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Are boxes just parentheses?

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Chapter 5 of Kamp and Reyle [**2**] formulates conditions of the form $\texttt{write}(e, x, y)$, where e is an event, as

(1) $$e \ : \ \boxed{\texttt{write}(x, y)}$$

to indicate that "the discourse referent for that event has a status different from the other discouse referents in the condition" (p. 511). States s are treated similarly, giving rise to conditions such as

(2) $$s \ : \ \boxed{\texttt{ill}(x)} \ .$$

Recently, de Swart [**5**] has argued that in some cases, a discourse referent of type state ought to be introduced alongside negative sentences, yielding conditions of the form

$$s \ : \ \neg K \ ,$$

where K is a DRS. This suggestion departs strictly from the treatment of negative sentences in Kamp and Reyle [**2**], requiring an extension of the model-theoretic framework there to specify when conditions

(3) $$s \ : \ \gamma$$

are verified, where γ is an *arbitrary* condition. De Swart also introduces a coercion operator C_{se} that takes predicates labeled by states to predicates labeled by events, as well as a complementary operator C_{es} that does the reverse (mapping event-labeled predicates into state-labeled ones). She borrows here the idea of a progressive operator PROG from page 576 of Kamp and Reyle [**2**], which applied to (1) leads to conditions of the form

(4) $$s \ : \ \boxed{\mathrm{PROG}(\texttt{write})(x, y)} \ .$$

But what exactly are these coercion operators? Can the boxes be put to better use than as parentheses? What does it mean to verify conditions such as (3)? And what about events? The present note links these questions, by proposing that

$(*)$ *states label conditions, while events label DRSs.*

Under $(*)$,

(i) the event-labeled condition corresponding to (3) would have the form

$$e \ : \ K \ ,$$

(ii) (1) would remain unchanged (at least under a certain interpretation described below in §3), but

(iii) (2) would be simplified into

$$s \; : \; \texttt{ill}(x) \; ,$$

while

(iv) the force of PROG in (4) would (under the simplest interpretation) be to unpack the box

$$s \; : \; \texttt{write}(x, y) \; .$$

1. Simple-minded coercion

A first attempt at implementing coercion is through the following systematic use of boxes —

C_{se}: draw a box around the condition to form a DRS

$$C_{se}(\gamma) \;\; = \;\; \boxed{\gamma}$$

C_{es}: negate the DRS, draw a box around it, and then negate once more

$$C_{es}(K) \;\; = \;\; \neg \boxed{\neg K} \; .$$

This is not the only system of coercion operators consistent with the proposal, just the first that comes to mind.[1] But what does it mean?

2. Some intuitions

On its face, the proposal ($*$) (viz., that states label conditions, while events label DRSs) goes beyond recognizing (as in Kamp and Reyle [**2**]) the special status of events and states (relative to other discourse referents), by further speculating about the difference between events and states. But what makes conditions state-like, while events DRS-like? There is, to begin with, the rather striking parallel between

the suggestion from de Swart [**5**] that the negation of an event is a state

and

the fact (by stipulation in DRT) that the negation of a DRS is a condition.

Then, there is the point that DRSs, like events, involve the possibility of change, whereas conditions, like states, do not.

More precisely, recall (if necessary, consulting Muskens [**4**] or Fernando [**1**]) that on the one hand, a DRS K can be interpreted semantically as a binary

[1] Other coercion operators might actually change atomic predicates, although, as Kamp and Reyle [**2**] point out in the case of PROG (page 576), just what that modified predicate is may not be terribly clear.

relation $P(K) \subseteq S \times S$ on the set S of world-sequence pairs (M, f), (N, g), characterized by

$$(M,f)\ P(K)\ (N,g) \quad \text{iff} \quad \begin{array}{l}\text{on input } (M,f),\\ K \text{ returns output } (N,g)\end{array}$$

(where $M = N$ and $f \subseteq g$ turn out to be necessary conditions for either side of the equivalence above). On the other hand, a condition γ amounts semantically to a subset $v(\gamma)$ of S, given by its verifying embeddings

$$(M,f) \in v(\gamma) \quad \text{iff} \quad f \text{ verifies } \gamma \text{ in } M.$$

In particular, returning to the coercion operations described in §1,

$$\begin{aligned} P(\boxed{\gamma}) &= \{((M,f),(M,f)) \mid (M,f) \in v(\gamma)\} \\ v(\neg \boxed{\neg K}) &= dom(P(K)) \ . \end{aligned}$$

3. Extending the semantic interpretation (two alternatives)

How can the model-theoretic framework in Chapter 5 be extended to treat $s : \gamma$ and $e : K$? Fix a first-order model M with additional binary predicates ϵ and ϵ', the idea being that ϵ specifies the objects of a state,[2] while ϵ' specifies the objects of an event, the significance of which is given by following definitions.

Definition 1. *An M-embedding f* verifies $s : \gamma$ *if either γ is an atomic condition*[3]*, in which case verification of $s : \gamma$ is treated as in Chapter 5 (i.e., with s added as an argument to γ), or γ is not atomic and the following holds:*

(i) $s \in dom(f)$,
(ii) *there is a subfunction $g \subseteq f$ such that for every $x \in dom(g)$, $g(x)\ \epsilon\ f(s)$, and*
(iii) *$g \cup \{(s, f(s))\}$ verifies γ.*

Similarly,

Definition 2. *An M-embedding f* verifies $e : K$ *if*

(i) $e \in dom(f)$,
(ii) *there is a subfunction $g \subseteq f$ such that for every $x \in dom(g)$, $g(x)\ \epsilon'\ f(e)$,*
(iii) *there is an M-embedding $h \supseteq g$ such that for every $x \in dom(h - g)$, $h(x)\ \epsilon'\ f(e)$, and*
(iv) *on input $g \cup \{(e, f(e))\}$, the DRS K can output $h \cup \{(e, f(e))\}$ — i.e.,*

$$(M, g \cup \{(e, f(e))\}) \quad P(K) \quad (M, h \cup \{(e, f(e))\}) \ .$$

[2] For example, Kamp [**3**] requires that an event e be temporally contained in a state s in order that e ϵ s.

[3] Atomic conditions are simply atomic formulas, and, if iterated labeling $s : s' : \cdots : s^{(n)} : \gamma$ is allowed, all conditions obtained from atomic formulas by such labeling.

Note that Definitions 1 and 2 impose no restrictions on the interpretations of non-atomic conditions γ and DRSs K beyond (a) that built into their constituent atomic conditions, and (b) the requirements on embeddings involving ϵ and ϵ'. Additional restrictions would, as suggested by Kamp [**3**], need to be explictly spelled out within the conditions and DRSs. A moment's reflection shows that the result of applying Definition 2 to $e : \boxed{\gamma}$ is not quite faithful to Chapter 5. The expression $e : \boxed{\gamma}$ from Chapter 5 should instead be regarded, under Definition 2, as an abbreviation of $e : \boxed{s_e : \gamma}$, where s_e is some (canonical) projection of the event e as a state which can then label γ. The question arises as to whether (or not) the proposal $(*)$ is an empty dogma (with certain perverse consequences, such as the cluttered notation s_e for e). Certainly, a good deal of work remains to be done to defend $(*)$ convincingly against that charge.[4]

It is easy enough, however, to read, within that "empty dogma," the expression $e : \boxed{\gamma}$ from Chapter 5 as $e : K$, where K is literally $\boxed{\gamma}$, by adopting a semantic interpretation that is different from (and arguably superior to) Definitions 1 and 2. Rather than introducing binary predicates ϵ and ϵ', non-atomic conditions and DRSs can be relativized to the states and events that (respectively) label them, by requiring that all constituent atomic conditions be verified relative to the labels. In particular, for every atomic formula γ, the condition $e : \boxed{\gamma}$ would be verified by the same embeddings as in Chapter 5. The only difference is that atomic relations must now be relativized to finite sequences of events and/or states, rather than just one state or event. Such an extension would in any case be required to support iterated labeling $s : s' : \cdots : s^{(n)} : \gamma$.

To be more precise, fix a first-order model M such that for every relation symbol R, and every finite sequence α of events and/or states (in M), the model M specifies an n-ary relation, call it R^{α}_{M}, on its universe.[5]

Revised definition. *An M-embedding f* verifies *a condition γ (exactly) if $f \in v^{\langle\rangle}_{M}(\gamma)$, where $\langle\rangle$ is the empty sequence, and the (α-relativized verification) sets $v^{\alpha}_{M}(\gamma)$ are defined alongside (α-relativized input/output) relations $P^{\alpha}_{M}(K)$ (in the style of Fernando [**1**]) for DRSs K and conditions γ generated*

[4] The reader not inclined to accept $(*)$ may nonetheless find Definition 1 useful for specifying when $s : \gamma$ is verified, where s is an *event* or state. The revised definition below, however, might, for that purpose, be better still.

[5] The sets R^{α}_{M} can be obtained by assuming the signature of M includes an $(n+k)$-ary relation symbol R^k, for every n-ary relation symbol R and every natural number $k \geq 0$. Then, for k equal to the length of α, take

$$R^{\alpha}_{M} \quad = \quad \{\langle m_1, \ldots , m_n\rangle \mid M \models R^k[m_1, \ldots , m_n, \alpha]\} \ .$$

Of course, if the model M is closed under finite sequences of states and/or events, a single $n+1$-ary relation symbol R^1 will do.

syntactically as follows

$$
\begin{array}{rcl}
K & ::= & (U, \emptyset) \ \mid \ K^\frown \gamma \\
\gamma & ::= & R(x_1, \ldots, x_n) \ \mid \ \neg K \ \mid \ s : \gamma \ \mid \ e : K
\end{array}
$$

where U is a set of variables (and a DRS can be flattened into a pair (U, C), with C a finite set of conditions, by setting $(U,C)^\frown\gamma = (U, C \cup \{\gamma\})$). The corresponding semantic interpretations (relativized to M and α) are

$$
\begin{array}{rcl}
f \ P_M^\alpha(U, \emptyset) \ g & \text{iff} & f \subseteq g \text{ and} \\
 & & dom(g) = dom(f) \cup U \\
f \in v_M^\alpha(R(x_1, \ldots, x_n)) & \text{iff} & R_M^\alpha(f(x_1), \ldots, f(x_n)) \\
f \ P_M^\alpha(K^\frown\gamma) \ g & \text{iff} & f \ P_M^\alpha(K) \ g \text{ and } g \in v_M^\alpha(\gamma) \\
f \in v_M^\alpha(\neg K) & \text{iff} & f \notin dom(P_M^\alpha(K)) \\
f \in v_M^\alpha(s : \gamma) & \text{iff} & s \in dom(f) \text{ and } f \in v_M^{\alpha^\wedge f(s)}(\gamma) \\
f \in v_M^\alpha(e : K) & \text{iff} & e \in dom(f) \text{ and} \\
 & & f \in dom(P_M^{\alpha^\wedge f(e)}(K))
\end{array}
$$

where $\alpha^\wedge\mathsf{a}$ is the sequence α, with a tagged on at the end.

Observe that the revised definition extends ordinary DRT in a conservative manner, and that the sequence superscript α can be ignored except for the conditions $s : \gamma$ and $e : K$. It differs from Definitions 1 and 2 in, for instance, relativizing γ to e in conditions such as $e : \boxed{\gamma}$ (as in Chapter 5), and pushing these relativizations through more complicated constructions such as $s : (e : K)$. The price paid is that suitable axioms should (according to one's favorite theory of states and events) be imposed relating R_M^α to R_M^β when (for example) α is a subsequence of β.

4. Discussion

Recall that event-labeled conditions in de Swart [**5**] are of the form $e : \gamma$ (or $e : \boxed{\gamma}$, with the box used parenthetically, as in Chapter 5 of Kamp and Reyle [**2**]). The extension described in the previous section raises the question as to whether there are natural languages (perhaps with more complicated tense systems than French) for which conditions of the form $e : K$ are useful, where K is a DRS (U, C) with a non-empty set U of discourse markers. Even if no such languages exist, however, it should be noted that de Swart [**5**] employs conditions of the form $s : \gamma$, with full-fledged DRSs built inside γ, suggesting that such event-labeled conditions may nevertheless be useful in analyzing how the $s : \gamma$'s can be formed from $e : K$'s. Such an analysis would presumably require coercion operations between states and events (and not just between conditions and DRSs), for which there are obvious candidates (in line with §1). As §3 stands, however, the characterization of verification of $s : \gamma$ is essentially independent of that of $e : K$.

It is true enough that the notion of a condition is, in principle, dispensable, as a condition can be understood as a special (pathological) kind of DRS (whose output can never differ from its input). In practice, however, the distinction between DRSs and conditions is a very convenient one. Furthermore, the possibility that there is more to the distinction between states and events than in that between conditions and DRSs is no argument against the proposal $(*)$, construed modestly.

References

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