Concepts across categories

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Abstract

Verbs or adjectives and their nominalizations and certain adverb adjective pairs can be argued to introduce the same concept. This can be shown through inference patterns, which can be explained if we assume Davidsonian eventualities underlying all predicates. We make a contribution to the underlying state discussion by investigating the advantages and disadvantages of Davidsonian versus Kimian states for statives such as copular predicates. Findings are implemented in our parser Delilah.

1 Introduction

Several computational semantics systems have by now implemented a form of event analysis for verbs [1,3]. There has been much debate on whether it is desirable to assume underlying states, parallel to underlying events. Katz [9] argues against an underlying state analysis, even for stative verbs, whereas Parsons [12] is ready to accept an underlying state analysis, even for simple nouns. It is clear that states are more problematic than events.

We discuss some cases where words of different categories can be argued to introduce the same concept: verbs and their nominalizations and adjectives and their corresponding abstract nouns. We show that underlying states give us the same advantages as underlying events, with respect to recognizing concepts across categories for the purpose of inference, as they reify the predicates. We then discuss an alternative representation for copular expressions, based on the conviction that the states in these expressions are ontologically different from eventualities, and show that it has unfavorable consequences for inference. We end with a short note on related adjective-adverb pairs.

The present research was carried out in the context of the Narrator project, which aims at the development of a system for storage and retrieval of personal illness relating narratives [13,14]. In this project we use and further develop a semantic parser/generator for Dutch, Delilah [5,4]. Delilah is driven by a Combinatory Categorial Grammar and has a semantic output in first order logic with neo-Davidsonian event structures.

2 Verbs and their nominalizations

In this section we use nominalizations of verbs to illustrate our main considerations. Sentence (1a) uses the noun *operatie* 'operation, surgery' and (1b) uses the verb *opereren* 'operate'. The intuition is that (1a) and (1b) are equivalent. They can be inferred from each other.

(1) a. Marie onderging een operatie.
Mary underwent an operation
'Mary went though/ had surgery.'

b. Marie werd geopereerd.
Mary was operated
'Mary was operated on.'

The same goes for (2a) and (2b), containing negation.

(2) a. Marie onderging geen operatie.
Mary underwent no operation
'Mary went though/ had surgery.'

b. Marie werd niet geopereerd.
Mary was not operated
'Mary was not operated on.'

Since the narratives in Narrator are about experiences of patients (in the prototype being currently developed, on breast cancer), this kind of information is rather relevant and should preferably not be missed or misinterpreted. If one of the search criteria is, for example, that the narrative should tell about a patient who had surgery, then each of these sentences above, if occurring in a narrative, provides the relevant information to determine wether it meets this search criterion or not. And of each pair, both variants provide the same information.

Opereren en *operatie* introduce the same concept. Also the relation between *opereren*/*operatie* and Marie is the same in both (1a) and (1b). Arguably it can also be inferred in both cases that there is yet someone else involved who is not mentioned, a filler for the agent-slot of *opereren*/*operatie*.

A form of neo-Davidsonian event analysis can be used to give both sentences the same semantic representation. The basic event representation for both (1a) and (1b) is illustrated below. The representation is based on Parsons [11]. (The "concept_of" relation is comparable to Jurafsky and Martin's "is-a" [8].). The verb form is taken to name the concept. The verb can be considered as basic in a situation like this, because underived nouns do not usually introduce events. As it does not lie within the scope of this paper to discuss what is the best way to represent time/tense, we keep the representations very simple in that respect.

(3) ∃e.event(e) & concept_of(e, operate) & agent_of(e, x) & theme_of(e, Mary) & at-time(e, past)

For (1b) this kind of representation is quite standard, and event representations for event-denoting nominalizations have also been suggested before [11,7]. The verb ondergaan in (1a) plays a special role. It places the event in time (makes it extensional) and it lets its subject be the theme of the surgery event.

3 Adjectives and nouns

In the previous section we have looked at nominalizations of verbs, and seen that event semantics helps us getting the right entailments. Now we will look at adjectives and their nominalizations. The pair below is at least close to equivalent. Who has an illness, is ill. Who is ill, has at least one illness.

(4) a. Marie had een ziekte.
Mary had an illness
'Mary had an illness.'

b. Marie was ziek.
Mary was ill
'Mary was ill.'

One could try to treat 'have an illness' as a kind of collocation and this way have (4a) interpreted as *ill(Mary)*. This, however leaves no space in the representation for the determiner, which may vary in form and accordingly in interpretation.

For the pair *boos*/*boosheid*, it is more difficult to come up with two equivalent sentences, for lack of a suitable "support verb". Still we can observe that (5a) entails (5b).

(5) a. Jan probeerde zijn boosheid te verbergen.
Jan tried his anger to hide
'Jan tried to hide his anger.'

b. Jan was boos.
Jan was angry
'Jan was angry'

For Katz, however, stative nominalizations denote either a fact or an extent/degree, but never a state. So (5a) could mean that Jan tried to hide (the fact) that he was angry, or how angry he was, but not the state of his being angry. At least the factive reading seems very intuitive here. It is not clear whether there is also a stative reading. In some other contexts, though, a factive reading is not possible. In (6a) *boosheid* is combined with a durational

predicate. (A fact does not have a duration; once a fact, always a fact.) An extent or degree reading doesn't seem to make a lot of sense either.

(6) a. Hun boosheid duurt nooit lang.
their anger lasts never long
'Their anger never lasts long.'

b. Ze zijn nooit lang boos.
they are never long angry
'They never are angry for a long time'

Besides, even if *zijn boosheid* in (5a) does only have a factive reading, how should we represent the content of this fact in such a way that (5b) follows from it and that we faithfully represent the quantifier? (*His anger* is deninite.) We can't choose a representation like *angry(Jan)*, because of the quantifier. But if we represent it as a noun (with a possessive kind of relation to *Jan*), while still using a traditional representation for (5b), then we lose the entailment. So even when embedded in a fact, reification of the predicate still yields better representations.

These considerations lead us to the following type of representation for sentences like (4b) and (5b).

(7) ∃e.state(e) & concept_of(e, ill/anger) & theme_of(e, Marie/Jan) & at-time(e, past)

Interestingly, for the adjective-noun pairs it is not always that clear and systematic which is the basic form. For the verb - noun pairs above the verb was always basic and the noun was its nominalization. There are also verbs derived from nouns, but they follow a different pattern. Adjective - noun pairs behave less systematically. In the pair *verdrietig* 'sad' - *verdriet* 'sadness', the adjective seems to be the derived form in Dutch, whereas in English the noun has a nominalizing suffix. And for *boos* 'angry' - *boosheid* 'anger' it is the other way around.

4 An alternative representation

We have seen that adjectives and their "nominalizations" display the same kind of inference patterns as verbs and their nominalizations, and that reification of the predicate, through postulating an eventuality argument, makes these patterns follow naturally. This reification seems to be the crucial point, though. And since independent evidence for a Davidsonian analysis for statives is kind of shaky, we should investigate whether we really need the full structure. Maienborn [10] proposes a representation for statives which does involve reification of the predicate, but is different from the Davidsonian event structure representation. In this section we discuss this alternative.

4.1 Kimian states

Maienborn argues for a distinction between Davidsonian states (D-states) and Kimian states (K-states). Examples of verbs introducing D-states are *stand*, *sit* and *sleep*. Examples of verbs introducing K-states are *know*, *hate*, *resemble* and copular expressions. In the latter it is the copula that introduces the K-state.

D-states introduce a normal Davidsonian argument, just like other eventualities. For the K-states Maienborn shows that, like D-states, they are available to anaphoric reference and time modification, and therefore they need a referential argument. This referential argument, she argues though, is of a different ontological kind than Davidsonian eventuality arguments. It is of a more abstract nature, similar to facts and propositions. The main argument is their deviant combinatorial behavior. K-state verbs can not serve as the infinitival complement of a verb of perception (see also examples (12b) and (14a) later in this section), they cannot combine with most adverbials, such as manner adverbs and instrumentals, and neither do they combine with locative modifiers, all of this in contrast with D-states and other eventualities. This brings her to the following (tentative) definition of K-states.

(8) *Kimian states:*
K-states are abstract objects for the exemplification of a property P at a holder x at a time t.

Here are some of Maienborn's (German) examples: (9a), with a D-state, is represented as (9b), and (10a), with a K-state, is represented as (10b). The representations are in a flat DRT notation.

(9) a. Carol schläft.
Carol sleeps
'Carol is sleeping.'

b. [s^e, v | sleep(s), theme(s, v), carol(v)]

(10) a. Carol ist müde.
Carol is tired
'Carol is tired.'

b. [s^z, v | s ≈ [tired(v)], carol(v)]

The embedded box in (10b) contains the property that is the K-state, and the discourse referent *s* reifies this property.

4.2 Some modifications

Engelberg [6] proposes a few modifications to this view on K-states. He argues the K-state should not be introduced by the copula, but rather by the post-

copula predicate (e.g. an adjective), because attributively used adjectives also show the relevant behavior, without being accompanied by a copula.

Also, he shows that it is problematic to put individuals introduced by an NP under the copula in the box that is introduced by "≈" and presents the 'content' of the state. Because in that case the state in (11a) (being related to Opus) would be a different one then the state in (11b) (being related to George). And while the states in (11b) and (11d) are the same, if Opus is the tuba player of the Deathtöngue, since the subject is in the outer box and therefore extensionalized over, this is not the case for the states in (11a) and (11c).

(11) a. George is related to Opus.
b. Opus is related to George.
c. George is related to the tuba player of the Deathtöngue
d. The tuba player of the Deathtöngue is related to George.

Identity relations between states get more coherent and intuitive if the content of the box embedded under "≈" is restricted to only the core predicate (e.g. *related(x, y)*).

Now if Engelberg is right that K-states are not more fine grained than events and D-states, and the content of the embedded K-state box is in all cases only a core predicate, one can wonder what the advantage of the Kimian style representation still is. For facts and propositions this kind of representation is useful, exactly because the content of a proposition is more than a single predicate; it is a full-fledged proposition, and it makes sense to assign a referential argument to the proposition as a whole. Individuals introduced by NPs in embedded propositions are not extensionalized over. If George said that he is related to Opus and if Opus is the tuba player of the Deathtöngue, it is not entailed that George said that he is related to the tuba player of the Deathtöngue. The main remaining difference between the D-state and K-state representations seems to be that the K-state predicate directly predicates over its argument(s), whereas in D-states this relation is mediated through theta roles. It is not clear why this should be the case.

4.3 Entailments between K-state and D-state verbs

Representing K-states in a different format than D-states, also causes another complication in the domain of inference. German *liegen* 'to lie' is a D-state verb, hence the grammaticality of (12a). *Sein* 'to be' and also *sich befinden* 'to be located' are K-state verbs, as shown by the ungrammaticality of (12b).

(12) a. Ich sah das Buch auf dem Tisch liegen.
I saw the book on the table lie
'I saw the book lie on the table.'

b. *Ich sah das Buch sich auf dem Tisch befinden.
I saw the book refl on the table be-located
'I saw the book be located on the table'

But (13a) entails (13b). [1] (Not all German speakers seem to like the version with the copula, but with *befinden* (13b) is certainly good.) If these two predicates introduce two very different types of states that require different styles of representation, this entailment is problematic.

(13) a. Das Buch liegt auf dem Tisch.
the book lies on the table
'The book is lying on the table.'

b. Das Buch befindet sich/ist auf dem Tisch.
the book located refl/ is on the table
'The book is (located) on the table'

It is of course conceivable that the verb *liegen* actually introduces two substates, one of which is Kimian. Intuitively positional location verbs (with their complements) such as *liegen* refer two different pieces of information. One of these is the location of the subject (expressed by the complement) and the other one is in what kind of position the subject is (upright or lying flat...). The locational information will have to be the K-state that gets us the entailment. That means that the positional information has to constitute the D-state that saves the construction in (12a).

So far the problem seems fixable, be it at the cost of losing the clear-cut distinction between D-state verbs and K-state verbs. (The positional location verbs *stand*, *sit* and *lie* are actually quite a substantial group within the D-state verb class). But it gets worse. The verb *to sleep* is a D-state verb and *to be asleep*, being a copula construction, behaves like a K-state expression, as is illustrated below.

(14) a. *Ik zag Carol diep in slaap zijn.
I saw Carol deep(ly) in sleep be
'I saw Carol be fast asleep.'

b. Ik zag Carol slapen.
I saw Carol sleep
'I saw Carol sleep.'

[1] These examples can be reproduced in Dutch, but there the copula version of (13b) is somewhat marginal.

But we can observe that (15a) entails (15b).

(15) a. Carol was diep in slaap.
Carol was deep(ly) in sleep
'Carol was fast asleep.'

b. Carol sliep.
Carol slept
'Carol was sleeping'

Here it is not plausible that (15a) contains a D-state as well as a K-state, because the presence of this D-state should save (14a). [2]

Although the distinction between two groups of statives with different behavior is very convincing, we conclude that in a semantic representation for inference purposes, it does not seem to be a good idea to treat *to sleep* and *to be asleep* as fundamentally different kinds of entities. We therefore stick to Davidsonian style representations for all states. The differences between the two classes that Maienborn shows are of course real. But as they mainly seem relevant for selectional restrictions, they can probably best be captured as part of the feature structure of the predicates, in a computational system like ours. In Delilah the decision of whether two constituents can combine to form a new one depends on the unifiability of their graphs of features. Here one can include a feature that says for example that a predicate is "abstract". Verbs of perception, all kinds of adverbials and locative modifiers can then be specified for combining only with concrete predicates. The semantic representation then only needs to contain information that is relevant for inference.

5 Adjectives and adverbs

Adjectives and adverbs are closely related categories [2]. (The main group of adverbs that also occur as adjectives are the manner adverbs.) If we assume

[2] An anonymous reviewer proposed the representation (1a) for 'Carol was asleep'. Made consistent with the view that a K-state is the exemplification of a property that would be (1b). (Where the property is 'being the theme of a sleep event')

(1) a. [s | s ≈ [s′, v | [sleep(s′), theme(s′, v), carol(v)]]
b. [s^z, v | s ≈ [s'^e | [sleep(s′), theme(s′, v)], carol(v)]

With a D-state embedded in a K-state, this looks like an interesting compromise. The main problem with it, is that Maienborn introduces K-states next to D-states in order to derive the different combinatory properties of K-states and D-states from their different ontological status. Now if a K-states embeds a D-state, with the same ontological status as any other D-state, one would expect the embedded D-state to also have the same properties as other D-states, such as being able to have a location. This would make the positing of K-states loose its main advantage.

underlying states for adjectives, we should do so for their adverbial counterparts as well. (This is one of the reasons Katz [9] does not want underlying states for adjectives.) This is not necessarily problematic, because the German *dabei*-construction which Maienborn uses as a diagnostic for whether a predicate has a referential argument, also seems to work for adverbs. In (16) the *da* in *dabei* refers to *schnell*. This means that *schnell* should introduce a referential argument.

(16) Erstaunlich ist, wie schnell und dabei zuverlässig der neue Mozilla
amazing is how fast and thereat reliably the new Mozilla
Firebird Seiten darstellt.
Firebird web sites displays
'Amazing is, how quickly and reliably the new Mozilla Firebird displays web sites.'

This suggests that our representation for these kinds of adverbs can be similar to the one that we have proposed for adjectives.

6 Conclusions and further research

We have shown that a nice side effect of (neo-)Davidsonian event representations, is that entailment relations between verbs and their nominalizations and between adjectives and their corresponding nouns follow naturally, without any extra machinery. We have defended the use of a Davidsonian representation for adjectives, by showing that assuming states of different ontological sorts obscures certain inferential relations. Our point of view is that semantic representations should only contain information that is needed for inference. Information that is relevant for selectional restrictions should be accommodated elsewhere, where it does not interfere with inference.

In our parser Delilah we have implemented event structures for verbs and nominalizations of verbs. We will proceed with implementing the proposed structures for adjectives along the same lines. We believe that in general semantic parsers that aim at producing structures that support inference can benefit from such an approach. Further research will have to show how much we need to further refine our event structures, for example by systematically including subevents.

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