

## **Applying Artificial Intelligence to Career Consultation: A Case Based Reasoning Paradigm for Knowledge Management**

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Human resource plays a key role in a society and also for all kind of organization, therefore offering a reasonable and intelligent way for selection of a suitable and essential career.

Artificial Intelligence (AI) is used today in science, engineering, business, manufacturing, management and many other fields. Expert systems as a branch of AI have attracted the attention of mostly large and medium organizations for doing some human's activities. Case Based Reasoning (CBR) is also a new problem solving paradigm that in many ways is fundamentally different from other major AI approaches. Instead of relying solely on general knowledge of a problem domain, or making associations along generalized relationships between problem descriptors and conclusions, CBR is able to utilize the specific knowledge of previously experienced situations.

This research work presents a model for designing an intelligent career consultation system using case-based reasoning which recommends suitable jobs for applicants. This system, as a sample, has been implemented in an Iranian organization.

**Key words:** human resource management, career consultation, case-based reasoning.

### **Introduction**

Human resource management (HRM) consists of numerous activities for the suitable utilization of human resources (HR) in an organization.

Possible areas which are in particular potentially suited to expert systems (ES) in HRM include: staffing, training, development, control, employee selection, wage adjustment, performance appraisal,

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and career counseling ( Extejt & Lynn, 1988; Humpert et al, 1989; Edwards, 1992; Lehner, 1992). This paper is going to concentrate on career counseling. Our main object of career consultation is to recommend a suitable job or career for an applicant.

The process of building an expert system is called knowledge engineering and is done by a knowledge engineer (Michie, 1973). Knowledge acquisition and representation are two major subjects in making the knowledge base for expert systems. There are also two main reasoning approaches to solve problem in expert systems i.e. Rule Based Reasoning (RBR) and Case Based Reasoning (CBR). Rule based reasoning uses rules for knowledge representation. A rule is an IF

THEN structure includes a small module of knowledge. For example, if the light is red then stop. The basic idea of case based reasoning is to adapt solutions that were used to solve old problems and use them to solve new problems(Turban & Aronson, 1998).

Case-Based Reasoning (CBR) is an artificial intelligence technique that has received a lot of attention over the recent years. It has become the rising star in knowledge-based decision support technology (Thompson, 1997). A case is the primary knowledge-base element for a CBR application. It defines a situation or problem along with it's solutions. Case based reasoning has several potential benefits, some of them are summarized in table 1(Turban & Aronson, 1998).

Table 1 Comparison of Case Based and Rule Based Reasoning

Criteria	RBR	CBR
Knowledge Unit	Rule	Case
Advantages	Flexible use of knowledge, Potentially optimal answers	Rapid response Rapid knowledge acquisition Explanation by examples
Disadvantages	Computationally expensive Long development time Back-box answers	Suboptimal solutions Redundant knowledge base
Granularity	Fine	Coarse
Explanation mechanism	Backtrack of rule firings	Precedent cases

A general CBR cycle may be described by the following four processes (Aamodt & Plaza, 1994).

- Retrieve the most similar case or cases
- Reuse the information and knowledge in that case to solve the problem

- Revise the proposed solution
- Retain the parts of this experience likely to be useful for future problem solving

This CBR cycle is schematically presented in Figure 1.

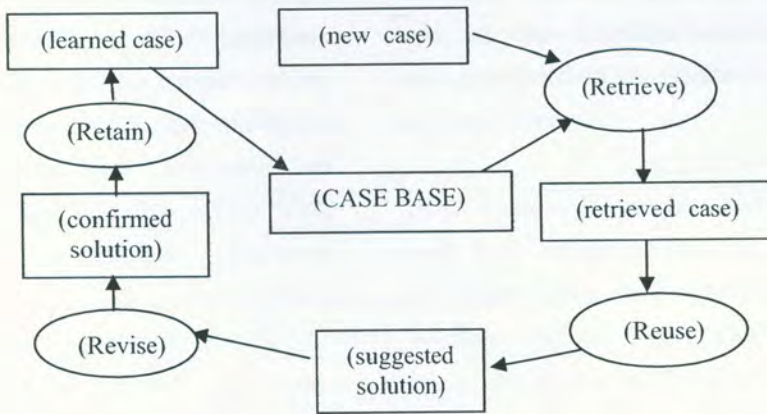


Figure 1 The CBR cycle

For developing a CBR system some important issues such as case representation and indexing, case retrieval, matching or similarity measure and case adaptation must be considered.

and the applicant's features is necessary to assure that the right jobs are assigned to people. Developing a CBR system for job consultation is based on the following stages:

**Designing a CBR Model for Intelligent Career Consultation**

The selection of suitable jobs for applicants is a major subject in Human Resource Management (HRM). One of the most important responsibilities for managers is to select suitable positions for employees. Making of a good adaptation between the jobs characteristics

**Making the Case Base for the System**

A case is the primary knowledge-base element for a CBR system. It consists of a problem and it's solution. In this paper, a case defines an organizational job with all of its characteristics. The case base is used for making the intelligent CBR system to decide about the suitable job for an applicant as shown in Figure 2.

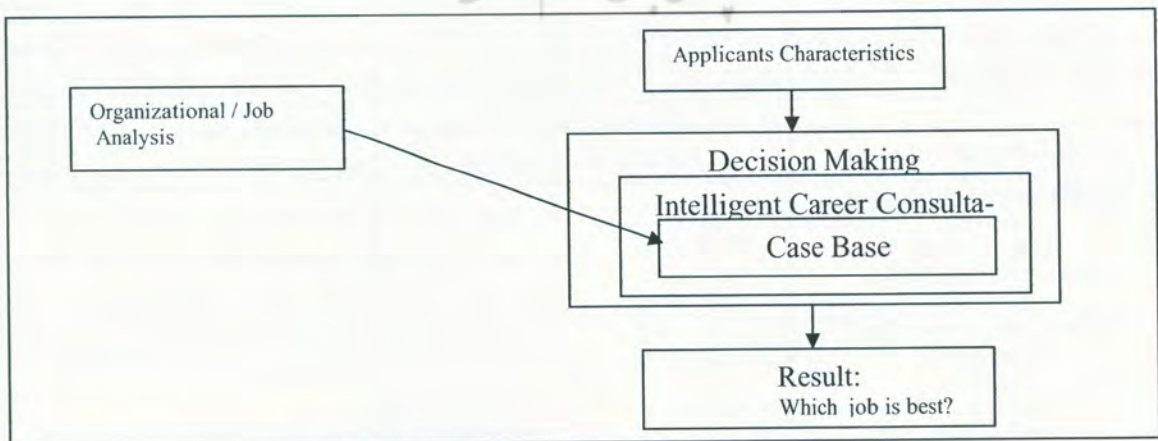


Figure 2 Intelligent Career Consultation Process

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First, in order to make the case base, the organizational jobs are analyzed and the jobs characteristics are which are distributed in two groups as follows:

1. Obligatory Criteria

These criteria (features) are dependent upon organizational and job circumstances and their existence for successful job performance are necessary. For example, the criteria such as physical and sex conditions and educational level can be obligatory.

2. Compensatory Criteria

Although these criteria (features) are not obligatory, however each of them has a weight that defines its importance among the others. The compensatory criteria and their weights vary from one job to another. In other words they are job-related and usually come from job and organizational studies.

For extraction of the compensatory criteria,

Multidimensional Scaling (MDS) can be used (Said & Fathian, 2002). The criteria such as self-confidence, creativity, responsibility and discipline that defines applicant's psychological and behavioral conditions and also computer skills, design skills and problem solving ability that describes applicant's job skills can be compensatory.

Table 2 shows a typical case for a job, consisting features names, features values, features weights and features types. In fact, such a case defines a successful personality model for a specific organizational job.

In the CBR system the problem is to select suitable jobs for a considered applicant. In this problem the jobs are identified as old cases in the case base and the applicants' characteristics are considered as queries (or new cases). For solving such problems, the similarity value between the queries and the old cases must be measured.

Table 2 A Sample Case

Feature Name	Feature Value	Feature Weight	Feature Type
Job Code	A Number	-----	Number
Job Title	Job Name	-----	Text
Job Description	A Definition	-----	Text
Work Place	Place Name	-----	Text
<b>Obligatory Criteria Like:</b>			
Physical Conditions: Vision Ability Hearing Ability Health and so forth	The Minimum Required Score (a number between 1 to 9 in an interval scale)	-----	Number
Required Educational Level	Accepted Educational Level Codes	-----	Number
Required Educational Field	Accepted Fields Codes	-----	Number
Age	Minimum and Maximum of Accepted Age	-----	Two Numbers
Sex	Accepted Sex Code	-----	Number
The other obligatory conditions	Related to the Conditions	-----	Related to the Conditions
<b>Compensatory Criteria like:</b>			
Job Skills : Computer Skills Problem Solving Ability and so forth	---	A Number ( $W_i$ )	Number
Psychological and Behavioral Conditions: Creativity Responsibility and so forth	---	A Number ( $W_i$ )	Number

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**Organizing the Case Base and Indexing**

Figure 3 illustrates a hierarchical organization of the case base for this system. Indexing is considered on the basis of this organization.

Therefore, each job has a specific index that is used for case retrieval. For determining the job index, each cell of the hierarchy levels gets an assigned number.

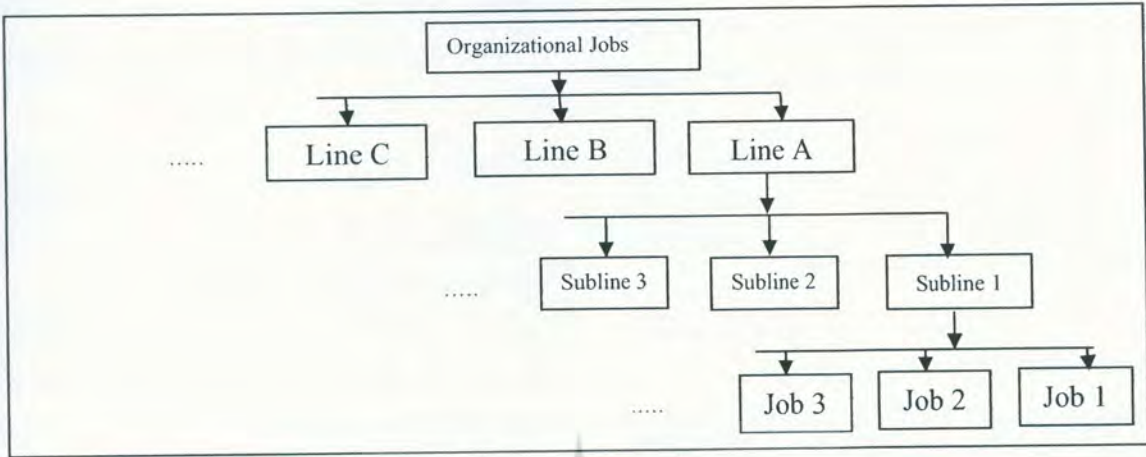


Figure 3 The Organization of the Case Base

**Similarity Measure**

One of the important issues in CBR systems is to determine similarity measure. It can be used to decide which old case is more similar to the new case or query. Concerning the obligatory criteria, the existence of complete similarity between query (the applicant's characteristics) and the case (the job) is necessary. In other words, the obligatory criteria are like obligatory rules in CBR system. For the compensatory criteria, the similarity measure must be calculated. In this research study, TOPSIS algorithm (Technique for Order Preference by Similarity to Ideal Solution) for the determination of the similarity metric has been used. If the utility of each feature is assumed either monotonically increasing or decreasing, using of TOPSIS algorithm will be very suitable. For the calculation of the similarity metric the following stages must be carried out:

- Determine ideal and negative-ideal applicant
- If the value increase of each feature causes

the utility to increase, the ideal applicant will receive the maximum score of the features and the negative-ideal applicant will receive the minimum score. An interval bipolar-scale can be used for the measurement of the features. Hence there are a number of options such as: very poor (1), poor(3),relatively good(5),good(7) and very good(9). Therefore, the feature values for the ideal and negative-ideal applicants will be consequently very good(9) and very poor(1).

Calculate the distance of new case (query) from the ideal and negative-ideal applicant.

The n-dimensional Euclidean distance is calculated by:

$$d_+ = \sqrt{\sum_{j=1}^m w_j^2 (v_j^+ - v_j)^2} \tag{1}$$

$$d_- = \sqrt{\sum_{j=1}^m w_j^2 (v_j^- - v_j)^2} \tag{2}$$

In the above relations:

$d_+$  is the distance value between new case and

the ideal applicant.

$d_-$  is the distance value between new case and the negative-ideal applicant.

$w_j$  is the weight of the  $j$ th feature in the considered case.

$m$  is the number of the features.

$v_j$  is the scaleless value of the  $j$ th feature in the new case(query). For making of the scaleless value of the  $j$ th feature, the initial value of the feature is divided by the maximum score in the interval scale (that is 9).

$v_j^+$  is the scaleless value of the  $j$ th feature for the ideal applicant (that equals  $\frac{9}{9} = 1$ )

$v_j^-$  is the scaleless value of the  $j$ th feature for the negative-ideal applicant (that equals  $\frac{1}{9}$ )

Calculate the similarity metric

The similarity metric between the new case (or query) and the old cases is computed on the basis of the closeness of the new case to the ideal applicant and the remoteness from the negative-ideal applicant as the following relation:

$$S = \frac{d_-}{d_- + d_+} \quad 0 \leq S \leq 1 \quad (3)$$

If  $S$  is equal to 1, the new case and the old case are completely identical and if  $s$  is equal to zero, they will be completely dissimilar. Meanwhile  $S_{L_i}$  is defined as an acceptance level for the  $i$ th case. If the similarity metric between an applicant(new case) and the  $i$ th job (old case)  $S_i$  is less than  $S_{L_i} - \alpha$ , therefore the job will not be suitable for the applicant. The applicants who have  $S_i$  almost equal to  $S_{L_i}$  ( $S_{L_i} - \alpha < S < S_{L_i} + \alpha$ ), are qualified for occupying the job. Finally, those who have  $S_i$

greater than  $S_{L_i} + \alpha$ , are overqualified for the job(as shown in figure 4).

The values of  $S_{L_i}$  and  $\alpha$ , in the figure 4, can be determined for the  $i$ th job by organizational experts and managers. Consequently, the CBR system for intelligent job consultation operates as:

- 1) The underqualified and overqualified applicants ( $S < S_{L_i} - \alpha$  or  $S > S_{L_i} + \alpha$ ) are not suitable for occupying the job.
- 2) The qualified applicants ( $S_{L_i} - \alpha < S < S_{L_i} + \alpha$ ) can be worthy for employment in the job.
- 3) Among the qualified applicants those who have the greater value of  $S$  are more suitable for the job.

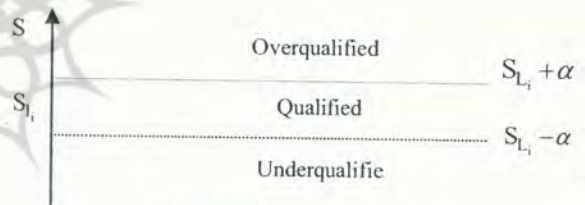


Figure 4. Interpretation of the S Value

### Other Issues

If the organizational jobs are increased, the new jobs, which are not similar to the old jobs, can be inserted in the case base of the CBR system.

The CBR system suggests a list of solutions and managers select a preferred solution. For example decision makers choose a job among the suggested jobs for an applicant. This property can be considered as adaptation in the system.

Learning in the CBR system occurs in two states. The first is to increase new jobs in the

case base and the second is to change features and their weights for the improvement of the system performance.

For measurement of the applicant's features, methods such as psychological tests, interviewing, work sampling and so forth can be used (Torrington & Hall, 1998).

### Implementing the Model in an Iranian Organization

The above described model has been implemented in an Iranian organization as a case study. This organization consists of nearly 200 jobs in lines such as official, managerial, technical, research and etc. After analyzing the organizational jobs, Microsoft Office Access tool is used for creation of case base. Each case shows an organizational job which is demonstrated by a table as mentioned previously. We use an object-oriented software tool such as DELPHI for implementation of whole system along with Access.

For evaluation of the system validity the following stages is accomplished:

- a. First, some employees with high or poor quality performance (for example 30 jobholders) are selected randomly.
- b. The job performance of the chosen employees are assessed through interviewing their managers and some of colleagues (performance appraisal).
- b. Characteristics of the chosen people are applied to the intelligent consultation system.
- c. The system recommends the best jobs for them.
- d. Comparison between recommended jobs and the results of performance appraisal determines the system validity as follows:

If the score of performance appraisal of an employee is good or excellent, his/her current job

should be recommended by the system.

If the score of performance appraisal of an employee is poor or less, his/her current job shouldn't be recommended by the system.

By using the above method, in considered organization, we found a high validity about 80 percent for the intelligent consultation system.

### Conclusions

Today, artificial intelligence is used in science, engineering, business, manufacturing, management and many other fields. To many managers decision-making about selection of the suitable job for an applicant is a difficult and complex problem. This paper shows the application of Case-Based Reasoning as an artificial intelligence technique for solving such problems. This research work demonstrates that the CBR system has some benefits such as rapid response, rapid knowledge acquisition, ease of knowledge acquisition, learning, ease of explanation, cost benefit to develop and so forth.

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