Event-related readings and degrees of difference[1]

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Abstract. I present an analysis of event-related readings that treats both them and object-related readings as resulting from quantification over temporal stages of individuals, with the distinction between the two arising from a difference in the degree of maximality that quantifiers require those stages to fulfil. The analysis accounts for the compositional-semantic effect of *different* in these examples, and the possibility of multiple event-related readings. I also examine the connection between this analysis and existing accounts of quantifier domain restriction.

Keywords: event-related readings, quantification, individuation, stages.

1. Introduction

Famously, (1) is ambiguous (Krifka, 1990). In addition to the expected **object-related reading**, it has an **event-related reading**, which is harder to account for.

(1) Four thousand ships passed through the lock last year.

On the object-related reading, there are four thousand ships, each of which passed through the lock last year. On the event-related reading, four thousand times last year, a ship passed through the lock. Importantly, on the event-related reading there need not even be as many as four-thousand ships in the model; it would be sufficient, for instance, for two thousand ships to have passed through the lock twice each (last year).

In this paper I will propose an account of event-related readings for sentences like (1), and also for sentences with nouns that seem to favour the event-related reading, such as *passenger* or *customer*. I will argue that both object-related and event-related readings involve quantification over temporal stages of individuals, with the difference between the two due to the degree of maximality (in a sense to be defined) that those stages must satisfy. That difference is introduced by the same contextual parameter that can be used to account for quantifier domain restriction. I will also show that my proposal accounts for situations where a sentence has more than one possible event-related reading.

The rest of the paper is structured as follows. In Section 2 I outline Krifka's (1990) own approach to the issue of event-related readings, and the arguments against it made by Barker (1999). I then set out my own proposals in Section 3: first regarding ontological assumptions in Section 3.1 and then regarding lexical and compositional semantics in Section 3.2. Those proposals are applied to examples like (1) in Section 4, where I also draw a connection to existing treatments of quantifier domain restriction. I tackle the issue of eventive nouns like *passenger*, and sentences with more than one event-related reading, in Section 5, and then conclude in Section 6.

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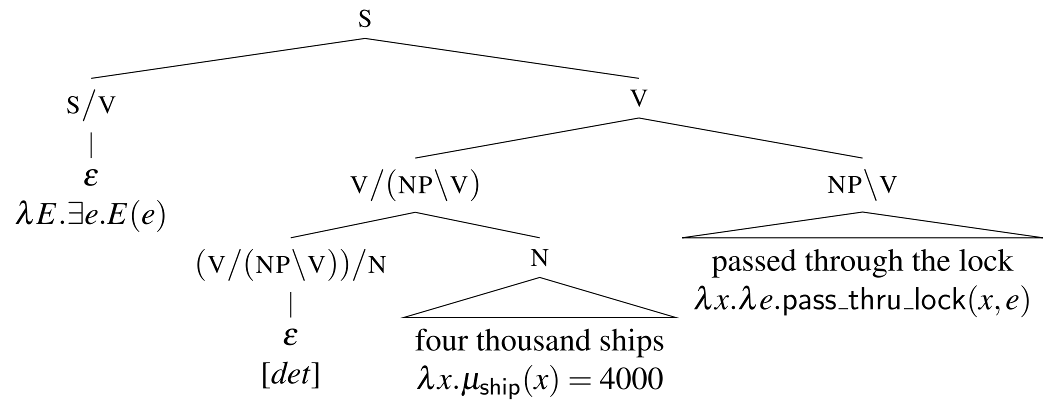
2. Background

Krifka (1990) attributes the difference between the object- and event-related readings of (1) to a difference between two possible phonologically-null determiners, either of which could fill the slot marked [*det*] in the structure shown in (2).[2]

(2)



In this semantics, $\mu_{\mathsf{ship}}(x) = n$ iff x is a (possibly singular) plurality of n ships. The object-related reading is achieved with the determiner shown in (3), and the event-related reading with the determiner shown in (4), producing the final interpretations shown.

(3) $\lambda F_{e\to t}.\lambda V.\lambda e.\exists x.F(x) \wedge V(x)(e)$
$\Rightarrow \quad \exists e.\exists z.\mathsf{pass\_thru\_lock}(z,e) \wedge \mu_{\mathsf{ship}}(z) = 4000$

(4) $\lambda F_{e\to t}.\lambda V.\lambda e.\mathsf{OEMR}(V)(e,F)$
$\Rightarrow \quad \exists e.\mathsf{OEMR}(\lambda x.\lambda e.\mathsf{pass\_thru\_lock}(x,e))(e,\lambda x.\mu_{\mathsf{ship}}(x) = 4000)$

The use of OEMR derives the event-related reading as follows: the final interpretation shown in (4) asserts that there is an event e such that

- e is an event of passing through the lock,
- e can be partitioned into sub-events $\{e_1,\ldots,e_n\} = E$ such that for every $e_i \in E$,
  - e_i is an event of passing though the lock, and
  - there are no two distinct sub-events of e_i such that they are both events of passing through the lock by the same thing, and
- $\sum_{i=1}^{n}$ the number of ships passing through the lock in $e_i = 4000$.

In effect, on this view we count $\langle$ship, lock traversal$\rangle$ pairs—a point brought out more clearly by Doetjes and Honcoop's (1997) development of Krifka's ideas.

2.1. The argument from *different*

Barker (1999) notes that only the object-related reading seems to be possible in (5).

(5) Four thousand different ships passed through the lock last year.

[2]In this categorial grammar syntax, the determiner is of category (V/(NP\V))/N.

This fact is hard to account for compositionally if the difference between object- and event-related readings comes down to a difference between determiners (as in Krifka's system), and the semantically-relevant constituency is [four thousand [different ships]] (as we would think).

Instead, Barker (1999: 688) suggests that what is going on in the event-related reading is quantification over *stages*:

> In both cases there must be 4000 ship entities present in the model—but several of those discourse entities (stages, if you prefer) may correspond to the same ship in the world of experience.

The use of quantification over stages to account for (at least some) event-related readings is defended elsewhere by Carlson (1982) and Musan (1995). However, of these authors Musan is the only one to both give an explicit compositional semantics and also apply the theory outside the area of eventive nouns like *passenger*.[3] Moreover, none of them (including Barker) gives a compositional semantics for *different* that would actually predict the disctinction between (1) and (5). In the remainder of this paper I will lay out a compositional semantics that applies both for eventive and non-eventive nouns and accounts for the semantic effect of *different*.

3. Proposal

My proposal for the semantics of event-related readings can be summarised in the following points:

- Stages, rather than 'whole' individuals, are the basic entities in the model. I make use of a substage relation $\sqsubseteq$, and individuals can be recovered as maximal stages on this relation.
- Event participation is temporally fine-grained: in general, whole individuals do not bear thematic relations to events (only specific substages thereof do).
- Both object- and event-related readings involve quantification over stages. The difference is in the degree of maximality that stages must satisfy in order to be counted.
- The word *different* introduces a maximality requirement of its own, thereby blocking the event-related reading.

I will now expand on these points.

3.1. Ontological assumptions

3.1.1. Stages

It is common to think of a stage as a time-slice of an individual (Carlson, 1982; Musan, 1995). But equivalently we can take stages to be the basic entities, and individuals as defined. Formally, we have a substage relation $\sqsubseteq$ with the properties shown in (6).

(6) Properties of $\sqsubseteq$
  a. $\sqsubseteq$ is a partial order:
    (i) $\forall x . x \sqsubseteq x$ (reflexivity)

[3] Carlson (1982) focusses on the noun *batter* in a game of baseball.

(ii) $\forall x.\forall y.\forall z.(x \sqsubseteq y \wedge y \sqsubseteq z) \to x \sqsubseteq z$ (transitivity)
(iii) $\forall x.\forall y.(x \sqsubseteq y \wedge y \sqsubseteq x) \to x = y$ (antisymmetry)

b. $\sqsubseteq$ partitions the stages (into individuals):
$\forall x.\forall y.\forall z.(x \sqsubseteq y \wedge x \sqsubseteq z) \to (y \sqsubseteq z \vee z \sqsubseteq y)$

In order to recover individuals, it is convenient to define a predicate $\mathsf{max}^{\sqsubseteq}$, as in (7). A maximal P is a P which is a proper substage of no P.

(7) $\mathsf{max}^{\sqsubseteq}(x, P) := P(x) \wedge \forall y.(P(y) \wedge x \sqsubseteq y) \to x = y$

Individuals can therefore be defined as maximal trivial property-satisfiers, as in (8).

(8) $\mathsf{ind}(x) := \mathsf{max}^{\sqsubseteq}(x, \lambda y.\top)$

3.1.2. Event participation

As mentioned above, I assume a fine-grained theory of event participation. Intuitively, I want to say that it is only the temporal stage of an individual that is relevant to the event in question that participates in that event. For the purposes of this paper it will suffice to say that for any semantic theta role θ, stage x and event e, if $\theta(x, e)$ holds then x must be temporally coterminous with e.[4] So for example, the interpretation of the sentence *John smiled* would be roughly as shown in (9) (given that $\mathsf{ind}(\mathsf{john})$ holds).

(9) $\exists e.\mathsf{past}(e) \wedge \exists x.x \sqsubseteq \mathsf{john} \wedge \mathsf{smile}(e) \wedge \mathsf{agent}(x, e)$

I make no assumptions about event participation being cumulative, and in fact try to avoid plural events or anything of the like.

3.2. Compositional semantics

I assume a neo-Davidsonian compositional semantic system. Notwithstanding the previous point about semantic theta roles, *grammatical* theta roles do at least potentially apply to individuals, in that they introduce substage predication. For example, the AGENT grammatical theta role has the semantics shown in (10).

(10) $\Theta_{agent} := \lambda y.\lambda e.\exists x.x \sqsubseteq y \wedge \mathsf{agent}(x, e)$

For the sake of concreteness, I will assume existential event closure at clause level, and that higher-type verbal arguments QR over it. The basic clausal structure is therefore as shown in Figure 1.

3.2.1. Common nouns

Common nouns denote sets of stages. For some such nouns, such as *ship*, its seems reasonable to assume that their denotations have the properties of **divisiveness** as defined in (11), and **persistence** as defined in (12).

[4] A reviewer points out that this will not work in general, for example in sentences like (i).

(i) John wrote a letter to himself.

In this case it seems that the John-stage which is the goal of the letter-writing event is not temporally coterminous with that event, but rather in the future relative to it.

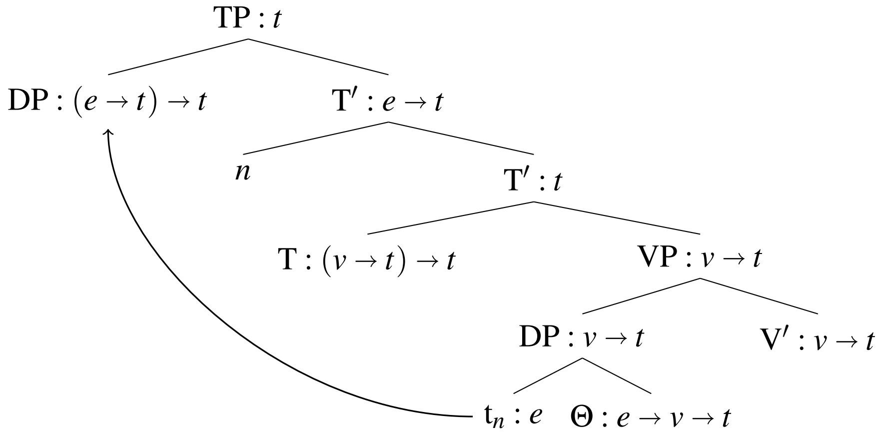


Figure 1: Basic clausal structure

(11) $\mathsf{divisive}(P) := \forall x.\forall y.(P(x) \wedge y \sqsubseteq x) \rightarrow P(y)$

(12) $\mathsf{persistent}(P) := \forall x.\forall y.(P(x) \wedge x \sqsubseteq y) \rightarrow P(y)$

In other words, if something is a ship then every substage and superstage of it is a ship. Of course, not all nouns have both or either of these properties. In particular, I do not make either of these assumptions with an eventive noun such as *passenger*, to be discussed in Section 5. In general, it seems to be more common for a common noun interpretation to be divisive than persistent.

3.2.2. Plurals

I will adopt a set-theoretic treatment of plural nominals, such that that plural morpheme has the interpretation $\wp^+$ defined in (13).

(13) $\wp^+ := \lambda Q_{e\rightarrow t}.\lambda P_{e\rightarrow t}.\exists x[P(x)] \wedge \forall x.P(x) \rightarrow Q(x)$

I will adopt Winter's (2001) atom/set predicate distinction, according to which all the verbal predicates we will look at will be 'atom predicates' and hence take arguments of type e (rather than $e \rightarrow t$). The verb can be raised to take a plural argument with a standard distributivity operator $\wp$, defined in (14).

(14) $\wp := \lambda Q_{e\rightarrow t}.\lambda P_{e\rightarrow t}.\forall x.P(x) \rightarrow Q(x)$

In keeping with the set-theoretic treatment of plurals, plural determiners are of type $((e \rightarrow t) \rightarrow t) \rightarrow ((e \rightarrow t) \rightarrow t) \rightarrow t$. An example is shown in (15), where $\bigcup := \lambda \mathscr{P}_{(e\rightarrow t)\rightarrow t}.\lambda y_e.\exists X_{e\rightarrow t}.\mathscr{P}(X) \wedge X(y)$.

(15) *four thousand* $\rightsquigarrow_C \lambda \mathscr{P}.\lambda \mathscr{Q}.\exists X.\forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\bigcup(\mathscr{P})(y) \wedge C(y))]$
$$\wedge |X| = 4000 \wedge \mathscr{Q}(X)$$

I note in passing the equivalences shown in (16).

(16) $\bigcup(\wp^+(P)) \equiv \bigcup(\wp(P)) \equiv P$

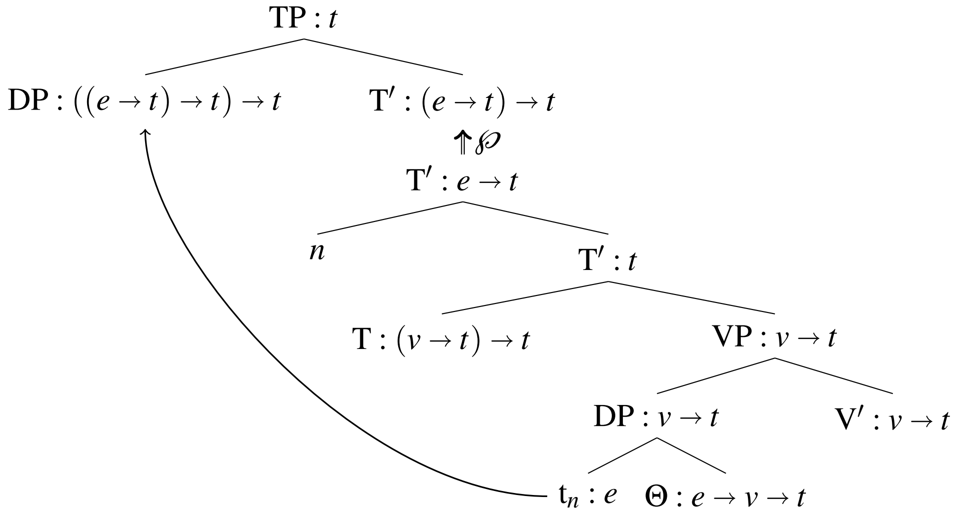


Figure 2: Basic clausal structure for a plural interpreted distributively

In (15), C is a contextual parameter which will be crucial in the analysis of event-related readings. There is an obvious parallel with the use of a contextual parameter to account of quantifier domain restriction, and this connection will be made more explicit in Section 4.2.

The basic clausal structure for a plural interpreted distributively is therefore as shown in Figure 2.[5]

4. The proposal in action

Krifka's example (1) is interpreted as shown in Figure 3, which of course is a special case of the generic structure shown in Figure 2.

As mentioned above, the distinction between object- and event-related readings comes down to the contextual choice of C. If C is the trivial property $\lambda x.\top$, which we can take to be a default, then the interpretation derived reduces to that shown in (17).

(17) $$\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \mathsf{ship})] \wedge |X| = 4000$$
$$\wedge \forall x.X(x) \to \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{last\_year}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z,e)$$

In (17) we count maximal ship stages, which means we have the object-related reading: given our assumptions about ships, in particular (12), counting maximal ship stages is equivalent to counting ship individuals. Note that (17) says that every maximal ship stage (i.e. ship) counted *has a substage* which is the theme of an event of passing through the lock. The fine-grainedness of event participation is thereby expressed.

To get the event-related reading, we let C be $\lambda x.\exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(x,e)$,[6] which—it

[5] With an atom predicate. In the case of set predicates, Θ would be of type $(e \to t) \to v \to t$. Where a set predicate is to be interpreted distributively, this would be achieved by composing $\wp$ with a singularization operator $\mathbb{S}$ defined in (i).

(i) $\mathbb{S} := \lambda \mathscr{P}_{(e\to t)\to t}.\lambda z_e.\mathscr{P}(\lambda y_e.y = z)$

[6] In this case it will not make a difference whether or not C also includes the conjunct $\mathsf{last\_year}(e)$, but in Section

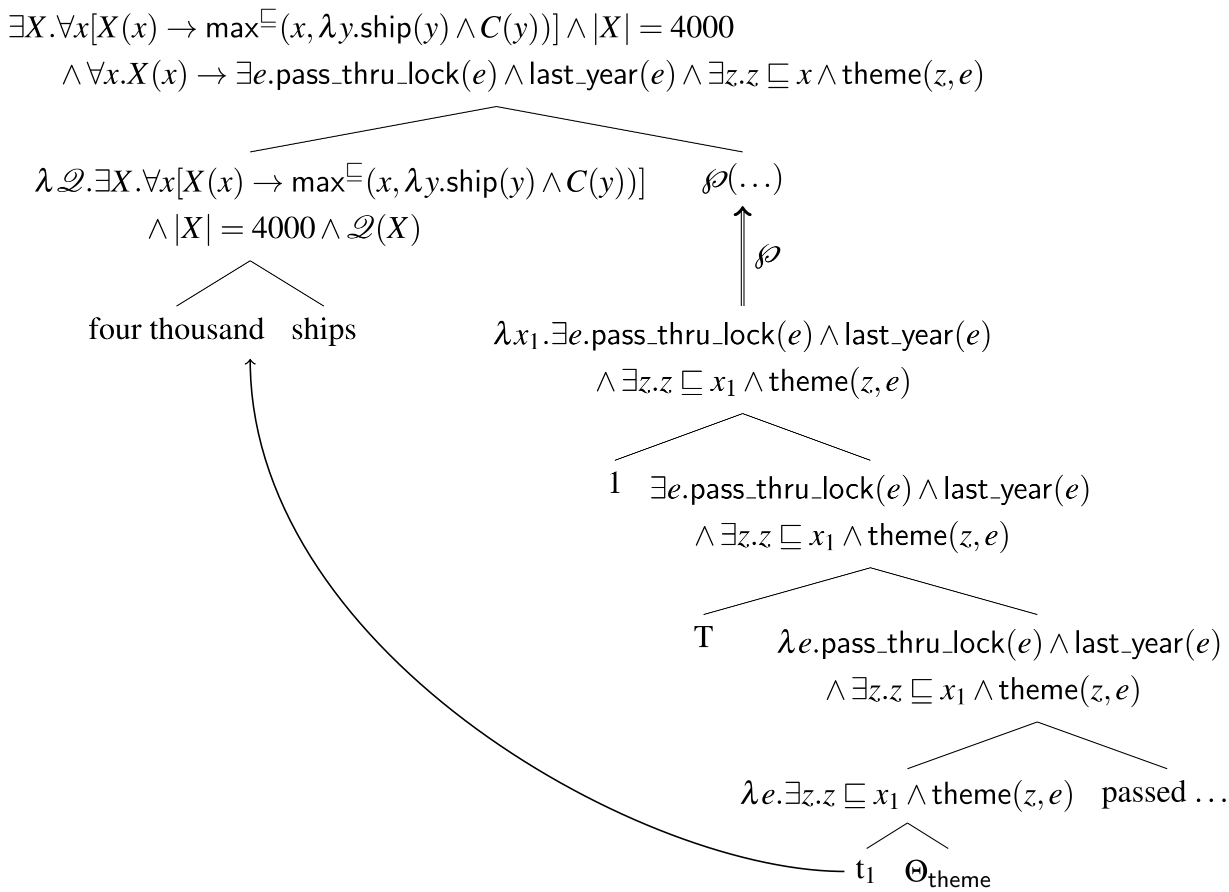


Figure 3: Interpretation of (1)

seems reasonable to assume—we can take to be a contextually salient property. Then we get the interpretation shown in (18).

(18) $\exists X.\forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(y,e))] \wedge |X| = 4000$
$\wedge \forall x.X(x) \rightarrow \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{last\_year}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z,e)\big)$

In (18) we count maximal ship-stages-that-are-themes-of-passing-events. Given our assumptions about the fine-grainedness of event participation—namely, that any theme of a passing event has to be temporally coterminous with that event—this is equivalent to counting passing events by ships. So, we have the event-related reading.

4.1. Different ships

The adjective *different* is a stage maximizer, with the interpretation shown in (19) and, therefore, the semantic effect on a plural noun shown in (20).

(19) *different* $\rightsquigarrow \lambda \mathscr{P}.\wp^{+}(\lambda z.\mathsf{max}^{\sqsubseteq}(z, \bigcup(\mathscr{P})))$

(20) *ships* $\rightsquigarrow \wp^{+}(\mathsf{ship})$
different ships $\rightsquigarrow \wp^{+}(\lambda z.\mathsf{max}^{\sqsubseteq}(z, \bigcup(\wp^{+}(\mathsf{ship}))))$
$\Rightarrow \wp^{+}(\lambda z.\mathsf{max}^{\sqsubseteq}(z, \mathsf{ship}))$ (from (16))

Therefore, *different* takes us from consideration of ship stages to consideration of *maximal* ship stages, i.e. ship individuals. This means that (5) has the interpretation shown in (21).

(21) $\exists X.\forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{max}^{\sqsubseteq}(y, \mathsf{ship}) \wedge C(y))] \wedge |X| = 4000$
$\wedge \forall x.X(x) \rightarrow \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z,e)\big)$

In (21), unlike in Figure 3, the property C is not intersected with the set of ship stages. Rather, as mentioned above, it is now intersected with the set of ship individuals. There is, therefore, no choice of C that could get an event-related reading. In particular, if C were to be the property chosen to derive an event-related reading in (18), namely $\lambda x.\exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(x,e)$, the resulting intersection would yield the empty set (which we can take to be ruled out by a pragmatic principle), since—according to our assumptions about the fine-grainedness of event participation—no ship individual is the theme of an event of passing through the lock. We therefore have an account of the ambiguity of (1) and the non-ambiguity of (5) due to the lexical semantics of *different*.

4.2. Quantifier domain restriction

As mentioned above, the contextual parameter C in the lexical entry for the determiner *four thousand* is similar to a device often used to account for contextual domain restriction (von Fintel, 1994). In fact, it can be used for just that purpose here as well, with interesting results. For example, Krifka (1990) draws attention to (22), which is problematic for some theories of event-related readings.

(22) Most ships passed through the lock at night.

4.2 we will see an example that indicates that this kind of modifier contribution should not be included.

The sentence (22) has three salient readings:

1. Most ships are like this: they passed through the lock at night.
2. Most ships *that passed through the lock* are like this: they passed through the lock at night.
3. Most lock traversals by ships occurred at night.

Reading 3 is an event-related reading. It is problematic for theories like that of Doetjes and Honcoop (1997) who rely on the determiner in an event-related reading being symmetric.[7] Readings 1 and 2 are both object-related, the difference being that reading 2 incorporates contextual domain restriction.

In order to account for (22), we need to take a more general view on determiners than has been afforded so far by focussing on *four thousand*, which is in some ways a special case. In (23) an operator DETOP is defined, which takes a conventional determiner meaning D of type $(e \to t) \to (e \to t) \to t$ and returns an appropriate plural determiner meaning for this system.[8]

(23) $$\mathrm{DETOP}_C(D) := \lambda \mathscr{P}.\lambda \mathscr{Q}.D\Big(\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\bigcup(\mathscr{P})(y) \wedge C(y))\Big) \Big(\bigcup\big(\lambda P.\wp\big(\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\bigcup(\mathscr{P})(y) \wedge C(y))\big)(P) \wedge \mathscr{Q}(P)\big)\Big)$$

The word *most* therefore has the interpretation shown in (24).

(24) $$\textit{most} \rightsquigarrow_C \lambda \mathscr{P}.\lambda \mathscr{Q}.\,\big(2 \times \big|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\bigcup(\mathscr{P})(y) \wedge C(y))\big|\big) > \Big|\bigcup\big(\lambda P.\wp\big(\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\bigcup(\mathscr{P})(y) \wedge C(y))\big)(P) \wedge \mathscr{Q}(P)\big)\Big|$$

Therefore, (22) is interpreted as shown in (25).

(25) $$\big(2 \times \big|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge C(y))\big|\big) > \left|\begin{array}{l}\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge C(y)) \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \\ \qquad \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z, e) \wedge \mathsf{at\_night}(e)\end{array}\right|$$

As before, the basic object-related reading (reading 1) is derived by letting C be the trivial property $\lambda x.\top$, and the event-related reading (reading 3) is achieved by letting it be $\lambda y.\exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(y, e)$. Reading 2 is achieved by letting C be the related property $\lambda y.\exists z.z \sqsubseteq y \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(z, e)$—i.e., instead of the property of *being the theme of a passing event*, the property of *having a substage that is the theme of a passing event*. The three readings are shown in Figure 4.

We therefore have a system for accounting for event-related readings that coheres with existing approaches to quantifier domain restriction. The same contextual parameter C can be used either for domain restriction or to generate an event-related reading, and in (22) we see examples of both.[9]

[7] Barker (1999) seems to imply this too

[8] DETOP is inspired by Winter's (2001) *dfit*. I am not, though, committing to such an operator being linguistically present; rather, I am simply treating it as an heuristic for discovering appropriate determiner meanings.

[9] Work on quantifier domain restriction also seeks to explain data like (i), which imply that the contextually-given set restricting quantification can be parameterized.

Reading 1:

$$\left(2 \times \left|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \mathsf{ship})\right|\right) >$$
$$\left|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \mathsf{ship}) \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z, e) \wedge \mathsf{at\_night}(e)\right|$$

Reading 2:

$$\left(2 \times \left|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge \exists z.z \sqsubseteq y \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(z, e))\right|\right) >$$
$$\left|\begin{array}{l}\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge \exists z.z \sqsubseteq y \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(z, e)) \\ \quad \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z, e) \wedge \mathsf{at\_night}(e)\end{array}\right|$$

Reading 3:

$$\left(2 \times \left|\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(y, e))\right|\right) >$$
$$\left|\begin{array}{l}\lambda x.\mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{ship}(y) \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \mathsf{theme}(y, e)) \\ \quad \wedge \exists e.\mathsf{pass\_thru\_lock}(e) \wedge \exists z.z \sqsubseteq x \wedge \mathsf{theme}(z, e) \wedge \mathsf{at\_night}(e)\end{array}\right|$$

Figure 4: Readings of (22)

5. Eventive nouns and event-related readings

As I have alluded to, certain nouns have a tendency, at least, towards event-related readings. For example, (26) is most naturally interpreted as a question about the number of fulfilled bookings on Ryanair flights last year, rather than the number of people who at any point last year took a Ryanair flight.

(26) How many passengers flew Ryanair last year?

For authors such as Gupta (1980), Luo (2012) and Carlson (1982), this tendency is in fact a law: it is a lexical fact about (at least some) such nouns that they have to be interpreted with an event-related reading in sentences such as (26) and (27).[10]

(27) 146 million passengers flew Ryanair last year.

Barker (2010) demurs, arguing that sentences like (26) and (27) can also have an object-related reading, and I agree. Modification of (26) with *different* does seem to be coherent, as in (28), and to at least possibly mean the same thing as (29).

(28) How many different passengers flew Ryanair last year?

(29) How many different people flew Ryanair last year?

(i) Only one class was so bad that not one student passed the exam. (Heim, 1991: 508)

On the most natural interpretation of (i), the contextual restriction of *not one student* varies by class: (i) means something like 'only one class was like this: it was so bad that not one student *in it* passed the exam'. I have not been able to find similar data with event-related readings; this is a topic for future research.

[10]Which, as of November 2020, is the answer you get if you ask Google the question in (26). Within a few months the answer will be rather different, I imagine.

Nevertheless, as I said event-related readings do generally seem to be favoured when eventive nouns like these are used, and it would be nice to account for this tendency. Moreover, eventive nouns potentially give rise to further ambiguities, as exemplified in (30).[11]

(30) 50 million passengers were served a hot meal by Ryanair last year.

In addition to an object-related reading, (30) actually allows for two event-related readings: on the first we count people-on-flights, and on the second we count servings-of-meals-to-people-on-flights. So if I flew Ryanair twice, and on each journey was served two hot meals, then that would be one passenger in one sense (me), two passengers in another sense (me on flight 1 and me on flight 2), and four passengers in another sense (meal servings 1–4). If *passengers* is modified with *different* as in (31), then only the last of these interpretations is excluded. We therefore have the three readings shown in (32), labelled R1–3 for future reference.

(31) 50 million different passengers were served a hot meal by Ryanair last year.

(32)

	Counted	(30)	(31)
R1	People	✓	✓
R2	People on flights	✓	✓
R3	Meal servings to people on flights	✓	×

5.1. Analysis

As mentioned above, I do not assume that eventive nouns like *passenger* are divisive or persistent. Rather, in keeping with the perspective of fine-grained event participation, I treat eventive nouns as denoting sets of event participants, as in e.g. (33).

(33) *passenger* $\rightsquigarrow \lambda x.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(x,e)$

Nevertheless, for reasons to be discussed below I will assume that there is an optional silent nominal modifier ζ, defined in (34), which produces a divisive and persistent output.

(34) $\zeta := \lambda P.\lambda y.\exists x.(x \sqsubseteq y \vee y \sqsubseteq x) \wedge P(x)$

Obviously, ζ would not make a difference when applied to a nominal denotation that is already divisive and persistent, such as that of *ship*.[12] Given ζ, there are two possible interpretations

[11]This is an adaptation of Barker's (2010) example of the Easyjet employee 'faced with a stack of receipts for drinks that have been bought on two recent Easyjet flights' and asked *How many different passengers do these receipts correspond to?*

[12]Although it would make a difference when applied to a denotation that is divisive but not persistent, such as (plausibly) that of *student*. In further work I would like to apply ζ in order to adopt Musan's (1995) account of the distinction between temporally-dependent and temporally-independent noun phrase interpretations, for example in (i).

(i) Many students were ill last year.

- *Temporally-dependent*:

  Last year, many people who were students at the time were ill.

- *Temporally-independent*:

  There are many people who are students now who were ill last year.

for the DP *50 million passengers*, shown in (35) and (36) respectively.

(35) $\lambda\mathscr{Q}.\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(y,e) \wedge C(y))]$
$|X| = 5 \times 10^7 \wedge \mathscr{Q}(X)$

50 million $\quad \wp^{+}(\lambda x.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(x,e))$

passenger -s

(36) $\lambda\mathscr{Q}.\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists z.(z \sqsubseteq y \vee y \sqsubseteq z) \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(z,e) \wedge C(y))]$
$\wedge |X| = 5 \times 10^7 \wedge \mathscr{Q}(X)$

50 million $\quad \wp^{+}\big(\lambda y.\exists x.(x \sqsubseteq y \vee y \sqsubseteq x)$
$\wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(x,e)\big)$

$\lambda y.\exists x.(x \sqsubseteq y \vee y \sqsubseteq x) \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(x,e)$ -s

$\Uparrow \zeta$

passenger

If we look at the crucial clause in (35),

$$\ldots \forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(y,e) \wedge C(y))] \ldots$$

we can see that in the absence of ζ, there is no possible value for C that would result in any reading other than one in which we count people-on-flights (R2), due to the fine-grainedness of event participation and the fact that C is being intersected with a set of event participants.[13]

However, things are different in the presence of ζ. If we look at the crucial clause in (36),

$$\ldots \forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists z.(z \sqsubseteq y \vee y \sqsubseteq z) \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(z,e) \wedge C(y))] \ldots$$

we see that the choice of C can make a difference. In particular:

- We get R1 if we let C be the trivial property $\lambda x.\top$ since we end up counting people: maximal superstages of travel event participants.
- We get R2 (again) if we let C be the nominal property $\lambda y.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(y,e)$, since then we count maximal superstages of travel event participants which are themselves travel event participants (i.e. people-on-flights).
- We get R3 if we let C be the verbal property $\lambda y.\exists e.\mathsf{service}(e) \wedge \mathsf{recipient}(y,e)$, since then we count meal servings: maximal substages of travel event participants which are serving event participants.

[13]In the rest of the discussion I abstract away from the possibility of deriving contextual domain restriction with values of C involving substage predication, as in reading 2 of (22). Such restrictions are certainly possible, but consideration of them here would distract from the point at issue.

Now let us think about (31), with and without ζ as shown in (37) and (38) respectively.

(37) $\lambda\mathscr{Q}.\exists X.\forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{max}^{\sqsubseteq}(y, \lambda z.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(z,e)) \wedge C(y))]$
$|X| = 5 \times 10^7 \wedge \mathscr{Q}(X)$

50 million $\quad \wp^{+}(\lambda z.\mathsf{max}^{\sqsubseteq}(z, \lambda y.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(y,e)))$

different $\quad$ passengers

(38) $\lambda\mathscr{Q}.\exists X.\forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{max}^{\sqsubseteq}(y, \lambda z.\exists v.(v \sqsubseteq z \vee z \sqsubseteq v) \wedge$
$\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(v,e)) \wedge C(y))]$
$|X| = 5 \times 10^7 \wedge \mathscr{Q}(X)$

50 million $\quad \wp^{+}(\lambda z.\mathsf{max}^{\sqsubseteq}(z, \lambda y.\exists x.(x \sqsubseteq y \vee y \sqsubseteq x) \wedge \exists e.\mathsf{travel}(e)$
$\wedge\, \mathsf{theme}(x,e)))$

different $\quad \zeta$ passenger -s

Without ζ, as in (37), R2 is still the only available interpretation: *different* makes no difference as it maximalizes something that is already maximal. However, with ζ, as in (38), *different* does make a difference. Let us look at the crucial clause:

$$\ldots \forall x[X(x) \rightarrow \mathsf{max}^{\sqsubseteq}(x, \lambda y.\mathsf{max}^{\sqsubseteq}(y, \lambda z.\exists v.(v \sqsubseteq z \vee z \sqsubseteq v) \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(v,e)) \wedge C(y))] \ldots$$

C is now intersected with the set of *maximal* superstages of participants in travelling events, i.e. people. There is no sensible value for C that could deliver a reading other than R1.[14]

In summary: the readings from (32) that this theory predicts are as shown in (39).

(39)

	without *different*, i.e. (30)	with *different*, i.e. (31)
without ζ	R2: see (35)	R2: see (37)
with ζ	any of R1–3, depending on C: see (36)	R1: see (38)

So, as desired, R1–3 are possible readings of (30) and R1 and R2 (but not R3) are possible readings of (31). The tendency towards R2 as the interpretation of (30) can be explained in two ways: R2 is the only interpretation available without ζ, and is available with or without ζ.

For reference, formal representations of R1–R3 are given in Figure 5.

6. Conclusion

By taking stages as the basic entities in the model, with individuals defined and quantification sensitive to maximality, we can go quite far in the analysis of event related readings. This analysis provides a natural explanation for why an event-related reading is favoured with eventive

[14] Again, abstracting away from the possibility of contextual domain restriction.

R1:

$$\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists z.z \sqsubseteq y \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(z,e))]$$
$$\wedge |X| = 5 \times 10^7 \wedge \forall x.X(x) \to \exists e.\exists y.y \sqsubseteq x \wedge \mathsf{serve\_hot\_meal}(e) \wedge \mathsf{theme}(y,e)$$

R2:

$$\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(y,e))]$$
$$\wedge |X| = 5 \times 10^7 \wedge \forall x.X(x) \to \exists e.\exists y.y \sqsubseteq x \wedge \mathsf{serve\_hot\_meal}(e) \wedge \mathsf{theme}(y,e)$$

R3:

$$\exists X.\forall x[X(x) \to \mathsf{max}^{\sqsubseteq}(x, \lambda y.\exists z.y \sqsubseteq z \wedge \exists e.\mathsf{travel}(e) \wedge \mathsf{theme}(z,e)$$
$$\wedge \exists e'.\mathsf{serve\_hot\_meal}(e') \wedge \mathsf{theme}(y,e))]$$
$$\wedge |X| = 5 \times 10^7 \wedge \forall x.X(x) \to \exists e.\exists y.y \sqsubseteq x \wedge \mathsf{serve\_hot\_meal}(e) \wedge \mathsf{theme}(y,e')$$

Figure 5: Readings listed in (32)

nouns like *passenger*, but object-related readings are favoured otherwise. In addition, the analysis provides to my knowledge the first compositional explanation of how the word *different* excludes certain event-related readings which are otherwise available. The analysis also seems to cohere well with existing accounts of quantifier domain restriction.

The major limitation of this analysis is that, so far, it has nothing to say about event-related readings with mass nouns, as in e.g. (40).

(40) Two thousand gallons of blood pass through your heart every day. (American Heart Association, 2018)

In future work I plan to extend the analysis to address examples like (40). In addition, I plan to explore the extent of the connection between event-related readings and quantifier domain restriction, and see if it can be connected to an account of temporally-dependent vs. temporally-independent noun phrases.

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