

A Speaker's Stance Semantics of Discourse

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Speaker's Stance

EX: *Currently, insurers can increase premiums by (levying surcharges if they determine (a driver) \downarrow_x is more than 50 percent to blame for a collision) \downarrow_e . (Such penalties) \downarrow_p ($e \in p$) often cost $0\uparrow_x$ hundreds of dollars annually for up to six years. (About half of (the 50,000 cases disputed each year) \downarrow_c ($c \sim p$) \downarrow_{c_h} ($card(c_h) \approx 0.5 card(c)$) are overturned by the appeals board. (Those drivers) \downarrow_d of $-\text{concern}(d, c_h)$ are issued refunds. [The Boston Globe, March 2, 2009]*

($E\downarrow_x$: object x references entity/event E , \uparrow_x : dereferenced E , $x \sim y$: co-referential.)

What is the source, which is the nature of this referential tagging?

- It represents elements of **Speaker's plan** of the discourse to be **expressed**.
- Subsequent discourse refines the previous discourse tagging (so this tagging is **dynamic**).

From the **Speaker's stance**:

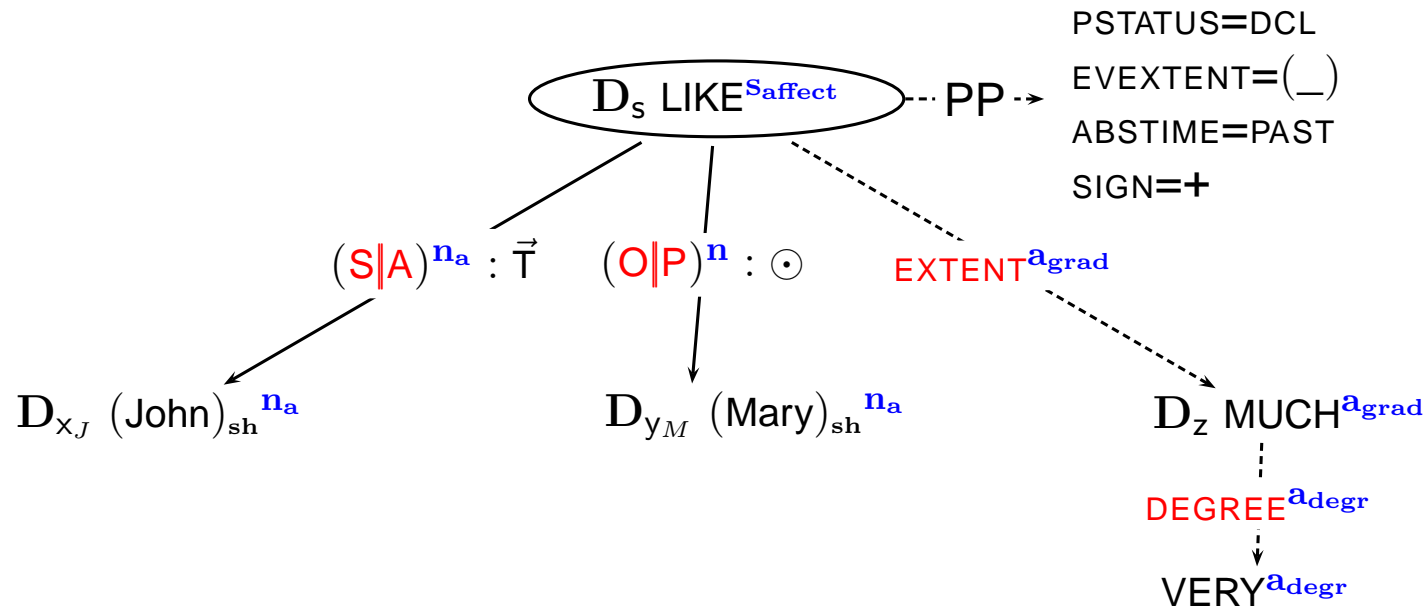
- the **reference** is **given**,
- the **facts** are **postulated**,
- to **express** means:
 - to **implement** the Discourse Plan with a **text**,
 - to **transform** the Discourse Plan into a **relational structure** (a **context**) suited for reasoning, in particular, for consistency checking.

Plan

- Discourse Plans by an Example
- Lexical Semantics
- Discourse Semantics
- Discussion and Conclusion

DISCOURSE PLANS (DP)

DP: functional typed expressions



DP of *John liked Mary very much*

Typed semantemes:

Primitive types: $(\text{John})_{\text{sh}}^{n_a}$ (animated nominal), $\text{VERY}^{a_{\text{degr}}}$ (degree attributor)

Composite types: $\text{LIKE}((\text{S|A})^{n_a}(\text{O|P})^n; \text{EXTENT}^{a_{\text{grad}}} \rightarrow \text{S}_{\text{affect}})$, $\text{MUCH}(\text{EXTENT}^{a_{\text{grad}}} \rightarrow a_{\text{grad}})$

Sorts: **roles** of **core** arguments: S|A, O|P; **attributes:** EXTENT, DEGREE.

PP-attributes: propositional parameters.

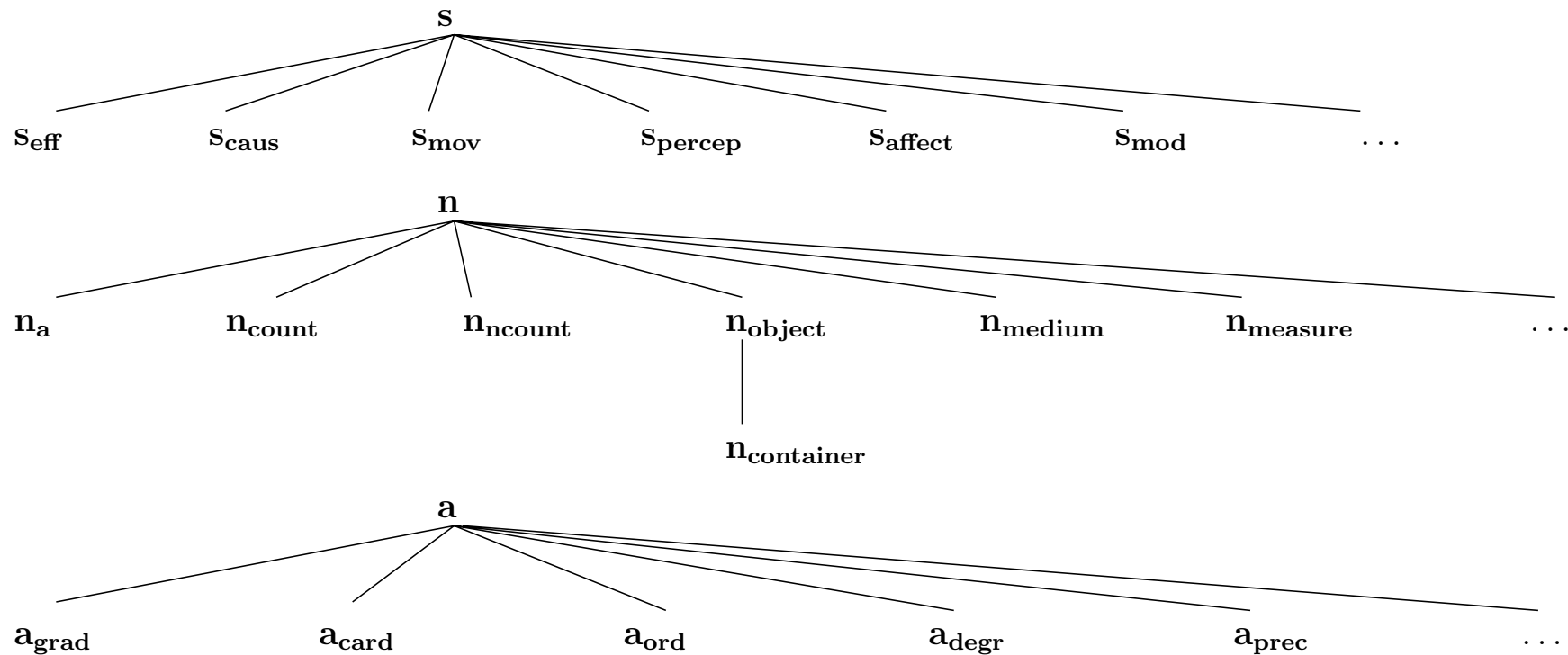
Determiners: $D_S, D_{x_J}, D_{y_M}, D_Z$

LEXICAL SEMANTICS

Lexical Types

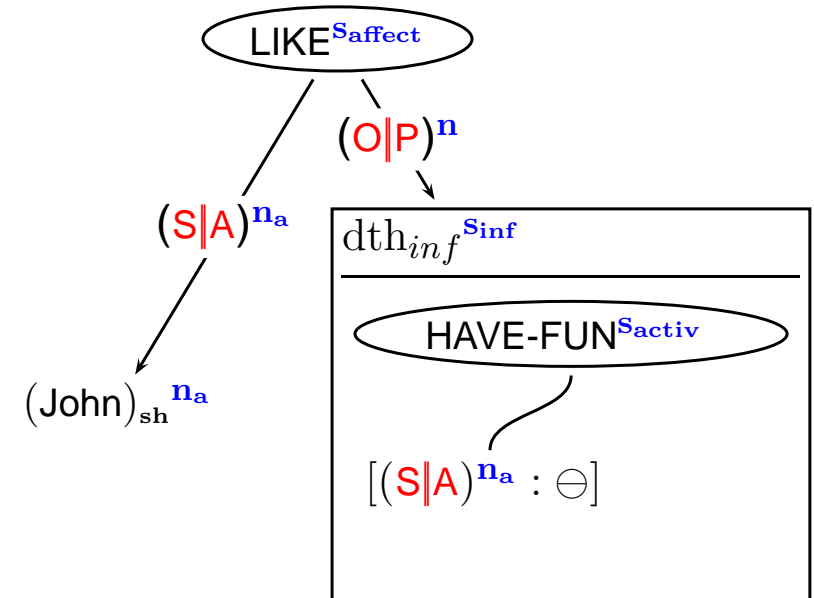
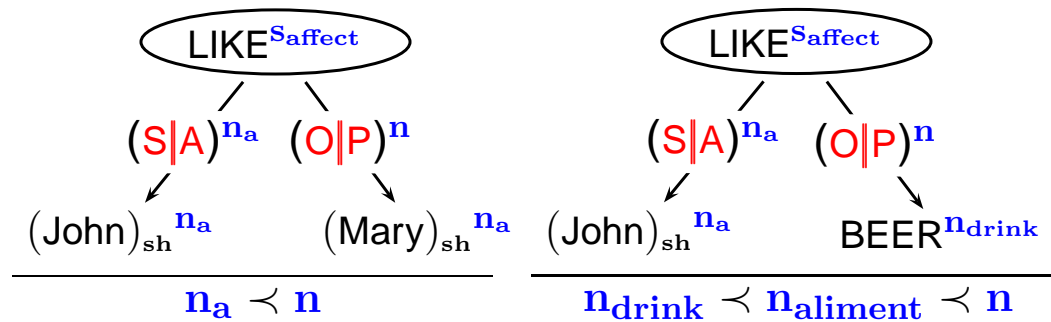
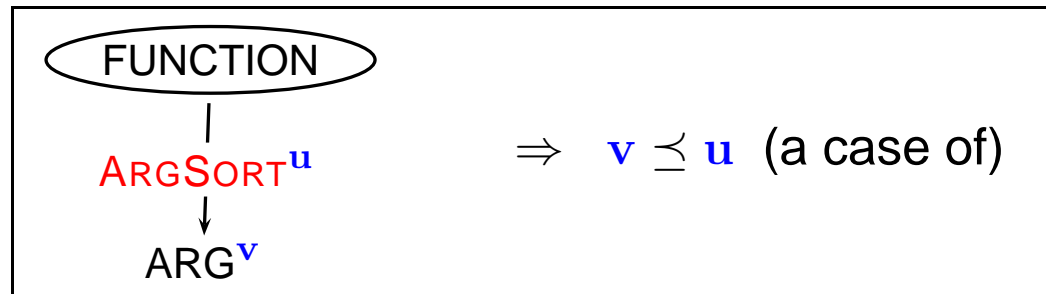
DP are **typed**.

Primitive types are partially ordered through **genericity**: $u \preceq v$ (u is a kind of v).



EX: MILK(**STATE** ^{a_{grad}} \rightarrow n_{ncount}), BOTTLE(**CONTENTS** ^{n_{ncount}} ; **FULLNESS** ^{a_{grad}} **QUANT** ^{a_{card}} \rightarrow $n_{container}$)

Compositionality principle

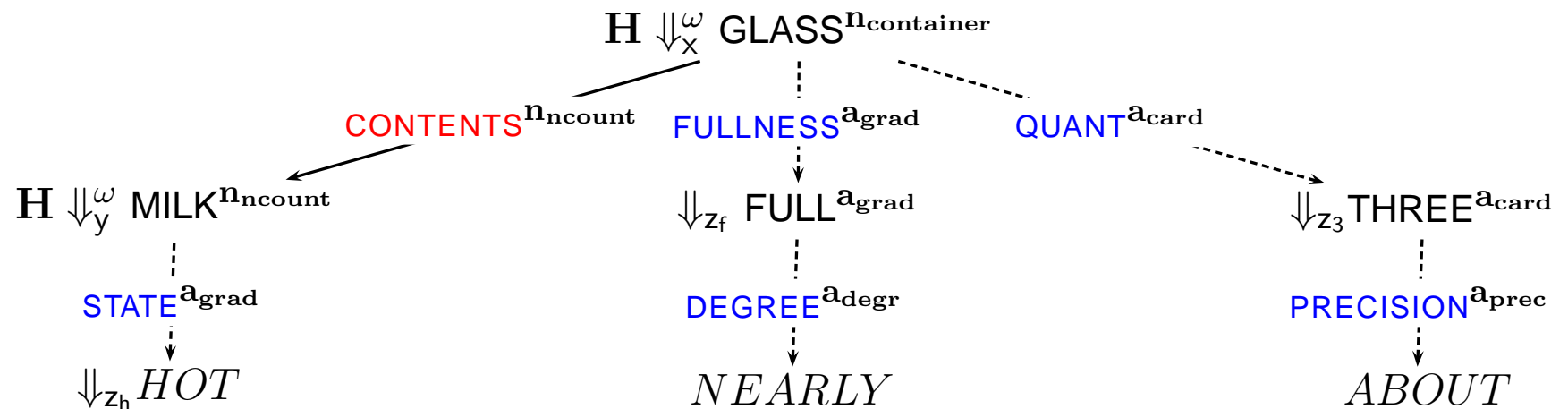


$S_{inf} \prec n$

Attributes

In DP, verbal circumstantials and nominal qualifiers are expressed through **attribute values** (not through **properties**, as in logical semantics)

EX:



A DP of *about three nearly full glasses of hot milk*.

E.g., **STATE**^{a_{grad}} is an attribute with value type a_{grad}. *HOT* describes its value.

Attribution principle

Attributes of a semanteme $W(\rho; A_1^{u_1} \dots A_m^{u_m} \rightarrow \mathbf{v})$ are uniquely determined by its value type \mathbf{v} : $Att(\mathbf{v}) = \{A_1^{u_1}, \dots, A_m^{u_m}\}$.

EX: Why both, *John found an interesting book* and *John found a heavy book* are normal, but **John struck him on the head with an interesting book* is not?

The type of **FIND**

$$((S|A)^{n_a} (O|P)^n \rightarrow S_{act})$$

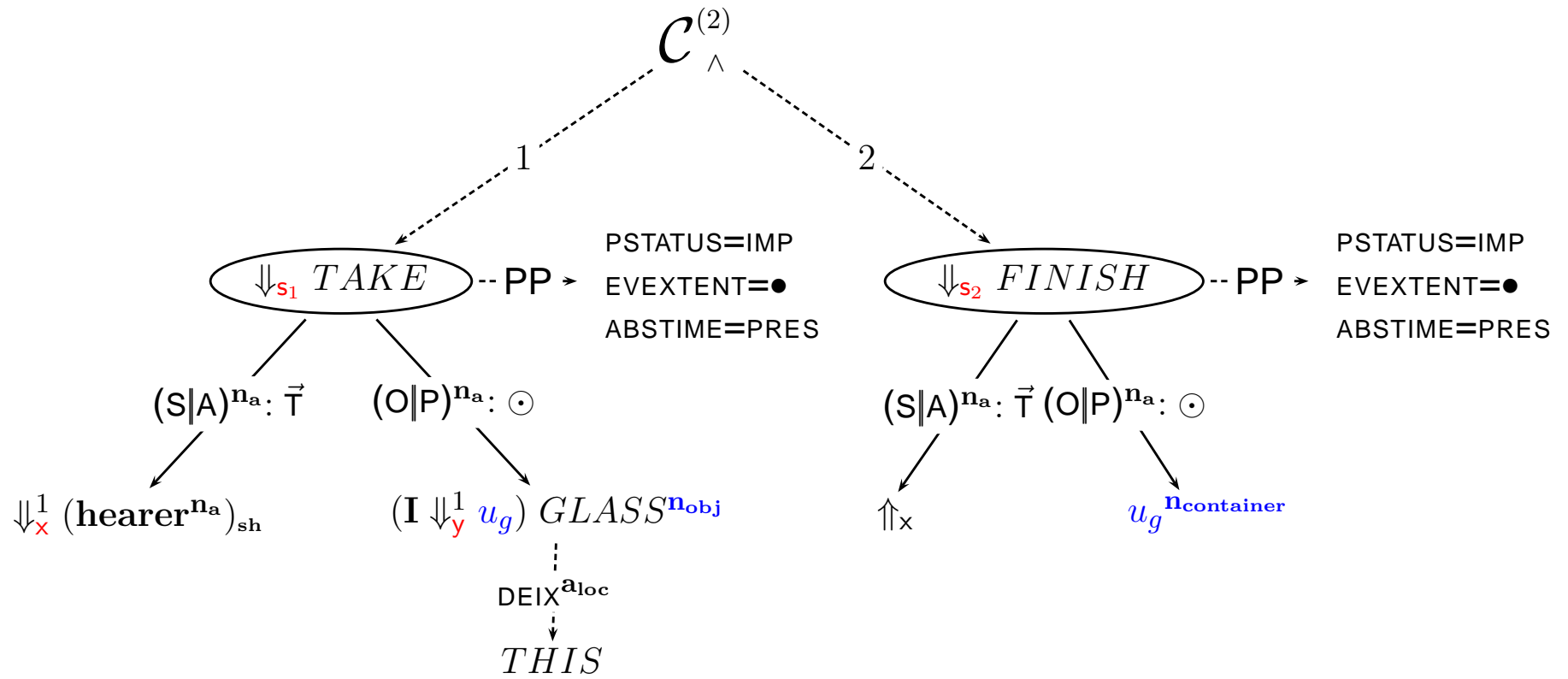
permits both types: $\mathbf{n}_{medium}, \mathbf{n}_{obj} < \mathbf{n}$. So both $BOOK^{\mathbf{n}_{medium}}$ and $BOOK^{\mathbf{n}_{obj}}$ are admissible **O|P**-arguments with attributes $HEAVY^{a_{weight}} \in Att(\mathbf{n}_{obj})$ and $INTERESTING^{a_{estim}} \in Att(\mathbf{n}_{medium})$.

But the type of **STRIKE**

$$((S|A)^{n_a} (O|P)^n (INS)^{\mathbf{n}_{obj}} (LOC)^n \rightarrow S_{act})$$

limits its **INS**-argument to \mathbf{n}_{obj} . So $BOOK^{\mathbf{n}_{medium}}$ is not admitted, $BOOK^{\mathbf{n}_{obj}}$ is admitted, but $INTERESTING^{a_{estim}} \notin Att(\mathbf{n}_{obj})$.

Co-predication



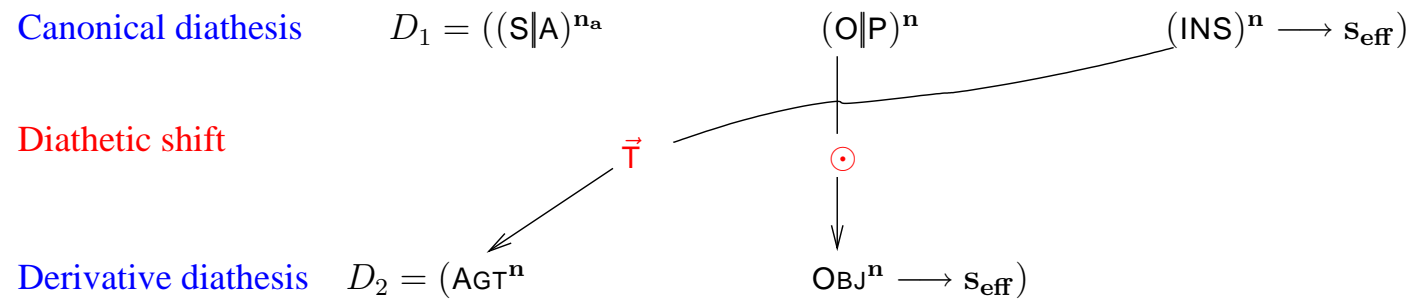
Take and finish this glass.

$n_{\text{container}} \preceq n_{\text{obj}}, \text{GLASS}^{n_{\text{container}}}$

Verbal Diatheses and Diathetic Shifts

Every verbal v has a unique **canonical type** D_c : its **canonical diathesis**.
Diatheses of v : its types derived from D_c using argument shifts and role changes.

EX: OPEN has canonical diathesis $D_c = ((S|A)^{n_a} (O|P)^n (INS)^n; \text{MANNER}^{a_{\text{grad}}} \rightarrow S_{\text{eff}})$.
 Its diathesis $D_{\text{ialt}} = (AGT^n \text{OBJ}^n; \text{MANNER}^{a_{\text{grad}}} \rightarrow S_{\text{eff}})$,
 is derived from D_c using the **diathetic shift** of INS-alternation:



To this diathetic shift corresponds:

Argument shift: $d_{\text{ialt}} = \{3 \rightarrow 1, 2 \rightarrow 2\}$ (a bijection from $\{2, 3\}$ to $\{1, 2, 3\}$)

Derivative: OPEN[d_{ialt}]($AGT^n \text{OBJ}^n; \text{MANNER}^{a_{\text{grad}}} \rightarrow S_{\text{eff}}$)

Rank assignments specify argument shifts and, eventually, surface features:

\vec{T} : 1st core arg, \odot : 2d core arg, \oplus : 3d core arg, \ominus : eliminated arg

Diathetic shifts as Role/Rank assignments:

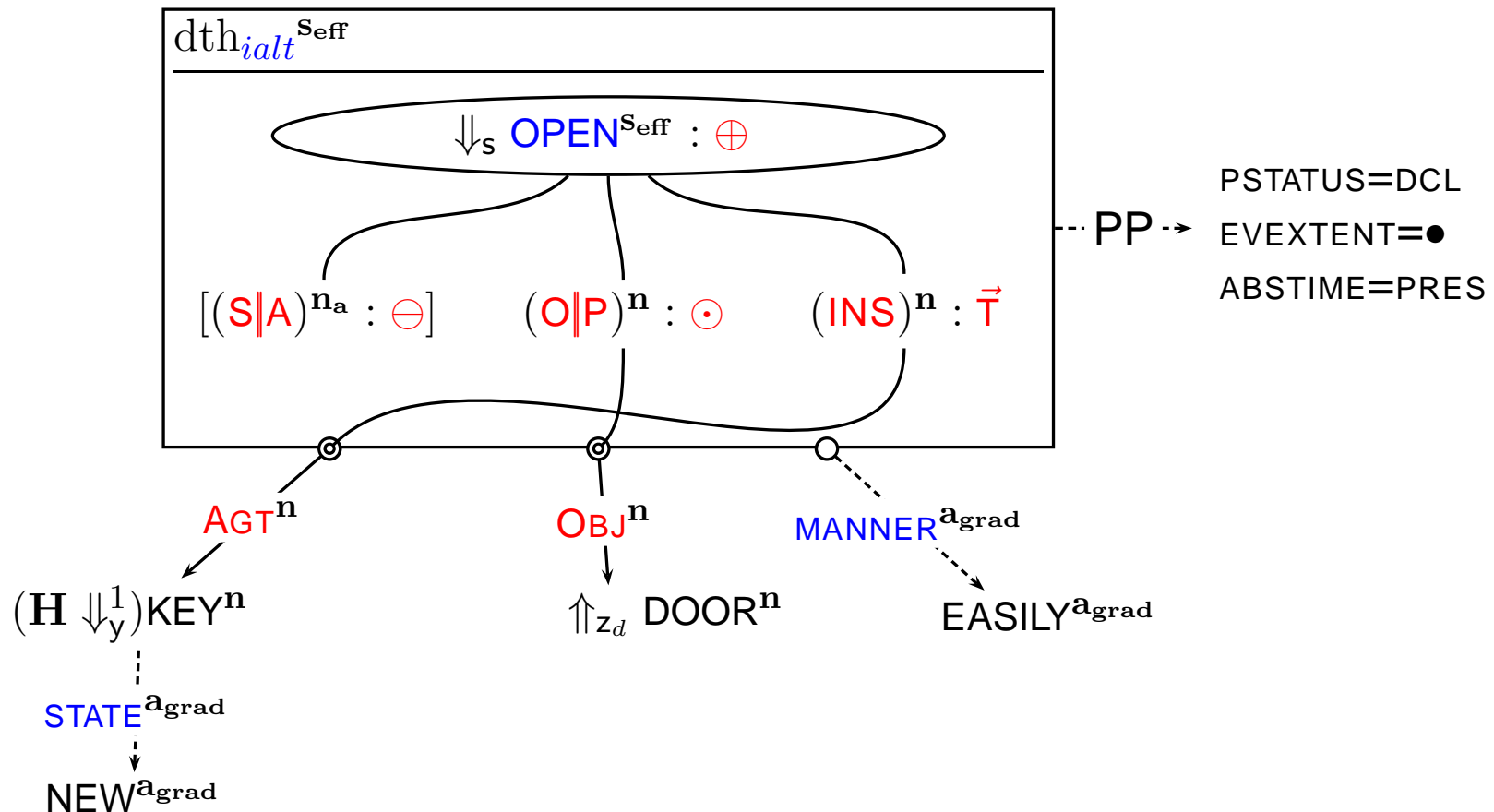
$$(\emptyset \leftrightarrow (S|A)_{\ominus}, AGT \leftrightarrow (INS)_{\vec{T}}, \text{OBJ} \leftrightarrow (O|P)_{\odot})^{S_{\text{eff}}}$$

Diathetic Shift Example

EX: *The new key easily opened the door*

Diathetic shift: $(\emptyset \leftrightarrow (S|A)_{\ominus}, AGT \leftrightarrow (INS)_{\vec{T}}, OBJ \leftrightarrow (O|P)_{\odot})^{S_{eff}}$

Derivative: $OPEN_{[D_{ialt}]}(AGT^n OBJ^n; MANNER^{a_{grad}} \rightarrow S_{eff})$



DISCOURSE SEMANTICS

Semantics of DP in a Context

Formal semantics of DP is defined through their **extension** in a **context**.

A **context** may be seen as a **DB** (a finite model) in which:

- **verbal DP** extensions are tables representing relations between objects,
- **nominal DP** extensions are sets of objects (singletons for singulars) and
- **attributor DP** extensions are sets of constraints on attribute values.

Extension $\|DP\|$ of $DP = \mathbf{D}_x W(DP_1, \dots, DP_n)$ is defined in the contexts Σ where DP is **realized** by a unique semantic **object** $o \in \mathbf{O}$, which means that:

$\Gamma(x) = o$ (**global** reference x is bound with object o) and $o \in H(W)$, where $H(W)$, the **horizon line** of W in Σ , is the part accessible in Σ of the extension $\|W\|$ of semanteme W .

The “value” $\|o\|$ of o , called **extension**, is a finite set of objects $\|o\| \subset \mathbf{O}$. $\|o\|$ is defined through $\|DP_1\|, \dots, \|DP_n\|$ and $\|DP\|$ is defined through $\|o\|$.

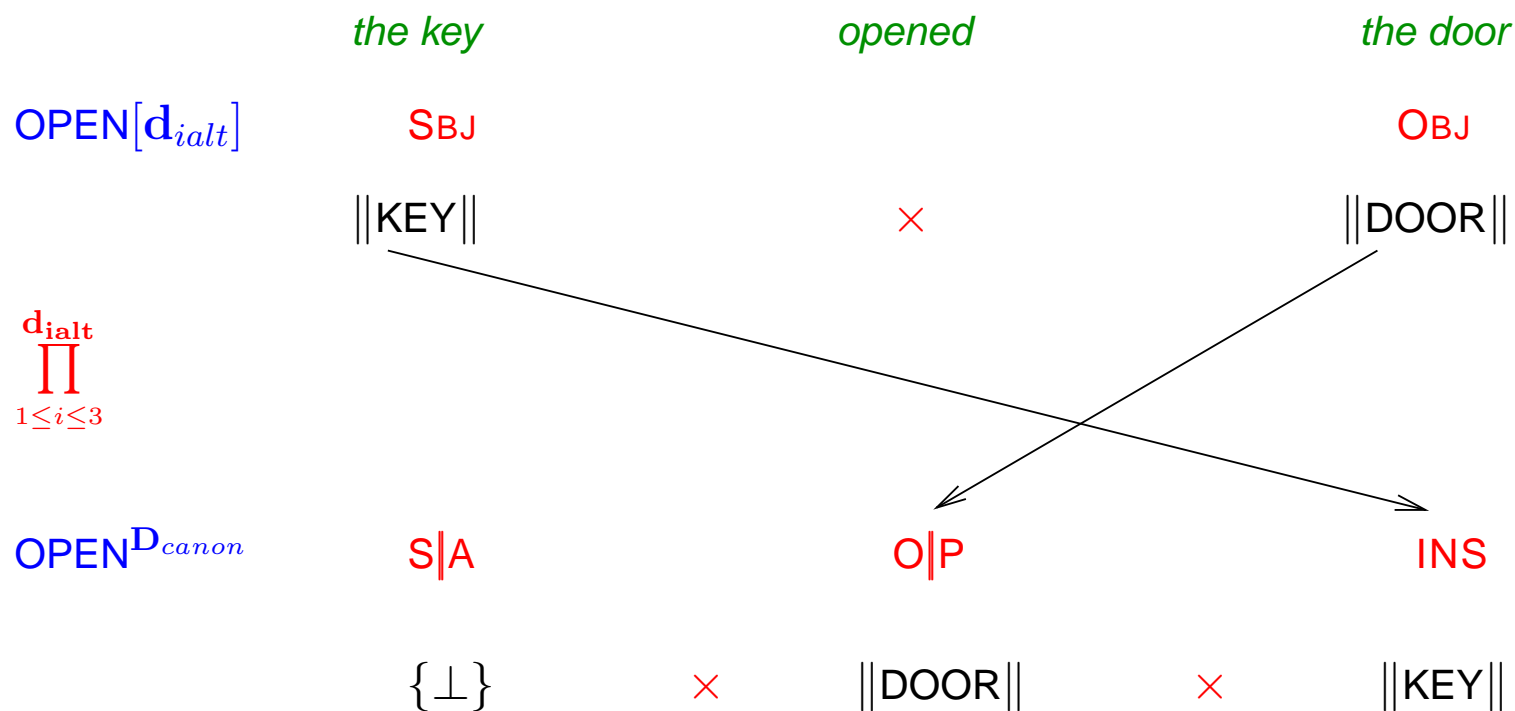
Verbals' Semantics

EX: For the canonical diathesis of OPEN:

$$\|\text{John opened the door with the key}\| = \|(\text{John})_{\text{sh}}\| \times \|\text{DOOR}\| \times \|\text{KEY}\|$$

Derivatives through diathetic shifts are reduced to the canonical diathesis

using **shifted product** $\prod_{1 \leq i \leq k}^{\mathbf{d}} s_i$:



Static semantics of sentential DP

Unit sentential plans.

$\pi = \Downarrow_x \mathbf{Verb}[\mathbf{d}](\mathbf{R}_1 : \pi_1, \dots, \mathbf{R}_k : \pi_k, \mathbf{A}_1 : \pi'_1, \dots, \mathbf{A}_m : \pi'_m)$,
where $\pi'_i = \Downarrow_{x_i} \pi''_i$, $1 \leq i \leq m$, are composite attributor DP.

$$\|\pi\| = \|\Gamma(x)\|,$$

$$\|\Gamma(x)\| = \prod_{1 \leq i \leq k}^{\mathbf{d}} \|\pi_i\|.$$

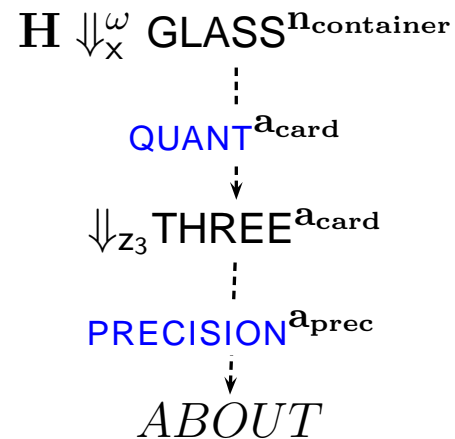
$$\Gamma(x) \in \|\mathbf{Verb}\| = H(\mathbf{Verb}),$$

$$\mathbf{A}_i(\Gamma(x)) = \Gamma(x_i) \text{ and } \|\mathbf{A}_i(\Gamma(x))\| = \|\pi'_i\|, 1 \leq i \leq m.$$

Semantics of attributors

Attributor DP are interpreted by **constraints** on attribute values

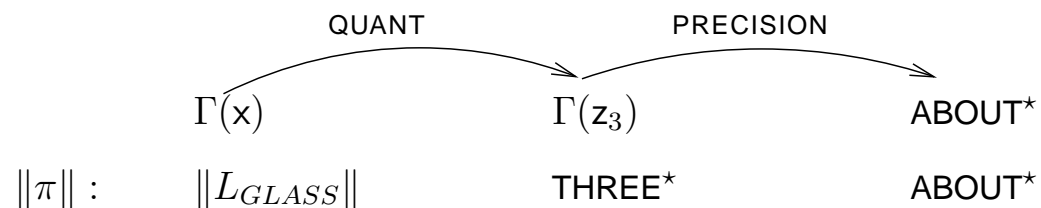
EX: The branch



of DP for *about three nearly full glasses of hot milk*

gives the attributor constraints:

$$\text{QUANT}(\Gamma(x)) = \Gamma(z_3), \|\Gamma(z_3)\| = \text{THREE}^*, \text{PRECISION}(\Gamma(z_3)) = \text{ABOUT}^*$$



Absolute nominal determiners

Nominal DP determiners take the place of quantifiers.

For $DP = D_x W(DP_1, \dots, DP_n)$, computation of extension $\|DP\|$ changes the context $\Sigma \Rightarrow \Sigma'$: a new object o (a realization of DP) is created in Σ' and global reference x is bound with o ($\Gamma(x) = o$).

Determiners $D_x = (Q \Downarrow_x^k u)$ are *holistic*, $Q = \mathbf{H}$, or *individual*, $Q = \mathbf{I}$.

EX: Holistic determiners as $D_1 = (\mathbf{H} \Downarrow_{x_f}^\omega u_f)$ in *Farmers_{D₁} work hard* and $D_2 = (\mathbf{H} \Downarrow_{x_m}^\omega u_m)$ in *He drinks milk_{D₂} every morning*.

If D_x is holistic ($Q = \mathbf{H}$), then $\|DP\| = \{o\}$ and local reference u_f is bound with $\{o\}$ ($\Lambda(u_f) = \{o\}$).

Such holistic extension $\|DP\|$ is *invariant* in discourse.

EX: Individual determiners as $D_3 = (\mathbf{I} \Downarrow_{x_f}^\omega u_f)$ in *All farmers_{D₃} left*.

If D_x is individual ($Q = \mathbf{I}$), then $\|DP\| = \{\perp\}$ and local reference u_f is bound with uncertain set $\{\perp\}$ ($\Lambda(u_f) = \{\perp\}$).

Such individual extension $\|DP\|$ may *vary* due to *relativized determiners* in subsequent discourse.

Relativized nominal determiners

Relativized determiners relate semantic objects with objects created earlier.

EX: In discourse *(Lincoln)_(H ↓_x¹ u) was born in 1809. (This President)_(H ↓_{y~x}¹ v) was a liberal*, the relativized determiner $(H ↓_{y~x}^1 v)$ establishes *co-reference constraint* $y \sim x$ saying that the (different) objects $\Gamma(x)$ and $\Gamma(y)$ represent the same entity.

EX: In *At least three girls gave (more roses than lilies)_{D_c} to John* the **cumulative** relativized determiner $D_c = \left(((H ↓_y^\omega \text{ROSE})(H ↓_z^\omega \text{LILIES})) (H ↓_x^\omega (\text{card}(y) > \text{card}(z))) \right)$ establishes *cardinality constraint* $\text{card}(y) > \text{card}(z)$ in subplan

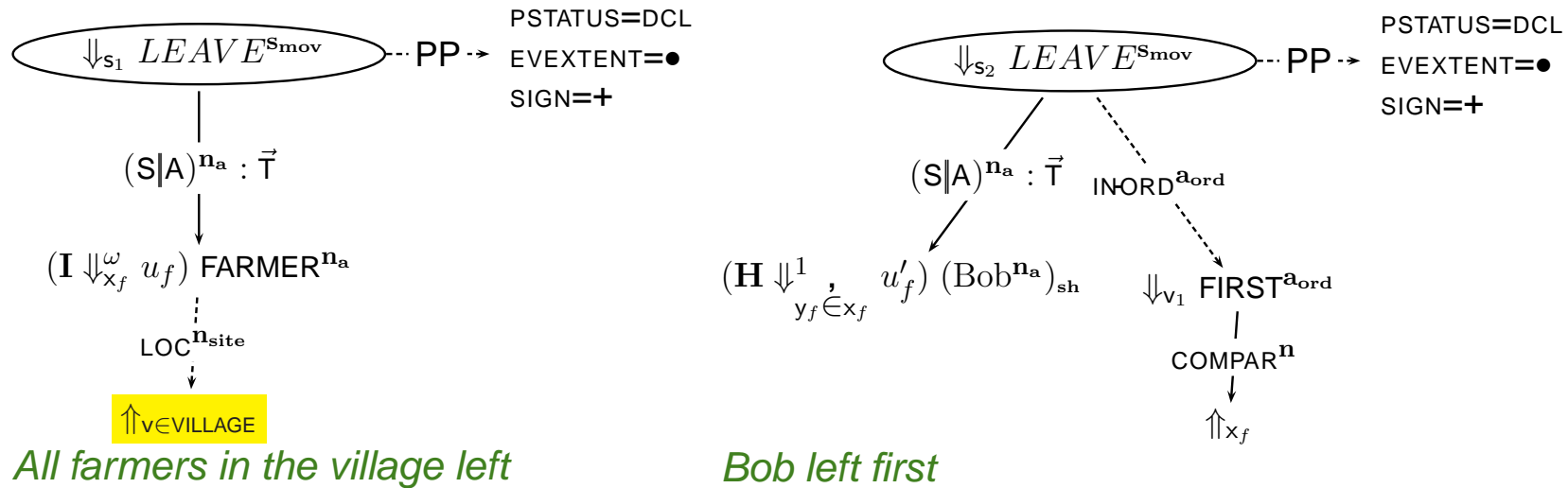
$$\left(((H ↓_y^\omega \text{ROSE})(H ↓_z^\omega \text{LILIES})) (H ↓_x^\omega (\text{card}(y) > \text{card}(z))) \right) \mathcal{A}_U \{ \uparrow_y, \uparrow_z \},$$

(\mathcal{A}_U is a nominal aggregate with union extension: $\|\mathcal{A}_U\{o_1, o_2\}\| = \|o_1\| \cup \|o_2\|$).

EX: In discourse *All farmers_(I ↓_{x_f}^ω u_f) left. John_(H ↓_{y_f ∈ x_f}¹ u'_f) left first*, relativized determiner $(H ↓_{y_f \in x_f}^1 u'_f)$ establishes membership $\Gamma(y_f) \in \|DP\| = \|\Gamma(x_f)\|$.

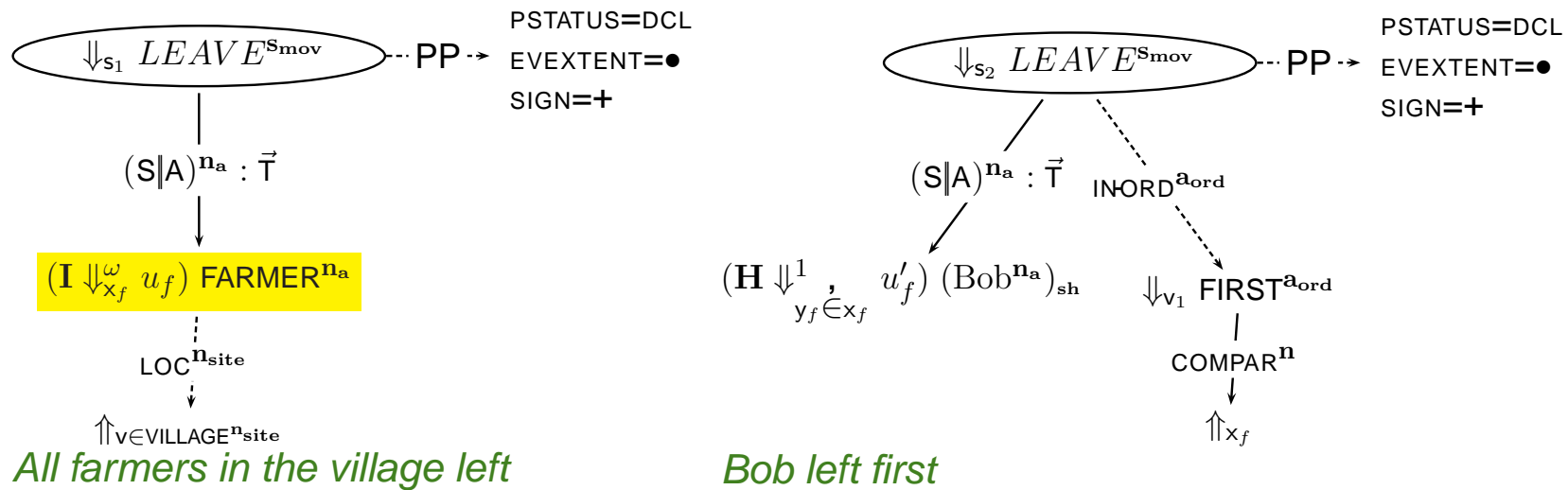
This *plurality-through-evidence* works as follows:

Effect of relativized determiners



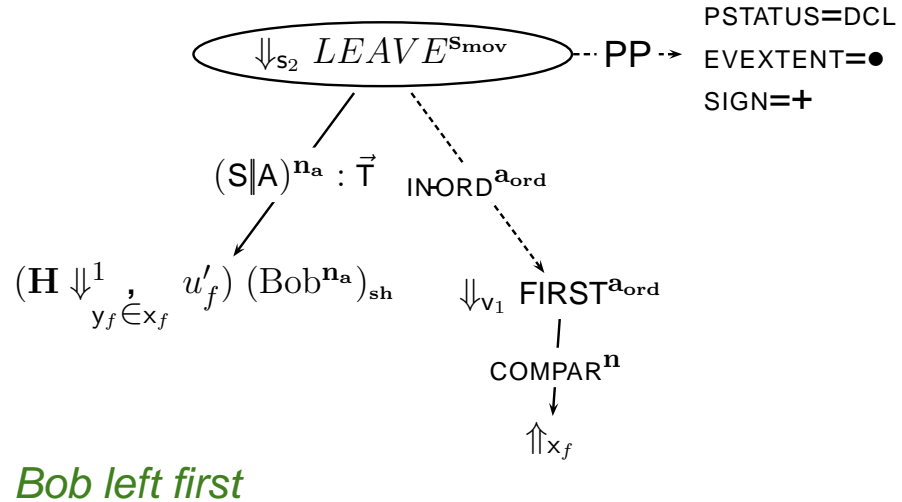
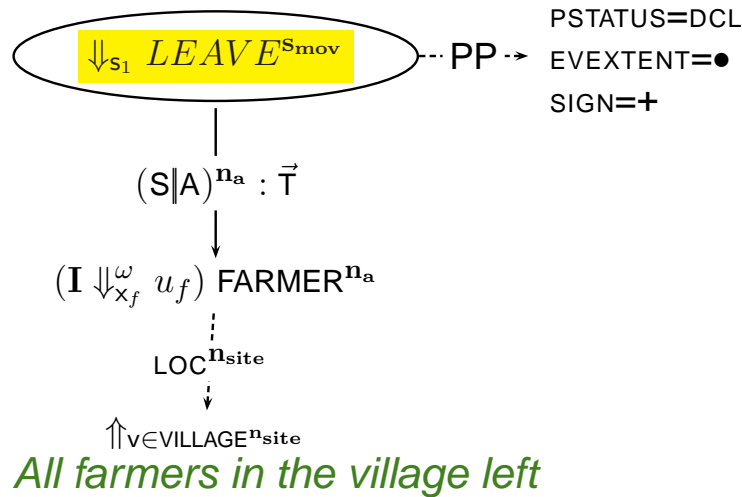
Context	GRef	Oid	Extension elements	LRef	LVal	Attributes	Semanteme
Σ_0	x_v	$o_v \in O^{n_{site}}$	$o_v \in H(VILLAGE)$				VILLAGE

Effect of relativized determiners



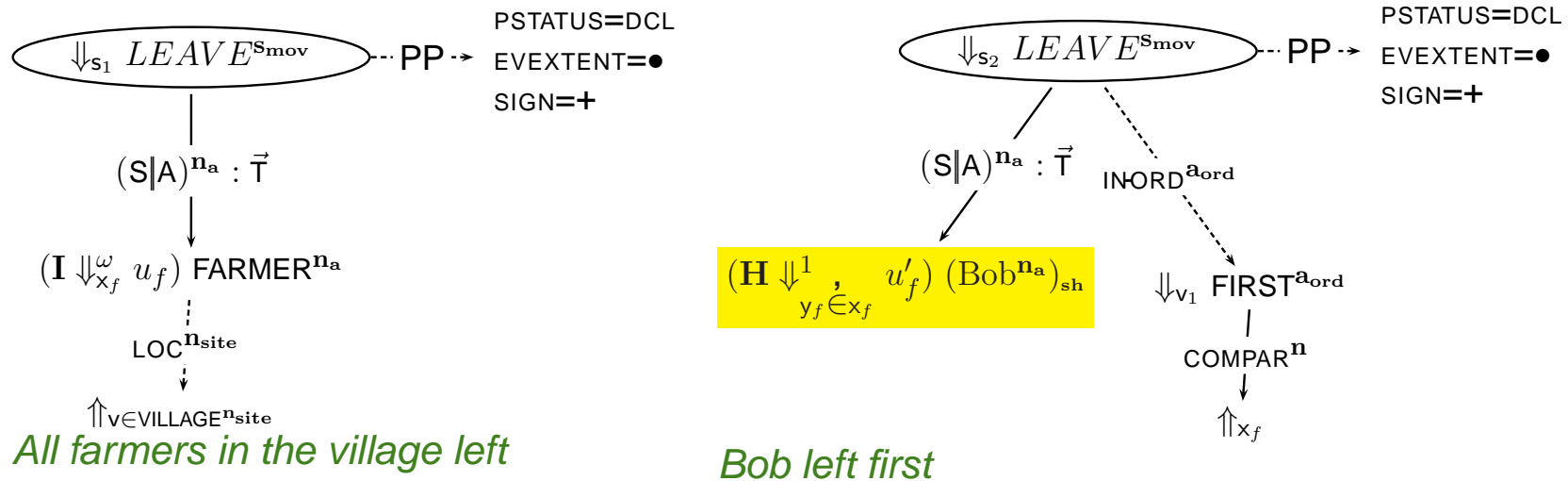
Context	GRef	Oid	Extension elements	LRef	LVal	Attributes	Semanteme
Σ_0	x_v	$o_v \in O^{n_{site}}$	$o_v \in H(VILLAGE)$				VILLAGE
Σ_1	x_f	$o_f \in O^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER

Effect of relativized determiners



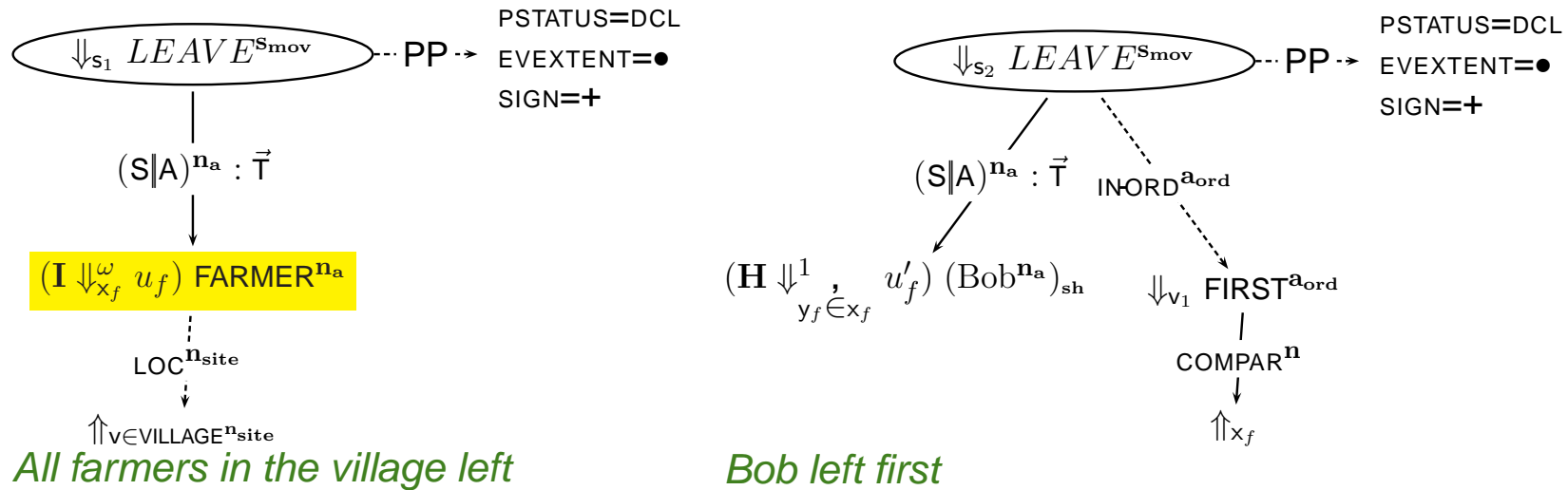
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Σ_0	x_v	$o_v \in O^{n_{site}}$	$o_v \in H(VILLAGE)$				VILLAGE
Σ_1	x_f	$o_f \in O^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in O^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE

Effect of relativized determiners



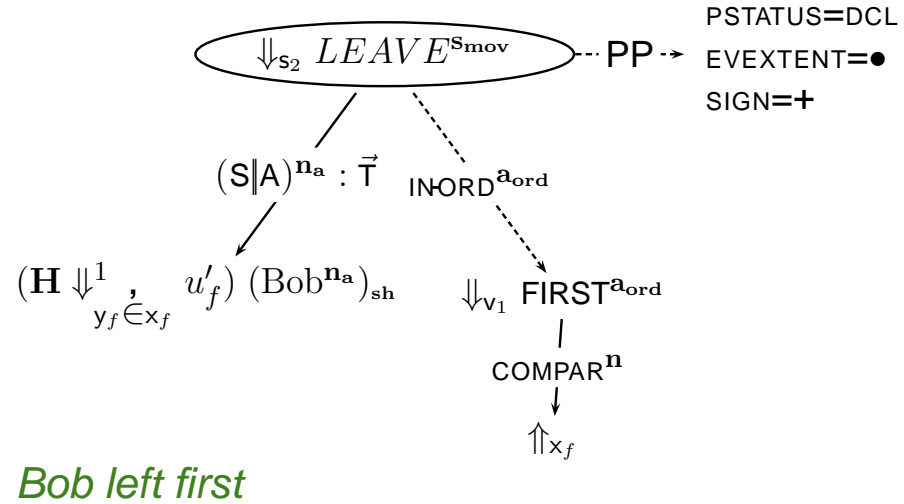
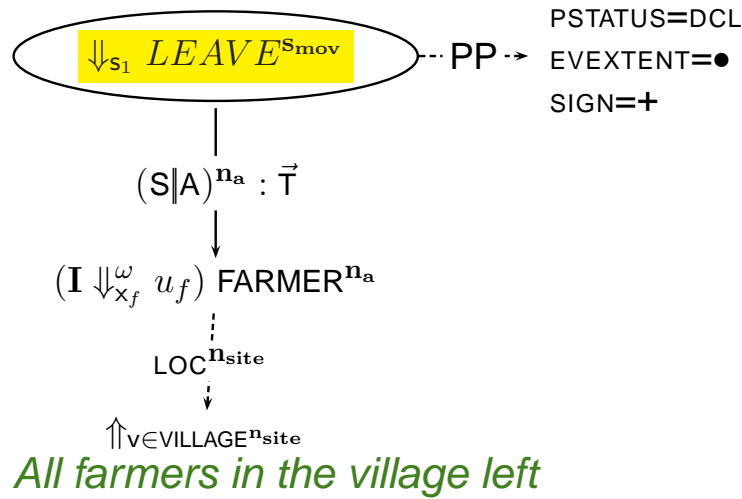
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Σ_1	x_f	$o_f \in \mathbf{O}^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in \mathbf{O}^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_3	y_f	$o_B \in \mathbf{O}^{n_a}$	$(Bob)_{sh}^*$	u'_f	$\{o_B\}$		$(Bob)_{sh}$

Effect of relativized determiners



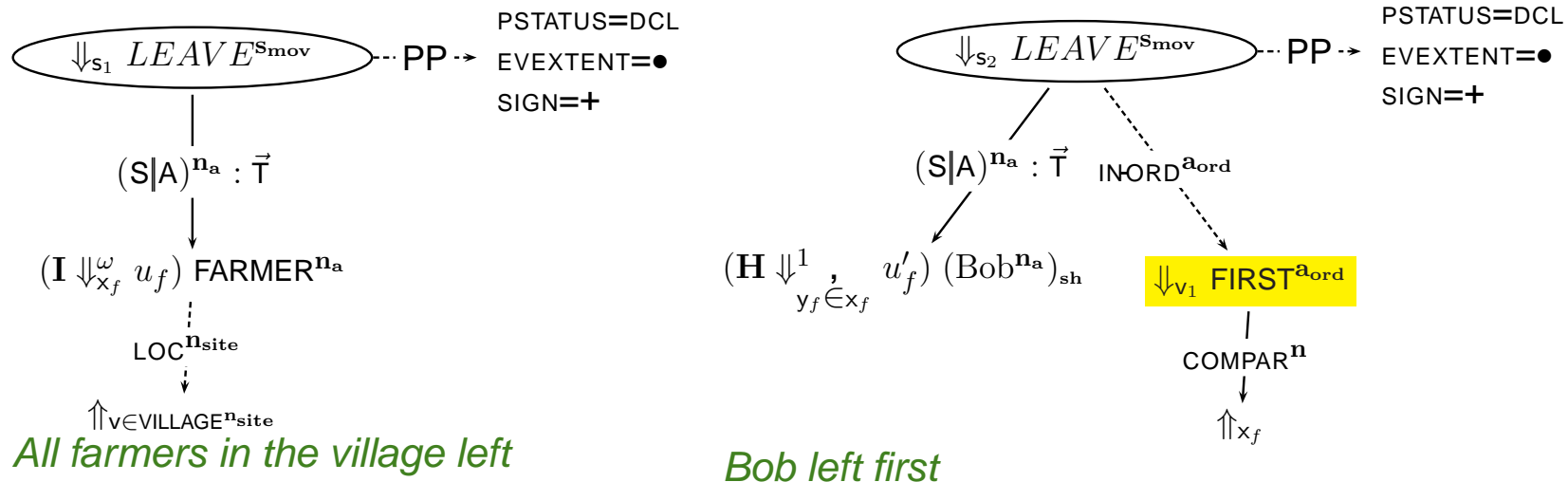
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Σ_1	x_f	$o_f \in \mathbf{O}^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in \mathbf{O}^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_3	y_f	$o_B \in \mathbf{O}^{n_a}$	$(Bob)_{sh}^*$	u'_f	$\{o_B\}$		$(Bob)_{sh}$
Σ_4	x_f	$o_f \in \mathbf{O}^{n_a}$	\perp, o_B	u_f	$\{o_B\}$	$LOC(o_f) = o_v$	FARMER

Effect of relativized determiners



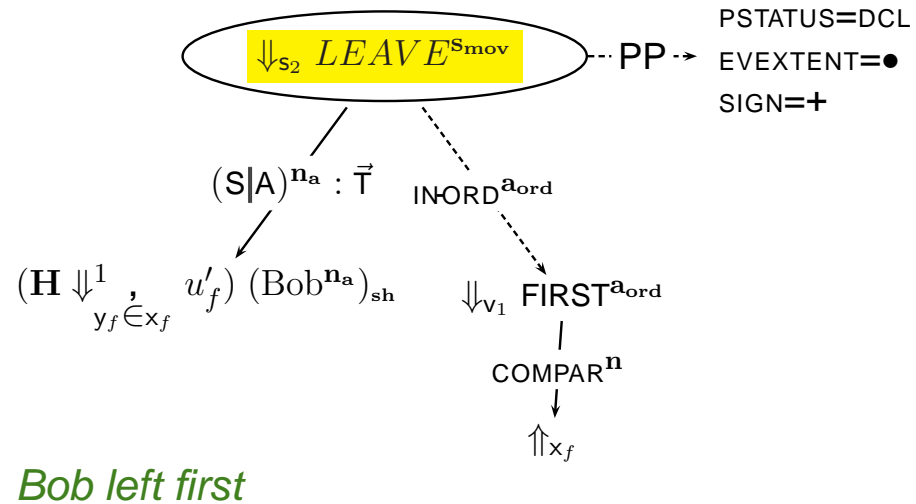
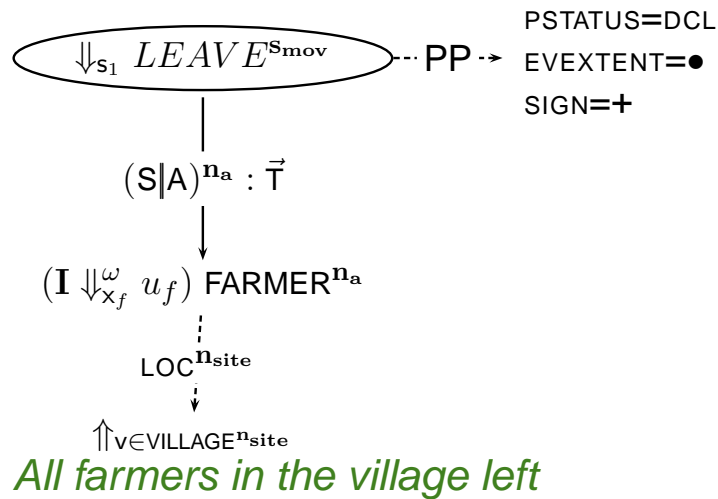
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Σ_1	x_f	$o_f \in \mathbf{O}^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in \mathbf{O}^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
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Σ_4	x_f	$o_f \in \mathbf{O}^{n_a}$	\perp, o_B	u_f	$\{o_B\}$	$LOC(o_f) = o_v$	FARMER
Σ_5	s_1	$o_{s_1} \in \mathbf{O}^{S_{mov}}$	$\langle S A : o_B \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE

Effect of relativized determiners



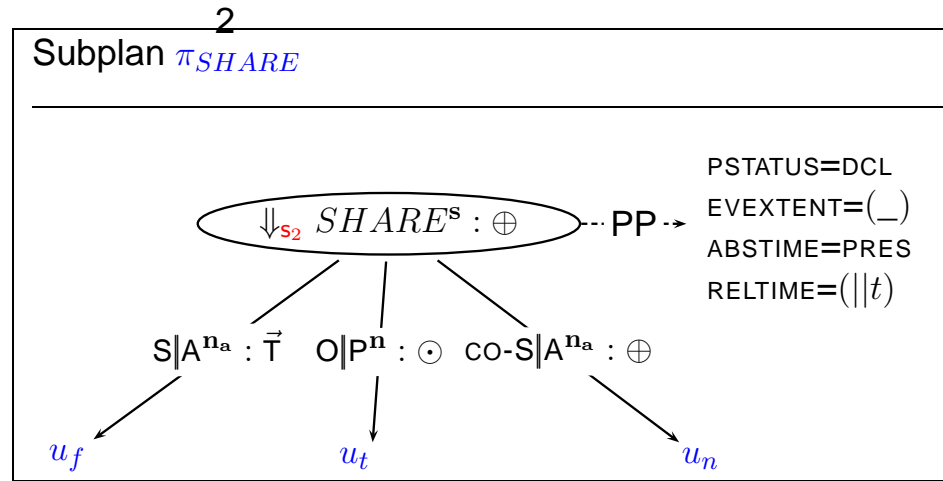
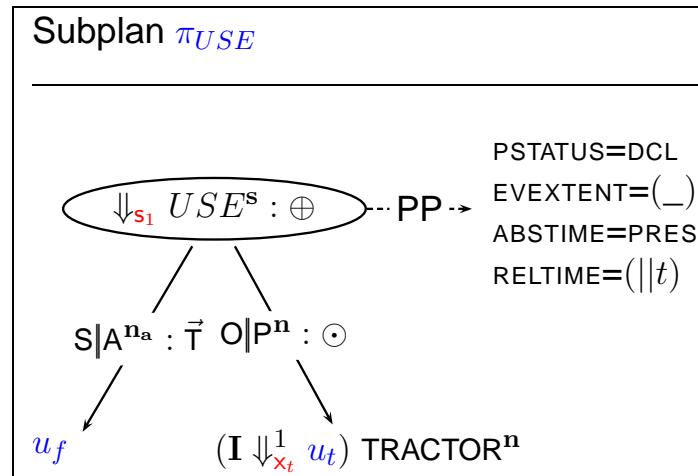
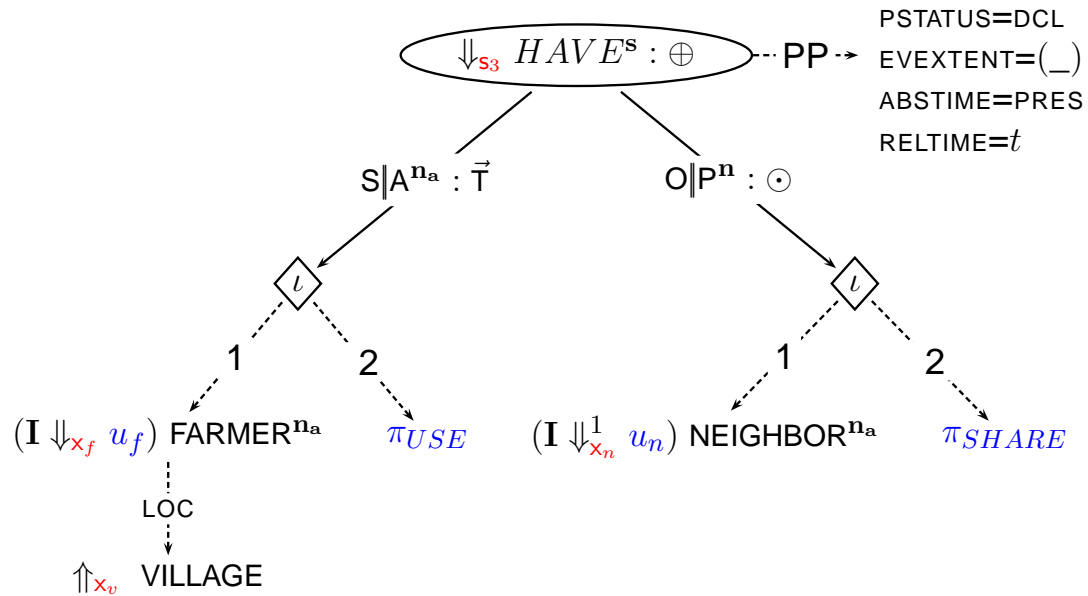
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Σ_1	x_f	$o_f \in O^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in O^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_3	y_f	$o_B \in O^{n_a}$	$(Bob)_{sh}^*$	u'_f	$\{o_B\}$		$(Bob)_{sh}$
Σ_4	x_f	$o_f \in O^{n_a}$	\perp, o_B	u_f	$\{o_B\}$	$LOC(o_f) = o_v$	FARMER
Σ_5	s_1	$o_{s_1} \in O^{S_{mov}}$	$\langle S A : o_B \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_6	v_1	$o_{ao} \in O^{a_{ord}}$	$\langle COMPAR : \{o_f\} \rangle$				FIRST

Effect of relativized determiners



Context	GRef	Oid	Extension elements	LRef	LVal	Attributes	Semanteme
Σ_0	x_v	$o_v \in O^{n_{site}}$	$o_v \in H(VILLAGE)$				VILLAGE
Σ_1	x_f	$o_f \in O^{n_a}$	\perp	u_f	$\{\perp\}$	$LOC(o_f) = o_v$	FARMER
Σ_2	s_1	$o_{s_1} \in O^{S_{mov}}$	$\langle S A : \perp \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_3	y_f	$o_B \in O^{n_a}$	$(Bob)_{sh}^*$	u'_f	$\{o_B\}$		$(Bob)_{sh}$
Σ_4	x_f	$o_f \in O^{n_a}$	\perp, o_B	u_f	$\{o_B\}$	$LOC(o_f) = o_v$	FARMER
Σ_5	s_1	$o_{s_1} \in O^{S_{mov}}$	$\langle S A : o_B \rangle$			$PSTATUS(o_{s_1}) = DCL^*, \dots$	LEAVE
Σ_6	v_1	$o_{ao} \in O^{a_{ord}}$	$\langle COMPAR : \{o_f\} \rangle$				FIRST
Σ_7	s_2	$o_{s_2} \in O^{S_{mov}}$	$\langle S A : o_B \rangle$			$INORD(o_{s_2}) = o_{ao},$ $PSTATUS(o_{s_2}) = DCL^*, \dots$	LEAVE

Relative nominal DP



Every farmer in the village, who uses a tractor, has a neighbor with whom he shares it.

Discussion/Conclusion

DP semantics has several distinctive properties:

- it represents the speaker's stance in which referential relations are presumed and facts are postulated ⇒
 - it is separated from logical consistency
 - in the place of quantifiers, it uses determiners referring to constant objects
 - it is completely compositional and incremental
- it is relative to finite contexts and dynamic ⇒
 - it is efficiently implementable
- it reduces verbal derivatives to the unique canonical diathesis and interprets verbal circumstantials and nominal qualifiers as attribute value constraints (not as properties) ⇒
 - DP are flexible and well adapted to the traditional linguistic semantical representations
 - semantical function-argument dependencies in DP semantics do not conflict with the natural surface syntactic dependencies
- it expresses plurality-through-evidence: only the entities witnessing facts in the discourse get to nominals' set-extension

Discussion/Conclusion

Comparison with logical semantics:

- In contrast with DRT-like semantics (cf. Heim'83, Kamp&Reyle'93, Muskens&Bentham&Visse'97), where references are treated as variables, DP semantics treats references using constants and simulates co-reference using special functions and relations on contexts.
- It is also the first discourse semantics relative to finite models \Rightarrow
 - it has a polynomial time complexity (model checking included), whereas all logical semantics are unfeasible
- All logical semantics are founded on the Leibniz's indiscernibles' identity principle: *entities indiscernible through their properties coincide*. In DP semantics, all objects are distinct, co-reference collapses to identity and this extensionality principle, does not apply.
- Extensions of objects being sets, the DP semantics expresses plurality. The expressive power of DP determiners is comparable with that of the generalized quantifiers formulas expressing plurality (cf. Keenan'96, Keenan&Westerstahl'97).

THANK YOU!