

Unknown Target
function, $f: x \rightarrow y$

Training Examples
 $\langle x_1, y_1 \rangle \dots \langle x_N, y_N \rangle$

Learning
Algorithm

Final
Hypothesis
 $g \approx f$

Hypothesis Set
 $H = \{h_1, h_2, \dots, h_M\}$

Learning
Diagram

What is learning?

When can we learn?

Can we Really learn?

How to learn?

How to learn/do
it well?

Path Ahead !!

► Hoeffding Inequality:

$$\text{Prob} \left[\left| \underline{E}_{\text{in}}(g) - \underline{E}_{\text{out}}(g) \right| > \epsilon \right] \leq 2Me^{-2\epsilon^2 N}$$

P.A.C.

Concept
Learning

Concept Learning (C TARGET)

Boolean functions

	Sky	Temp	Humid	Wind	Water	Forecast	EnjoySpt
c	Sunny	Warm	Normal	Strong	Warm	Same	Yes
c	Sunny	Warm	High	Strong	Warm	Same	Yes
c	Rainy	Cold	High	Strong	Warm	Change	No
c	Sunny	Warm	High	Strong	Cool	Change	Yes

$h \approx c$ (Sky = Sunny) \wedge (Humid = High)

- $h_1 = \langle \text{Sunny}, ?, \text{High}, ?, ?, ? \rangle$
 $h_2 = \langle \text{Rainy}, ?, ?, ?, \text{Cool}, ? \rangle$
 $h_3 = \dots$
 h_m

Training Example (TE)

? \rightarrow anything (TRUE)
 $\emptyset \rightarrow$ nothing (FALSE)

Only 4 TEs

Goal: $\forall x \in X, h(x) = c(x)$

Search Problem: Sky = { Sunny, Rainy, Cloudy } $\Rightarrow |Sky| = 3$
 $|Temp| = |Humid| = |Wind| = |Water| = |Forecast| = 2$

Instances = $3 \times 2 \times 2 \times 2 \times 2 \times 2 = 96 \rightarrow 2^{96}$ Hypothesis all together!

Hypothesis (our Restriction) = $(3+2) \times (2+2) \times (2+2) \times (2+2) \times (2+2) \times (2+2) = 5120$

Actual Possible = $4 \times 3 \times 3 \times 3 \times 3 \times 3 + 1$
 Hypothesis = 973

Concept Learning:

↳ Inductive Learning
Hypothesis Assumption

⇒ Hypothesis Constructed from Training Data → Approx. Test Data / Unknown f well.

↳ Hypothesis Set

Find-S Algorithm:

↳ Take +ve Examples only

↳ Start from h^S and Refine

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

TE₁: $\langle \text{Sunny, Warm, Normal, Strong, Warm, Same} \rangle$

TE₂: $\langle \text{Sunny, Warm, ?, Strong, Warm, Same} \rangle$

TE₃: DO NOTHING

TE₄: $\langle \text{Sunny, Warm, ?, Strong, ?, ?} \rangle$

ANSWER

Sky	Temp	Humid	Wind	Water	Forecast	EnjoySpt
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	Change	Yes

Training Data (TE)

↓
Learn Boolean function

▶ Most Specific Hypothesis

$h^S = \langle \phi, \phi, \phi, \phi, \phi, \phi \rangle$

▶ Most General Hypothesis

$h^G = \langle ?, ?, ?, ?, ?, ? \rangle$

NOTE:

(1) Correctness

(2) TE Noise

(3) Why most specific?

(4) Multiple Hyp??