4. Expert Systems

4.1. Definition

Feigenbaum: "An intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solution." (Davis and Buchanan, 1977).

Today, with the new advances, as expert system could be defined as:

"A computer system that simulates the learning, memorization, reasoning, communication and action processes of a human expert in a given area of science, giving, in this way, a consultant that can substitute the human expert with reasonable guarantee of success." (Castillo and Aluarez, 1991).

The ultimate aim of every expert system is the substitution of the human expert and to surpass his performance. In addition, there are many others:

- quality improvement of human expert knowledge,
- survival of knowledge when the physical death of the human expert occurs,
- increasing the number of experts and making existing knowledge more accessible to people,
- lowering the cost of knowledge.

Roles to be played by expert systems are diverse and mainly correspond to those played by human experts. Among them worthy of mention are the following:

- providing information
- solving problems
- giving explanations

Unique feature of expert systems over human:

- effectiveness
- efficiency
- awareness of limitations

Examples of expert systems:

- medical diagnosis - MYCIN
- mathematics - symbolic solution in algebra, calculus, differential equations
- computer - translator

4.2. Components of an Expert System

At the beginning, no one thought it was possible to have an expert system without the participation of a human expert. However, today we know that this is possible based on data or experience. Nevertheless, most of the existing expert systems were born from the joint work of human experts and knowledge engineers (Shortliffe *et al*., 1979; Mulsant and Servan-Schreiber, 1984). The first provides the knowledge in the area of concern and the second collaborates with him translating this knowledge so that the system can understand it and perform the knowledge acquisition process. Communication between both is a difficult process. As a result of this process, the human expert will become even more expert in his field, after being forced to order, structure and establish the basis of his knowledge, motivated by the invasion of questions the knowledge engineer will ask him, in order to get the desired information for the system. The engineer will not be satisfied with answers only and will require reasons and explanations of rules, controlling the coherence of knowledge as a whole.

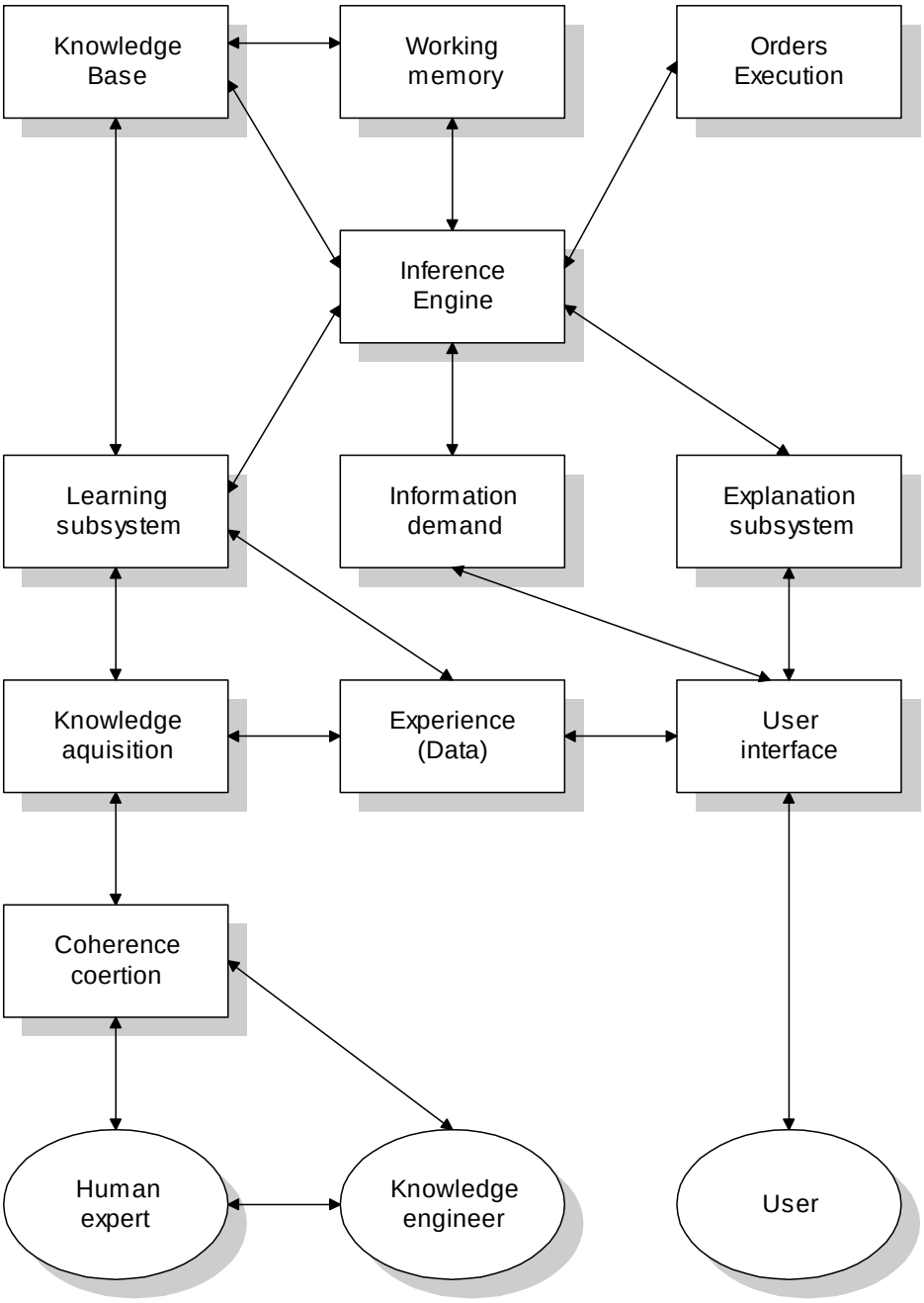

Fig. 4.1. Elements of an expert system.

All elements are clearly related to the roles of an expert system. Among others, it is worth mentioning the following:

- knowledge acquisition
- knowledge storage
- inference and reasoning
- demand for new information
- learning
- uncertainty propagation
- helping experts in giving coherent knowledge
- explaining conclusions
- taking actions as a consequence of reasoning
- control of knowledge coherence.

4.3. Historical Perspectives

Expert system is a branch of Artificial Intelligence (AI). According to Barr and Feigenbaum (1981),

"Artificial Intelligence is the part of computer science concerned with designing intelligent computer systems, that is, systems that exhibit the characteristics we associate with intelligence in human behavior -- understanding language, learning, reasoning, solving problems, and so on."

Artificial Intelligence deals with many areas. Among the most important are:

- automatic proof of theorems
- intelligent games
- natural language processing
- robotics
- artificial vision
- expert systems

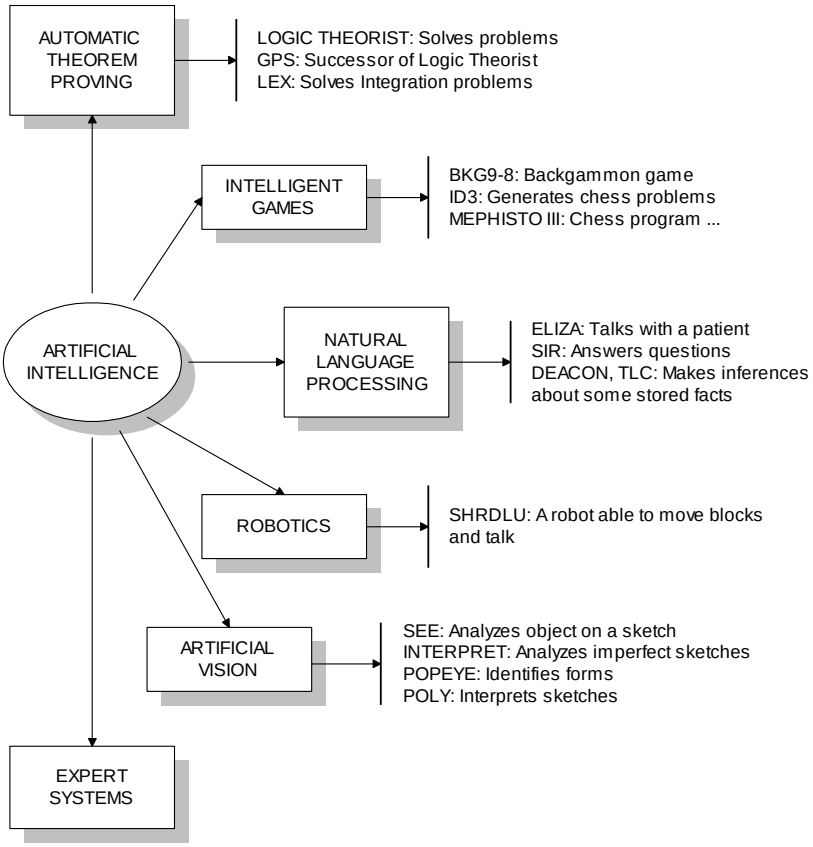

Fig. 4.2. Some branches of Artificial Intelligence.

Expert systems have been one of the AI fields of intensive research. They deal with programs able to help or substitute humans in some areas where expertise is required in order to solve problems.

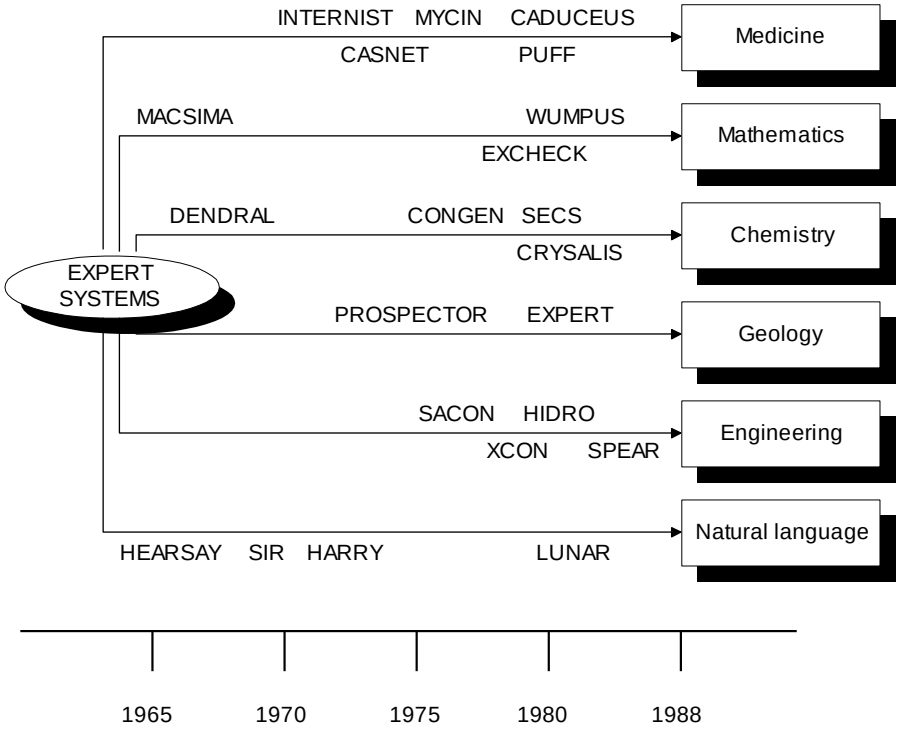

Fig. 4.3. Some expert systems.

4.4. Different Development Levels in Expert Systems

The degree of participation and the relation of users with expert systems can be very diverse. As one example, we can distinguish the following four typical cases of users:

(1) user of an expert system which has been completely developed by other people.

(2) user of a shell to incorporate the knowledge base.

(3) user of a tool to implement the inference engine and the knowledge base.

(4) user of a high level programming language (LISP, PROLOG, C, PASCAL, etc.) to define the structure of the knowledge base, the inference engine, the explanation mechanism, the use interface, etc.