Taking situational factors into account when resolving anaphora: an approach based on salience and events

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Content

Problems and objectives

- Examples with a linguistic context and a situational context
- Terminology
- Objectives

Linguistic and situational factors for anaphora resolution

- Quick review of anaphora resolution methods
- Determination of factors for linguistic salience
- Determination of factors for situational aspects

Confrontation of linguistic context and situational context

- An event based method that takes situational aspects into account
- Seven confrontation levels
- Quantification of linguistic and situational salience
- Illustration with our initial example

Conclusion and future work
Initial example

One of the first examples with situational aspects (Isard 1975)

situation = in a zoo, near a cage with a lion inside
event = a child is putting his hand on the bar of the cage
utterance = an adult tells him: “be careful, he might bite you!”

Characteristics

“he”: no concomitant deictic gesture, no linguistic antecedent
the identification of the referent is made through the child’s action, which is perceived by the speaker

Similar example

“he is really good”, talking about an actor who has not been previously mentioned, but who is particularly lighted up at the moment of the utterance
Anaphora versus deixis

<table>
<thead>
<tr>
<th>“anaphora”</th>
<th>“deixis”</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>anaphora</strong></td>
<td><strong>exophora</strong></td>
</tr>
<tr>
<td>(endophora)</td>
<td></td>
</tr>
<tr>
<td>• “he” and nominal phrases in general</td>
<td>• “he”, possessives, nominal phrases in general</td>
</tr>
<tr>
<td>• linguistic antecedent mandatory</td>
<td>• no linguistic antecedent</td>
</tr>
<tr>
<td>• no coreferent gesture</td>
<td>• no coreferent gesture (otherwise it is a deictic reference)</td>
</tr>
</tbody>
</table>

⇒ exophora = anaphora with a situational antecedent
Ambiguous variants of Isard’s example

Ambiguity between a linguistic antecedent and a situational one

- same situation = in a zoo, near the lions cage
- previous utterance = “Rex seems to be hungry”
- current event = a child is putting his hand on the bar of the cage
- current utterance = “be careful, he might bite you!”

Ambiguity between two situational antecedents

- same situation
- event 1 = the child is putting his hand on the bar of the cage
- event 2 = the zoo keeper is coming and looks like furious
- current utterance = “be careful, he might bite you!”

Ambiguity between two linguistic antecedents
classical problem of anaphora resolution...
Problems and objectives

1. The form of the anaphoric expression gives no indication on the nature of the antecedent (linguistic or situational)
   ⇒ we can limit our study (for now) to examples with the pronoun “he”

2. If linguistic factors are well studied, it is not really the case with situational factors
   ⇒ we want to propose a classification of situational factors

3. The linguistic and situational aspects belong to different domains, so that their confrontation is difficult (we need a point of departure, a common notion that allows them to be confronted)
   ⇒ with this aim we want to exploit the notion of salience

4. Resolving such exophora in human-machine dialogue systems can be done using a quantitative comparison of the various factors
   ⇒ we want to propose (or exploit) a quantification method
Classical anaphora resolution methods

1. Identifying and treating linguistic constraints (such as gender and number) so that only the adequate antecedents are kept.

2. If only one adequate antecedent is kept, the problem is solved. If several potential antecedents remain, there is the need to decide between them.

3. In this case, we can classify the antecedents in term of accessibility or salience (the aim is to keep the most salient antecedent).

4. Since the notion of salience groups a lot of factors, we need to quantify it so that a score is attributed to each potential antecedent. When confronting the scores, several methods are possible:
   - the factors sum or average
   - the optimal factor
   - the weighed average of factors (Alshawi 1987)
   - the procedural methods (Mitkov 1998)
   - the statistical methods (Pattabhiraman 1993)
   - the dynamic methods (Lappin & Leass 1994)
Formal linguistic factors of salience

- Salience that is intrinsic to the words
  Particular graphemes or phonemes. Some words because of their nature (e.g. proper nouns). Indexicals because they bring back to the situation.

- Salience due to an explicit emphasis
  Stress accent. Particular intonation / prosody. Presence of a deictic gesture. Presence of a pause before and after uttering a word or a noun phrase.

- Salience due to a dedicated syntactic construction
  Presentational cleft constructions or topic constructions (“it is ... that ...”).

- Salience linked to word order and frequency
  Privileged positions in the sentence: the beginning, the end. Repetition of a word or noun phrase. Presence of a symmetry.

- Salience linked to grammatical functions
  Subject > direct object > indirect object > other functions. Vocatives.
Semantic linguistic factors of salience

- **Salience linked to lexical semantics**
  Importance of some semantic features such as “human” or “animate”. Influences between the discourse entities (teacher > pupil).

- **Salience linked to verbal semantics** *(thematic roles)*
  Importance of the agent, the patient, the theme. Considering the semantics of the verb, i.e., aspect, semantic category, number and nature of its arguments, the agent may be more salient than the patient or the contrary.

- **Salience linked to sentence semantics** *(theme, sentence topic)*
  Theme / topic > rheme / comment (but not always and some of the previous parameters have to be integrated here, e.g. subject and/or first position).

- **Salience linked to discourse semantics** *(discourse topic, aboutness)*
  Introduction of the topic using a long and explicit noun phrase which has not the subject function. Aggregates of discourse entities (macrostructures).

- **Salience linked to cognitive semantics** *(inferences)*
  Explicitness > implicitness. Foreground > background (presupposition). Considering the context, given > new, or new > given...
Taking situational aspects into account

1. **Point of departure** = list of events that characterize the situation (action from the child, apparition of the zoo keeper...) → proposition of a first classification of events

2. **Modeling the micro-monde linked to each event** (child, arm, hand, cage, bar, lion, jaw...) → exploitation of an ontology

3. **Deducing**, for each event, the potential situational antecedents considering the linguistic constraints from the anaphoric expression ("he" ⇒ lion, zoo keeper) → exploitation of anaphora resolution methods

4. **Confronting** the potential linguistic and situational antecedents, using salience scores among several comparison axes (lion > zoo keeper > dog) → proposition of a first classification of comparison axes
Situational events

From the most to the less linked to the ongoing dialogue

1. Events linked to the enunciation
2. Events linked to a task that is joined to the dialogue
3. Events linked to a task that the dialogue has left aside, but that remains predictable
4. Events external to the dialogue and that are not predictable in the communicative context

Some details and examples

1. Events linked to the enunciation
   They concern the speaker and include all types of conversational gestures as well as postures and attitudes
   Examples: communicative gestures that participate to the dialogue (deictic, illustrative, expressive, paraverbal) + extra-communicative gestures (handling of a pen while talking → new potential antecedent → “you’re going to break it”)
Situational events (cont.)

2. Events linked to a task that is joined to the dialogue
   They concern both speaker and addressee (*simultaneous activities*)
   Examples: the participants are walking while talking; they are in a meeting room and exploit a blackboard as a support for their dialogue; they are writing a report → “it must be long”, “it seems to be incomplete”, etc.

3. Events linked to a task that the dialogue has left aside
   They concern the speaker and/or the addressee (*they bring constraints to the exchanges*)
   Example: dialogue during the waiting for a train: the pending apparition of the train is active in the participants’ mind, and the train does not need to be mentioned → “here it is”, “it is only 5 minutes late”, etc.

4. Events external to the dialogue
   They concern both speaker and addressee (*they can be at the origin of new dialogue situations*)
   Examples: fire alert, interruption by someone else → salience of the new element → “it/he never comes at the right time”
Axes for the confrontation

From the simplest to the most abstract

1. Temporal sequence of situational events and linguistic mentions
2. Prosodic aspects when uttering the anaphoric expression
3. Lexical aspects
4. Syntactic aspects
5. Semantic aspects
6. Pragmatic aspects
7. Cognitive aspects and hypotheses on the participants’ mental states

Some rules and examples

1. Temporal sequence of situational events and linguistic mentions
   The most recent situational or enunciative event is privileged because it is probably the most active in the participants’ minds

2. Prosodic aspects when uttering the anaphoric expression
   If a pause follows the linguistic antecedent mention, the resulting rupture leads to put the situational antecedent forward. The same if the two utterances are very different in term of prosody. Other cases: the linguistic antecedent is privileged.
3. **Lexical aspects**
   Some terms like “be careful!” leads the addressee to focus on something special

4. **Syntactic aspects**
   A lack in the linguistic cohesion is an indication for a difference between the mention of the linguistic antecedent and the mention of the anaphora. Other examples: the presence in the utterance of an isolated referring expression, the presence of a vocative expression, are arguments to bring back to the situation

5. **Semantic aspects**
   Expressions explicitly linked to the situation: “look!”, “here is the zoo keeper”. Coherence ruptures: when considering that a natural sequence of 2 sentences has the following characteristic: the rheme of the 1st corresponds to the theme of the 2nd, each breach of this principle can be an indication of the presence of an additional situational event, with for instance an anaphora in a 2nd rheme

6. **Pragmatic aspects**
   If it is correlated to the prosody, the situation is privileged when the utterance with the anaphoric expression has a different (unexpected) illocutionary force than the previous utterances
Back to our initial example

![Graph showing child's gesture and time with utterances: Rex seems to be hungry and be careful, he might bite you!]

<table>
<thead>
<tr>
<th>axis for the comparison</th>
<th>linguistic antecedent (the dog)</th>
<th>situational antecedent (the lion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>temporal sequence</td>
<td>(situational event + recent)</td>
<td>0</td>
</tr>
<tr>
<td>prosodic aspects</td>
<td>(stress for the 2nd utterance)</td>
<td>0</td>
</tr>
<tr>
<td>lexical aspects</td>
<td>(role of “be careful”)</td>
<td>0</td>
</tr>
<tr>
<td>syntactic aspects</td>
<td>(there is cohesion)</td>
<td>1</td>
</tr>
<tr>
<td>semantic aspects</td>
<td>(there is coherence)</td>
<td>1</td>
</tr>
<tr>
<td>pragmatic aspects</td>
<td>(other role of “be careful”)</td>
<td>0</td>
</tr>
<tr>
<td>salience in total</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
1. As usual, the dialogue makes the phenomena more complex and brings a set of additional parameters
   ⇒ the methods that were designed for the text are not sufficient

2. Situational aspects are heterogeneous: several communicative modalities, several dimensions to study...
   ⇒ we need notions that cover all these dimensions as well as linguistic aspects. The notion of salience seems to be adapted and efficient

3. It is not so easy to confront situational factors to linguistic factors
   ⇒ doing that using seven comparison levels is an efficient means to divide the problem into several well delimitated processes

4. A corpus based validation needs a very detailed corpus that includes a set of situation descriptions together with the transcriptions of the linguistic utterances
   ⇒ studying situation descriptions such as theater didascalies