Knowledge Representation

1. Relational approach
2. Logical Represention
   - Propositional
   - FOL
   - Predicate
3. Production Rules
   - If condition 1 & condition 2 are true then condition 3
4. Semantic Network
5. Frames

→ Knowledge can be defined as the body of facts and principles accumulated by human kind or the act, fact or state of knowing.

→ A knowledge representation is a study of ways of how knowledge is actually picturized and how effectively it resembles the representation of knowledge in human brain.

Approaches to knowledge Representation

Relational knowledge

→ It comprises objects consisting of attributes and associated values.

→ In this method, each fact is stored in a row of relational table as done in relational database.

→ A table is defined as a set of data values that is organized using a model of horizontal rows & vertical columns.

Cloumn – attribute names

Row – corresponding values.

Relational Table.

Name	Age (in years)	Sex	Qualification	Salary (in Rupees)
John	38	M	Graduate	20,000
Mike	25	M	U.G.	15,000
Mary	30	F	Phd	25,000
James.	29	M	Graduate	18,000

This representation helps in storing the facts but gives little opportunity for inferencing.

we can easily obtain the answer of the following:
what is the age of john?
How much does mary earn?

but: query like - Does a person having a PhD qualification earn more?
we can not obtain answer.

Knowledge Representation Using Semantic Network

→ Semantic Network is a graphical notation to represent knowledge, where nodes represent concept or objects and arcs represent relation b/w two concepts.

→ Nodes can be easily added to this network.

→ The concepts or objects are related to each other by certain relations and represented by bold directed links.
They may be defined as:

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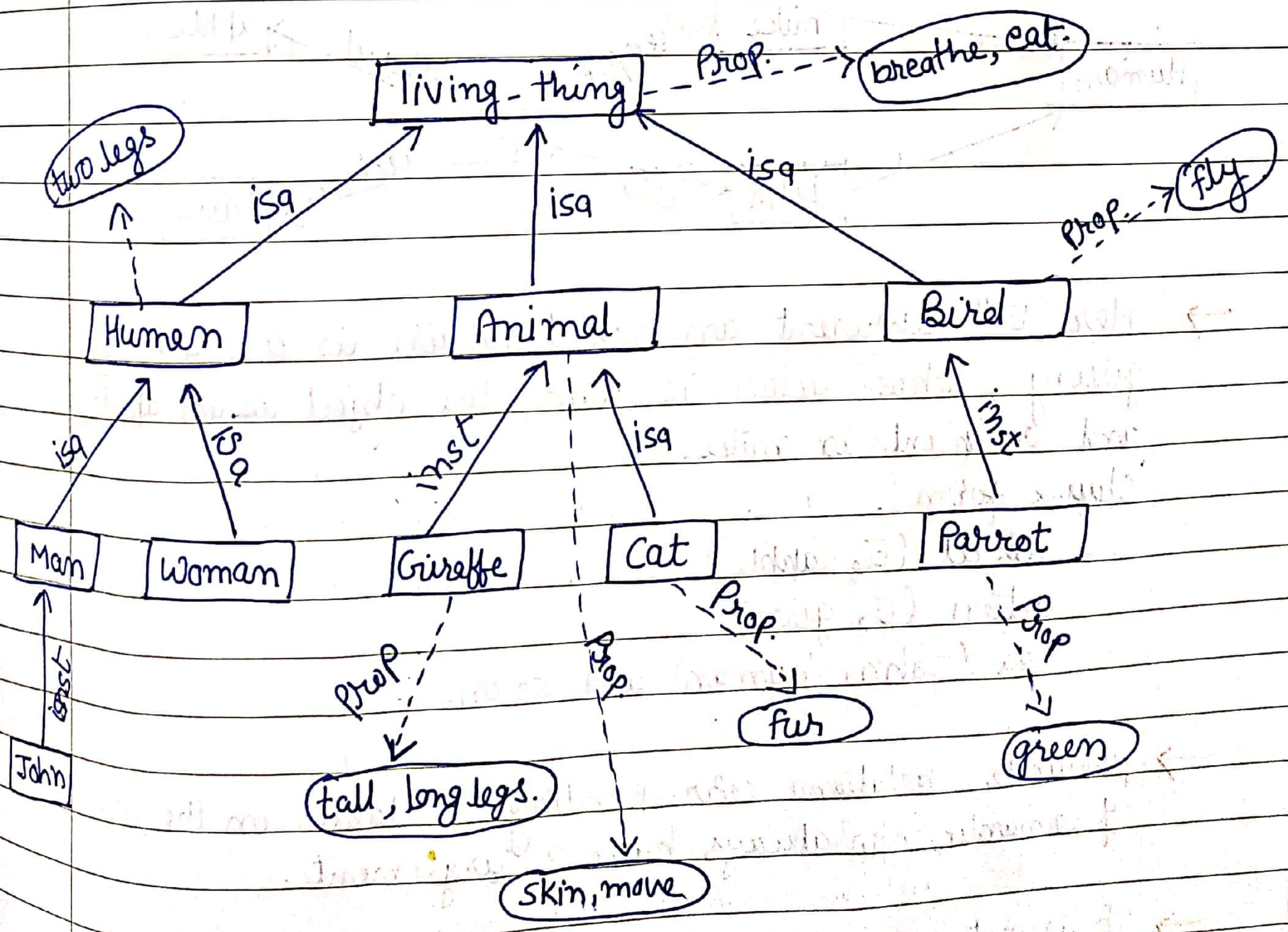
isa : Connects two classes, where one concept is a kind of or subclass of the other concept.
Man isa human.

inst : Relates specific member of a class.
John is an instance of man.

prop : property relations (can, has, colour, height), represented as dotted lines

Example : Every human, animal, and birds are living things who can breathe and eat. All birds can fly. Every Man and woman are human who have two legs. A cat has fur and is an animal. All animals have skin and can move. A giraffe is an animal and has long les and is tall. A parrot is a bird and is green in colour. John is a man



→ In conventional semantic n/w, we cannot express clausal form of logic. To overcome this shortcoming, Extended semantic n/w (ESNet) that combines the advantages of both logic & semantic N/w.

→ ESNet is a variant syntax for logic & semantic n/w but much powerful.

→ In ESNet terms are represented as nodes; constant, variable and functional terms are represented by constant, variable and functional nodes, respectively.

→ Binary predicate in logic represented by labels on arcs of ESNet.

love (John, mary)

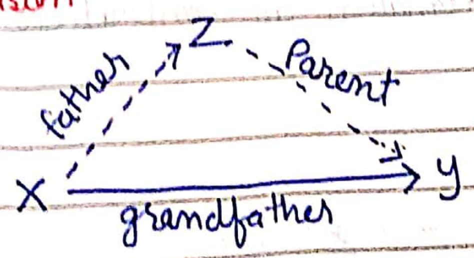
john $\xrightarrow{\text{love}}$ mary

→ Conclusion and conditions of clausal form are represented as – arcs denoting conditions (negative atoms) are drawn with dotted arrow lines. (denial links) - - - →

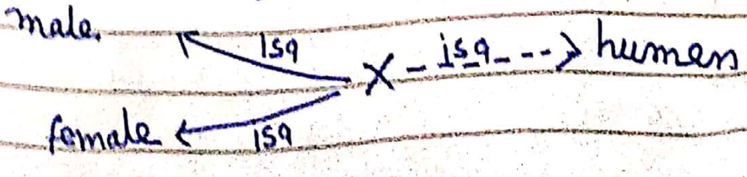
– arcs denoting conclusions (positive atom) are drawn with continuous arrow lines. ⟶

grandfather (X,Y) ⟵ father (X,Z), parent (Z,Y)

Conclusion   Condition

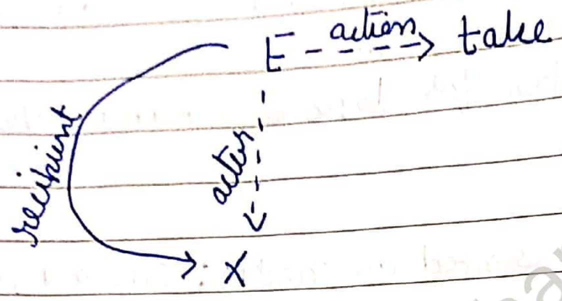


Similarly male (X), female (X) ⟵ human (X)



: Inference Rules :

recipient (E, X) ⟵ action (E, take), actor (E, X)



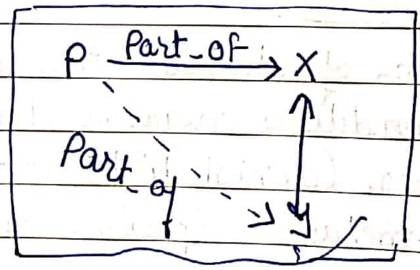
It is important to note that part-of link has a hidden existential quantifier.

Eg: human has two legs.

two-legs $\xrightarrow{\text{Part\_of}}$ human.

The Contradiction in ESNet can be represented as:

enclosed in rectangle.



Here P part_of X is conclusion and P part_of Y is condition, where Y is linked with X via isa link. Such kind of representation is contradictory.

Deduction in ESNet.

① Forward Resoning inference mechanism (Bottom up approach)
Derives new assertions from old ones, we start with the given assertion and derive new assertion using clausal rule.

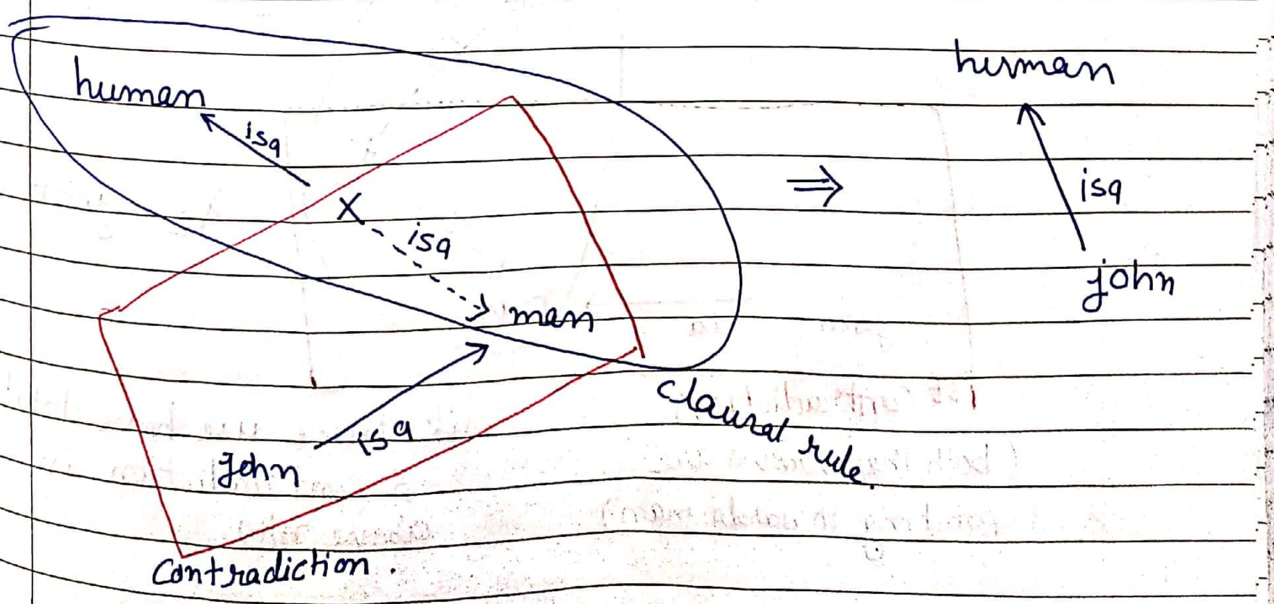
Given an ESNet, apply the following reduction using Modus - ponen rule.
(A ← B) and B
then A is true.

isa(X, human) ← isa(X, man)
isa (john, man)

using MP (replace x with john), we can easily derive isa (john, human) true.
Now By using ESNet presentation:

Given Set of clauses | Inferencing

isa (X, human) ← isa (X, man) | isa (john, human)
isa (john, man)



[remove contradiction by replacing x with john.]

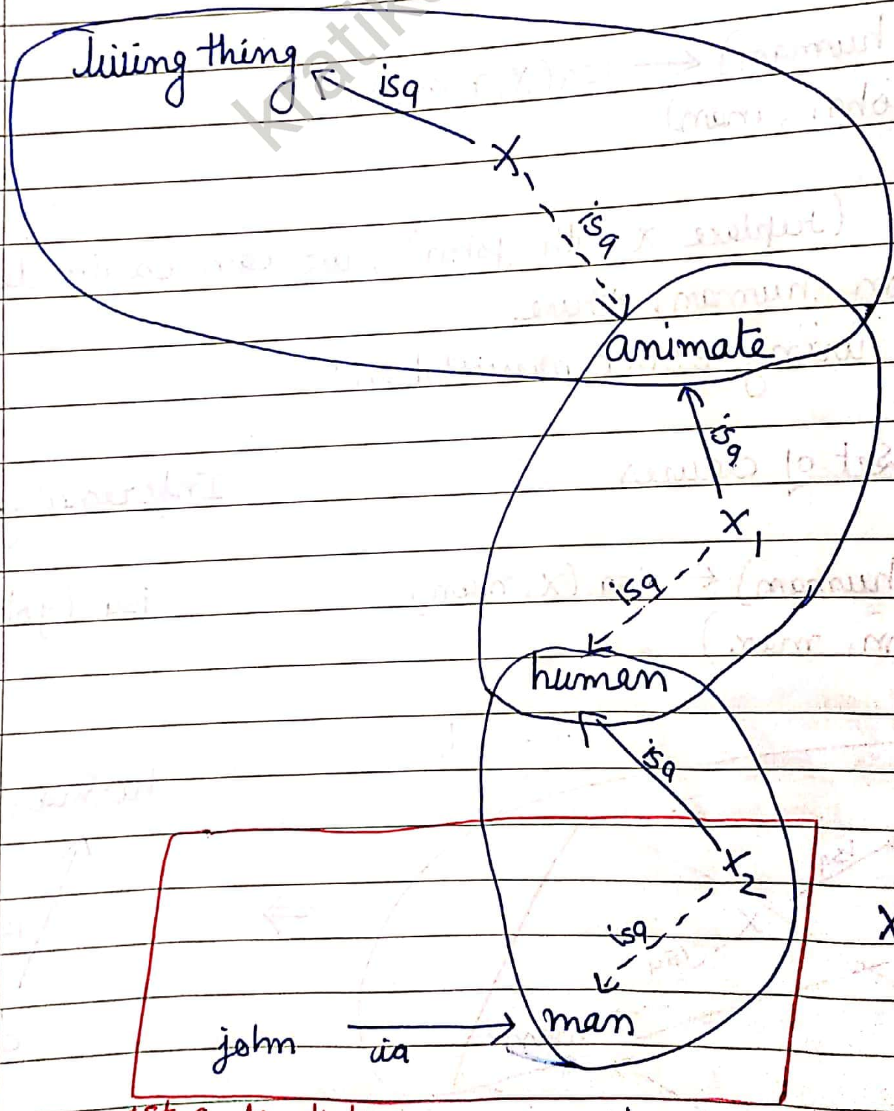
Example : 1

isa (x, living-thing) ← isa (x, animate)
isa (x, animate) ← isa (x, human)
isa (x, human) ← isa (x, man)
isa (john, man)

Conclude john is an animate and john is a living thing.

Solution: first draw ESNet for the above eg. and after that find out contradiction (ractangle) & clausal rule (eclipse)

step 1



X_2 = john

1st Contradiction
(both the arrows are pointing towards man)

likewise we have total 3 contradiction in above n/w.

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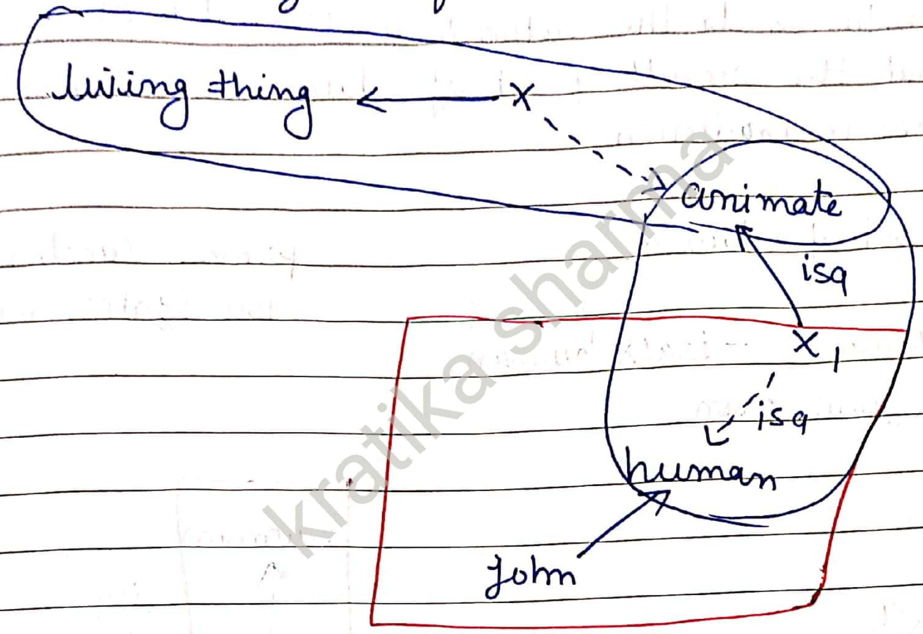
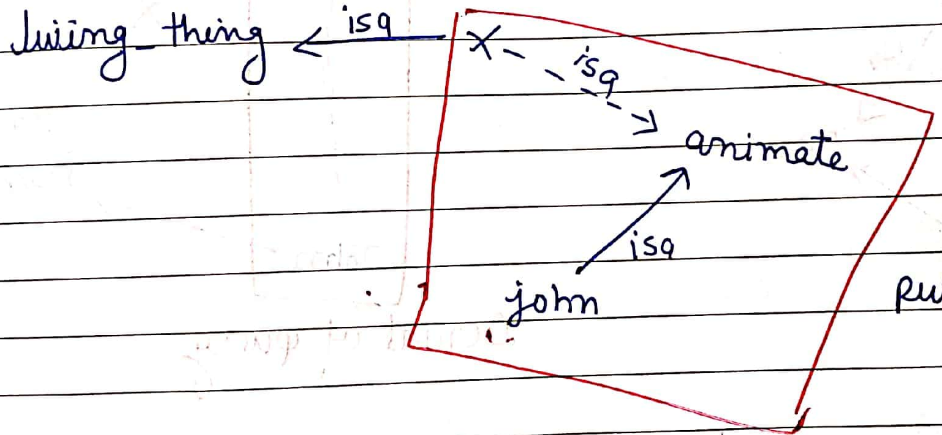
The new assertion john is human canbe inferred by removing first contradiction. (By putting X_2 = john.
Now, X_1 = john for 2nd contradiction – john – animate
& X = john for 3rd contradiction – john – living thing.

step 2



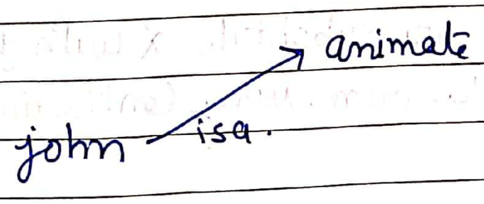
Put X_1 = john

step 3



Put X = john.

step 4



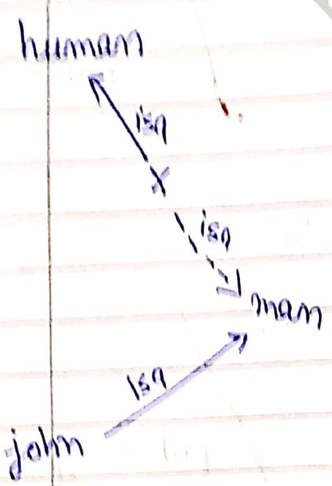
(2) Backward Reasoning Inference (Top-Down) (Resolution Refutation)

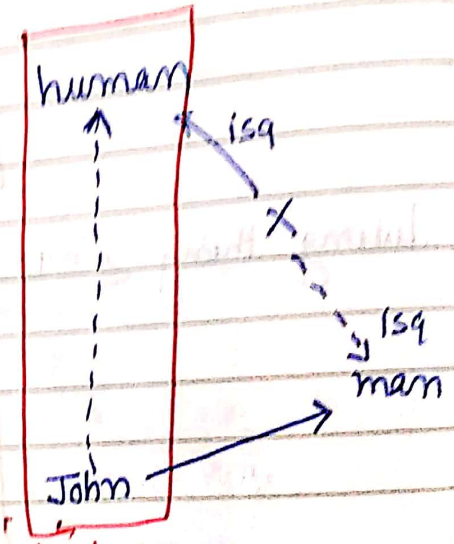
→ In this we prove a conclusion or goal from a given ESNet by adding the denial of the conclusion to the network and (dotted line) show that the resulting set of clauses in the n/w gives contradiction.

Given Set of clauses

prove Conclusion isa (john, human)

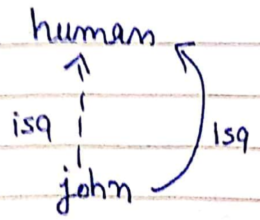
isa (X, human) ← isa(X, man)
isa (john, man)





Denial of query

now when you substitute X with john (here also you are removing Contradiction from ESNet)



Contradiction or empty n/w is generated. Hence isa (john, human) is proved.

⇒ Apply the same to solve example 1. In that draw a denial of query from john to living thing and substitute $X_2 X_1 X$ with john.

Q. Draw an extended semantic n/w for representing following sentence and infer conclusion for each:

1. Teachers who work hard are liked by students. Mary is a hardworking teacher. John is a student. conclude that John likes Mary.
2. Every member of an association named ROA is either retired or an officer of central govt. John is a member of ROA. conclude John is retired or an officer.

Knowledge Representation Using frames

→ Proposed by 'Marvin Minky (1975)'

→ Frames are extension of semantic n/w. Each nodes of semantic net is represented by frame.

→ It is a data structure that is used for representing a stereotyped situation.

→ It consists of collection of attributes or slots and associated values that describe some real world entity.

→ frames are slightly similar to the concept of object oriented; class also contains attributes and methods.

→ Frames, consist of attributes or slots;
slot described with <slot_name, value>

→ Slot have fillers (facets) describing their property. The value of slot may be primitive, such as text string, const, int or it may be another frame.

Structure of a frame

frame_name
slot - filler
default values
Constraints on values
pointer to other frame
ako (a-kind of or subclass)
inst (instance)
instantiation procedure
inheritence procedure
default inference procedure
triggers.

List of fillers (facts) in a frame

value, default, range, demons, other

procedural attachments, if-needed, if-deleted.

Example : Hospital frame

Slot Name	Filler Name	Filler Value
F_name	Value	Metro hospital
Country	Default	India
phone no	Default	23750
Address	Default	abc.

Frames in a n/w of frames are connected by ~~tiles~~ links:

AKO: A Kind Of : This link connects two class frames, one of which is the kind of other class.

inst: This link connects a particular instance frame to a class frame.

part-of: This link connects two class frames one of which is contained in other class.

A Simple Frame System