

HYPOTHESIS TESTING - 1

MOST DIFFICULT



TERMINOLOGY
EVERYWHERE!!!

Module

- ① Hypothesis Testing
- ② Advanced Distribution
 - Poisson, Exponential
 - Chi Square
 - Correlation Coefficient
- ③ Feature Engineering

Cricket Series Example → The captain always calls heads

1) 10 matches Series
7 Tosses were won

Is the Coin fair?

2) 100 matches Series
70 Tosses were won

Is the Coin fair?

3) 1000 matches Series
700 Tosses were won

Is the Coin fair?

YES	NO
48	10
28	10
10	34

We need a mathematical framework
which will Quantify this?

Cricket Series Example

"Status quo"

1) What is our default assumption?

It is a fair coin

2) When should we reject the assumption?

When we have enough conclusive evidence to prove otherwise.

Judge in Court

Assume that you are judging a murder case.

"Innocent until proven guilty"

1) What is our default assumption?

Person is innocent.

2) When should we reject the assumption?

When we have enough conclusive evidence to prove otherwise.

Machine Learning Model Deployment

ML algorithm is in production (legacy). You and your team have built a new model, and want to replace the legacy model.

1) What is our default assumption?

performance oldmodel = new model

2) When should we reject the assumption?

when we have enough conclusive
evidence to prove otherwise.

new model
>
old model

Third Umpire

Suppose you are the third umpire.

The ON field umpire has given a soft signal.

1) What is our default assumption?

On field is correct

2) When should we reject the assumption?

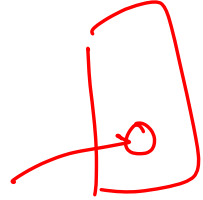
When we have enough conclusive evidence to prove otherwise.

Fingerprint Sensor

We unlock our phones using a fingerprint scanner. A finger is placed on the scanner.

1) What is our default assumption?

Finger print doesn't match with owner.



2) When should we reject the assumption?

When we have enough conclusive
evidence to prove otherwise.

Finger print = Shared finger print

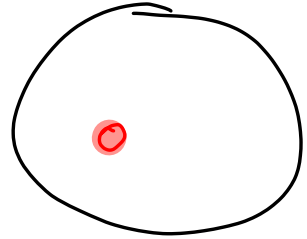
Radar Example

A Radar has to detect a plane.

1) What is our default assumption?

"Status quo"

Sky is clear, There is no enemy plane.



2) When should we reject the assumption?

When we have enough conclusive evidence to prove otherwise.

Terminologies

H_0 : NULL HYPOTHESIS

- ① Coin is fair
- ② Person is innocent
- ③ On field is correct
- ④ ML model new = legacy
- ⑤ Finger+print doesn't belong to owner
- ⑥ Clear sky

H_A : ALTERNATE HYPOTHESIS




When we
have enough conclusive
evidence
to prove otherwise

Judge in Court

H_0 : Person is innocent.

We shall reject H_0 only when we have conclusive evidences to prove person is not innocent.

Data :

- ① Person was carrying knife. "he is a chef" X
 - ② There was blood on the knife "he is a chef" X
 - ③ Blood matches with victim 
 - ④ Fingerprint of victim & blood was found Person's T-shirt 
 - ⑤ Eyewitness + CCTV 
- Reject H_0 .

Verdict :

prob of seeing data as extreme as was observed
under the assumption that H_0 is true.

$$P \left[\begin{array}{c|c} \text{data} & H_0 \text{ is true} \\ \hline \text{evidence} & \text{he is innocent.} \end{array} \right]$$

→ p value

↳ very low

Coin toss

Case 1 : 10 match series, 7 heads were observed. Would you believe that the coin is fair?

1) What is the random variable?

$X \rightarrow$ No of heads

$$\begin{aligned}n &= 10 \\k &= 7 \\p &= 0.5\end{aligned}$$

2) What is the distribution?

Binomial

3) What is the observed value?

7

4) What is probability of our observation assuming H_0 is true?

$$p\text{value} = 0.17$$

p value $< \alpha$

Reject H_0

p value $> \alpha$

fail to Reject H_0

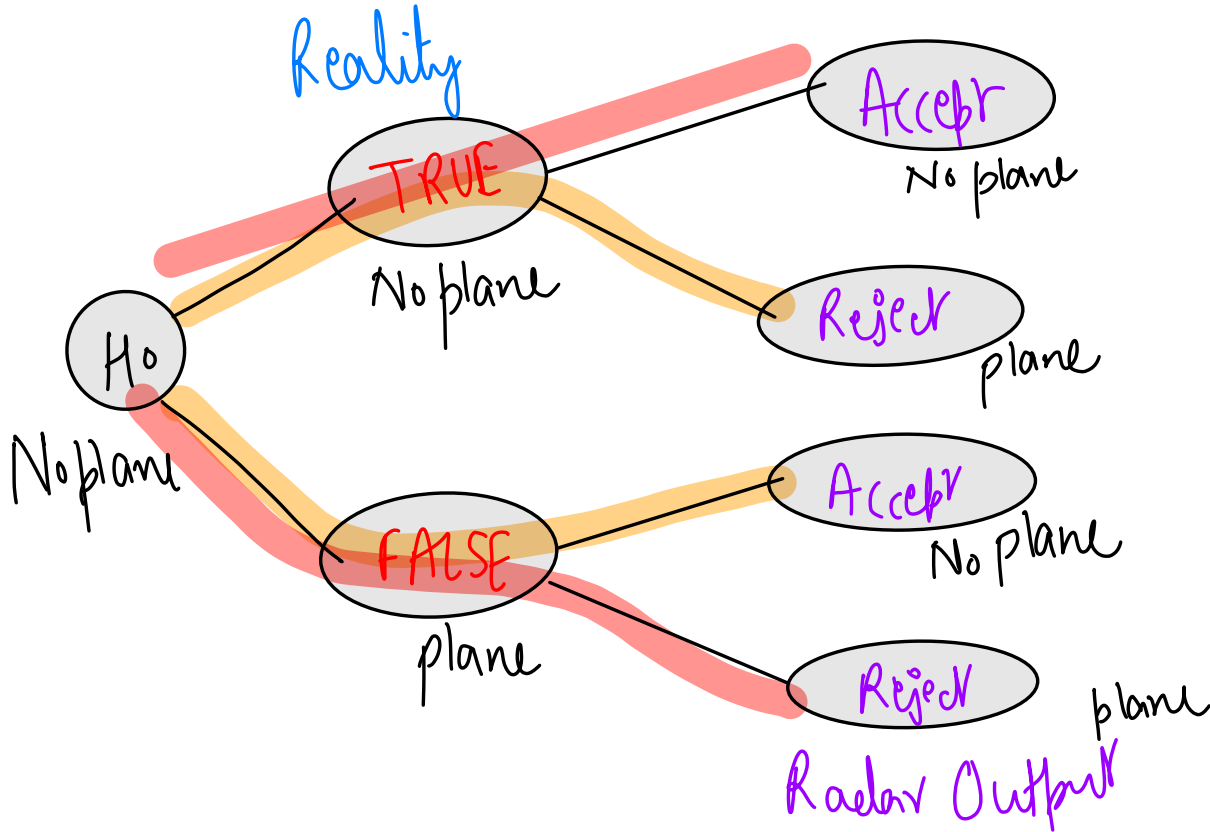
Radar

H_0 : No plane

"Null hypothesis"

H_a : plane

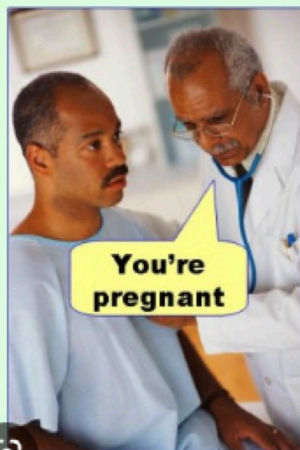
"Alternate hypothesis"



Reject H_0
plane

Fail to Reject H_0
Accept H_0
No plane

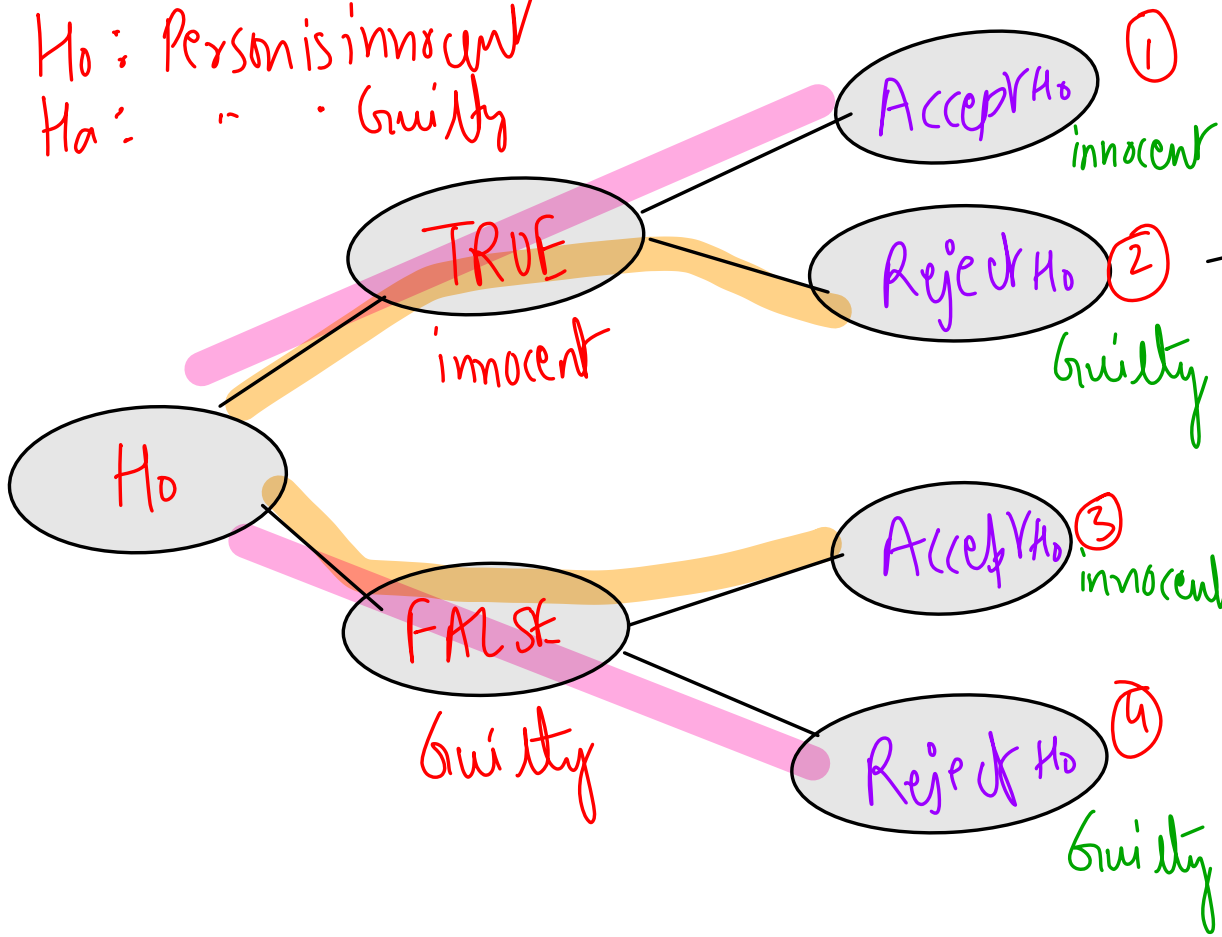
Type I error
(false positive)



Type II error
(false negative)



H_0 : Person is innocent
 H_a : " " " Guilty



TRUE POSITIVE
TRUE NEGATIVE
FALSE POSITIVE
FALSE NEGATIVE

Type I
error

Type II
error

Framework

- ① We define H_0 & H_a
- ② Choose / identify the distribution
- ③ Left / Right / two tailed.
- ④ Calculate p-value
- ⑤ If $p\text{-value} \leq \alpha \rightarrow \text{Reject } H_0$
 $p\text{-value} > \alpha \rightarrow \text{Fail to Reject } H_0.$

