Some Properties of IF Rough Relational Algebraic Operators in Medical Databases

Chhaya Gangwal, R. N. Bhaumik, Shishir Kumar

Abstract—Some properties of Intuitionistic Fuzzy (IF) rough relational algebraic operators under an IF rough relational data model are investigated and illustrated using diabetes and heart disease databases. These properties are important and desirable for processing queries in an effective and efficient manner.

Keywords— IF Set, Rough Set, IF Rough Relational Database, IF rough Relational Operators.

I. INTRODUCTION

Since Codd’s invention of the relational database (RDB) model in 1970 [5] and Chen’s introduction of the entity-relationship (ER) model in 1976 [4], these two models have gained great popularity owing to their fundamental in modeling, rigorousness in theory, and usefulness in practice. The two models have a underlying assumption that all data and information should be precisely given or represented and anything incomplete or certain is either artificially precisionized or precluded. However, in many cases, decision makers need to deal with uncertain and imprecise information. Therefore, databases, Fuzzy set theory [8], Intuitionistic Fuzzy (IF) set theory [1], rough set theory [2], [9] and fuzzy rough set theory [3] are finding wide usefulness. Recently [6], we presented an IF rough relational database model along with IF rough relational algebra for querying and applied [7] this model on diabetic patient databases. This paper deals with some properties of IF rough relational algebraic operators along with illustration by diabetes and heart disease databases which are important for query formulation and optimization in IF rough data manipulation.

II. PRELIMINARIES

A. IF Rough Set [6]:

Let U be a universe and X, a rough set in U. An IF rough set A in U is characterized by a membership function \( \mu_A: U \rightarrow [0, 1] \) and a non-membership function \( \nu_A: U \rightarrow [0, 1] \) such that

\[
\mu_A(x) + \nu_A(x) = 1, \quad 0 \leq \mu_A(x) \leq 1, \quad 0 \leq \nu_A(x) \leq 1.
\]

If \( (x \in U) \) and \( \mu_A(U - \bar{R}) = 0, \nu_A(U - \bar{R}) = 1 \) or \( \mu_A(x), \nu_A(x) \) = [1.0].

B. IF Rough Relational Database Model [6]:

In this model, a tuple \( t \) takes the form \((d_i \in D_i)| \) where \( d_i \) is a domain value of a particular domain set \( D_i \) and \( d_{ij} \in [0,1] \), the domain for IF membership and non-membership values denoted as \( d_{ij} \in [0,1] \).

The IF rough relational database except for the membership and non-membership values \( d_{ij} \in D_j \). In the IF rough relational database a tuple is an element of a particular relation and if \( d_{ij} \neq \phi \).

Definition 1: Let \( P(D_i) \) be the power set of \( Di \). An IF rough relation \( R \) is a subset of the product set \( P(D_1) \times P(D_2) \times \ldots \times P(D_n) \times D_{[0,1]} \), where \( D_{[0,1]} \) is the domain for membership and non-membership value of the closed interval \([0,1]\) and \( P(D_i) = P(D_i) - \phi \).

Example 1: For a specific relation, membership and non-membership are determined semantically. Given that \( D_i \) is the set of names of patients, \( D_i \) is the set of place of patients then, (Anil, Shamli Bazar, [1, 0]), (Gopal, {Durga Nagar, Rani Bazar}, [0.5, 0.5]) (Vishnu, Indra gandhi, [0,1]) are elements of the relation \( R(\text{Patient Name, Place, } [\mu, \nu]) \).

C. IF Rough Relational Operators [6]

The IF rough relational operations on subsets of tuples are shown below. Let \( T_1 \) and \( T_2 \) be two IF rough relations, then

1) IF Rough Difference: The IF rough difference between \( T_1 \) and \( T_2 \) is an IF rough relation \( R = T_1 - T_2 \) where

\[
T = \{ (d_1 \ldots, d_n | \mu_i > \mu_j) \} \in R T_1 \cup R T_2 \}
\]

2) IF Rough Union: The IF rough union between \( T_1 \) and \( T_2 \) is an IF rough relation \( R = T_1 \cup T_2 \) where

\[
R = \{ (d_1 \ldots, d_n | \nu_i > \nu_j) \} \in R T_1 \cup R T_2 \}
\]
3) **IF Rough Intersection:** The IF rough intersection between $T_1$ and $T_2$ is an IF rough relation, $T = T_1 \cap T_2$, where

$$
RT = \{ t \in RT_1 \cap RT_2 \}
$$

and

$$
\mu_{RT}(t) = \text{MIN} \{ \mu_{RT_1}(t), \mu_{RT_2}(t) \}, \text{ and if } \mu_{RT_1}(t) = \mu_{RT_2}(t), \nu_{RT}(t) = MAX \{ \nu_{RT_1}(t), \nu_{RT_2}(t) \}.
$$

4) **IF Rough Select:** The IF rough selection $\sigma_A \leq a (x)$, of tuples from $T_1$ is an IF rough relation $T_2$ having the same schema as $T_1$ and where

$$
RT_2 = \{ t \in T_1 : \sigma A \leq a (t) \}, \text{ and if } \mu_{RT_1(t)} = \mu_{RT_2(t)}, \nu_{RT_1(t)} = MAX \{ \nu_{RT_1(t)}, \nu_{RT_2(t)} \}.
$$

5) **IF Rough Project:** The IF rough projection of $T_1$ onto $Y$, $\pi_Y(T_1)$ is an IF rough relation $T_2$ with schema $T_2(Y)$ where

$$
T_2(Y) = \{ t(Y) : t \in T_1 \}.
$$

6) **IF Rough Join:** The IF rough join, $T_1 \text{ join } T_2$, of two relations $T_1$ and $T_2$, is a relation

$$
T(C_1, C_2, \ldots, C_{m+n}) \text{ where } T = \{ t \in T_1 \cap T_2 \} \text{ for } t_{T_1} = t(X), t_{T_2} = t(Y) \text{ and } t_{T_1}(X \cap Y) = t_{T_2}(X \cap Y), \mu = 1, \nu = 0 \text{ for } RT \text{ and } t_{T_1}(X \cap Y) \subseteq t_{T_2}(X \cap Y) \text{ or } t_{T_2}(X \cap Y) \subseteq t_{T_1}(X \cap Y), \mu = \text{MIN} \{ \mu_{T_1}, \mu_{T_2} \} \text{ and if } \mu_{T_1} = \mu_{T_2}, \nu = \text{MAX} \{ \nu_{T_1}, \nu_{T_2} \}, \text{ for } RT.
$$

III. **Properties of IF Rough Relational Algebraic Operators**

To consider above IF rough relational operators for data modeling and querying, we need to investigate the properties of the operators to address the issues such as how a certain operation could be formulated with other operations and how an expression could be transformed. In this section some properties of IF rough relational algebraic operators are investigated and the expressive power of the model demonstrated through its IF rough relational algebra taking examples of queries to the “diabetic’’ and “heart’’ patient database. Here, the indiscernibility relation is used for equivalence of attribute values rather than equality of values for all of these operators.

**A. Intersection Operator**

The IF rough intersection operation, a binary operation on relations $T_1$ and $T_2$ can be expressed in terms of IF rough difference $T_1 \cap T_2 = T_1 - (T_1 - T_2)$.

Let us first evaluate the left-hand side of the equation using the data from Table XIII and XIV of the Appendix. Let $T_1 = \text{DIABETIC PATIENTS}$ and $T_2 = \text{HEART PATIENTS}$ and we can calculate $T_1 \cap T_2$ by applying IF rough relational intersection operator.

**Table I**

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>$[\mu, \nu]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>414</td>
<td>F</td>
<td>Young-adult</td>
<td>Medium</td>
<td>{Normal, High}</td>
<td>{Normal, High}</td>
<td>[0.3,0.6]</td>
</tr>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>High, Very high</td>
<td>High</td>
<td>Very high</td>
<td>[0.4,0.4]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.6,0.3]</td>
</tr>
</tbody>
</table>

Now, we can compute the right-hand side of the equation and find $T_1 - T_2$.

**Table II**

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>$[\mu, \nu]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>402</td>
<td>M</td>
<td>Adult</td>
<td>Normal</td>
<td>Medium</td>
<td>Normal</td>
<td>[0.3,0.6]</td>
</tr>
<tr>
<td>410</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>High</td>
<td>Normal</td>
<td>[0.7,0.2]</td>
</tr>
<tr>
<td>409</td>
<td>M</td>
<td>Senior</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
<td>[0.8,0.1]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.7,0.2]</td>
</tr>
<tr>
<td>422</td>
<td>M</td>
<td>Adult</td>
<td>Medium</td>
<td>High</td>
<td>[0.4,0.3]</td>
<td></td>
</tr>
</tbody>
</table>

So we can find the results of $T_1 - (T_1 - T_2)$ in the following IF rough relation:

**Table III**

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>$[\mu, \nu]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>414</td>
<td>F</td>
<td>Young-adult</td>
<td>Medium</td>
<td>{Normal, High}</td>
<td>{Normal, High}</td>
<td>[0.3,0.6]</td>
</tr>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>(High, Very high)</td>
<td>High</td>
<td>Very high</td>
<td>[0.4,0.4]</td>
</tr>
</tbody>
</table>

Which is certainly not equal to $T_1 \cap T_2$.

Now we reverse the original relations, supposing $T_1 = \text{HEART PATIENTS}$ and $T_2 = \text{DIABETIC PATIENTS}$. The left-hand side of the equation will be unaffected since $T_1 \cap T_2 = T_2 \cap T_1$. On the right-hand side, we can calculate $T_1 - (T_1 - T_2)$. First we obtain the difference $T_1 - T_2$ which is (HEART PATIENTS - DIABETIC PATIENTS):

**Table IV**

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>$[\mu, \nu]$</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>M</td>
<td>Adult</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>[0.4,0.4]</td>
</tr>
<tr>
<td>418</td>
<td>M</td>
<td>Senior</td>
<td>Medium</td>
<td>Normal</td>
<td>[0.8,0.1]</td>
<td></td>
</tr>
<tr>
<td>424</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>High</td>
<td>[0.7,0.2]</td>
<td></td>
</tr>
</tbody>
</table>
We now subtract this IF rough relation from to obtain

\[
T = \sigma_{A=\alpha}(\{t: t \in T_1\}) \cap \sigma_{A=\alpha}(\{t: t \in T_2\})
\]
\[
T = \sigma_{A=\alpha}(T_1) \cap \sigma_{A=\alpha}(T_2).
\]

Consider the following example, which refer to Table XIII and XIV of the Appendix. Let \( T_1 = \text{DIABETIC PATIENTS} \) and \( T_2 = \text{HEART PATIENTS} \), and let us first evaluate the left-hand side of the proof using the data from DIABETIC PATIENTS and HEART PATIENTS.

\[\text{T(1) = DIABETIC PATIENTS} \cap \text{HEART PATIENTS} \text{ yields :}\]

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{ID} & \text{Sex} & \text{Age} & \text{Lipid Profile} & \text{BP} & \text{FBS} \\
\hline
414 & F & \text{Young-adult} & \text{Medium} & \{\text{Normal, High}\} & \{\text{Normal, High}\} \\
415 & F & \{\text{Senior, Adult}\} & \{\text{High, Very high}\} & \text{Normal} & \{\text{Normal, High}\} \\
420 & F & \text{Senior-Citizen} & \text{High} & \text{Very high} & \text{High} \\
\hline
\end{array}
\]

This is equal to the left-hand side \( T_1 \cap T_2 \) and not the same result as before. Therefore, because of the varying levels of uncertainties in similar tuples and the properties of the IF rough difference operator, the property \( T_1 \cap T_2 = T_1 \setminus (T_1 \setminus T_2) \) does not always hold in the IF rough relational database.

\[\text{B. Select Operator}
\]

\[\text{Property: IF rough select is a unary operator on relations. An interesting property is the distribution of the IF rough select operator over the Boolean operations. This property states that for an operator } \gamma \text{ and two IF rough relations } T_1 \text{ and } T_2 \text{ over the same schema,}
\]

\[
\sigma_{A=\alpha}(T_1 \gamma T_2) = \sigma_{A=\alpha}(T_1) \gamma \sigma_{A=\alpha}(T_2)
\]

where \( \gamma \in \{\cup, \setminus\} \).

The proof of this property is given below for distribution of selection over intersection:

\[\text{Proof: } \sigma_{A=\alpha}(T_1 \cap T_2) = \sigma_{A=\alpha}(T_1) \cap \sigma_{A=\alpha}(T_2) \text{ where}
\]

\[
T = \{t: t \in T_1 \text{ and } \exists s \in T_2: t \approx_R s \} \cup \{t: t \in T_2 \text{ and } \exists s \in T_1: t \approx_R s \}
\]

\[
\sigma_{A=\alpha}(T) = \left\{ t: t \in T \text{ and } \cup_i [a_i] = \cup_j [b_j] \right\} 
\]

\[
\exists t \in T \text{ and } \cup_i [a_i] = \cup_j [b_j]
\]

\[
\sigma_{A=\alpha}(T_1) \cap \sigma_{A=\alpha}(T_2) \text{ (i)}
\]

\[\text{and } T_1 \cap T_2 = T_1 \setminus (T_1 \setminus T_2) \text{ and}
\]

\[
T_1 \cap T_2 = T_1 \setminus (T_1 \setminus T_2)
\]

\[\text{by (i)}
\]

\[
\sigma_{A=\alpha}(T_1) \cap \sigma_{A=\alpha}(T_2) \text{ (ii)}
\]

\[
\text{Now let us perform a selection operation on } T(1) \text{ to complete the left-hand side of the equation of the previous proof. Let } \text{LHS } = \sigma_{\text{Lipid Profile } \approx \text{High}} T(1) \text{ yields the following IF rough set of tuples:}
\]

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{ID} & \text{Sex} & \text{Age} & \text{Lipid Profile} & \text{BP} & \text{FBS} \\
\hline
415 & F & \{\text{Senior, Adult}\} & \{\text{High, Very high}\} & \text{Normal} & \{\text{Normal, High}\} \\
420 & F & \text{Senior-Citizen} & \text{High} & \text{Very high} & \text{High} \\
\hline
\end{array}
\]

\[\text{From (i) and (ii)}
\]

\[
\text{\text{TABLE VII}}
\]

\[
\text{\text{TABLE VIII}}
\]
### Table IX

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>M</td>
<td>Adult</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>(High, Very high)</td>
<td>High</td>
<td>Very high</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>418</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>Medium</td>
<td>Normal</td>
<td>[0.8, 0.1]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.6, 0.3]</td>
</tr>
<tr>
<td>424</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>High</td>
<td>Normal</td>
<td>[0.7, 0.2]</td>
</tr>
</tbody>
</table>

When the intersection of T(2) and T(3) is taken next, the result is the same as that computed for the left-hand side of the equation: \( \text{RHS} = T(2) \cap T(3) \), which yields

### Table X

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>(High, Very high)</td>
<td>High</td>
<td>Very high</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.6, 0.3]</td>
</tr>
</tbody>
</table>

### C. Project Operator

Intuitionistic fuzzy (IF) rough project operator is also a unary operator on relations and chooses a subset of the columns. If two projections are performed in a row, the latter subsumes the former. Let \( T_1 \) be an IF rough relation on the schema \( R \), if \( \pi_{Y} \) is applied to the result of applying \( \pi_{Y} \) to \( T_1 \), the result is the same as if \( \pi_{Y} \) were applied directly to \( T_1 \), if the original application of \( \pi_{Y} \) was proper. More precisely, given \( T_1(R) \) and \( Y \subseteq X \subseteq R_{y} \), \( \pi_{X}(\pi_{Y}(T_1)) = \pi_{Y}(T_1) \).

A property of the IF rough projection operator is that for a string of projections upon a relation \( T_1 \) having schema \( R \), where only the outermost projection operator is necessary. Due to the indiscernibility, we are dealing with equivalence class values and not ordinary values in the removal of redundant tuples:

\[
\pi_{y_1}(\pi_{y_2}(\pi_{y_3}(\pi_{y_4}(\ldots(\pi_{y_n}(T_1))\ldots))) = \pi_{y_1}(T_1).
\]

Because each set of attributes \( Y_i \) is included in the set \( Y_{i+1} \), and because at every step of the sequence of projections on the left side of the equality a subset of the attributes is retained and redundant tuples removed until we reach the minimum subset \( Y_i \), the same IF rough relation would result by taking the subset of attributes \( Y_i \) to begin with and removing redundant tuples all at once.

The operations on both sides of the equality produce relations which are equal in the sense that every tuple in one IF rough relation has a corresponding tuple in the other IF rough relation such that the tuples are indiscernible from each other. In other words, every tuple of one relation is redundant with one and only one tuple of the other relation. For example, the operation

\[
\pi_{y_1}(\pi_{y_2}(\ldots(\pi_{y_n}(T_1))\ldots)) = \pi_{y_1}(T_1).
\]

This is equal to \( \pi_{y_1}(\ldots(\pi_{y_n}(T_1))\ldots) \), where \( A \) is the result of the inner projection shown in the following:

### Table XI

<table>
<thead>
<tr>
<th>Lipid Profile</th>
<th>FBS</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td></td>
<td>[0.3, 0.5]</td>
</tr>
<tr>
<td>(High, Very high)</td>
<td>Very high</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>High</td>
<td>Normal</td>
<td>[0.8, 0.1]</td>
</tr>
<tr>
<td>High</td>
<td>High</td>
<td>[0.6, 0.3]</td>
</tr>
</tbody>
</table>

The second projection operation results in the following:

### Table XII

<table>
<thead>
<tr>
<th>Lipid Profile</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>[0.3, 0.5]</td>
</tr>
<tr>
<td>(High, Very high)</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>High</td>
<td>[0.8, 0.1]</td>
</tr>
</tbody>
</table>

IV. CONCLUSION

The IF rough relational database is a sound model which incorporate the various types of uncertainty into the underlying data model and its algebra. The properties of IF rough relational algebraic operators investigated, in this paper, are important for query formulation and optimization in IF rough data manipulation.

APPENDIX

Consider the following three tables namely Diabetics and Heart disease having different attributes for getting the results of various operators and queries-
### TABLE XIII
Attributes of Diabetic Patients

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>402</td>
<td>M</td>
<td>Adult</td>
<td>Normal</td>
<td>Medium</td>
<td>Normal</td>
<td>[0.3, 0.6]</td>
</tr>
<tr>
<td>410</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>High</td>
<td>Normal</td>
<td>[0.7, 0.2]</td>
</tr>
<tr>
<td>414</td>
<td>F</td>
<td>Young-adult</td>
<td>Medium</td>
<td>[Normal, High]</td>
<td>[Normal, High]</td>
<td>[0.3, 0.6]</td>
</tr>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>[High, Very high]</td>
<td>High</td>
<td>Very high</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>419</td>
<td>M</td>
<td>Senior</td>
<td>Very high</td>
<td>Very high</td>
<td>Very high</td>
<td>[0.8, 0.1]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.7, 0.2]</td>
</tr>
<tr>
<td>422</td>
<td>M</td>
<td>Adult</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>[0.4, 0.3]</td>
</tr>
</tbody>
</table>

### TABLE XIV
Attributes of Heart Patients

<table>
<thead>
<tr>
<th>ID</th>
<th>Sex</th>
<th>Age</th>
<th>Lipid Profile</th>
<th>BP</th>
<th>FBS</th>
<th>[µ, ν]</th>
</tr>
</thead>
<tbody>
<tr>
<td>408</td>
<td>M</td>
<td>Adult</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>414</td>
<td>F</td>
<td>Young-adult</td>
<td>Medium</td>
<td>[Normal, High]</td>
<td>[Normal, High]</td>
<td>[0.3, 0.5]</td>
</tr>
<tr>
<td>415</td>
<td>F</td>
<td>{Senior, Adult}</td>
<td>[High, Very high]</td>
<td>High</td>
<td>Very high</td>
<td>[0.4, 0.4]</td>
</tr>
<tr>
<td>418</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>Medium</td>
<td>Normal</td>
<td>[0.8, 0.1]</td>
</tr>
<tr>
<td>420</td>
<td>F</td>
<td>Senior-Citizen</td>
<td>High</td>
<td>Very high</td>
<td>High</td>
<td>[0.6, 0.3]</td>
</tr>
<tr>
<td>424</td>
<td>M</td>
<td>Senior</td>
<td>High</td>
<td>High</td>
<td>Normal</td>
<td>[0.7, 0.2]</td>
</tr>
</tbody>
</table>

### TABLE XV
Summary of Attributes

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Description</th>
<th>Value description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Gender</td>
<td>M if male; F if female</td>
</tr>
<tr>
<td>Age</td>
<td>Age</td>
<td>18-30 years Young-Adult 31-34 years Adult 45-64 years {Senior or Elderly person} ≥65 years Senior-Citizen</td>
</tr>
<tr>
<td>Lipid Profile</td>
<td>Total cholesterol, [LDL-C, HDL-C and TGs]</td>
<td>&lt;200 mg/DL Normal Medium(Borderline) Medium Medium Medium</td>
</tr>
<tr>
<td>BP</td>
<td>Blood Pressure</td>
<td>&lt;120/80 Normal Medium Medium Very high</td>
</tr>
<tr>
<td>FBS</td>
<td>Fasting blood sugar</td>
<td>&lt;100 mg/DL Normal High Very high</td>
</tr>
</tbody>
</table>

### REFERENCES