Introduction to Intelligent Systems: Exam 3

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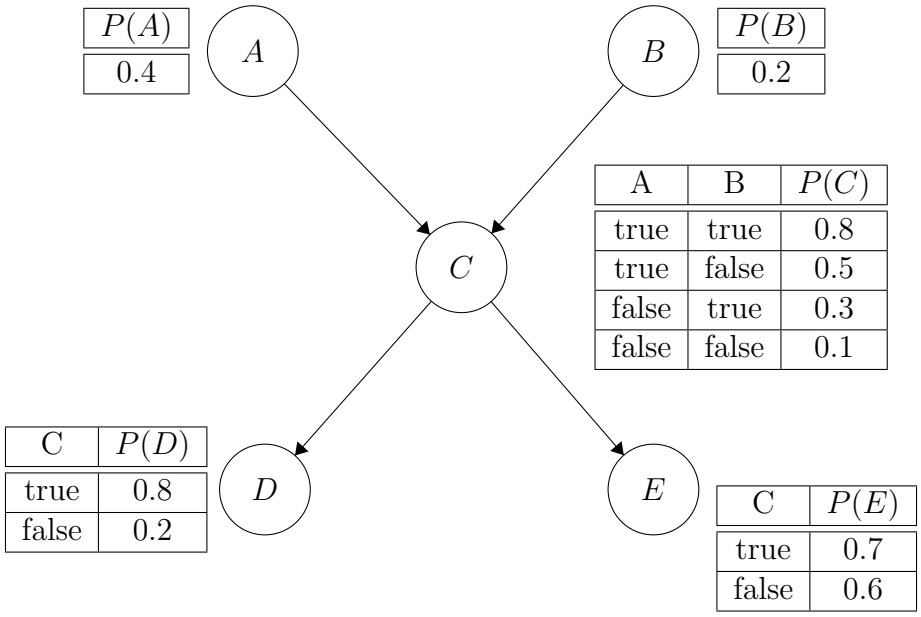
Problem 1

Consider the following Bayesian Belief Network.



(a) Calculuate the initial probability of C given the data in the table.

$$\begin{aligned}
P(C) = &P(C|A,B) \times P(A) \times P(B) + \\
&P(C|A,\neg B) \times P(A) \times P(\neg B) + \\
&P(C|\neg A,B) \times P(\neg A) \times P(B) + \\
&P(C|\neg A,\neg B) \times P(\neg A) \times P(\neg B) \\
&= (0.8 \times 0.4 \times 0.2) + \\
&(0.5 \times 0.4 \times (1-0.2)) + \\
&(0.3 \times (1-0.4) \times 0.2) + \\
&(0.1 \times (1-0.4) \times (1-0.2)) \\
&= 0.064 + 0.16 + 0.036 + 0.048 \\
&= 0.308
\end{aligned}$$

(b) Calculate $P(A, B, \neg C, \neg D, E)$

$$\begin{aligned}
P(A,B,\neg C,\neg D,E) &= P(A) \times P(B) \times P(\neg C|A,B) \times P(\neg D|\neg C) \times P(E|\neg C) \\
&= 0.4 \times 0.2 \times (1-0.8) \times (1-0.2) \times 0.6 \\
&= 0.00768
\end{aligned}$$

Decision Tree/Shannon Entropy

Consider the following table for the Restaurant problem previous discussed:

Num	Alt	Bar	Fri	Hun	Pat	Price	Rain	Res	Type	Est	Wait
x_1	yes	no	no	yes	some	$$$	no	yes	French	0-10	yes
x_2	yes	no	no	yes	full	$	no	no	Thai	30-60	no
x_3	no	yes	no	no	some	$	no	no	Burger	0-10	yes
x_4	yes	no	yes	yes	full	$	yes	no	Thai	10-30	yes
x_5	yes	no	yes	no	full	$$$	no	yes	French	>60	no
x_6	no	yes	no	yes	some	$$	yes	yes	Italian	0-10	yes
x_7	no	yes	no	no	none	$	yes	no	Burger	0-10	no
x_8	no	no	no	yes	some	$$	yes	yes	Thai	0-10	yes
x_9	no	yes	yes	no	full	$	yes	no	Burger	>60	no
x_{10}	yes	yes	yes	yes	full	$$$	no	yes	Italian	10-30	no
x_{11}	no	no	no	no	none	$	no	no	Thai	0-10	no
x_{12}	yes	yes	yes	yes	full	$	no	no	Burger	30-60	yes

Using the Shannon Entropy formula and our formula for *Gain*, calculate the amount of information obtained by choosing the attribute of *Price*.

$$\begin{aligned} Gain(Price) &= B(\frac{6}{12}) - \left[\frac{7}{12}B(\frac{3}{7}) + \frac{2}{12}B(\frac{2}{2}) + \frac{3}{12}B(\frac{1}{3})\right] \\ &= 1 - \left[\frac{7}{12} \times 0.985 + 0 + \frac{3}{12} \times 0.918\right] \\ &= 1 - \left[0.804\right] \\ &= 0.196 \text{ bits} \end{aligned}$$

If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech