Mapping ISO metadata standards to codemeta

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The codemeta project recently proposed a vocabulary for software metadata. ISO Technical Committee 211 has published a set of metadata standards for geographic data and many kinds of related resources, including software. In order for ISO metadata creators and users to take advantage of the codemeta recommendations, a mapping from ISO elements to the codemeta vocabulary must exist. This mapping is complicated by differences in the approaches used by ISO and codemeta, primarily a difference between hard and soft typing of metadata elements. These differences are described in detail and a mapping is proposed that includes sixty-four of the sixty-eight codemeta V2 terms. The codemeta terms have also been mapped to dialects used by twenty-one software repositories, registries and archives. The average number of terms mapped in these cases is 11.2. The disparity between these numbers reflects the fact that many of the dialects that have been mapped to codemeta are focused on citation or dependency identification and management while ISO and codemeta share additional targets that include access, use, and understanding. Addressing this broader set of use cases requires more metadata elements.

1   # Mapping ISO metadata standards to codemeta

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9   # Abstract

10   The codemeta project recently proposed a vocabulary for software metadata. ISO Technical
11   Committee 211 has published a set of metadata standards for geographic data and many kinds of
12   related resources, including software. In order for ISO metadata creators and users to take
13   advantage of the codemeta recommendations, a mapping from ISO elements to the codemeta
14   vocabulary must exist. This mapping is complicated by differences in the approaches used by
15   ISO and codemeta, primarily a difference between hard and soft typing of metadata elements.
16   These differences are described in detail and a mapping is proposed that includes sixty-four of
17   the sixty-eight codemeta V2 terms. The codemeta terms have also been mapped to dialects used
18   by twenty-one software repositories, registries and archives. The average number of terms
19   mapped in these cases is 11.2. The disparity between these numbers reflects the fact that many of
20   the dialects that have been mapped to codemeta are focused on citation or dependency
21   identification and management while ISO and codemeta share additional targets that include
22   access, use, and understanding. Addressing this broader set of use cases requires more metadata
23   elements.

24   # Introduction

25   The Codemeta Project recently proposed 1) a vocabulary for documenting software and 2)
26   mappings between metadata fields used by a broad range of software repositories, registries and
27   archives (https://codemeta.github.io/crosswalk/). The vocabulary was designed to support several
28   different software use cases, including citation, discovery, use and, to some degree,
29   understanding. ISO Technical Committee 211 has developed generic metadata standards that are
30   widely used for geographic data of many kinds. These standards were also designed to document
31   many kinds of things and support many use cases (Habermann, 2018).

32   This paper describes a mapping between the conceptual model that underlies ISO metadata (ISO
33   19115-1) and Codemeta with the goal of facilitating the creation of codemeta-compliant
34   descriptions of software that is documented using the ISO standards. The communities that
35   developed these two metadata dialects share the important goal of comprehensive standards that
36   address multiple use cases for many disciplines. Both groups pursue this goal by developing
37   consensus, but the details of the processes used to develop their standards differ. ISO TC211
38   represents a traditional International standards body with well-defined processes and publication

39   methods. Codemeta represents a community of practitioners with an initial set of proposed
40   conventions on the Web and an invitation for adoption, experimentation and evolution.

41   In addition to these process differences, there are also differences between the structures and
42   implementations of these two models. These are described below with the mappings following.

Dialect Coverage and Scope

43

44   Mapping metadata for software between different schemas and dialects is an important technical
45   goal of codemeta. This goal is supported using a crosswalk file that is maintained and
46   contributed to in the codemeta git repository (Codemeta, 2018). This file lists the codemeta terms
47   along with equivalents in twenty-one dialects. This crosswalk is the basis for translating content
48   between these dialects.

49   A similar situation occurs in many in science communities that are trying to support multiple use
50   cases, i.e. document, share, and trust, for datasets using multiple metadata dialects (see Gordon
51   and Habermann, 2018). The concept of "Dialect Coverage" has come up in those studies as the
52   amount (%) of the concepts in a particular recommendation that a dialect includes. In the
53   codemeta case, this is the number of codemeta concepts that can be represented in the dialects
54   listed in the crosswalk file. Figure 1 shows this count for each of the twenty-one dialects. Both
55   versions of codemeta and ISO 19115-3 are included on the left side of this Figure as well.

56   The data show that the ISO dialect covers very close to all of the codemeta concepts and the
57   difference between the ISO mapping and others is striking. This difference reflects the
58   significant difference in requirements for discovering and citing software (or data) and being
59   able to use it and trust it. In the current software citation landscape, this is the difference between
60   codemeta, i.e. metadata for code, and the FORCE11 Software Citation Guidelines, i.e. metadata
61   for code citation (Smith et al., 2016).

Model Characteristics

62

63   The ISO metadata standards are based on a [UML model](#) that is harmonized across all standards
64   developed and managed by the committee. The model is built around classes and attributes that
65   describe the structure of the standards and the relationships among objects. ISO 19115-1 includes
66   thirteen top-level objects that provide details on identification, content, constraints, distribution,
67   quality, usage, reference systems, spatial representation and several other areas.

68   The ISO standard includes a scope element at the root of each record that gives the type of
69   resource described by the metadata. The default scope is dataset, but other options include:
70   aggregate, application, attribute, attributeType, collection, collectionHardware,
71   collectionSession, coverage, dimensionGroup, document, feature, featureType, fieldSession,
72   initiative, metadata, model, nonGeographicDataset, otherAggregate, platformSeries, product,
73   productionSeries, propertyType, repository, sample, sensor, sensorSeries, series, service,
74   **software**, tile, transferAggregate (see Habermann, 2018). Mapping the codemeta vocabulary to
75   the ISO standard is an initial step toward defining the content that could be included in ISO
76   metadata records that describe software and applications, i.e. those where the scope is software.

77   The most commonly used representation of the ISO standards is XML. ISO xPaths uniquely
78   identify metadata content and follow the structure of the UML model, with levels in the XML
79   alternating between objects (with types) and properties. This results in XML that is "striped" like

80   the XML representation of RDF (W3C, 2014), i.e. role/type/role/type/content. Types generally
81   start with two uppercase letters (MD, CI, ...) that indicate the UML package that they are defined
82   in (metadata, citation, ...) followed by an underscore (MD_, CI_, ...). Properties (termed roles in
83   this discussion) are in lower camel case. A significant benefit of the striped XML is that
84   properties can be defined with abstract objects that can share properties while being instantiated
85   with different types. For example, the ISO CI_Party object is abstract and includes name and
86   contact properties. It is extended and specialized by CI_Individual and CI_Organisation objects
87   which add properties that are relevant for people and organizations, e.g. organizations can
88   include individuals, logos, and position names. This approach also facilitates reuse by allowing
89   standard objects (e.g. people, organizations, or citations) to be referenced using links rather than
90   repetitive content (https://geo-ide.noaa.gov/wiki/index.php?title=ISO_Components).

91   Another benefit of this approach in ISO is the same as that in the schema.org case – communities
92   can extend object definitions when necessary and, in the ISO case, the resulting extended objects
93   fit naturally into the ISO XML representation. This approach is similar to the schema extension
94   model used in codemeta to add properties deemed important by the codemeta community to the
95   more general SoftwareSourceCode schema that is also a specialization of the
96   schema.CreativeWork schema.

97   The namespace for each element in the XML is identified using a standard namespace prefix
98   (mdb, cit, ...). Asterisks are used in the xPaths to indicate locations where several objects can be
99   used. For example, mdb:identificationInfo/*/ indicates that either mdb:MD_DataIdentification or
100 srv:SV_ServiceIdentification objects can occur in that location.

101 A simplified notation is introduced for paths through the UML conceptual model in this
102 document that includes only the role names and no information that is specific to the XML
103 representation. For example, the xPath
104 /mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:resourceSpecificUsa
105 ge/mri:MD_Usage/mri:identifiedIssues/cit:CI_Citation/cit:onlineResource/cit:CI_OnlineResourc
106 e/cit:linkage is replaced by the concept path:
107 identificationInfo.resourceSpecificUsage.identifiedIssues.onlineResource.linkage. These
108 simplified "concept paths" improve readability and emphasize equivalences between codemeta
109 and ISO in the conceptual space. Specific xPaths can be constructed from these concept paths
110 when necessary to implement translation of existing ISO content to codemeta representations.
111 The reverse translation is not unique.

112 Codemeta specifies a vocabulary rather than a structural model. It includes properties from
113 several schema.org schemas listed in Table 1 along with the number of items from each schema.
114 These schemas exist in a schema.org hierarchy which is similar in many ways to the ISO
115 structure. SoftwareApplication and SoftwareSourceCode schemas are both specializations of the
116 Thing > CreativeWork schema. Codemeta extends these schemas (in
117 codemeta.SoftwareSourceCode) with several properties that lack clear equivalents in
118 schema.org.

119   Hard Types and Soft Types

120 All standards and vocabularies need to make choices between hard or soft typing. Hard typing
121 requires specific names for items and is the only choice available in situations where names
122 alone can be used to distinguish between items. For example, if publication and revision dates
123 are required for complete descriptions of a resource, hard types would include two items: e.g.
124 publicationDate and revisionDate. Soft Typing can be used in dialects which support item
125 attributes as well as values. In that case, these two dates could be represented with the same
126 name and distinguished by a type attribute date(type=publication) and date(type=revision).

127 The difference between these two approaches emerges as the dialects evolve. Hard types evolve
128 by adding new elements to the underlying model, i.e. adding creationDate (or some other type of
129 date) when it becomes apparent that it is needed. Soft types evolve by adding items to the shared
130 vocabulary of date types, typically a codelist or thesaurus.

131 The critical difference between hard and soft types boils down to differences in governance
132 models and change tolerance. In communities that use hard types, members must be tolerant to
133 changes in the models and, typically, changes in tooling built on them. Communities that use soft
134 typing must have mechanisms for sharing and evolving vocabularies, typically control bodies or
135 rules.

136 The ISO model is soft-typed and the Codemeta model is hard-typed. Differences related to these
137 different approaches are listed in Table 2 and described below.

Citations

139 Connecting users to resources is one of the most important roles of metadata. It is also one of the
140 most ubiquitous. Several classes of citations are important:
141 1. Citation to the resource being described in the metadata (*Resource Citation*)
142 2. Citations to related resources (*Related Resource Citation*)
143 3. Citations to other, typically specific, resources (*Specific Resource Citations*).

ISO Citations

145 ISO 19115-1 includes all three types of citations:

146 • The *Resource Citation* is unique and occurs at a specific location in the conceptual
147   model: identificationInfo.citation (xPath =
148   /mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation).
149 • *Related Resource Citations* also occur at a specific location in the model,
150   identificationInfo.associatedResource (xPath =
151   /mdb:MD_Metadata/mdb:identificationInfo/*/mri:associatedResource/mri:MD_Associate
152   dResource/mri:name/cit:CI_Citation along with two codelists (associationType and
153   initiativeType) that provide information about how the resource is associated.).
154 • *Specific Resource Citations* occur in a number of locations in the ISO model as part of
155   specific classes. For example, citations to additional documentation occur at
156   identificationInfo.additionalDocumentation and citations to quality reports occur at
157   dataQualityInfo.standaloneQualityReport.

158 All ISO Citations include elements of traditional citations to books or papers e.g. title, authors
159 (people or organizations in many roles), dates (many types), series information, page numbers,

160 etc., as well as identifiers (ISSN, ISBN, and other types) and URLs with titles, descriptions and
161 types. The xPaths to these items are:

Codemeta Citations

163 Codemeta includes twenty-six terms that represent resources that are related to or support the use
164 of the software being described. These terms have several different types (Text, URL, Text or
165 URL, CreativeWork, CreativeWork or URL, Computer Language or text, ...). In the mappings
166 below, these terms are mapped to the ISO citations. The specific types can be described by
167 adding the paths in Table 3 to the concept or xPaths.

Distribution

169 Many of the distribution systems for geographic data described by ISO metadata include
170 repositories (generally called archives or data centers) that manage and preserve data while
171 providing on-going support for users. ISO metadata standards accommodate approaches to
172 resource distribution with or without descriptions of repositories (termed distributors) and each
173 repository can provide several URLs (transferOptions) for each resource. These onlineResources
174 can have any of the functions included in the CI_OnLineFunctionCode codelist in Table 2. The
175 most common online functions are download and information and these are used in the mappings
176 to indicate direct access to the resource (function=download) or information about the resource
177 (function=information).

Additional Documentation

179 The codemeta vocabulary includes many items that are intended to help users use and understand
180 the software described in the metadata. In the ISO standards, these items can be described in two
181 ways: as associated resources (identificationInfo.associatedResource) or as additional
182 documentation (identificationInfo.additionalDocumentation). I have chosen the later in these
183 cases. In dialects without specific citations, e.g. Datacite, these would be referred to as
184 relatedIdentifiers with appropriate relationTypes as the DataCite dialect is soft typed (DataCite
185 Metadata Working Group, 2017).

186 One important goal of codemeta is to enable authors to cite software that is used to store,
187 process, analyze, and visualize the data and model results that they use in their work. Increasing
188 citations from the scientific literature is large part of this goal, but there are also significant
189 opportunities to improve the completeness of dataset metadata by citing software. This is
190 generally done as part of the provenance or lineage section of the metadata. The ISO standards
191 provide several specific resource citations for citing software, including:

192 • resourceLineage.processStep.processingInformation.algorithm.citation,
193 • resourceLineage.processStep.processingInformation.softwareReference, and
194 • resourceLineage.processStep.processingInformation.documentation.

Mappings

196 The mappings between codemeta and ISO are presented here in a series of tables that correspond
197 to the source schema.org schemas used in order to provide some structure that may help clarify
198 the relationships and improve understanding. The mappings include the names, types, and

199 descriptions from the codemeta vocabulary and conceptual paths for the ISO items (ISO 19115-
200 1).

Schema:Person

202 The schema.Person schema provides a vocabulary for properties of people. In the ISO standards,
203 people and organizations are both referred to as parties and names can be given as any
204 combination of individual names, organization names, or positions. This mapping includes seven
205 items listed in Table 4.

Schema:Thing

207 The schema.Thing schema provides a vocabulary for properties of the most generic type of item.
208 In the context of codemeta, this item is the resource described by the metadata which is software.
209 In ISO 19115-1, properties related to the identification of the resource being described are in the
210 identificationInfo section and many of the properties are included in the citation to that resource.
211 As described above, these properties (title, identifier, and link) are included in all citations in the
212 ISO model. This mapping includes six items listed in Table 5.

Schema:Thing.CreativeWork

214 The Thing.CreativeWork schema provides a vocabulary for the most generic kind of creative
215 work, including books, movies, photographs, software programs, etc. This mapping includes
216 twenty-four items listed in Table 6.

Schema:Thing.CreativeWork.SoftwareSourceCode

218 The Thing.CreativeWork.SoftwareSourceCode schema provides a vocabulary for describing
219 computer programming source code. This mapping includes four items listed in Table 7.

Codemeta:SoftwareSourceCode

221 The codemeta:SoftwareSourceCode schema extends Thing.CreativeWork.SoftwareSourceCode
222 with terms created by the codemeta project. This mapping includes ten items listed in Table 8.

Schema:Thing.CreativeWork.SoftwareApplication

224 The Thing.CreativeWork.SoftwareApplication schema provides a vocabulary for describing a
225 software application. This mapping includes fifteen items listed in Table 9.

Conclusions

227 The ISO metadata standards were originally developed by ISO Technical Committee 211 to
228 serve as the standard and structured part of the documentation needed to discover, access, use,
229 and understand datasets. The standards acknowledge that they are generic, and they include
230 several mechanisms for extension to address specific needs of communities that use the
231 standards. The generic nature of these standards is reflected in the breadth of the codelist that can
232 be used to describe the scope of a particular metadata record (see list above and Habermann,
233 2018).

234 The codemeta project recently proposed over sixty elements that can be used in metadata for
235 software. This recommendation provides a framework that provides insight into what ISO
236 metadata for software might contain. The process of creating a mapping between these two
237 approaches surfaced some differences in approach that complicate the mapping. Some of these
238 differences are related to hard and soft typing used in the two models and others are related to
239 increased flexibility that is required in a generic standard for documenting citations, distribution
240 channels, and related resources.

241 ISO mappings are proposed for sixty-four of the sixty-eight codemeta V2 terms. These mappings
242 can be used to create codemeta-compliant metadata from existing stores of ISO metadata and to
243 add codemeta compliant software citations in the future. This compares to an average of 11.2
244 mappings for other dialects included in the codemeta crosswalk. This disparity reflects the use
245 cases targeted by the dialects. Many of the dialects that have been mapped to codemeta are
246 focused on citation or dependency identification and management while ISO and codemeta share
247 additional targets that include access, use, and understanding.

Acknowledgements

249 Parts of this material are based upon work supported by the National Science Foundation under
250 Grant No. NSFDACS11C1675 and by NASA/GSFC under Raytheon Co. contract number
251 NNG15HZ39C. Any opinions, findings, and conclusions or recommendations expressed in this
252 material are those of the author(s) and do not necessarily reflect the views of the sponsors.

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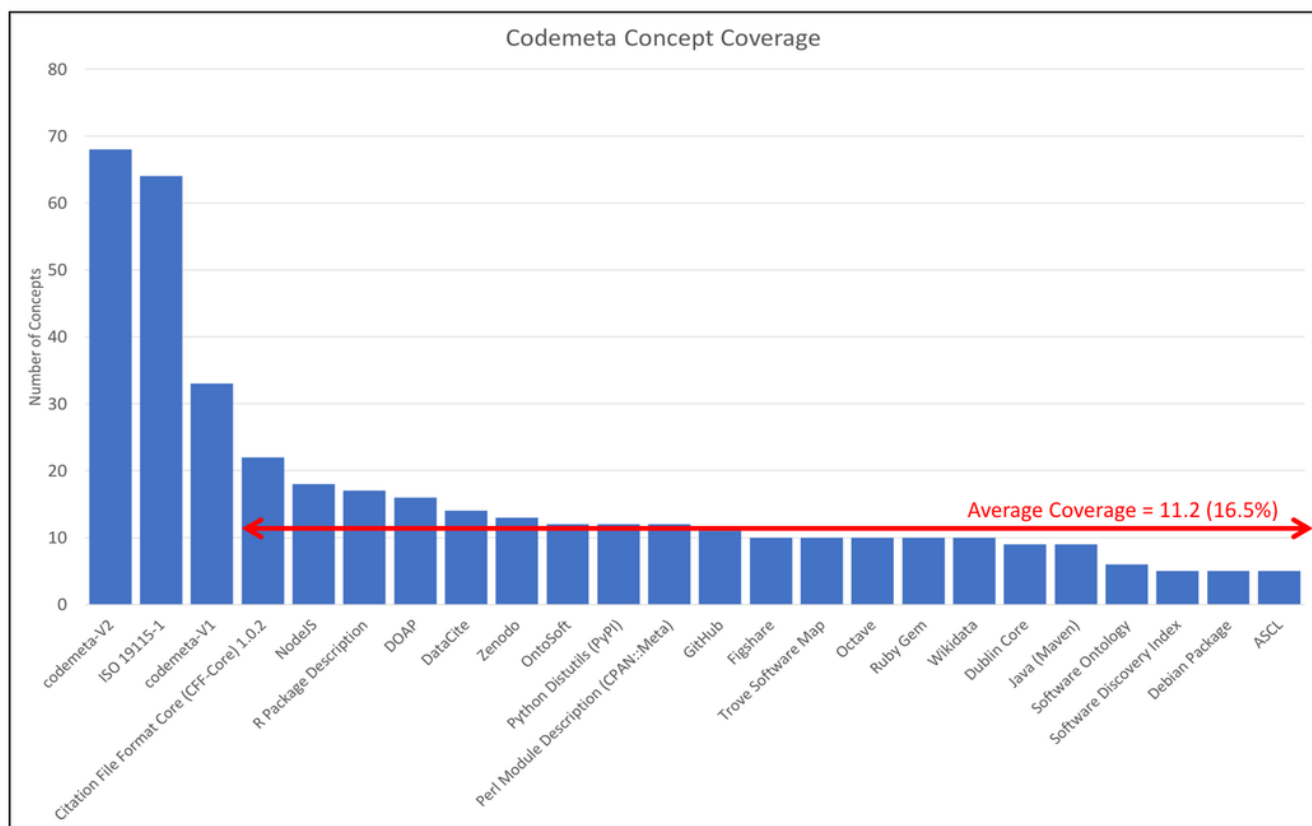
Figure 1

Coverage of codemeta concepts in multiple dialects.

The average number of codemeta concepts covered by twenty-one dialects is 11.2. The ISO dialect covers sixty-four of sixty-eight codemeta concepts.

Schema.org schemas and item counts for codemeta vocabulary.

Source	#Terms	Source	#Terms
schema:CreativeWork	24	schema:Thing	6
schema:SoftwareApplication	15	schema:SoftwareSourceCode	4
codemeta:SoftwareSourceCode	10	schema (not mapped)	2
schema:Person	7		

Codemeta hard types and related ISO codelists.

Item	Codemeta items	ISO 19115-1 codelist values*
Dates	embargoDate dateCreated dateModified datePublished	*CI_DateTypeCode*: creation publication revision expiry lastUpdate lastRevision nextUpdate unavailable inForce adopted deprecated superseded validityBegins validityExpires released distribution
People and Organizations	author contributor creator copyrightHolder editor funder producer provider publisher sponsor affiliation	*CI_RoleCode*: resourceProvider custodian owner user distributor originator pointOfContact principalInvestigator processor publisher author sponsor coAuthor collaborator editor mediator rightsHolder contributor funder stakeholder maintainer
Online Resource Types	buildInstructions contIntegration issueTracker readme id identifier downloadUrl installUrl codeRepository relatedLink sameAs url	*CI_OnLineFunctionCode*: download information offlineAccess order search completeMetadata browseGraphic upload emailService browsing fileAccess
Associations	supportingData	*DS_AssociationTypeCode*: crossReference largerWorkCitation partOfSeamlessDatabase stereoMate isComposedOf collectiveTitle series dependency revisionOf
Keyword	Keywords programmingLanguage applicationCategory applicationSubCategory	*MD_KeywordTypeCode*: discipline place stratum temporal theme dataCentre featureType instrument platform process project service product subTopicCategory taxon

2   *ISO 19115-1 Codelists from http://standards.iso.org/iso/19115/resources/Codelist/cat/codelists.html*

Relative xPaths to titles, identifiers, and URLs in ISO citations.

Item	xPath from CI_Citation
Title	cit:CI_Citation/cit:title/gco:CharacterString (concept = title)
Identifier	cit:CI_Citation/cit:identifier/mcc:MD_Identifier/mcc:code/gco:CharacterString (concept = identifier.code)
URL	cit:CI_Citation/cit:onlineResource/cit:CI_OnlineResource/cit:linkage/gco:CharacterString (concept = onlineResource.linkage)

Mapping of codemeta terms from the schema.Person schema to ISO 19115-1 and ISO 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
address	PostalAddress or Text	Physical address of the item.	party.contactInfo.address.deliveryPoint	cit:party/cit:CI_Organisation/cit:contactInfo/cit:CI_Contact/cit:address/cit:CI_Address/cit:deliveryPoint/gco:CharacterString
affiliation	Text	An organization that this person is affiliated with. For example, a school/university	party.name	cit:party/cit:CI_Organisation/cit:name/gco:CharacterString
email	Text	Email address	party.contactInfo.cit:address.electronicMailAddress	cit:party/cit:CI_Organisation/cit:contactInfo/cit:CI_Contact/cit:address/cit:CI_Address/cit:electronicMailAddress/gco:CharacterString
familyName	Text	Family name. In the U.S., the last name of an Person. This can be used along with givenName instead of the name property.	party.name	cit:party/cit:CI_Individual/cit:name/gco:CharacterString
givenName	Text	Given name. In the U.S., the first name of a Person. This can be used along with familyName instead of the name property	party.name	cit:party/cit:CI_Individual/cit:name/gco:CharacterString
identifier	URL	URL identifer, ideally an ORCID ID for individuals, a FundRef ID for funders	party.partyIdentifier.code	cit:party/cit:CI_Organisation/cit:partyIdentifier/mcc:MD_Identifier/mcc:code/gco:CharacterString
name	Text	The name of an Organization, or if separate given and family names cannot be resolved for a Person	party.name	cit:party/cit:CI_Organisation/cit:name/gco:CharacterString

Mapping of codemeta terms from the schema.Thing schema to ISO 19115-1 and ISO 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
description	Text	A description of the item.	identificationInfo.abstract	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:abstract/gco:CharacterString
identifier	PropertyValue or URL	The identifier property represents any kind of identifier for any kind of Thing, such as ISBNs, GTIN codes, UUIDs etc. Schema.org provides dedicated properties for representing many of these, either as textual strings or as URL (URI) links. See background notes for more details.	identificationInfo.citation.identifier.code	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:identifier/mcc:M D_Identifier/mcc:code
name	Text	The name of the item (software, Organization)	identificationInfo.citation.title	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:title/gco:Characte rString
relatedLink	URL	A link related to this object, e.g. related web pages	identificationInfo.citation.onlineResource [function='information']	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:onlineResource/ci t:CI_OnlineResource/mdb:MD_Metadata/mdb:i dentificationInfo/*/mri:citation/cit:CI_Citation/c it:onlineResource/cit:CI_OnlineResource[gmd:fu nction/gmd:CI_OnLineFunctionCode,'informatio n'] /cit:linkage
sameAs	URL	URL of a reference Web page that unambiguously indicates the item's identity. E.g. the URL of the item's Wikipedia page, Wikidata entry, or official website.	identificationInfo.citation.onlineResource [function='information']	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:onlineResource/ci t:CI_OnlineResource/mdb:MD_Metadata/mdb:i dentificationInfo/*/mri:citation/cit:CI_Citation/c it:onlineResource/cit:CI_OnlineResource[gmd:fu nction/gmd:CI_OnLineFunctionCode,'informatio n'] /cit:linkage
url	URL	URL of the item.	identificationInfo.citation.onlineResource [function='download']	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:onlineResource/ci t:CI_OnlineResource[gmd:function/gmd:CI_OnLi neFunctionCode,'download']/cit:linkage

Mapping of codemeta terms from the Thing.CreativeWork schema to ISO 19115-1 and ISO 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
author	Organization or Person	The author of this content or rating. Please note that author is special in that HTML 5 provides a special mechanism for indicating authorship via the rel tag. That is equivalent to this and may be used interchangeably.	identificationInfo.citation. citedResponsibleParty[role='author'].party.name or identificationInfo.citation. citedResponsibleParty[role='originator'].party.name	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='author'] or /mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='originator']
citation	CreativeWork or URL	A citation or reference to another creative work, such as another publication, web page, scholarly article, etc.	identificationInfo.associatedResource.name	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:associatedResource/mri:MD_AssociatedReso urce/mri:name/cit:CI_Citation
contributor	Organization or Person	A secondary contributor to the CreativeWork or Event.	identificationInfo.citation.citedResponsibleParty [not(role='author' or role='principalInvestigator' or role='originator')].party.name	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[not(cit:role/cit:CI_Role Code='author' or cit:role/cit:CI_RoleCode='principalInvestigator' or cit:role/cit:CI_RoleCode='originator')] /cit:party/*/cit:name
copyright Holder	Organization or Person	The party holding the legal copyright to the CreativeWork.	identificationInfo.resourceConstraints.reference. citedResponsibleParty	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:resourceConstraints/mco:MD_LegalConstrai nts/mco:reference/cit:CI_Citation/cit:citedRespo nsibleParty/cit:CI_Responsibility
copyright Year	Number	The year during which the claimed copyright for the CreativeWork was first asserted.	identificationInfo.resourceConstraints.reference. date[dateType='publication'].date	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:resourceConstraints/mco:MD_LegalConstrai nts/mco:reference/cit:CI_Citation/cit:date/cit:CI _Date[cit:dateType/cit:CI_DateTypeCode='public ation']/cit:dateType
creator	Organization or Person	The creator/author of this CreativeWork. This is the same as the Author property for CreativeWork.	identificationInfo.citation.citedResponsibleParty [role='author'].party.name or identificationInfo.citation.citedResponsibleParty[role='o riginator'].party.name	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='author'] or /mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='originator']
date Created	Date or DateTime	The date on which the CreativeWork was created or the item was added to a DataFeed.	identificationInfo.citation.date[dateType='creation']. date	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:date/cit:CI_Date[c it:dateType/cit:CI_DateTypeCode='creation']/cit: date/gco:DateTime
date Modified	Date or DateTime	The date on which the CreativeWork was most recently modified or when the item's entry was modified within a DataFeed.	identificationInfo.citation.date[dateType='revision']. date	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:date/cit:CI_Date[c it:dateType/cit:CI_DateTypeCode='revision']/cit: date/gco:DateTime

Property	Type	Description	ISO 19115-1	ISO 19115-3
date Published	Date	Date of first broadcast/publication.	identificationInfo.citation.date[dateType='publication'].date	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:date/cit:CI_Date[cit:dateType/cit:CI_DateTypeCode='publication']/cit:date/gco:Date
editor	Person	Specifies the Person who edited the CreativeWork.	identificationInfo.citation.citedResponsibleParty[role='editor']	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:citedResponsibleParty/cit:CI_Responsibility[cit:role/cit:CI_RoleCode='editor']
encoding	MediaObject	A media object that encodes this CreativeWork. This property is a synonym for associatedMedia. Supersedes encodings.		
fileFormat	Text or URL	Media type, typically MIME format (see IANA site) of the content e.g. application/zip of a SoftwareApplication binary. In cases where a CreativeWork has several media type representations, 'encoding' can be used to indicate each MediaObject alongside particular fileFormat information. Unregistered or niche file formats can be indicated instead via the most appropriate URL, e.g. defining Web page or a Wikipedia entry.	identificationInfo.resourceFormat.formatSpecificationCitation	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:resourceFormat/mrd:MD_Format/mrd:formatSpecificationCitation/cit:CI_Citation
funder	Organization or Person	A person or organization that supports (sponsors) something through some kind of financial contribution.	identificationInfo.citation.citedResponsibleParty[role='funder']	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:citedResponsibleParty/cit:CI_Responsibility[cit:role/cit:CI_RoleCode='funder']
hasPart	CreativeWork	Indicates a CreativeWork that is (in some sense) a part of this CreativeWork. Reverse property isPartOf	identificationInfo.associatedResource[associationType='isComposedOf'].name	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:associatedResource/mri:MD_AssociatedResource[mri:associationType/mri:DS_AssociationTypeCode='isComposedOf']/mri:name/cit:CI_Citation
isAccessible ForFree	Boolean	A flag to signal that the publication is accessible for free.	distributionInfo.distributionFormat.formatDistributor.distributionOrderProcess.fees	/mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:distributionFormat/mrd:MD_Format/mrd:formatDistributor/mrd:MD_Distributor/mrd:distributionOrderProcess/mrd:MD_StandardOrderProcess/mrd:fees
isPartOf	CreativeWork	Indicates a CreativeWork that this CreativeWork is (in some sense) part of. Reverse property hasPart	identificationInfo.associatedResource[associationType='LargerWorkCitation'].name	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:associatedResource/mri:MD_AssociatedResource[mri:associationType/mri:DS_AssociationTypeCode='LargerWorkCitation']/mri:name/cit:CI_Citation
keywords	Text	Keywords or tags used to describe this content. Multiple entries in a keywords list are typically delimited by commas.	identificationInfo.descriptiveKeywords[type='theme'].keyword	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:descriptiveKeywords/mri:MD_Keywords[mri:type/mri:MD_KeywordTypeCode='theme']/mri:keyword/gco:CharacterString
license	CreativeWork or URL	A license document that applies to this content, typically indicated by URL.	identificationInfo.resourceConstraints.reference	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:resourceConstraints/mco:MD_LegalConstraints/mco:reference/cit:CI_Citation

Property	Type	Description	ISO 19115-1	ISO 19115-3
position	Integer or Text	The position of an item in a series or sequence of items. (While schema.org considers this a property of CreativeWork, it is also the way to indicate ordering in any list (e.g. the Authors list). By default arrays are unordered in JSON-LD		
producer	Organization or Person	The person or organization who produced the work (e.g. music album, movie, tv/radio series etc.).	identificationInfo.citation.citedResponsibleParty [role='creator'].party	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='creator']/cit:party/*
provider	Organization or Person	The service provider, service operator, or service performer; the goods producer. Another party (a seller) may offer those services or goods on behalf of the provider. A provider may also serve as the seller. Supersedes carrier.	identificationInfo.pointOfContact [role='pointOfContact'].party	/mdb:MD_Metadata/mdb:identificationInfo/srv: SV_ServiceIdentification/mri:pointOfContact/ cit:CI_Responsibility[cit:role/cit:CI_RoleCode='pr ovider']/cit:party/*
publisher	Organization or Person	The publisher of the creative work.	identificationInfo.citation.citedResponsibleParty [role='publisher'].party	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='publisher']/cit:party/*
sponsor	Organization or Person	A person or organization that supports a thing through a pledge, promise, or financial contribution. e.g. a sponsor of a Medical Study or a corporate sponsor of an event.	identificationInfo.citation.citedResponsibleParty [role='sponsor'].party	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:citedResponsibleP arty/cit:CI_Responsibility[cit:role/cit:CI_RoleCod e='sponsor']/cit:party/*
version	Number or Text	The version of the CreativeWork embodied by a specified resource.	identificationInfo.citation.edition	/mdb:MD_Metadata/mdb:identificationInfo/mri: MD_DataIdentification/mri:citation/cit:CI_Citatio n/cit:edition/gco:CharacterString

Mapping of codemeta terms from the Thing.CreativeWork.SoftwareSourceCode schema to ISO 19115-1 and ISO 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
Code Repository	URL	Link to the repository where the un-compiled, human readable code and related code is located (SVN, github, CodePlex).	distributionInfo.distributor.distributorTransferOptions. onLine[function='download'].linkage or distributionInfo.distributor.distributorTransferOptions. onLine[function='information'].linkage or distributionInfo.transferOptions.onLine [function='download'].linkage or distributionInfo.transferOptions.onLine [function='information'].linkage or identificationInfo.citation.onlineResource [function='download'].linkage or identificationInfo.citation.onlineResource [function='information'].linkage	/mdb:MD_Metadata/mdb:distributionInfo/mrd: MD_Distribution/mrd:distributor/mrd:MDDistri butor/mrd:distributorTransferOptions/mrd:MD DigitalTransferOptions/mrd:onLine/cit:CI_OnLin eResource[cit:function/cit:CI_OnLineFunctionCo de='information']/cit:linkage/gco:CharacterStrin g or /mdb:MD_Metadata/mdb:distributionInfo/mrd: MD_Distribution/mrd:transferOptions/mrd:MD DigitalTransferOptions/mrd:onLine/cit:CI_OnLin eResource[cit:function/cit:CI_OnLineFunctionCo de='information'] /cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:onlineResource/ci t:CI_OnLineResource[cit:function/cit:CI_OnLineF unctionCode='information'] /cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:distributionInfo/mrd: MD_Distribution/mrd:distributor/mrd:MDDistri butor/mrd:distributorTransferOptions/mrd:MD DigitalTransferOptions/mrd:onLine/cit:CI_OnLin eResource[cit:function/cit:CI_OnLineFunctionCo de='download'] /cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:distributionInfo/mrd: MD_Distribution/mrd:transferOptions/mrd:MD DigitalTransferOptions/mrd:onLine/cit:CI_OnLin eResource[cit:function/cit:CI_OnLineFunctionCo de='download'] /cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:identificationInfo/*/ mri:citation/cit:CI_Citation/cit:onlineResource/ci t:CI_OnLineResource[cit:function/cit:CI_OnLineF unctionCode='download'] /cit:linkage/gco:CharacterString
Programmin gLanguage	Computer Language or Text	The computer programming language.	identificationInfo.descriptiveKeywords[type='theme']. keyword	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:descriptiveKeywords/mri:MD_Keywords[mri :type/mri:MD_KeywordTypeCode='theme']/mri: keyword/gco:CharacterString
Runtime Platform	Text	Runtime platform or script interpreter dependencies (Example - Java v1, Python2.3, .Net Framework 3.0). Supersedes runtime.	identificationInfo.environmentDescription	/mdb:MD_Metadata/mdb:identificationInfo/mri :MD_DataIdentification/mri:environmentDescri ption/gco:CharacterString
Target Product	Software Application	Target Operating System / Product to which the code applies. If applies to several versions, just the product name can be used.	identificationInfo.associatedResource	/mdb:MD_Metadata/mdb:identificationInfo/*/ mri:associatedResource/mri:MD_AssociatedRes ource/mri:name/cit:CI_Citation

Mapping of codemeta terms from the codemeta.SoftwareSourceCode schema to ISO 19115-1 and ISO 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
build Instructions	URL	link to installation instructions/documentation	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
cont Integration	URL	link to continuous integration service	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
development Status	Text	Description of development status, e.g. Active, inactive, supsended. See repostatus.org	identificationInfo.status	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:status/mcc:MD_ProgressCode
embargo Date	Date	Software may be embargoed from public access until a specified date (e.g. pending publication, 1 year from publication)	identificationInfo.citation.date[dateType='released'].date	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:date/cit:CI_Date[cit:dateType/cit:CI_DateTypeCode='released']/cit:date/gco:DateTime
funding	Text	Funding source (e.g. specific grant)	identificationInfo.associatedResource	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:associatedResource/mri:MD_AssociatedResource/mri:name/cit:CI_Citation
issueTracker	URL	link to software bug reporting or issue tracking system	identificationInfo.resourceSpecificUsage.identifiedIssues.onlineResource.linkage	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:resourceSpecificUsage/mri:MD_Usage/mri:identifiedIssues/cit:CI_Citation
maintainer	Person	Individual responsible for maintaining the software (usually includes an email contact address)	identificationInfo.pointOfContact	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:pointOfContact
readme	URL	link to software Readme file	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
reference Publication	ScholarlyArticle	An academic publication related to the software.	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
software Suggestions	SoftwareSourceCode	Optional dependencies, e.g. for optional features, code development, etc	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation

Mapping of Codemeta terms from the schema:Thing.CreativeWork.SoftwareApplication schema to ISO 19115-1 and 19115-3.

Property	Type	Description	ISO 19115-1	ISO 19115-3
application Category	Text or URL	Type of software application, e.g. 'Game, Multimedia'.	identificationInfo.descriptiveKeywords[type='theme'].keyword	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:descriptiveKeywords/mri:MD_Keywords[mri:type/mri:MD_KeywordTypeCode='theme']/mri:keyword/gco:CharacterString
application SubCategory	Text or URL	Subcategry of the application, e.g. 'Arcade Game'.	identificationInfo.descriptiveKeywords[type='theme'].keyword	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:descriptiveKeywords/mri:MD_Keywords[mri:type/mri:MD_KeywordTypeCode='theme']/mri:keyword/gco:CharacterString
download Url	URL	If the file can be downloaded, URL to download the binary.	distributionInfo.distributor.distributorTransferOptions.onLine[function='download'] or distributionInfo.transferOptions.onLine[function='download'].linkage or identificationInfo.citation.onlineResource[function='download'].linkage	/mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:distributor/mrd:MD_Distributor/mrd:distributorTransferOptions/mrd:MD_DigitalTransferOptions/mrd:onLine/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download']/cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:transferOptions/mrd:MD_DigitalTransferOptions/mrd:onLine/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download'] /cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:onlineResource/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download'] /cit:linkage/gco:CharacterString
fileSize	Text	Size of the application / package (e.g. 18MB). In the absence of a unit (MB, KB etc.), KB will be assumed.	distributionInfo.transferOptions.transferSize or distributionInfo.distributionFormat.formatDistributor.distributorTransferOptions.transferSize or distributionInfo.distributor.distributorTransferOptions.transferSize	/mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:transferOptions/mrd:MD_DigitalTransferOptions/mrd:transferSize/gco:Real or /mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:distributionFormat/mrd:MD_Format/mrd:formatDistributor/mrd:MD_Distributor/mrd:distributorTransferOptions/mrd:MD_DigitalTransferOptions/mrd:transferSize/gco:Real or /mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:distributor/mrd:MD_Distributor/mrd:distributorTransferOptions/mrd:MD_DigitalTransferOptions/mrd:transferSize/gco:Real
installUrl	URL	URL at which the app may be installed, if different from the URL of the item.	distributionInfo.distributor.distributorTransferOptions.onLine[function='download'].linkage or distributionInfo.transferOptions.onLine[function='download'].linkage or identificationInfo.citation.onlineResource[function='download'].linkage	/mdb:MD_Metadata/mdb:distributionInfo/mrd:MD_Distribution/mrd:distributor/mrd:MD_Distributor/mrd:distributorTransferOptions/mrd:MD_DigitalTransferOptions/mrd:onLine/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download']/cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:distributionInfo/mrd:

Property	Type	Description	ISO 19115-1	ISO 19115-3
				MD_Distribution/mrd:transferOptions/mrd:MD_DigitalTransferOptions/mrd:onLine/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download']/cit:linkage/gco:CharacterString or /mdb:MD_Metadata/mdb:identificationInfo/*/mri:citation/cit:CI_Citation/cit:onlineResource/cit:CI_OnlineResource[cit:function/cit:CI_OnLineFunctionCode='download']/cit:linkage/gco:CharacterString
memory Requirements	Text or URL	Minimum memory requirements.	identificationInfo.environmentDescription	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:environmentDescription/gco:CharacterString
operating System	Text	Operating systems supported (Windows 7, OSX 10.6, Android 1.6).	identificationInfo.environmentDescription	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:environmentDescription/gco:CharacterString
permissions	Text	Permission(s) required to run the app (for example, a mobile app may require full internet access or may run only on wifi).	identificationInfo.resourceConstraints or identificationInfo.resourceConstraints.reference.onlineResource.linkage	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:resourceConstraints/mco:MD_LegalConstraints or /mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:resourceConstraints/mco:MD_LegalConstraints/mco:reference/cit:CI_Citation/cit:onlineResource/cit:CI_OnlineResource/cit:linkage
processor Requirements	Text	Processor architecture required to run the application (e.g. IA64).	identificationInfo.environmentDescription	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:environmentDescription/gco:CharacterString
release Notes	Text or URL	Description of what changed in this version.	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
software Help	CreativeWork	Software application help.	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
software Requirements	SoftwareSourceCode	Required software dependencies	identificationInfo.additionalDocumentation	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:additionalDocumentation/cit:CI_Citation
software Version	Text	Version of the software instance.	identificationInfo.citation.edition	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:citation/cit:CI_Citation/cit:edition
storage Requirements	Text or URL	Storage requirements (free space required).	identificationInfo.environmentDescription	/mdb:MD_Metadata/mdb:identificationInfo/mri:MD_DataIdentification/mri:environmentDescription/gco:CharacterString
supporting Data	DataFeed	Supporting data for a Software Application.	identificationInfo.associatedResource.name	/mdb:MD_Metadata/mdb:identificationInfo/*/mri:associatedResource/mri:MD_AssociatedResource/mri:name/cit:CI_Citation