

## سوال اول

(الف)

$$P(w) = \sum_{o \in O} P(w, o) = \sum_{o \in O} P(w|o)P(o)$$

$$\Rightarrow P(+w) = P(+w|+o)P(+o) + P(+w|-o)P(-o) = 0.2 \times 0.5 + 0.2 \times 0.5 = 0.55$$

$$\Rightarrow$$

w	P(w)
+	0.55
-	0.45

(ب)

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

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

$$= 0.5 \times 0.1 \times 0.6 \times 0.8 \times 0.7 = 0.0168$$

(ج)

۱- درست (به شما دانستن بود پور، از باقی پور ما مستقل ایم)

۲- نادرست (هر دو در A تأثیر گذارند)

۳- نادرست (با دانستن نزد پور از فرضه ما مستقل نیست)

۴- درست (طبق شبکه بین)

(2)

$$P(O|A) \propto P(O, A) = \sum_{f, w, r} P(O, A, f, w, r)$$

$$= \sum_{f, w, r} P(O) P(w|O) P(f|O, w) P(r) P(A|f, r)$$

$$= \sum_{f, w} P(O) P(w|O) P(f|O, w) \underbrace{\sum_r P(A|f, r) P(r)}_{f_1(A|f)}$$

$$= \sum_{f, w} P(O) P(w|O) P(f|O, w) f_1(A|f)$$

$$= \sum_f P(O) f_1(A|f) \underbrace{\sum_w P(w|O) P(f|O, w)}_{f_2(O|f)}$$

$$= \sum_f P(O) f_1(A|f) f_2(O|f) = f_3(O|A)$$

$$P(+0|-a) = \frac{f_3(+0|-a)}{f_3(+0|-a) + f_3(-0|-a)}$$

HMM

$$\Pi = \begin{pmatrix} 0.25 \\ 0.25 \\ 0.25 \\ 0.25 \end{pmatrix}, B = \begin{matrix} & B & H & P & L \\ \begin{matrix} S \\ a \\ h \\ v \end{matrix} & \begin{pmatrix} 0.8 & 0 & 0 & 0.2 \\ 0 & 1 & 0 & 0 \\ 0 & 0.1 & 0.9 & 0 \\ 0.2 & 0 & 0.7 & 0.7 \end{pmatrix} \end{matrix} \quad (\text{ان})$$

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

$$\text{init } \begin{cases} a_1(s) = 0.25 \times 0.8 = 0.2, & a_1(h) = 0 \\ a_1(a) = 0, & a_1(r) = 0.25 \times 0.2 = 0.05 \end{cases}$$

$$\begin{cases} a_2(s) = \sum_{i=1}^4 a_1(i) a_{i3} b_s(B) = 0.2 \times 0.4 + 0.05 \times 0.2 = 0.072 \\ a_2(r) = \sum_{i=1}^4 a_1(i) a_{ir} b_r(B) = (0.2 \times 0.5 + 0.05 \times 0.6) \times 0.2 = 0.026 \end{cases}$$

$$a_2(a) = a_2(h) = 0$$

$$a_3(s) = 0.0068, \quad a_3(r) = 0.03612, \quad a_3(a) = a_3(h) = 0$$

$$\text{Recur-Step } a_4(s) = a_4(r) = 0$$

$$a_4(a) = 0.0068 \times 0.1 + 0.03612 \times 0 = 0.00068$$

$$a_4(h) = 0.0068 \times 0 + 0.03612 \times 0.2 = 0.007224$$

$$\text{Ter-min-ation } \sum_{i=1}^4 a_4(i) = 0.0074024$$

(2)

$$\gamma_2(i) = \frac{a_2(i)\beta_2(i)}{\sum_{j=1}^4 a_2(j)\beta_2(j)} ; \beta_4(i) \text{ for } i \text{ in } [a, b, s, r] = 1$$

$$\beta_3(s) = \sum_{j=1}^4 a_{sj} b_j(h) \beta_4(j) = 0 + 0 + 0.2 \times 0.1 \times 1 + 0 = 0.02$$

$$\beta_3(r) = 0 + 0 + 0.2 \times 0.1 \times 1 + 0 = 0.02$$

$$\beta_2(s) = 0.4 \times 0.2 \times 0.1 + 0.5 \times 0.7 \times 0.02 = 0.015$$

$$\beta_2(r) = 0.2 \times 0.2 \times 0.1 + 0.6 \times 0.7 \times 0.02 = 0.0124$$

$$\gamma_2(s) = \frac{0.072 \times 0.015}{0.072 \times 0.015 + 0.026 \times 0.0124} \approx 0.7$$

$$v_1(s) = \pi_s b_s(b) = 0.25 \times 0.8 = 0.2$$

(3)

$$v_1(a) = v_1(b) = 0, v_1(r) = 0.25 \times 0.2 = 0.05$$

$$v_2(s) = \max(0.2 \times 0.4, 0.05 \times 0.2) \times 0.8 = 0.064$$

$$v_2(r) = \max(0.2 \times 0.5, 0.05 \times 0.6) \times 0.2 = 0.02$$

$$v_3(s) = \max(0.064 \times 0.4, 0.02 \times 0.2) \times 0.2 = 0.00512$$

$$v_3(r) = \max(0.064 \times 0.5, 0.02 \times 0.6) \times 0.7 = 0.0224$$

$$v_4(a) = \max(0.00512 \times 0.1, 0.0224 \times 0) = 0.000512$$

$$v_4(h) = \max(0.00512 \times 0, 0.0224 \times 0.2) \times 0.1 = 0.000448$$

$\sim s, s, s, a$