Define what is meant by the term Artificial Intelligence

Artificial intelligence is a branch of computer science that deals with the creation of computer programs that can provide solutions that otherwise humans would have to solve.

On a broader spectrum artificial intelligence attempts to imitate human behavior and intelligence to generate these computer programs.

However artificial intelligence is the youngest of studies, and is evolving every day.

The ultimate aim of artificial intelligence and its study is to imitate and/or duplicate intelligence of humans in computers and robots.

Artificial Intelligence improves productivity, personnel upgrading, new training and to aid in the solving of difficult problems.

With the aid of a suitable diagram, illustrate the branches of A.I and define where Expert Systems reside within it.

[http://distancelearning.ksi.edu/demo/509/ch01a.html]
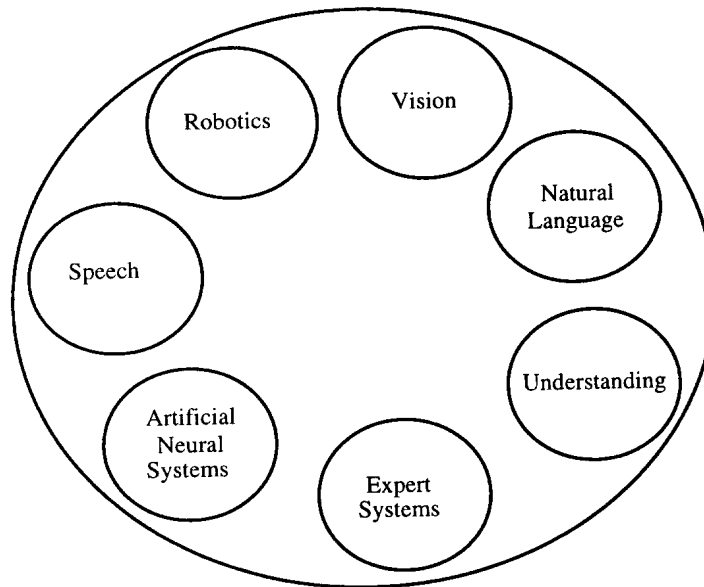
The diagram above illustrates the seven (7) areas that Artificial Intelligence is comprised of. Of course with the speed of progression of such a complex study such as Artificial Intelligence these areas are rapidly growing however they are more commonly defined in to one of these seven 'branches'.

"AI has many areas of interest. The area of expert systems is a very successful approximate solution to the classic AI problem of programming intelligence."
[[http://distancelearning.ksi.edu/demo/509/ch01a.html]

Expert systems are a branch of Artificial Intelligence that makes extensive use of specialized knowledge to solve problems at the same level as a human expert.

With the aid of suitable diagrams, define what an expert system is and its' functional and structural components.

One of the major results of the study of Artificial Intelligence is the development of a method that allows systems to be built that closely resemble human intelligence and logic in their implementation and evolution.

These systems effectively emulate human expertise in well defined problem domains.

The systems are recognised and commonly known as 'Expert Systems'.

An expert system is used to effectively advise, diagnose and troubleshoot problems that previously were performed by human experts.

The main advantage of using expert systems is that they bring specialised knowledge straight to the fingertips and observation of a novice.

An example of when an expert system would be used is as follows;

In business when people retire or leave expert systems are used to detain the vital information that would otherwise leave with the humans.

The basic shell architecture of an expert system is illustrated below:

Basic ES Structure

[http://www.ai.kun.nl/cursusinfo/aicourses/co313/]
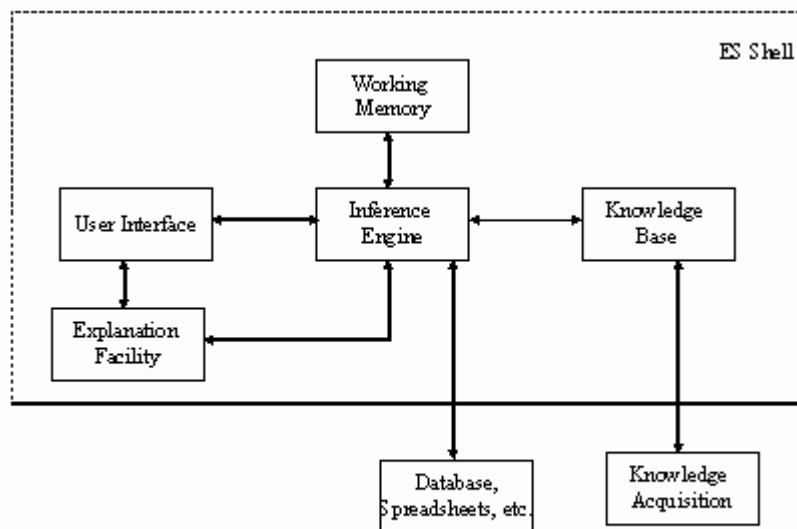
As the diagram shows there are three vital components that give an expert system its structure, each of which is described below.

User Interface

This is the area in which the user views, this usually is a simple and easy way of navigating a system and its areas.

The function of the user interface is to present questions and information to the operator and supply the operator's responses to the Inference Engine.

The interface is important because any values entered by the user must be received and interpreted. The interface and its construction is important in that it checks the the responses of the user to ensure that they are of a correct input type (validation). If the user is to incorrectly input a response the interface's job is to display to the user that they have entered the information incorrectly.

As previously explained the user interface is cross referenced with the inference engine, in that the communication is more often than not constant. This is done via the UICB (User Interface Control Block).

The user interface is extremely important if the user is to get the up most benefit from the system, it must not challenge the user or make it difficult or uncomfortable for them to find what they want.

This is because the user interface is where all the information is to be inputted, therefore if a comfortable interface is given to the user they are more likely to enter more accurate and quantity of information because they are not under pressure from the interface.

Expert systems use interactive dialogues to ask questions to the end user, by prompting the user with singular questions sequentially it can then select appropriately which question it is going to ask next to lead to the right result for the system.

Inference Engine

The inference engine has a simple definition; it is the brains of the expert system.

The inference engine is simply the brains in the expert system that implements the reasoning behind a problem solution.

The inference engine is basically made up of numerous rules that in turn draw up conclusions to proposed questions. These rules are simply IF...THEN statements that inevitably draw up the conclusion. These are used because it uses elimination and works closer to human understanding. The following shows a demonstration and explanation of this.

Problem: What sort of wine on average do people drink?

Q. Do You Drink Wine?

A. No

As the problem is to find out what sort of wine is drank on average, the expert system knows from the above answer that there is no need to commence on asking any more questions as they do not drink wine therefore no other questions are going to be appropriate.

Knowledge base

The knowledge base contains the knowledge necessary for understanding. Formulating and solving problems.

A knowledge base is comprised of two elements:

- Facts
- Special Heuristics (rules of thumb).

In reality knowledge is the primary raw material of any expert system, therefore it is critical for any expert system to contain it.

It is essential that the expertise required for building the knowledge base is readily available when starting to plan on building an expert system.

The knowledge base is extremely valuable alone, but when it is part of a system and is being used for a specific purpose i.e. teaching and testing its value is greatly increased.

Knowledge base's can also learn and expand its knowledge, for example if a rule has been entered that has not been used before but is known to be factual, i.e. ' if roads are wet, then roads are slick' then it is added to the database.

Define what an expert system does and how it achieves it

An expert system simply uses knowledge and decision making logic to find solutions to problems that would otherwise be solved by human intelligence.

Expert systems use rules and the knowledge in combination to find the best solution to the problem.

An expert system simply automates decision making and problem solving techniques in a domain which saves time and money as human intelligence is not required to be purchased to find a solution.

Dependant on how the expert system is used is highly conclusive on how the expert system achieves its tasks, for example in the medical field an expert system is used as a decision support, this is where a conclusion is made in the doctor's brain, but is then checked and checked against the knowledge and experience of the expert system. The most supported and use expert system technique is that of 'decision making' this is where prior entered knowledge and expertise is used to train or 'make decisions' beyond the level or expertise of the user.

Some expert systems however use set rules to determine an outcome, this is in the format of using IF…THEN…ELSE statements, this is where a decision is made or concluded in a particular state or situation. This is where conditions are checked against one another for example:

IF X is not = 5   THEN X = 10   ELSE "invalid figure"

Expert systems are made up on thousands of these statements, which are more commonly known as 'inference rules'

Expert systems and their evolution have brought about a clever methodology in which the rule base is segmented, allowing for elimination of segments of knowledge/data that are not relevant to the application process in hand.

Discuss the role and use of A.I in today's' society. Illustrate your answers with supportive evidence and findings.

Artificial Intelligence is a scientific breakthrough which has allowed the ultimate and extreme use of computers. Computers can do everything faster and more accurate than a human, therefore it is common sense to use them to do the tasks that humans find difficult or challenging.

A good example of this is Amazon Stores who trade via e-commerce over the internet.

Each customer has its own position in the database, the expert system closely monitors recent purchase's of the client and from this it uses its knowledge base to select categories of books that it thinks the customer will be interested in.

For example a customer purchase's a book on understanding computer science and a couple of days later orders a book on Artificial Intelligence, the database has learnt that this client is interested in computer related subjects and items, therefore other recommended items can be displayed to the client. This technique is a very effective marketing technique as it offers ease of use to the client when they want to look for items; this increases productivity levels of the company.

Over the previous decade or so expert systems have been increasingly effective in the medical profession, as expert systems have been created and implemented to help aid the cure and diagnosis of patients. Systems have been set up to allow symptoms to be input which in turn will result in a prognosis of the problem. This saves doctor's time.

A benefit of it is that advantage that the system can learn from the symptoms and results, to eventually combine them with new illnesses and their cure's.

Define what is meant by knowledge elicitation, acquisition and representation. Define why they are used and why they are important roles of the knowledge engineer.

In order for the knowledge base of an expert system to expand and evolve a knowledge engineer have two roles to carry out, they are:

- Knowledge Acquisition
- Knowledge Elicitation

Knowledge acquisition is the process/method used for acquiring the knowledge from human experts or other sources (books, manuals).

Knowledge acquisition can be defined as transferring problem solving expertise from one source to another.

The actual process however seems very easy, but in the real world it is very difficult as the knowledge engineer needs to work in partnership with the expert to convert the expertise in to a coded program.

However before the knowledge is acquired the knowledge engineer needs to identify the problem domain and choose the right expert for the knowledge acquisition. Once these have been completed the preparation of the knowledge acquisition can be planned.

The knowledge is 'captured' in many ways and no single way is the best, the most commonly used form of acquiring the information is via an interview.

The interview however has to be planned and designed effectively before meeting with the expert as the knowledge engineer needs to know exactly what approach they are going to have towards the expert and also what questions they are going to ask and how they ask the question i.e. are they going to be open questions which could lead to another question evolving from it, or are closed questions going to be asked in order to get a definite answer (such as yes/no). However usually a mixture of open and closed questions is asked in order to get an effective balance of knowledge acquisition.

Knowledge Elicitation

Eliciting knowledge is very difficult, this is because there are boundaries to which the brain can scope at a given time and also it is difficult for an expert to talk about their subject in great detail, sometimes experts can just do something without knowing why they do it or how they do it, this is the main reason why expert systems have not become as big as they should be. However interviews are expensive (as you have to pay high prices for the experts' time) they are also very time consuming which means the expert and interviewers will become restless and less willing to co-operate with one another.

Another way of eliciting information is via questionnaires, however although they are easy to produce they are not usually used as they have low return rates, and of the ones that are returned the results may not correspond with the actual true beliefs or behaviours of the individual.

Observations are another method that can be used and sometimes are used, however the results and credibility of this fact finding method is that the results and knowledge elicited is highly dependable on the level of detail of the notes of the observer.

Knowledge Representation
This is the process of effectively describing and mapping expert knowledge along with a meaningful structure.

An example of representing knowledge is using a Semantic Network. This method shows the relationships between the different properties. This then all links together to form a large network, which in turn is the systems knowledge base.

Another representation method is using systematic networks; they represent the path and sequential root that the expert would take to gain a conclusion or solution to a problem. It is very closely matched to that of how a human brain would think in order to reach a final conclusion. It works in a similar way to how a doctor would diagnose a patient.

Define three types of human learning. Describe the differences between these learning methods and the 'learning' capabilities of an Expert System.

Humans ultimately learn in three different ways:

- Learning by experience

Learning by experience is a significant sign of intelligence. Experts are often tested of their ability by simply doing recall tests, this is where they are asked questions in a domain that they are specialized in, and tests have shown that they have a much more rapid response time to the questions than that of non-experts.

A massive rise in Artificial Intelligence brought around the wish for computers to be able to learn from their own mistakes and experiences, an example of this is an expert system called "SOAR" , SOAR is an expert system created by the Carnegie Mellon University and Michigan University, the main operation of the expert system is that of remembering lines of reasoning that have been successful previously, these stored items can later be recalled in similar situations.

- Learning by example

Learning by example is perhaps a preferred approach to learning by most humans, every individual is unique and have different learning style preferences, however in tests and research in to this, it has been found that in a classroom by providing examples that humans can learn without the need for them to experience it in action.

Tests have shown that this method of human learning is more efficient than that of learning by experience.

- Learning by discovery

Learning by discovery is a very difficult method of learning to explain, however the main objective of it is for humans or machines to explore a specific area of subject without having an ultimate goal or aim. It is much like a human playing around with the features of a software package just to explore what things do without actually thinking of consequences etc..

As the summaries of the three human learning types indicate, learning and knowledge acquisition take time and humans do not simply acquire and remember knowledge straight away.

The expertise that a human can achieve however is attained through practicing of a task over and over again, this allows for them to become fluent in their knowledge and to eventually become experts in their domain.

The main difference between novices and experts is that of experience which is gained over years and years of practice and in sequence allow for humans to become experts by instinct of patterns, this meaning that words or phrases addressed as problems can be solved simply by the expert remembering a previous problem and from them learning from that experience.

Machines however use physical memory much like humans do, although it seems a machines memory can reach a limit, a human brain never seems to run out of space. Human memory however are very clever in that they store and organise the knowledge in such a way that it can easily be recalled, however unfortunately as of yet this is not possible by computer machines.

Define the three benefits of Expert Systems, their limitations, categories and activities.

Expert systems bring several benefits to companies and the industry as a whole; a few are listed below:

- Capture knowledge before it disappears with retiring or staff members that are leaving.
- Long term financial savings, because machines are a one off payment and experts are expensive to keep and require a salary every year. Expertise knowledge is very expensive.
- Training purposes saves hiring or using present staff's time for trainees, the system can be used as part of the learning curve.

Although the advantages above are not all that an expert system presents, as with all systems it has its limitations and flaws, these are briefly outlined below:

- Experts who know there field inside out and those who do are not always willing or able to give there complete knowledge to a system.
- Experts all approach and use different methods towards a subject in different ways, this can me misinterpreted and systems are then 'useless'.
- Renting or finding a high skilled knowledge engineer with experience is difficult, not to mention expensive.
- Artificial Intelligence is not completely understood nor trusted by today's society, people tend to look upon it as unproven philosophies, therefore the use and effect of the expert system is quite dramatically decreased.

Expert systems and their architecture and 'way of thinking' is often split in to categories the most popular three are briefly summarized below.

Forward-Chaining is where a set of rules are defined at the start and are fixed, this then gives a set of results when the input is processed.

Backward Chaining as its name signifies is a way of finding a hypothesis/method to a given solution.

Case based reasoning is when expert systems learn from experience, this is done in a fashion that a previous problem is compared to the existing solution and from this the most appropriate and perhaps successful result can be given. The 'store' in which the experience is kept is called the 'knowledge base'.

Define, using supportive evidence, the use of Expert Systems over human experts. Provide documentary evidence supporting your findings.

Lifetime is a massive advantage of an expert system over a human expert, this is because a humans knowledge in a specialized and expertise subject is probably prolonged in a career for a maximum of 40 years (after training) therefore once the expert passes away or retires the company then not only lose the expert they lose all the knowledge associated with him, however this is where expert systems come in, there aim is to capture his/her knowledge therefore the knowledge is never lost and the expert is not as much a loss to the company as they would be without the knowledge elicitation.

As briefly mentioned before the cost of ax expert is colossal in comparison to those of an expert system, the expert system initial set back is quite substantial but in the long term is a very worthwhile investment for both the company and the industries development in the domain. An expert costs a yearly salary not to mention holiday absence, which an expert system does not have; this is where expert systems are becoming largely preferred to in industry, however there is still a lot of time before the requirement for human experts is obsolete. However a human expert systems role in a job can be greatly decreased.

An expert systems decision making is perhaps not as complexed as a human expert, a human takes in to account other surrounding topics relative to the problem, however an expert system uses rules to obey by and in many cases cannot make a decision against rules because of a relevant topic. This is where a human brain has the advantage; however the growth of this subject will no doubt introduce an imitation of a human brain (the goal of AI) which will behave and respond down to every last fragment of a humans thinking.

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