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Rough Set–Based Classification Systems

Springer

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To my wife, Agnieszka.

Contents

Symbols

List of the most important symbols used in the book:

U, U_i	The universe of discourse, which is a set of objects or states under classification
V, V_i	The universe of discourse, which is a set of features values of objects under classification
Y, Y_i	Space of a direct output of a classifier
Z, $Z_i = [0, 1]$	Space of object memberships to class level (degree)
Q	Set of features of objects under classification
$C \subseteq Q$	Set of condition features
$D \subseteq Q$	Set of decision features
$P \subseteq C$	Set of condition features used in a classification process, with known values
$G \subseteq C$	Set of condition features not used in a classification process, with unknown values
$\Re$	Set of real numbers
$\Re^n$	n-dimensional space of vectors of real numbers
$X \subseteq U$	Set of objects or states
$\omega_j \subseteq U$	Class of objects
Ω	Set of classes under consideration
R	Relation, fuzzy relation
$[x]_R$	Equivalence class (atom) determined by object x and relation R
$\tilde{P}$	Indiscernibility relation determined by set P
$\overline{R}X$	R-upper approximation of set X
$\underline{R}X$	R-lower approximation of set X
$\{\underline{R}X, \overline{R}X\}$	Rough set
$A \subseteq U$, $A \subseteq V$, $B \subseteq Z$	Fuzzy sets

$A'_i \subseteq V_i$	Fuzzy set obtained in fuzzification of real value v_i
$A' = A'_1 \times A'_2 \times \ldots \times A'_n \subseteq V$	Fuzzy set obtained in fuzzification of vector $\mathbf{v}$
$A^r_i \subseteq V_i$	Fuzzy set occurring in an antecedent of rule R^r concerning feature q_i
$A^r = A^r_1 \times A^r_2 \times \ldots \times A^r_n \subseteq V$	Fuzzy set occurring in consequence of rule R^r
$B^r_j \subseteq Z_j$	Fuzzy set occurring in consequence of rule R^r concerning the membership of an object under classification to class ω_j
$B'^r_j \subseteq Z_j$	Fuzzy set which is the result of inference based on rule R^r, concerning the membership of an object under classification into class ω_j
$B'_j \subseteq Z_j$	Fuzzy set which is the result of inference, concerning the membership of an object under classification into class ω_j
$x \in U$, $x_i \in U_i$	Object or state under classification
$q_i \in Q$	Feature of an object or state under classification
$\mathbf{q} = [q_1, q_2, \ldots, q_n]$	Vector of features of an object under classification
$c_i \in C$	Condition feature of an object under classification
$\mathbf{c} = [c_1, c_2, \ldots, c_n]$	Vector of condition features of an object under classification
$\mathbf{c}_P$	Vector of condition features used in a classification process, with known values
$\mathbf{c}_G$	Vector of condition features not used in a classification process, with unknown values
$d, d_j \in D$	Decision feature
$d, d_j \in Y$	Reference (desired) output value
$v_i \in V_i$	Value of feature q_i
$\mathbf{v} = [v_1, v_2, \ldots, v_n] \in V$	Vector of feature values of an object under classification
$\mathbf{v}_P \in V_P$	Vector of feature values of an object under classification, used in classification process, with known values
$\mathbf{v}_G \in V_G$	Vector of feature values of an object under classification, not used in a classification process, with unknown values
y	Output variable of a fuzzy inference system
$\overline{y}$	Real value which is a representative of fuzzy set B', the result of defuzzification
$\overline{y}^r$	Real value which is a representative of fuzzy set B^r, the result of defuzzification or the only element of the core of set B^r
$\overline{z}_j$	Representative of set B_j in classifiers

n	Number of considered condition features of an object under classification, cardinality of set C
$i = 1, 2, \ldots, n$	Index of single input of a fuzzy system, index of a subsequent condition feature
n_P	Number of condition features of an object under classifications used in a classification process, with known values, cardinality of set P
n_G	Number of condition features of an object under classifications not used in a classification process, with unknown values, cardinality of set G
m	Number of considered classes, the number of decision features
ω_j	Single class with index j
τ	Index of a simple sample in a training or testing sequence
$\tau_{\mathbf{max}}$	Number of samples in a training or testing sequence
υ	Index of a single group of samples in a training or testing sequence
Υ	Number of groups in a training or testing sequence
t	Index of a subsystem in an ensemble
T	Number of the subsystems in an ensemble
h_t	Hypothesis inferred from the subsystem with index t
N	Number of rules in a decision system
$r = 1, 2, \ldots, N$	Index of a single rule
$\mu_A(x)$	Membership function of fuzzy set A
$sgn(a)$	Sign of value a
$A \cup B$	Sum of (fuzzy) sets A and B
$\bigcup_{i=1}^{n} A_i$	Sum of n (fuzzy) sets A_i
$A \cap B$	Intersection of (fuzzy) sets A and B
$\bigcap_{i=1}^{n} A_i$	Intersection of n (fuzzy) sets A_i
$\neg A$	Complement of set A
$A \times B$	Cartesian product of (fuzzy) sets A and B
$R \circ S$	Composition of fuzzy sets (fuzzy relation) R and S
$T(a, b)$	t-norm of a and b
$T(a_1, a_2, \ldots, a_n) = \underset{i=1}{\overset{n}{T}} a_i$	t-norm of n values (variables)
$S(a, b)$	t-conorm of a and b
$S(a_1, a_2, \ldots, a_n) = \underset{i=1}{\overset{n}{S}} a_i$	t-norm of n values (variables)
$N(a)$	Fuzzy negation