Situated Communication

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collaborations with Mattias Appelgren, Nicholas Asher and Julie Hunter

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Motivating example

I sent Charlotte to her room.

*I nod towards a scratch on the wall*

I was making dinner.
Nonlinguistic events must be *conceptualized* in a discourse-relevant way

- someone (or something) scratched the wall.
- Charlotte scratched the wall.

**Different utterance ⇒ different conceptualisation**

I moved the table into the living room this morning.

*I nod towards scratch on the wall*

I had to buy some new paint.
Features of the Scratches example
A nonlinguistic event appropriated as a discourse move

Linguistic units don’t refer to or describe the scratching event. The scratching event:

- is a part of the message
  - coherently related to linguistic moves
- affects how that message is **constructed**
- but is not produced as part of the discourse
Some assumptions

• A discourse move contributes (an instance of) a proposition
• It must be semantically related to some part of the discourse context
  • Explanation, Elaboration, Narration, Contrast, Result, etc.
• Salience: only certain parts of that context are available.
Salience: The Right Frontier Constraint

Subordinating relations ('push down')

Develop a certain point; maintain its salience
- Explanation, Elaboration, Background...

Coordinating relations ('push to the right')

Push the discourse forward, shutting off accessibility of previous moves
- Continuation, Narration, Result...

The Right Frontier Constraint (RFC)

New moves must attach to The Right Frontier:
- most recent move;
  extended segment(s) it’s part of;
  moves it’s subordinate to.
Max had a lovely evening.
He had a great meal.
He ate salmon.
He devoured lots of cheese.
He won a dancing competition.
Max had a lovely evening

Elaboration

He had a great meal  He won a dancing competition

Elaboration

Narration

He ate salmon  He devoured cheese

Narration

# It was a lovely pink.
Interaction between coherence and conceptualization

(1) I sent Charlotte to her room. (2’) She scratched the wall.

⇒ Explanation(1,2’)

(2’) \lessgtr_t (1)

Similarly for (1)+ non-linguistic:

⇒ Explanation(1,e)

\[ e: \text{Charlotte created} \ \textit{the scratch on the wall} \]_g
Non-linguistic events disambiguate linguistic moves

∀x∀y(red(x) \land on(x, y) \rightarrow blue(y)) \quad ∀x∀y(blue(y) \land on(x, y) \rightarrow red(x))

Red blocks should be on blue blocks!
Non-linguistic events disambiguate linguistic moves

Red blocks should be on blue blocks!

\[ \forall x \forall y (\text{red}(x) \land \text{on}(x, y) \rightarrow \text{blue}(y)) \quad \forall x \forall y (\text{blue}(y) \land \text{on}(x, y) \rightarrow \text{red}(x)) \]

Semantics of \textit{Correction}(a, u)

resolves the linguistic ambiguity
Two claims for *Situated Communication*

1. Nonlinguistic events affect **discourse structure, its evolution and its interpretation** in nontrivial ways.
   - Initial analysis via the STAC corpus
     *joint work with Julie Hunter and Nicholas Asher.*

2. The semantics of coherence relations influences **conceptualisation** of nonlinguistic events.
   - Experiments in Interactive Task Learning (ITL) involving corrective feedback.
     *joint work with Mattias Appelgren.*
## Theoretical Issues

### Salience
Is the RFC still valid?

### Semantics
Dynamic update with real world events

Use the **The STAC Corpus** as evidence.

(https://www.irit.fr/STAC/corpus.html)
Settlers of Catan

- multi-party, win-lose game
- players use resources (wood, clay, ...) to build roads and settlements
- board: multiple regions, each assigned a resource and number (2 - 12)
- players get resources by rolling dice, trading, or stealing
- robber: roll of a 7; discard, steal, move
The game board
Annotation

• 59 games, each with dozens of dialogues with 1-30+ turns
• Annotation in the style of SDRT (Asher & Lascarides 2003)
  • Also who offers what to whom (defined in a FS)
• Annotation was tackled in two phases: chat-only vs. chat + game
  20% of chat-only annotations were wrong!!

Is the RFC still valid?

• What are the constraints on how a speaker can exploit the world around her to accomplish her discourse purposes?
• And what happens when the world changes while she’s talking? Not a static set of indices (à la Kaplan)

⇒ Start by looking at what kind of structures are allowed.
Is the RFC still valid?

Game events moving forward do not shut off salience of previous events (in contrast to linguistic moves) *unless* we comment on them.

Example

159.1 Server ljay played a Soldier card.
159.4 Server ljay stole a resource from gwfs
160 Server ljay rolled a 4 and a 4.
161 Server gwfs gets 2 wheat.
163 gwfs touché
Is the RFC still valid?

Game events moving forward do not shut off salience of previous events (in contrast to linguistic moves) unless we comment on them.

Example

159.1  Server  ljay played a Soldier card.
159.4  Server  ljay stole a resource from gwfs
160    Server  ljay rolled a 4 and a 4.
161    Server  gwfs gets 2 wheat.
162    gwfs   the wheat’s growing again!
163    gwfs   # touché
Asymmetric structures

Similar to multiparty threads but one thread depends on moves in another for its interpretation (asymmetry)
An Example

341 Server gwfs rolled a 6 and a 3.
342 Server inca gets 2 wheat. dmm gets 1 wheat.
344 gwfs 9 nooo!
344.0.1 UI gwfs ended their turn.
344.0.2 Server It’s inca’s turn to roll the dice.
345 Server inca rolled a 1 and a 3.
346 Server CheshireCatGrin gets 1 ore, 1 wood. gwfs gets 2 wood.
347 gwfs 4 better :)

Contrast (344, 347) violates RFC.
An example with multiple dependencies

534  gwfs  anyone want to trade their ore for my wood?
535  ljay  nope
538  gwfs  it may prove a prudent trade, lj...
539  ljay  nope
539.1 Server  gwfs played a Soldier card.
539.4 Server  gwfs stole a resource from ljay
540  gwfs  apologies...

Result

534
QAP
535
QElab
538
QAP
539

Result

539.1 ...

Comment

539.4

540
Semantics

Build on existing models of dynamic semantics

- represent dialogue with commitment slates for each speaker, etc.
- add a representation of the sequence of events in the actual world through the course of the conversation
- speakers can take on commitments to actual events, and this limits discourse continuations
Coherence and Conceptualisation: Experiments in ITL

Blocks world: learning agent can put one block on another, and must build a single tower from blocks on the table.

- Ignorant of goal constraints:
  e.g., *each red block must be on a blue block*

- Unaware of the domain-level concepts that define the goal:
  Can observe RGB values, but doesn’t know the partition.

- Unaware of the colour terms: red, blue etc are neologisms.
The Interactive Learning Task

Learner’s Task

- Learn to solve the planning problem by learning:
  - the goal description
  - how to conceptualise the domain
    (i.e., how to partition the RGB spectrum into colour categories)
  using own experience and expert’s corrective feedback as evidence.

Evidence via Corrections

Correction($a, u$)

$a$: agent puts green block on blue block

$u$: No! Red blocks should be on blue blocks.

Challenge: Message is ambiguous and learner may not know the blocks are green and blue...
Formalising the set up

<table>
<thead>
<tr>
<th>Signal</th>
<th>Message</th>
<th>Rule name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red blocks should be on blue blocks</td>
<td>$\forall x \forall y (\text{red}(x) \land \text{on}(x, y) \rightarrow \text{blue}(y))$</td>
<td>$r_{1}^{r,b}$</td>
</tr>
<tr>
<td></td>
<td>$\forall x \forall y (\text{blue}(y) \land \text{on}(x, y) \rightarrow \text{red}(x))$</td>
<td>$r_{2}^{r,b}$</td>
</tr>
</tbody>
</table>

![Diagram showing signal $s_1$ and $s_2$]

- Can’t tell which message is intended in $S_1$ and $S_2$, even if you know the blocks’ colours!
- So signal includes **pointing** to the tower or the block on table to disambiguate the message (if you know the blocks’ colours).
Graphical Model for

“No! Red blocks should be on blue blocks” *points to tower*

\[
\begin{align*}
\text{Corr}(u, a) & \\
V(r_1^{r,b}, a) & \quad V(r_2^{r,b}, a) \\
\text{Red}(o_1) & \quad \text{Blue}(o_2) \\
F(o_1) & \quad F(o_2) \\
r_1^{r,b} \in G & \quad r_2^{r,b} \in G
\end{align*}
\]

Observed: grey
Latent: white
\(V(r, a)\): Boolean;
\(r\) violated by \(a\)
\(r \in G\): Boolean
\(r\) is a goal constraint
\(\text{Red}(o)\): Boolean; \(o\) is red
\(F(o)\): \(o\)’s RGB values

Posterior for \(r \in G, P(\text{Red}(o) | F(o))\) become priors for next move

Semantics of correction imposes constraints on combination of values of the random variables
Experiments

(Hidden) Goals

Two rules: $r_1^{red,blue}, r_2^{green,maroon}$

Three rules: $r_1^{red,blue}, r_2^{red,blue}, r_1^{purple,orange}$

Evidence

anaphor: that’s not red either, that’s wrong for the same reason or not

full: Learn from actions that aren’t corrected

Experimental run

- 50 trials per $G$ (two rules, or three rules)
- 10 blocks on table (chosen so that $G$ constraints are relevant)
- Learner is full or simple
- Expert is anaphor or no-anaphor
Results against Baselines: Cumulative Regret

**Simple+no-anaphor**: our simplest model.

**Naive**: Doesn’t learn between trials; simply avoids repeating corrected action.

**No Language**: Uses only “no”: blocks with similar RGB values to $o_1$ can’t be put on blocks with similar RGB values to $o_2$. 

![Graph showing cumulative regret for different baselines](image)
Results comparing models: Cumulative Regret

Two Rules:
\( r_1 \text{red,blue}, r_2 \text{green,maroon} \)

Three Rules:
\( r_1 \text{red,blue}, r_2 \text{red,blue}, r_1 \text{purple,orange} \)
Conclusion

- A formal semantics of embodied discourse calls for a radical overhaul of the types of structures and semantics we countenance.
- We need empirical embodied linguistic data to guide those revisions.
- The STAC corpus provides a basis for testing hypotheses about salience and model-theoretic semantics of embodied conversation.
- But the corpus doesn’t address how language influences conceptualisation of the domain.
- Experiments in ITL demonstrate that reasoning about discourse coherence (semantics, salience and anaphora) speeds up learning of: domain conceptualisation, symbol grounding, the planning problem.