0/5 Questions Answered

HW 6 (Electronic Component)

STUDENT NAME

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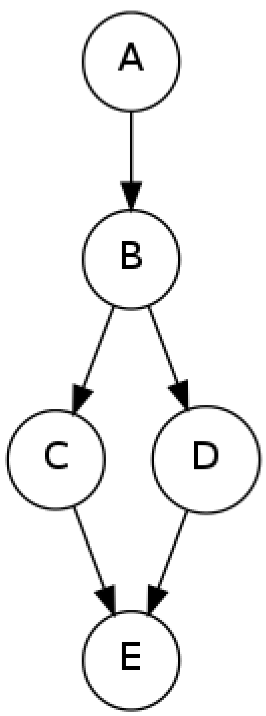
Q1 Likelihood Weighting

12 Points

We will work with a Bayes' net of the following structure.



In this question, we will perform likelihood weighting to estimate $P(C=1 \mid B=1, E=1)$. Generate a sample and its weight, using the random samples given in the table below. Variables are sampled in the order A, B, C, D, E. In the table below, select the assignments to the variables you sampled.

When generating random samples, use as many values as needed from the table below, which we generated independently and uniformly at random from $[0, 1)$. Use numbers from left to right. To sample a binary variable W with probability $P(W = 0) = p$ and $P(W = 1) = 1 - p$ using a value a from the table, choose $W = 0$ if $a < p$ and $W = 1$ if $a \geq p$.

0.249	0.052	0.299	0.773	0.715	0.550	0.703	0.105	0.236	0.153

A	$P(A)$
0	0.200
1	0.800

B	A	$P(B\|A)$
0	0	0.400
1	0	0.600
0	1	0.200
1	1	0.800

C	B	$P(C\|B)$
0	0	0.600
1	0	0.400
0	1	0.600
1	1	0.400

D	B	$P(D\|B)$
0	0	0.800
1	0	0.200
0	1	0.600
1	1	0.400

E	C	D	$P(E\|C, D)$
0	0	0	0.200
1	0	0	0.800
0	1	0	0.600
1	1	0	0.400
0	0	1	0.800
1	0	1	0.200
0	1	1	0.800
1	1	1	0.200

Input Answers Here

A:

Enter your answer here

B:

Enter your answer here

C:

Enter your answer here

D:

Enter your answer here

E:

Enter your answer here

What is the weight for the sample you obtained above?

Enter your answer here

Save Answer

Q2 Estimating Probabilities from Weighted Samples

6 Points

Below are a set of weighted samples obtained by running likelihood weighting for the Bayes' net from the previous question. Use them to estimate $P(C = 1 \mid B = 1, E = 1)$. Input -1 in the box below if the estimation cannot be made.

Sample 1

	0	1
A		x
B		x
C		x
D		x
E		x

Weight = 0.64

Sample 2

	0	1
A		x
B		x
C		x
D		x
E		x

Weight = 0.64

Sample 3

	0	1
A		x
B		x
C	x	
D		x
E		x

Weight = 0.32

Sample 4

	0	1
A		x
B		x
C	x	
D	x	
E		x

Weight = 0.16

Sample 5

	0	1
A	x	
B		x
C		x
D		x
E		x

Weight = 0.48

Estimation:

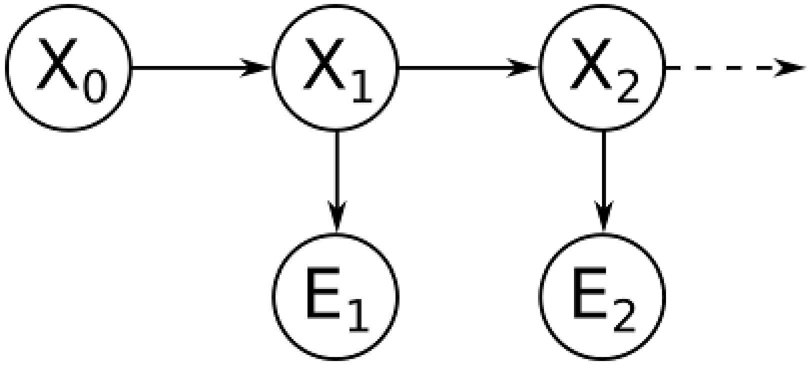
Enter your answer here

Save Answer

Q3 HMMs, Part I

20 Points

Consider the HMM shown below.



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

X_0	$P(X_0)$
0	0.15
1	0.85

X_{t+1}	X_t	$P(X_{t+1} \vert X_t)$
0	0	0.6
1	0	0.4
0	1	0.9
1	1	0.1

E_t	X_t	$P(E_t \vert X_t)$
a	0	0.8
b	0	0.15
c	0	0.05
a	1	0.35
b	1	0.05
c	1	0.6

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

X_1	$B'(X_1)$
0	0.855
1	0.145

Where $B'(X_t) = P(X_t \mid X_{t-1} = 0)B(X_{t-1} = 0) + P(X_t \mid X_{t-1} = 1)B(X_{t-1} = 1)$.

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

X_1	$P(E_1 = c \mid X_1)B'(X_1)$
0	0.04275
1	0.087

X_1	$B(X_1)$
0	0.329479768786
1	0.670520231214

Where $B(X_1) = \frac{P(E_1=c|X_1)B'(X_1)}{\sum_{x_1} P(E_1=c|X_1=x_1)B'(X_1=x_1)}$

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

$B'(X_2 = 0)$

Enter your answer here

$B'(X_2 = 1)$

Enter your answer here

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

$P(E_2 = c \mid X_2)B'(X_2)$ when $X_2 = 0$

Enter your answer here

$P(E_2 = c \mid X_2)B'(X_2)$ when $X_2 = 1$

Enter your answer here

$B(X_2 = 0)$

Enter your answer here

$B(X_2 = 1)$

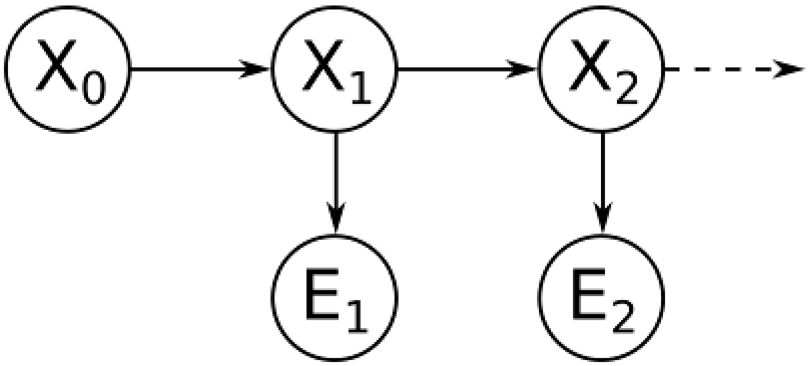
Enter your answer here

Save Answer

Q4 HMMs, Part II

20 Points

Consider the same HMM (but with different probabilities).



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

X_0	$P(X_0)$
0	0.2
1	0.8

X_{t+1}	X_t	$P(X_{t+1}\|X_t)$
0	0	0.3
1	0	0.7
0	1	0.05
1	1	0.95

E_t	X_t	$P(E_t\|X_t)$
a	0	0.3
b	0	0.15
c	0	0.55
a	1	0.1
b	1	0.45
c	1	0.45

In this question we'll assume the sensor is broken and we get no more evidence readings after E_2. 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 $P_\infty(X_\infty)$ defined as follows:

$$P_\infty(X_\infty) := \lim_{t \to \infty} P(X_t \mid E_1, E_2)$$

Q4.1

10 Points

Recall that the stationary distribution satisfies the equation

$$P_\infty(X_\infty) = \sum_{X_\infty} P(X_{t+1} \mid X_t) P_\infty(X_\infty)$$

for all values in the domain of X.

In the case of this problem, we can write these relations as the following equations:

$$aP_\infty(X_\infty = 0) + bP_\infty(X_\infty = 1) = P_\infty(X_\infty = 0)$$

$$cP_\infty(X_\infty = 0) + dP_\infty(X_\infty = 1) = P_\infty(X_\infty = 1)$$

In the spaces below, fill in the coefficients of the linear system.

a

Enter your answer here

b

Enter your answer here

c

Enter your answer here

d

Enter your answer here

Save Answer

Q4.2

10 Points

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 below.

$P_\infty(X_\infty = 0)$

Enter your answer here

$P_\infty(X_\infty = 1)$

Enter your answer here

Save Answer

Save All Answers

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