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Geografske informacije - Shema za geometrijo podatkovnega sloja in funkcije - 3. del: Osnove obdelave (ISO/DIS 19123-3:2022)

Geographic information - Schema for coverage geometry and functions - Part 3: Processing fundamentals (ISO/DIS 19123-3:2022)

Geoinformation - Coverage Geometrie- und Funktionsschema - Teil 3: Grundlagen der Verarbeitung (ISO/DIS 19123-3:2022)

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Geographic information — Schema for coverage geometry and functions —

Part 3: Processing fundamentals

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This document was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

A list of all parts in the ISO 19123 series can be found on the ISO website.

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Introduction

This standard defines, at a high, implementation-independent level, operations on coverages – i.e., digital representations of space-time varying geographic phenomena – as defined in ISO 19123-1. Specifically, regular and irregular grid coverages are addressed. The operations can be applied through an expression language allowing composition of unlimited complexity and combining an unlimited number of coverages for data fusion.

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Geographic information — Schema for coverage geometry and functions — Part 3: Processing Fundamentals

1 Scope

This document defines a coverage processing language for server-side extraction, filtering, processing, analytics, and fusion of multi-dimensional geospatial coverages representing, for example, spatio-temporal sensor, image, simulation, or statistics datacubes. Services implementing this language provide access to original or derived sets of coverage information, in forms that are useful for client-side consumption.

ISO 19123-3 relies on the abstract coverage model defined in ISO 19123-1. In this document, regular and irregular multi-dimensional grids are supported, for axis that may carry spatial, temporal, or any other semantics. Future versions may additionally support further axis types as well as point clouds and meshes.

The language is functionally defined and free of any side effects has a solid conceptual foundation; only two constructs establish all coverage processing:

A coverage constructor builds a coverage, either from scratch or by deriving it from one or more other coverages.

The ISO 19123-3 language is independent from any particular request and response encoding, as no concrete request/response protocol is assumed. Hence, this standard does not define a service, but acts as the foundation for defining service standards functionality. One such target framework is OGC Web Coverage Service (WCS)[3].

In its current version ISO 19123-3 supports ISO 19123-1 grid coverages with index, regular, and irregular axes. In the future it is foreseen that the standard gets extended so as to address all coverage types of ISO 19123-1.

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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 19123-1:2021, *Geographic information — Coverage Fundamentals*

3 Terms, definitions, abbreviated terms and notation

3.1 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:

— ISO Online browsing platform: available at https://www.iso.org/obp
— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
axis
⟨coordinate geometry⟩ linear feature from which a one-dimensional coordinate system is constructed

Note 1 to entry: This definition is established in accordance with ISO 19111:2019, Clause 10.4.

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[SOURCE: ISO 19123-1:2021, 3.1.2]

3.1.2
coordinate
one of a sequence of numbers designating the position of a point

Note 1 to entry: A direct position is described by an ordered sequence of coordinates. The number of elements in a direct position is established by the number of axes of the coverage.

[SOURCE: ISO 19123-1:2021, 3.1.2]

3.1.3
coordinate reference system
coordinate system that is related to an object by a datum

Note 1 to entry: Geodetic and vertical datums are referred to as reference frames.

Note 2 to entry: For geodetic and vertical reference frames, the object will be the Earth. In planetary applications, geodetic and vertical reference frames may be applied to other celestial bodies.

[SOURCE: ISO 19111:2019, 3.1.9]

3.1.4
coverage
feature that acts as a function to return values from its range for any direct position within its domain

[SOURCE: ISO 19123-1:2021, 3.1.8]

3.1.5
coverage CRS
the common CRS in which all coordinates of a coverage are expressed

Note 1 to entry: Sometimes a coverage's CRS is also referred to as the coverage's native CRS.

[SOURCE: ISO 19123-1:2021, 3.1.9]

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3.1.6
(coverage) dimension
coordinate dimension
<coordinate geometry> number of separate decisions needed to describe a position in a coordinate system

Note 1 to entry: This is equivalent to "the number of axes in the coordinate reference system of the coverage domain set".

[SOURCE: ISO 19123-1:2021, 3.1.10]

3.1.7
direct position
<geographic information> position described by a single set of coordinates within a coordinate reference system

Note 1 to entry: Cells in a grid coverage are identified by their direct position in the domain set of this coverage.

[SOURCE: ISO 19123-1:2021, 3.1.13]

3.1.8
domain
well-defined set

Note 1 to entry: All elements within a domain (set) are of a given type.

[SOURCE: ISO 19123-1:2021, 3.1.16]

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3.1.9
evaluation
<coverage> determination of the values of a coverage at a direct position within the domain of the coverage

[SOURCE: ISO 19123-1:2021, 3.1.18]

3.1.10
grid
<coverage> nonempty, ordered set of axes with a set of positions along each axis acting as reference points for connected compact smooth hypersurfaces

Note 1 to entry: In ISO 19123:2005, a grid consists of a network composed of one or more sets of curves in which the members of each set intersect the members of the other sets. This definition is intended to be applicable also to the 1-D case.

Note 2 to entry: The ISO 19123:2005 definition is equivalent to the revised definition of this document.

[SOURCE: ISO 19123-1:2021, 3.1.28]

3.1.11
grid coordinate reference system
coordinate reference system for the positions in a grid that uses a defined coordinate system congruent with the coordinate system described by the GridEnvelope and axisLabels of gml:GridType

Note 1 to entry: The grid's CRS is identical to the CRS of the coverage defined by that grid.

[SOURCE: ISO 19123-1:2021, 3.1.29]

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3.1.12
grid coordinates
sequence of two or more numbers specifying a position with respect to its location on a grid

[SOURCE: ISO 19115-2:2019, 3.1.5]

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3.1.13
index coordinate reference system
Index CRS
multi-dimensional non-georeferenced Cartesian grid coordinates reference system

[SOURCE: ISO 19115-2:2019, 3.1.39]

3.1.14
(coverage) probing function
function extracting information from the coverage

3.1.15
range
<coverage> set of feature attribute values associated by a function, the coverage, with the elements of the domain of a coverage

Note 1 to entry: This is consistent with the more generic definition of range in ISO 19107:2019.

[SOURCE: ISO 19123-1:2021, 3.1.47]

3.2 Abbreviated terms

CRS Coordinate Reference System

3.3 Notation

Table 1 lists the other standards and packages in which UML classes used in this document have been defined.

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Table 1 — Sources of externally defined UML classes

Prefix	International Standard	Package
CV	ISO 19123-1	Coverage Core

4 Conformance

4.1 Interoperability and Conformance Testing

This document being an abstract standard allows for multiple different implementations and does not define a standardized interoperable implementation. Hence, standardization target primarily are specifications of coverage operations and services which may use this language to describe the semantics of their operations.

Conformance testing is accomplished by validating a candidate concretization against all requirements by exercising the tests set out in Annex A.

4.2 Organization

Table 2 — Conformance classes

Conformance class	Clause	Identifying URL
Coverage Processing	6	https://standards.isotc211.org/19123/-3/1/conf/coverage-processing

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5 Coverage model

5.1 Overview

This standard defines a language whose expressions accept any number of input coverages (together with further common inputs like numbers) to generate any number of output coverages. Coverages are defined in ISO 19123-1.

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5.2 Coverage model

For the reader's convenience a brief informal (and non-normative) recapitulation is given. Following the mathematical notion of a function that maps elements of a domain (here: spatio-temporal coordinates) to a range (here: "pixel", "voxel", etc. values), a coverage consists of (Figure 1):

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a) an *identifier* which uniquely identifies a coverage in some context (here: the context of an expression)
b) a *domain set* of coordinate points (expressed in a common Coordiante Reference System, CRS): “*where in the multi-dimensional space can I find values?*”
c) a probing function which answers for each coverage coordinate in the domain set (“*direct position*”): “*what is the value here?*”
d) a *range type*: “*what do those values mean?*”
e) optional *metadata*: “*what else should I know about these data?*”

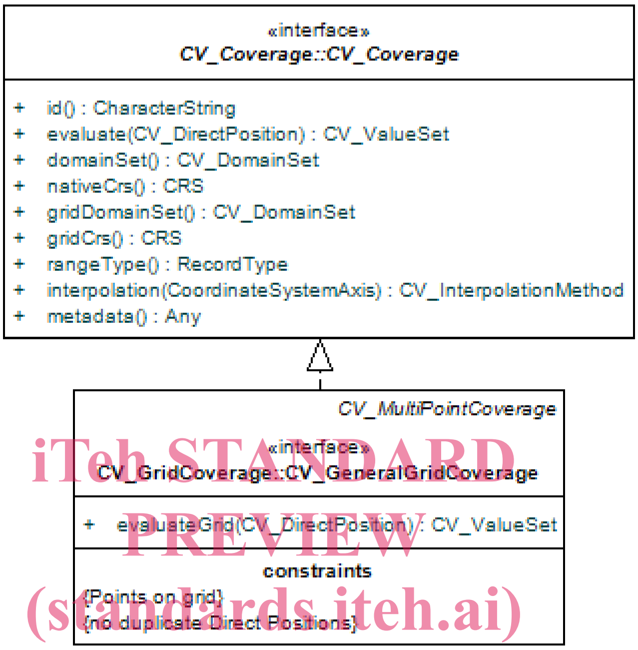

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Figure 1 — CV_Coverage and CV_GeneralGridCoverage with CV_Grid (ISO 19123-1)

NOTE CV_Coverage in ISO 19123-1 defines an interface which describes such an object’s behavior, but does not yet assume any particular data structure.

Below a brief recapitulation of ISO 19123-1 grid coverages is given; at the same time, probing functions are introducedwhich extracts components from some given coverage. These probing functions are defined as part of the ISO 19123-1 interface class definition. They serve to define this standard’s language semantics in Clause 6.

5.3 Coverage Identifier

Coverages have an identifier which is used in a ISO 19123-3 query to address a coverage. Therefore, this identifier must be unique within some context (here: an ISO 19123-3 query).

NOTE In a concrete service, coverages available typically would be those which are stored on this server, where access control allows addressing the coverage according to the user sending the request, etc. All these aspects are out of scope of this standard.

The corresponding ISO 19123-1 probing function for a coverage *C* is:

id(C)

Frequently new coverages are created in a query; initially, they do not carry any identifier, rather their id value is the empty string.

5.4 Domain Set

The domain set contains the coordinate tuples describing the coverage’s direct positions, which for the purpose of this standard all sit on a multi-dimensional grid. Informally speaking this means that every

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direct position inside the grid has exactly one next neighbor in both directions of every axis, except for the rim where obviously less neighbours are available. Figure 2 shows some regular and irregular grid examples.

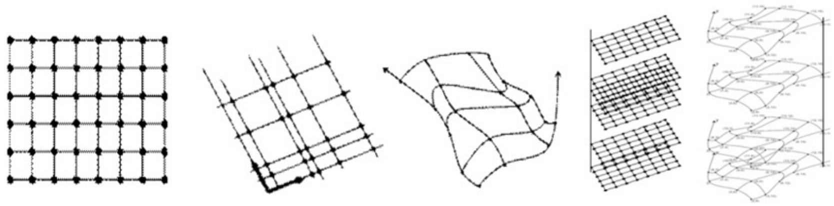

Figure 2 — Sample regular and irregular grid structures (ISO 19123-1)

The grid description depends on the complexity of the grid. As a grid is composed from an ordered sequence of axes the resulting complexity is determined by the types of axes (such as integer versus Lat versus time) as well as the rules determining the direct positions along these axes. The following axis types defined in ISO 19123-1 are supported by ISO 19123-3:

— A **Cartesian** (“index”) axis just requires lower and upper bound (which are of type integer).
— A **regular** axis which can be described by lower and upper bounds together with a constant distance, the resolution.
— An **irregular** axis which has individual distances, described by a sequence of coordinates.

NOTE 1 As explained in ISO 19123-1, the specialized grid types of superseded ISO 19123:2005 can be modeled through the ISO 19123-1 GeneralGridCoverage concept: a RectifiedGrid is a grid where all axes are of type Cartesian or regular; a ReferenceableGrid is a grid where at least one axis is not of these types.

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As per ISO 19123-1, the coverage domain set with its axes has a single native CRS which may allow georeferencing. Additionally, the underlying grid structure is defined through aCartesian grid CRS. Both CRSs have the same dimension, i.e.: number of axes. CRSs are addressed by name in ISO 19123-3 expressions. Both ISO 19123-1 and ISO 19123-3 do not make any assumptions about the nature of identifying CRSs, but rather treat them as opaque strings.

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The native CRS of a domain set is obtained through function *crs(C)*, its grid CRS through function *gridCrs(C)*.

nativeCrs(*C*)
gridCrs(*C*)

The particular definition of CRSs and axes is out of the scope of this standard, rather this is defined in ISO 19111. That said, this standard assumes an auxiliary probing function *axisList*() which extracts the ordered list of axes ($a_1,...,a_d$) from such a d-dimensional CRS:

axisList(*crs*)

NOTE 2 This function can be applied to both native and grid CRSs, so only one such function is necessary.

Each axis contributes coordinates from some nonempty, totally ordered set of values which can be numeric or, in the general case, strings (such as “2020-08-05T”).

For some given coverage *C*, two probing functions deliver the domain setof a coverage in its native CRS and in its Cartesian grid CRS, respectively:

domainSet(*C*)
gridDomainSet(*C*)

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The contents of the domain information describes the coverage's extent:

a) for each axis the lower and upper bound of the Direct Positions are listed in axis order
b) per axis, the following information is available:
   1) for index axes: nothing further;
   2) for regular axes: the resolution;
   3) for irregular axes: the sequence of points.

The contents of the grid information usually is simpler than the native domain because the underlying CRS is always index-only. Consequently, it consists of a list of lower bound / upper bound pairs, one per axis.

This information is accessible through overloaded versions of the abovementioned functions. For some coverage *C* that has an axis *a*, the following expressions return lower and upper bound, respectively:

domainSet(*C*, *a*).lo
domainSet(*C*, *a*).hi
gridDomainSet(*C*, *a*).lo
gridDomainSet(*C*, *a*).hi

5.5 Interpolation

In ISO 19123-1 a coverage contains admissible interpolation information, characterized individually per axis.

NOTE 1 As per ISO 19123-1 every coverage has one interpolation method associated per axis. In practice, coverages may allow several interpolation methods to be picked by the user. Conceptually, however, two coverages differing only in the interpolation methods are distinct as they will deliver identical range values on their direct positions, but differing values in between those. On the abstract level of ISO 19123-1 this ambiguity is not desirable.

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For the purpose of this standard a special interpolation method *none* is assumed in addition to those defined, e.g., in ISO 19123-1, Annex B. *None* indicates that no interpolation is possible along the axis under consideration.

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NOTE 2 Interpolation method none is different from nearest-neighbor: An interpolation of nearest-neighbor provides values inbetween Direct Positions which are derived from the closest Direct Position. Interpolation none means that no values are provided between Direct Positions, in other words: the evaluation function is undefined on any non-Direct Position.

Function interpolation(*C*,*a*) returns the list of interpolation methods applicable on each axis of coverage *C*, in order of the axis sequence. For *dimension*(*C*)=*d* the probing function delivers interpolation method list(m_1,...,m_d):

interpolation(C)

This function is overloaded to extract the interpolation method associated with axis a of *C*:

interpolation(*C*,*a*)

NOTE 3 Interpolation is particularly relevant with functions *scale*() and *project*().

5.6 Range Values

The range value at some direct positionpcan be obtained with function $evaluate_C(p)$ which, for some given coverage *C*, returns the value associated with $p \in domainSet(C)$ expressed in the coverage's native CRS. Simultaneously, function $evaluateGrid_C(p)$ does the same for some $p \in gridDomainSet(C)$ expressed in the coverage's grid CRS. The mechanics of a coverage, as per ISO 19123-1, ensures coherence between native and (Cartesian) grid coordinates.

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