

UD-SV : Urban Data, Services and Visualizations

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INSA



**UNIVERSITÉ
LUMIÈRE
LYON 2**



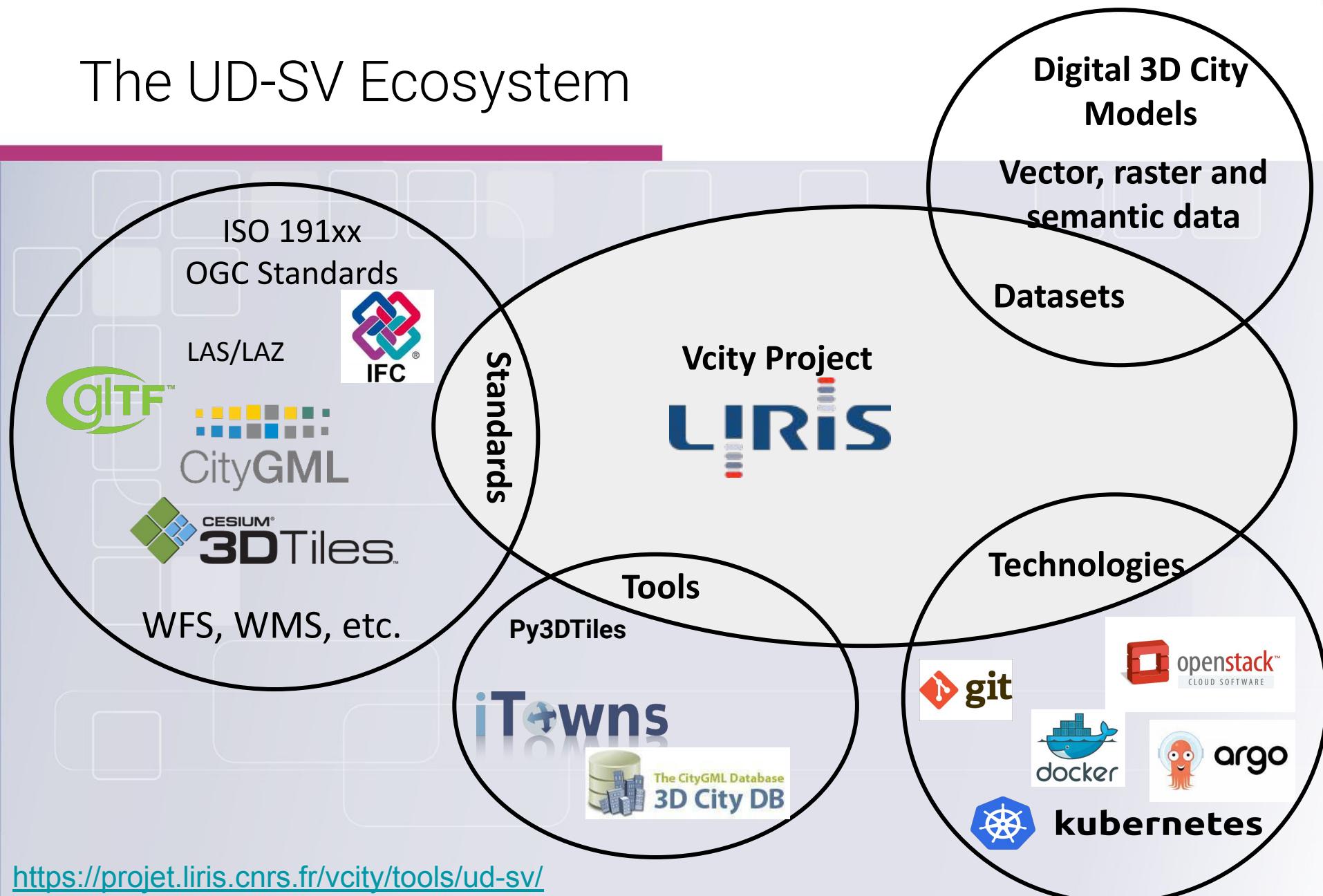
Vcity Research Project in LIRIS Lab

- **Urban Representations / Evolutions**
- **Pluridisciplinary** approach (crossing sciences for an holistic view)
- **"A downstream driven research"** : Starting from the needs and reaching the scientific and technical barriers to provide up to date research
- Providing a **software platform** as an intermediate object between experts



<https://projet.liris.cnrs.fr/vcity/>

The UD-SV Ecosystem



<https://projet.liris.cnrs.fr/vcity/tools/ud-sv/>

Clément Colin

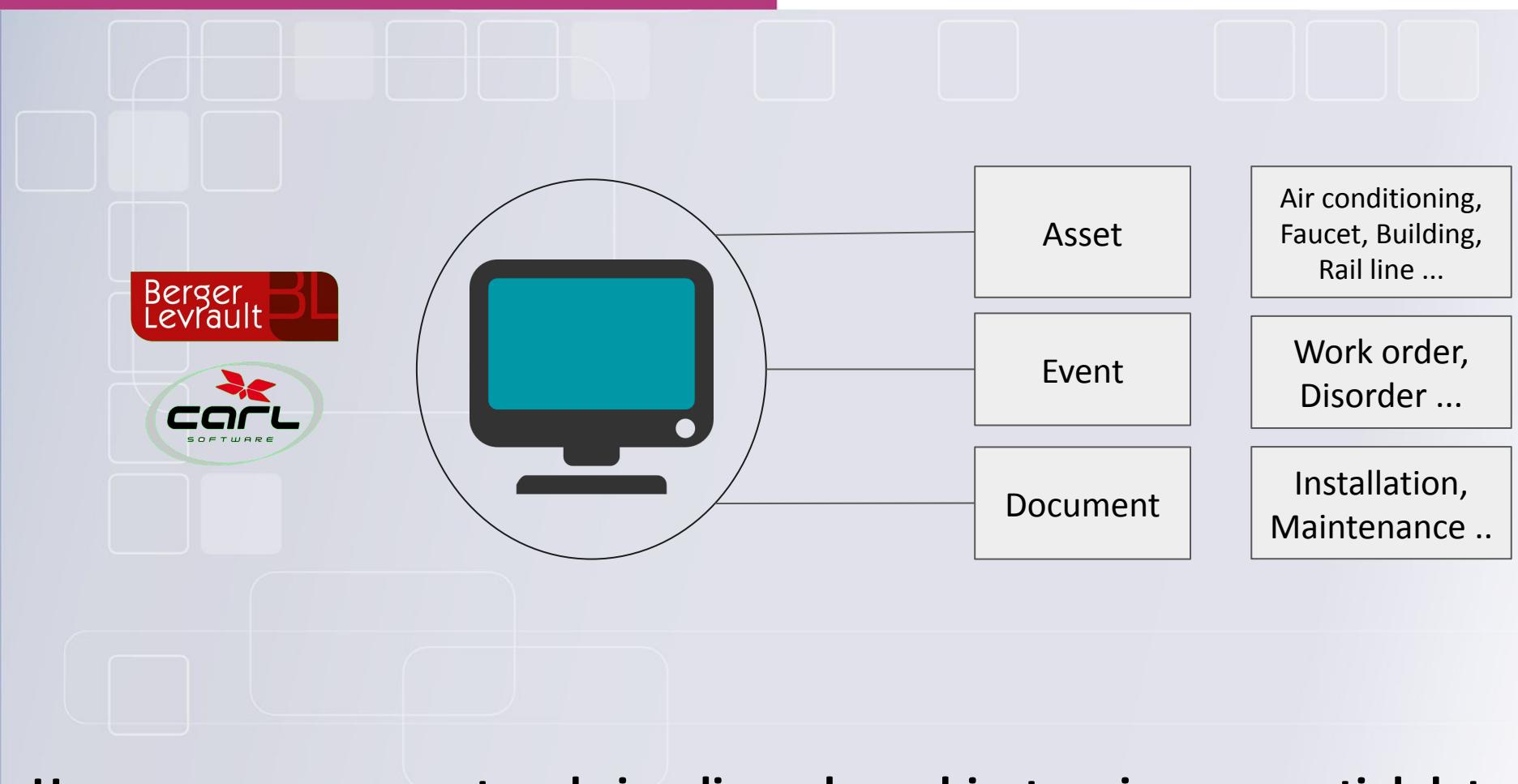
LIRIS PhD candidate, University Lumière Lyon 2

in collaboration with the Carl Software company



Multi-scale management, representation and visualization of urban objects

Computerized Maintenance Management System (CMMS)



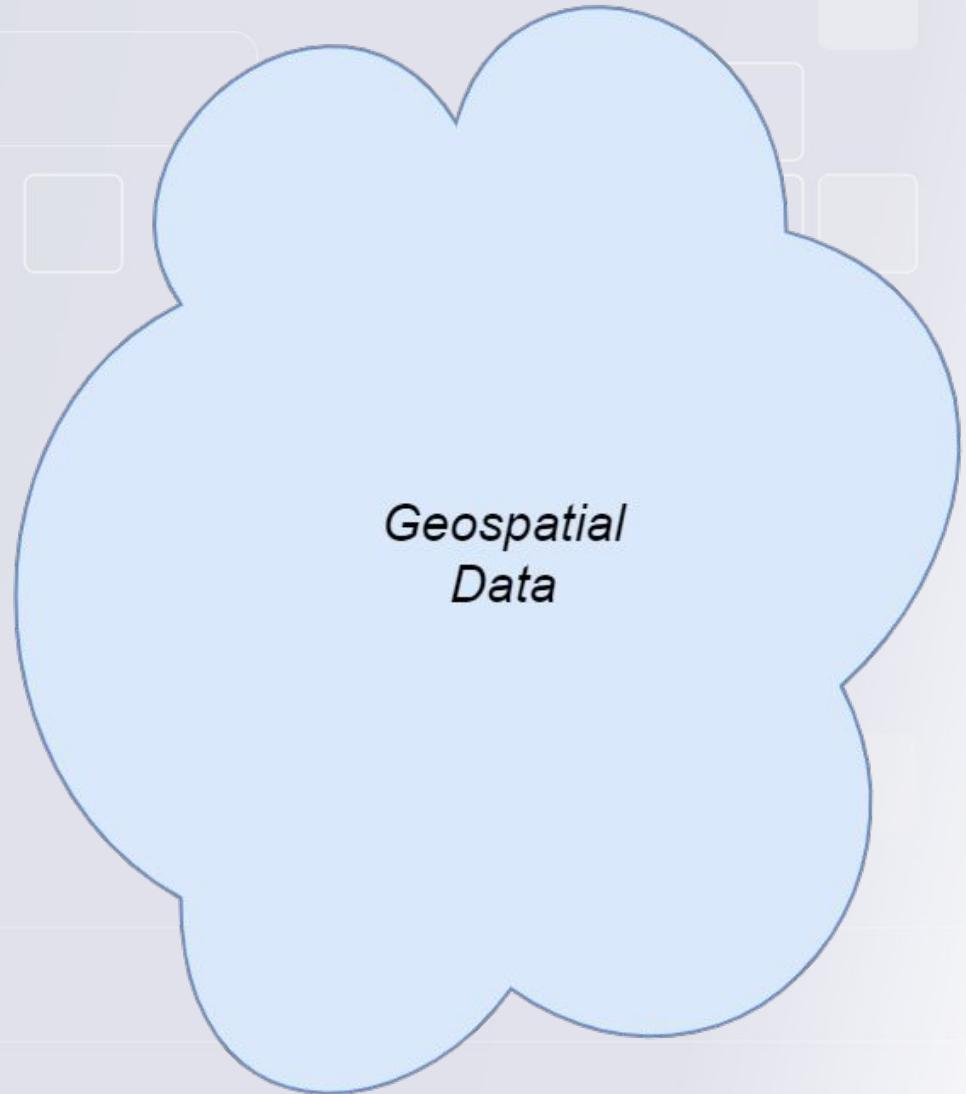
How can we represent and visualize urban objects using geospatial data on the Web in the same context ?



Geometry



Semantic Data

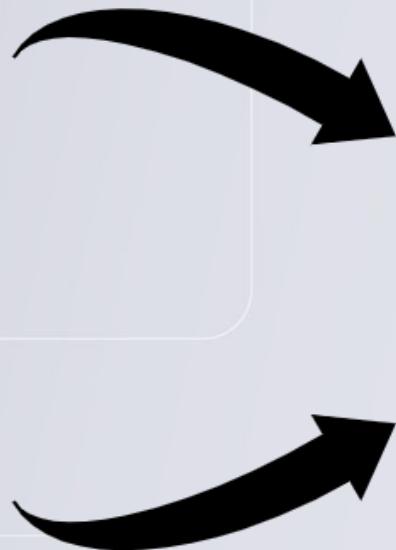
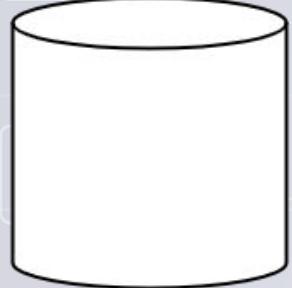




Geometry

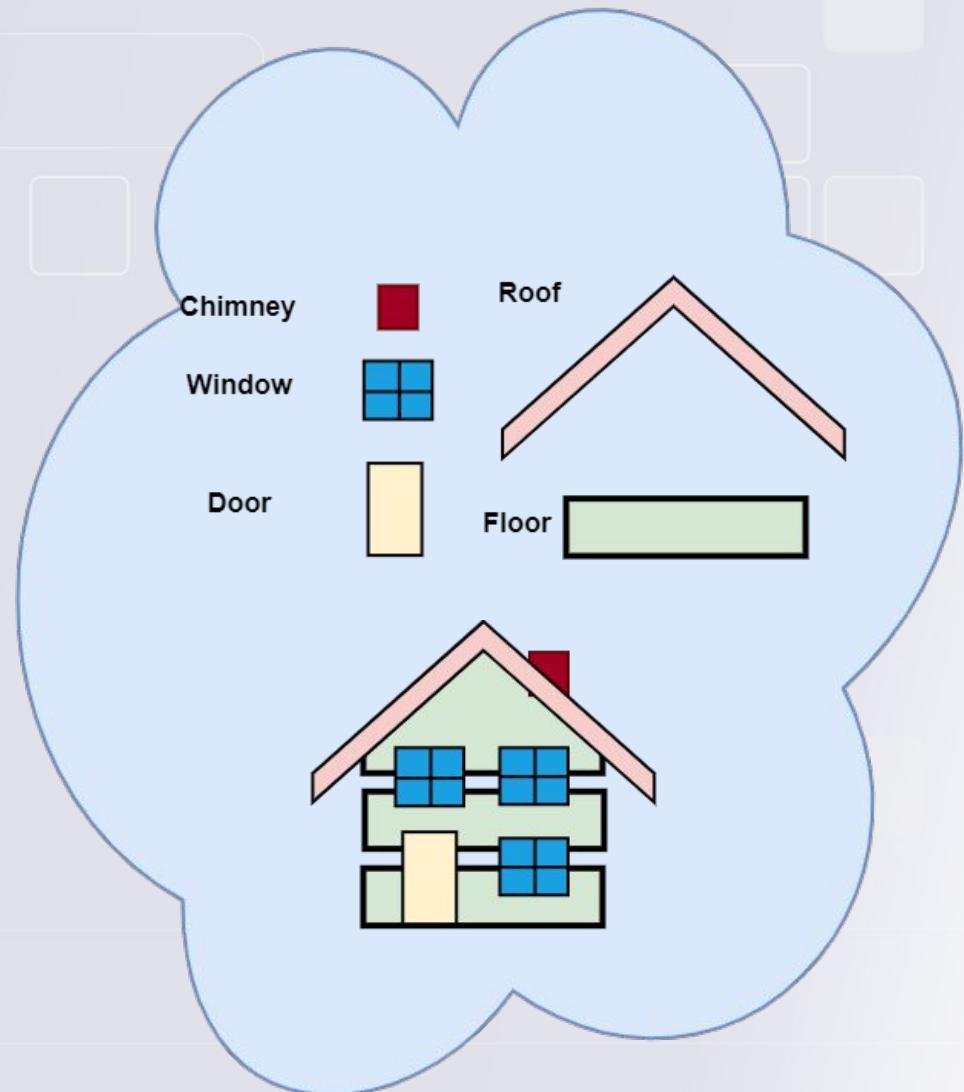
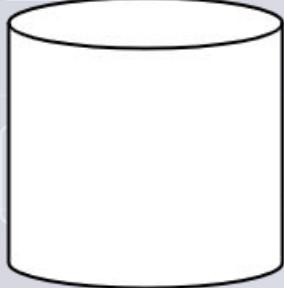


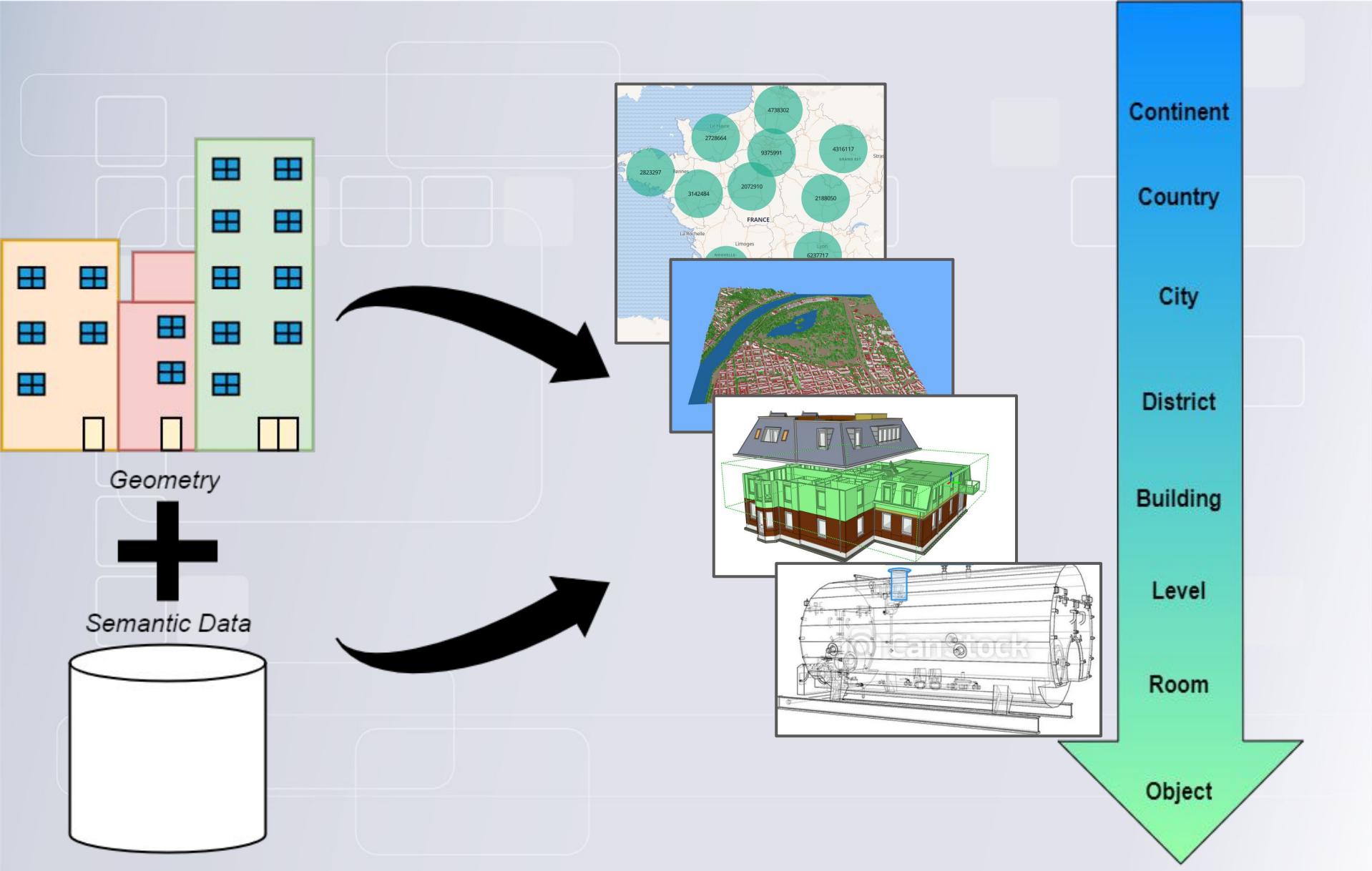
Semantic Data





Semantic Data

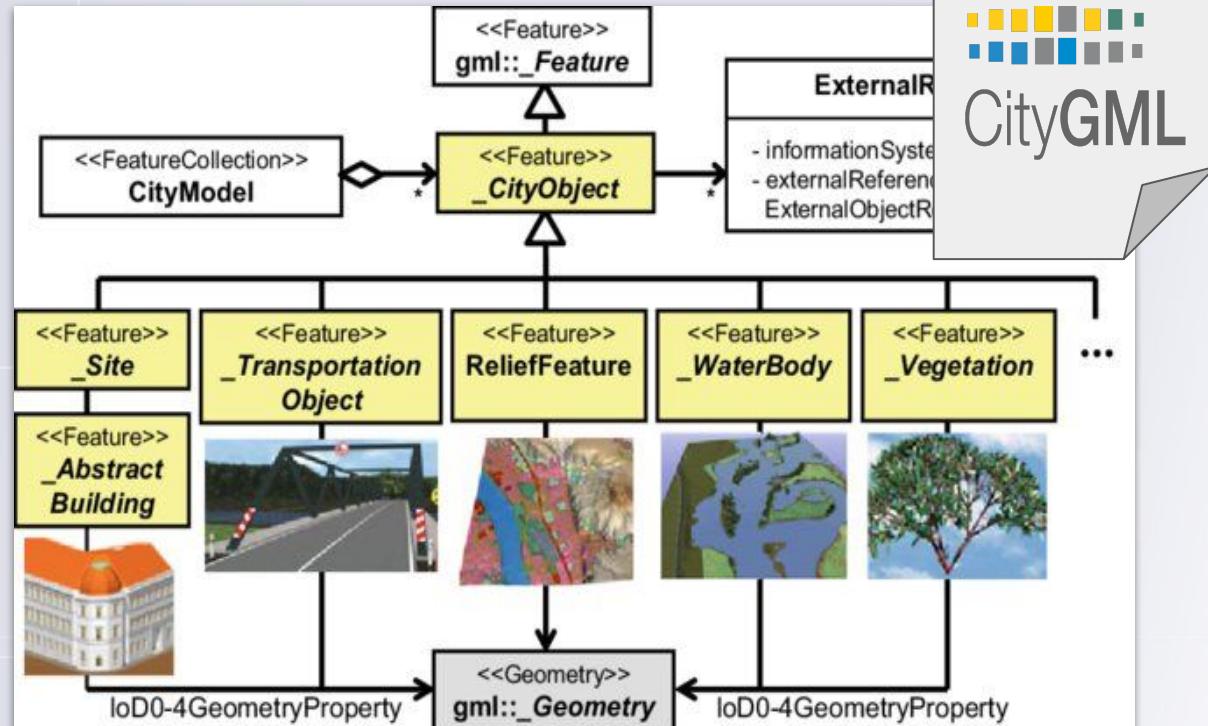




Continent
Country
City
District
Building
Level
Room
Object

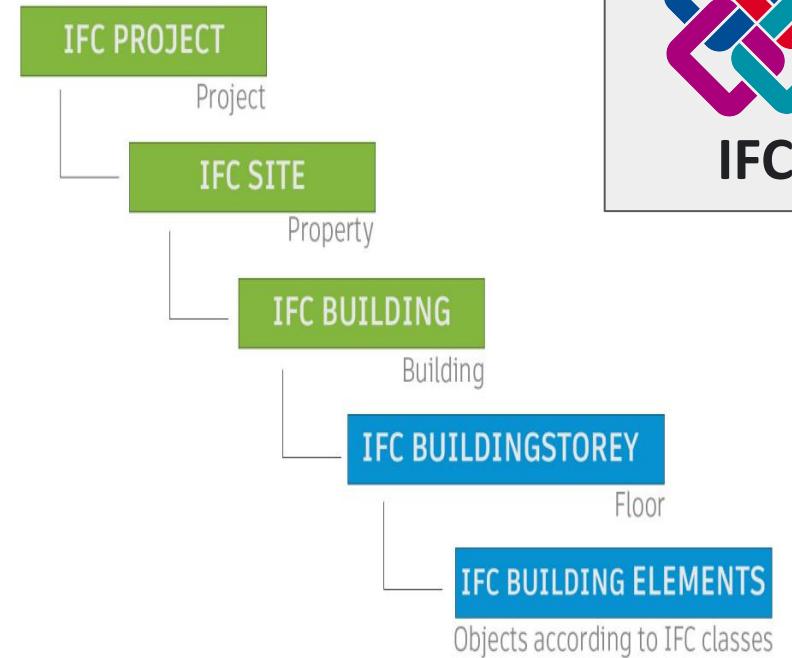
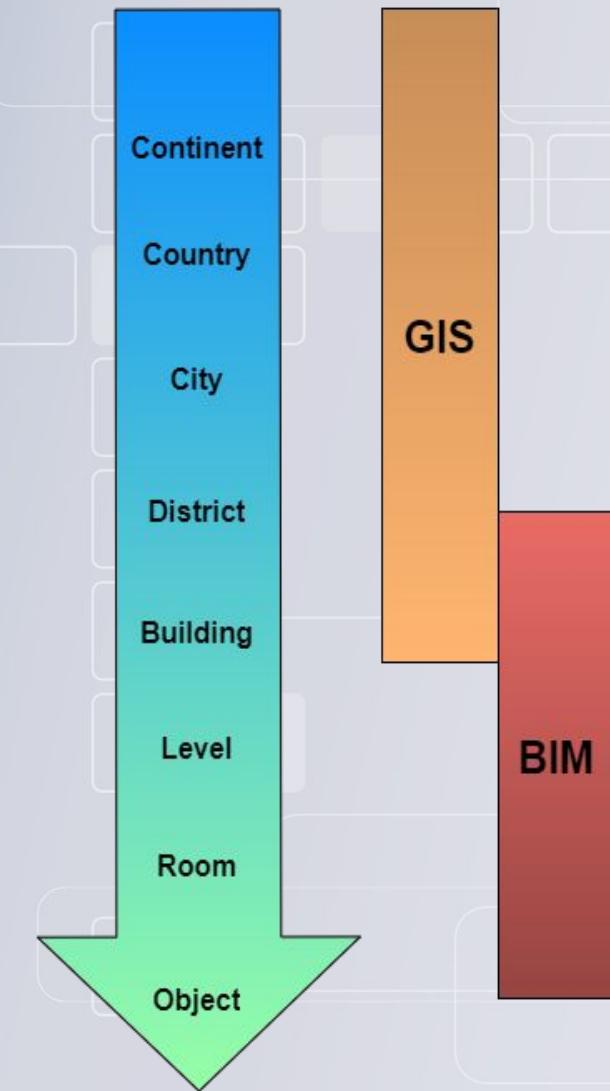
GIS

3D Geographic Information System



A comprehensive 3D city model object definition [Be2007]

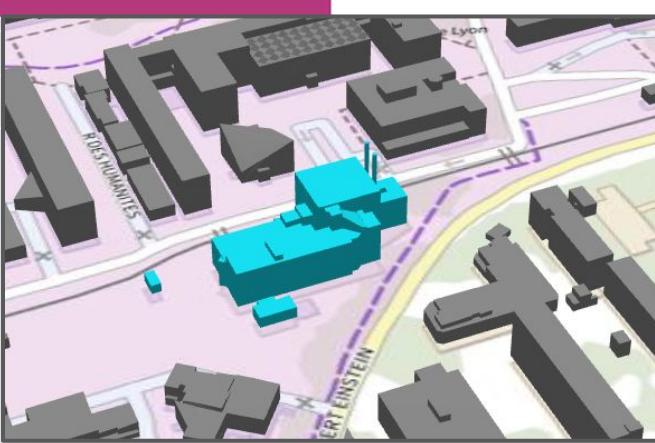
Building Information Model



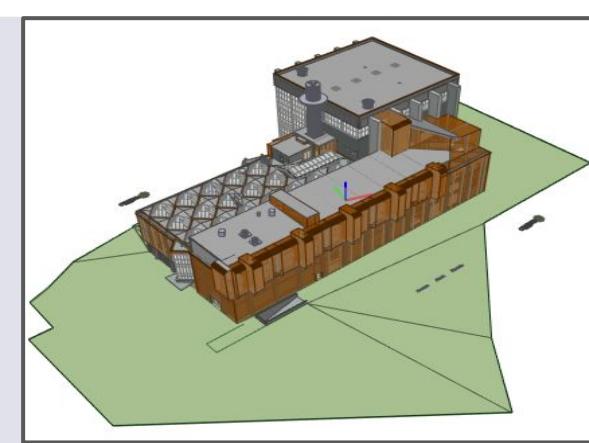
Heterogeneous representations of urban objects



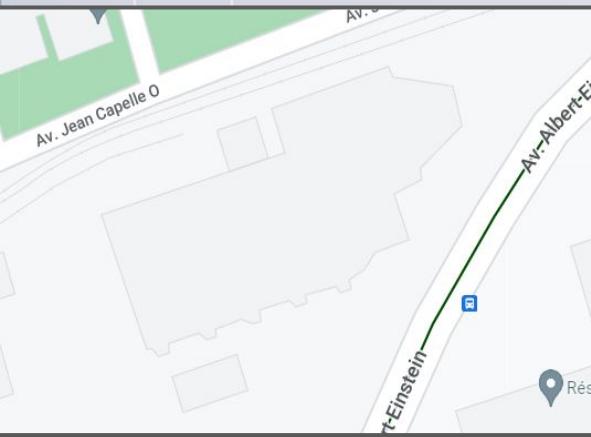
2D DWG Drawing



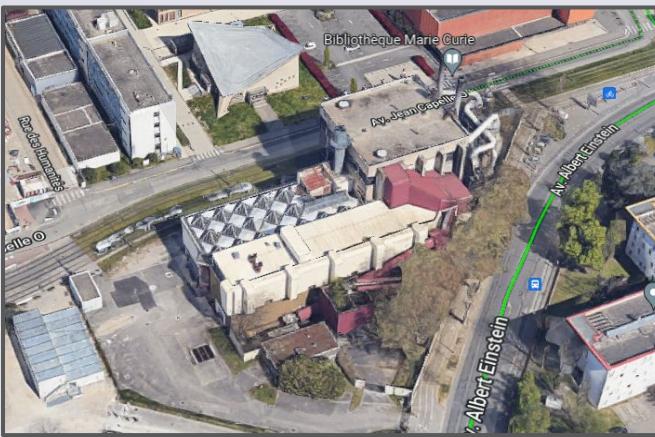
3D Geometry from a CityGML file



3D Geometry from an IFC file



2D Geometry from Google Map

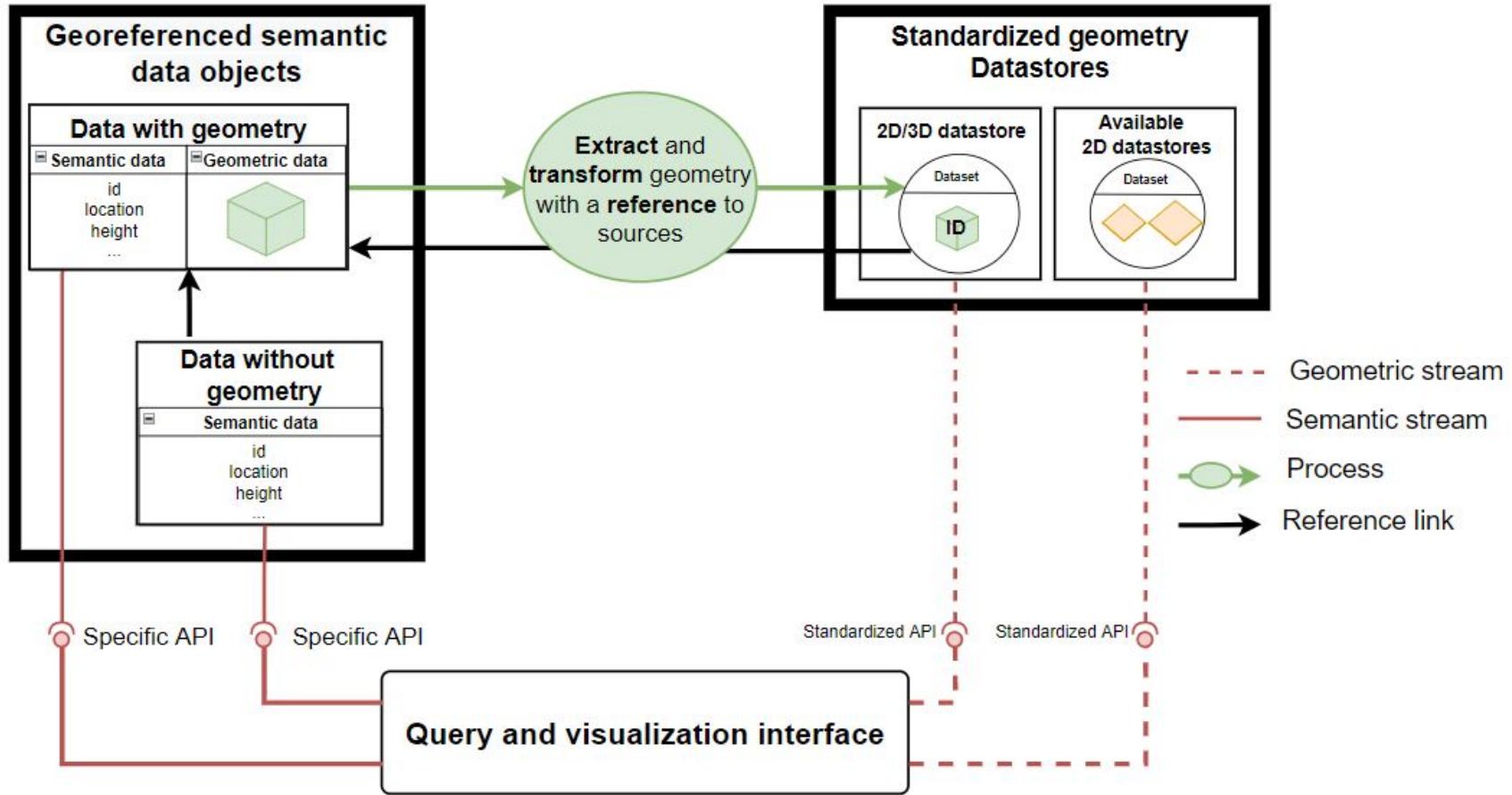


3D Geometry from Google Map

| Element Specific | |
|----------------------|---|
| FileName | ifc_doua.ifc |
| Guid | 0AhY_q3Qr4ZgkcnSHCY\$2 |
| IfcEntity | IfcProject |
| LongName | Nom du projet |
| Name | Numéro du projet |
| Phase | Etat du projet |
| File Header | |
| Description | ViewDefinition [CoordinationView_V2.0] |
| Implementation Level | 2;1 |
| Originating System | 20160225_1515(x64) - Exporter 17.0.416. |
| Preprocessor Version | The EXPRESS Data Manager Version 5.02.0 |
| Schema Identifiers | IFC2X3 |
| Time Stamp | 2018-12-05T12:45:06 |

Semantic data from an IFC file

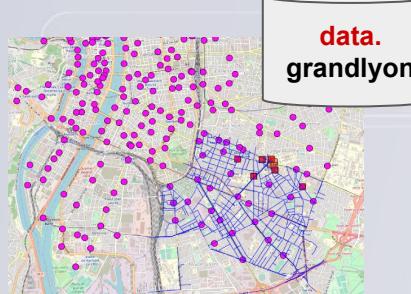
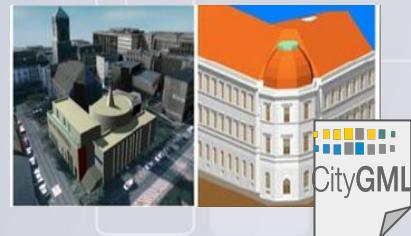
Proposed Logical Methodology for navigation in representations of urban objets



[Colin 2022]

Our solution using the UD-SV framework

1. Geospatial data



2. Transformation, storage and query using standards



3. Display and interaction on the Web



Navigate from a City View to an Object view



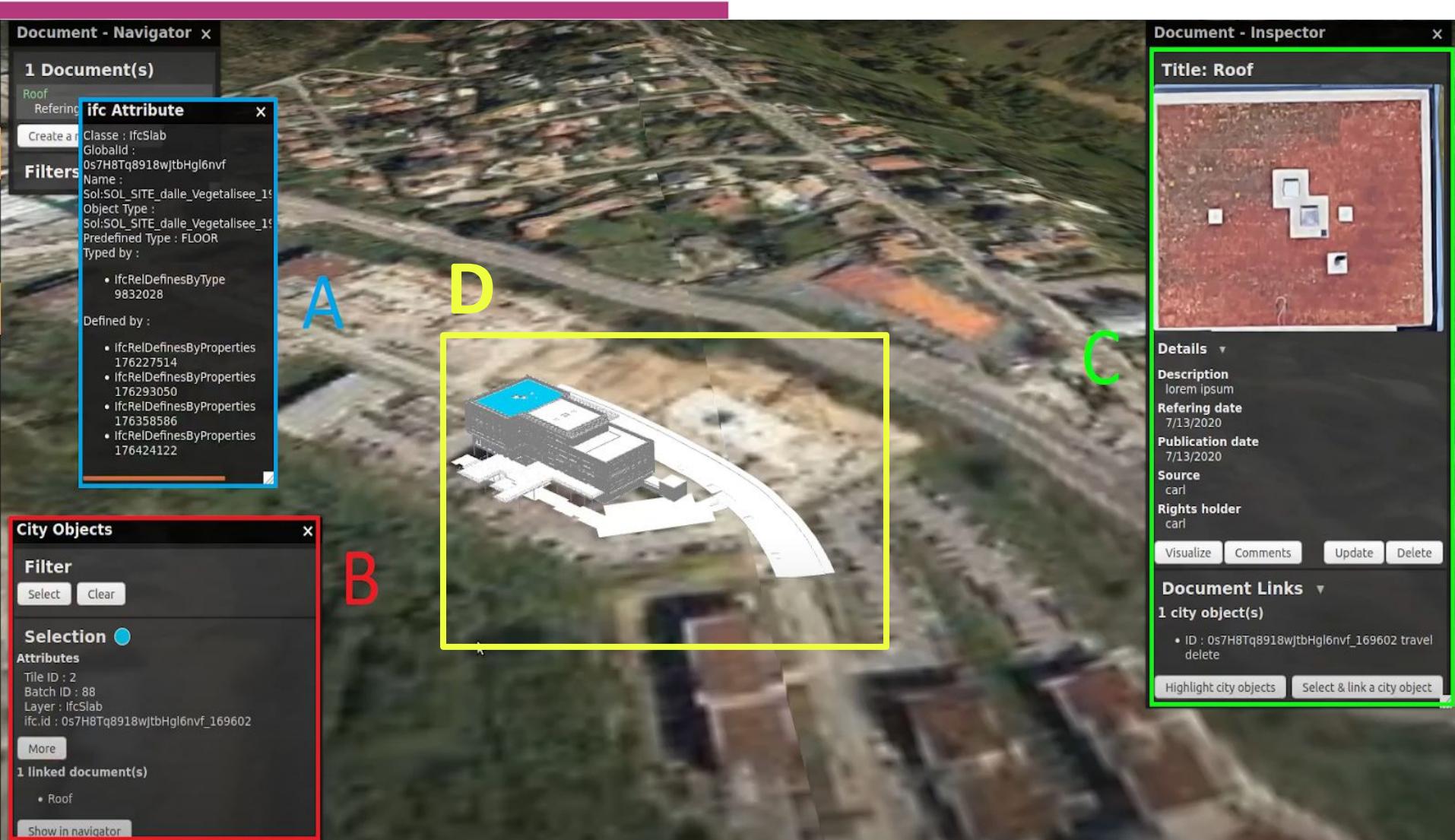
Navigate through heterogeneous representations

A : IFC Semantic

B : 3D Tiles Semantic

C : Linked Document

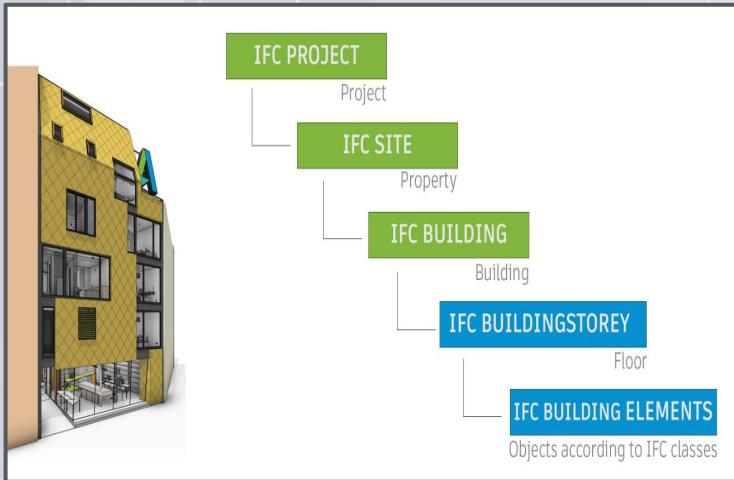
D : IFC Geometry



A CMMS application on the Anne de Bretagne bridge of Nantes

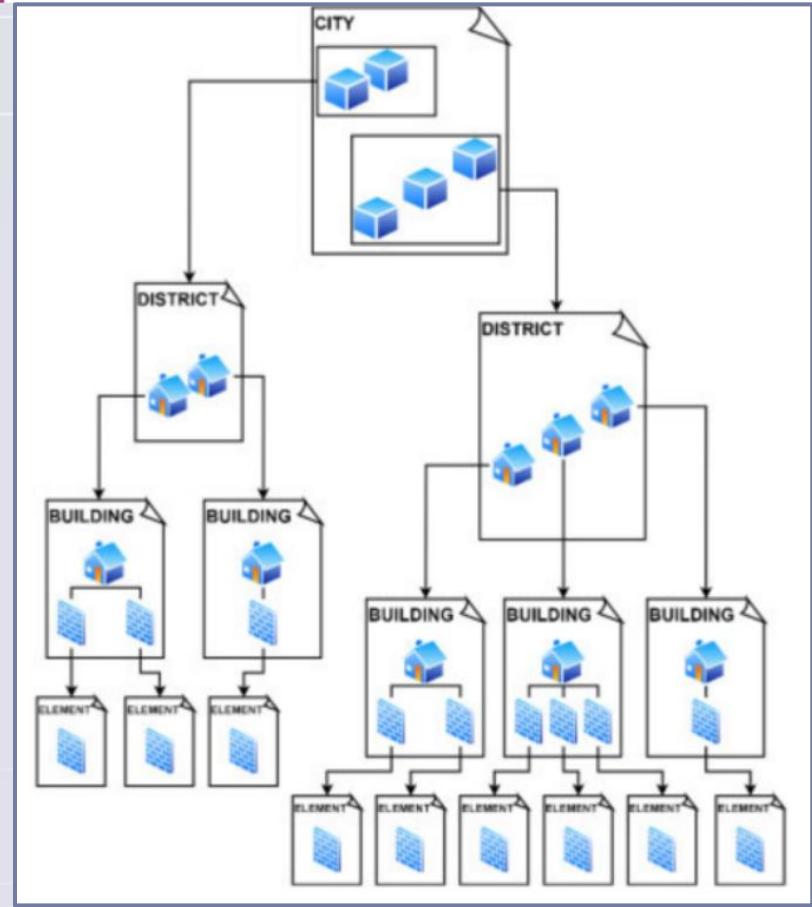


Future work : Multiscale management of urban objects



BIM Decomposition

Revit IFC manual



BIM/CIM Decomposition

City and building information modelling using IFC standard,

By V. Shutkin, N. Morozkin, V. Zolotov, V. Semenov

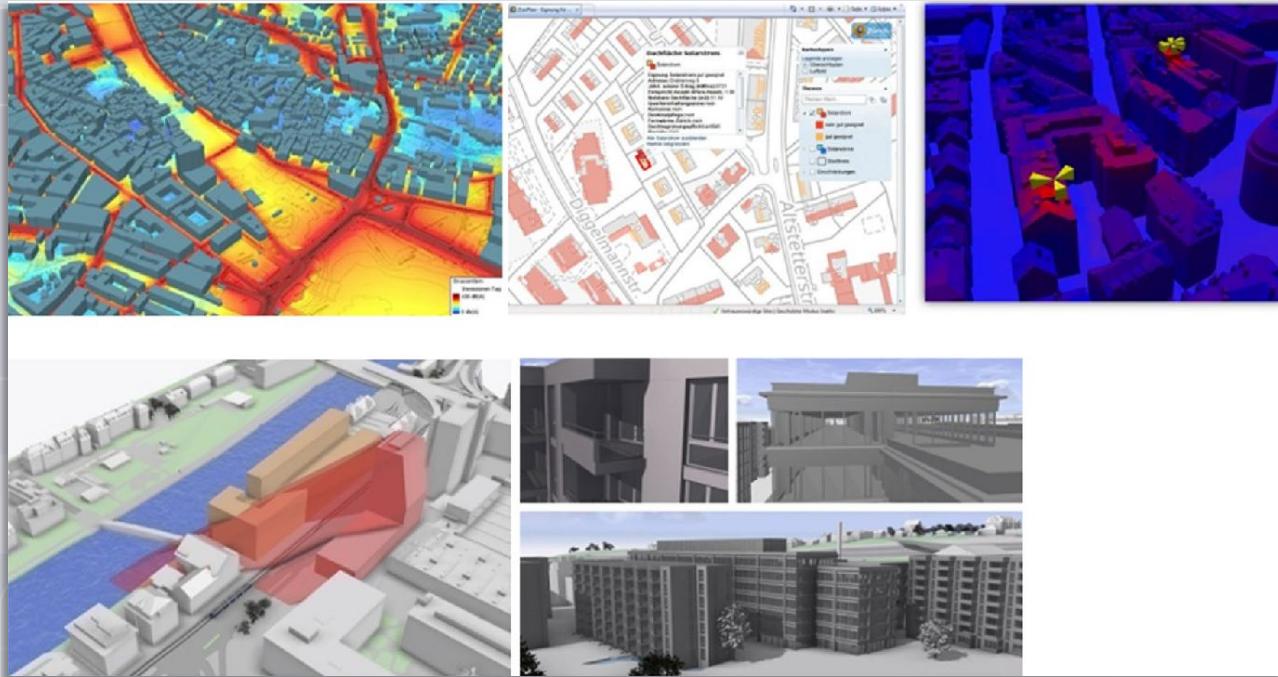
Diego Vinasco-Alvarez

LIRIS Ph.D candidate, University Lumière Lyon 2



Model-driven Integration of nD Multisource Urban Data

Illustrating the Urban Landscape with 3D City Models

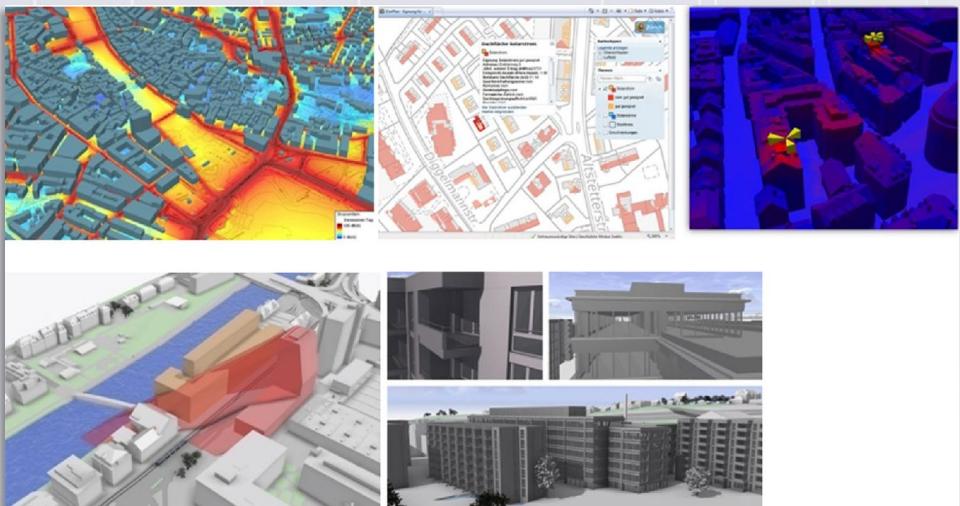


City of Zurich: urban digital twin established applications [Schrotter 2020]

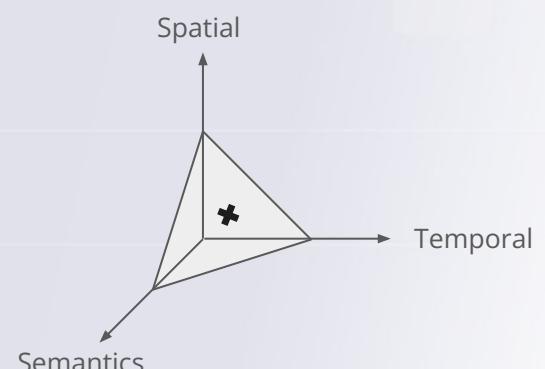
Illustrating the Urban Landscape with 3D City Models

Key-concepts:

- Multi-dimensional
- Multi-source

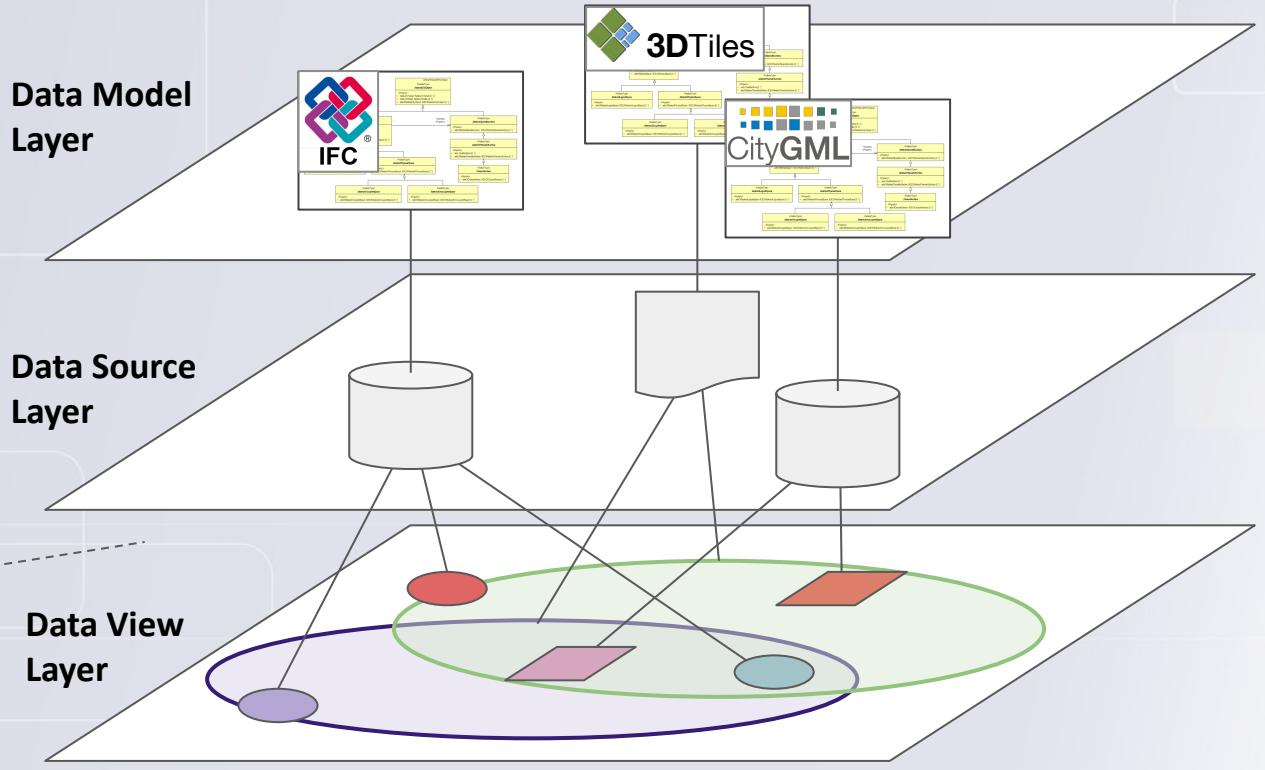


City of Zurich: urban digital twin established applications [Schrotter 2020]



Multisource Data Integration

“Data integration is the process of combining data from different sources to provide users a unified view of the data” [Tran 2016]



Integration Challenge: Overcoming Data Heterogeneity

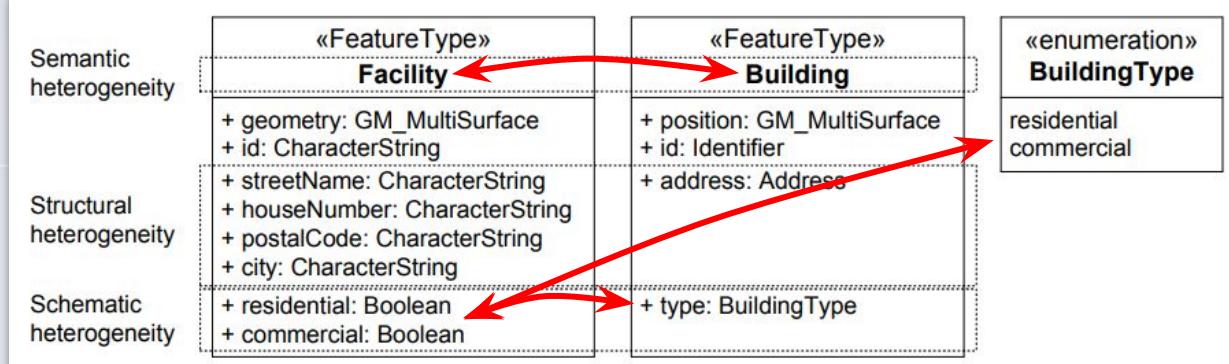
| Semantic heterogeneity | «FeatureType» Facility | «FeatureType» Building | «enumeration» BuildingType |
|--------------------------|---|---|-------------------------------|
| | + geometry: GM_MultiSurface + id: CharacterString | + position: GM_MultiSurface + id: Identifier | residential commercial |
| Structural heterogeneity | + streetName: CharacterString + houseNumber: CharacterString + postalCode: CharacterString + city: CharacterString | + address: Address | |
| Schematic heterogeneity | + residential: Boolean + commercial: Boolean | + type: BuildingType | |

Example of structural, schematic and semantic heterogeneity [Kutzner 2016]

Model-driven Transformations for Data Integration

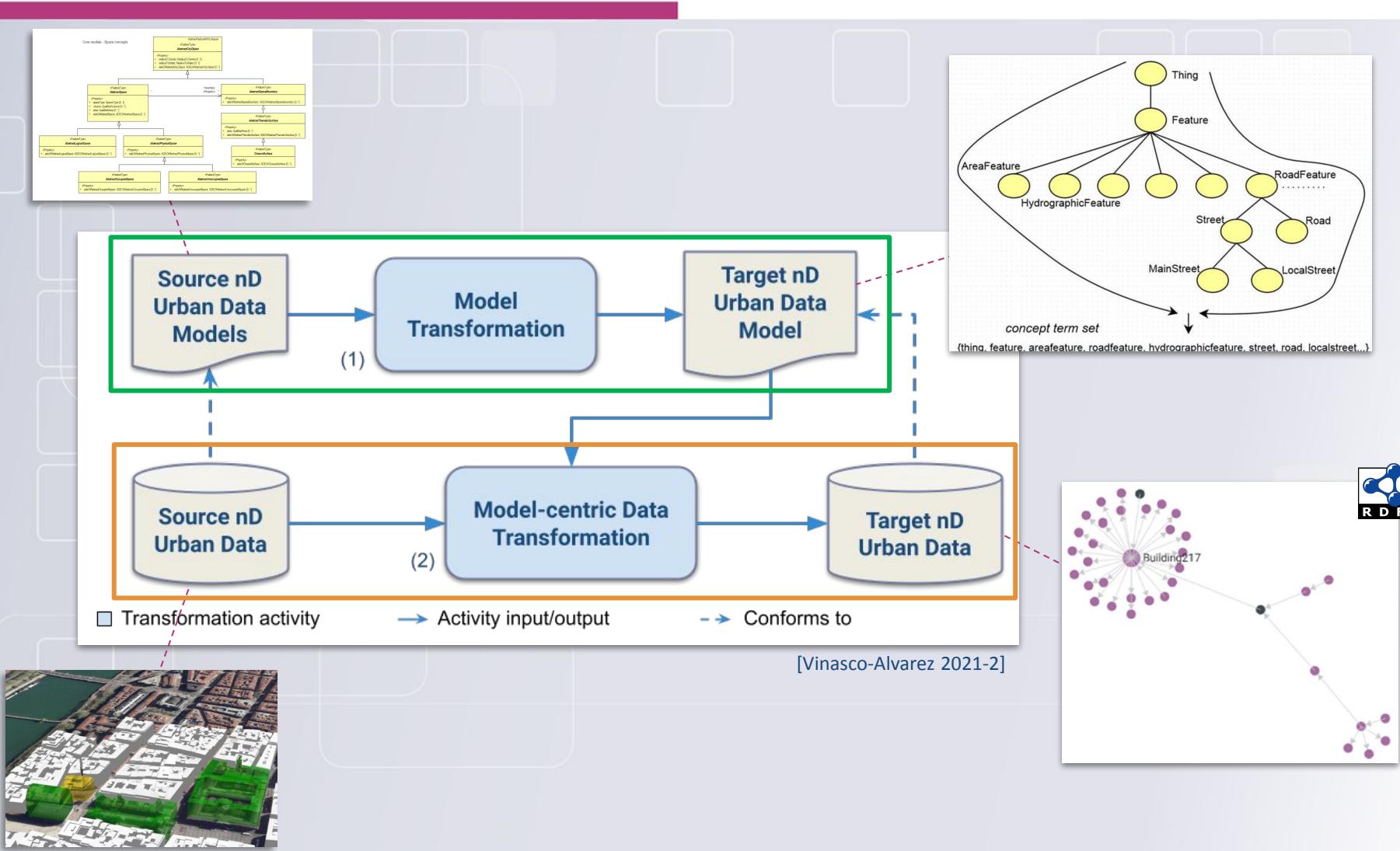
Transformation Characteristics [Kutzner 2016]

- Model-to-model/model-to-code transformation
- Vertical/horizontal transformation
- Endogenous/exogenous transformation
- Unidirectional/bidirectional transformation
- Syntactic/semantic transformation

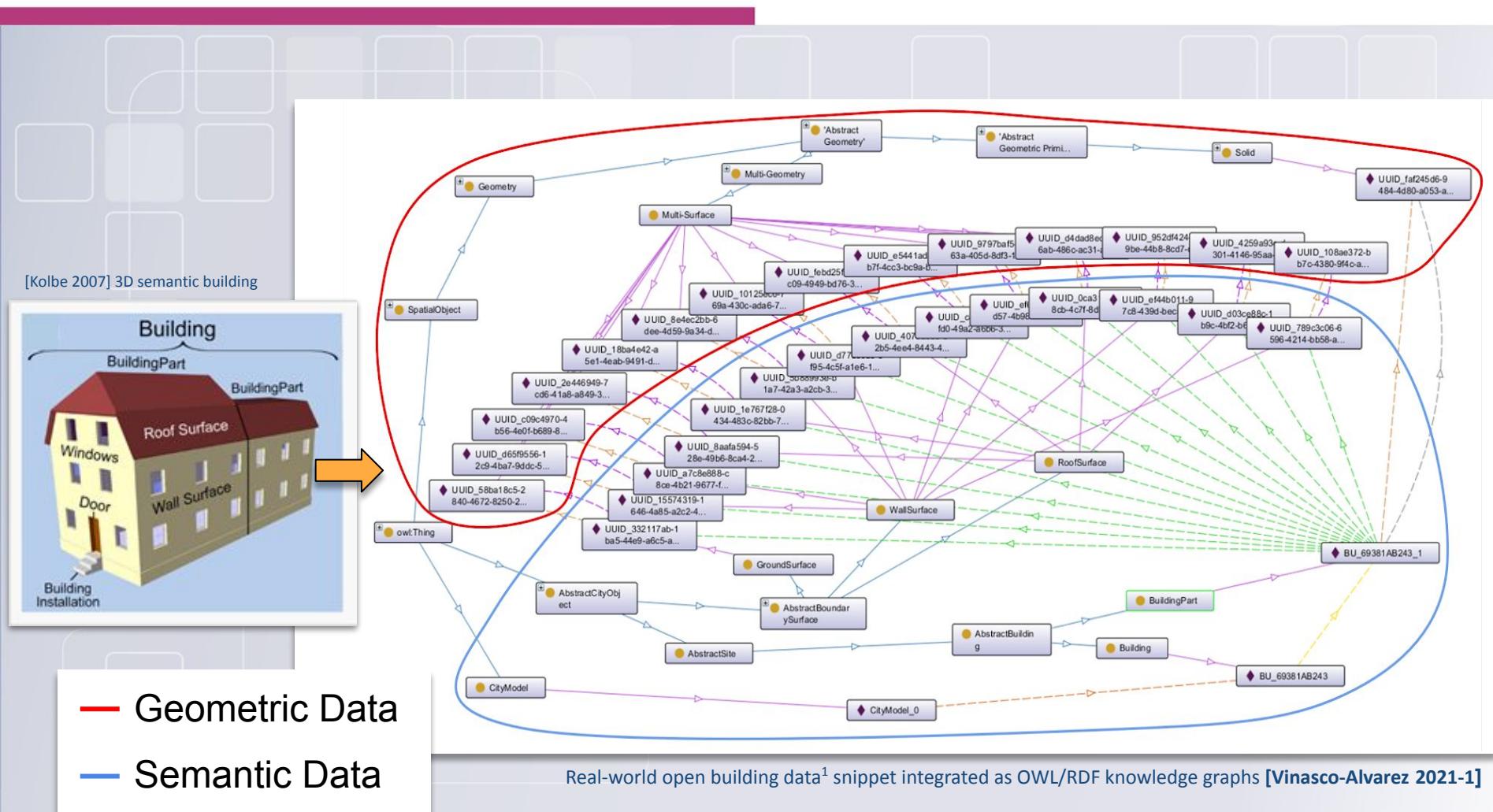


Example of structural, schematic and semantic heterogeneity [Kutzner 2016]

Proposed Model-driven Integration Methodology



Integrated Open Urban Data as Graphs



Urban Data Exploration through Data Views

The image displays two side-by-side screenshots of the UD-Viz application interface, which integrates a map view with a SPARQL query editor.

Left Screenshot: The title bar says "UD-Viz •". The main area shows a satellite map of a dense urban area with a river. On the left, there is a "SPARQL Query" window with the following content:

```
PREFIX skos: <http://www.w3.org/2004/02/skos/core#>
PREFIX core: <http://www.opengis.net/citygml/2.0/core#>
PREFIX bldg: <http://www.opengis.net/citygml/building/2.0/building#>

# Return all CityGML City Objects
SELECT *
WHERE {
  ?object a bldg:Building .
}
```

Below the query window is a "Select filter:" dropdown menu. At the bottom of the window are "Send" and "Results Format: Table" buttons.

Right Screenshot: The title bar says "UD-Viz •". The main area shows a satellite map of a city with a prominent river. On the left, there is a "SPARQL Query" window with the following content:

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX gmlowl: <http://www.opengis.net/ont/gml.owl#>
PREFIX units: <http://www.opengis.net/def/uom/OGC/1.0/>
PREFIX gen: <http://www.opengis.net/ont/geosparql#>
PREFIX geo: <http://www.opengis.net/def/function/geosparql#>
PREFIX core: <http://www.opengis.net/citygml/2.0/core#>
PREFIX bldg: <http://www.opengis.net/citygml/building/2.0/building#>

# Return all CityGML City Objects
SELECT *
WHERE {
  ?subject a core:CityModel ;
    ?predicate ?object ;
    ?object a ?objecttype .
  ?object a bldg:Building ;
  ?object a ?objecttype .
}
```

Below the query window are "Send" and "Results Format: Graph" buttons.

Corentin GAUTIER

LIRIS Ph.D. candidate, background in video game development



Dynamic, virtual and tangible representations of the city

Virtual/Tangible representation of the city

Finding new approaches to visualize digital city :

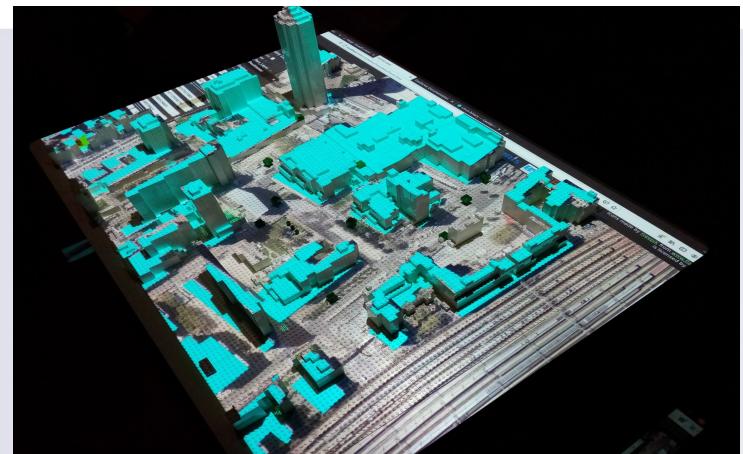
- Multimedia integration
- Tangible user interface
- Temporal city evolution
- Geometry semiology



An Interaction Framework
for Level-of-Abstraction
Visualization of 3D
Geovirtual Environments
[Semmo, Amir 2014]



Document visualized with
different transparency
values in 3D-USE
[Samuel 2016]

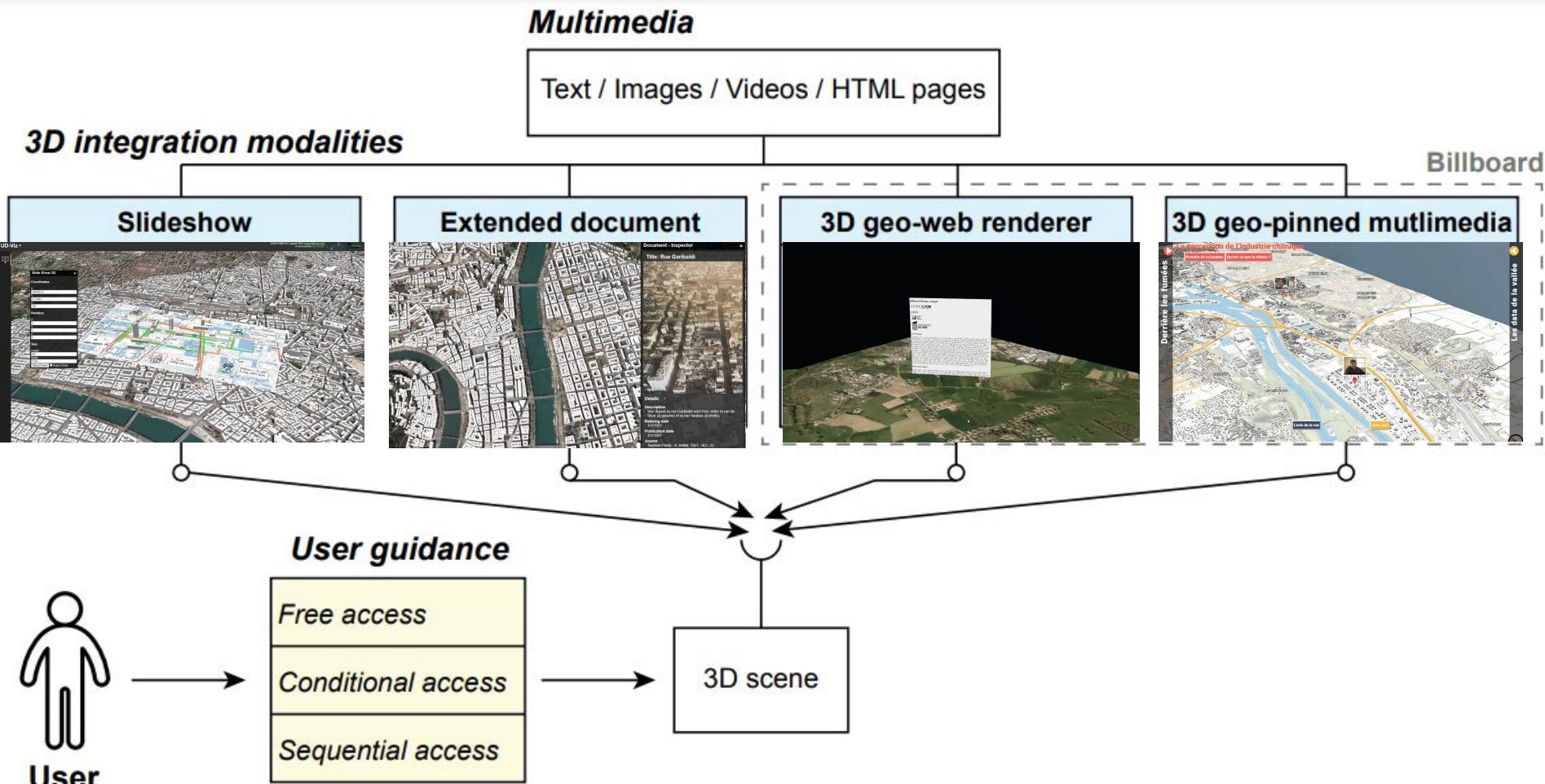


Part-Dieu model¹



Temporal navigation widget [Jaillot 2020]

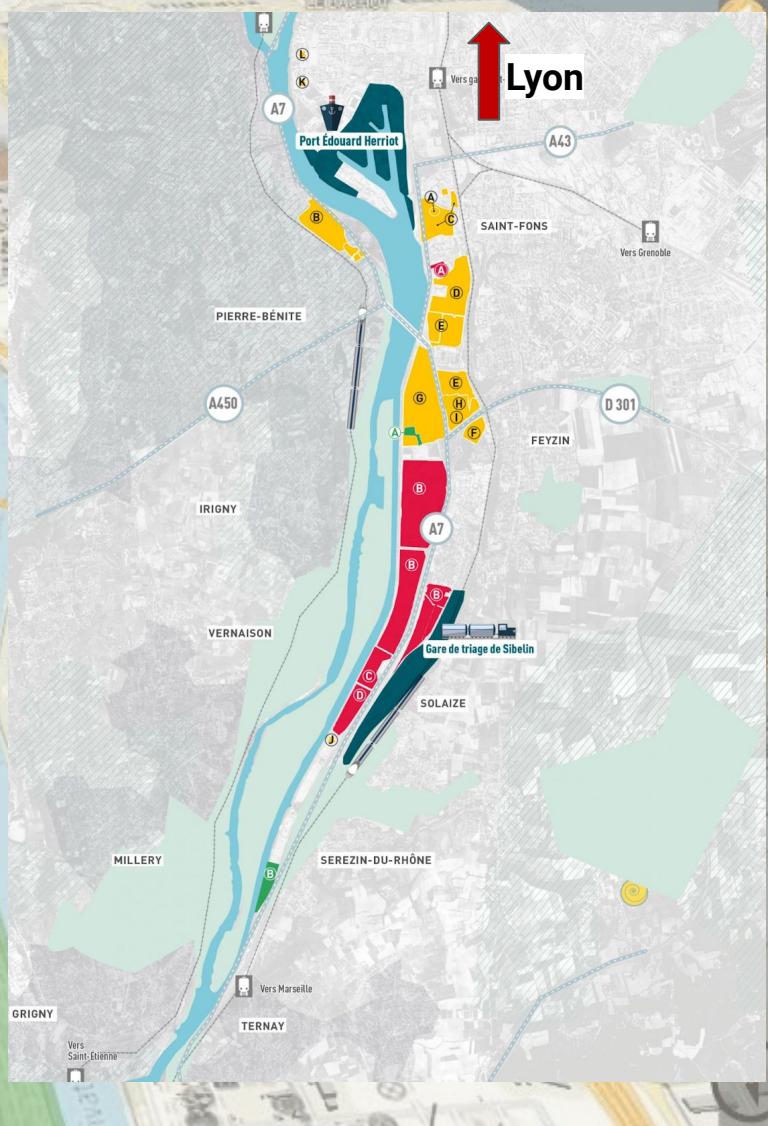
Multimedia integration in a 3D environment



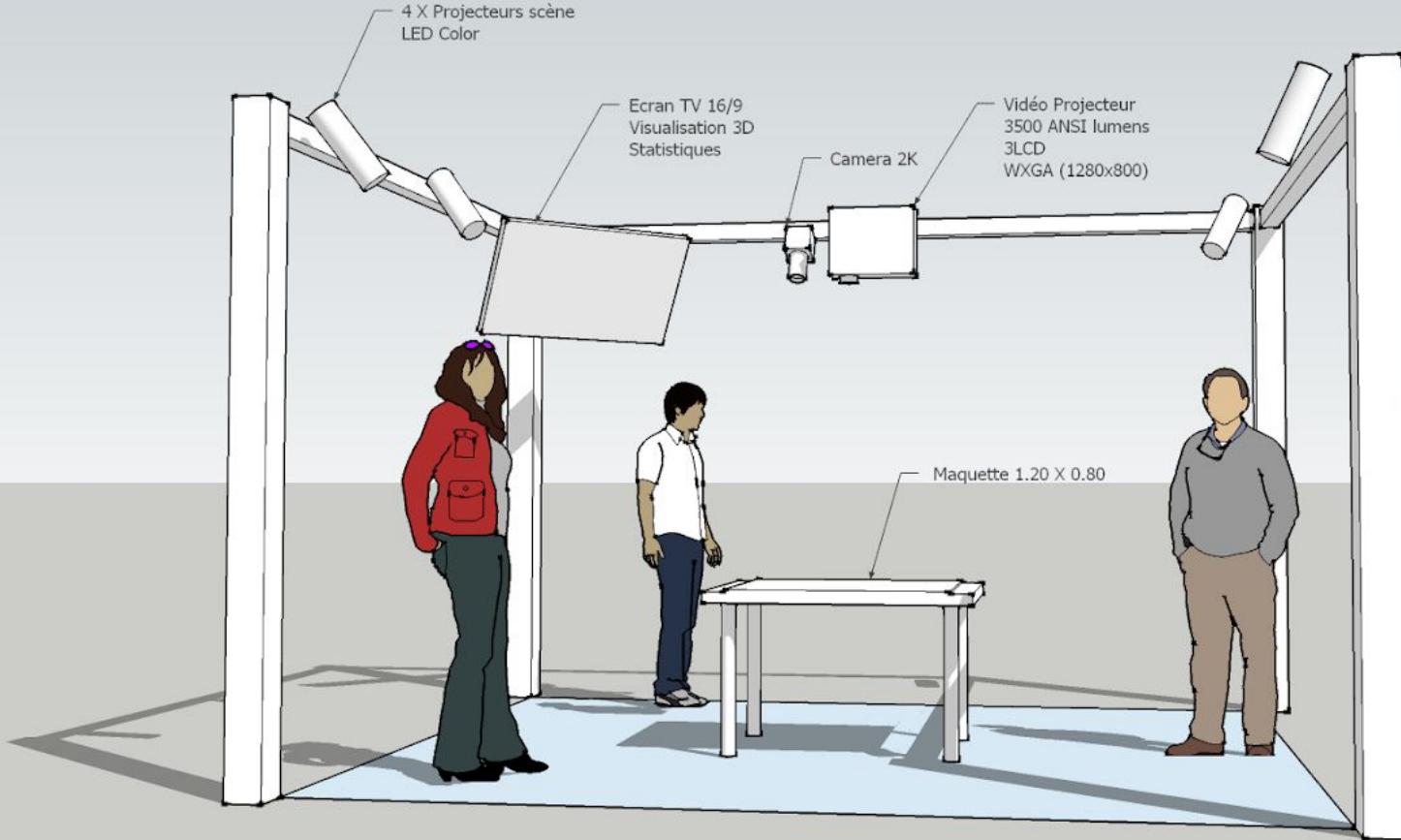
Integrating multimedia documents for augmented models to a better understanding of its territory [Gautier 2022]

Multimedia integration in a 3D environment

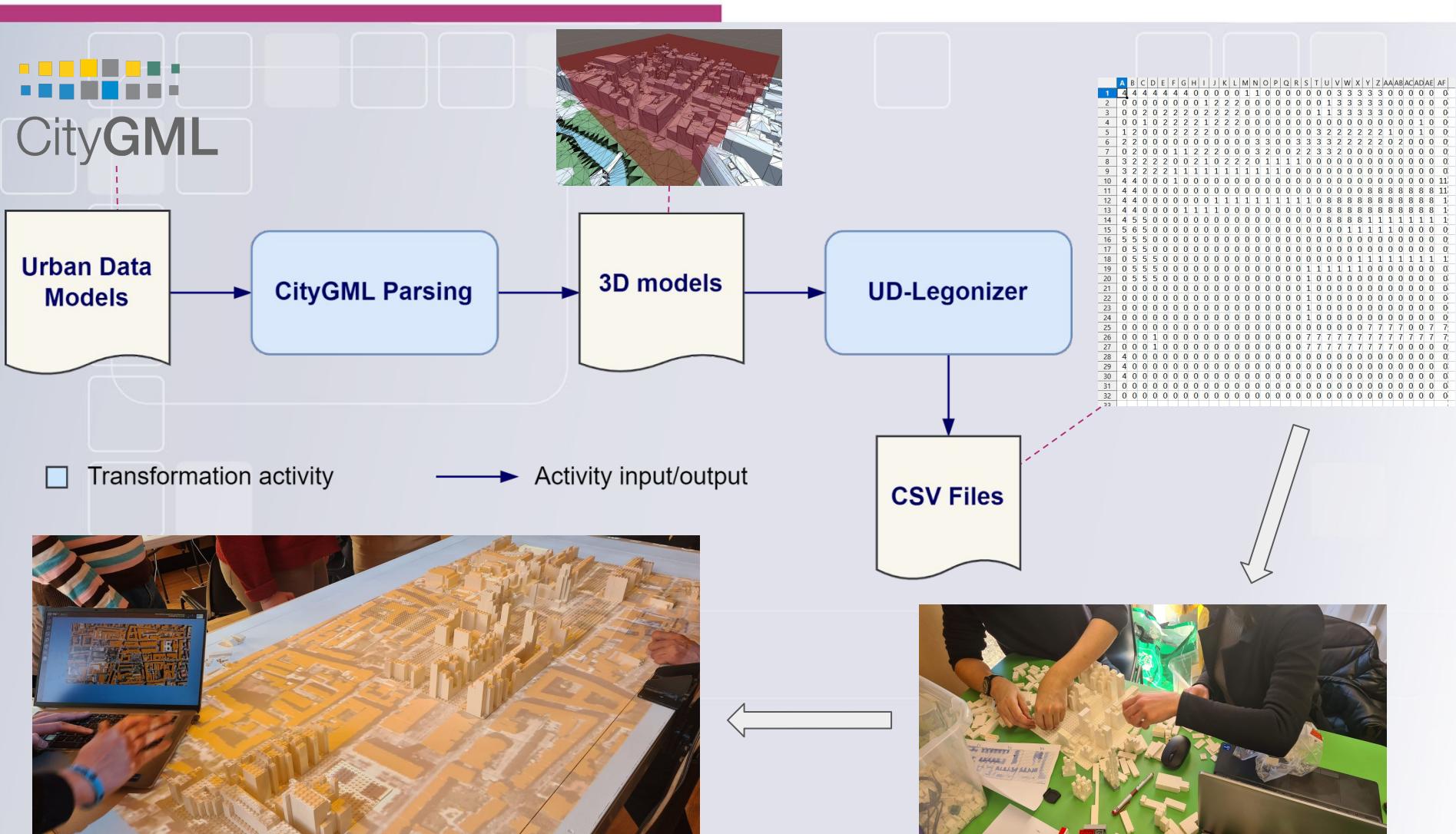
Derrière les fumées



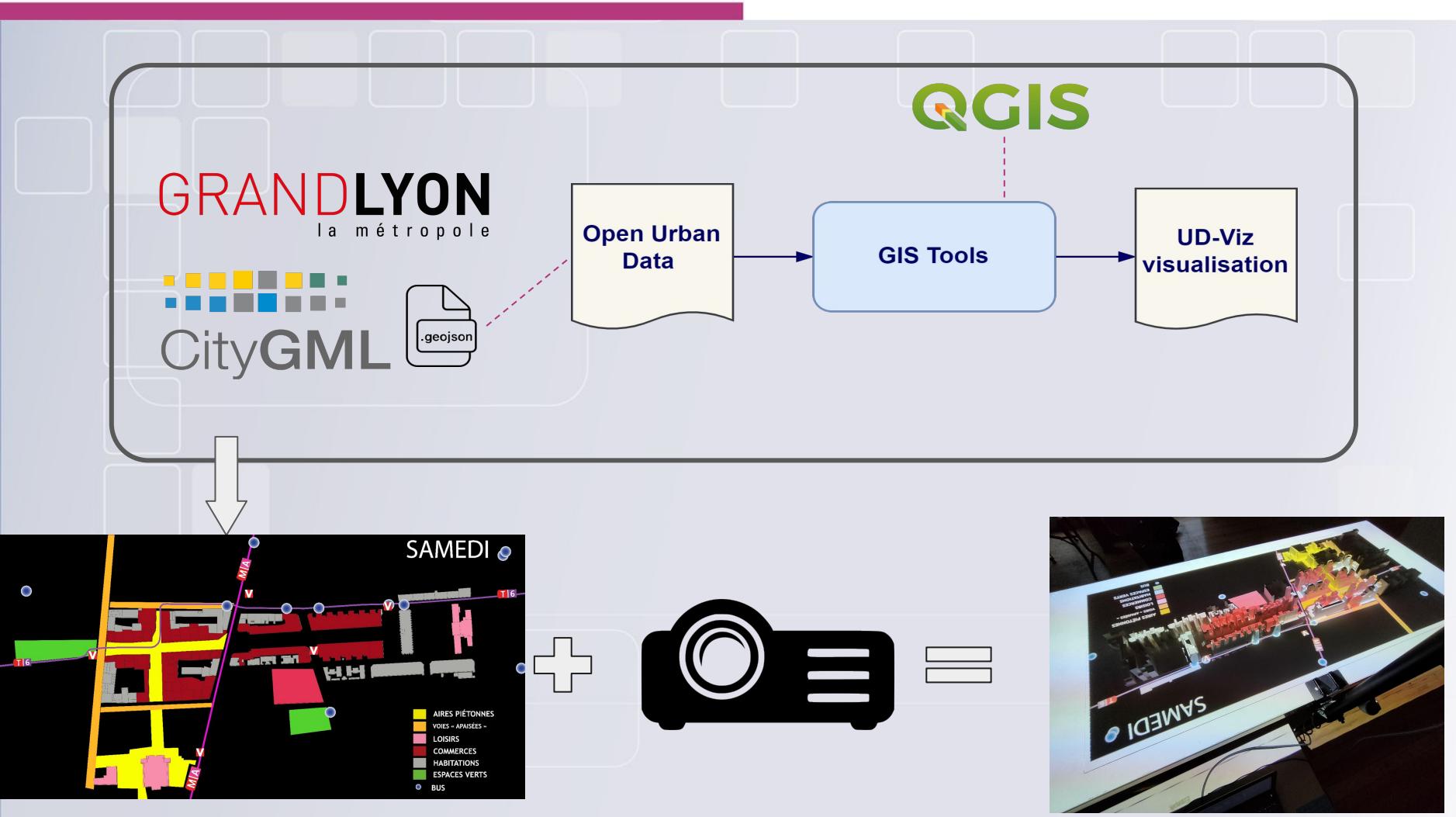
Tangible representation of the city



Model construction



Data projection



Use-case : Gratte-ciel project (2022)



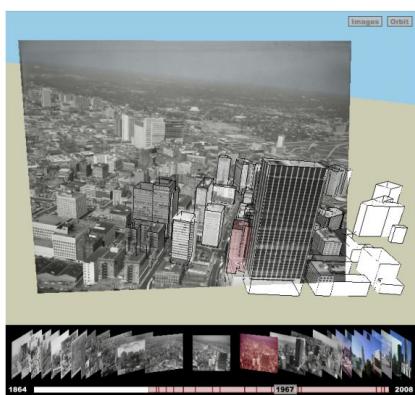
9 tiles :
~ **5000 Legos**

- Legos used :
- Bricks 1x1
 - Bricks 1x2
 - Bricks 2x2
 - Bricks 2x4
 - Bricks 1x2x5

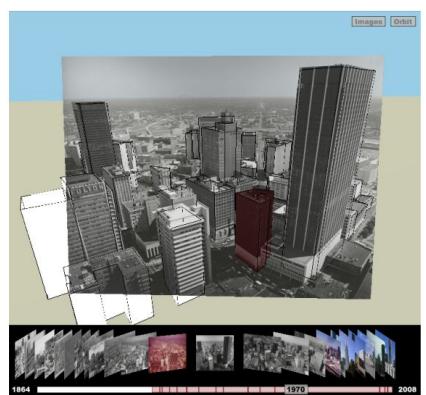


Table size :
7x3 ft

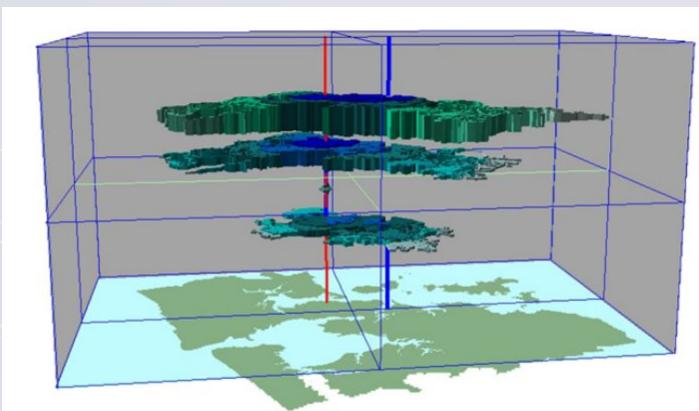
Temporal city evolution



4D Cities: Analyzing, Visualizing, and Interacting with Historical Urban Photo Collections [Grant Schindler 2012]



Delivering time-evolving 3D city models for web visualization [Jaillot 2020]



Spatiotemporal Visualisation: A Survey and Outlook [Chen Zhong 2012]



Clément Colin

LIRIS Doctoral candidate, in collaboration with the Carl Software company, with a background in data science and computer graphics. My research aims to integrate, visualize and interact in 2D, 3D, and 4D with multi-scale geospatial data in a web environment.



Corentin Gautier

LIRIS Doctoral candidate, with a background in video games development. My research focuses on developing new physical and digital territorial representations using gameplay mechanisms for both experts and the larger public.



Diego Vinasco-Alvarez

LIRIS Doctoral candidate with a background in industry 4.0 technologies. My research aims to establish data integration methods between urban data models and formats using semantic web technologies for multi-dimensional city representation navigation and visualization.

Any questions?

Bibliography

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