

Event containers

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Aidan Katson (akatson@ucsc.edu)
University of California, Santa Cruz

1 Introduction

Containers and *measures* are regularly used to quantize substances in the nominal domain (Chierchia 1998, Schwarzschild 2006, Rothstein 2009, Partee & Borschev 2012, Scontras 2014):

Containers:

- | | | |
|-----|----------------------------------|--------------------------------|
| (1) | a. two bags of apples | b. four bowls of flour |
| | c. three packages of rope | d. six bottles of water |

Measures:

- | | | |
|-----|--------------------------------|--------------------------------|
| (2) | a. two kilos of apples | b. four pounds of flour |
| | c. three meters of rope | d. six inches of water |

For the most part, containers define the substance with respect to some concrete object(s), with which it is “filled”, while measures quantize substances according to some physical dimension (weight, length, depth, etc.)

Notice that many nouns are **ambiguous** between a container and a measure use, like *cup*, though these uses can be disambiguated:

- | | | |
|-----|---|----------------------|
| (3) | a. There are two cups of wine on this tray. They are blue. | <i>container use</i> |
| | b. There's two cups of wine in this soup. It is too much. | <i>measure use</i> |

In this talk, I will explore the construction below, in which a temporal noun quantizes events with respect to **time** (similar examples are found in Grimm & McNally (2015:88) and Schwarzschild (2006:74)):

- | | |
|-----|---|
| (4) | a. [Twenty years of destruction] left the country in ruin. |
| | b. [Forty hours of Bill running] caused him to sprain his ankle. |
| | c. [Five minutes of Maggie playing the piano] went by quickly. |

Intuitively, the temporal nouns in (4) seem to *measure* events with respect to some unit of time supplied by the temporal noun (as argued in passing by e.g., Schwarzschild 2006).

However, I will argue that in addition to this intuitive measure use, these temporal nouns are just as polysemous as some traditional, concrete quantizing terms

→ That is, there is **an additional, overlooked container use** for the temporal nouns in (4)

I will provide an analysis of these container uses of temporal nouns, in which:

- (i) the temporal noun denotes time intervals of a particular calendric width (Kamp & Schiehlen 2002),
- (ii) these time intervals can be arranged into pluralities (see Link 1983), and
- (iii) each interval which is a member of the plurality is “filled” with events according to a contextually specified partition (Deo 2009, Deo & Piñango 2011)

In their container use, **temporal nouns** as in (4) **denote** pluralities of event-containing **temporal intervals**, not events measured according to some temporal yardstick (this would be the measure use of temporal nouns)

- This analysis captures several **empirical** parallels between container uses of concrete (*cup*) and temporal (*hour*) quantizers
- It draws an additional analytical parallel between the domains of individuals and events, beyond the well known ones (Link 1983, Bach 1986): events and individuals can be quantized by measures *and* containers
- It suggests that the domain of times includes pluralities, just like the domain of individuals, despite the basic differences between the atoms (intervals v. individuals) which make up these pluralities

2 Distinguishing container uses from measure uses

Many traditional, concrete quantizing terms are polysemous between container and measure uses (e.g., *cup*)¹

- So, diagnostics have been put forward in previous work (Scontras 2014, Chierchia 1998, Rothstein 2009, a.o.) which can distinguish between containers, measures, and other uses of quantizers
- I show that these diagnostics also disambiguate a container use from a measure use of temporal nouns

2.1 Container diagnostics

Containers, but not measures...

1. Can appear with quantifiers that operate over individuals

Quantifiers like *every*, *most*, and *no* are felicitous with containers but unacceptable with measures

(5) Containers

- a. I bought every/most/no bag(s) of rice from that store.
- b. Most bottles of wine in this cellar are polluted. (Chierchia 1998:73)

(6) Measures

- a. ??I bought every/most/no pound of rice from that store.
- b. ??Most liters of wine in this tank are polluted. (Chierchia 1998:73)

¹ This polysemy is in general related to the degree/individual polysemy that presumably all nouns display, discussed by Rett (2014).

→ Container uses of temporal nouns behave as concrete containers do, permitting such quantifiers:

- (7) a. **Every/No hour** of Bill running goes by without injury.
- b. **Most hours** of Bill running go by without injury.

Since measures are incompatible with these quantifiers (perhaps unless heavily coerced), the appearance of *every*, *most*, *no*, etc. disambiguate a polysemous temporal noun towards its container interpretation

2. Allow adjectival modification

Containers permit adjectival modification, while measures don't (Chierchia 1998:73)

- (8) a. I bought two **beautiful** boxes of pizza.
- b. #I bought two **beautiful** pounds of pizza.

→ Container uses of temporal nouns allow adjectival modification, like concrete containers

- (9) Five **beautiful** minutes of Maggie playing the piano were shown to the judges.

3. Pattern as plurals, anteceding plural pronouns and triggering plural verb agreement:

Containers (10a) may antecede a plural pronoun like *they*, while measures (10b) cannot

- (10) *Container*
 - a. There are [two cups of wine]₁ on this tray. **They**₁ are blue.
- Measure*
 - b. There's [two cups of wine]₁ in this soup. #**They**₁ are blue. (Rothstein 2009)

Measures but not containers can antecede a singular pronoun *it*:

- (11) *Container*
 - a. There are [two cups of wine]₁ on this tray. #**It**₁ is red.
- Measure*
 - b. There's [two cups of wine]₁ in this soup. **It**₁ might be too much.

→ Temporal nouns behave similarly, where under their container use, they can antecede a plural pronoun *they*:

- (12) Maggie has to complete [twenty hours of training]₁. **They**₁ don't need to be consecutive.

The measure use of a temporal noun is diagnosable by singular pronoun antecedence:

- (13) Maggie has to complete [twenty hours of training]₁. **It**₁ will be very difficult.

This pattern extends to agreement as well. Containers trigger plural agreement, while measures trigger singular:

- (14) *Container* (plural agreement)

- a. [Five minutes of Maggie playing the piano] **are** to be shown to the judges.
b. [Forty hours of Bill running] **were** recommended by the out-of-touch trainer.

- (15) *Measure* (singular agreement)

- a. [Five minutes of Maggie playing the piano] **was** enough to convince the judges.
b. [Forty hours of Bill running] **is** too much exercise for a novice.

4. Describe things relating to the sort of the quantizing noun, rather than the substance

Containers describe the container itself, while measures describe the substance being measured:

- (16) a. There are two glasses of wine on this tray. *(naturally refers to glasses, not wine)*
b. There's two cups of wine in this soup. *(naturally refers to wine, not glasses)*

Likewise, the container use of **temporal nouns describe times, not events**:

Temporal nouns under their container use can appear with predicates which only select for times (*elapse, went by*):

- (17) a. Five minutes went by/elapsed.
b. *Maggie playing the piano went by/elapsed.

- (18) Five minutes of Maggie playing the piano went by/elapsed.

→ In (19), the plural pronoun *them* forces a container reading. *Them* cannot appear as the complement to a verb of direct perception, but *it*, which allows a measure interpretation, can

→ The (c) examples show that a container use (and, therefore, a plural pronoun) is licit when there is no verb of direct perception

- (19) a. Maggie completed [twenty hours of training]₁.
b. I saw #**them**₁/**it**₁.
c. I approved **them**₁.

Before I advance an analysis of these container uses, I will provide some background on the semantics of traditional concrete containers

2.2 A brief overview of concrete containers

For concrete container constructions, the main class of approaches to capturing the four properties above is with a semantics in which they denote predicates of individuals (Landman 2004, Rothstein 2009, Scontras 2014).

→ These accounts differ, however, in the semantics of the concrete container noun itself, and whether it is relational (Landman 2004, Rothstein 2009) or not (Scontras 2014) (a decision which has cascading effects, e.g., on the semantic (non)vacuity of *of*).

One option is a non-relational, common noun-style denotation for the container term:

$$(20) \llbracket \text{glass} \rrbracket = \lambda x . \text{glass}'(x)$$

- with an operator, like Rothstein's (2009) Construct-State Shift operator, which shifts a *common noun* to a (relational) *container use*²

$$(21) \llbracket \text{CS-SHIFT}(\lambda x . N(x)) \rrbracket = \lambda P_{et} \lambda x . \exists y [N(x) \wedge P(y) \wedge \text{contain}(y)(x)]$$

- *glasses of wine* denotes a set of individuals which are glasses that contain wine

$$(22) \llbracket \llbracket \text{CS-SHIFT}(\lambda x . \text{glass}'(x)) \rrbracket \text{ of wine} \rrbracket = \lambda x . \exists y [\text{glass}'(x) \wedge \text{wine}'(y) \wedge \text{contain}(y)(x)]$$

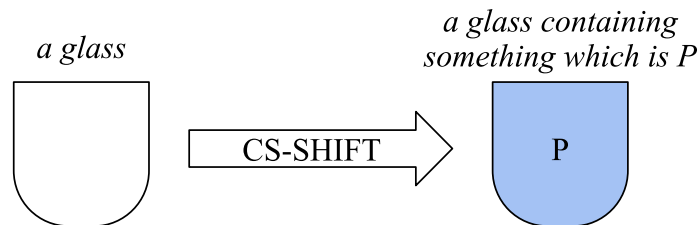


Figure 1: CS-SHIFT as a label maker

- To introduce the numeral, some additional material is needed, such as a functional head containing CARD (cardinality), a counting operator (Zabbal 2005)

$$(23) \llbracket \text{CARD} \rrbracket = \lambda P_{et} \lambda n \lambda x . P(x) \wedge \mu(x) = n$$

² The semantics introduced by this operator could very well live on the particle *of*, as well. For concreteness, I will call this an operator, and leave *of* semantically vacuous.

- *three glasses of wine* denotes a set of pluralities which are three in cardinality (they have three atoms), and each atom is a glass which contains wine

$$(24) \llbracket \text{three CARD} \llbracket [\text{CS-SHIFT}(\lambda x.\text{glass}'(x))] \text{ of wine} \rrbracket \rrbracket = \lambda x. \exists y[\text{glass}'(x) \wedge \text{wine}'(y) \wedge \text{contain}(y)(x)] \wedge \mu(x) = 3$$

I'll adapt this proposal to capture the empirical parallels between container uses of concrete and temporal quantizers

3 Proposal

I propose the following in my analysis of the container use of temporal nouns (reproduced from above)

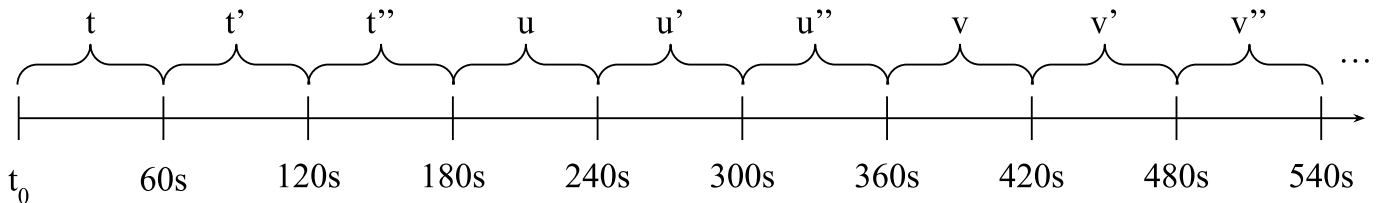
- (i) the temporal noun denotes time intervals of a particular calendric width (Kamp & Schiehlen 2002),
- (ii) these time intervals can be arranged into pluralities (see Link 1983), and
- (iii) each interval which is a member of the plurality is “filled” with events according to a contextually specified partition (Deo 2009, Deo & Piñango 2011)

3.1 The semantics of temporal nouns

I will start with (i), a semantics for temporal nouns (*minute, hour*):

→ Kamp & Schiehlen (2002) take temporal nouns to denote the elements in a partition (π) of a dense timeline into equal-length, abutting intervals:

Figure 2: $\pi_{\min} = \{t, t', t'', u, u', u'', v, v', v'', \dots\}$



(25) π_c is a set of time intervals, such that for all t and t' in π_c :

- (i) t and t' are of “**equal duration**,” $t \equiv t'$
- (ii) there are t'' and t''' in π_c which **abut** t , $\exists t'' \exists t''' [t'', t''' \in \pi_c \wedge t'' \supset t \wedge t \supset t''']$
- (iii) t and t' **do not overlap** $t \neq t' \rightarrow t < t' \vee t' < t$
- (iv) there is a start time t_0 that is **the initial boundary** of exactly one t'' in π_c $\exists! t'' [t'' \in \pi_c \wedge \neg \exists t''' [t_0 < t''' < t'']]$
(Toosarvandani, f.c.)

Minute simply denotes the set of intervals which are members of π_{\min} :

$$(26) \llbracket \text{minute} \rrbracket = \lambda t . t \in \pi_{\min}$$

I'll make the simplifying assumption that deverbal nominalizations and gerunds are simply predicates of events. Implicit arguments (agents) could be added, among many other things, but I omit them for readability:

$$(27) \llbracket \text{training} \rrbracket = \lambda e . \text{train}'(e)$$

In an example like:

$$(28) \text{ ten minutes of training}$$

there must be some relation between the predicate of times supplied by *minute* and the predicate of events supplied by *training*

→ Intuitively, this is something like that the event is “contained” within the *minute*

→ In the concrete domain, the contain relation was introduced by the CS-SHIFT operator (Rothstein 2009). We can imagine an analog of the CS-SHIFT operator in the temporal domain:

$$(29) \llbracket \text{OP} \rrbracket = \lambda T_{it} \lambda P_{et} \lambda t_i . \exists e [T(t) \wedge P(e) \wedge \tau(e) \subseteq t] \quad (\text{preliminary version})$$

The denotation of $\llbracket \text{OP } \textit{minute} \rrbracket$ (30) will thus take a predicate of events (delivered by e.g., a gerund) and return a predicate of times:

$$(30) \llbracket \text{OP } \textit{minute} \rrbracket = \lambda P_{et} \lambda t_i . \exists e [t \in \pi_{\text{min}} \wedge P(e) \wedge \tau(e) \subseteq t]$$

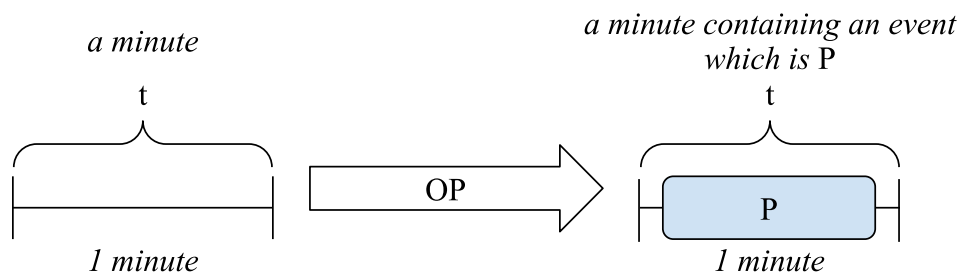


Figure 3: *OP as a label maker for intervals*

The predicate of times is such that the times it describes are of a *minute* length (they are members of the π_{min} set) and, roughly speaking, “includes” the runtime of some *P*-event

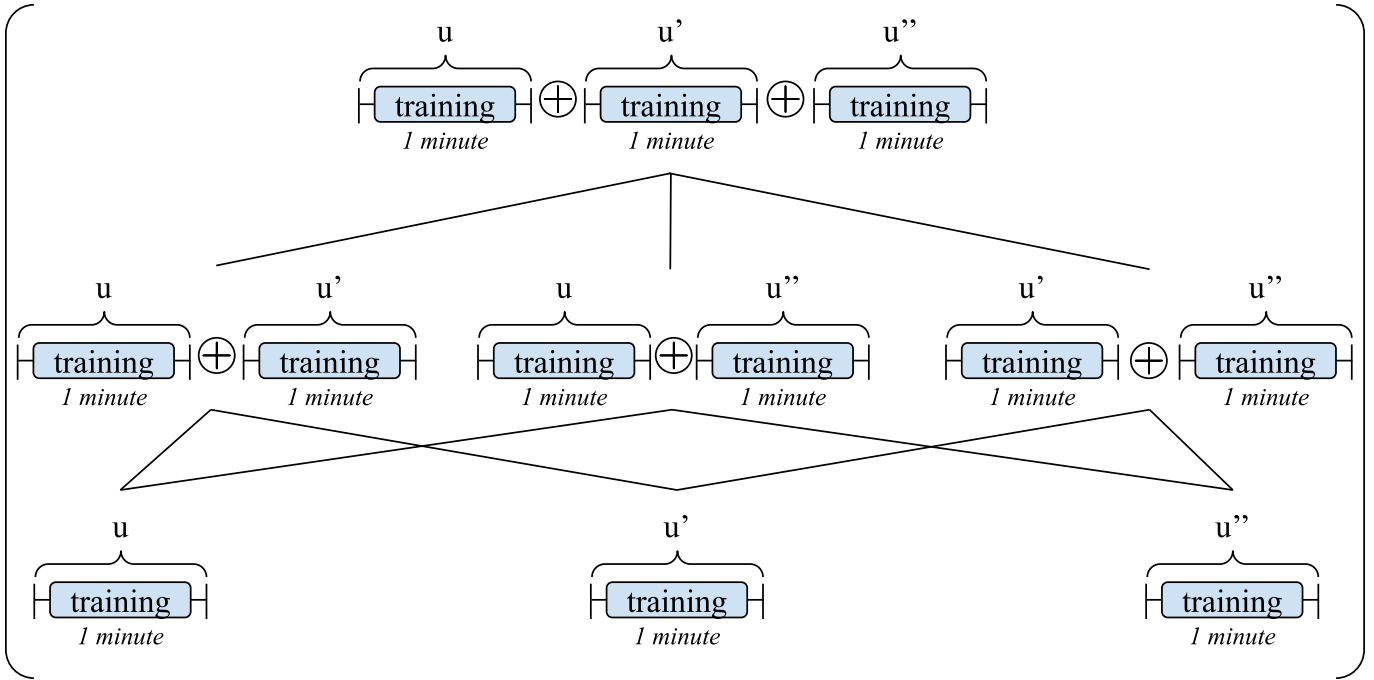
- “Includes” is an oversimplification. I’ll return to it in the next section; for now, know that ‘ \subseteq ’ is a stand-in for a somewhat more complex relationship than simple inclusion

3.2 Counting intervals

We must make a straightforward innovation in order to be able to count *minutes* under its container use:

→ Temporal nouns in their container use must denote *plural intervals* – with the same lattice structure as a plural individual (Link 1983) – note, though the smallest intervals they contain are not “atomic” in that they are single timepoints; rather, they are intervals of certain length

Figure 4: a plural interval t in a semilattice composed of three atomic minute subintervals



With pluralities of intervals, we require extra caution:

- Intervals aren't guaranteed to be distinct from one another like individuals are; but to count intervals, they must be non-overlapping.
- If they overlapped, certain timepoints could be “double counted”

With this in mind, we modify the CARD head to:

- (i) add a **non-overlap** condition (wrt the atomic subparts of a plurality)
- (ii) generalize it from being type $\langle et, \langle e, et \rangle \rangle$ to $\langle \sigma t, \langle e, \sigma t \rangle \rangle$, where σ is e or t
- (iii) specify that the predicate P apply to every atom, not just the entire plural individual

$$(31) \quad \llbracket \text{CARD} \rrbracket \\ = \lambda P_{\sigma t} \lambda n \lambda z_{\sigma}. \forall u [u \in \text{AT}(z) \rightarrow [P(u) \wedge \forall u' [u' \in \text{AT}(z) \wedge u \neq u' \rightarrow \neg(u' \circ u)]]] \wedge \mu(z) = n^3$$

→ CARD now takes a predicate and a numeral and delivers a predicate which describes a (plural) individual z which is composed of atoms u which all match a certain description P and **do not overlap**

→ The cardinality of the plural individual z is equal to the numeral n

→ We do not require a different CARD head to count temporal vs. concrete nouns; (31) can apply to either

³ The function AT makes atoms accessible by applying to a plural individual and returning the set of all its atoms

Putting everything together:

$$(32) \quad \llbracket \text{ten CARD OP minutes of training} \rrbracket \\ = \lambda t . \forall u [u \in AT(t) \rightarrow [\exists e [u \in \pi_{\min} \wedge \text{train}'(e) \wedge \tau(e) \subseteq u] \wedge \forall u' [u' \in AT(t) \wedge u \neq u' \rightarrow \neg(u' \circ u)]]] \\ \wedge \mu(t) = 10$$

So, *ten minutes of training* denotes a set of pluralities of time intervals which:

- (i) have a cardinality of 10, meaning they are composed of 10 atomic subintervals u , where
- (ii) these subintervals are members of the set π_{\min} (they are one minute length), and
- (iii) each subinterval “includes” the runtime of some event e which is a training event.

3.3 More than just a single startpoint

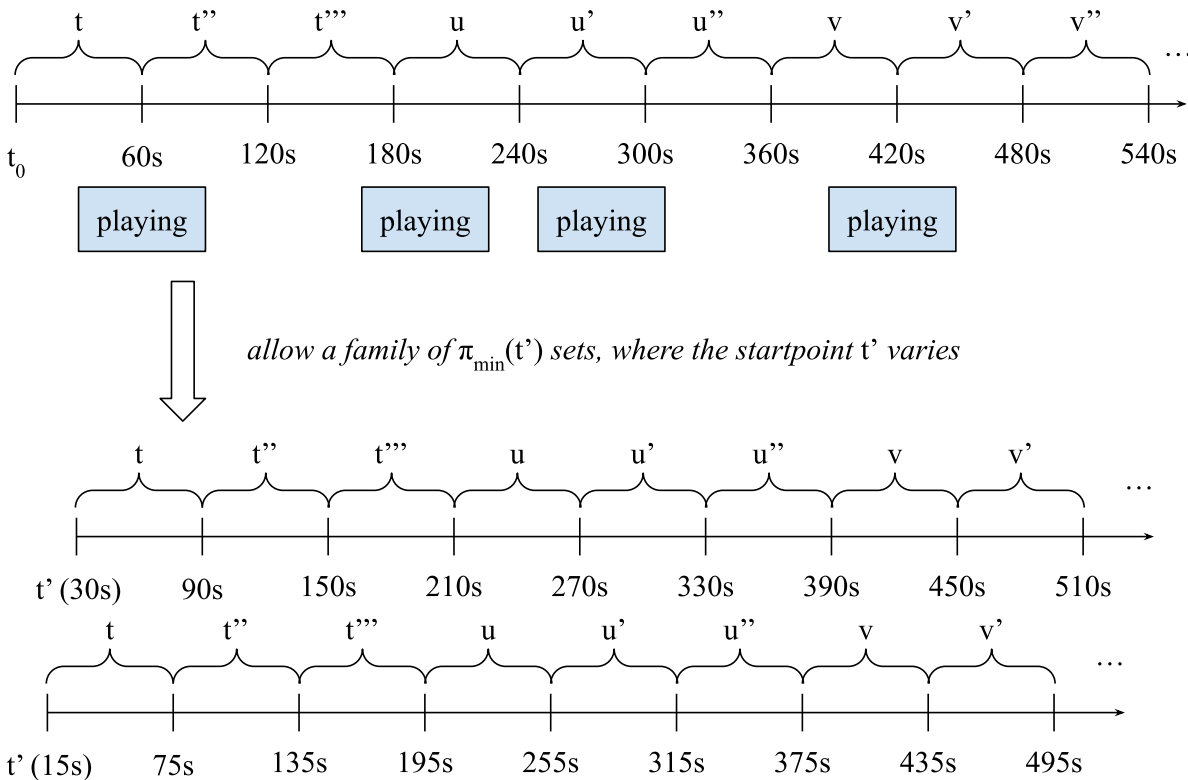
With this semantics so far, however, (32) can only find minutes which are aligned with a single calendrical startpoint.

→ If an event partially overlaps only some of the intervals in the plurality, then this runs into trouble

- (34) [Five minutes of Maggie playing the piano]₁ were shown to the judges. They₁ were one-minute selections cut completely at random from her entire recorded performance.

→ We must broaden the denotation of temporal nouns, under a container use – they must contain all intervals of certain size, not just the sequence of same-sized intervals starting from a single starting point

Figure 5: what to do when an event doesn't fit into a member of π_{\min}



...

To do this, I introduce existential quantification over start points in the denotation of temporal nouns, to allow for each interval to be a member of a potentially different set π with startpoint t' :

- (35) a. $\llbracket \text{minute} \rrbracket = \lambda t . \exists t' [t \in \pi_{\min}(t')]$
 ...
 b. $\llbracket \text{ten}_{\text{CARD}} [\text{OP minutes} [\text{of training}]] \rrbracket$
 $= \lambda t . \forall u [u \in \text{AT}(t) \rightarrow [\exists e [\exists t' [u \in \pi_{\min}(t')] \wedge \text{train}'(e) \wedge \tau(e) \subseteq u] \wedge \forall u' [u' \in \text{AT}(t)$
 $\wedge u \neq u' \rightarrow \neg(u' \circ u)]]] \wedge \mu(t) = 10$

With this first pass of a proposal, I will explore some additional properties of these container uses of temporal nouns, which reveal the need to expand on some of the simplified notions that have been introduced so far.

4 Additional properties of container uses of temporal nouns

4.1 Temporal discontinuity

Under a container use, a temporal noun can pick out temporally discontinuous events. (Note: A container use is forced below by the plural pronoun.)

- (36) We have [four Thursdays of interviewing applicants]₁ ahead of us. **They**₁ are going to be exciting.

→ Four Thursdays necessarily cannot form a continuous temporal interval

→ Nor do the four Thursdays necessarily have to be four consecutive Thursdays (e.g., in a scenario in which interviews take place every other Thursday)⁴

Likewise, in (37), it's improbable/impossible that Bill runs for forty hours straight. Rather, *forty hours of Bill running* describes the cumulative length of many individual runs

- (37) [Forty hours of Bill running]₁ lie ahead of him. **They**₁ are going to exhaust him.

→ Compare *for* adverbials, which require either a continuous event/interval out of the blue, or a larger, framing interval in order to pick out discontinuous times

- (38) a. Bill ran for three hours. *(infelicitous unless he went for only one run)*
 b. Bill ran for three hours this week: thirty minutes every day except Monday.

This property of temporal discontinuity is captured with the proposed semantics. The atomic members of the pluralities denoted by a temporal noun need only not overlap with one another; there's nothing that would require them to be adjacent

⁴ (i) $\llbracket \text{Thursday} \rrbracket = \lambda t . \exists t' [t \in \pi_{\text{day}}(t')] \wedge \text{Thursday}'(t)$

4.2 Atelicity

Under their container use (forced by the time-selecting predicate *went by*), temporal nouns require the accompanying event description to be atelic:

- (39) a. [Three hours of drinking] went by quickly.
 b. [Three hours of being sick] went by quickly.
 c. [Three hours of mowing the lawn] went by quickly.

(only felicitous if lawn mowing incomplete)

To capture the fact that the event description must exhibit the subinterval property, I replace the ‘ \subseteq ’ relation encoded in OP with Deo’s (2009) and Deo & Piñango’s (2011) contextually sensitive temporal partition (\mathcal{R}^c):

→ Partition an interval t into equi-measured and abutting subintervals of contextually determined size (a set $\mathcal{R}^c(t)$), each of which includes $\tau(e)$, ensuring that t is more “filled” with $\tau(e)$:

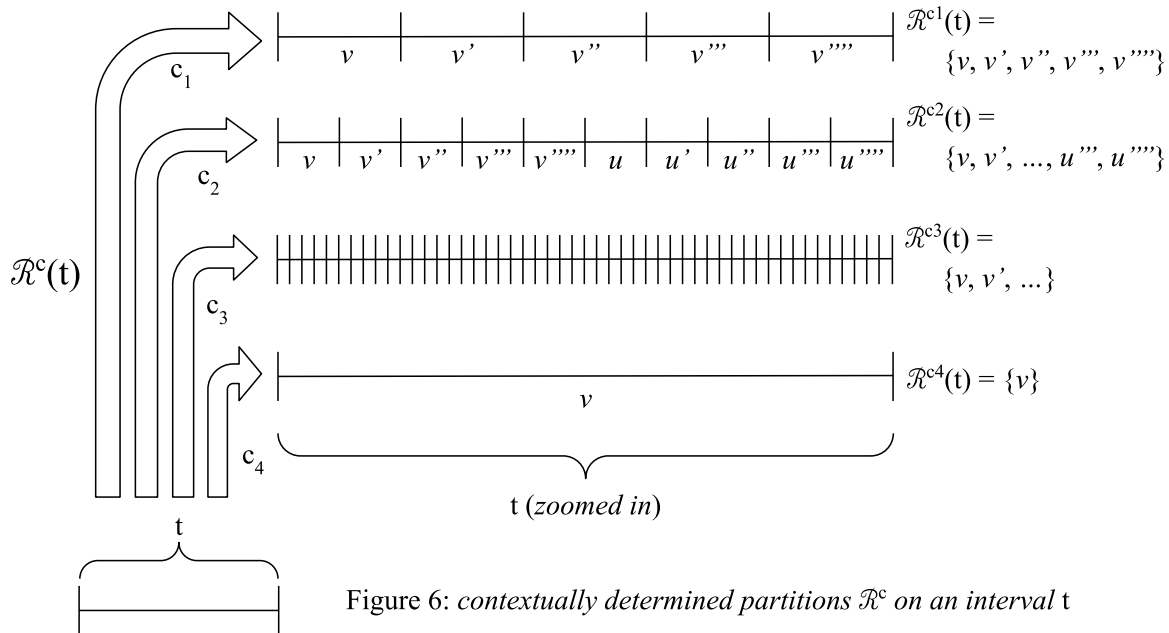
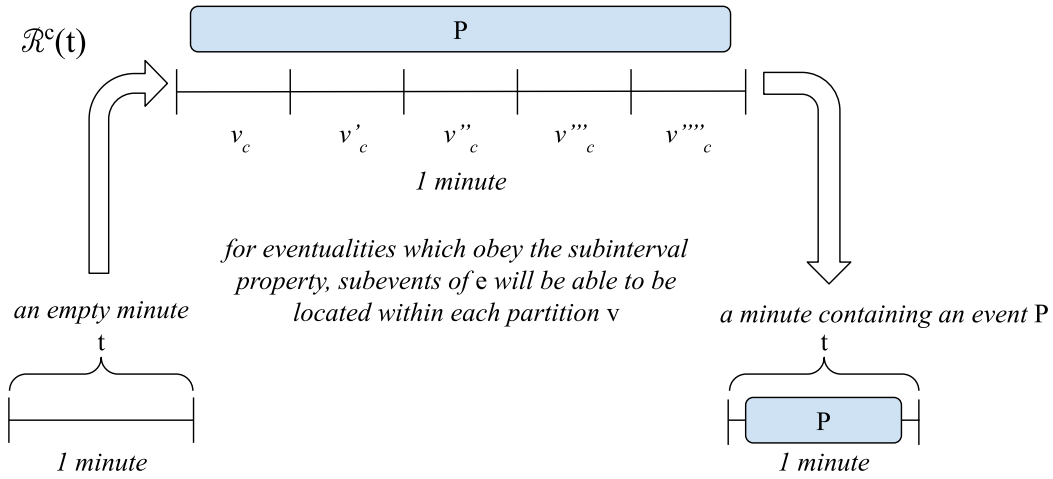


Figure 6: contextually determined partitions \mathcal{R}^c on an interval t

We’ll apply this contextually-determined partition to each atomic subinterval of the plural interval

$$(40) \quad [[\text{OP}]] = \lambda T_{it} \lambda P_{et} \lambda t_i . T(t) \wedge \forall v [v \in \mathcal{R}^c(t) \rightarrow \exists e [P(e) \wedge \tau(e) \subseteq v]] \quad (\text{final version})$$

Figure 7: *OP (full version) checks for fullness before labeling*



This allows some contextual flexibility (consider the difference between *four hours of interviewing applicants* and *four Thursdays of interviewing applicants*), while still capturing the subinterval property

Finally, putting everything together:

- (41) a. $[[OP \text{ minute}]] = \lambda P_{et} \lambda t_i . t \in \pi_{\min} \wedge \forall v [v \in \mathcal{R}^c(t) \rightarrow \exists e [P(e) \wedge \tau(e) \subseteq v]]$
 ...
 b. $[[ten \text{ CARD } [OP \text{ minutes } [of \text{ training}]]]]$
 $= \lambda t . \forall u [u \in AT(t) \rightarrow [\exists t' [u \in \pi_{\min}(t')] \wedge \forall v [v \in \mathcal{R}^c(u) \rightarrow \exists e [train'(e) \wedge \tau(e) \subseteq v]]] \wedge \forall u' [u' \in AT(t) \wedge u \neq u' \rightarrow \neg(u' \circ u)]]] \wedge \mu(t) = 10$

In this final edition of the semantics, the runtime of an event fitting the proper description must be found contained within every member v of a partition $\mathcal{R}^c(u)$, where u are the atomic subparts of a plural interval t .

4.3 Selection

Only derived nominals or ACC-ing gerunds can appear with container uses of temporal nouns, not finite CPs or infinitival clauses

- (42) a. *[Forty hours of/that Bill ran] caused him to sprain his ankle.
 b. *[Five minutes of/for Maggie to play the piano] went by quickly.

Non-event denoting constituents like finite CPs or infinitivals do not supply the right sort of semantic object to be located within the interval members of $\mathcal{R}^c(u)$

5 Conclusion

I've argued that temporal nouns have a container use, alongside a measure use, much like concrete quantizing nouns

→ Temporal nouns, then, can denote times (which contain events), rather than always denoting an event with a particular temporal extent

- The container use of temporal nouns reveals an additional parallel between individuals and events in that both can be quantized by containers, not just by measures
- This implies the domain of individuals and the domain of times allow for the same sort of plural individuals, despite the obvious differences between how these domains are structured

Is this desirable? Are there other phenomena that are more easily explained if we allow for plural intervals, or is this an unnecessary complication to the ontology?

I've been a bit glib concerning gerunds and nominalizations... but there are some complications:

- Temporal nouns are sensitive to rather fine grained distinctions in the structure of the gerunds they appear with, particularly in the *partitive* constructions we overlooked in this talk (Appendix A):

- (43) a. Maggie sat through 30 minutes of Bill congratulating the winners.
 b. *Maggie sat through 30 minutes of Bill's congratulating the winners.
 c. *Maggie sat through 30 minutes of Bill's congratulating of the winners.

ACC-*ing* gerunds are acceptable in the "pseudo-partitive" construction, as we've seen, but both POSS-*ing* gerunds with and without *of* seem degraded...

- There are more semantic intricacies and nuance to gerunds and nominalizations than we have explored in this talk; future work will be dedicated to just this point

Appendix A: What I didn't talk about

Partitives, which have definite complements to *of*

- (44) [Thirty seconds of **the** performance] was enough to convince the judges.

These are argued to have a different syntax than more "pseudo-partitive" constructions like (4) (with indefinite complements to *of*):

- Extraposition only possible with partitives (*the* is obligatory in (43a)) (Selkirk 1977:304)

- (45) a. How many minutes __ did you watch [of *(**the**) performance]?
 b. *How many minutes __ did you watch [of Maggie playing the piano]?

Crosslinguistic data

Data from languages other than English suggest that temporal nouns can also have a container use

For example, in Mandarin and Cantonese, nouns can be reduplicated to convey a meaning like *each* (Jess Law, p.c.). This is demonstrated below for Mandarin

- Measures like *jin* 'kati/catty' (roughly 500-600 grams) or *bang* 'pound' cannot be reduplicated, while containers like *bei* 'cup' or *bao* 'bag' can

(46) *jin-jin /bang-bang rou
kati-kati/pound-pound meat
Int. 'every kati/pound of meat'

(47) a. bei-bei shui
cup-cup water
'every cup of water'

b. bao-bao shupian
bag-bag chips
'every bag of chips'

Temporal nouns pattern like containers, and not like measures, in that they can be reduplicated:

(48) nian-nian/ yue-yue /tian-tian/ miao-miao
year-year/ month-month/day-day/ second-second
'every year/month/day/second'

Further data, in Mandarin, Cantonese, and other languages, might provide further evidence for container uses of temporal nouns, in addition to uncovering more properties to refine the analysis upon

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