Computational Models of Events

Lecture 5: Events above the Sentence: Discourse and Narratives

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Today's Outline

- Events in Discourse Structure
- Global Temporal Ordering of Events in Text
- Narrative Event Structures
- Latent Event Structure

Abductive Interpretation of Discourse Events

Hobbs et al (1988) - Slides from Alex Lascarides ☺

Compounds: Prove relation between modifier and head.

- *tea cup* vs. *ceramic cup*.

Sentences: Prove predicate argument structure.

- John believes men work.

Don't explain adjacency of *believes* and *men*, but rather:

- *men* and *work*; *believes* and *men work*; *John* and *believes men work*

Discourse: Prove a coherence relation between the segments:

- *I collect classic cars. My favourite is an Alfa Spider.*

Interpretation

(1) A car hit a jogger last night.

- We infer a causal relation between hitting and jogging, which goes beyond what is given by compositional semantics.
- This is just the same sort of inference that will go on at the inter-sentential level.
- We'll look at inferences at the intra-sentential level first, and extrapolate up.

Solving Pragmatics by Abduction

- Abduction is inference to the best explanation.

$$\frac{\begin{array}{l} p \rightarrow q \\ q \end{array}}{p}$$

- Abduction in NLP:
  - We must provide an explanation of why the sentence is true.

The Algorithm

To interpret a sentence:

- Prove the logical form of the sentence that's constructed in the grammar, together with the constraints that predicates impose on their arguments,
- allowing for coercions,
- Merging redundancies where possible,
- Making assumptions where necessary.

Proving: Prove logical form via FOL.

Redundancies: Merging redundancies $\approx$ the best explanation.

Abduction: Making assumptions is the abduction bit.

The Role of Abduction in Interpreting Utterances

S and *H* have

- their own beliefs
- mutual beliefs

The content of an utterance'mixes' mutual beliefs and *S*'s beliefs, and is an attempt to expand the set of mutual beliefs:

- The bits in mutual belief are *old information*
- The bits outside mutual belief are *new information*.
- The bits outside mutual belief will require abduction in order to prove them.

Proving a Discourse

(3) Max fell. John pushed him.

- You must prove that (3) is a discourse segment.
- You do this by proving a coherence relation between the sentences from rules like the following:

1. $\forall e_1, e_2, e(\mathit{CoherenceRel}(e_1, e_2, e) \rightarrow \mathit{Segment}(e))$
2. $\forall e_1, e_2, e((\mathit{Info}(e_1, e_2) \wedge \mathit{etc}_i) \rightarrow \mathit{CoherenceRel}(e_1, e_2, e))$

- *CoherenceRel* is coordinating: e must be computed from e_1 and e_2 together.
- *CoherenceRel* is subordinating: e is either e_1 or e_2.

Rules for (3)

- $\forall e_1, e_2, e(\mathit{CoherenceRel}(e_1, e_2, e) \rightarrow \mathit{Segment}(e))$
- $\forall e_2, e_1(\mathit{cause}(e_2, e_1) \rightarrow \mathit{Explanation}(e_1, e_2, e_1))$
- $\forall e_1, e_2, e(\mathit{Explanation}(e_1, e_2, e) \rightarrow \mathit{CoherenceRel}(e_1, e_2, e))$

- Abduce (i.e. assume) *cause*, and the appropriate conclusion follows.
- So abduce pushing caused the falling, and then you are assured that (3) is a coherent discourse segment.

Occasion

(4) a. At 5:00 the train arrived in Chicago.
b. At 6:00 Bill Clinton held the press conference.

Instead of Explanation, we have *Occasion*, which is proved when:

- Both events describe a change in state, and the final state of the first is the initial state of the second.

Parallel

- *Parallel*(e_1, e_2, e) is proved if:
  - The first segment S_1 (plus assumptions) entails $p(x_1, \ldots, x_n)$
  - The second segment S_2 (plus assumptions) entails $p(y_1, \ldots, y_n)$
  - x_i is similar to y_i in that they share some property.
- It's a coordinating relation.

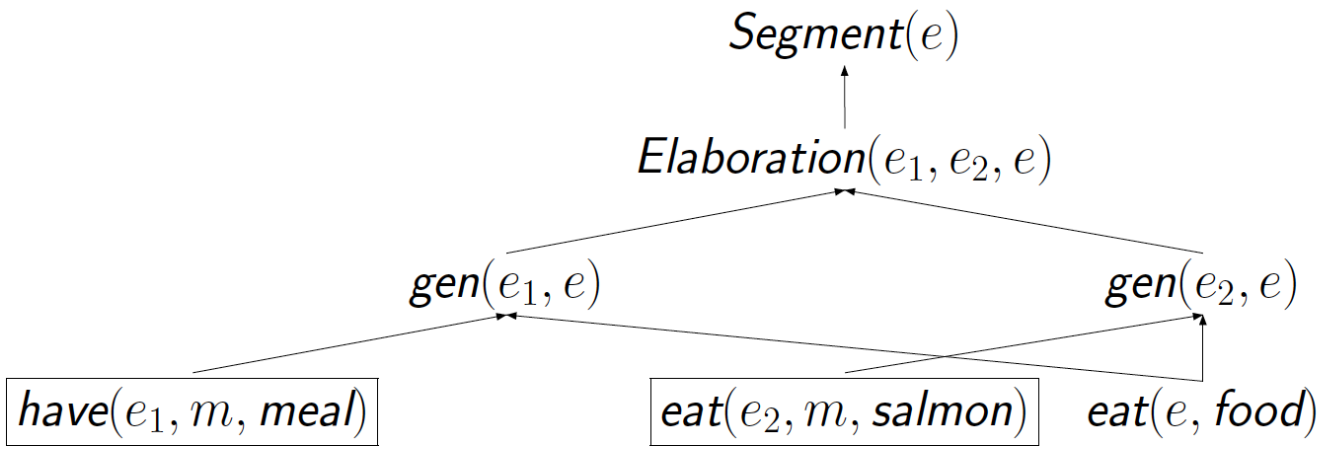
(5) John drank beer. Fred drank wine.

Elaboration

- Entities are not merely similar, but identical.
- At some level, both segments say the same thing.
- Proving Elaboration:
  If there is an event e that is generated by both e_1 and by e_2,
  then they are connected by Elaboration,
  and e acts as the summary.
  - $\forall e_1, e_2, e(gen(e_1, e) \wedge gen(e_2, e) \rightarrow Elaboration(e_1, e_2, e))$
- Elaboration is a subordinating relation.

Proving an Elaboration

(6) Max had a great meal.
He ate lots of salmon.



Proving Explanation

(9) a. The police prohibited the women from demonstrating.
b. They feared violence.

1. Prove that (9)a and (9)b are sentences.
2. Prove that together they form a segment.
   1. Aim for Explanation relation.
   2. So prove:
      - There is a prohibiting event e_1 of the police.
      - There is a fearing event e_2 of "them"
      - e_2 caused e_1.

Proving the Causal Relation

(9) a. The police prohibited the women from demonstrating.
b. They feared violence.

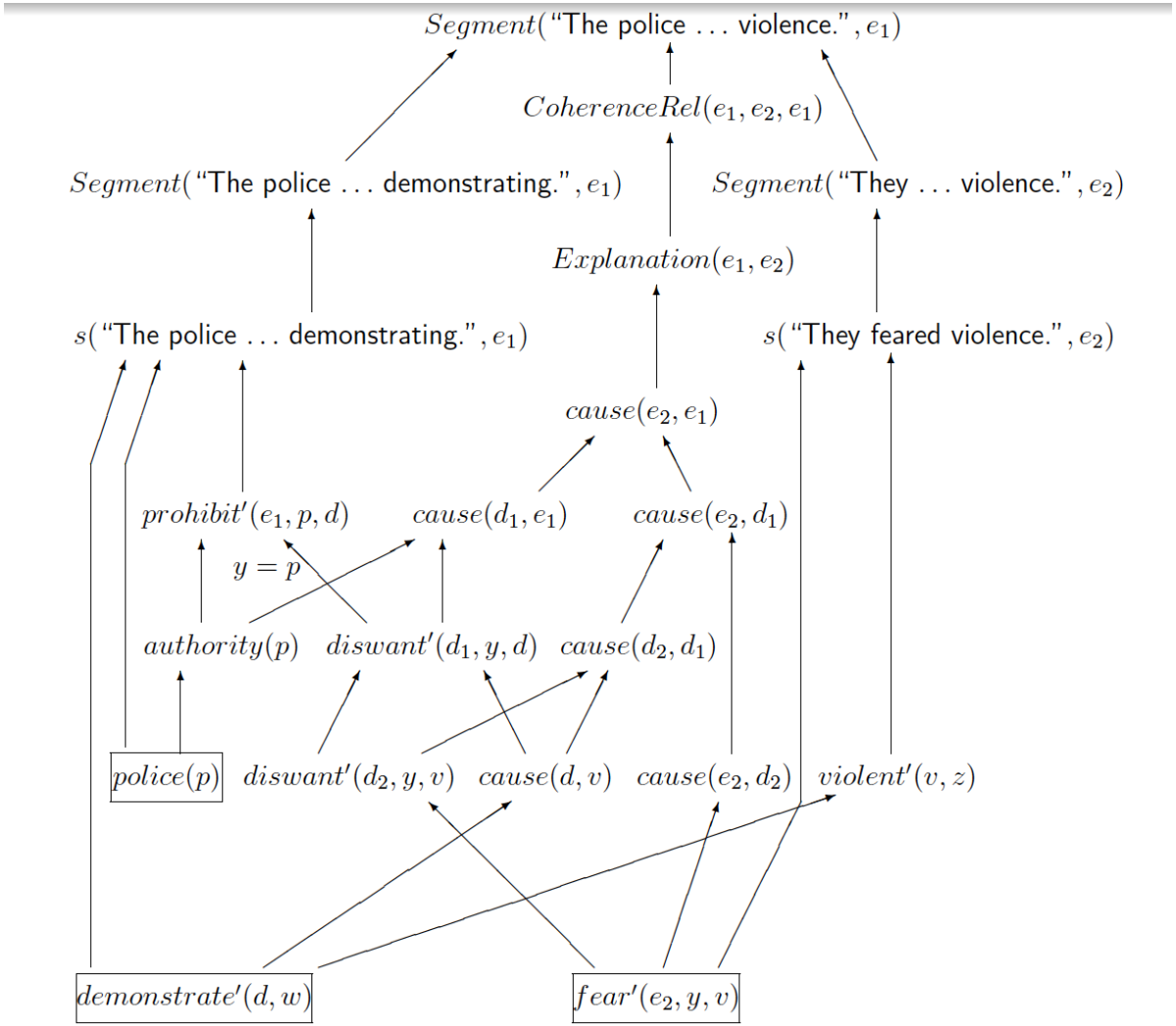
1. Prove that (9)a and (9)b are sentences.
2. Prove that together they form a segment.
   1. Aim for Explanation relation.
   2. So prove:
      - There is a prohibiting event e_1 of the police.
      - There is a fearing event e_2 of "them"
      - e_2 caused e_1.

The Proof Graph

(c) This can be proved if we have the following WK axioms:
  (i) If e_2 is a fearing by y of v, then this causes y not to want v
  (ii) If e_1 is a demonstration, then e_1 causes violence (v).
  (iii) If y doesn't want v, then this causes y to prevent v from happening.

(d) If we assume "they" is the police, then the proof of causation follows by the above WK axioms.

The Problem of Choice in Abduction



Abductive Interpretation of Discourse Events

Hobbs (1983)

(3) Max fell. John pushed him.

(10) Max fell. John helped him.

A $(\langle e_1, e_2 \rangle \wedge \mathit{cause}(e_2, e_1)) \rightarrow \mathit{Explanation}(e_1, e_2, e_1)$

B $(\langle e_1, e_2 \rangle \wedge \mathit{cause}(e_1, e_2)) \rightarrow \mathit{Narration}(e_1, e_2, e)$

- Need (B) to prove (10) is a segment. *Be Orderly*.
- But you can abduce on (B) to get the wrong interpretation of (3).
- There's a choice of what to abduce. How do we choose?

Abductive Interpretation of Discourse Events

Hobbs (1983)

- Assign costs to predicates.
- Guide abduction so that you abduce things that give the smallest overall cost.
- This amounts to the least risk strategy.

Falling and Pushing:

$$(\langle e_1, e_2 \rangle \wedge \text{FALL}(e_1, x) \wedge \text{PUSH}(e_2, y, x) \wedge \text{ETC}_n(e_1, e_2)) \rightarrow \text{CAUSE}(e_2, e_1)$$

ETC predicates generally assigned low weights.