



A.I

Cognitive
science
application

Robotic
application

Natural
interface

- * Visual perception
- * Tactility
- * Locomotive
- * Navigation

- * Natural language
- * Speech recognition
- * Multi sensory
interface
- * Virtual reality

Knowledge Engineer is the art, Crafts and Science of observing human expert building models of the expertise and refining the model until the human expert agrees that it works.

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Expert System & Machine Learning

Background & History :- Expert System
 Systems that emulates from area of Computing known as Artificial Intelligence (AI).

AI is the branch of Computer Science concerned with developing Computer that behaves like humans precisely, & occupy a Central place in the Cognitive Science aspect of AI as shown below:

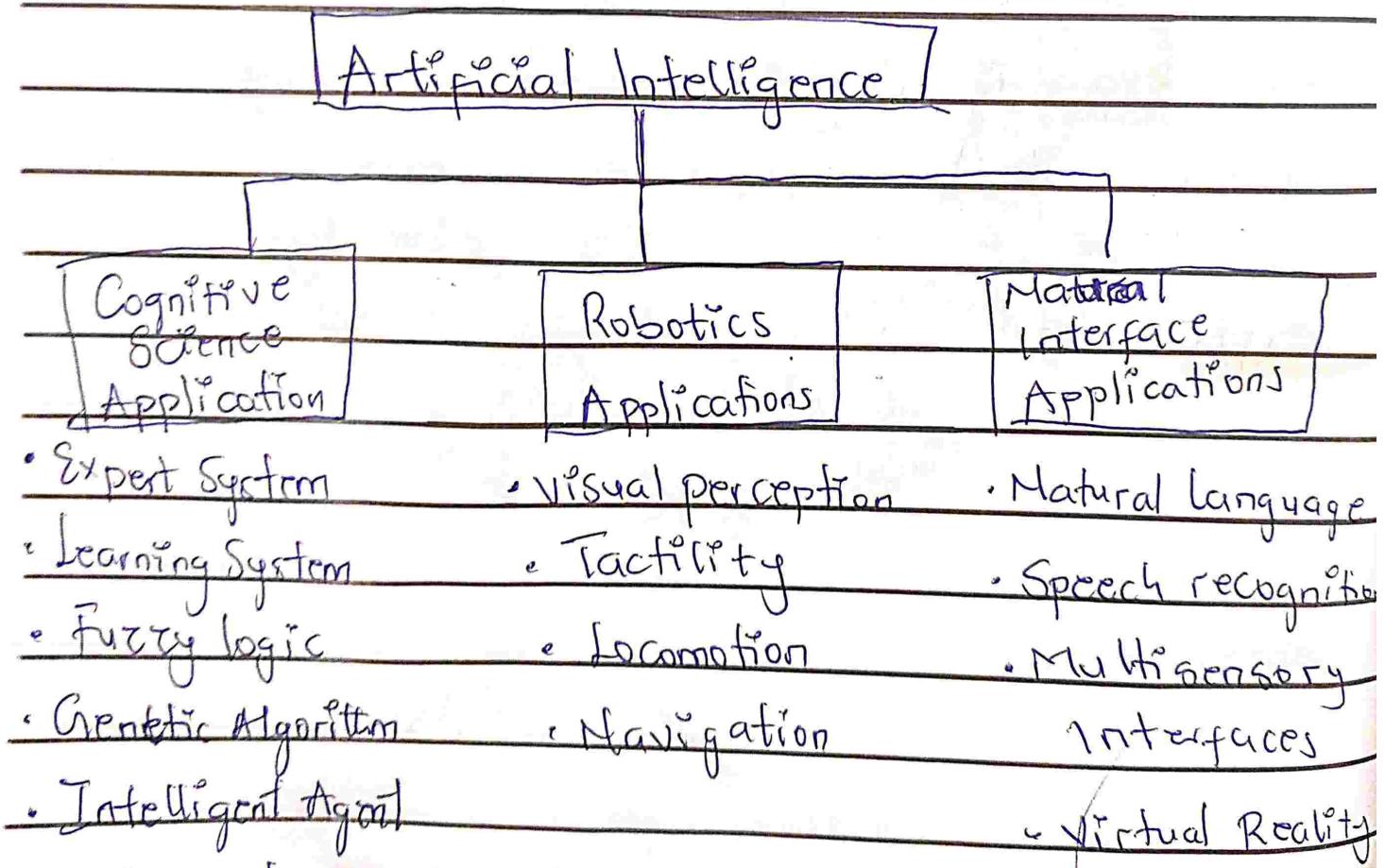


Fig1: Showing the place of Expert System in the broad AI domain.



In the mid-1960s, Edward A. Feigenbaum was one of the people in Artificial Intelligence research who decided that it was expedient to know how much a computer program can know & the best way to find out would be to try to construct an artificial expert. In the course of looking for an appropriate field of expertise, Feigenbaum collaborated with Joshua Lederberg, Nobel Laureate Biochemist, who then suggested that organic chemists sorely needed assistance in determining the molecular structure of chemical compounds.

In 1965, Lederberg & Feigenbaum together with Bruce Buchenau, according to the requirement of the National Aeronautics & Space Administration, at the Stanford University started work on Dendral, the first Expert System, at Stanford University. The project started because the conventional computer based systems had failed to provide organic chemists with a tool for forecasting molecular structure.

The DENDRAL system can automatically generate molecular structure that can interpret spectra. NAASS...making the world a better place



data.

The program is a first successful program that uses the knowledge of the problem itself rather than the Complex Search technology. The DENARAI guides AI & expert System researchers to realize, the Intelligent behaviour relies not only on Inference methods but also on the knowledge used in their inference. Researchers began to build the program that uses the rules of the Code to represent the knowledge to solve the input problem.

* Knowledge Engineering is the art, craft & science of observing human experts, building models of their expertise & refining the model until the human expert agrees that it works.

MIT has also developed the MACSYMA System. The MACSYMA was a mathematicians assistant, which uses heuristics to transform algebraic expressions. After continuous expansion, it can solve more than 600 kinds of mathematical problem including calculus, matrix operations, solving equations etc.

Many Researchers in the process of developing



expert System have realized that Knowledge representation, knowledge utilization, knowledge acquisition

use 3 basic issues of AI System

In the Mid-1970s MYCIN was developed by Edward H. Shortliffe, a physician & Computer Scientist at Stanford Medical School. MYCIN inference engine, known as E-MYCIN, was used by Researchers to produce PUFF, an expert System that assist in diagnosing certain lung disorders. An even newer system, CADUCEUS, now has a knowledge base larger than any doctor's of raw data comprising about 80% of the World's medical literature.

Expert System is referred to as a System that has the ability to emulate the cognitive skills of human expert to guide users through complex decision making processes. Expert System is now in commercial & research use in a number of fields:

- 1) KAS (Knowledge Acquisition System) & TEFRESAS help knowledge engineers build expert Systems.
- 2) ONCOCIN assists physicians in managing complex drug regiments for treating Cancer patients.

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- (iii) Molgene helps molecular biologist in planning DNA experiments.
- (iv) Guidon is an education experts that teaches students by correcting answers to technical questions.
- (v) Genesis assists scientist in planning cloning experiment.
- (vi) TAIR is used by Air force in planning attacks on enemy air bases.

What are Expert System

An ES belongs to a field of AI, & it is a computer program that simulates the judgment & behaviour of an individual that has expert knowledge & experience in a particular field. It is a knowledge-based computer program that exhibit a degree of expertise in a particular domain thereby solving problem or making decisions that are comparable to that of human expert.

ES is an application program that makes decision or solve problems in a particular field by using knowledge & analytical rules defined by expert in the field.



Summarily we can define Es as a knowledge-based computer program that exhibits, within a specific domain, a degree of expertise in problem solving that is comparable to that of a human expert. The two terms, expert System (Es) & Knowledge-Based system (KBS) are sometimes used synonymously. The area of human intellectual endeavour be captured in an Es is called the Task domain. Task refers to some goal-oriented, problem solving activity. Domain refers to area within which the task is being performed. Typical tasks are diagnosis, planning, scheduling, configuration & design. An example of task domain is Aircraft Crew Scheduling.

Expert System & Conventional Program

Es are different from traditional application programs in that their capability to deal with challenging real world problems through the application processes that reflects human judgement & intuition.



Expert Systems Application

1) Knowledge is fragmented & implicit is difficult to communicate except in small "chunks"

2) Rules are complex, conditions often defined as imprecise "rules of thumb"

3) The finished system captures knowledge expertise mate manual procedure

4) Problem-solving demands dynamic Content driven application of fact relations - Shhips rules

5) Inferencing

6) Knowledge based

7) Object class

Conventional System Application

Knowledge is Complete explicit, & is easily communicated with form of Algorithm. Rules are simple & few conditions.

Rules are Simple with few Conditions.

The finished product out distributes & leverage expertise mate manual procedure

Problem solving requires predictable & repetitive Sequence of actions.

Program flow

Database

Relational class



The Role of heuristic Knowledge in Es

Much of the knowledge of domain experts in solving practical problems consists of heuristics acquired through learning & experience.

A heuristic is a rule of thumb, fact, or even a procedure that can be used to solve some problems, but it is not guaranteed to do so. It may fail. Heuristics can conveniently be regarded as simplification of comprehensive formal description of a real world system. For many problems, domain experts find it practical & necessary to substitute heuristic knowledge for complex model. Es benefit from heuristic principles

Elements of an Es

Es store expert knowledge & apply it on demand to store problems. Most often the user of an Es is a person. The user may also be another software system, a mechanical device. A human user, known as end user usually provides information to the Es via a computer terminal. The Es uses inference procedure



to apply its stored knowledge to the facts describing a problem. The systematic application of inference leads to solution that are then displayed on the terminal.

Each of the major parts of the ES architecture can be further explain as below

① The Knowledge Base

knowledge is store in the knowledge base using symbols & data structures to stand for important concepts. The symbols & data structures are said to represent knowledge. Knowledge representation can take many forms. The most common form is the production rule. PR are a particular convention of expressing heuristic knowledge. The knowledge base refers to the actual store of knowledge for a particular ES.

Knowledge represented in data structure such as rules, is said to be stated declaratively.

2) The Inference Engine

The IE is a software module that execute process



ture for applying knowledge to produce new information about a problem. In production rule System an IF Compares rules against known facts in the context file to determine if new facts can be inferred. The Conditions in the premises, or IF, part of the production rules are compared against known facts. If these conditions are satisfied, the facts in the Conclusion; or THEN part, can be inferred. The newly concluded facts are then added to the Context file of the FS.

3) Expert System Interfaces

ES communicate with human users as well as other software & hardware systems. ES communicate with human users via an end user interface. The purpose of the end user interface is to obtain information about the problem from the end user & to display solutions. To obtain information, the interface may display questions at a terminal & prompt the end user for answers.



The Human Element in Expert system development

Building an ES is known as knowledge engineering & its practitioners are called knowledge engineers. The knowledge engineer must make sure that the computer has all the knowledge needed to solve a problem.

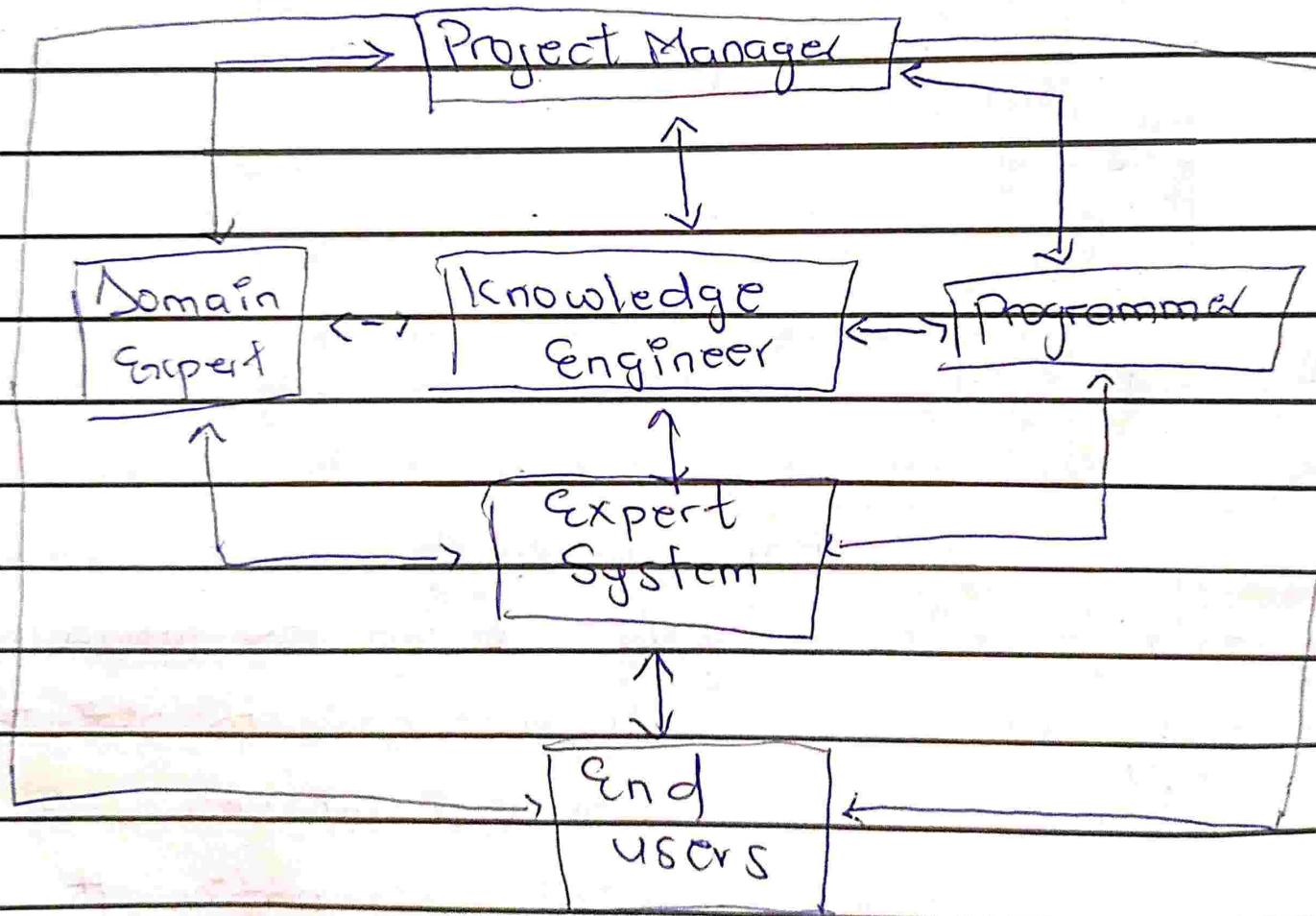


Diagram showing the human factors in the Es development team.



- Domain Expert: Anyone can be considered to be a domain expert if he or she has deep knowledge (of both facts & rules) & strong practical experience in a particular domain. Human expert examples: A Doctor, chess grandmaster, Financial wizard, A chef, an engineer, An Architect, a pharmacist.
- Knowledge engineers - The individual who encodes the expert knowledge in a declarative form can be used by the ES. They are also people who are capable of redesigning, building & testing an expert System. The person is responsible for selecting an appropriate task for the ES. He or she interviews the domain expert to find out how a particular problem is solved.
- The programmer is the person responsible for the actual programming describing the domain knowledge in terms that a Computer can understand. The programmer needs to have skills in Symbolic programming in such AI languages as LISP (List).



processing designed for easy manipulation of their strings & is the second oldest high level program level after FORTRAN) & PROLOG (Programming in logic). It is a logic programming language associated with AI & Computational linguistics. Prolog is a logic based programming language which while Python is an interpreted programming language.

In addition, the programmer should know conventional programming language like Python, JAVA, Pascal etc. FORTRAN etc. If an fs shell is used the knowledge Engineers can easily encode the knowledge into the expert system & this eliminate the need for the programmer. However if shell cannot be used, a programmer must develop the knowledge & data representation structures (knowledge base & database) Control Structure (inference engine) & dialogue Structure (user interface).

- The project manager: He is the leader of the ESDI, responsible for keeping the project on track. He must interact with the expert KE, programmer, EU.



End user: An individual who will be consulting with the system to get advice which would have been provided by the expert. He is the person who uses ES when it is developed.

Features of ES

- (1) Operates as an interactive system - This means ES:
 - (a) Respond to questions
 - (b) Ask for clarifications
 - (c) make recommendations
 - (d) Aids the decision making process
 - (2) Tools have the ability to sift (filter) knowledge.
 - (3) storage & retrieval of knowledge
 - (4) Mechanism to expand & update knowledge base on a continuing basis.
 - (5) Make logical inferences based on knowledge stored.
 - (6) Simple reasoning mechanism ^{is} used
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⑤ Mechanism to expand and update knowledge base
⑥ knowledge base must have means of exploiting the knowledge stored, else it is useless of learning all the words in a language without knowing how to combine those words to form a meaningful sentence.

④ Ability to explain reasoning.

⑤ Cost effective alternative to human expert.

Benefits / Advantages of Es

- ① Permanence → Es do not forget
- ② Reproducibility → Copies of an Es can be made
- ③ Powers → For applications where there is a lot of rules exhibited, it can be unraveled by the Es
- ④ Efficiency : Es can increase throughput & reduce personnel costs.

- Es are inexpensive to operate

- Es can eliminate routine costs & reduce major maintenance cost.

⑤ Consistency : with Es, similar events are handled the same way



- ⇒ Documentation: Es provide permanent documentation of the decision process
- ⇒ Completeness: Es can review all the transaction or possibilities.

Disadvantages (Assignment for Students)

Components of an Es

Es are usually built for Specific application area called Domain. The Components of Es is as follows:

(1) User Interface (2) Inference Engine

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- (iii) knowledge base (iv) working memory
- (v) explanation facility.

1) The user interface is the part of the System which takes in the user's query in a readable form, passes it to the inference engine then displays the results to the user. It is also a mechanism by which user & system communicate.

2) The knowledge base is the collection of facts & rules which describe all the knowledge about the problem domain. Knowledge is the primary raw material of ES. In a rule-based expert system the knowledge is represented as a set of rules. Each rule specifies a relation, recommendation, directive, strategy or heuristic & has the IF (condition) THEN (action) structure. When the condition part of a rule is satisfied, the rule is said to fire & the action part is executed.

3) The inference engine: Carries out the reasoning process.



whereby the ES reaches a solution. It links the rule given in the knowledge base with fact provided in the database.

- makes inference deciding which rules are satisfied & prioritizing
- The brain of the ES