Telescope of Incremental Quantification

Synopsis: Bumford (2015) argues that universal quantification in a dynamic semantics should be analyzed as a generalized dynamic conjunction. This analysis, however, is not compatible with existing analyses of telescoping (van den Berg, 1996; Nouwen, 2003; Brasoveanu, 2007, a.o.). This study proposes a way to resolve this conflict.

Incremental Quantification: Bumford (2015) analyzes a universal quantifier as a generalized dynamic conjunction. Thus sentence (1a) is analyzed as (1b), assuming our model contains the three relevant students, *John*, *Mary*, and *Fred*. (The analysis is formalized below.)

(1) a. Every student read a book.
    b. ⟦John read a book⟧ ; ⟦Mary read a book⟧ ; ⟦Fred read a book⟧

Bumford makes use of the analysis to account for various "pair-list" phenomena. One of them is a sentence-internal use of comparative, as exemplified in (2a). The sentence means each year Mary writes a better article than *the one(s) she wrote in the previous year(s)*. Informally, this interpretation is made possible with the successive dynamic conjunction in (2b) by letting *a better article* be interpreted as *a better article than anything mentioned before*.

(2) a. Each year Mary writes a better article.
    b. ⟦In 2019 she writes a better article⟧ ; ⟦In 2020 she writes a better article⟧; ⟦In 2021 she writes a better article⟧

A theoretical benefit of this analysis is that it predicts a close connection between the "pair-list" phenomena and universal quantification. The sentence-internal reading of comparative, for instance, is licensed by universal quantification, but not by existential quantification, or other quantifiers as *most*. This is because these quantifiers is not analyzed as a generalized dynamic conjunction.

Telescoping: *Telescoping* is exemplified in (3), taken from Groenendijk & Stokhof (1991). The examples are interpreted as if the quantifier *every* took scope over the entire sequence of sentences: *he* in (3) is interpreted as if it were a variable bound by *every*.

(3) Every player chooses a pawn. He puts it on square one.

Telescoping is successfully analyzed by van den Berg (1996) and Brasoveanu (2007) under a pluralized dynamic system. There, a sentence takes a *set* F of assignment functions and outputs a *set* G of assignment functions. Their analysis is schematically represented as table (9). *Every player*$_1$ *chooses a pawn*$_2$ updates each $f \in F$ into $g \in G$ so that g is at most different from f in that g assigns some player in the model to 1, and assigns some pawn in the model to 2. At this point G keeps track of the player-pawn dependency. The second sentence in (3) contains a covert distributer, which induces an *distributive update* of each $g \in G$ by *he*$_1$ *puts it*$_2$ *on square one*. It is thus interpreted as each of the players puts the pawn he chose on square one, as desired.

Issue: Bumford's analysis correctly captures the distribution of the sentence-internal use of comparative, which previous dynamic analyses didn't predict. However, his analysis is not compatible with the one of telescoping, because of the incrementality of quantification. This is unwelcome, because the sentence internal use can show up with telescoping, as (4). Resolving this conflict requires another way to handle telescoping with the incremental quantification.

(4) Each year Mary writes a better abstract. She submit it to SALT.

Proposal: I propose an analysis of telescoping which is compatible with the incremental quantification. I make two assumptions toward the proposal. Firstly, I follow Kamp (1979, 1981) in that a dynamic system contains a discourse referent for *events*. I assume verbs introduce an event discourse referent, though nothing hinges on this choice. Secondly, I adopt an incremental dynamic system discussed by van Eijck (2001) and Nouwen (2003).

The system contains three basic types, t for truth values; e for individuals; v for events. An assignment is a partial function from natural numbers to $D_e \cup D_v$. When some number n is in the domain of assignment f, then every number $n' \leq n$ is in the domain of f, as spelled out in (5a). Updating f (with its domain n) into g by introducing a discourse referent is defined as (5b). It extends the domain of f by 1, and assign some $d \in D_e \cup D_v$ to the new number in the domain. Introduction of a discourse referent is caused by names and indefinites.

(5) a. $\forall f, n, n' : [n' \leq n \wedge n \in \mathtt{Dom}(f)] \rightarrow n' \in \mathtt{Dom}(f)$ (Read $\mathtt{Dom}(f)$ as *the domain of f*)

b. $f \xrightarrow{d} g =_{\text{def}} \mathtt{Dom}(g) = n+1 \wedge g(n+1) = d$

The core of the proposal is sketched as follow. The incremental quantification analyzes the first sentence in (3) as (6), with relevant players x, y, z, and pawns a, b, c. Processing this sequence of conjunctions produces the assignment f in (10a). $\mathtt{e}_1$, $\mathtt{e}_2$, $\mathtt{e}_3$ are event discourse referents, introduced by the verb *chooses* in each conjunct. $\mathtt{e}_1$ is an event of $\mathtt{x}$ choosing $\mathtt{a}$, for example.

(6) a. $[\![x \text{ chooses } a]\!]$; $[\![y \text{ chooses } b]\!]$; $[\![z \text{ chooses } c]\!]$

Now, for each of those events $\mathtt{e} \in \{\mathtt{e}_1, \mathtt{e}_2, \mathtt{e}_3\}$, we can define a *subassignment* $f_{\mathtt{e}}$ of f w.r.t. $\mathtt{e}$, defined as (7). $f_{\mathtt{e}}$ is a minimal assignment that contains in its range $\mathtt{e}$, all of its participants in the range of f, and nothing else. (Read $\mathtt{Ran}(f)$ as *the range of f*.)

(7) $f_{\mathtt{e}}$ is a minimal assignment such that:

$$\mathtt{e} \in \mathtt{Ran}(f_{\mathtt{e}}) \wedge \forall d \in D_e : d \in \mathtt{Ran}(f_{\mathtt{e}}) \leftrightarrow \mathtt{participant}(d, \mathtt{e}) \wedge d \in \mathtt{Ran}(f)$$

The relevant subassignments $f_{\mathtt{e}_1}$, $f_{\mathtt{e}_2}$, $f_{\mathtt{e}_3}$ are visualized as (10b-d). Notice that due to the property of assignments defined in (5a), the domain of assignment is fixed to $\{1,2,3\}$. At this point we can appeal to a variant of the distributive update. The second sentence, *He$_1$ puts it$_2$ on square one*, update each of these subassignments, correctly capturing the player-pawn dependency.

Formalizing this idea does not require any significant change in the incremental quantification. I modify Bumford's system slightly and add a component of an event semantics (Parsons, 1990, a.o.), though I simplify a notation for a purpose of presentation. The successive update by sentence (3) is represented as (11). It is a set of pairs of assignments f, g such that f is incrementally updated into g. For instance, suppose that the domain of $f (= j_0)$ is n. Then f is first updated into j_1, which has the domain $n+3$, such that $j_1(n+1)$ is a player (d_1), $j_1(n+2)$ is a pawn (d_2), and $j_1(n+3)$ is an event (d_3) of d_1 choosing d_2. The successive updates result in an assignment equivalent to (10a). I discuss in the talk how to derive it compositionally.

The distributive operator which induces an update of subassignments is defined as (8). δ obtains indices $n, \ldots, m$, which should be indices for the relevant events. φ is a dynamic proposition. The operator calls for a test: it tests if each relevant subassignment can be updated into some assignment g (i.e., φ is *true* w.r.t. the subassignment).

(8) $\delta_{n,\ldots,m}(\varphi) \rightsquigarrow \lambda f.\lambda g.f = g \wedge \forall i \in \{n, \ldots, m\} : \exists g : \varphi(f_{f(i)})(g)$

(Defined iff $f(n), \ldots, f(m) \in D_v$)

Conclusion: The proposal resolves the conflict between the incremental quantification and telescoping. From a broader perspective, the proposal provides a new perspective to analyze telescoping *without* a pluralized dynamic system. In the talk I discuss the possibility to extend the analysis to other phenomena, e.g., quantificational subordination.

(9)
$$\begin{array}{c|cc} G & 1 & 2 \\ \hline g_1 & \texttt{x} & \texttt{a} \\ g_2 & \texttt{y} & \texttt{b} \\ g_3 & \texttt{z} & \texttt{c} \end{array} \quad \begin{array}{l} \\ \leftarrow \textit{he}_1 \textit{ puts it}_2\textit{...} \\ \leftarrow \textit{he}_1 \textit{ puts it}_2\textit{...} \\ \leftarrow \textit{he}_1 \textit{ puts it}_2\textit{...} \end{array}$$

(10) a.
$$\begin{array}{c|ccccccccc} & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 \\ \hline f & \texttt{x} & \texttt{a} & \texttt{e}_1 & \texttt{y} & \texttt{b} & \texttt{e}_2 & \texttt{z} & \texttt{c} & \texttt{e}_3 \end{array}$$

b.
$$\begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline f_{\texttt{e}_1} & \texttt{x} & \texttt{a} & \texttt{e}_1 \end{array} \leftarrow \textit{He}_1 \textit{ puts it}_2\textit{...}$$

c.
$$\begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline f_{\texttt{e}_2} & \texttt{y} & \texttt{b} & \texttt{e}_2 \end{array} \leftarrow \textit{He}_1 \textit{ puts it}_2\textit{...}$$

d.
$$\begin{array}{c|ccc} & 1 & 2 & 3 \\ \hline f_{\texttt{e}_3} & \texttt{z} & \texttt{c} & \texttt{e}_3 \end{array} \leftarrow \textit{He}_1 \textit{ puts it}_2\textit{...}$$

(11)
$$\left\{ \langle f, g \rangle \;\middle|\; \exists \overrightarrow{j} \begin{array}{l} f = j_0, g = j_3, \\ j_0 \xrightarrow{d_1,d_2,d_3} j_1, \texttt{player}(d_1), \texttt{pawn}(d_2), \texttt{choose}(d_3,d_1,d_2) \\ j_1 \xrightarrow{d_4,d_5,d_6} j_2, \texttt{player}(d_4), \texttt{pawn}(d_5), \texttt{choose}(d_6,d_4,d_5) \\ j_2 \xrightarrow{d_7,d_8,d_9} j_3, \texttt{player}(d_7), \texttt{pawn}(d_8), \texttt{choose}(d_9,d_7,d_8) \end{array} \right\}$$

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