

A Hybrid System for Selection of the Software Packages

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Abstract

This paper presents a hybrid system that integrates rule-based reasoning and case-based reasoning for selection of the software packages. Rule-based reasoning is used to store knowledge about software evaluation criteria and guide user to capture requirements of the desired software package. Case-based reasoning is used to retrieve ranked set of most similar packages that match requirements of the desired software package. Software packages to be evaluated are stored as cases in the system. We have discussed this approach with an illustrative example.

Key Words – Software evaluation, case-based reasoning, expert system

1. Introduction

Decision making in the field of software selection has become more complex due to availability of large number of software products in the market, ongoing improvements in information technology, incompatibilities between various hardware and software systems, lack of technical knowledge and experience for software selection decision making [12]. The task of software selection is often assigned under schedule pressure and evaluators are often first timers at the task. They may not use the most appropriate methods in the selection process [10].

Software selection can be formulated as Multiple Criteria Decision Making (MCDM) problem. MCDM

refers to making preference decisions over the available alternatives that are characterized by multiple usually conflicting attributes [26]. The goal of the MCDM is i) to help decision makers to choose the best alternative of those studied, ii) to help sort out alternatives that seem good among the set of alternatives studied, and iii) to help rank the alternatives in decreasing order of the performance [15].

Knowledge based system (KBS) are computer based information systems that represent the knowledge of experts, and manipulate the expertise to solve problems at an expert's level of performance. Case based reasoning (CBR) and Rule Based Reasoning (RBR) are two fundamental and complementary reasoning methods in the KBS. KBS has potential to play significant role in software selection decision making process [7, 24].

2. Related work

AHP technique has been widely used for evaluation and selection of the software packages. Other techniques discussed in the literature for software selection are weighted scoring method, and fuzzy based approach. Table 1 gives summary of major literature reviewed for selection of the software packages. Each technique has its own advantages and disadvantages. Here we attempt to analyze strength and weaknesses of these techniques.

Table 1. A summary of the literature reviewed for evaluation of the software packages

Sr. No	Author(s)	Type of the software system	Evaluation technique/Framework
1	Zahedi [27]	Database management system	AHP
2	Toshtzar [23]	Computer software	AHP
3	Kim and Yoon [9]	Expert system shell	AHP

4	Mohanty and Venkataraman [13]	Automated manufacturing system	AHP
5	Davis and Williams [6]	Manufacturing simulation software	AHP
6	Kontio et al. [10]	Reusable component	AHP
7	Kim and Moon [8]	Workflow management system	AHP
8	Shtub et al. [20]	Operations Management Software	AHP
9	Lai et al. [11]	Multimedia authoring system	AHP
10	Collier et al. [4]	Data mining software	Weighted scoring method
11	Ossadnik and Lange [17]	AHP software	AHP
12	Teltumbde [22]	ERP	AHP and nominal group technique
13	Morera [14]	COTS	DESMET and AHP Methodology
14	Bozdog et al. [2]	Computer integrated manufacturing system	Fuzzy multi-attribute group decision-making method
15	Phillips-Wren et al. [18]	Decision support system	AHP
16	Sarkis and Talluri [19]	e-commerce software and communication systems for a supply chain	AHP and Goal programming model
17	Colombo and Francalanci [5]	CRM Packages	AHP
18	Ngai and Chan [16]	Knowledge management tools	AHP
19	Cochran and Chen [3]	Object oriented simulation software	Fuzzy-based approach
20	Wei et al. [25]	ERP system	AHP
21	Lin et al. [12]	Data warehouse system	Fuzzy based approach

Analytic Hierarchy Process

Strengths:

- AHP enables decision makers to structure a decision making problem into a hierarchy, helping them to understand and simplify the problem.
- It is flexible and powerful tool for handling both qualitative and quantitative multi-criteria problems.
- AHP procedures are applicable to individual and group decision making.

Weaknesses:

- AHP is time consuming because of the mathematical calculations and number of pair wise comparisons that increases as the number of alternatives and criteria increases.
- The decision makers need to re-evaluate alternatives when the number of criteria or alternative's are changed.
- Ranking of alternatives depends on the alternatives considered for evaluation hence adding or deleting alternatives can lead to changes in the final rank.

Weighted Average Sum (WAS)

Strengths:

- Main advantage of WAS is its ease of use.

Weaknesses:

- Weights to the attribute are assigned arbitrary and it is very difficult to assign weight when number of criteria is high.
- To obtain score in this method common numerical scaling is required and Difficulty with this method emerges when it is applied to multi-dimensional MCDM problem.

Fuzzy based approach

Strengths:

- The decision makers can use linguistic terms to evaluate alternatives easily and intuitively
- It improves decision making procedure by accommodating the vagueness and ambiguity occurred during human decision making.

Weaknesses:

- Difficult to compute fuzzy appropriateness index values and ranking values for all alternatives.

All these techniques help to rank the available software packages and choose the best one with the highest score but lacks in describing how well each software package meets requirements of the organization. CBR system has capability to describe how well each candidate package meets requirements of the desired software package.

3. Hybrid system for evaluation of the software packages

In this paper we propose hybrid approach which integrates rule based and case based reasoning technique for selection of the software packages. So far this kind of approach for selection of the software packages is not discussed in the reviewed literature.

Rule based system, a deductive reasoning approach, is reasoning system which mimics problem solving behavior of the human experts. The knowledge base of rule-based system comprises the knowledge that is specific to the domain of application. It is appropriate for problem solving tasks that are well constructed. However it does not make substantial use of the knowledge embedded in previous cases. Case based reasoning, an inductive reasoning approach, is problem solving approach that solves problem by adapting solution of more similar case that has been solved in the past. A new problem is matched against cases in the case base using indexing method with one or more similar cases being retrieved. Solution suggested by matching cases is then reused and tested for success [1]. At this stage, if the best retrieved case is a perfect match then the system has achieved its goal and finishes. Integration of rule based and case based reasoning approach eliminates the drawbacks of pure inductive reasoning and pure deductive reasoning and solves problem in more intelligent way.

We have developed system for selection of the software packages using hybrid approach. Rule-base of the system consists of knowledge about the software evaluation criteria. These criteria are broadly categorized into functionality, vendor capability, cost and benefits, and quality of the software package. Rule based system is used to 1) guide user to select the criteria which he/she want to consider for evaluation of the software packages, and 2) capture requirements of the desired software package.

Requirements of the desired software package are captured using well defined set of evaluation criteria (features) with each criterion (feature) associated with well defined space of criterion values. Once requirements of the desired software package are captured from the user, these are submitted to the CBR system.

Case based reasoning technique is used to 1) compare requirements of the desired software package with the description of the candidate software packages stored as cases in the case-base of the system 2) retrieve ranked set most similar software packages in descending order of the similarity score. Figure 1 describes how CBR can be used for selection of the software packages. Software packages to be evaluated

are stored as cases in the case-base of the system. Case-base is made up of detailed descriptions of individual candidate software packages to be evaluated. Each software package is described using set of well defined features and feature values. Features used to describe software packages have the same vocabulary as that of criteria used for evaluation of the software packages. When user submits requirements of the software package, CBR returns ranked set of most similar software packages in descending order of the similarity score. Similarity score represents how well each candidate software package meets requirements of the desired software package.

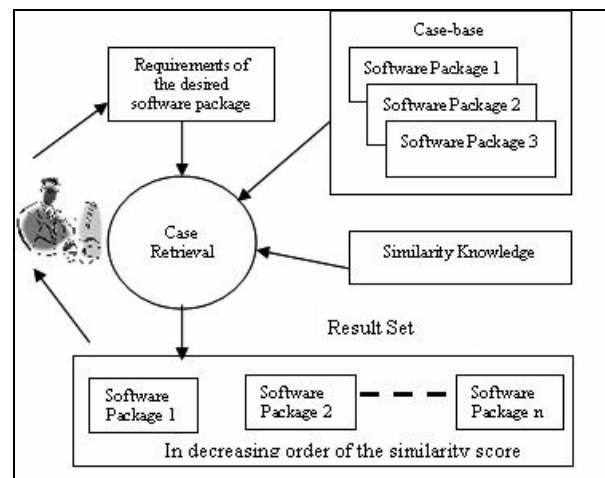


Figure 1. CBR for software evaluation

4. An example of hybrid system

We have developed system for selection of the accounting software package using an enterprise intelligent system development and solution framework described by Sonar [21]. The solution framework supports to develop, deploy and run web based applications and decision support systems backed by integrated architecture of rule-based reasoning, case-based reasoning, neural network and genetic algorithms. We have used only rule-based and case-based reasoning component of the solution framework for development of the hybrid system for selection of the accounting software packages.

4.1. Rule-based reasoning

Rule-based reasoning is used to guide user to select evaluation criteria, and capture requirements of the accounting software package. An example of how system guide user to suggest technical evaluation criteria and capture technical requirements of the

desired software package is illustrated in the Figure 2 and Figure 3 respectively. Rules in the system are written in the simple IF...THEN...ELSE format. An example of one of the rules written to suggest technical evaluation criteria and capture technical requirements of the software package is given below.

Rule No=6[94] ID=SoftwareSelection.Hardware And Software
 IF SoftwareSelection.MainTask IS Software Evaluation

AND SoftwareSelection.MainCriteriaCategory INCLUDES ANY OF [Other]
 AND SoftwareSelection.OtherCommonCriteria INCLUDES ANY OF [Hardware and Software]
 AND ASK(SoftwareSelection.TechnicalCriteria) AND
 ASK(SoftwareSelection.ShowForm_TechnicalCriteria) THEN SoftwareSelection.Final_Goal IS Hardware and Software Criteria

Figure 2. Interface to guide user to select technical criteria

Figure 3. Interface to capture technical requirements of the software package

4.2. Case-based reasoning

Accounting software packages to be evaluated are stored as cases in case-base of the system. Each case in the case-base is described using well defined set of features (i.e. evaluation criteria) and feature value. We have used MS-Access database system to store the cases. Advantages of using database management system for storing cases are as follows.

- It is very easy to add new cases and manage the cases.
- There is no need of separate indexing mechanism for CBR.
- Data security and integrity is assured.
- Same database can also be used for other applications.

In CBR case schema is collection of case features such as key, index, solution and output. We have defined case schema for 1) Quality criteria category- which includes quality features of the software package, 2) Vendor criteria category- which includes features related to the vendor of the software package, 3) Functional criteria category- which includes features related to the functionality of the software package, and 4) Other criteria category- which includes features related to the cost and benefits, technical requirements, and opinion of the people about the software package.

Assessing similarity at the case level involves combining the individual feature level similarities for the relevant features. Formula used to calculate case similarity is given below.

$$\frac{\sum_{i=1}^n W_i * \text{sim}(f_s, f_t)}{\sum_{i=1}^n W_i}$$

Similarity between target query and candidate case is the weighted sum of the individual similarities between the corresponding features of the target query and candidate case. Each weight W_i encodes the relative importance of a particular feature in the similarity assessment process, and each individual feature similarity is calculated according to a similarity function defined for that feature, $\text{sim}(f_s, f_t)$.

4.3. Results of the system

Result set of the system consists of ranked set of most similar software packages as shown in Figure 4. Case matching column represent the similarity score for each candidate software package. Similarity score represents how well each candidate software package meets requirements of the desired software package. Similarity score for each criteria category is first calculated and then it is calculated for each case. Table 2 describes how system calculates similarity score for each case.

Table 2. Similarity calculations

Criteria Category	Similarity Score	Criteria Category Weight	Weighted Score
Functional	76.00	0.25	19.00
Quality	100.00	0.25	25.00
Vendor	91.67	0.25	22.91
Other	70.67	0.25	17.67
Total Score (Case Matching Score)			84.58

EXPERT'S RECOMMENDATION						
Show Session Report Continue Session Restart Show All Outputs Save output on PC Show Closely Matching Information View Information						
Vendor List- Click on Vendor ID to see more detail						
Results from: 1 to 10 (Total: 26)						
VendorID	VendorName	Vendor Criteria	Quality Criteria	Other Common Criteria	Functional Criteria	Case Matching
27	Vendor 27	91.67	100.00	70.67	76.00	84.58%
4	Vendor 4	95.00	92.80	85.67	60.00	83.37%
13	Vendor 13	85.00	82.36	83.21	74.50	81.27%
17	Vendor 17	92.50	77.16	83.22	69.50	80.59%
15	Vendor 15	95.83	74.36	80.13	71.50	80.45%
23	Vendor 23	97.50	85.80	76.51	59.50	79.83%
20	Vendor 20	87.50	78.96	79.82	71.00	79.32%
5	Vendor 5	77.50	75.36	89.04	75.00	79.22%
16	Vendor 16	90.00	75.40	85.02	63.00	78.36%
22	Vendor 22	87.50	81.96	71.82	69.00	77.57%

Figure 4. System Result - most similar cases with similarity score

5. Conclusion

In this paper we proposed integrated rule-based and case-based reasoning system for selection of the software packages. The system assists decision makers not only in evaluation and selection of the software packages but also to specify requirements of the desired software package using well defined set of evaluation criteria and criterion values. Result set of the system present ranked set of software packages according to similarity score. Similarity score represents how well each candidate software package meets requirements of the desired software package.

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