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OF TRENTO - Italy

Know
dive



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– KNOWDIVE GROUP –

Geospatial Knowledge Graph

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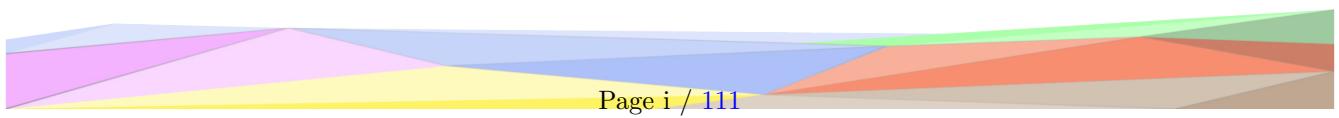


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| 1.9 | 16.12.2020 | All | Create and Add queries |



1 Knowledge Graph Codebook

The first of the two sections, in the current document, contains the codebook of the whole KG (Knowledge Graph), including the description of all the data and information that it contains.

1.1 Knowledge Graph general description

This sub section aims to give a general description of the KG, reporting:

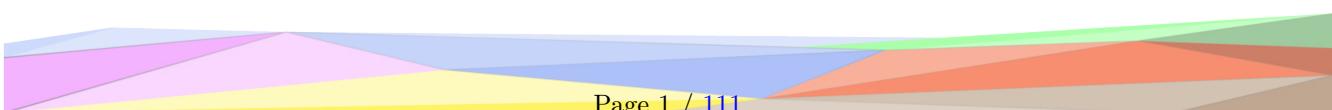
- the context/domain in which the KG lives and works;
- *The Problem* the KG aims to solve;
- How the KG can solve *The Problem*

The KG lives and works in the geospatial domain contest. As GeoSpatial data we intend all the data which are explicitly or implicitly connect to a location. And without thinking about it a lot of our everyday life is connected to some location information: for instance, if my wife has gone and we want to know something about her destination, or when we are deciding where to go out dinner and we want to try a new restaurant. The public administration is one of the entities which mostly uses geospatial data; a business estimate that 90% of the PA data are bounded with a location.

In particular, the problem that the KG aims to solve is very precise and focused in a specific contest of GeoSpatial Domain. In fact, as Geospatial field is very large, we decide to focus on the real estate, that is a very huge market. The real estate trading sector is valued 97.5 billions of euros per year. These numbers do not consider the rents market. In 2019 the new rent agreements reached the staggering amount of 1 million and 7 hundred units. In Italy, the biggest part of residential real estate units rented and traded are owned by physical persons. The Italian real estate market status is very different from other nations in Europe and this difference has caused the proliferation of the real estate agents in Italy and to resolve this problem various inter mediation portal was born.

Listings on this portals normally describe very well features of real estate unit, but they normally fail to describe the connected services. These include, for example, the internet connectivity available, the quality of schools in the nearby of the real estate unit or the presence of parking where people could leave their car. These data are sometimes sparse and difficult to retrieve, as a consequence the real estate agents sometimes do not know or have limited knowledge about these connected services. Our idea for the project is to build a knowledge graph which can help people looking for a real estate unit to buy or rent. In this way they could easily consult listing and quality of these connected services. Even if the knowledge graph can be useful in almost every location in the world (excluding Antarctica), we decide on a system which working the province of Trento (Italy), in the first phase, for the amounts of publicly available data sets.

In order to catch up the objective set, to cover all the facets of the problem we have initially created 4 different types of personas that could differentiate and lend the greater part of the customers of the market, from the part of the buyers, than we have described little ago. After having defined the various types of personas we have created a set of possible questions that the system must be asked to resolve that the various persons could make. So, the KG is design in order to solve this question and for this reason it can solve the problem.



1.2 Data level

1.2.1 Datasets general details

The first source of datasets considered, *OPENdata Trentino*¹, is a big web portal with a lot of different public data of the province of Trento. From there we took these datasets:

- 257 datasets (for 149 municipalities) of the **locations and points of interest**²: for every town in the province of Trento is provided a list in json of the relevant public locations like schools, parks, libraries, parking lots etc. with some additional information attached (name, coordinates, address, descriptions, photos, telephone number) and a GEO version (not present in all towns) with a lot more locations but with less information (only name, coordinates, address). Because of the high number of datasets to download, it has been written a script in python (`points_of_interests_download.py`³) to automate the operation, and manage the files. Those datasets during the Formal modeling phase are been used to extract the interested locations like: libraries⁴, bars, sport facilities, theaters, churches, ambulatories and eldery centers. They are been separated in single files.
- 7 datasets of **Bikesharing stations**⁵: the list in json of all the bikesharing stations in 7 towns of Trentino provided by the public transport service containing the name, position, address and the number of bike slots for every station.
The datasets are been filtered and merged in one single file `bikesharing_stations.json`⁶ in order to align it with the ontology.
- 3 datasets with **nursery**,⁷ **elementary**⁸ and **middle school**⁹ informations: the list of Trento's school with name, position, address, number of subscribers, number of staff for every school.
- `piste_cyclabili.csv` for the **bike trails**¹⁰ in Trento with the position, type, address and the length of the paths.
- `civici_web.json` for **civic numbers**¹¹ of buildings in the Municipality of Trento.

However the **high school** data is not present in the openData Tretino website, and to complete the missed data we did scraping in *comuniecittà.it*¹² containing less but still relevant informations (private or public school information, study paths) and saving the content in csv format. In order to align with the ontology: nursery, elementary, middle and high school datasets are been filtered and merged in a single file `schools.json`¹³

The second big source of datasets used to get a large amount of geo-spatial informations is *OpenStreetMap*¹⁴,

¹<https://dati.trentino.it>

²<https://dati.trentino.it/dataset?tags=luoghi+e+punti+di+interesse>

³https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/points_of_interests_download.py

⁴<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Formal%20Modeling/data/libraries.json>

⁵dati.trentino.it/dataset/stazioni-bike-sharing-emotion-trentino

⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Formal%20Modeling/data/bikesharing_stations.json

⁷dati.trentino.it/dataset/scuole-dinfanzia

⁸dati.trentino.it/dataset/scuole-elementari

⁹dati.trentino.it/dataset/scuole-media-inferiori

¹⁰dati.trentino.it/dataset/piste-cyclabili-open-data

¹¹dati.trentino.it/dataset/comune-di-trento-numeri-civici

¹²www.comuniecitta.it/scuole-secondarie-di-secondo-grado/comune-di-trento-22205

¹³<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/data/schools.json>

¹⁴www.openstreetmap.org

the biggest free license world map collaborative project. All the data were extracted using *Overpass Turbo*¹⁵: a tool to make query for specific data extraction from OpenStreetMap. The datasets extracted (all exported in geojson) then filtered and aligned during the phases:

- **bank.json:** all the banks located in Trentino.
- **buildings.json:** the buildings polygons divided in municipality
- **busstops.json:** all the bus stops with coordinates, the operator and (sometimes) the bus line.
- **cinema.json:** the list of the Trentino's cinema with coordinates and some relevant information where present (3D available, contact informations, number of rooms and other)
- **city_center.json:** provide informations about cities or villages boundary in Trentino and where each city centre is located.
- **climb.json:** the cliffs in Trentino where is possible to do climbing activities.
- **parking.json:** car parks with the capacity.
- **park.json:** all different types of public parks (also dog parks). The file has been divided in `park.json` and `playground.json` in order to align to the ontology.
- **pharmacy.json:** list pf pharmacies with position and (where present) the timetables.
- **post_office.json:** post offices with position and (where present) the timetables
- **railway.json:** train railways of Trentino.
- **railway_{stations}.json : trainstationsofTrentino.roads.json:alltheroadsofTrentino.**
- **areaski.jsoni:** all the areas where is possible to make ski activities in Trentino.
- **skislopes.json:** the ski slopes location in the Trentino. During the Formal phase, we assigned a ski area to every skislopes in order to cross information between them: the script `skislope_link.py`¹⁶ check if a ski area intersect a ski slope, if yes, the slope is assigned to the area.
- **supermarket.geojson:** supermarkets of Trentino.

In order to satisfy the request of a good internet connection of some personas, we took a dataset from *Infratel Italia s.p.a.*¹⁷ with all the information about the availability and the **quality of internet**¹⁸ per home in Trentino.

In order to collaborate with other groups, we looked for some dataset to integrate in our domain. We integrated the

¹⁵overpass-turbo.eu

¹⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/skislope_link.py

¹⁷www.infratelitalia.it

¹⁸www.infratelitalia.it/archivio-documenti/documenti/esiti-consultazione-2020-conclusa-una-prima-analisi-dei-dati-forniti-dagli-operatori

dataset: `outdooractive_trails.json`¹⁹, `stop.json`²⁰, `stop_times.json`²¹, `skiresort`²² (this then merged with `skiarea`) and then elaborated in order to allineate to our ontology.

1.2.2 Datasets metadata documentation

In this section are reported the metadata at dataset attribute level, through a description of each variable involved in the datasets collected, specifying the variable types, meanings, value-set (possible values), and every other meaningful variable information.

`areaski_METADATA.json`:

| Dataset Properties | Description | Type | Data Definition |
|-------------------------------|--|----------|-----------------|
| <code>type</code> | FeatureCollection | | |
| <code>generator</code> | overpass-ide | | |
| <code>copyright</code> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <code>timestamp</code> | 2020-10-19T19:05:03Z | | |
| <code>DatasetName</code> | KDI2020_21-Geospace-1.in ²³ | | |
| Attributes | | | |
| <code>name</code> | name of data | string | |
| <code>GeoShape</code> | object containing location information | GeoShape | Common |
| <code>totalLength</code> | total lenght of the ski slopes in the skairea | string | |
| <code>blackSlopeLength</code> | total lenght of black ski slopes in the skairea | string | |
| <code>redSlopeLength</code> | total lenght of red ski slopes in the skairea | string | |
| <code>blueSlopeLength</code> | total lenght of black blue slopes in the skairea | string | |
| <code>numberLifts</code> | number of lift in the skairea | int | |
| <code>adultPrice</code> | price for adult | string | |
| <code>youngPrice</code> | price for young | string | |
| <code>kidPrice</code> | price for kid | string | |
| <code>type</code> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <code>GeoCoordinates</code> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

`bank_METADATA.json`:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------------|------|-----------------|
| <code>type</code> | FeatureCollection | | |

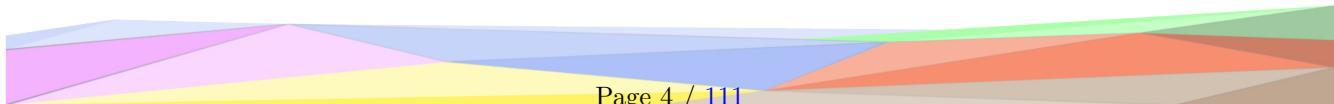
¹⁹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/data/outdooractive_trails.json

²⁰<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Formal%20Modeling/data/stops.json>

²¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Formal%20Modeling/data/stop_times.json

²²<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Formal%20Modeling/data/skiresort.json>

²³https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-1.in.json



| | | | |
|------------------------------|--|---------------|--------|
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:50:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-2.in ²⁴ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>hasAtm</i> | indicate the presence of an atm | boolean | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

cinema_METADATA.json:

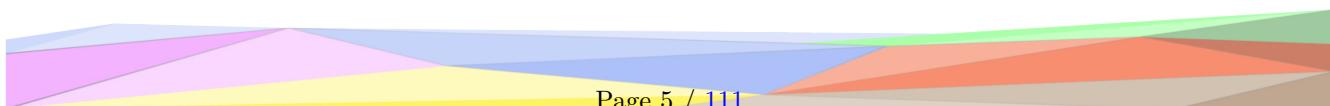
| Dataset Properties | Description | Type | Data Definition |
|----------------------|--|---------------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>copyright</i> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-6.in ²⁵ | | |
| <i>timestamp</i> | 2020-10-19T15:03:03Z | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

climb_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|-----------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:21:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |

²⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-2.in.json

²⁵https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-6.in.json



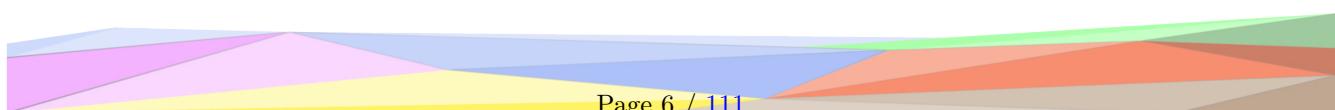
| | | | |
|----------------------|--|---------------|--------|
| <i>DatasetName</i> | KDI2020_21-Geospace-8.in ²⁶ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | Identifies the name of the climb | string | core |
| <i>height</i> | Indicates the height of the climbing | int | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

park_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--|---|---------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:30:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-14.in ²⁷ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>playground:basketswing</i> | describe if the facility have a basketswing | boolean | contextual |
| <i>playground:chain_ladder</i> | describe if the facility have a chain ladder | boolean | contextual |
| <i>playground:slide</i> | describe if the facility have a slide | boolean | contextual |
| <i>playground:swing</i> | describe if the facility have a swing | boolean | contextual |
| <i>playground:aerialrotator</i> | describe if the facility have an aerialrotator | boolean | contextual |
| <i>playground:basketball_backboard</i> | describe if a zone where play basketball is available | boolean | contextual |
| <i>playground:exercise</i> | describe if an equipment are for the exercise is present | boolean | contextual |
| <i>playground:horizontal_bar</i> | describe if an horizontal bar is present | boolean | contextual |
| <i>playground:seesaw</i> | describe if an seesaw is present | boolean | contextual |
| <i>playground:tunnel_tube</i> | describe if an tunnel tube is present | boolean | contextual |
| <i>playground:climbingframe</i> | describe if a climbing frame is present | boolean | contextual |
| <i>playground:multi_play</i> | describe if a multiple usage surface is available | boolean | contextual |
| <i>playground:sandpit</i> | describe if a sandpit is present | boolean | contextual |
| <i>playground:skate_equipment</i> | describe if the park is equipment to play with the skateboard | boolean | contextual |

²⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-8.in.json

²⁷https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-14.in.json



| | | | |
|-------------------------------|---|---------------|------------|
| <i>playground:teenshelter</i> | describe if a teen shelter is available | boolean | contextual |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

parking_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|---------------|------------------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T09:57:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-15.in ²⁸ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>fee</i> | The fee tag is for specifying whether a fee is usually charged for a service, or for access. | boolean | core |
| <i>capacity</i> | max capacity of the parking lot | int | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

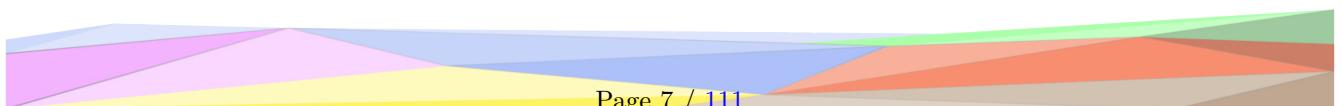
sport_facilities_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|--|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-17.in ²⁹ | | |
| <i>description</i> | dataset merged from 'luoghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

post_office_METADATA.json:

²⁸https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-15.in.json

²⁹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-17.in.json



| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|---------------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:26:03Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-19.in ³⁰ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>opening-hours</i> | the opening hours of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

railway_METADATA.json:

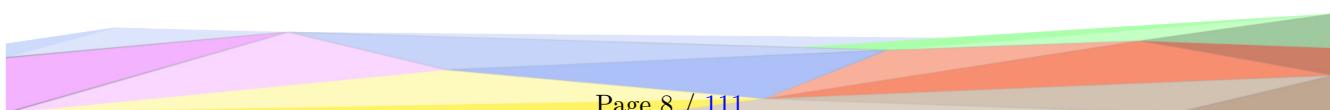
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T18:07:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-20.in ³¹ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of te location | string | core |
| <i>id</i> | unique identifier of the railway | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

roads_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------|------|-----------------|
|--------------------|-------------|------|-----------------|

³⁰https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-19.in.json

³¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-20.in.json



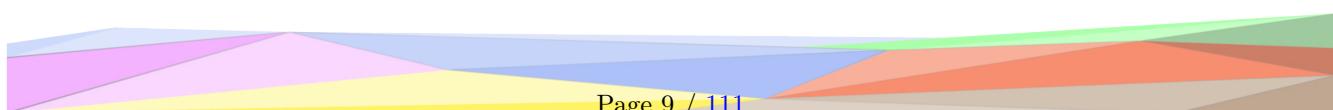
| | | | |
|------------------------------|--|----------|------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-20T07:44:03Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-21.in ³² | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>roadType</i> | type of road (trunk,primary, secondary, tertiary) | string | contextual |
| <i>name</i> | name of the road | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

skislopes_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:07:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-23.in ³³ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the ski slopes | string | core |
| <i>SlopeType</i> | type of the skiing available (nordic, downhill) | string | core |
| <i>SlopeDifficulty</i> | difficulty level of the skislope (easy, intermediate, advanced) | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>skiarea</i> | name of the ski resort where the ski slope is | string | contextual |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |

³²https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-21.in.json

³³https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-23.in.json



| | | | |
|-----------------------|--|--------|--------|
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |
|-----------------------|--|--------|--------|

supermarket_METADATA.json:

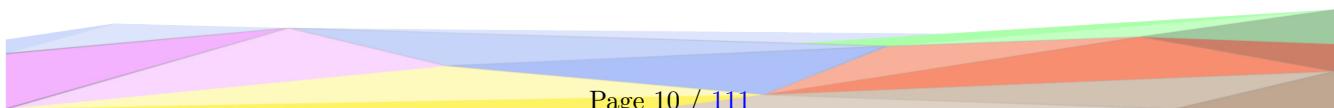
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|---------------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:28:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-26.in ³⁴ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the supermarket | string | core |
| <i>area</i> | area of the supermarket (m ²) | double | contextual |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

civici_web_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>Dataset ID</i> | 4f474fc8-181d-4b15-9ee4-60b3f54f4068 | | |
| <i>Source</i> | https://dati.trentino.it/dataset/comune-di-trento-numeri-civici | | |
| <i>Release date</i> | 22-02-2013 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | comune di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-7.in ³⁵ | | |
| <i>Temporal extension</i> | 'From': '22-02-2013' | | |
| <i>Holder</i> | 'Name': 'Comune di Trento', 'Code IPA/IVA': 'c_1378' | | |
| <i>Update frequency</i> | daily | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>city</i> | the city component of the address | string | common |
| <i>HouseNumber</i> | the house number component of the address | string | common |
| <i>postal_code</i> | the postcode component of the address | string | common |

³⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-26.in.json

³⁵https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-7.in.json



| | | | |
|----------------------|--|---------------|--------|
| <i>StreetName</i> | the street component of the address | string | common |
| <i>StreetType</i> | type of street (street, place, etc) | string | common |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

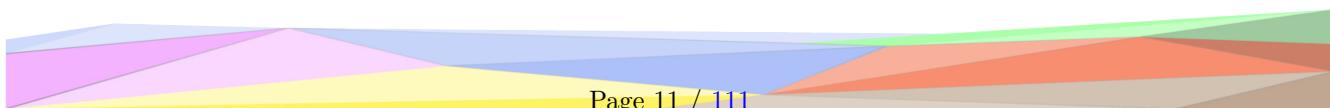
piste_ciclabili_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|-------------|------------------------|
| <i>Dataset ID</i> | c.l378-1129110 | | |
| <i>Holder</i> | 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c.l378' | | |
| <i>Release date</i> | 09-11-2017 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | Comune di Trento | | |
| <i>Source</i> | https://dati.trentino.it/dataset/piste-ciclabili-open-data | | |
| <i>GeoNames URI</i> | http://www.geonames.org/6541469 | | |
| <i>Dataset language</i> | italiano | | |
| <i>Update frequency</i> | continuous updating | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-18.in ³⁶ | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of cycle path | string | |
| <i>reservedForBike</i> | path dedicated only to cycle (1) or also pedestrian (0) | boolean | contextual |
| <i>totalLength</i> | total length of the path (km) | double | contextual |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

schools_METADATA.json:

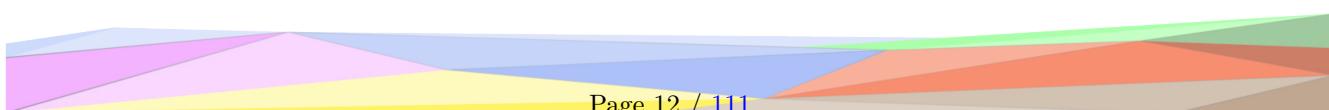
| Dataset Properties | Description | Type | Data Definition |
|---------------------------|--|-------------|------------------------|
| <i>high_school</i> | 'Release date': '19-09-2020', 'source': ' https://www.comuniecitta.it/scuole-secondarie-di-secondo-grado/comune-di-trento-22205 ', 'Geographical Coverage': 'Provincia di Trento', 'Update frequency': 'unknown', 'Format': 'json' | | |

³⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-18.in.json



| | | | |
|--------------------------|---|---------------|--------|
| <i>middle_school</i> | 'Dataset ID': 'c_l378-1129125', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'URI di GeoNames': 'http://www.geonames.org/6541469', 'source': 'https://dati.trentino.it/dataset/localizzazione-delle-scuole-medie-open-data', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c_l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |
| <i>nursery_school</i> | 'Dataset ID': 'c_l378-1129127', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'source': 'https://dati.trentino.it/dataset/localizzazione-scuole-dell-infanzia-open-data', 'GeoNames URI': 'http://www.geonames.org/6541469', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c_l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |
| <i>elementary_school</i> | 'Dataset ID': 'c_l378-1129126', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'Source': 'https://dati.trentino.it/dataset/localizzazione-delle-scuole-elementari-open-data', 'GeoNames URI': 'http://www.geonames.org/6541469', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c_l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-22.in ³⁷ | | |
| Attributes | | | |
| <i>SchoolType</i> | type of school (nursery, elementary, middle, high) | string | Core |
| <i>courseOfStudy</i> | the study paths offerted from the school (comma separated) | string | Core |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

³⁷https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-22.in.json



bikesharing_METADATA.json:

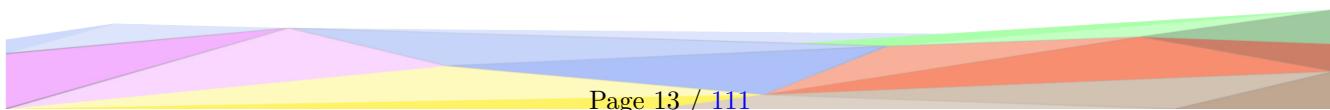
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|---------------|-----------------|
| <i>source</i> | https://dati.trentino.it/dataset/stazioni-bike-sharing-emotion-trentino | | |
| <i>format</i> | json | | |
| <i>timestamp</i> | 2020-10-18 | | |
| <i>Dataset ID</i> | p_TN:9b9c14d6-ee20-4802-a274-4c17ac96cdd5 | | |
| <i>Temi del dataset</i> | 'Trasporti': ['4816 trasporti terrestri', '4806 politica dei trasporti'], 'Energia': ['6626 energia dolce', '6606 politica energetica'] | | |
| <i>Dataset publisher</i> | 'Nome': 'Servizio Trasporti pubblici', 'Codice IPA/IVA': '0OK0PZ' | | |
| <i>Release date</i> | 18-11-2014 | | |
| <i>Modification date</i> | 03-07-2017 | | |
| <i>Geographical Coverage</i> | Comune di Trento | | |
| <i>GeoNames URI</i> | http://www.geonames.org/3165241 | | |
| <i>Dataset language</i> | italiano | | |
| <i>Holder</i> | 'Nome': 'Provincia Autonoma di Trento', 'Codice IPA/IVA': 'p_TN' | | |
| <i>Upload frequency</i> | continuous | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-4.in ³⁸ | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>rackSlot</i> | total number of slot bikes | int | Core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

hospital_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-11-15T17:12:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-10.in ³⁹ | | |
| <i>format</i> | json | | |

³⁸https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-4.in.json

³⁹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-10.in.json



| Attributes | | | |
|----------------------|--|---------------|--------|
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

bars_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-3.in ⁴⁰ | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

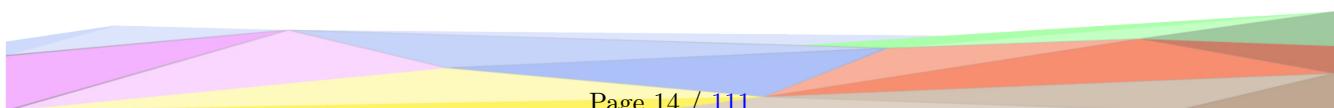
churches_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-5.in ⁴¹ | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

eldery_centers_METADATA.json:

⁴⁰https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-3.in.json

⁴¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-5.in.json



| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-9.in ⁴² | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

libraries_METADATA.json:

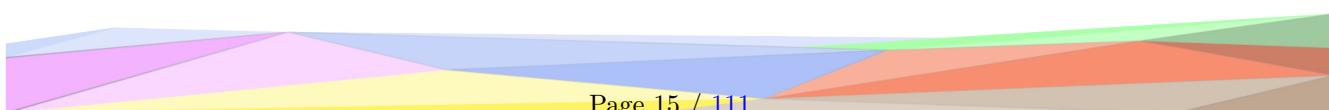
| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-12.in ⁴³ | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

theaters_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---------------------------|-------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |

⁴²https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-9.in.json

⁴³https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-12.in.json



| | | | |
|----------------------|---|---------------|--------|
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-27.in ⁴⁴ | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

ambulatories_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------------------|---|---------------|------------------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-28.in ⁴⁵ | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>city</i> | the city component of the address | string | common |
| <i>housenumber</i> | the house number component of the address | string | common |
| <i>PostalCode</i> | the postcode component of the address | string | common |
| <i>StreetName</i> | the street component of the address | string | common |
| <i>StreetType</i> | type of street (street, place, etc) | string | common |
| <i>address_additional_information</i> | additional address information | string | common |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

stop_times_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-----------------------------|---|-------------|------------------------|
| <i>Dataset Identifier</i> | p_TN: d3c9f167-3271-4a43-b5c1-e0879aa5ad3f | | |
| <i>Dataset Publisher</i> | 'Name': 'Public Transport Service', 'IPA/-VAT Code': '0OK0PZ' | | |
| <i>Date of modification</i> | 2017-10-24 | | |
| <i>Geographic coverage</i> | Trento | | |

⁴⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-27.in.json

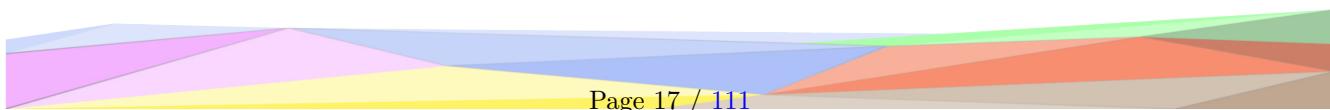
⁴⁵https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-28.in.json

| | | | |
|---------------------------------|---|--------|------------|
| <i>URI of GeoNames</i> | https://www.geonames.org/3165241 | | |
| <i>Languages of the dataset</i> | Italian | | |
| <i>Holder</i> | Autonomous Province of Trento | | |
| <i>Refresh Rate</i> | Half yearly | | |
| <i>Author</i> | 'Name': 'Public Transport Service', 'IPA/-VAT': '0OK0PZ' | | |
| <i>Url</i> | https://www.trentinotrasporti.it/opendata/google_transit_urbano_tte.zip | | |
| <i>License</i> | Creative Commons Attribution 4.0 International (CC BY 4.0) | | |
| <i>License_Type</i> | https://w3id.org/italia/controlled-vocabulary/licences/A21_CCBY40 | | |
| <i>DatasetName</i> | KDI2020.21-Geospace-24.in ⁴⁶ | | |
| <i>Format</i> | txt | | |
| Attributes | | | |
| <i>trip_id</i> | identification code of the trip line | int | Contextual |
| <i>arrival_time</i> | arrival time of the bus in that stop | string | Contextual |
| <i>departure_time</i> | departure time of the bus in that stop | string | Contextual |
| <i>stop_id</i> | identification code of the bus stop | int | Core |
| <i>stop_sequence</i> | | int | Core |

stops_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------------|---|-------------|------------------------|
| <i>Dataset Identifier</i> | p-TN: d3c9f167-3271-4a43-b5c1-e0879aa5ad3f | | |
| <i>Dataset Publisher</i> | 'Name': 'Public Transport Service', 'IPA/-VAT Code': '0OK0PZ' | | |
| <i>Date of modification</i> | 2017-10-24 | | |
| <i>Geographic coverage</i> | Trento | | |
| <i>URI of GeoNames</i> | https://www.geonames.org/3165241 | | |
| <i>Languages of the dataset</i> | Italian | | |
| <i>Holder</i> | Autonomous Province of Trento | | |
| <i>Refresh Rate</i> | Half yearly | | |
| <i>Author</i> | 'Name': 'Public Transport Service', 'IPA/-VAT': '0OK0PZ' | | |
| <i>Url</i> | https://www.trentinotrasporti.it/opendata/google_transit_urbano_tte.zip | | |
| <i>License</i> | Creative Commons Attribution 4.0 International (CC BY 4.0) | | |
| <i>License_Type</i> | https://w3id.org/italia/controlled-vocabulary/licences/A21_CCBY40 | | |
| <i>Format</i> | txt | | |

⁴⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-24.in.json



| | | | |
|----------------------------|---|--------|------------|
| <i>DatasetName</i> | KDI2020_21-Geospace-25.in ⁴⁷ | | |
| Attributes | | | |
| <i>stop_id</i> | identification code of the bus stop | int | Core |
| <i>stop_code</i> | | string | Core |
| <i>stop_name</i> | name of the bus stop | string | Core |
| <i>stop_desc</i> | | string | Contextual |
| <i>stop_lat</i> | latitude coordinate of the stop | double | Common |
| <i>stop_lon</i> | longitude coordinate of the stop | double | Common |
| <i>zone_id</i> | identification code of the zone | int | Contextual |
| <i>wheelchair_boarding</i> | number of wheelchair boarding | int | Core |

city_center_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|---------------|------------------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T10:54:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-29.in ⁴⁸ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | the name of the village/city | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

outdooractive_trails_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|-------------|------------------------|
| <i>lastModifiedAt</i> | 2020-07-02T08:14:00.000Z | | |
| <i>source</i> | www.outdooractive.com | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>sat_Id</i> | trail id in the SAT registry | String | |
| <i>trainType</i> | specifies whether the trail is a hiking, biking or snowshoe trail | String | |

⁴⁷https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-25.in.json

⁴⁸https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-29.in.json

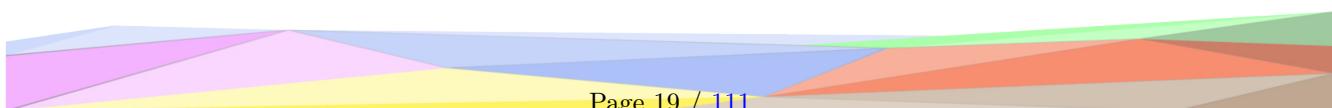
| | | | |
|-----------------------|--|------------------|--------|
| <i>name</i> | name of the trail | String | |
| <i>distance</i> | length of the trail | Double | |
| <i>open</i> | whether the trail is currently open | Boolean | |
| <i>monthTips</i> | optional monthly variance details | array | |
| <i>elevation</i> | elevation details | ElevationProfile | |
| <i>estimatedTime</i> | detail on the estimated time required | Duration | |
| <i>startRoute</i> | starting point for the trail | LocationPoint | |
| <i>endRoute</i> | ending point of the trail | LocationPoint | |
| <i>route</i> | collection of points marking the trail path | Route | |
| <i>difficulty</i> | description of the trail difficulty | String | |
| <i>tags</i> | array of tags | array | |
| <i>equipment</i> | equipments needed for the trail | String | |
| <i>stats</i> | scores for the trail | TrailStats | |
| <i>grounds</i> | array of types of grounds in the trail | array | |
| <i>metadata</i> | metadata | MetaData | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

pharmacy_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|---------------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:28:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-16.in ⁴⁹ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the facility | string | core |
| <i>opening-hours</i> | day and hours of opening | string | common |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

railwayStation_METADATA.json:

⁴⁹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-16.in.json



| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|---------------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T18:07:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-30.in ⁵⁰ | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>id</i> | unique identifier of the railway station | string | core |
| <i>name</i> | name of the railway station | string | core |
| <i>GeoCoordinate</i> | object containing location information | GeoCoordinate | Common |

internet_quality_trento_METADATA.json:

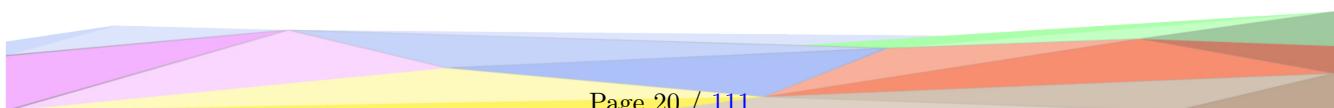
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>source</i> | www.infratelitalia.it | | |
| <i>timestamp</i> | 2020-09-09 | | |
| <i>update-frequency</i> | no update | | |
| <i>DatasetName</i> | KDI2020_21-Geospace-11.in ⁵¹ | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>current</i> | 2019 internet coverage | string | Core |
| <i>prediction2022</i> | 2022 internet coverage estimation | string | Core |
| <i>city</i> | the city component of the address | string | common |
| <i>HouseNumber</i> | civic code | int | Common |
| <i>StreetName</i> | the street component of the address | string | common |
| <i>StreetType</i> | type of street (street, place, etc) | string | common |
| <i>BarNumber</i> | sub-civic code | char | Common |

1.3 Ontology level

The ontology level section aims to describe the underlying KG ontology, through the description of its elements at each level, reporting so the language, conceptual and schema resources used within it.

⁵⁰https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-30.in.json

⁵¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Data%20Integration/metadata/KDI2020_21-Geospace-11.in.json



1.3.1 Ontology general details

This first sub section of the ontology level description, report the general details such as authors, sources and the description of external ontology eventually adopted to generate the final one.

This first sub section of the ontology level description reports the general details such as authors, sources and the description of external ontology eventually adopted to generate the final one.

The generation of the final ontology followed several key revisions and steps throughout the duration of the project. This section summarizes the key steps that are explained and commented on in much more detail in the project report.

Initially, the construction of the ontology started from scratch. In fact, we went to define the purpose of our project and after creating the competency queries, we defined which were the appropriate eTypes to have to answer those queries. This first process took place in close collaboration between knowledge engineers and data scientist to have in every moment of the project the certainty that the datasets would be able to support the ontology that we were building.

After this first phase of creation from scratch of the ontology based on our scope definition, we made the first and real first step of the ontology development process which consists in searching for other reference ontologies to allow us to align. We found two valid ontologies the schema.org ones ⁵² and the ones develop for the city of Florence by the DISIT group of the University of Florence, km4city ⁵³. While km4city is complete and already formalized a large number of the class we use it also use some things very specific to the city of Florence. For this reason, we decide to inspire our work to the schema.org ontology, that instead is more general and try to take in consideration more general needs. In this phase, in addition to aligning ourselves to a reference ontology, we began a process of sharing and aligning with two other groups (Tourist Facilities and Transportation Domain) that shared with us some important eTypes to satisfy our competency questions.

After this process our intention was to create L1 & L2 annotations starting from the concepts present in KOS. For this reason, in this formalization phase the ontology underwent some semantic linguistic modifications making it complete from an L1 L2 annotation point of view. From this phase, we derive our first finished product, an .owl file, created with Protege. This version, found on GitHub and explained in detail in the "Formal Modeling" chapter of the project report, is the most detailed and complete version in terms of object and data properties. In this process of linking eTypes and concepts present in the KOS we had to go in and add several new concepts do not present in the system. At this link you can find our complete ontology ⁵⁴

The last modification of the ontology happened at the moment of loading ontology in the KOS system. In fact, in this phase, as described in a special section of the report, the ontology had to receive many changes mainly due to two points. The first point is related to the fact that the KOS concepts do not define only in a semantic way the eTypes but it is a real upper ontology, while, the second is related to the fact that the KOS system was not able to manage particularly detailed and complex constructions. For this reason, the ontology has undergone a process of slight modification regarding the structure, due to the first point, while, it has received an important cleaning

⁵²<https://schema.org/>

⁵³<http://wlode.disit.org/WLODE/extract?url=http://www.disit.org/km4city/schema>

⁵⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/ontology_geospatial_complete.owl

regarding carnality and properties of object and data properties as they are not supported by the platform. Also, this last version of the ontology is present in GitHub and the changes with the more detailed and complete version are reported in the special section "Importing into the KOS system: changes and adaptations " of the project report. This ontology, modified for KOS system, can be find at this link ⁵⁵.

1.3.2 Ontology metadata documentation

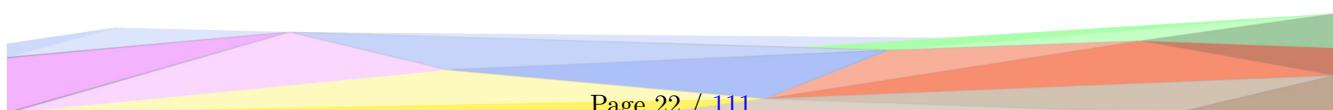
We can summarised the work made in the ontology with the following statistics:

| Metrics | | | |
|--|--------|--------------|-----------------------------|
| Description | Total: | Added by us: | Already present in KOS .owl |
| Class count | 82 | 54 | 28 |
| Object property count | 136 | 40 | 96 |
| Data property count | 162 | 108 | 54 |
| Individul count | 8 | 0 | 8 |
| Class axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| SubClass axioms count | 79 | 58 | 21 |
| Object property axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Sub object property axioms count | 132 | 104 | 28 |
| Inverse object properties axioms count | 11 | 11 | 0 |
| Object property domain axioms count | 133 | 104 | 29 |
| Object property range axioms count | 133 | 104 | 29 |
| Data property axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Sub data property axioms count | 156 | 133 | 23 |
| Data property domain axioms count | 159 | 133 | 26 |
| Data property range axioms count | 160 | 133 | 27 |
| Annotation axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Entity annotation axioms count | 565 | 478 | 87 |

During the development process a total of 52 ETy whole types was created. Of the related **53** concepts, **26** was created from zero. The list of the defined ETy whole types with the grouped definition is the following:

| KOS Concept: | KOS Concept GID: | Comment in ENG language: |
|--------------|------------------|--------------------------|
| | | |

⁵⁵https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/ontology_geospatial_for_kos.xml



| | | |
|-----------------------------------|--------|---|
| Address | 45803 | The place where a person or organization can be found or communicated with |
| Bank | 14896 | A building in which the business of banking transacted |
| Bicycle Path | 120049 | Concept indicating the cycle/bike paths |
| Bike Sharing Rack | 120042 | The racks of a bike sharing service |
| Building | 15668 | A structure that has a roof and walls and stands more or less permanently in one place |
| Bus Stop | 45937 | A place on a bus route where buses stop to discharge and take on passengers |
| Cafe | 15804 | A small restaurant where drinks and snacks are sold |
| Church | 16356 | A place for public (especially Christian) worship |
| Cinema | 16382 | A theater where films are shown |
| City Center | 45965 | The central part of a city |
| Doctor's Office | 120047 | Doctor's office or ambulatory |
| Drug Store | 17637 | A retail shop where medicine and other articles are sold |
| Eldery Center | 120043 | Elderly centers or a healthcare residence for elderly |
| Elevation Profile | 120059 | Describe the elevation profile of a path |
| GeoCoordinate | 120051 | Describe a single point in the earth |
| GeoShape | 120050 | Describe a shape in the world |
| Hospital | 19345 | A health facility where patients receive treatment |
| Internet Availability | 120052 | Describe the internet availability in a defined place |
| Library | 20052 | A depository built to contain books and other materials for reading and study |
| Line | 120060 | A long, narrow mark or band |
| Line Transport Calendar | 120055 | Describe when a line transport execute the stop |
| Line Transport Calendar Exception | 120056 | Describe an exception to the transportation line calendar |
| Location | 132 | Entities that have a somewhat fixed, physical extension. |
| Natural Climbing Wall | 120045 | A climbing wall of natural origin |
| Park | 46374 | A piece of open land for recreational use in an urban area |
| Parking | 73254 | Space in which vehicles can be parked |
| Path | 50035 | A line or route along which something travels or moves |
| Playground | 21826 | Yard consisting of an outdoor area for children's play |
| Polygon | 73713 | A closed plane figure bounded by straight sides |
| Post Office | 117866 | A public building in which mail is received, sorted and distributed |
| Line (railway) | 20111 | The road consisting of railroad track and roadbed |
| Railway Station | 22321 | Terminal where trains load or unload passengers or goods |
| Road | 22592 | An open way (generally public) for travel or transportation |
| School | 22899 | A building where young people receive education |
| Ski Area | 118065 | A developed recreational facility, usually on a mountain or large hill, containing ski trails and vital supporting services |

| | | |
|----------------------------|--------|---|
| Ski Slope | 50279 | A snow-covered slope for skiing |
| Slope Statistics | 120053 | Describe the statistics of a particular type of slopes |
| Sport Facility | 120048 | Sports location, such as playing fields. |
| Stop Time | 120054 | Describe the stop time of a bus in a bus stop |
| Supermarket | 24168 | A large self-service grocery store selling groceries and dairy products and household goods |
| Theater | 24522 | A building where theatrical performances or motion-picture shows can be presented |
| Trail | 24805 | A path or track roughly blazed through wild or hilly country |
| Trail Ground | 120057 | Describe the type of ground of a trail |
| Trail Statistics | 120058 | Describe the statistics of a trail |
| Street | 120106 | a public road in a city, town, or village, typically with houses and buildings on one or both sides |
| Statistic | 32674 | a datum that can be represented numerically |
| Enumerated type | 120127 | in CS enumerated type is a data type consisting of a set of named values |
| Internet Availability type | 120078 | The type of internet availability |
| Playground facility type | 120079 | The types of playground facility |
| Road type | 120080 | The road types |
| School type | 120081 | The types of school |
| Slope Difficulty Type | 120083 | The types of slope difficulty |
| Slope Type | 120082 | The types of slope |
| Trail path difficulty type | 120084 | The types of trail difficulty |
| Trail statistics level | 120085 | The types of trail statistics level |

During the development, we added 40 relations between the objects. This relations are listed on the table below. Considering we reuse for a larger part the concepts already used inside the ETypes, we think is a waste of space rewrite them below, so we add a small table before that describe only the new concept we introduced.

| Concept: | GID: | Concept description: |
|----------------|-------|---|
| hline Foreseen | 86907 | known beforehand |
| Actual | 81755 | presently existing in fact and not merely potential or possible |
| Area | 45835 | a particular geographical region of indefinite boundary (usually serving some special purpose or distinguished by its people or culture or geography) |
| Point | 31970 | a geometric element that has position but no extension |
| Experience | 31439 | the accumulation of knowledge or skill that results from direct participation in events or activities |
| Landscape | 46519 | an expanse of scenery that can be seen in a single view |
| Stamina | 27776 | enduring strength and energy |
| Technique | 30971 | a practical method or art applied to some particular task |

| Concept name: | Concept GID: | Domain: | Domain GID: | Range: | Range GID: |
|--------------------------------|--------------|-----------------------|-------------|----------------------------|------------|
| has_trail_path_difficulty_type | 120084 | Trail | 24805 | Trail Path Difficulty Type | 120084 |
| has_slope_type | 120082 | Ski Slope | 50279 | Slope Type | 120082 |
| has_slope_difficulty_type | 120083 | Ski Slope | 50279 | Slope Difficulty Type | 120083 |
| has_school_type | 120081 | School | 22899 | School Type | 120081 |
| has_road_type | 120080 | Street | 120106 | Road Type | 120080 |
| has_foreseen | 86907 | Internet Availability | 120052 | Internet Availability Type | 120078 |
| has_playground_facility_type | 120079 | Playground | 21826 | Playground Facility Type | 120079 |
| has_trail | 24805 | Trail Statistics | 120058 | Trail | 24805 |
| has_trail_statistics | 120058 | Trail | 24805 | Trail Statistics | 120058 |
| has_trail | 24805 | Trail Ground | 120057 | Trail | 24805 |
| has_trail_ground | 120057 | Trail | 24805 | Trail Ground | 120057 |
| has_ski_area | 118065 | Slope Statistics | 120053 | Ski Area | 118065 |
| has_slopes_statistics | 120053 | Ski Area | 118065 | Slope Statistics | 120053 |
| has_ski_area | 118065 | Ski Slope | 50279 | Ski Area | 118065 |
| has_trail | 24805 | Elevation Profile | 120059 | Trail | 24805 |
| has_elevation_profile | 120059 | Trail | 24805 | Elevation Profile | 120059 |
| has_ski_slope | 50279 | Ski Area | 118065 | Ski Slope | 50279 |
| has_location | 132 | GeoCoordinate | 120051 | Location | 132 |
| has_actual | 81755 | Internet Availability | 120052 | Internet Availability Type | 120078 |
| has_area | 45835 | Ski Area | 118065 | Polygon | 73713 |
| has_line_transport_calendar | 120055 | Stop Time | 120054 | Line Transport Calendar | 120055 |

| | | | | | |
|---------------------------------------|--------|-----------------------------------|--------|-----------------------------------|--------|
| has_line_transport_calendar_exception | 120056 | Line Transport Calendar | 120055 | Line Transport Calendar Exception | 120056 |
| has_elevation_profile | 120059 | Trail | 24805 | Elevation Profile | 120059 |
| has_geocoordinate | 120051 | Location | 132 | GeoCoordinate | 120051 |
| has_internet_availability | 120052 | Address | 45803 | Internet Availability | 120052 |
| has_line | 120060 | Path | 50035 | Line | 120060 |
| has_point | 31970 | GeoShape | 120050 | GeoCoordinate | 120051 |
| has_line | 20111 | Railway Station | 22321 | Line (Railway) | 20111 |
| has_busStop | 45937 | Stop Time | 120054 | Bus Stop | 45937 |
| has_stop_time | 120054 | Bus Stop | 45937 | Stop Time | 120054 |
| has_railway_station | 22321 | Line | 20111 | Railway Station | 22321 |
| has_address | 45803 | Internet Availability | 120052 | Address | 45803 |
| has_line_transport_calendar | 120055 | Line Transport Calendar Exception | 120056 | Line Transport Calendar | 120055 |
| has_stop_time | 120054 | Line Transport Calendar | 120055 | Stop Time | 120054 |
| has_geoshape | 120050 | GeoCoordinate | 120051 | Path | 50035 |
| has_experience | 31439 | Trail Statistics | 120058 | Trail Statistics Level | 120085 |
| has_landscape | 46519 | Trail Statistics | 120058 | Trail Statistics Level | 120085 |
| has_stamina | 27776 | Trail Statistics | 120058 | Trail Statistics Level | 120085 |
| has_technique | 30971 | Trail Statistics | 120058 | Trail Statistics Level | 120085 |

1.4 Knowledge Graph Evaluation

Final metrics have been computed in order to compare between the other phases:

Evaluation Metrics:

| Metric | Value |
|--------|-------|
|--------|-------|

| | |
|----------------------|-------|
| <i>Coverage</i> | 10.6% |
| <i>Flexibility</i> | 23.4% |
| <i>Extensiveness</i> | 17.4% |
| <i>Sparsity</i> | 84.1% |

Set parameters:

| Set | Cardinality |
|--------------------------------------|-------------|
| α (<i>schema reference</i>) | 235 |
| β (knowledge graph) | 80 |
| $\alpha \cap \beta$ | 25 |

In addition, in order to evaluate the correctness of SKG and DKG we performed some quires (related to the competency question designed in the Inception phase) using the GraphDB and SPARQL language and, moreover, we created some graphs of some subsets of data-sets. All information and links related to these tests can be found in the last section of the project report. [2.5.3.](#)

2 Knowledge Graph Development Process

The aim of this part of the document is describing the development process of the knowledge graph. We decided to use iTelos methodology for developing the knowledge graph because it will guide us step by step during the development process. At the beginning of the document we describe the contest, the problem we need to solve and the personas who can take benefit from our knowledge graph. In the inception phase we describe the Competence Query and an initial list and description of the datasets we used.

2.1 Scope Definition

In this section we describe the contest of the knowledge graph and some stereotypes of person that represent some potential user of our knowledge graph.

2.1.1 Problem contest definition

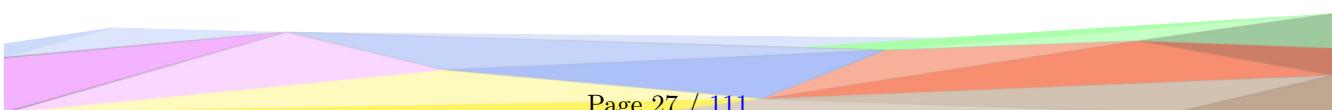
As GeoSpatial data we intend all the data which are explicitly or implicitly connect to a location. And without thinking about it a lot of our everyday life is connected to some location information: for instance, if my wife has gone and we want to know something about her destination, or when we are deciding where to go out dinner and we want to try a new restaurant. The public administration is one of the entities which mostly uses geospatial data; a business estimate that 90% of the PA data are bounded with a location. [56](#)

As Geospatial field is very large, we decide to focus on the real estate market. In year 2019 in Italy , according to the report from the Italian Tax Bureau, 603'541 residential real estate units were sold and bought [57](#) [58](#). These

⁵⁶<https://philly.curbed.com/2017/11/7/16617296/philly-philadelphia-properties-land-vacant-lot-atlas-map-tool>

⁵⁷<https://www.agenziaentratae.gov.it/portale/documents/20143/262485/StatisticheOMIRES1202020200605.pdf/3af07746-906c-45af-5853-da521605de03>

⁵⁸The given data do not include the Italian territories which use the Grundbuch (at the moment they are the provinces of Trento and Bolzano)



units are equal to the surface of the city of Bolzano. The real estate trading sector is valued 97.5 billions of euros per year. These numbers do not consider the rents market. In 2019 the new rent agreements reached the staggering amount of 1 million and 7 hundred units. In 2019 the 10% of residential rental units in Italy was rented; this flop generates a market of around 10 billion per year.⁵⁹

In Italy, the biggest part of residential real estate units rented and traded are owned by physical persons. The Italian real estate market status is very different from other nations in Europe, where rented and traded residential buildings are mostly owned by enterprises. In particular, these include banks or investment funds, which are usually protected by shields of ad-hoc front company. This difference has caused the proliferation of the real estate agents in Italy: in Italy there are 43'698 real estate agents for 59 million people, whereas in Germany, where most of the building is rented or bought by businesses, agents are 23'780 for 80 million people⁶⁰. Searching between a large number of real estate operators can represent a considerable expenditure of energy for who wants to rent or buy a unit. To resolve this problem various intermediation portal was born. In these portals, real estate agents (or also the owner directly) list the house. These portals are mainly owned by national companies, instead of being owned by foreign companies (usually this happen in other sectors, such us search engines).

Listings on this portals normally describe very well features of real estate unit, but they normally fail to describe the connected services. These include, for example, the internet connectivity available, the quality of schools in the nearby of the real estate unit or the presence of parking where people could leave their car. These data are sometimes sparse and difficult to retrieve, as a consequence the real estate agents sometimes do not know or have limited knowledge about these connected services. Sometimes agents know information but avoid to give them to the customer because it could lower property value. These considerations can sometimes be crucial since if the client know them it could choose a unit over instead of another.

Our idea for the project is to build a knowledge graph which can help people looking for a real estate unit to buy or rent. In this way they could easily consult listing and quality of these connected services. Even if the knowledge graph can be useful in almost every location in the world (excluding Antarctica), we decide on a system which work in the province of Trento (Italy), in the first phase, for the amounts of publicly available datasets. For some type of data we decide to focus only on the city of Trento, because they are not available at province level (e.g. civic numbers). The hypothetical user of our project is someone who want to rent or buy a real estate unit. Collecting money from multiple clients can be difficult, therefore also intermediation portals are a potential customer for our knowledge base. The intermediation portals can use our knowledge base to help customers compare the various listings available on the portal. This could potentially be provided through AI-based tools, which suggest the best unit for the customer needs.

As a future development, the knowledge base can be extended to be used by other figures in the buy/rent of a real estate unit market.

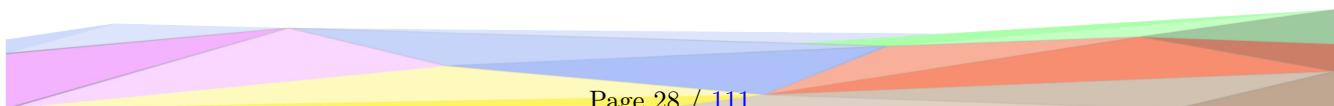
2.1.2 Personas

In this subsection is presented the scenario of competence of the project and in particular the different types of Personas that could be the actors of this scenario. All the 4 different types of user presented are characterized by the need for looking for an apartment or house to buy or rent in the geographical area of competence of the project, These people, however, have different attitudes and consequently different needs.

Giuseppe is 24 years old, he is a student of industrial engineering at the University of Trento in Povo. Despite

⁵⁹<https://www.idealista.it/news/immobiliare/residenziale/2020/05/07/140165-affitti-italia-focus-su-trend-del-mercato-proprietari-e-riduzione-del-canone-di>

⁶⁰<https://www.libropensieroimmobiliare.com/evoluzione-di-un-agente-immobiliare-italiano-dati-e-considerazioni/>



attending university in Povo, it would be very important for Giuseppe to find accommodation in the city in order to be close to essential services and university social life, without neglecting the need to move with public transport every day to reach the university outside the city. Giuseppe is not able to have a constant source of income and his accommodation expenses are paid entirely by his family, for this reason he is looking for a very economical situation. As well as most of his fellow students he is easily satisfied with a place in a room shared by other students. Since he does not have a private transport, he is not looking for an apartment with a private or public parking nearby. His university life and his hobbies take priority choosing the apartment. He would prefer to find accommodation in a home away from elementary schools and kindergartens and possibly away from the railway to have a quiet place to study. To be effective in the studio Giuseppe would need a house which is equipped with a broadband internet connection allowing him to increase his productivity, as well as having a quick access to many online multimedia content he watches in his spare time. Giuseppe also has a passion for fitness and is used to train 3 times a week. For this reason he would like to live near a gym.

Paola and Mario, 43 and 45 years old, respectively, are the parents of Luigi and Angela, twins of 8 years old. They need to find a new housing near the city to get closer to their workplace. Paola is lawyer in a firm based in the city center and prefers to move with her private vehicle because she has a covered parking near her work. His spouse Mario, a computer consultant, is used to go to work by car; however during summer he is inclined to use bike-sharing services offered in the city due to its strong sporting nature. For this reason the couple is looking for accommodation with a large garage but at the same time not too far from the bike-sharing services possibly. The couple's children are lively twins and for this reason Paola would like to find a house with a private garden and possibly in a quiet and safe area near the essential services for children (playground, elementary and middle school). Economically, the family is wealthy and prefers to spend an important amount of money for their new home as long as it meets with their needs about safety, size and proximity of services for children. Mario would also like the house to be located in a geographically interesting location for evening excursions, in fact he is a fan of running and trekking and after work would have the pleasure of leaving home a couple of hours to keep trained and run in a natural and unpolluted environment.

Giovanna is 35 years old and works remotely for a large software house in Milan. Giovanna, having the possibility to stay at home and work, is used to change house periodically and would like to find an apartment in the surroundings of Trento, which is a very dear place for her family origins. The accommodation she is looking for is an apartment to rent where she can work remotely and invite many guests. Giovanna loves to meet people and have many social interactions, because she thinks that social exchange enrich her. For these reasons Giovanna is looking for an apartment in an area full of people and with many possibilities to create communities and social exchanges of the city. She has no needs for private or public parking as she is a lover of a green lifestyle and would prefer to reach essential services by walking or cycling. For this reason she is looking for a home which is near to essential services such as supermarkets and pharmacies, but would also like to easily reach places of culture such as libraries, cinemas and theaters, because of her innate passion for art and culture. Given her working position, it is essential for Giovanna that her home be equipped with good network coverage and Internet connection. Last but not least, Giovanna loves outdoor sports and in particular she has been practicing climbing for a few years. For this reason, an useful information would be an overview of the rock cliffs in Trentino Alto Adige and their distances from the house.

Luciana and Corrado are a loving elderly couple, she is 73 years old and he is 75 years old, retired. The couple is looking for a setting for their winter and not searching for a classic vacation home; rather, a place where they can feel at home even when they go on vacation, as they plan to spend almost a third of the year in this residence. The couple, being very well off, is looking for a spacious and comfortable house in a quiet neighborhood and as

panoramic as possible. Although they have their own means of transport in Trentino, they want to relax and enjoy the peace of a small town. In the search for a house some features are very important for them. The house should be in a quiet area and with a private or public parking nearby and well equipped with essential services and with some ad hoc services to make them feel at home. In fact, Luciana and Corrado, because of their strong faith, think the house should be close to a church, in order to participate in Christian community life. In addition, they would like to have a few old people's homes nearby to spend a few days in company and participate in the activities organized by these centers. Luciana and Corrado have been passionate about winter sports since their youth and this was one of the reasons why they want to look for a house in Trentino-Alto Adige. In particular, in order to choose a house, they are interested in knowing where they are and what ski facilities are available within a few dozen kilometers from their future vacation home.

In the following a table that summarizes the personas is presented.

| Persona | Description | Usage |
|------------------------|---|--|
| <i>Giuseppe</i> | 24 y.o. engineering student who loves university social life and going to the gym but he has not a private car. | Giuseppe is looking for a student room in a quiet environment in the city (away from the railway and main roads) where he can study, equipped with fast internet connection and with the following facilities nearby: essential services (supermarket, bank, pharmacy), the bus stop 5/, a gym, library and nightclubs |
| <i>Paola and Mario</i> | Paola and Mario, 43 and 45 years old, respectively, are the parents of Luigi and Angela (twins of 8 years old). | Paola and Mario are, together with their children, looking for a house in the city in an uncrowded place. When choosing a house, the couple carefully assesses whether the services nearby meet their needs as parents and their hobbies. In particular, they would like to have them nearby: playground, elementary and middle schools, public parking and bike-sharing service to facilitate their mobility, routes and excursions to do after work |
| <i>Giovanna</i> | Giovanna is 35 years old and works remotely for a large software house in Milan. She loves culture. | Giovanna works at home, that's why she doesn't need a car and prefers to reach interesting places on foot or by bicycle. Besides having a good Internet connection, she wants to be located in an area of the city where there is a chance to meet many people. She loves social and cultural exchanges. She would like to look for a house close to essential services (supermarkets, drugs, banks) and close to the places she prefers to attend in her free time: cinemas and theaters. To keep fit Giovanna practises climbing and therefore it would be very useful for her to know which cliffs are available in Trentino in order to plan her weekend adventures. |

| | | |
|----------------------------|--|---|
| <i>Luciana and Corrado</i> | Luciana and Corrado are a loving elderly couple, she is 73 years old and he is 75 years old, retired. They search for a vacation home. | Luciana and Corrado are looking for a vacation home which should be in an uncrowded place. They are looking for a house which should be close to a parking lot, churches and old people's centers. In addition, the couple has a passion for skiing and would like to know which skiing areas are near their home. In addition, because of their age, the couple would like to live in a well-served area of emergency health services. |
|----------------------------|--|---|

2.2 Inception

This section first describe the Competency Queries in a informal format, then the datasets collected and the relative metadata will be described.

2.2.1 CQs definition

In this section we try to think what our example users can ask to the knowledge graph. Based on the datasets selected, we formalized a complete list of competency queries. This queries describe the need of the people as write in the storytelling.

| Person | Number | Question | Action |
|-----------------|--------|--|--|
| Giuseppe | 1.1 | Where is the closest library ? | The system given the unit position, returns the position of the nearest library |
| Giuseppe | 1.2 | How many library are there within a 5km radius ? | The system given the unit position, returns the number of library within the 5 km |
| Giuseppe | 1.3 | What are the nearest supermarket in the area ? What size is it ? | The system given the unit position, returns the distance of the nearest supermarket and it's size |
| Giuseppe | 1.4 | What kind of internet connection is available in the apartment? | The system given the unit position, returns the level of available internet connection |
| Giuseppe | 1.5 | Is there a pharmacy within a radius of 1Km? | The system given the unit position, returns the presence or absence of a pharmacy within a radius of 1Km |
| Giuseppe | 1.6 | Is the house in a quiet enough place ? | The system given the unit position, returns the major roads and railways closest to the house indicating the distance from the house. |
| Giuseppe | 1.7 | How far is it to the nearest bus stop where bus number 5 runs? | The system, given the location of the unit, returns the distance to the nearest bus stop where bus number 5 goes by. For this bus stop and line the system returns also the timetable. |
| Giuseppe | 1.8 | Where is the closest gym? | The system given the unit position, returns the position of the nearest gym |
| Giuseppe | 1.9 | What bank branches with an ATM are available in the nearby? | The system given the unit position, returns the distance of the nearest branch for each bank |
| Giuseppe | 1.10 | Where is the nearest bar ? | The system given the unit position, returns the position of the nearest bar |
| Giuseppe | 1.11 | How far is the train station ? | The system given the unit position, returns the distance of the train station |
| Giuseppe | 1.12 | Is there a bus station nearby where in the morning the line 5 passes ? | The system given the unit position, returns the position of the nearest bus stop where in the morning the line 5 passes and for this bus stop and line returns also the timetable |
| Paola and Mario | 2.1 | Is the apartment in a quiet place? | The system given the unit position, returns the major roads and railways closest to the house indicating the distance from the house. |

| | | | |
|-----------------|------|--|---|
| Paola and Mario | 2.2 | Where is the closest elementary school to the house? | The system given the unit position, returns the position of the nearest elementary school |
| Paola and Mario | 2.3 | How far is the nearest middle school? | The system given the unit position, returns the distance of the nearest middle school |
| Paola and Mario | 2.4 | How many playgrounds are there within 2 km from the house? | The system, given the location of the unit, returns the number of playing fields within 2 km and for each playground it lists the present games |
| Paola and Mario | 2.5 | Is the house in a crowded area? | The system given the unit position, counts the number of house in 3 km |
| Paola and Mario | 2.6 | Is there a bike-sharing service nearby? | The system given the unit position, returns the presence or absence of a bike-sharing service within a radius of 1Km and returns also the number of available bike in those racks |
| Paola and Mario | 2.7 | What are the bike paths within 1 km? | The system given the unit position, returns the bike paths within 1km |
| Paola and Mario | 2.8 | How many excursion or bike paths are there in the vicinity of the house (maximum 3 km)? | The system given the unit position, returns the number of different excursion and bike paths within 3 km. |
| Paola and Mario | 2.9 | What are the excursion paths within a radius of 3 km with a estimated duration of less that two hours? | The system given the unit position, select all the paths with a estimated duration of less that 2 hours and returns from this list the ones within 3km |
| Paola and Mario | 2.10 | Where is the closest parking lot to the house with a hourly fee of less than a 1.00 €? | The system given the unit position, check for all the parking with a fee less than 1.00 €, then return the nearest parking lot. |
| Paola and Mario | 2.11 | How far is the center of the city? | The system given the unit position, returns the distance of the city center. |
| Paola and Mario | 2.12 | Where is the closest middle school to the house? | The system given the unit position, returns the position of the nearest middle school |
| Paola and Mario | 2.13 | Which high schools are within a radius of 2 km ? | The system given the unit position, returns the the name of the high schools within a radius of two kilometers |
| Paola and Mario | 2.9 | What are the excursion paths in a radius of 3 km from the unit with a positive height difference of less than 200m ? | The system given the unit position, select all the paths with a height difference of less that 200m and returns from this list the ones within 3km |
| Giovanna | 3.1 | Know what type of Internet is available in the apartment | The system given the unit address, return the level of available internet connection |
| Giovanna | 3.2 | I want to live in place full of people to develop social exchanges. How many people live near the house ? | The system given the unit position, returns the number of people within 1 km. |
| Giovanna | 3.3 | What banks have a branch in the neighbourhood? | The system given the unit position and address, search the nearest bank branches, maximum one for each bank |
| Giovanna | 3.4 | What are the post offices and their timetables within a radius of 3 km ? | The system given the unit position, search for all the post offices within 3 km and their opening hours |
| Giovanna | 3.5 | Where is the nearest ambulatory? | The system given the unit position and address, returns the position of the nearest ambulatory |
| Giovanna | 3.6 | Which are the supermarkets within a radius of 2 km ? How big they are? | The system given the unit position, search the supermarkets within the 2km and returns a list of supermarket and for each one the area and the name |
| Giovanna | 3.7 | How far is the nearest pharmacy? | The system given the unit position, returns the distance of the nearest pharmacies |
| Giovanna | 3.8 | Which libraries are the closest? | The system given the unit position, returns the library within 1 km |
| Giovanna | 3.9 | Where is the nearest cinema? | The system given the unit position, search for the nearest cinemas |
| Giovanna | 3.10 | Where is the nearest theaters? | The system given the unit position, search for the nearest theaters |

| | | | |
|---------------------|------|--|---|
| Giovanna | 3.11 | What are the cliffs within a radius of 20 km ? | The system given the unit position, search for the nearest cliffs and return the position of the cliffs within of 20 km |
| Luciana and Corrado | 4.1 | I want to live in a quiet place. Where is the nearest railway line ? | The system given the unit position, search for the nearest piece of rail and return the distance between the unit and it |
| Luciana and Corrado | 4.2 | I want to live in a quiet place. Where are the nearest main roads ? | The system given the unit position, search for the nearest pieces of major road and return the distance between the unit and it |
| Luciana and Corrado | 4.3 | i want live in a small neighborhood | The system given the unit position, count the number of house in 5 km |
| Luciana and Corrado | 4.4 | How far is the nearest public parkings? | The system given the unit position, search for the nearest parkings with no fee or fee equal to zero and return the distance between the unit and the parking. It also return the capacity of the parking. |
| Luciana and Corrado | 4.5 | Where is the closest church? | The system given the unit position, search for the nearest church and return the position of the church |
| Luciana and Corrado | 4.6 | Ho far is the nearest center for elderly? | The system given the unit position, search for the center for elderly and return the distance between the unit and the center for elderly |
| Luciana and Corrado | 4.7 | Which ski areas are available within a radius of 35 km ? | The system given the unit position, search for ski area within 35 km and return the position and the distance between the unit and the ski area. For each ski area in order to provide more information the system returns also the website of the ski area. Moreover the system returns also the price of a daily ticket |
| Luciana and Corrado | 4.8 | Which are the hospitals in Trentino ? | The system returns all the hospitals in Trentino and for each of them return the name, the position and the distance to the unit position. |
| Luciana and Corrado | 4.9 | Are there ambulatory clinics within 3km from the house ? | The system given the unit position, check if there are some ambulatory clinics within 3km. If there are any ambulatory clinics return the name and position for each of them. |
| Luciana and Corrado | 4.10 | How far is the nearest hospital ? | The system given the unit position, search for the nearest hospital and return the distance between the hospital and the unit position. |
| Luciana and Corrado | 4.11 | Which are the 3 ski areas with the greatest number of kilometers of red slopes ? For each of these ski areas I would need to know the location, the website to know more about the location and the distance from the house. | The system given the unit position, search for the 3 ski areas with the highest number of black ski slopes and return a list with the name of the area, the location, the website and the distance from the location. |
| Luciana and Corrado | 4.12 | What kind of slopes are there in the ski area closest to the house ? | The system given the unit position, search for the nearest skairea and return the and for that returns the various types of difficulty of slopes present and their respective kilometers. |
| Luciana and Corrado | 4.13 | What are the nordic skiing trails within 35 km ? | The system given the unit position, returns a list with all the nordic skiing trails within 35 km. For each of them returns also the difficulty. |

Each query consult one or more type of data. The types of data needed to resolve the query and the connection between each type and the query that use it are given in the following table:

| Types: | Properties: | Notes: | CQ using the type: |
|------------------------|--|--------|--------------------|
| <i>Library</i> | Position [coordinate], Name [string] | | 1:1,2 3:9 |
| <i>Pharmacy</i> | Position [coordinate], Name [string], Opening hours [string] | | 1:5 3:8 |
| <i>School</i> | Position [coordinate], Name [string], Type [enum] | | 2:2,12,13 |
| <i>Sports Facility</i> | Position [coordinate],Name [string] | | 1:8 |

| | | | |
|--------------------------|---|--|------------------------|
| <i>Bar</i> | Position [coordinate], Name [string] | | 1:10 |
| <i>Building</i> | Position [coordinate] | | 2:5 4:3 |
| <i>Park</i> | Position [coordinate], types of games [list of string] | | 2:4 |
| <i>Bike path</i> | Initial Point [coordinate], End point [coordinate] | It combine dataset of province of Trento with that of the city of Trento | 2:7,8 |
| <i>Excursion path</i> | Initial Point [coordinate], End Point [coordinate], Height difference in m [int], Estimated duration [duration], Length in m [int] | | 2:8,9 |
| <i>City Center</i> | Position [coordinate], name [string] | | 2:11 |
| <i>Major Road</i> | Name [string], Initial Point [coordinate], End Point [coordinate], Type [enum] | | 1:6 2:3 3:3 4:2 |
| <i>Post Office</i> | Position [coordinate], Opening hours [string] | | 3:5 |
| <i>Ambulatory</i> | Position [coordinate] | | 3:6 |
| <i>Theater</i> | Position [coordinate], Name [string] | | 3:11 |
| <i>Church</i> | Position [coordinate] | | 4:5 |
| <i>Elderly center</i> | Position [coordinate], Name [string] | | 4:6 |
| <i>Ski area</i> | Position [coordinate], Name [string], Total lenght [float], Km Blue slopes [float], Km Red slopes [float], Km Black slopes [float], Price [decimal] | | 4:7,11,12 |
| <i>Cinema</i> | Position [coordinate], Name [string] | | 3:10 |
| <i>Bank Branch</i> | Position [coordinate], Name of the bank [string], ATM [bool] | | 1:9 3:4 |
| <i>Internet</i> | Address [composed field], Level_at_2019 [enum] | | 1:4 3:1 |
| <i>Supermarket</i> | Position [coordinate], Name[string], Area [double] | | 1:3 3:7 |
| <i>Train line</i> | Initial Point [coordinate], End Point [coordinate] | | 1:6 2:1 3:2 4:1 |
| <i>Train Station</i> | Position [coordinate], Name[string], Tratta [Train line] | | 1:11 |
| <i>Bus Stop</i> | Position [coordinate], Name[string], Lines [list of string] | Lines are the bus lines that go through this stop | 1:7,12 |
| <i>Bike-sharing</i> | Position [coordinate], rack slots [int] | | 2:6 |
| <i>Cliff</i> | Position [coordinate] | | 3:12 |
| <i>Car parking</i> | Position [coordinate], capacity [int], fee [decimal] | | 2:10 4:4 |
| <i>Ski slopes</i> | Pointchains [coordinate], name [string], type [string], difficulty [string] | | 4:13 |
| <i>Stop Times (GTFS)</i> | arrivalTime [timestamp], departureTime [timestamp], stopSequence [int], calendar [Calendar GTFS] | | 2:7,12 |

2.2.2 Initial Datasets description

The first source of datasets considered, *OPENdata Trentino*⁶¹, is a big web portal with a lot of different public data of the province of Trento. From there we took these datasets:

- 257 datasets (for 149 municipalities) of the **locations and points of interest**⁶²: for every town in the province of Trento is provided a list in json of the relevant public locations like schools, parks, libraries, parking lots etc. with some additional information attached (name, coordinates, address, descriptions, photos, telephone number) and a GEO version (not present in all towns) with a lot more locations but with less information (only name, coordinates, address). Because of the high number of datasets to download, it has been written a script in python to automate the operation, and another to manage the files.
- 7 datasets of **Bikesharing stations**⁶³: the list in json of all the bikesharing stations in 7 towns of Trentino provided by the public transport service containing the name, position, address and the number of bike slots for every station.
- 3 datasets with **nursery**,⁶⁴ **elementary**,⁶⁵ and **middle school**,⁶⁶ information: the list of Trento's school with name, position, address, number of subscribers, number of staff for every school.
- piste_ciclabili.csv for the **bike trails**⁶⁷ in Trento with the position, type, address and the length of the paths.

⁶¹dati.trentino.it

⁶²dati.trentino.it/dataset?tags=luoghi+e+punti+di+interesse

⁶³dati.trentino.it/dataset/stazioni-bike-sharing-emotion-trentino

⁶⁴dati.trentino.it/dataset/scuole-dinfanzia

⁶⁵dati.trentino.it/dataset/scuole-elementari

⁶⁶dati.trentino.it/dataset/scuole-media-inferiori

⁶⁷dati.trentino.it/dataset/piste-ciclabili-open-data

- `civici_web.json` for **civic numbers**⁶⁸ of buildings in the Municipality of Trento.

However the **high school** data is not present in the openData Tretino website, and to complete the missed data we did scraping in *comuniecittà.it*⁶⁹ containing less but still relevant informations (private or public school information, study paths) and saving the content in csv format.

The second big source of datasets used to get a large amount of geo-spatial informations is *OpenStreetMap*⁷⁰, the biggest free license world map collaborative project. All the data were extracted using *Overpass Turbo*⁷¹: a tool to make query for specific data extraction from OpenStreetMap. The datasets extracted (all exported in geojson):

- **areaski.geojson**: all the areas where is possible to make ski activities in Trentino.
- **bank.geojson**: all the banks located in Trentino.
- **building.geojson**: the buildings polygons divided in municipality
- **busstops.geojson**: all the bus stops with coordinates, the operator and (sometimes) the bus line.
- **cinema.geojson**: the list of the Trentino's cinema with coordinates and some relevant information where present (3D available, contact informations, number of rooms and other)
- **citycenter.geojson**: provide informations about cities or villages boundary in Trentino and where each city centre is located.
- **climb.geojson**: the cliffs in Trentino where is possible to do climbing activities.
- **parking.geojson**: car parks with the capacity.
- **park.geojson**: all different types of public parks (also dog parks).
- **pharmacy.geojson**: list pf pharmacies with position and (where present) the timetables.
- **post_office.geojson**: post offices with position and (where present) the timetables
- **railway.geojson**: train stations and railways of Trentino.
- **roads.geojson**: all the roads of Trentino.
- **skislopes.geojson**: the ski slopes location in the Trentino.
- **supermarket.geojson**: supermarkets of Trentino.
- **trails.geojson**: list of path (open to all non-motorized vehicles) or trails of Trentino

In order to satisfy the request of a good internet connection of some personas, we took a dataset from *Infratel Italia s.p.a.*⁷² with all the information about the availability and the **quality of internet**⁷³ per home in Trentino.

2.2.3 Datasets metadata documentation

Here the metadata documentation of the fields of the datasets. However, the number of fields in some dataset is very high (up to 193), then the tables shows a max of the 25 most important fields per dataset:

- **locations and point of interest:**

| Fields | Type | Description |
|---------------------|--------|--|
| <i>Titolo</i> | string | name of the location |
| <i>address</i> | string | street address |
| <i>description</i> | string | short description of the location |
| <i>image</i> | image | image of the location |
| <i>email</i> | string | official email of the location |
| <i>phone number</i> | string | official phone contact of the location |
| <i>url</i> | string | website of the location |
| <i>info</i> | string | short infos |
| <i>gps</i> | string | coordinates and accurate address |

⁶⁸dati.trentino.it/dataset/comune-di-trento-numeri-civici

⁶⁹www.comuniecittà.it/scuole-secondarie-di-secondo-grado/comune-di-trento-22205

⁷⁰www.openstreetmap.org

⁷¹overpass-turbo.eu

⁷²www.infratel.it

- locations and point of interest (GEO version):

| Fields | Type | Description |
|--------------------|----------|---|
| <i>id</i> | int | identification code |
| <i>coordinates</i> | float[2] | latitude and longitude of the location |
| <i>properties</i> | object | main properties of the location (name, address) |

- bikesharing_METADATA.json:

| Fields | Type | Description |
|-------------------|--------|--|
| <i>name</i> | string | name of the bike station |
| <i>address</i> | string | geographical address of the bike station |
| <i>id</i> | string | identifier |
| <i>bikes</i> | int | realtime data with the number of the present bikes |
| <i>slots</i> | int | realtime data with the number of the free slots |
| <i>totalSlots</i> | int | total number of slot bikes |
| <i>position</i> | int[2] | coordinates of the station |

- piste_cliclabili_METADATA.json:

| Fields | Type | Description |
|-------------------------------------|----------|--|
| <i>WKT</i> | list int | coordinates of the paths |
| <i>tipo</i> | string | name of the typology of path (not useful) |
| <i>fumetto</i> | string | name of the path |
| <i>descrizione</i> | string | name of the path (equivalent to 'fumetto') |
| <i>tipologia</i> | string | path dedicated only to cycle or also pedestrian |
| <i>tratto isolato ciclabile</i> | int | meters without path dedicated to cycle |
| <i>tratto isolato ciclopedenale</i> | int | meters without path dedicated to cycle or pedestrian |
| <i>anno</i> | int | building year of cycle path |

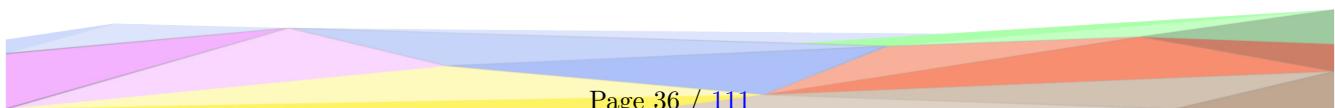
- nursery_elementary_and_middle_school_METADATA.json:

| Fields | Type | Description |
|-------------------|--------|------------------------|
| <i>WKT</i> | string | position in WKT system |
| <i>civico_alf</i> | int | civic number |
| <i>destra</i> | string | address |
| <i>sobborgo</i> | string | suburb |
| <i>scuola</i> | string | name of the school |
| <i>fumetto</i> | string | name of the school |
| <i>iscritti</i> | int | number of subscribers |
| <i>personale</i> | int | number of staff |
| <i>mail</i> | string | e-mail information |
| <i>telefono</i> | string | telephone number |

- high_school_METADATA.json:

| Fields | Type | Description |
|--------------------|--------|--------------------------|
| <i>name</i> | string | name of the school |
| <i>address</i> | string | address |
| <i>school type</i> | string | private or public school |
| <i>study paths</i> | string | study path offers |

- internet_quality_trento_METADATA.json:



| Fields | Type | Description |
|--------------------|--------|-------------------------------------|
| <i>cod_egonciv</i> | int | EGON civic code |
| <i>regione</i> | string | Only the TRENTINO-ALTO ADIGE region |
| <i>provincia</i> | string | only Trento province |
| <i>comune</i> | string | town |
| <i>frazione</i> | string | fraction of the town |
| <i>via</i> | string | street address |
| <i>civico</i> | int | civic code |
| <i>barrato</i> | char | sub-civic code |
| <i>class_19</i> | string | 2019 internet coverage |
| <i>class_22</i> | string | 2022 internet coverage estimation |

- **areaski_METADATA.json:**

| Fields | Type | Description |
|--------------------|--------|---|
| <i>@id</i> | string | name that identifies a unique object |
| <i>landuse</i> | string | describes the primary use of areas of land |
| <i>description</i> | string | describes the type of object |
| <i>area</i> | string | date rarely existing (value - yes/no) |
| <i>name</i> | string | name of data |
| <i>alt_name</i> | string | Another name or names by which the feature is known |
| <i>name:de</i> | string | german name of data |
| <i>name:it</i> | string | italian name of data |
| <i>name:lld</i> | string | Ladin name of data |
| <i>type</i> | string | type of data |
| <i>website</i> | string | website |
| <i>wikidata</i> | string | The ID of the Wikidata item about the feature |
| <i>ref:pat:cat</i> | string | identification |
| <i>ref:pat:id</i> | string | identification |
| <i>@relations</i> | map | describes the commercial relations with other ski areas |

- **bank_METADATA.json:**

| Fields | Type | Description |
|---------------------------------|---------|--|
| <i>@id</i> | string | identification code |
| <i>building</i> | string | type fo building |
| <i>name</i> | string | name of the facility |
| <i>type</i> | string | type of element |
| <i>atm</i> | boolean | indicate the presence of an atm |
| <i>automated teller machine</i> | boolean | see atm |
| <i>operator</i> | string | indicate the operator of the facility |
| <i>brand</i> | string | indicate the brand of the facility |
| <i>addr:housenumber</i> | string | the house number component of the address |
| <i>addr:street</i> | string | the street component of the address |
| <i>source</i> | string | the source of the data |
| <i>opening_hours</i> | string | the opening hours of the facility |
| <i>contact:website</i> | string | the website where contact the facility |
| <i>building:levels</i> | integer | the level above ground of the facility |
| <i>brand:wikidata</i> | string | wikidata identifier code |
| <i>brand: wikipedia</i> | string | the wikipedia page of the bank branch |
| <i>wheelchair</i> | boolean | describe if it is accesible for wheelchair users |
| <i>addr:city</i> | string | the city component of the address |
| <i>addr:postcode</i> | string | the postcode component of the address |
| <i>roof:levels</i> | integer | the level of the roof |
| <i>roof:shape</i> | string | the shape of the roof |
| <i>drive_through</i> | boolean | describe if the facility offer drive through |
| <i>addr:full</i> | string | the full address of the facility |
| <i>addr:country</i> | string | the country component of the address |
| <i>website</i> | string | the website of the facility |
| <i>phone</i> | string | the phone of the facility |

- **busstop_METADATA.json:**

| Fields | Type | Description |
|----------------------------|------------|---|
| <i>@id</i> | string | name that identifies a unique object |
| <i>highway</i> | string | name that identifies objective type |
| <i>public_transport</i> | string | name that denotes stop positions and platforms of public transport |
| <i>name</i> | string | name that identifies the name of the bus-stop |
| <i>shelter</i> | boolean | identifies the presence or absence of the shelter |
| <i>bus</i> | boolean | Access values describe restrictions or not of the bus in the bus-stop |
| <i>bench</i> | boolean | identifies the presence or absence of the shelter |
| <i>alt_name:lld</i> | string | another unofficial but locals fequently name in local dialects |
| <i>name:it</i> | string | Italin name of the bus-stop |
| <i>name:lld</i> | string | Ladin name of the bus-stop |
| <i>departures_board</i> | string | name that identifies the type of time table or departures present in the bus stop |
| <i>operator:old_name</i> | string | name that identifies company who is in charge of the service at the bus stop |
| <i>route_ref</i> | liststring | name that identifies a list of all bus lines that serve the stop |
| <i>bus_routes</i> | liststring | name that identifies a list of Flixbus that serve the stop |
| <i>created_by</i> | string | name that identifies the computer program (editor or script) which made the changes |
| <i>wheelchair</i> | string | identifies if the bus stop is suitable to be used with a wheelchair and a person with a disability who uses another mobility device (like a walker) |
| <i>note:tactile_paving</i> | boolean | identifies if there is Tactile paving |
| <i>covered:source</i> | string | identifies how the information was collected |
| <i>ref</i> | liststring | name that identifies a list of all bus lines that serve the stop |
| <i>name:de</i> | string | German name of the bus stop |
| <i>addr:city</i> | string | name identifying the name of the city where the bus stop is located |
| <i>addr:postcode</i> | int | number identifying the postcode of the city where the bus stop is located |
| <i>addr:street</i> | string | name identifying the name of the street where the bus stop is located |
| <i>alt_name</i> | string | alternative name of the bus stop |
| <i>amenity</i> | string | Describes useful and important facilities for visitors and residents |
| <i>bin</i> | boolean | identifies presence or absence of a waste basket |

- **cinema_METADATA.json:**

| Fields | Type | Description |
|-------------------------|---------|--|
| <i>@id</i> | string | Identifies univocally the object |
| <i>amenity</i> | string | Describes useful and important facilities for visitors and residents |
| <i>building</i> | boolean | Is used to mark a given object as a building |
| <i>name</i> | string | Identifies the name of the cinema |
| <i>email</i> | string | Identifies the e-mail ralated to the cinema |
| <i>phone</i> | string | Identifies the e-mail ralated to the cinema |
| <i>source</i> | string | Identifies the information source |
| <i>website</i> | string | Identifies the website related to the cinema |
| <i>addr:city</i> | string | Identifies in term of cities the position of the cinema |
| <i>addr:country</i> | string | Identifies in term of state the position of the cinema |
| <i>addr:housenumber</i> | int | Identifies the hosenumber of the cinema |
| <i>addr:postcode</i> | int | Identifies the postcode of the cities where the cinema is located |

| | | |
|------------------------|---------|---|
| <i>addr:street</i> | string | Identifies the street name where the cinema is located |
| <i>cinema:3D</i> | boolean | Identifies the possibility or not to watch 3D projection |
| <i>contact:phone</i> | string | Identifies the phone number of the cinema |
| <i>contact:website</i> | string | Identifies the website related to the cinema |
| <i>drive_in</i> | boolean | Indicates if a cinema is a drive-in cinema |
| <i>operator</i> | string | Indicates the main operator of the cinema |
| <i>ref:vatin</i> | string | VAT identification number of an object |
| <i>screen</i> | int | Identifies the number of screen |
| <i>wheelchair</i> | string | Identifies the possibility or not to access with a wheelchair |

- **city_center_METADATA.json:**

| Fields | Type | Description |
|---------------------|---------|---|
| <i>admin_level</i> | integer | the level of the administration roles tree |
| <i>boundary</i> | string | the type of boundary |
| <i>name</i> | string | the name of the area |
| <i>ref:ISTAT</i> | string | the reference to the ISTAT code |
| <i>ref:catastro</i> | string | the reference to the codice catastale |
| <i>type</i> | string | the type of the object |
| <i>wikidata</i> | string | link to the related wikidata object |
| <i>wikipedia</i> | string | the wikipedia page of the facility |
| <i>@id</i> | string | name that identifies a unique object |
| <i>name:cim</i> | string | the name in Cimbro |
| <i>name:it</i> | string | the name in Italian |
| <i>population</i> | string | the population of this administrative area |
| <i>old_name:de</i> | string | the old name in german |
| <i>natural</i> | string | describe the type of nature inside the boundary |
| <i>name:de</i> | string | the new name in german |
| <i>name:mhn</i> | string | the name in mócheno |
| <i>alt_name:de</i> | string | an alternative name in german |
| <i>reg_name</i> | string | the name of the region |
| <i>name:lld</i> | string | the name in ladin |
| <i>postal_code</i> | string | the postal code of the administrative area |
| <i>old_name</i> | string | the old name of the administrative area |
| <i>name:left</i> | string | the name from the left side |
| <i>name:right</i> | string | the name from the right side |
| <i>source</i> | string | the source of the information |
| <i>created_by</i> | string | who created this set |

- **climb_METADATA.json:**

| Fields | Type | Description |
|-------------------------|--------|---|
| <i>@id</i> | string | Used to univocally identifies the object |
| <i>climbing:rock</i> | string | Identifies the typology of rock |
| <i>name</i> | string | Identifies the name of the climb |
| <i>natural</i> | string | Is used to describe wide variety of physical geography, geological and landcover features |
| <i>sport</i> | string | Is used to identify one or more sports which can be played |
| <i>type</i> | string | Is used to set a relation's type |
| <i>building</i> | string | Indicates the presence or absence and the type of a building. |
| <i>leisure</i> | string | is for places people go in their spare time. |
| <i>addr:country</i> | string | Indicates the city in the address information |
| <i>addr:housenumber</i> | string | Indicates the housenumber in the address information |
| <i>addr:postcode</i> | int | Indicates the postcode in the address information |
| <i>addr:street</i> | string | Indicates the postcode in the address information |
| <i>email</i> | string | Indicates the email related to the climb |
| <i>fax</i> | string | Indicates the fax related to the climb |
| <i>opening_hours</i> | string | Indicates the opening hours of the climb spot |
| <i>phone</i> | string | Indicates the phone related to the climb |

| | | |
|-----------------------------|---------|--|
| <i>tourism</i> | string | Identifies the specific interest to tourists including places to see, places to stay, things and places providing information and support to tourists. |
| <i>website</i> | string | Indicates the website related to the climb |
| <i>climbing:bolted</i> | string | Provides a first indication how well the routes are secured in terms of anchors |
| <i>climbing:multipitch</i> | string | Indicates if there are multi-pitch routes and how many multi-pitch routes there are |
| <i>climbing:orientation</i> | string | Identifies orientation of the rock/wall face. |
| <i>climbing:quality</i> | string | Identifies the quality of the rock/ice. |
| <i>climbing:sport</i> | string | Indicates the practicable sports |
| <i>fee</i> | boolean | Indicates the presence or absence of fee |
| <i>outdoor</i> | boolean | Indicates if the climb is outside or not |
| <i>climbing:boulder</i> | boolean | Indicates the presence or absence of boulder |

- **park_METADATA.json:**

| Fields | Type | Description |
|-------------------|---------|--|
| <i>@id</i> | string | name that identifies a unique object |
| <i>leisure</i> | string | type of facility inside |
| <i>type</i> | string | type of data |
| <i>name</i> | string | the name of the facility |
| <i>wikidata</i> | string | link to the related wikidata object |
| <i>landuse</i> | string | describe the usage of the land |
| <i>access</i> | string | describe the access description |
| <i>operator</i> | string | the operator of the facility |
| <i>area</i> | boolean | describe if the area do not have any physical boundary |
| <i>source</i> | string | the source of the data |
| <i>alt_name</i> | string | an alternative name for the park |
| <i>short_name</i> | string | a short name for the park |
| <i>start_date</i> | date | the opening date of the facility |
| <i>amenity</i> | string | this variable describe the facility present at the park |
| <i>created_by</i> | string | the person that created the facility in openstreetmap |
| <i>old_name</i> | string | the old name of the facility |
| <i>barrier</i> | string | indicate the type of barrier that limit the facility |
| <i>tourism</i> | string | indicate why this facility can be of particular interest for the tourist |
| <i>wikipedia</i> | string | the reference to the wikipedia page |
| <i>ele</i> | integer | the elevation on the sea level |
| <i>natural</i> | string | describe the type of nature inside the boundary |
| <i>sport</i> | string | describe one or more sport that can be played in the facility |
| <i>surface</i> | string | type of surface in the park |
| <i>leaf_type</i> | string | describe the type of leave in the facility |
| <i>wheelchair</i> | boolean | wheelchair service is present |
| <i>baby</i> | string | specify if the item is tag friendly |

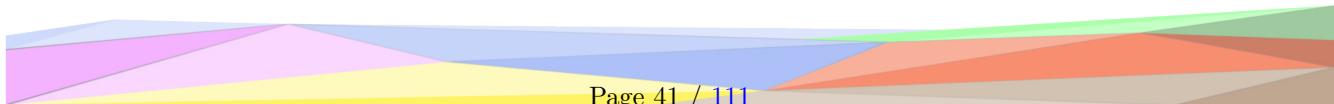
- **parking_METADATA.json:**

| Fields | Type | Description |
|----------------|---------|--|
| <i>@id</i> | string | identification code |
| <i>amenity</i> | string | For describing useful and important facilities for visitors and residents. Facilities include for example toilets, telephones, banks, pharmacies, prisons and schools. |
| <i>fee</i> | boolean | The fee tag is for specifying whether a fee is usually charged for a service, or for access. |
| <i>parking</i> | string | specify the type of parking facility. |
| <i>access</i> | string | describe restrictions on the use of highways and other transportation routes |

| | | |
|--------------------------|---------|--|
| <i>park_ride</i> | boolean | Park and ride facilities are parking lots with public transport connections that allow commuters and other people heading to city centres to leave their vehicles and transfer to a bus, rail system (rapid transit, light rail, or commuter rail), or carpool for the remainder of the journey. |
| <i>surface</i> | string | provide additional information about the physical surface |
| <i>capacity</i> | int | max capacity of the parking lot |
| <i>name</i> | string | name of the location |
| <i>barrier</i> | string | type of barrier of the parking lot |
| <i>source</i> | string | source of the data |
| <i>capacity:disabled</i> | boolean | Defines whether or not dedicated disabled parking spaces are available |
| <i>highway</i> | string | main key used for identifying any kind of road, street or path |
| <i>operator</i> | string | company of the parkig lot |
| <i>supervised</i> | string | indicates that there is a person who supervises the place |
| <i>wheelchair</i> | boolean | is wheelchair accessible? |
| <i>service</i> | string | describe details about types of 'service' roads, railways or waterways; or the service or services offered by a business. |
| <i>layer</i> | int | describe vertical relationships between crossing or overlapping features |
| <i>landuse</i> | string | describe the primary use of land by humans |
| <i>addr:housenumber</i> | int | civic code |
| <i>addr:postcode</i> | int | postal code of the location |
| <i>addr:street</i> | string | street address of the location |
| <i>opening_hours</i> | string | day and hours of opening |
| <i>smoothness</i> | string | a classification scheme regarding the physical usability of a way for wheeled vehicles, particularly regarding surface regularity/flatness. |
| <i>website</i> | url | wbesite of the location |
| <i>motorcycle</i> | string | Legal access restriction for motorcycles. |

- **pharmacy_METADATA.json:**

| Fields | Type | Description |
|-------------------------|---------|--|
| <i>@id</i> | string | identification code |
| <i>amenity</i> | string | For describing useful and important facilities for visitors and residents. Facilities include for example toilets, telephones, banks, pharmacies, prisons and schools. |
| <i>building</i> | string | type of building |
| <i>name</i> | string | name of the location |
| <i>addr:city</i> | string | city of the location |
| <i>addr:housenumber</i> | int | civic code |
| <i>addr:postcode</i> | int | postcode of the location |
| <i>addr:street</i> | string | street address of the location |
| <i>drive_through</i> | boolean | do it has the drive through? |
| <i>healthcare</i> | string | type of healthcare service |
| <i>dispensing</i> | boolean | specify whether a pharmacy dispenses prescription drugs or not |
| <i>opening_hours</i> | string | day and hours of opening |
| <i>operator</i> | string | name of the company |
| <i>ref:vatin</i> | string | VAT identification code |
| <i>wheelchair</i> | boolean | is wheelchair accessible? |
| <i>addr:country</i> | string | country of the location |
| <i>email</i> | string | email of contact |
| <i>phone</i> | string | phone number contact |
| <i>contact:website</i> | url | website of the location |
| <i>source</i> | string | source of the data |
| <i>website</i> | url | website of the location |



- **post_office_METADATA.json:**

| Fields | Type | Description |
|-------------------------|---------|---|
| <i>@id</i> | string | name that identifies a unique object |
| <i>addr:city</i> | string | city component of the address |
| <i>addr:country</i> | string | the country component of the address |
| <i>addr:housenumber</i> | string | the house number component of the address |
| <i>addr:postcode</i> | string | the postal code component of the address |
| <i>addr:street</i> | string | the street component of the address |
| <i>amenity</i> | string | this variable describe the usage of the building |
| <i>building</i> | boolean | describe if the facility is a building |
| <i>contact:website</i> | string | the website where contact the facility |
| <i>name</i> | string | the name of the facility |
| <i>operator</i> | string | the name of the facility operator |
| <i>atm</i> | boolean | if the facility have an atm |
| <i>building:colour</i> | string | the colour of the building |
| <i>building:levels</i> | integer | the number of above-ground levels of the buildings |
| <i>building:part</i> | string | describe a part of the building where the attribute are different |
| <i>height</i> | double | the height of the building |
| <i>opening_hours</i> | string | the opening hours of the facility |
| <i>roof:colour</i> | string | the color of the facility roof |
| <i>roof:shape</i> | string | the shape of the facility roof |
| <i>brand</i> | string | brand of the post office |
| <i>brand:wikidata</i> | string | wikidata identifier code |
| <i>brand:wikipedia</i> | string | brand associated with country |
| <i>addr:suburb</i> | string | the suburb component of the address |
| <i>contact:fax</i> | string | the fax to contact the facility |
| <i>contact:phone</i> | string | the phone to contact the facility |
| <i>description</i> | string | a description of the building |

- **railway_METADATA.json:**

| Fields | Type | Description |
|-----------------------------|---------|---|
| <i>@id</i> | string | identification code |
| <i>addr:city</i> | string | city of the location |
| <i>addr:postcode</i> | string | postcode of the location |
| <i>addr:street</i> | string | street address of the location |
| <i>building</i> | string | type of building |
| <i>name</i> | string | name of the location |
| <i>network</i> | string | network administration name |
| <i>operator</i> | string | operator administration name |
| <i>railway</i> | string | railway or station classification |
| <i>public_transport</i> | string | type of public transport of the location |
| <i>train</i> | boolean | it's a trainstation |
| <i>electrified</i> | string | description of the object electrified |
| <i>maxspeed</i> | int | speed limit of the railway |
| <i>name:de</i> | string | name in German |
| <i>passenger_lines</i> | int | number of lines |
| <i>railway:track_class</i> | string | The Track class of the railway line |
| <i>railway:traffic_mode</i> | string | Lines dedicated to passenger trains (might have some exceptions, especially temporally i.e. freight only during 0200-0330). |
| <i>ref</i> | int | The reference number of the railway line the track belongs to. |
| <i>usage</i> | string | usage of the rail line |
| <i>voltage</i> | int | Voltage of the railway electrification system |
| <i>bridge</i> | string | What kind of bridge carrying the track is |
| <i>layer</i> | int | To describe the vertical relationship to other bridges and features. |
| <i>start_date</i> | string | Date the Interlocking Tower was put into service |

| | | |
|-------------------|---------|---|
| <i>embankment</i> | boolean | Is the track elevated using earth or concrete dam |
| <i>service</i> | string | type of the track |
| <i>tunnel</i> | boolean | The track is in a tunnel |

- **roads_METADATA.json:**

| Fields | Type | Description |
|------------------------|---------|---|
| <i>@id</i> | string | identification code |
| <i>highway</i> | string | type of road (primary, secondary, tertiary) |
| <i>name</i> | string | name of the road |
| <i>oneway</i> | boolean | is oneway |
| <i>ref</i> | string | road code |
| <i>junction</i> | string | type of junction (roundabout) |
| <i>surface</i> | string | type of road surface (asphalt, paved) |
| <i>lanes</i> | int | number of lanes |
| <i>maxspeed</i> | int | speed limit |
| <i>nat_ref</i> | string | road code |
| <i>toll</i> | boolean | toll present |
| <i>cycleway:both</i> | boolean | have 2 way cycleway |
| <i>old_ref</i> | string | road code |
| <i>bridge</i> | string | it has a bridge |
| <i>source:maxspeed</i> | string | source of the speed limit data |
| <i>maxweight</i> | float | max weight in tons |
| <i>tunnel</i> | boolean | it has a tunnel |
| <i>foot</i> | boolean | can go by foot |
| <i>tunnel:name</i> | string | name of the tunnel |
| <i>access</i> | string | type of access |
| <i>horse</i> | boolean | horse can go |
| <i>length</i> | int | length of the road in mt |
| <i>incline</i> | string | road inclination information |
| <i>tunnel:length</i> | int | tunnel length in mt |
| <i>disabled</i> | boolean | the road is disable |

- **skislopes_METADATA.json:**

| Fields | Type | Description |
|-------------------------|---------|---|
| <i>@id</i> | string | identification code |
| <i>colour</i> | color | graphic color |
| <i>name</i> | string | name of the ski slopes |
| <i>network</i> | string | network administration of the ski slopes |
| <i>piste:type</i> | string | type of the skiing available (nordic, downhill) |
| <i>website</i> | url | link of the website of the skislope |
| <i>name:de</i> | string | name in German |
| <i>operator</i> | string | operator of the skislope |
| <i>distance</i> | float | distance between skislopes |
| <i>piste:difficulty</i> | string | difficulty level of the skislope (easy, intermediate, advanced) |
| <i>piste:grooming</i> | string | type of skiing available (classing, skating) |
| <i>source</i> | string | source of the data |
| <i>piste:name</i> | string | name of the piste |
| <i>sport</i> | string | sport available in the location |
| <i>bridge</i> | boolean | it's present a bridge |

- **supermarket_METADATA.json:**

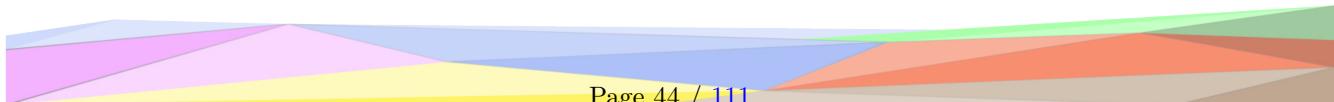
| Fields | Type | Description |
|-----------------|--------|-------------------------|
| <i>@id</i> | string | identification code |
| <i>building</i> | string | type of supermarket |
| <i>name</i> | string | name of the supermarket |

| | | |
|----------------------------|---------|---|
| <i>opening_hours</i> | string | days and hours of opening |
| <i>payment:cash</i> | boolean | accept cash |
| <i>payment:debit_cards</i> | boolean | accept debit card |
| <i>shop</i> | string | type of shop |
| <i>source</i> | string | source of data |
| <i>addr:city</i> | string | city of the location |
| <i>addr:country</i> | string | country if the location |
| <i>addr:housenumber</i> | int | civic code |
| <i>addr:postcode</i> | int | postcode |
| <i>addr:street</i> | string | street of the location |
| <i>operator</i> | string | operator of the supermarket (coop, conad, desper ...) |
| <i>ref:vatin</i> | string | value added tax identification number |
| <i>brand</i> | string | brand of the supermarket (coop, conad, desper ...) |
| <i>brand:wikidata</i> | string | wikidata identifier code |
| <i>brand:wikipedia</i> | string | brand associated with country |
| <i>toilets:wheelchair</i> | boolean | wheelchair toilets is present |
| <i>wheelchair</i> | boolean | wheelchair service is present |
| <i>website</i> | url | official website of the brand |
| <i>addr:province</i> | string | province of the location |
| <i>addr:state</i> | string | state code of the location |
| <i>building:levels</i> | int | number of levels of the building |
| <i>parking</i> | string | type of parking (underground) |
| <i>toilets</i> | boolean | it has toilets |

- **trails_METADATA.json:**

| Fields | Type | Description |
|--------------------------|---------|--|
| <i>id</i> | string | name that identifies a unique object |
| <i>cai_scale</i> | string | Identifies the cai scale difficulty classification |
| <i>distance</i> | int | Identifies the distance of the trials |
| <i>duration:backward</i> | string | Identifies the duration of the backward |
| <i>duration:forward</i> | string | Identifies the duration of the backward |
| <i>foot</i> | boolean | identifies the possibility to complete the path by foot |
| <i>from</i> | string | Indicates the start position |
| <i>highway</i> | string | path which has been look for these dataset |
| <i>mtb</i> | bool | Indicates if the path is practicable of mtb |
| <i>mtb:scale</i> | int | Indicates the difficult scale of the mtb path |
| <i>network</i> | string | specifies the hiking route as a local route (=lwn) |
| <i>note:project_page</i> | string | Indicates the project page url |
| <i>operator</i> | string | The name of the organization that maintains the path |
| <i>osmc:symbol</i> | string | describe route symbol that is used as waymarker or on guideposts |
| <i>sac_scale</i> | int | A difficulty rating scheme for hiking trails. |
| <i>source</i> | string | where these data came from |
| <i>to</i> | string | where the path ends |
| <i>trail_visibility</i> | string | describes attributes regarding trail visibility (not route visibility) and orientation |
| <i>type</i> | string | type of the path |
| <i>website</i> | string | link to the website of the organization |
| <i>@id</i> | string | identification number |
| <i>ascent</i> | int | meters of ascent |
| <i>descent</i> | int | meters of descent |
| <i>name</i> | string | name of the path |
| <i>surface</i> | string | Surface values provide additional information about the physical surface of roads/footpaths. |
| <i>bicycle</i> | bool | affordable for bycicle |

- **building_METADATA.json:**



| Fields | Type | Description |
|-------------------------|--------|--|
| <i>id</i> | string | identification code |
| <i>amenity</i> | string | For describing useful and important facilities for visitors and residents. Facilities include for example toilets, telephones, banks, pharmacies, prisons and schools. |
| <i>building</i> | string | The building tag is used to mark a given object as a building |
| <i>name</i> | string | name of the location |
| <i>type</i> | string | The key type is commonly used to set a relation's type |
| <i>wikidata</i> | string | The ID of the Wikidata item about the feature |
| <i>@id</i> | string | identification code |
| <i>historic</i> | string | used to identify features that are of historic interest |
| <i>addr:city</i> | string | city of the location |
| <i>addr:country</i> | string | country of the location |
| <i>addr:housenumber</i> | string | civic code |
| <i>addr:postcode</i> | string | postcode of the location |
| <i>addr:street</i> | string | street address |
| <i>contact:email</i> | string | email contact |
| <i>contact:fax</i> | string | fax contact |
| <i>contact:phone</i> | string | phone number contact |
| <i>contact:website</i> | url | website of the location |
| <i>email</i> | string | email contact |
| <i>operator</i> | string | used to name a company, corporation, person or any other entity who is directly in charge of the current operation of a map object. |
| <i>ref:vatin</i> | string | VAT code information |
| <i>castle_type</i> | string | used to distinguish between the various type of historic castles - stately vs defensive etc |
| <i>building:levels</i> | string | used for marking the number of above-ground levels of a building |
| <i>building:use</i> | string | describes what kind of function a building-* serves |
| <i>roof:levels</i> | string | For stating the number of levels in the roof of a building |
| <i>access</i> | string | describe restrictions on the use of highways and other transportation routes (railways, waterways), as well as facilities such as buildings, building entrances, amenities and leisure entities. |
| <i>layer</i> | string | one of several methods used to describe vertical relationships between crossing or overlapping features |

- civici_web_METADATA.json:

| Fields | Type | Description |
|-------------------|--------|--|
| <i>civico_num</i> | string | civic number (without slash) |
| <i>civico_let</i> | string | slash, if exist |
| <i>civico_alf</i> | string | numero civico con barra (se presente) |
| <i>desvia</i> | string | street description |
| <i>strada</i> | string | street code |
| <i>cap</i> | int | postal code |
| <i>tipo_num</i> | string | type of civic: 'principale' or 'secondaria' (language: italy) |
| <i>tipo_en</i> | string | type of civic: 'principal' or 'secondary' (language: english) |
| <i>ingresso</i> | string | entrance type: 'abitazione', 'cancello' or 'altro' (language: italy) |
| <i>ingr_en</i> | string | entrance type: 'abitation', 'gate' or 'other' (language: english) |
| <i>fumetto</i> | string | complete address |
| <i>url</i> | string | not useful |
| <i>sobborgo</i> | string | Cadastral community |

2.2.4 Datasets collection process

In order to download the 257 locations and point of interests datasets from open data Trentino we made a script in python to automate the process: the script "points_of_interests_download.py"⁷⁴ looks in the search page of the website with the tag "luoghi e punti di interesse"; starting from page 1 and going to 8, it looks all the datasets containing "luoghi" and "interesse" in the title, then for every dataset found it download in the dataset page the json, (half of the times) the GEO version of the dataset (which it has more records) and the metadata. After the download process it's been used "points_of_interests_reorganize.py"⁷⁵ to move the metadata files in the right folder.

Because of the missing high school data in open data Trentino, we made scraping in comuneCittà.it: the script "comuneCittà.download.py"⁷⁶ it take all the information in the main page (name, address, if it's private or public) and then for every school it take the study path information. Finally the script saves the data in csv format.

The information has been exported from **OpenStreetMap** thanks to **Overpass turbo**, a web based data mining tool for OpenStreetMap.

2.2.5 Inception level evaluation

We used schema.org as schema reference to make the evaluation, in particular we choose the subset of *Place* to compute the metrics, since is the most suitable macro-class for our domain. The metrics are illustrated in the table below:

Evaluation Metrics:

| Metric | Value |
|---------------|-------|
| Coverage | 7.7% |
| Flexibility | 4.7% |
| Extensiveness | 4.2% |
| Sparsity | 89% |

Set parameters:

| Set | Cardinality |
|-----------------------------|-------------|
| α (schema reference) | 235 |
| β | 29 |
| $\alpha \cap \beta$ | 18 |

2.3 Informal Modeling

This section describe the steps of the informal modelling phase of the iTelos methodology. This include a first section that describe the schema of the data (including the ER and variance respect to CQs) and a second section describing the data management and describe in detail the metadata.

2.3.1 Schema level

The schema level in this phase report the first informal definition of the ETypes and of the EER model constructed using them.

2.3.1.1 ETypes and EER Model definition

We have divided the ETypes in three categories, common that contain all the ETypes shared by the elements inside the core category. The core category contains all the ETypes key to answer to the competency questions describe above. The last category is the contextual ones that contain all the elements that are not strictly necessary to answer the CQs and are related to element into the core category. These ETypes are useful to help the CQs to be more complex and / or complete. In the ER schema we identify the common ETypes in blue, the core ones in green and the contextual in red. You can find the complete ER schema in fig. 1.

The presence of a line with a empty arrow at the end of a line inside the diagram means that the connected entities have a hierarchical dependency and the one with the arrow is the father. We use the empty rhombus form to identify a element where the maximum cardinality is 1, instead a full rhombus is used when the maximum cardinality is n . The connection reference is always stored inside the side without the rhombus. If the filled rhombus is present in both side of the line this mean that the relation have a cardinality n-n.

The central element of the common category is the etype point each point is a real world 3D space coordinate. Then a series of this point contribute to forming a chain. The point chain can be divided in paths (that group all the paths travelled for pleasure or more generally using human locomotion) and in transportation ways (that normally contains all the chain travelled for necessity and with the help of machines).

⁷⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/points_of_interests_download.py

⁷⁵https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/points_of_interests_reorganize.py

⁷⁶https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/comunecitta_download.py

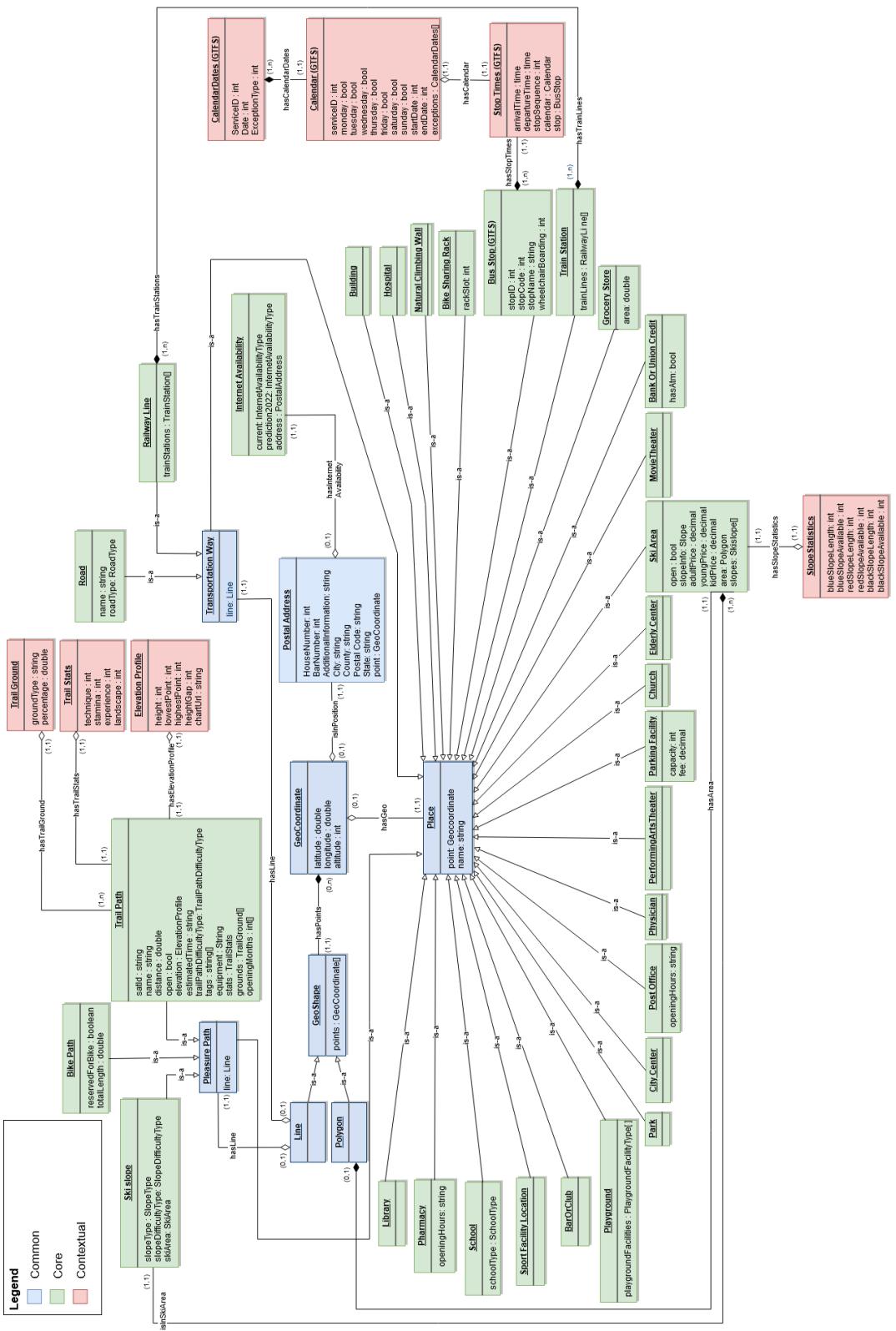


Figure 1: EER Diagram of the data used inside the project

Each point can be the position of an address, while we try to maintain a generic approach to the problems when possible, the address format is specific to each country, considering our context is the Province of Trento, we adopt the Italian format. Each point then can be a point of interest, exist various types of point of interest each one with different attributes, that are necessary to resolve the CQs, for this reason they are inserted inside the core category.

The core category contain all the various derivations of the points of interest. This include as an example the pharmacies, the libraries, the bars, ecc. The fields depend mostly on the type of the point of interest and are better describe in detail in the paragraph [2.3.2.2](#). A point can also represent the position of a building and we use this information aggregated together to estimate the density of a particular area. The last group of etypes inside the core category are the ones that are identifiable with a line, like for example the bike path. This one are divided into two group the first that inheritance from the path etype and the second that inheritance from the transportation way. The first group include the ski slopes, bike paths and excursion path. Transportation way include the roads and the train lines. Ski resort and excursion paths with the related entities are taken from the tourist facility group. The bus stop, stop time, calendar and calendar dates are taken from the transportation group. The metadata are described inside the ER.

The last category is represented by the contextual etypes. This category include a series of enumerator that describe the various values that the connected field can assume. For a detail description of the values please see the paragraph [2.3.2.2](#). Considering they are not critical for the resolution of the main problem also the stop times and route tables are inside the contextual category.

In the following there is a list of all the E-types presented in the EER model with a small semantic description and with the relation with other e-types and attribute. This types is defined trying to aligned our informal schema and our ontology, presented in the next section, with the etypes present in the schema.org ontology and the ontologies made by the transportation and tourist facilities group for the overlapping part:

Common Etypes

- **GeoCoordinate:** a *common type* entity describing a single point in the world.

Relations:

- it may have some Postal Address (has PostalAddress realtion that is the inverse relation of isInPosition)
- it may be part of some GeoShape (isContained relation that is the inverse relation of hasPoints)
- it is the position of one Place (coordinateHasPlace relation that is the inverse relation of hasGeo)

Attributes:

- **latitude:** latitude coordinate in the world
- **longitude:** longitude coordinate in the world
- **altitude:** height of the point from the sea level

- **Place:** a *common type* entity describing a point of interest entities that have a somewhat fixed, physical extension.

Relations:

- Is the super-class of the following classes: Library, Pharmacy, School, Sport Facility Location, Bar or Club, Playground, Park, City Center, Post Office, Physician, Performing Arts Theater, Parking Facility, Church, Elderly Center, Ski Area, Movie Theater, Bank or Credit Union, Grocery Store, Train Station, Bus Stop, Bike Sharing Rack, Natural Climbing Wall, Hospital and Building
- it has min 1 GeoCoordinate (hasGeo)

Attributes:

- **name:** it has max 1 string that refers to the name of the place.

- **Postal Address:** a *common type* entity describing the street address of a point.

Relations:

- it is in only one postion defined by the GeoCoordinate (isInPosition)
- it has zero or one Internet Availability (hasInternetAvailability)

attributes:

- **HouseNumber:** integer that defines the civic number of the building
- **BarNumber:** integer that defines the number of the door building
- **AdditionalInformation:** string that defines the additional information about the address
- **City:** string that defines the city of the address
- **County:** string that defines the county of the address
- **PostalCode:** string that defines the postal code of the address

- **State:** string that defines the state of the address
- **GeoShape:** a *common type* entity describing t a geographical shape such as line or polygon.
Relations:
 - it has min 2 Geocordinate
 - it is the superclass of the classes Line and Polygon

It hasn't other attributes
- **Line:** a *common type* entity describing a chain of points.
Relations:
 - it may be contained in the Pleasure Path or Transportation way path.
 - it is a Geo Shape class and for this reason it implies all the Geo Shape relations and attributes

It hasn't other attributes
- **Polygon:** a *common type* entity describing closed figure represented by a chain of points.
Relations:
 - it may be contained in the Ski Area.
 - it is a Geo Shape class and for this reason it implies all the Geo Shape relations and attributes

It hasn't other attributes
- **Pleasure Path:** a *common type* entity describing a path normally travelled for pleasure and using human locomotion.
Relations:
 - it has in the Ski Area.
 - it is a Place class and for this reason it implies all the Place relations and attributes

It hasn't other attributes
- **Transportation Way:** a *common type* entity describing cg a path traveled for duty using motorized transportation mean.
Relations:
 - it has in the Ski Area.
 - it is a Place class and for this reason it implies all the Place relations and attributes

It hasn't other attributes

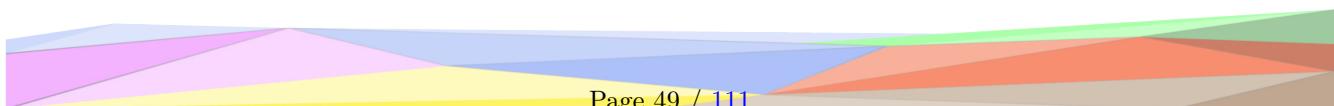
Core Etypes

- **Road:** a *core type* entity describing a general road or route.
Relations:
 - It is a Transportation Way and for this reason it implies all the Transportation Way relations and attributes.

Attributes:

 - **name:** it is a string that describe the name of the road
 - **type:** it is a enumeration class that describe the type of road (highway, primary, secondary tertiary)
- **Railway Line:** a *core type* entity describing a pair of rails on which a railway train runs or a group of railway tracks running parallel, allowing one track to be used for each direction (a double-track railway line), or allowing segregation of fast trains from stopping trains (a four-track railway line).
Relations:
 - It is a Transportation Way and for this reason it implies all the Transportation Way relations and attributes.
 - it has at least one Train Station or more (has TrainStations relation)

It hasn't other attributes
- **Internet Availability:** a *core type* entity describing t the availability of internet in a particular address.
Relations: it has minimum one Postal Address (hasInternetAvailability relation)
Attributes:



- **current**: current availability of internet and the type of service describe by an enumeration class called *InternetAvailabilityType* (`black_novhcn`, `black_novhcn_fo`, `black_novhcn_fwa`, `grey_novhcn_copper`, `grey_novhcn_radio`, `grey_novhcn_fo`, `grey_novhcn_fwa`, `no_covarage`)
 - **prediction2022**: prediction of the availability of internet and the type of service describe by an enumeration class called *InternetAvailabilityType* (`black_novhcn`, `black_novhcn_fo`, `black_novhcn_fwa`, `grey_novhcn_copper`, `grey_novhcn_radio`, `grey_novhcn_fo`, `grey_novhcn_fwa`, `no_covarage`)
- **Bike Path**: a *core type* entity indicating the cycle/bike paths
- Relations:*
- It is a Pleasure Path and for this reason it implies all the Pleasure Path relations and attributes.
- Attributes:*
- **reservedforBike**: it is a boolean that describes if the path is dedicated only to cycle or not.
 - **totalLength**: it is a double that describe the length of the path
- **Trail Path**: a *core type* entity indicating a path for excursion purpose
- Relations:*
- It is a Pleasure Path and for this reason it implies all the Pleasure Path relations and attributes.
 - It has one and only one trail stats class that describe the statistics of the trail path. (`hasTrailStats` relation)
 - It has one and only one elevation profile class that describe the elevation profile of the trail. (`hasElevationProfile` relation)
 - It has one and only one trail ground class that describe the typology of the ground. (`hasTrailGround` relation)
- Attributes:*
- **satId**: it has a string that describes trail id in the SAT registry
 - **name**: it has a string that describes name of the path
 - **distance**: it has a double that describes length of the path in meters
 - **open**: it is a boolean that indicates whether the trail is currently open
 - **estimatedTime**: it has a string that describes time estimated to run across the trail
 - **tags**: it has a list of string that describes the tags associated to the trail
 - **equipment**: it has a string that describes equipments needed for the trail
 - **openingMonths**: it has a list of integer that describes in month when the trail is usable.
- **Ski slope**: a *core type* entity describing ski.
- Relations:*
- It is a Pleasure Path and for this reason it implies all the Pleasure Path relations and attributes.
 - It is collocated in specific entity of the Ski Area etype (`isInSkiArea` relation)
- Attributes:*
- **SlopeType**: it has an enumeration type, called *SlopeType*, that describes the type ski track (nordic or downhill)
 - **SlopeDifficultyType**: It has an enumeration type, called *SlopeDifficultyType*, that describes the difficulty level of the skislope (easy, intermediate, advanced).
- **Library**: a *core type* entity describing libraries
- Relations:*
- It is Place and for this reason it implies all the Place relations and attributes.
- It hasn't other attributes*
- **Pharmacy**: a *core type* entity describing pharmacies or drug stores
- Relations:*
- It is a Place and for this reason it implies all the Place relations and attributes.
- Attributes:*
- **openingHours**: it is a string that describes timetable of the pharmacy

-
- **School:** a *core type* entity describing schools

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **SchoolType:** It has an enumeration class, called SchoolType, that describes type of the school (nursery, elementary, middle, high)

- **Sport Facility Location:** a *core type* entity describing sports location, such as playing fields.

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Bar or Club:** a *core type* entity describing bar, pub and cafes

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Playground:** a *core type* entity describing playgrounds.

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **playgroundfacilities:** it has an enumeration class, called PlaygroundFacilityType, that gives info about the facility that exist in the leisure

- **Park:** a *core type* entity describing parks.

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **City Center:** a *core type* entity describing the city centers of towns.

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Post Office:** a *core type* entity describing post offices

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **openingHours:** it has a string that describes opening hours of the post office

- **Physician:** a *core type* entity describing physician and ambulatory

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **PerformingArtsTheater:** a *core type* entity describing performing arts theaters. *Relations:*

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Church:** a *core type* entity describing churches

Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Elderly Center:** a *core type* entity describing elderly centers or a healthcare residence for Elderly Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Movie Theater:** a *core type* entity describing cinemas and movie theaters Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Hospital:** a *core type* entity describing hospitals. Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Building:** a *core type* entity contains the position of a generic building. Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Natural Climbing Wall:** a *core type* entity describing a climbing wall of natural origin Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

It hasn't other attributes

- **Bike Sharing Rack:** a *core type* entity describing the racks of a bike sharing service Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **rackSlot:** it has an integer that describes the number of rack slot.

- **Grocery Store:** a *core type* entity describing a grocery store or supermarket Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **area:** it has a double value that describes the size of the area that the supermarket covers.

- **Bank or Credit Union:** a *core type* entity describing bank or a credit union Relations:

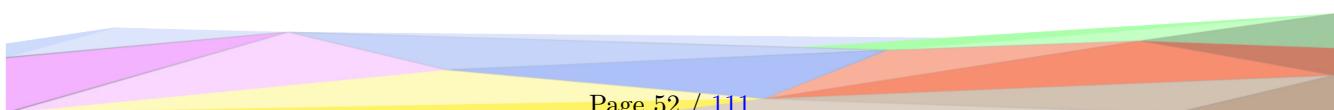
- It is a Place and for this reason it implies all the Place relations and attributes.

Attributes:

- **hasAtm:** it has a boolean value that gives the information about the presence or absence of an ATM.

- **Parking Facilities:** a *core type* entity describing a parking lot or other parking facility Relations:

- It is a Place and for this reason it implies all the Place relations and attributes.



Attributes:

- **capacity:** it has one integer that describes the maximum capacity of the parking lot.
- **fee:** it has a decimal value that gives the information about fee (is it charged for a service, or for access)

- **Bus Stop:** a *core type* entity describing the bus stops *Relations:*

- is a **Point of Interest**
- it has at least one **Stop Times** or more (hasStopTimes)

Attributes:

- **stopID:** an integer indicating uniquely the bus stop
- **stopCode:**
- **stopName:** name of the bus stop
- **wheelchairBoarding:** number of wheelchair boarding

- **Ski Area:** a *core type* entity describing ski resorts
relations:

- it is a **point of interest**
- it has one **slope statistics** (hasSlopeStatistics)
- it has one or more **skiSlope**
- its area is described by one **Polygon**

attributes:

- **name:** name of the ski resort
- **open:** current state of the resort (open or note)
- **slopeInfo:** general info of the resort divided for path difficulty
- **adultPrice:** price for adult
- **kidPrice:** price for kid

- **Train station:** a *core type* entity describing train stations *Relations:*

- it has at least one or more **TrainLines** (hasTrainLines)

it hasn't other attributes

Contextual Etypes

- **Trail Ground:** a *contextual type* entity describing the ground of the excursion path
Relations:

- it has exactly one **Excursion Path**

Attributes:

- **groundType:** type of the terrain of the trail
- **percentage:** percentage of the type of terrain the trail is composed

- **Trail Stats:** a *contextual type* entity describing scores of the difficulty of the excursion path
Relations:

- it has exactly one **Excursion Path**

Attributes:

- **technique:** technique score
- **stamina:** stamina score
- **experience:** experience score
- **landscape:** landscape score

- **Elevation Profile:** a *contextual type* entity describing the elevation of the excursion path

Relations:

- it has exactly one **Excursion Path**

Attributes:

- **lowestPoint:** altitude of the lowest point of the trail
- **highestPoint:** altitude of the highest point of the trail
- **height:** height of the trail
- **heightGap:** gap between the higher and lower points of the trail
- **chartURL:** url to the trail-elevation graph

- **Stop Times:** a *contextual type* entity describing the stop times of bus in Trentino

- Relations:*
- it has exactly one **Calendar** (**hasCalendar**)
 - it has at exactly one **Stop** (**hasStopTimes**)

Attributes:

- **arrivalTime:** arrival time of the bus in that stop
- **departureTime:** departure time of the bus in that stop
- **stopSequence:**

- **Calendar:** a *contextual type* entity describing the calendar (days of the week) for the bus in Trentino

Relations:

- it has one **CalendarDates** (**hasCalendarDates**), which describes exceptions
- it is contained in **Stop Times**

Attributes:

- **serviceID:** ID of the service
- **monday:** boolean which advise if something exist monday
- **tuesday:** boolean which advise if something exist tuesday
- **wednesday:** boolean which advise if something exist wednesday
- **thursday:** boolean which advise if something exist thursday
- **friday:** boolean which advise if something exist friday
- **saturday:** boolean which advise if something exist saturday
- **sunday:** boolean which advise if something exist sunday
- **startDate:** starting date of the time line
- **endDate:** end date of the time line

- **Calendar Dates:** a *contextual type* entity describing ...

Relations:

- it is contained in **Calendar**

Attributes:

- **ServiceID:**
- **Date:**
- **ExceptionType:**

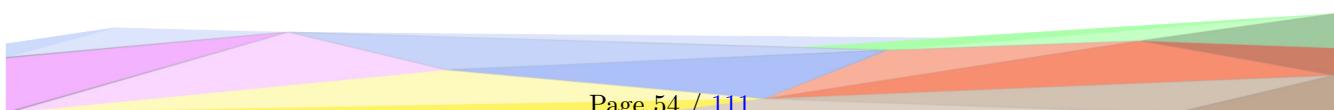
- **Slope Statistics:** a *core type* entity describing generically ski slopes in a resort

Relations:

- it is contained in **SkiArea**

Attributes:

- **blueSlopeLength:** number of kilometers of blue slopes in the resort
- **blueSlopeAvailable:**
- **redSlopeLength:** number of kilometers of red slopes in the resort intermediate, advanced)
- **redlopeAvailable:**
- **blackSlopeLength:** number of kilometers of black slopes in the resort
- **blackSlopeAvailable:**



2.3.1.2 Variance respect CQs definition

This section aims to define the variance between the schema elements produced in this phase, and the definition of the CQs reported in the previous phase. This is a way to define the quality of the outcomes for the current phase as well as the alignment of the overall project development process.

During the development of this phase we have revised and integrated some CQs from the last phase. This process was done to add complexity to the proposed CQs to make the project more complete and interesting for our purpose. Specifically, this enrichment of the questions has happened thanks to two different specific actions:

- More in-depth exploration of the previously recovered datasets allowing us to add to some interested etypes in the CQs made more complex others attributed initially discarded.
- Integration of our project with some parts of two projects developed by our colleagues. In particular, we have created a collaboration and exchange of data in a standardized and fully integrated way with the group "Transportation" and the group "Tourist facilities".

Specifically, thanks to the actions listed above, the CQs relating to the ski areas, ski slopes, hiking trails to playgrounds, Bank Branch and bus stops have been deepened. Thanks to the deeper exploration of the datasets now in fact the system is designed to answer much more detailed questions about these categories, for example:

- Which games are present in the nearest playground?
- Where is the bank with an available ATM?
- What are the Nordic skiing trails within 35 k?
- Which are the 3 ski areas with the greatest number of kilometers of red slopes?
- What are the excursion paths in a radius of 3 km from the unit with a positive height difference of less than 200m?

2.3.2 Data level

The data level section in this phase reports the evolution of the datasets collected previously, reporting the metadata information for each new data, or new version of data, obtained.

2.3.2.1 Datasets management process

All the datasets have been filtered using a script in python: `data_filtering.py`⁷⁷ read a configuration file (`data_filtering_config.json`⁷⁸) to understand for every dataset what fields to keep in the new datasets. We decide which attributes were useful by looking at the output provided by `count_json.m`⁷⁹: it shows for each attribute how many objects contain them. Therefore, only attributes which were not sparse in the datasets have been selected. Then, the script reads every dataset in the configuration file, it compares the files and it selects the ones appearing in the configuration file and finally it writes the selected data in a new file in the Informal Modeling folder. The "luoghi e punti di interesse per comune" and "building" datasets, because of the number of files, are directly filtered in the script without using the configuration file. Since there are two types of datasets in "luoghi e punti di interesse per comune" (the GEO version and the "rich" version), the files are merged with only the filtered attributes. All the files are converted in json and each record is listed in the same way in every file.

Using the same configuration file, the script `metadata_filtering.py`⁸⁰ applies the changes of the fields of the data in the metadata. All the metadata of "luoghi e punti di interesse per comune" are merged in a single file `luoghi_e_punti_di_interesse_per_comune_METADATA.json`⁸¹.

2.3.2.2 Datasets metadata documentation

These are the new metadata of the filtered data with some enrichment (like source, format or timestamp):

`areaski_Metadata.json`:

| Dataset Properties | Description | Type | Data Definition |
|------------------------|--|------|-----------------|
| <code>type</code> | FeatureCollection | | |
| <code>generator</code> | overpass-ide | | |
| <code>copyright</code> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |

⁷⁷https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/data_filtering.py

⁷⁸https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/data_filtering_config.json

⁷⁹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/count_json.m

⁸⁰https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/metadata_filtering.py

⁸¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Informal%20Modeling/metadata/luoghi_e_punti_di_interesse_per_comune_METADATA.json

| | | | |
|--------------------|--|--------|--|
| <i>timestamp</i> | 2020-10-19T19:05:03Z | | |
| Attributes | | | |
| <i>@id</i> | name that identifies a unique object | string | |
| <i>name</i> | name of data | string | |
| <i>type</i> | type of geometry | string | |
| <i>coordinates</i> | array the points which compose the polygon | array | |

luoghi_e_punti_di_interesse_per_comune_METADATA.json:

Since this includes 147 datasets and metadatas, here are reported the common properties and fields. The different values are set with *. The full metadata are in the repository ⁸²

| Dataset Properties | Description | Type | Data Definition |
|-----------------------------------|--|--------|-----------------|
| <i>source</i> | https://dati.trentino.it/dataset/* | | |
| <i>format</i> | json | | |
| <i>Identificativo del dataset</i> | * | | |
| <i>Data di rilascio</i> | * | | |
| <i>Data di modifica</i> | * | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Titolare</i> | * | | |
| <i>Frequenza di aggiornamento</i> | in continuo aggiornamento | | |
| <i>Autore</i> | * | | |
| Attributes | | | |
| <i>@id</i> | name that identifies a unique object | string | Common |
| <i>name</i> | name of data | string | Core |
| <i>type</i> | type of geometry | string | Common |
| <i>coordinates</i> | array the points which compose the polygon | array | Common |

bank_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|---------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:50:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | common |
| <i>name</i> | name of the facility | string | core |
| <i>atm</i> | indicate the presence of an atm | boolean | core |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:street</i> | the street component of the address | string | common |
| <i>addr:city</i> | the city component of the address | string | common |
| <i>addr:postcode</i> | the postcode component of the address | string | common |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

busstop_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|--|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>copyright</i> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |

⁸²https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/dataset/Informal%20Modeling/metadata/luoghi_e_punti_di_interesse_per_comune_METADATA.json

| | | | |
|----------------------|---|--------|--------|
| <i>timestamp</i> | 2020-10-19T10:54:03Z | | |
| Attributes | | | |
| <i>@id</i> | name that identifies a unique object | string | Common |
| <i>name</i> | name that identifies the name of the bus-stop | string | Core |
| <i>addr:city</i> | name identifying the name of the city where the bus stop is located | string | Common |
| <i>addr:postcode</i> | number identifying the postcode of the city where the bus stop is located | int | Common |
| <i>addr:street</i> | name identifying the name of the street where the bus stop is located | string | Common |
| <i>type</i> | type of geometry | string | Common |
| <i>coordinates</i> | array the points which compose the polygon | array | Common |

cinema_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>copyright</i> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <i>timestamp</i> | 2020-10-19T15:03:03Z | | |
| Attributes | | | |
| <i>name</i> | Identifies the name of the cinema | string | Core |
| <i>addr:city</i> | Identifies in term of cities the position of the cinema | string | Common |
| <i>addr:housenumber</i> | Identifies the house number of the cinema | int | Common |
| <i>addr:postcode</i> | Identifies the postcode of the cities where the cinema is located | int | Common |
| <i>addr:street</i> | Identifies the street name where the cinema is located | string | Common |
| <i>type</i> | type of geometry | string | Common |
| <i>coordinates</i> | array the points which compose the polygon | array | Common |

city_center_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T10:54:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | the name of the area | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

climb_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|-----------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:21:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |

| | | | |
|-------------------------|--|--------|--------|
| <i>@id</i> | Used to univocally identifies the object | string | core |
| <i>name</i> | Identifies the name of the climb | string | core |
| <i>addr:housenumber</i> | Indicates the housenumber in the address information | string | common |
| <i>addr:postcode</i> | Indicates the postcode in the address information | int | common |
| <i>addr:street</i> | Indicates the street in the address information | string | common |
| <i>opening_hours</i> | Indicates the opening hours of the climb spot | string | core |
| <i>height</i> | Indicates the height of the climbing | int | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

park_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--|---|---------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:30:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | name that identifies a unique object | string | core |
| <i>leisure</i> | type of facility inside | string | core |
| <i>name</i> | the name of the facility | string | core |
| <i>playground</i> | describe the type of playground available | string | contextual |
| <i>playground:basketswing</i> | describe if the facility have a basketswing | boolean | contextual |
| <i>playground:chain_ladder</i> | describe if the facility have a chain ladder | boolean | contextual |
| <i>playground:slide</i> | describe if the facility have a slide | boolean | contextual |
| <i>playground:swing</i> | describe if the facility have a swing | boolean | contextual |
| <i>opening_hours</i> | the opening hours of the park | string | contextual |
| <i>addr:city</i> | the city component of the address | string | common |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:postcode</i> | the postal code component of the address | string | common |
| <i>addr:street</i> | the street component of the address | string | common |
| <i>playground:aerialrotator</i> | describe if the facility have an aerialrotator | boolean | contextual |
| <i>playground:basketball_backboard</i> | describe if a zone where play basketball is available | boolean | contextual |
| <i>playground:exercise</i> | describe if an equipment are for the exercise is present | boolean | contextual |
| <i>playground:horizontal_bar</i> | describe if an horizontal bar is present | boolean | contextual |
| <i>playground:seesaw</i> | describe if an seesaw is present | boolean | contextual |
| <i>playground:tunnel_tube</i> | describe if an tunnel tube is present | boolean | contextual |
| <i>playground:climbingframe</i> | describe if a climbing frame is present | boolean | contextual |
| <i>playground:multi_play</i> | describe if a multiple usage surface is available | boolean | contextual |
| <i>playground:sandpit</i> | describe if a sandpit is present | boolean | contextual |
| <i>playground:theme</i> | describe the theme of the park | string | contextual |
| <i>playground:skate_equipment</i> | describe if the park is equipment to play with the skateboard | boolean | contextual |
| <i>playground:teenshelter</i> | describe if a teen shelter is available | boolean | contextual |
| <i>playground:water</i> | describe if a water playground is available | boolean | contextual |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

parking_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-----------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T09:57:03Z | | |

| | | | |
|------------------------------|--|---------|--------|
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>fee</i> | The fee tag is for specifying whether a fee is usually charged for a service, or for access. | boolean | core |
| <i>capacity</i> | max capacity of the parking lot | int | core |
| <i>name</i> | name of the location | string | core |
| <i>addr:city</i> | name of the city | string | common |
| <i>addr:housenumber</i> | civic code | int | common |
| <i>addr:postcode</i> | postal code of the location | int | common |
| <i>addr:street</i> | street address of the location | string | common |
| <i>opening_hours</i> | day and hours of opening | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

pharmacy_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:28:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>name</i> | name of the location | string | core |
| <i>addr:city</i> | city of the location | string | common |
| <i>addr:housenumber</i> | civic code | int | common |
| <i>addr:postcode</i> | postcode of the location | int | common |
| <i>addr:street</i> | street address of the location | string | common |
| <i>opening_hours</i> | day and hours of opening | string | common |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

post_office_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:26:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | name that identifies a unique object | string | core |
| <i>addr:city</i> | city component of the address | string | common |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:postcode</i> | the postal code component of the address | string | common |
| <i>addr:street</i> | the street component of the address | string | common |
| <i>name</i> | the name of the facility | string | core |
| <i>opening_hours</i> | the opening hours of the facility | string | core |
| <i>addr:province</i> | the province component of the address | string | common |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

railway_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T18:07:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>name</i> | name of te location | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

roads_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-20T07:44:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>highway</i> | type of road (trunk,primary, secondary, tertiary) | string | contextual |
| <i>name</i> | name of the road | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

skislopes_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:07:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>name</i> | name of the ski slopes | string | core |
| <i>piste:type</i> | type of the skiing available (nordic, downhill) | string | core |
| <i>piste:difficulty</i> | difficulty level of the skislope (easy, intermediate, advanced) | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

supermarket_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-----------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |

| | | | |
|------------------------------|--|--------|--------|
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:28:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>name</i> | name of the supermarket | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

trails_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T20:02:05Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification number | string | core |
| <i>name</i> | name of the path | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

building_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:50:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>@id</i> | identification code | string | core |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

civici_web_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>Dataset ID</i> | 4f474fc8-181d-4b15-9ee4-60b3f54f4068 | | |
| <i>Source</i> | https://dati.trentino.it/dataset/comune-di-trento-numeri-civici | | |
| <i>Release date</i> | 22-02-2013 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | comune di Trento | | |
| <i>Temporal extension</i> | 'From': '22-02-2013' | | |
| <i>Holder</i> | 'Name': 'Comune di Trento', 'Code IPA/IVA': 'c_l378' | | |
| <i>Update frequency</i> | daily | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>civico_num</i> | civic number (without slash) | string | common |
| <i>desvia</i> | street description | string | common |

| | | | |
|--------------------|--|--------|--------|
| <i>fumetto</i> | complete address | string | common |
| <i>sobborgo</i> | Cadastral community | string | common |
| <i>type</i> | type of geometry | string | common |
| <i>coordinates</i> | array the points which compose the polygon | array | common |

piste_ciclabili_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-------------------------------------|---|----------|-----------------|
| <i>Dataset ID</i> | c.l378-1129110 | | |
| <i>Holder</i> | 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c.l378' | | |
| <i>Release date</i> | 09-11-2017 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | Comune di Trento | | |
| <i>Source</i> | https://dati.trentino.it/dataset/piste-ciclabili-open-data | | |
| <i>GeoNames URI</i> | http://www.geonames.org/6541469 | | |
| <i>Dataset language</i> | italiano | | |
| <i>Update frequency</i> | continuous updating | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>WKT</i> | coordinates of the paths | list int | common |
| <i>tipo</i> | name of the typology of path (not useful) | string | |
| <i>fumetto</i> | name of the path | string | common |
| <i>descrizione</i> | name of the path (equivalent to 'fumetto') | string | common |
| <i>tipologia</i> | path dedicated only to cycle or also pedestrian | string | core |
| <i>tratto isolato ciclabile</i> | meters without path dedicated to cycle | int | core |
| <i>tratto isolato ciclopedenale</i> | meters without path dedicated to cycle or pedestrian | int | core |

elementari_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>Dataset ID</i> | 9368a92a-dbe9-4a43-9fc0-66a5f4695e16 | | |
| <i>Release date</i> | 28-04-2020 | | |
| <i>Modification date</i> | 31-03-2016 | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>Source</i> | https://dati.trentino.it/ | | |
| <i>GeoNames URI</i> | http://www.geonames.org/3165243 | | |
| <i>Holder</i> | 'Nome': 'Provincia autonoma di Trento', 'Code IPA/IVA': 'p-TN' | | |
| <i>Update frequency</i> | unknown | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>WKT</i> | Coordinates in Well-Known Text format | string | Common |
| <i>civico_alf</i> | civic number | string | Common |
| <i>destra</i> | street address | string | Common |
| <i>sobborgo</i> | suburb of the school | string | Common |
| <i>scuola</i> | name of the school | string | Core |

materne_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|------|-----------------|
| <i>Dataset ID</i> | 3dd956d1-a376-4e9a-8182-d839de4163dd | | |
| <i>Release date</i> | 28-04-2020 | | |
| <i>Modification date</i> | 31-03-2016 | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>Source</i> | https://dati.trentino.it/ | | |
| <i>GeoNames URI</i> | http://www.geonames.org/3165243 | | |
| <i>Holder</i> | 'Nome': 'Provincia autonoma di Trento', 'Code IPA/IVA': 'p-TN' | | |
| <i>Update frequency</i> | unknown | | |
| <i>Format</i> | json | | |

| Attributes | | | |
|-------------------|---------------------------------------|--------|--------|
| <i>WKT</i> | Coordinates in Well-Known Text format | string | Common |
| <i>civico_alf</i> | civic number | string | Common |
| <i>destra</i> | street address | string | Common |
| <i>sobborgo</i> | suburb of the school | string | Common |
| <i>scuola</i> | name of the school | string | Core |

medie_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>Dataset ID</i> | ade37eb8-13af-4584-a965-6765e26f1870 | | |
| <i>Release date</i> | 28-04-2020 | | |
| <i>Modification date</i> | 31-03-2016 | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>URI di GeoNames</i> | http://www.geonames.org/3165243 | | |
| <i>Holder</i> | 'Nome': 'Provincia autonoma di Trento', 'Code IPA/IVA': 'p-TN' | | |
| <i>Update frequency</i> | unknown | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>WKT</i> | Coordinates in Well-Known Text format | string | Common |
| <i>civico_alf</i> | civic number | string | Common |
| <i>destra</i> | street address | string | Common |
| <i>sobborgo</i> | suburb of the school | string | Common |
| <i>scuola</i> | name of the school | string | Core |

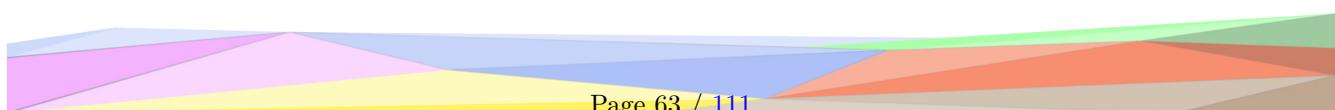
superiori_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>Release date</i> | 19-09-2020 | | |
| <i>source</i> | https://www.comunecitta.it/scuole-secondarie-di-secondo-grado/comune-di-trento-22205 | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>Update frequency</i> | unknown | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the school | string | Core |
| <i>address</i> | address of the school | string | Common |
| <i>school type</i> | type of school (public or private) | string | Core |
| <i>study paths</i> | the study paths offered from the school (comma separated) | string | Core |

internet_quality_trento_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|--------|-----------------|
| <i>source</i> | www.infratelitalia.it | | |
| <i>timestamp</i> | 2020-09-09 | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>comune</i> | town | string | Common |
| <i>via</i> | street address | string | Common |
| <i>civico</i> | civic code | int | Common |
| <i>barrato</i> | sub-civic code | char | Common |
| <i>class_19</i> | 2019 internet coverage | string | Core |
| <i>class_22</i> | 2022 internet coverage estimation | string | Core |

bikesharing_METADATA.json:



| Dataset Properties | Description | Type | Data Definition |
|-----------------------|---|--------|-----------------|
| source | https://dati.trentino.it/dataset/stazioni-bike-sharing-emotion-trentino | | |
| format | json | | |
| timestamp | 2020-10-18 | | |
| Dataset ID | p_TN:9b9c14d6-ee20-4802-a274-4c17ac96cdd5 | | |
| Temi del dataset | 'Trasporti': ['4816 trasporti terrestri', '4806 politica dei trasporti'], 'Energia': ['6626 energia dolce', '6606 politica energetica'] | | |
| Dataset publisher | 'Nome': 'Servizio Trasporti pubblici', 'Codice IPA/IVA': '0OK0PZ' | | |
| Release date | 18-11-2014 | | |
| Modification date | 03-07-2017 | | |
| Geographical Coverage | Comune di Trento | | |
| GeoNames URI | http://www.geonames.org/3165241 | | |
| Dataset language | italiano | | |
| Holder | 'Nome': 'Provincia Autonoma di Trento', 'Codice IPA/IVA': 'p-TN' | | |
| Upload frequency | continuous | | |
| Attributes | | | |
| name | name of the bike station | string | Core |
| address | geographical address of the bike station | string | Common |
| id | identifier | string | Core |
| totalSlots | total number of slot bikes | int | Core |
| position | coordinates of the station | int[2] | Common |

stops_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------------|---|----------------|-----------------|
| Dataset Identifier | p_TN: d3c9f167-3271-4a43-b5c1-e0879aa5ad3f | | |
| Dataset Publisher | 'Name': 'Public Transport Service', 'IPA/VAT Code': '0OK0PZ' | | |
| Date of modification | 2017-10-24 | | |
| Geographic coverage | Trento | | |
| URI of GeoNames | https://www.geonames.org/3165241 | | |
| Languages of the dataset | Italian | | |
| Holder | Autonomous Province of Trento | | |
| Refresh Rate | Half yearly | | |
| Author | 'Name': 'Public Transport Service', 'IPA/VAT': '0OK0PZ' | | |
| Url | https://www.trentinotrasporti.it/opendata/google_transit | urbano_tte.zip | |
| License | Creative Commons Attribution 4.0 International (CC BY 4.0) | | |
| License_Type | https://w3id.org/italia/controlled-vocabulary/licences/A21_CCBY40 | | |
| Format | txt | | |
| Attributes | | | |
| stop_id | identification code of the bus stop | int | Core |
| stop_code | | string | Core |
| stop_name | name of the bus stop | string | Core |
| stop_desc | | string | Contextual |
| stop_lat | latitude coordinate of the stop | double | Common |
| stop_lon | longitude coordinate of the stop | double | Common |
| zone_id | identification code of the zone | int | Contextual |
| wheelchair_boarding | number of wheelchair boarding | int | Core |

stop_times_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|--|------|-----------------|
| Dataset Identifier | p_TN: d3c9f167-3271-4a43-b5c1-e0879aa5ad3f | | |

| | | | |
|---------------------------------|---|--------|------------|
| <i>Dataset Publisher</i> | 'Name': 'Public Transport Service', 'IPA/VAT Code': '0OK0PZ' | | |
| <i>Date of modification</i> | 2017-10-24 | | |
| <i>Geographic coverage</i> | Trento | | |
| <i>URI of GeoNames</i> | https://www.geonames.org/3165241 | | |
| <i>Languages of the dataset</i> | Italian | | |
| <i>Holder</i> | Autonomous Province of Trento | | |
| <i>Refresh Rate</i> | Half yearly | | |
| <i>Author</i> | 'Name': 'Public Transport Service', 'IPA/VAT': '0OK0PZ' | | |
| <i>Url</i> | https://www.trentinotrasporti.it/opendata/google_transit_urbano.tte.zip | | |
| <i>License</i> | Creative Commons Attribution 4.0 International (CC BY 4.0) | | |
| <i>License_Type</i> | https://w3id.org/italia/controlled-vocabulary/licences/A21_CCBY40 | | |
| <i>Format</i> | txt | | |
| Attributes | | | |
| <i>trip_id</i> | identification code of the trip line | int | Contextual |
| <i>arrival_time</i> | arrival time of the bus in that stop | string | Contextual |
| <i>departure_time</i> | departure time of the bus in that stop | string | Contextual |
| <i>stop_id</i> | identification code of the bus stop | int | Core |
| <i>stop_sequence</i> | | int | Core |

trails_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|------------------|------------------------|
| <i>lastModified</i> | 2020-07-02T08:14:00.000Z | | |
| <i>source</i> | www.outdooractive.com | | |
| <i>update_frequency</i> | no update | | |
| <i>geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>sat_Id</i> | trail id in the SAT registry | string | core |
| <i>trainType</i> | specifies whether the trail is a hiking, biking or snowshoe trail | string | core |
| <i>name</i> | name of the trail | string | core |
| <i>distance</i> | length of the trail | double | core |
| <i>open</i> | whether the trail is currently open | boolean | core |
| <i>elevation</i> | contains other 5 attributes (lowestPoint, highestPoint, ascent, descent, chartUrl) | elevationProfile | contextual |
| <i>estimatedTime</i> | contains other 4 attributes (days, hours, minutes, seconds) | duration | core |
| <i>startRoute</i> | contains other 2 attributes (altitude, description) | locationPoint | core |
| <i>endRoute</i> | contains other 2 attributes (altitude, description) | locationPoint | core |
| <i>route</i> | contains other 2 attributes (description, geoPoints) | route | core |
| <i>difficulty</i> | description of the trail difficulty | string | contextual |
| <i>tags</i> | array of tags | array | core |
| <i>equipment</i> | equipments needed for the trail | String | core |
| <i>stats</i> | contains other 4 attributes (technique, stamina, experience, landscape) | TrailStats | contextual |
| <i>grounds</i> | contains other 2 attributes (groundType, percentage) | array | contextual |
| <i>monthTips</i> | contains other 2 attributes (month, open) | array | core |
| <i>metadata</i> | contains other 4 attributes (created, lastModified, source, resource) | MetaData | core |

skiResorts_currentState_METADATA:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|-------------|------------------------|
| <i>lastModified</i> | 2020-10-24 | | |
| <i>source</i> | https://www.skiresort.info/ski-resorts/trentino/ | | |
| <i>update_frequency</i> | unknown | | |
| <i>geographical Coverage</i> | Provincia di Trento | | |

| | | | |
|--------------------|---|--------|------------|
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | contains the name of the ski resort | string | core |
| <i>open/closed</i> | has the information if the resort is open or noty | string | contextual |

skiResorts_static_METADATA:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|--------|-----------------|
| <i>lastModified</i> | 2020-10-24 | | |
| <i>source</i> | https://www.skiresort.info/ski-resorts/trentino/ | | |
| <i>update_frequency</i> | unknown | | |
| <i>geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | contains the name of the ski resort | string | core |
| <i>Total lenght</i> | total number of kilometers available in the resort | double | contextual |
| <i>km blue slope</i> | number of kilometers of blue slopes in the resort | double | contextual |
| <i>km red slope</i> | number of kilometers of red slopes in the resort | double | contextual |
| <i>km black slope</i> | number of kilometers of black slopes in the resort | double | contextual |
| <i>price</i> | Price per person | string | contextual |

2.3.2.3 Variance respect Inception datasets

This section aims to define the variance between the data elements (datasets and attributes within them) produced in this phase, and the initial datasets collected in the previous phase. This is a way to define the quality of the outcomes for the current phase as well as the alignment of the overall project development process.

Datasets have been filter in order to reduce sparse attributes: in fact, datasets downloaded from Openstreetmap are often messy and many attributes exist only for few objects. Thus, the filtering has been applied mainly to Openstreetmap. Also, other information has been taken off in order to remove useless attributes.

A great difference can be also found in park dataset, since it initially included dog parks. It has been chosen to take it off.

Finally, area-ski and bus stop datasets have been integrated with dataset of other groups of work ("Transportation Tomorrow" and "Turist facilities"). Datasets involved in this collaboration and exchange of data are transportation, ski area and hike path. Particularly, the data provided by transportation group has been integrated with our dataset, which was previously filtered. Actually, datasets that provide information about bus stops are tree: `stops.json`, `stop.time.json` and `busstop.json`. On the other hand, ski area and trails datasets have been replaced by the ones provided by turist facilities group.

The following table shows the difference between dataset in the Scope Definition Inception phase and Informal modeling one.

| Dataset | Initial nr. of attributes | Final nr. of attributes |
|----------------------------|---------------------------|-------------------------|
| areaski | 17 | 5 |
| bank | 71 | 9 |
| bikesharing | 7 | 5 |
| building | 162 | 3 |
| busstop | 43 | 7 |
| stop time | / | 5 |
| stops | / | 8 |
| cinema | 23 | 7 |
| city center | 28 | 3 |
| civici web | 14 | 5 |
| climb | 73 | 9 |
| internet quality | 15 | 15 |
| luoghi e punti d'interesse | 21 | 5 |
| school: nursery | 12 | 5 |
| school: elementary | 12 | 5 |
| school: middle | 12 | 5 |
| school: high | 4 | 4 |
| park | 82 | 28 |
| parking | 116 | 11 |
| pharmacy | 51 | 9 |
| piste ciclabili | 8 | 8 |
| post office | 49 | 10 |
| railway | 50 | 4 |
| roads | 153 | 5 |
| skislopes | 69 | 6 |
| supermarket | 66 | 4 |
| trails | 193 | 29 |

2.3.3 Informal Modeling Evaluation

In this phase entities aren't changed in the direction of the reference schema, we tended to bring in relation the precedently defined classes instead of adding newer. The metrics are illustrated in the table below:

Evaluation Metrics:

| Metric | Value |
|----------------------|-------|
| <i>Coverage</i> | 8.5% |
| <i>Flexibility</i> | 9.3% |
| <i>Extensiveness</i> | 7.9% |
| <i>Sparsity</i> | 92.8% |

Set parameters:

| Set | Cardinality |
|--------------------------------------|-------------|
| α (<i>schema reference</i>) | 235 |
| β | 42 |
| $\alpha \cap \beta$ | 20 |

2.4 Formal Modeling

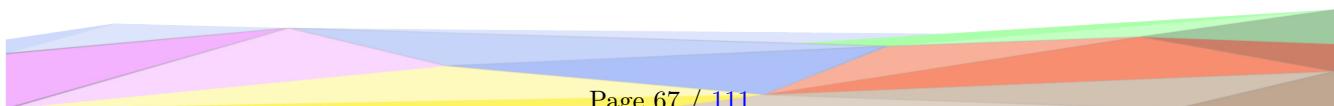
This section describe the Formal Modeling phase. The first part of the section describe the schema while the second part describe the data segment of the phase.

2.4.1 Schema level

Inside this subsection a first paragraph describe how we defined the ontology, the second one list the classes created. The last paragraph describe the change made to the schema compared to the informal phase.

2.4.1.1 Ontology definition

The first step of the process for the development of the ontology schema consist on searching for other reference ontologies. We found two valid



ontologies the schema.org ones ⁸³ and the ones develop for the city of Florence by the DISIT group of the University of Florence, km4city ⁸⁴. While km4city is complete and already formalized a large number of the class we use it also use some things very specific to the city of Florence. For this reason we decide to inspire our work to the schema.org ontology, that instead is more general and try to take in consideration more general needs.

Then we compare the names on our ER with the ones already present on KOS. Based on this we developed a first list of concepts to add to KOS. Then we download from KOS using the API, the already present ontology as a RDF/XML file. Then we start to add the classes necessary with the corresponding concept and adding the concept to KOS if necessary. We use Protégé to modify the RDF file. Then we add the data properties and the object properties using the same procedure. To add the enumerations we adopt a procedure differently from the ones publish inside the Manchester tutorial ⁸⁵, because it is not currently supported by the KOS system where we need to import the ontology. You can see the complete schema under the form of a graph in the Fig. 3, the EER updated with the changes made in the formal phase can be seen in the Fig. 4.

⁸³<https://schema.org/>

⁸⁴<http://wlode.disit.org/WLODE/extract?url=http://www.disit.org/km4city/schema>

⁸⁵http://mowl-power.cs.man.ac.uk/protegeowltutorial/resources/ProtegeOWLTutorialP4_v13.pdf

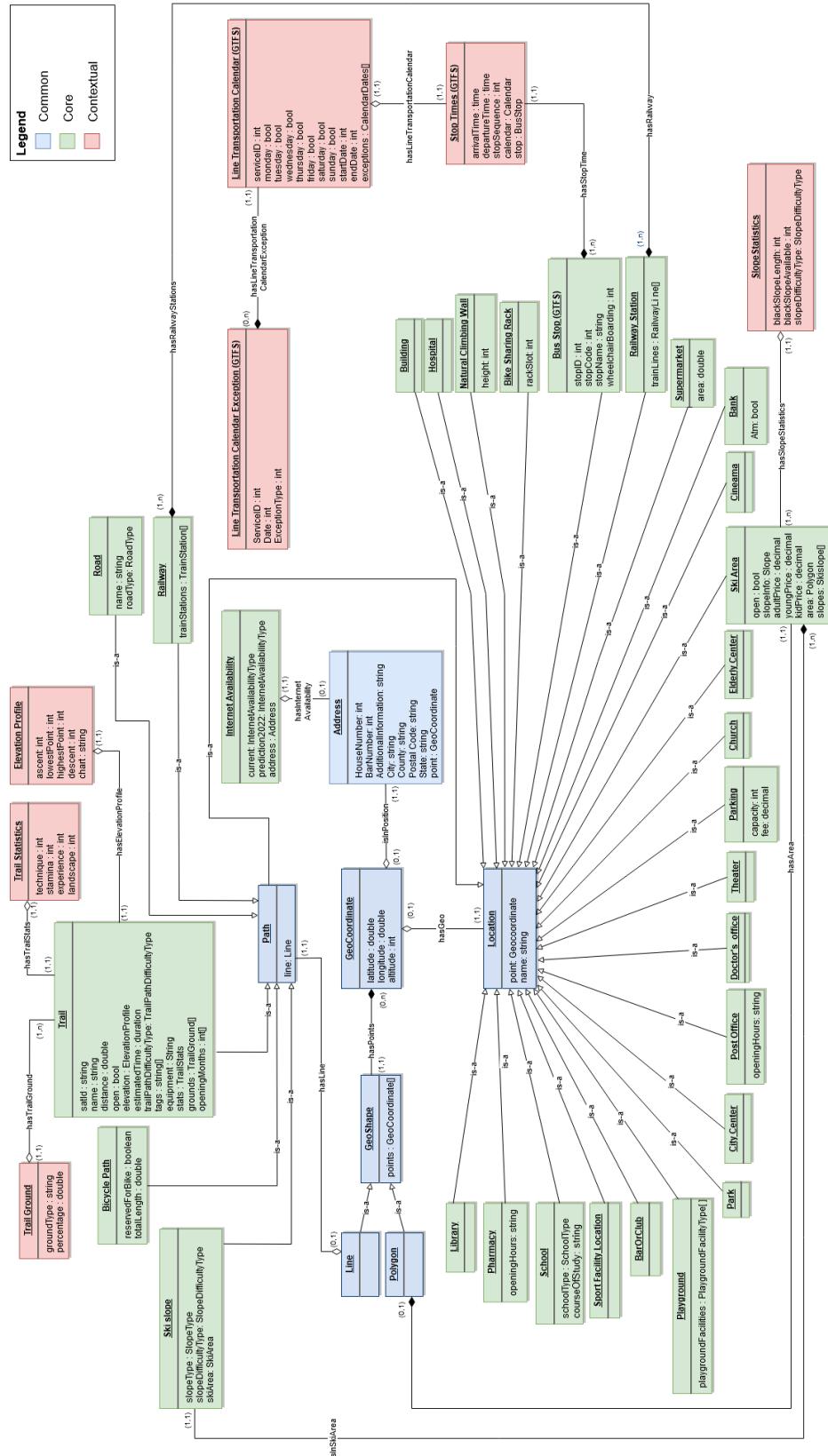


Figure 2: EER with the modification made during the execution of the formal phase

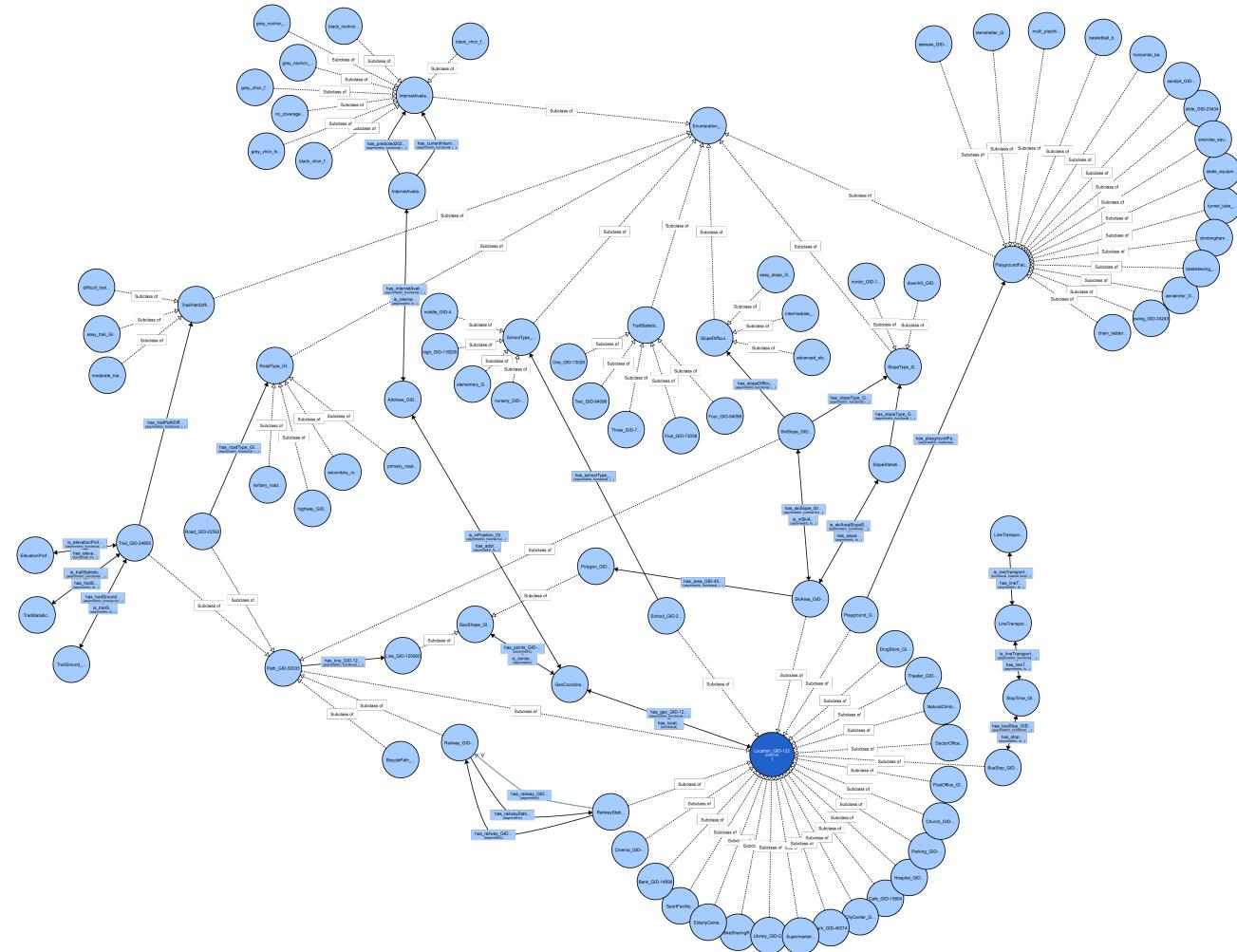


Figure 3: Image of the created schema under the form of a graph

In the following there is reported some ontology metrics in order to have an overview of the ontology.

| Ontology Metrics | | | |
|---|--------|--------------|-----------------------------|
| Description | Total: | Added by us: | Already present in KOS .owl |
| Class count | 122 | 98 | 24 |
| Object property count | 69 | 37 | 32 |
| Data property count | 92 | 63 | 29 |
| Individuals count | 8 | 0 | 8 |
| Class axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| SubClass axioms count | 218 | 197 | 21 |
| Disjoint classes axioms count | 15 | 15 | 0 |
| Object property axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Sub object property axioms count | 65 | 37 | 28 |
| Inverse object properties axioms count | 12 | 12 | 0 |
| Functional object property axioms count | 27 | 27 | 0 |
| Inverse functional object property axioms count | 14 | 14 | 0 |
| Anti-symmetric object property axioms count | 34 | 34 | 0 |
| Irreflexive object property axioms count | 27 | 27 | 0 |
| Object property domain axioms count | 66 | 37 | 29 |
| Object property range axioms count | 66 | 37 | 29 |
| Data property axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Sub data property axioms count | 86 | 63 | 23 |
| Data property domain axioms count | 89 | 63 | 26 |
| Data property range axioms count | 89 | 62 | 27 |
| Annotation axioms | | | |
| Description | Total: | Added by us: | Already present in KOS .owl |
| Entity annotation axioms count | 625 | 538 | 87 |

Moreover a list of metadata is reported in this section, in order to describe all the elements of the ontology defined.

2.4.2 Classes

In this table ⁸⁶ there is the list of the classes of our ontology and for each of this classes there are the related concept, GID and comment. In the last column of the table there is a Boolean value that indicate if the concept related to that class is imported by us in the ontology or not.

2.4.3 Data Property

In this table ⁸⁷ is instead reported the table that shows all the data properties of the ontology. For each data property in addition to the name is associated the name and the GID of the concept, the comment the domain and the range. In the last columns is reported the carnality.

⁸⁶<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/project%20report/Classes%20List.pdf>

⁸⁷<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/project%20report/DataProperties%20List.pdf>

2.4.4 Object Property

In this table ⁸⁸ the object properties of our ontology are listed. For each line is reported the formal name of the object property, followed by the name and GID of the concept, the Domain and range information and a series of Booleans that define the characteristics of the property. In the last columns are finally reported the cardinality and the inverse object property.

2.4.5 Enumeration Classes

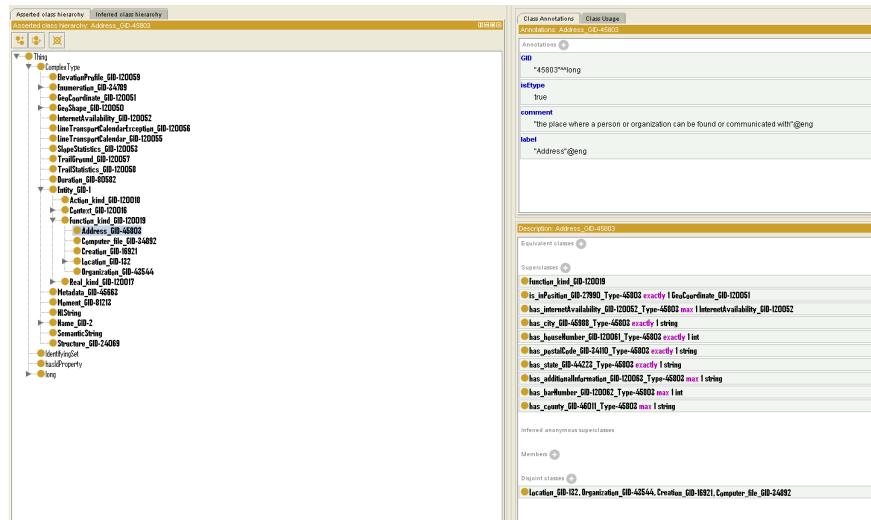
In this table ⁸⁹ the enumeration classes are reported instead. To create these classes, given the constraints of the system that did not allow us to search for individuals, we adopted and designed a design pattern different from that commonly found in literature. In our ontology the enumeration classes are defined as classes, therefore there is an object property that connects them to the classes that need these enumerations, that present as their sub-classes the various values that enumeration can assume. With this pattern we can afford to go, in the future, to insert more information and detail to these enumeration classes too.

2.4.6 Focus on Classes

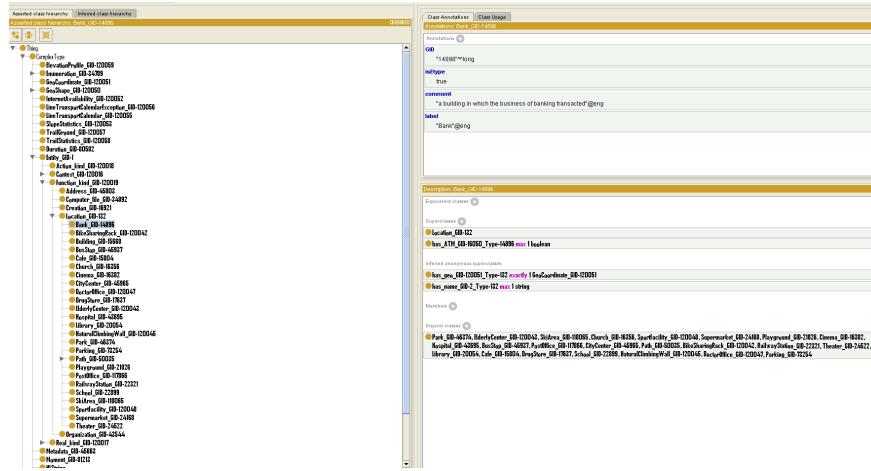
⁸⁸<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/project%20report/Object%20Properties%20List.pdf>

⁸⁹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/project%20report/Enumerations%20List.pdf>

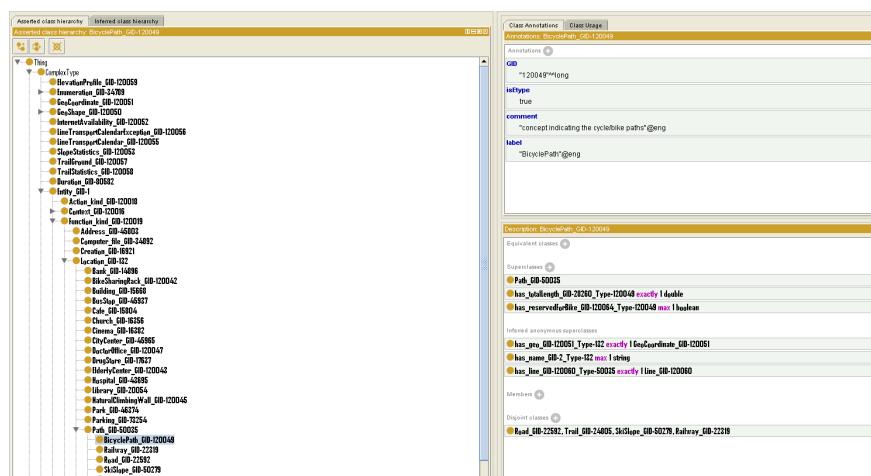
- Address_GID-45803



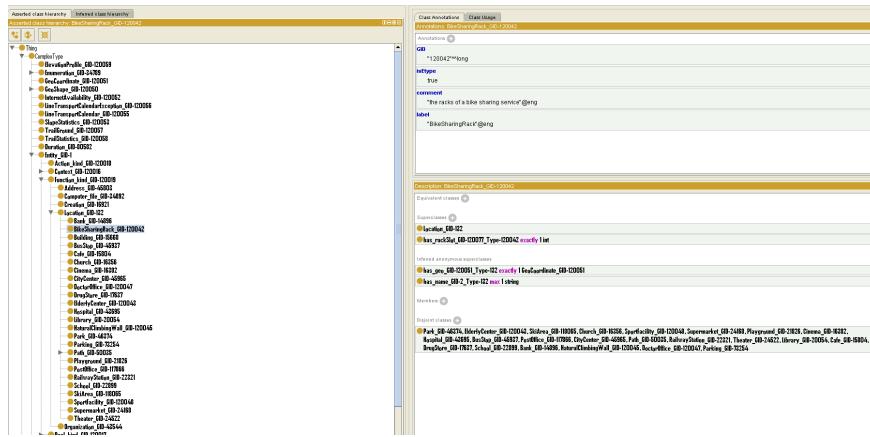
- Bank_GID-14896



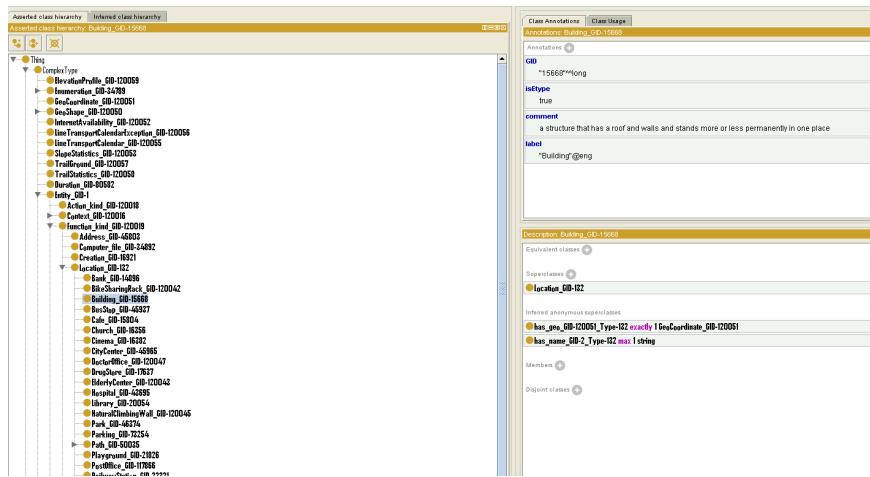
- Bicycle Path_GID-120049



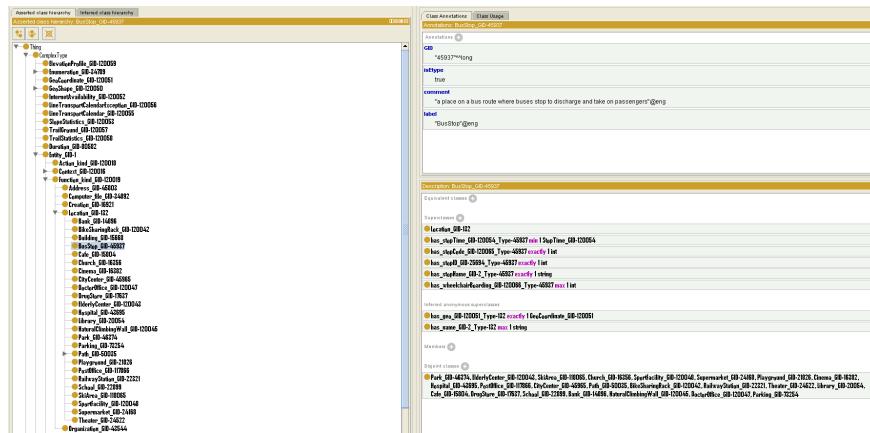
- Bike Sharing Rack_GID-120042



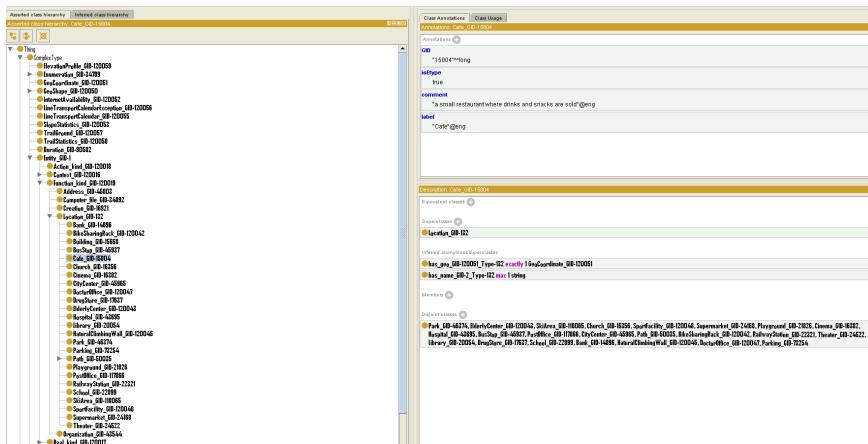
- Building_GID-15668



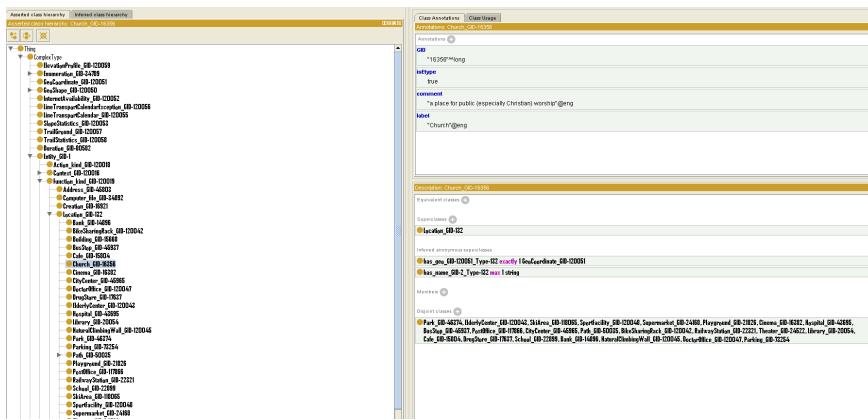
- Bus Stop_GID-45937



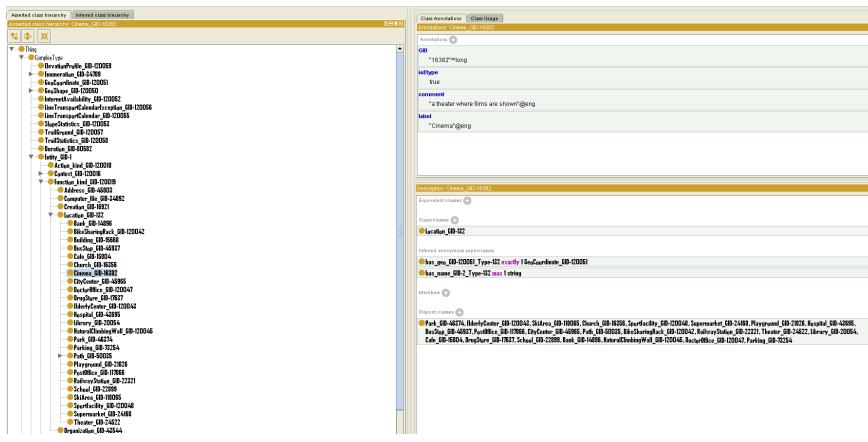
- Cafe_GID-15804



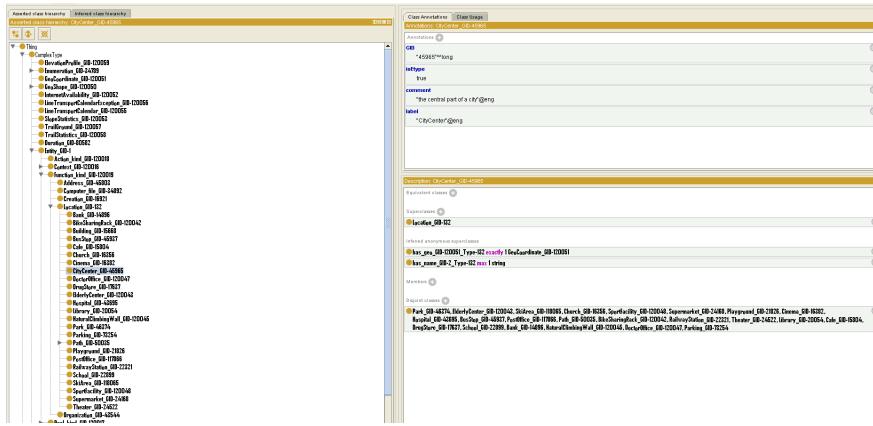
- Church_GID-16356



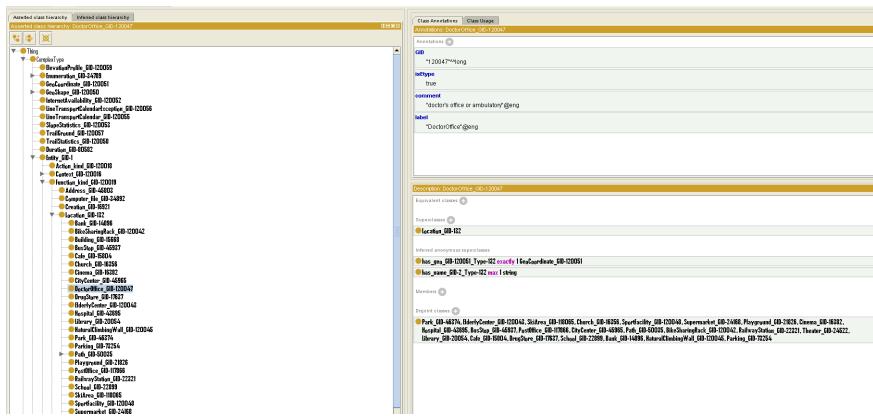
- Cinema_GID-16382



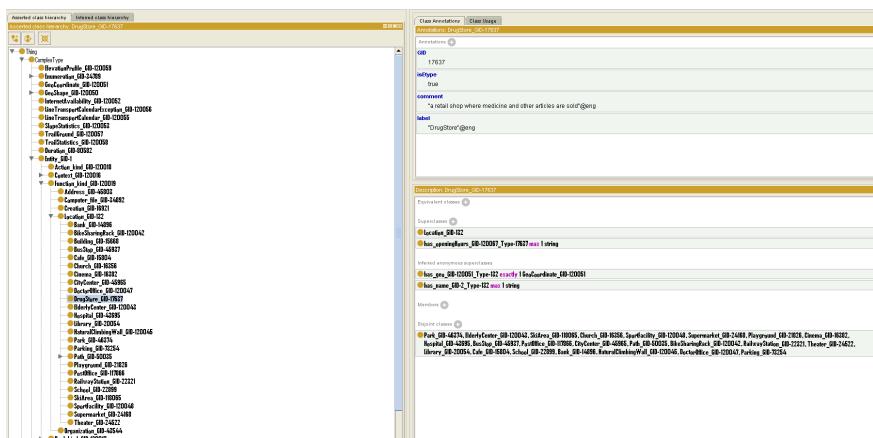
- City Center_GID-45965



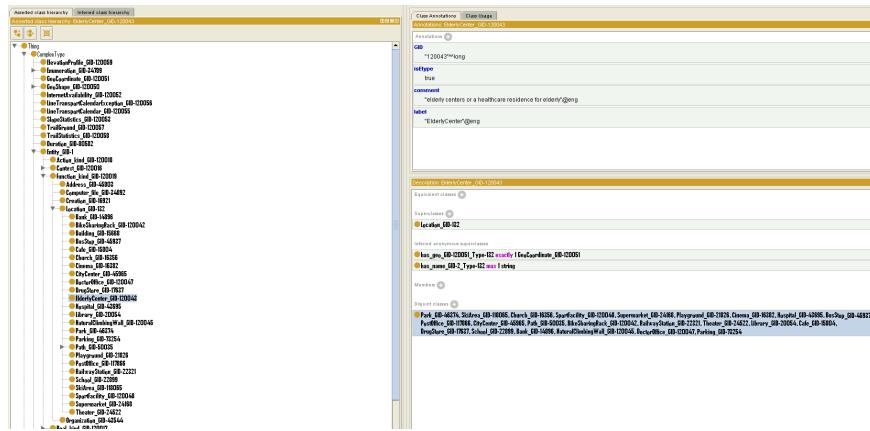
- Doctor's Office_GID-120047



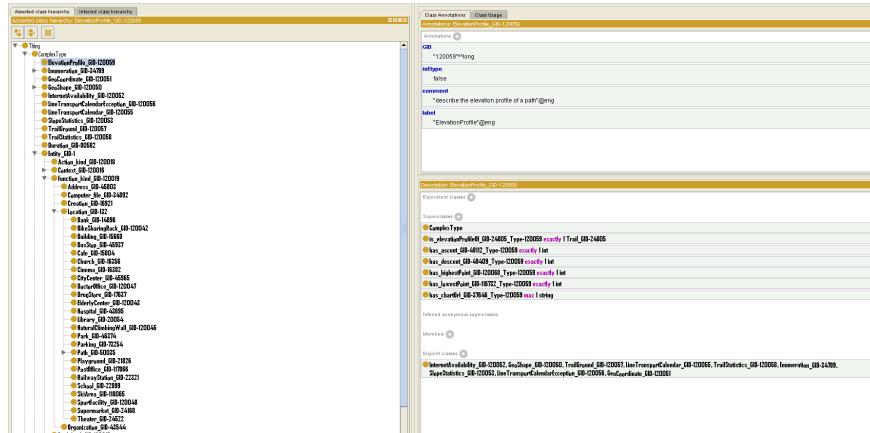
- Drug Store_GID-17637



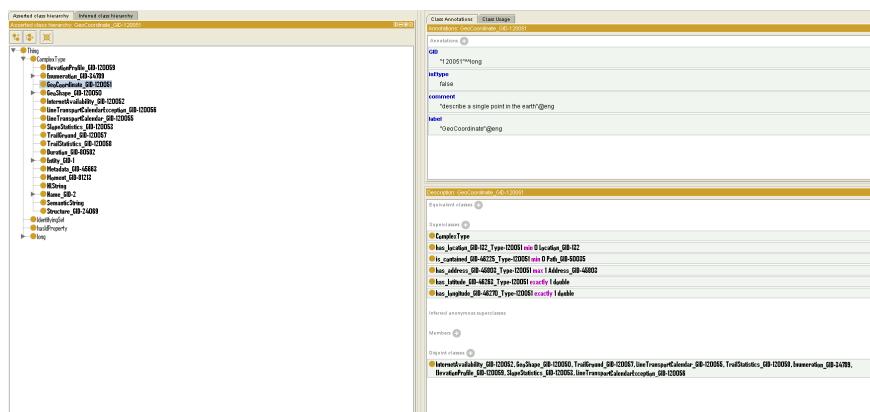
- Eldery Center_GID-120043



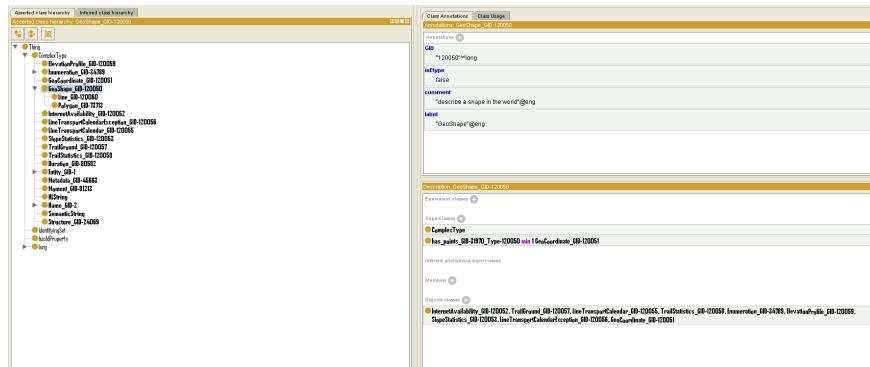
- Elevation Profile_GID-120059



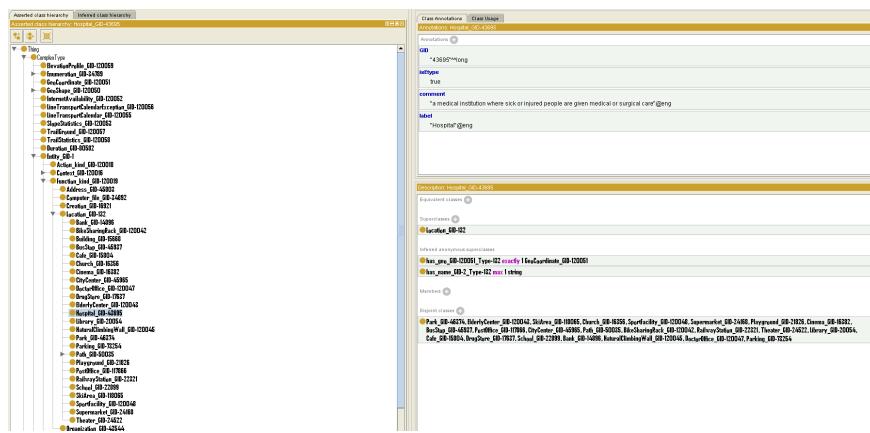
- #### ● GeoCoordinate GTD=120051



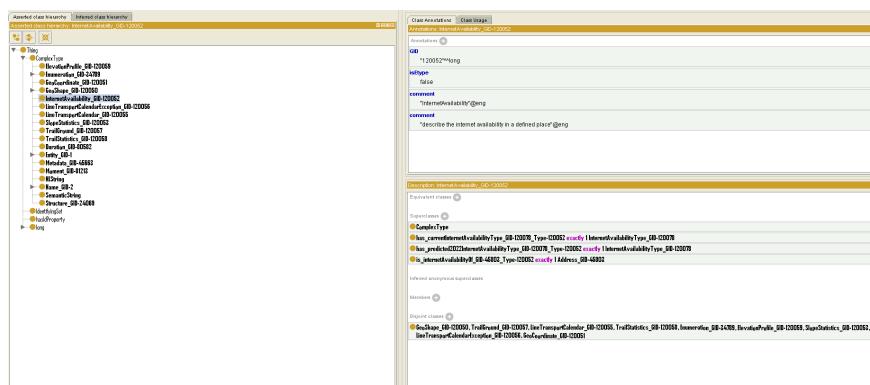
- GeoShape_GID-120050



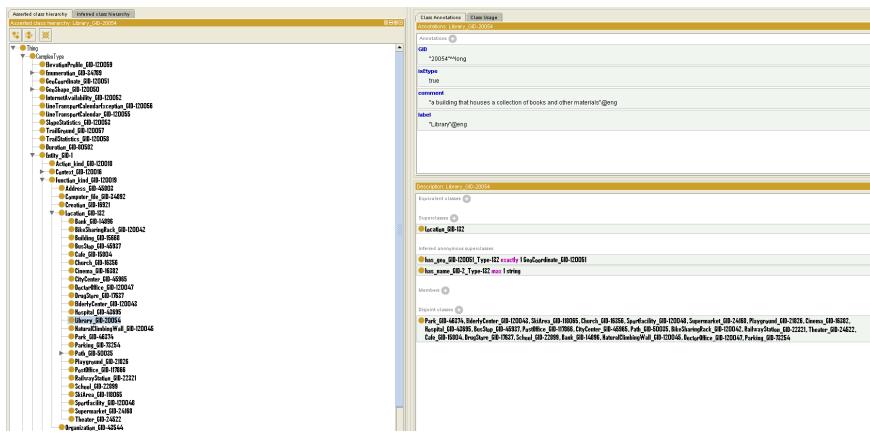
- Hospital_GID-43695



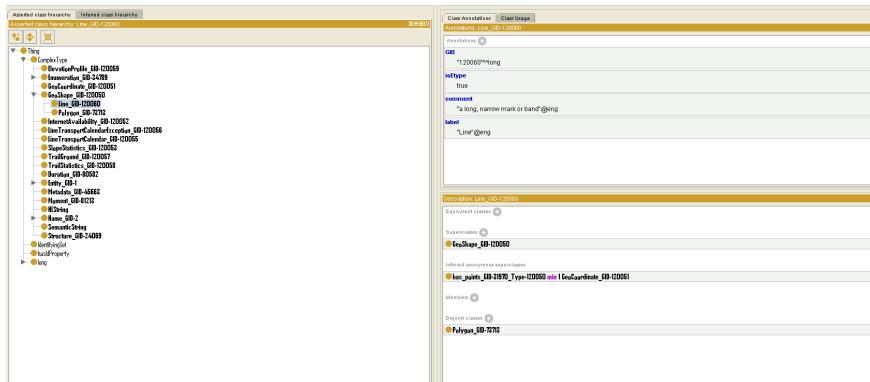
- Internet Availability_GID-120052



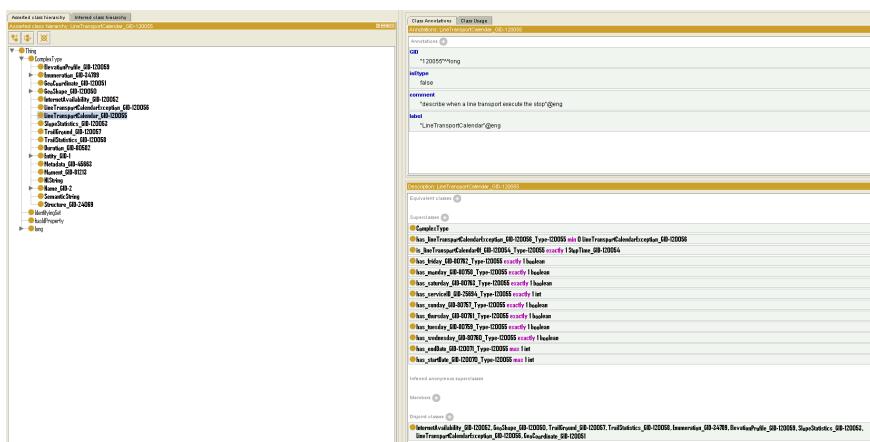
- Library_GID-20054



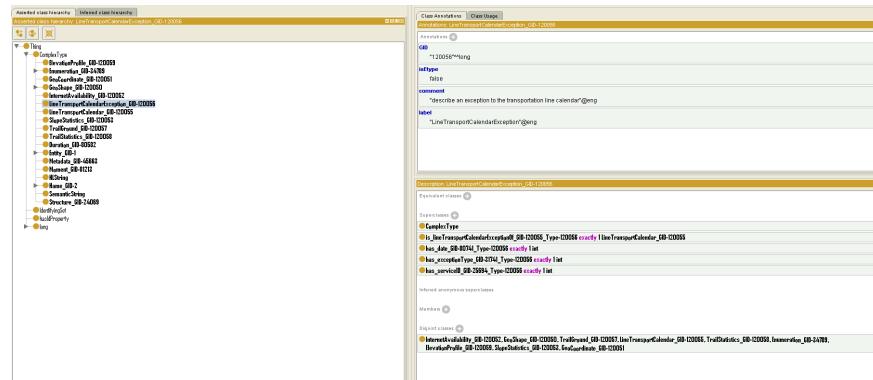
- Line_GID-120060



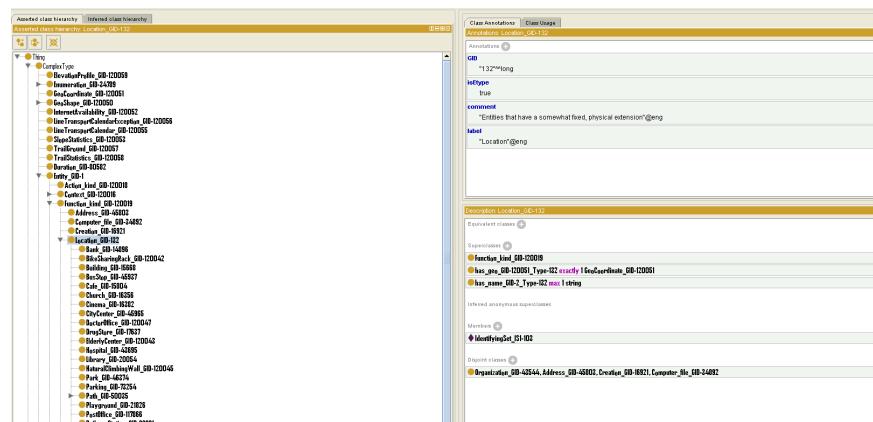
- Line Transport Calendar_GID-120055



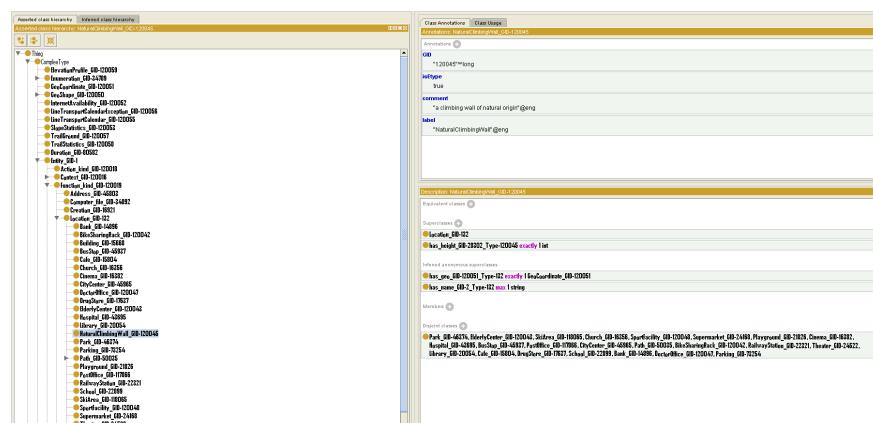
- Line Transport Calendar Exception.GID-120056



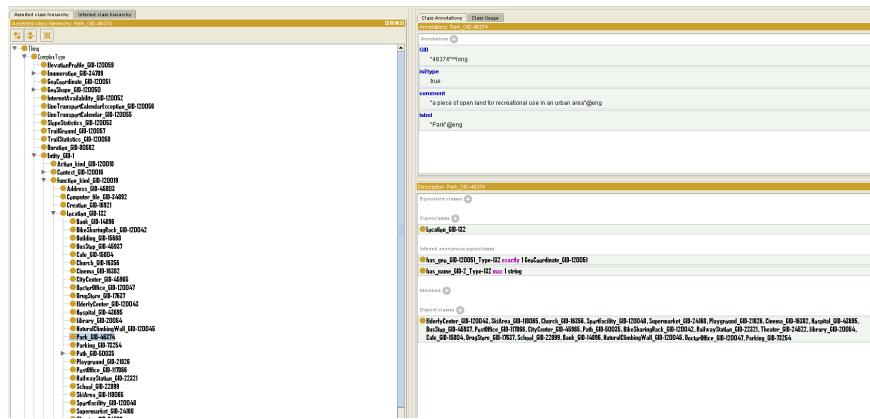
- Location_GID-132



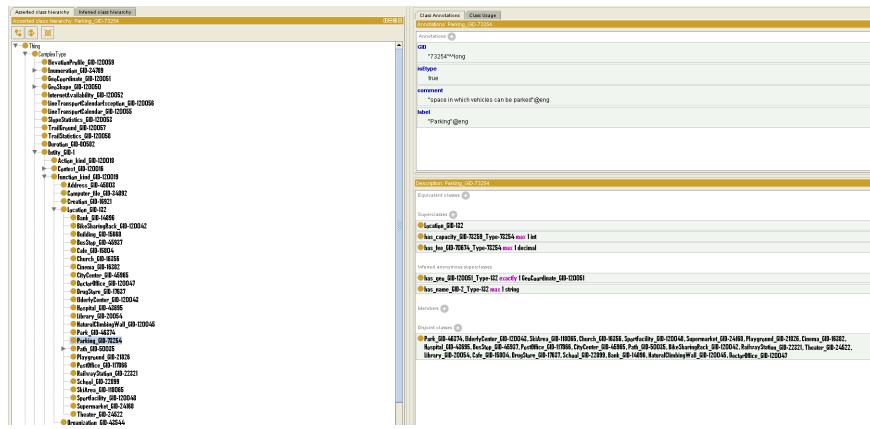
- Natural Climbing Wall_GID-120045



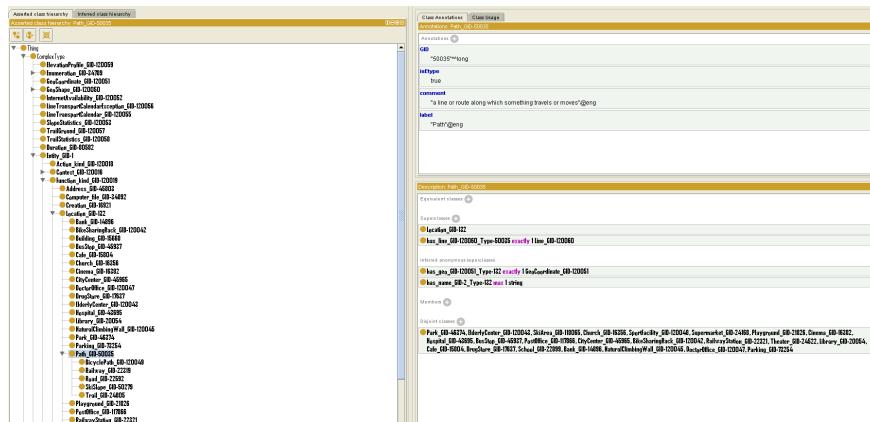
- Park_GID-46374



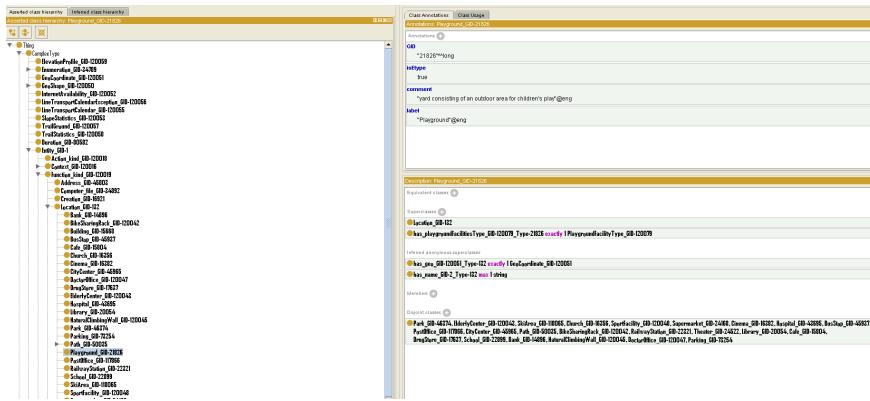
- Parking_GID-73254



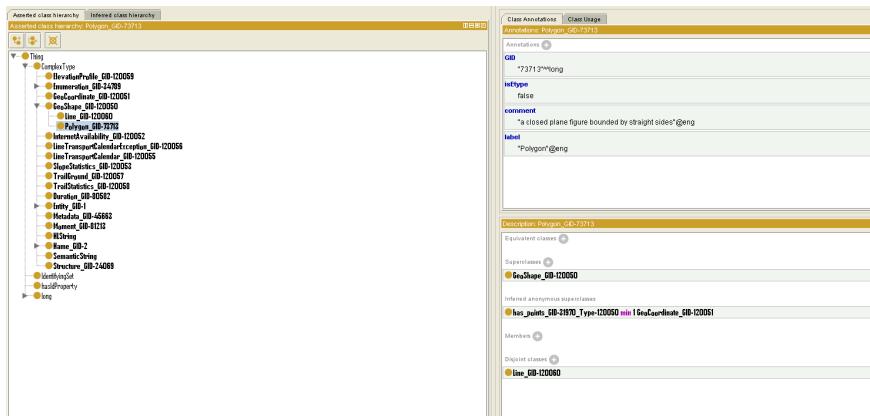
- Path_GID-50035



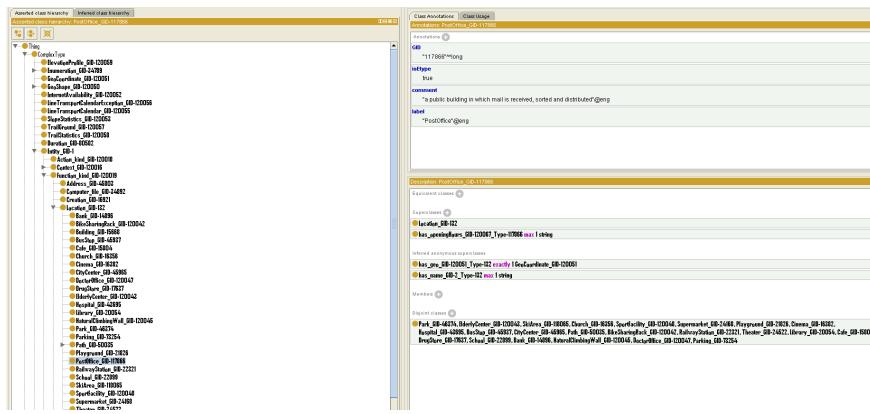
- Playground_GID-21826



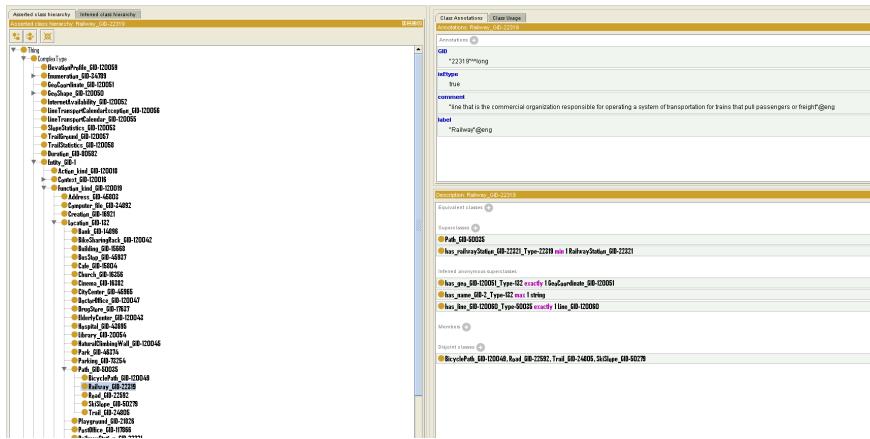
- Polygon_GID-73713



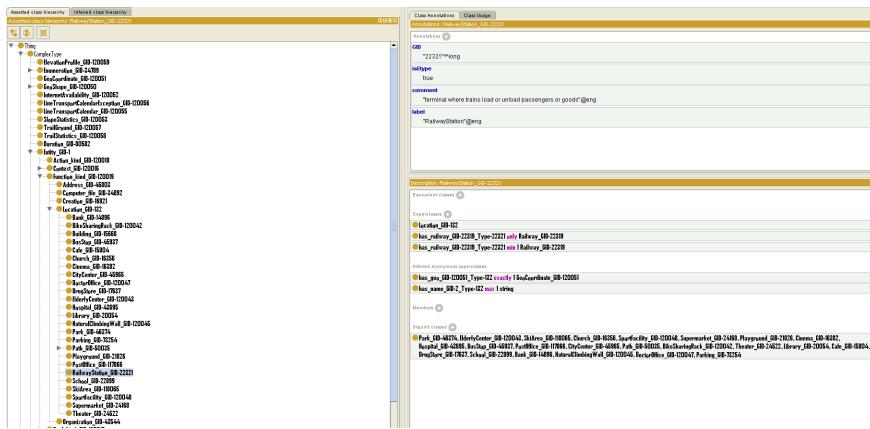
- Post Office_GID-117866



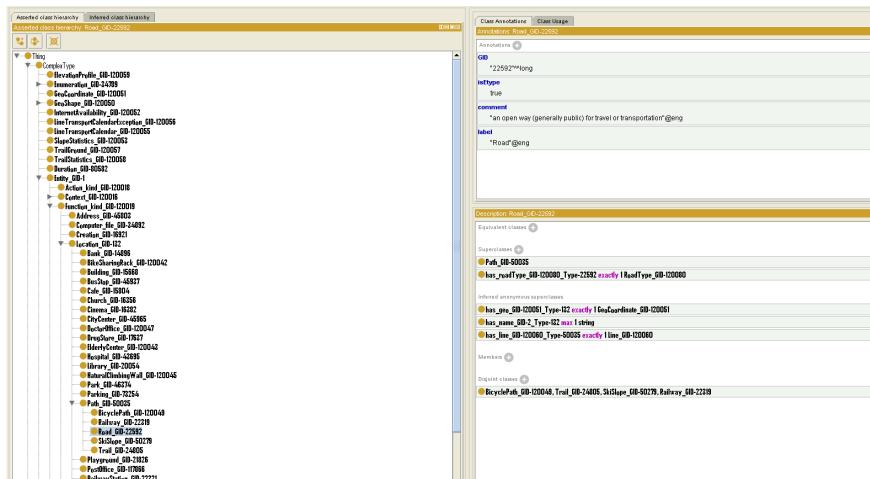
- Railway_GID-22319



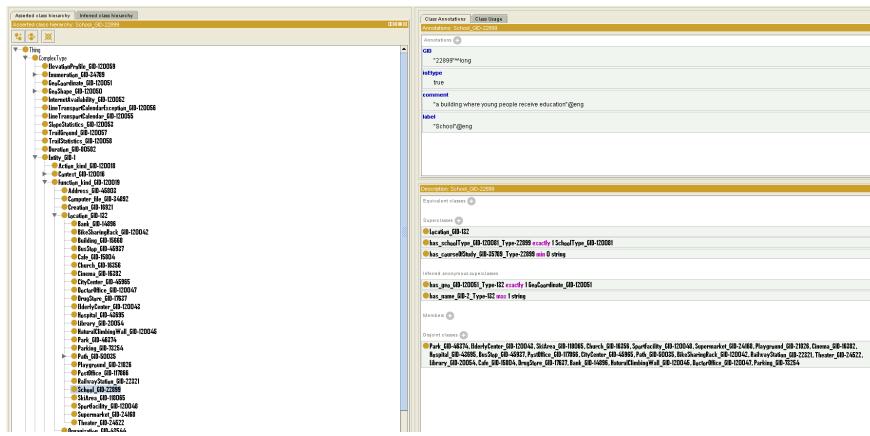
- Railway_Station_GID-22321



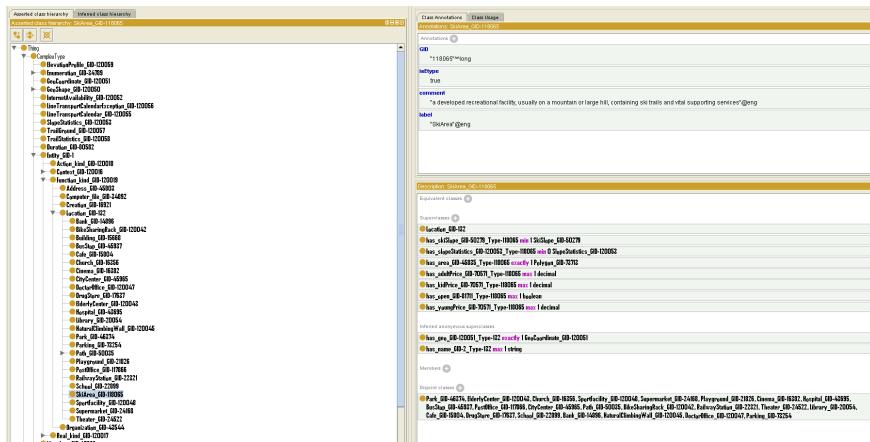
- Road_GID-22592



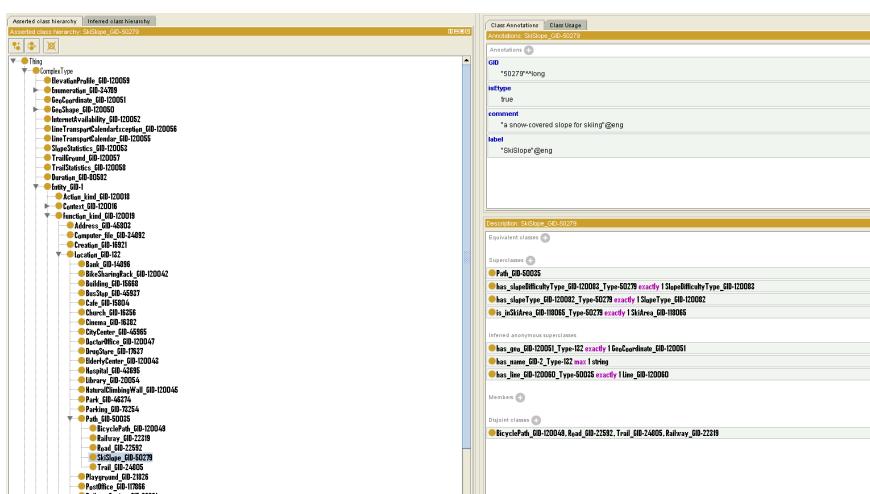
- School_GID-22899



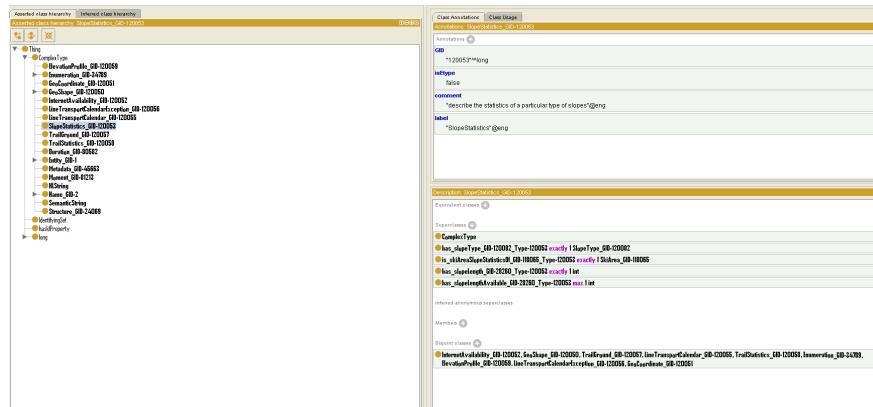
- Ski Area_GID-118065



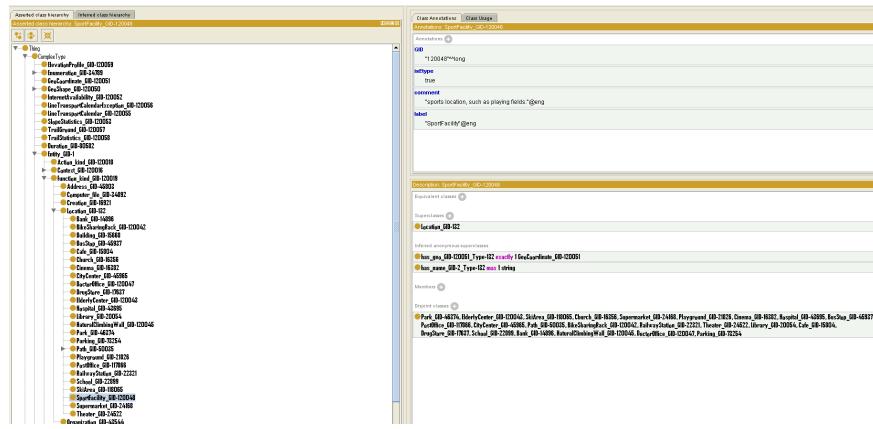
- Ski Slope_GID-50279



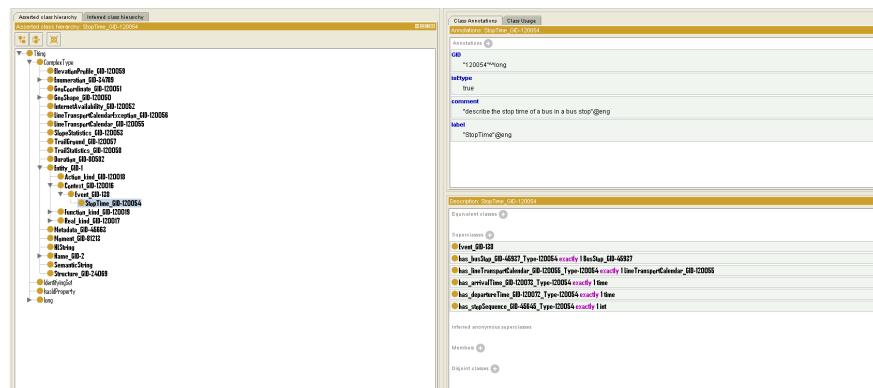
- Slope Statistics_GID-120053



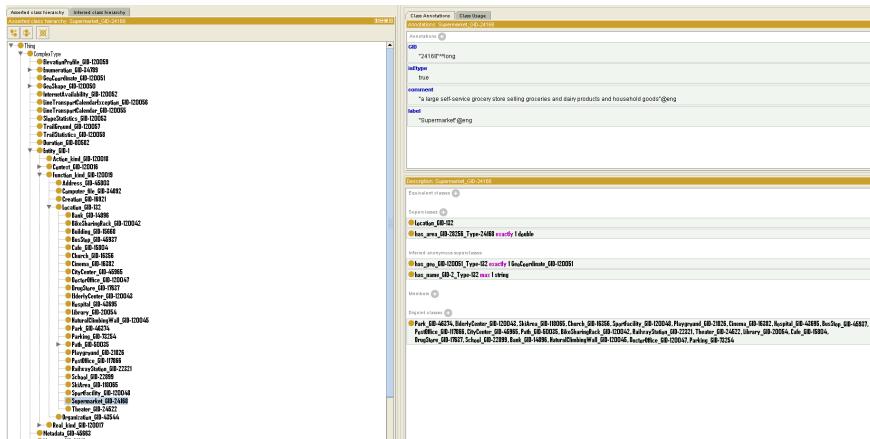
- Sport Facility_GID-120048



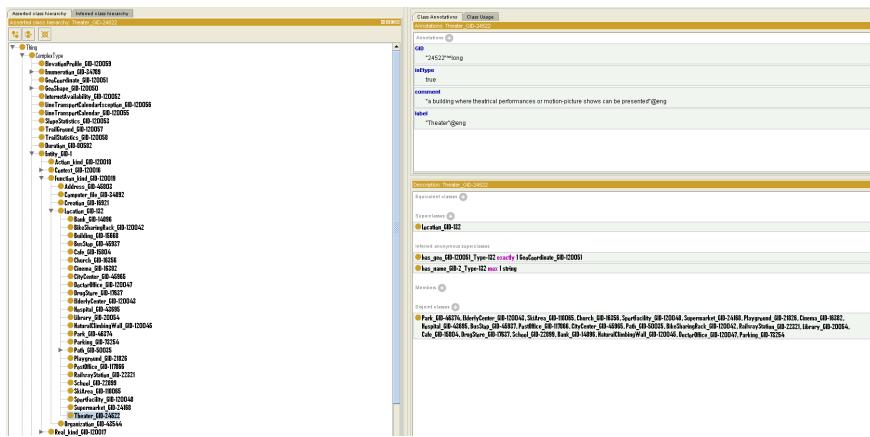
- Stop Time_GID-120054



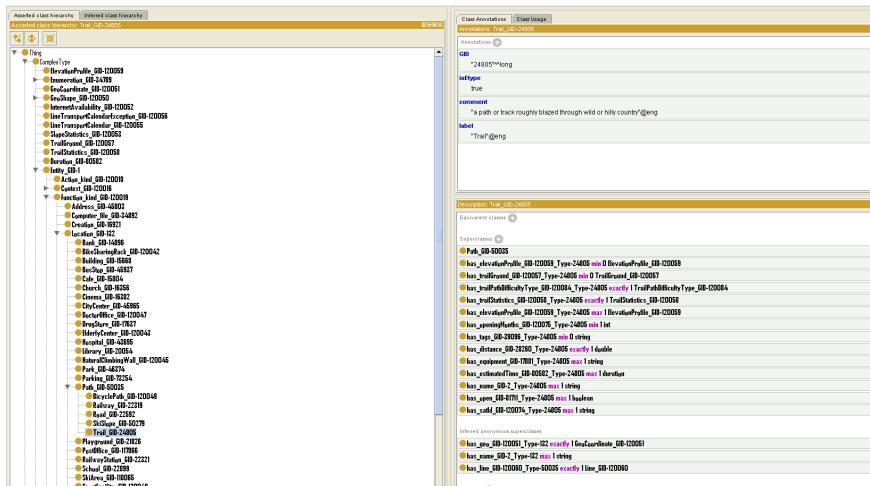
- Supermarket_GID-24168



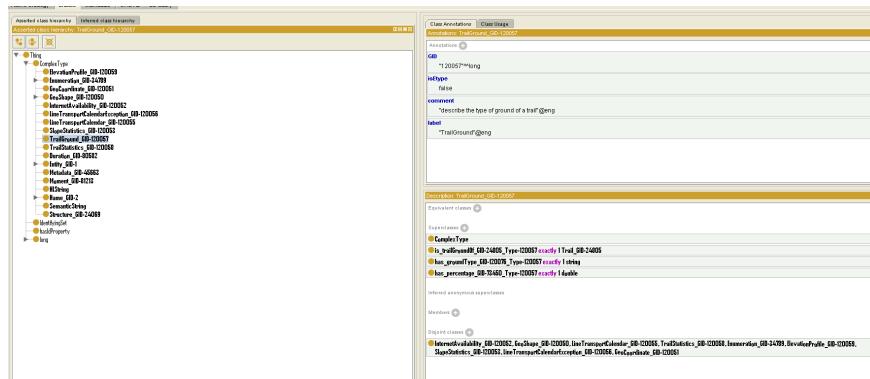
- Theater_GID-24522



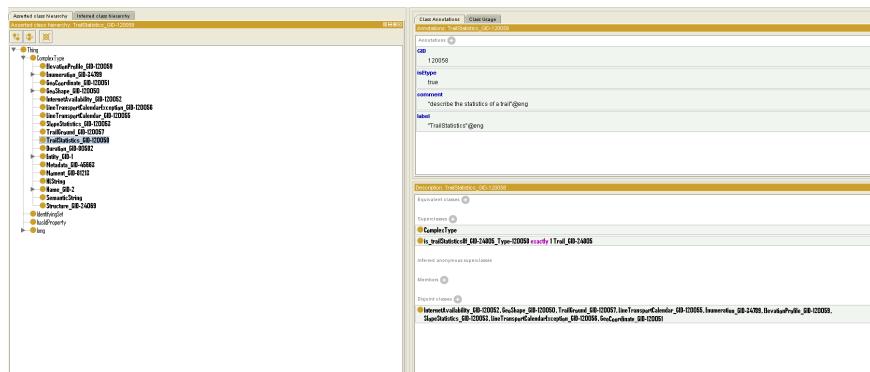
- Trail_GID-24805



- Trail_Ground_GID-120057



- Trail_Statistics_GID-120058



2.4.6.1 Variance respect to the EER Model

Once the ontology has been built, this section report the differences, and so the variance, respect the EER model defined in the previous phase. This a way to define the quality of the outcomes for the current phase as well as the alignment of the overall project development process. Compared to the EER model created in the previous phase, during this formalization phase the names of both classes and some attributes were changed, two new attributes were added and a small logical change of a class was made. These changes are mainly due to the link between class and concept found in KOS that allowed us to formalize classes. In addition, attributes have been added in the School class and the Natural Climbing Wall class. This addition is derived from a deeper analysis of the datasets we had available. Other small changes in attribute nomenclature, related to Trail and Trail related classes have been applied for a matter of alignment with the Tourist Facilities group. The most important conceptual change has been made with the elimination of the classes Pleasure Path and Transportation way that have been made to collapse in a single class named Path. This modification was guided by the meaning of Path found in ontology.

2.4.6.2 Importing into the KOS system: changes and adaptations

Starting from the EER model and the ontology created and just described in order to import correctly into the KOS system we had to do some cleaning, simplification and some modification work for two main issues:

- The previous ontology was created by aligning to the concepts in the KOS system thinking of it only as a support for generating L1 and L2 annotations. Instead the system treats the concepts as an upper ontology, and for this reason the conceptual relations in the system must be aligned to the ontology we created. In the first phase we had not aligned the concepts in terms of relations, this led us to make slight changes in the EER as well.
- The KOS system did not accept many things that we had designed in protégé.

Having defined the reasons for these changes, they are summarized below:

- - Three different eTypes had their concept GIDs changed since the previous ones, while conceptually aligned were semantically inaccurate given the relationships they possessed. The concepts in question with the new GIDs are as follows:
 - Hospital_GID-19345 that now has this description: health facility where patients receive treatment
 - Library_GID-20052 that now has this description: A depository built to contain books and other materials for reading and study

-
- Railway (line)_GID-20111 that now has this description: The road consisting of railroad track and roadbed
 - The position of some eTypes within the EER has been modified. This change visible in the Figure 4 is due to the fact that some of the concepts we used had slightly different relationships than the ones we created. It can be seen in particular that some classes have been moved from being derived from location to being derived from building and also the section describing the roads has been slightly changed, keeping the class road as a more generic class and going to submit to this class the various types of roads in our data. Note in particular that we have added the class Street_GID-120106 with the following description: a public road in a city, town, or village, typically with houses and buildings on one or both sides.
 - o In addition, enumerations have also undergone a change. Initially it was thought that the ontology pattern chosen was accepted by the system. Instead at the end of the work it was decided to remove the sub-classes and to insert the various types as single data properties to the enumeration class.
 - Finally, some slight changes have been made to the nomenclature, in particular the object properties have been changed as the system only accepts those preceded by "has_".

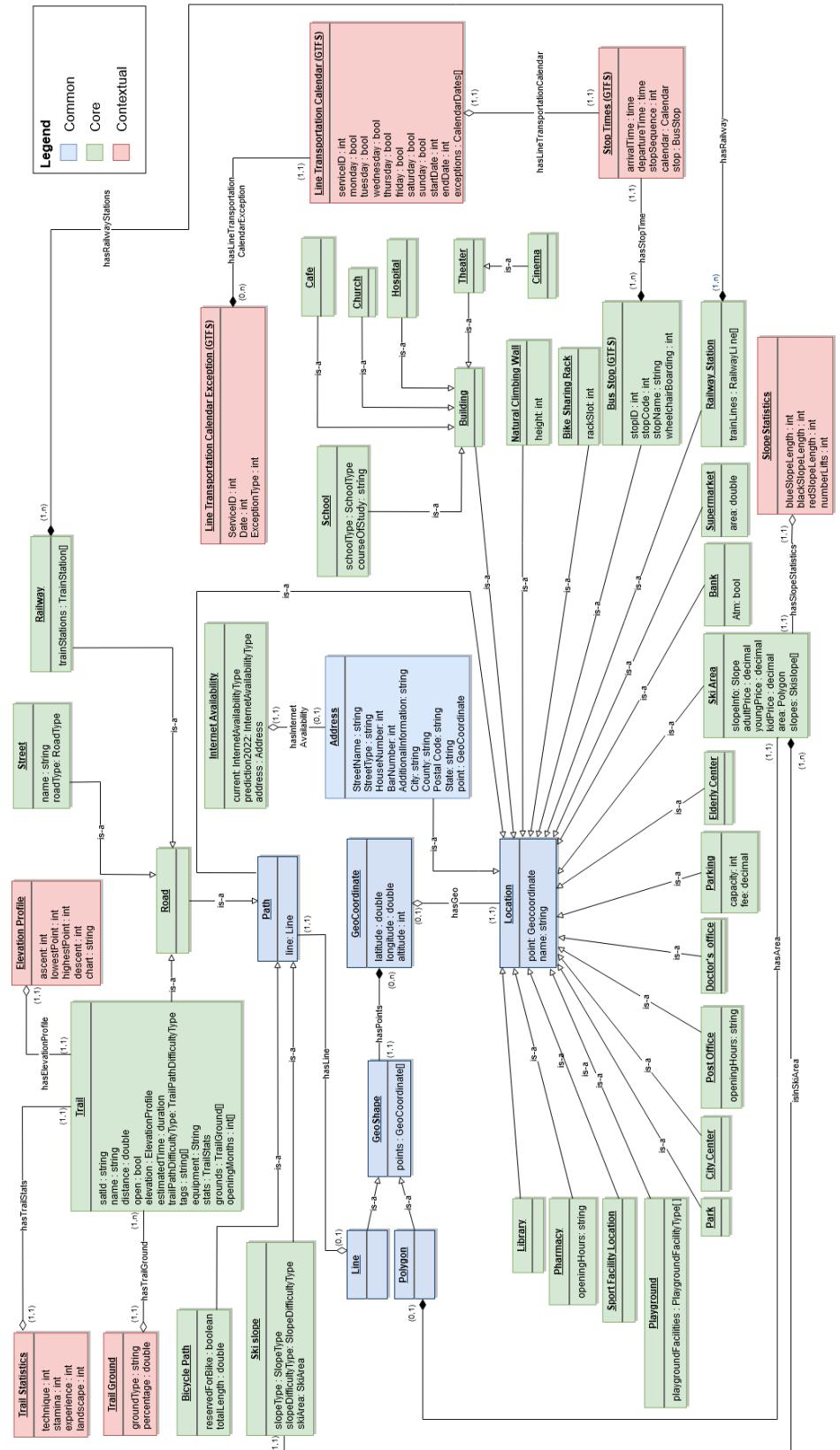


Figure 4: EER with the modification made during the execution for KOS system

2.4.7 Data level

As in the previous phase the data level section here, reports the description of the new version of the datasets, after formatting operations.

2.4.7.1 Formal Modeling datasets management

In the formal phase we organized better the data in order to align them to the ER schema:

- In the point of interests datasets we extracted some of the entities in the ER: PerformingArtsTheater, eldery center, Physician, BarOrClub, Library, SportFacilityLocation, church. We also changed the name of some attribute in order to align them with the attributes of the entities. We used the script `point_of_interests_allineation.py`⁹⁰ to make this work.
- The bikesharing datasets were merged in order to have a single file with all the bikesharing stations (renaming some attributes) using the script `bikesharing_allineation.py`⁹¹.
- The building datasets were merged in order to have all the buildings in a single file (renaming some attributes) using the script `building_allineation.py`⁹².
- The school datasets were merged in order to have all the schools in a single file renaming some attribute. We also reprojected the coordinates in the EPSG 4326 standard to align with the rest of the datasets. We used the script `school_allineation.py`⁹³ to do this work.
- The rest of the datasets were aligned using the script `everything_allineation.py`⁹⁴ which it has renamed some of the attributes in order to align with the ER and it has reprojected the coordinates present in `piste_ciclabili.json` in the EPSG 4326 standard. It rename also the attributes in the metadatas.

2.4.7.2 Datasets metadata documentation

In this section eventually new metadata information are added in order to describe the evolution of the datasets.

`areaski_METADATA.json`:

| Dataset Properties | Description | Type | Data Definition |
|-----------------------------|--|----------|-----------------|
| <code>type</code> | FeatureCollection | | |
| <code>generator</code> | overpass-ide | | |
| <code>copyright</code> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <code>timestamp</code> | 2020-10-19T19:05:03Z | | |
| Attributes | | | |
| <code>name</code> | name of data | string | |
| <code>GeoShape</code> | object containing location information | GeoShape | Common |
| <code>id</code> | name that identifies a unique object | string | |
| <code>type</code> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <code>GeoCoordinates</code> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

`bank_METADATA.json`:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------------|-----------------------|--------|-----------------|
| <code>type</code> | FeatureCollection | | |
| <code>generator</code> | overpass-ide | | |
| <code>source</code> | www.openstreetmap.org | | |
| <code>copyright</code> | ODbL | | |
| <code>timestamp</code> | 2020-10-19T13:50:02Z | | |
| <code>update_frequency</code> | no update | | |
| <code>Geographical Coverage</code> | Provincia di Trento | | |
| <code>format</code> | json | | |
| Attributes | | | |
| <code>name</code> | name of the facility | string | core |

⁹⁰https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/point_of_interests_allineation.py

⁹¹https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/bikesharing_allineation.py

⁹²https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/building_allineation.py

⁹³https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/school_allineation.py

⁹⁴https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/code/everything_allineation.py

| | | | |
|-------------------------|--|----------|--------|
| <i>atm</i> | indicate the presence of an atm | boolean | core |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:street</i> | the street component of the address | string | common |
| <i>addr:city</i> | the city component of the address | string | common |
| <i>addr:postcode</i> | the postcode component of the address | string | common |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

busstop_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-----------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>copyright</i> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <i>timestamp</i> | 2020-10-19T10:54:03Z | | |
| Attributes | | | |
| <i>name</i> | name that identifies the name of the bus-stop | string | |
| <i>addr:city</i> | name identifying the name of the city where the bus stop is located | string | |
| <i>addr:postcode</i> | number identifying the postcode of the city where the bus stop is located | int | |
| <i>addr:street</i> | name identifying the name of the street where the bus stop is located | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | name that identifies a unique object | string | |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

cinema_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>copyright</i> | The data included in this document is from www.openstreetmap.org. The data is made available under ODbL. | | |
| <i>timestamp</i> | 2020-10-19T15:03:03Z | | |
| Attributes | | | |
| <i>name</i> | Identifies the name of the cinema | string | |
| <i>addr:city</i> | Identifies in term of cities the position of the cinema | string | |
| <i>addr:housenumber</i> | Identifies the house number of the cinema | int | |
| <i>addr:postcode</i> | Identifies the postcode of the cities where the cinema is located | int | |
| <i>addr:street</i> | Identifies the street name where the cinema is located | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

city_center_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |

| | | | |
|------------------------------|--|----------|--------|
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T10:54:03Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | the name of the area | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

climb_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:21:03Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | Identifies the name of the climb | string | core |
| <i>addr:housenumber</i> | Indicates the housenumber in the address information | string | common |
| <i>addr:postcode</i> | Indicates the postcode in the address information | int | common |
| <i>addr:street</i> | Indicates the street in the address information | string | common |
| <i>opening_hours</i> | Indicates the opening hours of the climb spot | string | core |
| <i>height</i> | Indicates the height of the climbing | int | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | Used to univocally identifies the object | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

park_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------------------|--|---------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:30:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>leisure</i> | type of facility inside | string | core |
| <i>name</i> | the name of the facility | string | core |
| <i>playground</i> | describe the type of playground available | string | contextual |
| <i>playground:basketswing</i> | describe if the facility have a basketswing | boolean | contextual |
| <i>playground:chain_ladder</i> | describe if the facility have a chain ladder | boolean | contextual |
| <i>playground:slide</i> | describe if the facility have a slide | boolean | contextual |
| <i>playground:swing</i> | describe if the facility have a swing | boolean | contextual |
| <i>opening_hours</i> | the opening hours of the park | string | contextual |
| <i>addr:city</i> | the city component of the address | string | common |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:postcode</i> | the postal code component of the address | string | common |

| | | | |
|--|---|----------|------------|
| <i>addr:street</i> | the street component of the address | string | common |
| <i>playground:aerialrotator</i> | describe if the facility have an aerialrotator | boolean | contextual |
| <i>playground:basketball_backboard</i> | describe if a zone where play basketball is available | boolean | contextual |
| <i>playground:exercise</i> | describe if an equipment are for the exercise is present | boolean | contextual |
| <i>playground:horizontal_bar</i> | describe if an horizontal bar is present | boolean | contextual |
| <i>playground:seesaw</i> | describe if an seesaw is present | boolean | contextual |
| <i>playground:tunnel_tube</i> | describe if an tunnel tube is present | boolean | contextual |
| <i>playground:climbingframe</i> | describe if a climbing frame is present | boolean | contextual |
| <i>playground:multi_play</i> | describe if a multiple usage surface is available | boolean | contextual |
| <i>playground:sandpit</i> | describe if a sandpit is present | boolean | contextual |
| <i>playground:theme</i> | describe the theme of the park | string | contextual |
| <i>playground:skate_equipment</i> | describe if the park is equipment to play with the skateboard | boolean | contextual |
| <i>playground:teenshelter</i> | describe if a teen shelter is available | boolean | contextual |
| <i>playground:water</i> | describe if a water playground is available | boolean | contextual |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | name that identifies a unique object | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

parking_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T09:57:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>fee</i> | The fee tag is for specifying whether a fee is usually charged for a service, or for access. | boolean | core |
| <i>capacity</i> | max capacity of the parking lot | int | core |
| <i>name</i> | name of the location | string | core |
| <i>addr:city</i> | name of the city | string | common |
| <i>addr:housenumber</i> | civic code | int | common |
| <i>addr:postcode</i> | postal code of the location | int | common |
| <i>addr:street</i> | street address of the location | string | common |
| <i>opening_hours</i> | day and hours of opening | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

pharmacy_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|-----------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:28:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |

| | | | |
|-------------------------|--|----------|--------|
| <i>name</i> | name of the location | string | core |
| <i>addr:city</i> | city of the location | string | common |
| <i>addr:housenumber</i> | civic code | int | common |
| <i>addr:postcode</i> | postcode of the location | int | common |
| <i>addr:street</i> | street address of the location | string | common |
| <i>opening_hours</i> | day and hours of opening | string | common |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

post_office_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T15:26:03Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>addr:city</i> | city component of the address | string | common |
| <i>addr:housenumber</i> | the house number component of the address | string | common |
| <i>addr:postcode</i> | the postal code component of the address | string | common |
| <i>addr:street</i> | the street component of the address | string | common |
| <i>name</i> | the name of the facility | string | core |
| <i>opening_hours</i> | the opening hours of the facility | string | core |
| <i>addr:province</i> | the province component of the address | string | common |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | name that identifies a unique object | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

railway_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T18:07:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of te location | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

roads_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------------|------|-----------------|
| <i>type</i> | FeatureCollection | | |

| | | | |
|------------------------------|--|----------|------------|
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-20T07:44:03Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>highway</i> | type of road (trunk,primary, secondary, tertiary) | string | contextual |
| <i>name</i> | name of the road | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

skislopes_METADATA.json:

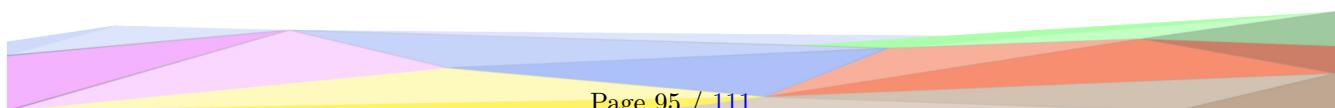
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T19:07:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the ski slopes | string | core |
| <i>piste:type</i> | type of the skiing available (nordic, downhill) | string | core |
| <i>piste:difficulty</i> | difficulty level of the skislope (easy, intermediate, advanced) | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

supermarket_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:28:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | name of the supermarket | string | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification code | string | core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

trails_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------|------|-----------------|
|--------------------|-------------|------|-----------------|



| | | | |
|------------------------------|---|------------------|--------|
| <i>lastModifiedAt</i> | 2020-07-02T08:14:00.000Z | | |
| <i>source</i> | www.outdooractive.com | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>sat_Id</i> | trail id in the SAT registry | String | |
| <i>trainType</i> | specifies whether the trail is a hiking, biking or snowshoe trail | String | |
| <i>name</i> | name of the trail | String | |
| <i>distance</i> | length of the trail | Double | |
| <i>open</i> | whether the trail is currently open | Boolean | |
| <i>elevation</i> | elevation details | ElevationProfile | |
| <i>estimatedTime</i> | detail on the estimated time required | Duration | |
| <i>startRoute</i> | starting point for the trail | LocationPoint | |
| <i>endRoute</i> | ending point of the trail | LocationPoint | |
| <i>route</i> | collection of points marking the trail path | Route | |
| <i>difficulty</i> | description of the trail difficulty | String | |
| <i>tags</i> | array of tags | array | |
| <i>equipment</i> | equipments needed for the trail | String | |
| <i>stats</i> | scores for the trail | TrailStats | |
| <i>grounds</i> | array of types of grounds in the trail | array | |
| <i>monthTips</i> | optional monthly variance details | array | |
| <i>metadata</i> | metadata | MetaData | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

building_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|-------------|------------------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-10-19T13:50:02Z | | |
| <i>update_frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | identification of the record | string | Core |
| <i>city</i> | city of the building | string | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

civici_web_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|-------------|------------------------|
| <i>Dataset ID</i> | 4f474fc8-181d-4b15-9ee4-60b3f54f4068 | | |
| <i>Source</i> | https://dati.trentino.it/dataset/comune-di-trento-numeri-civici | | |
| <i>Release date</i> | 22-02-2013 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | comune di Trento | | |
| <i>Temporal extension</i> | 'From': '22-02-2013' | | |
| <i>Holder</i> | 'Name': 'Comune di Trento', 'Code IPA/IVA': 'c_l378' | | |
| <i>Update frequency</i> | daily | | |

| | | | |
|-----------------------|--|----------|--------|
| Format | json | | |
| Attributes | | | |
| <i>civico_num</i> | civic number (without slash) | string | common |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>address</i> | street description | string | common |
| <i>city</i> | Cadastral community | string | common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

piste_ciclabili_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|-------------------------------------|---|-------------|------------------------|
| <i>Dataset ID</i> | c.l378-1129110 | | |
| <i>Holder</i> | 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c.l378' | | |
| <i>Release date</i> | 09-11-2017 | | |
| <i>Modification date</i> | 08-05-2019 | | |
| <i>Geographical Coverage</i> | Comune di Trento | | |
| <i>Source</i> | https://dati.trentino.it/dataset/piste-ciclabili-open-data | | |
| <i>GeoNames URI</i> | http://www.geonames.org/6541469 | | |
| <i>Dataset language</i> | italiano | | |
| <i>Update frequency</i> | continuous updating | | |
| <i>Format</i> | json | | |
| Attributes | | | |
| <i>tipo</i> | name of the typology of path (not useful) | string | |
| <i>descrizione</i> | name of the path (equivalent to 'fumetto') | string | common |
| <i>tipologia</i> | path dedicated only to cycle or also pedestrian | string | core |
| <i>tratto isolato ciclabile</i> | meters without path dedicated to cycle | int | core |
| <i>tratto isolato ciclopedenale</i> | meters without path dedicated to cycle or pedestrian | int | core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>address</i> | name of the path | string | common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

schools_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|-------------|------------------------|
| <i>high_school</i> | 'Release date': '19-09-2020', 'source': ' https://www.comuniecitta.it/scuole-secondarie-di-secondo-grado/comune-di-trento-22205 ', 'Geographical Coverage': 'Provincia di Trento', 'Update frequency': 'unknown', 'Format': 'json' | | |
| <i>middle_school</i> | 'Dataset ID': 'c.l378-1129125', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'URI di GeoNames': ' http://www.geonames.org/6541469 ', 'source': ' https://dati.trentino.it/dataset/localizzazioni-delle-scuole-medie-open-data ', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c.l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |
| <i>nursery_school</i> | 'Dataset ID': 'c.l378-1129127', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'source': ' https://dati.trentino.it/dataset/localizzazioni-scuole-dell-infanzia-open-data ', 'GeoNames URI': ' http://www.geonames.org/6541469 ', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c.l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |

| | | | |
|--------------------------|---|----------|--------|
| <i>elementary_school</i> | 'Dataset ID': 'c_l378-1129126', 'Release date': '09-11-2017', 'Modification date': '08-05-2019', 'Geographical Coverage': 'Provincia di Trento', 'Source': 'https://dati.trentino.it/dataset/localizzazione-delle-scuole-elementari-open-data', 'GeoNames URI': 'http://www.geonames.org/6541469', 'Holder': 'Nome': 'Comune di Trento', 'Code IPA/IVA': 'c_l378', 'Update frequency': 'continuously updated', 'Format': 'json' | | |
| Attributes | | | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>HouseNumber</i> | civic number | string | Common |
| <i>address</i> | street address | string | Common |
| <i>city</i> | suburb of the school | string | Common |
| <i>name</i> | name of the school | string | Core |
| <i>SchoolType</i> | type of school (nursery, elementary, middle, high) | string | Core |
| <i>study paths</i> | the study paths offered from the school (comma separated) | string | Core |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

bikesharing_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/dataset/stazioni-bike-sharing-emotion-trentino | | |
| <i>format</i> | json | | |
| <i>timestamp</i> | 2020-10-18 | | |
| <i>Dataset ID</i> | p_TN:9b9c14d6-ee20-4802-a274-4c17ac96cd5 | | |
| <i>Temi del dataset</i> | 'Trasporti': '[4816 trasporti terrestri', '4806 politica dei trasporti]', 'Energia': '[6626 energia dolce', '6606 politica energetica'] | | |
| <i>Dataset publisher</i> | 'Nome': 'Servizio Trasporti pubblici', 'Codice IPA/IVA': '0OK0PZ' | | |
| <i>Release date</i> | 18-11-2014 | | |
| <i>Modification date</i> | 03-07-2017 | | |
| <i>Geographical Coverage</i> | Comune di Trento | | |
| <i>GeoNames URI</i> | http://www.geonames.org/3165241 | | |
| <i>Dataset language</i> | italiano | | |
| <i>Holder</i> | 'Nome': 'Provincia Autonoma di Trento', 'Codice IPA/IVA': 'p_TN' | | |
| <i>Upload frequency</i> | continuous | | |
| Attributes | | | |
| <i>name</i> | name of the bike station | string | Core |
| <i>address</i> | geographical address of the bike station | string | Common |
| <i>city</i> | city of the bike station | string | Common |
| <i>id</i> | identifier | string | Core |
| <i>totalSlots</i> | total number of slot bikes | int | Core |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

skiResorts_static_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|------------------------------|--|------|-----------------|
| <i>lastModifiedAt</i> | 2020-10-24 | | |
| <i>source</i> | https://www.skiresort.info/ski-resorts/trentino/ | | |
| <i>update-frequency</i> | unknown | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |

| Attributes | | | |
|-----------------------|--|----------|--------|
| <i>name</i> | Name of the ski resort | String | |
| <i>Total lenght</i> | total number of kilometers available in the resort | double | |
| <i>km blue slope</i> | number of kilometers of blue slopes in the resort | int | |
| <i>km red slope</i> | number of kilometers of red slopes in the resort | double | |
| <i>km black slope</i> | number of kilometers of black slopes in the resort | int | |
| <i>price</i> | Price per person | double | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

hospital_METADATA.json:

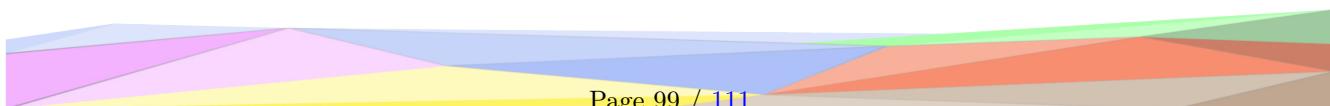
| Dataset Properties | Description | Type | Data Definition |
|------------------------------|---|----------|-----------------|
| <i>type</i> | FeatureCollection | | |
| <i>generator</i> | overpass-ide | | |
| <i>source</i> | www.openstreetmap.org | | |
| <i>copyright</i> | ODbL | | |
| <i>timestamp</i> | 2020-11-15T17:12:02Z | | |
| <i>update-frequency</i> | no update | | |
| <i>Geographical Coverage</i> | Provincia di Trento | | |
| <i>format</i> | json | | |
| Attributes | | | |
| <i>name</i> | | | |
| <i>addr:city</i> | Identifies in term of cities the position of the cinema | string | |
| <i>addr:housenumber</i> | Identifies the house number of the cinema | int | |
| <i>addr:postcode</i> | Identifies the postcode of the cities where the cinema is located | int | |
| <i>addr:street</i> | Identifies the street name where the cinema is located | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>id</i> | name that identifies a unique object | string | |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

bars_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|--|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'luoghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

churches_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|--------------------|-------------|------|-----------------|
|--------------------|-------------|------|-----------------|



| | | | |
|---------------------------|---|----------|--------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

eldery_centers_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

libraries_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|---|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'lu-oghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

theaters_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|--|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'luoghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

physician_METADATA.json:

| Dataset Properties | Description | Type | Data Definition |
|---------------------------|--|----------|-----------------|
| <i>source</i> | https://dati.trentino.it/ | | |
| <i>format</i> | json | | |
| <i>relese date</i> | 15-11-2020 | | |
| <i>Lingue del dataset</i> | italiano | | |
| <i>Upload frequency</i> | unknow | | |
| <i>Conforme a</i> | Standard: conforme a REST/JSON | | |
| <i>description</i> | dataset merged from 'luoghi_e_punti_di_interesse_per_comune' | | |
| Attributes | | | |
| <i>id</i> | identification code of the location | string | |
| <i>name</i> | name of the location | string | |
| <i>address</i> | address of the location | string | |
| <i>city</i> | city of the location | string | |
| <i>GeoShape</i> | object containing location information | GeoShape | Common |
| <i>type</i> | type of GeoShape (Line, Polygon, Point) | string | Common |
| <i>GeoCoordinates</i> | Coordinates of the location in EPSG 4326 projection standard | int[2] | Common |

2.4.7.3 Variance respect Informal Modeling datasets

The main variance respect the informal modeling dataset is caused by the *Data preparation*, which is composed by two main activities: *Data alignment* and *Data formatting*. Initially, in *informal phase*, school datasets were composed of 4 differents files: *materne*, *elementari.json*, *medie.json* and *superiori.json*. These have merged in order to obtain the unique dataset *schools.json*. An important work has been done in order to guarantee that data are in agreement with ETypes. Thus, many attribute names changed name. Then, as a problem in data format coordinates has been found, all the coordinates are aligned in the EPSG 4326 standard.

2.5 Data integration

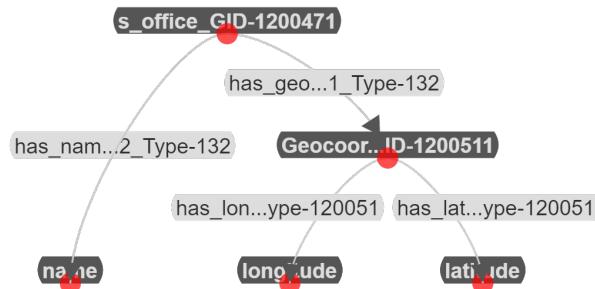
This section is dedicated to the Data Integration phase description.

2.5.1 Data integration operations and tool

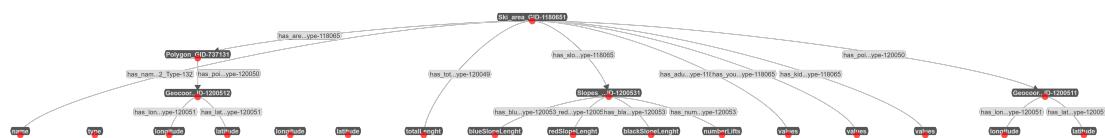
This section is dedicated to the description of the usage of the data integration tool that allows to map the datasets generated and well formatted in the previous phases, with the final ontology generated. The last datasets adaptation performed using the tool, as well as the mapping operation are here detailed.

The main tool used for the data integration phase is Karmalinker: a data linking tool allowing us to align reference data to the ontology created in the formal phase. These tool allowed us to generate three type of files for each dataset: a model file, an RDF file, and a EML file. The following list shows the model for each dataset in the footnote folder where the files are stored can be found.

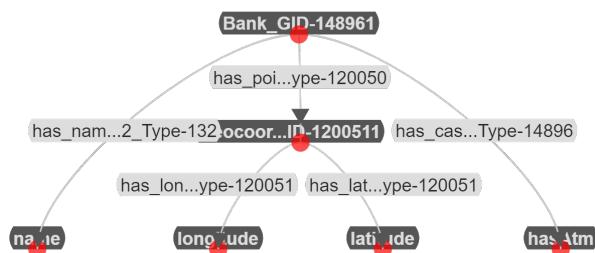
- ambulatories⁹⁵



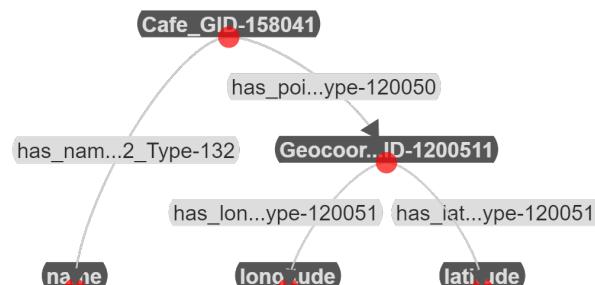
- areaSki⁹⁶



- bank⁹⁷

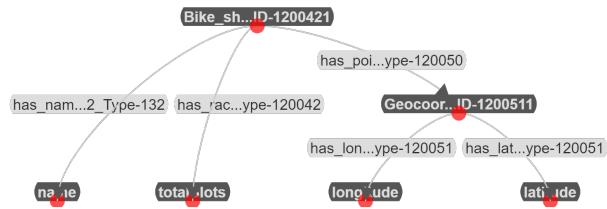


- bar⁹⁸

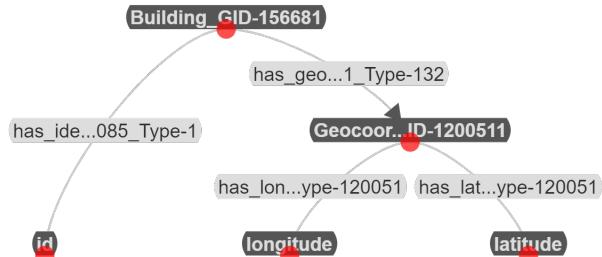


- bikesharing⁹⁹

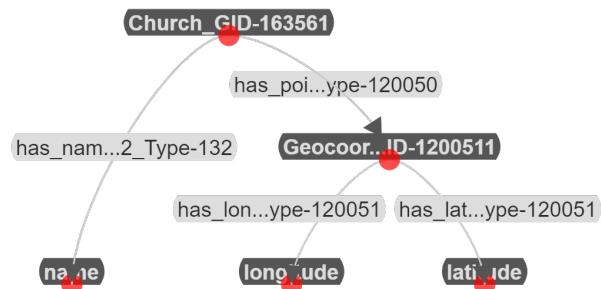
⁹⁵<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/ambulatories>
⁹⁶<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/areaSki>
⁹⁷<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/bank>
⁹⁸<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/bars>
⁹⁹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/bikesharing>



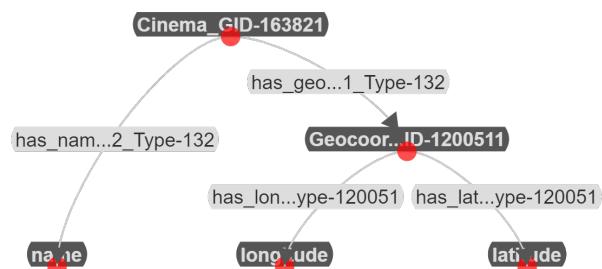
- buildings¹⁰⁰



- churches¹⁰¹



- cinema¹⁰²



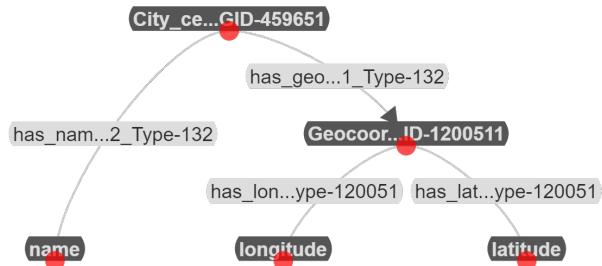
- cityCenter¹⁰³

¹⁰⁰<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/buildings>

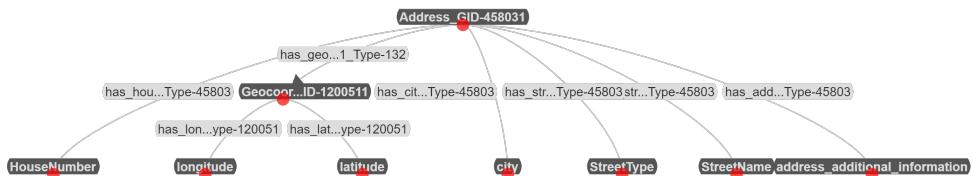
¹⁰¹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/churches>

¹⁰²<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/cinema>

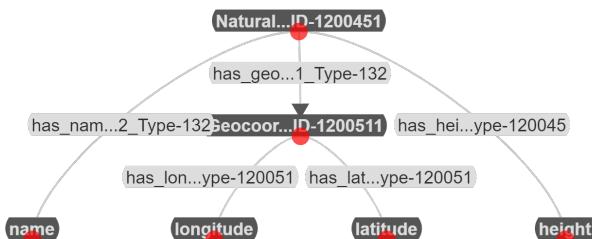
¹⁰³<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/cityCenter>



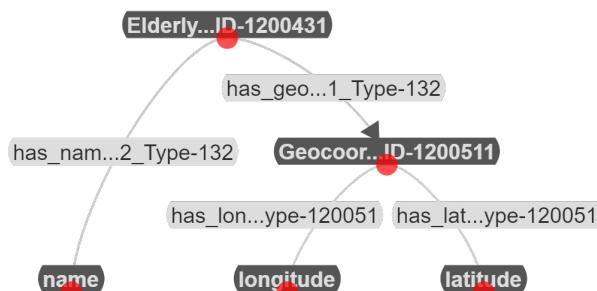
- [civiciWeb¹⁰⁴](#)



- [climb¹⁰⁵](#)



- [elderlyCenter¹⁰⁶](#)



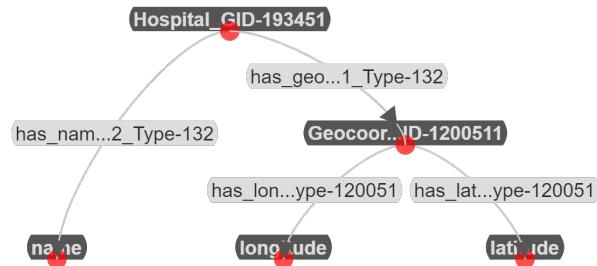
- [hospital¹⁰⁷](#)

¹⁰⁴<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/civiciWeb>

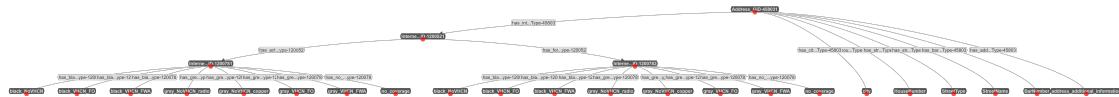
¹⁰⁵<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/climb>

¹⁰⁶<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/elderlyCenter>

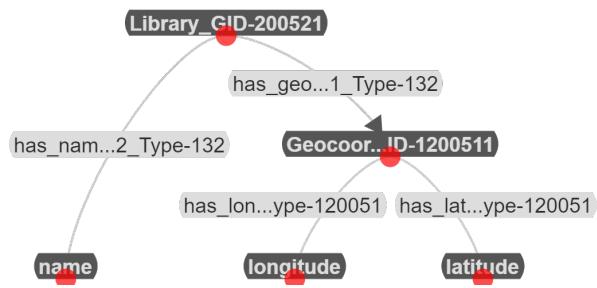
¹⁰⁷<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/hospital>



- `internetQuality`¹⁰⁸



- `libraries`¹⁰⁹

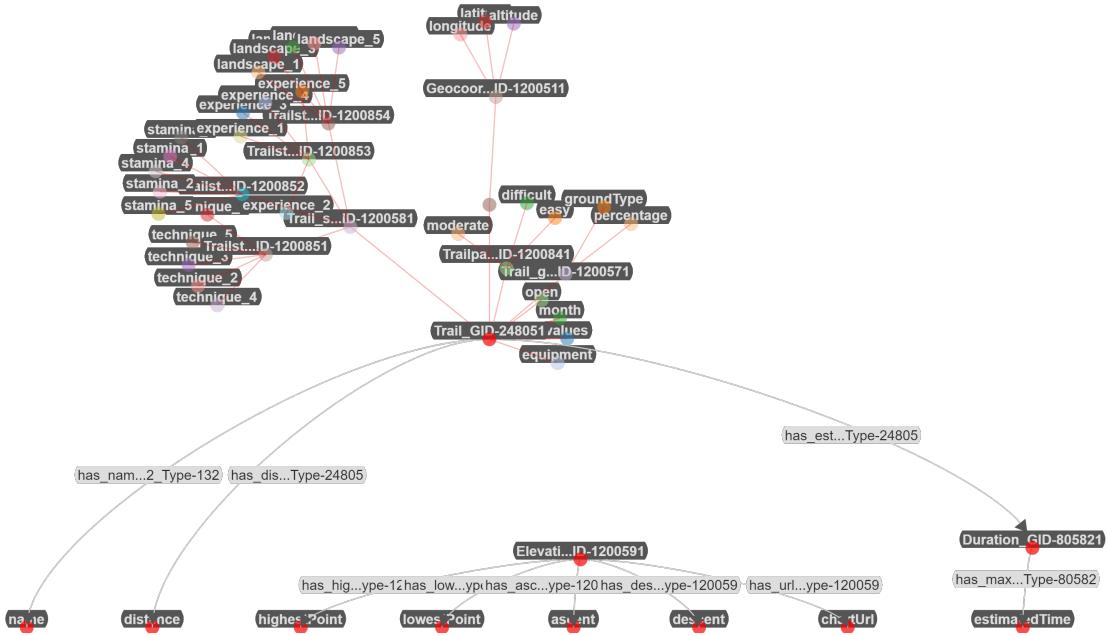


- `outdooractiveTrails`¹¹⁰

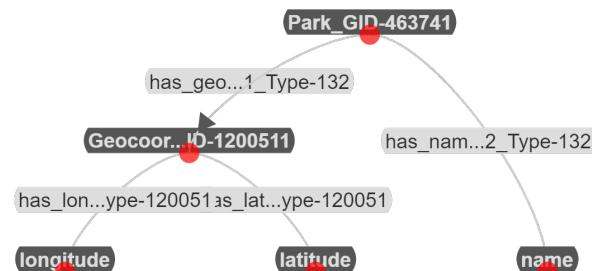
¹⁰⁸<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/internetQualityTrento>

¹⁰⁹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/libraries>

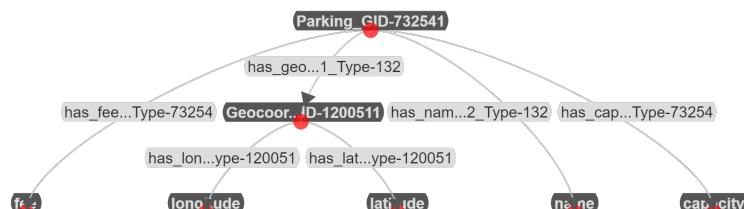
¹¹⁰<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/outdooractiveTrails>



- park¹¹¹

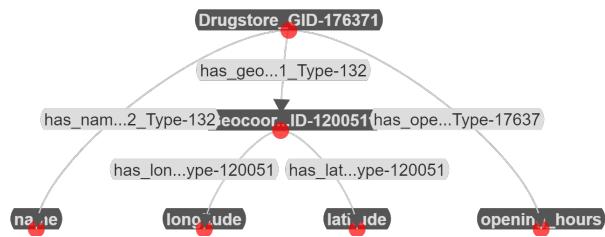


- parking¹¹²

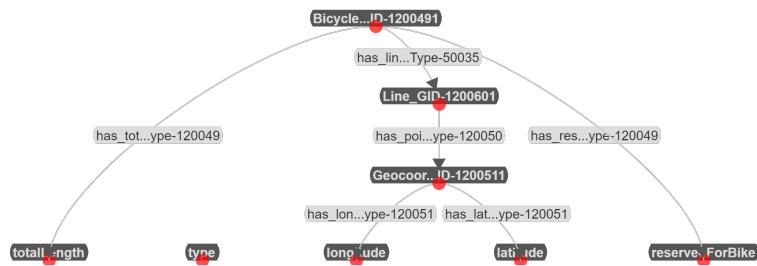


- pharmacies¹¹³

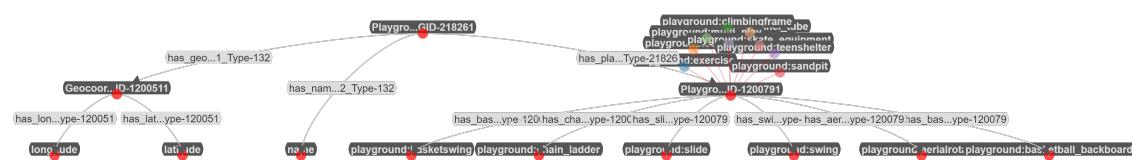
¹¹¹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/park>
¹¹²<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/parking>
¹¹³<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/pharmacy>



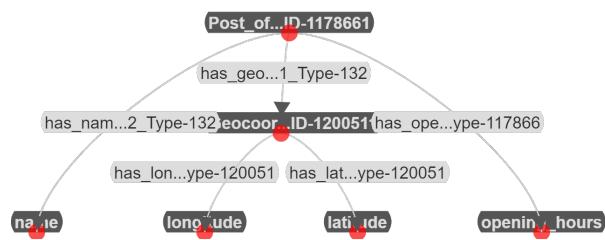
- pisteCiclabili¹¹⁴



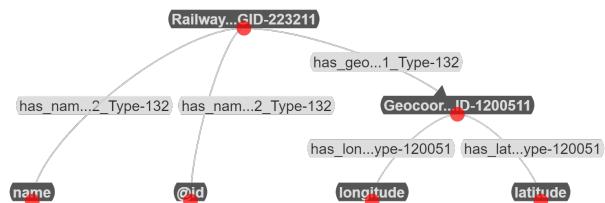
- playground¹¹⁵



- postOffice¹¹⁶



- railway¹¹⁷

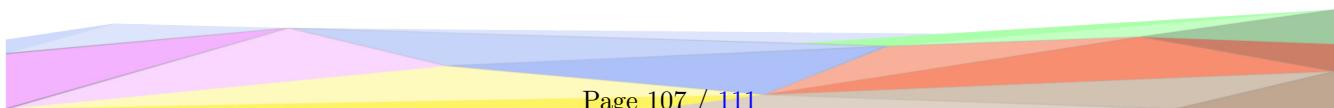


¹¹⁴<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/pisteCiclabili>

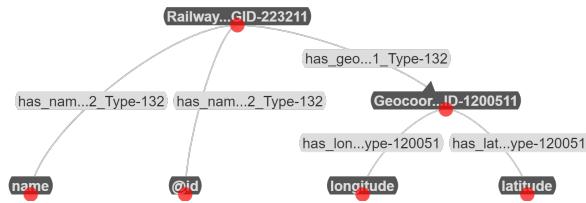
¹¹⁵<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/playground>

¹¹⁶<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/postOffice>

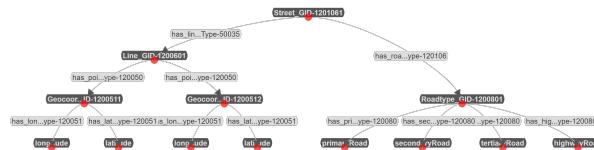
¹¹⁷<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/railway>



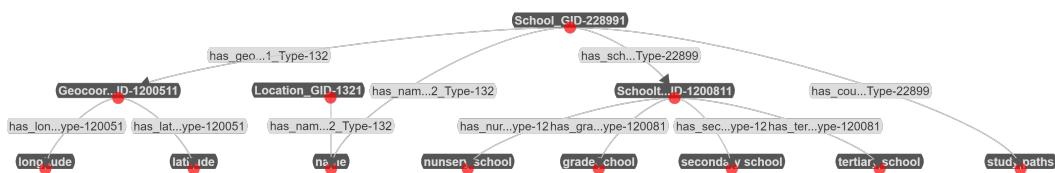
- railwayStation¹¹⁸



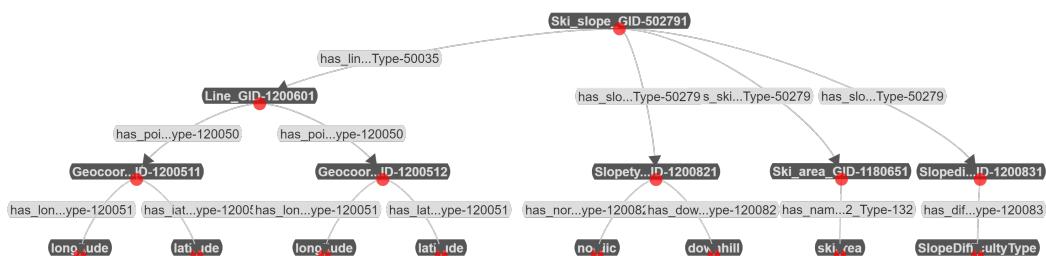
- roads¹¹⁹



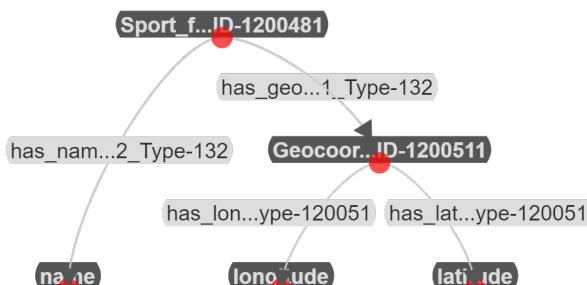
- schools¹²⁰



- skiSlopes¹²¹



- sportFacility¹²²



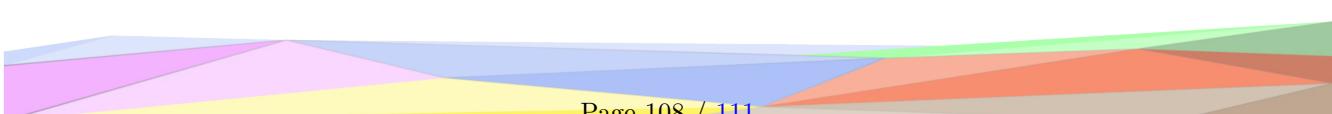
¹¹⁸<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/railwayStation>

¹¹⁹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/roads>

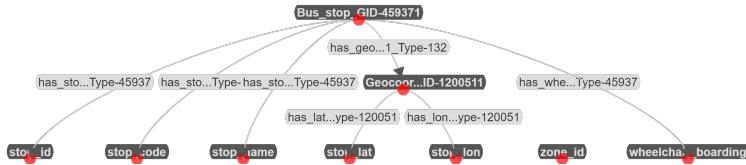
¹²⁰<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/schools>

¹²¹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/skiSlopes>

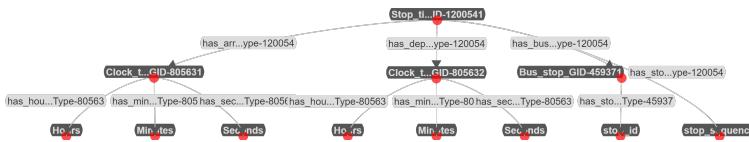
¹²²<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/sportFacility>



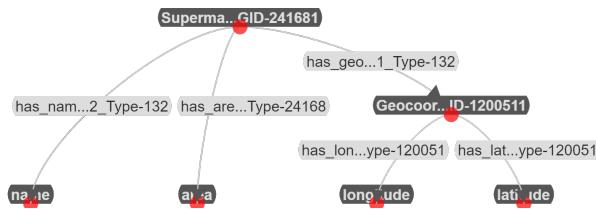
- stop¹²³



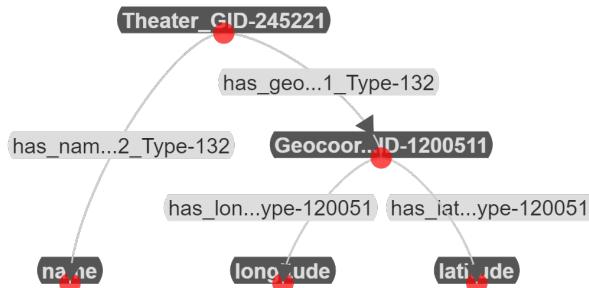
- stopTimes¹²⁴



- supermarket¹²⁵



- theater¹²⁶



2.5.2 Variance respect Formal Modeling datasets

The last section of the data integration phase aims to describe the variance, analyzing the differences, between the datasets integrated with the ontology, in the data integration platform which contain the KG, and the datasets collected in the previous phase. This analysis can highlight the results of the operations performed during the final phase of the data integration process.

In this last phase we have definitively aligned our dataset to the EER and to the ontology provided by our Knowledge Engineers.

Many operation, e.g attribute name modifications, have been applied manually. We does not use script since these procedures were very simple and does not need any complicated programmin code. Our scope was to have the same names between dataset and EER (little dissimilarity between dataset and ontology data property still exist, but do not influence the KarmaLinker mapping).

A great problem that we have solved in this last phase was the non uniform usage of the coordinates. Some location classes were described by a point, while other by a set of points. However, we wanted that all the location, such as Libraries, buildings, cafes, etc, are described by an unique point. So, we used a script which converted polygon of points of location (excluding path and location described by GeoShape, such us SkiArea, SkiSlope, path, etc) in only a point. The script (`everything_allineation.py`) works by checking if there is a set of coordinates, and in this case it computes the center of gravity.

¹²³<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/stops>

¹²⁴<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/stopTimes>

¹²⁵<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/supermarket>

¹²⁶<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/tree/master/dataset/final%20results/data/theater>

Another change in datasets occurs in the street names. The address initially included information such us street type (e.g. street, square), street name, city, and some other information. We separated them in different attributes thanks to the script `address_separation.py`, which has been applied to the datasets `CiviciWeb` and `internetQualityTrento`.

In order to achieve similarity between dataset and EER, we also added to the entity `Supermarket` the area of the building. We also added the attribute `AreaSki` to the entity `Supermarket`: this data property indicates the Ski resort in which the Ski slopes is located, allowing us to link the entity `Ski Area` to the entity `Ski slopes`, through the object property `has.Skiarea`. This was possible thanks to the `skislope.link.py` script. A similar operation has also been applied to `railway`, a dataset which contain both railways stations and railways paths. The link between these two different entities has been obtained thanks to `everything.allineation.py`.

2.5.3 Graph and Competency quires examples

With the purpose of evaluating the correctness of our DKG, two tests were performed:

- We generated the graph for two datasets in order to have a graphical visualization and check for correctness. The datasets for which we generated the graph were reduced in terms of instance to have a better visualization. The graphs were created for Bank¹²⁷ Etypes and for School¹²⁸. In order to generate these graphs have been used python library "rdflib" to generate from karmalinker output the .dot file, and Graphviz¹²⁹ software to render the .dot file just obtained. To get a decent view of the graph we recommend downloading the file (it's a svg) and opening it with an appropriate viewer.
- Using GraphDB with SPARQL language we have generated some meaningful queries starting from the competency questions described in the Inception phase to ensure that they had a correct answer. Below are the GraphDB screens of 3 significant quries and the GitHub link to the syntax of the various quries.

Giovanni 1.1¹³⁰: Where is the closest library?

The screenshot shows the GraphDB SPARQL interface. The query editor contains the following SPARQL code:

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX geo: <http://www.opengis.net/ont/geosparql#>
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>

SELECT ?library_name ?latitude ?longitude ?distance
WHERE {
    ?library geo:has_geocoordinate_GID-120051_Type-132 ?geocoordinate.
    ?geocoordinate geo:has_longitude_GID-46270_Type-120051 ?longitude.
    ?geocoordinate geo:has_latitude_GID-46263_Type-120051 ?latitude.
    BIND (xsd:float(?latitude) AS ?lat1).
    BIND (xsd:float(?longitude) AS ?lon2).
    BIND (46.06253391666666 AS ?lat1).
    BIND (11.12668658333333 AS ?lon1).
    BIND ((6371e3 * 2 * asin(sqrt((sin((?lat2 - ?lat1) * pi()/180)/2) * sin((?lat2 - ?lat1) * pi()/180)/2) + cos(?lat1 * pi()/180) * cos(?lat2 * pi()/180)) * asin(sqrt(1 - (sin((?lat2 - ?lat1) * pi()/180)/2) * sin((?lat2 - ?lat1) * pi()/180)/2) + cos(?lat1 * pi()/180) * cos(?lat2 * pi()/180))) AS ?distance)
}
ORDER BY ?distance
LIMIT 1
  
```

The results table shows one row:

| library_name | latitude | longitude | distance |
|---------------------------------------|------------|------------|------------------------------|
| "DAE Biblioteca centrale di via Roma" | 46.069688* | 11.120852* | "913.877214470929" xsddouble |

Giovanna 3.6¹³¹: Which are the supermarkets within a radius of 2 km ? How big they are?

¹²⁷https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/demo%20description/bank_graph.svg

¹²⁸https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/demo%20description/school_graph.svg

¹²⁹<https://graphviz.org/>

¹³⁰<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/demo%20description/Competency%20Queries/Giuseppe%201.1/query.rq>

¹³¹<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/demo%20description/Competency%20Queries/Giovanna%203.6/query.rq>

SPARQL Query & Update

Editor only Editor and results Results only

Unnamed X Unnamed X CQ_Giovanna_3_6 X +

```

1 PREFIX eftype: <http://knowdive.disi.unitn.it/etype#>
2 PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
3 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
4 PREFIX ofn: <http://www.ontotext.com/sparql/functions/>
5
6 select ?supermarket_name ?area ?latitude ?longitude ?distance
7
8 where {
9   ?supermarket eftype:has_name_GID-2_Type-132 ?supermarket_name.
10  ?supermarket rdf:type eftype:Supermarket_GID-24168.
11  ?supermarket eftype:has_geocoordinate_GID-120051_Type-132 ?geocoordinate.
12  ?geocoordinate eftype:has_longitude_GID-46270_Type-120051 ?longitude.
13  ?geocoordinate eftype:has_latitude_GID-46263_Type-120051 ?latitude.
14 }
```

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 4 of 4. Query took 0.4s, minutes ago.

| | supermarket_name | area | latitude | longitude | distance |
|---|--------------------|----------------------|----------------------|----------------------|----------------------|
| 1 | "EuroSpar" | "1583.199318260705" | "46.052897375" | "1127855075" | "700.2009659917982" |
| 2 | "Tovazzi Europesa" | "468.37916167083169" | "46.07006891428573" | "11.118663742857143" | "1041.61933217474" |
| 3 | "Margherita Conad" | "536.736391967187" | "46.053261355555556" | "11.123914755555555" | "1053.124409558152" |
| 4 | "Poli Regina" | "1180.104121725936" | "46.0471061249999" | "11.1261839" | "1715.8036565689306" |

Lucaina and Corrado 4.8¹³²: Which are the hospitals in Trentino ?

Unnamed X CQ_Luciana_4_10 X +

geospatial

```

1 PREFIX eftype: <http://knowdive.disi.unitn.it/etype#>
2 PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
3 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
4 select ?hospital_name ?longitude ?latitude
5
6 where {
7   ?hospital eftype:has_name_GID-2_Type-132 ?hospital_name.
8   ?hospital rdf:type eftype:Hospital_GID-19345.
9   ?hospital eftype:has_geocoordinate_GID-120051_Type-132 ?geocoordinate.
10  ?geocoordinate eftype:has_longitude_GID-46270_Type-120051 ?longitude.
11  ?geocoordinate eftype:has_latitude_GID-46263_Type-120051 ?latitude
12 }
```

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 34 of 34. Query took 0.1s, moments ago.

| | hospital_name | longitude | latitude |
|---|--|----------------------|----------------------|
| 1 | "Casa di Cura "Villa Bianca" | "11.12668658333333" | "46.06253591666666" |
| 2 | "Pronto Soccorso Ospedale Santa Maria del Carmine" | "11.0401616" | "45.8811754" |
| 3 | "Ospedale San Camillo" | "11.13200135833332" | "46.06490974166667" |
| 4 | "Pronto Soccorso Ospedale di Arco" | "10.875114" | "45.919077" |
| 5 | "Pronto Soccorso Ospedale Tione di Trento" | "10.7245566" | "46.0422014" |
| 6 | "Ospedale Riabilitativo Villa Rosa" | "11.12491253388889" | "46.06447616666669" |
| 7 | "Ospedale Valli del Noce" | "11.032800792307693" | "46.361310757692316" |

¹³²<https://github.com/UNITN-KDI-2020/GeoSpatial-Domain-project/blob/master/documentation/demo%20description/Competency%20Queries/Luciana%20E%20Corrado%204.8/query.rq>