Genbank: <https://www.ncbi.nlm.nih.gov/genbank/>

Variable Control:

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| **URI used** | <https://www.ncbi.nlm.nih.gov/nuccore/FJ750455.1> |
| **Analysis date** | 29/04/2020 |
| **Acronyms** | |
| **RaCE -** Researcher Compliance Experiment | |
| **MaCE -** Machine Compliance Experiment | |

FINDABLE

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| **Principle** | F1 | |
| **Description Principle** | (meta)data is assigned persistent and globally unique identifiers. | |
| **RaCE** | /\*Comments\*/  Local identifiers are standardized and documented.  / \* Globally Unique? \* /  The standardization, documentation, and use of URIs makes Identifiers globally unique.  / \* Persistent? \* /  No repository has been found to guarantee the persistence of Genbank's own identifiers.  They were not found in the following persistence repositories:  [https://www.re3data.org/repository/r3d100010528](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.re3data.org/repository/r3d100010528)  [http://identifiers.org/](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=http://identifiers.org/)  [https://github.com/perma-id/w3id.org](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://github.com/perma-id/w3id.org)  [https://archive.org/services/purl/domain\_search?q=genbank](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://archive.org/services/purl/domain_search%3Fq%3Dgenbank)  [http://bibpurl.oclc.org/maint/display.html](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=http://bibpurl.oclc.org/maint/display.html)  [https://n2t.net/e/pub/naan\_registry.txt](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://n2t.net/e/pub/naan_registry.txt) | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | Even with globally unique identifiers and the most used repository linked to the biological area, it is not possible to guarantee that the identifiers are persistent.  It is necessary that the identifiers are stored in a repository that guarantees their persistence. | |
| **MaCE** | **METRIC DESCRIPTION** | **ANALYZE** |
| **Unique Identifier**  Test whether the metadata resource has a unique identifier | It has an Uniform Resource Identifier type identifier. |
| **Identifier Persistence**  Metric to test whether the metadata resource's unique identifier is likely to be persistent. The known scheme is registered with FAIRSharing (https://fairsharing.org/standards/?q=&selected\_facets=type\_exact:identifier%20schema). For URLs that do not follow a scheme in FAIRSharing, we test known URL persistence schemes (purl, oclc, fdlp, purlz, w3id, ark). | The metadata GUID does not conform to any known permanent URL system. |
| **Data Identifier Persistence**  Metric to test whether the unique identifier for the data resource is likely to be persistent. The known scheme is registered with FAIRSharing (https://fairsharing.org/standards/?q=&selected\_facets=type\_exact:identifier%20schema). For URLs that do not follow a scheme in FAIRSharing, we test known URL persistence schemes (purl, oclc, fdlp, purlz, w3id, ark). | It is not possible to find the data identifier in the metadata using any (common) property / predicate reserved for that purpose. |
| **Result of RaCE (by color)** | **Unique Identifier** |  |
| **Identifier Persistence** |  |
| **Data Identifier Persistence** |  |
| **Recommendations?** | **Unique Identifier** | There are no improvements. |
| **Identifier Persistence** | It is necessary that the identifiers are stored in a repository that guarantees their persistence. |
| **Data Identifier Persistence** | It is necessary that the identifiers are stored in a repository that guarantees their persistence. |

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| **Principle** | F2 | |
| **Description Principle** | Data is described with rich metadata. | |
| **RaCE** | / \* Is there metadata standardization? \* /  Metadata standardization documents found  [https://www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.ncbi.nlm.nih.gov/Sitemap/samplerecord.html)  / \* Is the metadata complete? \* /  Perhaps, there is metadata external to the repository, where the connection could be improved. Ex: Use CURIE identification of type DOI in articles.  / \* Comments \* /  However, there is inconsistency in the description of these metadata as described in the article: “The variable quality of metadata about biological samples used in biomedical experiments”  [https://doi.org/10.1038/sdata.2019.21](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://doi.org/10.1038/sdata.2019.21) | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | As mentioned in the article that justified the result of this analysis, it is necessary for the repository to control the entry of metadata through its users, thus having a more rigid metadata upload policy. | |
| **MaCE** | **Structured Metadata**  Tests whether a machine is capable of finding structured metadata. They can be (for example) RDFa, embedded json, json-ld or structured metadata negotiated by content, such as RDF Turtle. | No structured metadata found (the extruct library in python and https://demos.algorithmia.com/web-page-inspector was used) |
| **Grounded Metadata**  Tests whether a machine is capable of finding grounded metadata. that is, metadata terms that are in a resolvable namespace, where the resolution leads to a definition of the meaning of the term. Examples include JSON-LD, embedded schema or any form of RDF. This test currently excludes XML, even when terms are spaced by name. Future versions of this test may be more flexible. | No structured metadata found (the extruct library in python and https://demos.algorithmia.com/web-page-inspector was used) |
| **Result of RaCE (by color)** | **Structured Metadata** |  |
| **Grounded Metadata** |  |
| **Recommendations?** | **Structured Metadata** | To meet this metric, it is necessary to contain structured metadata. There are numerous means of standardizing metadata structure, where they are located in the source code of the page, or by means of an extension and designated for structured data. |
| **Grounded Metadata** | In order to meet this metric, it is necessary in addition to containing structured metadata, “grounded” metadata where they have URIs that identify them thus solving them. |

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| **Principle** | F3 | |
| **Description Principle** | Metadata must clearly and explicitly include the data identifier described. | |
| **RaCE** | / \* Is it possible to identify the data in the metadata? How is it done? \* /  Yes, the identifier for the data is explicit. Sequence Versions treats the metadata and the data as one, the identifier is found in the data header and in the metadata LOCUS.    / \* Are there different identifiers for metadata and data? \* /    There is none, it uses the same identifiers. Data and Metadata are contained in the same place. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | There are no improvements. | |
| **MaCE** | **Data Identifier Explicitly in Metadata**  Metric to test whether metadata contains the data's unique identifier. This is done by looking for a variety of properties, including foaf: primaryTopic, schema: mainEntity, schema: distribution, sio: is-about and iao: is-about. The codeRepository scheme is used for software versions. | It was not possible to find the data identifier in the metadata using any (common) property / predicate reserved for that purpose.    Used: Extruct and Web Page Inspector |
| **Metadata Identifier Explicitly in Metadata**  Metric for testing whether the metadata contains the unique identifier for the metadata itself. This is done using a variety of scraping tools, including resolving DOI metadata, using the Python tool 'extruct' and other ... | No metadata identifier was found in the metadata record.    Used: Extruct and Web Page Inspector |
| **Result of RaCE (by color)** | **Data Identifier Explicitly in Metadata** |  |
| **Metadata Identifier Explicitly in Metadata** |  |
| **Recommendations?** | **Data Identifier Explicitly in Metadata** | To meet this requirement, it is necessary to have some type of (meta) structured data, in order to use identifier properties that are used in this standardization of structured data. |
| **Metadata Identifier Explicitly in Metadata** | As nothing useful was returned using scraping tools, therefore, it is necessary to provide means for the metadata to be resolvable, that is, to have URIs that identify them.  In addition, it is not possible to find CURIEs, such as DOI, even if they contain (meta)data referring to papers. As an improvement, it would be necessary to insert this type of CURIE to facilitate the reuse of (meta)data. |

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| **Principle** | F4 | |
| **Description Principle** | (meta)data is recorded or indexed in searchable resources. | |
| **RaCE** | / \* Does the URI or Local ID return registration in search engines? \* /  Yes, it is returned. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | There are no improvements. | |
| **MaCE** | **Searchable in Major Search Engine**  It tests whether a machine is able to discover the resource by searching, using Google. | The searcher used the identifier and returned the record of (meta)data |
| **Result of RaCE (by color)** | **Searchable in Major Search Engine** |  |
| **Recommendations?** | **Searchable in Major Search Engine** | There are no improvements. |

ACCESSIBLE

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| **Principle** | A1 |
| **Description Principle** | (meta)data is retrieved by its identifier using standardized communication protocols. |
| **RaCE** | / \* The database use standardized protocols? \* /    Yes, uses standardized protocols for data access    / \* The database has proprietary software for data access? \* /    It does not have any proprietary software.    /\*Comments\*/    According to re3data, Genbank provides application programming interfaces via FTP, ftp://ftp.ncbi.nlm.nih.gov/genbank/. |
| **Result of RaCE (by color)** |  |
| **Recommendations?** | There are no improvements. |
| **MaCE** | There is no FAIR METRICS GEN2 for this principle. |
| **Result of RaCE (by color)** | There is no FAIR METRICS GEN2 for this principle. |
| **Recommendations?** | There is no FAIR METRICS GEN2 for this principle. |

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| **Principle** | A1.1 | |
| **Description Principle** | Protocol is open, free and universally implemented. | |
| **RaCE** | / \* Does it have open, free and universally implemented access? \* /    There are no restrictions on access to (meta)data.    /\*Comments\*/    There are cases where senders can claim patents, copyrights or other intellectual property rights in all or part of the data they have submitted. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | There are no improvements | |
| **MaCE** | **Uses Open Free Protocol for data Retrieval**  The data can be recovered by an open and free protocol. Tests the data GUID for resolution protocol. Currently passes InChI keys, DOIs, identifiers and URLs. Recognition of other identifiers will be added at the request of the community. | Several identifiers are returned that link to the data, even those that are not in the repository. DOI, URL, proper identifiers are examples of return when using JSON. |
| **Uses Open Free Protocol for Metadata Retrieval**  Metadata can be retrieved using an open and free protocol. Tests the metadata GUID for resolution protocol. Currently passes InChI keys, DOIs, identifiers and URLs. Recognition of other identifiers will be added at the request of the community. | The identifier is of the URI type, which can be resolved by an open protocol. |
| **Result of RaCE (by color)** | **Uses Open Free Protocol for data Retrieval** |  |
| **Uses Open Free Protocol for Metadata Retrieval** |  |
| **Recommendations?** | **Uses Open Free Protocol for data Retrieval** | There are no improvements. |
| **Uses Open Free Protocol for Metadata Retrieval** | There are no improvements. |

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| **Principle** | A1.2 | |
| **Description Principle** | The protocol allows for authentication and authorization when necessary. | |
| **RaCE** | / \* Does protocol allow authentication and authorization? \* /    Yes, the established protocol allows authentication and authorization of the data, even if no repository is needed. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | There are no improvements | |
| **MaCE** | **Data Authentication and Authorization**  Test a discovered data GUID for the ability to implement authentication and authorization in resolution protocol. He currently passes InChI keys, DOIs, identifiers and URLs. He also searches the metadata for the Dublin Core 'accessRights' property, which can point to a document that describes the data access process. The recognition of other identifiers will be added at the request of the community. | The GUID returned from the metadata is a URI, known to allow authentication / authorization. |
| **Metadata Authentication and Authorization**  Tests the metadata GUID for the ability to implement authentication and authorization in its resolution protocol. Currently passes InChI keys, DOIs, identifiers and URLs. Recognition of other identifiers will be added at the request of the community. | The GUID returned from the metadata is a URI, known to allow authentication / authorization. |
| **Result of RaCE (by color)** | **Data Authentication and Authorization** |  |
| **Metadata Authentication and Authorization** |  |
| **Recommendations?** | **Data Authentication and Authorization** | There are no improvements. |
| **Metadata Authentication and Authorization** | There are no improvements. |

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| **Principle** | A2 | |
| **Description Principle** | Metadata must be accessible even when data is no longer available. | |
| **RaCE** | / \* Is there a data versioning policy? \* /  There is a versioning ID in the Local ID called *Accession*.  *Sequence Versions:*A sequence version number consists of a basic access number, a period and a version suffix that begins with 1.1 (it is generally called an “accession dot version”). The basic access number identifies the sequence record and the version suffixes form the version series, starting with 1.1. A sequence accession number without the version suffix always refers to the most recent version of the sequence.  / \* (meta)data can be erased? \* /  No, once added they cannot be deleted.  / \* (meta)data can be updated? \* /  Yes, can be updated by the data owner  / \* Is it possible to access metadata of data that no longer exists? \* /  It's not possible.  / \* Is there a persistence policy? \* /  There is no persistence policy.  /\*Comments\*/  Until then the data can only be updated but not deleted, however even if they were deleted, the data are linked to the papers, which in this case are considered as "metadata". However, it is not known, until then, about deleted data.  Means on how to perform UPDATES [https://www.ncbi.nlm.nih.gov/genbank/update/](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.ncbi.nlm.nih.gov/genbank/update/) | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | Even with versioning policies, there is no persistence policy in case the data is non-existent.  Thus, to meet this metric, it is necessary to create a persistence policy that provides the means so that when data is deleted, its metadata is still present in the repository.  Metadata in text type, link to the most up-to-date data, metadata about the data holder, link to versioning repository containing old metadata, are examples of improvement. | |
| **MaCE** | **Persistence Metadata**  Metric for testing whether metadata contains a persistence policy, explicitly identified by a key persistencePolicy (in hashed data) or by a http://www.w3.org/2000/10/swap/pim/doc#persistencePolicy predicate in linked data. | It was not possible to find any persistence policy using any approach |
| **Result of RaCE (by color)** | **Metadata Persistence** |  |
| **Recommendations?** | **Persistence Metadata** | In order to comply with this metric, it is necessary to indicate a persistence policy in the registration source code. |

INTEROPERABLE

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| **Principle** | I1 | |
| **Description Principle** | Meta) data use formal, accessible, shared and widely applicable language for knowledge representation. | |
| **RaCE** | / \* Is there a use of languages ​​to represent knowledge? \* /    It does not use any knowledge representation language.    / \* Taxonomies, ontologies, controlled vocabularies are referenced or found in the repository? (Must meet F1) \* /    Taxonomies ( [https://www.ncbi.nlm.nih.gov/taxonomy](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.ncbi.nlm.nih.gov/taxonomy) ), controlled vocabularies (performed at the time of submission), and ontologies (GeneOntology) are found, not all of which comply with the F1 principle.    /\*Comments\*/    In the character of a data model, both data and metadata are well defined by means of established standards, however, taking into account the article The variable quality of metadata about biological samples used in biomedical experiments ”, most metadata do not refer to BioSample , thereby leaving metadata untraceable. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | It is necessary to use some knowledge representation language (RDF, OWL, DAML-OIL, JSON LD, are highly used examples).  Taxonomies, ontologies, controlled vocabularies must comply with the F1 principle. | |
| **MaCE** | **Metadata Knowledge Representation Language (WEAK)**  Maturity indicator to test whether metadata uses a formal language widely applicable to knowledge representation. This particular test has a broad view of what defines a 'knowledge representation language'; in this assessment, anything that can be represented as structured data will be accepted. | Structured data is found in its simplest form, such as HTML tables. |
| **Metadata Knowledge Representation Language (STRONG)**  Maturity indicator to test whether metadata uses a formal language widely applicable to knowledge representation. This particular test has a broad view of what defines a 'knowledge representation language'; in this evaluation, a knowledge representation language is interpreted as one in which the terms are semantically based on ontologies. Any form of RDF will pass this test (including RDF that is automatically extracted by third-party analyzers, such as Apache Tika). | No well-founded knowledge representation language, such as RDF, is found. |
| **Result of RaCE (by color)** | **Metadata Knowledge Representation Language (WEAK)** |  |
| **Metadata Knowledge Representation Language (STRONG)** |  |
| **Recommendations?** | **Metadata Knowledge Representation Language (WEAK)** | There are no improvements. |
| **Metadata Knowledge Representation Language (STRONG)** | It is necessary to use some well-founded knowledge representation language. |

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| **Principle** | I2 | |
| **Description Principle** | (meta)data use vocabularies that follow the FAIR principles. | |
| **RaCE** | / \* Do vocabularies follow FAIR principles? \* /    They don't follow.    /\*Comments\*/    BioSample can be considered as a repository where controlled vocabularies are stored in order to centralize, manage and structure metadata descriptions. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | Vocabularies must meet all FAIR principles, as they can be “called” the base repository, vocabularies that meet FAIR principles facilitate the design of a repository based on FAIR principles.    Using FAIR DATA POINT can be a way of meeting this principle. | |
| **MaCE** | **Metadata Uses Fair Vocabularies (WEAK)**  Maturity indicator to test whether linked data metadata uses resolved terms. This only tests if they resolve, and FAIR data does not resolve, so it is a rather weak test. | No resolvable predicates were found. |
| **Metadata Uses Fair Vocabularies (STRONG)**  Maturity indicator to test whether linked data metadata uses resolved linked data (FAIR) terms. | No resolved predicates were found for linked data |
| **Result of RaCE (by color)** | **Metadata Uses Fair Vocabularies (WEAK)** |  |
| **Metadata Uses Fair Vocabularies (STRONG)** |  |
| **Recommendations?** | **Metadata Uses Fair Vocabularies (WEAK)** | In order to have at least some way to use linked data, it is necessary that the data be written in knowledge representation languages. |
| **Metadata Uses Fair Vocabularies (STRONG)** | For linked data to be used, for this to occur, it is necessary that data be written in knowledge representation languages.  Use of FAIR DATA POINTS would assist in meeting this metric. |

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| **Principle** | I3 | |
| **Description Principle** | (meta)data includes qualified references for other (meta)data. | |
| **RaCE** | / \* Are structured data languages ​​used? \* /    There is not.    / \* Is there qualification among (meta)data entities? \* /    There is not.    /\*Comments\*/    Use of knowledge representation languages ​​would meet this requirement. | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | It is necessary to use knowledge representation languages ​​such as RDF, so that it is possible to establish qualified relationships. | |
| **MaCE** | **Metadata Contains Qualified Outward References**  Maturity indicator to test whether metadata is externally linked to third-party resources. It only tests metadata that can be represented as linked data. | 0 out of 0 triple discoveries in metalinked data pointed to resources hosted elsewhere. The minimum to pass this test is 1. |
| **Result of RaCE (by color)** | **Metadata Contains Qualified Outward References** |  |
| **Recommendations?** | **Metadata Contains Qualified Outward References** | It is necessary to use knowledge representation languages, such as RDF, so that it is possible to establish linked data in the registry. |

REUSABLE

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| **Principle** | R1 |
| **Description Principle** | (meta)data are richly described with the plurality of precise and relevant attributes. |
| **RaCE** | / \* Is there a standardization of (meta)data? \* /    Yes, the data is standardized for submission, however users do not always meet the submission requirements.    / \* Is there reference to metadata in other repositories? \* /    There are references to metadata from other repositories belonging to the NCBI, but not to repositories outside the NCBI.    /\*Comments\*/    At first, it is seen that GenBank meets the requirements of R1 since it is highly used by the vast majority of researchers in the area, however if it is necessary to access the metadata for the data, another platform, BioSample, must be accessed. |
| **Result of RaCE (by color)** |  |
| **Recommendations?** | There are no improvements. |
| **MaCE** | There is no FAIR METRICS GEN2 for this principle. |
| **Result of RaCE (by color)** | There is no FAIR METRICS GEN2 for this principle. |
| **Recommendations?** | There is no FAIR METRICS GEN2 for this principle. |

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| **Principle** | R1.1 | |
| **Description Principle** | (meta)data is published with clear and accessible data usage licenses. | |
| **RaCE** | / \* Usage licenses are found in the registry? \* /    No.    / \* Use licenses found in the repository? \* /    Yes.    / \* Link to use licenses \* /  [https://www.re3data.org/repository/r3d100010528](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.re3data.org/repository/r3d100010528)  [https://fairsharing.org/FAIRsharing.9kahy4](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://fairsharing.org/FAIRsharing.9kahy4) | |
| **Result of RaCE (by color)** |  | |
| **Recommendations?** | The use licenses are found in the repository, however they are not referenced in the records. | |
| **MaCE** | **Metadata Includes License (Weak)**  Maturity indicator for testing whether metadata contains an explicit license pointer.This 'weak' test will use a case-insensitive regular expression and scan key / value style metadata as well as linked data metadata. Tests: license attributes xhtml, dvia, dcterms, cc, data.gov.au and Schema in linked data and validates the value of these properties. | No License properties were found in the metadata. |
| **Metadata Includes License (Strong)**  Maturity indicator to test whether the linked data metadata contains an explicit license pointer. Tests: license attributes xhtml, dvia, dcterms, cc, data.gov.au and Schema in linked data and validates the value of these properties. | No License properties were found in the metadata. |
| **Result of RaCE (by color)** | **Metadata Includes License (Weak)** |  |
| **Metadata Includes License (Strong)** |  |
| **Recommendations?** | **Metadata Includes License (Weak)** | It is necessary to include in the records means to be able to identify the use licenses. Use of license xhtml, dvia, dcterms, cc, data.gov.au and Schema in linked data are examples to meet this metric. |
| **Metadata Includes License (Strong)** | It is necessary to include in the records means to be able to identify the use licenses. Use of license xhtml, dvia, dcterms, cc, data.gov.au and Schema in linked data are examples to meet this metric. |

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| **Principle** | R1.2 |
| **Description Principle** | (meta)data are associated with detailed provenance. |
| **RaCE** | / \* Provenance (Meta)data is identified? \* /    Yes, the provenance metadata is identified, access via FTP has more provenance data.    / \* There are documents to describe the source \* /    There are no provenance documents, but a paper ( [https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5824777/](https://translate.google.com/translate?hl=pt-BR&prev=_t&sl=pt&tl=en&u=https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5824777/) ) was found that mentions the use of provenance. |
| **Result of RaCE (by color)** |  |
| **Recommendations?** | Even if the (meta)data is associated with detailed provenance, there is no connection or documents that refer to the conception of a provenance. |
| **MaCE** | There is no FAIR METRICS GEN2 for this principle. |
| **Result of RaCE (by color)** | There is no FAIR METRICS GEN2 for this principle. |
| **Recommendations?** | There is no FAIR METRICS GEN2 for this principle. |

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| **Principle** | R1.3 |
| **Description Principle** | (meta)data meet community standards relevant to the domain. |
| **RaCE** | It is not possible to analyze this principle. |
| **Result of RaCE (by color)** | It is not possible to analyze this principle. |
| **Recommendations?** | It is not possible to analyze this principle. |
| **MaCE** | There is no FAIR METRICS GEN2 for this principle. |
| **Result of RaCE (by color)** | There is no FAIR METRICS GEN2 for this principle. |
| **Recommendations?** | There is no FAIR METRICS GEN2 for this principle. |