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Towards enhancing European Material Modelling Ontology (EMMO) for use in AI-driven projects

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Methodologies for Building Ontologies – NeOn

- NeOn[1] methodology supports
  - different aspects of the ontology development process
  - the reuse and dynamic evolution of networked ontologies in distributed environments
- NeOn used to build ontology networks in different domains and areas and by people with diverse background
- Other methodologies such as DILIGENT[2], METHODOLOGY[3] and On-to-Knowledge[4] are focused in cases of a single ontology development from specifications to implementation
- NeOn proposes a variety of different pathways/scenarios to develop ontologies (*From Specification to Implementation, Reusing and re-engineering non-ontological resources, Reusing ontological resources* , *Reusing, merging, and re-engineering ontological resources* , *Reusing ontology design patterns etc.)*
- *CERTH brings experience in Neon methodology from*
  - Satisfactory EU project:
    - From Specification to Implementation scenario used in order to specify shop floor context which have its own vocabulary and knowledge structure
    - Reusing and re-engineering non-ontological resources scenario used in order to transform a Common Information Data Exchange Model (XML schema) for shop floors to ontologies
  - COMPOSITION EU project:
    - Reusing, merging, and re-engineering ontological resources scenario used in order to create a Collaborative Manufacturing Services Ontology from the existing ontologies MSDL, MASON and GoodRelations Language

[1] Suarez-Figueroa, M.C., Gomez-Perez, A., &Fernandez-Lopez, M. (2012). The NeOn Methodology for Ontology Engineering, 9-34. Springer Berlin Heidelberg, Berlin,Heidelberg.
[2] Fernández-López, M., Gómez-Pérez, A., & Juristo, N. (1997). "Methontology: from ontological art towards ontological engineering."
[3] Maedche, A., & Staab, S. (2001). "Ontology learning for the semantic web.", IEEE Intelligent systems, Page(s): 72-79.
[4] H.S. Pinto, S.Staa and C. Tempich (2004) DILIGENT: Towards a fine-grained methodology for DIstributed, Loosely-controlled and evolvInG Engineering of oNTologies

Domain Knowledge Improvement through Vocabulary Camps (VoCamps)

- What is a Vocamp
  - It is a series of informal events where experts can spend some dedicated time creating lightweight vocabularies (and ontologies) for the Semantic Web / Web of Data
  - Provides a vocabulary development process for domains with litter or no vocabulary coverage
    - For Instance AI-driven models for the European Material Ontology
  - Each VoCamp is oriented to hands-on technical work and practical outputs such as the development of new vocabularies
- Workshop/Event Procedure
  - Experts around the world were invited for the specific VoCamp event
  - A champion (chair) was nominated per each VoCamp
- CERTH's Expertise:
  - Vocabulary Camps (VoCamps) focusing on Data Modelling for Energy Efficient Buildings. CERTH in Adapt4EE EU project, with the collaboration of the EC, organized 5 specialized thematic workshops
    - VoCamps organized also under the auspices of **Ready4SmartCities-FP7-CSA** & **SWIMING** (H2020-CSA), where CERTH was co-leading these activities
- VoCamps or similar events can be organized for the purposes of the EUROPEAN MATERIALS MODELLING ONTOLOGY (EMMO)

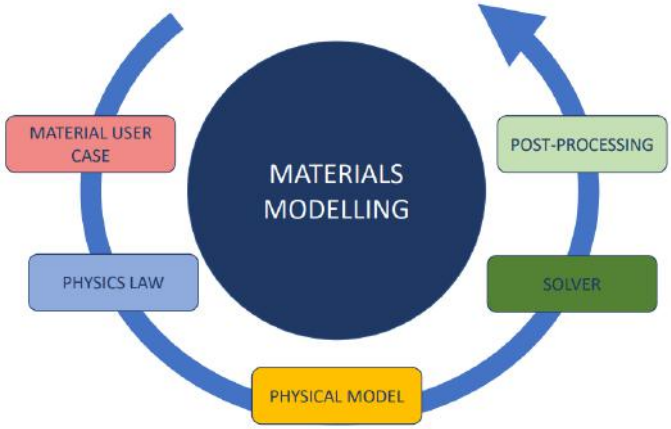
Potential enhancements related to different domains in EMMO

- EMMO can be connected with Industrial/Manufacturing domain ontologies. In this domain ontologies(e.g. MSDL, MASON etc.) the manufacturing processes are connected with machines and tools that applied at materials.
  - Industry Ontology Foundry which aims to create a suite of interoperable high quality ontologies covering the domain of industrial (especially manufacturing) engineering uses BFO as ontology basis such the EMMO
- Concepts of ontologies which describe concepts and relationships among the concepts in materials science and engineering can be evaluated and added
  - MATERIALS ONTOLOGY: AN INFRASTRUCTURE FOR EXCHANGING MATERIALS INFORMATION AND KNOWLEDGE [5]
  - AN ONTOLOGY-BASED KNOWLEDGE MODEL FOR ENGINEERING MATERIAL SELECTIONS [6]
- EMMO's Physical Property class can be extended with units of measurements concepts of ontologies such as the Ontology of units of Measure[7] and the Unit Ontology: An ontology of units of measurements[8]

[5] T. Ashino (2010) MATERIALS ONTOLOGY: AN INFRASTRUCTURE FOR EXCHANGING MATERIALS INFORMATION AND KNOWLEDGE, Data Science Journal, Volume 9
[6] Y. Zhang & X.Luo (2014) AN ONTOLOGY-BASED KNOWLEDGE MODEL FOR ENGINEERING MATERIAL SELECTIONS, International Conference of Innovative Design and Manufacturing
[7] Ontology of units of Measure: https://github.com/HajoRijgersberg/OM
[8] Unit Ontology: An ontology of units of measurements: http://bioportal.bioontology.org/ontologies/UO?p=classes&conceptid=root

Towards the preparation of Big Data and Artificial Intelligence (AI) activities in the NMBP domain based on EMMO & BFO

- European **Materials Modelling Ontology (EMMO)**
  - based on the **Basic Formal Ontology (BFO)** that enables interoperability between domain ontology development in multiple different areas
- Many ontology suites which use **Top Level Ontology (TLO)** hubs use **BFO** as the hub
  - TLOs should be a true top level (no overlap with domain ontologies)
  - Building Ontologies with BFO
    - https://mitpress.mit.edu/books/building-ontologies-basic-formal-ontology
- Related work in the AI domain that should be considered when building an AI ontology
  - Suggested Upper Merged Ontology (SUMO)
  - Knowledge Representation Framework (KRF)
  - FIPA Specifications (http://www.fipa.org/)
- Ontology Engineering & Big Data (https://www.slideshare.net/KoujiKozaki/ontology-engineering-for-big-data)
  - Mapping ontology to database
  - Adding metadata on data using vocabulary defined in ontology
  - Convert database (e.g. RDB) to ontology-based (RDF) database



...using BFO as top-level

Ontology suite	Domain	URL	TLO
Open Biomedical Ontologies (OBO)	life sciences	http://obofoundry.org	Yes
Performance Simulation Initiative (PSI) Ontology Suite	engineering design and performance	http://ermolayev.com/psi-public/psi-meta-v-2-2-draft.owl	Yes
Neon Project Ontologies	fisheries; pharmaceuticals	http://www.neon-project.org/nw/Ontologies	No
Semantic Web for Earth and Environmental Terminology (SWEET)	earth and environmental sciences	https://sweet.jpl.nasa.gov/	No
VIVO- Integrated Semantic Framework (VIVO-ISF)	scientific research (persons, works, relations of authorship)	https://bioportal.bioontology.org/ontologies/VIVO-ISF	Yes
The Semantic Publishing and Referencing Ontologies (SPAR)	document description, bibliographic resource identifiers, citations	http://www.sparontologies.net/	No
Planteome Ontologies	plant science including plant genomics	http://www.plantontology.org/	Yes
Common Core Ontologies (CCO)	military, intelligence and related domains	http://milportal.ncor.buffalo.edu/ontologies	Yes
Infectious Disease Ontology (ISO) suite	infectious diseases, vaccines	http://infectiousdiseaseontology.org/page/	Yes
United Nations Environment Program	UN Sustainable Development Interface	http://pre-uneplive.unep.org/portal	Yes

Questions ?

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