

Show all of your work for all problems. In all cases if you round your answer include at least three significant digits, e.g., 0.995, 0.00000456, etc.

## 1 No one warned me about the earthquakes...

Dr. Kuntz's dog barks a lot. He (the dog, not Dr. Kuntz) barks for many reasons. In the last few years, we've observed him bark under three events (Event = m,q,n): when the mailperson is here (m), when an earthquake happens (q), and when neither is happening (n). We have the probability distribution over the events,  $P(E)$ , and the conditional probability distributions of the boolean random variable barking ( $B = \{+b, -b\}$ ) given an event as:

Event	$P(E)$
m	0.10
q	0.02
n	0.88

Barking	Event	$P(B Event)$
+b	m	0.8
-b	m	0.2
+b	q	0.9
-b	q	0.1
+b	n	0.4
-b	n	0.6

Oh no! Dr. Kuntz's dog is barking again! We want to know the probability that an event is happening given the evidence of the dog barking.

**Given that the dog is barking** please compute the probability of each type of event by computing  $P(Event|+b)$ , filling in the table below. Show your work below the table.

Event	$P(Event   +b)$
m	
q	
n	

## 2 Inference

Given the boolean random variables  $X$ ,  $Y$ , and  $Z$ , and the following model:

$$P(+x) = 0.9$$

$$P(-x) = 0.1$$

$$P(+y|+x) = 0.7$$

$$P(+y|-x) = 0.6$$

$$P(+z|+x) = 0.7$$

$$P(+z|-x) = 0.3$$

$Y \perp\!\!\!\perp Z \mid X$  (i.e.,  $Y$  and  $Z$  are conditionally independent, given  $X$ )

Please compute (and show your work):

(a)  $P(-y|+x)$

Answer: \_\_\_\_\_

(b)  $P(-z|-x)$

Answer: \_\_\_\_\_

Name and UID: \_\_\_\_\_

(c)  $P(-y|+x,+z)$

Answer: \_\_\_\_\_

(d)  $P(+y,-z,-x)$

Answer: \_\_\_\_\_

(e)  $P(-y)$

Answer: \_\_\_\_\_

Name and UID: \_\_\_\_\_

(f)  $P(+y|+z)$

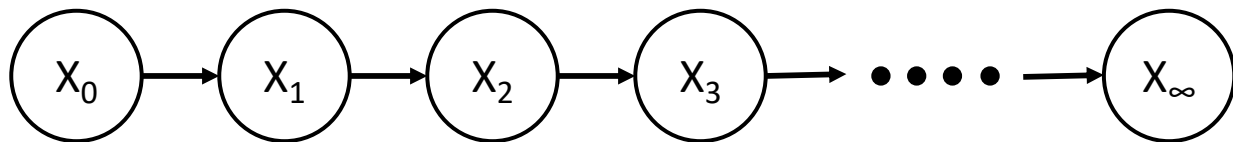
Answer: \_\_\_\_\_

(g)  $P(-y|+z)$

Answer: \_\_\_\_\_

### 3 Markov Models

Consider the following Markov model:



$X_0$	$P(X_0)$
$+x_0$	0.85
$-x_0$	0.15

$X_t$	$X_{t+1}$	$P(X_{t+1} X_t)$
$+x_t$	$+x_{t+1}$	0.7
$+x_t$	$-x_{t+1}$	0.3
$-x_t$	$+x_{t+1}$	0.4
$-x_t$	$-x_{t+1}$	0.6

Please answer the following questions, showing your work.

1. What is  $P(X_2)$ ?

Answer: \_\_\_\_\_

2. What is  $P(X_\infty)$ ?

Answer: \_\_\_\_\_