武漢大学
Wuhan University

Design and Development of a 3D Cadastral System Prototype based on LADM and 3D Topology

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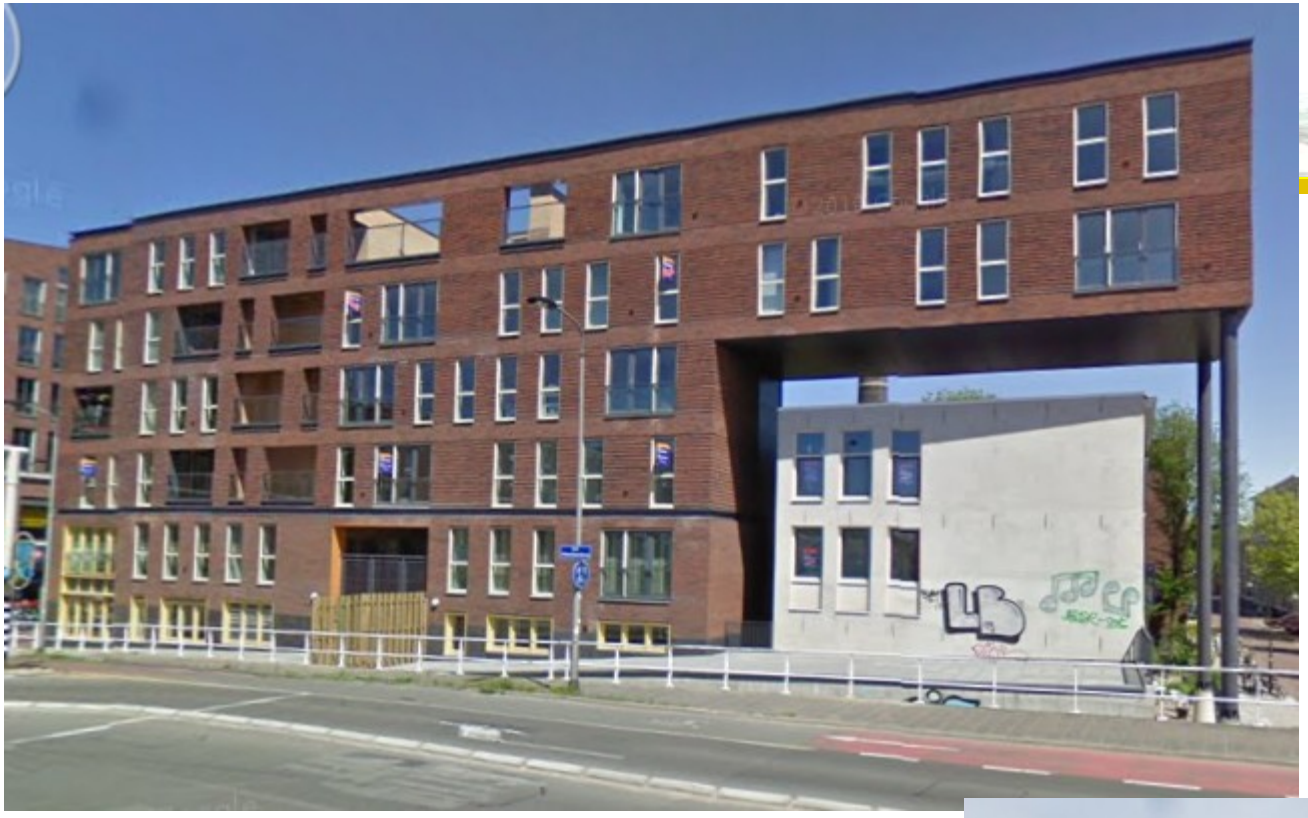
Overview

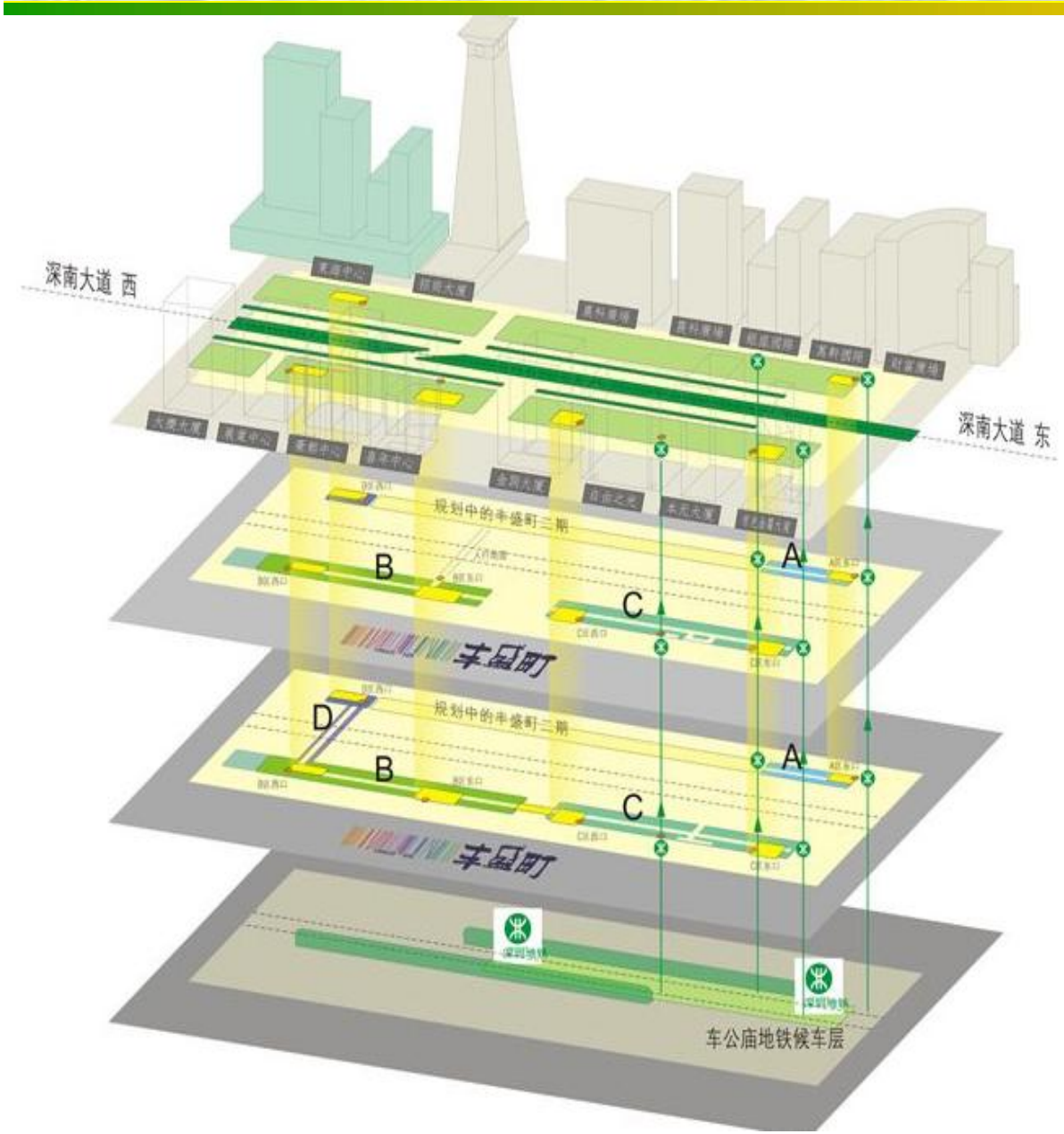
1. Introduction
2. 3D cadastral model in LADM and the prototype
3. Body construction based on SketchUp
4. Prototype system
5. Conclusion and prospective outlook

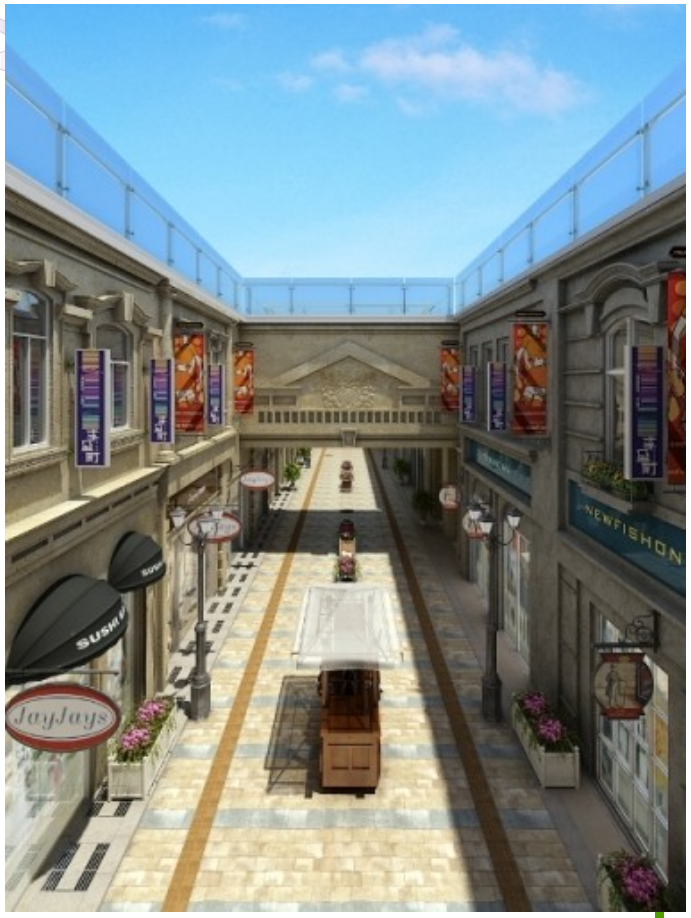


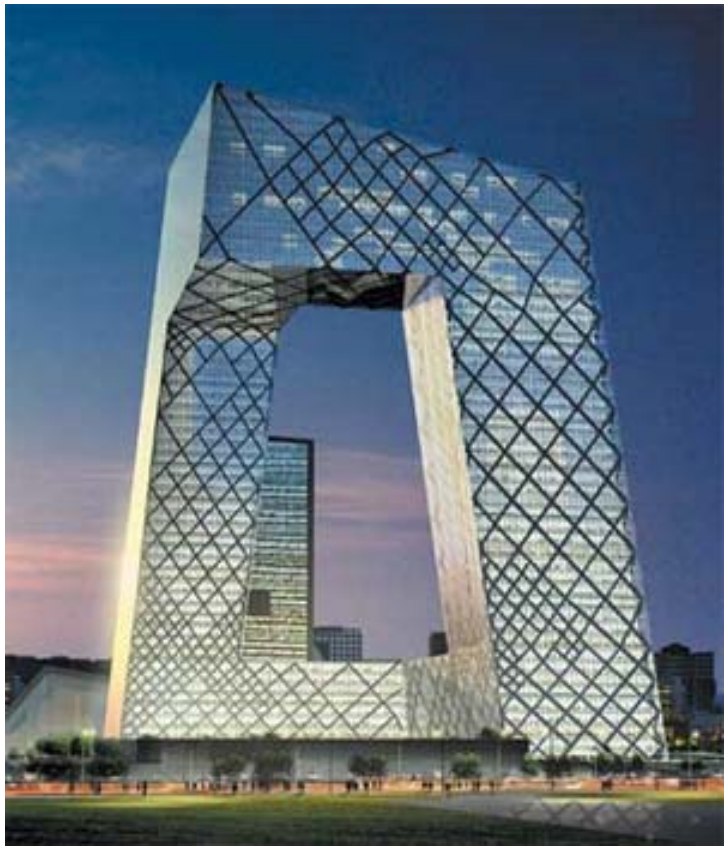

Sint Sebasti


partners in sport

Multi-layer land use







1.Introduction

- The development of land use has promote the land parcels to be subdivided in three dimensional (3D) space according to certain property rights.
- To manage 3D space becomes an urgent task for the government, so we should mode these 3D space with geometric representation as “solids”.
- The cadastral application requires the operations on the solid objects to manage, operate and analyse the 3D parcels.

Three aspects should be clearly described :

1) the precise geometric model that describe the shape and geographic location of various 3D parcels, mainly based on sets of boundary faces.

2) solid model that indicates all its boundary faces with orientation to present the corresponding 3D parcel object.

3) the topological relationship that encode all the information among the solids/parcels to keep the consistence of the objects' geometries.

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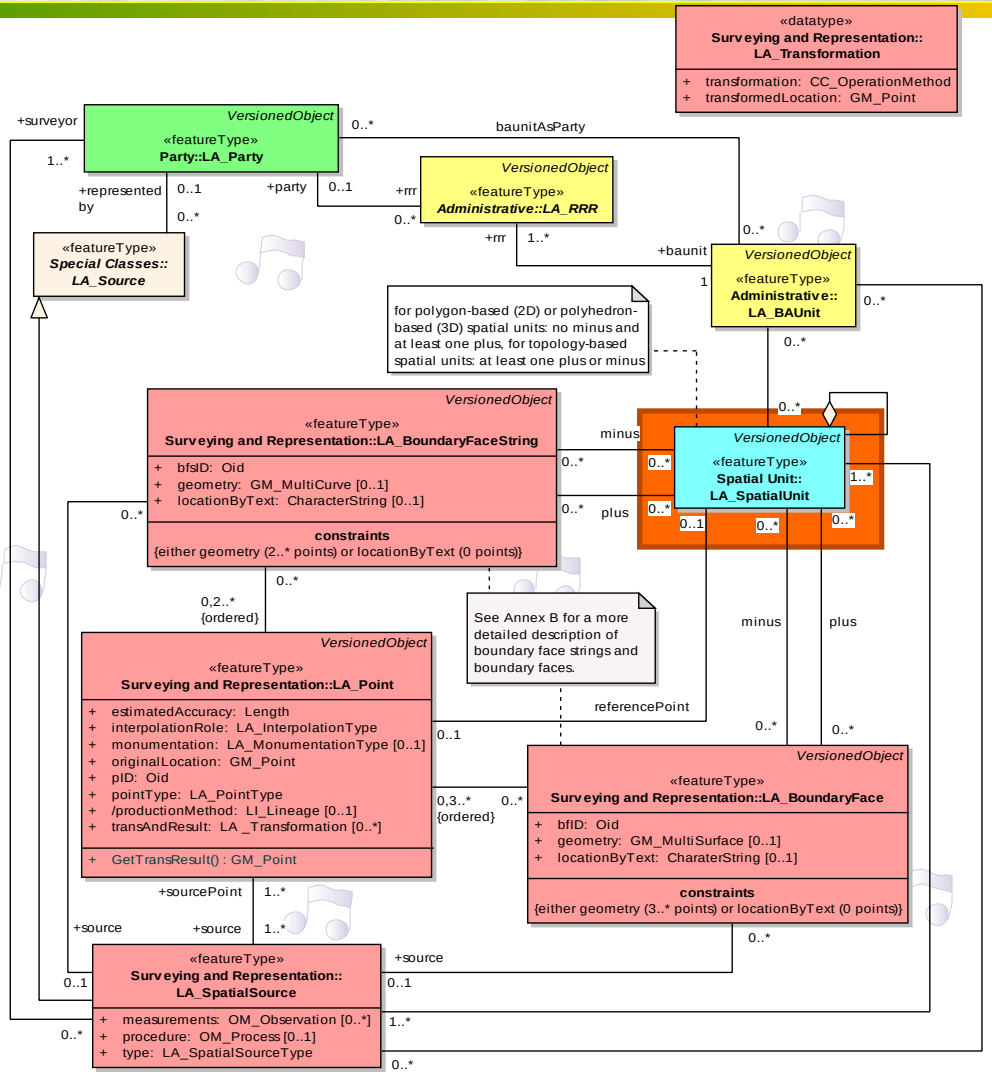
2. 3D cadastral model in LADM



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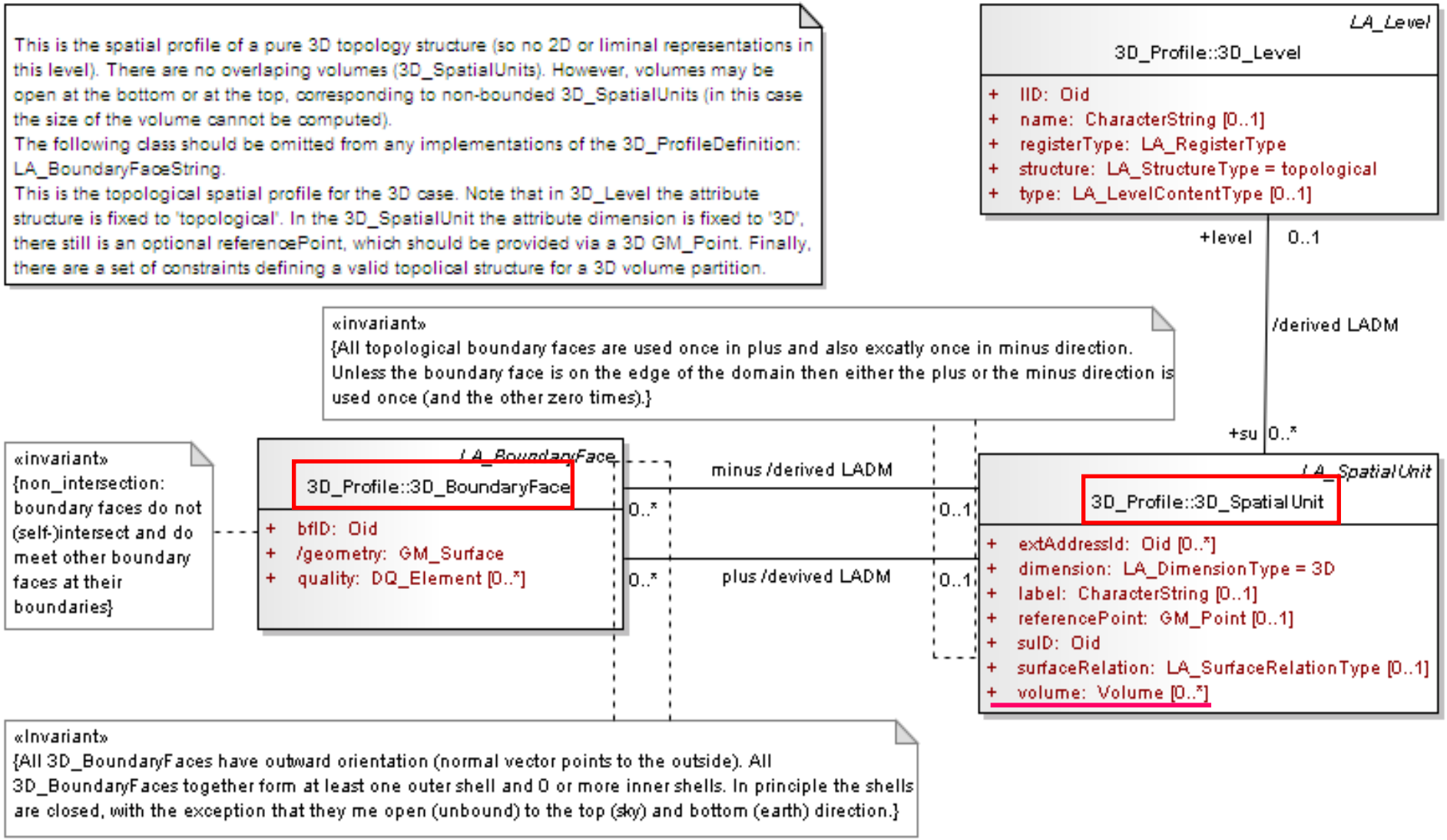
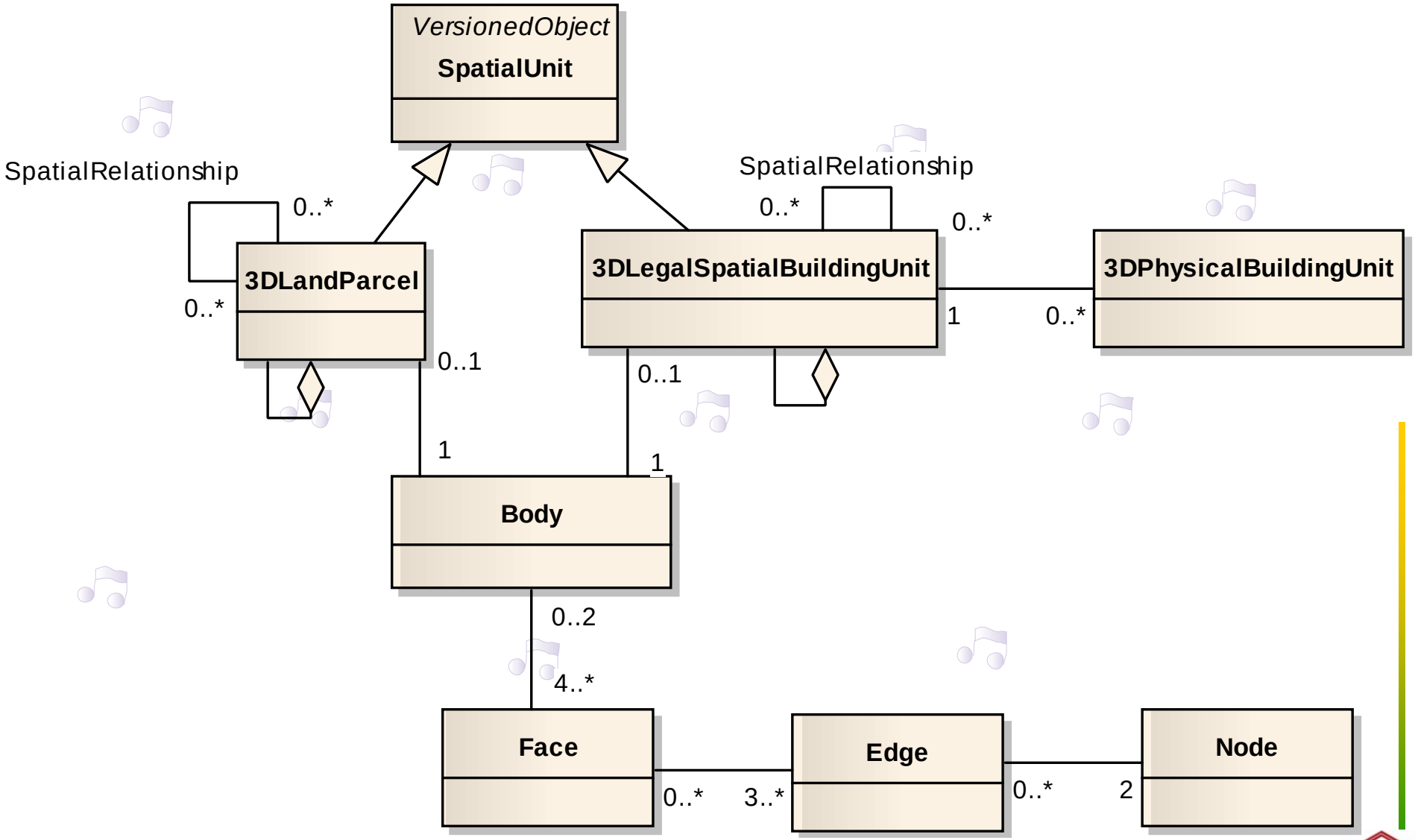
LA_PointType

2. 3D cadastral model in LADM

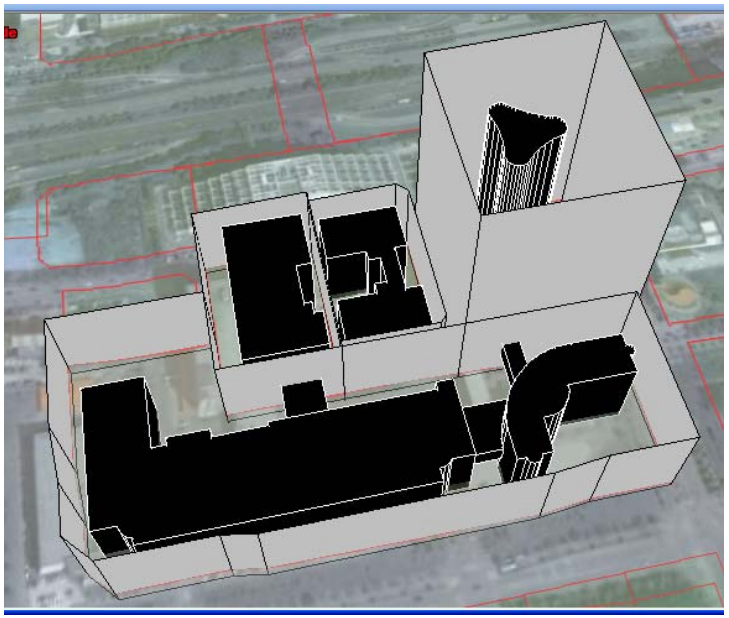


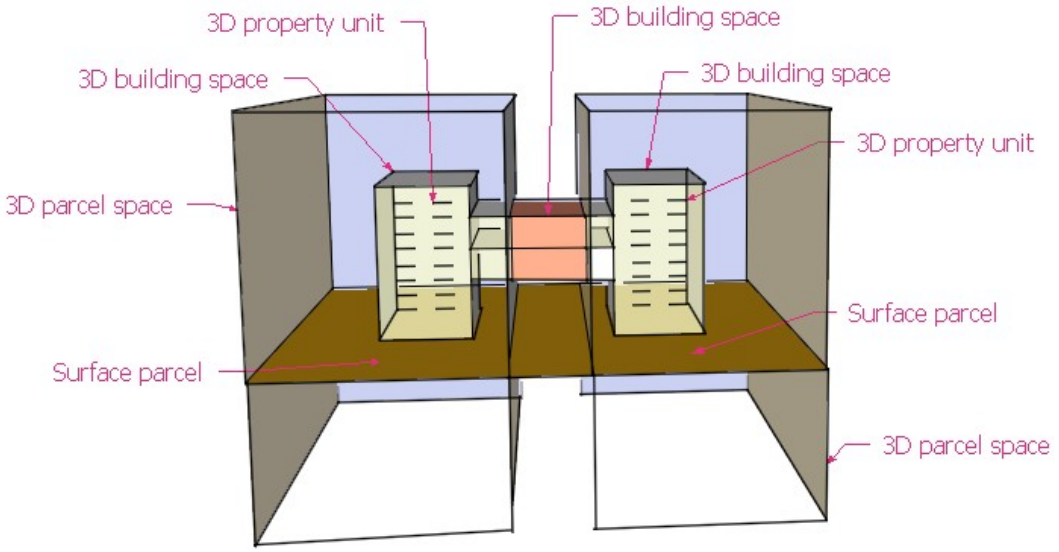
Data model in prototype system



3D land parcel and 3D legal space building unit

- 3D **parcel space** and 3D **legal building unit space**, are defined to describe the 3D space represented by 3D solid/body.
- Both focus on 3D body construction with surveyed boundary edges and faces, to assure all 3D cadastral objects are **valid 3D bodies** with **precise descriptions and consistent topology**.





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3. Body construction based on SketchUp

3.1 Definition of solid model and topology

3.2 Utilization of the topological model based SketchUp

3.3 Solid construction

3.3.1 Initial conditions and constraints

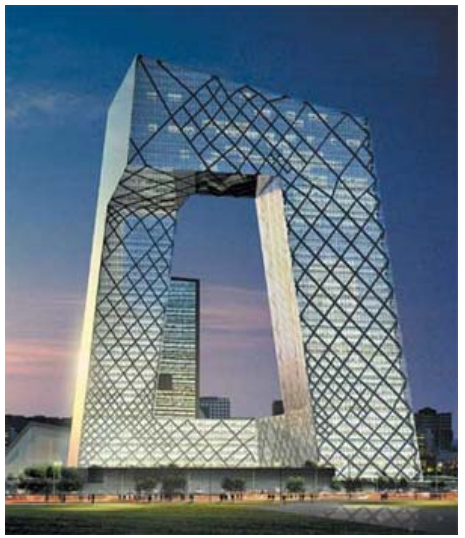
3.3.2 Sorting faces around edges

3.3.3 Reconstruction of the solids

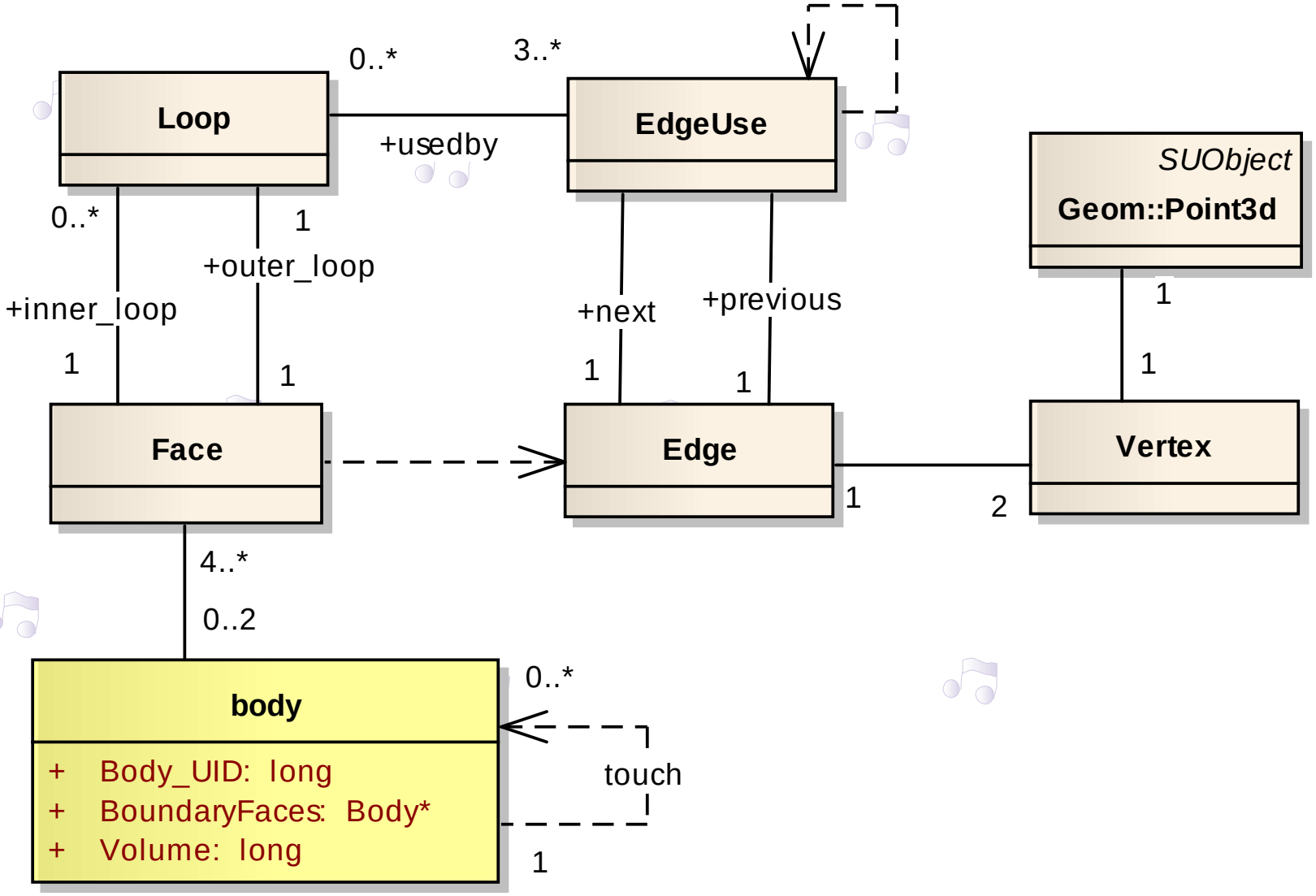
3.4 Handling complex configurations

3. Body construction based on SketchUp

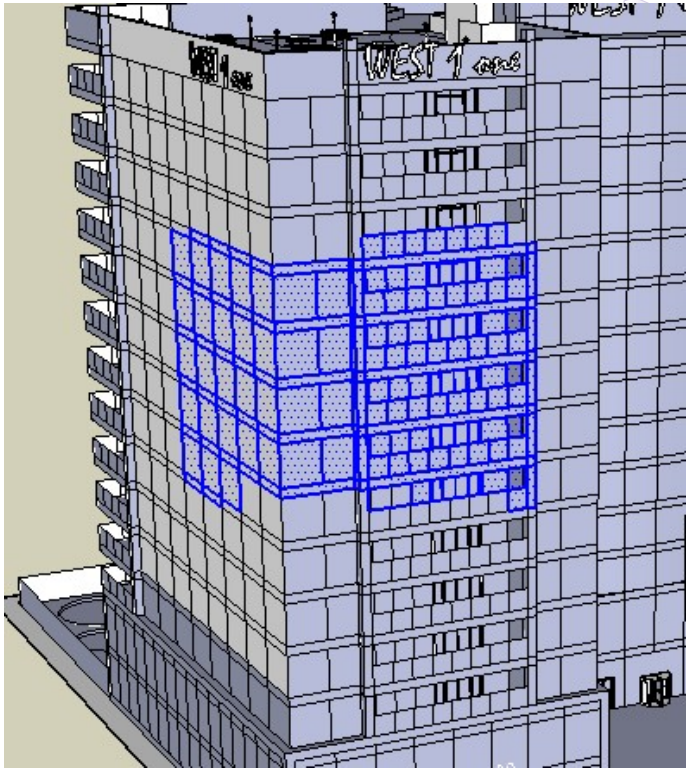
- A solid is defined as a seamless 3D space with interior orientation and its shell, which is closed and is made up of the faces.
- Unfortunately, many tools are not intelligent enough to recognize and define the closed body with the sets of faces.
- Some software (SUv8) know to check whether there is a correct solid / body with the selected faces, but do not know how detect and find the body from the “messed” faces, let alone the assembled bodies or bodies with holes.



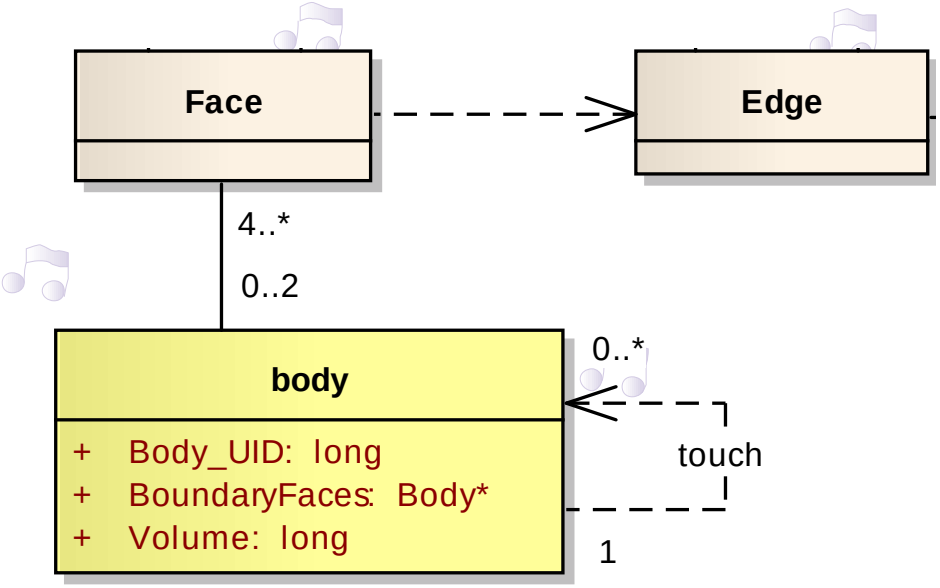
3.2 Topological model based SketchUp

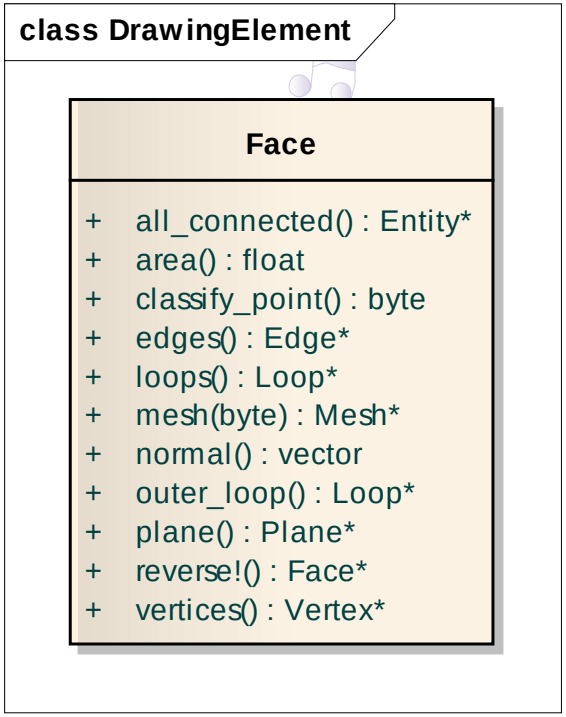


Google SketchUp

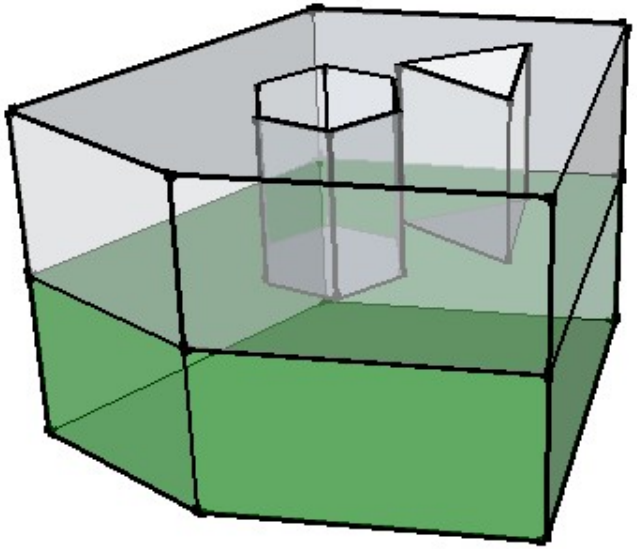


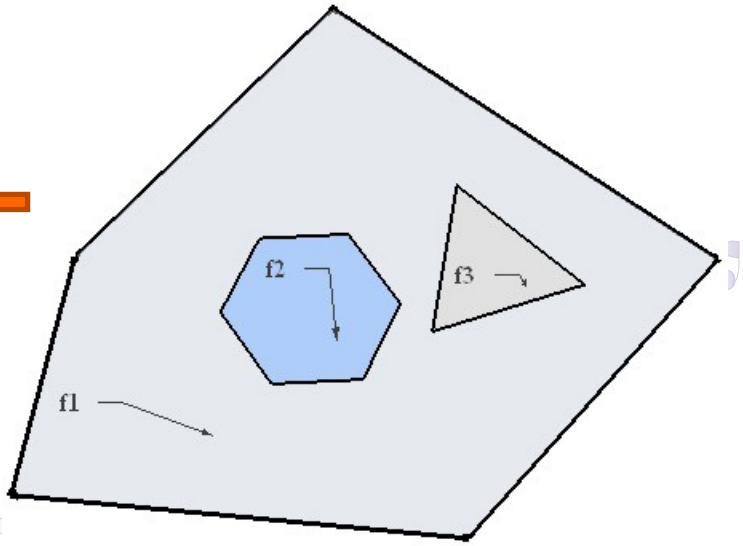
- **A 3D body is a 3D primitive and is basically incident to faces. So the class *Face* is the focused element to be handled to create the 3D body.**
- **class *Face* is a oriented facet/facets with one outer loop, and zero or more inner loops.**

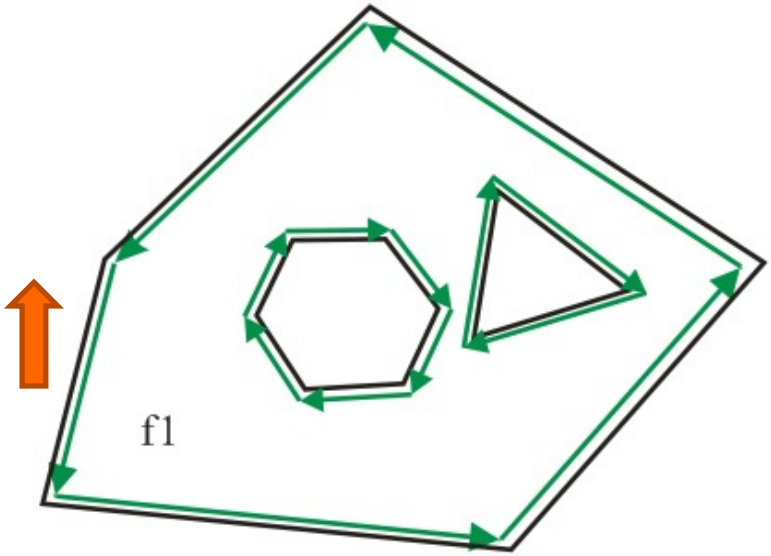


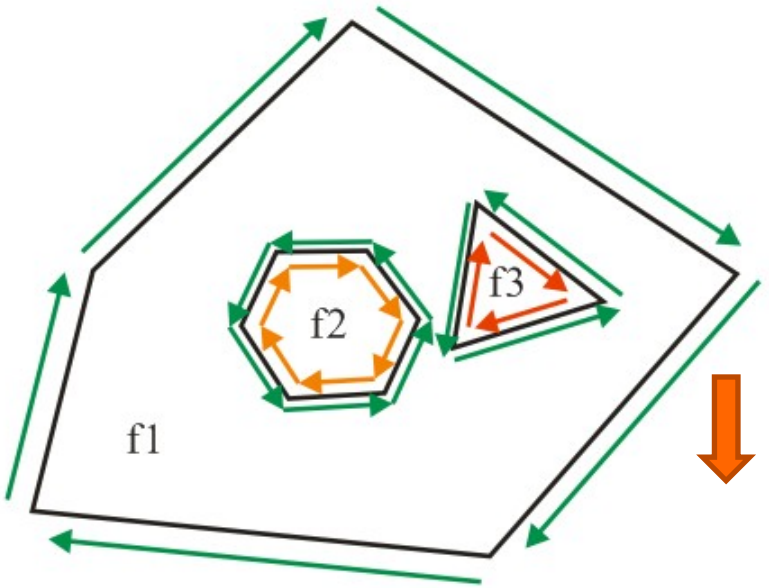


Hole in 2D and 3D



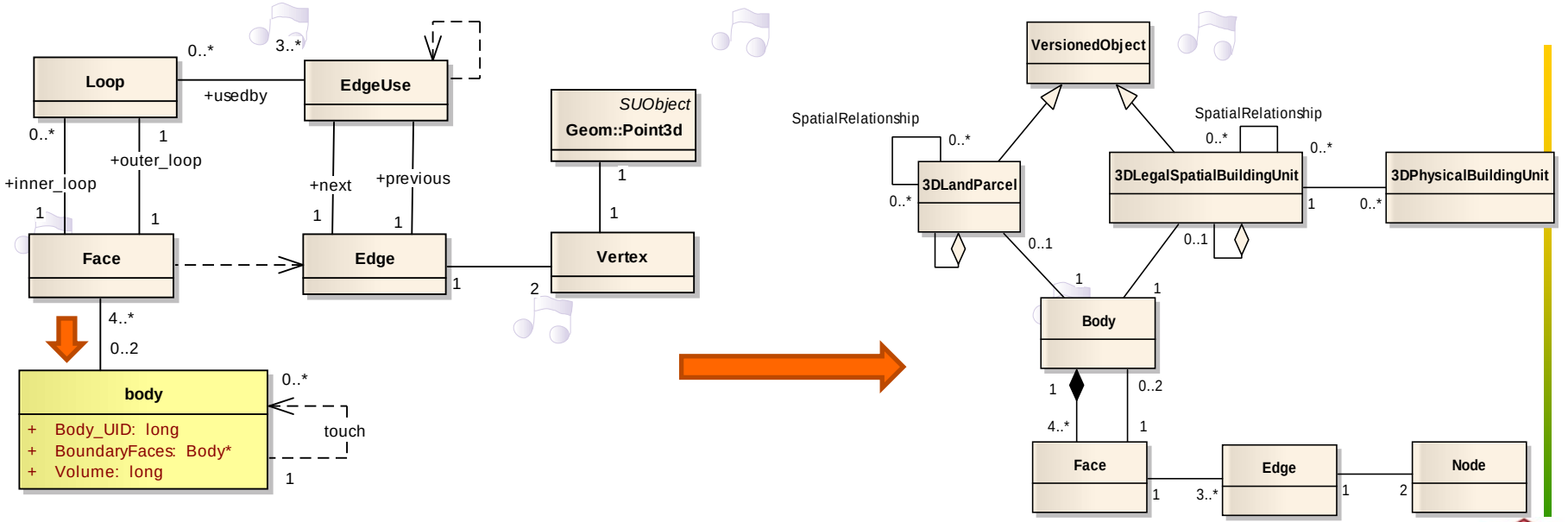






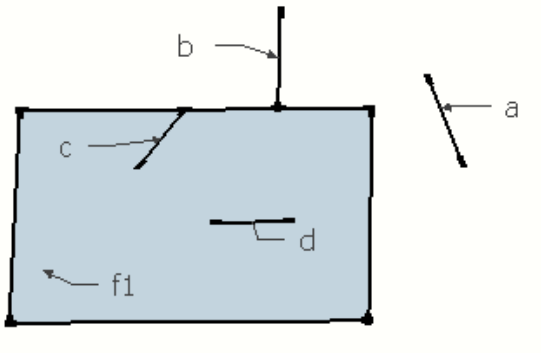
3.3 Solid construction

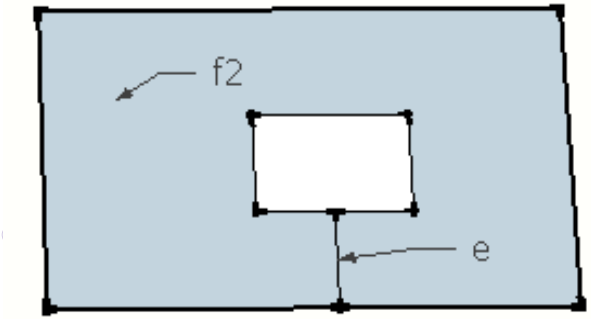
- **Input the faces, stored in the topological data structure provided by Google SketchUp.**
- **Navigate in the data structure to extract bodies that are deemed valid according to our definition.**
- **Store the bodies and relationships in prototype.**

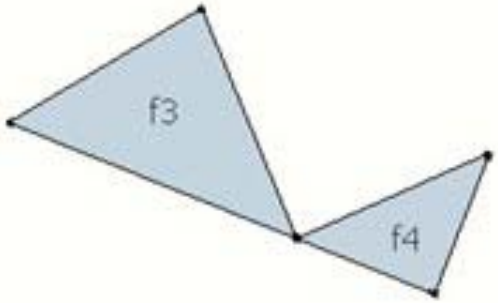


3.3.1 Initial conditions and constraints

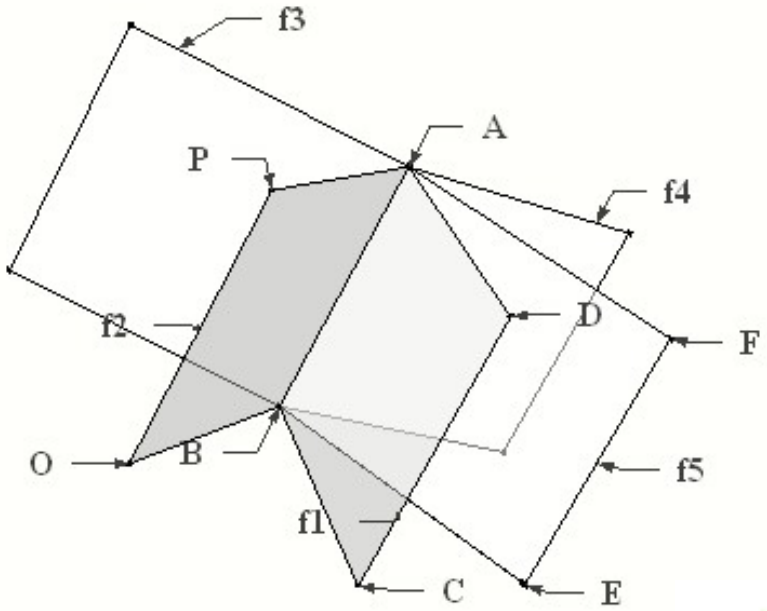
- **Each polygon is closed.**
- **Each face is a flat polygon and the curve face should be divided into several flat faces.**
- **No self-intersection with lines and no overlay between polygons.**
- **No isolate, hanging or dangling point and edge.**

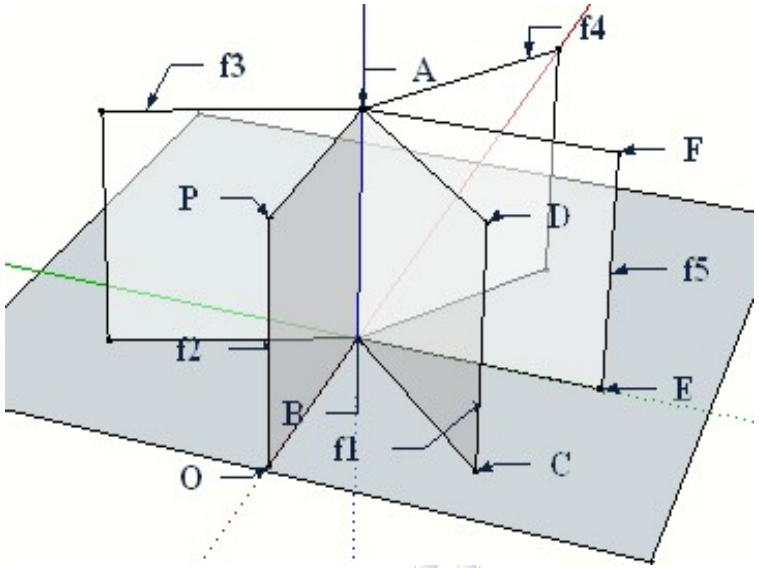


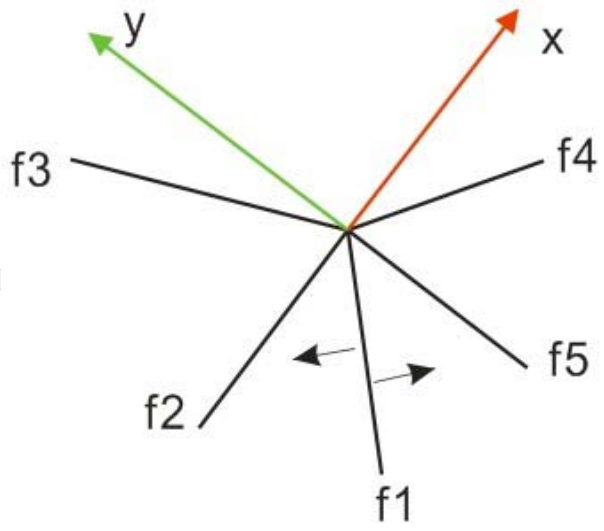




3.3.2 Sorting faces around edges

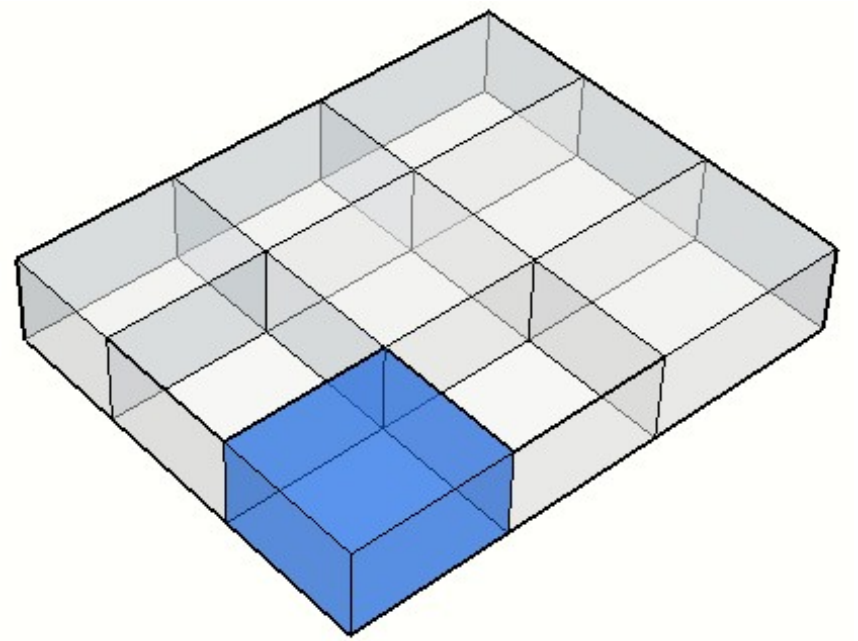


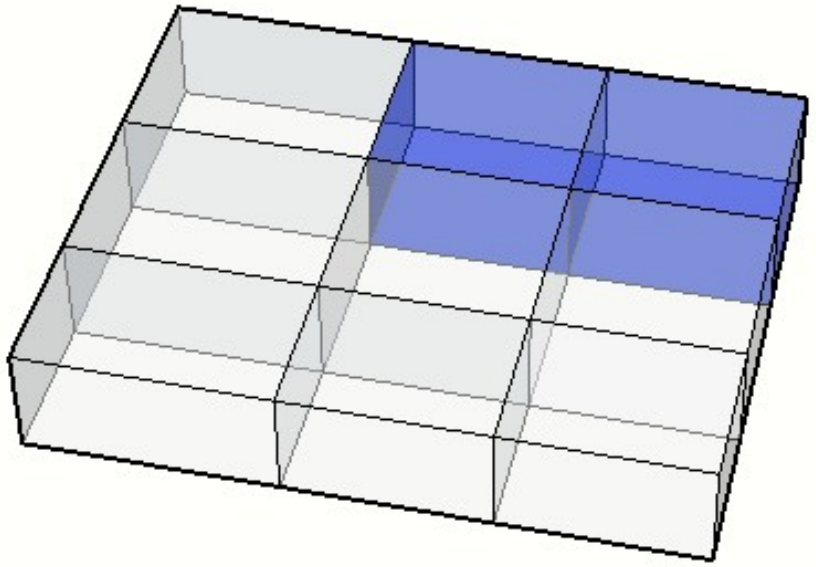




3.3.3 Reconstruction of the solids

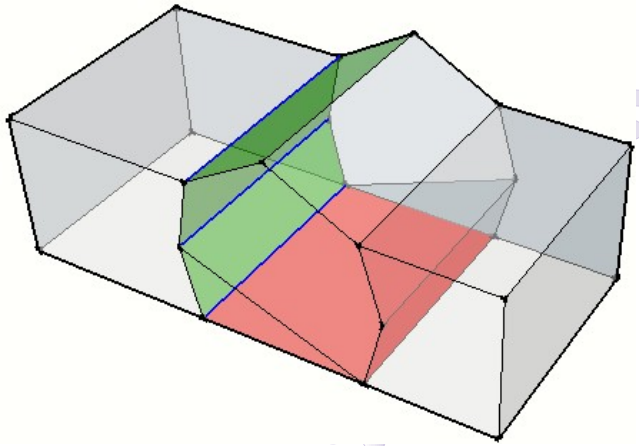
- **Minimum body**
- **uniqueness and homogeneity (cadastral object)**



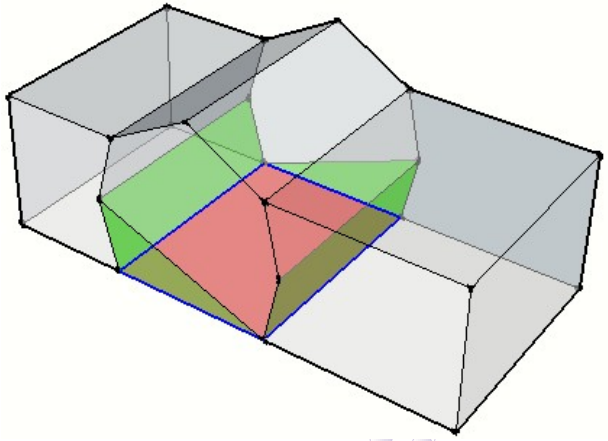


3.3.3 Reconstruction of the solids

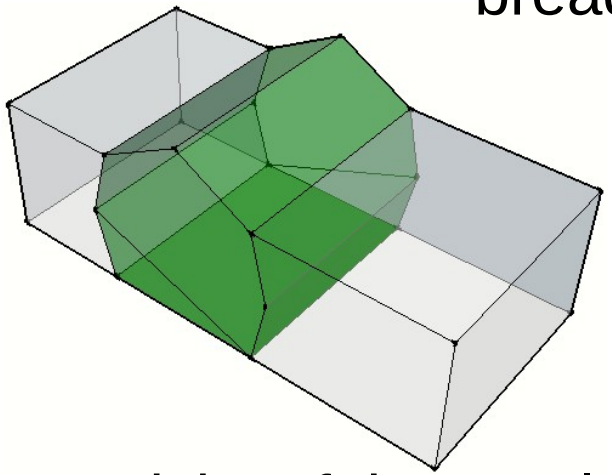
- **Connect the faces**



depth-first search

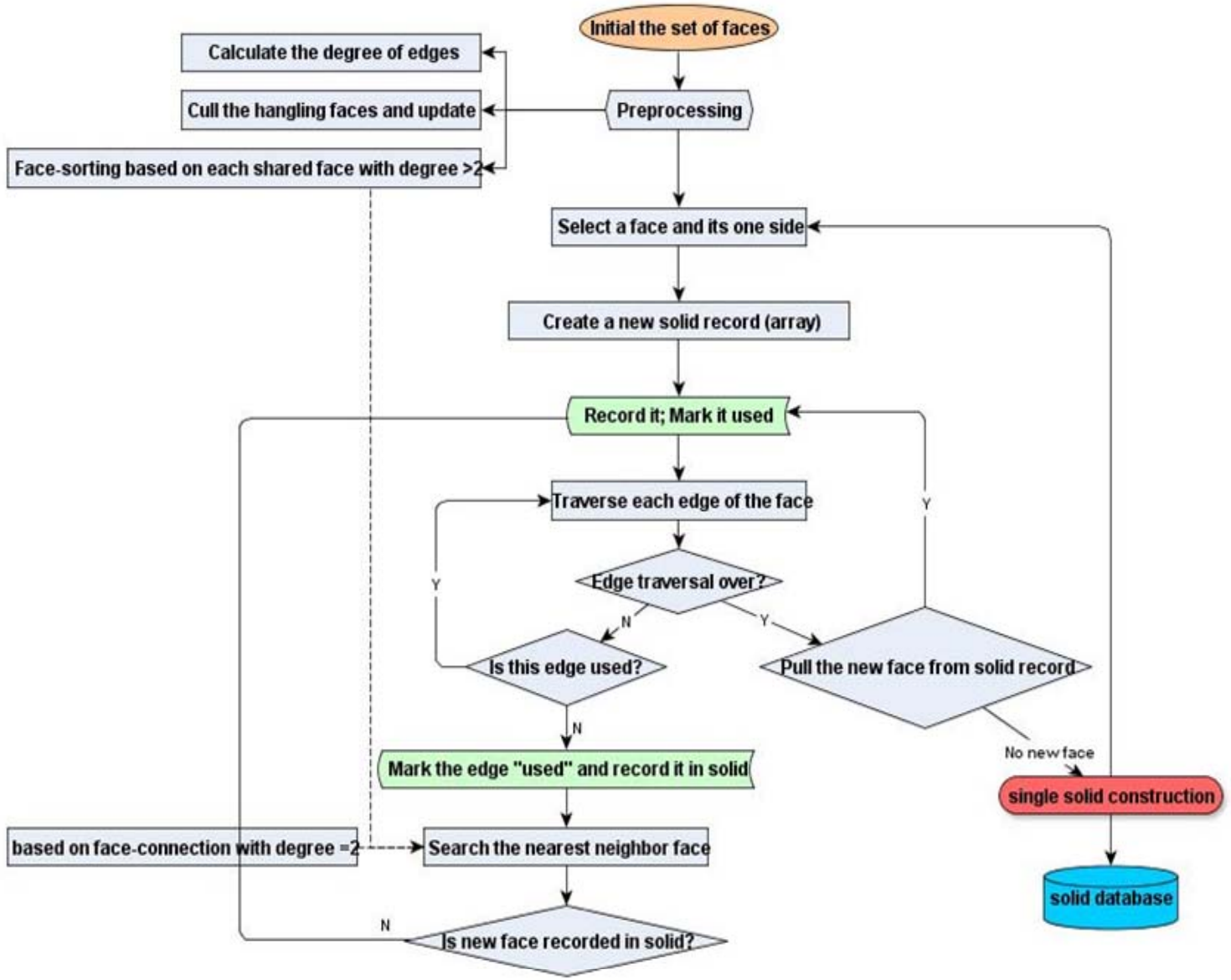


breadth-first search



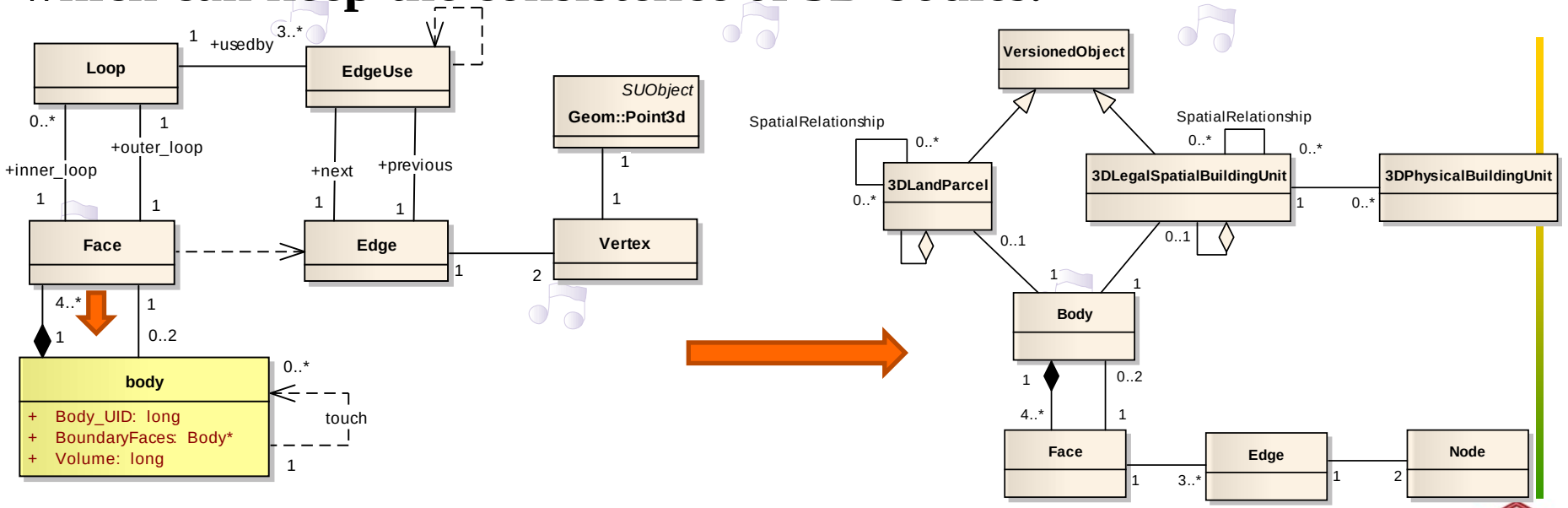
the unicity of the result

3.3.3 Reconstruction of the solids

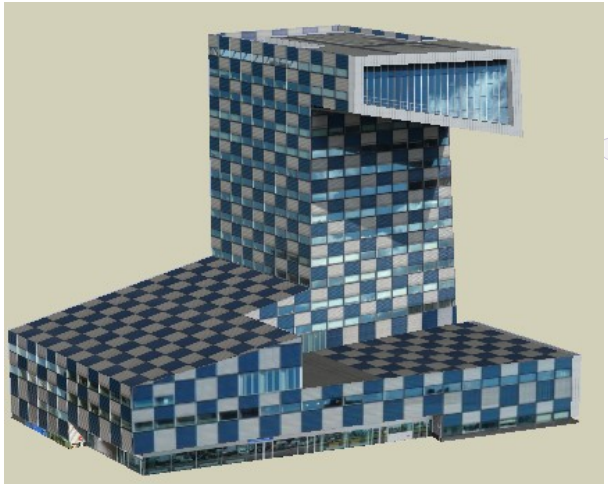


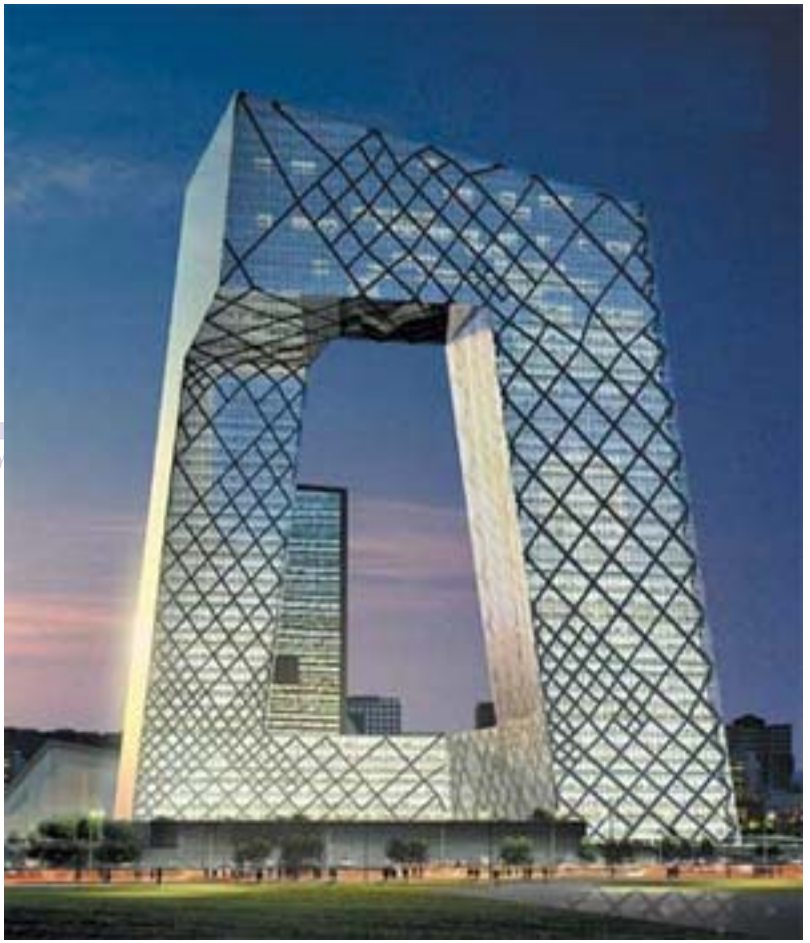
3.3.3 Reconstruction of the solids

- The approach records the direction of the faces and the interior of the body/solid.
- It is easy to get the neighbour bodies with the shared face/edge and build the topologic relationships among bodies.
- So the relationships of data model is implemented and filled in, which can keep the consistence of 3D bodies.



3.4 Handling complex configurations





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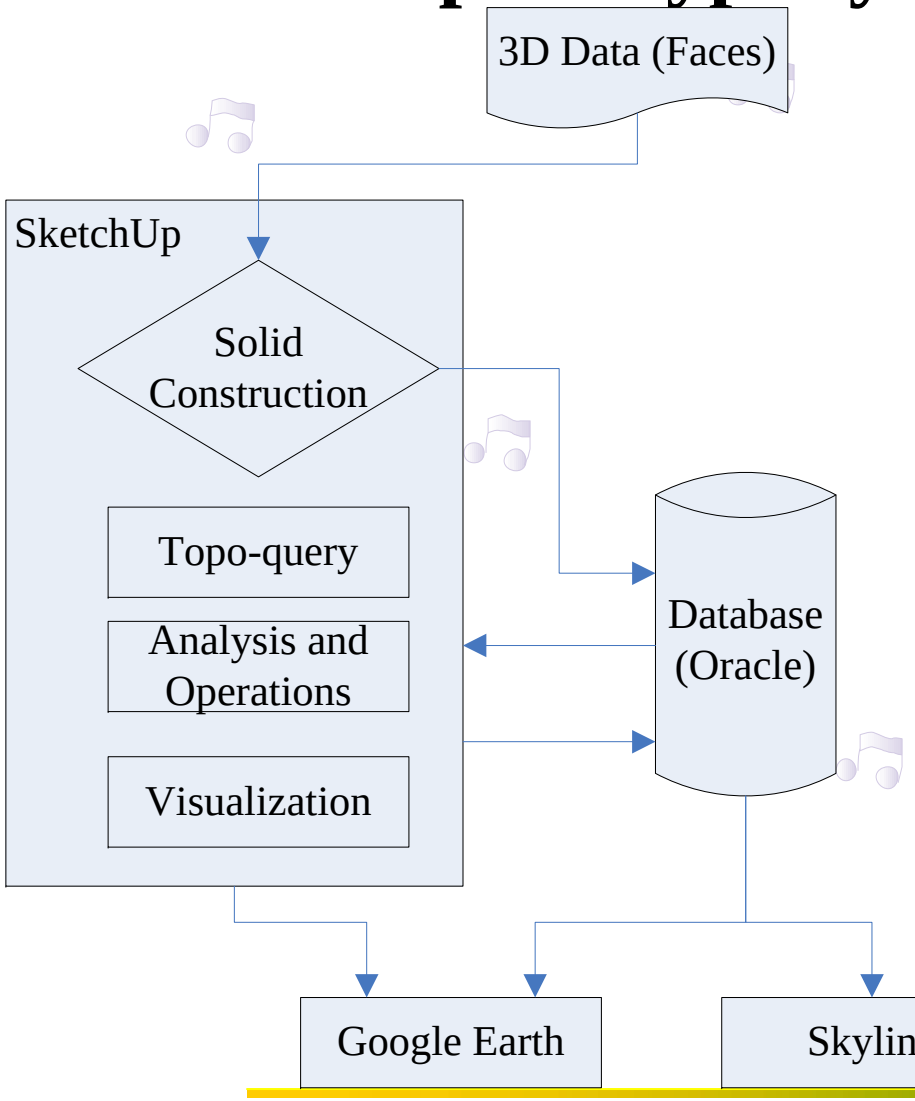
4.Prototype system

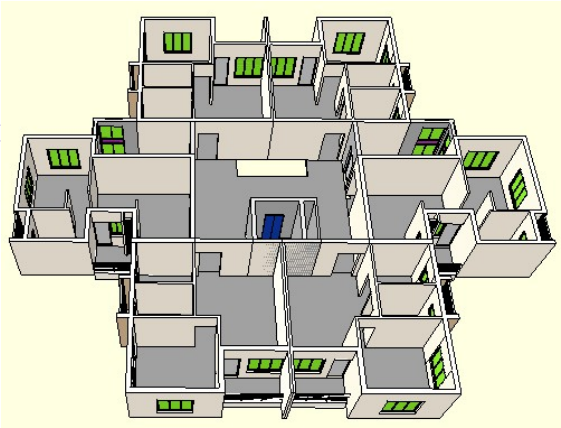
- **Framework of the prototype system**
- **Topological query**
- **Spatial operations**

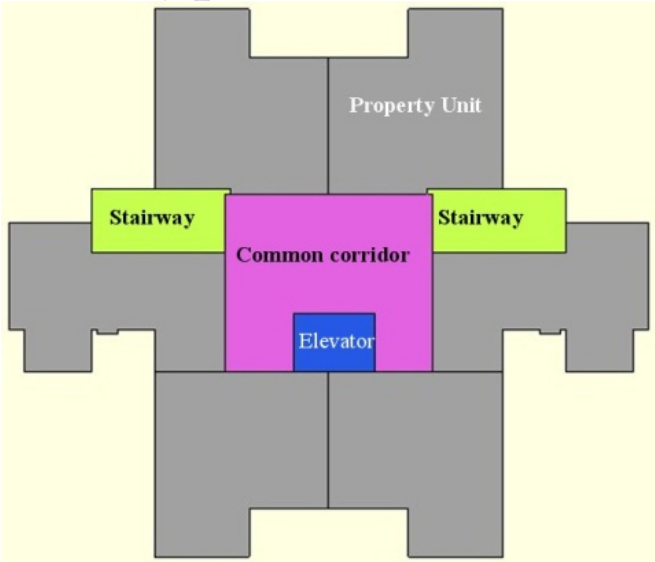
4.Prototype system

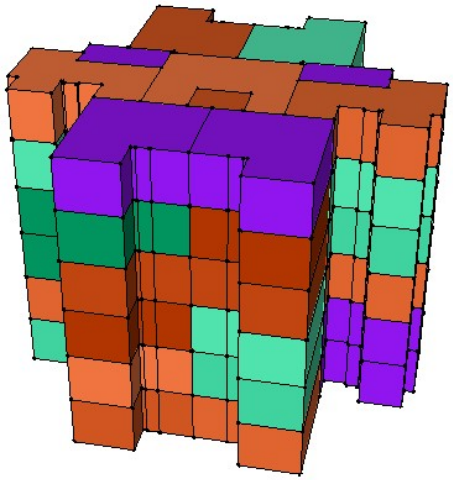
4.1 Framework of the prototype system



Test data

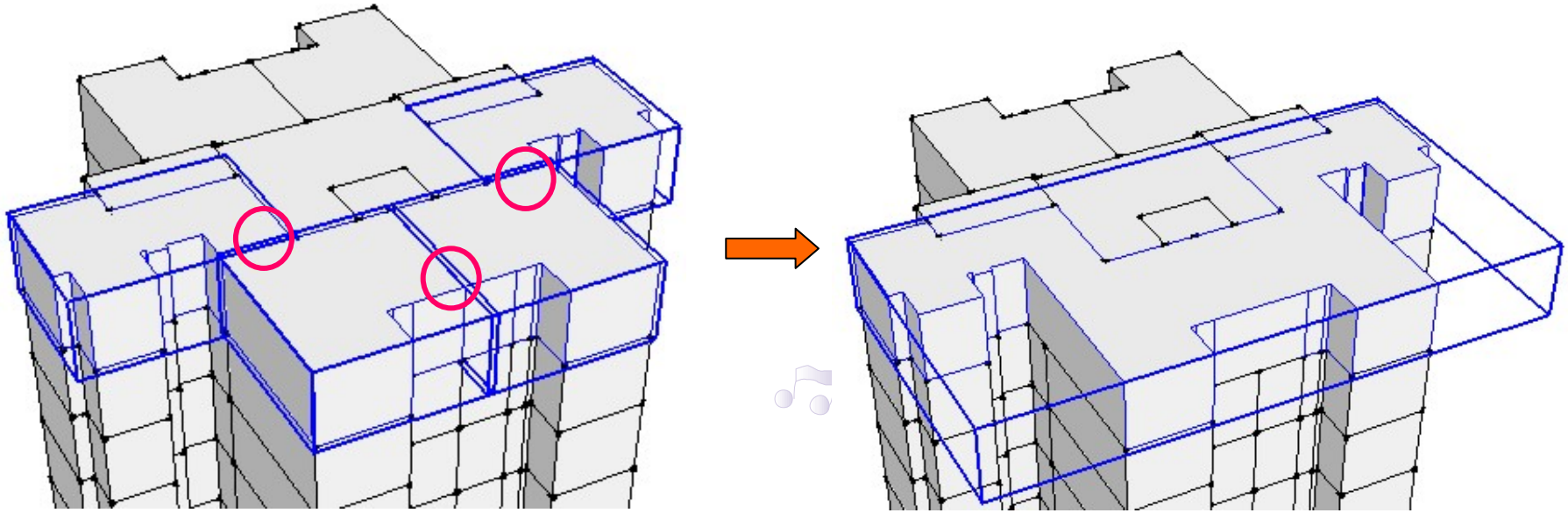


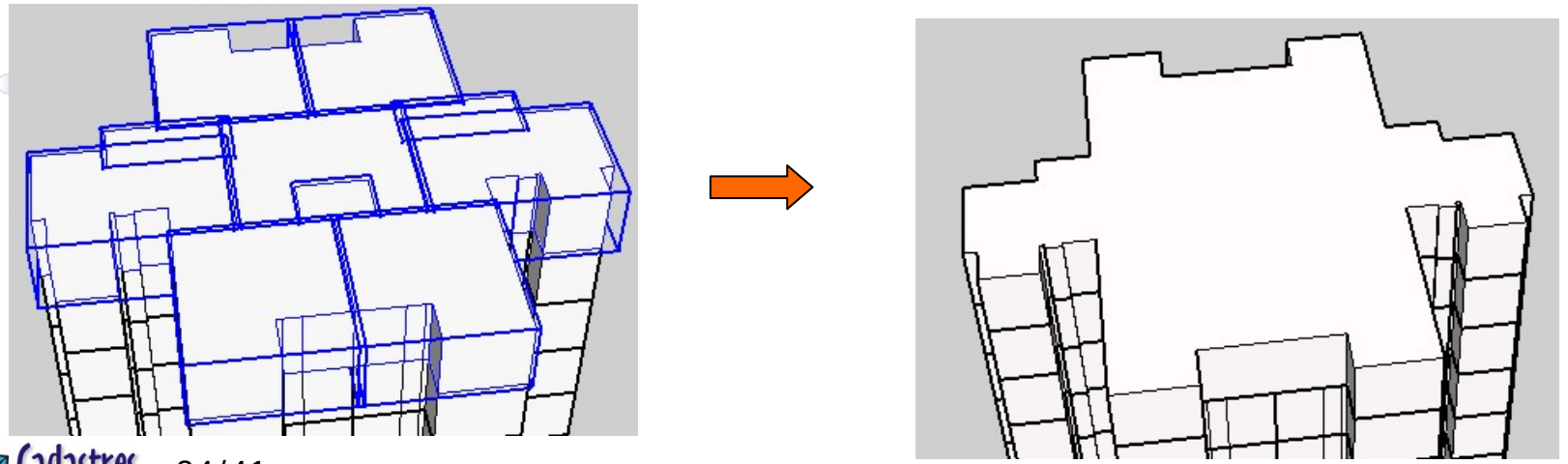

Property Unit
Stairway
Stairway
Common corridor
Elevator



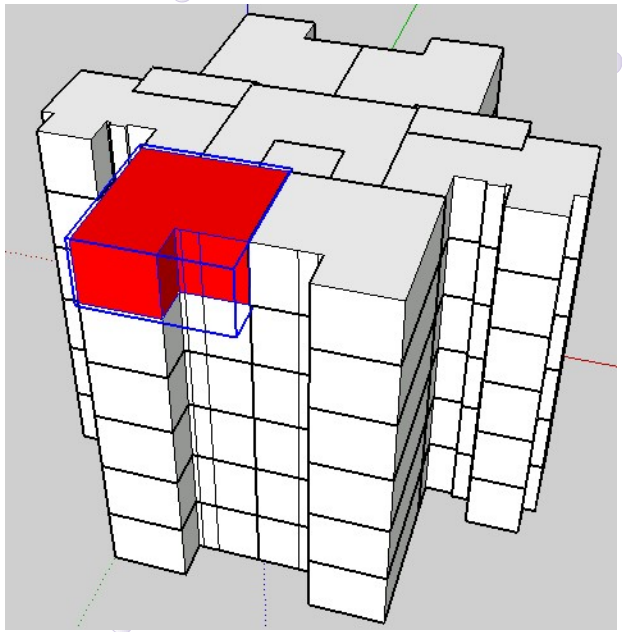
4.2 Operations and topological query

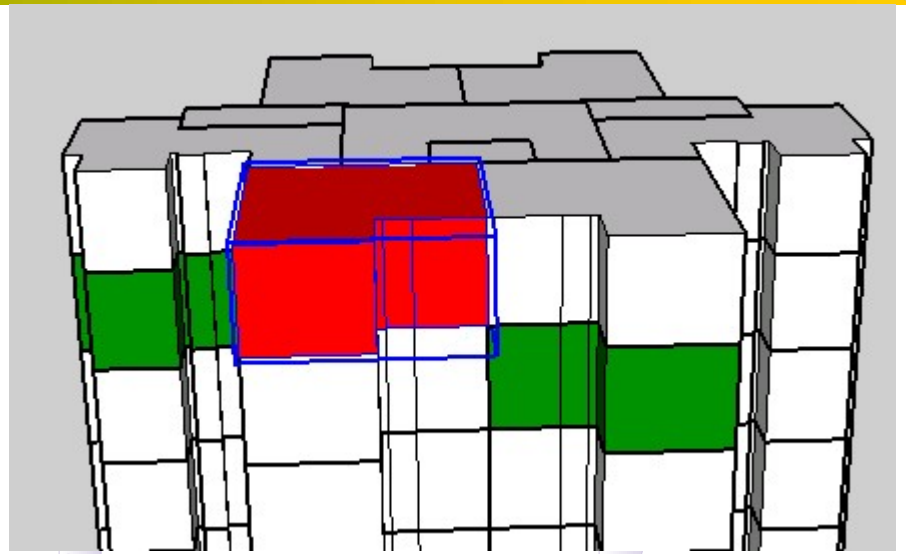
- **Mergence operator of four bodies**

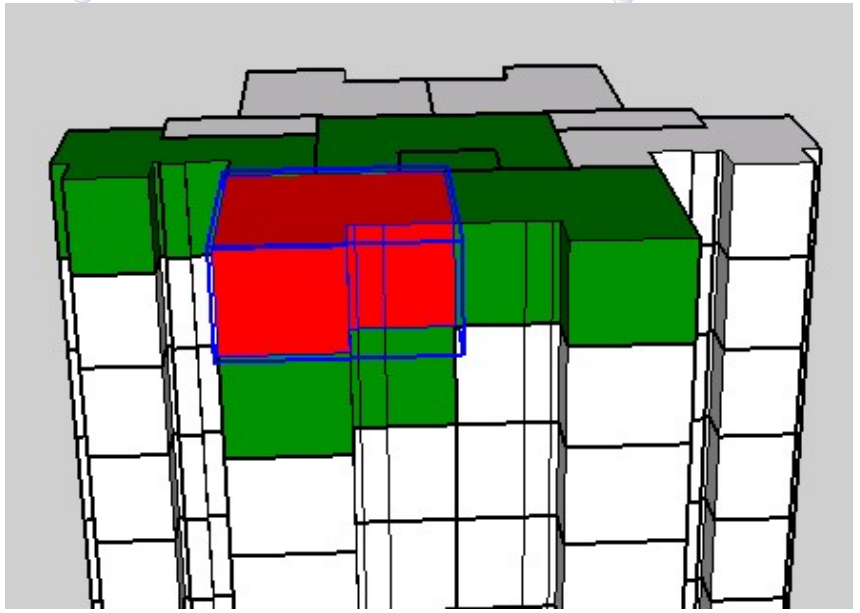




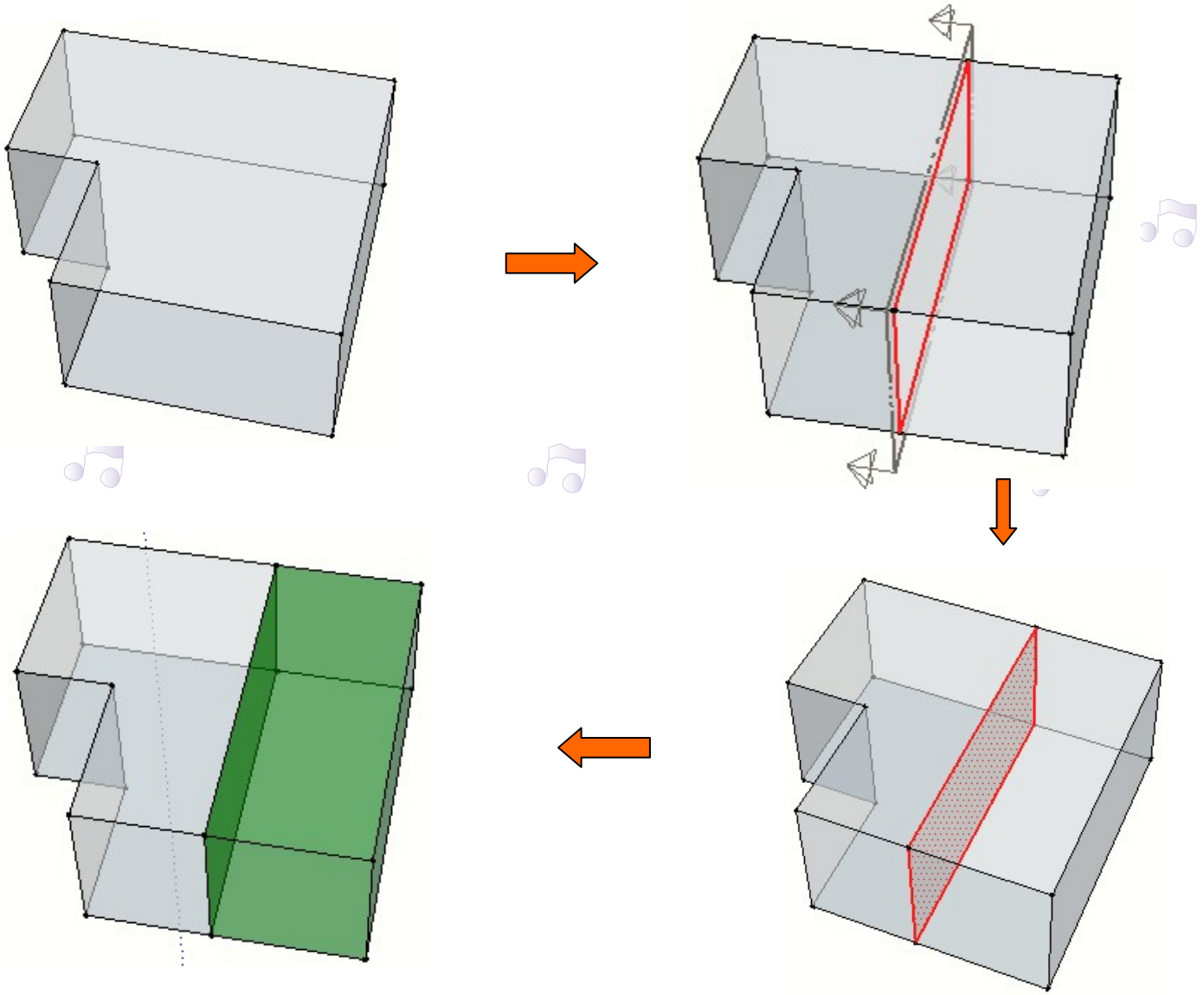
Topological query



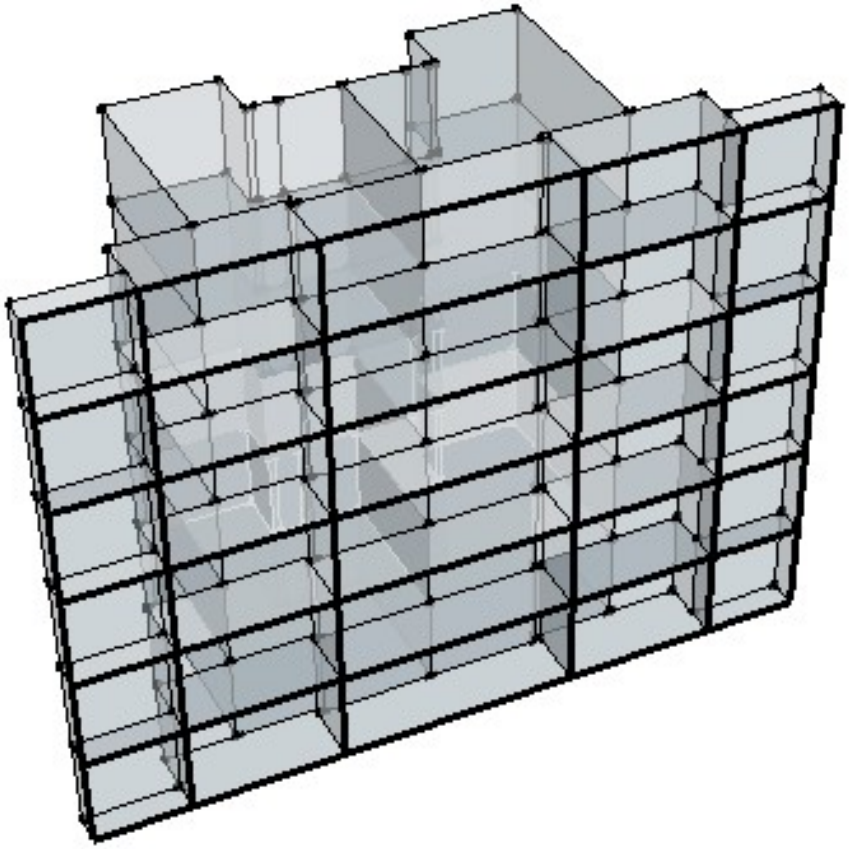




Process of splitting one unit into two units



- **Splitting section view**



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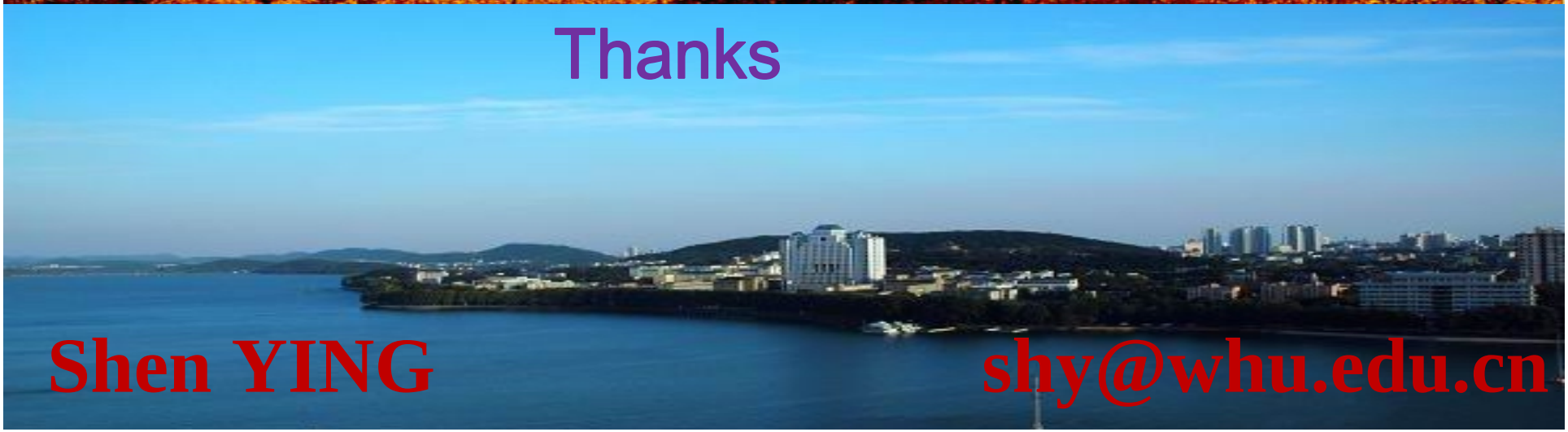
- **A 3D topology based on LADM is delivered.**
- **Real 3D bodies are constructed with the input faces and stored the references in the 3D topological model.**
- **Next, the faces can be extended to be surfaces that would support the curve surface and maintain the topology with other geometric elements (solid, edge).**

5. Conclusion and prospective outlook

- **The attention in the context of 3D cadastre is concentrating on the geometries, topological relationships, and the operations on the cadastral objects.**
- **when all these techniques are solved, associated with the registration and management, the complete 3D cadastre can be implemented and realized.**

Thanks



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