A Complex Dual Gaussian Fuzzy Number

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Abstract

In this paper, a novel complex dual Gaussian fuzzy number (CDGFN) is proposed to more accurately model two-dimensional uncertainty, which serves as the medium to represent generalized quantum basic belief assignment (GQBBA).

Keywords: Generalized quantum evidence theory; Pattern classification; Generalized quantum basic belief assignment; Discrete Fourier transform; Gaussian fuzzy number; Complex fuzzy number

1. The proposed method

Definition. (CDGFN membership function)

Let $|\mathcal{W}_p\rangle$ be a subclass in quantum frame of discernment $|\Omega\rangle$. Suppose there is an event x to be classified, which owns feature values α_q and θ_q in the frequency q for feature of magnitude α and phase θ. Then the degree of x for class $|\mathcal{W}_p\rangle$ in frequency q is defined by a CDGFN membership function:

$$\begin{aligned} f_{|\mathcal{W}_p\rangle q}(x) &= f^{\alpha}_{|\mathcal{W}_p\rangle q}(x) e^{i f^{\theta}_{|\mathcal{W}_p\rangle q}(x)} \\ &= e^{-\frac{(\alpha_q - \mu^{\alpha}_{|\mathcal{W}_p\rangle q})^2}{2{\sigma^{\alpha}_{|\mathcal{W}_p\rangle q}}^2}} e^{ie^{-\frac{(\theta_q - \mu^{\theta}_{|\mathcal{W}_p\rangle q})^2}{2{\sigma^{\theta}_{|\mathcal{W}_p\rangle q}}^2}}}, \end{aligned} \tag{1}$$

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where $\mu^{\alpha}_{|\mathcal{W}_p\rangle q}$ and $\mu^{\theta}_{|\mathcal{W}_p\rangle q}$ denote the average value of magnitude and phase in frequency q for class $|\mathcal{W}_p\rangle$ in the training set, while $\sigma^{\alpha}_{|\mathcal{W}_p\rangle q}$ and $\sigma^{\theta}_{|\mathcal{W}_p\rangle q}$ denote the standard deviation value of magnitude and pahse in frequency q for class $|\mathcal{W}_p\rangle$.

The modulus of $f_{|\mathcal{W}_p\rangle q}(x)$ represents the degree of x in class $|\mathcal{W}_p\rangle$. Due to $f^{\alpha}_{|\mathcal{W}_p\rangle q}(x)$ is in $[0,1]$, $|f_{|\mathcal{W}_p\rangle q}(x)|$ ($|\cdot|$ denotes the modulus function) is constrained in the interval of $[0,1]$, which obeys the rule of fuzzy number. Moreover, the greater the value of $|f_{|\mathcal{W}_p\rangle q}(x)|$, the higher the grade of membership of x in $|\mathcal{W}_p\rangle$.