Moving on from natural language: from two-level semantics to image schemas

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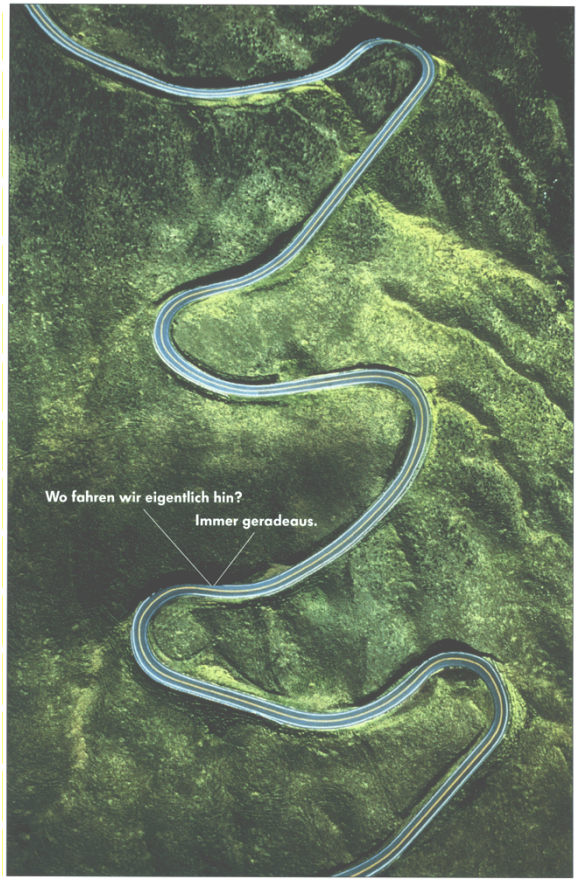
Beginning …

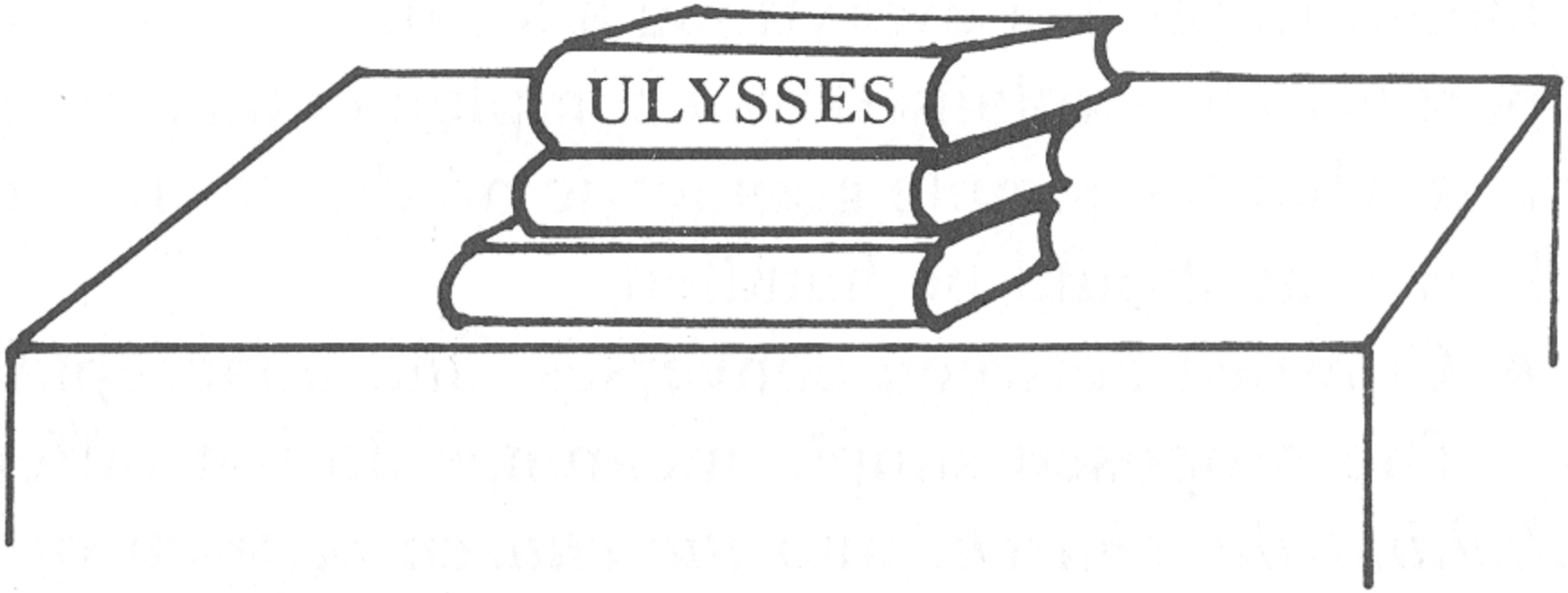
- This story is in many ways a continuation of the path started in our Cooperative Research Center on Spatial Cognition (2003-2014)



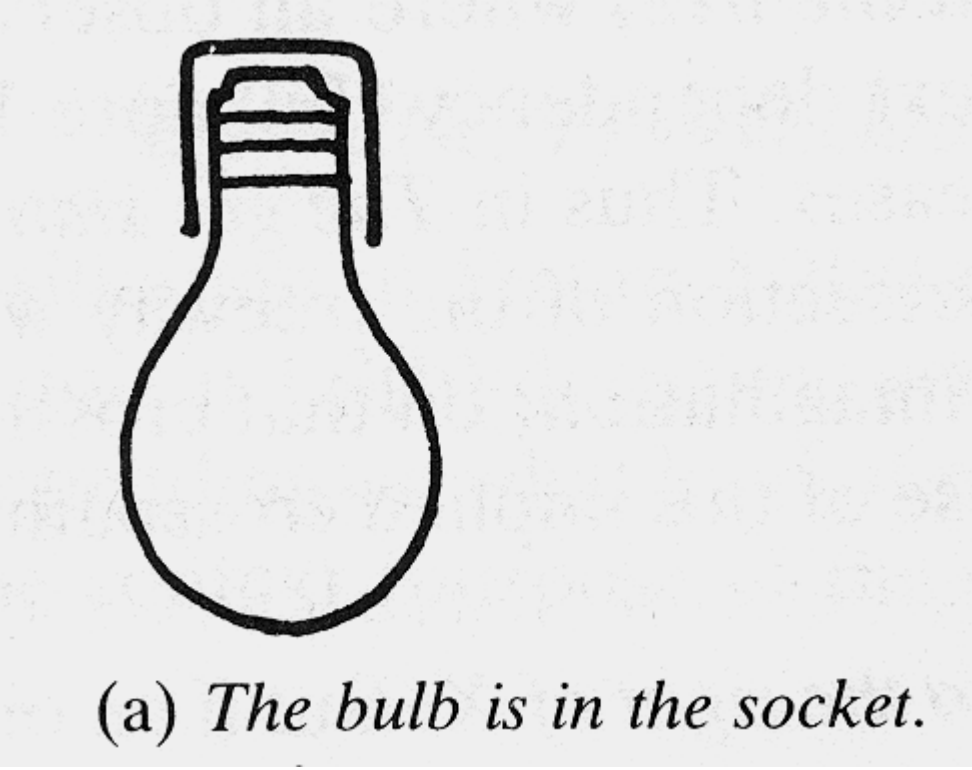
The flexibility of spatial language

Usage evidence from real language…

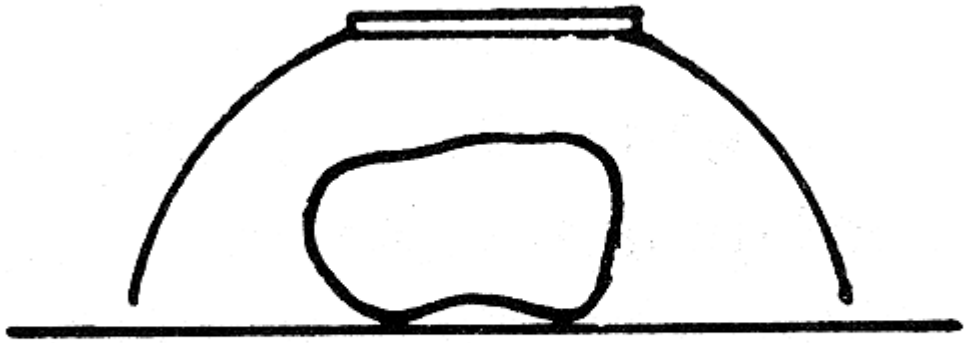
Herskovits (1986)



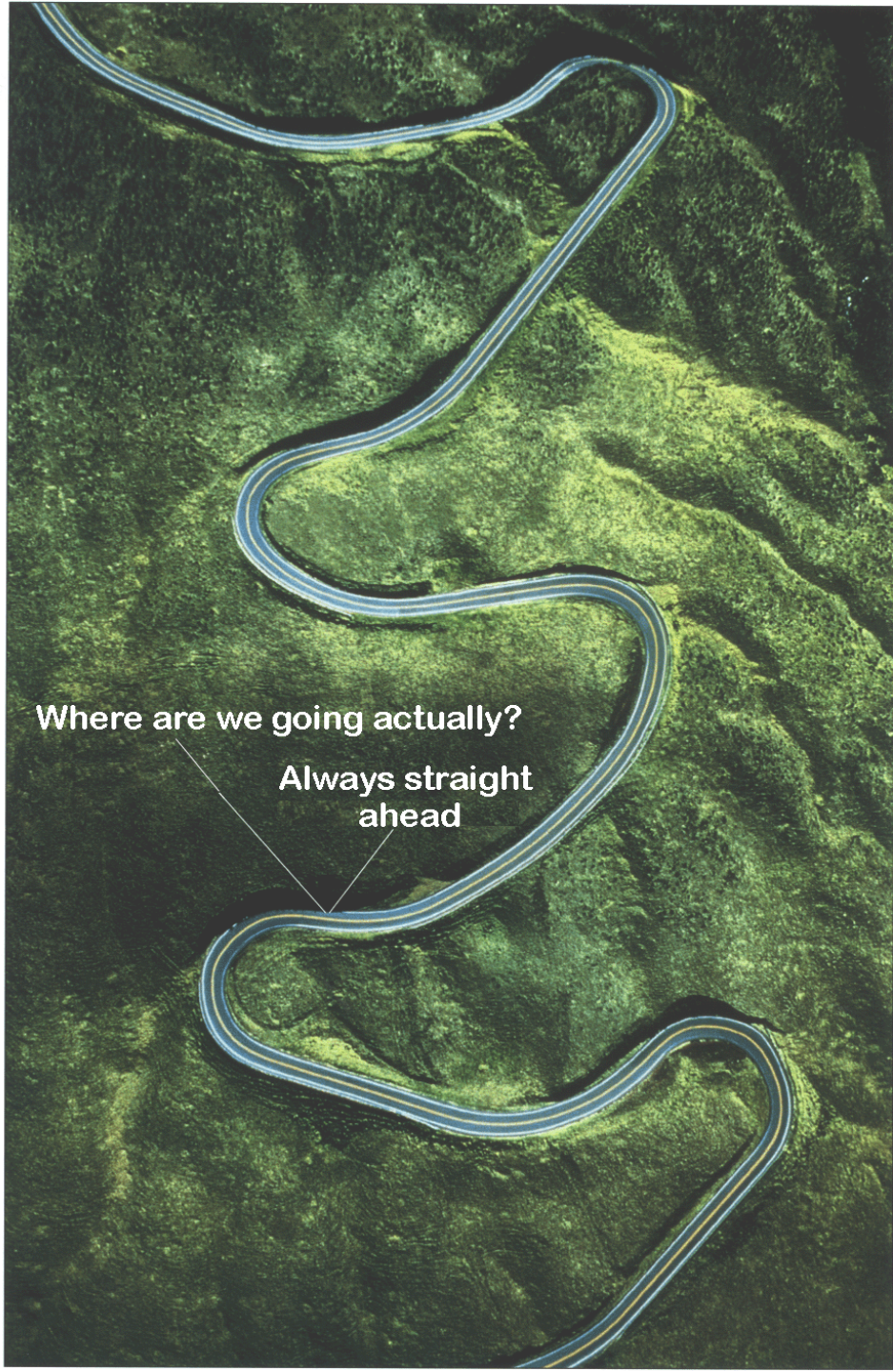
And more usage evidence…



(a) *The bulb is in the socket.*

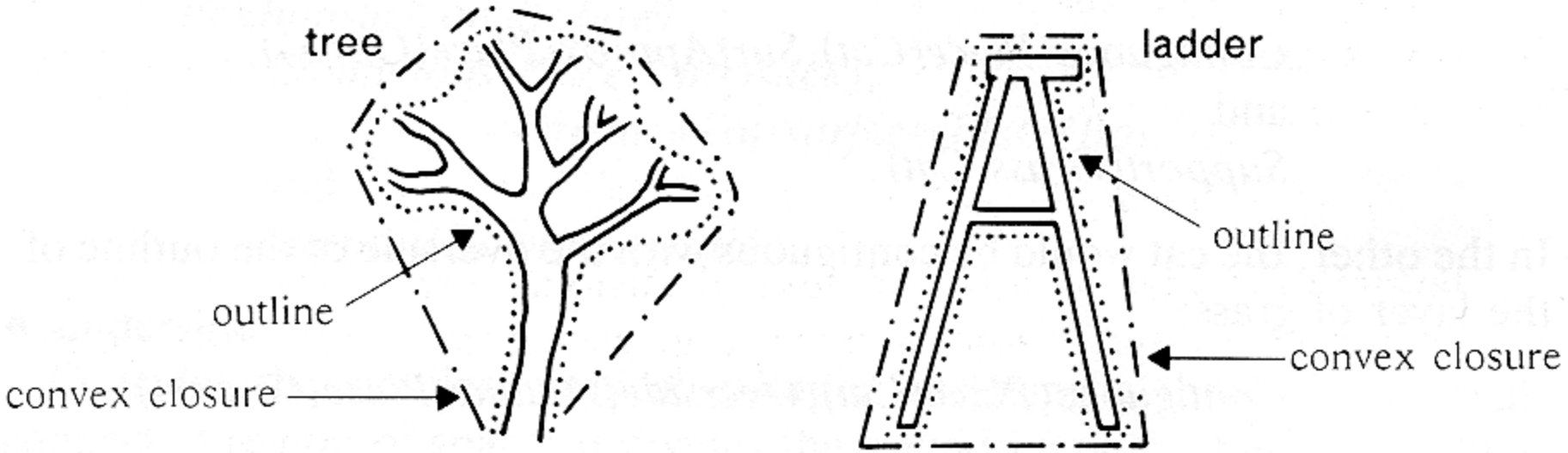


(b) *The potato is under the bowl.*


Where are we going actually?
Always straight ahead

Herskovits (1986:88)

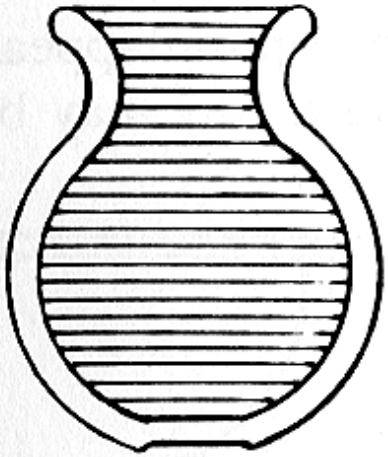
The bird is in the bush
Included(Part(Place(Bird)),
Interior(Outline(VisiblePart(Place(Bush)))))
cars along the waterfront
[A(Along)](Outline(Place(GroupOfCars)),
LineApprox(Place(WaterFront)))
man under the ladder
Under(Place(Man),Underside(Outline(Place(Ladder))))



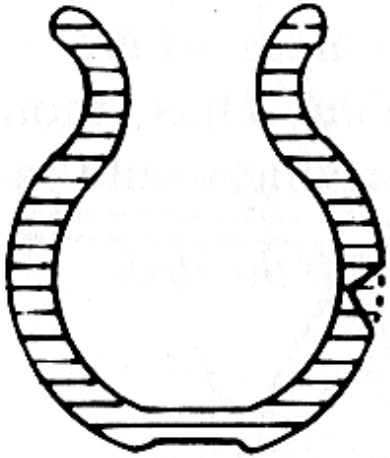
Outline and convex closure

Figure 5.2

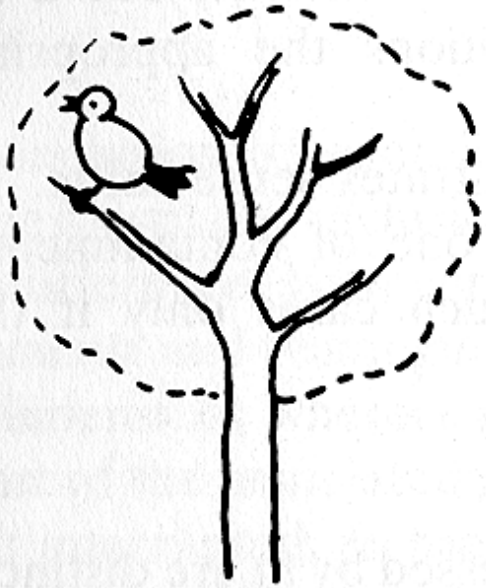
Or



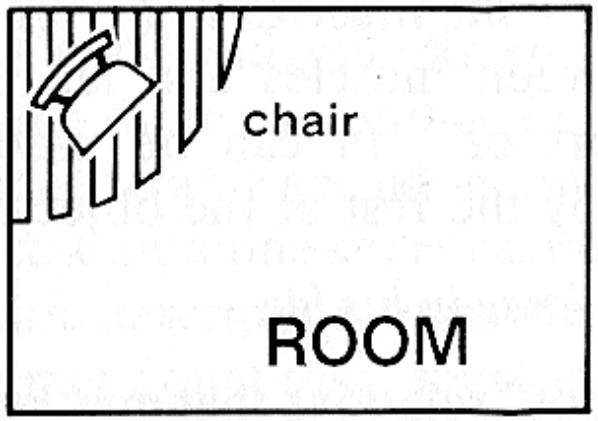
(a) *the water in the vase*



(b) *the crack in the vase*



(c) *the bird in the tree*



(d) *the chair in the corner*

Figure 4.1

Uses of 'in': Herskovits (1986:149)

- spatial entity in container
- gap/object "embedded" in physical object
- physical object "in the air"
- physical object in outline of another, or of a group of objects
- spatial entity in part of space or environment
- person in clothing
- spatial entity in area
- physical object in a roadway
- person in an institution
- participant in institution


Bondi Beach
Waverley Council
GENERAL WARNINGS
SHALLOW WATER
HIGH SURF
DANGEROUS CURRENT
CAUTION!
Thieves target beaches
LIFE SAVING SERVICES
PLEASE SWIM ONLY BETWEEN THE RED AND YELLOW FLAGS
This beach is patrolled where the red & yellow flags are displayed

Functional effects

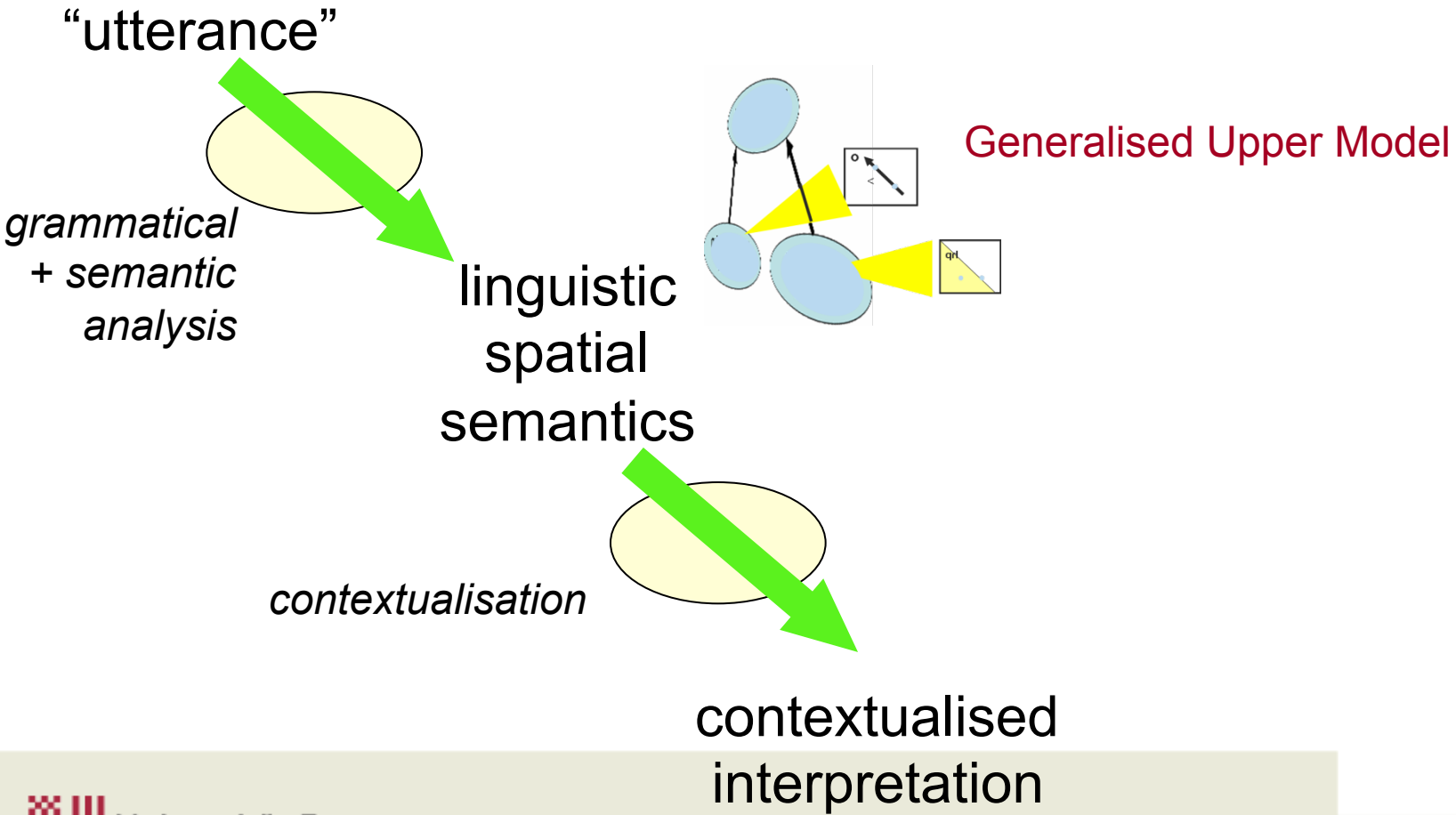
Coventry, Garrod and others

Ontological Considerations

"It is apparent that these cases reveal the limits of the approach insofar as it is purely geometric: a full account calls for a step into other territories where pragmatics, or functional and causal factors at large, must be taken into account."

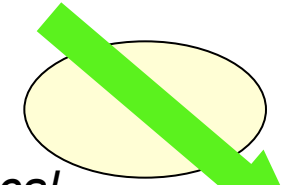
Casati & Varzi (1999) *Parts and places,* p. 140

Proposed Solution (2010): Two-level Semantics



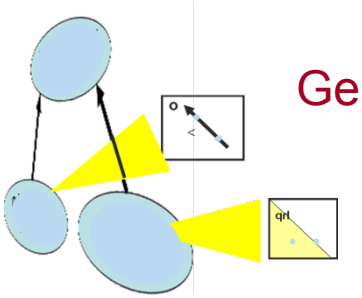
Interpretation

"between the flags"



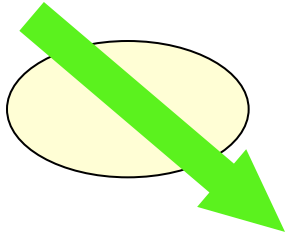
grammatical + semantic analysis

linguistic spatial semantics



Generalised Upper Model

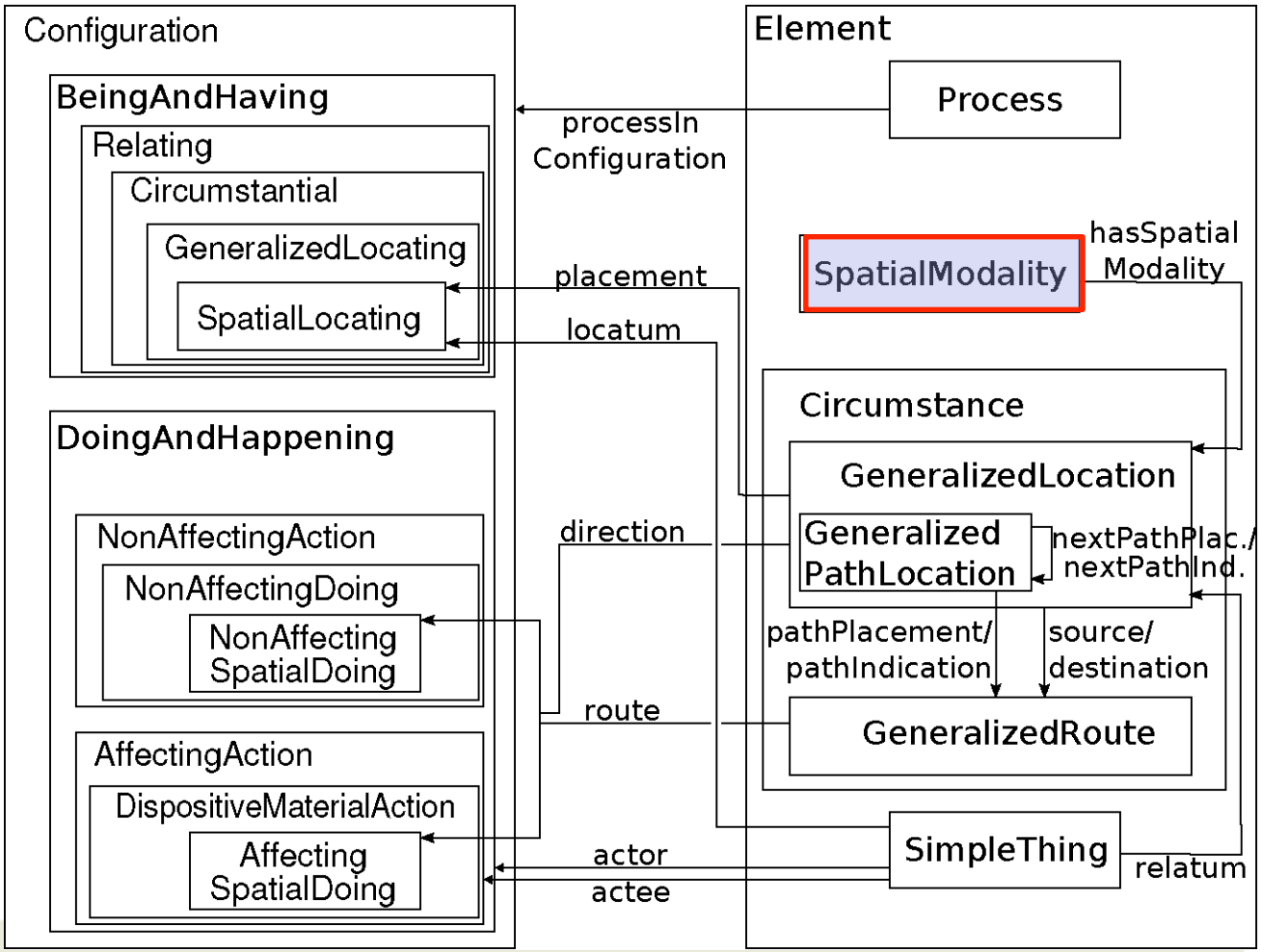
contextualisation



contextualised interpretation

Generalized Upper Model: linguistically motivated ontology

Dependencies

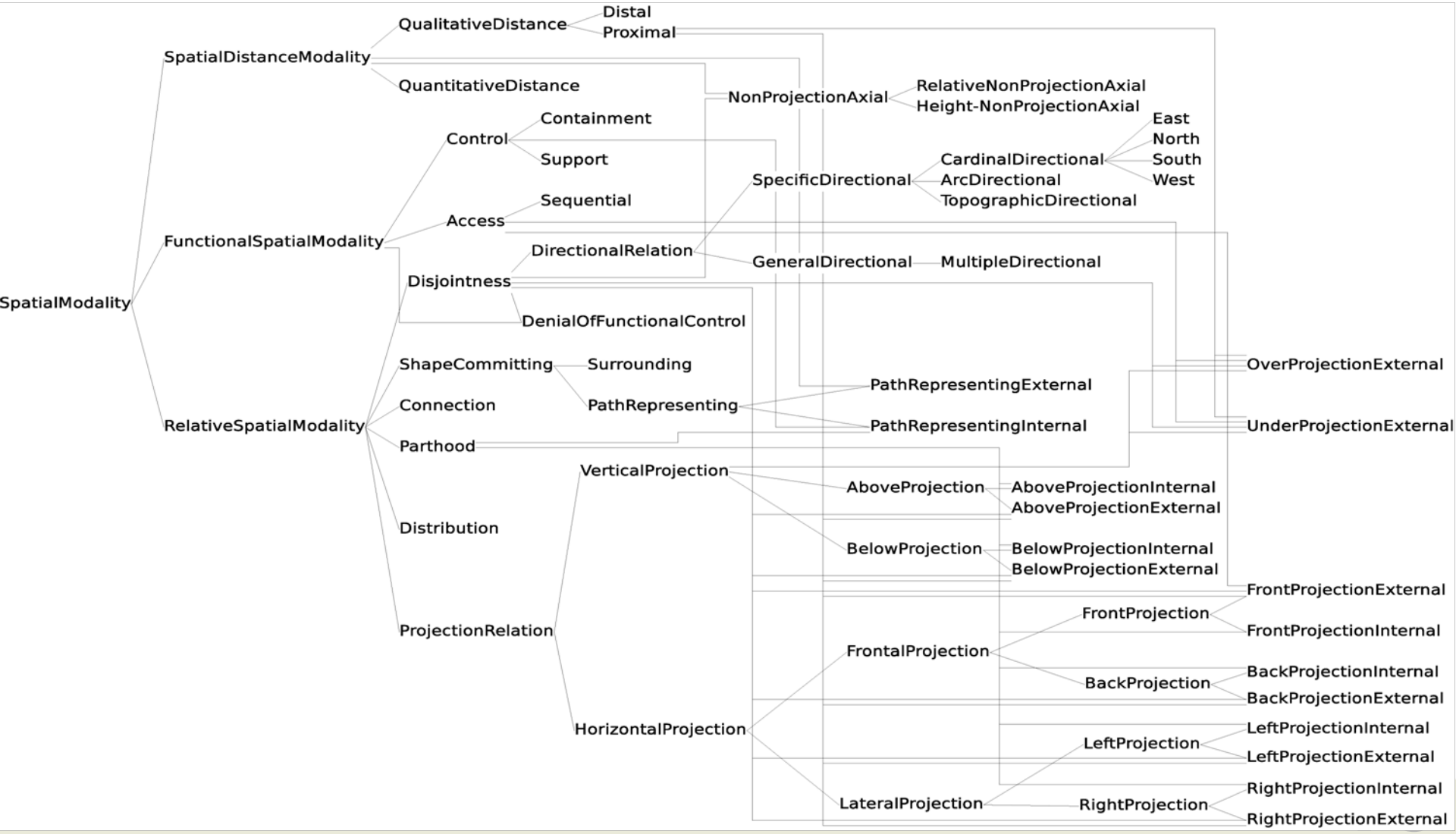


Semantic Structure of Generalized Locations

- hasSpatialModality
  - SpatialModality ..... left
- relatum
  - Element ..... house

Generalized Upper Model

Spatial Modalities

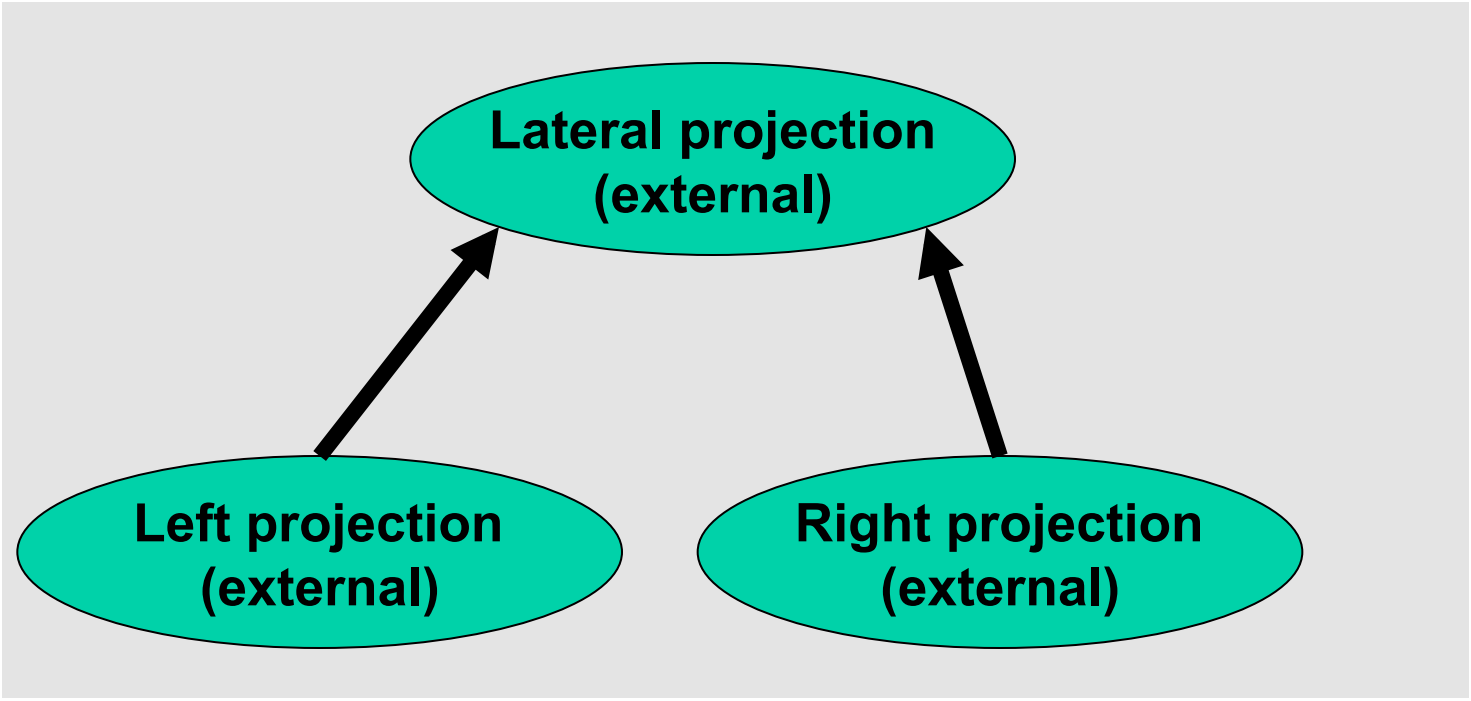


Defining spatial commitments

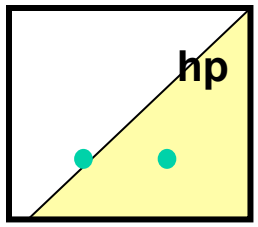
- linguistic semantics
  - (all and) **only** the commitments licensed by the linguistic constructions employed

spatial linguistic semantics

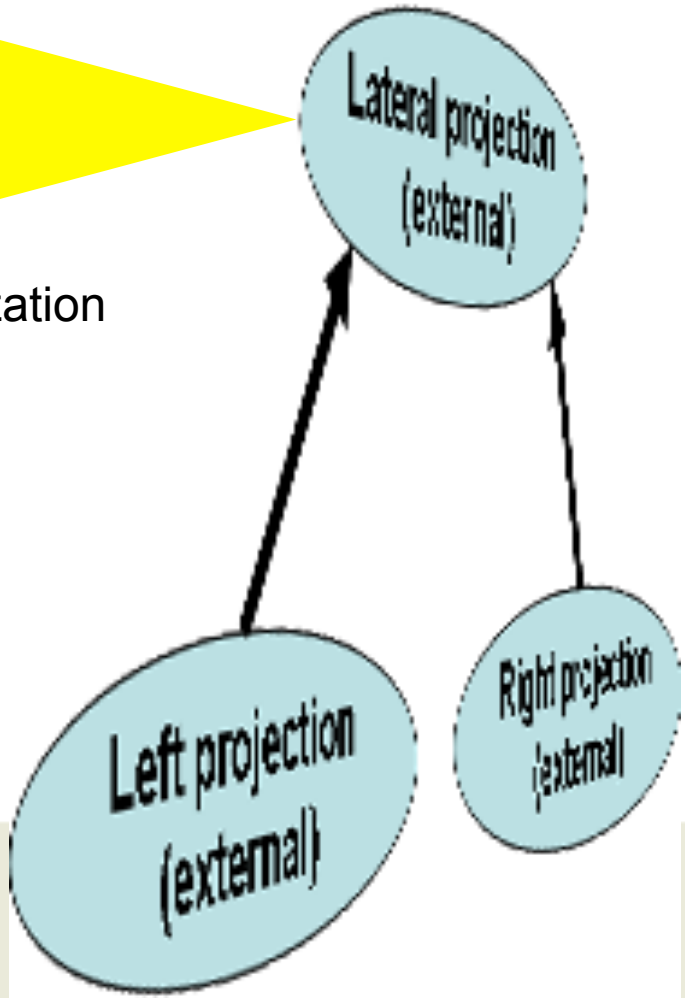
Linguistic ontology view



Linguistic ontology view: modularity



details of the axiomatization

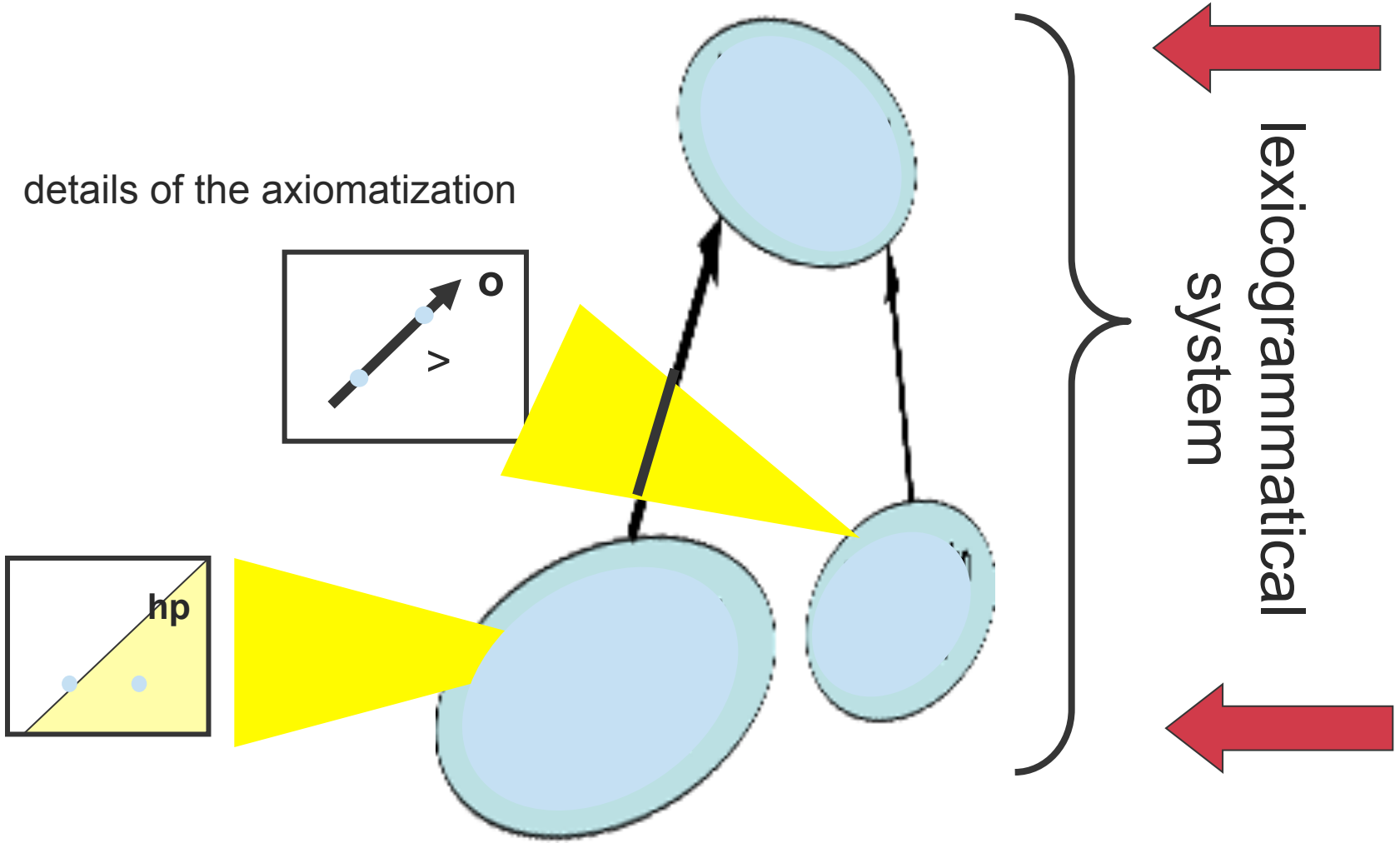


lexicogrammatical system

Linguistic ontology view

OntoSpace/DiaSpace

details of the axiomatization

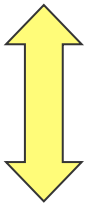


‘Two-level’ semantics

OntoSpace/DiaSpace

- linguistic semantics
  - (all and) **only** the commitments licensed by the linguistic constructions employed
- contextualised semantics
  - resolved to contextual descriptions

spatial linguistic semantics



spatial situation

Combining theories for semantic interpretation

driving along

the road to Bremen

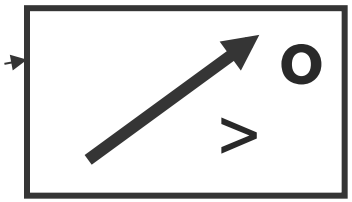
on the right

is a church

Combining theories for semantic interpretation

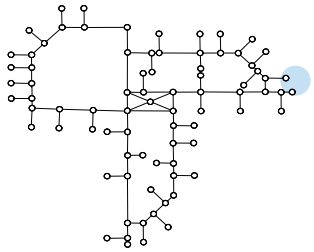
OntoSpace/DiaSpace

driving along



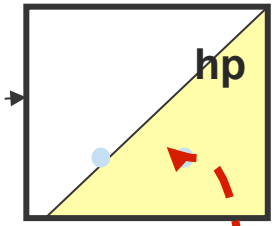
oriented path

the road to Bremen



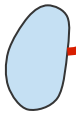
route graph

on the right



half-planes

is a church

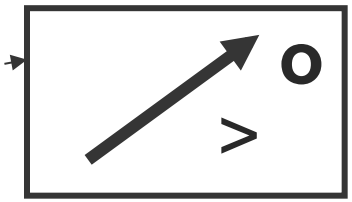


physical object occupying a region

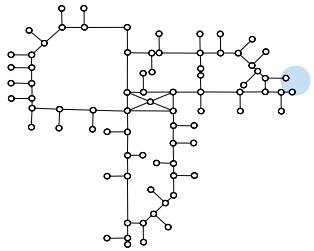
Combining theories for semantic interpretation

OntoSpace/DiaSpace

driving along



the road to Bremen



differing o

on the right

is a church

NL-Semantics is compositional with respect to **theories**, not just descriptions

OK, go towards the mountains along the main road

until you reach a large wooden house.

Be careful, the road gets a bit narrow where the old church sticks out.

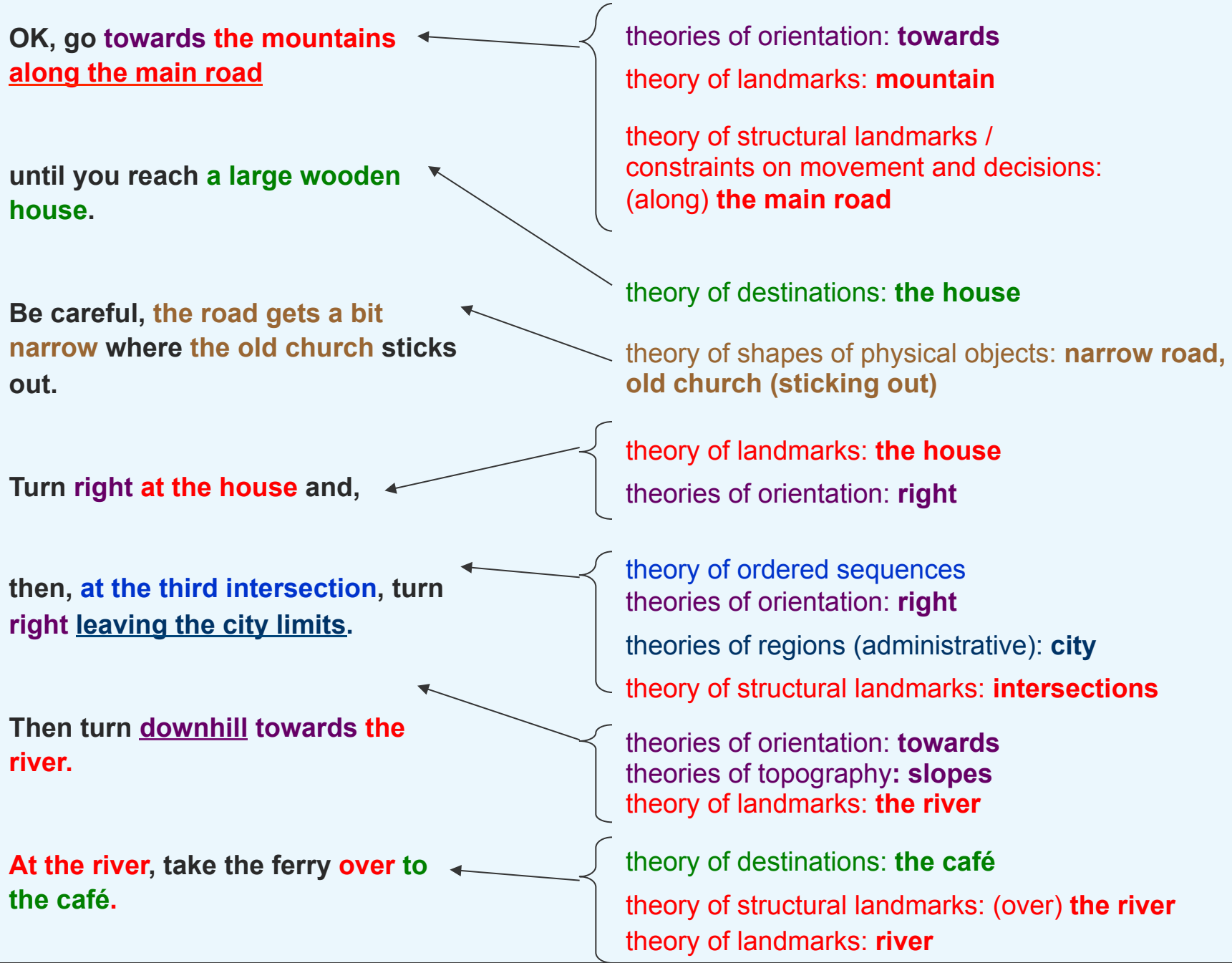
Turn right at the house and,

then, at the third intersection, turn right leaving the city limits.

Then turn downhill towards the river.

At the river, take the ferry over to the café.

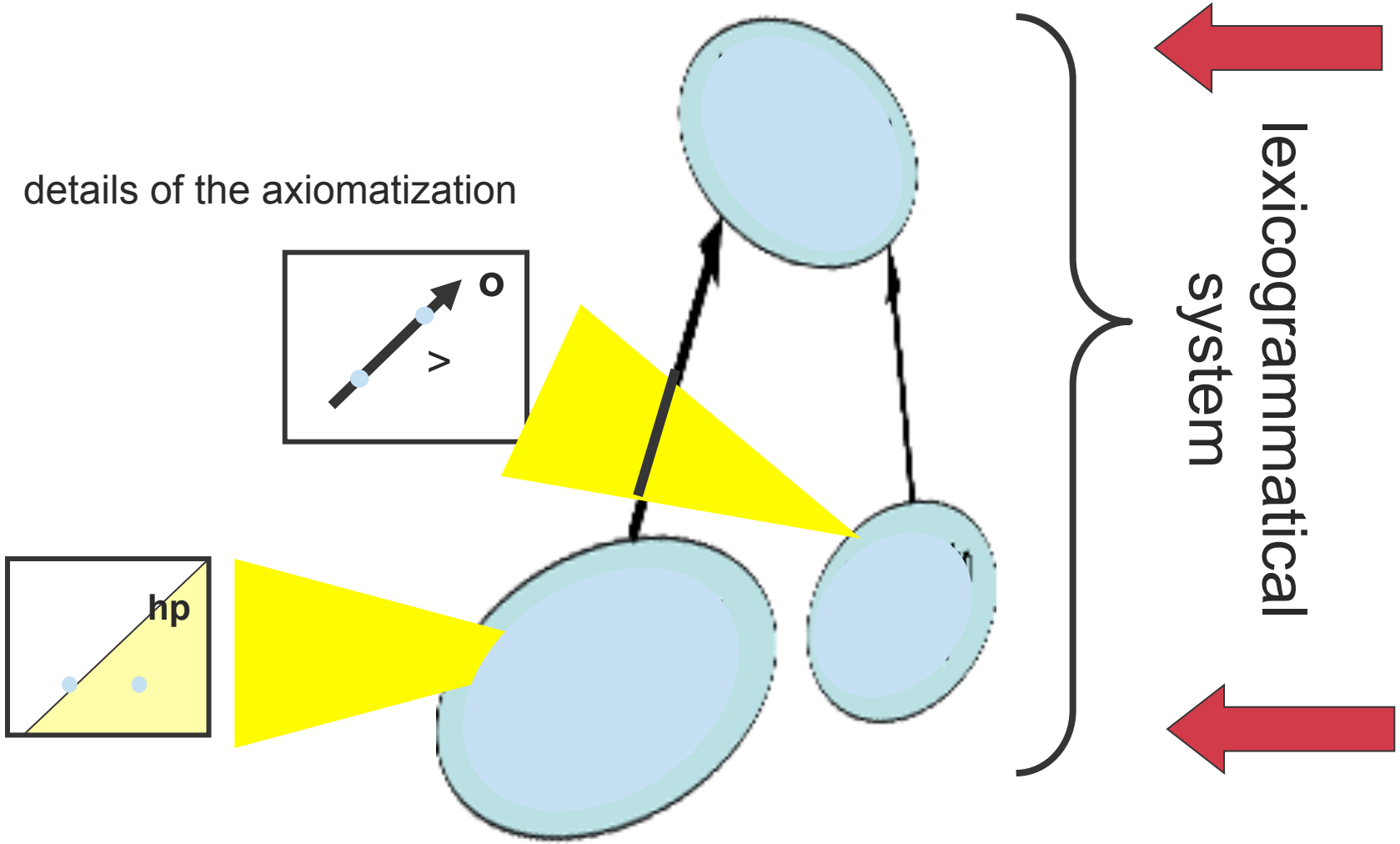
Theories needed for interpretation



Linguistic ontology view: -2014

OntoSpace/DiaSpace

details of the axiomatization



“The guard walked into the house”

Eschenbach

$$\lambda x \lambda s[VERB'(s,x,w) \wedge TO(w, IN^*(y)) \wedge D(x,w) \wedge HOUSE'(y)]$$

GUM3

```
( s / gum-DirectedNonAffectingMotion
    :gum-processInConfiguration (L1 / lm-walk)
    :actor (x / guard)
    :path-placement
            (w / GeneralizedLocation
                :hasSpatRel (m / functional-containment)
                :relatum (y / lm-house)))
```

Analysis results:
“the box in the kitchen on the shelf”

```
(@x1:gs-SpatialLocating(
                        <gs-locatum>b1:slm-Box ^
                        <gs-placement>(x2:gs-GeneralizedLocation ^
                                       <gs-hasSpatialModality>(i1:gs-Containment ^ in) ^
                                       <gs-relatum>(k1:slm-Kitchen ^ kitchen ^
                                                    <det>the ^
                                                    <ident>specific ^
                                                    <quant>singular)))
                        ^
@x3:gs-SpatialLocating(
                        <gs-locatum>b1:slm-Box ^
                        <gs-placement>(x4:gs-GeneralizedLocation
                                       <gs-hasSpatialModality>(o1:gs-Support ^ on) ^
                                       <gs-relatum>(s1:slm-Shelf ^ shelf ^
                                                    <det>the ^
                                                    <ident>specific ^
                                                    <quant>singular))) ^
@b1:slm-Box(box ^
              <d
              <i
              <q
```

Could we use these ‘hooks’ just as well for simulation-based modelling?

Sloman 1985

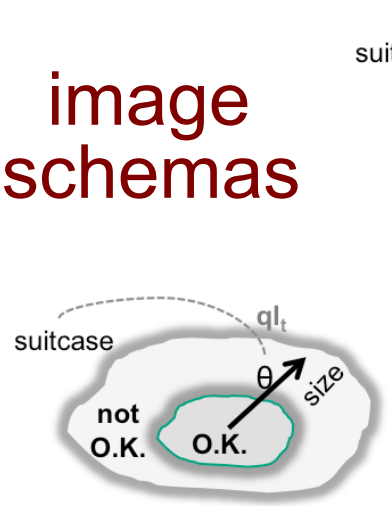
"Why We Need Many Knowledge Representation Formalisms"

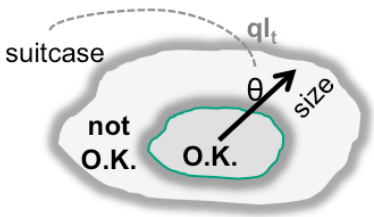
- "Against advocates of particular formalisms for representing all kinds of knowledge, this paper argues that different formalisms are useful for different purposes. Different formalisms imply different inference methods."

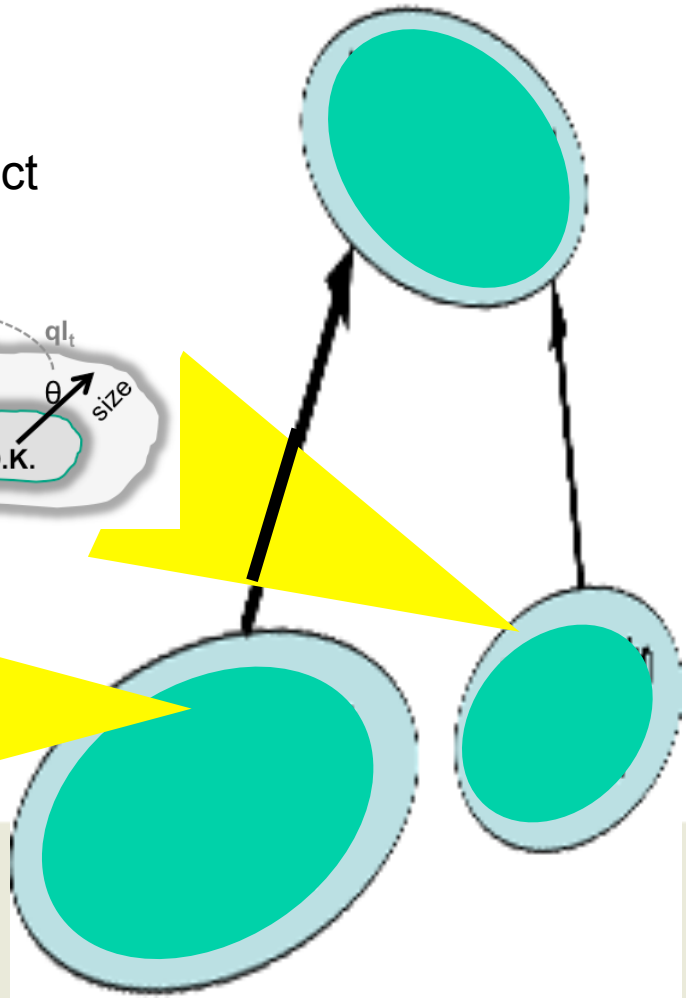
Proposal and our current approach:
Linguistic ontology combined with simulation

details of the an abstract simulation – 'diagram'

image schemas

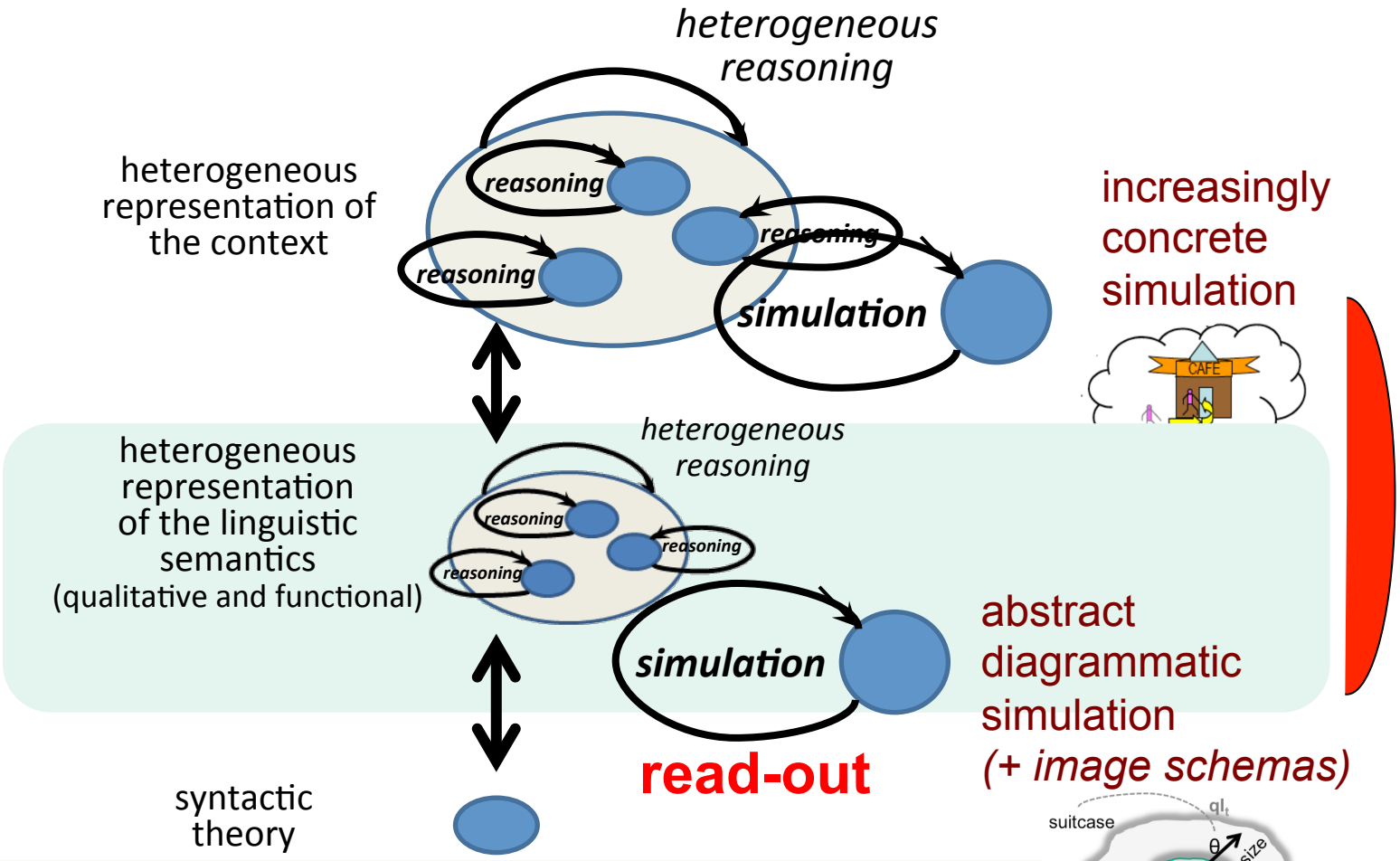






lexicogrammatical system

Language Architecture



Open questions for further discussion

- can we build abstract simulators that work with 'simplified' objects and which offer image schemas as their API?
- perhaps some folks already have? ☺
  (ECG, Feldman, etc.?)
- these could then be linked directly to the classes of an appropriate linguistic ontology respecting compositionality …