CHAPTER V

LOSSLESS JOIN DECOMPOSITION

Lossless Join of Fuzzy Relations

In designing a fuzzy relational database, one must consider the problem of join that may not recover the original relation. This problem is central to the designing of databases such as classical relational databases. Thus, lossless join decomposition in the presence of fuzzy multivalued dependency will be considered.

Definition 5.1. Let R be a scheme and $\rho=\{R_1, R_2, \ldots, R_s\}$ be a decomposition of R with $R = R_1R_2\ldots R_s$. This decomposition is lossless join with respect to a set of FMVDs M, if for every fuzzy relation r of R that satisfies these FMVDs, one has

$$r = m_{\rho}(r). \qquad (5.1)$$

This definition, however, can not be applied in practice. The problem is that in order to test lossless join of a given decomposition, one requires to test all possible combinations of domain values. Since it has been proved that FMVD and MVD have a common properties, the design theories of classical relational databases can be applied.

Fuzzy Multivalued Dependency and Lossless Join Decomposition

In the design theory of relational databases, it is well known that, if MVD:X->->Y then the decomposition $\rho=\{XY, XZ\}$ of R is lossless. This theory, however, cannot be applied to fuzzy relational databases, if one does not redefine the join operations.

<u>Example 5.1.</u> Consider the relation scheme R(ABC) with FMVD:A~->->B. An instance r of R is shown in Table 5.1. Let R_1(AB) and R_2(AC) be the decomposition of R. The projections r_1 and r_2 are shown in Table 5.2(a) and (b), respectively. Let $r=r_1 x r_2$. It is readily seen that all tuples in r have μ_r=0.9, i.e., that the decomposition based on this FMVD is lossy.

Table 5.1. An instance r of R(ABC)

A	B	C	μ
a	b	c	0.8
a	b_1	c	0.9
a	b	c_1	0.9
a	b_1	c_1	0.6

Table 5.2. Projections of r over R_1(AB) and R_2(AC)

A	B	μ
a	b	0.9
a	b_1	0.9

(a)

A	C	μ
a	c	0.9
a	c_1	0.9

(b)

This example is shown that the join preserves all tuples in an original relation, but the problem arises with μ that is not equal to μ of an original relation. This problem comes from max operator of projection operation. From fuzzy relational data model, it can be seen that the measure of association among attributes(μ_r) is measured again. The measurement is common to measuring an original relation to replace the min operator in (3.22). In this way the join of r_1 and r_2 in Example 5.1 preserves original information.

Finally, the ABU algorithm(Aho et.al.,1979) will be applied to test whether a decomposition is lossless, employing the algorithm;

Let a_i be a distiguished variable and b_{jk} be a non-distinguished variable.

Input : $\rho = \{R_1, R_2, \ldots, R_m\}$ and sets of FMVD

Output : Return "lossless", if the tableau has a row with all distinguished variables, and return "lossy" otherwise

Method :

1. Define the tableau T_ρ that has its column labelled by the attribute and S rows labelled by $R_1, R_2, \ldots, R_m$. Row R_i has the distinguished variable a_j in A_j-column iff A_j is in R_i. The remaining entries of R_i are the non-distinguished variables b_{ik} for each A_k-column, $k \neq j$.
2. For each FMVD : X ~->-> Y , add the two new rows in the tableau by interchanging Y-components.
3. Check each added row, if there is a row with all distinguished variables, then return "lossless", otherwise return "lossy."

From Example 5.1, construct the tableau

		A	B	C
T_ρ =	R_1	a_1	a_2	b_{13}
	R_2	a_1	b_{22}	a_3

by applying FMVD:A~->->B, one finds the new tableau called $CHASE_M(T_\rho)$.

		A	B	C
$CHASE_M(T_\rho)$ =	R_1	a_1	a_2	b_{13}
	R_2	a_1	b_{22}	a_3
		a_1	a_2	a_3
		a_1	b_{22}	b_{13}

It is seen that the third row contains only distinguished variables, i.e., the decomposition ρ is lossless join.