Discarding Expectations When Building Bridges: The Need for a Revision Procedure

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Abstract

In this paper we address the issue of how the resolution of definite descriptions in the so-called bridging phenomena (cf. Clark, 1975; Heim, 1982; Asher & Lascarides, 1998) affects the interpretation of connected discourse segments in which they appear. In particular, we will try to exploit the contribution of frame semantics to the interpretation of such phenomena, validating our assumptions by means of the analysis of a specific case, namely **the revision process**, which can come to be necessary in discourse updating.

Given a simple sentence α of the form NP VP, we assume that frames are activated for each phrase and that interpretation of α arises from their combination. The tendency is to match as many slots as possible in all the active frames, in order to get a highly structured sentence level frame, which bears on a default underground assumption. Given a following sentence β containing a definite description which refers back to an element not explicitly introduced in α but inferrable on the basis of the frames made active by α, the bridging inference is then supposed to fit as many slots as possible in all the active frames.

But it might happen that we are led to **revisit** the default underground assumption (as given by the structure level frame), if what is predicated about the definite description doesn't fit with the picture drawn by that underground assumption. By revision we mean then the process by which expectations set up by a sentence must be discarded and substituted by new ones, after the processing of a following sentence containing a definite description. We claim that this revision is *inherently procedural* and we propose a way of singling out and motivate the direction it must go.

1. Introduction

In this paper we address the issue of how the resolution of definite descriptions in the so-called bridging phenomena (cf. Clark, 1975; Heim, 1982; Asher & Lascarides, 1998) affects the interpretation of connected discourse segments in which they appear. In particular, we will try to exploit the contribution of frame semantics to the interpretation of such phenomena, validating our assumptions by means of the analysis of a specific case, namely the **revision process**, which can come to be necessary in discourse updating. Following Poesio et al. 1998, we define bridging phenomena as those uses of definite descriptions that refer to an object only indirectly

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introduced into the common ground as a result of the mention of a related object such as `the engine` in:
"I was driving my car. *The engine* made a weird noise."

1.1 Asher & Lascarides' Approach

It is widely assumed that interpretation of bridging phenomena is **inherently procedural** (cf. Bos et al., 1995; Asher & Lascarides, 1998). Asher & Lascarides, for example, define a four steps interpretation procedure, which can be summarised as follows:

- **If Possible Use Identity**, i.e., following van der Sandt's theory of presupposition (cf. van der Sandt 1992), a presupposition will bind in any context where there is an accessible discourse referent satisfying the same content, and the result is satisfiable and informative.
- **Bridges Are Plausible**, i.e., the bridge is built on the basis of lexical driven inferences associated with world knowledge.
- **Discourse Structure Determines Bridging**, i.e., when the rhetorical relation used to connect the constituents gives us a particular way of resolving a bridging description, we do it that way.
- **Maximise Discourse Coherence**, i.e., given that some rhetorical relations connect discourse segments more closely than others, the underspecified bridging description will be resolved so as to maximise discourse coherence.

2. To What Extent Bridges Are Plausible

Though maintaining the procedural nature of the interpretation process, we propose a slightly modified approach which has its roots in the notion of frames (cf. Minsky, 1975; Barsalou, 1992; Fillmore & Atkins, 1992). As far as Asher & Lascarides' second step is concerned, we intend to show that plausibility of a bridge is not a trivial issue which bears only on the intersection of lexical driven inferences and world knowledge, rather, the evaluation of plausibility must be built on well-defined and fine-grained mechanisms. We claim that a revisited notion of frames (see below, section 3.1) can work as a useful formal tool in refining the internal structure of Asher & Lascarides' procedure. We will show this, focusing on an activation of frames which seems to emerge in a clear hierarchical form, namely when expectations set up by the intersection of lexical and world knowledge defined above, must undergo a revision process in discourse updating. We develop this idea in section 3.

2.1 A Sketch of Frame Semantics

Following Fillmore & Atkins 1992, we assume that a speaker knows the meaning of a word only by first understanding the background frames that motivate the concept encoded by the word. Frames allow us to package together grammatical and semantic information: for example, given a structured situation such as a commercial transaction, in which several roles and categories (e.g. `buyer`, `seller`) are involved, each lexical item or phrase (e.g. the predicate `to buy`) has a *valence description*, i.e. a description that specifies, in both syntactic and semantic terms, the elements of the commercial transaction frame that must or may be given syntactic realisation and the nature of such realisations. The main advantage of frames is that we can include a certain amount of secondary information into them, i.e. roles or categories that would not be encoded by strongly constrained representations of lexical meaning, such as Pustejovsky's *argument structure* and *qualia structure* (cf. Pustejovsky 1995). Moreover, a frame allows specific procedures of revision, automatically activated under given circumstances: for instance, when a value for a feature *X* is filled, other slots come to be

automatically filled by means of inference (*if-needed* procedure). When a new exemplar of a class with idiosyncratic characteristics is encountered, a procedure (*if-added* procedure) is activated, which adds the new value to the range of possible choices.

3. A Compositional Frame Semantics

3.1 Frame Semantics in Action

The traditional view of frame semantics is a static one. In this section we will briefly illustrate that a frame semantics can, instead, be considered as **inherently dynamic**. Our main idea is that, when analysing a discourse segment, the activation of frames has a dynamic and compositional nature. This means that several frames must be put together (*composed*) and *dynamically* interact in order to yield a structured discourse universe ready to be updated as the discourse goes on. In this sense, compositional semantics proceeds through unification of frames. Frames are **not** activated **randomly**, rather accordingly to the **saliency** of sentence elements. Saliency is not meant to be only a syntactic feature, but it is based on cognitive grounds, too. It is the latter side which has been explored into the research carried out insofar. We deal only with simple sentences, aware that turning to more complex phenomena (e.g. quantification and negation) would require much more detailed and elaborated definitions and procedures.

3.2 The Role of Frames in Bridging Phenomena

Let us consider a simple sentence α of the form `NP VP`. We assume that frames are activated for each phrase. We define these frames as *argument frame* and *event frame*. An *argument frame* is activated for each noun phrase in the sentence, whereas an *event frame* is activated for each verb phrase. Interpretation of α arises from the combination of the frames. The tendency is to match as many slots as possible in both argument frame(s) and event frame(s), in order to get a highly structured sentence level frame.

Given a following sentence β containing a definite description which refers back to an element not explicitly introduced in α but inferrable on the basis of the frames made active by α, the bridging inference is supposed to be one that fits the slots of both argument and event frames.

Asher & Lascarides' approach doesn't take the notion of frames into account, but it predicts the same result in the resolution process of this kind of bridging phenomena. This is clearly shown by the following example they consider:

(1) I have just arrived. *The camel* is outside and needs water.

Let's briefly see how frames act in this plain bridging phenomenon. In processing the first sentence, two frames are activated. Each frame introduces into the discourse structure a number of potential discourse referents which correspond to the slots belonging to it. This means that in the `arriving` event, the *means of motion* has to be taken into account, even if its slot is not filled in the first sentence. In the second sentence a definite description is introduced: since, by world knowledge, we know that `the camel` can be a means of motion, the definite description can be resolved within the `arriving` frame set up by the first sentence. As far as the argument frame is concerned, we can assume, by default, that `the camel` "belongs" to `I`, who is the actor of the event.

Reasoning this way, the definite description fits perfectly both the frames. Is the solution always so straightforward?

3.3 The Revision Process

It isn't. It might happen that we are led to **revisit** the default underground assumption, if what is predicated

about the definite description doesn't fit with the picture drawn by that underground assumption, activated at sentence level. What then?
Since a **revision** has become necessary, we have to decide the direction the revision goes. We are led to a choice:

(a) The definite description is resolved within the event frame and the interpretation of the first sentence must resort to an alternative filler for the argument frame.

(b) The definite description is resolved within the argument frame and the interpretation of the first sentence must resort to an alternative filler for the event frame.

Given that this choice is not a matter of randomness, to decide between (a) or (b) could become a hot issue. This obstacle can be comfortably climbed over, if we let the choice be driven by a frame semantics compositionally revisited in the sense above (cf. 3.1). In both (a) and (b), an alternative filler is required. We claim that the tendency to "compose" all the active frames is still working in order to maximise discourse coherence. The result is a sentence level frame whose slots come to be filled by tentative items as obtained by inference mechanisms: we argue that these items must be ones still able to fit as many slots as possible in both frames.

3.3.1 A Case

Let's start with a case where the choice is not free, as it happens when a slot of the event frame is already fixed by lexical constraints. For example, when the slot *means of motion* in a motion verb is lexicalised (e.g. `to ski`, `to skate`, `to surf`), given the discourse segments

(2) Paul was skiing. *The skis* were at home, in the garage

the only possible choice is (b). Let's better explain this claim. We can assume that in any sentence which follows the first segment and contains the definite description `the skis`, this description can be interpreted as referring to the current means of the event under description and, by world knowledge, as we have seen for `the camel` above, it is highly probable that `the skis` belong to the event actor, i.e. `Paul`. Unfortunately, `the skis` cannot be at the same time the ones which belong to Paul and the ones in action in the event, because `the` (=`Paul's`) `skis` were at home, in the garage}. Given the fact that, since the means of motion is lexicalised, the actor cannot use anything else but skis in order to perform the motion act (which means that a slot cannot be otherwise filled), the solution must be found somewhere else. First, we have to abandon the optimum of matching the slots of argument and event frame. We resolve, then, the definite description within the argument frame (`the skis` as `Paul's skis`), and conclude that Paul is using someone else's skis. The reasoning which leads to such a conclusion will become clearer in what follows.

3.3.2 A More Complex Case

Let's then come closer to more interesting cases, namely when the choice appears to be free.
Taking again as example the verbs of motion, we explore now those which don't lexicalise the means of motion, arguing that the choice between the two readings is constrained by the **different flexibility** of argument and event frames.
We claim that **event frames are more flexible than argument frames**, and thus it seems to be easier to resort to an alternative filler for one of its slots, rather than for one of the argument frame. That's why the option (b) defined in 3.3 comes to be the preferred solution.

For instance, in the sentence α

(4a) Paul was driving,

world-knowledge based interpretation leads to assume that Paul was driving `a car` and this car is `his car`. If a following sentence contains the definite description `the car`, the most natural interpretation, as already seen, is the one that saturates both event and argument frames, matching the expectations set up by the first sentence, i.e. that `the car` is the means of transportation and it corresponds to Paul's car.

If, however, the second sentence β goes on blocking the natural inference, as, for instance:

(4b) The car was being repaired,

thus implying that Paul could not be driving his car (as it would be the most natural expectation set up by the sentence level frame - cf.above), we are led to revisit our interpretation of the first sentence. Resolving `the car}` in β within the argument frame, it can be assumed

- `either that Paul was driving someone else's car (i)`,
- `or that Paul was driving something other than a car (ii)`.

As it has been assumed above, in the resolution of a bridging the tendency to bind the object referred to by the definite description to as many activated frames as possible is working. We are then led to find an alternative filler within the event frame, which should fit the argument frame too. The only choice allowing this is (`ii`), because `something other than a car` is not only an item which fills the slot *means of motion* of the event frame (substituting `the car`), but can also be perfectly inserted into the argument frame, as "belonging" to Paul. The option (`i`) couldn't allow the same.

4. Conclusion and Future Work

In our analysis, we've only encountered cases where the definite description is resolved within the argument frame, and the interpretation of the first sentence must undergo revision and resort an alternative filler for the event frame (choice (b) in section 3.3). We suppose the existence of cases where it goes the other way round (choice (a) in section 3.3), and we intend to investigate them. Concerning this latter point, as a first remark we would like to note that it's highly probable that *rhetorical relations* will play a central role in it. Moreover, we would like to extend the analysis to other cases where hierarchies of activation seem to be at work (e.g. in question-answer), as e.g. in sentences containing a "composition" of adjective(s) and noun(s).

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