UDC: 007.52
Original scientific paper

KNOWLEDGE ELICITATION USING MULTIMEDIA POLLING TECHNIQUES

Sandra Medenjak, Božidar Kliček, Dobrica Pavlinušić

University of Zagreb, Faculty of Organization and Informatics, Varaždin , Croatia
E-mail: smedenjak@foi.hr or bklicek@foi.hr or dpavlin@foi.hr

This paper deals with usage of multimedia in the field of knowledge elicitation. It introduces the multimedia poll as a technique suitable for knowledge elicitation that would otherwise use the classic poll technique. The problems in its 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 the creation of semi-structured interviews (like genetic algorithms and decision trees), and data mining techniques for further analysis of results. A pro and con analysis of using multimedia is also presented.

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

1. INTRODUCTION

The process of knowledge elicitation for knowledge based systems (KBS) is usually called a "bottle-neck" in their development. Inappropriate knowledge at 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 an inadequate way (or not at all sometimes) and that is the basic problem [2]. Their implicit knowledge is gained through years of experience. It is built within their minds and they are using it without explicit thinking. This kind of knowledge an expert has probably never tried to express himself in words and it will create a major problem for him to express his knowledge during a knowledge elicitation (KEL) session. The elicitor must focus on all psychological aspects relevant to the session and choose the KEL technique that can most easily gain access to the desired knowledge.

There are many knowledge elicitation techniques today. They are divided into two groups: techniques for eliciting knowledge from a human expert (interviews, focused discussions, 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 environments, documents) [1]. All of these techniques, and others, are used in elicitation depending on circumstances.

Since knowledge elicitation is such a demanding part of the development of KBS, finding the right technique for a 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", a part of the project "Intelligent Systems for Decision Support in Complex Systems", funded by the Ministry of Science and Technology of the Republic of Croatia [4]. The 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 the newer techniques. This technique was extended through intelligence 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 [6], the work of G. Teccuci from George Manson University and the Romanian Academy about the integration of machine learning and knowledge acquisition presented at the IJCAI tutorial SA3 in 1995 [7], work about knowledge discovery in integrated call centres (from Proceedings of Third International Conference on Knowledge Discovery and Data Mining) by P. Xia [8] and work on user interface for knowledge acquisition from video by H. Lieberman presented at 1994's AAAI workshop [5].

2. REASONS FOR CREATING A NEW TECHNIQUE

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

The subproject mentioned above required research into the aesthetic preferences of potential tourists. This knowledge was needed for the development of a model of user's (potential tourist's) aesthetic preferences. This model would be used for interactive communication with the user and as a suggestion for his or her choice of an optimal holiday location. Seventy members of the local Rotary Club, 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 answer questions (with a selection of one or more answers) or lists of answers that where graded using a Likert type scale, based on importance or likability. The subjects were from different occupations and different educational backgrounds. The poll contained 206 different variables for: general characteristics (22), music style preferences (8), selection of film styles (11), painting style preferences (12) and customer preferences and possibilities (153). The processing of the 30 polls received, which comprised 43% of the total, showed that the classic poll is not a very good technique for eliciting aesthetic preferences. Although the group of people polled mostly had had a good education and a knowledge of art, they had problems with choosing from 8, 11 or 12 different

preference styles of the three polled aesthetic preference types (music, film, art). When people hear the term impressionism, they usually visualise a painting belonging to that style. Most people cannot distinguish between at least two styles because they cannot remember the main differences between them. This assumption is based on the fact that a number of subjects wrote down on the "other" (optional) line the name of an artist or a piece whose style was already on the list. This means that they did not relate the author (or his work) to a certain style. If educated people make some mistakes, all the others (and all of them are potential tourists) will make them also.

Because of the problems in distinguishing among multiple options, the poll can take much more time to fill out than necessary. That is why we are faced with two more problems. The first one is that both the subject and the elicitor spend more time on the answering and processing of the poll instead of on the other work they can do. The second problem is that the time and effort spent thinking about preference type questions can motivate the subject to give up on the poll or to answer randomly. In any case, we are left with answers that bear no resemblance to the preferences of the subject. It is evident that, using a classic poll in this situation, the elicitor can end up with wrong information or none at all.

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

According to Kliček [3], the advantages of a multimedia poll are:

- the comprehensibility of questions being attained, especially the ones that include "seeing or hearing" something, and consequently evaluation is easier,
- subjects feeling it is easy and interesting to answer the questions,
- after the development of a multimedia application, polling can be done very quickly and efficiently,
- on-line help provides an effective description of the questions asked if the subject needs it,
- it is easy to control the accuracy of the data (answers) input,
- the poll can be adjusted, for instance, to the decision tree technique or to 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 decrease in the technology investment costs,
- knowledge is gained using Knowledge Data Discovery (KDD), decision trees or neural networks.

The disadvantages, however, are:

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

It is obvious that the poll which includes questions about music or film becomes more comprehensive if the subject can hear the actual music or see a part of the actual film. This enables an easier evaluation during the polling. In addition, it is much more intriguing to receive different excitations to all the sense organs than just to have to read plain paper that usually demands hard thinking. Since a multimedia poll with vivid representation saves a lot of time, the polling can be done much earlier than classic polling even with a bigger group of people. The big advantage is the control over entered values. This cannot be done with a classic poll. Using the computer, the elicitor can restrict answers to a selected set of values. This saves time that would otherwise be used to clean the input data. After polling, the answers are already in databases in the 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, the time saving is even greater and a cost decrease is always an important advantage. To create a multimedia poll, a certain investment in the appropriate technology is needed. This investment is independent of the number of subjects. Since polling is mainly used with a larger group of people, the increase in the number of subjects participating in the polling relatively decreases the costs. Of course, the investment at the beginning must be substantial, because one must have powerful equipment to achieve quality multimedia polling. But, both the cost and the time spent creating such a poll are worth the result.

The last item we will deal with is using the decision tree technique or expert systems in polling. This is the field where the multimedia poll goes a step further than the classic one. The poll generally represents a structured interview because questions are given in the same order to all subjects. If answering one question depends on the answer to another, it is usually written beside that question. A computer, on the other hand, makes it possible to omit questions, which are dependent on others, without the intervention of the subject. This saves him or her time that would otherwise be used to deal with unnecessary questions. This kind of poll is similar to the semi-structured interview [1]. The usual way to implement such a poll is using classic structured programming tools. An 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 a person would like. A combination of different media cannot be made just by taking the best-graded preference styles. The best styles alone do 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 music and art styles. These additional 184 grades burden the subject with too many questions. Even the multimedia poll cannot help much in this

case. The result can again be inaccurate information or no information at all. Here the proposed solution is made by using Genetic Algorithms.

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

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

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

3. DESCRIPTION OF AN INTELLIGENT MULTIMEDIA POLLING TECHNIQUE FOR KNOWLEDGE ELICITATION

Kliček [3] suggests the steps for utilizing a technique for knowledge elicitation using intelligent multimedia polling as follows:

1. Selecting the goal of the research. Setting up a hypothesis and the variables used to prove the hypothesis. A decision about the technique used. The alternatives are classic or multimedia polls.

2. The creation of questions and the dependencies between them (using decision trees or if-then rules). The defining of question dependencies enables dynamic polling.
3. The creating of multimedia contents: pictures, sound, video sequences, animation etc. The content is then merged into one multimedia application. A preliminary test of the multimedia questionnaire is then done. An on-line help system is also created, along with an explanation of the questions and answers. Input limits and validations are added.
4. Testing on a 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 the subjects) is the performed. Results are gathered within the central database using floppy disks or e-mail. One of the options is to use the World Wide Web as an interface for the multimedia poll. The downside of that approach is the limited bandwidth which can disable the 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).

These proposed steps enable the creation of a quality intelligent multimedia poll that ensures the information that the elicitor needs for KBS development. The poll used for the needs of our subproject is developed according to these factors. This poll will be described in the next section.

4. AN EXAMPLE OF THE APPLICATION

The above-mentioned elicitation of aesthetic preference styles was also carried out in May 1998 using the techniques discussed in the second and third sections. The subjects were 104 students in their third and fourth year at college. They had to evaluate a number of aesthetic preference type combinations on a one-to-five Likert-type scale. The preference types included: background, picture, vignette, heading, text, menu and music. Each of these 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 the two best-graded styles of each type in the 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 the first generation by GA (chromosomes were randomly chosen combinations of all aesthetic preference types that included only the three best-graded styles of each type in the first step, meaning that the total number of combinations was 2187).

In other words, there were 126 combinations for evaluation. The subjects also answered questions about their sex, the district in which they reside, the population number in their habitat, their place of residence (such as city area or village), secondary school (types), economic ability, whether or not their family owns a car and the age of that car. It was presumed that there was a connection between these 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 aesthetic preference types

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

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

The records were first pre-processed using the Data View of the Analyser (Fig. 2). so that all types of attributes and outcome would be correct. From the obtained data a decision tree was then induced that showed the main interdependence among attributes in determining the outcome grade of combinations (Fig. 3). This step speeds up our finding of the rules needed for KBS development. These rules represent the main

factors that designate aesthetic preferences of potential tourists. The obtained decision tree can easily be built in the KBS that is being developed.

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

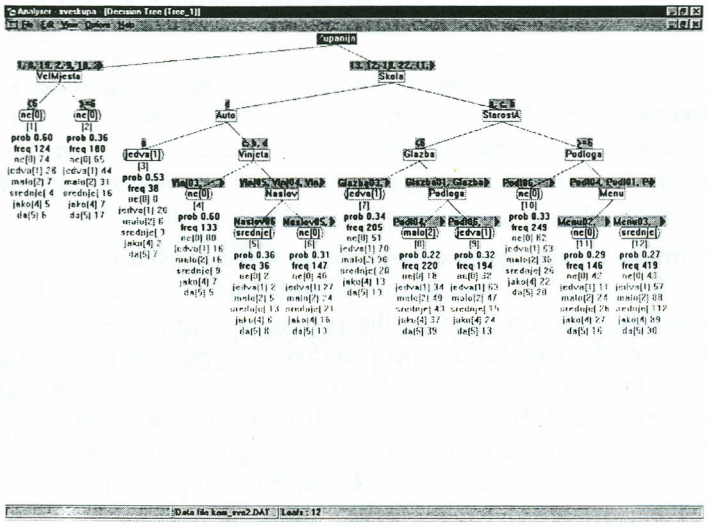

Figure 3. Decision tree induced from database

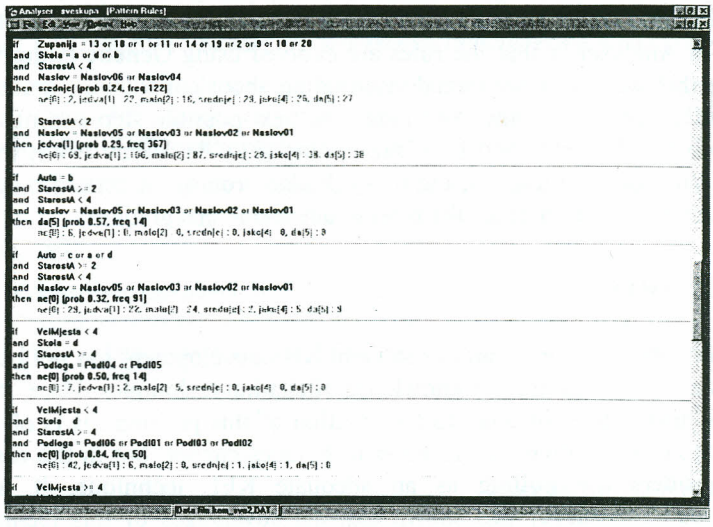

Figure 4. Rules evolved from polling data

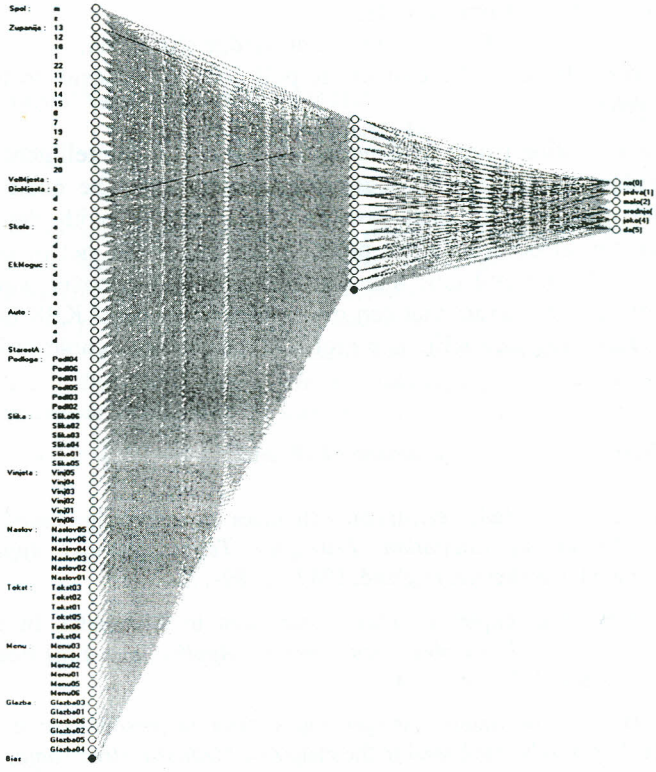

Figure 5. Neural network learned from obtained data

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

5. CONCLUSION

The "bottle-neck" label from this stage of KBS development has not been removed by the existence of a number of knowledge elicitation techniques. Here, the proposed technique is trying to contribute to the solution of this problem. It is obvious that it cannot be used in all situations, as other techniques cannot, but in the case where an elicitor considers the polling as an adequate KEL technique, it is the most recommended. The survey has shown that the advantages of this technique are as follows:

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

Knowledge elicitation using multimedia polling and such 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 a better utilisation of time and cost than the classic poll. Moreover, such knowledge elicitation minimises the errors that can overrun the process of KBS development at the beginning. Knowing that KEL is a problem stage of the whole process, this is a competitive advantage.

REFERENCES

[1] E. S. Cordingley. Knowledge elicitation techniques for knowledge-based systems. In D. Diaper, ed. *Knowledge Elicitation: Principles, Techniques and Applications*, Ellis Horwood Limited, Chichester, England, 1989, pp. 89-175.

[2] D. Diaper. Designing expert systems - from Dan to Beersheba. In D. Diaper, ed. *Knowledge Elicitation: Principles, Techniques and Applications*. Ellis Horwood Limited, Chichester, England, 1989, pp. 17-46.

[3] B. Kliček. Modeli i procedure inteligentnog sustava za personalizaciju multimedijskih prezentacija. Paper to be published in the magazine *Medijska istraživanja*, 1998.

[4] B. Kliček and S. Vidović. Complex intelligent systems: Case study of an intelligent tourist agency. In D. Buhalis, A. M. Tjoa and J. Jafari, eds. *Information and Communication Technologies in Tourism*. Springer, Wien, New York, 1998, pp. 36-45.

[5] H. Lieberman. A user interface for knowledge acqisition from video. *1994 AAAI Workshop*, URL <http://www.aaai.org/Workshops/1994/indexing.html>, 1994.

[6] K. J. Schnattinger. Towards text knowledge engineering. *Proc. 15th Nat. Conf. on AI (AAAI-98) and 10th Conf. on Innovative Applications of AI (IAAI-98)*, URL <http://www.aaai.org/Press/Proceedings/AAAI/98/Abstracts/A291.html>, 1998.

[7] G. Teccuci. IJCAI Tutorial SA3: Machine learning and knowledge acquisition: Integrated approaches. URL <http://www.aaai.org/Conferences/IJCAI/1995/Tutorials/ ijcai-sa3.html>, 1995.

[8] P. Xia. Knowledge discovery in integrated call centers: A framework for effective customer-driven marketing. *Proc. 3rd Int. Conf. on Knowledge Discovery and Data Mining*. URL <http://www.aaai.org/Press/Proceedings/KDD/1997/Abstracts/xia.html>, 1997.

Received: July 1998
Accepted: November 1998

Sandra Medenjak
Božidar Kliček
Dobrica Pavlinušić

ELICITACIJA ZNANJA KORIŠTENJEM TEHNIKA MULTIMEDIJSKOG ANKETIRANJA

Sažetak

Ovaj članak bavi se korištenjem multimedije u području elicitacije znanja. Predstavlja se multimedijska anketa kao tehnika prikladna za elicitaciju znanja u slučaju kad bi se koristila klasična tehnika anketiranja. Razmatraju se problemi njenog korištenja na primjeru i nude se moguća rješenja tih problema. Tehnike umjetne inteligencije mogu se dodati tehnikama multimedijskog anketiranja za kreiranje polustrukturiranih intervjua (na primjer, genetički algoritmi i stabla odlučivanja), kao i tehnike rudarenja podataka za analizu rezultata. Također je predstavljena analiza dobrih i loših strana korištenja multimedije.

Ključne riječi: elicitacija znanja, multimedijska anketa, tehnike umjetne inteligencije.