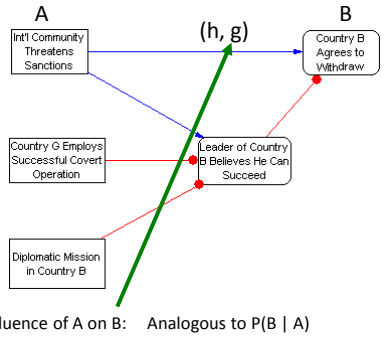
Probabilistic Reasoning

Unit # 18

Influence Nets

- A set of random variables that makes up the nodes of an IN. All the variables in the IN have binary states.
- A set of directed links that connect pairs of nodes.
- Each link has associated with it a pair of parameters that shows the causal strength of the link (usually denoted as h and g values).



h is Influence of A on B: Analogous to P(B | A)

g is Influence of ¬A on B: Analogous to P(B | ¬A)

Positive Impact

Negative Impact

Root Nodes

Non-root Nodes

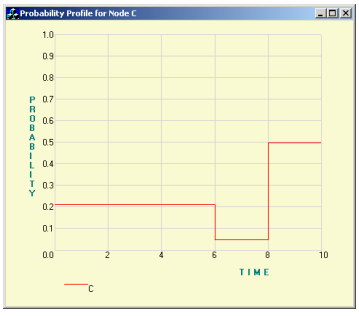
Timed Influence Net

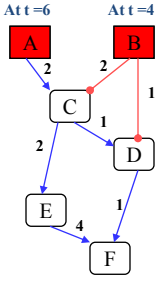
The specification of a TIN require the following additional parameters besides the one required for by an ordinary IN:

A time delay is associated with each arc.

A time delay is associated with each node.

Each actionable event is assigned time stamp(s) at which the decision(s) regarding the state of that action is(are) made

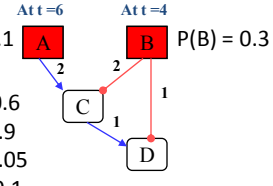




Wagenhals, L., Shin, I., and Levis, A. H., "Creating Executable models of influence nets with colored Petri nets," Int. J. STTT, 1998, No. 2, pp. 168-181

TIN Exercise

- At what time stamps, the probabilities of C and D is changed?
  - C @ {6, 8}
  - D @ {5, 7, 9}
- Compute probabilities of C & D at each of the time stamp mentioned above.

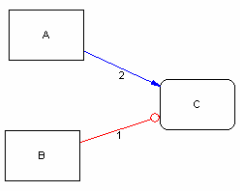


P(C|A,B) =0.6
P(C|A,~B) =0.9
P(C|~A,B) =0.05
P(C|~A,~B)=0.1

P(D|B, C) =0.7
P(D|B,~C) =0.9
P(D|~B,C) =0.05
P(D|~B,~C)=0.1

Time-Varying Influence (Persistence of Influence)

- Current implementation of TINs models time-invariant influences
- A scheme is proposed for modeling time-varying influences
- A list of influences along with their time of effect is specified for each arc in a TIN
- The proposed scheme can be used to model time-dependent structural changes in a TIN



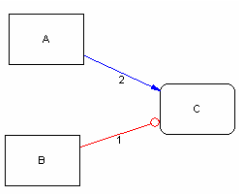
Influence of A on C when information at A is t time units old
Strong: $2 \leq t < 4$
Moderate: $4 \leq t \leq 6$
Low: $t > 6$

Influence of B on C when information at B is t time units old
Strong: $1 \leq t < 3$
Low: $t > 3$

Time-Varying Influence (Cont'd)

P(A) = 0.05 @ 0
= 1.0 @ 4

P(B) = 0.1 @ 0
= 0.6 @ 7
= 1.0 @ 10



Influence of A on C when information at A is t time units old
Strong: $2 \leq t < 4$
Moderate: $4 \leq t \leq 6$
Low: $t > 6$

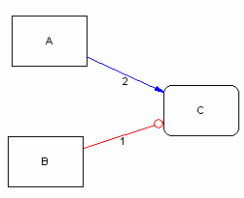
Influence of B on C when information at B is t time units old
Strong: $1 \leq t < 3$
Low: $t > 3$

- C is updated at time: 6, 8, 11
- At time 6: P(A) @ 4 is used, while P(B) @ 0 is used
  - Information coming from A is 2 time units old
  - Information coming from B is 6 time units old
    - C has strong influence of A and low influence of B at time 6
- At time 8: P(A) @ 4 is used, while P(B) @ 7 is used
  - Information coming from A is 4 time units old
  - Information coming from B is 1 time units old
    - C has moderate influence of A and strong influence of B at time 8

Non-Stationary Conditional Probabilities

P(A) = 0.05 @ 0
= 1.0 @ 4

P(B) = 0.1 @ 0
= 0.6 @ 7
= 1.0 @ 10



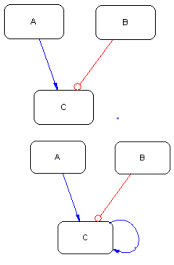
Influence of A on C when information at A is t time units old
Strong: $2 \leq t < 4$
Moderate: $4 \leq t \leq 6$
Low: $t > 6$

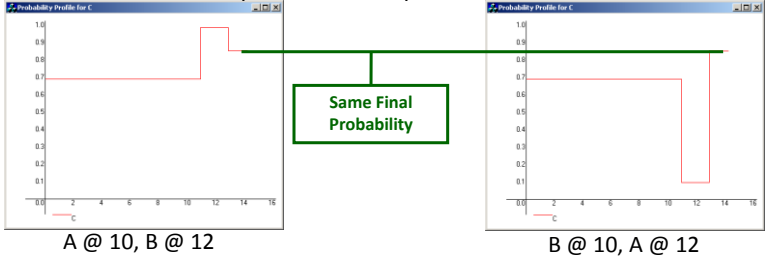
Influence of B on C when information at B is t time units old
Strong: $1 \leq t < 3$
Low: $t > 3$

		Time	
Parents Combination	6	8	11
P(C|¬A,¬B)	0.07	0.85	0.93
P(C|¬A, B)	0.03	0.02	0.03
P(C| A,¬B)	0.97	0.98	0.97
P(C| A, B)	0.93	0.15	0.07

Adding Memory to the Nodes in a TIN

- Current implementation of TINs assume that the nodes are memoryless
  - The impact of different sequences of actions on the final probability is not captured.
- An approach is proposed that adds memory to the nodes in a TIN
  - A self-loop is added to each node whose current state is dependent on its previous state.

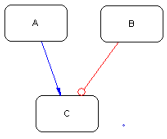


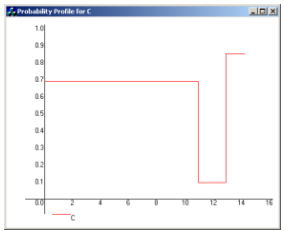


A @ 10, B @ 12

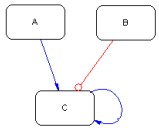
B @ 10, A @ 12

Adding Memory to the Nodes in a TIN (Cont'd)

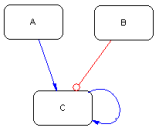




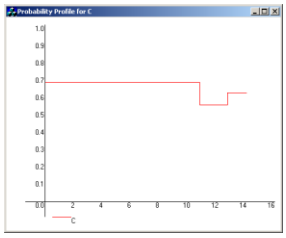
B @ 10, A @ 12

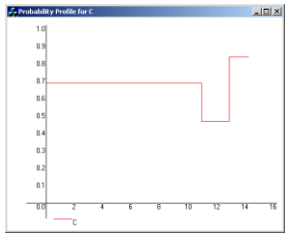


(0.33, -0.33)
Weak Memory



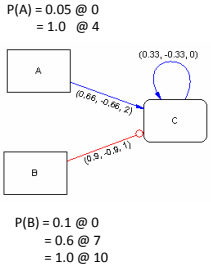
(0.90, -0.90)
Strong Memory





Dynamic Influence Nets

- Timed Influence Nets with
  - Time-varying influences
  - Memory represented by a self-loop



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