Deliverable3

SOME-SEMANTIC ONTOLOGY MODEL

This document is the deliverable of the Task 1.3 of the Virtual Mobility Grant SOME-SEMANTIC ONTOLOGY MODEL founded by the COST Action: CA19136 with Reference number: E-COST-GRANT-CA19136-d93c2bbe

The reference task is related to Knowledge Graph implementation of the SHAFE core ontology using NoSQL technology.

After some meetings with the Net4Age WG5 Leader, the glossary proposed in the deliverable 1 has been expanded. The new glossary is reported in table 1.

#	Term	Definition
1	acceptance	a disposition to tolerate or accept people or situations
2	aging	the organic process of growing older and showing the effects of increasing age
3	autonomy	personal independence
4	building	a structure that has a roof and walls and stands more or less permanently in one place
5	caregiver	a person who is responsible for attending to the needs of a child or dependent adult
6	citizen	a native or naturalized member of a state or other political community
7	city	a large and densely populated urban area
8	comfort	a state of being relaxed and feeling no pain
9	community	a group of people living in a particular local area
10	computer	a machine for performing calculations automatically
11	computer science	the branch of engineering science that studies (with the aid of computers) computable processes and structures
12	courtyard	an area wholly or partly surrounded by walls or buildings
13	design	an arrangement scheme
14	device	an instrumentality invented for a particular purpose
15	disease	an impairment of health or a condition of abnormal functioning
16	doctor	a licensed medical practitioner
17	education	the activities of educating or instructing
18	emergency	a sudden unforeseen crisis (usually involving danger) that requires immediate action
19	ethic	the principles of right and wrong that are accepted by an individual or a social group
20	experience	the accumulation of knowledge or skill that results from direct participation in events or activities
21	family	primary social group
22	friend	a person you know well and regard with affection and trust
23	funding	financial resources provided to make some project possible
24	health professional	a person who helps in identifying or preventing or treating illness or disability
25	healthcare	the preservation of mental and physical health by preventing or treating illness through services offered by the health profession

26	housing	structures collectively in which people are housed
27	impairment	the condition of being unable to perform as a consequence of physical or mental unfitness
28	inclusion	the state of being included
29	industry	the people or companies engaged in a particular kind of commercial enterprise
30	interoperability	the ability to exchange and use information
31	isolation	a feeling of being disliked and aloneinclusion
32	literacy	the ability to read and write
33	medical science	the science of dealing with the maintenance of health and the prevention and treatment of disease
34	neighbor	a person who lives (or is located) near another
35	nurse	one skilled in caring for young children or the sick (usually under the supervision of a physician)
36	participation	the act of sharing in the activities of a group
37	patient	a person who requires medical care
38	people	any group of human beings (men or women or children) collectively
39	place	any area set aside for a particular purpose
40	policy	a plan of action adopted by an individual or social grou
41	policy maker	someone who sets the plan pursued by a government or business etc
42	privacy	the quality of being secluded from the presence or view of others
43	researcher	a scientist who devotes himself to doing research
44	safety	the state of being certain that adverse effects will not be caused by some agent under defined conditions
45	security	the state of being free from danger or injury
46	sensor	any device that receives a signal or stimulus (as heat or pressure or light or motion etc
47	sustainability	the property of being sustainable
48	technology	the practical application of science to commerce or industry
49	terrace	usually paved outdoor area adjoining a residence
50	therapist	a person skilled in a particular type of therapy
51	transportation	a facility consisting of the means and equipment necessary for the movement of passengers or goods
52	usability	the quality of being able to provide good service
53	wellbeing	a contented state of being happy and healthy and prosperous

Table 1: The expanded Glossary

The glossary has only nouns because it is the natural lexical category used to represent concepts by humans (Rinaldi, 2014).

The ontological conceptual representation (Gruber, 1995) has been implemented as a logical knowledge graph (Fensel et al, 2020) using a physical multimodel NoSQL DBMS (Liu, 2018).

In the field of database design, a multi-model database is a database management system designed to support multiple data models. In contrast, most database management systems are organized around a single data model that determines how

data can be organized, stored, and manipulated. Document, graph, relational, and key–value models are examples of data models that may be supported by a multi-model database.

I have used this kind of NOSQL technology because the knowledge graph could be expanded with several new concepts and these concepts could be represented not only by textual information but also with multimedia ones.

The chosen DMBS has been Arango (ArangoDB, 2022).

ArangoDB is a free and open-source native graph database system developed by ArangoDB Inc. ArangoDB is a multi-model database system since it supports three data models (graphs, JSON documents, key/value) with one database core and a unified query language AQL (ArangoDB Query Language). AQL is mainly a declarative language and allows the combination of different data access patterns in a single query. ArangoDB is a NoSQL database system but AQL is similar in many ways to SQL.

The choice of ArangoDB is related to its free and open source license, its native multimodel nature, the user friendly interface and query language, the several features enabled on Arango for analyse and retrieve knowledge.

The entire WordNet (i.e. the general knowledge base used in this grant see Deliverable 1) has been imported in Arango Figure 1 shows the Arango management interface on the WordNet instance.
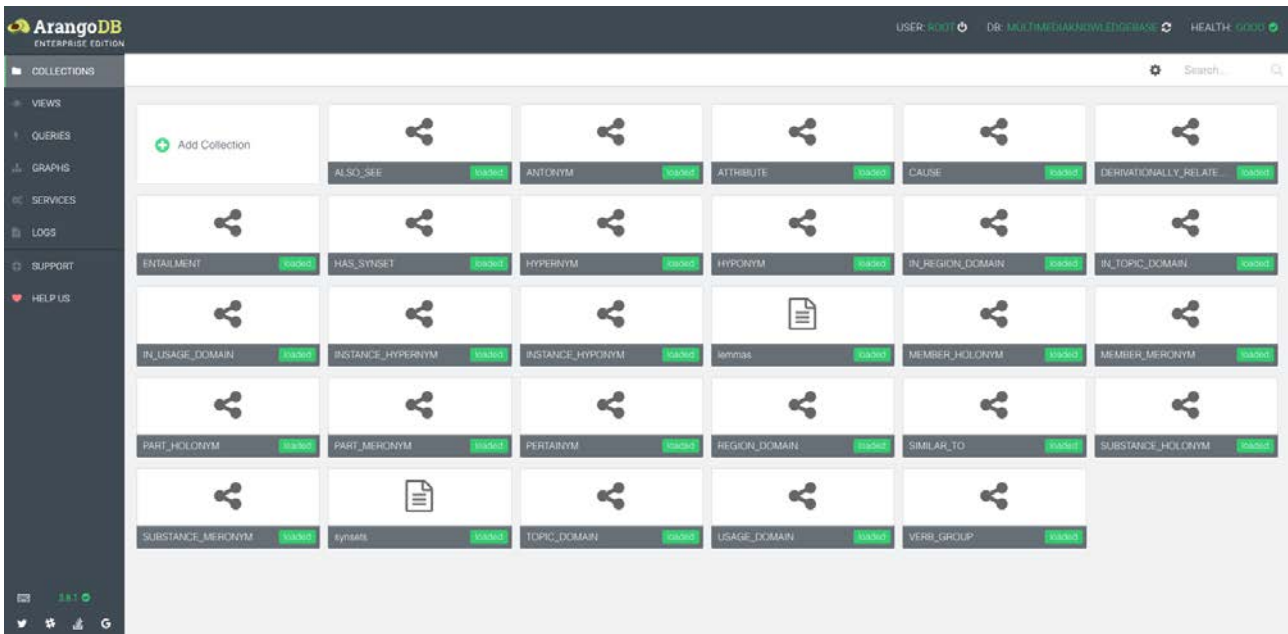

Figure 1: Arango management interface for WordNet

Starting from WordNet a subgraph has been extracted considering the terms in the glossary. These terms have been linked by the WordNet linguistic properties mapped by the model proposed in deliverable 2.

The subgraph has been recognized using a shortest path measure between the root WordNet synset (i.e. "entity") and the glossary terms considering the WordNet properties. We explicit point out that all terms are connected because WordNet has this common root.

I reported all concepts added in the subgraph to create the paths among glossary terms in Table 2.

#	Term	Definition
1	ability	possession of the qualities (especially mental qualities) required to do something or get something done
2	ability	the quality of being able to perform; a quality that permits or facilitates achievement or accomplishment
3	abstraction	a general concept formed by extracting common features from specific examples
4	accounting_principle	a principle that governs current accounting practice and that is used as a reference to determine the appropriate treatment of complex transactions
5	act	something that people do or cause to happen
6	activity	any specific behavior
7	adult	a fully developed person from maturity onward
8	alienation	the feeling of being alienated from other people
9	aloneness	a disposition toward being alone
10	area	a part of a structure having some specific characteristic or function
11	arrangement	an organized structure for arranging or classifying
12	artifact	a man-made object taken as a whole
13	assets	anything of material value or usefulness that is owned by a person or company
14	attribute	an abstraction belonging to or characteristic of an entity
15	body	the entire structure of an organism (an animal, plant, or human being)
16	bowleg	a leg bowed outward at the knee (or below the knee)
17	care	the work of providing treatment for or attending to someone or something
18	case	a person requiring professional services
19	causal_agent	any entity that produces an effect or is responsible for events or results
20	cheerfulness	the quality of being cheerful and dispelling gloom
21	chelation	(medicine) the process of removing a heavy metal from the bloodstream by means of a chelate as in treating lead or mercury poisoning
22	citizenry	the body of citizens of a state or country
23	cognition	the psychological result of perception and learning and reasoning

24	collection	several things grouped together or considered as a whole
25	colloquialism	a colloquial expression; characteristic of spoken or written communication that seeks to imitate informal speech
26	commercial_enterprise	an enterprise connected with commerce
27	concrete_jungle	an area in a city with large modern buildings that is perceived as dangerous and unpleasant
28	condition	a state at a particular time
29	condition	a mode of being or form of existence of a person or thing
30	content	the sum or range of what has been perceived, discovered, or learned
31	crisis	a crucial stage or turning point in the course of something
32	degeneration	the process of declining from a higher to a lower level of effective power or vitality or essential quality
33	dislike	a feeling of aversion or antipathy
34	disposition	your usual mood
35	education	knowledge acquired by learning and instruction
36	enterprise	an organization created for business ventures
37	entity	that which is perceived or known or inferred to have its own distinct existence (living or nonliving)
38	event	something that happens at a given place and time
39	execution	(computer science) the process of carrying out an instruction by a computer
40	expert	a person with special knowledge or ability who performs skillfully
41	eye_disease	any disease of the eye
42	facility	a building or place that provides a particular service or is used for a particular industry
43	feeling	the experiencing of affective and emotional states
44	fortune	your overall circumstances or condition in life (including everything that happens to you)
45	freedom	the condition of being free; the power to act or speak or think without externally imposed restraints
46	game	your occupation or line of work
47	gathering	a group of persons together in one place
48	generally_accepted_accounting_principles	a collection of rules and procedures and conventions that define accepted accounting practice; includes broad guidelines as well as detailed procedures
49	geographical_area	a demarcated area of the Earth
50	goal	the state of affairs that a plan is intended to achieve and that (when achieved) terminates behavior intended to achieve it
51	good_fortune	an auspicious state resulting from favorable outcomes
52	group	any number of entities (members) considered as a unit
53	group_action	action taken by a group of people
54	happening	an event that happens

55	harvey	English physician and scientist who described the circulation of the blood; he later proposed that all animals originate from an ovum produced by the female of the species (1578-1657)
56	heavy_lifting	difficult work
57	important_person	a person whose actions and opinions strongly influence the course of events
58	independence	freedom from control or influence of another or others
59	instrumentality	an artifact (or system of artifacts) that is instrumental in accomplishing some end
60	juncture	an event that occurs at a critical time
61	jungle	a location marked by an intense competition and struggle for survival
62	kin	group of people related by blood or marriage
63	leg	a human limb; commonly used to refer to a whole limb but technically only the part of the limb between the knee and ankle
64	location	a point or extent in space
65	macular_degeneration	eye disease caused by degeneration of the cells of the macula lutea and results in blurred vision; can cause blindness
66	medicine	the branches of medical science that deal with nonsurgical techniques
67	natural_object	an object occurring naturally; not made by man
68	object	a tangible and visible entity; an entity that can cast a shadow
69	occupation	the principal activity in your life that you do to earn money
70	organic_process	a process occurring in living organisms
71	organization	a group of people who work together
72	part	something less than the whole of a human artifact
73	permissiveness	a disposition to allow freedom of choice and behavior
74	person	a human being
75	physical_entity	an entity that has physical existence
76	plan_of_action	a plan for actively doing something
77	possession	anything owned or possessed
78	principle	a rule or standard especially of good behavior
79	process	a sustained phenomenon or one marked by gradual changes through a series of states
80	profession	an occupation requiring special education (especially in the liberal arts or sciences)
81	professional	a person engaged in one of the learned professions
82	property	a basic or essential attribute shared by all members of a class
83	prosperity	the condition of prospering; having good fortune
84	psychological_feature	a feature of the mental life of a living organism
85	quality	an essential and distinguishing attribute of something or someone; --Shakespeare
86	rattrap	filthy run-down dilapidated housing
87	reclusiveness	a disposition to prefer seclusion or isolation

88	region	a large indefinite location on the surface of the Earth
89	relation	an abstraction belonging to or characteristic of two entities or parts together
90	resource	available source of wealth; a new or reserve supply that can be drawn upon when needed
91	scientist	a person with advanced knowledge of one or more sciences
92	security_blanket	anything that an adult person uses to reduce anxiety
93	shooting_gallery	a building (usually abandoned) where drug addicts buy and use heroin
94	situation	the general state of things; the combination of circumstances at a given time; ; ; - Franklin D.Roosevelt
95	skill	an ability that has been acquired by training
96	social_group	people sharing some social relation
97	state	the way something is with respect to its main attributes
98	structure	the complex composition of knowledge as elements and their combinations
99	structure	a thing constructed; a complex entity constructed of many parts
100	thing	an entity that is not named specifically
101	upstairs	the part of a building above the ground floor
102	utility	the quality of being of practical use
103	whole	an assemblage of parts that is regarded as a single entity
104	work	activity directed toward making or doing something

Table 2: Added path terms

The total number of terms in the subgraph is 157 (i.e. 53 glossary terms and 104 added terms)

The knowledge graph statistics are in table 3.

SHAFE Glossary	53
Added terms path	104
HYPERNYM	130
PART_MERONYM	4
MEMBER_HOLONYM	2
IN_TOPIC_DOMAIN	3
IN_USAGE_DOMAIN	1
USAGE_DOMAIN	4
HYPONYM	9
PART_HOLONYM	2
INSTANCE_HYPERNYM	1
INSTANCE_HYPONYM	1

Table 3: Knowledge graph statistics

The obtained knowledge graph has been exported as OWL file following the proposed model and a part of this instance is in Appendix 1. Moreover, the knowledge graph has been drawn using a 3d graph visualization tool (i.e. Graphia[1]) showed in Figure 2.
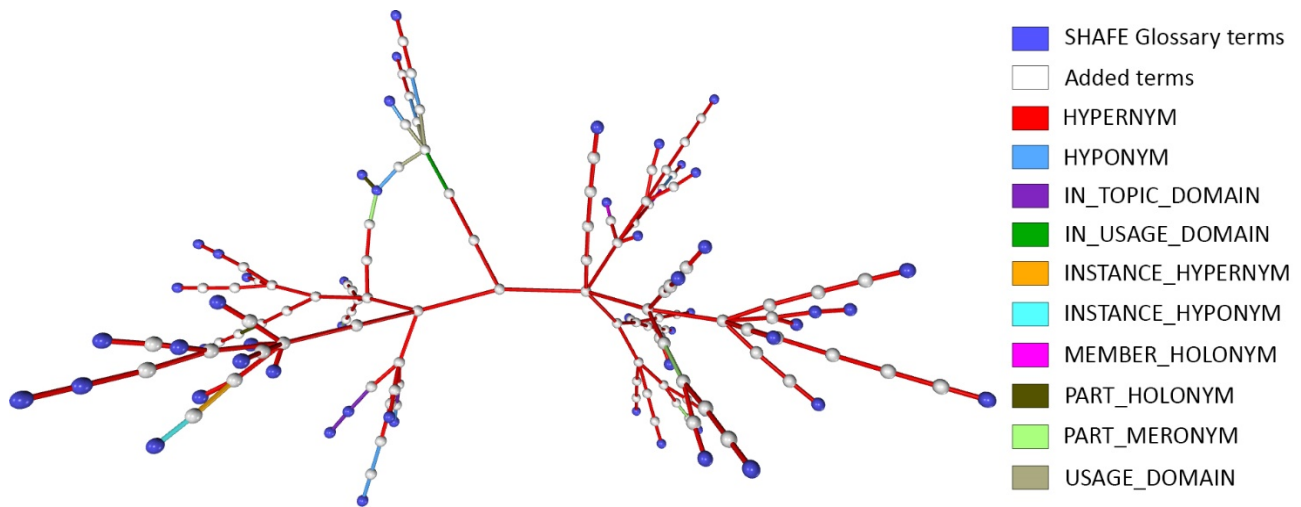

Figure 2: The Knowledge Graph

Bibliography

ArangoDB, 2022   Advantages of native multi-model in ArangoDB. ArangoDB. Retrieved 2022-07-26.

Fensel et al., 2020 Fensel, D., Simsek, U., Angele, K., Huaman, E., Kärle, E., Panasiuk, O., ... & Wahler, A. (2020). Knowledge graphs (pp. 1-10). Springer International Publishing.

Gruber, 1995   Gruber, T. R. (1995). Toward principles for the design of ontologies used for knowledge sharing?. International journal of human-computer studies, 43(5- 6), 907-928.

Liu et al., 2018   Liu, Z.H., Lu, J., Gawlick, D., Helskyaho, H., Pogossiants, G., Wu, Z. (2019). Multi-model Database Management Systems - A Look Forward. In: Gadepally, V., Mattson, T., Stonebraker, M., Wang, F., Luo, G., Teodoro, G. (eds) Heterogeneous Data Management, Polystores, and Analytics for Healthcare. 2018. Lecture Notes in Computer Science, vol 11470. Springer, Cham.

Rinaldi, 2014   Rinaldi, A. M. (2014). A multimedia ontology model based on linguistic properties and audio-visual features. Information Sciences, 277, 234-246.

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[1] https://graphia.app/

Appendix 1 – A selection of the OWL knowledge graph instance

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<NounSynset rdf:about="n10366966">

  <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

  <hypernymOf rdf:resource="n10165109"/>

  <containsWordSense rdf:resource="nurse-n"/>

  <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">10366966</s
ynsetId>

  <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">one
skilled in caring for young children or the sick (usually under the
supervision of a physician)</gloss>

</NounSynset>


<NounSynset rdf:about="n10165109">

  <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

  <hypernymOf rdf:resource="n10480253"/>

  <containsWordSense rdf:resource="health_professional-n"/>

  <containsWordSense rdf:resource="primary_care_provider-n"/>

  <containsWordSense rdf:resource="pcp-n"/>

  <containsWordSense rdf:resource="health_care_provider-n"/>

  <containsWordSense rdf:resource="caregiver-n"/>

  <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">10165109</s
ynsetId>

  <gloss  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a
person who helps in identifying or preventing or treating illness
or disability</gloss>

</NounSynset>


<NounSynset rdf:about="n1059900">

  <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>
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```xml
    <hypernymOf rdf:resource="n0654885"/>

    <containsWordSense rdf:resource="healthcare-n"/>

    <containsWordSense rdf:resource="health_care-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">1059900</sy
nsetId>

    <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the
preservation of mental and physical health by preventing or treating
illness through services offered by the health profession</gloss>

</NounSynset>


<NounSynset rdf:about="n0654885">

    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

    <hypernymOf rdf:resource="n0575741"/>

    <containsWordSense rdf:resource="care-n"/>

    <containsWordSense rdf:resource="attention-n"/>

    <containsWordSense rdf:resource="aid-n"/>

    <containsWordSense rdf:resource="tending-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">0654885</sy
nsetId>

    <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the
work of providing treatment for or attending to someone or
something</gloss>

</NounSynset>


<NounSynset rdf:about="n6043075">

    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

    <classifiedByTopic rdf:resource="n13445972"/>

    <containsWordSense rdf:resource="medicine-n"/>

    <containsWordSense rdf:resource="medical_specialty-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">6043075</sy
nsetId>
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```xml
    <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the
branches    of    medical    science    that    deal    with    nonsurgical
techniques</gloss>

  </NounSynset>


  <NounSynset rdf:about="n6045562">

    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

    <hyponymOf rdf:resource="n6043075"/>

    <containsWordSense rdf:resource="medical_science-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">6045562</sy
nsetId>

    <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the
science of dealing with the maintenance of health and the prevention
and treatment of disease</gloss>

  </NounSynset>


  <NounSynset rdf:about="n2913152">

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rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

    <partMeronymOf rdf:resource="n4515729"/>

    <hyponymOf rdf:resource="n4201992"/>

    <containsWordSense rdf:resource="building-n"/>

    <containsWordSense rdf:resource="edifice-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">2913152</sy
nsetId>

    <gloss   rdf:datatype="http://www.w3.org/2001/XMLSchema#string">a
structure   that   has   a   roof   and   walls   and   stands   more   or   less
permanently in one place</gloss>

  </NounSynset>


  <NounSynset rdf:about="n3120198">

    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>
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```xml
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    <containsWordSense rdf:resource="court-n"/>

    <containsWordSense rdf:resource="courtyard-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">3120198</sy
nsetId>

    <gloss  rdf:datatype="http://www.w3.org/2001/XMLSchema#string">an
area wholly or partly surrounded by walls or buildings</gloss>

</NounSynset>


<NounSynset rdf:about="n4515729">

    <rdf:type
rdf:resource="http://www.w3.org/2002/07/owl#NamedIndividual"/>

    <hypernymOf rdf:resource="n3892891"/>

    <containsWordSense rdf:resource="upstairs-n"/>

    <synsetId
rdf:datatype="http://www.w3.org/2001/XMLSchema#string">4515729</sy
nsetId>

    <gloss rdf:datatype="http://www.w3.org/2001/XMLSchema#string">the
part of a building above the ground floor</gloss>

</NounSynset>
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