**Chapter 14**

**Expert System**

**The chapter consist of Short type Questions &Answers , Descriptive Question & Answer and MCQs & answers.**

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# Short type Questions & Answers

Q Why a production system model was used to implement the first rule–based expert systems? Answer: Production systems (rule–based systems) became a convenient platform for models of human cognition. Because the aim of ES is to replicate human expertise, production rules (IF–THEN rules) can be used to represent and encode the knowledge of a human expert. Then the production system can apply this knowledge to new problems.

## Q What is the main purpose of Expert Systems?

Answer: The main purpose of ES is to replicate knowledge and skills of human experts in a particular area, and then to use this knowledge to solve similar problems without human experts participation (computationally).

## Q What is the main difference between conventional computer programs and production systems (rule–based systems)?

Answer: Conventional programs use pre–programmed algorithms usually with many control flow statements (loops, iterations) that clearly define the order in which the components of a program should work. Production systems use only IF–THEN rules, and there are no special instructions about the order in which they should be used. The system decides by itself which rules are used based on the situation (problem state, current goal, etc).

## Q Describe at least 3 advantages that expert systems offer organisations thatwould otherwise have to employ human experts.

Answer: There are many different possible advantages, depending on problem domain, organisational structure and design of the expert system. Someadvantages include:

• Increased output / productivity - expert systems can often make decisions much faster than humans, or deal with larger problems thanhumans. An example would be the XCON system that resulted insped up order processing by DEC.

• Availability of scarce / expensive expertise - while human experts areexpensive and can only be in one place at one time, once developedexpert systems are cheap to duplicate and can therefore offer theirexpertise at many locations simultaneously.

• Also the expertise of an ES may be used to provide training withoutthe need for so many human teachers.

• Reduced need for human work in dangerous situations - a self-sufficientrobot powered by an expert system can be used on Mars or underwateror in buildings that have collapsed, reducing human expose to dangerand speeding up rescue or exploration work.

## Q Why do many people say they will not trust a ‘robo-doc’ medical diagnosis expert system?

For ES to be useful users have to be able to trust their conclusions. When the conclusions have very important implications (such as life and death, large amounts of money, significant implications of the quality of people’s lives) it is only natural that people might prefer to trust in human decision makers. While it would be accepted that human decision makers make mistakes, they do not get ‘corrupt programs’ or behave erratically (unless mentally unstable) - human expertise exhibits graceful degradation in that as situations become less like those the expert has previously experienced, humans are still able to make reasonable decisions in most cases. Much work in modern artificial intelligence involves improving the ’grace’ of the responses of computer systems to unexpected situations. For many the best solution is to augment human expertise with ES. So, humans have assistance with their decision making (perhaps having suggestions made they had not thought of), and computers have their performance validated for unreasonable behaviour in the light of extraordinary combinations of circumstances.

## Q What are the main areas of application of ES according to Waterman (1986)?

Answer: The main areas of ES application are: Interpretation — drawing high–level conclusions based on data. Prediction — projecting probable outcomes. Diagnosis — determining the cause of malfunctions, disease, etc. Design — finding best configuration based on criteria. Planning — proposing a series of actions to achieve a goal. Monitoring — comparing observed behaviour to the expected behaviour. Debugging and Repair — prescribing and implementing remedies. Instruction — assisting students in learning. Control — governing the behaviour of a system.

## Q Describe the phases of designing an expert system? What term is used to call the whole process?

Answer: There are three stages in designing ES: Knowledge acquisition : the process of getting the knowledge from experts (by interviewing and/or observing human experts, reading specific books, etc).

Knowledge representation : selecting the most appropriate structures to represent the knowledge

Knowledge validation : testing that the knowledge of ES is correct and complete. The whole process is called knowledge engineering.

# Descriptive Question & Answer

Q Describe the main parts of an expert system. Show how they interact with one another.

A generic model is shown here

**User**

**Knowledge Base**

**Inference Engine**

Facts

Expertise

**Expert System**

And described as follows

The user (or more likely a knowledge engineer) will populate the knowledge base with facts.

The user will then interrogate the knowledge base via a suitable user interface. In turn the Expert System will supply the user with the answer in the form of “expertise.” The expert system actually comprises two main components (knowledge base and inference engine). The inference engine is responsible for using the knowledge base and, where necessary, it will infer new facts that have not explicitly been stored in the knowledge base

.

## Q Describe the advantages and disadvantages of an expert system

I will give one mark for each correct answer. Other answers, than those described below are acceptable as long as they are reasonable.

The following advantages were described in the lectures and were presented in the lecture handouts – the students only need to describe five.

* **Increased availability :** Expertise is available on any suitable computer.
* **Reduced cost :** The cost “per expert” is greatly reduced
* **Reduced danger :** Non-human experts can be used in dangerous environments.
* **Permanence :** The expert is permanent. Unlike a human which has time off, goes sick, does not work 24 hours a day and eventually retires and/or dies.
* **Multiple expertise :**Multiple experts can exist inside one expert system. This can either be expert knowledge from different areas or can be expert knowledge from experts in different fields, which can combine into an expert system that can be greater than any one single expert.
* **Increased confidence :** Expert systems can provide a second opinion that can be used to reinforce the decision made by a human expert. Or it could be used to arbitrate between two conflicting decisions by two human experts.
* **Explanation :** An expert system can explain its decision in detail and explain the decision every time. A human expert may be unwilling to do this, may make a mistake in explaining the reasoning or may not be able to explain how they reached the decision.
* **Fast response :** An expert system may be able to supply an answer faster than a human expert. In some emergency situations this may be an essential feature of the system.
* **Steady, unemotional and complete response at all times :** Whereas a human may not be able to perform at peak efficiency at all times an expert system can always perform at the same state of efficiency and without becoming emotionally involved in the decision.  
  An expert system will not be affected by stress or fatigue.
* **Intelligent tutor :** The expert system may be able to provide tuition for “novice experts.” The system may also allow sample decisions to be made to see what effect it would have.
* **Intelligent database :** Expert systems have access to an intelligent database which is a source of structured knowledge and can be updated as necessary.

Disadvantages (described in lectures and on handouts)

* **Explanation Facility :**Although the benefits of an explanation facility can be invaluable, the explanation may be shallow and it may not be possible for the user to seek clarification of a certain point. With a real expert you can interrogate them until you are satisfied with the answer.
* **Updating the Knowledge Base :**Updating the knowledge base, especially if the base is large, could be difficult and may lead to side effects which are either difficult to predict or could not be predicted at all.
* **Searching the Knowledge Base :**Searching for a solution may depend (almost definitely will do) on how the knowledge is represented and efficient searching can vary considerably from one representation to another for a given problem.

## Q Why is MYCIN considered important in the development of expert systems and how did it lead to EMYCIN?

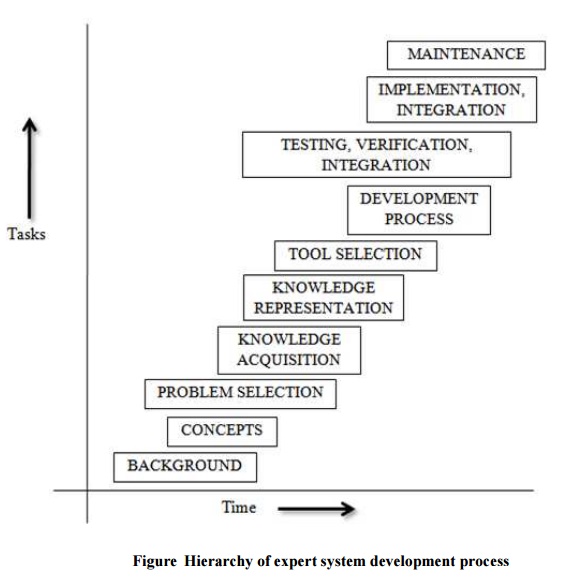
* It demonstrated that expert systems could be used for practical, real-world problems.
* It was the test bed of features such as an explanation facility, automatic acquisition of data and intelligent tutoring.
* It demonstrated the feasibility of the expert empty shell. MYCIN separated the knowledge base from the inference engine which meant that the main parts of the expert system could be re-used with a different knowledge base.  
  The shell produced by removing the medical knowledge was called EMYCIN (Empty-MYCIN).

## Q What Is difference between expert system and conventional system

The principle distinction between expert systems and traditional problem solving programs is the way in which the problem related expertise is coded. In conventional applications, problem expertise is encoded in both program and data structures. In the expert system approach all of the problem related expertise is encoded in data structures only, none is in programs. Generally in expert systems, the use of knowledge is vital. But in conventional system data is used more efficiently than knowledge. Conventional systems are not capable of explaining a particular conclusion for a problem. These systems try to solve in a straight forward manner. But expert systems are capable of explaining how a particular conclusion is reached and why requested information is needed during a process. However, the problems are solved more efficiently than a conventional system by an expert system. Generally in an expert system, it uses the symbolic representations for knowledge i.e. the rules, different forms of networks, frames, scripts etc. and performs their inference through symbolic computations. But conventional systems are unable to express these terms. They just simplify the problems in a straight forward manner and are incapable to express the “how, why” questions. Also the problem solving tools those are present in expert system are purely absent in conventional systems. The various types of problems are always solved by the experts in an expert system. So the solution of the problem is more accurate than a conventional system.

## Q Show the The Development Process of an Expert System

By the definition, an expert system is a computer program that simulates the thought process of a human expert to solve complex decision problems in a specific domain. The expert system’s knowledge is obtained from expert sources which are coded into most suitable form. The process of building an expert system is called knowledge engineering and is done by a knowledge engineer. The knowledge engineer is a human with a background in computer science and AI and he knows how to build expert systems. A knowledge engineer also decides how to represent the knowledge in an expert system and helps the programmers to write the code. Knowledge engineering is the acquisition of knowledge from a human expert or any other source. The different stages in the development of an expert system are illustrated in figure.



Some latest developments in the expert system area are as follows:

1.     Availability of many tools that are designed to expedite the construction of expert system at a reduced cost.

2.     Increased use of expert systems in many tasks ranging from help desks to complex military and space shuttle applications.

3.     Use of multiple knowledge bases.

4.     Improvements in knowledge acquisition.

5.     Use of the internet to disseminate software and expertise.

6.     Increased use of object oriented programming approach in knowledge representation.

7.     The multiple use of heuristic knowledge in several applications.

8.     Enables the user to think about hypothetical reasoning.

## Q What are various Benefits of Expert System:

An Es can complete its part of the tasks much faster than a human expert.  
  
2. The error rate of successful systems is low, sometimes much lower than the human error rate for the same task.  
  
3. ESs make consistent recommendations  
  
4. ESs are a convenient vehicle for bringing to the point of application difficult-to-use sources of knowledge.  
  
5. ESs can capture the scarce expertise of a uniquely qualified expert.  
  
6. ESs can become a vehicle for building up organizational knowledge, as opposed to the knowledge of individuals in the organization.  
  
7. When use as training vehicles, ESs result in a faster learning curve for novices.  
  
8. The company can operate an ES in environments hazardous for humans.

# MCQs & answers

**1.** \_\_\_\_\_ are knowledge based system to which present rules are applied to solve a particular problem.

(a) ES

(b) AI

(c) KBS

(d) Base rule 0

**2.** Which of the following is not true about expert systems?

(a) Expert systems are collections of human knowledge

(b) Export systems are expensive to design

(c) Export systems are usually designed to run on small general-purpose computers

(d) Maintenance support may be difficult to obtain for an expert system

**3.** Which of the following is a component of an expert system?

(a) Explanation module

(b) Knowledge base

(c) Natural language interface for the user

(d) All of the above

**4.** \_\_\_\_\_ is an application of the computer where the computer makes decisions or judgments that appear to require human intuition, reasoning and intelligence.

(a) AI

(b) ES

(c) KBS

(d) Base rule

5. In LISP, the function returns t if <integer> is even and nil otherwise:

(a) (evenp<integer>)

(b) (even <integer>)

(c) (numeven<integer>)

(d) (numnevenp<integer>)

6. Which of the following is an advantage of using an expert system development tool?

(a) imposed structure

(b) knowledge engineering assistance

(c) rapid prototyping

(d) All of the mentioned

7. Input segments of AI programming contain(s)

(a) sound

(b) smell

(c) touch

(d) None of the mentioned

8. In LISP, the function evaluates <object> and assigns this value to the unevaluated <sconst>.

(a) (constant <sconst><object>)

(b) (defconstant<sconst><object>)

(c) (eva<sconst><object>)

(d) (eva<object><sconst>)

**Answers**

**1. (a) 2. (d) 3. (d) 4. (a) 5. (a) 6. (d) 7. (d) 8. (b)**