Knowledge elicitation using multimedia polling techniques

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Abstract: *This paper deals with usage of multimedia in the field of knowledge elicitation. It introduces multimedia poll as a technique suitable for knowledge elicitation that would otherwise use classic poll technique. Problems in implementation are discussed using our system as an example and possible solutions to those problems are offered. Artificial intelligence techniques can be added to multimedia poll techniques for creation semi-structured interviews (like genetic algorithms and decision trees), and data mining techniques for further analysis of results. Pro and con analysis of using multimedia is also presented.*

Keywords: *knowledge elicitation, multimedia poll, artificial intelligence techniques*

1. Introduction

Process of knowledge elicitation for knowledge based systems (KBS) is usually called "bottle-neck" of their development. Inappropriate knowledge in the beginning of KBS development makes all the other steps wrong. So, how to gain adequate knowledge? There are many factors that knowledge elicitation depends on. Most of them are primarily psychological. Experts express their tacit (implicit) knowledge only partially or in inadequate way (or not at all sometimes) and that is the basic problem (Diaper, 1989). Their implicit knowledge is gained through the years of experience. It is built within their minds and they are using it without explicit thinking. That kind of knowledge expert probably never tried to express in words and it will make a big problem for him to express it during knowledge elicitation (KEL) session. Elicitor must focus on all psychological aspects relevant for session and choose KEL technique that can most easily gain access to desired knowledge.

There are many knowledge elicitation techniques today. They are divided into two groups: techniques for eliciting knowledge from human expert (interview, focused discussion, teachback, construct elicitation, sorting tasks, laddering, "20 questions", matrix generation, critiquing, protocols, role play, simulations) and techniques for knowledge elicitation from other sources (existing systems, physical or social environment, documents) (Cordingley, 1989). All of those techniques, and some others, are used in elicitation depending on situation.

Since knowledge elicitation is so demanding part of development of KBS, finding the right technique for certain situation is of the greatest importance. This article describes a new technique created for the purpose of research on the subproject "Intelligent Tourist Agency"

that is part of the project “Intelligent Systems for Decision Support in Complex Systems”, funded by the Ministry of Science and Technology, Republic of Croatia (Kliček, 1998b). Objective of this project is to create a new methodology to develop complex intelligent systems and plan their architecture. The survey included knowledge elicitation using multimedia, which is one of newer techniques. This technique is extended with intelligent techniques (like genetic algorithms, decision trees etc.) to achieve semi-structured interviews.

Other related work in the field of KEL includes Text Knowledge Engineering performed by K. J. Schnattinger from Freiburg University (Schnattinger, 1998), work of G. Teccuci from George Manson University and Romanian Academy about integration of machine learning and knowledge acquisition presented at IJCAI tutorial SA3 in 1995. (Teccuci, 1995), work about knowledge discovery in integrated call centers (from Preceedings of Third International Conference on Knowledge Discovery and Data Mining) by P. Xia (Xia, 1997) and work on user interface for knowledge acquisition from video by H. Lieberman presented on 1994 AAAI workshop (Lieberman, 1994).

2. Reasons for creating a new technique

When gathering information from larger group of people, classic poll is a technique for knowledge elicitation that is very suitable. Controllability of elicitation is in that case much lower than in interview with only one person at the time. Because of that, polls must have very good visualisation of areas of interest and must be as much interesting as possible. This is the goal of multimedia use. Under term multimedia poll is understood the use of different multimedia element variations to acquire correct and quality information. Classic polls that are filled out using computer are often called multimedia polls. That is the basic form of multimedia poll.

The subproject mentioned above required a research about aesthetic preferences of potential tourists. This knowledge is needed for development of model of user’s (potential tourist’s) aesthetic preferences. Model would be used for interactive communication with user and suggestion for hers or his choice of optimal vacation place. Seventy members of local Rotary, Inner Wheel and Rotaract Club from 20 to 70 years old were asked to fill out a classic poll during March of 1998. The poll was anonymous and provided multiple answers questions (with selection of one or more answers) or lists of answers that where graded using Likert type scale, based on importance or likability. Subjects had different occupations and education. The poll contained 206 different variables for: general characteristics (22), music styles preferences (8), selection of film styles (11), painting styles preferences (12) and customer preferences and possibilities (153). The processing of 30 received polls, which makes 43% of total, showed that classic poll is not a very good technique for eliciting aesthetic preferences. Although the group of people polled mostly had good education and knowledge of art, they had problems with choosing from 8, 11 or 12 different preference styles of all three polled aesthetic preference types (music, film, art). When people hear term impressionism, they usually visualise a painting belonging to that style. Most of the people cannot distinguish at least two styles because they cannot remember main difference between them. This assumption is based on the fact that some number of subjects wrote down at “other” (optional) line name of artist or piece which style was already on the list. That means that they did not relate author (or his work) with a certain style. If educated people made some mistakes, all the other (and all they are potential tourists) make them also.

Because of problems in distinguishing among multiple options, the poll can take much more time for filling out than necessary. That confronts us with two more problems. First one is that both the subject and the elicitor are spending more time on answering and processing of poll instead for other work they can do. Second problem is that time and effort spent for thinking about preference types questions can motivate subject to give up of poll or to answer randomly. In any case, we are left with answers that bear no resemblance with preferences of the subject. It is evident that, using classic poll in that situation, elicitor can end up with wrong information or without any.

Multimedia poll provides to the research more vivid approach. If the goal is to find out what kind of music, film and art person (dis)likes, the poll would have to help her or him to visualise them. Instead of list of styles, the subject gets one example from each style. Using programming tools that can achieve that, the elicitor or someone from team creates multimedia poll with music and film clippings, photographs, paintings, drawings and other forms of art. In that way, the subject can instantly see or hear a representative from a certain style and more easily recollect some other representative of that style that her or he (dis)likes. That will alleviate the choice to the subject.

According to Kliček (1998a), advantages of multimedia poll are:

- the comprehensibility of questions is attained, especially the ones that include "seeing or hearing" something, and consequently the evaluation is easier,
- subjects feel that is easy and interesting to answer the questions,
- after development of multimedia application, polling can be done very quickly and efficiently,
- on-line help provides effective description of questions asked if the subject needs it,
- it is easy to control accuracy of data (answers) input,
- the poll can be adjusted, for instance, for decision tree technique or expert systems,
- answers are written in databases and can be processed instantly after the polling,
- cost is decreased by the use of a large sample, because of the relative decreasing of the technology investment costs,
- knowledge is gained using Knowledge Data Discovery (KDD), decision trees or neural networks.

Disadvantages are:

- it is necessary to have a powerful multimedia configuration and other equipment with corresponding software for creating multimedia applications,
- a considerable amount of time is needed for creation and preparation of multimedia poll (even more than for classic poll).

It is obvious that poll which includes the questions about music or film becomes more comprehensive if the subject can hear the actual music or see a part of actual film. That enables easier evaluation during the polling. In addition, it is much more intriguing to receive different excitations to all organs of sense than just have to read plain paper that usually demands hard thinking. Since multimedia poll with vivid representations saves a lot of time, the polling can be done much earlier than classic polling even with a bigger group of people. Big advantage is the control over entered values. That cannot be done with classic poll. Using the computer, elicitor can restrict answers to selected set of values. That saves time that would otherwise be used for cleaning input data. After the polling, answers are already in databases in preferred form, so there is no need to retype them or scan them in for evaluation. This really saves a lot of time! If tools for automatic data processing are used, time saving is even bigger and cost decrease is always important advantage. To create multimedia poll, a certain

investment in appropriate technology is needed. This investment is independent of number of subjects. Since polling is mainly used with a larger group of people, increase in number of subjects participating in the polling relatively decreases the costs. Of course, investment at the begining must be substantial, because one must have a powerfull equipment to achieve quality multimedia polling. But, both the costs and the time spent to create such poll are worth the result.

The last item we have to deal with is using decision tree technique or expert systems in polling. This is the field where multimedia poll goes step further than classic one. The poll generally represents structured interview because questions are given in the same order to all subjects. If answering to one question depends on the answer of the other, it is usually written beside that question. Computer, on the other hand, gives the possibility to omit questions, which are depending on others, without intervention of subject. That saves her or him time that would otherwise be used for dealing with unnecessary questions. That kind of poll is similar to semi-structured interview (Cordingley, 1989). The usual way of implementing such poll is using classic structured programming tools. Alternative way is to use some artificial intelligence techniques.

One of the goals may be to find out preferable combinations of different preference types, e. g., what combination of music and painting would person like. Combination of different media cannot be made just by taking the best-graded preference styles. Best styles alone does not provide the best combination. The individual grade for objects can differ significantly from the grade for their combination. To find out combination preferences the subject must also evaluate combinations. In the case mentioned above, with 8 music, 11 film and 12 art preferences, the subject, for example, would have to grade 88 combinations of music and film styles and 96 of music and art styles. Those additional 184 grades burden the subject with too many questions. Even multimedia poll cannot help much in that case. The result can again be inaccurate information or no information at all. Here proposed solution is made using Genetic Algorithms.

Genetic Algorithms (GA) are one of the possibilities that expert systems have. Aimed at solving optimisation problems, they can be used for finding the optimal styles combination of preference types. The preference types are considered as genes by those algorithms. The value of each gene is one of preference styles of each preference type. All genes together make a chromosome. Chromosome changes values of genes through crossover during generations. The first generation with a pre-defined number of randomly chosen different chromosomes is created. After evaluation of chromosomes in first generation, the next generation of chromosomes is made by crossovering of the best chromosomes from previous generation. After the pre-defined number of generations, algorithm offers the optimal chromosome. The evaluation of style types combinations represents such problem. The goal is to find out what some person likes or dislikes. If there is a certain number of preference types, each one with large number of styles, number of inter-combinations can reach hundreds of thousands. One person cannot grade all those combinations in reasonable time. In that case is necessary to have an algorithm that can select only a certain number of combinations. Genetic Algorithms can provide that. They can be used in following ways:

1. manually, meaning that during the optimisation each combination is graded from subject,
2. automatically, based on individual grades of preference styles or other factors, using evaluation function that enables algorithm to perform the optimisation by itself.

Information entered in database during polling enables easy processing if information is entered in suitable form. Tools for data mining (finding the connections, causes and consequences) can very quickly transform obtained information in useful knowledge. Some data mining tools used in field of KBS enable induction of decision trees, pattern rules or neural networks. In that way, proposed rules or decision trees can be sent to application for KBS development and then modified according to needs. That gives us the ability to represent relations between data in a manner elicitor needs. That step will decrease errors and enable additional savings. Altogether, the use of multimedia poll with intelligent techniques, as Genetic Algorithms and data mining, minimises time, cost and errors that are three important factors in development of KBS.

3. Description of intelligent multimedia polling technique for knowledge elicitation

Steps for performing technique for knowledge elicitation using intelligent multimedia polling Kliček (1998a) suggests as follows:

1. Selecting the goal of research. Setting up hypothesis and variables used for proving the hypothesis. Decision about used technique. Alternatives are classic or multimedia poll.
2. Creating of questions and dependencies between them (using decision trees or if-then rules). Defining of question dependencies enables dynamic polling.
3. Creating of multimedia contents: pictures, sound, video sequences, animation etc. Content is then merged in one multimedia application. Preliminary test of multimedia questionnaire is made. On-line help system is also created along with explanation of questions and answers. Input limits and validations are added.
4. Testing on control group is performed. If needed, corrections in steps 1 to 3 can be made now.
5. Actual polling in multimedia labs or individually (using CD-ROMs that are delivered to subjects) is performed. Results are gathered in central database using floppy disks or e-mail. One of options is to use World Wide Web as an interface to multimedia poll. Downside of that approach is limited bandwidth that can disable usage of some rich media types (like full motion video etc.).
6. Processing of actual results using classic statistical methods or KDD techniques (Knowledge Discovery in Data that uses decision trees, pattern rules or neural networks).

Those proposed steps enable creating of quality intelligent multimedia poll that ensures information elicitor needs for KBS development. According to them is developed the poll used for the needs of our subproject. This poll will be described in the next chapter.

4. An example of application

Above-mentioned elicitation of aesthetic preference styles was also carried out in May 1998 using the techniques discussed in the second and third chapter. The subjects were 104 students of third and fourth year of college. They had to evaluate a number of aesthetic preference types combinations on a one-to-five Likert type scale. Preference types included: background, picture, vignette, heading, text, menu and music. Each of them offered six different styles or style representatives. The polling was performed in three steps:

1. grading of all 42 styles individually,
2. grading of 11 chosen combinations of two different aesthetic preference types that included only two best graded styles of each type in previous step, which gives 44 grades

(combinations were: background-picture, background-vignette, background-heading, background-text, background-menu, background-music, picture-vignette, picture-heading, picture-text, picture-music and heading-text),

3. grading of 40 chromosomes generated for first generation by GA (chromosomes were randomly chosen combinations of all aesthetic preference types that included only three best graded styles of each type in first step, meaning that total number of combinations was 2187).

In other words, there were 126 combinations for evaluation. Subjects also answered to the questions about their sex, district in which they reside, population number in their habitat, a place of their residence (such as city area or village), secondary school (types), economic ability, whether or not their family owns a car and oldness of that car. It was presumed that there is a connection between those factors and the subject's choice of aesthetic preference styles. The approximate time for filling out the poll was about 20 minutes (Fig. 1).

Figure 1: Grading of combinations of aestetic preference types.

This multimedia poll was created in XpertRule, a tool from Attar Software Ltd. that is designed for KBS development. XpertRule offers the use of Genetic Algorithms for solving optimisation problems. They were used for random selection of combinations in third step (for grading of combinations of aesthetic preference types).

Collected information was written in database during the polling automatically. The processing was performed in data mining tool Analyser from Attar Software Ltd. The first part of polling was processed in seven different analyses, one for each individual aesthetic preference type (624 records per each). The second part was processed in eleven different analyses, one for each combination of two different preference types (416 records per each). The last part was processed in one analysis for all combinations of all aesthetic preference types (4254 records). Here will be presented this last analysis as an example of proposed method.

Analyser - sveskupa - [Data View]

File Edit Options Options Help

Fields:16 | Attributes:15 | Outcome field:16 | Working sample:4254 | Total records:4254

	Name	Type	Values/Range	Usage	Grouping	Rank
1	Spol	Discrete	2	Attribute	-	-
2	Zupanija	Discrete	16	Attribute	-	-
3	VelMjesta	Numeric	1 to 9	Attribute	-	-
4	DioMjesta	Discrete	4	Attribute	-	-
5	Skola	Discrete	4	Attribute	-	-
6	EkMoguc	Discrete	5	Attribute	-	-
7	Auto	Discrete	4	Attribute	-	-
8	StarostA	Numeric	1 to 23	Attribute	-	-
9	Podloga	Discrete	6	Attribute	-	-
10	Slika	Discrete	6	Attribute	-	-
11	Vinjeta	Discrete	6	Attribute	-	-
12	Naslov	Discrete	6	Attribute	-	-
13	Tekst	Discrete	6	Attribute	-	-
14	Menu	Discrete	6	Attribute	-	-
15	Glazba	Discrete	6	Attribute	-	-
16	Ocjena	Discrete	6	Outcome	6	-

Figure 2: Structure of database containing information obtained during the polling.

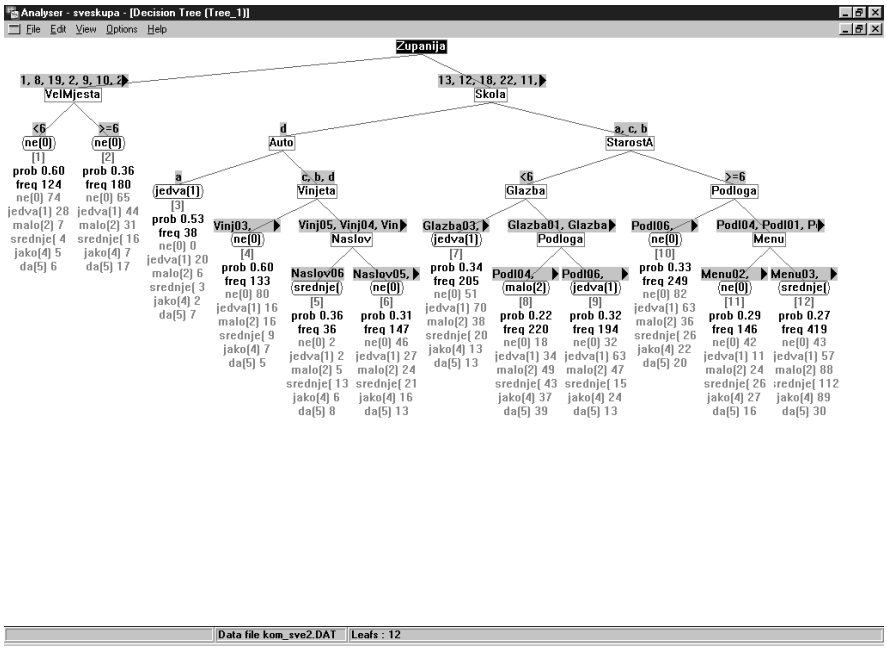

Figure 3: Decision tree induced from database.

Records were first pre-processed using Data View of Analyser (Fig. 2), so that all types of attributes and outcome would be correct. From obtained data was then induced a decision tree that showed main interdependence among attributes in determining the outcome grade of combinations (Fig. 3). This step fastens finding of the rules needed for KBS development. Those rules represent the main factors that designate aesthetic preferences of potential tourists. Obtained decision tree can easily be built in KBS that is being developed.

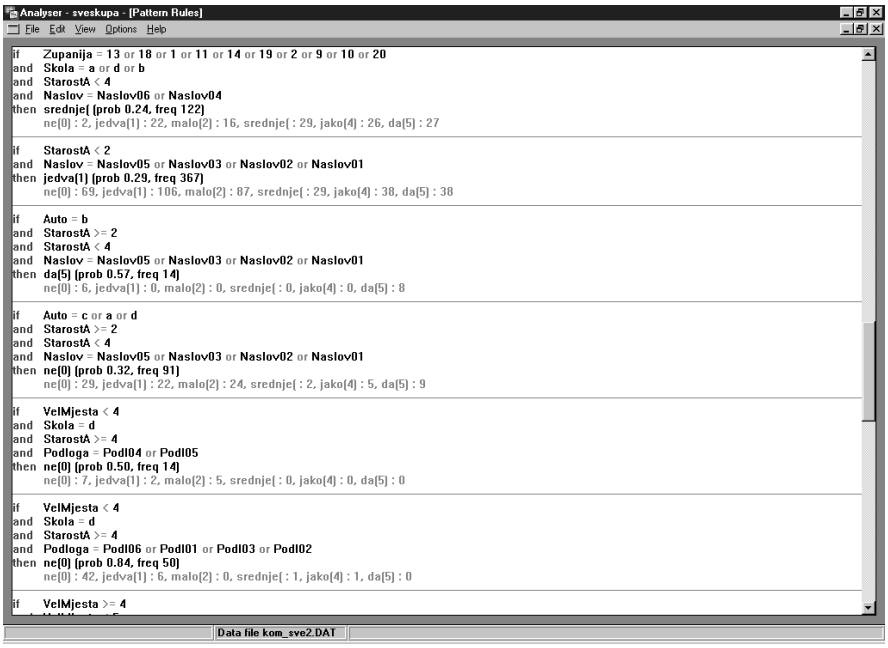

Figure 4: Rules evolved from polling data.

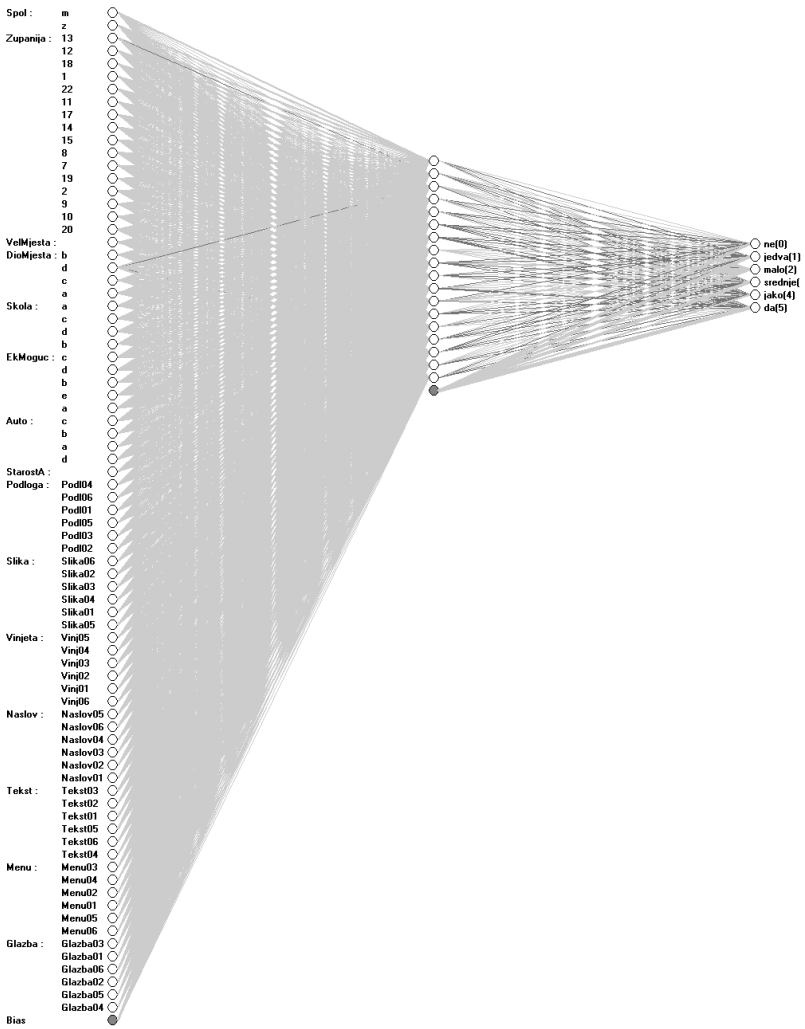

Figure 5: Neural network learned from obtained data.

Needed information can also be produced in form of the rules (Fig. 4). One advantage given from Analyser is that rules are evolved using Genetic Algorithms. Rules obtained in that way gave an additional information about connections among attributes and their influence on outcome grade. The next possible step is a neural network learned from data obtained from polling (Fig. 5). When given the values of attributes from potential tourists, the network also propose a certain outcome grade, giving us new information about rules for determining this grade.

4. Conclusion

Existence of number of knowledge elicitation techniques today did not remove the ”bottle-neck” label from this stage of KBS development. Here proposed technique is trying to contribute to solving of this problem. It is obvious that it cannot be used in all situations, as cannot any of other techniques, but in the case where elicitor considers the polling as adequate KEL technique, it is most recommended. The survey has showed that advantages of this technique are as follows:

1. minimisation of errors during polling,
2. improved response from subjects,
3. time savings in different steps of knowledge elicitation,
4. cost decrease because cost of the poll does not depend on size of subject group.

Knowledge elicitation using multimedia polling and intelligent techniques as Genetic Algorithms is an efficient technique that improves the quality of gathered knowledge and ensures additional savings. Used together with data mining and automatic induction of decision trees, pattern rules and neural networks, it enables better utilisation of time and cost than classic poll. Moreover, such knowledge elicitation minimises errors that can return the process of KBS development at the beginning. Knowing that KEL is a problem stage of the whole process, this is a competitive advantage.

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