CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

The present state-of-the-art of both Requirements Engineering and Fuzzy logic has been presented in Chapters 2 and 3 with particular reference to the concepts proposed to be used in this study. In Chapter 4, a detailed study and application of the concepts is sketched out. The application of the three main concepts Fuzzy Associative Memory (FAM), Fuzzy Approximation Theorem (FAT) and Adaptive Neural Nets have been worked out in examples with reference to readings of Pollution levels at Chennai city. Pollution levels of $\text{O}_3$, RSPM, TSPM, NOX, Relative Humidity etc. were recorded in studies by a team from Anna University in the summer of 2005. Although theoretical validation and short term study proves the concept, only long term studies can fully validate the method. These methods are planned to be used during later trials in other studies by the Environmental Pollution Lab at Anna University.

5.2 CONCLUSION

All data for validation of the Fuzzy Logic processes i.e. the readings of the climate and pollution parameters are taken from actual real life studies in the particular area concerned for a long period of time. Even the many other factors in nature which affect the pollutants, both known and unknown parameters are also affected in the readings. The unknown parameters will of course cause a skew in the result, but since each of these
natural phenomenon are also interrelated much of the effect of such unknown parameters would be reflected in readings of the known parameters. The skew will anyhow be much less than any mathematical model, which has to completely ignore unknown parameters. Moreover with time as more and more readings/data are available the Adaptive Neural net will fine-tune the rules to get more correct results. In this Adaptive system, even new parameters can be added and a rule discovery process started. This makes the process a continuously self improvement and correction system, it can also be shown that in a process using Fuzzy Cognitive Mapping (FCM) in which the interrelationships between parameters are more directly effected can also give comparable results.

This mapping and forecast can be refined continuously by the adaptive neural net after many seasons of data to increase the reliability of the forecast. The problem with all natural phenomenon like weather and other environmental factors which have a large bearing on Pollution is that they keep on changing with changes in the environment. In the present scenario where the huge man-made pollution by CO₂, ozone depleting chemicals, hazardous emissions from industrial processes, vehicular etc. are causing climatic changes of a very high order, it is very difficult in fact impossible to have an accurate formula to connect any of the parameters. Such a fuzzy adaptive engine will go a long way to get to more accurate and reliable predictions. Changes due to day-to-day climatic phenomenon will get incorporated into the result as this fuzzy engine will adapt the new readings as and when it is generated in real time.

In the normal digital methods, we first devise a mathematical model and get to a formula relating the input-to-output. This further to being complicated, we need a very high order of mathematical resource as also very
large computing resources (most of the supercomputers manufactured are working on such climate forecasting programs).

5.3 THE ROAD AHEAD

The growing influence of new programming practices like object-oriented programming etc. has led to the rise of many new paradigms for system and software requirements analysis. Even recent studies done by large software vendors like the US Department of Defense, NASA and others have shown that errors at inception i.e. Requirement stages are still causing huge losses. Application of fuzzy logic is fundamentally different from most requirement practices in vogue. Studies in this field has been going on for several years and many papers published. However, it is still not used in mainstream applications. Following are some of the other fundamentally different research in the field of requirement Analysis.

5.3.1 Problem Frames

Problem Analysis or the Problem Frames Approach is an approach to software requirements analysis developed by British software consultant Michael A. Jackson. The Problem Frames Approach was first sketched by Jackson in his book Software Requirements and Specifications (1995) and in a number of articles in various journals devoted to software engineering. It has received its fullest description in his Problem Frames: Analysing and Structuring Software Development Problems (2001).

Problem Frames approach is an approach - a set of concepts - to be used when gathering requirements and creating specifications for computer software. Its basic philosophy is strikingly different from other software requirements methods in insisting that:
The best way to approach requirements analysis is through a process of parallel — not hierarchical — decomposition of user requirements.

User requirements are about relationships in the operational context; not about functions that the software system must perform.

A problem frame is a description of a recognizable class of problems, where the class of problems has a known solution. In a sense, problem frames are problem patterns.

Today research on the Problem Frames Approach is being conducted at a number of universities, most notably at the Open University in the United Kingdom.

There are a few other software development ideas that are similar in some ways to problem analysis.

The notion of a design pattern is similar to Jackson's notion of a problem frame. It differs in that a design pattern is used for recognizing and handling design issues (often design issues in specific object-oriented programming languages such as C++ or Java) rather than for recognizing and handling requirements issues.

Aspect-Oriented Programming, AOP (also known as Aspect-Oriented Software Development, AOSD) is similarly interested in parallel decomposition, which addresses what AOP proponents call cross-cutting concerns or aspects. AOP addresses concerns that are much closer to the design and
code-generation phase than to the requirements analysis phase.

- Martin Fowler's, Analysis Patterns is very similar to problem analysis in its search for patterns. It doesn't really present a new requirements analysis method, however. And the notion of parallel decomposition - which is so important for problem analysis - is not a part of Fowler's analysis patterns.

### 5.3.2 Goal-Oriented Requirements Analysis

Goals are a logical mechanism for identifying, organizing and justifying software requirements. Strategies are needed for the initial identification and construction of goals.

This paradigm adopts ideas from object-oriented programming and blends them with ones from semantic data modeling and knowledge representation (notably semantic networks) into a modeling framework that is more powerful than traditional techniques such as data flow diagrams, structured analysis and the like.

Traditionally, requirements analysis practice has been driven by the programming paradigm of the day. Thus, in the days of structured programming, structured analysis ruled, whereas today interest is shifting to object-oriented analysis. Given the criticality of requirements analysis to the success of any large software development project, perhaps it is time to turn things around: suppose we let the concepts and techniques of goal-oriented analysis drive the design and implementation techniques that follow downstream. Actually, agent programming is gaining in popularity as the programming paradigm for network computing, so the possibility of a new
development methodology grounded on goal-oriented analysis and agent-based design.

5.3.3 Safety-Critical Requirements

A thorough requirements analysis is indispensable for developing and implementing safety-critical software systems such as nuclear power plant (NPP) software systems because a single error in the requirements can generate serious software faults. However, it is very difficult to completely analyze system requirements. Software inspection and requirements traceability analysis are widely considered the most effective software V and V methods. Although formal methods are also considered an effective V and V activity, they are difficult to use properly in the nuclear fields as well as in other fields because of their mathematical nature. An integrated environment (IE) approach for requirements, which is an integrated approach that enables easy inspection by combining requirement traceability and effective use of a formal method. The nuclear software inspection support and requirements traceability (NuSISRT) tool incorporates software inspection, requirement traceability, and formal specification capabilities.

5.3.4 Inquiry-Based Requirements Analysis

This approach emphasizes pinpointing where and when information needs occur. At its core is the inquiry cycle model, a structure for describing and supporting discussions about system requirements. The model's conversation metaphor follows analysis activities from requirements elicitation and documentation through refinement.
There are many other research projects going on in University of a fundamental nature and in Industry for their particular needs. Due to the huge cost savings seen Requirement Engineering will continue to attract large interest. In all the above and similar other work Fuzzy Logic concepts are being tried and will certainly find application. In fact many researchers in Universities are attempting to apply Fuzzy principles in safety-critical software systems on a priority basis due to the ever-increasing hazards.

5.4 CONTINUATION OF THIS WORK

Fuzzy approach will be cost effective in situations where there are very large numbers of Requirement parameters and many more possibly unknown. The fields this investigation is being extended to medical diagnosis and image interpreting. The same principals used in the present work can be applied in these fields with small variations.

There are enquiries from the data processing industry on the utility in applying the fuzzy process in accounting, finance and other business process applications. Effectiveness of fuzzy logic in these fields is not certain as most data track parameters, which are prioritized in deep management consultancy by experts in the field. Moreover, most data processing for business is on the basis of regulations by Government, professional bodies etc. There is little scope of ambiguity. Any that come up are for the Justice system to settle. However, it is possible to derive some amount of prioritizing of parameters using fuzzy methods.

Macroeconomics can definitely be another field, which should be open to utilize fuzzy methods. In fact there are many economic models, which work on a fuzzy process known as Fuzzy Cognitive Mapping (FCM). The large numbers of parameters and addition of new parameters which hitherto
were thought to have no influence on economic process is a clear indication for use of fuzzy methods. Developing fuzzy tools for economic process can also be of help in strategic planning by business entities.

The various possibilities of application of the fuzzy process in requirement engineering can become a large field by itself. However, this investigation is planned to continue to only the two fields envisaged earlier viz. medical diagnosis and image interpreting.