

Probabilistic Reasoning

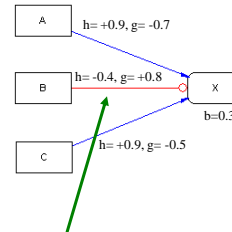
Unit # 9

CAST Logic

- CAusal STrength logic was developed at George Mason University in 1994 to elicit the large number of conditional probabilities from a small set of user-defined parameters.
- The logic has its roots in Noisy-Or.
- The logic requires only a pair of parameters for each dependency relationship between any two nodes.
- Each parameter can take values in the range of $(-1, 1)$.
 - Positive values on arcs are causal influences that cause a node to occur with some probability,
 - Negative values are influences that cause the negation of a node to occur with some probability.
- All non-root nodes are assigned a baseline probability, same as the leak probability in Noisy-Or.

Computation of CAST Logic

- There are four major steps:
 - Aggregate positive causal strengths
 - Aggregate negative causal strengths
 - Combine the positive and negative causal strengths, and
 - Derive conditional probabilities



The first value, referred to as h, states that if B is true, then this will cause X to be false with probability 0.4, while the second value, referred to as g, states that if B is false, then this will cause X to be true with probability 0.8.

Aggregate Positive Strengths

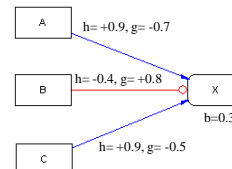
- In this step, the set of causal strengths with positive influence are combined. They are aggregated using the equation

$$PI = 1 - \prod (1 - S_i) \quad \forall S_i > 0$$

where S_i is the corresponding h or g value having positive influence and PI is the combined positive causal strength.

- To compute $P(X | A, B, \neg C)$, we have $\{0.9, -0.4, -0.5\}$

$$PI = 1 - (1 - 0.9) = 0.9$$



Aggregate Negative Strengths

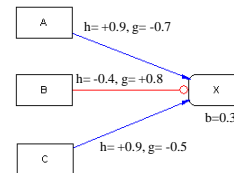
- In this step, the causal strengths with negative values are combined. The equation used for aggregation is

$$NI = 1 - \prod_i (1 - |S_i|) \quad \forall S_i < 0$$

where S_i is the corresponding h or g value having negative influence and NI is the combined negative causal strength.

- For our example,

$$NI = 1 - (1 - 0.4)(1 - 0.5) = 0.7$$



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Combine Positive and Negative Strengths

- In this step, aggregated positive and negative influences are combined to obtain an overall net influence.

If $PI > NI$

$$AI = \frac{PI - NI}{1 - NI}$$

If $NI > PI$

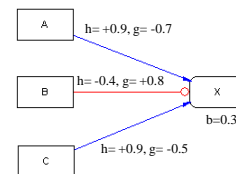
$$AI = \frac{NI - PI}{1 - PI}$$

If $PI = NI$

$$AI = 0$$

- For our example

$$AI = (0.9 - 0.7) / (1 - 0.7) = .66$$



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Derive Conditional Probabilities

- In the final step, the overall influence is used to compute the conditional probability value of a child for the given combination of parents.

$P(\text{child} \mid j\text{th state of parent states})$

$$= \text{baseline} + (1 - \text{baseline}) \times AI \quad \text{when } PI > NI$$

$$= \text{baseline} - \text{baseline} \times AI \quad \text{when } PI < NI$$

$$= \text{baseline} \quad \text{when } PI = NI$$

- For our example,

$$P(X \mid A, B, -C) = 0.3 + 0.7 * 0.66 = .762$$

- Practice Assignment: Compute the rest of the conditional probabilities**

CAST logic Modeling Using GeNIe and IBAYes