HomeWork-2

Sushma Kudlur Nirvanappa
907981 3292

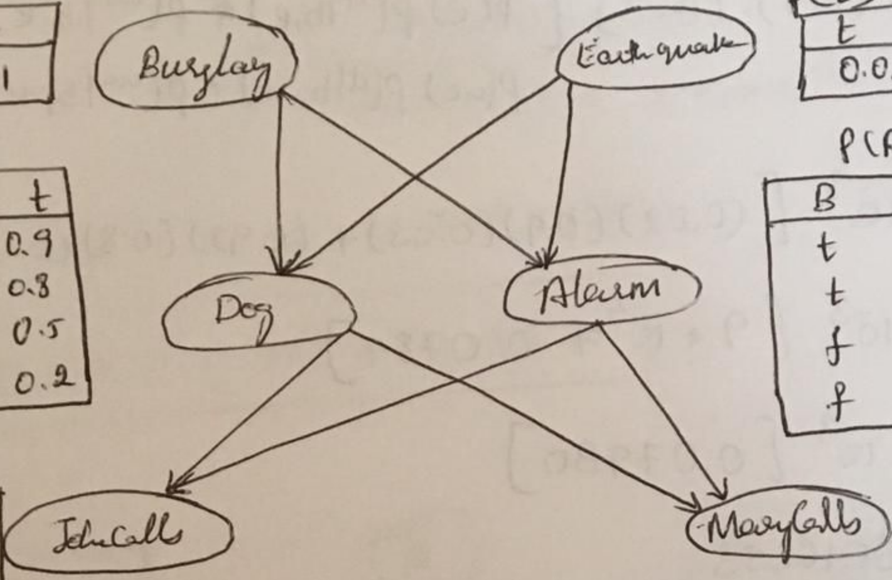
①

P(B)

t
0.01

P(E)

t
0.02



B	E	t
t	t	0.9
t	f	0.8
f	t	0.5
f	f	0.2

P(A)

B	E	t
t	t	0.95
t	f	0.9
f	t	0.3
f	f	0.01

P(J)

D	A	t
t	t	0.9
t	f	0.7
f	t	0.5
f	f	0.1

P(M)

D	A	t
t	t	0.7
t	f	0.3
f	t	0.4
f	f	0.2

Compute $p(d|b, \neg a, j, m)$.

$$\Rightarrow p(d|b,\neg a,j,m) = \frac{p(d,b,\neg a,j,m)}{p(b,\neg a,j,m)}$$

$$= \frac{p(d,b,\neg a,j,m)}{p(d,b,\neg a,j,m) + p(\neg d,b,\neg a,j,m)}$$

$$P(d,b,na,j,m) = \sum_{e,ne} P(b)\,P(E)\,P(d/b,E)\,P(na/b,E)\,P(j/na,d)\,P(m/na,d)$$

$$= P(b)\cdot P(j/na,d)\,P(m/na,d) \sum_{e,ne} P(E)\cdot P(d/b,E)\cdot P(na/b,E)$$

$$= (0.01)\cdot(0.7)\cdot(0.3)\left[\begin{array}{l} P(e)\,P(d/b,e) * P(na/b,e) + \\ P(ne)\,P(d/b,ne) * P(na/b,ne \end{array}\right]$$

$$= 2.1*10^{-3}\left[(0.02)(0.9)(0.05)+(0.98)(0.8)(0.1)\right]$$

$$= 2.1*10^{-3}\left[9*10^{-4}+0.0784\right]$$

$$= 2.1*10^{-3}\left[0.07930\right]$$

$$= 0.00016653$$

$$P(nd,b,na,j,m) = \sum_{e,ne} P(b)\,P(E)\,P(nd/b,E)\,P(na/b,E)\,P(j/na,nd)\,P(m/na,nd)$$

$$= P(b)\,P(j/na,nd)\,P(m/na,nd) \sum_{e,ne} P(E)\,P(nd/b,E)\,P(na/b,E)$$

$$= P(b)\,P(j/na,nd)\,P(m/na,nd)\left[\begin{array}{l} P(e)\,P(nd/b,e)\,P(na/b,e) + \\ P(ne)\,P(nd/b,ne)\,P(na/b,ne) \end{array}\right]$$

$$= (0.01)(0.1)(0.2)\left[\begin{array}{l} (0.02)\cdot(0.1)\cdot(0.05) + \\ (0.98)\cdot(0.2)\cdot(0.1) \end{array}\right]$$

$$= 2*10^{-4}\left[1*10^{-4}+0.0196\right]$$

$$= 2*10^{-4}\left[0.0196\right]$$

$$= 0.0394*10^{-4} = 3.94*10^{-6}$$

Now,

$$P(d \mid b, \sim a, j, m) = \frac{P(d, b, \sim a, j, m)}{P(d, b, \sim a, j, m) + P(\sim d, b, \sim a, j, m)}$$

$$= \frac{0.00016653}{0.00016653 + 3.94 \times 10^{-6}}$$

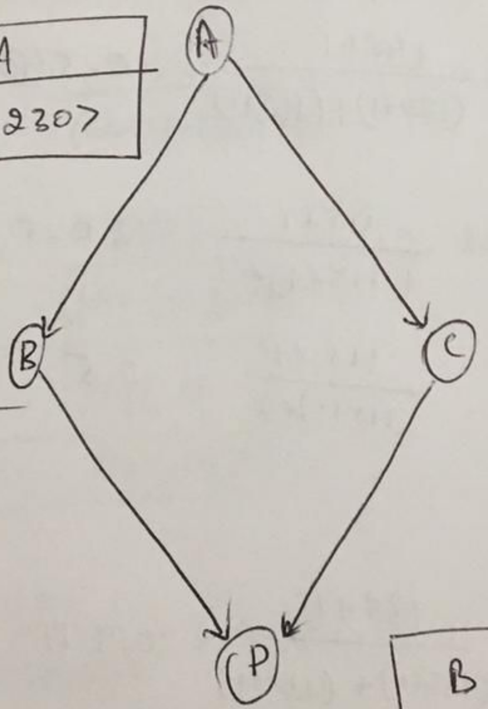
$$= 0.9768874$$

$$\boxed{P(d \mid b, \sim a, j, m) = 0.977}$$

(2)

(a)

A
<270, 230>



A	C/A
t	<138, 132>
f	<137, 93>

A	B/A
t	<122, 148>
f	<115, 115>

B	C	P/B,C
t	t	<66, 67>
t	f	<66, 38>
f	t	<64, 78>
f	f	<62, 59>

Computing Initial probability

A

<270, 230>

$$P_A(t) = \frac{270+1}{(270+1)+(230+1)} = 0.54$$

$$P_A(f) = \frac{230+1}{(270+1)+(230+1)} = 0.46$$

B

If $A = t$

$$P_B(t) = \frac{122+1}{(122+1)+(148+1)} = 0.452$$

$$P_B(f) = \frac{148+1}{(122+1)+(148+1)} = 0.548$$

If $A = f$

$$P_B(t) = \frac{115+1}{(115+1)*2} = 0.5$$

$$P_B(f) = \frac{115+1}{(115+1)*2} = 0.5$$

C

If $A = t$

$$P_C(t) = \frac{138+1}{(138+1)+(132+1)} = 0.511$$

$$P_C(f) = \frac{132+1}{(132+1)+(138+1)} = 0.489$$

If $A = f$

$$P_C(t) = \frac{137+1}{(137+1)+(93+1)} = 0.595$$

$$P_C(f) = \frac{93+1}{(137+1)+(93+1)} = 0.405$$

D

B	C	D|B,C
t	t	<66, 67>

$$P_D(t) = \frac{66+1}{(66+1)+(67+1)} = 0.496$$

$$P_D(f) = \frac{67+1}{(66+1)+(67+1)} = 0.504$$

B	C	D|B,C
t	f	<66, 38>

$$P_D(t) = \frac{66+1}{(66+1)+(38+1)} = 0.632$$

$$P_D(f) = \frac{38+1}{(66+1)+(38+1)} = 0.368$$

B	C	D|B,C
f	t	<64, 78>

$$P_D(t) = \frac{64+1}{(64+1)+(78+1)} = 0.451$$

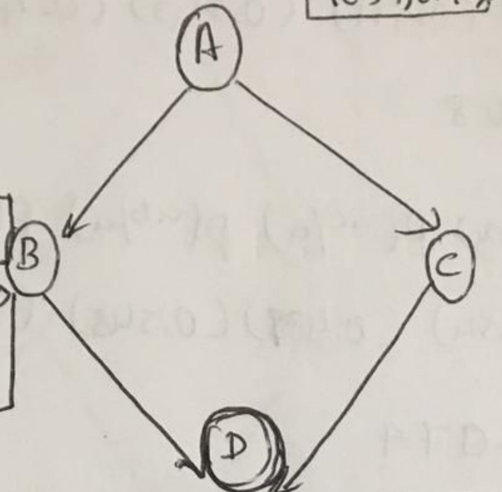
$$P_D(f) = \frac{78+1}{(64+1)+(78+1)} = 0.549$$

B	C	D|B,C
f	f	<62, 59>

$$P_D(t) = \frac{62+1}{(62+1)+(59+1)} = 0.512$$

$$P_D(f) = \frac{59+1}{(62+1)+(59+1)} = 0.488$$

A
$\langle 0.54, 0.46\rangle$



A	B/A
t	$\langle 0.452, 0.548\rangle$
f	$\langle 0.5, 0.5\rangle$

A	C/A
t	$\langle 0.511, 0.489\rangle$
f	$\langle 0.595, 0.405\rangle$

B	C	D/B,C
t	t	$\langle 0.496, 0.504\rangle$
t	f	$\langle 0.632, 0.368\rangle$
f	t	$\langle 0.451, 0.549\rangle$
f	f	$\langle 0.512, 0.488\rangle$

(2)(b) Given 10 new instance with A= true, B=false, d=true estimate C= ?

Let's ~~pred~~ calculate $P(C/a,\neg b,d)$ with existing conditional probability table

$$P(C/a,\neg b,d) = \frac{P(c,a,\neg b,d)}{P(a,\neg b,d)}$$

$$= \frac{P(c,a,\neg b,d)}{P(c,a,\neg b,d) + P(\neg c,a,\neg b,d)}$$

$$P(c, a, \neg b, d) = p(a)\, P(c|a)\, p(\neg b|a)\, P(d|\neg b, c)$$
$$= (0.54)(0.511)(0.548)(0.451)$$
$$= 0.068$$

$$P(\neg c, a, \neg b, d) = p(a)\, P(\neg c|a)\, p(\neg b|a)\, P(d|\neg b, \neg c)$$
$$= (0.54)(0.489)(0.548)(0.512)$$
$$= 0.074$$

so,
$$P(c|a, \neg b, d) = \frac{0.068}{0.068+0.074} = \underline{\underline{0.4788}} = \underline{\underline{0.479}}$$

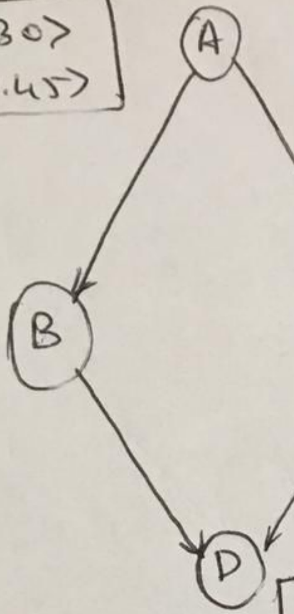
$$P(\neg c|a, \neg b, d) = \frac{0.074}{0.068+0.074} = \underline{\underline{0.5211}} = \underline{\underline{0.521}}$$

so, with 10 new instances added into the network,

$P_c(t) = 0.4788 * 10 = 4.788$
$P_c(f) = 0.5211 * 10 = 5.211$

are the new should added to the existing counts.

Hence the new conditional probability table after 1-iteration of E-M will be as shown below:

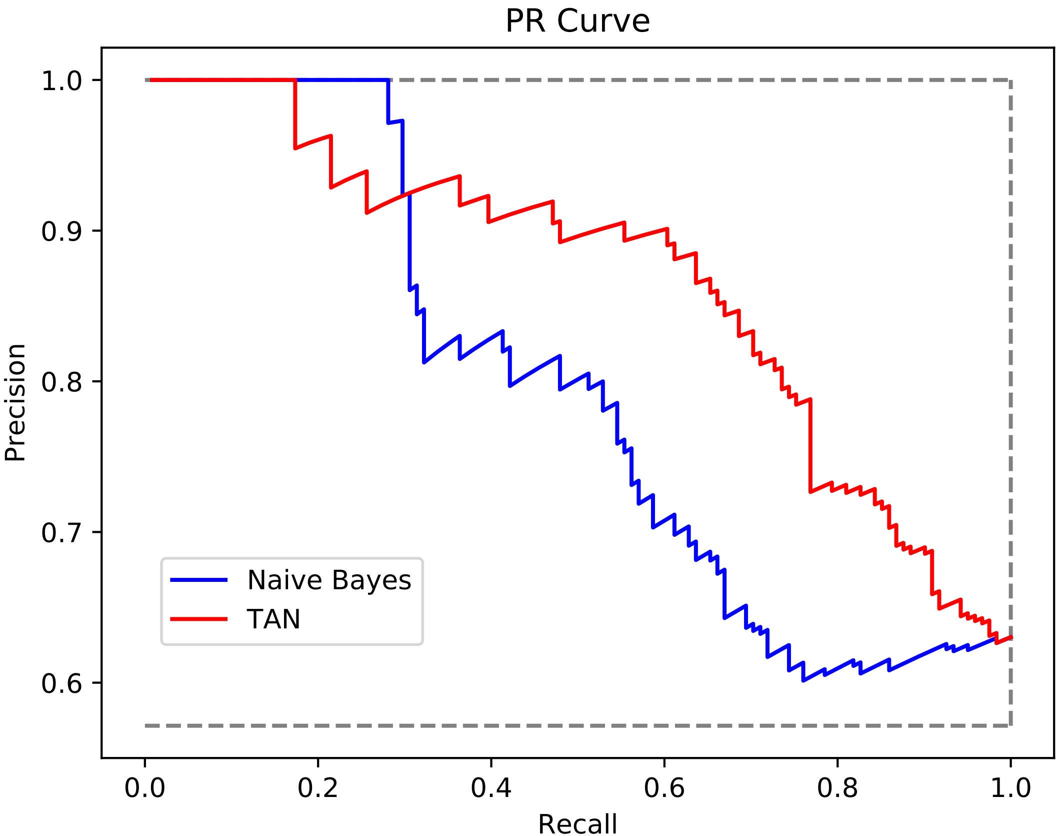


A
<280,230> <0.55,0.45>

A	B/A
t	<122,158> <0.436,0.564>
f	<115,115> <0.5,0.5>

A	~~A/C~~ C/A
t	<142.793, 137.207> <0.51, 0.490>
f	<137, 93> <0.595, 0.404>

B	C	D/B,C
t	t	<66,67> <0.496,0.503>
t	f	<66, 38> <0.632, 0.368>
f	t	<68.793, 78> <0.470, 0.530>
f	f	<67.207, 59> <0.532, 0.4[illegible]>



PR Curve
Precision
Recall
1.0
0.9
0.8
0.7
0.6
0.0
0.2
0.4
0.6
0.8
1.0
Naive Bayes
TAN

Part: 2

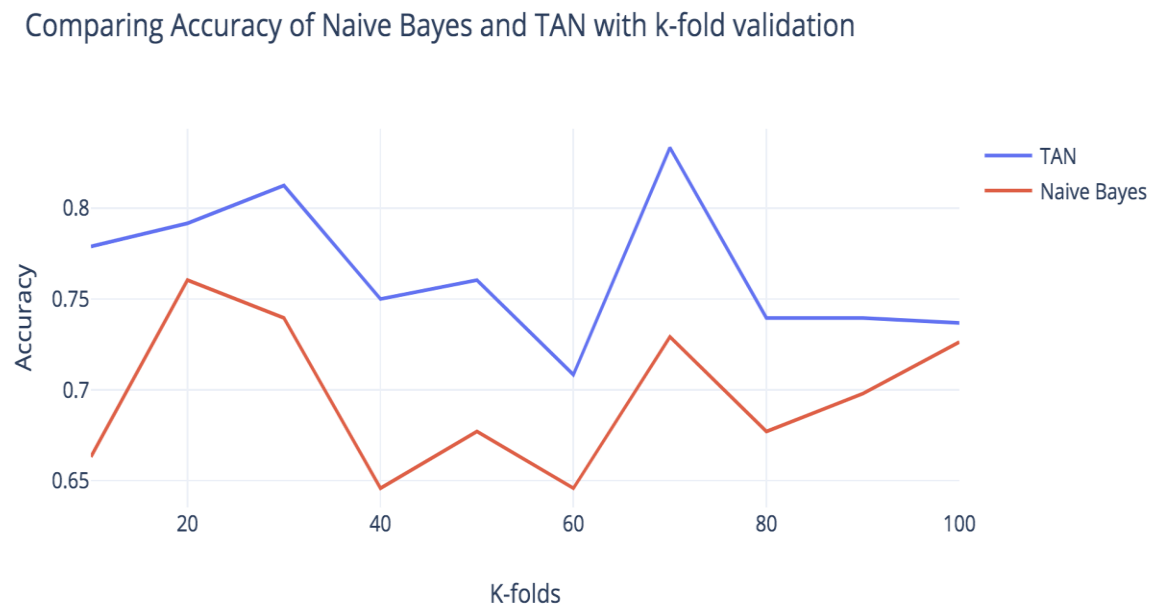
Precision-Recall curve:

We know that, a model with higher precision relates to low false positive rate and a model with higher recall relates to low false negative rate. In an idel case it is expected that a model has good recall as false negatives are more dangerous thet false positive (Ex: If an health check report is false negative, the patient may go untreated, which is about question of one's life). So, a model with higher recall & precision is always the best (not that precision being worst is fine, a good precision would still be expected).

After observing the P-R curve for both Naive-bayes & TAN, we can clearly see that TAN offered higher recall than Naive-bayes. Precision of TAN is comparitively better than Naive-bayes while we can see recall by TAN is substantially higher than Naive-bays. Hence TAN model is better and has more predictive power.

Thus a very high recall and better precision offered by TAN (compared with Naive bayes) makes it a more powerful predictive model.

Part-3



Calculated value:

Sample Mean : -0.06888157894736842

SD : 0.032494820478905485

t statistic : -6.703304560300331

P-value : 8.820443574104684e-05

Given Threshold: 0.05

In a statistical hypothesis test, a p-value would help us **to determine the significance of the result**. P-value is used to show if there is any significant difference between the systems. This offers a means to reject points to provide smallest level of significance at which the null hypothesis would be rejected. (NULL hypothesis: the hypothesis that there is no significant difference between specified populations). A small p-value (less than 0.05) suggests that null hypothesis is to be rejected while a large p-value (greater than 0.05) denotes that null hypothesis is to be accepted due to lack of counter proposition against it.

Here we see that the p-value is much smaller than 0.05. Hence **P-value helps us to show that there is a significant difference between the system.**