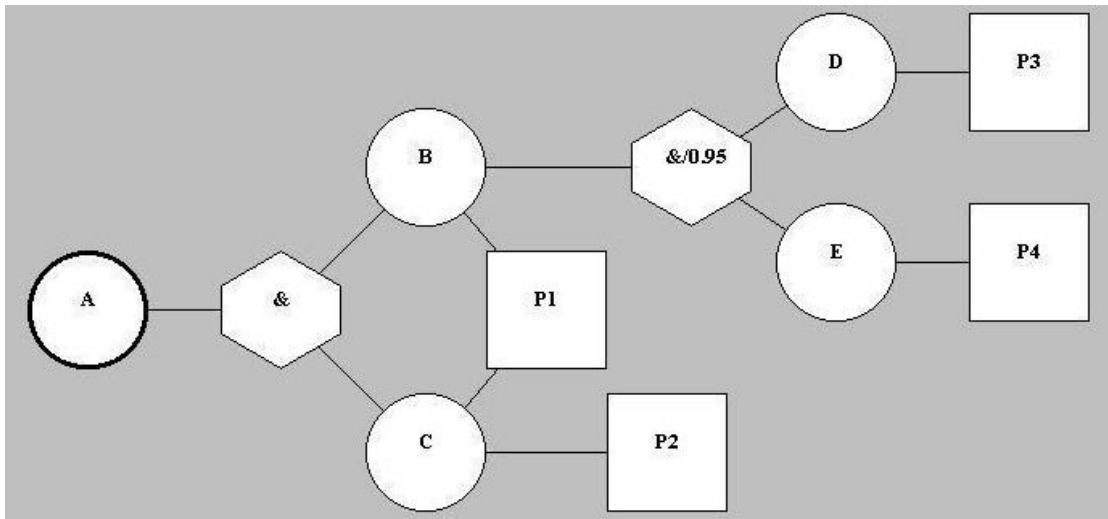
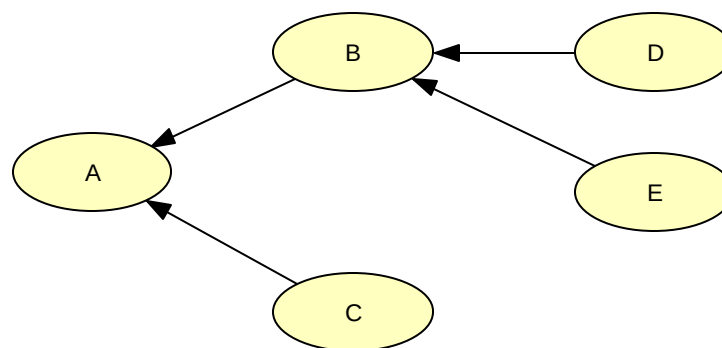


Assignment 6: Valuation Networks

- 1 Consider the following valuation network diagram discussed in the readings due December 9



In this diagram, the circular nodes represent different audit objectives, the square nodes represent items of audit evidence, and the hexagonal nodes represent logical relationships between objectives. In valuation networks, we show the valuations explicitly. In Bayesian networks, however, the valuations (in this case, conditional probability tables) are “hidden” behind the scenes, and the equivalent diagram would be:



- (a) Without referring to the solution in the reading, use the Shenoy-Shafer algorithm in the corrected form I gave you to produce a Join Tree for this problem. Submit your Join Tree so that I can see if you are still having difficulty with this construction. For the remaining parts of this assignment, however, use the Join Tree provided in the reading!

- (b) The audit procedure P1 provides evidence about objectives B and C simultaneously, and the auditor assesses the following probabilities:

$$P(B = b, C = c \mid \text{evidence}) = 0.6; P(B = b, C = \sim c \mid \text{evidence}) = 0.3;$$

$$P(B = \sim b, C = c \mid \text{evidence}) = 0.1; P(B = \sim b, C = \sim c \mid \text{evidence}) = 0$$

Similarly, audit procedures P2, P3 and P4 provide evidence about objectives C , D , and E respectively, assessed as follows:

$$P(C = c \mid \text{evidence}) = 0.65; P(C = \sim c \mid \text{evidence}) = 0.35$$

$$P(D = d \mid \text{evidence}) = 0.80; P(D = \sim d \mid \text{evidence}) = 0.20$$

$$P(E = e \mid \text{evidence}) = 0.70; P(E = \sim e \mid \text{evidence}) = 0.30$$

The probability tables for logical “AND” nodes and for the discounted “AND” node shown as “&/0.95” can be found in the slides for Class 12.

Compute, using the Shenoy-Shafer architecture, the auditor’s posterior probabilities for A after collecting the four items of audit evidence.

- (c) An equivalent formulation of this problem in belief function terms would be as follows in terms of bpa potentials (using somewhat briefer notation):

$$P1: \left[\begin{array}{c|c} \{(b, c)\} & 0.46 \\ \{(b, c), (b, \sim c)\} & 0.43 \\ \{(b, c), (\sim b, c)\} & 0.11 \\ \{(b, c), (b, \sim c), (\sim b, c), (\sim b, \sim c)\} & 0 \end{array} \right]$$

$$P2: \left[\begin{array}{c|c} \{c\} & 0.46 \\ \{\sim c\} & 0 \\ \{c, \sim c\} & 0.54 \end{array} \right]$$

$$P3: \left[\begin{array}{c|c} \{d\} & 0.59 \\ \{\sim d\} & 0 \\ \{d, \sim d\} & 0.41 \end{array} \right]$$

$$P4: \left[\begin{array}{c|c} \{e\} & 0.57 \\ \{\sim e\} & 0 \\ \{e, \sim e\} & 0.43 \end{array} \right]$$

Space and time do not permit an explication here of how this “equivalent” formulation was derived. The bpa potentials for logical “AND” nodes and for the discounted “AND” node are given on the slides for Class 12.

Compute, using the Shenoy-Shafer architecture, the auditor’s final beliefs for A after collecting the four items of audit evidence, expressed as a bpa.

- (d) An equivalent formulation of this problem in possibility theory terms would be as follows:

$$\begin{array}{l}
 \text{P1: } \left[\begin{array}{c|c} b, c & 1 \\ b, \sim c & 0.43 \\ \sim b, c & 0.11 \\ \sim b, \sim c & 0.11 \end{array} \right] \quad
 \text{P2: } \left[\begin{array}{c|c} c & 1 \\ \sim c & 0.54 \end{array} \right] \quad
 \text{P3: } \left[\begin{array}{c|c} d & 1 \\ \sim d & 0.25 \end{array} \right] \quad
 \text{P4: } \left[\begin{array}{c|c} e & 1 \\ \sim e & 0.43 \end{array} \right]
 \end{array}$$

The possibility potential for logical “AND” nodes is given on the slides for Class 13. Discounted “AND” nodes cannot be represented in possibility theory, and so you must also use an ordinary “AND” node for the relationship between B , C and D .

Compute, using the Shenoy-Shafer architecture, the auditor’s final possibility distribution for A after collecting the four items of audit evidence.

- (e) An equivalent formulation of this problem in Spohn’s epistemic calculus terms would be as follows:

$$\begin{array}{l}
 \text{P1: } \left[\begin{array}{c|c} b, c & 0 \\ b, \sim c & 5 \\ \sim b, c & 10 \\ \sim b, \sim c & 10 \end{array} \right] \quad
 \text{P2: } \left[\begin{array}{c|c} c & 0 \\ \sim c & 4 \end{array} \right] \quad
 \text{P3: } \left[\begin{array}{c|c} d & 0 \\ \sim d & 7 \end{array} \right] \quad
 \text{P4: } \left[\begin{array}{c|c} e & 0 \\ \sim e & 5 \end{array} \right]
 \end{array}$$

The disbelief potential for logical “AND” nodes is given on the slides for Class 13. Discounted “AND” nodes cannot be represented in disbelief theory, and so you must also use an ordinary “AND” node for the relationship between B , C and D .

Compute, using the Shenoy-Shafer architecture, the auditor’s final disbeliefs for A after collecting the four items of audit evidence.

- (f) Construct a binary Join Tree for this problem.

Extra Credit: Can you check the answer to part (b) using HUGIN or NETICA?
(Do not spend too long on this item!)