Fuzzy Logic. The equation for the scalar output of a fuzzy logic system is

\[ u(x) = \frac{\sum_{i=1}^{N} z_i \prod_{j=1}^{n} \mu_{ij}(x_j)}{\sum_{i=1}^{N} \prod_{j=1}^{n} \mu_{ij}(x_j)} \]

using product inferencing, centroid defuzzification, and singleton control MFs. There are \( N \) rules and \( n \) state components \( x_j, z_i \) are the control representative values, and \( \mu_{ij}(x_j) \) is the MF for state component \( j \) in rule \( i \).

Neural Networks. The equation for the \( i \)-th output of a neural network is

\[ u_i(x) = \sum_{j=0}^{n} w_{ik} \phi_k \left( \sum_{j=0}^{n} v_{kj} x_j \right) \]

with \( n \) state components \( x_j, x_0 = 1 \) a threshold offset, \( N \) hidden layer units, \( v_{kj} \) the input layer weights, \( w_{ik} \) the output layer weights. The activation functions are \( \phi_k(.) \), which can be nonlinear functions such as sigmoids, \( \tanh \), radial basis functions (Gaussian), etc.

Potential Fields. In mobile robot navigation, the equation for the total potential field is

\[ V(x) = \sum_{i=1}^{N} k_i V_i(x) \]

with \( V_i(x) \) the individual potential fields from the \( i \)-th obstacle/target, \( N \) the number of obstacles plus targets, and \( k_i \) some relative strength weighting coefficients.

Dempster-Shafer. The equation for Dempster-Shafer combination of evidence from two witnesses is

\[ m_{12}(A) = \frac{\sum_{B \cap C \subseteq A} m_1(A)m_2(B)}{\sum_{B \cap C = \phi} m_1(A)m_2(B)} \]

with \( \phi \) the empty set and \( m_i(A) \) the basic probability assignment of set \( A \) according to witness \( i \).

Relate these to each other.

Discuss.

Do simulations or make 3-D plots to see the relations.
Can you find a unified formulation for all of these?
Can you find other examples of representations from other topics in these formats?
Write a decent and interesting reprise. No longer than a normal homework length.