Ling 472 Section, December 3, 2003

Bill gave a puppy to John.
It bit him.
He gave it back to him.

Tree Search:

Step 1: Start at the NP for *it*,
Step 2: go up to the *S*. Node X = S and the path = S-NP.
Step 3: There are no branches to the left of node X, so
Step 4: go back to the previous tree. Search in this order, until you get to something that works for *it*. S, NP, VP, proper noun, verb, NP.

Step 1: Start at the NP for *him*
Step 2: go up to the S. Node X = S and the path = S-VP-NP.
Step 3: Traverse the nodes below X to the left of the path. NP (doesn't agree), verb, pronoun. Nothing works.
Step 4: Traverse the previous tree in the same order as before. This time, stop at the first NP, *Bill*.

At the third sentence:
Step 1: Start at the NP for *he*
Step 2: go up to the S.
Step 3: There are no nodes to the left of this path.
Step 4: Look back the next sentence. Traverse like so: S, NP (doesn't agree), VP, pronoun, verb, NP.

The process for the pronoun *it* works just like *him* for the previous sentence, but now it matches *it* (or *the puppy*).

Discourse Coherence

Let's establish the coherence of the following discourse, and determine the pronoun reference while we're at it.

The discourse:

(1) John ate Bill's peaches.
(2) He went ballistic.

The general coherence axioms:

If one utterance results from another, there's a coherence relation:
(3) $\forall e_i, e_j \; Result(e_i, e_j) \Rightarrow CoherenceRel(e_i, e_j)$

If one utterance causes another, that second one results from the first:
(4) $\forall e_i, e_j \; cause(e_i, e_j) \Rightarrow Result(e_i, e_j)$

Causation is transitive:
(5) $\forall e_1, e_2, e_3 \; cause(e_i, e_j) \wedge cause(e_j, e_k) \Rightarrow cause(e_i, e_k)$

Real-world axioms:

If somebody has peaches, they want to eat them:
(6) $\forall e_i, x, y \; Have(e_i, x, y) \wedge Peaches(y) \Rightarrow \exists e_j, e_k \; Want(e_j, x, e_k) \wedge Eat(e_k, x, y)$

If somebody eats something, that causes it to be gone:
(7) $\forall e_i, x, y \; Eat(e_i, x, y) \Rightarrow \exists e_j \; Gone(e_j, y) \wedge cause(e_i, e_j)$

If something is gone, that makes it impossible to eat it:
(8) $\forall e_i, e_j, x, y \; Gone(e_i, x) \wedge Eat(e_j, y, x) \Rightarrow \exists e_k \; Impossible(e_k, e_j) \wedge cause(e_i, e_k)$

If somebody wants something that's impossible, they go ballistic
(9) $\forall e_i, e_j, x \; Want(e_i, x, e_j) \wedge Impossible(e_j) \Rightarrow \exists e_k \; GoBallistic(e_k, x) \wedge cause(e_j, e_k)$

The content of the utterances themselves:

From (1):
(10) $Eat(e_1, John, p) \wedge Peaches(p) \wedge Have(e_2, Bill, p)$

From (2):
(11) $GoBallistic(e_3, he)$

Begin hypothesizing (abduction):

Assume we have a Coherence relation:
(12) Coherence(e_1, e_3)

From (12) & (3), we can hypothesize a Result relation:
(13) Result(e_1, e_3)

From (13) & (4), hypothesize that (1) caused (2)
(14) cause(e_1, e_3)

Start making deductions:

From (10) & (6), deduce that Bill wants to eat the peaches:
(15) Want(e_4, Bill, e_5) $\wedge$ Eat(e_5, Bill, p)

From (7) & (10), deduce that the peaches are gone:
(16) Gone(e_6, p) $\wedge$ cause(e_1, e_6)

From (8) and (16), deduce that it is impossible for Bill to eat the peaches:
(17) Impossible(e_7, e_5) $\wedge$ cause(e_6, e_7)

From (5), (16) & (17), deduce that John's eating the peaches caused it to be impossible for Bill to eat them:
(18) cause(e_1, e_7)

From (9), (15) & (17), deduce that Bill goes ballistic:
(19) GoBallistic(e_8, Bill) $\wedge$ cause(e_7, e_8)

From (5), (18) & (19), deduce that John's eating the peaches caused Bill to go Ballistic:
(20) cause(e_1, e_8)

If we replace *he* in (11) with *Bill*, we can assert that $e_3 = e_8$, and recast (19):
(21) GoBallistic(e_3, Bill) $\wedge$ cause(e_1, e_3)

Which is proof of what we hypothesized, establishing a coherence relation given a particular resolution for the pronoun *he*.