uncertain nature of web service. That means Fuzzy Logic can perform well at handling unpredictable problems such as in traffic regulations in wireless mesh networks by Castillo & Melin [1], processing human perception by Sepúlveda et al.[2], and network traffic policy by Mendel [3].