



Wuhan University

深圳市规划和国土资源委员会

Urban Planning, Land and Resources Commission of Shenzhen Municipality



The Conversion from CityGML to 3D Property Units

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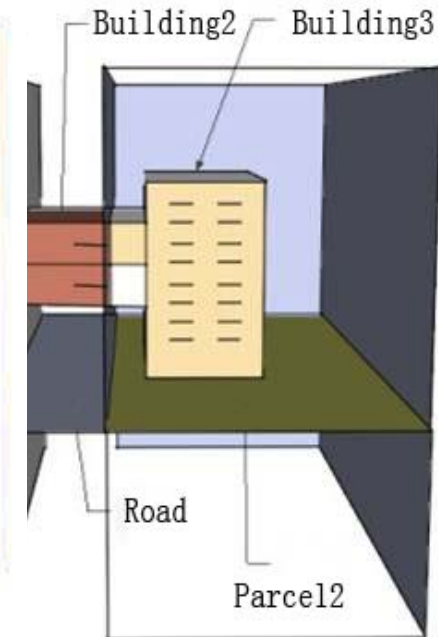
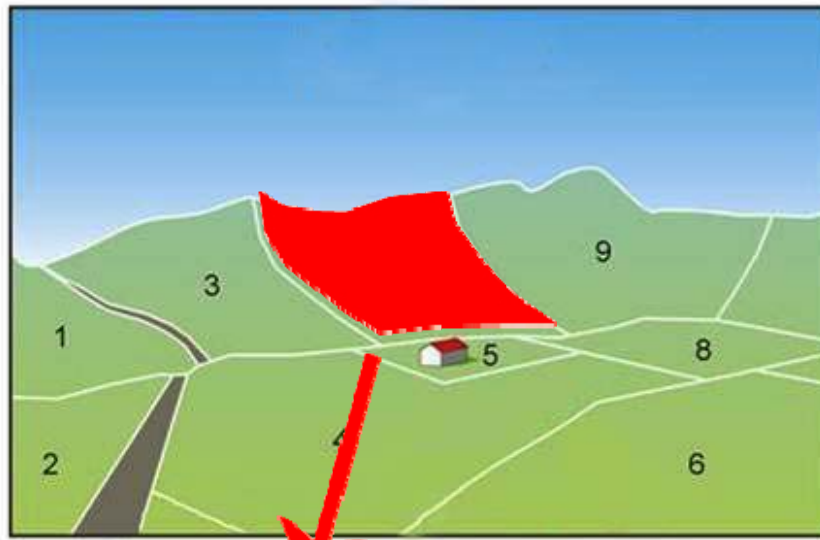
Part 1		Research Background
Part 2		3D Property units and CityGML
Part 3		Framework
Part 4		Experiment
Part 5		Conclusion and Question

1、 Research Background



Traditional Cadastre

2D Cadastre



Property Units in the air

2D cadastre cannot reflect the three-dimensional developments and utilizations of land and space.

3D Cadastre

Question

1、 Research Background

Current Cadastre

3D Cadastre

Source Data

Traditional data
collection method

- Measurement
- Photogrammetry
-



Use current 3D data

Time consuming and costly

1、 Research Background

Current 3D Data

CityGML

Visual Expression

CityGML is used in city modeling, and produces many semantic and geometric data

Using relative location

Geometry is discrete

Most objects are the elements of building

Key Point 、 difficulty

build the mapping rule between CityGML and 3D property unit and find relevant geometry

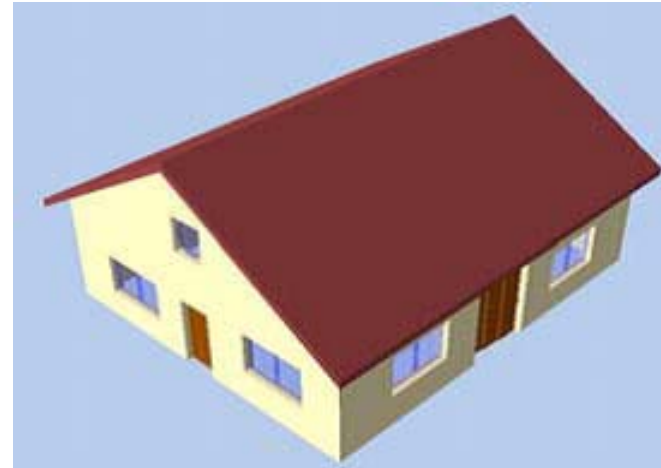


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3D Property Units and CityGML



CityGML provides a standard for the meaning and definition of city objects.

In CityGML there are five consecutive LODs, and more details come with increasing LOD, regarding both geometry and thematic differentiation.

3D Property Units and CityGML

3D property unit is a closed volume bounded by multiple faces.
3D space or geographic location is the “GENE” of 3D property unit.

3D
property
Units

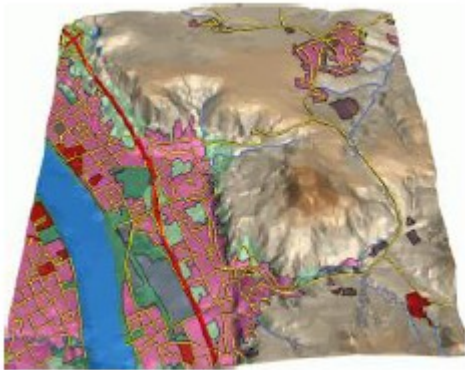
3D property unit is manifested by physical object, like building, room that bounded by walls and ceilings, etc.



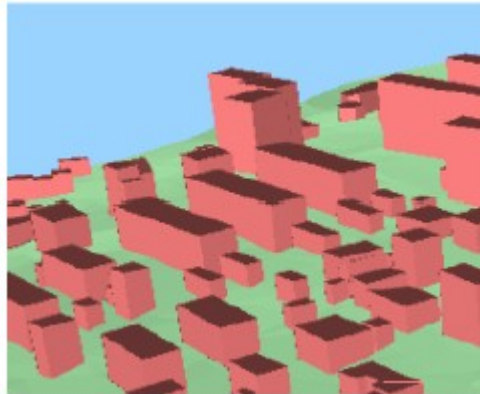
The semantic objects related with 3D property unit in CityGML

Objects	LoD1	LoD2	LoD3	LoD4
BuildingFurniture	--	--	--	×
CeilingSurface	--	--	--	√
ClosureSurface	--	--	--	√
Door	--	--	√	×
FloorSurface	--	--	--	√
GroundSurface	√	√	√	√
IntBuildingInstallation	--	--	--	×
InteriorWallSurface	--	--	--	×
RoofSurface	√	√	√	√
Room	--	--	--	×
RoomInstallation	--	--	×	×
WallSurface	√	√	√	√
Window	--	--	×	×
the objects except buildings	×	×	×	×

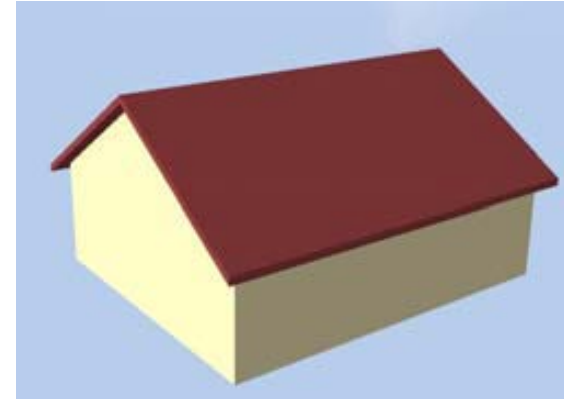
3D Property Units and CityGML



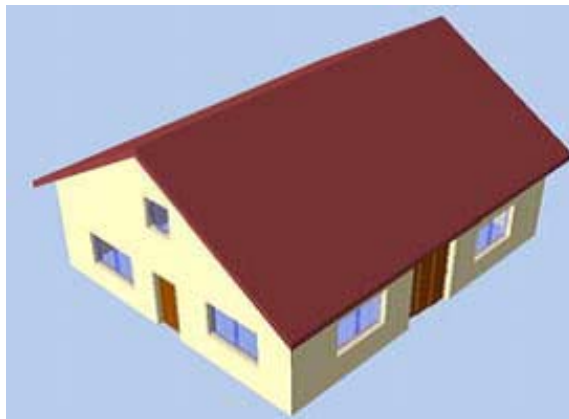
LoD0 landscape
2D Parcel



LoD1 city, region
Cluster property



LoD2 city districts, projects
3D Property



LoD3 city districts, building models
(exterior), landmark
3D Property



LoD4 building models (interior)
3D Property



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Framework

What is needed for 3D Property Units

CityGML file analysis

Semantic mapping

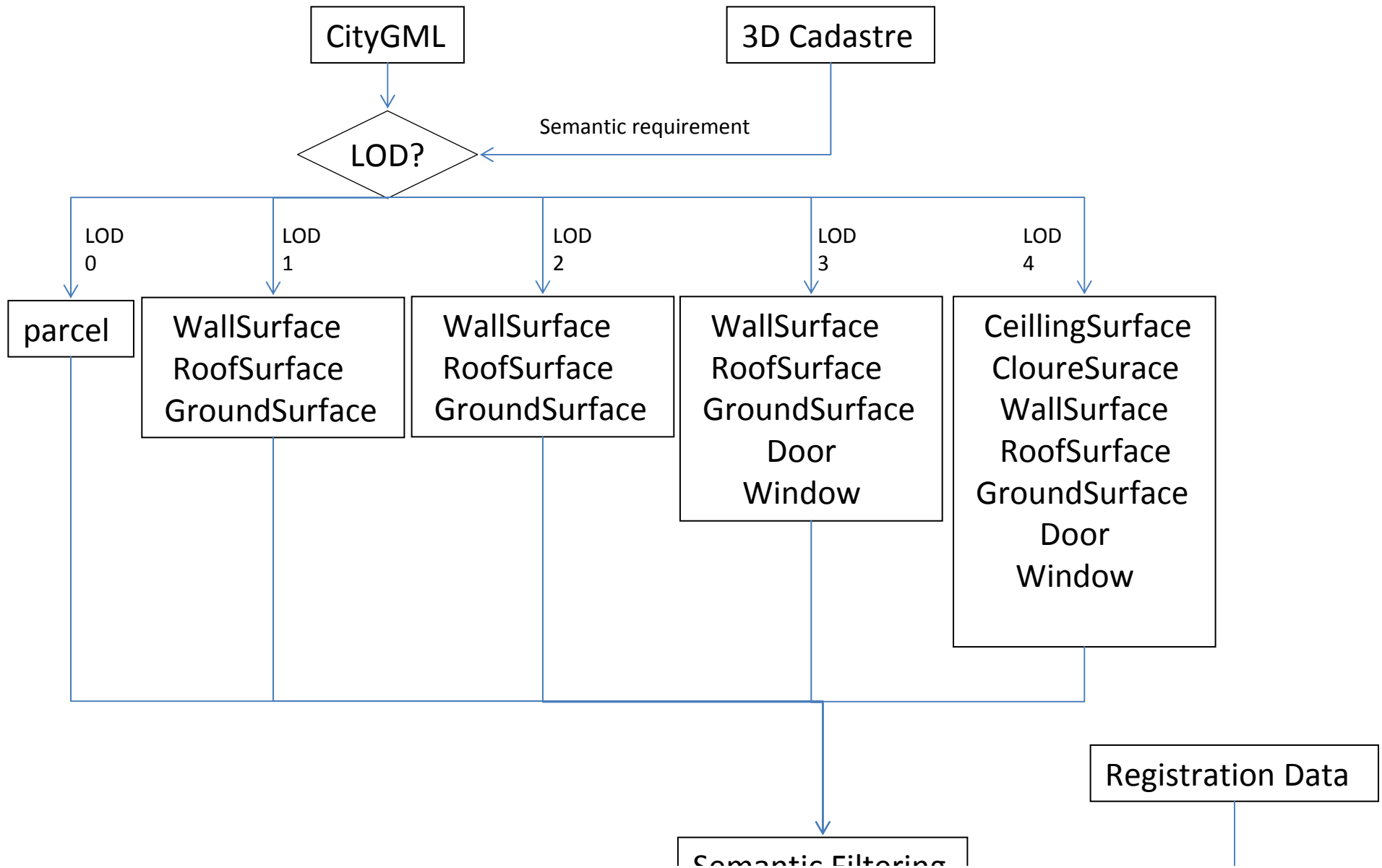
Geometric conversion

Validation and repair of 3D geometry

3D Property Units



Work flow



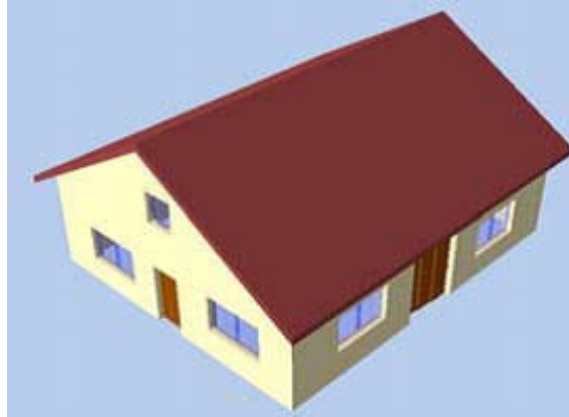


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Experiment



LoD3

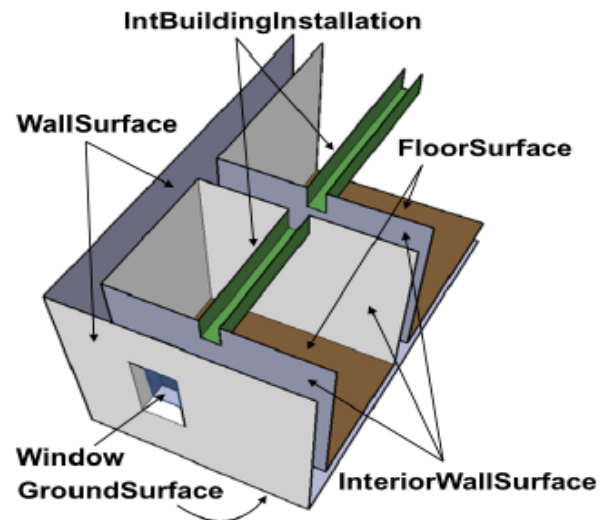
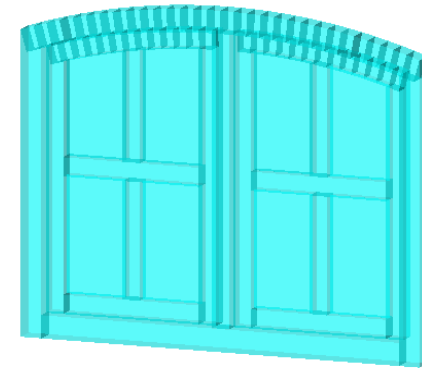
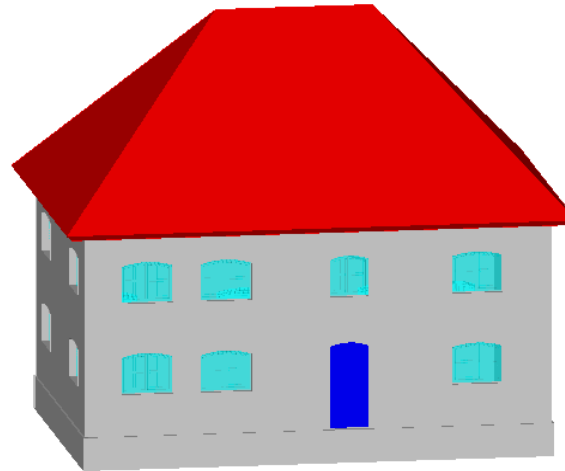
The data in LoD3 is more complicated

The data in LoD3 is more similar with 3D property units

4、Experiment

Model analysis

- [-] / 🏠 bldg:Building
 - [-] CityGML WallSurface [8]
 - / 🏠 bldg:WallSurface
 - / 🏠 bldg:WallSurface
 - / 🏠 bldg:WallSurface
 - / 🏠 bldg:WallSurface
 - / 🏠 bldg:WallSurface
 - [-] / 🏠 bldg:WallSurface
 - [-] CityGML Window [4]
 - / 🏠 bldg:Window
 - / 🏠 bldg:Window
 - / 🏠 bldg:Window
 - / 🏠 bldg:Window
 - + / 🏠 bldg:WallSurface
 - + / 🏠 bldg:WallSurface
 - [-] / 🏠 bldg:WallSurface
 - + CityGML Window [7]
 - + CityGML Door [1]
 - + CityGML RoofSurface [1]



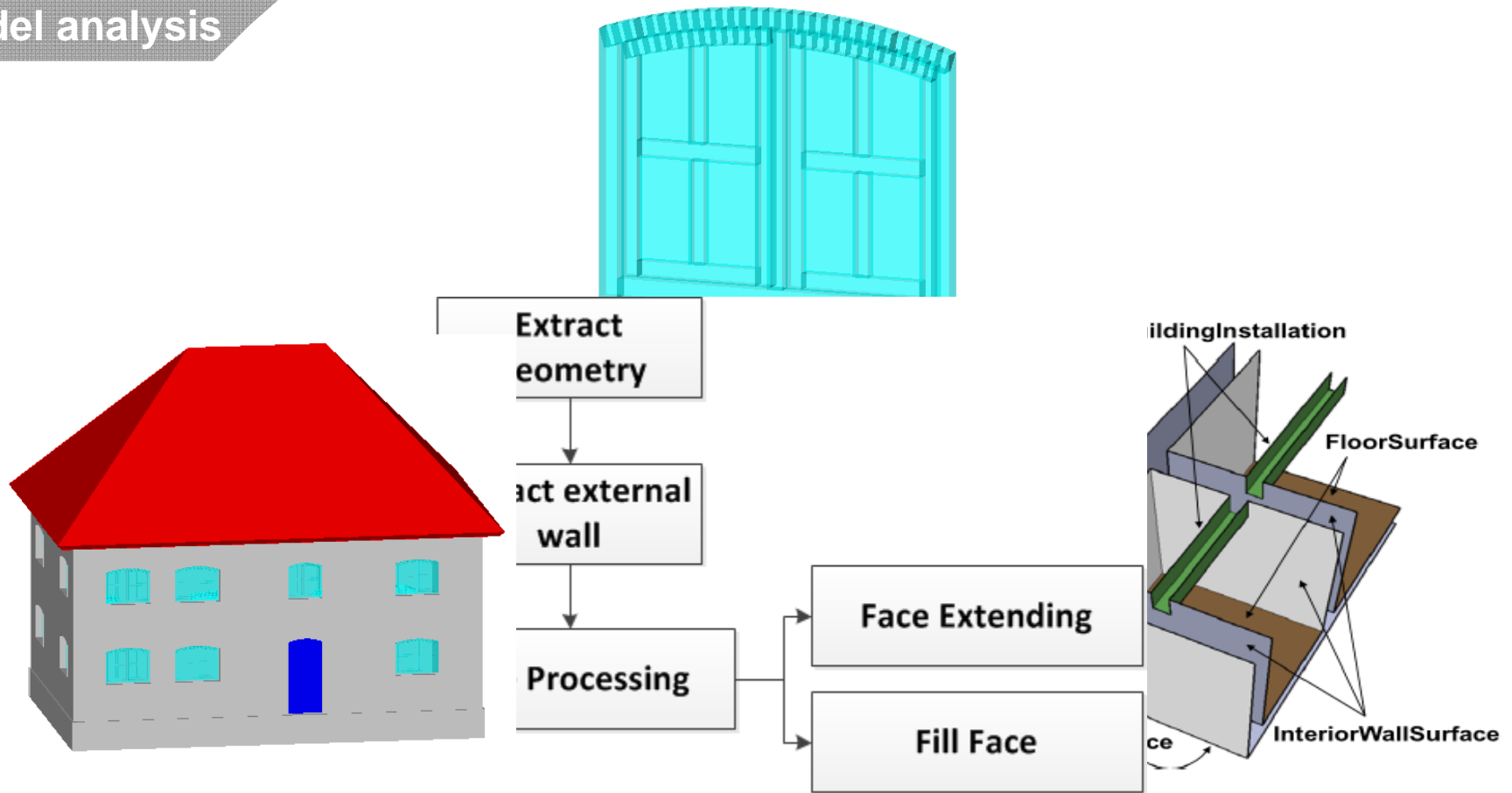
4、 Experiment

Model Conversion – Extract geometry

Objects	LoD1	LoD2	LoD3	LoD4
BuildingFurniture	--	--	--	×
CeilingSurface	--	--	--	√
ClosureSurface	--	--	--	√
Door	--	--	√	×
FloorSurface	--	--	--	√
GroundSurface	√	√	√	√
IntBuildingInstallation	--	--	--	×
InteriorWallSurface	--	--	--	×
RoofSurface	√	√	√	√
Room	--	--	--	×
RoomInstallation	--	--	×	×
WallSurface	√	√	√	√
Window	--	--	×	×
the objects except buildings	×	×	×	×

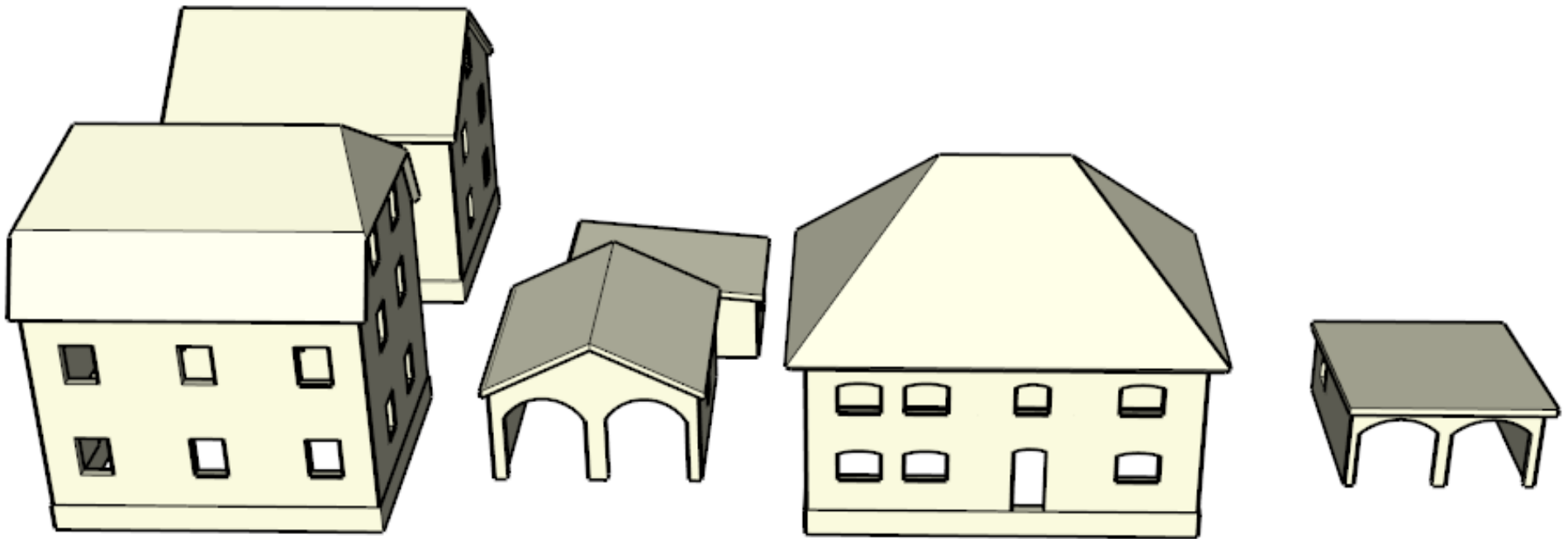
4、Experiment

Model analysis



4、Experiment

Model Conversion – Extract geometry



4、 Experiment

Model Conversion-preprocessing

doors and windows

---openings.

Each Opening

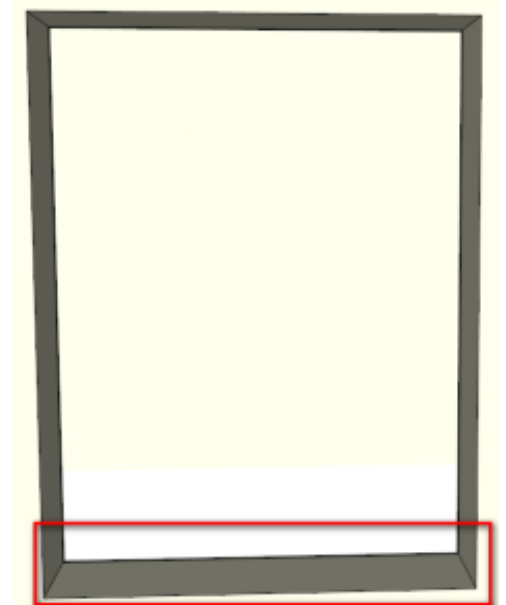
---MultiSurface geometry

deleting the door or window

---holes in the wall

a wall has a window

---new faces to store the door and the window.



Extract exterior wall

4、 Experiment

Model Conversion-preprocessing

Extract the exterior wall

-----obtain the topology information of the geometry data firstly

CityGML provides the relationship information in semantics

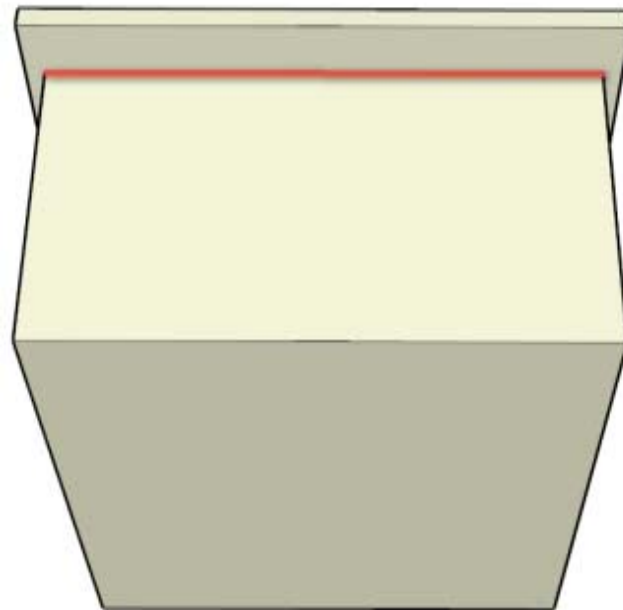
No topologic information

4、 Experiment

Model Conversion-preprocessing

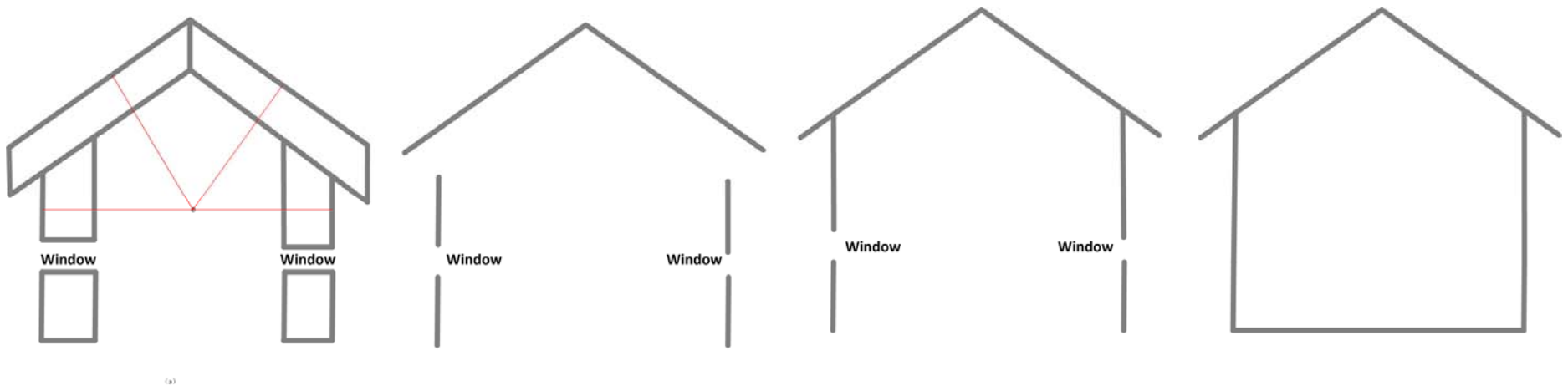
Topology analysis cross CityGML objects

The semantic objects in CityGML will be re-united into a 3D geometry



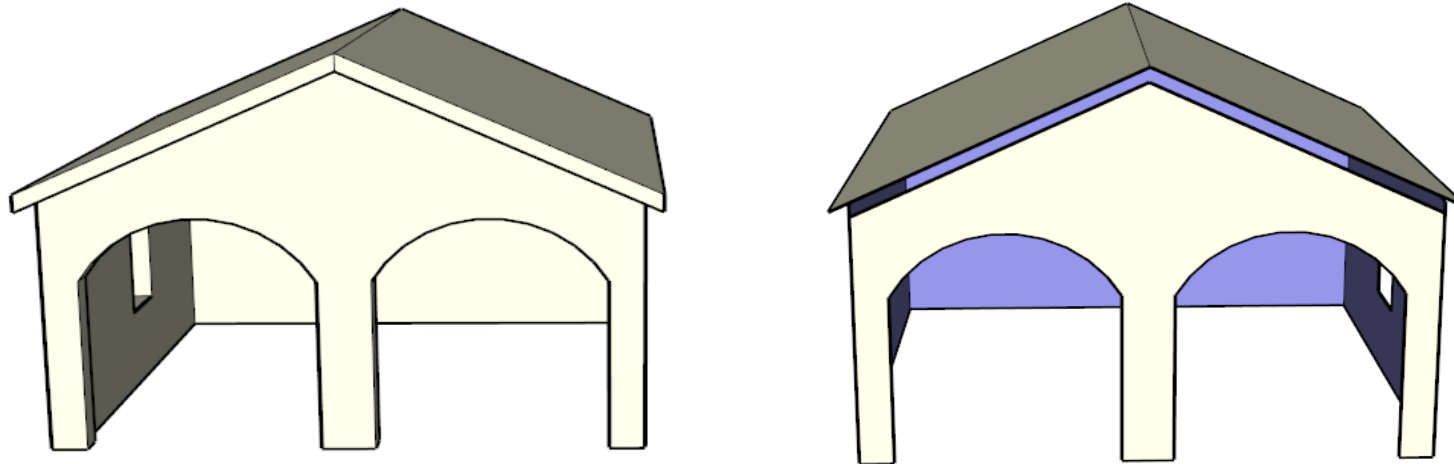
4、Experiment

Model Conversion-extract exterior wall



4、Experiment

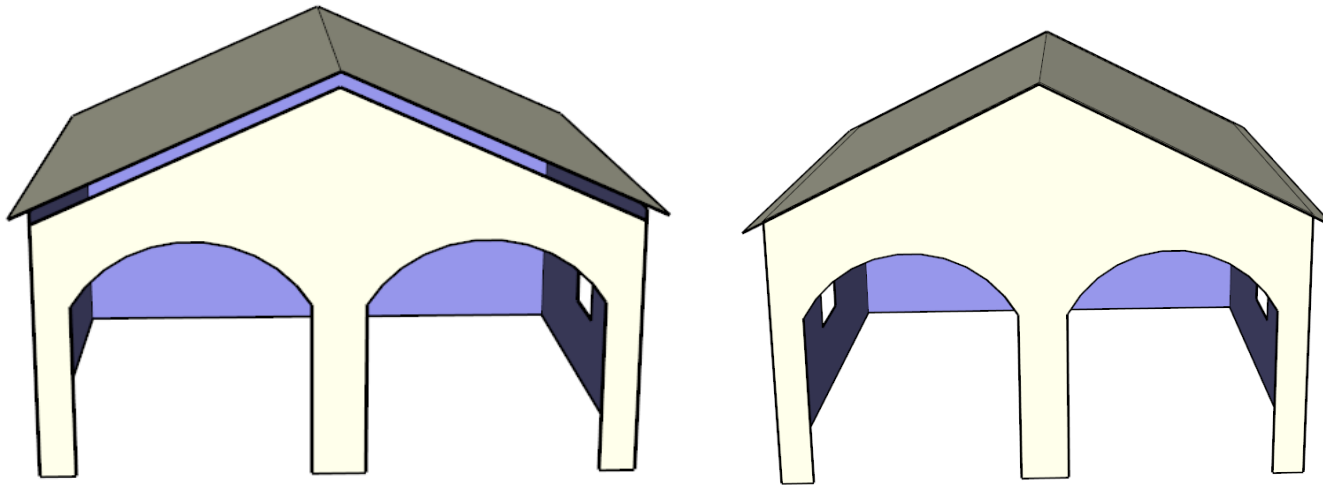
Model Conversion-extract exterior wall



Extract external walls and ceiling/roof

4、Experiment

Model Conversion-face processing



Face extending and face connecting

4、 Experiment

Model Conversion-face processing

In the processing of extraction and conversion, it will produce redundant data.

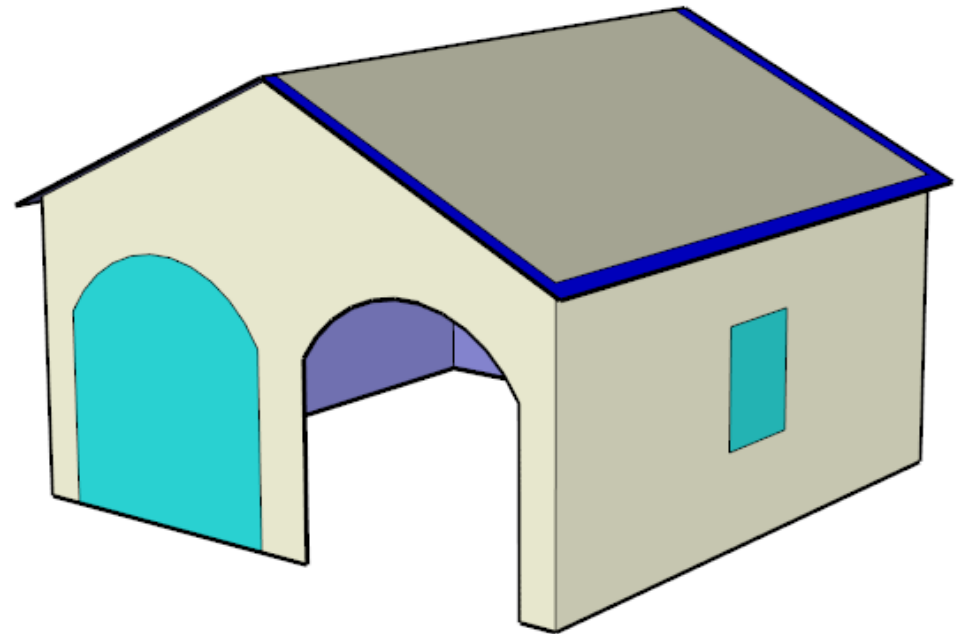
- 1. When two walls connect with each other, it will produce redundant edges**
- 2. Disconnection of the wall and roof;**
- 3. The roof may result in dangling faces;**
- 4. There may be 2D rings due to the exist of door and window**

4、 Experiment

Model conversion-solid repairing

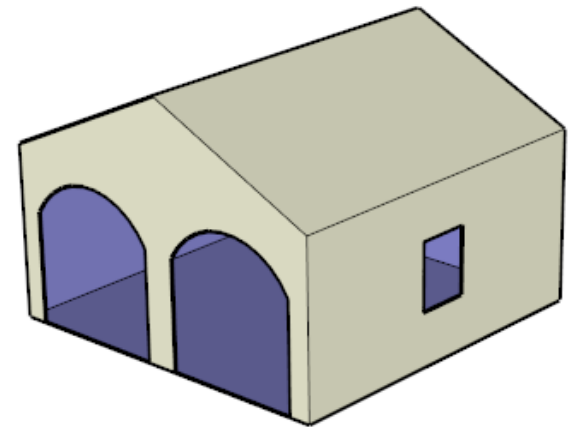
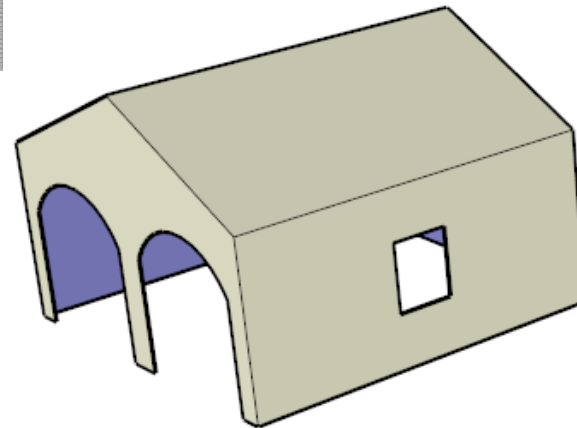
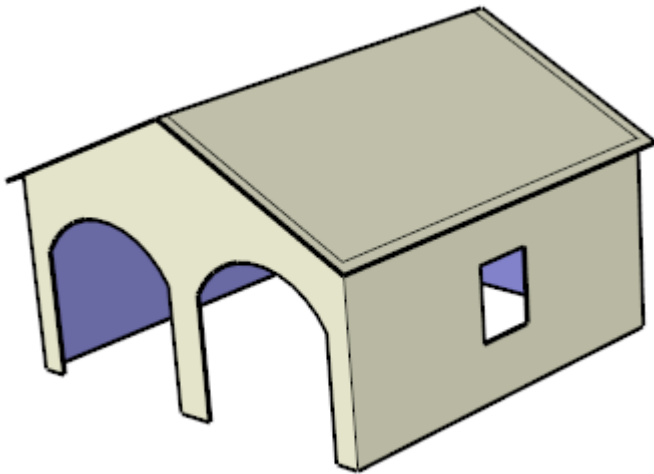
Solid repairing

- Delete isolate edges or faces
- Delete dangling edges or faces
- Delete repeated faces
- Merge co-planar faces
- Merge co-linear lines
- Add the lose faces to close the solid surface



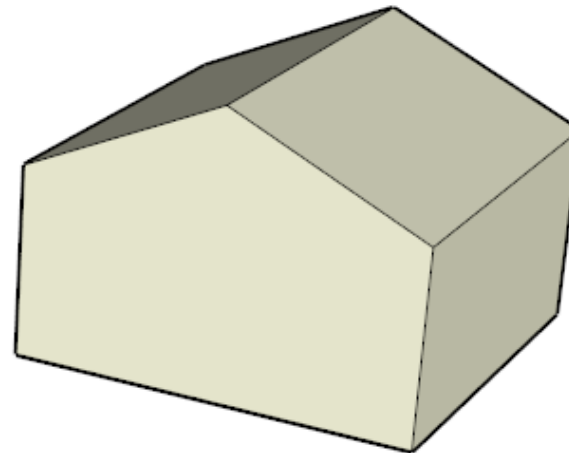
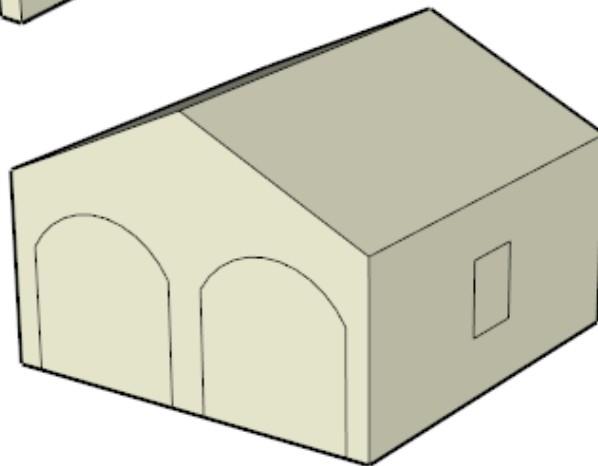
4、Experiment

Model conversion-repairing



Delete isolate edges or faces

Add lose faces



Repair doors and windows

Merge co-planar faces

4、 Experiment

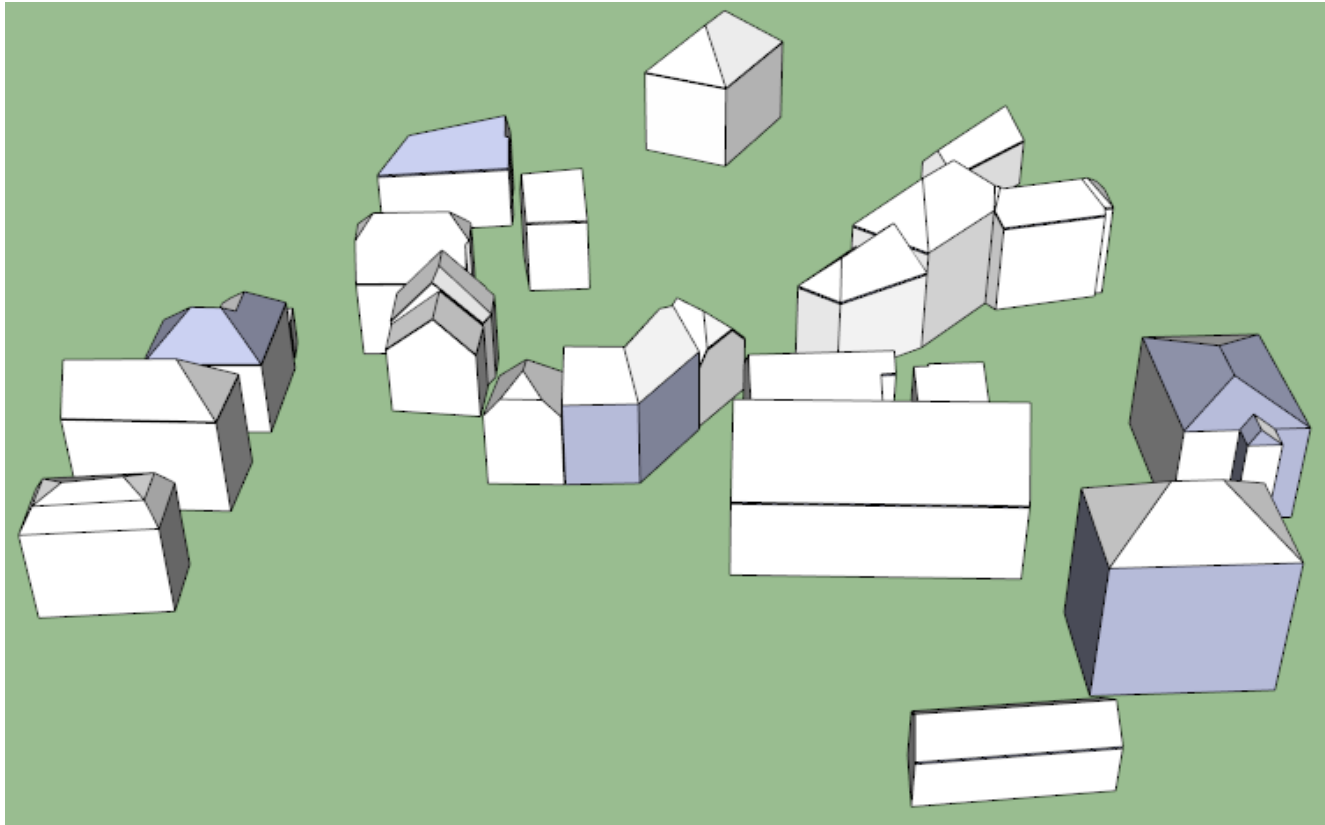
Model conversion-data test

**The main research question of this paper
---whether it is possible to do the conversion to support the
requirements from 3D cadastre.**

Use real data to test the conversion method

4、 Experiment

Model conversion-data test



22 3D geometric volumes which are constuted by 338 faces.
22 3D geometric volumes which are constuted by 5637 faces.

4、Experiment

3D Property Unit

After Conversion

spatial geometric information



ownership information and 3Rs

3D Property Unit



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5、 Conclusion and question

Conclusion

- **Mapping rule between the CityGML and 3D property units**
- **Conversion processing between CityGML and 3D property unit**
- **Repairing and validation of 3D Geometry.**

5、 Conclusion and question

Question

- **The update and reconstruction of cluster property units.**
- **The processing of non-manifold building.**



Thanks !
