Building/Assessing Bayes Net Models

In the lecture notes we saw that in many real work examples it was possible to find conditional independencies/causations that allow us to construct good Bayes Net models.

We can also use our understanding of causation/independence to critique different Bayes net models.

Building/Assessing Bayes Net Models

Two astronomers in different parts of the world make measurements M_1 and M_2 of the number of stars N in some small region of the sky, using their telescopes. Normally, there is a small probability e or error of up to one star in each direction. Each telescope can also be badly out of focus with probability f. Let F_1 and F_2 be boolean variables with $F_i = true$ being that the i-th telesope is out of focus. If the telescope is out of focus then the scientist will always undercount by 3 or more stars (or, if N is 3 or less, fail to detect any stars at all).

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Variables

N—true number of stars in that region of the sky

M1 measurement made by telescope one.

M2 measurement made by telescope two

F1 Telescope one is out of focus

F2 Telescope two is out of focus

N, M1, M2 integers >= 0

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Probabilities:

Each Telescope

f probability of being out of focus Fi = true

If Fi = false,

N - Mi = -1 probability e

N - Mi = 1 probability e

If Fi = true

N – Mi >= 3 probability 1.

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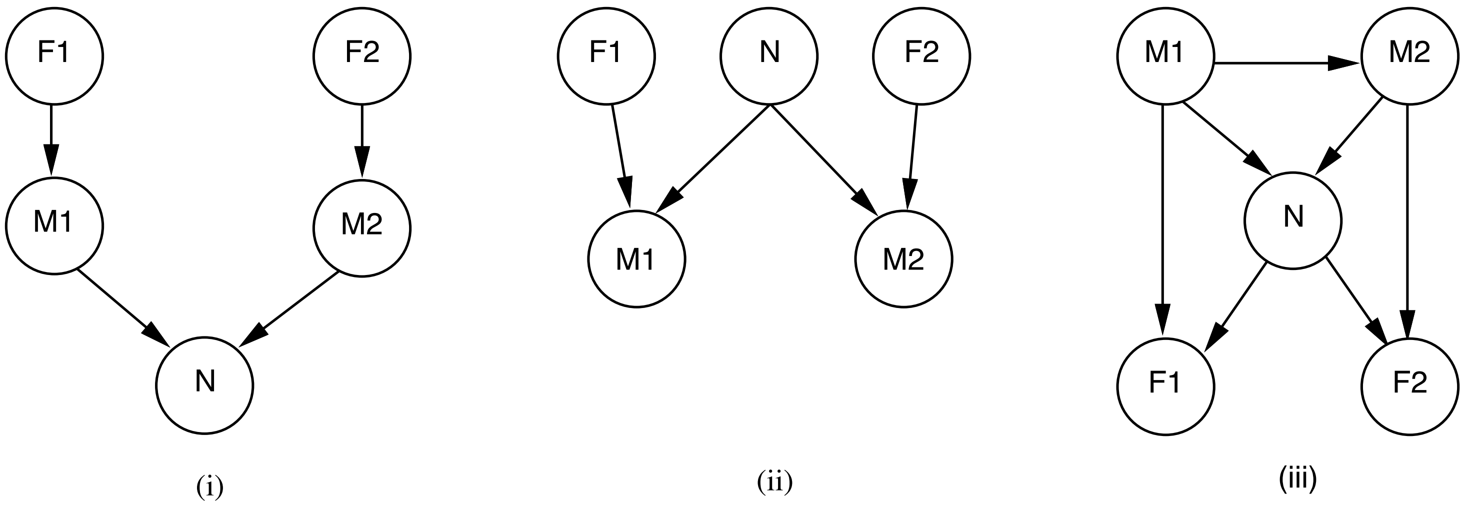

Which of these Bayes Nets can correctly represent this example?

Which of the correct Networks is the best representation

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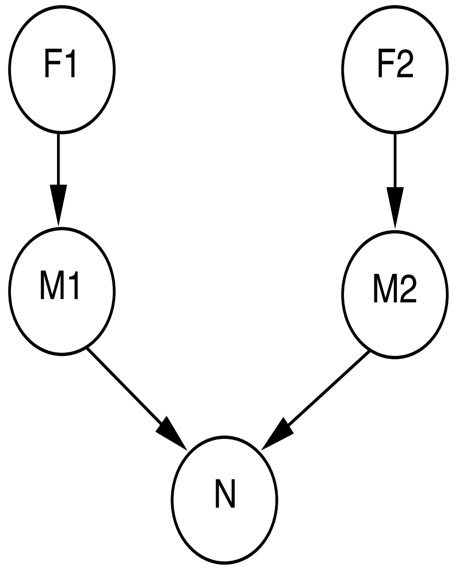

(i)

- Choose ordering of variables such that parents come before children.
- Write chain rule decomposition of this ordering—know that the chain rule always produces a correct decomposition.
- Using our common sense intuitions ask if this chain rule decomposition can be simplified to be the same decomposition as the Bayes net.

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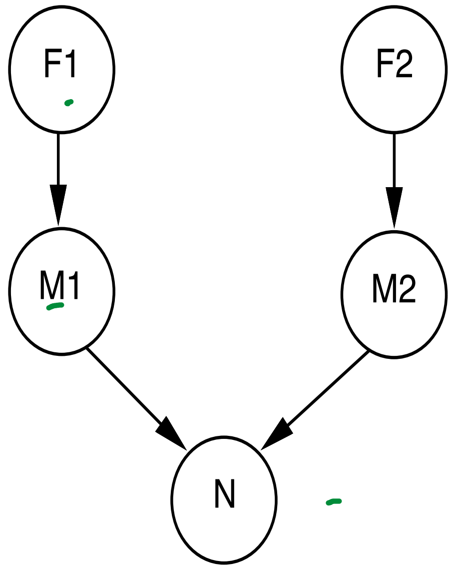

(i)

Chain Rule:

P(F1, F2, M1, M2, N) =
P(N | F1, F2, M1, M2)*
P(M2 | F1, F2, M1) *
P(M1 | F1, F2) *
P(F2 | F1) *
P(F1)

Bayes Net decomposition:

P(F1, F2, M1, M2, N)) =
P(N | M1, M2) *
P(M2 | F2) *
P(M1 | F1) *
P(F2) *
P(F1)

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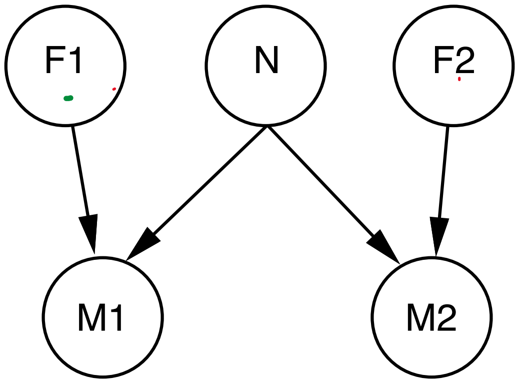

(ii)

Chain Rule:

P(F1, N, F2, M1, M2) =

P(M2 | F1, N, F2, M1)*
P(M1 | F1, N, F2) *
P(F2 | F1, N) *
P(N | F1) *
P(F1)

Bayes Net decomposition:

P(F1, N, F2, M1, M2) =

P(M2 | N, F2)*
P(M1 | F1, N) *
P(F2) *
P(N) *
P(F1)

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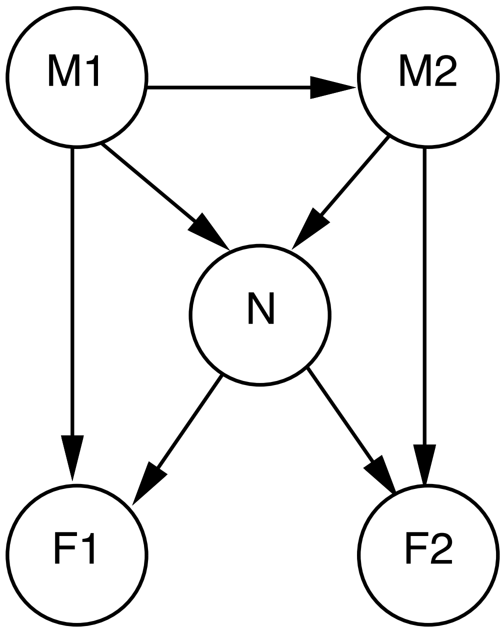

(iii)

Chain Rule:

P(M1, M2,N,F1, F2) =

P(F2 | M1, M2,N,F1)*
P(F1 | M1, M2,N) *
P(N | M1, M2) *
P(M2 | M1) *
P(M1)

Bayes Net decomposition:

P(M1, M2,N,F1, F2) =

P(F2 | M2, N)*
P(F1 | M1, N) *
P(N | M1, M2) *
P(M2| M1) *
P(M1)