Technische Universität Berlin

Institute of Geodesy and Geoinformation Science

Prof. Dr. Martin Kada

Geodesy @ Technische Universität Berlin

1770 : Founding of the Bergakademie
(from 1878 at Invalidenstraße 44)

1799 : Founding of the Bauakademie
(Painting by Eduard Gaertner, 1868)

Geodesy @ Technische Universität Berlin

Entrance to the
main building constructed **1884**

1879 : Founding of the
Königliche Technische Hochschule Charlottenburg

1899 : **Chair of Geodesy**

1930 : Chair of Photogrammetry

Lichthof in **1885**

Geodesy @ Technische Universität Berlin

09.04.1946 : Reopening as Technische Universität Berlin

April 1953 : Reopening of the southern part of the main building

Northern façade of main building
in November **1943**

Main building after the blasting
of the northern part in **1961**

Geodesy @ Technische Universität Berlin

15.04.1953 : Opening of the Geodätenstand

Astronomical geodetical observation station
on the roof of the main building

Geodesy @ Technische Universität Berlin

Technische Universität Berlin

Institute of Geodesy and Geoinformation Science

Technische Universität Berlin

Institute of Geodesy and Geoinformation Science (IGG)

Geodesy and Adjustment Theory	Methods of Geoinformation Science	Planetary Geodesy	Satellite Geodesy	Physical Geodesy	GNSS Remote Sensing, Navigation and Positioning
Prof. Dr. Frank Neitzel	Prof. Dr. Martin Kada	Prof. Dr. Jürgen Oberst	Prof. Dr. Harald Schuh	Prof. Dr. Frank Flechtner	Prof. Dr. Jens Wickert






Institute of Geodesy and Geoinformation Science

Technische Universität Berlin

Institute of Geodesy and Geoinformation Science (IGG)

Methods of Geoinformation Science	Planetary Geodesy	Satellite Geodesy	Physical Geodesy	GNSS Remote Sensing, Navigation and Positioning	Precision Navigation and Positioning
Prof. Dr. Martin Kada	Prof. Dr. Jürgen Oberst	Prof. Dr. Harald Schuh	Prof. Dr. Frank Flechtner	Prof. Dr. Jens Wickert	Prof. Dr. Roman Galas
					

Institute of Geodesy and Geoinformation Science

Technische Universität Berlin

Institute of Computer Science and Microelectronics

Computer Vision &
Remote Sensing

Prof. Dr.
Olaf Hellwich

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

Berlin:

- **3 universities,** 7 universities of applied sciences, 4 colleges of arts, > 60 non-university research institutions

B.Sc. and M.Sc. programmes at Beuth Hochschule (University of Applied Science)

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **International Master's Programme**
- **English** is teaching language
- **Four terms** with **120 ECTS** points
- **No tuition fees**
- **Around 55 first-year students per year**
- **Approx. 90% foreign students**

ASIIN e.V. akkreditierter Studiengang

EUR ACE® European Accreditation of Engineering Programmes

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

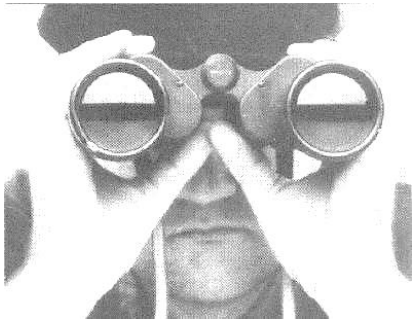
The masters programme focuses on…

Theory of Modelling, Management, Analysis, and **Presentation** of Spatially Referenced Data (GIS: Geoinformation Science)

Earth System and Planetary Research as well as
High Precision Navigation and Positioning
(SGN: Satellite Geodesy and Navigation)

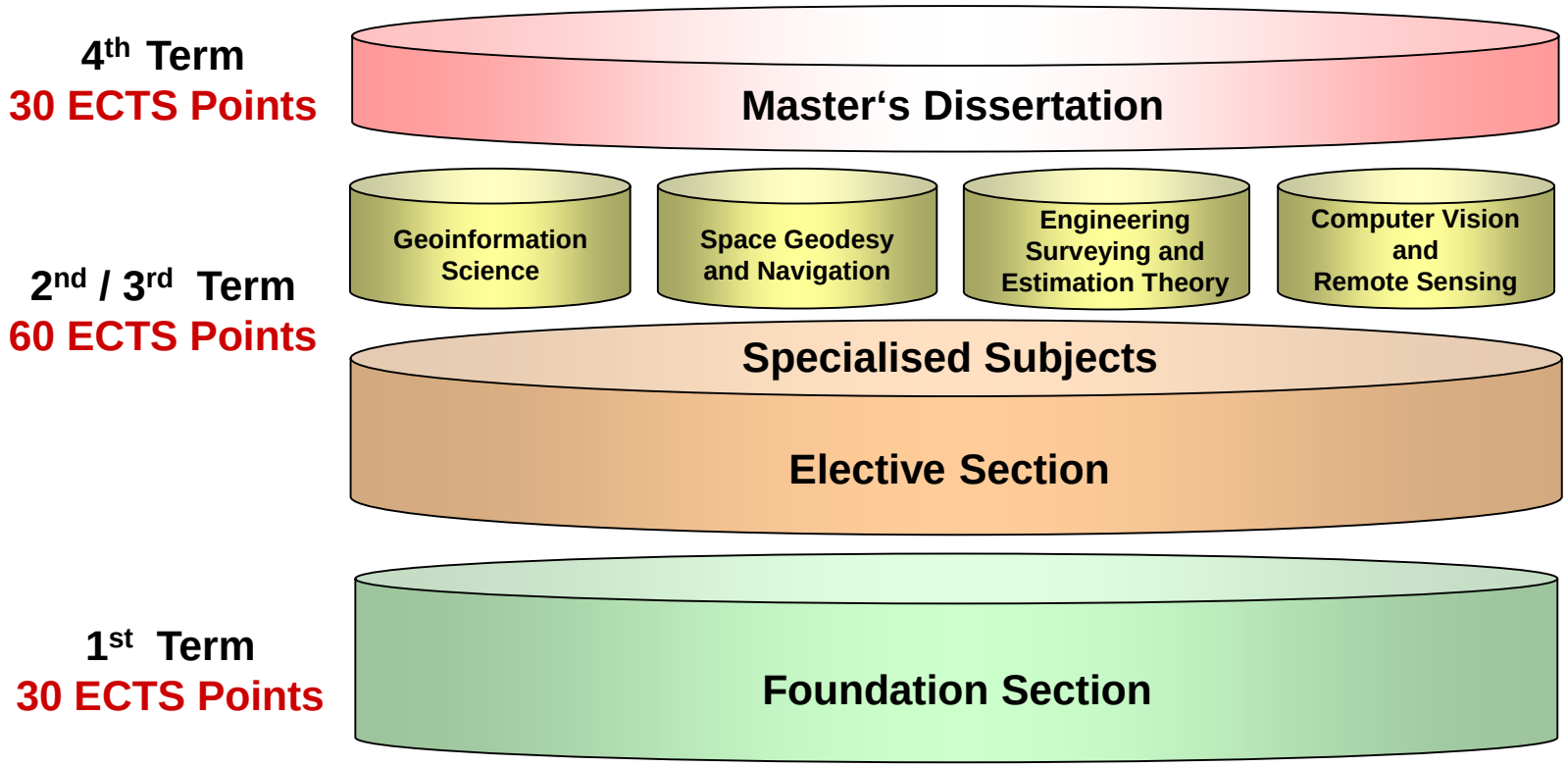
Geodetic Sensor Technology, Data analysis, Object motion,
Deformation Analysis
(EGA: Engineering Surveying and Estimation Theory)

Digital Image Processing, Automatic Image Analysis, and
Remote Sensing (CV: Computer Vision and Remote Sensing)



M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

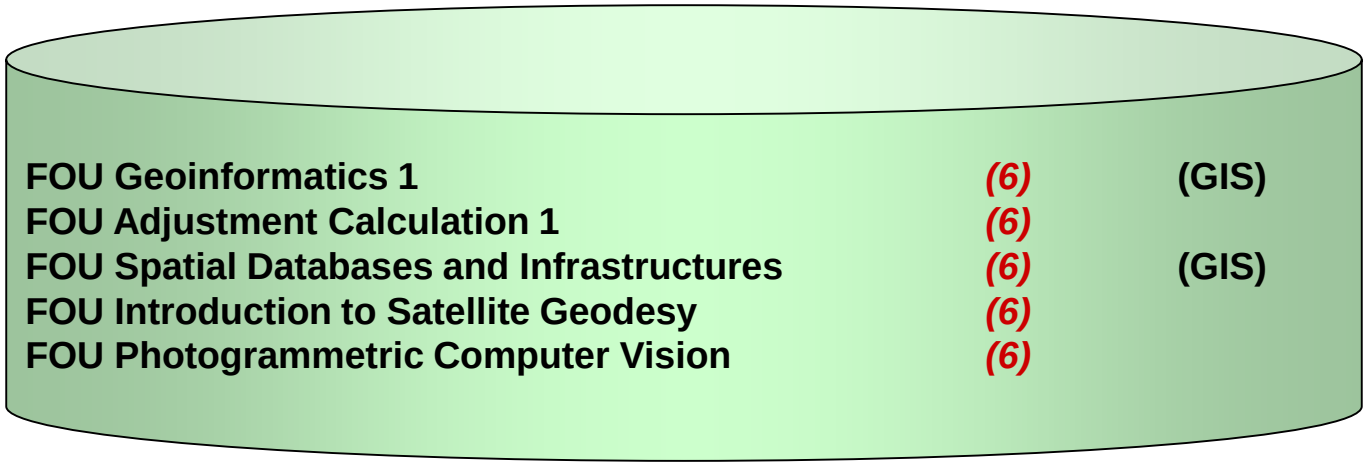


M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

1st Semester:

- Foundation modules amount to a total of **30 ECTS Points**



M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **Foundation Modules in Geoinformation Science (GIS):**
  - **Geoinformatics 1 (6 CP)**
    - Geometric, topologic and thematic **modeling** of geographical data
    - **Algorithms** and **data structures** for geospatial data management, analysis, and presentation
    - Hands-on experience in **ArcGIS Pro**
    - Programming exercises in **Python**
  - **Spatial Databases and Infrastructures (6 CP)**
    - Database management systems (**DBMS**)
    - **Relational data model** and data querying in **SQL**
    - **Geospatial data** in object-relational databases
    - **Web services** in spatial data infrastructures
    - Exercises with **PostGIS, GeoServer, etc.**

M.Sc. Geodesy and Geoinformation Science

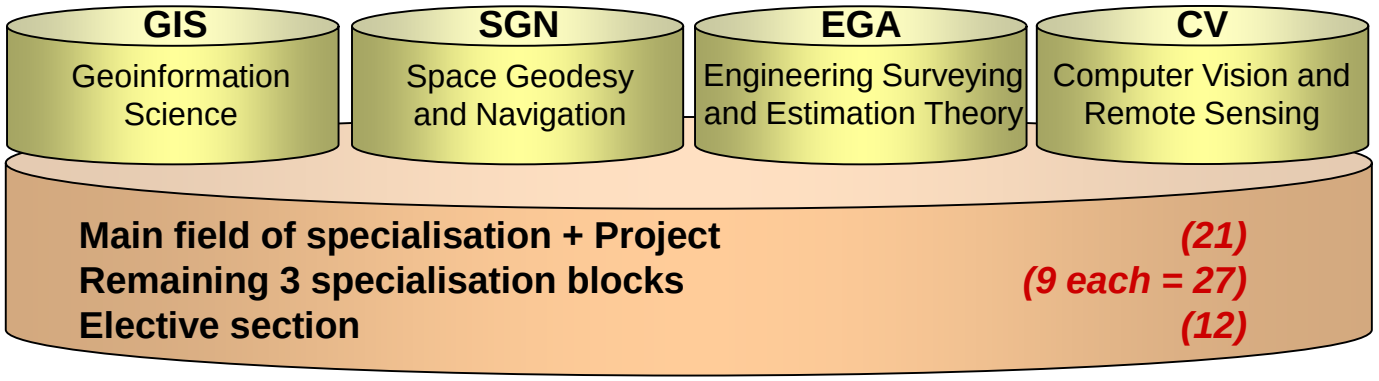
Technische Universität Berlin

2nd/3rd Semester:

- **Main field of specialisation:**
  - Modules that amount to at least **21 ECTS Points**
  - Including a project with 6 ECTS Points

- **Three other fields of specialisation** **27 ECTS Points**
  - Modules that amount to 3*9 ECTS Points

- **Free optional modules** **12 ECTS Points**
  - Free choice of modules from all Berlin universities



M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **Specialization Modules in Geoinformation Science (GIS):**
  - **Geoinformatics 2 (3 CP)**
    - Continuation of Geoinformatics 1
    - **Mandatory module for all students**

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **Specialization Modules in Geoinformation Science (GIS):**
  - **Geographical Information Systems A (6 CP)**
    - Theoretical foundations of geoinformation science and practical work with current geographical information software (ArcGIS Pro)
  - **Geographical Information Systems B (6 CP)**
    - Programming of extensions for geographic information systems and development of geoprocesses using (free) geoinformation software programming libraries
  - **Advanced Methods for Geospatial Analysis (6 CP)**
    - Relevant algorithms and methods for solving geoscientific problems from the fields of computational geometry, graph theory, machine and deep learning, etc.

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **Specialization Modules in Geoinformation Science (GIS):**
  - **Geovisualization (6 CP)**
    - Programming and development of 2D/3D visualizations of geographical data (graphical user interfaces, scene modeling, rendering pipelines)
  - **Semantic 3D/4D City Models (6 CP)**
    - Applications, data acquisition, methods for object extraction and reconstruction of 3D city models, level of details concepts and cartographic generalization of geographical 3D data
  - **Internet, Mobile, and Distributed GIS (6 CP)**
    - Internet technologies, web mapping, standardized geo web services, mobile geoinformation systems, geo sensor networks

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

- **Specialization Modules in Geoinformation Science (GIS):**
  - **Selected Sections of Geoinformatics (6 CP)**
    - Current research topics in the field of geoinformatics

M.Sc. Geodesy and Geoinformation Science

Technische Universität Berlin

4th Semester:

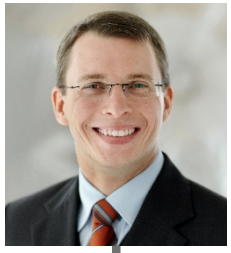
- Master thesis with **30 ECTS Points**

MSC Master‘s thesis ***(30)***

After no less than 4 semesters, our students are awarded the degree of a

M.Sc. Geodesy and Geoinformation Science

Methods of Geoinformation Science (GIS)



Prof. Dr.-Ing. Martin Kada
Head of Chair

Technical Staff Members

Scientific Staff Members

Dipl.-Ing. (FH)
Hartmut Lehmann

Dr. Andreas
Fuls

M.Sc. Amgad
Agoub

Generative Adversarial Networks (GANs) for Context-Aware 3D Urban Scene Generation

M.Sc. Izabela
Karut

Integrated LOD Concepts for 3D Building Models

M.Sc. Valentina
Schmidt

Deep Learning for 3D Building Reconstruction

- 2 scientific staff positions vacant
- Several Ph.D. students

Education @ Chair GIS

Object oriented modelling of geographical phenomena

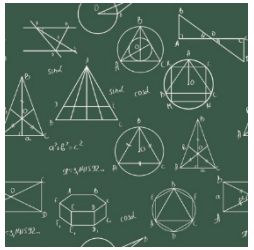
Algorithms and data structures for geospatial data

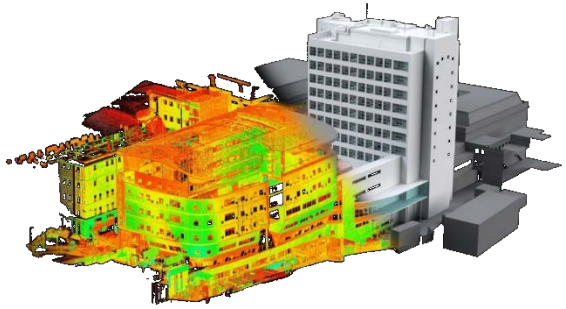
3D/4D modelling of urban areas

Machine learning for geospatial data

Geovisualization and cartographic aspects

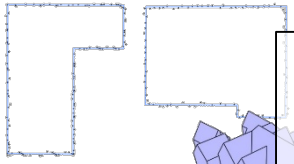
Geographical Information Systems (GIS)



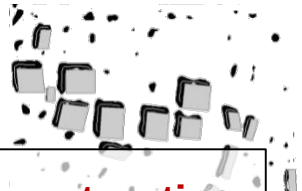


Research @ Chair GIS

Technische Universität Berlin



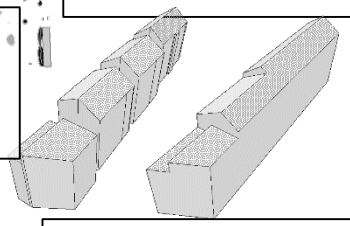
3D Building Reconstruction

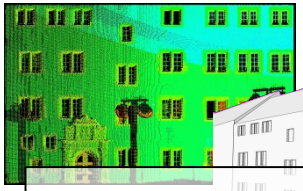


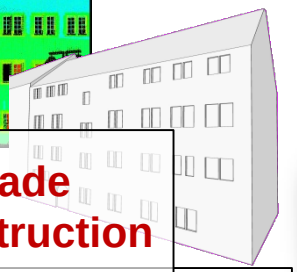
Building Aggregation

Ground Plan Reconstruction

3D Reconstruction from Shadows

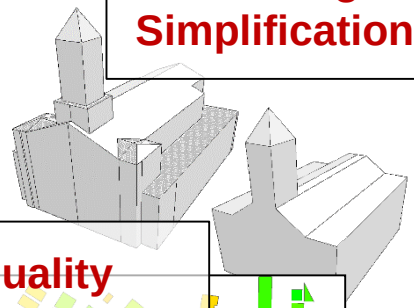




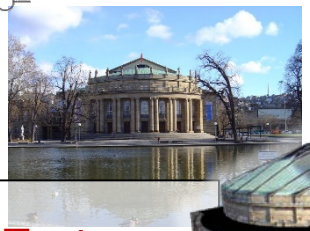


Façade Reconstruction

Building Simplification

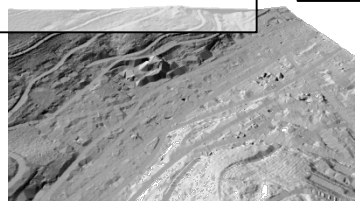


Point Cloud Classification



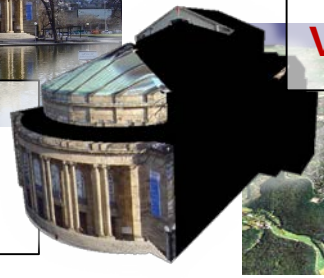
Real-Time Visualization

DTM Generalization



Quality Assessment

Texture Txtraction



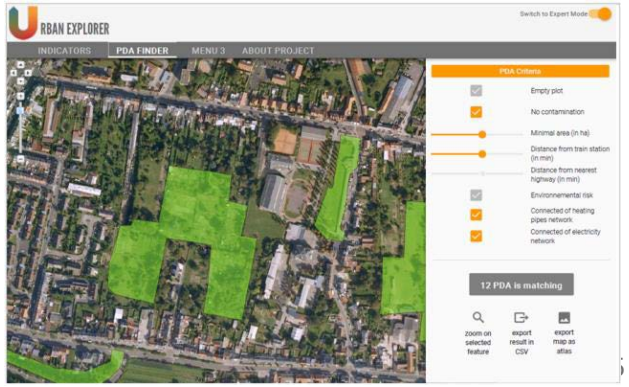
Research @ Chair GIS

Technische Universität Berlin

Reconstruction of
(photo-)realistic 3D city models
with semantic structure

Cartographic generalization
and modelling in
multiple levels of detail

GIS analyses and web based
spatial decision support systems



Research @ Chair GIS

Technische Universität Berlin

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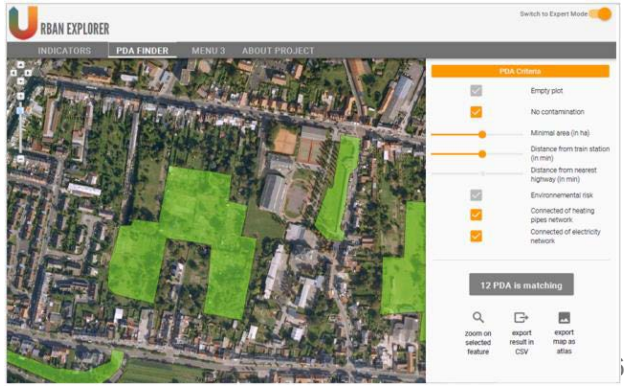
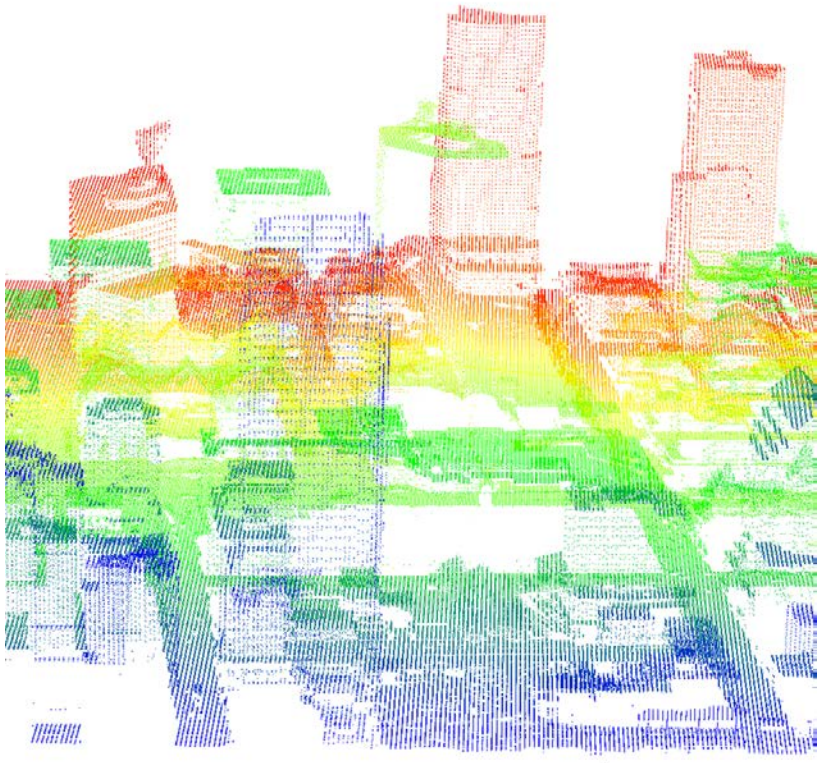
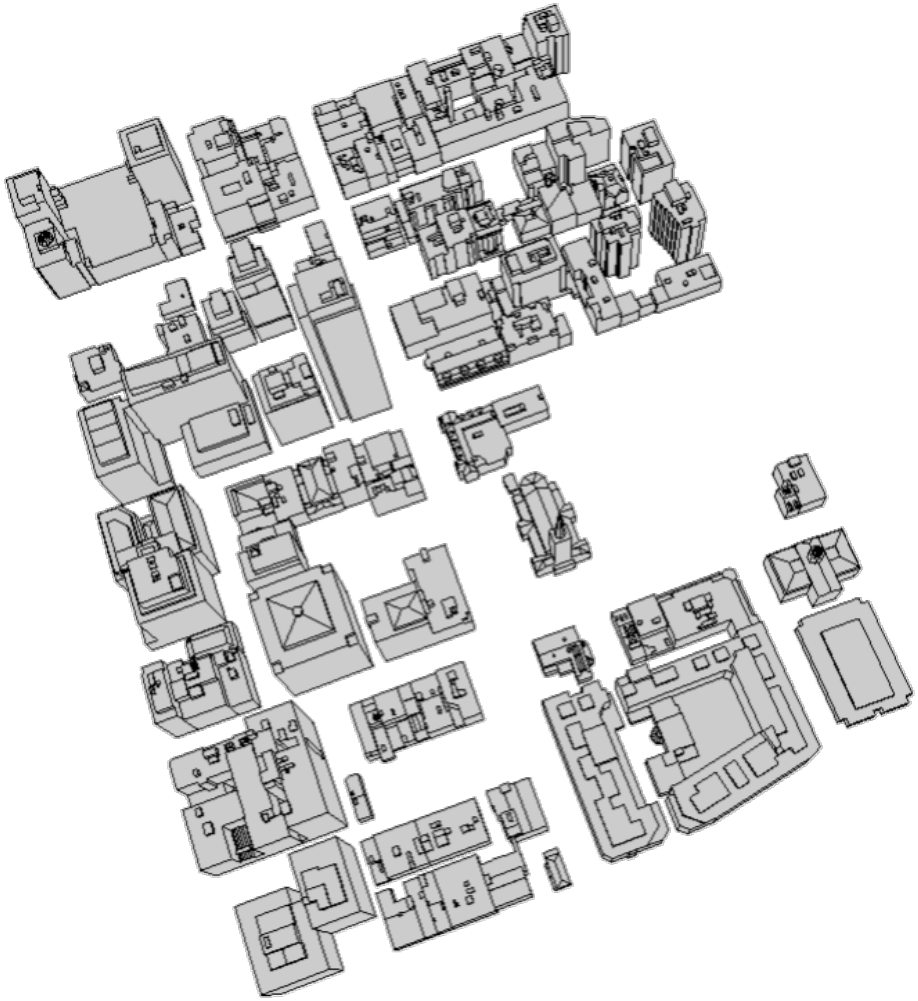


Research @ Chair GIS

Technische Universität Berlin

Automatic reconstruction
from aerial 3D point clouds





Research @ Chair GIS

Technische Universität Berlin

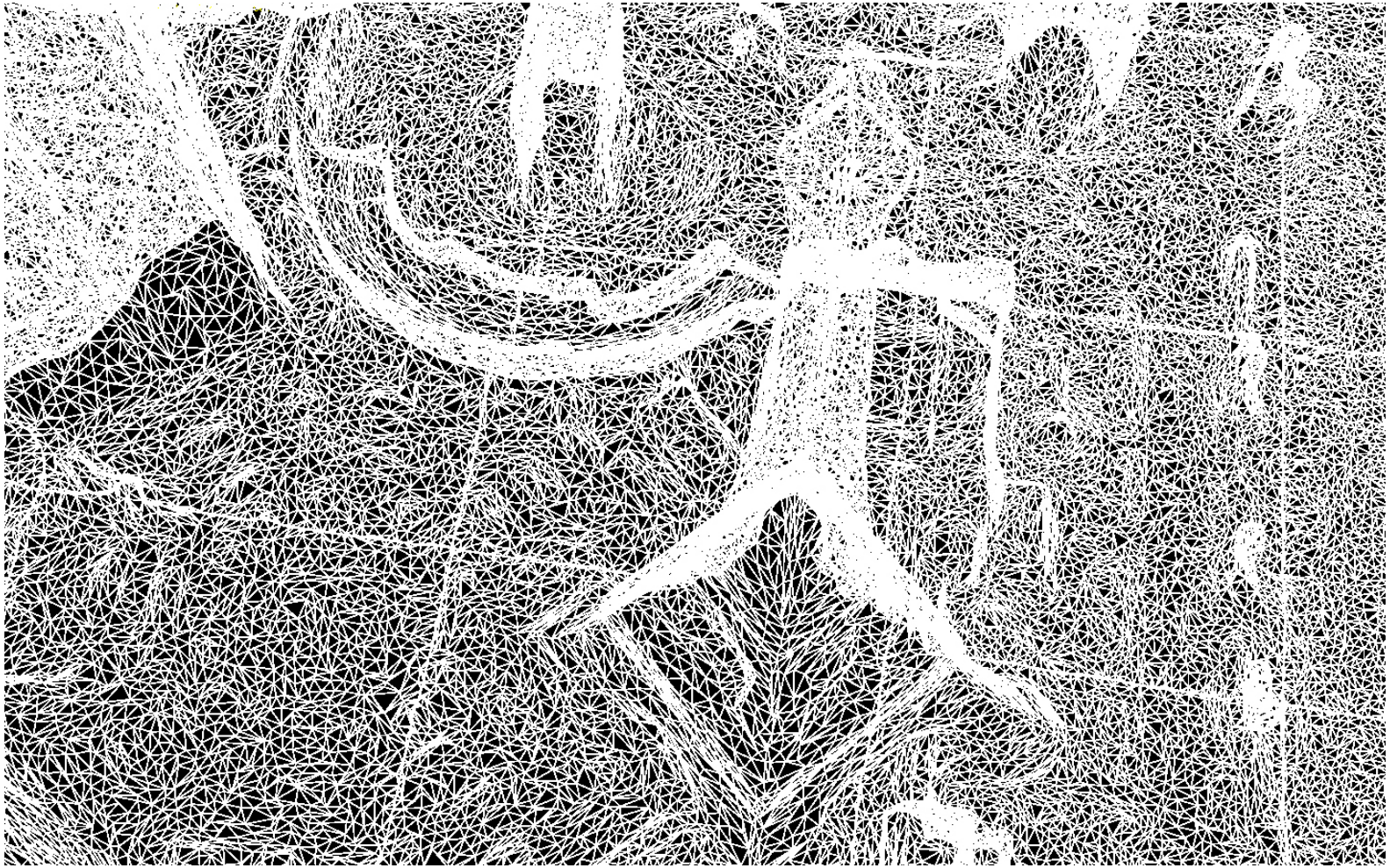
Google Maps

Apple Maps

Microsoft
Bing Maps

Research @ Chair GIS

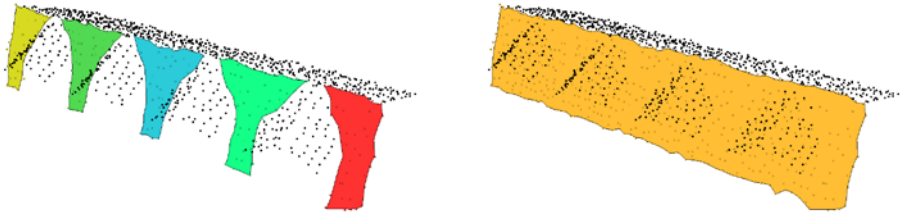
Technische Universität Berlin



Research @ Chair GIS

Technische Universität Berlin

Algorithms and methods for
3D point cloud processing

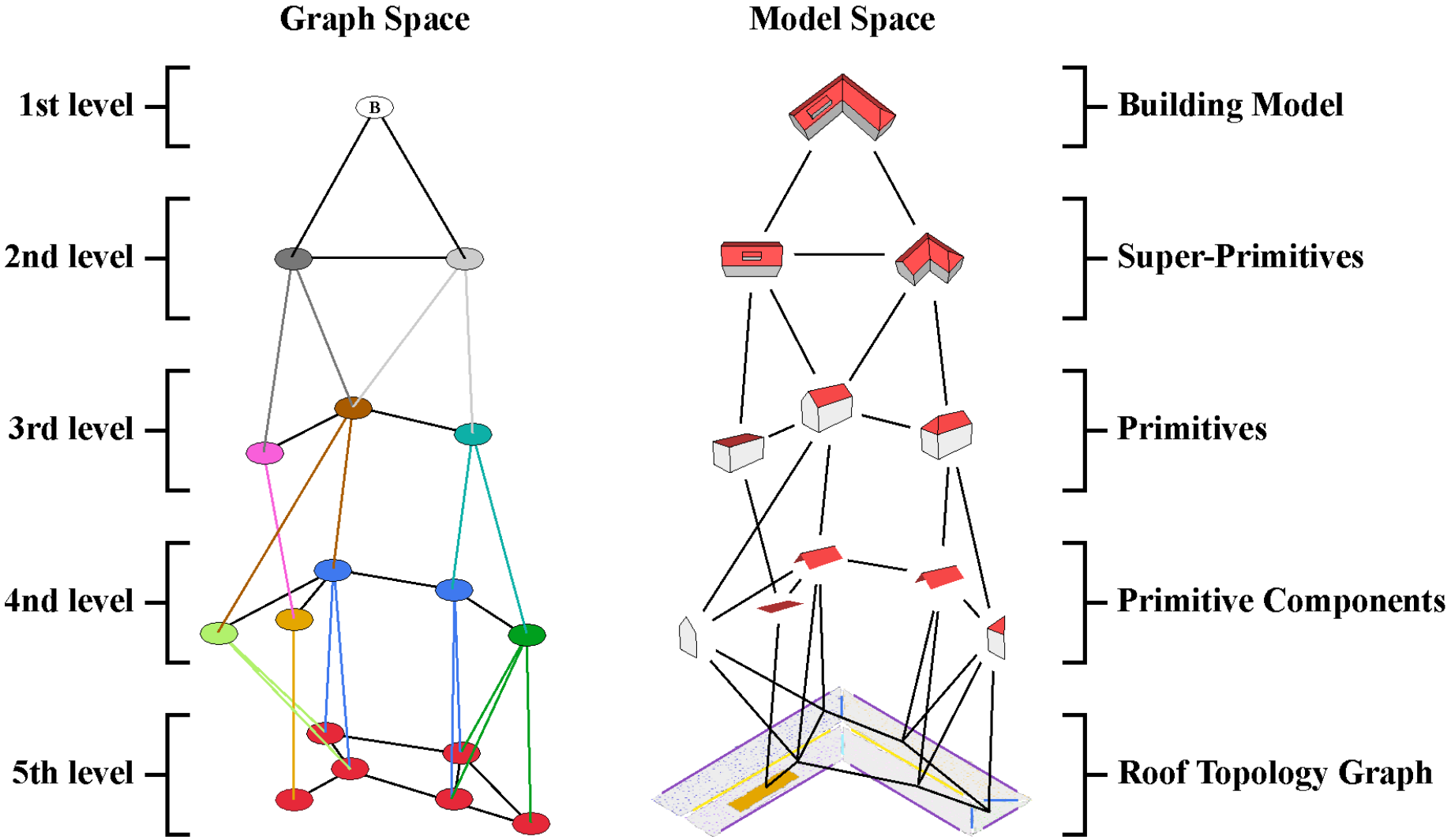


Graph grammars
for multi-scale augmentation
of structural information

$$O_z(v_1) = "sloped" \wedge O_z(v_2) = "sloped" \wedge AD(e) = "3D" \wedge$$
$$Presence(e) = "Surface\ Points" \wedge O_{intersection}(e) = "sloped" \wedge$$
$$Visibility(e) = " - " \wedge CP\_PC(e) = "none" \wedge$$
$$\left(O_{xy}(e) = " \perp " \vee O_{xy}(e) = "\neg(\parallel \vee \perp)"\right) \wedge CV(e) > threshold$$

Research @ Chair GIS

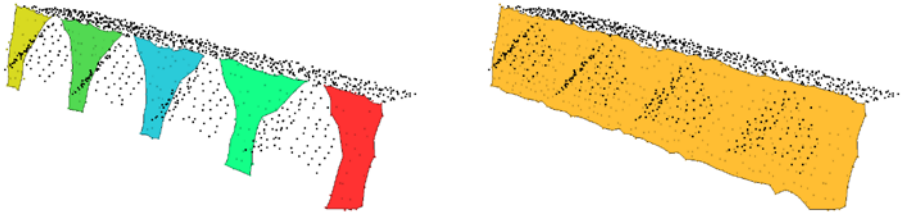
Technische Universität Berlin



Research @ Chair GIS

Technische Universität Berlin

Algorithms and methods for
3D point cloud processing



Graph grammars
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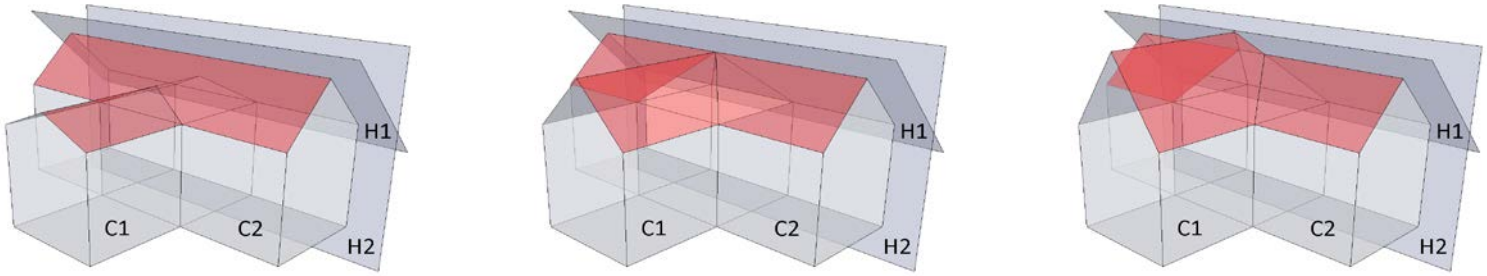
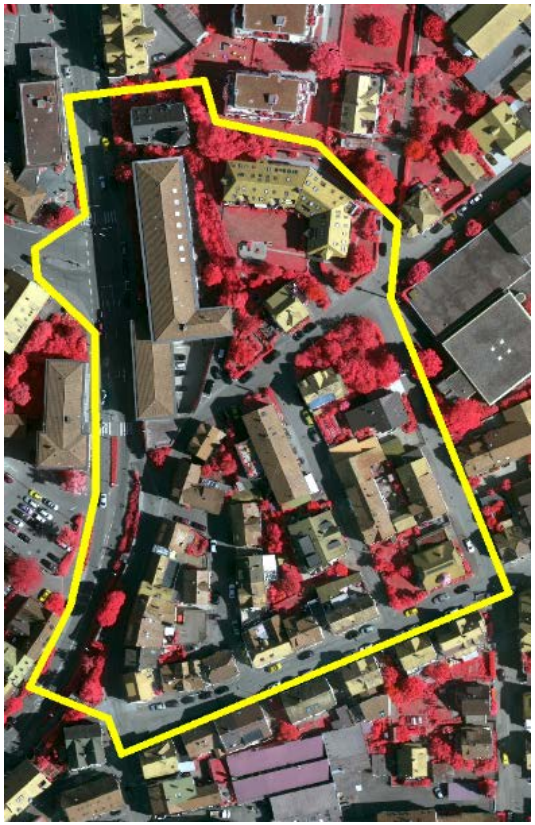
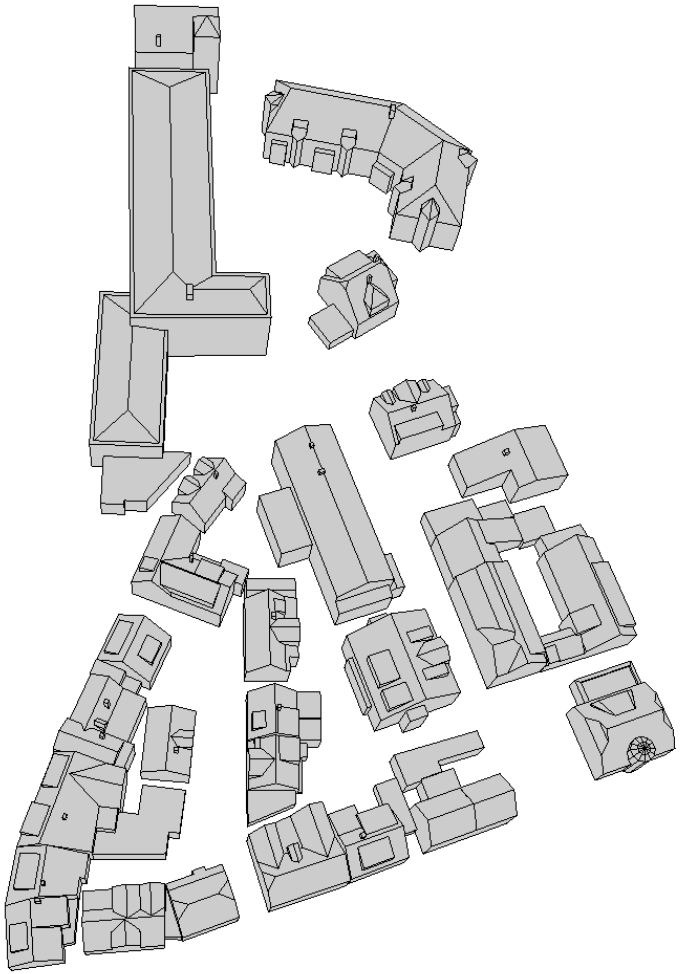
$$Visibility(e) = " - " \wedge CP\_PC(e) = "none" \wedge$$
$$\left(O_{xy}(e) = " \perp " \vee O_{xy}(e) = "\neg(\parallel \vee \perp)"\right) \wedge CV(e) > threshold$$

3D modelling with half spaces



Research @ Chair GIS

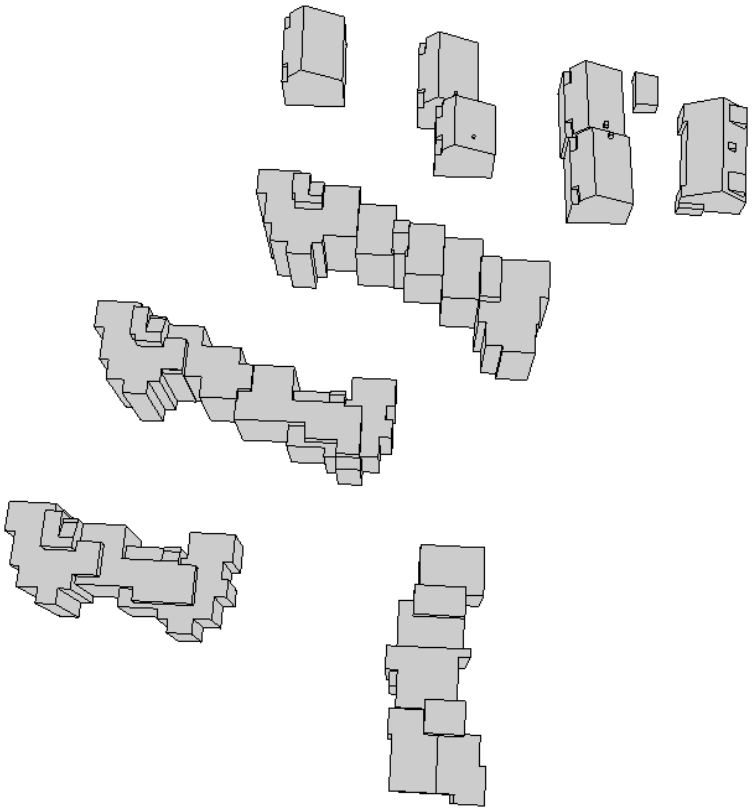




	Comp [%]	Corr [%]
CKU	86.8	98.9
ITCE1	60.8	96.6
ITCE2	65.3	**100.0**
ITCX1	76.0	99.2
ITCX2	84.7	96.2
ITCX3	**89.2**	96.4
TUD	67.4	96.2
VSK	72.2	96.7
YOR	88.2	98.5
MON	76.4	83.3
MON_mod	75.0	95.3
MON2	66.0	91.7
TUD2	73.3	**100.0**
MEL_HE	88.2	99.5
BNU2	84.7	99.3
MON5	74.3	98.7
TUB	**89.2**	95.9

Research @ Chair GIS

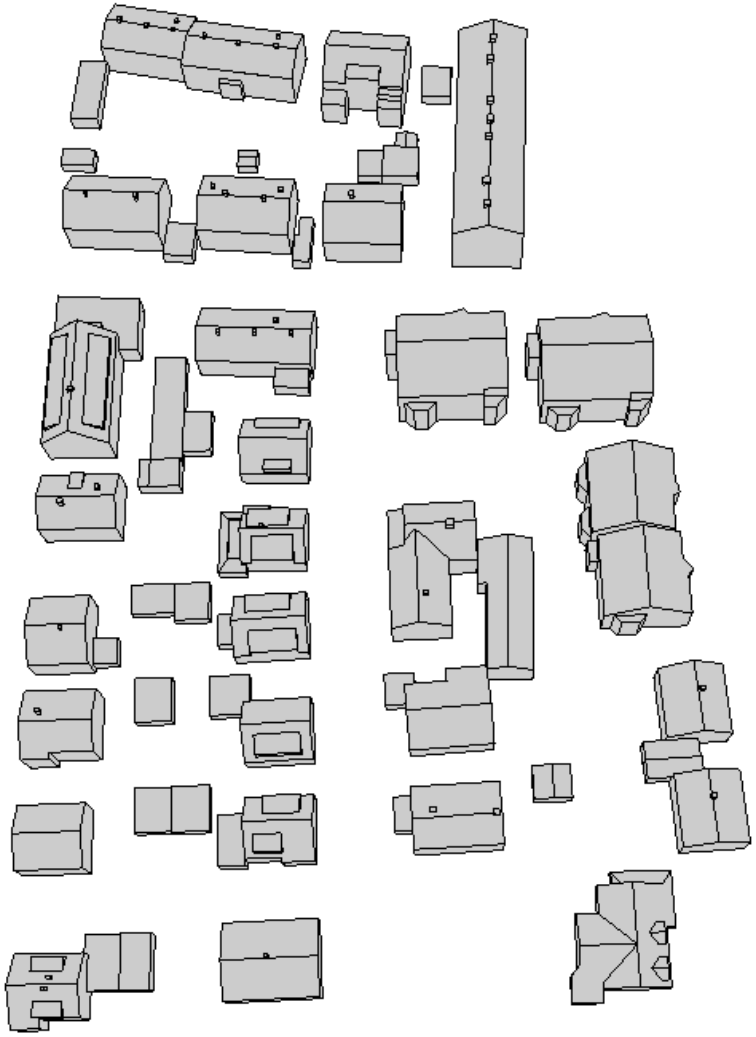
Technische Universität Berlin



	Comp [%]	Corr [%]
CKU	78.3	93.1
ITCE1	**79.7**	73.7
ITCE2	**79.7**	95.0
ITCX1	62.3	95.1
ITCX2	75.4	98.2
ITCX3	71.0	**100.0**
TUD	68.1	98.1
VSK	73.9	**100.0**
YOR	66.7	**100.0**
CAS	63.8	**100.0**
MON	73.9	91.9
MON_mod	69.6	96.8
MON2	71.0	90.7
TUD2	71.0	**100.0**
MEL_HE	71.0	98.1
BNU2	73.9	**100.0**
MON5	72.5	94.8
TUB	72.5	97.1

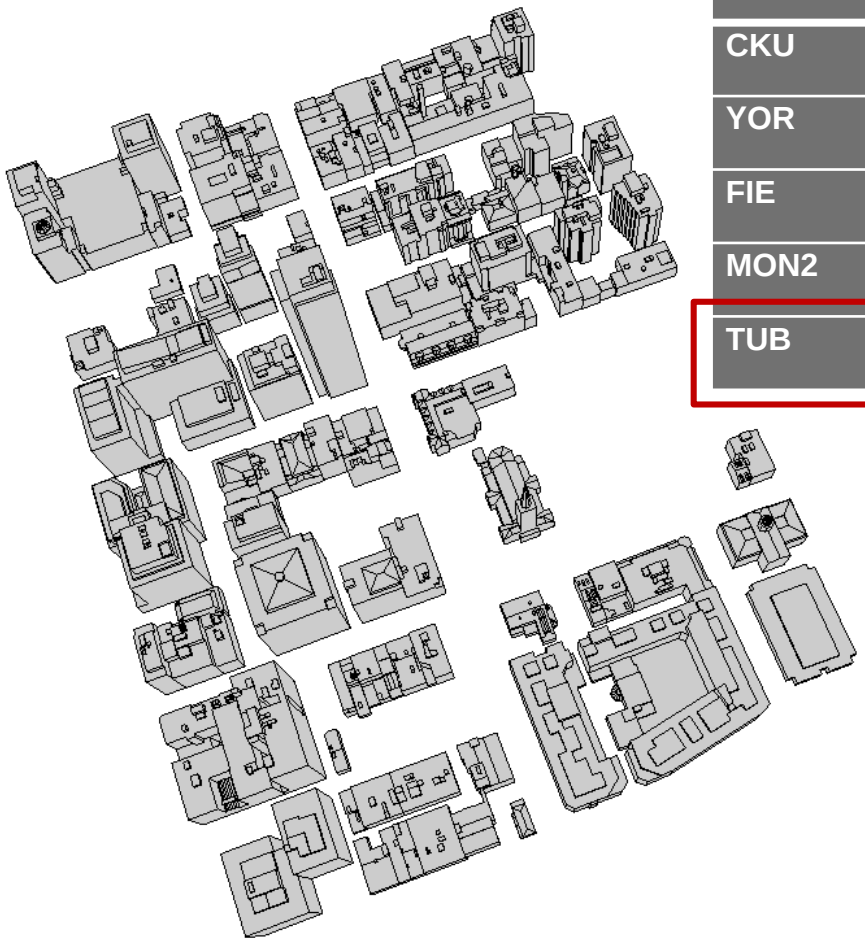
Research @ Chair GIS

Technische Universität Berlin



	Comp [%]	Corr [%]
CKU	81.3	98.4
FIE	82.6	83.1
ITCE1	67.7	**100.0**
ITCE2	64.3	**100.0**
ITCX1	70.2	**100.0**
ITCX2	86.0	84.4
ITCX3	**88.1**	88.2
TUD	74.5	93.0
VSK	76.6	99.1
YOR	84.7	**100.0**
CAS	73.2	**100.0**
MON	82.1	93.9
KNTU	80.4	96.7
BNU	87.2	**100.0**
MON_mod	74.5	96.2
MON2	73.2	89.2
TUD2	73.6	**100.0**
MEL_HE	82.6	97.8
WROC	80.4	98.2
WROC_2a	81.3	**100.0**
WROC_2b	81.7	**100.0**
MON5	80.9	99.3
TUB	85.1	96.7

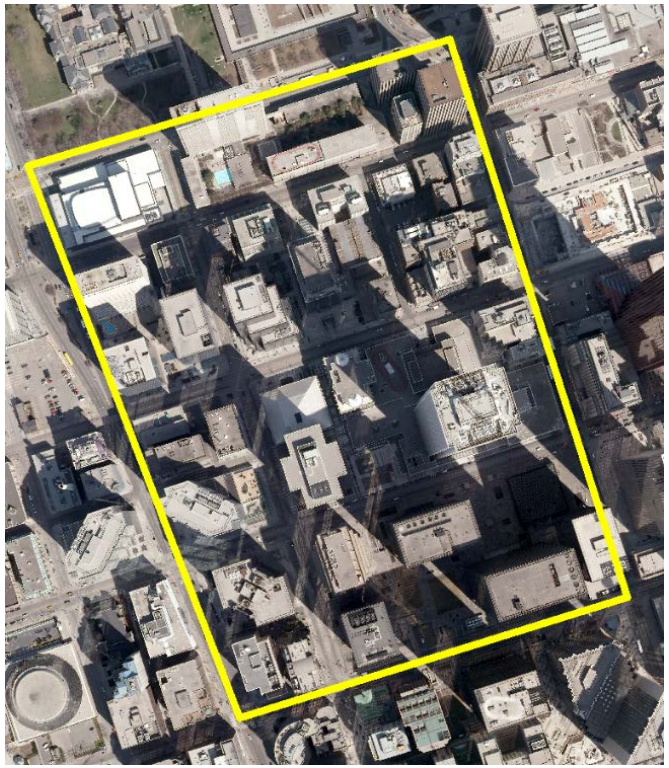
Research @ Chair GIS

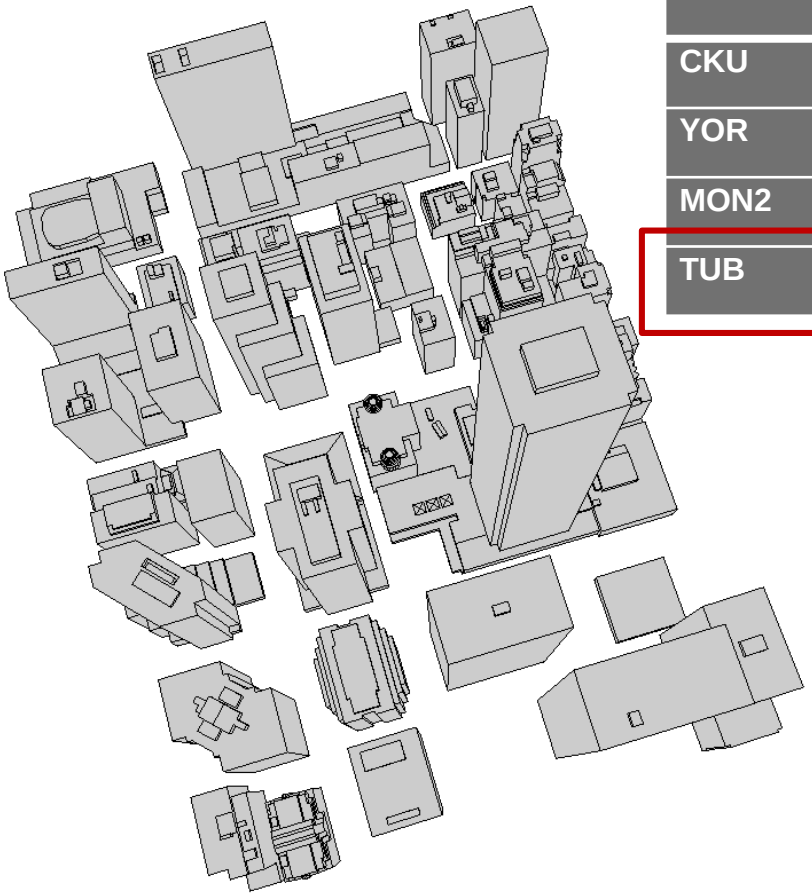


	Comp [%]	Corr [%]
CKU	68.6	80.2
YOR	75.5	**97.5**
FIE	52.3	91.5
MON2	70.2	78.3
TUB	**88.1**	93.4

Research @ Chair GIS

Technische Universität Berlin

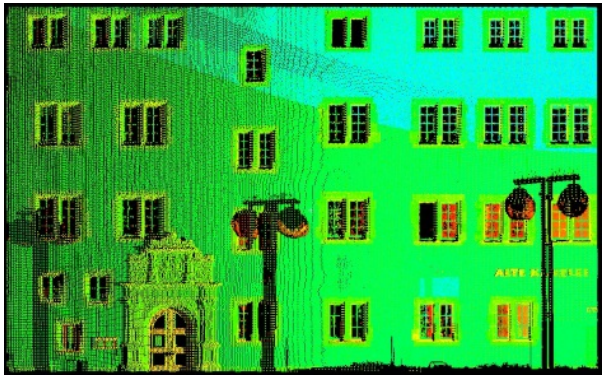


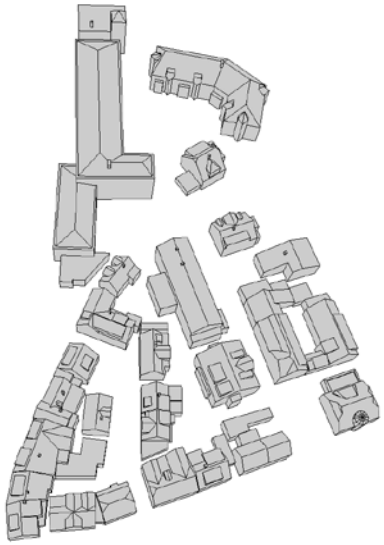


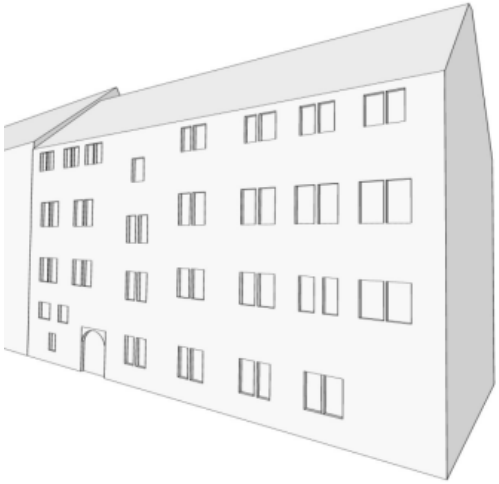
	Comp [%]	Corr [%]
CKU	70.3	83.3
YOR	64.5	**85.8**
MON2	67.9	80.7
TUB	**84.7**	82.2

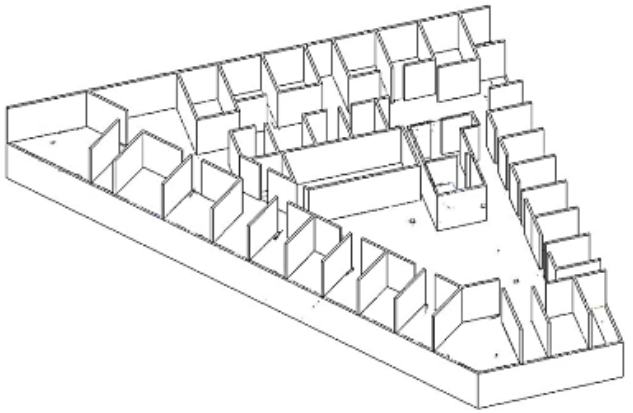
Research @ Chair GIS

Technische Universität Berlin









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The 3D Berlin Project

- **472,000 buildings** (857 km² area)
  - 1s/building (geometry) → ~ **6 days**
- Project duration approx. 9 month
  - Automation rate:
    70% - 80% inner city areas
    80% - 85% residential areas
- (Semi-)automatic texturing from approx. 100,000 oblique aerial images
- 80 landmarks modelled by hand

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Frankfurt am Main (200.000)

Köln (280.000)

Others:

- Nürnberg (170.000)
- Helsinki (80.000)
- Potsdam (43.000)
- Innsbruck (28.000)
- Freistaat Bayern (8.000.000)

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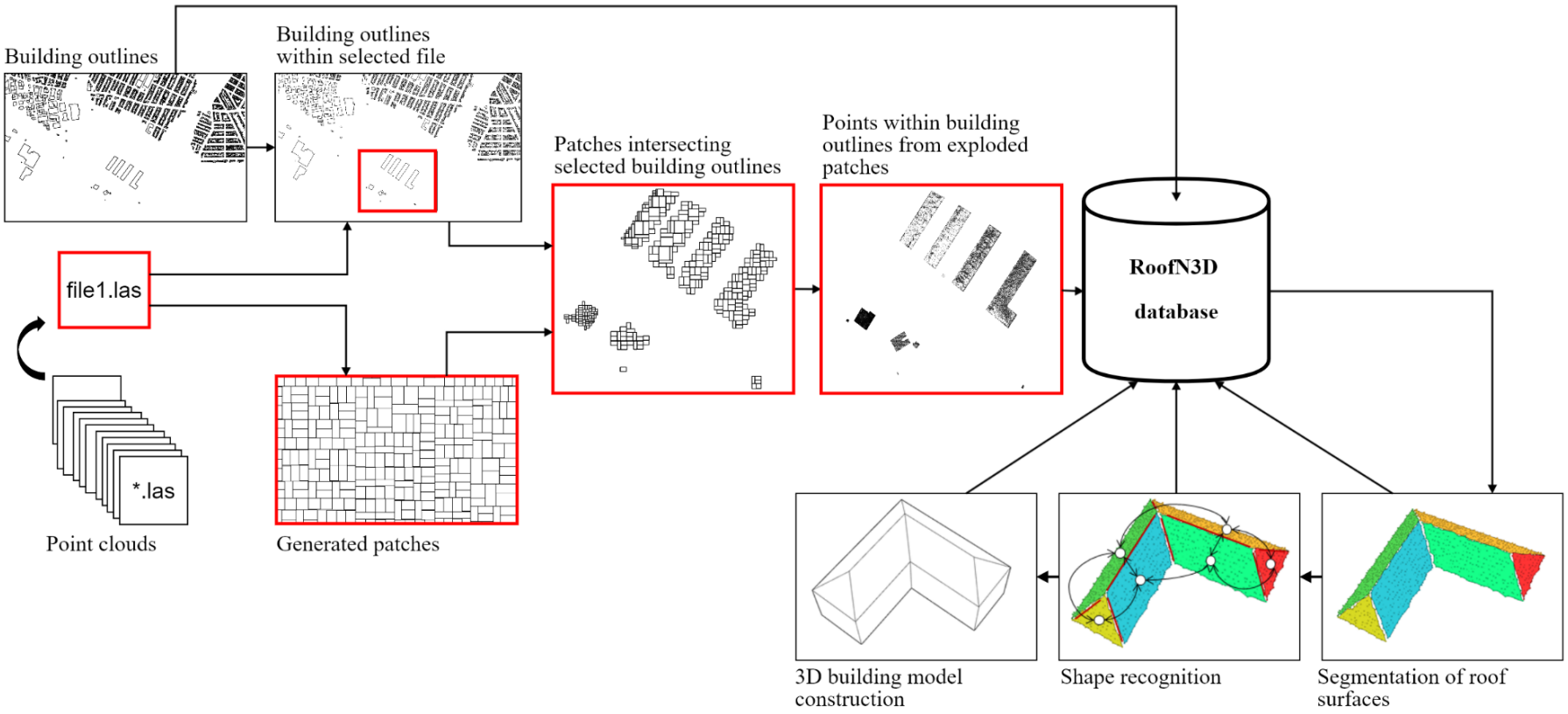
RoofN3D



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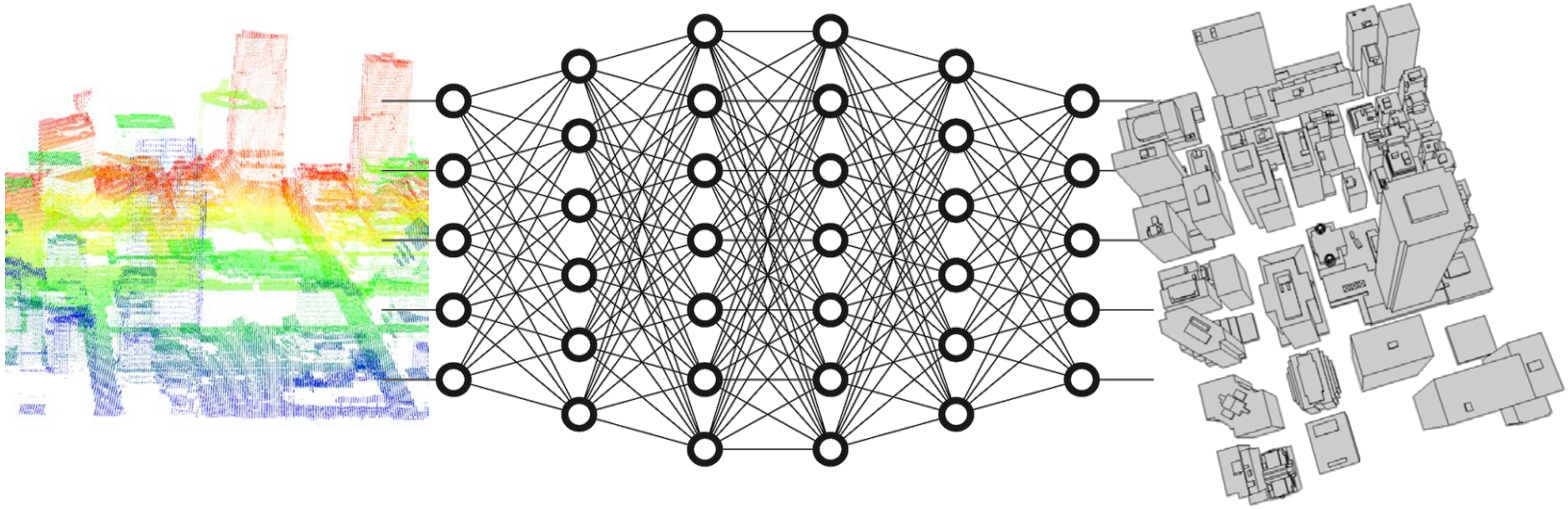

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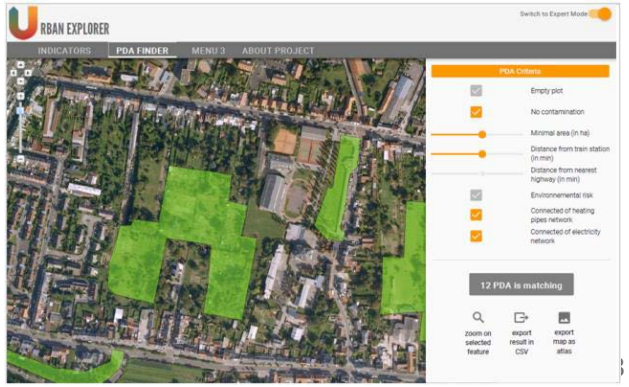
Reconstruction of
(photo-)realistic 3D city models
with semantic structure

Cartographic generalization
and modelling in
multiple levels of detail

GIS analyses and web based
spatial decision support systems



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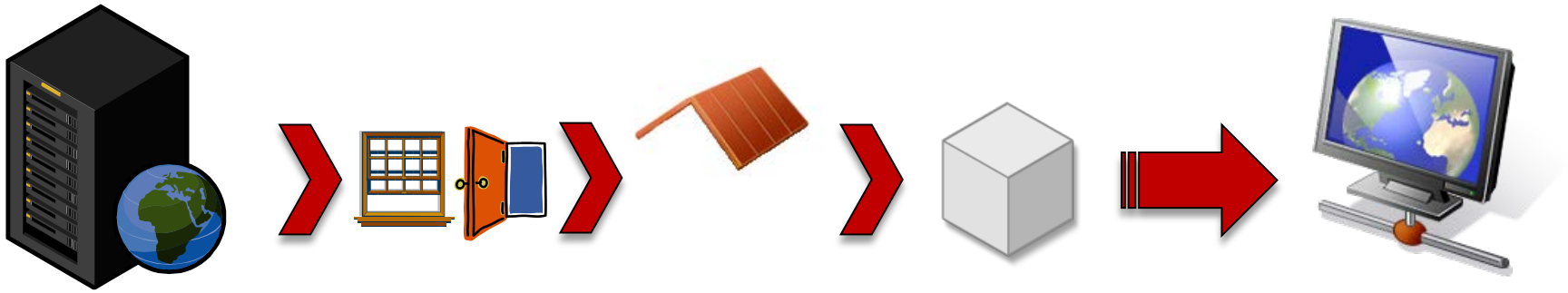

Server

Client

Simulations

Analyses

Visualizations

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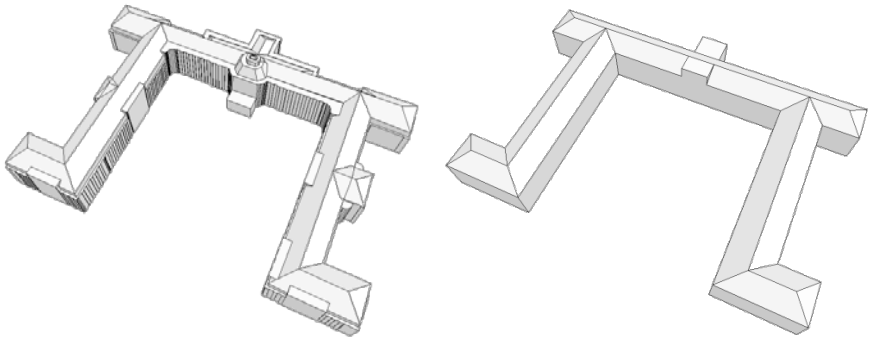
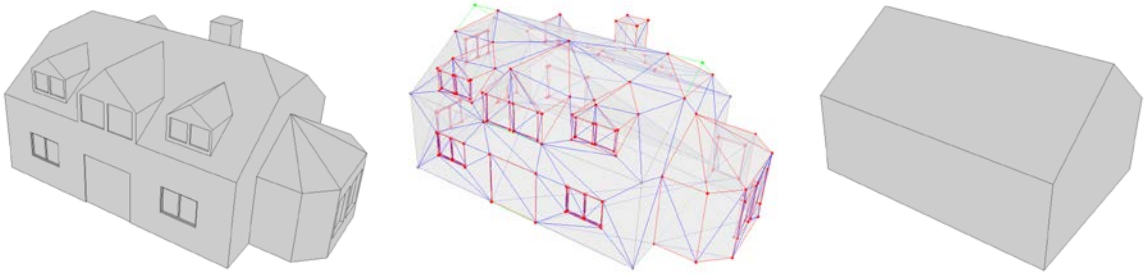
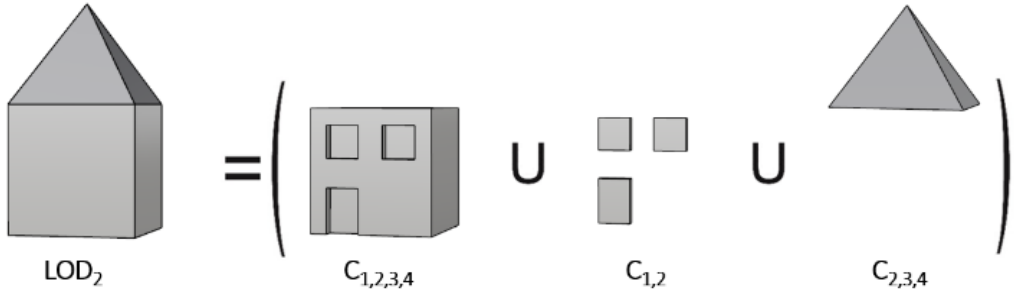
Operators for the cartographic generalization of 3D building models



Animation strategies for smooth transitions between levels of detail



Integrated modelling of multiple levels of detail



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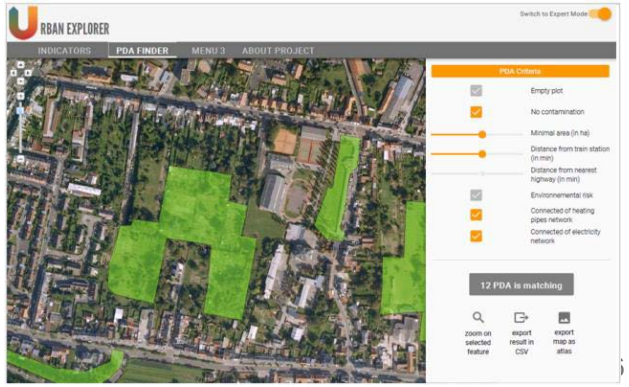

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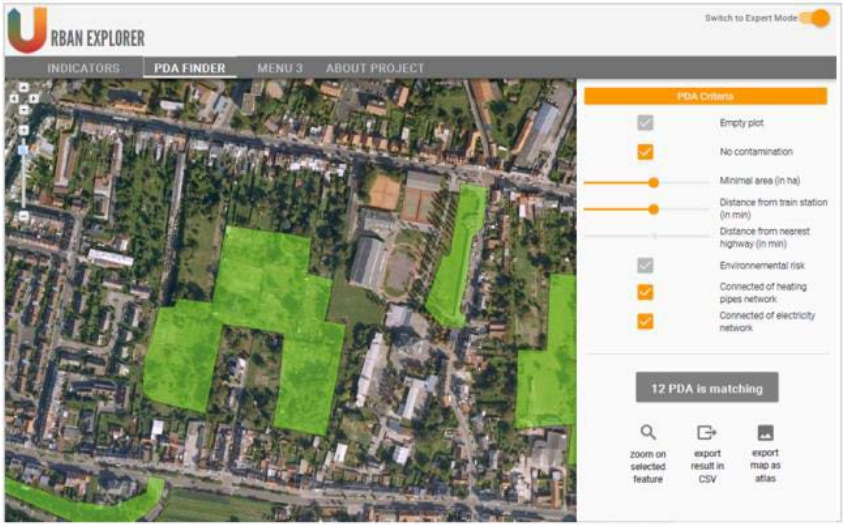
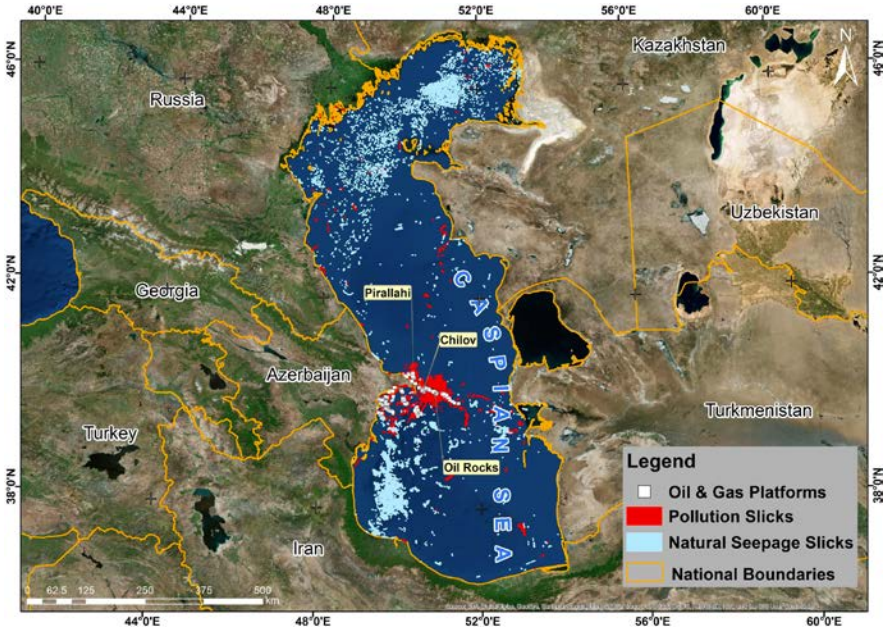


Vacant urban spaces
in European agglomerations



Oil spill pollution
in the Caspian Sea

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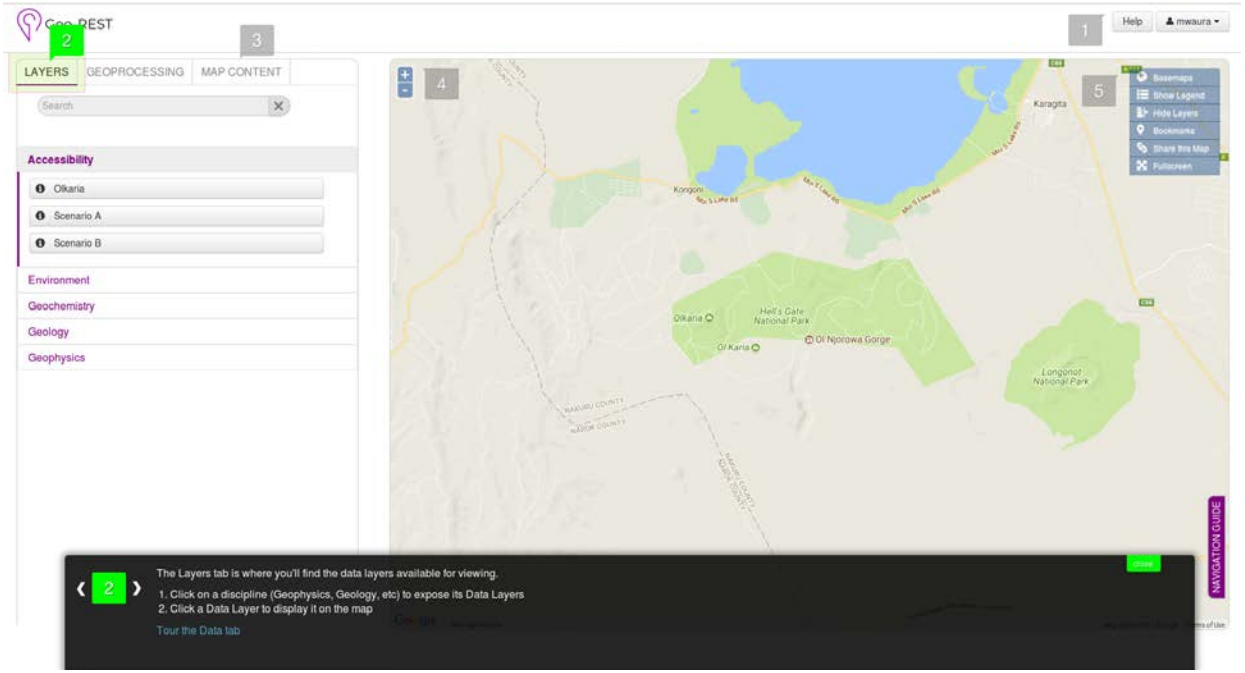
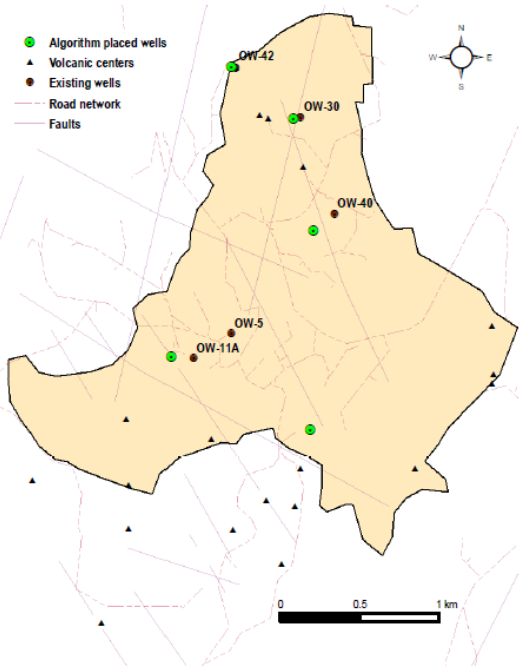


Planning of geothermal wells



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Thank you for your Attention!