3D indoor models for the fire department

SIMs3D

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Smart 3D indoor models to support crisis management in large public buildings (SIMs3D)

- Management of large public buildings in emergency cases requires:
- up-to-date 3D indoor models
- detailed geometric and semantic information
- automatic approaches for navigation

- Intelligent models of 3D indoor environments is largely missing

- Use (preparedness and response)
- train the emergency response officers (BHV)
- plan optimized evacuation routes
- quickly built rough 3D models
- provide context-aware navigation.

www.sims3D.net

TU Delft
Delft University of Technology
UNIVERSITY OF TWENTE.
cyclomedia
Smart Imagery Solutions
CGI
crotec
OGC
Open Geospatial Consortium, Inc.
Leap 3D SOLUTIONS
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BRANDWEER Rotterdam-Rijnmond
Veiligheidsregio HOLLANDS MIDDEN
Samen sterk voor meer veiligheid!
veiligheidsregio limburg-noord
veiligheidsregio Noord- en Oost-Gelderland
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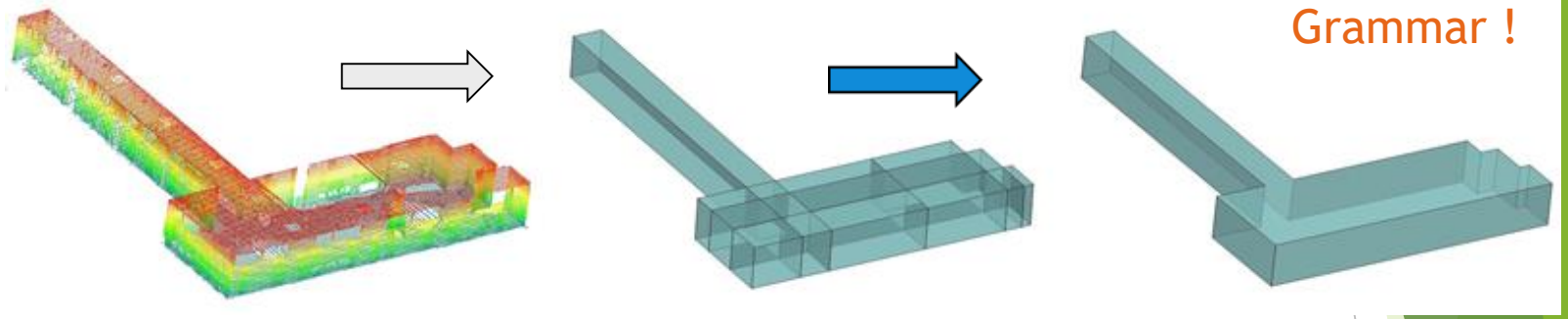
maps4society

Goal: reconstruct & subdivide



Grammar !

- point cloud
- cuboid shapes
- final model

- 3D model
- space subdivision
- network

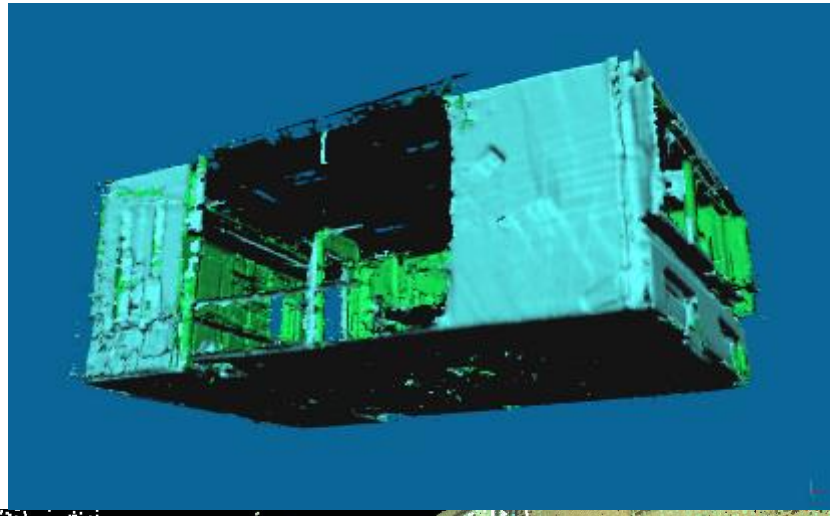
IndoorGML concept!

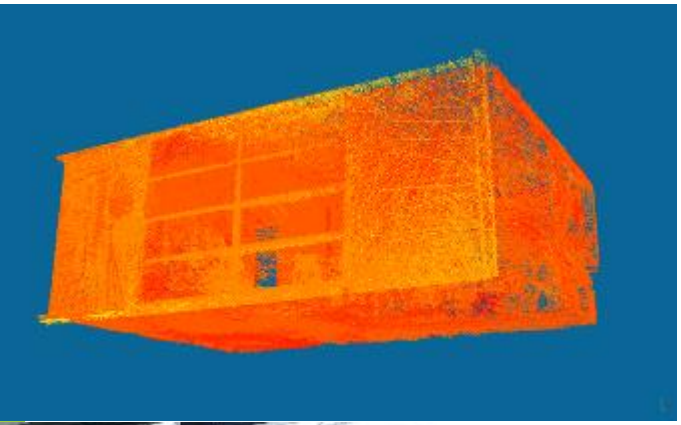
Developments

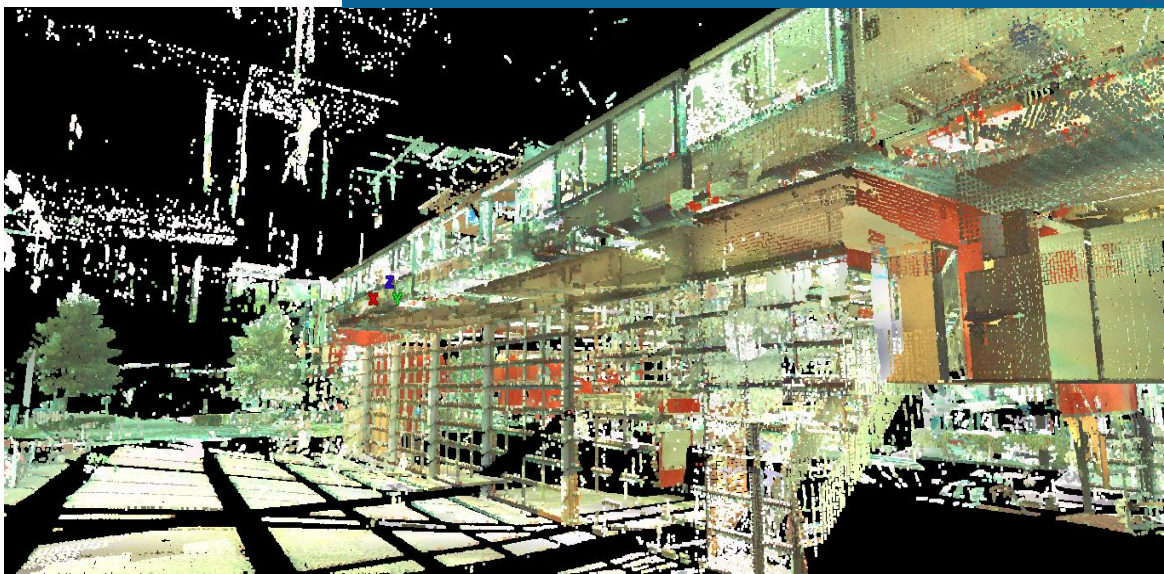
- User investigations: what kind of 3D models are needed
- 3D reconstruction
  - Point clouds
- ‘Empty space’ construction
  - From point clouds
  - From vector model (BIM, CityGML, considering all details)
- Empty space subdivision
  - Voxelisation (master thesis)
  - Octree (master thesis)
  - …

3D reconstruction
Scanning two buildings

- Fire brigade station
- ZEB1, Google Tango, Leica

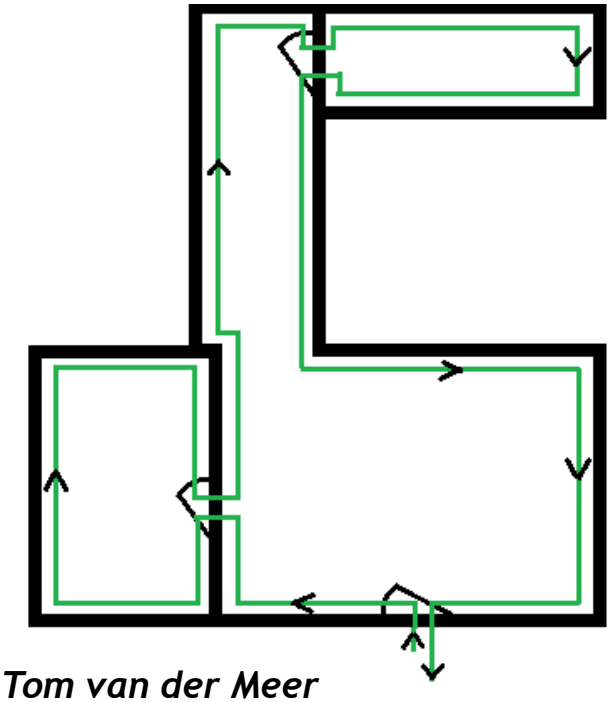






User requirements

- Current maps
- Exploration of a building
- Objects (moveable and static)



Tom van der Meer

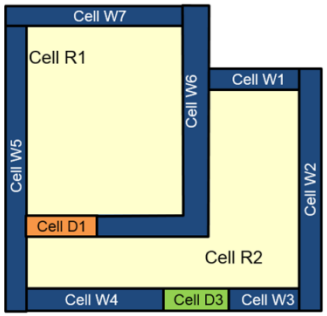
User requirements

- 3D is important in all stages
  - Existing models
    - Function and condition (school, industrial, ..)
    - Form of rooms, doors, windows, floors/ceilings
    - Objects (material they are built of), obstacles
    - Installations
  - Models after the fire

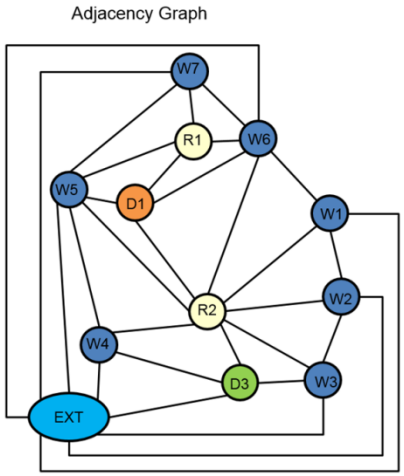
Tom van der Meer

IndoorGML concept

- Cell is the most important unit
- Complete space subdivision
- Poincaré duality

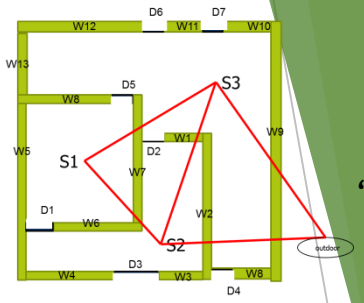


Primal Space

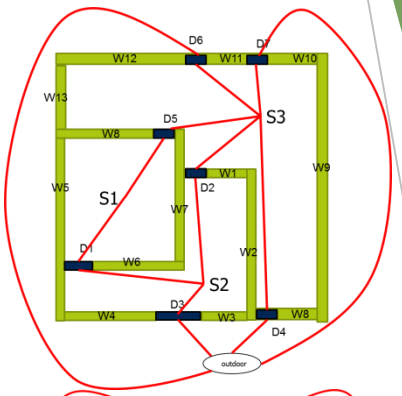


Dual Space

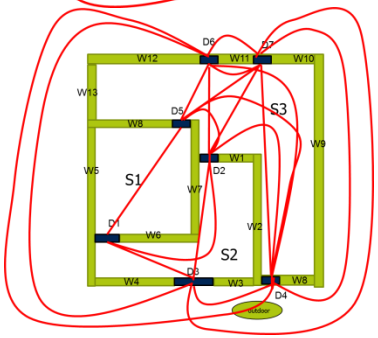
Green: primal space
Red: dual space



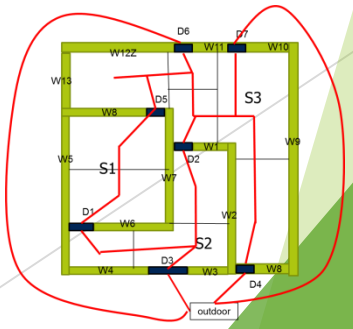
'Thin' door



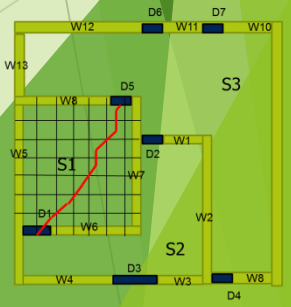
'Thick' door



'Thin' room
(visibility graph)



Space
subdivisions



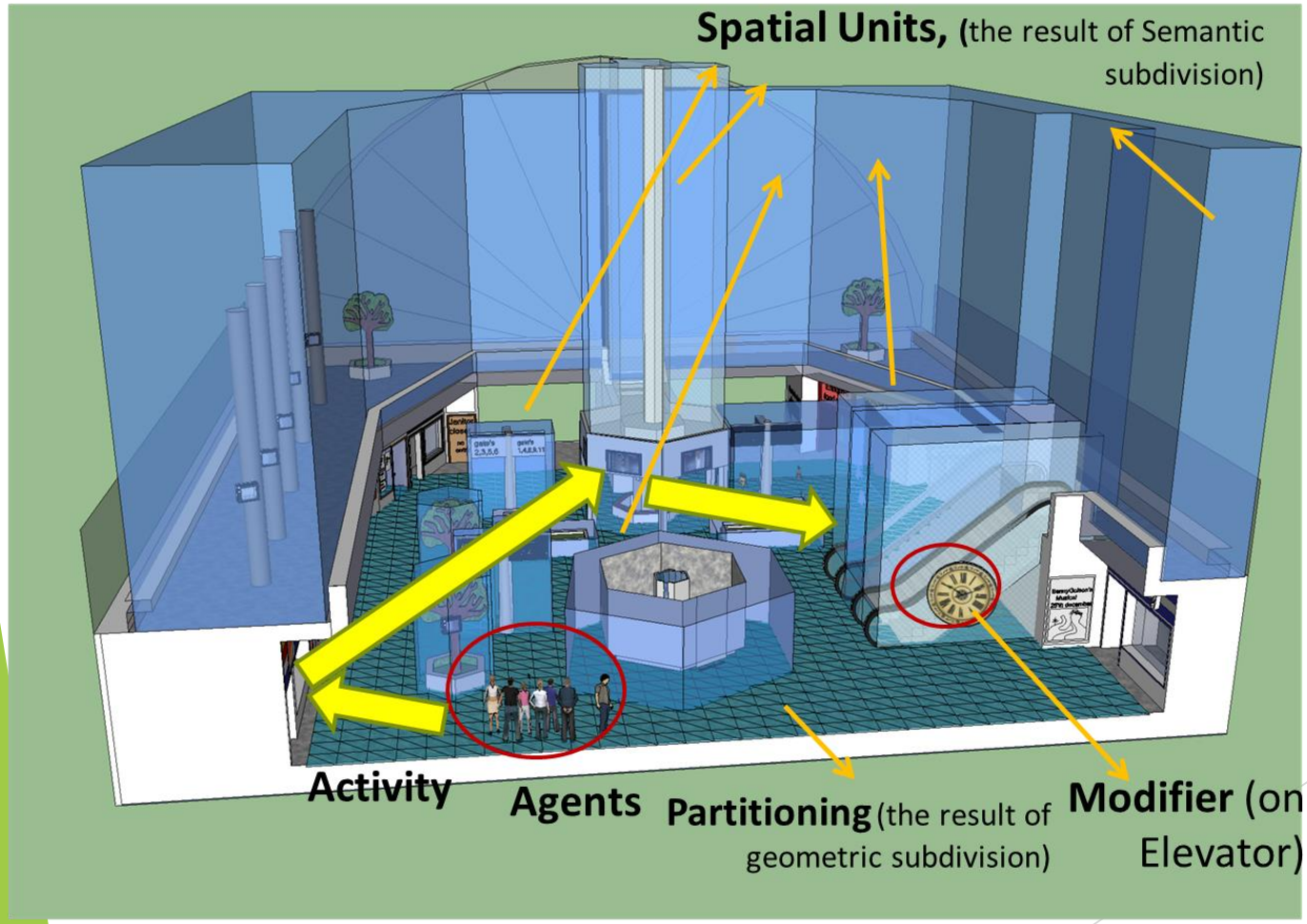
Framework for space subdivision/union

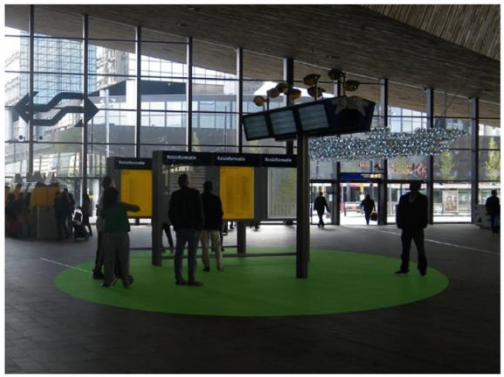
- ***Agent***: client in certain navigation
- ***Activity*** **:** task and navigation behavior performed by an *agent*.
- ***Resource***: things that an *agent* can use in a *sub-space* or take from a *sub-space*.
- ***Modifier***: define what event impacts which *agents/resources/activities* and on which aspects.

The space can be subdivided differently !!!

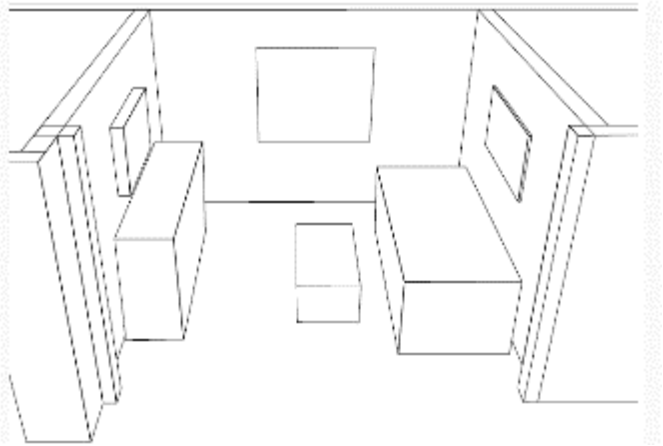
Zlatanova, S., L. Liu, and G. Sithole, 2013. A Conceptual Framework of Space Subdivision for Indoor Navigation. ISA '13 Proceedings of the Fifth ACM SIGSPATIAL International Workshop on Indoor Spatial Awareness, ACM New York, NY, USA. pp. 44-48 (pdf)

Semantic and geometric subdivision/union

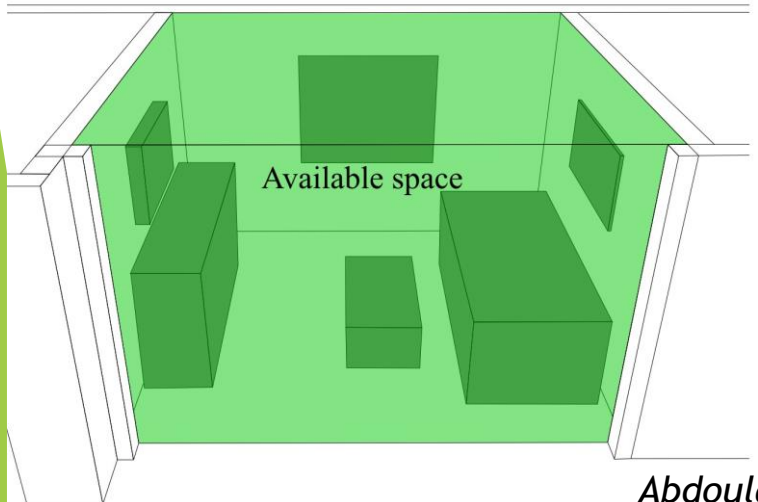


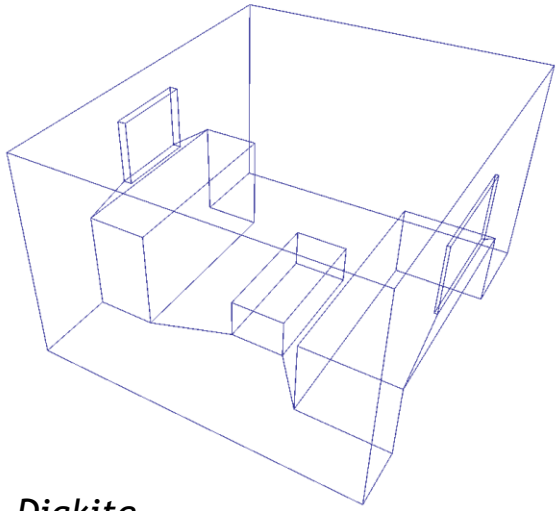


Identify navigable space excluding obstacles and functional areas



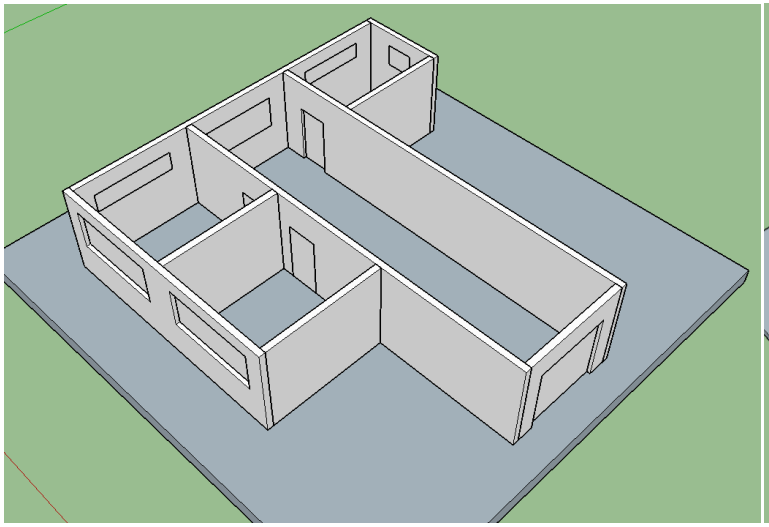
Box (objects and functional areas)

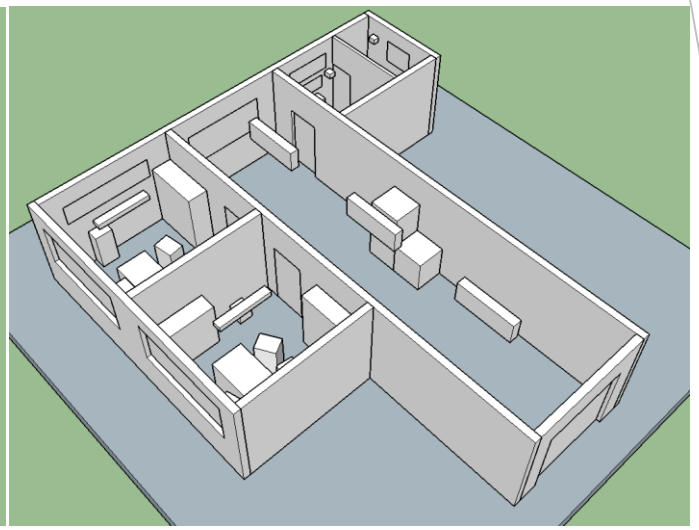


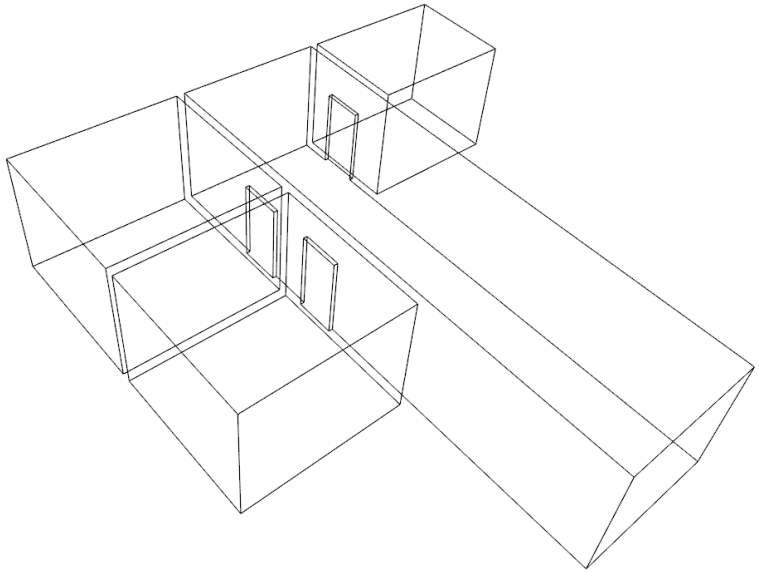


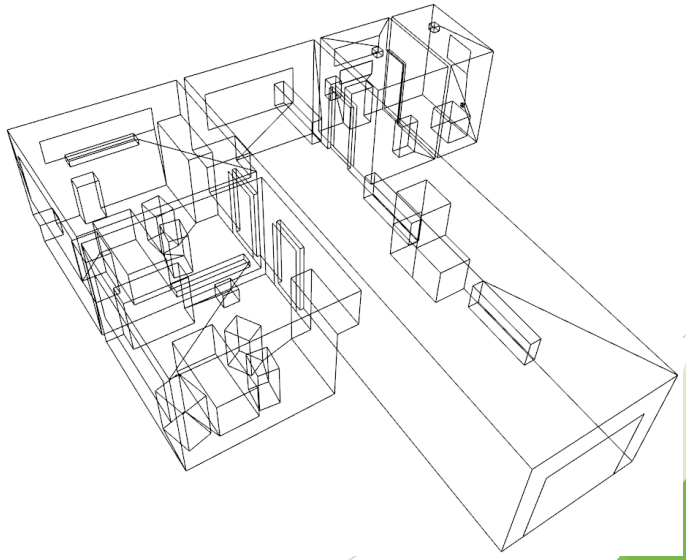
3D cell: navigable space

Some results





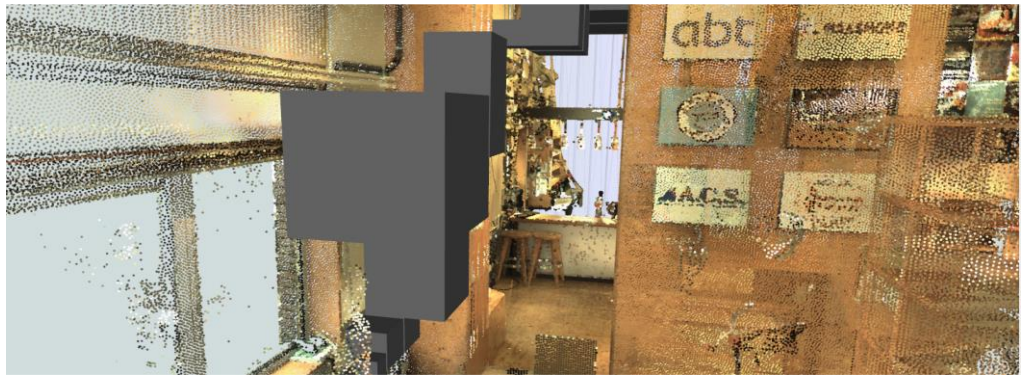


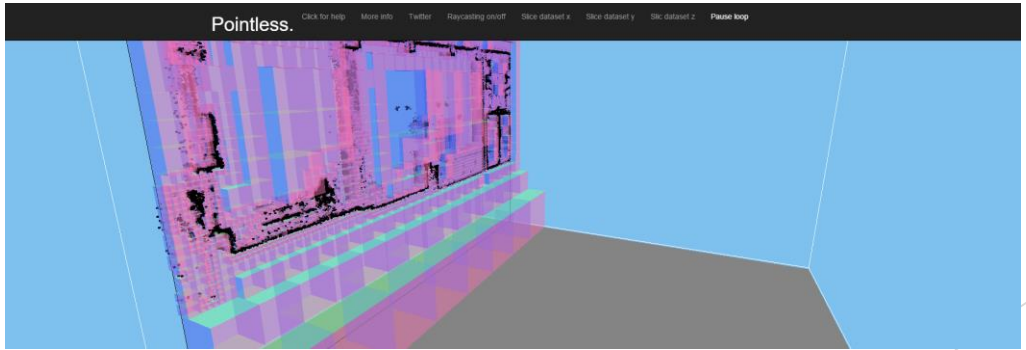


Abdoulaye A. Diakite

Identifying navigable space in indoor point clouds (unstructured data)

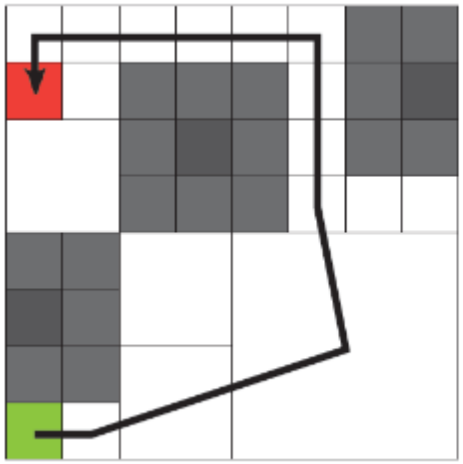
- **Project Pointless: Identifying, visualising and pathfinding through empty space in interior point clouds using an octree approach (student project) (pdf)**

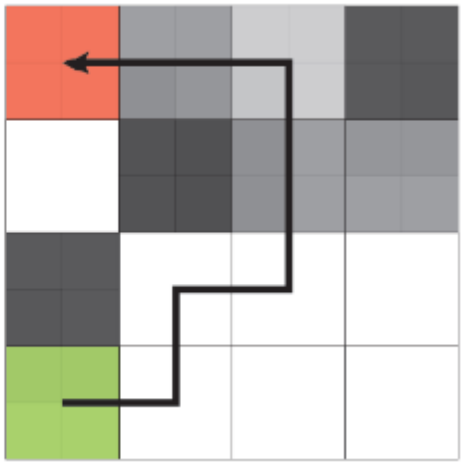




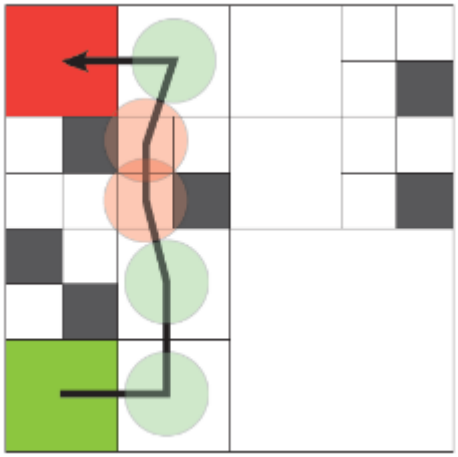
Ivo de Liefde, Florian Fichtner, Eri
Heeres, Olivier Rodenberg and Tom
Broersen

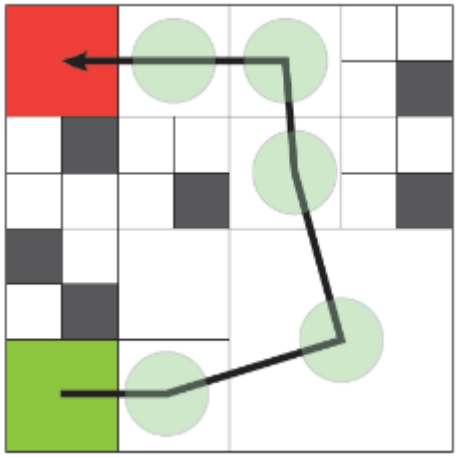
Path finding: octree





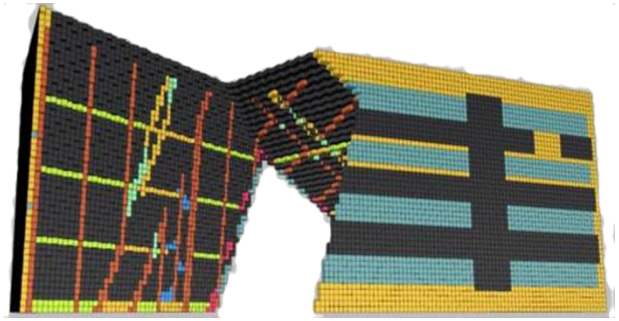
Olivier Rodenberg

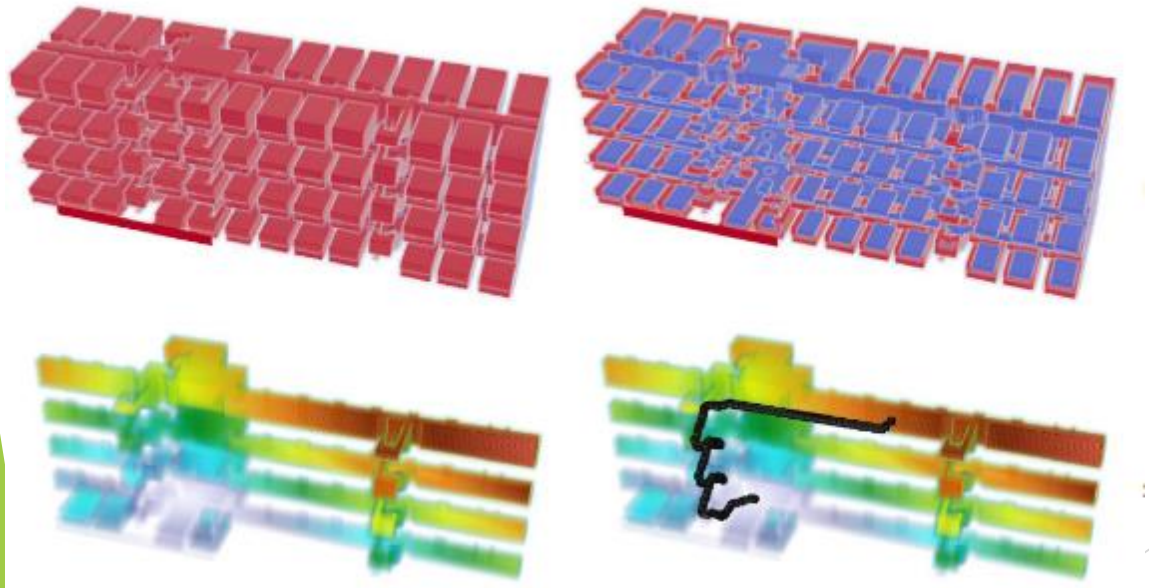




- What kind of octree?
- How to make the path more precise?
- How to consider the size?

Path finding: voxels

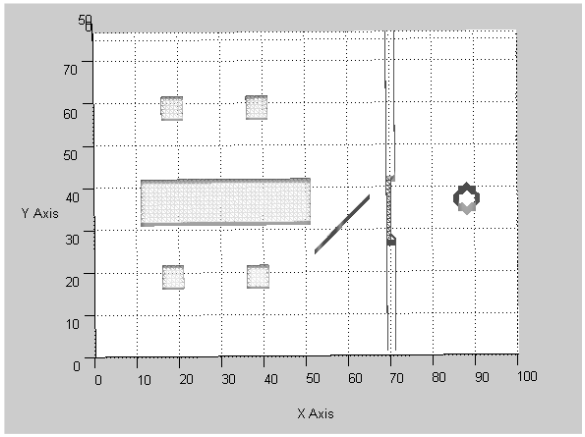


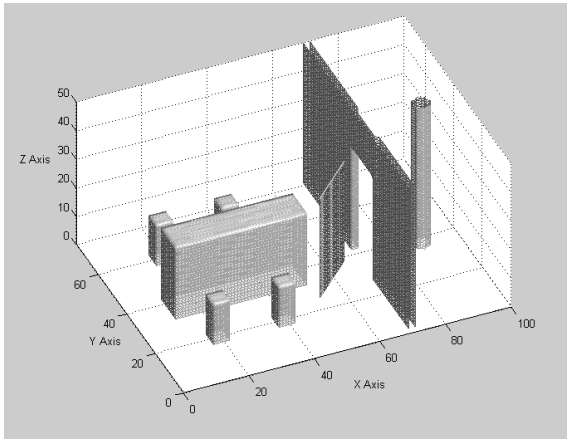


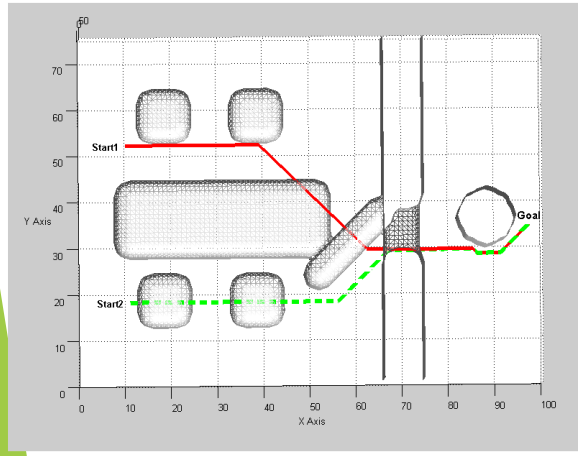
- Distance field transform in 3D

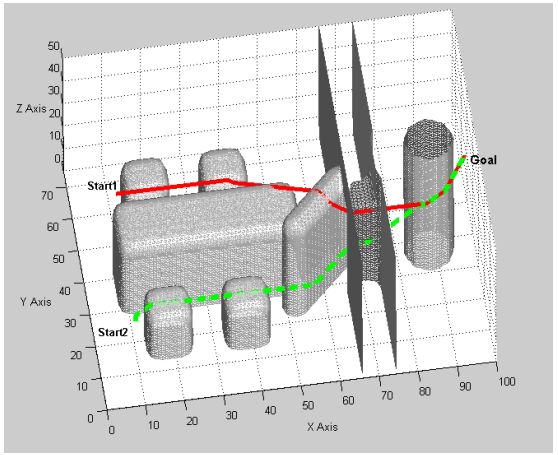
Martijn Koopman

Path finding: voxels





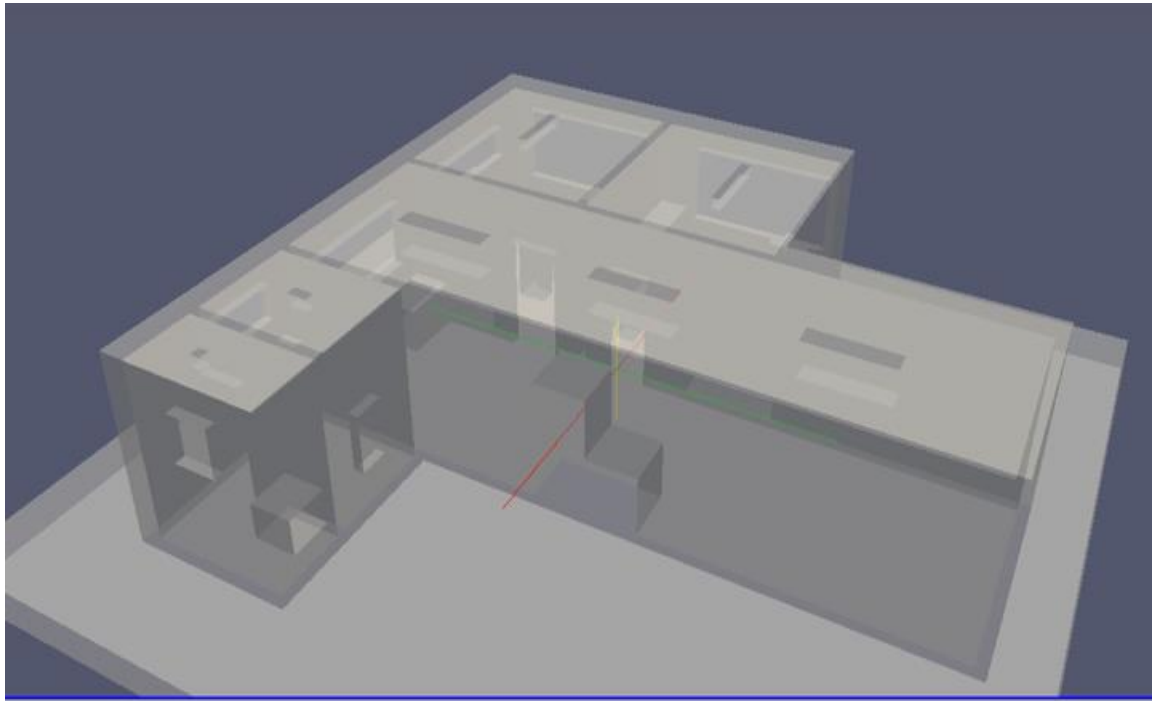




- Indoors with obstacles

Fangyu Li

Voxelisation of a closed polyhedron



Ben Gorte

Conclusions

- Navigable space can be extracted automatically (from unstructured and structured data)
- Space subdivision is a powerful concept for 3D: regular (voxel, octree) or irregular (convex spaces?) partitioning of space.

- Semantics of spaces is important
- Users, environment and different conditions can be taken into consideration