Chapter 1

Introduction

In the last decade there has been an increased interest on competence and competency mapping of employees in almost every organization. Competency mapping has been linked to a gamut of HR activities and is quite often instrumental in positioning of an employee inside an organization. In this thesis, competency mapping has been performed for the faculties of a technical institution using two of the most widely used computational approaches: Multi-objective Particle Swarm Optimization (MOPSO) and Sugeno Fuzzy Inference System. Two specific competency mapping tasks have been solved namely: academic load allocation to the faculty members of a technical institute using multi-objective particle swarm optimization and variable pay allocation using Sugeno fuzzy inference system.

In this chapter the genesis of the problem has been discussed, followed by the need for competency mapping and the various aspects related to competency mapping. The motivation behind the research and the specific objectives are presented. Subsequently the scope and the novelty of this work is presented followed by the focus of the thesis. The generic computational approaches used in the field of competency mapping along with PSO and fuzzy inference systems are discussed in a nutshell. Finally the outline of the remaining chapters is sketched.

In the recent past we have witnessed sea change in the operational dynamics of an organization. This is in the wake of rapid industrialization, globalization, advancement and automation in many fields. But at the same time a dichotomous situation is crippling the growth avenues. On one hand almost every developing country is facing the burning issue of unemployment and on the other hand the issue of unemployability is rising exponentially. The major chunk of the unemployable human
resource is technically qualified. As per a report supported by NASSCOM only 25% of the technical graduates and 15 percent of other graduates are considered employable by IT and ITES industries [123]. Hence the crux of the problem is not scarcity of human resource but unavailability of employable human resource.

It has been predicted that by 2030, one in every four graduates in the world will be a product of the Indian education system [127]. Hence the true harnessing of India’s demographic dividend can be done by concentrating on education. Its about time institutions private and government, the regulatory authorities and the industries aim for a symbiotic association amongst them to foster inclusive growth.

None of the studies in the past have been able to identify the true reason or reasons behind the above-mentioned menace. Its not that the graduates do not have the skills but they do not possess the right kind of skills required by the industry [127]. There is a gulf between what is acquired and what is required. Sometimes even if the right skills are acquired they become obsolete by the time they are put to use. Hence there is a need to constantly adapt to the changing environment. So it is very essential that employability be considered holistically- that is acquiring of the right skills along with the inculcation of the right kind of attitudinal, behavioral and cognitive capabilities [66]. This brings us to our first construct- Competency. The term competency has caught the fancy of many researchers, but its worth pondering whose competency one should be concerned about- the students who will constitute the future workforce or the resource that is constantly associated with the students during their formative years- the faculty members.

In today’s changing landscape private universities have emerged to be game-changers, where state-run universities are crippled by systematic problems related to improper planning and lack of autonomy etc. Hence it’s important to ensure that those private universities be equipped with adequate and competent faculties as faculties form the core of any educational institution.

Hence this work is dedicated to the competency aspects of the faculty members of technical institutions in the wake of the problem discussed above. Before going into the objectives it would be worthwhile to consider the rationale behind considering the faculty members and their competency aspects in a technical institution. For that it’s essential to first focus on the issues with the current technical education system in India. As per the project implementation plan of TEQIP (Technical Education Quality Improvement Program) of the Government of India there are several issues
which limit the scope of technical education in India. Some of the reported issues are mentioned below: [127]

- Irrelevant curricula and absence of agile methodologies for frequent revision of curriculum in response to the technological advancements and required as well as anticipated market demands.
- Inability of the Institutions to attract and retain quality personnel because of traditional recruitment procedures and failure to provide incentives for quality performance and complete non-existence or no implementation of staff development policies at the Institute level.
- Poor or rather no involvement in relevant knowledge creation and dissemination.
- Limited or no community interaction.

To tackle with the issues mentioned above, the Government and other authorities have come up with several measures. For example under the TEQIP program, initiatives have been undertaken to enable bi-directional sharing of resources, faculty and staff development, need based flexible curriculum development, building infrastructure and resources for research etc. AQIS - AICTE Quality improvement scheme has floated schemes like: NAFETIC (National Facilities in Engineering and Technology with Industry Collaboration) which aims to create national facilities in AICTE approved institutions in collaboration with Industry for design, instrumentation, testing and manufacturing, NCP (Nationally Coordinated Project Scheme) promotes research on themes of national and social importance which involves networking among several institutions and organizations. Some of the other floated schemes which have a direct or indirect impact under AQIS are EDC (Entrepreneurship Development Cell), MODROBS (Modernization and removal of obsolescence), RPS (Research Promotion Schemes), and IIPC (Industry Interface Partnership Cell) [127]

Apart from the Government initiatives, industries are also collaborating with academia to bridge the skill gap. Some of the industry initiatives are mentioned below:

- Infosys Campus Connect is an industry-academia collaboration initiative started in 2004 with 60 colleges which has increased to more than 350 colleges. It is continuously working with policy making bodies to take steps to improve behavioral skills in technical graduates to make them industry ready.
- TCS Academic Interface Program is an initiative of similar kind which conducts Workshop for students, Faculty Development Programs (FDP) for teachers, Stu-
dent Awards to encourage healthy competition at colleges, Internship Training opportunity for students, and Global Internship program.

- Delhi Technological University (DTU) and Samsung India Electronics Pvt. Ltd have collaborated for setting up a Samsung Software Lab at DTU. Under this collaboration DTU will organize a customized B.Tech. program for SIEL employees. This initiative is aimed at reducing the gap between lab level research and research required by the industry in developing new technologies to strengthen the knowledge and innovation eco-system in the country.

- Times of India Employability Potential Assessment at Campus (EPAC) is a paper based test battery which can be implemented at all AICTE approved B Schools in the country to test the prospective candidates for communication skills, analytical abilities and managerial capabilities and provide a standard and scientific measure to the corporate for taking recruitment decisions. The major crux here is not ranking the students rather the thrust is on clustering the students into groups based on the specific requirements of the respective companies and job profiles.

- NASSCOM has tied up with UGC for strengthening the IT workforce of the country by undertaking intensive faculty development programmes for upgrading skill sets and knowledge base of existing technical faculty. This will be done through mentorship programs, workshops, seminars, projects and development of case studies which can be emulated.

- Some of the other prominent initiatives are by Wipro Council for Industrial Research, ICICI Udaan, and Pantaloons Retail.

Considering the various issues, challenges and the different measures proposed and undertaken, a root cause analysis was done for the problem. Root cause analysis is a systematic technique which breaks down a problem into components and goes to the root of failure. Several techniques are used to present a root cause analysis, but in this context a Fish-bone diagram as shown in Figure 1.1 has been used because of its simple yet powerful visualization. [127]
A close examination of the root cause analysis reveals that most of the issues, problems and the proposed measures boil down to three major aspects: student, faculty and curriculum. Considering the symbiosis between the three it is almost apparent that most of the proposed measures have to be strategic in nature i.e. require intervention and initiative at a higher level, but as researchers we can focus attention on one aspect that is the faculties. Being part of an educational institution, having access to huge amount of data, definitely calls for undivided attention on this aspect. Hence the major focus of this study would be the faculty members of technical institutions and their competency aspects.

It would be worthwhile to mention that the term faculty is very generic, but normally used in the context of professional education. In the context of this thesis, faculty members are those who are engaged in technical institutions imparting engineering education both at the under-graduate as well as post-graduate level. The problem discussed at the outset necessitates that these faculties should be in a constant state of flux in terms of their competencies so that they can cater to the changing demands with utmost agility. Helen Caldicott very aptly quoted “Teachers, I believe, are the most responsible and important members of society because their professional efforts affect the fate of the earth”.

1.1 Motivation

Faculty performance is ubiquitous in the sense that it is affected by so many factors and in turn directly affects the immediate environment that is the student. Under-performance, inadequate performance or negative performance, all of them have adverse effects which negatively impact the teaching learning process. The negative
impact then triggers a chain reaction that ultimately culminates in the students. At the very outset the focus was on the menace of un-employability which has implications in a nation's economic, financial and overall development. It also impacts the positioning of a country in the global arena. Though interventions can be made at various levels as pointed out in Fig 1.1, they are costly and difficult to implement because of standard protocols & multiple regulatory authorities. In a broader sense they are not comparable to the impact that an effective faculty can have on the teaching-learning process. It is difficult to isolate a single factor responsible for the competence of students but the contribution of an effective teacher is far reaching and immediate. Some of the studies have precisely measured the impact of effective teachers on student achievements [62]. Several studies have indicated the need for better, recruitment, training, transparent evaluation strategy and making informed decisions [62], [24].

Hence the process of imparting skills must be considered with utmost priority. At the helm of such affairs are the faculty members and there is no doubt that the motivation levels of an individual affect his performance. So instead of being reactive in managing performance of faculties it would be more appropriate to pro-actively manage performance. But how is performance of a faculty affected?? The factors that contribute to the performance of a faculty are holistically related to his/her competence and a proper mapping of his/her competence. The generic nuances of competency mapping are discussed in Section 1.6, 1.6.1, 1.6.2.

Considering the nature of a faculty’s job the most important aspect is being in a position or job that he is well suited to in terms of his experiences and qualifications and that matches his expectations as well. Hence it is essential to allocate the teaching load to a faculty in the most precise manner as possible in order to achieve the above mentioned objectives. Traditional approaches based on heuristics and subjective data will not guarantee precision and accuracy, hence scientific approaches need to be incorporated to bring precision and objectivity in the results. One more crucial aspect is the reward or the outcome of performance appraisal. Every individual expects the rewards to be in tandem with his performance ensuring utmost fairness. But the traditional techniques are mostly subjective and fail to achieve fairness with precision. Hence this brings us to the basic premises of this work: to scientifically allocate load to the faculties and manage rewards proportionate to performance.
1.2 Research objectives

The purpose of this research is primarily to study the existing process of load allocation to faculties and analyze the nuances of such a process, and based on the characteristics of the process, select an appropriate computational approach to scientifically allocate load to faculties. Another aspect of this study will concentrate on finding the various aspects or outcomes of the performance appraisal systems and devise or propose a model which will take care of the fairness in the decisions that are based on the outcomes of performance appraisal systems.

Since this work will incorporate computational approaches for both the above mentioned aspects, primary data from a premier technical institute will be used to perform the simulation and validate the results. It will also consider the attributes specified by UGC for appraisal of academic faculties in the form of API or academic performance indicators [139].

The objectives of this research are:

1. Propose an approach for scientific allocation of academic load to faculties in a technical institution.
2. Develop a model based on computational intelligence to determine the reward/variable pay component based on the appraisal of faculties.
3. Identify research gaps that can be pursued to construct a competency framework for a technical institution in the wake of the problem discussed at the outset, using proven computational models.

1.3 Scope of research

This work will focus on faculty members of a technical institution offering undergraduate and post-graduate courses in engineering disciplines. The definition of faculty members includes those resources who are engaged in any kind of teaching activity in the under-graduate and post-graduate courses.

The research will encompass capturing the values for various parameters which are decisive in allocating academic load to faculty members. Using those values the proposed model will be simulated and the results will be analyzed. It will also collect the API (Academic Performance Indicator Scores) for each faculty and use this scores as input to an inference model so as to assign a performance score to an individual
in the most scientific manner. The performance scores will be used to determine the variable pay component of the faculty members. The API scores will be collected from the said institute, but the instruments used to capture the API scores will not be discussed.

This research will use actual data for the proposed models so that the models are validated in the actual application environment. The first contribution that this thesis will make regarding academic load allocation is a standard and mandatory process across our universities and institutes. And it takes into account parameters relevant to the process, but the parameters and objectives can always be changed as per requirement. Moreover, the model relies on established computational techniques; hence the basic framework of the proposed model can be used by any academic institution or university. The second contribution is based on even more standard parameters i.e. the API (academic performance indicators) scores laid down by UGC for its affiliated institutes pan India. Hence the model can be used by any academic institution in India for the performance appraisal of faculties, and the output can be used for various compensation and reward related decisions.

1.4 Novelty of research

1. Most of the research works using evolutionary computation techniques specifically optimization techniques like PSO and GA have not focused much on their application to the HR activities of an academic institution. They are restricted to specific tasks of allocation and scheduling in nursing, consulting and construction industries. This research will propose a model to scientifically allocate academic load to faculty members instead of relying on heuristics. This kind of work has not been attempted before as per available literature.

2. There is lot of subjectivity in the performance appraisal procedures. Even a properly designed and implemented technique based on the traditional approaches will not guarantee fairness of assessment. This work will propose a model which will work on standard assessment parameters of faculty members but will provide accurate results about performance which can be used for other decisions like rewards and compensation. Though several times computational approaches have been used in the past in this context, the results have neither been validated, nor the authors have demonstrated the practical usage of the
outputs of the proposed models. This work will precisely demonstrate a particular usage of the output of the model and compare it against the traditional approach.

3. From the review of literature, this work will identity enough gaps which will help in exploiting the potential of computational intelligence, so that a competency framework for a technical institution could be developed. This will help in making the process generic and replicable.

1.5 Research focus and key contributions

This section presents the key elements that will drive this research. First and foremost providing the theoretical framework in terms of review. The theoretical framework will concentrate on three aspects: Competency Mapping, Computational Intelligence Techniques for Optimization, Computational Intelligence Techniques for Inference Systems. Second select the most appropriate or relevant technique for the purpose of optimization of objectives in the case of academic load allocation. Third select the appropriate inference model for performance appraisal and in turn determine compensation / rewards of the faculty members. Fourth provide the analysis and interpretations of the results. The focus of this research is summarized in the following: Figure 1.2 - Figure 1.5.
Figure 1.2: Components of the thesis

Figure 1.3: Components of the theoretical framework
Figure 1.2 depicts the major components of this thesis. The significant steps have been presented in the subsequent figures. Figure 1.3 depicts step no 2 i.e. providing the theoretical framework in terms of its components. To gain sufficient insight into the problem under consideration the review is done on the available literature on competency mapping, optimization techniques / multi-objective optimization techniques, particle swarm optimization and finally inference models specifically fuzzy inference systems. Figure 1.4 presents step 3 i.e. the overview of implementation of our first
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objective i.e. scientific load allocation for faculty members in academic environment. Basically it will focus on selecting an appropriate optimization technique and modeling the manual process of academic load allocation using that technique. The o/p that is the optimized load allocation has to be analyzed to judge the efficacy of the model in terms of the degree of satisfaction of the objectives and constraints.

Figure 1.5 depicts step no 4 which is our second objective i.e. propose a CI model for the performance appraisal of faculty members to determine the reward component in the form of variable pay. The o/p of this model will also be compared with the traditional approach to determine the efficiency of the model.

Last but not the least the inferences, gaps and analysis will open up avenues for potential research problems which need immediate attention.

But before proceeding further it is essential to understand the contextual meaning of competency, the components of competency and establish whether it is static or dynamic

1.6 Competency mapping and major aspects

David McClelland in the year 1973 [100] coined the idea of competency, since then several researchers, academicians have rendered their interpretations of the term competency. In a very generic sense competency can be defined as a collection of those attributes that one can have or acquire, where the attributes manifest as behaviors and behaviors produces the output in terms of products and services. But the term has different specifications for different professionals. The required attributes and behavior do differ in different setups. And since the setups and environment are dynamic, the required competencies are bound to be dynamic.

1.6.1 Techniques of competency mapping

Competency mapping is done with the prime objective of putting the right person, in the right place at the right time. Here an individual’s skills and abilities are identified in terms of their relative strengths and weakness, with the objective of finding the gap and bridging that gap. But all this is done in the context of a specific job and organizational setting. Some of the most traditional and prominent techniques for competency mapping are Job Profiling, Role Profiling, Expert panels, Organizational Surveys, 360 degree multi rater Feedback, Repertory Grid System, Behavioral Event
Interview, Norm Referencing and Criteria Referencing, Performance Assessment, Self and Peer Assessment etc. Among the new ones Complete Personality Typology, Classification and Job Suitability Analysis take centre stage [136]. Competency mapping can be considered the spine of competency based HRM as it is central to recruitment and selection, training and development, assessment and planning, rewards and compensation and performance management etc. In the past several researches have ranked different competencies in terms of their relevance, or frequency of appearance in research works. But it is always appropriate to define competencies in the context of organizational and specific job setting.

1.6.2 Trends in competency mapping

Various trends pertaining to competency mapping have caught the fancy of many researchers. Some of the facets that are trending off late are articulation of underlying characteristics, understanding of global, social, political and legal issues, agility to deal with contingencies and unpredictable environments, emotional management, culture-shock management, interpersonal relationship and linking of performance with organizational strategy.

Though the concept of competency mapping is being handled in a holistic manner, the actual implementation in any organization has never been precisely reported in any published literature as per our knowledge. Many authors have penned techniques, organizations have laid strategies but none of them have reported the exact implementation mechanism and more important there is no evidence of any crisp outcome that has helped decision makers in taking decisions in applied domains. Though the details of the theoretical framework on which this thesis rests will be dealt with in Chapter 3, the concepts have been briefly presented in the following section.

1.7 Computational intelligence and evolutionary computation

At this juncture it would be apt to introduce computational models which have forayed into numerous domains with huge success. The nature and relevance of competency mapping makes it a suitable candidate for exploiting the power of computational intelligence.
Computational intelligence refers to the incorporation of computational models for solving problems, related to classification, clustering, and optimization to name a few. In the last two decades lots of research and literary efforts have gone into computational models and their applications. Several models have gained prominence because of their extensive application and precision in obtaining results; some of them are mentioned below:

- **Artificial Neural Networks**: It is an aspect of computational neuroscience, which is known for its learning ability and capability to re-orient its structure based on input and output. It is inspired by the central nervous system of human beings and is used for finding associations, predictions and optimization etc [152], [95].

- **Fuzzy Logic**: is based on the set theory concept which has the ability to handle vague, ambiguous, imprecise and subjective information [170].

- **Evolutionary Computing**: is that aspect of computer science which takes inspiration from the theory of biological evolution and Darwinians principle of survival of fittest. Some of the most prominent and widely used evolutionary computation techniques are: Genetic Algorithms (GA), Genetic Programming (GP), Evolutionary Programming (EP), Evolutionary Strategies (EA), Differential Evolution (DE) and Differential search algorithm (DSA). GAs and GPs are used for optimization and are based on the selection, cross-over and mutation operators and follow Darwinians principle. EP, EAs and DE mainly rely on the mutation operation for bringing variations in solutions and are used in a wide range of optimization problems.

- **Swarm intelligence**: represents those class of CI techniques based on the collective behavior of a swarm [46]. Some of the widely applied and studied swarm intelligence techniques are: Particle Swarm Optimization (PSO), Ant colony Optimization (ACO), Bacteria Foraging Optimization (BFO) and Honey BEE Algorithm. PSO is a stochastic technique based on the collective behavior of a flock of birds. ACO mimics the behavior of an ant colony and is considered very powerful in routing and combinatorial optimization problems. BFO is based on the group foraging policies of the bacteria E-Coli and is applied in distribution optimization and control problems. The honey BEE algorithms has many variations namely Artificial Bee Colony (ABC), Queen Bee (QB) etc. and is based on the mating of Honey bees. It is normally applied for clustering
and classification.

1.7.1 Computational approaches for competency mapping

Like any other domain computational approaches mentioned above have also been used for different aspects of competency mapping, but the number is few. Though many of the processes in competency mapping need objectivity, not much has been done to exploit the power of computational approaches, in bringing the much needed objectivity.

Powerful visualization tools like expertise knowledge map have been constructed in the past for locating expertise in a particular skill for the purpose of HR planning, allocation and performance management [97].

In order to predict academic trends and patterns, a-priori and k-means have been used to classify and cluster data in educational databases. Expert systems have been proposed for the purpose of competency mapping in educational institutions, Analytical Hierarchy Process has been used for the recruitment and selection of new lecturers [114], [151], [111].

Some studies have also demonstrated the successful application of various evolutionary computing approaches to competency mapping. Fuzzy logic approach has been used for: competency based selection and assignment of human resources to construction projects, design of performance appraisal system using multi-source feedback for teaching faculties [135], [101].

Particle swarm optimization has been used for assigning manpower in consulting engineering firms with the objective of maximizing profit, balancing workloads and avoiding excessive over time etc [165]. It has been used for optimized allocation of human resource based on competence model theory. The concern here is to not assign employees to tasks for which they are not well suited [158]. A variation of the PSO algorithm has also been used for optimal allocation of a limited amount of resource. The problem of worker scheduling has also been dealt using PSO and its variants [78].

PSO has been used for course scheduling with the objective of minimizing or eliminating clashes during load allocation for students and faculties [150]. It has also been used for student group formation and for teaching evaluation for the purpose of appraisal, training and performance management [174]. Fuzzy classification combined with genetic algorithm has been used for optimizing the process of assigning reviewers
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There is very little evidence regarding the application of evolutionary computing approaches specifically to academics and faculty members to be precise. Competency mapping in the context of academics has not been reported much. Specifically very less work has been done taking into consideration the faculty members of a technical institution. But whatever literary evidence is available regarding educational institutions, faculty members, competency mapping and computational approaches; it is enough to trigger deep exploration to reveal the symbiotic relationship that these aspects have with each other.

The domain in which evolutionary computing approaches or CI based approaches can be applied is varied but the nature of application in the context of this study is limited, mostly it is restricted to performance appraisal, scheduling and task allocation but at an abstract level. PSO and fuzzy logic are frontrunners among the computational approaches. GA is also widely used but again is restricted mostly to scheduling.

There is huge amount of data lying idle in educational databases or academic institutions. Unlike other organizations, these databases are not mined to make any inferences. In fact most of the studies concerning human resource management have not considered faculty members as human resources in the context of their studies. Hence incorporation of competency mapping techniques for faculties and using computational approaches for the same has not been considered much as per available literature. The two computational approaches selected for this study are briefly discussed in Section 1.7.2 and Section 1.7.3.

1.7.2 Optimization and PSO

Most of the problems related to competency mapping in the context of this study need to take care of number of objectives simultaneously and handle the associated constraints as well. Since the crux of this work is to deal with the load allocation process using computational intelligence the most widely used and validated optimization technique i.e. particle swarm optimization (PSO) will be used for this purpose. PSO is a swarm intelligence technique developed by Russell Eberhart and James Kennedy in the year 1995, inspired by the movement aesthetics of a flock of birds trying to get closer to the food source and locate the food source. It is an iterative process.
where each bird adjusts its velocity to be as close as possible to the bird which in
closest to the food source at any point of time. Here the swarm of birds is analogous
to a swarm of solutions which represents a wide range of solutions to choose from.
But this is impossible to arrive at using any traditional technique. Since the problem
under concern has to handle multiple objectives, the multi-objective variant of PSO
i.e. MOPSO will be used for implementation. The choice of PSO is backed by the
fact that it is not restricted to any particular kind of problem domain, can be eas-
ily hybridized with other techniques for performance enhancement and has very less
computational burden.

1.7.3 Inference using Fuzzy

The second objective of this thesis requires that the decisions related to the outcome
of performance appraisal should be taken in a very fair manner. But these kinds of
problems have to deal with a lot of information which are imprecise or ambiguous in
nature. Fuzzy logic and fuzzy set theories are proven techniques for handling such
kind of information. Some of the inference models are based on fuzzy concepts which
will be considered for this problem.

There are three widely used fuzzy inference systems namely: Mamdani Fuzzy In-
ference System (Mamdani FIS), Sugeno/TSK Fuzzy Inference System(Sugeno FIS)
and Tsukamoto Fuzzy Inference System (Tsukamoto FIS). Reportedly the Mamdani
FIS is the most widely used inference system and Sugeno FIS has demonstrated ex-
emplary success in several applications. The Sugeno model can be hybridized with
other techniques for further enhancements and it is less complex and less time con-
suming in comparison to the other fuzzy inference systems. The Takagi Sugeno model
or TSK model or Sugeno model as it is popularly known, was introduced by Takagi,
Sugeno and Kang in 1985. In this model a crisp output is obtained by processing the
different rules devised for the inference system.

1.8 Thesis outline

This thesis is organized as follows:

Chapter 2 reviews the concept of competency mapping. It concentrates on how
the dimensions of competency have evolved over years, various aspects and techniques
for competency mapping and the trends in competency mapping etc. The various ap-
Applications like design of role directories, design of performance appraisal systems, development of training and development plans, assessment and development centers, recruitment and selection, human resource information system etc. have been discussed. The techniques used for competency mapping like behavioral event interview, assessment centers, repertory grid, critical incident technique, 360 degree feedback and STAR have been presented in terms of their essential features. The various computational approaches that can be potentially used in this field have been discussed and the inferences have been presented.

**Chapter 3** presents the research methodology adopted for this study. Considering the characteristics of this study a be-spoke methodology has been proposed. The premises, the assumptions and the theory that led to the adoption of the methodology have been discussed. Along with the methodology the two computational approaches selected for this research have been discussed in breadth.

**Chapter 4** proposes a multi-objective PSO approach for load allocation in academic environment. It provides a background for the process, discusses related literature and their relative scopes. The multi-objective PSO (MOPSO) approach is represented along with a rationale for the choice of the approach. The experimental results have been analyzed from the perspective of the objectives of optimization. The simulation has been done using primary data.

**Chapter 5** proposes a novel approach for computing the variable pay of employees based on TSK/Sugeno FIS. The chapter starts with a background of the currently adapted bell curve system and the academic appraisal process. It also discusses the basic fuzzy concepts and the Sugeno fuzzy inference system. There after the model is proposed taking the appraisal parameters as input. The simulation results have been presented by computing the variable pay for each of the faculty members and comparing the results against the outcomes of the traditional approach.

**Chapter 6** presents the conclusion in terms of the achievements of the study based on the contributions made. It also discusses the significance of the study. This chapter is not a mere conclusion but is also used to present the results of the third objective of this thesis and discuss the gaps and inferences which have tremendous potential for future research.