



Visibility Analysis in a 3D Cadastre

Gerhard Navratil, Paolo Fogliaroni

Vienna University of Technology,
Austria

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Outline

- Introduction
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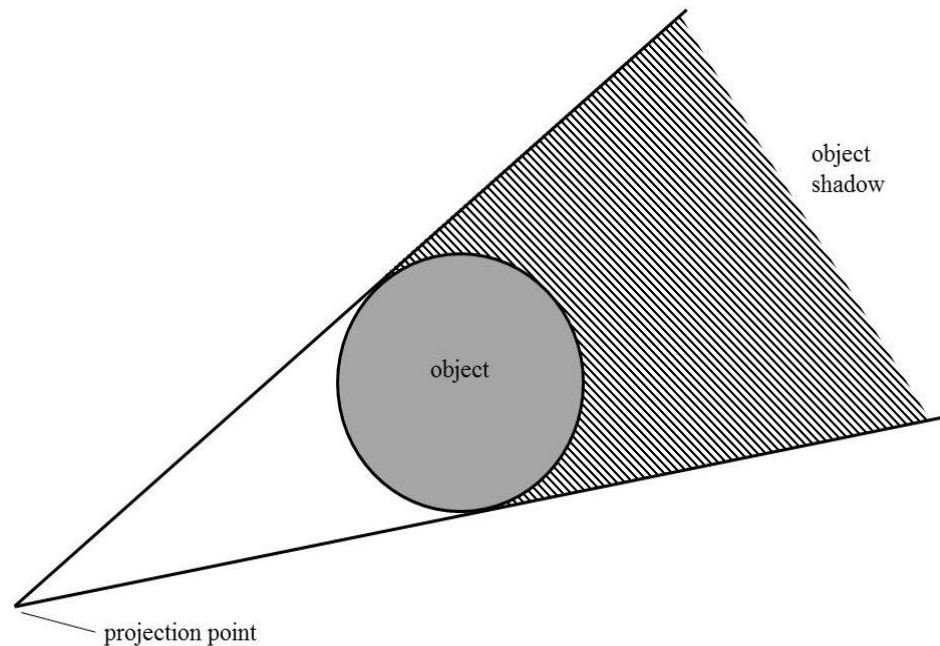
Introduction

- Cadastre basis for different aspects of public administration, e.g.,
 - Spatial Planning
 - Land Tax(es)
- Improvement by 3D cadastre if visibility is essential

What is possible? How could it be used?

Visibility Analysis: 2D (1)

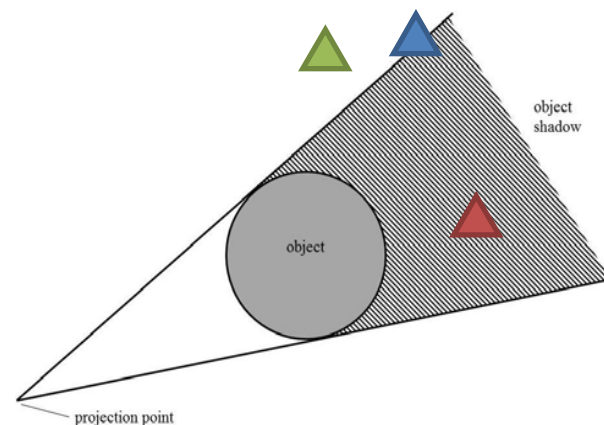
- Objects represented by footprints
- Objects block a sector defined by the tangents to the object



Visibility Analysis: 2D (2)

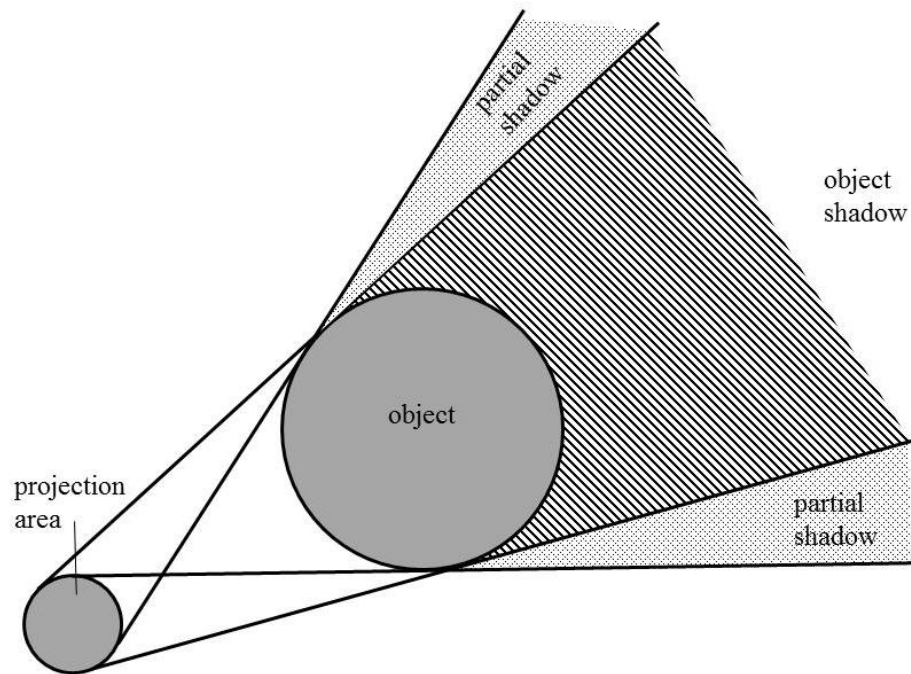
Topological relations

- Objects contained by the shadow: Invisible
- Objects intersecting the shadow: partially visible
- Objects disjoint from the shadow: visible



Visibility Analysis: 2D (3)

What about shadows with respect to projection area?



Visibility Analysis: 2+1D

- Examples are computer games: Early first person shooters
- 3D rendering of visible objects: Visibility analysis on 2D projections, then height added
- GIS application: View shed analysis
 - Based on terrain model
 - Result depends on the algorithm and its implementation (Fisher, 1993)
- Implemented in current GIS software: Determination of building shadows (Yang et al., 2007)

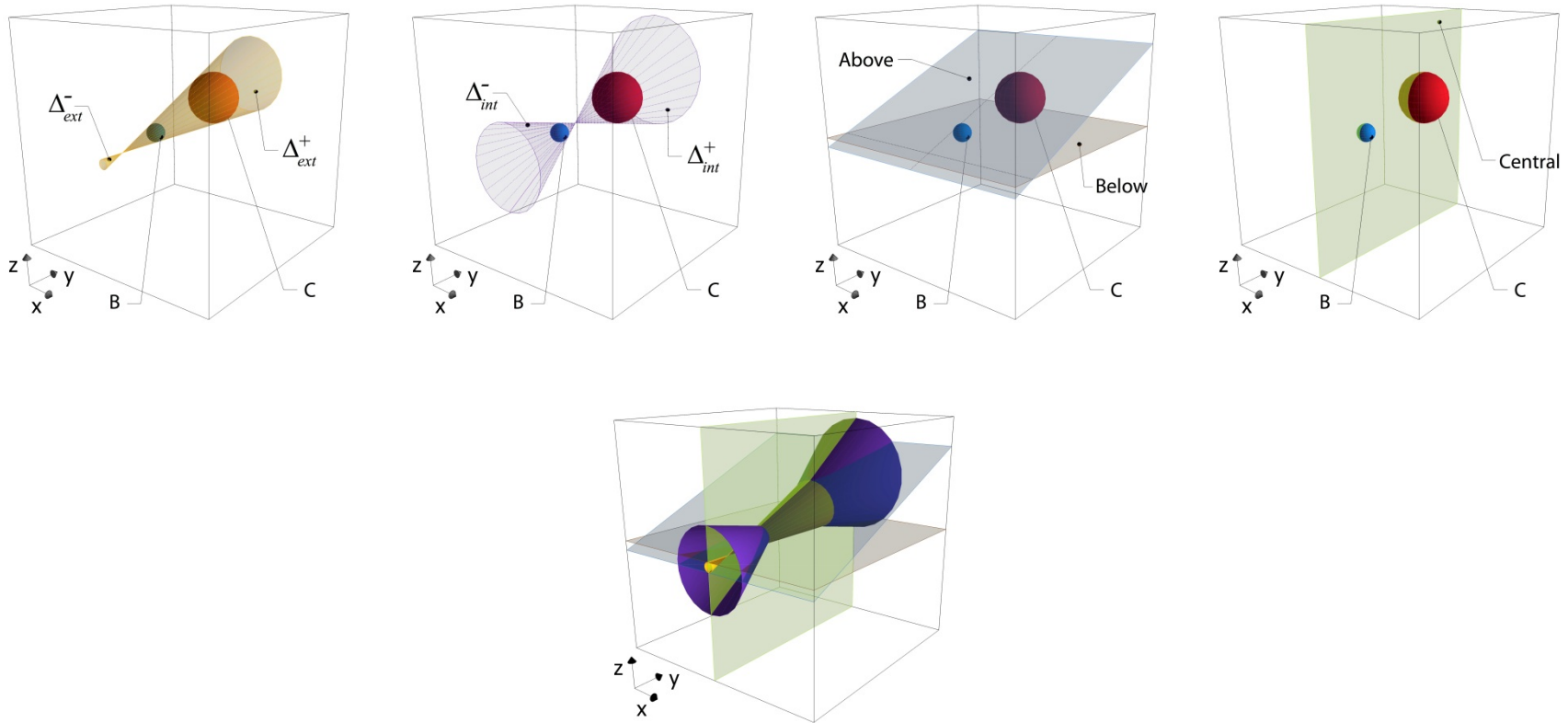
Visibility Analysis: 3D

- Correct solution for a single projection centre:
Ray tracing – computationally intensive
- CAD systems: More efficient but less accurate algorithms
 - Useful for 3D cadastres implemented in a CAD environment
 - 3D objects necessary, e.g., CityGML
 - Other approach: 3D Voronoi Diagrams (Gold, Tse & Ledoux, 2006) – not implemented in CAD systems

Qualitative Visibility Analysis (1)

- Qualitative model for visibility relations among three solids in space (Fogliaroni & Clementini, 2014)
- Spatial predicates of the form $R_{vis}(A, B, C)$ capturing the semantics of the visibility relation between an observer (B) and an observed object (A) when a third, opaque, object (C) acts as an obstacle.
- Extension of previously developed qualitative calculi (Billen & Clementini, 2006; Fogliaroni et al., 2009)

Qualitative Visibility Analysis (2)



Qualitative Visibility Analysis (3)

Properties of the solution

- low computational effort
- works in full 3D
- can even be used for flying objects

Data for Visibility Analysis in a 3D Cadastre (1)

- 2D cadastre: Parcels form a partition
- 3D cadastre: parcels should form a partition but
 - different representations
 - unbounded space (height restriction)
- Public law restrictions on constructions
- 3D city models: Complete (?) inventory of buildings as real objects
- Terrain model

Data for Visibility Analysis in a 3D Cadastre (2)

Problems

- Different height systems? (compare Navratil & Unger 2013)
- Model by Fogliaroni & Clementini can cope with different types of geometry but curvature of the earth ignored

Sample Applications: Property Value (1)

Value of a property depends on

- Location
- Quality
- Size
- Possible use (public law restrictions)
- ...

But also the view from the property

Sample Applications: Property Value (2)

Which apartment will have a higher value?



(Picture by Gerhard Navratil)



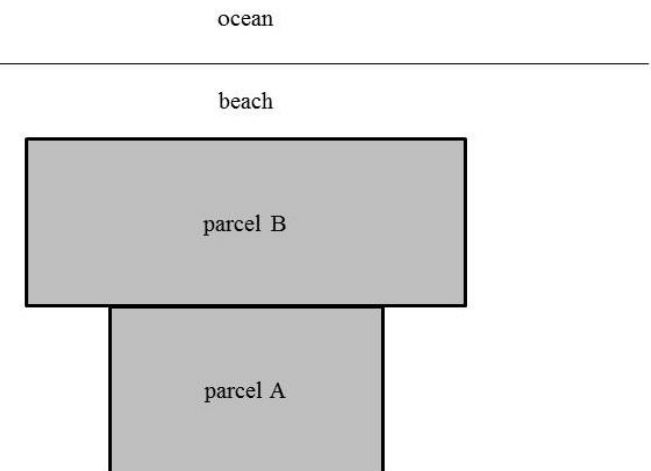
(Picture by Roland Navratil)

Sample Applications: Property Value (3)

3D visibility analysis can determine

- Sun exposure (3D city model)
- Current objects visible from planned apartment (3D cadastre + 3D city model)

Combination with building regulations allows including future developments



Sample Applications: Spatial Planning

- Land administrators can be supported in decision making about land use
- Visibility is important in spatial planning (e.g., wind power plants)
- Protection of UNESCO World Heritage – change in visibility

Conclusions

- Applications of computational method for 3D cadastres
- Applications need data from other sources as well: 3D city models, public law restrictions, ...
→ Methods to combine 3D cadastre with other models are essential
- Algorithm needs further improvement
 - Uncertain outline (rooftop gardens)
 - Curvature of the earth