### Making Terminologies FAIR

The FAIR principles have recently been implemented as “Ten simple rules for making a vocabulary FAIR” by Cox et al., 2021 (<https://doi.org/10.1371/journal.pcbi.1009041>) to transform a legacy vocabulary into a FAIR vocabulary. This can be used to provide unambiguous annotation of data which increases interoperability and enables data integration. The ten simple rules are applied to Simple Knowledge Organisation System (SKOS) and Web Ontology Language (OWL) with examples. This open source (CC BY 4.0) publication is summarized as follows (adapted from Table 1):

Findability

* Each vocabulary is denoted by a global, unique, persistent and machine resolvable identifier (GUPRI).
* Each term is denoted by a GUPRI.
* It is possible to search for a term or vocabulary and get a GUPRI for it.
* The vocabulary is available from at least one repository recognised by the community.

Accessibility

* When the term identifier is requested, a machine-readable representation of the term is returned using semantic web standards (<https://www.w3.org/standards/semanticweb/data>).

Interoperability

* At least one representation conforms to a community standard for vocabularies. The vocabulary includes mapping relations to other vocabularies.

Reusability

* The license for use of the vocabulary is clear, accessible, and denoted by a GUPRI.
* Enough metadata at vocabulary and term levels is provided to include provenance and maintenance information.
* The definitions are sufficient for a user to understand what each term means.

### Selection of Terminologies

There are many terminologies and ontologies available via public repositories such as the BioPortal ([https://bioportal.bioontology.org](https://bioportal.bioontology.org/)) hosted by NBCO and Ontology Lookup Service, OLS (<https://www.ebi.ac.uk/ols/index>) hosted by EMBL-EBI. In addition, they are also available directly from the terminology or ontology providers e.g. SNOMED CT, MeDRA amd LOINC. The selection of terminologies and ontologies for a particular application can be difficult, although this can be informed by further set of simple rules such as Malone et al 2016 (<https://doi.org/10.1371/journal.pcbi.1004743>).

### **Using Terminologies in HL7 FHIR**

Many elements in HL7 FHIR have a coded value, such as "gender" in the Patient resource or "bodySite" in the Observation resource. These codes are part of a code system that can be defined at different places (see the [HL7 FHIR Terminology](https://www.hl7.org/fhir/terminologies.html)):

* A set of fixed values from the HL7 FHIR specification (e.g. in the case of administrative gender this can be one out of four [values](https://www.hl7.org/fhir/codesystem-administrative-gender.html), namely "male", "female", "other", or "unknown")
* A code included in a Request for Comments (RFC) from the Internet Engineering Task Force (e.g. MIME types) or HL7 specifications (e.g. HL7 v2)
* A dictionary, look up table, or enumeration that is locally maintained and defined by an application
* An external terminology or ontology (e.g. SNOMED CT or LOINC)

In the context of this IG, we focus mainly on external terminologies or ontologies.

The HL7 FHIR specification describes how to select code systems in section 4.1.2 of the Terminology page ([https://www.hl7.org/HL7 FHIR/terminologies.html#system](https://www.hl7.org/fhir/terminologies.html#system)) and the recommendations given here are an addition to what is mentioned on that page.

Implementing FAIR requires the use of terminologies that are themselves FAIR-compliant. To reach an acceptable level of FAIRness, the terminology should follow the ten simple rules for making a vocabulary FAIR, as described by Cox et al.

A vocabulary offered through a HL7 FHIR terminology service, makes it substantially FAIR.

First of all, a HL7 FHIR terminology service ensures that every code system, code, value set, and concept map has an unique identifier.

Enable the provision of rich metadata.

HL7 FHIR has a representation as Turtle RDF that offers a bridge to Semantic Web. In any case, a HL7 FHIR terminology service uses the standard HL7 FHIR operations and data formats, making it interoperable with other HL7 FHIR servers and clients. Finally, the terminology service Capability Statement provides a machine-readable representation of the functionality supported by a terminology server, helping reusability.