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Generalized Parametric Fuzzy Divergence Model based on Single Valued Neutrosophic sets

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ABSTRACT

In diverse real-life decision-making problems, the divergence models establish informative measures in conducting impreciseness and improbability surrounded by various factors of the decision-making process. This eagerness encourages one to instigate new fuzzy divergence models in convincing flexibility in assorted disciplines. The present communication is an accurate footstep in the direction of shaping a single-valued generalized neutrosophic parametric fuzzy divergence model and complete examination of its wide-ranging properties.

Keywords: Fuzzy divergence, Truth-membership function, Probability spaces, Single valued neutrosophic set.

INTRODUCTION

The distance models supply a crucial liability because of their applications in the direction of assortment fields and one of the core concerns is to discover such a well-fitting distance model in the probability spaces. Such a model is a dynamic tool for the pronouncement of innumerable solutions concerning multidisciplinary optimization problems. It has been a matter of fact that the basic essential and practical well-known divergence model in the probability spaces is owed to

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Kullback and Leibler [11] with the quantitative structure having legitimate properties. After this divergence model in probability spaces, numerous new divergence models have been produced by a variety of researchers. Some of these are:

$$D_\lambda(P:Q)=\frac{1}{\lambda}\sum_{i=1}^{n}(1+\lambda\ p_i)\ln\frac{1+\lambda\ p_i}{1+\lambda\ q_i},\lambda>0\ (1.1)$$

which is Ferreri's [7]model.

$$D(P:Q)=\frac{1}{\alpha-1}\ln\left(\sum_{i=1}^{n}\ p_i^{\alpha+\beta-1}q_i^{1-\alpha}\Big/\sum_{i=1}^{n}\ p_i^{\beta}\right)\qquad(1.2)$$

which are Kapur [9] divergence models.

$$D_\alpha(P:Q)=\frac{1}{2^\beta-1}\left(\left(\sum_{i=1}^{n}p_i^\alpha q_i^{1-\alpha}\right)^{\frac{\beta-1}{\alpha-1}}-1\right),\ \alpha,\beta>0,\ \alpha\neq 1,\beta\neq 1.\quad(1.3)$$

which is Sharma and Mittal's [19] model.

Lin [12] observed that Kullback and Leibler's [11] model is indeterminate if $q_i=0$ and $p_i\neq 0$ and to overcome this problem, produced a modified descriptionof Kullback and Leibler's [11] divergence. Parkash and Kumar [16] created an analogous divergence model in the subsequent look:

$$D\left(P;Q\right)=\sum_{i=1}^{n}p_i\ln\frac{p_i}{\left(\frac{\sqrt{p_i}+\sqrt{q_i}}{2}\right)^2}\qquad(1.4)$$

Stimulated by the idea of weighted information wrought by Guiasu [8], Kapur [9] created quite a lot of suitable weighted divergence models, some of which are:

$$D_1\left(P;Q:W\right)=\sum_{i=1}^{n}w_i\left[\frac{p_i-p_iIn\,p_i-q_i+q_iIn\,q_i}{In\,q_i}+p_i-q_i\right](1.5)$$

Motivated by the technique employed by Kapur [9], Parkash, Kumar, and Kakkar [17] produced the subsequent weighted divergence model:

$$D_\alpha(P,Q;W)=\frac{1}{2^{1-\alpha}-1}\sum_{i=1}^{n}w_i\left[\left(\alpha-1\right)p_i-p_i^\alpha q_i^{1-\alpha}+\alpha p_i^{\frac{1}{\alpha}}q_i^{1-\frac{1}{\alpha}}+2\left(1-\alpha\right)q_i\right],\ \alpha>1\,(1.6)$$

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Employing the above configuration, quite a lot of complementary weighted divergence models can be developed to deliver their applications.

On the erstwhile, Zadeh's [22]unbelievable theory of fuzzy sets extended the possibility of research and this novelty gave internment to divergence models in a fuzzy environment. Bhandari and Pal [3] recommended a divergence model for such situations whereas Couso, Jains, and Montes [4] twisted fuzzy divergence models to accept the prevalent situations. Some recent developments regarding the divergence models in the fuzzy environment have been made by Kapur [10], Parkash, Sharma, and Kumar [18], Markechová, Mosapour, and Ebrahimzadeh [13], Mishra et. al. [14], etc.

It is supplementary that the above hypothesis was additionally promoted with the perception of intuitionistic fuzzy sets (IFSs) originated by Atanassov [2]. Originally projected by Smarandache [20], neutrosophy is a stem of philosophy analyzing the ancestor, environment, and purview of neutralities, along with their exchanges with dissimilar approximate spectra. The quantified unambiguity in the neutrosophic set plays a critical responsibility in numerous applications. The intuitionistic fuzzy sets (IFSs) think regarding together types of memberships and are capable of controlling the partial information. A single-valued neutrosophic set (SVNS) delivers an episode of a neutrosophic set fashioned to make available supplementary likelihood to signify uncertainty in the real world for applying in decision-making. Some pioneers to develop models on neutrosophic sets include Das et al. [5], Wei and Zhang [21], Pamucar and Bozanic [15], Abobalaet. al. [1], Zulqarnainet. al. [23], Farooq, Saqlain and Rehman [6], etc.

The present communication consists ofinvestigations and proposals of a new generalized parametric fuzzy divergence model based on SVNSs and has graceful properties to augment the employability of the model.In the sequel; we shape the model with certain well desirable properties indispensable for the development of our model.

2. GENERALIZED PARAMETRIC FUZZY DIVERGENCE MODEL BASED ON SVNS

With the allocation of all standard notationsof truth-membership function, indeterminacy-membership function, and falsity-membership function, let G and H be two fuzzy sets having these values as $T_G(x_d), I_G(x_d), F_G(x_d)$ and $T_H(x_d), I_H(x_d), F_H(x_d)$ respectively. We now recommend the subsequent parametric fuzzy divergence model:

$J^{s}_{r\{\gamma\}}(G,H)$

$$= \frac{r}{n(2-s)} \sum_{i=1}^{n} \left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d) \log \frac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) T_H^{\frac{r}{2-s}}(x_d)} + \left(1 - T_G^{\frac{r}{2-s}}(x_d)\right) \log \frac{1 - T_G^{\frac{r}{2-s}}(x_d)}{1 - \left(\gamma T_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) T_H^{\frac{r}{2-s}}(x_d)\right)} \\ + I_G^{\frac{r}{2-s}}(x_d) \log \frac{I_{\hat{A}}^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) I_H^{\frac{r}{2-s}}(x_d)} + \left(1 - I_G^{\frac{r}{2-s}}(x_d)\right) \log \frac{1 - I_A^{\frac{r}{2-s}}(x_d)}{1 - \left(\gamma I_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) I_H^{\frac{r}{2-s}}(x_d)\right)} \\ + F_G^{\frac{r}{2-s}}(x_d) \log \frac{F_A^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) F_H^{\frac{r}{2-s}}(x_d)} + \left(1 - F_G^{\frac{r}{2-s}}(x_d)\right) \log \frac{1 - F_G^{\frac{r}{2-s}}(x_d)}{1 - \left(\gamma F_G^{\frac{r}{2-s}}(x_d) + (1-\gamma) F_H^{\frac{r}{2-s}}(x_d)\right)} \end{array} \right];$$

$0 \le \gamma \le 1;\ r, s > 0, s \ne 2$

It may be noted from the definition of $J_{r\{\gamma\}}^{s}(G,H)$ is not a symmetric measure, so to imbue the measure with symmetry, a generalized symmetric fuzzy divergence measure based on neutrosophic sets can be defined as follows

Definition 2.1. A generalized symmetric fuzzy divergence model for two SVNSs G and H based on r, s and γ is given as

$J_{r\{\gamma\}}^{s}(G,H) = J_{r\{\gamma\}}^{s}(G,H) + J_{r\{\gamma\}}^{s}(H,G)$

From the definition of $D_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right)$**,** It has been observed that

(i) $D_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right) \ge 0$

(ii) $D_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right) = 0$ if and only if $\mu_{\hat{A}}(x_i) = \mu_{\hat{B}}(x_i) \,\&\, \nu_{\hat{A}}(x_i) = \nu_{\hat{B}}(x_i)$

(iii) $D_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right) \ne D_{\hat{E}}^{\hat{\alpha}}\left(\hat{B},\hat{A}\right)$ but $K_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right) = D_{\hat{E}}^{\hat{\alpha}}\left(\hat{A},\hat{B}\right) + D_{\hat{E}}^{\hat{\alpha}}\left(\hat{B},\hat{A}\right)$ is symmetric.

We have confirmed that it satisfies every one advantageous possession of being a fuzzy divergence, that's why we assert that the above appearance represents an indisputable model of fuzzy divergence.

Property2.1. If G and H be the two IFSs defined on universal set X, such that they satisfy for any $x_i \in X$ either $G \subseteq H$ -or $G \supseteq H$, then

$J_{r\{\gamma\}}^{s}(G \cup H; G \cap H) = J_{r\{\gamma\}}^{s}(G; H).$

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Proof: It is clear that

$$J^{s}_{r\{\gamma\}}\left(G\cup H;G\cap H\right)=J^{s}_{r\{\gamma\}}\left(G\cup H\middle|G\cap H\right)+J^{s}_{r\{\gamma\}}\left(G\cap H\middle|G\cup H\right)$$

Now, $J^{s}_{r\{\gamma\}}\left(G\cup H\middle|G\cap H\right)$

$$=\frac{r}{n(2-s)}\sum_{i=1}^{n}\left[\begin{array}{l}T_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\dfrac{T_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma T_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cap H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)}\\ +I_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\dfrac{I_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma I_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cap H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)}\\ +F_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\dfrac{F_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma F_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cap H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

$$=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l}T_{H}^{\frac{r}{2-s}}(x_d)\log\dfrac{T_{H}^{\frac{r}{2-s}}(x_d)}{\gamma T_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_{H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G}^{\frac{r}{2-s}}(x_d)\right)}\\ +I_{H}^{\frac{r}{2-s}}(x_d)\log\dfrac{I_{H}^{\frac{r}{2-s}}(x_d)}{\gamma I_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_{\hat{B}}^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_i)}{1-\left(\gamma I_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G}^{\frac{r}{2-s}}(x_d)\right)}\\ +F_{H}^{\frac{r}{2-s}}(x_d)\log\dfrac{F_{H}^{\frac{r}{2-s}}(x_d)}{\gamma F_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{H}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_{H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

$$+\frac{r}{n(2-s)}\sum_{x\in X_2}\left[\begin{array}{l}T_{G}^{\frac{r}{2-s}}(x_d)\log\dfrac{T_{G}^{\frac{r}{2-s}}(x_d)}{\gamma T_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{G}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)\right)}\\ +I_{G}^{\frac{r}{2-s}}(x_d)\log\dfrac{I_{G}^{\frac{r}{2-s}}(x_d)}{\gamma I_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{G}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)\right)}\\ +F_{G}^{\frac{r}{2-s}}(x_d)\log\dfrac{F_{G}^{\frac{r}{2-s}}(x_d)}{\gamma F_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{G}^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

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$$J_{r\{\gamma\}}^{s}\left(G\cap H\middle|G\cup H\right)$$

$$=\frac{r}{n(2-s)}\sum_{i=1}^{n}\left[\begin{array}{l}T_{G\cap H}^{\frac{r}{2-s}}(x_d)\log\frac{T_{G\cap H}^{\frac{r}{2-s}}(x_d)}{\gamma T_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_{G\cap H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)}\\+I_{G\cap H}^{\frac{r}{2-s}}(x_d)\log\frac{I_{G\cap H}^{\frac{r}{2-s}}(x_d)}{\gamma I_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_{G\cap H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)}\\+F_{G\cap H}^{\frac{r}{2-s}}(x_d)\log\frac{F_{G\cap H}^{\frac{r}{2-s}}(x_d)}{\gamma F_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{G\cap H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_{G\cap H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{G\cap H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

$$=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l}T_{G}^{\frac{r}{2-s}}(x_d)\log\frac{T_{G}^{\frac{r}{2-s}}(x_d)}{\gamma T_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{G}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)\right)}\\+I_{G}^{\frac{r}{2-s}}(x_d)\log\frac{I_{G}^{\frac{r}{2-s}}(x_d)}{\gamma I_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{G}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)\right)}\\+F_{G}^{\frac{r}{2-s}}(x_d)\log\frac{F_{G}^{\frac{r}{2-s}}(x_d)}{\gamma F_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{G}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_{G}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{G}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

$$+\frac{r}{n(2-s)}\sum_{x\in X_2}\left[\begin{array}{l}T_{H}^{\frac{r}{2-s}}(x_d)\log\frac{T_{H}^{\frac{r}{2-s}}(x_d)}{\gamma T_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-T_{H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_{H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G}^{\frac{r}{2-s}}(x_d)\right)}\\+I_{H}^{\frac{r}{2-s}}(x_d)\log\frac{I_{H}^{\frac{r}{2-s}}(x_d)}{\gamma I_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-I_{H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_{H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G}^{\frac{r}{2-s}}(x_d)\right)}\\+F_{H}^{\frac{r}{2-s}}(x_d)\log\frac{F_{H}^{\frac{r}{2-s}}(x_d)}{\gamma F_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G}^{\frac{r}{2-s}}(x_d)}+\left(1-F_{H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_{H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G}^{\frac{r}{2-s}}(x_d)\right)}\end{array}\right]$$

By adding the above equations, we get

$$J_{r\{\gamma\}}^{s}\left(G\cup H\middle|G\cap H\right)+J_{r\{\gamma\}}^{s}\left(G\cap H\middle|G\cup H\right)=J_{r\{\gamma\}}^{s}\left(G\middle|H\right)+J_{r\{\gamma\}}^{s}\left(H\middle|G\right)$$

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$= J^{s}_{r\{\gamma\}}\left(G;H\right)$

Hence the result holds.

Property2.2. For any two SVNSs G and H, we have

(a) $J^{s}_{r\{\gamma\}}\left(G;G\cup H\right)=J^{s}_{r\{\gamma\}}\left(H;G\cap H\right),$

(b) $J^{s}_{r\{\gamma\}}\left(G;G\cap H\right)=J^{s}_{r\{\gamma\}}\left(H;G\cup H\right),$

(c) $J^{s}_{r\{\gamma\}}\left(G;G\cup H\right)+J^{s}_{r\{\gamma\}}\left(G;G\cap H\right)=J^{s}_{r\{\gamma\}}\left(G;H\right),$

(d) $J^{s}_{r\{\gamma\}}\left(H;G\cup H\right)+J^{s}_{r\{\gamma\}}\left(H;G\cap H\right)=J^{s}_{r\{\gamma\}}\left(G;H\right).$

Proof: We prove only (a). All other parts (b), (c,), and (d)) can be proved similarly.

$$J^{s}_{r\{\gamma\}}\left(G\middle|G\cup H\right)+J^{s}_{r\{\gamma\}}\left(G\cap H\middle|G\right)=J^{s}_{r\{\gamma\}}\left(H\middle|G\cap H\right)+J^{s}_{r\{\gamma\}}\left(G\cap H\middle|H\right).$$

From the definition of divergence, let $J^{s}_{r\{\gamma\}}\left(G\middle|G\cup H\right)$

$$=\frac{r}{n(2-s)}\sum_{i=1}^{n}\left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d)\log\dfrac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)} \\ +I_G^{\frac{r}{2-s}}(x_d)\log\dfrac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)} \\ +F_G^{\frac{r}{2-s}}(x_d)\log\dfrac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cup H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

$$=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d)\log\dfrac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_{H}^{\frac{r}{2-s}}(x_d)\right)} \\ +I_G^{\frac{r}{2-s}}(x_d)\log\dfrac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_{H}^{\frac{r}{2-s}}(x_d)\right)} \\ +F_G^{\frac{r}{2-s}}(x_d)\log\dfrac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_{H}^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

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$$+\frac{r}{n(2-s)}\sum_{x\in X_2}\left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d)\log\frac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)\right)} \\ +I_G^{\frac{r}{2-s}}(x_d)\log\frac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)\right)} \\ +F_G^{\frac{r}{2-s}}(x_d)\log\frac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

$$=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d)\log\frac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_H^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_H^{\frac{r}{2-s}}(x_d)\right)} \\ +I_G^{\frac{r}{2-s}}(x_d)\log\frac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_H^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_H^{\frac{r}{2-s}}(x_d)\right)} \\ +F_G^{\frac{r}{2-s}}(x_d)\log\frac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_H^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_H^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

and $J_{r\{\gamma\}}^{s}\left(G\cup H|G\right)$

$$=\frac{r}{n(2-s)}\sum_{i=1}^{n}\left[\begin{array}{l} T_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\frac{T_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma T_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)}+\left(1-T_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)\right)} \\ +I_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\frac{I_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma I_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)}+\left(1-I_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)\right)} \\ +F_{G\cup H}^{\frac{r}{2-s}}(x_d)\log\frac{F_{G\cup H}^{\frac{r}{2-s}}(x_d)}{\gamma F_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)}+\left(1-F_{G\cup H}^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_{G\cup H}^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_{G\cup H}^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

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$$
=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l}
T_H^{\frac{r}{2-s}}(x_d)\log\dfrac{T_H^{\frac{r}{2-s}}(x_d)}{\gamma T_H^{\frac{r}{2-s}}(x_i)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)}+\left(1-T_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)\right)}\\
+I_H^{\frac{r}{2-s}}(x_d)\log\dfrac{I_{\hat{B}}^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)}{\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)}+\left(1-I_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)\right)}\\
+F_H^{\frac{r}{2-s}}(x_d)\log\dfrac{F_H^{\frac{r}{2-s}}(x_d)}{\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)}+\left(1-F_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)\right)}
\end{array}\right]
$$

$$
=\frac{r}{n(2-s)}\sum_{x\in X_2}\left[\begin{array}{l}
T_G^{\frac{r}{2-s}}(x_d)\log\dfrac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)\right)}\\
+I_G^{\frac{r}{2-s}}(x_d)\log\dfrac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)\right)}\\
+F_G^{\frac{r}{2-s}}(x_d)\log\dfrac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)\right)}
\end{array}\right]
$$

$$
=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l}
T_H^{\frac{r}{2-s}}(x_d)\log\dfrac{T_H^{\frac{r}{2-s}}(x_d)}{\gamma T_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)}+\left(1-T_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-T_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)\right)}\\
+I_H^{\frac{r}{2-s}}(x_d)\log\dfrac{I_H^{\frac{r}{2-s}}(x_d)}{\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)}+\left(1-I_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-I_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)\right)}\\
+F_H^{\frac{r}{2-s}}(x_d)\log\dfrac{F_H^{\frac{r}{2-s}}(x_d)}{\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)}+\left(1-F_H^{\frac{r}{2-s}}(x_d)\right)\log\dfrac{1-F_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{\hat{\alpha}}{2-\hat{\beta}}}(x_d)\right)}
\end{array}\right]
$$

Similarly, $J^s_{r\{\gamma\}}\left(H\middle|G\cap H\right)$

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$$=\frac{r}{n(2-s)}\sum_{x\in X_2}\left[\begin{array}{l} T_G^{\frac{r}{2-s}}(x_d)\log\frac{T_G^{\frac{r}{2-s}}(x_d)}{\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_H^{\frac{r}{2-s}}(x_d)}+\left(1-T_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_H^{\frac{r}{2-s}}(x_d)\right)} \\ +I_G^{\frac{r}{2-s}}(x_d)\log\frac{I_G^{\frac{r}{2-s}}(x_d)}{\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_H^{\frac{r}{2-s}}(x_d)}+\left(1-I_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_H^{\frac{r}{2-s}}(x_d)\right)} \\ +F_G^{\frac{r}{2-s}}(x_d)\log\frac{F_G^{\frac{r}{2-s}}(x_d)}{\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_H^{\frac{r}{2-s}}(x_d)}+\left(1-F_G^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_G^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_G^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_H^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

and,

$J^s_{r\{\gamma\}}\left(G\cap H|H\right)$

$$=\frac{r}{n(2-s)}\sum_{x\in X_1}\left[\begin{array}{l} T_H^{\frac{r}{2-s}}(x_d)\log\frac{T_H^{\frac{r}{2-s}}(x_d)}{\gamma T_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)}+\left(1-T_H^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-T_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma T_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)T_G^{\frac{r}{2-s}}(x_d)\right)} \\ +I_H^{\frac{r}{2-s}}(x_d)\log\frac{I_H^{\frac{r}{2-s}}(x_d)}{\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)}+\left(1-I_H^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-I_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma I_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)I_G^{\frac{r}{2-s}}(x_d)\right)} \\ +F_H^{\frac{r}{2-s}}(x_d)\log\frac{F_H^{\frac{r}{2-s}}(x_d)}{\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)}+\left(1-F_H^{\frac{r}{2-s}}(x_d)\right)\log\frac{1-F_H^{\frac{r}{2-s}}(x_d)}{1-\left(\gamma F_H^{\frac{r}{2-s}}(x_d)+(1-\gamma)F_G^{\frac{r}{2-s}}(x_d)\right)} \end{array}\right]$$

By using equation (2.1), we get the result.

CONCLUDING REMARKS

In the dynamic invented story of divergence models, one gets inspired to summarize pioneering models to persuade flexibility in divergent disciplines. A new-fangled fuzzy divergence model on SVNSs with valuable properties has been investigated in the present communication. Such numerous innovative fuzzy divergence models can be produced for the continuance of research in these disciplines.

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