Course introduction

GEO1004:
3D modelling of the built environment

https://3d.bk.tudelft.nl/courses/geo1004

3D geoinformation
Department of Urbanism
Faculty of Architecture and the Built Environment
Delft University of Technology

Ken Arroyo Ohori

Hugo Ledoux

Ravi Peters

guest
lecture

And you?

Name, experience and interest in 3D modelling

Course contents

- How is the built environment modelled in 3D?
  - Fundamentals / concepts
  - Data models and data structures
  - Guest lecture: reconstructing a city in LoD2
  - Applications

New-ish course

- Continuous improvements
  - 2020: Entirely new contents
  - 2022: 3D book
  - 2024: More info: Minkowski sum, new lesson
- Feedback is appreciated!

Prerequisites

- GEO1000 or knowledge of scripting/programming (in any language)
- GEO1002 or basic knowledge of (2D) GIS

- Optional: GEO1015 (Q2) covers complementary topics (2.5D vs 3D)

Blended learning

Beginning of contact hours:

1. Short lectures, demos, discussion
2. Hw intro, hw/exam feedback
3. Discuss hw progress, common issues

Rest of contact hours + your own time:

1. Answering questions, help with hw assignments
2. Study materials
3. Work on hw assignments

Contact hours?

- Per week:
  - Monday & Wednesday (13:45 - 15:30) - with ~1h of content + ~1h of help
  - Friday (10:45 - 12:30) - 2h of help
- Note: different classrooms! (check schedule)
- At other times, you can still ask questions on Discord. We might just take longer to answer.

Friday help sessions

Hidemichi Baba

student
assistant

Help with C++ setup and assignments

Fridays 10:45 - 12:30

Geolab

How to make the most of it

1. Keep up with the course schedule
2. Study (or at least skim) lessons in advance
3. If you have any doubts, ask questions
4. Make sure you can answer questions (at the end of book chapters)
5. Optional: read one or two external sources (in notes in each chapter)
6. Spend more time on assignments than on lessons

Lessons

- 1.2: Intro [K]
- 2.1: B-rep [K]
- 2.2: 3D DT / Voronoi [H]
- 3.2: Voxels [K]
- 4.1: ISO 19107 [H]
- 4.2: 3D city models [H]
- 5.1: MAT [K]
- 5.2: Curves [K]
- 6.1: CSG [K]
- 6.2: BIM [K]
- 7.1: LoD2 reconstruction [R]
- 7.2: G-maps / c-maps [K]
- 8.2: Applications [K]

Assignments

- Programming tasks using C++ and open source libraries
- 10% hw1, 20% hw2 and hw3

- 0: C++ preparation (no deadline / not marked)
- 1: Simple polyhedron processing (May 12) -> available from Monday
- 2: Creating a 3D city model from public datasets (May 28) -> available in week 4
- 3: BIM processing (June 13) -> available in week 6

Two exams (in person)

- Mid-term
  - Lessons 1.2 - 4.2
  - May 21
  - 5% of final mark
- Final
  - All lessons
  - June 23 @ 9:00
  - 45% of final mark
- Weighted average of 50% to pass the course

External help, plagiarism and AI

- You are welcome to use external help or AI assistants (eg ChatGPT, DeepSeek or Gemini), but in your final submission:
  - all significant parts of the work that you submit must be done by you, and
  - how you use form of external help is documented and acknowledged in the submission.
- If significant work not done by you...
  - and it is acknowledged: penalty on mark
  - but it is not acknowledged: considered as plagiarism with disciplinary action.
- How we check? by asking you to explain any part of code or report

External help, plagiarism and AI

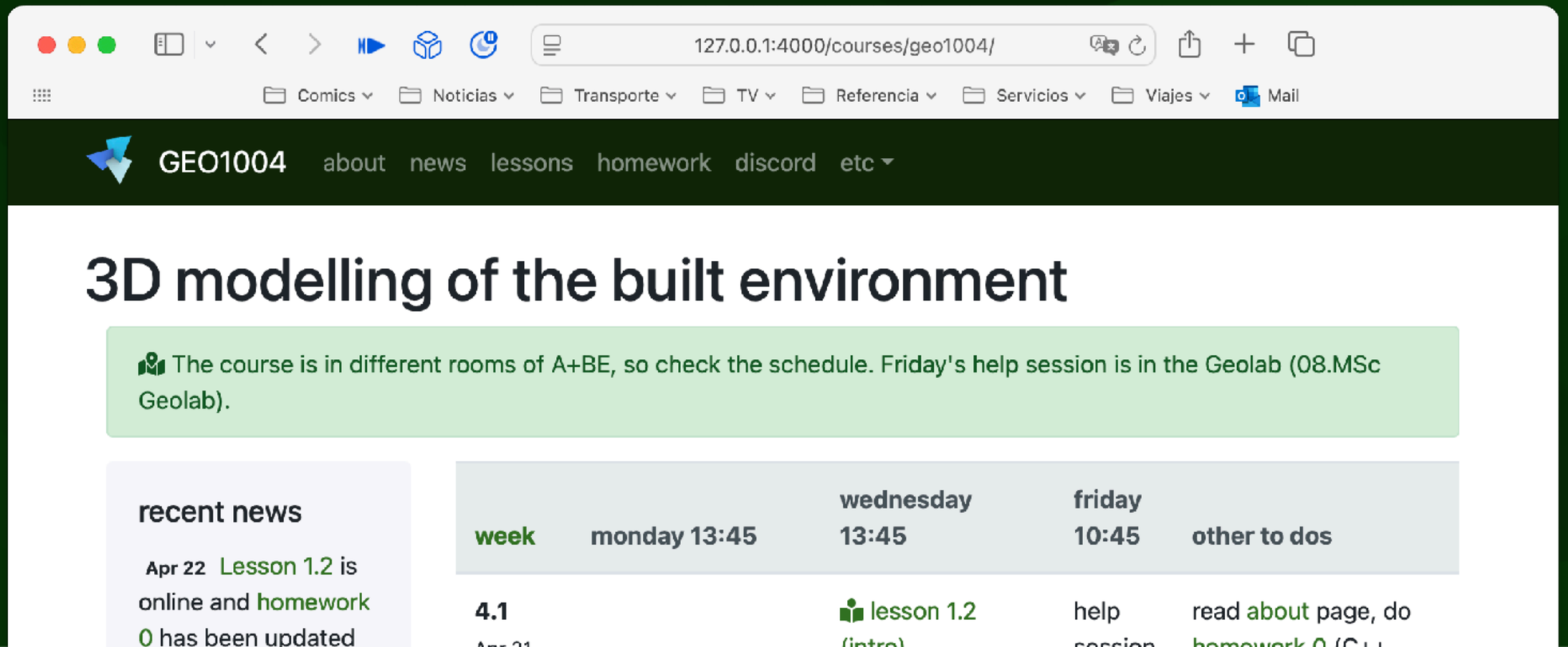
- Examples of good prompts:
  - How do I compute a normal vector?
  - What is the difference between a surface and a polygon?
  - How do I write to a file in C++?
  - How do I use the function ...?
  - How do I fix the error ...?
  - What should the sections of my report be?
  - What are some interesting plots I can include in my assignment about ...?
  - Rephrase this paragraph in a clearer way: ...

Resits

- One resit for both exams together (50%)
- One resit per assignment (mostly likely redo of assignment with modified tasks)
- July 14 @ 9:00

Course website

- No Brightspace!
- Everything is here: https://3d.bk.tudelft.nl/courses/geo1004/



Questions?

- In person during contact hours or Discord anytime:

- Don’t hesitate to ask! General software/programming questions are fine too
- If possible, use geo1004 channel -> everyone can benefit from answers
- E-mail or Discord DM for personal matters

Introduction to 3D modelling of the built environment

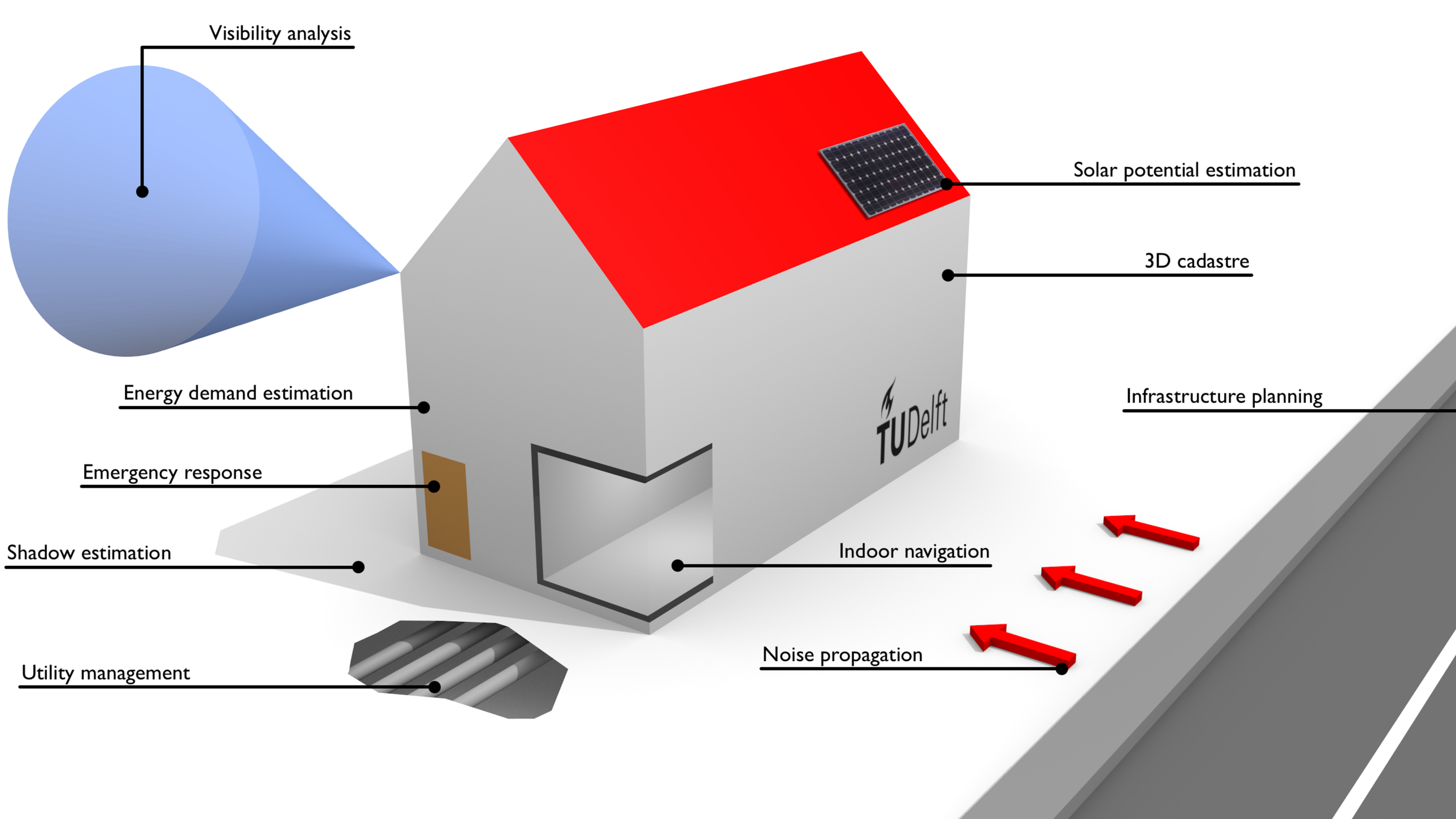
Introduction to 3D modelling of the built environment

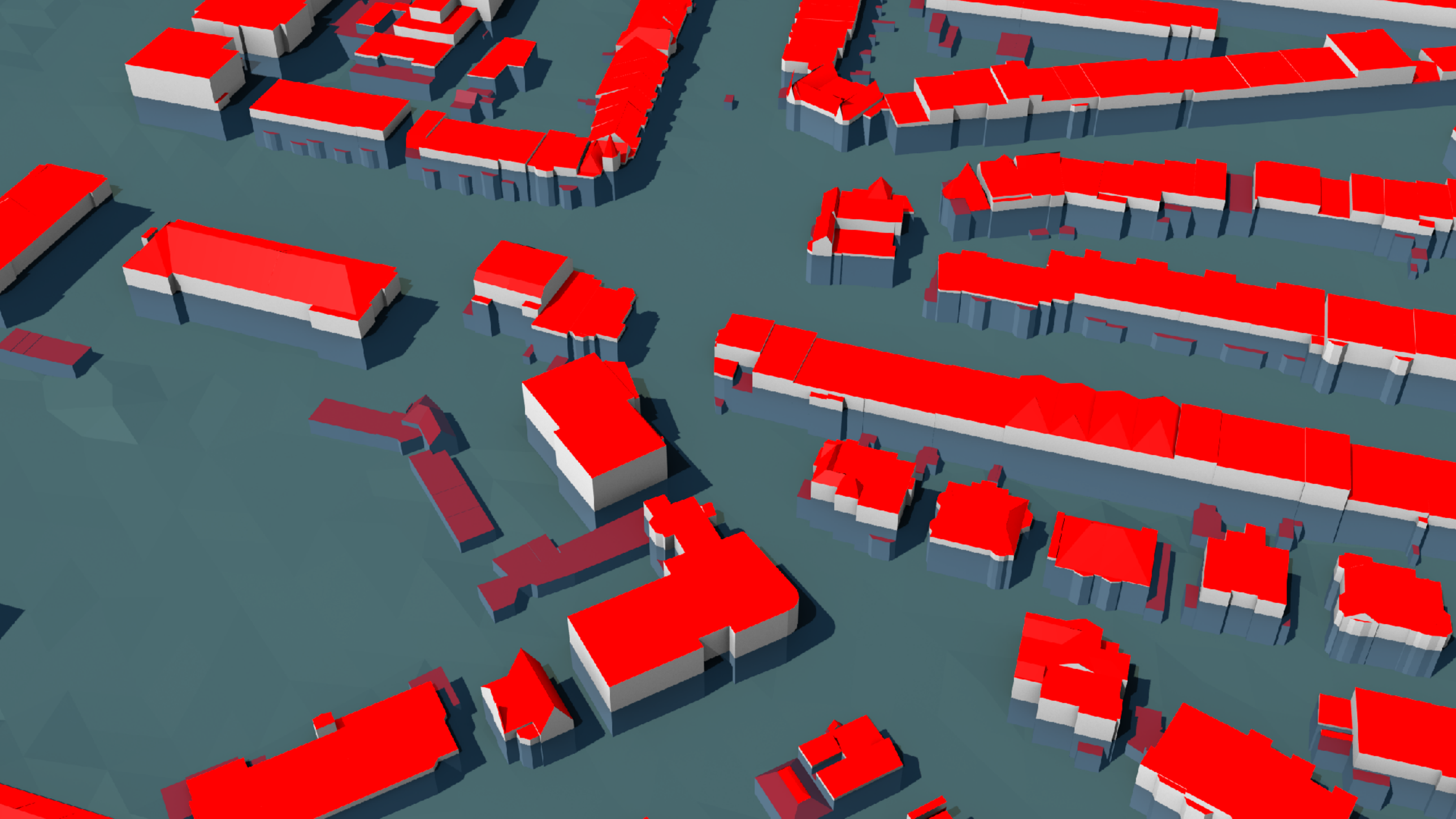
3D modelling of the built environment

- creation of 3D representations
- ...of anything, real world or not
- ...for animation, films, video games, industrial design, etc.

- focus on representations and techniques that are useful
- ...for real-world objects and fields
- ...in applications within geomatics and related fields

Why 3D?


Visibility analysis
Solar potential estimation
3D cadastre
Energy demand estimation
Infrastructure planning
Emergency response
Shadow estimation
Indoor navigation
Noise propagation
Utility management
TUDelft



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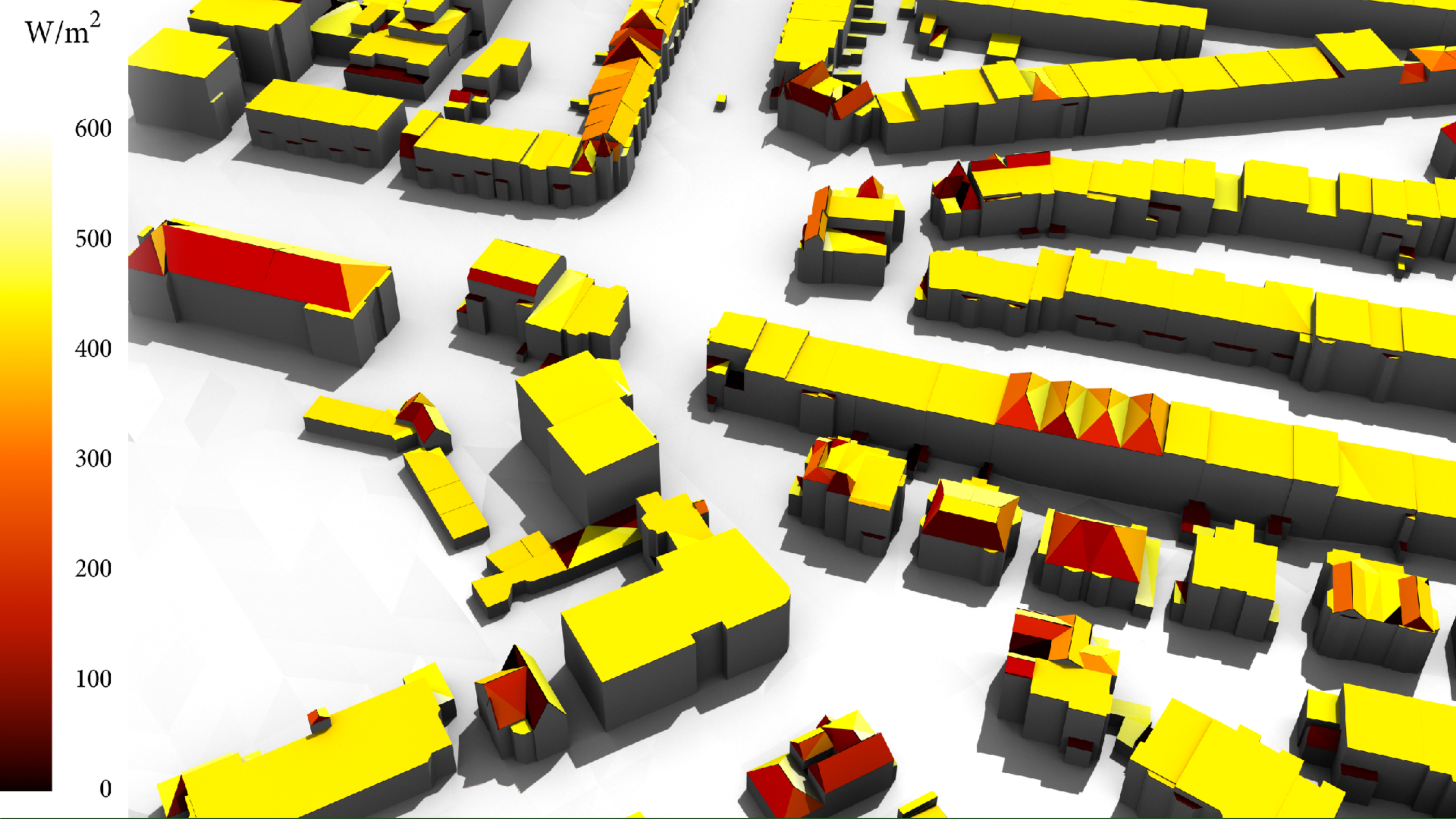
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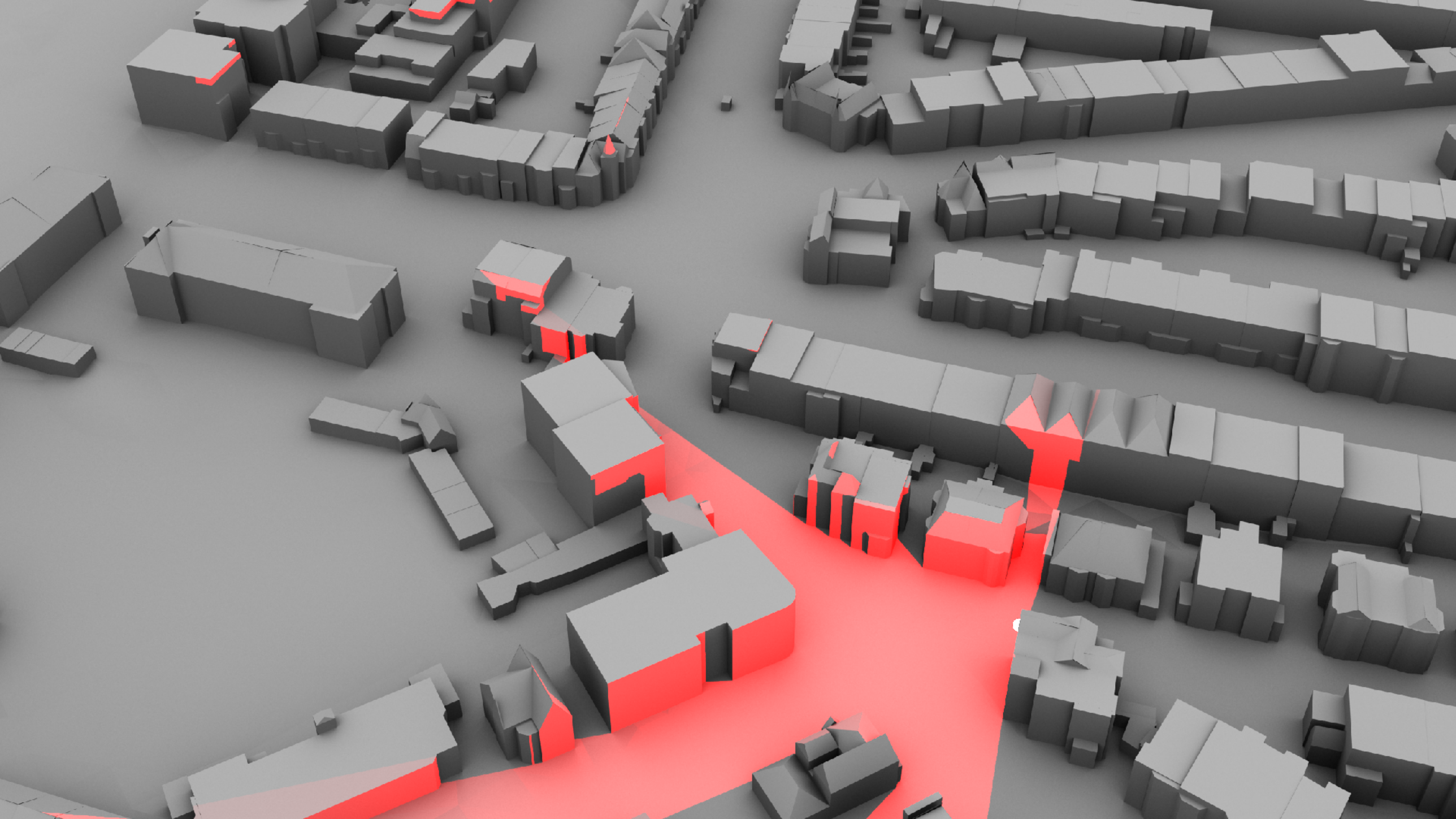
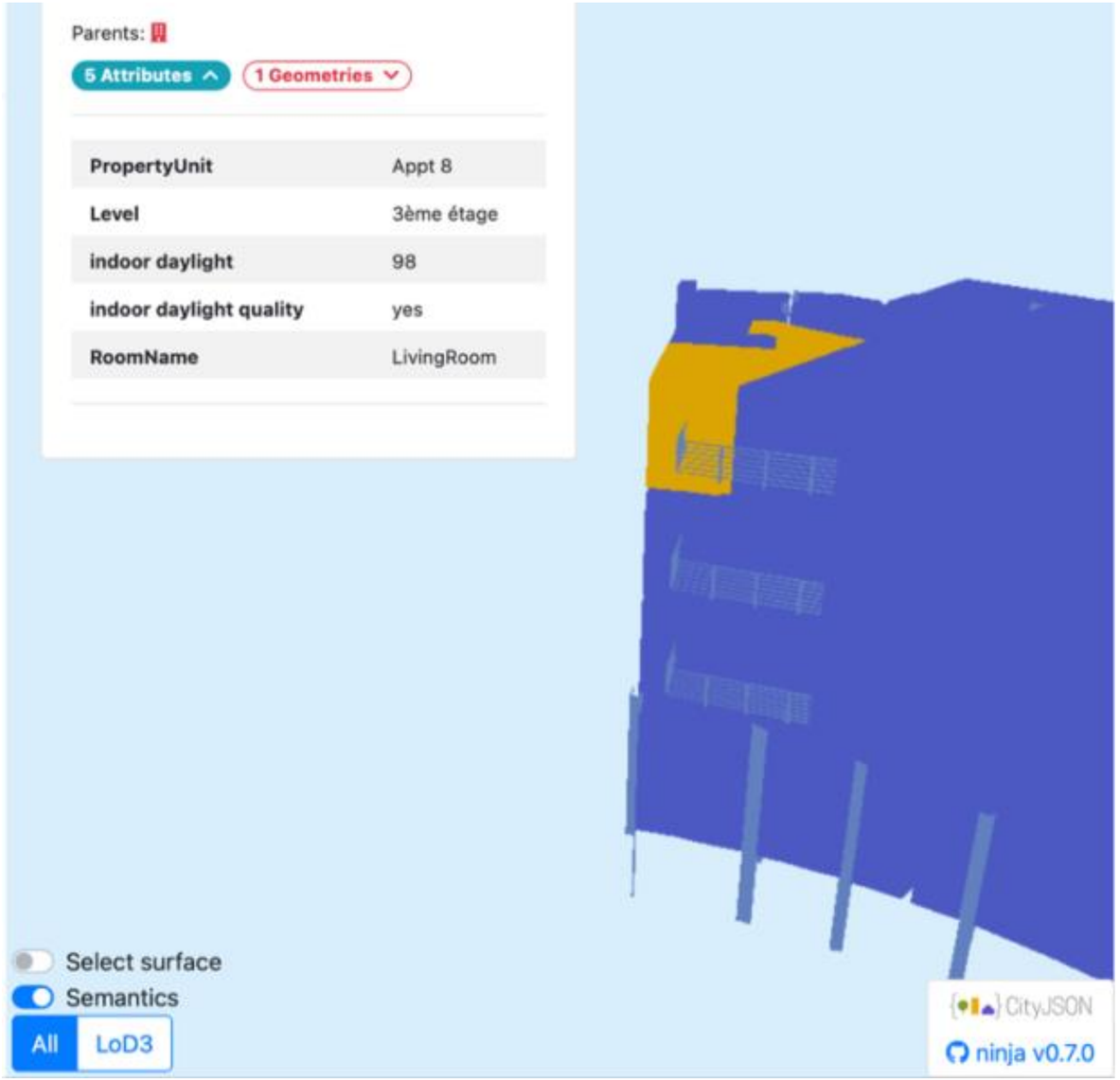


Other applications

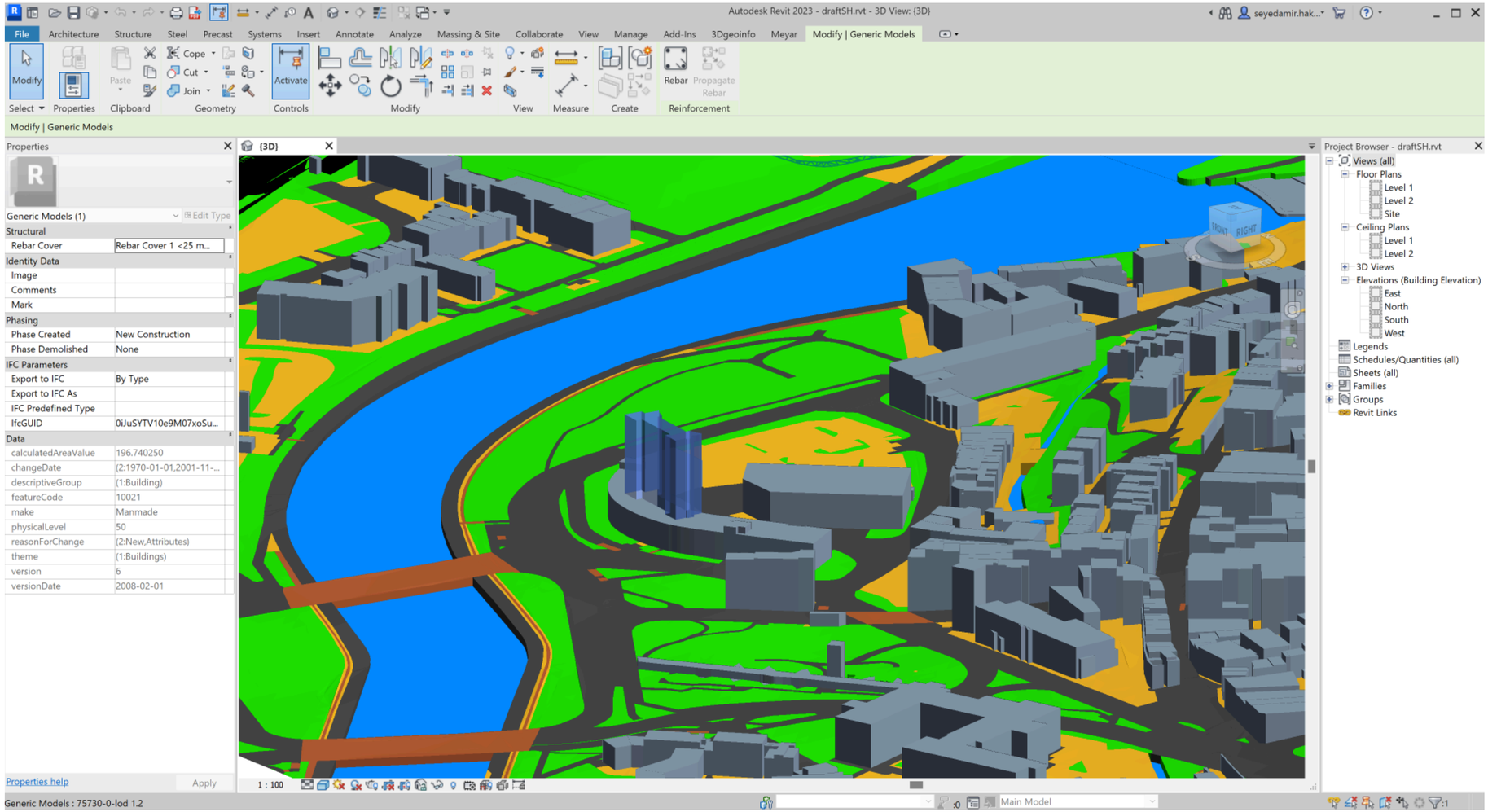
- Visualisation (eg for gaming, tourism, navigation, etc)
- Energy demand estimation (and potential for retrofitting)
- Computational fluid dynamics (eg for wind speeds, air quality, effects on buildings, etc)
- Shadow casting (eg for building permits, visibility analysis, improving energy demand/ solar potential calculations, etc)

Some nice recent-ish results

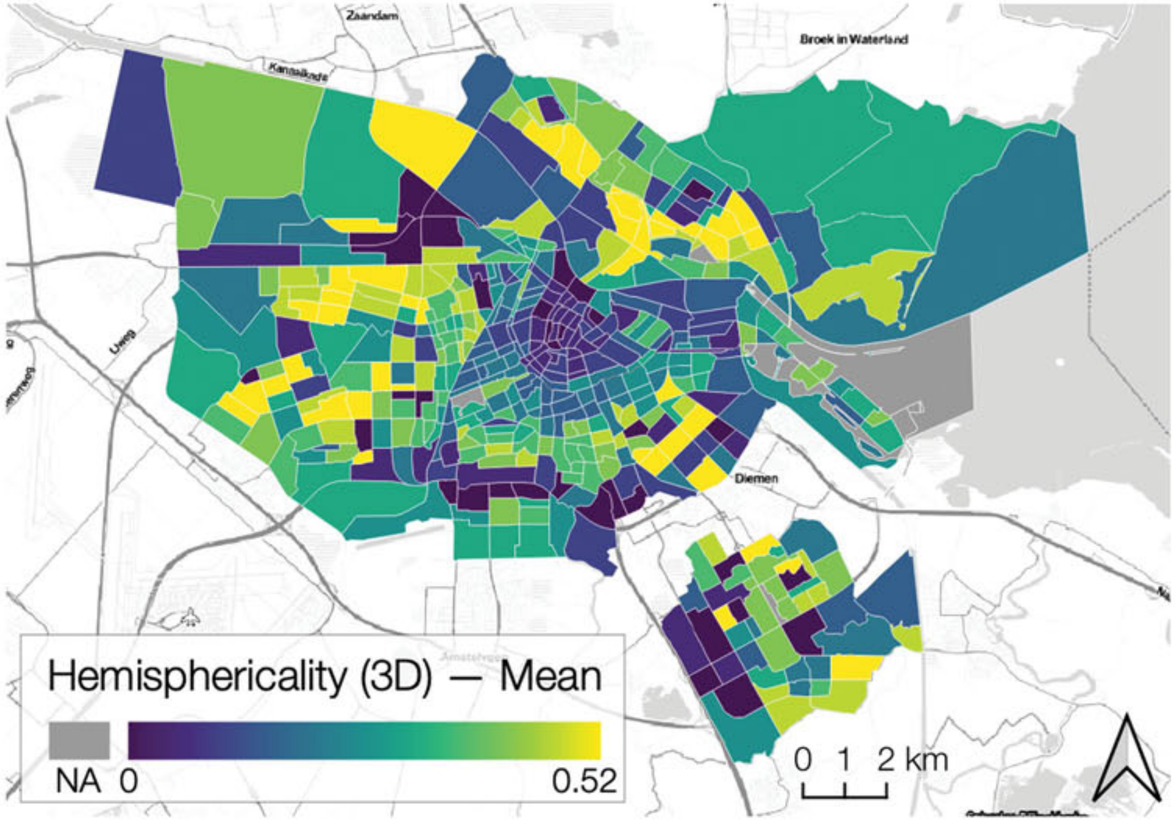
Property valuation

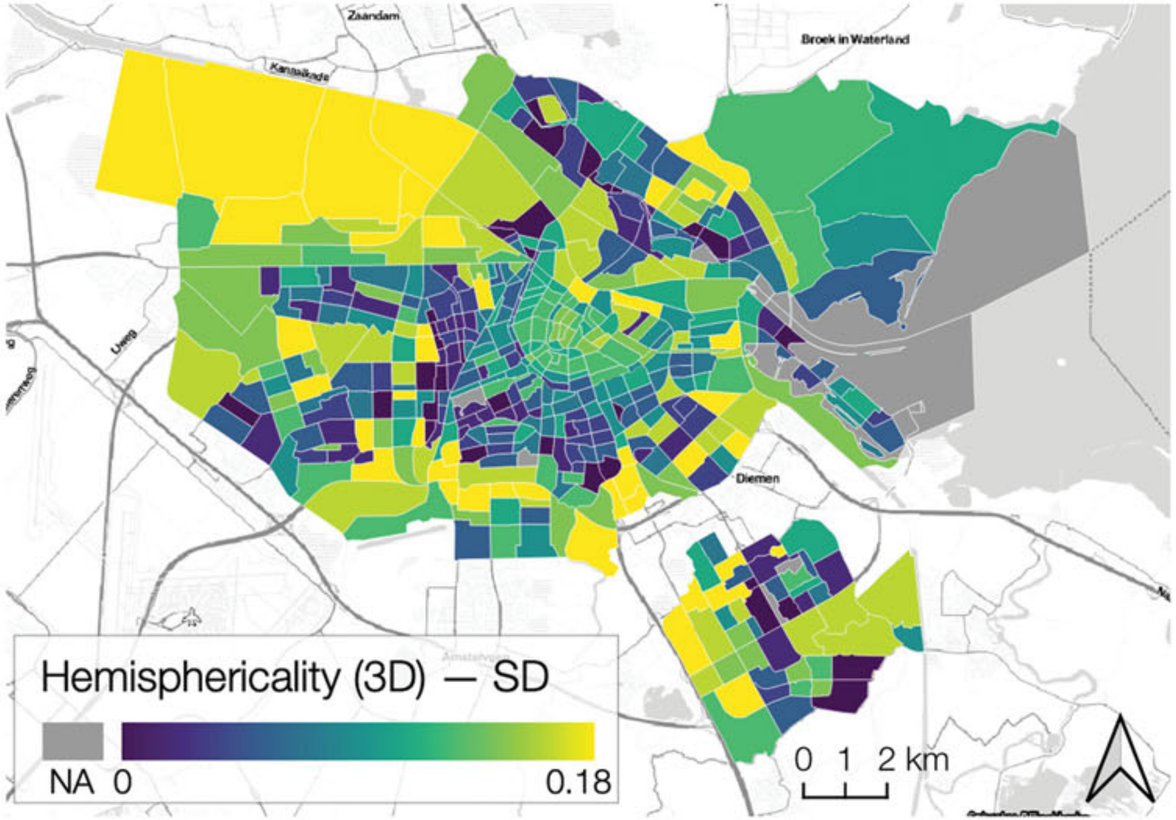


Importing 3D city models into Revit

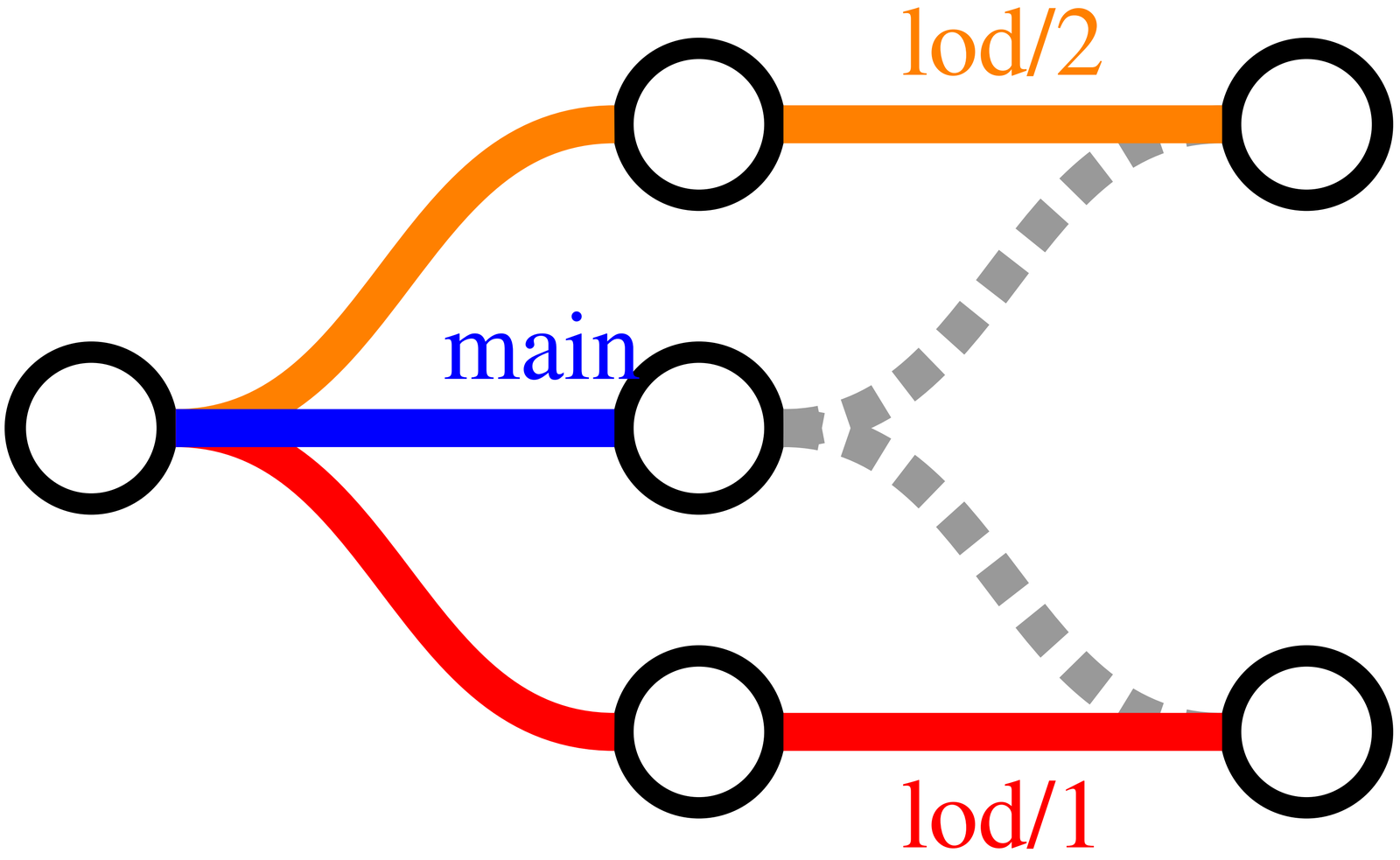


3D metrics to characterise neighbourhoods





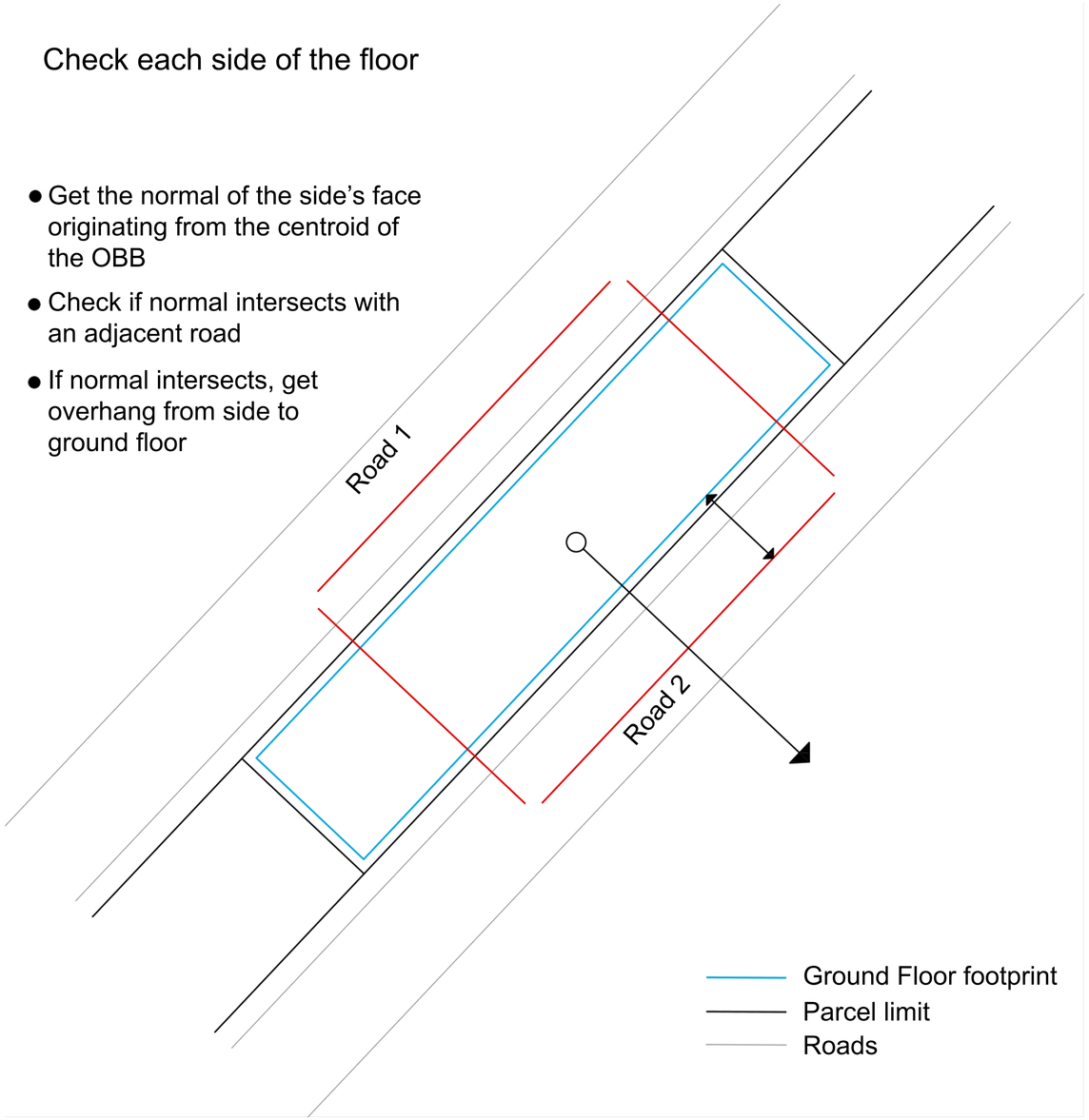
Applying versioning to 3D city models



Calculations for building permits

Check each side of the floor

- Get the normal of the side's face originating from the centroid of the OBB
- Check if normal intersects with an adjacent road
- If normal intersects, get overhang from side to ground floor



Homework 0 intro

Lesson 1.1 (intro)

- More of a glossary than a lesson. Read to know some important concepts and revisit it if you have doubts later in the course.
- Concepts behind the 3D modelling of the built environment:
  - Different ways to conceptualise 3D modelling process (abstractions vs. chain)
  - Geometry, topology and semantics: links to branches of mathematics
  - Objects vs. fields
  - Data models and data structures

What to do next?

1. Today:
   - Homework 0 (install required software for C++ assignments)
   - Go to geo1004 website and study today's lesson (3D book Chapter 1)
   - If you have extra time, study Monday's lesson (3D book Chapter 2)
2. Monday: short lecture on b-rep, intro to homework 1 and help with any questions about this week's lessons or C++ installation

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References

- [23-27]: Level of detail in 3D city models. Filip Biljecki.
- [30]: Towards extending CityGML for property valuation: property valuation ADE. Siham El Yamani, Rafika Hajji, Roland Billen, Ken Arroyo Ohori, Jasper van der Vaart, Amir Hakim and Jantien Stoter
- [31]: Development of a Geo to BIM converter: CityJSON importer plugin for Autodesk Revit. Amir Hakim, Jasper van der Vaart, Ken Arroyo Ohori and Jantien Stoter.
- [32]: 3D building metrics for urban morphology. Anna Labetski, Stelios Vitalis, Filip Biljecki, Ken Arroyo Ohori and Jantien Stoter.
- [33]: Applying versioning to 3D city models. Stelios Vitalis, Ken Arroyo Ohori and Jantien Stoter.
- [34]: GeoBIM information to check digital building permit regulations. Nadine Hobeika, Jordi van Liempt, Francesca Noardo, Ken Arroyo Ohori and Jantien Stoter.