PROBABILISTIC REASONING

Unit # 5 – CAST Logic (Influence Net)

CAST LOGIC (INFLUENCE NET)

INFLUENCE NET

The special instance of BNs which employs the CAST logic for knowledge elicitation is referred to as Influence Nets (INs).

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.

CAST LOGIC

The modeling of the causal relationships is accomplished by creating a series of cause and effect relationships between variables representing:

- desired effect(s) and
- actionable events

Typically, the actionable events are drawn as root nodes(nodes without incoming edges), while the desired effect is modeled as a leaf node (node without outgoing edges).

CAST LOGIC (CONT'D)

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.

INFLUENCE NET

1. A set of random variables that makes up the nodes of an IN. All the variables in the IN have binary states.

2. A set of directed links that connect pairs of nodes.

3. Each link is associated with a pair of CAST logic parameters that show the causal strength of the link (usually denoted as h and g values).

4. Each non-root node has an associated CAST logic parameter (denoted as the baseline probability), while a prior probability is associated with each root node.

CAST LOGIC (CONT'D)

- Each edge is assigned a pair of values (h , g)
- The first value, referred to as h, states that if the event say A is true, then this will cause X to occur wit a certain probability.
- while the second value, referred to as g, states that if A is false, then this will cause X to occur with a certain value.

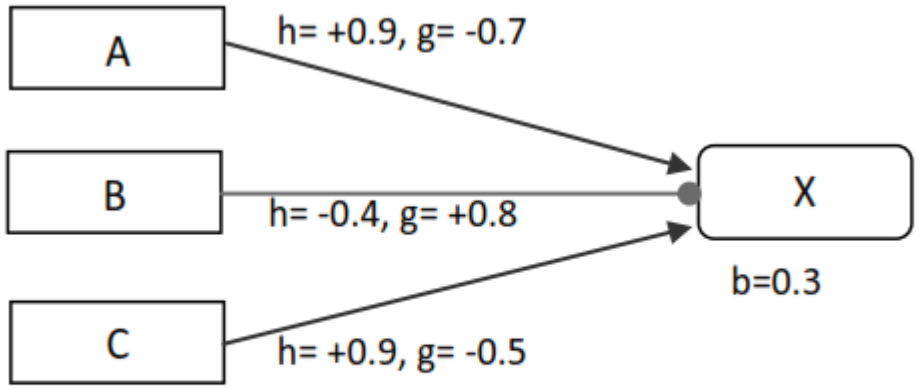
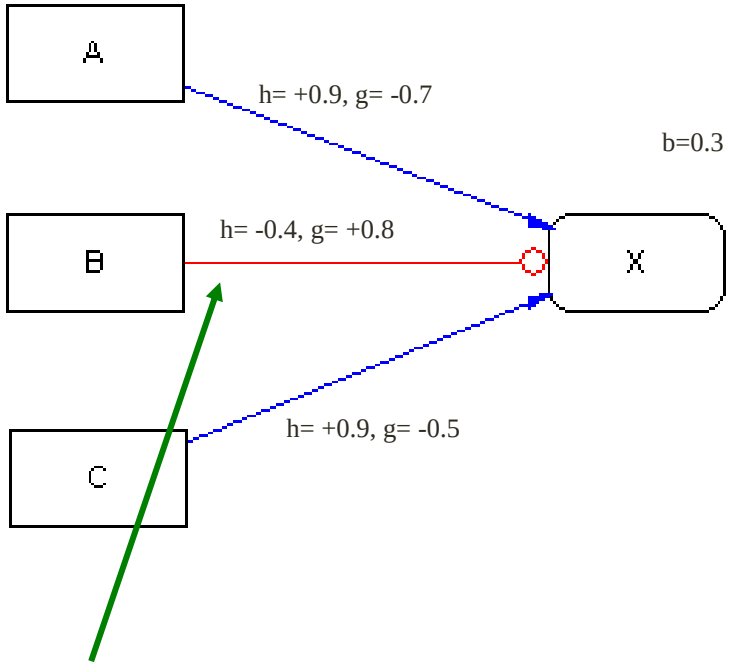


Figure 2. An influence network with CAST logic parameters.

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



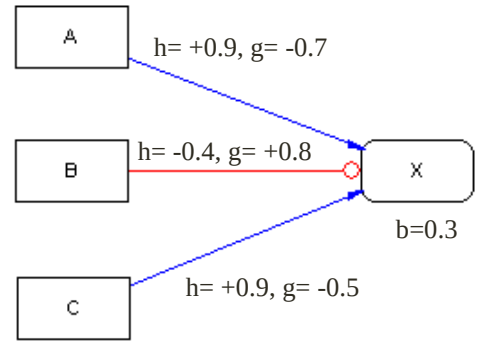
The first value, referred to as h, states that if B is true, then this will cause X to be false with probability 0.4, while the second value, referred to as g, states that if B is false, then this will cause X to be true with probability 0.8.

AGGREGATE POSITIVE STRENGTHS

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

$$PI = 1 - \prod_{i} (1 - S_i) \quad \forall S_i > 0$$

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



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

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

AGGREGATE NEGATIVE STRENGTHS

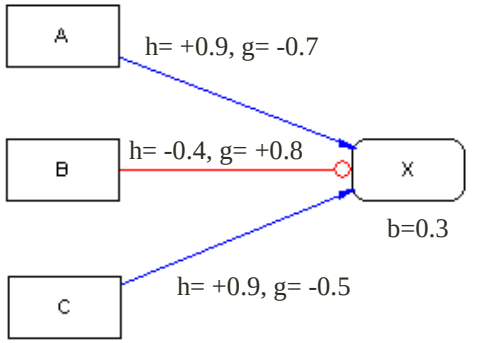
In this step, the causal strengths with negative values are combined. The equation used for aggregation is

$$NI = 1 - \prod_{i} (1 - |S_i|) \qquad \forall S_i < 0$$

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

For our example,

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



COMBINE POSITIVE AND NEGATIVE STRENGTHS

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

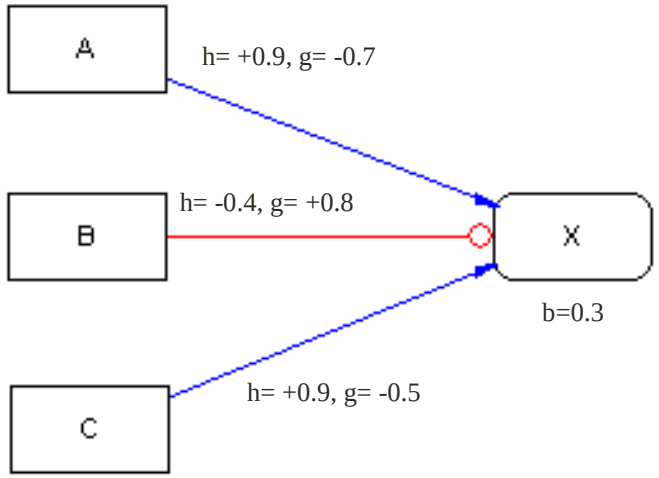
- *If PI > NI*

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

- *If NI > PI*

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

- *If PI = NI* $AI = 0$



For our example, $AI = (0.9 - 0.7) / (1 - 0.7) = .66$

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.

$P(child \mid jth\ state\ of\ parent\ states)$

$= baseline + (1 - baseline) \times AI$ when $PI > NI$

$= baseline - baseline \times AI$ when $PI < NI$

$= baseline$ when $PI = NI$

For our example,

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

Practice Assignment: Compute the rest of the conditional probabilities

CAST LOGIC DEMO USING IBAYES

Excel Sheet Demonstration