Fuzzy ARTMAP systems with graded signal function and with point-box coding

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This study presents an analysis of two modified fuzzy ARTMAP neural networks. The modifications are first introduced mathematically and their performance is studied on benchmark examples. Then, the performance of the systems is examined on data from the domain of remote sensing. It is shown that each modified ARTMAP system achieves classification accuracy superior to that of standard fuzzy ARTMAP, while retaining comparable complexity of the internal code.

In the first modified ARTMAP system, a graded choice-by-difference (CBD) signal function takes the choice signal T_j to be dependent on the input position, even when the input lies within the category box R_j. Namely, an input near the center of the box R_j generates a larger signal T_j than an input near the boundary of the box (Figure 1). In order to ensure that the same input would choose the same category if it were immediately re-presented (direct access), the ART match rule was also modified, to correspond to the new choice rule. The resulting graded signal function system creates more accurate decision boundaries, especially when these boundaries are not parallel to the input space axes (Figure 2).

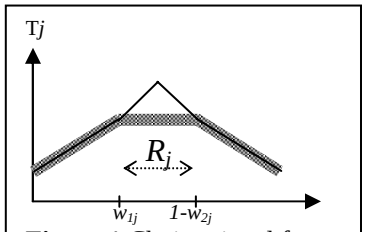

Figure 1 Choice signal for standard CBD (▩) vs. graded CBD (—)

In the second modified ARTMAP system, all category boxes R_j are point boxes. This simplified network learns with a *fast-commit/no-recode* rule, which does not allow any learning at node *j* once category *j* has been established. In addition, vigilance (ρ) is set to zero, which eliminates the matching system. Each input that makes a predictive error creates a new category, which is encoded as the input itself. The classification accuracy obtained with this point-box system is better than that of the other studied systems. However, the point-box system has a potential drawback in that its memory requirements may be high for large databases. To alleviate this problem, two strategies for on-line pruning of redundant categories are proposed and evaluated. These strategies can be interpreted as rules for on-line forgetting of certain stored memories. Their application leads to a significant reduction in memory requirements while retaining classification accuracy.

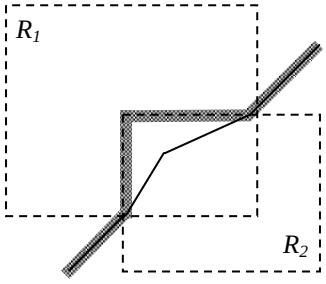

Figure 2 Decision boundaries with standard CBD (▩) vs. graded CBD (—)

The results obtained with the two modified ARTMAP networks indicate that the systems can be used for many types of pattern recognition problems.