An Applicative Approach for Spatial Relationships Determination of 3D Volumetric Parcels in 3D Cadastral Systems

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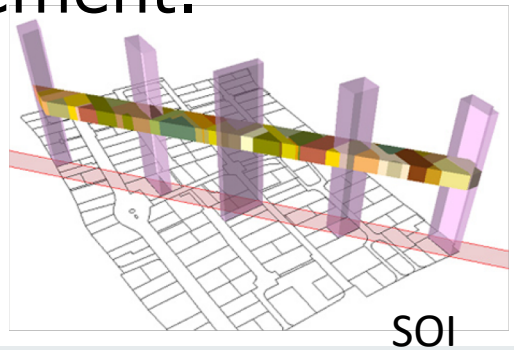
MAPPING & GEO INFORMATION ENGINEERING

Introduction

Transferring and adapting 2D land management systems to 3D ones

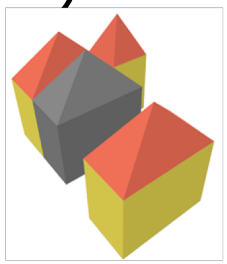
- Population growth, urbanization complexity, and industrialization.
- World's population living in urban areas is expected to increase, reaching 66% by 2050.
- Effective urban planning and management.



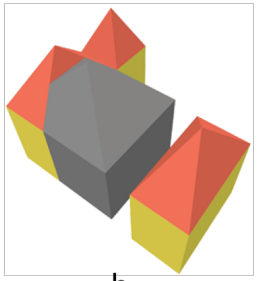
SOI

3D land management systems

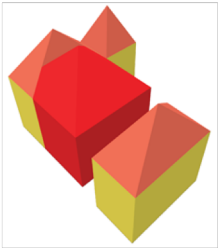
- Enabling search, selection and visualization of 3D volumetric parcels that fall inside a volumetric extent.
- Enforcing 3D geometric and cadastral constraints (e.g. minimal 3D volumetric parcel volume, minimal area of faces, parallelism or perpendicularity between faces of the 3D parcels, etc.).



a



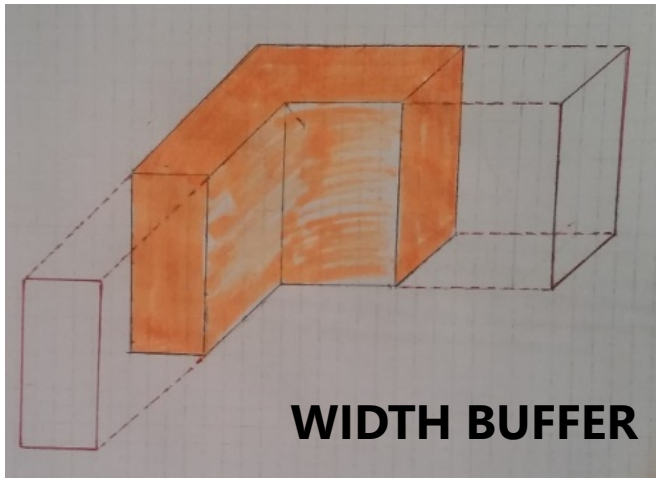
b

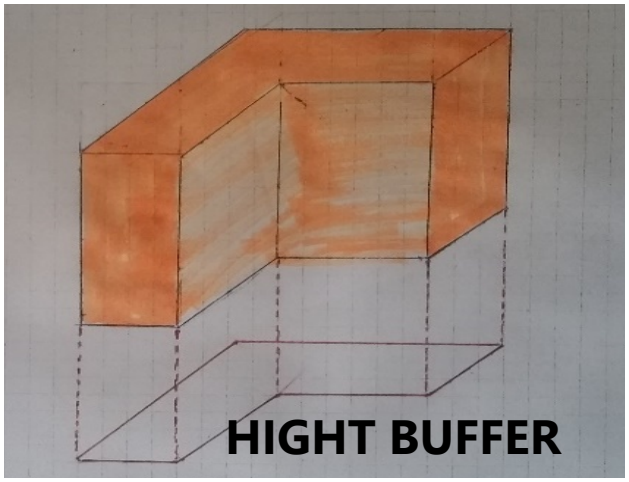


c

3D land management systems

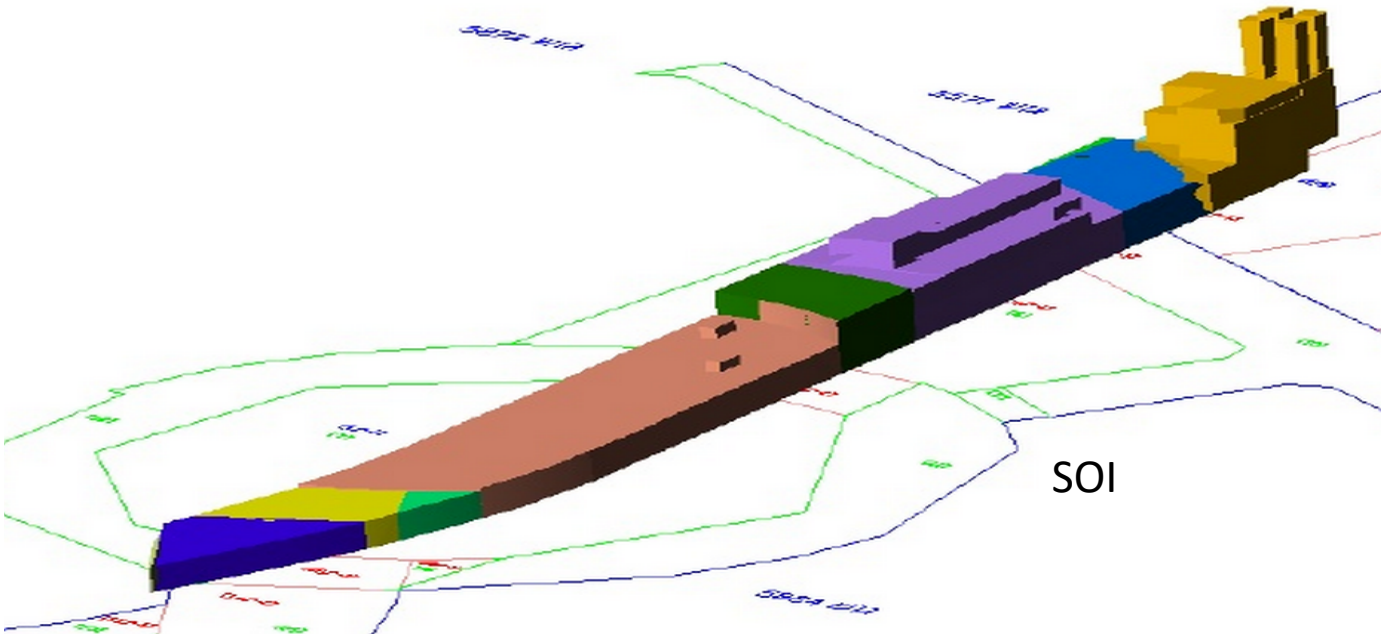
- Functionalities:



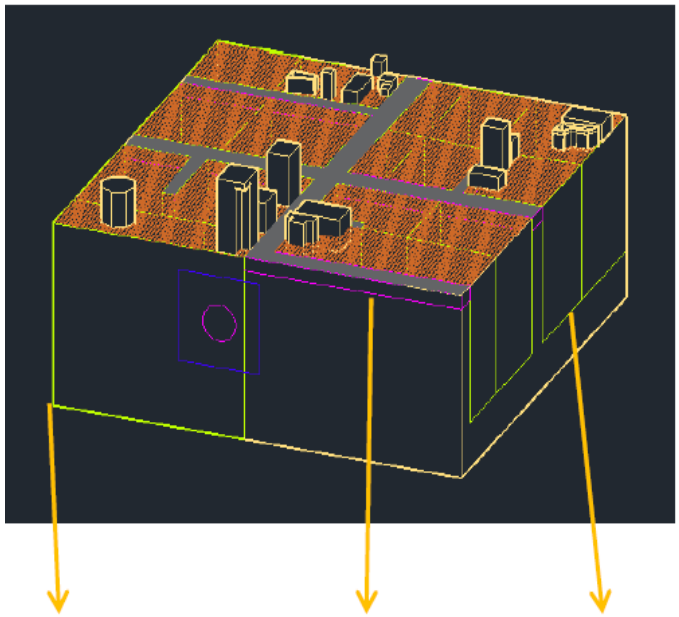


3D land management systems

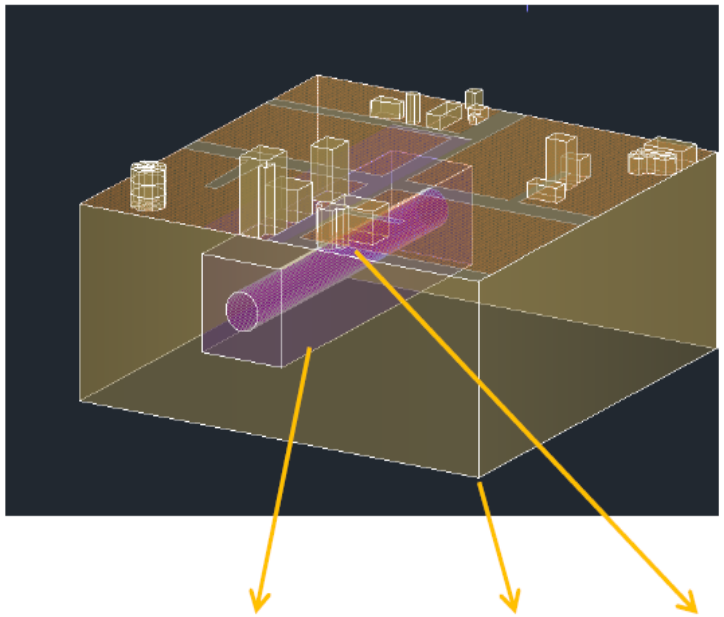
- Functionalities:



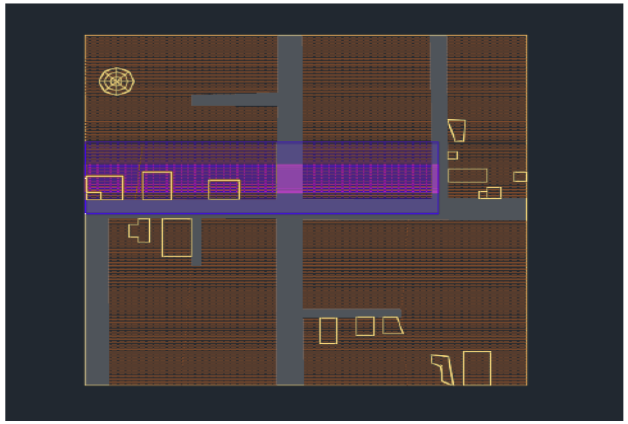
Research Problem

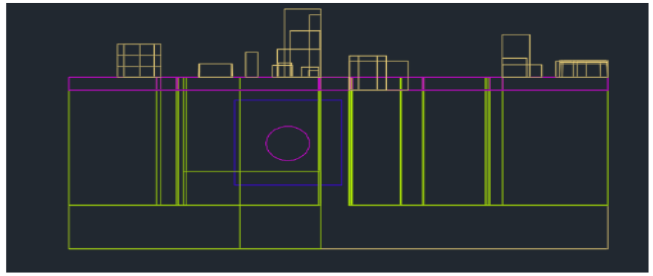


Depth Street and parcel depth



Safe distance Infrastructure Buildings



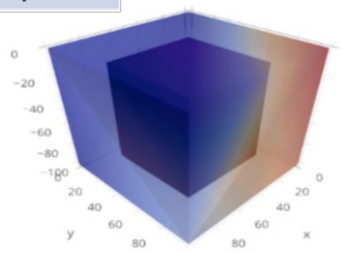


Suggested Solution

Algorithm

	Vertices of A in Relation to B			Vertices of B in Relation to A		
	vertices inside B	vertices outside B	vertices touch B	vertices inside A	vertices outside A	vertices touch A
A inside B	¬ø	ø	ø	ø	¬ø	ø
A contains B	ø	¬ø	ø	¬ø	ø	ø
A equal B	ø	ø	¬ø	ø	ø	¬ø
A covers B	ø	¬ø	¬ø/ø	¬ø/ø	ø	¬ø
A covered by B	¬ø/ø	ø	¬ø	ø	¬ø	¬ø/ø
A overlap B	¬ø/ø	¬ø	¬ø/ø	¬ø/ø	¬ø	¬ø/ø
A meet B	ø	¬ø	¬ø/ø	ø	¬ø	¬ø/ø
A disjoint B	ø	¬ø	ø	ø	¬ø	ø

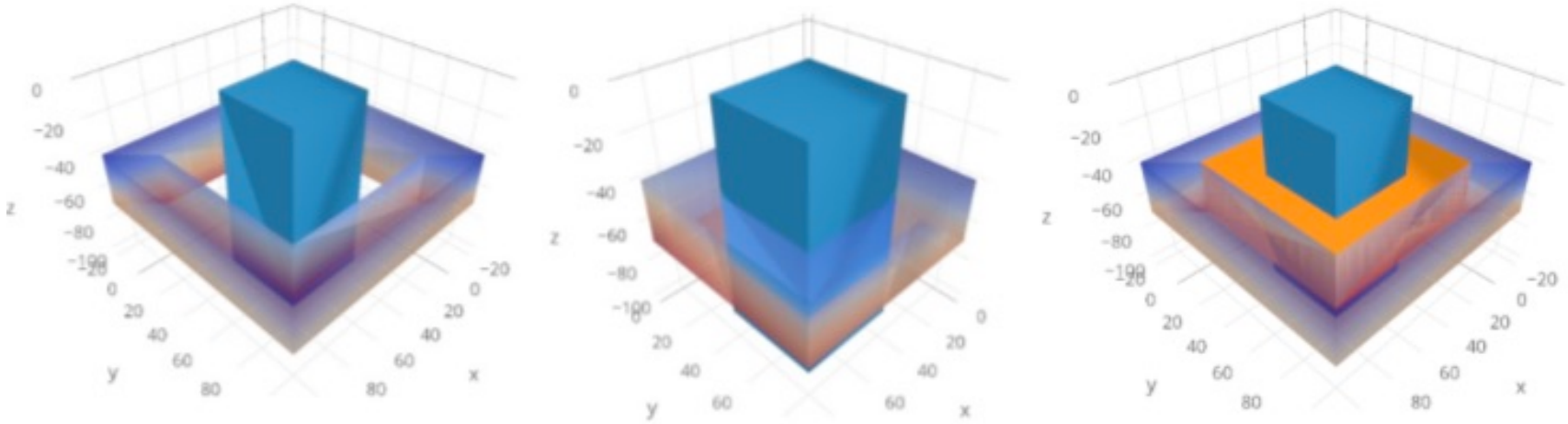
ø	Empty
ø¬	Not Empty
ø/ø¬	Empty/ Not empty



Suggested Solution - Special Cases

Hollowed parcel

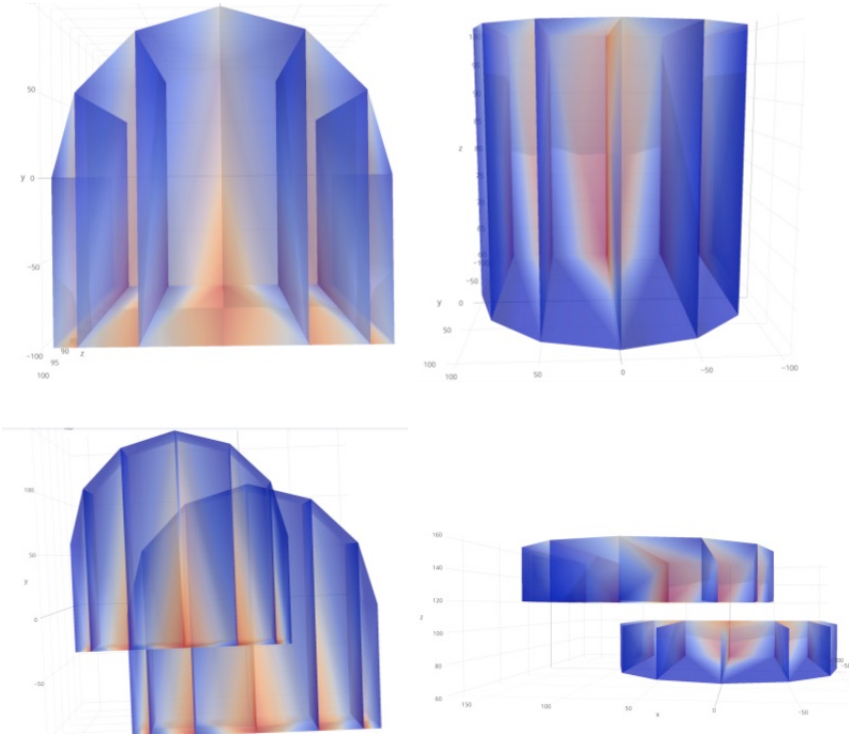
- Binary operations



Suggested Solution - Special Cases

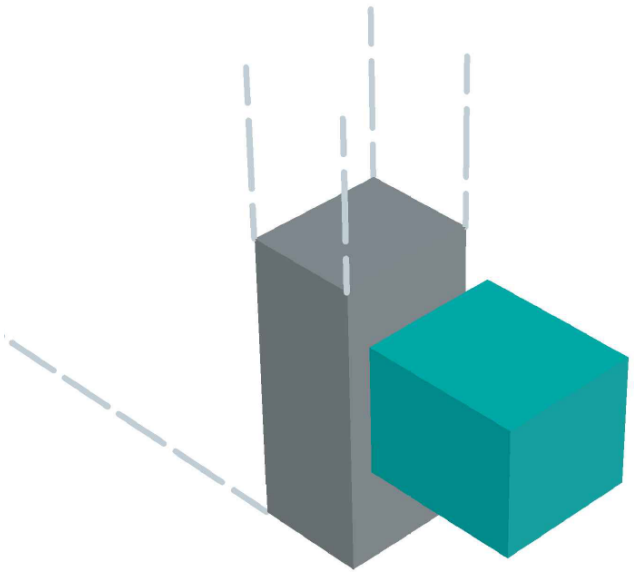
Non parallel facades

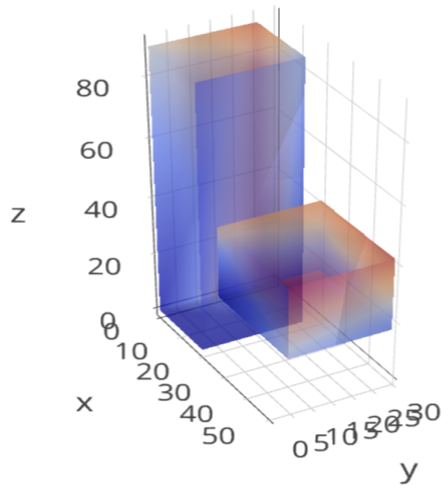
- Mathematical approximation



Unbounded parcel

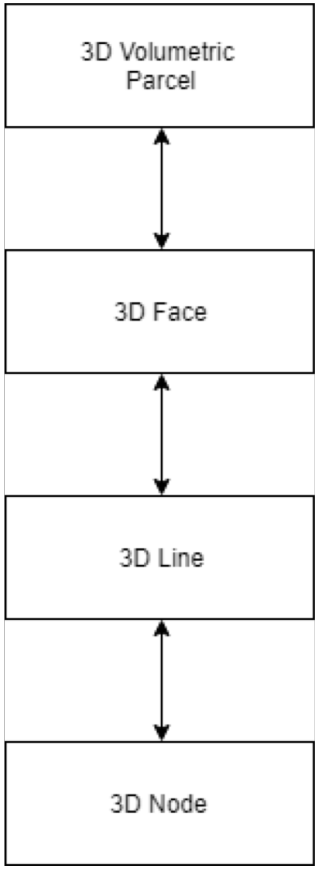
- Artificial roof/floor creation

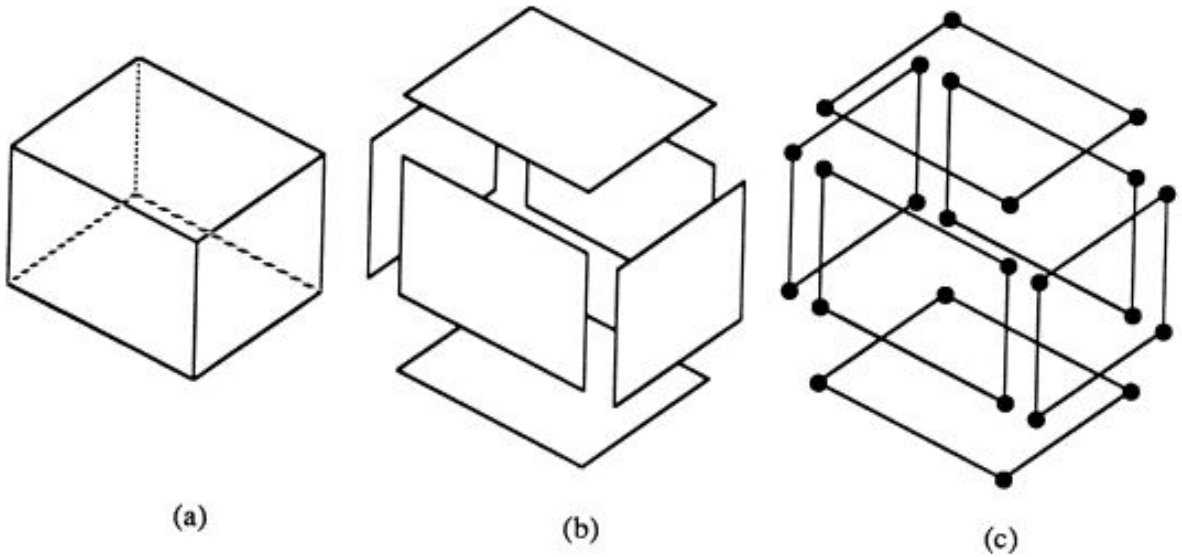




Research Problem

Data hierarchy

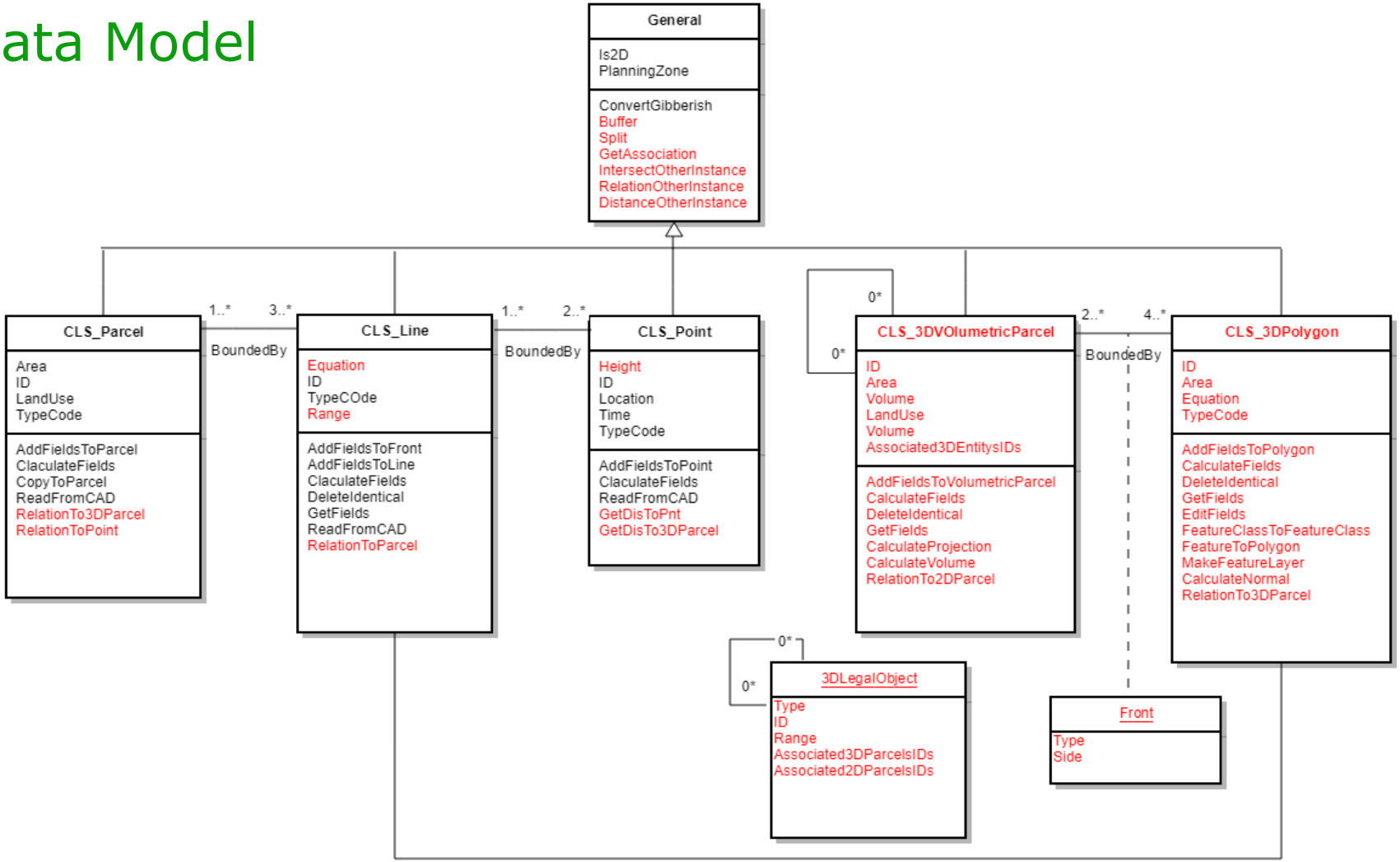




IEEM 575 | boundary representation in computer graphics

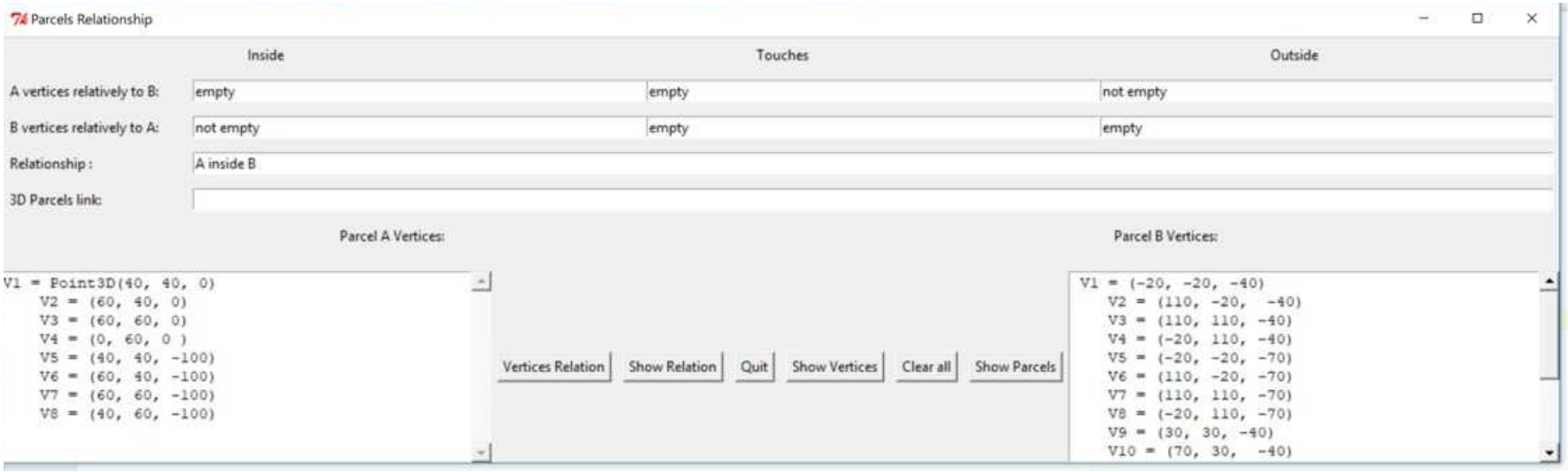
Suggested Solution

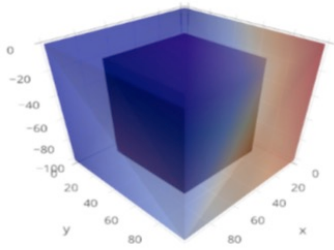
Data Model



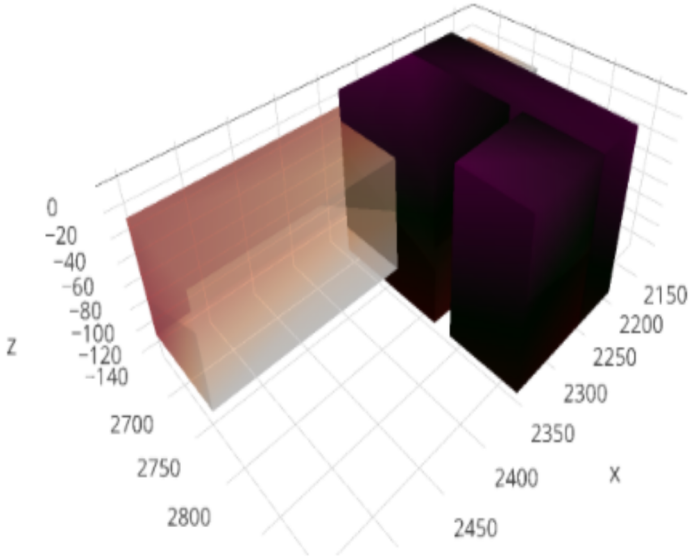
Implementation

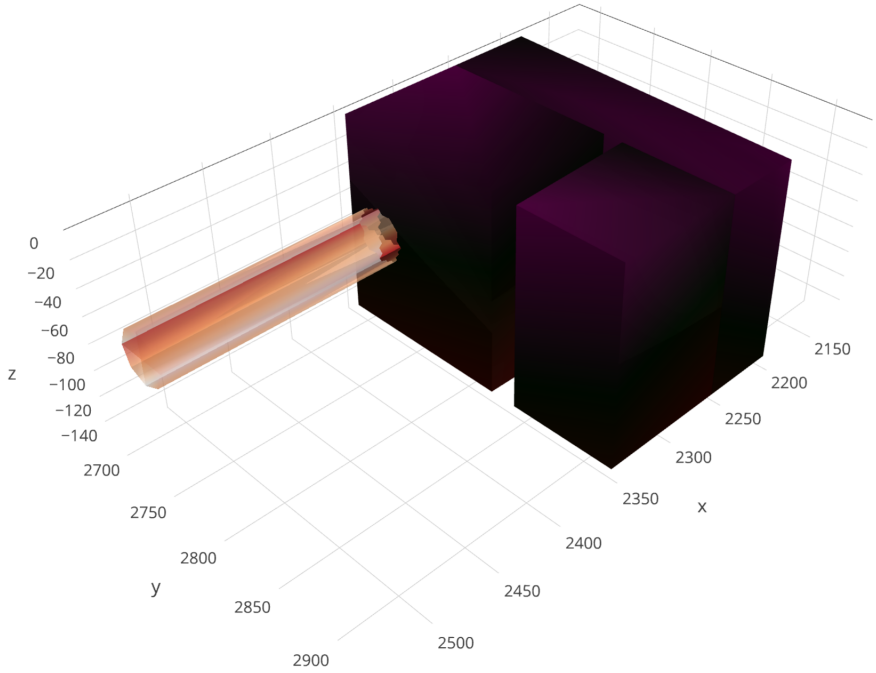
GUI



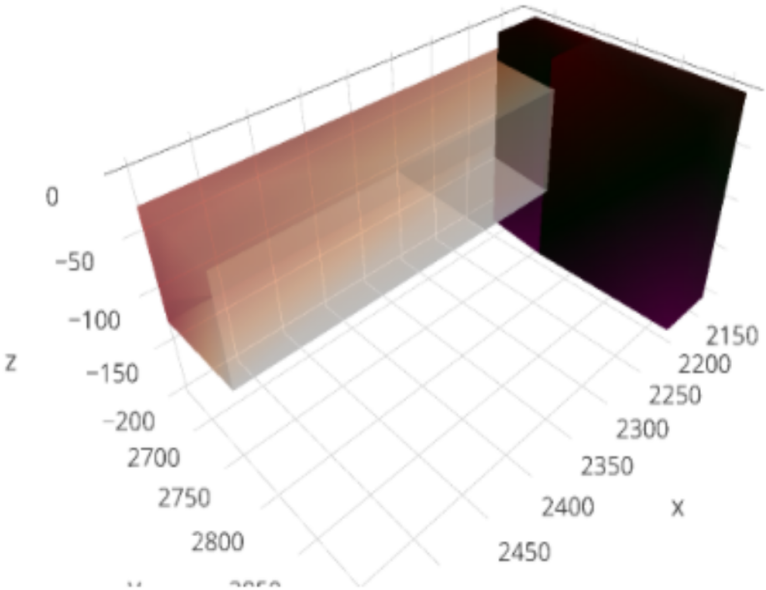


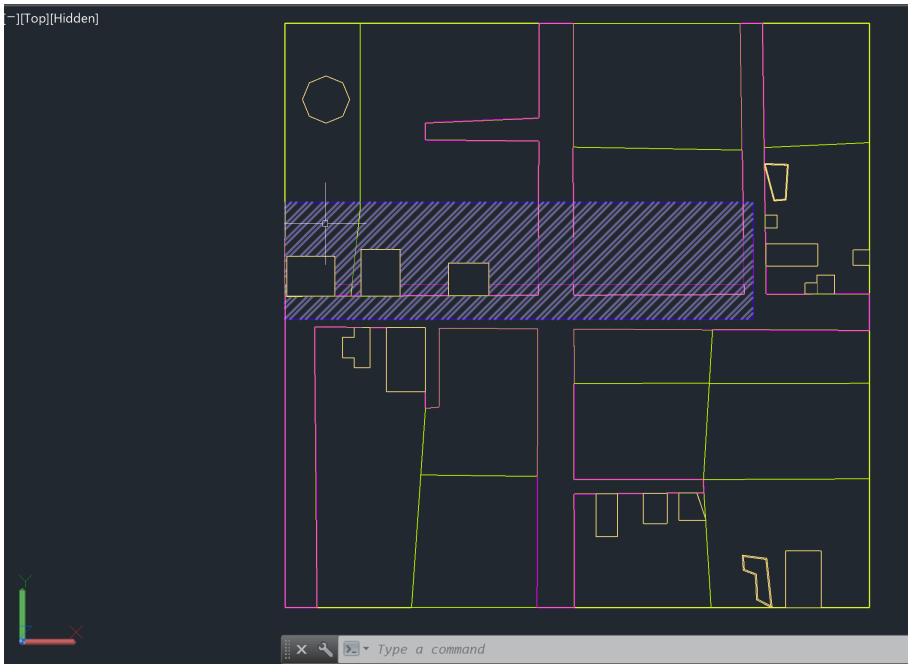
Approximation vs. Safe distance





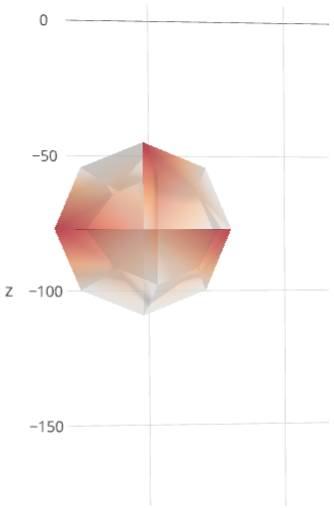
Stage1 - Safe Distance

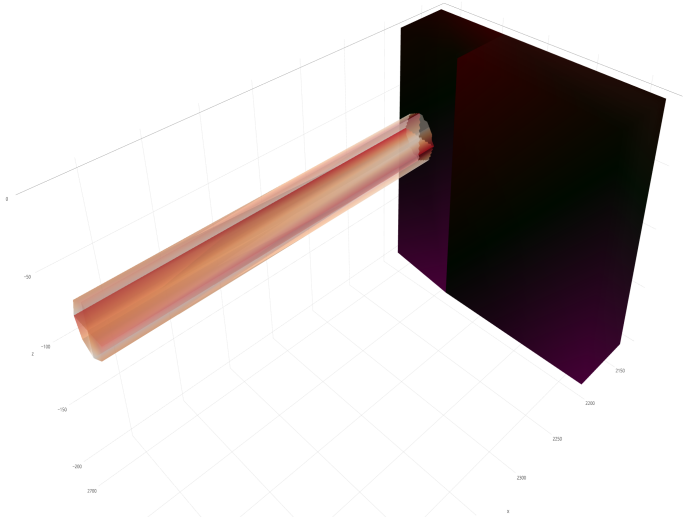




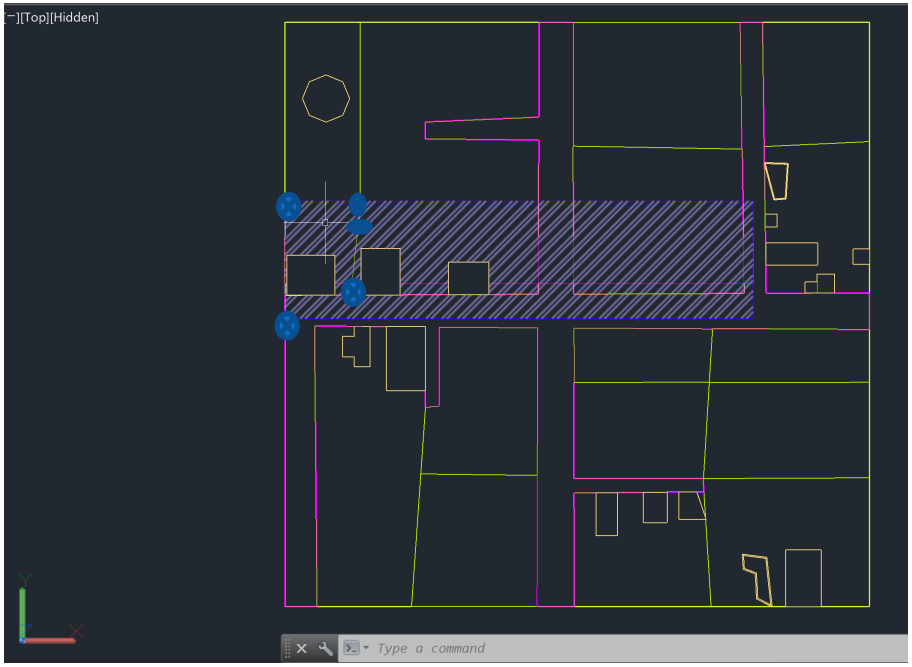
Stage2 - Approximation

```
xCentre2=2130.246
xCentre1=2530.246
yCentre=2716.168
zCentre=-77.445
radius=20

P1 = Point3D(xCentre1, yCentre+radius*math.cos(math.radians(0)), zCentre+radius*math.sin(math.radians(0)), "1")
P2 = Point3D(xCentre1, yCentre+radius*math.cos(math.radians(45)),  zCentre+radius*math.sin(math.radians(45)), "2")

P11 = Point3D(xCentre2, yCentre+radius*math.cos(math.radians(0)), zCentre+radius*math.sin(math.radians(0)), "11")
P12 = Point3D(xCentre2, yCentre+radius*math.cos(math.radians(45)),  zCentre+radius*math.sin(math.radians(45)), "12")
```





Intersection points



	X	Y	Z
1	2130.246	2685.834	-26.438
2	2130.246	2685.834	-126.438
3	2130.246	2766.168	-26.438
4	2130.246	2766.168	-126.438
5	2186.579	2686.071	-26.438
6	2186.579	2686.071	-126.438
7	2194.947	2760.822	-26.438
8	2194.947	2760.822	-126.438
9	2194.947	2766.168	-26.438
10	2194.947	2766.168	-126.438

Conclusion

- Accurate and reliable
- Automatic process
- Tailored data structure
- Practical cadastral analysis
- Suggested solutions for more special cases.
- Cadastral process based on separated operations

Thank You!

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