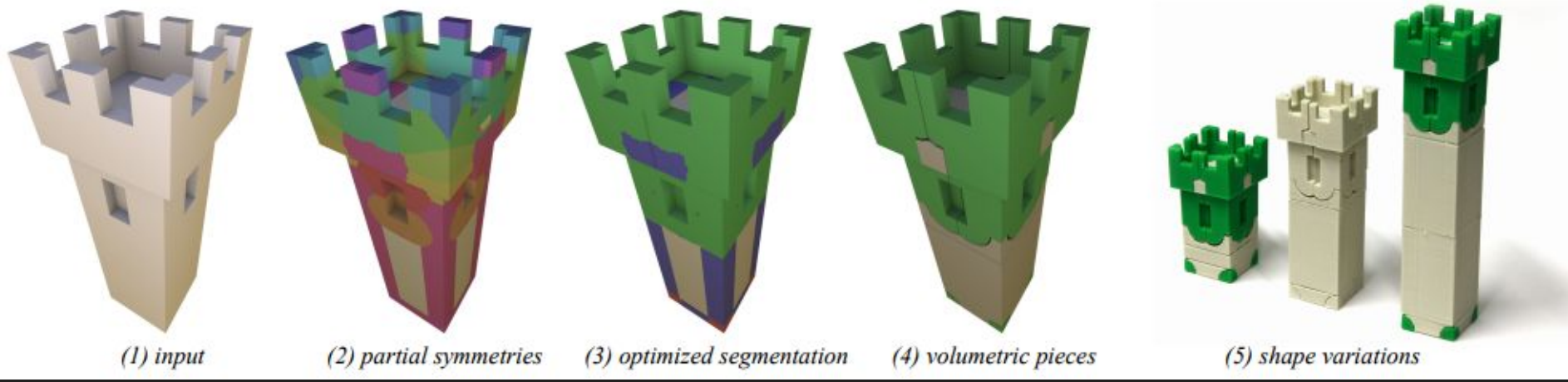
Building Construction Sets by Tiling Grammar Simplification



Construction set fabrication from model

Creating “bricks”

Reassembly into varied geometry

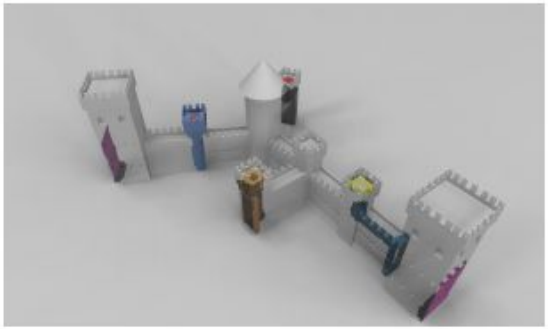
Intro

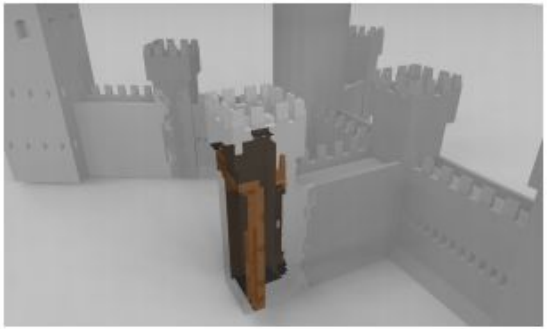
Varied geometry

Minimize required art

Simple building blocks

Tradeoff against expressiveness





Inverse procedural modeling

- Decomposition into blocks
- Assembly rules

Avoid complex shapes

Avoid complex assembly rules

Simplifying tiling grammars

Start with complex tiling grammar

Minimize objective function

- Complexity vs. expressiveness

Approximate shape matching to minimize building blocks

Monte Carlo search

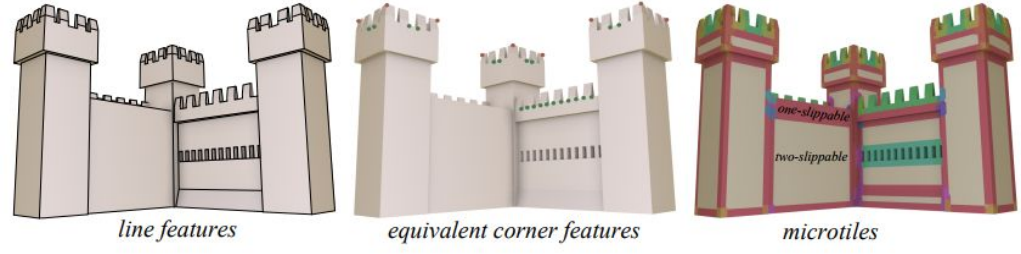
Grammar generation

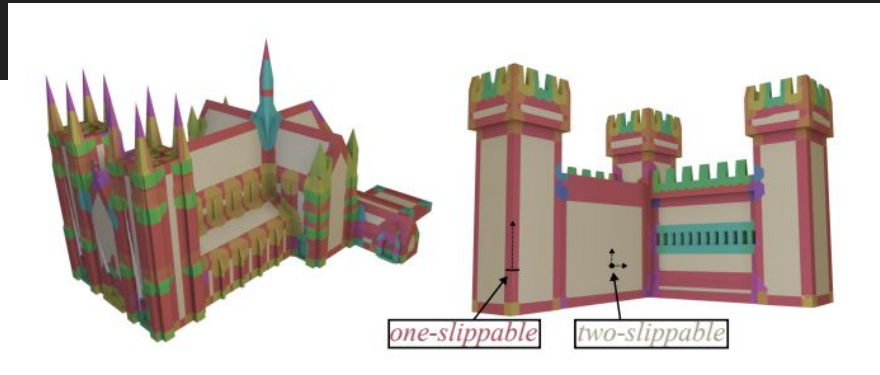
Identify partial symmetries

r-symmetry - Identical spherical neighborhoods

r-similarity - Every point r-symmetric to point in another shape

Microtiles - Connected points sharing symmetry transformations



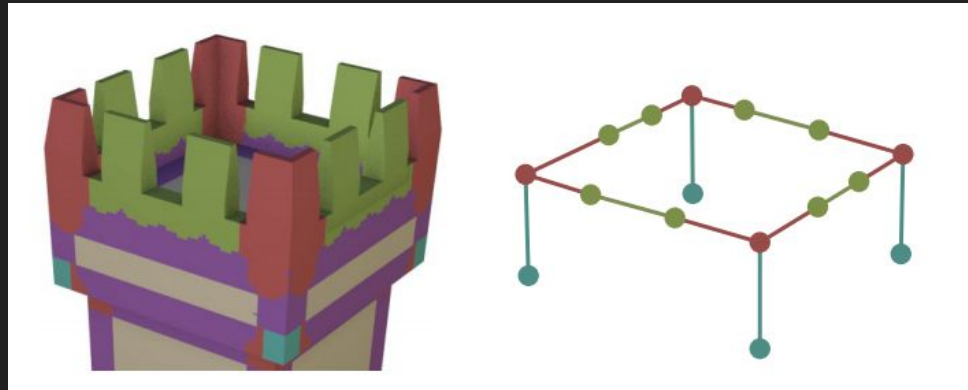


Tiling graphs

Show adjacency

Implicit grammar encoding

Object valid if all connections exist in graph



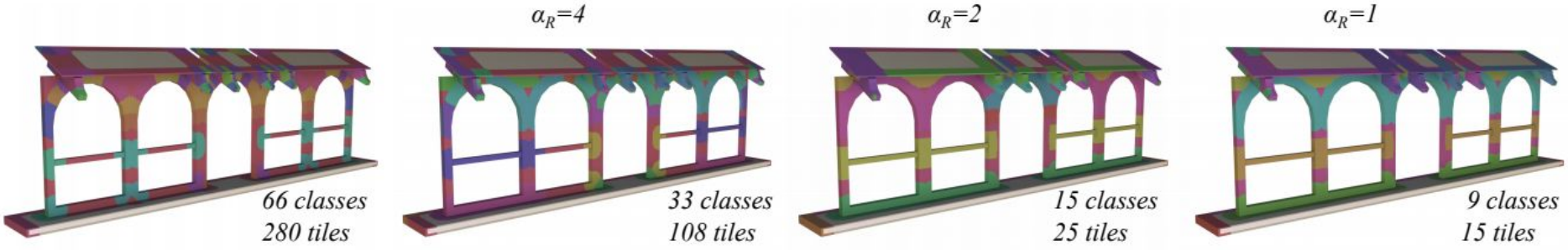
Grammar simplification

Cost function - Suitability for 3D manufacturing

Reduce # of pieces

Simplify tiling graph; grammar implicitly updated

Redundancy - Minimize # of times a piece of geometry is repeated

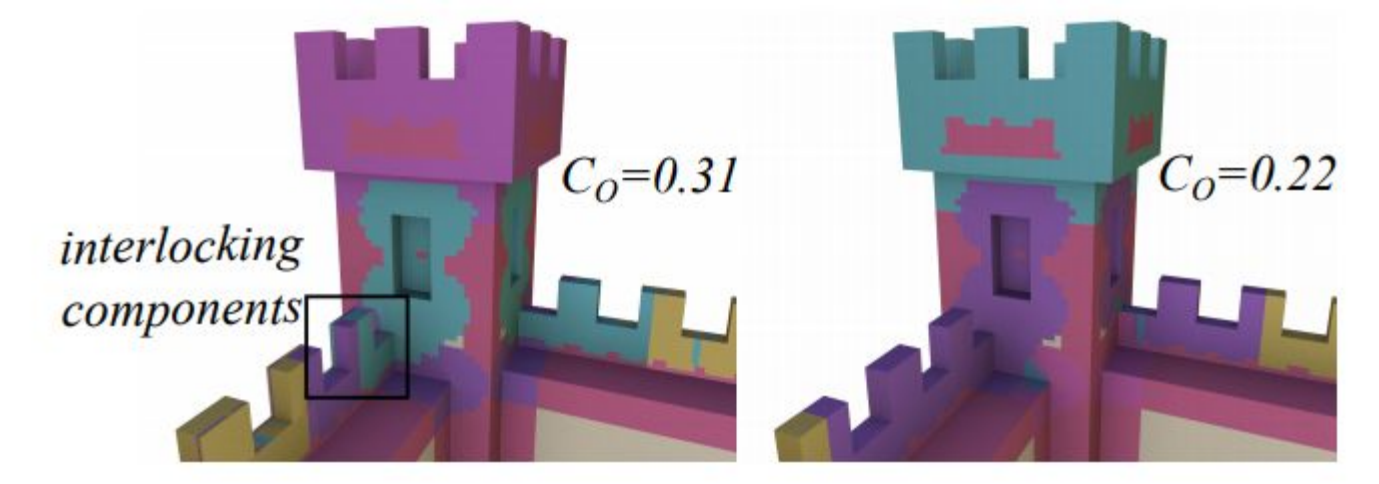


Grammar simplification

Simplicity - Minimize the # of different piece types

Assemblability - Minimize bounding box overlap

Shape variability - Minimum number of global symmetric cuts



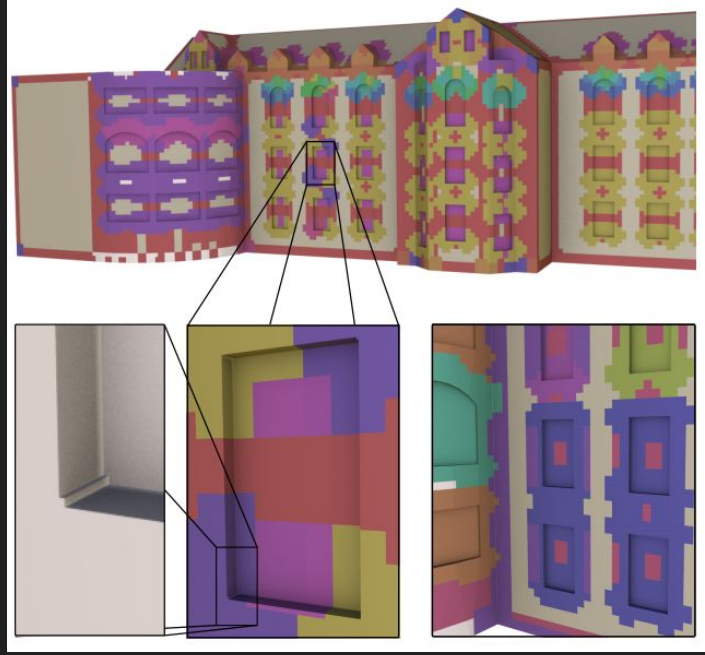
Grammar simplification

Edge collapses - Merging two tiles

Tile replacement - Making two similar tiles equivalent

Counters artist errors

Monte Carlo search of transformation series



Evaluation

Order of magnitude improvement to cost function

Improvement on manual decomposition

3D-printable

Variable complexity

Reasonably fast

Limitations

Assumes planar cuts are ideal

Structural strength

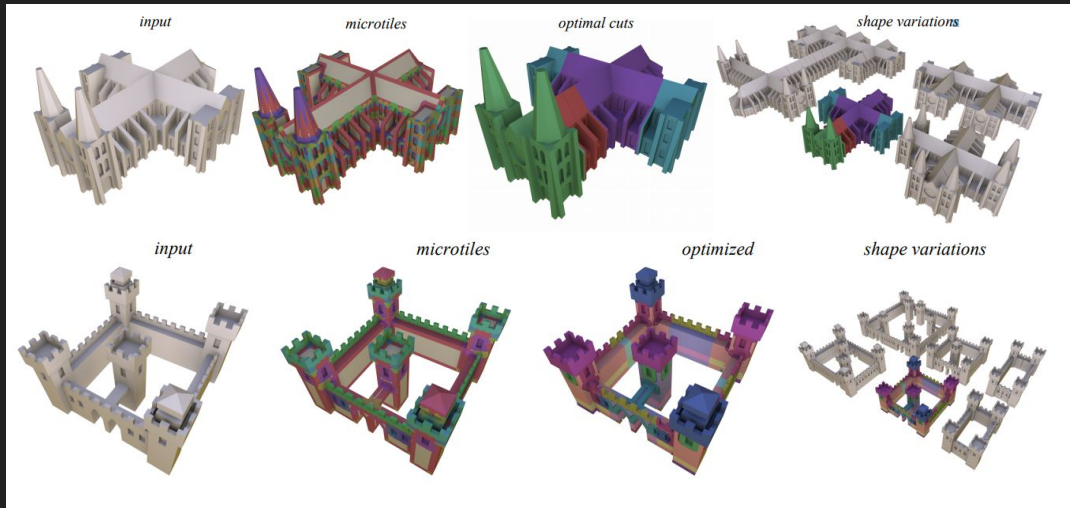
Requires symmetry

Further work

Structural strength

Human reception

Arbitrarily shaped cuts



Applications

Construction game

Procedural generation

Modeling tool