

The Negation of Action Sentences

Are there Negative Events?

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Events have three properties: they have causes and effects, they need a time and space zone and they can happen. In his work, Davidson (1967, 1969) argues that events are necessary to provide a logical form for action sentences. We can then ask what happens when action sentences are negated: do they still refer to events? Native speakers often have the feeling that, when an action sentence is negated, it means that it refers to something that did not happen. Is it possible that an action sentence could describe something that is not happening? Or is it possible that a negative sentence could represent an action sentence and could therefore refer to an event?

1. Introduction

Various entities, such as events, states and facts, exist in language as they do in the world. An ontology of such entities needs to be established in order to be used in NLP applications, such as machine translation, natural language understanding or generation, as well as in more theoretical semantic work. Since Davidson (1967, 1969), it is accepted that events are necessary to provide a logical form for action sentences. We can ask what happens when action sentences are negated: do they still refer to events? Native speakers often have the feeling that, when an action sentence is negated, it means that nothing happened. Is it possible that an action sentence could describe something that did not happen? Or is it possible that a negative sentence could represent an action sentence and could therefore refer to an event? The first section of this paper will present a few definitions of abstract entities and a presentation of Davidson's and Parsons' (1990) respective work on events. The second section will concentrate on negation: what happens when an action sentence is negative, does it have a standard logical form? What happens when this logical form does not represent the actual sentence? The last, and most important, section presents a classification of the various cases where the logical form of negative action sentences is not as one might expect.

2. *Abstract Entities*

2.1. *Useful Definitions*

According to Parsons' ontology, there are three main types of entity: events, states and facts. On one hand we have events and states, which are eventualities (along with processes) and on the other hand we have facts, which are propositional. Events have three properties: they have a spatio-temporal localisation, they have causes and effects, and they can happen, or culminate. States also last for a certain period of time but do not have a culmination point. Lastly, facts are propositional and have the property of always being true.

2.2. *Davidson's representation of action sentences*

Davidson's work has been very influential in the field of philosophy of language. He suggested that the logical form of a sentence needs to include enough information to be consistent. From Davidson's point of view, every action verb has an argument position reserved for an event. This event is necessary to build the logical form, in which it needs to be existentially quantified.

(1) Brutus stabbed Caesar

Ignoring verb tense, this sentence would have the following logical form:

(2) $\exists e \text{ stab}(\text{Brutus}, \text{Caesar}, e)$

For the first time, the original sentence does not appear in the logical form.

2.3. *Parsons' logical form*

The logical form suggested by Parsons is a lot more detailed than Davidson's. It is a paraphrase: there is an event about which we can say as many things as we want.

(3) Brutus stabbed Caesar

(4) For some event e , e is a stabbing, and the agent of e is Brutus, and the object of e is Caesar, and e culminated at some time in the past.

In Parsons' theory, verbs are similar to nouns: each common noun refers to a kind of object (and not to a particular object) and each verb refers to a kind of action or state. Parsons' logical form has an advantage: it makes predictions possible. For example, from Parsons' logical form, it is possible to predict *Mary runs* from *Mary runs slowly*. Parsons' and Davidson's founding works have been very influential and they have formed the base for all further work on event representation. Davidson's representation has been adopted here because it was more convenient for this work but we should not forget that Parsons' view could be considered more complete and, therefore, his ontology has been used.

3. Negation of action sentences

3.1. Expected Logical Form

According to Davidson's representation, the logical form of a standard action sentence begins with $\exists e$, we might expect the logical form of a negated action sentence to start with $\neg\exists e$.

(5) Paul laughed

Ignoring verb tense, a sentence like this one would have a logical form like:

(6) $\exists e \text{ laugh}(\text{Paul}, e)$

For negative sentences, it would work as follow:

(7) Paul did not laugh

(8) $\neg\exists e \text{ laugh}(\text{Paul}, e)$

This logical form works with more complicated examples as well, like:

(9) John won the chess game

(10) He did not win the chess game.

But it is incompatible with a number of properties of negated sentences.

3.2. Objection to this Logical Form

Following the expected logical form, negative sentences never refer to events. But after studying negated sentences, it was found that they can have the same properties as positive action sentences. This is why we can not accept the expected logical form every time. The three properties which typify events can also be found in some negated action sentences. These negated action sentences can have causes and effects.

(11) John fell out of the tree because [he did not go to school]

In this sentence, *he did not go to school* can be understood as the cause of the first part *John fell out of the tree*. We could object to this argument by pointing out that even if *because* is a linguistic mark of causality, it does not necessarily imply a causal relation in the world. But here, we can assume that *if John had gone to school, he would not have been in a tree*. Negative sentences can also describe something that happens:

(12) John did not come to school, it happened yesterday.

Finally, they may express a location in time and space:

(13) Yesterday, John did not go to school.

We have thus seen that a single negative action sentence *John did not go to school*, may possess the three properties of events that we exposed earlier. This provides a basis on which to reject the standard logical form of negative sentences, in which events do not exist.

4. Classification

Departing from the work on events and/or negation by De Swart and Molendijk (1999), Przepiórkowski (1999), Amsili & Le Draoulec (1998) or Cooper, an attempt has been made to identify which negated action sentences could not be given the expected logical form. After studying these sentences, they have been classified into four classes, which are presented here. Many of the examples used come from Przepiórkowski (1999) but they are not necessarily his own.

4.1. Factual Discourse Referent

It is a general assumption that the pronoun *it* may be used to refer to an event. This assumption is validated by the fact that *it* can be placed in an event container (a predicative context subcategorising an event in argument position):

(14) [John did not stop at the gas station], it happened yesterday.

We could then assume that *John did not stop at the gas station* involves an event. But is it still clear in the following example?

(15) [John did not stop at the gas station], it surprised Mary.

It is not certain that the verb *surprise* requires an event subject.

(16) The color of the car surprised Mary.

In this sentence, it is obvious that *the color of the car* does not correspond to an event but it may be factual, propositional. We can make the same observation for other sentences:

(17) John did not kiss Mary, which made her angry.

John did not kiss Mary may not refer to an event since it can not be placed in an event container:

(18) *John did not kiss Mary, it happened yesterday.

The situation is the same in sentences with durative complements:

(19) After John did not arrive on the 10 o'clock train, Eva left the train station.

These sentences do not refer to events, but to facts, to situations which can be perceived.

4.2. Positive Equivalent Sentences

It is commonly assumed that when a perception verb is followed by an infinitive, it refers to an event. This would then be the case in Higginbotham's (1983) famous example :

(20) I saw John not stop at the red light.

But these sentences are rare and often unnatural:

(21) ?I saw Mary not knit.

It may be suggested that this kind of negative sentence is natural when there is an equivalent positive sentence. Instead of *I saw John not stop at the red light*, we could easily say *I saw John cross the road*. It is more difficult to find a matching positive sentence for *not knit*. *Not close* would correspond to *leave open*, *not give to keep*, and so on. We observe that the negative sentences which have a positive equivalent can be placed in an event container:

(22) What happened is that John did not stop at the red light.

It is more difficult for the sentences that do not have this equivalent:

(23) *What happened is that Mary did not knit.

Negative sentences with a positive equivalent may also have causes and effects, which is not the case for the other sentences:

(24) John had an accident because he did not stop at the red light.

It is hard to find a sentence in which *Mary did not knit* would have a cause or consequence. It may therefore be concluded that when a negative sentence has a positive equivalent sentence, the latter refers to a standard - positive - event. The problem is that the speaker's intuition is necessary to identify these sentences, which makes them hard to process automatically.

4.3. Temporal Quantification

(25) Often, John has not paid his taxes.

Sentences like this one seem to refer to an event and reveal the breaking of a habit: *usually, John does pay his taxes, we expect him to do so*. But it is hard to establish the logical form corresponding.

(26) \neg often ($\exists e$ pay (John, taxes, e))

(27) often ($\exists e \neg$ pay (John, taxes, e))

In the first logical form proposed here, the negation has a wide scope: *there are not a lot of occasions where John pays his taxes*. But in this logical form there seems to be an event of *John paying his taxes*. In the second logical form, it is the adverb that has a wide scope but we can

understand it as *often*, *there is an event such as John is not paying his taxes*. We need to account for the relations between temporal adverbs and negation. To understand that the sentence refers to the breaking of a habit, we often need the context:

(28) Mary did not turn off the stove.

In this example (Partee), it does not mean that *she never did it*. It could mean that *she did not the last time she left the kitchen: there is no event of Mary turning off the stove for a certain period of time*. We can make similar observations with cardinal adverbs:

(29) Twice, he did not laugh

Does *twice* mean that there are two events or two periods of time? I noticed that there is no good logical form for this kind of sentence. The need seems apparent for a theory accounting for the interaction between time, aspect and negation. De Swart (1996) tried to establish such a theory but it is very complicated and will not be explored here.

4.4. Negative Substantive

(30) The non-explosion - the invalidation

These words (from Higginbotham 1983) are negative substantives and may be the closest thing to negative events. They do not involve a phrasal negation, but a noun that is negated. This noun could refer to an event, since it can be placed in an event container:

(31) The non-explosion of the gases happened yesterday in public.

This sentence could seem unnatural but it is not so hard to find a context in which it is not:

(32) The chemists try to mix two gases but they explode every time. Yesterday the non-explosion of the gases happened after all.

This morphological negation is restrained: it is *the non-explosion* and not *the no-explosion*, *invalidation* and not *devalidation* and so on. The discourse referent of this kind of sentence is thus an event. There is no problem with regards to logical form since the negation is included in the noun, the logical form can start with $\exists e$. The only thing to keep in mind is that not all the verbs have equivalent negative substantives, so this can not be generalized.

4.5. Summary

The cases in which the logical form of a negative action sentence is not the expected form ($\neg\exists e$) have been classified into four classes. Firstly, a negative action sentence can provide a factual discourse referent instead of an event. For the sentence *John did not arrive, it surprised Mary*, to be consistent, the first proposition *John did not arrive* needs to be true. If we can say of a sentence that it is true, then it means that it refers to a fact. Here, the pronoun *it* refers to a fact

and not to an event. This fact is expressed by the negative sentence. Secondly, some negative sentences can be understood thanks to their positive equivalent action sentence: we refer to a standard, positive event but we express it with a negative sentence. When we say *Paul did not stop at the red light*, we picture *him driving across the intersection*, and this is clearly an event. Thirdly, when there is a quantification over time, it is hard to establish a correct logical form. We need a new theory accounting for the interactions between time, aspect and negation. This theory could handle sentences like *Often, he has not paid his taxes*. Last, when the negation is morphological and concerning the noun, the discourse referent which is made available is an event but the sentence is not negative. There is no problem with the standard logical form $\exists e$.

5. Conclusion

In order to improve on this work, one of the first steps would be to try to establish a complete theory of the interaction between tense, aspect and negation. It would be interesting to study more carefully the notion of event containers and what happens when there is a negation in such a container. This work could be useful in NLP applications such as text generation and machine translation. It could be enlarged to other entities and maybe integrated in DRT. It is naturally assumed that negation is posterior to affirmation. But a psycho-linguistic study showed that negative sentences do not take more time to be produced than positive ones. It could therefore be suggested that negation is not an operator but that it is at the same level as positive productions. Another lead to follow is the effect of neg-raising, which has been mentioned by Horn. In some sentences, the negation may not be informative but purely pragmatic, which explains why it may be moved by a neg-raising phenomenon. A similar idea, that of the positive equivalent sentence, has been evoked here, but it may be applied to temporal quantification as well: *Mary usually turns off the stove, but not this time...* It can therefore be concluded that the logical form of negated sentences is $\neg\exists e$ except in some cases, which are very disparate.

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