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An Experiment to Signify Fuzzy Logic as an Effective User Interface Tool for Artificial Neural Network

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Abstract—

Artificial Neural Networks are bio-inspired mechanisms for intelligent decision support. Artificial Neural Networks have got remarkable ability to learn and derive meaning from large amount of domain data. The paper discusses the limitations of ANN from user interface perspective and emphasizes how fuzzy logic can serve as an effective user interface tool for ANN. The paper presents a framework for mere ANN based system considering a case of decision making problem of employee evaluation as well as discusses technical details of its implementation. The research work focuses on enhancing the ANN based system by developing Neuro-Fuzzy architecture for employee evaluation system as well as discusses technical details of its implementation.

Keywords— Artificial Neural Network, Employee Evaluation, Evaluation parameters, Fuzzy logic, User Interface

I. INTRODUCTION

A user interface is a program that controls a display for the user and that allows the user to interact with the system. Users differ in ability, training and job experience. Design of the user interface must take account of these human factors. The design of user interface is critical for effective system performance. The users' view of a system is conditioned chiefly by experience with its interface. If the user interface is unsatisfactory, the users' view of the system will be negative regardless of any niceties of internal computer processing [1]. Many technological innovations rely upon user interface design to elevate their technical complexity to a usable product. Technology alone may not win user acceptance and subsequent marketability. The user experience, or how the user experiences the end product, is the key to acceptance [2].

II. ARTIFICIAL NEURAL NETWORK: USER INTERFACE PERSPECTIVE

Artificial Neural Network (ANN) is a step towards simulation of brain, where knowledge is stored in the interconnected processing elements called neurons. Artificial Neural Networks have got remarkable ability to learn and derive meaning from large amount of domain data. A trained ANN can be considered as tool to document generalized rules and detect patterns from enormous amount of complicated or imprecise data. ANN has the ability to tolerate faults and distributed control. ANN systems have been widely used for classification, pattern recognition, forecasting and learning.

ANN operates on crisp data. Preparation of large crisp data sets is a tedious and time consuming procedure, which can be avoided by facilitating an interface which directly inputs the environmental fuzzy data. Since the knowledge in such ANN system is stored in generalized connection between neurons in implicit fashion, which does not help in providing proper explanation and reasoning to users of the system and results in low level of user friendliness [3].
Thus ANN systems may contain complicated decision-making algorithms, such as learning; they pose problems with interface design. User interface design might need rethinking when it comes to ANN interfaces [4].

III. FUZZY LOGIC: AN EFFECTIVE USER INTERFACE TOOL

Fuzzy Logic has proven high importance in artificial intelligence, due to its adequate pseudo verbal representation of knowledge; it is well suited to serve as an interface [5]. Fuzzy logic is a flexible machine learning technique as against traditional crisp logic. Crisp logic is two-valued logic representing two possible solution states, often represented by yes/no or 0/1. Fuzzy logic is multi-valued logic that attempts at mimicking the logic of human thoughts. Human logic is flexible and less rigid when compared to crisp logic. Fuzzy logic allows intermediate values to be defined between two usual extreme points.

Humans routinely and subconsciously place things into classes whose meaning and significance are well understood but whose boundaries are not well defined. Old man, young boy, high temperature and good student are few such examples. With crisp logic, it is difficult to represent the notions like somewhat slow, slightly tall mathematically and have them processed by machines. Such linguistic terms help in applying a more humanlike way of thinking to the programming of computers. Fuzzy logic makes the system more flexible, transparent and user friendly.

In real world systems, the decision–making problems are often uncertain or vague in a number of ways. However in many areas of daily life, such as engineering, manufacturing, education, human judgment or performance assessment often employs natural language to express thinking so it is likely to come up with a subjective perception. Furthermore, based on individuals' subjective perceptions or personality, human judgment of events may be different [6]. In decision

making process the decision makers can incorporate a large number of criteria in their actions and fuzzy logic overcomes the difficulty of expressing decision makers' opinions by crisp value in practice. Fuzzy logic allows computers to make decisions as human being do, so it can be used in any area where human decision is necessary. Application of fuzzy logic in such decision making process combines the decision ability of human beings and speed of the computers resulting in to an excellent decision making system under imprecise, vague and uncertain conditions [7].

The research work emphasizes the significance of fuzzy interface that allows inputting domain knowledge in the form of linguistic variables that do not have sharp distinction like black or white but have colours of spectrum. Such human like approach is well implemented using fuzzy logic, which results into a very user friendly system where knowledge is represented in highly readable form and provides justification about decision being taken since the knowledge is explicitly stored in the system.

IV. The Experiment: A Case of Employee Evaluation

Employee Evaluation is a formal management system that provides for the evaluation of the quality of an individual's performance in an organization [8]. Employee evaluation has the means to evaluate an employee's current and past performance relative to the employee's performance standards. It is a process of evaluating employee's actual performance relative the standard performance so as to give feedback to the employee that will help him or her to improve the job performance [9].

Employee evaluation rely on large amount of data and actions and since ANN gives solution as it learn and derive meaning from large amount of data, ANN is suitably applicable for employee evaluation. Artificial Neural Network models expert behaviour. The goal is to mimic the actions of an expert who solves complex problems [10]. A trained ANN can be thought of as an expert in a particular category of information it has been given to analyse. This expert could be used to provide projections in new situations of interest and answer "what if" questions [11]. ANN estimates input-output functions without any mathematical model and learn from experience with sample data. ANN learns employee evaluation parameters based on input/ output training data sets and assist in decision making process of employee evaluation.

Employee evaluation represents a critically important decision that often involves subjective information. It is common to use discreet scales with sharp real values in the evaluation process. It would be preferable if an evaluator gets an opportunity to consider fuzzy scales. The theory of fuzzy sets allows for the use of such linguistic fuzzy scales, where the various scale values are expressed linguistically and modelled by fuzzy numbers. The purpose of using the instruments of linguistic fuzzy modelling is, on the one hand, an exact mathematic data processing that excludes unwanted subjective influence, and, on the other hand, the natural expression of the expertly defined vague evaluations using natural language [12].

Since ANN have capability to learn from data but cannot provide explicit justification of the decision made and documentation of the knowledge for future use. Hence, it is needed to have a kind of interface which helps to fuzzify and normalize the input parameters to the base ANN system as well as provide justification of the results of the ANN system. The proposed research work implements fuzzy logic as interface to ANN that will map user's vague parameters into the both fuzzy and normalized crisp values through membership functions. The fuzzy interface to ANN helps to receive results from the network and to present it to user after fine tuning and justification. The received output is also in the linguistic form to increase the level of understanding and acceptability of the system.

The Experiment covers:

1. Design and Development of ANN based employee evaluation system without a fuzzy interface
2. Enhancing ANN based employee evaluation system with fuzzy interface

A. Significant Employee Evaluation Parameters

Employee performance evaluation hinges on both qualitative and quantitative parameters. While the ratings assigned on the basis of measurable factors can be justified, it would be difficult to quantify intangible skills. An impartial assessment of these parameters is difficult, if not impossible. Generally employee evaluation includes measuring the things that make the most difference. The problem is that many of the things that make the most difference are not easily quantifiable. Performance is a blend of what you do and how you do it. The sort of parameters that can be considered includes attendance and punctuality, initiative, dependability, attitude, communication, productivity, interpersonal relationships, organizational & time management, knowledge sharing, safety, etc [13].

After reviewing evaluation criteria of various multinational companies and performance appraisal reports of different organizations evaluation parameters shown in Table 1 have been considered:

TABLE I
EMPLOYEE EVALUATION PARAMETERS

Evaluation Parameters on the basis of General Qualities	Field Specific Evaluation Parameters
Personality	Qualifications
Attendance	Work Experience

Punctuality	Job Knowledge
Initiative	Leadership
Self control	Innovativeness
Responsibility	Accomplishments
Quality of Interpersonal Relationships	Effectiveness
Quality of work	Result-Oriented
Attitude	
Commitment	
Communication skills	
Cooperative	

V. FRAMEWORK FOR ANN BASED EMPLOYEE EVALUATION SYSTEM

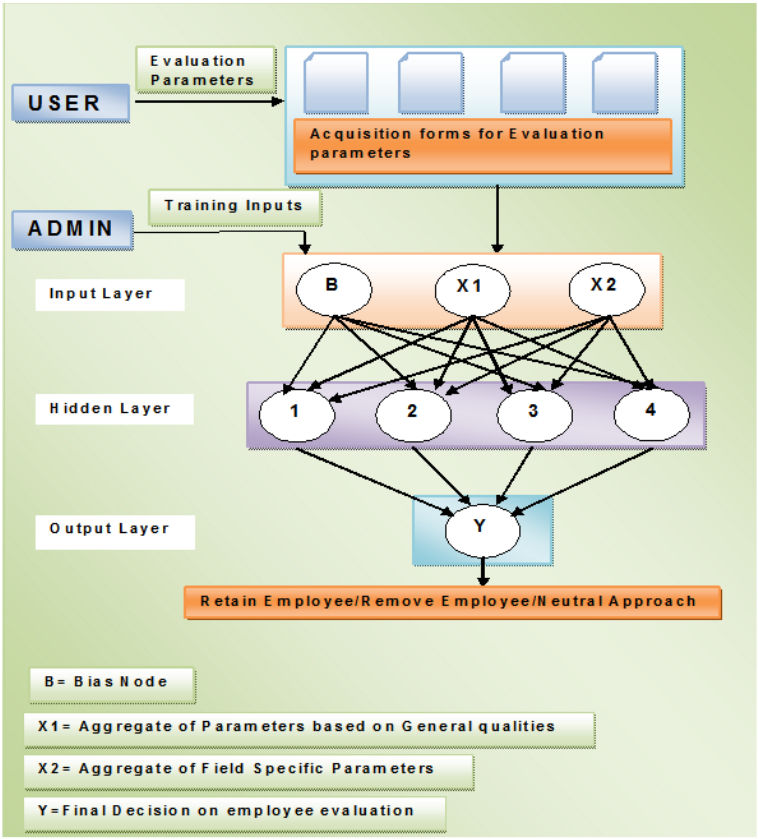

Fig. 1 Structure of ANN for Employee Evaluation

Fig. 1 shows the structure of Feed Forward fully connected ANN that processes aggregate values of evaluation parameters to give the decision. This is a Multi-Layer Perceptron (MLP) with 3 input nodes with one being the bias node, one that takes aggregate value for general parameters and other takes aggregate value for field specific parameters. Bias node feeds a constant input value, 1, into the set of weights. Bias node weights are treated in the same manner as per other node weights. There is one hidden layer with 4 nodes and the output layer with 1 node [14].

Input data are weighted according to the values in the weight matrix and combined in the hidden layer. This weighted sum is then modified by what is known as an activation function. This two-step process of summation of inputs and then modification of this sum by an activation function create the output value. ANN is then trained using different training sets and finetuned to give the decision. There are three possible outcomes i.e. Retain Employee, Neutral Approach or Layoff Employee.

A. Implementation of ANN based employee evaluation system

The data dictionary for the system considers recording data as follows:

- List of users

- Employee information for different organizational level
- Details of evaluation parameters
- Evaluation details of employee in terms evaluation parameters.

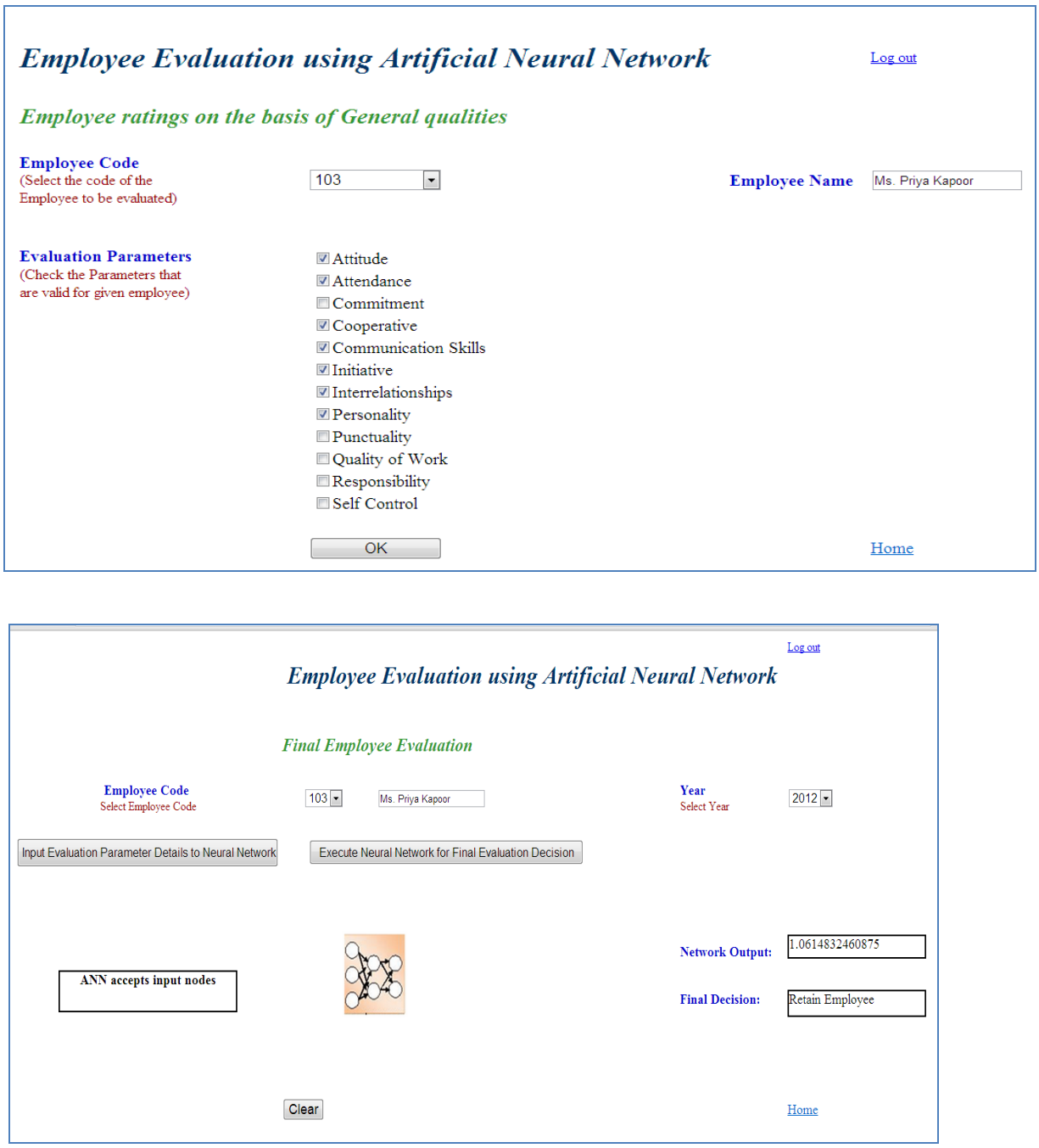

Fig. 2 Sample Screens for ANN based employee evaluation system

Fig. 2 represents an interface for employee evaluation through ANN. The user give input for evaluation parameters and aggregate values are calculated. Aggregate values for evaluation parameters are given as inputs to ANN. The ANN gives the final Decision on employee evaluation i.e. if an employee is to be Retained, Removed or has a Scope of Improvement.

VI. Enhancing ANN based Employee Evaluation System with Fuzzy Interface

Employee evaluation represents a critically important decision that often involves subjective information. Thus employee evaluation is vague, uncertain and imprecise. Employee evaluation is based on many parameters like Commitment, Attitude, Communication Skills, Leadership qualities, Innovativeness, Responsibility, etc. These parameters are fuzzy in nature. Fuzzy logic provides a simple way to draw definite conclusions from vague, ambiguous

or imprecise information. It resembles human decision making with its ability to work from approximate data and find precise solutions. Each evaluation parameter is expressed using linguistic fuzzy scales. The evaluator gets an opportunity to consider evaluation parameters in form of intervals. In this case objectiveness can be associated with fuzzy scales of evaluation parameters by defining weights for each evaluation parameter.

Moreover, the evaluation methodology considers different organizational levels i.e. Strategic, Tactical and Operational. It is obvious that not all the parameters are equally important for the employees at different organizational levels hence weight matrix is defined for each evaluation parameter against the management level in the organization. Weight Matrix indicates the significance of particular parameter for an employee at a particular organizational level. The weight matrix indicates linguistic fuzzy scales for each evaluation parameters. Considering these weight matrices weights are assigned to each fuzzy scale for each parameter for different organizational levels. Also the expected weight for each parameter for an employee at a particular organizational level is assigned [15].

A. Neuro-Fuzzy Architecture

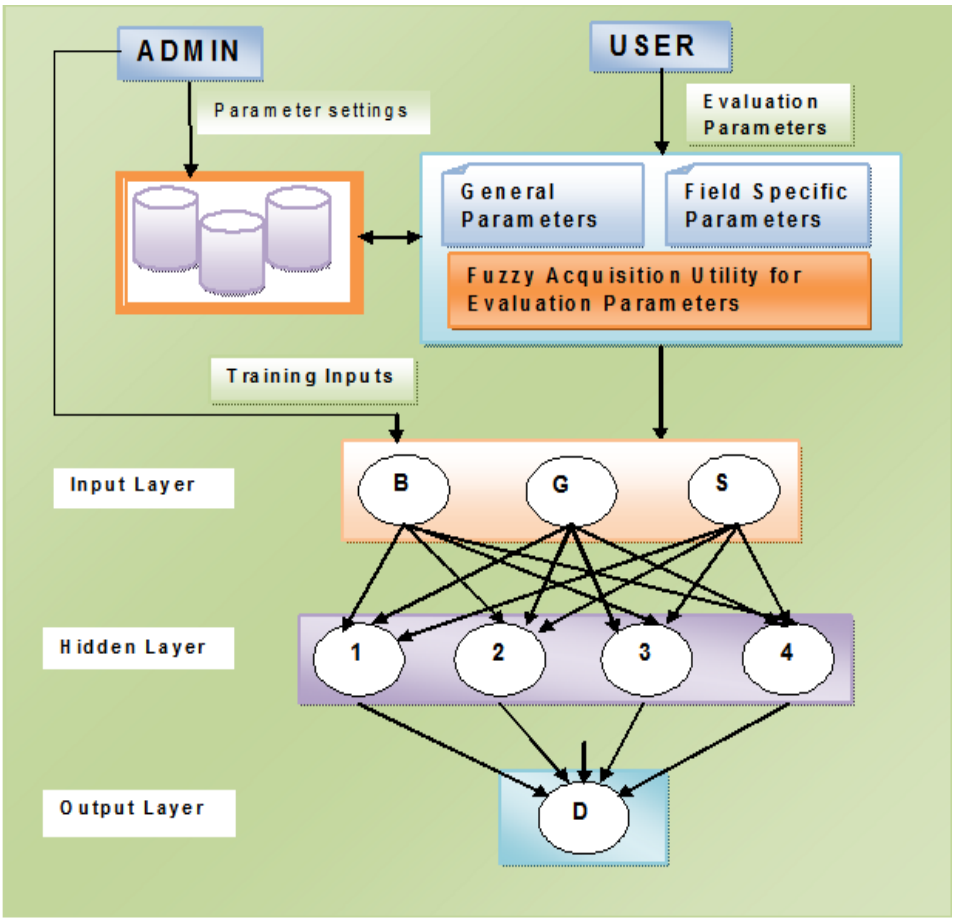

Fig. 3 shows fuzzy acquisition utility through which fuzzy parameters and employee information for employee evaluation is provided by the user. Users can retrieve data through interface from database as when required. Front end also includes interfaces for Administrator to add, set or delete parameters, to set parameter weight, to manage users.

When the evaluation is done as per the employee's performance and attitude different fuzzy values for each parameter are selected. As per the selection actual weight for each parameter for each employee is obtained. The weighted average method is used to calculate aggregate value for parameters based on general abilities and field specific parameters. The weighted average is calculated considering the expected weights and actual weights for all the evaluation parameters. The aggregate value for both the types of parameters is passed to the feed forward fully connected MLP ANN. ANN is trained using different training sets and finetuned to give the decision. The outcome from ANN is passed through the fuzzy rule set that defines threshold values for three possible outcomes i.e. Retain, Neutral or Layoff Employee. The outcome is compared against these threshold values and relevant fuzzy rule is fired and final decision is obtained.

B. Implementation of Neuro-Fuzzy Employee Evaluation system

The data dictionary considers following data to be recorded:

- List of users

- Employee information for different organizational level
- Details of evaluation parameters
- The weights given to different fuzzy scales for the evaluation Parameters
- The weight expected for different evaluation parameters for employees of different organizational level.
- Evaluation details of employee in terms evaluation parameter, its expected weight and actual weight obtained.

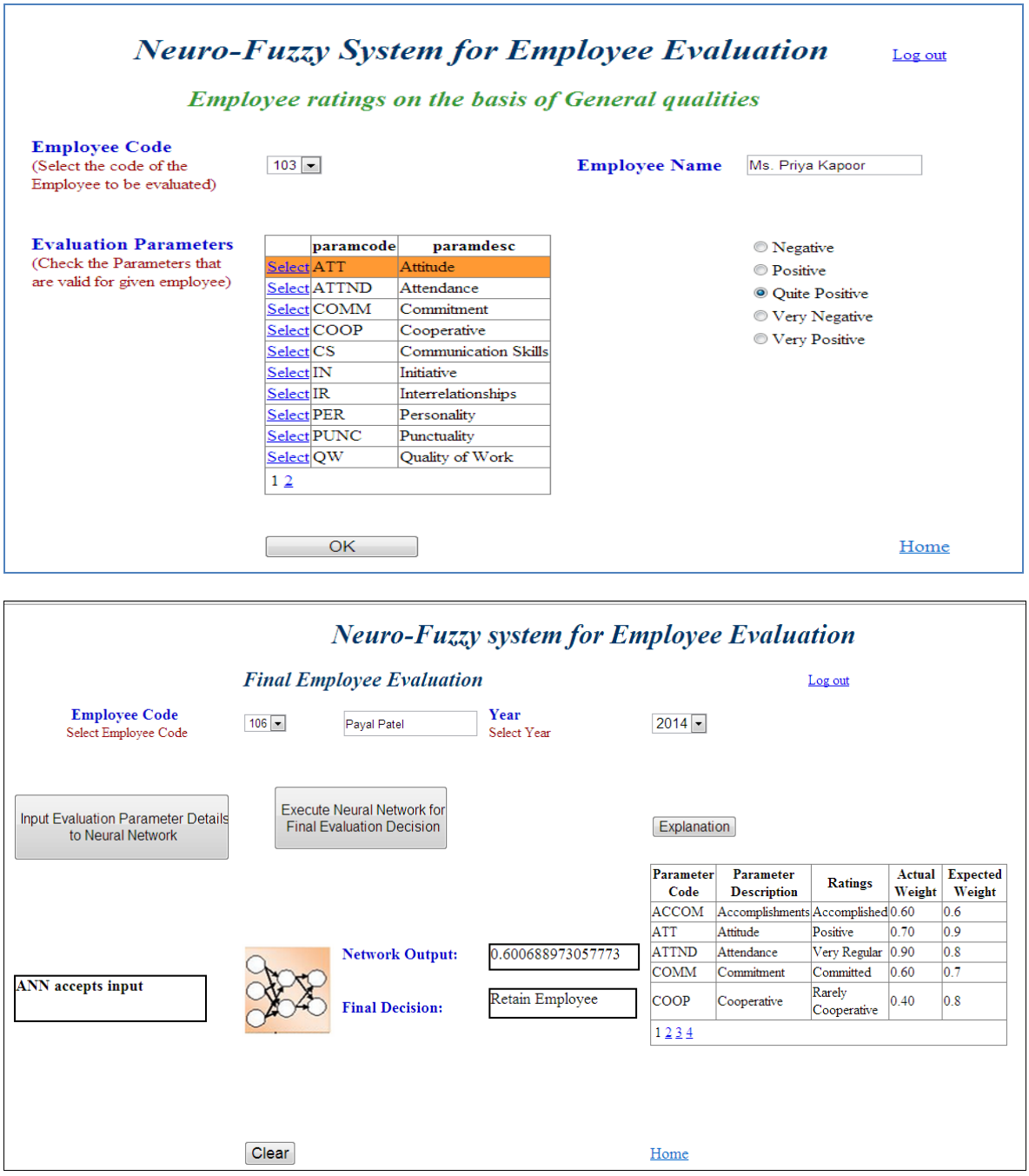

Fig. 4 Sample screens for Neuro-Fuzzy employee evaluation system

Fig. 4 shows fuzzy input interface where user inputs evaluation for each evaluation parameter. When user selects any evaluation parameter in the given list, corresponding linguistic fuzzy scales display. On selection of fuzzy value applicable for the employee the corresponding fuzzy value and weights for an employee get stored year wise. Moreover, Fig. 4 shows interface for final employee evaluation with ANN where by aggregate values for evaluation parameters are taken as input and processed to give final decision. The interface also includes an explanation facility that gives justification for the decision being given by ANN.

VII. OUTCOMES AND ADVANTAGES

The research work signifies fuzzy logic as an effective user interface for enhancing ANN based system. The hybridization of fuzzy logic and ANN offers dual advantages of both the techniques. ANN offers advantages training and self learning and fuzzy logic offers advantages of user-friendliness and explicit knowledge representation for better justification of the decision suggested. Neuro-fuzzy system for employee evaluation is a generic product suitable to different companies. Since the knowledge base is empty, user can define company specific evaluation parameters and evaluation criteria and ANN is trained with company specific data. Thus it supports process of Employee reward system, retains key people in organization, motivates employees to perform better, creates healthy competitive environment.

VIII. FUTURE SCOPE

The Neuro- Fuzzy system can be used for different other domains like student evaluation, production evaluation or software quality assurance, etc with minor modifications. Fuzzy membership functions are predefined and may not equally be applicable to every other domain. Hence, future work can be done in area of extracting dynamic domain specific fuzzy membership functions through interactive user interface.

IX. CONCLUSION

The experiment enhances ANN based employee evaluation system through fuzzy interface where it allows human like perception based approach of inputting evaluation details and also provides reasoning and explanation for the decision being taken resulting into a very user friendly system. Neuro-Fuzzy approach can be considered significant methodology for such decision making problems in real world. The research work focuses on how the hybridization of fuzzy logic and ANN results in to intelligent system that demonstrate human-like reasoning style of fuzzy systems with learning and connectionist structure of ANNs.

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