Generative Lexicon Theory: Integrating Theoretical and Empirical Methods

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Course Outline

- July 11: Introduction to GL and Data Analytics
- July 12: Qualia Structure
- July 13: Event Structure
- July 14: Argument Structure
- July 15: Meaning Composition

Lecture 1- July 11

Introduction to Generative Lexicon

- Basic concepts in GL
  - Motivation
  - Notation and Language: typed feature structures
  - Meaning Composition in GL
- Polysemy and the Lexicon-Pragmatics Interface
- Evidence-based linguistics and data analytics

Lecture 2- July 12

Qualia Structure

- What is a Quale?
- What motivates Qualia?
- Default Qualia and context updating
- Methodology to identify Qualia
- Data for each Quale
- Qualia and Conventionalized Attributes
- Qualia for Verbs

Lab on Qualia identification and extraction

Lecture 3- July 13

Event Structure

- Events as Structured Objects
- Event Types
    - States
    - Transitions
    - Point Verbs
    - Processes
- Events as Labeled Transition Systems
- Dynamic Event Models

Lab on identification of event types

Lecture 4- July 14

Argument Structure

- Argument Types in GL
  - True Arguments
  - Shadow Arguments
  - Hidden Arguments
- Argument Structure Representation
- Arguments and Defaulting

Lab on hidden and shadow arguments

Lecture 5- July 15

Meaning composition

- Basic Assumptions
- Simple Function Application
- Coercion
- Subselection
- Co-composition

Lab or assignment on coercion

Lecture 3: Event Structure

- Feedback on Qualia extraction Lecture 2
- Lexical redundancy
- Classic Event Structure
- Making ES dynamic
- Dynamic Event Models in GL

Results from CQL Queries and Lab

- Qualia values for F relation.
- Qualia values for C relation.
- Qualia values for T relation.
- Qualia values for A relation.

Redundancy

- Some word combinations are not possible because they are redundant.
- That is, a member of the combination somehow repeats a piece of lexical information provided by another member.
- Synthesis in Jezek 2016.

Lexical Redundancy

- Verbs with incorporated arguments are a case in point.
- They entail one or more participants that, being already incorporated in the verb, cannot be expressed, unless they are more specifically described.
- *He smelled gas with his nose.
- *We were swimming in water.
- We were swimming in cold water.
- I saw it with my own eyes!

Lexical Redundancy

- adjective-noun combinations
- rapid explosion
- invited guest
- mental thought
- round circle
- final end

Lexical Redundancy

- verb-adverb combinations
- He devoured his portion voraciously.
- They were whispering softly.
- You are now ready to begin collaborating together.

Aktionsarten – conceptual categories of event types

- Stative vs. Non-stative
- States -Conceived of as not changing over time, as well as extended in time and permanent.

(1) a. John is tall.
b. Mary knows the answer.
c. It is 8:00 p.m.
d. ! John is being tall.

Generally only compatible with simple present, but notice extended use of progressive and subtle meaning differences:

(2) . a. The statue stands in the square.
b. The statue is standing in the square.

Structural vs. Phenomenal distinction – Goldsmith and Woisetschlager (1979)

Temporary vs. permanent states

As seen with the English progressive marking before, states are not always permanent. Other languages also mark these differences (but not always for the same concepts).

- Spanish – *ser* vs. *estar*

  (3) a. Soy enfermo (I am a sickly person)
  b. Estoy enfermo (if I have a cold)

Processes

- Involve change and are extended in time. In present tense they need to be used in the progressive (unless habitual)

(4) . a. John ran a mile in under four minutes.
b. Sheila wrote three letters in an hour.
c. !John ran a mile for six minutes.
d. !Sheila ate an apple for ten minutes.

(5) a. John ran for twenty minutes.
b. Sheila ate apples for two days straight.
c. !John ran in twenty minutes.
d. !Sheila ate apples in two days.

Distinguishing Processes from Transitions

- Activities: Atelic i.e. have no natural endpoint or goal (e.g. *I'm running in the park*) Compatible with a durative adverbial (e.g. *for*) that profiles the amount of time the activity takes.
- Accomplishments: Telic i.e. have a natural endpoint of goal (e.g. *I'm running a mile*) Compatible with a container adverbial (e.g. *in*) that profiles the amount of time taken to reach the desired goal.

Typological Effects

Some languages are more systematic than English in distinguishing indicators of actual and potential terminal points. Thus Swedish use different prepositions:

(6) Jeg reser till Frankrike *på* två månader.
I('m) going to France for two months.

(7) Jeg reste i Frankrike *i* två månader.
I traveled in France for two months.

Achievements and points

Achievements: Events that are conceived of as instantaneous. Often, however, there is an underlying activity that causes a change of state. Their point-like nature tends to require them to be described in the past tense or narrative present.

(8) a. John shattered the window.
b. ! John shatters/is shattering the window.
c. The canals froze.
d. Mary found her keys.
e. *Mary is finding her keys.
f. John reached the top.

Achievements and points

Points: Similar to achievements in being conceived as instantaneous, but without the underlying run-up activity that characterizes gradual achievements

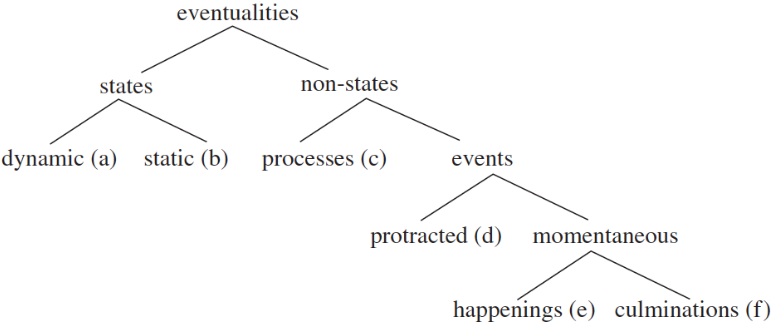
(9) a. Bill coughed.
b. The light flashed.
c. Bill is coughing.
d. The light is flashing.

(c) and (d) have an iterative interpretation. Compare with the gradual achievements *John is reaching the top* or *The canals are freezing*.

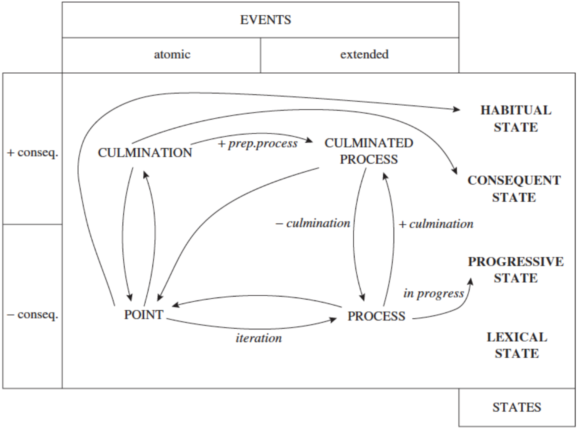
Vendler Event Classes + Semelfactive

- STATE: John loves his mother.
- ACTIVITY: Mary played in the park for an hour.
- ACCOMPLISHMENT: Mary wrote a novel.
- ACHIEVEMENT: John found a Euro on the floor.
- POINT: John knocked on the door (for 2 minutes).

Bach Eventuality Typology (Bach, 1986)


eventualities
states
non-states
dynamic (a)
static (b)
processes (c)
events
protracted (d)
momentaneous
happenings (e)
culminations (f)

Event Transition Graph (Moens and Steedman 1988)



Incremental Theme Verbs

- “Certain NP’s measure out the event. They are direct objects consumed or created in increments over time (cf. *eat an apple* vs. *push a chart*)” (Tenny 1994).
- In *Mary drank a glass of wine* “every part of the glass of wine being drunk corresponds to a part of the drinking event” (Krifka 1992)
- “Incremental themes are arguments that are completely processed only upon termination of the event, i.e., at its end point” (Dowty 1991).

Degree Achievements

- Verbs with variable aspectual behavior: they seems to be change of state verbs like other achievements , but allow durational adverbs (Dowty 1979, Hay, Kennedy and Levin 1999, Rappaport Hovav 2008).
- No implication that exactly the same change of state took place over and over again (no semelfactives).
- Scalar predicates: verbs which lexically specify a change along a scale inasmuch as they denote an ordered set of values for a property of an event argument (Hay, Kennedy and Levin 1999, Rappaport Hovav 2008).
- For example *cool*, *age*, *lenghten*, *shorten*; *descend*.
- *Let the soup cool for 10 minutes*.
- *I went on working until the soup cooled*.

Points

- Moens and Steedman 1988 analyze point expressions as those that are not normally associated to a consequent state (consequent state defined as no transition to a new state in the world – according to Moens and Steedman a point is an event whose consequences are not at issue in the discourse).
- Semelfactives (Smith 1990, Rothstein 2004).
- **arrived/landed for five minutes*, *knocked/tapped for five minutes*.
- Points admit iterative readings under coercive contexts (Moens and Steedman 1988).

Aspectual Composition

- Bare plurals and mass-terms arguments can make a sentence with a telic predicate behave as if it were 'durative' or 'imperfective' in aspect (Verkuyl 1972).
- *John drank a glass of beer* (perfective).
- *John drank beer* (imperfective).

Aspectual Coercion

- "A person *leads* somebody somewhere" (PROCESS) vs. "A road *leads* somewhere" (STATE)
- "An object *falls* to the ground" (TRANSITION) vs. "A case *falls* into a certain category" (STATE)

Subatomic Event Structure

Pustejovsky (1991)

(10) a. EVENT → STATE | PROCESS | TRANSITION

b. STATE: → e

c. PROCESS: → $e_1 \ldots e_n$

d. TRANSITION_{ach}: → STATE STATE

e. TRANSITION_{acc}: → PROCESS STATE

Qualia Structure for Causative

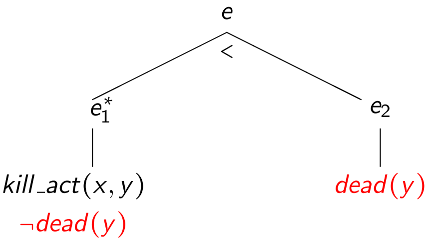
Pustejovsky (1995)

$$\begin{bmatrix} \textbf{kill} & & \\ \text{EVENTSTR} & = & \begin{bmatrix} \text{E}_1 & = & \textbf{e}_1\textbf{:process} \\ \text{E}_2 & = & \textbf{e}_2\textbf{:state} \\ \text{RESTR} & = & <_\propto \\ \text{HEAD} & = & \textbf{e}_1 \end{bmatrix} \\ \text{ARGSTR} & = & \begin{bmatrix} \text{ARG1} & = & \boxed{1}\begin{bmatrix} \textbf{ind} & & \\ \text{FORMAL} & = & \textbf{physobj} \end{bmatrix} \\ \text{ARG2} & = & \boxed{2}\begin{bmatrix} \textbf{animate\_ind} & & \\ \text{FORMAL} & = & \textbf{physobj} \end{bmatrix} \end{bmatrix} \\ \text{QUALIA} & = & \begin{bmatrix} \textbf{cause-lcp} & & \\ \text{FORMAL} & = & \textbf{dead}(\textbf{e}_2, \ \boxed{2}\ ) \\ \text{AGENTIVE} & = & \textbf{kill\_act}(\textbf{e}_1, \ \boxed{1}\ , \ \boxed{2}\ ) \end{bmatrix} \end{bmatrix}$$

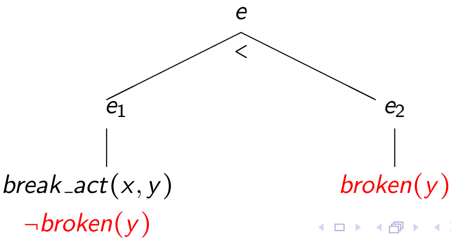
Opposition Structure

Pustejovsky (2000)

(11) kill



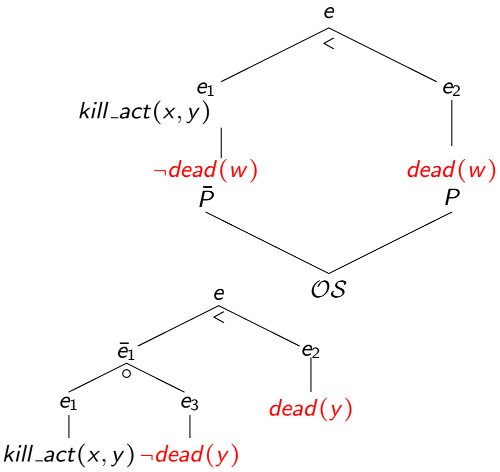
(12) break



Qualia Structure with Opposition Structure

$$
\begin{bmatrix}
\textbf{kill} & & \\
\text{EVENTSTR} & = & \begin{bmatrix} \text{E}_0 & = & \mathbf{e_0}\textbf{:state} \\ \text{E}_1 & = & \mathbf{e_1}\textbf{:process} \\ \text{E}_2 & = & \mathbf{e_2}\textbf{:state} \\ \text{RESTR} & = & <_\propto \\ \text{HEAD} & = & \mathbf{e_1} \end{bmatrix} \\
\text{ARGSTR} & = & \begin{bmatrix} \text{ARG1} & = & \boxed{1}\begin{bmatrix}\textbf{ind} & & \\ \text{FORMAL} & = & \textbf{physobj}\end{bmatrix} \\ \text{ARG2} & = & \boxed{2}\begin{bmatrix}\textbf{animate\_ind} & & \\ \text{FORMAL} & = & \textbf{physobj}\end{bmatrix} \end{bmatrix} \\
\text{QUALIA} & = & \begin{bmatrix} \textbf{cause-lcp} & & \\ \text{FORMAL} & = & \textbf{dead}(\mathbf{e_2}, \boxed{2}) \\ \text{AGENTIVE} & = & \textbf{kill\_act}(\mathbf{e_1}, \boxed{1}, \boxed{2}) \\ \text{PRECOND} & = & \neg\textbf{dead}(\mathbf{e_0}, \boxed{2}) \end{bmatrix}
\end{bmatrix}
$$

Opposition is Part of Event Structure



e

$<$

e_1 e_2

$kill\_act(x, y)$

$\neg dead(w)$ $dead(w)$

$\bar{P}$ P

$\mathcal{OS}$

e

$<$

$\bar{e}_1$ e_2

$\circ$

e_1 e_3 $dead(y)$

$kill\_act(x, y)$ $\neg dead(y)$

Dynamic Extensions to GL

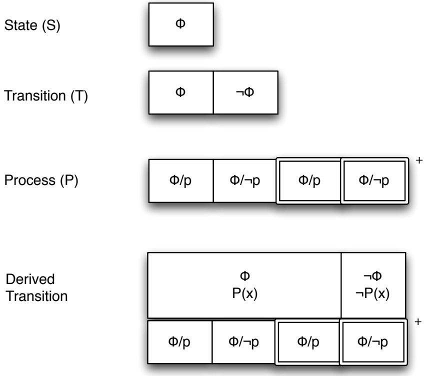
- Qualia Structure: Can be interpreted dynamically
- Dynamic Selection: Encodes the way an argument participates in the event
- Tracking change: Models the dynamics of participant attributes

Inherent Dynamic Aspect of Qualia Structure

- Parameters of a verb, P, extend over sequential frames of interpretation (subevents).
- P is decomposed into different subpredicates within these events:

$$\text{Verb}(\text{Arg}_1\text{Arg}_2) \implies \lambda y \lambda x \boxed{P_1(x, y)}_A \boxed{P_2(y)}_F$$

Frame-based Event Structure



State (S)

Φ

Transition (T)

Φ ¬Φ

Process (P)

Φ/p Φ/¬p Φ/p Φ/¬p +

Derived Transition

Φ P(x)

¬Φ ¬P(x)

Φ/p Φ/¬p Φ/p Φ/¬p +

2nd Conference on CTF, Pustejovsky (2009)

Dynamic Event Structure

- Events are built up from multiple (stacked) layers of primitive constraints on the individual participants.
- There may be many changes taking place within one atomic event, when viewed at the subatomic level.

Dynamic Interval Temporal Logic

(Pustejovsky and Moszkowicz, 2011)

- Formulas: ϕ propositions. Evaluated in a state, s.
- Programs: α, functions from states to states, $s \times s$. Evaluated over a pair of states, (s, s').
- Temporal Operators: $\bigcirc\phi$, $\Diamond\phi$, $\Box\phi$, $\phi\,\mathcal{U}\psi$.
- Program composition:
  1. They can be ordered, $\alpha;\beta$ (α is followed by β);
  2. They can be iterated, a^* (apply a zero or more times);
  3. They can be disjoined, $\alpha \cup \beta$ (apply either α or β);
  4. They can be turned into formulas
     $[\alpha]\phi$ (after every execution of α, ϕ is true);
     $\langle\alpha\rangle\phi$ (there is an execution of α, such that ϕ is true);
  5. Formulas can become programs, $\phi?$ (test to see if ϕ is true, and proceed if so).

Dynamic Event Structure

(13) a. Mary was sick today.
b. My phone was expensive.
c. Sam lives in Boston.

We assume that a *state* is defined as a single frame structure (event), containing a proposition, where the frame is temporally indexed, i.e., $e^i \rightarrow \phi$ is interpreted as ϕ holding as true at time i. The frame-based representation from Pustejovsky and Moszkowicz (2011) can be given as follows:

Dynamic Event Structure

(14) $\boxed{\phi}^{i}_{e}$

Propositions can be evaluated over subsequent states, of course, so we need an operation of concatenation, +, which applies to two or more event frames, as illustrated below.

(15) $\boxed{\phi}^{i}_{e} + \boxed{\phi}^{j}_{e} = \boxed{\phi}^{[i,j]}_{e}$

Semantic interpretations for these are:

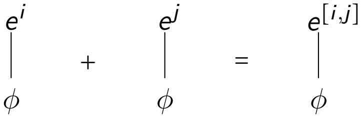
(16) a. $[\![\boxed{\phi}]\!]_{\mathbf{M},i} = 1$ iff $V_{\mathbf{M},i}(\phi) = 1$.

b. $[\![\boxed{\phi}\boxed{\phi}]\!]_{\mathbf{M},\langle i,j\rangle} = 1$ iff $V_{\mathbf{M},}(\phi) = 1$ and $V_{\mathbf{M},j}(\phi) = 1$, where $i < j$.

Dynamic Event Structure

(17)

Tree structure for event concatenation:



Labeled Transition System (LTS)

The dynamics of actions can be modeled as a Labeled Transition Systems (LTS).

An LTS consists of a 3-tuple, $\langle S, Act, \rightarrow \rangle$, where

(18) a. S is the set of states;
b. Act is a set of actions;
c. $\rightarrow$ is a total transition relation: $\rightarrow \subseteq S \times Act \times S$.

(19) $(e_1, \alpha, e_2) \in \rightarrow$

cf. Fernando (2001, 2013)

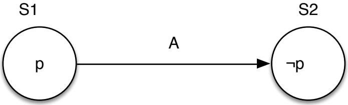
Labeled Transition System (LTS)

An action, α provides the labeling on an arrow, making it explicit what brings about a state-to-state transition.

As a shorthand for

(20) a. $(e_1, \alpha, e_2) \in\rightarrow$, we will also use:

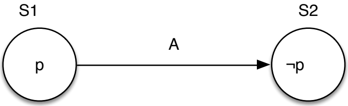
b. $e_1 \xrightarrow{\alpha} e_3$



Labeled Transition System (LTS)

If reference to the state content (rather than state name) is required for interpretation purposes, then as shorthand for: $(\{\phi\}_{e_1}, \alpha, \{\neg\phi\}_{e_2}) \in \rightarrow$, we use:

(21) $\boxed{\phi}_{e_1} \xrightarrow{\alpha} \boxed{\neg\phi}_{e_2}$



Temporal Labeled Transition System (TLTS)

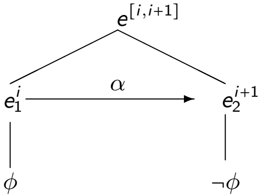
With temporal indexing from a Linear Temporal Logic, we can define a Temporal Labeled Transition System (TLTS). For a state, e_1, indexed at time i, we say $e_1@i$.

$(\{\phi\}_{e_1@i}, \alpha, \{\neg\phi\}_{e_2@i+1}) \in \rightarrow_{(i,i+1)}$, we use:

(22) $\boxed{\phi}^{i}_{e_1} \xrightarrow{\alpha} \boxed{\neg\phi}^{i+1}_{e_2}$

Dynamic Event Structure

(23)

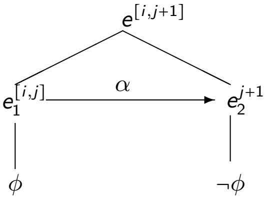


Dynamic Event Structure

(24) Mary awoke from a long sleep.

The state of being asleep has a duration, $[i, j]$, who's valuation is gated by the waking event at the "next state", $j + 1$.

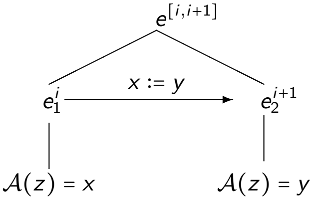
(25)



Simple First-order Transition

(26) $x := y$ (ν-transition)
"x assumes the value given to y in the next state."
$\langle \mathcal{M}, (i, i+1), (u, u[x/u(y)]) \rangle \vDash x := y$
iff $\langle \mathcal{M}, i, u \rangle \vDash s_1 \wedge \langle \mathcal{M}, i+1, u[x/u(y)] \rangle \vDash x = y$

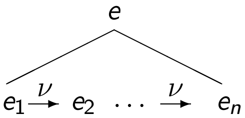
(27)



Processes

With a ν-transition defined, a *process* can be viewed as simply an iteration of basic variable assignments and re-assignments:

(28)



Spatial Relations in Motion Predicates

- Topological Path Expressions
  arrive, leave, exit, land, take off
- Orientation Path Expressions
  climb, descend
- Topo-metric Path Expressions
  approach, near, distance oneself
- Topo-metric orientation Expressions
  just below, just above

Language Data

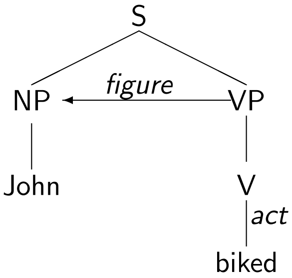
- Manner construction languages
  Path information is encoded in directional PPs and other adjuncts, while verb encode manner of motion
  English, German, Russian, Swedish, Chinese
- Path construction languages
  Path information is encoded in matrix verb, while adjuncts specify manner of motion
  Modern Greek, Spanish, Japanese, Turkish, Hindi

Defining Motion (Talmy 1985)

(29) a. The *event* or situation involved in the change of location ;
b. The object (construed as a point or region) that is undergoing movement (the *figure*);
c. The region (or *path*) traversed through the motion;
d. A distinguished point or region of the path (the *ground*);
e. The *manner* in which the change of location is carried out;
f. The *medium* through which the motion takes place.

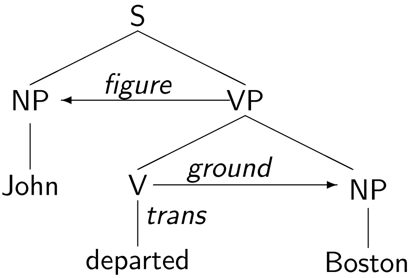
Manner Predicates

(30)



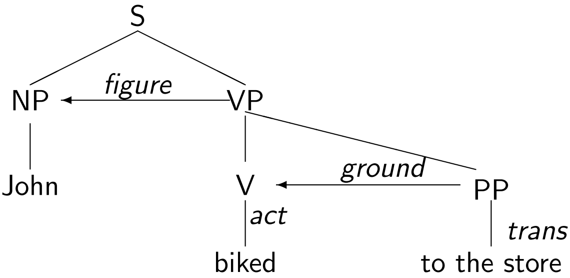
Path Predicates

(31)



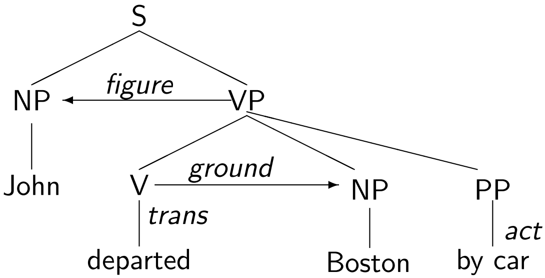
Manner with Path Adjunction

(32)



Path with Manner Adjunction

(33)



Path+manner Predicates (Talmy 2000) 1/2

(34) a. Isabel climbed for 15 minutes.
b. Nicholas fell 100 meters.

(35) a. There is an action (*e*) bringing about an iterated non-distinguished change of location;
b. The figure undergoes this non-distinguished change of location;
c. The figure creates (leaves) a path by virtue of the motion.
d. The action (*e*) is performed in a certain manner.
e. The path is oriented in an identified or distinguished way.

Path+manner Predicates (Talmy 2000) 2/2

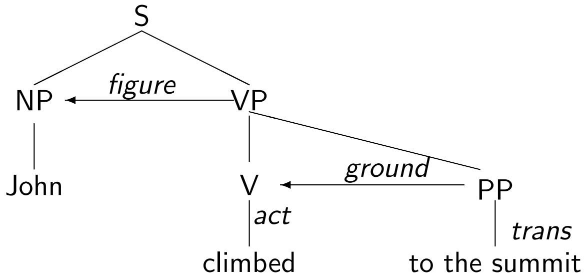
Unlike pure manner verbs, this class of predicates admits of two compositional constructions with adjuncts.

(36) **Manner of motion verb with path adjunct;**
John climbed to the summit.

(37) **Manner of motion verb with path argument;**
John climbed the mountain.

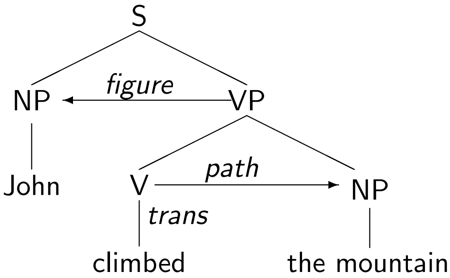
With Path Adjunct

(38)

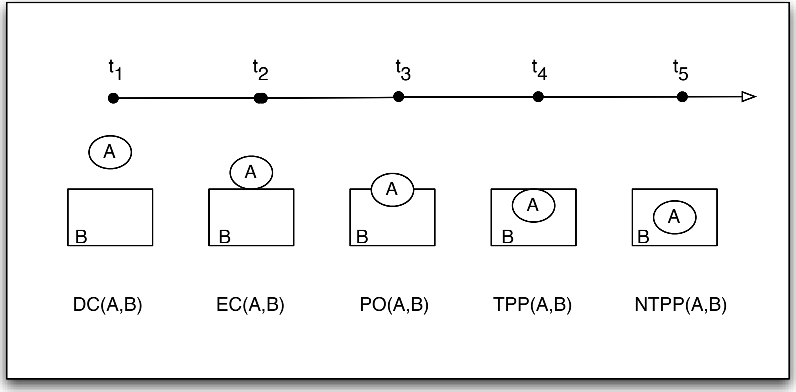


With Path Argument

(39)



Tracking Motion with RCC8: example of enter



Capturing Motion as Change in Spatial Relations

Dynamic Interval Temporal Logic

- Path verbs designate a distinguished value in the change of location, from one state to another.
  The change in value is tested.
- Manner of motion verbs iterate a change in location from state to state.
  The value is assigned and reassigned.

Directed Motion

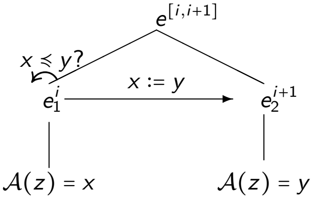
(40) $\overset{\overset{x \neq y?}{\curvearrowleft}}{\boxed{loc(z) = x}}_{e_1} \xrightarrow{\nu} \boxed{loc(z) = y}_{e_2}$

When this test references the ordinal values on a scale, $\mathcal{C}$, this becomes a *directed ν-transition ($\vec{\nu}$)*, e.g., $x \preccurlyeq y$, $x \succcurlyeq y$.

(41) $\vec{\nu} =_{df} \overset{\overset{\mathcal{C}?}{\curvearrowleft}}{e_i} \xrightarrow{\nu} e_{i+1}$

Directed Motion

(42)



Change and Directed Motion

- Manner-of-motion verbs introduce an assignment of a location value:
  $loc(x) := y; y := z$
- Directed motion introduces a dimension that is measured against:
  $d(b, y) < d(b, z)$
- Path verbs introduce a pair of tests:
  $\neg\phi? \ldots \phi?$

Change and the Trail it Leaves

- The execution of a change in the value to an attribute $\mathcal{A}$ for an object x leaves a trail, τ.
- For motion, this trail is the created object of the path p which the mover travels on;
- For creation predicates, this trail is the created object brought about by order-preserving transformations as executed in the directed process above.

Motion Leaving a Trail

(43) MOTION LEAVING A TRAIL:

a. Assign a value, y, to the location of the moving object, x.

$$loc(x) := y$$

b. Name this value b (this will be the beginning of the movement);

$$b := y$$

c. Initiate a path p that is a list, starting at b;

$$p := (b)$$

d. Then, reassign the value of y to z, where $y \neq z$

$$y := z, y \neq z$$

e. Add the reassigned value of y to path p;

$$p := (p, z)$$

e. Kleene iterate steps (d) and (e);

Quantifying the Resulting Trail

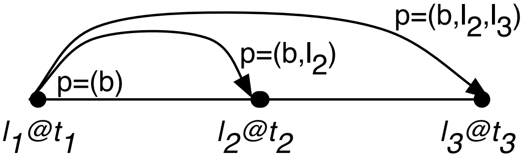


Figure: Directed Motion leaving a Trail

(44) a. The ball rolled 20 feet.
$\exists p \exists x[[roll(x,p) \wedge ball(x) \wedge length(p) = [20, foot]]$
b. John biked for 5 miles.
$\exists p[[bike(j,p) \wedge length(p) = [5, mile]]$

Generalizing the Path Metaphor

- We generalize the Path Metaphor to the analysis of the creation predicates.
- We analyze creation predicates as predicates referencing two types of scales.

Type of Creation Verbs

(45) a. John wrote a letter.
b. Sophie wrote for hours.
c. Sophie wrote for an hour.

(46) a. John built a wooden bookcase.
b. *John built for weeks.

Linguistic View on Scales

- Some verbs expressing change are associated with a scale while others are not (scalar vs. non-scalar change).
- There is a single scale domain (ordinal scale), which varies with respect to mereological complexity (two-point vs. multi-point) and specificity of the end point (bounded vs. unbounded).
- Scales are classified on the basis of the attribute being measured:
  - PROPERTY SCALES: often found with change of state verbs.
  - PATH SCALES: most often found with directed motion verbs.
  - EXTENT SCALES: most often found with incremental theme verbs.

Linguistic View on Scales

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- For example, Rappaport Hovav 2008, Kennedy 2009 claim that "the scale which occurs with incremental theme verbs (extent scale) is not directly encoded in the verb, but rather provided by the referent of the direct object".
- This has lead them to the assumption that when nominal reference plays a role in measuring the change, V is not associated with a scale (denoting a non-scalar change).

Challenge for Scalar Models

- Identify the source(s) of the measure of change.
- What is the basic classification of the predicate with respect to its scalar structure?
- What is the exact contribution of each member of the linguistic expression to the measurement of the change?
- What is the role of nominal reference in aspectual composition?

How Language Encodes Scalar Information

Pustejovsky and Jezek 2012

- Verbs reference a specific scale.
- We measure change according to this scale domain.
- Scales are introduced by predication (encoded in a verb).
- Scales can be introduced by composition (function application).
- Verbs may reference multiple scales.

Scale Theory: Stevens (1946), Krantz et al (1971)

- Nominal scales: composed of sets of categories in which objects are classified;
- Ordinal scales: indicate the order of the data according to some criterion (a partial ordering over a defined domain). They tell nothing about the distance between units of the scale.
- Interval scales: have equal distances between scale units and permit statements to be made about those units as compared to other units; there is no zero. Interval scales permit a statement of “more than” or “less than” but not of “how many times more.”
- Ratio scales: have equal distances between scale units as well as a zero value. Most measures encountered in daily discourse are based on a ratio scale.

Generalizing the Path Metaphor to Creation Predicates

Pustejovsky and Jezek 2012

- Use multiple scalar domains and the “change as program” metaphor proposed in Dynamic Interval Temporal Logic (DITL, Pustejovsky 2011, Pustejovsky & Moszkowicz 2011).

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- If the program is “change by testing”, Result refers to the current value of the attribute after an event (e.g., the house in build a house, the apple in eat an apple, etc.).
- If the program is “change by assignment”, Result refers to the record or trail of the change (e.g., the path of a walking, the stuff written in writing, etc.).

Scale shifting

- Scale Shifting is mapping from one scalar domain to another scalar domain.
  ordinal ⇒ nominal
  nominal ⇒ ordinal
  ordinal ⇒ interval
  ...
- Scale Shifting may be triggered by:
- Adjuncts: *for*/*in* adverbials, degree modifiers, resultative phrases, etc.
- Arguments (selected vs. non-selected, semantic typing, quantification).

Generalizing the Path Metaphor to Creation Predicates

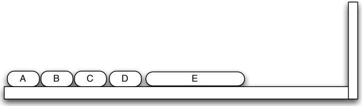
Pustejovsky and Jezek 2012

Accomplishments are Lexically Encoded Tests.
John built a house.

- Test-predicates for creation verbs
- build selects for a quantized individual as argument.
- $\lambda\vec{z}\lambda y\lambda x[build(x,\vec{z},y)]$

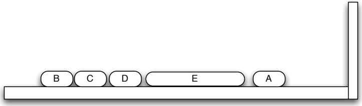
- An ordinal scale drives the incremental creation forward
- A nominal scale acts as a test for completion (telicity)

Incremental Theme and Parallel Scales



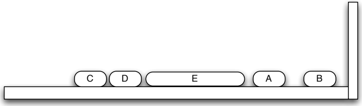
- Mary is building a table.
- Change is measured over an **ordinal scale**.
- Trail, τ is null.

Incremental Theme and Parallel Scales



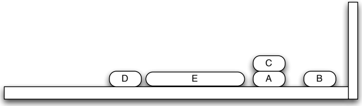
- Mary is building a table.
- Change is measured over an **ordinal scale**.
- Trail, $\tau = [A]$.

Incremental Theme and Parallel Scales



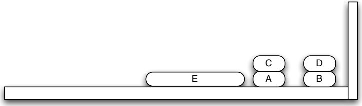
- Mary is building a table.
- Change is measured over an **ordinal scale**.
- Trail, $\tau = [A, B]$

Incremental Theme and Parallel Scales



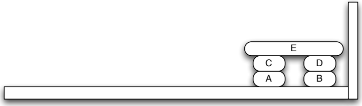
- Mary is building a table.
- Change is measured over an **ordinal scale**.
- Trail, $\tau = [A, B, C]$

Incremental Theme and Parallel Scales



- Mary is building a table.
- Change is measured over an **ordinal scale**.
- Trail, $\tau = [A, B, C, D]$

Incremental Theme and Parallel Scales



- Mary built a table.
- Change is measured over a **nominal scale**.
- Trail, $\tau = [A, B, C, D, E]$; $table(\tau)$.

Accomplishments

(47) a. John built a table.
b. Mary walked to the store.

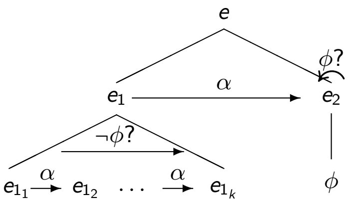
$build(x,z,y)$	$build(x,z,y)^+$	$build(x,z,y), y = v$
$\neg table(v)$		$table(v)$

$_{\langle i,j \rangle}$

Table: Accomplishment: parallel tracks of changes

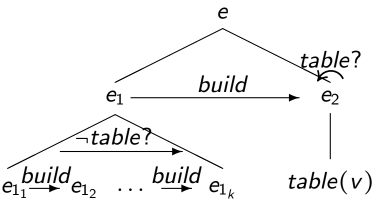
Dynamic Event Structure

(48)



Parallel Scales define an Accomplishment

(49)



Corpus Study of Detecting Aktionsarten

- [V . . . **for** **TIME EXPRESSION**]
- "for" [word!="\."]{0,5}
  [lemma="second | minute | hour | day | week | month | year"]
- [V . . . **in** **TIME EXPRESSION**]
- "in" [word!="\."]{0,5}
  [lemma="second | minute | hour | day | week | month | year"]