Bayes Theorem

In probability theory and statistics, Bayes' theorem (alternatively Bayes' law or Bayes' rule; recently Bayes) named after Thomas Bayes, describes the probability of an event, based on prior knowledge of conditions that might be related to the event

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$$P(A \mid B) = \frac{P(B \mid A)P(A)}{P(B)}$$

A & B: events

 $P(A \mid B)$: the probability of event A occurring given that B is true. It is also called the posterior probability of A given B

 $P(B \mid A)$: the probability of event B occurring given that A is true. It can also be interpreted as the likelihood of A given a fixed B

P(A) and P(B) are the probabilities of observing A and B respectively without any given conditions; they are known as the marginal probability or prior probability.

exemple:

below is a statistic table of clothing shop, the owner get cloths from 2 factory fact A & Fact B

	FACT A	FACT B	total
Shirt	65	55	120
trousers	72	25	97
jacket	44	52	96
chapeau	21	23	44
			357

P(SHIRT) All shirt / ALL cloth
P(A | SHIRT) = Shirt Fact A / ALL Shirt
P(B | SHIRT) = Shirt Fact B / ALL Shirt
same way with trousers jacket chapeau.........

$$P(A) = P(A \mid SHIRT) * P(SHIRT) + P(A \mid trousers) * P(trousers) + \dots$$

 $P(B) = P(B \mid SHIRT) * P(SHIRT) + P(B \mid trousers) * P(trousers) + \dots$

computing.....

FACT A:

$$P(SHIRT) = 120/357 = 0.336$$
 $P(trousers) = 97/357 = 0.271$ $P(jacket) = 96/357 = 0.268$ $P(chapeau) = 44/357 = 0.123$

$$P(A \mid SHIRT) = 65/120 = 0.541$$
 $P(A \mid trousers) = 72/96 = 0.75$ $P(A \mid jacket) = 44/96 = 0.485$ $P(A \mid chapeau) = 21/44 = 0.477$

$$P(A) = (0.547*0.336) + (0.75*0.271) + (0.485*0.268) + (0.477*0.123)$$

$$P(A) = 0.1837 + 0.2032 + 0.1299 + 0.0586 = 0.5754$$

FACT B:

$$P(SHIRT) = 120/357 = 0.336$$
 $P(trousers) = 97/357 = 0.271$ $P(jacket) = 96/357 = 0.268$ $P(chapeau) = 44/357 = 0.123$

$$P(B) = (0.336*0.458) + (0.257*0.271) + (0.541*0.268) + (0.123*0.522)$$

$$P(B) = 0.1538 + 0.0696 + 0.1449 + 0.0642 = 0.4325$$

P(A) > P(B) ... that means .. cloth from factory A is most wanted that factory B

Price	Buyers	Sellers	1
50	70%	30%	100
60	68 %	32%	100
80	38%	62%	100
90	55%	45%	100
	•		400

$$P(P50) = 100 / 400 = 0.25$$

 $P(B \mid P50) = 70 / 100 = 0.7$ $P(S \mid P50) = 30 / 100 = 0.3$

$$P(P60) = 100 / 400 = 0.25$$

 $P(B \mid P60) = 68 / 100 = 0.68$ $P(S \mid P60) = 32 / 100 = 0.32$

$$P(P80) = 100 / 400 = 0.25$$

 $P(B \mid P80) = 38 / 100 = 0.38$ $P(S \mid P80) = 62 / 100 = 0.62$

$$P(B) = (0.7 * 0.25) + (0.68 * 0.7) + (0.7 * 0.38) + (0.7 * 0.55)$$

 $P(B) = 0.175 + 0.476 + 0.266 + 0.385 = 1,302$

$$P(S) = (0.7 * 0.3) + (0.7 * 0.32) + (0.7 * 0.62) + (0.7 * 0.45)$$

 $P(S) = 0.21 + 0.224 + 0.434 + 0.315 = 1.183$

P(B) > P(S) thats means Buyers dominate the market

	Temperature	02	CO2	rate
Test 1	20	20	2	bad res
Test2	30	21	11	good res
Test3	35	22	10	very gd res
Test4	40	18	14	good res
Test5	45	11	21	bad res
Test6	50	30	4	very bad res
Test7	60	22	14	very bad res
	280	144	76	

500

Predict The rate of the following parameter:

parameter 01:

temp = 38

O2 = 4

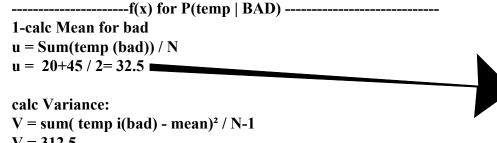
Co2 = 5

to define the rate ..we have to Calcul the Propability density Function of every parametre , we have 4 class

bad, good, very good, very bad

lets start with first class: (BAD)

	$(x-\mu)^2$
$f(x) = \frac{1}{\sqrt{2}}e^{-x}$	$2\sigma^2$
$\sigma\sqrt{2\pi}$	



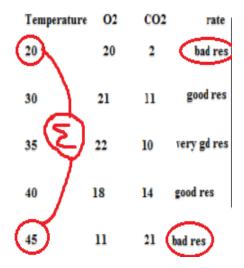
V = 312.5Sigma = squart root(V) = 17.67767

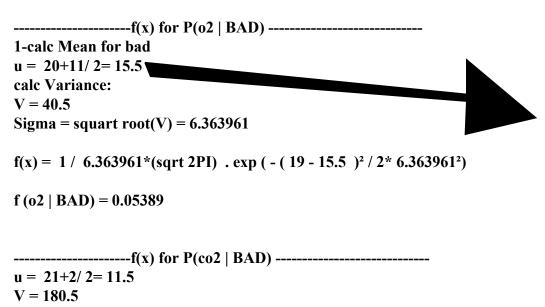
 $f(x) = 1 / Sigma*(sqrt 2PI) . exp(-(temp_param1 - u)^2 / 2* sigma^2)$

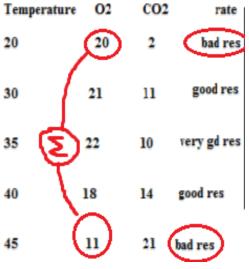
 $f(x) = 1 / 17.67767*(sqrt 2PI) . exp(-(38-32.5)^2/2*17.67767^2)$

f (temp | BAD) = 0.02150

Sigma = 13.435029f (co2 | BAD) = 0.02641







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-----calc Propability of BAD:
P(BAD) = BAD count / All rate
P(bad) = 2 / 7 = 0.28
P(bad \mid param1) = P(temp \mid BAD) *P(bad) + P(o2 \mid BAD) *P(bad) + P(co2 \mid BAD) *P(bad)
                                       0.05389 * 0.28 + 0.02641 * 0.28
P(bad | param1) = 0.02150 * 0.28 +
P(bad | param1) = 0.00602 + 0.015064 + 0.073948 = 0.095028
second class: (GOOD)
-----f(x) for P(temp | good) ------
u = Sum(temp (good)) / N
u = 30+40/2=35
calc Variance:
V = sum(temp i(good) - mean)^2 / N-1 V = 50
Sigma = squart root(V) = 7.0710678
f (temp | good) = 0.05156
  -----f(x) for P(o2 | good) ------
u = 21+18/2 = 19.5
calc Variance:
V = 4.5
Sigma = squart root(V) = 2.1213203
f(o2 \mid good) = 0.18291
   -----f(x) for P(co2 | good) -----
u = 11+14/2=12.5
V = 4.5
Sigma = 2.1213203
f(co2 \mid good) = 0.00036
-----calc Propability of good:
P(good) = good count / All rate
P(bad) = 2 / 7 = 0.28
P(good \mid param1) = P(temp \mid good) *P(good) + P(o2 \mid BAD) *P(good) + P(co2 \mid good) *P(good)
P(good | param1) = 0.05156 * 0.28 +
                                       0.18291 * 0.28 + 0.00036 * 0.28
P(good | param1) = 0.144368 + 0.0512148 + 0.0001008 = 0.1956836
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third class: (very good) u = Sum(temp (very good)) / N μ Paramètre de position u = 35/1 = 35(réel) calc Variance: b>0 Paramètre V = 0d'échelle (réel) Sigma = squart root(V) = 0f (temp | very good) = 0 $x \in (-\infty; +\infty)$ Correction $\frac{1}{2b} \exp\left(-\frac{|x-\mu|}{b}\right)$ x = (38) $f \text{ (temp | very good)} = 1/2 \exp(-3)$ f (temp | very good) = 0.02489-----f(x) for P(o2 | very good) -----u = 22/1 = 22calc Variance: V = 0Sigma = squart root(V) = 0 $f(o2 \mid very good) = 0$ x = (19)f(o2 | very good) = 1/2 exp(-3)f(o2 | very good) = 0.02489-----f(x) for P(co2 | very good) -----u = 10/1 = 10V = 0Sigma = 0f(co2 | very good) = 0.00036

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x= (19)
f (co2 | very good) = 1/2 exp(- 9)
f (co2 | very good) = 0.0001234098

-------calc Propability of good:
P(very good) = very good count / All rate
P(bad) = 1 / 7 = 0.1428
P(v good | param1) = P(co2 | vgood) *P(vgood) + P(co2 | vgood) *P(vgood) + P(co2 | vgood) *P(vgood)
P(very good | param1) = 0.02489 * 0.1428 + 0.0001234098 * 0.1428
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 $P(\text{very good} \mid \text{param1}) = 0.003554292 + 0.003554292 + 0.00001762291944 = 0.0071262$

fourth class: (very bad) u = Sum(temp (very bad)) / N

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V = 50
Sigma = squart root(V) =7.0710678
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 $f (temp \mid very bad) = 0.00314$

-----f(x) for P(o2 | very bad) ------

u = 30/22 = 26

u = 50/60 = 55 calc Variance:

calc Variance:

V = 32

Sigma = squart root(V) = 5.6568542

 $f(o2 \mid very bad) = 0.03280$

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-----f(x) for P(co2 | very bad) ------
u = 4/14=9
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u = 4/14 = 9V = 50

Sigma = 7.0710678

f(co2 | very bad) = 0.04808

-----calc Propability of good:

P(very bad) = very bad count / All rate

P(very bad) = 2 / 7 = 0.28

P(v bad | param1) = P(co2 | vbad) *P(vbad) + P(co2 | vbad) *P(vbad) + P(co2 | vbad) *P(vbad)

 $P(\text{very bad} \mid \text{param1}) = 0.00314 * 0.28 + 0.03280 * 0.28 + 0.04808 * 0.28$

 $P(\text{very good} \mid \text{param1}) = 0.0008792 + 0.009184 + 0.0134624 = 0.0071262 = 0.0235256$

P(bad | param1) = 0,095028 P(good | param1) = 0,1956836 P(very good | param1) = 0,0071262 P(very good | param1) = 0,0235256

Param 01 : temp= 38 O2=19 CO2=5 classified in (Good)