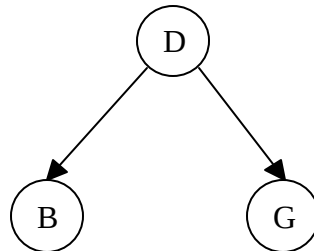


Assignment 3: Local Propagation

- 1 Consider a Bayesian Network for the Diabetes problem shown below:



Each variable has just two values in its frame, as in Assignment 2, and the probabilities, as before, are as follows:

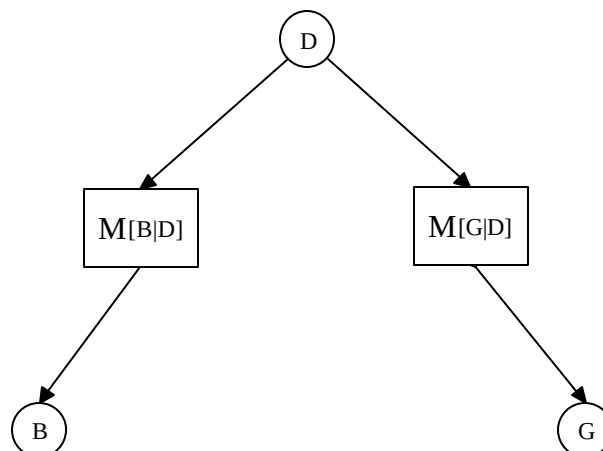
$$P(d) = 0.100 \quad P(b|d) = 0.014 \quad P(b|\neg d) = 0.006 \quad P(g|d) = 0.900 \quad P(g|\neg d) = 0.010$$

Note that I have only given values for one outcome of each variable – the missing values are, of course, just 1 – the values above. Also, I have now shown values for G conditioned only on the values for D ; as we saw in solving the previous assignment, it transpired by examining the numerical values that G is independent of B , conditional upon D . This is precisely what makes this the correct Bayesian network. *If G depended on both D and B , there would have needed to be an arrow in the diagram from B to G !*

Now suppose that E_0 denotes the background knowledge embedded in the Bayesian network model, but that you now observe new evidence E_1 for B and E_2 for G such that, assuming E_0 , E_1 , and E_2 are independent: $P(b|E_1) = 0.300$; $P(\neg g|E_2) = 0.900$.

Compute the marginals of the posterior distribution for all three variables using Pearl's propagation scheme, showing in your workings all messages that are sent between nodes.

Hint: You may find it convenient to start with a diagram like this, where the matrices are the conditional probability tables:



- 2 Consider the Asia example in the Lauritzen & Spiegelhalter paper, relating to tuberculosis, lung cancer and bronchitis. The case where a patient presents at a chest clinic with dsypnoea and has recently visited Asia is addressed in Table 3 of the paper. Further observation reveals that the patient has not smoked and has a negative x-ray. Compute the marginals of the posterior distribution for the unobserved variables, summarizing your work in the form of Table 3 using a spreadsheet to show the potentials from the probability tables, potentials after absorbing the four items of evidence, potentials from the set chain (after inward propagation) and clique marginals (after outward propagation).

Hint: The required marginals are shown in Figure 8 of the paper – use this to check your work.

- 3 Download a demonstration version of the Bayesian network software HUGIN Lite 5.3 from www.hugin.com.
- (a) use HUGIN to build a Bayesian network to represent the Diabetes problem
 - (b) use the resulting network to solve Problem 1 above again
 - (c) use HUGIN to build a Bayesian network to represent the Asia problem
 - (d) use the resulting network to solve Problem 2 above again.

A model for this problem is included as a demonstration with the software. Please do not refer to this until after you have done your own work.

- 4 Download a demonstration version of the Bayesian network software NETICA from www.norsys.com.
- (e) use NETICA to build a Bayesian network to represent the Diabetes problem
 - (f) use the resulting network to solve Problem 1 above again
 - (g) use NETICA to build a Bayesian network to represent the Asia problem
 - (h) use the resulting network to solve Problem 2 above again.

My intention is that you should spend no more than an hour on each of questions 1, 3 and 4; question 2 may take longer if you are still trying to figure out what goes on in the paper. You should not, however, spend more than 5 or 6 hours in total on this assignment.