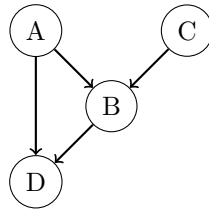


Q1. Bayes Nets: Representation



Consider the Bayes net graph depicted above.

(a) Select all conditional independences that are enforced by this Bayes net graph.

- $A \perp\!\!\!\perp B$
- $D \perp\!\!\!\perp C \mid A, B$
- $A \perp\!\!\!\perp C$
- $D \perp\!\!\!\perp C$

(b) Here are some partially-filled conditional probability tables on $A, B, C,$ and D . Note that these are not necessarily factors of the Bayes net. Fill in the six blank entries such that this distribution can be represented by the Bayes net.

A	C	$P(C \mid A)$
$+a$	$+c$	0.8
$+a$	$-c$	0.2
$-a$	$+c$	0.8
$-a$	$-c$	0.2

A	B	D	$P(D \mid A, B)$
$+a$	$+b$	$+d$	0.60
$+a$	$+b$	$-d$	0.40
$+a$	$-b$	$+d$	0.10
$+a$	$-b$	$-d$	0.90
$-a$	$+b$	$+d$	0.20
$-a$	$+b$	$-d$	0.80
$-a$	$-b$	$+d$	0.50
$-a$	$-b$	$-d$	0.50

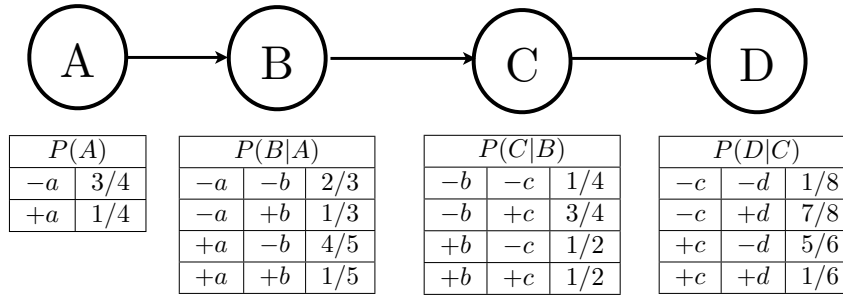
A	B	C	$P(C \mid A, B)$
$+a$	$+b$	$+c$	0.50
$+a$	$+b$	$-c$	0.50
$+a$	$-b$	$+c$	0.20
$+a$	$-b$	$-c$	0.80
$-a$	$+b$	$+c$	0.90
$-a$	$+b$	$-c$	0.10
$-a$	$-b$	$+c$	0.40
$-a$	$-b$	$-c$	0.60

C	$P(C)$
$+c$	(i)
$-c$	(ii)

A	B	C	D	$P(D, C \mid A, B)$
$+a$	$+b$	$+c$	$+d$	(iii)
$+a$	$+b$	$-c$	$-d$	(iv)
$+a$	$-b$	$+c$	$+d$	(v)
$+a$	$-b$	$-c$	$-d$	(vi)
\vdots	\vdots	\vdots	\vdots	\vdots

Q2. Bayes' Nets Sampling

Assume the following Bayes' net, and the corresponding distributions over the variables in the Bayes' net:



(a) You are given the following samples:

$(+a, +b, -c, -d)$
 $(+a, -b, +c, -d)$
 $(-a, +b, +c, -d)$
 $(-a, -b, +c, -d)$

$(+a, -b, -c, +d)$
 $(+a, +b, +c, -d)$
 $(-a, +b, -c, +d)$
 $(-a, -b, +c, -d)$

(i) If these samples came from doing Prior Sampling, calculate our sample estimate of $P(+c)$.

(ii) Now we will estimate $P(+c | +a, -d)$. Above, clearly cross out the samples that would **not** be used when doing Rejection Sampling for this task, and write down the sample estimate of $P(+c | +a, -d)$.

(b) Using Likelihood Weighting Sampling to estimate $P(-a | +b, -d)$, the following samples were obtained. What is the weight of each sample?

Sample	Weight
$-a \quad +b \quad +c \quad -d$	_____
$+a \quad +b \quad +c \quad -d$	_____
$+a \quad +b \quad -c \quad -d$	_____
$-a \quad +b \quad -c \quad -d$	_____

(c) From the weighted samples, estimate $P(-a | +b, -d)$.

(d) Recall that during Gibbs Sampling, samples are generated through an iterative process.

Assume that the only evidence that is available is $A = +a$. Which sequence(s) below could have been generated by Gibbs Sampling?

Sequence 1	Sequence 2	Sequence 3	Sequence 4
1: $+a \quad -b \quad -c \quad +d$	1: $+a \quad -b \quad -c \quad +d$	1: $+a \quad -b \quad -c \quad +d$	1: $+a \quad -b \quad -c \quad +d$
2: $+a \quad -b \quad -c \quad +d$	2: $+a \quad -b \quad -c \quad -d$	2: $+a \quad -b \quad -c \quad -d$	2: $+a \quad -b \quad -c \quad -d$
3: $+a \quad -b \quad +c \quad +d$	3: $-a \quad -b \quad -c \quad +d$	3: $+a \quad +b \quad -c \quad -d$	3: $+a \quad +b \quad -c \quad +d$