ASAM OpenLABEL V1.0.0

Scenario Tagging

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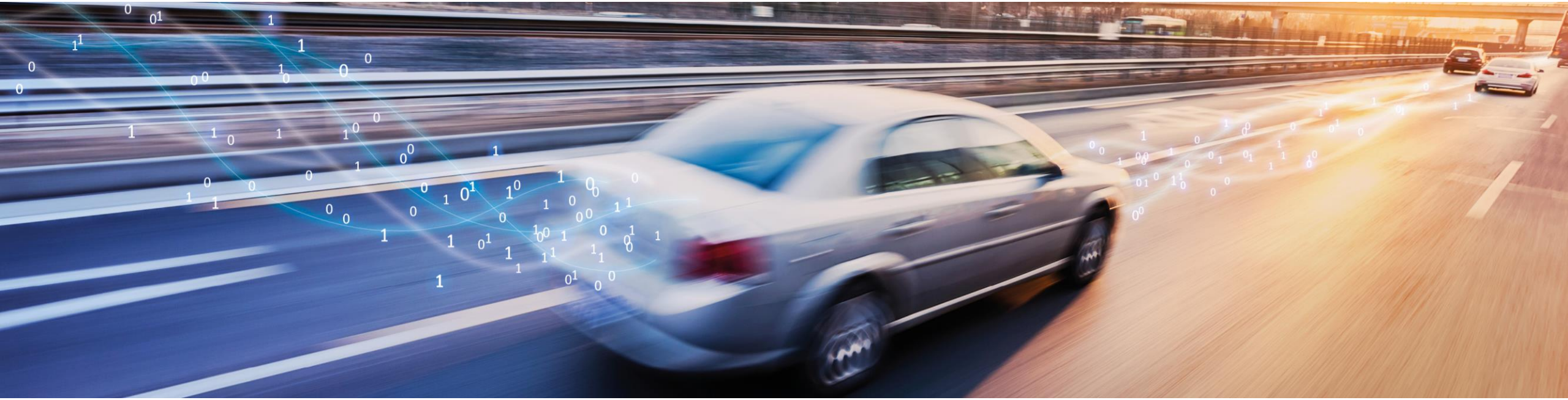
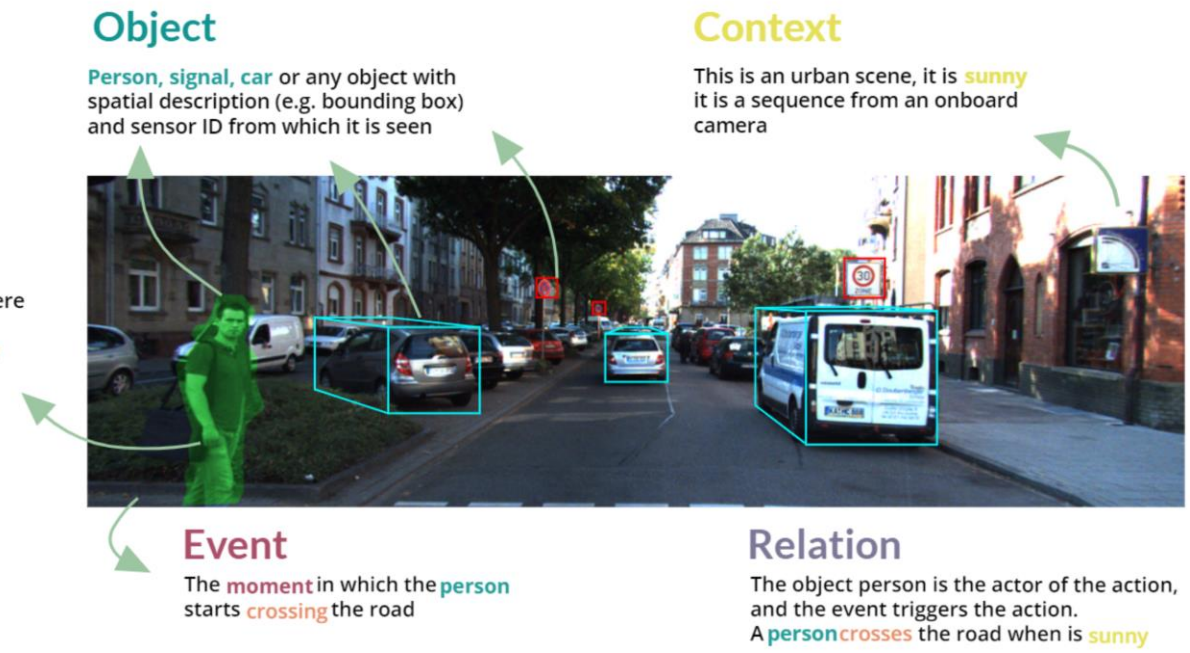
Webinar, Online



ASAM Association for Standardization of Automation and Measuring Systems

Scenario Tagging vs Labelling

Scene labelling illustration



Extracted individual tags

- Creation time
- ‘Project demo’
- Pedestrian
- Car
- Cross
- Day
- Traffic sign
- Paved shoulder
- Vegetation
- Buildings

Admin tags

Road user

Behaviour

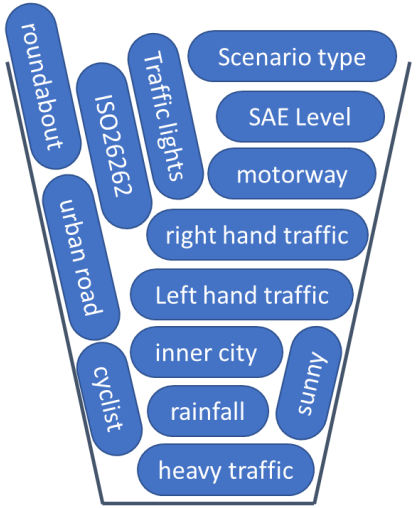
Environmental

Scenery

"VCD - Video Content Description", *Vcd.vicomtech.org*, 2021. [Online]. Available: https://vcd.vicomtech.org/. [Accessed: 08- Jun- 2021].

High Level Tagging Workflow

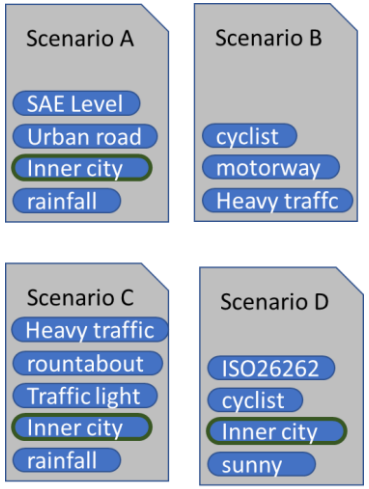
Bucket of tags



Ontology
(domain + application)

Associate tags to scenarios

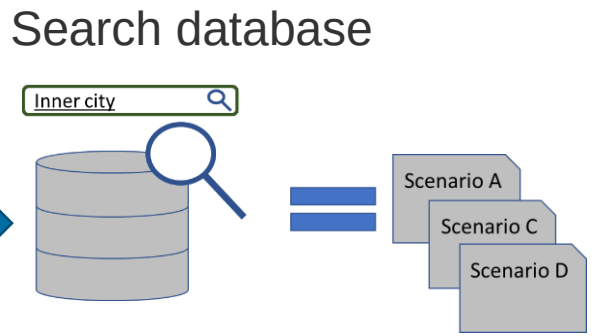
tag



Tagging rules, format

Facilitate database storage/query

save



Example

Scenario Tagging Model

Scenario tagging class hierarchy

- Scenario
- Tag
  - AdminTag
  - Behaviour
    - BehaviourCommunication
    - BehaviourMotion
  - Odd
    - OddDynamicElements
      - DynamicElementsSubjectVehicle
      - DynamicElementsTraffic
    - OddEnvironment
      - EnvironmentConnectivity
      - EnvironmentIllumination
      - EnvironmentParticulates
      - EnvironmentWeather
    - OddScenery
      - SceneryDrivableArea
      - SceneryFixedStructure
      - SceneryJunction
      - ScenerySpecialStructure
      - SceneryTemporaryStructure
      - SceneryZone
  - RoadUser
    - RoadUserAnimal
    - RoadUserHuman
    - RoadUserVehicle

- dataSunElevationValue
- horizontalCurvesValue
- illuminationCloudinessValue
- laneSpecificationDimensionsValue
- laneSpecificationLaneCountValue
- licenseURI
- longitudinalDownSlopeValue
- longitudinalUpSlopeValue
- motionAccelerateValue
- motionDecelerateValue
- motionDriveValue
- ownerEmail
- ownerName
- ownerURL
- particulatesWaterValue
- scenarioCreatedDate
- scenarioDefinition
- scenarioDefinitionLanguageURI
- scenarioDescription
- scenarioName
- scenarioParentReference
- scenarioUniqueReference
- scenarioVersion
- scenarioVisualisationURL
- subjectVehicleSpeedValue
- trafficAgentDensityValue
- trafficFlowRateValue
- trafficVolumeValue
- weatherRainValue
- weatherSnowValue
- weatherWindValue

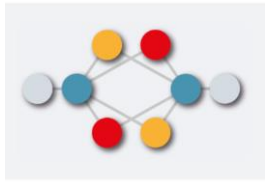
- hasTag
- trafficAgentTypeValue

Tagging model

- Admin tags → Application level
- ODD dynamic
- ODD environment
- ODD scenery

  → Aligned with OpenODD and OpenXOntology, mapped to BSI PAS 1883
- Road user → One-to-one mapping to OpenXOntology
- Behaviour →

ASAM OpenXOntology



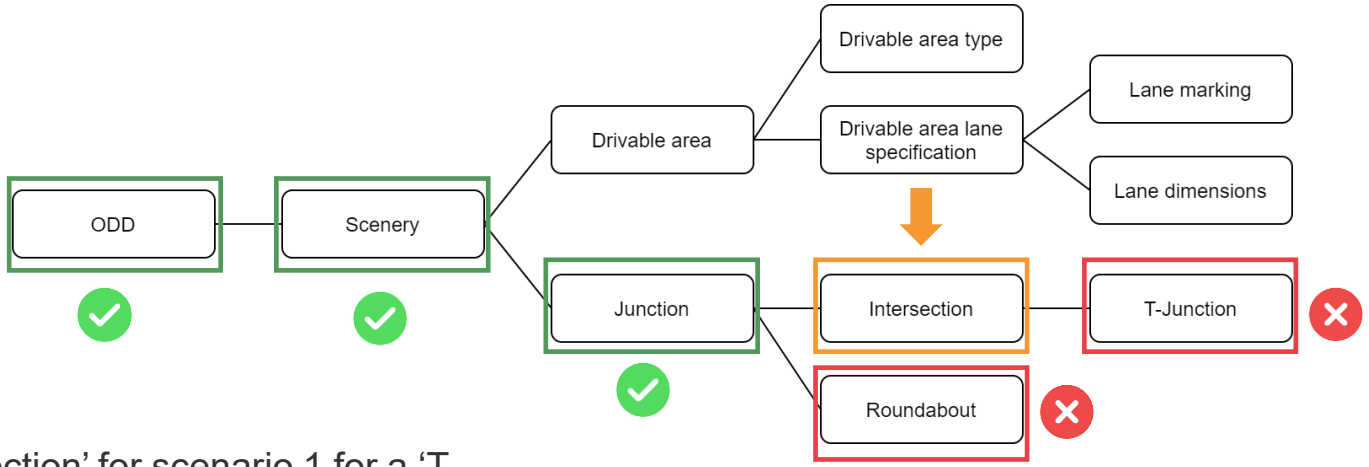
Core Domain Model for the ASAM Simulation Domain

ASAM OpenODD

Defining the Operational Design Domain for Automated Vehicles

Tagging Rules - Inheritance

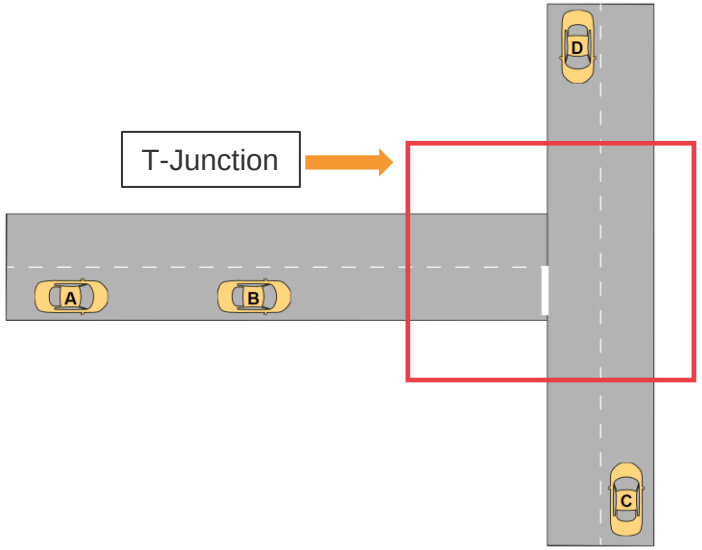
When tagging a non-leaf node class, all the parent node classes will be tagged, all the children node classes



Providing a demo ontology, user places a tag on ‘Intersection’ for scenario 1 for a ‘T-Junction’ layout.

Example 1:
If search based on tags of ‘ODD’, ‘Scenery’, ‘Junction’, scenario 1 **will** be returned since all these tags are applicable for scenario 1.

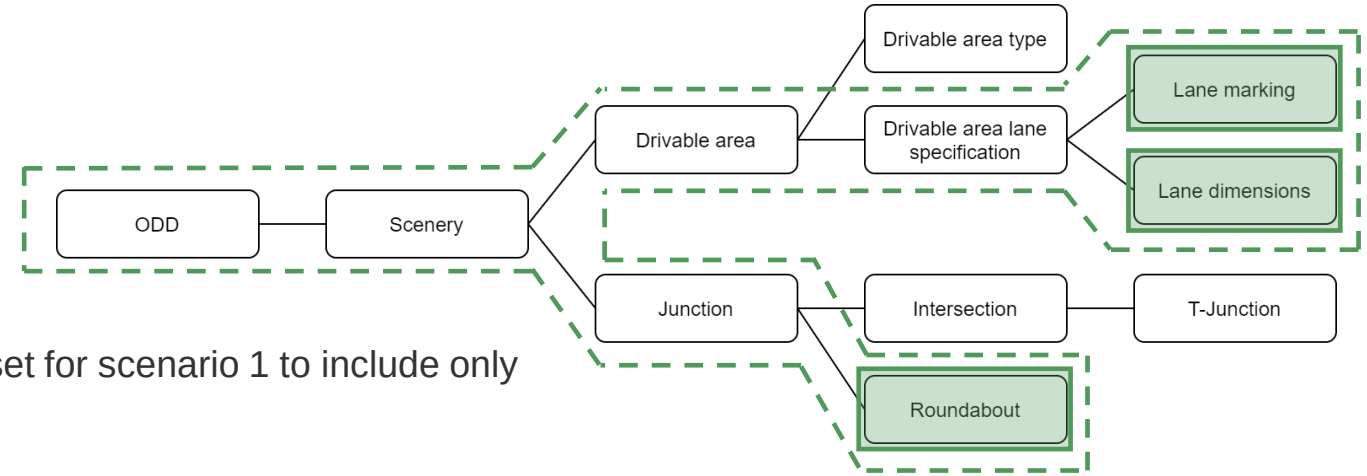
Example 2:
If search based on tags of ‘T-Junction’, ‘Roundabout’, scenario 1 **will not** be returned since the details of ‘T-Junction’ are not defined by the ‘Intersection’, and ‘Roundabout’ is not tagged.



➡ Allow users to tag at any abstraction level based on use case

Tagging Rules – Tagging Subset

Tagging subset defines what are considered during a tagging process.

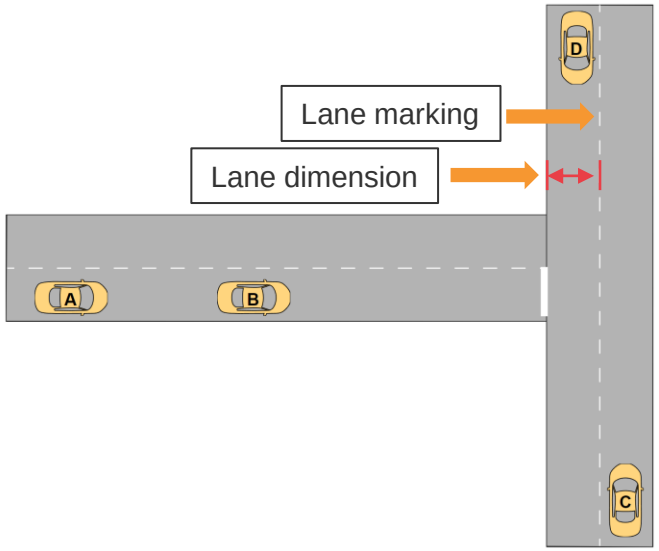


Providing a demo ontology, user defines the tagging subset for scenario 1 to include only ‘lane marking’, ‘Lane dimensions’ and ‘Roundabout’.

Example 1:
If search based on ‘T-Junction’ tag, scenario 1 **will not** be returned due to: 1) ‘T-Junction’ is not in the tagging subset, 2) ‘T-Junction’ tag is not present.

Example 2:
If search based on tags of ‘Lane marking’, scenario 1 **will** be returned since ‘Lane marking’ tag is within the tagging subset and also is present.

Example 3:
If search based on tags of ‘Roundabout’, scenario 1 **will not** be returned since although ‘Roundabout’ tag is within the tagging subset, it is not present.



- Allow users to focus on specific use case, differentiate between ‘not present’ and ‘not considered’
- Handles ‘incomplete’ tags
- Always uses classes at the lowest hierarchical levels

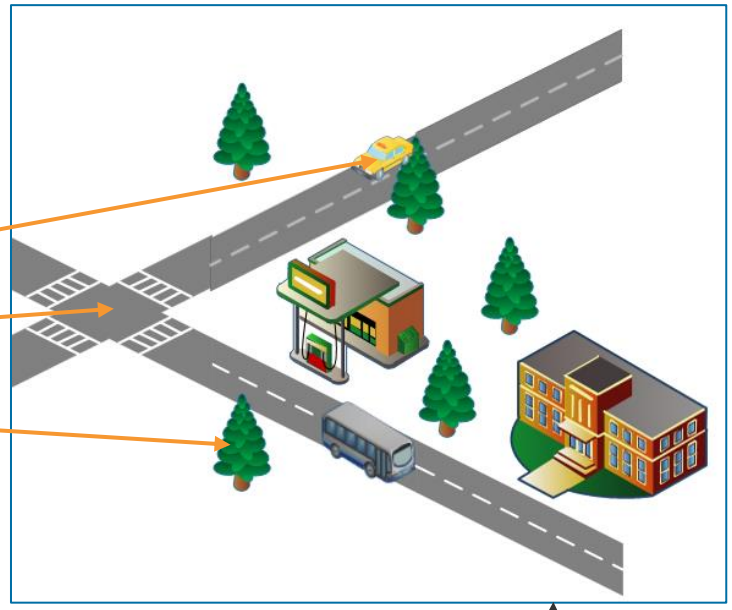
Scenario Tagging JSON Schema

Scenario tagging uses a subset of the OpenLabel JSON Schema

OpenLabel scenario tagging instance

```
{
    "openlabel": {
        "tags": { ... },
        "metadata": { ... },
        "ontologies": { ... },
    }
}
```

Scenario



OpenLabel scenario tagging ontology

```
@base <https://openlabel.asam.net/V1-0-0/ontologies#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

<Tag> a rdfs:Class ;
    rdfs:subClassOf rdfs:Class ;
    rdfs:label "Base Tag"@en ;
    rdfs:comment "The base tag"@en .

<Odd> a rdfs:Class ;
    rdfs:subClassOf <Tag> ;
    rdfs:label "ODD"@en ;
    rdfs:comment "Refer to BSI PAS-1883 Section 5"@en ;
    rdfs:seeAlso "https://www.bsigroup.com/en-GB/CAV/pas-1883" .
```

Scenario definition

```
<?xml version="1.0" encoding="utf-8"?>
<OpenSCENARIO>
  <FileHeader revMajor="1" revMinor="1" date="2021-07-09T10:00:00" description="ALKS Scenario
  <ParameterDeclarations>
    <!--The ParameterDeclarations section is needed for easy variation.-->
    <ParameterDeclaration name="Ego_InitSpeed_Ve0_kph" parameterType="double" value="60.0">
      <ConstraintGroup>
        <!--The scenarios are meant to be run with a positive ego speed up to 60 kph.-->
        <ValueConstraint rule="greaterThan" value="0.0" />
        <ValueConstraint rule="lessOrEqual" value="60.0" />
      </ConstraintGroup>
    </ParameterDeclaration>
  </ParameterDeclarations>
  <CatalogLocations>
    <VehicleCatalog>
      <Directory path="../Catalogs/Vehicles" />
    </VehicleCatalog>
```

Scenario Tagging Ontologies

The OpenLabel Scenario Tagging Ontology defines the tags and their relationships in a human and machine-readable Turtle (W3C Recommendation) file using RDF triples.

OpenLabel Ontology Turtle file

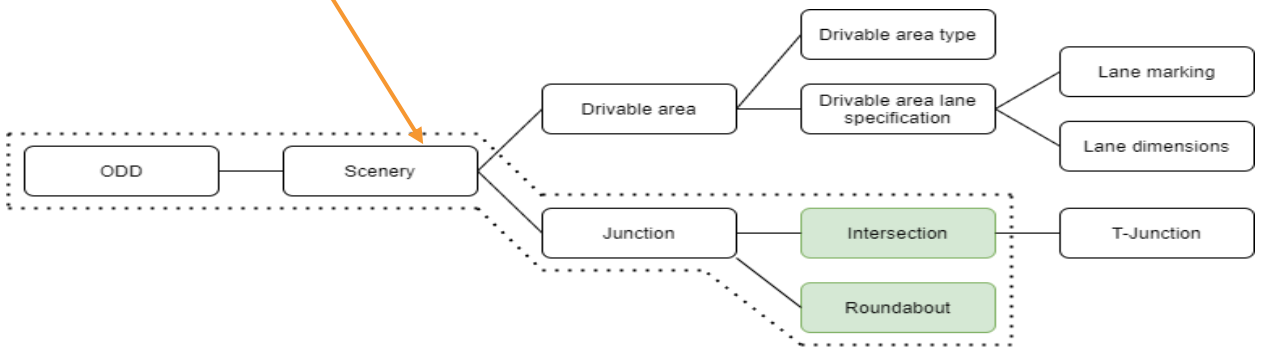
```
@base <https://openlabel.asam.net/V1-0-0/ontologies#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .

<Tag> a rdfs:Class ;
    rdfs:subClassOf rdfs:Class ;
    rdfs:label "Base Tag"@en ;
    rdfs:comment "The base tag"@en .

<Odd> a rdfs:Class ;
    rdfs:subClassOf <Tag> ;
    rdfs:label "ODD"@en ;
    rdfs:comment "Refer to BSI PAS-1883 Section 5"@en ;
    rdfs:seeAlso "https://www.bsigroup.com/en-GB/CAV/pas-1883" .

<OddScenery> a rdfs:Class ;
    rdfs:subClassOf <Odd> ;
    rdfs:label "Junction"@en ;
    rdfs:comment "Refer to BSI PAS-1883 Section 5.1.a"@en ;
    rdfs:seeAlso "https://www.bsigroup.com/en-GB/CAV/pas-1883" .

<SceneryJunction> a rdfs:Class ;
    rdfs:subClassOf <OddScenery> ;
    rdfs:label "Junction"@en ;
    rdfs:comment "Refer to BSI PAS-1883 Section 5.2.1.c"@en ;
    rdfs:seeAlso "https://www.bsigroup.com/en-GB/CAV/pas-1883" .

<JunctionIntersection> a rdfs:Class ;
    rdfs:subClassOf <SceneryJunction> ;
    rdfs:label "Intersection"@en ;
    rdfs:comment "Refer to BSI PAS-1883 Section 5.2.4"@en ;
    rdfs:seeAlso "https://www.bsigroup.com/en-GB/CAV/pas-1883" .
```

Ontology available from here:

https://openlabel.asam.net/V1-0-0/ontologies/openlabel_ontology_scenario_tags.ttl

OpenLabel ontologies element

```
"ontologies": {
    "0": {
        "uri": "https://openlabel.asam.net/V1-0-0/ontologies/openlabel_ontology_scenario_tags.ttl",
        "boundary_list": ["JunctionIntersection", "JunctionRoundabout"],
        "boundary_mode": "include"
    }
},
```



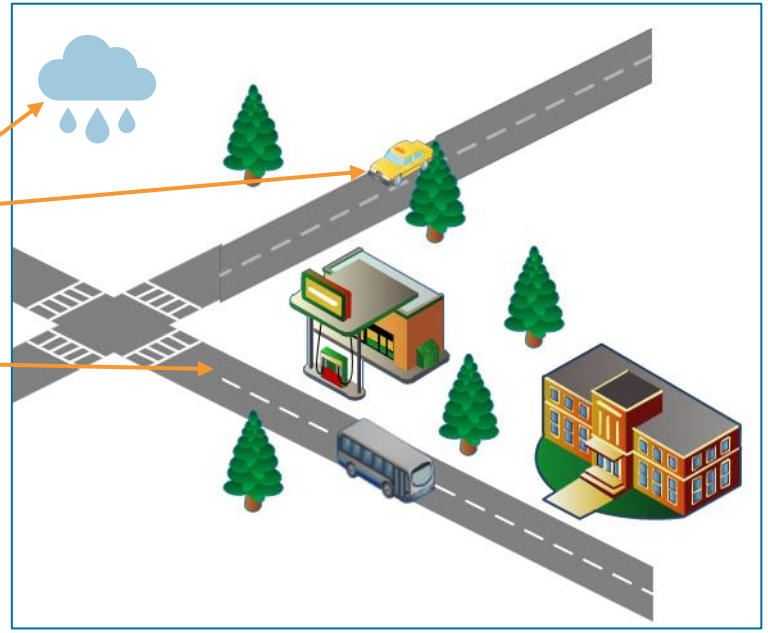
Scenario Tagging

OpenLabel scenario tagging is used to summarise scenario content

OpenLabel tagging instance (extract)

```
        "ontologies": {
            "0": {
                "uri": "https://openlabel.asam.net/V1-0-
0/ontologies/openlabel_ontology_scenario_tags.ttl"
            }
        },
        "tags": {
            "0": {
                "type": "VehicleCar",
                "ontology_uid": "0"
            },
            "1": {
                "type": "RoadTypeMinor",
                "ontology_uid": "0"
            },
            "2": {
                "type": "WeatherRain",
                "ontology_uid": "0",
                "tag_data": {
                    "vec": [{
                        "type": "range",
                        "val": [1.2, 3.1]
                        }
                    ]
                }
            },
            "15": {
                "type": "scenarioUniqueReference",
                "ontology_uid": "0",
                "tag_data": {
                    "text": [{
                        "type": "value",
                        "val": "c133241e-f325-11eb-a72f-e817714ba02d"
                    }]
                }
            },
```

Scenario



Types of Tag Data

- Number (num)
- Text (text)
- Vector (vec)

Multiple ranges

```
"tag_data": {
    "vec": [{
        "type": "range",
        "val": [3.4, 3.7]
        }, {
        "type": "range",
        "val": [3.9, 4.1]
    }]
}
```

Multiple values

```
"tag_data": {
    "vec": [{
        "type": "values",
        "val": [2, 3]
    }]
}
```

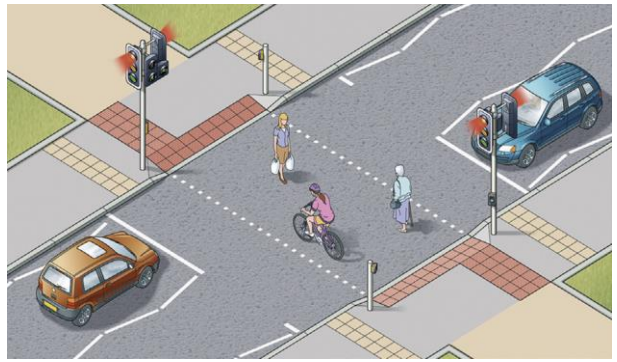
Range using Min/Max

```
"tag_data": {
    "num": [{
        "type": "min",
        "val": 1.2
    }]
}
```

ASAM

Scenario Tagging Ontology extension

Example of the OpenLabel Scenario Tagging ontology 'Pedestrian crossings' tag extended with a 'Toucan crossing' tag from a custom ontology.



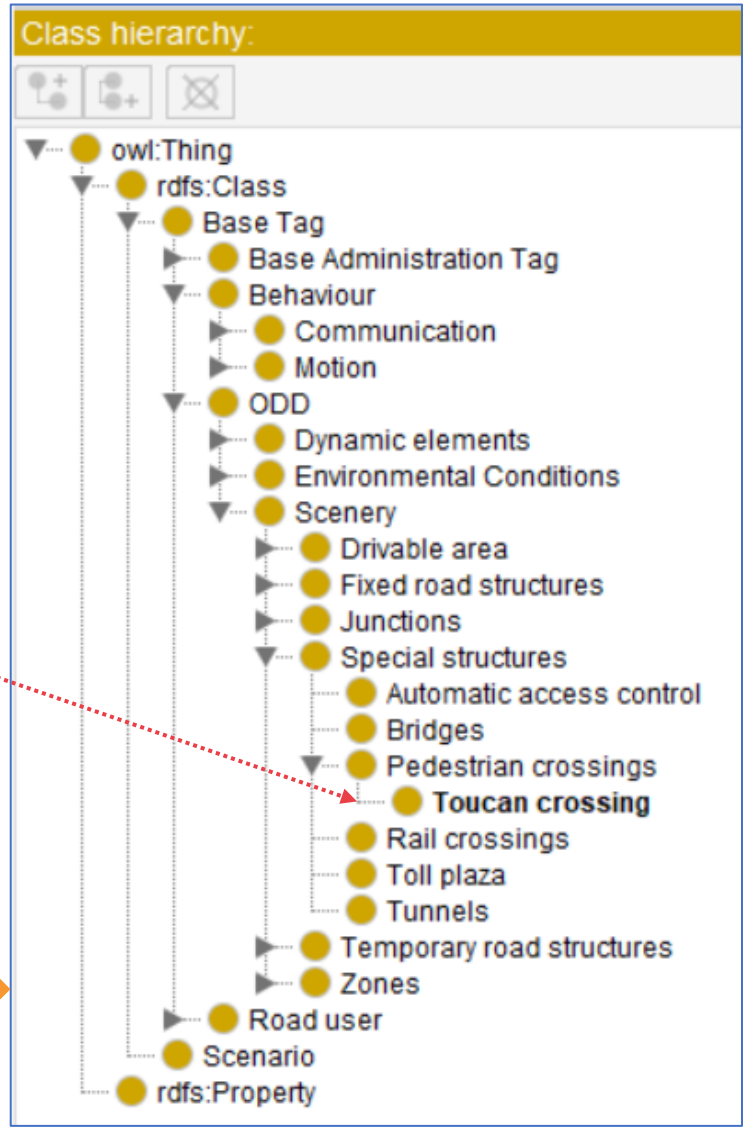
Ontology extension (Turtle)

```
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix xsd: <http://www.w3.org/2001/XMLSchema#> .
@prefix ol: <https://openlabel.asam.net/V1-0-0/ontologies#> .
@prefix ex: <https://example.org/ontologies/v1#> .

ex:ToucanCrossing a rdfs:Class ;
    rdfs:subClassOf ol:SpecialStructurePedestrianCrossing ;
    rdfs:label "Toucan Crossing" ;
    rdfs:comment "A type of crossing designed for both pedestrians and cyclists" ;
    rdfs:seeAlso "https://docs.example.org/ontologies/v1#ToucanCrossing" .
```

OpenLabel tagging instance

```
"ontologies": {
    "0": {
        "uri": "https://openlabel.asam.net/V1-0-0/ontologies/openlabel_ontology_scenario_tags.ttl"
    },
    "1": {
        "uri": "https://example.org/ontologies/v1"
    }
},
```

Extended OpenLabel ontology



Scenario Definition Linking and Embedding

An OpenLabel file may either be linked to an external scenario definition or a scenario definition can be embedded in the OpenLabel file.

OPTION A: OpenLabel instance linked to scenario file

```
{
    "openlabel": {
        "metadata": {
            "schema_version": "1.0.0",
            "tagged_file": "../resources/scenarios/scenario123.xosc"
        },
```

OpenScenario file 'scenario123.xosc'

```
<?xml version="1.0" encoding="utf-8"?>
<OpenSCENARIO>
  <FileHeader revMajor="1" revMinor="1" date="2021-07-09T10:00:00" description="ALKS Scenario
  <ParameterDeclarations>
    <!--The ParameterDeclarations section is needed for easy variation.-->
    <ParameterDeclaration name="Ego_InitSpeed_Ve0_kph" parameterType="double" value="60.0">
      <ConstraintGroup>
        <!--The scenarios are meant to be run with a positive ego speed up to 60 kph.-->
        <ValueConstraint rule="greaterThan" value="0.0" />
        <ValueConstraint rule="lessOrEqual" value="60.0" />
      </ConstraintGroup>
    </ParameterDeclaration>
  </ParameterDeclarations>
  <CatalogLocations>
    <VehicleCatalog>
      <Directory path="../Catalogs/Vehicles" />
    </VehicleCatalog>
```

OR

OPTION B: OpenLabel instance with embedded scenario

```
        "tags": {
            "0": {
                "type": "scenarioDefinitionLanguageURI",
                "ontology_uid": "0",
                "tag_data": {
                    "text": [{
                        "type": "value",
                        "val": "https://example.org/languages/SDL/1.0/"
                    }]
                }
            },
            "1": {
                "type": "scenarioDefinition",
                "ontology_uid": "0",
                "tag_data": {
                    "text": [{
                        "type": "value",
                        "val": "def ra1 as Roundabout; def r1, r2, r3 as Road.Minor;
ra1.Exits = [r1,r2,r3]; r1.Lanes = 2;"
                    }]
                }
            }
```

OpenLabel Admin tags are used to embed the scenario definition and to specify the scenario definition language used.

Tagged Scenario Implementation Example

OpenLabel scenario tags can be used for cataloguing scenarios in a database

Safety Pool™ Database

ADS Tech

- Home
- Scenarios
- Libraries
- Test Suites
- Testbeds
- Users
- Roles
- Settings
- Audit Log

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← Scenario

Download | Copy | Add to Test Suite

ALKS Cut-Out Multiple Blocking Targets

Tags | Definition | Files | Route Locations | Versions

Scenery

- Broken line
- Divided road
- Drive on right
- Lane dimensions [Width (m): 3.4 to 3.7]
- Level plane
- Motorway
- Number of lanes [Lanes: 3]
- Straights
- Traffic lane

Environmental Conditions

- Cloudiness [Cloud cover (okta): 0 to 1]
- Day
- Sun elevation [Angle (degree): 10 to 30]
- Sun in front
- Wind [Speed (m/s): 0 to 0.2]

Agents

- Cut-out
- Drive
- Lane change left
- Move away
- Stop
- Vehicle

General

URN

efd5ad1b-9de9-4b81-92e7-0c189657b6f7

Library

Automated Lane Keeping System (ALKS)

License

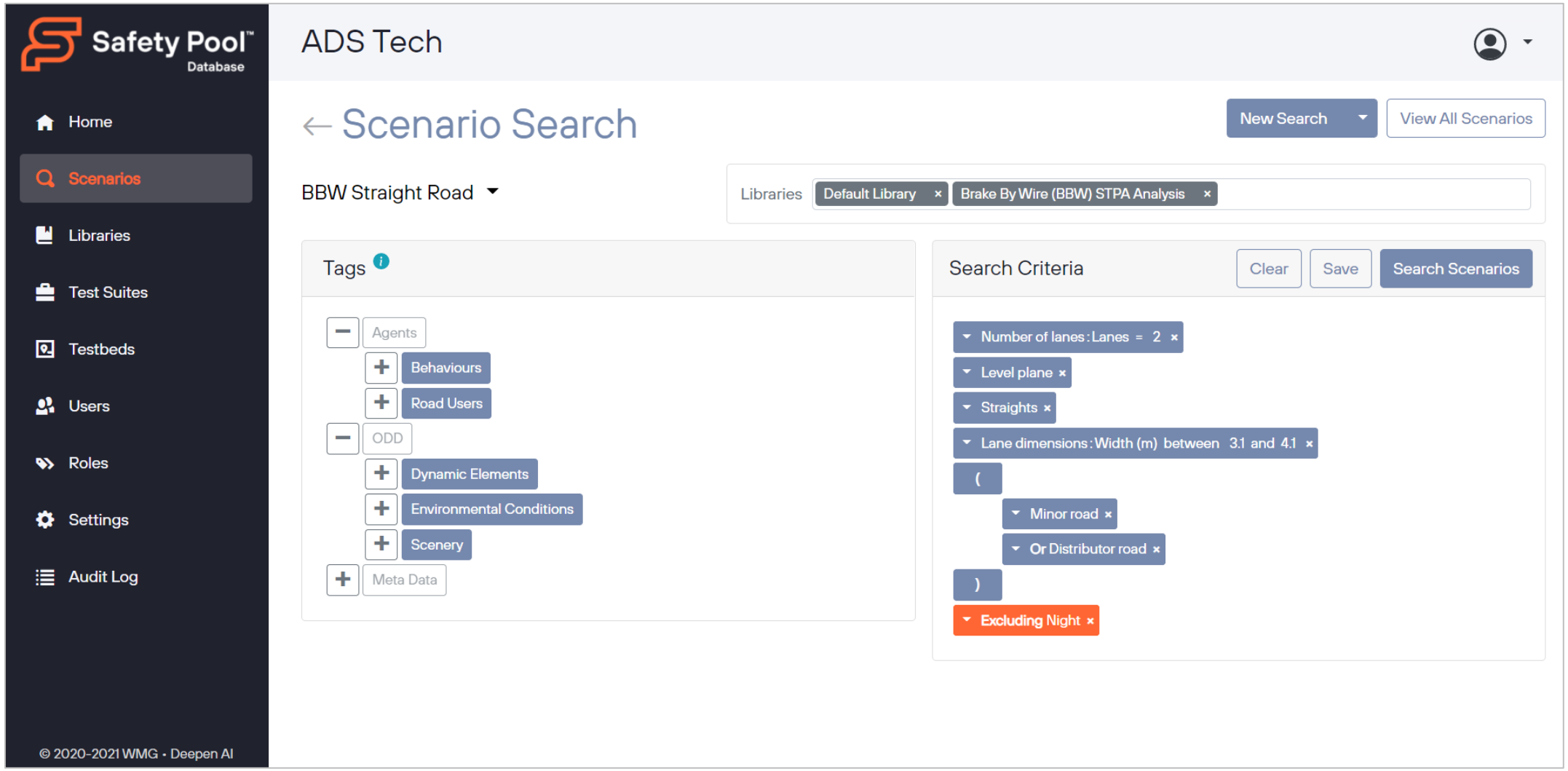
Safety Pool™ Test Script License

Version

1.0

Scenario Search Example

Cataloguing scenarios using OpenLabel tags enables scenarios to be matched to a standards based ODD



Thank you for your attention!

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