Preface

Relational Database System [1] introduced by Codd in 1970 was a great achievement. However, these databases can only handle crisp, precise and non-ambiguous data. In other words, these systems do not deal with vague and ambiguous data which are fuzzy in nature - even though much of the human reasoning is based on fuzzy reasoning. In fact, fuzzy data arise constantly in real life from human thought and cognition processes and we often make decision based on them. It is always expected that useful information should be accessible in an easy and natural manner. Clearly, as DBMS becomes more important for decision making, the problem of handling fuzzy data, being more compatible with human thought, will become increasingly important. Such a DBMS, if implemented, will improve human-machine interface and broaden the application areas of DBMS. Attempts to build DBMS's which are able to represent and manipulate fuzzy data have received the attention of researchers recently. Consider the classical relational data model, three assumptions exist, though implicitly: (i) value of an attribute must be
atomic (ii) the domain elements must be mutually distinct; (iii) any tuple present in a relation must fully belong to the relation. Based upon Zadeh’s fuzzy set and possibility theory which introduces a gradual transition from non-membership to full-membership for any subset, different fuzzy extensions of the classical relational data model have been proposed depending on how and to what extent the 3 above-mentioned assumptions are generalized. For example, Buckles and Petry [2-3] presented a similarity-based approach, Prade and Testemale [4] presented a possibility-based approach, Baldwin and Zhou [5] gave a fuzzy-relation-based approach, Chen, Kerre, and Vandenbulcke [6] presented an extended-possibility-based approach.

A fuzzy database utilizes the fuzzy logic, where fuzzy relational schemas are used to represent imprecise data. But in some application fuzzy sets are found unsatisfactory in capturing the imprecise information. So to deal with the application where classical fuzzy set are inappropriate to handle the situation, Intuitionistic fuzzy sets are used.

Intuitionistic fuzzy set theory (IFS) is a significant generalization of fuzzy set. It was introduced by Kasimir Atanassov [7-10] in year 1983. There have been many extension of Zadeh’s [11] Fuzzy set but Intuitionistic
fuzzy set has been found very useful to deal with vague information. Intuitionistic fuzzy sets can be useful in situations when description of a problem by a (fuzzy) linguistic variable, given in terms of a membership function only, seems insufficient to give best result. For example, in decision making problems, particularly in the case of medial diagnosis, sales analysis, new product marketing, financial services, etc. there is a fair chance of the existence of a non-null hesitation part at each moment of evaluation of an unknown object. To be more precise - intuitionistic fuzzy sets let us understand some conditions that are not very clear.

Many authors have presented intuitionistic fuzzy sets as a tool for reasoning in the presence of imperfect facts and imprecise knowledge. One must emphasize that Atanassov's intuitionistic fuzzy sets do offer some interesting new possibilities of applications e.g. in problems of decision making [12-13]. More precisely, in comparison with fuzzy sets, they seem to be better suited for expressing a degree of hesitation of a decision maker.

The concept of an intuitionistic fuzzy set can be viewed as an alternative approach to define a fuzzy set in cases where available information is not
sufficient for the definition of an imprecise concept by means of a conventional fuzzy set. As the intuitionistic fuzzy sets is the generalization of fuzzy sets it is expected that intuitionistic fuzzy sets could be used to simulate human decision making processes and any activities requiring human expertise and knowledge, which are inevitably imprecise or not totally reliable. Recently, intuitionistic fuzzy sets have been used to build soft decision making models that can accommodate imprecise information, and two solution concepts about the intuitionistic fuzzy core and the consensus winner for group decision making have also been developed by many researchers using intuitionistic fuzzy sets.

As it is explained that in real world application data available is not always crisp rather fuzzy or intuitionistic fuzzy in nature. So Fuzzy Database System was introduced to handle such data. Later on, considering intuitionistic fuzzy sets as a useful and interesting topic Biswas, De. and Roy introduced Intuitionistic Fuzzy Databases (IFDB) [14-18]. Based upon different approaches and frameworks, most of research on fuzzy databases in the last decade centered on fuzzy queries,
fuzzy data representation, and definitions of fuzzy functional dependency etc.

Normal forms define by classical relational database theory provides guidelines for designing relational database. Since in fuzzy relational data model where attribute values are represented by possibility distributions and domains are associated with closeness relations, the problems of update anomalies and data redundancy may exist.

However, there is not much work reported on to remove redundancy from fuzzy database especially intuitionistic fuzzy databases which is indeed an important issue in a database. As we know that in any database redundancy can be very well reduced by normalization process. Normalization of an Intuitionistic fuzzy relational database into first normal form is already proposed by Alam [19]. In this thesis, we have analyzed the approach used for of Fuzzy database normalization and we proposed an approach to normalize an Intuitionistic fuzzy database into second and third normal form. We have also introduced object oriented implementation of the method proposed for normalization.
This thesis comprises seven chapters.

Chapter-1: This chapter gives brief introduction of Fuzzy set theory along with some basic concepts applicable on it. We have also summarized different types of membership function and membership function determination methods. Further, we have defined fuzzy relation and its related operation and properties.

Repeating to the need for knowledge based systems possessing more sophisticated representation and manipulation skills tolerant of vagueness and uncertainty, there is a need to introduced Intuitionistic fuzzy set. An IFS is defined with detailed explanation of different operation applicable on it. Intuitionistic Fuzzy Relational Calculus as a framework for processing imprecise data represented as IF relations. Different concept based on IF relations are also summarized. At the end of the section application of IFR calculus is mentioned for proper understanding.

Chapter- 2 : In the first part of this chapter we will study the need of database management system, needs of DBMS to accommodate fuzzy data and finally the evolution of fuzzy relational database. In the second
part we will study about Intuitionistic fuzzy database and its definition. A more detailed discussion on intuitionistic fuzzy database can be seen in paper of S.K. de, R. Biswas and A.R. Roy [14].

Chapter-3: The theory of normalization introduced by Codd is a systematic approach to properly design the schema of database. There are many normal forms introduced by Codd, and they must be followed one after another to makes a relational schema more consistent. First normal form, emphasizes that the data in a relation schema should be atomic. So if at least one data is intuitionistic fuzzy, relation schema can not be called in 1NF.

In this chapter we will study an approach to normalize an intuitionistic fuzzy relational schema into first normal form also called as IF 1NF and it was introduced by Alam, Biswas and Ahmed [19]. Later on they have also presented an efficient Implementation of Intuitionistic fuzzy 1NF [20].

Chapter-4: An important feature of database management systems (DBMS) is their capability to handle properties that data should fulfill,
known as integrity constraints, which reflect properties of the real world. When any modification and updating is done on a database it must be ensured that any integrity constraints valid in the database are not violated.

Different types of integrity constraints have been identified among which a particular type came out very early, along with the relational model called as functional dependencies. We also know that if we have a relation in a database satisfying a functional dependency, then there can be redundancy and update problems. In order to avoid them, we can decompose the original relation into two or more new relation. Similarly in an IF database we have to analyze the Intuitionistic fuzzy functional dependency to check the integrity constraint of a relation. In this chapter we propose an approach to normalize a relation into IF2NF and we will also analyze the normalization process of fuzzy model.

Chapter -5: Database theory describes a table's degree of normalization in terms of normal forms of successively higher degrees of strictness. A table in third normal form (3NF), for example, is consequently in second normal form (2NF) as well; but the reverse is not necessarily the case. In
this chapter we will first investigate the normalization process of fuzzy model into third normal form. Further we propose an approach to normalize an IF relation into IF3NF.

Chapter 6: In this chapter we have given an object oriented implementation of the methods proposed for normalization of Intuitionistic fuzzy database into 2NF and 3NF.

At the end we have made an overall conclusion of our complete work reported in this thesis and also mention future scope of our work.