A Typology of Locatives and Event Composition in English*

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1. Introduction

This paper provides a semantic typology of locative prepositional phrases (PPs) in English and a compositional semantics for interpreting event structures. Extending Nam’s (1995) logic of space, the semantics proposed here is built on the notions path and orientation (front/back, left/right, up/down, etc.): the latter for stative readings, and the former for non-stative readings.

Formally, in terms of mereological primitives (a space of regions (Σ) and a part-to-whole relation (⊆) between regions) we define path structure and orientation structure: Thus, paths are certain ‘sequences of regions’ and orientations are ‘directed rays’ with a designated region (the origin).

We propose, based on Nam (1995a), the following typology of locative PPs, where belong four classes of locatives.

(1) Four Classes of Locative PPs
   a. Stative Locatives — PPs with at, in, on, in front of/behind, above/below
   b. Symmetric Locatives — PPs with across, through, over, past, around
   c. Telic Locatives — PPs with to, onto, into, out of, from
   d. Atelic Locatives — PPs with towards, along

A locative PP is interpreted as denoting either a path or an orientation, depending on the preposition and the eventuality of the predicate. The typology of locative PPs illustrated above will be claimed to predict the eventuality class of the predicate containing the locative.

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First, before getting into logical technicals, in section 2 we formally characterize five types of eventualities, which are extended from Pustejovsky (1995). Section 3, defining *path structure* and *orientation structure*, builds up an intuitive logic of space, and proposes general interpretive rules for locative PPs. Section 4 illustrates several types of event composition including the patterns of telicity shifting. Section 5 accounts for the telic/atelic contrast of *to/towards* in terms of “homogeneity” of paths, and further Section 6 accounts for the quantificational and perspectival issues of symmetric locatives in terms of “symmetry” of paths.

2. Typology of Eventuality

Following Vendler (1967) and Dowty’s (1979) tradition, Pustejovsky (1995) formally characterized four different types of events in terms of two primitive notions of ‘process’ and ‘state.’ Pustejovsky (1995) does not clearly constrain the general ‘event structure,’ but we propose formal constraints on possible event structures of lexical predicates.

Pustejovsky (1991, 1995) assumes that events can be subclassified into at least three sorts: Processes, States, and Transitions. In order to characterize lexical eventualities, this paper only makes use of two atomic event types – Process and State, and characterizes complex events as a binary event at most, i.e., a complex event consists of at most two subevents, e1 and e2. Then we have the following event types:

\[
\begin{align*}
(2) & \quad a. \ E = e1[\text{state}] \\
    & \quad b. \ E = e1[\text{process}] \\
    & \quad c. \ E = e1[\text{process/state}] + e2[\text{process/state}]
\end{align*}
\]

Let us call (a-b) ‘simplex event’ and (c) ‘complex event.’ Complex events can be further classified due to the choice between ‘process’ and ‘state’ in the two subevents of (c), but this alternation is not of our concern here. Of our concern is the aspectual differences among the complex events, so how to represent different eventualities in terms of event structure of lexical items and further to establish a compositional semantics of lexical eventualities and locative modifiers.

Pustejovsky (1995) proposes a way of distinguishing accomplishment verbs from achievement verbs. He claims that the difference is how they pick up a subevent to be focused in a complex event, so assigns a HEAD-value to one of the two subevents. This event-headedness indicates prominence or distinction of a subevent: Thus, a headed event e1* or e2* is defined as the most prominent
subevent in the whole event of a predicate. Now the following characterization is proposed for accomplishment/achievement distinction.

(3)  
   a. accomplishment verbs: $E = e_1^*[\text{process}] + e_2[\text{state}]$
   b. achievement verbs: $E = e_1[\text{process}] + e_2^*[\text{state}]$

(3a) describes an eventuality of accomplishment by assigning HEAD-value to the first subevent $e_1^*$, and (3b) an achievement by assigning HEAD-value to the second subevent $e_2^*$. In other words, an accomplishment event has a prominence or focus on its first subevent ($e_1$), which will be identified later as a “preparatory process” to bring about its subsequent result state ($e_2$). The preparatory process of an achievement, however, is not significant, since the process is neither focused nor long enough to be described as a recognizable process.

Not all binary event structures denote a telic eventuality of the above (3a) or (3b), or assign HEAD-value to a subevent. So for example the verb *accompany* is lexically represented as a binary event with no headed subevent $[e_1+e_2]$, but Pustejovsky (1995:70) notes that the headedness of the event is underspecified, so to be interpreted either as telic or atelic depending on the context, as shown in the following:

(4) “accompany”  
   E = e_1[process] + e_2[process]  
   a. *John will accompany you to the store.* [telic] $E = e_1+e_2^*$  
   b. *Mary accompanied me while I was walking.* [atelic] $E = e_1+e_2$

Following Pustejovsky’s (1995:74) claim, we interpret the PP *to the store* in (4a) modifies the designated head of the event ($e_2^*$) rather than the entire event structure. We will return to this point in section 4, where we propose a compositional semantics of locative PPs and predicates. Let us just note that the following sentences from Pustejovsky (1995:74) illustrate the same pattern of the telicity interpretation, where each sentence denotes a binary event structure and the durative adverbials headed by *for* indicate the duration period of result states ($e_2$).

(5)  
   a. *John ran home for an hour.* ‘John spent an hour at home’  
   b. *My terminal died for two days.* ‘my terminal was dead for two days’  
   c. *Mary left town for two weeks.* ‘Mary was out of town for two weeks’

Now we note another type of eventuality, i.e., a compositionally derived accomplishment. The verb *load* is characterized as an accomplishment verb, so to denote a complex event with its first subevent headed as shown in (6a) below.
(6) a. load the hay \( E = \text{e1*[process]} + \text{e2*[state]} \)
b. loaded the hay on the truck

Combining with the PP on the truck as in (6b), the verb derives a complex event structure which is slightly different from the normal accomplishment type of (a). Thus we have the following contrast:

(7) a. John loaded the hay all day long.
   b. John loaded the hay on the truck all day long

(7b) above is ambiguous, so the modifier all day long can modify either one of the two subevents. Thus the sentence either means (i) that ‘John spent the whole day to load the hay on the truck,’ or (ii) that ‘the hay was on the truck all day long.’ This second reading suggests that the eventuality denoted by (7b) is different from ordinary accomplishment, and we claim that both of the two subevents of (7b) are focused so to be assigned HEAD-value. Thus we have the following event structure derived from accomplishment verbs:

(8) “load the hay on the truck”
   \[ E = \text{e1*[process]} + \text{e2*[state]} \]

Section 4 will illustrate various patterns of event composition including the ones discussed so far.

3. The Natural Logic of Space

3.1. Mereological Primitives

We build up a logic of space based on the primitive notion of region, and we interpret locative PPs as denoting predicate modifiers represented in terms of properties and relations over the regions in space. Locative PPs in a sentence now indicate a spatial property or a relation for its compositional interpretation. This section, based on these ontological primitives, defines more complex notions like path and orientation.

The space \( \Sigma \) is basically structured with a mereological primitive, part-to-whole relation \( \subseteq \), and the elements in \( \Sigma \) are called regions, so \( \Sigma \) is the set of regions.

\[ 1 \text{ Tarski's (1959) axiom system for Elementary Geometry introduces a ternary primitive relation, betweenness, and a quaternary primitive relation, equidistance } \ (AB=CD: "A is as distant from B as C is from D."). Our formalism with the relative nearness is richer than \]
The space $\Sigma$, $\subseteq$, $\phi$, BETWEEN, NEARER:

a. $\Sigma$: The set of regions

b. $\phi$: The special element (the empty region)
   
   For any region $A \in \Sigma$, $\phi \subseteq A$.

c. $\subseteq$: Binary part-to-whole relation in $\Sigma$.
   
   - Reflexive, transitive, and antisymmetric; i.e., Partial order

d. BETWEEN: Ternary betweenness relation in $\Sigma$.
   
   - Transitive: If BETWEEN(X,Y,Z) and BETWEEN(Z,Y,U), then BETWEEN(X,Y,U)
   - Symmetric on 2nd-3rd arguments:
     BETWEEN(X,Y,Z), then BETWEEN(X,Z,Y)

e. NEARER: Ternary relative nearness relation in $\Sigma$.
   
   - Irreflexive: NEARER(X,Y,X) & NEARER(Y,X,X)
   - Transitive: If NEARER(X,Y,Z) & NEARER(Z,Y,U), then NEARER(X,Y,U)
   - Asymmetric on 1st-3rd arguments:
     If NEARER(X,Y,Z), then NEARER(Z,Y,X)

(9) introduces two primitive ternary relations among regions, which impose geometric structures on the space $\Sigma$. First, the betweenness relation (BETWEEN) is given as transitive and symmetric on its second and third arguments, and BETWEEN(X,Y,Z) is intended to mean "X lies between Y and Z." The other ternary relation, NEARER(X,Y,Z) is intended to mean "X is nearer to Y than Z is," and it is given as irreflexive, transitive, and asymmetric on its first and third arguments.

3.2. Path Structure

Meanings of the spatial expressions in English can be roughly categorized into two classes: (i) movement-directional, and (ii) stative-locational. Movement-directional meaning emerges when the sentence describes change of location, and stative-locational meaning is identified when an event takes place in Tarski's, since the relative nearness relation can easily define the equidistance relation. Robinson (1959) shows that it is impossible for one or more binary relations to serve as the primitive notions in Euclidean geometry. Thus the ternary nature of spatial relations reveal that the space is more complex than the temporal domain which is usually characterized by the binary relations, precedence and overlap relations (e.g., Kamp 1979; van Benthem 1983).
a stative context without changing location. Our logic accommodates this contrast in terms of *path* and *orientation*.

Path is one of the basic concepts discussed in the literature on spatial language and it is claimed to be a crucial notion in perception/cognition of movement or journey. Further, many cognitive approaches employ the concept of ‘path’ as one of the main cognitively motivated devices for representing changes of location (see Miller and Johnson-Laird (1976), Cresswell (1978) and Jackendoff (1983, 1990) among others). Our definition of path is very simple: “A path is a sequence of regions.” The notion of path we are defining here is not of course a physical one but an abstract one. The same physical path so can be represented as different abstract paths: If John flew from Seoul to Hong Kong and then to Birmingham, John’s path can be represented either as a sequence of `<Seoul, Hong-Kong, Birmingham>` or as `<Seoul, Birmingham>`. The abstract notion of path now lacks the continuity of physical movement (or geometric lines). This is what renders our semantics of space sufficiently elegant as to interpret spatial expressions.

Now Path Structure is defined as a set of paths which are partially ordered by the subpath relation (⊆Π). Notice that the definition of path is time-free: It is defined as a sequence of regions, and a sequence is a function with a domain of natural numbers from zero through some k ∈ ℕ, represented as [0,k] in (10), and the range of the function is the set of regions, i.e., the space Σ.

\[(10) \text{Path Structure}: \langle \Pi \Sigma, \subseteq_{\Pi}, + \rangle: \]

a. ΠΣ: The set of paths in a local space Σ.

b. A path π is a sequence of regions, i.e., π ∈ [[0,k]→Σ]
   for some natural number k ∈ ℕ, where [0,k] = \{n ∈ ℕ | 0 ≤ n ≤ k\}, such that
   \[\forall i \in \text{Domain}(\pi), \pi(i-1) \notin \pi(i) \notin \pi(i+1).\]

c. ⊆Π: Binary relation (subpath) between paths defined by:
   Let π and π’ be paths, then π’ is a subpath of π, π’ ⊆Π π, if
   (i) Domain(π’) ⊆Π Domain(π) and Range(π’) ⊆Π Range(π), and
   (ii) there is some i ∈ Domain(π) such that
   \[\pi'(0) = \pi(i) \text{ and for all } j \in \text{Domain}(\pi'), \pi'(j) = \pi(i+j).\]

d. +: Concatenation function in [ΠΣ × ΠΣ → ΠΣ] defined as:
   Let π and π’ be arbitrary paths with Domain(π) = [0,n] and Domain(π’) = [0,m].
   The concatenation of π and π’, π + π’, is defined by:
   (i) if π(k) = π’(0),
   \[(π + π')(k) = \begin{cases} \pi(k) & \text{if } 0 \leq k \leq n \\ \pi'(k-n) & \text{if } n < k \leq n + m \end{cases}\]
   (ii) otherwise, i.e., π(k) ≠ π’(0), (π + π’)(k) is undefined.

(10b) imposes a general condition on the path structure which is linguistically
motivated by the following sentences:

(11) a. #John drove from Seoul to Korea.
    b. #John drove from Korea to Seoul.

The locative PPs in (11a) and (11b) make the sentences meaningless since due to (10b) they fail to refer to a legitimate path. Thus we rule out paths such that some region in the path-sequence is included in the next region of the path, or vice versa. There is no path in $\Pi_\Sigma$ like the following: <Seoul, Korea> or <Korea, Seoul>.

We can prove from the definition of subpath relation in (10c) that the relation is reflexive, transitive, and antisymmetric. Also notice that the concatenation function in (10d) is not a total function, i.e., for some path $\pi$ and $\pi'$, $(\pi+\pi')$ may not be defined. This is due to the condition given in the definition, i.e., the last region of $\pi$ and the first region of $\pi'$ have to coincide, i.e., $\pi(k) = \pi'(0)$. In other words, concatenation of $\pi$ and $\pi'$ exists iff the goal of $\pi$ and the source of $\pi'$ are identical. The goal and the source of a path are defined as follows.

(12) Definitions:
Let $\pi$ be a path with $\text{Domain}(\pi) = [0, k]$, then
the goal of $\pi$, $\pi_g$, is $\pi(k)$; and the source of $\pi$, $\pi_s$, is $\pi(0)$.

Now we define a very special relation between paths—converse relation. For all paths $\pi$, we have a path which reverses the ordering of $\pi$. We define:

(13) Definition:
Let $\pi$ be a path with $\text{Domain}(\pi) = [0, k]$, then
$\pi^{-1}$, the converse of $\pi$ (or "$\pi$-converse") is defined by:
$\text{Domain}(\pi^{-1}) = [0, k]$, and
for all $i \in \text{Domain}(\pi^{-1})$, $\pi^{-1}(i) = \pi(k-i)$.

By the definition, $\pi^{-1}(0) = \pi(k)$, $\pi^{-1}(k) = \pi(0)$, i.e., the source of $\pi^{-1}$ is the goal of $\pi$ and the goal of $\pi^{-1}$ is the source of $\pi$. Section 6 below uses the notion of path-converse for the semantics of symmetric locatives.

We note two advantages of our semantics of path: (i) Our notion of path is not temporal, so paths are introduced as purely spatial entities, and (ii) it is flexible enough to accommodate cyclic paths that allow some regions can occur more than once in a single path.

The intuitive notion of path involves a movement/trajectory of an object. Now to represent the notion of movement through a path, we introduce a predicate $\text{TRAV}$ which is a ternary relation in $\mathcal{E} \times \Pi_\Sigma \times \mathbb{T}$, where $\mathcal{E}$ is the universe of individuals, $\Pi_\Sigma$ the set of paths in the local space $\Sigma$, and $\mathbb{T}$ the set of time intervals. Informally, $\text{TRAV}(x, \pi, T)$ means 'x traverses the path $\pi$ during the interval T.' Here $\pi$ is a sequence of regions with its domain in natural numbers, $\mathbb{N}$, and $T$ a
linearly ordered set of time points. Then, during an interval T, x traverses π if x goes through the regions of π in the same order of the sequence π.

In order to define this predicate formally, we use the function \( \circ \in \{ [\mathbb{R} \times \mathbb{T}] \rightarrow \Sigma \} \) which assigns a unique region to each individual object at an interval. Thus, for some object x, and a time interval T, \( \circ(x)(T) \) denotes the region which x occupies during the interval T. The function \( \circ \) is defined as a binary one, but we will ignore the interval argument T if the object is not mobile, so we have \( \circ(\text{the-post-office}) \). Now formally,

(14) Definition:

\( \text{TRAV}(x, \pi, T) \) is True iff there is an "order-preserving" map \( \mu \) from \( \text{Range}(\pi) \) to T such that for all \( i \in \text{Domain}(\pi) \),

\( \circ(x)(\mu(\pi(i))) \) intersects with \( \pi(i) \), i.e., \( \circ(x)(\mu(\pi(i))) \cap \pi(i) \neq \emptyset \).

We take an interval T as a linearly ordered set of time points, but the domain of \( \mu \) is not an ordered set but a set of regions, i.e., \( \text{Range}(\pi) \) for some \( \pi \). Thus we use the term "order-preserving" in a special sense defined as follows:

(15) Definition:

For a path \( \pi \) and an interval T, a function \( \mu \) from \( \text{Range}(\pi) = \{ \pi(i) \mid i \in \text{Domain}(\pi) \} \) to T is order-preserving iff

for all \( i, j \in \text{Domain}(\pi) \), if \( i \leq j \), then \( \mu(\pi(i)) \leq T \mu(\pi(j)) \) and \( \mu(\pi_s) = 0_T \) and \( \mu(\pi_g) = 1_T \).

An interval T is ordered by the temporal precedence relation \( \leq T \): The least element of T, \( 0_T \), refers to the initial point of the interval T, and the greatest element \( 1_T \) refers to the terminal point of T. The TRAV relation will be used to interpret sentences referring to a path and a movement. For example, \( \text{John ran into the house} \) will be interpreted to be true iff 'John ran' and 'John traversed the path \( \pi \), i.e., \( \text{TRAV}(\text{john}, \pi, T) \), such that the source of the path is outside the house and the goal is inside the house'.

3.3 Orientation Structure

Natural language expressions refer to spatial orientations to locate some object in the space, so for example, the PP in (16) below refers to the front-orientation of the car to locate the subject argument 'John.'

(16) \textit{John is sitting in front of the car}

Thus the sentence is true only if John's region is on the front-orientation of the car. Roughly, the front-orientation of a car can be characterized as a half axis moving out from the car in the direction to its front part. That is, we take orientations as
spatial objects like rays which have a designated region (= Origin) and a direction. Rays, in their geometric sense, are collections of atomic regions. Orientation Structure is defined as the set of orientations with the containment relation (⊆R) between them.

(17) Orientation Structure: <RΣ, ⊆R>:
   a. RΣ: The set of orientations in a local space Σ.
   b. ⊆R: Binary relation (containment) between orientations.
   c. An orientation ρ ∈ RΣ is a linearly ordered set (ρ, <) of atomic regions such that
      (i) there is a unique least element (Origin(ρ)),
      (ii) there is an atomic region X ∈ ρ such that for all atomic regions Y ∈ Σ,
           Y ∈ ρ iff either BETWEEN(Y, Origin(ρ), X) or BETWEEN(X, Origin(ρ), Y), and
           (iii) for all atomic regions X, Y ∈ ρ,
                X < Y iff NEARER(X, Origin(ρ), Y).

The linear order for an orientation is intended to be the relative distance relation from the origin of the orientation, as defined in (17c.iii). A linear order is total, irreflexive, asymmetric, and transitive. The betweenness condition given in (17c.ii) guarantees that for any orientation ρ, there is a line such that all the atomic regions in ρ belong to the line. Orientations will be used to interpret symmetric locatives as well as orientational locatives.

For any object, its internal properties determine its intrinsic orientations if any, e.g., front/back, top/bottom, left/right, and in/out orientations. We claim here that such objects get their intrinsic orientations due to their different parts. In other words, if an object has inherent front and back parts, it can be assigned front/back orientations determined by them. For example, a car has an inherent front part, no matter how it is determined (whether it is determined by the normal direction of movement or by a formal characteristics of its front part), so we can assign front and back orientations to a car. In other words, we think of intrinsic orientation as a derived concept from parts of objects. The following illustrate different primitive functions partitioning an object into different parts. For instance, Pfront(x) refers to the front part of the car, and so on. These functions are partial since objects may lack some (or all) of the intrinsic orientations.

(18) Pfront(x), Pback(x), Ptop(x), Pbottom(x), Pleft(x), Pright(x), Pinside(x), Poutside(x), Pcenter(x)

Now we define orientations as determining a ray with an origin and a direction in terms of parts of objects (equivalently, a linearly ordered set of minimal regions with the least element), and the orientations are given as a function from pairs of an object and a time interval to rays, i.e., [Σ×T]→ RΣ, where Σ is the universe of
individuals, \( \mathcal{T} \) a set of intervals, and \( \mathbb{R}_\Sigma \) the set of orientations in \( \Sigma \).

(19) \( \Omega_{\text{front}}(x,t) \) is an orientation \( \rho \) such that 
Origin(\( \rho \)) = \( \mathcal{T}(P_{\text{center}}(x),t) \) and 
\( \rho \) intersects \( \mathcal{T}(P_{\text{front}}(x),t) \), i.e., \( \rho \cap (P_{\text{front}}(x),t) \neq \emptyset \).

(20) \( \Omega_{\text{back}}(x,t), \Omega_{\text{up}}(x,t), \Omega_{\text{down}}(x,t), \Omega_{\text{left}}(x,t), \Omega_{\text{right}}(x,t) \)

Each function assigns an intrinsic orientation to an object at an instance, and the orientation has its origin at the center of the object and intersects its relevant part. In front of the car, for example, involves the front orientation of 'the car', \( \Omega_{\text{front}}(\text{the car}, t) \), which is a linearly ordered set of minimal regions with its origin at the center of 'the car' and directed to its front side. The following illustrate some objects with their intrinsic orientations:

(21) man, car: Top/Bottom, Front/Back, Right/Left, In/Out
telephone: Top/Bottom, Front/Back, In/Out
vase, boulder: Top/Bottom, In/Out
tree: Top/Bottom
rocket: Front/Back
box, ball: In/Out

Finally we define a binary relation INTR ("intersection") between regions and extend it to hold between a region and an orientation.

(22) Definitions
a. A region A is called an intersection of a set R of regions (\( \cap R \)) if A is non-empty part of each element of R and if there is no region B such that B is a part of each element of R and A is a proper part of B.

b. Regions A and B intersect each other, INTR(A, B), if there is an intersection of \{A, B\}.

c. For X a region and \( \rho \) a set of regions, INTR(X, \( \rho \)), X intersects \( \rho \), iff there is a region A \( \in \rho \) such that A \( \subseteq \) X.

(22b) defines INTR relation to hold between regions, and (22c) extends the relation to hold between a region and a set of regions. Thus a region may bear the INTR relation to either an orientation or a path.
3.4. Two General Interpretative Rules

Based on the formal structures of paths and orientations, we now interpret locatives with a couple of rules general enough to interpret diverse locative PPs. Due to the intuitive dichotomy of movement vs. stative readings of locatives, we interpret locatives as denoting paths or orientations. A path is associated with a movement reading induced by a motion verb, and an orientation is associated with a stative reading induced by a stative verb. The first rule in (23) is for interpreting sentences with a motion verb and a locative PP, which naturally induces a path that an object traverses.

(23) Semantic Rule–1:
For \( m \) a one-place motion verb, and \( f \) an extensional locative modifier,
interpret the VP \( m + f \), the concatenation of \( m \) and \( f \) by:
\[
f(m)(x) \text{ iff } m(x) \text{ and } \text{TRAV}(x, \pi_f, T),
\]
where \( \pi_f \) is a path determined by \( f \).

Different locatives determine different paths. For example, \textit{into the library} refers to a path whose source is a region outside the library, and whose goal is a region inside the library, and \textit{over the fence} refers to a path whose source and goal are on the opposite sides of the fence, etc. Thus, \textit{John jumped over the fence} is true if and only if 'John jumped during a past interval \( T \) and John traversed the path from one side of the fence to the other during \( T \).'</n
The second rule in (24) is for interpreting sentences with a stative verb and a locative PP, so their interpretations do not involve a change of location.

(24) Semantic Rule–2:
For \( s \) a one-place stative verb, and \( f \) an extensional locative modifier,
interpret the VP \( s + f \) by:
\[
f(s)(x) \text{ iff } s(x) \text{ and } \text{INTR}(\mathcal{F}(x), \rho_f)
\]
where \( \rho_f \) is an orientation or a region determined by \( f \).

Stative locatives like \textit{in front of the house} determines an orientation (front/back, left/right, top/bottom), and some of the orientations are intrinsic ones of the reference object: That is, \textit{in front of the house} refers to the intrinsic front orientation of the house. Due to (24), \textit{John is sitting in front of the house} is true just in case 'John is sitting at the utterance time and John's region intersects the front orientation of the house.'

4. Types of Event Compositions

This section illustrates several types of event compositions, which are claimed to
be predicted by the eventuality of the predicate and the semantic type of the locative PP combining with the predicate. Thus the subsequent sections 5 and 6 account for the different event compositions in terms of different types of paths. In section 2, we proposed that there are at least five event structures for lexical and derived complex predicates. Thus we have the following event structures:

(25) Event-Structures of Predicates

a. state: \( E = e_1[\text{state}] \)
b. activity: \( E = e_1[\text{process}] \)
c. achievement: \( E = e_1[\text{process}]+e_2[\text{state}] \)
d. accomplishment-1: \( E = e_1[\text{process}]+e_2[\text{state}] \)
e. accomplishment-2: \( E = e_1[\text{process}]+e_2[\text{state}] \)

(25a,b) are represented as simplex events and (25c-e) as complex ones. A complex event is composed of two subevents \([e_1+e_2]\), where \(e_1[\text{process}]\) temporally precedes (or overlaps with) \(e_2[\text{state}]\). Let us call \(e_1\) “source event” and \(e_2\) “goal event.” First we note combinatorial contraints of locatives and predicates in terms of eventuality, and then characterizes the patterns of aspectual composition.

The following again illustrate the four classes of locative PPs introduced in section 1:

(26) Four Classes of Locative PPs

a. Stative Locatives — PPs with \(\text{at, in, on, in front of/behind, above/below}\)
b. Symmetric Locatives — PPs with \(\text{across, through, over, past, around}\)
c. Telic Locatives — PPs with \(\text{to, onto, into, out of, from}\)
d. Atelic Locatives — PPs with \(\text{towards, along}\)

The event type of (25a), unlike the others, does not combine with a telic/atelic locative of (26c,d), thus we have:

(27) a. *John found Mary into the garden.
b. *John visited Mary into her office.
c. *John was looking for a child into the house.

Stative or symmetric locatives, however, seem to be free to combine with any type of eventuality, and when they combine with an activity event type, they derive either the same event type or a complex event structure with its goal-event \(e_2^*\) headed, so to be ambiguous. For example, \textit{walk} denotes a simple activity with a simplex process as in (28) below, and combining with a stative locative \textit{in the room}, it derives either the same event type \(e_1[\text{process}]\) or a complex type as in (28b). Thus in (28a) the PP denotes a circumstantial location of the ‘walking’ event, and does not imply change of location. (28b), however, implies change of location, so its subject argument walks into the room from outside. Therefore (28b) but not (28a) is represented as a telic event.
(28) \(V.\text{walk}: e1[\text{process}] + \text{PP.} \text{in the room}\)
\[\rightarrow\]
a. \text{VP.} \text{walk in the room} \quad e1[\text{process}]
b. \text{VP.} \text{walk in the room} \quad e1[\text{process}] + e2*[\text{state}]

The following constructions also illustrate the same compositional pattern:

(29) a. John was jogging across the street.
b. The dog chased the cat in the house.

We note also that telic locatives of (26c) always derive a complex event structure with its second event e2* headed. (30) below shows the same type of event composition, where the subject argument changes its location:

(30) \(V.\text{run}: e1[\text{process}] + \text{PP.} \text{into the room}\)
\[\rightarrow\]  
\(\text{VP.} \text{run into the room}: e1[\text{process}]+e2*[\text{state}]\)

(31) a. John drew the box into the room.
b. John escorted Mary into the museum.

The transitive verbs in (31) imply location change of their object arguments (the box and Mary), so the whole VPs derive a complex event structure. Further, if the sentences are modified by an adverbial like \textit{continually} together with durative adverbial \textit{all day long}, we get a repetitive reading.

(32) a. John continually drew the box into the room all day long.
b. John continually drew the box toward the room all day long.

Thus in (32a) John repeated drawing the box into the room for the whole day (since someone else put it back outside). However, (32b) with an atelic locative \textit{toward the room} does not derive a telic event but an atelic event of activity, so (32b) simply says that John was drawing the box toward the room without stopping all day long.

This telicity shifting can be also attested in (33) below, where the durative adverbial \textit{for three hours} refers to the duration of the result state of the whole event, i.e., the goal-event e2*. This reading can be identified in (34), too.

(33) John escorted Mary into the museum for three hours.
(34) a. John ran home for three hours.
b. John went into the house for three hour.

The verbs \textit{draw} and \textit{escort} in (31a,b) denote a simple activity event, but as we mentioned in section 2 the verb \textit{load} (the hay) denotes a complex event type of accomplishment, and derives a new event type, combining with a telic locative.
(35) \[ V'.load\ the\ hay: e1*[process]+e2*[state] \]
\[ PP.on\ the\ truck \]
\[ \rightarrow\ VP.load\ the\ hay\ on\ the\ truck: e1*[process]+e2*[state] \]

The derived event structure of (35) assigns HEAD-value to both of the subevents, so the following sentences show different types of temporal interpretation.

(36) a. John loaded the hay all day long.
    b. John loaded the hay on the truck all day long.

In section 2, we have noted that (36b) but not (36a) is ambiguous, and the durative adverbial all day long in (36b) can either indicate the duration of ‘loading’ event (e1) or the duration of the result state (e2). This ambiguity supports the claim that (36b) denotes a complex event like (35). Notice the difference between (36b) and (34a,b): The durative adverbial for three hours in (34) only denotes the duration of the result state (goal-state), so the event structure of (34a,b) assigns HEAD-value to its derived second subevent e2*, so the derived whole event is just like an achievement.

Atelic locatives headed by along and towards, combining with an activity event, do not change the event structure. So the VP cannot be modified by a frame adverbial like in an hour as shown in (37b).

(37) \[ V.walk: e1*[process]+PP.along\ the\ fence \]
\[ \rightarrow\ VP.walk\ along\ the\ fence: e1*[process] \]
    a. John walked along the fence for an hour.
    b. #John walked along the fence in an hour.

Notice here that locative PPs are mostly goal-oriented in the sense that they describe the spatial location of the goal-event e2 of a complex event structure. For instance, the PP in (38a) below specifies the location of the result state (goal-event) in the whole event: i.e., ‘the box was in the room.’

(38) a. Sue drew the box in/into the room.
    b. John went to the office.
    c. John mixed water and flour on the plate.

This general property of locative PPs reveals the ways how locative PPs are interpreted with respect to the arguments of predicates. Sondheimer (1978) and Parsons (1990) propose a way to interpret locative PPs as “oriented to a particular argument of predicates.” Nam (1995), criticizing their approaches, claims that the argument orientation patterns of locative PPs are mostly determined by the lexical verbs. Thus, if a non-stative (symmetric/telic/atelic) locative combines with a transitive verb, it is always oriented to the object argument, i.e., the locative specifies the location of the object argument. Stative locatives, combining with a
transitive verb (with some exceptions), are also oriented to object argument. This observation reveals that locative PPs basically refers to the goal-location of a Theme-argument, which is identified in the goal-subevent e2* of the whole event structure.

5. Telic/Atelic Locatives and Homogeneous Paths

Prepositional phrases with (i) to, from, onto, into, out of, and (ii) towards, along are often called directional locatives, which indicate directions of movement by referring to the source/goal of a path. Thus, to, onto, into, and towards refer to the goal of a path. At the beginning of the paper, we called the first group (i) “telic locative” and the second group (ii) “atelic locative,” and noted in section 2 and 4 that to and towards induce a difference in aspectual interpretation: telic vs. atelic.

In Hinrichs (1986), (39a) and (39b) are classified into Vendler’s classes of accomplishment (telic) and activity (atelic), respectively.

(39) a. Fangs slithered to the rock
    b. Fangs slithered toward the rock

Hinrichs (1985:204, 1986:349) identifies the aspectual difference between to and towards with the following examples.

(40) a. John walked to the library in an hour
    b. *John walked toward the library in an hour
    c. It took Fangs ten minutes to slither to the rock
    d. *It took Fangs ten minutes to slither toward the rock

Now we want to account for the event composition in terms of lexical semantics of locative modifiers and predicates. In order to identify aspectual contribution of the locative PPs, we start with the lexical semantics of to and towards, and characterize their aspectual difference in terms of homogeneity of paths. A locative PP with to, as defined in (41), determines a set of paths which share a specific goal region of the reference object. Thus, due to the semantic rule–1 of (23) proposed in Section 3, we interpret the PP combining with a motion predicate as in (42), and this interprets the sentence John ran to the post office as in (43). The truth conditions in (43) guarantees that the sentence entails (44).

(41) “to α” determines a set of paths π such that
    \[ π_\text{g} = \text{®}(α) \text{ and } π_\text{g} \cap π_\text{s} = φ. \]

(42) Let \( m \) be a one-place motion verb, and \( α \) an NP denoting an individual, interpret the VP \( m+\text{to}+α \), the concatenation of \( m \) and the PP to \( α \), by:
(to $\alpha(m)(x)$ iff $m(x)$ and TRAV($x, \pi, T$)

where $\pi_g = \mathbb{R}(\alpha)$ and $\pi_g \cap \pi_s = \emptyset$.

(43) *John ran to the post office* is true iff

there is an interval $T<\text{now}$, and a path $\pi$ such that

ran($\text{john}, T$) and TRAV($\text{john}, \pi, T$)

where $\pi_g = \mathbb{R}(\text{the post office})$ and $\pi_g \cap \pi_s = \emptyset$.

(44) *John was at the post office*

Atelic locatives with *towards* get interpreted quite differently from those with *to*. First of all, the set of paths denoted by the PP *towards the post office* does not share the same goal region, but simply specifies the direction of the movement: That is, the movement is directed toward the post office. In other words, the distance from the moving object to the post office is continuously decreasing. We interpret this then in terms of "relative nearness" relation. Thus, *towards* $\alpha$ is interpreted as determining a set of paths as shown in (45).

(45) "towards $\alpha$" determines a set of paths $\pi$ such that

for all $i, j \in \text{Domain}(\pi)$, if $i \leq j$ then NEARER ($\pi(j), \mathbb{R}(\alpha), \pi(i)$).

(46) *John ran towards the post office* is true iff

for an interval $T<\text{now}$, and for a path $\pi$,

ran($\text{john}, T$) and TRAV($\text{john}, \pi, T$), where

for all $i, j \in \text{Domain}(\pi)$, NEARER ($\pi(j), \mathbb{R}(\text{the post office}), \pi(i)$).

Then, due to the Semantic Rule–1 we get the interpretation as shown in (46), and we can see that the sentence does not entail (44) *John was at the post office*.

Now the difference between *to* in (41) and *towards* in (45) can be identified in terms of "homogeneous" paths defined below:

(47) Definition: Homogeneous Paths

For $f$ a locative PP, $f$ determines a homogeneous set $\Pi_f$ of paths

iff $\forall \pi \in \Pi_f$, if $\pi'$ is a subpath of $\pi$, $\pi' \in \Pi_f$,

i.e., $\Pi_f$ is closed with respect to "subpath" relation.

From the definition (47), we see that the PP *towards the post office* determines homogeneous paths, but *to the post office* does not. As we mentioned earlier, Hinrichs (1985) adopts Vendler's (1967) temporal criteria (continuity vs. punctuality and homogeneity vs. heterogeneity) for his four verb classes, and he characterizes the difference between *to* and *towards* in terms of temporal heterogeneity/homogeneity. Hinrichs gives a lexical account of the aspectual difference with the notion of spatio-temporal location and Carlson's (1977)
dichotomy of stage level and individual level predicates. Hinrichs paraphrases Vendler’s (1967:101) ideas as follows:

"Since doing something for x amount of time means doing something during most if not all subintervals of the interval x, sentences such as (46), which refers to atelic events or activities, can be characterized as being temporally homogeneous....

To do something in x amount of time, on the other hand, means to do something at some unique interval within x. Since telic events or accomplishments can be modified by temporal in, they, in contrast to activities or atelic events, can be described as being temporally heterogeneous, ..." (Hinrichs 1986:349)

Vendler characterizes the difference in terms of temporal heterogeneity vs. temporal homogeneity, but here we associate the aspectual difference with the difference among paths that the locatives determine. The parallel definition given in (47) reveals an intuitive correspondence between the temporal homogeneity of events and the spatial homogeneity of paths.

We can show that, due to the homogeneity of the paths determined by towards the post office, the interpretation in (46) above implies the temporal homogeneity of the event: That is, if the sentence is true for some past interval T<now, then for all subintervals T' of T, the sentence is true. But we can notice quickly that PPs with to do not determine homogeneous paths, and so the interpretation of (43) John ran to the post office does not imply temporal homogeneity of the event.

6. Symmetric Locatives

Symmetric locatives include PPs with across, through, over, around, and past, and their semantics crucially involve betweenness relation (cf. Nam(1995) for detailed semantic/syntactic analyses of symmetric locatives). This section shows how symmetric locatives derive event composition and accounts for the compositional patterns in terms of semantic features of the symmetric locatives. Here we propose lexical semantics of across and through, then characterizes the class of symmetric locatives as determining symmetric paths.

Symmetric locatives can modify either an activity verb or a state verb as shown in the following:

(48) a. John ran across the street.
b. John drove through the tunnel.
c. The horse jumped over the fence.
When the symmetric locatives modify a state event as in (49), they do not change the event type, so to denote a state, i.e., \( E = e_1[\text{state}] \). But the symmetric locatives change the event structure, when they modify an activity event as in (48). So the contrast in the following sentences reveals that the derived event type is not just simple activity.

(50) a. John swam for an hour.
    b. #John swam in an hour.

(51) a. #John swam across the strait for an hour.
    b. John swam across the strait in an hour.

The verb \( \text{swim} \) denotes a simple activity event, so the verb does not go with a frame adverbial like \( \text{in an hour} \). (51a) shows that a symmetric locative derives a telic event from an activity/process. Further, if a symmetric locative PP combines with \( \text{swim} \) as in (51b), frame adverbials can modify the whole VP. We can represent the event compositions as the following schema:

\[
(52) \quad \text{V. sit } e_1[\text{state}] + \text{PP. across the street } \Rightarrow \text{VP. sit across the street: } e_1[\text{state}]
\]

\[
(53) \quad \text{V. run } e_1[\text{process}] + \text{PP. across the street } \Rightarrow \text{VP. run across the street: } e_1[\text{process}] + e_2*[\text{state}]
\]

The derived event type in (53) is achievement, so the second subevent is specified as a HEAD of the whole event.\(^2\)

As illustrated so far, symmetric locatives can modify an activity event or a state, and they derive ambiguity when modifying an activity verb. Now we want to account for the event shifting composition like (53), where a symmetric locative modifies an activity. (54) and (55) below, due to (23) Semantic Rule-1, define the meaning of \( \text{across}-\text{NP} \) and \( \text{through}-\text{NP} \) as a predicate modifier.

(54) \( \text{across } \alpha \):

For \( m \) a intransitive activity verb, and for \( \alpha \) a noun phrase denoting an individual, interpret the VP \( m + \text{across} + \alpha \), as follows:

\(^2\) In fact, (48a) is ambiguous: The locative \( \text{across the street} \) can denote either (i) the movement paths of John, so ‘John crossed the street by running,’ or (ii) the circumstantial location of the ‘running’ event, so ‘John was across the street when he was running.’ (53) only represent the first reading, but the second reading does not derive a complex event structure. (28) in section 4 notes the same ambiguity derived by stative locatives.
(across(\textit{x}))(m)(x) = 1 \iff m(x) \text{ and TRAV}(x, \pi, T),
where BETWEEN(\textcircled{\textit{x}}(\textit{a}), \pi_s, \pi_g), and for some t \in T,
ON(\textcircled{\textit{x}}, t, \textcircled{\textit{a}}, t))

(55) through \textit{a}:
For \textit{m} a intransitive activity verb, and for \textit{a} a noun phrase
denoting an individual, interpret the VP \textit{m}+through+\textit{a}, as follows:
(through(\textit{x}))(m)(x) = 1 \iff m(x) \text{ and TRAV}(x, \pi, T),
where BETWEEN(\textcircled{\textit{x}}(\textit{a}), \pi_s, \pi_g), and for some t \in T,
IN(\textcircled{\textit{x}}, t, \textcircled{\textit{a}}, t))

The only difference between across and through defined above is their last
condition on the intermediate location of the moving object: ON(\textcircled{\textit{x}}, t, \textcircled{\textit{a}}, t))
for across \textit{a} and IN(\textcircled{\textit{x}}, t, \textcircled{\textit{a}}, t)) for through \textit{a}. Thus, across requires the object
\textit{x} to be "on" the reference object, whereas through requires \textit{x} to be "in" the
reference object. The following examples illustrate how those PPs are interpreted
in a sentence, and we see that (56) entails 'John was on the street,' and (57) 'John
was in the tunnel.'

(56) \textit{John ran across the street} is true iff
for some interval T < now, run (\textit{john}, \pi, T),
for a path \pi, where BETWEEN(\textcircled{\textit{street}}(\textit{a}), \pi_s, \pi_g), and
for some t \in T, ON(\textcircled{\textit{john}}, t, \textcircled{\textit{street}}, t)).

(57) \textit{John drove through the tunnel} is true iff
for some interval T < now, drive(\textit{john})(T) and TRAV(\textit{john}, \pi, T),
for a path \pi, such that BETWEEN(\textcircled{\textit{tunnel}}(\textit{a}), \pi_s, \pi_g), and
for some t \in T, IN(\textcircled{\textit{john}}, t, \textcircled{\textit{tunnel}}, t)).

The lexical semantics of across and through given in (54-55) reveals some unique
characteristics of the symmetric locatives. Notice that the paths determined by the
PPs share the same "betweeness" condition, i.e., BETWEEN(\textcircled{\textit{x}}(\textit{a}), \pi_s, \pi_g). This
condition simply states that the path contains the region of the reference object \textit{a},
and the direction of the paths is not specified in the condition. So we identify
symmetric locatives as ones determining a set of paths which is closed under
"path-converse" relation defined in (13). That is, if a path \pi is determined by a
symmetric locative \textit{f}, then \pi^{-1} is also determined by \textit{f}.

(58) Definition: Symmetric Locatives
For \textit{f} a locative modifier, \textit{f} is symmetric iff
\textit{f} determines a set \Pi_{\textit{f}} of paths such that \forall \pi \in \Pi_{\textit{f}}, \pi^{-1} \in \Pi_{\textit{f}},
i.e., \Pi_{\textit{f}} is closed with respect to "path-converse" relation.
For example, as we see in (56), the PP *across the street* determines a path such that BETWEEN ($\text{®}$(*the street*), $\pi_s$, $\pi_g$), and since the relation BETWEEN is symmetric on second and third arguments, it is also true that BETWEEN ($\text{®}$(*the street*), $\pi_g$, $\pi_s$). Then by definition, $\pi_s = \pi^{-1}_g$, and $\pi_g = \pi^{-1}_s$, and so BETWEEN ($\text{®}$(*the street*), $\pi^{-1}_s$, $\pi^{-1}_g$). Therefore, the same PP *across the street* also determines $\pi^{-1}$, thus symmetric. This definition now identifies the class of symmetric locatives in terms of path structure.

7. Concluding Remarks

This paper, based on Nam’s (1995) logic of space, proposes a compositional semantics of event structures in terms of eventuality type of predicates and the semantics of locatives. We have identified five classes of eventualities, extending the version of Pustejovsky’s (1995) Event Structure: $e_1[^\text{state}]$, $e_1[^\text{process}]$, $e_1[^*\text{process}]+e_2[^\text{state}]$, $e_1[^\text{process}]+e_2[^*\text{state}]$, and $e_1[^*\text{process}]+e_2[^*\text{state}]$. We also characterized different patterns of telicity shifting which arise in semantic composition of predicates and locatives. Thus we have:

\[(59) \quad \begin{align*}
(\text{i}) \quad & e_1[^\text{process}] \to e_1[^\text{process}]+e_2[^*\text{state}] \\
& \text{walk in the room, run into the room, jog across the street} \\
& \text{walk to the house} \\
(\text{ii}) \quad & e_1[^*\text{process}]+e_2[^\text{state}] \to e_1[^*\text{process}]+e_2[^*\text{state}] \\
& \text{load the hay on the truck, escort Mary into the museum}
\end{align*}\]

Further, based on Path Structure and Orientation Structure defined in Section 3, we have accounted for the contrast between telic and atelic locatives in terms of “homogeneity” of paths, and further symmetric locatives are defined as determining “symmetric” paths, which are closed under path-converse relation.

The paper interprets English locatives in terms of spatial concepts only, and this approach reveals the close correlation between the spatial path structures and quantization of theme with respect to telicity of eventualities.

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