

Dialogue Processing as Incremental Lattice Extension

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... and Pat, Chris, Graham, Eleni, Wilfried, Robin and Ruth ...

The Dynamics of Conversational Dialogue (DynDial)
www.kcl.ac.uk/research/groups/ds

Sentences as Grammatical Units

A sentence:

And finally, as a bonus, we will show that this concept of context extends seamlessly to dialogue exchange phenomena in which an utterance fragment depends for its construal on what has been built up as representation of content immediately prior to the utterance of the fragment with the effect that the elliptical fragment is construed as providing an extension or modification of what has just been said by the other party to the dialogue.

(Kempson et al., 2009)

Sentences as Grammatical Units?

The same sentence in dialogue?

A: And finally,

B: uh-huh

A: as a bonus,

B: lucky me!

A: we will show that this concept of context

B: content?

A: conTEXT

B: ok

A: extends seamlessly to dialogue exchange err

B: phenomena

A: right, phenomena, in which an utterance fragment ...

Moves as Dialogue Units

A dialogue:

A:	Paris, please.	TELL-DEST
B:	Paris, France?	CHECK
A:	Right.	CONFIRM
B:	OK.	BACKCHAN
	Where from?	ASK-ORIG
A:	New York.	TELL-ORIG
B:	New York to Paris.	CHECK
	Checking ...	HOLD

- We might need keywords, but otherwise this is pretty good

Moves as Dialogue Units?

The same sentence in dialogue?

A: And finally,	RHET-SEQ
B: uh-huh	BACKCHAN
A: as a bonus,	PROMOTE
B: lucky me!	SARCASM
A: we will show that this concept of context	ASSERT
B: content?	CLARIFY
A: conTEXT	ANSWER
B: ok	ACCEPT
A: extends seamlessly to dialogue exchange err	CONTINUE
B: phenomena	SUGGEST
A: right, phenomena, in which an utterance	CONTINUE

Dialogue Phenomena

- Non-sentential fragments about 10% of utterances
 - [Fernández and Ginzburg, 2002]
- Clarification requests about 4% of utterances
 - [Purver et al., 2001]
- Split utterances are an important phenomenon
 - [Purver et al., 2009, Howes et al., 2009]
- Nearly 20% of BNC “sentences” continue another “sentence”
 - 85% of those are same-person
 - but nearly 50% are cross-turn
- Over 70% continue something already apparently complete
- Not just string concatenation *“Did you burn . . . Myself? No.”*

Moves as Dialogue Units?

A real dialogue system problem

A: Well maybe by uh Tuesday you could

B: Uh-huh

A: revise the uh

C: proposal

B: Mmm Tuesday let's see

A: and send it around

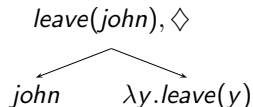
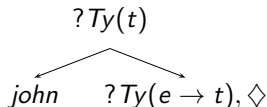
B: OK sure sounds good

- We're not dealing with individual grammatical *sentences*
- It's not enough to recognise discrete dialogue *moves*
- What to do?

When I first met Ruth ...

- DS provides an incremental perspective on language processing
- ... with semantic interpretation
- ... and bidirectional
- Can it provide what we need here?

- First attempt [Purver and Kempson, 2004]



Requirements for a Model of Context

- (see [Purver et al., 2006, Cann et al., 2007])
- We have (partial) trees
- Fragments, anaphora, split utterances
- *A: Who likes Mary? B: John.*
- We have a record of action sequences
- Sloppy, “antecedent-contained” ellipsis
- *A: Mary loves her mother. B: John does too.*
- We have a record of the words used
- Priming or “alignment” phenomena

DS and Dialogue Phenomena

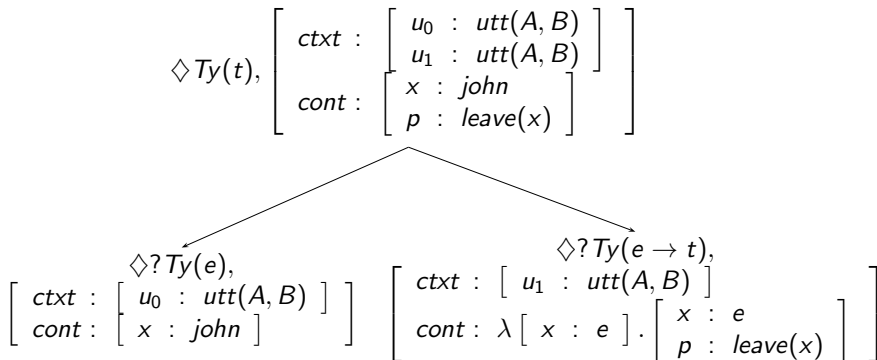
- *The Dynamics of Conversational Dialogue*
- [Cann et al., 2007, Gregoromichelaki et al., 2009, Gargett et al., 2009] and lots more
- Split utterances via tree extension
- Fragments via LINK or LOCAL-*-ADJUNCTION
- Clarification requests, confirmations, short answers
- VP ellipsis, gapping via action-replay
- What is there, and can we really cope with it?

Requirements for Structured Representations

- Indexicals: need an interface to utterance context
- Particularly for split utterances: *I like ... Yourself!*
- Ownership: need a record of “responsible party”
- Particularly for split utterances: *I like ... John? Why?*
- Inference: handling illocutionary force
- Particularly for split utterances: *I like ... John?*

Type Theory with Records

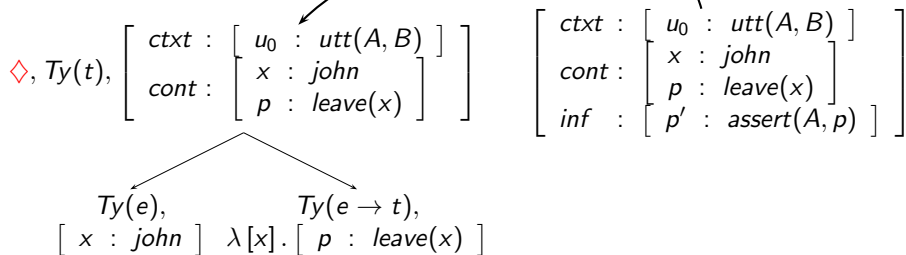
- Following [Cooper, 2005] and lots more



- cont via beta-reduction as before, ctxt via extension

Adding dialogue function

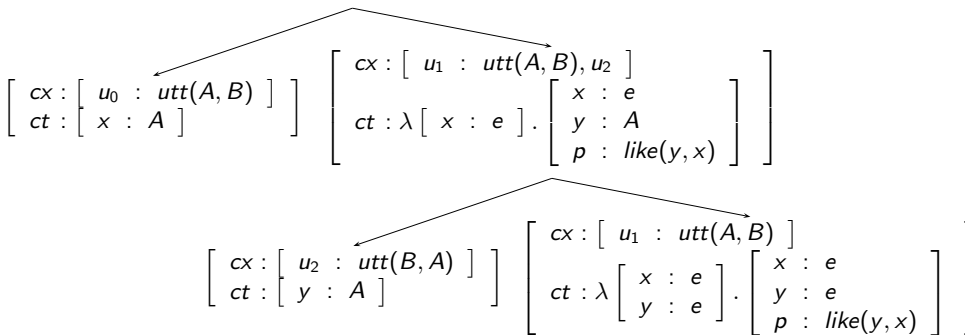
- Allow *optional* inferences about speech acts via LINK
- “John left”:



A Proper Treatment of Split Utterances?

- A: I like ... B: yourself.

$$Ty(t), \left[\begin{array}{l} \text{ctxt} : \left[\begin{array}{l} u_0 : \text{utt}(A, B), u_1, u_2 \end{array} \right] \\ \text{cont} : \left[\begin{array}{l} x : A \\ y : A \\ p : \text{like}(x, y) \end{array} \right] \end{array} \right]$$



A “clarificational” split utterance

A: “John ...” B: “left?”

$$\left[\begin{array}{l} \text{ctxt} : \left[\begin{array}{l} u_0 : \text{utt}(A, B) \\ u_1 : \text{utt}(B, A) \end{array} \right] \\ \text{cont} : \left[\begin{array}{l} x : \text{john} \\ p : \text{leave}(x) \end{array} \right] \\ \text{inf} : \left[p' : \text{ask}(B, ?\text{assert}(A, p)) \right] \end{array} \right]$$

$$\left[\begin{array}{l} \text{ctxt} : \left[\begin{array}{l} u_0 : \text{utt}(A, B) \\ u_1 : \text{utt}(B, A) \end{array} \right] \\ \text{cont} : \left[\begin{array}{l} x : \text{john} \\ p : \text{leave}(x) \end{array} \right] \end{array} \right]$$

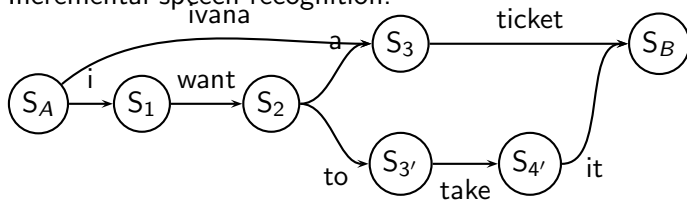
$$\left[\begin{array}{l} \text{ctxt} : \left[u_0 : \text{utt}(A, B) \right] \\ \text{cont} : \left[x : \text{john} \right] \end{array} \right] \left[\begin{array}{l} \text{ctxt} : \left[u_1 : \text{utt}(B, A) \right] \\ \text{cont} : \lambda [x]. \left[p : \text{leave}(x) \right] \end{array} \right]$$

Dynamic Syntax for Dialogue Modelling?

- So we seem to have a system which lends itself to dialogue
- Inherently incremental
- Basic principle of extension/growth
- Analyses for split utterances, fragments, VP ellipsis . . .

Incremental Dialogue Systems

- Recent interest in incremental dialogue systems
 - [Schlangen and Skantze, 2009, Buß et al., 2010] etc.
- Incremental speech recognition:



- (Not much linguistics/semantics)
- Capable of incremental input processing, mid-utterance backchannels, unfinished utterances ...

Incremental Dialogue Systems

[Demo of Jindigo]

[Schlangen et al., 2010, Skantze and Hjalmarsson, 2010]

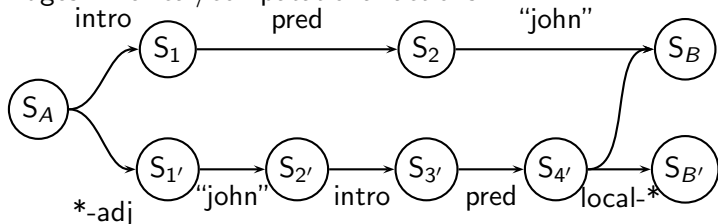
Dialogue Systems and Incrementality

- Treat utterances independently
 - Incremental only during sentence/move construction
- One utterance = one move
- Next utterance = new move
- Interpretation via general mechanisms (e.g. fragment resolution)
- Are we missing something?

A: I want to go to ...	A: I want to go to Paris.
B: Uh-huh	B: OK. When do you ...
A: ... Paris by train.	A: By train.

DS and Lattice Representations

- DS parsing can be seen as a lattice [Sato, 2010]
- Nodes = partial trees
- Edges = lexical/computational actions

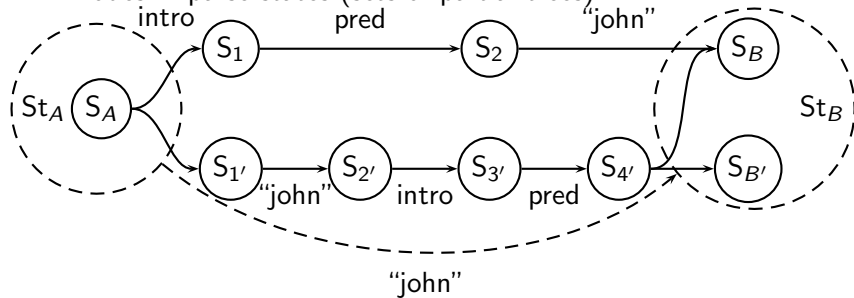


- Call this the *tree* lattice

merge

DS and Lattice Representations

- Can also take a coarser-grained *state* lattice
- Edges = word hypotheses
- Nodes = parse states (sets of partial trees)



- Provides us with the DS concept of *context*
- Isomorphic to the standard ASR word lattice

An Incremental DS Dialogue System?

- Seems like a good fit . . .

[Demo of DSJindigo]

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