

# Survey on Development of Expert System from 2010 to 2015

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## ABSTRACT

In this paper we survey development of Expert System by methodologies and applications from 2010 to 2015 through a literature review and classification papers as a basis. This paper surveys and classifies Expert System methodologies using four categories: Intelligent agents, modeling, Ontology and System architecture with their applications for different research and problem domains. Additionally discussion was presented, and from this discussion we provided some suggestion that should be taken into consideration in the future regarding to the development of Expert Systems in methodologies and applications: first, Expert Systems methodologies are destined to develop by using expertise of Expert System applications in the domain. Secondly, the different social science methodologies should be including also to give more opportunity for explores the methodologies and applications. Thirdly, the ability to continually change and get new understanding is the driving power of Expert System methodologies, and should be the Expert Systems application of future works.

## Keywords

Expert systems; Expert system methodologies; Expert system applications; Literature survey

## 1. INTRODUCTION

Expert system is computer software had been designed for Simulates human expert in acts and activates, by the system's capability to find new facts from available facts and render advice, to teach and execute intelligent tasks [1]. The development environment includes the activities and support that are necessary to acquire and represent the knowledge as well as to make inferences and provide explanations. The major players in this environment are the knowledge engineer and the domain expert who act as builders. Once the system is completed it is used for consultation by the non-expert user via the consultation environment [2].

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The part of expert system that considered as brain is the inference engine that provides the ways for reasoning about information in the knowledge base. Inference can be performed using semantics networks, production rules, and logic statement. In this research we surveys the development of Expert System in methodologies and applications from 2010 to 2015 through a literature review and classification of articles as a basis, we already made exploring on the Expert System by methodologies and applications during that period. We start working on This literature survey in April 2015 and it was based on a search in the keyword index and article abstract for 'Expert System'. After we had the nomination process, there were 80 articles from 67 journals related to the keyword 'Expert System applications', 65 of which were connected to the methodology of keyword 'ES methodology'. Based on the scope of 80 articles on Expert System applications, this paper surveys and classifies Expert System methodologies using four categories: Intelligent agents, modeling, Ontology and System architecture with their applications for different research and problem domains. This paper is continues of my other paper which published in November 2015. Sections of this survey are arranged as follows. Sections 2–5 present the survey results of ES methodologies and applications based on the above categories, respectively. Section 6 presents some discussion, Limitations and suggestions for future development of Expert System methodologies and applications. The last Section 7 contains a conclusion.

## 2. INTELLIGENT AGENTS AND THEIR APPLICATION

Intelligent agents are computer program that it will be stay working but in background up to some event will happen by user. An intelligent agent performs an action such as sounding an alarm or displaying a reminder at a certain time or date. In the field of artificial intelligence, it is an independent entity which will monitor by sensors and acts according to an environment to direct the activities to achieve the destination. It can be learn something from practice or it can be use the knowledge to achieve their destination. The Intelligent agents can be simple and can be very complex. An intelligent agent also will gather information without your instant presence and on some regular schedule on the internet. The applications of rule base system on ESs are including: Agent [3], training driver candidates [4], Micro Context-Aware Agents [5], Managing web 2.0 services [6], GAIA: A CAD Environment [7], Antagonistic Intelligent Agents [8], simulation [9], Analysis [10], Intra-agent explanation [11], Repair and maintenance [12], Monitoring system [13], Healthcare Interoperability [14], Supporting [15], Maintenance and Repair [16], Simulation /Evaluation [17], Control Law Merging [18], privacy [19], Automatic Blocking System [20] and Detect Tabnabbing Attack [21] See Table1.

**Table1. Intelligent agent's application**

Intelligent agents /application	Author Name	Country	Year
Agent	K. Centarowicz, M. Paszyński, D. Pardo, T. Bosse, and H. La Poutre	Poland	2010
training driver candidates	A. Çavuşoğlu and I. Kurnaz	Türkiye	2011
Micro Context-Aware Agents	P. Roy, B. Abdulrazak, and Y. Belala	Canada	2011
Managing web 2.0 services	C. F. Lin, Y. Yeh, Y. H. Hung, and R. I. Chang	Taiwan	2012
GAIA: A CAD Environment	S. Rugaber, A. Goel, and L. Martie	USA	2013
Antagonistic Intelligent Agents	J. Da Rosa, M. T. De Souza, L. D. O. Rech, L. Q. Magnabosco, and L. C. Lung	Brazil	2013
simulation	P. C. Tissera, A. Castro, a. M. Printista, and E. Luque	Argentina	2013
Analysis	A. Ghosh, J. W. Tweedale, and A. Nafalski	Australia	2013
Intra-agent explanation	A. H. Sbaï, W. L. Chaari, and K. Ghédira	Tunisia	2013
Repair and maintenance	M. V. Denisov, V. a. Kamaev, and a. V. Kizim	Russia	2013
Monitoring system	a. Meera and S. Swamynathan	India	2013
Healthcare Interoperability	L. Cardoso, F. Marins, F. Portela, A. Abelha, and J. Machado	Portugal	2014
Supporting	a. V. Kizim, M. V. Denisov, S. V. Davydova, and V. a. Kamaev	Russia	2014
Maintenance and Repair	V. V. Panteleev, V. a. Kamaev, and a. V. Kizim,	Russia	2014
Simulation and Evaluation	D. V. Voloshin, K. a. Puzyreva, and V. a. Karbovskii	Russia	2014
Control Law Merging	B. Dafflon, J. Vilca, F. Gechter, and L. Adouane	France,	2015
privacy	C. Dhasarathan, S. Dananjayan, R. Dayalan, V. Thirumal, and D. Ponnurangam	India	2015
Automatic Blocking System	R. I. Rajkumar, P. E. Sankaranarayanan, and G. Sundari	India	2015
Detect Tabnabbing Attack	S. Sarika and V. Paul	India	2015

### 3. Modeling and their application

Modeling methodology turns into a multidisciplinary methodology of expert system in order to construct official relations with logical model design in different knowledge/problem domains. Additionally, modeling technology can certainly supply quantitative methods to evaluate data to represent or acquire expert knowledge with inductive logic programming or algorithms so that AI, mental science and other research sections may include broader platforms to apply technologies for expert system development. The applications of

Modeling on ESs are including: Modeling and Analyzing [22], Realizing [23], Simulation [24], Medical [25], Inverse design [26], Optimization [27], A holistic modeling [28], Simulation supporting [9], Linear Algebra [29], Software Intensive System [30], Management [31], Building Software [32], Autonomous system [33], Modeling and analysis [34], Bridging the Gap [35], Bus Movement [36], Dynamics Modeling [37], Analysing [38], Integrated local-scale [39], Simulation of Masticatory Muscles [40], PartiSim [41], Medical [42], electricity peak load [43], Granular system modeling [44] and CORAS [45] see table 2.

**Table2. Modeling application**

Modeling /application	Author Name	Country	Year
Modeling and Analyzing	I. Grabe, M. M. Jaghoori,	Germany	2010
Realizing	S. K. Das, S. N. Shome, S. Nandy, and D. Pal	INDIA	2010
Simulation	M. Xiong, M. Lees, W. Cai, S. Zhou, and M. Y. H. Low	Singapore	2010
Medical	B. Dantu and E. Smith	USA	2011
Inverse design	L. Leifsson, S. Koziel, and S. Ogurtsov	Iceland	2011
Optimization	C. Y. Lin, N. H. Kilicay-Ergin, and G. E. Okudan	Malvern	2011
A holistic modeling	R. Wang and C. H. Dagli	U.S.A	2012
Simulation supporting	P. C. Tissera, A. Castro, a. M. Printista, and E. Luque	Argentina	2013
Linear Algebra	J. Cámara, J. Cuenca, L. P. García, and D. Giménez	Spain	2013
Software Intensive System	M. Farah-Stapleton and M. Auguston	USA	2013
Management	A. Kukushkin and S. Zykov	Russia	2013
Building Software	K. Panitsidis, P. Lefakis, Z. Andreopoulou, and A. Kokkinakis,	Greece	2013
Autonomous system	R. M. Husar and J. Stracener	USA	2013
Modeling and analysis	P. Sivaprakasam, P. Hariharan, and S. Gowri	India	2014
Bridging the Gap	W. Böhm, S. Henkler, F. Houdek, A. Vogelsang, and T. Weyer	Germany	2014
Bus Movement	D. Reijsbergen, S. Gilmore, and J. Hillston	Scotland	2014
Dynamics Modeling	A. Bueno, L. T. Carreño, D. J. Delgado, and R. Llamasa-Villalba	Colombia	2014
Analysing	C. Martin and P. a. Vanrolleghem	Canada	2014
Integrated local-scale	E. Koomen, V. Diogo, J. Dekkers, and P. Rietveld	Netherlands	2015
Simulation of Masticatory Muscles	E. Garcia, M. M. Leal, and M. B. Villamil	Brazil	2015
PartiSim	A. a. Tako and K. Kotiadis	UK	2015
Medical	B. M. Boshkoska, T. Damij, F. Jelenc, and N. Damij	Slovenia	2015
electricity peak load	L. Ramirez Camargo, R. Zink, W. Dorner, and G. Stoeglehner	Germany	2015
Granular system modeling	W. Pedrycz	Canada	2015
CORAS	A. Larionovs, A. Teilans, and P. Grabusts	Latvia	2015

#### 4. Ontology and their application

Ontology is a system of words, which generally is used basically as a primary idea for stating the mission/field knowledge to be identified. These words are used basically as a communication basis between domain experts and knowledge engineers. Appropriately, a re-usable task/field model can be represented and a computer program code is made in that ontology for knowledge acquisition, re-use, heuristic learning. The applications of Ontology on ESs are including: Requirements

Engineering [46], Guiding Requirements Elicitation [47], Software Customization [48], Power grid reasoning expert system [49], Data Mining System [50], Repair and maintenance [12], MBSE [51], Adaptive e-Learning systems [52], Handicraft domain [53], Health [54], ontology evaluation [55], Design [56], Healthcare System [57], Image Retrieval [58], IT Support Service [59], Information Retrieval in Semantic Web [60], Reasoning [61], intelligent assistance robot [62] and Personalized Information Retrieval [63] see table 3.

**Table3. Ontology application**

Ontology /application	Author Name	Country	Year
Requirements Engineering	V. Castañeda, L. Ballejos, M. L. Caliusco, M. R. Galli		2010
Guiding Requirements Elicitation	I. Omoronyia, G. Sindre, T. Stålhane, S. Biffl, T. Moser, and W. Sunindyo	NORWAY	2010
Software Customization	X. Zhang	CANADA	2011
Power grid reasoning expert system	W. Deng, K. Du, W. Lin, J. Guo, F. Huang, and L. Huang,	CHINA	2012
Data Mining System	C. Djellali	CANADA	2013
Repair and maintenance	M. V. Denisov, V. a. Kamaev, and a. V. Kizim	RUSSIA	2013
MBSE	L. Petnga and M. Austin	ATLANTA,	2013
Adaptive e-Learning systems	B. Saleena and S. K. Srivatsa	INDIA	2014
Handicraft domain	R. Dhaouadi, A. Benmiled, and K. Ghédira	TUNISIA	2014
Health	D. Mendes, I. P. Rodrigues, C. F. Baeta, and C. Solano-Rodriguez	PORTUGAL	2014
ontology evaluation	D. Choukri	CANADA	2014
Design	M. Vigo, S. Bail, C. Jay, and R. Stevens	UK	2014
Healthcare System	Abinaya, V. Kumar, and Swathika	INDIA	2015
Image Retrieval	A. Khodaskar and S. Ladhake	INDIA	2015
IT Support Service	N. Shanavas and S. Asokan	INDIA	2015
Information Retrieval in Semantic Web	K. Balasubramaniam	INDIA	2015
Reasoning	A. H. Khan and I. Porres	FINLAND	2015
intelligent assistance robot	N. T. Djaid, N. Saadia, and A. Ramdane-Cherif	ALGERIA	2015
Personalized Information Retrieval	T. Helmy, A. Al-Nazer, S. Al-Bukhitan, and A. Iqbal	Saudi Arabia	2015

#### 5. SYSTEM ARCHITECTURE AND THEIR APPLICATION

System architecture of the expert systems are similar to the architectural drawing of the house. It provides users a universal suggestion of what the system is going to look like and how it is going to implement systems. The architecture shows the standard functionality of the system, the users' interfaces, system capabilities, system (data) flow, system management, DBMS, necessary process, and exact programming language, such as blackboard architecture, CommonKADS, etc. Once the system

architecture design and implementation are completed, users can change and manage system functions on the system architecture. The applications of System architecture on ESs are including: Combining [64], Medical [25], Cognition Evolutionary [65], utilize [66], modeling and simulation [67], Healthcare [68], Decision Making [69], Mobile [70], Medical [71], Service-Oriented Architectures [72], Analysis and design [73], Analysis and diagnosis [74], Dynamic Planning [75], Migration Planning [76], Design and Evolution [77], (DELS) [78], decision-support systems [79] and Document Anonymization[80] see table4.

**Table4. System architecture application**

System architecture /application	Author Name	Country	Year
Combining	F. Brosch, R. Gitzel, H. Kozirolek, and S. Krug	Germany	2010
Medical	B. Dantu and E. Smith	USA	2011
Cognition Evolutionary	F. Yang, C. Dagli, and W. Wang	China	2011
utilize	A. Bodenhamer	USA	2012
modeling and simulation	M. W. Schreiner and J. R. Wirthlin	US	2012
Healthcare	B. Yuan and J. Herbert	Ireland	2012
Decision Making	Z. M. Fang, D. DeLaurentis, and N. Davendralingam	USA	2013
Mobile	E. R. Sykes	Canada	2014
Medical	S. H. El-Sappagh and S. El-Masri	Saudi Arabia	2014
Service-Oriented Architectures	B. Śnieżyński	Poland	2014
Analysis and design	H. B. Christensen, K. M. Hansen, M. Kyng, and K. Manikas	Denmark	2014
Analysis and diagnosis	N. Gartiser, C. Zanni-merk, L. Boullosa, and A. Casali	France	2014
Dynamic Planning	Z. Fang and D. DeLaurentis	USA	2014
Migration Planning	V. Agievich and K. Skripkin	Russia	2014
Design and Evolution	C. Guariniello and D. DeLaurentis	USA	2014

(DELS)	T. Sprock and L. F. McGinnis	Georgia	2015
decision-support systems	B. Huijbrechts, M. Velikova, S. Michels, and R. Scheepens	Netherlands	2015
Document Anonymization	H. Vico and D. Calegari	Uruguay	2015

## 6. DISCUSSIONS, LIMITATIONS, AND SUGGESTIONS

The Discussions has been attended in our survey as well as describe of the limitations in the development and we get some suggestions about how development the expert systems as below:

### 6.1 Discussions

Expert System techniques and apps are a extensively classification of research issues on Expert System. Some of them are introduced as examples for discovering the ideas and solutions to certain Expert System problem domains. Which is the reason, methodologies and applications of Expert System are enticing greatly interest and endeavors, both the educative and practical. We are able to understand out of this literature review that Expert System methodologies and applications developments are diversity because of their authors' knowledge, and problem domains. This is why some authors can appear in the literature on various methodologies and applications. Further, some methodologies have common concepts, and kinds of methodology. Just for example: intelligent agents, or System architecture methodology. However a very little of the authors has been accomplish the task in several methodologies and applications of expert system. This shows that the path of development on methodology is varied too due to the author's research interests and capacity in the methodology and problem domain. This may refer to that the development of Expert System methodologies is Going towards experience orientation. Moreover, there is some applications have a high degree of nip up in different methodologies. Example of this methodologies applications, teaching, training, medical, Production planning, system design, system development, modeling, decision making, biomedical, robotic systems, ecological planning, agriculture planning are all topics for applications of different methodologies, and this will lead to development of Expert System. We has been discussed in this paper different paper from various categories, this categories are: Computer science, ecology, education, energy, engineering, entomology, environmental sciences, genetics, geochemistry, health care sciences, hematology, hydrology, materials, mathematics, mechanics, medical, military, operation research/management sciences, ontology, plant science, remote sensing, robotics, and water resources. The different between our work and other are: We do not include Expert System methodologies and applications that are not used to improve the systems in other fields. However, we could just like to find out more Expert System ways to development in methodologies and applications of different research fields see the graphical Analysis Figure 1.

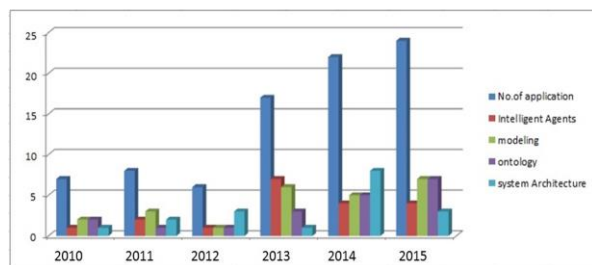


Figure 1 Graphical analysis results

### 6.2 Limitations

From our survey we get some limitations as follow:

- Most of the author has a limited knowledge about how to presenting all idea of the subject.
- The practical papers and reports are not included in this survey.
- Some papers have been publishing in non-English journals so they will not consider in this survey.

### 6.3 Suggestions

From our survey we get some suggestions as follow:

- Other methodologies like social science. In this paper, we definition the Expert System methodology but some methodologies didn't mention there, like the methodologies of social science, because it is not in our area and it need long time to read and understand. However, other methodologies such as qualitative questionnaires and statistical methods are another research that used to solve problems in social studies. Therefore, other social sciences methodologies may include in future work.
- Merging of methodologies. Expert System is multi specialization research topics. For this reason, future Expert System developments need implementation with different methodologies, and this Merging of methodologies.
- Change is a resource of development in Expert System over time. The change really should be depending on ideas in social science.

## 7. CONCLUSION

In this paper we make survey on development of Expert System from 2010 to 2015 by the methodologies and applications over a literature review and classification papers as a basis. Our survey dealt with four methods intelligent agents, modeling, ontology and System architecture according to their applications. In this survey we observed that Expert System methodologies and applications developments have inclination to develop according to authors' knowledge and expertise of Expert Systems applications in problem domain. So we should take into consideration that we can use other methodologies from other area such as social science to develop expert system. Therefore, other methodologies may include in future work. Also we suggest to merging methodologies of different area because Expert System is multi specialization research topics. Moreover, changing the resource of development of Expert System in future, because that change will offer more chance to the scientists to develop the expert systems.

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