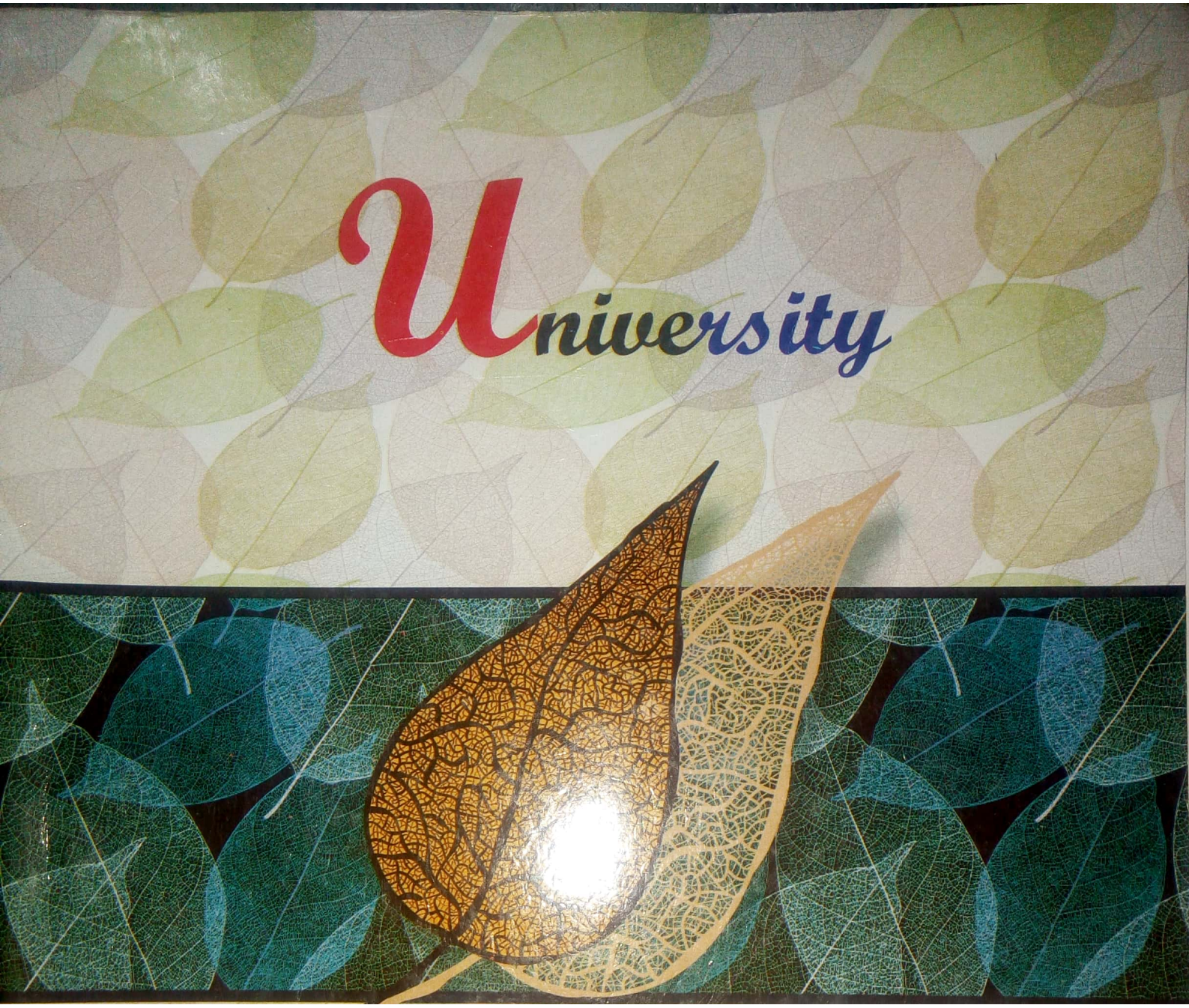
University



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06.05.18.

$a = 10$

$b = 5$

$a^2 + 2ab + b^2$

$= (a+b)^2$

$= (15)^2$

$= 225$

Algorithm:

(i) Input value of all variable

(ii) Distinct each compound variable

(iii) Evaluation according to operators precedence.

Previous Knowledge:

Computers program

↳ set of instruction.

Previous requirements:

(i) Algorithm

(ii) Discrete mathematics

(iii) Data Structure

Programming language

1001 +

1101 −

1011 /

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low level language

↳ Machine code

1001

Assembly language

Compilers, Interpreters

ADD

SUB

MUL

+, −, * → Mid level

High level (GUI)

Data Structure:

BFS → Queue → FIFO

DFS → Stack → LIFO

Advanced → A* search

LISP language

www.sdmgap-ict.com

www.tutorialcare.com → AI

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"AI Sessional" 06.05.18

Prolog → AI language

Procedural Programming language.

↓

Declarative Programming language.

Relations

Facts / Clause

Rules

lectures(turing, 100).

1st argument will start with small letters → turing

Bound variable will be capital letters → X

lectures(turing, X).

X = 100

lectures(X, 100).

X = turing.

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09.05 18

* Definition:

Artificial Intelligence is a branch of computer science which concerned with the design of Intelligence in an artificial device.

Discrete Mathematics:

Rules of Inference

Nodi is a student of BAUST
Nitu " " " " "

classmate (Nodi, Nitu);

Fuzzy logic

All man is mortal, Medha is a man,
Medha is mortal.

$\forall$ Man (mortal) $\wedge$ Man (Medha) $\rightarrow$ Mortal (Medha)

* There are idea in the term of artificial intelligence:

(i) Artificial $\rightarrow$ AI device

(ii) Intelligence.

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* Intelligence:

The ability to acquire, understand an apply Knowledge. Ability to exercise thought and reason.

* Properties of an intelligence system:

→ An intelligent system expected as behave as likely human.

→ An intelligence system expected as possible best manner.

* Types of AI Problem:

Two types of AI problem:

(i) Common place tasks

(ii) Expert system tasks

(i) Common place tasks:

a). Human recognition / recognizing object.

↳ Image processing.

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b). Communicating (through natural language).

c). Navigating around obstacle in street.

(ii) Expert system tasks:

a). Medical diagnosis

b). Solving mathematical problem

c). Playing game. i.e. chess board.

* AI are not possible?

(i) Read human mind, body language.

(ii) Read newspaper, and summerize about that paper.

* Applications of AI:

(i) Game playing

(ii) Speech recognition → Speech signal processing

(iii) Worker

a). chemical Industry.

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(iv) Aviation

a). Auto pilot

b). Aircraft control using speech command

(v) Telecommunication system

a). Satellite.

* Subarea of AI:

(i) Machine learning

(ii) Natural language processing

(iii) Signal Processing

(iv) AI neural network

(v) Robotics

(vi) Perception, vision and speech Understanding.

(vii) Reasoning & decision making.

a). Knowledge Representation

b). Reasoning (logic/Probability)

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Job sectors:

(i) Samsung company

(ii) BJIT

(iii) MCC

(iv) BSK

Statistics

ECG

EEG signal

Electromayo graphy.

i). lie Detection

ii). Sleep "

iii). Alzhiermer "

iv). Epilopsy. "

v). Motor imagery classification.

—x—

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10.05.18

* Ref. Book:

(i) Artificial Intelligence Hierarchical approach
— Russel

(ii) Synthesis of Artificial Intelligence.
— Norv & Norvles.

* LAB for AI:

(i) Uninformed Search:

(i) BFS
(ii) DFS
(iii) Game playing
8 Queen problem
3X3, 4X4 Puzzle game.

(ii) Informed search:

(i) A* Problem
(ii) Best first search
(iii) Heuristic function.

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* Knowledge:

i). Knowledge is a familiarity with someone or something which includes fact, information, description or skills acquired through experience or education.

ii). It can refer to theoritical or practical skills in a subject (implicit, explicit).

iii). Act, fact, state of Knowing.

* Belief:

Belief represents any ~~meanig~~ meaningful expression that is justified true.

* Hypothesis:

A justified belief that is not known either true or false. If p then q.

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Knowledge	Expression
Apu is tall.	An attribute possed by a student.
X loves Y	A complex relationship between two person.
Bangladesh is a developing country ↓ financial ↓ Economics.	An economic status of a country.

* 5 types of Knowledge :

(i) Declarative Knowledge
(ii) Procedural "
(iii) Heuristic "
(iv) Epistemology "
(v) Meta "

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* Declarative Knowledge:

Knowledge express statement fact about the word.

I am a girl.

we are student.

* Procedural Knowledge:

Knowledge represents steps to solve a problem.

* Heuristic Knowledge:

A special Kind of Knowledge to solve a problem.

$a^2+2ab+b^2$

* Epistomology Knowledge:

Epistomology is one Kind of way to express nature of existing Knowledge.

a). What type of Knowledge.

b). How efficient of this Knowledge.

c). What necessary of this Knowledge.

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* Meta Knowledge:

Knowledge about Knowledge.

i.e. what Knowledge we Know?

we are expert about computer science.

* AI Programming language:

(I) Prolog (reasoning, logic)

(II) c++

(III) Java

(IV) Python

(V) LISP (List Processing language).

—x—

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"Chapter-2" 13.05.18

"Search Strategy"

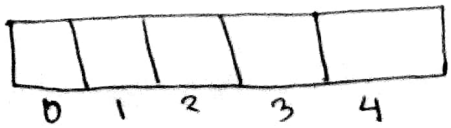
Baust is a university that is controlled by Bangladesh army, there studies 500 students and has 20 Teachers.

Data
Information
Knowledge

(i) Array
(ii) Linked list
(iii) Stack/Queue
} linear Data structure

(iv) Tree
(v) Graph
} Non-linear Data structure

(i) Sequential collection of Data, those are homogeneous is called array.



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int a[5]

5	3	10	50	60
a[0]	a[1]	a[2]	a[3]	a[4]

5	3	10	60	Deleted 50
	3	10	60	Deleted 3
3	1000	10	60	Inserted 1000

Stack

↓ insert, delete

5	3	10	50	60	80

→ LIFO

80

Queue

5	3	10	50	60	

→ FIFO

↑ Delete

↑ insert

60	Top
50	
10	
3	
5	initial

Stack

60	FRONT
50	
10	
3	
5	REAR RARE

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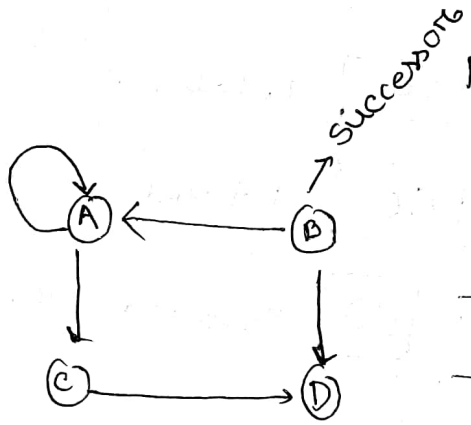
* Graph:

(i) Vertex (node)

(ii) Edge

(iii) Cost



Adjacent Matrix

	A	B	C	D
A	1	0	1	0
B	1	0	0	1
C	0	0	0	1
D	0	0	0	0

(i) Initial location

(ii) Goal / Destination

(iii) Successor

(iv) Cost

* Problem formulation / Searching process:

1. check the current state
2. Execute allowable actions to find the successor state
3. Pick one of the new states
4. check if new state is a solution state. If not, new state becomes current and repeated.

Scanned by CamScanner

"Sessional"

13.05.18

* Programming language:

1. Procedural
2. Declarative.

Objects
Properties
facts → any statement is called facts.
Rules

Relation

Grass is green.

color(grass, green).
color(sky, blue).

Variable → Capital letters.

trace.

Studies(jill, c)
Studies(jill, _2182)?
Studies(jill, 9314)?

c=9314.

, → And
; → OR

} In case of facts.

Scanned by CamScanner

trace

lectures (turing, Course), studies (fred, Course).

Course = 9020.

trace

lectures (turing, course); studies (fred, Course).

lectures (codd, c); studies (henry, c).

C = 9311.

lectures (codd, c), studies (henry, c).

C = 9314.

* Rules:

teaches (Teacher, Student) :-

lectures (Teacher, Course),
studies (Student, Course).

trace.

teaches (codd, Student).

Student = jack;
student = bill;
student = henry.

Scanned by CamScanner

more_advance(S1, S2) :-

year(S1, Year1),

year(S2, Year2),

Year1 > Year2.

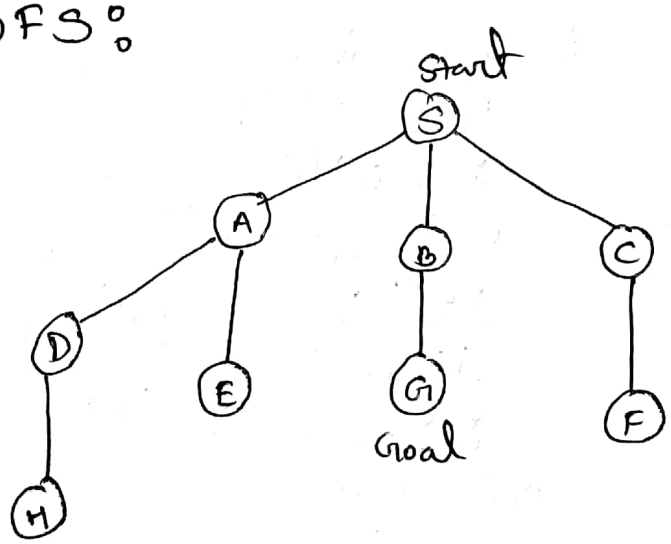
——x——

16.05.18

Uninformed Search / Blind search Control strategy:

1. BFS
2. DFS
3. DLS (Depth Limited search)

* BFS:



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Nodi	Modina	Nabila

Front = 1 Rear = 3

			Amrita

Delete Rear = 4

Insert

Expanded Node	Queue
	S ↓ ∅ → origin
S not goal	A ↓ S, B ↓ S, C ↓ S
A not goal	B ↓ S, C ↓ S, D ↓ A, E ↓ A
B not goal	C ↓ S, D ↓ A, E ↓ A, G ↓ B
C not goal	D ↓ A, E ↓ A, G ↓ B, F ↓ C
D not goal	EG ↓ A, ~~D~~ ↓ B, F ↓ C, ~~H~~ ↓ D
E not goal	G ↓ B, F ↓ C, H ↓ D
G goal	Not expand

S				
1				
	A	B	C	
1	2	3	4	
		B	C	D	E
		3	4	5	6
		Front			Rear

Path: G → B → S

Scanned by CamScanner

2	8	3
1	6	4
7		5

Start

1	2	3
8		4
7	6	5

Goal

* DFS:

Expanded Node	STACK
	S
S not goal	A B C
C not goal	A B F
F not goal	A B
B not goal	A G
G goal	Not expand

Path: G → B → S

* DFS is ~~more~~ faster than BFS.
* less memory use

—— x ——

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20.05.18

Informed Search:

Searching Technique / Strategy

- Uninformed search / blind search
  - BFS
  - DFS
- Informed search / Heuristic Search
  - Best first search
  - A* search

$f(n) = h(n)$

Heuristic Function:

$f(n) = h(n)$

$f(n)$ → Total cost

$h(n)$ → Estimatted cost to reach the destination.

Previous Knowledge:

Start	Cost
Rangpur	500
Chapai	600
Naugaon	550
Rajshahi	450
Naton	300
Bogra	250
Dhaka	0

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h(Rangpur) = 500

h(Chapai) = 600

1. Euclidean distance
2. Manhattan "

(x_1, y_1) (x_2, y_2)

1. $\dfrac{(x_2 - x_1)^2 + (y_2 - y_1)^2}{2}$

2. $\dfrac{|x_2 - x_1| + |y_2 - y_1|}{2}$

f(n) = h(n)

h(n) = euclidean distance (between two points)

h(Kolkata) = euclidean distance (Kolkata, Guwahati).

n = starting notation

h(Rangpur) = euclidean-distance (Rangpur, Dhaka)

h(Rangpur) = 380 Km.

h(Rangpur) = 500 TK

$\boxed{\text{Previous Knowledge}}$

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* Informed search:

① Heuristic value
" function
$f(n) = h(n)$

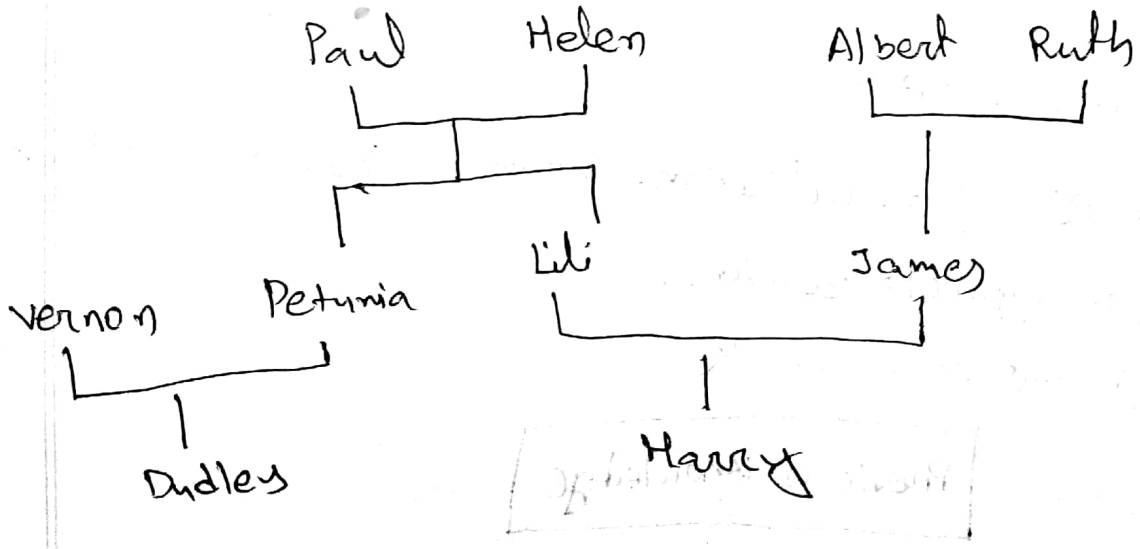
1. Best First Search
2. A* Search
3. Iterative Dependent A*
4. Shortest memory A*

Best First Search:

Priority Queue.

—x—

"Sessional" 20.05.18



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23.05.18

Searching Strategy:

h(Dhaka) = euclidian-distance (Dhaka, Kalkata).

↓

heuristic function

↓

estimated cost

Fringe = Priority Queue

* Best First Search:

	Cost
Tangail - Tangail	→ 0
Shinajganj	→ 400
Bogra	→ 500
Nator	→ 600
Rajshahi	→ 700
Naogaon	→ 750
Chapai	→ 800
Saidpur	→ 750
Rangpur	→ 700
Gaibandha	→ 600
Pabna	→ 550

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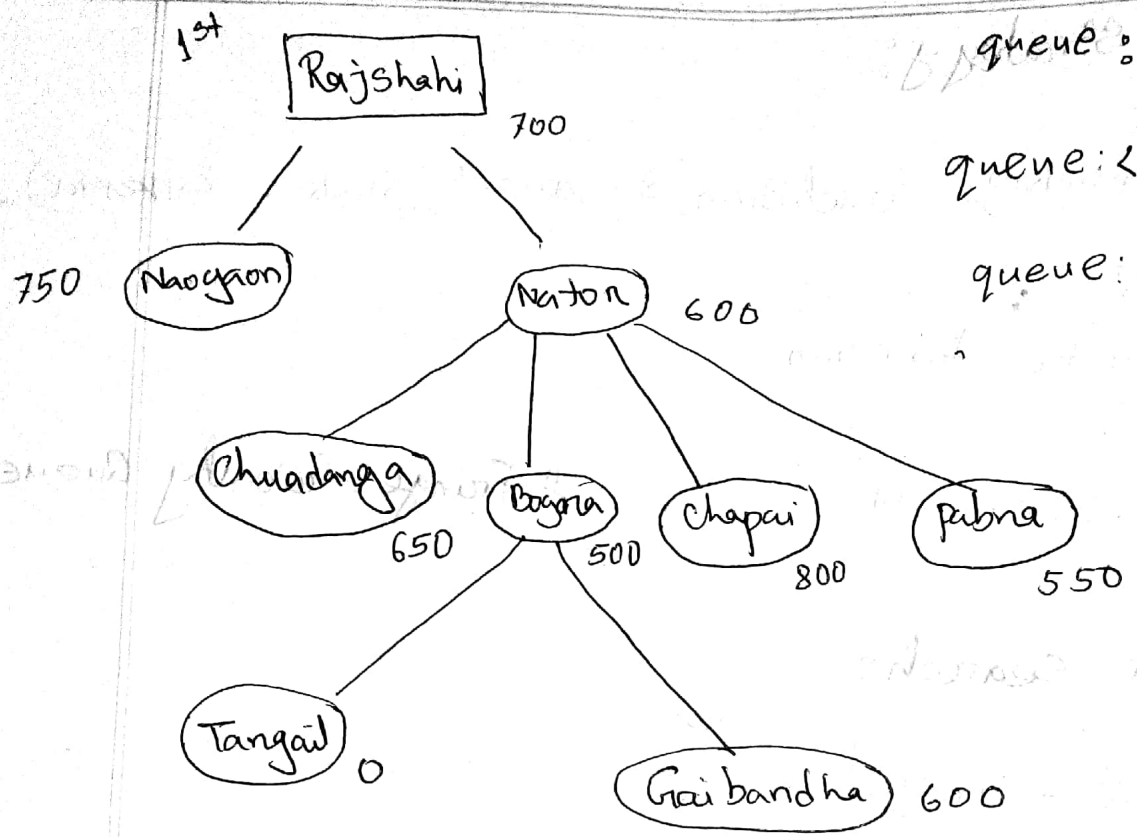

queue : <Rajshahi>

queue: <Nator, Naogaon>

queue: <Naogaon>

queue: <Naogaon, chuadanga, Bogra, chapai, pabna>

queue : <Naogaon, chuadanga, chapai, pabna>

queue : <Naogaon, chuadanga, chapai, pabna, Tangail, Gaibandha>

queue: <Naogaon, chuadanga, chapai, pabna, Gaibandha>

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Assignment: + Presentation: BFS, DFS

1st

(i) A* ~~BF~~ Best First Search

(ii) IDA*

(iii) SMA*

} - informed Algorithm

(iv) Hill climbing Search

(v) Simulated Anneling

} local searching

(vi) Constraint Satisfaction Problem → Theory.

Submission Date: 03.06.18.

CT-1

(I) Theory

~~(II) BFS, DFS~~

Date: 31.05.18

Time:

* Propositional logic → next class.

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24.05.18.

Propositional Logic:

(i) Proposition.

(ii) Logical Connectivity.

x greater than y

$x \rightarrow y$

* Knowledge Representation and Reasoning:

Perceiving

Knowledge Representation

Reasoning

Acting

logic

Syntax

Semantics

Scanned by CamScanner

NOT

x	x'
True	False
False	True

OR

x	y	output
False	False	False
False	True	True
True	False	True
True	True	True.

implies ($\longrightarrow$)

$x \rightarrow Y$; if x then Y

x	y	$x \rightarrow Y$
F	F	T
F	T	T
T	F	F
T	T	T

if x then y

$\neg x$	$\vee Y$	$x \rightarrow Y = (\neg x \vee Y)$
T	F	T
T	T	T
F	F	F
F	T	T

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XOR gate

x	y	$x \oplus Y$
F	F	F
F	T	T
T	F	T
T	T	F

Equivalent to ($\leftrightarrow$)

x	y	$x \leftrightarrow Y = (x \oplus Y)' = (x \to Y) \wedge (Y \to x)$
F	F	T
F	T	F
T	F	F
T	T	T

$$\underset{\text{Condition}}{x} \longrightarrow \underset{\text{Conclusion.}}{Y}$$

X = study hard

Y = rewarded

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wff → well formed formula

(i) S is a sentence S = it is hot.

(ii) If S is a sentence, ¬S is also a sentence

¬S = it is not hot.

(iii) If S and T are sentence, then

$S \vee T$, $S \wedge T$, $S \rightarrow T$, $S \leftrightarrow T$ are sentence.

—— x ——

"Sessional" 27.05.18

* series sum,
tibonacci,
power calculate } using prolog

↳ next lab.

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30.05.18

Propositional logic:

$\longrightarrow$ (if . . . then . . .)

p	q	$p \to q$
0	0	1
0	1	1
1	0	0
1	1	1

Let.

p = -1 is a positive number

q = (2+2 = 5)

$p \to q$ (True)

Biconditional:

p	q	$p \leftrightarrow q$ $(p \to q) \wedge (q \to p)$
0	0	1 (if and only if)
0	1	0
1	0	0
1	1	1

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Semantics:

↳ Meaning

T & ¬F
↓
T & T
↓
T

i.e. $((P \& -Q) \rightarrow R) \vee Q$

P = true
Q = false
R = false

(true & true → true)
∨ false

(True → true) ∨ false

= false.

9). i.e. $(-P \vee Q) \& R \rightarrow S \vee (-R \& Q)$

= (false ∨ true) & false → true ∨ (~~false~~ true & true)

~~= false & false → true ∨ (true)~~

~~= false → true~~ = true & false → true ∨ (true)

~~= true.~~ = false → true

= true.

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b). $(\sim P \vee Q) \& R \rightarrow S \vee (\sim R \& Q)$

$= (\text{false} \vee \text{false}) \& \text{true} \rightarrow \text{true} \vee (\text{false} \& \text{false})$

$= \text{false} \& \text{true} \rightarrow \text{true} \vee \text{false}$

$= \text{false} \rightarrow \cancel{\text{false}}\ \text{true}$

$= \text{true}.$

* $\sim (P \vee \sim Q) \& (R \rightarrow S)$

$= \sim (\text{true} \vee \text{true}) \& (\text{true} \rightarrow \text{false})$

$= \sim (\text{true}) \& \text{false}$

$= \text{false} \& \text{false}$

$= \text{false}.$

—o—

Scanned by CamScanner

* $P \leftrightarrow Q$ and $(P \rightarrow Q)$ & $(Q \rightarrow P)$

P	Q	$P \rightarrow Q$	$Q \rightarrow P$	$(P \leftrightarrow Q)$ ~~and~~ & $(Q \rightarrow P)$	$P \leftrightarrow Q$
0	0	1	1	1	1
0	1	1	0	0	0
1	0	0	1	0	0
1	1	1	1	1	1

———x———

03.06.18

i) Proposition

ii) Logical connectivity → Logic gate

* Properties of statement :

Compound Proposition → $(P \vee q) \wedge S$ → Sentance.

$\vee$ ↓ or

$\wedge$ ↓ and

Tautology: If all the outputs of a compound proposition is 1 then it called a tautology.

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Contradiction: All outputs are 0, then contradiction.

Contingency: Neither a tautology, nor a contradiction.

Equivalence: If outputs of two sentence is same.

$\neg(P \vee q) = \neg P \vee \neg q$

$P \rightarrow q = \neg P \vee q$

$P \leftrightarrow q = (P \rightarrow q) \,\&\, (q \rightarrow P)$

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logical Equivalence:

$\neg(p \vee q) = \neg p \cap \neg q$

$p \rightarrow q = \neg p \vee q$

$p \longleftrightarrow q = (p \rightarrow q) \,\&\, (q \rightarrow p)$

p	q	$p \vee q$	$\neg(p \vee q)$	$\neg p$	$\neg q$	$\neg p \vee \neg q$
0	0	0	1	1	1	1
0	1	1	0	1	0	0
1	0	1	0	0	1	0
1	1	1	0	0	0	0

$\therefore \neg(p \vee q) = \neg p \vee \neg q$

logical Consequences:

Universal set U

$S = \{ S_1, S_2, S_3, S_4, S_5, S_6 \}$

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$$(p \to r) \vee (q \to r) \equiv (p \wedge q) \to r$$

Ex:

p	q	r	$p \to r$	$q \to r$	$(p \to r) \vee (q \to r)$	$p \wedge q$	$(p \wedge q) \to r$
0	0	0	1	1	1	0	1
0	0	1	1	1	1	0	1
0	1	0	1	0	1	0	1
0	1	1	1	1	1	0	1
1	0	0	0	1	1	0	1
1	0	1	1	1	1	0	1
1	1	0	0	0	0	1	0
1	1	1	1	1	1	1	1

Modus Ponens:

Proposition $\to$ Conclusion

Inference

* Rules of Inference:

(i) Modus Ponens rule

(ii) Modus Tonens

(iii) Chain Rule/Syllelisn

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Modus Ponens:

$$\frac{\begin{array}{c} P \\ P \to Q \end{array}}{Q} \qquad \left.\frac{\begin{array}{c} \neg P \\ \neg Q \to \neg P \end{array}}{\neg Q}\right\} \text{Conversion}$$

Modus Tonens:

$$\cancel{\frac{\begin{array}{c} \neg P \\ P \to Q \end{array}}{\neg P}} \qquad \cancel{\frac{\begin{array}{c} \neg P \\ Q \to P \end{array}}{}} \qquad \frac{\begin{array}{c} \neg Q \\ P \to Q \end{array}}{\neg P}$$

$$P \to Q = \neg P \vee Q$$

$$Q \vee \neg P$$

A, B

$$= \cancel{\neg(\neg Q) \to}$$

$$= \neg(\neg Q) \vee \neg P$$

$$= \neg A \vee B$$

$$= A \to B$$

$$= \neg Q \to \neg P$$

$A \to B$

$\neg A \vee B$

$A = \neg Q$

$B = \neg P$

Modus Tonens

$$\frac{\begin{array}{c} \neg Q \to \neg P \\ \neg Q \end{array}}{\neg P}$$

$$P \to Q \equiv \neg P \vee Q \equiv Q \vee \neg P \equiv \neg Q \to \neg P$$

Chain Rule:

$$\frac{\begin{array}{c} P \to Q \\ Q \to R \end{array}}{P \to R}$$

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"sessional" 03.06.18.

$\boxed{\text{2nd week after eid} \rightarrow \text{Lab Test}}$

Finding paths through a maze.

Traveling by car, train, and plane

→ cs.union.edu / ~~str~~
course
prolog program
prolog practical.day

——×——

06.06.18

Propositional logic:

↳ Proposition
↳ logical connectivity

* Rules of inference:

(I) Modus Ponens:

(II) Modus Tonens:

(III) Chain Rule:

(IV) Simplification: / Simplifies rule:

$$\frac{p \wedge q}{p}$$

Scanned by CamScanner

Theorem:

$u = \{1, 2, 3, 4, 5, 6\}$

$S = \{S_1, S_2, S_3, S_4, S_5\}$

$S_1 \& S_2 \& S_3 = 1$

if, $S_1 \& S_2 \& S_3 \& S_4 \& S_5 = 1$, then $S = 1$

Steps:

(I) Logical compound from sentence.

(II) Proof conclusion by using rules of inference.

p = It's sunny this afternoon.

q = It's colder than yesterday.

r = we will go swimming

s = we will take a canoe trip

t = we will be home by sunset.

a. $\neg p \wedge q$

b. $r \rightarrow p$

c. $\neg r \rightarrow s$

d. $s \rightarrow t$

Scanned by CamScanner

Proof:

Conclusion: we will be home by sunset.

$\neg p \wedge q$

$= \neg p$ (using simplifies rule)

$$\frac{r \rightarrow p}{\neg r}$$ (using Modus Tonens rule)

$$\frac{\neg r \rightarrow s}{s}$$ (using Modus ponens rule)

$$\frac{s \rightarrow t}{t}$$ (using Modus pones rule)

t = we will be home by sunset ; which is conclusion.

[Proved]

— x —

Scanned by CamScanner

Scanned by CamScanner

27.06.18.

What is propositional logic? → (like C)

First Order Periodic Logic (FOPL) :→ (like c++, OOP)

* If you attend the class, then you can pass.

attend (class) → Pass (Exam).

Propositional logic (PL): (For single Object)

$\wedge$	And
$\vee$	or
$\neg$	not
$\rightarrow$	if, then
$\leftrightarrow$	if and only if

Students are smart

Students → Smart.

*FOPL → Generalization: (Universal).

All student are smart. $(\forall x)$ student (x)

Some student are failed.

Quantifiers:

① Existential Quantifier $(\exists)$

② Universal " $(\forall)$

Scanned by CamScanner

$\forall x$ student $(x) \longrightarrow$ smart (x)

$\exists x$ student $(x) \longrightarrow$ failed (x)

* FOPL also includes all the symbols of PL and ~~with~~ the Quantifiers.

Predicate $\longrightarrow$ Relation.

All student are smart

$\forall x$ student $(x) \wedge$ smart (x) [rarely used]

$\forall x$ student $(x) \longrightarrow$ smart (x) ✓

Some student are smart

$\exists x$ student $(x) \wedge$ smart (x) ✓

$\exists x$ student $(x) \longrightarrow$ smart (x) [rarely used]

$(\forall x)(\forall y)\, P(x,y) \longleftrightarrow (\forall y)(\forall x)\, P(x,y)$

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* Everyone likes someone.

$\forall x \; \exists x \text{ likes } (x, x)$

or, $\forall x \; \exists y \text{ likes } (x, y)$

* x is father of y → ~~FATHER~~ (x, y)

K married to Z. → ~~Married~~

MARRIED (K, Z)

Mr.M is friend of Mr.L → FRIEND (L, M)

Ex.:

$P(x)$ = x pass the course

$H(x)$ = Done homework

$L(x)$ = x attend class lecture.

~~H(b)~~

(i) $\forall x \, (P(x) \rightarrow H(x) \vee L(x))$, (ii) $\neg L(b)$, (iii) $P(b)$

$P(b) \rightarrow H(b) \vee L(b)$ —— (i)

$P(b)$ —— (ii)

$H(b) \vee L(b)$ [Modus Ponens]

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$H(b) \vee L(b)$

$\neg L(b)$

$H(b)$

$\therefore$ Bob Did the homework.

[Proved]

Quantifier:

28.06.18

Some people . $\exists x$ people(x)

All people . $\forall x$ people(x)

* First Order Periodic Translation:

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

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

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

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

$\forall x$ purple-mushroom$(x) \rightarrow$ poisonous(x)

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$\forall x$ purple_mushroom $(x) \rightarrow \neg$poisonous (x)

$\neg$tall (clinton):

Assume:

$E(x)$ = x is an Employee.

$i(x)$ = income of x.

$T(x)$ = x pay Tax per year.

$GE(x, y)$ = x is greater than or equal y.

E_1: All Employees earning \$1400 or more per year pay ~~taxes~~ taxes.

$\forall x \; E(x) \; \&\& \; i(x)$

$\forall x \; E(x) \; \&\& \; i(GE(1400 \text{ or more})) \rightarrow T(x)$

$\forall x \; E(x) \; \&\& \; GE(i(x), 1400) \rightarrow T(x)$

$\forall x \; E(x) \wedge GE(i(x), 1400) \rightarrow T(x)$

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E2: Some Employees are sick today.

$E(x)$ = x is an Employee

$S(x)$ = Sick today

$\exists x\, E(x) \rightarrow S(x)$

$\exists x\, E(x) \wedge S(x)$ [more appropriate]

E3: No Employees earnings is not more than the President

$\forall x\, y\; E(x) \wedge P(y) \rightarrow \neg GE(i(x), i(y))$

* Disjunction

Disjunctive Normal Form (DNF)

Conjunctive Normal Form (CNF)

$a \wedge b \vee c \wedge k \vee \neg P$

$(a \wedge b) \vee (c \wedge k) \vee \neg P$ [Disjuctive NF]

$a \wedge (b \vee c) \wedge (k \vee \neg P)$ [CNF]

Convert FOPL to CNF:

Steps:

(1) Eliminate $\rightarrow$, $\leftrightarrow$ from the expression

$a \rightarrow b \Rightarrow \neg a \vee b$

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(ii) Move $\neg$ into precceed the single atom.

$\neg(a \vee b)$

$\Rightarrow \neg a \wedge \neg b$

$\neg(\exists x . P(x))$

$\Rightarrow \forall x \; P(x)$

(iii) Rename the variable name.

$\forall x \; P(x) \; \exists x \; Student(x)$

$\Rightarrow \forall x \; P(x) \; \exists y \; Student(y)$

(iv) Eleminate/Remove $\exists x$ quantifier

$\exists x \; P(x)$

$= P(c)$

$\forall x \exists y \; P(x, y)$

$= \forall x \; P(x, f(x))$

(v) Remove $\forall x$ quantifier

$\forall x \; P(x, f(x)) \Rightarrow P(x, f(x))$

(vi) If need apply distributivity.

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01.07.18

PL:

$\wedge$

$\vee$

$\neg$

$\rightarrow$

$\leftrightarrow$

FOPL:

Quantifier:

$\forall$ Universal Quantifier — All people

$\exists$ Existential " — Some people.

1. Every gardener likes the Sun.

$= \forall x \; gardener(x) \rightarrow L(s)$

$L(s)$ = likes Sun.

2. You can fool some of the people all of the time.

$= \exists x \; people(x) \wedge \forall y \; time(y) \rightarrow \cancel{S(f)} \; S(x, y)$

You can fool $= S(x, y)$

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3. You can fool all of the people some of the time.

$= \forall x \; \exists t \; people(x) \wedge time(t) \rightarrow can\text{-}fool(x, t)$

4. All purple mashrooms are poisonous.

$= \forall x \; purple_mashrooms(x) \rightarrow poisonous(x)$

5. No purple mashroom is poisonous.

$= \forall x \; purple_mashroom(x) \rightarrow \neg poisonous(x)$

6. Clinton is not tall.

$= \neg tall(clinton)$.

* Disjunctive Normal Form (DNF).
* Conjunctive Normal Form (CNF).

$\vee \quad \wedge \quad \neg$

$a \vee b \wedge c \vee k \wedge L \vee M$

$= a \vee (b \wedge c) \vee (k \wedge L) \vee M$ [DNF]

$= (a \vee b) \wedge (c \vee k) \wedge (L \vee M)$ [CNF]

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* <u>Example:</u> FOPL $\rightarrow$ CNF

$$\exists x \forall y \forall z \; P(f(x), y, z) \rightarrow (\exists u \, Q(x,u) \; \& \; \exists v \, R(y,v))$$ [FOPL]

$$= \neg(\exists x \forall y \forall z \; P(f(x), y, z)) \vee (\exists u \, Q(x,u) \; \& \; \exists v \, R(y,v))$$

$[a \rightarrow b = \neg a \vee b]$

$\Rightarrow \neg \forall x \rightarrow \exists x$

$\Rightarrow \neg \exists x \rightarrow \forall x$

$$= \forall x \forall y \forall z \; P(f(x), y, z) \vee (\exists u \, Q(x,u) \wedge \exists v \, R(y,v))$$

$\Rightarrow \exists x \; P(x) = P(c)$

$\Rightarrow \forall y \exists x \; P(y,x)$

$= \forall y \; P(y, f(y))$

$$= \forall x \; P(f(x), f(x), f(x)) \vee (Q(c) \wedge R(c))$$

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$\Rightarrow \forall x\, P(x) = P(x)$

$= P(f(x), f(x), f(x)) \vee (Q(c) \wedge R(c))$

$\Rightarrow$ Distributivity law,

$a \vee (b \wedge c)$

$\Rightarrow (a \vee b) \wedge (a \vee c)$

$= (P(f(x), f(x), f(x)) \vee Q(c)) \wedge (P(f(x), f(x), f(x)) \vee R(c))$

HW.

$\Rightarrow \exists x \forall y (\sim \forall z\, P(f(x), y, z) \vee (\exists u\, Q(x, u) \;\&\; \exists v\, R(y, v)))$

$\Rightarrow \forall y (\exists z \sim P(f(c), y, z) \vee (\exists u\, Q(x, u) \;\&\; \exists v\, R(y, v)))$

$\Rightarrow \forall y (\sim P(f(c), y, g(y)) \vee (Q(c, h(y)) \;\&\; R(y, i(y))))$

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"Sessional" 01.07.18.

Path finding Problem / Graph connectivity:

Next lab:
BFS
DFS
Genetic Algorithm

Lab Report:

1. Introduction to AI
2. Areas and scopes of AI
3. AI Programming tools and languages
   a. Compilers
   b terms of languages (Fact, Rules, Backtracking Recursive ...)
4. Problems and solution
5. Future AI trends
6. Conclusion

Submission → 2nd Next lab

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04.07.18.

Propositional logic

FOPL

True = 1 0, 1

False = 0

Probability:

0–1

$\frac{1}{40} = \frac{1}{\text{total number}}$

Coin toss:

$1/2 = 50\%$

Random variable:

a, b, c, d, e = 45, 40, 55, 40, 46

$\text{Mean} = \frac{a+b+c+d+e}{5}$

Median = C = 55 (if odd $\frac{n+1}{2}$, else $\frac{n}{2}$)

Mode = 40 (highest frequency)

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* Prior Probability:

(Unconditional probability) or (independent probability)

If a an event,

then probability of $a = P(a)$

* Conditional Probability: (Dependent probability)

Two event: a, b;

$P(a/b) = P(a)$

[depends on b]

$P(\text{cough}) = 2\%$

$P(\text{cough} \mid \text{cold})$ = Probability increases

$P(\text{dengue} \mid \text{symptom}) = 90\%$

$$\boxed{P(a \wedge b) = P(a \mid b)\, P(b)}$$

$$\boxed{P(a \wedge b) = P(b \mid a)\, P(a)}$$

→ Product rule / conditional probability

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KOLMOGOROV'S AXIOMS:

(i) $0 \leq x \leq 1$ [0-1]

(ii) True, 1 or False, 0

↓ max. probability

↓ Min. probability.

(iii) Sum Rules:

$$P(a \vee b) = P(a) + P(b) - P(a \wedge b)$$

1. Probability
2. Unconditional Probability.
3. Conditional Probability.
4. Kolmogorov's axioms.

—x—

Final

Difference between heuristic, A*, IDA*.

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08.07.18.

* Student = 40

$P(1) = \frac{1}{40}$

$P(\text{solem}) = \frac{1}{40}$

* 1, 2, 3, 4, 5, 6

$\frac{1}{6}$

Probability:

(i) Prior probability / Unconditional

(ii) Conditional Probability.

A

B → 50%

$P(A|B) = P(A \wedge B) / P(B)$

$P(A \wedge B) = P(A|B)\,P(B)$

$P(A, B) = P(A|B)\,P(B)$ —— (i)

$P(A, B) = P(B|A)\,P(A)$ —— (ii)

* Product Rule:

$P(A \wedge B) = P(A|B)\,P(B)$

* Sum Rule:

$P(A \vee B) = P(A) + P(B) - P(A \wedge B)$

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Monogrov Axiom:

(I) $0 \leq x \leq 1$ (Probability Range)

(II) An event can either be true or false

(III) $P(B) = \sum_{i=1}^{n} P(B|A_i)P(A_i)$

Sunny → 70%.

Cloudy → 20%.

Rainy → 10%.

100%.

$B = \sum_{i=1}^{n} D_i$

Thomas Bayes:

$P(A,B) = P(A|B)\,P(B)$ — (I)

$P(A,B) = P(B|A)\,P(A)$ — (II)

$P(A|B)\,P(B) = P(B|A)\,P(A)$

$P(A|B) = \dfrac{P(B|A)P(A)}{P(B)}$ — (III) [Baysian Rule]

$P(A_i|B) = \dfrac{P(B|A_i)\,P(A_i)}{\sum_{i=1}^{n} P(B|A_i)P(A_i)}$ — (IV) extended version of Baysian Rule.

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i.e.: Rainy day = 5

not rainy = 360

$P(WM) = 90\%$

$\neg P(WM) = 10\%$

$P(J|W) = ?$

$P(A_1) = \frac{5}{365}$

$P(A_2) = \frac{360}{365}$

$$P(A_1|B) = \frac{P(B|A_1)P(A_1)}{P(B|A_1)P(A_1) + P(B|A_2)P(A_2)} \quad \text{--- (1)}$$

$P(B|A_1) = 90\%$

$P(B|A_2) = 10\%$

From (1),

$$P(A_1|B) = \frac{0.90 \times \frac{5}{365}}{\frac{5}{365} \times 0.90 + 0.10 \times \frac{360}{365}}$$

$= \cancel{0.6239} = 0.111$

(Ans.)

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i.e.: Rainy day = 5

not rainy = 360

$P(WM) = 90\%$

$\neg P(WM) = 10\%$

$P(y \mid w) = ?$

$P(A_1) = \frac{5}{365}$

$P(A_2) = \frac{360}{365}$

$$P(A_1 \mid B) = \frac{P(B \mid A_1)\, P(A_1)}{P(B \mid A_1)\, P(A_1) + P(B \mid A_2)\, P(A_2)} \quad \text{--- (1)}$$

$P(B \mid A_1) = 90\%$

$P(B \mid A_2) = 10\%$

From (1),

$$P(A_1 \mid B) = \frac{0.90 \times \frac{5}{365}}{\frac{5}{365} \times 0.90 + 0.10 \times \frac{360}{365}}$$

$\cancel{= 0.6239} = 0.111$

(Ans.)

11.07.17

Probability:

Conditional probability

Using the axioms of Probability:

$P_{rod} = 70\%$

$P_{fail} = (100-70)\% = 30\%$

Basic Formulas for Probability:

1. Product Rule;
2. Sum Rule
3. Theorem of Total probability.

BAYES Rule:

$$P(b|a) = P(a|b)\,P(b) \quad \text{--- (i)}$$

$$P(a|b) = P(b|a)\,P(a) \quad \text{--- (ii)}$$

From (i) & (ii)

$$P(b|a) = \frac{P(a|b)}{P(a)}$$

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Example-1 :

$P(\text{stiff_neck} / \text{meningitis}) = 50\% = 0.5$

$P(\text{meningities}) = \frac{1}{50000}$

$P(\text{stiff-neck}) = \frac{1}{20}$

$P(\text{Meningitis} \mid \text{stiff-neck}) = ?$

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

$$P(B) = \sum_{i=1}^{n} P(B|A_i)\,P(A_i)$$

$$P(\text{Meningitis} \mid \text{Stiff-neck}) = \frac{P(\text{Stiff-neck} \mid \text{meningitis})\,P(\text{Meningitis})}{P(\text{stiff-neck})}$$

$$= \frac{0.5 \times \frac{1}{50000}}{\frac{1}{20}} \times 100\%$$

$$= 0.02\%$$

(Ans.)

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12.07.18.

Example-2:

Event A_1 : It will rain tomorrow.

A_2 : It will not rain tomorrow.

B : weatherman's prediction.

$$P(A_1) = \frac{5}{365}$$

$$P(A_2) = \frac{360}{365}$$

$$\cancel{P(A_1 | B) = \frac{90}{100}}$$

$$\cancel{P(A_2 | B) = \frac{10}{100}}$$

$$P(B | A_1) = \frac{90}{100}$$

$$P(B | A_2) = \frac{10}{100}$$

$$P(A_1 | B) = ?$$

$$\rightarrow P(A|B) = \frac{P(B|A)\,P(A)}{P(B)}$$

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$$P(A_1 | B) = \frac{P(B | A_1) P(A_1)}{P(B)}$$

$$\rightarrow P(B) = \sum_{i=1}^{n} P(B | A_i) P(A_i)$$

$$\therefore P(A_1 | B) = \frac{P(B | A_1) P(A_1)}{\sum_{i=1}^{2} P(B | A_i) P(A_i)}$$

$$= \frac{P(B | A_1) P(A_1)}{P(B | A_1) P(A_1) + P(B | A_2) P(A_2)}$$

$$= \frac{90/100 \times 5/365}{(90/100 \times 5/365) + (10/100 \times 360/365)}$$

$$= 0.111 \times 100 = 11.11\%$$

(Ans.)

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Joint Probability Mass Function:

$x\ (0, 1)$ $\quad$ $y\ (0, 1)$

x	y	Probability
1	1	
1	0	
0	1	
0	0	

What is a Bayesian Network?

A graphical model that efficiently encodes the joint probability distribution for a large set of variables.

A_1 Parent (Known)

$\downarrow$

B_1 child (Unknown)

$P(\text{child} \mid \text{Parent}) = P(B_1 \mid A_1)$

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Bayesian Network rules: (Belief Network)

(i) A set of random variable (set of event)

(ii) ~~Must have~~ It must be a directed graph.

(direction indicates parent and child)

(iii) Don't have any cycle.

(iv) It expresses with conditional probability.

$P(A_1|B_1)$

i.e.:

F = Flue

C = Cough

$$F \rightarrow C$$

$P(F) = 0.1$

$P(C|F) = 0.8$

$P(C|\neg F) = 0.3$

F	C	Probability
t	t	$0.1 \times 0.8 = 0.08$
t	f	$0.1 \times 0.2 = 0.02$
f	t	$0.9 \times 0.3 = 0.27$
f	f	$0.9 \times 0.7 = 0.63$

$P(\neg a) = 1 - P(a)$

$P(a) = 1 - P(\neg a)$

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15.07.18.

Probability:

↳ (i) Prior Probability → Unconditional

(ii) Posterior " → Conditional

* BAYES RULE:

$$P(b|a) = \frac{P(a|b)}{P(a)}$$

$P(a \wedge b) = P(a|b)\,P(b)$

$P(a \wedge b) = P(b|a)\,P(a)$

, = intersection ($\wedge$)

+ = OR ($\vee$)

i.e.:

$P(\text{Burglary})$

$P(\text{Alarm}_1 \mid \text{Burglary})$

$P(\text{Alarm}_2 \mid \text{Burglary})$

$P(\text{Alarm}_1 \mid \neg\text{Burglary})$

$P(\text{Alarm}_2 \mid \neg\text{Burglary})$

$P(\text{Alarm}_2 \mid \text{Burglary} \wedge \text{Alarm}_1) =$

$P(\text{Alarm}_1 \wedge \text{Alarm}_2 \wedge \text{Burglary}) / P(\text{Burglary} \wedge \text{Alarm}_1)$

$P(\text{Alarm}_1 \wedge \text{Alarm}_2 \wedge \text{Burglary}) = P(\text{Burglary} \wedge \text{Alarm}_1)$
$- P(\text{Alarm}_2 \mid \text{Burglary} \wedge \text{Alarm}_1)$

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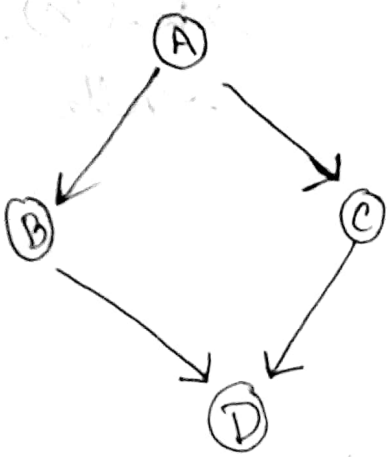
$$P(A, B, C) = P(A, B) - P(C \mid A, B)$$

$$\Rightarrow P(C \mid A, B) = P(A \wedge B \wedge C) - P(A, B)$$

$$= P(A)P(B)P(C) - P(A, B)$$



15.07.18

"Sessional"

Usage of prolog:

Solution finding

Backtracking

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Facts:

pen (yellow).

Rules → clause.

↓ fact name (Functors) (Predicate)

↓ Properties/value.

>> pen (yellow).

→ true

>> Pen (X).

→ yellow.

, → AND

; → OR

>> lectures (x, 05), lectures (y, 06).

lectures (x, C), lectures (Y, C).

>> lectures (Codd, C), studies (N, C).

Rules:

Formal parameter

Neck

Head → teacher (X, Y) :-

lectures (X, C), studies (Y, C).

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```
more_advanced(S1, S2):-
    year(S1, Year1),
    year(S2, Year2),
    Year1 > Year2.
```

Lists:

Constants, variables, structures

[1, 6, 9] → [1, 6, 9, [ ]]

↑ Head ↑ Tail

↑ empty list

[6] → Tail → empty list [ ]

↑ Head

Head → one element

Tail → list

[a, b, [c, d, 1]]

[X | Y]

↑ Head ↑ Tail

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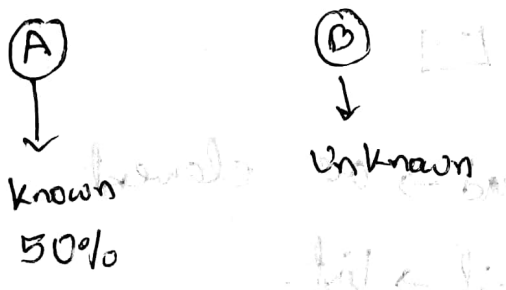
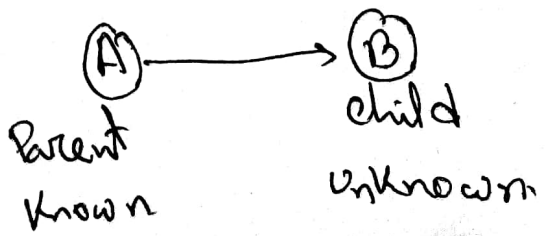
```
concat ([], L, L).        → dominating condition
concat ([X|M], N, [X|Q]) :-
        concat (M, N, Q).

?- concat ([3,1,4],[7,8],K).
   K = [3,1,4,7,8].

?- trace.
   true.
[trace] ?- concat ([2,1],[4,6],D).
```

———————×———————

Bayesian Network: 18.07.18



P(B/A)



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$P(A)$ $\qquad$ $P(B \mid A)$

Bayesian Network:

1. A set of random variables
2. set of directed nodes

i.e: $A, B \rightarrow$ event

$P(A, B) = P(A \mid B) \times P(B)$ [A unknown]

$= P(B \mid A) \times P(A)$ [B unknown]

$P(A, B, C) = P(A \mid B, C) \times P(B) \times P(C)$ [A unknown]

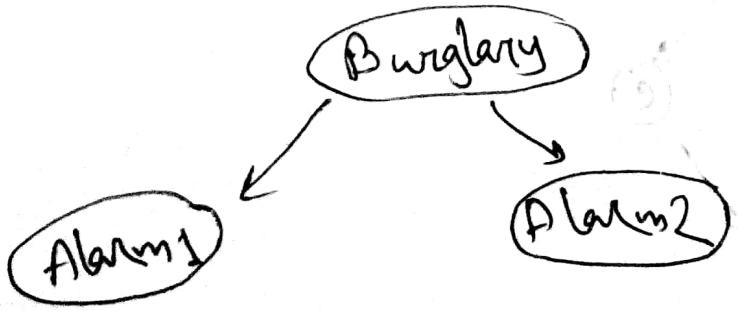
$= P(B \mid A, C) \times P(A) \times P(C)$ [B unknown]

$= P(C \mid A, B) \times P(A) \times P(B)$ [C unknown]

$\Rightarrow P(A \mid B, C) = P(A, B, C) / P(B) \times P(C)$

$P(Alarm_2 \mid Burglary, Alarm_1) =$

$P(Alarm1, Alarm2, Burglary) / P(Burglary) \times P(Alarm1)$ —— (1)



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$$P(A)P(B) = P(A, B)$$
$$P(\neg a) = 1 - P(a)$$

$P(Alarm_1, Alarm_2, Burglary)$

$= P(Burglary \mid Alarm_1, Alarm_2) \times P(Alarm_1) \times P(Alarm_2)$

$P(Alarm_1, \neg Alarm_2, Burglary) =$

$P(Burglary \mid \neg Alarm_2, Alarm_1) \times P(Alarm_1) \times P(\neg Alarm_2)$

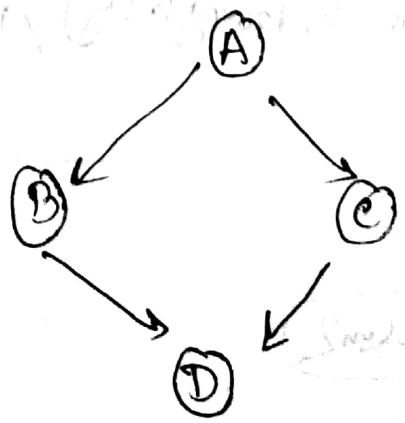
$P(A, B) = P(A, B, C) + (P(A, B, \neg C)$

$\therefore P(Burglary, Alarm_1) = P(Burglary, Alarms_1, Alarm_2)$

$+ P(Burglary, Alarm_1, \neg Alarm_2)$

---

i.e.:



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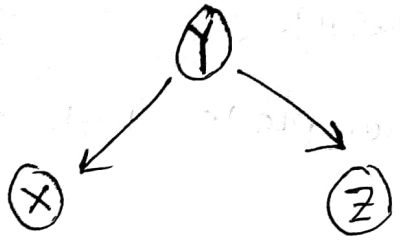
$P(Y) = 0.5$



$P(A) \times P(B) = P(AB)$

$P(x) = P(x|y) \times P(y) + P(x|\neg y) \times P(\neg y)$

$P(x|Y) = 0.5$ $\quad$ $P(z|Y) = 0.5$

$P(x|\neg Y) = 0.5$ $\quad$ $P(z|\neg Y) = 0.5$

$\therefore P(z) = P(z|y) \times P(y) + P(z|\neg y) \times P(\neg y)$

$= 0.5 * 0.5 + 0.5 * 0.5$

$= 0.5$

$P(x, z) = P(x, z, y) + P(x, z, \neg y)$

$= P(x|y) \times P(y) \times P(z|y) \times P(y)$

$+ P(x|\neg y) \times P(\neg y) \times P(z|\neg y) \times P(\neg y)$

—x—

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22.07.18.

Why Bayesian Network?

1. Handling of Incomplete Data Sets.
2. L

Limitations of Bayesian Networks?

1. NLP hard tasks.
2. Unanticipated probability of an event is not taken care of.

~~Dest~~. Decision Network:

$$A \longrightarrow B$$

$P(A)$	$P(B\|A)$
Known	Unknown

Bayesian Network

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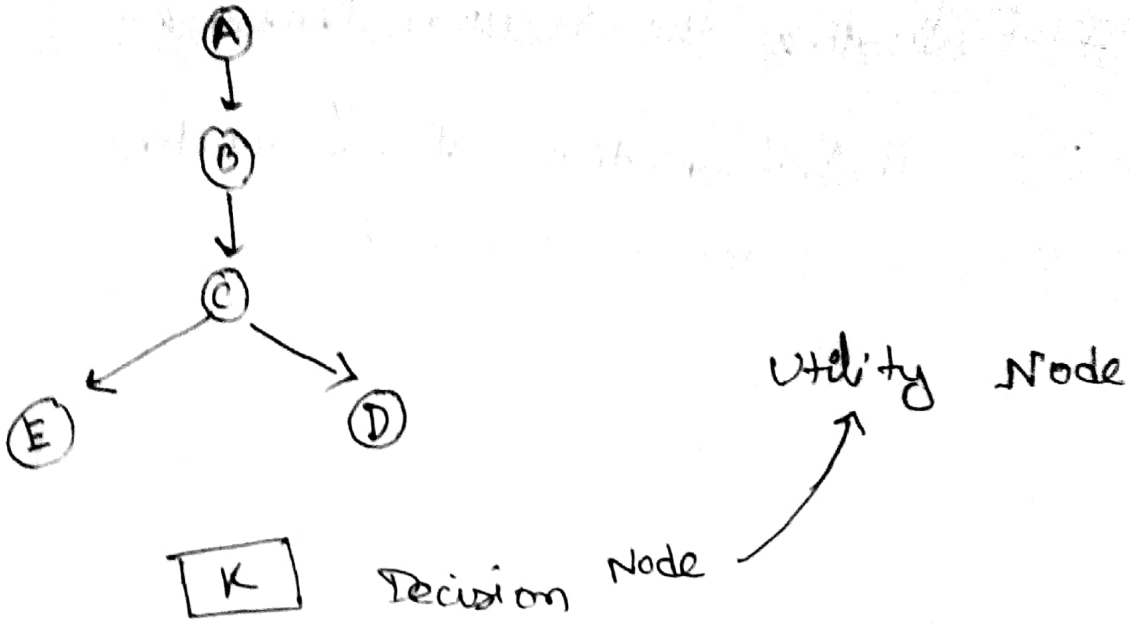

Decision Network

1. Bayesian Network / Multiple events (Random variable)
2. Decision Node / Action
3. Utility Node / function

Decision Network representation:

Chance : ⬭

Decision : ▭

Utility / value : ◇

(I) Decision Network

(II) Decision Tree.

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* Evaluating the Decision Network:

(I) Initialization of all random variables of Bayesian Network.

(II) For each possible decision,

→ calculate conditional probability according to Bayesian Network

→ Calculate Utility function for each possible decision.

(III) Return the action with the highest Utility.

Expected Utility:

—x—

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"Sessional" 22.07.18.

Lab Test → 05.08.18

Quiz

viva

India Bix

Section: 1, 2, 3

Teacher, Student Relationship

Sum Series

```
go:- write ("Enter a name"), nl,
        read (Name), nl, Print (Name).

Print(Name):- write (Name), write (", Hello!!!").
```

logic Gates.

```
and (A, B) :- A, B.
or (A, B) :- A; B.
nand (A, B) :- not (and(A, B)).
nor (A, B) :- not (or (A, B)).
Xor (A, B) :- or (A, B), nand (A, B).
```

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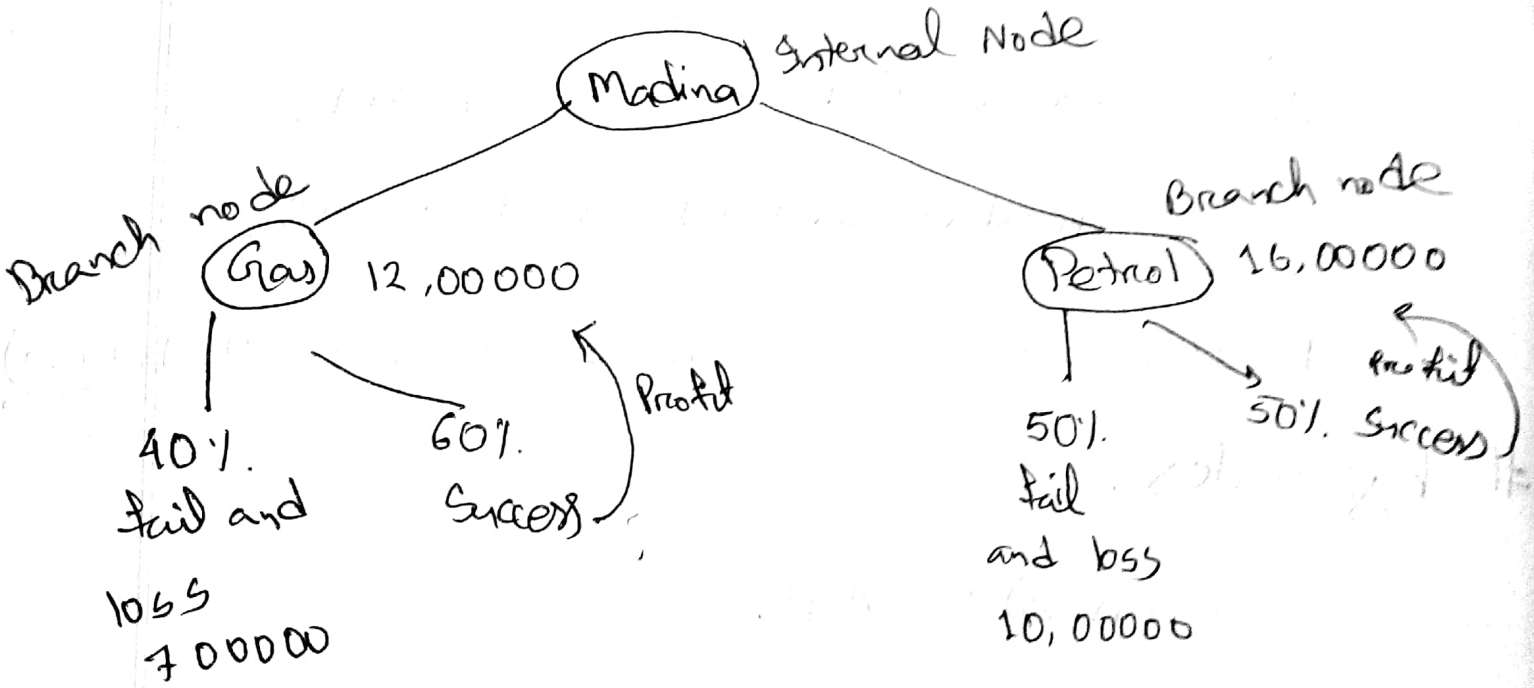
monkey - banana

25.07.18

Decision tree: Decision tree is a one type of classification method that takes input as a situation on attribute and returns a decision.



Petrol = 50% * 16,00000 + 50% * 10,00000

= 13,00000

Gas = 60% * 12,00000 + 40% * 7,00000

= 10,8 0000

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* There are three nodes in Decision tree:

(i) Internal node / Root node

(ii) Branch Node

(iii) Leaf Node (Decision point)

No.	Refund	Marital Status	Tax. In.	cheat
Amrita	NO	single/divorce	$x > 80\$$	Yes
Madina	NO	Married	95 $	NO
Shuvo	Yes	Married	100$	No

* Two types of class. here:

(i) Yes → class 1

(ii) No → class 2.

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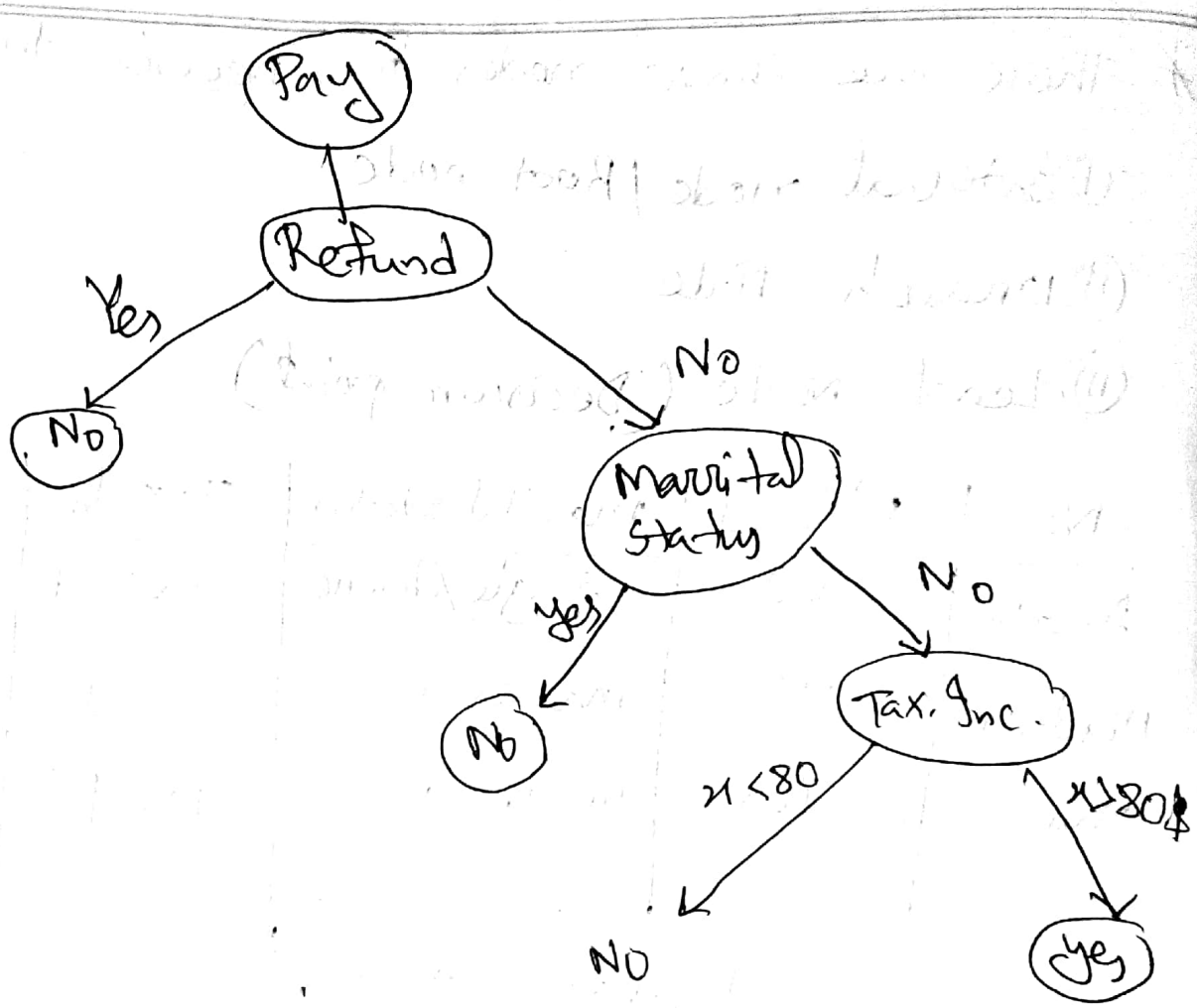

Long

male: $x > 5ft$

female: $x > 4ft$

Short

$x < 4ft$

$x < 3.5ft$

Medium

$x > 4$ & $x \leq 5$ OR

$5 \geq x > 4$

$x > 3.5$ & $x \leq 4$ OR

$4 \geq x > 3.5$

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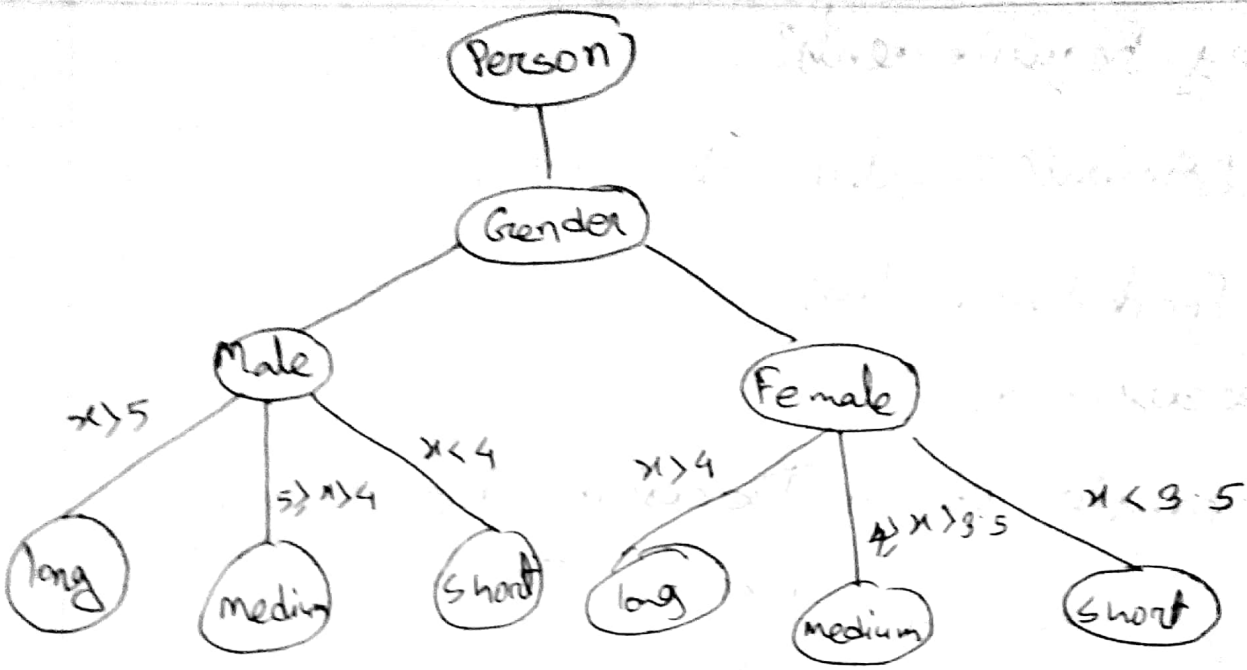
Decision tree:

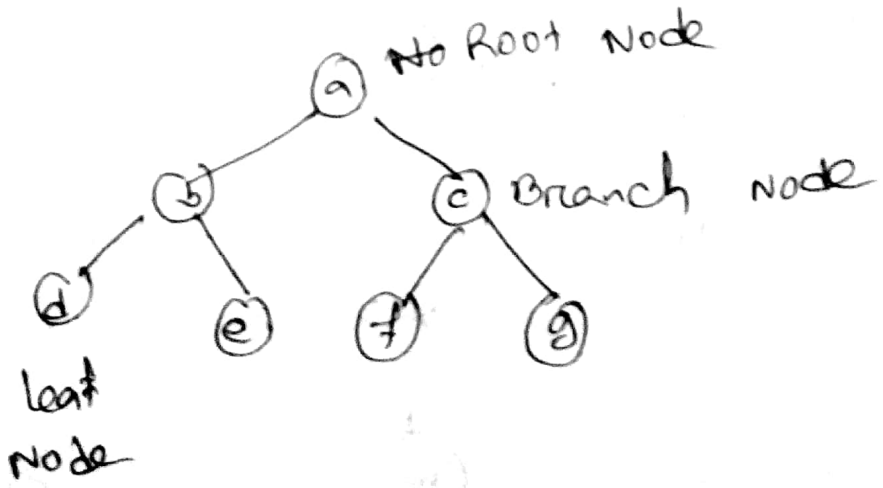


29.07.18

(i) Internal Node (Root)

(ii) Branch node

(iii) Leaf Node (outcome)



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* Key Requirements:

Attribute – Value description

Predefined class

* Decision tree:

Example of a Decision Tree:

Tid	Refund	Mar. St.	Tax. Inc.	Cheat
	No	yes	60	No
X	yes	No	$x > 80\$$	No
	No	Single	$x > 80\$$	yes

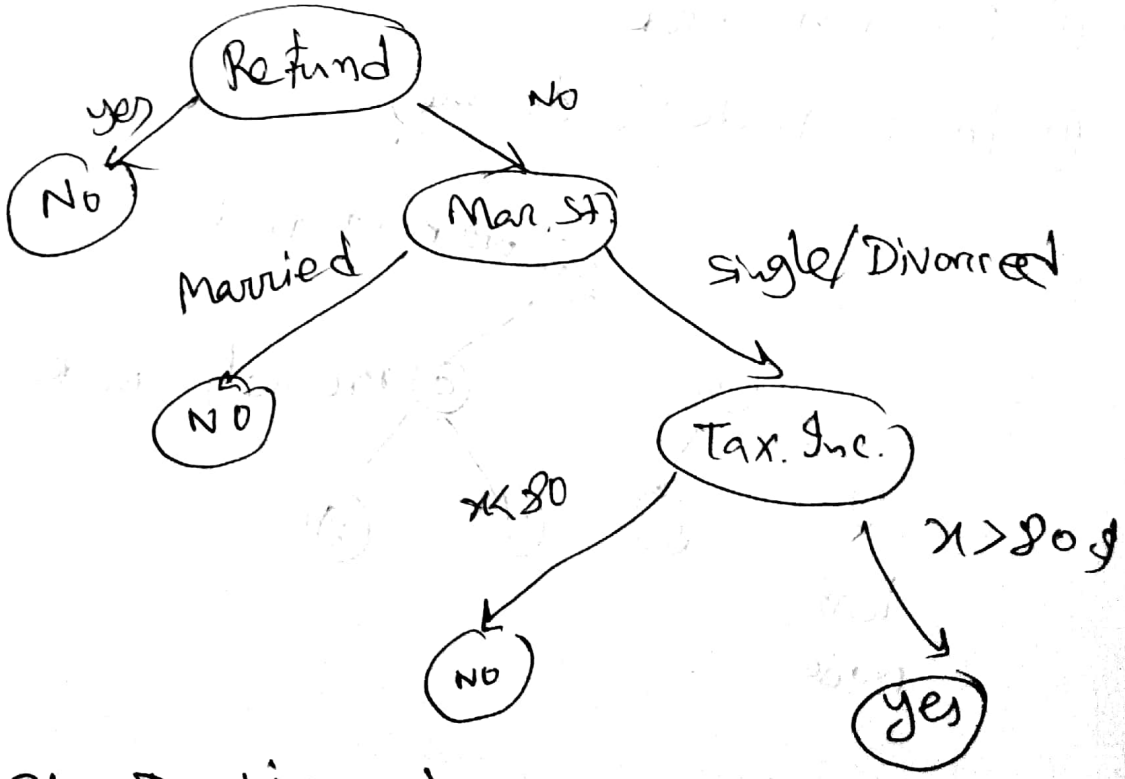

Fig: Decision tree

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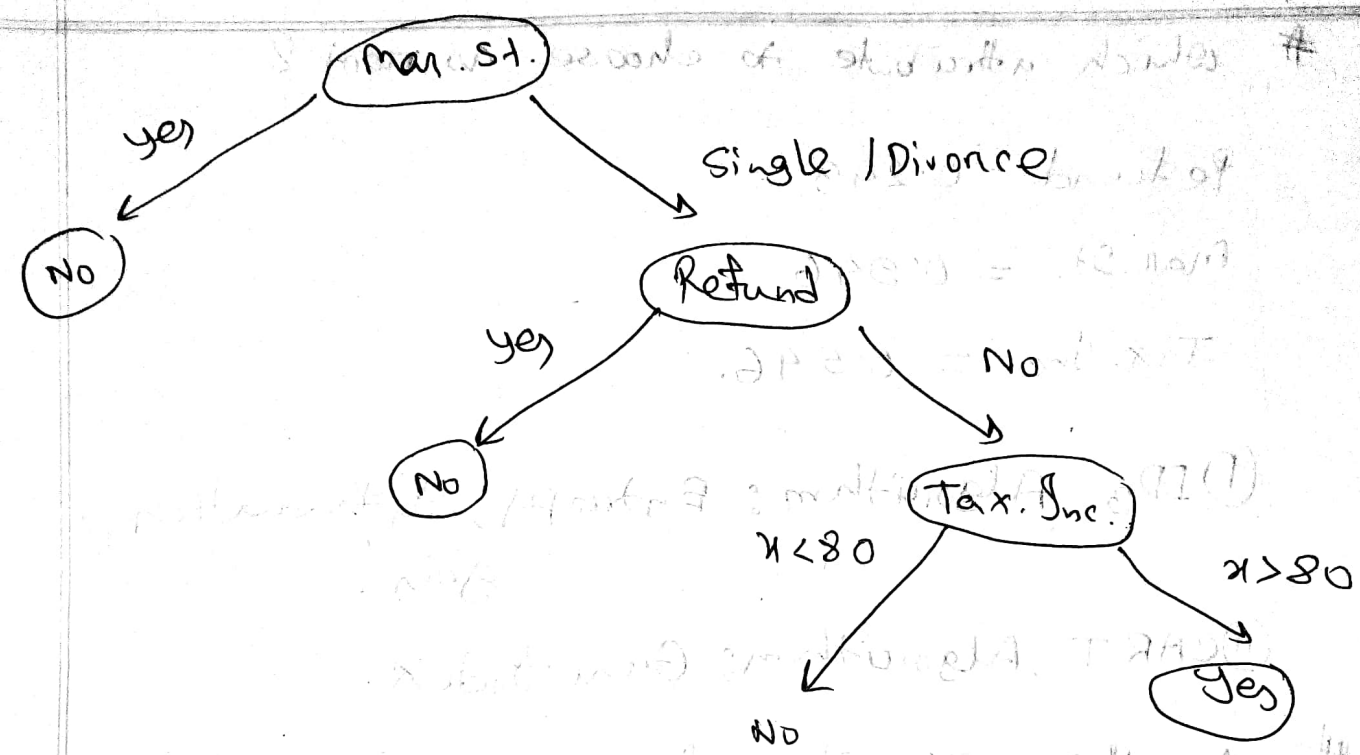

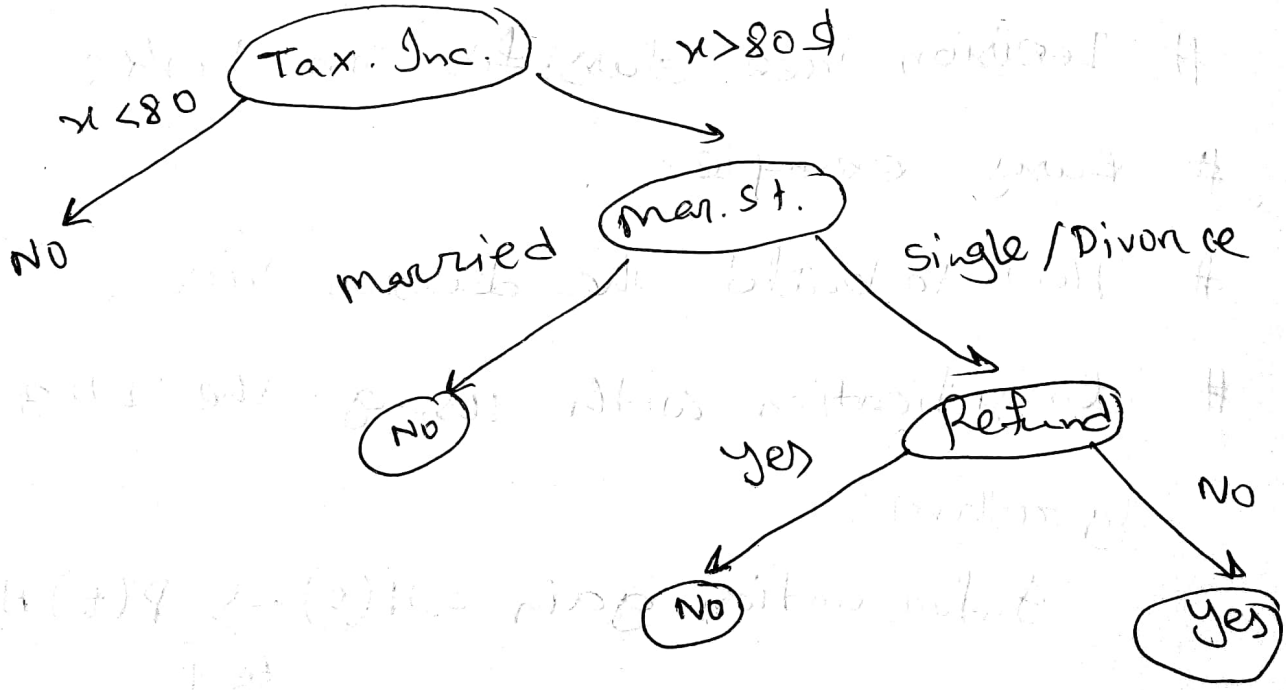

$3! = 1 \times 2 \times 3 = 6$

6 types of Decision tree can be made.

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which attribute to choose as root?

Refund = 0.243

Mar.St. = 0.946

Tax. Inc. = 0.546.

(I) ID_3 Algorithm: Entropy, Information gain.

(II) CART Algorithm: Gini Index.

Another example of Decision tree:

Decision tree classification task:

Easy example:

How to build the decision tree:

classification with using the ID_3 algorithm:

$$\text{Information gain} = H(S) - \sum_{t \in T} P(t) H(t)$$

$$\text{Entropy}, H(S) = \sum_{s \in S} P(c) \log_2 P(c)$$

$H(S)$, $H(t)$ $\longrightarrow$ Entropy.

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$C = \text{Yes}, \text{No}$

$$\frac{\text{Positive class}}{\text{Total class}} + \frac{\text{Negative class}}{\text{Total class}}$$

Entropy for yes $= \frac{9}{14} \log_2 \frac{9}{14}$

Entropy for No $= \frac{5}{14} \log_2 \frac{5}{14}$

$$H(S) = \frac{9}{14} \log_2 \frac{9}{14} + \frac{5}{14} \log_2 \frac{5}{14}$$

Outlook — Sunny, overcast, Rainy

Sunny	Rainy	overcast
No	yes	yes
No	yes	yes
No	yes	yes
yes	No	yes
yes	No	

5

$\frac{5}{14} \leftarrow H(\text{outlook} = \text{Sunny}) = \frac{2}{5} \log_2 \frac{2}{5} + \frac{3}{5} \log_2 \frac{3}{5}$

$\frac{5}{14} \leftarrow H(\text{outlook} = \text{Rainy}) = \frac{3}{5} \log_2 \frac{3}{5} + \frac{2}{5} \log_2 \frac{2}{5}$

$\frac{4}{14} \leftarrow H(\text{outlook} = \text{overcast}) = \frac{4}{4} \log_2 \frac{4}{4} + 0$

"Sessional" $\longrightarrow$ 29.07.18.

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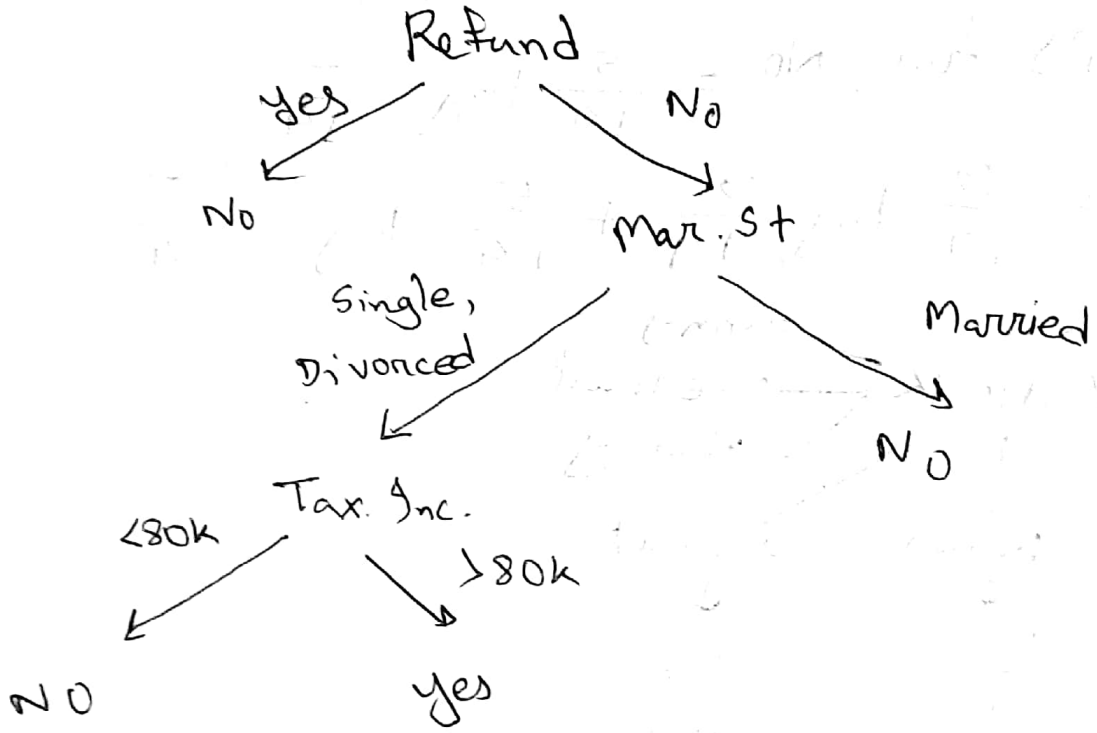
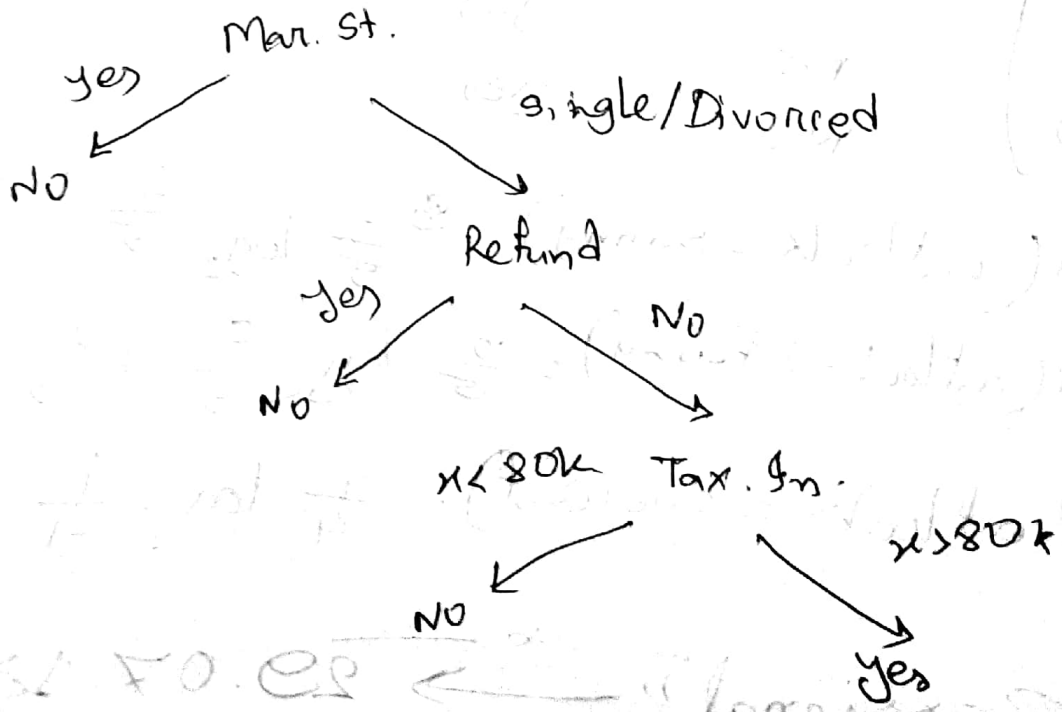
01.08.18

"Decision Tree"

* Classification:





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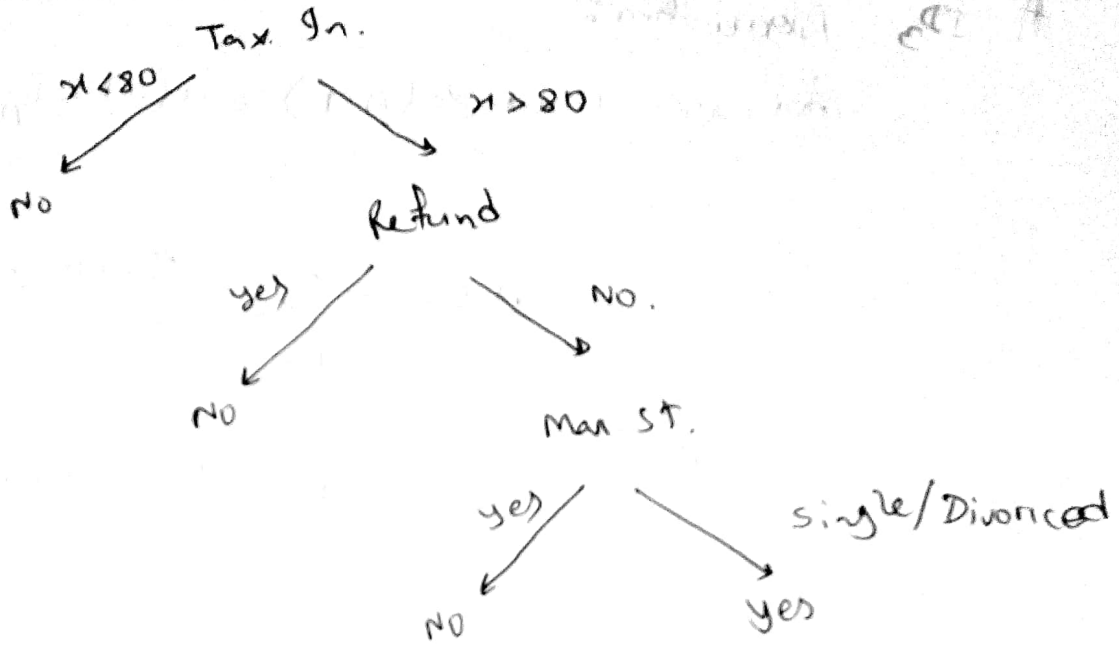

attributes = 3 ;

No. of possible tree = 3! = 6

Algorithm for Decision tree generation:

(i) ID_3 algorithm — $\boxed{\text{information gain}}$

(ii) CART algorithm

$\boxed{\text{Gini index}}$

(iii) C 4.5 algorithm (Extended version of ID_3)

$\boxed{\text{Gain ratio}}$

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ID_3 Algorithm:

Information Gain $\alpha(A, D) = H(D) - E_A(D)$

$$= H(S) - \sum_{t \in T} P(t) H(t)$$

$$H(S) = -\sum_{c \in C} P(c) \log_2 P(c)$$

$$H(S) = \frac{3}{10} \log_2 \frac{3}{10} + \frac{7}{10} \log_2 \frac{7}{10}$$

$$P_{yes} = \frac{3}{10} \log_2 \frac{3}{10}$$

$$P_{NO} = \frac{7}{10} \log_2 \frac{7}{10}$$

$\rightarrow$ 0.987 (suppose).

Entropy calculation

~~α (Refund~~

$$H(\text{Mar.St.} - \text{single}) = \underbrace{\frac{2}{4} \log_2 \frac{2}{4}}_{\text{Yes}} + \underbrace{\frac{2}{4} \log_2 \frac{2}{4}}_{\text{No}}$$

$$H(\text{Mar.St.} - \text{Divorce}) = \frac{1}{2} \log_2 \frac{1}{2} + \frac{1}{2} \log_2 \frac{1}{2}$$

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Mar. St.

Single (4)	Married (4)	Divorce (2)
yes	yes = 0	yes
yes	No	No
No	No	
No	No	
	No	

$$H(\text{mar.st} - \text{Married}) = 0 + \frac{4}{4}\log_2 \frac{4}{4}$$

$$= 1 \log_2 1$$

$$\alpha(\text{mar.st.}) = \cancel{H(S)}\ 0'987 - \left[\frac{4}{10} \times \left(\frac{2}{4}\log_2 \frac{2}{4} + \frac{2}{4}\log_2 \frac{2}{4}\right) + \frac{2}{10} \times \left(\frac{1}{2}\log_2 \frac{1}{2} + \frac{1}{2}\log_2 \frac{1}{2}\right) + \frac{4}{10} \times (1 \log_2 1)\right]$$

$$P(t) = P\left(\frac{J}{n}\right) = P\left(\frac{4}{10}\right) \rightarrow \text{single}.$$

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Attribute	Information Gain
Mar. St.	0.437
Refund	~~0.437~~ 0.768
Tax. In.	0.34

(Suppose)

—— x ——

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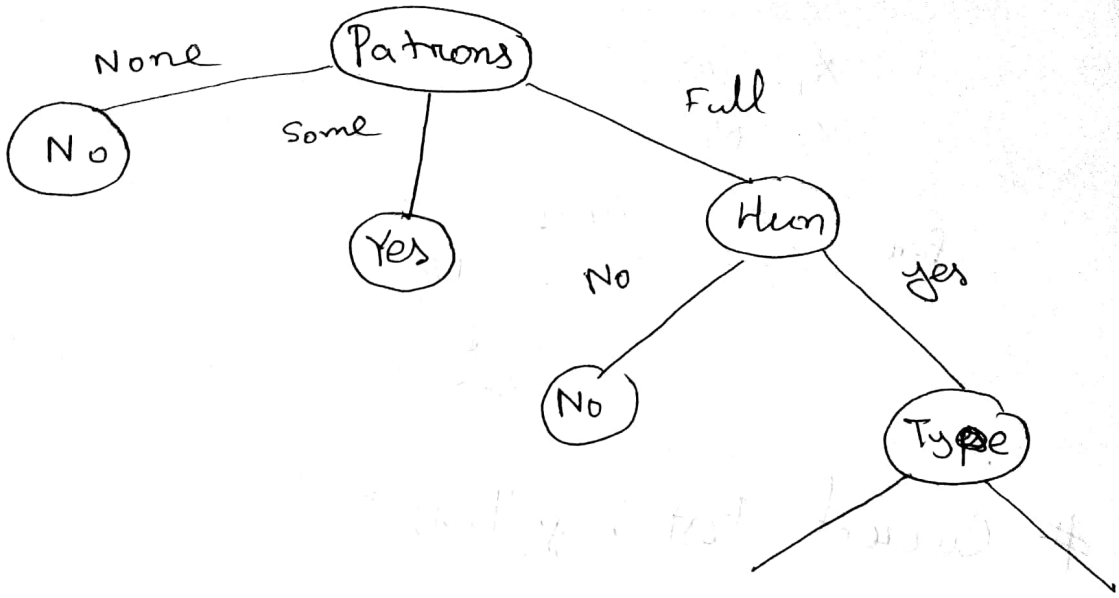
"Logical Description Hypothesis"

29.08.18.

Decision Tree:



* Logical Description Hypothesis:

H_1: $\forall x$ will wait $\Leftrightarrow$ Alt (x) Positive

~~H_2: $\forall x$ will wait $\Leftrightarrow$ Alt (x) Negative, Positive False Positive.~~

X_1 = Positive hypothesis.

X_2 = False Negative hypothesis.

(1) False negative $\rightarrow$ Generalization

(1) False Positive $\rightarrow$ Specification.

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H_2 : $\forall x$ willwait $\Leftrightarrow$ Alt $(x) \wedge$ Pat (x, some)

x_1 : Yes

x_2 = No

for , x_3 = $0 \wedge 1$

$0 \rightarrow$ No

$\downarrow$

yes (false positive)

Current Best hypothesis :

H_3 : $\forall x$ willwait $\Leftrightarrow$ Alt $(x) \wedge \neg$ Bar (x)

05.09.18

06.09.18

CT-4 $\rightarrow$ Bayesian Networks .

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09.09.18

Genetic Algorithm:

gene

Father
Mother > child

0111100
0001111 > 0111111

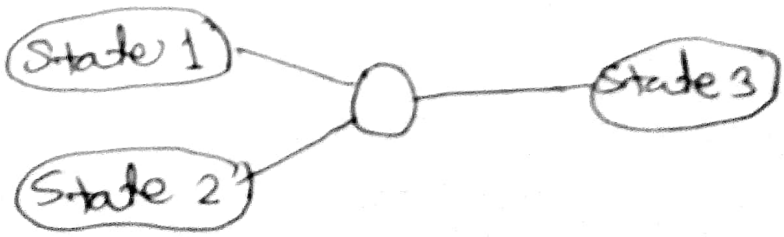
* Classes of search Algorithm:

Genetic ~~alg~~ algorithm: A genetic algorithm (GA) is a variant of stochastic beam search in which successor states are generated by combining two parent states rather than by modifying a single state.

* Why genetic Algorithms?

For black box testing

* Genetic Algorithm:



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09.09.18

Genetic Algorithm:

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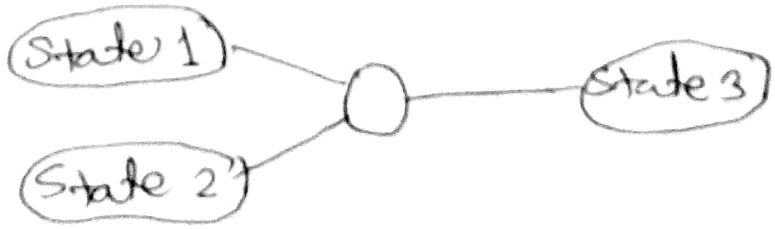

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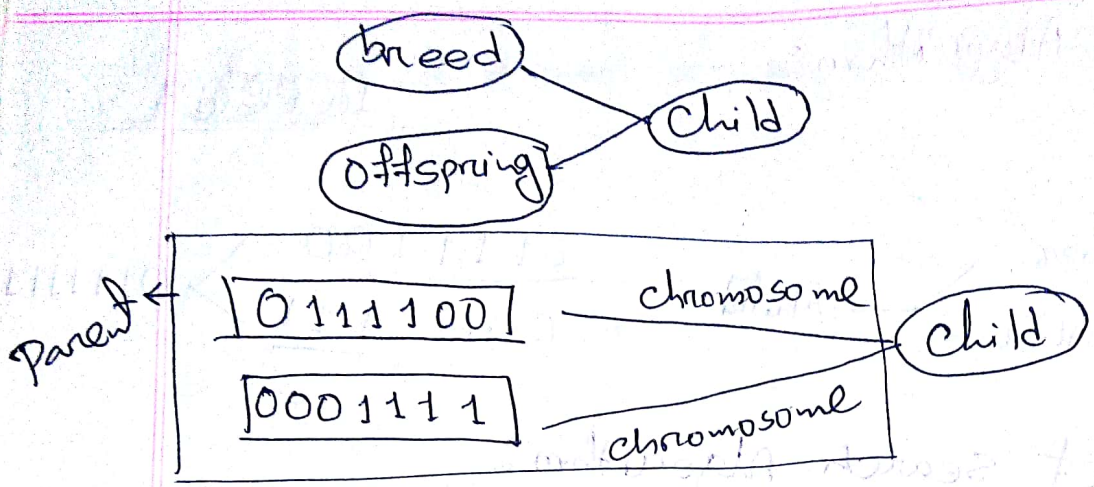


* Implementation Details:

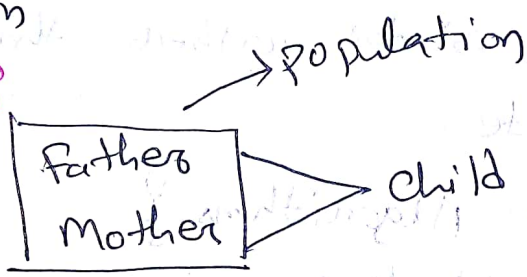
i) Population

ii) Selection

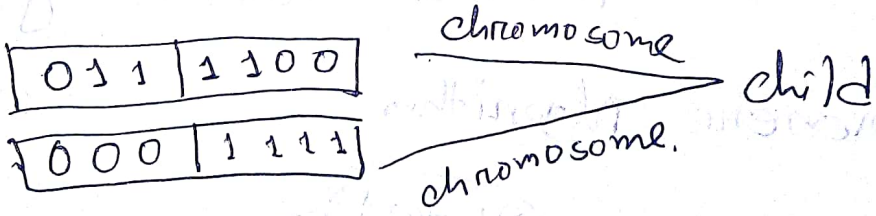
iii) Crossover / Recombination

iv) Mutation

Population:



Selection:



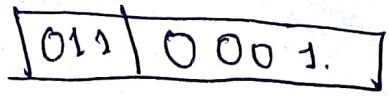
Crossover:

011 | 0011

000 | 1000

Mutation:

011 | 0011
000 | 1000



* Simple Genetic Algorithm: Fig:1

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12.09.18.

Natural Language Processing:

(i) English → SVO structure (Sub + V + Obj)

(ii) Arabic → O + V + S

(iii) Hindi → S + O + V

* Steps of NLP:

1. Morphology (Meanings) — Phonology
2. Syntax
3. Semantics
4. Pragmatics
5. Discourse
6. World knowledge

—x—

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13.09.18.

Genetic Algorithm: (Evolution Algorithm)

Gene → 0, 1 [Attribute]

chromosome → 0 1 1 1 1

population → $\boxed{01111}$ $\boxed{1\ 1000}$

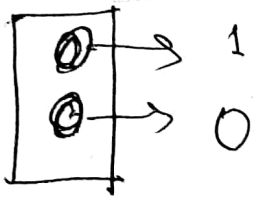
Gene
↓
Chromosome
↓
population.

* Three steps:

(i) selection

(ii) Crossover

(iii) Mutation.



X	Y	Z
1	0	1

$\boxed{101}$ → chromosome

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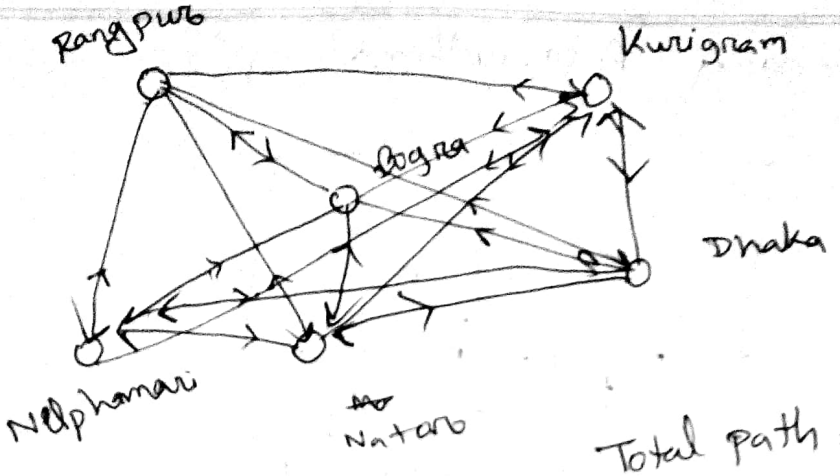


Total path = 30 Gene

$= n(n-1)$

Edge = Gene

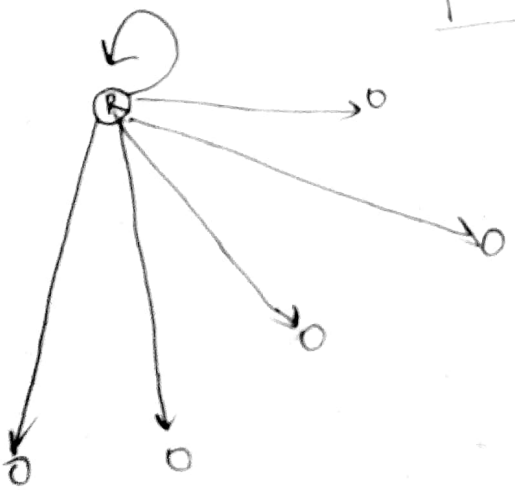
↓

Without Direction

$= \frac{n(n-1)}{2}$

↓

Genetic Algo.



6 gene → 1 chromosome

111111 → chromosome

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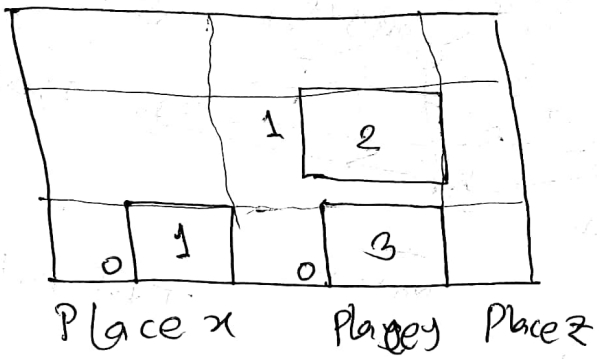
Evolutionary Algorithms (2P):



1010 → Chromosome

gene gene gene

. Total combination can be $3! = 6$ To rearrange their positions

∴ Total gene will be = 3×6

No. of Gene — No. of combination

⇒ Get to initial state.

—∞—

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