Artificial Intelligence :

Thinking Humanly

The exciting new effort to make computers think... machines with minds, in the full and literal sense.

Example: The cognitive modeling approach (decision-making, problem solving, learning)

If we are going to say that a given program thinks like a human, we must have a way of determing how humans think. There are 3 steps:

- trying to catch our own thoughts as they go by; through psychological experiments.
- Observing a person in action; and through brain imaging.
- observing the brain in action;

· The GPS (General problem solver) Needs understanding of How human thinks

Act Humanly : Turing Test approach

- The art of creating machines that performs function that require intelligence when performed by people (Kurzwail, 1990)
  - The computer passes the test if a human interogator, after posing some written questions, can't tell whether the responses were made

· Capabilities need of the computer for the tests:

- NLP (ability to communicate succesfully
- Knowledge representation (store what it knows or hears)
- Automated reasoning (use stored information to answer qn and draw conclusion)
- Machine Learning (adapt a new circumstances and to detect and extrapolate patterns)

Think rationally : The laws of thought approach

- The study of mental faculties through the use of computational models.
- The study of the computations that make it possible to perceive, reason and act.

Think rationally means: thinking right) which is irrefutable reasoning process.

- syllogisms provides a pattern for argument structures that always yielded correct conclusions, when given correct premises.

Example: Sanjay is a man
All men are mortal
∴ Sanjay is a mortal.

- These laws of thought were supposed to govern the operation of the mind & called Logic
- Logistic tradition within AI hopes to build on such programs to create Intelligent systems.

Act Rationally : The Rational Agent approach

An agent is something that acts (or to do). of course, all computers programs do something and are expected to do more, agent must operate ~~ano~~ autonomolly, perceive their environment, persist over a prolonged time period, adapt to change, create and pursue goal.

A rational Agent is one that act so as to achieve the best outcome or where there is uncertaintay, the best expected outcome.

→ In 'laws of thought approach', AI emphasis on correct inferences, making correct inferences is a part of being rational agent.

Limited rationally means acting appropriately when there is not enough time to do all the computations one might like.

Application of A.I :

- Autonomous planning and Scheduling
- Game Playing
- Autonomous control
- Diagnosis
- Logistics planning
- Robotics
- Language understanding and problem solving.

Importance of AI :

- Create a never ending thought process and Collective that could solve our problem
- Thinking of every ~~problem~~ possible solution
- with Artificial intelligence, we could buid computea, upon thousands of computers, that could all work in unison to solve our gread and dire problems.

Knowledge vs Learning

(1) Knowledge is a collection of information
It is the justified true belief
· Data → information → knowledge

(2) Learning is the process of acquiring new or modifying and reinforcing the existing knowledge, behaviours, skills or values through the synthesis and manipulation of information.

(3) Machine Learning means embedding the learning ability into machine or computers.

Why Knowledge and Learning :

For understanding the environment
For updating the knowledge base
For problem solving
For Decision making
For Building Intelligent system.

Agent:

An agent is a thing that can be viewed as percieving its environment through sensors and acting upon that environment through actuators.

Rational agent: striving to do the right thing based on what it perceive and the action it can perform.
example: Vaccum cleaner, self driving car.

types of agent (RMGU)

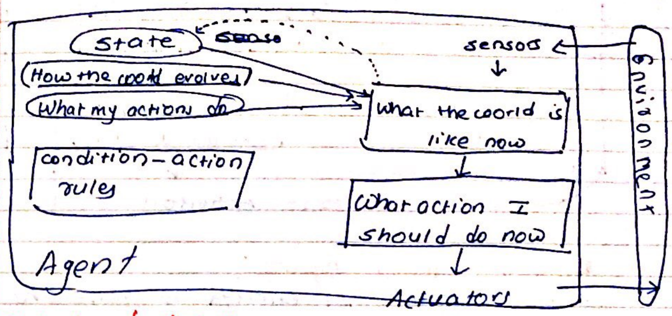
- Simple Reflex agents (R)
- Model-based reflex agent (M)
- Goal-based agents (G)
- Utility-based agents (U)

a. simple reflex agents:

These agents select actions on the basis of the current percept, ignoring the rest of the percept history.
Example: vaccum cleaner: It's decision is based only on the current location and on whether that location contain dirt.

b. Model-based agents:

The most effective way to handle partial observability is for the agent to keep the track of the past of the world it can't see now by maintaining internal state

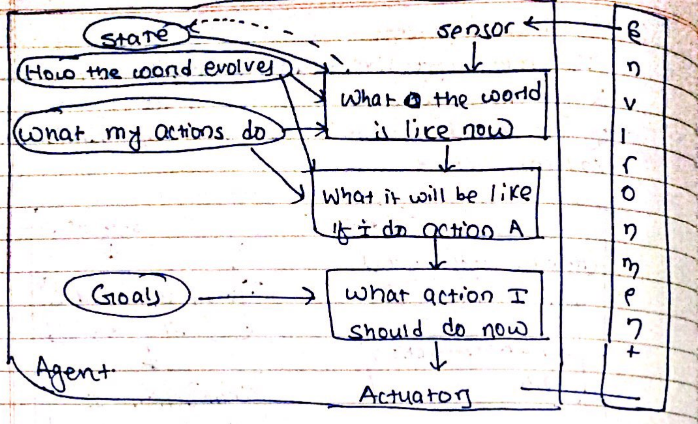


c. Goal based Agents

Knowing something about the current state of the environment is not always enough to decide what to do. for example, at a road junction, the taxi can turn left, turn right or go straight on.
The agents needs some sort of goals information that describles the situation that are desirable

It keep track of the world state as well as a set of goals it is trying to achieve, and chooses an action that will (eventually) lead to the achievement of its goals.

searching and planning is mandatory.

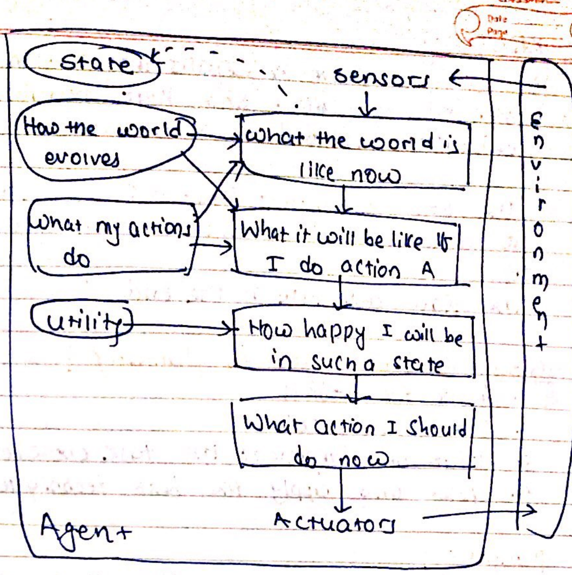


Utility Based Agents:

Goals alone are not enough to generate high quality behaviour in most environments. For example, many action sequences will get the taxi to its destination (thereby achieving the goal) but some are quicker, safer, more reliable and cheaper than others.

Goal achieved or not ???
happy ☺ or not ☹

- It uses a model of the world, along with a utility function that measures its preferences among states of the world. Then it chooses the action that leads to the best expected utility, where expected utility is computed by averaging overall possible outcome states, weighted by the probability of the outcome.



Goals in problem solving

Chapter-1

Goal: The state of affairs that a plan is intended to achieve and that terminates behaviour intended to achieve it

(The state of affairs that a plan is intended to achieve and terminates when achieved.
or
The place designate at the end

Goal schema used in planning:
1. define the problem
2. Analyse the problem
3. Isolate and represent the task knowledge
4. Choose and apply the best techniques.

planning:
To find a sequence of actions that achieves a given goal.

problem solving agents + knowledge based agents
= Planning Agents.

Planning types
a. Linear planning
· works on one goal until completely solved before moving onto the next goal.
· Planning algorithm maintain goal stack.
· Linear planning is sound, it reduced search space, since goal are solved at a time
· Linear planning may produce suboptimal sol?
· It is incompletes.

b. Non-Linear planning
- use goal set instead of ~~a~~ goal-stack. Include in the search space all posible sub goal orderings.
- Handles goal interaction by interleaving.
- It is sound, complete
- It may be optimal wrt plan length.
- Somewhat more complex; more bookkeeping

Means End Analysis
- Means end analysis (MEA) is a problem solving technique used commonly in A.I for limiting search in AI programs.

- It centers around finding the difference between current state and goal state.
- reducing difference between current state and goal state. stop when differen is
. goal
- both fwd and backword chaing

MEA is also considered a way ~~as~~ to break up the problem into pieces (subgoal)
GPS was first AI program

algorithm MEA is
If current state – goal state = 0
· describe curent state, goal state and difference betn them
· use the difference that will get nearer to goals
· use procedure and update current state
If goal reached succes
else fail

Analogy :

Borrowing a solution used to solve similar problem
example: patient has tumors in location no operation
break the beam into very low wavelength
and penetrates from many sides at once

production Rule system :

A production rule system consists of a set of rules, each consisting a left side (a pattern), that determines the applicability of the rule and a right side that describes the operation to be performed and the rule is applied

Control strategy :

control strategy specifies the order in which the rules will be selected and a way of resolving the conflicts that arise when several rules matched at once
(यदि One condition को लागि mutiple rules use गर्न मिल्छ भने, best rule select गर्छ)
Requirement:

- it cause motion
- it should be systematic

Forward and Backward chaining

Forward and backward chaining are strategies used to specify how rules contained in a knowledge base rule system are to be executed.

- Forward chaining goes forward from starting point, via the conclusion generated at each step
- Backward chaining works backward from the conclusion.

Example: IF the weather is Rainy AND
the distance is >= 100 KM THEN
transportation is by cars — 1.

- If transportation is by car THEN
passenger insurance will be considered — 2.

If passenger insurance is considered THEN
insurance cost = Rs 10,000 — 3

Backward chaining: Example, If we have fact- "Transportation insurance cost = 10,000" assume we only know. "The whether is rainy and distance is 150 km".

1. Is this fact known? → No
Can it be obtained from rule? → Yes, from 3
what facts we known → passenger insurance is considered

2. is this fact known? → No
Yes from rule 2
transportation by car

3. Is this fact known? NO
Yes from rule 1
The whether is rainy and distance is 100Km

4. Are these facts known → Yes
The whether is rainy and
distance is 150 km

Therefore it is true that "transportation insurance cost = 10000"

Backward chaing is also known as goal-directed, top down, consequence driven
It is applied when a goal or hypothesis is ~~also known a~~ choosen as starting point for problem solving

FORWARD Chaining:
1. Is the fact known → No.
what fact we know? whether rainy distance 100km
which fact we get: transportation by car (1)

2. Is this we want to prove → No
which fact we get: passenger insurance considered (rule 2)

3. Is this what we want to prove → No
what fact follow from it
"Transportation ~~co~~ insurance cost = 10000"

4. Is this what we want → Yes.

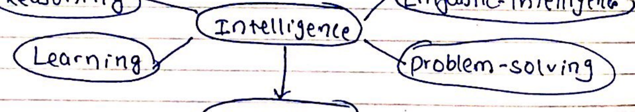
Mycin - style probabilities and its Application
- An Expert System (ES) for treating blood infection
- MYCIN would adapt to diagnose patients based on reported symptoms and medical test ~~input~~ results
- it could ask for more information and lab test results for diagnosis
- uses about 500 production rules
- it operated roughly as same level of competence as human specialist in blood infection
- it used backword ~~reasoning~~ chaining for reasoning.
- it would recommended course of treatments, if requested MYCIN would explain the reasoning that lead to its diagnosis and recommendation.

Unit-2 Intelligence

Intelligence: The ability of system to calculate, reason, perceive relationships and analogies, learn from experience, store and retrieve information from memory, solve problems, comprehend complex ideas, use natural language fluently, classify, generalize and adapt new situations.

Types:
- Linguistic (Narrator)
- Musical (musicians, composers)
- Logical mathematical (scientist)
- Spatial (map readers)
- Bodily-kinestic (players, dancer)
- Intra-personal (Buddha)
- inter-personal. (~~com~~ interviewers)

Intelligence composed of:



1. **Reasoning.** It is the set of processes that enables us to provide basis for judgement, making descisions and prediction.
   Inductive (Broad रिट) vs deductive (narrow रिट)

2. **Learning:** It is the activity of gaining knowledge or skill by studying, practising, being taught or experiencing something. Learning enhance the awareness of the subjects of the study.
   Learning is categorized as:
   - Auditory learning: from listening & hearing
     example: recorded audio lectures, student listening to
   - Episodic Learning: ~~lea~~ from sequence of events that one has experienced. or witnessed
     It is linear and orderly
   - Motor-Learning: शारीरिक learning, learning by precise movement of muscles.
     picking objects etc.
   - Observational Learning: learn by watching and imitating others
     Ex - child tries to learn from their parents

3. **Problem solving:** It is the process in which one perceives and tries to arrive at a desired solution from a present situation by taking some path, which is blocked by known or unknown hurdles.
   - It also include decision making to select best solution

4. **Perception:** process of acquiring, intrepreting, selecting and organizing sensory information. It presumes sensing. In human perception is aided by sensory organ. In AI, perception mechanism puts the data acquired by sensor together in a meaningful manner

5. **Linguistic Intelligence:** It's one's ability to use, comprehend, speak and ~~intelligence~~ write the verbal and written language. It is important in interpersonal communication.

Human VS Machine intelligence:

- Humans perceive by patterns whereas machine perceive by set of rules and data.
- Human store and recall information by pattern. But machines do it by searching algorithms.
  Example, number 40404040 is easy because its pattern is simple
- Human can figure out the complete Object even if some part of it is missing or distorted whereas machines cannot correctly.

Chapter-3 KNOWLEDGE REPRESENTATION

- formal logic
- propositional logic
- Horn Clauses
- Semantic Network
- Frames
- Truth table
-

Inferences:

- A conclusion reached on the basis of evidence and reasoning.
- Inferences are steps of reasoning, moving from premises to conclusions.
  - rules of inferences
  - unification
  - resolution and refutation system

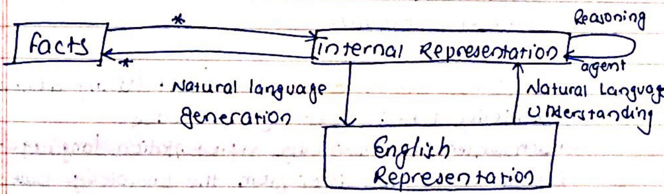
statistical reasoning

- probability and Bayes Network
- casual N/W
- Reasoning in believe N/W.

~~KR~~ knowledge representation

- It is the area of AI whose fundamental goal is to represent knowledge in a manner that facilitates inferring or drawing conclusion from knowledge.
- Analyses how to think formally, how to use symbol to represent a domain of discource along with the function that allow inference about the objects
- technique to represents facts
- How to reason them

Its main objective is to express knowledge in a computer tractable form so that agent can perform well.



Knowledge representation approaches

- Representable Adequacy: domain मा आउने सबै प्रकारको knowledge लाई represent गर्न सक्छ।
- Inferential Adequacy: Ability to manipulate the representational structure
- Inferential Efficiency: Ability to incorporate into knowledge structure that used to focus the attention of the

inference mechanism in the most promising direction
Acquisitional efficiency: Ability to acquire new information easily

* Types
- Simple relational knowledge (database को रूपमा)
- Inferential knowledge (formal logic represent)
- Inheritable knowledge (structure must be designed)
- Procedural/imperative knowledge (knowledge excersiled in the performance of some task.

* Issues
- At what level should knowledge be represented?
- How could set of objects be represented?
- Are there any ~~other~~ imp. relationship that exist among attributes of objects (generally relation exist among objects)
- Are there any attributes of object that they have been occurred in almost every problem domain.

* Knowledge Based Agent : an agent having a knowledge base
- Knowledge base: set of sentence
- Each sentence is knowledge representation language.
- Logical agents must infer from the knowledge base that has the information from the past or background knowledge

- Levels of knowledge base

a. Knowledge level : abstract level
describes agent by saying what it knows.
example: An intelligent taxi might know Bagmati bridge connects Kathmandu with lalitpur.

b. Logical level:
- The level at which the knowledge is encoded into formal sentences.
example: Joins(Bagmati bridge, Kathmandu, lalitpur)

c. Implementation level:
physical representation of the sentences in the logical level.
example: objects, string, dams etc

Approach of system building:

Delarative approach	procedural approach
- Designing the representation language to make it easy to express the knowledge in the form of sentences	- Encoded desired behaviour directly as program code.

1. # Logic :
- formal standard to express sentences so that the sentences are well formed.
- An inference algorithm that derives only entailed sentences is called sound or truth preserving.
- Completeness is desirable

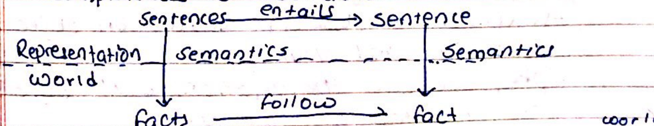


fig: semantics map sentences in logic to fact in the world example:

- knowledge base
  1. Socrates is a man
  2. ~~oo~~ All men are mortal
  3. All men are kind

- Inference algorithm is applied to the above base.
- Inferring "socrates is mortal"
- 'Socrates is kind" follows the sentence "All men are kind'

* Truth Table or Valid sentences

P	PV!P
T	T
F	T

→ Tautology: A notation used in formal logic which is always true and valid.

- If all the ~~co~~ condition for a statement is true then it is tautology

* Knowledge models.:

A model is a world in which a sentence is true under a particular interpretation.

types:
- First order Logic
- Procedural representation model
- Relational representation model
- Hierarchical representation model
- Semantic Nets

□ First order Logic : FOPL
- It consists of objects, predicates on objects connectives and quantifier.
- predicates are the relations betn objects or properties of objects.
- connective and quantifiers allow for universal sentence
- either true or false

□ Procedural: Representation model:
- This model of knowledge representation encodes facts along with the sequence of operations for manipulation and processing of the facts.
- Expert system are based on this model [doctor app]

□ Relational representation Model :
- Collection of knowledge are stored in tabular form
- db like MySQL, Oracle, SQLite etc.
- relational calculus.
- problem arises when more than one subject are is attempted

□ Hierarchical representation model
- Based on inherited knowledge and the relationship and shared attributes betn objects

* □ Semantic Nets
- knowledge is store in the form of graph with
- • nodes representing objects (entity) in the world
- • edges representing relationship between b those objects

Propositional logic
□ It is declarative sentences which can either be true or false only.
□ A very simple logic
- A mathematical model that allows us to reason about the truth or falsehood of logical expressions

A predicate is a propisition that contain one or more variables or parameters in other word a predicate is a parameterized proposition.

proposition, P: 2 is an integer
predicate, P(x): x is an integer

In proposition —
- Atomic sentence (P, Q)
- compound sentence (¬P, P∨Q)
- unsatisfiable / contradiction (all false) (clear sky in rainy day)
- satisfiable (atleast one is true)

Laws:

I) Equivalence laws:

$P \to Q$: $\neg P \vee Q$

$P \leftrightarrow Q$: $(P \to Q \vee Q \to P)$

· distributive laws

$A \wedge (B \vee C) = (A \wedge B) \vee (A \wedge C)$

$A \vee (B \wedge C) = (A \vee B) \wedge (A \vee C)$

· De-morgan's laws

$\neg(A \wedge B \wedge C) = \neg A \vee \neg B \vee \neg C$

$\neg(A \vee B \vee C) = \neg A \wedge \neg B \wedge \neg C$

II) Inferences rules:

· modus ponen rule $\dfrac{P \to Q,\ P}{Q}$

· elimination rule $\dfrac{A \wedge B}{A \mid B}$

· double negation $\dfrac{\neg\neg P}{\neg P}$

· unit Resolution $\dfrac{A \vee B,\ \neg A}{B}$

· Modus Tollens $\dfrac{P \to Q,\ \neg Q}{\neg P}$

· Resolution chaining $\dfrac{P \to Q,\ Q \to R}{P \to R}$

$\dfrac{\neg P \to Q,\ Q \to R}{\neg P \to R}$

~~BNF~~ Backus Normal form / Backus Naur form:
It's a notation technique for context free grammer often used to describe the syntax of languages used in computing
it is used in two ways:
- to generate strings belonging to the grammer.
- To recognize strings belonging to the grammer

First order predicate Logic (FOPL)
- propositional logic is impossible to specify many pieces of knowledge.
example: If a person is rich, they have car then we can only represent as impractical (not generalization)
Bob is rich -> Bob has car

In FOPL, english statement are translated into symbolic structure composed of predicates, functions, variables, constants, quantifier and logical connectives.

syntax
Connective → $\neg, \vee, \wedge, \to, \leftrightarrow$
quantifier → $\forall, \exists$
Constant → A, X, John
variable → a/x/s

predicate: used to denote properties of objects and relationship among them

Function: ~~~~ map the specified number of input objects to objects

Quantifier: used to quantify set of objects
- → Universal ($\forall$): for all, for every
- ↳ Existential ($\exists$): existence of obj, there exist some

relation:

$$\forall x \neg P = \neg \exists x P$$
$$\exists x \neg P = \neg \forall x P$$
$$\forall x P = \neg \exists x \neg P$$
$$\exists x P = \neg \forall x \neg P$$

example ① sita owns two cars

$\exists x \exists y$: owns (sita, x) $\wedge$ owns (sita, y) $\wedge$ cars(x) $\wedge$ cars(y) $\wedge \neg$equal (x, y)

② everyone is married to exactly one person

~~$\exists x$~~ $\forall x \exists x$: married(x, y) $\wedge$ $\forall z$: person(z) $\rightarrow$ $\neg$((x = z) $\wedge$ (y $\neq$ z))

③ There are exactly two purple flowers

$\exists x \exists y$: flower(x) $\wedge$ purple(x) $\wedge$ flower(y) $\wedge$ purple(y) $\wedge$ $\neg$equal(x, y) $\wedge$ $\forall z$ (flower(z) $\wedge$ purpule(z)) $\rightarrow$ equal (x, z) $\vee$ equal (y, z)

Well formed formula: (WFF)

A sentence that has all its variables properly introduced using quantifiers is a well formed formula.

Notes:
- predicates can't be quantifiers
- Constant can't be negative
- Letter cases must be well considered

Resolution

- produces proof by refutation (proof statement that is wrong).
- Resolution can be applied to conjunctive normal form (CNF).

Process:
- Convert all sentence to CNF
- Negate x
- Add negate x to premises.
- repeat until either a contradiction is detected or no progress is made

CNF (Conjunctive Normal Formal)

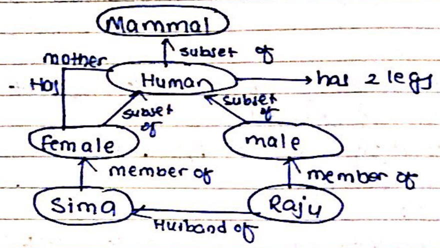
- Eliminate all implication
- ~~reduce~~ use de'morgans law of any negation
- standarize variables
- skolemization
- drop all universal quantifiers
- Distribute $\wedge$ over $\vee$

Knowledge

Data → Information → Knowledge

facts: ~~so~~ that we want to represent the truth in the representing world.
representation: in some formal way.

Semantic Networks



Frames

A frame is a collection of attributes (slots) and associated values and possibly constraints on values that describes some entity in the world.

example: Human
Isa: mammal
cardinality: 6000000000
*Legs: 2

Male
isa: Human
cardinality: 5000000000

Scripts:

- A script is a ~~sculpture~~ structure that is ~~focused~~ used to describe the sequence of events in a particular context.
- It consist of set of slots.
- Scripts seems to be similar to frames but these have more detailed

UNIT - 4 INFERENCES AND REASONING

- Inference Theorems
- Deduction and Truth maintainance.
- Heuristic search state-space Representation
- Game playing.
- Reasoning About Uncertainty Probability.
- Bayesian Network.
- Case Based Reasoning.

Heuristic search state space representation:
searching technique

- by eliminating the unpromising states and their descendats from consideration, heuristic algorithms can find acceptable solutions.
- It is a strategy of problem solving where problem specific knowledge is known along with problem definition.
- It's the approach following an informed guess of next step to be taken.
- It is often based on experience.
- Heuristic have limited information and hence can lead to suboptimal solution or even fail to find any solution at all.

A restricted state-transition system is a triple

$\Sigma = (S, A, \gamma)$

$S = \{s_1, s_2, \cdots\}$ → set of state

$A = \{a_1, a_2, \cdots\}$ → set of actions

$\gamma: S \times A \rightarrow S$ is a state transition function

Search problems:

- initial state
- set of ~~problem~~ possible action/ applicability conditions
  - successor function: state → set of <action, state>
  - successor function + initial state = state space
  - path (solution)
- goal
  - goal state or goal test function
- path cost function
  - for optimality
  - assumption: path cost = sum of steps cost

① Missionaries (m) and cannibals (c):

- initial state
  - all missionaries, all cannibals, and boat are on the left bank.
- 5 possible actions
  - one m crossing
  - one c crossing
  - two m crossing
  - two c crossing
  - one m and one c crossing

state	set of <action, state>
(L: 3m, 3c, b – R: 0m, 0c)	{ <2c, (L: 3m, 1c – R: 0m, 2c, b)>
	<1m 1c, (L: 2m

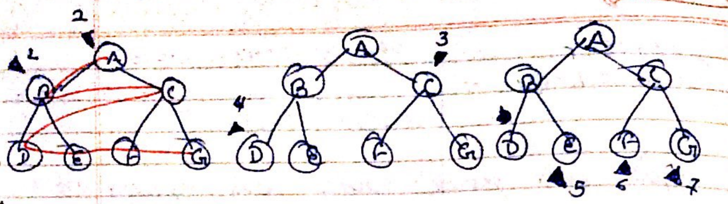
बाँकी सबै possible state हरु specify गर्ने।

A. # Uninformed search strategies (Blind search)

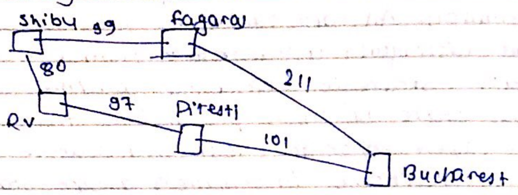
- This strategy have no additional information about states beyond that provided in the problem definition. All they can do is generate successors and distinguish a goal state from a non goal state. Strategies that know whether one non goal state is 'more promising' than another are called informal (heuristic) search.
- No additional information about states beyond problem definition.
- Only goal states and non-goal states can be distinguished

a. Breadth-first search (BFS)

BFS is a simple strategy in which the root node is expanded first, then all the successors of the root node are expanded next, then their successors, and so on. In general, all the nodes are expanded at a given depth in the search tree before any nodes at the next level are expected.



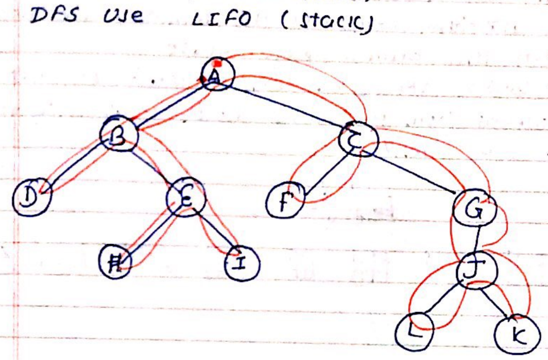
6. Uniform cost - search (UCS)
when all step costs are equal, BST is optimal because it always expand the shawollest unexpanded node. UCS expands the node n with the lowest_path_cost g(n). This is done by storing frontier as priority queue order by g. UCS doesnot care about no. of steps a path has, but only about their total cost.



Here, Fagaras has 99 and RV has 80 path cost from Shibu ∴ so lowest cost path is RV 80 is selected so (80+97) = 177, adding Pitesto and Fagaras is 99 so lowest is Fagaras and (99+211) = 310, adding Bucharest. Now goal is generated, but UCS keep going on search for other posible so adding Bucharest from Pitesti 177+101=278 so it is selected.

Depth first search:
DFS always expand the deepest node in the current frontier of the search tree. The progress of the search proceeds immediately to the deepest level of the search tree, where nodes is leaf nodes. As that nodes are expanded, they are droped from the frontier so then search 'backs up' to the next deepest node

BFS uses FIFO (Queue)
DFS use LIFO (stack)



B. Informed (Heuristic) Search strategy
- One that uses problem specific knowledge beyond the definition of problem itself.
- can find solutions more effectively than an uniformed strategy.

The general purpose we consider is called Best-first search. Tree of graph is expansion based on evaluation function f(n)

A* search $f(n) = g(n) + h(n)$

↳ heuristic cost

↳ path cost

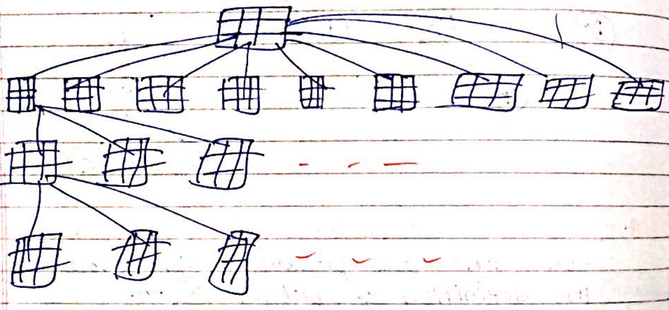
↳ cheapest estimated cost

Greedy best first Search $f(n) = h(n)$

Game playing

A. MinMax Algorithm

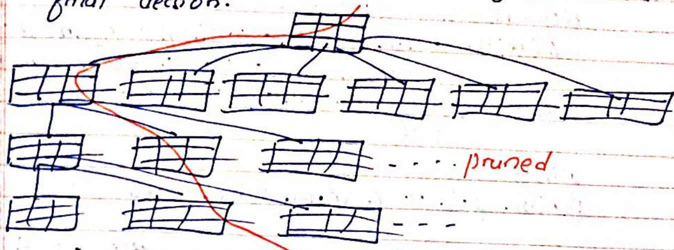
- max → first player, min → second player
- This algorithm computes the minimax decision from the current ~~page~~ state.
- It uses a recursive computation: recursion proceeds from the initial node to all leaf nodes
- it uses depth first



minmax → examine exponentially increasing no. of move.

Alpha beta pruning

- By not considering a large part of the tree, no. of steps to be calculated is cut down
- when applied to a standard minimax tree, Alpha beta pruning returns the same move as minimax would, but prunes away the branches which couldn't possible influence the final decision.



Reasoning about Uncertainty Probability

- One of the most common characteristics of the human information available is its imperfection due to partial observability, non deterministic or both.
- An agent may not know what state it is or will be after certain sequence of action.

Uncertainty? The lack of exact knowledge that would enable us to reach a perfectly reliable sources:

Weak implication: hypothesis (weak) → leads to weak conc.

Imprecise language

Unknown data

Mutually exclusive

$$P(\text{success}) = \frac{\text{no of success}}{\text{possible outcomes}}$$

$$P(\text{success}) = \frac{S}{S+F} \qquad P(\text{failure}) = \frac{F}{S+F}$$

$$p+q=1$$

Non-mutual exclusive

$$P(A|B) = \frac{\text{the number of times A and B can occur}}{\text{the number of times B can occur}}$$

$$P(A|B) = \frac{P(A\cap B)}{P(B)} \rightarrow \text{joint probability}$$

where

$P(A|B)$: prob. of A when B had already occurred.

$$P(A\cap B) = P(A|B) * P(B) = P(B/A) * P(A)$$

$$\therefore P(A|B) = \frac{P(B/A) * P(A)}{P(B)} \quad \text{--- ⓐ}$$

where ⓐ is bayesian rule.

when combined:

$$\sum_{i=1}^{n} P(A\cap B_i) = \sum_{i=1}^{n} P(A|B_i) * P(B_i)$$

summed over an exhaustive

$$\therefore P(A) = \sum_{i=1}^{n} P(A|B_i) \times P(B_i)$$

Similarly $P(B) = P(B/A) \times P(A) + P(B/\neg A) \times P(\neg A)$

$\therefore$

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

Bayesian N/w:

why?

- it shows probalistic relation betn two classes
- it avoid dependencies betn attribute
- Bayes Network, Beliefs N/w, probabilistic N/w

Directed Acyclic Graph (DAG) → Conditional Prob. Table (CPT)

BN is directed graph, no directed cycle

Node: set of random variables which may be discrete or continous

directed links (Arcs): $X \rightarrow Y$: X has a direct influence on Y

$Y \rightarrow Z$ — Y is parent or immediate predecessor of Z, decendant of Y

$$~~P(J|B) = ?~~ \quad \frac{P(J\cup B)}{P(B)} = \frac{P(B|J) * P(J)}{P(B|E) * P(E)}$$

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

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

$$P(M|B) = P(A/B) * P(M) + P(\neg A|B) * P(\neg M)$$

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

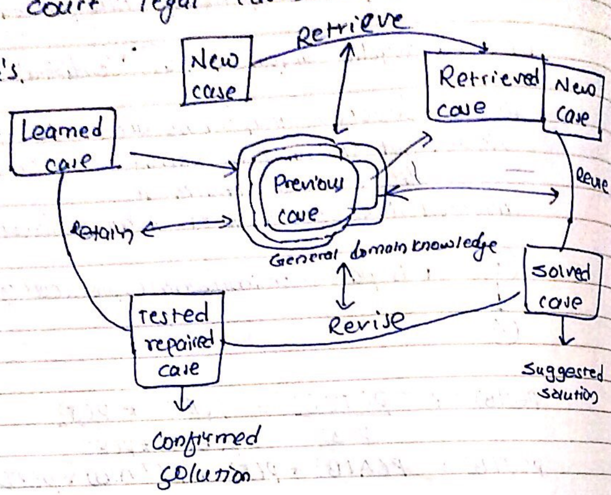
benefit of BN:

- it can readily handle data sets
- use of prior knowledge
- provide a natural representation of conditional
- more complex to construct a graph.

Case Base Reasoning

- Reasoning that adapts previous solutions for similar problem in solving new problem
  - not have to start from scratch.
  - court legal cases

4 Re's.
Retrieve
Reuse
Revise
Retain



Component of CBR:
- case indexing
- case base organization
- case Adaption

Development of CBR
- case ~~ca~~ Represent
- similarity measure
- Adaptation
- case base organization

CBR Application
- Legal reasoning [hypo, judge]
- Diagnosis ~~egs~~ [CASEY]
- Design
- schedule
- Help desk support
- planning

Chapter-5 Machine Learning

- concept of learning
- Learning by Analogy
- Inductive learning
- Neural N/W
- Genetic Algorithms
- Explanation based Learning
- Boltzman machine

Learning:
- Acquiring new knowledge - knowledge acquisition.
- modifying old knowledge, behaviour, and skill.
- Learning is also based on feedback.

types:
→ Rote Learning :- focuses on memorization
- avoids understanding the inner complexities and inferences of the subject that is being learned and instead focuses on memorizing the materials
- based on repetition

→ Learning by example:
- Agent learns by seeing examples and classify the similar object to some class.

→ Explanation based Learning.
describes objects in brief.

→ Learning by taking advice:

→ Learning by analogy.

Learning — Inductive
— deductive

Machine Learning:

- Branch of A.I that use algorithms to allow computer to evolve behaviours based on data collect from database or gathered through sensors.
- Focused on prediction

Cases of Machine Learning

Supervised: input & output binds together.
Unsupervised Learning: only inputs available for learner.
Reinforcement learning: learning based on reward or punishment

Concept of Learning:

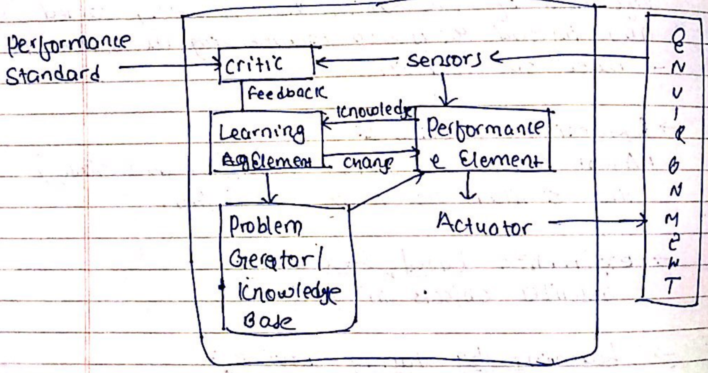
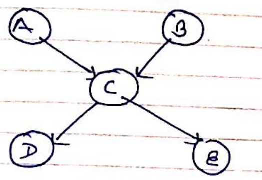


fig: Machine Learning Framework

Explonation Based Learning

EBL uses a domain theory to construct an explanation of the training example, usually a proof that the example logically follows from the theory

Understanding of Bayes Network



→ P(A), P(B) (No Incoming)

→ P(C|A, B) → two incoming

→ P(D|C), P(E|C)

$P(A,B,C,D,E) = P(A)\cdot P(B)\cdot P(C|A,B)\cdot P(D|C)\cdot P(E|C)$