An Application of Knowledge-based System

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Summary
This paper presents an implementation of Information processing system for the social relationships as knowledge-based system and concentrating in the use of problem reduction methodology for solving problem through the implementation of the inference engine of the knowledge-based system. The search technique is Depth-First-Search with backtracking of PROLOG language. Therefore, PROLOG language is used for the implementation of the system and the problem reduction method is used to solve the problem of asking queries in subset of English language, as subset of query language, and get the answers in English language too. The implementation presents new methods for representing the facts associated with the family in the knowledge base and prove that this method is efficient in term of storage and process. The system can be used in the Humanoid Robotics to present the capabilities of using natural language.

Key words:
AI, knowledge-based system, Problem Solving, Natural Language Processing and Humanoid Robotics

1. Introduction

Most people know the term artificial intelligence concerning about how to build an intelligent machine. This machine should have certain capabilities such as: behaves like a human being, smart, problem solver of unstructured and complex problems as human does, understands languages, learner, and able to reason and analyze data and information, and so on. Therefore must design a machine behaves as human beings; this means, the machine must do all the activities that human does during his life, such as expert system where a trial is made to embody experts knowledge in certain domain in a computer program for carrying out some task. The vision for dealing with three dimensions world represented together with the intention and the expectation in the scene. The speech for replace the keyboards for dealing with computerized Natural Language Processing System (either written or spoken).

The machine should have the facilities of recognition, analysis, deduction, and induction [1]. This machine is smart; this term usually has many meanings in the English language; so, the meaning is concerned with Intelligent Machine to be smart, psychologically, smart means everything gives pleasure and happiness to humans, through the facilities available in all sort of multimedia equipments. Also this machine is problem solver of unstructured and complex problems; in this context humans usually solve algorithmic and non algorithmic problems and most problems are non algorithmic [2], therefore we have to consider methodologies for representing the non algorithmic problems in a form that enable us to develop a problem solving methods. This capability is the most important and most of the pioneers of A.I. are concentrating on them [3]-[6], from previous statements we derive that understanding views of all the capabilities that were considered are non touchable things which can't be manufactured in factories but can be simulated, therefore we call it artificial intelligence not industrial intelligence. In this context we can give an understandable definition of AI that considers all capabilities mentioned above, which is, Artificial Intelligence is a concept of study and research for finding a relationships between cognitive science and computation theories in order to represent these relationships as either data structures, search techniques, problem solving methods or representation forms for knowledge and the final goal of AI is to build an intelligent machine. During the study in A.I., there is another benefit which is better understanding of human thinking. So based on this view the developing of the structure of knowledge based system can be through the functional model of human system, which will be presented in the next section [7].

2. Structure of Knowledge Based System

The structure of knowledge based system depending on the proposed functional model of human system, which was constructed according to the direction of arrow from top to down as seen in Fig-1.
The communication with the environment unit presents the five senses; these are vision, hearing, touching, smelling, and tasting and through these senses humans gather their knowledge. These senses consist of five information processing systems; these are information processing

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system for vision, information processing system for hearing, information processing system for touching, information processing system for smelling, and finally information processing system for tasting. All these systems are depending on the representation of the relative knowledge about the information processing. The main functions of human inference engine are; first choosing the right form for knowledge representation in long term memory; second are the processes of representing the knowledge in long term memory; third are the processes for clarifying the ambiguity of the new knowledge, through calling an existing knowledge from the long term memory, and fourth is the processes of retrieving the adequate knowledge from long term memory according to the assertions given to solve relative problem in a certain domain. All of the mentioned functions (of human inference engine) have their own roles in the construction of human career and it is very important. So we believe that the inference engine as the following non touchable activities which are: willing and needs, vision, Incentives, hobbies, and the effect of environment. Therefore we believe any human can't have any job without the knowledge of doing that job, and the knowledge can't be well represented in his long term memory without the influence of the combination of the above activities.

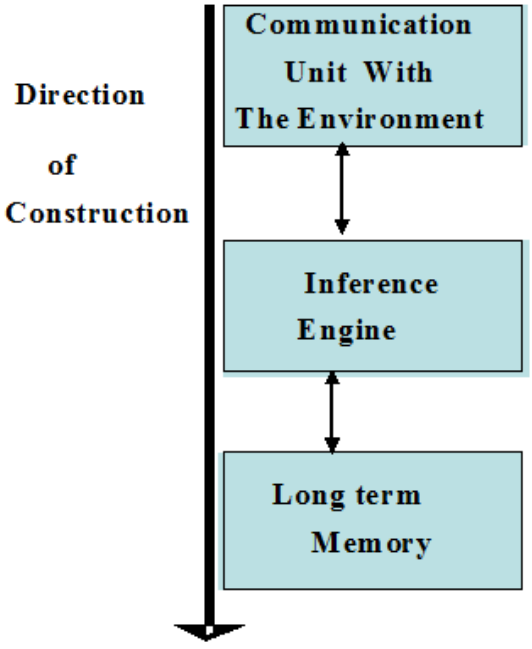

Fig-1 Functional model of human system

But the design and implementation of knowledge based system will be from bottom to up as seeing in figure-2. Therefore we will start from implementing the knowledge base and then we will proposing an inference engine and a user interface which are suitable to the knowledge base representation forms.

This means proposing problem solving method according to the knowledge base representation forms for a narrow and specific domain and appropriate search technique to search the knowledge base according to both a certain proposed assertion formats, presented through the user interface, and knowledge base representation form. In the following subsections will be the details implementation of the knowledge-based system for social relationships, according to the direction of arrow in Fig-2, starting from proposing the knowledge base representation form and accordingly the inference engine and user interface.

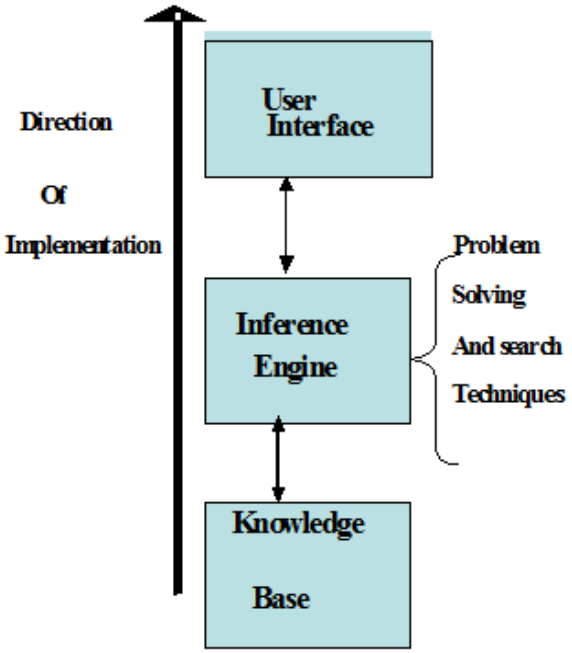

Fig-2 Structure of knowledge-based system

3. The Knowledge Base

The knowledge base represents the repository of knowledge for specific and narrow domain [8]. The domain concerned in this implementation is the social relationships and the form used will be rule base. Usually, in any knowledge base there are many facts, rules, and meta-knowledge, therefore the following Fig.3, Fig.4, Fig.5 are parts of the knowledge base used, present all the three categories of the knowledge, respectively, used in social relationships.

Facts: The information about a family will be present in three facts, these are:

```
married (ahmed, sue).
/* means Ahmed is married to Sue. */
haschildren (ahmed, [sara, ali, sammer, nadia]).
/* means Ahmed has list of children Sara, Nadia, Sammer, and Ali. */
Status (ahmed, [f, m, m, f]).
/* means the children of Ahmed are female, male, male, and female */
```

Fig.3. Facts

Rules: There are many rules in the social relationships such as:

```
father(X, Y) :- married(X, Z), haschildren(X, W), member(Y, W).
/* means X is father of Y if X married to somebody Z and has children list W and Y is member in the list W.*/
brother(X,Y) :- father(Z,X), father(Z,Y), male(X), X<>Y.
/* means X is brother to Y if there is Z is father of X and Z is the father of Y and X is male and X not the same Y.*/
sister(X,Y) :- father(Z,X), father(Z,Y), female(X), X<>Y.
/* means X is sister to Y if there is Z is father of X and Z is the father of Y and X is female and X <> Y. */
male(X) :- father(Z,X), haschildren(Z,W),position(X,W,N), status(Z,K), position(L,K,N),L=m.
/* means X is male is his father is Z and Z haschildren list W and X his position in W is N and the status of the children of Z are K and L is in K has the position N and L=m. notes if L=f the same rule can be rewrite for female. */
```

Fig.4. Rules

Meta-knowledge: there are many meta-knowledge such as:

```
mother(X, Y) :- married (Z, X), father (Z, Y).
/* means X is mother to Y if there is Z married to X and Z is the father of Y. */
uncle(X, Y) :- father (Z, Y), brother(X, Z).
/* means X is uncle of Y if there is a father Z of Y and X is the brother of Z. */
aunt(X, Y) :- father (Z, Y), sister(X, Z).
/* means X is aunt of Y if there is a father Z of Y and X is sister of Z. */
```

Fig.5. Meta-Knowledge

In the knowledge base also there are supplementary knowledge's, which are used for list processing, as seen in Fig.6.

There are many supplementary knowledge's are used for list processing the following part of them.

```
member(X, [X|Y]).
/* means X is member is any list if it is a head. */
member(X,[H|Y] :- member(X, Y).
/* X is member in a list and is not ahead and X is member in the tail Y. */
position(X,[X|T],1).
/* means X has position 1 in any list if it is the head of the list. */
position(X, [H|T], N) :- position(X, T, N1), N=N1+1.
/*means X has position N in any list and it is not the head and has position in the tails as N1 and N=N1+1. */
append([],L,L).
/* means append empty list with a list is the list itself */
append([H|T],L,[H|T1]) :- append(T,L,T1).
/* means append any list with any list L to get new list its head is H and tail T1 if append T with L get T1. */
```

Fig.6. supplementary knowledge

4. User Interface

The user interface simulates the communications with the environment unit of the functional model of human system, which means an interaction between the user of the knowledge-based system and the system itself. Therefore, this interaction will be through displaying three forms, as seen in Fig.7.

1. Form for entering the quires.
2. Form for displaying the answer.
3. Form for displaying massages either for "there is an error in the queries" or "there is no knowledge about the correct queries".

Fig.7.Types of Display Forms

In this implementation, have been used the natural language which is subset of English language for the queries and the answers. For the queries, using a subset of query language format based on case grammars [9], see Fig.8.

1. Who is the [Relation] of [Subject]
2. How many [Relation] has [Subject]
3. Tell me who is the [Relation] of [Subject]
4. Tell me How many [Relation] has [Subject]
5. Is [Subject] [Relation] of [Object]
6. Tell me is [Subject] [Relation] of [Object]

Fig.8. samples of case grammar

The answer will be also displayed in natural language, for example if the query is "who is the father of ali" then the system will display the answer as "the father of ali is ahmed". According to the knowledge base if there is the family facts, but if there is no facts of the family the system will display "sorry I don't know". But if there is an error in the structure of query, means not acceptable according to the proposed syntax of queries) then the system will display the massage "sorry your question is syntactically incorrect".

5. The Inference Engine

The inference engine was playing the most important role in the construction of functional model of human system as mentioned in section-2. Therefore, the implementation of inference engine will be regarded as a combination of problem solving methodology, reasoning agent and search technique. But this implementation depends on the representation of knowledge in the knowledge base for the knowledge based system. Unfortunately, it is difficult to implement general problem solving method for any field, or a general search technique for any field also. Therefore, the problem reduction methodology has been used and the depth-first search technique with backtracking of PROLOG language is applied [10]. The reasoning agent is responsible to accept sophisticated queries concerning some specific knowledge.

This service is provided by a special application programming interface mechanism provided in the user interface which introduces a set of fundamental data types that can be coherently used for various complex queries and assertions such as list. The power of the solver reasoning Agent can be increased by implementing a larger number of solvers and by enhancing their capabilities to solve complex tasks.

The inference engine of knowledge based system is artificially representing all that sort of untouchable activities of human as mention in section-2. In the next section will be the description and implementation of problem reduction methodology used.

6. Problem Reduction Methodology

The way we represent the problem space is very important for choosing a method to solve a problem, and usually any method to be used highly depending on the problem space representation. In reality the behavior of human problem solving takes place in problem spaces that are either well known or vary only slightly from familiar situations. It is rare for a person to encounter a problem that bears no relation to similar problem solved or observed in past experience. Such knowledge once acquired can be exploited in the problem solving process. Therefore, the problem reduction methodology has been used in the implementation of the knowledge-based system for social relationships through dividing the general-problem into sub-problems and all the solutions of the sub-problems are stored in the knowledge base. The general-problem is that "the user asking queries in natural language then the system must produce the answers in natural language also". So this problem is divided into four sub-problems, these are; reading the query as English sentence and converted into a list of words, finding the relationship and the object

concern, construct the query in PROLOG language, and finally display the answer as English sentence also. Fig.9. presents the PROLOG language's rule.

```
General-problem : - reading_sentence (X),
finding_relation_and_object(X,Rel, Obj),
construct_query (X,Rel, Obj),
writing_answer(X,Rel, Obj).
```

Fig.9 PROLOG language's rule, the general problem

The predicate reading_sentence became general_ problem and must be divided into sub-problems and its task to accept user queries in natural language (as English sentence) and then converting the queries into list of the words of the sentence, Fig.10. shows the PROLOG codes accepts one line in English language as a query then convert the query into a list of the words.

```
reading_sentence([H|T])  :- readln(X),
                            fronttoken(X, H , Rest_x),
construct_list (Rest_x,T),!.

construct_list([X, [H|T])  :-  fronttoken(X, H , Rest_x),
                               construct_list (Rest_x,T).
construct_list (_ , []).
```

Fig.10. Reading English sentence and produce list of the words

The predicate finding_relation_and_object have many forms according to the syntax of the subset of the query language, Fig.11 Presents two samples.

```
finding_relation_and_object(X,Y,Z) :-
                        append([who,is,the], [Y,of, Z|_],X).
finding_relation_and_object(X, Y,Z) :-
                        append([how,many], [Y,has, Z|_],X).
```

Fig.11. Using append predicate to find the relation and the object

The predicate construct_query have many forms according to the stored knowledge base for social relationships, Fig.12. Presents three samples used.

```
construct_query(X,Y,Z)   :-   X=father,
                              father ( Z,Y).

construct_query(X,Y,Z)   :-   X=brother,
                              brother ( Z,Y).

construct_query(X,Y,Z)   :-   X=uncle,
                              uncle ( Z,Y).
```

Fig.12. Construction the predicate for a query

The predicate writing_answer have many forms according to predefine answers, such as the following one:

```
writing_answer(X,Y,Z)   :-   write("the",X,"of",Y,"is",Z).
```

Furthermore, there are many rules have been used in the implementation of the information system for social relationships which are not included in this paper.

7. Application of Knowledge Based System

Since the structure of knowledge based system is as simulation of functional model of human system therefore the applications of knowledge based system is in the areas where human beings work. In this context the application areas vary from one area to another such as diagnoses, maintenance, performance, data base management, controlling, consultation, and manufacturing. In this paper present an application as an information system for social relationships. The application shows how step by step the implementation of knowledge-based system can be done according to the philosophical view presented in this paper. This system can be used in the Humanoid Robotics after replacing the writing queries as spooking queries in order to present the capabilities of answering in spooking natural languages.

Conclusion

In this paper we presenting a philosophy for analysis and design of the knowledge based system as a simulation of the proposed Functional Model of Human System in the Computer System. Based on this view, an implementation of the information processing system for social relationships has been implemented as knowledge-based system, using the PROLOG programming language. The

implementation present new methods of representing the facts associated to the family in the knowledge base and prove that this method is efficient in term of storage and process. Furthermore, the implementation demonstrating the capabilities of PROLOG language of deduction and easy used in natural language processing. The Inference Engine of the knowledge-based system regarded as the search technique of ROLOG language, which is Depth-First-Search with backtracking, the problem solving method which is problem reduction method, and the reasoning agent which is responsible to accept sophisticated queries concerning some specific knowledge. This system can be used to demonstrating the capabilities of the Humanoid Robotics using natural language.

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