Decision Making Approach in Recruitment using Neuro-Fuzzy System

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ABSTRACT
Growing digitalisation in every aspect of business functioning has resulted in a need of automated systems to select the employee for the job. Rather than the traditional way of scanning the CVs personally and accessing them by the HR executives and subject matter experts(SME), a new computerized system which does the same but in less time is the need of the hour. Industries keep on hiring employees throughout the year to increase workforce and for that they require to shortlist the contenders from many applicants. This initial step requires segregation of the submitted resumes. Shortlisting resumes requires a panel of HR managers and field experts of the particular job field which check for the particular skills of individuals to select or score them by collective decision of group. This contains high uncertainty when it needs to be automated. The concepts of soft computation like Fuzzy Logic helps to deal with that kind of uncertainty and Neural network could be used to assign weights and then score the CVs to rank them. Using such hybrid system application would highly benefit the organisation to choose a quality employee based on his/her characteristics. It only requires requirements to be specified to the system which in turn would automate the ranking.

General Terms
Decision making neuro fuzzy algorithm

Keywords
Digitalisation, CV, SME, soft computing, Fuzzy logic, neural network

1. INTRODUCTION
To keep up with the pace of the world and not be left behind every organisation is taking the help of the computation power [1]. Ever increasing population and directly proportionate demand for jobs along with the financial crunches in the past decade has made companies rethink on their recruitment process [4]. This forces the organisation to employ most effective personnel available from many seekers for a very less vacancy. The recruitment for the organisation is done by is Human Resource department which personally skims and scans the resumes submitted by potential candidates for the job. Thus this process involves the HR executive and an expert in the job specification to short-list the CVs based on the set particular skills required for that job description. The group now has to decide which of the applied candidates are best suitable and must be shortlisted as per their standing i.e. the rank. The human decision may include a bias factor that can disturb the ranking order. Some field-expert may find a particular skill important and some could find another due to varying knowledge and experience of various expert [1]. Arriving at a common conclusion to select one candidate over the other thus involves higher levels of uncertainties. Besides that the annual auditing of the companies involves checking of all the details of the organization where recruitment is also inspected. The company has to show which all people applied and how some were selected over the others. Secondly, after the shortlisting there exists a whole process of interviews and then the training. The expense of recruiting the wrong candidate has made many companies to adopt a robust and more digitally precise model to deal with uncertainties concerned. The current implementation of digitally selecting the CVs include a simple if-then ruling mechanism. If a skill is present select it or else reject it which does not handle the uncertainties referred formally. Fuzzy methods have become increasingly popular when uncertainties are concerned [5]. The use of neural networks also allows the weighting of the entities that is the CVs and thus ranking them respectively. Fuzzy set allot a membership value to each element thus making it feasible for better ranking the elements. Developing hybrid methodology based on fuzzy linguistic and neural weighting to those candidates that fit the requirement criteria would solve the uncertainties in ranking [2]. A scoring method to assign values to the selected CVs would make the system transparent enough to reason the selection. The scores are mapped to the fuzzy variables for consistent reasoning and output.

2. PROBLEM STATEMENT
The enhancement in technology and cultural shifts are causing huge changes in the Information Technology firms. The HR professional plays vital role in assorting expert workforce of organization. The HR department examine their recruitment tools for software and employee management strategies. HR Recruiters spend huge amount of time in inputting candidate's information into systems and speaking with managers about the specific requirements of certain position.HR professionals also faces problem of receiving resumes from candidates with strong backgrounds or skill sets needed for the position. One of the main goals of the organization is finding more powerful ways of assessing and recruiting personnel. To strike a great balance between hiring someone for position need versus hiring someone that's great regardless of position there is need to automate the procedure of personnel assortment of the candidate. The aim is to develop a neuro-fuzzy based system that will help HR department to specify requirement criteria (skills, vacancies, experience etc.) for given job role and shortlisting their Curriculum Vitae(CV). A neuro-fuzzy based system will automatically determine job characteristics defined by domain experts, then record ranking decision made by expert and assigning a constant numeric value for shortlisting CVs. The neuro-fuzzy based system uses hybrid network combining the principles of neural networks and

fuzzy logic. A fuzzy logic is multi-layer neural network of special structures without feedback, in which weighed method and membership functions are used. The system will first model the set of skills attributes & will specify role required for particular job specification. The system will then record ranking decision on CV's made by each expert on set of requirement specifications. The fuzzy sets are used to model this ranking decision made by expert. A consistent coefficient is assigned to weigh CV and this will help HR department to shortlist candidate CV. This enables to automate the process of job requirements specification for candidate ranking in HR systems. This system will help the human resource department to select right candidate for particular job profile, which in turn provide expert workforce for the organization.

3. LITERATURE REVIEW

Due to the shrinking job market and higher volume of job seekers, it is necessary to effectively short-list and rank candidates for the particular job role [1]. This is based on matching the applicant's profile and Curriculum Vitae (CV) against the requirements criteria (experience, skills, knowledge, qualifications, etc) which the post holder needs in order to perform the duties of the job. This process is usually conducted by recruitment personal and also involves experts from within the job area [1].

3.1 Fuzzy Logic for Staff Selection

Fuzzy logic is the best tool for decision making problem when there is not accurate or partially accurate description available. Selection of staff for an enterprise is a very old problem. This problem can be easily solved by using fuzzy logic [2].The fuzzy logic concept was thought by Bellman and Zadeh (**R. E. Bellman and L. A. Zadeh, "Decision making in fuzzy environment,"** ***Management Science,*** **vol. 17, 1970, pp. 241-164).** Decisions in fuzzy logic can be done using numerical values and also non numerical i.e. human description of candidate performances. In fuzzy logic, Numerical evaluation is quite easier than non- numerical evaluation. Numerical evaluation is based on criteria such as candidate weight, height, age, experience (no of years), number of marks scored in test [5]. Non numerical evaluation is based on Physical, psychical performance of candidate, skills, qualification. Depending upon the requirement of the job profile, selection criteria may be different. In numerical evaluation, two methods are proposed- Performance index P and index of Demand Satisfaction DS. These two methods are used in selection of staff in an organisation. In performance index (P) method, candidate's performance is compared with performance required for candidate for the particular job profile. Depending upon the performance a membership function μCi**,** of fuzzy set representing consistence between feature μFi and demand μDi is calculated which is given as,

$$\boldsymbol{\mu Ci}=\mathbf{inf}\,[\boldsymbol{\mu Fi}(\mathbf{x}), \boldsymbol{\mu Di}(\boldsymbol{x})]$$

This consistence may be expressed as index of compliance ***Ki***

$$\mathbf{Ki}=\sup_{\mathbf{x}} \boldsymbol{\mu Ci} = \sup_{\mathbf{x}}\{\inf(\boldsymbol{\mu Fi}(\boldsymbol{x}), \boldsymbol{\mu Di}(\boldsymbol{x})\}$$

Total evaluation of the candidate performances must be numerical and it is given as weighted mean

$$\mathbf{P} = \frac{\sum_i \boldsymbol{IiKi}}{\sum_i \boldsymbol{Ii}}$$

Here *Ii* is i-th requirement level of importance.

Thus this solution have disadvantage where candidates fulfil same requirement and we cannot judge which candidate is better. For example, one candidate has secondary education, second candidate is graduated. So both the candidates fulfill requirement i.e "at least secondary education". Here candidate solution is not unique. So to avoid the problem we use the second method that is Demand Satisfaction in which solution based on common area calculations are suggested. It is assumed that the levels ***Li*** of any feature ***Fi*** may be ordered. In other way there are no possibilities to compare levels Li for different candidates. Now, the membership μCi which is the result of comparison of feature ***Fi*** with demand ***Di*** of the fuzzy set ***Ci.*** Let surfaces under membership functions are equal $\mathbf{Sc_i}$ and $\mathbf{Sd_i}$. So demand satisfaction *DS* is defined as follows

$$\mathbf{DS} = \frac{\mathbf{1}}{\boldsymbol{n}} \sum_{\boldsymbol{i=0}}^{\boldsymbol{n}} \frac{\boldsymbol{I_i S_{C_i}}}{\boldsymbol{S_{Di}}}$$

So here are some method which are used for selection of staff for a particular enterprise. Two methods are proposed - performance index P and index of demand satisfaction *DS.* In this DS is considered as a better method then performance index.[2]

3.2 Neuro-Fuzzy Recruitment System

This neuro-fuzzy based system uses hybrid network which combines the principles of neural networks and fuzzy logic.[1] A fuzzy logic is multi-layer neural network of special structures without feedback that uses weighed method and activation functions. The main aim of this system is to take sample data set as input which will help them in determining parameters required for membership function.[2] In this system, training neural networks are used for determining parameters of membership function. This system makes use of ANFIS architecture ***(Jang, Sun & Mizutani 1997)***, which is structure of adaptive neural network of special propagation that will determine the parameters of neuro-fuzzy system and also it will inherent characteristics of fuzzy interference system and neural networks. In this system, the fuzzy logic is implemented with the help of Sugeno fuzzy algorithm which takes set of data set as input and generates a weighted average value as an output.[3] The processing of Sugeno algorithm deals with five stages where first stage deals with input parameters, second layer includes a set of fuzzy rules, third layer normalizes the rules of execution, fourth layer deals with inference of rules and fifth layer determines the output variable. The two rules which are use in fuzzy set function for determining output variable are as follows:

Rule 1: If $x\ is\ A_1\ and\ y\ is\ B_1\ then\ f_1 = p_1 + q_1 + r_1$

Rule 2: If $x\ is\ A_2$ and $y\ is\ B_2\ \ then\ f_2 = p_2 + q_2 + r_2$

The 1st layer of the *ANFIS* system **(Jang, Sun & Mizutani 1997)** processes the incoming data set of variable x & y.

$$O_{1,i} = \mu_{A_i}(x), for\ i = 1,2\ or$$

$$O_{1,i} = \mu_{B_{i-2}}(x), for\ i = 3,4\ ,$$

Where x is the input to the node $i;\ A_i\ and\ B_i$ is the linguistic term associated with this node

The 2nd layer consists of layer of rules. Each node in this layer is denoted by **π** which determines the product of two input signals,

$$O_{2,i} = W_i = \mu_{A_i}(x).\mu_{B_i}(x), i = 1,2.$$

In 3rd layer, the output of neuron of layer 2 is use as input and this layer computes degree of execution of fuzzy rule

$$O_{3,i} = \varpi_i = \frac{W_i}{W_1 + W_2}, i = 1,2.$$

The 4th layer computes the contribution of i-th rule to the overall result.

$$O_{4,i} = \varpi_i f_i = \varpi_i (p_i x + q_i y + r_1)$$

The 5th layer sums the output of previous layer and thus determines the output value of the ANFIS system

$$O_{5,i} = \sum \varpi_i f_i = \frac{\sum w_i f_i}{\sum w_i}.$$

This determines the assessment quality of candidate. In this way, Neuro-fuzzy Recruitment system uses Sugeno algorithm to process the input data set into 5 layers of hybrid neuro-fuzzy network and generates a weighted average value as an output.

3.3 Fuzzy Linguistic Approach

In fuzzy set theory, the problem of decision making when incomplete or uncertain information is available has been the topic of research over the last decade. The basic assumption behind this is that there are situations where it is easy to handle uncertainty by fuzzy set theory than by probability theory. Here we present a technique for fuzzy decision making that is based on linguistic approximation and truth qualification [6].

The main feature of this approach is that it creates a linguistic assessment for decision, thus making clear and subjective nature of any choice that is made using fuzzy information.

I] Here we discuss multi-choice decision problems in which information about the "suitability" of the alternatives is given by a set of fuzzy sets. We show how to create a single fuzzy set that aggregates all the suitability information and how this may be interpreted as the basic fuzzy decision.

II] Then it is concerned with the development of ideas in linguistic approximation and truth qualification. Following Zadeh [2], we introduce the concept of a truth-qualified proposition in natural language and show how this may be made the basis for a linguistic decision.

III] And finally we present decision in which the ratings are linguistic rather than numerical.

In situations where fuzzy sets are a suitable way of representing uncertainty, the decisions taken must be fuzzy. It is surely not appropriate to give the final choice some artificial precision; decisions should be linguistic rather than numerical. In developing a technique that creates linguistic decisions we have drawn heavily on the idea of linguistic approximation, pattern recognition, and fuzzy numbers. This has meant that our procedures are complex, though not complicated, and necessitate the use of a digital computer. The result is an easily used tool for structuring and solving fuzzy decision problems [6]. The decision maker can interact with the decision process at every level and, as a consequence, we feel that our method is of direct practical benefit.

Table 1: MCDM methods used for personnel selection

Fuzzy linguistic evaluation	10
Fuzzy Expert System	2
Neuro-fuzzy integrated method	5

4. PROPOSED SYSTEM

This will enable a more effective way to short list submitted candidate CVs from a large number of applicants providing a consistent and fair CV ranking policy, which can be legally justified. System will rank the experience and key skills required for particular job position. Than system will rank the CVs based on the experience and other key skills, which are required for particular job profile. This system will help the HR department to easily shortlist the candidate based on the CV ranking policy. This system will focus not only in qualification and in experience but also focuses on other important aspects, which are required for particular job position. This system will help the human resource department to select right candidate for particular job profile, which in turn provide expert workforce for the organization.

4.1 Features:

- This system will automatically determine the key skill characteristic by defining each expert's preferences and ranking decisions.
- The presented system automates the processes of requirements specification and applicant's ranking.
- The proposed system produces ranking decisions that were relatively highly consistent with those of the human experts.
- This system will enable a more effective way to short list submitted candidate CVs from a large number of applicants providing a consistent and fair CV ranking policy

4.2 Technique used:

Our neuro-fuzzy group decision modelling and ranking approach consists of five phases of operation as shown in Fig. 1

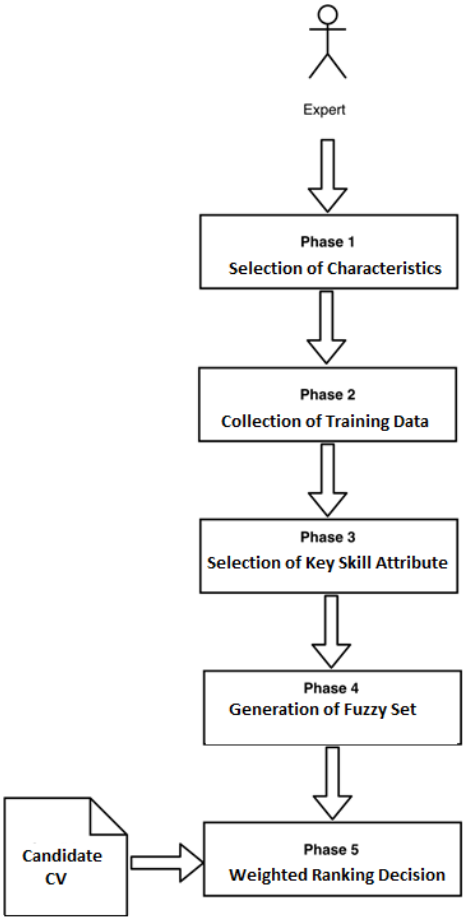

Figure 1: Phases of the modelling

In phase 1, each expert initially selects a subset of occupation characteristics which they think should form the requirements criteria of the person specification for the given job role. Experts use an intuitive online web-based interface for completing the selection of their person specification characteristics.

In phase 2, training data is collected from each recruitment expert on their ranking decisions for a sample set of candidate CVs. Each expert assesses and ranks the CVs based on the subjective person specification characteristics they have specified in phase 1. In our system, an applicant CV is ranked according to the three linguistic labels: 'Poor', 'Moderate' and 'Good' that indicate the degree to which the skills possessed by the candidate, meet the requirements defined in the person specification. A web-based interface is used to allow experts to review each CV and record their ranking decisions, which can be unobtrusively incorporated into their regular CV review and assessment decision-making process.

In phase 3, a neural network feature weighting method is used to analyze the training data collected from each expert. The skills present in the sample CVs that match the expert's requirements criteria are weighted using the neural network-training algorithm to determine the key skill attributes that classify the three ranking decisions.

In phase 4, the selected skill attributes characterizing each expert's ranking decisions are used to generate fuzzy sets that describe the three linguistic labels for ranking the applicant CVs. As each expert will have varying preferences, the shape and size of their generated fuzzy sets will also be different due to the uncertainties in the meaning of the linguistic labels between different experts. The consistency of each expert's ranking behavior is validated over the sample set of CVs. The generated fuzzy sets for the three linguistic labels are used to rank the sample CVs. The fuzzy ranking decisions generated by the system are then compared with the expert's own ranking of the CVs. This determines a numerical coefficient of how consistent the expert is in ranking the CVs according to the skill preferences they are using to characterize their ranking decisions.

In phase 5, new CVs are scored based on comparing their extracted skills with the rated skill attributes characterizing each expert's ranking decisions. The final score for each CV is then mapped to the fuzzy sets modelling each expert's linguistic ranking decisions, which are also weighted by the expert's consistency coefficient. The system then aggregates the weighted fuzzy mappings together for each expert to derive an overall ranking for the CV based on the group decision. The system can be adaptive to the different job roles or the changing opinions and preferences of the experts. Phases 1 to 4 can be periodically repeated or run in parallel based on evaluating and feeding back the system's ranking decisions to improve its accuracy

5. CONCLUSION

By understanding and reviewing the literatures written we are trying to develop an automated web system that will help so that the recruiter will be able to capture the most important job requirements preferences from the panel Of experts to generate a person specification, that reflects the collective unbiased opinion of the experts in a consistent and objective way contributing to group decision-making process. The presented system would benefit the Organizations as it automates the processes of requirements specification and applicant's ranking, saving organizations resources such as time and money. The system could be further improved on the following future scope points.

5.1 Future scope:

- Storing the contact details of the candidates shortlisted and alerting them for further interview round.
- Providing the linguistic output to HR management rather than the numerical ranks for better understanding.

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