UNIT-I

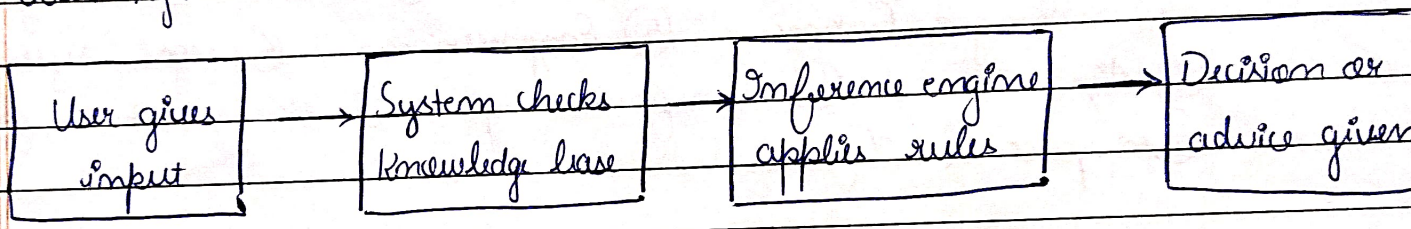
Intro to Expert System :-

→ A computer-based system that acts like a human expert.
→ It uses stored knowledge & logical reasoning to solve complex problems in a specific field such as medicine, law, engineering, or finance.

Limitation

Need :- ① Human experts are not always available
② Experts can be expensive
③ Expert knowledge can be stored & reused
④ Provides fast & consistent decisions

Working :-



Examples :- MYCIN – Medical diagnosis

Advantages :- ① Fast & accurate ② Available 24/7
③ Consistent decisions ④ Preserves expert knowledge

Characteristics :-

① Expert-level performance : It gives solutions as good as ~~solv~~ human expert in a specific field.
② Knowledge-based : It works using stored knowledge (facts & rules), not guessing.
③ Reasoning ability : It can think logically & reach conclusions using rules (if-then logic)
④ Domain Specific : It is designed for one particular area (like medical, legal, banking), not everything.
⑤ Explanation facility : It can explain how & why it reached a decision

⑥ User-friendly interface : Easy for normal users to use without technical knowledge.

⑦ Consistency : It gives the same answer every time for the same problem (no mood, no fatigue)

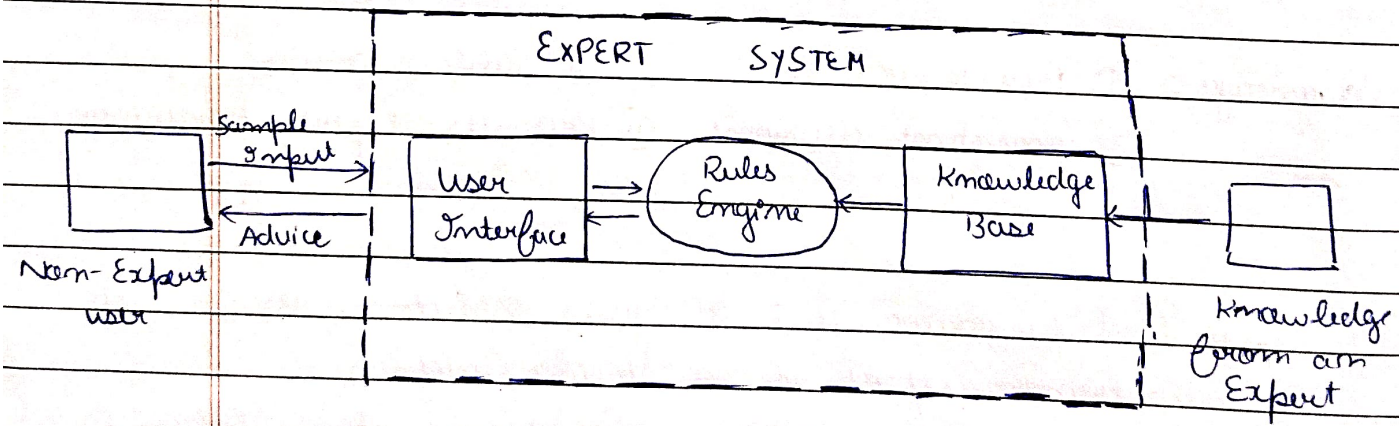
⑧ High reliability : Provides accurate & dependable results when knowledge is correct.

⑨ Handles uncertainty : Can work even when some info is missing or unsure.

⑩ Easy to update : Knowledge can be modified or added without changing the whole system.

Applications :- ① Medical field ② Education ③ Business & Management ④ Banking & Finance ⑤ Engineering ⑥ Legal systems ⑦ Agriculture ⑧ Manufacturing ⑨ Computer & IT field ⑩ Space & defense.

Architecture :



① User Interface :

This is the communication bridge between the user & the system

Functions : • Takes input from the user
• Displays advice, decisions or solutions
• Allows non-technical users to interact easily

Need : A good user interface makes the system easy & friendly

② Inference Engine : This is the brain of the Expert System.
→ Need → It controls how the system thinks
→ Function → • Applies rules from the knowledge base
• Matches rules with given facts
• Draws conclusions or decisions
→ Reasoning methods :
① Forward chaining : • Starts from facts
• Moves forward to conclusions
• Used in diagnosis systems
② Backward chaining : • Starts with a goal
• Works backward to check facts
• Used in design & advisory systems

③ Knowledge base : This is the heart of the ES.
→ Need : Without a knowledge base, an expert system is useless
→ It contains :
• Facts → basic info about the problem
• Rules → Expert's logic (IF-THEN rules)
→ Example :
IF patient has fever AND cough
THEN patient may have flu
→ Types :
• Factual knowledge — data & facts
• Heuristic " — experience-based rules (rules of thumb)

Data
Page

Types of problems handled by ES :

① Diagnosis problems : Finding the cause of a problem based on symptoms
Example : ◦ Disease diagnosis from symptoms
◦ Machine fault detection

② Interpretation problems : Understanding & explaining data
Example : ◦ Medical test report analysis
◦ Weather data interpretation

③ Prediction problems : Predicting future outcomes based on current data
Example : ◦ Weather forecasting
◦ Stock market trends

④ Planning problems : Deciding what steps to take & in what order
Example : ◦ Travel planning
◦ Project scheduling

⑤ Design problems : Helping in creating or designing systems
Example : ◦ Computer system configuration
◦ Building design support

⑥ Monitoring problems : Continuously checking systems to detect problems early
Example : ◦ Patient health monitoring
◦ Network performance monitoring

⑦ Debugging & repair problems : Finding errors & suggesting how to fix them.
Example : ◦ Software debugging
◦ Equipment repair advice.

⑧ Decision-making problems : Choosing the best option among many.
Example : ◦ Loan approval
◦ Medical treatment selection.

Date
Page

Techniques of representing the knowledge :

Knowledge representation means how expert knowledge is stored inside an ES so that the computer can understand, reason & make decisions like a human expert.

Important :

- It decides how smart the ES will be.
- Makes reasoning easy & fast
- Helps in updating & Explaining decisions

Rule-based knowledge representation :

- A method of storing knowledge in the form of rules.
- Each rule follows a simple IF-THEN structure, just like human thinking
- IF some condition is true
  THEN take an action or draw a conclusion

Basic str. : IF <condition(s)>
THEN <action/conclusions>

Example : IF patient has fever AND cough
THEN patient has flu

Working :

1. User gives input (facts).
2. Facts are stored in working memory.
3. Inference engine checks which rules match the facts
4. Matching rule is fired.
5. Conclusion is produced.

Advantages :- ① Simple & Easy to Understand ② Works well defined problems ③ Easy to Modify & Update ④ Clear Reasoning ⑤ Suitable for Expert knowledge representations ⑥ Consistent

Types of rules → Types :-

① Deterministic rules : Always gives the same result.
Eg:- IF water reaches 100°C
THEN water boils

② Probabilistic rules : Gives results with uncertainty
Eg:- IF chest pain AND sweating
THEN heart attack (80% chance).

→ Chaining :-

① Forward Chaining : • Starts from facts
• Moves forward to conclusions
Example: Fact → Rule → New fact → Conclusion

② Backward Chaining : • Starts from goal.
• Works backward to verify facts
Example: Goal → Rule → Check Facts.

Frame based representation :

- A way of storing knowledge in the form of frame
- A frame is like a record, table or object that represents a real-world concept.
- Each frame contains :
  - → Frame name
  - → Slots (attributes)
  - → Slot values

- Basic Str.

Frame Name	
Slot 1	: Value
Slot 2	: value
Slot 3	: value

- Eg:-

STUDENT	
Name	: Nusrat
Age	: 22
Course	: Btech

• Inheritance in frame-based Representation:
Frames can be connected in a parent-child relationship
The child frame inherits properties from the parent fram

Example :- Animal frame

Frame: ANIMAL	→	Frame : DOG
Name : Yes		Sound : Bark
Breaths : Yes		Legs : 4

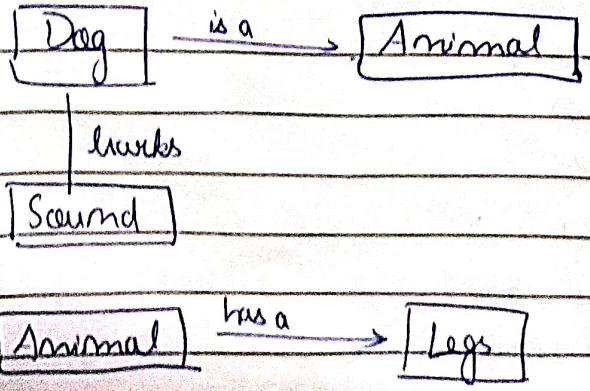
Dog inherits properties of ANIMAL

Semantic Network representation :-
A way of storing knowledge using a network of nodes & li
- Nodes → Objects, people or concepts
- Links → relationships btw them

It looks like a graph & shows how things are related.

Example : Statements :

- Dog is an Animal
- Animal has legs
- Dog barks



Predicate logic :

A formal & mathematical way representing knowledge using : • Predicates • Objects • Variables • Logic symbols

Main Elements :-

① Constants : Specific objects or names.
Eg :- Muskan, Delhi, Dog.

② Variables : Represent general objects.
Eg :- x, y, z

③ Predicates : Describe properties or relationships
Eg :- Student(x)
Human(Muskan)
Loves(Ram, Sita)

④ Functions : Returns a value
Eg :- FatherOf(x)
AgeOf(Muskan)

⑤ Quantifiers :
(a) Universal Quantifier (∀) - "for all"
Eg :- ∀x Student(x) → Human(x)
(All students are humans).
(b) Existential Quantifier (∃) - "there exists"
Eg :- ∃x Doctor(x)
(There exists at least one doctor)

⑥ Logical Connectives :

Symbol	Meaning
∧	AND
∨	OR
¬	NOT
→	IMPLIES
↔	IF AND ONLY IF

Date
Page

Prepositional Logic :

A way of representing knowledge using simple statements called propositions.
Each proposition is either true or false, nothing else.

Symbols :	Meaning	Example
P, Q, R	Proposition	P: It is hot
¬	NOT	¬P
∧	AND	P∧Q
∨	OR	P∨Q
→	Implies	P→Q
↔	IF AND ONLY IF	P↔Q

Examples:-

P = It is raining
Q = Roads are wet
→ Rule : P→Q
Meaning : If it is raining, then roads are wet.