A semantics for temporally dependent referring expressions

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Overview

- what are the problems considered
- some existing answers
- the problem in a different ontological framework
- semantic consequences

Interpreting some noun phrases

(1) Every art student visited the Musée d'Orsay.

(2) The hostage attended the party in her/his honor.

(3) Most lawyers had an unhappy childhood.

- Is every art student a student at the time of the visit of the MO ?
- When is the "hostage" actually detained ?

$\rightarrow$ interaction between the time of an event and the time of other predications

Putting time into NPs

If we assume :
x is an hostage at t_1 and attend the party at t_2

- what are the constraints on the relation between t_1 and t_2 ?

Phenomenon not restricted to nouns :

(4) A drunk(t_1) hostage(t_2) missed(t_3) the party(t_4)

(5) The woman (on the deck)$_{t_1}$ dove$_{t_2}$ (into the water)t_3.

An essentially ontological problem

some solutions given to the temporal interpretation of noun phrases in the literature :

- Enç : time index for every predication
- Tonhauser : time index for every predication (pragmatically constrained)
- Carlson, Musan : time index for some predication

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  life-time properties vs. temporary properties

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The usual ontology

- a domain of entities D
- a domain for times (instants e.g.) T
- a domain for space S
- predicates either atemporal or temporalised : subsets of D or $D \times T$

then interpretation with temporal effects (Musan, 1999) :

$$[\![P(x,t) \ \wedge \ PAST(t)]\!] = 1 \text{ iff } x \ is \ P \ at \ t \ \& \ t < TU$$

One or two existences ?

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  (to distinguish being $not(P)$ at t with not being at t)

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(9) The King of France is bald.

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(10) The King of France is bald.

$$\exists x(...king\_of\_france(x) \ \wedge \ bald(x) \ \wedge \ exists(x, now))$$

So there are two kinds of existence, one logical and one material.

An alternative ontology

Inspired by Russell, Quine.

- everything is a spatio-temporal region (Russell : a S-T event, Quine : a "worm")

what does it mean ?

- predicates hold of "stages"
- persistent objects are mental reconstructions of "reality"

Philosophical recent revival ("four-dimensionalism") : (Heller, 1990, Sider, 2001).

Ontology semantics

$\mathcal{M} = \langle E, \prec, \approx, [\![\cdot]\!] \rangle$ a model

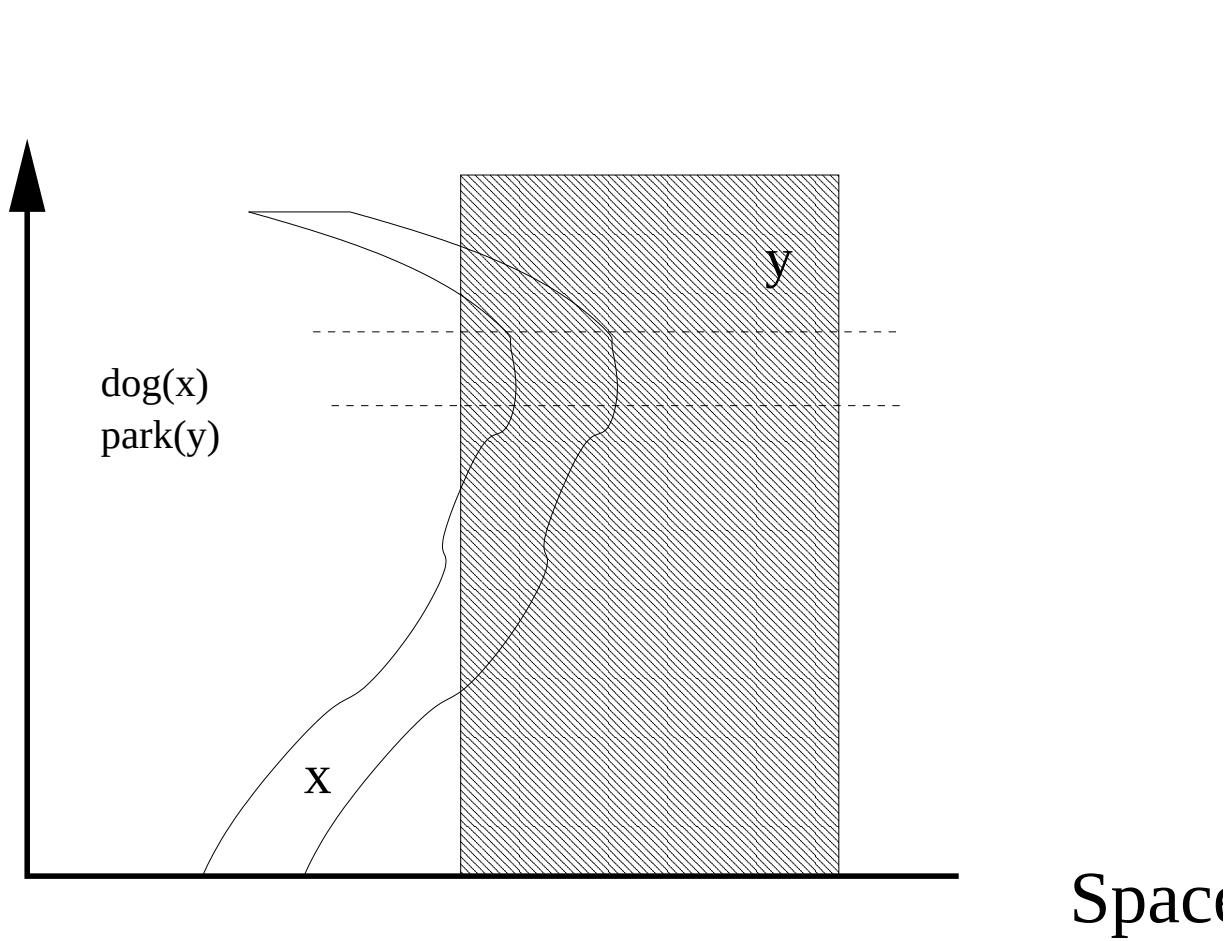
- g a variable assignment $g : D \rightarrow X \in P(E)$.
- D is the set of variables of the language.
- E is a set of spatio-temporal "points" (the most fine-grained spatio-temporal events),
- $\approx$ is a contemporaneity relation on spatio-temporal points
- $\prec$ is a total linear ordering on classes of equivalence of E with respect to $\approx$.
- $[\![\cdot]\!]$ is an interpretation function.

A maximal set of contemporaneous points can be interpreted as an "instant".

Formal vocabulary

- $<$ "is before"
- $stage$ "is a stage of"
- $\subseteq_t$ "is temporally included in"
- $[\![x < y]\!]_g$ =true iff $\forall \alpha \in [\![x]\!]_g \, \forall \beta \in [\![y]\!]_g \, (\alpha \prec \beta)$
- $[\![x \subseteq_t y]\!]_g$ =true iff $\forall \alpha \in [\![x]\!]_g \, (\exists \beta \in [\![y]\!]_g \, \alpha \approx \beta)$
- $[\![stage(x, y)]\!]_g$ =true iff
  $[\![x]\!]_g \subseteq [\![y]\!]_g \ \wedge \ \forall \alpha \in [\![y]\!]_g \, [(\exists \beta \in [\![x]\!]_g \ \wedge \ \beta \approx \alpha) \rightarrow \alpha \in [\![x]\!]_g]$
- in addition, the sum of objects (+) is defined as set union : $[\![x + y]\!]_g = [\![x]\!]_g \cup [\![y]\!]_g$.
- $[\![P(x, y)]\!]_g$ =true if and only if $[\![x]\!]_g \subseteq [\![y]\!]_g$.

Illustration



The dog walked in the park.

Types of predication

stage-level (temporary property) vs individual level (essential property).

(11) Most lawyers had an unhappy childhood.

(12) Most human beings had an happy childhood.

Also, a-temporal properties :

(13) Frege is famous.

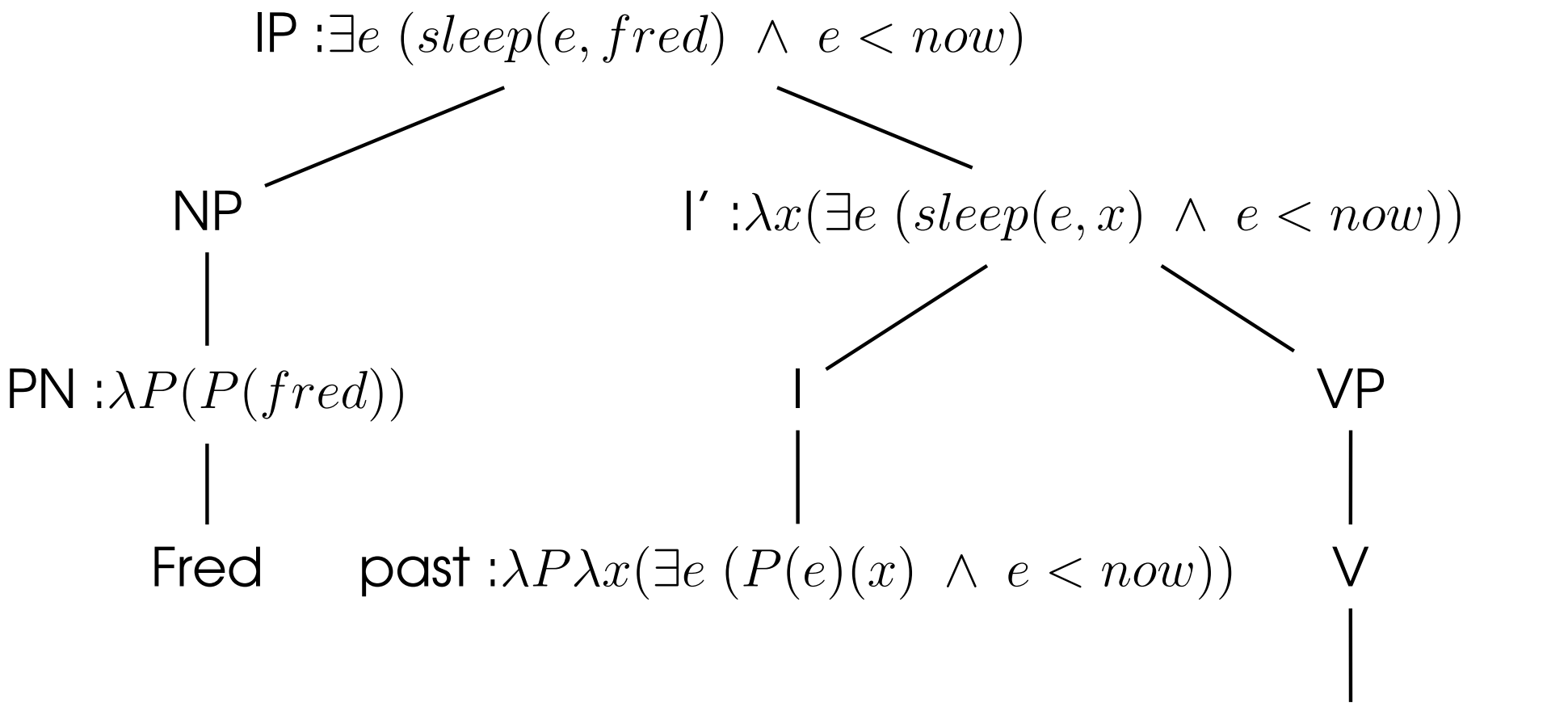
Other ?

(14) Frege is dead.

$frege < now$

Syntax/semantics interface (classical ontology+events)

(15) Fred slept.



The syntax-semantics interface re-visited

Now, with our ontology where every object has a life-span and can be predicated over by temporal relations :

$[\![past]\!] = \lambda Q \lambda x(\exists y\ Q(y)(x)\ \wedge\ y < now)$

$[\![sleep]\!] = \lambda y \lambda x(stage(y, x)\ \wedge\ sleep(y))$

$[\![Fred]\!] = \lambda P\ P(fred)$

$[\![Fred]\!]\,([\![past]\!]\,([\![sleep]\!]))$

$\Rightarrow \exists y\ stage(y, fred)\ \wedge\ y < now\ \wedge\ sleep(y)$

The syntax-semantics interface re-visited

For nouns :

$[\![man]\!] = \lambda x(\exists t\ stage(t, x)\ \wedge\ man(t))$

$[\![a]\!] = \lambda P \lambda R(\exists x(P(x)\ \wedge\ R(x)))$

A man slept :

$\exists x \exists t \exists e\ (stage(t, x) \wedge man(t) \wedge stage(e, x) \wedge sleep(e) \wedge e < now)$

A hostage slept :

$\exists x \exists t \exists e\ (stage(t, x) \wedge hostage(t) \wedge stage(e, x) \wedge sleep(e) \wedge e < now)$

$\Rightarrow$ not constrained enough

Individual vs stage : nouns

Semantic difference between the two kinds :

- hostage :$\lambda y(\exists x\ hostage(x) \wedge stage(x,y) \wedge x \neq y)$
- man : $\lambda y(\exists x\ man(x) \wedge stage(x,y) \wedge x = y)$

then "a man slept" becomes simply

$\exists x \exists e\ (man(x) \wedge sleep(e) \wedge stage(e,x) \wedge e < now)$

but :

$\exists x \exists t \exists e\ (stage(t,x) \wedge hostage(t) \wedge x \neq\ t \wedge stage(e,x) \wedge$

$sleep(e) \wedge e < now)$

Adjectives

(16) Olga was sick/Polish.

$[\![be]\!] = \lambda P \cdot P$

$[\![sick]\!] = \lambda y(\exists z\ sick(z) \wedge stage(z, y))$

PN(I(V(A)))$\Rightarrow$

$\exists z(z < now \wedge sick(z) \wedge stage(z, o))$

Individual vs. stage : adjectives

Distinction between types of predicates and semantics as nominal predicate :

- sick :$\lambda y(\exists z\ sick(z) \wedge stage(z, y) \wedge z \neq y)$
- Polish : $\lambda y(\exists z\ polish(z) \wedge stage(z, y) \wedge z = y)$

this correctly predicts (Vendler, 1967, Larson, 1998) :

(17) # Olga was sick and Polish.

because the coordination of the two adjectives yields a contradiction (the sick stage must be the same stage as the Polish stage, which is the whole entity).

$\exists s(s < now\ \wedge\ sick(s)\ \wedge\ stage(s, o))\ \wedge\ s = o\ \wedge\ s \neq o \models \bot$

Another prediction :

(18) Olga was Polish/a woman $\Rightarrow$ Olga is dead

because then

$(s < now \ \wedge \ polish(s) \ \wedge \ stage(s, o) \ \wedge \ s = o)$

is equivalent to

$polish(o) \ \wedge \ o < now$

if Olga's history is in the past of the speech time, it means she's dead.

Adjectives continued : predicating objects or events ?

"Non-intersective" readings (Larson, 1998) :

(19) Olga is a beautiful dancer.

event or object ?

(1) $beautiful(x) \ \wedge \ olga(x) \ \wedge \ dancer(x)$

(2) $olga(x) \ \wedge \ (\forall e(dance(x,e) \rightarrow beautiful(e))$

within our semantics : just different stages

$\ldots \ \wedge \ stage(z,o) \wedge dancer(z) \wedge beautiful(z)$

$\ldots \ \wedge \ stage(z,o) \wedge dancer(z) \wedge beautiful(o)$

assuming :

$dancer(z) \leftrightarrow \exists u(stage(u,z) \wedge dance(u))$

(vs. $dancer(x) \leftrightarrow \exists e \ dance(x,e)$)

Universal quantification and the question of identity across time

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classical $[\![every]\!] = \lambda P \lambda Q(\forall x(P(x) \rightarrow Q(x)))$

yields :

$\forall x(man(x) \rightarrow has\_one\_drink(x)))$

Universal quantification and the question of identity across time

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classical $[\![every]\!] = \lambda P \lambda Q(\forall x(P(x) \rightarrow Q(x)))$
yields :
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revised with stages (maximality of the stage) :
$\forall x(man(x) \rightarrow$
$has\_one\_drink(x)$
$\wedge [\exists y\ stage(y, x) \wedge has\_one\_drink(y)] \rightarrow x = y)$

(inspired by analysis of (Noonan, 1976))

Open questions

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  Frege is famous. Frege is dead.

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  We had a sad party
- a. *Tired, the boys didn't go to the party.* (didn't)
  b. *The boys didn't go to the party tired.* (did)

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Anaphora and predicate types

- *The man was drunk an hour ago. He is sober now.*

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- *The man was drunk an hour ago. He is sober now.*
- *The man was drunk an hour ago. # He is a woman now.*

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- *The man was drunk an hour ago. He is sober now.*
- *The man was drunk an hour ago. # He is a woman now.*
- *The man had an operation. He is a woman now.*

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Anaphora and predicate types

- *The man was drunk an hour ago. He is sober now.*
- *The man was drunk an hour ago. # He is a woman now.*
- *The man had an operation. He is a woman now.*
- *The drunk jumped into the pool. ? He is sober now.*

Conclusion

that was in the past, this should be in the future :

- preposition phrases
  The woman on the deck dove into the water
- discursive effects
- temporal modifiers as “previous”, “former”, etc

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