

$\frac{1}{2} \left[ \left( \frac{20}{100} \right) \left( \frac{20}{100} \right) - \left( \frac{20}{100} \right) \left( \frac{20}{100} \right) \right]$   
 $\frac{1}{2} \left[ \left( \frac{20}{100} \right) \left( \frac{20}{100} \right) - \left( \frac{20}{100} \right) \left( \frac{20}{100} \right) \right]$

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HW - 3

CSCF 5380

02)

$x_1$     $x_2$   
 $\frac{1}{2}$   
 $0$   
 $0$

Total posit  
 Total, neg

②, p

$p$   
 $x_1$   
 $x_2$   
 $x_3$

$$① P(S|G) = 0.45\%$$

$$P(S|G) = 0.25\%$$

$$P(G) = 1/5 = 0.25$$

$$P(UG) = 0.8$$

$$P(G|S) = P(G \cap S) / P(S)$$

$$\text{and } P(G \cap S) = P(G) \cdot P(S)$$

$$= 0.2 \times 0.25 = 0.05$$

$$P(S) = (0.2 \times 0.25) + (0.8 \times 0.15) = 0.17$$

$$P(G|S) = 0.05 / 0.17 = 0.294$$

$$\rightarrow 29.4\%$$

independent.

②

$x_1$	$x_2$	$x_3$	+ve	-ve
1	1	1	20	8
1	0	0	20	17
0	1	0	5	8
0	0	0	5	17
			50	50

$$E80.0 = \frac{2}{50} =$$

Consider  $x_1$  &  $x_2$  only

$x_1$	$x_2$
1	1
1	0
0	1
0	0

(+ | -ve = not selected)

$$E80.0 = \frac{+ve - case}{50} =$$

	1	0
1	20/50	20/50
0	5/50	5/50

$$E80.0 \times E80.0 =$$

$$P(x_1=1 \cap x_2=1) = \frac{20}{50} = 0.4$$

$$P(x_1=1 \cap x_2=0) = \frac{20}{50} = 0.4$$

$$P(x_1=0 \cap x_2=1) = \frac{5}{50} = 0.1$$

$$P(x_1=0 \cap x_2=0) = \frac{5}{50} = 0.1$$

$$P(X_1=1) = \frac{20+20}{50} = \frac{40}{50} = 0.8$$

$$P(X_1=0) = \frac{5+5}{50} = 0.2$$

$$P(X_2=1) = \frac{20+5}{50} = 0.5$$

$$P(X_2=0) = \frac{20+5}{50} = 0.5$$

$$\text{Variance} = \frac{25}{2} \times \frac{0.1}{2} = (1-x) \cdot (0-x)$$

$$P(X_1=1, X_2=1) = \frac{8}{50} = 0.16$$

1	0
0.16	0.34
0.16	0.34
0	0

$$P(X_1=1, X_2=1) = \frac{8}{50} = 0.16$$

$$P(X_1=1, X_2=0) = \frac{17}{50} = 0.34$$

$$P(X_1=0, X_2=1) = \frac{4}{50} = 0.08$$

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$$P(X_1=0, X_2=0) = \frac{17}{50} = 0.34$$



Calculation  ~~$P(A \cap B)$~~  =  $P(X_1=1) P(X_2=1)$

$$\rightarrow \frac{40}{50} \times \frac{25}{50} = \frac{4}{5}$$

$$\rightarrow P(X_1=1) P(X_2=0) = \frac{40}{50} \times \frac{25}{50} = \frac{2}{5}$$

$$P(X_1=0) \cdot P(X_2=1) = \frac{10}{50} \times \frac{25}{50} = \frac{1}{10}$$

$$P(X_1=0) \cdot P(X_2=0) = \frac{10}{50} \times \frac{25}{50} = \frac{1}{10}$$

In case +ve

$$\rightarrow P(X_1 \cap X_2) = P(X_1) \cdot P(X_2) \text{ for any value}$$

0 or 1

Case -ve

$$P(X_1=1) P(X_2=1) = \frac{25}{50} \times \frac{16}{50} = \frac{8}{50}$$

$$P(X_1=1) P(X_2=0) = \frac{25}{50} + \frac{34}{50} = \frac{17}{50}$$

$$P(X_1=0) P(X_2=1) = \frac{16}{50} + \frac{18}{50} = \frac{9}{50}$$

$$P(X_1=0) P(X_2=0) = \frac{25}{50} + \frac{34}{50} = \frac{17}{50}$$

$$P(X_1 \cap X_2) = P(X_1) \cdot P(X_2)$$

$X_1$  and  $X_2$   
Each other

(3)

$x_1$	$x_2$	$x_1$	$x_2$	$x_1$	$x_2$
1	1	0	0	0	0
1	2	0	1	0	0
2	1	0	0	0	0
2	2	0	0	0	0

$x_1$  and  $x_2$  are independent of each other

$$\begin{aligned}
 8.0 &= 02/04 = (+/1 = +)9 \\
 2.0 &= 02/25 = (-/1 = +)9 \\
 2.0 &= 2/28 = (+/1 = +)9 \\
 18.0 &= 02/21 = (-/1 = +)9 \\
 4.0 &= 2/05 = (+/1 = +)9 \\
 4.0 &= 2/9 = (-/1 = +)9
 \end{aligned}$$

$$1 = 1 \quad 1 = 1 \quad 1 = 1 \quad (1)$$

$$(+/1 = +)9 \times (+/1 = +)9 \times (+/1 = +)9 = (+/1 = +)9$$

$$8.0 \times 2.0 \times 2.0 = 21.0$$

$$\begin{aligned}
 &= 1/10 \\
 &= 1/10 \\
 &= 1/10 \\
 &= 17/50 \\
 &= 9/50 \\
 &= 34/50 = 17/25
 \end{aligned}$$

③

$x_1$	$x_2$	$x_3$	+	-
1	1	1	20	8
1	1	0	20	17
1	0	0	5	8
0	1	0	5	17
0	0	0	5	

$$P(x_1=1|+) = 40/50 = 0.8$$

$$P(x_1=1|-) = 25/50 = 0.5$$

$$P(x_2=1|+) = 25/50 = 0.5$$

$$P(x_2=1|-) = 16/50 = 0.32$$

$$P(x_3=1|+) = 20/50 = 0.4$$

$$P(x_3=1|-) = 9/50 = 0.18$$

(i)  $x_1=1 \quad x_2=1 \quad x_3=1$

$$P(x|+) =$$

$$P(x_1=1|+) \times P(x_2=1|+) \times P(x_3=1|+)$$

$$0.8 \times 0.5 \times 0.4$$

$$= 0.16$$

$$P(x_1=0|+) = 10/50$$

$$P(x_1=0|-) = 25/50$$

$$P(x_2=0|+) = 25/50$$

$$P(x_2=0|-) = 34/50$$

$$P(x_3=0|+) = 30/50$$

$$P(x_3=0|-) = 41/50$$

$$P(x_1=1, x_2=1, x_3=1) = 0.16$$

$$P(x_1=1, x_2=1, x_3=0) = 0.16$$

$$P(x_1=1, x_2=0, x_3=1) = 0.08$$

$$P(x_1=1, x_2=0, x_3=0) = 0.08$$

$$P(x_1=0, x_2=1, x_3=1) = 0.08$$

$$P(x_1=0, x_2=1, x_3=0) = 0.16$$

$$P(x_1=0, x_2=0, x_3=1) = 0.08$$

$$P(x_1=0, x_2=0, x_3=0) = 0.16$$

$$P(x_1 = 0 | +) = 10/50 = 0.2$$

$$P(x_1 = 0 | -) = 25/50 = 0.5$$

$$P(x_2 = 0 | +) = 25/50 = 0.5$$

$$P(x_2 = 0 | -) = 34/50 = 0.68$$

$$P(x_3 = 0 | +) = 30/50 = 0.6$$

$$P(x_3 = 0 | -) = 42/50 = 0.84$$

$$P(x | -) =$$

$$P(x_1 = 1 | -) \times P(x_2 = 1 | -) \times P(x_3 = 1 | -)$$

$$= 0.5 \times 0.32 \times 0.16$$

$$P(+ | x) = P(+)$$

$$P(- | x) = P(-)$$

$$\therefore P(+ | x) > P(- | x)$$

Class is positive +





(ii)  $x_1 = 1, x_2 = 0, x_3 = 0$

$$P(x|+) = P(x_1=1|+) \cdot P(x_2=0|+) \cdot P(x_3=0|+)$$

$$= 0.8 \times 0.5 \times 0.6 = 0.24$$

$$P(x|+) = 0.24$$

$$P(+|x) = P(+). P(x|+)$$

$$= 0.5 \times 0.24 = 0.12$$

$$P(x|-) = P(x_1=1|-) \cdot P(x_2=0|-) \cdot P(x_3=0|-)$$

$$= 0.5 \times 0.68 \times 0.84 = 0.2856$$

$$P(-|x) = P(-) \cdot P(x|-) = 0.5 \times 0.2856 = 0.1428$$

$P(-|x) > P(+|x)$   
class = -

$(1, 0, 0) \rightarrow$  class = -

(iii)  $x_1 = 0, x_2 = 1, x_3 = 0$

$$P(x|+) = P(x_1=0|+) \cdot P(x_2=1|+) \cdot P(x_3=0|+)$$

$$= 0.2 \times 0.5 \times 0.6 = 0.06$$

$$P(+|x) = P(+). P(x|+)$$

$$P(x|-) = P(x_1=0|-) \cdot P(x_2=1|-) \cdot P(x_3=0|-)$$

$$P(-|x) = P(-) \cdot P(x|-)$$

$P(-|x) > P(+|x)$   
class = -

(iv)  $x_1 = 0, x_2 = 1, x_3 = 1$

$$P(x|+) = P(x_1=0|+) \cdot P(x_2=1|+) \cdot P(x_3=1|+)$$

$$= 0.2 \times 0.5 \times 0.4 = 0.04$$

$$P(+|x) = P(+). P(x|+)$$

$$P(x|-) = P(x_1=0|-) \cdot P(x_2=1|-) \cdot P(x_3=1|-)$$

$$P(-|x) = P(-) \cdot P(x|-)$$

$$(iii) x_1 = 0, x_2 = 1, x_3 = 0$$

$$P(x|+) = P(x_1=0|+) \times P(x_2=1|+) \times P(x_3=0|+)$$

$$= 0.2 \times 0.5 \times 0.6 = 0.06$$

$$P(+|x) = P(+). P(x|+) = 0.5 \times 0.06 = 0.03$$

$$P(x|-) = P(x_1=0|-) \times P(x_2=1|-) \times P(x_3=0|-)$$

$$= 0.5 \times 0.32 \times 0.84 = 0.1344$$

$$P(-|x) = \frac{P(-) \cdot P(x|-)}{P(-) \cdot P(x|-) + P(+|x)} = \frac{0.5 \times 0.1344}{0.5 \times 0.1344 + 0.03} = 0.81$$

$$P(-|x) > P(+|x) \quad \text{Class } -$$

$$(0, 1, 0) \rightarrow \text{Class } -$$

$$(iv) x_1 = 0, x_2 = 0, x_3 = 0$$

$$P(x|+) = P(x_1=0|+) \times P(x_2=0|+) \times P(x_3=0|+)$$

$$= 0.2 \times 0.5 \times 0.6 = 0.06$$

$$P(+|x) = P(+). P(x|+) = 0.5 \times 0.06 = 0.03$$

$$P(x|-) = P(x_1=0|-) \times P(x_2=0|-) \times P(x_3=0|-)$$

$$= 0.5 \times 0.6 \times 0.84 = 0.252$$

$$P(-|x) = \frac{P(-) \cdot P(x|-)}{P(-) \cdot P(x|-) + P(+|x)} = \frac{0.5 \times 0.252}{0.5 \times 0.252 + 0.03} = 0.88$$

$$P(-|x) > P(+|x) \quad \therefore \text{Class } -$$

$$x_1 \quad x_2 \quad x_3 \quad + \quad \text{predicted} = 10$$

$$(10 = 2x) \times (11 = x) \times (10 = x) \div 20 = 11.8$$

$$1 \quad 1 \quad 1$$

$$1 \quad 0 \quad 0$$

$$20.0 = 2.0 \times 2.0 \times 5.0 = 20$$

$$20.0 = 2.0 \times 2.0 \times 5.0 = (15) \times (8) \div 10 = (15 + 5)$$

$$(-10 = 2x) \times (-11 = x) \times (-10 = x) \div 20 = (-11.8)$$

$$20.0 = 2.0 \times 2.0 \times 5.0 =$$

$$\text{Error rate} = \frac{8 + 20 + 5 + 5}{100} = \frac{38}{100} = 0.38\%$$

error rate  $\rightarrow$  0.38 or 38%

$$0 = x \quad 0 = x \quad 0 = x$$

$$(10 = 2x) \times (10 = x) \times (10 = x) \div 20 = 10$$

$$20.0 = 2.0 \times 2.0 \times 5.0 =$$

$$20.0 = 2.0 \times 2.0 \times 5.0 = (15) \times (8) \div 10 = (15 + 5)$$

$$(-10 = 2x) \times (-11 = x) \times (-10 = x) \div 20 = (-11.8)$$

$$228.0 = 28.0 \times 2.0 \times 2.0 =$$

$$228.0 = 28.0 \times 2.0 \times 2.0 = (-11) \times (-3) \div 10 = (-11 - 3)$$



④

Accident	Weather	Construction		Count	P(+) = 25/60	P(-) = 35/60
		no	yes			
No	good	no	yes	5	10	20
No	good	no	yes	10	10	5
Yes	good	no	yes	10	5	5
Yes	bad	no	yes	5	0	0
Yes	bad	no	yes	5	0	0

$$P(\text{Accident} = \text{yes} | +) = \frac{25}{40} = 0.625$$

$$P(\text{Accident} = \text{yes} | -) = \frac{10}{60} = \frac{1}{6} = 0.16$$

$$P(\text{Weather} = \text{good} | +) = \frac{10+10+5}{40} = \frac{25}{40} = 0.625$$

$$P(\text{Weather} = \text{good} | -) = \frac{30+20+5}{60} = \frac{55}{60} = 0.91$$

$$P(\text{Construction} = \text{yes} | +) = \frac{15}{40} = 0.37$$

$$P(\text{Construction} = \text{yes} | -) = \frac{20}{60} = \frac{1}{3} = 0.33$$

$$150 \cdot 0 =$$



(b)  $P(\text{Accident} = \text{no} \mid \text{weather} = \text{bad}, \text{Construction} = \text{yes})$

$40\% = 0.4$  (Congestion)

$50\% = 0.5$  (no congestion)

(1) Congestion case

$P(\text{Accident} = \text{no} \mid +ve)$

$= \frac{15}{40} = 0.375$

$P(\text{weather} = \text{bad} \mid +) = \frac{15}{40} = 0.375$

$P(\text{Construction} = \text{yes} \mid +) = \frac{15}{40} = 0.375$

Using Bayes Theorem

$P(\text{no} \mid +, \text{no}, \text{bad}, \text{yes}) = 0.375 \times 0.375 \times 0.375 \times 0.4$

$= 0.021$

(ii) No Congestion case

$P(\text{Accident} = \text{no} \mid -ve)$

$= \frac{50}{60} = \frac{5}{6}$

$P(\text{weather} = \text{bad} \mid -ve) = \frac{5}{60}$

$P(\text{Construction} = \text{yes} \mid +) = \frac{20}{60}$

Bayes theorem

$P(-ve \mid \text{no}, \text{bad}, \text{yes}) = 0.83 \times 0.083$

$= 0$

$0.021$

→ There exists highway for po

(ii) No Congestion Case

$$P(\text{Accident} = \text{no} | -ve)$$

$$= \frac{50}{60} = \frac{5}{6} = 0.83$$

$$P(\text{weather} = \text{bad} | -ve)$$

$$= \frac{5}{60} = 0.083$$

$$P(\text{Construction} = \text{Yes} | +)$$

$$= \frac{20}{60} = 0.33$$

Bayes theorem

$$P(-ve | \text{no, bad, Yes})$$

$$= 0.83 \times 0.083 \times 0.33 \times 0.6$$

$$= 0.0136$$

$$0.0217 = 0.0136$$

→ There exists traffic Congestion on highway for particular day