Assignment 5 Bo Lin 1001778270

# Task 1

## part a:

A have 8 values and each $B_1$ $B_2$ ... $B_{10}$ have 5 values

so. $8 \times 5^{10} = 8 \times 9765625 = 78125000$

## part b:

Each $B_i$ is conditionally indepedent of all other 9 $B_j$ variables

so $8 \times 5 \times 10 = 400$

## part c:

Yes, this scenario follow the Naive-Bayes model

# Task 2.

a. c c c c c L

c $P(c) = 0.1 \times 1 + 0.2 \times 0.75 + 0.4 \times 0.5 + 0.2 \times 0.25 + 0.1 \times 0$
$= 0.5$

$P(h_1) = \frac{0.1 \times 1}{0.5} = 0.2$ $\quad P(h_2) = \frac{0.2 \times 0.75}{0.5} = 0.3$

$P(h_3) = \frac{0.4 \times 0.5}{0.5} = 0.4$ $\quad P(h_4) = \frac{0.2 \times 0.25}{0.5} = 0.1$

$P(h_5) = \frac{0.1 \times 0}{0.5} = 0$

c $P(c) = 0.2\times1 + 0.3\times0.75 + 0.4\times0.5 + 0.1\times0.25 + 0\times0$

$= 0.65$

$P(h_1) = \frac{0.2\times1}{0.65} = 0.30769$ $P(h_2) = \frac{0.3\times0.75}{0.65} = 0.34615$

$P(h_3) = \frac{0.4\times0.5}{0.65} = 0.30769$ $P(h_4) = \frac{0.1\times0.25}{0.65} = 0.03846$

$P(h_5) = \frac{0\times0}{0.65} = 0$

c $P(c) = 0.30769\times1 + 0.34615\times0.75 + 0.30769\times0.5 + 0.03846\times0.25 + 0\times0$

$= 0.73077$

$P(h_1) = \frac{0.30769\times1}{0.73077} = 0.42105$ $P(h_2) = \frac{0.34615\times0.75}{0.73077} = 0.35526$

$P(h_3) = \frac{0.30769\times0.5}{0.73077} = 0.21053$ $P(h_4) = \frac{0.03846\times0.25}{0.73077} = 0.01316$

$P(h_4) = \frac{0\times0}{0.73077} = 0$

c $P(c) = 0.42105\times1 + 0.35526\times0.75 + 0.21053\times0.5 + 0.01316\times0.25 + 0\times0$

$= 0.79605$

$P(h_1) = \frac{0.42105\times1}{0.79605} = 0.52893$ $P(h_2) = \frac{0.35526\times0.75}{0.79605} = 0.33471$

$P(h_3) = \frac{0.21053\times0.5}{0.79605} = 0.13223$ $P(h_4) = \frac{0.01316\times0.25}{0.79605} = 0.00413$

$P(h_5) = \frac{0\times0}{0.79605} = 0$

c $P(c) = 0.52893\times1 + 0.33471\times0.75 + 0.13223\times0.5 + 0.00413\times0.25 + 0\times0$

$= 0.84711$

$P(h_1) = \frac{0.52893\times1}{0.84711} = 0.62439$ $P(h_2) = \frac{0.33471\times0.75}{0.84711} = 0.29634$

$P(h_3) = \frac{0.13223\times0.5}{0.84711} = 0.07805$ $P(h_4) = \frac{0.00413\times0.25}{0.84711} = 0.00122$

$P(h_5) = \frac{0\times0}{0.84711} = 0$

L $P(L) = 0.62439 \times 0 + 0.29634 \times 0.25 + 0.07805 \times 0.5 + 0.00122 \times 0.75 + 0 \times 1$

$= 0.11402$

$P(h_1) = \frac{0.62439 \times 0}{0.11402} = 0$ $\quad$ $P(h_2) = \frac{0.29634 \times 0.25}{0.11402} = 0.64973$

$P(h_3) = \frac{0.07805 \times 0.5}{0.11402} = 0.34225$ $\quad$ $P(h_4) = \frac{0.00122 \times 0.75}{0.11402} = 0.00802$

$P(h_5) = \frac{0 \times 1}{0.11402} = 0$

b. CLCLCL

C $P(C) = 0.1 \times 1 + 0.2 \times 0.75 + 0.4 \times 0.5 + 0.2 \times 0.25 + 0.1 \times 0$

$= 0.5$

$P(h_1) = \frac{0.1 \times 1}{0.5} = 0.2$ $\quad$ $P(h_2) = \frac{0.2 \times 0.75}{0.5} = 0.3$

$P(h_3) = \frac{0.4 \times 0.5}{0.5} = 0.4$ $\quad$ $P(h_4) = \frac{0.2 \times 0.25}{0.5} = 0.1$

$P(h_5) = \frac{0.1 \times 0}{0.5} = 0$

L $P(L) = 0.2 \times 0 + 0.3 \times 0.25 + 0.4 \times 0.5 + 0.1 \times 0.75 + 0 \times 1$

$= 0.35$

$P(h_1) = \frac{0.2 \times 0}{0.35} = 0$ $\quad$ $P(h_2) = \frac{0.3 \times 0.25}{0.35} = 0.21429$

$P(h_3) = \frac{0.4 \times 0.5}{0.35} = 0.57143$ $\quad$ $P(h_4) = \frac{0.1 \times 0.75}{0.35} = 0.21429$

$P(h_5) = \frac{0 \times 1}{0.35} = 0$

C $P(C) = 0 \times 1 + 0.21429 \times 0.75 + 0.57143 \times 0.5 + 0.21429 \times 0.25 + 0 \times 0$

$= 0.50000$

$P(h_1) = \frac{0 \times 1}{0.50000} = 0$ $\quad$ $P(h_2) = \frac{0.21429 \times 0.75}{0.50000} = 0.32143$

$P(h_3) = \frac{0.57143 \times 0.5}{0.50000} = 0.57143$ $\quad$ $P(h_4) = \frac{0.21429 \times 0.25}{0.50000} = 0.10714$

$$P(h_5) = \frac{0 \times 0}{0.50000} = 0$$

L $P(L) = 0 \times 0 + 0.32143 \times 0.25 + 0.57143 \times 0.5 + 0.10714 \times 0.75 + 0 \times 1$

$= 0.44643$

$$P(h_1) = \frac{0 \times 0}{0.44643} = 0 \qquad P(h_2) = \frac{0.32143 \times 0.25}{0.44643} = 0.18000$$

$$P(h_3) = \frac{0.57143 \times 0.5}{0.44643} = 0.64000 \qquad P(h_4) = \frac{0.10714 \times 0.75}{0.44643} = 0.18000$$

$$P(h_5) = \frac{0. \times 1}{0.44643} = 0$$

C $P(C) = 0 \times 1 + 0.18000 \times 0.75 + 0.64000 \times 0.5 + 0.18000 \times 0.25 + 0 \times 0$

$= 0.50000$

$$P(h_1) = \frac{0 \times 1}{0.50000} = 0 \qquad P(h_2) = \frac{0.18000 \times 0.75}{0.50000} = 0.27000$$

$$P(h_3) = \frac{0.64000 \times 0.5}{0.50000} = 0.64000 \qquad P(h_4) = \frac{0.18000 \times 0.25}{0.50000} = 0.09000$$

$$P(h_5) = \frac{0 \times 0}{0.50000} = 0$$

L $P(L) = 0 \times 0 + 0.27000 \times 0.25 + 0.64000 \times 0.5 + 0.09000 \times 0.75 + 0 \times 1$

$= 0.45500$

$$P(h_1) = \frac{0 \times 0}{0.45500} = 0 \qquad P(h_2) = \frac{0.27000 \times 0.25}{0.45500} = 0.14835$$

$$P(h_3) = \frac{0.64000 \times 0.5}{0.45500} = 0.70330 \qquad P(h_4) = \frac{0.09000 \times 0.75}{0.45500} = 0.14835$$

$$P(h_5) = \frac{0 \times 1}{0.45500} = 0$$

c. c c c L L L

c $P(c) = 0.1\times1 + 0.2\times0.75 + 0.4\times0.5 + 0.2\times0.25 + 0.1\times0$
$= 0.5$

$P(h_1) = \frac{0.1\times1}{0.5} = 0.2$ $\quad P(h_2) = \frac{0.2\times0.75}{0.5} = 0.3$

$P(h_3) = \frac{0.4\times0.5}{0.5} = 0.4$ $\quad P(h_4) = \frac{0.2\times0.25}{0.5} = 0.1$

$P(h_5) = \frac{0.1\times0}{0.5} = 0$

c $P(c) = 0.2\times1 + 0.3\times0.75 + 0.4\times0.5 + 0.1\times0.25 + 0\times0$
$= 0.65$

$P(h_1) = \frac{0.2\times1}{0.65} = 0.30769$ $\quad P(h_2) = \frac{0.3\times0.75}{0.65} = 0.34615$

$P(h_3) = \frac{0.4\times0.5}{0.65} = 0.30769$ $\quad P(h_4) = \frac{0.1\times0.25}{0.65} = 0.03846$

$P(h_5) = \frac{0\times0}{0.65} = 0$

c $P(c) = 0.30769\times1 + 0.34615\times0.75 + 0.30769\times0.5 + 0.03846\times0.25 + 0\times0$
$= 0.73077$

$P(h_1) = \frac{0.30769\times1}{0.73077} = 0.42105$ $\quad P(h_2) = \frac{0.34615\times0.75}{0.73077} = 0.35526$

$P(h_3) = \frac{0.30769\times0.5}{0.73077} = 0.21053$ $\quad P(h_4) = \frac{0.03846\times0.25}{0.73077} = 0.01316$

$P(h_4) = \frac{0\times0}{0.73077} = 0$

L $P(L) = 0.42105\times0 + 0.35526\times0.25 + 0.21053\times0.5 + 0.01316\times0.75 + 0\times1$
$= 0.20395$

$$P(h_1) = \frac{0.42105 \times 0}{0.20395} = 0 \qquad P(h_2) = \frac{0.35526 \times 0.25}{0.20395} = 0.43548$$

$$P(h_3) = \frac{0.21053 \times 0.5}{0.20395} = 0.51613 \quad P(h_4) = \frac{0.01316 \times 0.75}{0.20395} = 0.04839$$

$$P(h_5) = \frac{0 \times 1}{0.20395} = 0$$

L $\quad P(L) = 0 \times 0 + 0.43548 \times 0.25 + 0.51613 \times 0.5 + 0.04839 \times 0.75 + 0 \times 1$

$$= 0.40323$$

$$P(h_1) = \frac{0 \times 0}{0.40323} = 0 \qquad P(h_2) = \frac{0.43548 \times 0.25}{0.40323} = 0.27000$$

$$P(h_3) = \frac{0.51613 \times 0.5}{0.40323} = 0.64000 \quad P(h_4) = \frac{0.04839 \times 0.75}{0.40323} = 0.09000$$

$$P(h_5) = \frac{0 \times 1}{0.40323} = 0$$

L $\quad P(L) = 0 \times 0 + 0.27000 \times 0.25 + 0.64000 \times 0.5 + 0.09000 \times 0.75 + 0 \times 1$

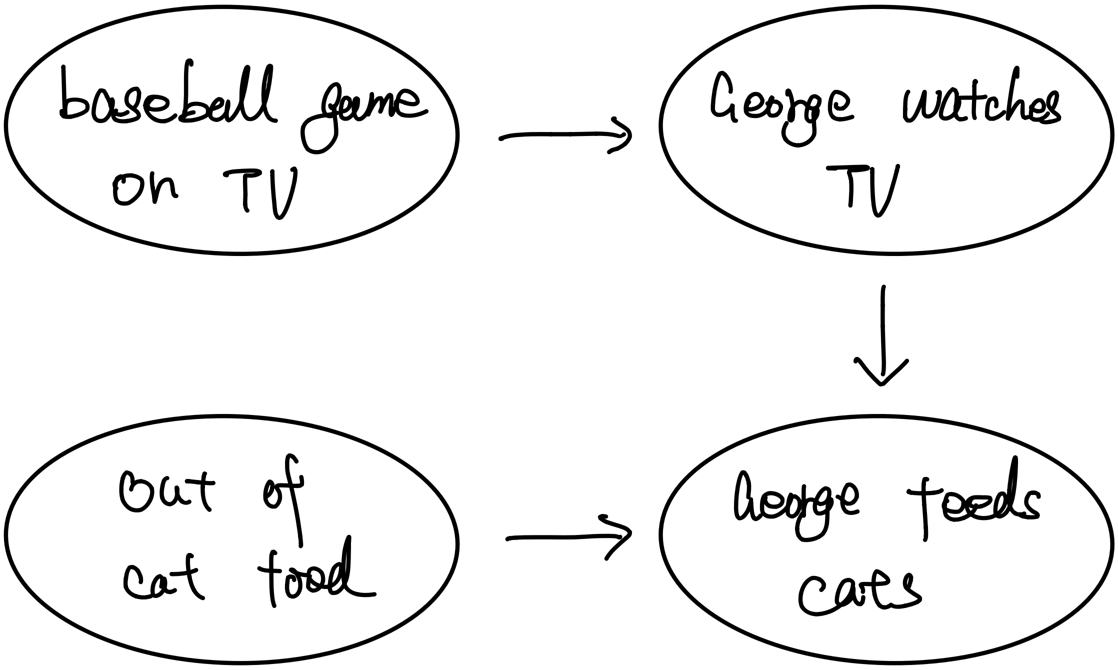
$$= 0.45500$$

$$P(h_1) = \frac{0 \times 0}{0.45500} = 0 \qquad P(h_2) = \frac{0.27000 \times 0.25}{0.45500} = 0.14835$$

$$P(h_3) = \frac{0.64000 \times 0.5}{0.45500} = 0.70330 \quad P(h_4) = \frac{0.09000 \times 0.75}{0.45500} = 0.14835$$

$$P(h_5) = \frac{0 \times 1}{0.45500} = 0$$

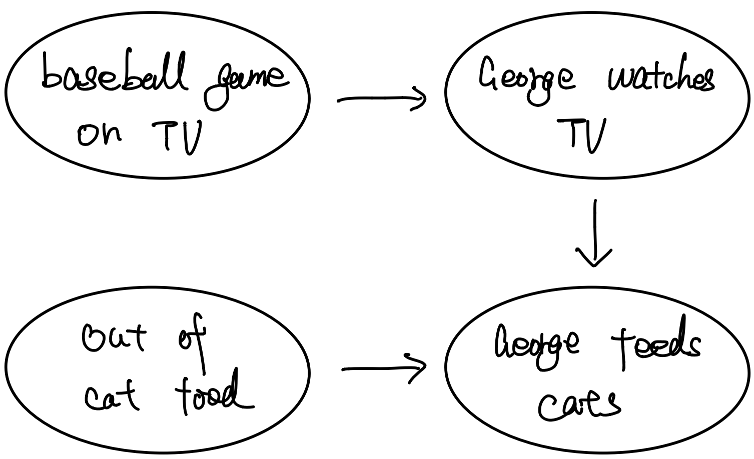
# Task 3




# Task 4

$P_{base} = \frac{111}{365}$

$P_{out} = \frac{62}{365}$




| base | $P_{watch}$ |
|---|---|
| 1 | $\frac{103}{131}$ |
| 0 | $\frac{30}{254}$ |

| watch | out | $P_{feed}$ |
|---|---|---|
| 1 | 1 | $\frac{1}{24}$ |
| 1 | 0 | $\frac{77}{109}$ |
| 0 | 1 | $\frac{12}{38}$ |
| 0 | 0 | $\frac{186}{194}$ |

# Task 5

$$P(\text{not (feed)} \mid \text{baseball})$$

$$= \frac{P(\text{not feed}, \text{baseball})}{P(\text{baseball})}$$

for $P(\text{not feed}, \text{baseball})$ :

$= P(\text{not feed} \mid \text{watch}, \text{out}) \cdot p(\text{watch} \mid \text{baseball})\, p(\text{out})\, p(\text{baseball}) +$
$P(\text{not feed} \mid \text{not watch}, \text{out})\, P(\text{not watch} \mid \text{baseball})\, P(\text{out})\, p(\text{baseball}) +$
$P(\text{not feed} \mid \text{watch}, \text{not out})\, p(\text{watch} \mid \text{baseball})\, p(\text{not out})\, p(\text{baseball}) +$
$P(\text{not feed} \mid \text{not watch}, \text{not out})\, P(\text{not watch} \mid \text{baseball})\, p(\text{not out})\, P(\text{baseball}) +$

$= 0.11801$

$p(\text{not feed} \mid \text{baseball})$

$= 0.38804$

# Task 6

a. node a (parent)

node P, node Q (children)

node K node M (children's parents)

b. $P(C, H) = P(H|C) \cdot P(C)$

$= 0.6 \times 0.6$

$= 0.36$

It is derived from $P(C)$ and $P(H|C)$

c. $P(O \mid not(J), G) = \dfrac{P(O, not(J), G)}{P(not(J), G)}$

$= \dfrac{P(O|not(J)) \cdot P(not(J)|G) \cdot P(G)}{P(not(J) \mid G) \cdot P(G)}$

$= 0.8$

It is derived from $P(O|not(J)) \cdot P(not(J)|G) \cdot P(G)$