UNIVERSAL ONTOLOGY OF GEOGRAPHIC SPACE (UOGS) – a tool for MACHINE & HUMAN - UNDERSTANDABLE records

dr. Marjan Čeh

University of Ljubljana, Slovenia

WHY, PROBLEMS ?

NMCA and STATE ARCHIVE

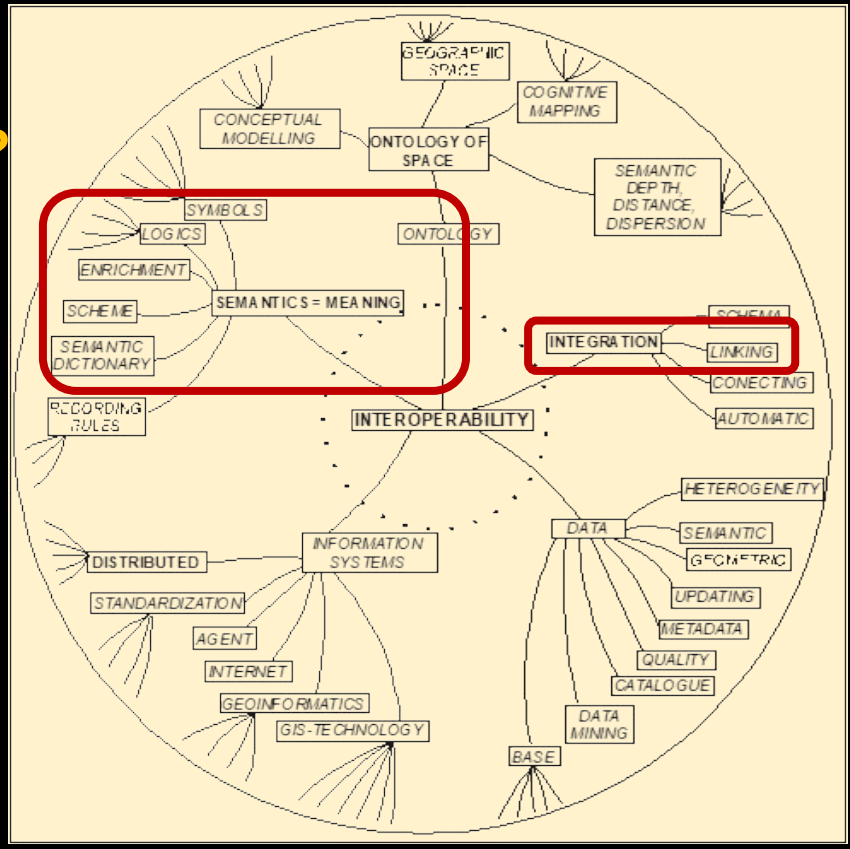
GEOSPATIAL DATA computerized frameworks **SILOS** – dispersed data

FLOW TO ARCHIVES AND BACK, PROVIDED?, OPEN?

LACK OF NATIONAL SEMANTIC INFRASTRUCTURE

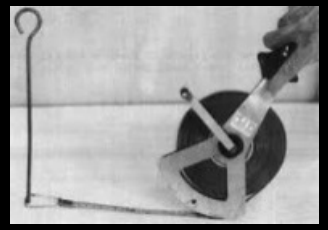
FORMAL INCENTIVES:

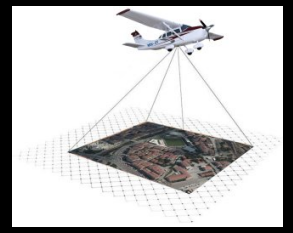
- **UN GGIM** agenda 2030
- **INSPIRE** and **GREEN DEAL DATA SPACE**

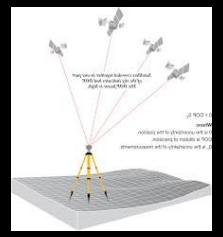


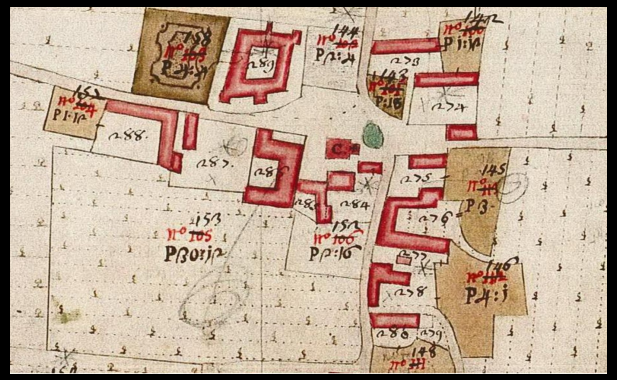
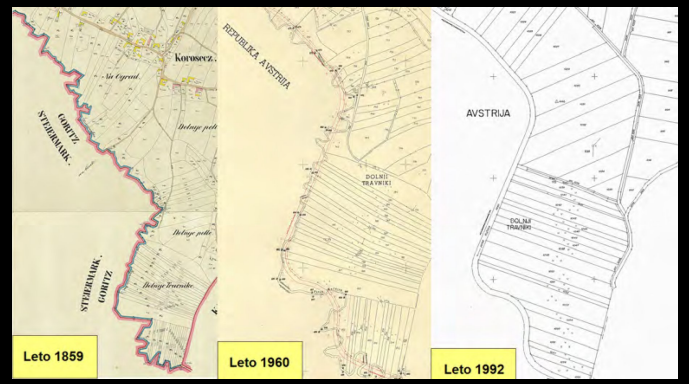
SEMANTICS of geospatial DATA & TECH

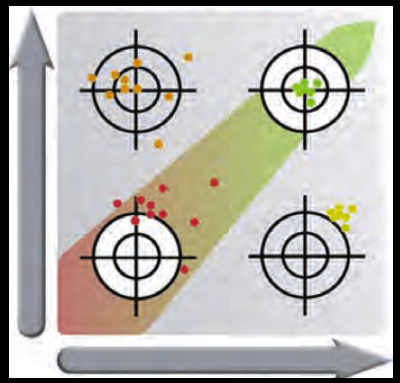








TEMPORALITY

more problems ...

- DIVERSE DATA PROVENANCE, LEVELS OF **COMPLEXITY, QUALITY**
- A **COMMUNICATION GAP** (spatial data **PRODUCER, USER, AI**)
- **AI** integration, LLM **HALUCINATIONS** - model's **LIMITED CONTEXTUAL UNDERSTANDING**
- **NON - COMPREHENSIVE METADATA**
  - different descriptions for the same object type (ex. Building)

SEMANTICS - MEANING OF SYMBOLS

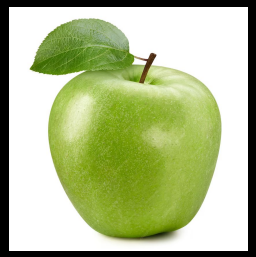
- WORDS apple
- CODES 1 apl.
- ICONS

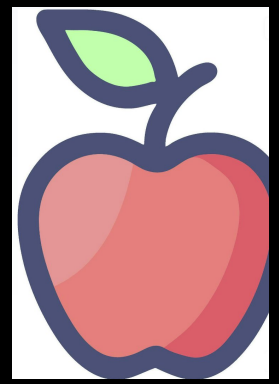
LANGUAGE MODELS (GRAPHS)

DB CODE **TABLES**

CARTOGRAPHIC **LEGENDS**

PARTICULARS : UNIVERSAL





ONTOLOGY

SEMANTIC COMPLEXITY

HOW do we **COMPARE** similar **CONTENT** of **GEOSPATIAL** data in **TIME**?

GEO SPATIAL DATA

COMPLEXITY:

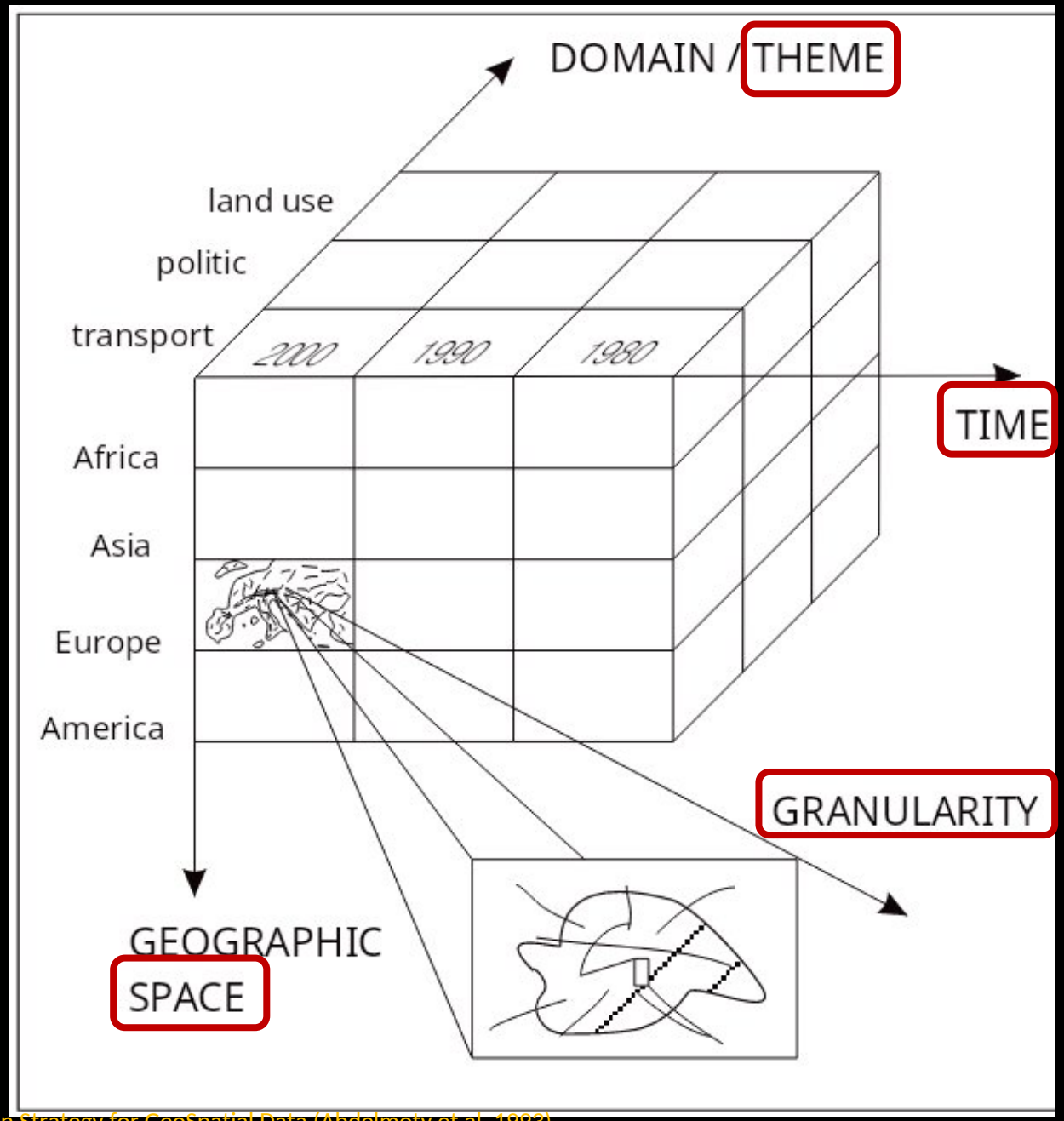
SPACE TIME

THEME

HISTORY

MONUMENT

ARCHIVE



SOURCE: Different dimensions of geographic data in the National Information Strategy for GeoSpatial Data (Abdelmoty et al. 1993)

HOW TO ORGANIZE knowledge?

ONTOLOGY in PHILOSOPHY (Sowa, 2003):

„the CATEGORIES of THINGS that EXIST in DOMAIN“

ONTOLOGY in AI Gruber (1993:

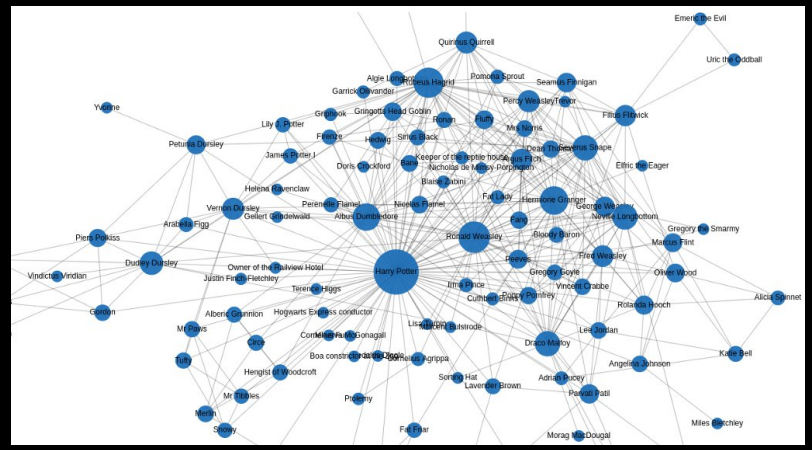
„**EXPLICIT** SPECIFICATION of a CONCEPTUALIZATION“

„an abstract, **SIMPLIFIED** view of human conceptualisation“

Ontology web language (**OWL**)
Resource Description Framework (**RDF**) “subject – predicate – object“

KNOWLDEGE GRAPH

– **INTERLINKED** DESCRIPTIONS OF ENTITES



Source: **Tomaž Bratanič, Graph ML and GenAI Research, Ne**

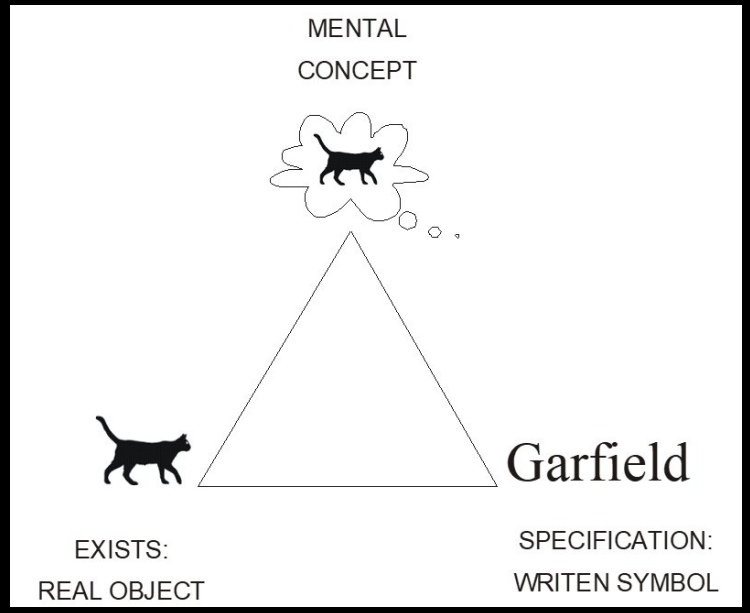
ONTOLOGY

HOW VIEW THE WORLD ?

MENTAL CONCEPTS

WHAT THERE IS (EXISTS) ?

REALITY



(1923) **Ogden/Richards Triangle of meaning** / semiotic triangle

SPECIFICATION OF

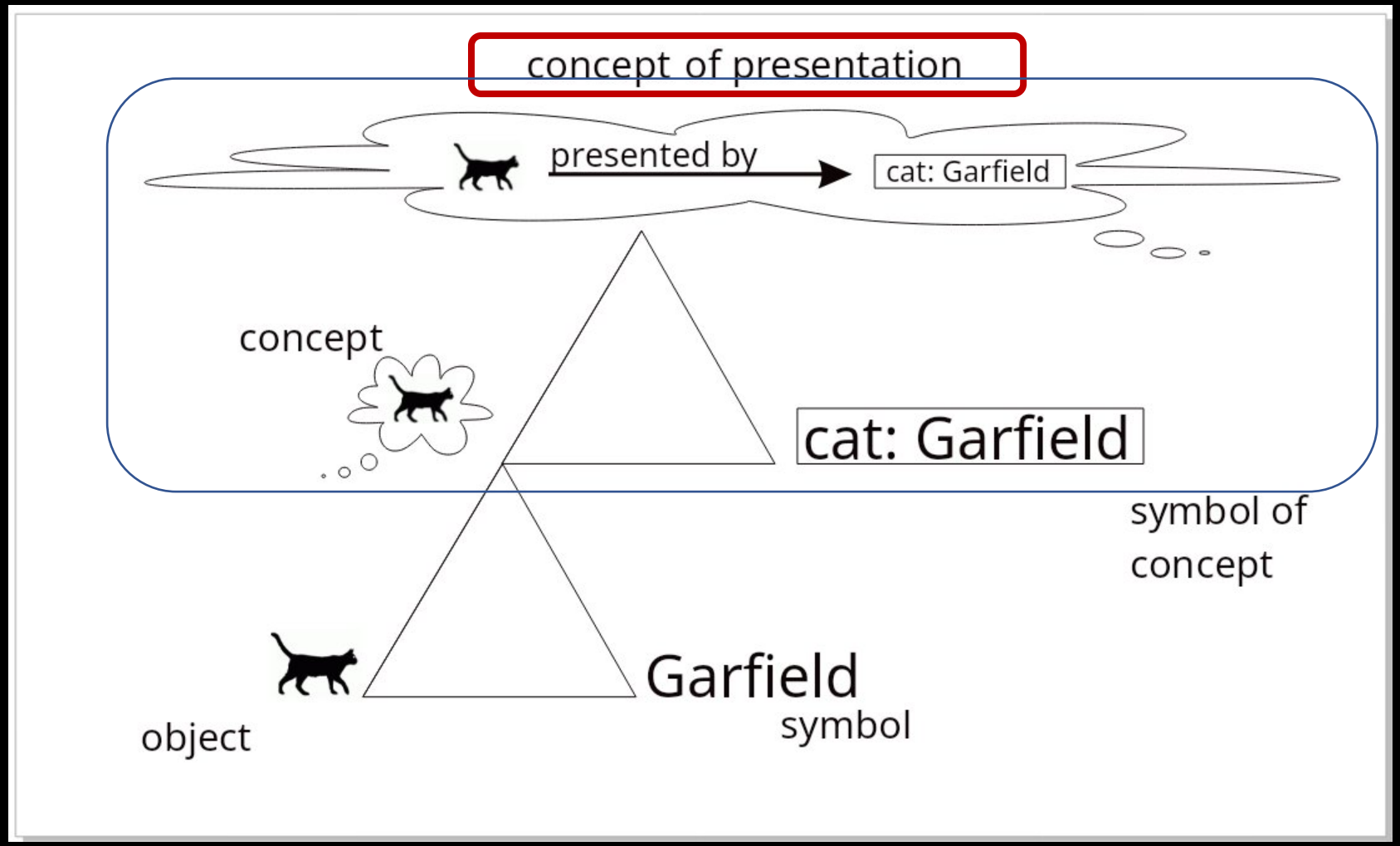
CONCEPTUALIZATIONS

STATEMENTS OF TRUTH

ORGANISED KNOWLEDGE - GRAPH

DATA – INFORMATON - INTELIGENCE

SPECIFICATION OF the „concept of presentation“



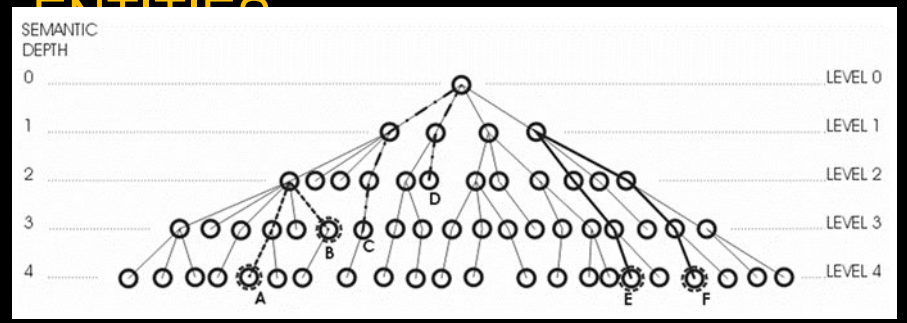
TAXONOMY VS. ONTOLOGY

SIMPLE

HIERARCHICAL

ARRANGEMENT

of the CLASSES REPRESENTING

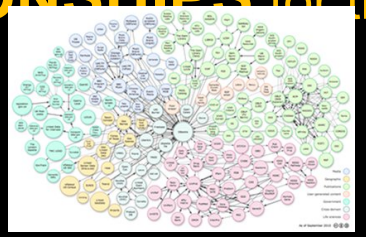


COMPLEX VARIATION OF TAXONOMY

RELATIONAL ONTOLOGY

CONSTRAINTS on the

RELATIONSHIPS for these entities

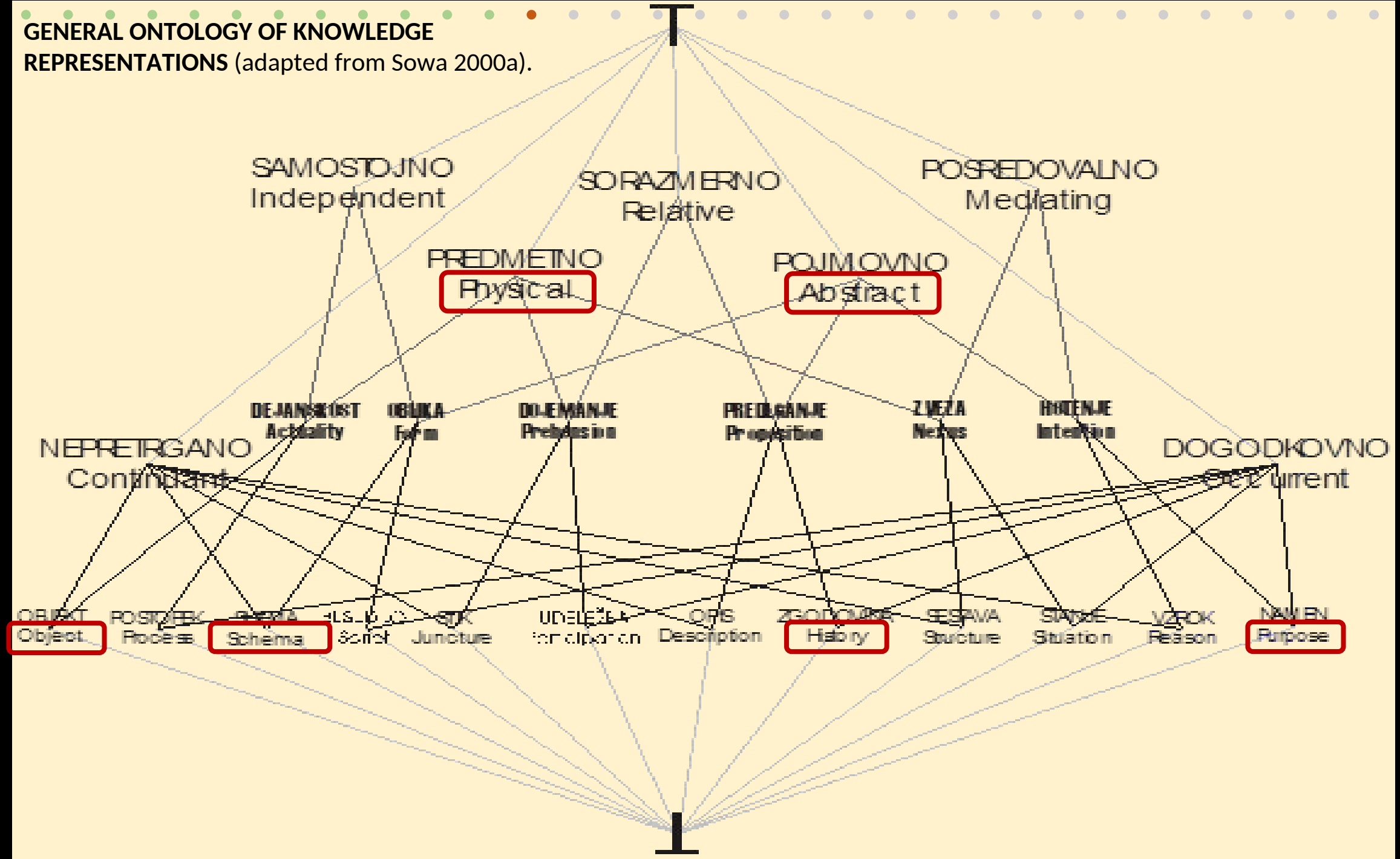


WHERE TO START

with ontology modelling

IN GENERAL?

GENERAL ONTOLOGY OF KNOWLEDGE REPRESENTATIONS (adapted from Sowa 2000a).



CONTEXT:

CIRCUMSTANCES,

SETTING FOR THE **TERM** TO BE FULLY **UNDERSTOOD**

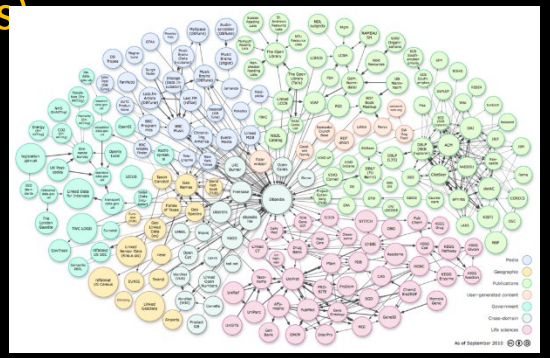
STRONG REFERENCE : **WEAK** REFERENCE

POOR CONTEXT – WEAK SEMANTICS

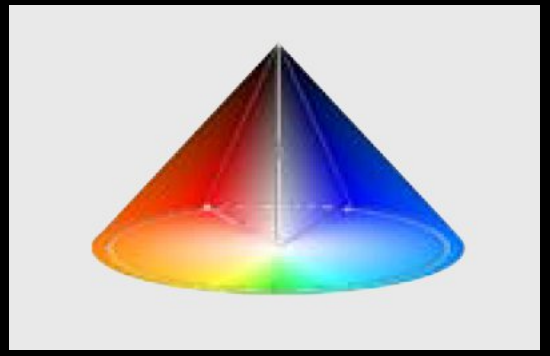
SOLUTION: **SEMANTIC REFERENCE SYSTEM**

SEMANTIC REFERENCE SYSTEMS (Kuhn, Janowicz 2008):

1. Semantic **REFERENCE SPACE** (knowledege partitions labeled with symbols)

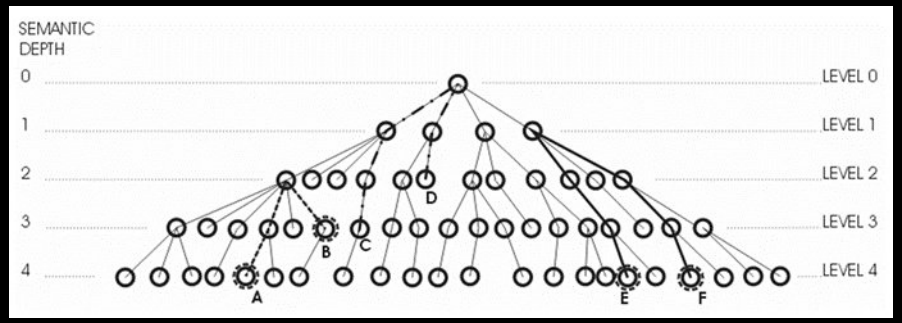


2. Semantic **DATUM** (grounds to **PHISICALLY OBSERVABLE PHENOMENA**)



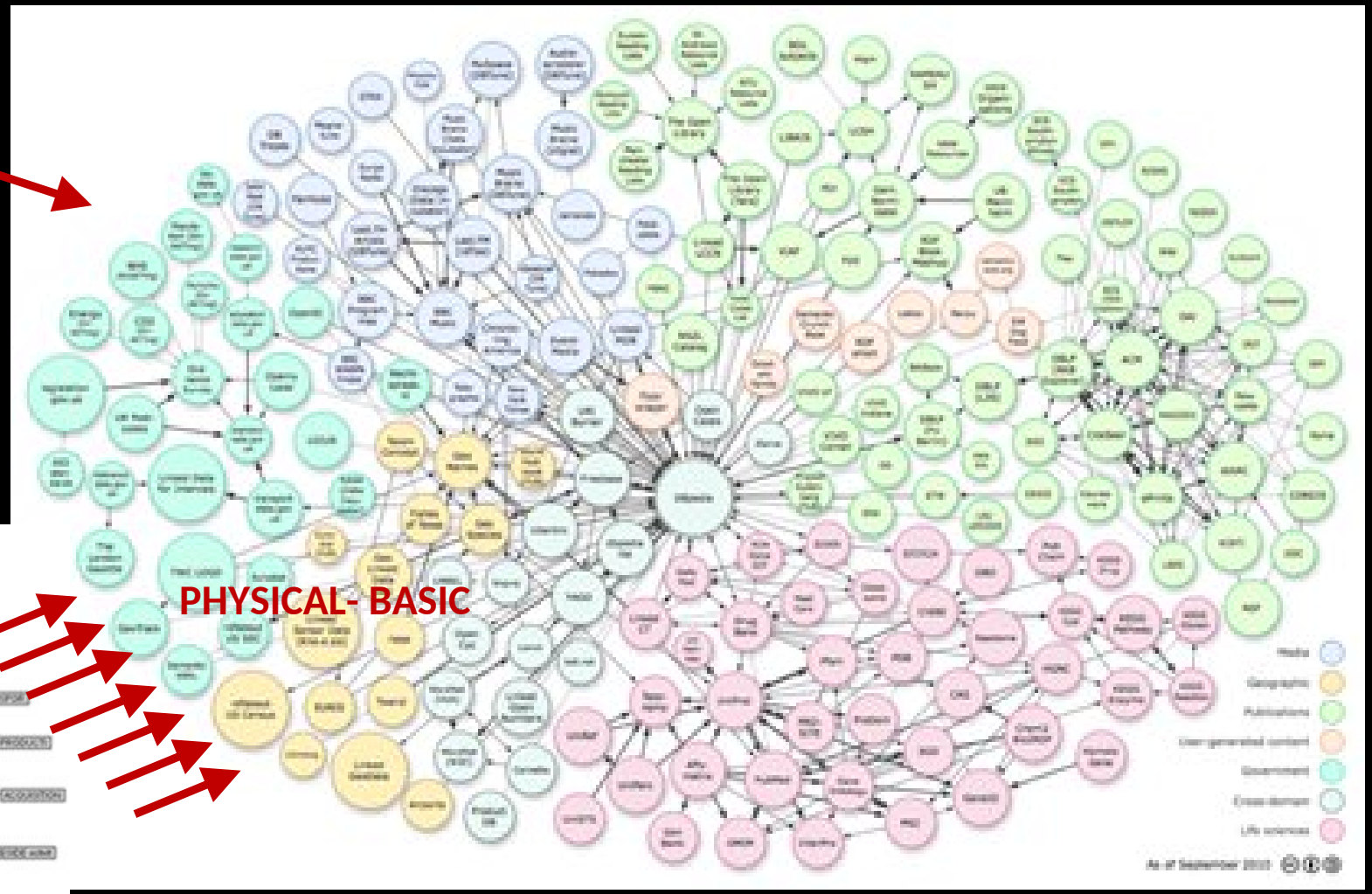
3. Semantic **RELATIONS** (allow for calculation in semantic space: **DISTANCE**)

COMPARE MEANINGS - Quality indicator is semantic **SIMILARITY**

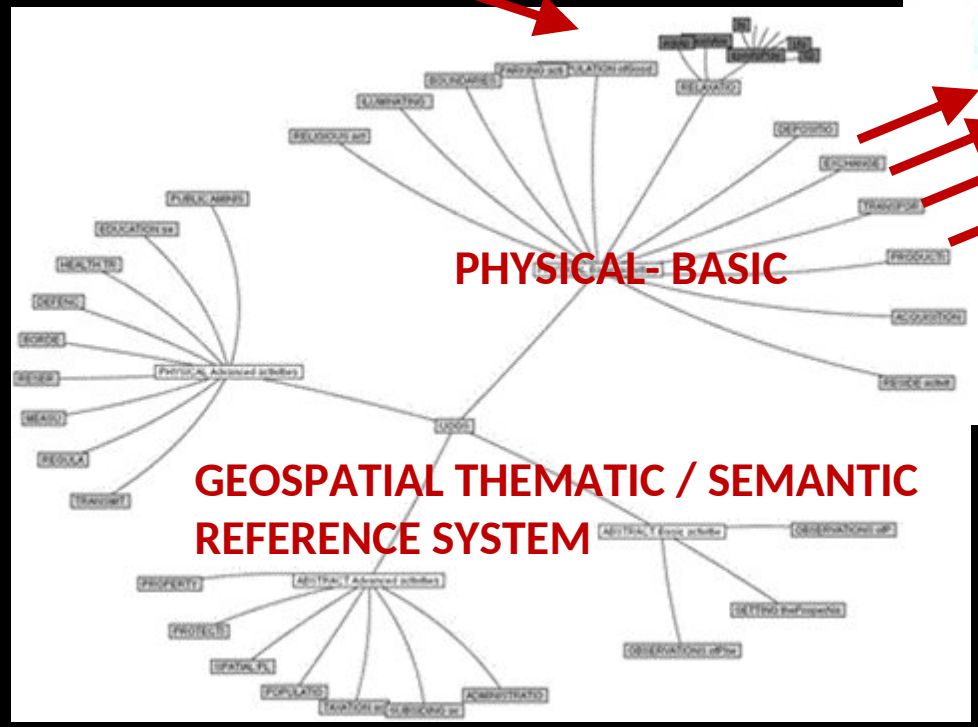


1. SPACE (SEMANTIC) –

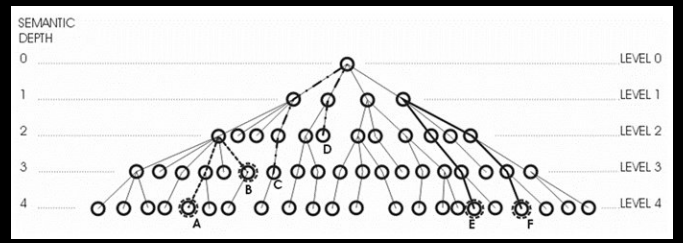
UNIVERSAL KNOWLEDGE BASE



2. DATUM - GROUNDING

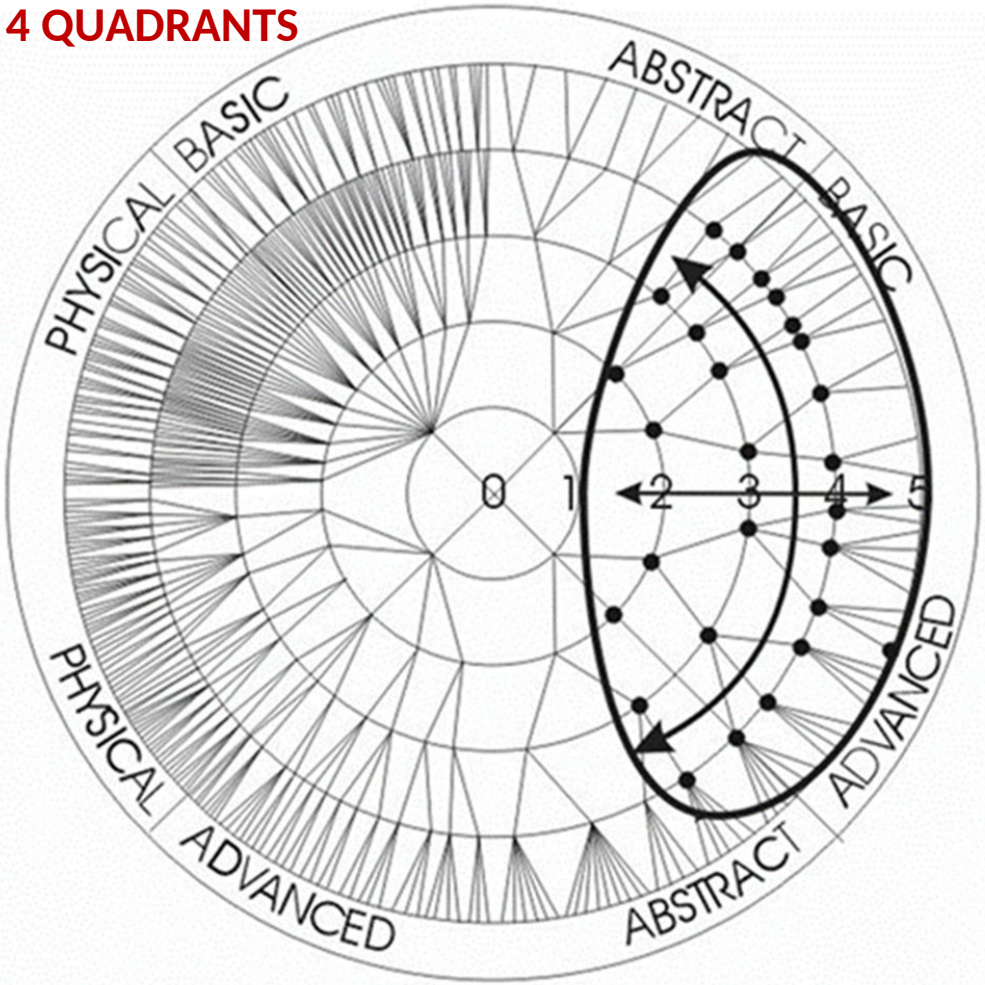


3. RELATIONS: SEMANTIC MEASURES

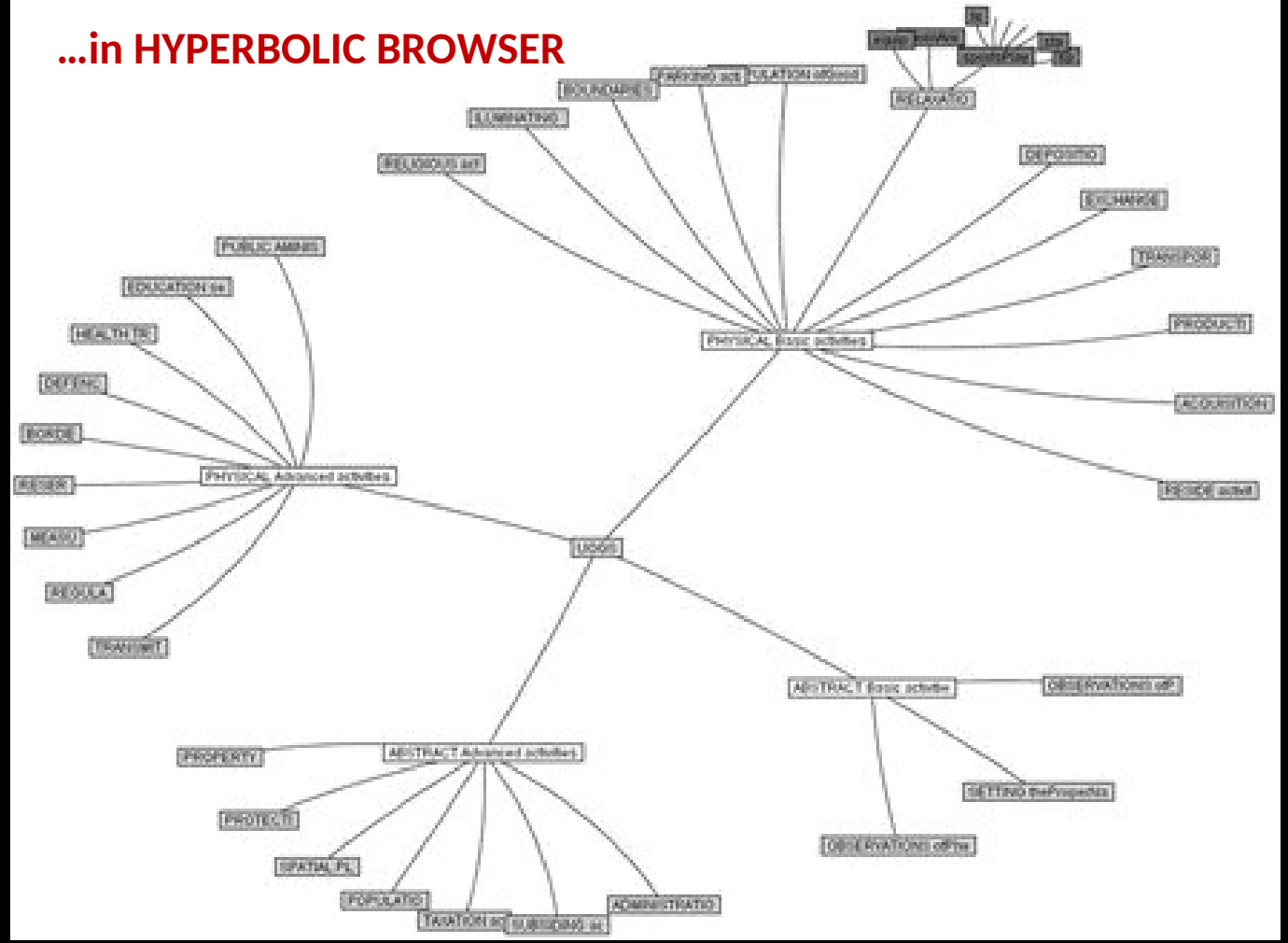


(Čeh, 2001) **UNIVERSAL ONTOLOGY OF GEOGRAPHICAL SPACE** (UOGS) – knowledge graph **taxonomy**

4 QUADRANTS



...in HYPERBOLIC BROWSER



WHERE / WHAT IS THE ORIGIN ?

HIERARCHICAL NODALITY IN GEOGRAPHICAL TIME-SPACE

Philbrick (2016)

HIERARCHY OF HUMAN FUNCTIONS

inside to outside **RELATIONSHIPS** of **a HUMAN SYSTEM MODEL**.

- **LOWER-ORDER (BASIC) FUNCTIONS (PURPOUSE)**

  represented by **RESIDENTIAL** building cover, **RETAIL sales** space, and **INDUSTRIAL** building cover.

- **HIGHER-ORDER (ADVANCED) FUNCTIONS (PURPOUSE)**

  shown for the last kilometer of **AGGREGATION in the city**.

AKSIOMS (Description Logic) (Sowa)

The **ACTIVITIES** of **AGENTS** in

the **SPACE OF GEOGRAPHICAL DIMENSIONS** are

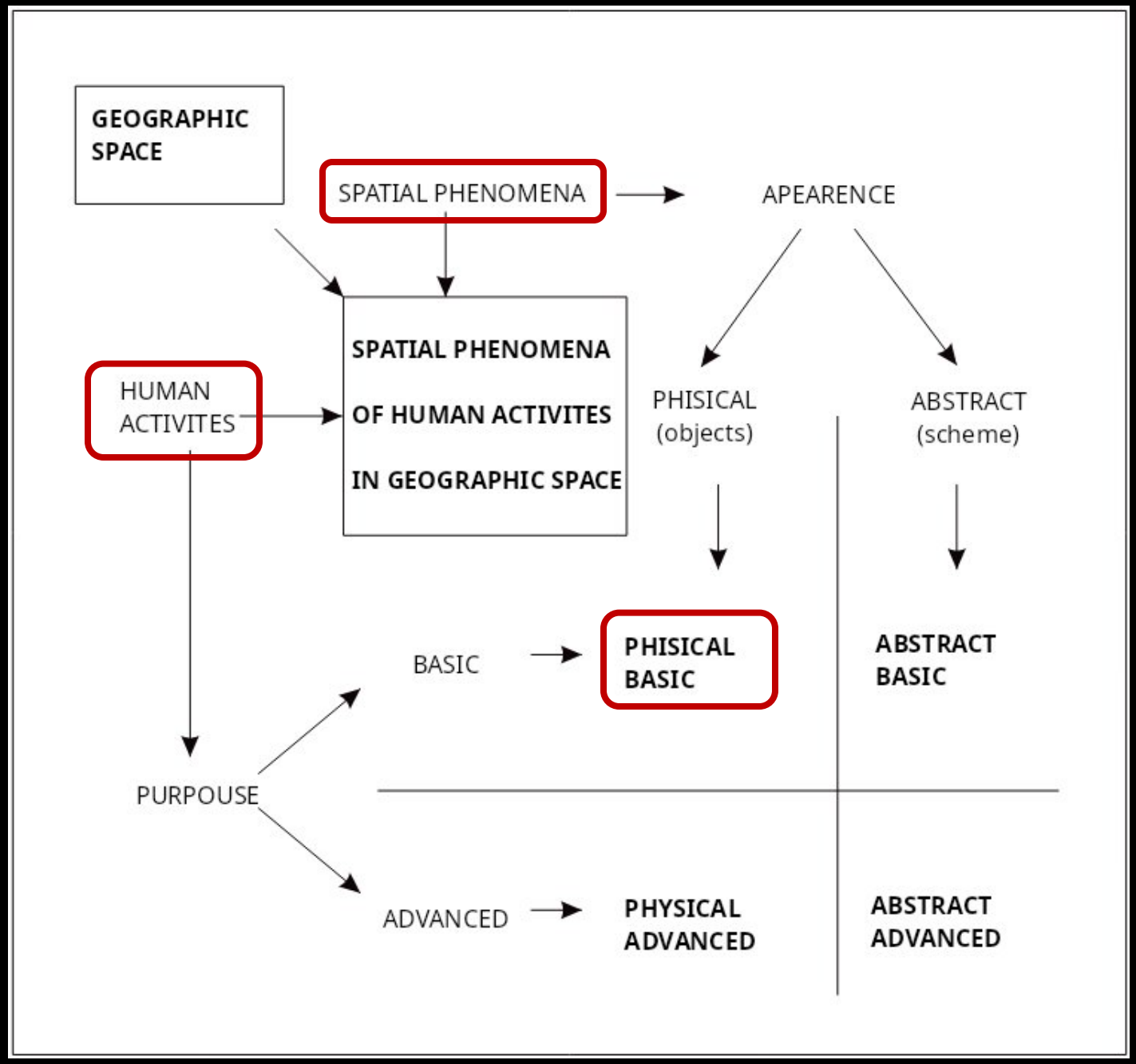
defined by the category "**PURPOSE**".

$ **PURPOSE** = conceptual ☁ mediational ☁ emergent

$ **OBJECT** = physical ☁ independent ☁ continious

SCHEMA = abstract ☁ independent ☁ continious

Universal Ontology of Geographic Space (UOGS):

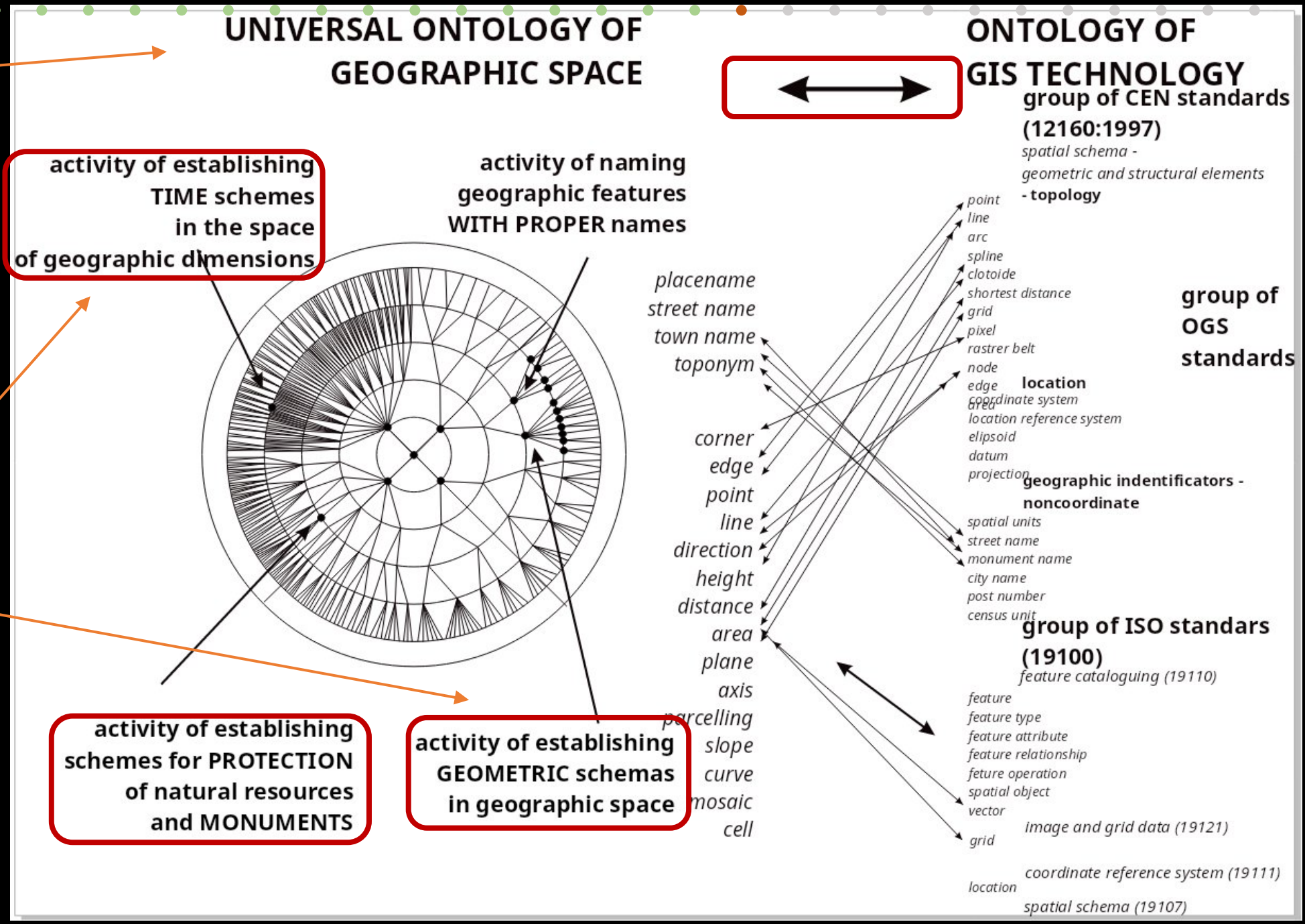


semantic reference system:

UOGS

application:

ARCHIVING

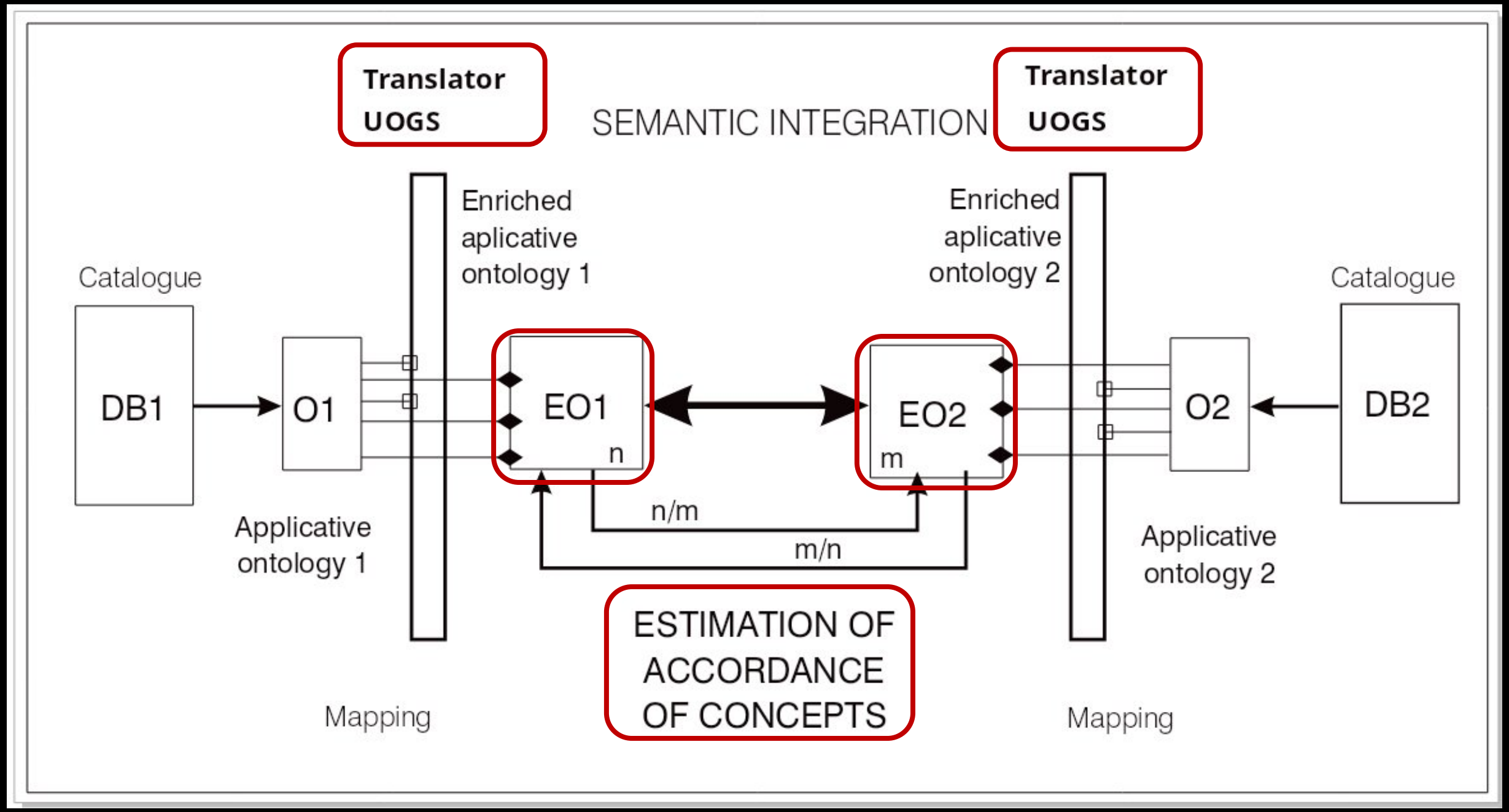


CONTEXTS vs. CONCEPTS

(UOGS taxonomy - sem. ref. sys.) (~ 700 single terms)

	category (induced)	context/superclass	class(theme)	object/schema/phenomena (concept)	a
1					
2	1	I. PHYSICAL object of the BASIC human activity		UNIVERSALS	
3	101	01 Objects of activity ACCOMMODATION			
4	10101	0101	01 Everyday residence		f
5	1010101	010101	0101	01 house	fl
6	1010102	010102	0102	02 condominium	
7	1010103	010103	0103	03 skyscraper	
8	1010104	010104	0104	04 housing unit	
9	10102	0102	02 Non-permanent and seasonal stay		s
10	1010201	010201	0201	01 cottage	
11	1010202	010202	0202	02 garden house	v
12	1010203	010203	0203	03 shepherd's dwelling	
13	102	02 Objects of EXTRACTION of raw materials and energy			
14	10201	0201	01 Extraction of minerals (rock, clay, coal, crude oil, gas, minerals)		
15	1020101	020101	0101 01	mine underground mining area	
16	1020102	020102	0102 02	mine open pit area	
17	102010201		02	pit	g
18	1020103	020103	0103 03	elevator	
19	1020104	020104	0104 04	conveyor	
20	1020105	020105	0105 05	silos	
21	1020106	020106	0106 06	storage tank, reservoir, collector	
22	1020107	020107	0107 07	pump	
23	1020108	020108	0108 08	drilling rig	

ENRICHMENT


Translator
UOGS
SEMANTIC INTEGRATION
Translator
UOGS
Enriched
aplicative
ontology 1
Enriched
aplicative
ontology 2
Catalogue
Catalogue
DB1
O1
EO1
n
EO2
m
O2
DB2
n/m
m/n
Applicative
ontology 1
Applicative
ontology 2
ESTIMATION OF
ACCORDANCE
OF CONCEPTS
Mapping
Mapping

summarise …(1)

- **UOGS** ONTOLOGY AS **CONTEXT** SEMANTIC **REFERENCE SYSTEM**
- **SIMPLE** ONTOLOGY **- TAXONOMY**
- PROVIDING **UNAMBIGUITY of meaning of terms**
- **NATURAL LANGUAGE** EXPRESSED **KNOWLEDGE – (LD)**

summarise …(1)

- SMALL **VOCABULARY – „LIGHT“ ONTOLOGY**
- FROM **GENERAL CONCEPTS** TO SPECIALISED **TERM COMBINATIONS**
- ONTOLOGY AS **SEARCHING TOOL** (HYPERBOLIC BROWSER)
- **METADATA** INTEGRATOR – **ENRICHMENT OF INSPIRE**
- **ONTOLOGICAL OBLIGATION** of AGENTS in the EU

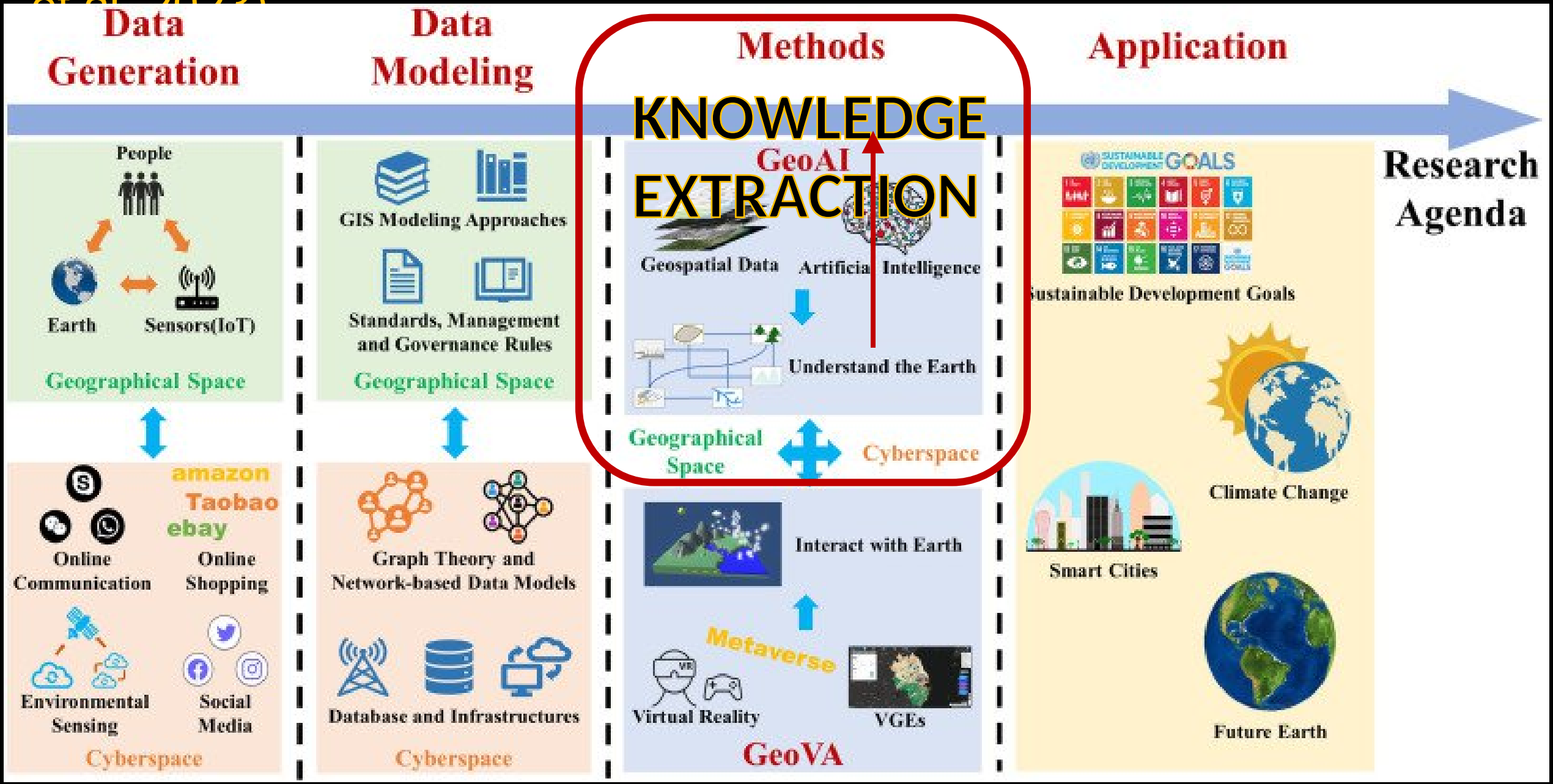
WHAT NEXT?

PUBLISHING UOGS in the Semantic Web

LINKING to other domain ontologies

TEACHING AI of UOGS knowledge

An integrated view of **GIScience** and **CYBERSPACE** (Chen et al. 2023)



some references

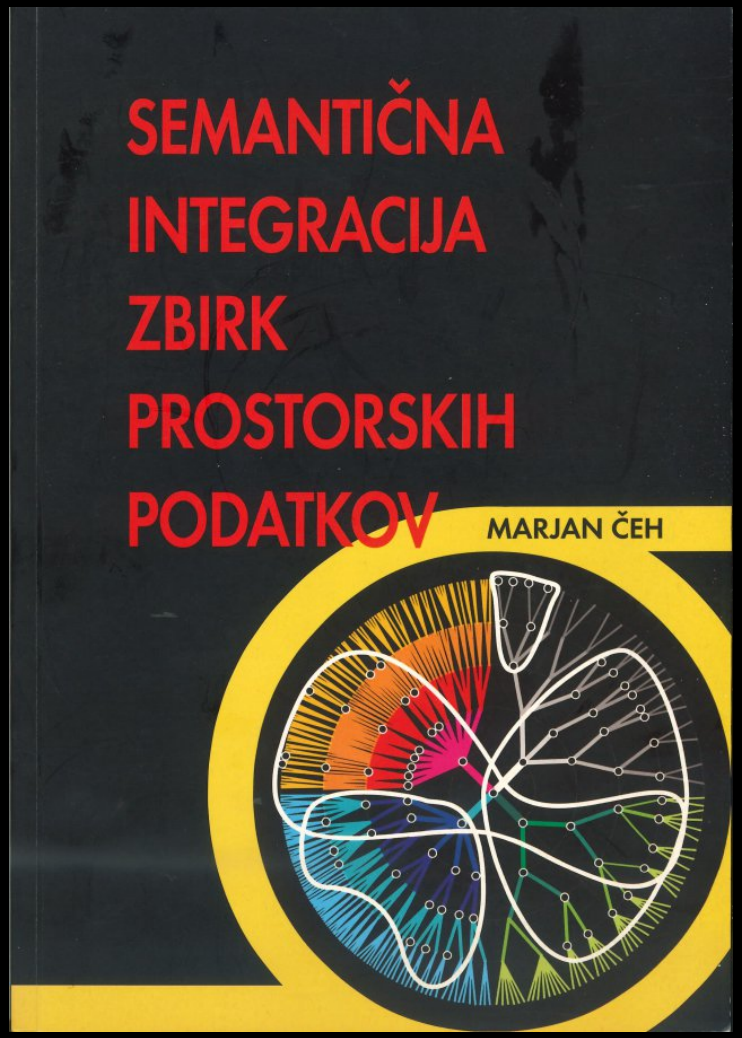
Project:

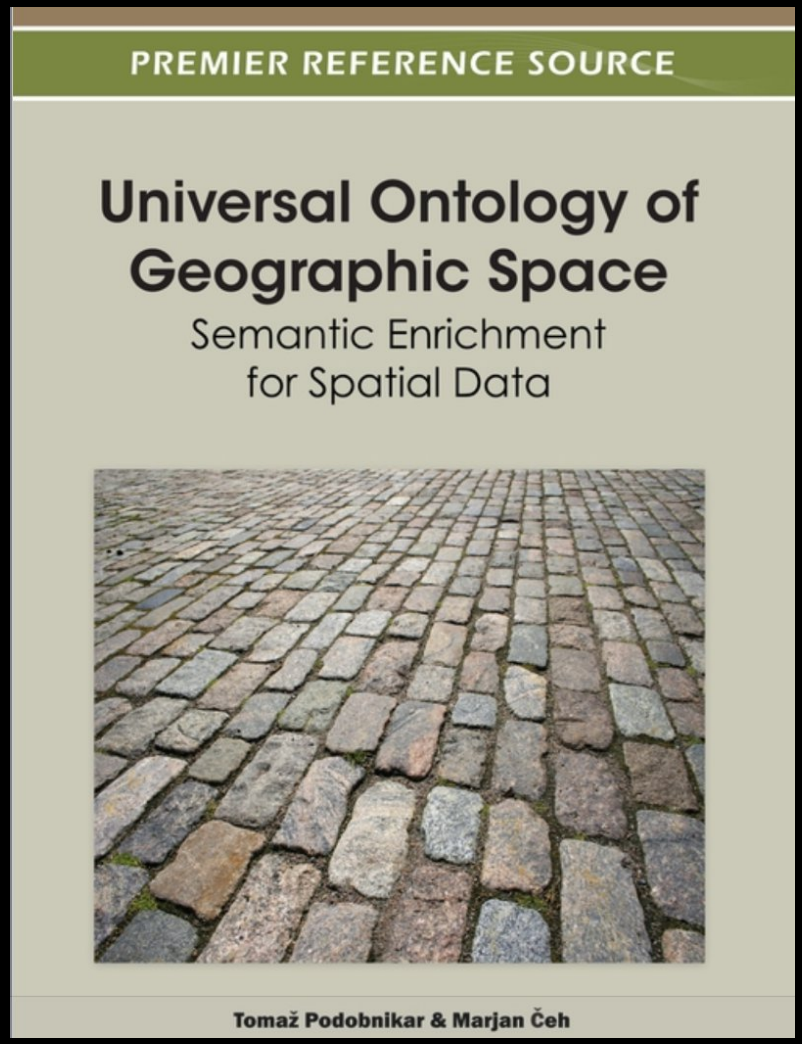
Developing guidelines to impreve semantic interoperability in spatial database management and geoinformatics in Slovenia

Slovenian research project V2-2295 (2022-2024)

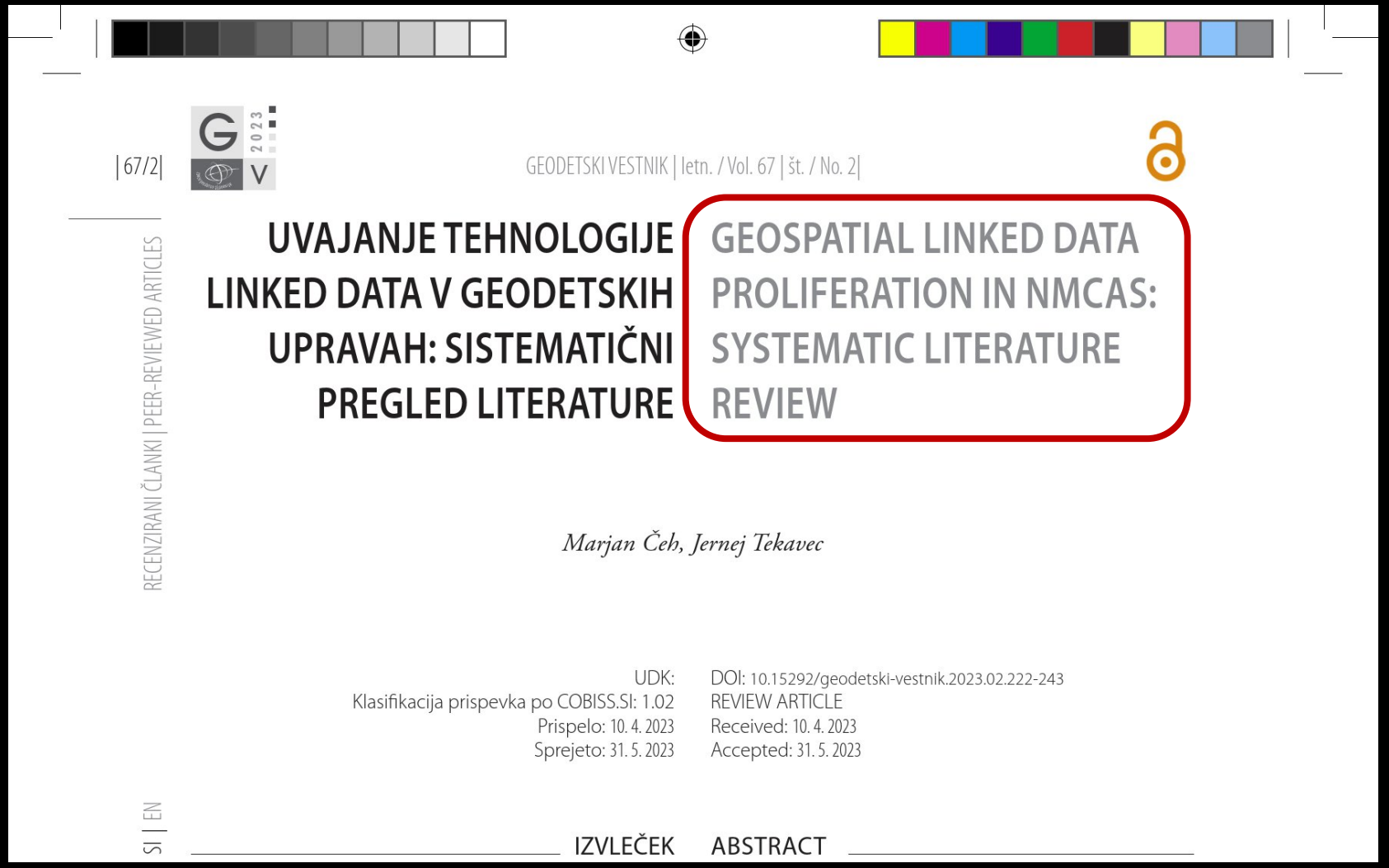
Chair of Geoinformatics and RE Cadastres

SEMANTIC INTEGRATION OF GEOSPATIAL DATABASE





recent article:



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UVAJANJE TEHNOLOGIJE LINKED DATA V GEODETSKIH UPRAVAH: SISTEMATIČNI PREGLED LITERATURE

GEOSPATIAL LINKED DATA PROLIFERATION IN NMCAS: SYSTEMATIC LITERATURE REVIEW

Marjan Čeh, Jernej Tekavec

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IZVLEČEK ABSTRACT

QUESTIONS TO:

marjan.ceh@fgg.uni-lj.si

gregor.zavrsnik@fgg.uni-lj.si

University of Ljubljana
Faculty of Civil and Geodetic Engineering