Dynamic Typing and Non-monotonic Reasoning

Principles for a Semantic Interpreter

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Content List

1. Background and History
2. Basic principles - Interpretation paradigm
3. Concept architecture and semantic space
4. Transformation process

Background and History

Semfinder	Program for automatic ICD-10 / OPS coding of medical diagnoses and procedures in daily use in more than 300 hospitals
1989	First Program for automatic ICD-coding (Clinic St. Leonhard, St. Gallen)
1996	Starting point: concept molecules
1999	Foundation of the Semfinder company
2009	300 hospitals in Germany 25 hospitals in Switzerland

Basic Principles → Interpretation Paradigm

Not a copy	→ Models are an interpretation of reality
Information reduction	→ Models contain less information than reality
No model is complete	→ Different models are possible

Basic Principles → Interpretation Paradigm

Not a copy → Models are an interpretation of reality

Information reduction → Models contain less information than reality

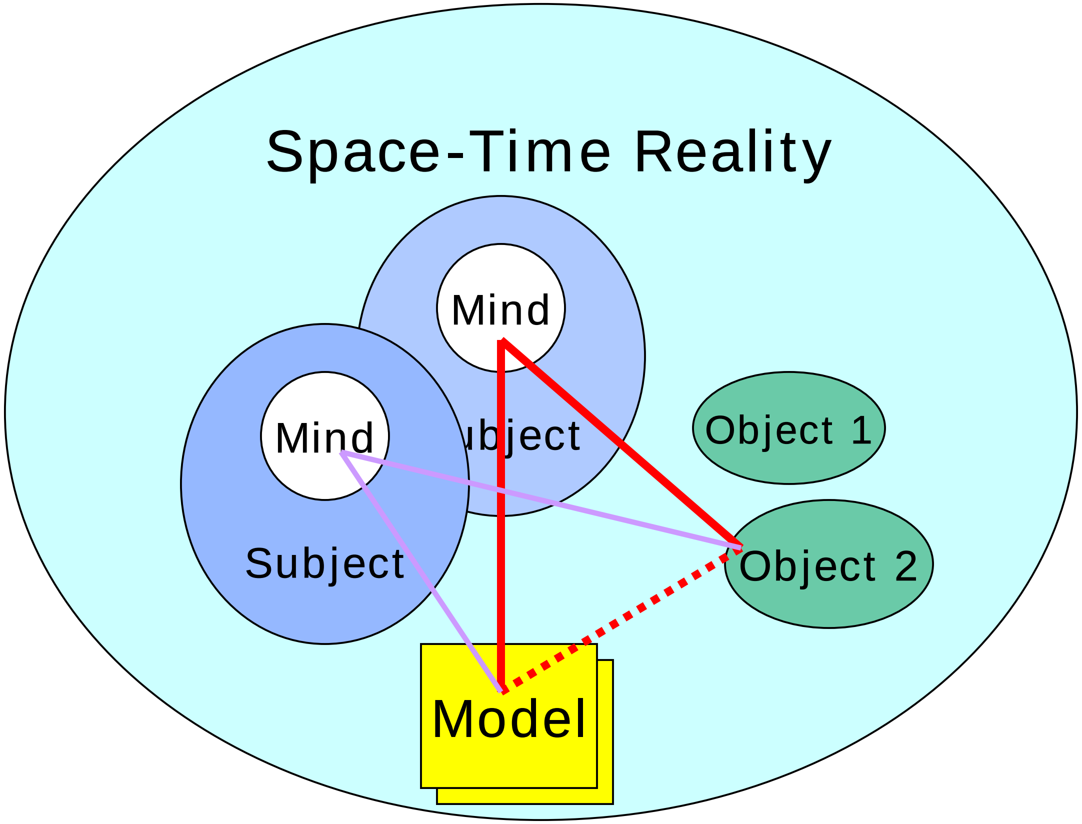
No model is complete → Different models are possible

Consequences

A) Look for the perfection of your model
→ static view → monotonic reasoning (DL, FOL)

B) Look for a way to transform models
→ dynamic view → non-monotonic reasoning

Basic Principles → Semiotic Triangle



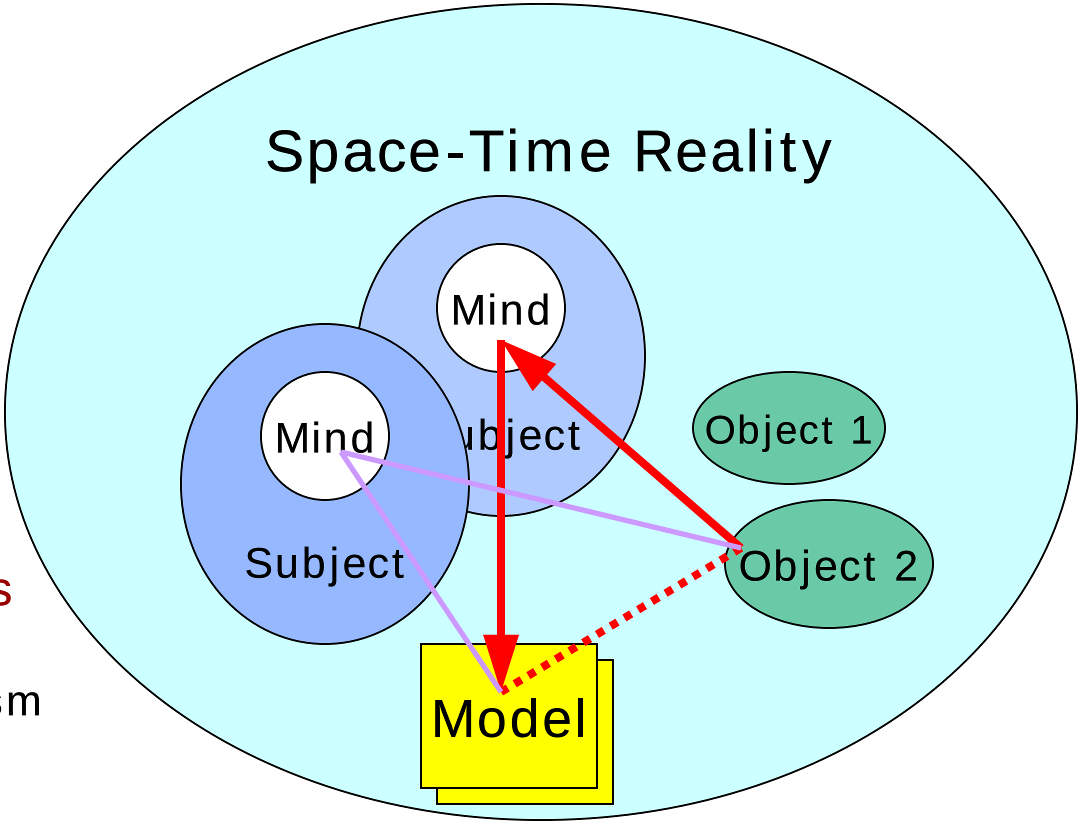
World	→ Elements
- Reality	→ Space-time objects
- Individual minds	→ Concepts
- Models	→ Symbols

Different worlds ↔ Different behaviour

Basic Principles → Semiotic Triangle

Mind follows reality
= realism

Model follows mind
= conceptualism



World	→ Elements
- Reality	→ Space-time objects
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Basic Principles → concept ≠ object

	Objects	Concepts
World	space/time reality	mental space (mind)
Visibility	visible	invisible
Bounderies	**disjunct,** concrete	**overlapping**, diffuse (fields)
Existence	**autonomous**	**context dependent**
Composition	**addition**	**complex mix**
Composed of	similar, but smaller objects	different (and bigger) concepts

Basic Principles → concept ≠ object

Example (context dependency of concepts)

foot (as a body part)

lower limb (as a body part)

foot (as a location)

lower limb (as a location)

Basic Principles → concept ≠ object

Example (context dependency of concepts)

foot	(as a body part)	
		is_part_of
lower limb	(as a body part)	

foot	(as a location)	
		is_a
lower limb	(as a location)	

Basic Principles → concept ≠ object

Example (context dependency of concepts)

foot	(as a body part)	
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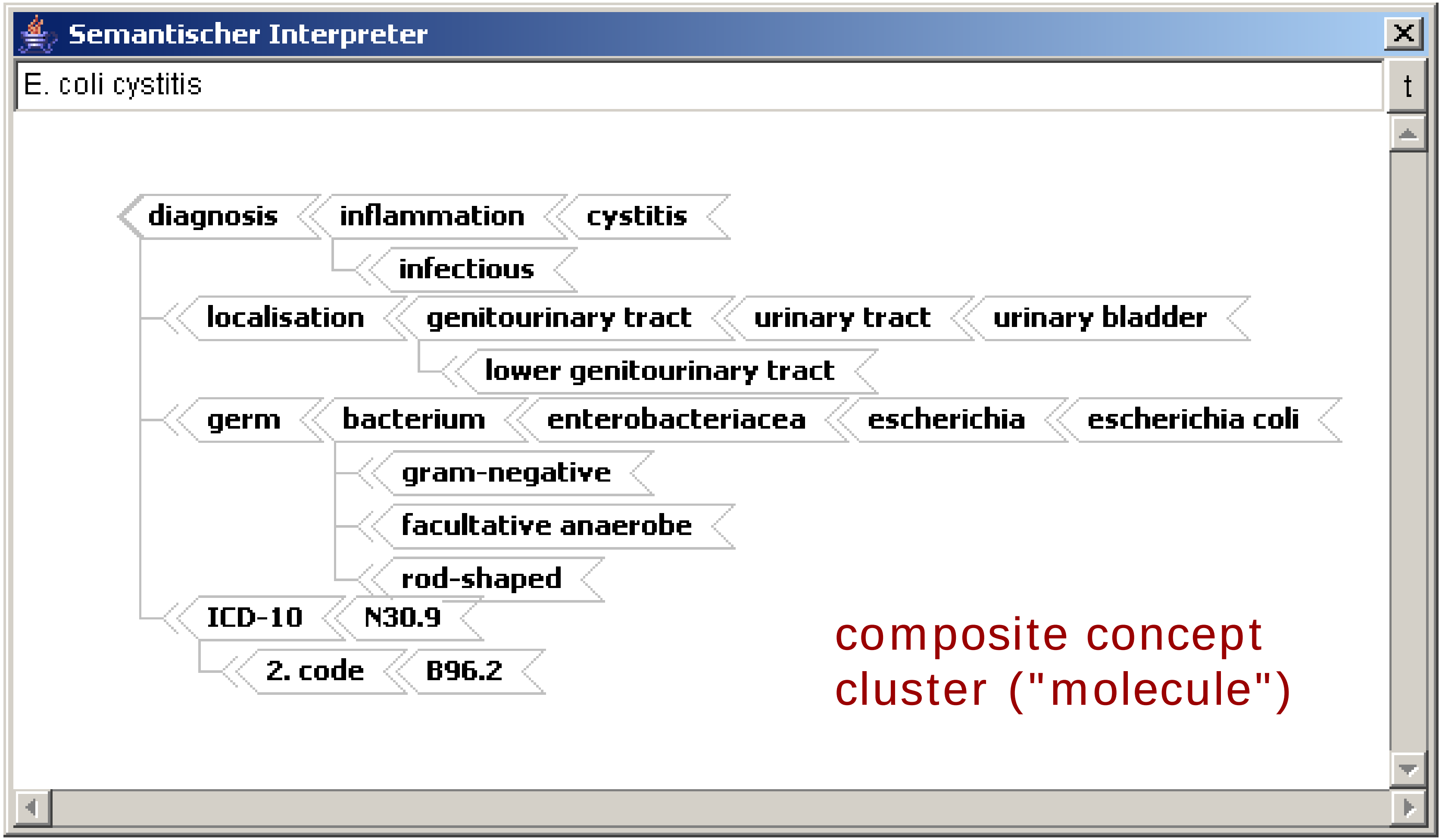
foot	(as a location)	
		is_a
lower limb	(as a location)	

If concepts are not typed, false conclusion are inherent.
The same concept (foot) can have different types.
Different Relationships follow.

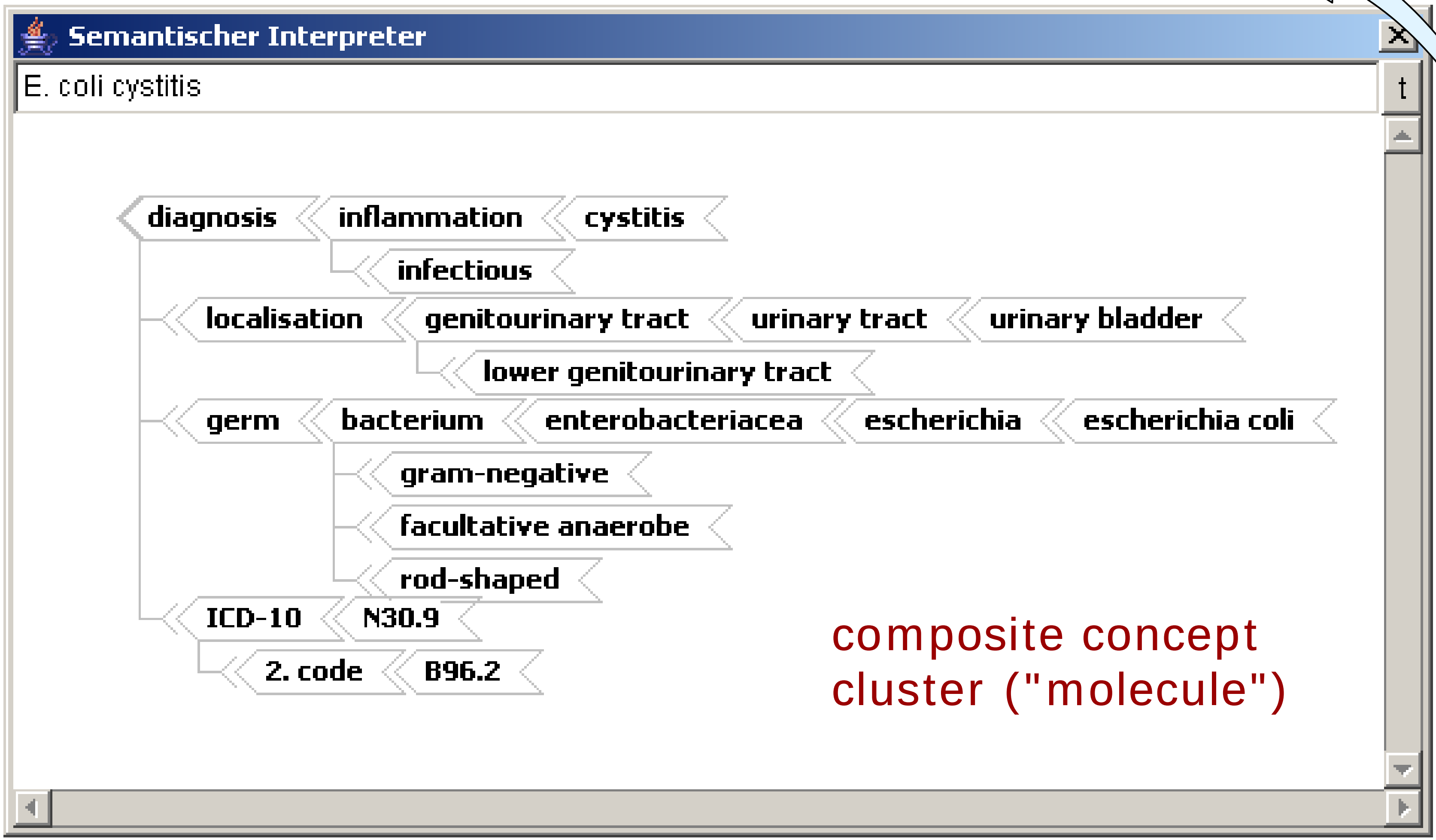
→ allow dynamic typing! ← use typed (composite) concepts (not untyped, unlinked objects)

Basic Principles → concept ≠ object



→ use composition (postcoordination) whenever possible
→ keep the atomic concepts inside the clusters
→ give the cluster an adequate structure

Basic Principles → concept ≠ object



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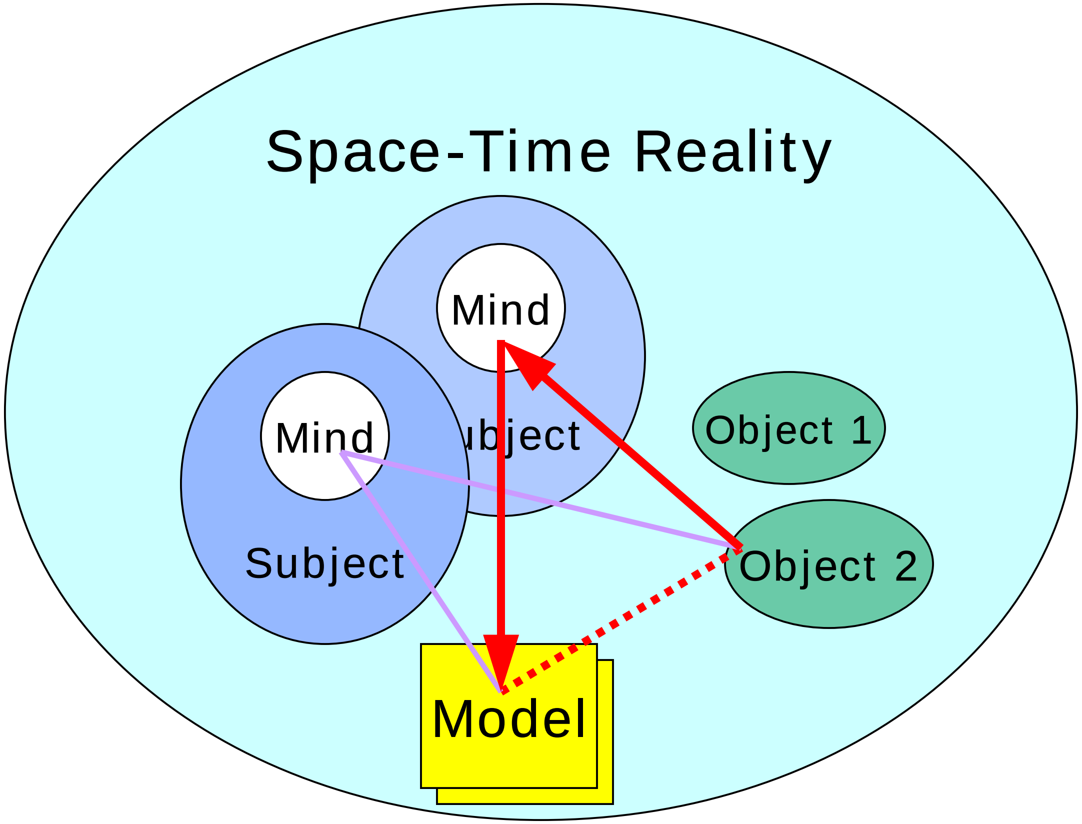
Basic Principles → Semiotic Triangle



World → Elements

Different worlds

- Reality → Space-time objects
- Individual minds → Concepts
- Models → Symbols

Different behaviour

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How to structure concepts? → 3 formal elements

injury

① atomic concept

How to structure concepts? → 3 formal elements

① atomic concept

An atom is equally type and expression

→ Bifaciality

How to structure concepts? → 3 formal elements

① atomic concept

An atom is equally type and expression

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← Hierarchic chain

How to structure concepts? → 3 formal elements

① atomic concept

An atom is equally type and expression

→ Bifaciality

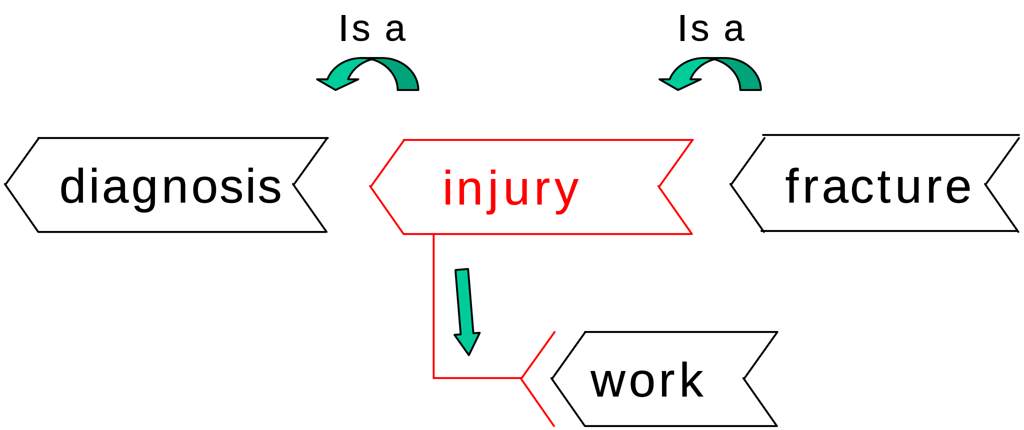
② hierarchic relationship

How to structure concepts? → 3 formal elements

① atomic concept

An atom is equally type and expression

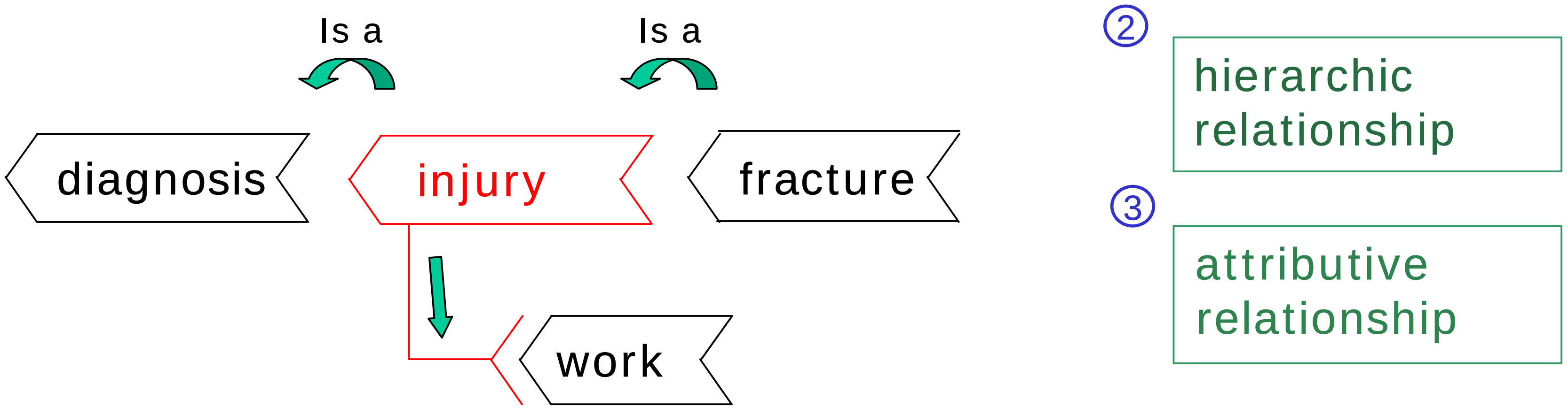
→ Bifaciality



② hierarchic relationship

③ attributive relationship

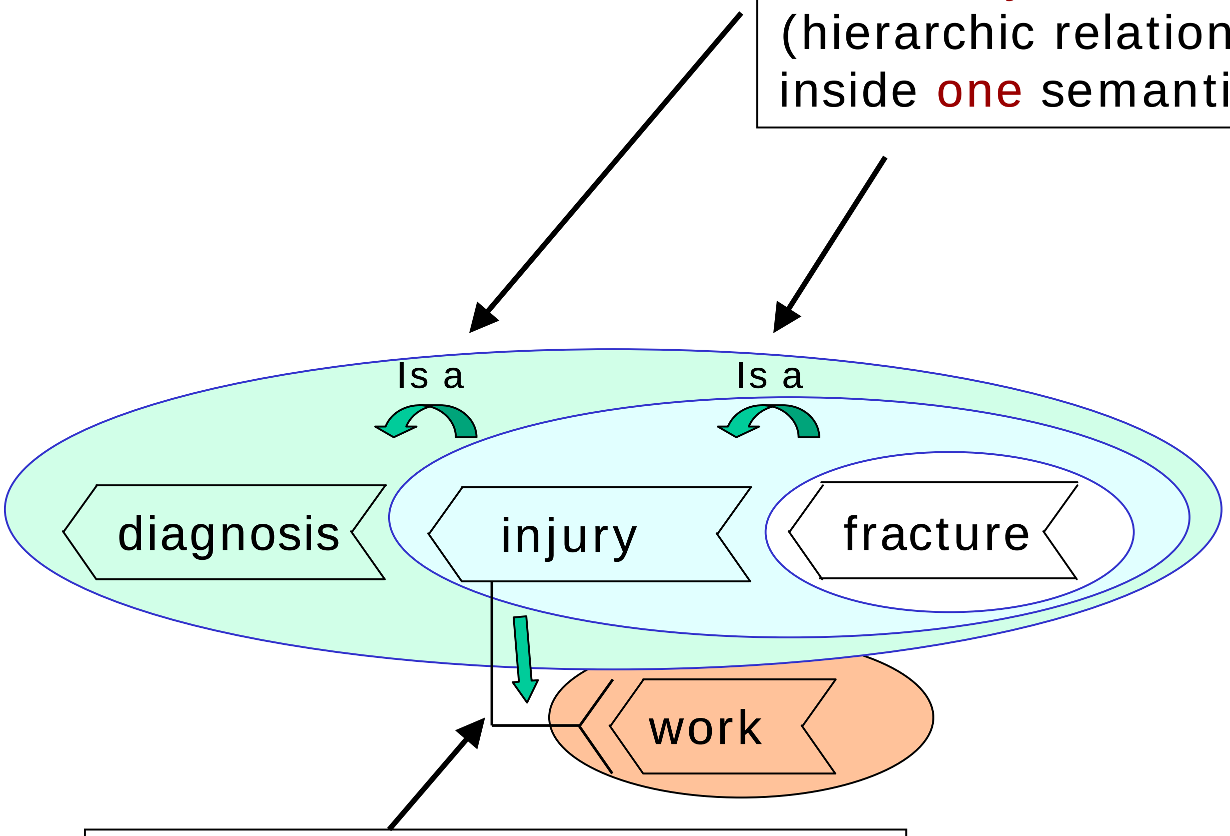
How to structure concepts? → 3 formal elements



The relationships are invisible on screen, but their positions indicate and distinguish them → Economy

The two relationships span the semantic space

Set theory conditions work inside hierarchies
(hierarchic relationships link concepts inside one semantic dimension)

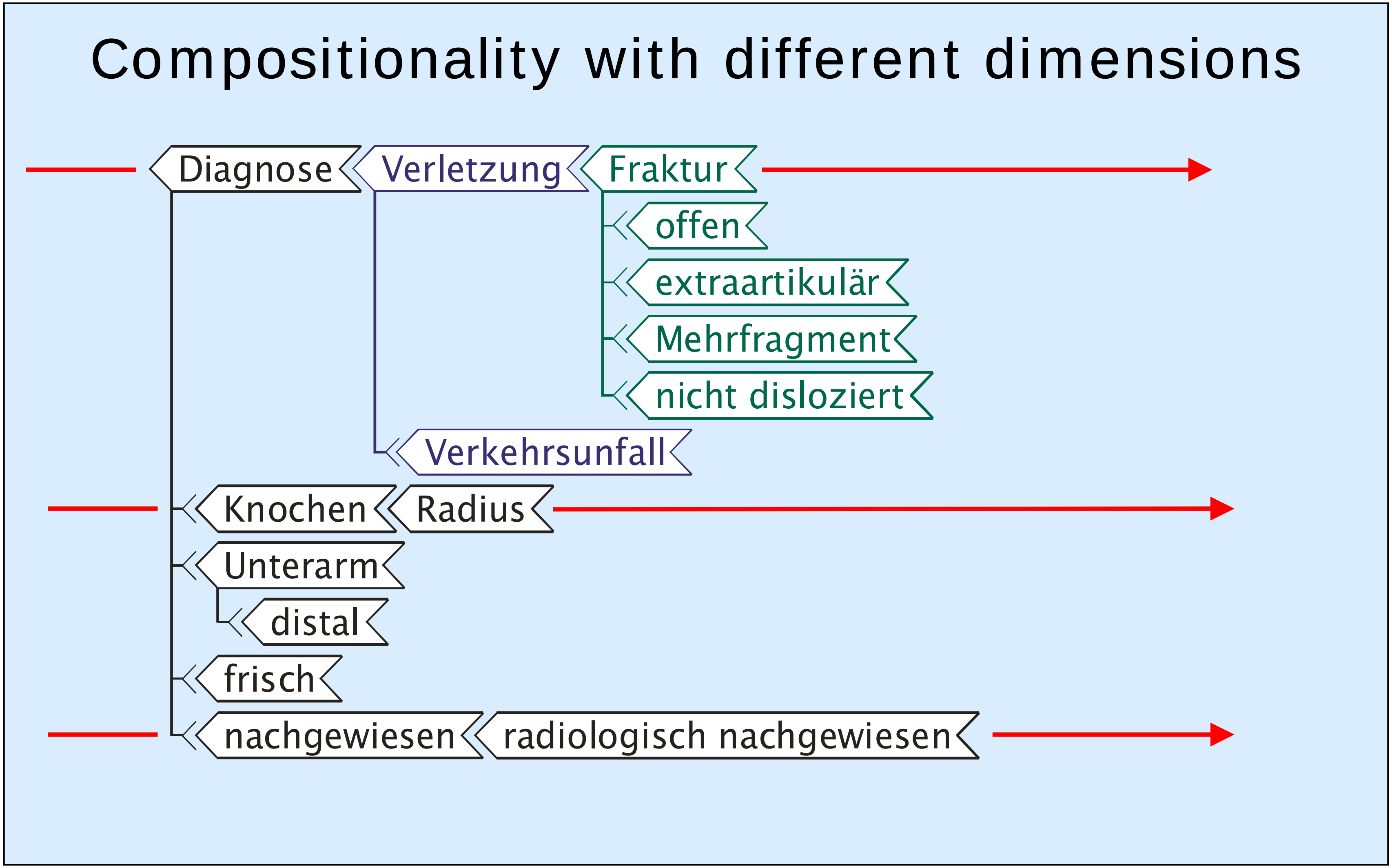


② hierarchic relationship

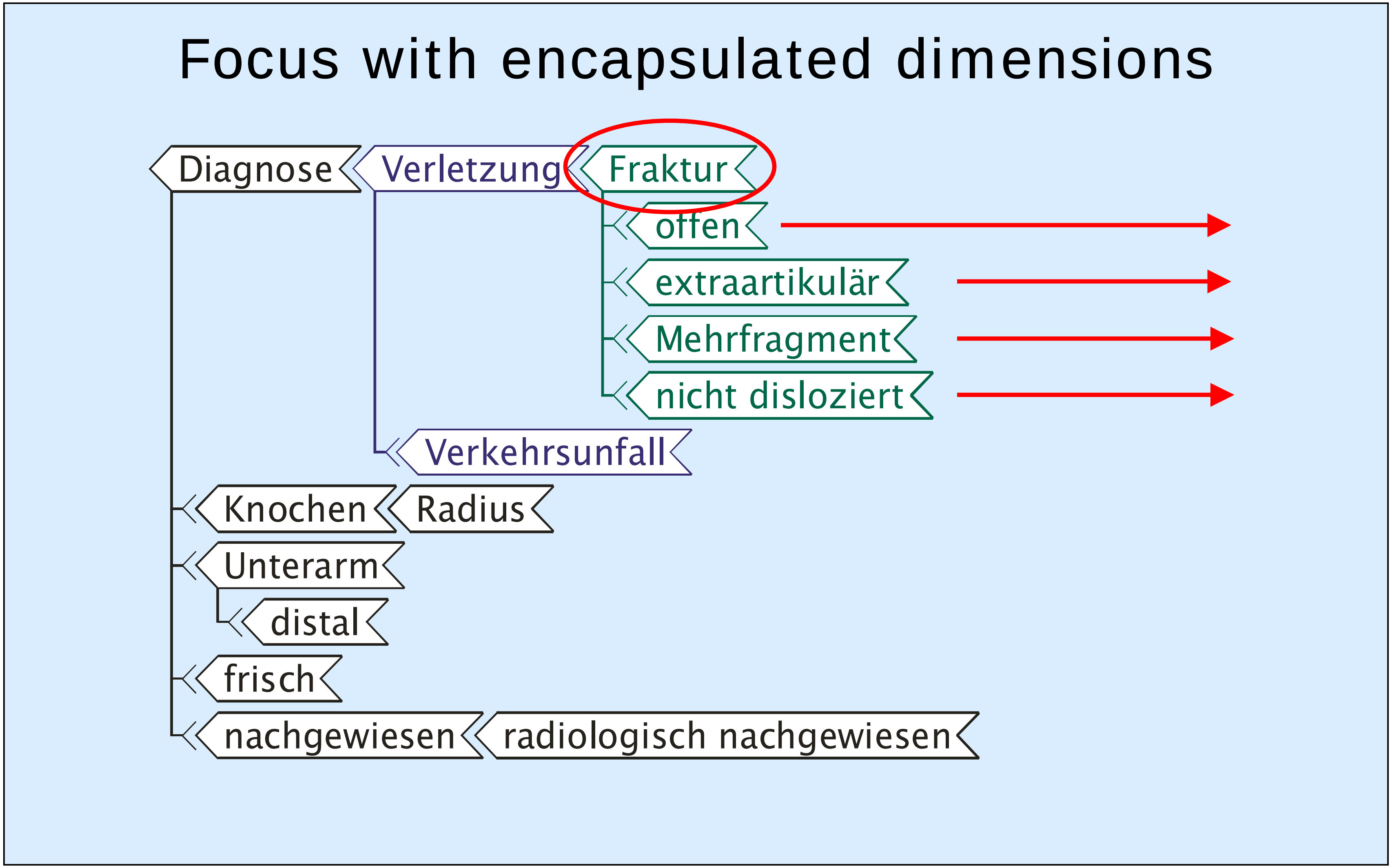
③ attributive relationship

Attributive relationships knit the different semantic dimension

The two relationships span the semantic space

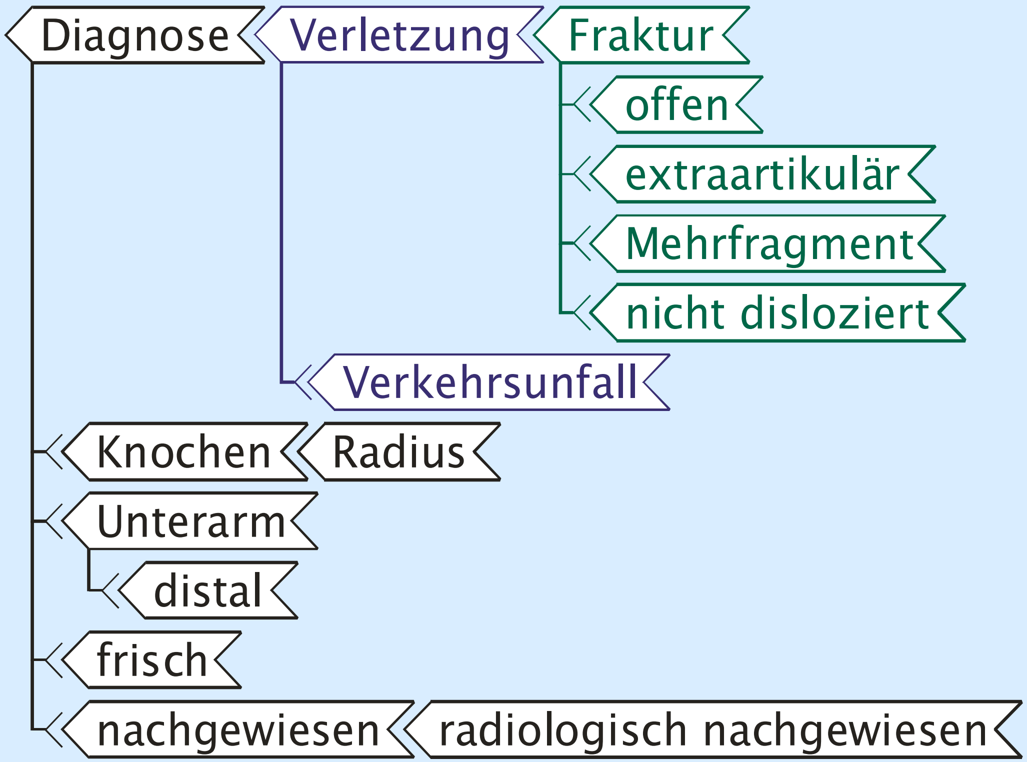


The two relationships span the semantic space



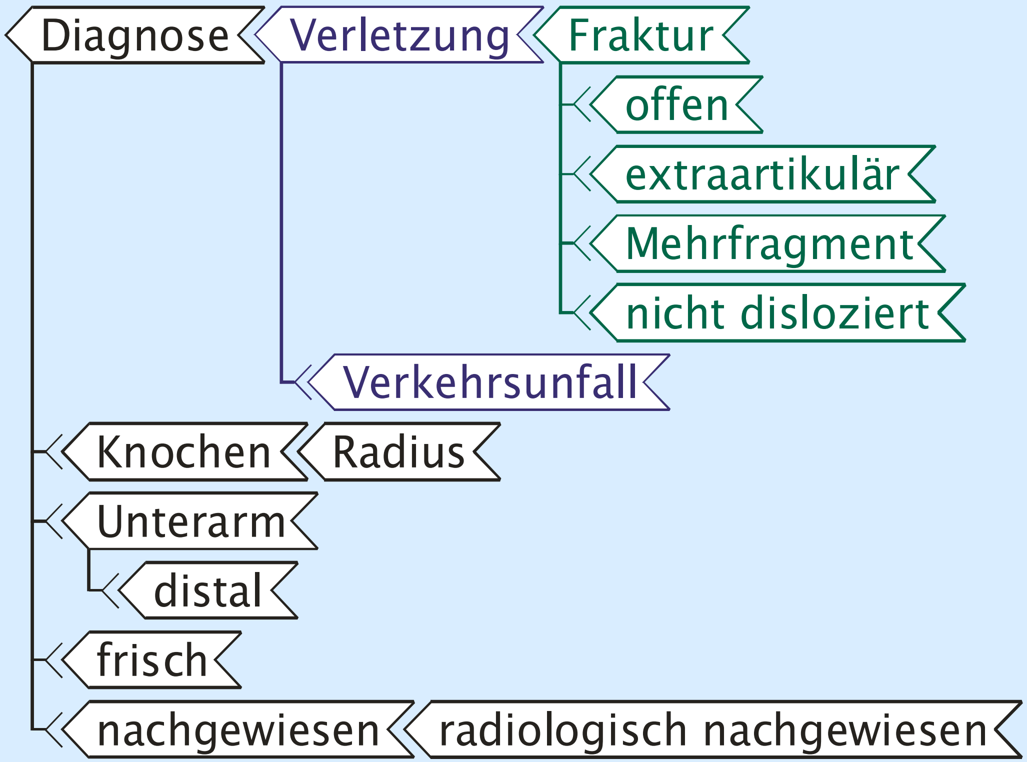
The two relationships span the semantic space

Pseudotree structure helps computability



The two relationships span the semantic space

Only 1 formal element visible → readability



Top Level Ontology

We distinguish between formal and content TLO:

Formal TLO

→ 3+1 Elements

1 atomic concept + 2 relationships + 1 multiplication element

These 4 Elements are not to change,
but can be filled (named) with any content

Content TLO

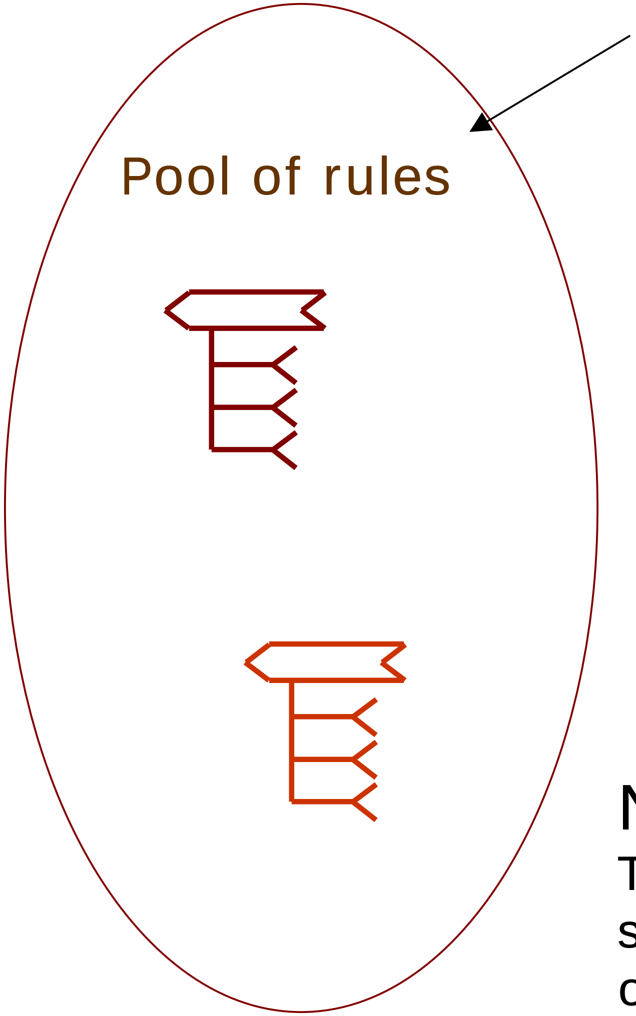
Content TLO is not proprietary in our system

In principle any content can be given to the four formal elements

Thus we can model other systems and transform them
(semantic interoperability)

Transformation process (inference process)

Transformation process



Intelligence

The rule pool represents the intelligence of the system (includes thus the human engineers brain)

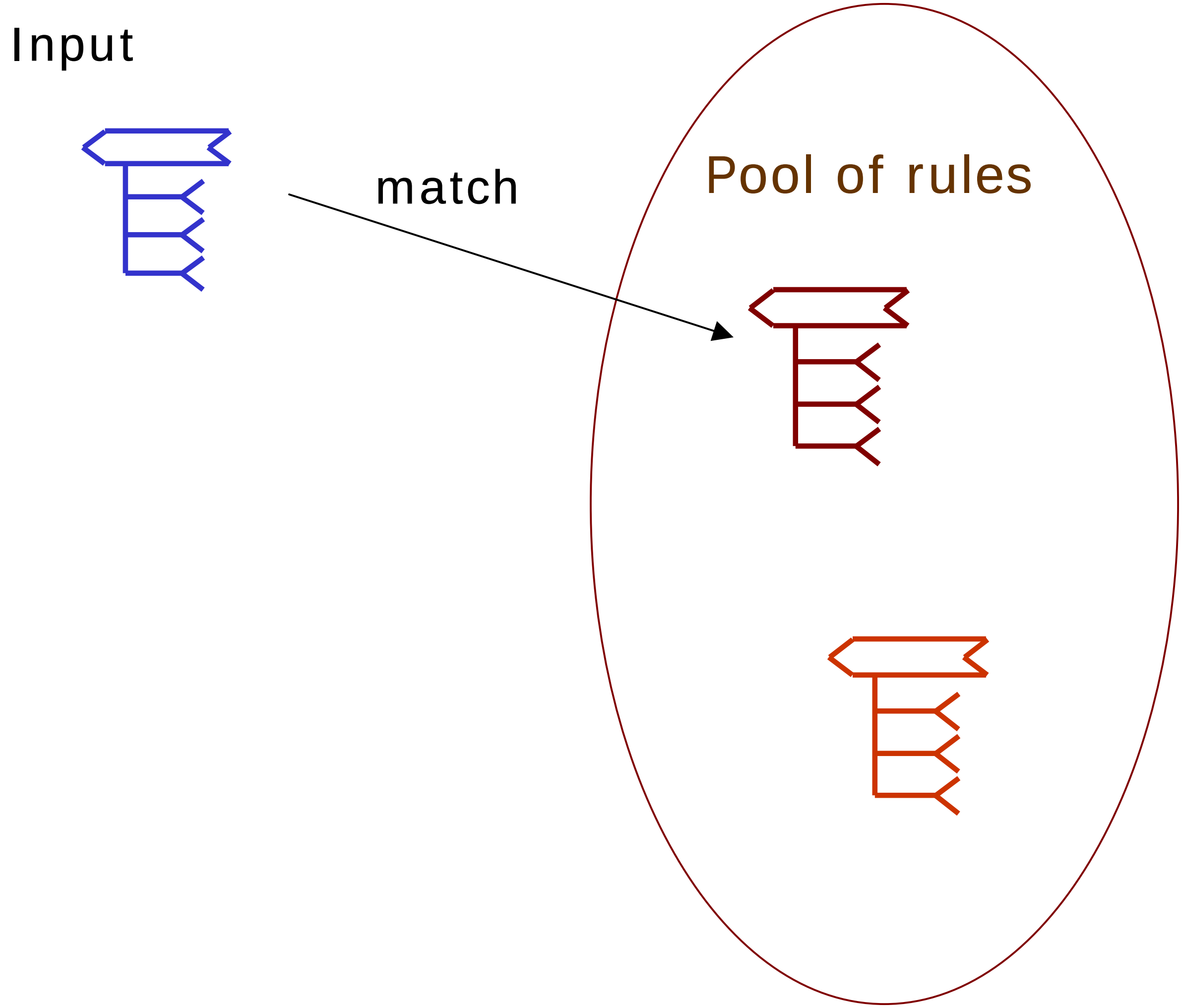
Form of rules

Rules have the same multidimensional, strict composite and pseudohierachical form like all other concepts

No definitions

The non-monotonic system comprises only rules (which can be overruled) and no definitions

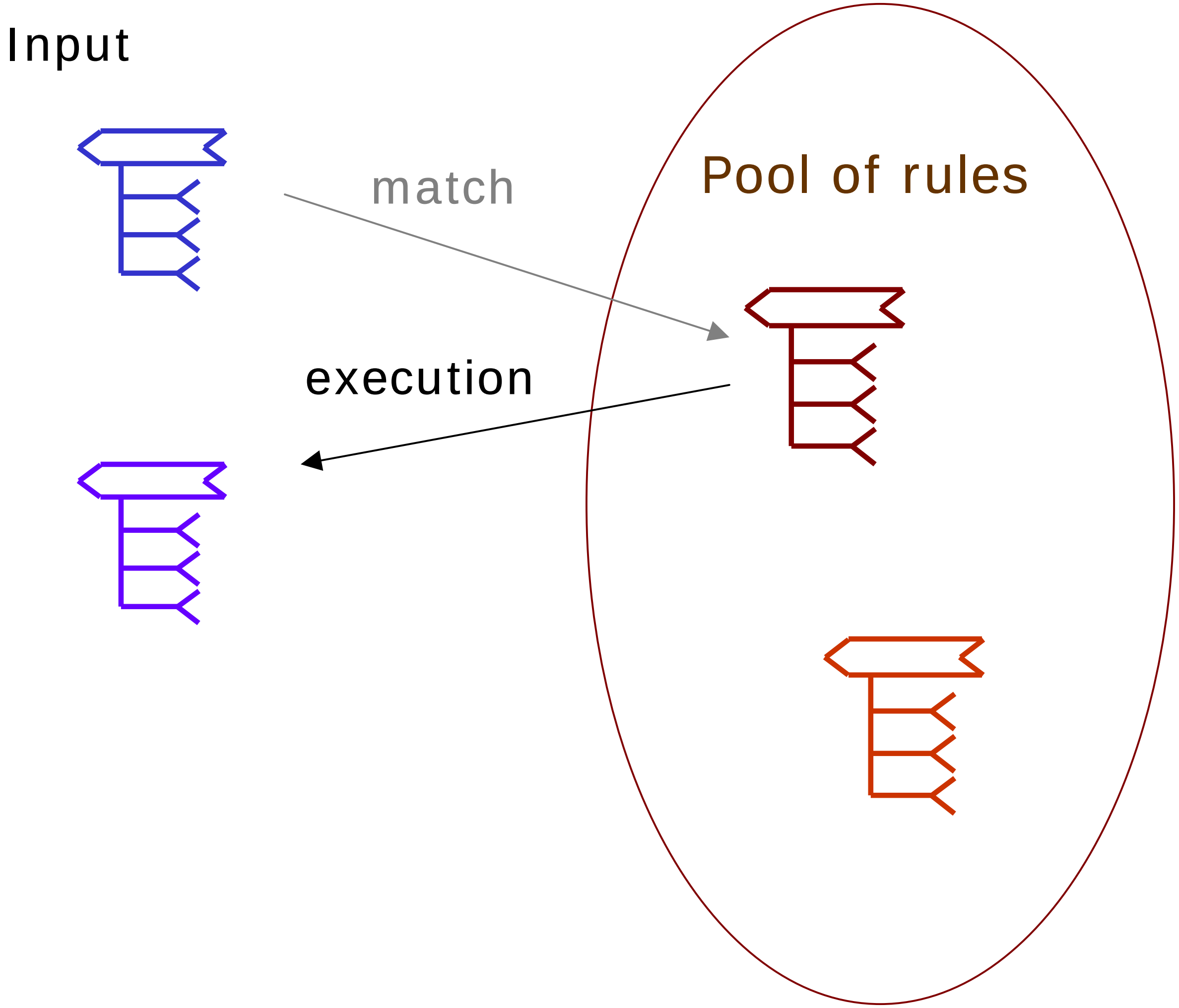
Transformation process



Match

The composite and multidimensional form of both input and rules allow a fast match of the most appropriate rule

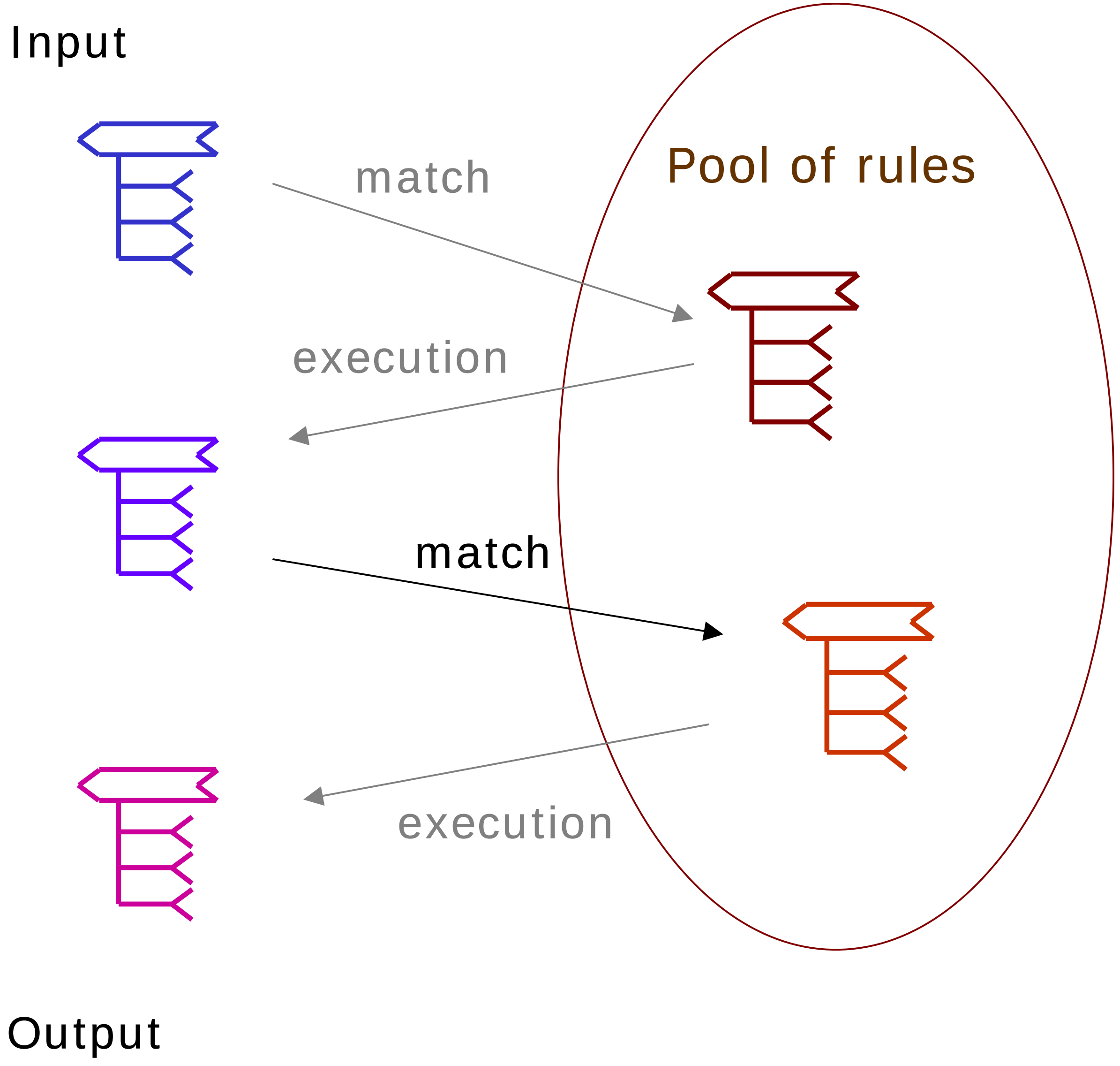
Transformation process



Execution

The rule contains ifs for the match and thens for the modification of the input

Transformation process

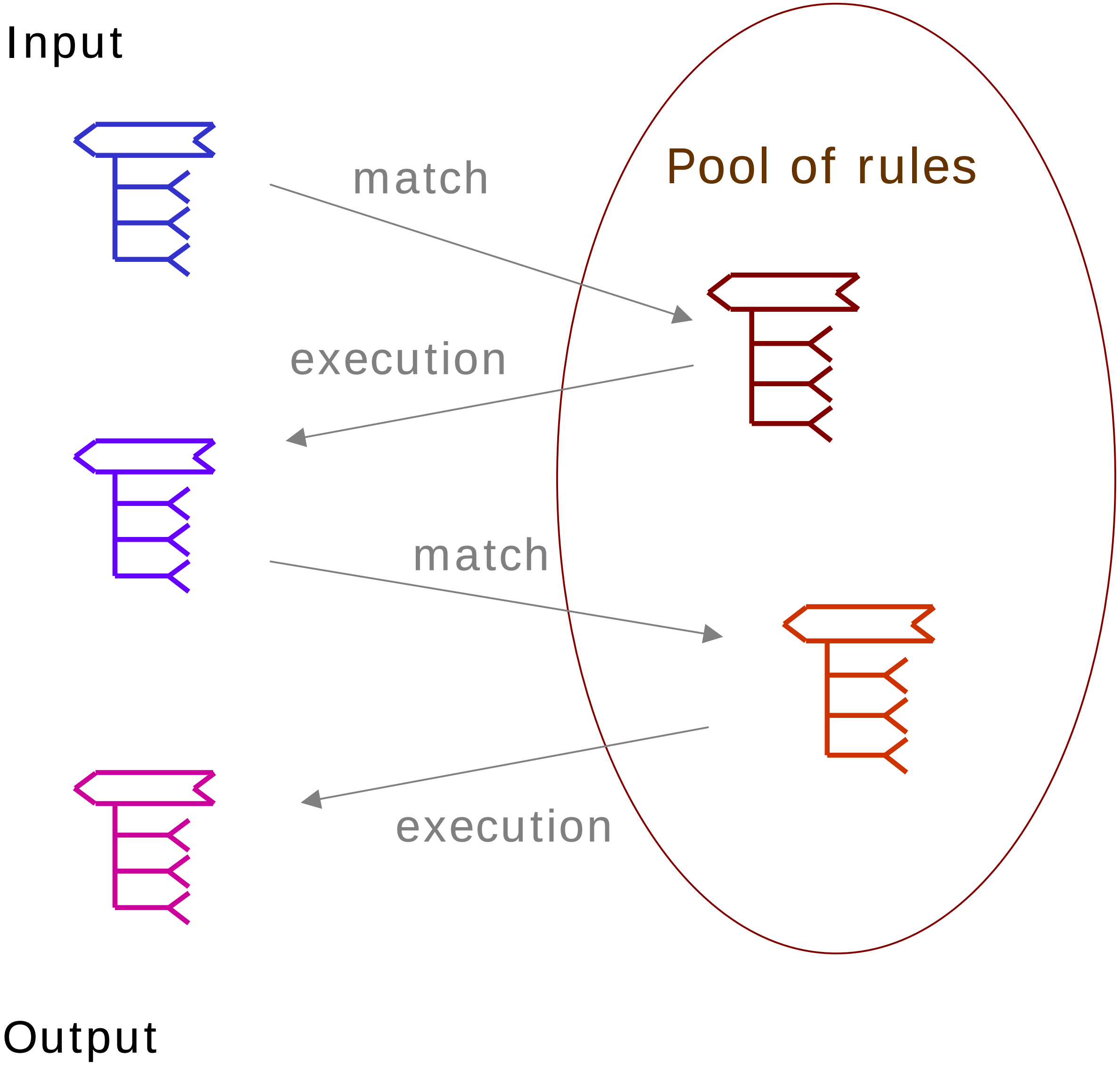


Next rules

The modified input matches with a different rule which is then executed

Procedure continues until no more rules do match → output

Transformation process



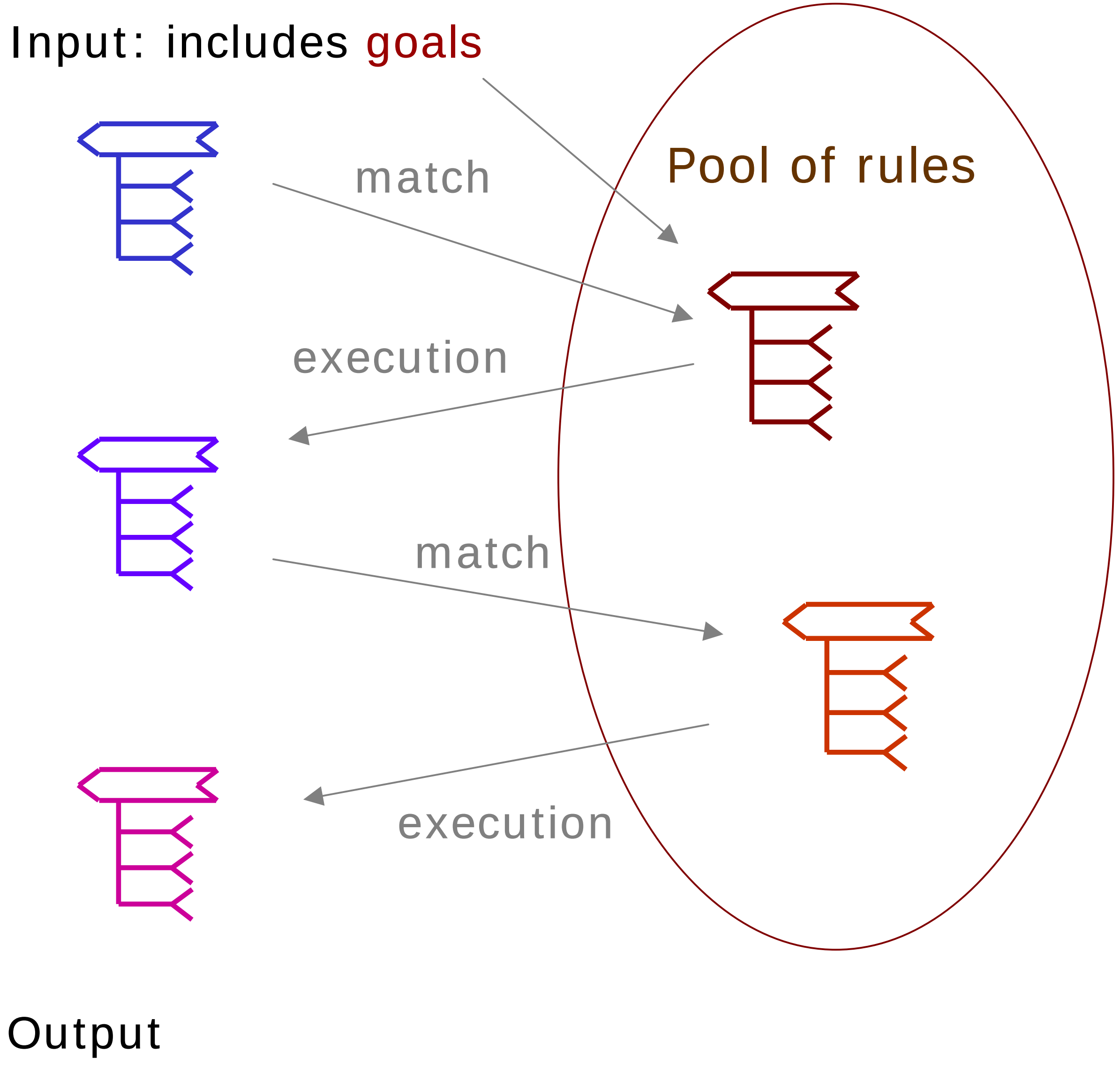
Semantic way of chronology control

Which rule is executed?

Chronology is controlled by the information of the actual input and by dynamic triggers installed into the status during the execution of the process.

The control lies there-fore in the concepts of input and rules (in the semantics) and not in algorithm steps of the program

Transformation process



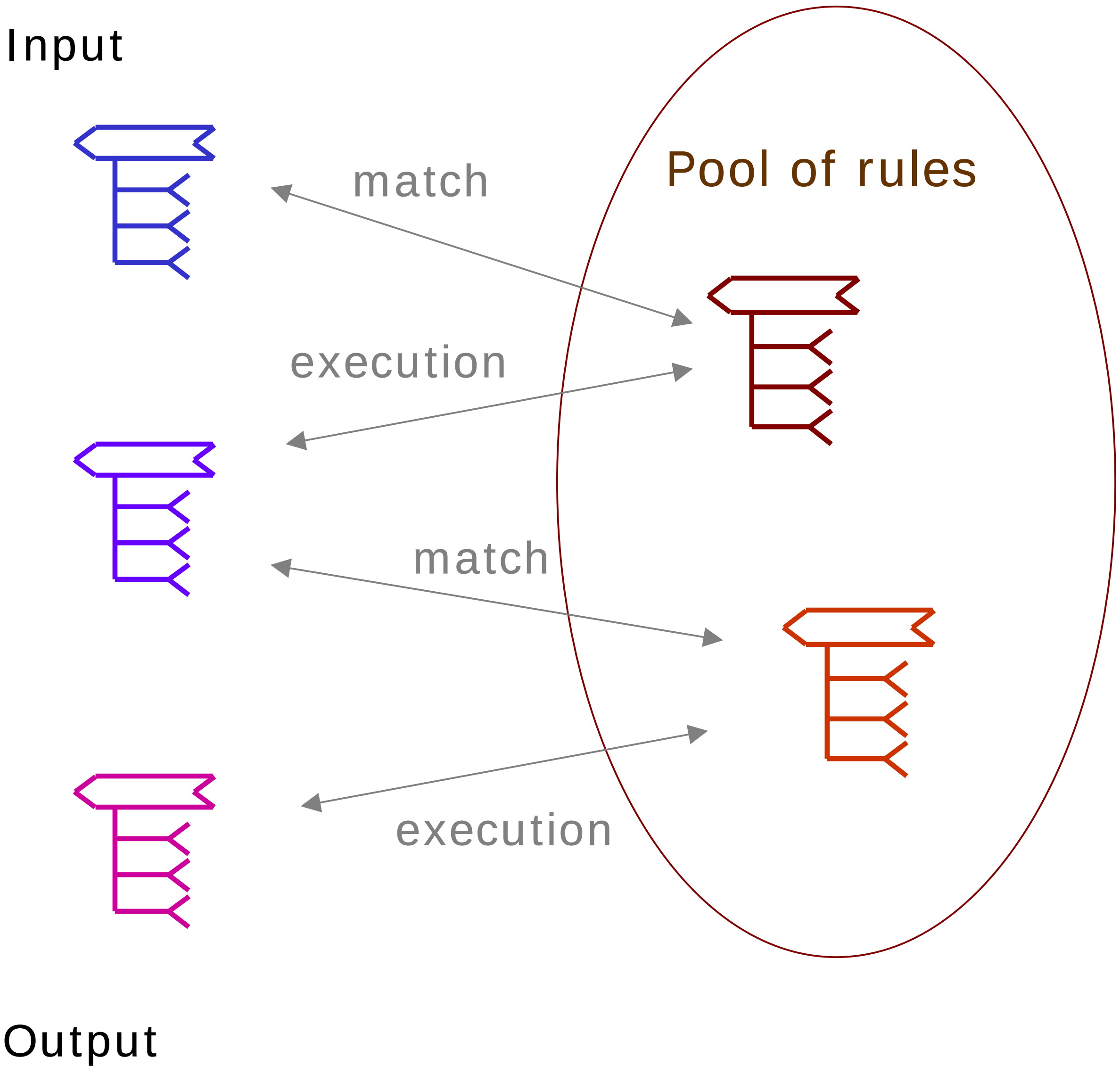
Semantic way of chronology control

Which rule is executed?

The Input contains information about the observations to be processed (objective input) as well as information about the goal of the interpretation process (subjective input).

Both are given to match in the pool of rules and to select the rule to be executed

Transformation process



Semantic way of chronology control

Chronology of inference is controlled by the semantic concepts of input and rules.

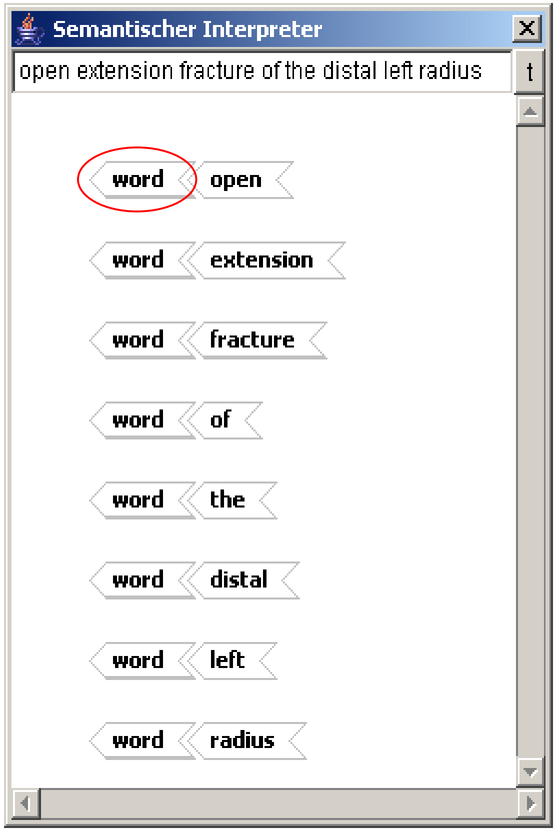
Non-monotonism

The actual state of the transformation process determines which rule matches. Contradicting rules can thus coexist. Context decides which one is active.

Visibility

All rules and steps are visible to the human knowledge engineer.

Transformation example: from words to meaning



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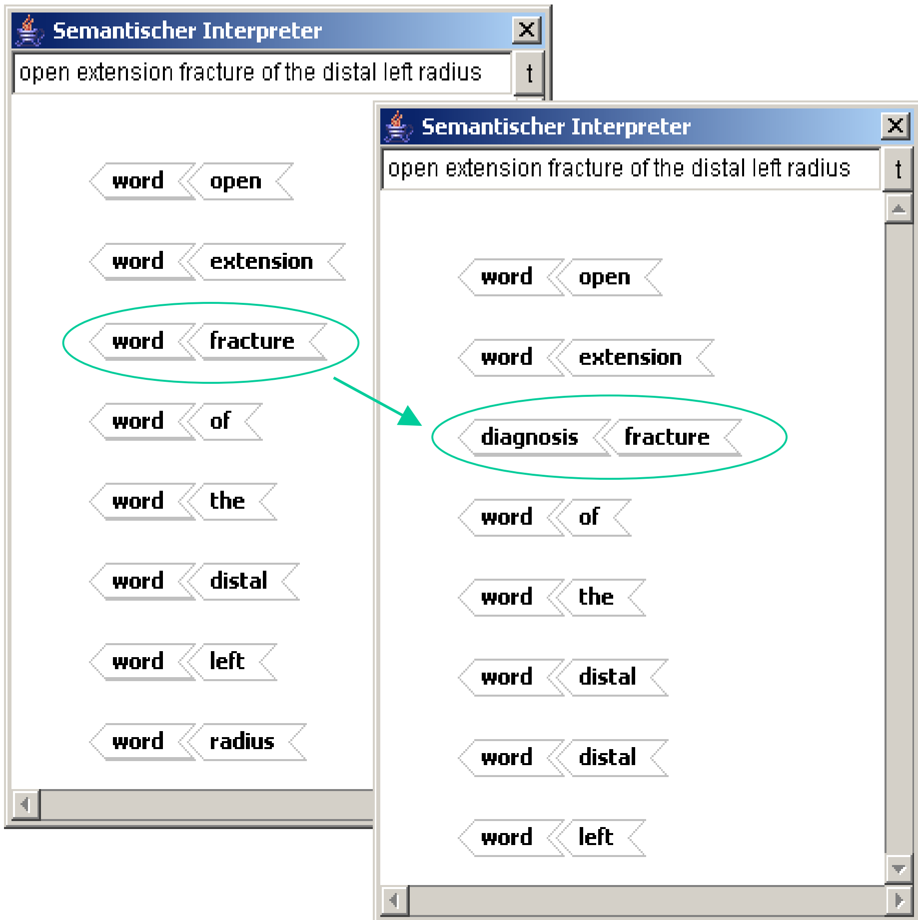
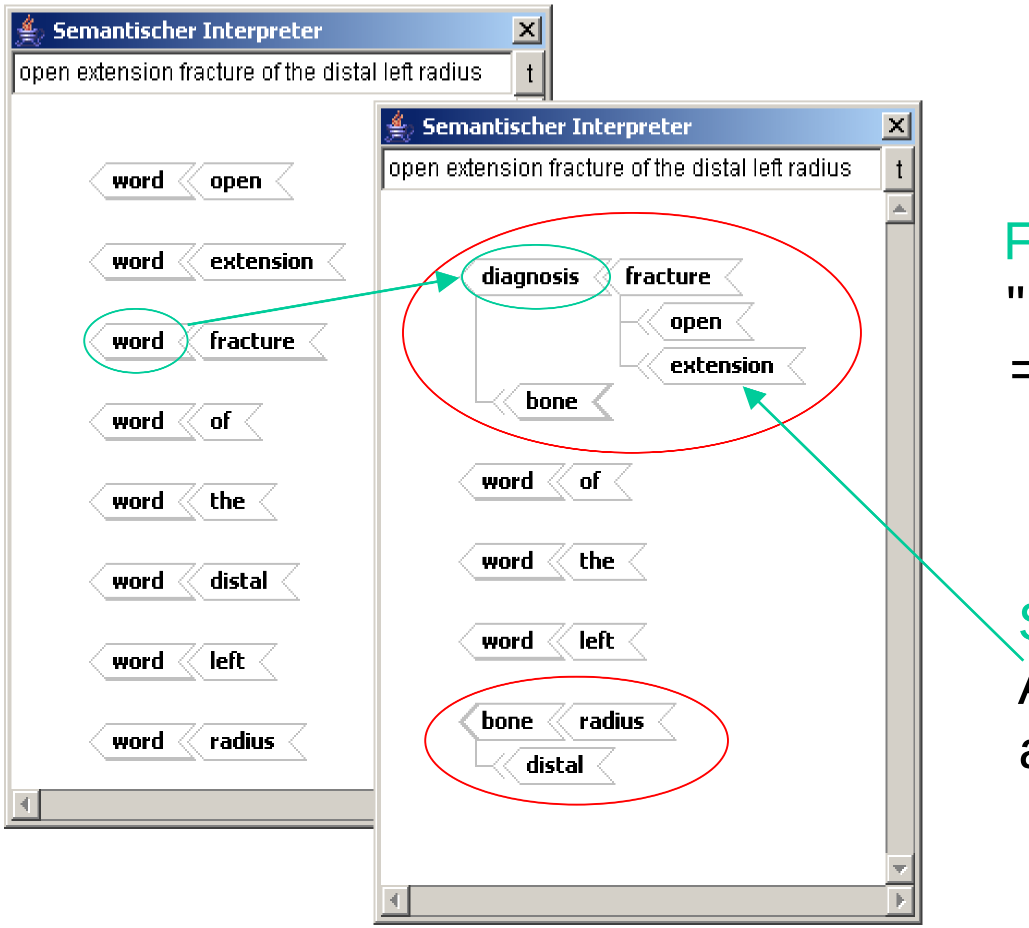


First step

"Fracture" becomes a diagnosis

= conceptualisation

Transformation example: from words to meaning



First step

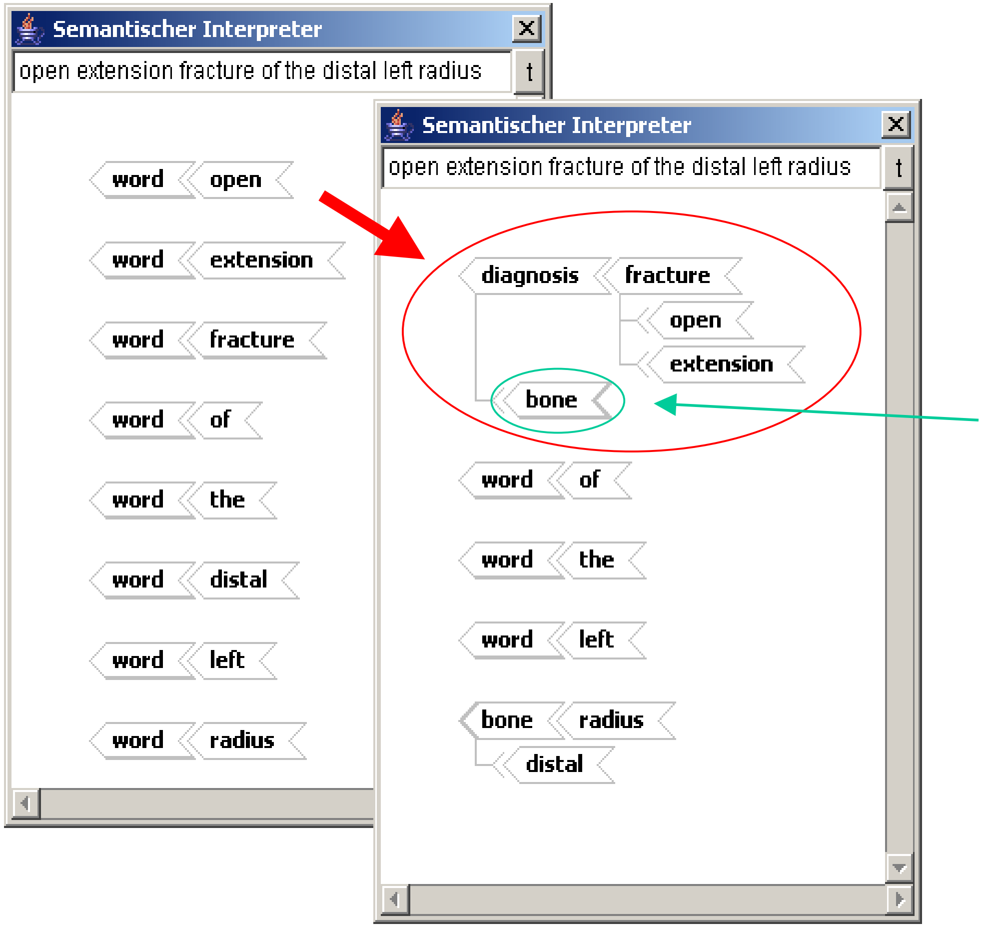
"Fracture" becomes a diagnosis

= conceptualisation

Second step

Attributes from the input are added

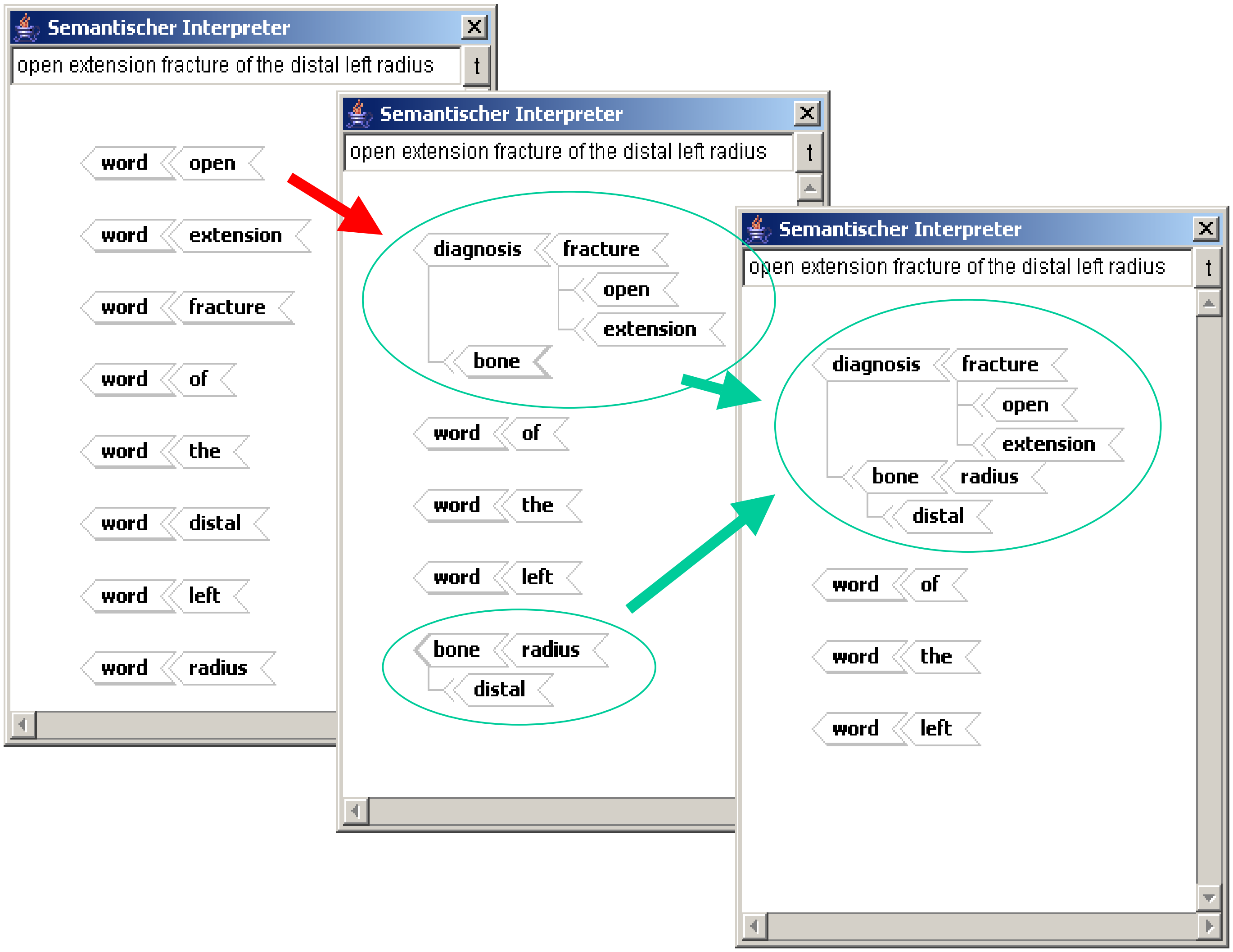
Transformation example: from words to meaning



Implicit information

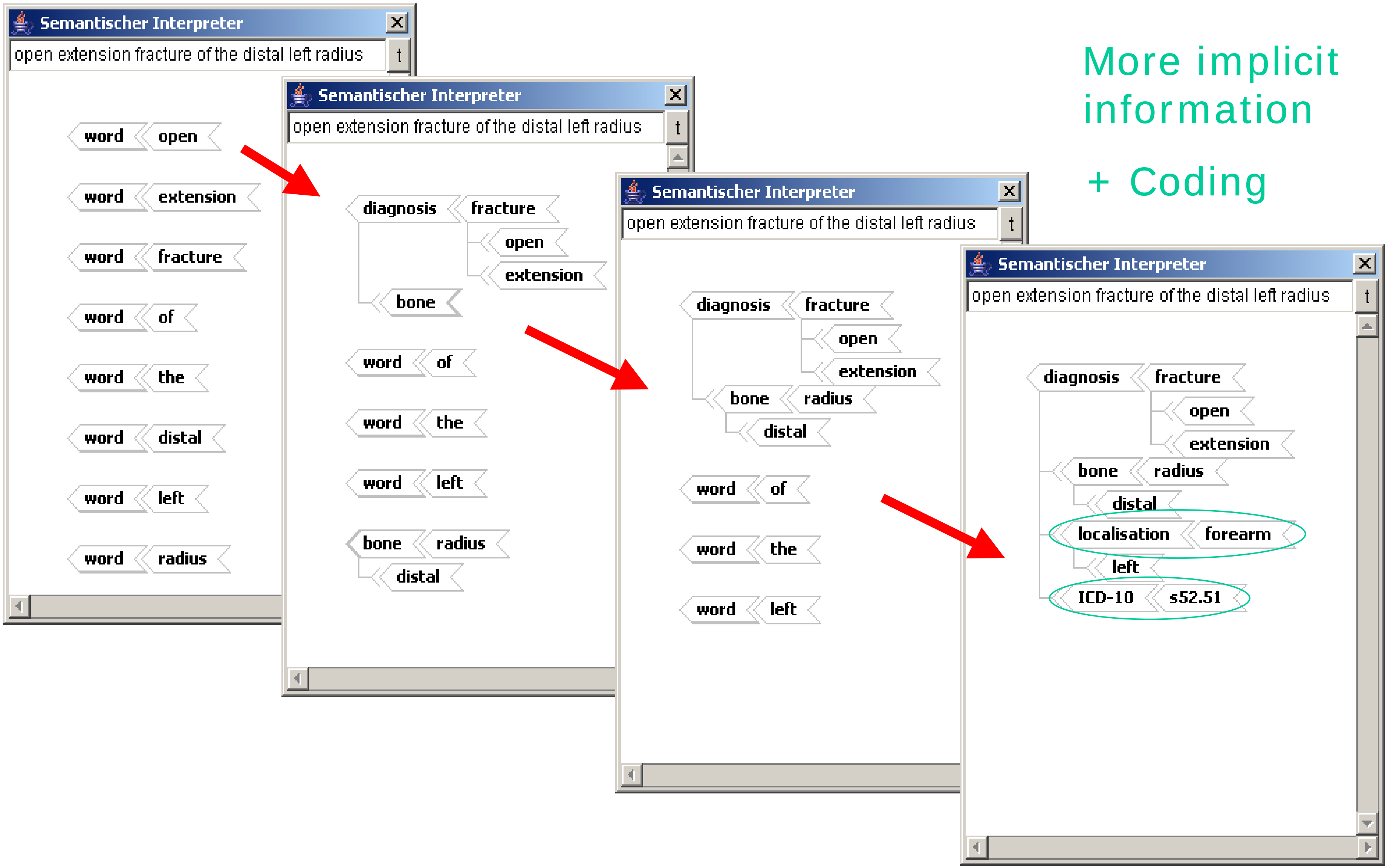
"Bone" was not mentioned in the input, but is implicitly deduced by the system

Transformation example: from words to meaning



2 Molecules are joined

Transformation example: from words to meaning



More implicit information

+ Coding

Conclusions

- It is possible to have a non-monotonic system working

- Concepts are not objects

- Use well-structured composite concept clusters

Thank you for your attention!