# Towards porting PLN to MeTTa

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# PLN Recall

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

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

# PLN rules: Deduction

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

where

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

# PLN rules: Implication Direct Introduction

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

where

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

# Temporal Deduction ↦ Deduction

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

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

# Temporal Procedural Deduction ↦ Deduction

$$\dfrac{\dfrac{\dfrac{P \wedge \hat{A} \rightsquigarrow^{T_1} Q}{P \wedge \hat{A} \rightarrow \tilde{Q}^{T_1}}\,(\text{PI2I}) \qquad \dfrac{\hat{B}}{\overleftarrow{\hat{B}}^{T_1}}\,(\text{TS})}{P \wedge \hat{A} \wedge \overleftarrow{\hat{B}}^{T_1} \rightarrow \tilde{Q}^{T_1} \wedge \overleftarrow{\hat{B}}^{T_1}}\,(\text{CI}) \qquad \dfrac{\dfrac{Q \wedge \hat{B} \rightsquigarrow^{T_2} R}{Q \wedge \hat{B} \rightarrow \tilde{R}^{T_2}}\,(\text{PI2I})}{\tilde{Q}^{T_1} \wedge \overleftarrow{\hat{B}}^{T_1} \rightarrow \tilde{R}^{T_1+T_2}}\,(\text{TS}) \qquad P \wedge \hat{A} \wedge \overleftarrow{\hat{B}}^{T_1} \qquad \dfrac{Q \wedge \hat{B}}{\tilde{Q}^{T_1} \wedge \overleftarrow{\hat{B}}^{T_1}}\,(\text{TS}) \qquad \dfrac{R}{\tilde{R}^{T_1+T_2}}\,(\text{TS})}{\dfrac{P \wedge \hat{A} \wedge \overleftarrow{\hat{B}}^{T_1} \rightarrow \tilde{R}^{T_1+T_2}}{\left((P \wedge \hat{A}) \nearrow^{T_1} \hat{B}\right) \rightsquigarrow^{T_1+T_2} R}\,(\text{I2PI})}\,(\text{DED})$$

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

# Conclusion

Demo Time