

# Towards an integrated definition of the concept of level of detail in 3D city modelling

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Filip Biljecki  
Junqiao Zhao  
Jantien Stoter  
Hugo Ledoux

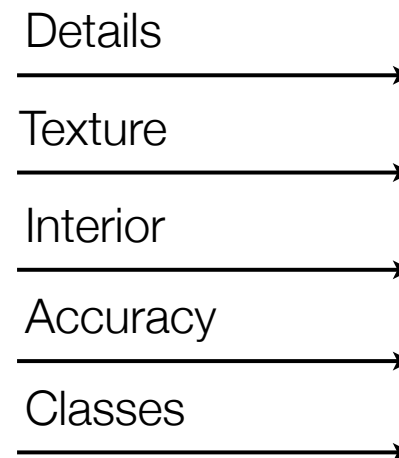
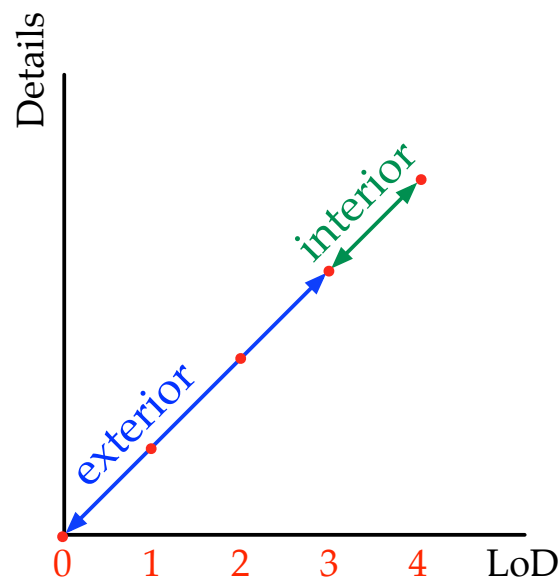
GIS technology, Delft University of Technology

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# Analysis of CityGML et al. (1/3)

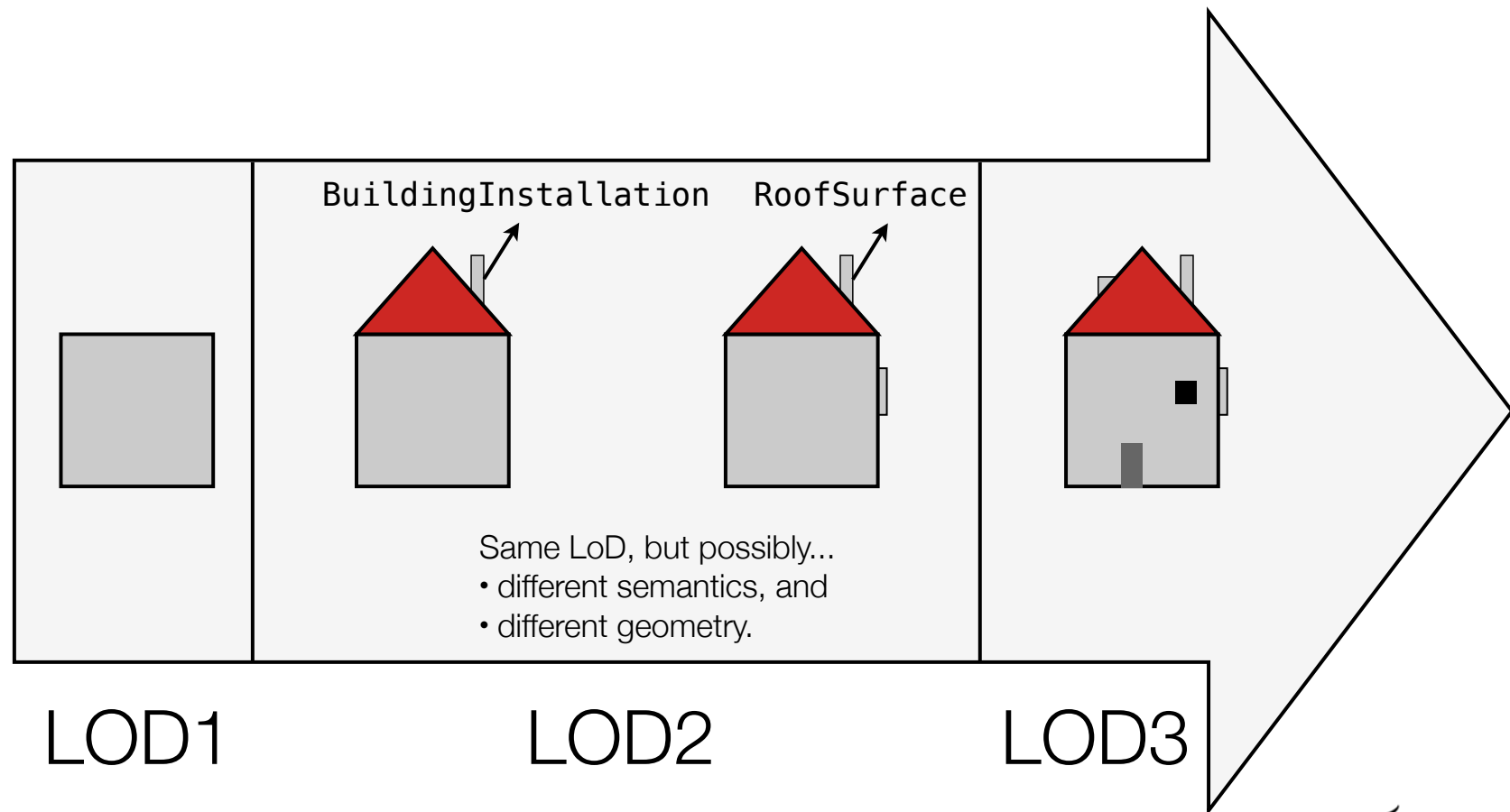
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- “Driving factors” other than geometry are not clearly defined, and are “multi-dimensional” not necessarily progressing together
- Applications have different requirements and priorities



# Analysis of CityGML et al. (2/3)

- The specification is not fine enough (two different datasets can be same LoD)

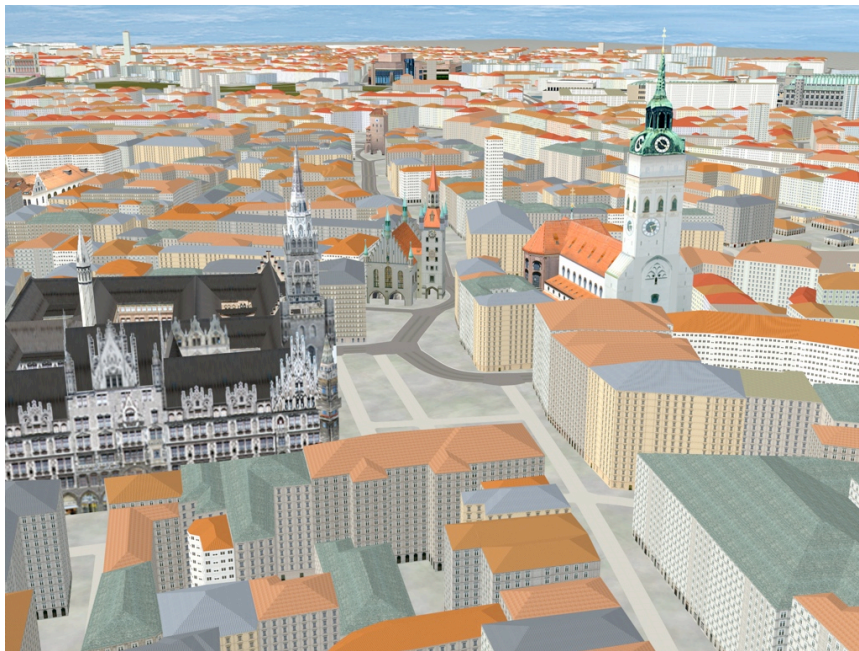


# Analysis of CityGML et al. (3/3)

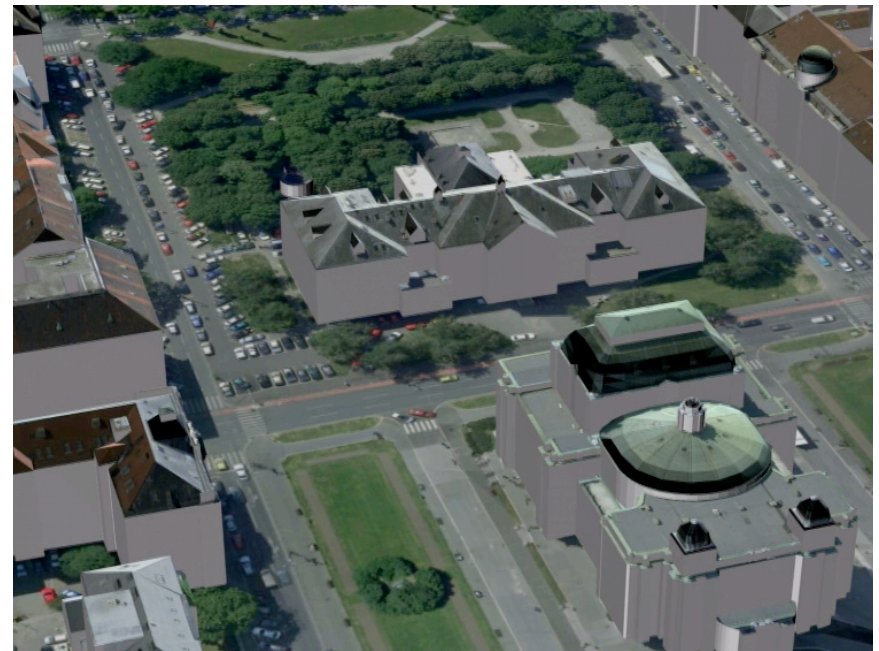
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- Not covering the case of combining different LoDs of **objects** and LoDs of **parts**

City objects LoD mix (Munich by NAVTEQ)



Parts of buildings mix (Zagreb by Geofoto)



# Propositions (1/3)

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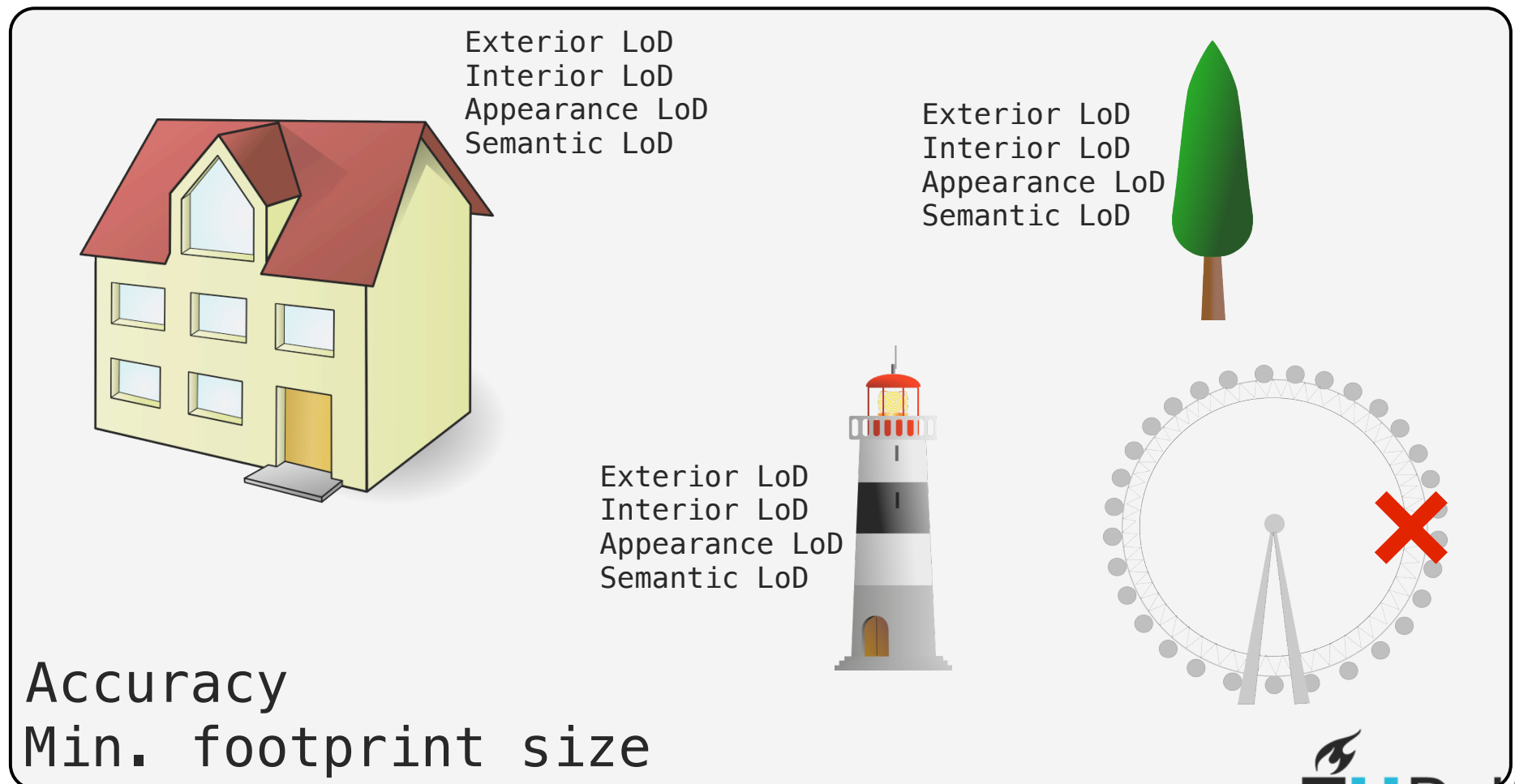
- Several *ingredients* (factors) other than geometry that define the LoD:
  - Selection of city objects and their parts (elements) to be acquired/modelled
  - General factors such as accuracy, acquisition method, min. object footprint

- Exterior geometry LoD
- Interior geometry LoD
- Appearance LoD
- Semantics LoD

Four (sub-)levels of detail

# Propositions (2/3)

- Separating city object's four LoDs and having joint LoDs

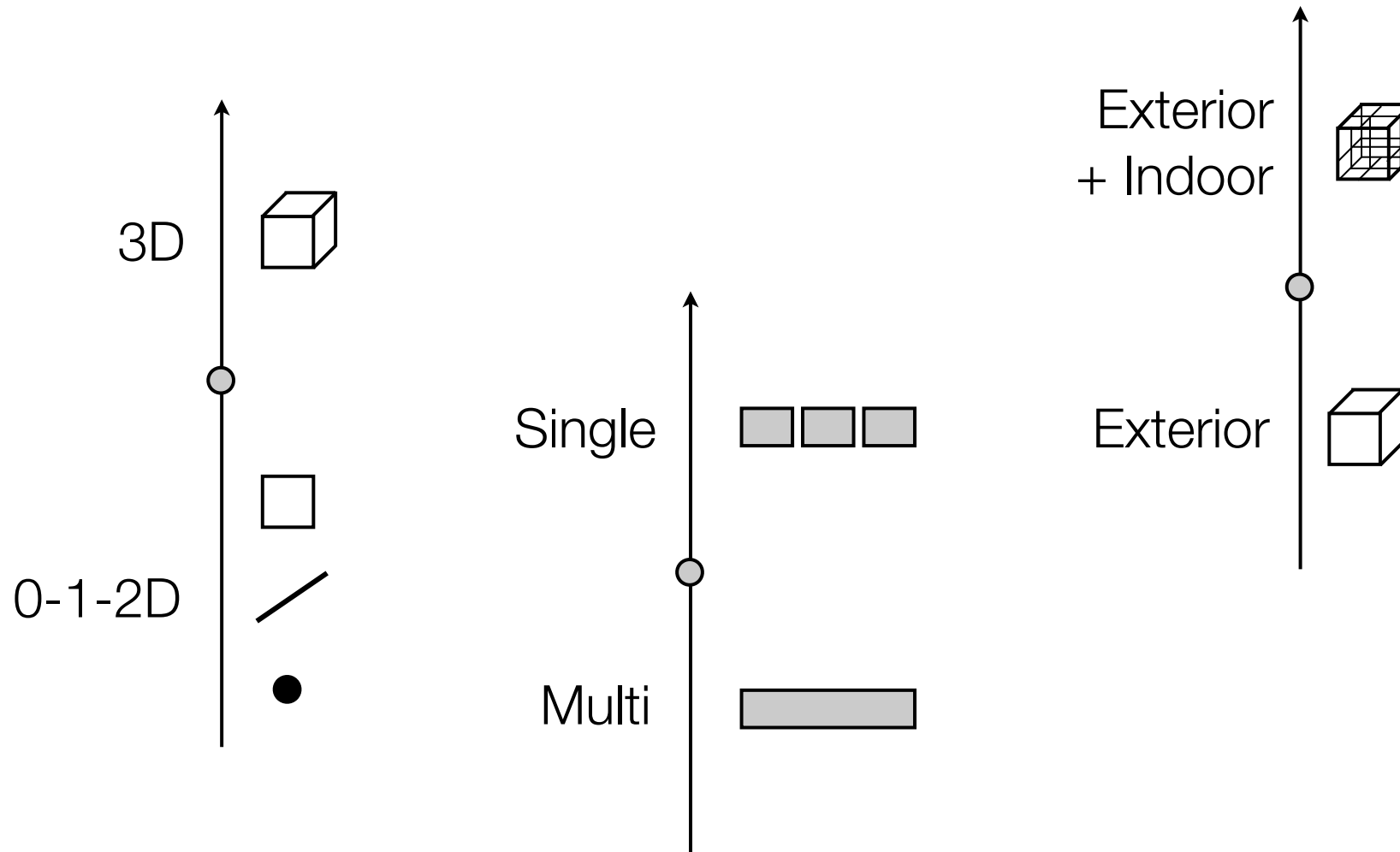


# Propositions (3/3)

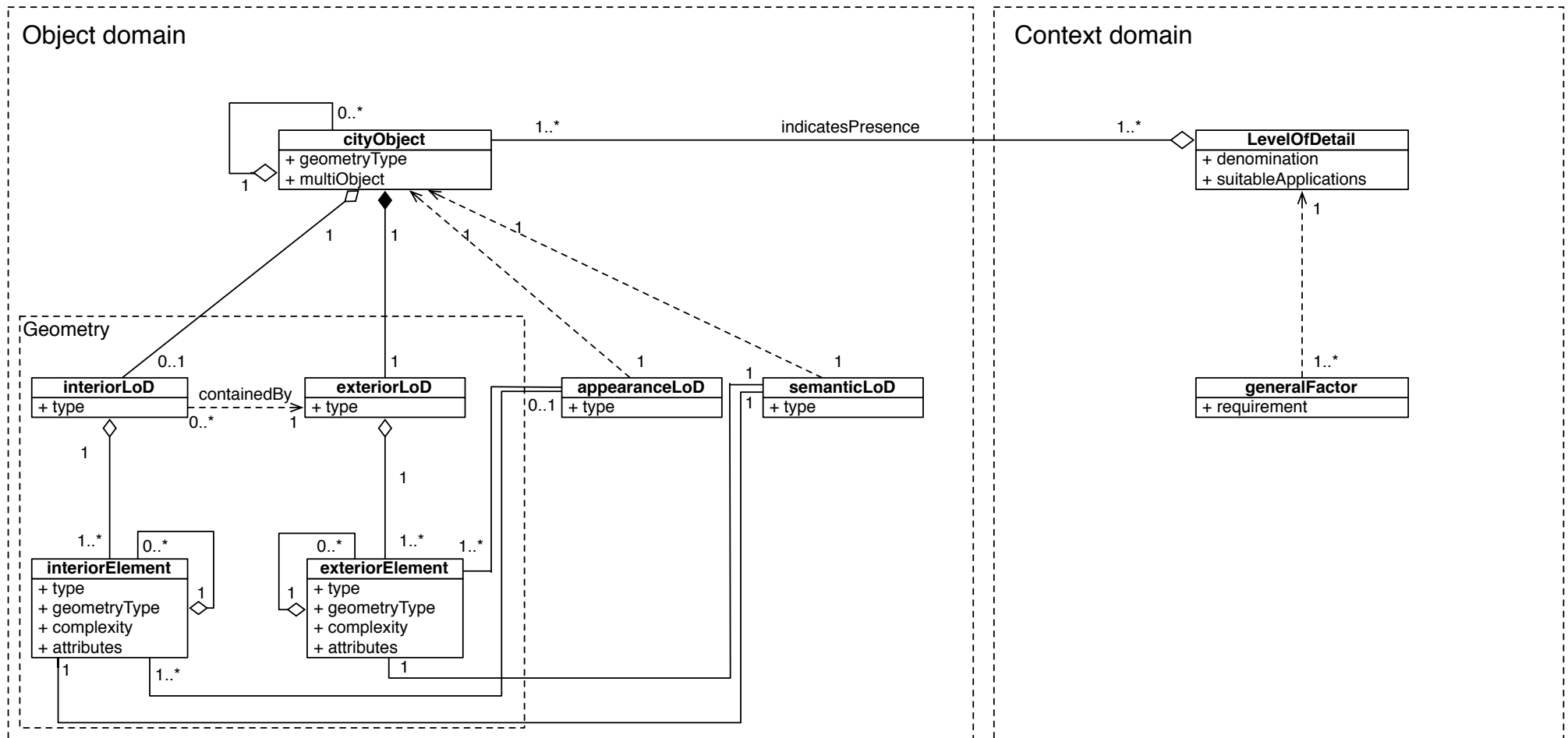
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- Focusing on elements (city object's parts) rather than on objects and/or scene
- Finer geometry definition: presence, complexity, and dimensionality, with the extension of types of geometric representations:
  - 0D - point, symbol
  - 1D - line (e.g. road, river)
- Dataset-based and object-based constraints:
  - Interior <-> Exterior
  - Accuracy <-> Geometric complexity

# Indoors, 0D/1D/2D, and multi object integration

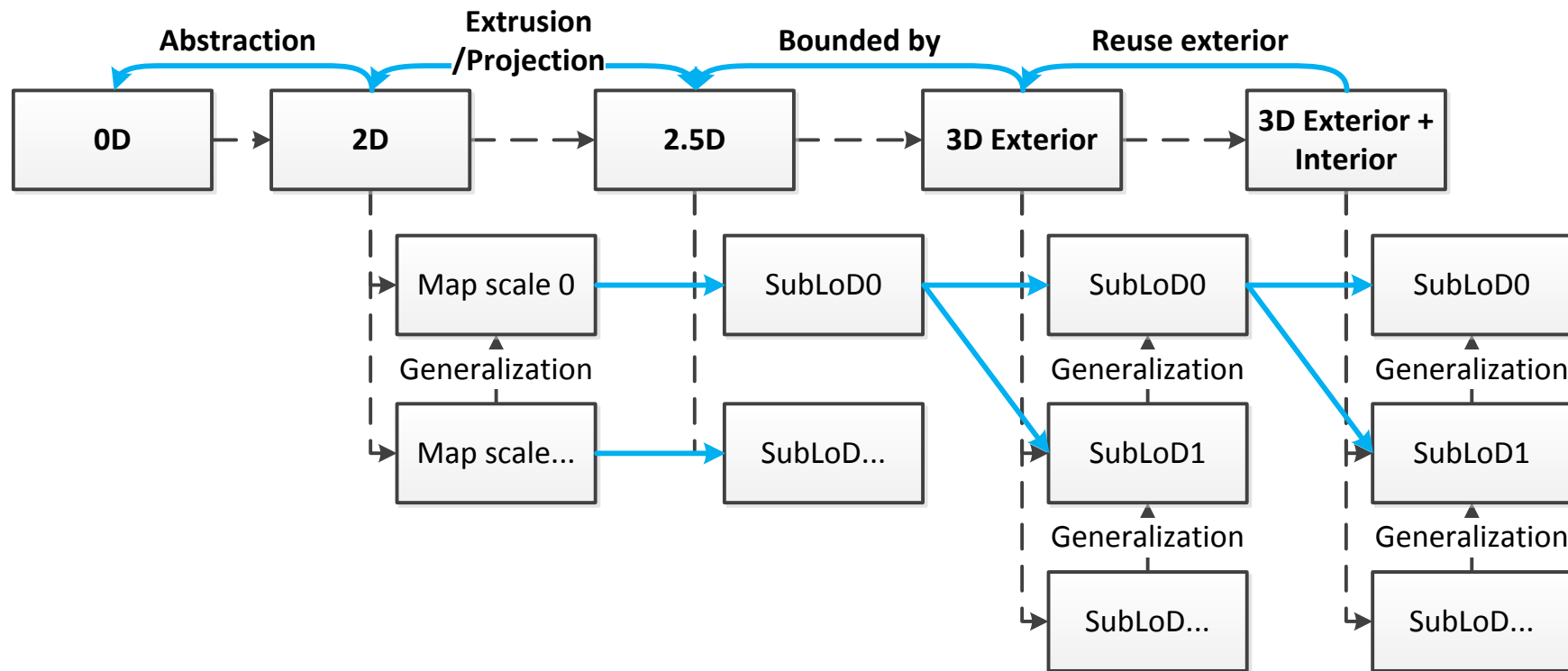


# Framework (UML)



# Relationships and constraints

- (Sub-)LoDs in different dimensions should link and comply to certain constraints (e.g. consistency). Allows re-usage.



# Realisation: LoD specification

- Finer specification of 3D city models (user request list, tendering or company portfolio)

	Level of Detail			LOD-A					LOD-B				
General factors	generalFactor: Accuracy			0.5 m					0.2 m				
	generalFactor: Texture			Yes, exterior only (generic library or photorealistic)					None				
	generalFactor: Interior			None					Allowed				
City objects	cityObject	exteriorElement	interiorElement	isPresent	exteriorLoD / interiorLoD		appearanceLoD	semanticLoD	isPresent	exteriorLoD / interiorLoD		appearanceLoD	semanticLoD
					geometryType	attributes	appearance	semanticClass		geometryType	attributes	appearance	semanticClass
	Building	Roof		Yes	3D	-	Orthophoto 10 cm	Building	Yes	3D	Material	Dominant colour	Roof
		Roof: Dormer		No	-	-	-	-	Yes	3D	-	-	RoofPart
		ExteriorWall		Yes	3D	-	Library	Building	Yes	3D	-	Dominant colour	Wall
			Room	No	-	-	-	-	Yes	3D	Area	-	Interior
	Road >3 m	CenterLine		Yes	1D	Width	-	Road	No	-	-	-	-
		TrafficArea		No	-	-	-	-	Yes	2D	Lanes	-	Road
	Tree	Canopy		Yes	0D	-	-	Tree	Yes	1D	TreeType	Single colour	Tree
	Lamp posts	LampPole		Yes	1D	-	-	Lamp	No				

# Specification (LOD-A)

	Level of Detail			LOD-A				
General factors	generalFactor: Accuracy			0.5 m				
	generalFactor: Texture			Yes, exterior only (generic library or photorealistic)				
	generalFactor: Interior			None				
City objects	cityObject	exteriorElement	interiorElement	isPresent	exteriorLoD / interiorLoD		appearanceLoD	semanticLoD
					geometryType	attributes	appearance	semanticClass
	Building	Roof		Yes	3D	-	Orthophoto 10 cm	Building
		Roof: Dormer		No	-	-	-	-
		ExteriorWall		Yes	3D	-	Library	Building
			Room	No	-	-	-	-
	Road >3 m	CenterLine		Yes	1D	Width	-	Road
		TrafficArea		No	-	-	-	-
	Tree	Canopy		Yes	0D	-	-	Tree
	Lamp posts	LampPole		Yes	1D	-	-	Lamp

# Specification (LOD-B)

	Level of Detail			LOD-B				
General factors	generalFactor: Accuracy			0.2 m				
	generalFactor: Texture			None				
	generalFactor: Interior			Allowed				
City objects	cityObject	exteriorElement	interiorElement	isPresent	exteriorLoD / interiorLoD		appearanceLoD	semanticLoD
					geometryType	attributes	appearance	semanticClass
	Building	Roof		Yes	3D	Material	Dominant colour	Roof
		Roof: Dormer		Yes	3D	-	-	RoofPart
		ExteriorWall		Yes	3D	-	Dominant colour	Wall
			Room	Yes	3D	Area	-	Interior
	Road >3 m	CenterLine		No	-	-	-	-
		TrafficArea		Yes	2D	Lanes	-	Road
	Tree	Canopy		Yes	1D	TreeType	Single colour	Tree
	Lamp posts	LampPole		No				

# Different use-cases have different requirements

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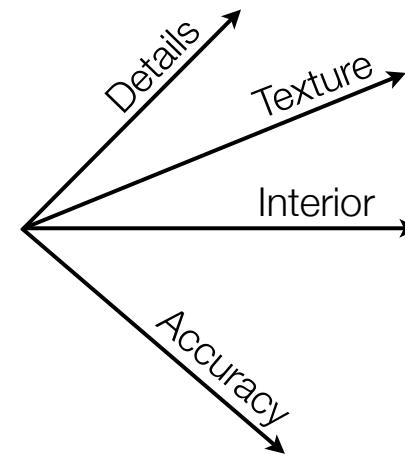
- Customised LoDs for each application. Combination of different factors.

Users/ factors	Government				Private sector		
	Municipalities	Military	Environment	...	Noise	Solar	...
Objects							
Elements							
Accuracy							
Semantics							
Appearance							
Acq. method							
Budget							
...							

# How to measure such LoDs?

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- Lots of combinations (permutations) - denomination problem
- Hard to quantify and/or sort different combinations and “degrees of quality progressiveness”
  - LOD-A (better appearance) vs. LOD-B (better accuracy, semantics, interior)?
- Measuring wealth of details/elements?
- Measuring accuracy requirements?
  - 0.2 m is better than 0.5 m, but by how much?



# Benefits

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- Identification and **separation** of factors that constitute an LoD
- Use-case/application oriented, allowing custom LoDs
- A finer specification enabling different combinations of factors
- Specifying the level of detail for city object parts (elements)

# Questions / discussion

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**Thank you for your attention**

Filip Biljecki <f.biljecki@tudelft.nl>

Junqiao Zhao <johnzjq@gmail.com>

Jantien Stoter <j.e.stoter@tudelft.nl>

Hugo Ledoux <h.ledoux@tudelft.nl>

Section GIS technology, Delft University of Technology

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