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University of Münster

What does it take to interoperate?

Semantic interoperability revisited in terms of human digital communication

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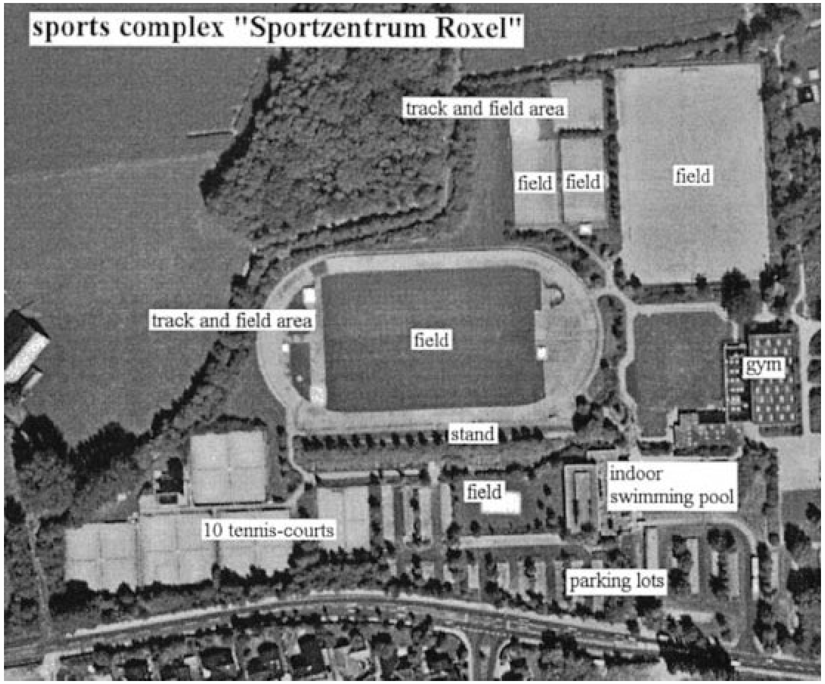
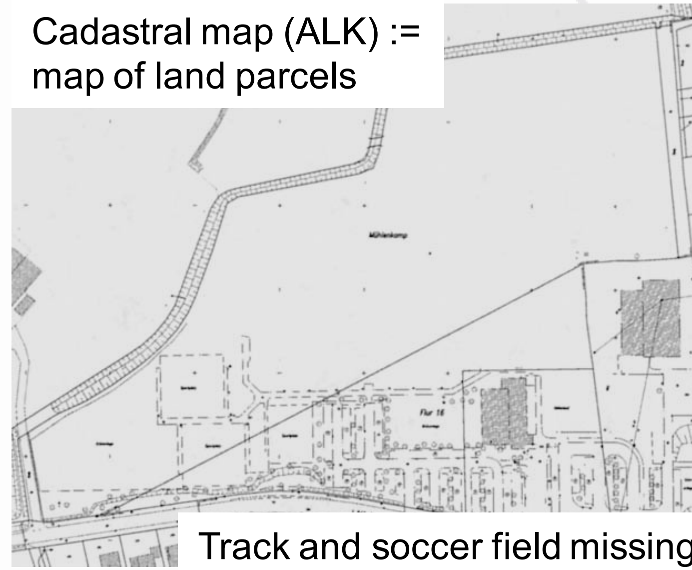
EarthScienceOntolog:
Panel Session-03 - Thu 2012-10-11

Illustration 1: How to map a sports ground



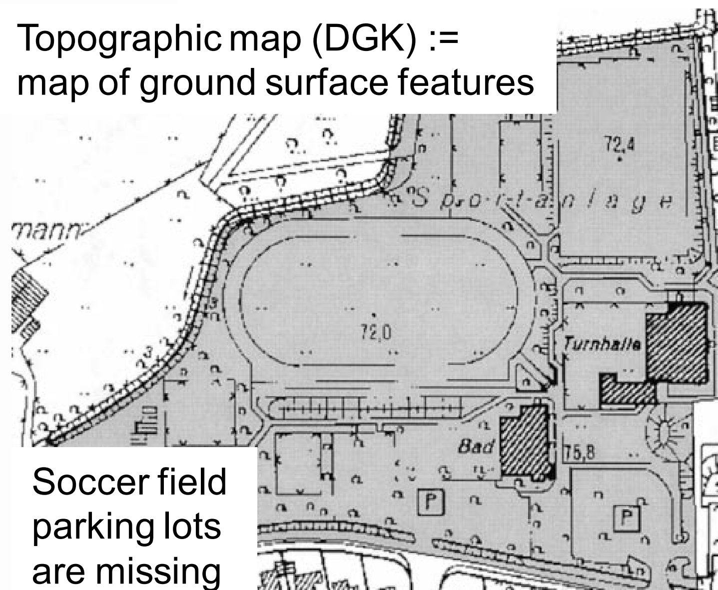
Taken from Harvey et al.1999

Cadastral map (ALK) := map of land parcels



Track and soccer field missing

Topographic map (DGK) := map of ground surface features



Soccer field parking lots are missing

Google maps

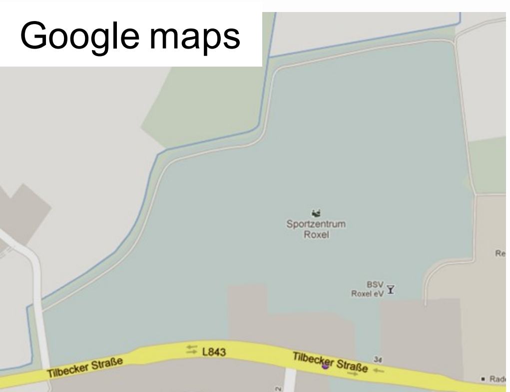
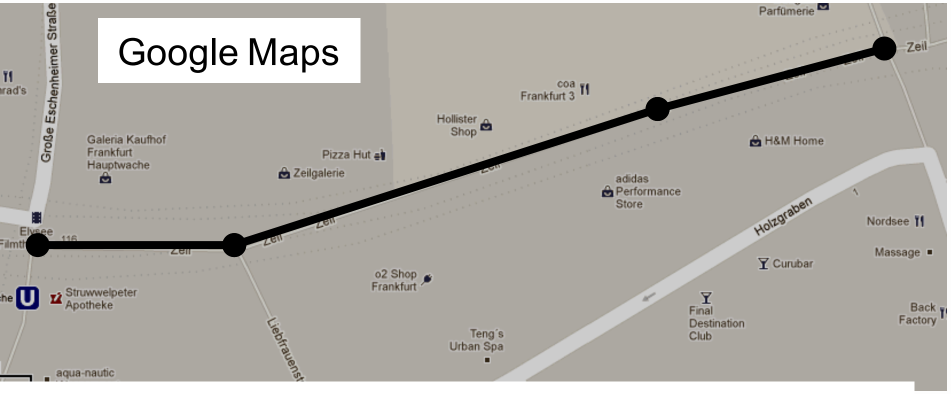


Illustration 2: How to represent Frankfurt Zeil

Frankfurt Zeil is a famous pedestrian shopping area in Frankfurt a. Main

Is it a road object with motor traffic restrictions? Or a public place? Or a non-identifiable part of the city surface?



Type of a road object without motor traffic (embedded road graph)

Part of a city surface

The challenge of interoperability in a nutshell

name1 → ● ← name2

Source: A. Kleon

From multi term -- single perspective

- The problem cannot be reduced to labeling, i.e., to establishing standard terms for given concepts
- Conceptualizations vary considerably, that is, each dataset comes with an intrinsic perspective, and for good reasons
- To the extent that things and their categories in one perspective do not exist in another one
- Sometimes, terms may not even be comparable across perspectives

name1 → ● - - ? - - → ▲ ← name2

"Is this a meadow, a field, or a vacant lot?"

… to multi term -- multi perspective

Paradigms of semantic interoperability and corresponding strategies

Paradigm	Main idea	Heterogeneity strategy	Means to semantic interoperability	Critical assumption
Holistic standardization	Term-meaning standardization	Heterogeneity resolution	Ability to subscribe to a standard	Term-meaning can be standardized
Top-level ontology alignment	Alignment with core standard	Heterogeneity avoidance	Ability to align with core standards	Core term-meaning can be standardized
Pluralist peer-to-peer translation	Term similarity and translation	Heterogeneity mitigation	Ability to translate between similar terms	Term-meanings are comparable and mappable
Bottom-up construction	Term-meaning generation	Heterogeneity articulation	Ability to understand semantic differences	Term-meanings can be reconstructed
Human-machine-human communication	Term-meaning communication	Heterogeneity articulation	Ability to act on information	Term-meanings can be communicated

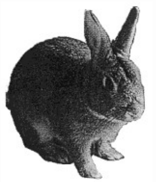
Semantic imitation

Interoperability as communication problem

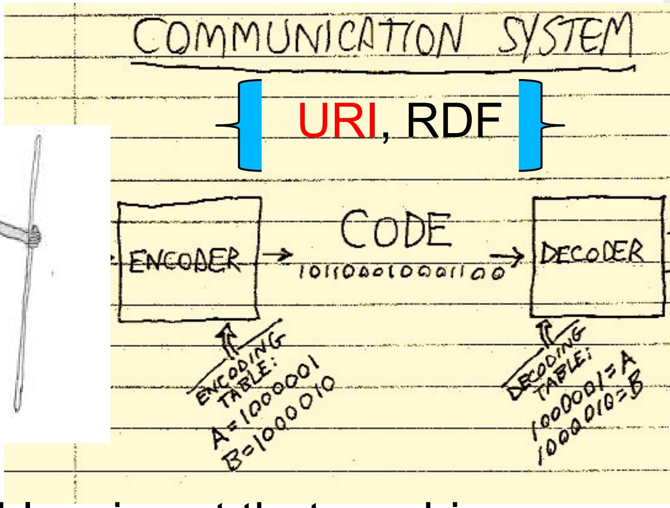
Sharing meanings is a result of human communication. It requires understanding **acts of reference.**

Human - machine - human

Domain of experience of encoder



Act of reference of encoder



Act of interpretation of decoder

?

Domain of experience of decoder

"The problem is not that machines cannot communicate,

but that humans misunderstand each other when communicating via machines"

Reference gets lost
since it is generated outside the machine

musil

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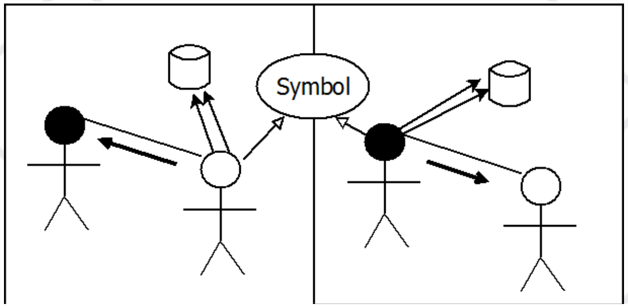
Sharing meaning requires recomputing it in terms of shared operations

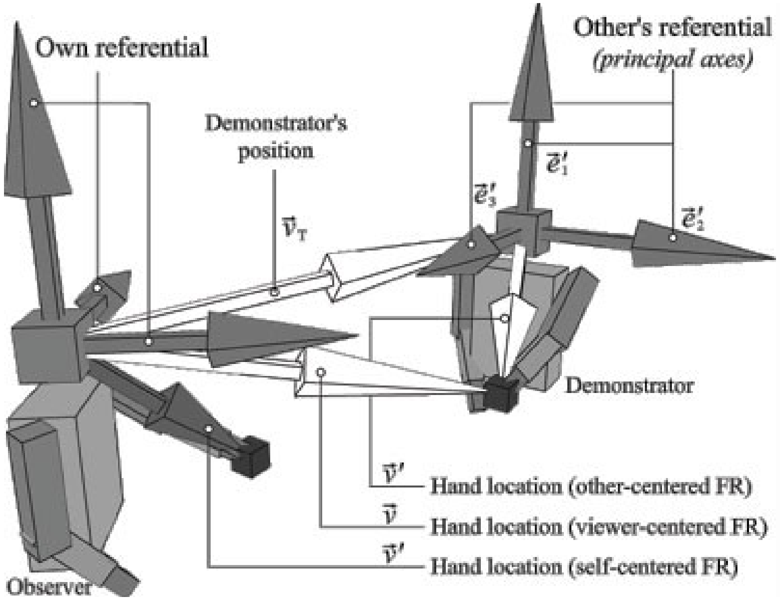
Theses (c.f. Scheider 2012):

- Meaning is something that observers do (speech act that joins human attention on a reproducible phenomenon)
- Sharing meaning requires „**imitation**“: Regenerating it in terms of shared operations (perceptual, technical, and constructive)
- Conventional reference formalisms can be **grounded in such operations**

  ≅ Semantic Reference Systems (Kuhn 2003)

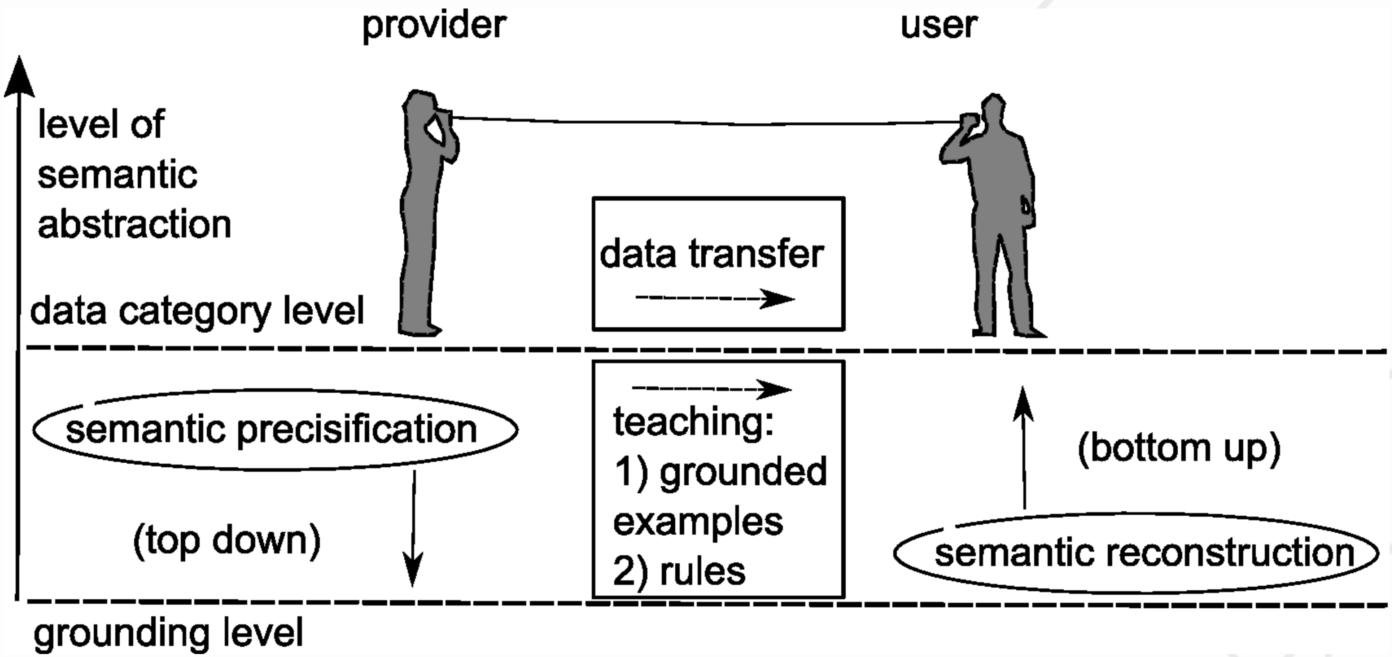


Joining attention (Tomasello 1999)



Imitation of „**holding sth. in front**“ by robots (Sauser and Billard 2005)

Interoperability as result of semantic imitation



- The provider supplies data and takes on the role of a teacher.
- The user tries to imitate the provider by **reconstructing data categories** in terms of a grounding level
- The task of the provider is to **teach data categories** with respect to a grounding level (by examples and rules)
- The game is evaluated by **classification quality** (precision and recall) of examples

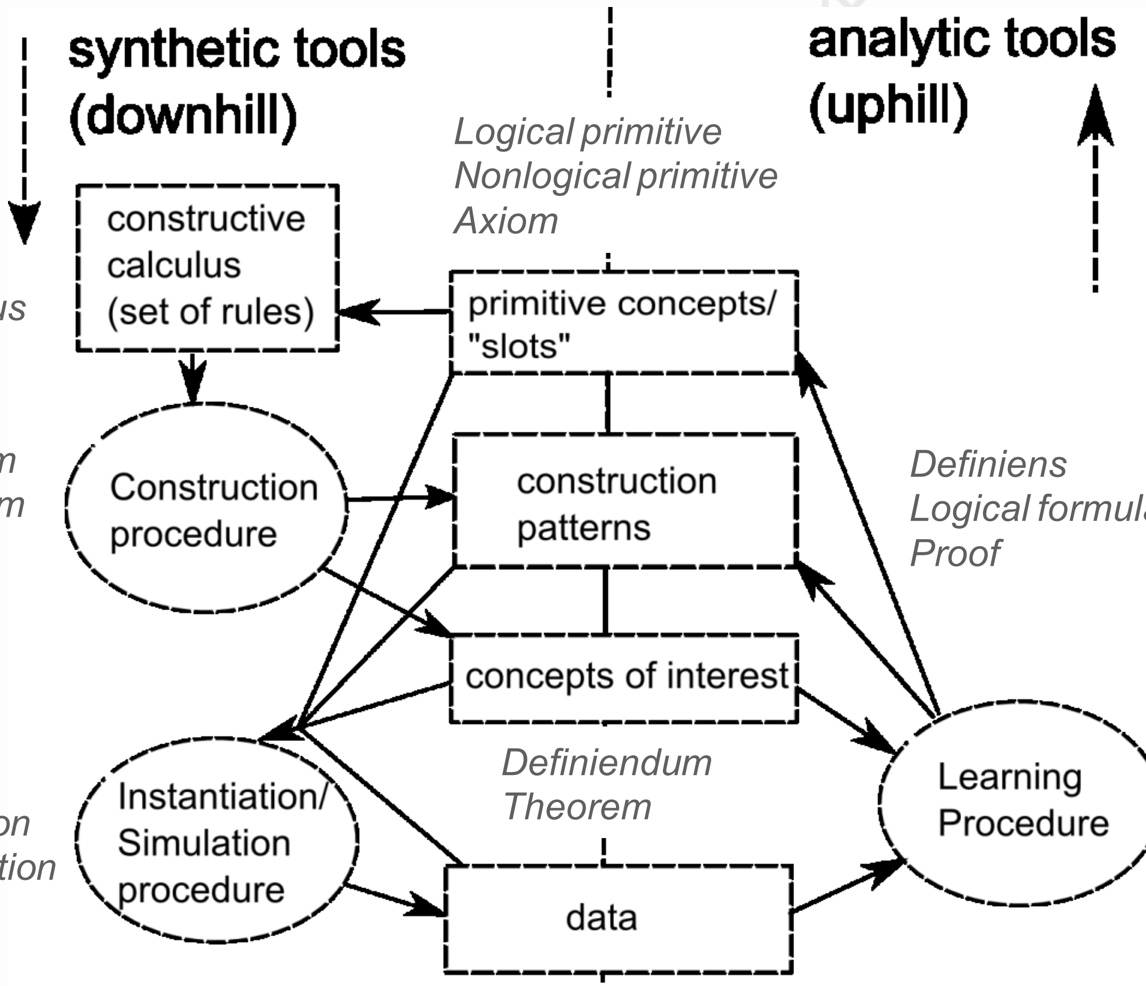
Semantic imitation tools: the big picture

Logic inspired examples:

Logical syntax
Inference calculus
Intuitionistic calculus

Formation algorithm
Resolution algorithm
Tableau algorithm

Variable instantiation
Quantifier instantiation



Logical primitive
Nonlogical primitive
Axiom

Definiens
Logical formulae
Proof

Definiendum
Theorem

Syntax parsers
Inductive logic programming

Ground sentences
A-Box

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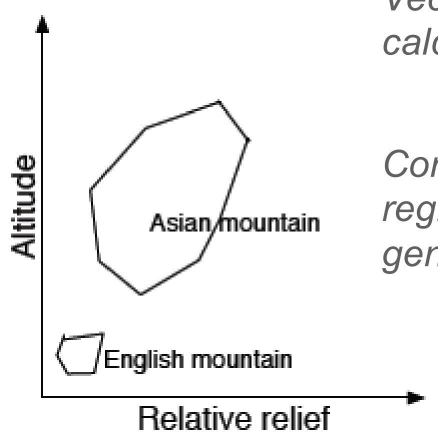
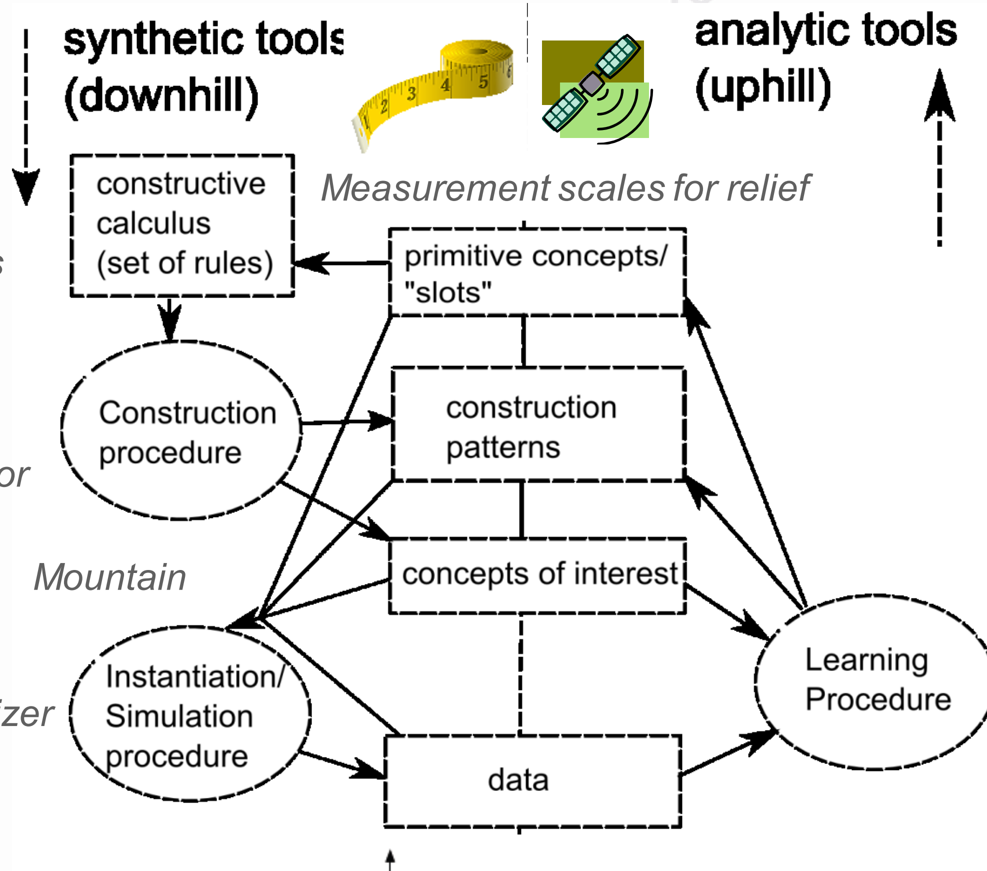
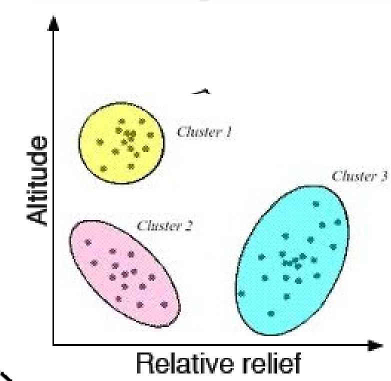
Semantic imitation tools: example 1

Category construction

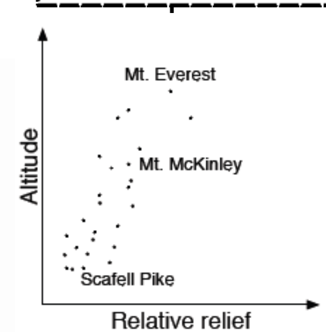
Mountains as regions in conceptual spaces:







Unsupervised learning (Cluster analysis)



Mountain data

(Adams Janowicz 2011)

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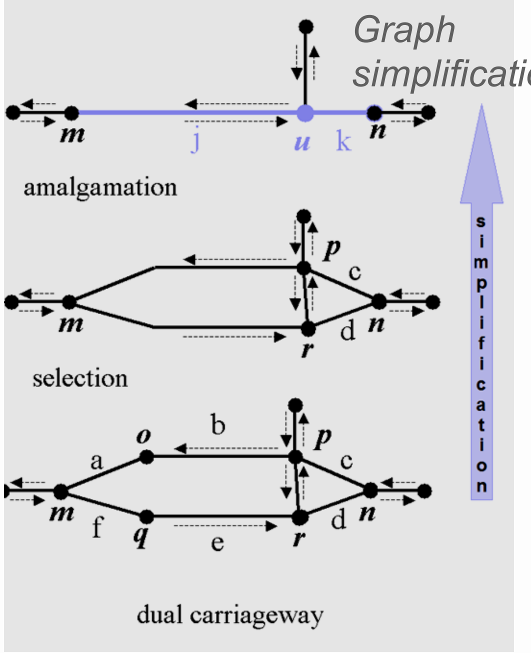
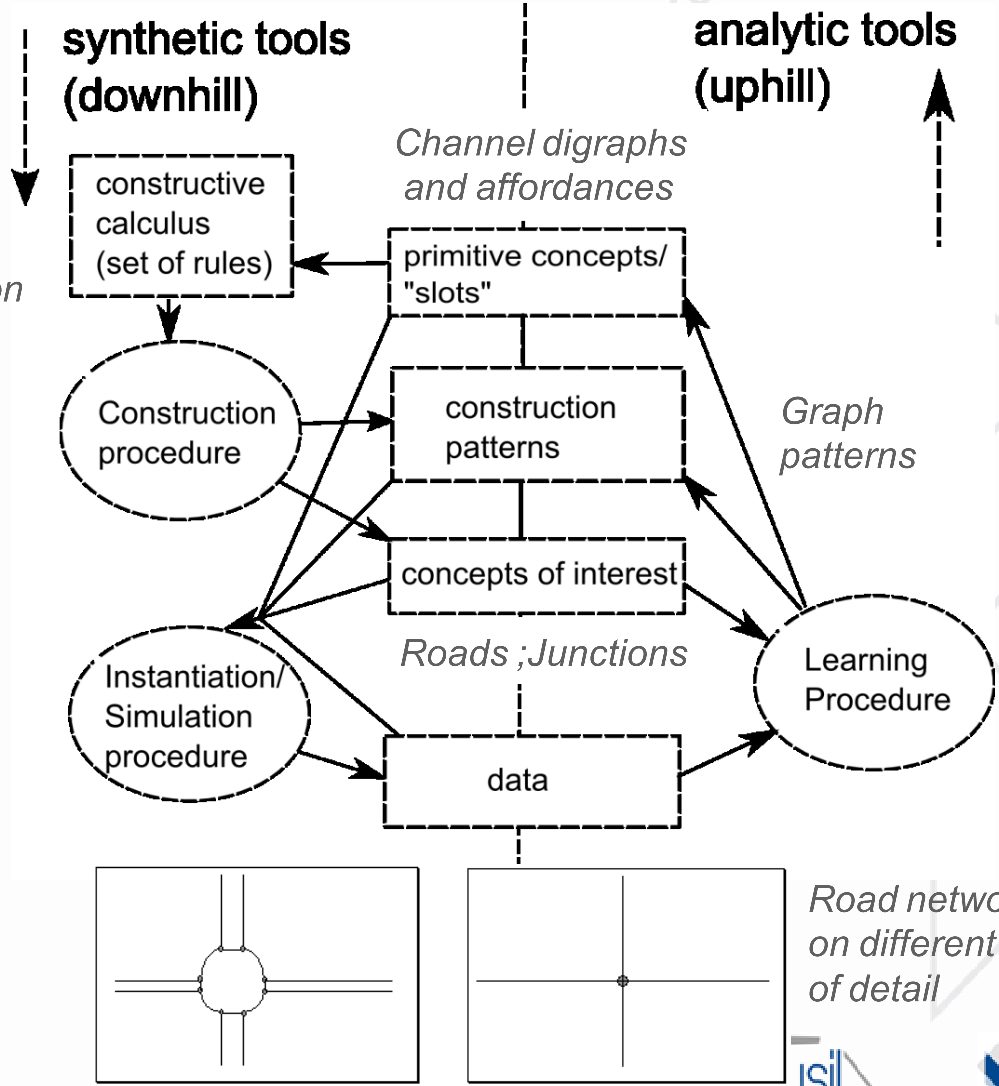
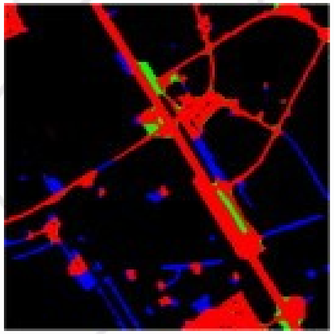
Semantic imitation tools: example 2

Object construction:
Roads and junctions as embedded graphs:





Delineation of roads



(Scheider Possin 2012)

Thank you!

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