

## Software Lab:

Modeling:	<input type="checkbox"/>
Mathematics:	<input type="checkbox"/>
Programming:	<input type="checkbox"/>
Science:	<input type="checkbox"/>

# Graph-Driven Parametric Construction Models

## Description

In this project you will investigate a graph-driven approach to parametric construction modeling in which a Neo4j property graph acts as the single-source-of-truth, while three-dimensional geometry is generated imperatively through Rhino and Grasshopper. Instead of embedding design logic directly in parametric models, construction elements and connections are represented as typed nodes with explicit properties (e.g. dimensions, interfaces), and their relationships are expressed as edges encoding structural support, alignment, and connectivity. Based on node labels and properties, specific Grasshopper definitions are selected and invoke Rhino Compute Scripts, with graph data mapped to parametric inputs. Geometry is thus derived as a projection of the graph, rather than being manually modeled or interactively edited. Dimensional consistency is ensured by combining graph-level constraints enforced through Neo4j schemas and Cypher rules with bounded parametric definitions in Grasshopper, preventing the generation of invalid or non-buildable geometry. The approach aims to enable reproducible, scalable generation of construction models and supports systematic evaluation of how much design knowledge can be shifted from parametric scripts into explicit, queryable graph structures, offering a foundation for rule-based design automation in construction engineering. Additionally, off-loading geometric logic into proven geometry-kernels can make the graph more accessible and queryable.



Figure 1: Sample Resulting Modular Bridge Model

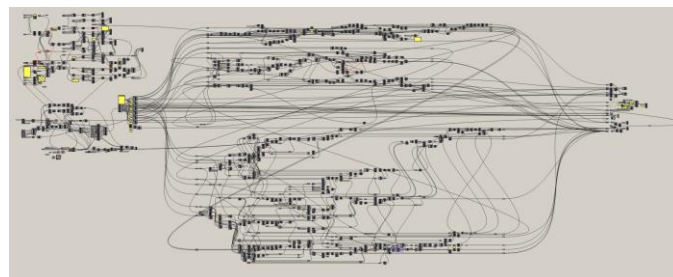


Figure 2: Sample Grasshopper Script

## Task

### GENERAL INSTRUCTIONS:

- Get accustomed to Neo4j, Cypher, Grasshopper, and Rhino Compute (Materials will be provided).
- Develop a graph meta-model for the Neo4j Host-Graph
- Decide on sample use-cases
- Model and design a Grasshopper Parts-Catalog
- Develop a method of invoking the Grasshopper scripts when querying the graph

## Supervisor

Benedict Harder, Chair of Computing in Civil and Building Engineering, [benedict.harder@tum.de](mailto:benedict.harder@tum.de)

## References

<https://www.grashopper3d.com/>

<https://neo4j.com/>

Figure 2: <https://global.discourse-cdn.com/mcneel/uploads/default/original/4X/b/c/1/bc1f8453aed382db91dad321d0ec05542704b8a5.png>