$p(J|B) = p(A|B) * p(J) + p(\neg A|B) * p(\neg J)$

$p(A|B) = p(B) * p(E) * p(B \cap E) +$
$p(B) * p(\neg E) * p(B \cap \neg E)$

Frames :

used to represent common sense knowledge

slots	fillers
publisher	Thomson
title	expert system
author	Nikely
page	600

2016 fall

1(a) What do you mean by Production rule system? Explain wate jug problem wrt production rule system.

→ A production system consists of a set of rules, each consisting of a left side (a pattern) that determines the applicability of the rule and a right side that describes the operation to be performed in the rule is applier
Example
[A, clean] → move righ.

~~let s~~ In water jug problem, we are given 2 jugs of different sizes and we have to obtain ~~et~~ some sort of water with respect to jug quantity.
In production system, we defined the set of rule and action
The various operator (production rules) can be stated as
let jug be X and Y
and X is m litre and Y is n litre
then production rules are :
start start (0,0) WRONG
Rule No. production
1 (x,y) → (m,y)
if x<m

m & n भन्दा
4 र 3
लिएर example
दिने

Suppose we are give two jugs, a 4l one and a 3l another. None of them has any measuring marker on it. How can we get exactly 2l water on 4l jug.

Start (0,0) → (2,n)

Production rules are

rule No	production rule	Action
1.	$(x,y) \rightarrow (4,y)$ if $x<4$	fill the 4l jug
2.	$(x,y) \rightarrow (x,3)$ if $y<3$	fill the 3l jug
3.	$(x,y) \rightarrow (0,y)$ if $x>0$	empty the 4l jug
4.	$(x,y) \rightarrow (x,0)$ if $y>0$	empty the 3l jug
5.	$(x,y) \rightarrow (x-d,y)$ if $x>0$ ~~and~~ or $x \geq d$	pour some water out of 4l jug
6.	$(x,y) \rightarrow (x,y-d)$ if $y>0$ or $x \geq d$	pour some water out of 3l jug
7.	$(x,y) \rightarrow (4, y-(4-x))$ if $x+y \geq 4$ & $y>0$	put some water to 4l jug to make it full from 3l jug
8.	$(x,y) \rightarrow (x-(3-y), 3)$ if $x+y \geq 3$ & $x>0$	put some water to 3l jug to make it full
9.	$(x,y) \rightarrow (0, x+y)$ if $x+y<3$, $x>0$	pour all water from 4l to 3l
10.	$(x,y) \rightarrow (x+y, 0)$ if $x+y<4$, $y>0$	pour all water from 3l to 4l

water Qty in 4l jug	water Qty in 3l jug	Rule applied
0	0	2
0	3	10
3	0	2
3	3	7
4	2	4
0	2	10
2	0	

Finally, we have 2l water in 4l jug using production rule system.

(11b) What are the differences between human and machine intelligence? Provide an example for representing intelligence.

- Human intelligence is something natural, no artificiality is involved in it, human intelligence related to the adaption and pattern
- AI is designed to add human like qualities in robotics machine.

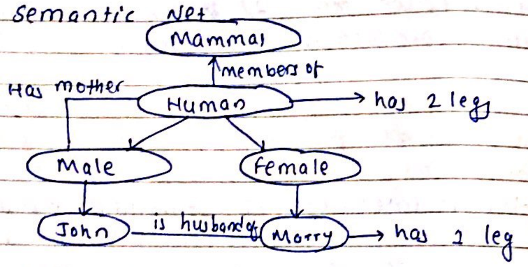
Major differences are:
- Human perceive by patterns but machine perceive by set of rules and data.
- Human can figure out the complete data even if some part of it is missing but AI judges directly.
- Human uses analogue (signal). AI uses digital
- Human needs to recall using patterns but AI recall using searching algorithm

Example. me vs google

Intelligence is represent by using set of rules and data. On the other hand, knowledge is represented in computer so, there are different technique to represent intelligen

- Semantic nets
- Frames
- Truth tables
- First order predicate logic (FOPL)

In semantic Net



In FOPL: Dashrath is father of Ram

father(Dashrath, Ram)

2(a) Compare and contrast Semantic Nets with Frames. Construct semantic network for following statement.
First part: Note
Second part:

P.T.O

Relaxo is a chair. A chair is a furniture. Color of my chair is tan which means Brown. My chair is covered by leather. I own my chair and I am a person.

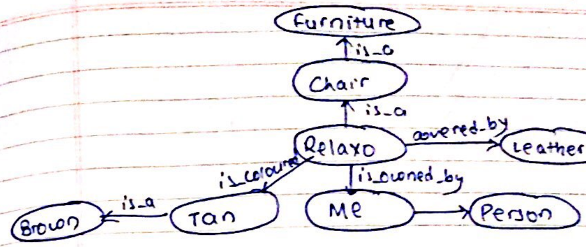


Fig: Semantic Nets

2(b). Convert into FOPL (First order predicate Logic)

1. All dogs have 4 legs
$\forall x$: dog(x) $\rightarrow$ leg(x, 4) (best)
or leg(dogs, 4)

2. All barking dogs are irritating
$\forall x$: dog(x) $\wedge$ barks(x) $\rightarrow$ irritating(x)

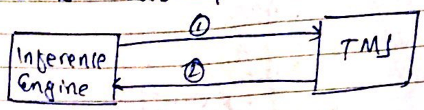
3. Father are male parents with children
~~male-p~~
$\forall x$: male_parent(x) $\wedge$ have_children(x) $\rightarrow$ father(x)

4. Students are people who are enrolled in courses
$\forall x$: people (x) $\wedge$ enrolled-in-course(x) $\rightarrow$ student(x)

3(a). What do you mean by Truth Maintainenance System (TMS)? With the help of an example, explain Bayesian Network with its conditional probability table and diagram.

$\rightarrow$ TMS is a knowledge representation method for representing both beliefs and their dependencies.

TMS is a useful problem solver module.



① → Justification, assumption

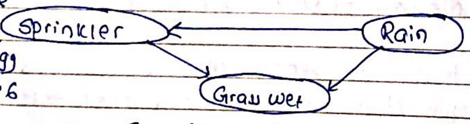
② Beliefs, contradiction

A TMS maintains consistency betⁿ old believed knowledge and current believed knowledge and current believed knowledge in the knowledge Base (KB) through revision. If the current believed knowledge contradicts, it updates with new knowledge.

example:

Bayesian Network (Bayes N/w, belief N/w or probabilistic acyclic graphical model is a probabilistic graphical model that represent a set of random variable and their dependcies. Bayes N/w could represent the probabilistic relationship between two classes.

	Sprinkle T	F
Rain T	0.01	0.99
F	0.4	0.6



Rain T	F
0.2	0.8

Sp	Rain	Grass wet T	F
T	T	0.99	0.01
T	F	0.9	0.1
F	T	0.8	0.2
F	F	0.0	1.0

~~P(G∩R∩S)=~~

Suppose: two events which could cause grass to be wet: either the sprinkler is on or it's raining.
G= Grass wet S= sprinkler R= raining

What is the probability that it is raining, given the grass is wet

better provide Book example

$$P(R|G) = \frac{P(\overset{T}{G} \cap \overset{T}{R})}{P(G)_T} = \frac{P(\overset{T}{G} \cap R \cap \overset{T}{S})}{P(G, S, \underset{T}{R})}$$

$$P(G=T, S=T, R=T) = P(G=T / S=T, R=T) * P(S=T / R=T) * P(R=T)$$

$$= 0.99 * 0.01 * 0.2 = 0.00198$$

~~P(R=T)~~ →

[tail Q/N]

3(b) How Bayes N/w used to reason the uncertain data explain

BN provides a means of parsimoniously expressing joint probability distributions over many interelated hypothesis. BN consists of a directed acyclic graph (DAG) and set of local ~~operation~~ distribution. Each node represent a random variable.

A random variable may denotes an Attributes, features or hypothesis which we may be uncertain. Each random variable has set of mutually exclusive and collectively exhaustive possible values. That is, exactly one of possible values is or will be the actual value, and we are uncertain about which one it is.

Q6. We cannot always know everything relevant to the problem before we select an action.
- environment that are non deterministic, partially observable.
- Noisy sensors
- some features may be too complex.

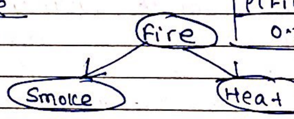
Baye's Rule defined A and B are two not mutually exclusive events such that probability of B occure if A has already given is:

$$P(B/A) = \frac{P(A|B) * P(B)}{P(A)}$$

- Representing uncertainty is useful in knowledge base
- Rational agent canot voilates probability theory

Example

P(fire)
0.1



Fire	P(Smoke)
T	0.90
F	.001

Fire	P(heat)
T	0.99
F	.0001

P(where there's smoke, there's (probably) fire)

$$P(F=T / S=t) = \frac{P(F=T \cap S=T)}{P(S=T)}$$

P(fire = t & smoke = t) =

$= \sum_{heat} P($ fire = t & smoke = t & heat)

$= \sum_{heat} P($ smoke = t & heat | fire = t) P(fire = t)

$= \sum_{heat} P($ smoke = t | fire = t) · P(heat | fire = t) P(fire = t)

$=$ P(smoke = t | fire = t) P(heat = t | fire = t) P(fire = t)
+ P(smoke = t | fire = t) · P(heat = F | fire = t) · P(fire = t)

$= 0.90 * 0.99 * 0.1 + 0.90 \times 0.1 * 0.1$

$= 0.09$

P(smoke = t)

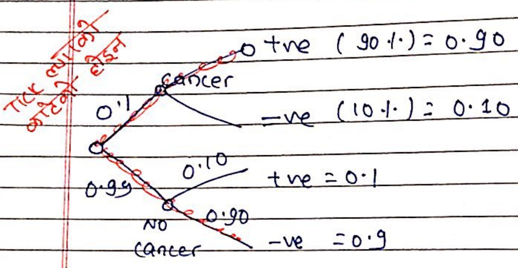
$= \sum$ fire

Example: Approx 1% of women aged 40-50 have breast cancer. A women with breast cancer has 90% chance of a positive test while a woman without has a 10% chance of a false positive result.
What is the probability a woman has cancer given that she just had a positive test?

→ Let B = woman has breast cancer
A = a positive test

$P(B/A) = P(\text{cancer}/\text{+ve test})$

$= \dfrac{P(A|B) \cdot P(B)}{P(A)} = \dfrac{P(\text{+ve}/\text{cancer}) \cdot P(\text{cancer})}{P(\text{+ve test})}$



$P(\text{+ve}/\text{cancer}) = 0.90$

$P(\text{cancer}) = 0.1$

$P(\text{+ve test}) = 0.90 * 0.1 + 0.99 * 0.1$

$P(B/A) = \dfrac{0.090 * 0.1}{0.90 * 0.1 + 0.99 * 0.1} = \dfrac{9}{108} = 0.083$

$= 8.3\%$

4(a) Use genetic algorithm optimize the equation $f(x) = 15x - x^2$ [sample 0-31, pop^n size = 4]

Steps are:

1. Generating initial population. ie chromosomes/genotypes are: (randomly selects 4 random variable each of bit size ~~max~~ 5 [11111] (it need 5 bit)

ie: 01011, 01000, 00111, 01110

2. Calculate fitness and phenotypes
   - Phenotypes are:
   01011 → 11, 01000 → 8, 00111 → 7, 01110 → 14
   - $f(x) = 15x - x^2$
   11 → 44, 8 → 56, 7 → 56, 14 → 14

3. We use roulette wheel for selection of best chromosomes (selecting two best parent for crossover based on their fitness in P_i)

$$P_i = f_i / \sum_{j=1}^{n} f_j$$

String No	Chromosome	X value	Fitness f_i	P_i	Expected count $N * P_i$
1	01011	11	44	0.258	1.036
2	01000	8	56	0.329	1.316
3	00111	7	56	0.329	1.316
4	01110	14	14	0.083	0.332
Sum			170	1	4.00
Average			42.5	0.25	1.00
Max			56	0.329	1.316

String 2 and 3 has max^m chance of selection (most probably 2, FIFO)

4. Produce a new generation
we divide the range into 4 bins, sized according to relative fitness

Strings	Prob i	Associated bins
01011	0·258	0·0 ------- 0·258
01000	0·329	0·268 ----- ~~0·329~~ 0·587
00111	0·329	0·587 ------- 0·916
01110	0·083	0·916 ------ 1·00

by generating 4 unifor (0,1) random values and seeing in which bin they fall.

Random No	Falls into Bin	Chooden string
0·32	0·258 ---- 0·587	01000
0·59	0·587 --- 0·916	00111
0·90	0·587 --- 0·916	00111
0·15	0·0 ---- 0·258	01011

5. within each pair, swap part to create offspring
For first pair: 01000, 00111

0 1 0 0|0 ⇒ 01001
0 0 1 1|1 ⇒ 00110

for second pair

0|0 1 1|1 ⇒ 00111 ⇒
0|1 0 1|1 ⇒ 01011

6. Go back and re-evaluate fitness of pop^n

string No	chromosome	phenotype (x-value)	fitness $f(x)=15x-x^2$	P_i	Expected count
1	01001	9	54	0·259	1·036
2	00110	6	54	0·259	1·036
3	00111	7	56	0·269	1·076
4	01011	11	44	0·213	0·852
total			208	1·00	4·0
Average			52	0·25	1·0
max			56	0·269	1·076

observe that:

1. Initial population: At start step 1
   01011, 01000, 00111, 01110
2. After one cycle, new pop^n in step 6
   01001, 00110, 00111, 01011
3. The total fitness has gone from 170 to 208 in a single generation
4. The possible solution is string NO3
   00111 (x = 7)

(4 b) How is learning process in Winston learning different from that of Boltzman machines? explain

Winston Learning or Semantics Nets Learning is a program operated in simple blocks world program. Goal is to construct representation of the definition of concept in the block domain

Example: concept of house, tent

Boltzman machine were one of the first examples of neural network capable of learning internal representation and are able to represent and solve difficult combinatoric problems. Boltzman machine, like a Hopfield network, is a network of units with an energy. It's a network of symetrically connected, neuron like units that make stochastic decision about whether to be on or OFF. It is very slow learning

Output y is given by $y = b_i + \sum x_j w_{ij}$

probability of being ON is: $P(x_j=1) = \frac{1}{1+e^{-y}}$

Winston also a machine learning but based on the concept of an arch and have a concept of Near Misses, something that is almost, but not quite, an arch

[elaborate This]

(5 b) What is Knowledge Acquisition process? Write some techniques of knowledge elicitation

→ Knowledge acquisition is a process used to define the rules and ontologies recquired for Knowledge Based (KB) System. Knowledge Acquisition is the process of extracting, structuring and organizing knowledge from one source (usually human experts) So it can be represent in software like Expert System.

Step for knowledge acquisition process:

- domain must be evaluated to determine if domain is suitable for ES (expert System)
- The source of expertise must be identified and evaluated to ensure that the specific level of knowledge
- If major sources is human expertise, the specific knowledge acquisition techniqueres and participants need to be identified

Knowledge Acquisition Technique

- observe a person solving real problem
- through discussion, identify data & knowledge
- Build scenarios
- Have the expert to solve a series of problem.

A knowledge Elicitation is the process of acquiring knowledge from a domain expert to enter into the knowledge base of an expert. it is a process of gaining knowledge from a specific domain. It is the most important task on development of ES since it has directly impact. it is bottleneck of ES.

Knowledge is extracted (elicted) chiefly from experts in the field of data/ information. There are variety of elicitation technique used as the nature of situation.

Techniques are

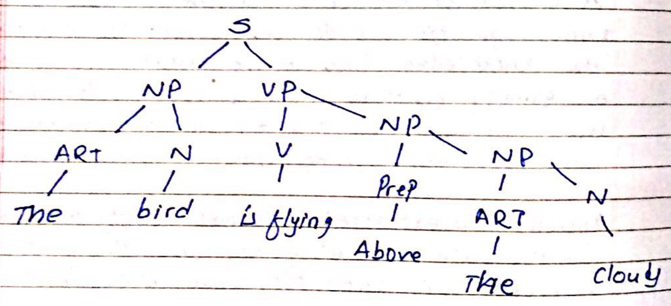
① Document analysis: Used for orientation and preparation. document is most common source of information (often available)

· Interview : interviews are oldest and common tool used for data collection. An interview can be structured or unstructured.

· Observation : the system doesnot interact with expert in action. The intention is to observe how task is being performed

· Questonnaires
· Protocol Analysis
· Laddering
· Repertory Grid Technique

6(a) Draw a syntatic parse tree of given sentence "The bird is flying above the clouds"



2015 spring

2(a) Define state-space. Draw BFS search-tree for missionary and cannibal problem.

State space search is a process used in the field of computer science including artificial intelligence (AI), in which successive configuration or states of an instance are considered, with the goal of finding a goal state

- state space : a set of state that a problem can be in

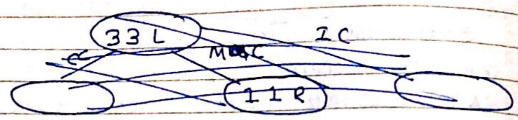
State space in AI is the group consisting of all the attainable states of a problem. It is usually shown by directed graph with nodes as states and arc as operators.

Missionaries and cannibals :

lets say, 3 missionarries and 3 cannibals wants to cross from left bank of a river to the right. There is a boat on the left, but only carries at most two object. If cannibal ever outnumber missionaries on either bank, cannibals will eat missionaries.

let a state represented be (m, c, b)
where m = no. of missionaries
c = cannibals and b = boat either left or right
for example, the initial state is (3 3 L)
Operators are
MM : 2 missionaries cross the river
CC : 2 cannibal " " "
M : 1 Missionary " " "
C : 1 cannibal " " "
MC : 1 missionary and 1 cannibal " " "

The State Space



L(3m, 3c, b) R(0m, 0c)

cc | 1m 1c | 1c

L(3m, 1c) R(0m, 2c, b)

L(2m, 2c) R(1m, 1c, b)

~~L(0m, 1c)~~ L(3m, 2c) R(0m, 1c, b)

1c 1m

L(3m, 2c, b) →2c L(3m, 0c) →1c L(3m, 1c, b)
R(0m, 1c) R(0m, 3c, b) R(0m, 2c)

2m

L(0m, 2c) b ←2m L(2m, 2c, b) ←1c L(1m, 1c)
R(3m, 1c, b) R(1m, 1c) 1m R(2m, 2c, b)

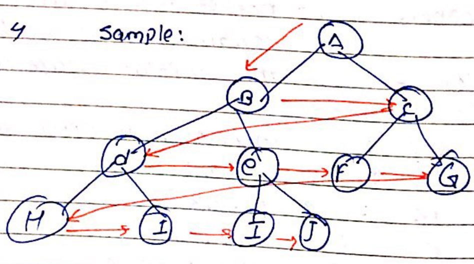
1c

L(0m, 3c, b) →2c L(0m, 1c) →1c L(0m, 2c, b)
R(3m, 0c) R(3m, 2c, b) R(3m, 1c)

↓1m ↓2c

L(1m, 1c, b) →1m 1c L(0, 0)
R(2m, 1c) R(3m, 3c, b)

Cost = 11
Solution = 4 Sample:



Breadth-first search (12)

cc. 3m/3c	← boat Left	0m/0c
3m/1c	boat right →	0m/2c
3m/2c	← boat Left	0m/1c
3m/0c	boat right →	0m/3c
3m/1c	← boat left	0m/2c
1m/1c	boat right →	2m/2c
2m, 2c	← boat left	1m/1c
0m, 2c	boat right →	3m, 1c
0m, 3c	← boat left	3m, 0c
0m, 1c	boat right →	3m, 2c
0m, 2c	← boat left	3m, 1c
0M 0C	boat right →	3m, 3c

Depth first search [level 12]

3m 3c	left	0M, 0C
2m 2c	right	1M, 1C
3M 2C	left	0N, 1C
3M 0C	right	0M, 3C
3M 1C	left	0M, 2C
1M 1C	right	2M, 2C
2M 2C	left	1M, 1C
0M 2C	right	3M, 1C
0M 3C	left	3M, 0C
0M 1C	right	3M, 2C
1M 0C	left	2M 3C
0M 0C	right	3M, 3C

(2b) Convert the following sentence into FOL

(i) Hilary is not wife of Obama

¬wife(Hilary, Obama)

(ii) You can't fool all of the people some of the time.

∀x: people(x) ∧ ∃y: Time(y) → ¬fool(x,y)

~~∀x∀y~~

∀x∃y: people(x) ∧ time(y) → ¬Fool(x,y)

∀x∃t: person(x) → time(t) ∧ ¬canfool(x,t)

(iii) Some students fail in exam

∃x: student(x) ∧ fail_in_exam(x)

(iv) Everyone is younger than his father

∀x: person(x) → younger(x, father(x))

(v) Bob is a boy

boy(Bob)

(vi) Tom caught a bird

~~caught~~ catch(Tom, bird)

(vii) Hitler tried to kill joey

tried_to_kill(Hitler, joey)

- You can fool some of the people all of the time

∃x ∀t: people(x) ∧ time(t) → fooled(x,t)

- You can fool all of the people some of the time

∀x ∃t: people(x) ∧ time(t) → can_be_fooled(x,t)

- All purple mushrooms are poisonous

∀x: purple(x) ∧ mushroom(x) → poisnous(x)

- No purple mushroom is poisonous

∀x: purple(x) ∧ mushroom(x) → ¬poisnous(x)

¬∀x: purple(x) ∧ m(x) ∧ poisnous(x)

- There are exactly two purple mushrooms.

∃x∃y: purple(x) ∧ mushroom(x) ∧ purple(y) ∧ mushroom(y) ∧ ¬equal(x, y) ∧ ∀z: purple(z) ∧ mushroom(z) → equal(x, z) ∨ equal(y, z)

- There is a barber who shaves all men in town who do not shave themselves

∃x∀y: barber(x) ∧ people(y) ∧ ¬shave(y,y) → shave(x,y)

- A person born in UK, each of whose parents is a UK citizen or a UK resident, is a UK citizen by birth.

∀x: ~~born(x,~~ people(x) ∧ born(x,UK) ∧ (∀y: parent(

Qn.3(a) Bayes Network is used to solved uncertain condition. Explain with an example.

[done 2016 fall 2(b)]

3(b)] Define machine learning. Explain genetic algorithm with the help of flow-chart.

Machine Learning is a branch of AI that use algorithms to allow computer to evolve behaviours based on data collected from database or gathered through sensors.

Genetic Algorithms

- search procedure based on a simple model of evolution
- Uses a random process to explore search space
- Has been applied in many domains.
- Begin with a population of individuals. Each individual represents a solution to the problem we are trying to solve.
- A data structure describes the genetic structure of the individual (Assume for initial discussion that this is a string of 0's and 1's)
- In genetics, the strings are called chromosomes and the bits are called genes.
- The string associated with each individual is its genotype.
- Selection is based on fitness of individuals
- Each evolving popⁿ of Individual is called a generation.
- Given a popⁿ of individuals corresponding to one generation the algorithm simulates natural selection and reproduction in order to obtain the next generation

The basic operations:

1) Reproduction: individuals from one generation are selected for the next generation

2) Crossover: Genetic material from one individual is exchanged with genetic material from another individual.

iii) Mutation: Genetic material is altered

General G.A. procedure (Genetic Algorithm)

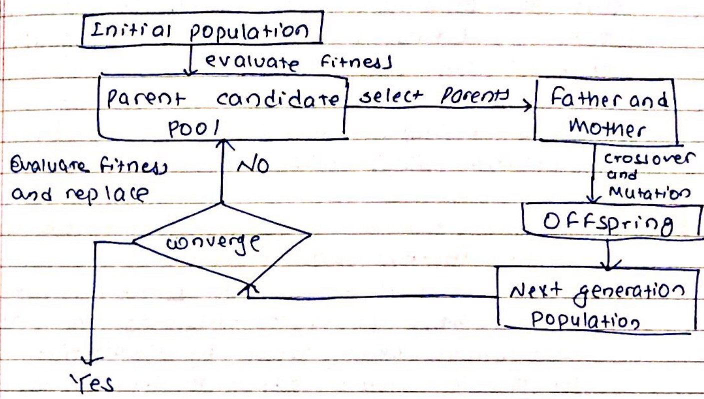
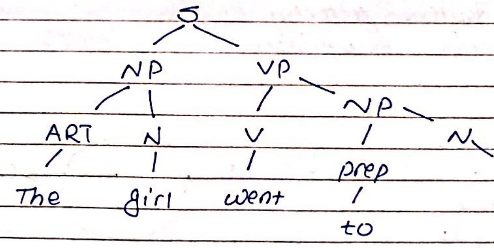


Fig: selection, crossover and mutation process.

(4b) The girl went to school



Qn 5(a) What is Means end Analysis. provide a stepwise example of backward chaining system.

→ Reducing differences between current state and goal state and stop when difference is zero. It breaks the problem into subgoal.
example: GRE comes first.

Stepwise example: Unit 1 Goals in problem solving page no: 24 (5th page)

5(b) Write about Adaline with suitable example diagram. How does Hopfield network works.

- Stand for Adaptive Linear Element
- It is a simple perceptron-like system that accomplishes classification by modifying weights in such a way as to diminish the mean square error at every iteration. This can be accomplished using gradient Adaptive Linear Element [Adaline]
- Used in Neural network for
  - Adaptive filtering
  - Pattern Recognition

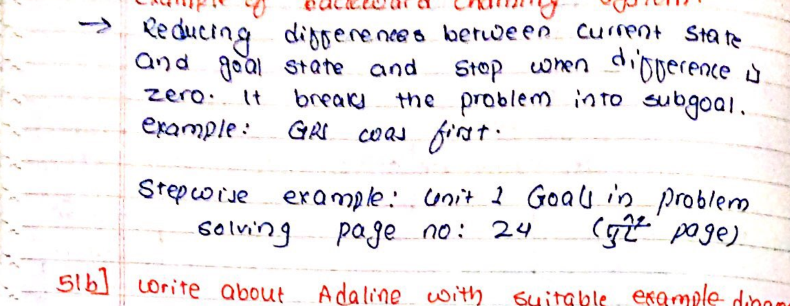


fig: Adaline

Neural network with feedback system are called Hopfield networks.
After applying a new input, the network output is calculated ~~and~~ again and the process is repeated until the o/p becomes constant.

6(b) Compare and contrast procedural and declarative knowledge with relevant examples.

Declarative knowledge is knowledge based on the learned or studied facts. for example you're teached that colors are build from three orthogonal components: Red, Green and Blue is called declarative knowledge. This knowledge has been declared as such in published and accepted papers about the relevant subject
Example: declarative knowledge can be learned out of published books and digital manuscripts.

Procedural knowledge is knowledge based on learned/experienced facts on how to handle problems by heart ie. collective thought process that define how things are done ie. knowing the actual procedure to handle a certain action. The action Actions donot have to be physical but can also be intellectual.
Example: The art of bicycling is an example of procedural knowledge.

· Declarative knowledge is defined as the factual information stored in memory and known to be static in nature. eg: descriptive or propisitional knowledge (name)

· Procedural knowledge is the knowledge of how to perform or how to operate. eg: know-how (name)

Procedural knowledge	Declarative knowledge
- low level of abstraction	- high level of abstraction
- suitable for dependent facts	- suitable for independent facts.
- low modifiability	- Good modifiability
- low readability	- Good readability
- better for knowledge engineers	- better for domain expert
- high computational efficiency.	- low computational efficiency
- Long-term retention	- Easily forgotten

2015 Fall:

1(a) What is planning? Explains Means - End Analysis with an example.

→ planning (foreThought) is the process of making plans for something or usually to achieve goal. Planning is the process of thinking about and organizing the activities required to achieve a desired goal. Planning means looking ahead and charting out future courses of action to be followed.
second part: already done.

1(b) Why is AI important these days? Write about types of Intelligence Agent.

Artificial intelligence is the machines program or software which are designed and programmed in such a ~~way~~ manner that they and think and act like a human.

- These technology reduces human effort
- Increment of efficiency and speed of work.
- AI brings the idea of error free world
- solving complex problems
- Critical thinking

- Uses of AI in medical science: eg virtual doctor
- Heavy industry
- Critical environment
- AI role in Gaming zone.

Types of Intelligent agents are: (R, M, G, U)
- Simple Reflex agent (R)
- Model Based Reflex agents (M)
- Goal Based agents (G)
- Utility Based agents (U)

Description in Note copy (Chapter 0)

3(a) Convert the following into FOPL

1) John hates all the people who doesnot hate themselve
$\forall x:$ people(x) $\wedge$ $\neg$ hate(x, x) $\rightarrow$ hate(John, x)

(2) Every gardener likes the sun.

$\forall x$: gardener(x) $\rightarrow$ likes(x, sun)

(3) You can fool some of the people all of the time

$\exists x \forall t$: people(x) $\wedge$ time(t) $\rightarrow$ can-be-fool(x,t)

(4) You can fool all of the people some of the time

$\forall x$: people(x) $\rightarrow$ $\exists t$: time(t) $\wedge$ canbefool(x,t)

or

$\forall x \exists t$: people(x) $\wedge$ time(t) $\rightarrow$ can-be-fool(x,t)

(3(b)) Convert into FOL:

(i) Sompal is a bowler

bowler(sompal)

(ii) Andrew is father of Patrick

father(Andrew, patrick)

(iii) Some students are Smart

$\exists x$: Student(x) $\rightarrow$ smart(x)

(iv) Everyone is younger than his father

$\forall x$: people(x) $\rightarrow$ younger(x, father(x))

(v) John likes mary

likes(John, mary)

(vi) VascoDaGamma tried to assasinate Luther

tried-to-~~kill~~ assasinate(VascoDaGamma, Luther)

(vii) All purple mushroom are poisonous

$\forall x$: mushroom(x) $\wedge$ purple(x) $\rightarrow$ poisonous(x)

3(a) What is Uncertainty? What are the sources of uncertain knowledge. Explain Bayes N/W.

$\rightarrow$ The lack of exact knowledge that would enable us to reach a perfectly reliable conclusion

Sources are:

(i) Weak implication: domain expert and knowledge engineer have rather painful or hopeless task of establishing concrete co-relation between hypothesis (p) and conclusion (q) ie $p \rightarrow q$

(ii) Imprecise Language: Natural language processing is ambiguous and imprecise. We define facts interm of ~~fact~~ 'often', 'sometime', 'frequently', 'hardly ever'. It can effect if-then implication

(iii) Unknown Data: incompletes and missing data should be process to an approax reasoning with this values

(iv) ~~Combining the views of differently experts~~: Large system uses data from many expert.

3(b) Describe about Inductive bias learning with example.

The inductive bias (~~ie~~ learning bias) of a learning algorithm is the set of assumptions that the learner uses to predict outputs given inputs that it has not encountered.

In machine learning, one aims to construct algorithm that are able to learn to predict a certain target ~~about~~ output.

A classical example of an inductive bias is "~~Oc~~ Occam's razor", assuming that the simplest consistent hypothesis about the target function is actually the best.

→ Every machine algorithm with an ability to generalize beyond the training data that it sees has, by definition, some type of inductive bias.

Qn 4(a) Done in Note

Qn 4(b) Done in Note

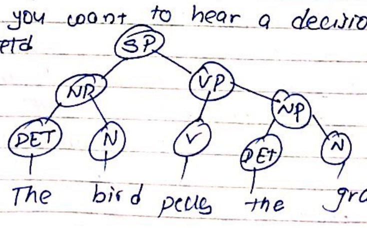
Qn no 5(a) Done in Note

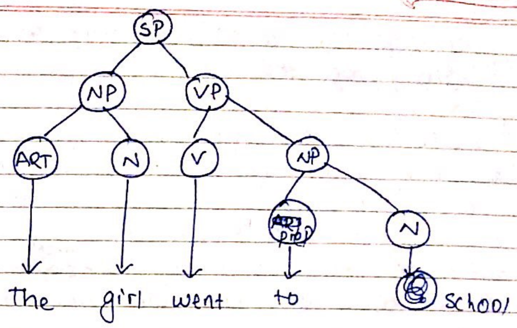
Qn no 5(b) Done already

Qn no: 6(a) Define NLP. "The girl went to school"

Natural language processing (NLP) refers to AI method of communicating with an Intelligent systems using a natural language such as english. Process of NL is required
- when you want an intelligent system to perform as per your instruction
- when you want to hear a decision

~~The Field~~





- speech or written text are output of NLP.

Qn no 6(b) Why is knowledge acquisition necessary? How is the knowledge acquired from human expert to build an expert system? ~~??~~ Explain with suitable diagram.

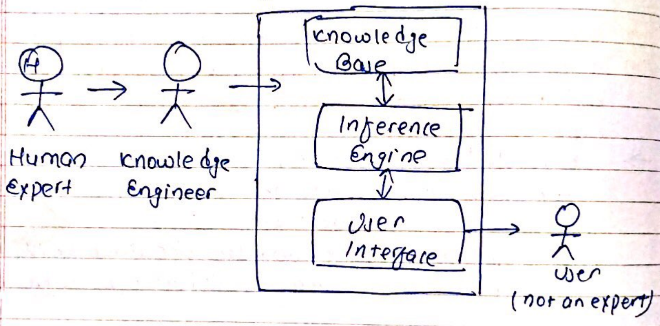
→ Knowledge Acquisition is necessary because
- Allow non experts to understand the knowledge.
- can capture tacit knowledge
- validate the knowledge acquired with other experts and make modifications where necessary.
- Represent these knowledge elements using the most appropriate model.

Second part:

The success of any expert system majorly depends on the quality, completeness, and accuracy of the information stored in the knowledge base.

The knowledge base is formed by reading from various experts, scholars and knowledge Engineers. The knowledge engineer is a person with the qualities of empathy, quick learning and case Analyzing skills.

He acquires information from the subject expert by recording, interviewing and observing him at work etc. He then categorizes and organizes the information in a meaningful way, in the form of IF-THEN-ELSE rules to be used by interference machine. The knowledge ~~man~~ engineer also monitors the development of the ES.



(Explain the figure)

2014- Spring

1(a) done already in Note

1(b) done already in Note

1(c) What are the required capabilities of an agent so that it is supposed to be intelligent. Explain.

In AI, Intelligent Agent (IA) is an autonomous entity which observes through sensors and acts upon an environment using actuators (it is an agent) and direct its activity towards achieving goal. Intelligent agent may ~~are~~ also learn or use knowledge to achieve the goal

The capability ~~are~~ required to be C

1. Reactivity: intelligent agent perceive and responds in a timely fashion to changes that occur in their environment inorder to satisfy their design objectives

2. Pro-activeness: goal directed and reacting to an environment.

3. Social Ability: Intelligent agent must be capable of communicating with other agents.

4. mobility: can be moved around

learning / adaptation: improve performance over time

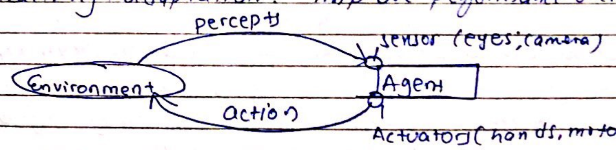


Fig: A generic Agent diagram

5. ~~Autonomy: An agent must be capable of reacting appropriately to influences~~

(5) Autonomy
An agent must have both control over it's action and internal state.

(6) Goal oriented: An agent must have well defined goals

Application are:
(i) News watcher
(ii) Shopping Agent
(iii) Scheduling Agent

Example: Automated Taxi Driver

Percepts	camera, GPS, sonar, Speedometer
Actions	Steer, accelerate, Brake
Goal	Safely to destination
Environment	Traffic ligh, Pedestrian,

2(a) Compare and contrast knowledge and intelligence

Knowledge is the collection of skills and information a person has acquired through experience. Intelligence is the ability to apply knowledge. Just because someone lacks knowledge of a particular subject doesnot mean they cant apply their intelligence to solve problem

Knowledge is a techniques so it fades intelligence sustains.

KNOWLEDGE	INTELIGENCE
(1) knowledge is ~~acce~~ the information that is meaning ful to intelligence.	(1) intelligence is a ability to create imagine, socialize, solve problems, make decision and think rationality.
(ii) knowledge is acceptance of facts.	(ii) Intelligence is implementation of those facts wisely.
(iii) knowledge comes through Books, material	(iii) Intelligence is present into genes (naturally intelligent)
(iv) knowledge is what we know	(iv) intelligence is how we used that acquired knowledge
(v) knowledge is about asking or Learning anything	(v) Intelligence is about doing right thing.

On 2(b) Done in Note
3(a) done already
3(b) done already
4(a) already done
4(b) already done in Note

Note: Expert System / Neural Network are pending

ALERT!!!

2016 spring

1(a) Mention some of AI's attribute (2-marks)

Application of AI are (for previous qn)

- Gaming: chess
- Natural Language processing: understand
- Expert System: reasoning and advising
- vision system: doctors, spying drone
- Speech recognition
- Handwritten recognition
- Intelligent Robot

Intelligence is intangible and composed of:

- Learning
- Reasoning
- problem solving
- Linguistic intelligence
- perception

(1b) Difference betn informed and uninformed search. which one is preferred for problem searching optimization process.

→ Informed is preferred for problem searching optimization process because it uses problem specific knowledge beyond the definition of problem itself

P.T.O

a. uninformed/blind search:

- doesnot have additional info about states beyond problem definition
- Total search space is looked for solution
- No info is used to determine preferences of one child over other.

Example: Breadth first search (BFS), Depth first search (DFS)

- can distinguish a goal state from non-goal state

b. Informed/directed/Heuristic search

- some info about problem space (heuristic) is used to compute preference among the children for exploration.
- Example: Best first search, Mean-End Analysis
- uses heuristic function
  - It maps each state to a numerical value which depicts goodness of a node

$H(n) = \text{value}$

↳ heuristic funtion & n is current state.

2(a) Convert int. FOPL

(i) Hillary is wife of Bill

wife(Hillary, Bill)

(ii) Mr. Thapa is not a president

$\neg$ president(Mr. Thapa)

(iii) Ramesh attempted to sue John

attempted_to_sue(Ramesh, John) or

sue(Ramesh, John)

(iv) Few Students are genius

$\exists x$: student(x) $\longrightarrow$ genius(x)

(V) Everyone is loyal to someone

$\forall x \exists y$: loyal(x, y)

(VI) Every fan likes his idol

$\forall x$: fan(x, idol(x)) $\longrightarrow$ likes (x, idol(x))

(VII) All black mushrooms are poisonous

$\forall x$: mushroom(x) $\wedge$ black(x) $\rightarrow$ poisnous(x)

2014 2.1b) FOPL

(i) Marcus was a man
man(marcus)

(ii) clinton is not tall
$\neg$tall(clinton)

(iii) John likes mary
likes (John, mary)

(iv) Some students are smart
$\exists x$: Student (x) $\longrightarrow$ smart(x)

(v) Everyone is loyal to someone
$\forall x \exists y$: loyal(x, y)

vi. Marcus tried to Assassinate ceasar
tried_to_assassinate (Marcus, ceason)

vii. All purple mushrooms are poisnous
$\forall x$: mushroom (x) $\wedge$ purple(x) $\rightarrow$ poisnous(x)

~~2014~~ 2013 fall 3.19 FOL or FOPL Conversion

(i) John Likes all kind of food

~~$\forall x$ Likes(~~

~~$\forall x$: food(X) $\rightarrow$ Likes(John, x)~~

ii) Apples are food

iii) chicken is food

iv) Anything one any one eats and is not killed by is food.

v. Bill eats peanuts and is still alive.

vi. sue eats everything Bill eats

Resolution, prove that John likes peanuts.

~~Taking negation of prove:~~

Step 1: convert it into FOPL:

1. $\forall x$: food(x) $\longrightarrow$ Likes(John, x)
2. food (Apples)
3. food (Chicken)
4. $\forall x y$ eats (x, y) $\wedge$ $\neg$killed (x, y) $\rightarrow$ food(x)
5. eats (Bill, peanuts) $\wedge$ $\neg$killed (Bill, peanuts)
6. $\forall x$: eats(Bill, x) $\rightarrow$ eats(sue, x)

prove: likes (John, peanut)

Taking negation of conclusion, we get
$\neg$Likes (John, peanut)

~~Converting into predicate Logi~~

Step 2: Eliminating all implication

1. $\forall x$: $\neg$ food (x) $\vee$ Likes(John, x)
2. food(apples)
3. food (Chicken)
4. $\forall x, y$: $\neg$ (eats (x, y) $\wedge$ $\neg$killed (x, y)) $\vee$ food(x)
5. eats (Bill, peanuts) $\wedge$ $\neg$killed (Bill, peanuts)
6. $\forall x$: $\neg$eats(Bill, x) $\vee$ eats(sue, x)

→ Using de-morgan's law:
1. ∀x: ¬food(x) ∨ likes(John, x)
2. food(apples)
3. food(chicken)
4. ∀x,y: ¬eat(x,y) ∨ killed(x,y) ∨ food(y)
5. eats(Bill, peanuts)
6. ¬killed(Bill, peanuts)
7. ∀x: ¬eats(Bill, x) ∨ eats(sue, x)

→ ~~Skolomization (Eliminating ∃)~~
~~→ Not Existencial quantifier in FOPL~~

→ ~~Standarazie variable~~
~~No Existentencial~~

→ ~~Droping all Universal quantifier~~
~~1.~~

→ Standarize variable
1. ∀x: ¬food(x) ∨ Likes(John, x)
4. ∀y,z: ¬eats(y,z) ∨ killed(y,z) ∨ food(y)
7. ∀w: ¬eats(Bill,w) ∨ eats(sue, w)

→ Skolomization (Eliminating ∃)
→ No Existencial (∃) quantifier exist

Droping universal quantifier
1. ¬food(x) ∨ Likes(John, x)
2. food(apples)
3. food(chicken)
4. ¬eats(y,z) ∨ killed(y,z) ∨ food(z)
5. eats(Bill, peanuts)
6. ¬killed(Bill, peanuts)
7. ¬eats(Bill, w) ∨ eats(sue, w)
8. proved: ¬Likes(John, peanut)

prove by Resolution:
Taking 8 and 1. (conjuction)
¬Likes(John, peanut) ∨ ¬food(x) ∨ Likes(John, x)
x/Peanut

¬food(peanut) — 9.

Taking 9 and 4
¬food(peanut) ∨ ¬eats(y,z) ∨ killed(y,z) ∨ food(z)
~~y/peanut~~ z/peanut
¬food(peanut) ∨ ¬eats(y, peanut) ∨ killed(y, peanut) ∨ food(peanut)

¬eats(y, peanut) ∨ killed(y, peanut) — 10.

Taking 10 and 5
¬eats(y, peanut) ∨ killed(y, peanut) ∨ eats(Bill, peanut)
y/Bills
¬eats(Bill, peanut) ∨ killed(Bill, peanuts) ∨ eats(Bill, peanut)

killed(Bill, peanuts) — 11

Taking 11 and 6
killed(Bill, peanuts) ∨ ¬killed(Bill, peanuts)

null(ϕ)

since, we arrived at the contradictory situatoin ie null clauss. Therefore our assumptions
~~[illegible]~~ ¬likes(John, peanut) is false
Hence, The given statement which is
likes(John, peanut) is true //

2(b) 2012 Spring: 2(b): Convert into FOPL.

(i) Marcus was a man
man(Marcus)

(ii) Marcus was a pompeian
pompeian(marcus)

(iii) All pompeians were Roman
Roman(pompeians)

iv. Ceaser was a ruler
ruler(ceaser)

v. All Roman were either loyal to ceasar or hated him
$\forall x$: Roman(x) $\rightarrow$ loyal(x, ceasor) V hate(x, ceasor)

vi. Everyone is loyal to some one.
$\forall x \exists y$: loyal(x,y)

vii. people only try to assasinate rulers they are not loyal to
$\forall x \exists y$: people(x) $\wedge$ ruler(y) $\wedge$ ¬loyal(x,y) $\rightarrow$ assasinate(x, y)

viii. Marcus tried to assasinate ceaser
tried-to-assasinate(Marcus, ceaser)
or, assasinate(Marcus, ceaser)

3(a) Convert above FOL into CNF
1 same
2. same
3. same
4. same
5. $\forall x$: ¬roman(x) V loyal(x, ceasor) V hate(x, ceasor)
6. same
7. $\forall x \exists y$: ¬(people(x) $\wedge$ ruler(y) $\wedge$ ¬loyal(x, y)) V assasinate(x, y)
= $\forall x \exists y$: ¬people(x) V ruler(y) V ¬loyal(x,y) V assasinate(x, y)
8. same

2012 3(a) Fall Resolution
i) Kabita likes only easy courses
ii) All science courses are hard
iii) All arts courses are easy
iv) A101 is an arts course
v. S202 is a science course
prove which courses does Kabita like ?
let ~~like(steve, x)~~ Like(Kabita, x)

1→ Converting into FOPL
(i) $\forall x$: easy ~~course~~(x) $\longrightarrow$ likes(Kabita, x)
(ii) $\forall x$: science_course(x) $\rightarrow$ ~~hard(x~~ ¬easy(x)
(iii) $\forall x$: ~~courses~~ art_course(x) $\longrightarrow$ easy(x)
(iv) art_course(A101)
(v) science_course(S202)
vi. ~~like(steve, x)~~ Like(Kabita, x)

2→ Converting into clausal form
1

1. $\forall x: \neg easy(x) \vee$ ~~Kabital~~ $likes(Kabita, x)$
2. $\forall x: \neg science\_course(x) \vee \neg easy(x)$
3. $\forall x: \neg art\text{-}course(x) \vee easy(x)$
4. $art\text{-}course(A101)$
5. $science\text{-}course(S202)$
6. ~~Like(Steve, x)~~ $Like(Kabita, x)$

2. Standarize variable
   1. $\forall y: \neg easy(y) \vee likes(Kabita, y)$
   2. $\forall s: \neg science\_course(s) \vee \neg easy(s)$
   3. $\forall a: \neg art\text{-}course(a) \vee easy(a)$
   4. $art\_Courses(A101)$
   5. $science\_course(S202)$
   6. ~~Like(Steve, x)~~ $Like(Kabita, x)$

3. Skolomization (Elimination of $\exists$) and droping $\forall$: quantifiers
   1. $\neg easy(y) \vee likes(Kabita, y)$
   2. $\neg science\_courses(s) \vee \neg easy(s)$
   3. $\neg art\_course(a) \vee easy(a)$
   4. $art\_courses(A101)$
   5. $science.courses(S202)$
   6. ~~Like(Steve, x)~~. $Like(Kabita, x)$

Taking Negation of result/conclusion :
6 : $\neg$~~Like(Steve, x)~~ $\neg Like(Kabita, x)$

4. Resolution

Taking 6 and 1, conjucting

$\neg Like(\cancel{Steve}^{Kabita}, x) \vee \neg easy(y) \vee likes(Kabita, y)$

y/x

$\neg Likes(\cancel{Steve}^{Kabita}, x) \vee \neg easy(x) \vee \cancel{likes(Kabita, x)}$

$\neg easy(x)$ ——— 7

Taking 7 and 3

$\neg easy(x) \vee \neg art\_course(a) \vee easy(a)$

a/x

$\neg \cancel{easy(x)} \vee \neg art\_course(x) \vee \cancel{easy(x)}$

$\neg art\_course(x)$ ——— 8

Taking 8 and 4

$\neg art\text{-}course(x) \vee art\text{-}course(A101)$

$\therefore x = A101$ (we replace x by A101) — ⓐ

$\neg art\_course(A101) \vee art\_course(A101)$

$null(\phi)$

So x is A101 by relation ⓐ

2011 Spring

(8)

(3/a) Convert the following centence into FOL → CNF

(i) All men are mortal

FOL: $\forall x: men(x) \rightarrow mortal(x)$

we know $A \rightarrow B$ is equivalent to $\neg A \vee B$

CNF: $\forall x: \neg men(x) \vee mortal(x)$

(ii) No mortal lives longer than 150

$\forall x \forall t1 \forall t2: Mortal(x) \wedge Born(x, t1) \wedge Greater\_than(t2 - t1, 150) \rightarrow dead(x, t2)$

CNF: $\forall x \forall t1 \forall t2: \neg mortal(x) \vee \neg Born(x, t1) \vee \neg Greater\_than(t2 - t1, 150) \vee dead(x, t2)$

(iii) If someone dies then he is dead all-later time ('>')

FOL: $\forall x, t1, t2$: Died (x, t1) $\wedge$ GT(t2, t1) $\rightarrow$ Dead (x, t2)

CNF: $\forall x, t1, t2$: $\neg$ Died (x, t1) $\vee$ $\neg$ GT (t2, t1) $\vee$ Dead (x, t2)

iv) People only try to assasinate rulers they are not loyal to

$\forall x, \exists y$: people(x) $\wedge$ ruler(y) $\wedge$ $\neg$loyal(x, y) $\rightarrow$ assasinate (x, y)

CNF: $\forall x \exists y$: $\neg$people(x) $\vee$ $\neg$ruler(y) $\vee$ loyal(x, y) $\vee$ assasinate (x, y)

Qn no: 11 b) $\boxed{\text{2014- fall}}$

Define : well defined formula

Any problem in which the initial state or starting position, the allowable operations, and the goal state are clearly specified and a unique solution can be shown to exist.

Example: Tower of Hanoi, waterjar problem.

A problem that lacks one or more of these specified properties is an ill-defined problem.

(3105)

"Hari wants to write a program"

WRONG