Questions 6

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Question 1

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).*

Question 2

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).*

Question 3

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.*

Question 4

What types of knowledge are used by neural networks and by rule–based systems? What kinds of systems are they with respect to the type of knowledge they use?

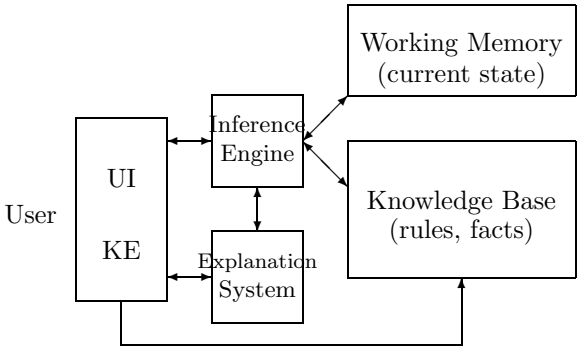
Answer: *Neural networks use sub–symbolic knowledge stored in a form of weights of many neurons. Rule–based systems use symbolic knowledge stored in a form of rules and facts. Thus, neural networks are sub–symbolic while rule–based are symbolic systems.*

Question 5

What are the main components of a rule–based system?

Answer: *The main components are:*

- *Knowledge base*
- *Working memory*
- *Inference engine*
- *Explanation system*
- *User interface*
- *Knowledge base editor*



Question 6

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**.

Question 7

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.*

Question 8

Why is knowledge acquisition often referred to as the ES 'bottleneck'?

Answer: *Human experts are rare, expensive to train and limited in how much they can do. While humans may be expert at problem solving they may not understand much about how their perform their decision making. Therefore, while there may be many problem domains suitable for ES development, the cost and time and effort to acquire knowledge from human experts often means projects take a long time, are expensive or may never to started since they would be uneconomic.*

However, with ever improving methods of automated processing (and 'machine learning') from data in electronic form, in problem domains where there are large amounts of data available, it may soon be possible to automate all or part of the knowledge acquisition process. Such developments may be one way to reduce the reliance on human experts and begin to 'unblock' the bottleneck of knowledge acquisition at present.

Question 9

Why do many people say they will not trust a 'robo-doc' medical diagnosis expert system?

Answer: *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.

Question 10

Describe at least 3 advantages that expert systems offer organisations that would 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. Some advantages include:*

- *Increased output / productivity - expert systems can often make decisions much faster than humans, or deal with larger problems than humans. An example would be the XCON system that resulted in sped up order processing by DEC.*
- *Availability of scarce / expensive expertise - while human experts are expensive and can only be in one place at one time, once developed expert systems are cheap to duplicate and can therefore offer their expertise at many locations simultaneously.*
- *Also the expertise of an ES may be used to provide training without the need for so many human teachers.*
- *Reduced need for human work in dangerous situations - a self-sufficient robot powered by an expert system can be used on Mars or underwater or in buildings that have collapsed, reducing human expose to danger and speeding up rescue or exploration work.*