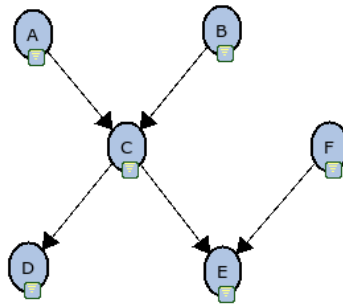


Exercises for the Lecture Techniques in Artificial Intelligence

Inference in Bayesian Networks

- 1) Consider the following Bayesian Network, which contains the (not necessarily boolean) random variables A - F .



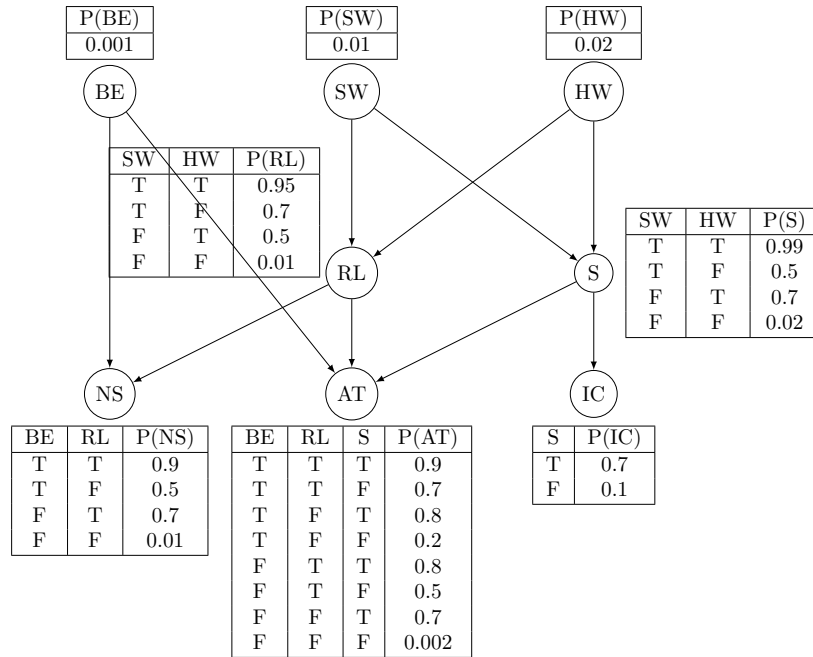
Do exact inference for the following queries by reducing the queries to the conditional probabilities given in the net. Also state the kind of inference (causal, diagnostic, etc.).

- (a) $P(d \mid b)$
- (b) $P(f \mid b)$
- (c) $P(b \mid c)$
- (d) $P(a \mid e, f)$
- (e) $P(c \mid b, d)$

Notation: As usual, a is short hand notation for $A = a$

- 2) The following Bayes Net is to be used for diagnosing problems in a autonomous robot system. It contains three directly observable variables: The robot is talking nonsense while communicating with others (N); the robot attacks others (AT); the robot ignores commands (IC).

These externally visible behaviours can be caused by problems in the reasoning/language modules (RL) or in the sensory modul of the robot (S). On the other hand, it could be actually sensible behaviour which can be explained by the robot encountering a bizarre event (BE). Problems in the reasoning, language or sensory modules can in turn be caused by problems in hardware (HW) or software (SW).



- (a) Which kinds of inference (causal, diagnostic, intercausal, mixed) are present in:
- (i) $P(S \mid IC)$ (ii) $P(S \mid BE, \neg AT)$ (iii) $P(RL \mid SW)$ (iv) $P(HW \mid NS)$
- (b) Which of these statements are true?
- (i) RL and S are independent.
 - (ii) RL and S are conditionally independent given SW .
 - (iii) RL and S are conditionally independent given SW and HW .
 - (iv) RL and S are conditionally independent given IC .
 - (v) NS and SW are independent.
 - (vi) NS and SW are conditionally independent given RL .
 - (vii) HW and SW are independent.
 - (viii) HW and SW are conditionally independent given RL .
 - (ix) HW and SW are conditionally independent given IC .
 - (x) HW and SW are conditionally independent given BE .
- (c) What is the probability of ...
- (i) the robot ignoring commands?
 - (ii) the sensory module being broken, if the robot ignores commands?
 - (iii) the robot attacking someone if a bizarre event occurs?
 - (iv) the sensory module being broken if a bizarre event occurred?
 - (v) the sensory module being broken if a bizarre event occurred and the robot does not attack anyone?
 - (vi) the sensory module being broken, if the hardware has no problems and the robot ignores commands?
- (d) Compute the probability $P(\neg BE, SW, \neg HW, RL, \neg S, \neg NS, AT, IC)$.