

Modelling Higher Dimensional Data for GIS Using Generalised Maps

Ken Arroyo Ohori

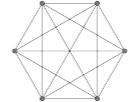
Hugo Ledoux

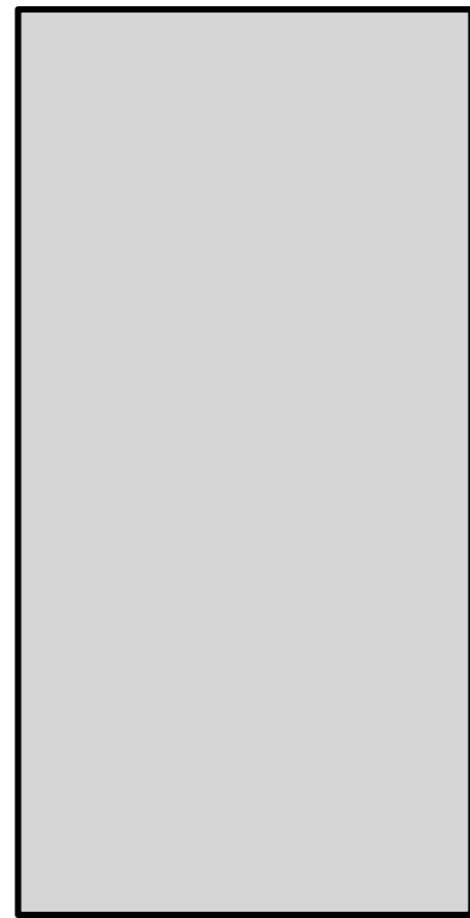
Jantien Stoter

June 24, 2013
ICCSA 2013



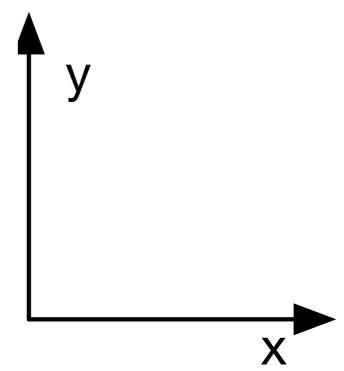
5D project

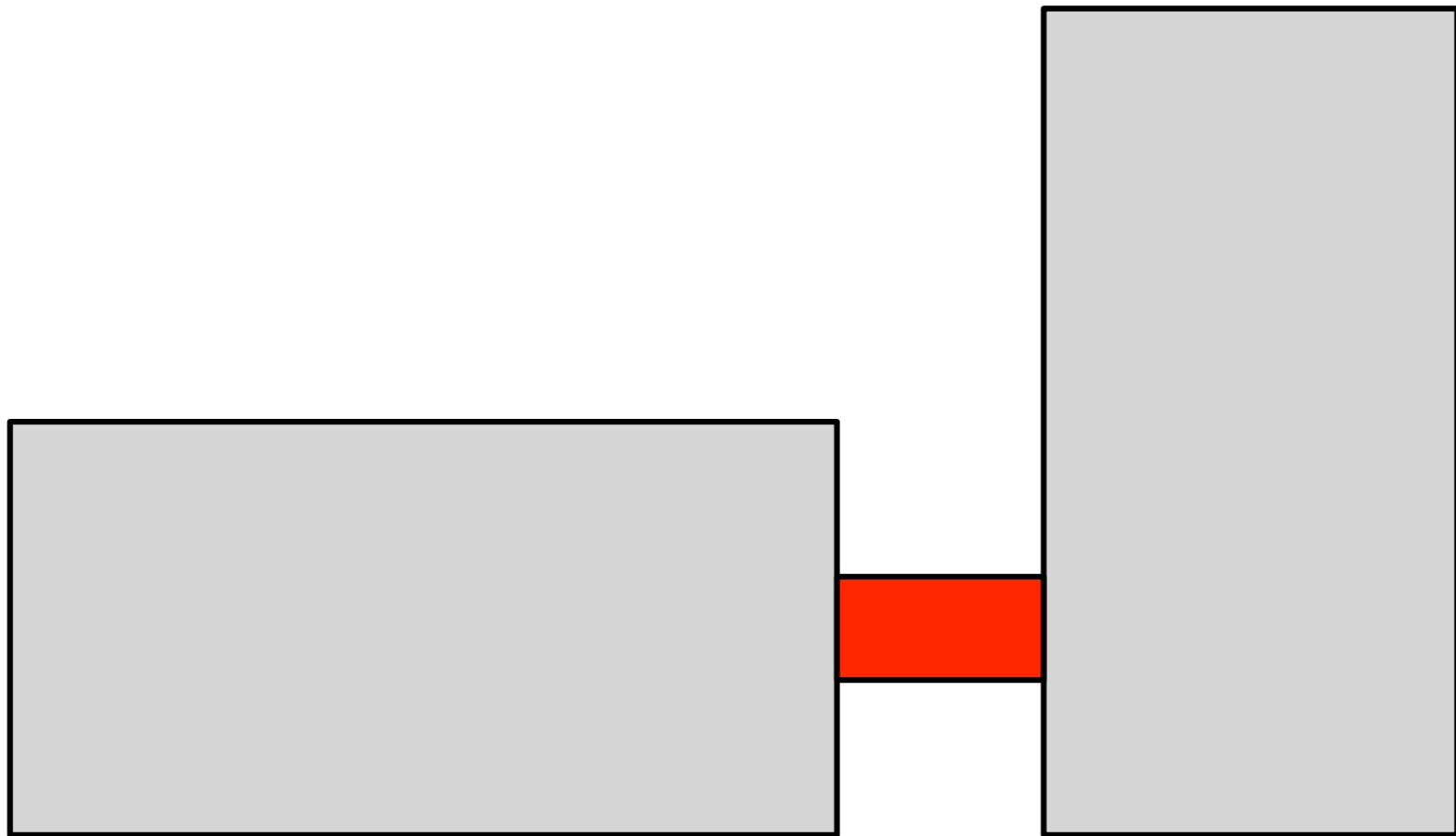
- +  3D space
 - +  Scale
 - +  Time
-
- =  5D modelling



Examples

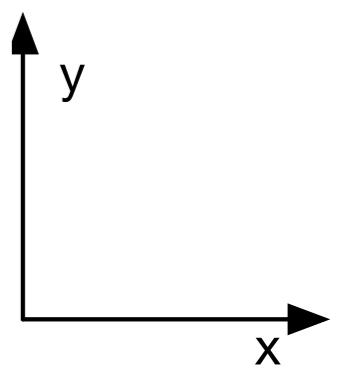
2D

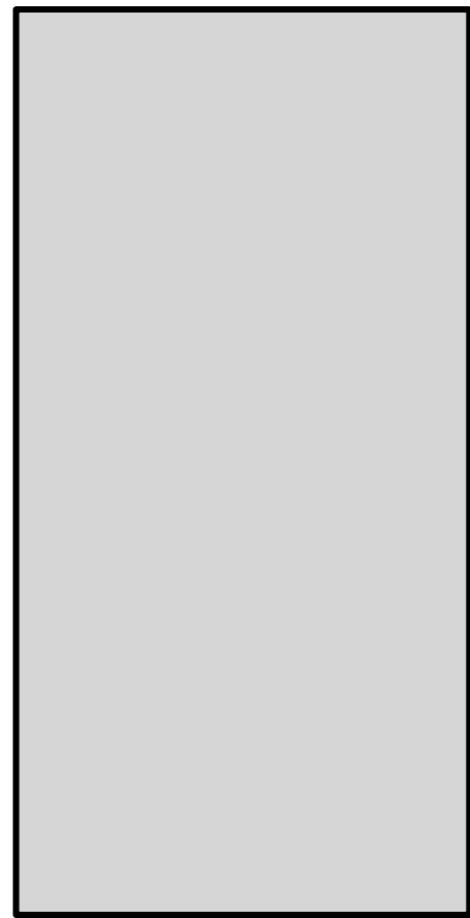




Examples

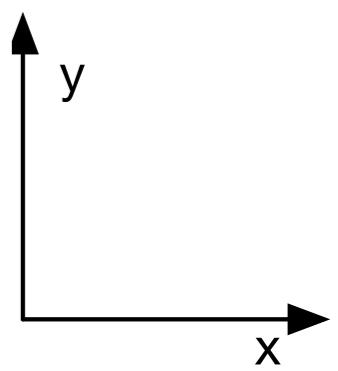
2D





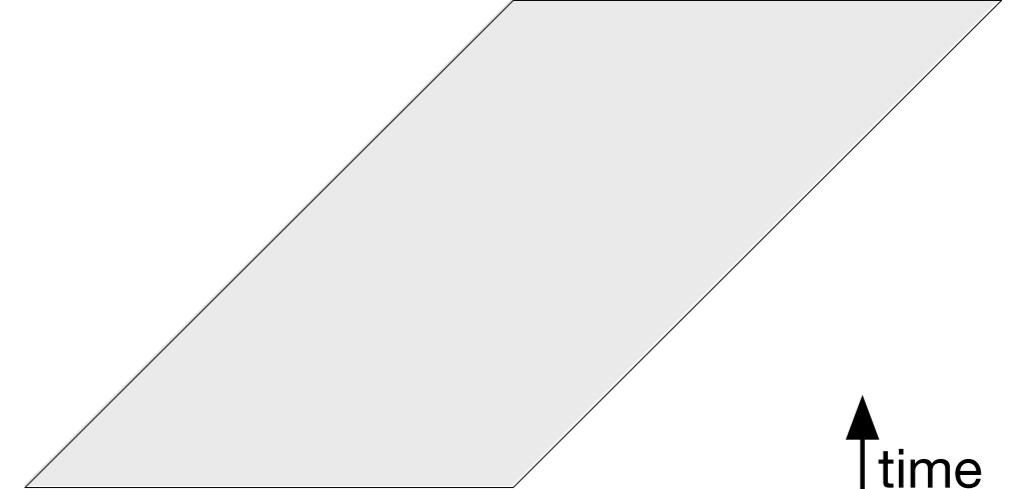
Examples

2D

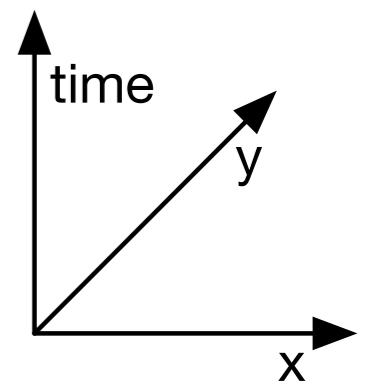


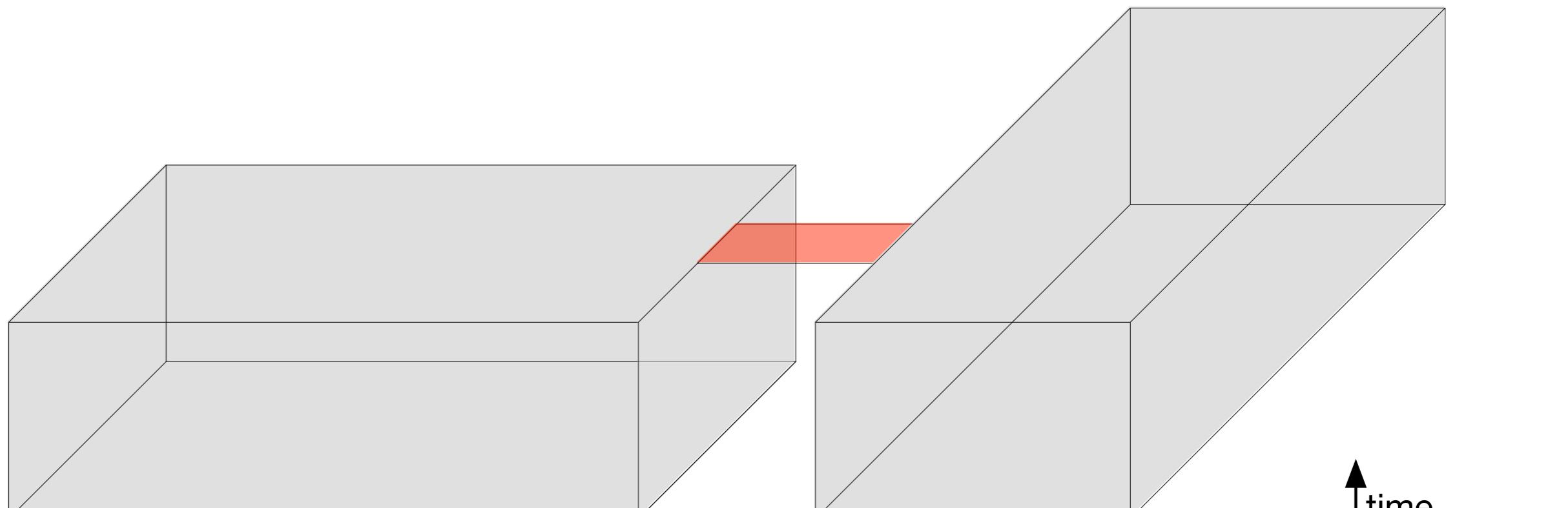


Examples



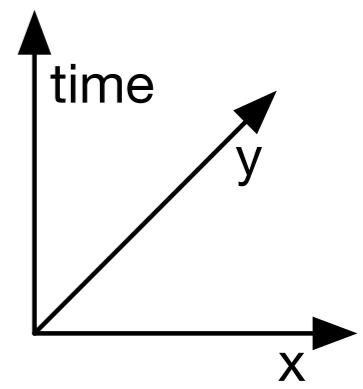
Move to 3D

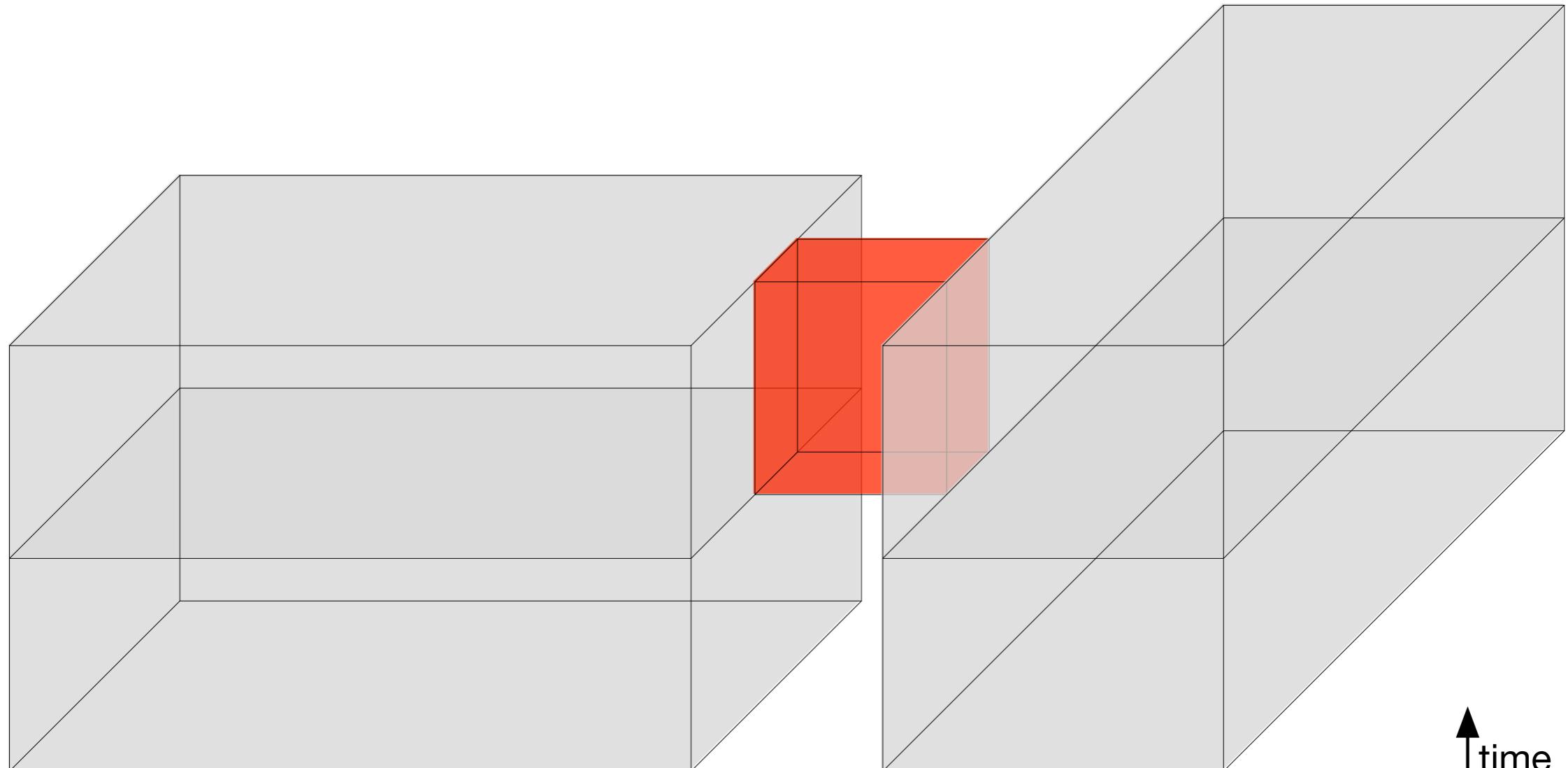




Examples

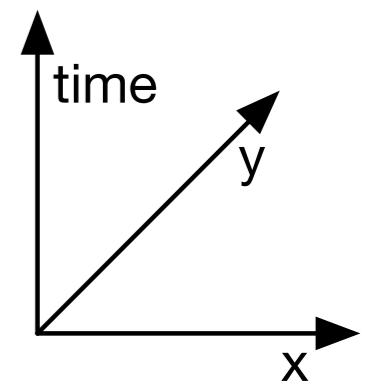
Move to 3D

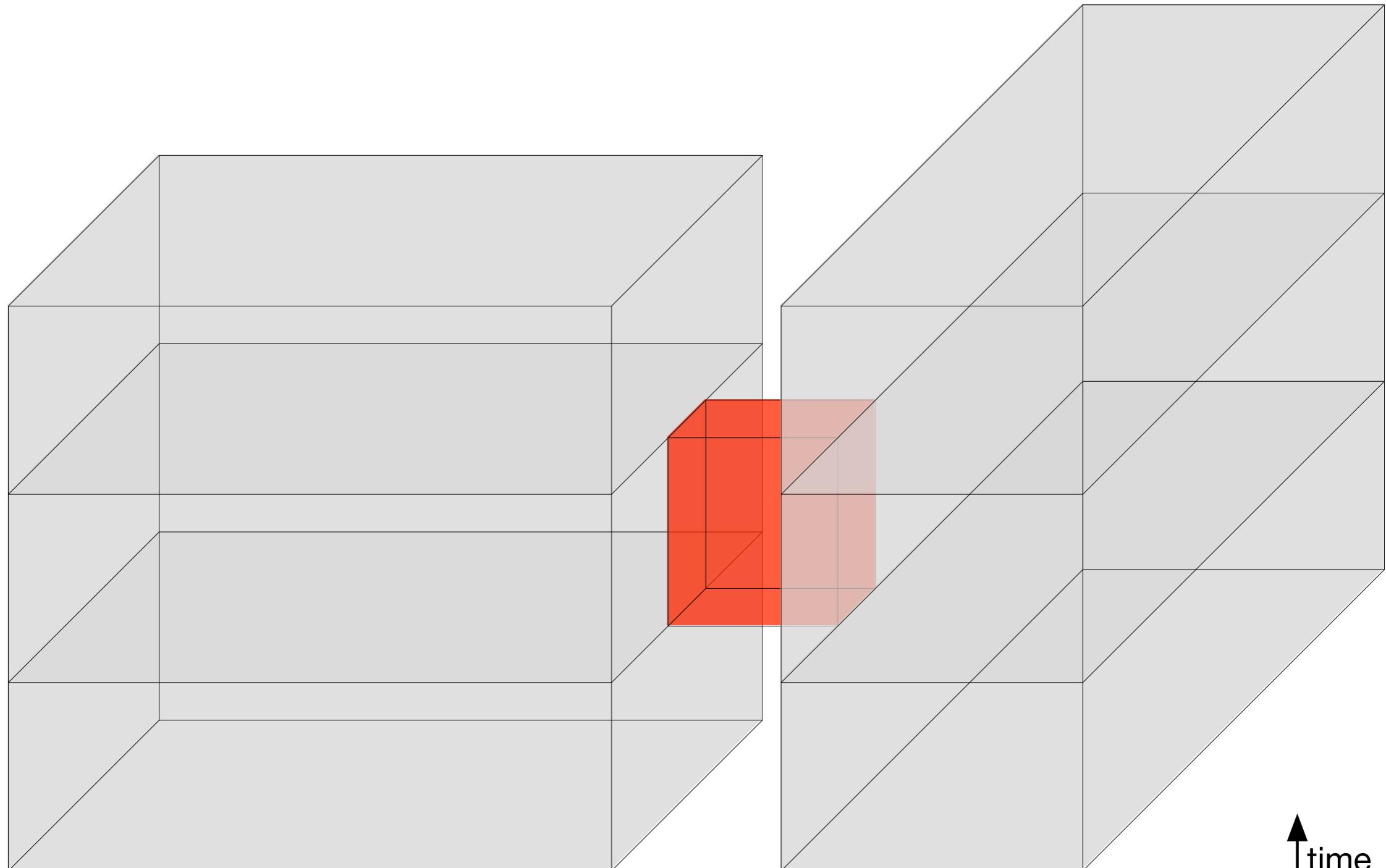




Examples

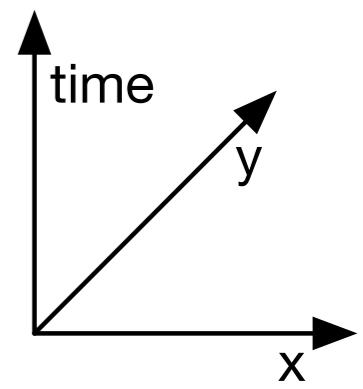
Move to 3D

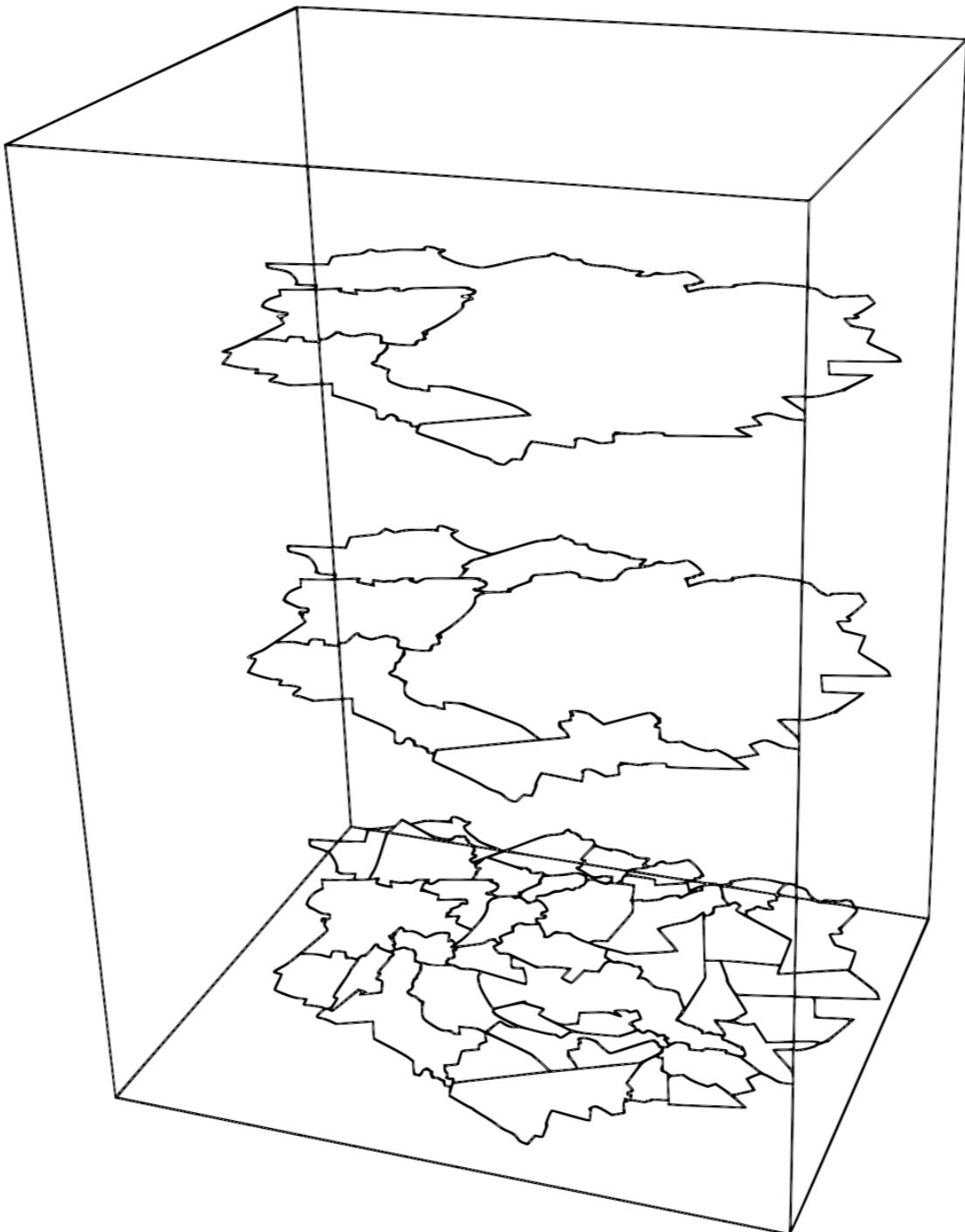




Examples

Move to 3D





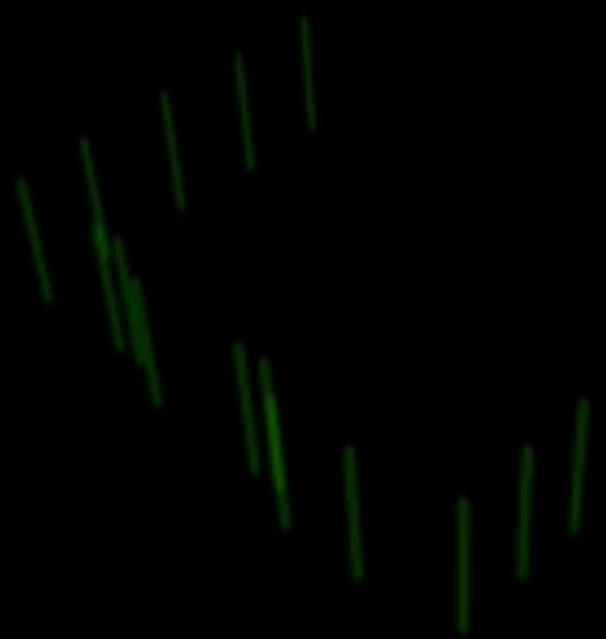
Meijers and van Oosterom (2011)

Other possibilities

Scale

4D data sources

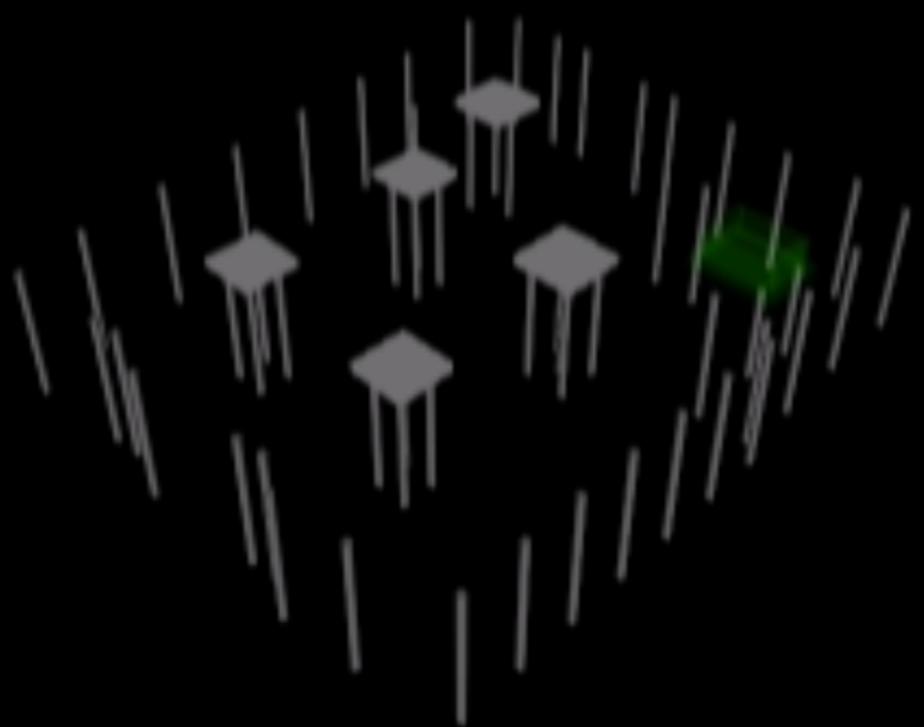
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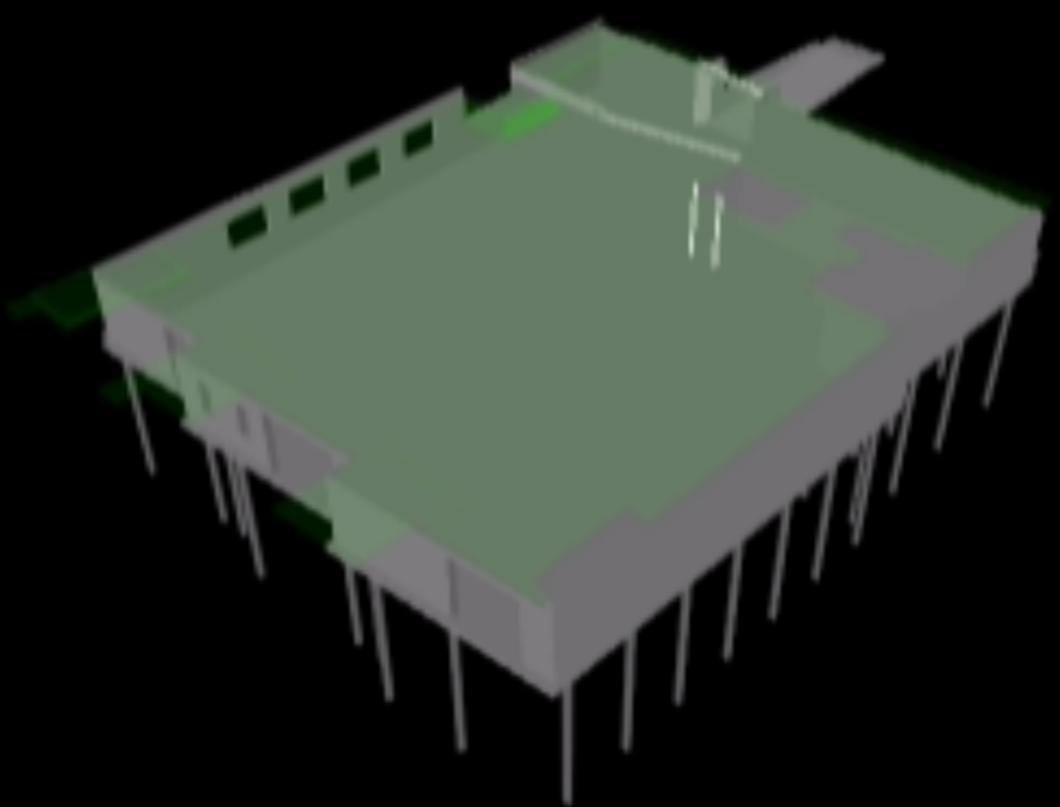
dinsdag 11:31:12 24-8-2010 Day=7 Week=1



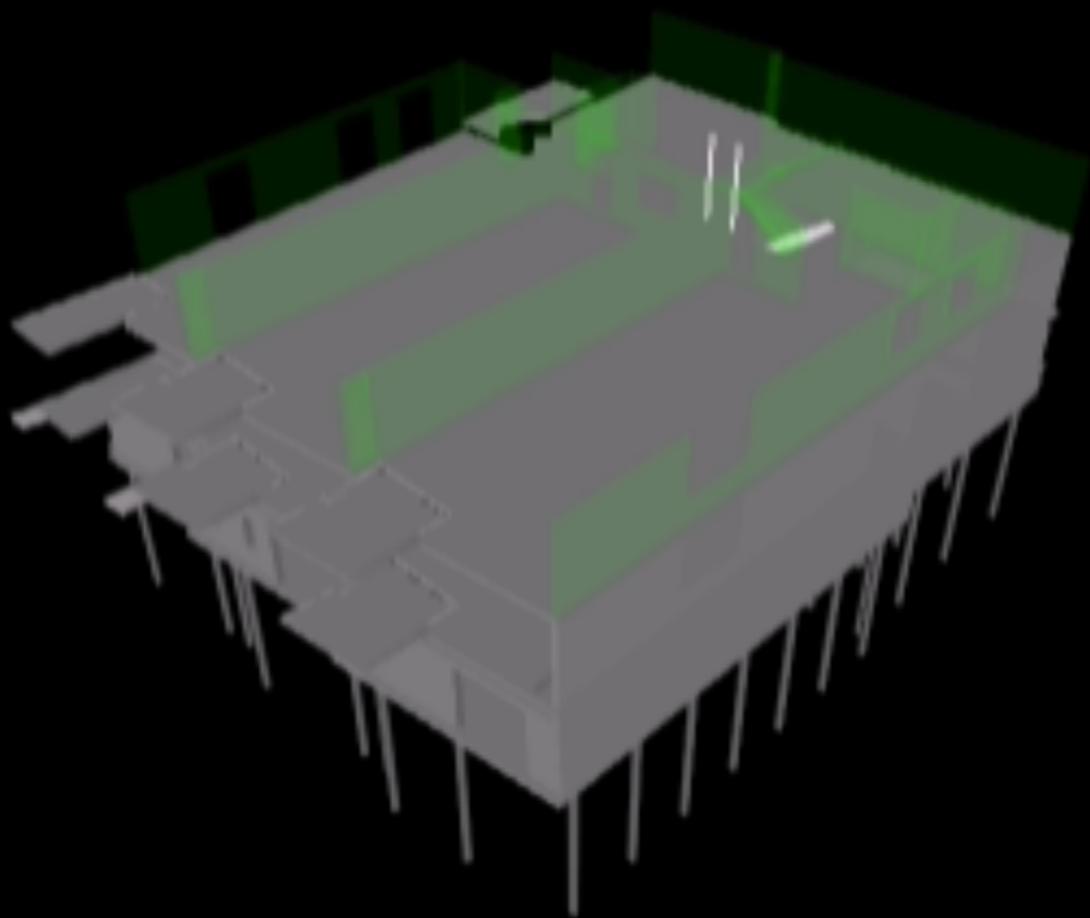
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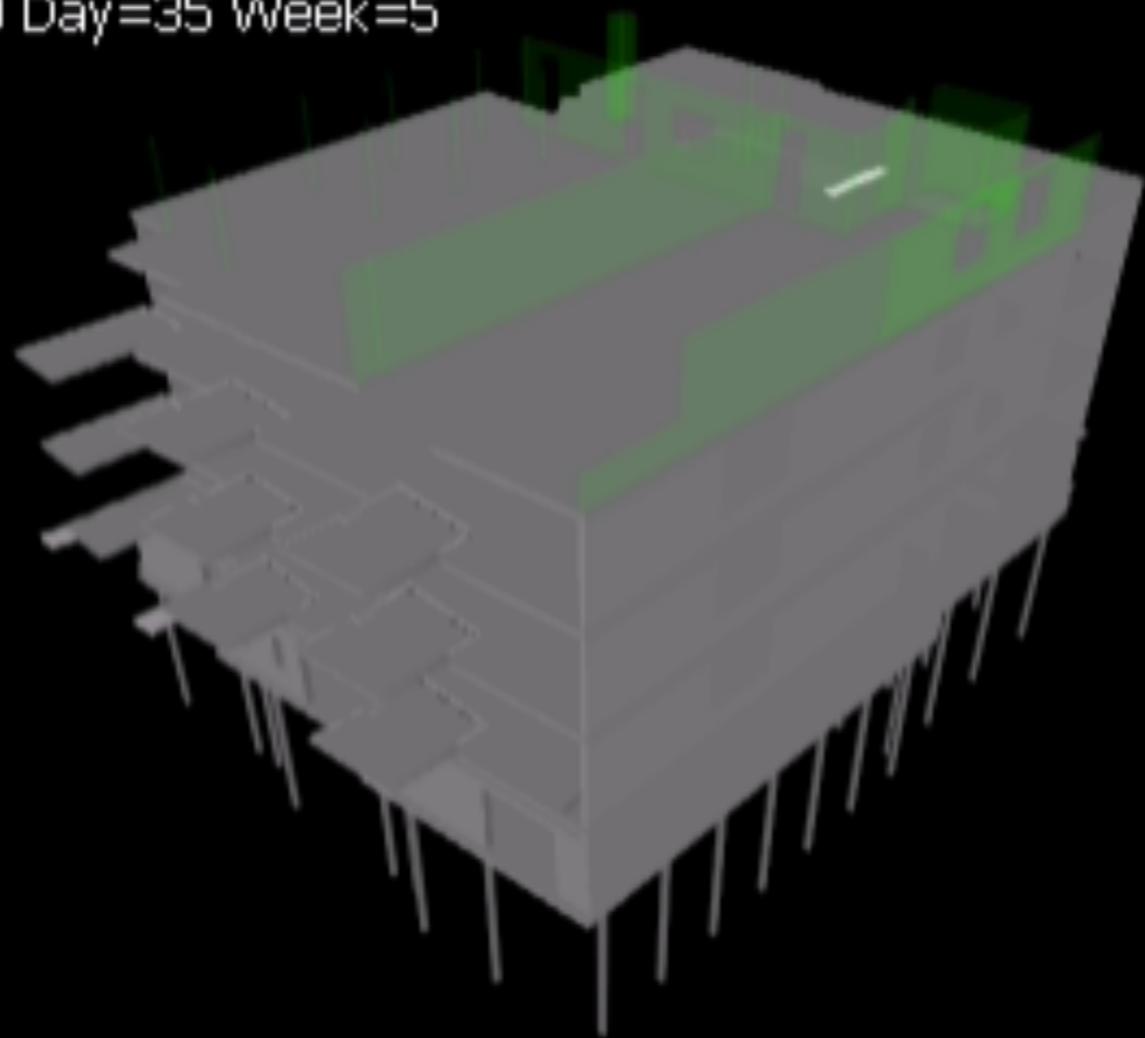
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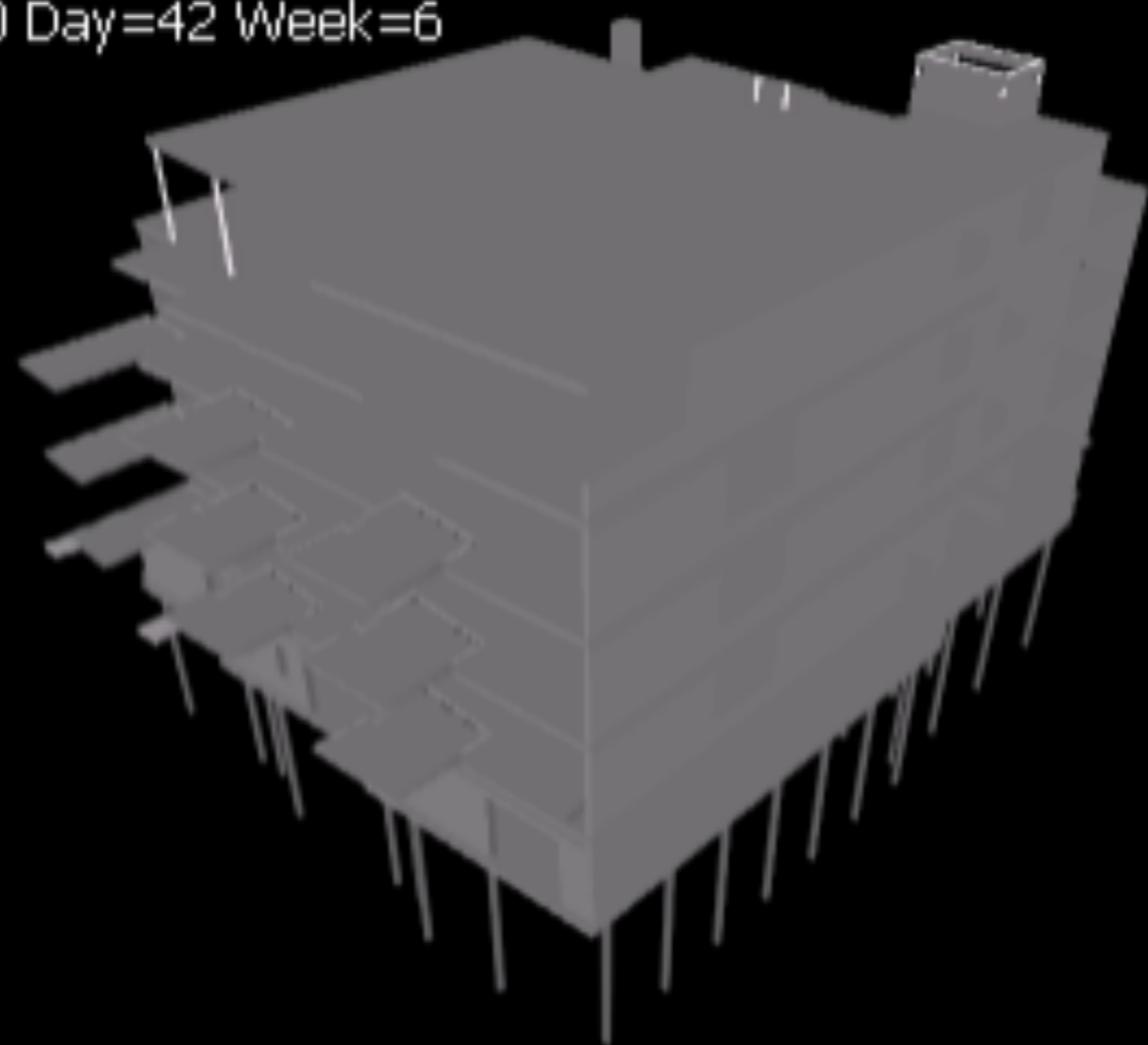
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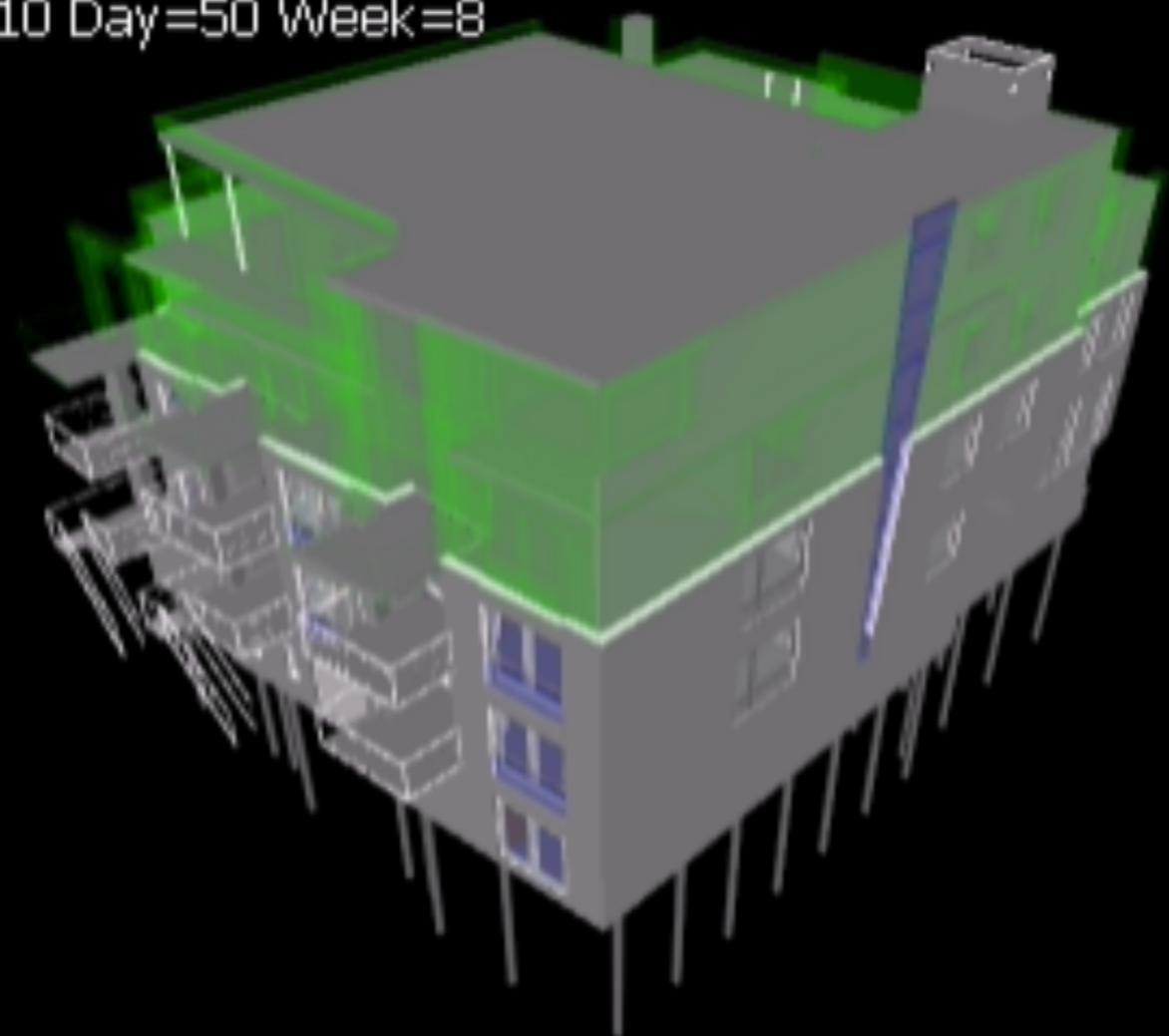
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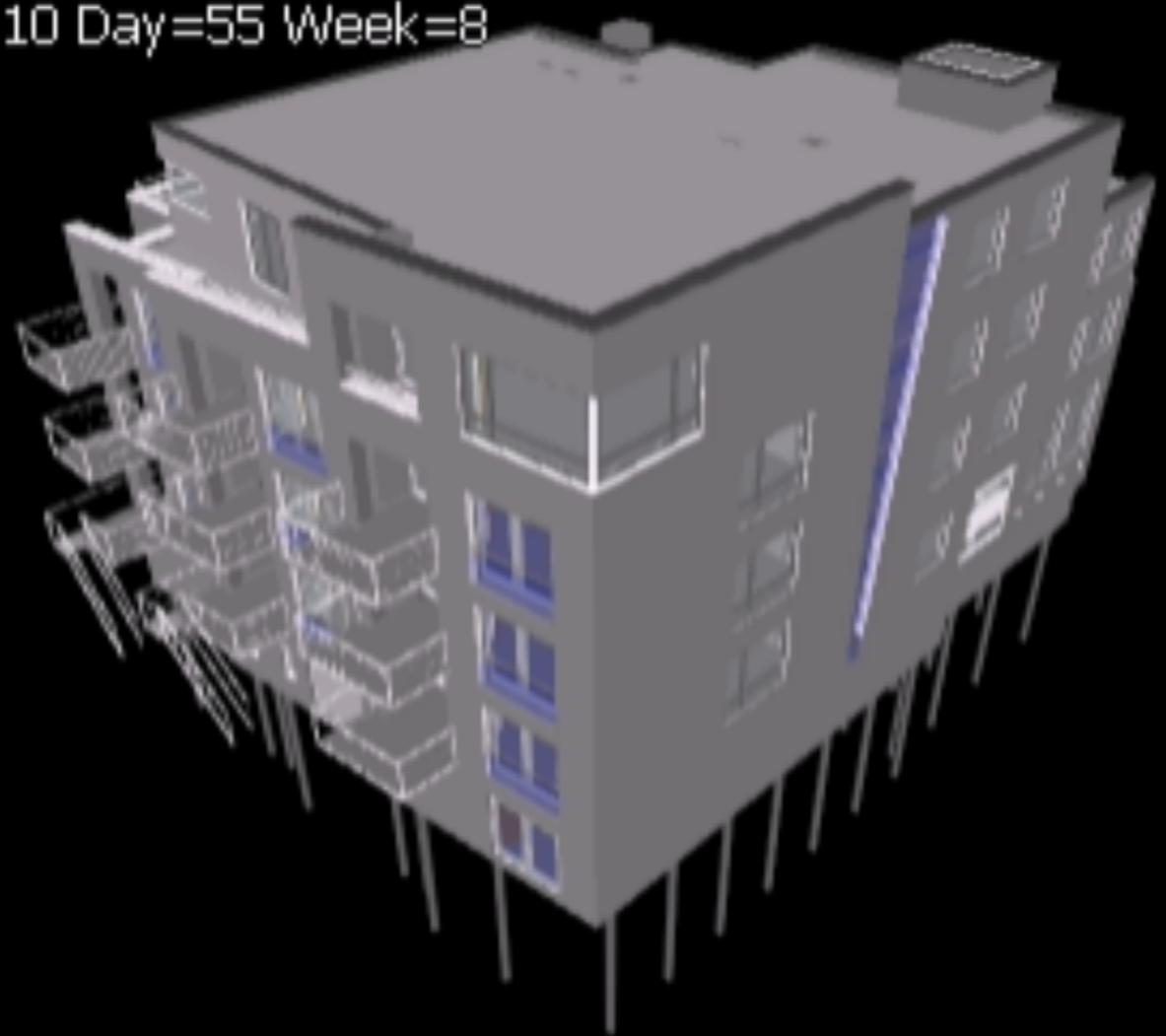
dinsdag 20:24:00 28-9-2010 Day=42 Week=6



woensdag 1:12:00 6-10-2010 Day=50 Week=8



maandag 0:00:00 11-10-2010 Day=55 Week=8



Why higher dimensional information?

- Full topology, i.e. all links exist
 - Analyse using queries along all dimensions
 - Consistency of data
 - Genericity, i.e. add anything that makes sense as a dimension
- n-d data models
 - n-d data structures
 - n-d algorithms

Why higher dimensional information?

Functional

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- Analyse using queries along all dimensions
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- Genericity, i.e. add anything that makes sense as a dimension

Technical

- n-d data models
- n-d data structures
- n-d algorithms

Why higher dimensional information?

Functional

- Mathematically strong models that work on any type of data and can be extended

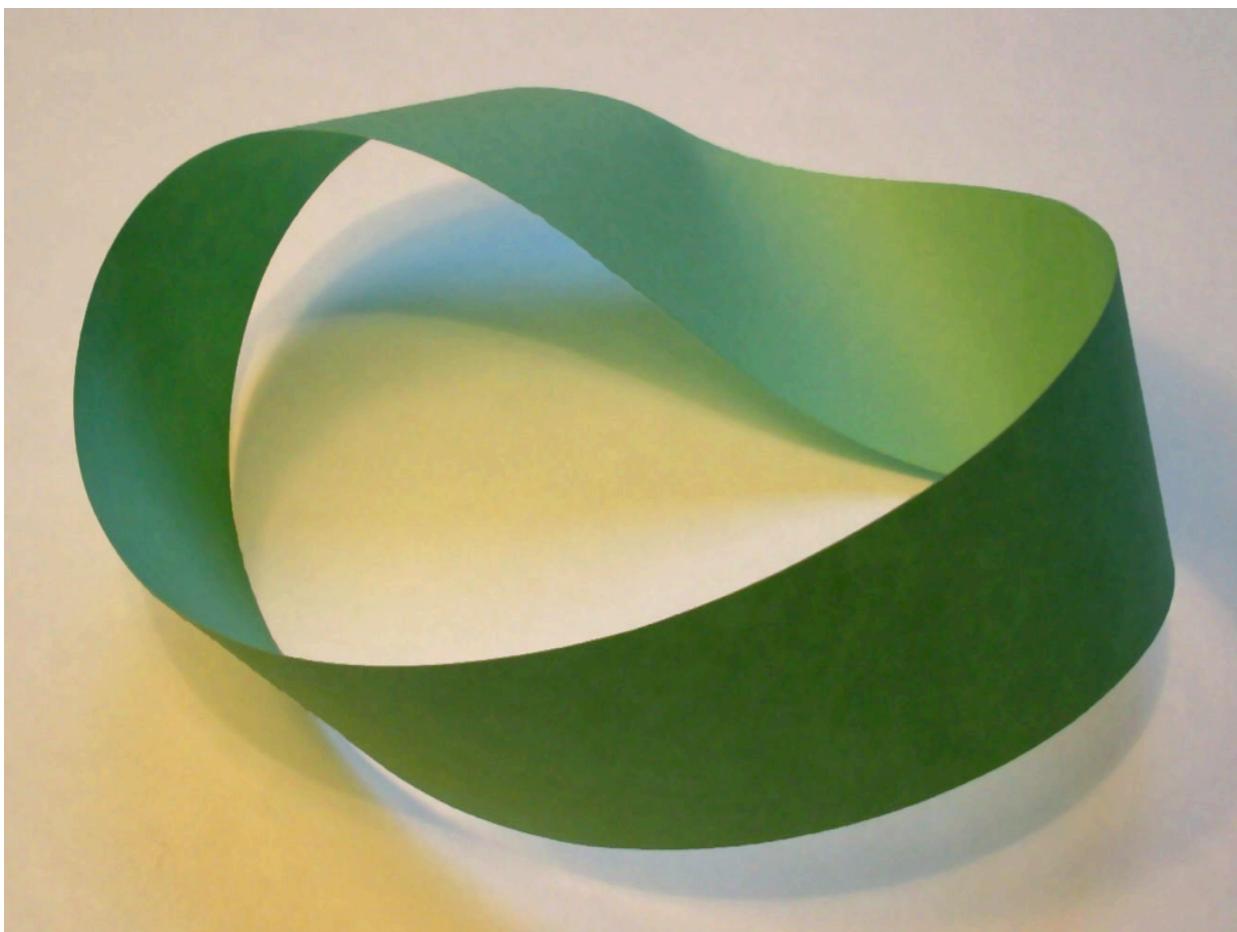
Technical

- Ongoing research on higher dimensional models, structures and algorithms

Why higher dimensional information?

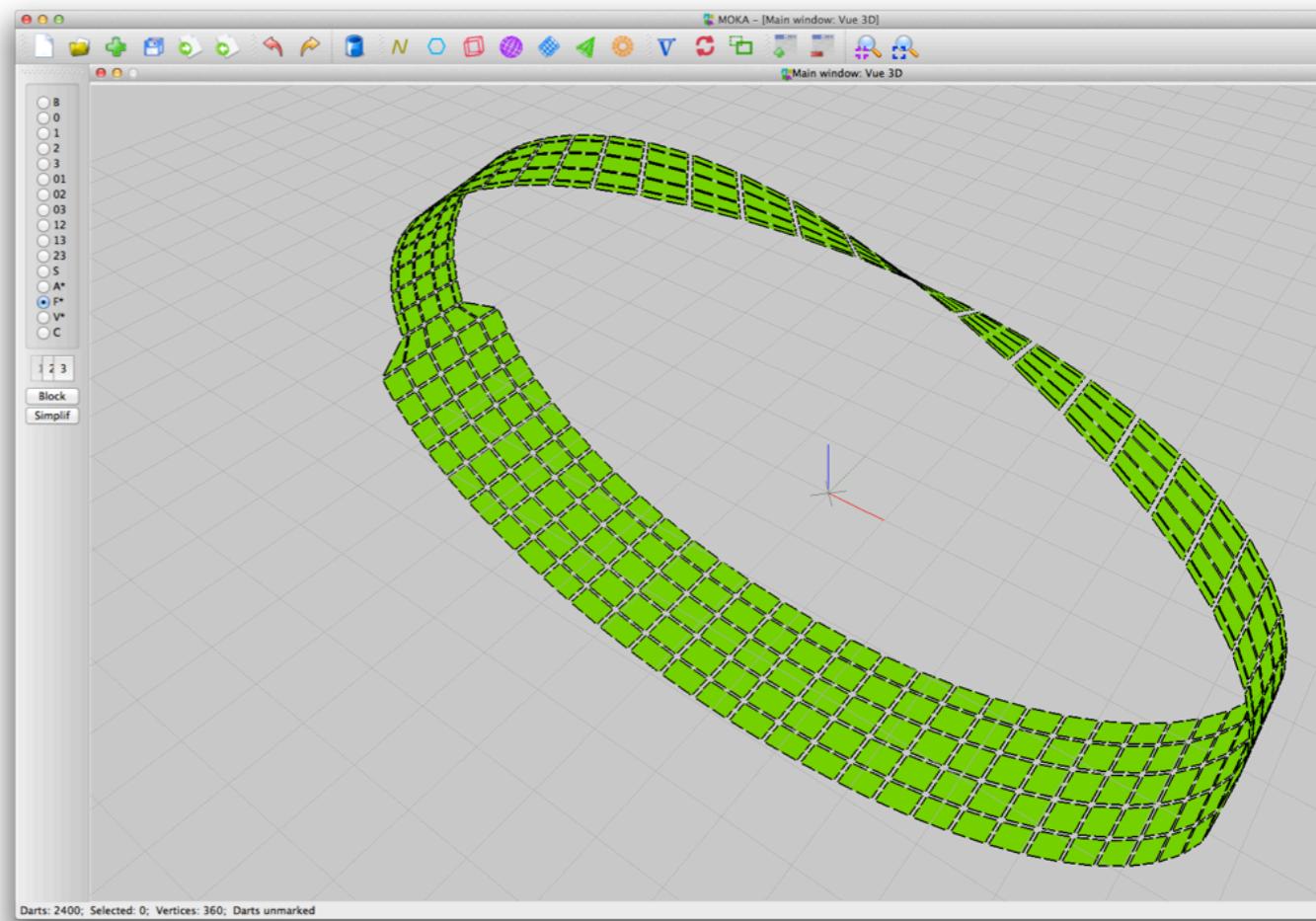
Functional

- Mathematically strong models that work on any data and can be extended



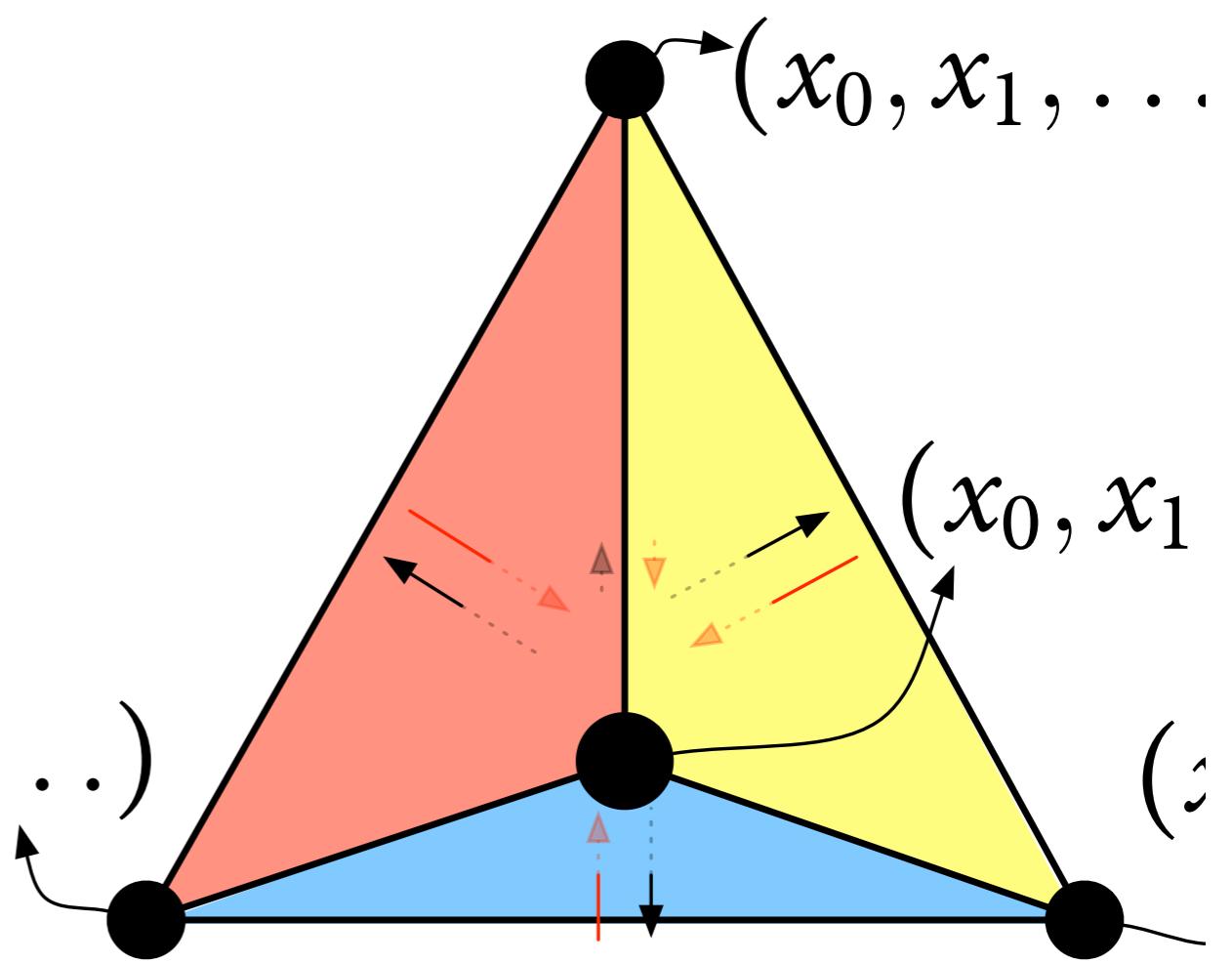
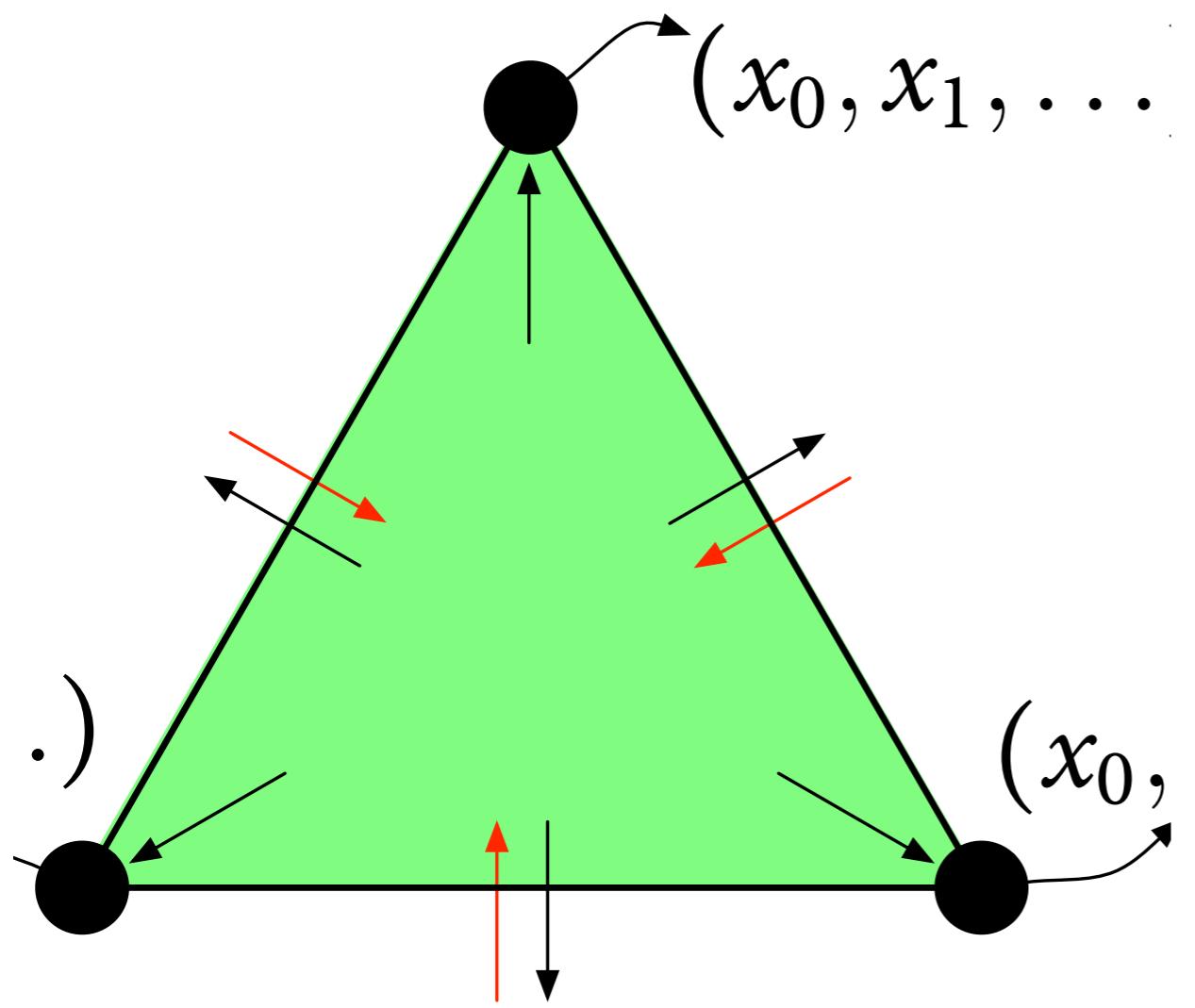
Technical

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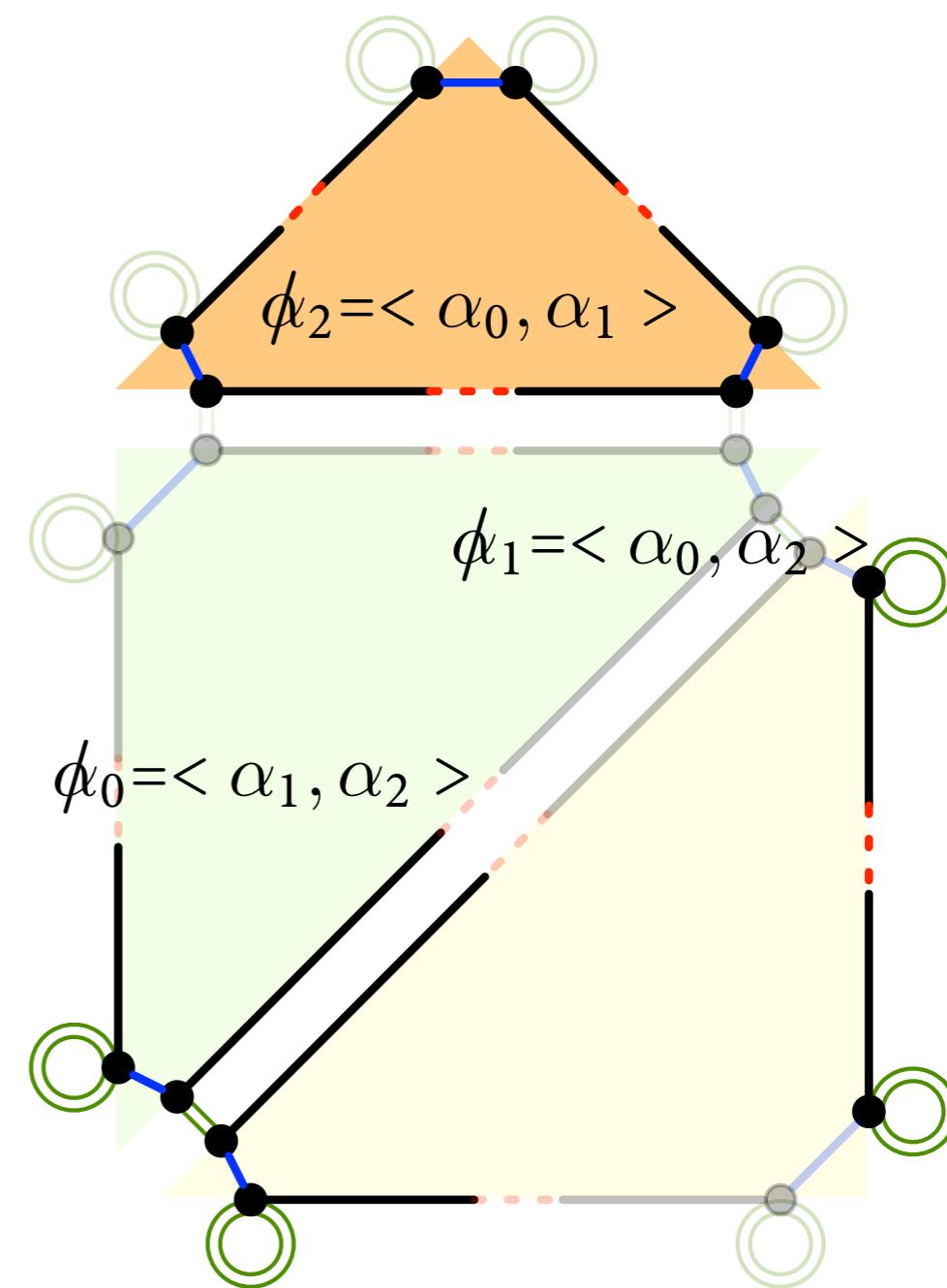
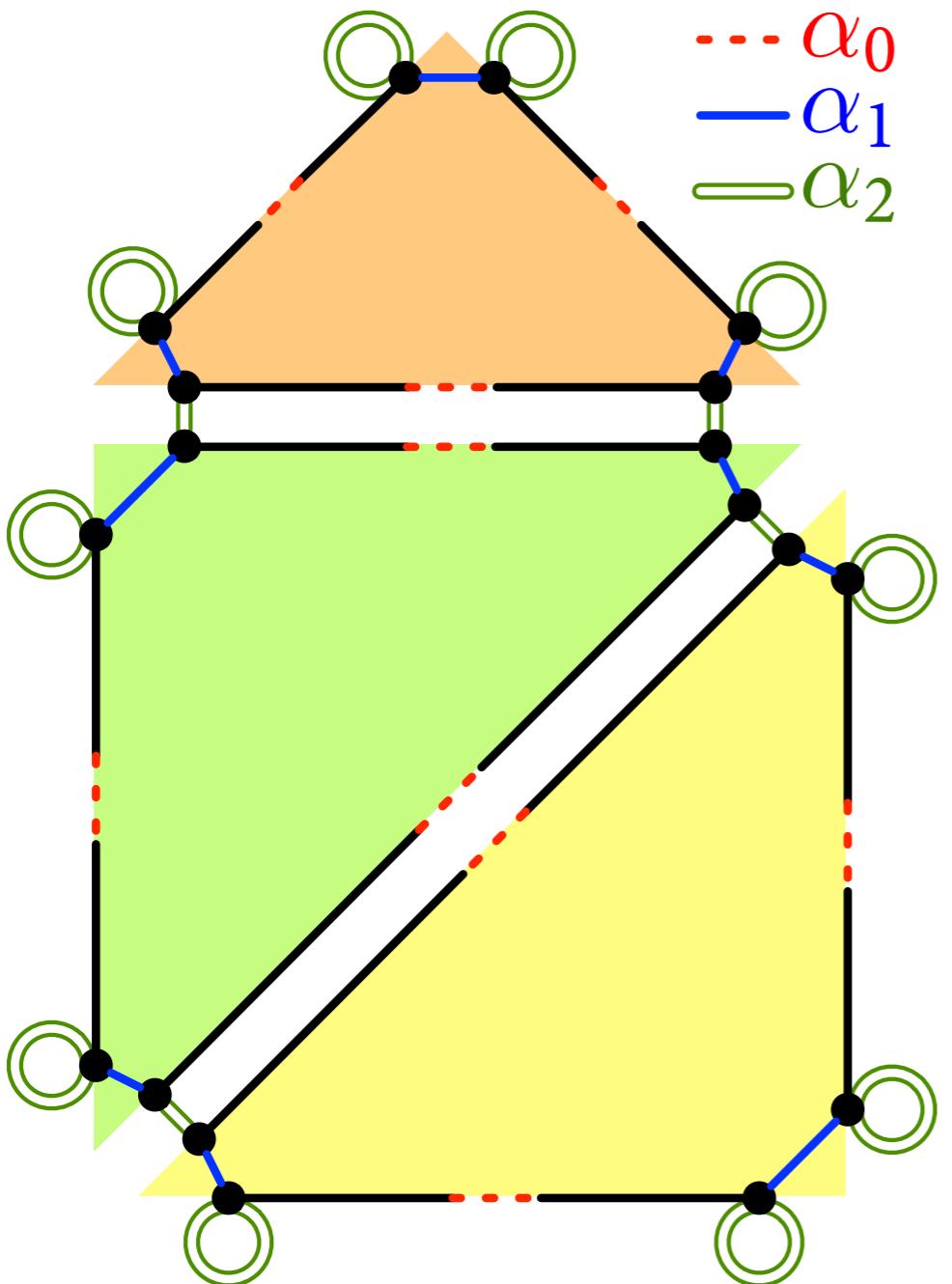
Possible higher dimensional models

- Simplicial complexes (triangulations)
- Boundary representation
- Constructive solid geometry
- Nef polyhedra



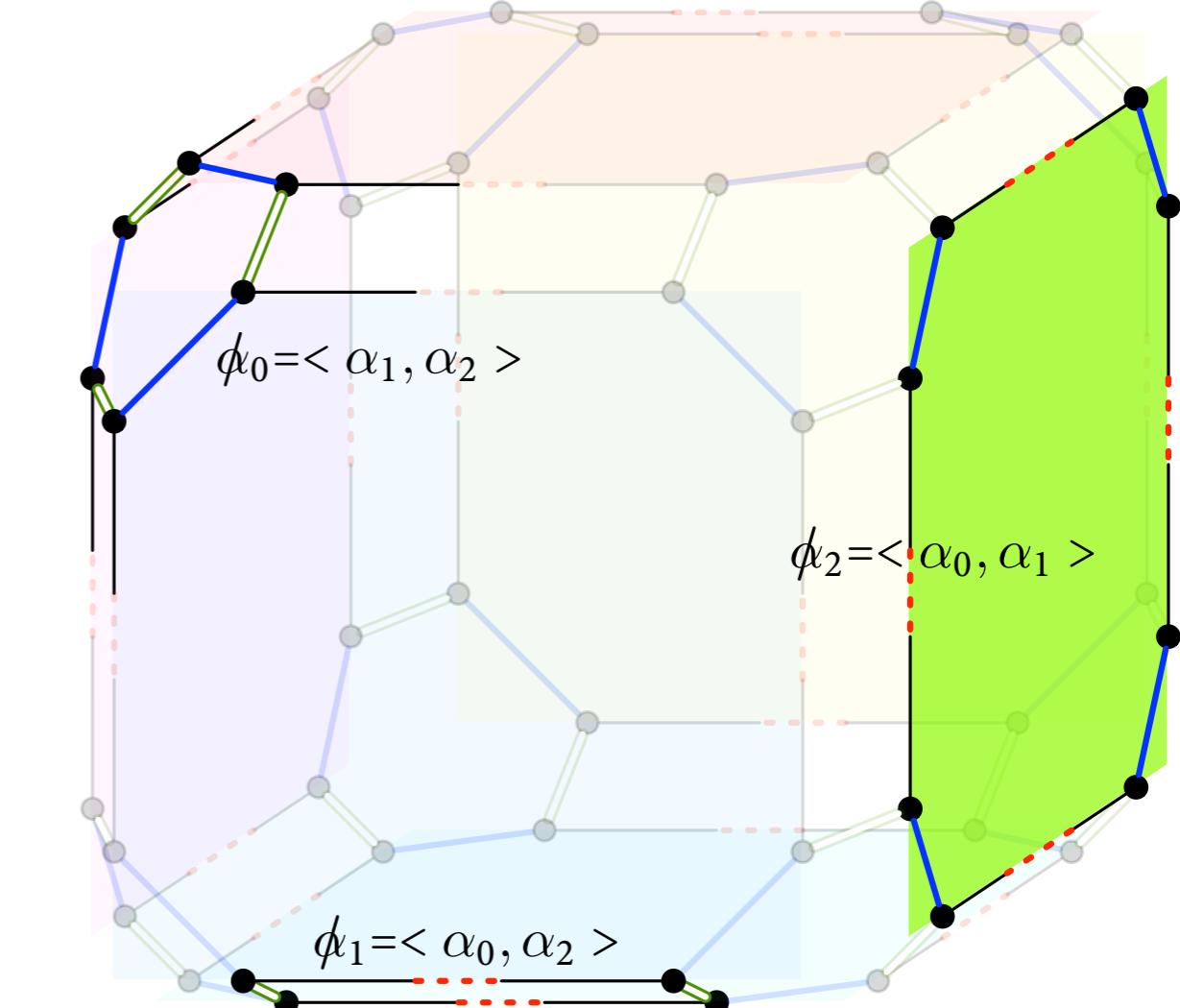
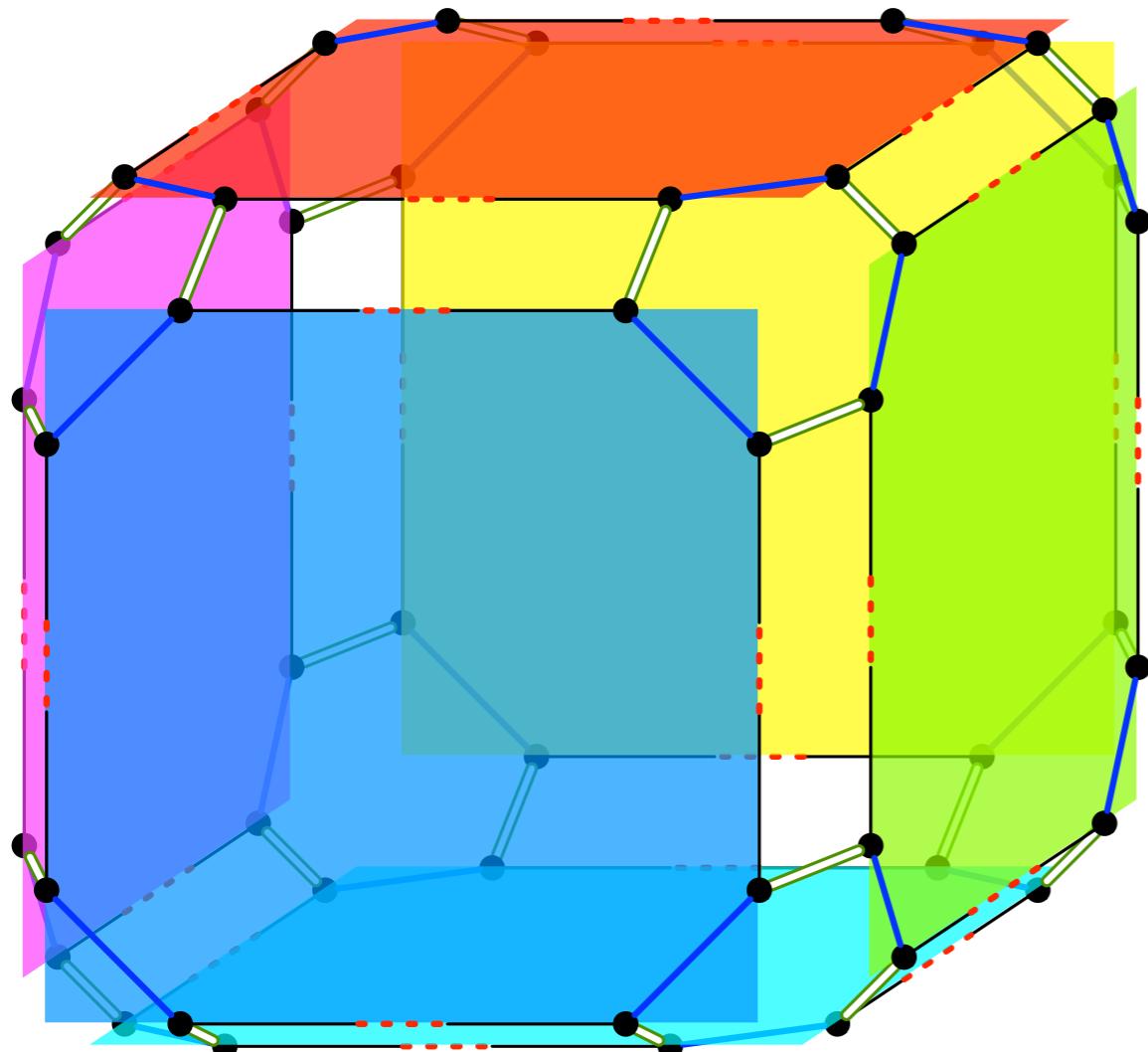
Simplicial complexes

2D & 3D



Generalised maps

2D

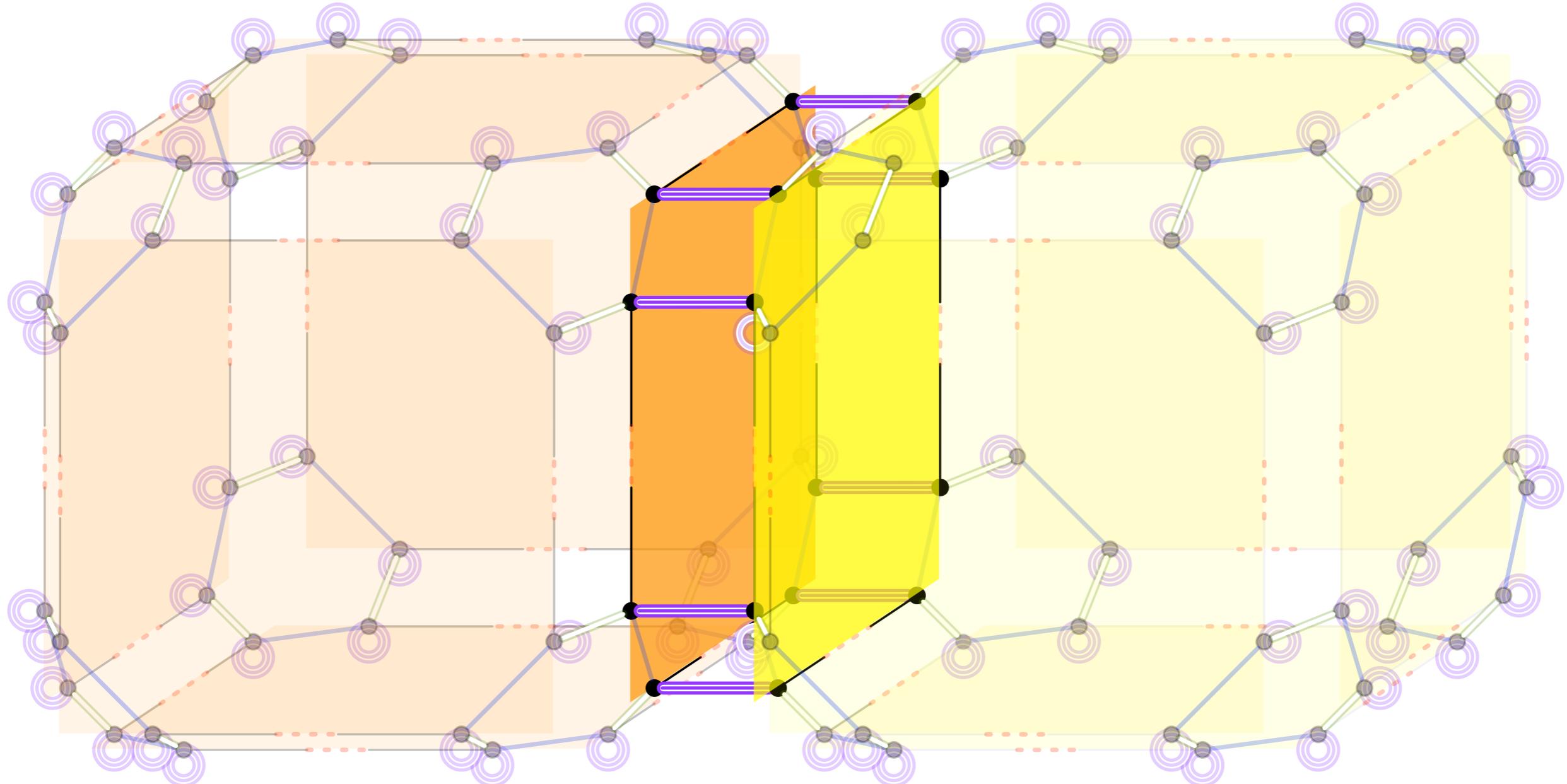


Generalised maps

3D

Generalised maps

3D



Possible higher dimensional models

- Simplicial complexes (triangulations)
- Boundary representation
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Generalised maps

- Data model
- Combinatorial (topological) structure
- How to store geometry?
- How to store attributes?

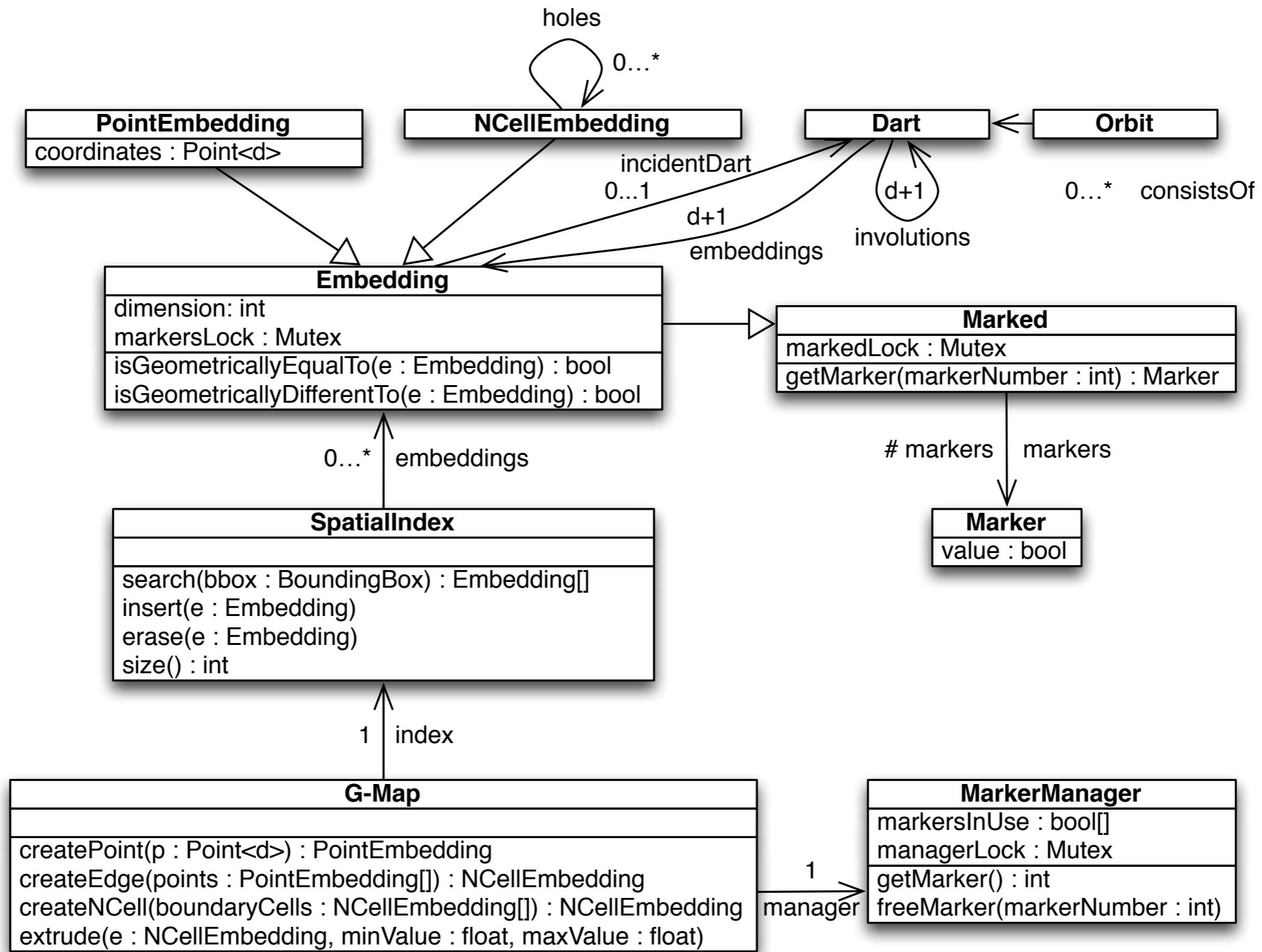
```
struct Dart {  
    Dart *involutions[n+1];  
};
```

```
struct Involution {  
    id dart1, dart2;  
};
```

Why GIS data is “special”

- Storing geometry, topology and computed values
- Complex handling of attributes: numeric, text, classes
- Construction from invalid or non topological data
- Queries: geometric, topological, attribute based, or a combination
- Holes, in possibly every dimension > 0
- Disconnected objects

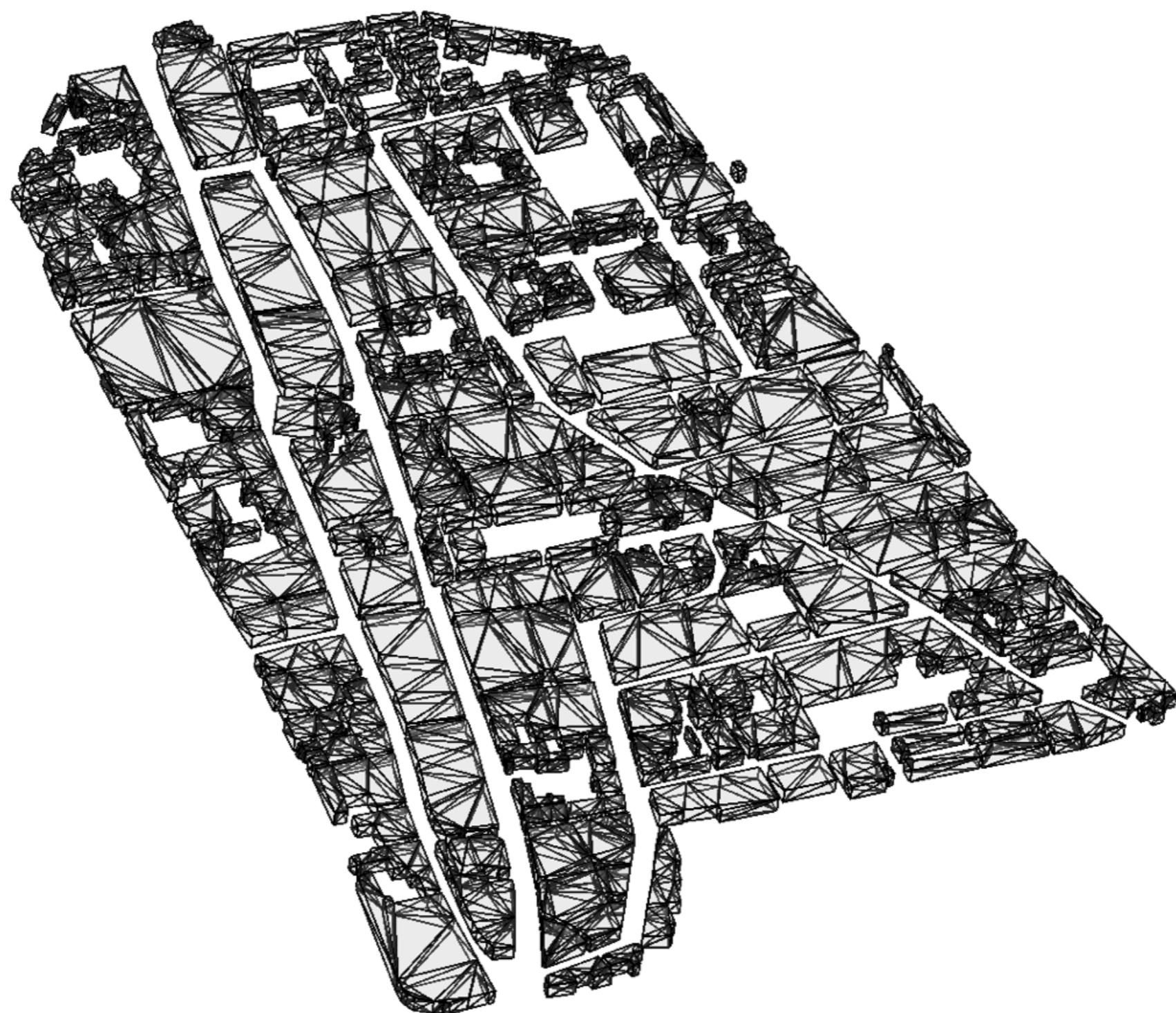
The resulting model





Other possibilities

Extruded data



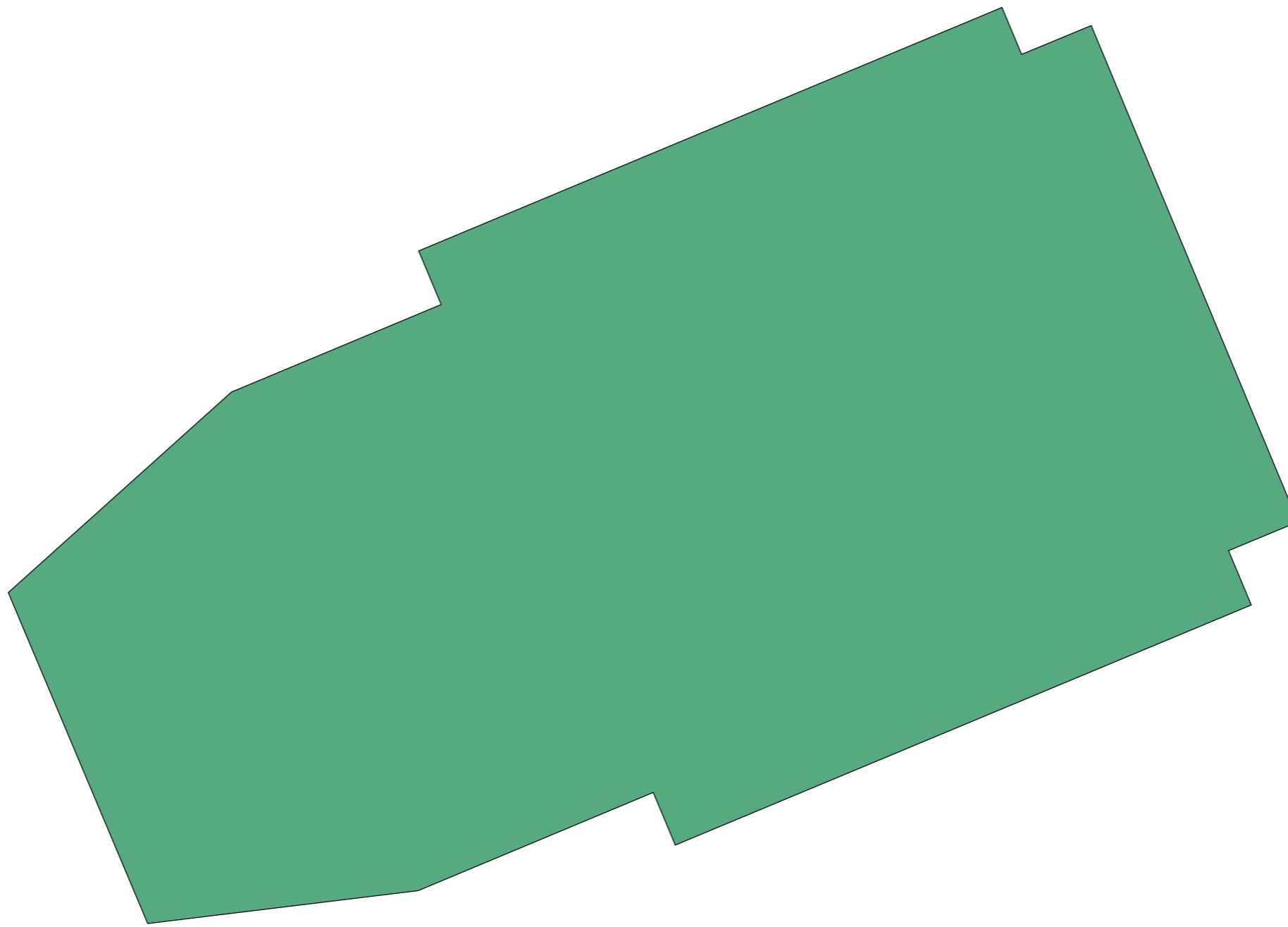
Other possibilities

Extruded data



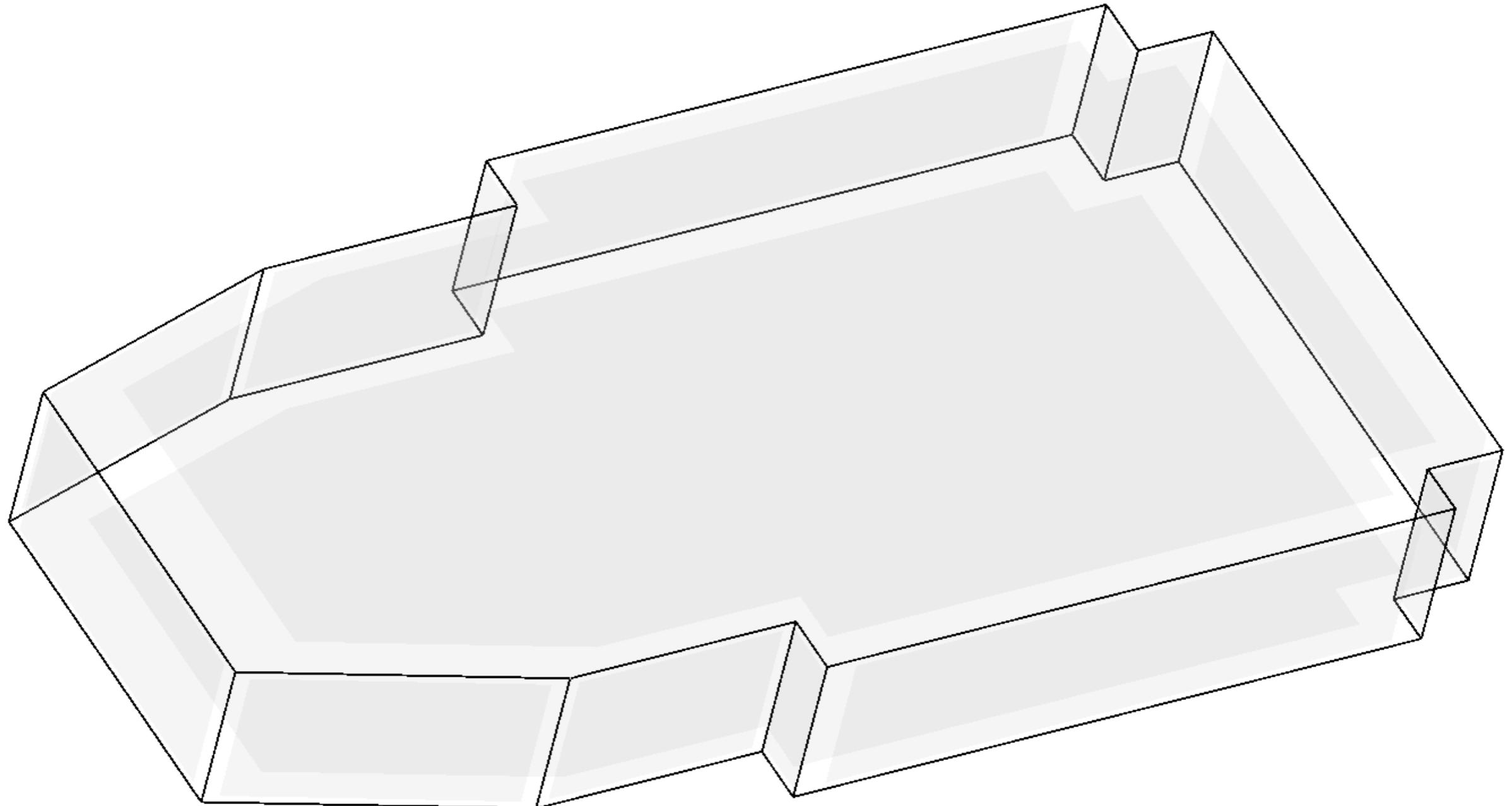
Other possibilities

Extruded data



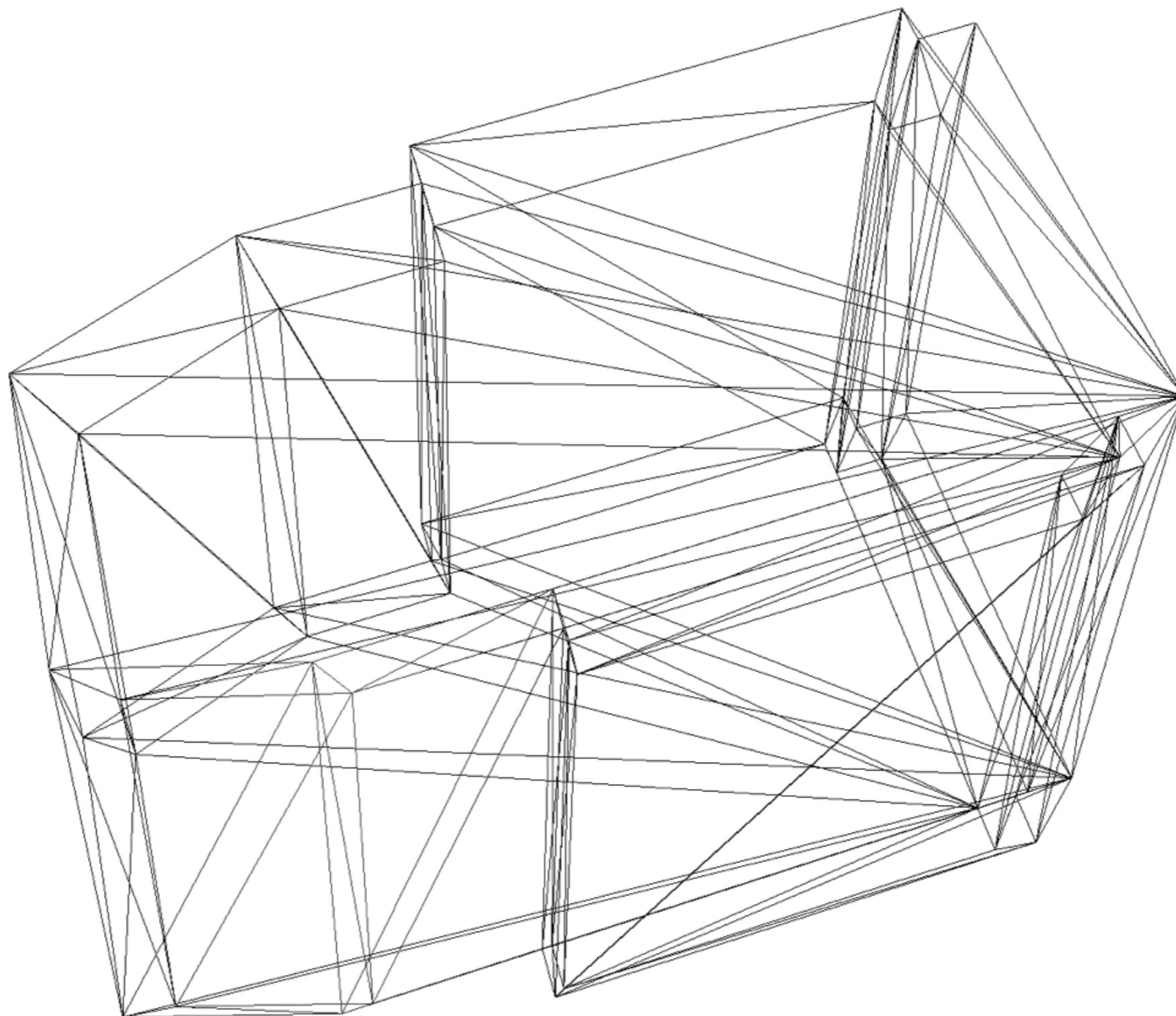
Other possibilities

Extruded data



Other possibilities

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Other possibilities

Extruded data

In short

- Study of higher mathematical models (generalised maps)
- How can these be adapted/implemented for GIS data
- Developing useful operations

Thank you.

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