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Artificial Intelligence(AI) application in Library Systems in Iran: A taxonomy study

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Artificial Intelligence(AI) application
in Library Systems in Iran: A taxonomy study

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Abstract: With introducing and developing AI logic, this science as a branch of computer science could impact and improve all sciences which used computer systems. LIS also could get benefit from AI in many areas. This paper survey applications of AI in library and information science and introduce the potential of library system to apply AI techniques. Intelligent systems have contributed for many librarian purposes like cataloging, indexing, information retrieval, reference, and other purposes. We applied Exploratory Factor Analysis (EFA) as a primer method for identification of the most applicable AI techniques categories in LIS. ESs are the most usable intelligent system in LIS which mimic librarian expert's behaviors to support decision and management. AI also can utilize in many areas such as speech recognition, machine translation and librarian robots. In this study four criteria for the application of AI in the library systems in Iran was considered and it is determined in three area included public services, technical services, and management services. Then, degree of development these services was studied using taxonomy method. The results showed that most developed Recommender Systems (RM) in library systems in Iran and Natural Language Processing (NLP) is the most undeveloped criterion.

Index terms: Artificial Intelligence (AI), Expert System (ES), Recommender Systems (RM), Natural Language Processing (NLP), Data Mining (DM), Library System, Exploratory Factor Analysis (EFA).

I. INTRODUCTION

AI is the area of computer science focusing on creating machines that can engage on behaviors that humans consider intelligent. AI involves following areas of researches: (1) expert system, (2) fuzzy logic, (3) artificial neural network, (4) evolutionary algorithms, (5) case base reasoning, (6) image processing, (7) natural language processing, (8) speech recognition and (9) robotic. These areas are not separate and in many intelligent systems at the same time two or more AI techniques are contributed to solve problem. AI techniques or tools has utilized in many areas such business, management, medicine, military and etc. Also has developed in using intelligent systems. The Ideas of utilization intelligent system instead of classic system in libraries started from 1990. Intelligent library systems utilize AI technologies to provide knowledge-based services to library patrons and staff AI is a broad, complex area of study, which can be difficult for non-specialists to understand. Yet, its ultimate promise is to create computer systems that rival human intelligence, and this clearly has major implications for librarianship. Different studies are

about AI applications in library system such as: descriptive cataloging, technical services, collection development, subject indexing, reference services, database searching, and document delivery. Some papers deal with the underlying design issues of knowledge representation and natural language processing. Many authors have previously provided in-depth overviews of AI technologies. There have also been several reviews of research and development efforts relevant to librarianship based on a review of major models of human intelligence. It is concluded that the following ten factors are most pertinent to ES research: acquisition, automatization, comprehension, memory management, met control, numeric ability, reasoning, social competence, verbal perception, and visual perception [1].

Today with the advent of the computer and 50 years of research into AI programming techniques, the dream of smart libraries is becoming a reality. Researchers are creating systems which can mimic librarian thought and behavior which never before was possible. The Basic problem in this research was the state of library development in the use of AI in the field of public services, technical services, and management services in Iran. Therefore, the qualitative development of these three activities in use of AI were studied based on four criteria. The practical criteria or factors are identified through factor analysis method. The practical criteria included the use of expert systems / knowledge systems, intelligent decision support systems / recommender systems, intelligent data mining, and intelligent natural language processing systems is a library system. Accordingly, the development of these facilities were studied with using taxonomy method in three areas of public service, technical services, and management services according to experts views in Iran.

II.   ARTIFICIAL INTELLIGENCE (AI)

AI is the science and engineering of making intelligent machines, especially intelligent computer programs. It is Concerned with the study and creation of computer systems that exhibit some form of intelligence: system that learn new concepts and tasks, systems that can reason and draw useful conclusions about the world around us, systems that can understand a natural language or perceive and comprehend a visual scene, and systems that perform other types of feat that require human types of Intelligence [2].

It is the Application of Computer and utilization of computer based products and services in the performance of different library operations and functions or in the prevision of various services and production of output products. Automation implies degree of mechanization where the routines and receptive jobs or operation are left to be performed by machines with little or no intervention by human beings. Lesser the degree of human intervention, greater the degree of automation this does not mean that automation does away with human beings. On the contrary human being sari relieved of routine chores giving them more time for task which require their intelligence.

III.   INTELLIGENT SYSTEM (IS)

Any Computer-based that helps in the task of subject indexing can be thought of as an ES at least in the loosest sense of that term, especially if it helps ales experienced person to approximate the work of an expert indexer and systems that suggest term to indexers, or correct certain indexer errors, can be

considered to offer at least a modicum of "intelligence" [4]. One of the clearest statement relating to the scope of AI is the following:

… Computer programs have been developed which exhibit human- like reasoning, which may be able to learn from their mistakes, and which quickly and cleverly perform tasks normally done by scarce and expensive human experts [4].

IV. EXPERT SYTEMS (ESs)

ESs are computer based systems witch simulate human decision makings. In general they ask question from user and take user's answer as input then explain rational for decision result.

Building an ES first involves extracting the relevant knowledge from the human expert such knowledge is often heuristic in nature. ESs have been used to solve a wide range of problems in domains such as medicine, mathematics, engineering, geology, computer science, business, law, defiance, education, etc [2]. Some of the requirements to development of an ESs are included: Expert on the problem exist; Experts have the time to dedicate to the project Export system development is possible; Experts can articulate their methods; Problem is not too difficult; Problem is not poorly understood; Problem requires Cognitive Skills only; and results are measurable and can be agreed upon by the experts [4].

V. APPLICATION IS / AI / ES IN THE LIBRARY SYSTEM

ESs consist of two main elements: knowledge base and inference engine. Knowledge base is involving all information needed which human/librarian experts are using them to make decision. This information present in knowledge base as fact and rules. ESs can make much better decision than librarian decision makers because their knowledge base can involve experiences of team of best experts. To design rules of knowledge base, the manner of librarian experts to make decision is emulated. The rules are consisting two main phases: If phase and then phase. If phase is consisting conditions and then phase is consisting results. The only thing which distinguishes ESs from other computer systems is inference engine. The inference engine simulates human decision makings based on knowledge base and rule base.

An obvious potential application of ES within libraries is for the selection of book sellers or other vendor of library materials carried to its logical conclusion, a system might be developed to select a vendor automate ethical based on past performance in the supply of publications of a particular type such a capability would be especially valuable in the acquisition of material that are less routine-conference proceeding. Certain technical report, publications in certain languages, publications from certain countries, and soon [3].

Other ESs, designed to help library user satisfy their own needs, have also include document- orders aid. Systems have also been designed within the library community to aid in the selection process, systems of this type have been discussed by some of the researchers.

The term "referral system", as used here, relates to systems that & are designed to refer library users to information sources likely to provide the answer to a particular question of the factual of "information"

type within the library community more work has been done on system of this kind than on any other ES. The objective of such systems is obvious: to guide library users to a reference suitable source when a librarians not available to help them form reference referral system cover knowledge as a whole in the coverage of a general reference library while other are restricted to highly specialized domain [3]. The librarian robot consists of a manipulator, which can recognize and manipulate books, and a mobile platform, which can localize itself and navigate using ambient RFID tags embedded in a floor. AI techniques such genetic algorithm, artificial neural network, fuzzy logic or hybrid methods can improve librarian robots. For example JT2FIS is a Java Class Library for Interval Type-2 Fuzzy Inference Systems that can be used to build intelligent object-oriented applications. The architecture of the system is presented and its object-oriented design is described [11]. It is mentioned that AI is a branch of Science, which deals with helping machines, finds solutions to complex problems in a more human-like fashion, this generally involves borrowing characteristics from human intelligence and applying them as algorithms in a computer friendly way. It can use for NLP and help to search relevant information from databases, indexing and to reduce language barrier. In information retrieval process the user can state his information requirement in natural language making the searching more easily and fruitful this allows users to state complex retrieval languages [2].

Many activities in the provision of library and information services involve expertise, and thus provide application where ES techniques and technology to improve performance. We are using integrated MCDM techniques in different applications [13]. Analysis of the literature on the applications of ESs in LIS yields the application areas: Knowledge base indexing [5]; NLP and abstracting [6]; Reference work [7]; Cataloguing [7]; Online information retrieval [8] and [2]; Intelligent interface, in particular interfaces for online information retrieval systems; Subject analysis and representation, including classification, indexing and abstracting service; Reference and referral systems; Hypertext and hypermedia; and Collection development [2]. In view of the various features of a modern computer system we find that it has been applied in several areas: acquisition, cataloguing, serials control and circulation, information retrieval, and dissemination, inter library loan, cooperative acquisition and cataloguing have been automated in library [3]. For example OSCAL is an online library that helps students trying to learn operating system concepts and AICAL is a similar online library with Artificial Intelligence concepts. Both these libraries offer graphical animations of operating system and artificial intelligence concepts [9].

Also, the concept of digital library is utilizing science ES in the process of cataloging and searching digital collections. By using this digital library based of ES, users can search the collection, reading collection, and download the desired collection by online system [10]. We can use system of intelligent library retrieval based on data mining. Also DM can use in on-line library system and help to find user's information needs. Today, RM have extend applications in the library systems. They help to end user to select suitable keyword/ phrase in information retrieval. Different studies are on the user-centered design of a recommender system for library catalogue and other divisions of the library system.

VI. METHODOLOGY

In general, numerical taxonomy analysis is a great method to grading, classification, and comparison of different activities according to the benefit and enjoyment of the activities based on the considered criteria. The ability of this method, it is able to do the two works together. The first, it can divided the evaluated sets based on the criteria presented into homogeneous subsets. The second, it can to grade the elements and members of each homogeneous subset.

In this research we used of Taxonomy Method to examine amount of development the library systems in Iran in three area: 1. Public Services (PS), 2. Technical Services (TS), and 3. Management Services (MS). Previous studies mentioned various AI techniques to address the above areas. Some of the mentioned techniques in literature had different names with the same application in LISs. Therefore, we applied Exploratory Factor Analysis (EFA) (Osborne and Costello, 2009) to group the techniques with same application. EFA is a statistical method that shows the variability of observed, correlated variables in terms of potential groups of variables called factors. For example, it is possible that variations in four observed variables mainly reflect the variations in two groups of variables. EFA searches for such relate variations to join them as group of variables. Here EFA is used to identify complex interrelationships among AI techniques and group them that are part of unified applications in LIS. Finaly four groups of AI techniques were identified as criteria for assessment in numerical taxonomy analysis method. The criteria (identified AI technique groups) included: A1. Expert systems / knowledge systems (ES), A2. Intelligent decision support systems / recommender systems (RS), A3. Intelligent data mining (DM), and A4. Intelligent natural language processing systems (NLP). Figure 3 show the Asemi's model for library system development assessment in using AI.
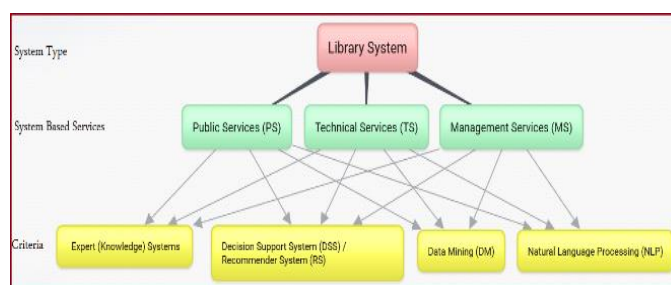

Figure 3. Asemi's Library System Development Assessment Model in using AI

The researchers used of nine degree scale to receive experts view.

Strongly Disagree	Disagree	Moderately Disagree	Mildly Disagree	Undecided	Mildly Agree	Moderately Agree	Agree	Strongly Agree
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

During a web-survey, collected experts' viewpoints about their agreements amount with development of use of AI in the three areas mentioned based on four criteria. In the following are presented the findings based on the taxonomy steps.

VII.   FINDING

a. *Data matrix*

The options matrix in rows and columns are criteria. Table 1 and 2 respectively show the type of metrics and data matrix.

Table 1. Type of the indices

	PS	TS	MS
Indices type	+	+	+

Table 2. Data Matrix

	PS	TS	MS
ES	3	9	9
RS	8	7	8
DM	9	4	8
NLP	8	6	3

b. *The standard matrix (synchronize data using formula Z- Score)*

The quantities given in the table is measured by different units. In this case, each of the above matrix elements change by the following equation and data matrix convert to standard matrix. Thus different units remove and replace with the scale unit. Table 3 show the standard matrix.

$$Z_{ij} = \frac{X_{ij} - X_{oj}}{sd_j}$$

i= option   j=criterion

X_{oj}= criterion average j sd_j=Standard Deviation j

Table 3. Standard Matrix

	PS	TS	MS
ES	-1.477	1.201	0.739
RS	0.369	0.24	0.369
DM	0.739	-1.201	0.369
NLP	0.369	-0.24	-1.477

c. *Calculate and determine the compound distances between places*

Compound distances between places within a symmetric matrix obtained by the following formula:

$$d_{ab} = \sqrt{\sum_{i=1}^{m} (z_{aj} - z_{bj})^2}$$

a represents first choice option *b* Represents the second choice option to calculate the distance. Based on the above formula, between the pair options should calculate combined distance. For example, we would calculate combined distance between option 1 and option 2. For this purpose, the criterion value for option 1 subtract from the criterion value for option 2 then the answer to be power of 2. For the other criteria do the same thing and in the end, sum the collected values for all criteria. Next, we take the square root from the answers obtained (Table 4).

Table 4. Commercial intervals

	ES	RS	DM	NLP

ES	-	2.114	3.289	3.224
RS	2.114	-	1.488	1.908
DM	3.289	1.488	-	2.114
NLP	3.224	1.908	2.114	-

d. The determination of shortest distances (dr) in each row of matrix symmetrical

At this stage based on the distances matrix, in each row, obtain the shortest distances. Table 5 show dr values.

Table 5. *dr* values

	shortest distance
ES	2.114
RS	1.488
DM	1.488
NLP	1.908

e. Calculate distances upper (+ O) and lower (-O) to clear homogeneous places

Options that indicate within the upper limit and lower limit are called homogeneous options. All of the options up and down under consideration are eliminated. The interval can be obtained from the following equation:

$Or = \overline{dr} \pm 2sd$ sd = Standard Deviation dr

$\overline{dr}$ = Average dr sd = Standard Deviation dr

The value of distance is: Lower: 1.122   Upper: 2.376

Accordingly, all options that are in this range are homogeneous and present calculations and other options will be removed. Homogeneous data Matrix is given in Table 6.

Table 6. Homogeneous data matrix[1]

	PS	TS	MS
ES	3	9	9
RS	8	7	8
DM	9	4	8
NLP	8	6	3

f. Standard matrix of homogeneous options

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[1] Note: If this matrix with initial data matrix are the same, it means that all options are homogeneous.

In this stage, we standardize (normalize) data matrix (table 7).

Table 7. The data matrix matched standard

	PS	TS	MS
ES	-1.477	1.201	0.739
RS	0.369	0.24	0.369
DM	0.739	-1.201	0.369
NLP	0.369	-0.24	-1.477

g. Determine the ideal values (D_{oj}) of the homogeneous data standard matrix

The ideal values are derived from homogeneous data standard matrix.

If the criterion is positive: the ideal value is the largest value of that criterion in homogeneous data standard matrix. If the criterion is negative: The ideal value is the smallest value of that criterion in homogeneous data standard matrix. The following table (8) show the ideal values.

Table 8. The ideal values

PS	TS	MS
0.739	1.201	0.739

h. Calculation of the model of development (C_{io})

Development model is obtained of the following equation. Table 9 show development model in this research.

$$C_{io} = \sqrt{\sum_{i=1}^{m} (z_{ij} - d_{oj})^2}$$

z_{ij} = Homogeneous data matrix d_{oj} = Ideal values

Table 9. Development Model

	C_{io}
ES	2.216
RS	1.094
DM	2.43
NLP	2.669

i. Calculate the degree of development (F_i)

At this stage of development degree of each option is calculated according to the following equation:

$$F_i = \frac{C_{io}}{CO} \qquad CO = \bar{C}_{io} + 2s_{io}$$

The following table show degree of development of each option and ranking of them. There is an inverse relationship between the degree of development and status of the options. It means that if value of the development is less, it is a better option.

Table 10. Ranking of Development

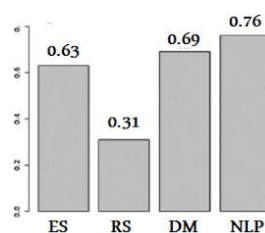|	fi	Ranking
ES	0.634	2
RS	0.313	1
DM	0.695	3
NLP	0.763	4

Figure 4 show the values table 10.

Figure 4. Degree of Development

CONCLUSION

In this paper, by determining the degree of underdevelopment, the AI application development were evaluated in varying sizes. In this study, the concepts of "development degree" and "underdevelopment rank" of an activity reflects the amount of use AI criteria/ facilities. These criteria called criteria of library systems development in use of AI. Thus, the activity (PS, TS, and MS) which had more use of the AI facilities (included ES, RS, DM, and NLP), in comparison than others, called "Developed Service". Also the activity that had lower among of these criteria and had more distance than to desirable activity, called "Undeveloped Service". Based on taxonomy method, the results showed that most developed Recommender Systems (RM) in library systems in Iran and Natural Language Processing (NLP) facility is the most undeveloped criterion.

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