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Geographic information - Schema for coverage geometry and functions - Part 1: Fundamentals (ISO/DIS 19123-1:2022)

Geoinformation - Coverage Geometrie- und Funktionsschema (ISO/DIS 19123-1:2022)

Information géographique -- Schéma de la géométrie et des fonctions de couverture - Partie 1: Principes de base (ISO/DIS 19123-1:2022)

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Geographic information — Schema for coverage geometry and functions —

Part 1: **Fundamentals**

Information géographique — Schéma de la géométrie et des fonctions de couverture —

Partie 1: Principes de base

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Contents

Foreword

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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.

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.

Introduction

This standard defines, at a high, implementation-independent level, the notion of coverages as digital representations of space-time varying geographic phenomena, corresponding to a field in physics: a physical quantity that has a value for each point in space-time. Such coverages can be discrete or continuous.

Historically, geographic information has been treated in terms of two fundamental types called vector data and raster data.

"**Vector data**" deals with discrete phenomena, each of which is conceived of as a feature. The spatial characteristics of a discrete real-world phenomenon are represented by a set of one or more geometric primitives (points, curves, surfaces or solids). Other characteristics of the phenomenon are recorded as feature attributes. Usually, a single feature is associated with a single set of attribute values. ISO 19107:2019 provides a schema for describing features in terms of geometric and topological primitives.

"**Raster data**[1]", on the other hand, deals with real-world phenomena that vary over space and time. It contains a set of values, each associated with one of the elements in an array of points or cells. It is usually associated with a method for interpolating values at spatial positions between the points or within the cells. Since this data structure is not the only one that can be used to represent phenomena that vary continuously over space, this document uses the term "coverage," adopted from the Abstract Specification of the Open Geospatial Consortium (OGC) [11], to refer to any data representation that assigns values directly to spatio-temporal position. A coverage is a function from a spatial, temporal or spatio-temporal domain to an attribute range. A coverage associates a position within its domain to a record of values of defined data types.

A coverage function has as its domain, an area or space defined by any combination of the three physical spatial dimensions plus the physical dimension time. Mathematics also uses the word dimension to represent an axis in a numeric space. The mathematical meanings of dimension and space are broader than those used in the physical world. The three physical spatial dimensions plus the physical dimension time may be mapped to mathematical dimensions. The range of a coverage function is a set of attribute values for each of the attribute types. These range values may also be represented as mathematical dimensions. That is, we have two complementary ways of viewing a coverage function, as a domain and range or as a mathematical space based on axes.

In this document, coverage is modelled as a subtype of feature as defined in ISO 19101. A coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.

A coverage consists of spatio-temporally extended objects where information content depends on (and varies with) the particular coordinate where it is probed. Standardization in this area is a cornerstone for other geographic information design, specification and standardization.

Such space-time varying objects are described as sets of geographic objects ("features"), called coverages. The feature objects collected in a coverage define the positions where values are available (called Direct Positions), and the individual values associated with each feature.

NOTE Direct Positions can be of different dimensions. For example, in a raster image modelled as a coverage the Direct Positions will be the grid points; in a Multi-Solid Coverage a Direct Position is given by the interior of a 3D solid.

In practice, coverages encompass regular and irregular grids, point clouds, and general meshes. Examples include raster data, triangulated irregular networks, point sets and polygon coverages. Coverages are multi-dimensional, including examples like 1D sensor timeseries, 2D satellite images, 3D x/y/t image

[1] "Raster" is a widely used but imprecise colloquial term that encompasses imagery, gridded and other types of coverage data.

timeseries and x/y/z geophysical voxel data, and 4D x/y/z/t climate and ocean data. Axes of such coverages can have spatial, temporal, or any other dimension, and they can be combined freely.

EXAMPLE The electromagnetic spectrum is an example for an axis with neither spatial nor temporal semantics. As such a spectral axis can be defined following the rules of ISO 19111, so it qualifies as a coverage axis.

A coverage which provides values only at the Direct Positions is called “a discrete coverage” (discrete in its domain); if interpolation information is added so that values can be obtained also beyond the coverage’s Direct Positions such a coverage is called “a continuous coverage”.

Just as the concepts of discrete and continuous phenomena are not mutually exclusive, their representations as discrete features or coverages are not mutually exclusive. The same phenomenon may be represented as either a discrete feature or a coverage. A city may be viewed as a discrete feature that returns a single value for each attribute, such as its name, area and total population. The city feature may also be represented as a coverage that returns values such as population density, land value or air quality index for each position in the city.

A coverage, moreover, can be derived from a collection of discrete features with common attributes, the values of the coverage at each position being the values of the attributes of the feature located at that position. Conversely, a collection of discrete features can be derived from a coverage; each discrete feature being composed of a set of positions associated with specified attribute values.

The previous version of this standard ISO 19123:2005 addressed coverage modelling on both conceptual and (to some extent) implementation level. For this edition of the document, coverage modelling has been split into two separate, but connected documents: ISO 19123-1 (this document) establishes an abstract, high-level coverage model while ISO 19123-2 establishes an implementation-level model ensuring interoperability, based on the concepts of ISO 19123-1.

Geographic information — Schema for coverage geometry and functions — Part 1: Fundamentals

1 Scope

This document defines a conceptual schema for coverages. A coverage is a mapping from a spatial, temporal or spatio-temporal domain to attribute values sharing the same type within the domain. A coverage domain consists of a collection of direct positions in a coordinate space that may be defined in terms of spatial and/or temporal dimensions. Examples of coverages include meshes/grids, triangulated irregular networks, point coverages and polygon coverages. Coverages are the prevailing data structures in a number of application areas, such as remote sensing, meteorology and mapping of bathymetry, elevation, soil and vegetation. This document defines the relationship between the domain of a coverage and an associated attribute range. The characteristics of the domain are defined whereas the characteristics of the attribute range are not part of this standard.

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/TS 19101-2:2018, *Geographic information — Reference model — Part 2: Imagery*

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

ISO 19107:2019, *Geographic information — Spatial schema*

ISO 19108:2002, *Geographic information — Temporal schema*

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

ISO 19111:2019, *Geographic information — Referencing by coordinates*

ISO 19115-1:2014, *Geographic information — Metadata — Part 1: 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
analytical coverage
type of continuous coverage which is a spatially bounded, but transfinite set of direct positions, and a mathematical function that relates direct position to feature attribute value

3.1.2
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.

3.1.3
continuous coverage
coverage that returns different values for the same feature attribute at different direct positions within a single spatial object, temporal object or spatio-temporal object in its domain

Note 1 to entry: Although the domain of a continuous coverage is ordinarily bounded in terms of its spatial and/or temporal extent, it can be subdivided into an infinite number of direct positions.

3.1.4
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 19111:2019, 3.1.5, modified — Original Note 1 to entry has been replaced with a new note to entry.]

3.1.5
coordinate dimension
<coordinate geometry> number of measurements separate decisions needed to describe a position in a coordinate system

Note 1 to entry: The number of separate decisions corresponds to the number of axes.

[SOURCE: ISO 19107:2019, 3.17, modified — Original Note 1 to entry has been replaced with a new note to entry.]

3.1.6
coordinate system
set of mathematical rules for specifying how coordinates are to be assigned to points

[SOURCE: ISO 19111:2019, 3.1.11]

3.1.7
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]

3.1.8
coverage
feature that acts as a function to return values from its range for any direct position within its domain

3.1.9
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.

3.1.10
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 19107:2019, 3.17, modified — Original Note 1 to entry has been replaced with a new note to entry.]

3.1.11
coverage geometry
configuration of the domain of a coverage described in terms of coordinates

3.1.12
Delaunay triangulation
network of triangles such that the circle passing through the vertices of any triangle does not contain, in its interior, the vertex of any other triangle

3.1.13
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 19136-1:2020, 3.1.20, modified — Note 1 to entry has been added.]

3.1.14
cell
<coverage> neighbourhood around a direct position in a coverage grid

Note 1 to entry: Coverage cells are also known as grid cells.

3.1.15
discrete coverage
coverage that returns the same feature attribute values for every direct position within any object in its domain

Note 1 to entry: The domain of a discrete coverage consists of a finite set of spatial, temporal, or spatio-temporal objects.

Note 2 to entry: Discrete coverages have values only where they are defined, whereas continuous coverages can be interpolated thereby providing intermediate values.

3.1.16
domain
well-defined set

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

[SOURCE: ISO 19109:2015, 4.8, modified — Original Note 1 to entry has been replaced with a new note to entry.]

3.1.17
external coordinate reference system
coordinate reference system whose datum is independent of the object that is located by it

[SOURCE: ISO 19130-1:2018, 3.25]

3.1.18
evaluation
<coverage> determination of the values of a coverage at a direct position within the domain of the coverage

3.1.19
feature
abstraction of real world phenomena

[SOURCE: ISO 19101-1:2014, 4.1.11, modified — Note 1 to entry has been removed.]

3.1.20
feature attribute
characteristic of a feature

Note 1 to entry: Also known as "feature property" and may support potential attribute, quality, or characteristic of a feature.

[SOURCE: ISO 19101-1:2014, 4.1.12, modified — Original Notes to entry have been deleted and a new Note 1 to entry added.]

3.1.21
function
<mathematics, programming> rule that associates each element from a domain ("source domain", or "domain" of the function) to a unique element in another domain ("target domain", "co-domain" or "range" of the function)

[SOURCE: ISO 19107:2019, 3.41]

3.1.22
geometric dimension
<geometry, topology> largest number n such that each point in a set of points can be associated with a subset that has that point in its interior and is topologically isomorphic to $\mathbb{E}^n$, Euclidean n-space

[SOURCE: ISO 19107:2019, 3.48 modified — Original Notes to entry have been deleted.]

3.1.23
geometric object
<geometry> spatial object representing a geometric set

Note 1 to entry: A geometric object consists of a geometric primitive, a collection of geometric primitives, or a geometric complex treated as a single entity. A geometric object may be the spatial representation of a feature object.

[SOURCE: ISO 19107:2019, 3.49]

3.1.24
geometric set
<geometry> set of direct positions

[SOURCE: ISO 19136-1:2020, 3.1.32, modified — Original Note to entry has been deleted.]

3.1.25
georectified
corrected for positional displacement with respect to the surface of the earth.

[SOURCE: ISO 19115-2:2019, 3.11]

3.1.26
georeferenceable
associated with a geopositioning information that can be used to convert grid coordinate values to values of coordinates referenced to an external coordinate reference system related to the Earth by a datum.

[SOURCE: ISO 19163-1:2016]

3.1.27
georeferencing
geopositioning an object using a Correspondence Model derived from a set of points for which both ground and image coordinates are known.

[SOURCE: ISO 19130-1:2018, 3.37]

3.1.28
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 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 19123:2005 definition is equivalent to the revised definition of this document.

3.1.29
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 19136-2:2015, 4.2.1, modified — Original Note 1 to entry has been deleted and a new Note 1 to entry added.]

3.1.30
grid coordinate system
coordinate system in which a position is specified relative to the intersection of curves

[SOURCE: ISO 19115-2:2019, 3.14]

3.1.31
grid coordinates
sequence of two or more numbers specifying a position with respect to its location on a grid

[SOURCE: ISO 19115-2:2019, 3.15]

3.1.32
grid point
point located at the intersection of two or more curves in a grid

3.1.33
gridded data
data whose attribute values are associated with positions on a grid coordinate system.

Note 1 to entry: Gridded data are a subtype of coverage data, which represent attribute values of geographic features in terms of a spatial grid

[SOURCE: ISO 19115-2:2019, 3.16, modified — Note 1 to entry has been added.]

3.1.34
image coordinate system
Image CS
two-dimensional non-georeferenced Cartesian grid coordinate system

Note 1 to entry: An Image CS is a two-dimensional Index CS, hence a special case of an Index CS.