Unification of Fusion Rules (UFR)

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In this short note we give a formula for the unification of a class of fusion rules based on the conjunctive and/or disjunctive rule at the first step, and afterwards the redistribution of the conflicting and/or non-conflicting mass to the non-empty sets at the second step.

Fusion of masses \( m_1(.) \) and \( m_2(.) \) is done directly proportional with some parameters and inversely proportional with other parameters (parameters that the hypotheses depend upon). The resulting mass is noted by \( m_{\text{UFR}}(.) \).

a) If variable \( y \) is directly proportional with variable \( p \), then \( y = k_1 p \), where \( k_1 \neq 0 \) is a constant.

b) If variable \( y \) is inversely proportional with variable \( q \), then \( y = k_2 \cdot (1/q) \), where \( k_2 \neq 0 \) is a constant; we can also say herein that \( y \) is directly proportional with variable \( 1/q \).

In a general way, we say that if \( y \) is directly proportional with variables \( p_1, p_2, \ldots, p_m \) and inversely proportionally with variables \( q_1, q_2, \ldots, q_n \), then:

\[
y = k (p_1 p_2 \ldots p_m)/(q_1 q_2 \ldots q_n) = k \cdot P/Q,
\]

where \( P = \prod_{i=1}^{m} p_i \), \( Q = \prod_{j=1}^{n} q_j \), and \( k \neq 0 \) is a constant.

With such notations we have a general formula for a UFR rule:

\[
m_{\text{UFR}}(\phi) = 0, \quad \text{and} \quad \forall A \in S^\Theta \setminus \phi \quad \text{one has:}
\]

\[
m_{\text{UFR}}(A) = \sum_{X_1 \times X_2 \in S^\Theta \setminus A} \text{d}(X_1 \times X_2) T(X_1, X_2)
\]

\[
+ \frac{P(A)}{Q(A)} \sum_{X \in S^\Theta \setminus A} \text{d}(X \times A) \frac{T(A, X)}{P(A)/Q(A) + P(X)/Q(X)}
\]

where * can be an intersection or a union of sets,

\( d(X \times Y) \) is the degree of intersection or union,

\( T(X, Y) \) is a T-norm fusion combination rule (extension of conjunctive or disjunctive rules),

\( Tr \) is the ensemble of sets (in majority cases they are empty sets) whose masses must be transferred,

\( P(A) \) is the product of all parameters directly proportional with \( A \),

while \( Q(A) \) the product of all parameters inversely proportional with \( A \),

\( S^\Theta \) is the fusion space (i.e. the frame of discernment closed under union, intersection, and complement of the sets).

At the end we normalize the result.

Reference: