

About Semantic Granularity

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- Some issues of “classical” DRT
- Some remarks about discourse representation and interpretation
- Fine-grained and coarse-grained theories
- ontological granularity
- propositional granularity
- outlook: textual granularity

Some Issues of “classical” DRT

- Quantification and the reference of pronouns

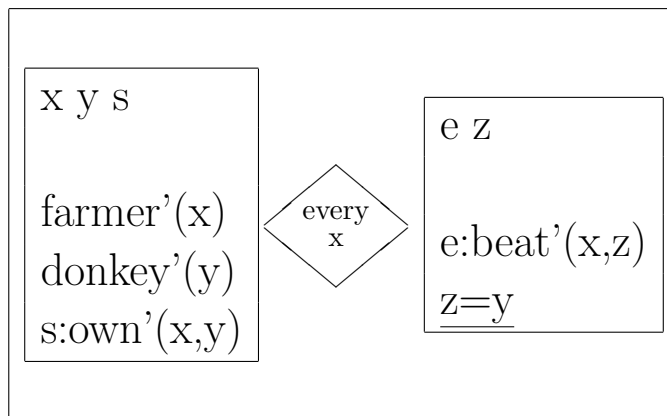
(1) *Every farmer who owns a donkey beats it.*

$$\forall x(\text{farmer}'(x) \wedge \exists y(\text{donkey}'(y) \wedge \text{own}'(x, y)) \longrightarrow \text{beat}'(x, ?z))$$

problem: PL-quantifier scope & compositionality

~> accessibility in hierarchically structured representations

(Kamp 81)



Some Issues of “classical” DRT

- (Temporal) links between the sentences of a discourse

(2) *Vite, docteur, dépêchez-vous. Mon mari a pris deux cachets d'aspirine, il a avalé sa lotion contre les aigreurs d'estomac, il s'est mis un suppositoire contre la grippe, il a pris un comprimé à cause de son asthme, il s'est mis des gouttes dans le nez, et puis il a allumé une cigarette. Et alors, il y a eu une enorme explosion.*

(Kamp Rohrer 83)

$$\begin{array}{l} S_1 \quad \rightsquigarrow \quad P(\exists x(\text{deux_cachets}'(x) \wedge \text{mon_mari}'(a) \wedge \text{prendre}'(a, x))) \\ S_2 \quad \rightsquigarrow \quad P(\text{aval}'(a, b) \wedge \text{lotion}'(b)) \\ \vdots \quad \quad \quad \vdots \end{array}$$

$$||T|| = ||S_1|| \cap ||S_2|| \cap \dots \cap ||S_n||$$

problem: truth of the text is independent on the order of the sentences

\rightsquigarrow the sentence completes the (preceding) context.

sp a e1 x e2 b e3 y ... e7 z

mari(a,sp)

deux_cachets'(x)

e1:prendre(a,x)

lotion'(b)

e2:aval'(a,b)

suppositoire'(y)

e3:se_mettre(a,y)

⋮

⋮

e7:exploser(a)

e1 < e2 < e3 < ... < e7

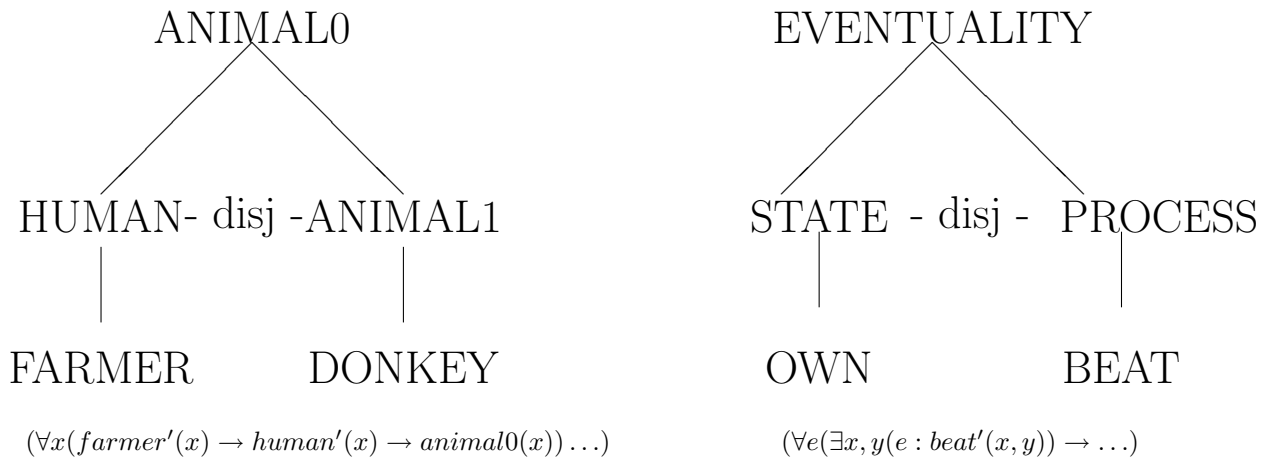
Discourse Representations I

W.r.t. the structural phenomena exemplified by (1) and (2), it is appropriate:

- to analyze
lexical items into basic predicates
-

farmer		$\lambda x.farmer'(x)$
donkey	into	$\lambda x.donkey'(x)$
own		$\lambda y,x,s. s:own'(x,y)$
beat		$\lambda y,x,e. e:beat'(x,y)$

possibly (but not necessarily) interrelated by sortal/implicational links:



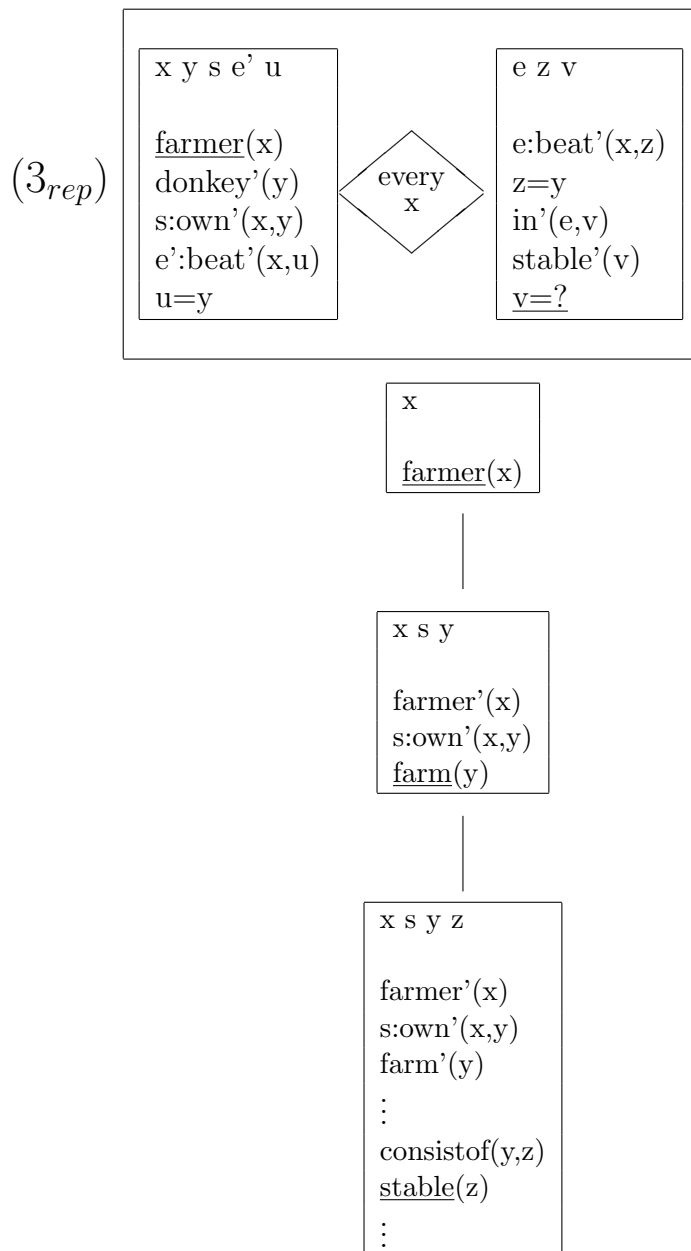
- to analyze
tense/aspect information into simple temporal relations
-

passé simple - passé simple	into	\prec
passé simple - imparfait	into	$= (\emptyset, \subseteq)$

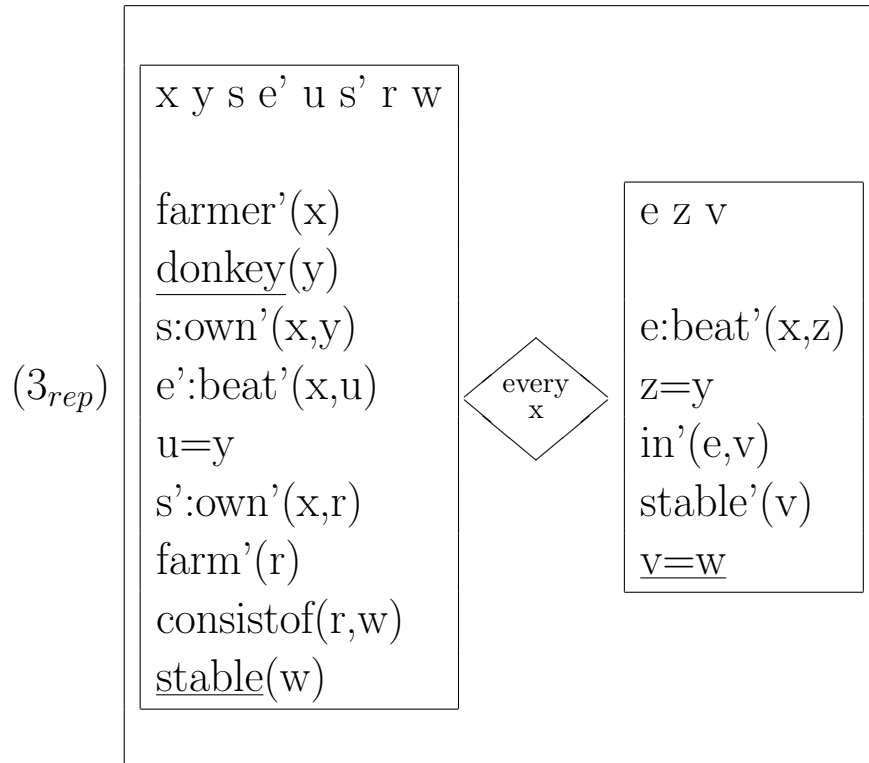
Discourse Representations II

The scenario is different, in case there is more material / the fragment is richer:

- (3) *Every farmer who owns a donkey and beats it beats it in the stable.*



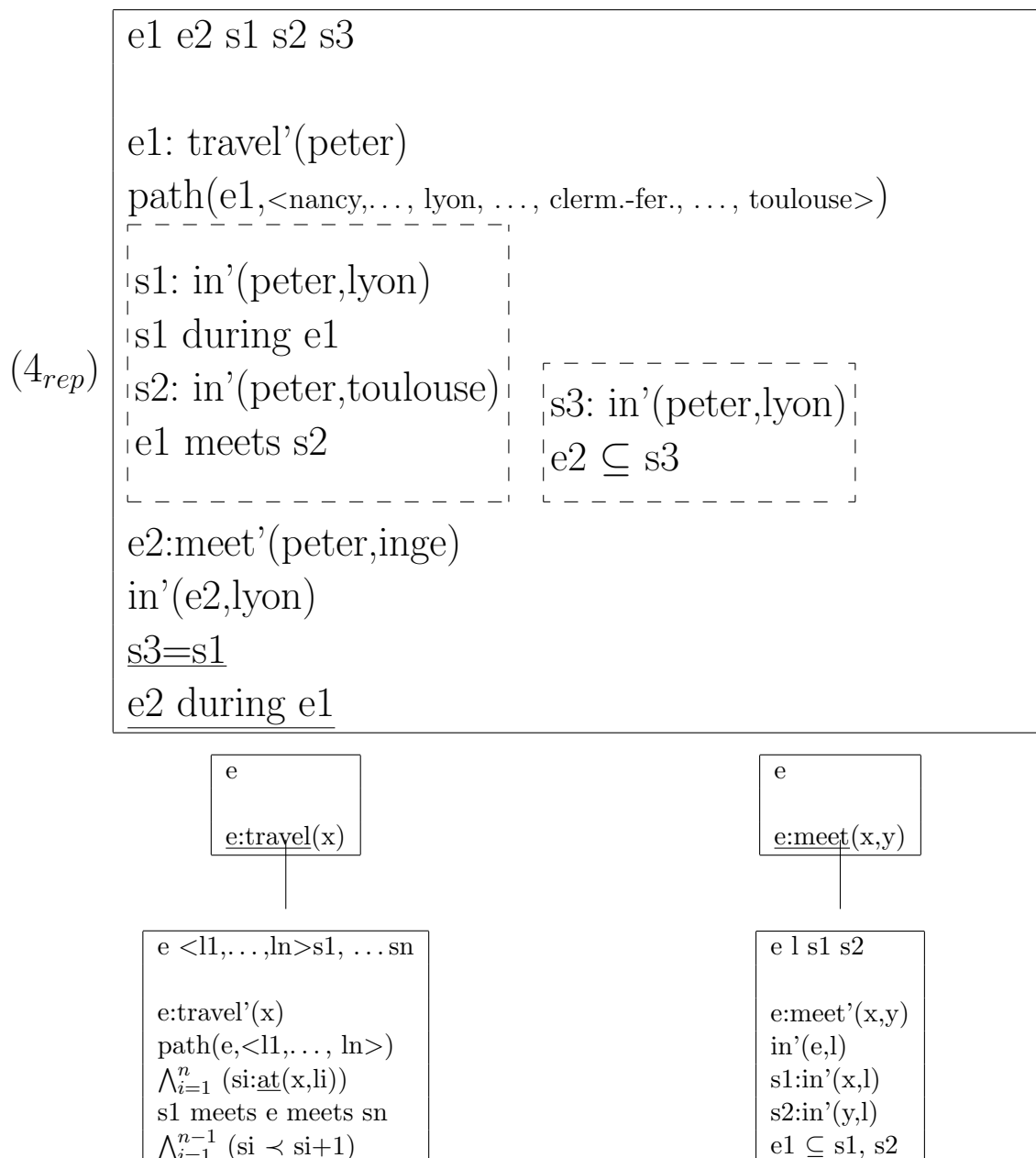
Discourse Representations III



Discourse Representations IV

The fragment allows for other discourse relations:

- (4) *Peter travelled from Nancy to Toulouse via Lyon et Clermond-Ferrand. In Lyon he met Inge.*



Discourse Interpretations I

For

sp a e1 x e2 b e3 y ... e7 z

mari'(a,sp)

deux_cachets'(x)

e1:prendre(a,x)

lotion'(b)

(*2_{rep}*) e2::avaler(a,b)

suppositoire'(y)

e3:se_mettre(a,y)

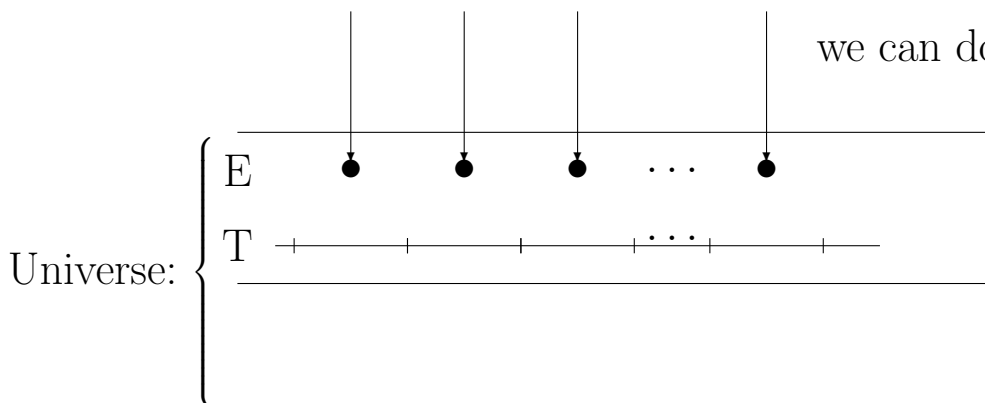
⋮

⋮

e7:exploser(a)

e1 < e2 < e3 < ... < e7

we can do with interpretations:



the vocabulary of
point structures: = , <

... that satisfy to the **theory of point structures** Φ_{\leq}^p .

Discourse Interpretations II

For

e1 e2 s1 s2 s3

e1: travel'(peter)

path(e1, <nancy, ..., lyon, ..., clerm.-fer., ..., toulouse>)

s1: in'(peter, lyon)

s1 during e1

(4_{rep}) s2: in'(peter, toulouse)

e1 meets s2

e2: meet'(peter, inge)

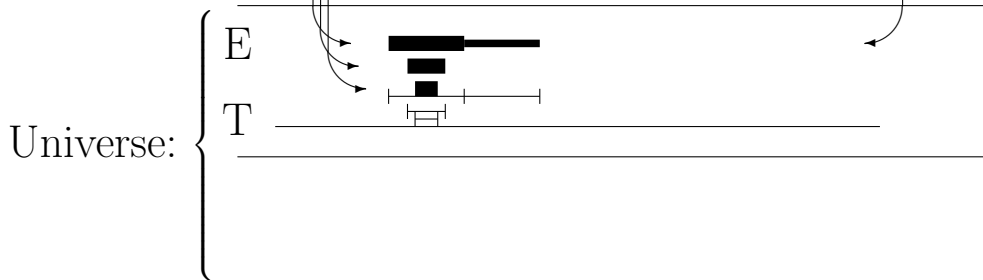
in'(e2, lyon) e2 ⊆ s3

s3: in'(peter, lyon)

s3 = s1

e2 during e1

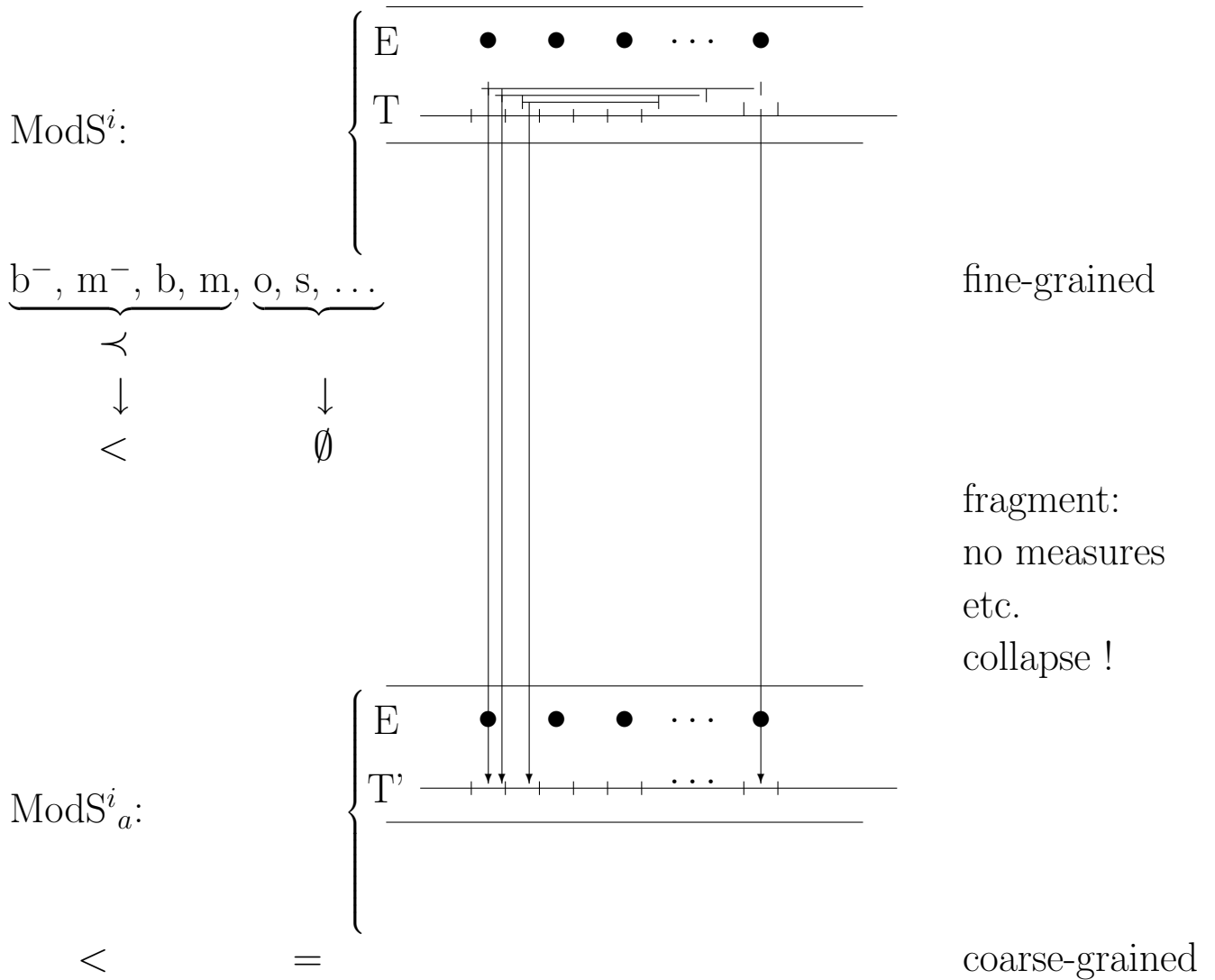
we need interpretations:



the vocabulary of
interval structures: b, m, o, s, d, ...

... that satisfy to the **theory of interval structures** $\Phi_{b,m,o,s,d,\dots}^i$.

Discourse Interpretations III



advantage:

transitive closure

fine-grained theory: $\Phi_{b,m,s,\dots}^i + \text{DB} \models i R j$ NP-complete

coarse-grained theory: $\Phi_{=, <}^p + \text{DB} \models t R' t'$ polynomial

In case we know that the fragment is such that all events that overlap only trivially overlap, in the sense that, in this case, they refer to the same time, we can collapse a fine-grained model (for interpreting (all kinds of) interval statements) in a more coarse-grained model that will do for interpreting the texts of the fragment; for instance by choosing a (discrete) suborder (the times of the considered events) and by mapping every interval to the first of this sequence that it overlaps with.

Fine-grained and Coarse-grained Theories

- Jerry Hobbs: *Granularity* (1985)

- fine-grained complex theory

- coarse-grained simple theory

$$T_0|_{\text{over } P_1, \dots, P_m, \dots, P_n} \xrightarrow{k} T_1|_{\text{over } k(P_1), \dots, k(P_m)}$$

domain:

S_0

S_1

x_1, x_2, x_3, \dots

$x_i \sim x_j \leftrightarrow \forall 1 \leq r \leq i (P_r(x_i) \leftrightarrow P_r(x_j))$
 (“indistinguishable” w.r.t. P_1, \dots, P_I)

$k(x_i) = k(x_j) \leftrightarrow x \sim x_j$

$k(x_1), k(x_4), \dots$

complex world with
different objects, agents ...

the schematic simple
blocks world

simplification
 $\xrightarrow{\quad}$

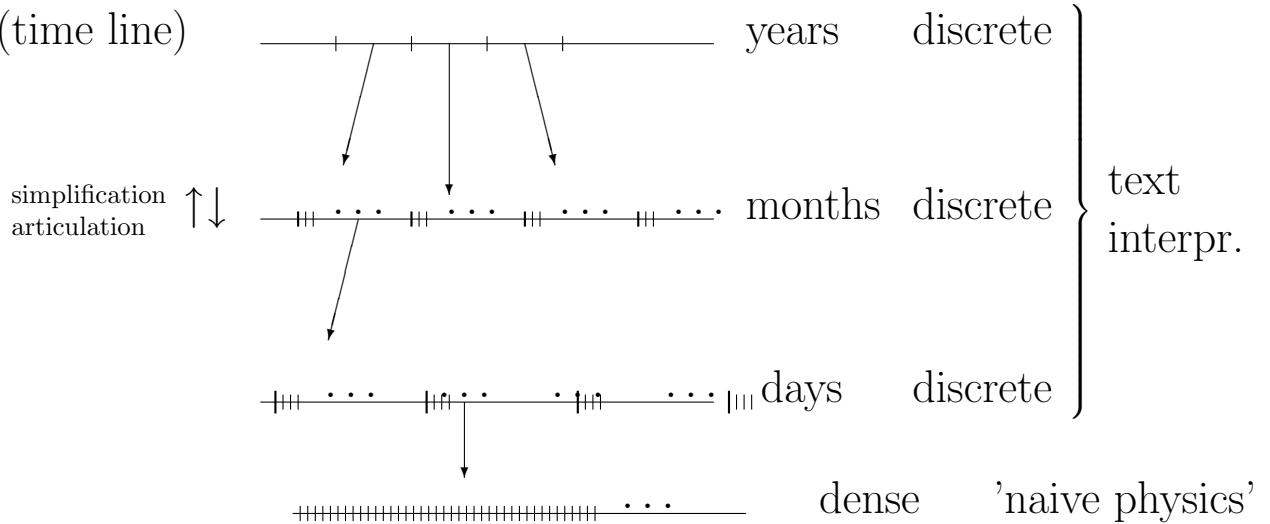
articulation
 $\xleftarrow{\quad}$

Ontological Granularity - Examples

(Text model simpler than 'naive physics' model)

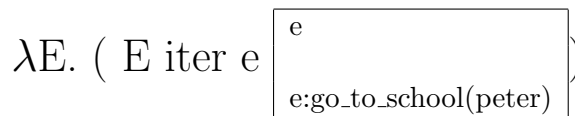
calendar:

(time line)

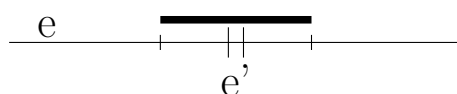
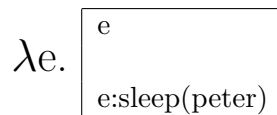
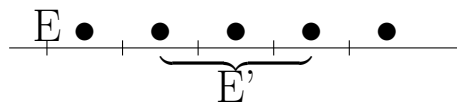


homogeneity of event types:

coarse-grained perspective



fine-grained perspective



Ontological Granularity - Examples

(Text model simpler than 'naive physics' model)

paths

Peter travelled from Germany to France.

e e:travel(peter) path(e,<germany,france>)

Peter travelled from Kaiserslautern to Toulouse via ...

e e:travel(peter) path(e,<kaiserslautern,...,lyon,...,toulouse>)

more specific path:

$\forall w, w' \in WEG$

$$\begin{aligned} & (w \leq^s w' \leftrightarrow [hproj_1(w) \leq_f hproj_1(w') \wedge hproj_{weite(w)}(w) \leq_f hproj_{weite(w')}(w') \\ & \wedge (\forall j \in \mathbb{N} \quad (1 < j < weite(w') \\ & \quad \rightarrow \exists i \in \mathbb{N} \quad (1 \leq i \leq weite(w) \wedge hproj_i(w) \leq_f hproj_j(w')))) \\ & \wedge (\forall i, j \in \mathbb{N} \quad (1 \leq i < weite(w) \wedge 1 \leq j < weite(w') \wedge hproj_i(w) \leq_f hproj_j(w') \\ & \quad \rightarrow hproj_{i+1}(w) \leq_f hproj_j(w') \vee hproj_{i+1}(w) \leq_f hproj_{j+1}(w')))] \end{aligned}$$

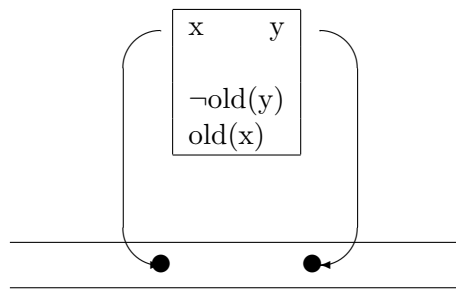
Ontological Granularity - Examples

('naive physics' model simpler than text model)

The ring is not old, but the gold that makes up the ring is old.

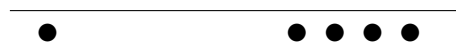
(Link 83)

object
+
substance



text model

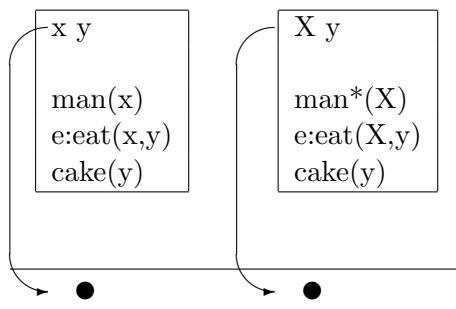
f



'naive physics'

The man ate the cake / the men ate the cake

plural



text model

{...}

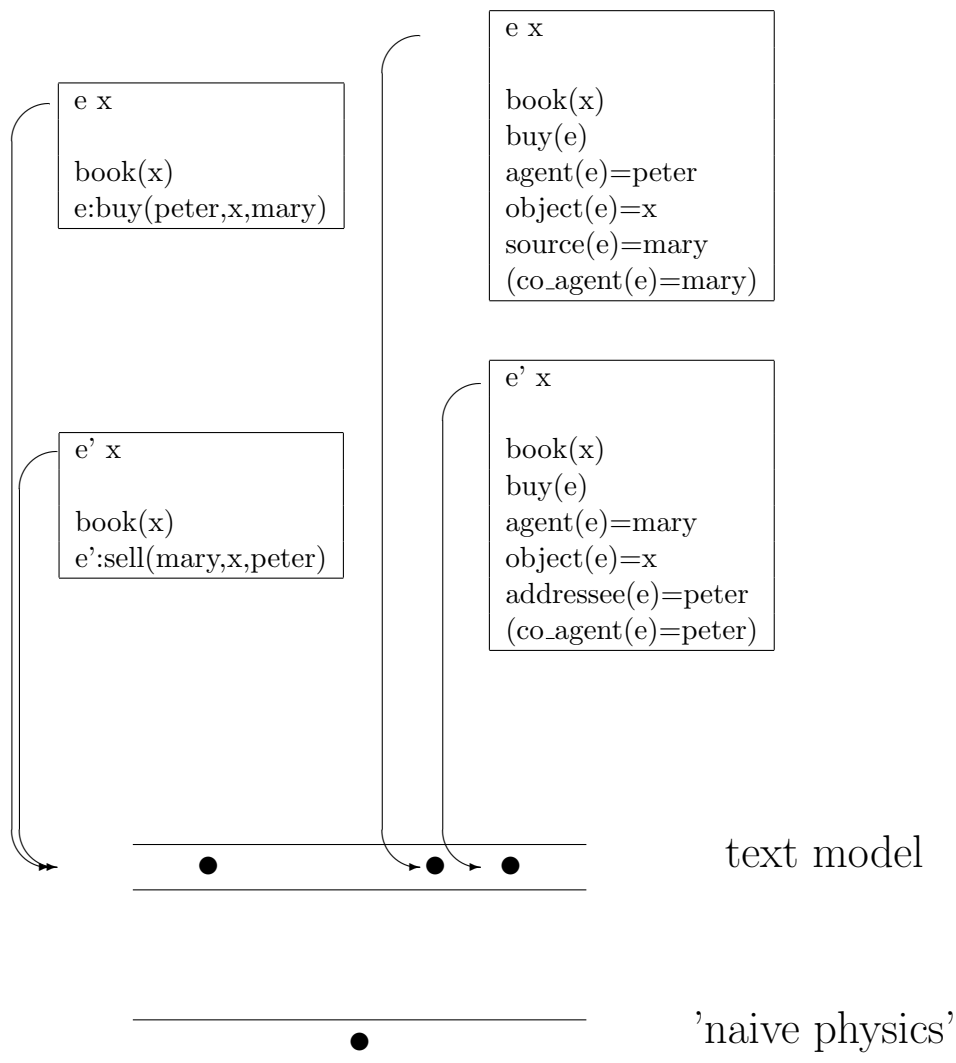


'naive physics'

Ontological Granularity - Examples

(‘naive physics’ model simpler than text model)
influence of the representation format

- (5) *Peter bought the book from Mary.*
Mary sold the book to Peter.



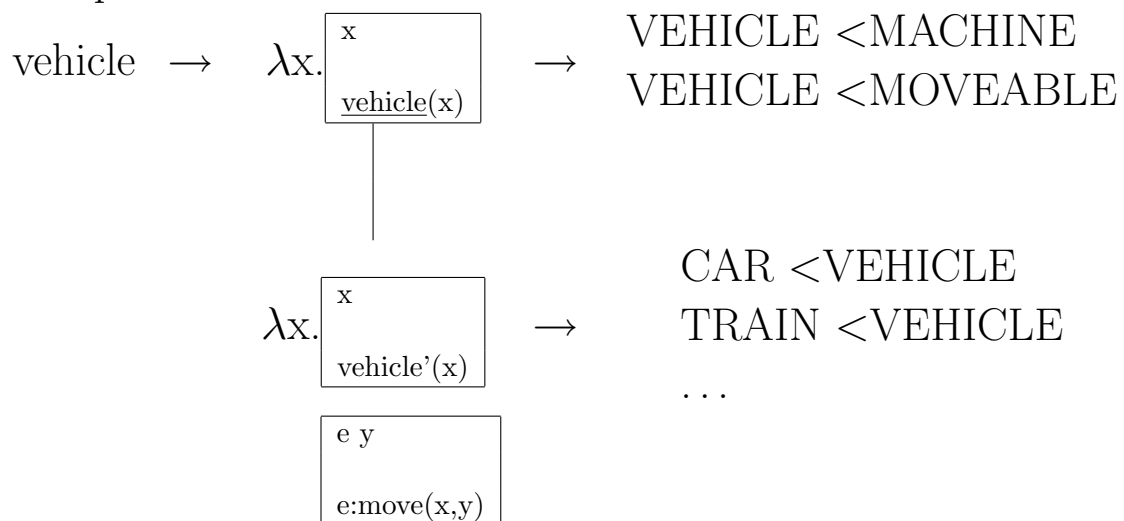
Strategy: Keep the theory and interpreting structures as simple as appropriate

~> transition to a more fine-grained level only when needed.

What does this mean?

- the text system should not be backed by an overall available fine-grained theory
- the text elements
 - i) define their level of granularity;
i.e. relate themselves to the relevant characterizations of this level
 - ii) define their specific contribution to articulation

example:



Propositional Granularity

- The lexicon specifies (parts of) the relevant theory
- The text - via composition - defines a database and theory of a certain granularity

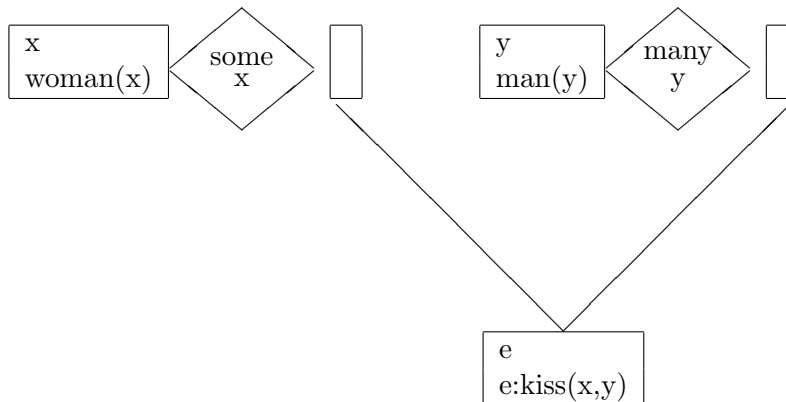
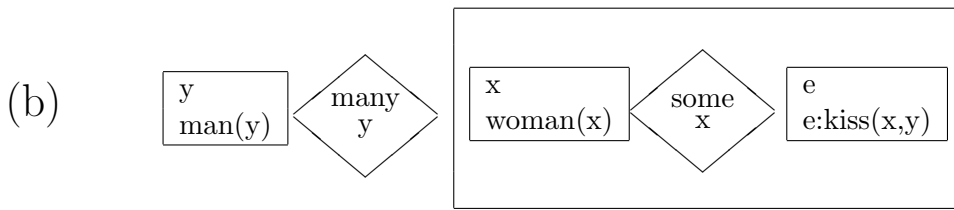
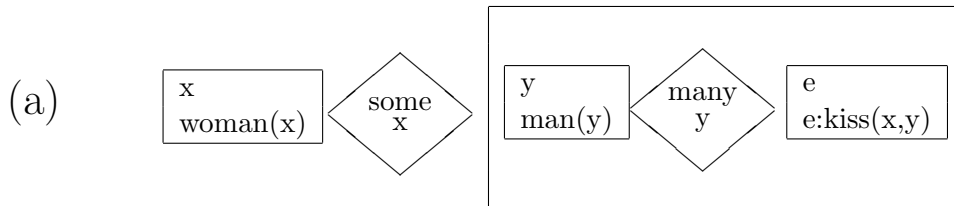
- Two sources of granularity:
 - variable depth of the analysis of lexical items
 - variable depth of the analysis of the interplay between the lexical contributions in the sentence
(between the sentences in the text)
→w.r.t. the interplay of quantificational (and other scope bearing) expressions:
underspecified DRT (UDRT -Reyle)

Propositional Granularity - Examples

UDRT

(6) *Vielen Männern gaben einige Frauen einen Kuss.*

Many men were kissed by some women.

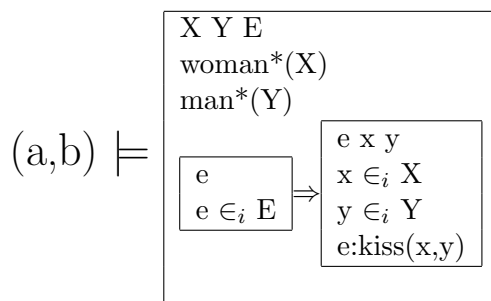


(a,b)

\rightsquigarrow (claim:) psychologically motivated level of abstraction

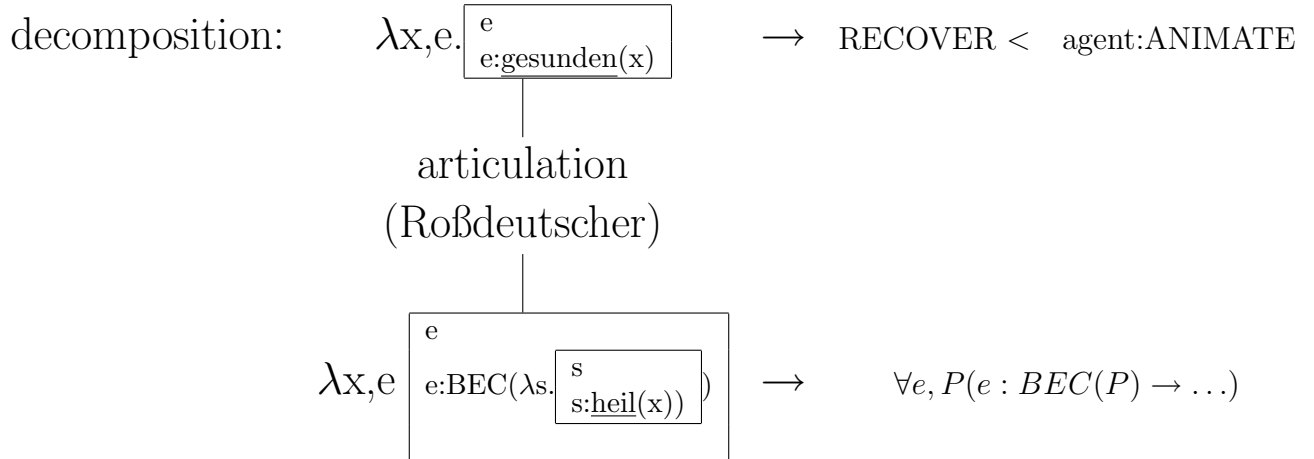
\rightsquigarrow legitimates the outlining of

a logic for the ambiguity preserving representation format



Propositional Granularity - Examples

Lexical Analyses



problems:

generic term

vs.

ambiguity

$\lambda x. \boxed{\begin{matrix} x \\ \text{vehicle}(x) \end{matrix}}$

$\lambda x. \boxed{\begin{matrix} x \\ \text{bank}_{\text{german}}(x) \end{matrix}}$

$\lambda x. \boxed{\begin{matrix} x \\ \text{car}(x) \end{matrix}}$ $\lambda x. \boxed{\begin{matrix} x \\ \text{train}(x) \end{matrix}}$...

$\lambda x. \boxed{\begin{matrix} x \\ \text{bank}(x) \end{matrix}}$ $\lambda x. \boxed{\begin{matrix} x \\ \text{bench}(x) \end{matrix}}$...

Peter has no vehicle

Peter sucht keine Bank

\leadsto no car, no bicycle ...

Peter doesn't look for a bank

or

Peter doesn't look for a bench

\rightarrow context dependence

(local vs. global evaluation of the analytic disjunction)

Propositional Granularity - Examples

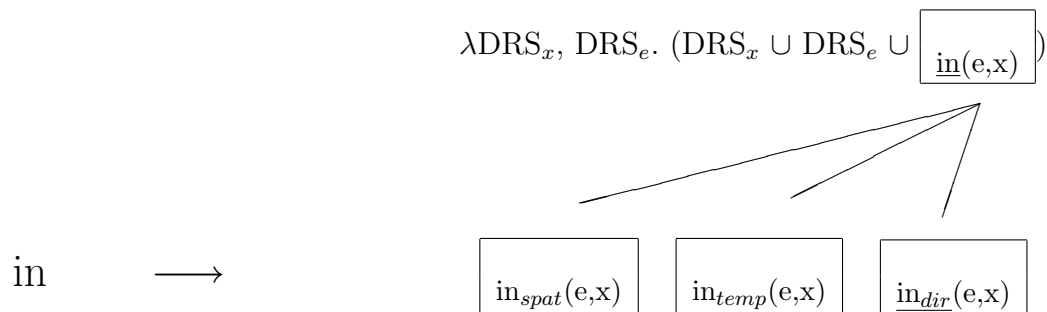
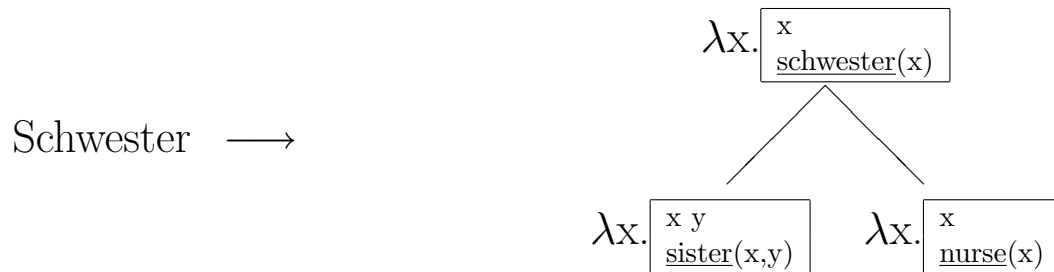
correlated ambiguities (Reyle)

Peter sucht eine Bank_{1,bank/2,bench}, findet aber keine_{1,bank/2,bench}.

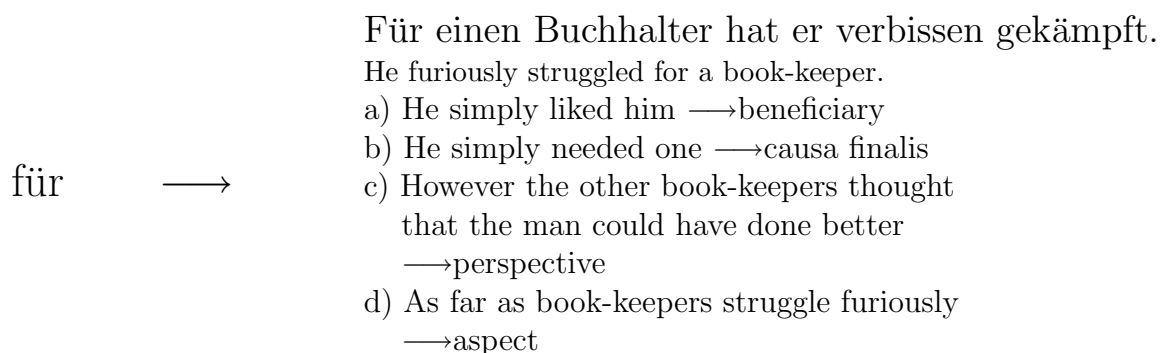
Many men_{wide/narrow} were kissed by some women_{narrow/wide} and
many dogs_{wide/narrow} were given a bone by some cooks_{narrow/wide}.

Propositional Granularity - Examples

problem: diverging representational format of the different meanings



the flower in the vase / the money in the pocket / the hole in the wall



Für einen Buchhalter hat er verbissen gekämpft.

- a) for the benefit of a book-keeper
- $$\begin{array}{l}
 x_{pro} \text{ e } y \\
 e:\text{struggle}(x) \\
 \text{beneficiary}(e)=y \\
 \text{book-keeper}(y)
 \end{array}$$
- b) in order to obtain a book-keeper
- $$\begin{array}{l}
 x_{pro} \text{ e } p \\
 e:\text{struggle}(x) \\
 \text{causa_finalis}(e,p) \\
 \hline
 \begin{array}{l}
 y \\
 p: \text{book-keeper}(y) \\
 R(x,y)
 \end{array}
 \end{array}$$
- a), b) → existential reading of the external argument

- c) from the perspective of a (specific) book-keeper
- $$\begin{array}{l}
 y \\
 \text{book-keeper}(y) \\
 \hline
 \begin{array}{c}
 \text{für}_{2,1} \\
 \diamond \\
 y
 \end{array}
 \quad
 \begin{array}{l}
 x_{pro} \text{ e} \\
 e:\text{struggle}(x)
 \end{array}
 \end{array}$$
- d) compared to the repertoire of book-keepers
- $$\begin{array}{l}
 \hline
 \begin{array}{c}
 \text{für}_{2,2} \\
 \diamond \\
 \lambda x. \text{b.k.}(x)
 \end{array}
 \quad
 \begin{array}{l}
 x_{pro} \text{ e} \\
 e:\text{struggle}(x)
 \end{array}
 \end{array}$$
- c), d) → relativized characterization of the world

Correlated Ambiguities

Für einen Buchhalter hat er verbissen gekämpft.

He furiously struggled for a book-keeper.

Für einen Sekretär hat er keinen Finger gerührt.

For a secretary, he did not lift a finger.

Representation:

$$\lambda \text{DRS}_x, \text{DRS}_e. \boxed{\text{für}(\text{DRS}_x, \text{DRS}_e)} \longrightarrow \text{logic ?}$$

$$\boxed{\text{für}_2(\text{DRS}_x) \text{DRS}_e} \longrightarrow \begin{array}{l} \text{modal, epistemic logic} \\ \text{s:att}(x, \{ \langle \text{BEL}, \square \rangle \}) \end{array}$$

$$\text{DRS}_e \cup \boxed{\text{für}_1(e, \text{DRS}_x)} \longrightarrow \begin{array}{l} \text{deontic logic} \\ \text{s:att}(\text{agent}(e), \{ \langle \text{DESIRE}, \square \rangle \}) \end{array}$$

Realization:

Macros: hierarchically specify lexical entries:

- `prepsem(für,flat)`
- `prepsem(für,rel;modop)`
- `prepsem(für,rel(ext(benf);int(causfin));modop(asp;persp))`

define CUF-sorts (Categorial unification formalism):

$$\begin{aligned} \underline{\text{für}}(\text{DRS}_x, \text{DRS}_e) &:= \text{merge}(\text{DRS}_e, \underline{\text{für}}_1(e, \text{DRS}_x)) \\ &:= \left(\begin{array}{l} \text{modop: } \underline{\text{für}}_2(\text{DRS}_x) \ \& \\ \text{modarg: } \text{DRS}_e \end{array} \right) \end{aligned}$$

evaluation: controlled by **wait**-statements

- `wait(für(-, $\text{DRS}_{e_{agentive}}$) \rightarrow -).`
- `wait(für(-, $\text{DRS}_{e_{nonagentive}}$) \rightarrow -).`
- quantifier ? \rightsquigarrow perspective: possible / aspect: not possible
- information structure

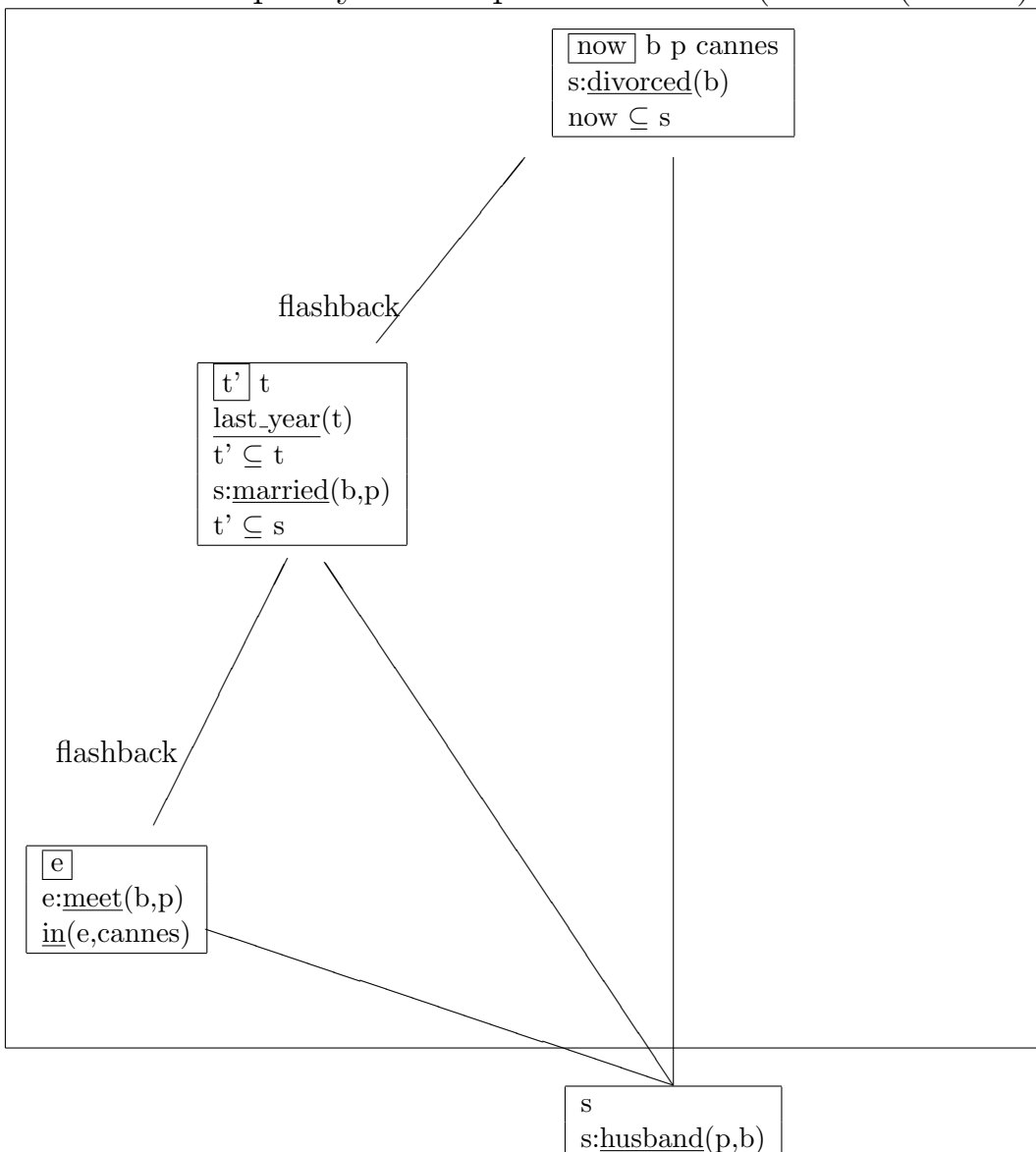
Outlook: Textual Granularity

- (7) *Mme B. ist geschieden. Noch letztes Jahr war sie allerdings verheiratet, mit Pierre E. Sie hatte **ihren Mann** in Cannes kennengelernt.*

Mme B. is divorced. However, last year she still was married - to Pierre E. She had met her husband in Cannes.

↷ the meeting \neq Pierre is her husband

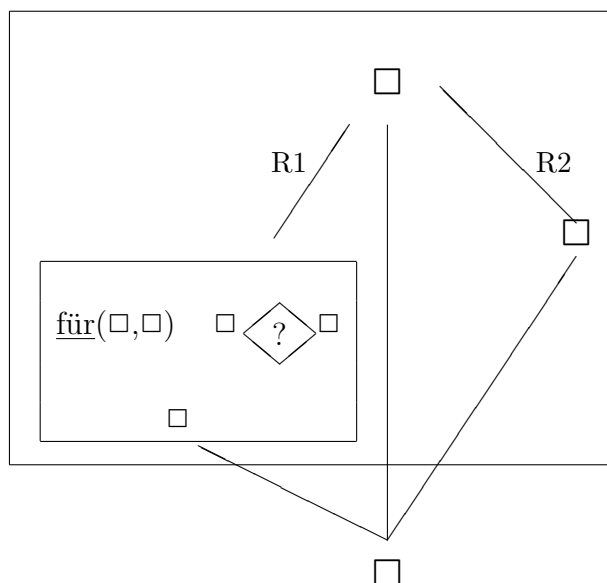
↷ underspecify text representations: (SDRT (Asher) \rightarrow uSDRT)



Summary

Suggestion: two step analysis

- 0) the background theory (specific to the scenario)
distributed over the lexicon
- 1) composition:
flat underspecified text representation
 \rightsquigarrow partial DRSs linked to each other
 - links can be refined
 - partial DRSs (conditions) can be expanded



- 2) inspection routine:
 - infers constraints (refine links)
 - triggers articulation, if needed (expand DRSs)

(The two steps might be interleaved)

|| the sentence completes the context and
|| triggers articulation of the
|| context theory and database