Natural Logic (NLog) & EL/EPILOG

NLog: Enables some obvious lexical inferences to be made easily from parsed, annotated NL.

Two main ideas:

1. Replace terms by more general ones in positive (upward entailment) phrasal contexts, and by more specific ones in negative (downward entailment) ones. So, inference is "polarity-based".
   - e.g., All dogs bark $\rightarrow$ All poodles make noises.

2. Infer the (positive or negated) complement of implicative & presuppositional verbs
   - e.g., Ed managed to graduate $\rightarrow$ Ed graduated
   - e.g., Ed failed to graduate $\rightarrow$ Ed did not graduate
   - e.g., Ed knows he is lazy $\rightarrow$ Ed is lazy

Combining these methods

- e.g., Ed managed to buy a truck $\rightarrow$ Ed acquired a vehicle

- e.g., (from MacCartney & Manning, 2009)
  - Jimmy Dean refused to move without his blue jeans
    $\downarrow$ $\downarrow$ $\downarrow$
    $\rightarrow$ $\downarrow$ $\downarrow$

- James Dean did not dance without pants

Episodic Logic (EL) & the EPILOG inference engine

EL is an extension of FOL to cover modification and reification of predicates & sentences, and to allow association of episodes with arbitrary sentences.

- e.g., Ed knows that he is very lazy $\rightarrow$ (approximately)
  
  $\exists e$: [e at-about Now34]

- WordNet-based disambiguation
  - [[Ed knows3,v (that [Ed (very lazy)])] $\exists$ e]

- Skolemize:
  - $\exists x (\forall y (\forall e (\forall p: [[x \text{ knows}_3,v p]] e) [\exists x \text{ believes}_1,v e] [\exists [p \text{ True}]]))$
  - $[[\text{Ed knows}_3,v (that [Ed (very lazy)])]] E3$
  - $[[\text{Ed believes}_1,v (that [Ed (very lazy)])]] E3$

- Partially describes
EL also allows schemas (containing syntactic metavariables)

\( \forall w \ [ ((\text{that } w) \ True) \iff w] \)

\( \forall \text{pred } P \ (\forall \text{term } t \ [ t(\text{very } P) \Rightarrow [t \ P]]) \)

Thus, being very lazy implies being lazy

So we can derive

\[ [\text{Ed lazy}] \]  ("lazy" construed as an enduring, nonepisodic property)

In general, EL (implemented in the EPLaCe engine) uses

- generalized polarity-based forward & backward inference (of resolution, w/o conversion to clauses)

\[
\text{forward: } \quad \text{MAT}^-(\phi), \text{MIN}^+(\phi') \quad \sigma \text{ unifies } \phi, \phi' \\
\text{backward: } \quad \text{MAT}^+_\sigma(\neg(\text{MIN}^+_\sigma(\bot))) \\
\text{example: } \quad \text{Dog}(x) \lor \text{Pet}(x), \quad \text{Dog}(\text{Fifi}) \lor \text{Cat}(\text{Fifi}), \quad \sigma = (x/\text{Fifi})
\]

- Some natural deduction rules:
  - assumption of antecedent in proving \([\phi \Rightarrow \psi]\]
  - assumption of false disjunct in proving \([\phi \lor \psi]\]
  - some others

- Specialists (e.g., for taxonomies, parts, times, arithmetic, \ldots) to accelerate inference.