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### OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 3: XML Encoding Standard

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## **i. Abstract**

Extensible Markup Language (XML) is a widely utilized format for encoding data in various applications. It employs a markup structure where data is enclosed in tags represented by opening and closing elements. These elements can have attributes and may contain nested elements, allowing for a hierarchical representation of structured information. This OGC Standard describes an XML encoding for geospatial training datasets. It is based on OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1: Conceptual Model Standard.

## **ii. Keywords**

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, artificial intelligence, machine learning, deep learning, earth observation, remote sensing, training data, training sample, encoding, XML

## **iii. Preface**

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. The Open Geospatial Consortium shall not be held responsible for identifying any or all such patent rights.

## **iv. Security Considerations**

No security considerations have been made for this Standard.

## **v. Submitting organizations**

The following organizations submitted this Document to the Open Geospatial Consortium (OGC):

Organization name(s)

## **vi. Submitters**

All questions regarding this submission should be directed to the editor or the submitters:

Name	Affiliation

## **vii. Contributors**

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# Chapter 1. Scope

This OGC Standard defines an XML encoding of training datasets. The Standard provides a document model for the exchange of information describing training datasets, both within and between different organizations.

The document model is derived from the conceptual models defined in the OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1: Conceptual Model Standard.

# Chapter 2. Conformance

This Standard defines an XML encoding for AI training datasets. The standardization targets for this Standard is:

- TrainingDML-AI XML Encoding Schema

Conformance with this Standard shall be checked using all the relevant tests specified in Annex A (normative) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and [the OGC Compliance Testing website](#).

All requirements-classes and conformance-classes described in this document are owned by the standard identified.

# Chapter 3. Normative References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

- [OGC: OGC 23-008r2, OGC Training Data Markup Language for Artificial Intelligence \(TrainingDML-AI\) Part1: Conceptual Model Standard, 2023](#)
- [OGC: OGC 07-036, OpenGIS Geography Markup Language \(GML\) Encoding Standard, 2023](#)
- [ISO 19107:2019 Geographic information — Spatial schema](#)
- [ISO 19115-1:2014 Geographic information — Metadata — Part 1: Fundamentals](#)
- [ISO 19157-1 Geographic information — Data quality — Part 1: General requirements](#)



# Chapter 4. Terms and Definitions

This document used the terms defined in [OGC Policy Directive 49](#), which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this Standard and OGC documents do not use the equivalent phrases in the ISO/IEC Directives, Part 2.

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

## 4.1. Artificial Intelligence (AI)

refers to a set of methods and technologies that can empower machines or software to learn and perform tasks like humans.

SOURCE: OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1: Conceptual Model Standard

## 4.2. Machine Learning (ML)

is an important branch of artificial intelligence that gives computers the ability to improve their performance without explicitly being programmed to do so. ML processes create models from training data by using a set of learning algorithms, and then can use these models to make predictions. Depending on whether the training data include labels, the learning algorithms can be divided into supervised and unsupervised learning.

SOURCE: OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1: Conceptual Model Standard

## 4.3. Deep Learning (DL)

is a subset of machine learning, which is essentially a neural network with three or more layers. The number of layers is referred to as depth. While a neural network with a single layer can still make approximate predictions, additional hidden layers can help to optimize and refine for accuracy.

SOURCE: <https://www.ibm.com/topics/deep-learning>

## 4.4. Training Dataset

a collection of samples, often labelled in terms of supervised learning. A training dataset can be divided into training, validation, and test sets. Training samples are different from samples in OGC Observations & Measurements (O&M). They are often collected in purposive ways that deviate from purely probability sampling, with known or expected results labelled as values of a dependent variable for generating a trained predictive model.

SOURCE: OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1:

## 4.5. Label

refers to known or expected results annotated as values of a dependent variable in training samples. A training sample label is different from those on a geographical map, which are known as map labels or annotations.

SOURCE: OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 1: Conceptual Model Standard

## 4.6. Extensible Markup Language (XML)

is a simple, very flexible text format derived from SGML (ISO 8879). Originally designed to meet the challenges of large-scale electronic publishing, XML is also playing an increasingly important role in the exchange of a wide variety of data on the Web and elsewhere.

SOURCE: <https://www.w3.org/XML/>

## 4.7. XML Schema

is a means for defining the structure, content and semantics of XML documents.

SOURCE: <https://www.w3.org/XML/Schema>

# Chapter 5. Conventions

This section provides details and examples for any conventions used in the document.

## 5.1. Identifiers

The normative provisions in this specification are denoted by the URI:

<http://www.opengis.net/spec/TrainingDML-AI-3/1.0>

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

## 5.2. Abbreviated Terms

In this document the following abbreviations and acronyms are used or introduced:

- AI — Artificial Intelligence
- DL — Deep Learning
- EO — Earth Observation
- ISO — International Organization for Standardization
- JSON — JavaScript Object Notation
- ML — Machine Learning
- OGC — Open Geospatial Consortium
- RS — Remote Sensing
- TD — Training Data
- UML — Unified Modelling Language
- XML — Extensible Markup Language

# Chapter 6. Overview

This standard defines a XML-based serialization syntax for geospatial training datasets. While other serialization forms are possible, such alternatives are not discussed in this document.

When serialized, absent properties in XML are typically represented by leaving the corresponding elements empty, without any content. Alternatively, certain XML-based formats may use attributes to signify the absence of a property. These representations convey semantic equivalence. An empty or missing element signifies that no value has been assigned, distinct from the interpretation that the provided value is empty or nil.

XML employs a formal class model through the use of elements and attributes, allowing for a more structured representation of data. XML documents are hierarchical in nature, composed of nested elements that can contain both data and metadata.

A training dataset document conforming to this standard is an XML document whose root element is an `AI_TrainingDataset` element.

## 6.1. Extensible Markup Language

Extensible Markup Language (XML) is a versatile and widely used markup language designed for encoding documents in a format that is both human-readable and machine-readable. It provides a set of rules for defining custom markup languages and is often employed for representing structured data in a hierarchical and platform-independent manner. XML documents consist of elements, attributes, and text content organized within a tree-like structure. Elements are enclosed within tags, and attributes provide additional information about the elements.

XML has widespread applicability and is utilized in various domains, including web development, data interchange, configuration files, and more. Its flexibility allows users to define their own document structures, making it suitable for a broad range of applications. XML is supported by many programming languages and technologies, contributing to its interoperability and adoption.

# Chapter 7. Requirements for TrainingDML-AI XML Encoding

## 7.1. Requirements Class: base

### 7.1.1. Requirements Class: XML base type

This requirements class defines the base requirements for XML encodings, which includes definitions of common types used in the TrainingDML-AI XML encoding.

Requirements class	
/req/base/xmlbasetype	
Dependency	XML
Requirement	/req/base/xmlbasetype/xml
Requirement	/req/base/xmlbasetype/datetime
Requirement	/req/base/xmlbasetype/namedvalue

The first requirement is that a TrainingDML-AI XML document is a valid XML document.

Requirement	/req/base/xmlbasetype/xml
	An instance shall be a conformant XML document, as defined by W3C Recommendation

XML has a limited range of built-in types (<https://www.w3.org/TR/xmlschema11-2/>). The following requirements provide standard XML representations of additional types required across all requirements within this specification.

A DateTime is encoded as an XML element defined as one of three elements of type "data", "time", "dateTime".

Requirement	/req/base/xmlbasetype/datetime
	Each DateTime value shall be encoded as an XML element of one of three types "data", "time", "dateTime", while the type of "data" is xs:data, the type of "time" is xs:time and the type of "dateTime" is xs:dateTime.

Examples:

a) 2022-08-08T08:08:00.00+08:00

b) 2022-08-08T08:08:00.00Z

c) 2022-08-08

d) 12:34:56

e) 12:34:56.123

A NamedValue is encoded as an XML element with two elements named “key” and “value”.

Requirement	/req/base/xmlbasetype/namedvalue
	Each NamedValue value shall be encoded as an XML element with elements "key" and "value", while the type of "key" is CharacterString.

Examples:

a) <key>forest</key>  
<value>RGB(0,255,255)</value>

b) <key>precision</key>  
<value>0.8</value>

### 7.1.2. Requirements Class: ISO metadata type

This requirement class defines the requirements for XML encoding of ISO metadata types.

Requirements class	
/req/base/isometadatatype	
Dependency	XML
Requirement	/req/base/isometadatatype/band
Requirement	/req/base/isometadatatype/extent
Requirement	/req/base/isometadatatype/citation
Requirement	/req/base/isometadatatype/scope

An MD\_Band is encoded as a text string or an XML element.

Requirement	/req/base/isometadatatype/band
	Each MD_Band value shall be encoded as a text string or an XML element matching the XML Schema type:  <a href="https://schemas.isotc211.org/19115/-1/mrc/1.3.0/mrc/#element_MD_Band">https://schemas.isotc211.org/19115/-1/mrc/1.3.0/mrc/#element_MD_Band</a>

Examples:

a) red  
b) B4  
c) <mrc:boundMax>690</mrc:boundMax>

```
<mrc:boundMin>630</mrc:boundMin>  
<mrc:boundUnits>nm</mrc:boundUnits>
```

An EX\_Extent is encoded as a text string or an XML element.

Requirement	<p>/req/base/isometadatatype/extent</p> <p>Each EX_Extent value shall be encoded as a text string or an XML element matching the XML Schema type:</p> <p><a href="https://schemas.isotc211.org/19115/-1/gex/1.3.0/gex/#element_EX_Extent">https://schemas.isotc211.org/19115/-1/gex/1.3.0/gex/#element_EX_Extent</a></p>
-------------	--

Examples:

```
a) 120.0 30.0 130.0 40.0  
b) 120.0 30.0 10.0 130.0 40.0 20.0  
c) <geographicElement>  
    <westBoundLongitude>-171.76409</westBoundLongitude>  
    <eastBoundLongitude>-157.86768</eastBoundLongitude>  
    <southBoundLatitude>-14.42443</southBoundLatitude>  
    <northBoundLatitude>21.31573</northBoundLatitude>  
</geographicElement>
```

A CI\_Citation is encoded as a text string or an XML element.

Requirement	<p>/req/base/isometadatatype/citation</p> <p>Each CI_Citation value shall be encoded as a text string or an XML element matching the XML Schema type:</p> <p><a href="https://schemas.isotc211.org/19115/-1/cit/1.3.0/cit/#element_CI_Citation">https://schemas.isotc211.org/19115/-1/cit/1.3.0/cit/#element_CI_Citation</a></p>
-------------	--

Examples:

```
a) http://www.opengeospatial.org  
b) <cit:title>Open Geospatial Consortium</cit:title>  
    <cit:alternateTitle>OGC</cit:alternateTitle>  
    <cit:identifier>  
        <cit:code>  
            https://portal.ogc.org/files/?artifact_id=1046058&version=1  
        </cit:code>  
    </cit:identifier>
```

An MD\_Scope is encoded as an XML element.

Requirement	/req/base/isometadatatype/scope  Each MD_Scope value shall be encoded as an XML element matching the XML Schema type:  <a href="https://schemas.isotc211.org/19115/-1/mcc/1.3.0/mcc/#element_MD_Scope">https://schemas.isotc211.org/19115/-1/mcc/1.3.0/mcc/#element_MD_Scope</a>
-------------	--

Example:

```
<mcc:level>dataset</mcc:level>
<mcc:levelDescription>
  <mcc:dataset>whu_rs19</mcc:dataset>
</mcc:levelDescription>
```

### 7.1.3. Requirements Class: ISO quality type

This requirement class defines the requirements for XML encoding of ISO quality types.

Requirements class	
/req/base/isoqualitytype	
Dependency	XML
Requirement	/req/base/isoqualitytype/element

A QualityElement object is encoded as an XML element with properties shown in Table 1.

Requirement	/req/base/isoqualitytype/element  Each QualityElement value shall be encoded as an XML element with properties shown in Table 1.
-------------	--

Table 1. QualityElement properties

XML Property	Definition	Data type and values	Obligation
type	The type of the quality element object.	CharacterString [1..1]	Mandatory
measure	Reference to measure used.	MeasureReference [1..1]	Mandatory
evaluationMethod	Evaluation information.	EvaluationMethod [1..1]	Mandatory
result	Value obtained from applying a data quality measure.	QualityResult [1..*]	Mandatory

Example:



```

<type>FormatConsistency</type>
<measure>
  <measureDescription>
    Percentage of training samples with inconsistent image format
  </measureDescription>
</measure>
<evaluationMethod>
  <evaluationMethodDescription>
    Full test method to calculate the percentage of training samples with
    inconsistent format
  </evaluationMethodDescription>
</evaluationMethod>
<result>
  <quantitativeResult>
    <value>
      0
    </value>
    <valueUnit>
      %
    </valueUnit>
  </quantitativeResult>
</result>

```

#### 7.1.4. Requirements Class: geospatial type

This requirement class defines the requirements for XML encoding of geospatial types.

Requirements class	
/req/base/geospatialtype	
Dependency	XML
Dependency	GML
Requirement	/req/geospatialtype/feature

The encoding of Feature follows GML for Feature.

Requirement	/req/geospatialtype/feature
	<p>Each Feature value shall be encoded using the GML feature encoding defined by OpenGIS in GML Section 3.2:</p> <p><a href="http://www.opengis.net/gml/3.2">http://www.opengis.net/gml/3.2</a></p>

Examples:

```

a) <gml:metaDataProperty>
  <gml:GenericMetaData>

```

```

        <truncated>0.0</truncated>
        <occluded>0</occluded>
        <alpha>-0.2</alpha>
    </gml:GenericMetaData>
</gml:metaDataProperty>
<gml:location>
    <gml:GeometricComplex>
        <gml:element>
            <gml:Polygon>
                <gml:exterior>
                    <gml:LinearRing>
                        <gml:posList>
                            51.556272 -0.2803943 51.5562758 -0.2787397 51.5556539
                            -0.278736 51.5556501 -0.2803906 51.556272 -0.2803943
                        </gml:posList>
                    </gml:LinearRing>
                </gml:exterior>
            </gml:Polygon>
        </gml:element>
    </gml:GeometricComplex>
</gml:location>

```

```

b) <gml:metaDataProperty>
    <gml:GenericMetaData>
        <iscrowd>0</iscrowd>
        <area>2580</area>
    </gml:GenericMetaData>
</gml:metaDataProperty>
<gml:location>
    <gml:GeometricComplex>
        <gml:element>
            <gml:Polygon>
                <gml:exterior>
                    <gml:LinearRing>
                        <gml:posList>
                            274 1602 273 1603 272 1603 271 1603 270 1604 269 1604
                            268 1604 267 1604 266 1605 265 1605 264 1605 263 1606 262 1606 261 1606 260 1607 259
                            1607 258 1607 257 1608 256 1608 255 1608 254 1609 253 1610 252 1611 251 1611
                        </gml:posList>
                    </gml:LinearRing>
                </gml:exterior>
            </gml:Polygon>
        </gml:element>
    </gml:GeometricComplex>
</gml:location>
<gml:boundedBy>
    <gml:Envelope>
        244 1602 306 1653
    </gml:Envelope>

```

## 7.2. Requirements Class: AI\_TrainingDataset

This requirements class defines a XML encoding for AI\_TrainingDataset module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitrainingdataset	
Dependency	XML
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/aitrainingdata
Dependency	/req/aitask
Dependency	/req/ailabeling
Dependency	/req/aidataquality
Dependency	/req/aitdchangeset
Requirement	/req/aitrainingdataset/trainingdataset
Requirement	/req/aitrainingdataset/metricsinliterature
Requirement	/req/aitrainingdataset/eotrainingdataset

An AI\_TrainingDataset object is encoded as an XML element with properties shown in Table 2.

Requirement	/req/aitrainingdataset/trainingdataset
	Each AI_TrainingDataset object shall implement the properties shown in Table 2.

Table 2. AI\_TrainingDataset properties

XML Property	Definition	Data type and values	Obligation
type	Type of the training dataset.	"AI_AbstractTrainingDataset"	Mandatory
id	Identification of the AI training dataset.	CharacterString [1..1]	Mandatory
doi	Digital object identifier of the AI training dataset.	CharacterString [0..1]	Optional
scope	Description of the scope of the training dataset.	MD_Scope [0..1]	Optional

XML Property	Definition	Data type and values	Obligation
name	Name of the AI training dataset.	CharacterString [1..1]	Mandatory
description	Description of the AI training dataset.	CharacterString [1..1]	Mandatory
version	Version number of the AI training dataset.	CharacterString [0..1]	Optional
amountOfTrainingData	Total number of training samples in the AI training dataset.	Int [1..1]	Mandatory
createdTime	Time when the AI training dataset was created.	DateTime [0..1]	Optional
updatedAtTime	Time when the AI training dataset was updated.	DateTime [0..1]	Optional
license	License description of the AI training dataset.	CharacterString [0..1]	Optional
providers	People or organizations who provide the AI training dataset.	CharacterString [0..*]	Optional
keywords	Keywords of the AI training dataset.	CharacterString [0..*]	Optional
metricsInLIT	Results of performance metrics achieved by AI/ML algorithms in the peer-reviewed literature.	AI_MetricsInLiterature [0..*]	Optional
statisticsInfo	Statistics results of training samples in each class.	NamedValue [0..*]	Optional
dataSources	Citation of data sources.	CI_Citation [0..*]	Optional
numberOfClasses	Total number of classes in the AI training dataset.	Int [1..1]	Mandatory
classificationSchema	Classification schema for classes used in the AI training dataset.	CharacterString [0..1]	Optional
classes	Classes used in the AI training dataset.	NamedValue [1..1]	Mandatory

XML Property	Definition	Data type and values	Obligation
tasks	Task description of the training dataset.	AI_Task [1..*]	Mandatory
labeling	Provenance information of how the training dataset is labeled.	AI_Labeling [0..*]	Optional
quality	Quality information of the training dataset.	DataQuality [0..*]	Optional
changesets	Changeset between two versions of the training dataset.	AI_TDChangeset [0..*]	Optional
data	Training data in the training dataset.	AI_TrainingData [1..*]	Mandatory

Example:

```

<type>AI_AbstractTrainingDataset</type>
<id>whu_rs19</id>
<name>WHU-RS19</name>
<description>Wuhan University-Remote Sensing 19 Categories (WHU-RS19) has 19 classes
of remote sensing images scenes obtained from Google Earth</description>
<amountOfTrainingData>1013</amountOfTrainingData>
<createdTime>2010-01-01</createdTime>
<providers>
  <provider>Wuhan University</provider>
</providers>
<keywords>
  <keyword>Remote Sensing</keyword>
  <keyword>Scene Classification</keyword>
</keywords>
<numberOfClasses>19</numberOfClasses>
<classes>
  <class>Airport</class>
  <class>Beach</class>
  <class>Bridge</class>
  <class>Commercial</class>
  <class>Desert</class>
  <class>Farmland</class>
  <class>footballField</class>
  <class>Forest</class>
  <class>Industrial</class>
  <class>Meadow</class>
  <class>Mountain</class>
  <class>Park</class>
  <class>Parking</class>
  <class>Pond</class>

```

```

<class>Port</class>
<class>railwayStation</class>
<class>Residential</class>
<class>River</class>
<class>Viaduct</class>
</classes>
<tasks>
  <type>E0Task</type>
  <id>whu_rs19-task</id>
  <description>Structural high-resolution satellite image indexing</description>
  <taskType>Scene Classification</taskType>
</tasks>
<data>
  <type>E0TrainingData</type>
  <id>airport_01</id>
  <dataSources>
    <dataSource>googleEarth</dataSource>
  </dataSources>
  <dataURL>image/Airport/airport_01.jpg</dataURL>
  <labels>
    <type>SceneLabel</type>
    <class>Airport</class>
  </labels>
</data>

```

An `AI_MetricsInLiterature` is encoded as XML element with properties shown in Table 3.

Requirement	/req/aitrainingdataset/metricsinliterature  Each <code>AI_MetricsInLiterature</code> value shall implement the properties shown in Table 3.
-------------	---

Table 3. *AI\_MetricsInLiterature* properties

XML Property	Definition	Data type and values	Obligation
doi	Digital object identifier of the peer-reviewed literature.	CharacterString [1..1]	Mandatory
algorithm	AI/ML algorithms used in the peer-reviewed literature.	CharacterString [0..1]	Optional
metrics	Metrics and results of AI/ML algorithms in the peer-reviewed literature.	NamedValue [1..*]	Mandatory

Example:

```

<doi>10.1109/TGRS.2019.2917161</doi>
<algorithm>FACNN</algorithm>
<metrics>
  <key>Overall Accuracy</key>
  <value>0.9881</value>
</metrics>

```

An AI\_EOTrainingDataset object is encoded as an XML element with properties shown in Table 2 and Table 4.

Requirement	/req/aitrainingdataset/eotrainingdataset
	Each AI_EOTrainingDataset object shall implement the properties both shown in Table 2 and Table 4.

Table 4. AI\_EOTrainingDataset properties

XML Property	Definition	Data type and values	Obligation
type	Type of the training dataset.	"AI_EOTrainingDataset"	Mandatory
extent	Spatial extent of the EO training dataset.	EX_Extent [0..1]	Optional
bands	Bands description of the images used in the EO training dataset.	MD_Band [0..*]	Optional
imageSize	Size of the images used in the EO training dataset.	ChracterString [0..1]	Optional

Example:

```

<type>AI_EOTrainingDataset</type>
<id>whu_rs19</id>
<name>WHU-RS19</name>
<description>Wuhan University-Remote Sensing 19 Categories (WHU-RS19) has 19 classes of remote sensing images scenes obtained from Google Earth</description>
<amountOfTrainingData>1013</amountOfTrainingData>
<createdTime>2010-01-01</createdTime>
<providers>Wuhan University</providers>
<keywords>Remote Sensing</keywords>
<keywords>Scene Classification</keywords>
<numberOfClasses>19</numberOfClasses>
<extent>-180</extent>
<extent>-90</extent>
<extent>180</extent>
<extent>90</extent>
<bands>red</bands>

```

```

<bands>green</bands>
<bands>blue</bands>
<imageSize>6000x7600</imageSize>
<classes>Airport</classes>
<classes>Beach</classes>
<classes>Bridge</classes>
<classes>Commercial</classes>
<classes>Desert</classes>
<classes>Farmland</classes>
<classes>footballField</classes>
<classes>Forest</classes>
<classes>Industrial</classes>
<classes>Meadow</classes>
<classes>Mountain</classes>
<classes>Park</classes>
<classes>Parking</classes>
<classes>Pond</classes>
<classes>Port</classes>
<classes>railwayStation</classes>
<classes>Residential</classes>
<classes>River</classes>
<classes>Viaduct</classes>
<tasks>
  <type>AI_EOTask</type>
  <id>whu_rs19-task</id>
  <description>Structural high-resolution satellite image indexing</description>
  <taskType>Scene Classification</taskType>
</tasks>
<data>
  <type>AI_EOTrainingData</type>
  <id>airport_01</id>
  <dataSources>googleEarth</dataSources>
  <dataURL>image/Airport/airport_01.jpg</dataURL>
  <labels>
    <type>AI_SceneLabel</type>
    <class>Airport</class>
  </labels>
</data>

```

## 7.3. Requirements Class: AI\_TrainingData

This requirements class defines an XML encoding for AI\_TrainingData module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitrainingdata	
Dependency	XML



Requirements class	
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/ailabel
Dependency	/req/ailabeling
Dependency	/req/aidataquality
Requirement	/req/aitrainingdata/trainingdata
Requirement	/req/aitrainingdata/eotrainingdata

An AI\_TrainingData object is encoded as an XML element with properties shown in Table 5.

Requirement	/req/aitrainingdataset/trainingdata
	Each AI_TrainingData object shall implement the properties shown in Table 5.

Table 5. AI\_TrainingData properties

XML Property	Definition	Data type and values	Obligation
type	Type of the training data.	"AI_AbstractTrainingData"	Mandatory
id	Identification of the AI training data.	CharacterString [1..1]	Mandatory
datasetId	Identification of the training dataset that the training sample belongs to.	CharacterString [0..1]	Optional
trainingType	Training type of the individual AI training sample.	AI_TrainingTypeCode [0..1]	Optional
numberOfLabels	Total number of labels in the individual AI training sample.	Int [0..1]	Optional
dataSources	Citation of inputs to prepare a training sample.	CI_Citation [0..*]	Optional
labels	Labels in the training data.	AI_Label [1..*]	Mandatory
labeling	Provenance information of how the training data is labeled.	AI_Labeling [0..*]	Optional
quality	Quality information of the training data.	DataQuality [0..*]	Optional

Example:

```
<type>AI_AbstractTrainingData</type>
<id>airport_01</id>
<dataSources>googleEarth</dataSources>
<dataURL>image/Airport/airport_01.jpg</dataURL>
<labels>
  <type>AI_SceneLabel</type>
  <class>Airport</class>
</labels>
```

An AI\_TrainingTypeCode is encoded as a text string whose value is one of “training”, “validation” or “test”.

Requirement	/req/aitrainingdataset/trainingtypecode
	Each AI_TrainingTypeCode value shall be a text string whose value is one of "training", "validation" or "test".

Examples:

- a) training
- b) validation
- c) test

An AI\_EOTrainingData object is encoded as an XML element with properties both shown in Table 5 and Table 6.

Requirement	/req/aitrainingdataset/eotrainingdata
	Each AI_EOTrainingData object shall implement the properties both shown in Table 5 and Table 6.

Table 6. AI\_EOTrainingData properties

XML Property	Definition	Data type and values	Obligation
type	Type of the EO training data.	"AI_EOTrainingData"	Mandatory
extent	Spatial extent of the individual EO training sample.	EX_Extent [0..1]	Optional
dateTime	Data time when the EO data was obtained.	DateTime [0..*]	Optional
dataURL	URL of the EO data.	URL [1..*]	Mandatory

Example:

```

<type>AI_E0TrainingData</type>
<id>airport_01</id>
<dataSources>googleEarth</dataSources>
<dataURL>image/Airport/airport_01.jpg</dataURL>
<labels>
  <type>AI_SceneLabel</type>
  <class>Airport</class>
</labels>

```

## 7.4. Requirements Class: AI\_Task

This requirements class defines a XML encoding for AI\_Task module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitask	
Dependency	XML
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Requirement	/req/aitask/task
Requirement	/req/aitask/eotask

An AI\_Task object is encoded as an XML element with properties shown in Table 7.

Requirement	/req/aitask/task
	Each AI_Task object shall implement the properties shown in Table 7.

Table 7. AI\_Task properties

XML Property	Definition	Data type and values	Obligation
type	Type of the task object.	"AI_AbstractTask"	Mandatory
id	Identification of the task.	CharacterString [1..1]	Mandatory
datasetId	Identification of the training dataset the training sample belongs to.	CharacterString [0..1]	Optional
description	Description of the AI task.	CharacterString [0..1]	Optional

Example:

```

<type>AI_AbstractTask</type>
<id>image-indexing-task</id>
<description>Structural high-resolution satellite image indexing</description>

```

An AI\_EOTask object is encoded as an XML element with properties both shown in Table 7 and Table 8.

Requirement	/req/aitask/task
	Each AI_EOTask object shall implement the properties shown in Table 7 and Table 8.

Table 8. AI\_EOTask properties

XML Property	Definition	Data type and values	Obligation
type	Type of the task object.	"AI_EOTask"	Mandatory
taskType	Type of the EO task.	CharacterString [1..1]	Mandatory

Example:

```

<type>AI_EOTask</type>
<id>image-indexing-task</id>
<description>Structural high-resolution satellite image indexing</description>
<taskType>Scene Classification</taskType>

```

## 7.5. Requirements Class: AI\_Label

This Requirements class defines an XML encoding for AI\_Label module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/ailabel	
Dependency	XML
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/base/geospatialtype
Requirement	/req/ailabel/label
Requirement	/req/ailabel/scenelabel
Requirement	/req/ailabel/objectlabel
Requirement	/req/ailabel/pixellabel

An AI\_Label object is encoded as an XML element with properties shown in Table 9.

Requirement	/req/ailabel/label
	Each AI_Label object shall implement the properties shown in Table 9.

Table 9. AI\_Label properties

XML Property	Definition	Data type and values	Obligation
type	Type of the label object.	"AI_AbstractLabel"	Mandatory
isNegative	Whether the training sample related to the label is a positive or negative sample.	bool [0..1]	Optional
confidence	Confidence score of the labeler.	Float [0..1]	Optional

Example:

```
<type>AI_AbstractLabel</type>
<isNegative>false</isNegative>
```

An AI\_SceneLabel object is encoded as an XML element with properties shown in Table 10.

Requirement	/req/ailabel/scenelabel
	Each AI_SceneLabel object shall implement the properties shown in Table 10.

Table 10. AI\_SceneLabel properties

XML Property	Definition	Data type and values	Obligation
type	Type of the label object at the scene level.	"AI_SceneLabel"	Mandatory
class	Class that records the semantic of the scene of the training sample.	CharacterString [1..1]	Mandatory

Example:

```
<type>AI_SceneLabel</type>
<class>Airport</class>
```

An AI\_ObjectLabel object is encoded as an XML element with properties shown in Table 11.

Requirement	/req/ailabel/objectlabel
	Each AI_ObjectLabel object shall implement the properties shown in Table 11.

Table 11. AI\_ObjectLabel properties

XML Property	Definition	Data type and values	Obligation
type	Type of the label object at the object level.	"AI_ObjectLabel"	Mandatory
object	Feature that represents the position and attributes of the object.	Feature [0..1]	Optional
bboxType	Type of the bbox.	CharacterString [0..1]	Optional
class	Class that records the semantic of the object type.	CharacterString [1..1]	Mandatory
dateTime	Created time of the object label.	DateTime [0..1]	Optional

Example:

```

<type>AI_ObjectLabel</type>
<class>Pedestrian</class>
<object>
  <gml:metaDataProperty>
    <gml:GenericMetaData>
      <truncated>0.0</truncated>
      <occluded>0</occluded>
      <alpha>-0.2</alpha>
    </gml:GenericMetaData>
  </gml:metaDataProperty>
  <gml:location>
    <gml:GeometricComplex>
      <gml:element>
        <gml:Polygon>
          <gml:exterior>
            <gml:LinearRing>
              <gml:posList>
                51.556272 -0.2803943 51.5562758 -0.2787397 51.5556539
                -0.278736 51.5556501 -0.2803906 51.556272 -0.2803943
              </gml:posList>
            </gml:LinearRing>
          </gml:exterior>
        </gml:Polygon>
      </gml:element>
    </gml:GeometricComplex>
  </gml:location>
</object>

```

```
<bboxType>Horizontal BBox</bboxType>
```

An AI\_PixelLabel object is encoded as an XML element with properties shown in Table 12.

Requirement	/req/ailabel/pixellabel
Each AI_PixelLabel object shall implement the properties shown in Table 12.	

Table 12. AI\_PixelLabel properties

XML Property	Definition	Data type and values	Obligation
type	Type of the label object at the pixel level.	"AI_PixelLabel"	Mandatory
imageUrl	URL of the images representing the label information.	URL [1..*]	Mandatory
imageFormat	Image data format.	CharacterString [1..1]	Mandatory

Example:

```
<type>AI_PixelLabel</type>
<imageUrl>/label_5classes/GF2_PMS1__L1A0000647767-MSS1_label.tif</imageUrl>
<imageFormat>image/tiff</imageFormat>
```

## 7.6. Requirements Class: AI\_Labeling

This requirements class defines a XML encoding for AI\_Labeling module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/ailabeling	
Dependency	XML
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Requirement	/req/ailabeling/labeling
Requirement	/req/ailabeling/labeler
Requirement	/req/ailabeling/labelingprocedure

An AI\_Labeling object is encoded as an XML element with properties shown in Table 13.

Requirement	/req/ailabeling/labeling
	Each AI_Labeling object shall implement the properties shown in Table 13.

Table 13. AI\_Labeling properties

XML Property	Definition	Data type and values	Obligation
type	Type of the labeling object.	"AI_Labeling"	Mandatory
id	Identifier of the labeling.	CharacterString [1..1]	Mandatory
scope	Description of the scope of the labeling.	MD_Scope [1..1]	Mandatory
labelers	Labelers of the labeling activity.	AI_Labeler [0..*]	Optional
procedure	Procedure used in the labeling activity.	AI_LabelingProcedure [0..1]	Optional

Example:

```

<type>AI_Labeling</type>
<id>0</id>
<scope>
  <level>dataset</level>
  <levelDescription>
    <dataset>whu_rs19</dataset>
  </levelDescription>
</scope>
<labelers>...</labelers>
<procedure>...</procedure>

```

An AI\_Labeler object is encoded as an XML element with properties shown in Table 14.

Requirement	/req/ailabeling/labeler
	Each AI_Labeler object shall implement the properties shown in Table 14.

Table 14. AI\_Labeler properties

XML Property	Definition	Data type and values	Obligation
type	Type of the labeler object.	"AI_Labeler"	Mandatory
id	Identifier of the labeler.	CharacterString [1..1]	Mandatory
name	Name of the labeler.	CharacterString [1..1]	Mandatory

Example:



```

<type>AI_Labeler</type>
<id>0</id>
<name>Tom</name>

```

An AI\_LabelingProcedure object is encoded as an XML element with properties shown in Table 15.

Requirement	/req/ailabeling/labelingprocedure
	Each AI_LabelingProcedure object shall implement the properties shown in Table 15.

Table 15. AI\_LabelingProcedure properties

XML Property	Definition	Data type and values	Obligation
type	Type of the labeling procedure object.	"AI_LabelingProcedure"	Mandatory
id	Identifier of the labeling procedure.	CharacterString [1..1]	Mandatory
methods	Methods used in the labeling procedure.	CharacterString [1..*]	Mandatory
tools	Tools or software used in the labeling procedure.	CharacterString [0..1]	Optional

Example:

```

<type>AI_LabelingProcedure</type>
<id>0</id>
<methods>
  <method>manual</method>
</methods>
<tools>
  <tool>ArcGIS</tool>
</tools>

```

## 7.7. Requirements Class: AI\_DataQuality

An AI\_ClassBalanceDegree object is encoded as an XML element with properties shown in Table 16.

Requirement	/req/aidataquality/classbalancedegree
	Each AI_ClassBalanceDegree object shall implement the properties shown in Table 16.

Table 16. AI\_ClassBalanceDegree properties

XML Property	Definition	Data type and values	Obligation
type	Type of the class balance degree object.	"AI_ClassBalanceDegree"	Mandatory
measure	Reference to measure used.	MeasureReference [1..1]	Mandatory
evaluationMethod	Evaluation information.	EvaluationMethod [1..1]	Mandatory
result	Value obtained from applying a data quality measure.	QualityResult [1..*]	Mandatory

Example:

```
<type>AI_ClassBalanceDegree</type>
<measure>Balance degree of label classes</measure>
<evaluationMethod>Counting the number of training samples belonging to each class and
calculating the balance degree</evaluationMethod>
<result>0.935</result>
```

## 7.8. Requirements Class: AI\_TDChangeset

This requirements class defines an XML encoding for AI\_TDChangeset module, which is based on the current version of the UML model presented in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitdchangeset	
Dependency	XML
Dependency	/req/base/xmlbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/tdtrainingdata
Requirement	/req/aitdchangeset/tdchangeset

An AI\_TDChangeset object is encoded as an XML element with properties shown in Table 17.

Requirement	/req/aitdchangeset/tdchangeset
	Each AI_TDChangeset object shall implement the properties shown in Table 17.

Table 17. AI\_TDChangeset properties

XML Property	Definition	Data type and values	Obligation
type	Type of the TD changeset object.	"AI_TDChangeset"	Mandatory
id	Identifier of the changeset.	CharacterString [1..1]	Mandatory
datasetId	Identifier of the training dataset the changeset belongs to.	CharacterString [0..1]	Optional
version	Version of the training dataset that the changeset belongs to.	CharacterString [0..1]	Optional
changeCount	Total number of changed training samples.	Int [1..1]	Mandatory
createdTime	Created time of the changeset.	DateTime [0..1]	Optional
add	Added training samples.	AI_TrainingData [0..*]	Optional
modify	Modified training samples.	AI_TrainingData [0..*]	Optional
delete	Deleted training samples.	AI_TrainingData [0..*]	Optional

Example:

```

<type>AI_TDChangeset</type>
<id>changeset-dota_v1.5</id>
<datasetId>dota_v1.5</datasetId>
<createdTime>2019-01-01</createdTime>
<changeCount>9</changeCount>
<modify>
  <type>E0TrainingData</type>
  <id>P1228</id>
  <dataSources>GF</dataSources>
  <dataURL>train/images/P1228.png</dataURL>
  <numberOfLabels>50</numberOfLabels>
  <trainingType>training</trainingType>
  <labels>...</labels>
</modify>

```

# Annex A: Abstract Test Suite (Normative)

## A.1. Introduction

Conformance is tested using the XML Schema document which formalize the requirements described above.

## A.2. Conformance Class: base

This conformance class tests that occurrences of the basic types are encoded according to the requirements.

Conformance Class	/conf/base	
Requirements	/req/base	
Dependency	An XML Schema Validator	
Test	/conf/base/xml	
	Requirement	/req/base/xmlbasetype/xml
	Test purpose	Verify that the document is well-formed XML.
	Test method	Load the document in an XML validator. Pass if no errors reported. Fail otherwise.
	Test type	Capability
Test	/conf/base/type	
	Requirement	/req/base/xmlbasetype/datatype, /req/base/xmlbasetype/namedvalue, /req/base/isometadatatype, /req/base/isoqualitytype, /req/base/geospatialtype
	Test purpose	Verify that the related values and objects are encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema. Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.3. Conformance Class: AI\_TrainingDataset

This conformance class tests the training dataset object is encoded according to the requirements.

Conformance Class	/conf/aitrainingdataset	
Requirements	/req/aitrainingdataset	
Dependency	An XML Schema Validator	
Test	Test purpose	Verify that the training dataset object is encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.4. Conformance Class: AI\_TrainingData

This conformance class tests the training data objects are encoded according to the requirements.

Conformance Class	/conf/aitrainingdata	
Requirements	/req/aitrainingdata	
Dependency	An XML Schema Validator	
Test	Test purpose	Verify that the training data objects are encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.5. Conformance Class: AI\_Task

This conformance class tests the task objects are encoded according to the requirements.

Conformance Class	/conf/aitask	
Requirements	/req/aitask	
Dependency	An XML Schema Validator	
Test	Test purpose	Verify that the task objects are encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.6. Conformance Class: AI\_Label

This conformance class tests the label objects are encoded according to the requirements.

Conformance Class	/conf/ailabel	
Requirements	/req/ailabel	
Dependency	An XML Schema Validator	
Test	Test purpose	Verify that the label objects are encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.7. Conformance Class: AI\_Labeling

This conformance class tests the labeling objects are encoded according to the requirements.

Conformance Class	/conf/ailabeling	
Requirements	/req/ailabeling	
Dependency	An XML Schema Validator	
Test	Test purpose	Verify that the labeling objects are encoded using the specified property names and structures.
	Test method	Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

## A.8. Conformance Class: AI\_TDChangeset

This conformance class tests the TD changeset objects are encoded according to the requirements.

Conformance Class	/conf/aitdchangeset	
Requirements	/req/aitdchangeset	
Dependency	An XML Schema Validator	

Test	Test purpose	Verify that the TD changeset objects are encoded using the specified property names and structures.
	Test method	<p>Validate the XML instance document using the appropriate object definition from the TrainingDML-AI.xsd XML Schema.</p> <p>Pass if no errors reported. Fail otherwise.</p>
	Test type	Capability

# Annex B: Example (Informative)

## B.1. TrainingDataset Encoding Examples

### B.1.1. WHU-RS19 Dataset

The WHU-RS19 dataset is widely used in scene classification of remote sensing images. This dataset is collected from Google Earth and has 19 classes including airport, beach, bridge, commercial, desert, farmland, football field, forest, industrial, meadow, mountain, park, parking, pond, port, railway station, residential, river, and viaduct. Each class contains around 50 images, with the image size 600×600 and a resolution of 0.5m.

An example of XML encoding of the WHU-RS19 dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/WHU-RS19.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-RS19.xml).

### B.1.2. DOTA-v1.5 Dataset

The DOTA-v1.5 dataset is a large-scale dataset for object detection in aerial images. The sources for content in the dataset include Google Earth, Gaofen-2, and Jilin-1 imagery provided by China Resources Satellite Data Center. The 16 classes in DOTA-v1.5 are plane, ship, storage tank, baseball diamond, tennis court, basketball court, ground track field, harbor, bridge, large vehicle, small vehicle, helicopter, roundabout, soccer ball field, swimming pool, and container crane. Compared with other aerial image object detection datasets, the dataset has the largest number of classes. The images in the dataset have various image sizes (from 800×800 to 2000×2000) and resolutions (Google Earth/0.1m-1m, Gaofen-2/1m, Jilin-1/0.72m).

An example of XML encoding of the DOTA-v1.5 dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/DOTA-v1.5.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/DOTA-v1.5.xml).

### B.1.3. KITTI 2D Object Detection Dataset

The KITTI 2D object detection dataset is a novel open-access dataset and benchmark for road area and ego-lane detection. KITTI 2D consists of 7481 annotated training images of high variability from the KITTI autonomous driving platform by 2 PointGrey Flea2 color cameras, capturing a broad spectrum of urban street views and road scenes. The eight (8) classes in the KITTI 2D object detection dataset are car, van, truck, pedestrian, person\_sitting, cyclist, tram, and misc. Compared with other street view object detection datasets, this dataset compresses diverse scenarios and captures real-world traffic situations, ranging from freeways over rural areas to inner-city scenes with many static and dynamic objects.

An example of XML encoding of the KITTI 2D object detection dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/KITTI.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/KITTI.xml).



#### B.1.4. GID Dataset

The GID dataset is one of start-of-art land cover classification datasets. This dataset has a large spatial coverage covering many provinces in China with a relatively high spatial resolution (2m). GID has two sets. One is the GID-5C. It has 150 images (image size 7200×6800) that are classified into 5 land cover classes. The other set is GID-15C. The images from GID-5C are sliced into 30,000 patches in GID-15C, which have three types of patch sizes (56×56, 112×112, 224×224) and are classified into 15 land cover classes.

An example of XML encoding of the GID-5C dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/GID-5C.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/GID-5C.xml).

#### B.1.5. Toronto3D Dataset

The Toronto3D dataset is a large urban outdoor point cloud dataset for segmentation collected by the Mobile Laser Scanning System. The dataset covers about 1 km of scene streets in Toronto, including four areas named L001, L002, L003, and L004, with a total of 78.3 million points. Each point in this dataset has 10 attributes representing the 3D position, RGB color, intensity, GPS time, scan angle rank, and category, respectively. This dataset has eight categories, including road, road mark, natural, building, utility line, pole, car, and fence.

An example of XML encoding of the Toronto3D dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/Toronto\\_3D.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/Toronto_3D.xml).

#### B.1.6. WHU-Building Dataset

The WHU-Building dataset is a change detection dataset collected from the Land Information New Zealand Data Service. The dataset is composed of images (with the resolution 0.2m) in 2012 and 2016, covering 20.5 km<sup>2</sup>. It includes 12,796 and 16,077 buildings respectively in 2012 and 2016.

An example of XML encoding of the WHU-Building dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/WHU-building.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-building.xml).

#### B.1.7. California Change Detection Dataset

The California Change Detection Dataset is composed of two images and a label image. The first image is a Landsat 8 acquisition covering Sacramento County, Yuba County and Sutter County, California, on 5 January 2017. It has nine channels covering the spectrum from deep blue to short-wave infrared, plus two long-wave infrared channels. The second image was acquired on 18 February 2017 by Sentinel-1A over the same area after the occurrence of a flood. The image is recorded in polarizations VV and VH and augmented with the ratio between the two intensities as a third channel. All these channels are log-transformed.

An example of XML encoding of the California change detection dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/UiT\\_HCD\\_California\\_2017.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/UiT_HCD_California_2017.xml).

### B.1.8. WHU MVS Dataset

The WHU MVS dataset is a synthetic aerial dataset created for large-scale and high-resolution Earth surface reconstruction. The basic training sample of the dataset is a multi-view unit consisting of five aerial images, and their corresponding depth maps are taken as ground truth. There are a total of 5680 pairs of five-view aerial images in the dataset. All the images are simulated from a 3D surface model, which is produced by Smart3D software using Unmanned Aerial Vehicle (UAV) images and refined by manual editing.

An example of XML encoding of the WHU MVS dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/WHU\\_MVS.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU_MVS.xml).

## B.2. DataQuality Encoding Example

### B.2.1. WHU-RS19 Data Quality

An encoded data quality example of the WHU-RS19 datasets following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/WHU-RS19-quality.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-RS19-quality.xml).

## B.3. TDChangeset Encoding Example

### B.3.1. DOTA-v1.5 Changeset

DOTA-v1.5 uses the same images as DOTA-v1.0, but the extremely small instances (less than 10 pixels) are also annotated. Moreover, a new category "container crane" is added. It contains 403,318 instances in total. The number of images and dataset splits are the same as DOTA-v1.0. This version was released for the DOAI Challenge 2019 on Object Detection in Aerial Images in conjunction with IEEE CVPR 2019.

An encoded changeset example between the DOTA-v1.0 and DOTA-v1.5 datasets following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/tree/main/use-cases/examples/1.0/DOTA-v1.5-changeset.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/DOTA-v1.5-changeset.xml).

## B.4. Non-EO Imagery TrainingDataset Encoding Examples

### B.4.1. ERA5 Dataset

The source data for the ERA5 dataset is in-situ observational data (Copernicus product), and we limit its usage scenario to the autoregression problem of time series data. Therefore, its label is the data itself. Similar to unsupervised learning, the autoregression task for time series data do not require additional labeled data. For this dataset, we have not defined any inheritance class for AI\_AbstractLabel, although this class is required in the existing standard (please note that these test cases are for future versions of the standard). In addition, we have added additional attributes to

support the complete representation of dataset information.

An example of XML encoding of the ERA5 dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/blob/main/use-cases/examples/1.0/ERA5\\_hourly\\_data.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/ERA5_hourly_data.xml).

### **B.4.2. SCIRec Dataset**

The source data for the SCIRec dataset is textual data, and its labels are the classification of the text. This dataset is a text classification problem, with the goal of information extraction and entity recognition. For this textual dataset, we inherit the Abstract class and define `AI_TextTrainingDataset`, `AI_TextTrainingData`, `AI_TextTask`, and `AI_EntityLabel` respectively. In addition, we have added additional attributes to support the complete representation of dataset information.

An example of XML encoding of the SCIRec dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/blob/main/use-cases/examples/1.0/SCIRec.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/SCIRec.xml).

### **B.4.3. nuScenes Dataset**

This dataset is a public large-scale dataset for autonomous driving developed by the team at Motional (formerly nuTonomy). The full dataset includes approximately 1.4M camera images, 390k LIDAR sweeps, 1.4M RADAR sweeps and 1.4M object bounding boxes in 40k keyframes. Although the training data may come from different domains, the 3D annotation boxes captured by numerous sensors in the same keyframe are targeted at the same object and are unique. Based on this, we use a 3D annotation box to organize each 3D object using `AI_ObjectLabel`. Since each training data and each 3D object require many additional attributes to be fully described, we have added many additional attributes to provide a detailed description of the training dataset, training data, labels, etc.

An example of XML encoding of the SCIRec dataset following the TrainingDML-AI UML model can be found in [https://github.com/opengeospatial/TrainingDML-AI\\_SWG/blob/main/use-cases/examples/1.0/nuScenes.xml](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/nuScenes.xml).

# Annex C: Revision History (Informative)

Date	Release	Author	Paragraph modified	Description

# Annex D: Bibliography

- [1] Yue, P., ed., 2023. OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part1: Conceptual Model Standard, OGC 23-008r3. Wayland, MA: Open Geospatial Consortium Inc. <https://docs.ogc.org/is/23-008r3/23-008r3.html>
- [2] Portele, C., 2007. OpenGIS Geography Markup Language (GML) Encoding Standard, OGC 07-036. Wayland, MA: Open Geospatial Consortium Inc. [https://portal.ogc.org/files/?artifact\\_id=20509](https://portal.ogc.org/files/?artifact_id=20509)
- [3] World Wide Web Consortium. Extensible Markup Language (XML). <https://www.w3.org/XML/>
- [4] World Wide Web Consortium. XML Schema. <https://www.w3.org/XML/Schema>
- [5] ISO, 2019. ISO 19107: 2019. Geographic information — Spatial schema. <https://www.iso.org/standard/26012.html>
- [6] ISO, 2022. ISO 19157-1: 2022. Geographic information — Data quality. <https://www.iso.org/standard/32575.html>
- [7] ISO, 2014. 19115-1:2014, Geographic information — Metadata — Part 1: Fundamentals. <https://www.iso.org/standard/53798.html>
- [8] Landry, T., ed., 2018. OGC Testbed-14: Machine Learning Engineering Report, OGC 18-038r2. Wayland, MA: Open Geospatial Consortium Inc. <https://docs.ogc.org/per/18-038r2.html>
- [9] Meek, S., ed., 2019. OGC Testbed-15: Machine Learning Engineering Report, OGC 19-027r2. Wayland, MA: Open Geospatial Consortium Inc. <https://docs.ogc.org/per/19-027r2.html>
- [10] Schumann, G., ed., 2020. OGC Testbed-16: Machine Learning Training Data Engineering Report, OGC 20-018. Wayland, MA: Open Geospatial Consortium Inc. <https://docs.ogc.org/per/20-015r2.html>
- [11] Yue, P., Shangguan, B., Hu, L., Jiang, L., Zhang, C., Cao, Z., Pan, Y., 2022. Towards a training data model for artificial intelligence in earth observation. International Journal of Geographical Information Science, 1-25. <https://doi.org/10.1080/13658816.2022.2087223>