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Geographic information — Classification systems —

Part 1: Classification system structure

Information géographique — Systèmes de classification —

Partie 1: Structure de système de classification

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 19144-1 was prepared jointly by the Food and Agriculture Organization (FAO) of the United Nations and Technical Committee ISO/TC 211, *Geographic information/Geomatics* under a cooperative agreement between the two organizations.

ISO 19144 consists of the following parts, under the general title *Geographic information — Classification systems*:

— *Part 1: Classification system structure*

The following part is under preparation:

— *Part 2: Land cover classification system (LCCS)*

Introduction

This part of ISO 19144 is based on publications of the Food and Agriculture Organization (FAO) of the United Nations [1][2]. The first in a series of International Standards related to geographic classification systems, it defines the structure of such systems, together with the mechanism for defining and registering classifiers.

Since there are many different possible application areas, there is no single classification system that will serve all needs. The method by which classifiers are defined depends upon the application area. In addition, the classifiers used within a particular application area might not be adequate for all situations encountered within that application area and could need to be augmented over time. To facilitate extension of the set of classifiers in a particular application area, classifiers are registered in a register structure compliant with ISO 19135. This allows the set of classifiers to be maintained. The use of the ISO 19135 registration mechanism allows for separate registers to be defined for different sets of classifiers within multiple information communities, thereby satisfying application needs. This approach allows for independence between information communities, but also allows relationships to be developed between different classification systems that potentially allow the conversion, or partial conversion, of data from one classification system to another, or the fusion of data from two separate sources.

The concept of classification systems is well known in the geographic information community. A classification system can be used to subdivide any geographic area into small units, each of which carries an identifier that describes its type. The results can then be represented as a discrete coverage as described in ISO 19123. Many such classification systems can be defined to address any geographic area. Different application areas and different information communities can define their own classification systems. However, if the classification system is defined in a compatible way, interaction between different information communities becomes possible. In addition, in a particular application area, it is desirable that there be a few well-established classification systems, and that these themselves be standardized within information communities.

This part of ISO 19144 describes the common structure, while subsequent parts will allow for the standardization of specific classification systems.

A *coverage* is a function that returns values from its range for any direct position within its spatial, temporal or spatiotemporal domain. A *discrete coverage* is a function that returns the same feature attribute values for every direct position within any single spatial object, temporal object or spatiotemporal object in its domain. The domain is an area covered by the coverage function, and the discrete coverage breaks that area down into a set of spatial, temporal or spatiotemporal objects. The geometry of the discrete coverage used to represent the results of applying a classification system can be any type of discrete coverage — for example, a set of polygons fitted together like a jig-saw puzzle, a set of grid cells, or a set of points or curves.

A classification system consists of a set of classifiers. These classifiers may be algorithmically defined, or established according to a set of classification system definitions. The classifiers are application-area-dependent and are or will be defined in the other parts of ISO 19144 or other standards or publications. A register allows for the maintenance of a set of classifiers for a particular application area. A spatial, temporal or spatiotemporal object defined in terms of a set of classifiers is a *classified* object.

There is a commonality between conventional geographic features and classified objects. A *feature* is defined in ISO 19101 as an abstraction of real world phenomena. An example of a class of feature is a *building*, and a particular building, e.g. the UN building in New York, is an instance of a *feature class*. Conventional geographic features are *atomic units* that are assembled to build one type of geographic information data set.

A classification system works in the opposite manner, from the top down, by successively decomposing the whole within a coverage area. Classified objects are features, in that they are an abstraction of a real world phenomena, but classified objects are *not* atomic, because they are necessarily related to each other by the classifiers that decompose the whole. In a simple example of a classification system, the earth as a whole can be covered by either “land” or “water”, and two classifiers can be defined partitioning the attribute range into

two, identifying objects as being either land or water. Any particular area on the earth, corresponding to a classified object, would be of type “land” or “water”.

ISO 19135 specifies that a *technical standard* be required to define the item classes in any conformant register. This part of ISO 19144 defines schemas for registers conformant to ISO 19135 and serves as the technical standard that defines the item classes required for the registration of classifiers. It establishes a set of rules for specifying definitions that can be used in a particular context to establish classified objects.

Registers of classifiers can serve as sources of reference for similar registers established by other geographic information communities as part of a system of cross-referencing. Cross-referencing between respective items in registers of classifiers might be difficult in cases where the structure of registers differs between information communities. This part of ISO 19144 can serve as a guide for different information communities for the development of compatible registers that can support a system of classifier cross-referencing.

The structure of a classification system together with the mechanism of defining and registering classifiers defined in this part of ISO 19144 is general and can be applied to many different information-community-defined classification systems, including soil, landform, vegetation, urbanization and systems for understanding biodiversity and climate change. The use of this document will allow the relationship between different classification systems to be described.

Geographic information — Classification systems —

Part 1:
Classification system structure

1 Scope

This part of ISO 19144 establishes the structure of a geographic information classification system, together with the mechanism for defining and registering the classifiers for such a system. It specifies the use of discrete coverages to represent the result of applying the classification system to a particular area and defines the technical structure of a register of classifiers in accordance with ISO 19135.

The structure can be used to develop specific classification systems that address particular application areas, specified in other parts of ISO 19144.

2 Conformance

2.1 Classes

Three conformance classes are identified in this part of ISO 19144.

2.2 Conformance of a classification system

Any classification system for which conformance to this part of ISO 19144 is claimed shall be in accordance with Annex A (see A.2).

2.3 Conformance of a register of classifiers

Any register of classifiers for which conformance to this part of ISO 19144 is claimed shall be in accordance with Annex A (see A.3) and ISO 19135:2005, A.1.

2.4 Representation of classification results

Any legend of classifiers for which conformance to this part of ISO 19144 is claimed shall be in accordance with Annex A (see A.4).

3 Normative references

The following referenced documents are indispensable for the application 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 19103:2005, *Geographic information — Conceptual schema language*

ISO 19110:2005, *Geographic information — Methodology for feature cataloguing*

ISO 19115, *Geographic information — Metadata*

ISO 19123, *Geographic information — Schema for coverage geometry and functions*

ISO 19135:2005, *Geographic information — Procedures for item registration*

4 Terms, definitions and abbreviated terms

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

4.1 Terms and definitions

4.1.1
***a posteriori* classification**
classification (4.1.4) scheme based upon definition of classes after clustering the field samples collected

NOTE 1 Taken from FAO LCCS version 2 (see Reference [2]).

NOTE 2 See Annex B for an examination of this and ***a priori* classification** (4.1.2).

4.1.2
***a priori* classification**
classification (4.1.4) scheme structured so that the classes are abstract conceptualizations of the types actually occurring

NOTE 1 Taken from FAO LCCS version 2 (see Reference [2]).

NOTE 2 The approach is based upon the definition of classes before any data collection actually takes place.

NOTE 3 See Annex B for an examination of this and ***a posteriori* classification** (4.1.1).

4.1.3
classified object
spatial object, temporal object or spatiotemporal object assigned to a specific **legend class** (4.1.16)

4.1.4
classification
abstract representation of real world phenomena using **classifiers** (4.1.6)

4.1.5
classification system
system for assigning objects to classes

4.1.6
classifier
definition used to assign objects to **legend classes** (4.1.16)

NOTE Classifiers can be defined algorithmically or according to a set of **classification system** (4.1.5) specific rules.

4.1.7
coverage
feature (4.1.10) that acts as a function to return values from its **range** (4.1.17) for any direct position within its spatial, temporal or spatiotemporal **domain** (4.1.9)

[ISO 19123:2005]

EXAMPLE Raster image, polygon overlay, digital elevation matrix.

NOTE 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.

4.1.8
discrete coverage
coverage (4.1.7) that returns the same **feature attribute** (4.1.11) values for every direct position within any single spatial object, temporal object, or spatiotemporal object in its **domain** (4.1.9)

[ISO 19123:2005]

NOTE The domain of a discrete coverage consists of a finite set of spatial, temporal, or spatiotemporal objects.

4.1.9
domain
well-defined set

[ISO/TS 19103:2005]

NOTE Domains are used to define the domain and **range** (4.1.17) of operators and functions.

4.1.10
feature
abstraction of real world phenomena

[ISO 19101:2002]

EXAMPLE The phenomenon “Eiffel Tower” can be classified with other similar phenomena into a feature type “tower”.

NOTE A feature can occur as a type or an instance. In this part of ISO 19144, *type* is meant unless otherwise specified.

4.1.11
feature attribute
characteristic of a **feature** (4.1.10)

[ISO 19101:2002]

4.1.12
feature concept dictionary
dictionary that contains definitions of, and related descriptive information about concepts that may be specified in detail in a **feature** (4.1.10) catalogue

[ISO 19126:—[1)]]

4.1.13
identifier
linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated

[ISO 19135:2005]

4.1.14
item class
set of items with common properties

[ISO 19135:2005]

NOTE “Class” is used in this context to refer to a set of instances, not the concept abstracted from that set of instances.

1) To be published.

4.1.15
legend
application of a **classification** (4.1.4) in a specific area using a defined mapping scale and specific data set

NOTE Taken from FAO LCCS version 2 (see Reference [2]).

4.1.16
legend class
class resultant from the application of a **classification** (4.1.4) process

NOTE The result of a classification process is termed *legend class* in this part of ISO 19144 in order to avoid confusion with the term "class" as used in UML modelling.

4.1.17
range
⟨coverage⟩ set of **feature attribute** (4.1.11) values associated by a function with the elements of the **domain** (4.1.9) of a **coverage** (4.1.7)

[ISO 19123:2005]

4.1.18
register
set of files containing **identifiers** (4.1.13) assigned to items with descriptions of the associated items

[ISO 19135:2005]

4.1.19
registry
information system on which a **register** (4.1.18) is maintained

[ISO 19135:2005]

4.1.20
technical standard
standard containing the definitions of **item classes** (4.1.14) requiring registration

[ISO 19135:2005]

4.1.21
vector geometry
representation of geometry through the use of constructive geometric primitives

[ISO 19107:2003]

4.2 Abbreviated terms

4.2.1 General

CRS Coordinate Reference System

LCCS Land Cover Classification System

UML Unified Modelling Language

4.2.2 Notation

The conceptual schema specified in this part of ISO 19144 is described using the Unified Modelling Language (UML), following the guidance of ISO/TS 19103.

Several model elements used in this schema are defined in other standards in the ISO 19100 series. By convention within this suite of International Standards, names of UML classes[2)], with the exception of basic data type classes, include a two-letter prefix that identifies the International Standard and the UML package in which the class is defined.

UML classes defined in this part of ISO 19144 have the two-letter prefix “CL”.

Table 1 lists the other International Standards and the packages in which UML classes used in this part of ISO 19144 have been defined.

Table 1 — Sources of externally defined UML classes

Prefix	International Standard	Package
CV	ISO 19123	Coverage core and discrete coverages
DS	ISO 19115	Metadata application information
GF	ISO 19109	General feature model
GM	ISO 19107	Geometry root
MD	ISO 19115	Metadata entity set information
MI	ISO 19115-2	Metadata entity set imagery
RE	ISO 19135	Procedures for registration
SC	ISO 19111	Spatial referencing by coordinates
TM	ISO 19108	Temporal objects

5 Classification systems

5.1 Concept

A discrete coverage returns the same feature attribute for every direct position within any single geometric object in its spatiotemporal domain. The spatiotemporal domain consists of a set of geometric objects that together form the coverage.

EXAMPLE 1 The discrete coverage of postal zones within a country: each zone has a different code and it is not possible to interpolate between these codes. Nevertheless, there could be a high level relationship between the codes. The small country of Monaco is divided into five *quartiers*: “Moneghetti”, “La Condamine”, “Fontvieille”, “Monaco-Ville” and “Monte-Carlo”. These political jurisdictions completely cover the area of the country. The area of Monaco can be represented as a discrete coverage with five spatial objects where each object has the geometry of a polygon. The attribute value for each spatial object is the name of the political jurisdiction. See Figure 1.

2) There is potential confusion between the use of the term “class” as used in UML, “class” as used in a classification scheme and “item class” as used in the procedures for registration. Class as used in a classification scheme is termed legend class in this part of ISO 19144.

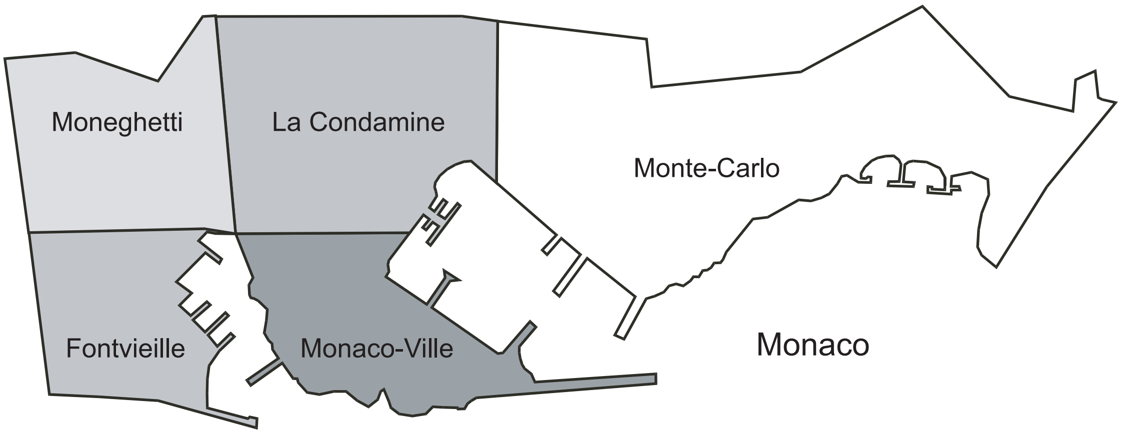

Figure 1 — Example of discrete coverage with polygon geometry

The geometry of the spatial objects associated with a discrete coverage can also be grid cells within a grid structure. Each of the grid cells may carry an attribute.

EXAMPLE 2 A discrete coverage with grid geometry of the same area as used in the previous example. See Figure 2. The figure legend identifies the instances of the attribute values that actually exist in the data.

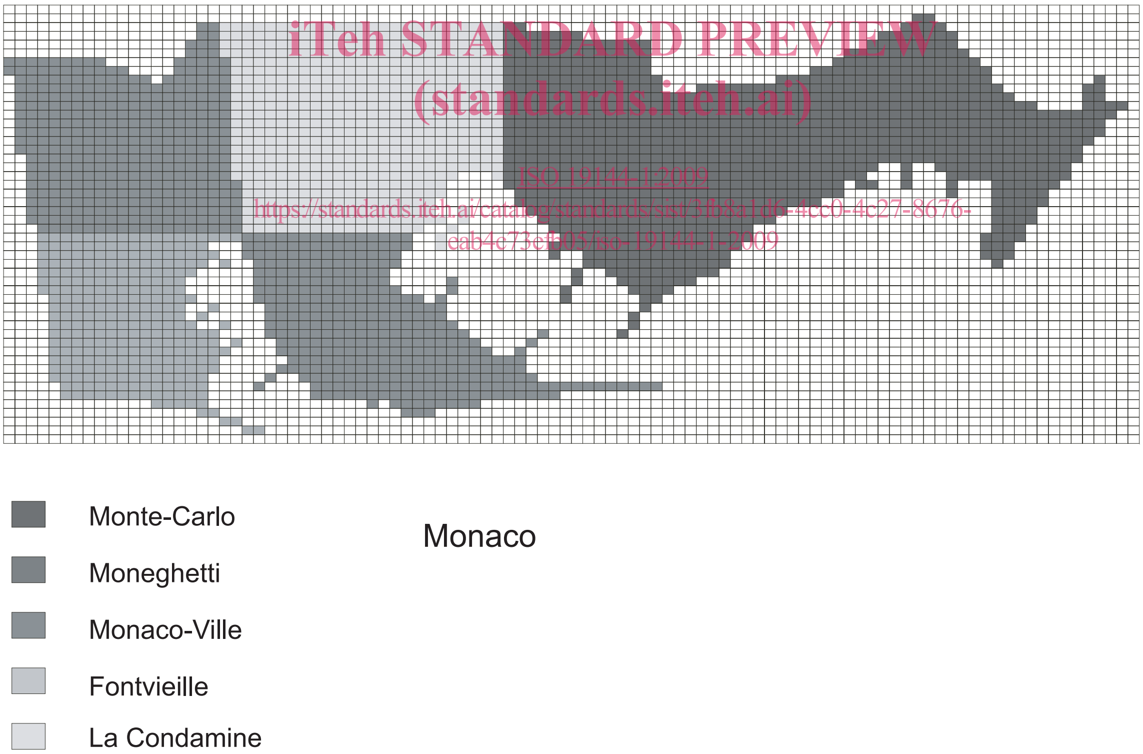

Figure 2 — Example of discrete coverage with grid geometry

NOTE The discrete coverages illustrated by the above examples are simple because only one relatively simple attribute has been used. However, in reality the attributes for each of the coverage spatial objects can be very complex. In order to describe land cover it is necessary to integrate a large number of descriptive parameters related to soil, biology and density into a comprehensive land cover classification system. Such a classification system is of course application-area-dependent. An oceanographer will have a different classification system than that of a meteorologist. Classification systems can vary widely in different application areas, but for similar application areas there needs to be some commonality in order for data from different sources to be used together.

