MACHINE INTELLIGENCE

Concept Learning

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Concept Learning

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Concept Learning

- what is a concept?
- we will try to understand it practically

does not belong to the concept

Concept	Data object	
C	x	
		label
x- belongs to concept c		1
or		
not belongs to concept c		0

CONCEPT?
YES

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Concept Learning

- what is a concept?
- we will try to understand it practically

each object x is is defined by specific features
over job is to make machine learn this unknown
through which we can decide if it belongs to the
concept (shape, size, colour attributes (&
and once we know it we can label any new data
accordingly.....this the concept learning task

Concept	Data object	
C	x	
		label
X = {	belongs to concept c (oval,large,dark),.....(circular,small,light) or not belongs to concept c	1 0

shape-oval,circular
size-large,small
colour-dark,light

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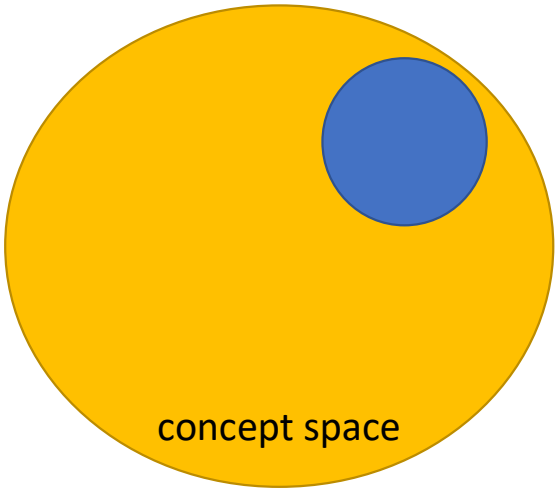

2^8 concepts.....how???

suppose our data is defined using d binary attributes then there are 2^d let us say it as b ,then we have 2^b concepts

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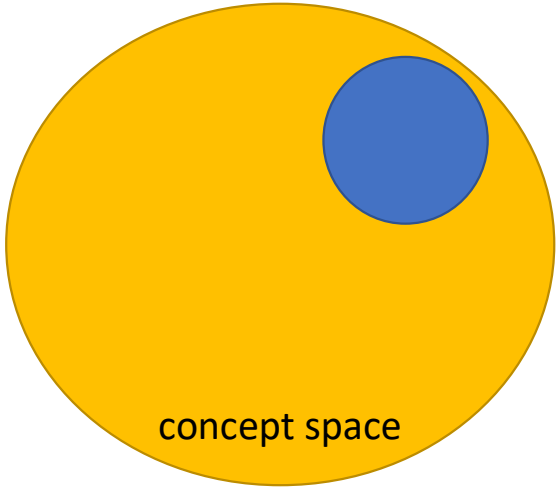
Inductive bias



X_1 -> (1,0,1)
X_2 -> (0,0,1)

circular ^ dark

the reason we call this concept
is only if both of this is true for a data object
then the object belongs to the concept

we will see what it is

(logical AND) of few of these
basically a subset of all possible feature

0	1
oval	circular
small	large
light	dark

Inductive bias

__ ^ __ ^ __

circular ^ dark can be represented like this

circular ^ _?_ ^ dark

? means anything,that is any value there is true

since we have three attributed here we can mention our conjunctive concept something like this

? ^ ? ^ ? is a concept that accepts everything ,we call it accept all

Ø is a concept that rejects everything ,we call it reject all

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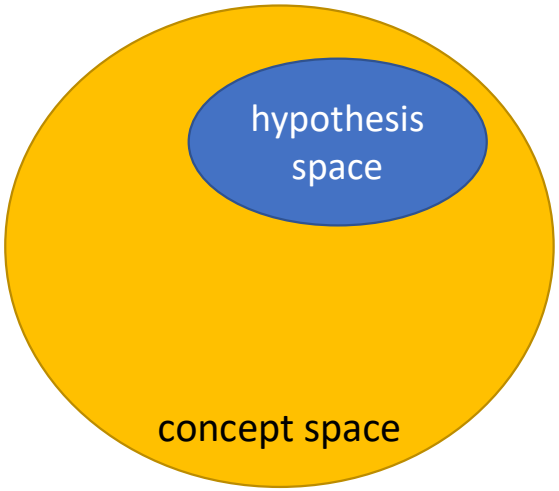
Inductive bias

for every position we can have three value that is two among the binary value and one **?**
also we have one concept of **Ø**
so we have (3 x 3 x3)+1=28 conjunctive concepts

In general if we have 'n' features then we will have 3n+1 conjunctive concepts for a object with 3 binary attributes

if u carefully observe we had total of 256 concepts in our concept space but now we have only 28 concepts in our conjunctive concept space
i.e we have shrunk our search space
this shrunk space is what we call as hypothesis space



Concept- Days on which person enjoys sports

Attributes-
Sky-sunny,rainy
Temp-warm,cold
Humidity-Normal,High
Wind- strong,weak
Water-warm,cool
Forecast-same,change

[illegible] that is Find S algorithm

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Find S algorithm

1. **start with h=Ø**
2. **use next input {x,c(x)}**
3. **if c(x)=0 ,go to step 2**
4. **h <--- h ^ x (pairwise-and)**
5. **if more examples .Go to step 2**
6. **stop**

Let us look at the pseudo code of this algorithm

Pairwise -and rules

$$a_h \wedge a_x = \begin{cases} a_x & : \text{if } a_h = \emptyset \\ a_x & : \text{if } a_h = a_h \\ ? & : \text{if } a_h \neq a_x \\ ? & : \text{if } a_h = ? \end{cases}$$

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Find S algorithm-Problem

step1: start with h=Ø

h={Ø,Ø,Ø,Ø,Ø,Ø}

step2: use next input {x,c(x)}

x={sunny,warm,normal,strong,warm,same}
c(x)=yes==1

step3: if c(x)=0 ,go to step 2
step4: h <--- h ^ x (pairwise-and)

$h_0=h_0$^ x
h_0={sunny,warm,normal,strong,warm,same}

step5: if more examples .Go to step2

h(0)=sunny
h(1)=warm
h(2)=normal
h(3)=strong
h(4)=warm
h(5)=same

we will take a concept step by step and rule we need to learn this concept with the training data below

sky	temp	humidity	wind	water	forecast	enjoy
sunny	warm	normal	strong	warm	same	yes
sunny	warm	high	strong	warm	same	yes
rainy	cold	high	strong	warm	change	no
sunny	warm	high	strong	cool	same	yes

$$a_h \wedge a_x = \begin{cases} a_x & : \text{if } a_h = \emptyset \\ a_x & : \text{if } a_h = a_h \\ ? & : \text{if } a_h \neq a_x \\ ? & : \text{if } a_h = ? \end{cases}$$

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Find S algorithm-Problem

step2: next input {x,c(x)}

x={sunny,warm,high,strong,warm,same}
c(x)=yes==1

step3: if c(x)=0 ,go to step 2
step4: h <--- h ^ x (pairwise-and)

$h_0=h_0$^ x
h_0={sunny,warm,?,strong,warm,same}

step5: if more examples Go to step 2

h(0)=sunny
h(1)=warm
h(2)=?
h(3)=strong
h(4)=warm
h(5)=same

sky	temp	humidity	wind	water	forecast	enjoy
sunny	warm	normal	strong	warm	same	yes
sunny	warm	high	strong	warm	same	yes
rainy	cold	high	strong	warm	change	no
sunny	warm	high	strong	cool	same	yes

$$a_h \wedge a_x = \begin{cases} a_x & : \text{if } a_h = \emptyset \\ a_x & : \text{if } a_h = a_h \\ ? & : \text{if } a_h \neq a_x \\ ? & : \text{if } a_h = ? \end{cases}$$

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Find S algorithm-Problem

step2: next input {x,c(x)}

x={rainy,cold,high,strong,warm,change}
c(x)=yes==0

step3: if c(x)=0 ,go to step 2

sky	temp	humidity	wind	water	forecast	enjoy
sunny	warm	normal	strong	warm	same	yes
sunny	warm	high	strong	warm	same	yes
rainy	cold	high	strong	warm	change	no
sunny	warm	high	strong	cool	same	yes

$$a_h \wedge a_x = \begin{cases} a_x & : \text{if } a_h = \emptyset \\ a_x & : \text{if } a_h = a_h \\ ? & : \text{if } a_h \neq a_x \\ ? & : \text{if } a_h = ? \end{cases}$$

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Find S algorithm-Problem

step2: next input {x,c(x)}

x={sunny,warm,high,strong,cool,same}
c(x)=yes==1

step3: if c(x)=0 ,go to step 2
step4: h <--- h ^ x (pairwise-and)

$h_0=h_0$^ x
h_0={sunny,warm,?,strong,?,same}

step5: if more examples Go to step 2
step6: stop

h(0)=sunny
h(1)=warm
h(2)=?
h(3)=strong
h(4)=?
h(5)=same

sky	temp	humidity	wind	water	forecast	enjoy
sunny	warm	normal	strong	warm	same	yes
sunny	warm	high	strong	warm	same	yes
rainy	cold	high	strong	warm	change	no
sunny	warm	high	strong	cool	same	yes

$$a_h \wedge a_x = \begin{cases} a_x & : \text{if } a_h = \emptyset \\ a_x & : \text{if } a_h = a_h \\ ? & : \text{if } a_h \neq a_x \\ ? & : \text{if } a_h = ? \end{cases}$$

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Find S algorithm-prediction

C={sunny,warm,?,strong,?,same}

x={sunny,warm,high,strong,warm,same}

c(x)=1

suppose now we give the test data set and we can pass the data through our concept and we give our final hypothesis as our concept that we use the concept learnt to predict the labels that is if the person will play a sport or no

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Version space

a hypothesis is said to be consistent wrt to training data set if it classifies all the object of training data set to their corresponding classes

X	C(X)
x_1	$c(x_1)$
x_2	$c(x_2)$

so on.....

a hypothesis is said to be consistent if $h(x_i)=C(x_i)$

at any given point let H be our hypothesis space
so a version space is a subset of H
but all concepts in version space VS are consistent wrt to training set

i.e VS={h : h $\in$ **H** and h is consistent with $D_{training}$

this ensures our algorithm learns only the best hypothesis

[illegible] the hypothesis space may never find the right concept that is to be learned and always predict wrong.

THANK YOU

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