Towards porting PLN to MeTTa

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PLN Recall

$P, Q, ... \ : \ Atom^n \to \{\top, \bot\}$ (possibly fuzzy)

Atomese	MeTTa	Math
$(P \ tv)$	$(\overset{\mathrm{m}}{=} P \ tv)$	$\mathcal{Pr}\left(\mathcal{S}(P)\right) \approx tv.mean$
$(Not \ tv \ P)$	$(\overset{\mathrm{m}}{=} (\neg \ P) \ tv)$	$\mathcal{Pr}\left(\overline{\mathcal{S}(P)}\right) \approx tv.mean$
$(Or \ tv \ P \ Q)$	$(\overset{\mathrm{m}}{=} (\vee \ P \ Q) \ tv)$	$\mathcal{Pr}\left(\mathcal{S}(P) \cup \mathcal{S}(Q)\right) \approx tv.mean$
$(And \ tv \ P \ Q)$	$(\overset{\mathrm{m}}{=} (\wedge \ P \ Q) \ tv)$	$\mathcal{Pr}\left(\mathcal{S}(P) \cap \mathcal{S}(Q)\right) \approx tv.mean$
$(Implication \ tv \ P \ Q)$	$(\overset{\mathrm{m}}{=} (P \to Q) \ tv)$	$\mathcal{Pr}\left(\mathcal{S}(Q)|\mathcal{S}(P)\right) \approx tv.mean$
$(Evaluation \ tv \ P \ (List \ X_1 \ ... \ X_n))$	$(\overset{\mathrm{m}}{=} (P \ X_1 \ ... \ X_n) \ tv)$	$\mathcal{Pr}\left(P(X_1, ..., X_n) = \top\right) \approx tv.mean$

PLN rules: Deduction

$$\frac{P \to Q \overset{\mathrm{m}}{=} tv_{PQ} \qquad Q \to R \overset{\mathrm{m}}{=} tv_{QR} \qquad P \overset{\mathrm{m}}{=} tv_{P} \qquad Q \overset{\mathrm{m}}{=} tv_{Q} \qquad R \overset{\mathrm{m}}{=} tv_{R}}{P \to R \overset{\mathrm{m}}{=} tv} \text{(DED)}$$

$$tv.mean = tv_{PQ}.mean \times tv_{QR}.mean + \frac{(1 - tv_{PQ}.mean) \times (tv_{R}.mean - tv_{Q}.mean \times tv_{QR}.mean)}{1 - tv_{Q}.mean}$$

PLN rules: Implication Direct Introduction

$$\frac{(P\ a_1) \overset{\mathrm{m}}{=} tv_{Pa_1} \qquad (Q\ a_1) \overset{\mathrm{m}}{=} tv_{Qa_1} \qquad ... \qquad (P\ a_n) \overset{\mathrm{m}}{=} tv_{Pa_n} \qquad (Q\ a_n) \overset{\mathrm{m}}{=} tv_{Qa_n}}{P \to Q \overset{\mathrm{m}}{=} tv} \text{(IDI)}$$

$$tv.mean = \frac{\sum_x tv_{Px}.mean \times tv_{Qx}.mean}{\sum_x tv_{Px}.mean}$$

Evidential Truth Value

```
;; TruthValue type and constructors
(: TruthValue Type)
(: Bl (-> Bool TruthValue))
(: Pr (-> Number TruthValue))
(: PrCnt (-> Number Number TruthValue))

;; TruthValue methods
(: mode (-> TruthValue Number))
(: mean (-> TruthValue Number))
(: pos_count (-> TruthValue Number))
(: neg_count (-> TruthValue Number))

;; EvidentialTruthValue type and constructors
(: EvidentialTruthValue Type)
(: ETV (-> (Set $a) TruthValue EvidentialTruthValue))
```

Atomese	MeTTa	Math
(stv s (count->confidence c))	(PrCnt s c)	$<s\ c>$
-	(ETV E tv)	(E, tv)

PLN rules: Implication Direct Introduction (Recursive Decomposition)

- Base

$$\overline{P \to Q \overset{\mathrm{m}}{=} (\emptyset, <1\ 0>)} \text{ (IDI Axiom)}$$

- Recursion

$$\frac{(P\ a) \overset{\mathrm{m}}{=} tv_{Pa} \qquad (Q\ a) \overset{\mathrm{m}}{=} tv_{Qa} \qquad P \to Q \overset{\mathrm{m}}{=} (E, tv_{PQ}) \qquad a \notin E}{P \to Q \overset{\mathrm{m}}{=} (\{a\} \cup E, tv)} \text{ (IDI Induction)}$$

$$tv.count = tv_{PQ}.count + tv_{Pa}.mean$$

$$tv.mean = \frac{tv_{PQ}.pos\_count + tv_{Pa}.mean \times tv_{Qa}.mean}{tv.count}$$

Temporal Deduction $\mapsto$ Deduction

$$\cfrac{P \rightsquigarrow^{T_1} Q}{P \rightarrow \overleftarrow{Q}^{T_1}} \text{ (PI2I)} \qquad \cfrac{\cfrac{Q \rightsquigarrow^{T_2} R}{Q \rightarrow \overleftarrow{R}^{T_2}} \text{ (PI2I)}}{\overleftarrow{Q}^{T_1} \rightarrow \overleftarrow{R}^{T_1+T_2}} \text{ (TS)} \qquad P \qquad \cfrac{Q}{\overleftarrow{Q}^{T_1}} \text{ (TS)} \qquad \cfrac{R}{\overleftarrow{R}^{T_1+T_2}} \text{ (TS)}}{\cfrac{P \rightarrow \overleftarrow{R}^{T_1+T_2}}{P \rightsquigarrow^{T_1+T_2} R} \text{ (I2PI)}} \text{ (DED)}$$

- DED: Deduction
- TS: Temporal Shift
- PI2I: PredictiveImplication to Implication
- I2PI: Implication to PredictiveImplication

Temporal Procedural Deduction $\mapsto$ Deduction

$$\frac{\dfrac{P \wedge \widehat{A} \leadsto^{T_1} Q}{P \wedge \widehat{A} \rightarrow \check{Q}^{T_1}} \text{(PI2I)} \quad \dfrac{\widehat{B}}{\check{\widehat{B}}^{T_1}} \text{(TS)}}{P \wedge \widehat{A} \wedge \check{\widehat{B}}^{T_1} \rightarrow \check{Q}^{T_1} \wedge \check{\widehat{B}}^{T_1}} \text{(CI)} \quad \dfrac{\dfrac{Q \wedge \widehat{B} \leadsto^{T_2} R}{Q \wedge \widehat{B} \rightarrow \check{R}^{T_2}} \text{(PI2I)}}{\check{Q}^{T_1} \wedge \check{\widehat{B}}^{T_1} \rightarrow \check{R}^{T_1+T_2}} \text{(TS)} \quad P \wedge \widehat{A} \wedge \check{\widehat{B}}^{T_1} \quad \dfrac{Q \wedge \widehat{B}}{\check{Q}^{T_1} \wedge \check{\widehat{B}}^{T_1}} \text{(TS)} \quad \dfrac{R}{\check{R}^{T_1+T_2}} \text{(TS)}$$

$$\frac{P \wedge \widehat{A} \wedge \check{\widehat{B}}^{T_1} \rightarrow \check{R}^{T_1+T_2}}{\left((P \wedge \widehat{A}) \nearrow^{T_1} \widehat{B} \right) \leadsto^{T_1+T_2} R} \text{(I2PI)}$$

- CI: Conjunction Introduction
- TS: Temporal Shift
- DED: Deduction
- PI2I: PredictiveImplication to Implication
- I2PI: Implication to PredictiveImplication

Conclusion

Demo Time