Lecture 4. Describing Change and Changing Descriptions

- Persistence and Predication
- Descriptions undergoing Change
- Is Change Selected for by an Argument?

The “Fail Early” Strategy of Selection

(1) Arguments can be viewed as pretests for performing the action in the predicate.

(2) If the argument conditions are not satisfied, the predicate does not get interpreted.

Argument Typing as Abstracting from the Predicate

(3) Richer typing for arguments:

i. Identifies specific predicates in the body of the expression that are characteristic functions of an argument;

ii. pulls this subset of predicates out of the body, and creates a $pretest$ to the expression as a restricted quantification over a domain of sorts, denoted by that set of predicates.

Argument Typing as Abstracting from the Predicate

(4)

$$\lambda x_2 \lambda x_1 [\Phi_1, \ldots \overbrace{\Phi_{x_1}}^{\tau}, \ldots \overbrace{\Phi_{x_2}}^{\sigma}, \ldots, \Phi_k]$$

σ and τ are sets of predicates describing properties of arguments to the predicate complex.

Predicate Abstractions Become Argument Types

(5)

$$\lambda x_2 : \sigma \; \lambda x_1 : \tau[\Phi_1, \ldots, \Phi_k - \{\Phi_{x_1}, \Phi_{x_2}\}]$$

(6) σ and τ have now become reified as types on the arguments.

Selecting for Change

(7) a. Mary broke the glass.
b. John built a house.
c. The child ate a cookie.

(8) a. The father comforted the crying child.
b. The woman on the boat jumped into the water.
c. Mary rescued the drowning man.

(9) a. Mary repaired every leaky faucet in the house.

b. John mixed the powdered milk into the water.

c. Nicholas fixed the flat.

Event Persistence Structure

(10) DISPLACED TEMPORAL REFERENCE

a. The President was born in 1946.

b. Tom met his wife in 1988.

c. All rich men were obnoxious children.

Tracking Descriptions in Discourse

(11)a. John escaped from the police.

b. The man escaped from the police.

c. The prisoner escaped from the police.

(12) *passenger*, *pedestrian*. *victim*

(13) DISCOURSE EPITHETS

a. Five prisoners have escaped from Huntsville Prison.

b. [. . .] The escaped prisoners are hiding out in the woods around Crawford.

(14) The audience$_i$ left the music hall.

(15) a. $*$It$_i$ then went home.

b. They$_i$ then went home.

c. It$_i$/They$_i$ had just heard Bernard Haitink's last performance.

Coherent Event Descriptions

(16)a. John comforted the crying child.

b. Cathie mended the torn dress.

(17)a. The plumber fixed every leaky faucet.

b. The plumber fixed every blue faucet.

(18)a. !Mary cleaned the clean table.

b. !John built the built house.

c. !John drank the empty glass of milk.

What Changes and What Doesn't

(19) a. Mary was hired as lecturer on Tuesday.

b. Mary painted the house green.

c. Mary showered and dried herself off.

(20) a. Situations: s, how the world may be described;

b. Fluents: f, time-varying properties of individuals;

c. Actions: a, operators that change the value of fluents.

(21) a. Effect Axioms: take into account the preconditions of an action for it to happen;

b. Frame Axioms: take into account what does not change with an action

c. Order of $f \times a$ frame axioms for a given domain.

Tense Interpretation

Tense is a function over event descriptions, $\mathcal{E}$, which are of type $e^\sigma \rightarrow t$, and is itself of type $(e^\sigma \rightarrow t) \rightarrow t$. The anchoring relation $anch$ embeds an event within an interval structure (Pustejovsky, 1995).

(22) $[\![Tns_\alpha]\!] = \lambda\mathcal{E}\exists i\exists e[\alpha(i,n) \wedge anch(i,e) \wedge \mathcal{E}(e)]$

English tenses where n is Kamp's now operator:

(23)a. $[\![PAST]\!] = \lambda\mathcal{E}\exists i\exists e[i \leq n \wedge anch(i,e) \wedge \mathcal{E}(e)]$

b. $[\![FUT]\!] = \lambda\mathcal{E}\exists i\exists e[n \leq i \wedge anch(i,e) \wedge \mathcal{E}(e)]$

c. $[\![PRES]\!] = \lambda\mathcal{E}\exists i\exists e[i \subseteq n \wedge anch(i,e) \wedge \mathcal{E}(e)]$

Tense and Ordering in Discourse

(24)a. Sophie$_i$ walked in wet.

b. Cathie dried her$_i$ off.

(25) a. $\exists i_1 \exists e_1 [wet(e_1, s) \wedge anch(i_1, e_1)]$

b. $\exists i_2 \exists e_1 [dry(e_2, s) \wedge anch(i_2, e_2)]$

c. $i_1 \leq i_2$

(26) a. Sophie's hamster$_i$ died today.

b. He$_i$ had been sick.

(27) a. $\exists i_1 \exists e_1[die(e_1, oreo) \wedge anch(i_1, e_1) \wedge i_1 \leq n]$

b. $\exists i_2, i_3 \exists e_1[sick(e_2, oreo) \wedge anch(i_2, e_2) \wedge i_2 \leq i_3 \wedge i_3 \leq n]$

c. $i_2 \leq i_1$

(28) a. John$_i$ walked in.

b. He$_i$ sat down.

(29) a. $\exists i_1 \exists e_1[walking(e_1, j) \wedge anch(i_1, e_1)]$

$\models \exists i_1 \exists e_1[standing(e_3, j) \wedge anch(i_1, e_3)]$

b. $\exists i_2 \exists e_2[sitting(e_2, j) \wedge anch(i_2, e_2)]$

c. $i_1 \leq i_2$

Argument Selection and Argument Description

For a description, D, in a situation, s, with the application of an action, a, D can be characterized in one of two ways:

- Persistent Description: The descriptive force of D in s holds persistently throughout the action, a;
- Dynamic Description: The descriptive force of D in s is altered by virtue of the action, a, rendering D unsatisfiable with the resulting situation, s'.

Principles of Adjectival Selection

Every Phrase, X, occurring as modifier to a head, N, is associated with a specific qualia role for N. If X modifies:

i. $\textsc{Formal}$: then the event corresponds to overlap, '$\circ$', with the head N;

ii. $\textsc{Telic}$: then the event corresponds to either '$>$' relation or a generic interpretation. $\circ_g$;

iii. $\textsc{Agentive}$: then the event corresponds to the '$<$' relation relative to N;

iv. $\textsc{Const}$: then the event corresponds to overlap, '$\circ$', relation with the head N.

(30)

Adjective	Qualia Selection
well-built	Agentive
unbaked	Agentive
red	Formal
stone	Constitutive
wooden	Constitutive
useful	Telic
carved	Agentive
effective	Telic
fast	Telic
heavy	Formal
dense	Const
large	Formal

Table of Qualia Selection Properties

(31)a. a well-built (A_1) house ($[F, C, A_1, T]$)

b. a two-story (F_1) house ($[F_1, C, A, T]$)

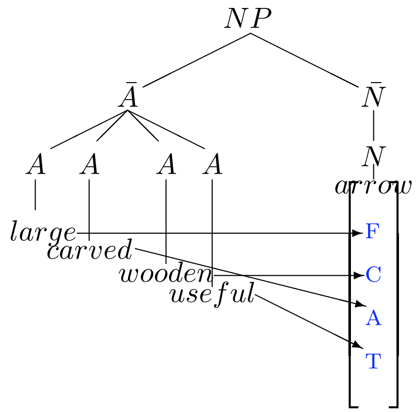
c. a vacation (T_1) house ($[F, C, A, T_1]$)

d. a brick (C_1) house ($[F, C_1, A, T]$)

(32)a. a large carved wooden useful arrow

b. a large (F_1) carved (A_2) wooden (C_3) useful (T_4) arrow
($[F_1, C_3, A_2, T_4]$)

(33)



Events and the Arguments they Select

(34) a. John kissed Mary.

b. $\exists e[kiss(e, j, m)]$

c.

$$\overbrace{\quad\overbrace{kiss}\qquad\qquad\qquad}^{John, Mary}$$

(35) Mary broke a glass.

(36) a. $\exists i_0 \exists e_0 [breaking(e_0) \wedge anch(i_0, e_0)]$

b. $\exists x \exists e_1 \exists e_2 [glass(x) \wedge \neg broken(e_1, x) \wedge broken(e_2, x) \wedge e_1 < e_2]$

c. $\exists i_1 \exists i_2 [anch(i_1, e_1) \wedge anch(i_2, e_2)] \wedge i_1 < i_2$

d. $i_1 \subseteq i_0, i_2 \subseteq i_0$

e.

$$\exists x \, \overbrace{\overbrace{break\_act}^{glass(x)} \qquad \overbrace{broken}^{\neg glass(x)}}^{John}$$

(37) a. John died.

b. $\exists i_0 \exists e_0 [dying(e_0) \wedge anch(i_0, e_0)]$

c. $\exists e_1 \exists e_2 [alive(e_1, j) \wedge dead(e_2, j) \wedge e_1 < e_2]$

d. $\exists i_1 \exists i_2 [anch(i_1, e_1) \wedge anch(i_2, e_2)] \wedge i_1 < i_2$

e. $i_1 \subseteq i_0, i_2 \subseteq i_0$

(38) a. John hit a pedestrian.

b.

$$\overbrace{\overbrace{\overbrace{hit}}^{pedestrian}}^{John}$$

(39) a. $\exists x, e_1[john(e_1, x) \wedge anch(i_0, e_1)]$

b. $\exists y, e_1[pedestrian(e_2, y) \wedge anch(i_1, e_2)]$

c. $\exists e_3[hitting(e_3, x, y) \wedge anch(i_2, e_3)]$

d. $i_2 \subseteq i_1 \subseteq i_0 \wedge i_2 < n$

(40) LEXICAL CLASSES OF CHANGE (LEVIN, 1993)

a. CREATION AND TRANSFORMATION: build, assemble, bake, cook, construct, design.

b. DESTRUCTION: destroy, annihilate, decimate, demolish, ruin, wreck.

c. CHANGE OF STATE: break, crack, crush, rip, tear, bend, fold, cook, bake, boil.

d. CALIBRATABLE CHANGE OF STATE: climb, decline, decrease, fall, drop, increase, jump.

Qualia Structure for Causatives

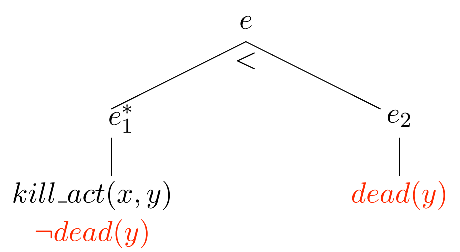
$$\begin{bmatrix} \textbf{kill} & \\ \text{EVENTSTR} = & \begin{bmatrix} \text{E}_1 = \mathbf{e_1{:}process} \\ \text{E}_2 = \mathbf{e_2{:}state} \\ \text{RESTR} = <_\alpha \\ \text{HEAD} = \mathbf{e_1} \end{bmatrix} \\ \text{ARGSTR} = & \begin{bmatrix} \text{ARG1} = \boxed{1} \begin{bmatrix} \textbf{ind}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

Qualia Structure with Opposition

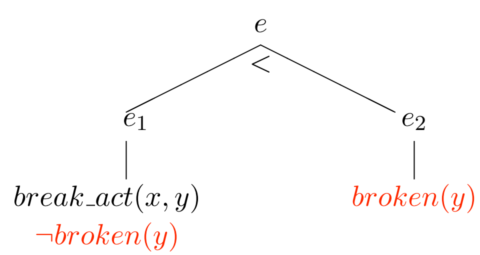
$$
\begin{bmatrix}
\textbf{kill} & \\
\text{EVENTSTR} = & \begin{bmatrix} \text{E}_0 = \textbf{e}_0\textbf{:state} \\ \text{E}_1 = \textbf{e}_1\textbf{:process} \\ \text{E}_2 = \textbf{e}_2\textbf{:state} \\ \text{RESTR} = <_\propto \\ \text{HEAD} = \textbf{e}_1 \end{bmatrix} \\
\text{ARGSTR} = & \begin{bmatrix}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

Opposition Structure: Predicate Decomposition

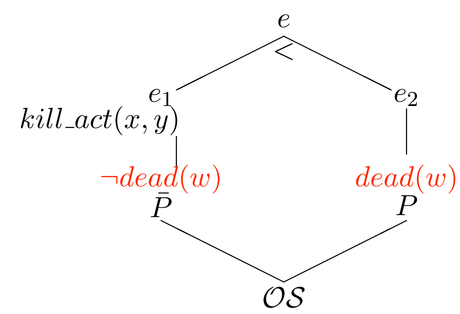
(41) kill

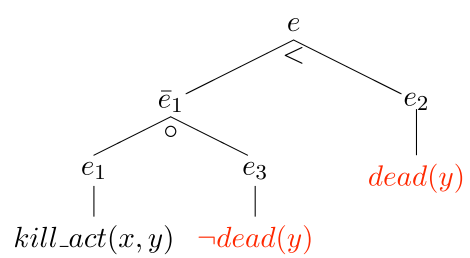


(42) break



Opposition is Part of Event Structure





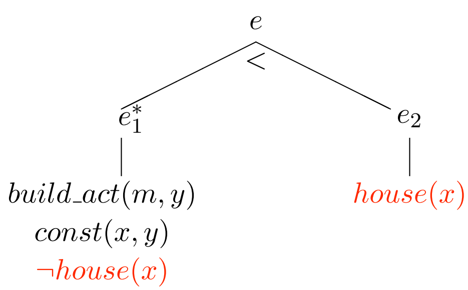
(43) build

$$\begin{bmatrix} \textbf{build} \\ \textsc{argstr} = \begin{bmatrix} \textsc{arg}_1 = x\textbf{:animate\_individual} \\ \textsc{arg}_2 = \begin{bmatrix} \textbf{y:artifact} \\ \textsc{const} = z \end{bmatrix} \\ \textsc{d-arg}_1 = z\textbf{:material} \end{bmatrix} \end{bmatrix}$$

Dynamic Descriptions

What happens when the description of the argument does not properly hold throughout the event?

(44) build a house



$$\lambda y \lambda^* z \lambda x \lambda e_2 \exists e_1 \exists P[build_1(e_1, x, z) \wedge P(e_2, y) \wedge e_1 \leq e_2]$$

Selective Typing for Adjectives

(45) a. *heavy*, *two-story*: $(\text{PHYS} \multimap \underline{t}) \multimap (\text{PHYS} \multimap \underline{t})$

b. *useful*, *vacation*: $(\text{PHYS} \otimes_T \tau) \multimap (\text{PHYS} \multimap \underline{t})$

c. *unbaked*, *well-built*: $(\text{PHYS} \otimes_A \tau) \multimap (\text{PHYS} \multimap \underline{t})$

d. *dense*, *brick*: $(\text{PHYS} \copyright \tau) \multimap (\text{PHYS} \multimap \underline{t})$

Adjectives and the Functions that Control them

If this is the way to type adjectives, then the way to get the sortals into and out of these states can be accomplished by $gating$ $functions$ introduced in predication, and interpreted dynamically.

Types of Opposition

(46) a. Bill is healthy
  a'. Bill is not healthy.

b. Bill is sick.
  b'. Bill is not sick.

(47) a. Jan is male.
  a'. Jan is not male.

b. Jan is female.
  b'. Jan is not female.

Types of Opposition: II

(48)a. For a binary predicate, P, the opposition is $\neg P$.

b. If the language lexicalizes both forms, then $\langle P, \neg P \rangle$, $\langle P, Q \rangle$, $\langle \neg Q, Q \rangle$.

c. For a binary adjective, $\lambda x \lambda e[dead(e, x)]$ is equivalent to $\lambda x \lambda e[\neg alive(e, x)]$.

(49)a. Polar Opposites over Scale: $sick/healthy$ and $tall/short$:

b. defined in terms of a sortal array with distinguished elements.

Principle of Sortal and Property Inertia

(50) 1. A sortal fluent f_S is not affected by the matrix predicate, unless explicitly asserted by the predication in the sentence.

2. A property fluent f_D is not affected by the matrix predicate, unless explicitly asserted by the predication in the sentence.

(51) a. $\lambda x \lambda e[man(e, x)]$

b. $\lambda x \lambda e[rock(e, x)]$

c. $\lambda x \lambda e \lambda e'[fall\_act(e', x) \wedge fall\_result(e, x) \wedge e' < e]$

Computing Event Persistence Structure

(52)a. The Principle of Inertia; objects and their properties tend to remain as they are unless explicitly affected;

b. Qualia Selection Thesis; modifiers selectively bind to specific qualia of the head noun.

(53)a. Assign each predicate an event description; $\{\delta_i\}$. The set of event descriptions will be referred to as Δ.

b. We denote the event description assigned to the matrix predicate of the clause, P, as the *core event* *structure*.

Given Δ, and the construction of the core event structure, for each event-denoting predicate in the expression, we apply a single test, *gate*, defined as follows.

(54) a. GATE: For an event description, $\delta \in \Delta$, in the domain of the matrix predicate P, δ is *gated* by P only if the property denoted by δ is either *initiated* or *terminated* by successful assertion of P.

b. PERSIST: If δ is not gated, then it is said to *persist* relative to the matrix predicate, P.

(55) a. Associate each event description to the event introducing it.

b. If an event description does not take wide scope (such as all those that are gated), then it is narrow scope, and is associated only with the appropriate subevents.

c. All persisting events are factored out of the expression in the event structure. They will be said to take wide $persistence$ scope (p-scope) over the event description.

Examples of Event Persistence Structure

(56)a. The argument persists;

b. The head of the argument does not persist;

c. The head of the argument persists, but there are properties of the head introduced by predication that do not persist.

d. The head of the argument persists, but there are inherent properties of the head expressed in the referring expression that do not persist.

(57)a. Mary saw John.

b. A man sat on a bench.

(58) a. Mary built a house.

b. Mary ate a cookie.

(59) a. John closed the door.

b. Mary cleaned the table.

c. John painted the house.

d. A man sat down on a bench.

(60) a. People filled the empty hall.

b. Mary cleaned the dirty table.

(61) a. Mary fixed the tire.

b. Mary fixed the flat tire.

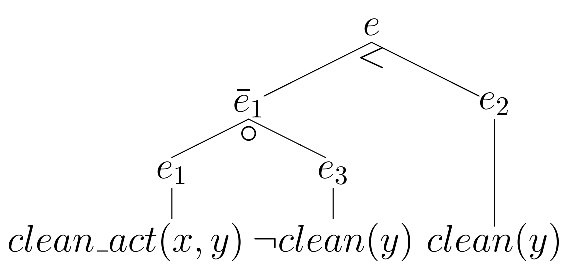
Example 1

(62) Mary cleaned the table.

(63) $\Delta = \{$mary(e$_1$,x), table(e$_2$,y), clean_act(e$_3$,x,y), ¬clean(e$_4$,y), clean(e$_5$,y)$\}$

From Δ, we construct an event structure associated with the matrix predicate of the sentence, shown in (97):

(64)

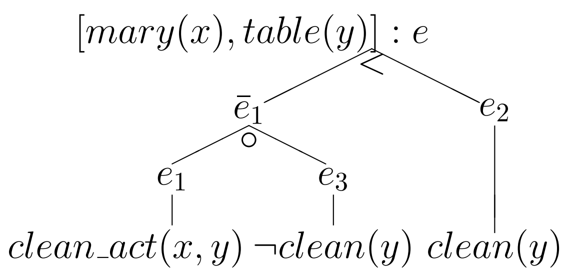


Then we apply the operation $gate$:

(65)a. $gate$(mary) fails;

b. $gate$(table) fails;

(66)



Example 2

(67) Mary cleaned the dirty table.

(68) $\Delta = \{$mary(e$_1$,x), table(e$_2$,y), clean_act(e$_3$,x,y),
$\neg$clean(e$_4$,y),
clean(e$_5$,y), dirty(e$_6$,y)$\}$

Again, we apply the operation $gate$:

(69)a. $gate$(mary) fails;

b. $gate$(table) fails;

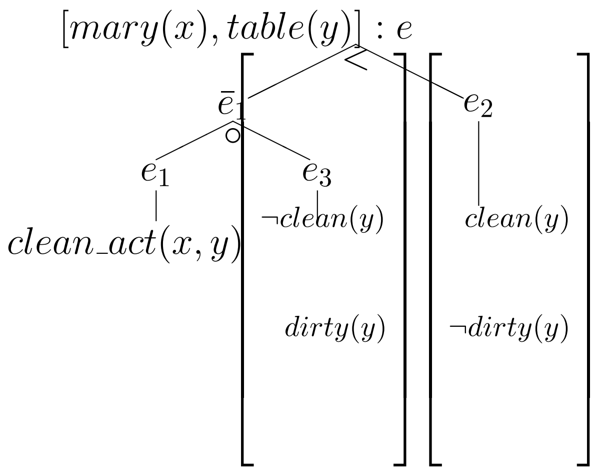
c. $gate$(dirty) succeeds;

There are two opposition structures for an adjective like *dirty*:

(70)a. $\langle dirty, \neg dirty \rangle$: Binary opposition

b. $\langle dirty, clean \rangle$: Polar opposition

(71)



Opposition Structures

Dynamic Lexical Semantics: I

(cf. Harel (1984), Renardel de Lavalette (2000))

(72) Whenever the predicate α is performed succesfully, ϕ holds in the discourse.

$$[\alpha]\phi$$

(73) It is possible to do α such that ϕ holds in the discourse.

$$\langle\alpha\rangle\phi$$

Dynamic Lexical Semantics: II

(74) Lexicalizing the statement of change

b. $[kill(x, y)]dead(y)$

c. $[[break(x, y)]broken(y)$

(75)a. $kill$: $anim \rightarrow (e_N \rightarrow t)$

b. $\lambda y\colon anim\ \lambda x\colon e_N[kill(\text{x},\text{y})]$

(76) Consider a set of type operators, $\ulcorner$ and $\urcorner$, that initiate or terminate a process or state. We will call the resulting transformations, *gating functions*.

Dynamic Lexical Semantics: III

(77) a. If a is a type, then $\ulcorner a$ and $a\urcorner$ are types.

b. $\ulcorner\ulcorner a = \ulcorner a$.

c. $a\urcorner\urcorner = a$.

(78) a. If $a \longrightarrow b$ is a type, then $\ulcorner a \longrightarrow b$ and $a\urcorner \longrightarrow b$ are types.

(79) a. If $a \otimes c \longrightarrow b$ is a type, then $\ulcorner a \otimes c \longrightarrow b$ and $a\urcorner \otimes c \longrightarrow b$ are types.

b. If $a \otimes c \longrightarrow b$ is a type, then $a \otimes \ulcorner c \longrightarrow b$ and $a \otimes c\urcorner \longrightarrow b$ are types.

(80) a. If $a \bullet c \longrightarrow b$ is a type, then $\ulcorner a \bullet c \longrightarrow b$ and

$a^\urcorner \bullet c \longrightarrow b$ are types.

b. If $a \bullet c \longrightarrow b$ is a type, then $a \bullet {}^\ulcorner c \longrightarrow b$ and $a \bullet c^\urcorner \longrightarrow b$ are types.

(81) Composition of Gates:

a. $({}^\ulcorner a \rightarrow t) \circ (a^\urcorner \rightarrow t) = {}^\ulcorner a^\urcorner \rightarrow t$.

b. Hence, ${}^\ulcorner a^\urcorner$ could be said to designate the total history of type a.

Typing the Predicate as a Change

(82) Given a discourse where ϕ holds, the successful performance of the predicate α brings about $\neg\phi$ in the discourse.

$$\phi[\alpha]\neg\phi$$

Now assume that a gate can mark which argument undergoes the update:

(83) Gating embeds change into predicate's type:

a. $kill$: $anim^{\neg} \rightarrow (e_N \rightarrow t)$

b. $\lambda y : anim^{\neg}\ \lambda x : e_N[kill(\mathrm{x},\mathrm{y})]$

c. $\neg dead(y)[kill(x,y)]dead(y)$

Dynamic Lexical Semantics: III

(84)a. The door opened.

b. The window closed.

(85) State Transitions:

a. $open$: $phys \bullet \ulcorner aperture \rightarrow t$

b. $close$: $phys \bullet aperture \urcorner \rightarrow t$

(86) $\neg open(x)[open]open(x)$

(87) Predicates as terminating and initiating functions:

fill, empty

Two-Gate Transitions

(88) John gave a book to Mary.

(89) State Transitions:

a. $give$:

$phys \longrightarrow (human \otimes \ulcorner have \longrightarrow (human \otimes have\urcorner \longrightarrow t))$

(90) a. $have(x, y)[give(x, y, z)]\neg have((x, y)$

b. $\neg have(z, y)[give(x, y, z)]have((z, y)$

Gates are Methods for Qualia Structure

To formally identify specific actions or relations with objects or entities, e.g., qualia roles and affordances:

1. Gates over Natural

    animal: be born, die

    apple: grow, eat

2. Gates over Functional

    prisoner: arrest, escape

    audience: assemble, disperse

    cake: bake, eat

3. Gates over Complex

door: build, destroy, open, close

talk: begin, end, prepare

Examples of Gates

(91)a. The prisoner escaped from the prison.

c. The audience left the theatre.

$$\begin{bmatrix} \textbf{prisoner} \\ \text{QS} = \begin{bmatrix} \text{F} = human(x) \\ \text{T=A} = \exists e[captive(e,x)] \end{bmatrix} \end{bmatrix}$$

$$\begin{bmatrix} \textbf{audience} \\ \text{QS} = \begin{bmatrix} \text{F} = human(x) \\ \text{T=A} = \exists e,y[attend(e,x,y)] \end{bmatrix} \end{bmatrix}$$

(92)a. prisoner: $human \otimes captive$

b. audience: $human \otimes attend$

(93)a. capture$_1$: $e_N \otimes \ulcorner captive \rightarrow (e_N \rightarrow t)$

b. escape: $e_N \otimes captive \urcorner \rightarrow t$

c. capture$_2$: $e_N \otimes free \urcorner \rightarrow (e_N \rightarrow t)$

Spoiling an Event

(94) And why is it whenever you choose to roll out the seventy foot or more of polythene , which has humped up your overdraft considerably , a perfect tranquil morning is spoilt by a freak hurricane.

(95) in that the singers may learn their parts more thoroughly and thus, knowing the music perfectly, may act with greater confidence and not spoil the opera.

(96)a. $spoil$: $\epsilon \otimes T^{\neg} \longrightarrow (e_N \longrightarrow t)$

b. $\lambda e : \epsilon_F \lambda x : e_N[spoil(\mathrm{e})(\mathrm{x})]$

Mechanisms of Selection and Coercion with Gates

For a given argument, α, in the runtime of an event $\mathcal{E}$, one of the three situations holds:

i. α has the denotative integrity as selected by the predicate associated with $\mathcal{E}$;

ii. α acquires the denotative integrity as a result of the successful runtime of $\mathcal{E}$;

iii. α stops having the denotative integrity as a result of the successful runtime of $\mathcal{E}$.

Coercion with Gates

(1) Verbs encode specific gating functions:

a. thing: $phys$

b. animal: $anim$

c. die: $anim^{\urcorner} \rightarrow t$

(2) Exploitation Gating:

a. The animal died.

b. $\lambda x : anim^{\urcorner}[die(\mathsf{x})](the\ animal : anim)$

(3) Introduction Gating:

a. The thing died.

b. $\lambda x : anim^{\urcorner}[die(\mathsf{x})](the\ thing : phys)$

(1) a. man: $human$

b. prisoner: $human \otimes captive$

c. escape: $e_N \otimes captive^{\urcorner} \longrightarrow t$

(2) Exploitation Gating:

a. The prisoner/captive escaped.

b. $\lambda x: e_N \otimes captive^{\urcorner}[escape(\mathsf{x})]$

$(the\ prisoner : human \otimes captive)$

(3) Introduction Gating:

a. The man escaped.

b. $\lambda x: e_N \otimes captive^{\urcorner}[escape(\mathsf{x})]$

$(the\ man: human)$

Type Characterization of Verb Classes

(1) a.Let $\bar{\alpha} =_{df} \ulcorner \alpha \vee \alpha \urcorner$.

1. b. An unaccusative can be characterized as having the type $\bar{\alpha} \rightarrow t$.
2. c. An unergative can be characterized as having the type $\alpha \rightarrow t$.

Opposition Structure (OS). 1

- $\lambda e_2, e_1 \lambda x[\mathsf{OS}(e_1(x), e_2(x))]$
- Relation involving one object predicated of a predicate, P, and its negation. The eventualities associated with these two expressions are ordered in a Narration relation, $\leq$.
- For a predicate break: $p \otimes \ulcorner broken \multimap t$, the OS refers to the transition from $\neg broken(x)$ to $broken(x)$.

Derivation involving Gating: Introduction

1. Mary cleaned the car.
2. John filled the glass.
3. Mary broke vase.

Encoding Change on the Argument

(97) John cleaned the car.

(98) a. $\lambda y \lambda x(clean(x, y)), \langle y \colon p, x \colon p\rangle$

b. clean : $p \multimap (p \multimap t)$

Encoding the change, we would have the introduction of a gated predicate over the internal argument y:

(99) clean : $p \otimes \ulcorner clean \multimap (p \multimap t)$

$$\frac{\{\lambda \mathcal{P}\phi, c(\mathcal{P} \colon ((\alpha \otimes \ulcorner\beta) \multimap \gamma) \multimap \delta)[\lambda P\psi(P[x]), c'(P \colon \alpha \multimap \gamma)]}{\{\lambda \mathcal{P}\phi, \}\ [\lambda P\psi\{\frac{\exists v(\Delta(\psi,x)\{\frac{v}{x}\}\wedge \mathsf{OS}(v,x))}{\Delta(\psi,x)}\}, c' * (x \colon \alpha \otimes \beta, v \colon \alpha)]}$$

Example Walk-through of Gate-Introduction

(100)

$$\exists e_3, e_2, e_1[clean\_act(e_1, j, x) \wedge \neg clean(e_2, x,) \wedge clean(e_3, x) \wedge e_1 \circ e_2 \ \wedge e_2 \leq e_3];$$

Derivation involving Gating: Exploitation

1. an escaped prisoner.
2. a former mayor.
3. Mary release the prisoner.

Gate-Exploitation is an Elimination Operation

an escaped prisoner

(101) $\lambda P \lambda x \exists e[\text{escaped}(e, x) \wedge P(e, x)]$

x: p;

escaped: $(p \otimes captive^{\neg} \multimap t) \multimap (p \otimes captive^{\neg} \multimap t)$.

(102) $\lambda v \text{prisoner}(v)$: $(human \otimes captive) \multimap t$

(103) $[\![\text{escaped}]\!] = \lambda P \lambda x \lambda e_2 \exists e_1[\neg captive(e_2, x) \wedge captive(e_1, x) \wedge e_1 \leq e_2 \wedge P(e_2, x)]$;

(104) $[\![\text{prisoner}]\!] = \lambda x \lambda e[human(x,) \wedge captive(e, x)]$

(105) Apply Gate Exploitation, giving:

$[\![$escaped prisoner$]\!] =$
$\lambda x \lambda e_2 \exists e_1[\neg captive(e_2, x) \wedge captive(e_1, x) \wedge e_1 \leq e_2 \wedge human(e_2, x)]$;

Temporal Adjectives as Gate-Exploitation

a former boxer

(106) former: $(p \otimes E^{\neg} \multimap t) \multimap (p \otimes E^{\neg} \multimap t)$.

(107) λvboxer(v) : $(human \otimes_T box) \multimap t$

(108) $[\![$former$]\!] =$
$\lambda P \lambda x \lambda e_2 \exists e_1[\neg P(e_2, x) \wedge P(e_1, x) \wedge e_1 \leq e_2]$;

(109) $[\![$boxer$]\!] = \lambda x \lambda e[human(x,) \wedge box(e, x)]$

(110) Apply Gate Exploitation, giving:
$[\![$former boxer$]\!] =$
$\lambda x \lambda e_2 \exists e_1[\neg box(e_2, x) \wedge box(e_1, x) \wedge e_1 \leq e_2 \wedge human(e_2, x)]$;

Prepositional Selection

Polysemy of AT

(111)a. John is swinging at the ball.

b. Mary ate at noon/midnight.

c. Mary is at peace with her decision.

d. We were at war with Iraq.

(112)a. The temperature is at 70 degrees.

b. John's weight is holding at 200 pounds.

c. Shares opened at $34.00.

Locative Data

(113)a. Mary is at the blackboard.

b. Mary is standing/writing/ at the blackboard.

c. Mary is near the blackboard.

(114)a. Jane is at her desk.

b. Jane is working/sleeping at her desk.

c. Jane is near/on/under her desk.

(115)a. Zac is in/at school today.

b. Zac's mother is in/at the school today.

Resultatives and Nonimplicatives

(116)a. John washed his car.

b. John cleaned his car.

(117) $$\lambda y \lambda x \lambda e \begin{bmatrix} \textbf{wash} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \\ \text{ARG2} = y \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{E}_0 = e : \mathit{transition} \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \textbf{washed(y)} \\ \text{TELIC} = \textbf{clean\_state(y)} \\ \text{AGENTIVE} = \textbf{wash-act(x,y)} \end{bmatrix} \end{bmatrix}$$

(118) $$\lambda y \lambda x \lambda e \begin{bmatrix} \textbf{clean} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \\ \text{ARG2} = y \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{E}_0 = e : \mathit{transition} \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \textbf{clean\_state(y)} \\ \text{AGENTIVE} = \textbf{clean-act(x,y)} \end{bmatrix} \end{bmatrix}$$

(119)a. John washed his car clean.

b. TELIC is promoted to FORMAL.

(120) $$\lambda y \lambda x \lambda e \begin{bmatrix} \textbf{wash clean} \\ \text{ARGSTR} = \begin{bmatrix} \text{ARG1} = x \\ \text{ARG2} = y \end{bmatrix} \\ \text{EVENTSTR} = \begin{bmatrix} \text{E}_0 = e : transition \end{bmatrix} \\ \text{QUALIA} = \begin{bmatrix} \text{FORMAL} = \textbf{clean\_state(y)} \\ \text{AGENTIVE} = \textbf{wash-act(x,y)} \end{bmatrix} \end{bmatrix}$$