Integration of Expert Systems with Intelligent Agents

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Abstract— Software Engineering is difficult with Artificial Intelligence particularly Expert Systems. The Intelligent Agents and Expert Systems has common features like search and actions(reasoning). Software Engineering shall be made easy by Integrating Expert Systems with Intelligent Systems in this paper integrated Expert Systems with Intelligent Agents for Software Engineering because Expert Systems and Intelligent Agents. are having common factors like search engine, reasoning and user interface. Infrastructure for implementation of Intelligent Agents/Expert Systems is discussed. .

Index Terms— Software Engineering, Intelligent Agents, Expert Systems, Intelligent Agent Infrastructure.

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1 Introduction

Softwre Engineeringis difficult in writing AI programming particularly Expert Systems. Intelligent Agents are equivalent to Expert Systems because they are equivalent in many functions like search and inference. It is easy to programming Intelligent Agents with tools like JESS and CLIPS.

An Expert System is program which is provide expertise and act as independent Intelligent Agent.. An Intelligent Aent is component which perform independent activity.which is provide search and reasoning. So, the Expert System and Intelligent Agent has similarities. For example Business Intelligence is application of Expert Systems and Intelligent agents.

In the following, Intelligent Agents and Expert Systems are discussed with common features, Integration of Expert Systems with Intelligent Agents and different types of Intelligent Agents and Expert Systems.

2 Expert Systems

Expert systems are programs which provid with expertise of some application field. Expert system has mainly three components
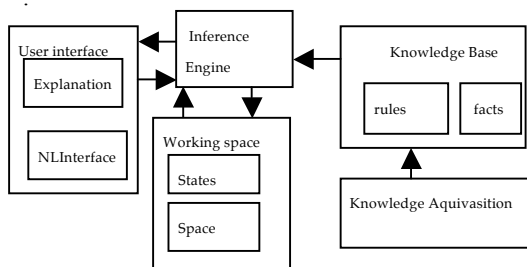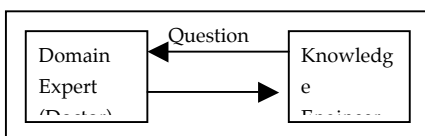.

Fig. 2.1 Expert System

Fig.2.2 Question Answering Sub-System

Knowledge base: The knowledge engineering encode the knowledge from the domain expert using knowledge acquisition and represent in one of the form such as rule , frames, semantic nets, conceptual dependency and scripts. The acquired knowledge may be uncertain, so such knowledge may be treated with fuzzy logic.

Inference engine: The inference engine applies control strategies and reasoning techniques on the knowledge base.

Workspace: The expert systems may have large knowledge base. It takes much time when processor approaches the main memory to fetch the knowledge. The workspace must be provided for fast access. The techniques used such as blackboard systems for appropriate information using the index method partitioning the knowledge base.

User interface: User interface provide framework to communicate the user and system. It provides knowledge base manager.

Expert systems are class of intelligent systems in Artificial Intelligence, the key component of these systems is Knowledge base. The knowledge base is representation considered here as rule-based. For instance, the knowledge base is defined by rule-based with fact and rules.

For instance,

x is A
y is B
If x is A than y is B
Where "x is A" and "y is B" are the facts, and " if x is A than y is B" is rule.

If the knowledge base is incomplete, imprecise, vague and inconsistent than Fuzzu Logic[] is needed to deal such in information in exert systems.

Usually expert system is single system that captures application expert knowledge base and provides solution. Some times expert systems are need cooperation and coordination for their solution in some applications like Decision making in business. The decomposition of special experts organized in an individual, linear, circular, and hierarchical and network fashion. Some times techniques may be parallel, concurrent and distribution. The decomposition several types of expert systems may be represented as class of expert systems.

3 Class of Expert systems

The Expert systems are to be cooperated and coordinated and these expert systems are similer to Intelligent Agents.
Individual Expert systems: The development of expert systems for application is treated as hole. The individual expert system takes expertise of application from single expert and provides solution.
Linear expert systems: The systems are divided in to umber of

special experts. Each expert takes expertise and provides solution. These out come expertise are input for next expert and goes on. **Circular expert systems**: The systems are divided into number of special experts like in linear expert systems. The expert solution of the last expert system l is input expertise for the first system. The solution is provided until all the systems consulted.

Hierarchical expert system: the system is divided in to miumber of special experts and arranged in hierarchical for some applications such as decision making of hierarchical experts in business system and communicate at different levels of experts.

Network expert system: The system is divided in to number of special experts and communicates experts in some applications such as sales experts systems.

4   Techniqes for Expert Systems

Parallel expert systems: The divided system in to number of experts is some times independent. These experts shall be processed parallel. Usually in   applications, expert system is to processes large knowledge base, so the parallel processing technique will be very useful.

Distributed expert systems: Some times the expert systems are to be coordinated and cooperated depending on application. The expert systems are to be co-ordinate and communicate for solving the problems. In   this case, the communication of information among the expertsystems are needed. The information is distributed and solves the expert problems with Expert systems/Intelligent Agents.

.**Concurrent expeal systems**: in the distributed expert systems, the experts may be independent or depending on the application and   these experts are to be synchronized. The distribution and synchronized processing is required in the concurrent process for the expert systems/ Intelligent Agents.

5   Intelligent agents

Software agent is component which performs independently. An Intelligent Agent is Software Agent which is incorporated some intelligence like Expert systems. Intelligent Agent is defined as software component which act intelligently on environment changes and use's input [5, 9]. Intelligent Agent reflects the processing independently like Expert System [1].
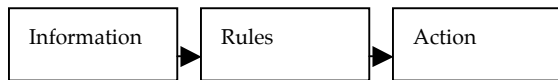

Fig. 5.1 Intelligent Agent

Intelligent Agent is created based on the requirement of domain application, the Intelligent Agent planner provide alternatives or choices and Intelligent Agent manage provided changes and removal of data.

Characteristics of Intelligent Agent:

- ▸ Intelligent Agent shall be run independently on behalf of the user
- ▸ Intelligent Agents are independently accessible.
- ▸ Intelligent Agents are easily modifiable according to the changes in the application domain.
- ▸ Intelligent Agent must perform automatically removable of resources. Intelligent Agent based framework must provide user interface.
- ▸ Intelligent Agent must provide search

and operation manager.

▸

6   Integration of Expert Systems with Intelligent Agents

An Intelligent Agent is created and run on its own   like Expert System because they have common features like search engine, knowledge base and work space. The Intelligent Agent run on its own and communicates the other Agent through the message passing. The Intelligent Agent can stop at any time and restart for execution. Each Intelligent Agent contains message methods. These methods of incoming messages are to and from another Intelligent Agent, and these message methods are synchronized. The message request method will allow or wait by the other Intelligent Agent. Fig.6.1 shows the Intelligent Systems equivalent to Expert Systems.
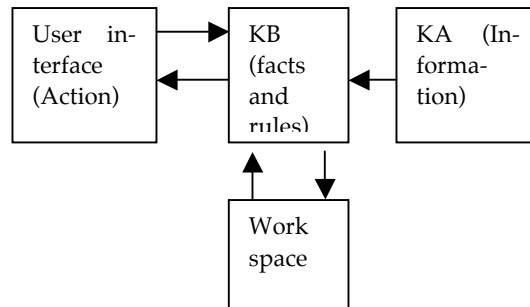
KB: Knowledge Base   KA: Knowledge Acquisition

Fig.6.1 Intelligent Agent equivalent to Expert System

The Software Agents are cooperated and coordinated by a set of distributed Intelligent Agents with Multi Intelligent Agents. The Intelligent Agent conceptual model consists of Intelligent Agent model and domain semantic concepts This Intelligent Agent model is to define Intelligent Agents, communications, framework and distribution. The domain semantic concepts are semantics, goals and concepts of the application domain.

In the multi Intelligent Agent system, each Intelligent Agent act independently on behalf of the user. The multi Intelligent Agent systems co-ordination and co-operation in the application systems like Business, Medical and e-Governance.

Intelligent Agents has user interface. Natural Language interface will provide by Intelligent Agent.

The are different kind of Intelligent Agents like home Intelligent Agents, application Intelligent Agents, gateway Intelligent Agents and kernel Intelligent Agents. Different Intelligent Agent is discussed briefly in the following.

User interface: Intelligent Agent: This Intelligent Agent must provide interface. The interface provided through the Intelligent Agent based framework, search and inference.

.**Home Intelligent Agents**: Home Intelligent Agents work on behalf of the user. The home Intelligent Agents receive the messages on the request and pass through the application Intelligent Agents, and respond to the request.

Application Intelligent Agents: The application Intelligent Agents performs the domain semantic concepts. It receives the requests and communicates on the co-ordinate architecture. The co-ordinate architecture consists of operation environment, a shared workspace, concurrency and distribution.

Gateway Intelligent Agents: The gateway Intelligent Agents receive the requests of the application Intelligent Agents and provide corresponding response back to the appropriate Intelligent Agent.

The Common Gateway Interface technology is used for gateway Intelligent Agents.

Kernel Intelligent Agents: The kernel Intelligent Agents provide services to the application Intelligent Agents. It provides access to the local workspace provide mobility of the Intelligent Agents on different machines, distribution and concurrency services.

The characteristics of multi Intelligent Agents

- Easily modifiable according to the changes in the application domain
- The Intelligent Agents must coordinate and cooperate among themselves
- The Intelligent Agents work in the distributed environment over the Internet
- The Intelligent Agents must perform automatically removable of resources
- The Intelligent Agent-based framework must provide user interface, it must provide search and operation manager
- Synchronized the communication Intelligent Agents
- The Intelligent Agent is independently accessible
- Intelligent Agents can run and independently can interact

7 Intelligent Systems Infrastructure

The Intelligent Agent architecture contains Intelligent Agent conceptual model and Intelligent Agent frame work [4].

For instance, Intelligent Agent architecture consists of multi Intelligent Agents, Web technology and Java technology and implements cooperation, coordination, concurrency and distribution of Intelligent Agents/ expert systems.

Intelligent Agent technology is the implementation of Intelligent Agent architecture. Intelligent Agent architecture need coordination among the Intelligent Agents for distributed applications and for implementation requires mechanism like remote procedure calls and message passing which provide an application programming interface for posting messages and receiving messages. Intelligent Agent technology use object model [6, 7, and 8]. An Intelligent Agent is object acts or executes on its own and it respond to the incoming messages. Intelligent Agent technology creates the objects and provides semantics of the domain concepts. The messages are exchanged between the Intelligent Agent objects or components.

Intelligent Agent technology described with two techniques, Intelligent Agent analysis and Intelligent Agent design. Intelligent Agent technology l use object-oriented technology. The same object-oriented analysis and design can be adapted to Intelligent Agents/Expert Systems. The Intelligent agent technology/Expert System shall be implemented using Programming Languages Lisp, Perl and Java or shall be implemented using Tools IBM Aglets, JESS, CLIPS and EMYCIN.

8 Conclusion

Software Engineering is difficult to program with Artificial Intelligence and Expert Systems. Software Engineering is made easy by integrating Expert Systems with Intelligent Agents Expert systems and Agents are having common factors like search engine and inference engine. In this paper, Integration of Expert Systems with Intelligent Agents is discussed. .Infrastructure for Intelligent Systems/Expert Systems is discussed for application development. Intelligent The Expert systems/Intelligent Agents shall be implemented for application like Medical, Business Intelligence, Stock marketing using tools IBM Aglets, JESS, CLIPS.

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