Bauhaus-Universität Weimar

Speaker: **Julia Tschetwertak M.Sc.**

Does the sequence matter?

Investigating the impact of the order of design decisions on the life cycle performance

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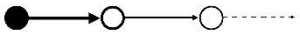
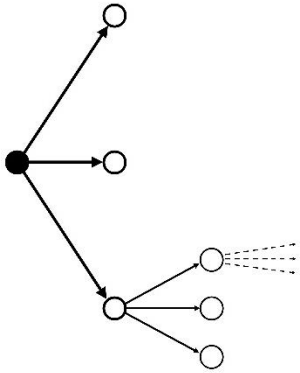
Design Strategies

Design strategies by Rittel



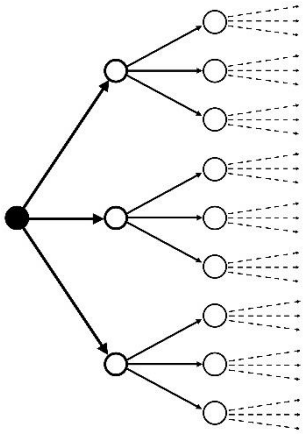
a)

Linear process



b)

Simplified multi-stage decision-making process



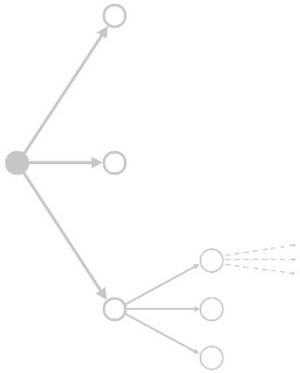
c)

Multi-stage decision-making (MD) process

Design strategies by Rittel

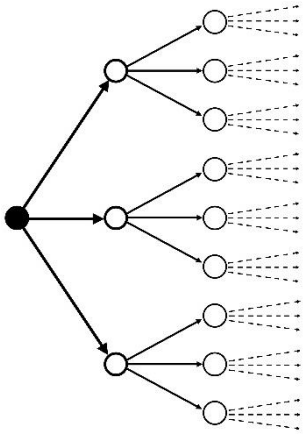
a)

Linear process



b)

Simplified multi-stage decision-making process

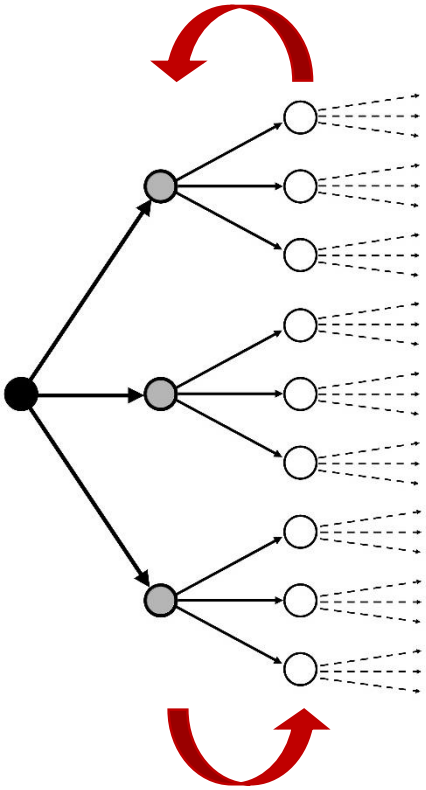


c)

Multi-stage decision-making (MD) process

Research Topic

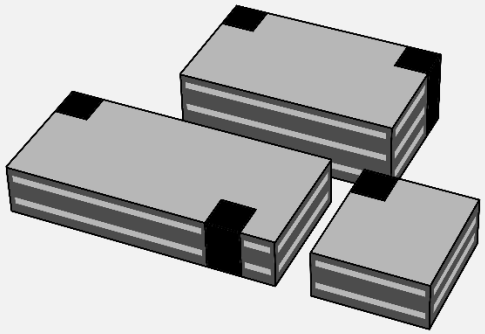
Does the sequence matter?



Changing the
stage order
within the MD Tree

Case Study

Design Components

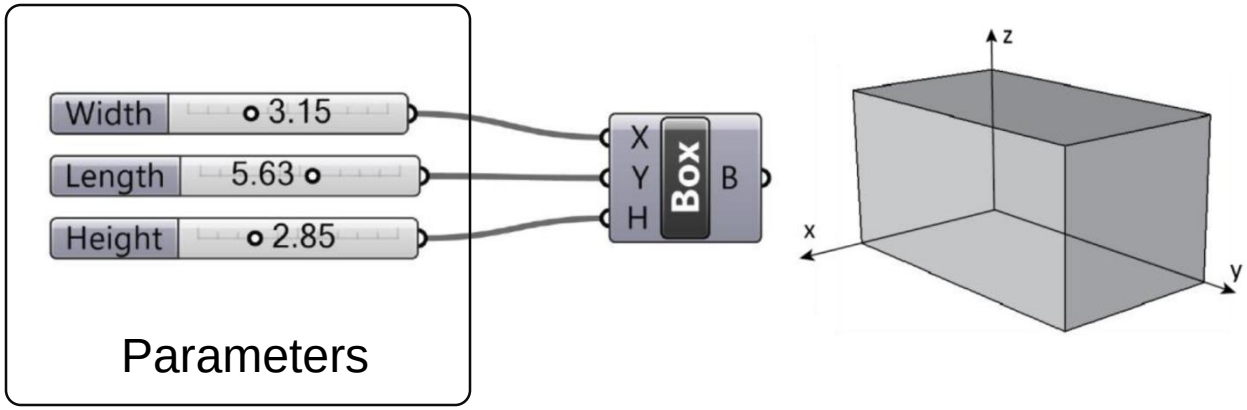


Volumes & Circulation cores

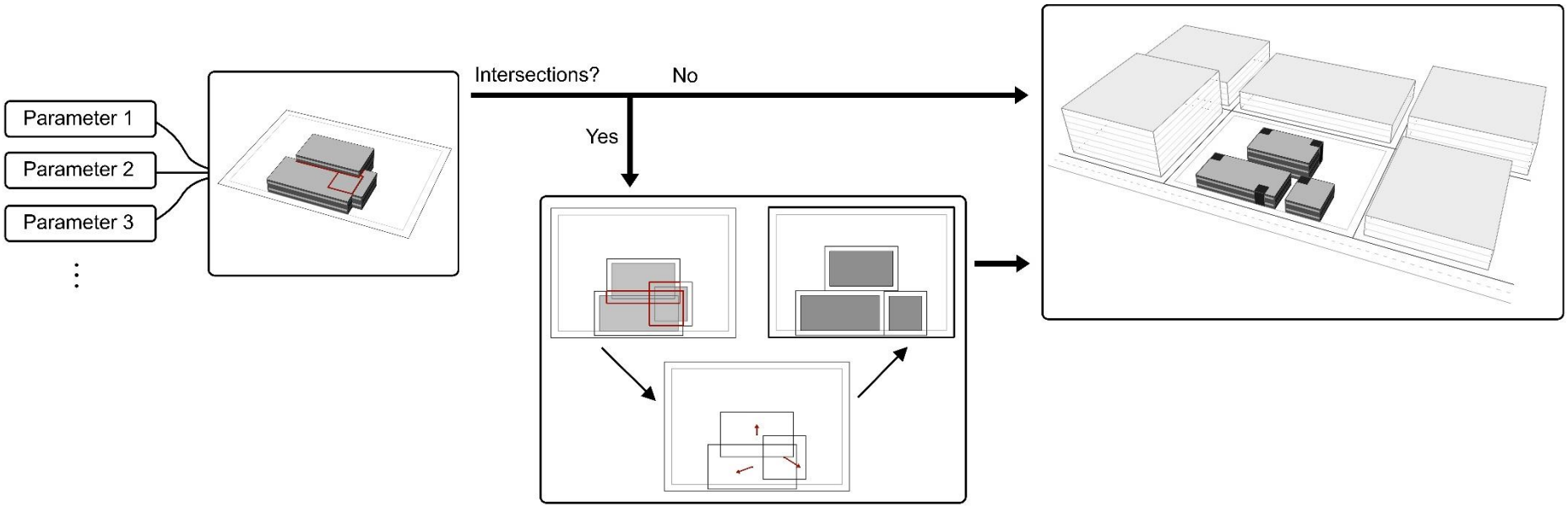
- ETICS
- Brick
- Concrete
- Wood
- Ventilated facade
- Double shell masonry

Construction types

Parametric Modeling

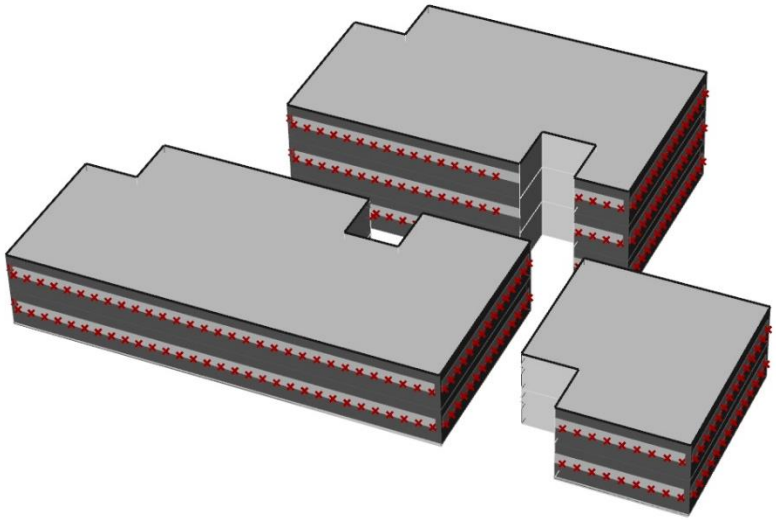


1. Model Generation



2. Model Analysis

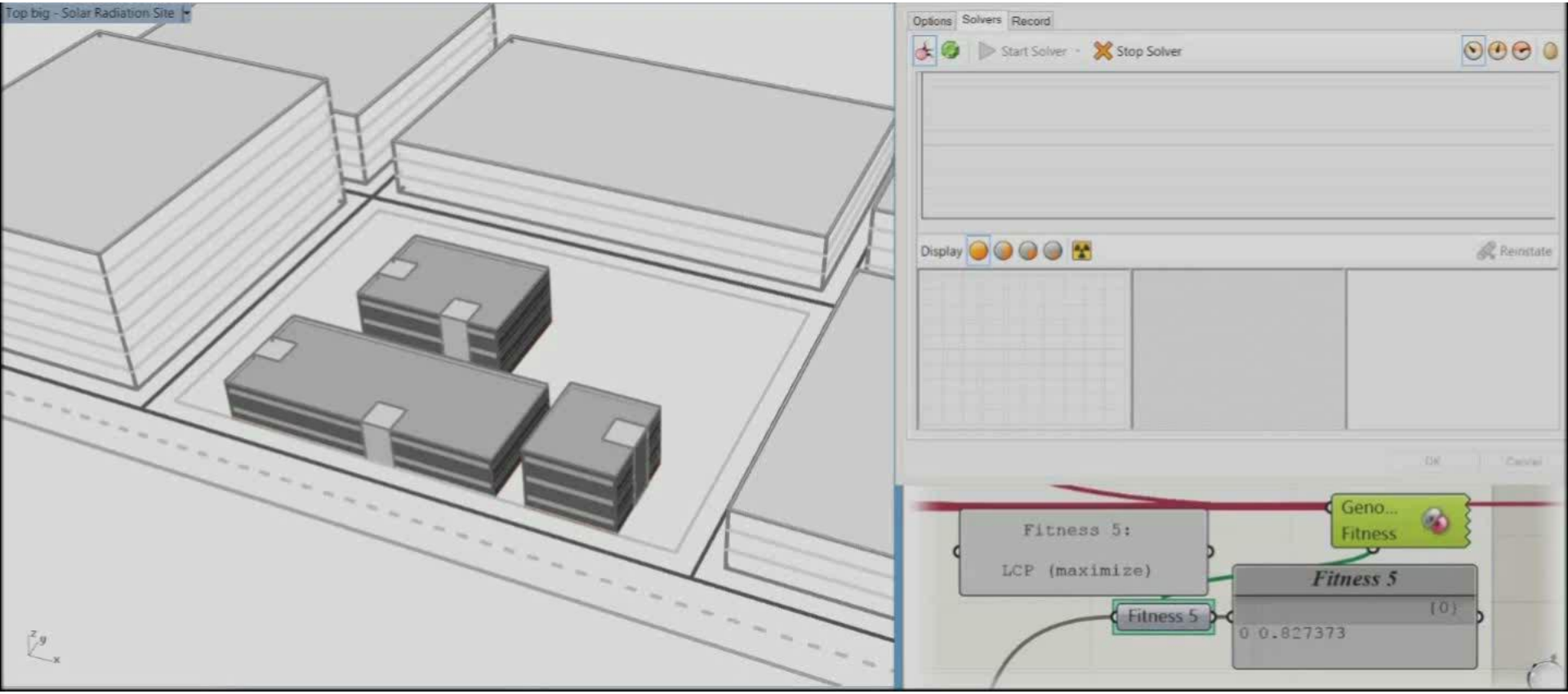
Life Cycle Performance (LCP)



… is a measure of the environmental impact of buildings during their whole lifespan

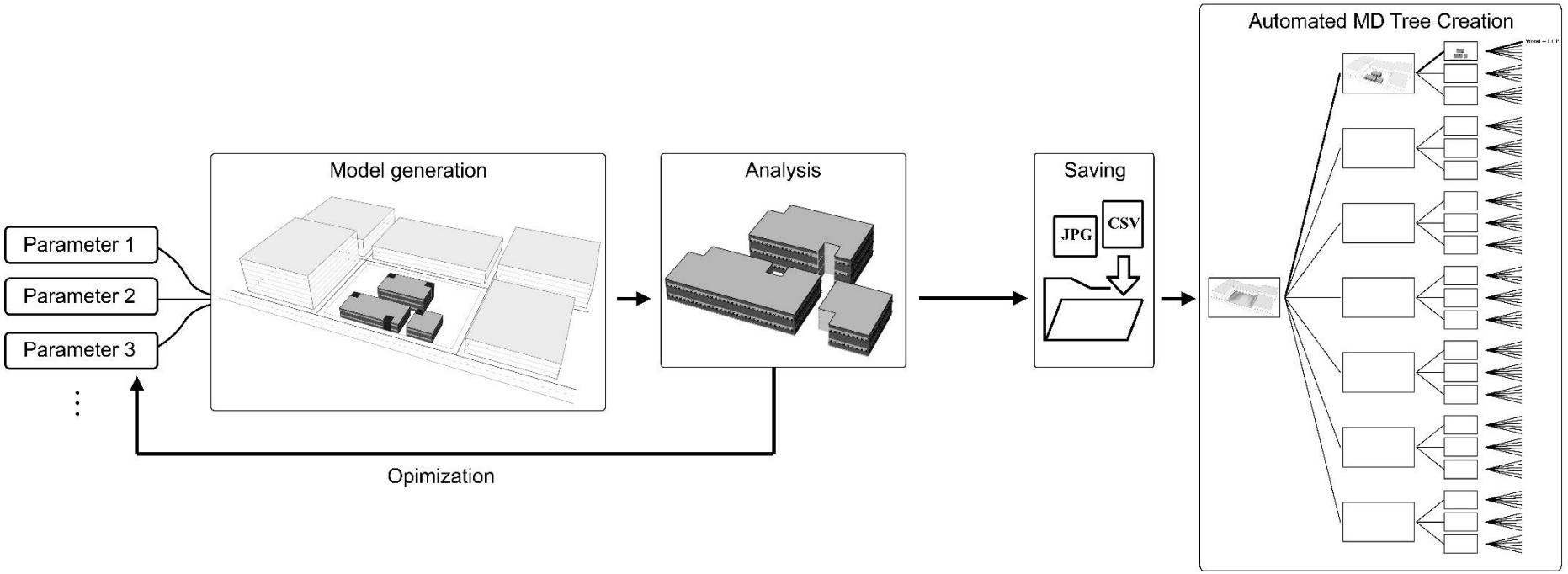
Using the LCA tool by Hollberg (2016)

3. Optimization



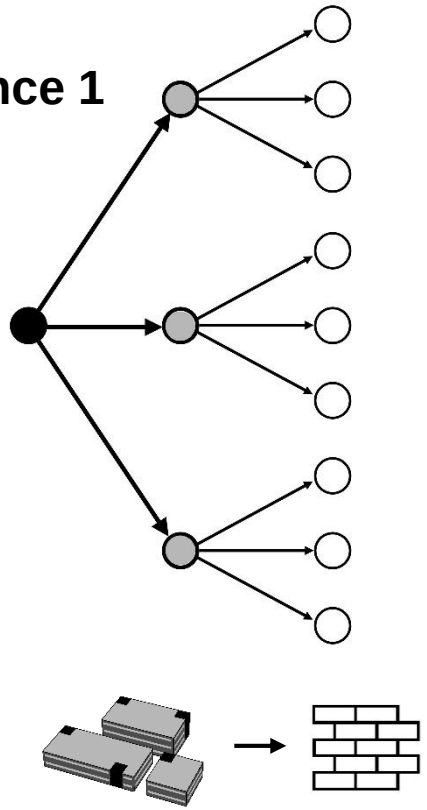
Using **Evolutionary Algorithms**

4. Automated MD Tree Creation

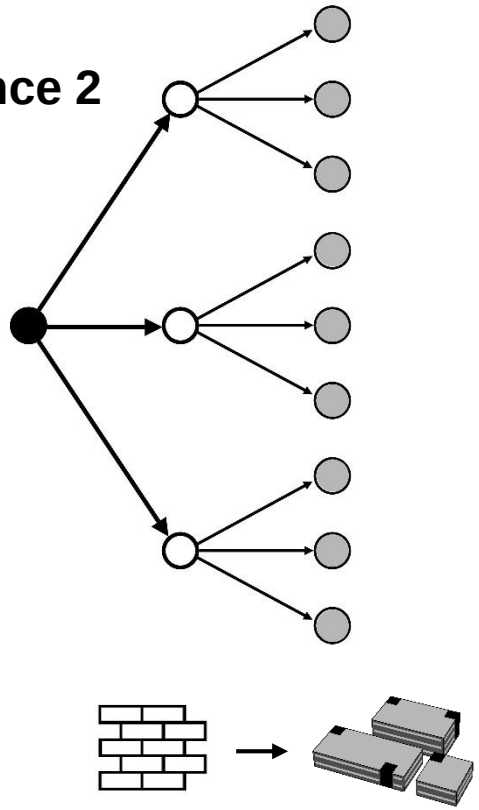


Sequences

Sequence 1

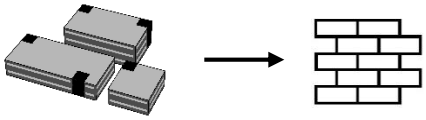


Sequence 2



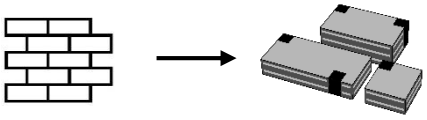
Fitness Functions

Sequence 1



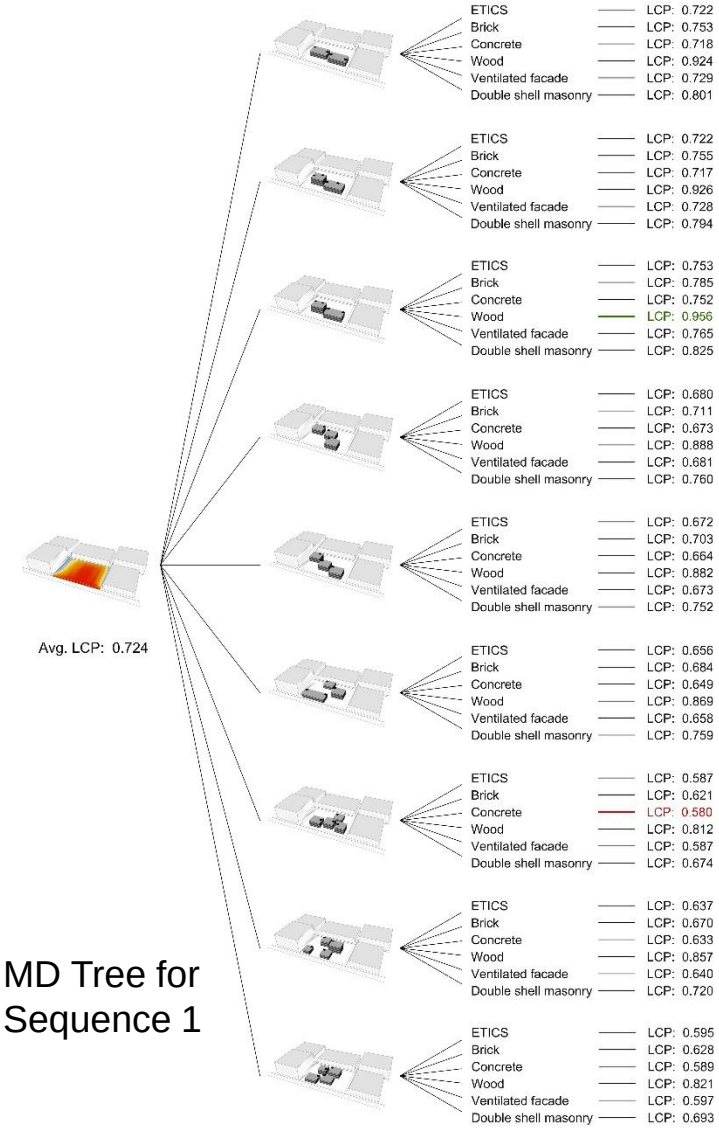
Fitness = Custom fitness function

Sequence 2

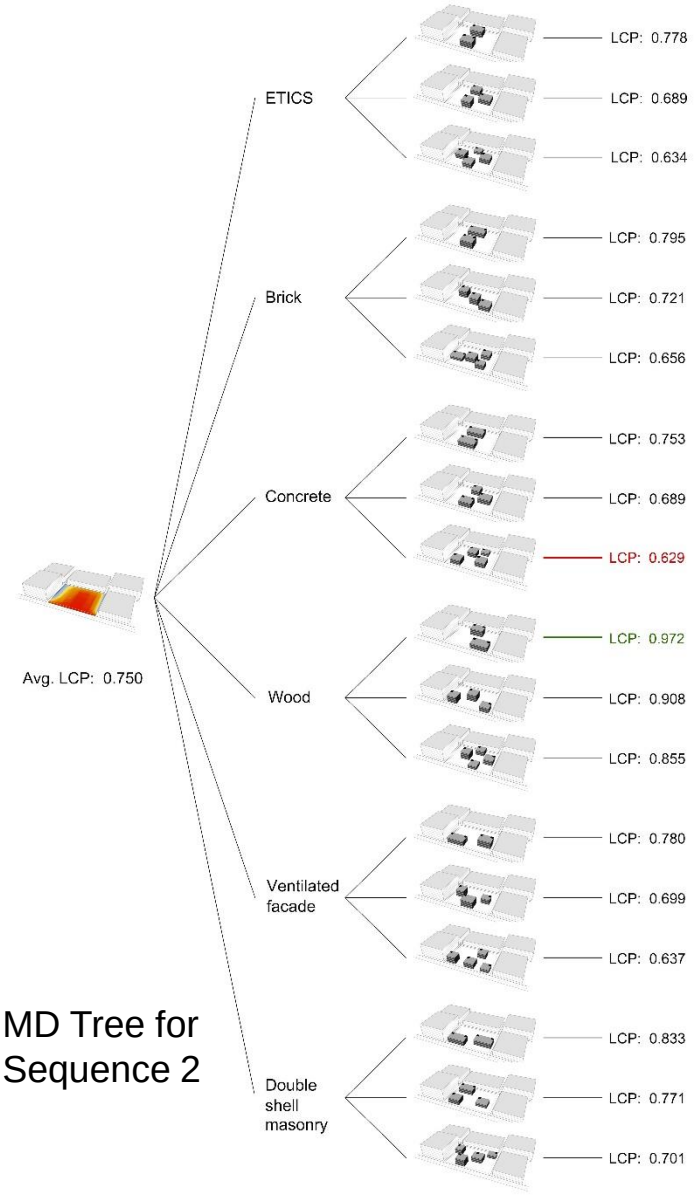


Fitness = LCP

Results



MD Tree for Sequence 1



MD Tree for Sequence 2

Evaluation

Performance	Average Sequence 1	Average Sequence 2	Difference
LCP [WBP]	0.724	0.750	**+ 3.6 %**
Distance [m]	4.52	10.27	**+ 127.2 %**
S/V [m^{-1}]	0.352	0.352	**± 0 %**
Solar radiation [kWh/m^2]	370.477	399.170	**+ 7.7 %**

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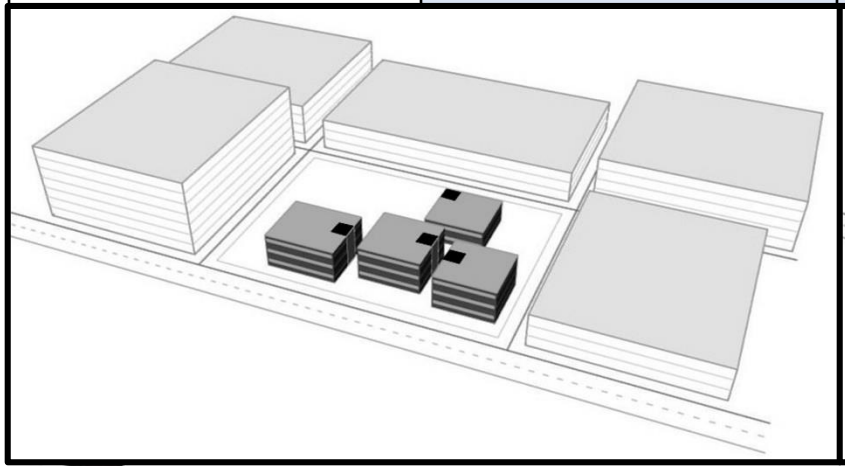
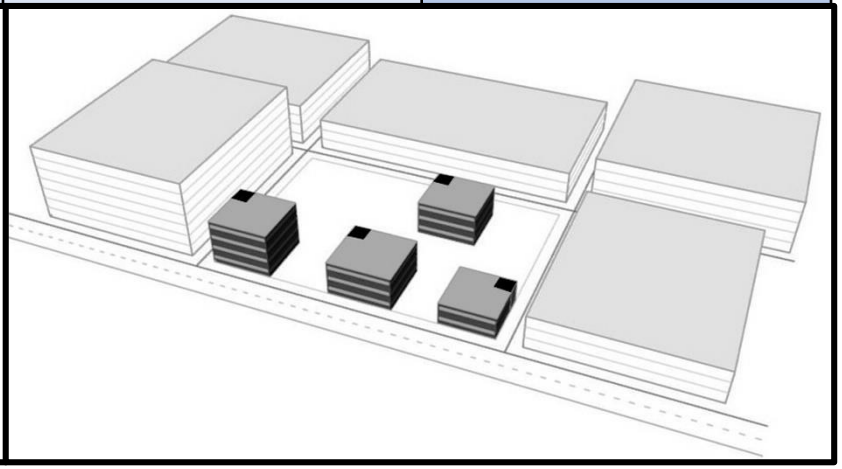
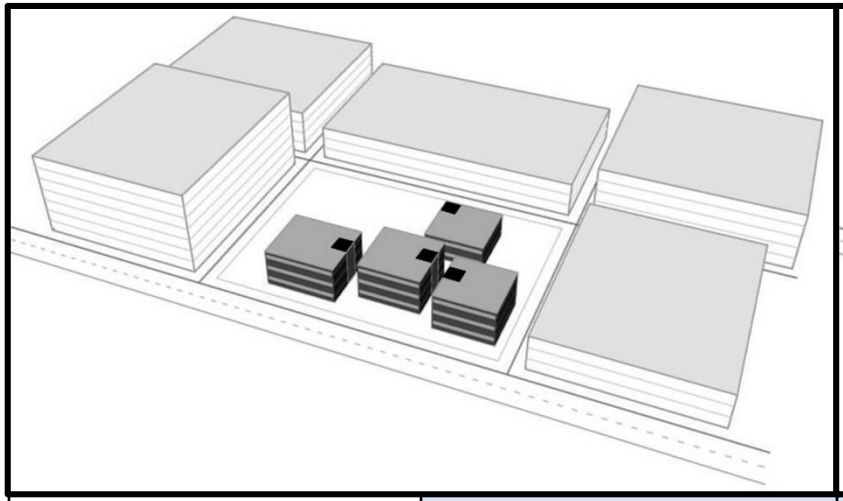
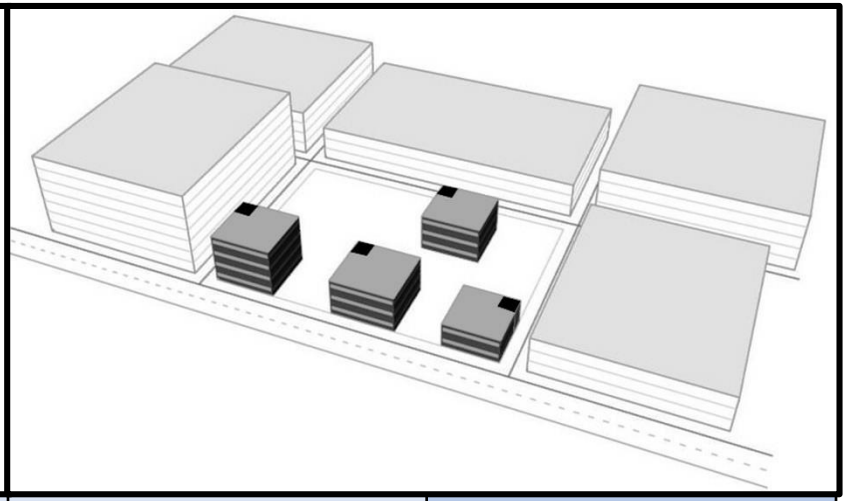




Evaluation





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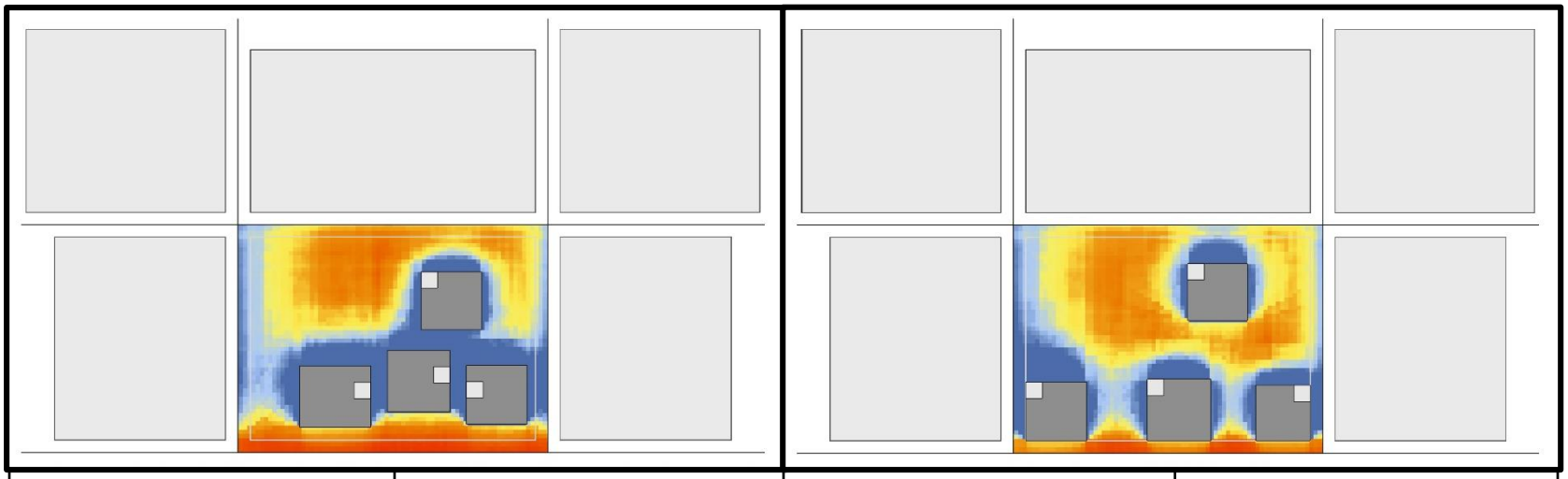

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Conclusion

- Defining an appropriate sequence for the MD process is highly dependent on the **individual design problem**.

- A **custom fitness function** is needed if crucial information for the main design evaluation method (EM) is not available at a design stage where optimization is to be conducted.

- Establishing custom fitness functions can be **complex** and create **worse solutions**.

- The custom fitness function needs to be **tailored towards the EM** while taking into account the components involved and their relationships.

- Conducting **optimization after obtaining all crucial information** for the EM is beneficial because from this point the main design evaluation method EM can be used as the fitness function.

References

Hollberg, A., 2016. A parametric method for building design optimization based on Life Cycle Assessment. Dissertation, Weimar: Bauhaus University Weimar.

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Thank you