LIÈGE université
GeoScITY

Les jumeaux numériques urbains pour l'aménagement et l'urbanisme - niveaux de maturité et perspectives

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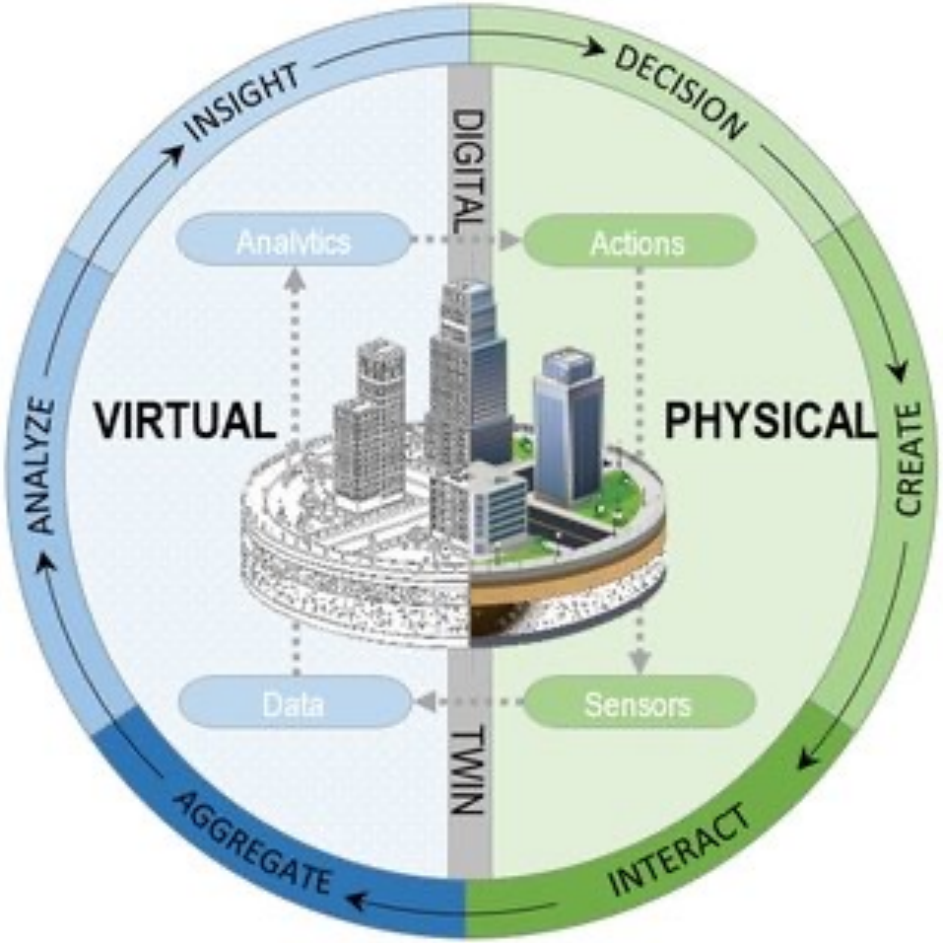
Full Professor at GeoScITY Lab - Geomatics Unit - University of Liège

Monday, 23/09/2024

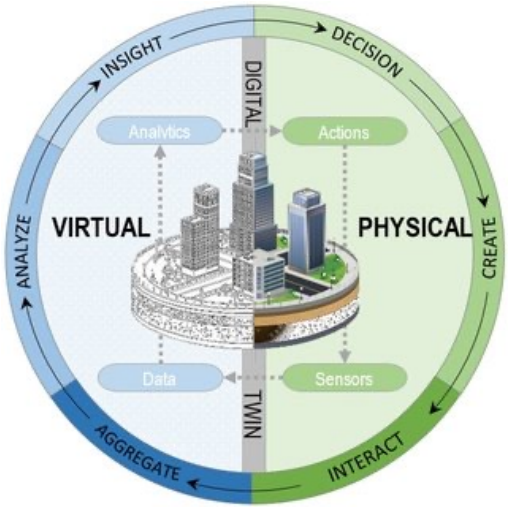
Midi du Lepur, University of Liège, Belgium

Definition



A virtual representation/digital replica of real-world entities, processes, and human activities synchronized at a specified frequency and fidelity ensuring a seamless data connections between the digital and real counterparts.

Conceptual

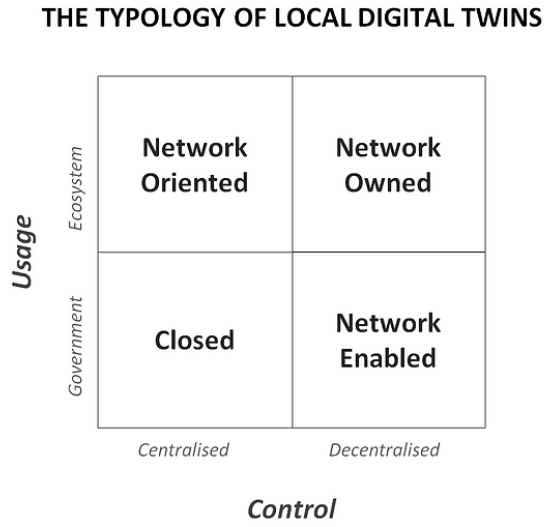


Methodological Framework for Digital Transition and Performance Assessment of Smart Cities

Technical

Zurich 4D

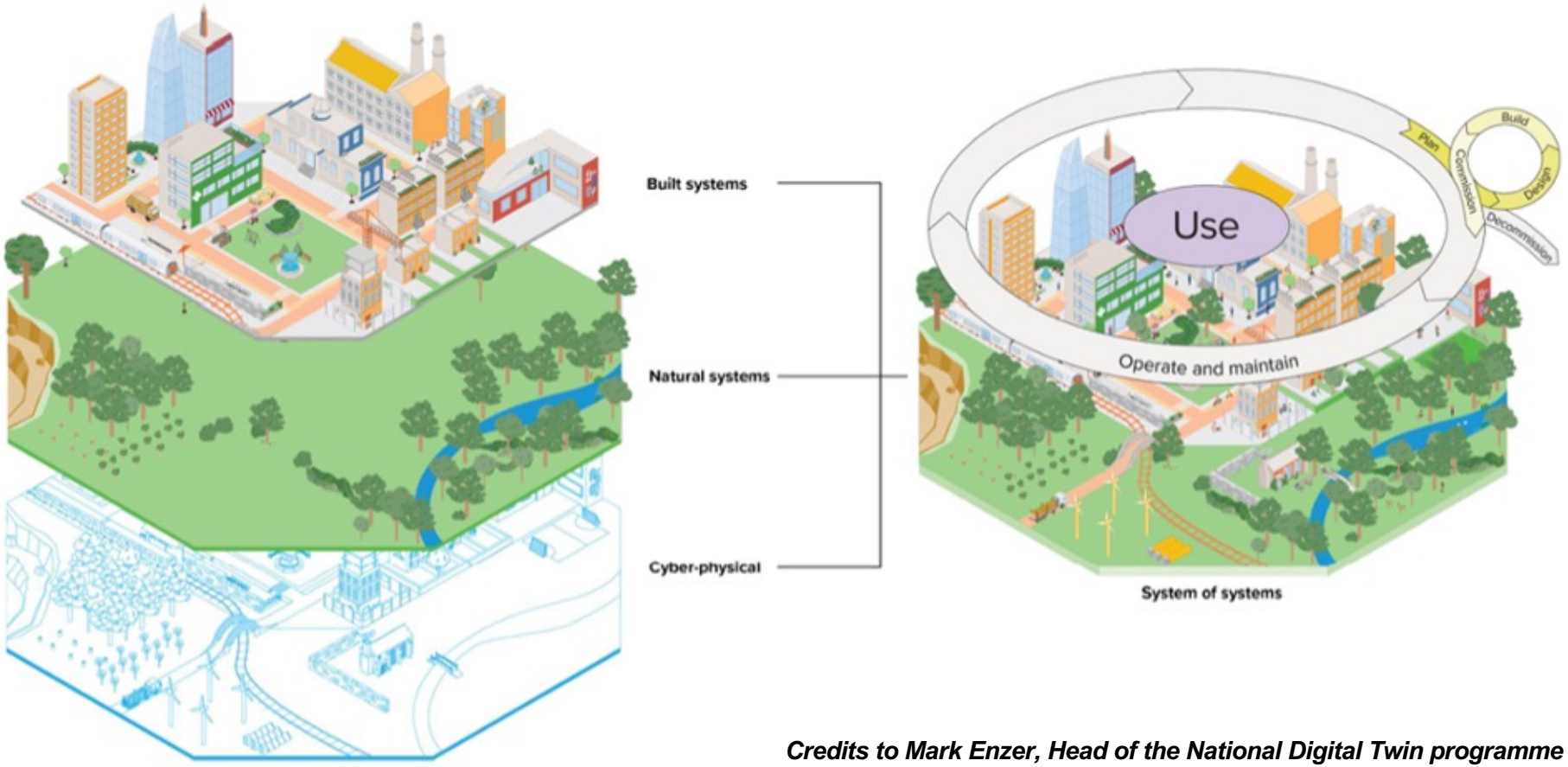
Organizational



https://www.digitalurbantwins.com/post/the-taxonomy-of-local-digital-twins-lessons-from-smart-cities

Conceptual

- An excellent illustration of a functioning system of systems, as they are structured into a hierarchy of interconnected DT instances that process and share a huge amount of data subject to different access and usage policies.

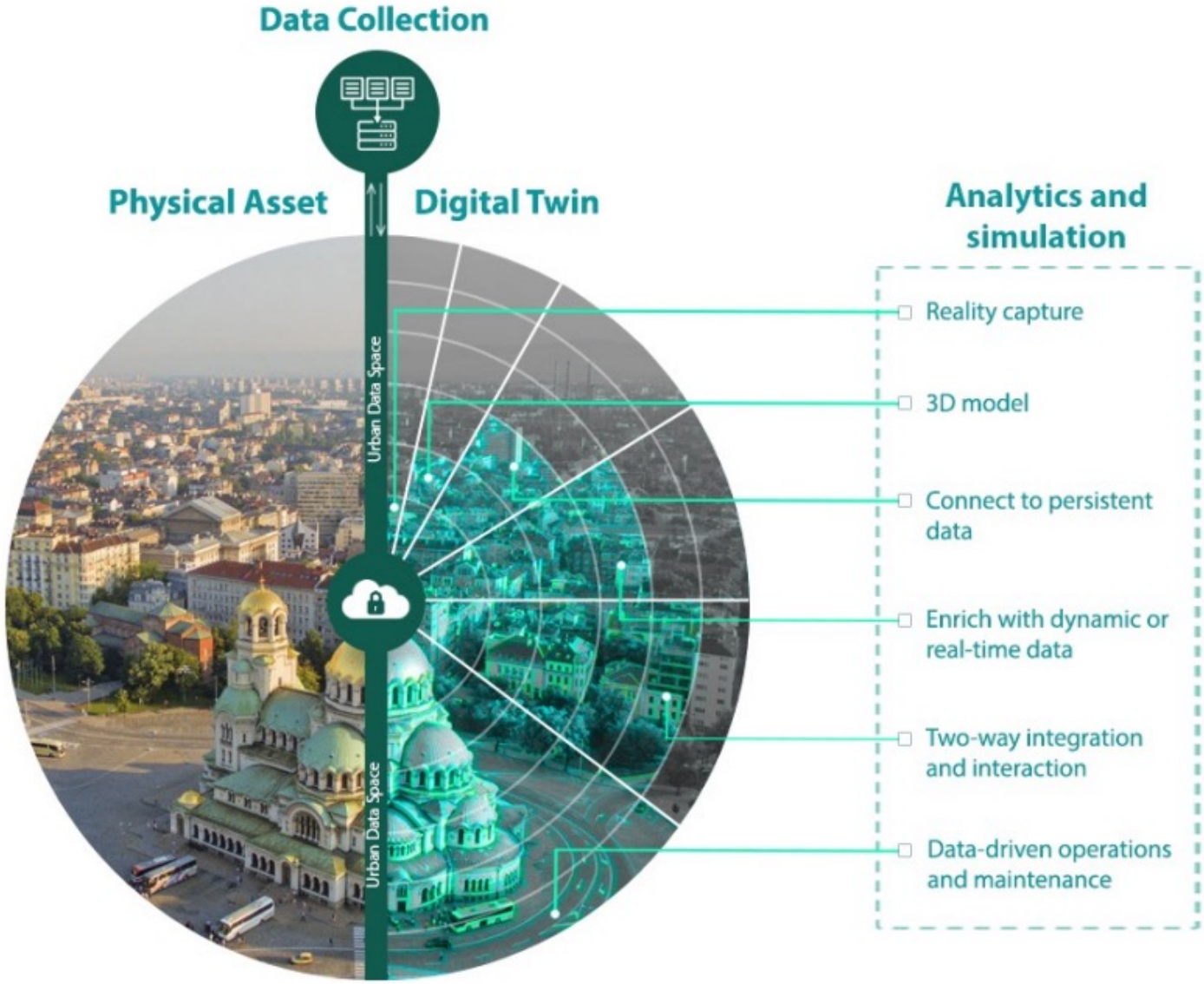


Credits to Mark Enzer, Head of the National Digital Twin programme

Technical

- 3D city models with geometric and semantic information
- Integration of historical and dynamic data in near or real time
- Enabling a connection between the real counterpart and the virtual twin and vice versa
- Allowing updates and analysis through a variety of data analytic, machine learning , simulations, predictions
- An integrated and unified view of the multiple datasets, models through its life cycle allowing to understand and adapt city current and future states → Visualization tools.

UDT seen as enhanced 3D city models …

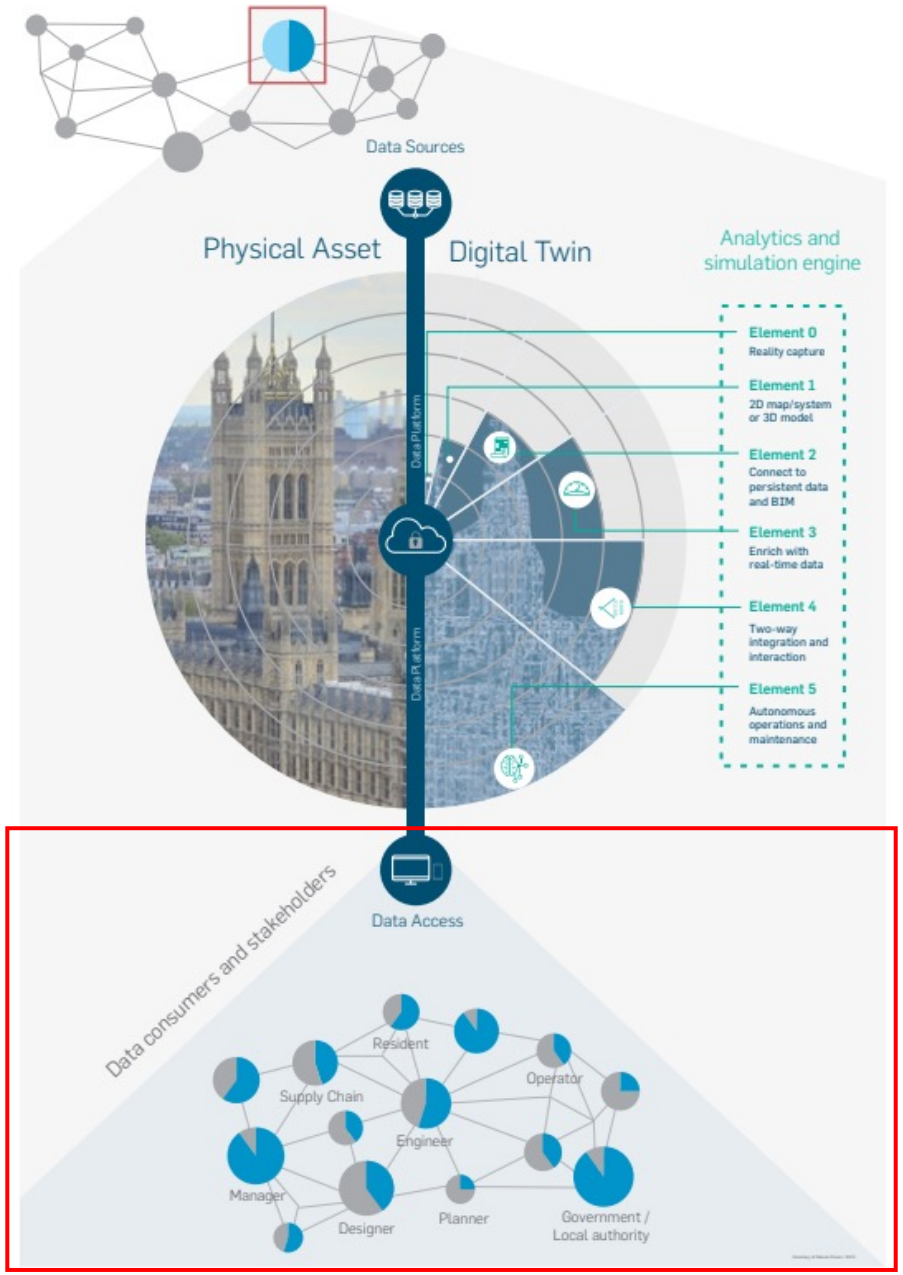


7th Smart Data Smart Cities & 17th 3D GeoInfo Joint International Conferences

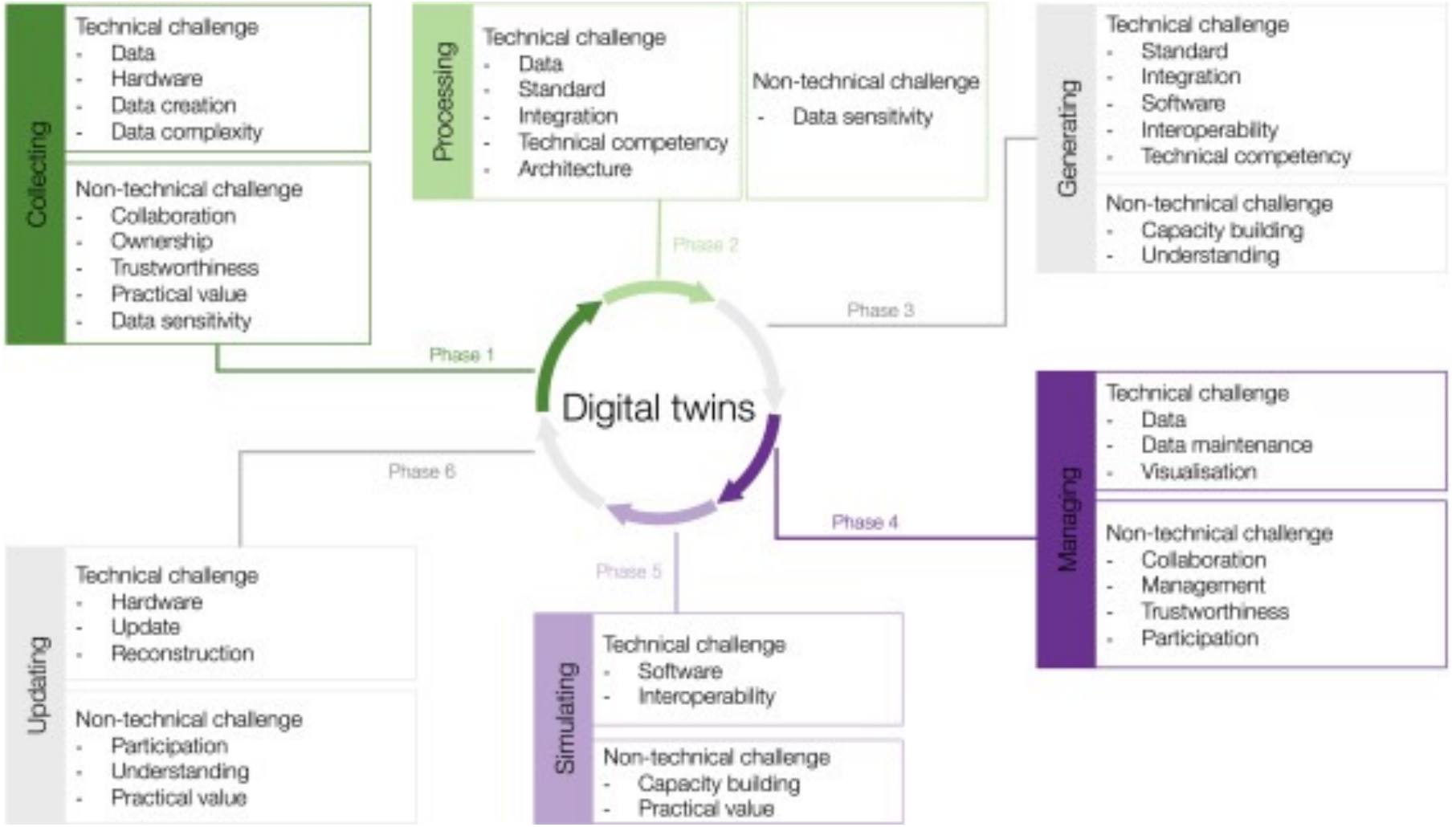
Organizational

- An ultimate tool to support sustainable urban development, to transform the design, and to assist the city management.
- A new way of working and becoming a purely data-driven organization by integrating the City Information Model, processes, concepts and services, and also interacting between the real world and the digital world, in order to create a common image of reality.
- A collaboration and communication tool for urban planners, designers, and the general public, enabling more intentional decision-making for creating smart and sustainable cities
- A risk-free testing tool for urban planners to evaluate the impacts of various urban planning interventions and future changes.

Promote data access, sharing and dissemination



Issues and challenges through the lifecycle

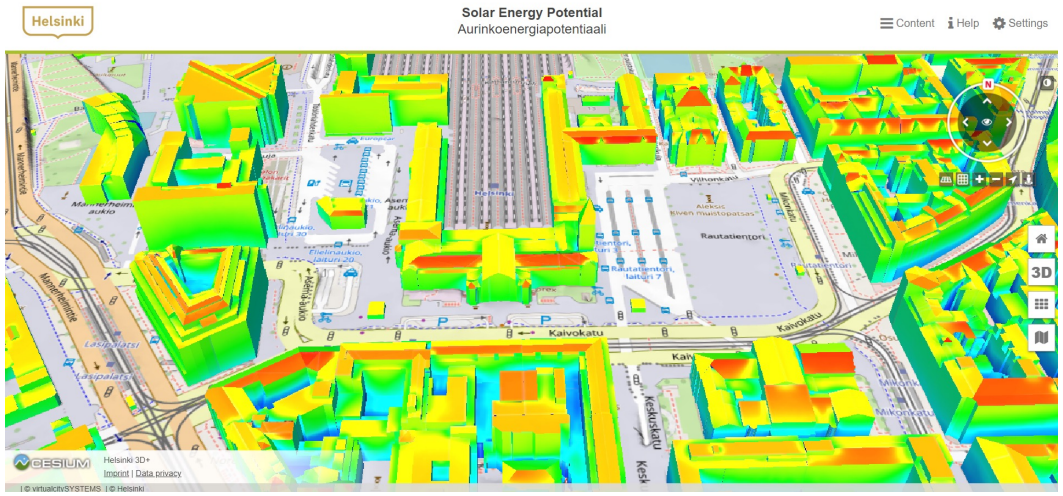


« Challenges of urban digital twins: A systematic review and a Delphi expert survey », Automation in Construction, 2023 : Binyu, Janssen, Stoter, Biljecki

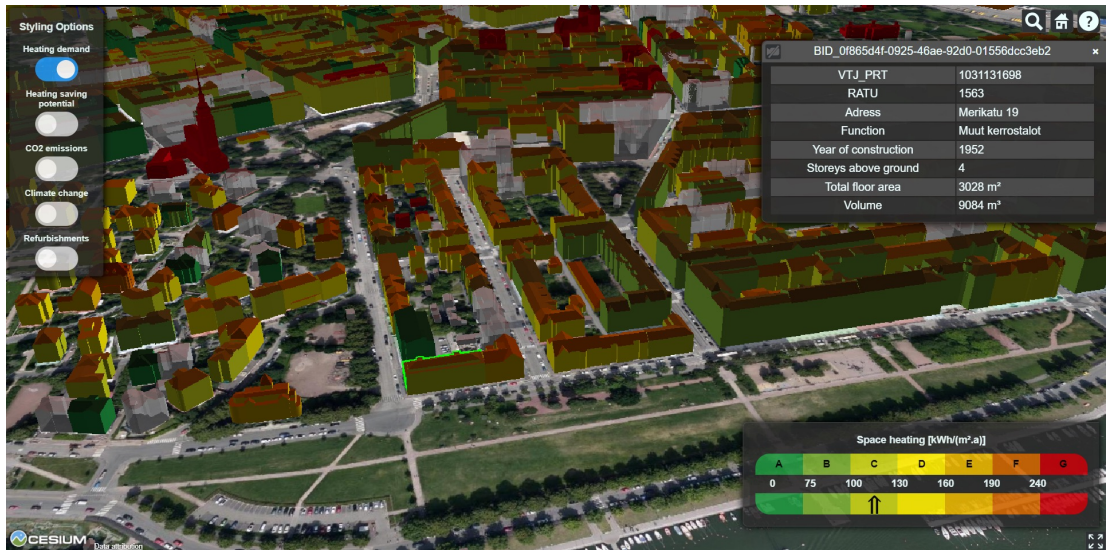
Helsinki

Urban planning and city management

Heat stress



Solar Energy Potential



Heating demand prediction

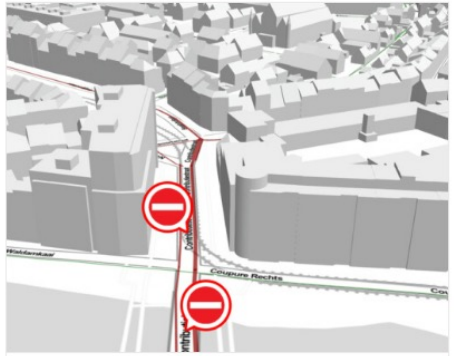
DUET-Flanders

Flanders – Citizen Science sensor map

August 3rd, 2023 | Flanders, Urbanage

My_trees

January 18th, 2023 | Belgium, Duet, Flanders, Ghent, Uncategorized



Ghent – simulation closure Contributie bridge

September 20th, 2022 | Belgium, Duet, Flanders, Ghent, Pilots, Uncategorized

Ghent – Citizens evaluate impact of closing a bridge for traffic

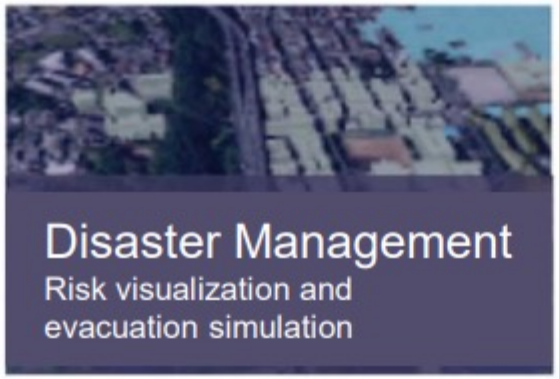
February 10th, 2022 | Duet, Flanders, Uncategorized

Urbanage test case – Find shadow rich locations in the city of Ghent

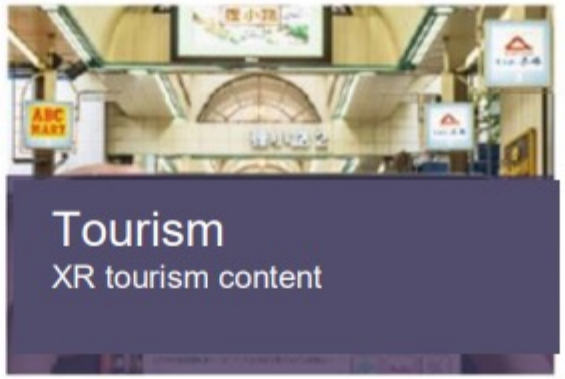
January 13th, 2022 | Flanders, Urbanage

Project PLATEAU- Japan

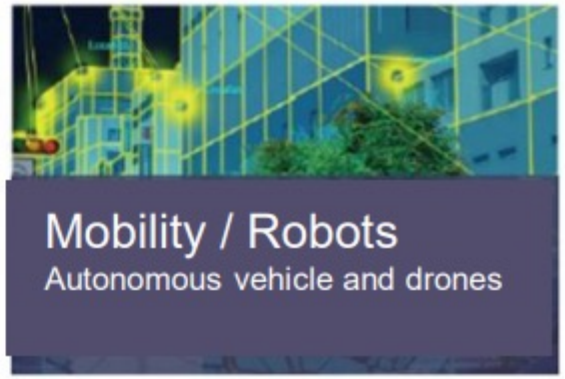
Urban planning
Simulation and consensus building



Disaster Management
Risk visualization and evacuation simulation

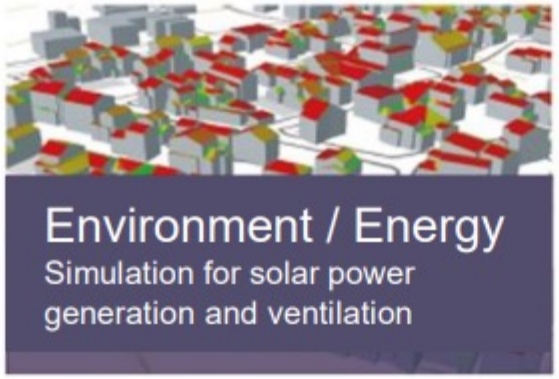


Tourism
XR tourism content



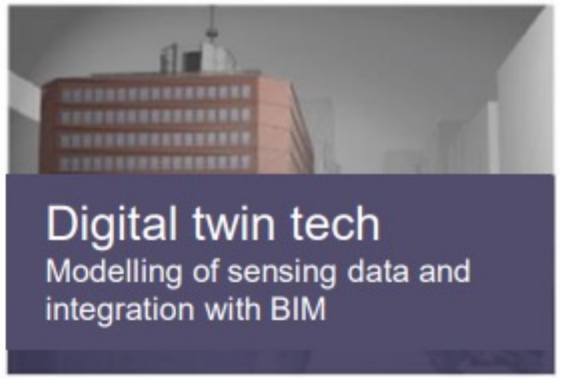
Mobility / Robots
Autonomous vehicle and drones

Public Participation
Visualization through XR technologies



Environment / Energy
Simulation for solar power generation and ventilation

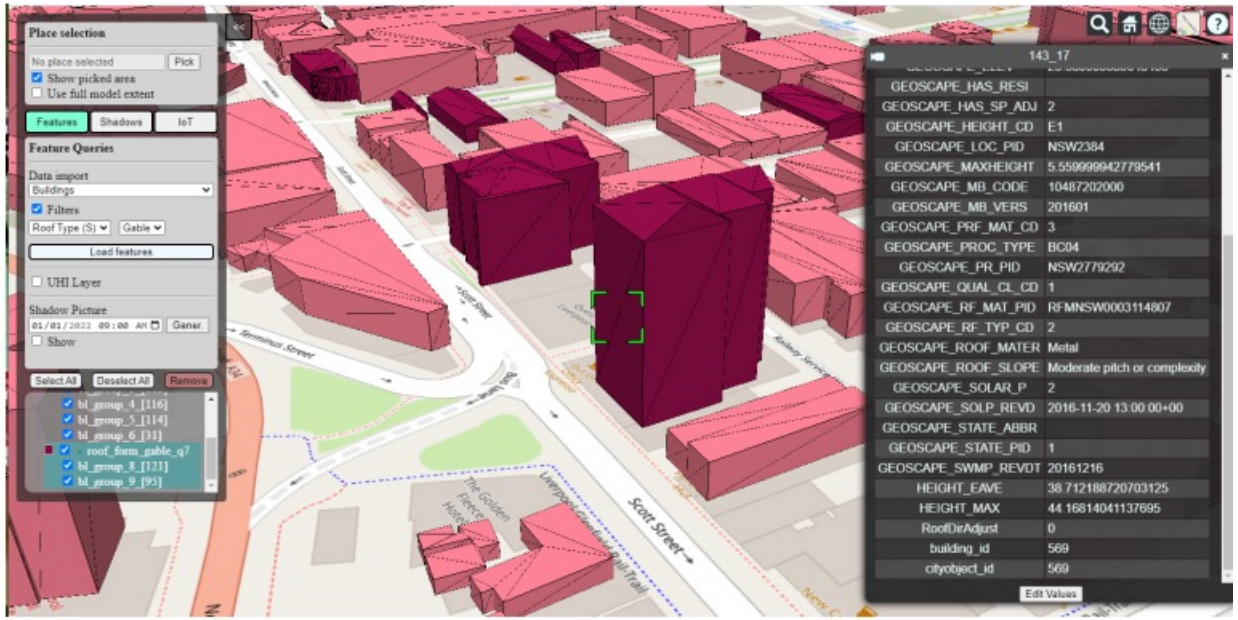
Infrastructure
Facilities management through IoT data

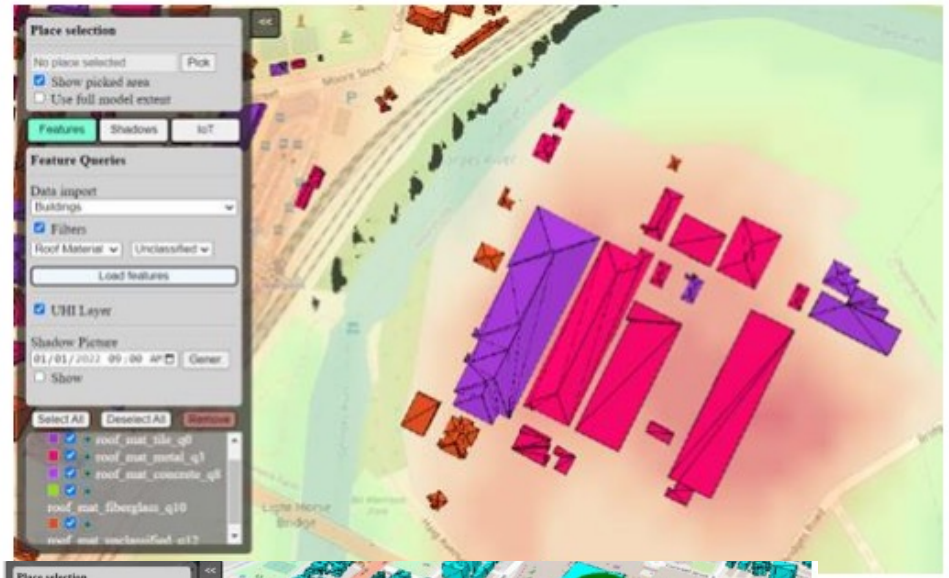


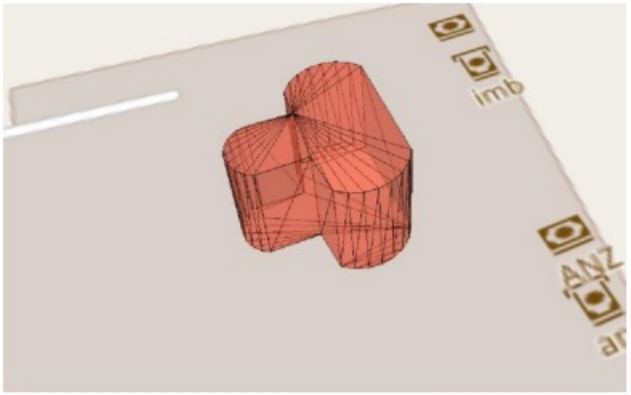
Digital twin tech
Modelling of sensing data and integration with BIM

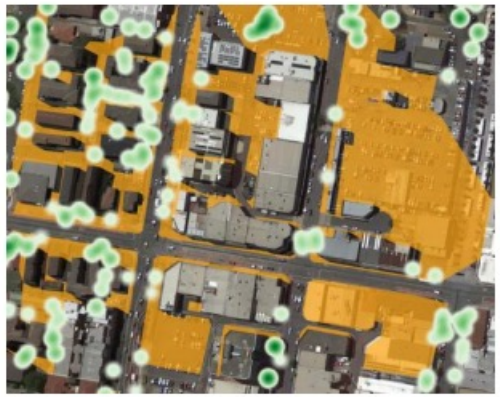
Establishment of an eco-system of 3D City Models through the development of data and use cases concurrently
Development of PLATEAU Use Cases for Digital Transformation of Society

Australia



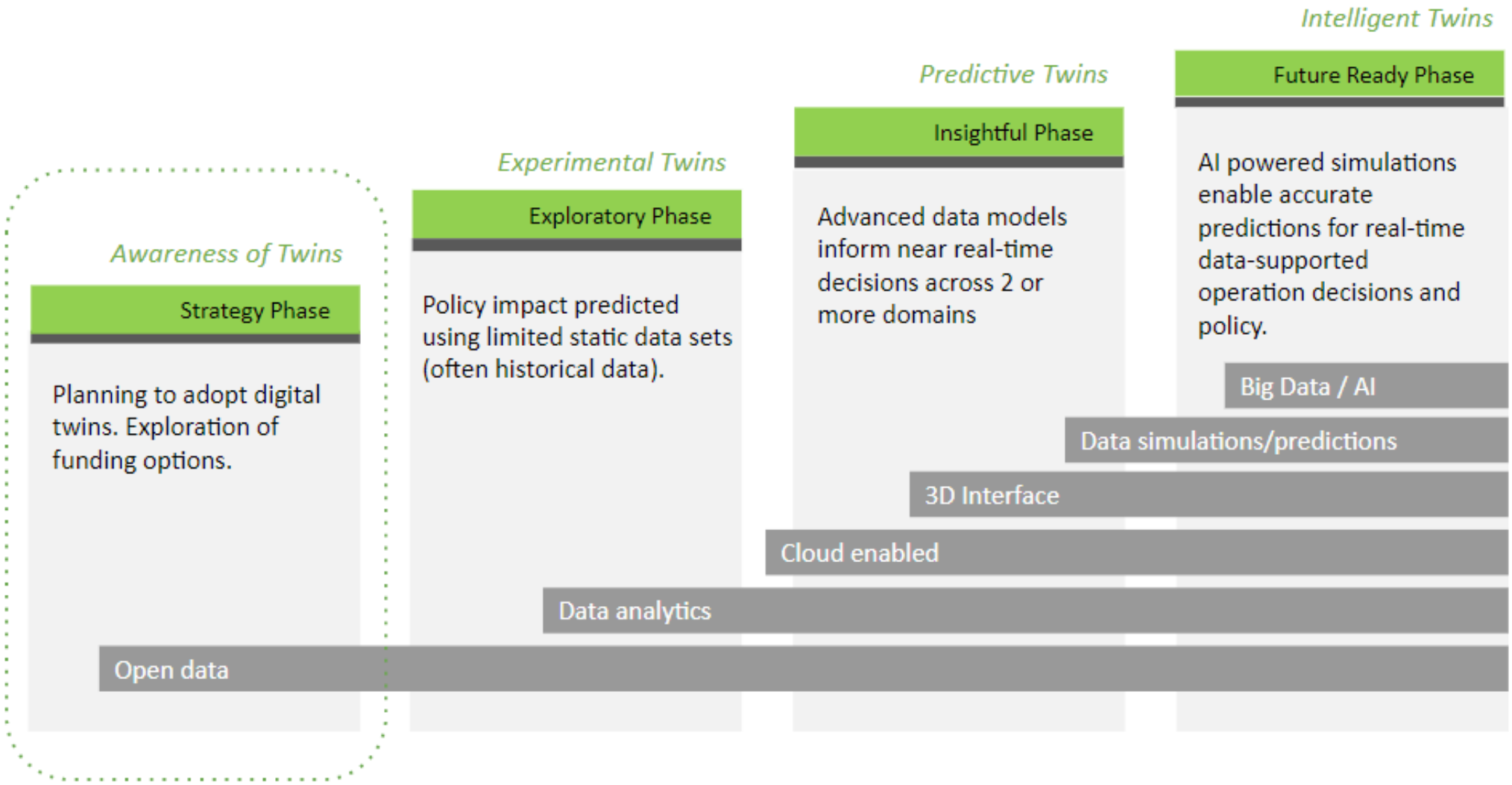






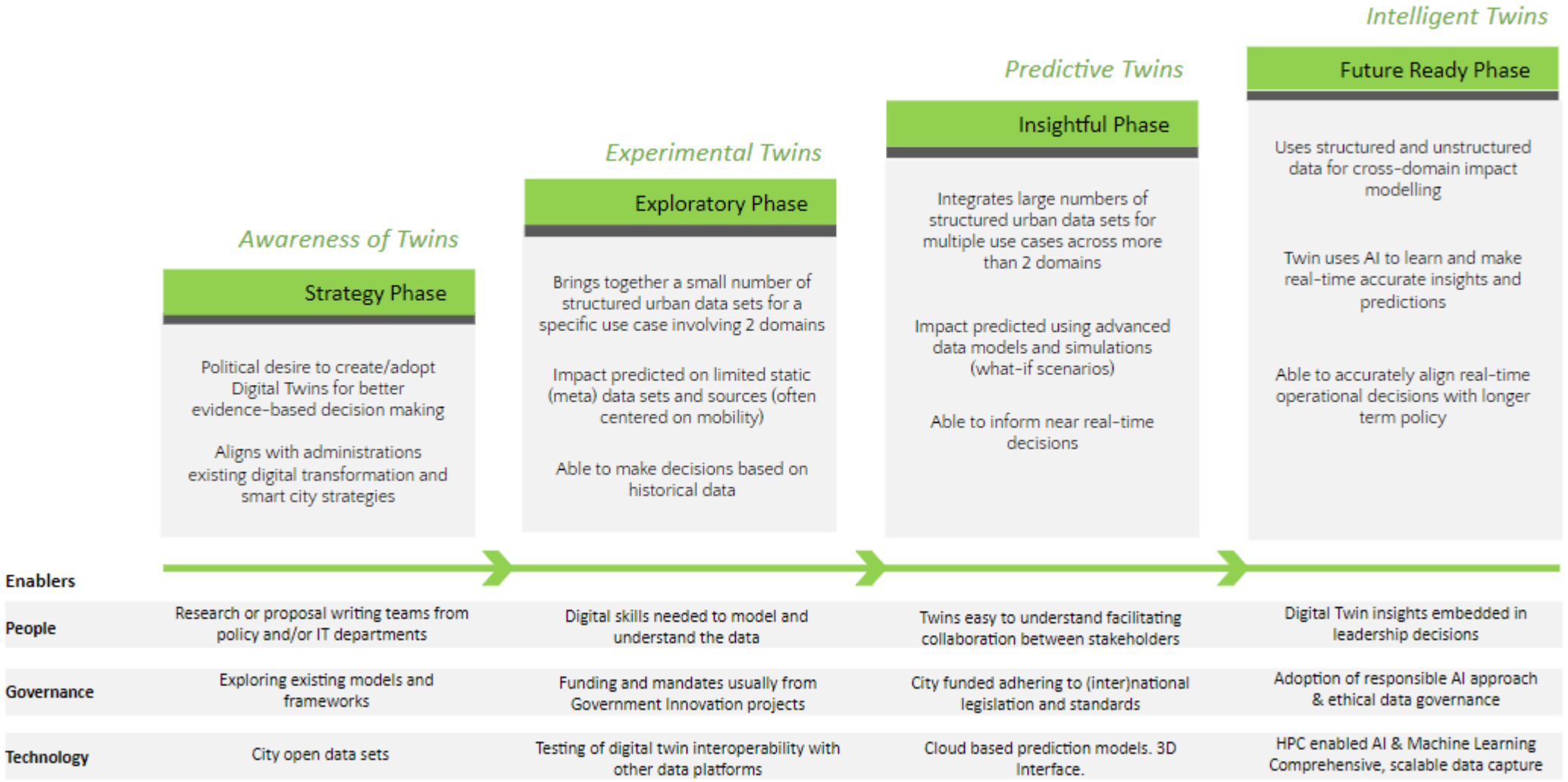
Liveable City Digital Twin
LCDT Project - Live Demo (unsw.edu.au)

Governance & Maturity model



Digital Twin Maturity Model – DUET (https://www.digitalurbantwins.com/)

Governance & Maturity model



https://www.digitalurbantwins.com/digitaltwinmaturitymodel

LIÈGE université GeoScITY

ABOUT TEAM RESEARCH RESEARCH RESOURCES RESOURCES TEACHING

GeoScITY

The “Geospatial Data Science and City Information Modeling” Lab is a research group specialising in spatial information modelling. Its activities cover both theoretical aspects (qualitative spatial reasoning, spatial ontologies, etc.) and operational developments (use of AI methods in geospatial data processing, development of spatial data infrastructures, etc.). Research focuses mainly on urban applications, from the territorial to the building scale, without excluding other themes such as digital heritage.

LEARN MORE

Team

Post-docs and Prof: **3**
Researchers and PhD students: **5**
Teaching and Admin staff: **2**

External Collaborators: **4**

>100 scientific publications
>30 funded research's projects

PhD completed : 8

Affiliation

Teaching Faculty of Sciences / Département of Geography

Research

LIÈGE université SPHERES

LIÈGE université Geomatics

LIÈGE université GNSS - Géodésie

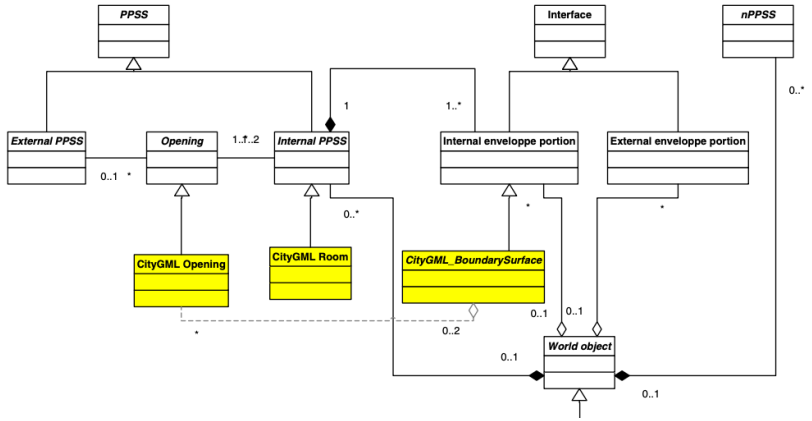
LIÈGE université GeoScITY

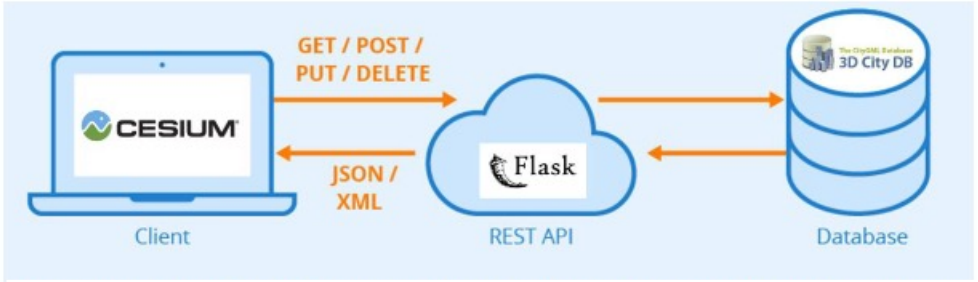
LIÈGE université EOSystM

...

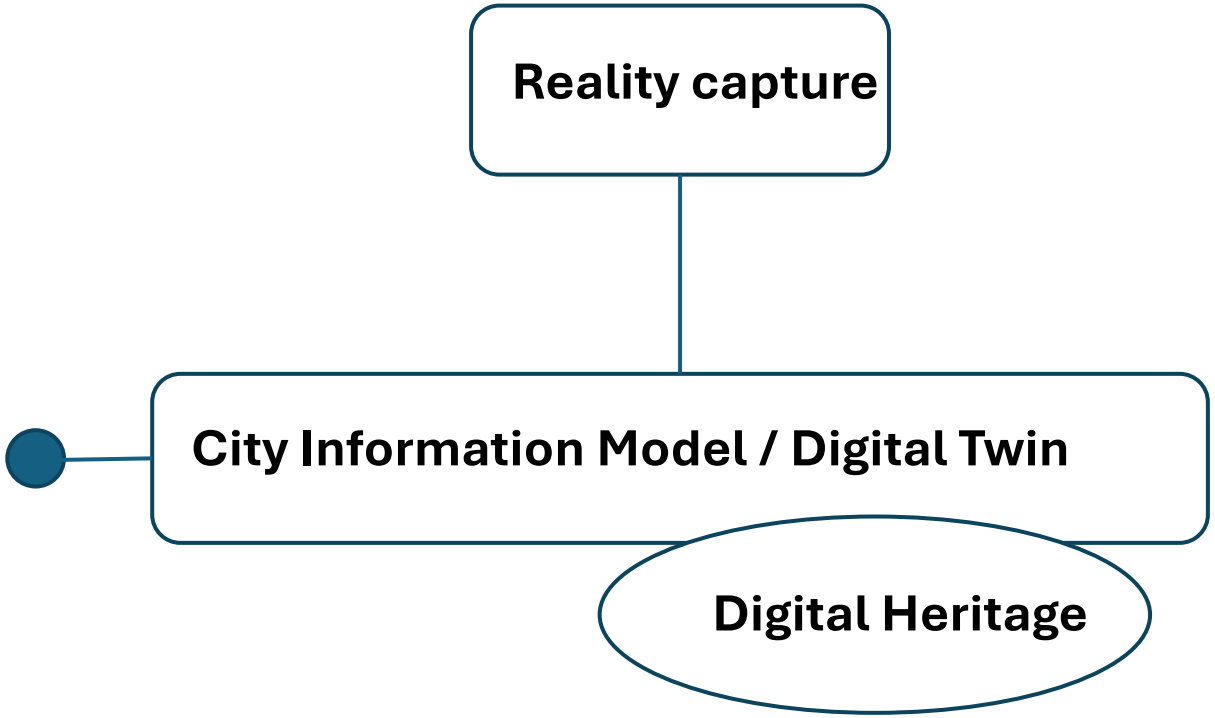
From Theory …

- Geoinfo Modeling and Reasoning
- (3D) Geoprocessing
- Spatial Data Infrastructure



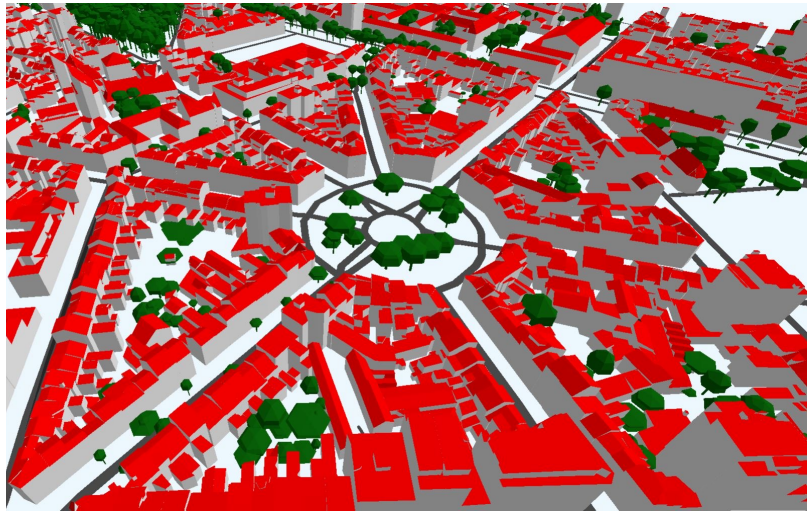


To Applications

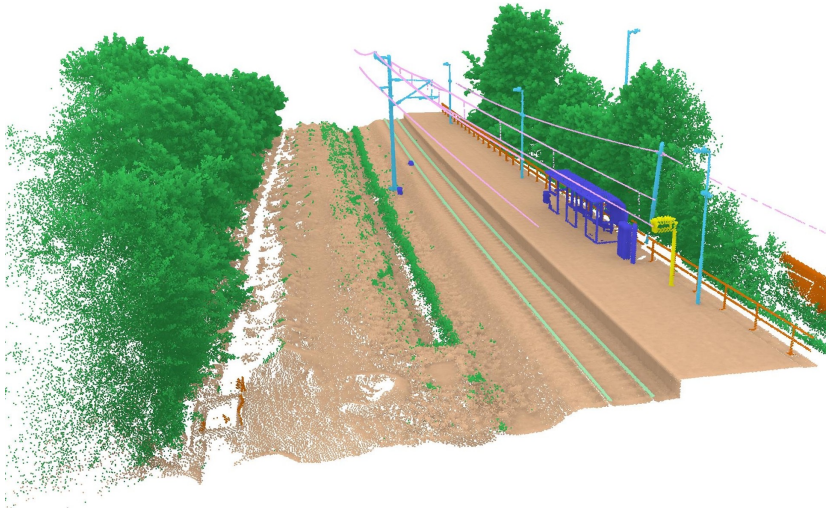


Urban Digital Twin Projects

SEM 3D



TrackGen



WA-LOD2

City2Twin

CITY2TWIN

Liège

Tremplin. IA
By DigitalWallonia4.ai

Research Innovation award BeGEO 24

Objectifs scientifiques

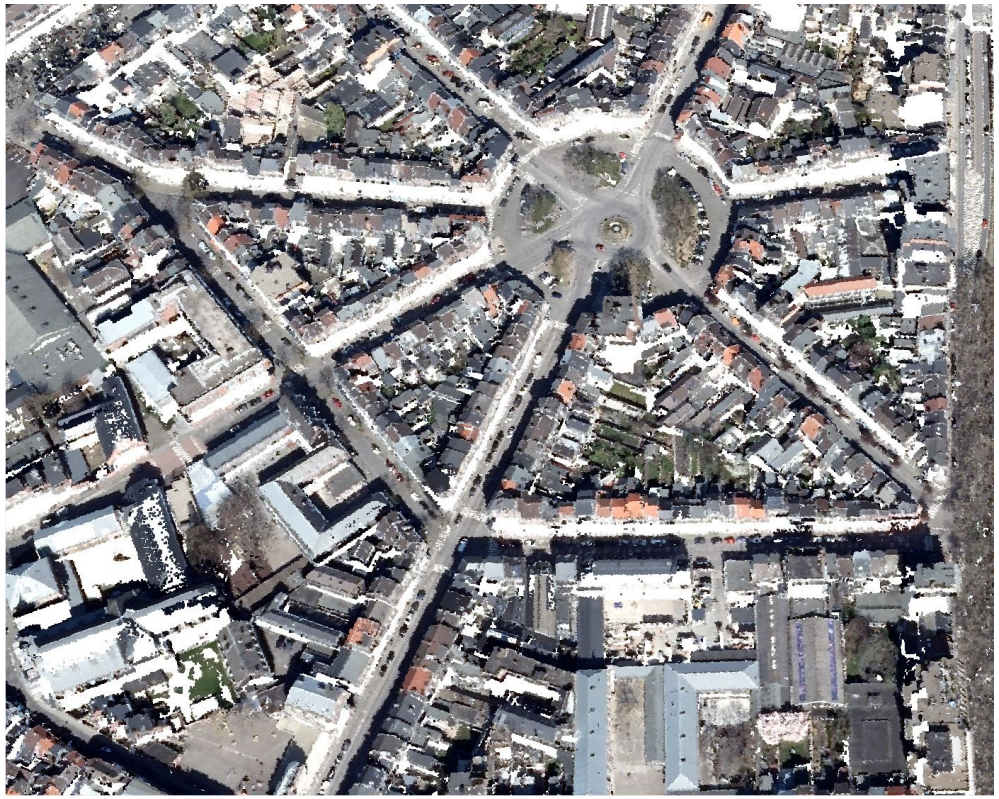
Mise en place de procédures d'extraction d'objets urbains 3D enrichis sémantiquement à partir de données issues de capteurs aériens ou terrestres (LiDAR et spectraux) en utilisant des techniques d'intelligence artificielle (IA) de type Deep Learning (DL).

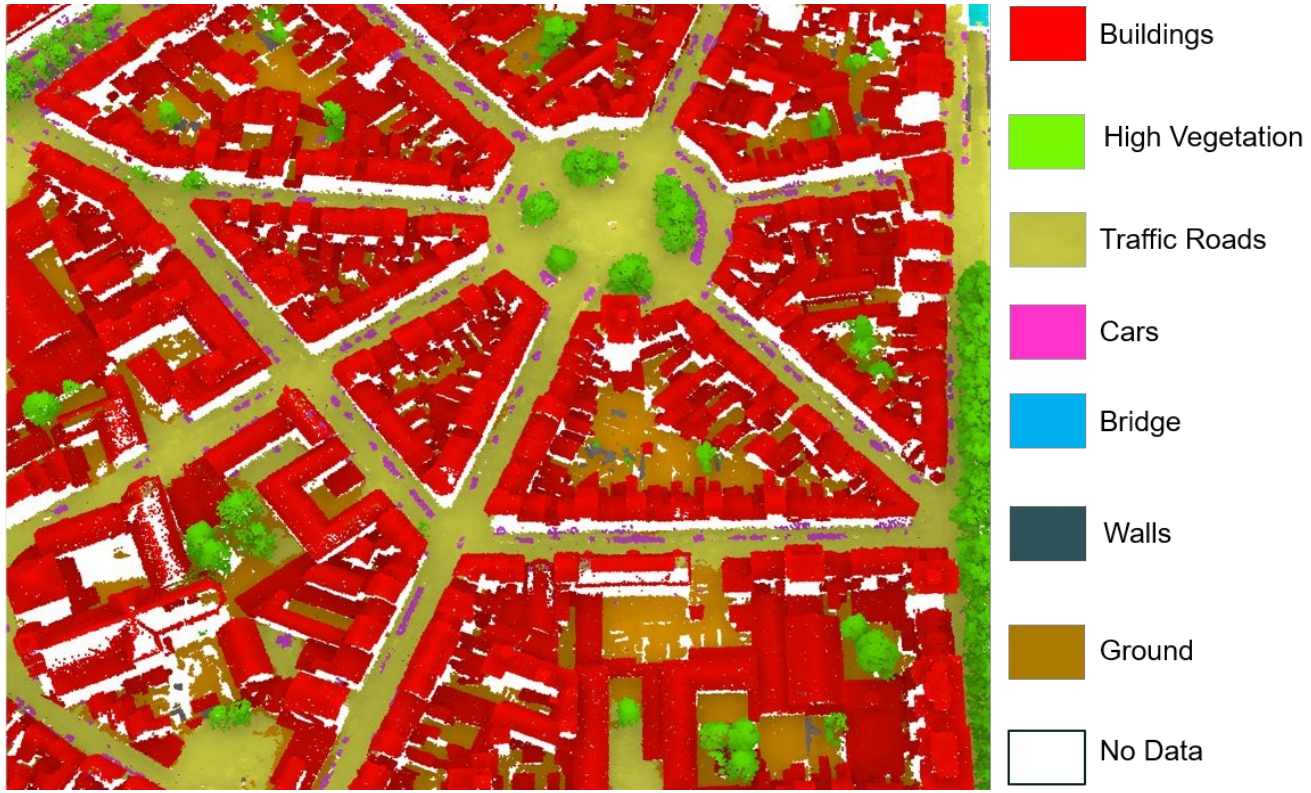
En pratique...

Permettre à la Ville de Liège d'améliorer la gestion urbaine à l'aide d'objets 3D (bâtiments, arbres, routes, etc.) obtenus à partir de données mises à disposition par la Région wallonne.

Classification des points

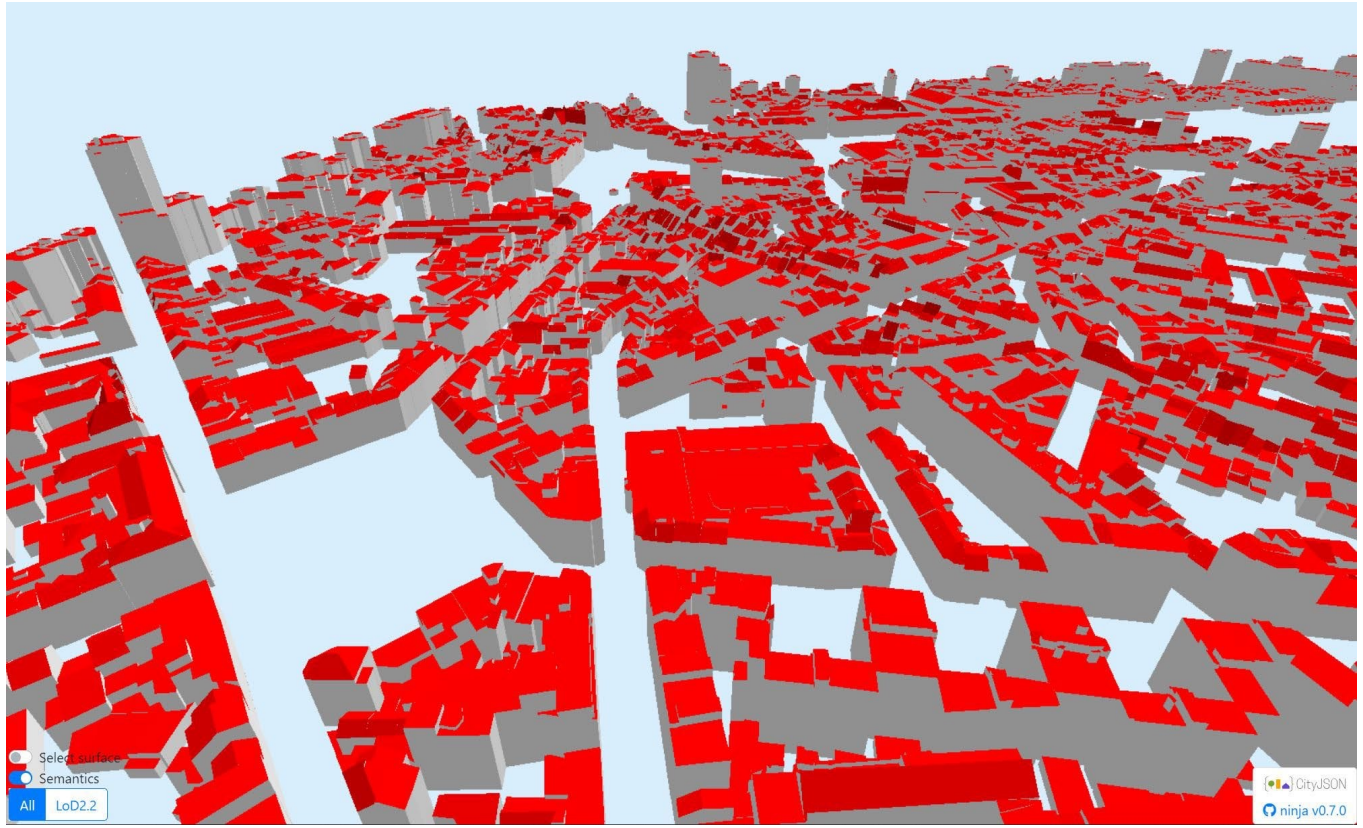
- *Classification 3D de points en plusieurs catégories à l'aide de techniques d'apprentissage profond (IA).*

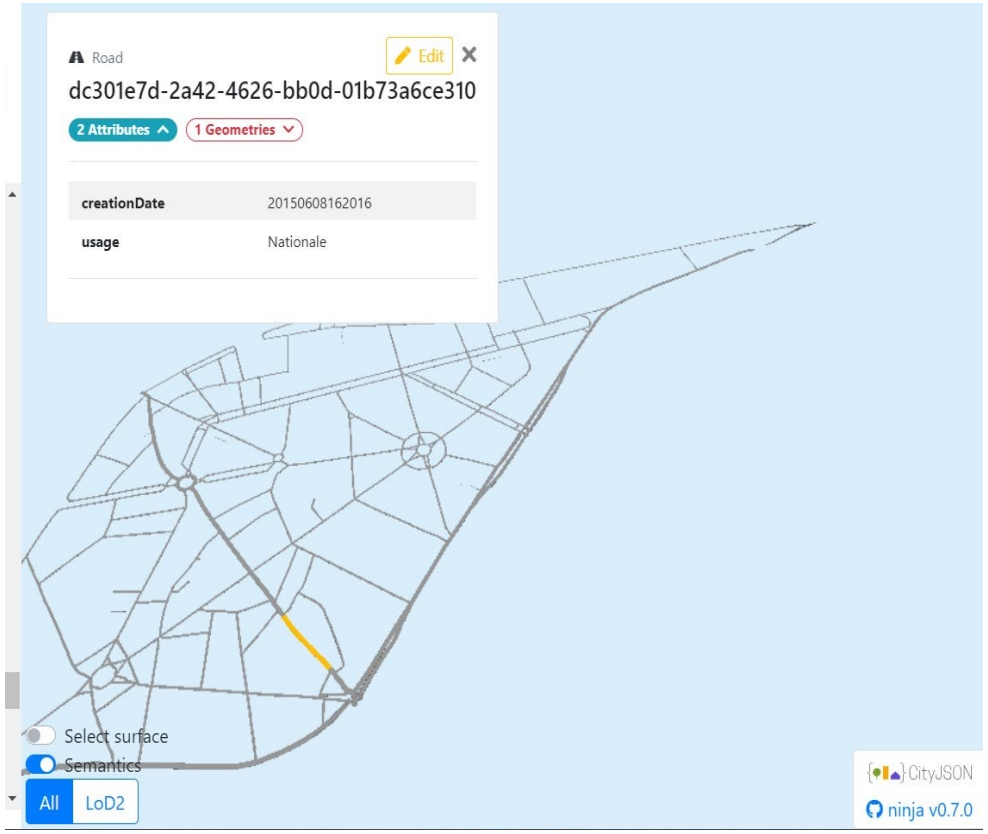




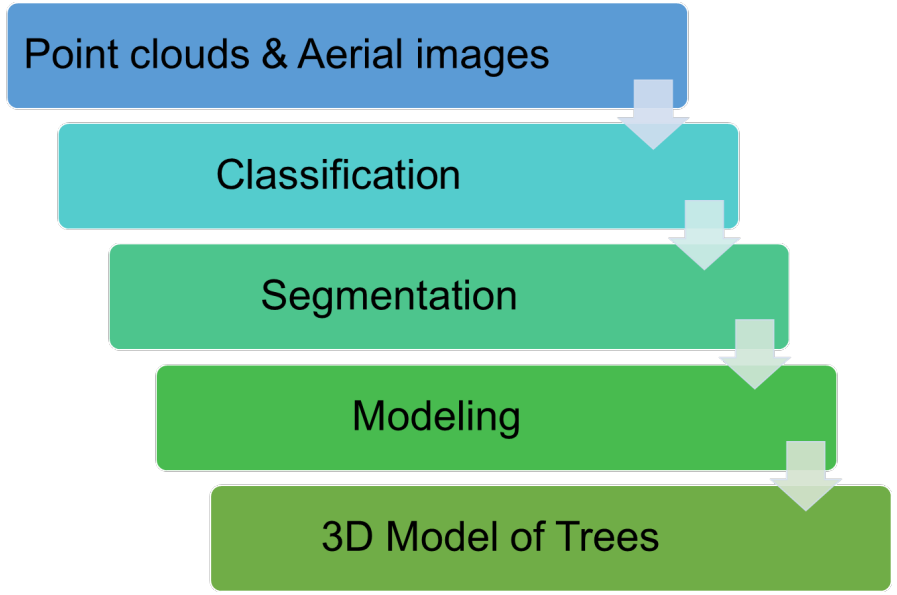
Création de modèles de villes en 3D

- *Basé sur des points classifiés et des données vectorielles 2D*
- *Bâtiments et routes*

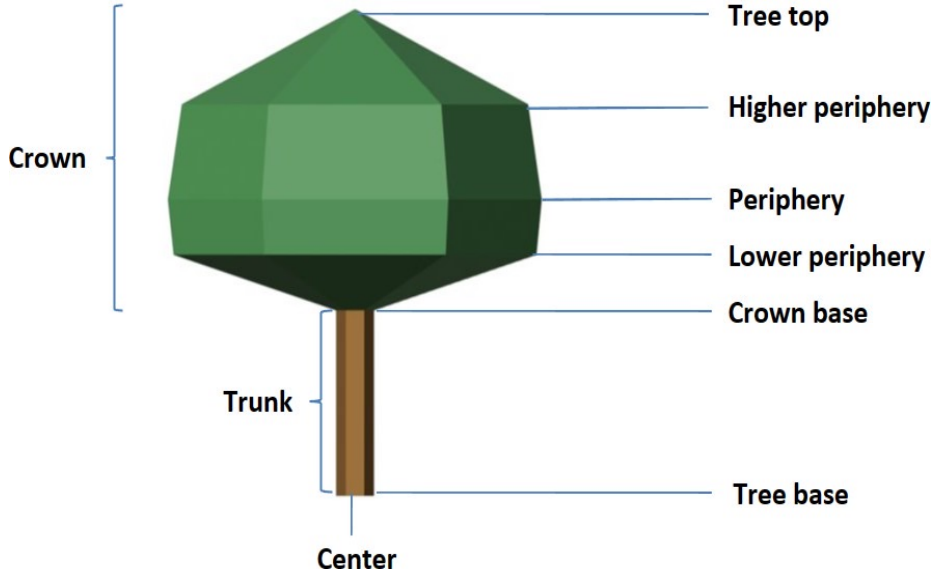




Végétation



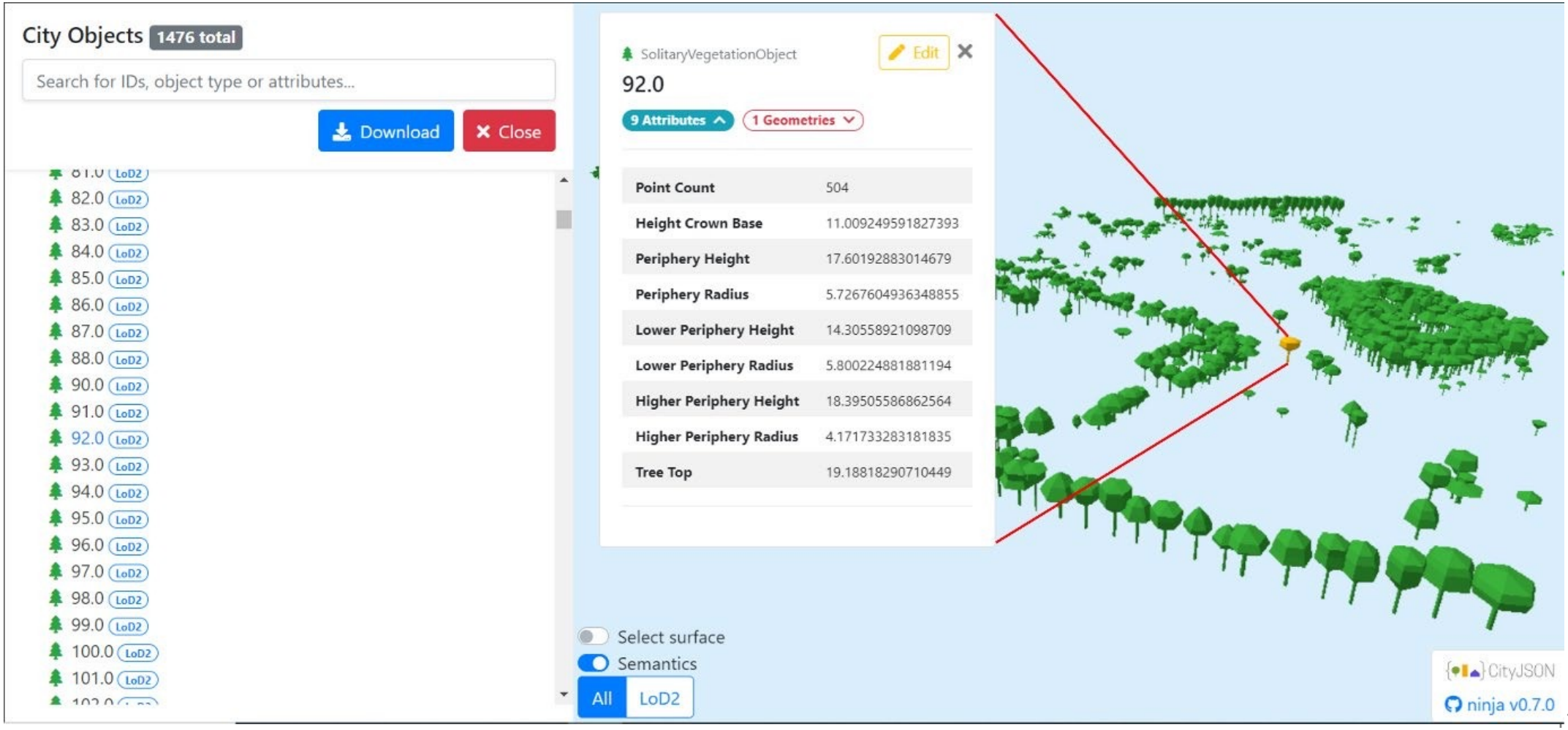
General Workflow for Tree Modeling



Tree construction parameters

Detail levels

Végétation

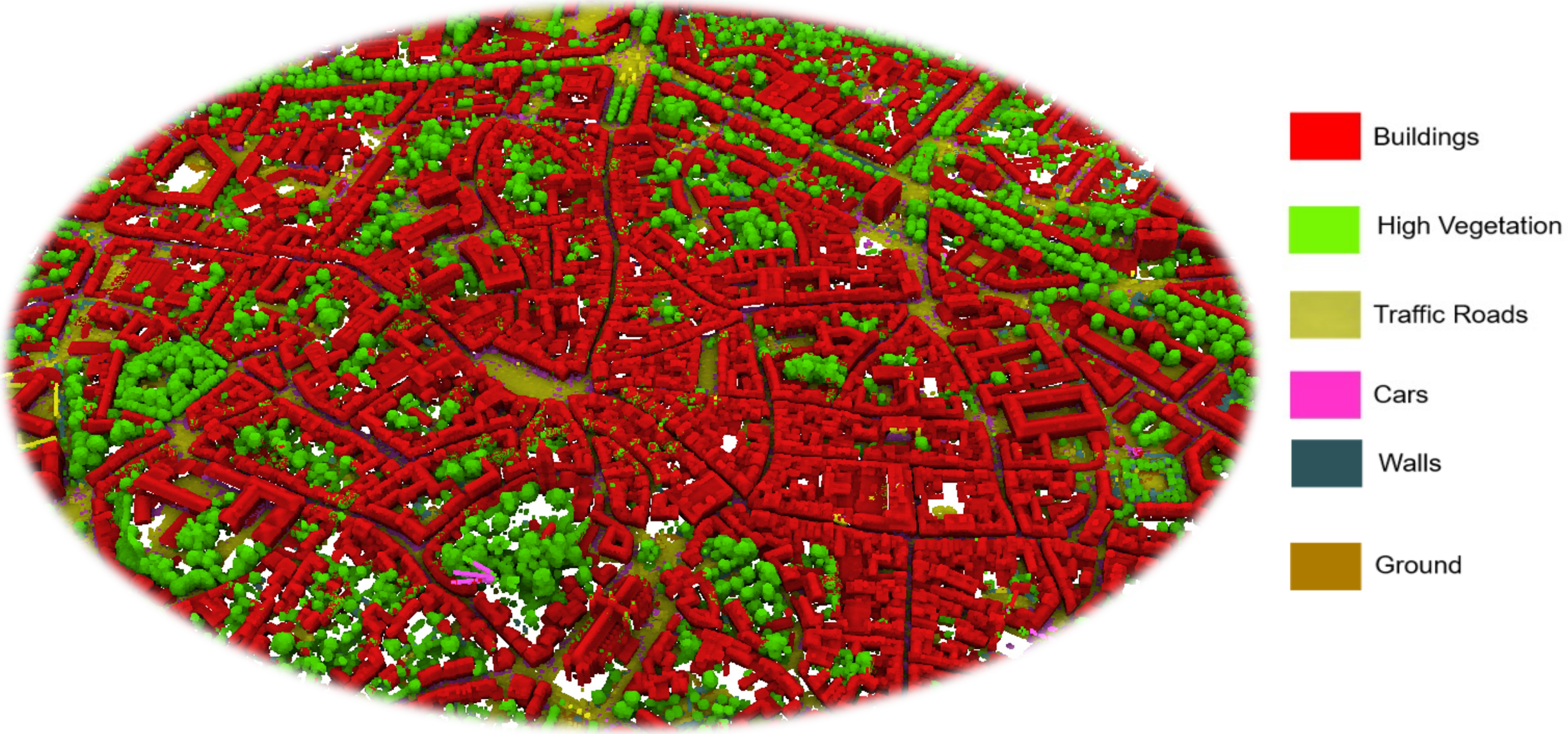

City Objects 1476 total
Search for IDs, object type or attributes...
Download
Close
82.0 LoD2
83.0 LoD2
84.0 LoD2
85.0 LoD2
86.0 LoD2
87.0 LoD2
88.0 LoD2
90.0 LoD2
91.0 LoD2
92.0 LoD2
93.0 LoD2
94.0 LoD2
95.0 LoD2
96.0 LoD2
97.0 LoD2
98.0 LoD2
99.0 LoD2
100.0 LoD2
101.0 LoD2
SolitaryVegetationObject
Edit
92.0
9 Attributes
1 Geometries
Point Count 504
Height Crown Base 11.009249591827393
Periphery Height 17.60192883014679
Periphery Radius 5.7267604936348855
Lower Periphery Height 14.30558921098709
Lower Periphery Radius 5.800224881881194
Higher Periphery Height 18.39505586862564
Higher Periphery Radius 4.171733283181835
Tree Top 19.18818290710449
Select surface
Semantics
All
LoD2
CityJSON
ninja v0.7.0

Obtention d'objets sémantiques 3D pour les applications urbaines (SEM3D)

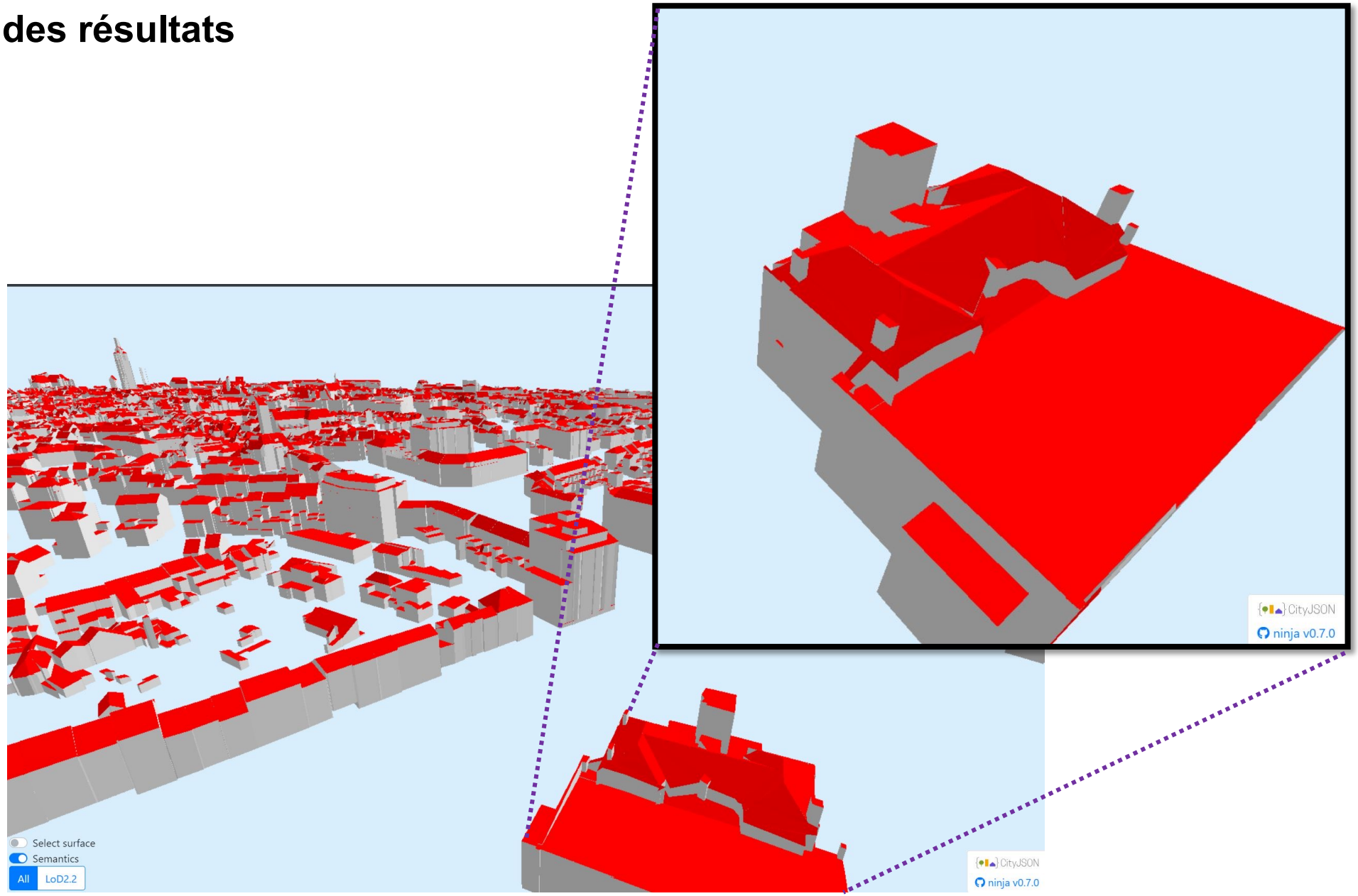
Financé par : Tremplin IA Digital Wallonia

Roland Billen | Zouhair Ballouch | Jean-Paul Kasprzyk | Michel Duc | Natacha Linder | Bernard Lechanteur

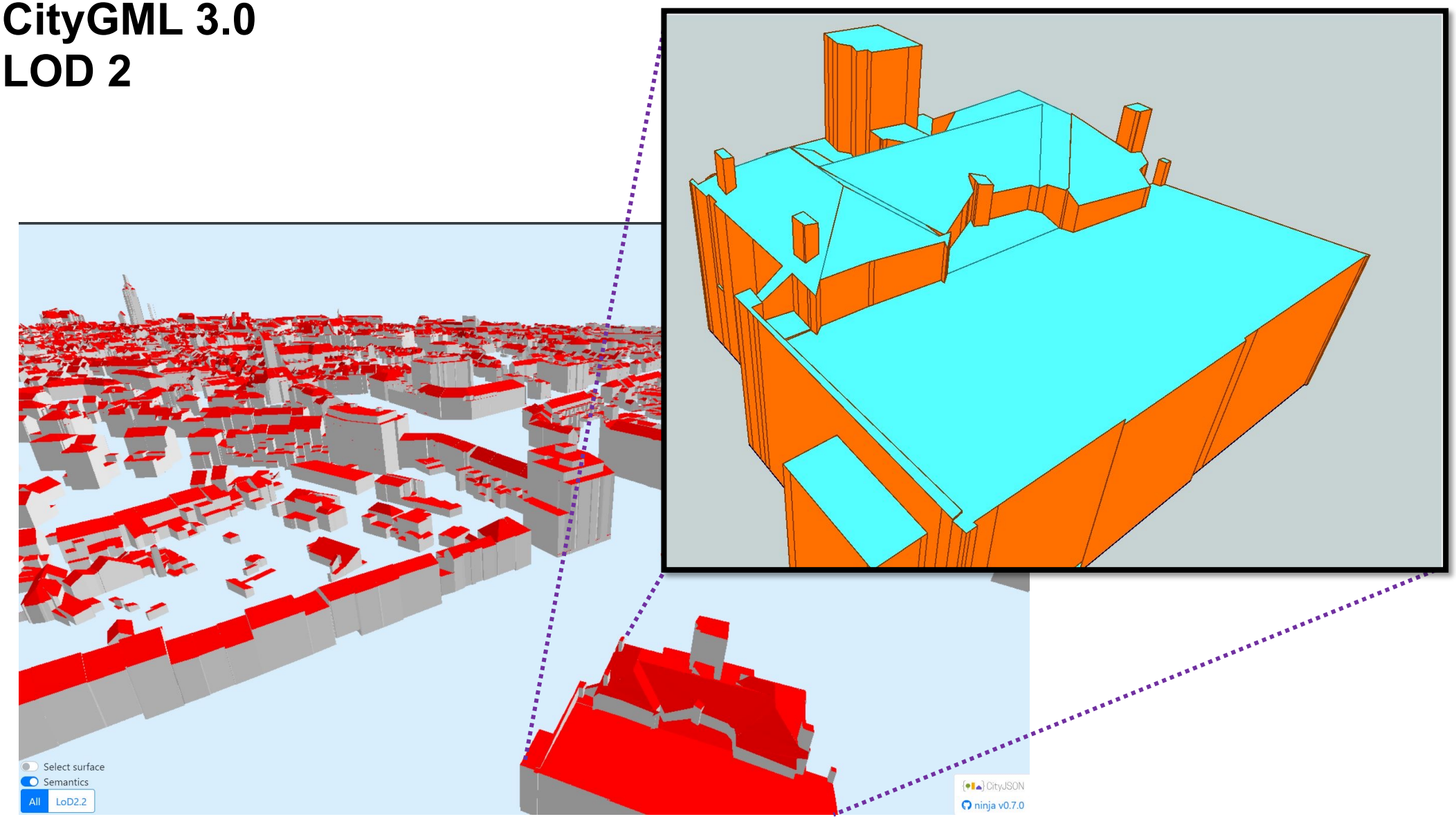
Classification 3D avec les techniques d'intelligence artificielle



Exemple des résultats

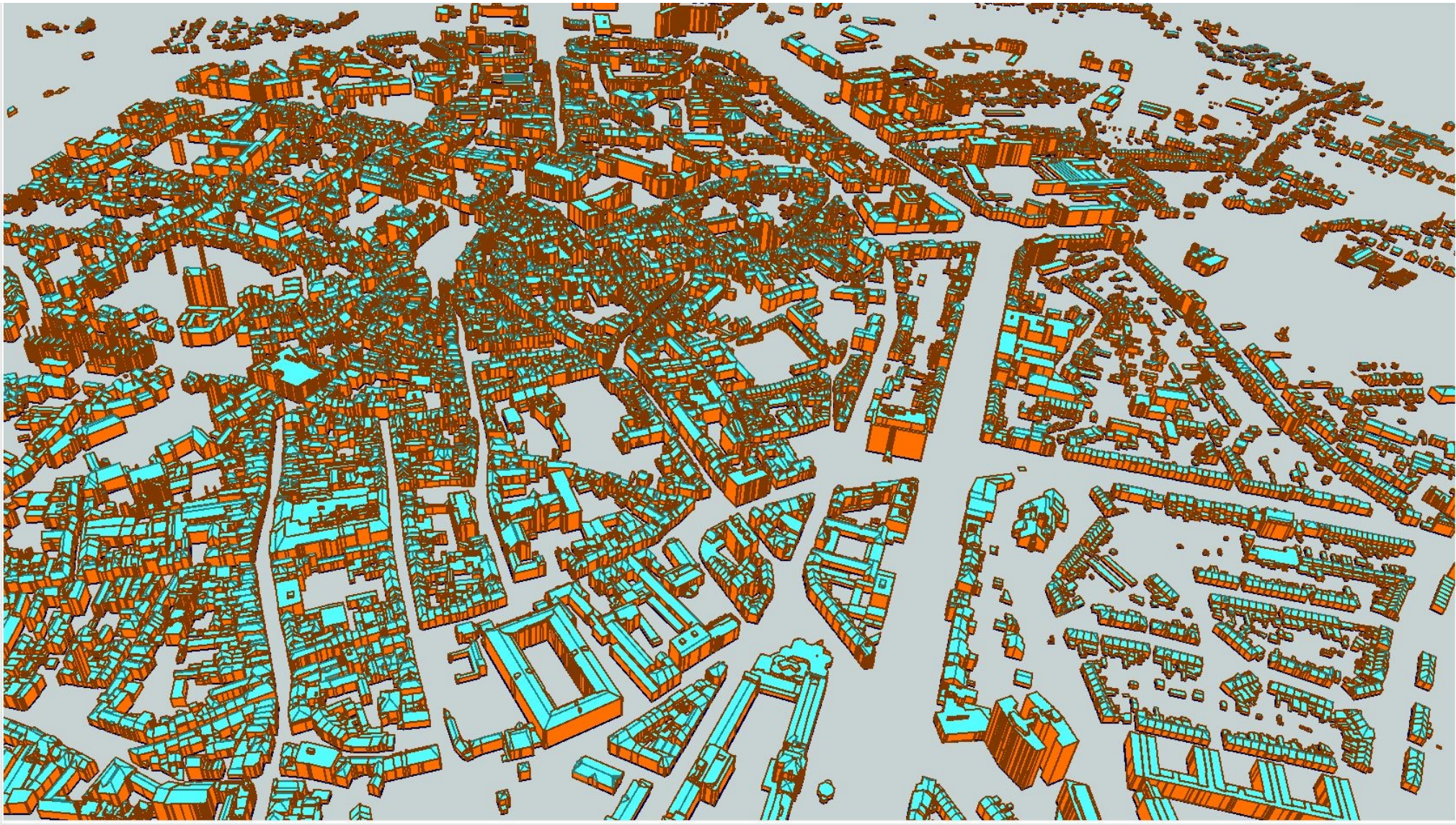


- **CityGML 3.0**
- **LOD 2**



Exemple des résultats

ew 1 (123241)
test10_new [CITYGML] (123241)
Building (22416)
BuildingPart (22416)
CityModel (1)
GroundSurface (22208)
RoofSurface (22218)
WallSurface (33982)

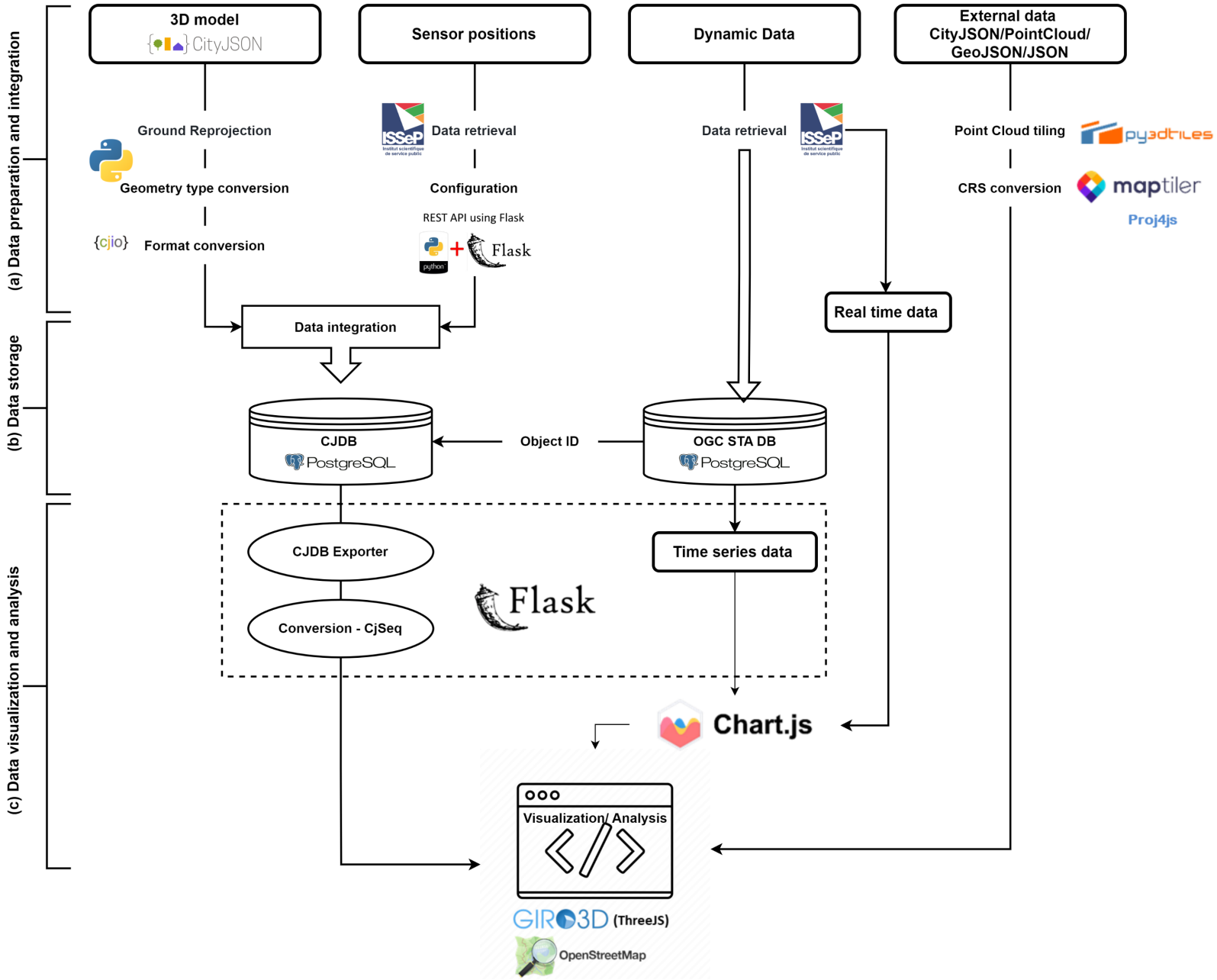


CityJSON

CJDB

Technological framework

- Data preparation and integration
- Data storage and management
- Data visualization and analysis



- **Urban Digital Twins for cities are coming and will improve urban planning and management**

  → All the stakeholders should be prepared

  → There is a need for a Walloon strategy in line with the international initiatives

- **GeoScITY UDT objectives**
  - Enhance demonstrators and technology platforms – looking for partnerships
  - Support cities and institutions in their transition to digital twins

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Questions?

www.geoscity.uliege.be

GeoScITY

ULiege - Geomatics Unit