Three Geometric Approaches for representing Decision Rules in a Supervised Learning System

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This paper describes a system for learning rules based on different geometric representations. The method uses a genetic algorithm (GA) to find out decision rules according to one of the three possible shapes: hyperrectangles, rotated hyperrectangles and hyperellipses. These geometric representation are internally codified as individuals of the population of the GA. The result is a decision queue (DQ) for each representation. It means that the obtained rules must be applied in specific order. With this policy, the number of rules may be reduced because the rules could be one inside of another. The user decides what representation provides the best accuracy and what produces the smaller number of rules. Sometimes, the linguistic interpretation of the rule set –with few rules- is more important than the exact classification of an unseen example –with too many rules-. Therefore, the system offers an ideal tool to select the best solutions oriented to our particular problem.

In previous works [1,3], we presented a system to classify databases by using hyperrectangles (axis-parallel). This system used a GA to search the best solutions and produced a hierarchical set of rules. The hierarchy follows that an example will be classified by the i-rule if it does not satisfy the conditions of the i-1 precedent rules. The rules are sequentially obtained until the space is totally covered. The behavior is similar to a queue, for that reason we have given the name decision queue (DQ) to the produced rule set. This concept is based on the k-DL, the set of decision lists with conjunctive clauses of size at most k at each decision [4].

DQ is based on DL. Really, DQ is a DL-generalization because it permits codifying functions f_i of continuous attributes and the values v_i can belong to any set.

DQ presents the following structure:

If *conditions* Then *class*
Else If *conditions* Then *class*
Else If *conditions* Then *class*
....
Else "*unknown class*"

The experiments described in this section are from UCI Repository.

DATABAS	C4.5		AXIS-PARALLEL		ROTATED HYPERREC.		HYPERELLIPTICAL	
	#RULES	ERROR	#RULES	ERROR	#RULES	ERROR	#RULES	ERROR
IRIS	4.4	6.3	**3.4**	7.47	3.6	**4.83**	4.2	5.6
PIMA	77.6	28.4	20.0	27.2	17.4	**26.35**	**7.4**	26.8
CANCER	5.2	13.8	**2.2**	**4.24**	2.2	5.38	2.6	5.0

Table. Databases (number of examples, dimension, number of classes).

The number of rules is reduced with regard to other systems, like C4.5 [2], and improves the flexibility to construct a classifier varying the relaxing coefficient.

References:

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