

Machine Learning

Machine Learning:

Learner or train model/logic from data

Classical Learning:

Define algo/logic to
Compute output

Classical Learning

Data (input)

Program/ Algo/ logic

→ output

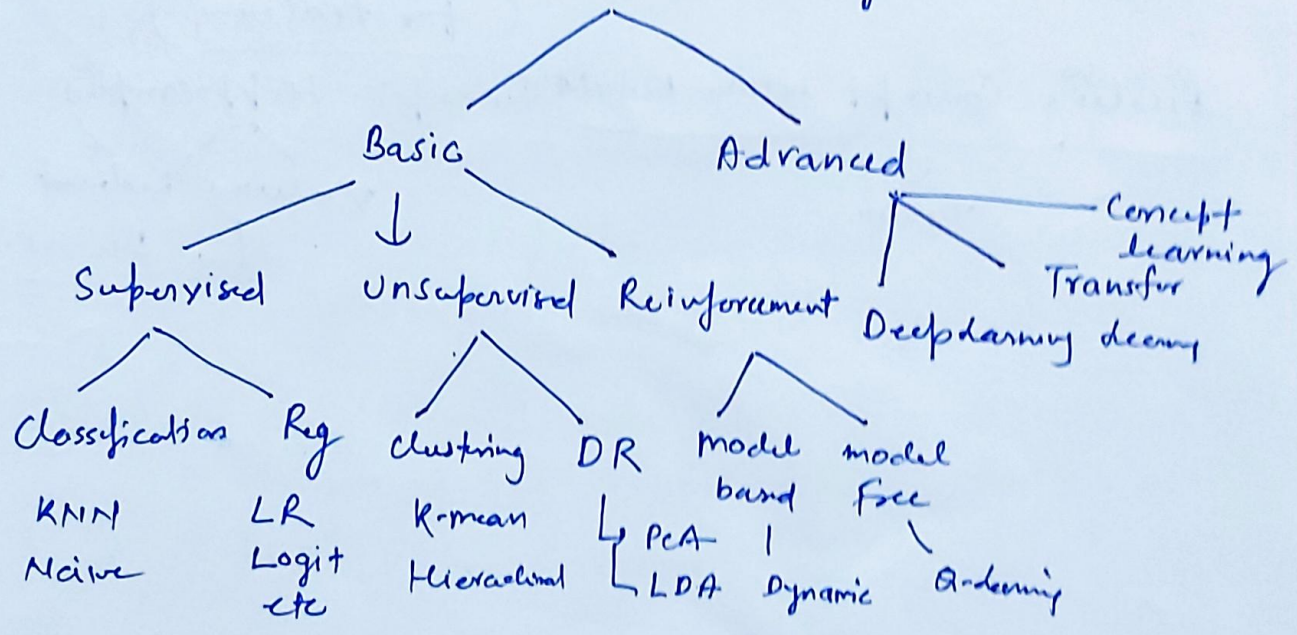
machine learning

Data (input) / Training

output

→ model/ logic/ Program

machine learning



Concept learning / Concept learning as Search

(2)

Concept learning is used to recognize patterns or concept within dataset. The general idea behind concept learning is to develop a hypothesis or set of rules that can accurately classify new instances based on their attributes (features).

Basically it is extension of Supervised learning

* → Spam mail identification. ✓

* → Alzheimer's Disease Staging using Concept learning
→ Early, mild, moderate, Severe

Correlation b/w features → Pattern of features.
(for training)

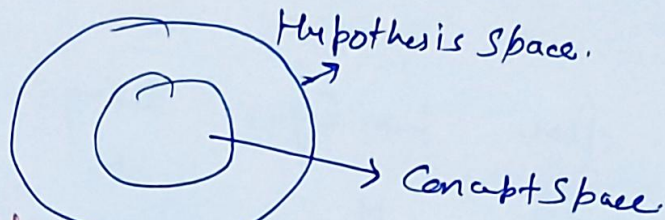
finding Concept within dataset For ex:- Hippocampus

↓
Train.

Volume Reduced
↳ Severe

Concept Learning as Search!

Searching a Solution through a hypothesis space.
for best fits Search strategy or solution to a problem



Example! Loyalty program Concept

Customer ID	Age	Gender	Income	Amount Spent	F/Member	High value
1	35	M	70K	200	Y 5 Y	X
2	45	F	75K	300	H 8 M	X
3	28	M	40K	150	3 Y	N
4	50	F	100K 100000	500	10 Y	Y
5	40	M	60K	250	6 No	N

Concept Search Space

IH: - if a customer Spends more than \$300, they are a high-value Customer

evaluation: - Incorrectly classifies some high value Customers who spend less than \$300

RH: if a customer Spends more than \$300 and is a member of the loyalty program, they are a high-value Customer.

evaluation: - Correctly classifies most high value Customers but misclassifies non high value Customers who also meet same criteria.

FR: - if a customer spends more than \$300 or
 , is a member of the loyalty program,
 , and has an income greater than 60K they
 are high valued customer.

Animal

Animal	fur	Lay Eggs	wings	Label
			M.	mammal
Dog	Y	H	Y	Bird
Eagle	Y	H	H	Reptile
Snake	H	H	Y	mammal
Bat	Y	H	H	Bird
Penguin	Y	Y	M.	Reptile.
Crocodile	H	Y		

if an animal has fur, it is mammal.

Concept learning - find(S) maximum specific Hypothesis

Exp	Sky	Airtemp	Humidity	Wind	Water	forecast	Enjoy spots
1	Sunny	warm	Normal	Strong	warm	same	Yes
2	Sunny	warm	High	Strong	"	same	Yes
3	Rainy	cold	High	"	"	change	No
4	Sunny	warm	High	"	Cool	"	Yes

Attribute
Target Value

1. initialize h to the most specific hypothesis in H

$$h(0) = \langle \phi, \phi, \phi, \phi, \phi, \phi \rangle$$

a_1 a_2 a_3 a_4 a_5 a_6

$$x_1 = \langle \text{Sunny}, \text{warm}, \text{Normal}, \text{Strong}, \text{warm}, \text{Same} \rangle$$

Iteration-1

$$\rightarrow h_1 = \langle \text{Sunny}, \text{warm}, \phi, \text{Normal}, \text{Strong}, \text{warm}, \text{Same} \rangle$$

Iteration-2

$$\rightarrow x_2 = \langle \text{Sunny}, \text{warm}, \text{High}, \text{Strong}, \text{warm}, \text{Same} \rangle$$

$$\rightarrow h_2 = \langle \text{Sunny}, \text{warm}, ?, \text{Strong}, \text{warm}, \text{Same} \rangle$$

Iteration-3 - ignore $\rightarrow x_3$

$$\rightarrow h_3 = \langle \text{Sunny}, \text{warm}, ?, \text{Strong}, \text{warm}, \text{Same} \rangle$$

$h_3 = \langle \text{Sunny, warm, ? strong, warm, same} \rangle$
iteration-4
 $X_4 = \langle \text{Sunny, warm, high, strong, cool, change} \rangle$
 $h_4 = \langle \text{Sunny, warm, ?, strong, ? ?} \rangle$

if sky is sunny, Airtemp is warm, ~~ok~~,

if sky = Sunny, Airtemp = warm, wind = strong

then only enjoy sports.

example	Outdoors	Size	in lib	price	edition	buy
1	Some	small	no	affordable	many	no
2	many	big	no	expensive	one	yes
3	Some	big	always	"	few	no
4	many	medium	no	"	many	yes
5	many	small	no	affordable	many	yes

Ans $h_5 = (\text{Outdoors} = \text{many}, \text{in library} = \text{no}) = \text{buy (Yes)}$

How many Concept are possible :-

$$2 \times 3 \times 2 \times 2 \times 3 = \underline{\underline{72}}$$

How many Hypothesis are possible :-

$$4 \times 5 \times 4 \times 4 \times 5 = 1600$$

Sematically.

Distinct Hypothesis :- $(3 \times 4 \times 3 \times 3 \times 4) + 1 = 433$

Candidate Elimination Algorithm: Constant Hypothesis

Exp	Sky	AirTemp	Humidity	Wind	Water	Forecast	EnjoySport
1	Sunny	Warm	Normal	Strong	Warm	Same	Yes
2	Sunny	Warm	High	Strong	Warm	Same	Yes
3	Rainy	Cold	High	Strong	Warm	Change	No
4	Sunny	Warm	High	Strong	Cool	Change	Yes

Yes

S₀: most specific boundaries

$\langle \phi, \phi, \phi, \phi, \phi, \phi \rangle$

S₁:

$\langle \text{Sunny}, \text{Warm}, \text{Normal}, \text{Strong}, \text{Warm}, \text{Same} \rangle$

S₂: S₃

$\langle \text{Sunny}, \text{Warm}, \text{No?}, \text{Strong}, \text{Warm}, \text{Same} \rangle$

S₄:

$\langle \text{Sunny}, \text{Warm}, \text{?}, \text{Strong}, \text{?}, \text{?} \rangle$

G₃:

$\langle \text{Sunny}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$ $\langle \text{? Warm}, \text{Normal} \langle \text{Cool} \rangle \langle \text{Same} \rangle$

G₂

$\langle \text{?}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$

G₁:

$\langle \text{?}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$

No

most

G₀: Generic boundaries

$\langle \text{?}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$

G₁, G₂

S $\langle \text{Sunny}, \text{Warm?}, \text{Strong?}, \text{?}, \text{?} \rangle$

$\langle \text{Sunny}, \text{?}, \text{?}, \text{Strong}, \text{?}, \text{?} \rangle$ $\langle \text{Sunny}, \text{Warm}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$

$\langle \text{? Warm}, \text{?}, \text{Strong}, \text{?}, \text{?} \rangle$

G $\langle \text{Sunny}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$ $\langle \text{? Warm}, \text{?}, \text{?}, \text{?}, \text{?} \rangle$

Total = 6

Version space:

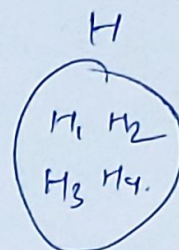
Subset of Hypothesis H consistent with the training examples D

$$VS_{H,D} = \left\{ h \in H \mid \text{consistent}(h, D) \right\}$$

(h is consistent with D)

Where H = hypothesis

D = Training examples.

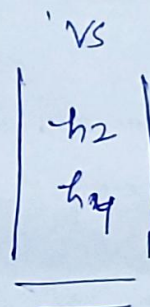
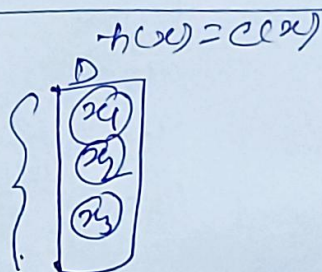
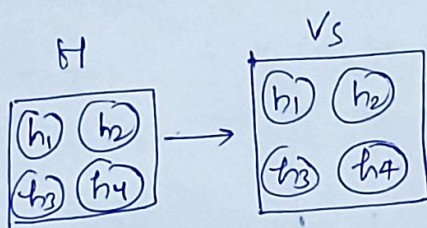


Consistent? $\Rightarrow h(x) = C(x)$

\downarrow
Hypothesis

\rightarrow Target function

Exp:



$$h_1(x_1) = C(x_1)$$

$$h_1(x_2) \neq C(x_2)$$

$$h_2(x_1) = C(x_1)$$

$$h_2(x_2) = C(x_2)$$

$$h_2(x_3) = C(x_3)$$

✓

Exp!

< Sunny, warm, ? Strong, ?, ? >

< Sunny, ? ? strong, ?? > < Sunny, warm, ? ? ? ? >

< ?, warm, ?, Strong, ?, ? >

< Sunny, ?, ?, ? ? ? > < ?, warm, ? ? ? ? >

find the tuples

	sky	Airtemp	Humidity	wind	water	forecast	Enjoy sports
A	sunny	warm	Normal	Strong	Cool	change	?
B	Rainy	Cold	Normal	light	warm	Same	?
C	sunny	warm	Normal.	light	warm	Same	?
D	Sunny	Cold	Normal.	Strong	warm	Same	?

Counter not / with the example

Exp	Citations	Size	Lib Avl	Price	edition	Buy
1	Some	Small	NO	<10K	one	No
2	many	Big	YES	>10K	many.	Yes

$h_1 = (?, ?, No, ?, many) \rightarrow \begin{matrix} \text{No} \checkmark \\ \text{Yes} \end{matrix} \left. \vphantom{\begin{matrix} \text{No} \checkmark \\ \text{Yes} \end{matrix}} \right\} \text{Consistent} \checkmark$

$h_2 = (?, ?, No, ?, ?) \rightarrow \text{not consistent}$