A New Expert System Shell in Turkish Language for Training

Kemal Tutuncu, and Murat Koklu

***Abstract*—** The aim of this study is to design an Expert System (ES) Shell in Turkish language for training license students about building ES. All the current ES shells and tools are required to know English and/or other foreign language. Since most of Turkish university present education in Turkish language and students are not good at any other foreign language, It is vital them to use education materials in Turkish language. The software developed for this study will help lecturer to teach ES, ES application and ES construction in a specific field. The developed ES shell has rule based knowledge-base, forward-chain inference mechanism and certainty factor for including fuzzy logic. The developed ES shell has user-friendly Graphical User Interface where all the menu items and tools are presented in Turkish language. In order to build a new ES in any area It facilitate easy entrance of domain specific variables, range and values that variables can have and rules that uses these variables. Apart from building new ESs in different areas the students will learn structural parts of ES (knowledge-base, working memory, inference mechanism, and etc.) by looking at the source code of the prepared ES shell.

***Keywords*—** ES Shell, ES application, Fuzzy Logic, Knowledge-base, Inference Mechanism.

I. Introduction

AN ES shell, is a software development environment containing the basic components of ESs. They are developed for the application that requires only the knowledge base from the user. They have inference engine, structure of knowledge representation (frame, rules, etc.), different utilitiy programs (editors, plotting programs and etc.) and no information about the field. In addition to these properties, some shells offer the user to create his or her inference mechanism. EMYCIN shell (empty MYCIN) can be given as an example to this. This shell appears by purifying medicine information from MYCIN ES. MYCIN was using for identification the illnesses by using backward chaining.

In Table I, some of ES shells are listed with their properties. The table that contains complete list of the ES shell can be found in [1]. In Japan a lot of studies have already been done for ES shells and tools. ESHELL (lisp based) produced by Fujitsi, ES/KERNEL (written in C for UNIX station) produced by Hitachi and GENZO (diagnostic, classification, interpretation) produced by Shimadzu are some of the shells that developed in Japan. The list of the shells and tools produced in Japan can be obtained from [2].

In this study, a framework for the development of expert systems based on a knowledge representation model that is easy to understand for people without specific training in Artificial Intelligence (AI) is prepared in Turkish language. The proposed framework facilitates the simple and fast creation and exploitation of ES. Since the course of AI is offered in most of Turkish university, Turkish materials are quite necessary for the students who have minor information about foreign language. A sub-section of AI course is ES and to teach students ES with applicable manner an ES shell must be thought especially in mother tounge. In Faculty of Technical Education, the difficulties observed when the students asked to build ES in any given area by using ES shell or tool. They find many ES shells and tools as listed in Table 1, but unfortunately they can't use them to build an ES in a specific area due to foreign language problem. This study will not only aid licence students to create different ES in sprecific areas but also to learn and combine parts of ES such as knowledge-base, working memory, inference mechanism.

II. Expert System Shells

Many commercial shells are available today as can be seen from Table I [1]. These shells are ranging in size from shells on PCs to shells on workstations, to shells on large mainframe computers. They range in price from hundreds to tens of thousands of dollars and range in complexity from simple, forward-chained, rule-based systems requiring two days of training. Their common properties are having GUI in any other foreign language but not in Turkish language.

Current challenge for the development of ES is related with integrating it in a framework which permits the exploitation of systems created quickly and easily through the Internet, making it accessible to conventional browsers as well as mobile devices [3]. There are some researches and constructed ES shell for this aim [4,5,6,7,8,9,10,11]. Some of these applications have been developed ad hoc, using technologies like PERL, ASP or CGI combined with HTML to generate the user interface. However, it is necessary that, in general, the one responsible for representing knowledge has notions of representation in AI and reasoning strategies. But again their common properties are having GUI in any other foreign language but not in Turkish language.

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TABLE I
ES SHELLS AND PROPERTIES

Shell's name	Usage fields	Type	Knowledge representation	Inference engine	Written in	Platform	Fee ($)	Produced by
Gensym's G2	Diagnosis, control and view	Dynamic	Object oriented	Forward and backward chaining	-	-	-	Gensym
GBB	In blackboard based application	Dynamic	KS presentation language and blackboard	Forward and backward chaining	-	Dos, Windows, Mac, Unix Workstation	-	Blackboard Tech. Group
Guru	Diagnosis, control and finance	Static	Production rules	Forward and backward chaining	Prolog	Dos, Windows	-	Micro Data Base Systems inc.
Hugin	In the systems that include uncertainty and modelling	Static	Object oriented	Forward chaining	-	PC Windows, Sun Workstation	-	Hugin inc.
Kes and Snap	Diagnosis, control and view	Static	-	Forward and backward chaining	Prolog	PC , Workstation and IBM Mainframe	10000 – 60000	Software architecture and eng.

III. MATERIALS AND METHODS

The components of a typical ES part is as shown in Fig. 1. In this study, a new ES shell is developed that has Turkish GUI, forward chain Inference Mechanism (uses fuzzy) and rule-based knowledge-base.

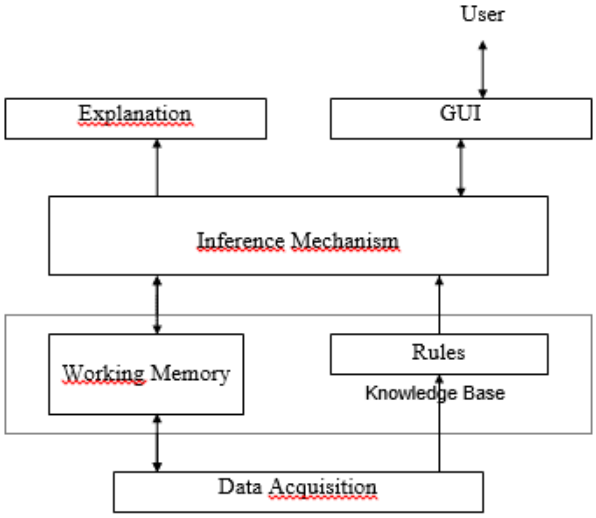

Fig. 1 The components of ES

Delphi 8.0 is used to develop ES shell since it provides to create visual GUI in an easy way. Intel(R) Core(TM) 2 Duo CPU P8700 @2.53GHz computer is used to run Delphi 8.0. Prepared ES shell doesn't have data acquisition component like all other Es shell. Data acquisition component of ES is generally implemented by Es tools that use different methods such as interview, question-answer and etc.

When the components of the developed ES shell is considered closely;

A. Knowledge Base:

It consists of rules and working memory. Rules are formed as "IF CONDITION then RESULT" structure. Certainty factor is used to construct the CONDITION and RESULT parts of the rules to care uncertain situation. Let's say we are seeking for the reliability of an enterprise for business cooperation. The rules that determine the reliability of the enterprises as follow:

- Rule 1: IF Financial=Good Financial Situation (with cf=60) then company=reliable (with cf=90)
- Rule 2: IF Claim=No bad claim (with cf=60) then company=reliable (with cf=80)
- Rule 3: IF Statue=Good Statues of Enterprise (with cf=100) then company=reliable (with cf=50)
- Rule 4: IF Distance<=1000 KM (with cf=100) then company=reliable (with cf=70)

As can be seen from upper rules each condition and result part of the rules have certainty factor (cf). Each rule has weighted contribution for determining final decision (reliability of the company in this example). Calculation of the rules to for a given final decision will be explained in Inference mechanism.

B. Inference Mechanism:

The developed ES shell uses forward chaining inference mechanism. It means a data driven model going from evidence to hypothesis. Calculation of the rules for a given final decision will be explained by using Fig. 2 that is symbolic representation of the rules given in Knowledge Base component of the developed ES. Table II will be used to calculate final reliability value of a given company with the certainty factor used in rules.

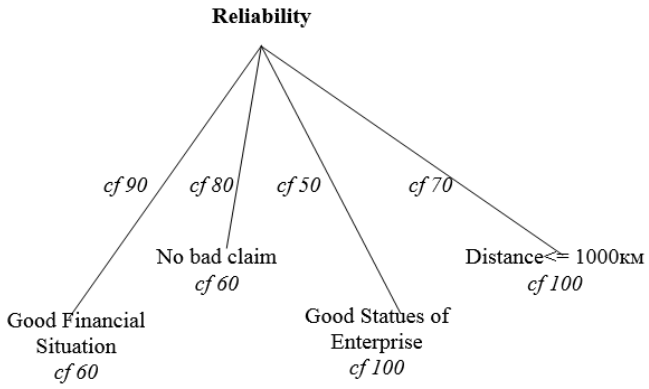

Fig. 2 Symbolic representation of the rules in Knowledge Base

TABLE II
JOINING CERTAINTY FACTOR

CFJO (AND)	CFCO (OR)
Joining certainty factors of CONDITION and RESULT parts of a rule	Joining certainty factors taken from more than one rule for a variable
MIN (a, b)	MAX (a, b)
P: (a • b) /100	P: a + b - (a • b) /100

In Fuzzy Logic, you can calculate AND operation on two Fuzzy values (let's say a and b) by simply taking minimum of them. This is valid for the OR operation by taking maximum of them. This is the simplest and less sensitive way. Additionally, for AND operation (a • b) /100 and for OR operation a + b - (a • b) /100 formula can be used to have robust, less error prone and correct result. So that for the proposed ES shell, second method is used. By using Fig. 2 and Table II;

- For Rule 1, joint CF is 60*90/100=54. Likewise 60*80/100=48, 50*100/100=50, 70*100/100=70 are found joint certainty factor of the Rule 2, Rule 3 and Rule 4, respectively.
- To calculate CF value of Reliability (goal variable) of a company a + b - (a • b) /100 formula is used. Starting from Rule 1 and Rule 2 nested calculation is done and shown as follows:

For Rule 1 and Rule 2: $CF_{RELIABILITY}$ = 54+48-(54*48)/100= 76

For Rule 1, Rule 2 and Rule 3: $CF_{RELIABILITY}$ = 76+50-(76*50)/100= 88

For Rule 1, Rule 2 and Rule 3: $CF_{RELIABILITY}$ = 88+70-(88*70)/100=**96**

So that calculated reliability of the company have %96 certainty value.

C. GUI:

When the developed ES shell is run main window as shown in Fig. 3 is displayed.

It has "Sistem Oluşturma-New ES", "Sistem Çalıştırma-ES run" and "Sistem Düzenleme-ES Edit" buttons on top of it. "Sistem Oluşturma-New ES" button is chosen as default. On the bottom of the main window it has "Anamenu-Main Menu", "Yardım-Help", "Hakkında-About" and "Exit-Çıkış" buttons. In this screen a new ES is created by entering name of it in "Sistem Adı-System Name" field together with explanation of the system in the "Açıklama-Explanation" field. Input variables of the ES are entered in the "Etkenler-Variables" columns starting from the first column titled "1. Etken- 1st Variable". The values that a variable can take is entered in the rows starting from "1. Değişken- 1st value". The result or goal variable is entered in the "Sonuçlar-Goal" field. When the entrance of the variables and goal variable are completed the system is saved by clicking "Kaydet-Save" button. A sample ES is created for choosing the present for a friend as can be seen in Fig. 4. The variables are "Cinsiyet-Gender", "Yaş-Age", "Relationship-İlişki", "Finans-Finance", and the goal variable is "Hediye-Gift". According to the gender, age, relationship and financial situation this ES will suggest a gift to buy. "Cinsiyet-Gender" can be "kadın or erkek-male or female", "Yaş-Age" can be between "20-30. 30-50, over 50", "Relationship-İlişki" can be "karı-koca, husband-wife", "arkadas-friend", "iş arkadaşı-business mate", "Finans-Finance" can be "az-little, çok-much". Suggested values for gift variable are "çiçek-flower", "kozmetik-cosmetic products", "Ev eşyası-house stuff", "züccaciye-glassware", "saat-watch", and etc. The number of input variables, the values of input variables and also goal variable can be increased or decreased at this window. After entering all necessary values of input and output (goal) variables "Kaydet" button is clicked to save the information created till this point.

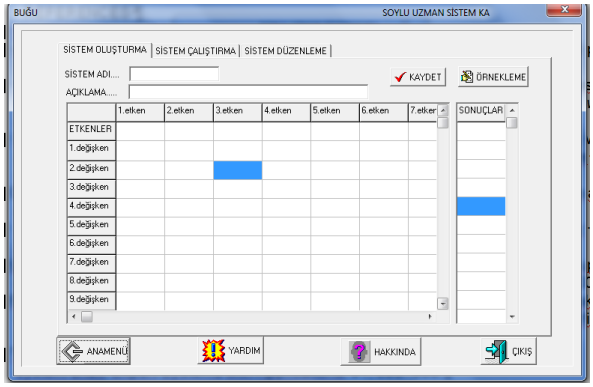

Fig. 3 Main window of proposed ES shell

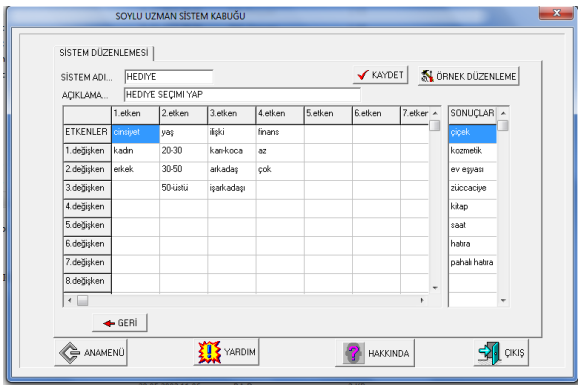

Fig.4 Sample ES for gift selection

The next step for forming ES is to form rules simply by clicking "Ornek Düzenleme- Rule Forming" button as shown in Fig. 5. Firstly, the input variable that will take place in the

rule will be chosen from "Etkenler-Variables" field. As soon as it is chosen, the values of the related variable are listed in "Değişkenler-Input Variables" field. The next step is to transfer the related value to the related rule "1-> Ornek-1st Rule" by selecting it and clicking the arrow button. All possible values of the goal variable (here is gift) are listed in "Sonuçlar-Results" fields and will be transferred to the related rules by selecting it and clicking the arrow button. Since the input variables have definite values such as female-male, little-much, friend-husband-wife, the cf factor is only used for goal variable (gift) for this ES. The cf value of the goal variable is entered in the "Ağırlık (1-10)-Certainty" field. If it is necessary to assign cf factor for input variable, related value of input varable is chosen first, then "Ağırlık (1-10)-Certainty" field is filled with cf value. To keep simple cf value of goal variable of the prepared ES is kept as 10. Here,from 1 to 10 means from 1% to 100% by dividing related numbers to 10. If we look at the closer view for the rules formed for this example in Fig. 5;

Rule 1- IF Gender=woman AND Age=20-30 AND Relation=wife-husband AND Finance=little THEN Gift= flower (cf 100%100)

Rule 2- IF Gender=woman AND Age=20-30 AND Relation=wife-husband AND Finance=much THEN Gift= house stuff (cf 100%100)

Since Gender, Age, Relation and Finance variables can have 2, 3, 3 and 2 values, respectively, totally 36 rules were created similar to the upper rules.

After forming the rules by clicking "Kaydet" button, the system is saved. It is ready to run. Clicking "Geri-Back" button bring us main window of the prepared ES system as can be seen in Fig. 3. After clicking "Sistem Çalıştırma- ES run" button we will have the window shown in Fig. 6. "Hediye-Gift" from "Çalıştırılacak Sistemi Seçin-Choose the ES" field is chosen first and then "Çalıştır-Run" button clicked. Then the window in Fig. 7 is displayed on the screen. As can be seen from Fig.7, Gender, Age, Relationship and Finance are chosen as woman, 30-50, friend and little, respectively. The suggested gift by ES is Glassware with 100% certainty factor. More complex ES can be built with prepared ES shell. Certainty factors can be assigned to the values of both input variables and output variable as mentioned before. The prepared ES sample is kept small and basic due to be more clear, understandable and also page limitation.

IV. Results And Discussions

The developed ES shell is used and tested for forming other ES related with specific fields. Adding cf value to both input and output variables resulted in robust and reliable systems. Joining cf as mentioned in Inference Mechanism sub-section was implemented successfully by developed ES shell for forming any ES.

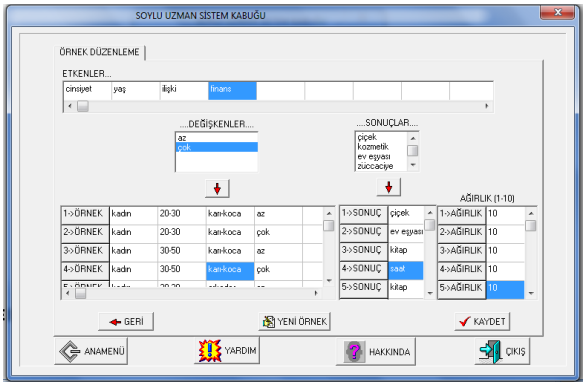

Fig. 5 Rules forming window of sample ES

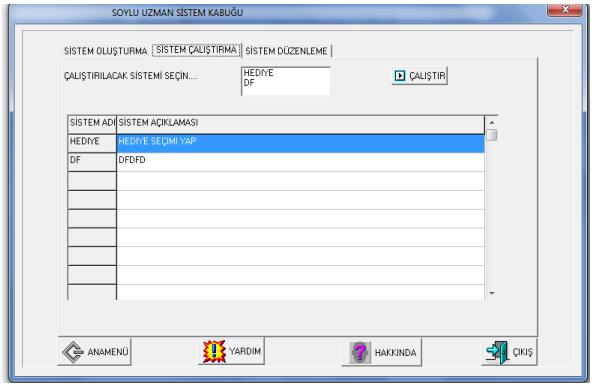

Fig. 6 ES run windows of sample ES

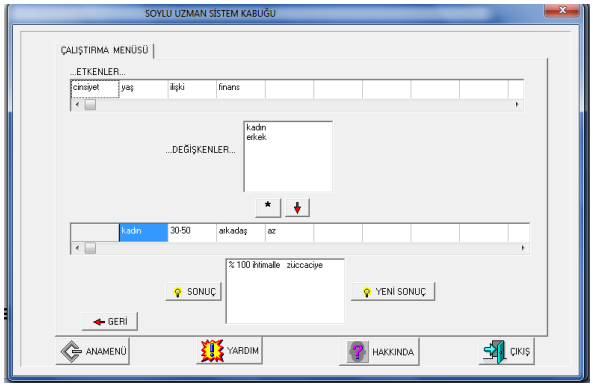

Fig. 7 Execution of sample ES

Total number of student was 100 that includes both branches named 4-A and 4-B. Both shell were introduced and thought to them. Since their foreign language is at the beginner level, they had difficulties to build an ES named "Computer Failure Diagnosis" by using GURU shell. The rules that they will were given them as text format. Only 10 students graduated from high schools whose education environment were English succeeded to form related ES. All other students were failed to form the related ES in 60 minutes. On the other hand when they are asked to form same ES with the developed ES shell that has GUI in Turkish language only 6 students didn't succeed due to lack of knowledge about general concept and structure of ES.

The results showed that prepared ES shell is quite useful for the students who has minor information and skill about foreign language. The students also checked the source code of the developed ES shell and learnt how to combine component of a given ES presented in Fig. 1. They are asked to create ES shell without including cf factor. 90% of the students submitted the working ES shell. 10% of them didn't succeed due to different situations such as lack of domain knowledge, family reason and etc. This showed that prepared ES shell was quite successful for training aims for Turkish license students.

The future study related with developed ES shell can be integration to the Internet and making it accessible to conventional browsers as well as mobile devices. By this way, It can be used as distance education material for any Turkish licence students or someone working on ESs.

ACKNOWLEDGMENT

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