Tid	Refund	Marital Status	Taxable Income	Evade
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

Class - Refund
Marital status
Taxamble income.

$P(No) = 7/10$ $\quad P(Yes) = 3/10$

For discrete Attribute:

$P(Status = Married | No) = 4/7$ ✓ $\frac{4+1}{7+10}$

$P(Refund = Yes | Yes) = 0$

$P(Status = Married | Yes) = 0$ ✓ $0+1 / 3+10$

$P(Refund = No | Yes) = 3/3 = 1$

$P(Refund = Yes | No) = 3/7$ ✓

$P(Refund = No | No) = 4/7$

$P(status : Married ? Yes) = 0$

P(status = Married, Refund = NO, Income = 120K)

$$P(X \mid Class = No) = P(Status = Married \mid No) \times P(Refund = No \mid No) \times P(Income = 120K \mid No) \times P(No)$$

$$= 4/7 \times 4/7 \times 7.19 \times 10^{-3} \times 7/10$$

$$= 0.0024$$

$$P(X \mid Class = Yes) = P(Status = Married \mid Yes)\, P(Refund = No \mid Yes)\, P(Income = 120K \mid Yes) \times P(Y)$$

$$= 0 \times 1 \times 1.2 \times 10^{-9} \times 3/10$$

$$= 0$$

So, NO has the highest Probality, that's why the resulted class is no.

Taxable Income	Evade
125K	No
100K	No
70K	No
120K	No
95K	Yes
60K	No
220K	No
85K	Yes
75K	No
90K	Yes

$P(\text{Income} = 120 \mid \text{NO})$ NO

$$\mu = \frac{125 + 100 + 70 + 120 + 60 + 220 + 75}{7}$$

$= 110K$ ANO

$$\sigma^2 = \frac{(x-\mu)^2}{n-1}$$

$$= \frac{(125-110)^2 + (100-110)^2 + (70-110)^2 + (120-110)^2 + (60-110)^2 + (220-110)^2 + (75-110)^2}{7-1}$$

$= 2975$

$$P(\text{Income} = 120K \mid \text{No}) = \frac{1}{\sqrt{2\pi}\,\sigma} e^{-\frac{(x-\mu)^2}{2\sigma^2}}$$

$$= \frac{1}{\sqrt{2\pi} \times \sqrt{2975}} e^{-\frac{(120-110)^2}{2 \times 2975}}$$

$= 7.19 \times 10^{-3}$

$P(\text{Income} = 120K \mid \text{Yes}) = 1.2 \times 10^{-9}$

Name	Give Birth	Can Fly	Live in Water	Have Legs	Class	
human	yes	no	no	yes	mammals	1
python	no	no	no	no	non-mammals	1
salmon	no	no	yes	no	non-mammals	2
whale	yes	no	yes	no	mammals	2
frog	no	no	sometimes	yes	non-mammals	3
komodo	no	no	no	yes	non-mammals	4
bat	yes	yes	no	yes	mammals	3
pigeon	no	yes	no	yes	non-mammals	5
cat	yes	no	no	yes	mammals	4
leopard shark	yes	no	yes	no	non-mammals	6
turtle	no	no	sometimes	yes	non-mammals	7
penguin	no	no	sometimes	yes	non-mammals	8
porcupine	yes	no	no	yes	mammals	5
eel	no	no	yes	no	non-mammals	9
salamander	no	no	sometimes	yes	non-mammals	10
gila monster	no	no	no	yes	non-mammals	11
platypus	no	no	no	yes	mammals	6
owl	no	yes	no	yes	non-mammals	12
dolphin	yes	no	yes	no	mammals	7
eagle	no	yes	no	yes	non-mammals	13

Give Birth	Can Fly	Live in Water	Have Legs	Class
yes	no	yes	no	?

M → Mammals. N = Non mammals.

$P(M) = 7/20 \qquad P(N) = 13/20$

$P(B=Yes|M) = 6/7 \qquad P(L=Yes|M) = 2/7$

$P(B=Yes|N) = 1/13 \qquad P(L=Yes|N) = 3/13$

$P(C=No|M) = 6/7 \qquad P(H=no|M) = 2/7$

$P(C=No|N) = 10/13 \qquad P(H=no|N) = 4/13$

$$P(A|M) = P(B=Yes|M)\,P(C=No|M) \times P(L=Yes|M) \times P(H=No|M) \times P(M)$$

$$= 6/7 \times 6/7 \times 2/7 \times 2/7 \times 1/20$$

$$P(A|N)P(N) = P(B=Yes|N)\,P(C=No|N)\,P(L=Yes|N)\,P(H=No|N) \times P(N)$$

$$= 7/13 \times 10/13 \times 3/13 \times 4/13$$

Doc	I	loved	this	Hotel	Hated	A	Great	Bad	Service	Good	Class
1	1	1	1	1							+
2	1		1	1	1						-
3				2		1	1			1	+
4								1	1		-
5				1		1	1		1	1	+

Doc	I	loved	this	Hotel	Hated	A	Great	Bad	Service	Good	Class
1	1	1	1	1							+
3				2		1	1			1	+
5				1		1	1		1	1	+

smothed: $p(x_1 = T \mid Y = spam)$

$$= \frac{\text{frequent of } T \text{ in spam} + 1}{\text{total number of spam instances} + V}$$

$$P(w_k \mid +) = (n_k + 1) / (n + |vocal|)$$

$$P(I \mid +) = (1+1) / (14+10)$$

$$P(loved \mid +) = (1+1) / (14+10)$$

$$P(this \mid +) = (1+1) / (14+10)$$

$P(\text{Hotel} \mid t) = (4+1) / (14+10)$

$P(x1) = 0.60$ $\quad P(y1 \mid x1) = 0.40$ $\quad P(z1 \mid y1) = 0.25$ $\quad P(w1 \mid z1) = 0.45$

$P(y1 \mid x0) = 0.30$ $\quad P(z1 \mid y0) = 0.60$ $\quad P(w1 \mid z0) = 0.30$

$x \to y \to z \to w$

Random Variables, x, y, z, w

$P(x_1) = 0.60$	$P(x_0) = 0.40$
$P(y_1 \mid x_1) = 0.40$	$P(y_1 \mid x_0) = 0.30$
$P(z_1 \mid y_1) = 0.25$	$P(z_1 \mid y_0) = 0.60$
$P(w_1 \mid z_1) = 0.45$	$P(w_1 \mid z_0) = 0.30$
$P(y_1) = 0.36$	$P(y_0) = 0.64$
$P(z_1) = 0.474$	$P(z_0) = 0.526$
$P(w_1) = 0.37$	$P(w_0) = 0.63$

1) Compute $P(y_1)$, y is dependent on x

$$P(y_1) = \sum P(y_1|x) = P(y_1, x_1)\,P(x_1) + P(y_1, x_0)\,P(x_0)$$

$$= 0.4 \times 0.6 + 0.3 \times 0.4 \qquad = 0.36$$

$$P(z_1) = \sum P(z_1|y) = P(z_1, y_1)\,P(y_1) + P(z_1, y_0)\,P(y_0)$$

$$= 0.25 \times 0.36 + 0.60 \times 0.64$$

$$=$$

$$= 0.474$$

$$P(w_1) = \sum P(w_1|z) = P(w_1, z_1) \times P(z_1) + P(w_1, z_0)\,P(z_0)$$

$$= 0.45 \times 0.474 + 0.30 \times 0.526$$

$$= 0.374$$

$P(x1)=0.60$	$P(y1\mid x1)=0.40$	$P(z1\mid y1)=0.25$	$P(w1\mid z1)=0.45$
	$P(y1\mid x0)=0.30$	$P(z1\mid y0)=0.60$	$P(w1\mid z0)=0.30$
x	$\rightarrow y$	$\rightarrow z$	$\rightarrow w$
$P(x0)=0.40$	$P(y0\mid x1)=0.60$	$P(z0\mid y1)=0.75$	$P(w0\mid z1)=0.55$
	$P(y0\mid x0)=0.70$	$P(z0\mid y0)=0.40$	$P(w0\mid z0)=0.70$
	$P(y1)=0.36$	$P(z1)=0.47$	$P(w1)=0.37$
	$P(y0)=0.64$	$P(z0)=0.53$	$P(w0)=0.63$

a) If x is measured to be $x=1$ $(x1)$, compute $P(z1|x1)$ *and* $P(w0|x1)$.

b) If w is measured to be $w=1$ $(w1)$ compute $P(z1|w1)$].

1) $P(z_1|x_1) = P(z_1|y_1,x_1)\,P(y_1|x_1) + P(z_1|y_0,x_1) \times P(y_0|x_1)$

$= P(z_1|y_1)\,P(y_1|x_1) + P(z_1|y_0) \times P(y_0|x_1)$

$= 0.25 \times 0.40 + 0.60 \times 0.60$

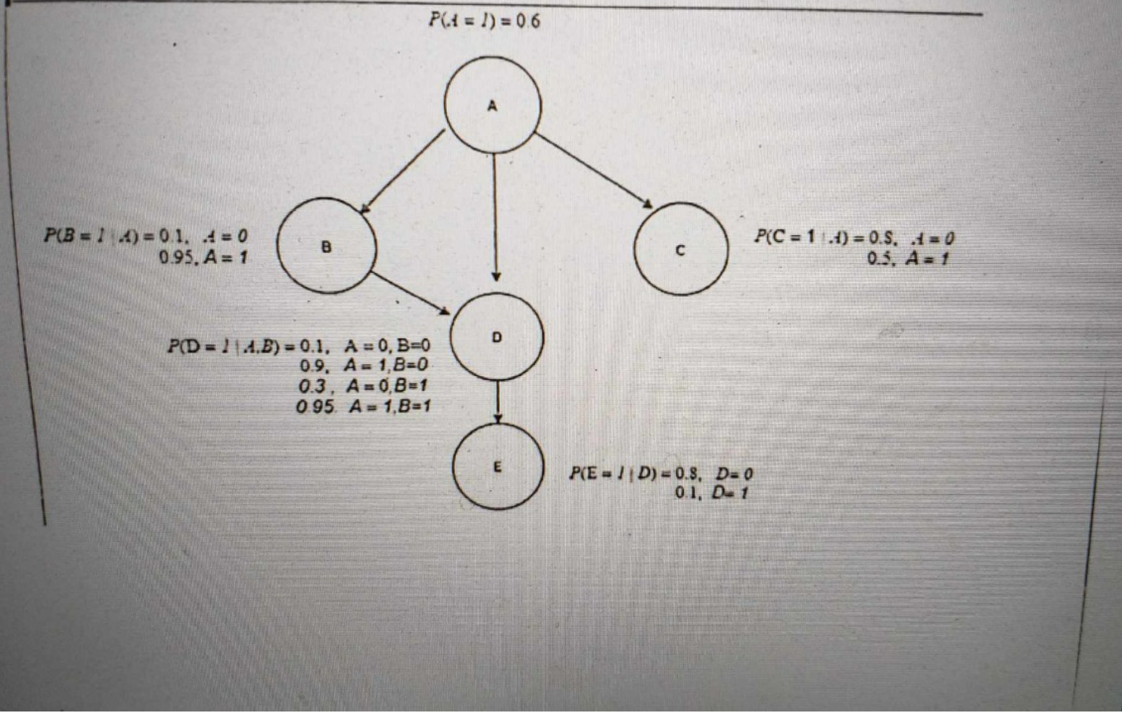
$=$

$P(w_0|x_1) = P(w_0|z_1,x_1)\,P(z_1,x_1) + P(w_0|z_0,x_1)\,P(z_0,x_1)$

$= P(w_0|z_1)\,P(z_1|x_1) + P(w_0|z_0) \times P(z_0|x_1)$

$$P(z_1|w_1) = \frac{P(w_1|z_1)\,P(z_1)}{P(w_1)} =$$

Find the value of P (A=1, B=1, C=1, D=1, E=1) from the Bayes network below.: [3]



$P(B_1|A_0) = 0.1$ $\quad$ $P(B_1|A_1) = 0.95$ $\quad$ $P(A_1) = 0.6$

$P(C_1|A_0) = 0.5$ $\quad$ $P(C_1|A_1) = 0.5$

$P(D_1|A_0, B_0) = 0.1$ $\quad$ $P(D_1|A_0, B_1) = 0.3$

$P(D_1|A_1, B_0) = 0.9$ $\quad$ $P(D_1|A_1, B_1) = 0.95$

$P(E_1|D_0) = 0.8$

$P(E_1|D_1) = 0.1$

$P(A_1, B_1, C_1, D_1, E_1)$

$= P(A_1) \times P(B_1|A_1) \times P(C_1|A_1) \times P(D_1|B_1, A_1) \times P(E_1|D_1)$

$= 0.6 \times 0.95 \times 0.5 \times 0.95 \times 0.1$

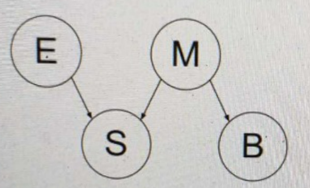
$=$

Name:

1. A Bayesian network and corresponding conditional probability tables for are shown below. Compute the following probabilities. **[6]**

P(E)	
$+e$	0.4
$-e$	0.6

P(S|E, M)			
$+e$	$+m$	$+s$	1.0
$+e$	$+m$	$-s$	0.0
$+e$	$-m$	$+s$	0.8
$+e$	$-m$	$-s$	0.2
$-e$	$+m$	$+s$	0.3
$-e$	$+m$	$-s$	0.7
$-e$	$-m$	$+s$	0.1
$-e$	$-m$	$-s$	0.9



P(M)	
$+m$	0.1
$-m$	0.9

P(B|M)		
$+m$	$+b$	1.0
$+m$	$-b$	0.0
$-m$	$+b$	0.1
$-m$	$-b$	0.9

(a) *P (-e, -s, -m, -b)*
(b) *P(+b)*
(c) *P(+m | + b)*

2. What is Maximum a Posteriori (MAP) estimation in statistical inference and how does it differ from Maximum Likelihood Estimation (MLE)? **[4]**

1) $P(-e, -s, -m\ -b)$

$= P(-e) \times P(-S|-E,-M) \times P(-M) \times P(-M)-B)$

$= 0.6 \times 0.9 \times 0.9 \times 0.9$

2) $P(+b) = \Sigma\ P(+b|M)$

$= P(+b|+M) \times P(+M) + P(+b|-M)\, P(-M)$

$= 1 \times 0.1 + 0.9 \times 0.1$

$=$

c) $P(+m|+b) = \dfrac{P(+b|+M)\, P(+M)}{P(+b)}$

$= \dfrac{1 \times 0.1}{0.19} = 0.52$