Expert Systems

What are Expert Systems?

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The expert systems are the computer applications developed to solve complex problems in a particular domain, at the level of extra-ordinary human intelligence and expertise.

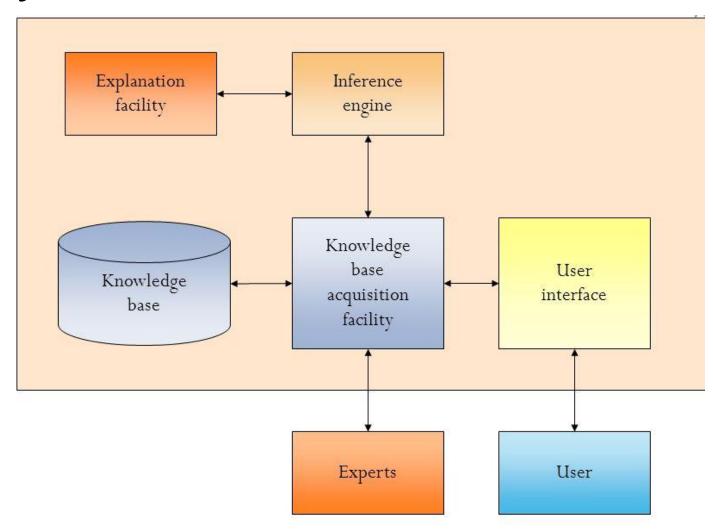
An expert system compared with traditional computer :

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Inference engine + Knowledge = Expert system

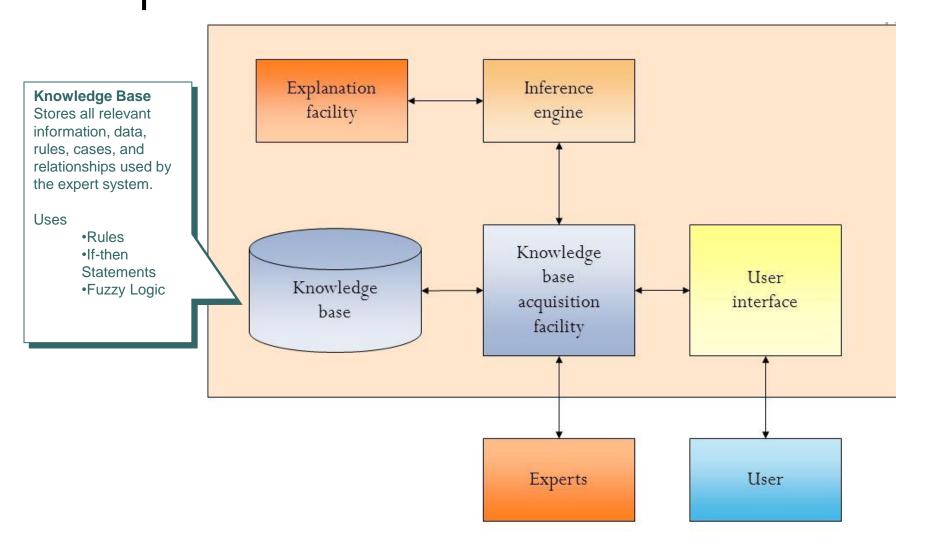
( Algorithm + Data structures = Program in traditional computer )
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 First expert system, called DENDRAL, was developed in the early 70's at Stanford University.

Components of an Expert System



Knowledge Base



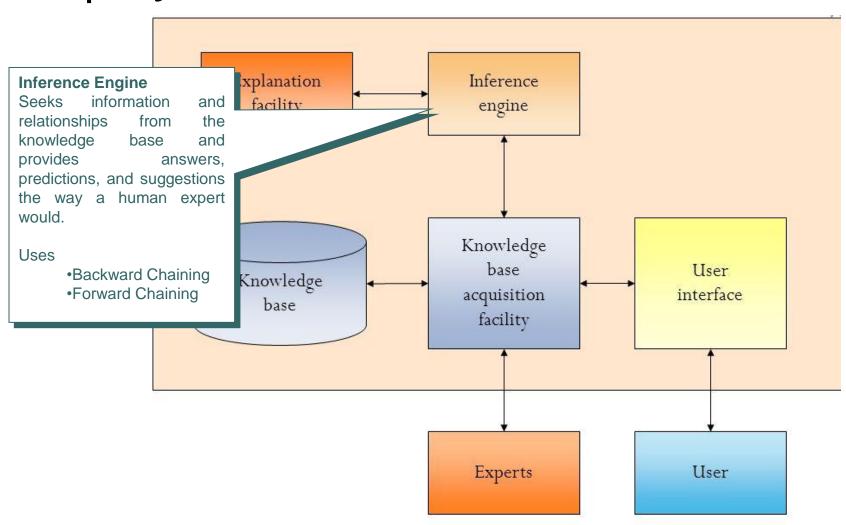
• • Knowledge Base

- The knowledgebase is a type of storage that stores knowledge acquired from the different experts of the particular domain.
- It is considered as big storage of knowledge. The more the knowledge base, the more precise will be the Expert System.
- It is similar to a database that contains information and rules of a particular domain or subject.
- One can also view the knowledge base as collections of objects and their attributes. Such as a Lion is an object and its attributes are it is a mammal, it is not a domestic animal, etc.

Components of Knowledge Base

- Factual Knowledge: The knowledge which is based on facts and accepted by knowledge engineers comes under factual knowledge.
- Heuristic Knowledge: This knowledge is based on practice, the ability to guess, evaluation, and experiences.
- Knowledge Representation: It is used to formalize the knowledge stored in the knowledge base using the If-else rules.
- Knowledge Acquisitions: It is the process of extracting, organizing, and structuring the domain knowledge, specifying the rules to acquire the knowledge from various experts, and store that knowledge into the knowledge base.

Components of an Expert System



Inference Engine(Rules of Engine)

- The inference engine is known as the brain of the expert system as it is the main processing unit of the system.
- It applies inference rules to the knowledge base to derive a conclusion or deduce new information.
- It helps in deriving an error-free solution of queries asked by the user.
- With the help of an inference engine, the system extracts the knowledge from the knowledge base.
- There are two types of inference engine:
 - **Deterministic Inference engine:** The conclusions drawn from this type of inference engine are assumed to be true. It is based on facts and rules.
 - Probabilistic Inference engine: This type of inference engine contains uncertainty in conclusions, and based on the probability.

Inference Engine(Rules of Engine)

- Inference engine uses the below modes to derive the solutions:
 - Forward Chaining: It starts from the known facts and rules, and applies the inference rules to add their conclusion to the known facts.
 - Backward Chaining: It is a backward reasoning method that starts from the goal and works backward to prove the known facts.

Mortgage Application for Loans from \$100,000 to \$200,000

If there are no previous credit problems and

If monthly net income is greater than 4 times monthly loan payment and

If down payment is 15% of the total value of the property and

If net assets of borrower are greater than \$25,000 and

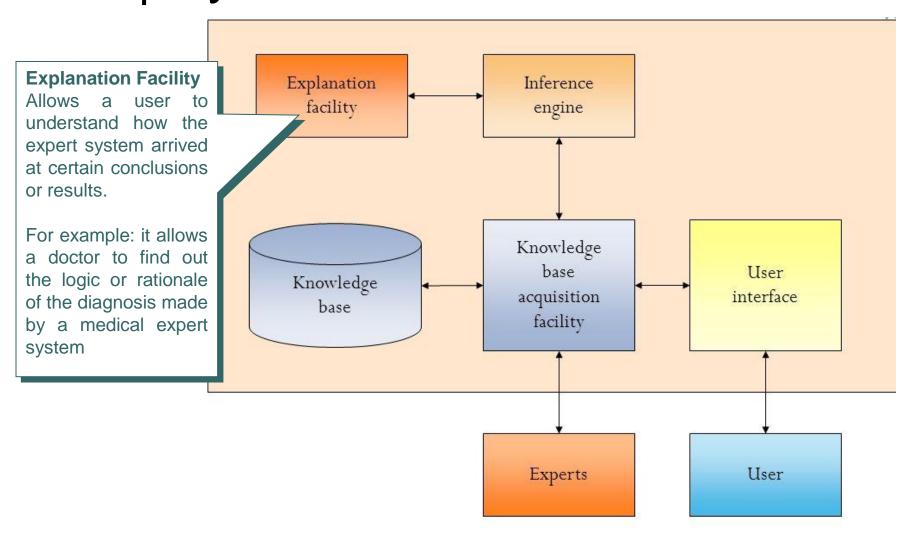
If employment is greater than three years at the same company

Then accept loan application

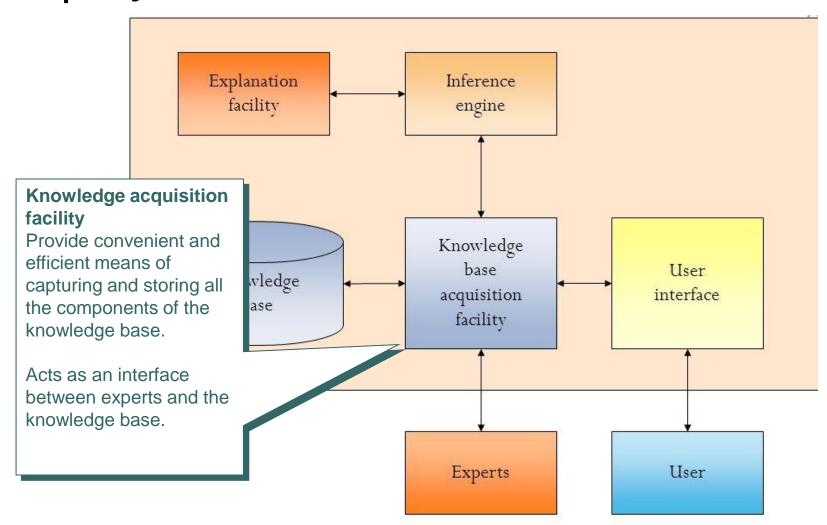
Else check other credit rules

Rules for a Credit Application

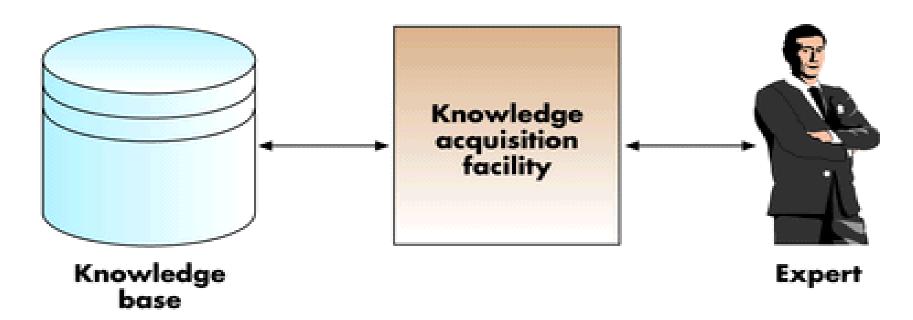
Components of an Expert System



Components of an Expert System



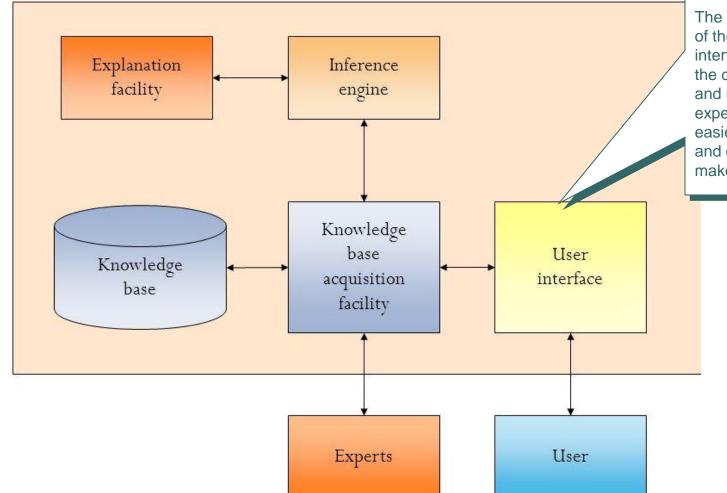
Knowledge Acquisition Facility



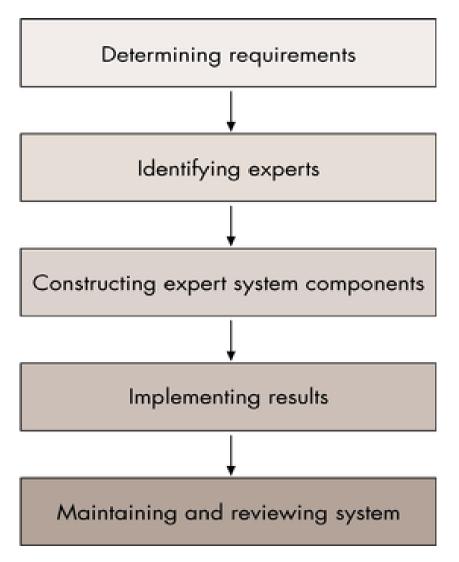
Components of an Expert System

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Expert System Development Process



Development of Expert Systems: General Steps

Identify Problem Domain

- The problem must be suitable for an expert system to solve it.
- Find the experts in task domain for the ES project.
- Establish cost-effectiveness of the system.

Design the System

- Identify the ES Technology
- Know and establish the degree of integration with the other systems and databases.
- Realize how the concepts can represent the domain knowledge best.

Develop the Prototype

- From Knowledge Base: The knowledge engineer works to -
 - Acquire domain knowledge from the expert.
 - Represent it in the form of If-THEN-ELSE rules.

Development of Expert Systems: General Steps

Test and Refine the Prototype

- The knowledge engineer uses sample cases to test the prototype for any deficiencies in performance.
- End users test the prototypes of the ES.

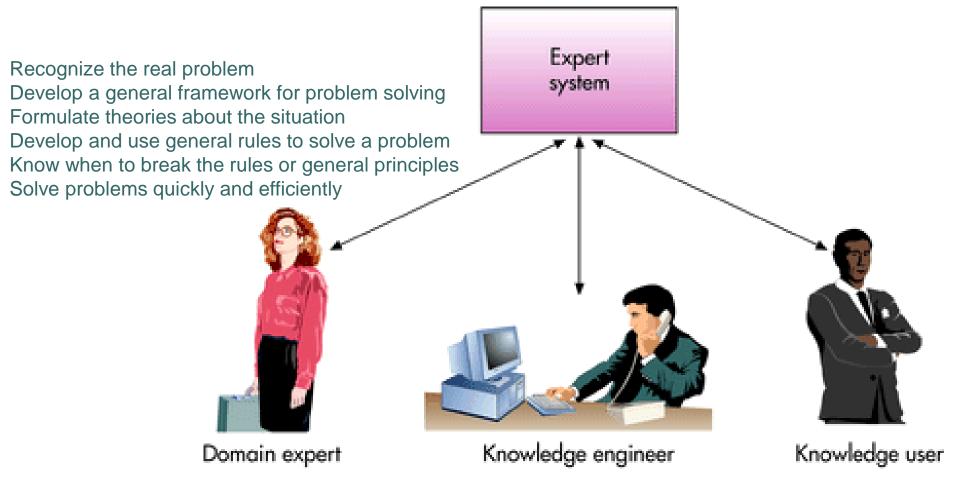
Develop and Complete the ES

- Test and ensure the interaction of the ES with all elements of its environment, including end users, databases, and other information systems.
- Document the ES project well.
- Train the user to use ES.

Maintain the System

- Keep the knowledge base up-to-date by regular review and update.
- Cater for new interfaces with other information systems, as those systems evolve.

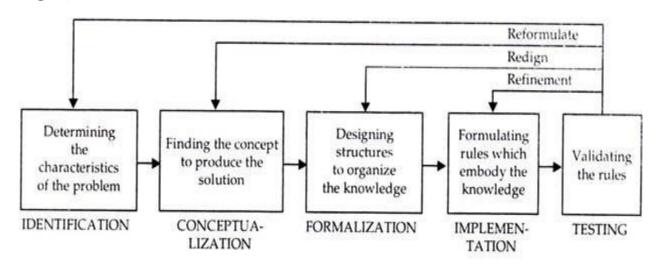
Participants in Expert System Development



- There are three primary participants in the building of Expert System:
- **Expert:** The success of an ES much depends on the knowledge provided by human experts. These experts are those persons who are specialized in that specific domain.
- **Knowledge Engineer:** Knowledge engineer is the person who gathers the knowledge from the domain experts and then codifies that knowledge to the system according to the formalism.
- **End-User:** This is a particular person or a group of people who may not be experts, and working on the expert system needs the solution or advice for his queries, which are complex.

Stages for designing Knowledge Base

- 1. Identification
- 2. Conceptualisation
- 3. Formalisation (Designing)
- 4. Implementation (Rule formation)
- 5. Testing (Validation, Verification and Maintenance).



Some popular examples of the Expert System

- o **DENDRAL:** It was an artificial intelligence project that was made as a chemical analysis expert system. It was used in organic chemistry to detect unknown organic molecules with the help of their mass spectra and knowledge base of chemistry.
- MYCIN: It was one of the earliest backward chaining expert systems that
 was designed to find the bacteria causing infections like bacteraemia and
 meningitis. It was also used for the recommendation of antibiotics and the
 diagnosis of blood clotting diseases.
- PXDES: It is an expert system that is used to determine the type and level of lung cancer. To determine the disease, it takes a picture from the upper body, which looks like the shadow. This shadow identifies the type and degree of harm.
- CaDeT: The CaDet expert system is a diagnostic support system that can detect cancer at early stages.

• • Expert System Characteristics

- Can explain their reasoning or suggested decisions
- Can display "intelligent" behavior
- Can draw conclusions from complex relationships
- Can provide portable knowledge
- Can deal with uncertainty

• • Expert System Limitations

- Not widely used or tested
- Difficult to use
- Limited to relatively narrow problems
- Cannot readily deal with "mixed" knowledge
- Possibility of error
- Cannot refine own knowledge base
- Difficult to maintain
- May have high development costs
- Raise legal and ethical concerns

When to Use Expert Systems

- High payoff
- Preserve scarce expertise
- Distribute expertise
- Provide more consistency than humans
- Faster solutions than humans
- Training expertise
- No memory Limitations
- High Efficiency
- Expertise in a domain
- Not affected by emotions
- High security

Applications of Expert System

- Credit granting and loan analysis
- Stock Picking
- Catching cheats and terrorists
- Budgeting
- Information management and retrieval
- Games
- Virus detection
- Hospitals and medical facilities