Towards Materials and Manufacturing Commons - the enablers Digital Marketplaces, FAIR Principles and Ontologies
Berlin – April 4th – 6th 2023

FAIR Semantics

A requirement for interoperability

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OntoCommons "Ontology-driven data documentation for Industry Commons" has received funding from the European Union's Horizon Programme call H2020 -NMBP-TO-IND-2020-singlestage, Grant Agreement number 862136

Why FAIR Semantics?

- Semantic landscape heterogeneous:
  - ✓Different levels of semantics (from weak to strong)
  - ✓Different formats: RDF/XML, OWL, Turtle,…
  - ✓Different names: ontologies, controlled vocabularies, thesauri, codelists, …
  - ✓Different community's best practices
  - ✓Different ways of sharing/publishing

Hard to find and reuse ontologies within and across domains + Interoperability problems = NOT FAIR

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FAIR Principle I2. (meta)data use vocabularies that follow FAIR principles

What do we mean by FAIR Semantics?

FAIR Semantics means that **semantic artefacts** should adhere to the FAIR principles. We consider semantic artefacts as a specific type of data, used to describe or annotate other data, i.e. as metadata.

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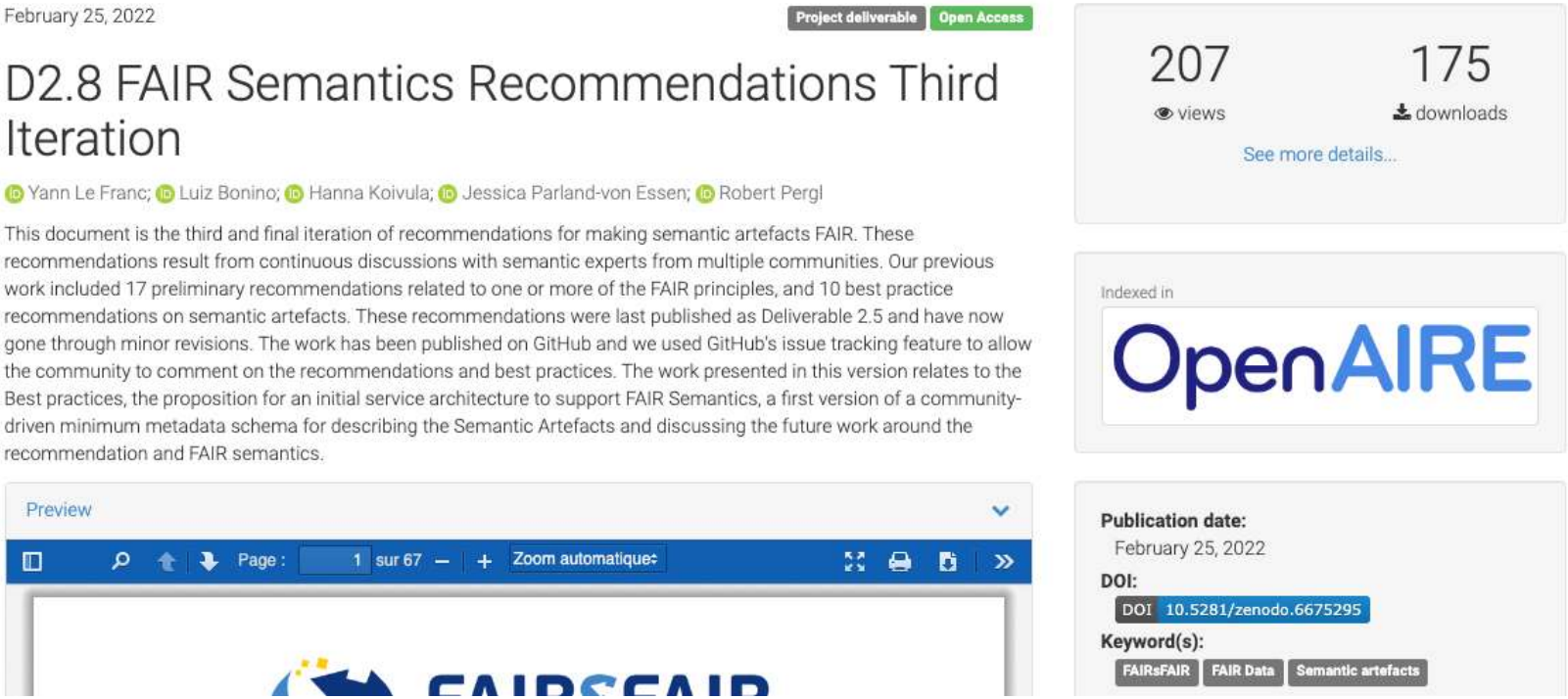
A ***semantic artefact*** is defined within our work as a machine-actionable and -readable formalisation of a conceptualisation, enabling sharing and reuse by humans and machines. These artefacts may have a broad range of formalisation, from loose sets of terms, taxonomies, thesauri to higher-order logics. Moreover, semantic artefacts are serialised using a variety of digital representation formats, e.g., RDF Turtle, and OWL, using XML (RDF) and JSON-LD.

What does it mean for an ontology to be FAIR?

- 17 generic recommendations and 12 Best Practices
- Recommendation aligned with RFC 2119 (MUST, SHOULD, MAY)
  - 9 MUST
  - 7 SHOULD
  - 1 MAY
  - 1 Undetermined

https://github.com/FAIRsFAIR/FAIRSemantics



February 25, 2022

Project deliverable | Open Access

D2.8 FAIR Semantics Recommendations Third Iteration

Yann Le Franc; Luiz Bonino; Hanna Koivula; Jessica Parland-von Essen; Robert Pergl

This document is the third and final iteration of recommendations for making semantic artefacts FAIR. These recommendations result from continuous discussions with semantic experts from multiple communities. Our previous work included 17 preliminary recommendations related to one or more of the FAIR principles, and 10 best practice recommendations on semantic artefacts. These recommendations were last published as Deliverable 2.5 and have now gone through minor revisions. The work has been published on GitHub and we used GitHub's issue tracking feature to allow the community to comment on the recommendations and best practices. The work presented in this version relates to the Best practices, the proposition for an initial service architecture to support FAIR Semantics, a first version of a community-driven minimum metadata schema for describing the Semantic Artefacts and discussing the future work around the recommendation and FAIR semantics.

Preview

Page : 1 sur 67 Zoom automatique

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DOI 10.5281/zenodo.6675295

Keyword(s):
FAIRsFAIR | FAIR Data | Semantic artefacts

How did we built them?

Collaboration with RDA

Moving toward FAIR Semantics

Home » *Plenaries* » Moving toward FAIR Semantics

05 DEC 2019

By Yann Le Franc

Group(s) submitting the application: Vocabulary Services IG

Meeting objectives:

- Collaborative Notes
  Link: **https://docs.google.com/document/d/18CyQ2WsOxG_0zzzteubJyPveZzr8KPH4iuvo...**

Semantic artifacts (ontologies, controlled vocabularies, thesauri, glossaries...) are vital to the realisation of the FAIR principles, as they enhance data and information with well

FAIR Semantics, the Semantic Web Universe and Everything

Home » *Plenaries* » FAIR Semantics, the Semantic Web Universe and Everything

04 AUG 2020

By Yann Le Franc

Group(s) submitting the application: Vocabulary Services IG

Meeting objectives:

The VSSIG is a unique platform for international Semantic Web experts to address key issues in this field and to share tips and tricks as well as ongoing activities. One of the hot discussion topics within the group is about FAIR Semantics—that is, how to make semantic artifacts (ontologies, controlled vocabularies, thesauri, glossaries...) understandable by

Collaboration with RDA

- RDA VSSIG Task Group on Minimum Metadata – C. Jonquet & L. Bonino
  - Define a minimum metadata schema for FAIR semantic artefacts (i.e. ontologies,…
  - Define a DCAT profile to publish collections of semantic artefacts
- RDA VSSIG Task Group on FAIR Semantic repositories – A. Kokkinaki & G. Coen
  - Evaluate recommendations from the perspective of ontology repositories
  - Establish a list of possible technical implementation of the recommendations

Not reinventing the wheel

- FAIR Semantics recommendations are linked to similar work
  - Best practices for implementing fair vocabularies and ontologies on the web - Daniel Garijo and Maria Poveda (2020)
  - Ten simple rules for making a vocabulary FAIR – Cox et al. (2021)
  - OBO Foundry principles
  - IOF principles

Applying FAIR to Semantic Artefacts

This approach allows us to consider each individual FAIR principle in the context of semantic artefacts. This implies the following:

- usage of globally unique persistent and resolvable identifiers for semantic artefacts, their content (i.e. concept/term/class and relation) and their version,
- machine-readable metadata to describe the semantic artefacts themselves and their content,
- usage of repositories to share, publish and retrieve semantic artefacts and their content
- defining common API(s) to access and index semantic artefacts and their content,
- interoperability approaches to make sure that semantic artefacts of various degrees of complexity and encoding format should work together including publishing mappings and crosswalks between semantic artefacts,
- semantic artefacts and their content should be retrievable through search engines.

Are ontologies for industry FAIR?

- What are the existing ontologies or vocabularies relevant for industry?
- What are their characteristics (format, logic, serialisations, …)?
- Are they aligned with Top Level Ontologies?

Landscape analysis of domain ontologies for industry

How did we collect our sample?

https://ontocommons.eu/node/146

- Internal project knowledge
- Workshops with experts
- Survey

Metadata for OntoCommons ontology catalogue

This survey is oriented to people who are aware of any ontology that could be useful for materials, manufacturing or related domains.

Our final goal is to develop an ontology catalogue in order to provide the materials and manufacturing communities with the most suitable ontologies in this area. In addition the catalogue also contains general domain ontologies frequently used across domains.

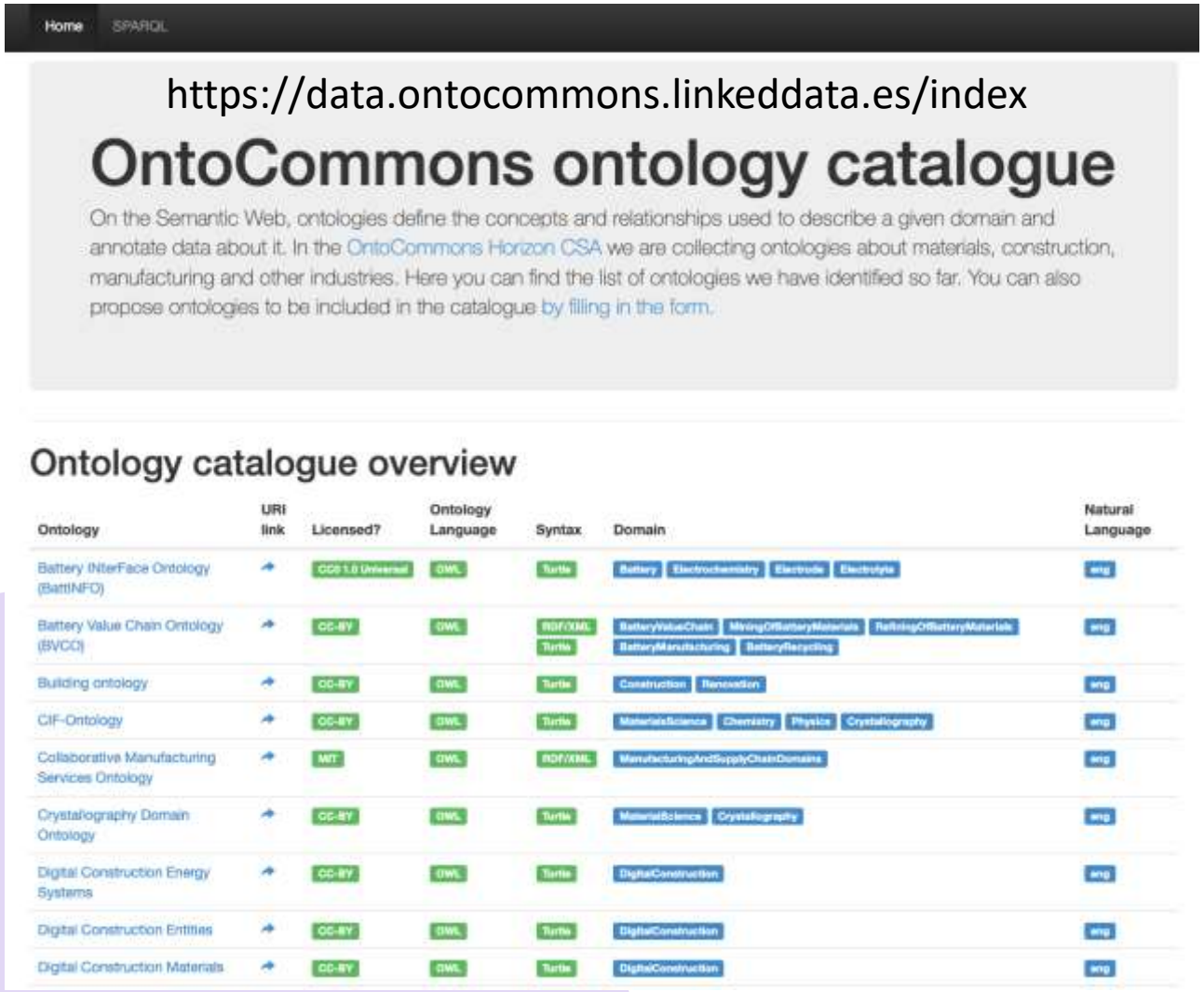
The estimated time required to complete the questionnaire is of 10 minutes. Once the form about an ontology is submitted it will be manually assessed and automatically processed. After this, the ontology will be included in the future OntoCommons Catalogue. Please note that there is a manual component in the process, therefore the on-line catalogue will not be updated immediately after the submission.

The questionnaire does not include any personal question and the confidentiality of the answers will be preserved. We only ask for an email address just in case you want to obtain information about the results we produce.

This questionnaire is being performed in the context of the OntoCommons HORIZON2020 project.
If you have any question or comment about the questionnaire contact **ontocommons.registry[at]delicias.dia.fi.upm.es**

Sharing our dataset

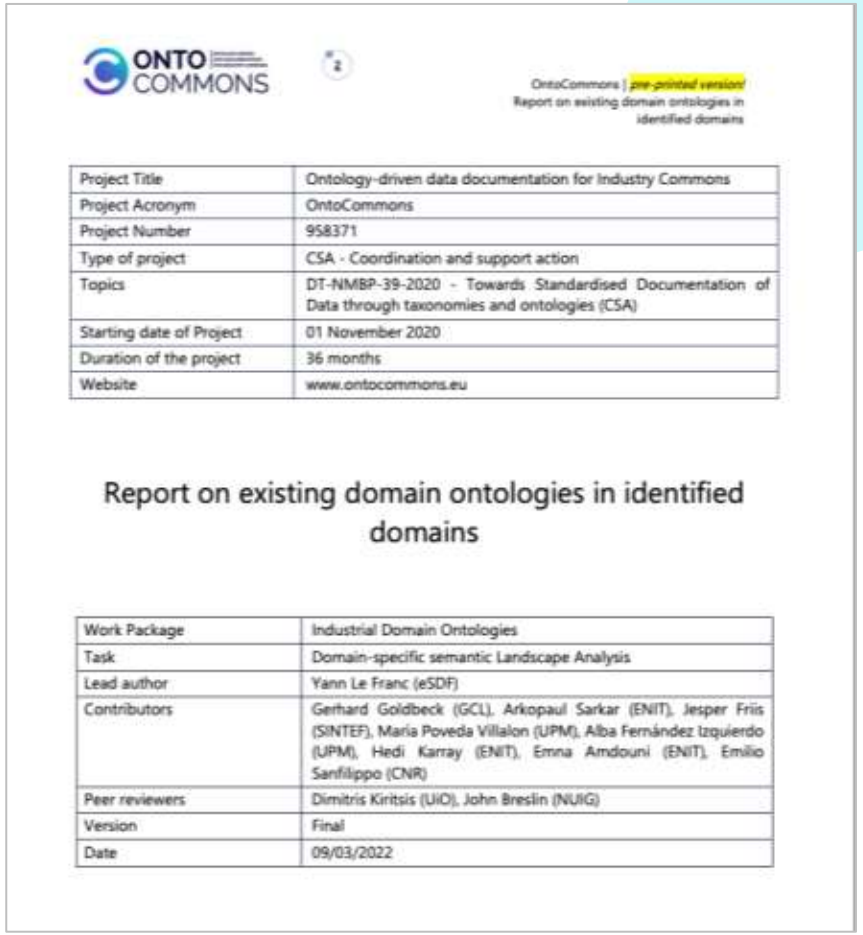
https://data.ontocommons.linkeddata.es/index



https://zenodo.org/record/6504584

Our dataset

- 130 ontologies
- Classified in 5 domains
  - Physics and Chemistry
  - Mechanical and Industrial Engineering
  - Thermal and Process Engineering
  - Material Sciences and Engineering
  - Computer Sciences, Systems and Electrical Engineering



ONTO COMMONS

OntoCommons | *pre-printed version*
Report on existing domain ontologies in identified domains

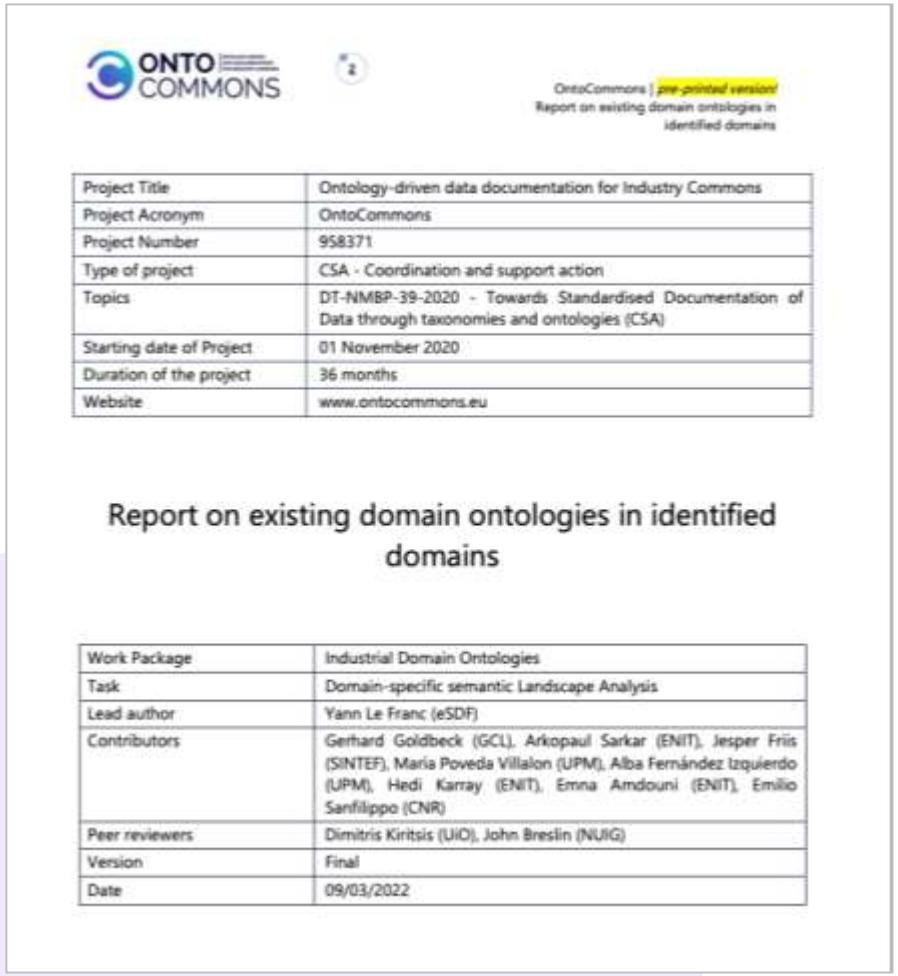
Project Title	Ontology-driven data documentation for Industry Commons
Project Acronym	OntoCommons
Project Number	958371
Type of project	CSA - Coordination and support action
Topics	DT-NMBP-39-2020 - Towards Standardised Documentation of Data through taxonomies and ontologies (CSA)
Starting date of Project	01 November 2020
Duration of the project	36 months
Website	www.ontocommons.eu

Report on existing domain ontologies in identified domains

Work Package	Industrial Domain Ontologies
Task	Domain-specific semantic Landscape Analysis
Lead author	Yann Le Franc (eSDF)
Contributors	Gerhard Goldbeck (GCL), Arkopaul Sarkar (ENIT), Jesper Friis (SINTEF), Maria Poveda Villalon (UPM), Alba Fernández Izquierdo (UPM), Hedi Karray (ENIT), Emna Amdouni (ENIT), Emilio Sanfilippo (CNR)
Peer reviewers	Dimitris Kiritsis (UiO), John Breslin (NUIG)
Version	Final
Date	09/03/2022

https://zenodo.org/record/6504553

Analysis of the dataset



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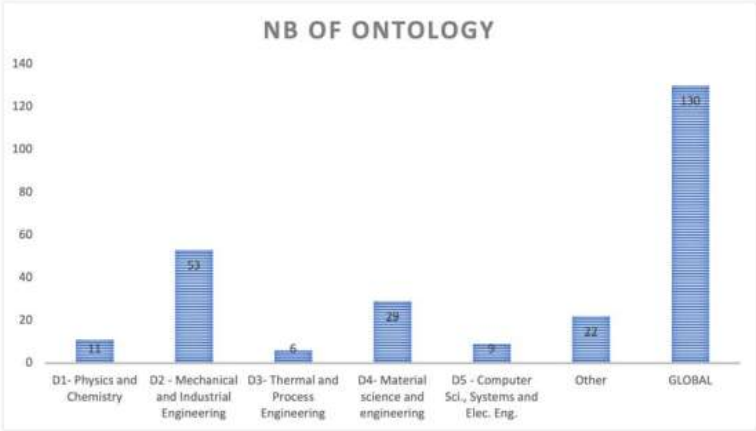

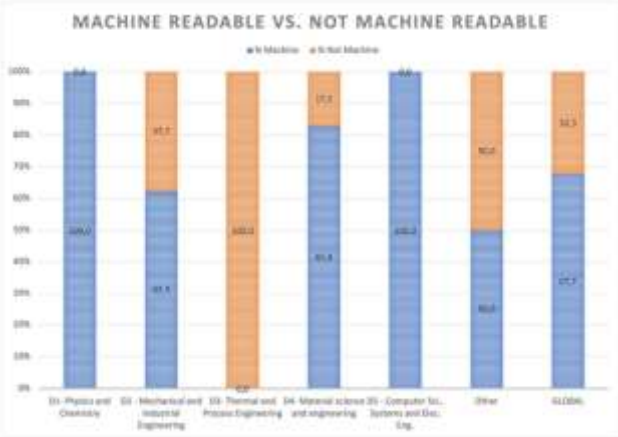

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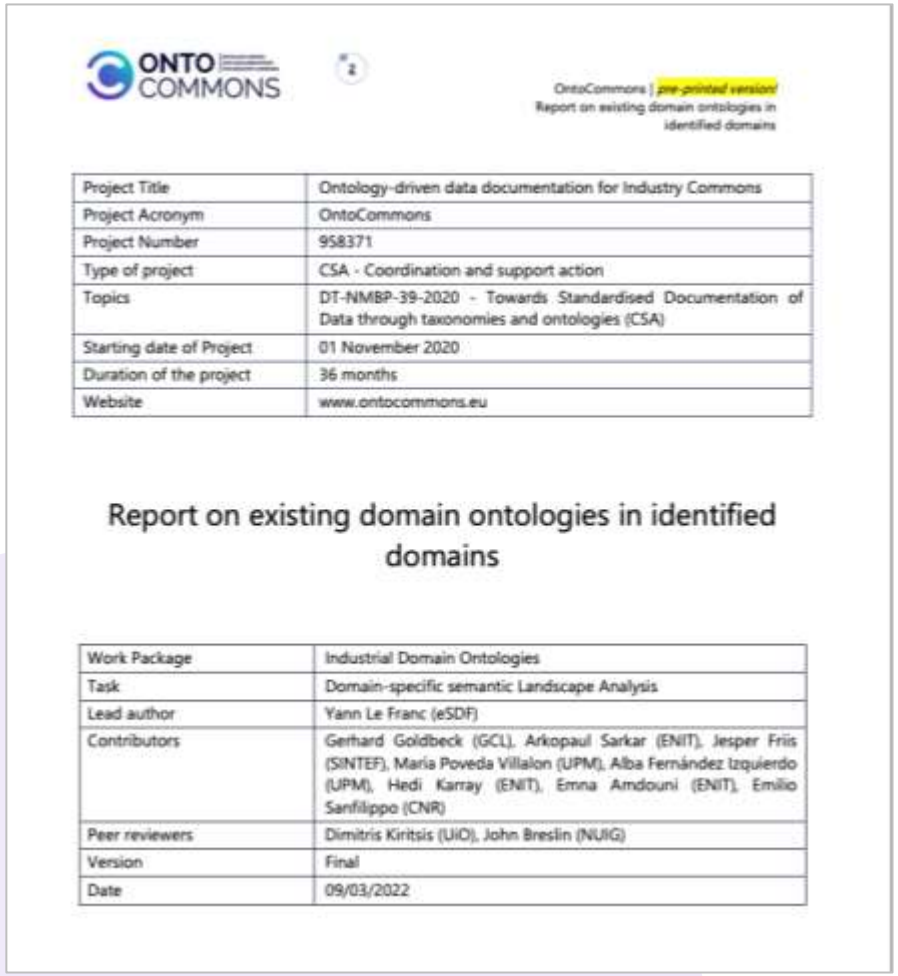

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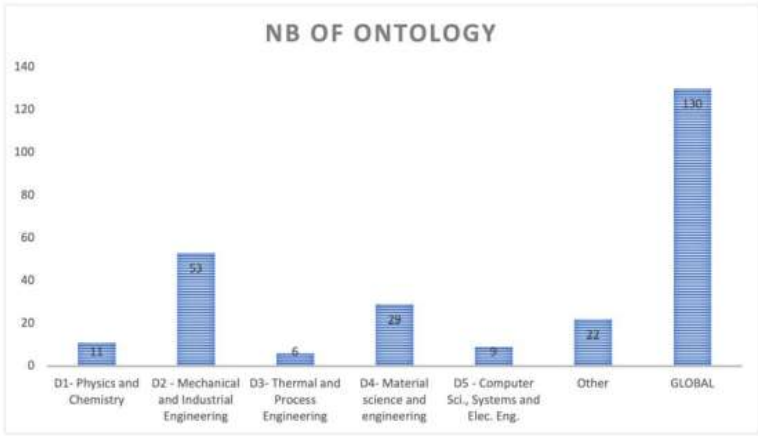

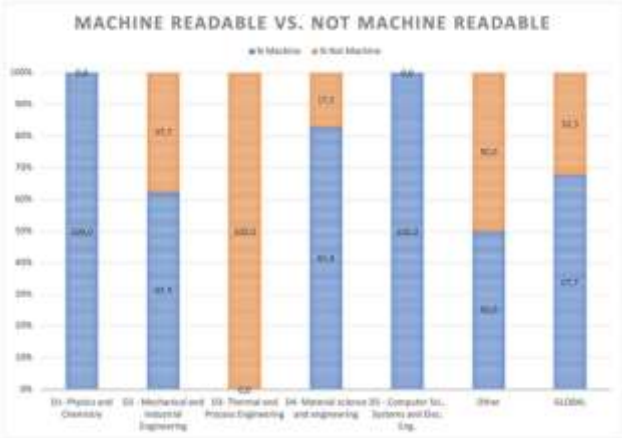

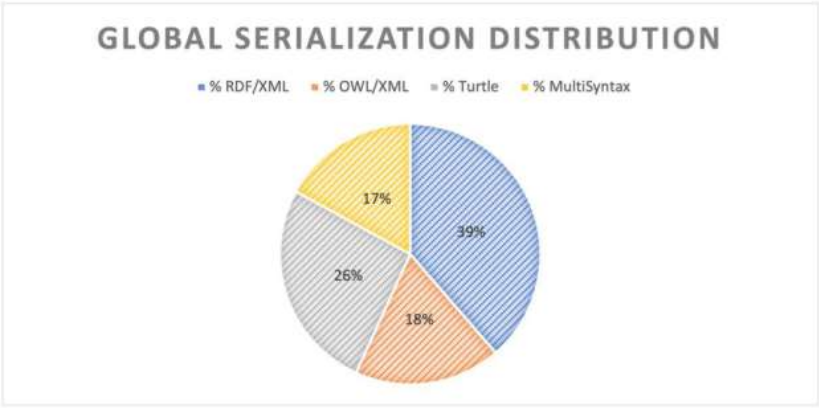

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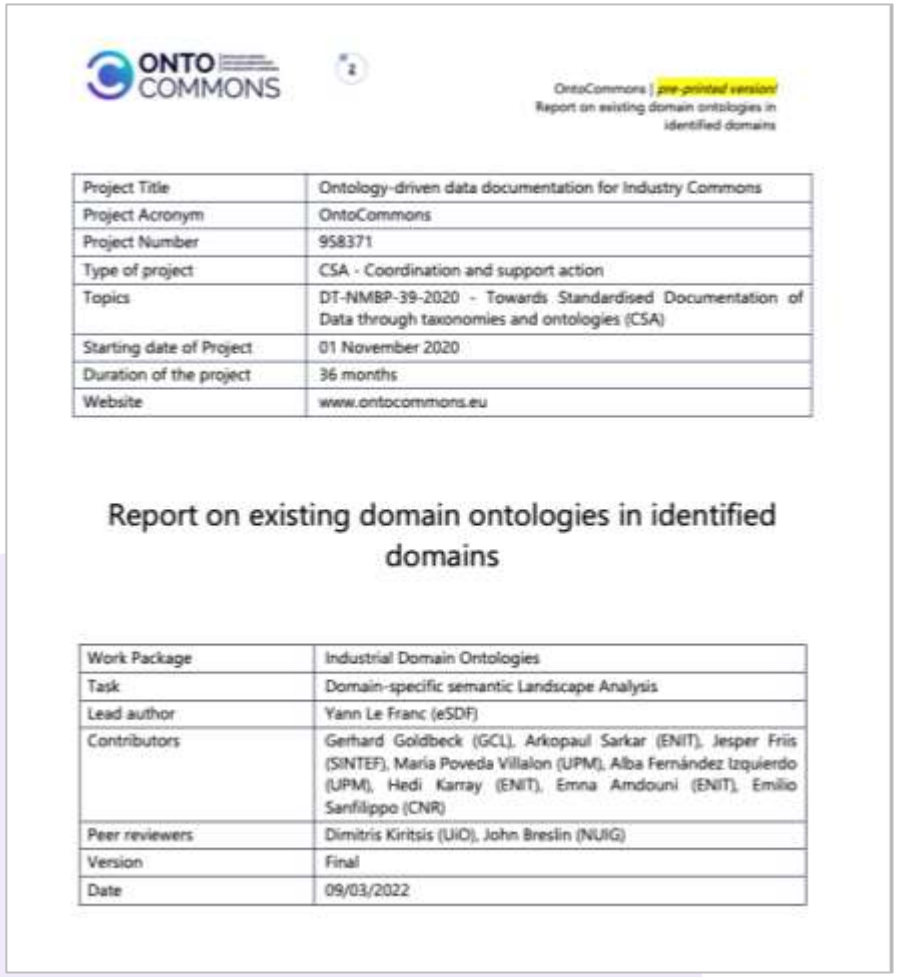

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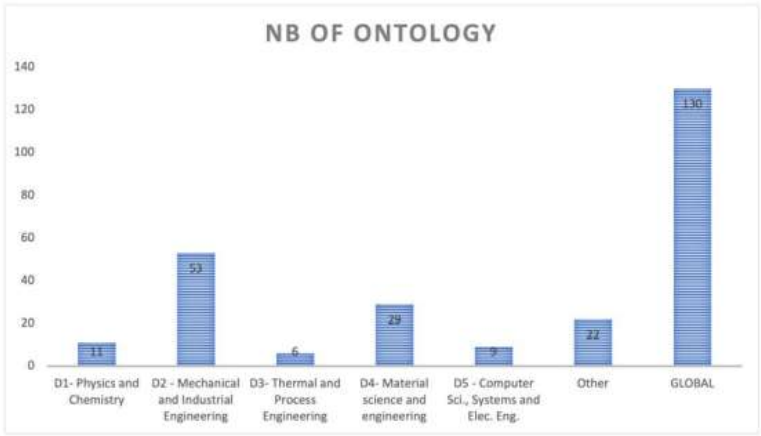
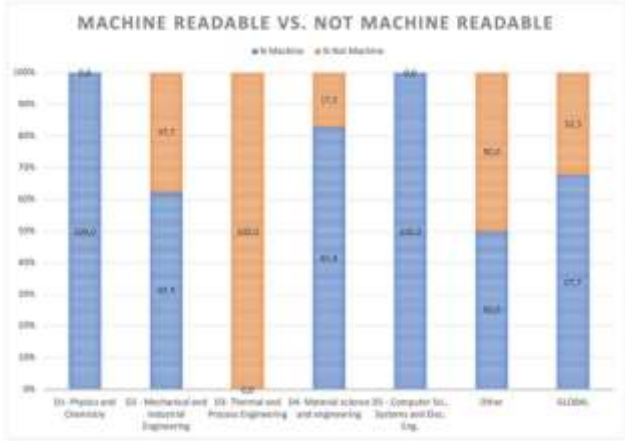
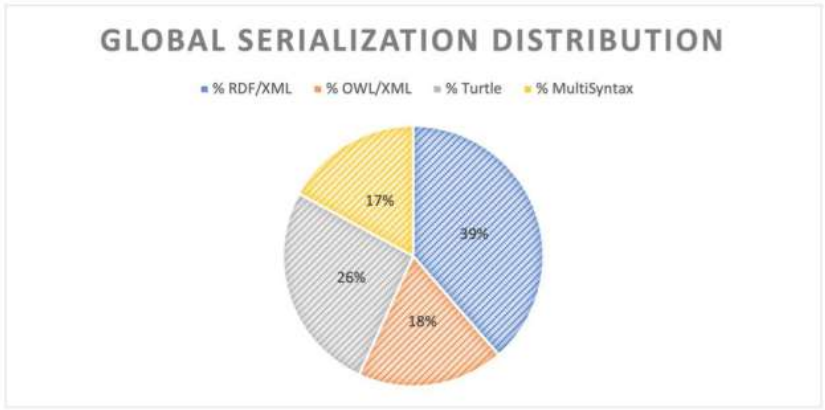






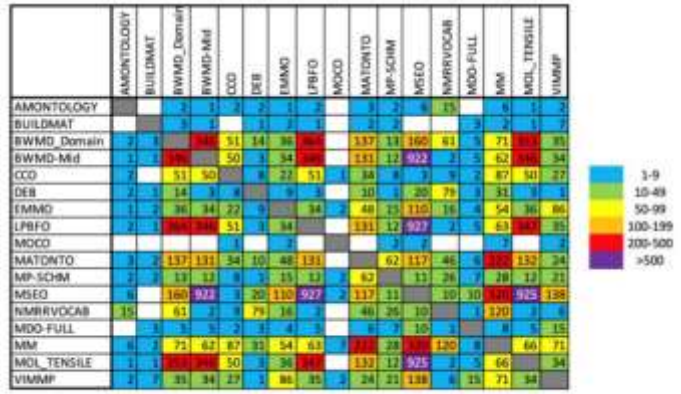
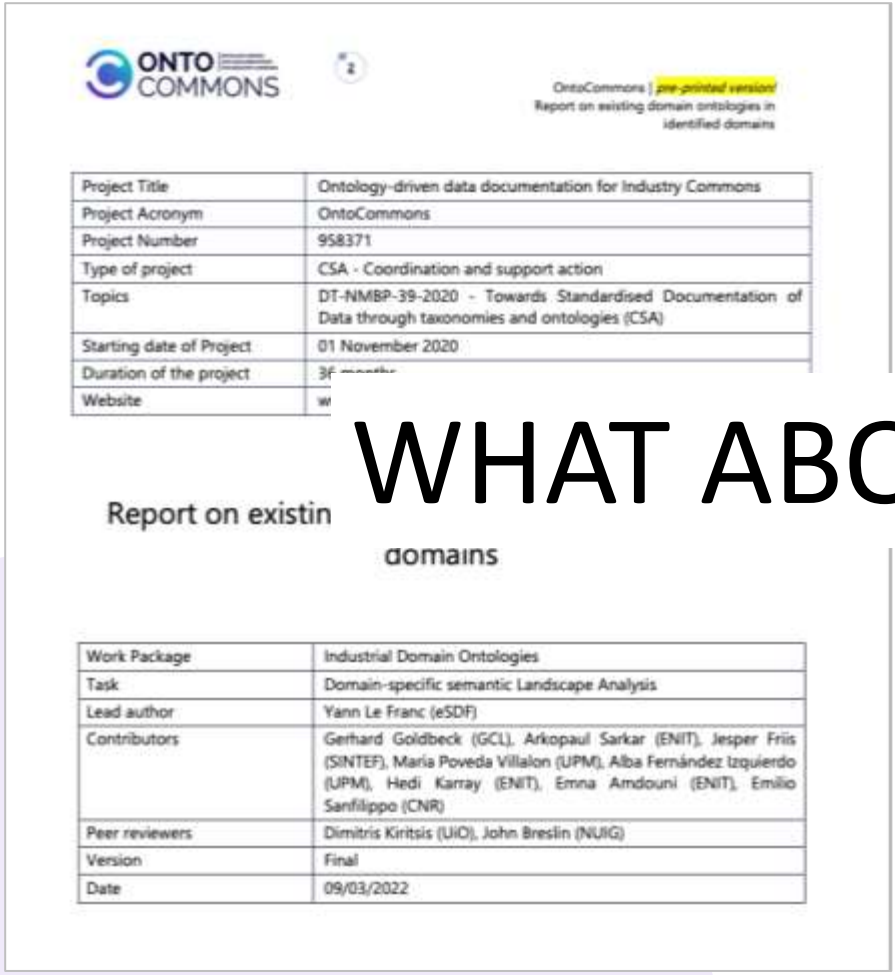


Figure 32 - Ontology overlap expressed as number of mappings between every pair of ontologies from MatPortal.

Analysis of the dataset



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Report on existin

domains

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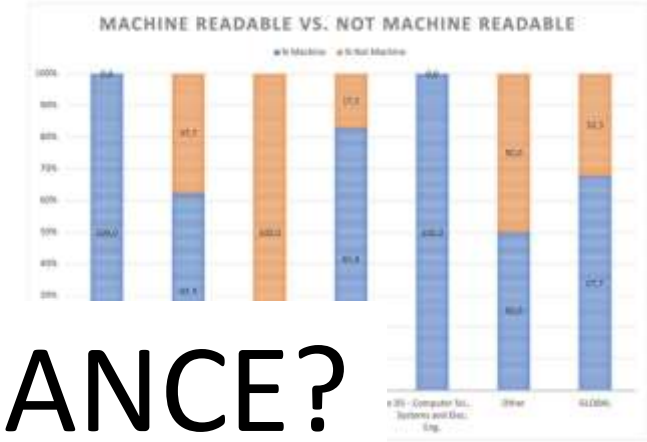
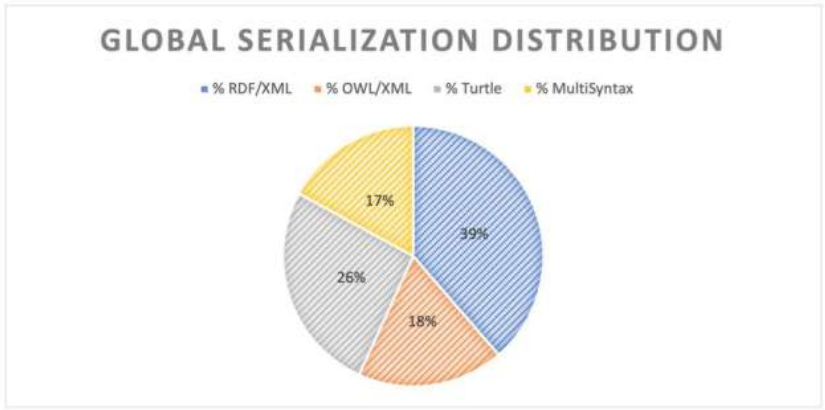


WHAT ABOUT FAIR COMPLIANCE?



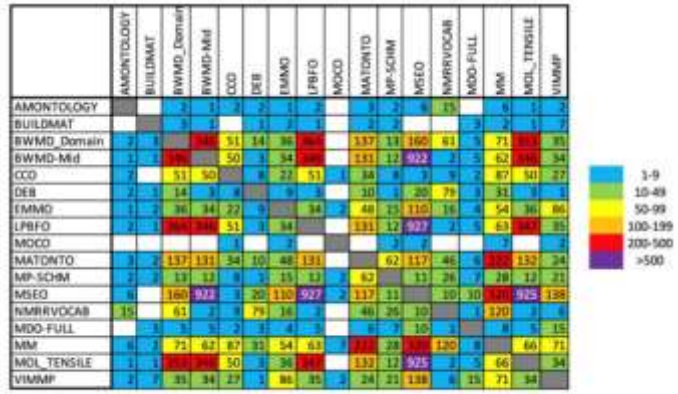


Figure 32 - Ontology overlap expressed as number of mappings between every pair of ontologies from MatPortal.

Identify the recommendations relevant to ontologies

Rec #	Recommendation	Target
P-Rec 1	Globally Unique, Persistent and Resolvable Identifiers MUST be used for Semantic Artefacts, their content (terms/concepts/classes and relations), and their version	Ontology
P-Rec 2	Globally Unique, Persistent and Resolvable Identifiers MUST be used for Semantic Artefacts metadata records. Metadata and data must be published separately, even if it is managed jointly	Ontology/Repository
P-Rec 3	A common minimum metadata schema MUST be used to describe semantic artefacts and their content	Ontology
P-Rec 5	Semantic repositories MUST offer access to Semantic Artefacts and their content using community standard APIs and serializations to support both use/reuse and indexation by search engine	Repository
P-Rec 7	Repositories MUST offer a secure access protocol, and appropriate user access control functionalities	Repository
P-Rec 8	Human and machine-readable persistence policies for semantic artefacts metadata and data MUST be published	Repository
P-Rec 9	Semantic artefacts MUST be made available as a minimum portfolio of common serialization formats	Ontology/Repository
P-Rec 16	The Semantic Artefact MUST be clearly licenced for use by machines and humans	Ontology
P-Rec 17	Provenance MUST be clear for both humans and machines	Ontology

Rec #	Recommendation	Target
P-Rec 4	Semantic artefacts and its content SHOULD be published in a trustworthy semantic repository	Ontology
P-Rec 11	A standardized knowledge representation language SHOULD be used for describing semantic artefacts	Ontology
P-Rec 12	Semantic mappings between the different elements of semantic artefacts SHOULD be published in machine readable format	Semantic Community
P-Rec 13	Crosswalks, mappings and bridging between semantic artefacts SHOULD be documented, published, and curated	Semantic Community
P-Rec 14	Standard vocabularies SHOULD be used to describe semantic artefacts	Ontology
P-Rec 15	Provenance information regarding the reuse of components from third-party semantic artefacts SHOULD be made explicit	Ontology
P-Rec 10	Foundational Ontologies MAY be used to align semantic artefacts	Ontology
P-Rec 6	Build semantic artefact search engines that operate across different semantic repositories	

Define the questions to answer for each of the relevant recommendations

- 13 yes/no questions
- 1 or more questions for each recommendations

Rec #	Topic	Question
P-Rec 1	GUPRI	Does the SA have a persistent identifier of type purl, w3id or handle except for DOI?
P-Rec 1	GUPRI	Does the identifier resolve to a machine-readable format?
P-Rec 1	GUPRI	Does the SA provide a GUPRI for version?
P-Rec 3	Metadata	Does the SA have descriptive metadata?
P-Rec 14	Standard Vocabularies	Does SA's metadata use widely used vocabularies (dc, dct, …)?
P-Rec 17	Provenance	Does the SA have provenance information?
P-Rec 17	Provenance	Does the SA use W3C Prov?
P-Rec 15	Provenance	Does the SA describe imports with provenance?
P-Rec 4	Publication	Is the SA published on a dedicated trusted semantic repository?
P-Rec 16	Licence	Does the SA have a license?
P-Rec 16	Licence	Is the license machine-readable?
P-Rec 11	Language	Does the SA use a standard knowledge representation such as SKOS, OWL…?
P-Rec 10	TLO	Does the SA align with a Top-Level Ontology?

Establish a measurement method

- **Method**
  - If a recommendation is fulfilled we score 1 else we score 0
  - If a recommendation is represented by several questions and if all these questions are answered positively we score 1 else we score 0

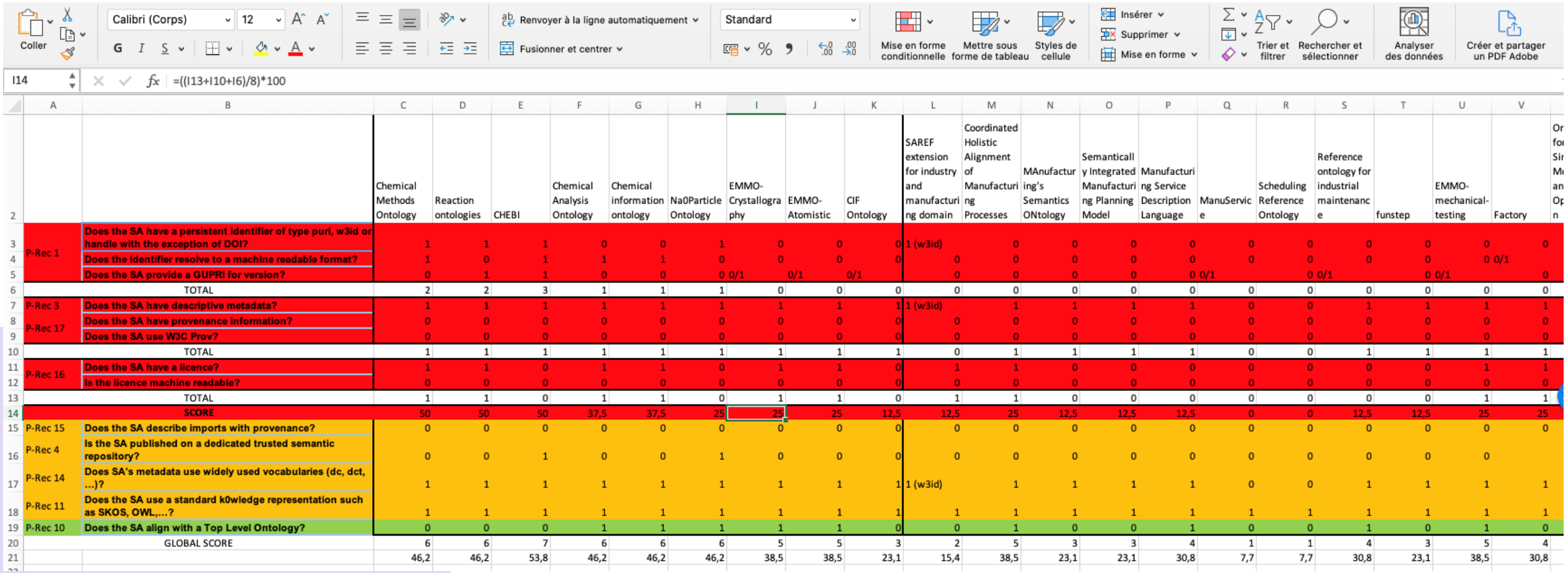
FAIR Score

Percentage of mandatory recommendations fulfilled

Global FAIR Score

Percentage of all the fulfilled recommendations

Measurement in practice



Calibri (Corps) 12 — Renvoyer à la ligne automatiquement — Standard — Mise en forme conditionnelle — Mettre sous forme de tableau — Styles de cellule — Insérer — Supprimer — Mise en forme — Trier et filtrer — Rechercher et sélectionner — Analyser des données — Créer et partager un PDF Adobe

I14 =((I13+I10+I6)/8)*100

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
2			Chemical Methods Ontology	Reaction ontologies	CHEBI	Chemical Analysis Ontology	Chemical information ontology	Na0Particle Ontology	EMMO-Crystallography	EMMO-Atomistic	CIF Ontology	SAREF extension for industry and manufacturing domain	Coordinated Holistic Alignment of Manufacturing Processes	MAnufacturing's Semantics ONtology	Semantically Integrated Manufacturing Planning Model	Manufacturing Service Description Language	ManuService	Scheduling Reference Ontology	Reference ontology for industrial maintenance	funstep	EMMO-mechanical-testing	Factory
3	P-Rec 1	Does the SA have a persistent identifier of type purl, w3id or handle with the exception of DOI?	1	1	1	0	0	1	0	0	0	1 (w3id)	0	0	0	0	0	0	0	0	0	0
4		Does the identifier resolve to a machine readable format?	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/1
5		Does the SA provide a GUPRI for version?	0	1	1	0	0	0	0/1	0/1	0/1	0	0	0	0	0	0/1	0	0/1	0	0/1	0
6		TOTAL	2	2	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	P-Rec 3	Does the SA have descriptive metadata?	1	1	1	1	1	1	1	1	1	1 (w3id)	1	1	1	1	0	0	1	1	1	1
8	P-Rec 17	Does the SA have provenance information?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9		Does the SA use W3C Prov?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10		TOTAL	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1
11	P-Rec 16	Does the SA have a licence?	1	1	0	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	1	1
12		Is the licence machine readable?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		TOTAL	1	1	0	1	1	0	1	1	0	1	1	0	0	0	0	0	0	0	1	1
14		SCORE	50	50	50	37,5	37,5	25	25	25	12,5	12,5	25	12,5	12,5	12,5	0	0	12,5	12,5	25	25
15	P-Rec 15	Does the SA describe imports with provenance?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	P-Rec 4	Is the SA published on a dedicated trusted semantic repository?	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	P-Rec 14	Does SA's metadata use widely used vocabularies (dc, dct, ...)?	1	1	1	1	1	1	1	1	1	1 (w3id)	1	1	1	1	0	0	1	1	1	1
18	P-Rec 11	Does the SA use a standard k0wledge representation such as SKOS, OWL,...?	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
19	P-Rec 10	Does the SA align with a Top Level Ontology?	0	0	0	1	1	1	1	1	0	0	1	0	0	1	0	0	1	0	1	0
20		GLOBAL SCORE	6	6	7	6	6	6	5	5	3	2	5	3	3	4	1	1	4	3	5	4
21			46,2	46,2	53,8	46,2	46,2	46,2	38,5	38,5	23,1	15,4	38,5	23,1	23,1	30,8	7,7	7,7	30,8	23,1	38,5	30,8

Some results

- FAIRness assessment performed on 44 out of 74 machine-readable ontologies. Average FAIRness score by domain is

Domain	FAIR Score	Global FAIR Score
Physics and Chemistry	**34,7 % (± 13,7 %)**	**42,7 % (± 8,7 %)**
Mechanical and Industrial Engineering	**18,8 % (± 14,4%)**	**27,8 % (± 11,8%)**
Material Science and Engineering	**28,8 % (± 21,3 %)**	**40,8 % (± 16,2 %)**
Computer Science, Systems and Electrical Engineering	**25 % (±19,1 %)**	**30,8 % (16,6)**

- Physics and Chemistry is the domain with the highest FAIR Score on average.
- Allotrope ontology (in material science domain) being most FAIR ontology.
- no ontologies passed the threshold of minimally FAIR.

Conclusions

- Great tool to get started (tested during Agrohackathon 08/22)
- Incomplete approach as several FAIR principles are not covered
- Based on high level recommendations: need to define practical implementations
- No consideration about the metadata content describing ontologies
- Comparaison with FOOPS!

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Identifier

Rec #	Recommendation	FAIR Principle
P-Rec. 1	Globally Unique, Persistent and Resolvable Identifiers **MUST** be used for Semantic Artefacts, their content (terms/concepts/classes and relations) and their versions	F1
P-Rec. 2	Globally Unique, Persistent and Resolvable Identifiers **MUST** be used for Semantic Artefact Metadata Record. Metadata and data must be published separately, even if it is managed jointly	F1, F3

Metadata

Rec #	Recommendations	FAIR principle
P-Rec 3	A common minimum metadata schema **MUST** be used to describe semantic artefacts and their content	F2, R1.1, R1.2 and R1.3
P-Rec. 8	Human and machine-readable persistence policies for semantic artefacts metadata and data **MUST** be published	A2
P-Rec. 9	Semantic artefacts **MUST** be made available as a minimum portfolio of common serialization formats	I1
P-Rec. 14	Standard vocabularies **SHOULD** be used to describe semantic artefacts	I2
P-Rec. 15	Provenance information regarding the reuse of components from third-party semantic artefacts **SHOULD** be made explicit	I3, R1.2
P-Rec. 16	The semantic artefact **MUST** be clearly licenced for use by machines and humans	R1.1
P-Rec. 17	Provenance **MUST** be clear for both humans and machine	R1.2

« Semantic alignment »

Rec #	Recommendations	FAIR Principles
P-Rec. 10	Foundational Ontologies **MAY** be used to align semantic artefacts	I1, I2, I3
P-Rec. 11	A standardized knowledge representation language **SHOULD** be used for describing complex logical relations (semantic artefact)	I1
P-Rec. 12	Semantic mappings between the different elements of semantic artefacts **SHOULD** be published in machine-readable formats	I1, I3, R1.3
P-Rec. 13	Crosswalks, mappings and bridging between semantic artefacts **SHOULD** be documented, published and curated	R1.2, R1.3

Repository

Rec #	Recommendation	FAIR Principles
P-Rec. 4	Semantic Artefact and its content **SHOULD** be published in a trustworthy semantic repository	F4
P-Rec.5	Semantic repositories **MUST** offer access to Semantic Artefacts and their content using community standard APIs and serializations to support both use/reuse and indexation by search engines	F4, A1, A1.1
P- Rec. 6	Build semantic artefacts' search engines that operate across different semantic repositories	F4
P-Rec. 7	Repositories **MUST** offer a secure access protocol and appropriate user access control functionalities	A1.2