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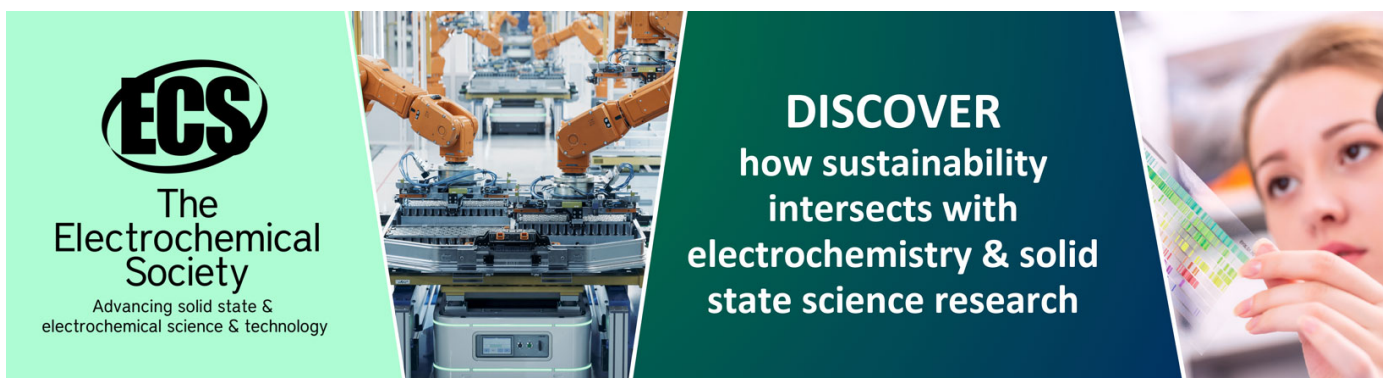
Expert system building tools based on dynamically updated knowledge

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Expert system building tools based on dynamically updated knowledge

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Abstract. The paper presents a developed software tool that includes software systems Prolog, JavaScript, Python, as well as database management systems PostgreSQL and MySQL. With the help of the created integrated development environment, experimental versions of specialized expert systems in the field of education and health care were developed. In the field of education, a prototype of an expert system focused on the support of the discipline “development and analysis of requirements for the creation of a software product” was created. This prototype of the expert system should provide an opportunity for students to build various software systems based on the formulated requirements and rules from the knowledge base of the expert system, taking into account the specifics of the relevant subject areas. In the field of health care, a prototype of an expert system focused on supporting the processes of vaccination of patients has been created. The knowledge base of the expert system includes clinical characteristics of patients, as well as a set of rules governing the decision - making processes for vaccines.

1. Introduction

Recently, CASE-tools [2], providing automation of design, development and implementation of various software applications, have become widely popular. CASE-tools can significantly reduce the complexity of software development and improve their quality [1]. Especially important is the use of CASE-tools to build intelligent systems such as expert systems.

In the framework of the scientific research were used methods and techniques in the field of artificial intelligence, expert systems[3, 4], systems of support of decision-making, development and analysis of requirements for software products, which are presented in scientific works of scientists: G. S. Osipova, V. N. Vagina, I. B. Fominykh, M. R. Romanov, A. N. Shvetsov, D. V. Alexandrov, M. D. Shapot, V. E. Wolfengagen, M. R. Quillian, S. L. Goldstein, N. Nilsson, M. Simon, and others.

Software tools based on the development of expert systems [5], have been rapidly spread in modern IT technologies. Modern software tools for organizing the construction of expert systems, significantly increase the efficiency of the use of computer technology in various fields of human activity (health, education, economics, law, etc.), namely by expanding them to new solutions and tasks that were previously solved by traditional approaches.

One of the important advantages of using such systems is as follows:

- software tools for the organization of interaction of software systems significantly expand the range of practical tasks, the development of which brings savings in time, finance;
- technologies of construction of expert systems are the most important software in solving the problems of traditional programming, which consist in great complexity and high cost of developing complex applications;



- software development based on dynamically updated knowledge bases and programming technologies adds new qualitative advantages to software products by providing dynamic modification and updating of the application knowledge base by the user rather than the programmer, which makes software products more friendly for user interaction with applications.

Analysis of the state of software tools aimed at building expert systems [6–10]. Software products such as NEXPERT OBJECT, EXSYS, XpertRule, GURU, FLEX, ACQUIRE, ReSolver can be distinguished [11]. To date, there are a number of negative factors and difficulties affecting the development of software tools that provide interaction of software systems to automate the construction of expert systems:

- the problems of building a knowledge base for dynamically changing facts and rules of the subject area, which come in real time, and the complexity of their subsequent structuring;
- complexity of interaction between different programming paradigms and systems in a single integrated development environment aimed at building dynamic expert systems;
- high cost of foreign analogues of software and tools for building expert systems;
- lack of such open source software tools (open source) for flexible change of knowledge bases;
- lack of a universal UML model for building an integrated environment for the development of expert systems based on dynamically updated knowledge bases.

The above problems determine the complexity of the construction of such software, in particular systems for building expert systems based on dynamically updated knowledge bases.

2. Method of research

To date, there is no comprehensive or partial solution, as well as a universal approach aimed at solving the problems presented at all stages of the life cycle of the development of such complex systems.

The above analysis of modern tools, as well as the main problems in the creation of software tools, are the key points of scientific research in the field of expert systems.

It is known that the least studied of these tasks is the development of an integrated environment, which includes interrelated approaches for the organization of interaction of software systems, which will later be used in the life cycle of the development of software tools and will provide automation of the construction of expert systems based on dynamic updated knowledge bases.

The development and implementation of the expert system is quite a time-consuming process, so the use of appropriate CASE-tools would significantly reduce the complexity of the development and implementation of expert systems.

CASE-tools for the development of various software applications have been used for a long time, but these tools for automating the construction of intelligent applications (in particular expert systems) have been actively used recently.

A distinctive feature of the proposed project is the creation of an integrated development environment, which includes a wide range of popular software systems (PROLOG, C#, Python, database management systems PostgreSQL, MySQL, machine learning tools. Another feature is the possibility of dynamic updating of knowledge bases, providing for the filling of knowledge bases with new facts and new rules.

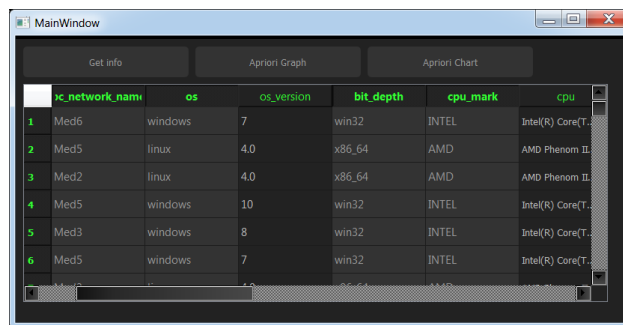
The research methods are based on CASE technologies, the theory of the production model of knowledge representation, the development of the software module of telemetry tools, the theory of syntactic construction of facts and rules in the knowledge base, as well as algorithms for the analysis of the search for associative rules. Based on the proposed approaches, the following has been accomplished:

- developed an integrated environment that allows professionals who do not have programming skills to create practical applications, which dramatically expands the use of expert systems in everyday life;
- representation of the structure of the integrated development environment aimed at automating the development of expert systems;
- integration of software systems Prolog, JavaScript, Python, as well as database management systems PostgreSQL, MySQL in integrated applications;

- a software module aimed at the qualitative integration of experimental expert systems in the processes of collection and analysis of requirements, which includes telemetry and search algorithm of Association rules Apriori;

- the integration of logical rules into the integrated development environment was applied.

To form requirements for the software being developed, an analysis was made of the area in which the expert systems will be used (figure 1).



	xe_network_name	os	os_version	bit_depth	cpu_mark	cpu
1	Med6	windows	7	win32	INTEL	Intel(R) Core(T...
2	Med5	linux	4.0	x86_64	AMD	AMD Phenom II
3	Med2	linux	4.0	x86_64	AMD	AMD Phenom II
4	Med5	windows	10	win32	INTEL	Intel(R) Core(T...
5	Med3	windows	8	win32	INTEL	Intel(R) Core(T...
6	Med5	windows	7	win32	INTEL	Intel(R) Core(T...

Figure 1. Formation requirement interface.

3. Research

Programmable expert system shell presented in figure 3 and is described further in system RBSofExpert is a reasonable compromise between generality and specialization where the expert provides the means for dynamic modification of many elements of the system taking into account the nature of work in each subject area. The possibility of such a dynamic change and development of human-machine system with the accumulation of experience and knowledge distinguish such systems from other developments in this area.



Figure 2. Experimental version of the expert system for the course “Development and analysis of requirements”.

Associations rules learning

To search and analyze the data, an algorithm for searching Association rules was used. This module was implemented in Python programming language and Apyori library (figure 5).

Education on association rules (hereinafter Associations rules learning - ARL) is quite often applicable in real life method of finding relationships (associations) in a data set. For the first time, Piatetsky-Shapiro G wrote about this in detail in “Discovery, Analysis, and Presentation of Strong Rules”.

There are a number of basic concepts in ARL:

- Support
- Confidence
- Lift (support)

Support

To check when a transaction is a single element set Result, (1) is used:

$$supp(X) = \frac{|\{t \in T, X \in t\}|}{|T|} \quad (1)$$

Where,

X is a data element to determine the similarity in a set of sets in all transactions.

T is the number of transactions.

To check several items (Figure 2.) with transaction (2):

$$supp(x_1 \cup x_2) = \frac{\sigma(x_1 \cup x_2)}{|T|} \quad (2)$$

Where,

σ is the number of transactions containing x_1 and x_2

T is the number of transactions.

In the example of collecting and analyzing performance requirements:

$$supp = \frac{\text{Windows transactions and resolution 1280: 768}}{\text{all transactions}} = P(A \cup B) \quad (3)$$

The result is presented in the form of a diagram created with the matplotlib module (Figure 3) in Python:

$$\begin{aligned} supp &= 80\% \text{ (Windows OS)} \\ supp &= 100\% \text{ (Screen resolution)} \end{aligned} \quad (4)$$

Confidence

This indicator is designed to test the entire set of Result elements, (5) is applied:

$$conf(x_1 \cup x_2) = \frac{supp(x_1 \cup x_2)}{supp(x_1)} \quad (5)$$

where,

$conf(x_1 \cup x_2)$ – the rule is checked, namely in which transactions the rule “A” supp (X) is executed, in the elements A to H “Results”:

$$supp(X \cup Y) \quad (6)$$

Lift

The Lift indicator is used in identifying how items of items are dependent on each other (7):

$$lift(x_1 \cup x_2) = \frac{supp(x_1 \cup x_2)}{supp(x_1) \times supp(x_2)} \quad (7)$$

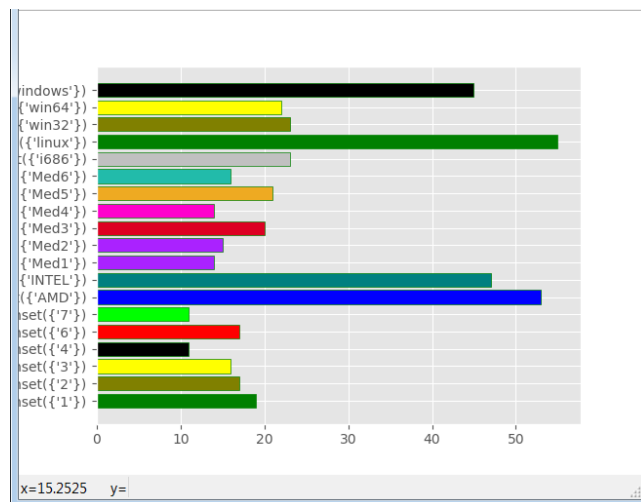


Figure 3. The use of the algorithm for finding Association rules.

4. Results

Software tool RBSofExpert is a software shell. Such a shell can be reprogrammed for a specific task. It is important to note that the system configuration RBSofExpert on a new task an order of magnitude easier than creating a new system, because neither the format of the knowledge base or the machine output is unaffected, instead, the reprogramming is implemented by inclusion in the knowledge base of the so-called attached procedures, the possibility of which is stipulated in most major expert systems and shells.

The peculiarity of the logical functions in the system R B Soft Expert is that they are able to influence the algorithm of the system and, if necessary, almost completely change it. For example, the expert system shown in figure 4 uses the reverse output “from the target”, but you can use the attached functions to make it work in the forward direction, “from the data”.

Название отчёта: RBSofExpert

Наименование программного продукта: RBSofExpert

Проблема которую решает проект: Построение экспертных систем, структуризацию данных

Цель проекта: Разработать программный продукт направленный на разработку ЭС

Задачи: 1. Обзор литературы 2. Формирование UML модели 3. Выбор программного обеспечения 4. Разраб

Стек технологий: PHP, JavaScript, Prolog, HTML, CSS, MySQL, PostgreSQL

Уровни	Наименования работ	Срок сдачи	Факт исполнения	Результат
Определение концепции	выбор предметной	04.02.2016	04.02.2016	10
Сбор требований	общение, анкетир	15.05.2016	15.05.2016	10
Анализ требований	анализ, структури	09.08.2016	09.08.2016	20
Проектирование	разработка, UML	15.12.2017	15.12.2017	20
Тестирование	автоматизирован	15.05.2019	15.05.2019	20
Сдача проекта	эксплуатация	25.07.2019	30.07.2019	20

Figure 4. Interface with experimental data.

Experimental versions of specialized expert systems in the field of education and health care were built using the integrated development environment. Namely, the following is done:

- in the field of education, a prototype of an expert system focused on the support of the discipline “Development and analysis of requirements for the creation of a software product” was created. This prototype of the expert system provides an opportunity for students to build various software systems based on the formulated requirements and rules from the knowledge base of the expert system, taking into account the specifics of the relevant subject area;

- in the field of health care, a prototype of an expert system has been created to support patient vaccination processes. In this case, the knowledge base of the expert system includes clinical characteristics of patients, as well as a set of rules governing the decision-making processes in vaccination.

In parallel with the theoretical studies of dynamic production systems, a dynamic version of the RBSoftExert system was created, in which users themselves had the opportunity to dynamically simulate the graphical shell of the template (figure 5), setting the necessary requirements for the system.

Назад Редактировать Удалить

Название шаблона: Анализ требований к программному продукту

Название элемента	Факт Prolog	Тип поля
Наименование программного продукта	projectName	Строка
Проблема которую решает проект	problem	Строка
Цель проекта	goal	Строка
Задачи	tasks	Строка
Стек технологий	techn	Строка
Таблица исполнения	table	Таблица (фикс.)

Уровни	Наименования работ	Срок сдачи	Факт исполнения	Результат
Определение концепции	Данные			
Сбор требований				
Анализ требований				
Проектирование				
Тестирование				
Сдача проекта				

Исполнители	performers	Строка
Заказчик(и)	customer	Строка
Дата	date	Дата

Figure 5. Dynamic modeling of the system.

Acknowledgments

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References

- [1] Cholewa W, Amarowicz M, Chrzanowski P and Rogala T 2013 *5th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2013)* Proc. of the Intern. Conf. on KEOD ed J Filipe and J Dietz (Science and Technology Publications)
- [2] Burnashev R A, Gubajdullin A V and Enikeev A I 2018 Specialized case tools for the development of expert systems *Advances in Intelligent Systems and Computing* Vol **745** 599–605
- [3] Zainullina A R, Larionov G V and Burnashev R A 2017 Development of the Prototype Expert System “Data Base Recommender” *Journal of Fundamental and Applied Sciences* **9** 1417–1429
- [4] Burnashev R, Gubaydullin A and Enikeev A 2018 On The Development Of Expert Systems

- National Academy Of Managerial Staff Of Culture And Arts Herald* Vol 2 80–84
- [5] *Computer-aided design of information management systems. Design of expert systems based on system modeling* 1999 ed G G Kulikov (Ufa: USATU) p 223
 - [6] Kinnucan P 1985 *Software Tools Speed Expert System* (Development High Technology)
 - [7] Peat F D 1985 *Artificial Intelligence* (Simon & Schuster)
 - [8] Waterman D 1986 *A Guide to Expert Systems* (Addison-Wesley)
 - [9] Korbicz J, Kościelny J M, Kowalczyk Z and Cholewa W 2004 *Fault diagnosis. Models, artificial intelligence, applications* (Berlin: Springer-Verlag)
 - [10] Psiuk K 2008 Knowledge editor for the diagnostic expert system Diadyn *4th International Congress on Technical Diagnostics. Diagnostics '2008* (Olsztyn) p 147
 - [11] Naykhanova L V and Naykhanova I V 2018 Conceptual model of knowledge base system *Journal of Physics: Conference Series* Vol **1015** 3 (IOP Publishing) 1–4