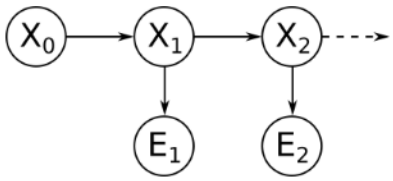
复查测验提交: Homework 4

用户	信息科学与技术学院 周守琛
课程	人工智能I
测试	Homework 4
已开始	23-12-1 下午2:33
已提交	23-12-3 下午6:41
截止日期	23-12-6 下午11:59
状态	已完成
尝试分数	得 100 分，满分 100 分
已用时间	52 小时 8 分钟
显示的结果	所有答案, 已提交的答案, 正确答案

问题 1

得 20 分，满分 20 分

Consider the HMM shown below.



The prior probability $P(X_0)$, dynamics model $P(X_{t+1}|X_t)$, and sensor model $P(E_t|X_t)$ are as follows:

X_0	$P(X_0)$
0	0.35
1	0.65

X_{t+1}	X_t	$P(X_{t+1}\|X_t)$
0	0	0.05
1	0	0.95
0	1	0.05
1	1	0.95

E_t	X_t	$P(E_t\|X_t)$
a	0	0.15
b	0	0.3
c	0	0.55
a	1	0.7
b	1	0.05
c	1	0.25

We perform a first dynamics update, and fill in the resulting belief distribution $B'(X_1)$.

X_1	$B'(X_1)$
0	0.05
1	0.95

We incorporate the evidence $E_1 = c$.We fill in the evidence-weighted distribution $P(E_1 = c|X_1)B'(X_1)$, and the (normalized) belief distribution $B(X_1)$.

X_1	$P(E_1 = c\|X_1)B'(X_1)$
0	0.0275
1	0.2375

X_1	$B(X_1)$
0	0.103773584906
1	0.896226415094

You get to perform the second dynamics update. Fill in the resulting belief distribution $B'(X_2)$.

Your answers will be evaluated to 4 decimal places.

X_2	$B'(X_2)$
0	**[q1.1]**
1	**[q1.2]**

Now incorporate the evidence $E_2 = b$. Fill in the evidence-weighted distribution $P(E_2 = b|X_2)B'(X_2)$, and the (normalized) belief distribution $B(X_2)$.

X_2	$P(E_2 = b\|X_2)B'(X_2)$
0	**[q1.3]**
1	**[q1.4]**

X_2	$B(X_2)$
0	**[q1.5]**

1	[q1.6]

q1.1 的指定答案: 0.0500

q1.2 的指定答案: 0.9500

q1.3 的指定答案: 0.0150

q1.4 的指定答案: 0.0475

q1.5 的指定答案: 0.2400

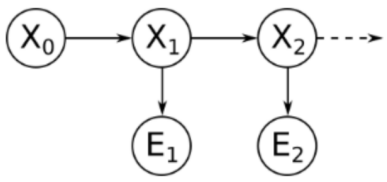
q1.6 的指定答案: 0.7600

q1.1 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.05	
q1.2 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.95	
q1.3 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.015	
q1.4 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.0475	
q1.5 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.24	
q1.6 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.76	

问题 2

得 20 分，满分 20 分

Consider the same HMM.



The prior probability $P(X_0)$, dynamics model $P(X_{t+1}|X_t)$, and sensor model $P(E_t|X_t)$ are as follows:

X_0	$P(X_0)$
0	0.5
1	0.5

X_{t+1}	X_t	$P(X_{t+1}\|X_t)$
0	0	0.5
1	0	0.5
0	1	0.2
1	1	0.8

E_t	X_t	$P(X_{t+1}\|X_t)$
a	0	0.5
b	0	0.3
c	0	0.2
a	1	0.8
b	1	0.1
c	1	0.1

In this question we'll assume the sensor is broken and we get no more evidence readings. We are forced to rely on dynamics updates only going forward. In the limit as $t \to \infty$, our belief about X_t should converge to a stationary distribution $\tilde{B}(X_\infty)$ defined as follows:

$$\tilde{B}(X_\infty) := \lim_{t\to\infty} P(X_t|E_1, E_2)$$

Recall that the stationary distribution satisfies the equation

$$\tilde{B}(X_\infty) = \sum_{X_\infty} P(X_{t+1}|X_t)\tilde{B}(X_\infty)$$

for all values in the domain of X.

In the case of this problem, we can write these relations as a set of linear equations of the form

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} \tilde{B}(X_\infty = 0) \\ \tilde{B}(X_\infty = 1) \end{bmatrix} = \begin{bmatrix} \tilde{B}(X_\infty = 0) \\ \tilde{B}(X_\infty = 1) \end{bmatrix}$$

In the spaces below, fill in the coefficients of the linear system. The system you have written has many solutions (consider (0,0), for example), but to get a probability distribution we want the solution that sums to one. Fill in your solution in the table below. (Hint: to check your answer, you can also write some code and run till convergence.)

Your answers will be evaluated to 4 decimal places.

coefficient	value
a	**[q2.1]**
b	**[q2.2]**

c	**[q2.3]**
d	**[q2.4]**

X_∞	$\widetilde{B}(X_\infty)$
0	**[q2.5]**
1	**[q2.6]**

q2.1 的指定答案: 0.5000

q2.2 的指定答案: 0.2000

q2.3 的指定答案: 0.5000

q2.4 的指定答案: 0.8000

q2.5 的指定答案: 0.2857

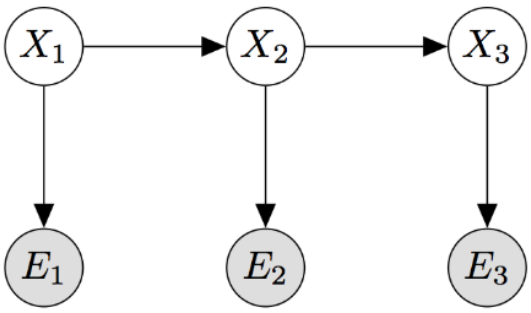
q2.6 的指定答案: 0.7143

q2.1 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.5	
q2.2 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.2	
q2.3 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.5	
q2.4 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.8	
q2.5 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.285	
q2.6 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.714	

问题 3

得 10 分，满分 10 分

Consider the HMM graph structure shown below.



Recall the Forward algorithm is a two step iterative algorithm used to approximate the probability distribution

$P(X_t|e_1, \ldots, e_t)$.

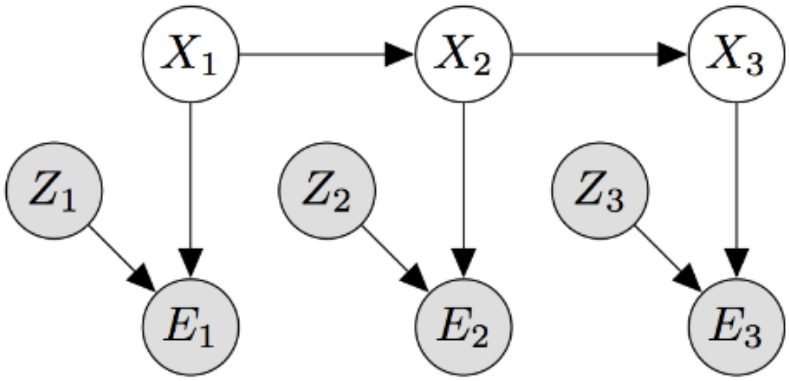
The two steps of the algorithm are as follows:

Elapse Time: $P(X_t|e_{1\ldots t-1}) = \sum_{x_{t-1}} P(X_t|x_{t-1})P(x_{t-1}|e_{1\ldots t-1})$

Observe Time: $P(X_t|e_{1\ldots t}) = \frac{P(e_t|X_t)P(X_t|e_{1\ldots t-1})}{\sum_{x_t} P(e_t|x_t)P(x_t|e_{1\ldots t-1})}$

For this problem we will consider modifying the forward algorithm as the HMM graph structure changes. Our goal will continue to be to create an iterative algorithm which is able to compute the distribution of states, X_t, given all available evidence from time 0 to time *t*.

Consider the graph below where new observed variables, Z_i, are introduced and influence the evidence.



What will the modified elapse time update be?

$P(X_t|e_{1\ldots t-1}, z_{1\ldots t-1}) =$

所选答案: D. $\sum_{x_{t-1}} P(X_t|x_{t-1})P(x_{t-1}|e_{1\ldots t-1}, z_{1\ldots t-1})$

答案: A. $\sum_{x_{t-1}} P(X_t|z_{1\ldots t-1})P(x_{t-1}|e_{1\ldots t-1}, z_{1\ldots t-1})$

B. $\sum_{x_{t-1}} P(X_t|e_{1\ldots t-1}, z_{1\ldots t-1})P(x_{t-1}|x_{t-1}, z_{1\ldots t-1})$

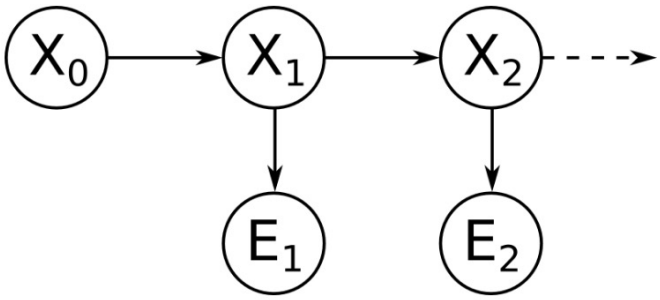
C. $\sum_{x_{t-1}} P(X_t|x_{t-1})P(x_{t-1}|e_{1...t-1})$

D. $\sum_{x_{t-1}} P(X_t|x_{t-1})P(x_{t-1}|e_{1...t-1},z_{1...t-1})$

问题 4

得 20 分，满分 20 分

Consider this HMM.



The prior probability $P(X_0)$, dynamics model $P(X_{t+1}|X_t)$, and sensor model $P(E_t|X_t)$ are as follows:

X_0	$P(X_0)$
0	0.5
1	0.5

X_{t+1}	X_t	$P(X_{t+1}\|X_t)$
0	0	0.5
1	0	0.5
0	1	0.2
1	1	0.8

E_t	X_t	$P(E_t \mid X_t)$
a	0	0.5
b	0	0.3
c	0	0.2
a	1	0.8
b	1	0.1
c	1	0.1

If the $E_1 = a, E_2 = b, E_3 = c$, what is the most likely explanation $X^*_{1:3} = argmax P(X_{1:3} \mid E_{1:3})$

X^*_1 = **[a]**

X^*_2 = **[b]**

X^*_3 = **[c]**

a 的指定答案: 1

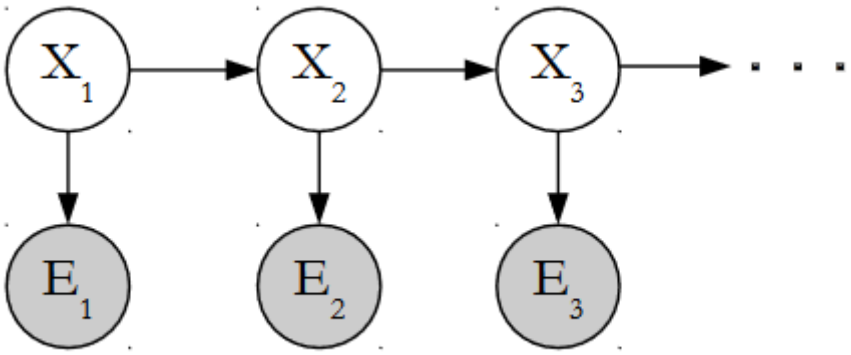
b 的指定答案: 1

c 的指定答案: 1

a 的正确答案:		
评估方式	**正确答案**	**区分大小写**
完全匹配	1	
b 的正确答案:		
评估方式	**正确答案**	**区分大小写**
完全匹配	1	
c 的正确答案:		
评估方式	**正确答案**	**区分大小写**
完全匹配	1	

问题 5

得 10 分，满分 10 分



The Viterbi algorithm finds the most probable sequence of hidden states $X_{1:T}$, given a sequence of observations $e_{1:T}$. For the HMM structure above, which of the following probabilities are maximized by the sequence of states returned by the Viterbi algorithm? Select all correct option(s).

所选答案:
- C. $P(X_{1:T}|e_{1:T})$
- D. $P(X_{1:T}, e_{1:T})$
- E. $P(X_1)P(e_1|X_1)\prod_{t=2}^{T} P(e_t|X_t)P(X_t|X_{t-1})$

答案:
- A. $P(X_{1:T})$
- B. $P(X_T|e_T)$
- C. $P(X_{1:T}|e_{1:T})$
- D. $P(X_{1:T}, e_{1:T})$
- E. $P(X_1)P(e_1|X_1)\prod_{t=2}^{T} P(e_t|X_t)P(X_t|X_{t-1})$
- F. $P(X_1)\prod_{t=2}^{T} P(X_t|X_{t-1})$
- G. None of above

问题 6

得 20 分，满分 20 分

After observing step of particle filtering, the particles and its weight are as follow:

Particles	Weight
A	0.3
B	0.4
C	0.9
D	0.5
A	0.3
C	0.9
A	0.3
D	0.5
D	0.5
A	0.3

Fill in the weighted sample distribution $P'(X)$ you used in the resampling step. Your answers will be evaluated to 4 decimal places.

P'(A) = **[a]**

P'(B) = **[b]**

P'(C) = **[c]**

P'(D) = **[d]**

a 的指定答案: 0.2449

b 的指定答案: 0.0816

c 的指定答案: 0.3673

d 的指定答案: 0.3061

a 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.244	
b 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.081	
c 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.367	
d 的正确答案:		
评估方式	**正确答案**	**区分大小写**
包含	0.306	

← 確定