CS440 Assignment2

Yeoun Chan Kim John Strauser Xuanang Wang

November 17, 2019

P1

A)
All five True = P(A,B,C,D,E) = P(A)P(B)P(C)P(D|A+B)P(E|B+C)
P(A) = 0.2
P(B) = 0.5
P(C) = 0.8
P(D|A+B) = 0.1
P(E|B+C) = 0.3
P(A,B,C,D,E) = 0.2*0.5*0.8*0.1*0.3 = 0.0024

B)
All five false = P(!A,!B,!C,!D,!E) = P(!A)P(!B)P(!C)P(!D|!A+!B)P(!E|!B+!C)
P(!A) = 0.8
P(!B) = 0.5
P(!C) = 0.2
P(!D|!A+!B) = 0.1
P(!E|!B+!C) = 0.8
P(!A,!B,!C,!D,!E) = 0.8*0.5*0.2*0.1*0.8 = 0.0064

C)
P(!A|B+C+D+E) = P(!A+B+C+D+E) / P(B+C+D+E)
P(!A+B+C+D+E) = P(!A)P(B)P(C)P(D|!A+B)P(E|B+C) = 0.8*0.5*0.8*0.6*0.3 = 0.0576
P(B+C+D+E) = P(B)P(C)P(D|B)P(E|B+C) = 0.5*0.8*0.7*0.3 = 0.084
P(!A|B+C+D+E) = 0.0576 / 0.084 = 0.6857

P2

A)
P(Burglary|JohnCalls + MaryCalls) = P(B,J,M,A,E) + P(B,J,M,A,!E) + P(B,J,M,!A,E) + P(B,J,M,!A,!E) / P(B,J,M) + P(!B,J,M)

P(B,J,M,A,E) = P(B)P(J|A)P(M|A)P(A|B+E)P(E) = 0.001*0.9*0.7*0.95*0.002 = 0.000001197

P(B,J,M,A,!E) = P(B)P(J|A)P(M|A)P(A|B+!E)P(!E) = 0.001*0.9*0.7*0.94*0.998 = 0.000591

P(B,J,M,!A,E) = P(B)P(J|!A)P(M|!A)P(-A|B+E)P(E) = 0.001*0.05*0.01*0.05*0.002 = 0.000000000005

P(B,J,M,!A,!E) = P(B)P(J|!A)P(M|!A)P(!A|B+!E)P(!E) = 0.001*0.05*0.01*0.06*0.998 = 0.0000000299

P(B,J,M) = P(B)(P(J|A)+P(J|!A))(P(M|A)+P(M|!A)) = 0.001*(0.9+0.05)*(0.7+0.01) = 0.0006745

P(!B,J,M) = P(!B)(P(J|A)+P(J|!A))(P(M|A)+P(M|!A)) = 0.999*(0.9+0.05)*(0.7+0.01) = 0.674

P(Burglary|JohnCalls + MaryCalls) = (0.000001197 + 0.000591 + 0.000000000005 + 0.0000000299)/(0.0006745 + 0.674) = 0.001

B) enumeration tree would be a straight line. Therefore worst case is that all n variables must be checked.

complexity using enumeration = O(n)

complexity using variable elimination = O(n)

P3

A)

OC : card holder owns a computer or smart phone.

Fraud : current transaction is fraudulent.

Trav : card holder is currently travelling.

FP : current transaction is a foreign purchase.

IP : current purchase is an internet purchase.

CRP : a computer related purchase was made in the past week

Trav | P(Fraud)
True 0.01
False 0.004

P(Trav) = 0.05

Trav Fraud | P(FP)
True True 0.9
True False 0.9
False True 0.1
False False 0.01

P(OC) = 0.75

OC Fraud | P(IP)
True True 0.01
True False 0.02
False True 0.001
False False 0.011

OC | P(CRP)
True 0.1
False 0.001

B)
P(Fraud) = (P(Fraud + Trav) + P(Fraud + !Trav)) / (P(Fraud) + P(!Fraud))
P(Fraud) = (P(Fraud|Trav)P(Trav) + P(Fraud|!Trav)P(!Trav)) / (1)
P(Fraud) = 0.01*0.05 + 0.004*0.95
P(Fraud) = 0.0043
P(Fraud | FP + !IP + CRP) = (P(Fraud + FP + !IP + CRP + Trav + OC)
+ P(Fraud + FP + !IP + CRP + Trav + !OC) + P(Fraud + FP + !IP + CRP
+ !Trav + OC) + P(Fraud + FP + !IP + CRP + !Trav + !OC))/(P(Fraud +
FP + !IP + CRP) + P(!Fraud + FP + !IP + CRP + Trav + OC))
P(Fraud + FP + !IP + CRP + Trav + OC) = P(Fraud|Trav)P(FP|Trav+Fraud)P(!IP|OC+Fraud)P(CR
= 0.01 * 0.9 * 0.99 * 0.1 * 0.05 * 0.75 = 0.0000334125
P(Fraud + FP + !IP + CRP + Trav + !OC) = P(Fraud|Trav)P(FP|Trav+Fraud)P(!IP|-
OC+Fraud)P(CRP|!OC)P(Trav)P(!OC) = 0.01 * 0.9 * 0.999 * 0.001 * 0.05 *
0.25 = 0.0000001124
P(Fraud + FP + !IP + CRP + !Trav + OC) = P(Fraud|!Trav)P(FP|!Trav+Fraud)P(!IP|OC+Fraud)P(C
= 0.004 * 0.1 * 0.99 * 0.1 * 0.95 * 0.75 = 0.000028215
P(Fraud + FP + !IP + CRP + !Trav + !OC) = P(Fraud|!Trav)P(FP|!Trav+Fraud)P(!IP|-
OC+Fraud)P(CRP|!OC)P(!Trav)P(!OC) = 0.004 * 0.1 * 0.999 * 0.001 * 0.95 *
0.25 = 0.0000000949
P(Fraud + FP + !IP + CRP) = (P(Fraud|Trav)+P(Fraud|!Trav))(P(FP|Trav+Fraud)+P(FP|!Trav+Fra
= (0.01+0.004)(0.9+0.1)(0.99+0.999)(0.1+0.001) = 0.014 * 1 * 1.989 * 0.101 =
0.002812446
P(!Fraud + FP + !IP + CRP) = (P(!Fraud|Trav)+P(!Fraud|!Trav))(P(FP|Trav+!Fraud)+P(FP|!Trav+!
= (0.99+0.996)(0.9+0.01)(0.98+0.989)(0.1+0.001) = 1.986 * 0.91 * 1.969 *
0.101 = 0.3594079889
P(Fraud | FP + !IP + CRP) = (0.0000334125 + 0.0000001124 + 0.000028215
+ 0.0000000949)/(0.002812446 + 0.3594079889) = 0.00017