

Room-Element-Aggregation Algorithm to Enhance the Quality of Observed 3D Building Information

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Overview



- Motivation
- Sketching building topology
- Validation of building information
 - ▶ Room-Element-Aggregation
 - ▶ Euler-Characteristic Value
- Conclusions

Motivation

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- Digital Building Models

- Marketing (Internet)
- Facility management
- Building analysis (energy, static, sound insulation)
- Indoor navigation



- ▶ Different functions generate different demands on the accuracy
- ▶ Today we have different geometric solutions for the different tasks
- ▶ Searched is an **workflow**, which can be used for all of these tasks and integrates all given information

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Motivation

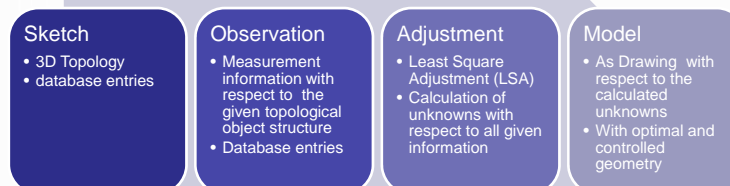
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- ▶ With respect to these search, **POPA 3D** was developed at our Department

Planes from **Observations** in a **Probabilistic Data Model** made for the Adjustment of **3D** building models; **Dr. Clemen, Dr. Gielsdorf**

- ▶ based on the least square adjustment



- ▶ **Model as result out of observations and conditions**

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Motivation

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- Basic Idea of POPA 3D
- Take the **plane parameter as unknowns**
- Describe the **observations related to the plane parameter**
- **Topological information describes the point**
 - ▶ **Point geometry as intersection** out of three planes
- The model is a special view on the calculated adjustment result

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Motivation

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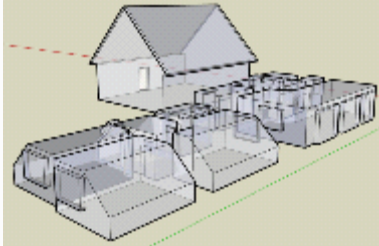
- Tasks for the data acquisition
- To **sketch in 3D** an easy to use graphical user interface must be found
 - we took SketchUp with self developed plug-ins
- **Solve the data acquisition for independent teams**
 - Cut the building information into logical pieces (room surfaces)
- **Validate the data** to use the adjustment application POPA 3D

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Sketching building topology

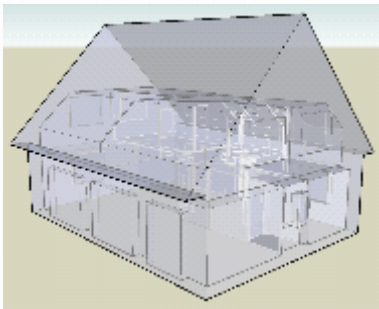
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▶ to catch the data with individual teams we describe the building model as a composition of surface-objects

▶ solid orientated workflow

1. Sketch **individual closed room-surfaces** with SketchUp (only **relative** measurements)
2. To **combine all room-surfaces** we use connection faces like doors or windows (passage-face)

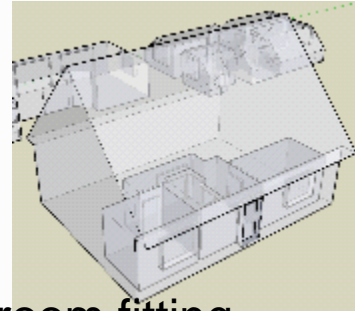
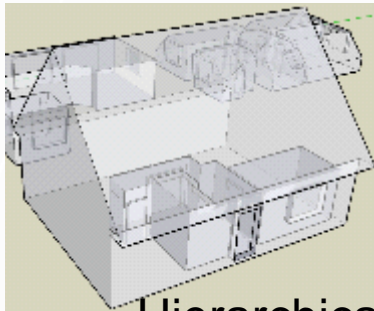


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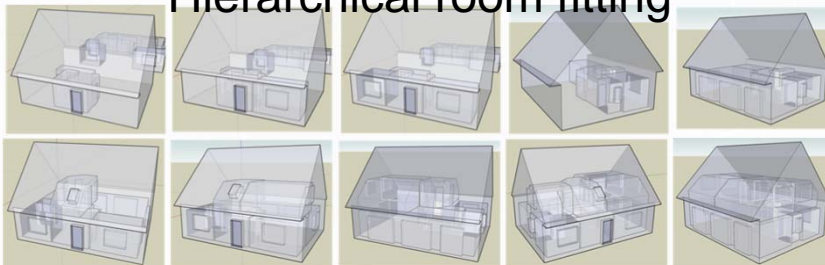
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Sketching building topology

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Hierarchical room fitting



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Sketching building topology

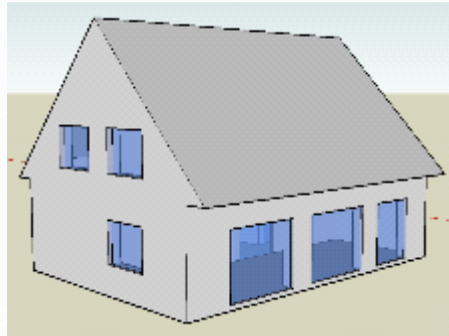
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After hierarchical room fitting not used passage faces has to be modeled manually

Perhaps invalid data model

Model has to be proven (room extraction helpful)



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Validation of building information

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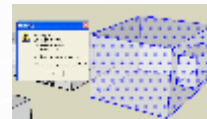
- Get a room-surface out of the sketch

- Room-Element-Aggregation



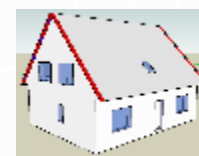
- Logical validation of the room surfaces

- Euler-Characteristic value?



- Element validation

- All faces are assign to one room-surfaces?
- All vertices are assign to three independent planes?



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Room-Element-Aggregation

given:

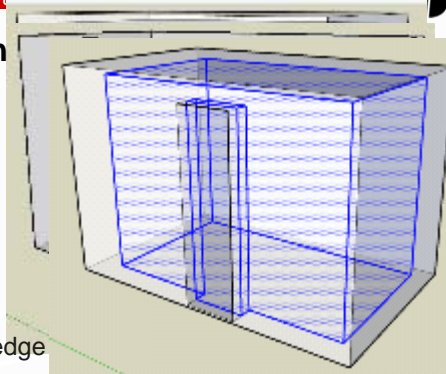
- ▶ SketchUp model
- ▶ One start edge

wanted:

- ▶ All elements of a closed room

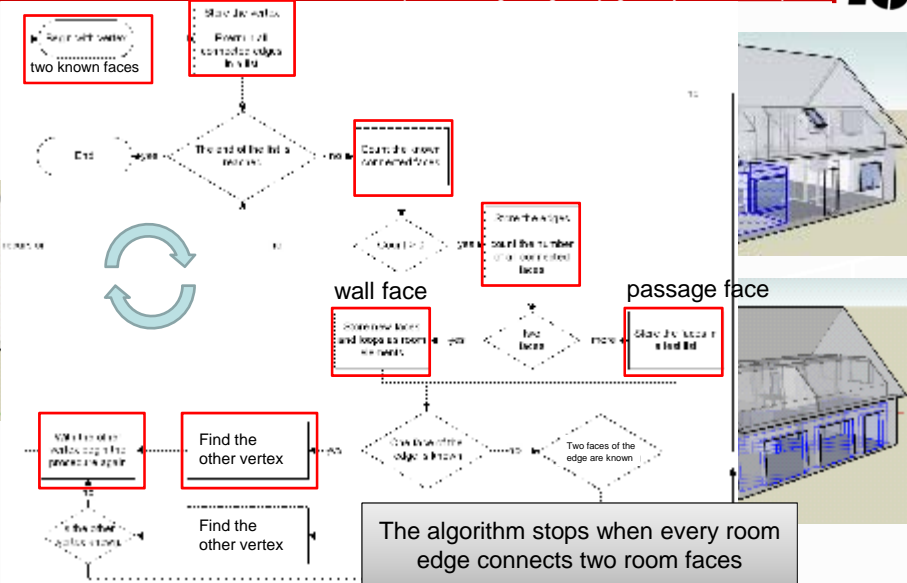
Procedure (simplified):

1. Flag the faces of the start edge
2. Search one vertex of the start edge
3. Search all edges at that vertex
4. Determine all edges conjoined to the flagged faces
5. Flag that edges
6. Determine and flag the faces at the new edges
7. Use the opposite vertex of the regarded edge and start with 4.-7. in a recursive way until every edge is flagged with two known faces



Validation of building information

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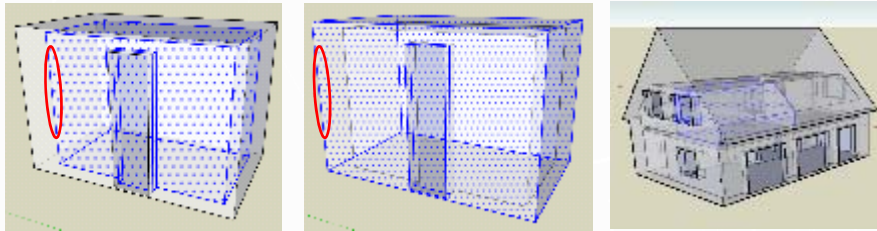


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- Note that the algorithm can be used to find a **exterior or interior surface**



- In the next step all aggregated **elements were count** to calculate the Euler-Characteristic value

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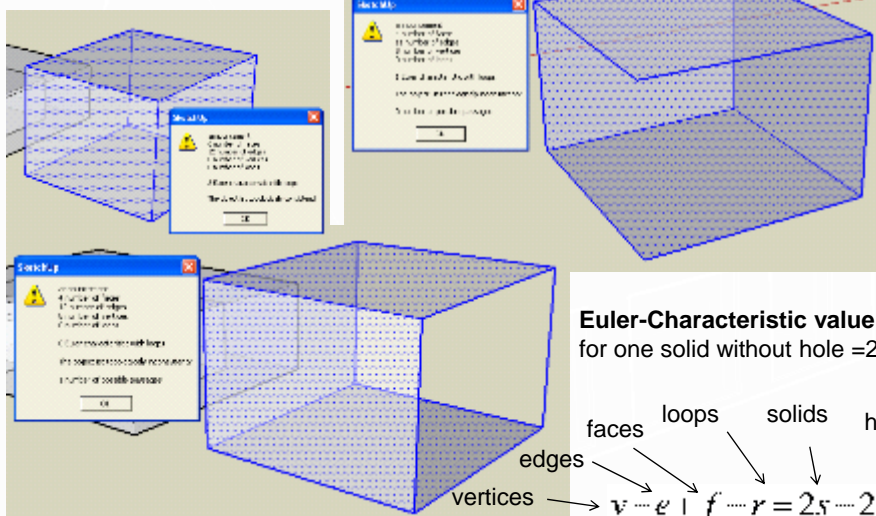
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Solid features of a room



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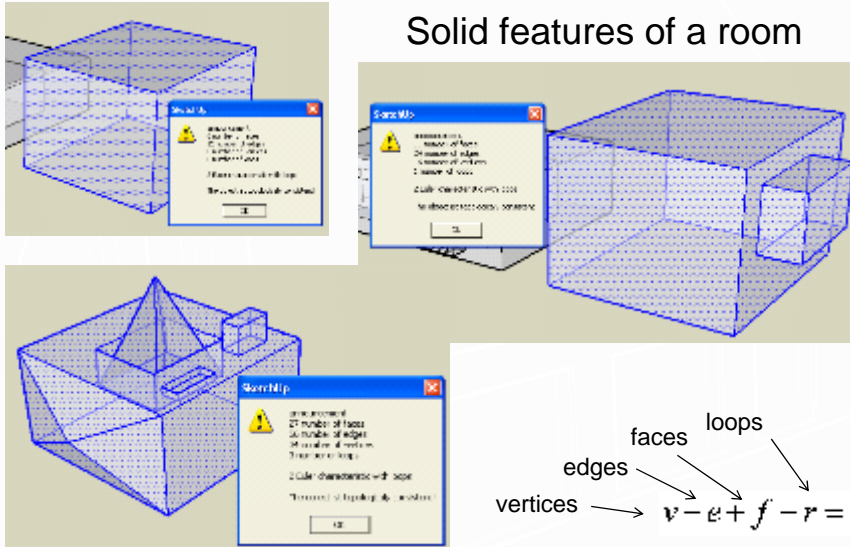
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Solid features of a room



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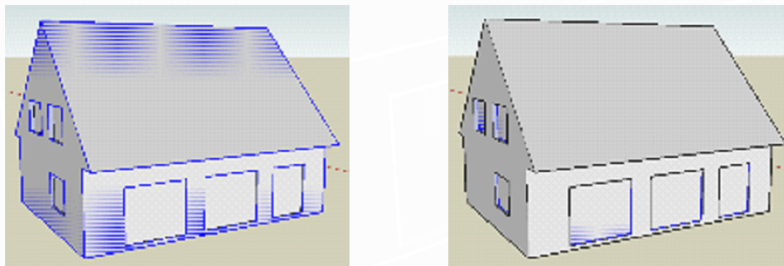
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After attributing all faces, two kind of faces can be distinguished.

Wall faces	Passage faces
The most surrounding edges are assigned to two faces	All surrounding edges are assigned to three faces
The wall faces are assigned to only one room-surface	The passage faces are assigned to two room-surfaces

Over the different features we can separate the faces automatically



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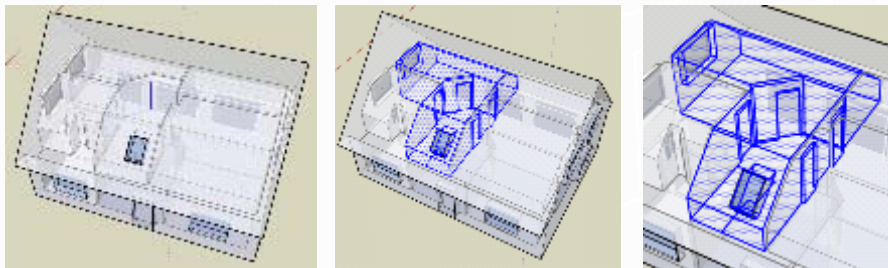
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• Automated Room-Element-Aggregation

- By using passage-face-edges as start edge we get all elements of two rooms
- If one of these rooms was attributed -> then all unattributed elements belongs to the new room and can be attributed
- That can be done step by step through the whole building, therefore only the passage faces has to be separated



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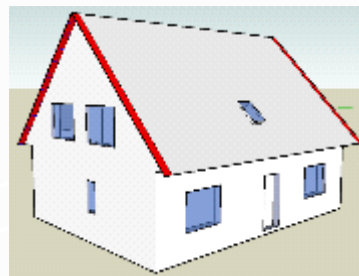
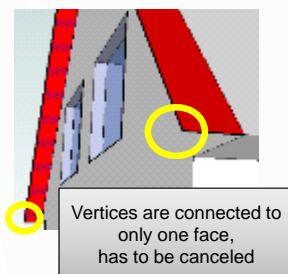
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• Element validation

- ▶ All face are assign to one room-surfaces?
- ▶ All vertices are assign to three independent planes?



- **After that we have valid data to use the adjustment application POPA 3D**

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Conclusions

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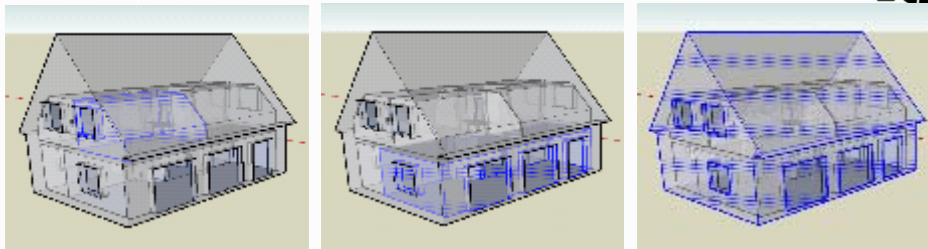
- Data acquisition with independent teams is possible
- Only relative information is used
- The extraction of semantic room information is automated
- A valid Digital Object Model (DOM) can be written for the adjustment with POPA 3D
- Extended room features can add into the DOM
- Observation can be attend with respect to the given topology

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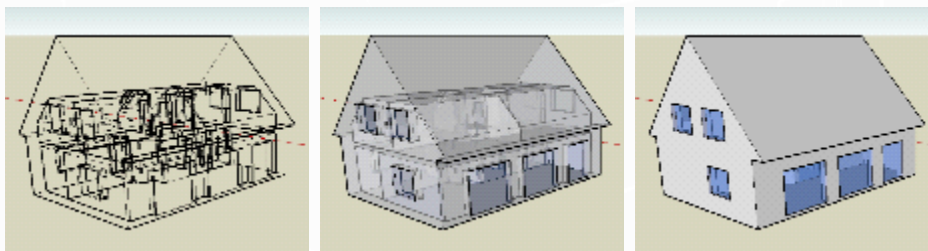
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Thanks for your attention.



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