

## Open Geospatial Consortium

Submission Date: <yyyy-mm-dd>

Approval Date: <yyyy-mm-dd>

Publication Date: <yyyy-mm-dd>

External identifier of this OGC® document: <http://www.opengis.net/doc/{doc-type}/{standard}/{m.n}>

Internal reference number of this OGC® document: YY-nnnrx

Version: n.n.n

Editor: Peng Yue, Ruixiang Liu, Boyi Shangguan

### OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 2: JSON Encoding Standard

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Document type: OGC® Standard

Document subtype: if applicable

Document stage: Draft

Document language: English

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## **i. Abstract**

The OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part 2: JSON Encoding Standard defines requirements for encoding AI training datasets as JSON. JavaScript Object Notation (JSON) is widely used for encoding data in Web-based applications. It consists of sets of objects described by name/value pairs. TrainingDML-AI Part 2 is based on the 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, JSON

## **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):

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- Pixalytics Ltd
- WiSC Enterprises
- George Mason University
- Laboratoire d'Informatique de Grenoble
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## **vii. Acknowledgments**

Thanks to the members of the TrainingDML-AI Standards Working Group of the OGC as well as all contributors of change requests and comments. In particular: Scott Simmons, Carl Reed, Kaixuan Wang, Zhipeng Cao, Shuaiqi Liu, Ming Zhao, Hanwen Xu, Haipeng Deng, Baoxin Teng.

# Chapter 1. Scope

This OGC TrainingDML - AI Part 2: JSON Encoding Standard defines a JSON encoding for the exchange of training datasets. The TrainingDML - AI Part 2 Standard provides a JSON-based encoding 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 a JSON encoding for AI training datasets. The standardization target for this Standard is:

- TrainingDML-AI JSON 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 23-008r3, OGC Training Data Markup Language for Artificial Intelligence (TrainingDML-AI) Part1: Conceptual Model Standard, 2023
- IETF: RFC 7159, The JavaScript Object Notation (JSON) Data Interchange Format, 2014
- IETF: RFC 7946, The GeoJSON Format, 2016
- IETF: RFC 3986, Uniform Resource Identifiers (URI): Generic Syntax, 2005
- IETF: RFC 3339, Date and Time on the Internet: Timestamps, 2002
- IETF: RFC 2046, Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types, 1996
- ISO 19107:2019 Geographic information — Spatial schema
- ISO 19115-1:2014 Geographic information — Metadata — Part 1: Fundamentals
- ISO 19157-1:2023 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. Dataset

identifiable collection of data

Note 1 to entry: A dataset can be a smaller grouping of data which, though limited by some constraint such as spatial extent or feature type, is located physically within a larger dataset. Theoretically, a dataset can be as small as a single feature or feature attribute contained within a larger dataset. A hardcopy map or chart can be

considered a dataset.

[SOURCE: ISO 19115-1:2014, 4.3]

## 4.5. Training Dataset

is a collection of samples, often labeled 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 labeled 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: Conceptual Model Standard

## 4.6. 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

## 4.7. Class

<classification> result of a classification process as part of a classification system which subdivides concepts within a given topic area.

[SOURCE: ISO 19144-2:2023, 3.1.6]

## 4.8. Task

the specific goal that an AI application want to achieve.

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

## 4.9. Provenance

information about entities, activities, and people involved in producing a piece of data or thing, which can be used to form assessments about its quality, reliability or trustworthiness. In this standard provenance is a record of how training data were prepared.

SOURCE: W3C (<https://www.w3.org/TR/prov-overview/>)

## 4.10. Quality

degree to which a set of inherent characteristics of an object fulfils requirements [ISO 9000:2015, 3.6.2, modified—Notes 1 and 2 to entry have been deleted]. Quality of training data (such as data imbalance and mislabeling) can impact the performance of AI/ML models.

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

## 4.11. Earth Observation

data and information collected about our planet, whether atmospheric, oceanic or terrestrial. This includes space-based or remotely-sensed data, as well as ground-based or in situ data.

SOURCE: GEO ([https://earthobservations.org/geo\\_wwd.php](https://earthobservations.org/geo_wwd.php))

## 4.12. Scene Classification

task of identifying scene categories of images, on the basis of a training set of images whose scene categories are known.

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

## 4.13. Object Detection

task of recognizing objects such as cars from images. The objects are often localized using bounding boxes.

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

## 4.14. Semantic Segmentation

task of assigning class labels to pixels of images or points of point clouds.

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

## 4.15. Change Detection

task that finds the changes in an area between images taken at different times.

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

## 4.16. 3D Model Reconstruction

task that builds 3D objects and scenes from multi-view images.

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

## 4.17. Generative Model

is one of the methods of large model training, which improve model performance through unsupervised pre-training. In the fine-tuning phase, labeled data plays a critical role in optimizing the model for specific vertical domains or tasks. By incorporating labeled data, the model can learn to accurately identify and extract relevant features, leading to better performance on specific downstream tasks. Overall, the combination of generative models and fine-tuning with labeled data can significantly improve the performance of large models in specialized domains or tasks.

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

## 4.18. JavaScript Object Notation (JSON)

is a lightweight, text-based, language-independent syntax for defining data interchange formats. It was derived from the ECMAScript programming language but is programming language independent. JSON defines a small set of structuring rules for the portable representation of structured data.

SOURCE: ECMA-404 The JSON data interchange syntax 2nd edition, December 2017

## 4.19. JSON Schema

is a vocabulary that allows you to annotate and validate JSON documents.

SOURCE: <https://json-schema.org/>

## 4.20. Training Dataset Publisher

refers to the entity or individual responsible for creating and releasing the JSON-based serialization syntax for geospatial training datasets, as defined in the TrainingDML-AI Part 2: JSON Encoding Standard.

# Chapter 5. Conventions

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

## 5.1. Identifiers

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

<http://www.opengis.net/spec/TrainingDML-AI-2/1.0>

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
- IETF — Internet Engineering Task Force
- 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
- URL — Uniform Resource Locator
- UTC — Coordinated Universal Time
- W3C — World Wide Web Consortium
- XML — Extensible Markup Language

# Chapter 6. Overview

The TrainingDML-AI Part 2: JSON Encoding Standard defines a JSON-based serialization syntax for geospatial training datasets. While other serialization formats are possible, such alternatives are not discussed in this Standard.

When serialized, absent properties are represented by either (a) setting the property value to null, or (b) by omitting the property declaration altogether at the option of the training dataset publisher. These representations are semantically equivalent. If a property has an array value, the absence of any items in that array shall be represented by omitting the property entirely or by setting the value to null. The appropriate interpretation of an omitted or explicitly null value is that no value has been assigned, as opposed to the view that the given value is empty or nil.

JSON does not have a formal class model. JSON objects are just sets of properties. However, the JSON encoding described in this Standard features a "type" property on each JSON object.

A training dataset document conforming to this Standard is a JSON document whose root value is an `AI_TrainingDataset` object.

## 6.1. JavaScript Object Notation

JavaScript Object Notation (JSON) is a lightweight, text-based, language-independent data interchange format that defines a small set of formatting rules for the portable representation of structured data. JSON is derived from the object literals of JavaScript, as defined in the ECMAScript Programming Language Standard and can represent four primitive types (strings, numbers, Boolean values, and null) and two structured types (objects and arrays). The ordering of the members or properties of any JSON object is considered irrelevant. Even though JSON is based on a subset of the JavaScript Programming Language it is currently well-supported by nearly all programming languages, including Java, Python, and C#.

The JSON format is currently described by two competing standards, RFC7159 and ECMA-404. Both standards documents are consistent, but the latter defines mainly the grammatical syntax where the former provides some additional semantic and security points.

# Chapter 7. Requirements for TrainingDML-AI JSON Encoding

## 7.1. Requirements Class: Base

### 7.1.1. Requirements Class: JSON Base Type

The JSON Base Type requirements class defines the base requirements for JSON encodings, which includes definitions of common types used in the TrainingDML-AI JSON encoding.

Requirements class	
/req/base/jsonbasetype	
Dependency	JSON
Requirement 1	/req/base/jsonbasetype/json
Requirement 2	/req/base/jsonbasetype/datetime
Requirement 3	/req/base/jsonbasetype/namedvalue
Requirement 4	/req/base/jsonbasetype/url

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

Requirement 1	/req/base/jsonbasetype/json
	An instance SHALL be a conformant JSON document, as defined in ECMA-404

JSON has a limited range of built-in types (<http://json.org/>). The following requirements provide standard JSON representations of additional types required across all requirements within this specification.

The DateTime is encoded as a text string.

Requirement 2	/req/base/jsonbasetype/datetime
	Each DateTime value SHALL be encoded as a text string defined in Date and Time on the Internet: Timestamps <a href="#">RFC 3339 Section 5.6</a> .
	RFC 3339 is a profile of the ISO 8601 standard for representation of dates and times using the Gregorian calendar.
	The specification of date and time in any JSON encoding of training set data SHALL be specified in UTC.

Examples:



- a) "2022-08-08T08:08:00.00Z"
- b) "2022-08-08"
- c) "12:34:56"
- d) "12:34:56.123"

The NamedValue is encoded as a JSON object with two properties named "key" and "value".

Requirement 3	/req/base/jsonbasetype/namedvalue
	Each NamedValue value SHALL be encoded as a JSON object with properties "key" and "value", while the value of property "key" is a text string.

Examples:

- a) {"key": "forest", "value": "RGB(0,255,255)"}
- b) {"key": "precision", "value": 0.8}

The URL is encoded as a text string.

Requirement 4	/req/base/jsonbasetype/url
	Each URL value SHALL be encoded as a text string defined in Uniform Resource Identifier (URI): Generic Syntax <a href="#">RFC 3986 Section 4.1</a> .

Examples:

- a) "http://www.opengeospatial.org"
- b) "/file.txt"

### 7.1.2. Requirements Class: ISO Metadata Type

The ISO Metadata Type requirements class defines the requirements for JSON encoding of ISO metadata types.

Requirements class	
/req/base/isometadatatype	
Dependency	JSON
Dependency	GeoJSON
Requirement 5	/req/base/isometadatatype/band
Requirement 6	/req/base/isometadatatype/extent
Requirement 7	/req/base/isometadatatype/citation
Requirement 8	/req/base/isometadatatype/scope

The MD\_Band is encoded as a text string or a JSON object.

Requirement 5	<p>/req/base/isometadatatype/band</p> <p>Each MD_Band value SHALL be encoded as a text string or a JSON object matching the XML Schema types defined in:</p> <p><a href="https://schemas.isotc211.org/19115/-1/mrc/1.3.0/content.xsd">https://schemas.isotc211.org/19115/-1/mrc/1.3.0/content.xsd</a></p>
---------------	---

Examples:

- a) "red"
- b) "B4"
- c) {"boundMax": 690, "boundMin": 630, "boundUnits": "nm"}

The EX\_Extent is encoded as a GeoJSON bounding box or a JSON Object.

Requirement 6	<p>/req/base/isometadatatype/extent</p> <p>Each EX_Extent value SHALL be encoded using the GeoJSON bounding box encoding as defined in The GeoJSON Format <a href="#">RFC 7946 Section 5</a>,</p> <p>or a JSON object matching the XML Schema type as defined in:</p> <p><a href="https://schemas.isotc211.org/19115/-1/gex/1.3.0/extent.xsd">https://schemas.isotc211.org/19115/-1/gex/1.3.0/extent.xsd</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,  
        "eastBoundLongitude": -157.86768,  
        "southBoundLatitude": -14.42443,  
        "northBoundLatitude": 21.31573  
    }  
}

The CI\_Citation is encoded as a text string or a JSON object.

Requirement 7	<p>/req/base/isometadatatype/citation</p> <p>Each CI_Citation value SHALL be encoded as a text string or a JSON object matching the XML Schema type as defined in:</p> <p><a href="https://schemas.isotc211.org/19115/-1/cit/1.3.0/citation.xsd">https://schemas.isotc211.org/19115/-1/cit/1.3.0/citation.xsd</a></p>
---------------	---

Examples:

```
a) "http://www.opengeospatial.org"
b) {"title": "Open Geospatial Consortium", "alternateTitle": ["OGC"], "identifier":
{"code": "https://portal.ogc.org/files/?artifact_id=104605&version=1"}}
```

The MD\_Scope is encoded as a JSON object.

Requirement 8	/req/base/isometadatatype/scope
	Each MD_Scope value SHALL be encoded as a JSON object matching the XML Schema type as defined in:  <a href="https://schemas.isotc211.org/19115/-1/mcc/1.3.0/commonClasses.xsd">https://schemas.isotc211.org/19115/-1/mcc/1.3.0/commonClasses.xsd</a>

Example:

```
{
  "level": "dataset",
  "levelDescription": {
    "dataset": "whu_rs19"
  }
}
```

### 7.1.3. Requirements Class: ISO Quality Type

The ISO Quality Type requirements class defines the requirements for JSON encoding of ISO quality types.

Requirements class	
/req/base/isoqualitytype	
Dependency	JSON
Requirement 9	/req/base/isoqualitytype/element

The QualityElement object is encoded as a JSON object with properties shown in Table 1.

Requirement 9	/req/base/isoqualitytype/element
	Each QualityElement value SHALL be encoded as a JSON object with properties shown in Table 1.

Table 1. QualityElement properties

JSON 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",
  "measure": {
    "measureDescription": "Percentage of training samples with inconsistent image format"
  },
  "evaluationMethod": {
    "evaluationMethodDescription": "Full test method to calculate the percentage of training samples with an inconsistent format"
  },
  "result": [
    {
      "quantitativeResult": {
        "value": [
          0
        ],
        "valueUnit": "%"
      }
    }
  ]
}
```

#### 7.1.4. Requirements Class: Geospatial Type

The Geospatial Type requirements class defines the requirements for JSON encoding of geospatial types.

Requirements class	
/req/base/geospatialtype	
Dependency	JSON
Dependency	GeoJSON
Requirement 10	/req/geospatialtype/feature

The encoding of one or more features follows the GeoJSON RFC rules for encoding a Feature object, with members “type”, “geometry” and “properties”. A Feature object represents a spatially bounded thing. Every Feature object is a GeoJSON object no matter where it occurs in a GeoJSON text. [RFC 7946](#)

Requirement 10	/req/geospatialtype/feature  Each Feature value SHALL be encoded using the GeoJSON feature encoding defined in The GeoJSON Format <a href="#">RFC 7946 Section 3.2</a> .
----------------	--

Examples of Feature encodings are:

```

a) {"type": "Feature", "geometry": {"type": "Point", "coordinates": [120.0, 30.0]},
   "properties": {"class": "station"}}
b) {"type": "Feature", "geometry": {"type": "LineString", "coordinates": [[120.0,
   30.0], [130.0, 40.0]]}, "properties": {"class": "road"}}
c) {"type": "Feature", "geometry": {"type": "Polygon", "coordinates": [[[120.0,
   30.0], [130.0, 30.0], [125.0, 40.0], [120.0, 30.0]]]}, "properties": {"class":
   "building"}}

```

## 7.2. Requirements Class: AI\_TrainingDataset

The AI\_TrainingDataset requirements class defines a JSON encoding for the AI\_TrainingDataset module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitrainingdataset	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/aitrainingdata
Dependency	/req/aitask
Dependency	/req/ailabeling
Dependency	/req/aidataquality
Dependency	/req/aitdchangeset
Requirement 11	/req/aitrainingdataset/trainingdataset
Requirement 12	/req/aitrainingdataset/metricsinliterature
Requirement 13	/req/aitrainingdataset/eotrainingdataset

The AI\_TrainingDataset object is encoded as a JSON object with properties shown in Table 2.

Requirement 11	/req/aitrainingdataset/trainingdataset  Each AI_TrainingDataset object SHALL implement the Mandatory properties shown in Table 2.
----------------	---

Table 2. AI\_TrainingDataset properties

JSON 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
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 [0..1]	Optional
createdTime	Time when the AI training dataset was created.	DateTime [0..1]	Optional
updatedAt	Time when the AI training dataset was updated.	DateTime [0..1]	Optional
license	License description of the AI training dataset.	CharacterString [1..1]	Mandatory
providers	People or organizations who provide the AI training dataset.	CharacterString [0..*]	Optional
keywords	Keywords of the AI training dataset.	CharacterString [0..*]	Optional

JSON Property	Definition	Data type and values	Obligation
metricsInLIT	Results of performance metrics achieved by AI/ML algorithms in the peer-reviewed literature.	AI_MetricsInLiterature [0..*]	Optional
statisticsInfo	Statistical results for training samples in each class.	NamedValue [0..*]	Optional
dataSources	Citation for the data sources.	CI_Citation [0..*]	Optional
numberOfClasses	Total number of classes in the AI training dataset.	Int [0..1]	Optional
classificationSchema	Classification schema for classes used in the AI training dataset.	CharacterString [0..1]	Optional
classes	Classes used in the AI training dataset.	NamedValue [0..*]	Optional
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",
  "id": "whu_rs19",
  "name": "WHU-RS19",
  "description": "Wuhan University-Remote Sensing 19 Categories (WHU-RS19) has 19 classes of remote sensing images scenes obtained from Google Earth",
  "amountOfTrainingData": 1013,
  "createdTime": "2010-01-01",
```

```

    "providers": ["Wuhan University"],
    "keywords": ["Remote Sensing", "Scene Classification"],
    "numberOfClasses": 19,
    "classes": ["Airport", "Beach", "Bridge", "Commercial", "Desert", "Farmland",
"footballField", "Forest", "Industrial", "Meadow", "Mountain", "Park", "Parking",
"Pond", "Port", "railwayStation", "Residential", "River", "Viaduct"],
    "tasks": [{"type": "EOTask", "id": "whu_rs19-task", "description": "Structural high-
resolution satellite image indexing", "taskType": "Scene Classification"}],
    "data": [{"type": "EOTrainingData", "id": "airport_01", "dataSources":
["googleEarth"], "dataURL": ["image/Airport/airport_01.jpg"], "labels": [{"type":
"SceneLabel", "class": "Airport"}]}, ...]
}

```

If the optional element `AI_MetricsInLiterature` is specified, this element is encoded as JSON object with properties as shown in Table 3.

Requirement 12	<code>/req/aitrainingdataset/metricsinliterature</code>  Each <code>AI_MetricsInLiterature</code> value SHALL implement the Mandatory properties shown in Table 3.
----------------	--

Table 3. *AI\_MetricsInLiterature* properties

JSON 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",
  "algorithm": "FACNN",
  "metrics": [{"key": "Overall Accuracy", "value": 0.9881}]
}

```

The `AI_EOTrainingDataset` object is encoded as a JSON object with properties shown in Table 2 and Table 4.



Requirement 13	/req/aitrainingdataset/eotrainingdataset
	Each AI_EOTrainingDataset object SHALL implement the Mandatory properties both shown in Table 2 and Table 4.

Table 4. AI\_EOTrainingDataset properties

JSON 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",
  "id": "whu_rs19",
  "name": "WHU-RS19",
  "description": "Wuhan University-Remote Sensing 19 Categories (WHU-RS19) has 19 classes of remote sensing images scenes obtained from Google Earth",
  "amountOfTrainingData": 1013,
  "createdTime": "2010-01-01",
  "providers": ["Wuhan University"],
  "keywords": ["Remote Sensing", "Scene Classification"],
  "numberOfClasses": 19,
  "extent": [-180, -90, 180, 90],
  "bands": ["red", "green", "blue"],
  "imageSize": "6000x7600",
  "classes": ["Airport", "Beach", "Bridge", "Commercial", "Desert", "Farmland", "footballField", "Forest", "Industrial", "Meadow", "Mountain", "Park", "Parking", "Pond", "Port", "railwayStation", "Residential", "River", "Viaduct"],
  "tasks": [{"type": "AI_EOTask", "id": "whu_rs19-task", "description": "Structural high-resolution satellite image indexing", "taskType": "Scene Classification"}],
  "data": [{"type": "AI_EOTrainingData", "id": "airport_01", "dataSources": ["googleEarth"], "dataURL": ["image/Airport/airport_01.jpg"], "labels": [{"type": "AI_SceneLabel", "class": "Airport"}]}, ...]
}
```

## 7.3. Requirements Class: AI\_TrainingData

The AI\_TrainingData requirements class defines a JSON encoding for the AI\_TrainingData module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitrainingdata	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/ailabel
Dependency	/req/ailabeling
Dependency	/req/aidataquality
Requirement 14	/req/aitrainingdata/trainingdata
Requirement 15	/req/aitrainingdata/trainingtypecode
Requirement 16	/req/aitrainingdata/eotrainingdata

The AI\_TrainingData object is encoded as a JSON object with properties shown in Table 5.

Requirement 14	/req/aitrainingdataset/trainingdata
	Each AI_TrainingData object SHALL implement the Mandatory properties shown in Table 5.

Table 5. AI\_TrainingData properties

JSON 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

JSON Property	Definition	Data type and values	Obligation
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",
  "id": "airport_01",
  "dataSources": ["googleEarth"],
  "dataURL": ["image/Airport/airport_01.jpg"],
  "labels": [{"type": "AI_SceneLabel", "class": "Airport"}]
}
```

The AI\_TrainingTypeCode is encoded as a text string whose value is one of "training", "validation" or "test".

Requirement 15	/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"

The AI\_EOTrainingData object is encoded as a JSON object with properties both shown in Table 5 and Table 6.

Requirement 16	/req/aitrainingdataset/eotrainingdata
	Each AI_EOTrainingData object SHALL implement the Mandatory properties as defined in Table 5 and Table 6.

Table 6. AI\_EOTrainingData properties

JSON 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_EOTrainingData",
  "id": "airport_01",
  "dataSources": ["googleEarth"],
  "dataURL": ["image/Airport/airport_01.jpg"],
  "labels": [{"type": "AI_SceneLabel", "class": "Airport"}]
}
```

## 7.4. Requirements Class: AI\_Task

The AI\_Task requirements class defines a JSON encoding for the AI\_Task module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitask	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Requirement 17	/req/aitask/task
Requirement 18	/req/aitask/eotask

The AI\_Task object is encoded as a JSON object with properties as shown in Table 7.

Requirement 17	/req/aitask/task
	Each AI_Task object SHALL implement the Mandatory properties shown in Table 7.

Table 7. AI\_Task properties

JSON 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",
  "id": "image-indexing-task",
  "description": "Structural high-resolution satellite image indexing"
}
```

The AI\_EOTask object is encoded as a JSON object with properties both shown in Table 7 and Table 8.

Requirement 18	/req/aitask/eotask  Each AI_EOTask object SHALL implement the Mandatory properties shown in Table 7 and Table 8.
----------------	--

Table 8. AI\_EOTask properties

JSON 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",
  "id": "image-indexing-task",
  "description": "Structural high-resolution satellite image indexing"
  "taskType": "Scene Classification"
}
```

## 7.5. Requirements Class: AI\_Label

The AI\_Label requirements class defines a JSON encoding for the AI\_Label module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/ailabel	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/base/geospatialtype
Requirement 19	/req/ailabel/label
Requirement 20	/req/ailabel/scenelabel
Requirement 21	/req/ailabel/objectlabel
Requirement 22	/req/ailabel/pixellabel
Requirement 23	/req/ailabel/imageformatcode

The AI\_Label object is encoded as a JSON object with properties as shown in Table 9.

Requirement 19	/req/ailabel/label
	Each AI_Label object SHALL implement the Mandatory properties shown in Table 9.

Table 9. AI\_Label properties

JSON 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]  Default: false	Optional
confidence	Confidence score of the labeler.	Float [0..1]  Default: 1.0  Range: [0, 1]	Optional

Example:

```
{  
  "type": "AI_AbstractLabel",  
  "isNegative": false
```

```
}
```

The AI\_SceneLabel object is encoded as a JSON object with properties as shown in Table 10.

Requirement 20	/req/ailabel/scenelabel  Each AI_SceneLabel object SHALL implement the properties shown in Table 10.
----------------	--

Table 10. AI\_SceneLabel properties

JSON 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",  
  "class": "Airport"  
}
```

The AI\_ObjectLabel object is encoded as a JSON object with properties shown in Table 11.

Requirement 21	/req/ailabel/objectlabel  Each AI_ObjectLabel object SHALL implement the Mandatory properties shown in Table 11.
----------------	--

Table 11. AI\_ObjectLabel properties

JSON 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 [1..1]	Mandatory
bboxType	Type of the bbox.	CharacterString [0..1]	Optional
class	Class that records the semantic of the object type.	CharacterString [1..1]	Mandatory

JSON Property	Definition	Data type and values	Obligation
dateTime	Created time of the object label.	DateTime [0..1]	Optional

Example:

```
{
  "type": "AI_ObjectLabel",
  "class": "Truck",
  "object": {"type": "Feature", "properties": {"truncated": 0.0, "occluded": 0,
"alpha": -1.57}, "geometry": {"type": "Polygon", "coordinates": [[2257.0, 332.0],
[2271.0, 332.0], [2271.0, 350.0], [2257.0, 350.0], [2257.0, 332.0]]},
  "bboxType": "Horizontal BBox",
}
```

The AI\_PixelLabel object is encoded as a JSON object with properties as shown in Table 12.

Requirement 22	/req/ailabel/pixellabel
	Each AI_PixelLabel object shall implement the Mandatory properties shown in Table 12.

Table 12. AI\_PixelLabel properties

JSON 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.	AI_ImageFormatCode [1..*]	Mandatory

Example:

```
{
  "type": "AI_PixelLabel",
  "imageURL": ["/label_5classes/GF2_PMS1__L1A0000647767-MSS1_label.tif"],
  "imageFormat": ["image/tiff; application=geotiff"]
}
```

The AI\_ImageFormatCode is encoded as a text string whose value is defined in Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types [RFC 2046](#).



Requirement 23	/req/ailabel/imageformatcode  Each AI_ImageFormatCode value SHALL be encoded as a text string defined in Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types <a href="#">RFC 2046</a> .
----------------	--

Examples:

- a) "image/tiff; application=geotiff"
- b) "application/x-netcdf"
- c) "image/png"
- d) "image/jp2"

## 7.6. Requirements Class: AI\_Labeling

The AI\_Labeling requirements class defines a JSON encoding for the AI\_Labeling module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/ailabeling	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Requirement 24	/req/ailabeling/labeling
Requirement 25	/req/ailabeling/labeler
Requirement 26	/req/ailabeling/labelingprocedure
Requirement 27	/req/ailabeling/labelingmethodcode

The AI\_Labeling object is encoded as a JSON object with properties shown in Table 13.

Requirement 24	/req/ailabeling/labeling  Each AI_Labeling object SHALL implement the Mandatory properties shown in Table 13.
----------------	---

Table 13. AI\_Labeling properties

JSON 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

JSON Property	Definition	Data type and values	Obligation
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",
  "id": "0",
  "scope": {
    "level": "dataset",
    "levelDescription": {
      "dataset": "whu_rs19"
    }
  },
  "labelers": [{..}],
  "procedure": {..}
}
```

The AI\_Labeler object is encoded as a JSON object with properties as shown in Table 14.

Requirement 25	/req/ailabeling/labeler  Each AI_Labeler object SHALL implement the Mandatory properties shown in Table 14.
----------------	---

Table 14. AI\_Labeler properties

JSON 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",
  "id": "0",
  "name": "Tom"
}
```

An AI\_LabelingProcedure object is encoded as a JSON object with properties as shown in Table 15.

Requirement 26	/req/ailabeling/labelingprocedure  Each AI_LabelingProcedure object SHALL implement the Mandatory properties shown in Table 15.
----------------	---

Table 15. AI\_LabelingProcedure properties

JSON 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.	AI_LabelingMethodCode [1..*]	Mandatory
tools	Tools or software used in the labeling procedure.	CharacterString [0..*]	Optional

Example:

```
{
  "type": "AI_LabelingProcedure",
  "id": "0",
  "methods": ["manual"],
  "tools": ["ArcGIS"]
}
```

The AI\_LabelingMethodCode is encoded as a text string whose value is one of “manual”, “semi-automatic” or “automatic”.

Requirement 27	/req/ailabeling/labelingmethodcode  Each AI_LabelingMethodCode value SHALL be a text string whose value is one of “manual”, “semi-automatic” or “automatic”.
----------------	--

Examples:

- a) "manual"
- b) "semi-automatic"
- c) "automatic"

## 7.7. Requirements Class: AI\_DataQuality

The AI\_ClassBalanceDegree object is encoded as a JSON object with properties as shown in Table 16.

Requirement 28	/req/aidataquality/classbalancedegree  Each AI_ClassBalanceDegree object SHALL implement the Mandatory properties as shown in Table 16.
----------------	---

Table 16. AI\_ClassBalanceDegree properties

JSON 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",
  "measure": {
    "measureDescription": "Balance degree of label classes"
  },
  "evaluationMethod": {
    "evaluationMethodDescription": "Counting the number of training samples belonging to each class and calculating the balance degree"
  },
  "result": [
    {
      "quantitativeResult": {
        "value": [
          93.5
        ],
        "valueUnit": "%"
      }
    }
  ]
}
```

## 7.8. Requirements Class: AI\_TDChangeset

The AI\_TDChangeset requirements class defines a JSON encoding for the AI\_TDChangeset module, which is based on the UML model specified in the TrainingDML-AI Part 1: Conceptual Model Standard.

Requirements class	
/req/aitdchangeset	
Dependency	JSON
Dependency	/req/base/jsonbasetype
Dependency	/req/base/isometadatatype
Dependency	/req/tdtrainingdata
Requirement 29	/req/aitdchangeset/tdchangeset

The AI\_TDChangeset object is encoded as a JSON object with properties shown in Table 17.

Requirement 29	/req/aitdchangeset/tdchangeset
	Each AI_TDChangeset object SHALL implement the Mandatory properties as shown in Table 17.

Table 17. AI\_TDChangeset properties

JSON 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	The time that the changeset was created.	DateTime [0..1]	Optional
add	Added training samples.	AI_TrainingData [0..*]	Optional
modify	Modified training samples.	AI_TrainingData [0..*]	Optional

JSON Property	Definition	Data type and values	Obligation
delete	Deleted training samples.	AI_TrainingData [0..*]	Optional

Example:

```
{
  "type": "AI_TDChangeset",
  "id": "changeset-dota_v1.5",
  "datasetId": "dota_v1.5",
  "createdTime": "2019-01-01",
  "changeCount": 9,
  "modify": [{"type": "E0TrainingData", "id": "P1228", "dataSources": ["GF"],
"dataURL": ["train/images/P1228.png"], "numberOfLabels": 50, "trainingType":
"training", "labels": [{"type": "ObjectLabel", "class": "ship", "object": {"type":
"Feature", "geometry": {"type": "Polygon", "coordinates": [[2306.0, 729.0], [2330.0,
729.0], [2330.0, 744.0], [2306.0, 744.0], [2306.0,729.0]]}}, "bboxType": "Horizontal
BBBox"}, ...]]}
}
```

# Annex A: Abstract Test Suite (Normative)

## A.1. Introduction

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

## A.2. Conformance Class: Base

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

Conformance Class	/conf/base	
Requirements	/req/base	
Dependency	A JSON Schema Validator	
Test	/conf/base/json	
	Requirement	/req/base/jsonbasetype/json
	Test purpose	Verify that the document is well-formed JSON.
	Test method	Load the document in a JSON validator. Pass if no errors reported. Fail otherwise.
	Test type	Capability
Test	/conf/base/type	
	Requirement	/req/base/jsonbasetype/datetime, /req/base/jsonbasetype/namedvalue, /req/base/jsonbasetype/url, /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 JSON instance document using the appropriate object definition from the TrainingDMLAI.json JSON Schema. Pass if no errors reported. Fail otherwise.
	Test type	Capability

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

The AI\_TrainingDataset conformance class tests that the training dataset object is encoded

according to the requirements.

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

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

The AI\_TrainingData conformance class tests that the training data objects are encoded according to the requirements.

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

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

The AI\_Task conformance class tests that the task objects are encoded according to the requirements.

Conformance Class	/conf/aitask	
Requirements	/req/aitask	
Dependency	A JSON Schema Validator	



Test	Test purpose	Verify that the task objects are encoded using the specified property names and structures.
	Test method	Validate the JSON instance document using the appropriate object definition from the TrainingDML-AI.json JSON Schema.  Pass if no errors reported. Fail otherwise.
	Test type	Capability

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

The AI\_Label conformance class tests that the label objects are encoded according to the requirements.

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

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

The AI\_Labeling conformance class tests that the labeling objects are encoded according to the requirements.

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

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

The AI\_TDChangeset conformance class tests that the TD changeset objects are encoded according to the requirements.

Conformance Class	/conf/aitdchangeset	
Requirements	/req/aitdchangeset	
Dependency	A JSON Schema Validator	
Test	Test purpose	Verify that the TD changeset objects are encoded using the specified property names and structures.
	Test method	Validate the JSON instance document using the appropriate object definition from the TrainingDML-AI.json JSON Schema.  Pass if no errors reported. Fail otherwise.
	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 an image size of 600×600 and a resolution of 0.5 m.

An example of JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-RS19.json).

### 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/0.1 m-1 m, Gaofen-2/1 m, Jilin-1/0.72 m).

An example of JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/DOTA-v1.5.json).

### 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 two 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/KITTI.json).

### B.1.4. GID Dataset

The [GID dataset](#) is one of state-of-art land cover classification datasets. This dataset has a large spatial coverage covering many provinces in China with a relatively high spatial resolution (2 m). 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/GID-5C.json).

### 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/Toronto_3D.json).

### 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 0.2 m) 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-building.json).

### 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/UiT_HCD_California_2017.json).

### 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 JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU_MVS.json).

### B.1.9. iSAID Dataset

The [iSAID dataset](#) is the first benchmark dataset for instance segmentation in aerial images. This large-scale and densely annotated dataset contains 655,451 object instances for 15 categories across 2,806 high-resolution images. The images of iSAID is the same as the DOTA-v1.0 dataset, which are mainly collected from the Google Earth, some are taken by satellite JL-1, the others are taken by satellite GF-2 of the China Centre for Resources Satellite Data and Application. The object categories in iSAID include: plane, ship, storage tank, baseball diamond, tennis court, basketball court, ground track field, harbor, bridge, large vehicle, small vehicle, helicopter, roundabout, soccer ball field and swimming pool.

An example of JSON encoding of the iSAID 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/iSAID.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/iSAID.json).

## 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/tree/main/use-cases/examples/1.0/WHU-RS19-quality.json).

## 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->

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

### B.4.1. ERA5 Dataset

The ERA5 dataset is derived from 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 does not require additional labeled data. For this dataset, inheritance classes for AI\_AbstractLabel are not defined, although this class is required in the existing standard (please note that these test cases are for future versions of the standard). In addition, additional attributes to support the complete representation of dataset information were added.

An example of JSON 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/ERA5_hourly_data.json).

### B.4.2. SCIERC Dataset

The SCIERC dataset is derived from 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, the Abstract class is inherited and AI\_TextTrainingDataset, AI\_TextTrainingData, AI\_TextTask, and AI\_EntityLabel respectively are defined. In addition, additional attributes to support the complete representation of dataset information were added.

An example of JSON encoding of the SCIERC 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/SCIERC.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/SCIERC.json).

### B.4.3. nuScenes Dataset

The nuScenes 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, a 3D annotation box is used to organize each 3D object using AI\_ObjectLabel. Since each training data and each 3D object require many additional attributes to be fully described, many additional attributes to provide a detailed description of the training dataset, training data, labels, etc. were added.

An example of JSON encoding of the nuScenes 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.json](https://github.com/opengeospatial/TrainingDML-AI_SWG/blob/main/use-cases/examples/1.0/nuScenes.json).

# Annex C: Revision History (Informative)

Date	Release	Author	Paragraph modified	Description
2023-07-28	0.1	Peng Yue, Ruixiang Liu, Boyi Shangguan	All	Draft for internal review.
2023-12-15	0.2	Peng Yue, Ruixiang Liu, Jim Antonisse	Most	Revisions based on comments from Jim Antonisse.
2024-02-26	0.3	Peng Yue, Ruixiang Liu, Carl Reed	Most	Merge edits and comments from Carl Reed.

# 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] Freed, N., 1996. RFC 2046. Multipurpose Internet Mail Extensions (MIME) Part Two: Media Types. <https://www.ietf.org/rfc/rfc2046.txt>
- [3] Klyne, G., 2002. RFC 3339. Date and Time on the Internet: Timestamps. <http://www.ietf.org/rfc/rfc3339.txt>
- [4] Berners-Lee, T., 2005. RFC 3986. Uniform Resource Identifier (URI): Generic Syntax. <http://www.ietf.org/rfc/rfc3986.txt>
- [5] Bray, T., ed., 2014. RFC 7159. The JavaScript Object Notation (JSON) Data Interchange Format. <http://www.ietf.org/rfc/rfc7159.txt>
- [6] Butler, H., ed., 2016. RFC 7946. The GeoJSON Format. <http://www.ietf.org/rfc/rfc7946.txt>
- [7] ISO, 2019. ISO 19107: 2019. Geographic information — Spatial schema. <https://www.iso.org/standard/66175.html>
- [8] ISO, 2022. ISO 19157-1: 2022. Geographic information — Data quality. <https://www.iso.org/standard/78900.html>
- [9] ISO, 2014. 19115-1:2014, Geographic information — Metadata — Part 1: Fundamentals. <https://www.iso.org/standard/53798.html>
- [10] 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>
- [11] 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>
- [12] 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>
- [13] 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>