Anaphora and Ambiguity in Narratives

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Question of the day

How do we explain that a pair of discourse units (DUs) are related via a particular coherence relation (or relations)?

- **Why** does "John took a train from Paris to Istanbul. He has family there" exemplify Explanation?

- So far, we have simply assumed that there is *some* mechanism (magic!) that does the trick.

Recalling the plan

Linguistic Forms

are interpreted to

SDRSs — describe discourse structure

are converted to

DRSs — describe event structure

are evaluated in

Models

What goes into interpreting (1) to SDRSs? A naive/intuitive answer...

(1) John took a train from Paris to Istanbul. He has family there.

- Compositional semantics to derive the literal meaning of (1): two independent assertions about John.
- Common sense reasoning about these independent assertions to derive Explanation.
  - > What else besides an effect-cause ordering of eventualities would make sense?

On deck...

- Go over a set of data that challenges this naive/intuitive answer
- Take away message: Common sense reasoning is very complex
  - Semanticists should take great care in providing general rules of inference (a pragmatic waste bucket is not acceptable!)
  - Semanticists should take great care in providing specific constraints that must be met in order for a given coherence relation to hold between two DUs.
    - As it turns out, the constraints are more fine grained than is typically assumed; some constraints are aspectually driven!

Resemblance vs. Cause: The power of Parallel

(2) Ava ate a brownie. Justin ate a cookie.

(3) Phil tickled Stanley. Liz poked him. (Smyth 1994)

(4) ?Margaret Thatcher admires Ronald Reagan, and George W. Bush absolutely worships her. (Kehler 2002)

How do we make sense of the data?

Why is Parallel so powerful? How do we capture its power?

Contiguity vs. Cause: The power of Narration

(5) The train arrived in Chicago at 3.
Obama held a press conference at 5. (after Hobbs 1990)

How do we make sense of the data?

Why is Narration so powerful? How do we capture its power?

Cause vs. Effect: The power of Background

(6) The Hampshire barn was red. I painted it.
I painted the Hampshire barn. It was red.

(7) Max was on the ground. Akna pushed him.
Akna pushed Max. He was on the ground.

(8)
Al was a student at Harvard. He got 100% on the entrance exam.
Al got 100% on the entrance exam. He was a student at Harvard.

(9) Bill was dead. John shot him.
John shot Bill. %He was dead.

(10) Hans' shirt was wet. I threw a giant water balloon at him.
I threw a giant water balloon at Hans. %His shirt was wet.

Cause vs. Effect: The power of Background continued...

(11) Akna was in the southern most point in Spain.
She took a bus from Madrid.

(12) Akna took a bus from Madrid.
She was in the southern most point in Spain.

Result suddenly appears!

(13) I painted the Hampshire barn. So it was red.

(14) Akna pushed Max. As a result he was on the ground.

(15) Al got 100% on the entrance exam.
As a result he was a student at Harvard.

(16) John shot Bill. As a result he was dead.

(17) I threw a giant water balloon at Hans.
As a result, his shirt was wet.

(18) Akna took a bus from Madrid.
? As a result, she was in the southern most point in Spain.

The power of Result

(19) Jameson switched off the light. It was pitch dark around him.

(after Hinrichs 1986)

(20) I gave Arpine a dozen roses. She was thrilled.

How do we make sense of the data?

- Mini-discourses consisting of stative-eventive descriptions naturally trigger an Explanation.
- Mini-discourses consisting of eventive-stative descriptions naturally trigger Background, while resisting Result; there are a some cases, however, where Result seems to be triggered and cases where where Result is definitely triggered (with cue phrases)

Cataphoric Background?

(21) It was dark. I nevertheless walked into the room.

- Asher et al (2007) called such phenomena cataphoric, claiming a processor builds expectations to resolve the temporal extent of the darkness state to the temporal extent of some event later described in the discourse (in this case, the walking-in event).

- This expectation is arguably analogous to the expectation to resolve *it* in the first sentence to a later described entity (in this case, the room).

Issues with Background

- Backward vs. Forward Background – or Anaphoric vs. Caraphoric Background?
- Background has magical anaphoric properties (see yesterday's slides)
- What exactly is Background? Is it a primitive or something that should be derived from other cognitive principles related to Ground/Figure in Gestalt Psychology?

A possible strategy (Asher et al. 2007)

- Assume that the arguments to Background are a discourse unit and a topical CDU (TCDU), which is elaborated upon.

A man was sitting on a bench. A woman walked over to him.

- Suppose the state described by the first sentence is part of the presupposed content of the entire discourse.
- What is projected as part of a TCDU is the individual man of whom the state holds.
- This man is then elaborated upon by the second second sentence: this man relates to a walking over event by being the theme of that event, whose agent is a woman.

Research questions about cataphora

It is generally assumed that cataphora only arises with (particular) subordinate coherence relations.

- Is that correct?
- What are the particular coherence relations that license cataphora?
- Why those relations and in what contexts?
- What would it mean for a coordinating discourse move to license cataphora?

Summary

- When a Parallel interpretation is possible, it seems to be preferred, at times even necessary!
- Mini-discourses consisting of eventive-eventive descriptions naturally trigger Narration rather than Result.
- Mini-discourses consisting of stative-eventive descriptions naturally trigger an Explanation, though can sometimes also trigger a cataphoric Background.
- Mini-discourses consisting of eventive-stative descriptions naturally trigger Background, while resisting Result; there are a some cases, however, where Result seems to be triggered and cases where where Result is definitely triggered (with cue phrases)

Discourse reanalysis

(22) Phil tickled Stanley. Liz poked him...

- Let's assume that Parallel is inferred in (22), thereby leading the hearer to resolve *him* to Stanley.

- Let's further assume that (22) is followed-up with (23):

(23) Phil stopped. Stanley thanked her.

- Consequently, the hearer could revise the coherence relation in (22) as being Result and thus the antecedent for *him* would also be revised, namely as being Phil.

Accounting for discourse reanalysis within a model theoretic framework: Option 1

- Pronouns are coindexed with their antecedents in the syntactic representation.

- Such representations are assigned as many LFs as there are coindexation possibilities.

- (22) would be treated as being *semantically ambiguous*. That is, after hearing *Liz poked him*, the hearer would choose one LF from two possibilities. Upon hearing, e.g. (23), the hearer could then revise this choice, selecting the other LF.

Accounting for discourse reanalysis within a model theoretic framework: Option 2

- Deny that (22) involves reanalysis. Pronouns are underspecified! (22) is not *semantically ambiguous* but rather underspecified with respect to two possible readings
- Such representations are assigned as many LFs as there are coindexation possibilities.
- After hearing *Liz poked him*, the hearer would not resolve *him* to a particular antecedent. It's only upon hearing, e.g. (23), that the antecedent of the pronoun would be specified.
- It's only when there is enough content in the discourse that a pronoun gets its value from that context.

Some worries/open questions for coindexation approach

- If pronoun resolution and coherence establishment are, in fact, correlated and mutually constraining tasks, it is far from obvious how to capture this in a coindexation approach

- Unless the syntax has access to the discourse structure (which seems dubious), we must generate two LFs with different indexations for *him* in (22), then try to attach each LF to the previous sentence with Parallel and Result, and assess the relative plausibility of the combinations.

- What happens when we are interpreting a large text, where the number of LFs grow exponentially?

Some worries/open questions for underspecification approach

- A lot of pressure is put on the processor. The processor has to keep the multiple parses in memory, which makes the process much like a filler-gap situation.
- A prediction of the underspecification account is that one would get longer reading times in (22) if you lengthen the material that's intervening between the pronoun and (23). If longer times are not observed, then this be would be evidence for the coindexation approach.
- How would an underspecification approach account for comedic sketches and texts with an unreliable narrator when one is forced to revise assumptions?

The Best/Worst of Both Worlds

- SDRT does both:
- Have the syntax generate an underspecified form.
- Hand this form to an entirely different system.
- And let this system compute all plausible interpretations.

- Pro: generates less logical forms to search through.
- Con: “plausible” may require more frequent revision.
  - Still have to store everything (incl the least plausible ones).
  - “Plausible” itself is computationally very expensive.

Summary

Linguistic Forms

are interpreted to

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Summary

Linguistic Forms	
are interpreted to	
Underspecified Logical Forms	partially describe content
are specified to	
SDRSs	describe narrative structure
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Underspecified Logical Form

- The idea is this: we construct a language for incomplete descriptions of SDRSs.
- So we need a language for “underspecified logical form” (ULF).
- We need a formal statement for “this SDRS is described by this ULF”.

ULF Language: atoms and variables

- So what are the bits and pieces of an SDRS?

- DRSs
  > Any DRS K is an "atom" (or, constant symbol).
  (you can underspecify these too, but I won't)

- Labels
  > Take variable symbols for labels $l_1, l_2, \ldots$

- Coherence relations
  > Take a constant symbol D_R for each coherence relation R
  > Plus corresponding variable symbols $D_1, D_2, \ldots$

ULF Language: Structure

- We underspecify:
- What the contents are.
- Which contents are connected.
- How they are connected.

- Take two predicate symbols to describe assignment:
  - > $\mathit{labels}(l, K)$
  - > $\mathit{relates}(l_1, l_2, l_3, D)$

- And three to describe structure:
  - > $\mathit{outscopes}(l_1, l_2)$
  - > $\mathit{accessible}(l_1, l_2)$
  - > $\mathit{last}(l_1)$

ULF Language: Anaphor

- Anaphora are a type of underspecification.
- So take a constant symbol v_x for each DRT-variable x (do this for every type of variable).
- And add a predicate symbol:
  - > $\mathit{anaphor}(l, v)$

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- And add a predicate symbol:
  - > $anaphor(l, v)$
- (If you extend the language to partially describe microstructure, you can write anaphora as $x =?$ to indicate something like "x is not in the universe of K".)

Examples

- ULFs are constructed from surface form.

(24) There is a woman.

$$labels(l_1, \begin{array}{|l|}\hline \text{x} \\ \hline \texttt{woman}(\text{x}) \\ \hline \end{array})$$

(25) She runs.

$$labels(l_2, \begin{array}{|l|}\hline \text{e,y} \\ \hline \texttt{run}(\text{e}) \\ \texttt{actor}(\text{e,y}) \\ \hline \end{array}) \wedge anaphor(l_2, v_y)$$

Two Sentence Example

(26) There is a woman. She runs.

$$
\begin{aligned}
& \mathit{labels}(l_1, \boxed{\begin{array}{l} \text{x} \\ \hline \texttt{woman}(\text{x}) \end{array}}) \\
\wedge\ & \mathit{labels}(l_2, \boxed{\begin{array}{l} \text{e,y} \\ \hline \texttt{run}(\text{e}) \\ \texttt{actor}(\text{e,y}) \end{array}}) \wedge \mathit{anaphor}(l_2, v_y) \\
\wedge\ & \mathit{relates}(l_0, l_1, l_2, D) \\
\wedge\ & \mathit{last}(l_2)
\end{aligned}
$$

ULF Language: Cue Phrases

- Add an (empirically sourced) vocabulary of linguistic cues to this language.

- therefore $\rightsquigarrow$ *therefore*(*l*)
- and then $\rightsquigarrow$ *and-then*(*l*)
- I hereby command $\rightsquigarrow$ *command*(*l*)
- I hereby assert $\rightsquigarrow$ *inform*(*l*)

- Including grammatical features:

- *declarative*(*l*)
- *interrogative*(*l*)
- *imperative*(*l*)

- Plus tense, aspect... — **anything useful from the grammar!**

From ULF to SDRS

- The underspecified language has the formulas we seen so far, closed under the logical constants $=$, $\neg$, $\vee$ and $\wedge$.
- Call a formulae in this language an ULF (underspecified logical form).

From ULF to SDRS

- The underspecified language has the formulas we seen so far, closed under the logical constants $=$, $\neg$, $\vee$ and $\wedge$.
- Call a formulae in this language an ULF (underspecified logical form).
- Now, this is conceptually a bit weird, but not hard:
- We want to define a turnstile $\models$ such that for an SDRS *S* and an ULF $\mathcal{K}$, $S \models \mathcal{K}$ iff all descriptions from $\mathcal{K}$ are realised in *S*.

Assignment Function

- Let $S = (\Pi, \mathcal{F}, L)$ be an SDRS and A be a function s.t.:
  - for each variable l_i, $A(l_i) \in \Pi$
  - for each variable D_i, $A(D_i)$ is some coherence relation.
  - $A(D_R) = R$ for all coherence relations R
  - $A(v_x) = x$ for all and DRT-variables x.

- (i.e. the variables are implicitly existentially quantified)

Satisfaction

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- $S, A \models \mathit{last}(l_1)$ iff $A(l_1) = L$.
- $S, A \models \mathit{labels}(l, K)$ iff $K \subseteq \mathcal{F}(A(l))$ and $\mathcal{F}(A(l))$ does not use relation symbols not in K.

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    i. there is a relation R and labels α and β with $\mathcal{F}(\alpha) = R(\beta, A(l))$;
    ii. λ is accessible to β; and
    iii. $\mathcal{F}(A(l))$ has a conjunct $A(v) = z$.

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- $S, A \models \mathit{anaphor}(l, v)$ iff there is a DRT variable z introduced in some segment $\lambda \in \Pi$ (of S) such that
  i. there is a relation R and labels α and β with $\mathcal{F}(\alpha) = R(\beta, A(l))$;
  ii. λ is accessible to β; and
  iii. $\mathcal{F}(A(l))$ has a conjunct $A(v) = z$.
- If $\mathit{cue}(l)$ is a linguistic cue predicate, $S, A \models \mathit{cue}(l)$ always.

Linguistic Form to Narrative Structure

- So, given the linguistic form of a discourse, we:
  - Compute for every *clause* the corresponding DRS K (by the DRT construction algo), except that we don't resolve anaphora here.
  - Pick an unused label variable l_1 and add $labels(l_1, K)$.
  - (If there is an ambiguity, you can also add $labels(l_1, K) \vee labels(l_1, K')$).
  - For every anaphor x in K add $anaphor(l_1, v_x)$.
  - Add appropriate predicates on l for cue phrases and linguistic features (aspect etc.).
  - For every clause except the very first one, pick another two unused label variables l_0, l_2 and add $relates(l_0, l_2, l_1, D)$ (i.e. l_1 attaches somewhere)
- Call the conjunction of all these $\mathcal{K}$.

Two Sentence Example

(27) Phil tickled Stanley. He laughed.

$$
\begin{array}{ll}
 & \mathit{labels}(l_1, \begin{array}{|l|} \hline p, s, e_1 \\ \hline \texttt{tickling}(e_1) \\ \texttt{actor}(e_1, p) \\ \texttt{object}(e, s) \\ \hline \end{array}\ ) \\
\wedge & \mathit{labels}(l_2, \begin{array}{|l|} \hline e_2, y \\ \hline \texttt{laughing}(e_2) \\ \texttt{actor}(e_2, x) \\ \hline \end{array}\ ) \\
\wedge & \mathit{anaphor}(l_2, v_y) \\
\wedge & \mathit{relates}(l_0, l_1, l_2, D) \\
\wedge & \mathit{last}(l_2)
\end{array}
$$

Two Sentence Example

(27) Phil tickled Stanley. He laughed.

$A(l_0) = \pi_0, A(l_1) = \pi_1$
$A(l_2) = \pi_2, A(D) = Result$

$\Pi = \{\pi_0, \pi_1, \pi_2\}, L = \pi_2$

$$\mathcal{F}(\pi_1) = \begin{array}{|l|}\hline p, s, e_1 \\ \hline \texttt{tickling}(e) \\ \texttt{actor}(e_1, p) \\ \texttt{object}(e, s) \\ \hline\end{array}$$

$$\mathcal{F}(\pi_2) = \begin{array}{|l|}\hline e_2, y \\ \hline \texttt{laughing}(e_2) \\ \texttt{actor}(e_2, x) \\ y = s \\ \hline\end{array}$$

$\mathcal{F}(\pi_0) = Result(\pi_1, \pi_2)$

$$\models \quad labels(l_1, \begin{array}{|l|}\hline p, s, e_1 \\ \hline \texttt{tickling}(e_1) \\ \texttt{actor}(e_1, p) \\ \texttt{object}(e, s) \\ \hline\end{array})$$

$$\wedge \quad labels(l_2, \begin{array}{|l|}\hline e_2, y \\ \hline \texttt{laughing}(e_2) \\ \texttt{actor}(e_2, x) \\ \hline\end{array})$$

$\wedge \quad anaphor(l_2, v_y)$

$\wedge \quad relates(l_0, l_1, l_2, D)$

$\wedge \quad last(l_2)$

Two Sentence Example

(27) Phil tickled Stanley. He laughed.

$$A(l_0) = \pi_0, A(l_1) = \pi_1$$
$$A(l_2) = \pi_2, A(D) = \mathit{Correction}$$

$$\Pi = \{\pi_0, \pi_1, \pi_2\}, L = \pi_2$$

$$\mathcal{F}(\pi_1) = \begin{array}{|l|}\hline p, s, e_1 \\ \hline \texttt{tickling}(e) \\ \texttt{actor}(e_1, p) \\ \texttt{object}(e, s) \\ \hline \end{array}$$

$$\mathcal{F}(\pi_2) = \begin{array}{|l|}\hline e_2, y \\ \hline \texttt{laughing}(e_2) \\ \texttt{actor}(e_2, x) \\ y = p \\ \hline \end{array}$$

$$\mathcal{F}(\pi_0) = \mathit{Correction}(\pi_1, \pi_2)$$

$$\models$$

$$\mathit{labels}(l_1, \begin{array}{|l|}\hline p, s, e_1 \\ \hline \texttt{tickling}(e_1) \\ \texttt{actor}(e_1, p) \\ \texttt{object}(e, s) \\ \hline \end{array})$$

$$\wedge \quad \mathit{labels}(l_2, \begin{array}{|l|}\hline e_2, y \\ \hline \texttt{laughing}(e_2) \\ \texttt{actor}(e_2, x) \\ \hline \end{array})$$

$$\wedge \quad \mathit{anaphor}(l_2, v_y)$$

$$\wedge \quad \mathit{relates}(l_0, l_1, l_2, D)$$

$$\wedge \quad \mathit{last}(l_2)$$

The Best/Worst of Both Worlds

- SDRT does both:
- Have the syntax generate an underspecified form.
- **Hand this form to an entirely different system.**
- And let this system compute all plausible interpretations.

A system, not a solution

We need construction rules that enable one to:

- Explain why a particular coherence relation (or relations) is inferred.
  - Inference from non-specific information.
- Explain how discourse reanalysis arises.
  - Revision to previously "implausible" interpretations.