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CS165a Homework 2

1.

A. No, it is not true because X and Y are not conditionally independent given W. If W was the parent of X and Y, then they would be conditionally independent. Also, W and Y are not independent variables, meaning P(W) does not equal P(W, Y)

B. P(X|Y) = ∑i∑j ∑k ∑l P(X, Y, Ui, Vj, Wk, Zl)/ ∑i ∑j ∑k ∑l ∑m P(Xi, Y, Zj, Uk, Vl, Wm)

C. Yes, because all paths between the have to go through Y which is in the evidence set, or through a mutual descendent, that is not in the evidence set, and neither are any of its children.

D. No, they are not conditionally independent given U, because they have a common child in the evidence set.

E. No, they are not independent because they share a common ancestor.

F.

G. P(U = 1 | W = 1, V = 1) \* P(W = 1 | X = 0, Y = 0) \* P(V = 1 | Z = 1 , Y = 0) \* P(X = 0) \* P(Y = 0) \* P(Z = 1)

2.

Model A

|  |  |
| --- | --- |
| Open | P(Open) |
| T | 0.5 |
| F | 0.5 |

Open Surgery

|  |  |
| --- | --- |
| Open | P(Recover  | Open) |
| T | 0.78 |
| F | 0.83 |

Recovery

Model B

|  |  |
| --- | --- |
| Size | P(Size) |
| Large | 0.49 |
| Small | 0.51 |

Stone Size

Open Surgery

|  |  |
| --- | --- |
| Open | P(Open) |
| T | 0.5 |
| F | 0.5 |

Recovery

|  |  |  |
| --- | --- | --- |
| Size | Open | P(Recover  | Open, Size) |
| Large | T | 0.73 |
| Small | T | 0.93 |
| Large | F | 0.69 |
| Small | F | 0.87 |

Model C

|  |  |
| --- | --- |
| Open | P(Recover  | Open) |
| Large | 0.49 |
| Small | 0.51 |

Stone Size

Open Surgery

|  |  |
| --- | --- |
| Size | P(Open  | Size) |
| Large | 0.77 |
| Small | 0.23 |

Recovery

|  |  |  |
| --- | --- | --- |
| Size | Open | P(Recover  | Open, Size) |
| Large | T | 0.73 |
| Small | T | 0.93 |
| Large | F | 0.69 |
| Small | F | 0.87 |

B. No, Small puncture is better when only considering open surgery vs small puncture, and when not considering stone size. This is not consistent across all models, because the probabilities do not get weighted based upon their stone size in every model. When considering stone size, we see that open surgery is better for both stone sizes, however there is a higher probability that small stones will be removed with small puncture, and that large stones will be removed with open surgery. We clearly see that the best surgery type depends on the size of the stone as well. Small stone with open surgery has best rate of recovery, but that option has a lower probability of occurring.

C.

In Model B, Open Surgery and Stone Size are marginally independent.

No nodes are conditionally independent in Model B.

No nodes are marginally independent in Model C.

No nodes are conditionally independent in Model C.

D. I think that model C is the best model, because it shows how the size of the stone affects both the surgery type and the recovery rate. This helps better characterize exactly how the size of the stone effect the recovery both directly and indirectly through the surgery type. The conditional probability greatly effects the interpretation of the data, as well as being able model it more accurately.

3.

A.

Likelihood(θ | x) = PDFθ(x)

Likelihood(θ | x) = PDFθ(xi; μ, σ)

Likelihood(θ | xi; μ, σ) = Πni=1 (1/(σ(2π)1/2))\*(e-1/2((xi-μ)/σ)^2))

B.

LogLikelihood = ln(Likelihood(θ | xi; μ, σ))

LogLikelihood(θ | xi; μ, σ) = ln(Πni=1 (1/(σ(2π)1/2))\*(e-1/2((xi-μ)/σ)^2)))

LogLikelihood(θ | xi; μ, σ) = ln((1/(σ(2π)1/2))n) + Σni=1 ln(e-1/2((xi-μ)/σ)^2))

LogLikelihood(θ | xi; μ, σ) = -n\*ln(σ)/2 – n\*ln(2π)/2 + Σni=1 -1/2((xi-μ)/σ)2

C.

MLEμ = d/dμ (ln((1/(σ(2π)1/2))n + Σni=1 -1/2((xi-μ)/σ)2)

x ̅ = Σni=1 xi/n

Σni=1 xi-μ = (x ̅ - μ)\*n

MLEμ = 0 – ½\*-2n( -μ)/σ2

0 = – ½\*-2n( -μ)/σ2

μ =

MLEσ = d/dσ (ln((1/(σ(2π)1/2))n + Σni=1 -1/2((xi-μ)/σ)2)

MLEσ = d/dσ (nln(1) – n\*ln((σ(2π)1/2)) + Σni=1 -1/2((xi-μ)/σ)2)

MLEσ = d/dσ (nln(1) – n\*ln(σ) + (n/2)\*ln(2π) + Σni=1 -1/2((xi-μ)/σ)2)

MLEσ = 0 – n/σ + 0 – Σni=1 ½\*((xi-μ)2 \* σ-3 \* (-2)

nσ2 = Σni=1 (xi-μ)2

σ = ((Σni=1 (xi-μ)2)/n)1/2

D.

4.

A.

All – {a:3, great:1, game:2, the:1, election:2, was:2, over:1, very:1, clean:2, match:1, but:1, forgettable:1, it:1, close:1}

B.

D= 14

B = 5

K = 2

C. The sentence belongs to the “sports” class

D.

Laplace Smoothing estimates the expected value of the posterior distribution, while the MAP estimates the mode of the posterior distribution. If the distribution is a normal distribution, they the values will be equal but if the distribution is different this may not be the case.