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ISO 19157-1:2023

Australian/New Zealand Standard™

Geographic information — Data quality

Part 1: General requirements

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Geographic information — Data quality

Part 1: General requirements

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Preface

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee IT-004, Geographical Information/Geomatics, to supersede AS/NZS ISO 19157:2015 and its Amendment 1 (2019)

The objective of this document is to establish the principles for describing the quality of geographic data. The document outlines the following:

(a) a well-considered system of components for describing data quality;

(b) the process for defining additional, domain-specific components for describing data quality;

(c) components and the content structure of data quality measures;

(d) general procedures for evaluating the quality of geographic data; and

(e) principles for reporting data quality.

This document is applicable to data producers providing quality information to describe and assess how well a data set conforms to its product specification and to data users attempting to determine whether or not specific geographic data are of sufficient quality for their particular application.

This document does not attempt to define minimum acceptable levels of quality for geographic data. Such information is usually present as a requirement in a data product specification, defined in accordance with AS/NZS ISO 19131, for example.

This document is identical with, and has been reproduced from, ISO 19157-1:2023, *Geographic information — Data quality — Part 1: General requirements.*

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The terms “normative” and “informative” are used in Standards to define the application of the appendices or annexes to which they apply. A “normative” appendix or annex is an integral part of a Standard, whereas an “informative” appendix or annex is only for information and guidance.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287, *Geographic Information,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This first edition of ISO 19157-1, together with ISO 19157-3, cancels and replaces the first edition (ISO 19157:2013), which has been technically revised. It also incorporates the Amendment ISO 19157:2013/Amd 1:2018.

The main changes are as follows:

A list of all parts in the ISO 19157 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

Geographic data are increasingly being shared, interchanged and used for purposes other than their producers' intended ones. Information about the quality of available geographic data is vital to the process of selecting a dataset in that the value of data are directly related to their quality. A user of geographic data can have multiple datasets from which to choose. Therefore, it is necessary to compare the quality of the datasets to determine which best fulfils the requirements of the user.

The purpose of describing the quality of geographic data is to facilitate the comparison and selection of the dataset best suited to application needs or requirements. Complete descriptions of the quality of a dataset will encourage the sharing, interchange and use of appropriate datasets. Information on the quality of geographic data allows a data producer to evaluate how well a dataset meets the criteria set forth in its product specification and assists data users in evaluating a product's ability to satisfy the requirements for their particular application. For the purpose of this evaluation, clearly-defined procedures are used in a consistent manner.

To facilitate comparisons, it is essential that the results of the quality are expressed in a comparable way and that there is a common understanding of the data quality measures that have been used. These data quality measures provide descriptors of the quality of geographic data through comparison with the universe of discourse. The use of incompatible measures makes data quality comparisons impossible to perform. This document standardizes the components and structures of data quality measures and defines commonly used data quality measures.

This document recognizes that a data producer and a data user can potentially view data quality from different perspectives. Conformance quality levels can be set using the data producer's product specification or a data user's data quality requirements. If the data user requires more data quality information than that provided by the data producer, the data user can follow the data producer's data quality evaluation process flow to get the additional information. In this case the data user requirements are treated as a product specification for the purpose of using the data producer process flow.

The objective of this document is to provide a framework for defining the quality of geographic data. This includes principles for evaluating quality, a conceptual model for handling quality information, a structure and content of data quality measures, and guidelines for reporting a quality evaluation. The framework is extensible, with rules for how to add additional data quality measures. It also provides for complex dimensions of data quality.

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Australian/New Zealand Standard

Geographic information — Data quality

Part 1: General requirements

1 Scope

This document establishes the principles for describing the quality of geographic data. It:

This document is applicable to data producers providing quality information to describe and assess how well a dataset conforms to its product specification and to data users attempting to determine whether or not specific geographic data are of sufficient quality for their particular application.

This document does not attempt to define minimum acceptable levels of quality for geographic data. Such information is usually present as a requirement in a data product specification, defined in accordance with ISO 19131, for example.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 19103:2015, *Geographic information — Conceptual schema language*

ISO 19109:2015, *Geographic information — Rules for application schema*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: Fundamentals*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

3.1
accuracy
closeness of agreement between a test result or measurement result and the true value

Note 1 to entry: In this document, the true value can be a reference value that is accepted as true.

[SOURCE: ISO 3534-2:2006, 3.3.1, modified — Notes 1, 2 and 3 to entry have been removed. A new Note 1 to entry has been added.]

3.2
conformance
conformity
fulfilment of a requirement

Note 1 to entry: When there is no ambiguity, the modifier "conformance" may be omitted. For example, "test report" is the same as "conformance test report".

[SOURCE: ISO 19105:2022, 3.4]

3.3
conformance quality level
threshold value or set of threshold values for data quality results used to determine how well a dataset meets the criteria set forth in its data product specification or user requirements

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3.4
correctness
correspondence with the universe of discourse

3.5
coverage
feature that acts as a function to return values from its range for any direct position within its domain

[SOURCE: ISO/FDIS 19123-1:—,[1)] 3.1.8]

3.6
data product specification
specification of a data product together with additional information that will enable it to be created, supplied to and used by another party

Note 1 to entry: A data product specification provides a description of the universe of discourse and a specification for mapping the universe of discourse to a data product. It may be used for production, sales, end-use or other purposes.

Note 2 to entry: A specification is a document stating requirements (see ISO 9000:2015, 3.8.7).

Note 3 to entry: A data product is a dataset or a dataset series that may be supplied (see ISO 19131:2022, 3.8),

[SOURCE: ISO 19131:2022, 3.9, modified — Notes 2 and 3 to entry have been added.]

3.7
data quality
degree to which a set of inherent characteristics of data fulfils requirements

[SOURCE: ISO 8000-2:2022, 3.8.1, modified — Note 1 to entry has been removed.]

3.8
data quality measure
variable to which a value is assigned as the result of measurement of a data quality characteristic

[SOURCE: ISO/IEC 25012:2008, 4.5, modified — Note 1 to entry has been removed.]

3.9
data quality unit
combination of a scope and data quality elements

3.10
dataset
identifiable collection of data

Note 1 to entry: A dataset can be a smaller grouping of data which, though limited by some constraint such as spatial extent or *feature type*, is located physically within a larger dataset. Theoretically, a dataset can be as small as a single *feature* or *feature attribute* contained within a larger dataset. A hardcopy map or chart can be considered a dataset.

[SOURCE: ISO 19115-1:2014, 4.3]

3.11
dataset series
collection of datasets sharing common characteristics

[SOURCE: ISO 19115-1:2014, 4.4]

1) Under preparation. Stage at the time of publication: ISO/FDIS 19123-1:2023.

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3.12
feature
abstraction of real world phenomena

Note 1 to entry: A feature can occur as a type or an instance. Feature type or feature instance will be used when only one is meant.

[SOURCE: ISO 19101-1:2014, 4.1.11]

3.13
feature attribute
characteristic of a feature

Note 1 to entry: A feature attribute has a name, a data type and a value domain associated with it. A feature attribute for a feature instance also has an attribute value taken from the value domain.

[SOURCE: ISO 19101-1:2014, 4.1.12 modified — Examples 1 and 2, and Notes 2 and 3 to entry have been removed.]

3.14
feature instance
individual of a given feature type having specified feature attribute values

[SOURCE: ISO 19101-1:2014, 4.1.14]

3.15
feature operation
operation that every instance of a feature type may perform

[SOURCE: ISO 19110:2016, 3.7, modified — Example and Note 1 to entry have been removed.]

3.16
feature type
class of features having common characteristics

[SOURCE: ISO 19156:2011, 4.7]

3.17
geographic data
data with implicit or explicit reference to a location relative to the Earth

[SOURCE: ISO 19109:2015, 4.13, modified — Note 1 to entry has been removed.]

3.18
item
anything that can be described and considered separately

Note 1 to entry: An item can be any part of a *dataset*, such as a *feature*, feature relationship, *feature attribute*, or combination of these.

[SOURCE: ISO 2859-5:2005, 3.4, modified — Example has been removed. Note 1 to entry has been added.]

3.19
lineage
provenance, source(s) and production process(es) used in producing a resource

[SOURCE: ISO 19115-1:2014, 4.9]

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3.20
metadata
information about a resource

[SOURCE: ISO 19115-1:2014, 4.10]

3.21
metaquality
information describing the quality of data quality

3.22
quality
degree to which a set of inherent characteristics of an object fulfils requirements

[SOURCE: ISO 9000:2015, 3.6.2, modified — Note 1 and 2 to entry have been removed.]

3.23
quality evaluation
systematic examination of the extent to which an entity is capable of fulfilling specified requirements

[SOURCE: ISO/IEC/IEEE 24765:2017, 3.3267, modified — Note 1 to entry has been removed.]

3.24
register
set of files containing identifiers assigned to items with descriptions of the associated items

[SOURCE: ISO 19135-1:2015, 4.1.9]

3.25
requirement
need or expectation that is stated, generally implied or obligatory

[SOURCE: ISO 9000:2015, 3.6.4, modified — Notes 1-6 to entry have been removed.]

3.26
quality evaluation report
quality report
free text document providing fully-detailed information about data quality evaluations, results and measures used

3.27
uncertainty
measurement uncertainty
parameter, associated with the result of measurement, that characterizes the dispersion of values that could reasonably be attributed to the measurand

Note 1 to entry: Uncertainty of measurement comprises, in general, many components. Some of these components may be evaluated from the statistical distribution of the results of series of measurements and can be characterized by experimental standard deviations. The other components, which can also be characterized by standard deviations, are evaluated from assumed probability distributions based on experience or other information.

[SOURCE: ISO 19116:2019, 3.28, modified — Note 1 to entry has been removed and replaced with Note 2 to entry from ISO 19101-2:2018, 3.40.]

3.28
universe of discourse
view of the real or hypothetical world that includes everything of interest

[SOURCE: ISO 19101-1:2014, 4.1.38]

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4 Abbreviated terms and packages

4.1 Abbreviated terms

ADQR aggregated data quality result

AQL acceptance quality limit

GML Geographic Markup Language

UML Unified Modelling Language

XML Extensible Markup Language

4.2 Abbreviated packages

Abbreviations are used to denote the package that contains a class. Those abbreviations precede class names, connected by a "_". A list of those abbreviations is listed in Table 1. The International Standard in which the classes are located is indicated in parentheses.

Table 1 — Package abbreviations

CI	Citation [ISO 19115-1:2014]
DS	Dataset [ISO 19115-1:2014]
GF	General Feature [ISO 19109:2015]
LI	Lineage [ISO 19115-1:2014]
MD	Metadata [ISO 19115-1:2014]

5 Conformance

5.1 General

In this document two conformance classes are defined (see 5.2 and 5.3). The related tests are provided in the abstract test suit in Annex A.

Requirements, recommendations and permissions are explicitly marked and assigned a requirement, recommendation or permission identifier.

The name and contact information of the maintenance agency for this document can be found at www.iso.org/maintenance_agencies.

5.2 Content of a data quality model

Table 2 describes the conformance class for the content of a data quality definition.

Table 2 — Content conformance class

Conformance class	https://standards.isotc211.org/19157/-1/1/conf/content
Standardization target type	Instance of a data quality definition, regardless of data encoding.

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Table 2 *(continued)*

Dependency	https://standards.isotc211.org/19103/-/1/ (Conceptual schema language) https://standards.isotc211.org/19109/-/2/ (Rules for application schema) https://standards.isotc211.org/19115/-1/1/ (Metadata – Part 1: Fundamentals)
Requirements class	https://standards.isotc211.org/19157/-1/1/req/content (see Clause 6)
Tests	All tests in Clause A.1.

5.3 XML encoding of a data quality model

Table 3 describes the conformance class for the XML representation of a data quality model.

Table 3 — XML encoding conformance class

Conformance class	https://standards.isotc211.org/19157/-1/1/conf/xml
Standardization target type	XML document representing a data quality model.
Dependency	https://standards.isotc211.org/19157/-1/1/conf/content
Requirements class	https://standards.isotc211.org/19157/-1/1/req/xml (see Clause 12)
Tests	All tests in Clause A.2.

6 General requirements for geographic information quality

6.1 General

Clauses 8 to 11 describe the components of data quality based on the conceptual Unified Modelling Language (UML) model defined in this document, which is part of the ISO/TC 211 harmonized model. Furthermore, additional descriptions, requirements and recommendations are included. A dictionary of elements in the UML model is provided in Annex C.

The requirements, recommendations and permissions defined in this document are summarized in Tables 4, 5 and 6.

6.2 Data quality — general requirements, recommendations and permissions

Table 4 lists the requirements defined in this document.

Table 4 — List of requirements

Requirement class	https://standards.isotc211.org/19157/-1/1/req/content
Standardization target type	Instance of a data quality definition regardless of data encoding.
Dependency	https://standards.isotc211.org/19103/-/1/ (Conceptual schema language)
Dependency	https://standards.isotc211.org/19109/-/2/ (Rules for application schema)
Dependency	https://standards.isotc211.org/19115/-1/1/ (Metadata — Part 1: Fundamentals)
Requirement 1	https://standards.isotc211.org/19157/-1/1/req/content/dataQuality

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Table 4 *(continued)*

Requirement 2	https://standards.isotc211.org/19157/-1/1/req/content/additionalQualityElement
Requirement 3	https://standards.isotc211.org/19157/-1/1/req/content/qualityMeasure
Requirement 4	https://standards.isotc211.org/19157/-1/1/req/content/additionalQualityMeasure
Requirement 5	https://standards.isotc211.org/19157/-1/1/req/content/dataQualityMetadata
Requirement 6	https://standards.isotc211.org/19157/-1/1/req/content/qualityEvaluationReport
Requirement 7	https://standards.isotc211.org/19157/-1/1/req/content/aggregatedResult
Requirement 8	https://standards.isotc211.org/19157/-1/1/req/xml

In addition to the requirements class in Table 4, a recommendations class is defined in Table 5 and a permission class is defined in Table 6. These recommendations and permissions, when implemented, can contribute to improved content of a data quality definition. However, recommendations and permissions are optional and do not have an impact on the results of the conformance testing; thus the recommendation class in Table 5 and the permission class defined in Table 6 are not related to any of the conformance classes defined in Clause 4.

Table 5 — List of recommendations

Recommendation class	https://standards.isotc211.org/19157/-1/1/req/optionalContent
Standardization target type	Instance of a data quality definition regardless of data encoding.
Dependency	https://standards.isotc211.org/19157/-1/1/req/content
Recommendation 1	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/dateTime
Recommendation 2	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/identifier
Recommendation 3	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/additionalQualityMeasure
Recommendation 4	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/description
Recommendation 5	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/qualityEvaluationProcess
Recommendation 6	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/evaluationMethodType
Recommendation 7	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/reportReference
Recommendation 8	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/aggregatedResult
Recommendation 9	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/sameQualityElement
Recommendation 10	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/differentQualityElement
Recommendation 11	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/qualityEvaluationReport
Recommendation 12	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/derivedResultMetadata
Recommendation 13	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/hierarchy

Table 6 lists the permissions defined in this document.

Table 6 — List of permissions

Permission class	https://standards.isotc211.org/19157/-1/1/req/permittedContent
Standardization target type	Instance of a data quality definition regardless of data encoding.
Dependency	https://standards.isotc211.org/19157/-1/1/req/content
Permission 1	https://standards.isotc211.org/19157/-1/1/per/permittedContent/additionalQualityElement
Permission 2	https://standards.isotc211.org/19157/-1/1/per/permittedContent/conformanceResult

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Table 6 *(continued)*

Permission 3	https://standards.isotc211.org/19157/-1/1/per/permittedContent/sourceReference

7 Overview of data quality

Working with data quality includes the following points.

NOTE 1 The development of application schemas is described in ISO 19109.

A data quality evaluation can be applied to a dataset series, a dataset or a subset of data within a dataset sharing common characteristics so that its quality can be evaluated.

Data quality elements and their descriptors are used to describe how well a dataset meets the criteria set forth in its data product specification or user requirements and provide quantitative quality information.

Requirement 1:	https://standards.isotc211.org/19157/-1/1/req/content/dataQuality
	Data quality shall be described in conformance with the components of data quality and data quality measures as defined by the UML figures in Clauses 8 and 9 of this document.

When data quality information describes data that have been created without a detailed data product specification or with a data product specification that lacks quantitative measures and descriptors, data quality may be evaluated in a non-quantitative subjective way with a descriptive result (see 8.5.4.4) used to report the evaluation result for each of the applicable data quality elements.

Some quality-related information is provided by purpose, usage and lineage. This information is reported as metadata in conformance with ISO 19115-1.

NOTE 2 'Purpose' describes the rationale for creating a dataset and contains information about its intended use, which can potentially be not the same as the actual use of the dataset. 'Usage' describes the application(s) for which a dataset has been used, either by the data producer or by other data users. 'Lineage' describes the history of a dataset and recounts the life cycle of a dataset from collection and acquisition through compilation and derivation to its current form. This general, non-quantitative information is illustrative for users and can help in assessing the quality of a dataset, especially in cases where it is used for a particular application that differs from the intended application (see also 10.2.3).

This document recognizes that data quality elements may have associated quality which is termed metaquality. Metaquality describes the quality of the data quality results in terms of defined characteristics.

NOTE 3 The concept of metaquality is described in 8.3.7 and the descriptors of metaquality are defined in 8.5.5.

Figure 1 provides an overview of data quality information.

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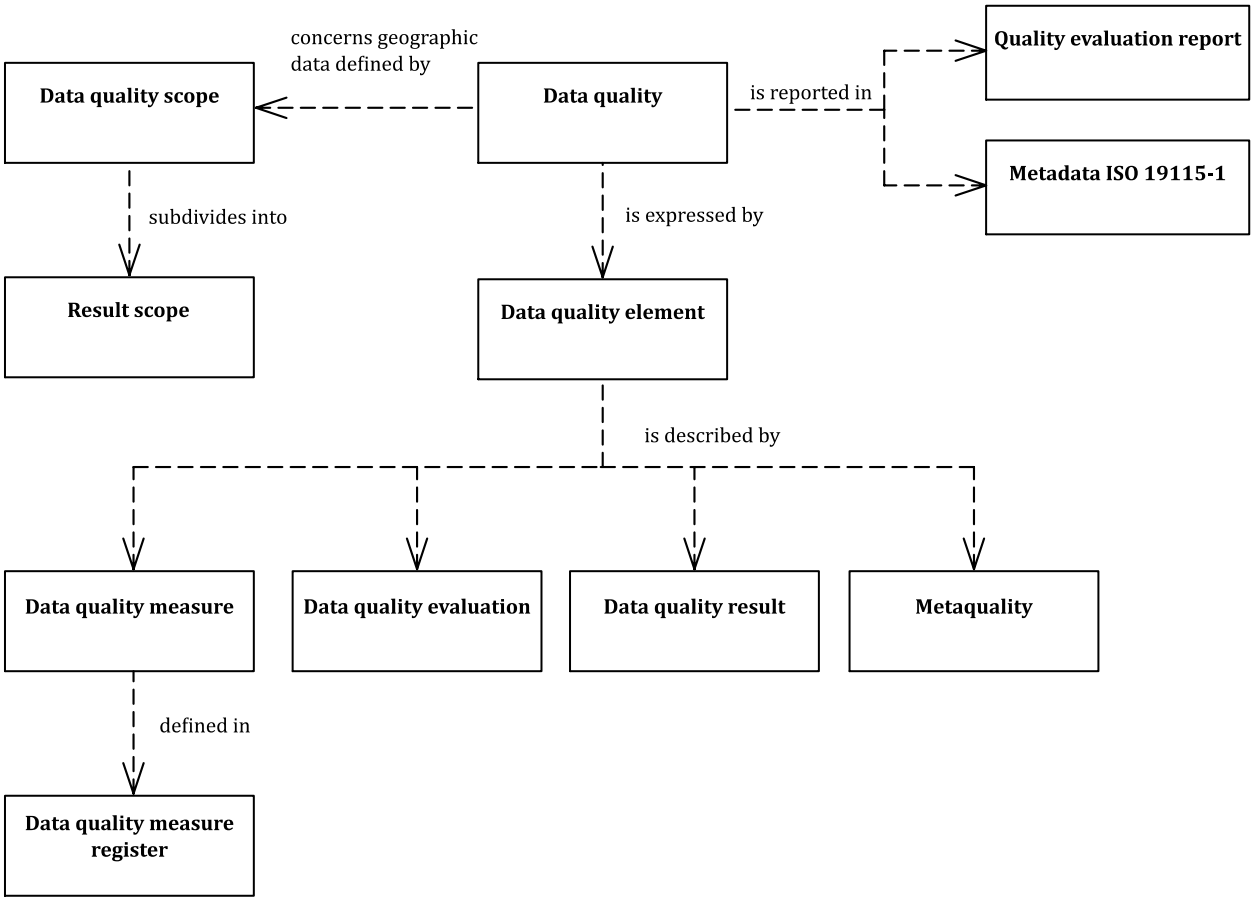

Figure 1 — Conceptual model of quality for geographic data

8 Components of data quality

8.1 Overview of the components

The components of data quality are described in Clause 8. Figure 2 presents an overview of the components and the connections between them. See the data dictionary defined in Annex C for more details about components and their attributes.

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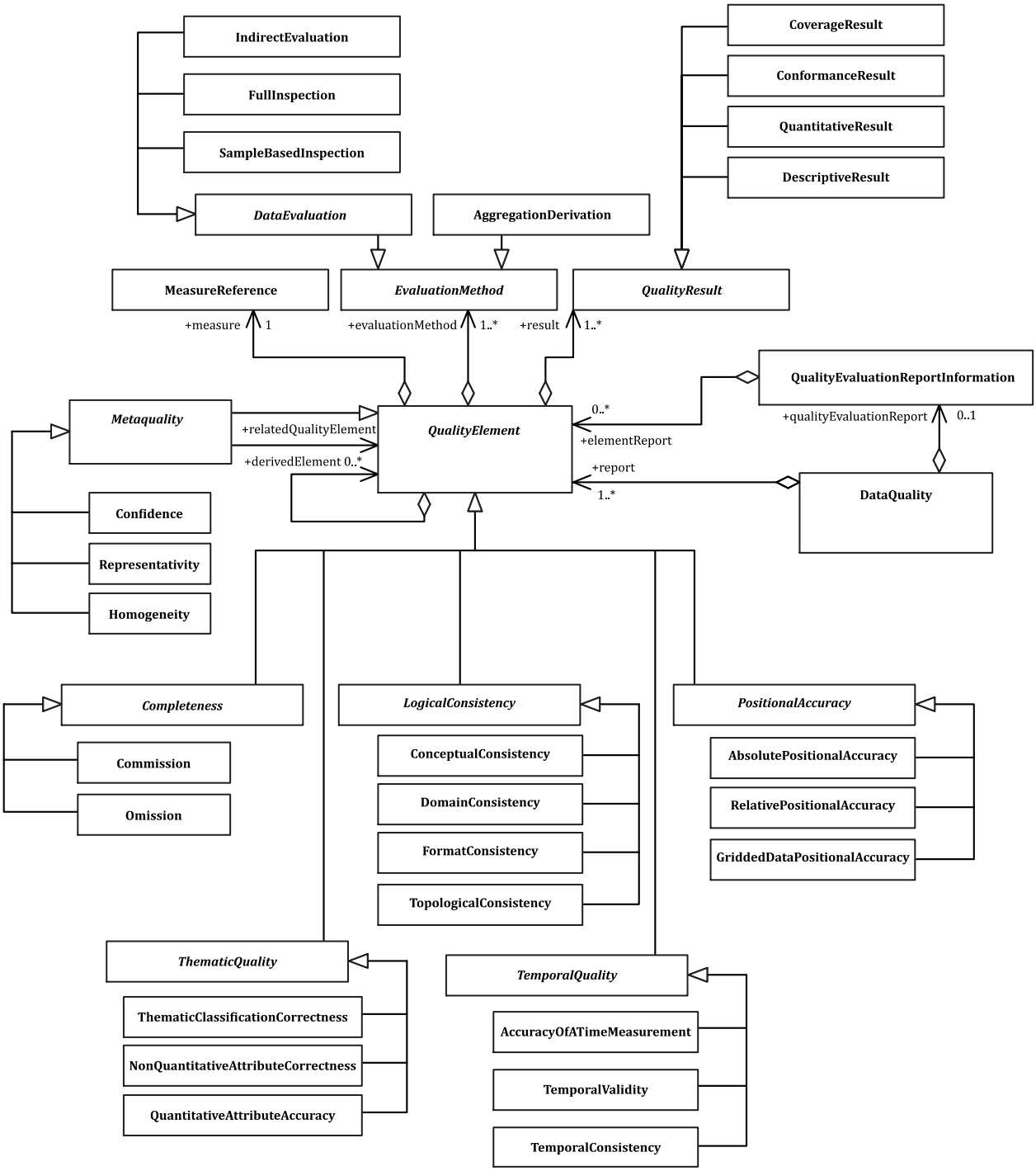

Figure 2 — Overview of the components of data quality

8.2 Data quality unit

When describing the quality of geographic data, different quality elements and different subsets of the data may be considered. In order to describe these, data quality units are used. A data quality unit is the combination of a scope and data quality elements; see Figure 3 and Table C.1.

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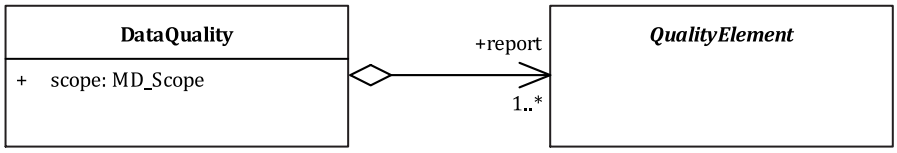

Figure 3 — Data quality unit

The scope of the data quality unit(s) specifies the extent, spatial and/or temporal, and/or common characteristic(s) that identify the data on which data quality is to be established and evaluated.

Since scopes are often different for individual data quality elements, one data quality report (metadata or quality evaluation report) may encompass several data quality units. These different scopes may be, for example, spatially separate, overlapping or even sharing the same extents.

NOTE If a dataset is a result of integration of datasets of various scopes, data quality values or weights of quality elements, such a new dataset needs to establish its new data quality unit, i.e. define its own data quality scope and specify quality elements of interest.

The following are examples of what defines a data quality scope (see also MD_Scope in ISO 19115-1):

a) a dataset series;

b) a dataset;

c) a subset of data defined by one or more of the following characteristics:

   1) types of items (sets of feature types, feature attributes, feature operations or relationships among features),

   2) specific items (sets of feature instances, attribute values or instances of feature relationships),

   3) geographic extent,

   4) temporal extent (the time frame of reference and accuracy of the time frame);

d) a coverage.

8.3 Data quality elements

8.3.1 General

A data quality element is a component describing a certain aspect of the quality of geographic data. In this document, these have been organized into groups of quality elements, with each group defined in 8.3.2 to 8.3.7. The relationship among various aspects of quality and their corresponding quality elements are illustrated in Figure 4, where groups of elements are represented by abstract classes and elements are represented by their subclasses.

NOTE Depending on the tool used and/or organizational preferences, implementations of the data quality conceptual model presented in Figure 4 vary. Advising on best implementation practice is out of the scope of this document.

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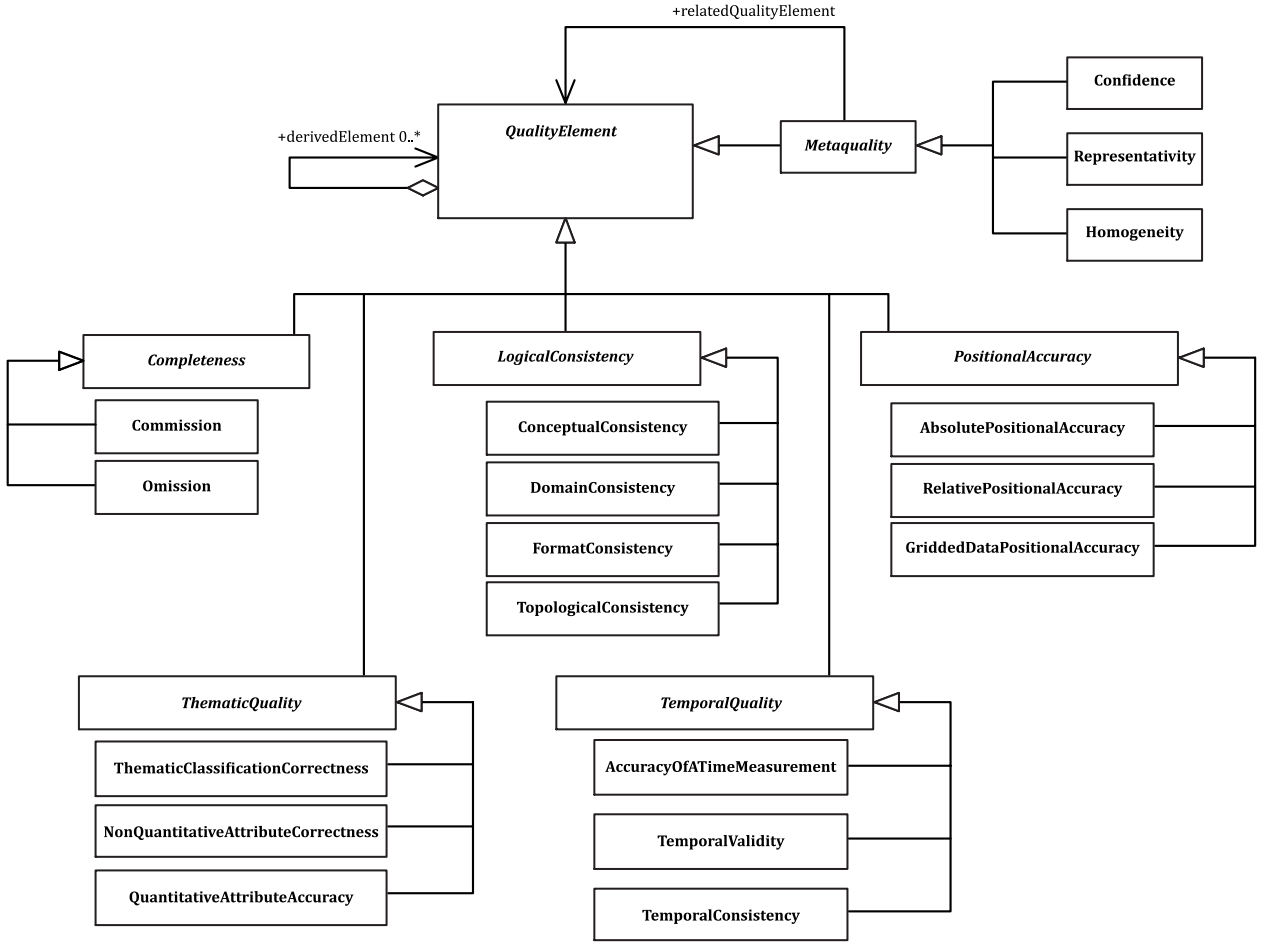

Figure 4 — Overview of the data quality elements

Permission 1:	https://standards.isotc211.org/19157/-1/1/per/permittedContent/additionalQualityElement
	If quality elements defined in this document are not sufficient for expressing the quality of the dataset, new elements can be defined and used according to the requirements specified in 8.4.

8.3.2 Completeness

Completeness is defined as a degree to which a dataset (or dataset series) representing a feature (or features) has values for all expected attributes and related entity instances at the time at which the dataset has been created (ISO 8000-2; ISO/IEC 25012). As such, completeness refers to the presence and/or absence of features, their attributes and relationships. In this document, two elements (and their associated measures) define completeness:

8.3.3 Logical consistency

Logical consistency is defined as the degree of adherence to logical rules of data structure, attribution and relationships (data structure can be conceptual, logical or physical). If these logical rules are documented elsewhere (for example, in a data product specification) then the source should be referenced (for example, in the data quality evaluation). This document specifies logical consistency with data quality elements (and their associated measures):

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8.3.4 Positional accuracy

Positional accuracy relates to measurement accuracy (ISO/IEC Guide 98-3; ISO/IEC Guide 99) and it represents a closeness of agreement between a measured position of features and a position accepted as true within a spatial reference system. Depending on the scope and type of the reference system, this document specifies the following three data quality elements for expressing positional accuracy:

Positional accuracy is an estimate of the uncertainty of measurement results (ISO 19116) and should therefore be expressed with measures of uncertainty.

8.3.5 Temporal quality

Temporal quality is defined as the quality of the temporal attributes and temporal relationships of features. Temporal quality can be described by the following data quality elements (and their associated measures):

NOTE 1 Timeliness, currentness (ISO/IEC 25012), up-to-dateness and actuality are used as synonyms for temporal validity.

NOTE 2 Temporal validity is different from domain consistency of temporal values. For example, a value of '33 March 2020' representing a date indicates a domain inconsistency. An example of temporal invalidity is a dataset that contains objects that did not exist in the timestamp associated with their record.

8.3.6 Thematic quality

Thematic quality is defined as the accuracy of quantitative attributes and the correctness of non-quantitative attributes and of the classifications of features and their relationships. This document specifies thematic quality with three data quality elements (and their associated measures):

8.3.7 Metaquality elements

Metaquality elements are a set of quantitative and qualitative statements about a quality evaluation and its result. The knowledge about the quality and the suitability of the evaluation method, the measure applied, and the given result may be of the same importance as the result itself.

See D.5.3 for an example of metaquality evaluation.

Metaquality should be described using the following elements.

8.4 Extending the data quality information model

This document recognizes that for many domain-specific purposes, it is necessary or convenient to extend the standard data quality information model as defined in 8.3. The extension includes adding data quality elements (or one of its specializations as defined in 8.3) and data quality measures.

EXAMPLE Data producers can wish to provide means for their users to record feedback on a dataset. As an example, an information model for such feedback (i.e. new quality elements) can be defined with elements from Reference [36].

Requirement 2:	https://standards.isotc211.org/19157/-1/1/req/content/additionalQualityElement
	A new quality element shall be defined as a specialization of *QualityElement*, (see 8.3) in conformance with the rules for metadata extensions (ISO 19115-1:2014, Annex C) and rules for domain profiles of standard schemas (ISO 19109:2015, 8.3). NOTE If applicable, elements defined in other International Standards (e.g. ISO/IEC 25000) can be used for extending the set of quality components as defined in Clause 8.

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8.5 Descriptors of data quality elements

8.5.1 General

A data quality element is described by a reference to a quality measure, an evaluation method, quality result and a metaquality element. These are shown in Figure 5, and are described in 8.5.2 to 8.5.5.

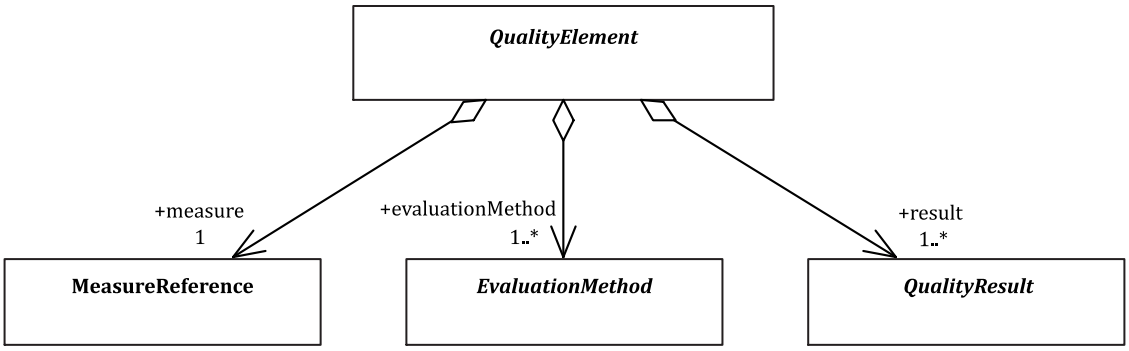

Figure 5 — Data quality element descriptors

8.5.2 Measure reference

Data quality elements refer to measures by means of a measure reference (see Figure 6), providing an identifier of a measure fully described elsewhere.

NOTE The full description can be found within a measure register or catalogue, which can form part of a data product specification or a quality evaluation report.

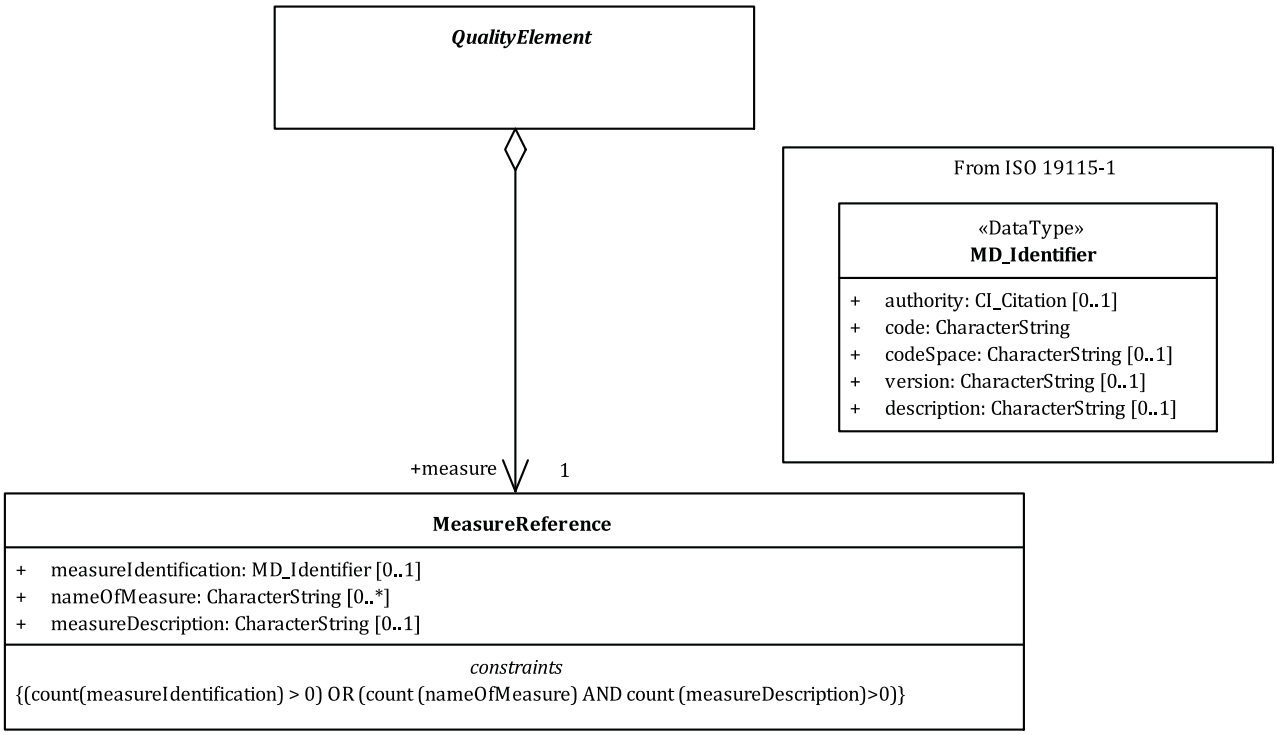

Figure 6 — Data quality measure reference

Data quality measures are further described in Clause 9 of this document.

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EXAMPLE The percentage of the values of an attribute which are correct.

This document recognizes that the quality of a dataset is measured using a variety of methods. A single data quality measure can be insufficient for fully evaluating the quality of the data specified by a data quality scope and providing a measure of quality for all possible utilizations of a dataset. A combination of data quality measures can give useful information. Multiple data quality measures may be reported for the data specified by a data quality scope. The data quality report should then include one instance of *QualityElement* for each measure applied.

8.5.3 Evaluation method

A data quality evaluation method describes those procedures and methods which are applied to the geographic data to arrive at a data quality result; see Figure 7. Different evaluations are often used for the various data quality elements.

A data quality evaluation method is used for describing, or for referencing documentation describing, the methodology used to apply a data quality measure to the data specified by a data quality scope.

NOTE Data quality evaluation is further described in Clause 10.

EXAMPLE Examples of documentation are data product specifications (e.g. ISO 19131), published articles or accepted industry standards.

Recommendation 1:	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/dateTime
	One date or range of dates (conforming to ISO 19108) should be included for each evaluation. If the evaluation was carried out on non-consecutive dates, each single date should be included.

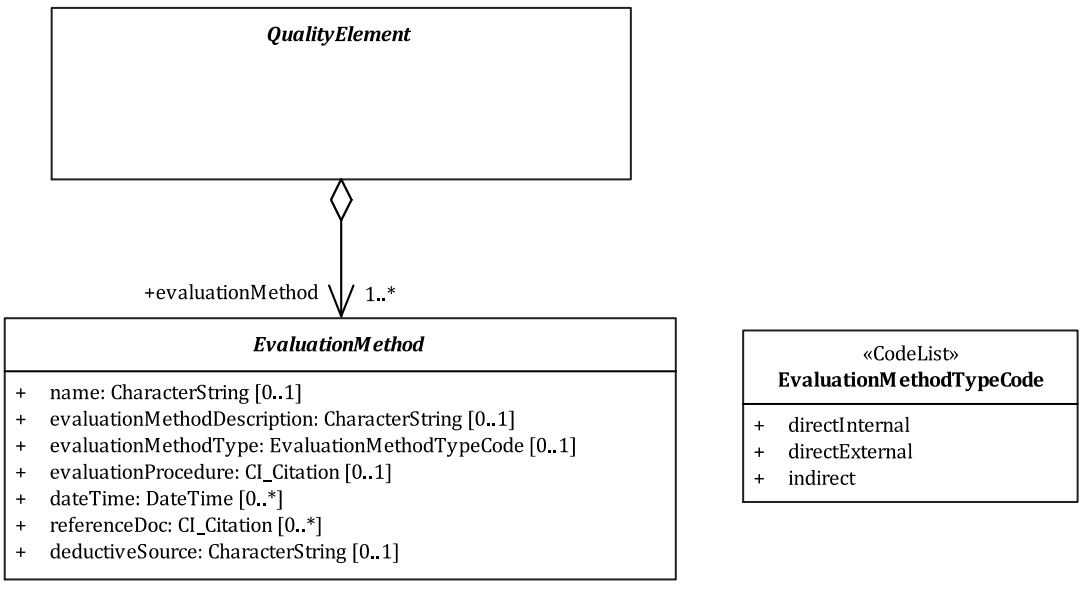

Figure 7 — Data quality evaluation method

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8.5.4 Quality result

8.5.4.1 General

A data quality result is provided for each data quality element. This can be a quantitative result, a conformance result, a descriptive result or a coverage result; see also Figure 8.

NOTE Different types of results can be provided for the same data quality element.

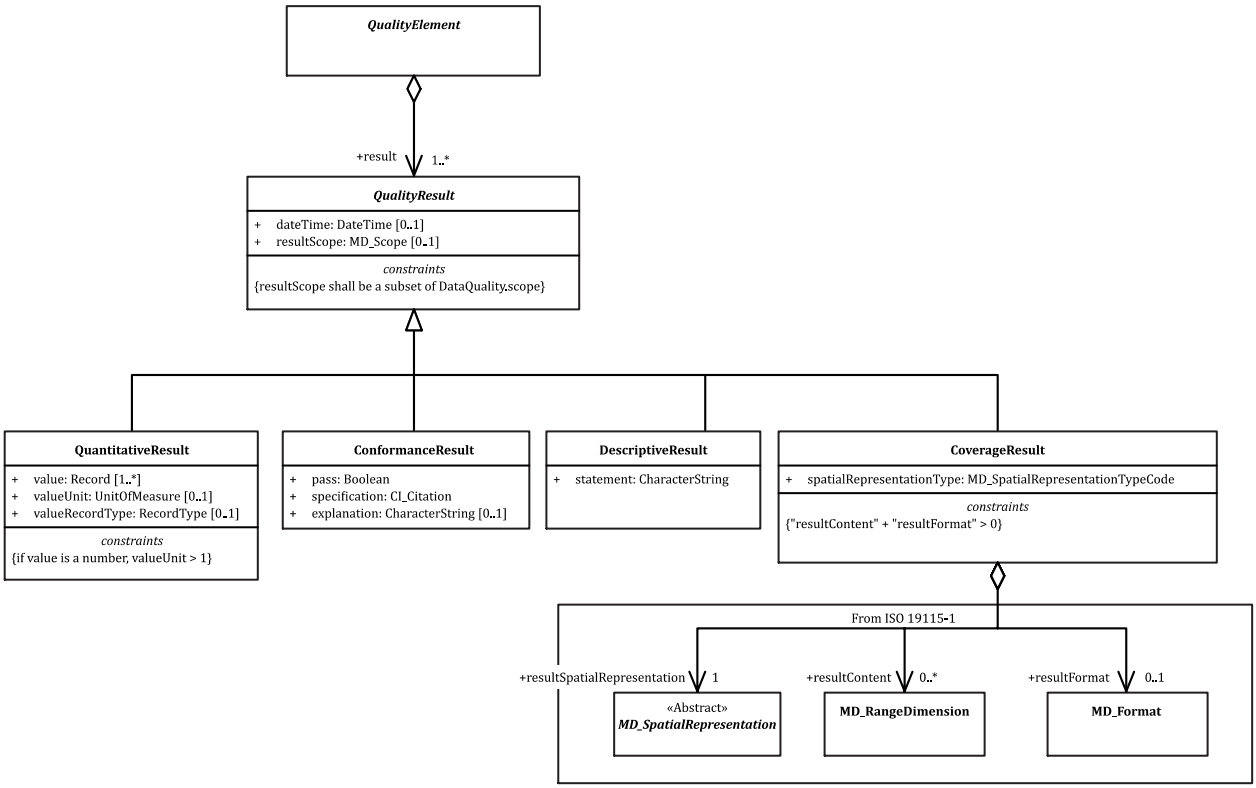

Figure 8 — Data quality result

Quality frequently differs between various parts of the dataset for which quality is evaluated. Therefore, several evaluations may be applied for the same data quality element to more fully and in more detail describe quantitative data quality. To avoid repeating the measure and evaluation procedure descriptions in several instances of data quality element (*QualityElement*), several results with individual result scopes can be used.

EXAMPLE A dataset contains features of identical type but whose positions have been established with various methods yielding different positional accuracies. The same quality evaluation method and the same measure are, however, applied for the whole dataset, and provide different results depending on the data acquisition method. In this case, it can be desirable to have several results with individual result scopes (the area covered by each data acquisition method) and one data quality scope (the dataset).

8.5.4.2 Quantitative result

A quantitative result may be a single value or multiple values, depending on the values of attributes *valueType* and *valueStructure* defined in the description of the measure applied.

The attribute *valueRecordType* is used to describe how the *valueType* and *valueStructure* defined in the measure are implemented to provide the value of the quantitative result.

NOTE The attribute valueRecordType is of type RecordType, which is a generic data type defined in ISO 19103. Its value changes depending on which implementation solution is used for providing the quantitative result. An example of Extensible Markup Language (XML) implementation for recordType is provided in ISO/TS 19139-1.

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EXAMPLE 1 Using an XML implementation: simple example: value = 5, valueRecordType = gco:Integer, valueUnit = "metre."

EXAMPLE 2 Within the description of the measure, the *valueType* is an integer, the *valueStructure* is an $n \times n$ (square) matrix. The *value* attribute of the quantitative result provides the result matrix itself, within a numeric encoding using a particular XML type called MatrixType. The attribute *valueRecordType* provides the description of the type MatrixType in XML. If another encoding is used, the attribute *valueRecordType* will change to provide the description of the type Matrix in the other encoding, and the implementation of the attribute value will change accordingly, but the value itself will not change.

EXAMPLE 3 Measure "Rate of excess items" is used to evaluate the number of excess items in the dataset in relation to the number of items that are expected to be present. The quantitative result value is of value type Real. The value unit is used in this case to show that the value is a percentage; the value has been multiplied by 100. In this example the value unit is "%".

8.5.4.3 Conformance result

A conformance result is the outcome of comparing the value or set of values obtained from applying a measure to the data specified by a data quality scope with a specified conformance quality level (e.g. as recorded in an ISO 19131-conformant data product specification).

When a conformance quality level is defined, the obtained result is compared with this to evaluate if the quality of the data meets the specified level of quality.

A conformance result may be provided for each measure. The conformance quality level is typically specified in suitable reference documentation such as the data product specification (e.g. an ISO 19131-conformant data product specification) or a user-defined requirements specification. If conformance is evaluated, a reference to the relevant reference documentation shall be made and the conformance quality level used shall be specified.

The conformance result is not to be used for specifying the conformance quality level in an ISO 19131-conformant data product specification.

Recommendation 2:	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/identifier
	An *identifier* should be provided for the *specification* attribute of *ConformanceResult*. NOTE *specification* is of type *CI_Citation*, in which, as defined by ISO 19115-1, the *identifier* is optional.

Permission 2:	https://standards.isotc211.org/19157/-1/1/per/permittedContent/conformanceResult
	If an evaluation has been performed against conformance levels originating from different sources, more than one data quality *ConformanceResult* may be provided for the same measure.

8.5.4.4 Descriptive result

In some cases (e.g. with thematic and geoscientific observations), it is not possible to produce a quantitative result for a data quality element. A subjective evaluation of an element can then be expressed with a textual statement as a data quality descriptive result.

EXAMPLE The relative positional accuracy is higher between a geological feature and a nearby feature from a base map (roads, rivers, lakes etc.) than the absolute positional accuracy on the geological feature itself.

This descriptive result can also be used to provide a short synthetic description of the result of the data quality evaluation, to accompany the complete quantitative result or replace it, if no quantitative value can be provided.

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8.5.4.5 Coverage result

A data quality result can be provided as information in a coverage. A UML model for a coverage result is provided in Figure 8.

8.5.5 Descriptors of a metaquality element

A metaquality element is described by the same descriptors as for the quality element: measure, evaluation method and result (see Figure 9).

NOTE The related quality element is the element on which the metaquality element applies.

See E.5.3 for an example of metaquality evaluation.

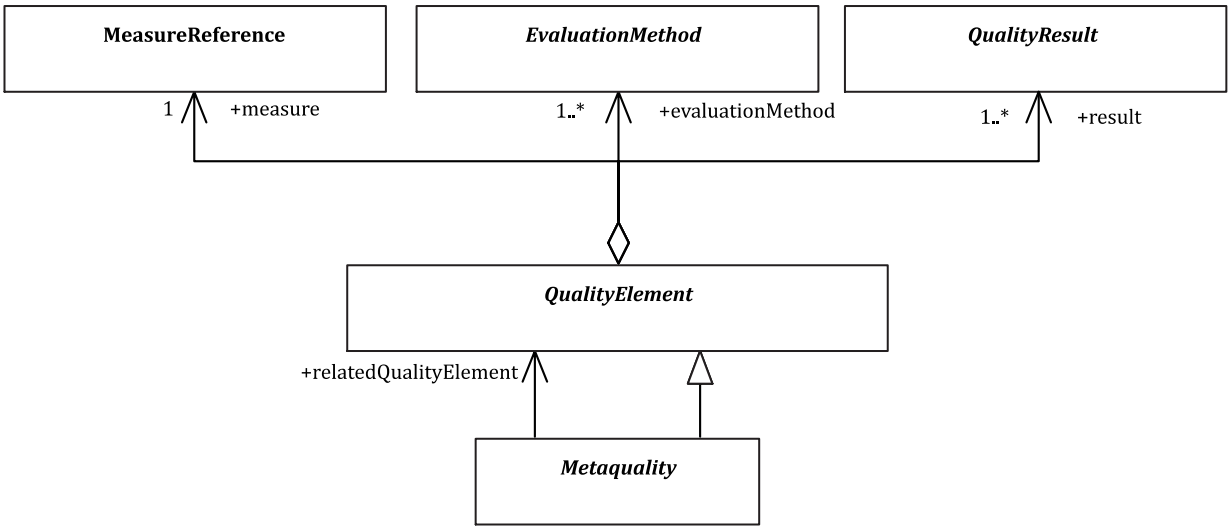

Figure 9 — Metaquality descriptors

9 Data quality measures

9.1 General

To facilitate dataset comparisons, evaluations and data quality reports (metadata or a quality evaluation report) have to be expressed in a comparable way, and it is necessary to have a common understanding of the data quality measures that have been used.

Requirement 3:	https://standards.isotc211.org/19157/-1/1/req/content/qualityMeasure
	When possible, measures defined in a quality measures register for geographic information shall be used in data quality evaluations and to represent the result of the quality evaluation in quality evaluation reports and metadata. NOTE 1 If no measure as defined in a quality measures register for geographic information is applicable, additional, user-defined measures can be used (see 9.3). NOTE 2 Elements defined in other International Standards (e.g. ISO/IEC 25000) can be used for extending the quality model, if applicable.

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9.2 Standardized data quality measures

9.2.1 General

The structure of standard data quality measures is illustrated in Figure 10.

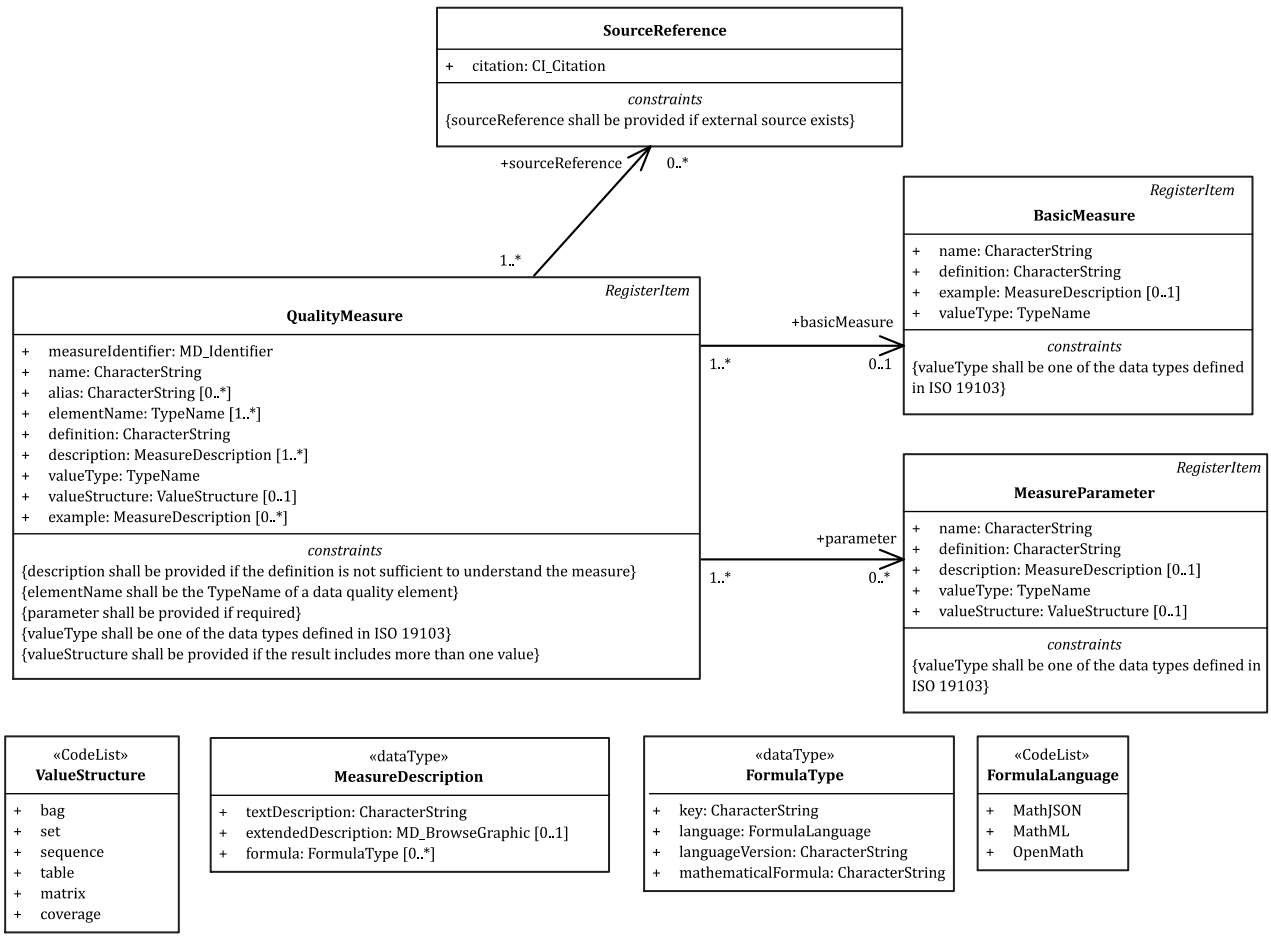

Figure 10 — Data quality measures

Each data quality measure is described by the following components:

Multiple measures can be defined for each data quality element. The choice of which one to use will depend on the type of the data and its intended purpose. A list of standardized data quality measures is given in a data quality measure register defined in conformance with ISO 19135-1.

9.2.2 Measure identifier

The identifier is a value uniquely identifying a measure within a namespace.

NOTE This identifier enables references to the data quality measure within the data quality elements (see 8.5.2).

9.2.3 Name

The name is the name of the measure.

NOTE If the measure already has a commonly used name, this name is be used. If no name exists, a name that reflects the nature of the measure is chosen.

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9.2.4 Alias

The alias is another recognized name for the same data quality measure. It may be a different commonly-used name, or an abbreviation, or a short name. More than one alias may be provided.

9.2.5 Element name

The element name is the name of the data quality element (see 8.3 and 8.4) to which a measure applies. More than one element name may be provided.

9.2.6 Basic measure

Basic measures are defined by their *name*, *definition*, *example* and *valueType* (see Figure 10).

The basic measures should also be used for creating new measures if applicable. For example, to report unclosed surface patches or other application-dependent measures.

Recommendation 3:	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/additionalQualityMeasure
	Whenever possible, a *BasicMeasure* should be used as the basis for defining a new quality measure. NOTE A variety of measures are based on counting of erroneous items. There are also several measures dealing with the uncertainty of numerical values. In order to avoid repetition, the most common methods of constructing count-related measures, as well as general statistical measures, for one- and two-dimensional random variables are defined in terms of basic measures.

9.2.7 Definition

The definition is a representation of a concept by a descriptive statement which serves to differentiate it from related concepts (ISO 19104).

NOTE If the measure is derived from a basic measure, the definition is based on the basic measure definition and specialized for this measure.

9.2.8 Description

The measure description is the description of the measure including methods of calculation, with all formulae and/or illustrations needed to establish the result of applying the measure.

If the measure uses the concept of errors, it should be stated how an item is classified as incorrect. This is the case when the quality can only be reported as correct or incorrect.

Recommendation 4:	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/description
	If a measure uses the concept of errors for reporting correct or incorrect items, *description* should contain an explanation of when an item is classified as incorrect.

9.2.9 Parameter

A measure parameter is an auxiliary variable used by the measure.

9.2.10 Value type

The value type is the data type used for reporting the result of the measure. The data types defined in ISO 19103 shall be used.

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9.2.11 Value structure

A result may consist of multiple values. In such cases, the result shall be structured using the value structure as given in C.3.3.

9.2.12 Source reference

The source reference is the citation of the documentation of the measure.

9.2.13 Example

The example is an example of applying the measure or the result obtained for the measure. More than one example may be provided.

9.3 User-defined data quality measures

Due to the nature of quality and geographic data, the list of standardized data quality measures cannot be complete. There can potentially be cases where the user of this document has to devise other data quality measures. When possible, these measures shall be defined using the data quality basic measures and the measure shall be defined using the structure given in Clause 9. Additional examples of data quality measures can be found in ISO 19160-3:2020, Annex C.

Requirement 4:	https://standards.isotc211.org/19157/-1/1/req/content/additionalQualityMeasure
	A new quality measure shall be defined as a specialization of *QualityMeasure*, or one of its subtypes (see Clause 9) according to the rules for metadata extensions (ISO 19115-1:2014, Annex C) and rules for domain profiles of standard schemas (ISO 19109:2015, 8.3). If the quality measure is derived from a basic measure, the basic measure shall be referenced. If an item is adopted from an external source, the reference to the external source shall be given. If a measure uses an auxiliary variable, a reference *MeasureParameter* shall be provided for the measure.

10 Data quality evaluation

10.1 The process for evaluating data quality

10.1.1 Introduction

Quality evaluation processes are used in different phases of a product life cycle, having different objectives in each phase. The phases of the life cycle considered here are specification, production, delivery, use and update.

The process for evaluating data quality is a sequence of steps to produce a data quality result.

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10.1.2 The process flow

The quality evaluation process is a sequence of steps followed to produce a quality evaluation result. Figure 11 illustrates a possible workflow for evaluating data quality; see also Annex D for a description of the concepts for evaluating and reporting data quality.

Recommendation 5:	https://standards.isotc211.org/19157/-1/1/rec/content/qualityEvaluationProcess
	When evaluated geographic dataset is heterogeneous and quality is specified for its individual parts, separate evaluation should be carried out for individual parts of the dataset.

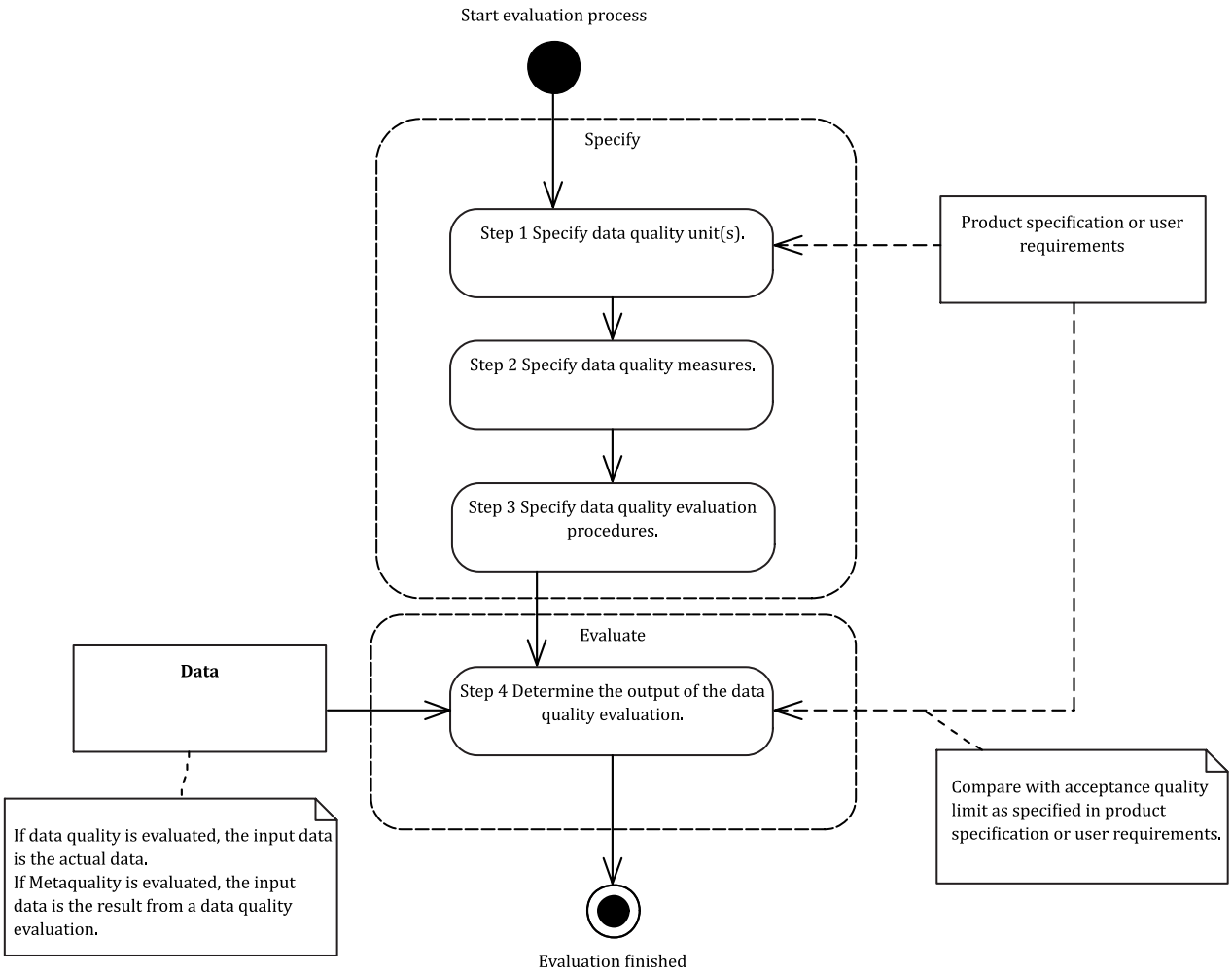

Figure 11 — Evaluating data quality

10.1.3 Process steps

Table 7 specifies the process steps involved in quality evaluation as illustrated in Figure 11.

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Table 7 — Process steps

Process step	Action	Description
1	Specify data quality unit(s)	A data quality unit is composed of a scope and quality element(s); see 8.2. All data quality elements relevant to the data for which quality is to be described should be used. NOTE The data quality elements to be tested are described in 8.3 and Annex D provides guidelines for the use of quality elements. As described in 8.4, additional elements can be defined and used in quality evaluation.
2	Specify data quality measures	A measure should be specified for each data quality element. If no measure can be identified, a descriptive result may be provided.
3	Specify data quality evaluation procedures	A data quality evaluation procedure consists of applying one or more evaluation methods. Including:
4	Determine the output of the data quality evaluation	A result is the output of applying the evaluation. A conformance to data product specification or user requirements is part of the quality evaluation output. The output is presented as metadata (e.g. in MD_Usage defined in ISO 19115-1) and a quality evaluation report.

Evaluation of metaquality may be performed after obtaining the output of the quality evaluation. The workflow described above is also a possible workflow for evaluating metaquality, with the following process steps: specify the metaquality element and the quality evaluation for which metaquality is evaluated, then specify a measure and an evaluation method and determine the output of the metaquality evaluation.

10.2 Data quality evaluation methods

10.2.1 Classification of data quality evaluation methods

A data quality evaluation procedure comprises one or more data quality evaluation methods. Data quality evaluation methods can be divided into two main classes: direct and indirect. Direct evaluation methods determine data quality through the comparison of the data with internal and/or external reference information. Indirect evaluation methods infer or estimate data quality using information on the data such as lineage.

Recommendation 6:	https://standards.isotc211.org/19157/-1/1/rec/optionalContent/evaluationMethodType
	Direct evaluation methods (*directInternal* or *directExternal*) should be used in preference to indirect evaluations.

The direct evaluation methods are further sub-classified by the source of the information needed to perform the evaluation, i.e. internal or external. Figure 12 shows the classes used for describing the evaluation methods.

NOTE Lineage is described in ISO 19115-1.

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