CELL COMPLEXES TOPOLOGICAL LINKS FOR BUILDINGS IN CITYGML

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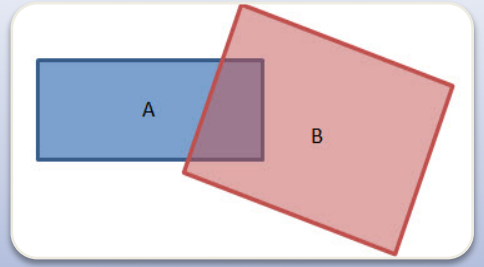
3D Geoinfo Conference, October 1-2, Delft 2018

Introduction

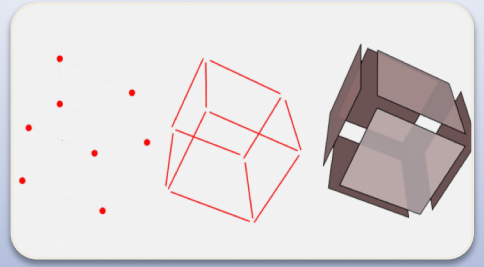


Topological Information

- Describe connectivity information between buildings (Krämer & Huhnt, 2009)
- Comprehensive connectivity information is required to support 3D exploratory analyses (Isikdag et al., 2013; Moser et al., 2010; Ellul, 2007)

CityGML

- XML links or “XLink” mechanism relates explicitly stored objects (Kolbe, 2009)
- No maintenance of relationships between 0D,1D, and 2D primitives (Ghawana & Zlatanova, 2012)
- Neighbouring buildings often modelled using separate (“invisible”) surfaces to facilitate efficient and consistent visualisation (Gröger et al., 2005)



Cell Complexes Topological Links

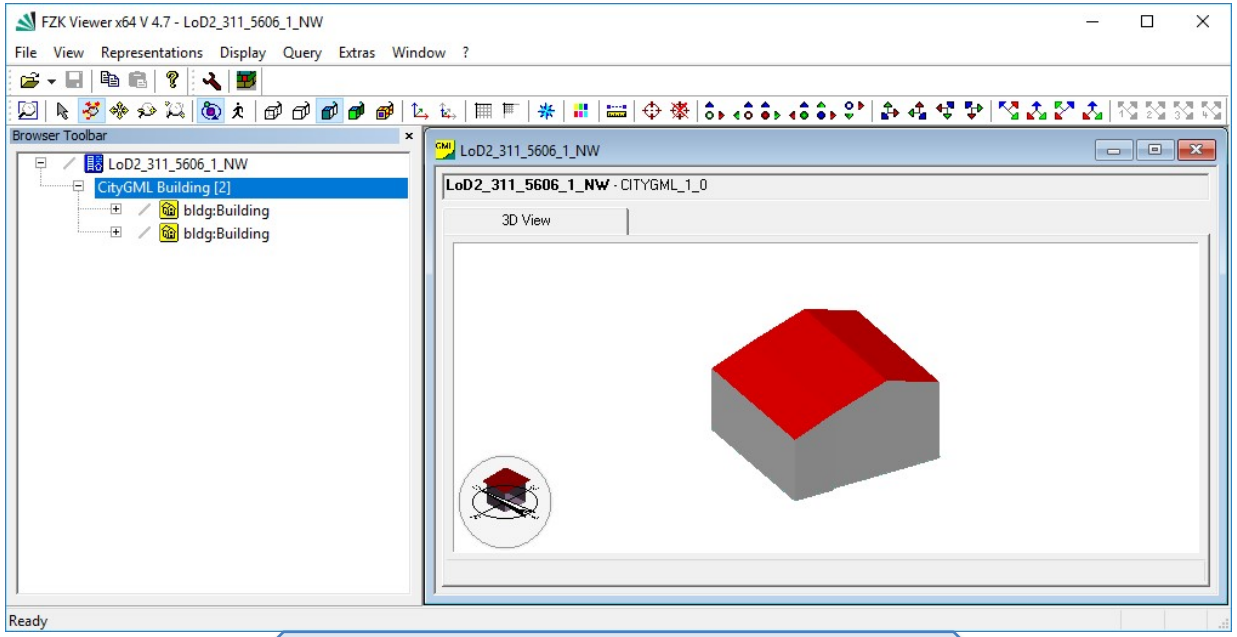
- Clear storage of topological information in a topological data structure is preferable for extraction of connectivity information (Boguslawski et al., 2011)
- Traverse via decomposed lower dimension primitives such as 0D points, 1D lines and 2D surfaces to make up a 3D object while preserving connectivity information

Methodology

Extraction of geometrical properties

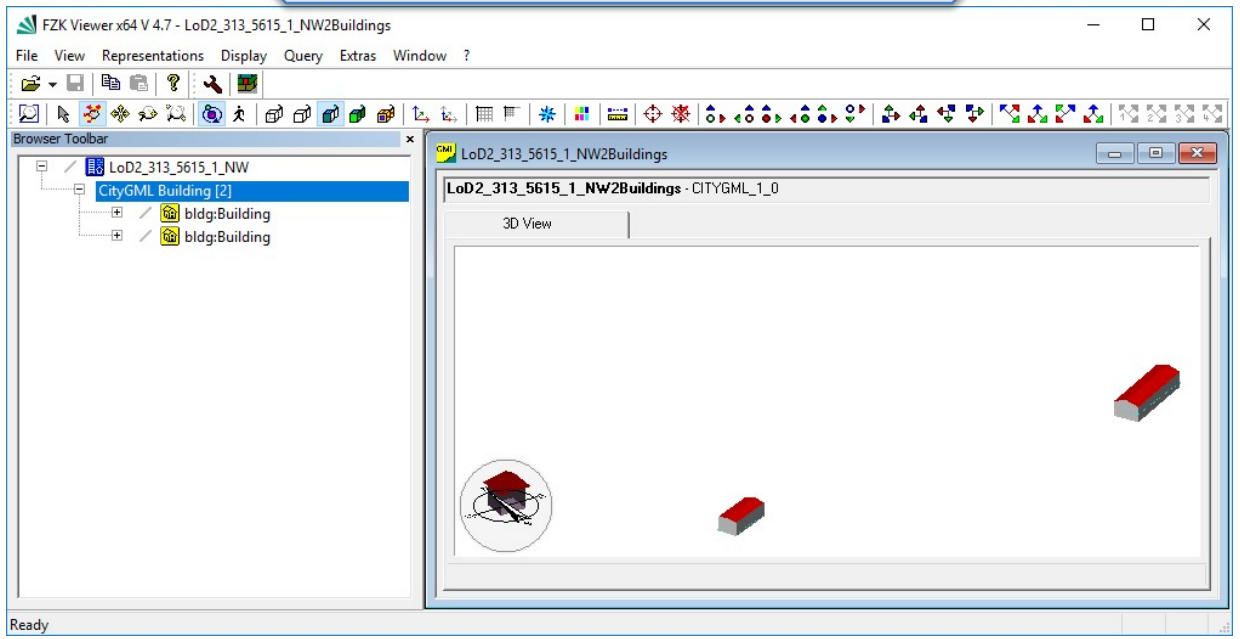
Generate topological links based on the extracted properties

CityGML Datasets



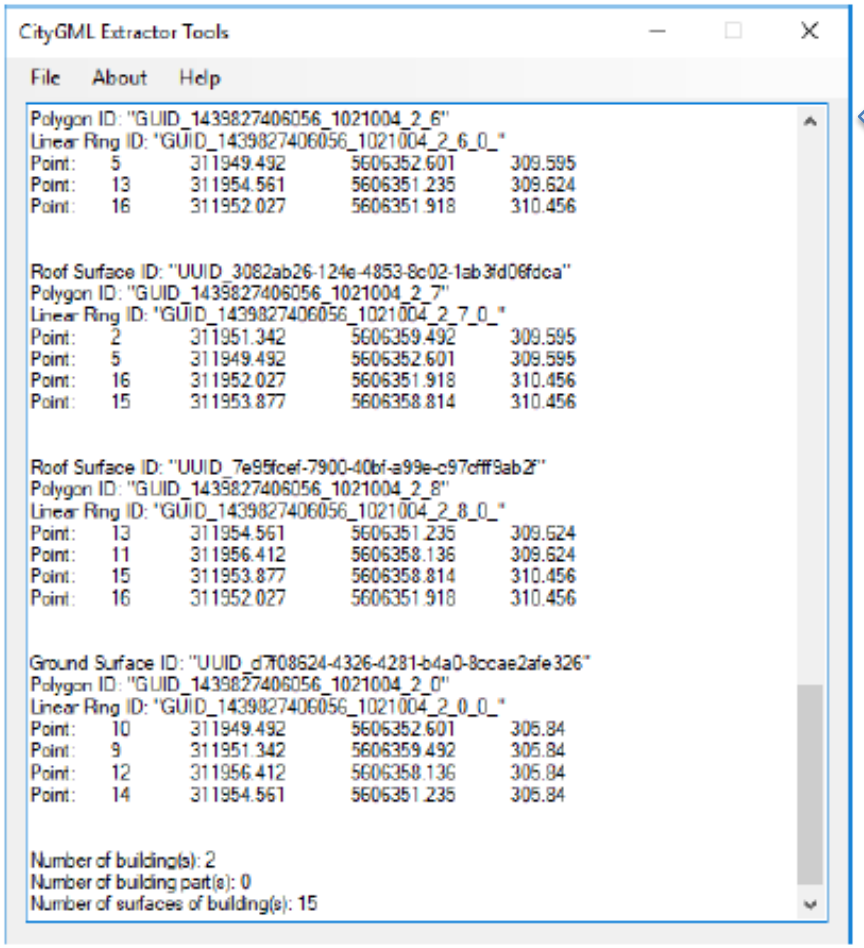
Dataset A: Two connected buildings

Dataset B: Two disjointed buildings



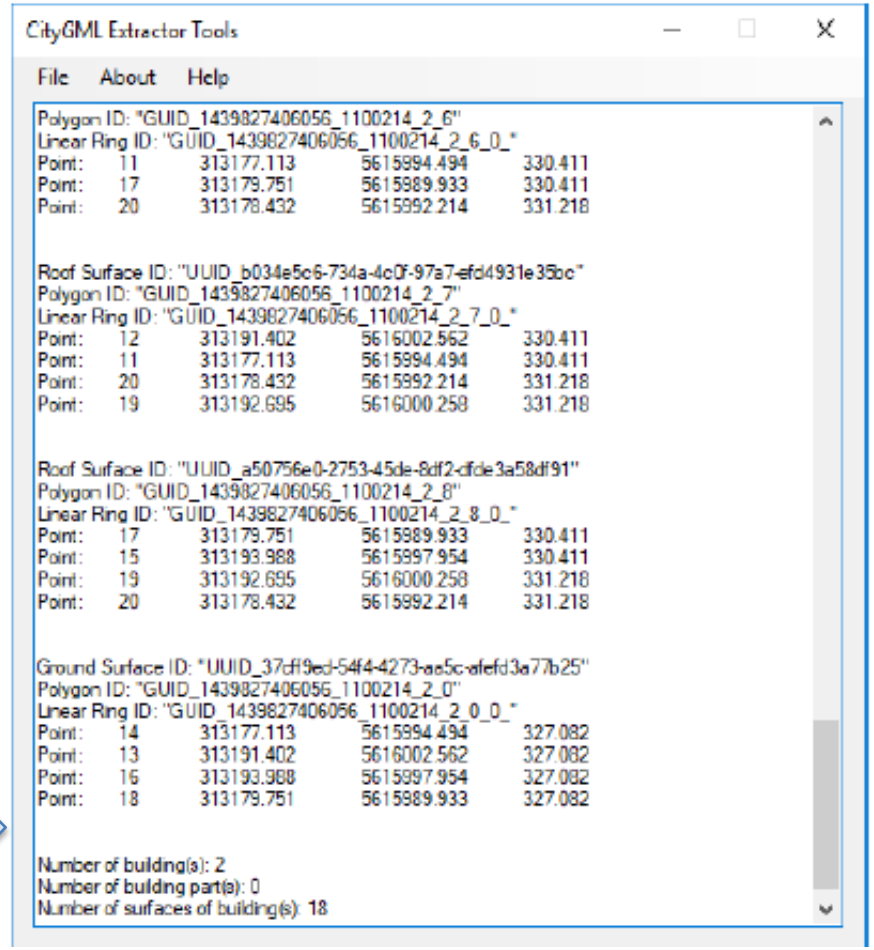
**The CityGML datasets used in this study were obtained freely from Nordrhein-Westfalen Open Data*

Extraction of Geometric Properties

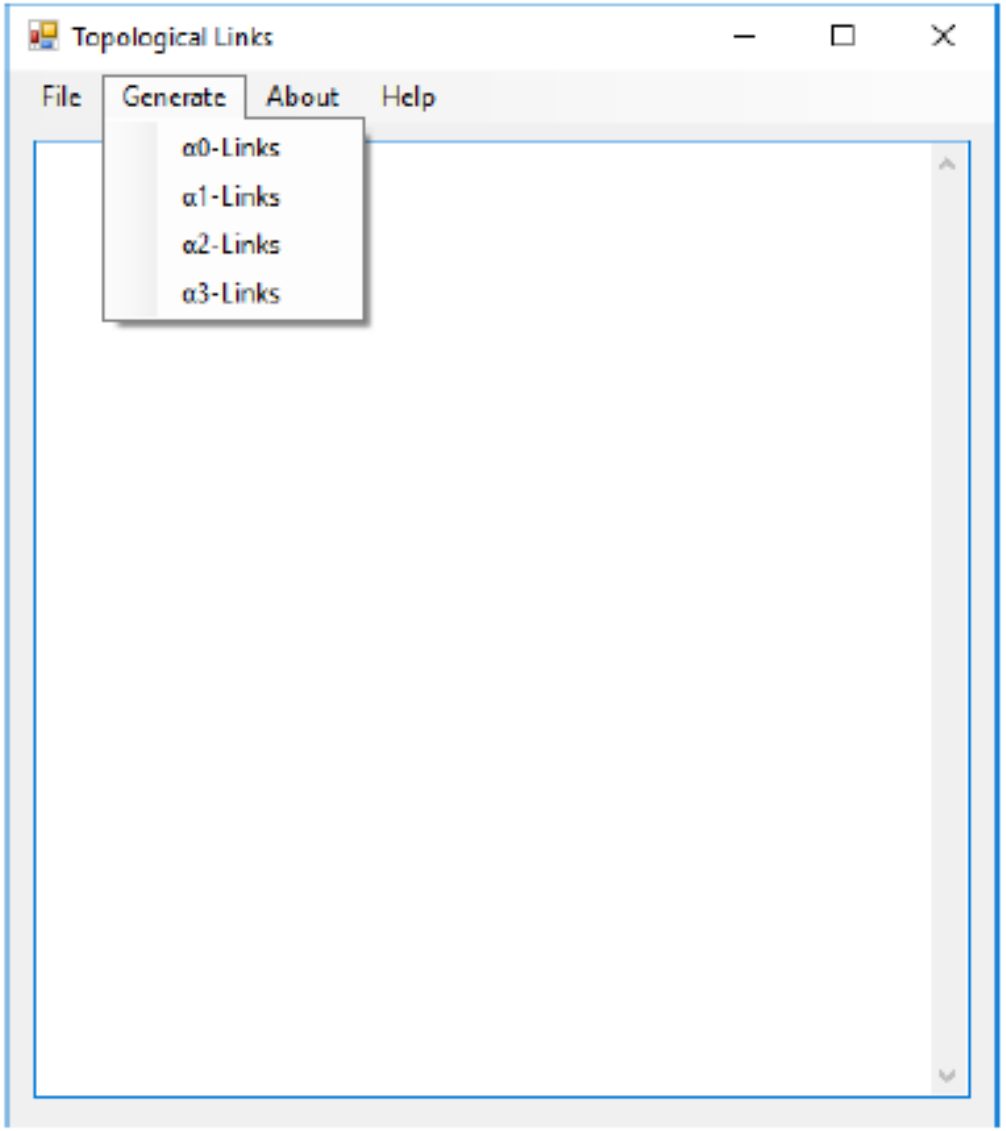


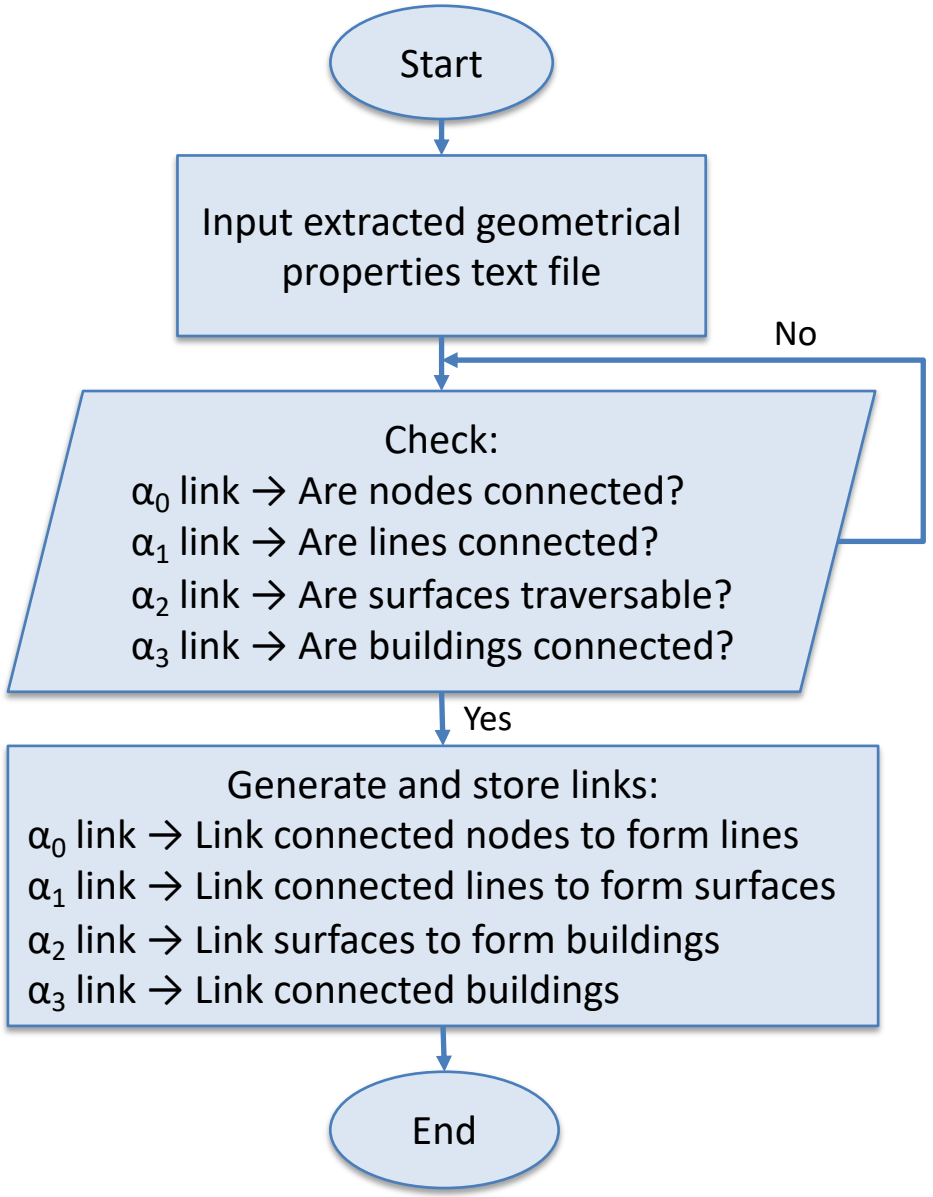
Dataset A:
- 2 Buildings
- 15 Surfaces
- 16 Nodes

Dataset B:
- 2 Buildings
- 18 Surfaces
- 20 Nodes



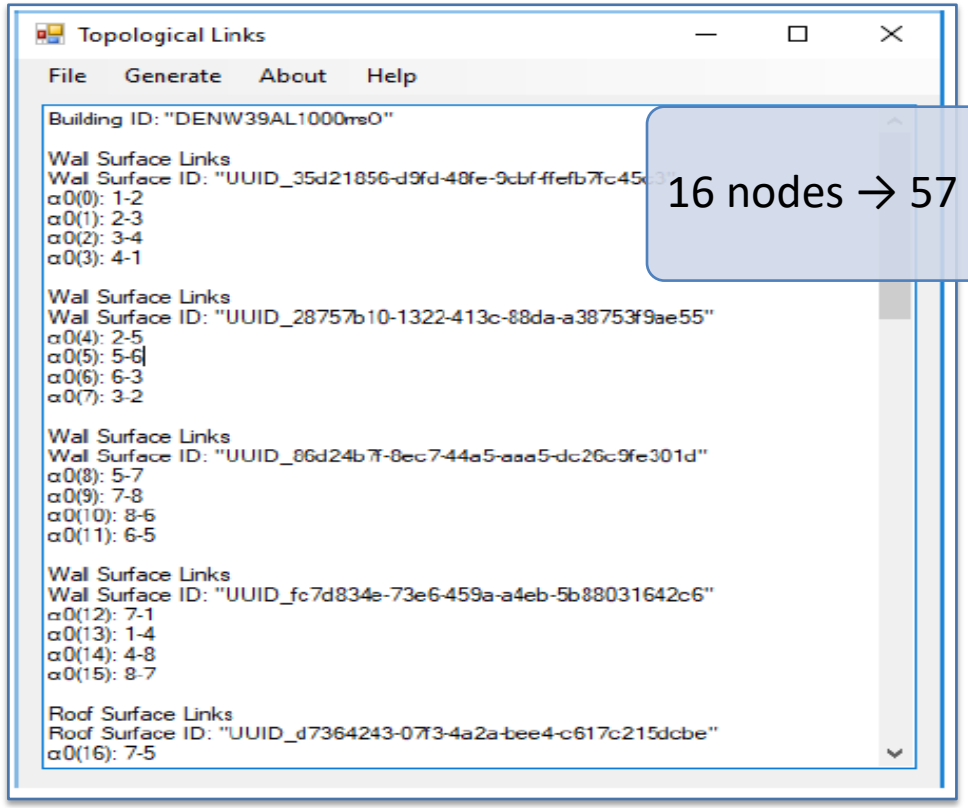
Generating Topological Links





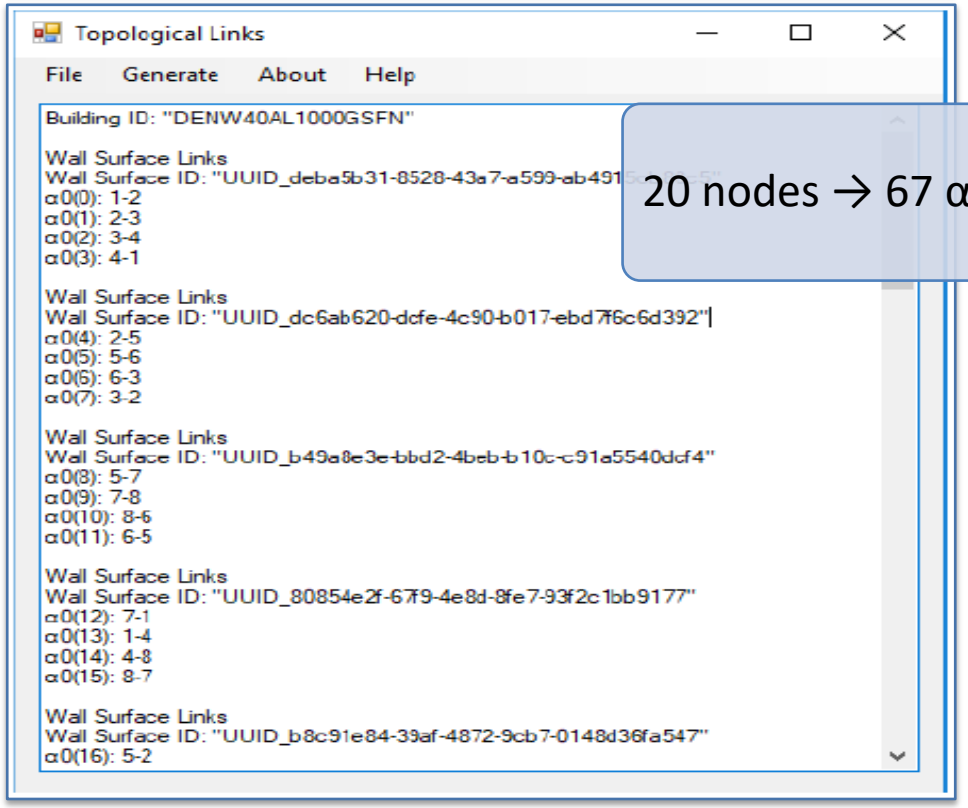
Results (1D α_0 links)

a_0 Links for Dataset A



16 nodes → 57 α_0 links

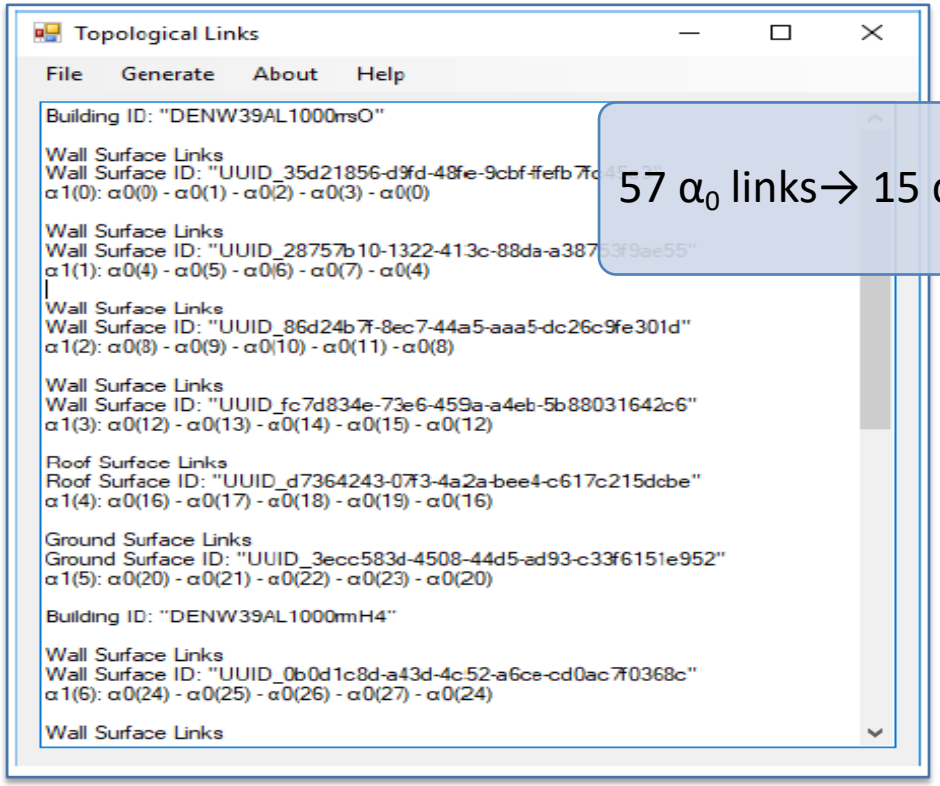
α_0 Links for Dataset B



20 nodes → 67 α_0 links

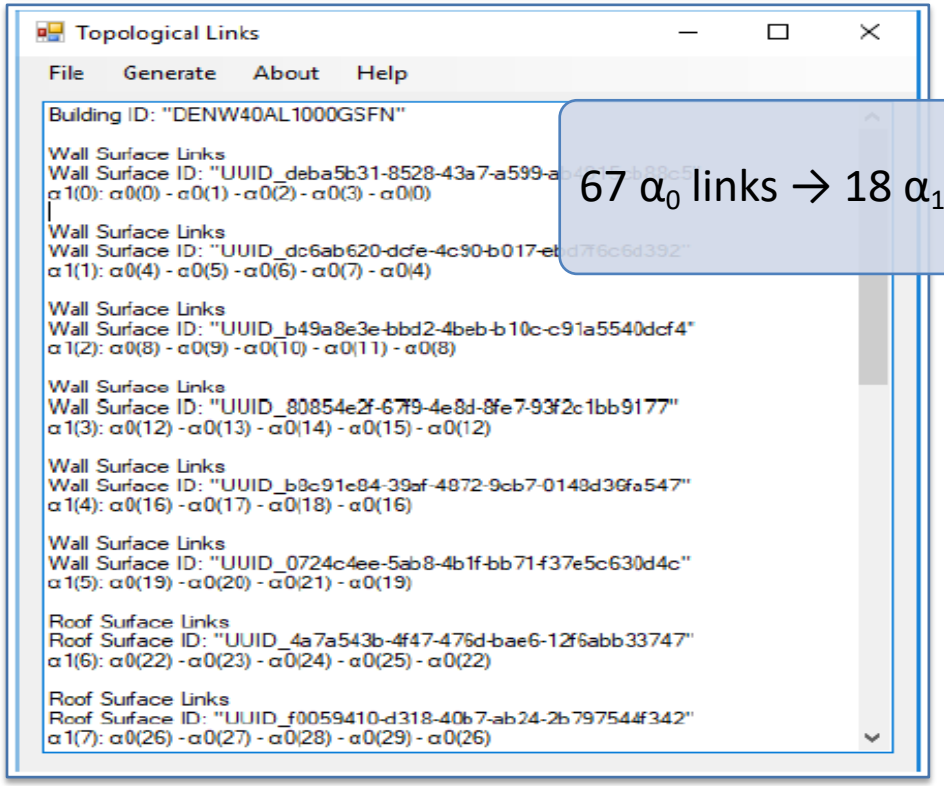
Results (2D α_1 links)

α_1 Links for Dataset A



57 α_0 links→ 15 α_1 links

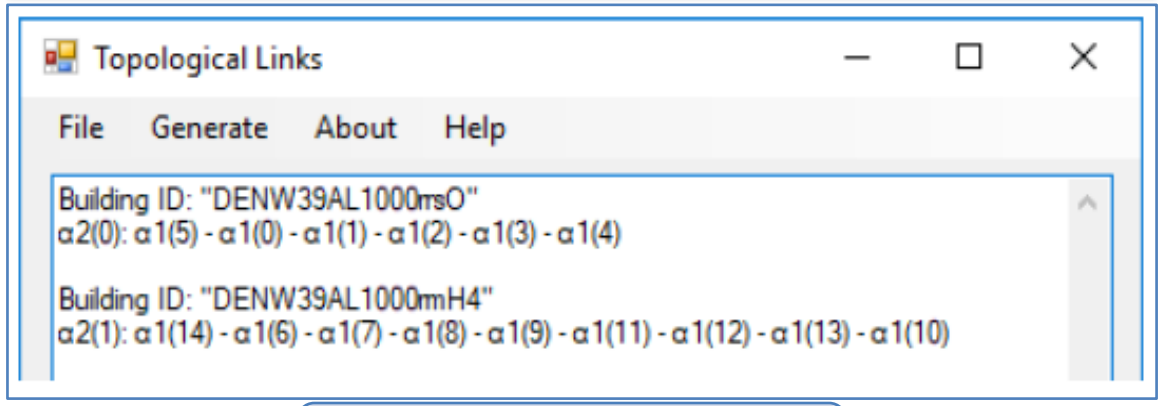
α_1 Links for Dataset B



67 α_0 links → 18 α_1 links

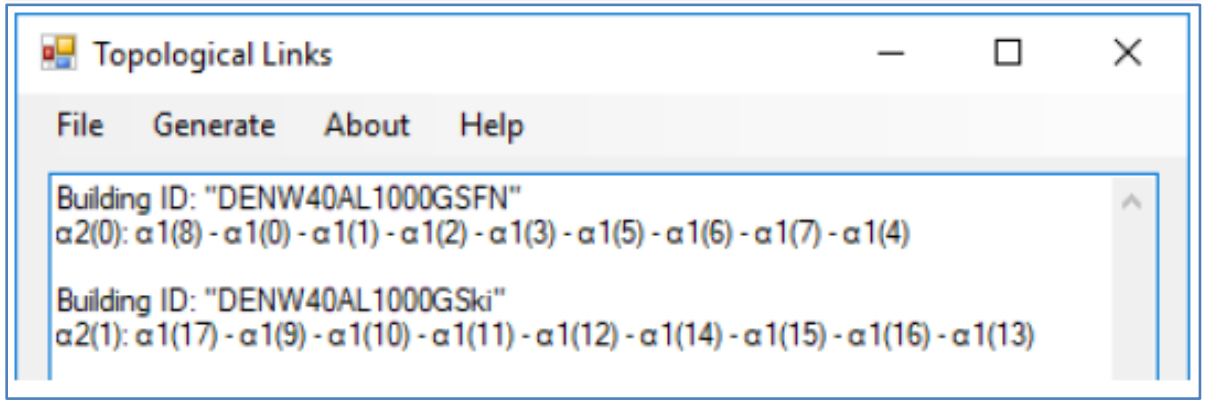
Results (3D α_2 links)

α_2 Links for Dataset A



15 α_1 links → 2 α_2 links

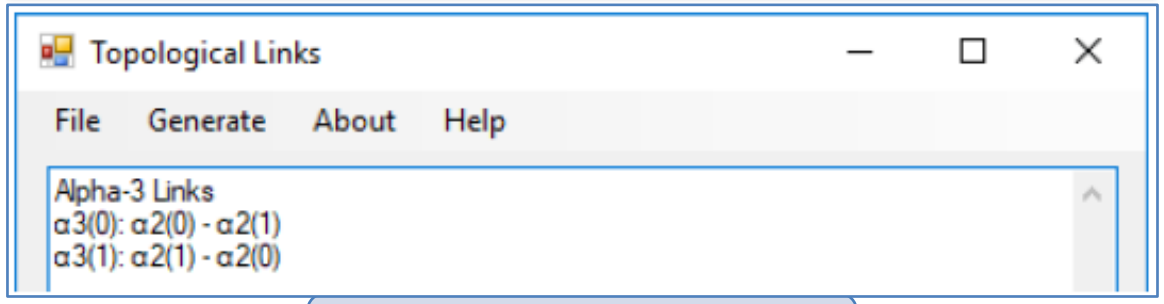
α_2 Links for Dataset B



18 α_1 links → 2 α_2 links

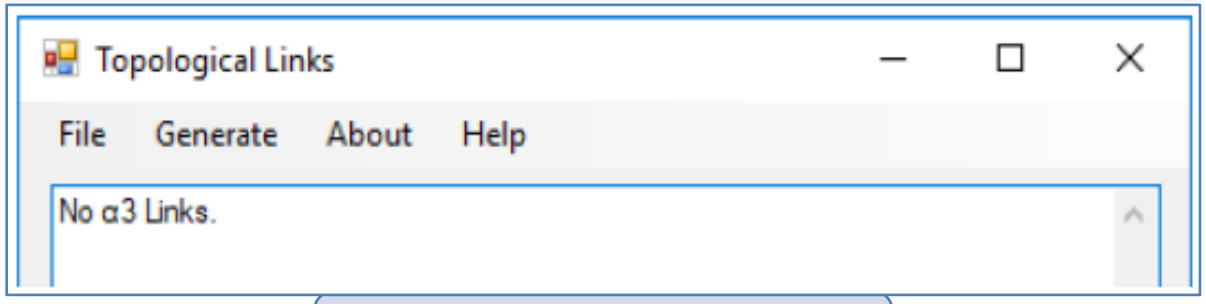
Results (α_3 links)

α_3 Links for Dataset A



2 α_2 links → 2 α_3 links

α_3 Links for Dataset B



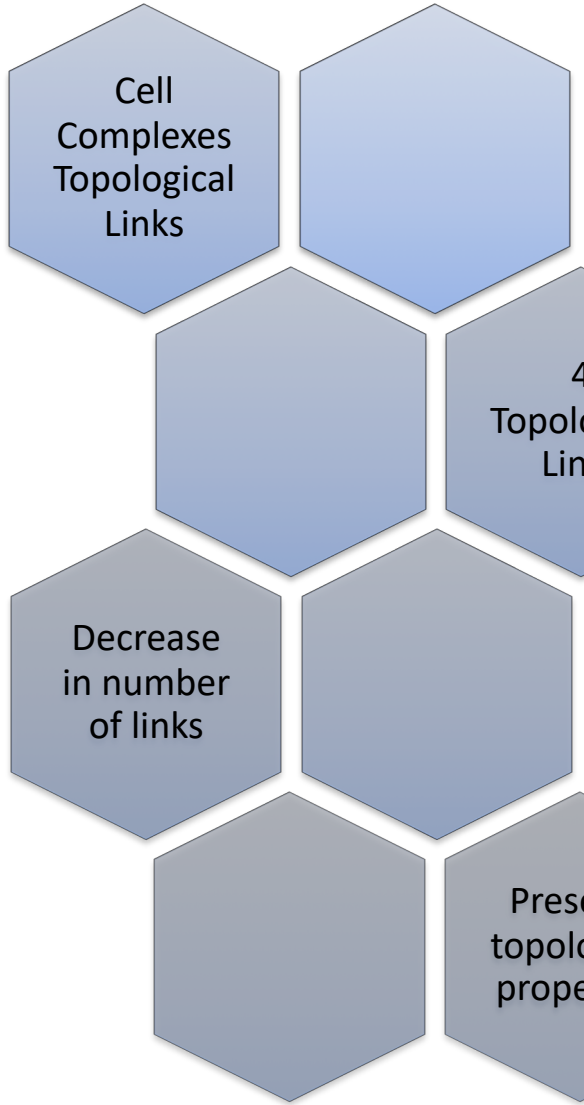
No connected buildings

The α_3 links describe the connection between the buildings of Dataset A which could not be referenced in CityGML due to being connected via an “invisible” face.

Conclusion

Dataset A: 2 connected buildings

Dataset B: 2 disjointed buildings



α_0 link: 0D nodes to 1D lines

α_1 link: 1D lines to 2D surfaces

α_2 link: 2D surfaces to 3D volumes

α_3 link: connections between 3D volumes

Dataset A: 57 α_0 links to 2 α_2 links

Dataset B: 67 α_0 links to 2 α_2 links

Simple and compact

One α_2 link per building

Describe how surfaces are connected (via an “invisible” face)

Allows navigation through topological links

Future Research

- *n*-dimensional case study
- 3D Smart Cities
- BIM
- Urban Pollutions (multi-dimensional)
- Visual Positioning System (VPS) Integration (local positioning)

Acknowledgements

- The CityGML datasets used in this study were obtained freely from Nordrhein-Westfalen Open Data.
- The CityGML viewer used in this study is the FZK Viewer developed by Karlsruhe Institute of Technology.
- This work is supported by the UTM Research University Grant, Vot Q.J.130000.2527.15H49 and Vot Q.J.130000.2527.11H78.

Thank you

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