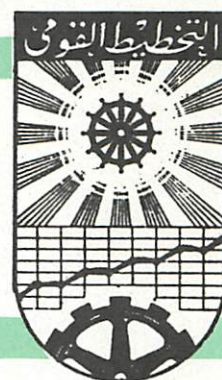


# ARAB REPUBLIC OF EGYPT

## THE INSTITUTE OF NATIONAL PLANNING



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EXPERT SYSTEMS : AN OVERVIEW

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**ABSTRACT :**

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At present, the most important application areas of Artificial Intelligence (AI) would be centered on knowledge engineering and ,more particularly, on Expert Systems (ESs).

Today, ESs are used in business, science, engineering, manufacturing, and many other fields.

This memo introduces just the fundamental principles of ESs and their advantages in real world applications. Knowledge representation, searching methods, inference mechanism are also included.

The memo. also mentions the development of ES shells and/or programming languages which minimize the effort needed for constructing a knowledge representation system and an inference engine for a particular applications.

At the end, it ends with the future of ESs in general.

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## **Introduction to Artificial Intelligence (AI):**

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The intelligence of a human being is the ability to understand, think, and reason on the available knowledge. It also includes the ability to update and upgrade this knowledge.

Generally, AI is that area of a computer science concerned with trying to make computers as smart as human beings. That is to make computers able to speak, listen, see, think, reason, understand, and do manual jobs.

But as "intelligence" is uncertain word, so is AI is not a well-defined field. AI is often means advanced software engineering, sophisticated software techniques for hard problems that cannot be solved in any easy way.

Another thing, AI often means the non-numeric methods of solving problems. Non-numeric methods are often "common sense" methods, not necessarily the best ones.

So, AI programs like people are usually not perfect, and even makes mistakes.

The AI domain is usually divided into several fields :

1, Natural Languages Processing : Natural languages refer to human being languages, such as english, arabic,etc. It will be nice if we can communicate with computers using our languages, and not the conventional computer languages. The AI field concerned with communicating with computers in our languages is called natural language processing.

2, Voice Synthesis and Recognition : The AI field concerned with communicating with computers directly by human voice is known as voice synthesis and recognition field. General speaking, voice recognition means making computers able to listen (understanding our speech).

3, Computer Vision : This field is devoted to process of emulating the human sight. It looks for techniques to analyze and interpret visual information in order to replace the human sight.

4, Robotics : The robotics is the field which concern with simulating both the human peripherals and the part of the human brain that controls these peripherals of the human body.

5, Understanding (Inference) : This field is mainly devoted to the researches leading the computer to remember complicated interrelated facts, and draw conclusions from them in a way like the emulation of the human being understanding and thinking process.

6, Expert Systems (ESs) : ES are AI programs that allow computers to simulate a human expert in a subjected knowledge area. For example, MYCIN is an ES which was designed to deal with problems in the treatment and diagnosis of infectious diseases.

7, Artificial Neural Systems (ANS) : ANS is a new development in computer programming arose in 1980's, based on how the human's brain processes information. ANS has had remarkable success in providing real-time response to complex pattern recognition problems. In one case, ANS running on an ordinary micro-computer obtained a very good solution to the "traveling salesperson problem" in 0.1 second compared to the optimum solution that required an hour of CPU time on a main-frame [ 6 ].

In summary, the following shows some areas of AI fields :

Natural language processing	Voice synthesis and recognition (Speech)
Computer vision	Robotics
Understanding (Inference)	Expert systems
Artificial Neural Systems	. . . . .

## EXPERT SYSTEMS :

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### Introduction :

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One area of AI research which is quite advanced is that of ESs. Indeed, ESs is one of the few areas of AI which has moved out of the research laboratory and moved into the real world and is beginning to realize its potential in industrial and commercial applications.

An ES is an AI computer program which makes the computers act as a human expert within one particular domain of knowledge.

An ES is an AI computer program which makes extensive use of a knowledge base to solve problems at a human expert level.

The knowledge of one or more experts in a specific area (domain) is packaged into a knowledge base that can be processed by an ES. Even if the domain is a complex one, ES tries to achieve the same result that the expert could achieve.

Ideally, the ES can also learn from its mistakes and gain experience from its successes and failures. The ES should also be able to explain the reasoning behind the way in which it has arrived at a particular conclusion.

The ES has ,generally, 2 main parts :

- 1, A knowledge base, and
- 2, An Inference engine.

The Knowledge base is that part which represents the knowledge of the expert in his specific domain. A knowledge base usually contain facts and rules.

The inference engine is that part which represents the way of thinking and searching through the knowledge base of an ES. The inference engine searches through the knowledge base using either of the forward chaining or the backward chaining. That is, searches from the initial conditions to the goal or from the goal to the initial conditions.

## ADVANTAGES OF HAVING AN ES :

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There are many benefits that can be gained from the introduction of ESs technology within a particular area. Some of the more obvious benefits include :

1. **Increased availability :** The use of ESs increases the availability of expertise. Recall that the computers can ,now, be available anywhere and anytime.
2. **Reduced cost :** ESs can be much more cost effective (i.e.,much cheaper) than hiring the services of a real human expert.
3. **Reduced danger :** ESs can be used in environments that might be dangerous for a human.
4. **Performance :** The expertise is permanent, unlike human experts; they are scarce, their service are expensive, they are usually very much in demand and are very busy, and they are mortal (cannot live for ever). ESs do not suffer from these drawbacks.
5. **Multiple Experts :** The expertise are gathered from several experts. Hence, the knowledge of multiple experts can be made available to work simultaneously and continuously on a problem anytime.
6. **High productivity :** ESs are usually faster and never get tired. This means that the productivity of ES is higher than human expert.

7. **Saving the user's money and time :** ESs can save user's money and time by avoiding costly mistakes and bad decisions that can be made by a non-experienced human professionals. Consulting ES is much cheaper and faster than consulting a human expert. This is a direct result of reducing cost per site and increasing productivity.
8. **Updating and qualifying :** The knowledge of human experts must be put into an explicit form for entering in the computer. Because the knowledge is then explicitly known instead of being implicit in the expert's mind, it can be examined for correctness, consistency and completeness. The knowledge may then have to be adjusted or reexamined which improves the quality of the knowledge.
9. **Explanation :** The ES can explicitly explain in detail the reasoning that led to a conclusion. A human expert may be too tired, unwilling or unable to do this all the time. This increases the confidence that the correct decision is made.
10. **Fast response :** Fast or real-time response may be necessary for some applications. Depending on the software and hardware used, an ES may respond faster and be more available than a human expert. Some emergency situations may require responses faster than a human and so a real-time ES is a good choice.

## USE OF ESs :

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ESs are gradually finding their way into many areas of modern life. Indeed, only certain types of applications are suited to implementation in ES form.

How do we determine whether or not a particular area is suitable for ESs treatment? General speaking, most of problems which ,mainly, need practical experience in order to be solved. Anyhow, the following rules give an indication of the sort of criteria which must be satisfied in order for a particular application area to benefit from ES treatment :

- The problem under consideration should be able to be reduced into a series of rules rather than mathematical formulas or equations. In particular, ES treatment is not applicable if the problem involves a large number of calculations.
- The problem under study should be well understood so that well defined rules can be formulated to represent human expertise.
- The field under study should not comprise problems which take too short time ( < 0.5 an hour) or too long time ( > one week).
- There should be general agreements among recognized experts in the field (no use if all experts have different ideas or theories --- in such a case whose knowledge would be computerized).
- The number of rules necessary to describe the system should be sufficiently large to warrant the development of an ES.
- There should be one or more experts who are agreeable to their involvement in the project.

## ESs APPLICATIONS :

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ESs have applied to several fields of knowledge to solve specific problems. Some have been designed as research tools, while others fulfill important business, science, engineering and military functions.

- **Business ESs** : loan evaluation ESs, tax advising ESs, and business management ESs are examples of the business ESs. Banks have standard criteria for evaluating loan applications. In addition, Expert loan-evaluation bankers have their own experience. Both the standard criteria and the expert knowledge can be gathered in a knowledge base to be used in a loan evaluation ES.

Taxes are a vital part of the financial strategies of both individuals and companies. Tax advising ES which helps individuals and companies make good tax decisions are now amiable.

Business management ESs being developed. These ESs perform a variety of financial analysis and make recommendations to the management. There are also other business ESs which are used to evaluate business plans.

- **Science and Engineering ESs** : Engineers are using knowledge based Computer-Aided-Design (CAD) systems to create new products. Ford organization used ES to diagnose machine tool problems. In the computer's system configuration field, one of the most common ESs is XCON of digital equipment corporation. The configuration of a computer system means that when a customer places an order, all the right parts (software, hardware, and documentation) should be supplied. An ES which is designed to aid medical practitioners in the diagnosis of specific pain would have a knowledge base which is contained facts and rules about the likely causes of such pain, and the particular symptoms related to each of these causes. MYCIN of MIT is an example of such ESs.

- Military ESs : The military people see intelligent software as a way to improve performance and gain competitive advantages. Several military ESs for the air forces, army, and navy were developed.

. Air force ESs : Air crew ES helps pilots to do their jobs more efficiency. A program called "Pilot Associate" helps pilots plane in their missions. It also monitors the air craft subsystem for problems and informs the pilot. Some air forces are already using ESs to perform maintenance on combat air crafts. Most of these ESs run on PCs and are designed to diagnose problems in the air craft engine and avionics.

. Army ESs : In the army, some ESs which help in training commanders, upgrading the way a weapon works, maintaining and repairing of equipment are built. It should be noted that the use of ESs to improve the ability to maintain and repair equipment, should lead to reduce the maintenance costs and increasing the equipment preparedness.

. Navy ESs : The navy uses ESs in budget analysis. Navy budgets are large and complex, and requires numerous analysis to determine their content and make good decisions based on priorities..

Also, in general, there are ESs for use in agriculture, chemistry, oil exploration, low, meteorology, physics, process control, education, etc.

The following illustrates some available ESs in many real world applications :

## 1. Medical Applications :

MYCIN : Diagnosis and treatment of meningitis and certain other blood diseases.

EMYCIN : ES shell developed from MYCIN.

AL/X : ES shell based on MYCIN and PROSPECTOR.

CADUCES : Diagnosis internal medicine diseases.

VM : Monitors intensive care patients.

GUIDON : Instruction, bacterial infections.

INTERNIST : Diagnose internal medicine problems.

CASNET : Management of glaucoma treatment.

## 2. Chemistry Applications :

DENDRAL : Identify organic compounds from mass spectrometer data.

META-DENDRAL : Induces rules of molecular structure from mass spectrometer data.

CLONER : Design new biological molecules.

SECS : DEsign complex and organic molecules.

MOLGEN : Plan experiments on molecular genetics.