INTERNATIONAL STANDARD

ISO 19137

First edition
2007-05-01

Geographic information — Core profile of the spatial schema

Information géographique — Profil minimal du schéma spatial

Reference number
ISO 19137:2007(E)

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Published in Switzerland

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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 19137 was prepared by Technical Committee ISO/TC 211, *Geographic information/Geomatics*.

Introduction

This International Standard provides a core profile of the geometry part of the spatial schema specified in ISO 19107 that is easy to understand and has a low cost of implementation. The profile is intentionally small and limited in order to increase the chance of gaining widespread market acceptance.

A simple topology package extension of the profile might be developed as a future part of this International Standard. Many user communities have requirements that go beyond the capabilities provided by this International Standard, and they may define custom profiles.

While ISO 19136 also implements a profile of ISO 19107, it is a comprehensive profile, not a core profile.

This International Standard supports data types for geometric primitives of 0, 1 and 2 dimensions. It satisfies the conformance test A.1.1.3 of ISO 19107:2003. It is in conformance class 1 of ISO 19106.

Annex A lists some specifications that were supported by this International Standard at the time of its publication. Annex B specifies an abstract test suite for determining whether an application schema or profile is conformant to the core profile. Annex C discusses how to extend the core profile. Annex D presents two examples.

Geographic information — Core profile of the spatial schema

1 Scope

This International Standard defines a core profile of the spatial schema specified in ISO 19107 that specifies, in accordance with ISO 19106, a minimal set of geometric elements necessary for the efficient creation of application schemata.

This International Standard supports many of the spatial data formats and description languages already developed and in broad use within several nations or liaison organizations.

NOTE Data modelled with this International Standard are consistent with spatial models already developed and used by a number of organizations; see Annex A.

2 Conformance

An abstract test suite for this International Standard is given in Annex B.

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 19107:2003, *Geographic information — Spatial schema*

ISO 19111:2003, *Geographic information — Spatial referencing by coordinates*

4 Terms, definitions, symbols and abbreviated terms

For the purposes of this document, the same terms, definitions, symbols and abbreviated terms given in ISO 19107 apply.

5 Geometry packages

5.1 Class diagram

Figure 1 depicts the complete profile of ISO 19107. The constraints on ISO 19107 are too many to be shown graphically in Figure 1, but are described in 5.2 to 5.12. This International Standard is limited to applications in which

— there is a 1:1 mapping between features and geometric primitives,

— all geometric primitives are referenced to a single coordinate reference system,

— all curves are composed of line segments, and

— all surfaces are composed of planar facets.

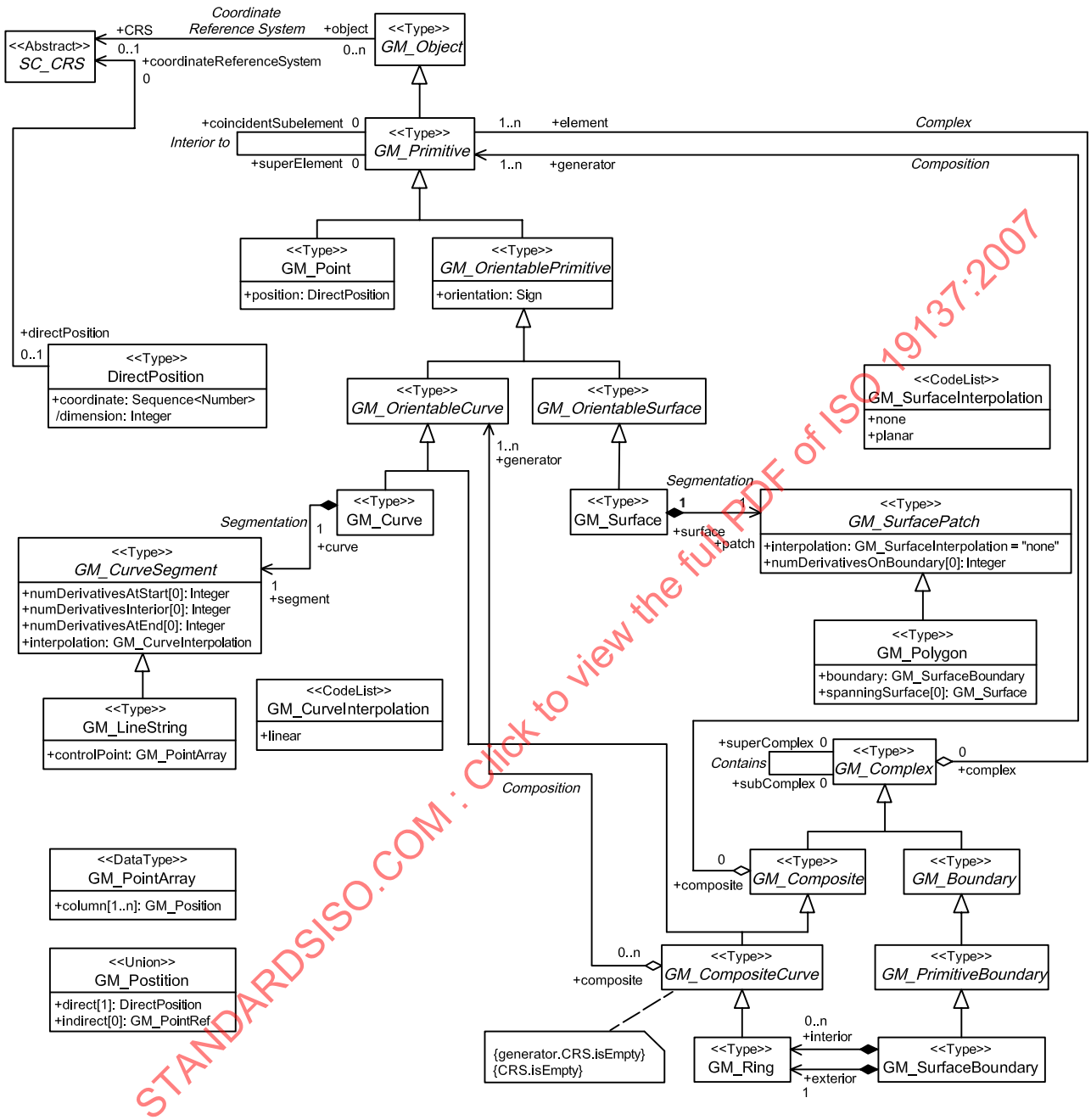

Figure 1 — The complete profile

Abstract classes that appear in Figure 1 and are needed to provide compatibility with ISO 19107 are omitted from the simplified representation in Figure 2.

NOTE Abstract classes that are needed for compatibility with ISO 19107 have been omitted. Also, the inheritance relation between GM_Ring and GM_Object is not shown here.

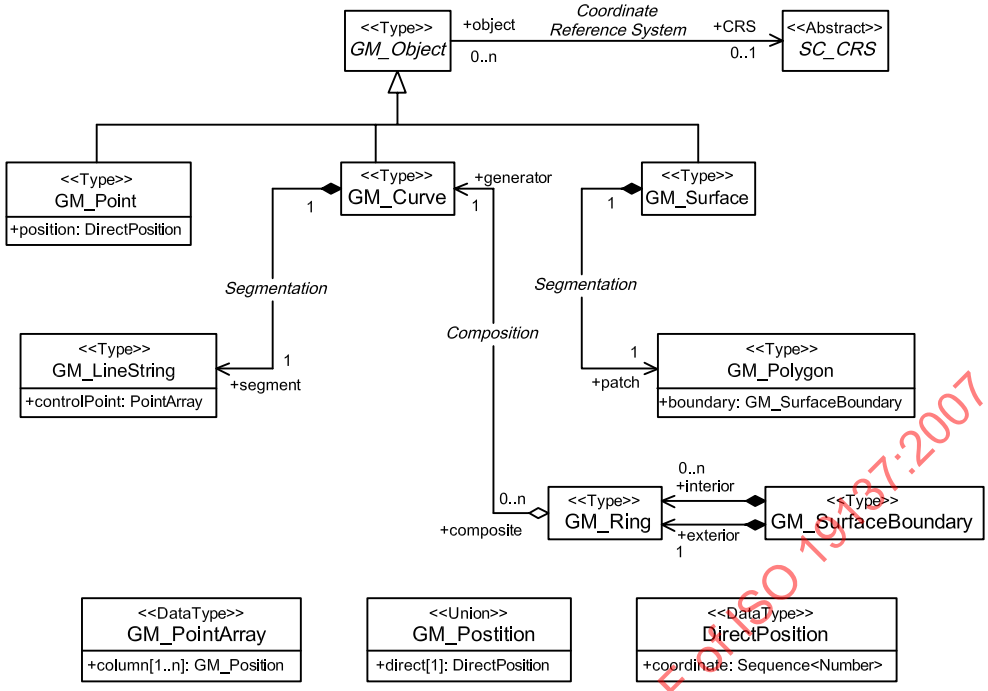

Figure 2 — A simplified, "flattened" view to the profile for illustrating its structure

5.2 Omitted constructs

This International Standard uses no operations or interfaces from ISO 19107. Also, any other constructs from ISO 19107 are omitted in this International Standard unless they are mentioned in 5.3.

5.3 Classes retained without additional constraints

The following classes are the same as in ISO 19107.

— **Abstract classes**: GM_Object (ISO 19107:2003, 6.2.2); GM_Boundary (6.3.2); GM_PrimitiveBoundary (6.3.4); GM_Primitive (6.3.10); GM_OrientablePrimitive (6.3.13); GM_Complex (6.6.2); GM_Composite (6.6.3).

— **Concrete classes**: GM_Ring (ISO 19107:2003, 6.3.6), GM_SurfaceBoundary (6.3.7); GM_Point (6.3.11); GM_Curve (6.3.16); GM_Surface (6.3.17); DirectPosition (6.4.1); GM_PointArray (6.4.6); GM_LineString (6.4.10).

Like ISO 19107, this International Standard refers to the abstract class SC_CRS, which is defined in ISO 19111.

5.4 Concrete classes made abstract

The following classes are concrete in ISO 19107, but abstract in this profile: GM_OrientableCurve (6.3.14); GM_OrientableSurface (6.3.15); GM_CompositeCurve (6.6.5).

5.5 Associations

5.5.1 Associations retained without additional constraints

The following associations are the same as in ISO 19107: Coordinate Reference System (ISO 19107:2003, 6.2.2.17); association "Composition" between GM_CompositeCurve and GM_OrientableCurve (ISO 19107:2003, Figure 28).

5.5.2 Segmentation between GM_Curve and GM_CurveSegment

The association “Segmentation” between GM_Curve and GM_CurveSegment (ISO 19107:2003, 6.3.16.3) is changed as follows: the multiplicity of the “curve” role is restricted from [0,1] to [1], and the multiplicity of the “segment” role is restricted from [1..n] to [1]. Instances of GM_CurveSegment thus cannot exist without being part of a GM_Curve.

`GM_CurveSegment::curve[1] : Reference<GM_Curve>` (multiplicity restricted from [0,1])

5.5.3 Segmentation between GM_Surface and GM_SurfacePatch

The association “Segmentation” between GM_Surface and GM_SurfacePatch (ISO 19107:2003, 6.3.17.3) is changed as follows: the multiplicity of the “surface” role is restricted from [0,1] to [1]. Instances of GM_SurfacePatch thus cannot exist without being part of a GM_Surface.

`GM_SurfacePatch::surface[1] : Reference<GM_Surface>` (multiplicity restricted from [0,1])

5.5.4 DirectPosition::coordinateReferenceSystem

The multiplicity of the association role “coordinateReferenceSystem” of the data type DirectPosition (ISO 19107:2003, 6.4.1.4) is restricted from [0,1] to [0]. As a consequence, individual points cannot specify a reference system; this has to be established via GM_Object::CRS.

The data in any dataset that conforms to this International Standard shall be in one and only one coordinate reference system.

`DirectPosition::coordinateReferenceSystem[0] : ISO19111::SC_CRS` (multiplicity restricted from [0,1])

5.5.5 GM_SurfaceBoundary::exterior

The multiplicity of the association role “exterior” of GM_SurfaceBoundary (ISO 19107:2003, 6.3.7.2) is restricted from [0,1] to [1]. Thus, all surfaces are required to have an exterior boundary and the “universe face” is not permitted in this International Standard.

`GM_SurfaceBoundary::exterior[1] : GM_Ring` (multiplicity restricted from [0,1])

5.5.6 Interior to

The multiplicity of the association roles “coincidentSubelement” and “superElement” of GM_Primitive (ISO 19107:2003, 6.3.10.4, association “Interior to”) is restricted on both ends to [0]. Thus, this International Standard excludes GM_Primitives which are coincident with one another.

`GM_Primitive::coincidentSubelement[0] : GM_Primitive` (multiplicity restricted from [0..n])
`GM_Primitive::superElement[0] : GM_Primitive` (multiplicity restricted from [0..n])

NOTE ISO 19107:2003, Figure 8 calls these association ends “containedPrimitive” and “containingPrimitive,” respectively, although they are called "coincidentSubelement" and superElement" in the text of ISO 19107.

5.5.7 Contains

The multiplicity of the association roles “subComplex” and “superComplex” of GM_Complex (ISO 19107:2003, 6.6.2.3, association “Contains”) is restricted on both ends to [0]. Thus, this International Standard excludes GM_Complexes which are coincident with one another.

`GM_Complex::subComplex[0] : GM_Complex` (multiplicity restricted from [0..n])
`GM_Complex::superComplex[0] : GM_Complex` (multiplicity restricted from [0..n])

5.5.8 Complex

The multiplicities of the association roles “element” and “complex” between GM_Primitive and GM_Complex (ISO 19107:2003, 6.6.2.4, association “Complex”) are restricted to [0]. Thus, geometric primitives cannot be part of a complex as complexes exceed the minimal capabilities required by this International Standard.

`GM_Primitive::complex[0] : GM_Complex` (multiplicity restricted from [0..n])

5.5.9 Composition

The multiplicities of the association roles “generator” and “composite” between GM_Primitive and GM_Composite (ISO 19107:2003, Figure 25, association “Composition”) are restricted to [0]. Thus, geometric primitive cannot be part of a composite as composites exceed the minimal capabilities required by this International Standard.

`GM_Primitive::composite[0] : GM_Composite` (multiplicity restricted from [0..n])

5.6 GM_Position

The data type GM_Position (ISO 19107:2003, 6.4.5) is restricted as follows: the multiplicity of its attribute “direct” is restricted to [1] and the multiplicity of its attribute “indirect” is restricted to [0]. Thus, the data type only allows the identification of a position as a coordinate (the direct variant). The indirect variant is not used.

`GM_Position::direct[1] : DirectPosition` (multiplicity restricted from [0,1])
`GM_Position::indirect[0] : GM_PointRef` (multiplicity restricted from [0,1])

5.7 GM_CurveSegment

The multiplicity of the attributes GM_CurveSegment::numDerivativesAtStart, numDerivativesInterior and numDerivativesAtEnd (ISO 19107:2003, 6.4.9.3) is restricted from [0,1] to [0]. Thus, only simple continuity within and between adjacent curve segments is described.

`GM_CurveSegment::numDerivativesAtStart[0] : Integer` (multiplicity restricted from [0,1])
`GM_CurveSegment::numDerivativesInterior[0] : Integer` (multiplicity restricted from [0,1])
`GM_CurveSegment::numDerivativesAtEnd[0] : Integer` (multiplicity restricted from [0,1])

5.8 GM_CurveInterpolation

The code list GM_CurveInterpolation (ISO 19107:2003, 6.4.8) is restricted to “linear”. Thus, the interpolation between the points of a curve is restricted to straight lines, excluding all other interpolations, such as geodesic, elliptical, clothoid, etc.

5.9 GM_SurfaceInterpolation

The code list GM_SurfaceInterpolation (ISO 19107:2003, 6.4.32) is restricted to “planar” and “none”. Thus, the interior of a surface is either a plane, or is not specified and hence is defined by the reference surface.

5.10 GM_SurfacePatch

The multiplicity of the attribute GM_SurfacePatch::numDerivativesOnBoundary (ISO 19107:2003, 6.4.34.3) is restricted from [0,1] to [0]. Thus, only simple continuity at the boundary between adjacent surfaces is described.

`GM_SurfacePatch::numDerivativesOnBoundary[0] : Integer` (multiplicity restricted from [0,1])

5.11 GM_Polygon

The multiplicity of the attribute GM_Polygon::spanningSurface (ISO 19107:2003, 6.4.36.3) is restricted from [0,1] to [0]. Thus, the interior of a polygon shall not be described by a spanning surface, such as an elevation model.

`GM_Polygon::spanningSurface[0] : GM_Surface` (multiplicity restricted from [0,1])

5.12 GM_CompositeCurve

GM_CompositeCurve (ISO 19107:2003, 6.6.5) is made abstract. In addition, it is required that neither the GM_CompositeCurve nor its generator specifies a coordinate reference system (which is interpreted, according to ISO 19107, as having the same reference system as its container).

```
GM_CompositeCurve:
    CRS.isEmpty
    generator.CRS.isEmpty
```

6 Topology packages

This International Standard does not use the topology packages from ISO 19107.

NOTE This decision was made for the sake of simplicity and low cost of implementation. However, some user communities might need topology classes. As with any other construct, they are free to define an extension of this International Standard, adding the entire topology framework or a suitable subset thereof. ISO 19107:2003, Annex D, might serve as an illustration for combining geometry with topology.

Annex A
(informative)

Supported specifications

A.1 Introduction

This International Standard is based on spatial models already developed and in use by a number of organizations. Spatial data modelled with this International Standard are expected to be consistent with subsets of the specifications listed below. Therefore, little effort should be required for transferring "profile-compliant" data into systems that were developed for any of the listed specifications.

However, data modelled with extensions of the core profile will not necessarily be consistent anymore. For example, if an extension incorporates GM_Clothoid from ISO 19107, the modelled data will only be consistent with those standards that actually support clothoids. Most of the listed specifications extend the common core specified by this International Standard. This is illustrated in Figure A.1.

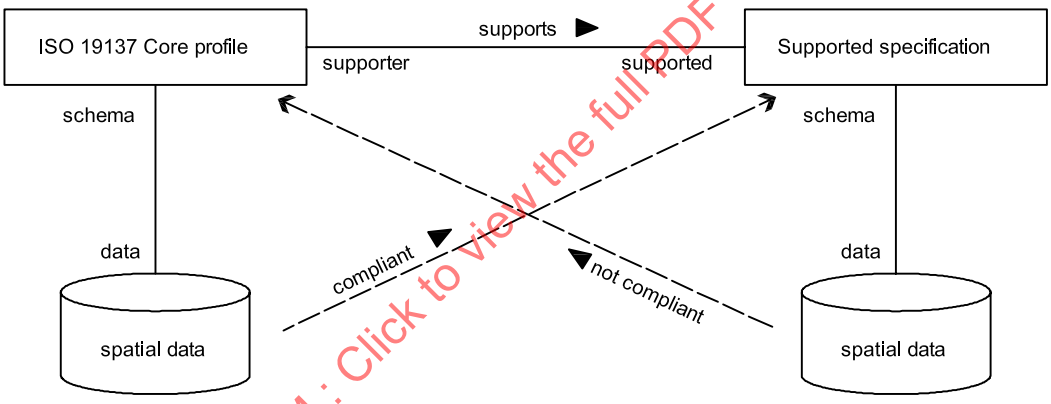

Figure A.1 — Relationship between ISO 19137 and specifications with extensions

A.2 List of supported specifications

At the date of publication, the following specifications were known to be consistent with this International Standard. However, some of these specifications have extensions to this document.

— ALKIS, Working Committee of the Surveying Authorities of the States of the Federal Republic of Germany (Arbeitsgemeinschaft der Vermessungsverwaltungen der Länder der Bundesrepublik Deutschland), 2003.

— DGIWG and IHO, Profile(s) of ISO 19107 that support two-dimensional topology. Digital Geographic Information Working Group and International Hydro-graphic Bureau, 2003.

— GeoWin, Chinese Association for Geodesy, Photogrammetry and Cartography, 2002.

— INTERLIS, Swiss National Standard SN 612031. Association Suisse de Normalisation, 2003.

— ISO 19136, *Geographic information — Geography Markup Language*.

— OpenGIS Simple Features, OpenGIS Consortium, 1999.

— SOSI Coordinated approach for spatial data — Norwegian standard, part 1 Geometry model.

Annex B
(normative)

Abstract test suite

B.1 Data types for 0-dimensional geometry

a) Test purpose: Verify that an application schema or profile instantiates GM_Point with the attribute *position* and the association *Coordinate Reference System* inherited from GM_Object.

b) Test method: Inspect the documentation of the application schema or profile.

c) Reference: ISO 19107:2003, A.1.1.1.

d) Test type: Capability.

B.2 Data types for 1-dimensional geometry

a) Test purpose: Verify that an application schema or profile satisfies all the requirements of B.1 and instantiates GM_Curve with the attribute *orientation* and the association *segmentation*, and GM_LineString with the attribute *controlPoint*.

b) Test method: Inspect the documentation of the application schema or profile.

c) Reference: ISO 19107:2003, A.1.1.2.

d) Test type: Capability.

B.3 Data types for 2-dimensional geometry

a) Test purpose: Verify that an application schema or profile satisfies all the requirements of B.2 and instantiates GM_Surface with the attribute *orientation* and the association *segmentation*, and GM_Polygon with the attribute *boundary*.

b) Test method: Inspect the documentation of the application schema or profile.

c) Reference: ISO 19107:2003, A.1.1.3.

d) Test type: Capability.

NOTE ISO 19107:2003, test A.1.1.3, mandates that the association GM_Primitive::interiorTo (6.3.10.4) be instantiated. This International Standard instantiates this association, but restricts the multiplicity to 0.

Annex C
(informative)

Extending the core

C.1 Introduction

The purpose of this International Standard is to provide a core of ISO 19107 that is easy to understand and has a low cost of implementation. A small, very limited, core has a better chance to gain widespread market acceptance. Thus, a broad core profile would defeat the very purpose of its existence.

However, many user communities have requirements that go beyond the capabilities provided by this International Standard. Such communities may define custom profiles, which shall consist of the core profile defined in this International Standard, but can weaken its restrictions and add other constructs. If their profile is of general interest, it can undergo the standardization process for becoming an ISO standard. While readers should refer to ISO 19106 for the process of profiling, this informative annex might serve as a guideline for some typical needs.

C.2 Geometric aggregates

Application schemas are free to use associations, aggregations and compositions between user classes, whose attributes can be of geometric type. For example, an orchard can be modelled as an aggregation of fruit trees, each having a position attribute. Also, a periodic survey of temperature samples could be modelled as shown in Figure C.1.

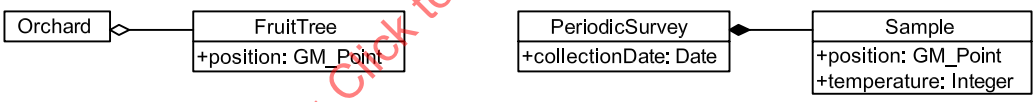

Figure C.1 — Examples of defining aggregation and composition in application schemas

In many cases, aggregation can be modelled at the level of the application schema. These examples use only GM_Point, which is a type supported by the core profile. In this case, the core profile is sufficient, so no extension would be needed.

However, some user communities might have a requirement for the geometric aggregate types of ISO 19107, such as GM_MultiPoint or GM_MultiCurve. These communities are free to define an extension to this International Standard that includes these types.

C.3 Three-dimensional geometry

While this International Standard does not support three-dimensional geometric primitives (solids), it does allow zero-, one- and two-dimensional geometric primitives to exist within a three-dimensional coordinate reference system.

In particular, the curve which constitutes the exterior boundary of a GM_SurfacePatch may consist of GM_LineStrings with 3D control points. If the position of interior points is not determined, the surface interpolation shall be “none.” The “planar” interpolation would be only acceptable if all points were lying on a plane.

If some user communities wish to use solids, such as GM_Conic or GM_Sphere, they are free to define an extension to this International Standard.

C.4 Additional subclasses of GM_CurveSegment

In this International Standard, GM_LineString is the only subclass of GM_CurveSegment. However, some user communities might need additional curve segment types of ISO 19107, such as GM_Arc, GM_Clothoid, or GM_BSplineCurve. These communities could define an extension to this International Standard that would include the required subclasses of GM_CurveSegment.