

Temporal Reasoning with OpenCog

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SingularityNET & OpenCog Foundations



SingularityNET



Why Temporal Reasoning?

- 1 Lag between cause and effect
- 2 Meta-reasoning: Think about think about think about think about ...

PLN Recall

$P, Q, \dots: Atom^n \rightarrow \{True, False\}$

And <TV>

P

\equiv

$\mathcal{P}(P, Q) \approx TV.strength$

Q

Not <TV>

P

\equiv

$\mathcal{P}(P) \approx 1 - TV.strength$

Implication <TV>

P

\equiv

$\mathcal{P}(Q|P) \approx TV.strength$

Q

PLN rules: Implication Direct Evaluation

Evaluation

P

Ei

...

Evaluation

Q

Ei

|-

Implication <TV>

P

Q

$$TV.strength = \frac{\sum_x f_{\wedge}(P(x).strength, Q(x).strength)}{\sum_x P(x).strength}$$

PLN rules: Deduction

Implication

P

Q

Implication

Q

R

| -

Implication <TV>

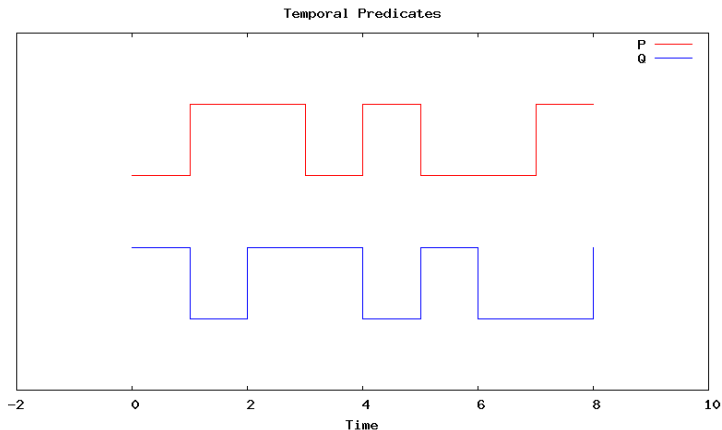
P

R

$$TV.strength = \mathcal{P}(R|Q, P) \times \mathcal{P}(Q|P) + \mathcal{P}(R|\neg Q, P) \times \mathcal{P}(\neg Q|P)$$

Temporal Predicate

$$P : Atom^n \times Time \rightarrow \{True, False\}$$



LagLink and LeadLink

- **Lag**: brings **past** into present

LagLink

P

T

≡

LambdaLink

x, t

P (x, t-T)

- **Lead**: brings **future** into present

LeadLink

P

T

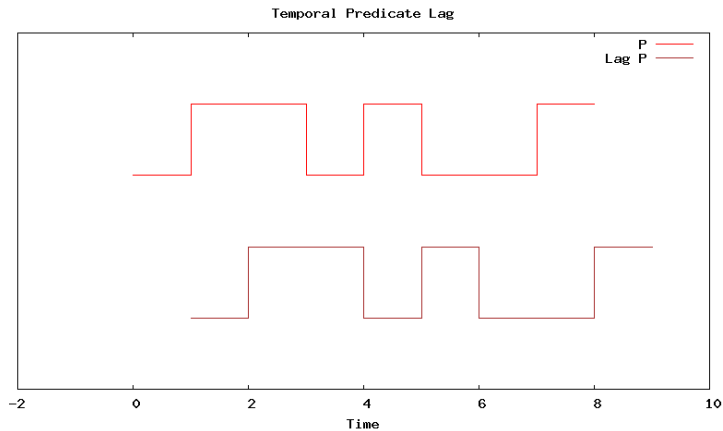
≡

LambdaLink

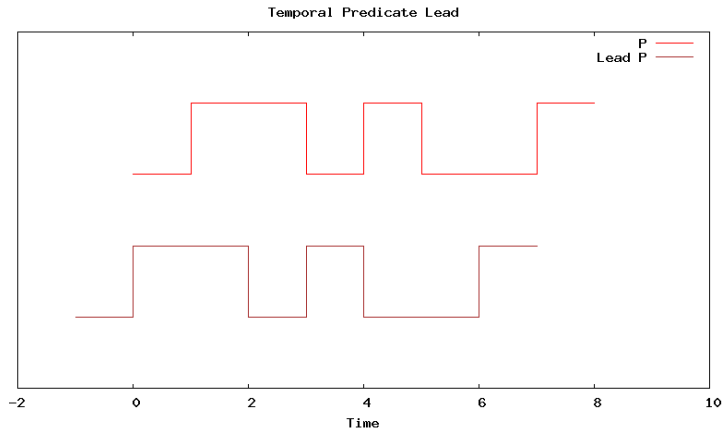
x, t

P (x, t+T)

Lag: example



Lead: example



SequentialAnd

BackSequentialAnd <TV>

T

P

Q

≡

ForeSequentialAnd <TV>

T

P

Q

≡

And <TV>

Lag

P

T

Q

And <TV>

P

Lead

Q

T

PredictiveImplication

BackPredictiveImplication <TV>

T

P

Q

≡

ForePredictiveImplication <TV>

T

P

Q

≡

Implication <TV>

Lag

P

T

Q

Implication <TV>

P

Lead

Q

T

PredictiveImplication

BackPredictiveImplication <TV>

T

P

Q

≡

ForePredictiveImplication <TV>

T

P

Q

≡

Implication <TV>

Lag

P

T

Q

Implication <TV>

P

ForeSequentialAnd

T

P

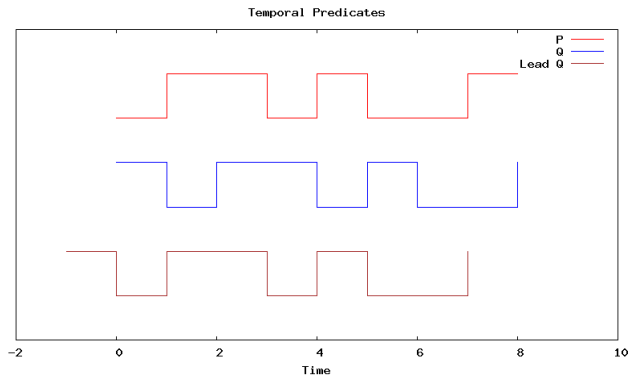
Q

Predictive Implication

Implication $\langle s=0.25 \rangle$

P

Q



PredictiveImplication

Implication $\langle s=0.25 \rangle$

P

Q

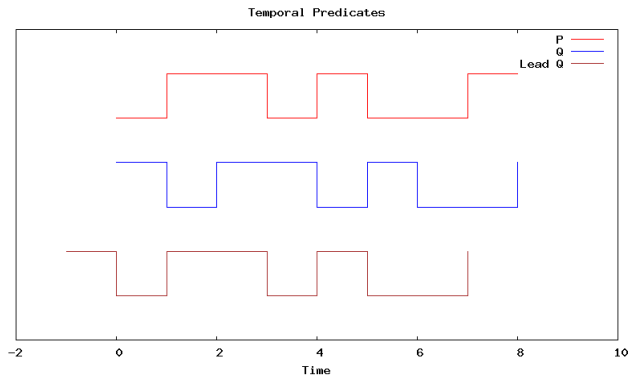
Implication $\langle s=0.75 \rangle$

P

Lead

Q

1



PredictiveImplication

Implication $\langle s=0.25 \rangle$

P

Q

Implication $\langle s=0.75 \rangle$

P

Lead

Q

1

PredictiveImplication $\langle s=0.75 \rangle$

1

P

Q

