Problem Statement:

- A laboratory test for detecting COVID-19 is 98% efficient. $\boxed{0.98}$
- It also has a false-positive rate of 1%. $= 0.01$
- $\boxed{0.005}$ 0.5% of population is actually infected with COVID-19.

No Sir $P(T/I^c)$

Suppose your Lab test results +ve, find the probability that you are actually infected with COVID-19.

I^c/T Given

$P(I) = ?$

You are actual Infected $= I$ Lab Test Result is +ve $= T$

$= 1 - .005$

$= .995$

$P(T/I) = 0.98$ $P(I) = .005$ $\boxed{P(T/I^c) = 0.01}$

$P(I^c)$

$= 1 - P(I)$

$$\boxed{P(I/T)} = \frac{\overset{0.98}{P(T/I)}\ \overset{.005}{P(I)}}{P(T)}$$

Prior

$$P(T) = P(T \cap I) + P(T \cap I^c)$$

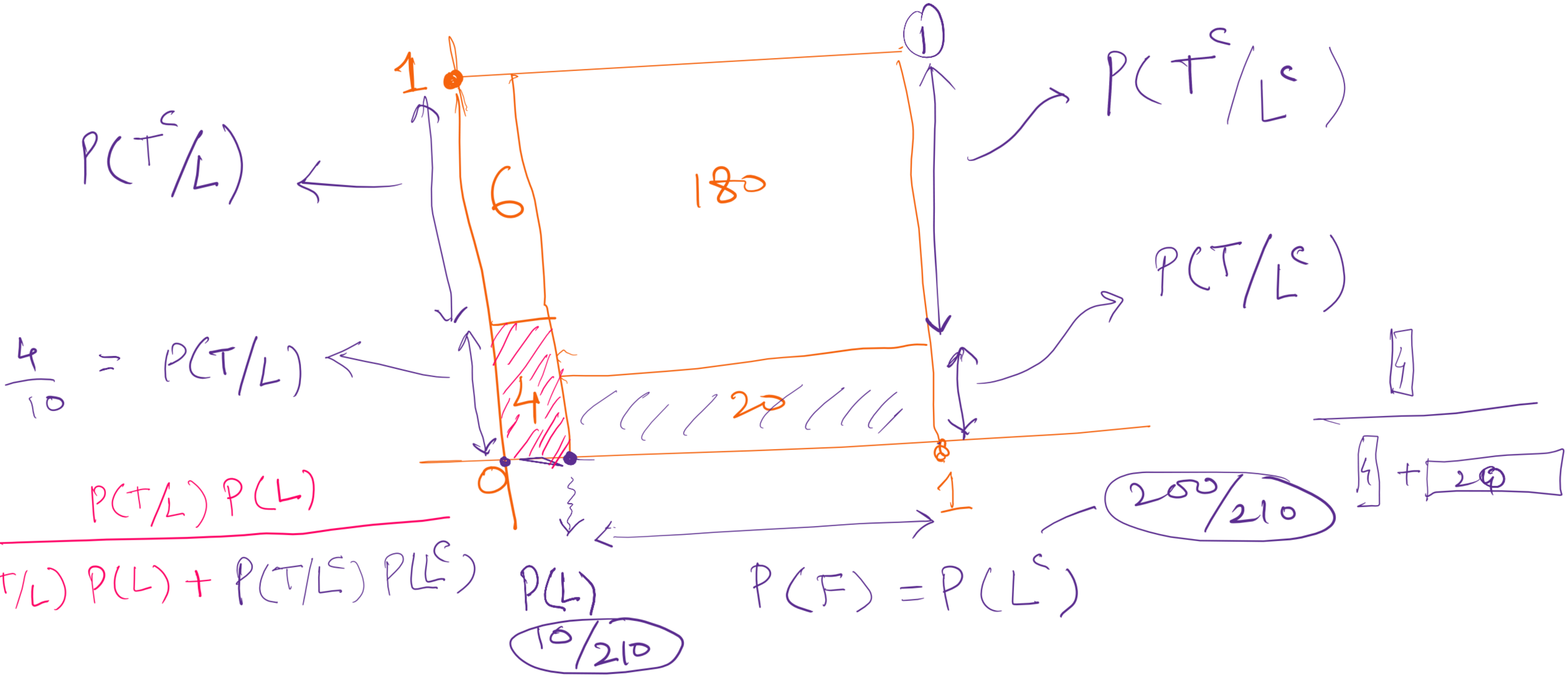
$$P(T) = P(T/I)P(I) + P(T/I^c)P(I^c)$$

$$= (0.98)(.005) + (0.01)(.995)$$

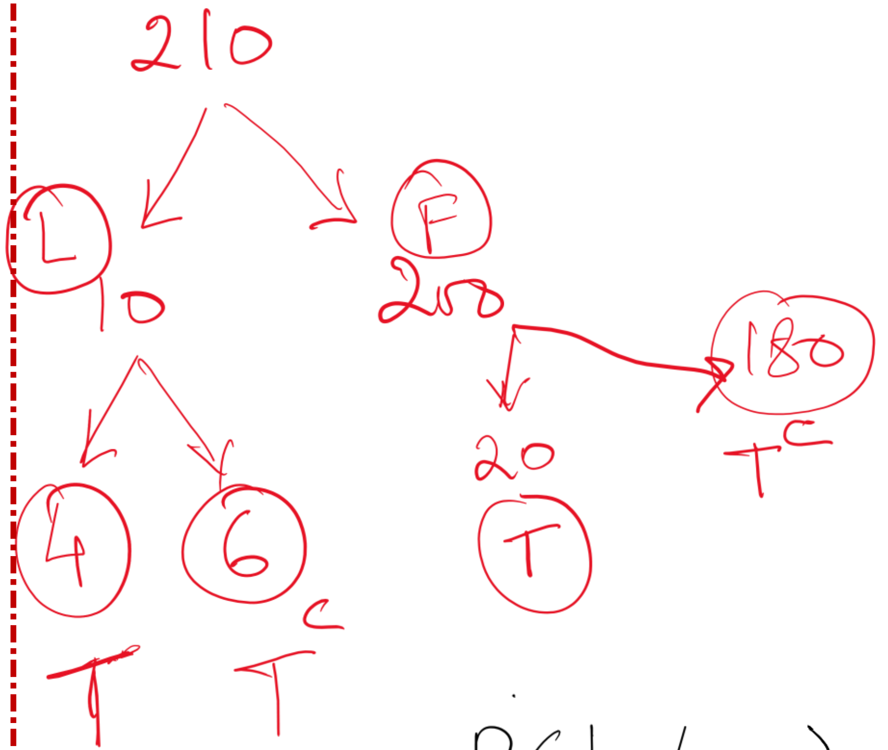
$$\boxed{0.33} = \frac{(0.98)(.005)}{(.98)(.005) + (.01)(.995)}$$

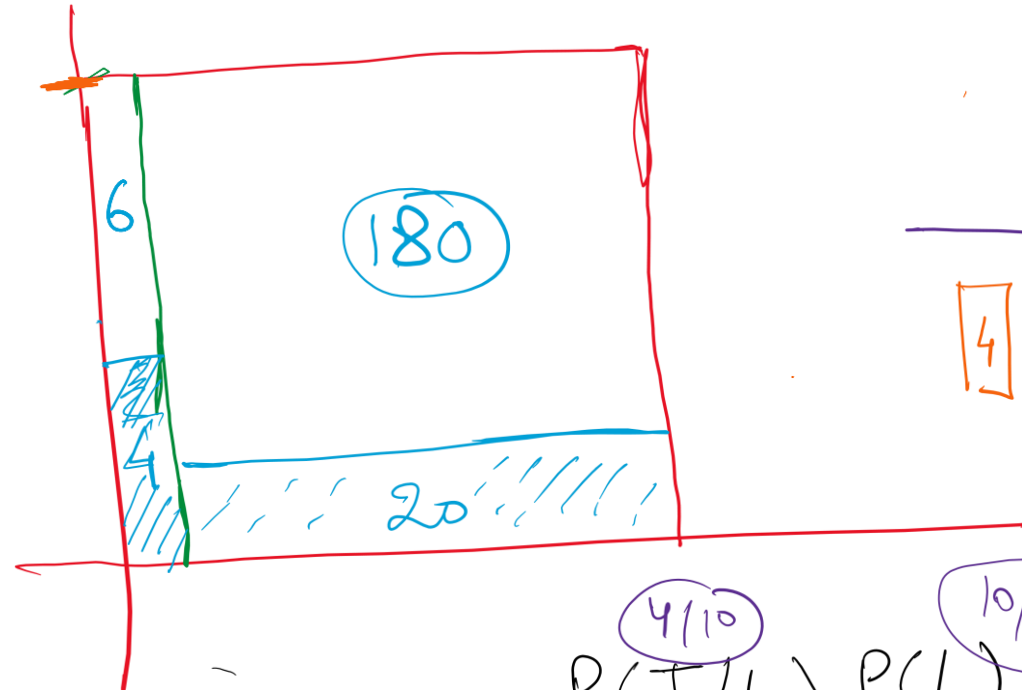
Librarian ~ Farmers ~ Tidy ~ Untidy

Example from Youtube Video



$$\frac{P(T/L)\,P(L)}{P(T/L)\,P(L) + P(T/L^c)\,P(L^c)}$$





$$\frac{\boxed{4}}{\boxed{4} + \boxed{20}}$$

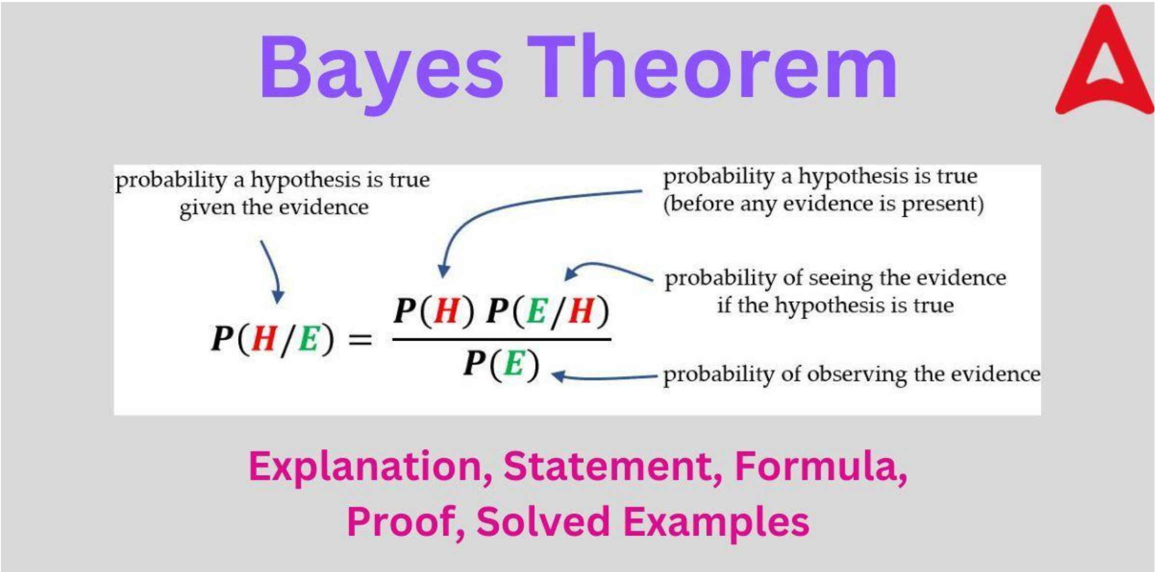
$$P(L/T) = \frac{4}{24} = \frac{4}{4+20} = \frac{\overset{4/10}{P(T/L)}\,\overset{10/210}{P(L)}}{\underbrace{P(T/L)}_{4/10}\,\underbrace{P(L)}_{10/210} + \underbrace{P(T/L^c)}_{20/200}\,\underbrace{P(L^c)}_{200/210}}$$

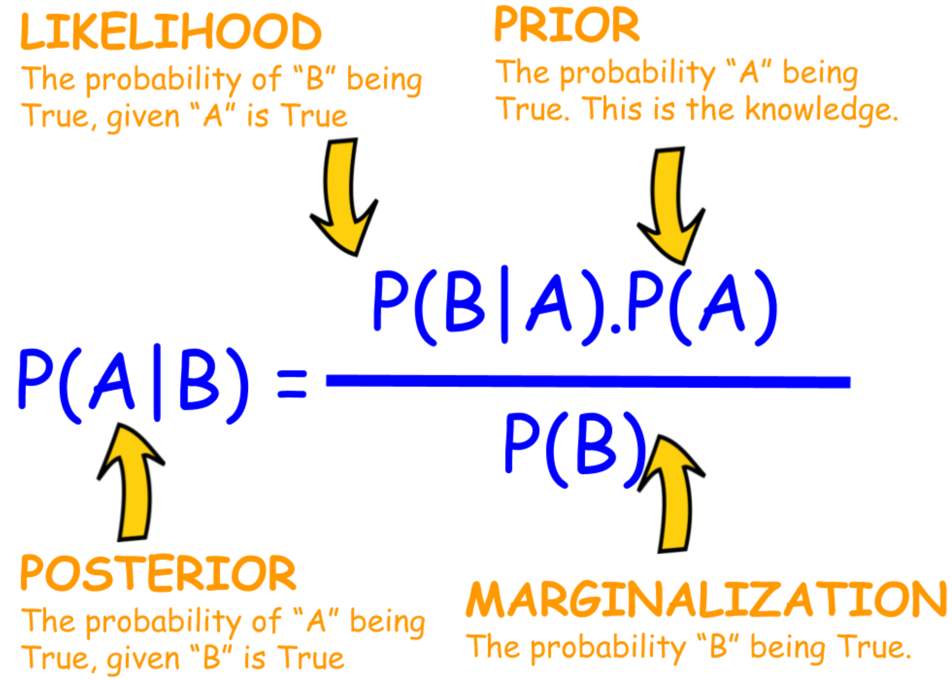
- 60% of all email in 2016 is spam. $P(S) = 0.6$, $P(S^c) = 0.4$
- 20% of spam has the word "Dear" $P(D/S) = 0.2$
- 1% of non-spam (aka ham) has the word "Dear" $\rightarrow$ $P(D|S^c) = 0.01$

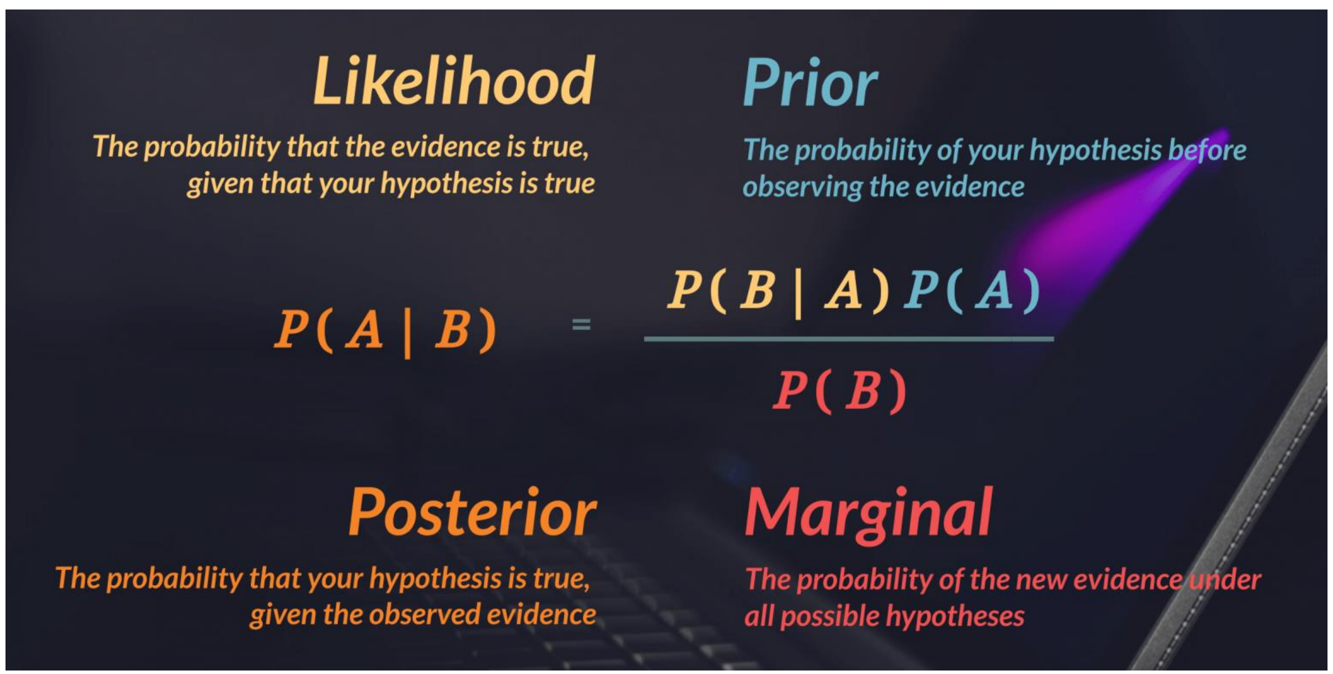
You get an email with the word "Dear" in it.
What is the probability that the email is spam? $\rightarrow$ $P(S|D) = ?$

$$P(S|D) = \frac{P(D/S)\,P(S)}{P(D/S)\,P(S) + P(D/S^c)\,P(S^c)} = \frac{(0.2)(0.6)}{(0.2)(0.6) + (.01)(.4)} = \frac{0.12}{0.12 + .04}$$

$$= \frac{0.12}{0.124} = 0.96 = 96\%$$


Bayes Theorem
probability a hypothesis is true given the evidence
probability a hypothesis is true (before any evidence is present)
probability of seeing the evidence if the hypothesis is true
P(H/E) = P(H) P(E/H) / P(E)
probability of observing the evidence
Explanation, Statement, Formula, Proof, Solved Examples


LIKELIHOOD
The probability of "B" being True, given "A" is True
PRIOR
The probability "A" being True. This is the knowledge.
P(A|B) = P(B|A).P(A) / P(B)
POSTERIOR
The probability of "A" being True, given "B" is True
MARGINALIZATION
The probability "B" being True.


Likelihood
The probability that the evidence is true, given that your hypothesis is true
Prior
The probability of your hypothesis before observing the evidence
P(A | B) = P(B | A) P(A) / P(B)
Posterior
The probability that your hypothesis is true, given the observed evidence
Marginal
The probability of the new evidence under all possible hypotheses