

(Semi-)automatic modeling of indoor building 3D models for daylight simulation with LiDAR-enabled mobile devices



P5
Final Thesis Presentation

Supervisors

1st supervisor: Dr.ir. G.A.K. Arroyo Ohori MSc

2nd supervisor: Dr. E. Brembilla

3rd supervisor: N. Forouzandeh Shahraki MSc

Giorgos Iliopoulos

#5842247

Delegate

Ir. H.W. de Wolff

Co-reader

Dr. A. Rafiee

16 January 2026

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- Research questions
- Methodology
- Results
- Conclusions & Limitations



Introduction / Daylight & Indoor environments



Photo by Donald Tong on Pexels.



Photo by Marc Mueller on Pexels.





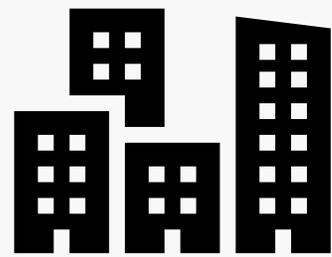
Introduction / Daylight & Indoor environments



Physiologically



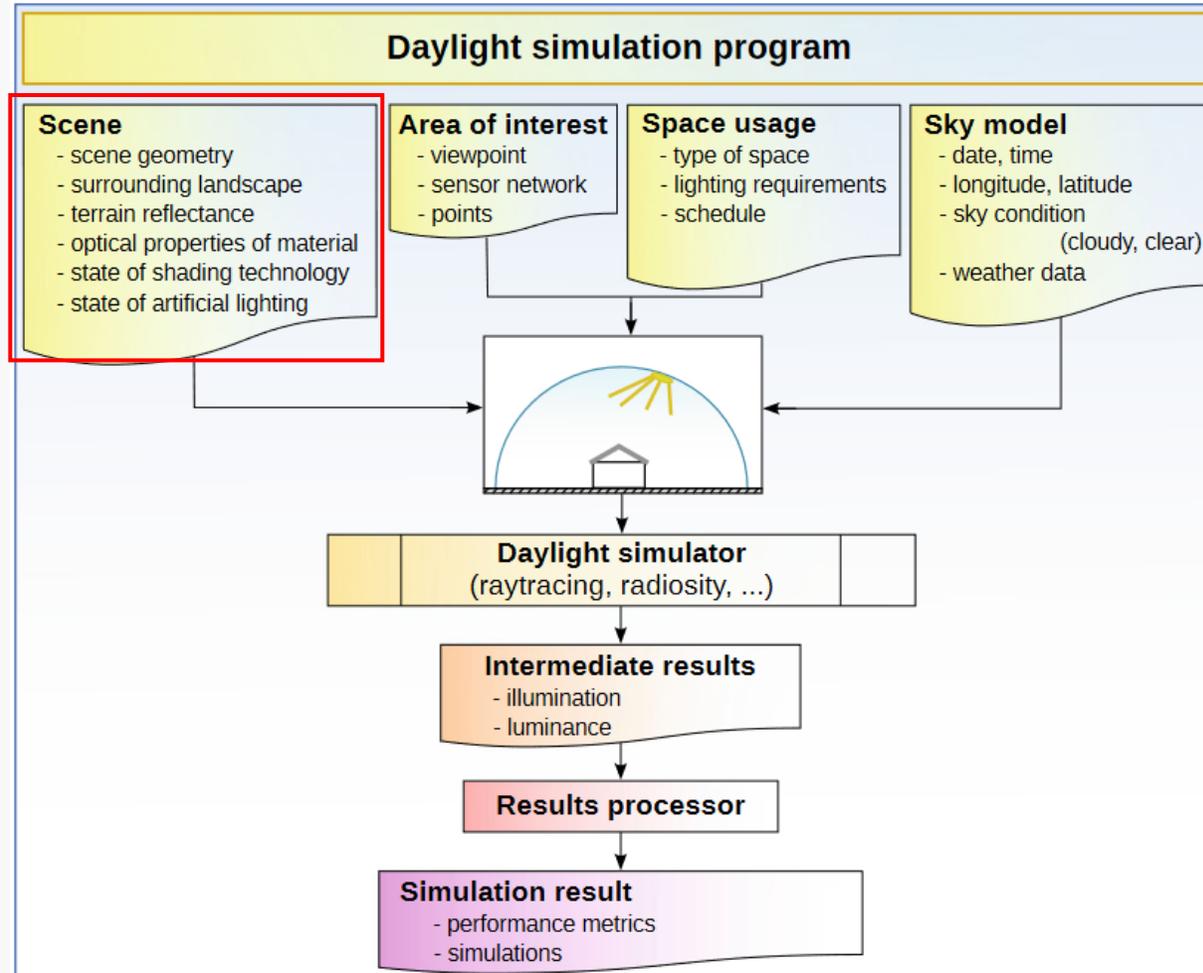
Psychologically



Heating / Cooling
+
Lighting



Introduction / Daylight simulations



Hensen and Lamberts (2019) as cited in Dolníková (2025)



Introduction / 3D modeling



Measure tape
Junkyardsparkle,
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Total station.
Photo by Anthony Desrochers on [Pexels](#)



Leica Terrestrial LiDAR Scanner by David Monniaux, CC BY-SA 3.0, via [Wikimedia Commons](#)



Microsoft HoloLens by Microsoft Sweden,
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Rear camera of an iPhone 15 Pro Max by Ayamano2021,
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Introduction / 3D modeling

3D reconstruction

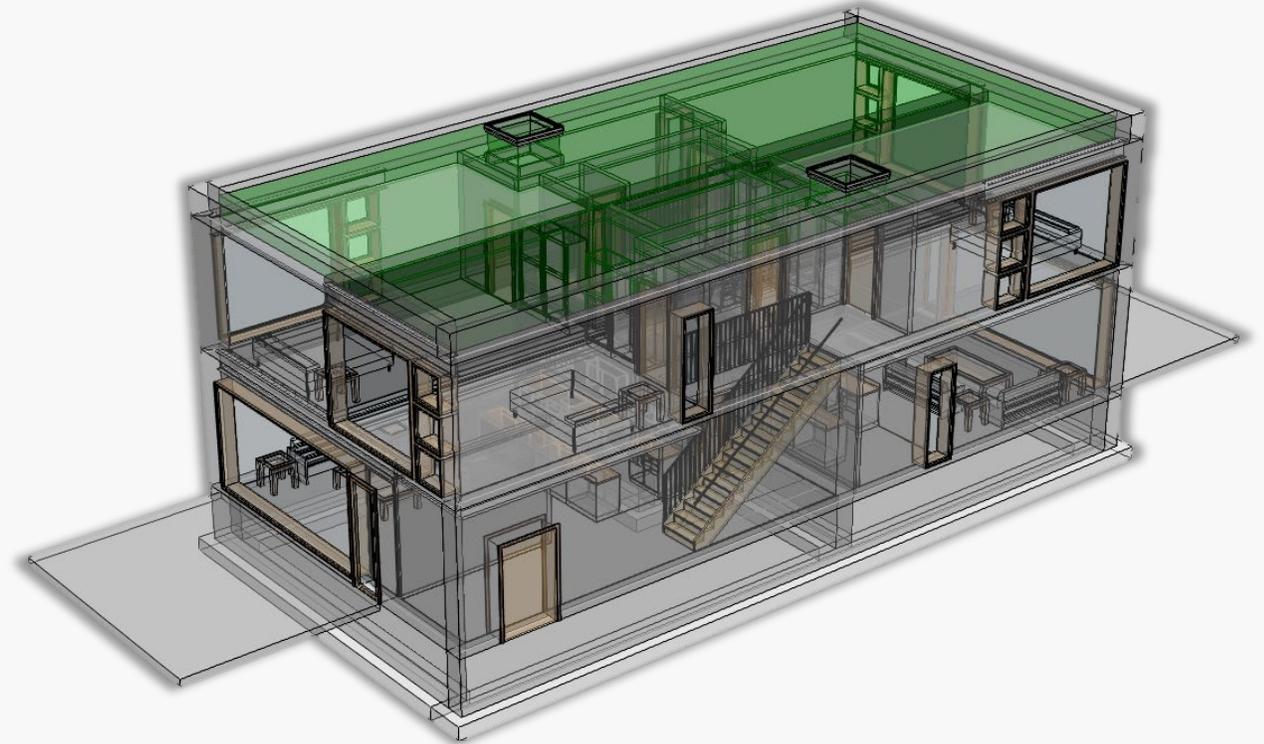
Geometric modeling is the process of constructing simplified representations of the 3D shape of building components, such as walls, windows, and doors, from point cloud data.

Semantics

Semantic modeling is the process of labeling a set of data points or geometric primitives extracted from the data with a named object or object class.

Topological modeling

Relationship modeling refers to the modeling of spatial relations between objects (i.e., aggregation, topological, directional)



Duplex apartment IFC test model from: <https://github.com/youshengCode/IfcSampleFiles>



Introduction / RoomPlan



Source: <https://developer.apple.com/augmented-reality/roomplan/>



Research questions

Main research question

“How feasible and accurate is the use of iPhone for generating 3D indoor models suitable for daylight simulation?”

Sub-questions

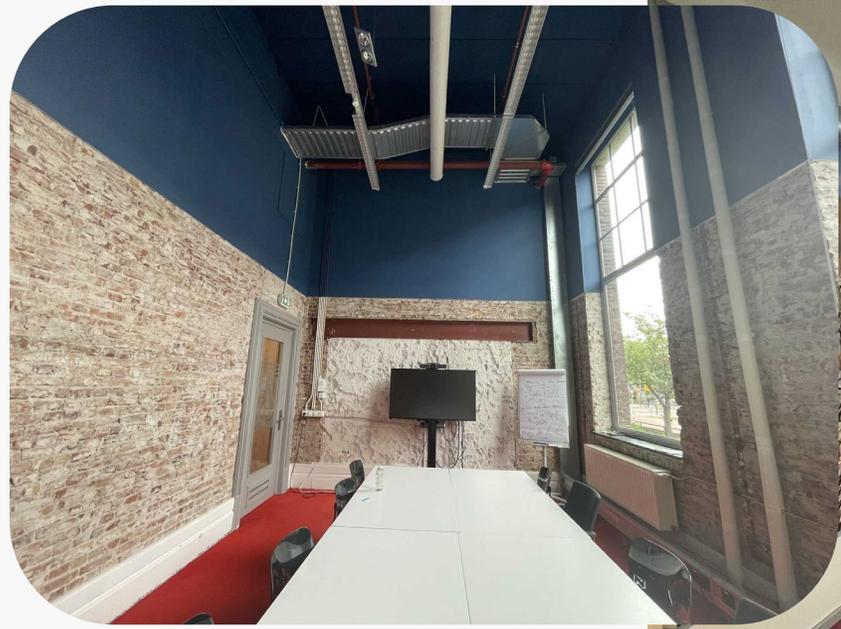
1. What are the possibilities of using the RoomPlan API and accessing data from iPhone’s sensors for daylight simulations?
2. How can the RoomPlan API’s model be transformed into a format compatible with daylight simulation tools?
3. How do RoomPlan generated models perform compared to manually reconstructed models with respect to geometrical accuracy and daylight simulations results?



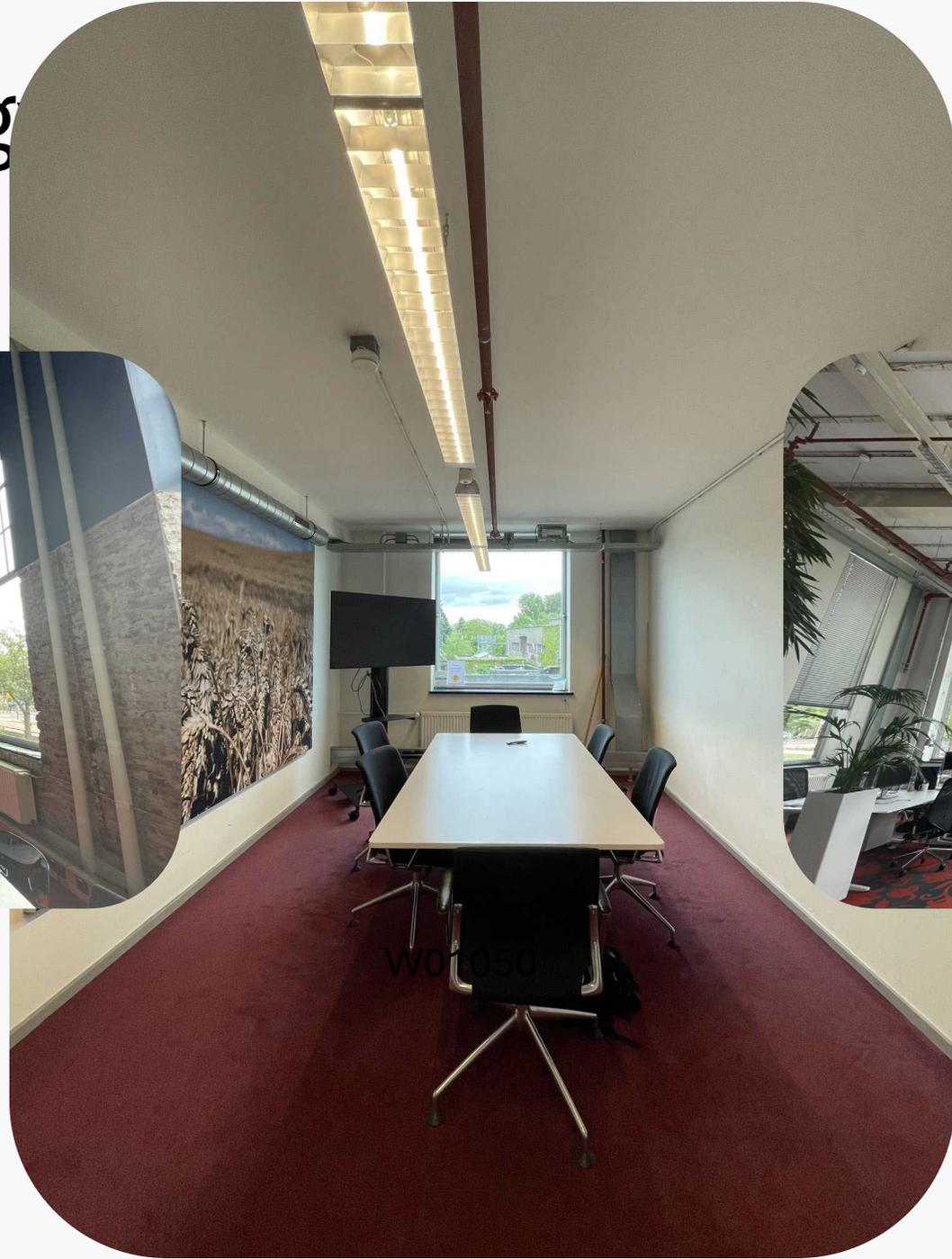
Methodology



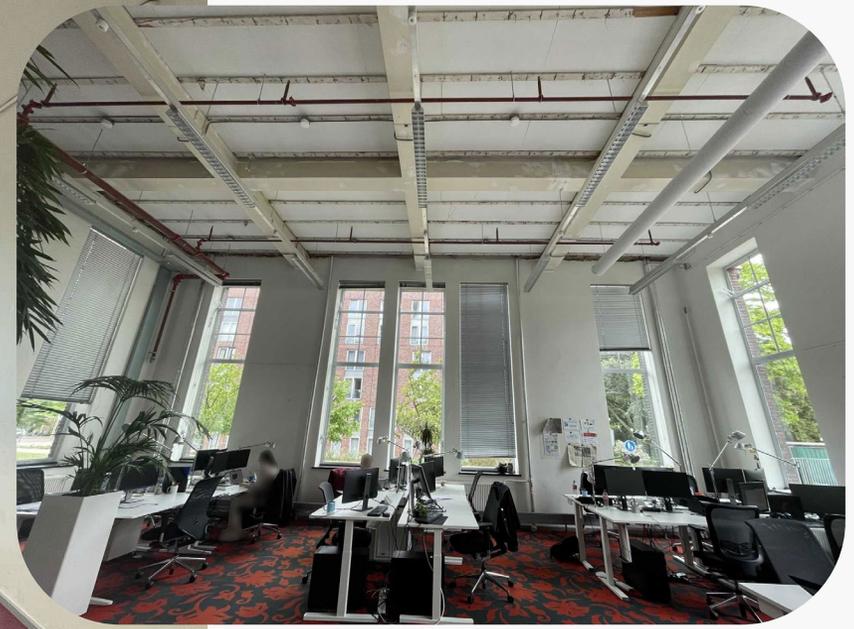
Methodology



BGW640



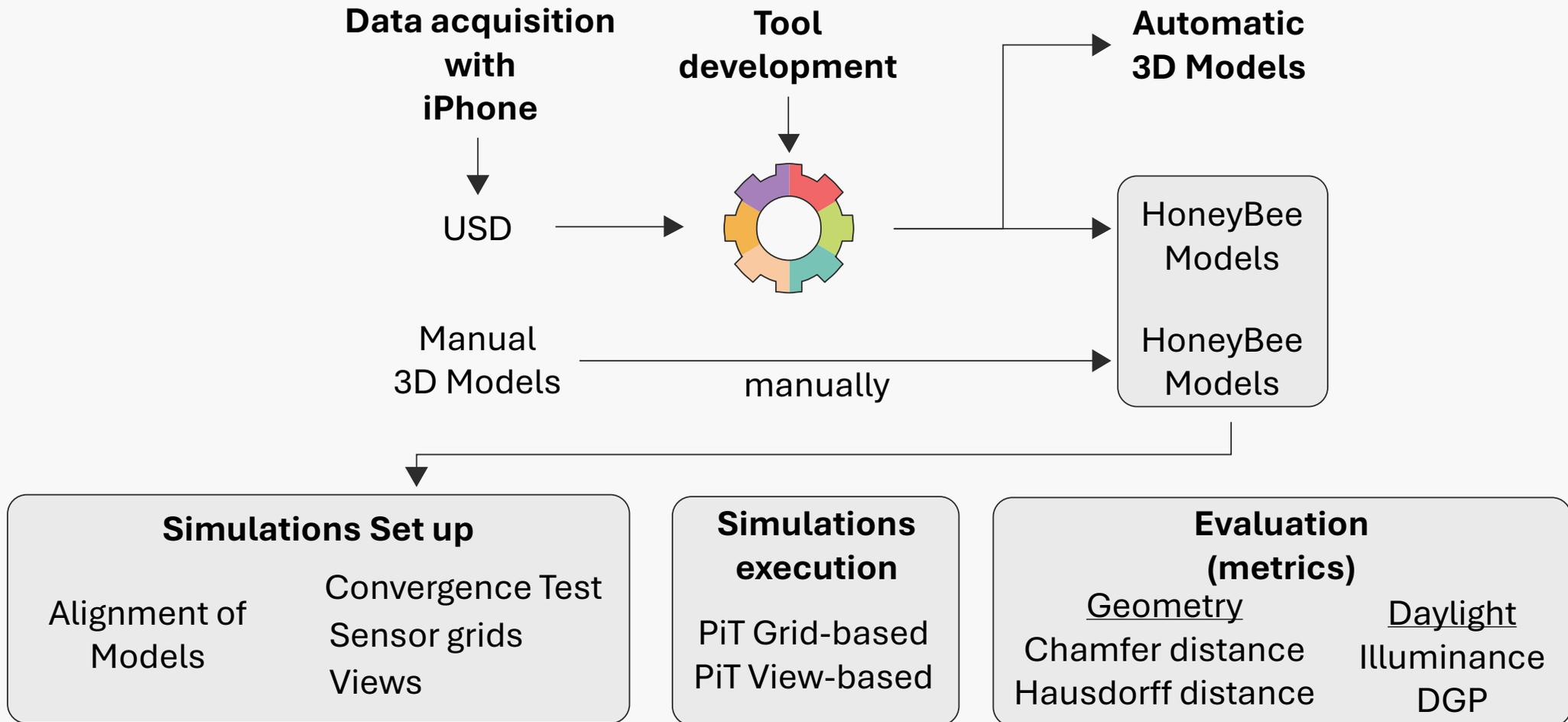
W01050



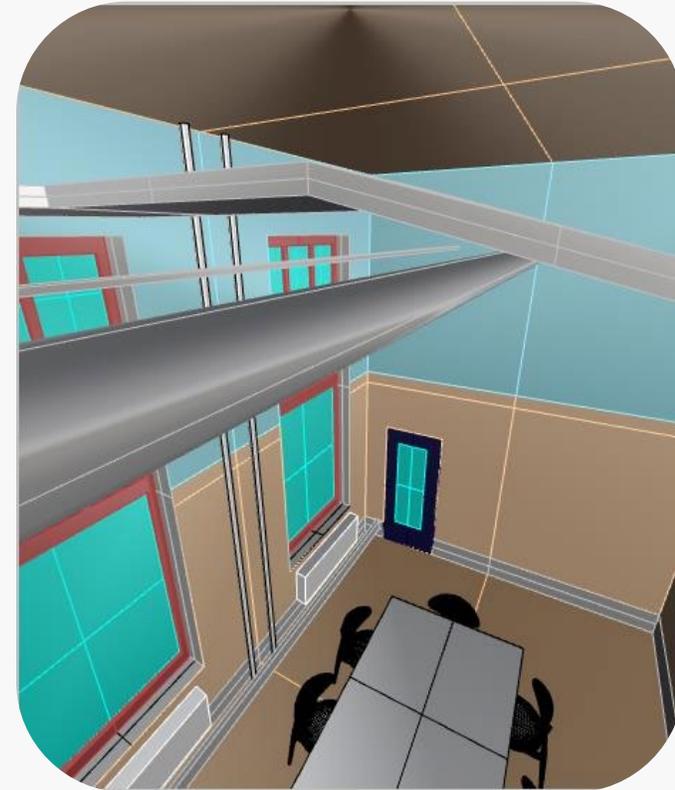
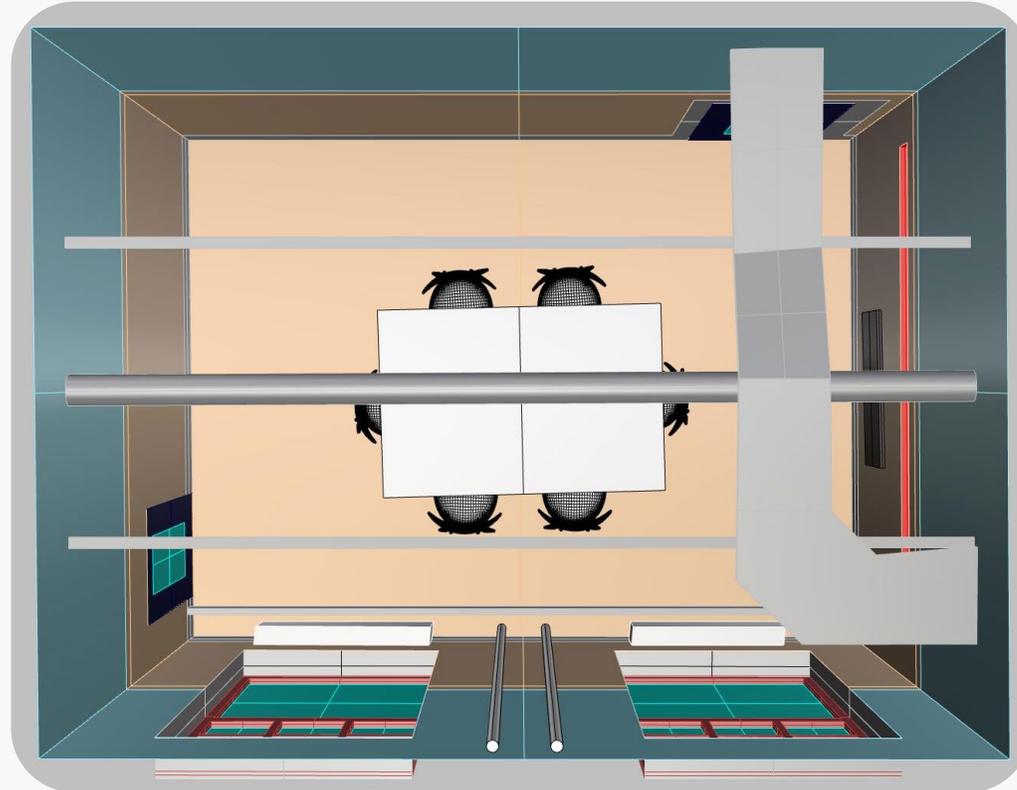
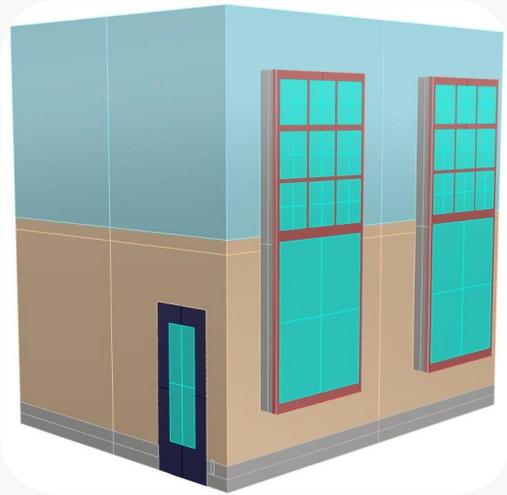
GeoinfoLab



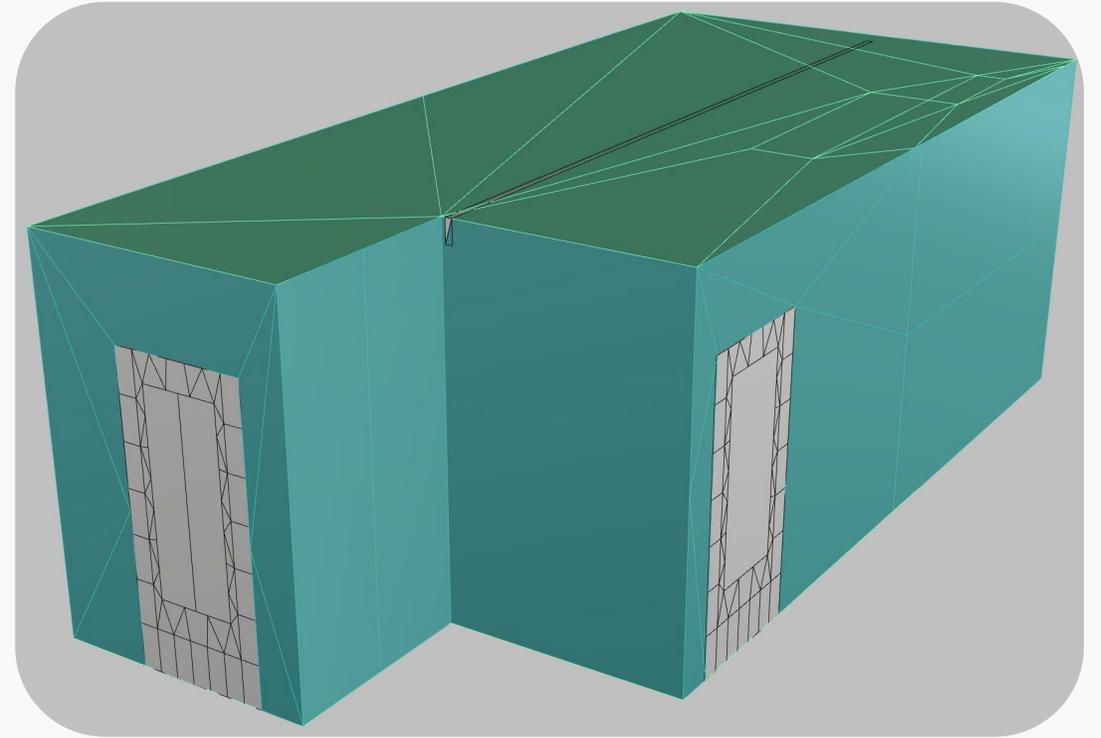
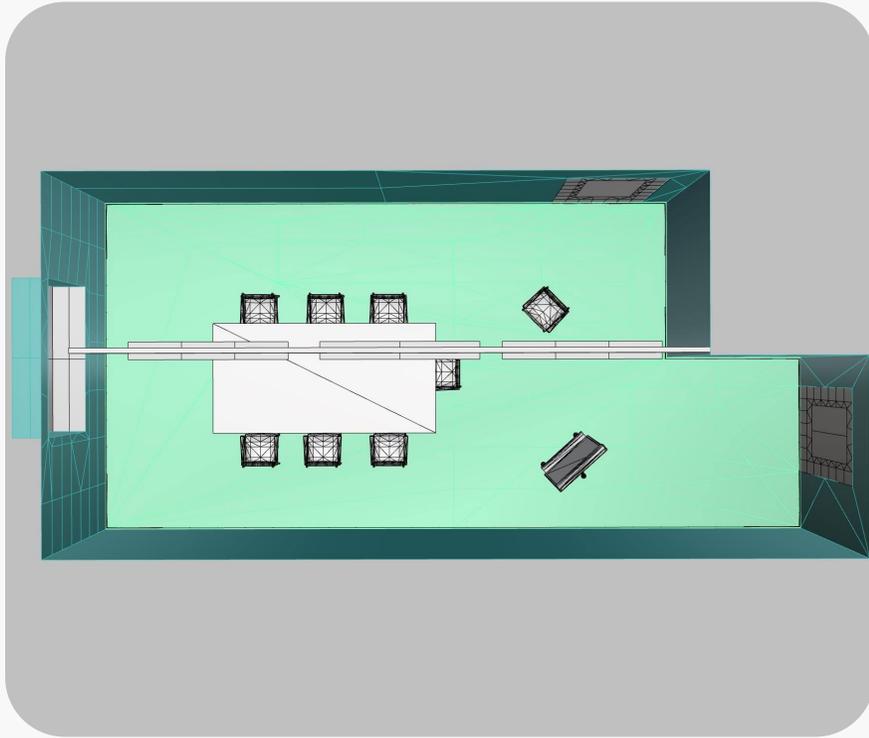
Methodology



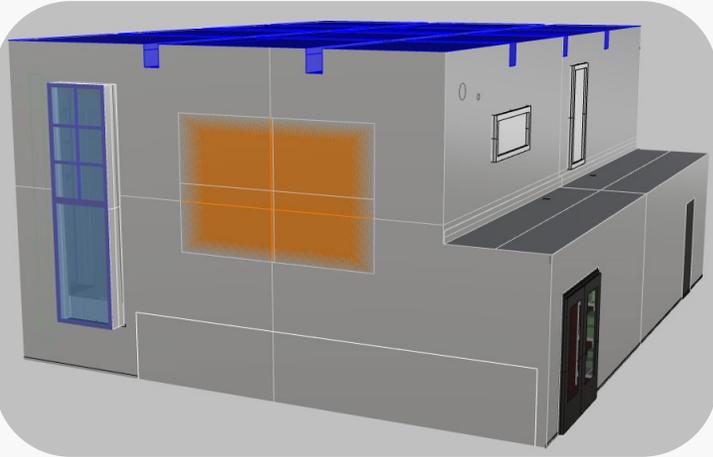
Data/Manual/Room BGW640



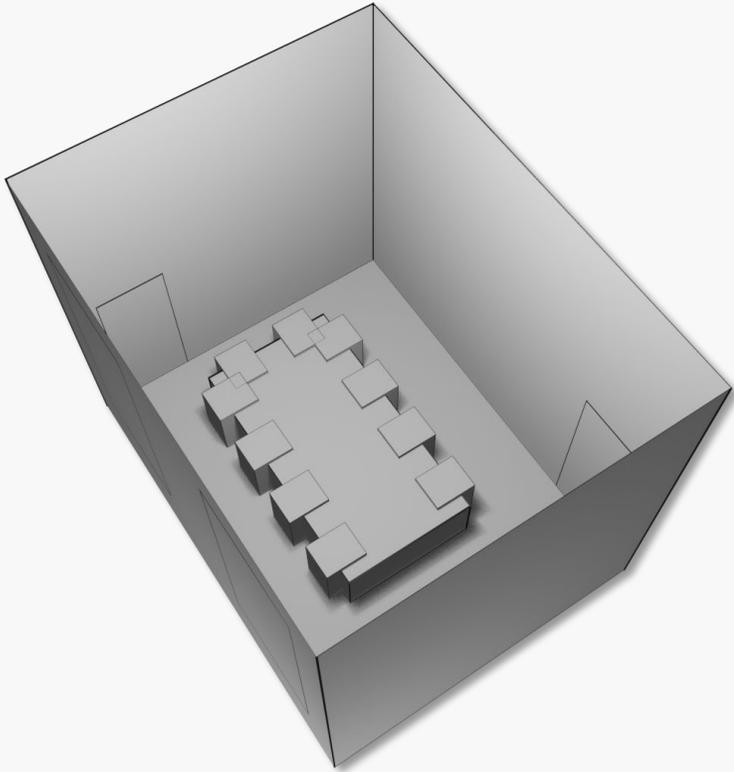
Data/Manual/Room 01050



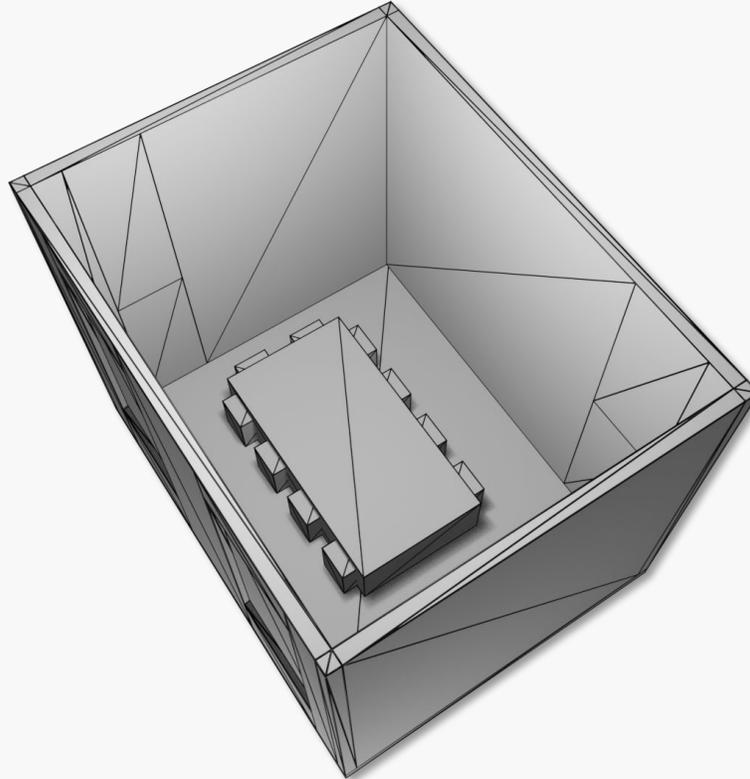
Data/Manual /GeoinfoLab



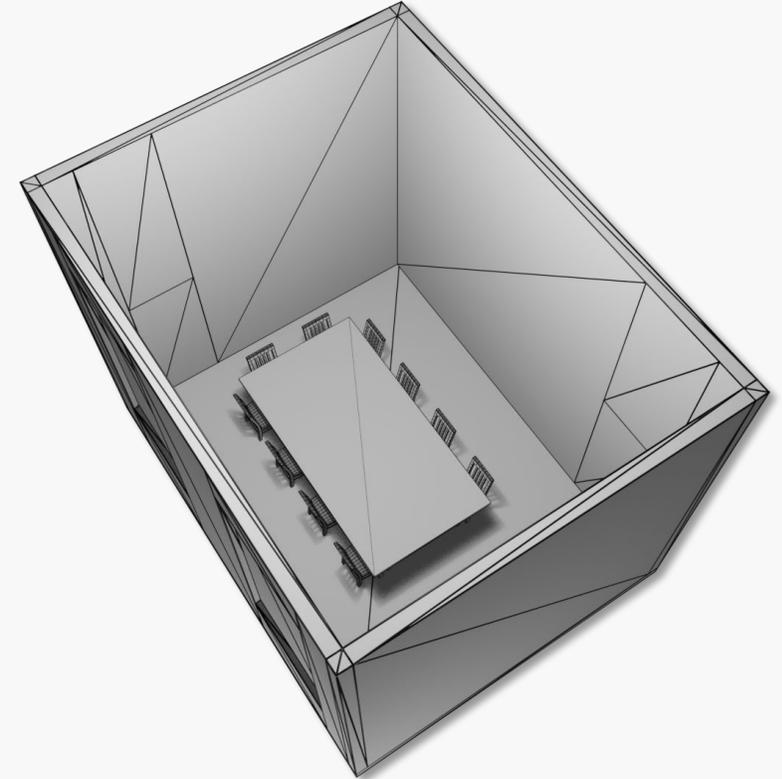
Data/RoomPlan/Room BGW640



Parametric



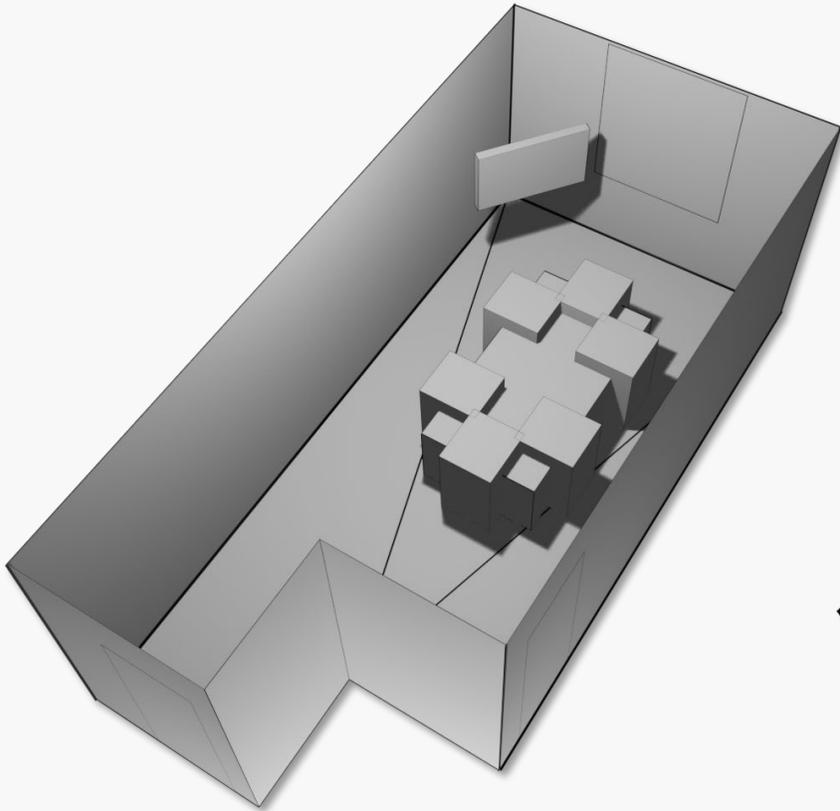
Mesh



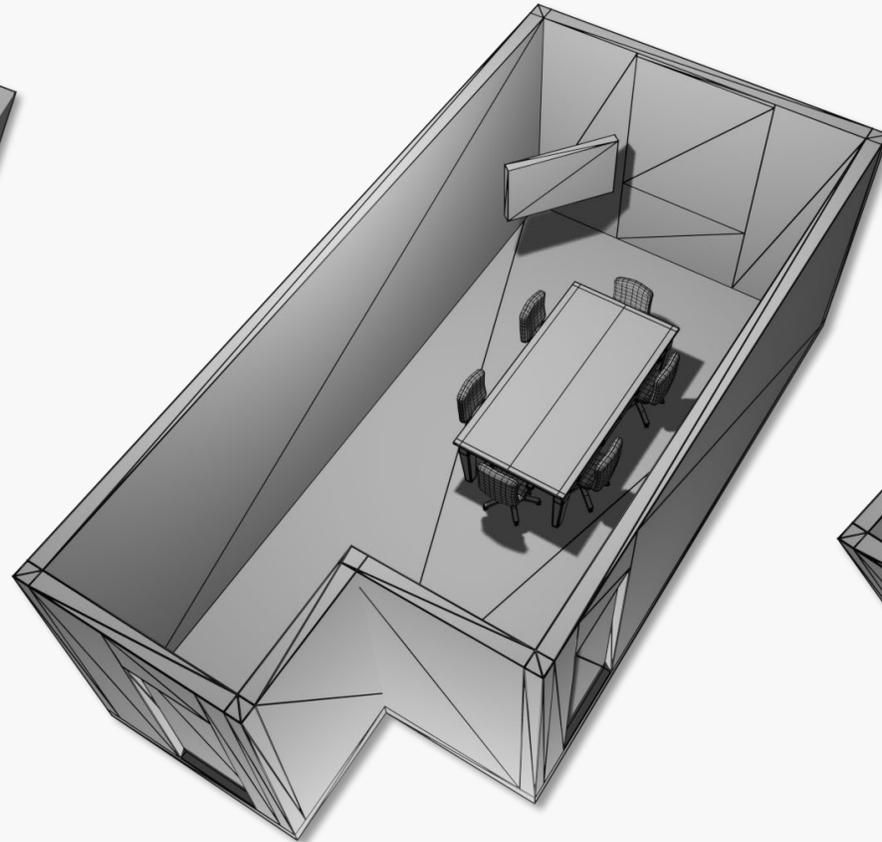
Model



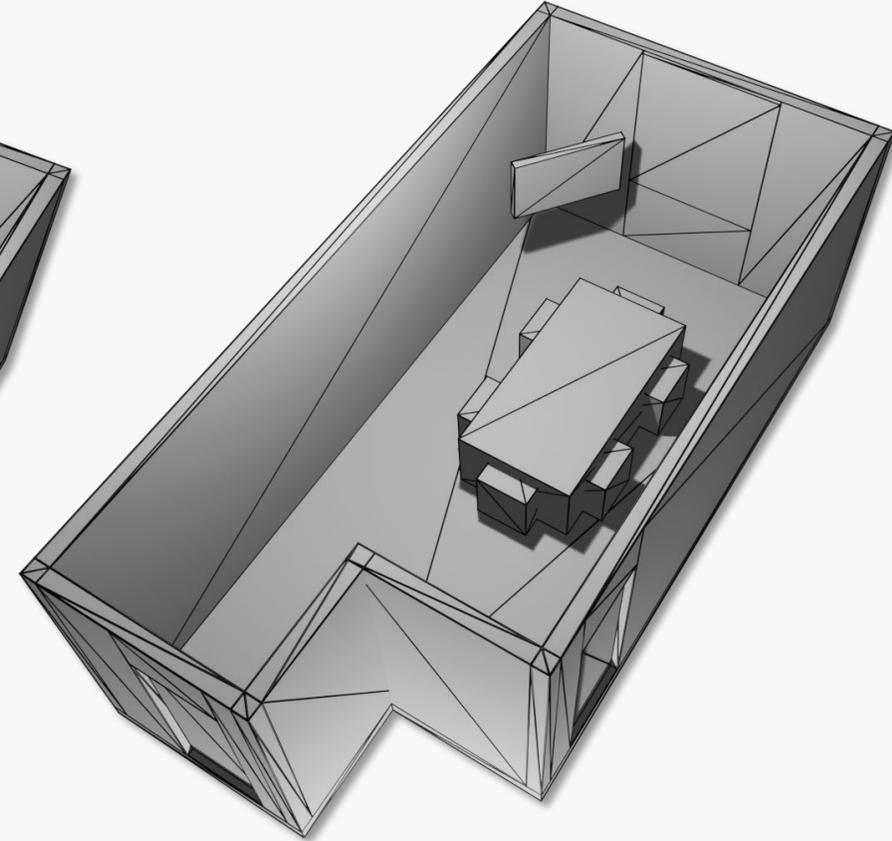
Data/RoomPlan/Room 01050



Parametric



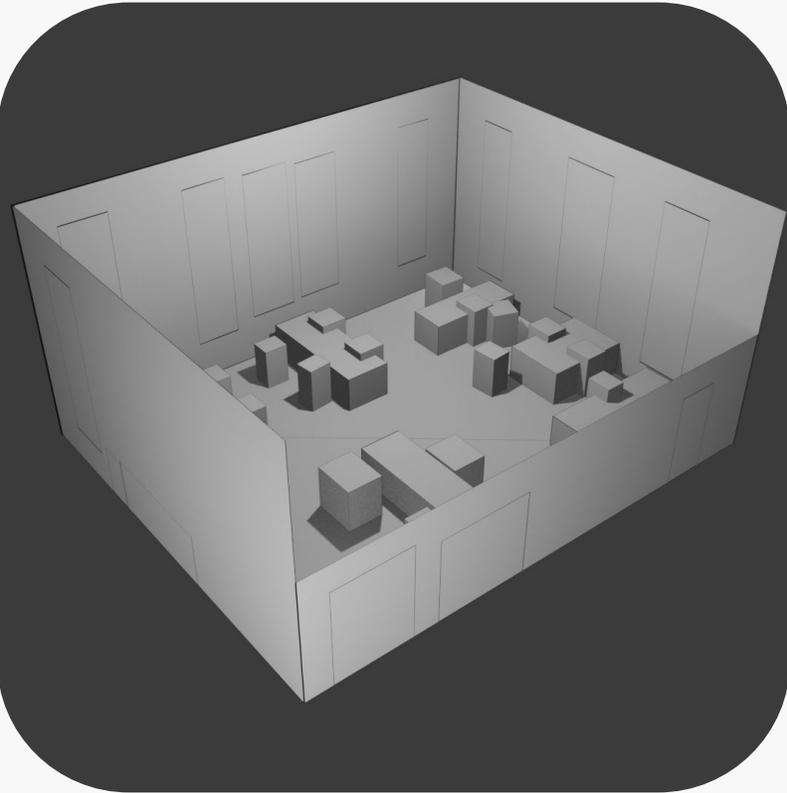
Mesh



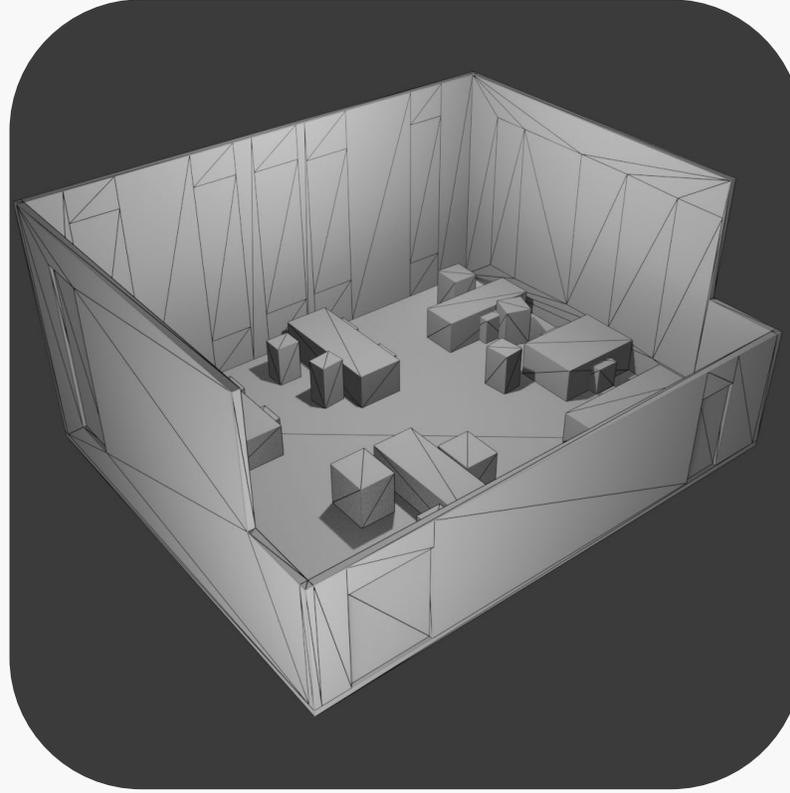
Model



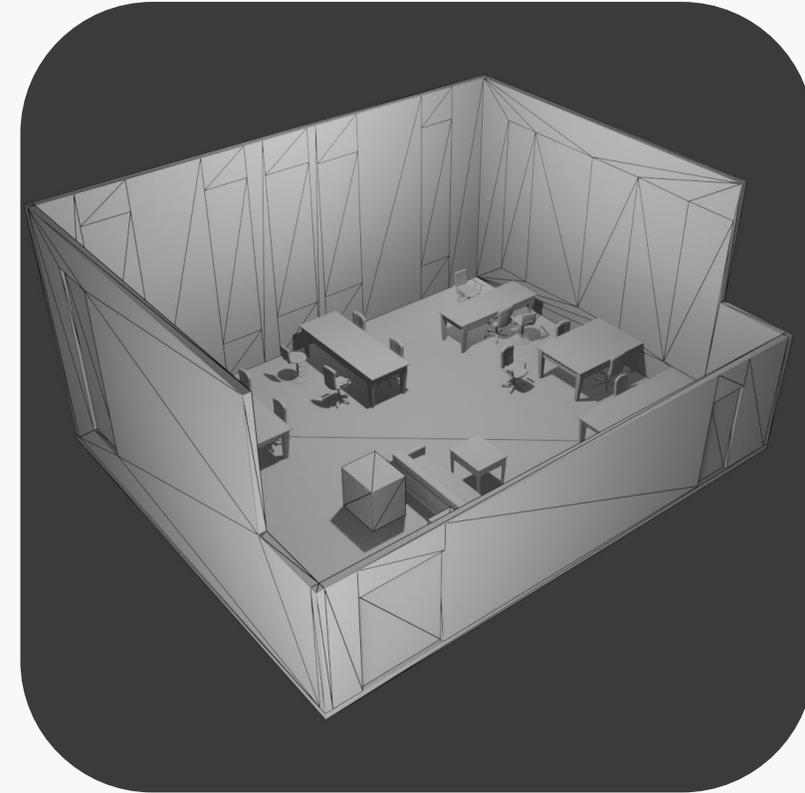
Data/RoomPlan /GeoinfoLab



Parametric



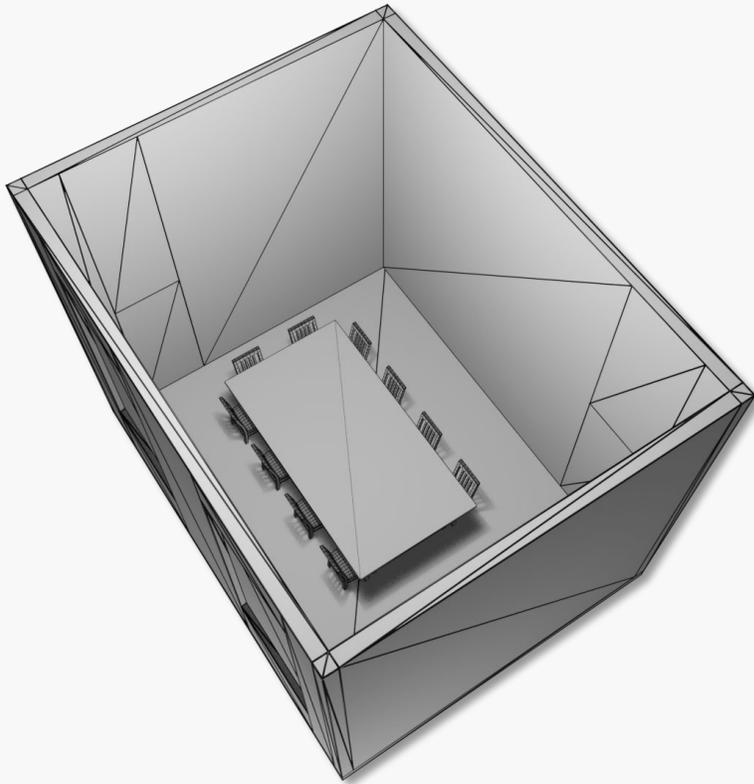
Mesh



Model



Data/RoomPlan



▼ root				
▼ Room	Xform	V		default
▶ Section_grp	Xform	V		default
▶ Mesh_grp	Xform	V		default
▶ Parametric_grp	Xform	V		default
▼ Model_grp	Xform	V		default
▼ Arch_grp	Xform	V		default
▼ Wall_0_grp	Xform	V		default
Door1	Mesh	V		
▶ Door1_color	Material			
Wall0	Mesh	V		
▶ Wall0_color	Material			
▶ Wall_1_grp	Xform	V		default
▶ Wall_2_grp	Xform	V		default
▶ Wall_3_grp	Xform	V		default
▶ Floor_grp	Xform	V		default
▶ Object_grp	Xform	V		default

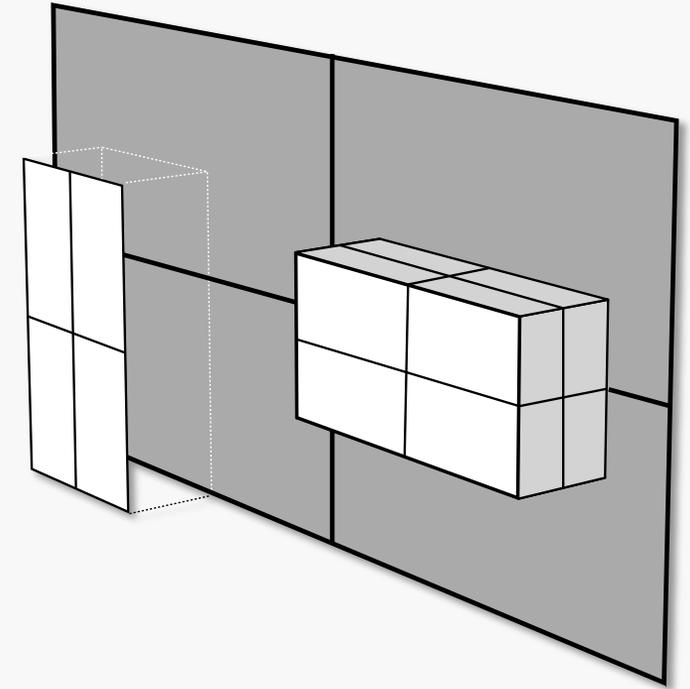
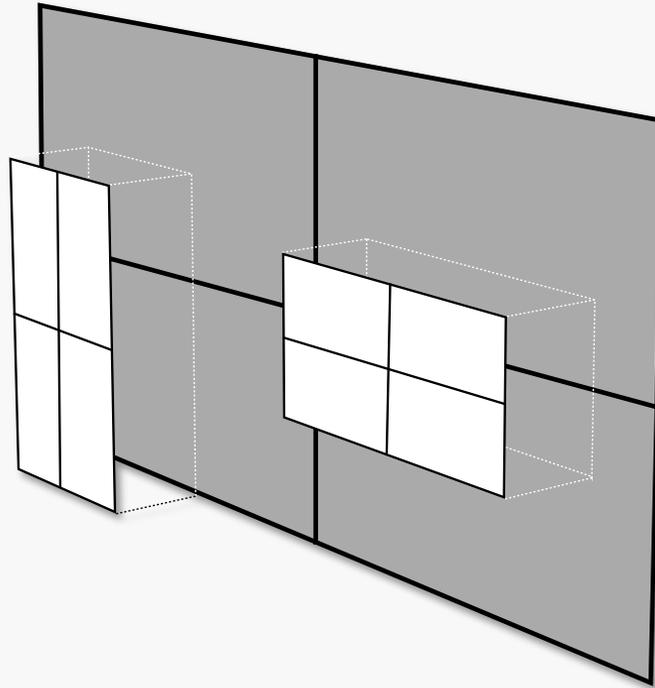
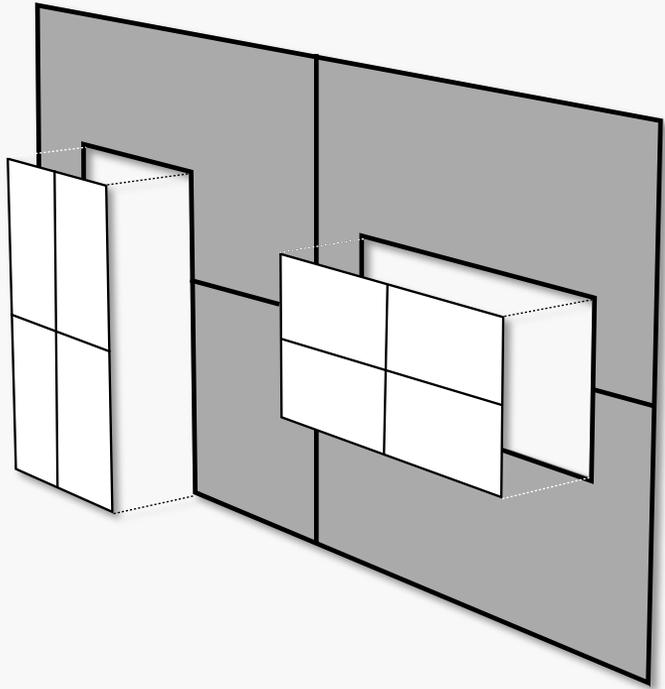
Hierarchical structure of USD data format.

Known semantics and relations



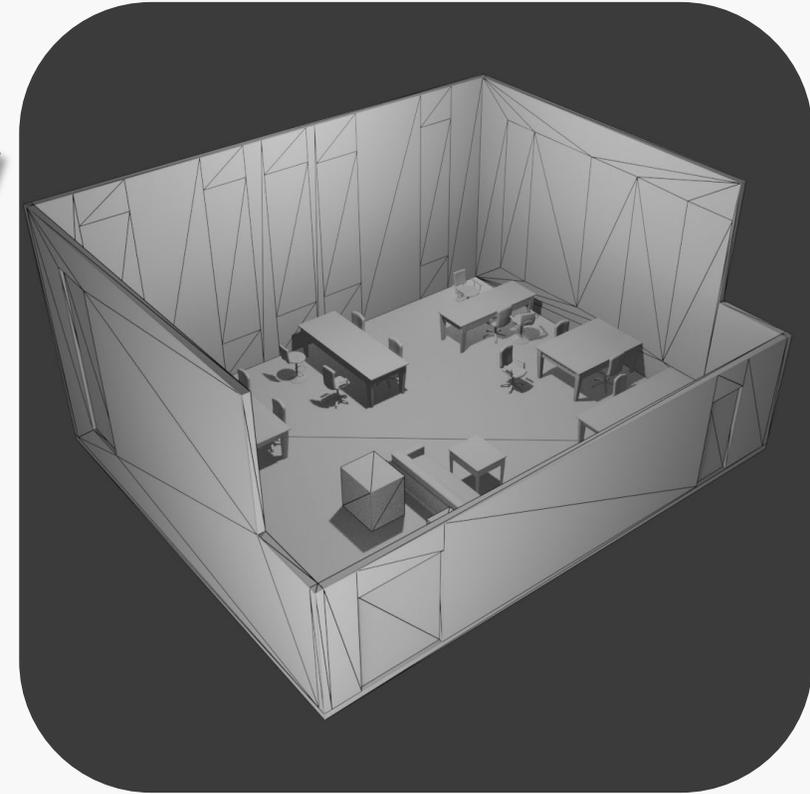
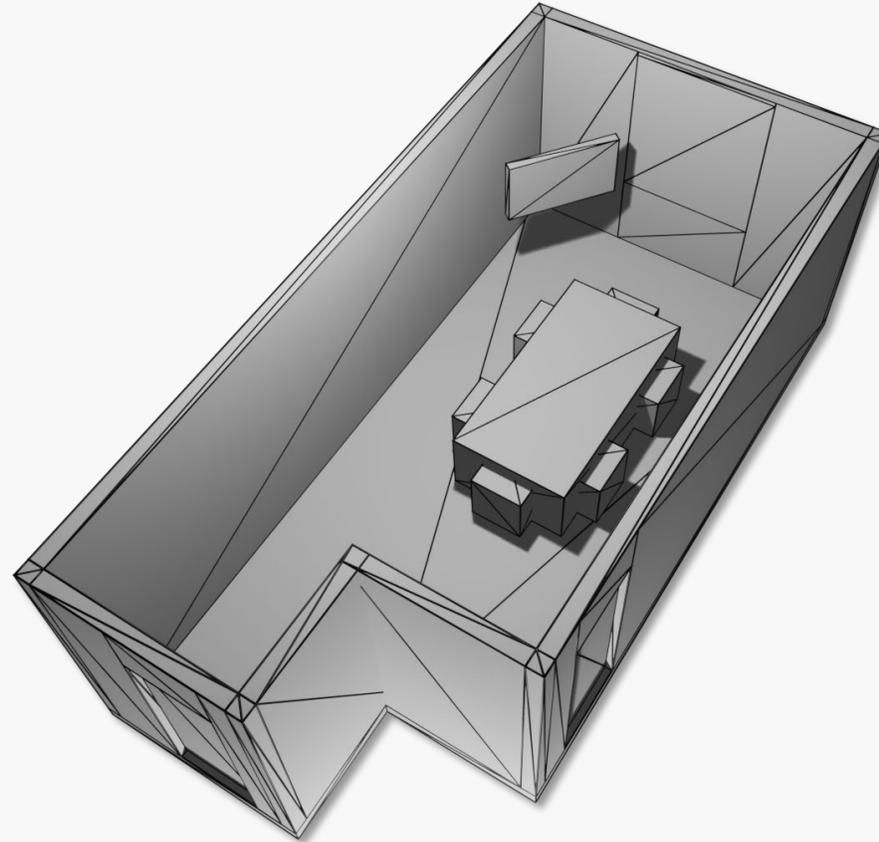
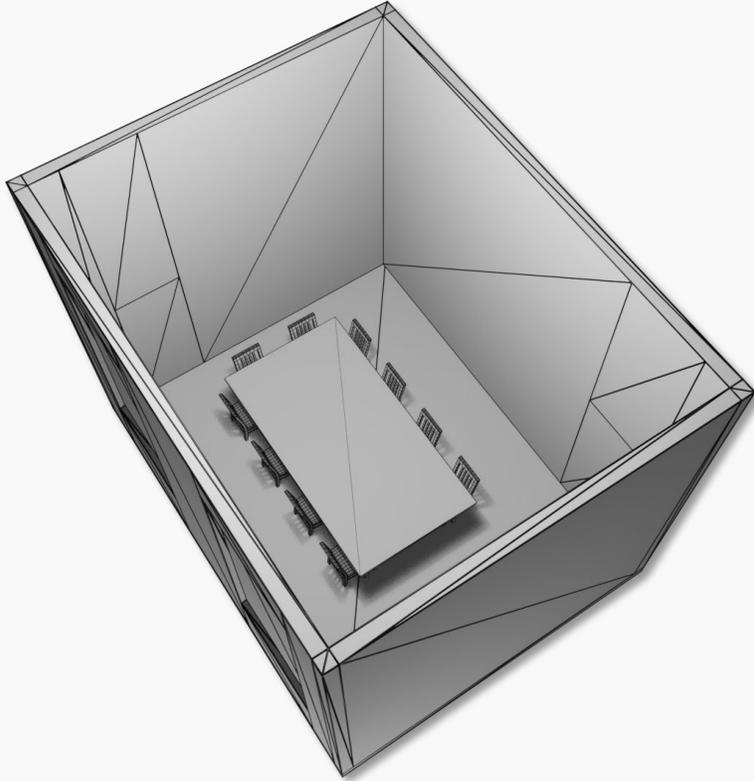
Simulation ready geometry

How windows and doors can be modelled in the world of HoneyBee



Simulation ready geometry

Convert USD model to HoneyBee models



Solution approach

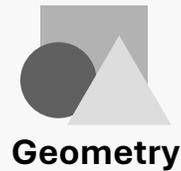


Simulation set up



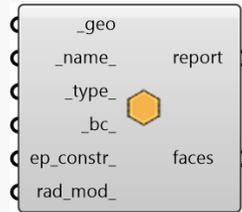
- Manually for manual models in Grasshopper
- Directly from the script for Roomplan models

- Manually for both models in Grasshopper

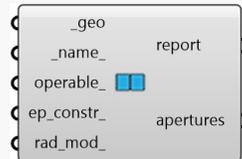


Geometry

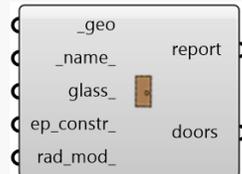
Face



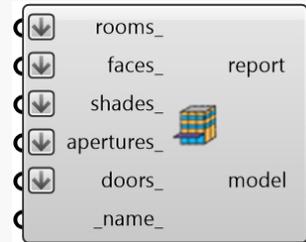
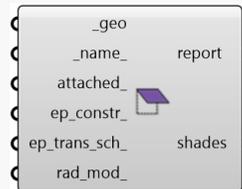
Aperture



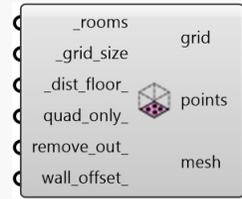
Door



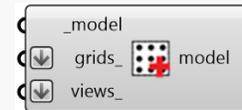
Shade



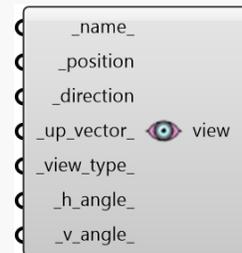
Model



Sensor Grid



Assign grid & views



View

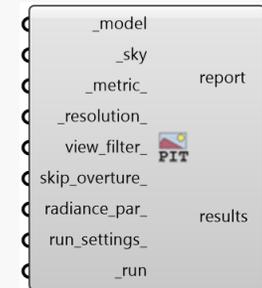


Sky

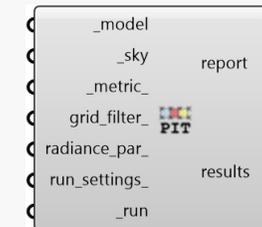


Wea

Recipes



Point-in-Time View-based



Point-in-Time Grid-based

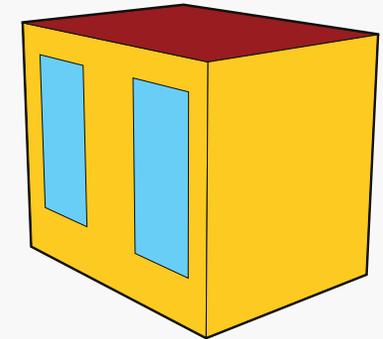
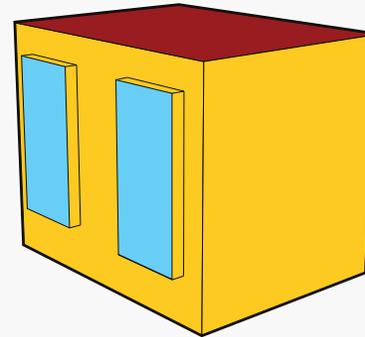
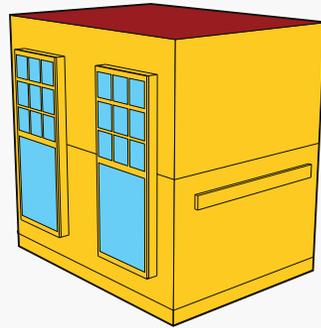
Dataflow



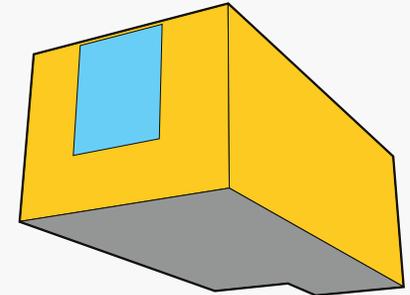
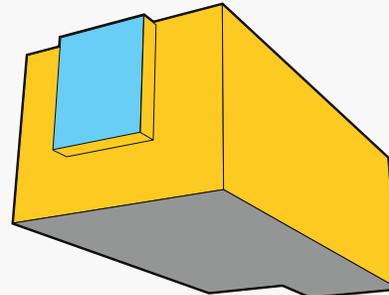
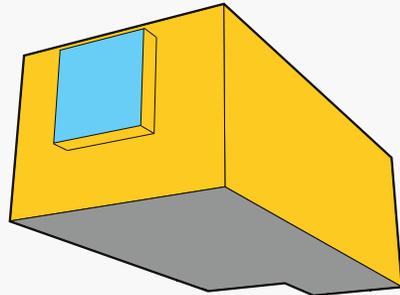
Simulation set up

HoneyBee models

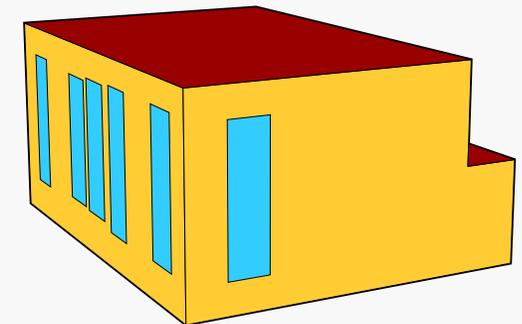
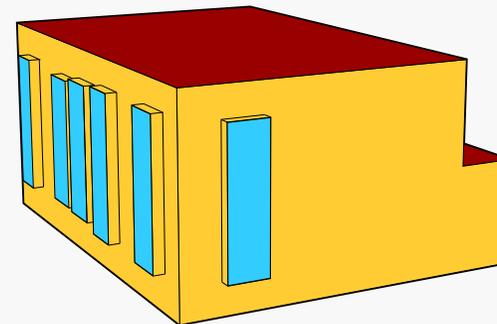
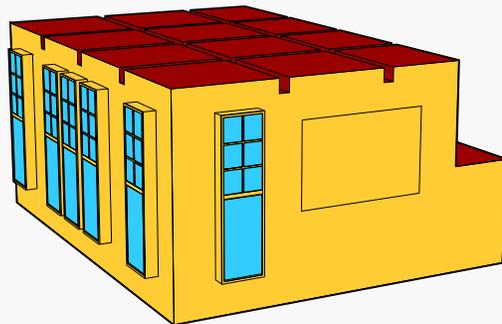
BGW640



W01050



GeoinfoLab



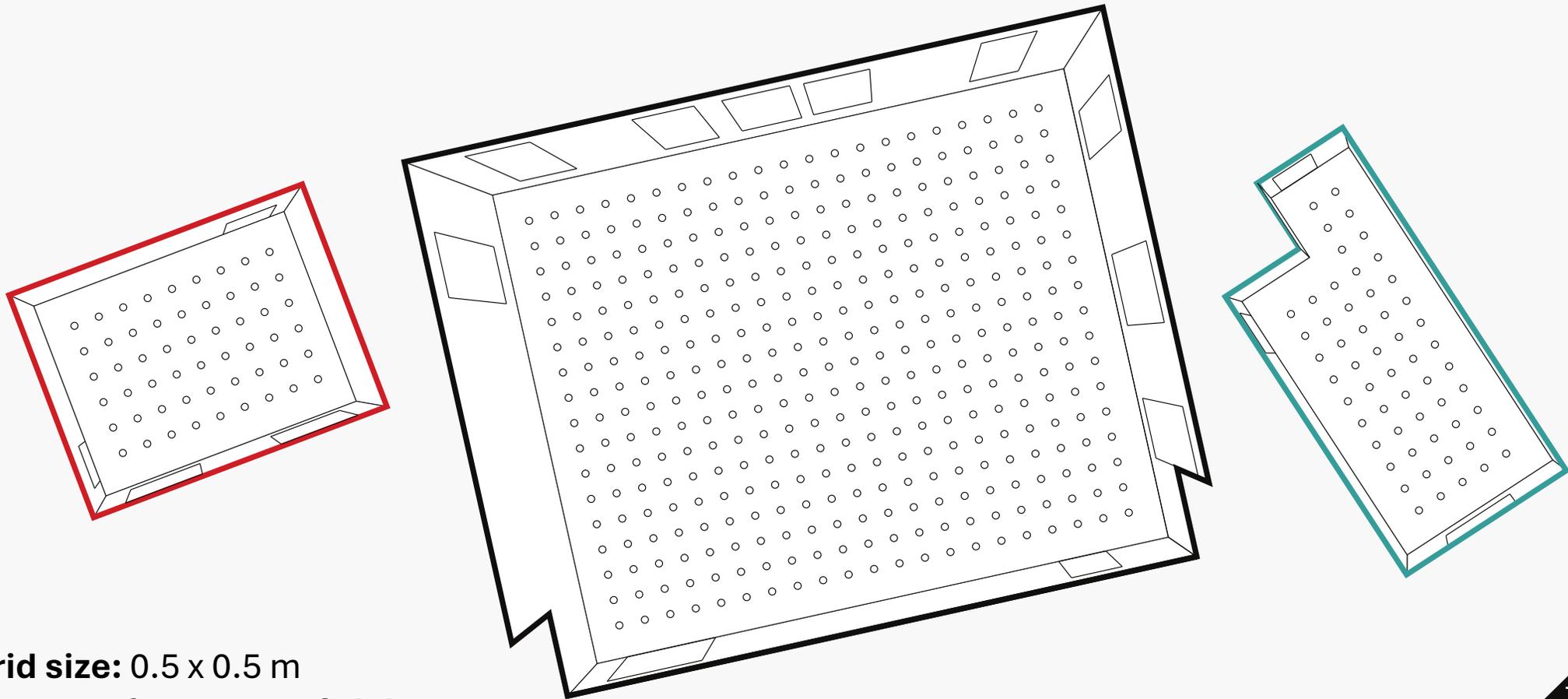
Manual

Extruded

Not extruded



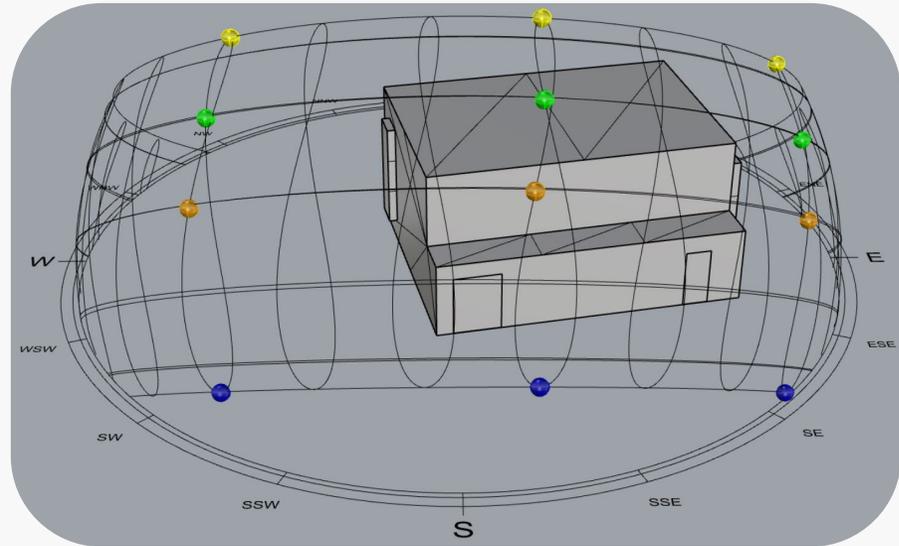
Simulation set up/Sensor grids



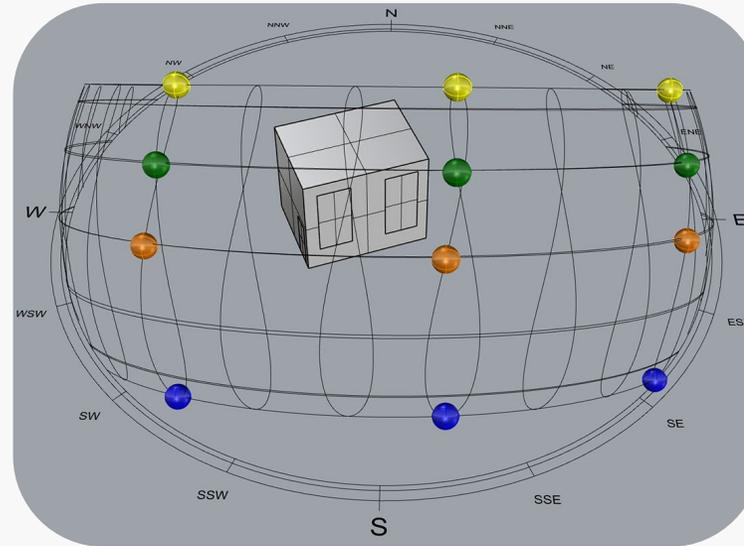
Grid size: 0.5 x 0.5 m
Distance form ground: 0.8 m



Simulation set up/Sun paths



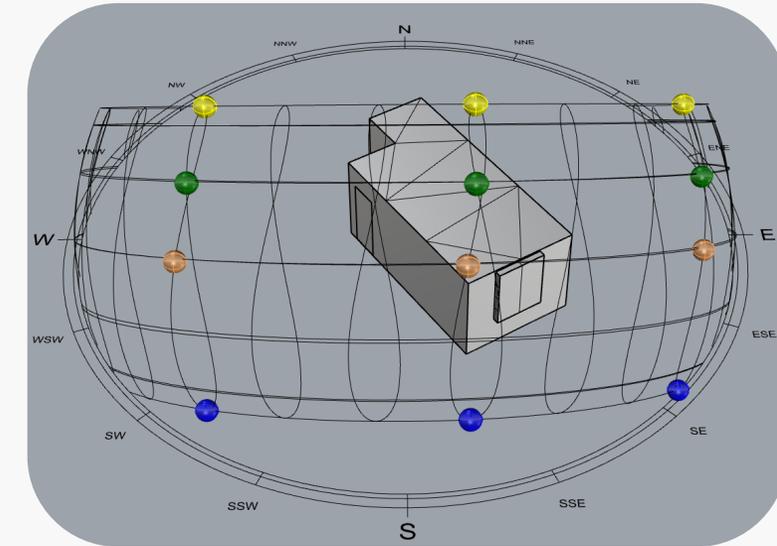
Spring Equinox
20 March



Summer Solstice
21 June



Autumn Equinox
22 September



Winter Solstice
21 December



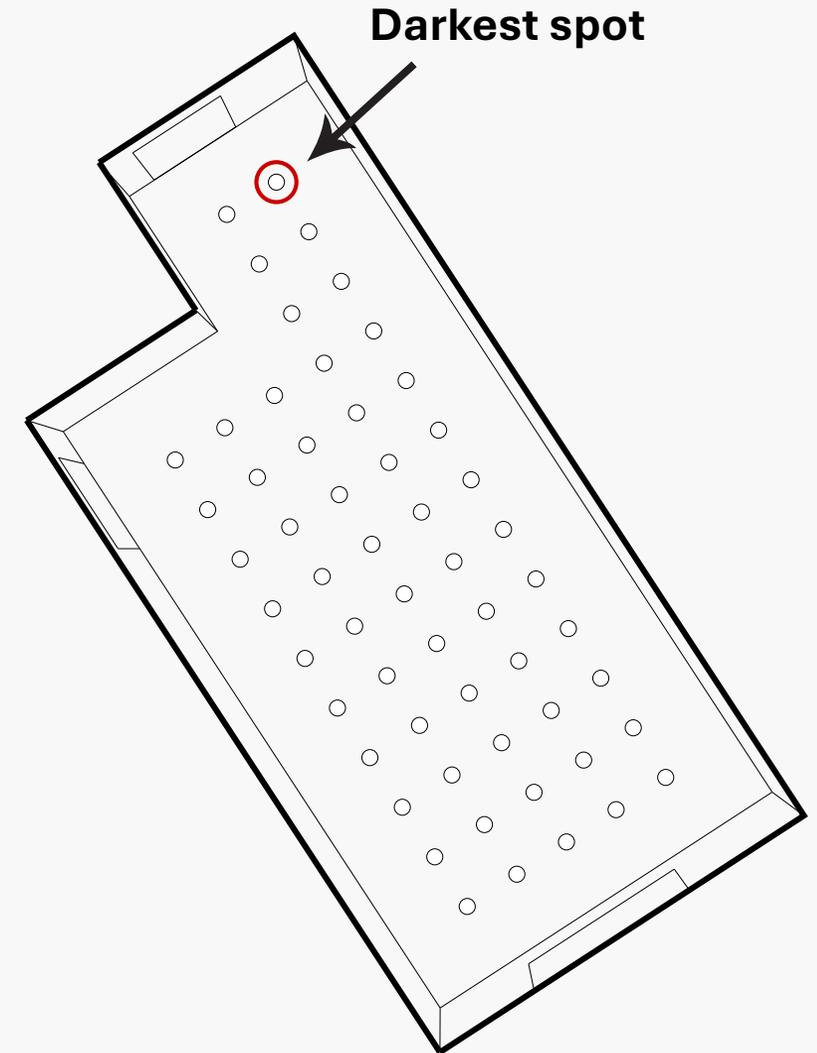
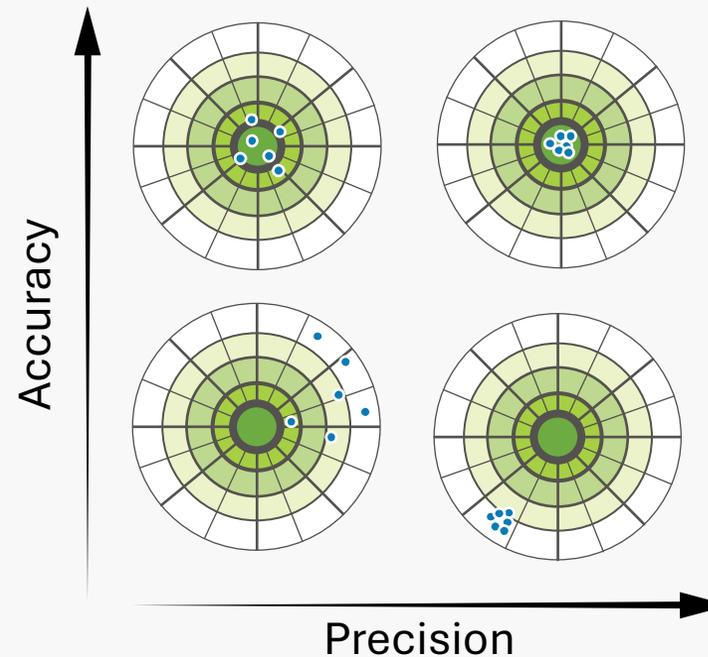
Simulation set up/Convergence test

Why?

> Stochastic nature of daylight simulations.

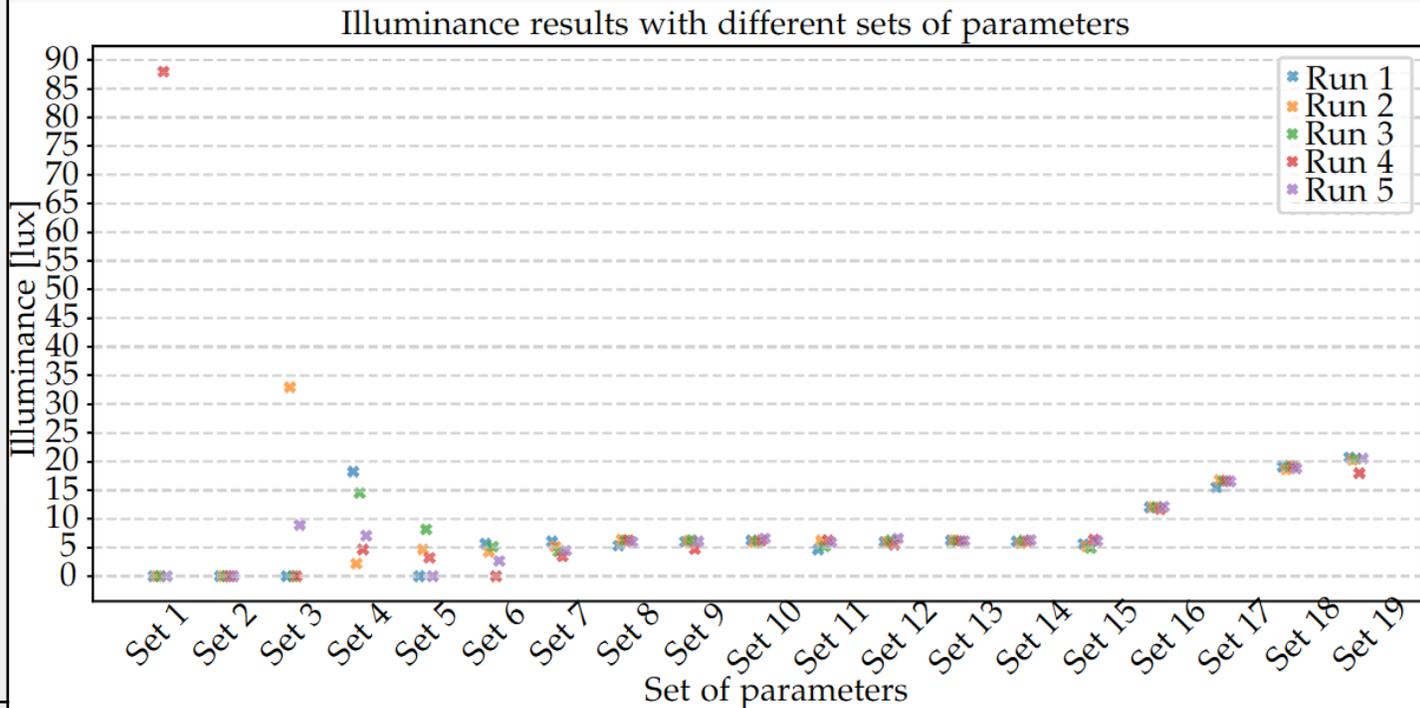
Objective

> Choose parameters which produce similar results between runs. ($\leq 5\%$)

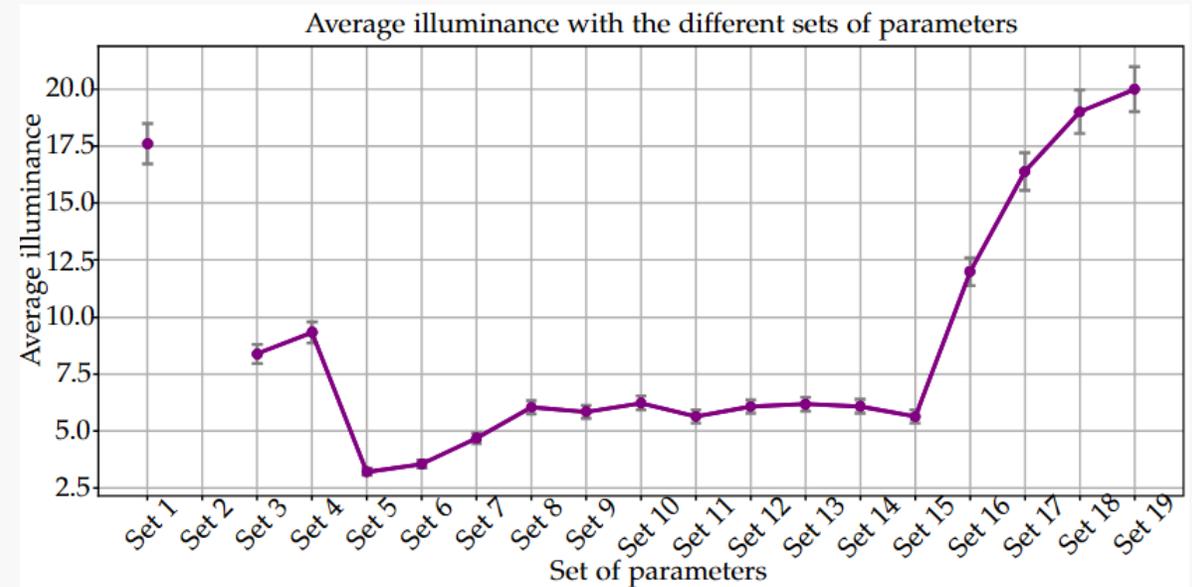
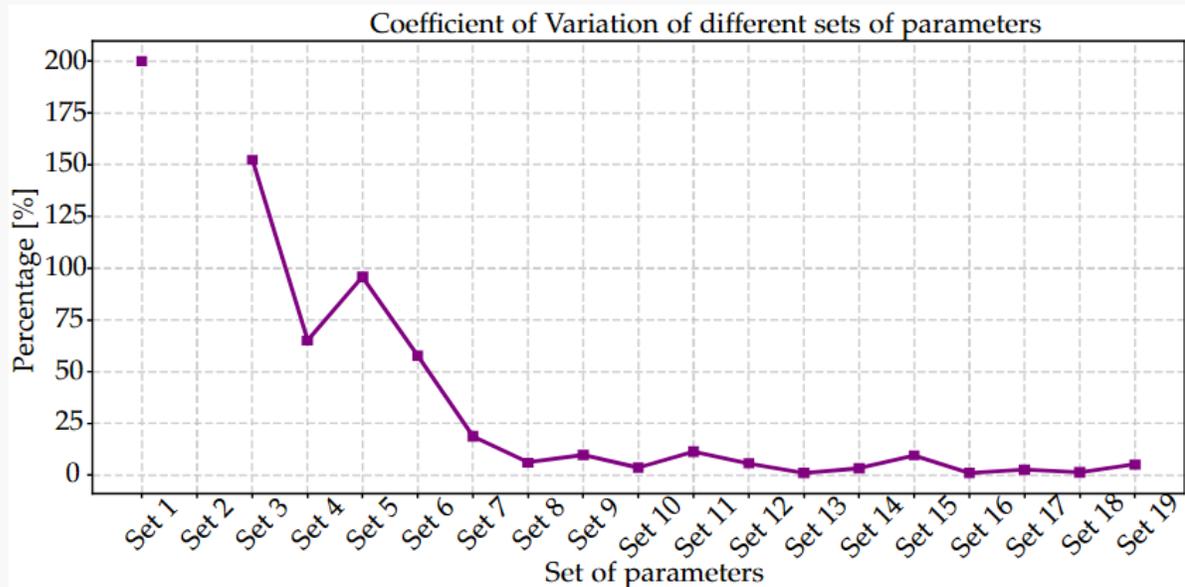


Simulation set up/Convergence test

	Parameters						
	ad	as	ar	aa	ab		
Set 1	32	16	8	0.4	1		
Set 2	64	32					
Set 3	128	64					
Set 4	256	128					
Set 5	512	256					
Set 6	1024	512					
Set 7	2048	1024					
Set 8	4096	2048	16	0.2	1		
Set 9			32				
Set 10			64				
Set 11			128				
Set 12			0.1				
Set 13			0.05				
Set 14			32			0.02	2
Set 15							3
Set 16							4
Set 17							5
Set 18	5						
Set 19	5						



Simulation set up/Convergence test

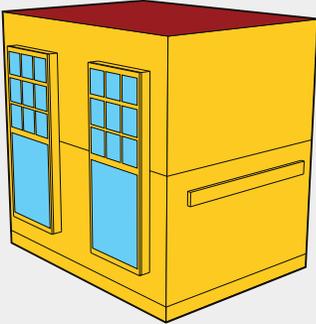
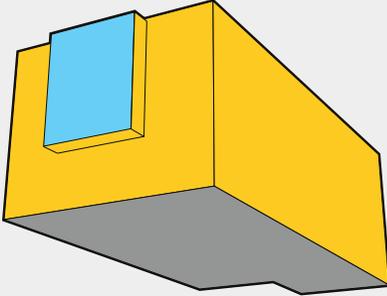
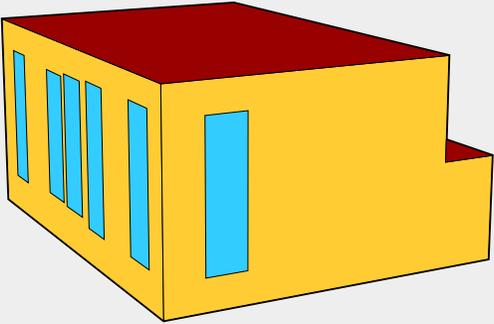


The error bars denote $\pm 5\%$

Set 18 -ad:4096 -as: 2048 -ar 32 -aa: 0.02 -ab: 4



Simulation set up

Dates of Interest	Spring Equinox 20 March 	Summer Solstice 21 June 	Autumn Equinox 22 September 	Winter Solstice 21 December 	} = 12 Points in Time
Hours of Interest		9 AM 12 PM 15 PM			
3 models for each room	 Manual	 Extruded	 Not extruded	} = 9 models	
	3 rooms	BGW640	W01050		GeoinfoLab
Simulations types	Grid-based		View-based		= 2

216 simulations in TOTAL

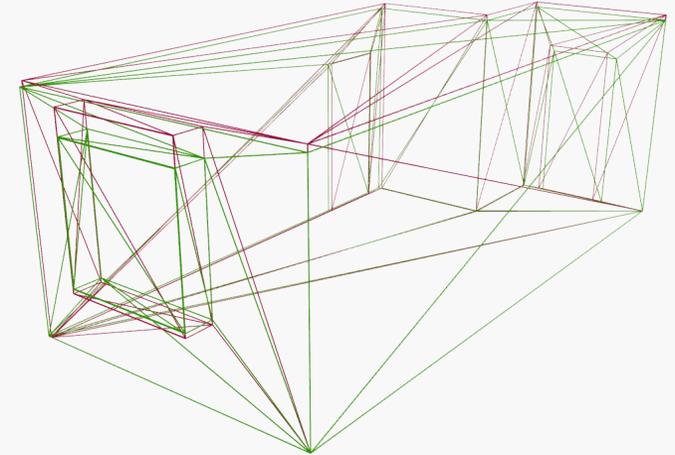
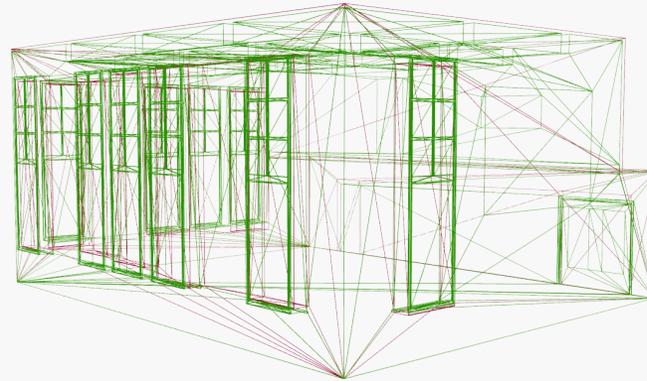
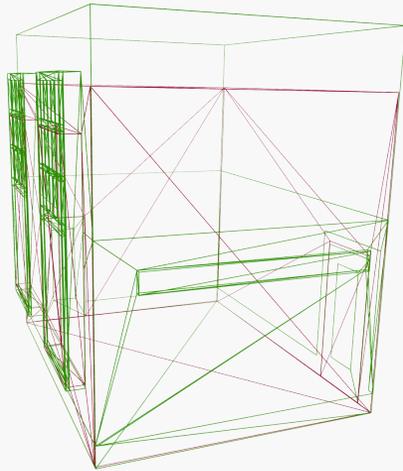


Results

Geometric assessment

Daylight assessment

Results / Geometric assessment



Distance	BGW640			GeoinfoLab			W01050		
	M-R	M-N	R-N	M-R	M-N	R-N	M-R	M-N	R-N
Chamfer (m2)	0,1111	0,1171	0,0049	0,0021	0,004	0,0031	0,0092	0,012	0,0099
Hausdorff (m)	0.8987	0.8983	0.2695	0.2825	0.3457	0.3456	0.4568	0.4568	0.3435

M: Manual

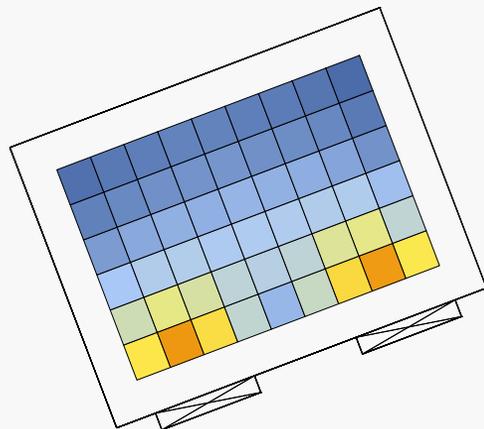
R: RoomPlan Extruded

N: RoomPlan Not Extruded

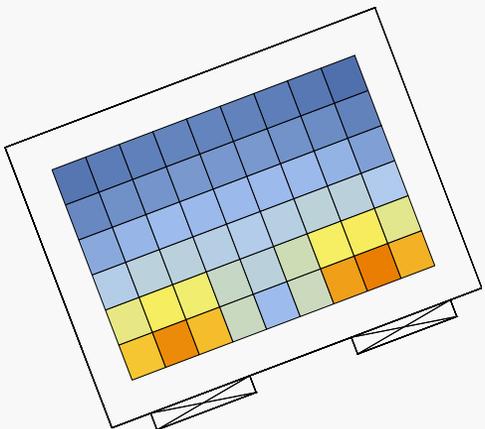




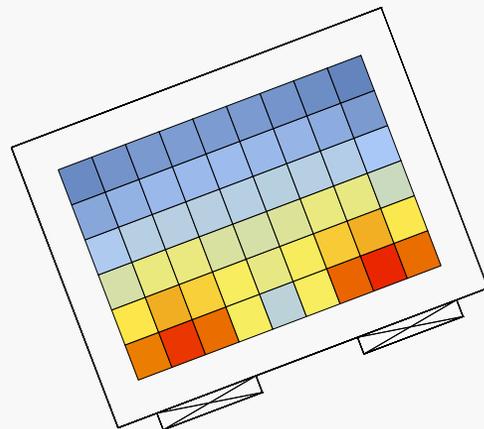
Results / Daylight assessment / Heatmaps



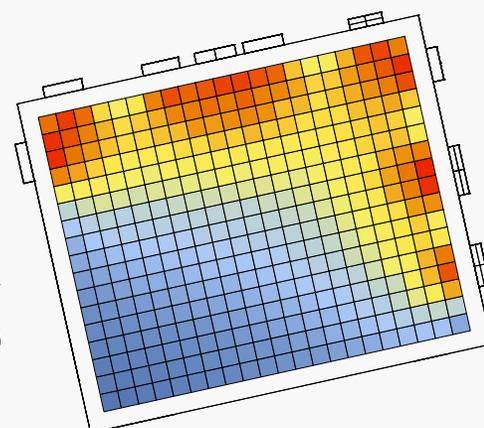
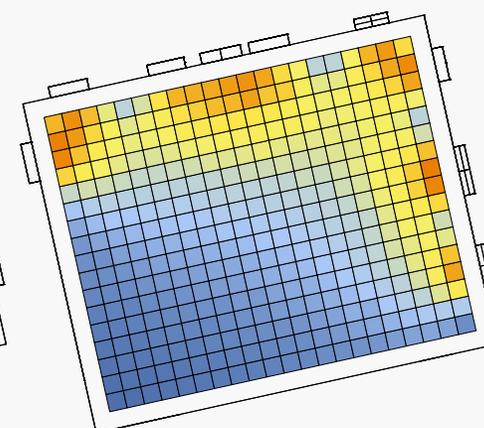
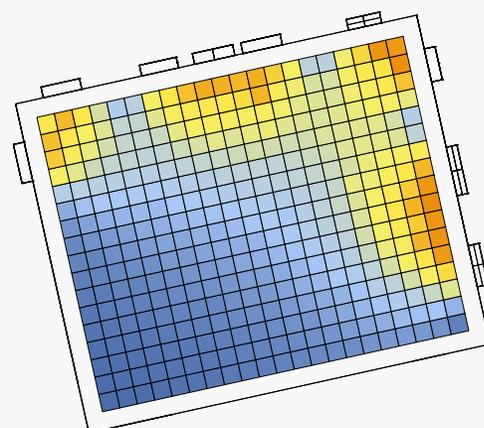
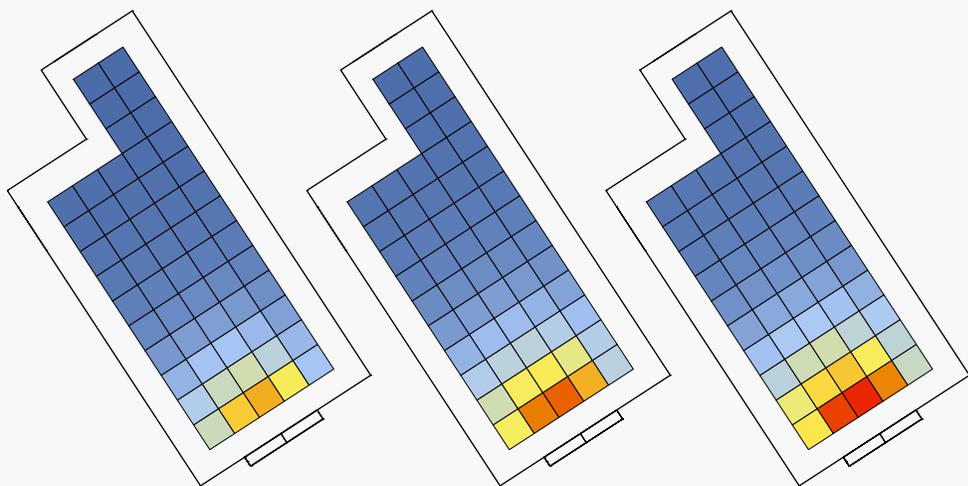
Manual



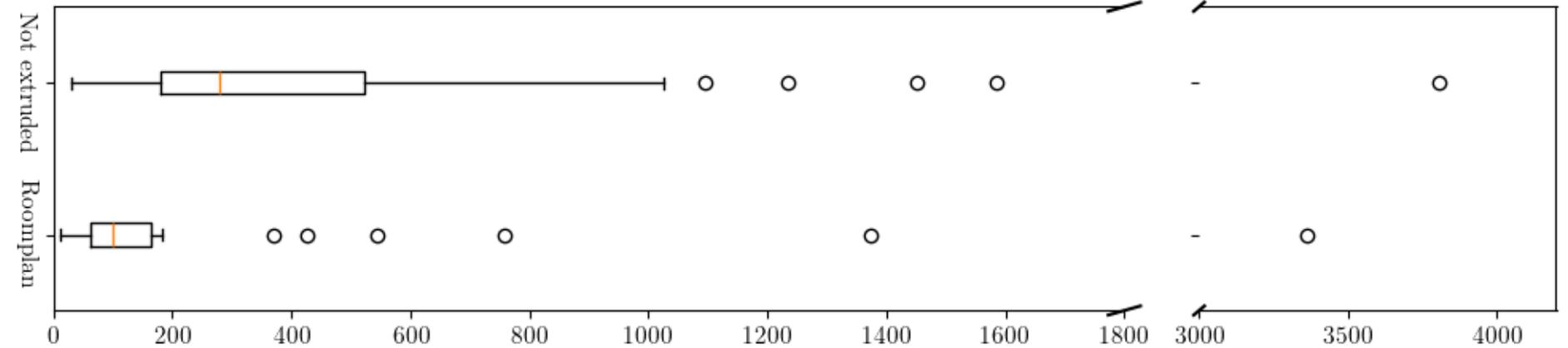
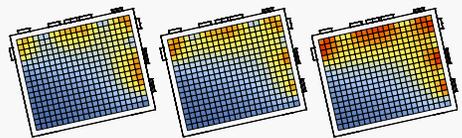
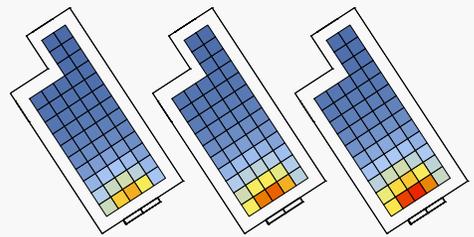
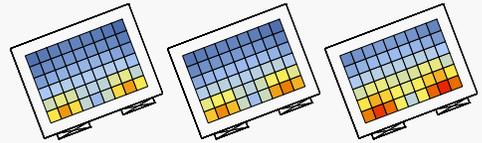
RoomPlan
Extruded



RoomPlan
Not Extruded



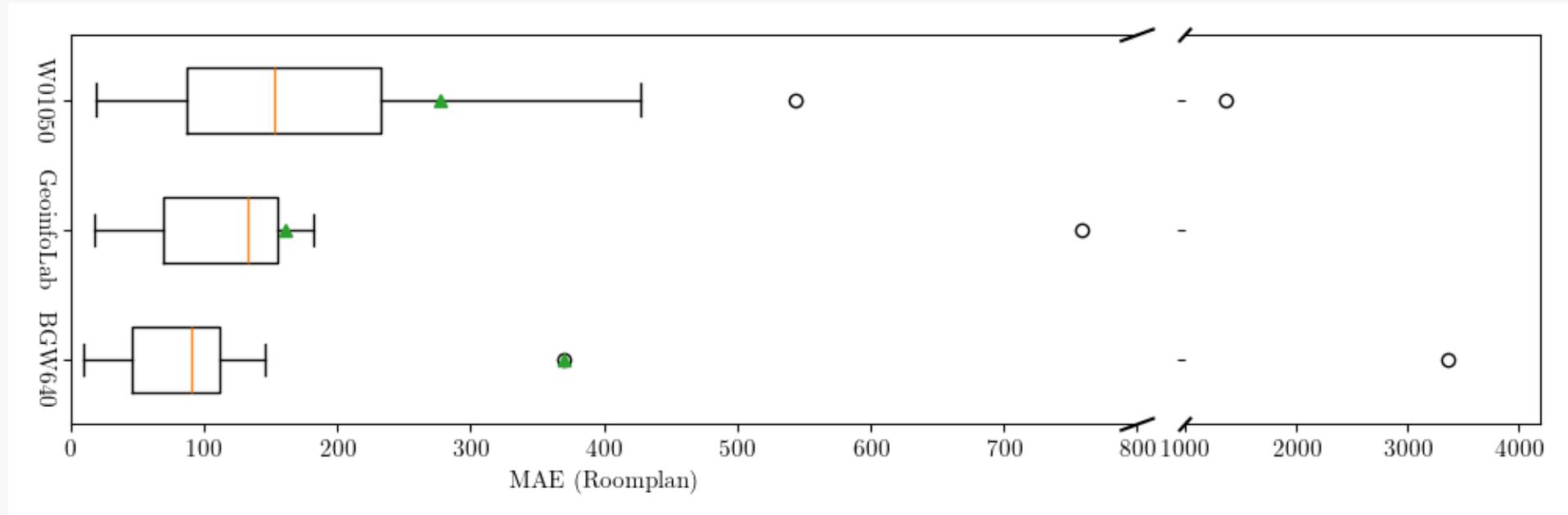
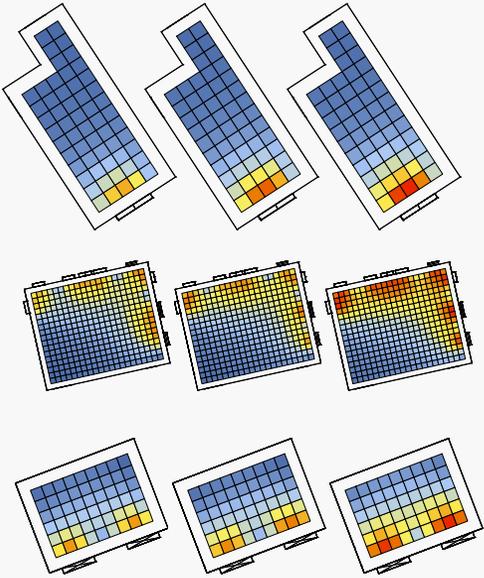
Results / Daylight assessment / Heatmaps



Illuminance Mean Absolute Error



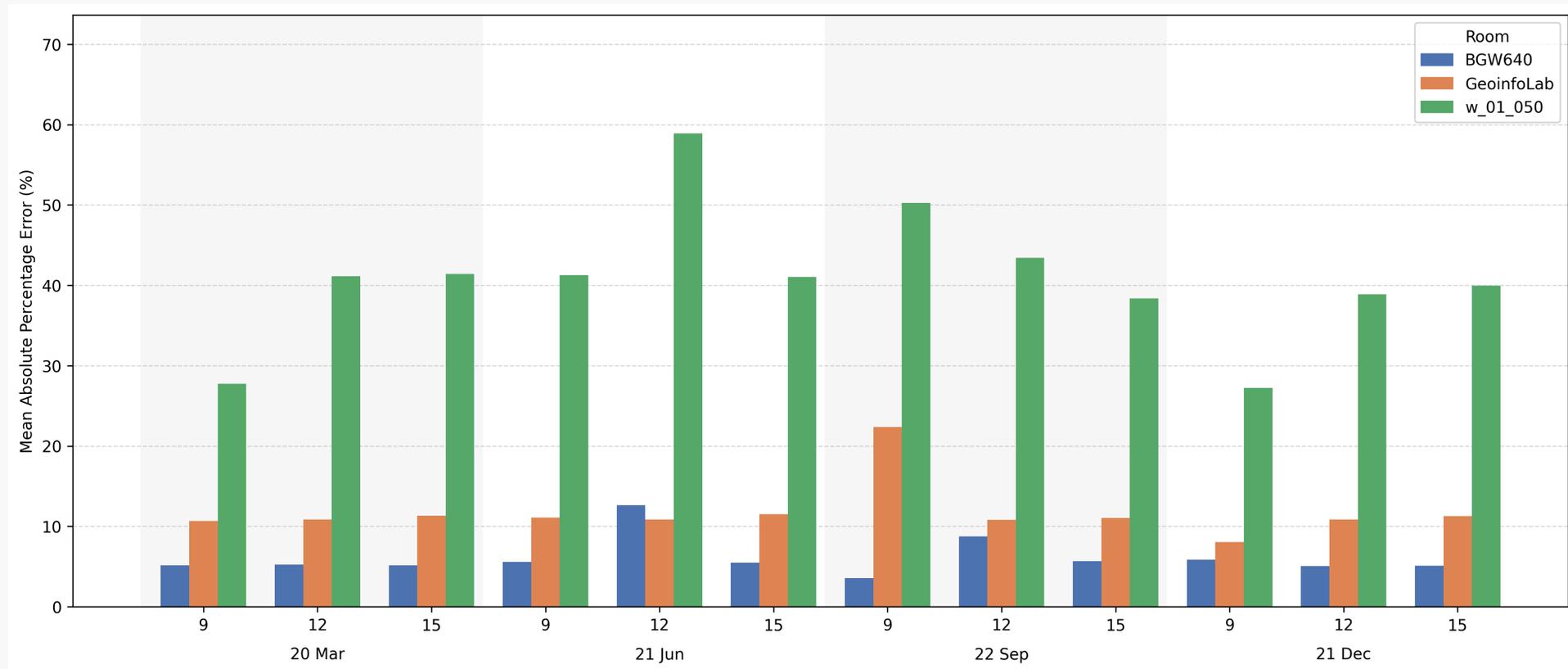
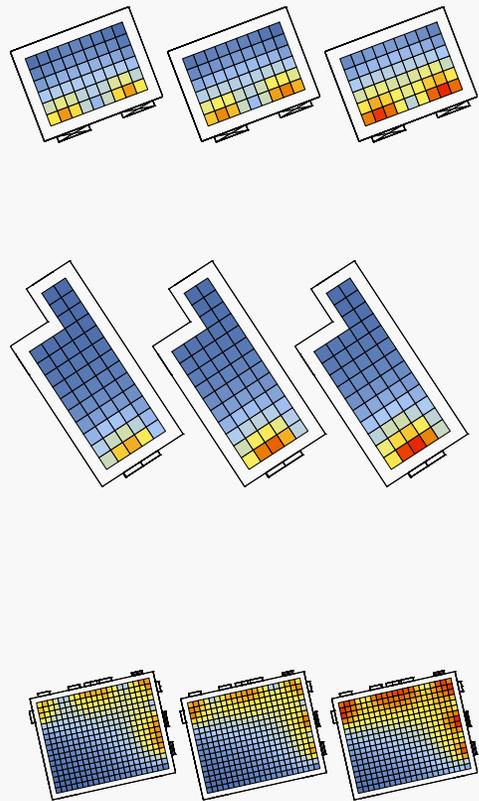
Results / Daylight assessment / Heatmaps



Illuminance Mean Absolute Error per Room for Roomplan models



Results / Daylight assessment / Heatmaps



Mean Absolute Percentage Error of illuminance for RoomPlan models

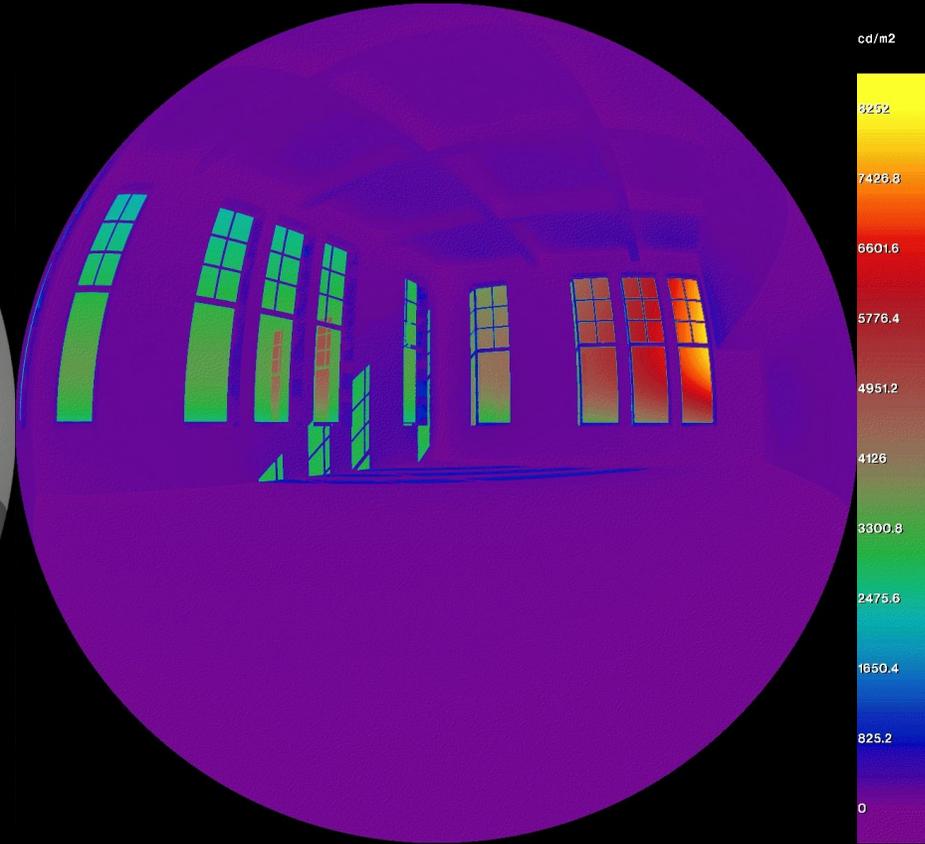


Results / Daylight assessment / Renders

> Example: GeoinfoLab
22-September 9AM



Grayscale



False-color

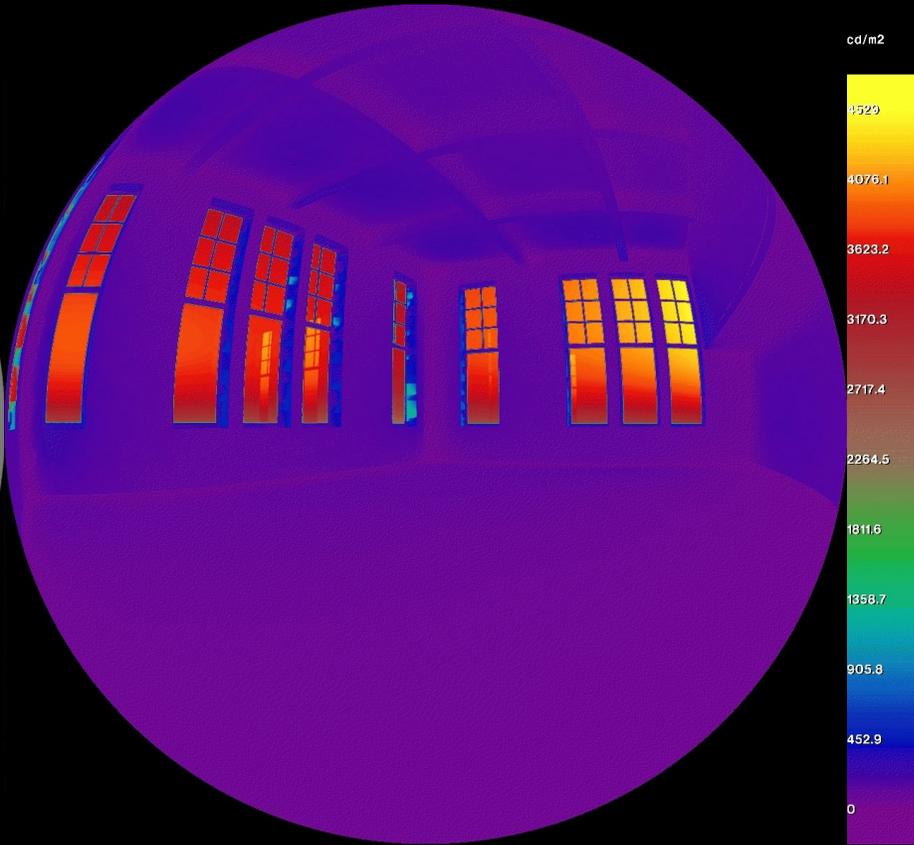


Results / Daylight assessment / Renders

> Example: GeoinfoLab
22-September 12AM



Grayscale



False-color

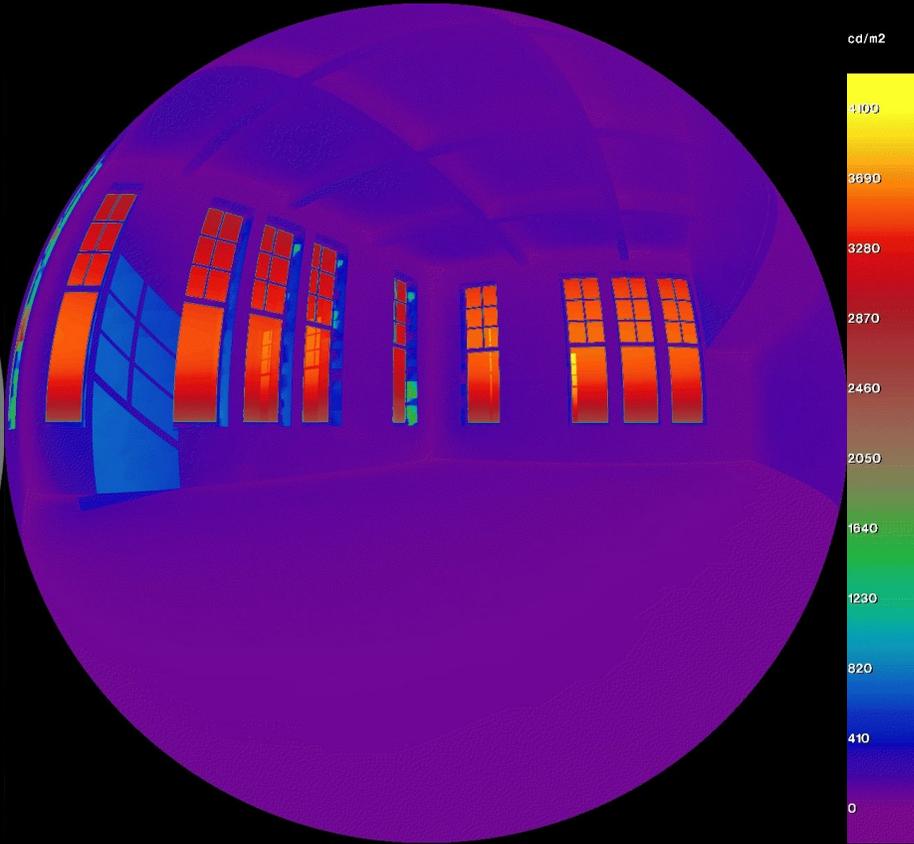


Results / Daylight assessment / Renders

> Example: GeoinfoLab
22-September 15AM



Grayscale



False-color



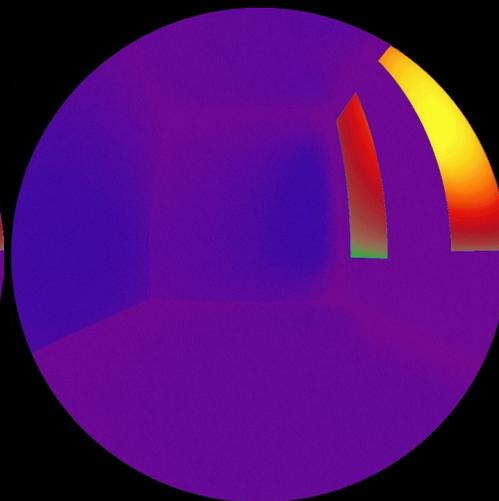
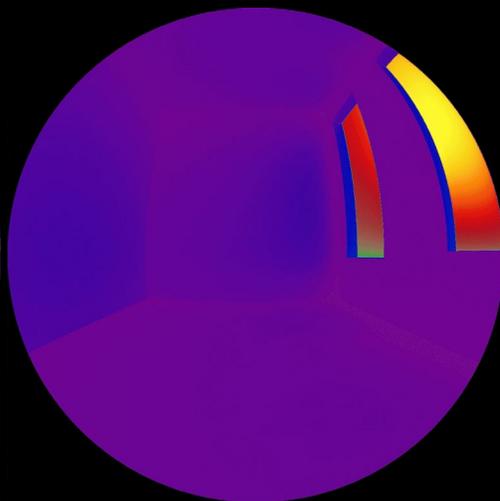
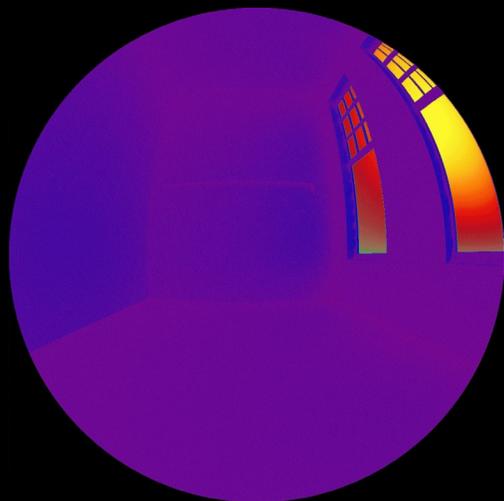
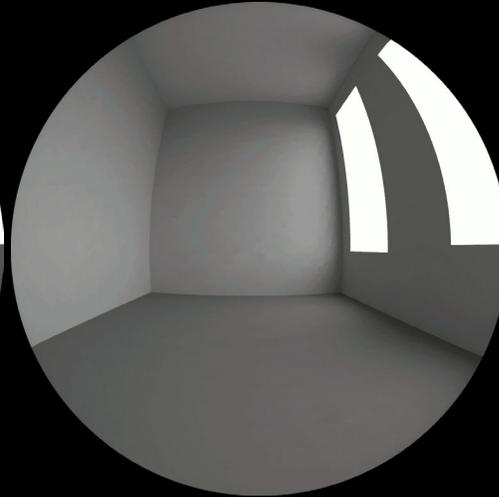
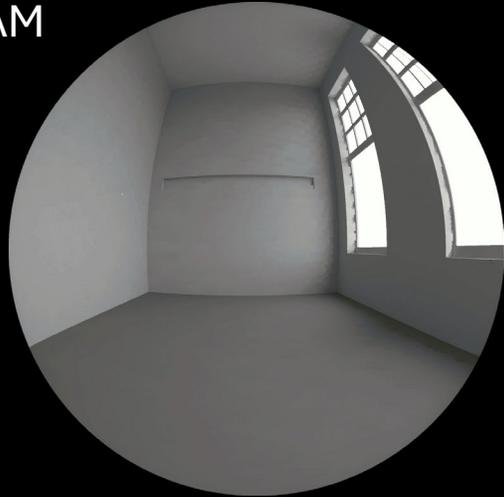
Results / Daylight assessment / Renders

> Example: BGW640
20-March 9AM

Manual

RoomPlan

Not Extruded



DGP: 0.20194

Category: Imperceptible Glare

DGP: 0.20385

Category: Imperceptible Glare

DGP: 0.20972

Category: Imperceptible Glare

*Daylight Glare Probability (DGP)



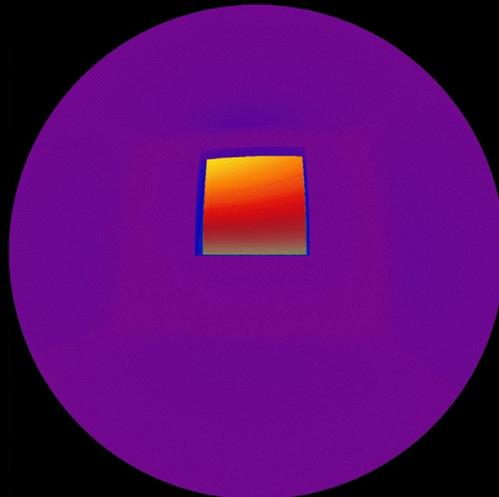
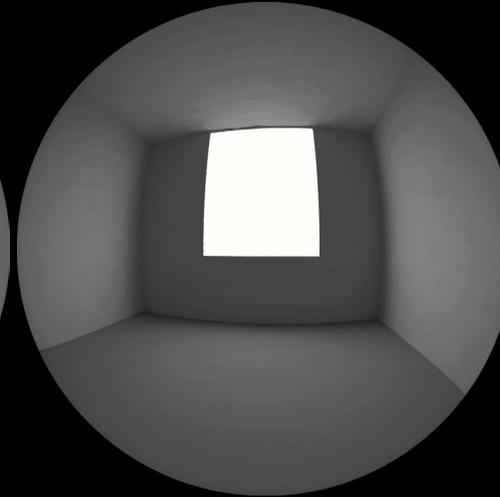
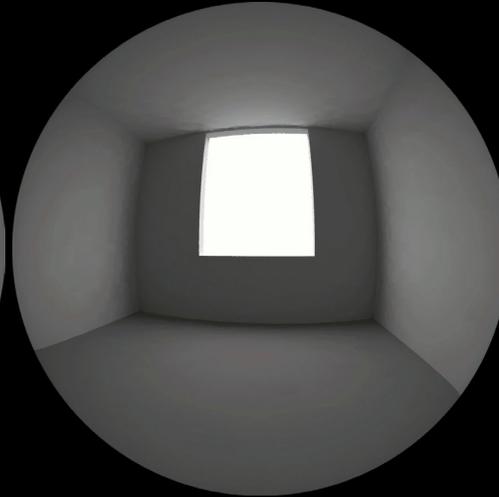
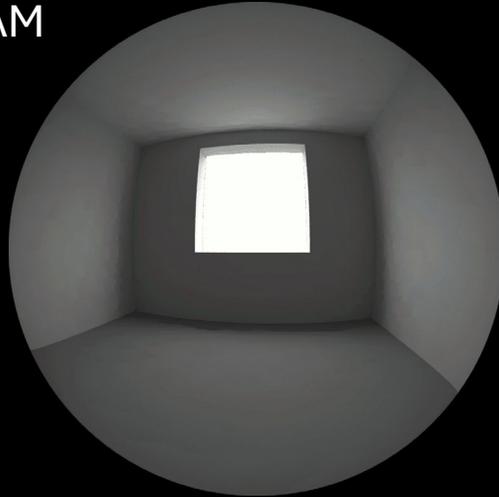
Results / Daylight assessment / Renders

> Example: W01050
20-March 9AM

Manual

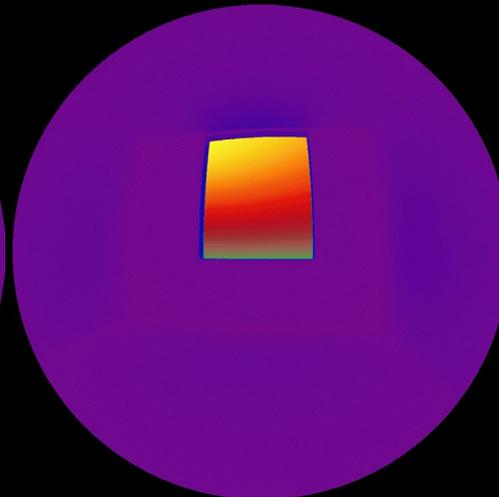
RoomPlan

Not Extruded



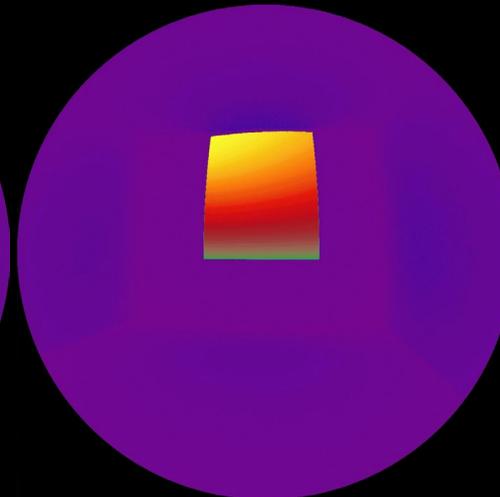
DGP: 0.23637

Category: Imperceptible Glare



DGP: 0.23503

Category: Imperceptible Glare



DGP: 0.23551

Category: Imperceptible Glare



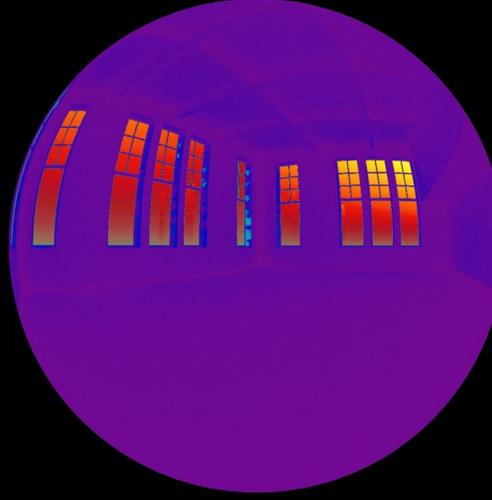
*Daylight Glare Probability (DGP)



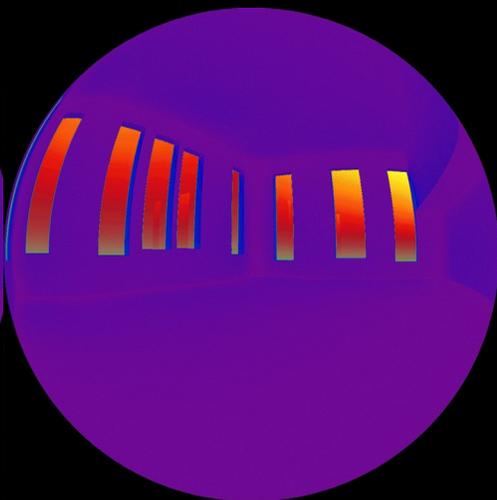
Results / Daylight assessment / Renders

> Example: GeoinfoLab

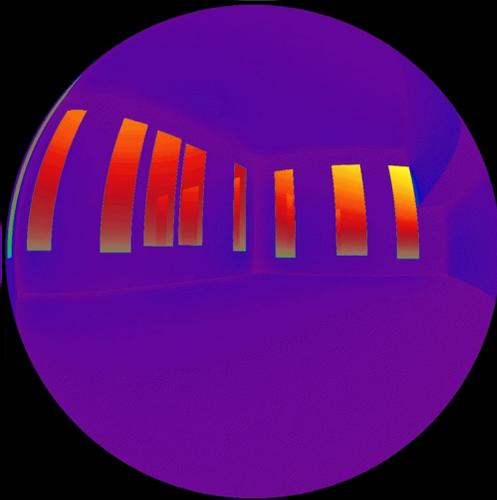
20-March 9AM



DGP: 0.20392
Category: Imperceptible Glare



DGP: 0.20595
Category: Imperceptible Glare



DGP: 0.21268
Category: Imperceptible Glare

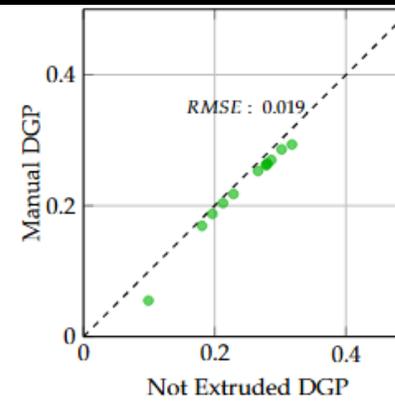
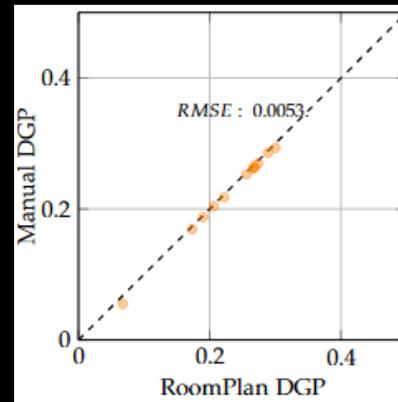
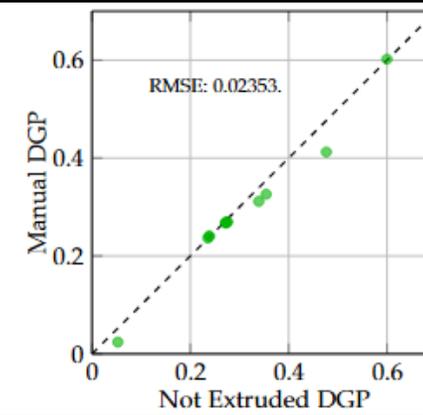
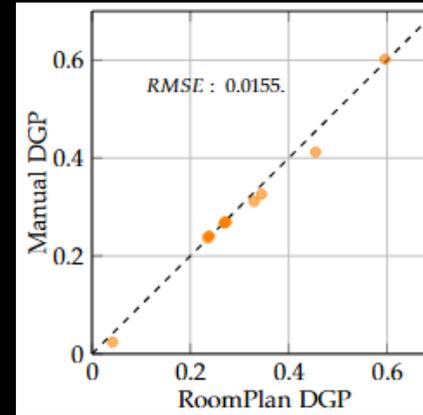
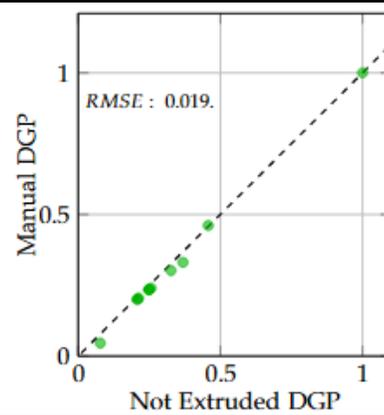
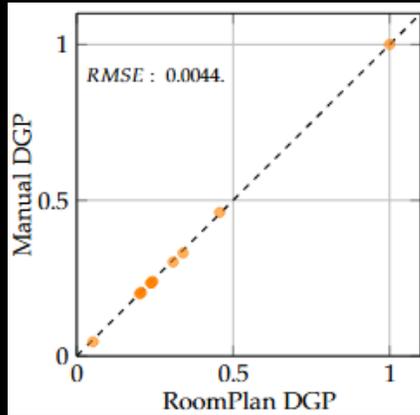


*Daylight Glare Probability (DGP)



Results / Daylight assessment / Renders

> Statistics



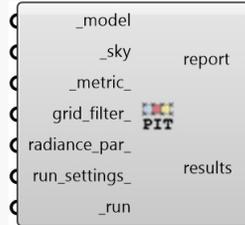
	RMSE	
	Roomplan	Not Extruded
BGW640	0.0044	0.019
W01050	0.0155	0.024
GeoinfoLab	0.0053	0.019



Limitations



Only 3 rooms were tested



Point-in-Time Grid-based



Point-in-Time View-based

**Only
Point in Time
simulations**



Furniture were not used



Conclusions

Main contribution

- Python-based tool to convert RoomPlan's *model* option to HoneyBeeJSON, which also allows for integration with the LadyBug ecosystem for other types of buildings' simulations.
- RoomPlan provides a fast and intuitive way to scan indoor environments compared to TLS.
- The results for the luminance are more accurate than the results for the illuminance.





Answering research questions

Main research question

“How feasible and accurate is the use of iPhone for generating 3D indoor models suitable for daylight simulation?”

Sub-questions

What are the possibilities of using the RoomPlan API and accessing data from iPhone’s sensors for daylight simulations?

Answer:

Using the sample code, it is easy to utilize the API and acquire the data. The lack of previous experience in developing iPhone apps limited the exploration to integrate the orientation of the phone while capturing the data so that the models are oriented.



Answering research questions

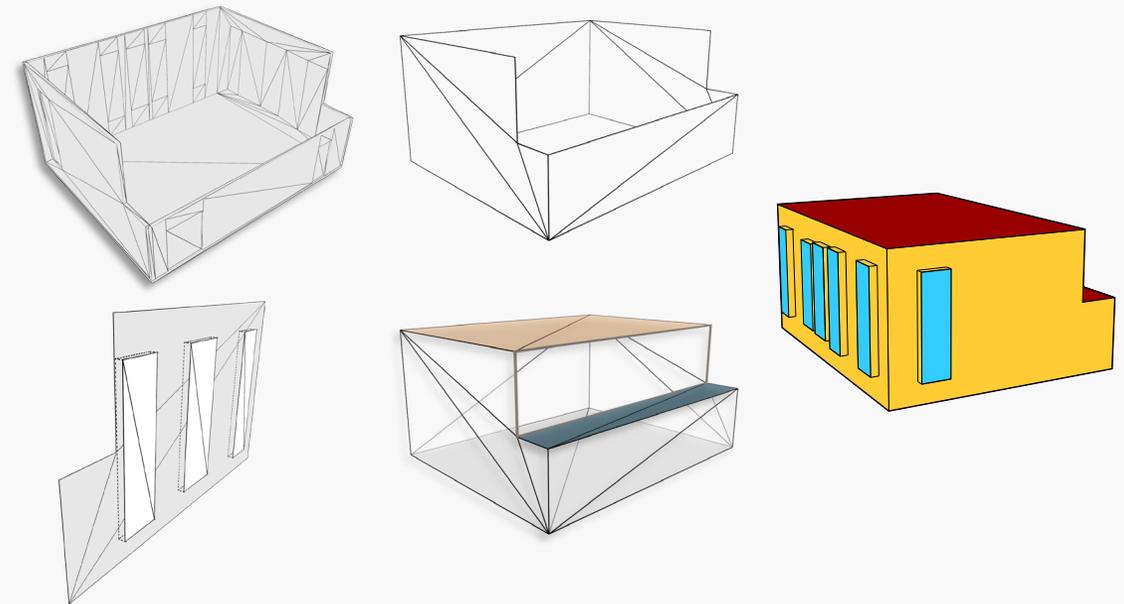
Main research question

“How feasible and accurate is the use of iPhone for generating 3D indoor models suitable for daylight simulation?”

Sub-question

How can the RoomPlan API’s model be transformed into a format compatible with daylight simulation tools?

1. Isolation of the interior faces of the walls.
2. Creation of faces without holes or cavities.
3. Creation of windows’ frames.
4. Creation of the floor and the ceiling.
5. Creation of HoneyBee Model.



Answering research questions

Main research question

“How feasible and accurate is the use of iPhone for generating 3D indoor models suitable for daylight simulation?”

Sub-questions

How do RoomPlan generated models perform compared to manually reconstructed models with respect to geometrical accuracy and daylight simulations results?

Geometrical accuracy

Distance	BGW640			GeoinfoLab			W01050		
	M-R	M-N	R-N	M-R	M-N	R-N	M-R	M-N	R-N
Chamfer (m2)	0,1111	0,1171	0,0049	0,0021	0,004	0,0031	0,0092	0,012	0,0099
Hausdorff (m)	0.8987	0.8983	0.2695	0.2825	0.3457	0.3456	0.4568	0.4568	0.3435

Daylight accuracy

Illuminance (grid-based)

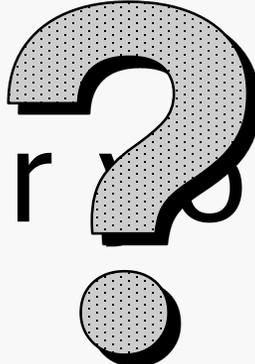
M.A.E: 269 lux

Luminance (view-based)

RMSE less than 0.01

1 category mismatch



Thank you for  our attention!

GitHub repo

<https://zenodo.org/records/18222557>