Chapter 10

Bibliography

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10.1 Appendices

10.1.1 Appendix A

Some basic operations on neutrosophic sets [149, 150].
Let, $\tilde{\tilde{A}} = \{(T_A(x), I_A(x), F_A(x))\ ;\ x \in X\}$ and $\tilde{\tilde{B}} = \{(T_B(x), I_B(x), F_B(x))\ ;\ \in X\}$ be two neutrosophic sets over X. Then, some possible classes of intersection operations ($\cap_N$) and union operations ($\cup_N$) between them are as follows:

- $\tilde{\tilde{A}} \cap_N \tilde{\tilde{B}} = (T_A(x) \cap_F T_B(x), I_A(x) \cup_F I_B(x), F_A(x) \cup_F F_B(x))$;
- $\tilde{\tilde{A}} \cap_N \tilde{\tilde{B}} = (T_A(x) \cap_F T_B(x), I_A(x) \cap_F I_B(x), F_A(x) \cup_F F_B(x))$;
- $\tilde{\tilde{A}} \cap_N \tilde{\tilde{B}} = (T_A(x) \cap_F T_B(x), I_A(x) \cap_F I_B(x), F_A(x) \cap_F F_B(x))$;
- $\tilde{\tilde{A}} \cap_N \tilde{\tilde{B}} = (T_A(x) \cap_F T_B(x), \frac{I_A(x)+I_B(x)}{2}, F_A(x) \cup_F F_B(x))$;
- $\tilde{\tilde{A}} \cap_N \tilde{\tilde{B}} = (T_A(x) \cap_F T_B(x), 1 - \frac{I_A(x)+I_B(x)}{2}, F_A(x) \cup_F F_B(x))$;
- $\tilde{\tilde{A}} \cup_N \tilde{\tilde{B}} = (T_A(x) \cup_F T_B(x), I_A(x) \cap_F I_B(x), F_A(x) \cap_F F_B(x))$;
- $\tilde{\tilde{A}} \cup_N \tilde{\tilde{B}} = (T_A(x) \cup_F T_B(x), I_A(x) \cup_F I_B(x), F_A(x) \cap_F F_B(x))$;
- $\tilde{\tilde{A}} \cup_N \tilde{\tilde{B}} = (T_A(x) \cup_F T_B(x), I_A(x) \cup_F I_B(x), F_A(x) \cup_F F_B(x))$;
- $\tilde{\tilde{A}} \cup_N \tilde{\tilde{B}} = (T_A(x) \cup_F T_B(x), \frac{I_A(x)+I_B(x)}{2}, F_A(x) \cap_F F_B(x))$;
- $\tilde{\tilde{A}} \cup_N \tilde{\tilde{B}} = (T_A(x) \cup_F T_B(x), 1 - \frac{I_A(x)+I_B(x)}{2}, F_A(x) \cap_F F_B(x))$.

where, $\cap_F$ and $\cup_F$ are the fuzzy t-norm (fuzzy intersection) and fuzzy t-conorm (fuzzy union).

10.1.2 Appendix B

Some set theoretic operations on complex fuzzy sets [185].
Let, $\tilde{F}_A$ and $\tilde{F}_B$ be two complex fuzzy sets over the universe X where, $\mu_{\tilde{F}_A}(x) = r_{\tilde{F}_A}(x)e^{iu_{\tilde{F}_A}(x)}$ and $\mu_{\tilde{F}_B}(x) = r_{\tilde{F}_B}(x)e^{iu_{\tilde{F}_B}(x)}$.
Complex fuzzy bounded difference.
The complex fuzzy bounded difference of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\ominus}_F \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\ominus}_F \tilde{F}_B}(x) = max(0, r_{\tilde{F}_A}(x) - r_{\tilde{F}_B}(x))e^{imax\left(0, u_{\tilde{F}_A}(x) - u_{\tilde{F}_B}(x)\right)}$.

- **Complex fuzzy standard intersection.**
The complex fuzzy bounded difference of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\cap}_F^{min} \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\cap}_F^{min} \tilde{F}_B}(x) = min(r_{\tilde{F}_A}(x), r_{\tilde{F}_B}(x))e^{imin(u_{\tilde{F}_A}(x), u_{\tilde{F}_B}(x))}$.

- **Complex fuzzy standard union.**
The complex fuzzy bounded difference of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\cup}_F^{max} \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\cup}_F^{max} \tilde{F}_B}(x) = max(r_{\tilde{F}_A}(x), r_{\tilde{F}_B}(x))e^{imax(u_{\tilde{F}_A}(x), u_{\tilde{F}_B}(x))}$.

- **Complex fuzzy product.**
The complex fuzzy product of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\circ}_F \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\circ}_F \tilde{F}_B}(x) = r_{\tilde{F}_A}(x).r_{\tilde{F}_B}(x)e^{i2\pi\left(\frac{u_{\tilde{F}_A}(x)}{2\pi}.\frac{u_{\tilde{F}_B}(x)}{2\pi}\right)}$.

- **Complex fuzzy algebraic sum.**
The complex fuzzy algebraic sum of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{+}_F \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{+}_F \tilde{F}_B}(x) = (r_{\tilde{F}_A}(x) + r_{\tilde{F}_B}(x) - r_{\tilde{F}_A}(x).r_{\tilde{F}_B}(x))e^{i2\pi\left(\frac{u_{\tilde{F}_A}(x)}{2\pi}+\frac{u_{\tilde{F}_B}(x)}{2\pi}-\frac{u_{\tilde{F}_A}(x)}{2\pi}.\frac{u_{\tilde{F}_B}(x)}{2\pi}\right)}$.

- **Complex fuzzy bold intersection.**
The complex fuzzy bold intersection of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\Cap}_F \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\Cap}_F \tilde{F}_B}(x) = max(0, r_{\tilde{F}_A}(x) + r_{\tilde{F}_B}(x) - 1)e^{i\ max\left(0, u_{\tilde{F}_A}(x)+u_{\tilde{F}_B}(x)-2\pi\right)}$.

- **Complex fuzzy bold sum.**
The complex fuzzy bold sum of $\tilde{F}_A$ and $\tilde{F}_B$ is denoted by, $\tilde{F}_A \tilde{\Cup}_F \tilde{F}_B$ where, its membership is defined as,
$\mu_{\tilde{F}_A \tilde{\Cup}_F \tilde{F}_B}(x) = min(1, r_{\tilde{F}_A}(x) + r_{\tilde{F}_B}(x))e^{i\ min\left(2\pi, u_{\tilde{F}_A}(x)+u_{\tilde{F}_B}(x)\right)}$.

10.1.3 Appendix C

Addition of complex neutrosophic sets.
Consider m complex neutrosophic sets $\tilde{C}_1, \tilde{C}_2, .., \tilde{C}_m$ over the universal set X where,
$\tilde{C}_s = (p_s e^{iu_s}, q_s e^{iv_s}, r_s e^{iw_s}); s = 1, 2, .., m$. Then, the addition of m complex neutrosophic sets is denoted by, $\tilde{C}_1 \tilde{\oplus}_N \tilde{C}_2 \tilde{\oplus}_N .. \tilde{\oplus}_N \tilde{C}_m$ and is defined as,
$\tilde{C}_1 \tilde{\oplus}_N \tilde{C}_2 \tilde{\oplus}_N .. \tilde{\oplus}_N \tilde{C}_m = \big(min(1, p_1 + p_2 + .. + p_m)e^{imin(2\pi, u_1+u_2+..+u_m)}$,
$min(1, q_1 + q_2 + .. + q_m)e^{imin(2\pi, v_1+v_2+..+v_m)}, min(1, r_1 + r_2 + .. + r_m)e^{imin(2\pi, w_1+w_2+..+w_m)}\big)$