

# Episodes, Characterising Sentences and Causes: A Critique of Episodic Logic\*

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March 1994

EPISODIC LOGIC (EL), as described in Chung Hee Hwang and Lenhart K. Schubert's paper "Episodic Logic: a Situational Logic for Natural Language Processing" [Hwang and Schubert, to appear], is a formal theory of natural language semantics which has an extensive coverage of phenomena. The theory has been applied effectively in various software implementations of natural language systems.

This paper is not intended to undermine this theoretical and applied work. It aims merely to illustrate some problems with the informal intuitions that purport to explain and justify the formal theory of EL. In particular, this paper criticises the view that we should think of events as situations (episodes) which can be completely characterised by natural language sentences. I argue that: (1) there are no genuine natural language examples which require it; (2) it results in a loss of expressiveness; and (3) it leads to problems when giving the logical form of causal statements. I suggest that the motivating example can be dealt with adequately using a (neo-) Davidsonian approach.

That these arguments do not undermine the formal theory of EL and its application in various systems can be seen from the fact (discussed at the end of §II) that the formal theory appears to make no use of the problematic notions; they only appear in its informal motivation. In effect, EL can be seen to provide a neo-Davidsonian theory.

This paper is structured as follows: §I introduces those aspects of EL relevant for the discussion; §II presents detailed criticisms; §III re-appraises the (neo-) Davidsonian approach to events, and shows how it can cope with Hwang and Schubert's motivating example; and §IV makes some concluding remarks.

## I

Episodic Logic (EL) is a form of situation logic [Barwise and Perry, 1983]. Situation logics give the truth of expressions with respect to the utterance context and some partially described state of affairs. Rather than giving the truth conditions of sentences with respect to some static situation, EL uses a notion of time bounded events or states, referred to as *episodes*. So, an episode is to be thought of as a situation or an event.<sup>1</sup> With EL, in addition to the standard notion of a situation (episode,

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\*This paper was written for the BMFT funded VERBMOBIL project.

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<sup>1</sup>The words *event*, *episode* and *situation* will be taken to be roughly synonymous for the purposes of this discussion.

in this case) supporting a sentence, there is a stronger notion of a sentence completely characterising an episode. Hwang and Schubert use examples of anaphoric reference to illustrate the need for this latter notion. According to them, any additions to the content of a characterising utterance, via meaning postulates for example, characterises a different, although related, episode. To this end, they adopt an information ordering for episodes independent from a notion of spatial or temporal containment. This ordering on episodes parallels the information content of sentences which refer, in some sense, to the same state of affairs. The merits of this proposal are discussed in §II.

Hwang and Schubert claim that EL respects Montague’s concerns for compositionality, and that its syntax is more “natural language-like” than other situation logics. This shall not be explored here. They suggest that EL differs from other situation logics in that it abandons the *relational theory of meaning* espoused by situation theory (where the meaning of an utterance is a relation between the *utterance situation*, and the *described situation*): in EL sentences are first mapped into what they call *indexical logical form*. Expressions in this form are then translated into a *non-indexical form*. Hwang and Schubert suggest that the latter form is easier to use in theorem proving. In effect, this *de-indexing* turns expressions containing tense operators into expressions containing quantified episode variables, and ordering relations between them. In this way, part of the utterance situation becomes incorporated into the semantic representation of utterances, and so the meaning of a sentence can no longer be taken to be a relation between the utterance situation and the described situation.

Hwang and Schubert have the following two operators  $**$  and  $*$ . These hold between propositions and episodes. The operator  $*$  is effectively a truth operator:

$$\varphi * s$$

which means that  $\varphi$  is true in episode  $s$ . In situation theory, this is often written as:

$$s \models \varphi$$

The operator  $**$  supports a stronger notion:

$$\varphi ** s$$

means that  $\varphi$  is true in  $s$ , and no smaller episode supports it. This notion is to capture the idea of minimal sufficient causes. Assuming, as Hwang and Schubert do, that episodes can act as causes, then we might wish to say that a minimal episode which supports  $\varphi$  may act as a cause of some consequence  $c$ . A more general episode may support the truth of  $\varphi$ . There is a sense in which this general episode causes  $c$  but it is the minimal episode which supports  $\varphi$  that is the specific cause. In EL, the operator  $**$  is introduced by natural language sentences (utterances) and  $*$  is generally introduced by meaning postulates. Hwang and Schubert go further, and say that in  $\varphi ** s$ ,  $\varphi$  *completely* characterises  $s$ . It is this idea, that propositions (derived from NL) completely characterise causes, which will be the centre of critical attention. They argue that sentences (and utterances), must completely describe events, or episodes—and thus motivate this fine-grained treatment of events, or episodes—because of examples involving alleged anaphoric reference to events. With the sentences:

John kicked Pluto.  
This caused Pluto to bite John.

in the circumstances where John kicked Pluto at the same time as yelling at Pluto to get lost, they claim that “This” refers to the event described by “John kicked Pluto”, but if anaphoric reference is made to events only partially described by utterances, then we might mistakenly claim that “This” could refer to John’s shouting at Pluto. Later I shall question this analysis, and argue that this example does not support the idea that:

“[...] the notion of complete description (characterization) of a situation, expressed by ‘\*\*’, is crucial for interpreting anaphoric reference to situations and for representing causal relationships among situations.” [Hwang and Schubert, to appear, §2, ¶3].

Indeed, I suggest that the idea that sentences should be taken to completely describe situations prevents the representation of causal relationships, as argued by Davidson [Davidson, 1967a], and that a Davidsonian treatment of events [Davidson, 1967b] provides all that Hwang and Schubert require in terms of minimal episodes supporting a sentence.

A final detail of EL, relevant for the next section, concerns the orderings on episodes. Hwang and Schubert introduce two such orderings,  $\sqsubseteq$  and  $\preceq$ , which are taken to be “metapredicates”. The first can be thought of as a *part of* ordering on events. If  $e \sqsubseteq e'$ , then  $e$  is part of  $e'$ . Note that  $e$  need not be spatio-temporally co-extensive with  $e'$ . Although not done explicitly in EL, it is possible to give the least upper bound of episodes:

$$e \oplus e'$$

such that:

$$\begin{aligned} e &\sqsubseteq e \oplus e' \\ e' &\sqsubseteq e \oplus e' \\ \forall s (e \sqsubseteq s \ \& \ e' \sqsubseteq s \rightarrow e \oplus e' \sqsubseteq s) \end{aligned}$$

along the lines suggested for events [Bach, 1986, Link, 1987, Krifka, 1986, Hinrichs, 1985]. The second ordering  $\preceq$  seems more related to information ordering in situations. If  $s \preceq s'$ , then  $s$  is less informed but spatio-temporally co-extensive with  $s'$ . Any propositions supported by  $s$  persist in  $s'$ . Thus, the significant of the ordering  $\preceq$  is dependent upon the notion of \*\*: episodes related by  $\preceq$  are effectively manifested in the same state of affairs, but are characterised by different utterances.

## II

In this section I shall present several arguments against Hwang and Schubert’s view that sentences should completely characterise episodes, or events. A final point I shall make is that these criticisms do not seem to apply to EL as formalised, in that the problematic intuition is not captured by the model for EL.

Hwang and Schubert use the kicking-yelling example to motivate their view of sentences: if it is true, as they claim, that examples can be constructed where reference is to the minimal episode which supports a proposition, then sentences should be represented in terms of propositions *completely* characterising episodes. Reference to causes (via “this” for example) is then represented by reference to characterised episodes. If we later expand upon an episode, it is a different episode, although it may in some sense be part of the same state of affairs.

There are difficulties with this however: (i) we may wish to elaborate on an episode without necessarily then being committed to characterising a different episode; (ii) there are problems with their kicking-yelling example and it appears there are no

clear examples where we *must* take sentences to completely characterise episodes; (iii) philosophical problems result if we take sentences to completely characterise episodes which then play a role in cause and effect.

Concerning (i), *elaborating an episode*: it seems that the notion of episode may be too fine-grained in the general case. Taking the referent of such anaphora to be minimal episodes described by a previous utterance means that we cannot revise a previously characterised episode, just as we cannot revise a previous utterance. In combination with their use of ‘actions’ for resolving VP ellipsis certain problems of expressibility arise. If we assert:

John pulled the trigger.  
He did it intentionally.

we can surely infer that:

John pulled the trigger intentionally.

However, this example is problematic in EL. Each utterance must describe a different episode. As a result, the representation of the concluding sentence cannot be inferred from those of the preceding sentences. Ignoring additional constraints concerning the relationship between the event time and the utterance time, the sentences are represented roughly as follows:

$$\begin{array}{l} [PJ ** e_1] \\ [[J|e_1]D ** e_2] \\ [PJ \& [J|e_3]D ** e_3] \end{array}$$

where  $[J|e_1]$  is intended to mean the action of John’s in episode  $e_1$ , and  $[J|e_1]D$  means that that action was deliberate. Note that because of the characterisation of the “operator”  $**$ , the episodes  $e_1, e_2, e_3$  must all be different. The third expression cannot be inferred from the first two, although we can derive  $[PJ \& [J|e_1]D ** e_3]$ . Thus EL does not capture what might seem to be an intuitively acceptable inference. The only sense in which EL captures the inference is if  $e_1$  and  $e_3$  are really thought of as the same event, and  $\preceq$  is not an ordering on event like objects, but is just an ordering on partial states (in the informational sense). It may be thought problematic to take them to be the same episode, as we may use “this” either to refer to the shooting, or to the fact that the shooting was deliberate. However, this would be to assume that all anaphoric reference is to episodes or events. In this context note:

“We think [...] that sentences typically make available multiple referents for anaphora, including multiple events (or situations), facts (or propositions), actions, and (depending on the syntactic constructs used) event types and action types.”  
[...]  
“Anaphora resolution [...] often requires extra processing.” [Hwang and Schubert, pc].

Concerning (ii) *whether there are clear examples which demand that sentences completely characterise episodes*: Hwang and Schubert argue that we cannot base a theory on  $*$  for the reasons given in the kicking-yelling example. As this is an important issue for the purposes of this discussion, let me quote extensively from a personal communication:

“Let us just try once more to reiterate our argument [...]. The only other assumption we make here is that if  $e$  causes  $E$ , and  $e'$  is obtained from  $e$  by

“adding” further situational information to it (i.e.,  $e$  is part of  $e'$  in the situation semilattice), then  $e'$  also causes  $E$ . (In particular, if kicking Pluto caused him to bite John, then kicking Pluto while yelling at him also caused him to bite John—assuming the yelling-while-kicking did actually occur.) To wit:

$$[[P \text{ bite } J] * E]$$

The causal accounts for  $E$ :

- (1)  $\exists e_1([[J \text{ kick } P] * e_1] \& [e_1 \text{ cause-of } E])$   
 versus  
 (2)  $\exists e_2([[J \text{ yell-at } P] * e_2] \& [e_2 \text{ cause-of } E])$

These are perfectly consistent if situations form a semilattice; for suppose (1) is true. Then pick an  $e$  such that  $[[J \text{ yell-at } P] * e]$  (such an  $e$  exists, by the assumed scenario). Form  $e_2 = \text{lub}\{e_1, e\}$ . But then we still have  $[[J \text{ yell-at } P] * e_2]$  (via persistence) and we also have  $[e_2 \text{ cause-of } E]$  since  $e_2$  now includes the (main) cause of  $E$ . [...] Thus (1) and (2) cannot be correct.” [Hwang and Schubert, pc].

It is assumed that the kicking and yelling, at some level, occurred in the same situation  $e_2$ . But is the yelling incident  $e \preceq e_2$ ? Although one could argue that both the yelling and kicking took place in the same place and at the same time, in a finer sense they did not: the manifestation of the yelling was in John’s vocal cords and the surrounding air, whereas the kicking took place at the end of John’s foot. Putting it differently, whilst agreeing that:

“[...] *there is* a larger more complex event, that of John’s kicking Pluto while yelling at him.” [Hwang and Schubert, pc] (Their emphasis).

the question is whether we should take this “larger more complex event”  $\text{lub}\{e_1, e\}$  to be the same situation as  $e_1$  (or rather, a spatio-temporally co-extensive situation) with additional information, or a different situation, containing  $e_1$  (more like  $e_1 \oplus e$ ). If it is a different situation in this sense, then the causal relation will presumably not persist in the more general episode:

“Only telic and unlocated (eternal) sentences are guaranteed to have persistent extensions through  $\sqsubseteq$  ordering.” [Hwang and Schubert, to appear, §2].

If we try to construct an example along the same lines, where two descriptions clearly describe spatio-temporally coextensive episodes, then it is not obvious that we want anaphoric reference to some minimal episode *completely* characterised by a sentence. Take the sentences:

John kicked Pluto [whilst wearing hob-nail boots].  
 This caused Pluto to bite John.

it may be the case that plain kicking does not bother Pluto, and that it was the kicking *with hob-nail boots* that bothered him, and thus led him to bite John. This might be evident in the continuation:

[why?] ... because John was wearing hob-nail boots.

This is perhaps an argument for anaphoric reference to events, but not to the event completely characterised by a sentence. The question still appears open as to whether there are any genuine examples of anaphoric reference to events which cannot be

treated by any means other than by assuming that sentences completely characterise episodes. Indeed, in the light of the next point, it would seem unlikely that there could be any.

Concerning (iii), *the philosophical problems of taking sentences to completely characterise events*: Mill says that we have not given the cause of a particular outcome until we have given a complete description of it. In part of an argument relevant to this discussion, Davidson says that Mill confuses (a) referring to a cause and (b) giving sufficient information about the cause so that in conjunction with causal laws, it is possible to deduce the effect. In particular, it is possible to give the logical form of causal statements if we assume sentences partially describe events. Of particular relevance to this discussion of EL is the following extract:

“Mill [...] was wrong in thinking we have not specified the whole cause of an event when we have not wholly specified it. And there is not, as Mill and others have maintained, anything elliptical in the claim that a certain man’s death was caused by his eating a particular dish, even though death resulted only because the man had a particular constitution, a particular state of health, and so on. On the other hand Mill was, I think quite right in saying that ‘there certainly is, amongst the circumstances that took place, some combination or other on which death is invariably consequent ... the whole of which circumstances perhaps constituted in this particular case the conditions of the phenomenon ...’ (*A System of Logic*, book III, chap. v, §3.) Mill’s critics are no doubt justified in contending that we may correctly give the cause without saying enough about it to demonstrate that it was sufficient; *but they share Mill’s confusion if they think that every deletion from the description of an event represents something deleted from that event.*” [Davidson, 1967a, §III, ¶4] (My emphasis).

In connection with this, we may question what it can mean for an episode to be completely characterised by the negation of a proposition, as allowed in EL. It is hard to see how something *completely* described by the absence of its support of a proposition can play any causal role.

Davidson’s argument can essentially be viewed as in favour of a primitive notion of events. Events partake in cause-effect relations, and are partially described by sentences. It is unreasonable to expect sentences to completely specify a cause so that we might verify that it was the cause. Hwang and Schubert would seem to agree that there should be event-like objects which partake in causal relations:

“One of the most important features of situations is that sentences are viewed as describing *situations* (events, states, eventualities, etc.), where these situations are correlated with partial as opposed to *complete* states of affairs. So construed, situations can be used among other things, as causal antecedents and consequents and as anaphoric referents [...]” [Hwang and Schubert, to appear, §1, ¶1].

although even in this quote we see a problem in that the described situations themselves (rather than the descriptions) are taken to be partial.

So it would seem that taking sentences to completely characterise episodes (which are themselves partial) prevents the expression of apparently acceptable inferences; there do not seem to be examples for which it is essential; and it leads to philosophical difficulties.

There is perhaps one other issue to explore: whether the ordering  $\preceq$  might provide indirect motivation for taking sentences to completely characterise events. This ordering is on spatio-temporally co-extensive episodes characterised by sentences. If we are to reject the idea that sentences are completely characterised by sentences, then

this ordering will cease to have any useful meaning. If there is independent motivation for keeping this ordering on episodes, then this would support the idea that sentences completely characterise episodes. Let us look at a Davidsonian-style treatments of events [Davidson, 1967b] to see whether this ordering might play some role in that theory. Perhaps like EL, if we describe the manifestation of an event differently in a Davidsonian analysis then we may be describing a different, although related, event. Although EL makes no claims to a Davidsonian analysis, we might out of curiosity wonder whether something like this relationship between the different events is captured by  $\preceq$  in EL. The issues involved in this treatment can be summarised as follows: from an event  $e$  described by the sentence “John swam the Channel” we might infer that there must also be an event  $e'$  described by “John crossed the Channel”. The question is whether the two events  $e, e'$  are really the same event, namely, Johns crossing the Channel, by swimming. The Davidsonian argument is that the events may be distinguished because John might have swum quickly, yet the crossing would be slow. An event cannot be both quick and slow. This assumes that adverbials modify events, although this need not be the case (but it does give a first-order representation of adverbials). The interdependence of the two events requires a relationship defined with roughly the following meaning:

- (i) The two events  $e, e'$  were simultaneous.
- (ii) Event  $e$  is sufficient for the event  $e'$ ,
- (iii) If  $e$  had not been the case, then  $e'$  would not have been the case.

Assuming that  $e'$  (or rather, its characterising sentence) was derived from  $e$  by meaning postulates, then we might like to say  $e \preceq e'$ . However, EL requires that  $e$ 's characterising utterance is also supported by  $e'$ . This, in general, is not the relationship between different events with the same manifestation.

In summary, taking sentences to completely characterise episodes does not appear to have any clear motivating examples; inhibits the expression of some inferences; and causes philosophical difficulties. Further, as the ordering  $\preceq$  on episodes does not appear to improve the expressiveness of the language in a way useful for NL semantics, it cannot be used as indirect motivation for interpreting  $\varphi ** \eta$  as  $\varphi$  completely characterises  $\eta$ .

As the intuitions behind the operator  $**$  causes difficulties, it seems prudent to reconsider them. If the notion  $**$ , as characterised in EL, need not be used in the formal semantics of NL then we might question why we should use a logic with such an operator when it is possible to manage without it. If a certain notion or a certain ontology seems appropriate for use in NL semantics but NL semantics does not require it then perhaps this is cause to reflect upon our philosophical intuitions used in composing the representation theory.

To close this critical section, I shall make some remarks on their model for EL, and some of the axioms. Here we shall see that indeed the model for EL does not make use of the problematic intuitions. Hwang and Schubert give the following clauses for the operators  $*$ ,  $**$  [Hwang and Schubert, to appear, §4.3]:

$$\begin{aligned} \llbracket \varphi * \eta \rrbracket^s &= 1 \text{ only if } \textit{Actual}(\llbracket \eta \rrbracket, s) \text{ and } \llbracket \varphi \rrbracket^{\llbracket \eta \rrbracket} = 1; \\ &= 0 \text{ only if } \textit{Nonactual}(\llbracket \eta \rrbracket, s) \text{ or } \llbracket \varphi \rrbracket^{\llbracket \eta \rrbracket} \neq 1; \\ \llbracket \varphi ** \eta \rrbracket^s &= 1 \text{ only if } \llbracket \varphi * \eta \rrbracket^s = 1 \text{ and there is no } r \sqsubset \llbracket \eta \rrbracket \text{ such that } \llbracket \varphi \rrbracket^r = 1; \\ &= 0 \text{ only if } \llbracket \varphi * \eta \rrbracket^s = 0 \text{ or for some } r \sqsubset \llbracket \eta \rrbracket \text{ such that } \llbracket \varphi \rrbracket^r = 1; \end{aligned}$$

For the special case that  $s \in \mathcal{H}$  (i.e.,  $s$  is an exhaustive situation), these conditionals (‘only if’s) become biconditionals (‘iff’s).

where  $Actual(d, s)$ ,  $Nonactual(d, s)$  mean that situation  $d$  is (is not, respectively) a felicitous situation with respect to  $s$ .

Intuitively,  $\varphi * \eta$  means that  $\varphi$  holds in situation  $\eta$ ,  $\varphi$  being a function from possible situations to truth-values. The expression  $\varphi * \eta$  is also understood to be a function from situations to truth values. It is true (false) only if  $\varphi$  holds in  $\eta$ , and  $\eta$  is “actual” in  $s$  ( $\varphi$  does not hold in  $\eta$  or  $\eta$  is “nonactual” in  $s$ , respectively). Presumably,  $s$  is typically the utterance situation.<sup>2</sup> As these rules only become biconditionals when  $s$  is complete, we can see that the model reflects their intuitions that partiality lies in the episode described, not the description of the episode. We may question in what sense an utterance can ever be said to be complete. Concerning this note:

“[a complete episode]  $e_h$  [ $\in \mathcal{H}$ ] is describable, but not completely describable”.  
[Hwang and Schubert, pc].

which might make it hard to see how the model can effectively be made to verify the axiom:

$$[\varphi ** \eta] \leftrightarrow [\varphi * \eta] \& \sim \exists e([e \text{ proper-subep-of } \eta] \& [\varphi * e])$$

for example [Hwang and Schubert, to appear, §4, Axiom 3] unless we abandon the situation-theoretic view of evaluation, and do not take  $s$  to be a situation.

The clauses in the model for  $**$  do not follow precisely the intuitions given by Hwang and Schubert: all the model requires for the expression  $\varphi ** \eta$  to be true (for example) is that  $\varphi * \eta$  is true, and there is no smaller episode in  $\eta$  which supports  $\varphi$ . There is no formal mention of the idea that  $\eta$  is completely specified by  $\varphi$ , and that no other non-equivalent expression can be supported by  $\eta$ . Nor is there any appearance of the ordering  $\preceq$  in the model. Thus the very aspects of EL which seem problematic are not mentioned in the model. Indeed, the model seems more in keeping with the spirit of a (neo-) Davidsonian treatment of events than the radical intuitions expressed by Hwang and Schubert.

### III

I shall sketch the essence of Davidson’s approach, and show that it really does provide all that is needed to cope with Hwang and Schubert’s kicking-yelling example. In a Davidsonian-style analysis, all appropriate basic predications are indexed with an event marker (or a quantified event variable) [Davidson, 1967b]. The atomic proposition:

$$p(e, x_1, \dots, x_n)$$

means  $p$  holds of  $x_1, \dots, x_n$  in event  $e$ . This could be taken to correspond with:

$$p(x_1, \dots, x_n) ** e$$

as there is no smaller event than  $e$  which supports the predication.

When events  $e, e'$  are combined where:

$$\begin{aligned} p(e, x_1, \dots, x_n) \\ q(e', x'_1, \dots, x'_m) \end{aligned}$$

then it could be argued that:

$$p(e, x_1, \dots, x_n) * (e \oplus e')$$

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<sup>2</sup>Although this may not be the case: why should the truth of a proposition  $\varphi$  in a situation  $\eta$  be given in terms of the utterance situation (remembering that EL abandons the situation-theoretic relational theory of meaning [Hwang and Schubert, to appear, §1, ¶2])?

In the yelling-kicking example, used to motivate EL’s characterisation of \*\*, we would have:

bite( $E, J, P$ )  
kick( $e_1, P, J$ )  
yell-at( $e_2, P, J$ )

There is a larger more general event, consisting of  $e_1 \oplus e_2$ , but from:

$e_1$  cause-of  $E$

we cannot deduce that  $e_1 \oplus e_2$  cause-of  $E$  (unless “cause-of” means “contains the cause of”, rather than “minimal sufficient cause”) and we certainly cannot infer that  $e_2$  cause-of  $E$  (on either reading of “cause-of”).

Using a Davidsonian-like treatment of events, where predications can be indexed by quantified event variables, does not have to mean that we have to be restricted to a pure, extensional, first-order predicate logic, where adverbs, for example, must be treated as predications of events. Presumably EL adopts elements of a situation-theoretic approach to address issues such as how to give an acceptable representation of the propositional attitudes. However, there are other intensional theories which can offer solutions to these problems (such as Property Theory [Turner, 1992], to pick an example at random). It is possible to add the Davidsonian treatment of events to such a theory. Alternatively, in a situation-theoretic paradigm, the idea that an episode (or a situation corresponding to some event) can be completely characterised, and that partiality lies in the situation-as-event itself (rather than in its description) must be abandoned.

A Davidsonian style analysis could be thought to create problems for Hwang and Schubert’s “de-indexing” process, where context-dependent temporal expressions are reduced to expressions involving quantified indices (the episodes). It might seem that this reduction requires there to be a unique episode for each utterance, so supporting the more intensional view of episodes. However, this is not so. That would be to claim that unique variable names must have unique values. It is interesting to note that the “de-indexed” expressions have one episode variable for each predication, as predicted by the Davidsonian analysis.

Finally, the partiality of natural language description can simply be modelled with partial descriptions. If we wish to have partiality *in* the language, then something along the following lines may be relevant: given sets of propositions  $s, s'$ , then  $s \preceq s'$  iff  $s \subseteq s'$  and if  $p \in s'$ , then  $p \in \text{Thm}(s)$ .

#### IV

This discussion seems to boil down to Davidson’s argument: a theory will face serious problems if it maintains that sentences can *completely* characterise events. There seem to be no clear examples which motivate this requirement; it prevents the expression of inference which present no intuitive problems; and it leads to great difficulties when constructing the logical form of causal statements.

If there were no alternatives, then these would be difficulties that would have to be faced up to, but there are alternative intuitions which cope well with Hwang and Schubert’s motivating example, and suffer none of the problems mentioned.

This certainly does not mean that the formal theory of EL and implementations based upon it have to suffer from these problematic intuitions, especially since the formalisation of EL does not seem to embody them. However, it does mean that the intuitions underlying EL should be re-appraised.

To summarise, it seems essential to have a structure for events, given in part by  $\sqsubseteq$ . In such an ordering, it is helpful for an analysis of cause and effect to have a notion of an episode offering minimal support to a proposition. It may also be desirable to have some information ordering on situations, or partial states of affairs, as characterised by  $\preceq$ , where the partiality is actually in the description of the state of affairs. What does seem clear, however, is that these notions should not be confused. The notion of informational equivalence in situations-as-described is too intensional to also play the role of equivalence between events. Events are surely basic, and cannot be taken to be characterised by sentences without resulting in considerable philosophical difficulties.

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