CALL CENTRE KNOWLEDGE ACQUISITION AND DECISION SUPPORT PROTOTYPE

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ABSTRACT

The purpose of this paper is to present the approach to knowledge acquisition and computer reasoning support in a call center environment. The common problem in such environments (especially in technical call centers) is that the call operators are usually just the interface to the experts inside the company. They often lack the detailed technical knowledge in the field of study, especially when they are newcomers who just started with their job. For this reason we developed the expert system (ES) that is able to obtain needed expertise from technical staff and it is able to assist less technically versed operators to provide feedback to customers and acquire the knowledge needed to fix the particular customer problem. The prototype implementation of the ES was built for the national roadside assistance call center which is focused on car fault diagnosis.

1 INTRODUCTION

Fault diagnosis in technical fields has received a lot of attention over the last years. To solve these problems, various Artificial Intelligence techniques were used, which can to some extent successfully simulate processes that are similar to those that human brain performs when making a decision. As one of those techniques, Expert systems (ES) are commonly used in this domain. They perform reasoning over representations of human knowledge and solve problems using heuristic knowledge rather than precisely formulated relationships, in forms that reflect more accurately the nature of most human knowledge [4].

The idea behind ES is to collect knowledge from human experts and store it on computer. When users need an advice the computer can make inferences and find a solution. The solution is introduced to the user and when required, an explanation is provided. In a rule-based ES expertise is collected and then stored in a knowledge base in the form of rules. The inference engine then uses these rules to come to appropriate conclusion. The knowledge-based ES (KBS) are human-centered and usually have four main components: knowledge base (KB), an inference ngine, a knowledge engineering tool and a user interface. [4]

The ES we present in this paper is an inference engine and knowledge-based system that uses ontology driven natural language (NL) dialogs as a communication basis between domain experts, knowledge engineers and call operators. One of the improvements over the standard ES approaches is that the system is using the same expert knowledge inside KB for the NL dialog production. In its first experimental version it is also able to learn and acquire previously nonexistent concepts from its users. For example new engine faults, new type of transmission failure symptoms, etc.

2 RELATED WORK

Suryadi and Nurzal [1] had introduced a decision model for car fault diagnosis. Their ES is composed of an inference engine, knowledge base, data base, system-user interaction and adaptive component. Because there is a small number of outputs with many possible inputs backward chaining is used in the inference engine. Adaptive component is able to acquire additional knowledge base rules within the system-user interaction module.

A car failure detection ES was proposed by Al-Taani [3]. The user communicates with the system through the natural language user interface, which is represented as a menu that displays Yes-no questions to the user. Both English and Arabic languages were implemented. It has an “Explanation facility” part, which can explain the reasoning of the decision to the user. The CLIPS expert system language is used to store knowledge collected by mechanics, books and car websites. Knowledge is represented in rules. The inference engine decides which rules are satisfied by facts stored in the working memory, executes the rule and proposes proper solution. Forward chaining is used due to the data-driven nature of the domain and because of convenience using CLIPS. Good results during the test stage indicated a practical and useful ES approach. Further work is needed to improve it by adding sufficient domain knowledge, though.

In research paper [2] Car Failure and Malfunction Diagnosis Assistance System is presented with the aim to provide quick and precise expert guidance to car fault diagnosis. It is composed of three main parts: the knowledge acquisition module, GUI and the reasoning module. The reasoning module consists of Reasoning Specification part, which assist the inference engine in translating the logical results into meaningful text, the User Advisor, which assists the user how to handle the given problem and the Inference engine which is of forward chaining type. Rule-based approach is used as this is a good candidate to the problems that can be represented in decision tree form. Prototype of the system was successfully implemented and validated. However, further improvement to the system domain knowledge specifications is required to enhance domain knowledge representation.

3 RESEARCH OBJECTIVES

Nowadays, when a car breaks down it is very common to call a road service provider for help. But the customer service representatives (CSR) are very likely to lack of technical knowledge which means that they would not obtain all the relevant information. This results in assistance providers sending towing vehicles not only when necessary but also when the malfunction could be solved on the spot. However, towing vehicles consume much more gasoline than smaller vehicles. So, in order to reduce consumption, effectiveness in finding the car fault and appropriate response of the road assistance company has to be increased.

Thus, in this research interactions between a certain car part malfunction and severity of car fault are explored.

The main objective is to enable our ES to effectively obtain the most relevant information and based on this newly acquired knowledge find a solution for the road service provider. In the case of a minor malfunction this means that the ES has to exactly define the malfunction so that the mechanics can resolve it on spot. Otherwise, towing vehicle is required.

To achieve that, an appropriate knowledge representation and knowledge acquisition rules have to be designed, supported by the statistical analysis of the malfunctions reported to the call center.

4 IMPLEMENTATION

4.1 Architecture

The ES represented in this paper consists of four main parts: knowledge base, user interface, inference engine (IE) and knowledge acquisition (KA) module. It uses the Cyc AI Environment for three of those parts: the knowledge base (Cyc KB), IE and parts of the KA module, as shown in Figure 1.

In the knowledge base, the domain expertise is stored in the form of logical assertions and rules between them. The initial expertise is obtained by a knowledge engineering module which is currently not the part of the final application presented to the user. Furthermore, the KA module enables adding new knowledge to KB via the natural language interface on the fly as the side effect of using the ES. Cyc KB attempts to assemble a comprehensive ontology and knowledge base of everyday common sense knowledge, with the goal of enabling AI applications to perform human-like reasoning. It basically contains all the concepts, expertise and historical data that is available in the ES. Cyc KB is divided into many “contexts” (or “micro theories”) in which assertions that share a common set of assumptions are collected. Using contexts makes inference a lot faster by directing it on a relevant set of theories.

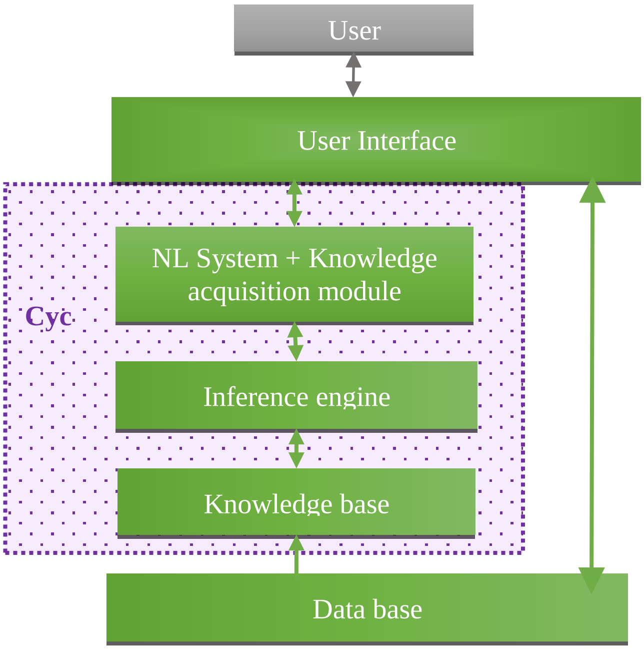


Figure 1 System's architecture.

User communication is over the list of natural language questions and responses. The language is converted into logic and vice versa in the KA module. Cyc offers a sophisticated natural language (NL) understanding. The lexicon, which is the main component of Cyc NL system, contains information about English words. Each word is represented as a Cyc concept. The system also provides natural language generation from its internal logic language (CycL) knowledge representation. This is achieved by templates that are specific enough to represent the mapping from logic precisely. They use predicates and functions that describe linguistic characteristics of a certain word or sentence. Since the NL Generator is a part of Cyc KB, the user himself can directly create new concepts and assertions in the KB about the specific domain. [5][6]

Here is an example of NL Generation template:

```
In Mt: EnglishParaphraseMt.
f: (genTemplate hasID
(ConcatenatePhrasesFn
   (ParaphraseFn-Np :ARG1)
   (HeadVerbForInitialSubjectFn Have-TheWord)
   (WordFormFn-Constrained nonPlural-Generic ID-
   TheWord)
   (ParaphraseFn-Np :ARG2))).
```

Cyc inference engine does the forward inference over the known facts to produce conclusions and goal-driven backward inference as well when the system is being queried. In forward type of chaining the engine goes through all the rules in knowledge base and triggers those, in which the obtained facts meet the conditions, producing new facts, or assertions which trigger KA module to ask a question or provide a suggestion. The IE is able to produce new questions for the user, relying on the previously acquired knowledge. Cyc can also add assertions independently if new knowledge triggers rules that lead to new conclusions. New assertions can then provoke further rule implementation. However, these assertions are removed from the KB if the data that they depend on become unavailable.

4.2 Functionality of the ES

The system is intended to be used in roadside assistance call centers. It can be utilized by an experienced or non-experienced CSRs. It is designed in a way that it leads the user through the conversation and obtains relevant information in as few questions as possible. The system provides a comprehensive application that can be used in call centers but the focus is on car fault diagnosis Based on the newly acquired knowledge, about a certain issue, the system reasons and tries to ask for additional information until it identifies the car fault reason.

All the collected data is stored in a database, available for further exploration and enlarging the knowledge.

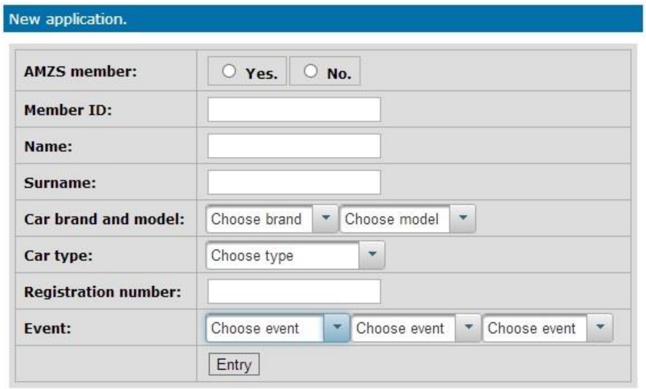
4.3 Ontology

An automobile consists of many parts that can be unified in few main components. These components interact with each other and this makes it a tremendously sophisticated unit. Because of that a car fault diagnosis is a complicated process. For that reason a rule-based approach that can be represented in a complex decision tree is used in our ES.

In the following paragraph a simple CycL example rule used in the reasoning process is presented.

```
Direction: Forward.
f: (implies
(and
        (malfunctionTypeAffectsSit ?SIT RoadVehicle
        VehicleIgnitionMalfunction)
        (situationBeforeEvent ?SIT
        ConsumerElectronicDevice Device-On)
        (stateOfDeviceTypeInSituation ?SIT
        ChargingSystemIndicatorLight Device-On))
(and
       (stuffNeeded ?SIT JumperCables)
       (stuffNeeded ?SIT RoadsideAssistanceCar)).
```

The condition part consists of tree sentences. If the road vehicle is experiencing an ignition malfunction and there was a consumer device turned on before the malfunction arose and the charging system indicator light is turned on then the assistance provider can solve the problem on spot and all the equipment they need are jumper cables.



New application.

AMZS member:	○ Yes. ○ No.
Member ID:	
Name:	
Surname:	
Car brand and model:	Choose brand ▾ Choose model ▾
Car type:	Choose type ▾
Registration number:	
Event:	Choose event ▾ Choose event ▾ Choose event ▾
	Entry

Figure 3 System's main page.

4.4 Prototype

When user (CSR) runs the program the main page displays, as shown in Figure 3.

There are a few lines dedicated to collecting client's information and at the end a drop-down menu opens from which the user can choose what the malfunction event is about. In this first level the event is divided into few basic sub events: ignition malfunction, engine malfunction, chassis malfunction, tire malfunction, transmission malfunction, electricity malfunction, lock malfunction and, if none of this is the case, an option "other" is available. When the user chooses one of these options two more drop-down menus open. They both contain some possible sub events according to the event chosen in the previous step. The user can leave these fields empty if the real event does not correspond to any of the offered possibilities.

Roadside assistance van is needed to free a vehicle from Vehicle malfunction of vzig 130.

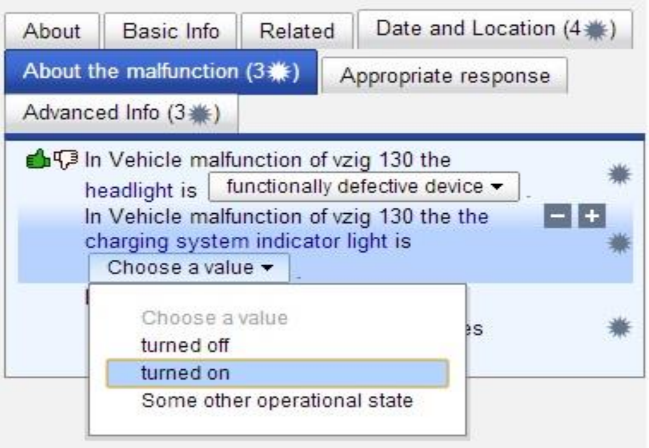
tangible thing is needed to free a vehicle from Vehicle malfunction of vzig 130.

Figure 2: Firstly proposed solution.

When the "Entry" button is chosen all the data is stored in both, database and knowledge base and user is redirected on next page. There a KA window opens showing the facts that are already known and asking further questions, which are chosen correspondingly to the previous answers. All of it is separated into few thematically chosen tabs, which are controlled by knowledge base and inference engine as well.

The following paragraphs are an example of a dialogue that may occur. Let's say that in the main page the user had chosen that the client has problem with igniting the car and further, an electricity consumer was on before that problem occurred.

Based on these two facts Cyc can only tell, according to the rules, in "Appropriate response" tab that a roadside assistance van is required, as shown in Figure 2. Under that there is another very similar sentence starting with a yellow box in which the user can manually assert if anything else is required. "Tangible thing" inside the box is a condition to what that required thing can be. For instance, "sadness" cannot be inserted in that sentence since it is not a specialization of Partially tangible in Cyc's KB. Screwdriver, on the other hand, satisfies the condition.



In Vehicle malfunction of vzig 130 the headlight is functionally defective device ▾

In Vehicle malfunction of vzig 130 the the charging system indicator light is Choose a value ▾

Figure 4: Knowledge acquisition.

In Figure 4 we can see the "About the malfunction" tab from the same step. The system asks whether the headlights are malfunctioning – they are, and whether the charging system indicator light is on – it is.

Car battery is needed to free a vehicle from Vehicle malfunction of vzig 130.

Roadside assistance car is needed to free a vehicle from Vehicle malfunction of vzig 130.

Figure 5: The lastly proposed solution.

Our ES processes newly obtained knowledge and provides a new solution, as shown in Figure 5. Now the service can send a car mechanics expert and resolve the problem on the spot, instead of a more expensive option – sending a much bigger vehicle that has a possibility of towing the vehicle into a workshop. Since the final solution was found, no further questions are asked.

5 CONCLUSIONS

In this paper an ES for car failure diagnosis was presented. The system consists of four main components and was implemented using Cyc AI Environment. The proposed system can be used to assist technically inexperienced operators in a roadside assistance call center to obtain the relevant information and diagnose the car fault. During the test phase the system provided appropriate solutions according to the rules. That implies that the final system will be functional and helpful.

However, the information about location of event has to be integrated in the system, since it has a lot of influence on decision making. Also, the logical rules which assist the fault diagnosis process have to be expanded so that the diagnosis can be more exact. The future plan is to extend the KA part to be able to elicit these rules from experts as well. Furthermore, knowledge based on statistical analysis has to be integrated on the fly, so that not only will the system provide solutions for cars in general but it will also recognize and take into account characteristics of individual car brand and models, without encoding this knowledge by hand. Additionally, an extra branch of the knowledge acquisition module will be implemented. In case the system does not recognize the car fault, the system will obtain the information about it after the event. Meaning, when an expert identifies the fault, feedback is provided and the system learns it. Similarly, feedback should be provided by an expert in case that the system's car fault diagnosis was wrong.

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