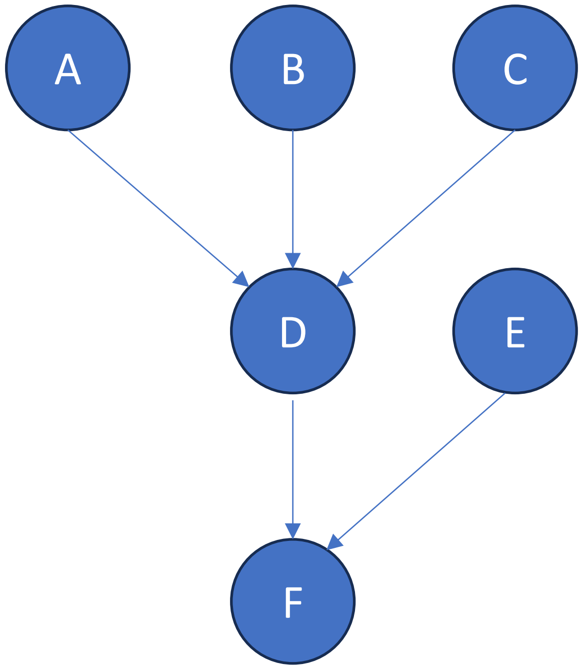
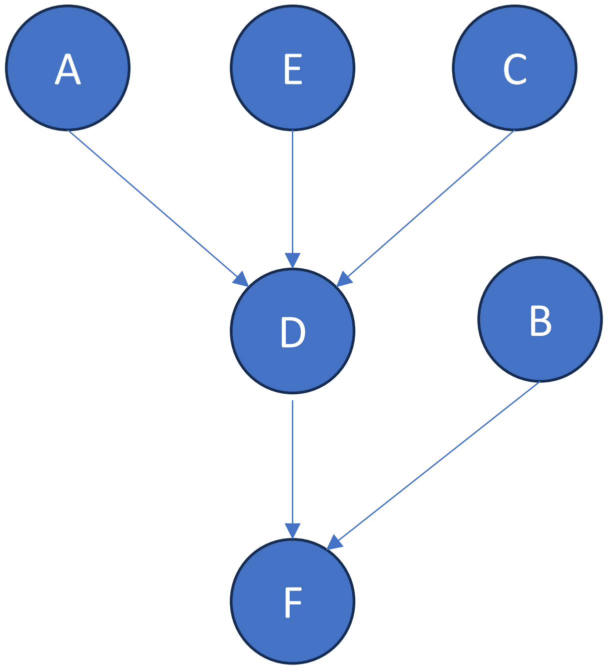
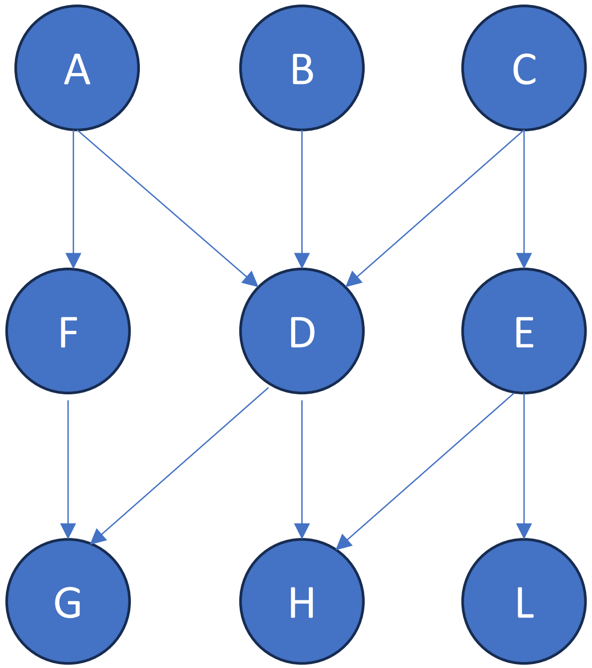
Answer

Among the following Bayesian networks, which graphs imply “F conditionally independent of A given D and E”?





Given the following Bayesian network, determine which of the given independence relationship holds correct.



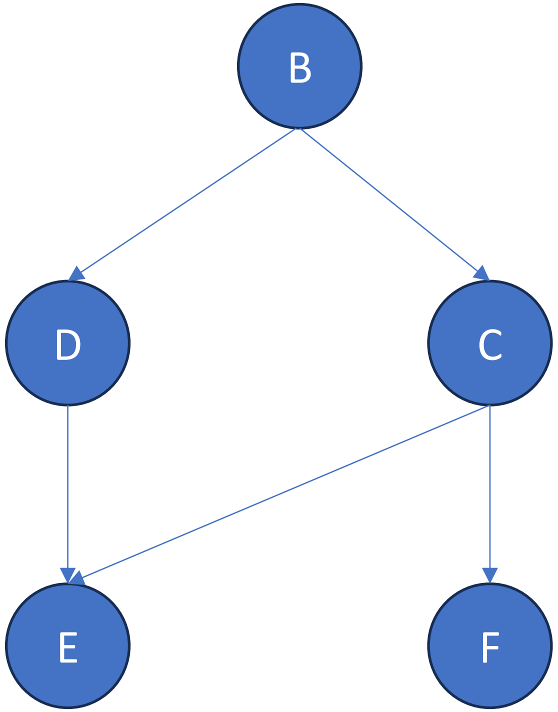
a) C independent of A
b) H independent of A
c) C independent of H
d) A independent of G

Answer

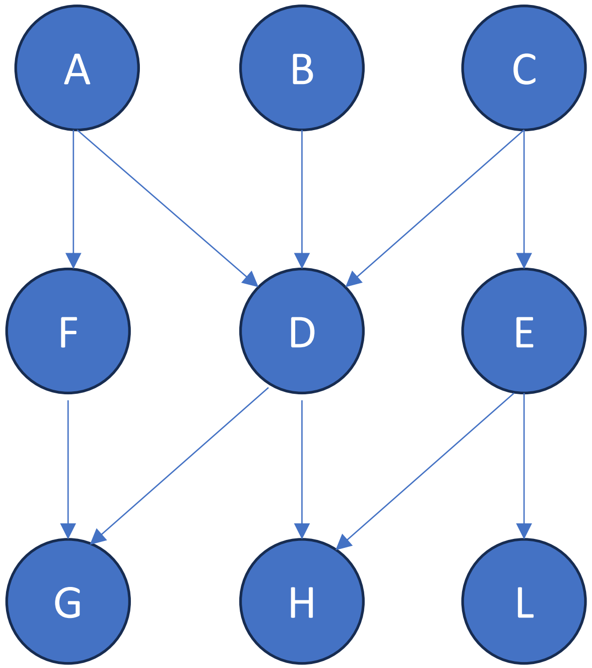
Given the following Bayesian Network, determine the number of independent parameters required to specify this Bayesian network.

1 for B
2 for D | B ➔ **(D=T|B=T) =0.8 and (D=T|B=F)=0.3**, (D=F|B=T) =1-0.8 =0.2, (D=F|B=F) =1-0.3 = 0.7
2 for C | B
4 for E | D, C ➔ (E=T|D=T,C=T)=0.1, (E=T|D=T,C=F)=0.2, (E=T|D=F,C=T)=0.3, (E=T|D=F,C=F)=0.5
2 for F | C

Total = 11 independent parameters. Rest can be generated using the complement.



In the given Bayesian Network, which node(s) when considered as evidence would render the statement "A and B are independent" as False?



- A) G, H or D

- B) E or L

- C) Only D

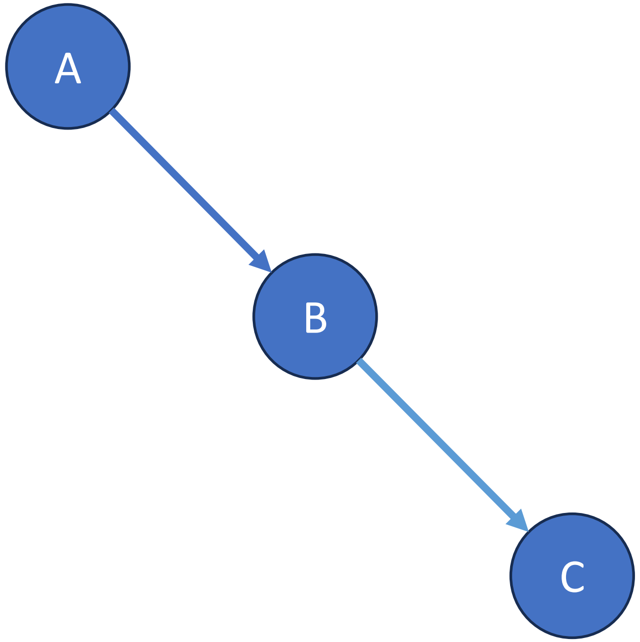
- D) F or E

Consider a Bayesian network with three binary variables A, B, and C. The network structure is as shown in figure. If B is unobserved, which statement about conditional independence is correct?

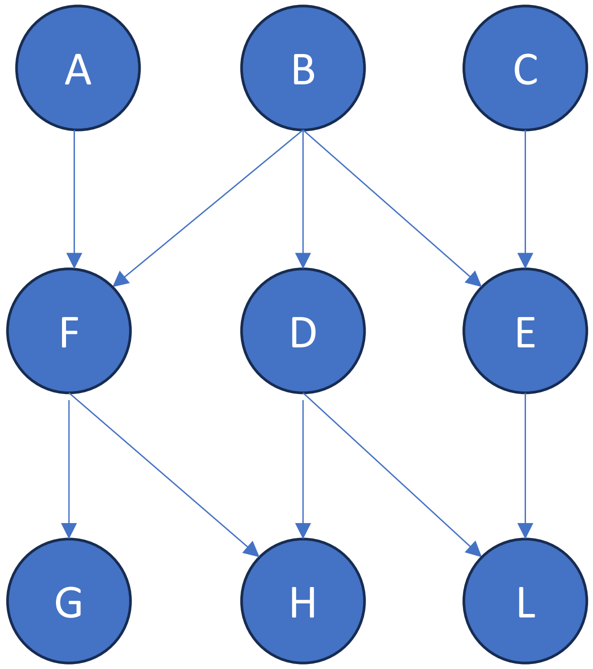
A) A and C are unconditionally dependent

B) A and C are unconditionally independent

C) No conditional independence statements can be made about A and C



Which of the following statements is correct for the given Bayesian Network?



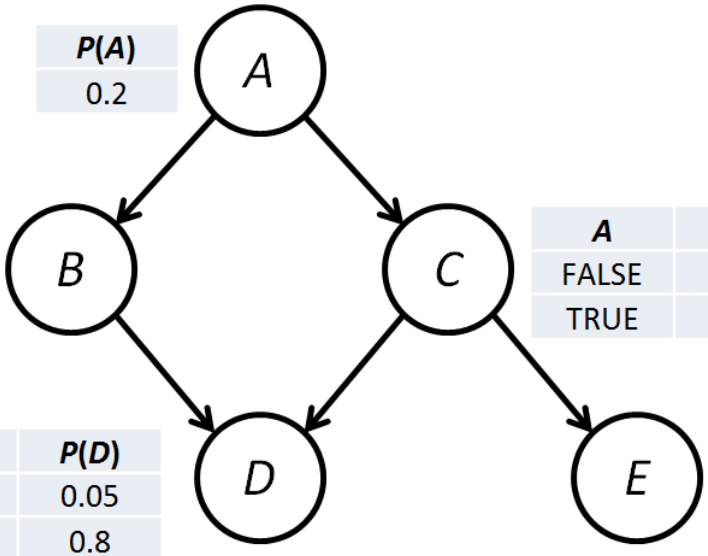
A) A and G are conditionally independent given E

B) B and L are conditionally independent given E and D

C) C and E are independent

D) D and L are conditionally independent given C

For the given Bayesian Network, calculate the probability of P(+D | -A, -C, +B, +E). Give your answer to the tenths place.



P(A)
0.2

A	P(B)
FALSE	0.2
TRUE	0.8

A	P(C)
FALSE	0.05
TRUE	0.2

B	C	P(D)
FALSE	FALSE	0.05
FALSE	TRUE	0.8
TRUE	FALSE	0.8
TRUE	TRUE	0.8

C	P(E)
FALSE	0.6
TRUE	0.8

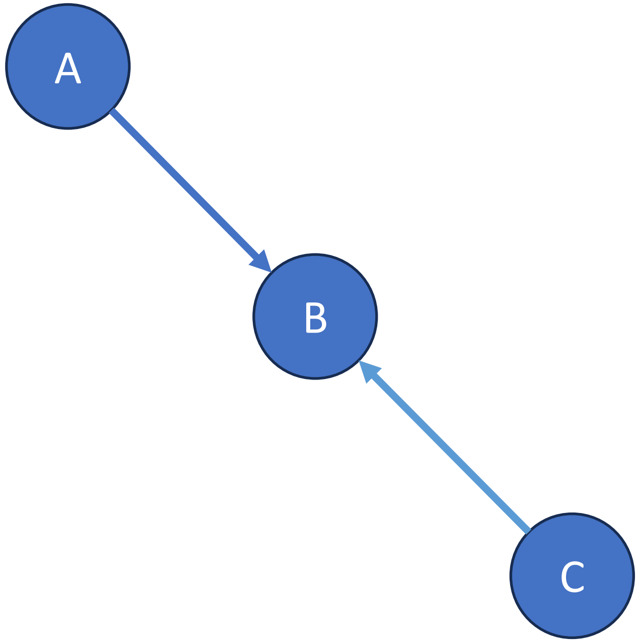
"Each variable is conditionally independent of all its non- descendants in the graph given the value of all its parents."

$$P(+D|-A,-C,+B,+E)=P(+D|-C,+B)=0.8$$

Image Credits: http://modelai.gettysburg.edu/2017/mc2/index.html

Consider a Bayesian network with three binary variables A, B, and C. The network structure is as shown in figure. If B is observed to be true, which statement about conditional independence is correct?

- A) A and C are conditionally independent given B
- B) A and C are conditionally dependent given B
- C) A and C are unconditionally independent
- D) No conditional independence statements can be made about A and C



Consider a mouse exploring a 6-by-6 grid of cheese locations labeled using (row, column) coordinates from (1,1) to (6,6). At each time step t, the mouse is at some location X(t). With probability 0.3, it teleports randomly to a new location. Otherwise, it moves randomly to an adjacent location, unless that would take it outside the grid.

Suppose at t=1, X(1)=(1,1). At t=2, it moves to X(2)=(4,2). At time t=3, you then observe E(3)=(5,Y) where Y is unobserved.

Given the observations so far, what is the probability the mouse is at location (5,2) at time t=3?

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2,	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

First fill in the blanks then solve the question:
* At t=1, X(1)=(1,1)
* At t=2, X(2)=(4,2)
* At t=3, we observe E(3)=(5,Y) where Y is unobserved. This tells us the mouse is in row 5 at t=3.
* We want to find P(X (t=3)= (5,2) |E(3))
* With probability 0.3, the mouse teleports randomly to any cell
* With probability 0.7, the mouse moves randomly to an adjacent cell
* Since E(3)=5, the mouse must be in row 5 at t=3
* There are 6 possible cells in row 5

Answer

- We know that at t=2, the mouse was at (4,2) [GIVEN E(2) = (4,2)]
- Without considering the Evidence E(3) = (5,Y)
  - At t=3, P(5,2) = P(adj movement) + P(teleportation) = (0.7 * 1/4) + (0.3 * 1/36) = 0.175 + 0.008 = 0.183
  - At t=3, P(5,Y) = P(adj movement) + P(teleportation) = (0.7 * 0) + (0.3 * 1/36) = 0 + 0.008 = 0.008
- Now, considering the evidence E(3) = (5,Y), meaning the mouse is in row 5 at time step 3.
- Given this evidence, the possibility of mouse being in any row other than Row 5 is eliminated. Therefore, we must normalize the probabilities to reflect the probability of being in any given cell in Row 5.
- Normalization Constant = 1/z = 1 / {(1 * 0.183) + (5 * 0.008)} = 1 / 0.223
- P(5,2) normalized = 0.183 * 1/z = 0.183 * 1/0.223 = 0.820 = P(X(t=3) = (5,2) | E(t=3) = (5,Y))

Follow-up question on the previous environment and conditions.

What is the probability of mouse being in cells (5,1), (5,2), (5,5), (5,6)?

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2,	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

Which statement accurately describes the purpose of sampling methods in Bayesian networks?
- Sampling methods provide a way to estimate and approximate complex probability distributions.

In Bayesian networks, what is the primary purpose of D-separation?
- To reason about conditional independence relationships in the network.

Which of the following statements best describes the difference between rejection sampling and likelihood weighting for approximate inference in Bayesian networks?
- Likelihood weighting fixes the evidence variables while rejection sampling samples all variables

Answer

- We know from previous calculation:
  - Without considering the Evidence E(3) = (5,Y)
    - At t=3, P(5,2) = P(adj movement) + P(teleportation) = (0.7 * 1/4) + (0.3 * 1/36) = 0.175 + 0.008 = 0.183
    - At t=3, P(5,Y) = P(adj movement) + P(teleportation) = (0.7 * 0) + (0.3 * 1/36) = 0 + 0.008 = 0.008
  - Normalization Constant = 1/z = 1 / {(1 * 0.183) + (5 * 0.008)} = 1 / 0.223
  - P(5,2) normalized = 0.183 * 1/z = 0.183 * 1/0.223 = 0.820
- We need to calculate P(5,Y) normalized:
  - P(5,Y) normalized = 0.008 * 1/z = 0.008 * 1/0.223 = 0.035
- P(X={(5,1), (5,2), (5,5), (5,6)}) = P(5,2) + P{(5,1), (5,5), (5,6)} = 0.820 + (3 * 0.035) = 0.820 + 0.105 = 0.925

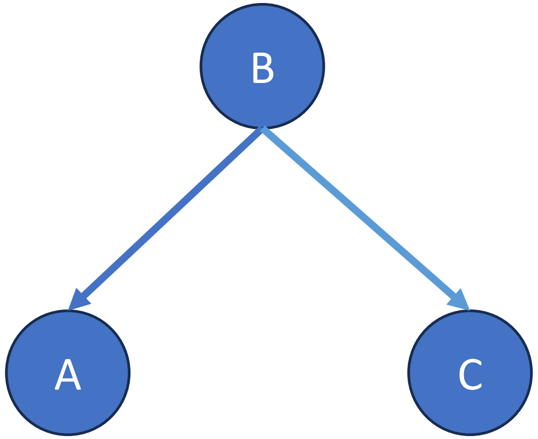
Consider a Bayesian network with three binary variables A, B, and C. The network structure is as shown in the figure. If B is observed to be false, which statement about conditional independence is correct?

A) A and C are conditionally independent given B

B) A and C are conditionally dependent given B

C) A and C are unconditionally independent

D) No conditional independence statements can be made about A and B



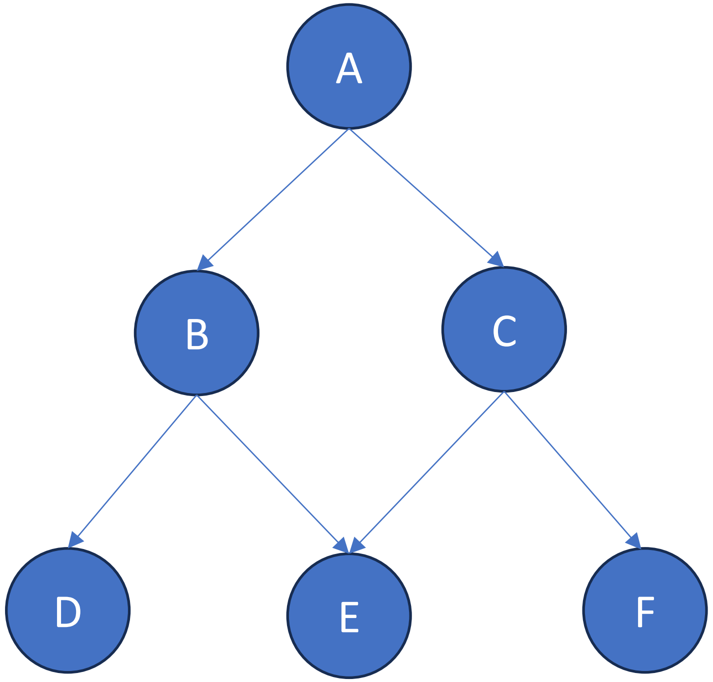
Consider the following table with Input Features (F1, F2, F3, F4, and F5) and Class Label (L). Assume the table shows all possibilities. Given a new example (Test) calculate the probability P(L = 1 | F4 = 1).

- **No.ofsampleswith(F4=1)=6**
- **No.ofsampleswith(F4=1andL=1)=3**
- **P(L=1|F4=1) = # of samples(F4=1, L=1) / # of samples(F4=1) = 3/6**
- **P(L=1|F4=1) = 1/2**

F1	F2	F3	F4	F5	L
0	1	0	1	1	0
1	0	1	0	1	1
1	1	0	1	0	1
0	0	1	1	1	0
1	1	1	0	0	1
0	1	1	1	0	0
1	0	0	1	1	1
1	1	1	1	1	1
0	0	0	0	1	0
1	0	1	0	0	1

Answer

`Given the following Bayesian Network, how many factors are needed to sample "A" using MCMC sampling? (Integer answer type question.)`



- MCMC sampling is used for ascertaining Posterior Distributions.
- A is parent to only B and C
- A has no parents
- Factors needed to sample A:
  - P(B|A)
  - P(C|A)

Answer

`Given the following Bayesian Network, how many factors are needed to sample "C" using MCMC sampling? (Integer answer type question.)`

- C has a parent A
- C is a parent to E and F.
- Essentially, we need to factor all distributions where value C effects the CPT.
- Therefore, factors are:
    - P(C|A)
    - P(F|C)
    - P(E|B,C)
- Therefore, the answer is 3.