Joint Probabilities

1. $P(X_n|X_{n-1}, X_{n-2}...X_1) = P(X_n|Parents(X_n))$
   $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = P(¬c|¬b)P(¬w|¬b)P(¬b|¬i,¬s)P(¬f|¬i)P(¬st|¬i)P(¬s)P(¬i)$
   $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = 0.93 * 0.999 * 0.9999 * 0.95 * 0.999 * 0.8 * 0.95$
   $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = 0.67005073968$
2. $P(¬c,¬w,¬b,¬f,st,¬s,¬i) = P(¬c|¬b)P(¬w|¬b)P(¬b|¬i,¬s)P(¬f|¬i)P(st|¬i)P(¬s)P(¬i)$
   $P(¬c,¬w,¬b,¬f,st,¬s,¬i) = 0.93 * 0.999 * 0.9999 * 0.95 * 0.001 * 0.8 * 0.95$
   $P(¬c,¬w,¬b,¬f,st,¬s,¬i) = 0.00067072146$
3. $P(¬c,¬w,¬b,¬f,¬s,¬i) = P(¬c,¬w,¬b,¬f,st,¬s,¬i) + P(¬c,¬w,¬b,¬f,¬st,¬s,¬i)$
   $P(¬c,¬w,¬b,¬f,¬s,¬i) = 0.67005073968 + 0.00067072146$
   $P(¬c,¬w,¬b,¬f,¬s,¬i) = 0.67072146114$
4. $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = P(¬st|¬c,¬w,¬b,¬f,¬s,¬i)P(¬c,¬w,¬b,¬f,¬s,¬i)$
   $P(¬st|¬c,¬w,¬b,¬f,¬s,¬i) = 0.999$ as per the query
   $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = 0.999 * 0.67072146114$
   $P(¬c,¬w,¬b,¬f,¬st,¬s,¬i) = 0.67005073967$, same as the previous result
5. $P(st,f) = P(st,f|I)P(I)$
   $P(st,f) = P(st|I)P(f|I)P(I)$
   $P(st,f) = P(st|¬i)P(f|¬i)P(¬i) + P(st|i)P(f|i)P(i)$
   $P(st,f) = 0.001 * 0.05 * 0.95 + 0.3 * 0.9 * 0.05$
   $P(st,f) = 0.0135475$

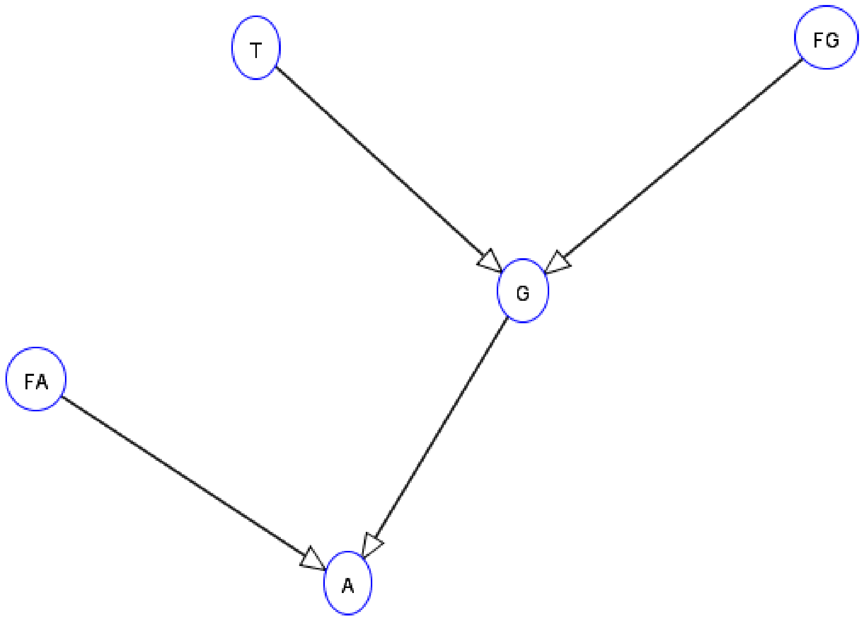
Independence

1. As per the definition of the conditional probability tables in a bayesian network, we can write that $P(x_1,x_2,...x_n) = \Pi P(x_1|Parents(x_1))$ and since neither influenza or smoking have parents, the probabilities of each of them are simply P(i) and P(s) respectively, and these do not share anything in common, so they will be independent of each other. Mathematically, we can prove that P(I,S) = P(I)P(S). The queries give us values of P(i) = 0.05, P(s) = 0.2, P(¬i) = 0.95, P(¬s) = 0.8, P(¬i,¬s) = 0.76, P(¬i,s) = 0.19, P(i,¬s) = 0.04, and P(i,s) = 0.01, all of which follow P(I,S) = P(I)P(S).
2. Since both influenza and smoking do not have parents, neither of them can be descendants of each other. Therefore, they must be independent of each other, as they do not depend on the value of their parents, and they are nondescendants.

Knowledge Representation With Bayesian Networks

The probability that the core temperature is high given that neither the gauge or the alarm is faulty and the alarm sounds is given by P(t|¬fa,¬fg,a).
P(t|a,¬fa,¬fg) =P(t|a,¬fg) since t is independent of the value of fa (fa is not a parent or descendant of t)
$P(t|a,¬fa,¬fg) = [P(a|¬g)P(¬g|¬fg,t) + P(a|g)P(g|¬fg,t)]P(t)P(¬fg)$
$P(t|a,¬fa,¬fg) = [0*0.1 + 0.5*0.9] * 0.3 * 0.9$
$P(t|a,¬fa,¬fg) = 0.1215$

Bayesian Net:



A CP-table:

Probability Table for A

G	FA	P(A=T)	P(A=F)
Normal	T	0.0	1.0
Normal	F	0.0	1.0
High	T	0.0	1.0
High	F	1.0	0.0

Observed value : T

OK Cancel

FA CP-table:

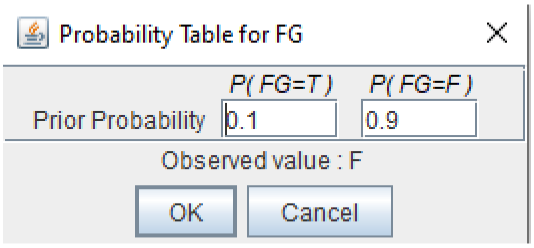
Probability Table for FA

	P(FA=T)	P(FA=F)
Prior Probability	0.5	0.5

Observed value : F

OK Cancel

FG CP-table:



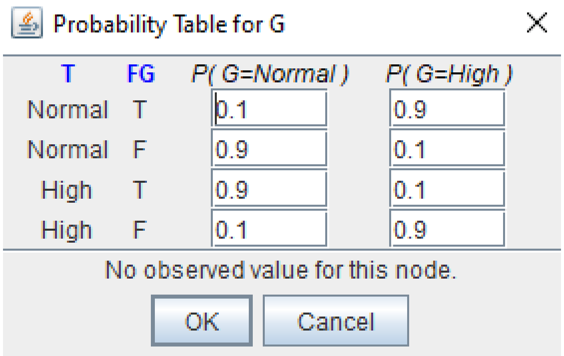
Probability Table for FG

	P(FG=T)	P(FG=F)
Prior Probability	0.1	0.9

Observed value : F

OK Cancel

G CP-table:



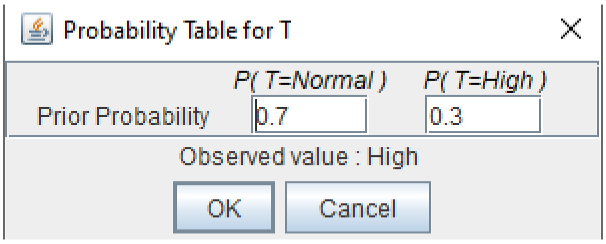
Probability Table for G

T	FG	P(G=Normal)	P(G=High)
Normal	T	0.1	0.9
Normal	F	0.9	0.1
High	T	0.9	0.1
High	F	0.1	0.9

No observed value for this node.

OK Cancel

T CP-table:



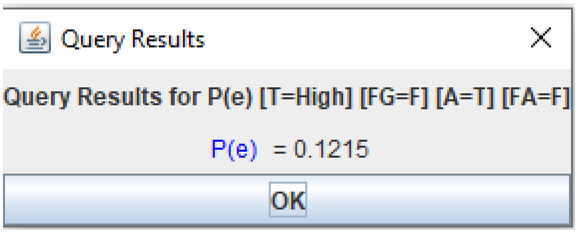
Probability Table for T

	P(T=Normal)	P(T=High)
Prior Probability	0.7	0.3

Observed value : High

OK Cancel

Query and answer:



Query Results

Query Results for P(e) [T=High] [FG=F] [A=T] [FA=F]

P(e) = 0.1215

OK