

Subject:

8101013 81

تمرین دوم هوش مصنوعی - بخش سیمی

امین آقاگیری

Year

Month

Date

( )

## Bayes nets

سوال اول

eliminate o

join on o

$$P(w) = \sum_o P(o) P(w|o)$$

 $P(o, w)$ 

| o | w | $P(w o)$ |
|---|---|----------|
| + | + | 0.9      |
| + | - | 0.1      |
| - | + | 0.2      |
| - | - | 0.8      |

| o | $P(o)$ |
|---|--------|
| + | 0.5    |
| - | 0.5    |

X →

| o | w | $P(o, w)$ |
|---|---|-----------|
| + | + | 0.45      |
| + | - | 0.05      |
| - | + | 0.1       |
| - | - | 0.4       |

eliminate o →

| w | $P(w)$ |
|---|--------|
| + | 0.55   |
| - | 0.45   |

(ج)

$$P(+o, -w, +f, -r, +a) = P(+o) P(-w|+o) P(+f|+o, -w) P(-r) P(+a|+f, -r)$$

با توجه به سوال اول  
↑ این احتمالها را جایگزین می کنیم

$$(0.5)(0.1)(0.6)(0.8)(0.7) = \boxed{0.0168}$$

① درست است . زیرا با داشتن پدر (F) یک نود (A) ، آن نود (A) از تمام غیر نودگان شامل 0 خود مستقل می شود .

② نادرست است . پدران به شرط داشتن فرزند از هم مستقل نمی شوند!

③ نادرست است . فرزند به شرط داشتن پدران خود (w و o) از غیر نودگان خود مستقل می شود.

(A از نودگان F درست است)

④ درست است . پدران یک فرزند بدون شرط ، از هم مستقل اند.

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$$P(+o|-a) \propto P(+o, -a)$$

$$\rightarrow P(+o, -a, f, w, r)$$

$$P(+o, -a) = \sum_w \sum_r \sum_f P(+o) P(w|+o) P(f|+o, -a) P(-a|f, r) P(r)$$

$$\begin{aligned} &= \sum_f P(f|+o, -a) \underbrace{\sum_w P(w|+o) P(+o)}_{\substack{\text{join on } +o \\ \text{eliminate } w}} \underbrace{\sum_r P(-a|f, r) P(r)}_{\substack{\text{join on } r \\ \text{eliminate } r}} \\ &\quad \underbrace{\hspace{10em}}_{\substack{\text{join on } +o, -a \\ \text{eliminate } f}} \end{aligned}$$



HMM

سوال اول

الف

$$\pi = \begin{matrix} & s & a & h & r \\ \begin{matrix} s & a & h & r \end{matrix} & \begin{bmatrix} 0.25 & 0.25 & 0.25 & 0.25 \end{bmatrix} \end{matrix}$$

$$A = \begin{matrix} & s & a & h & r \\ \begin{matrix} s & a & h & r \end{matrix} & \begin{bmatrix} 0.4 & 0.4 & 0 & 0.2 \\ 0.1 & 0.4 & 0.1 & 0 \\ 0 & 0.2 & 0.5 & 0.2 \\ 0.5 & 0 & 0.4 & 0.6 \end{bmatrix} \end{matrix}$$

$$B = \begin{matrix} & s & a & h & r \\ \begin{matrix} s & a & h & r \end{matrix} & \begin{bmatrix} 0.8 & 0 & 0 & 0.2 \\ 0 & 1 & 0.1 & 0 \\ 0 & 0 & 0.9 & 0.1 \\ 0.2 & 0 & 0 & 0.7 \end{bmatrix} \end{matrix}$$

ب)  $\alpha_1(j) = \pi_j b_j(a_1)$ ;  $1 \leq j \leq N$

$$\alpha_1(s) = 0.25 \times 0.8 = 0.2, \alpha_1(a) = 0.25 \times 0 = 0, \alpha_1(h) = 0.25 \times 0 = 0, \alpha_1(r) = 0.25 \times 0.2 = 0.05$$

$$\alpha_2(s) = \sum_{i=1}^4 \alpha_1(i) \overset{P(s|i)}{\underset{\uparrow}{a_{is}}} \overset{B}{\underset{\uparrow}{b_s(a_2)}} = 0.2 \overset{0.08}{(0.2 \times 0.4 + 0 + 0 + 0.05 \times 0.2)} = 0.072$$

$$\alpha_2(a) = 0, \alpha_2(h) = 0$$

$$\alpha_2(r) = 0.2 \overset{0.1}{(0.2 \times 0.5 + 0 + 0 + 0.05 \times 0.6)} = 0.026$$



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 $b_3(L)$ 

0.0288

0.0052

$$\alpha_3(S) = 0.2(0.072 \times 0.4 + 0 + 0 + 0.026 \times 0.2) = 0.0068$$

$$b_3(L) = 0, b_3(H) = 0$$

$$\alpha_3(a) = 0, \alpha_3(h) = 0$$

0.036

0.0156

$$\alpha_3(r) = 0.7(0.072 \times 0.5 + 0 + 0 + 0.026 \times 0.6) = 0.03612$$

$$b_4(S) = 0, b_4(r) = 0$$

$$\alpha_4(S) = 0, \alpha_4(r) = 0$$

$$P(x_t = S | x_{t-1} = S)$$

$$\alpha_4(a) = 1(0.0068 \times 0.1 + 0 + 0 + 0) = 0.00068$$

$$\alpha_4(h) = 0.1(0 + 0 + 0 + 0.03612 \times 0.2) = 0.0007224$$

$$P(0|x) = \sum \alpha_4(j) = 0 + 0 + 0.00068 + 0.0007224 = 0.0014024$$

$$\text{smoothing: } P(\hat{S}^{x_2} | 0:4) = \frac{f_{1:2} \times b_{3:4}}{\text{Normalizer}} \times \frac{1}{P(0:4)} = \frac{1}{P(0)} \rightarrow \text{دقیق ترین مقدار}$$

$$f_{1:2}(S) \propto \alpha_2(S)$$

$$b_{3:4}(S) \propto \beta_2(S)$$

$$\beta_4 = 1, \beta_3(S) = 1 \times (0.1 \times 1) = 0.1$$

$$\beta_3(a) = 1 \times (0.2 \times 0.1 + 0.4 \times 1) = 0.42, \beta_3(h) = 1 \times (0.1 \times 1 + 0.5 \times 0.1) = 0.15$$

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$$\beta_3(r) = 1(0.2 \times 0.1) = 0.02$$

$$\beta_2(s) = \underbrace{(0.4 \times 0.1 \times 0.2)}_{\substack{\uparrow s \\ 0.008}} + (0) + (0) + \underbrace{(0.5 \times 0.02 \times 0.7)}_{\substack{\uparrow r \\ 0.007}} = 0.015$$

$$C_1 = \frac{\alpha_2(s) \times \beta_2(s)}{P(e)} = \frac{0.072 \times 0.015}{0.0014024} = \boxed{0.77010839}$$



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$$\Rightarrow V_1(S) = 0.25 \times 0.8 = 0.2, V_1(A) = 0, V_1(H) = 0, V_1(R) = 0.25 \times 0.2 = 0.05$$

$$\hookrightarrow bt_1 = 0$$

$$V_2(S) = \max(0.8 \times 0.2 \times 0.4, 0, 0, 0.8 \times 0.05 \times 0.2) = 0.064$$

$$V_2(A) = \max(0, 0, 0, 0) = 0, V_2(H) = 0$$

$$\xrightarrow{\text{ar max}} bt_2 = S$$

$$V_2(R) = \max(0.2 \times 0.2 \times 0.5, 0, 0, 0.2 \times 0.05 \times 0.6) = 0.02$$

$$V_3(S) = \max(\underbrace{0.2 \times 0.064 \times 0.4}_{0.0266}, 0, 0, \underbrace{0.2 \times 0.02 \times 0.2}_{0.004}) = 0.00512; bt_3(S) = S$$

$$V_3(A), V_3(H) = 0$$

$$V_3(R) = \max(\underbrace{0.7 \times 0.064 \times 0.5}_{0.032}, 0, 0, \underbrace{0.7 \times 0.02 \times 0.6}_{0.012}) = 0.0224; bt_3(R) = S$$

$$V_4(S), V_4(R) = 0$$

$$\rightarrow P_{\max} = 0.000512$$

$$V_4(A) = \max(1 \times 0.00512 \times 0.1, 0, 0, 0) = 0.000512$$

$$\hookrightarrow bt = S$$

$$V_4(H) = \max(0, 0, 0, 0.1 \times 0.0224 \times 0.2) = 0.00448$$

$$\xrightarrow{\text{ar max}} bt_4 = S$$

$$\hookrightarrow bt = r$$

جواب:  $\text{sum} = \$\$ \$ \$$   
 $\text{P*} = 0.000512$

$$P^* = \max_{i=1}^N V_4(i) = 0.000512$$

$$q^* = \text{ar max}_{i=1}^N V_4(i) = q$$

Sunwood

Start of backtrace