

CS 486/686 Spring 2023

Assignment 2 Solutions

February 10, 2026

Question 2a

D	$Pr(D)$
f	0.9
t	0.1

Y	$Pr(Y)$
f	0.2
t	0.8

Y	M	$Pr(M Y)$
f	f	0.9
f	t	0.1
t	f	0.96
t	t	0.04

Y	M	S_1	$Pr(S_1 M, Y)$
f	f	f	0.98
f	f	t	0.02
f	t	f	0.8
f	t	t	0.2
t	f	f	0.98
t	f	t	0.02
t	t	f	0.95
t	t	t	0.05

D	M	S_2	$Pr(S_2 D, M)$
f	f	f	0.99
f	f	t	0.01
f	t	f	0.99
f	t	t	0.01
t	f	f	0.5
t	f	t	0.5
t	t	f	0.9
t	t	t	0.1

D	S_3	$Pr(S_3 D)$
f	f	0.95
f	t	0.05
t	f	0.8
t	t	0.2

Question 2b

Part I - Prior Probability

Renaming CPTs as factors:

D	$f_0(D)$
f	0.9
t	0.1

Y	$f_1(Y)$
f	0.2
t	0.8

Y	M	$f_2(Y, M)$
f	f	0.9
f	t	0.1
t	f	0.96
t	t	0.04

Y	M	S_1	$f_3(Y, M, S_1)$
f	f	f	0.98
f	f	t	0.02
f	t	f	0.8
f	t	t	0.2
t	f	f	0.98
t	f	t	0.02
t	t	f	0.95
t	t	t	0.05

D	M	S_2	$f_4(D, M, S_2)$
f	f	f	0.99
f	f	t	0.01
f	t	f	0.99
f	t	t	0.01
t	f	f	0.5
t	f	t	0.5
t	t	f	0.9
t	t	t	0.1

D	S_3	$f_5(D, S_3)$
f	f	0.95
f	t	0.05
t	f	0.8
t	t	0.2

Eliminating hidden variables:

Eliminating Y : new factor

M	S_1	$f_6(M, S_1)$
f	f	0.92904
f	t	0.01896
t	f	0.0464
t	t	0.0056

Eliminating M : new factor

D	S_1	S_2	$f_7(D, S_1, S_2)$
f	f	f	0.9656856
f	f	t	0.0097544
f	t	f	0.0243144
f	t	t	0.0002456
t	f	f	0.5062800
t	f	t	0.4691600
t	t	f	0.0145200
t	t	t	0.0100400

Eliminating S_2 : new factor

D	S_1	$f_8(D, S_1)$
f	f	0.97544
f	t	0.02456
t	f	0.97544
t	t	0.02456

Eliminating D : new factor

S_1	S_3	$f_9(S_1, S_3)$
f	f	0.9120364
f	t	0.0634036
t	f	0.0229636
t	t	0.0015964

Eliminating S_3 : new factor

S_1	$f_{10}(S_1)$
f	0.97544
t	0.02456

Multiplying remaining factors and normalizing the answer:

S_1	$Pr(S_1)$
f	0.97544
t	0.02456

Part II - Posterior Probability

Renaming CPTs as factors and restricting factors:

D	$f_0(D)$
f	0.9
t	0.1

Y	$f_1(Y)$
f	0.2
t	0.8

Y	M	$f_2(Y, M)$
f	f	0.9
f	t	0.1
t	f	0.96
t	t	0.04

Y	M	S_1	$f_3(Y, M, S_1)$
f	f	f	0.98
f	f	t	0.02
f	t	f	0.8
f	t	t	0.2
t	f	f	0.98
t	f	t	0.02
t	t	f	0.95
t	t	t	0.05

D	M	$f_4(D, M)$
f	f	0.99
f	t	0.99
t	f	0.5
t	t	0.9

D	$f_5(D)$
f	0.05
t	0.2

Eliminating hidden variables:

Eliminating Y : new factor

M	S_1	$f_6(M, S_1)$
f	f	0.92904
f	t	0.01896
t	f	0.0464
t	t	0.0056

Eliminating M : new factor

D	S_1	$f_7(D, S_1)$
f	f	0.9656856
f	t	0.0243144
t	f	0.5062800
t	t	0.0145200

Eliminating D : new factor

S_1	$f_8(S_1)$
f	0.05358145
t	0.00138455

Multiplying remaining factors and normalizing the answer:

S_1	$Pr(S_1 S_3=t, S_2=f)$
f	0.97481083
t	0.02518917

Question 2c

Part I: $Pr(S_1|S_3=t, S_2=f, M=t)$

Renaming CPTs as factors and restricting factors:

	D	$f_0(D)$
	f	0.9
	t	0.1
	Y	$f_1(Y)$
	f	0.2
	t	0.8
	Y	$f_2(Y)$
	f	0.1
	t	0.04
Y	S_1	$f_3(Y, S_1)$
f	f	0.8
f	t	0.2
t	f	0.95
t	t	0.05
	D	$f_4(D)$
	f	0.99
	t	0.9
	D	$f_5(D)$
	f	0.05
	t	0.2

Eliminating hidden variables:

Eliminating Y : new factor

S_1	$f_6(S_1)$	
f		0.0464
t		0.0056

Eliminating D : new factor

$$f_7()$$

$$0.06255$$

Multiplying remaining factors and normalizing the answer:

S_1	$Pr(S_1 S_3=t, S_2=f, M=t)$
f	0.89230769
t	0.10769231

Part II: $Pr(S_1|S_3=t, S_2=f, do(M)=t)$

Renaming CPTs as factors and restricting factors:

D		$f_0(D)$
f		0.9
t		0.1
Y		$f_1(Y)$
f		0.2
t		0.8
Y	S_1	$f_2(Y, S_1)$
f	f	0.8
f	t	0.2
t	f	0.95
t	t	0.05
D		$f_3(D)$
f		0.99
t		0.9
D		$f_4(D)$
f		0.05
t		0.2

Eliminating hidden variables:

Eliminating Y : new factor

S_1	$f_5(S_1)$
f	0.92
t	0.08

Eliminating D : new factor

$f_6()$
0.06255

Multiplying remaining factors and normalizing the answer:

S_1	$Pr(S_1 S_3=t, S_2=f, do(M)=t)$
f	0.92
t	0.08

Question 3a

Each question 2 points, 1 for correct answer, 1 for justification.

- i Dependent. Apply rule 1. Path open: $D \rightarrow G, D \rightarrow F \rightarrow G$.
- ii Dependent. Apply rule 1. Path open: $D \rightarrow G$.
- iii Independent. Apply rule 3. Path blocked: $A \rightarrow B \leftarrow \sim G$
- iv Dependent. Apply rule 3. Path open: $A \rightarrow B \leftarrow \sim G$
- v Independent. Apply rule 1. Path blocked: $A \sim \leftarrow C \leftarrow \sim G$. Apply rule 2 or rule 3. Path blocked: $A \sim \leftarrow C \rightarrow \sim G$. Path blocked: $A \sim \leftarrow E \rightarrow \sim G$.
- vi Independent. Apply rule 2. Path blocked: $A \sim \leftarrow D \rightarrow \sim G$. Apply rule 3. Path blocked: $A \sim \rightarrow E \leftarrow \sim G$
- vii Dependent. Apply rule 3. Path open: $A \sim \rightarrow B \leftarrow \sim \rightarrow E \leftarrow \sim G$

Question 3b

2 points will be subtracted if one relevant variable is wrong. 1 points will be subtracted if justification is wrong.

- C is relevant because it is query.
- D is relevant because it is a parent of relevant variable(C).
- E is relevant because it is in evidence and a descendent of relevant variable(C,D)
- F is relevant because it is a parent of relevant variable(E).