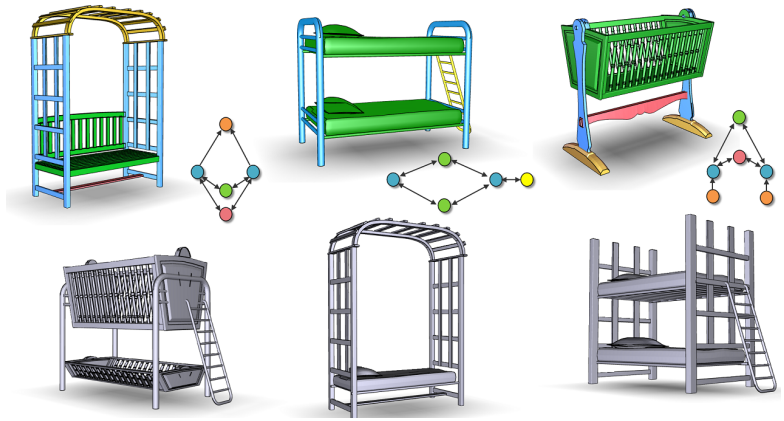
Smart Variations

Functional Substructures for Part Compatibility



Youyi Zheng

Daniel Cohen-Or

Niloy J. Mitra

UCL

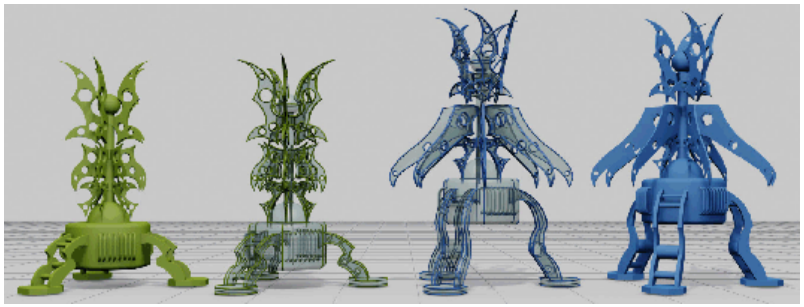
How to Create 3D Models?

How to Create 3D Models?

easy access to 3D models

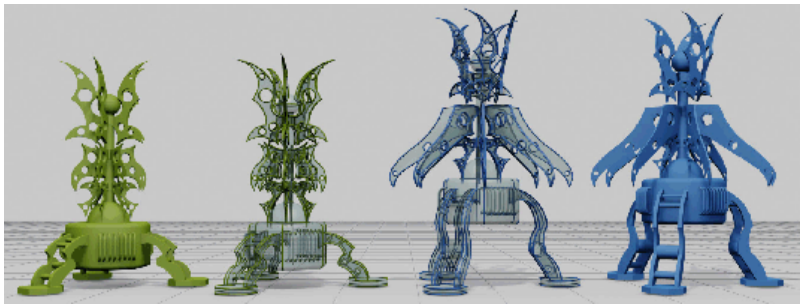
Creating Shape Variations

Creating Shape Variations



[Gal et al. 2009]

Creating Shape Variations



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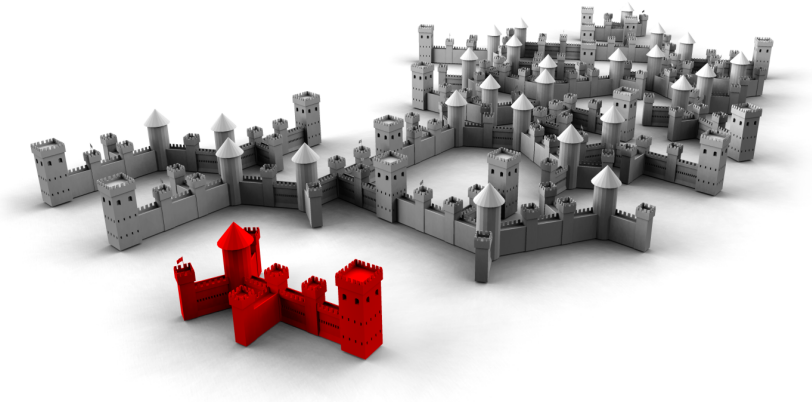
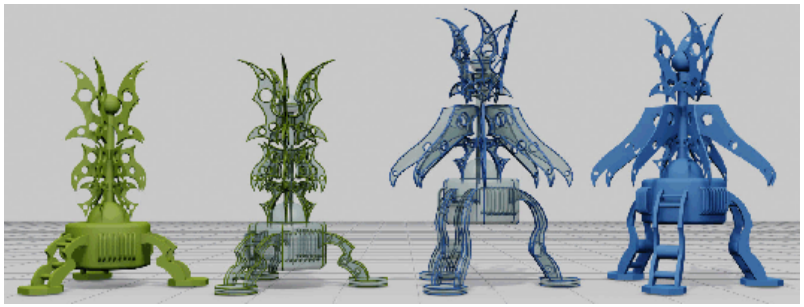


[Bokeloh et al. 2010,2011]

Creating Shape Variations



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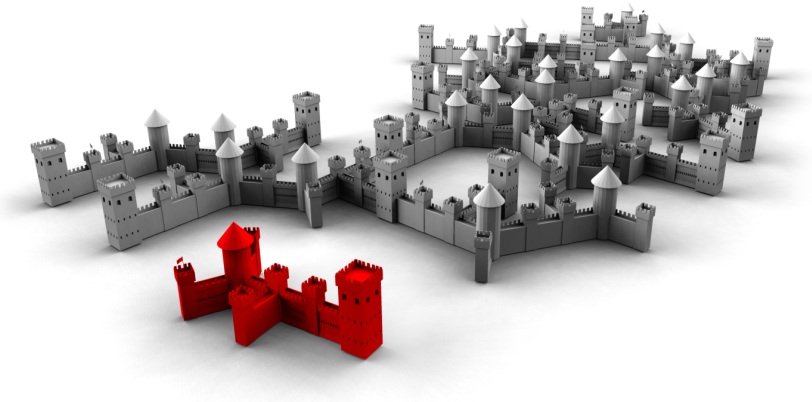

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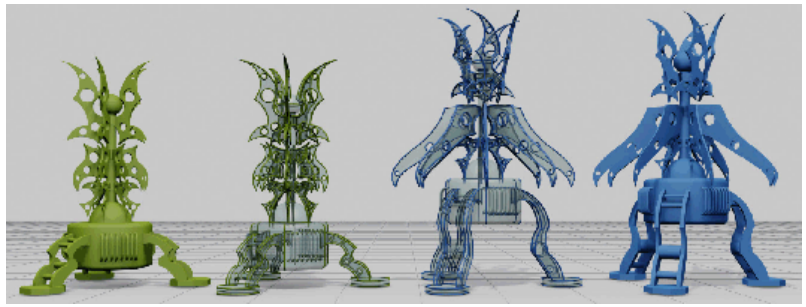
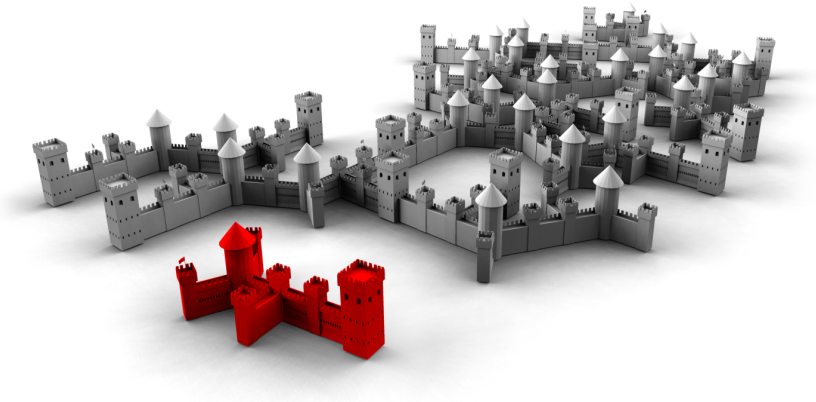


[Gal et al. 2009]

[Jain et al. 2012]



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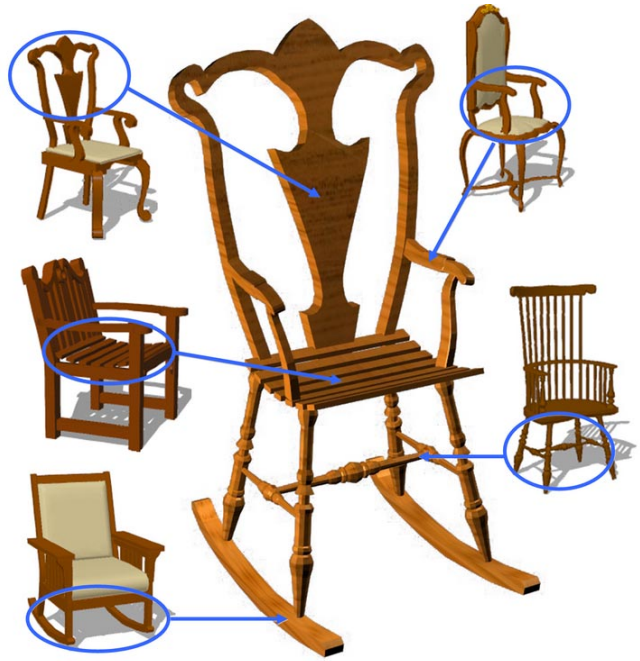
Compositional Modeling

Compositional Modeling



[Funkhouser et al. 2004]

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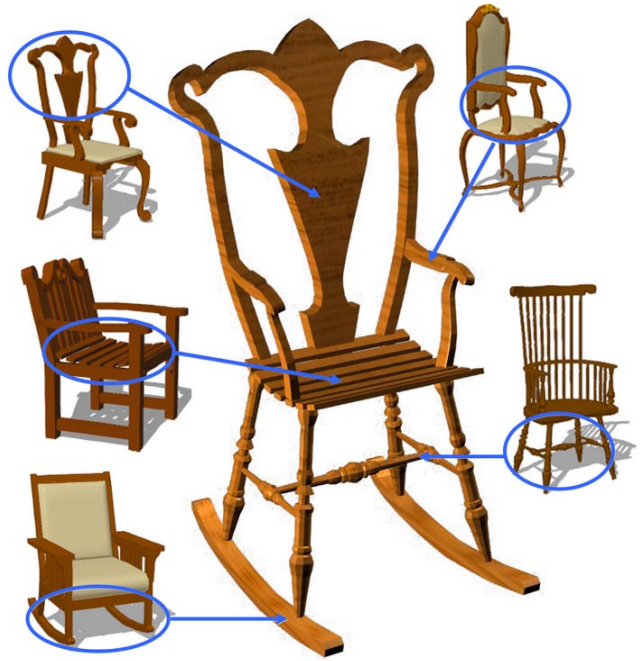

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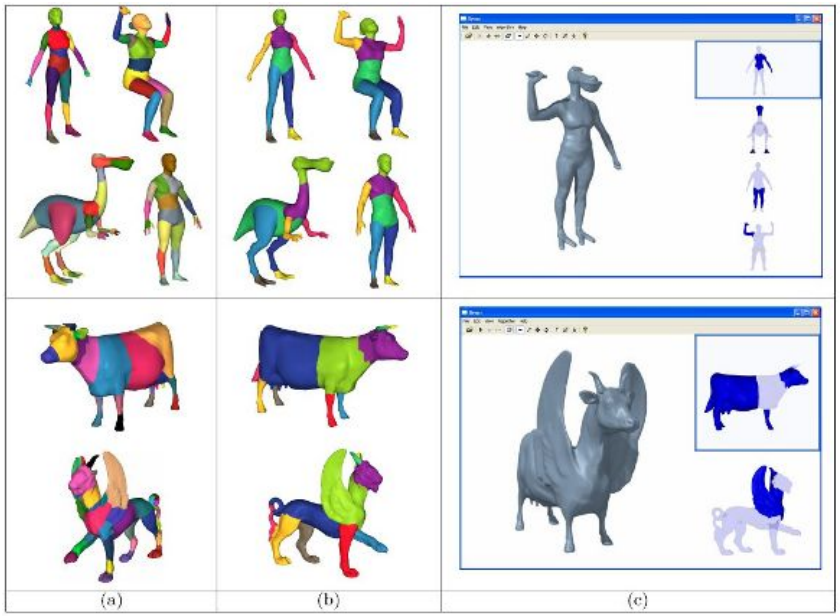

[Kraevoy et al. 2007]

Learning Shape Variations

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[Xu et al. 2012]

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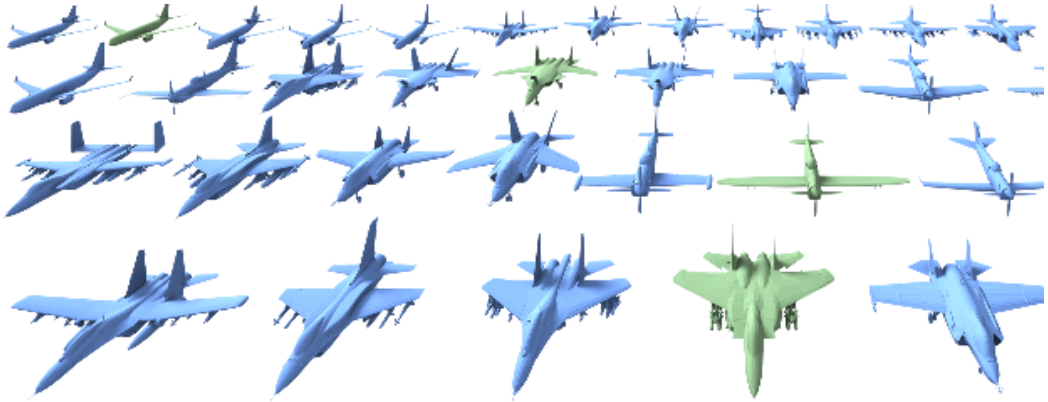
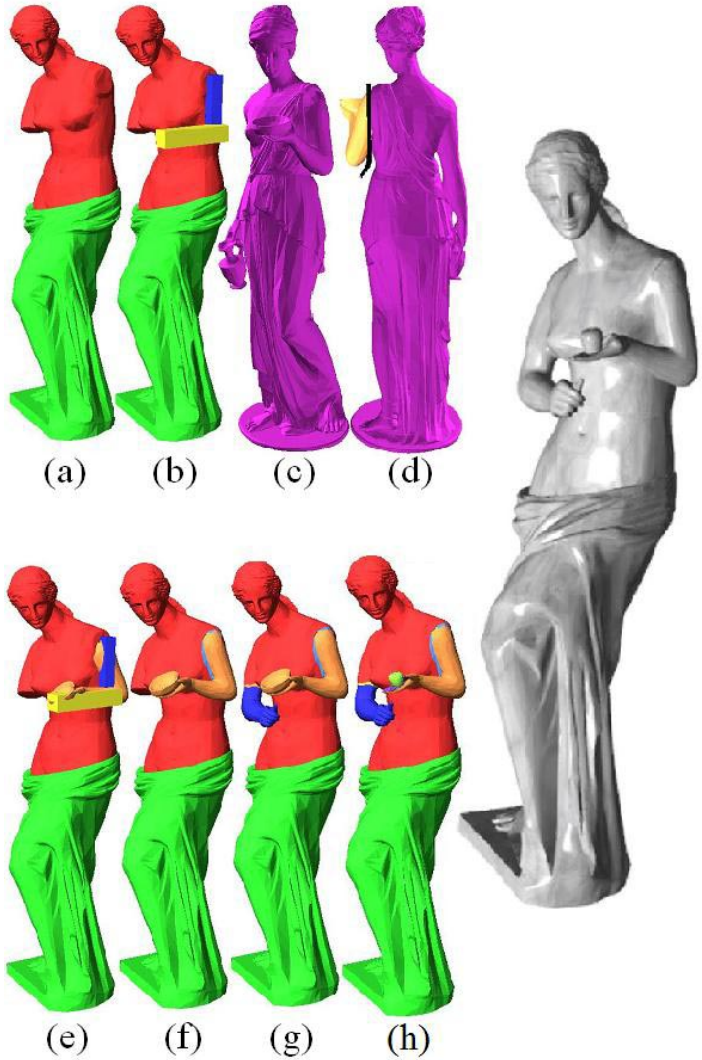


[Kalogerakis et al. 2012]

Compositional Modeling



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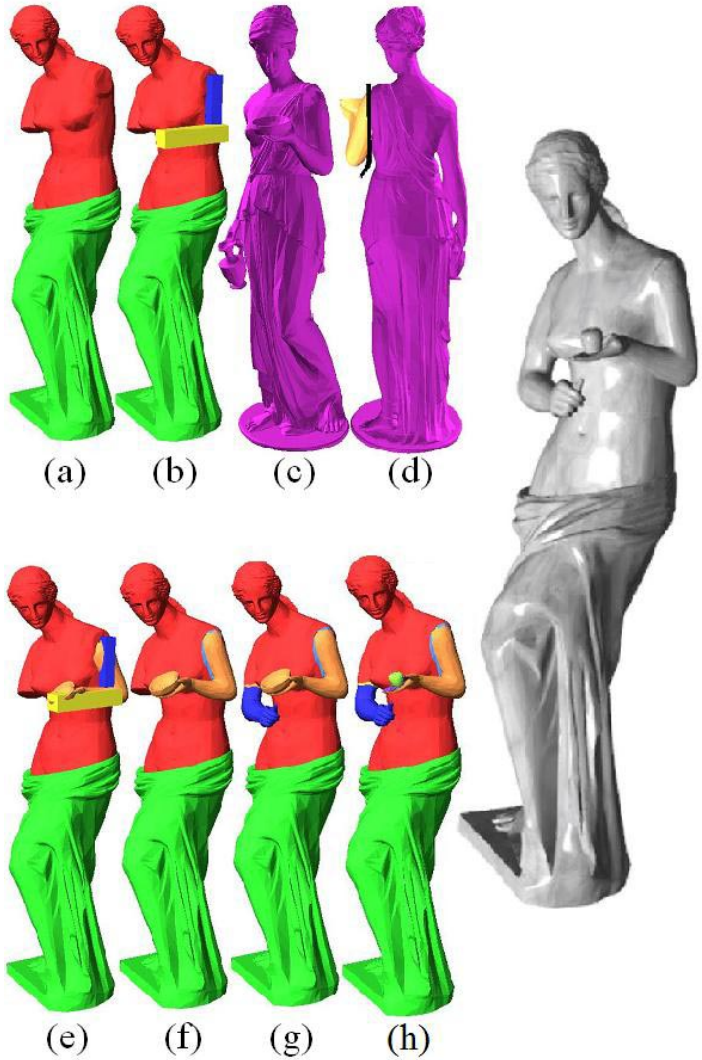

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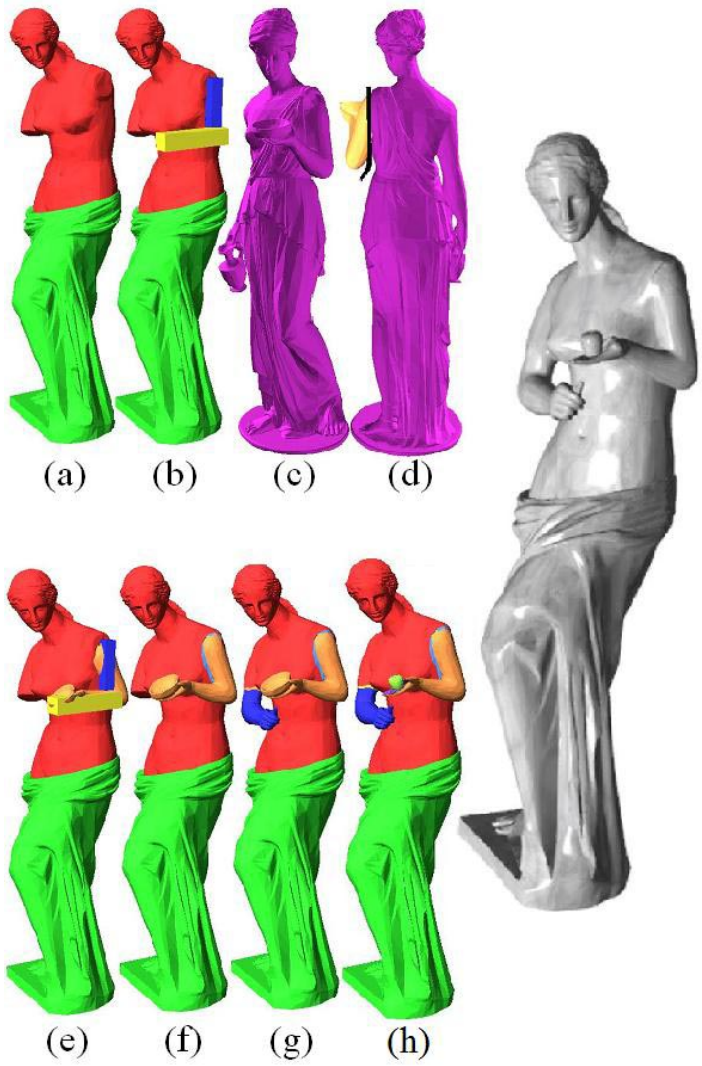
1. Which part(s) to replace?

Compositional Modeling

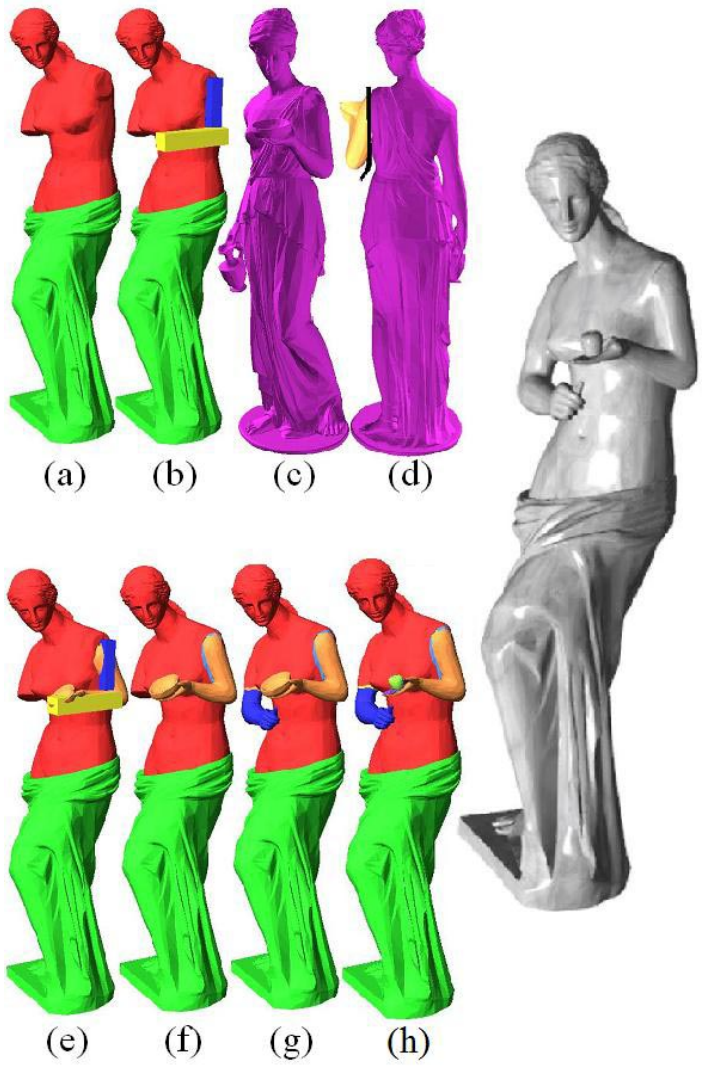


[Funkhouser et al. 2004]

1. Which part(s) to replace?

2. What to replace with?

Compositional Modeling



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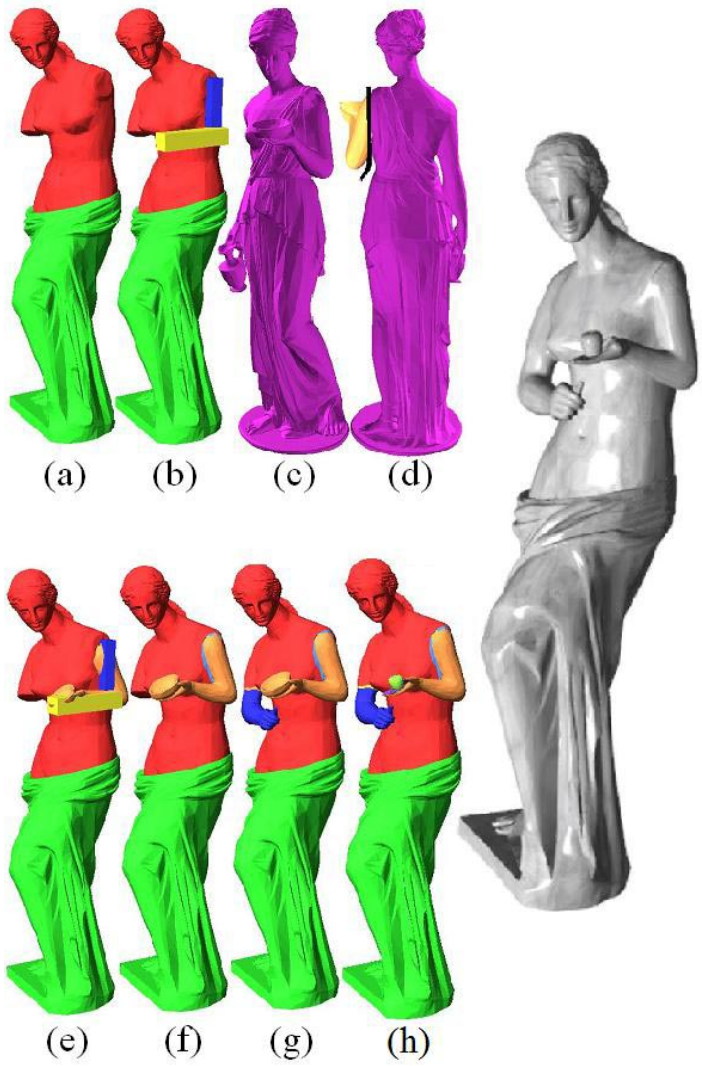
Compositional Modeling



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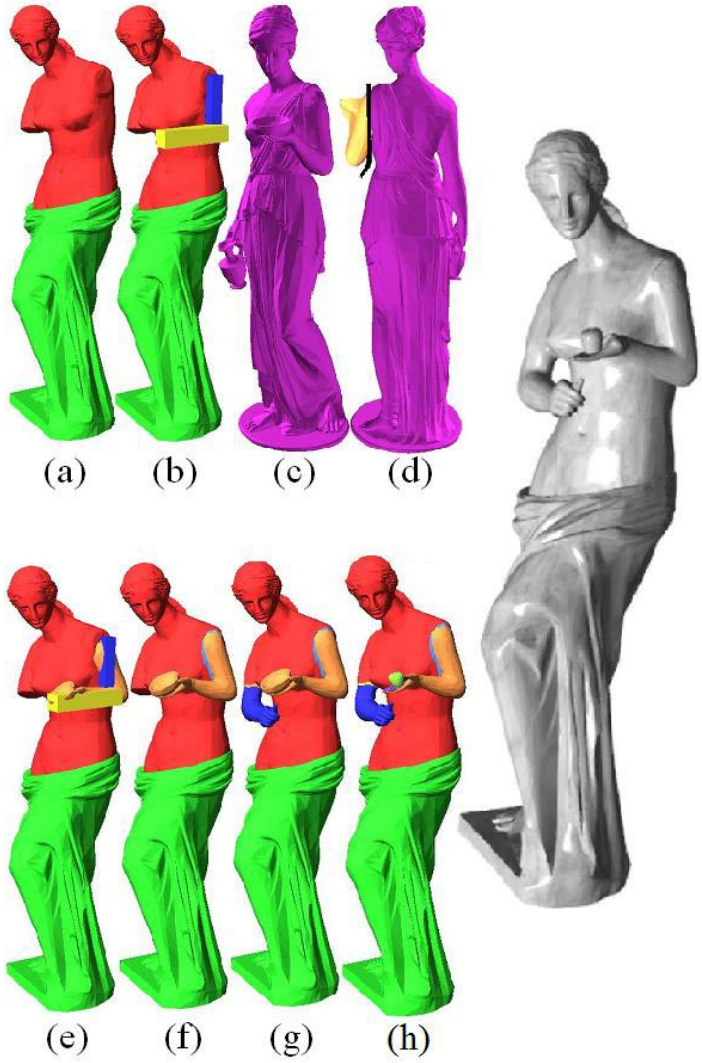
geometric similarity

Compositional Modeling



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geometric similarity

restricted to the same object class

Beyond Geometric Similarity

What are the parts and ***how*** are they connected?

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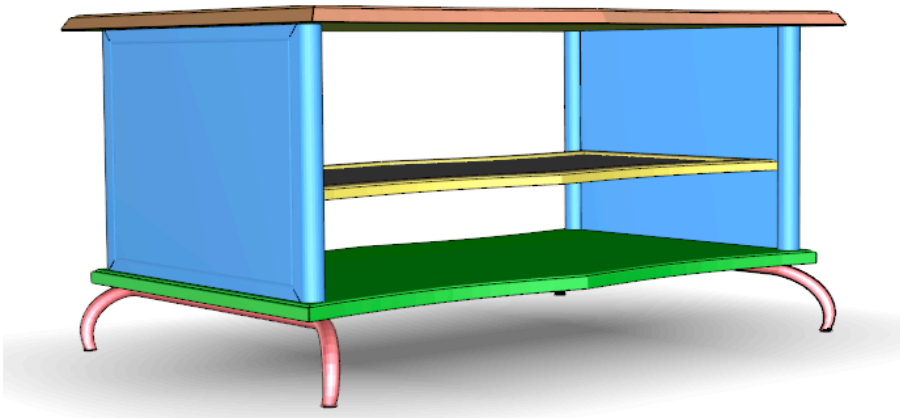

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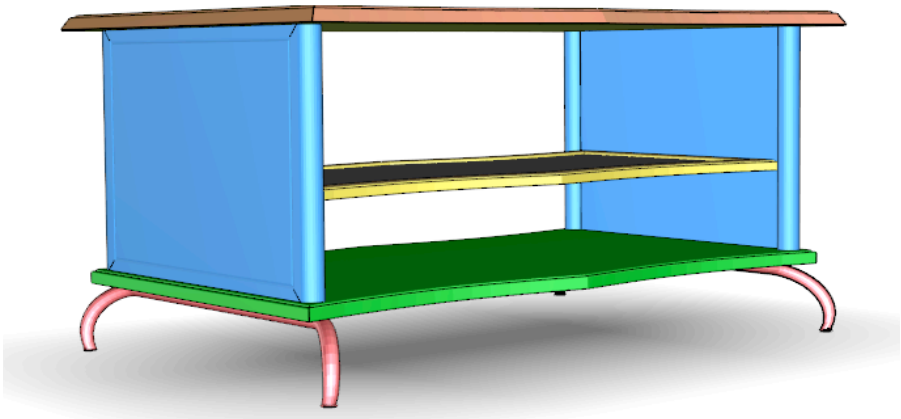

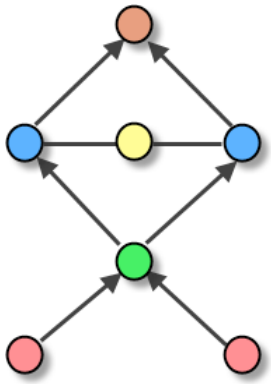

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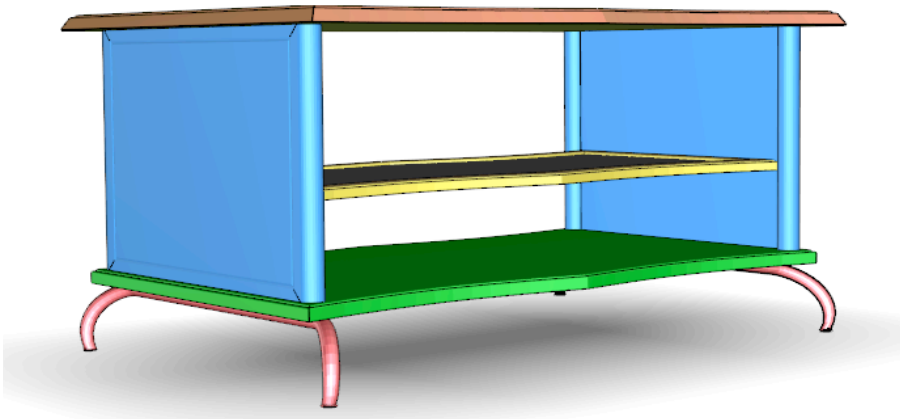
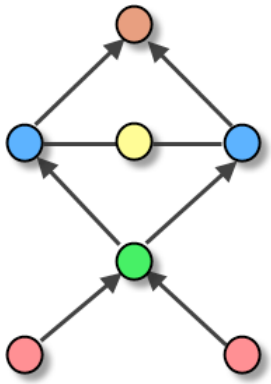
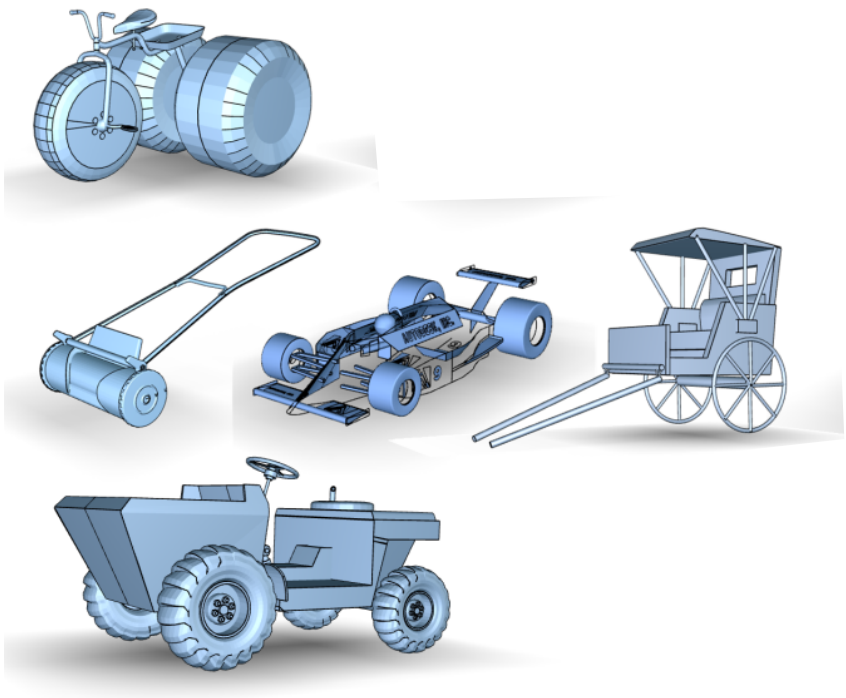




part-level 3D model ⟶ directed graph

Our Approach



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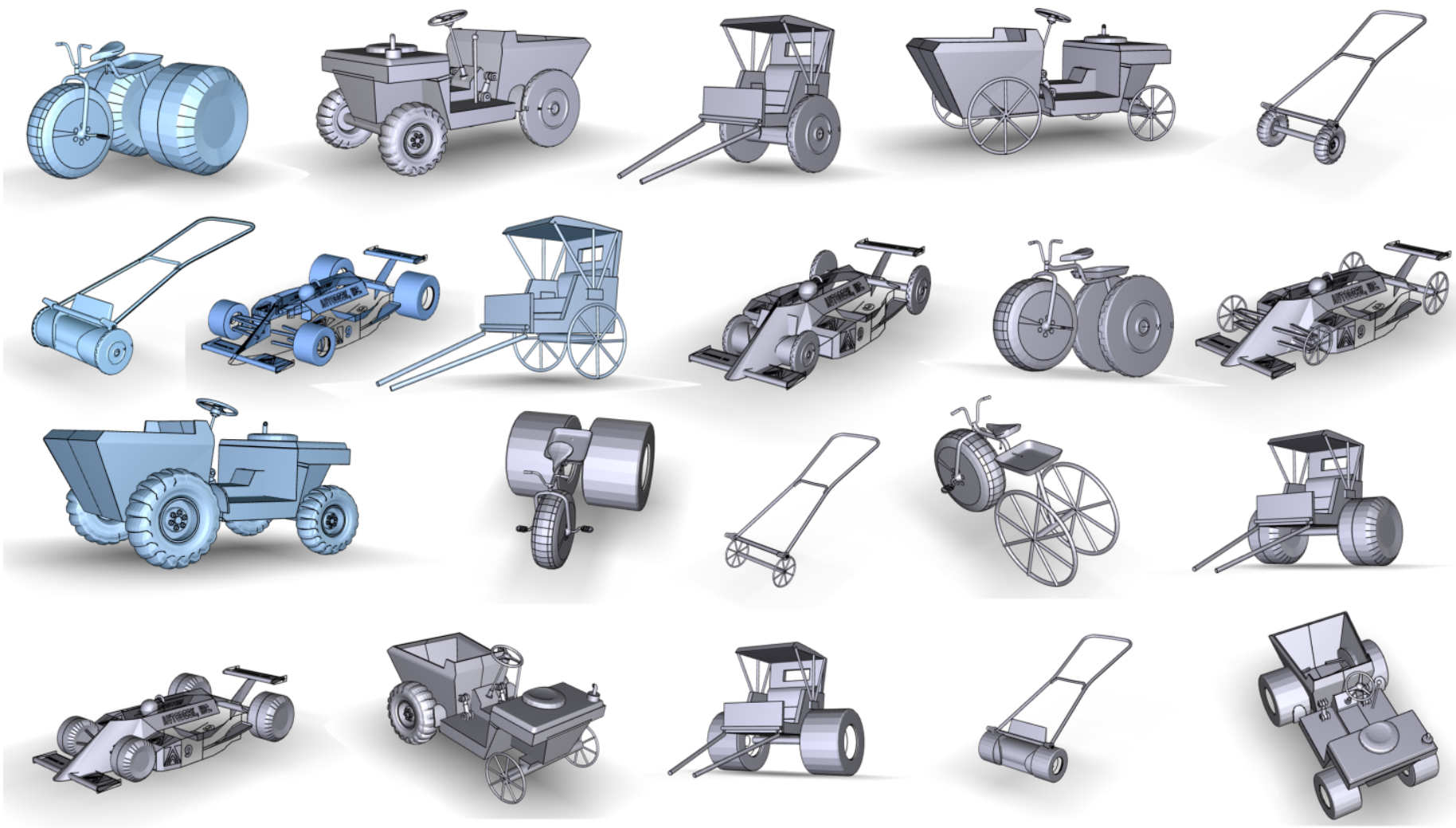

Hypothesis

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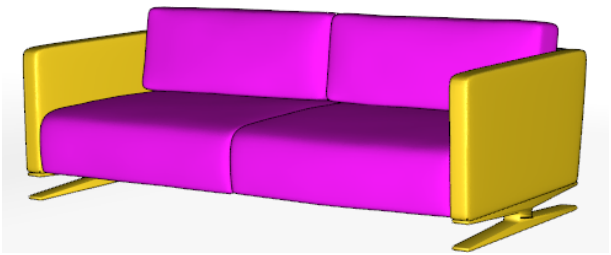

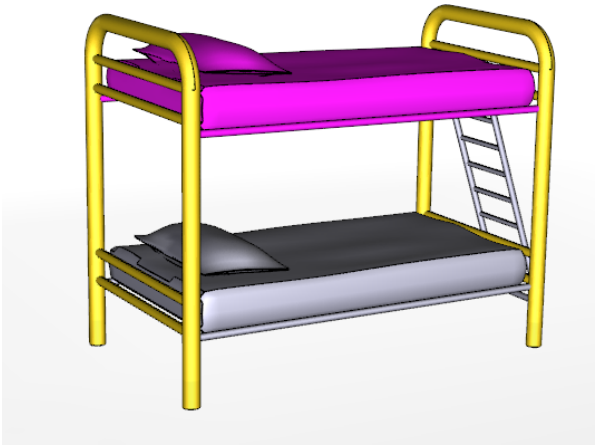

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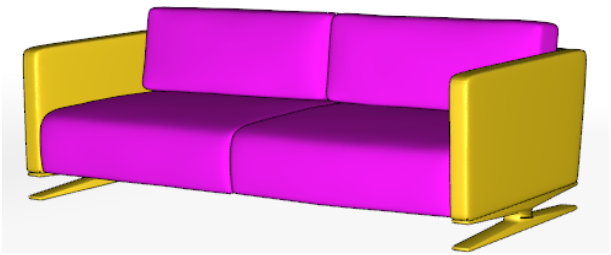

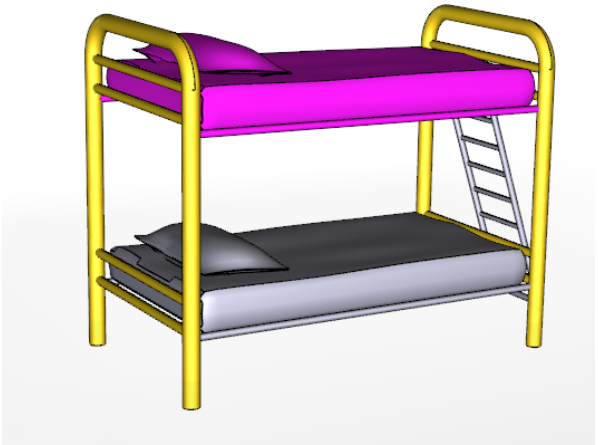

arrangement ⟶ triplet of parts

Algorithm: Structure Analysis

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symmetry analysis + contact analysis

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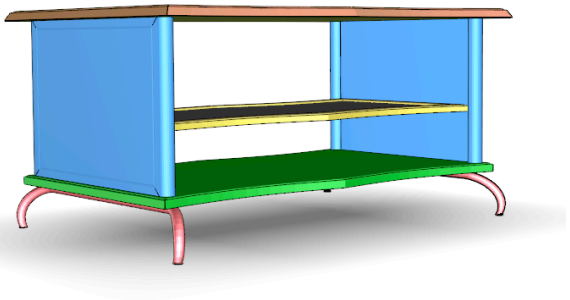

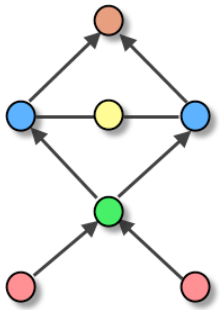

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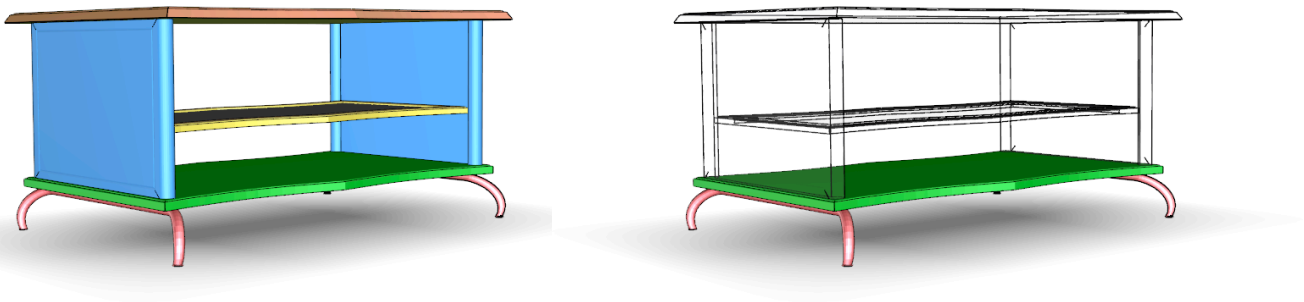

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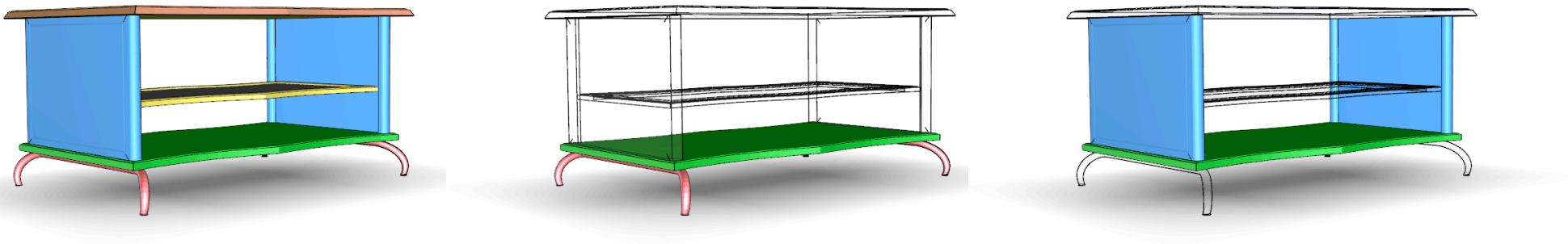

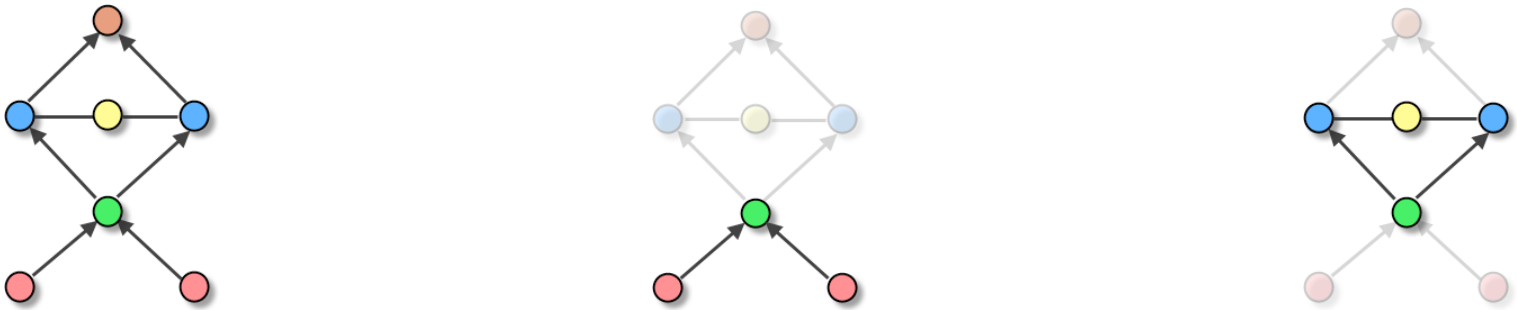

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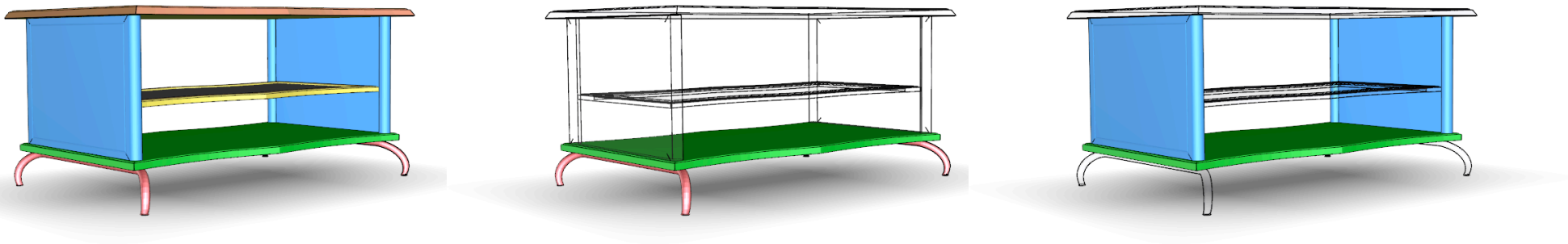

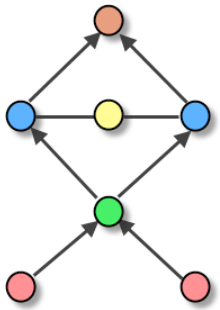

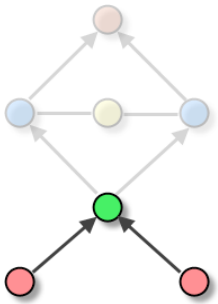

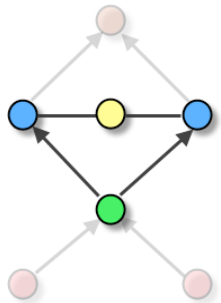

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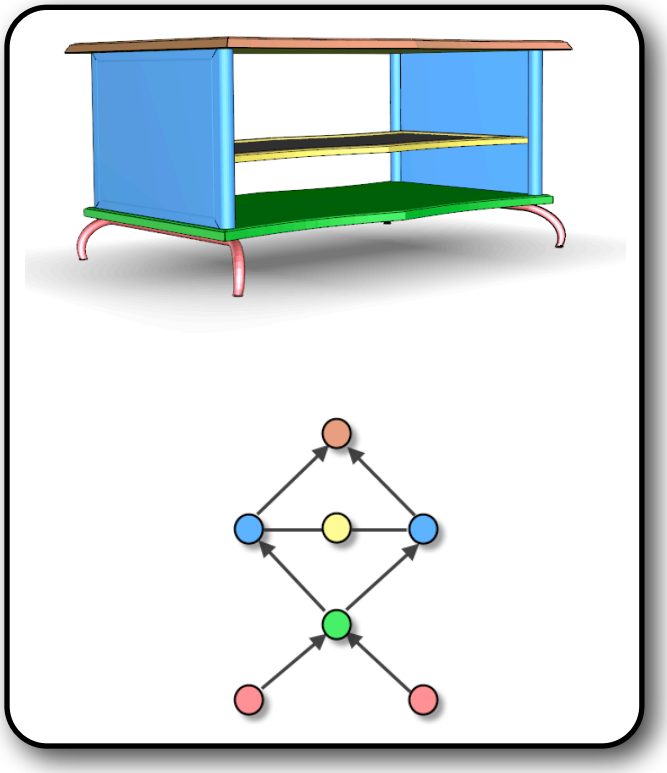
symmetry analysis + contact analysis

Functional Substructures (sFarr)



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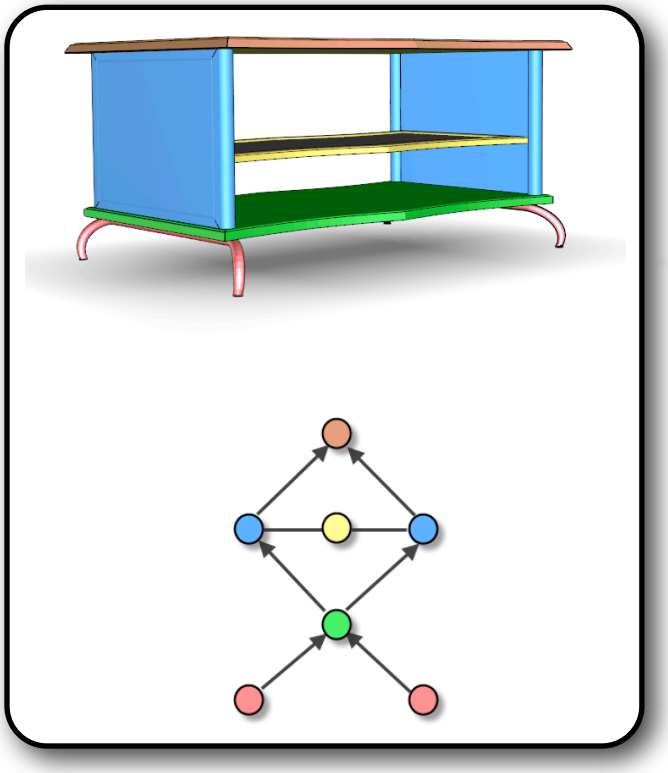

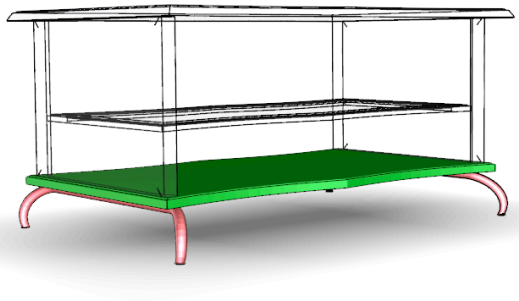

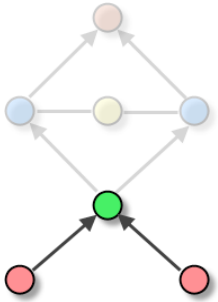

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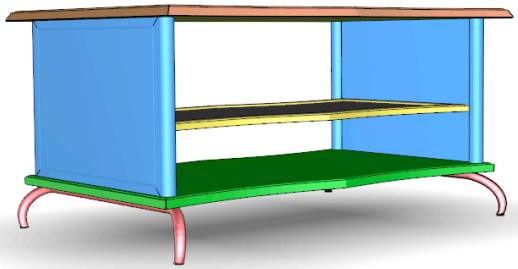

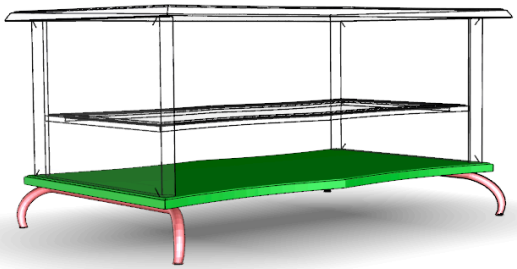

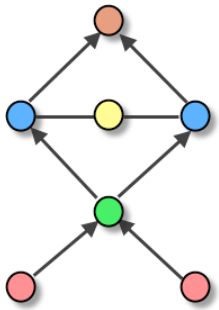

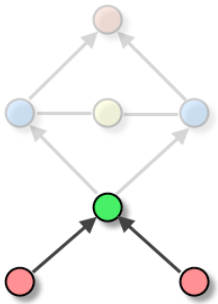

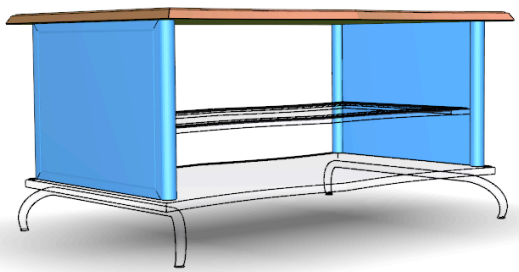

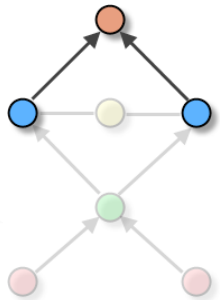

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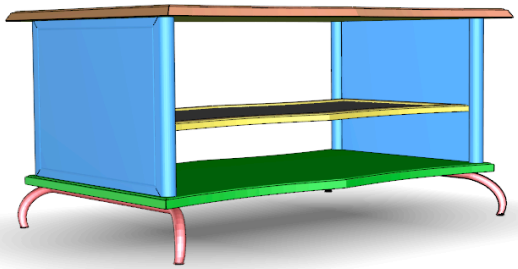
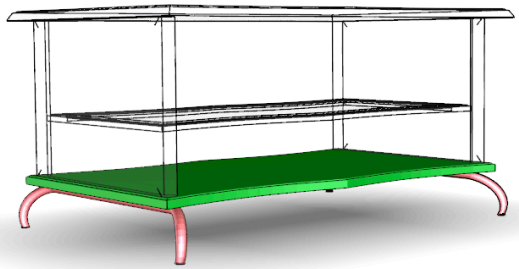
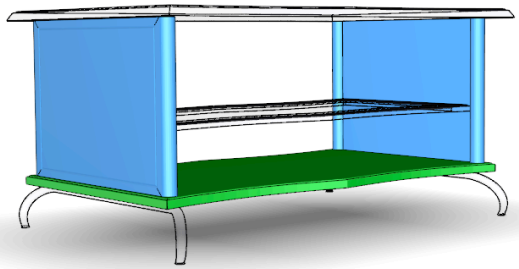
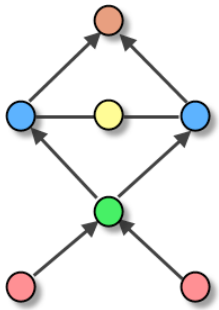
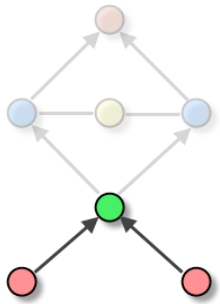
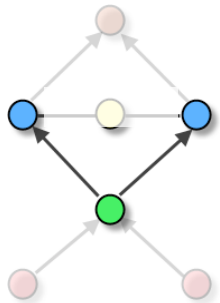


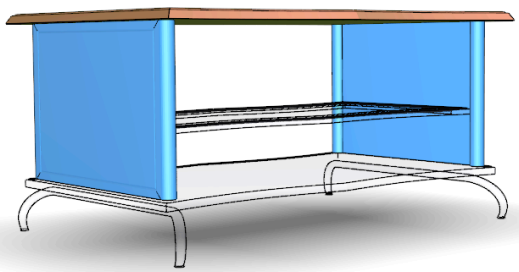


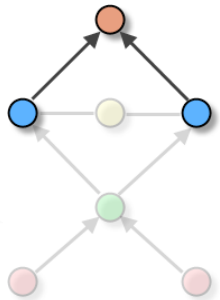




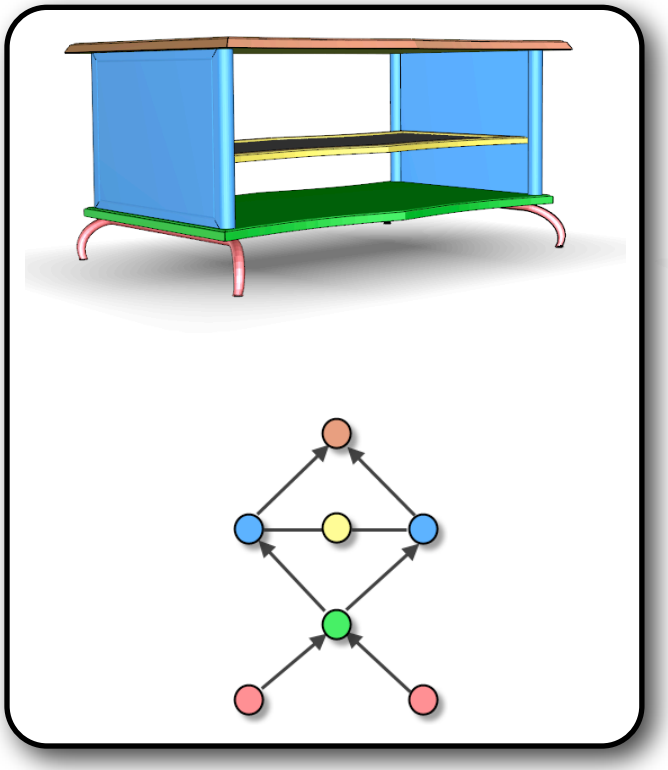


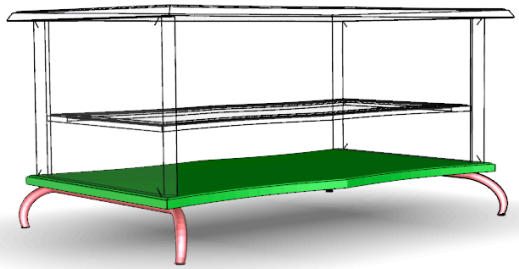


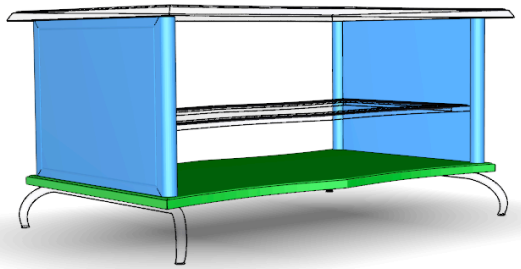


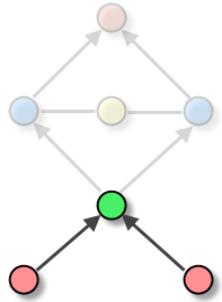


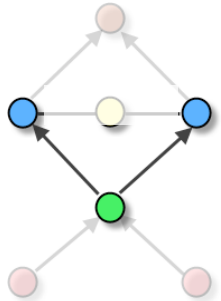
Functional Substructures (sFarr)

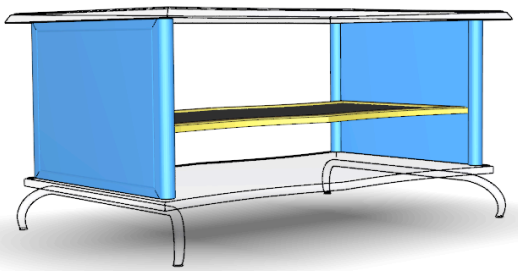


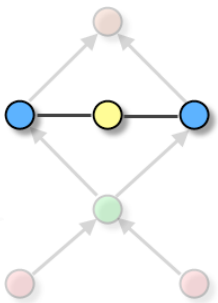


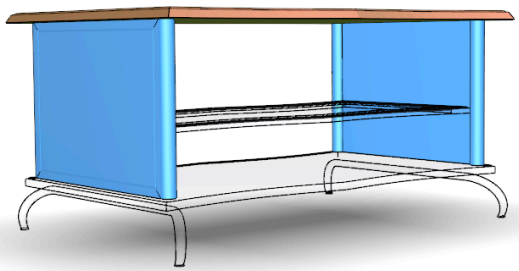


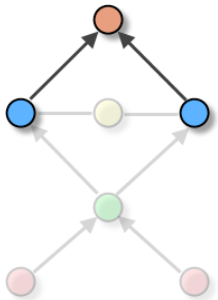












Types of sFarrs

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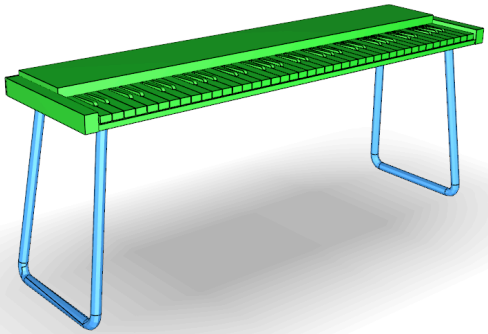
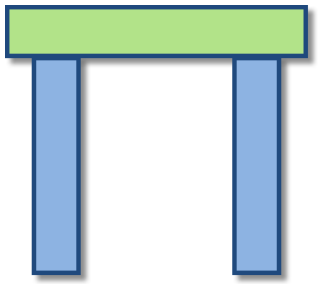
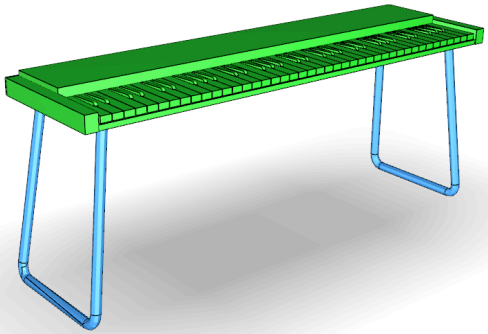
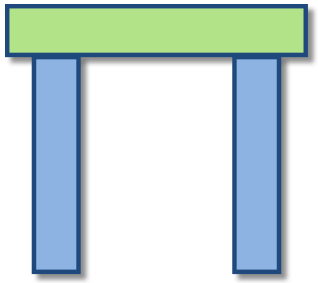




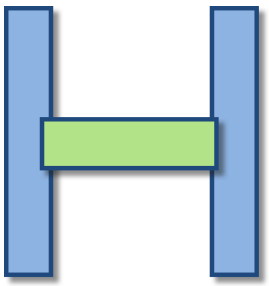
support

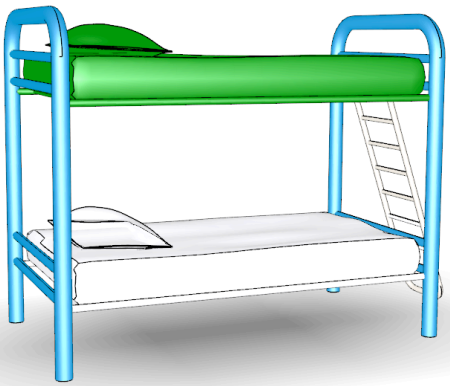
Types of sFarrs





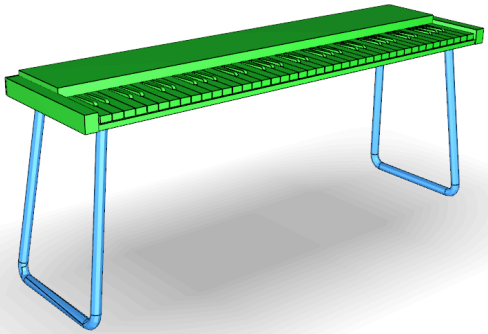
support

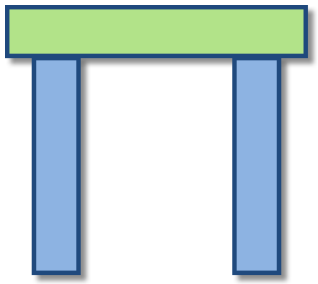




embed

Types of sFarrs





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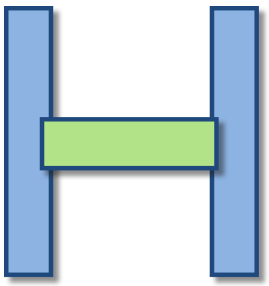

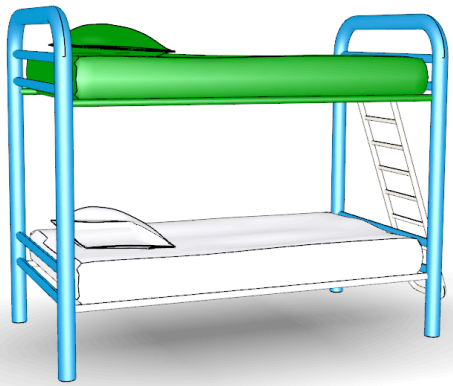

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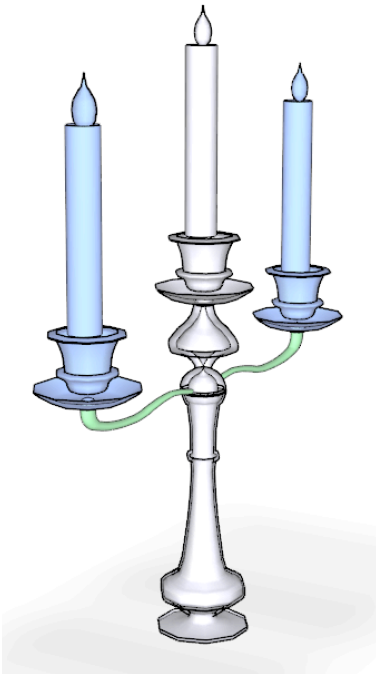

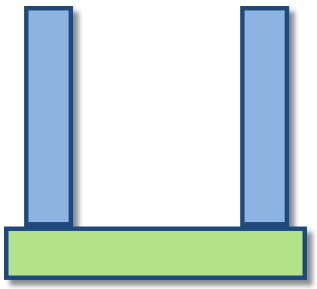

placement

Substructure Attributes

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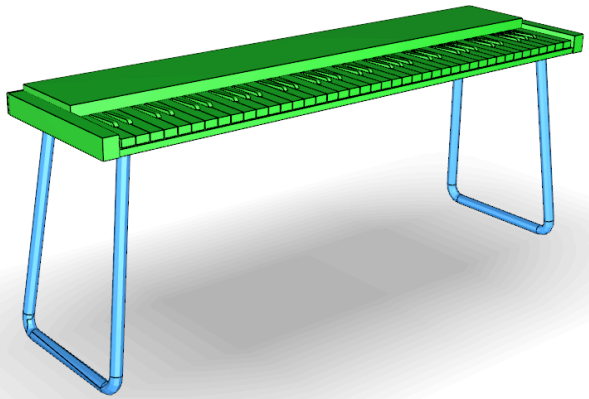
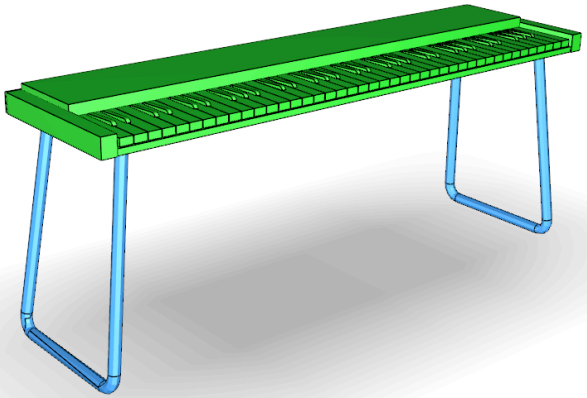
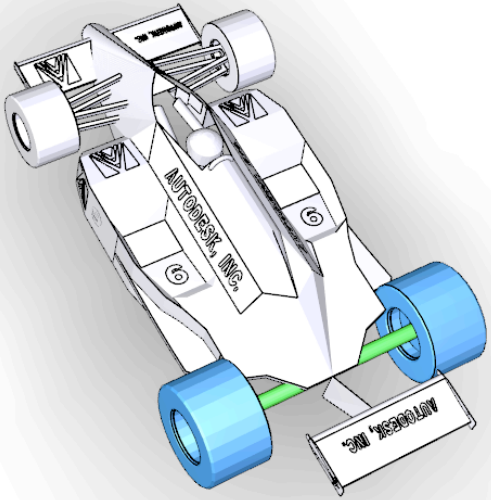


stability

Substructure Attributes



stability



co-axial

Compatible sFarrs

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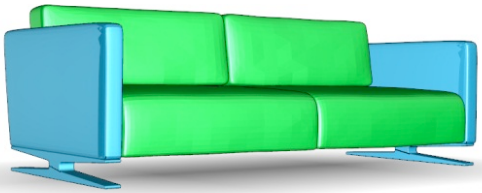
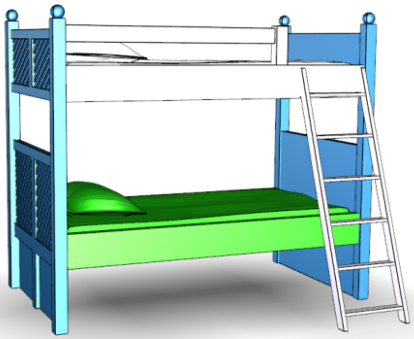
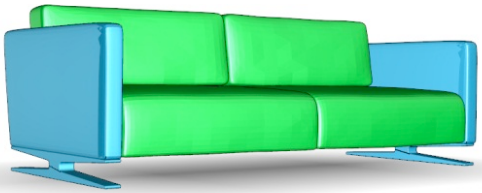
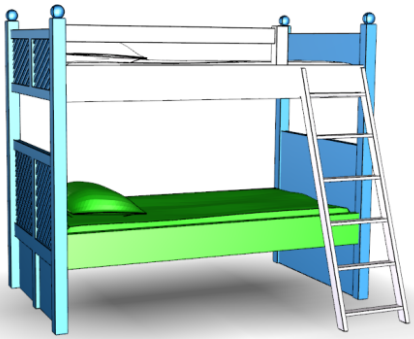


*Compatible **embed** sFArrs*



Compatible sFarrs





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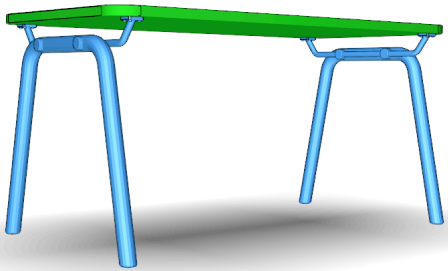

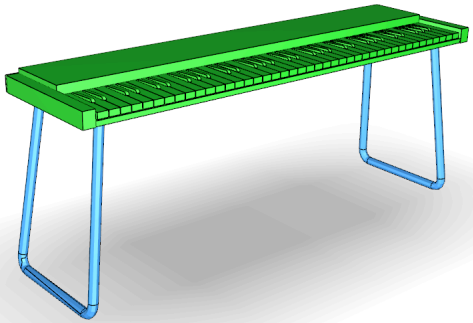

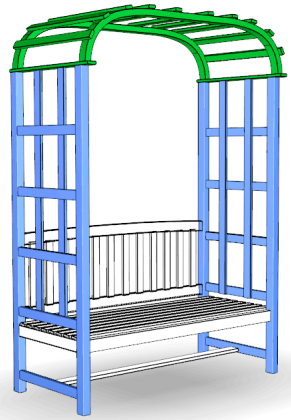

*Compatible **support** sFArrs*

Group sFarr

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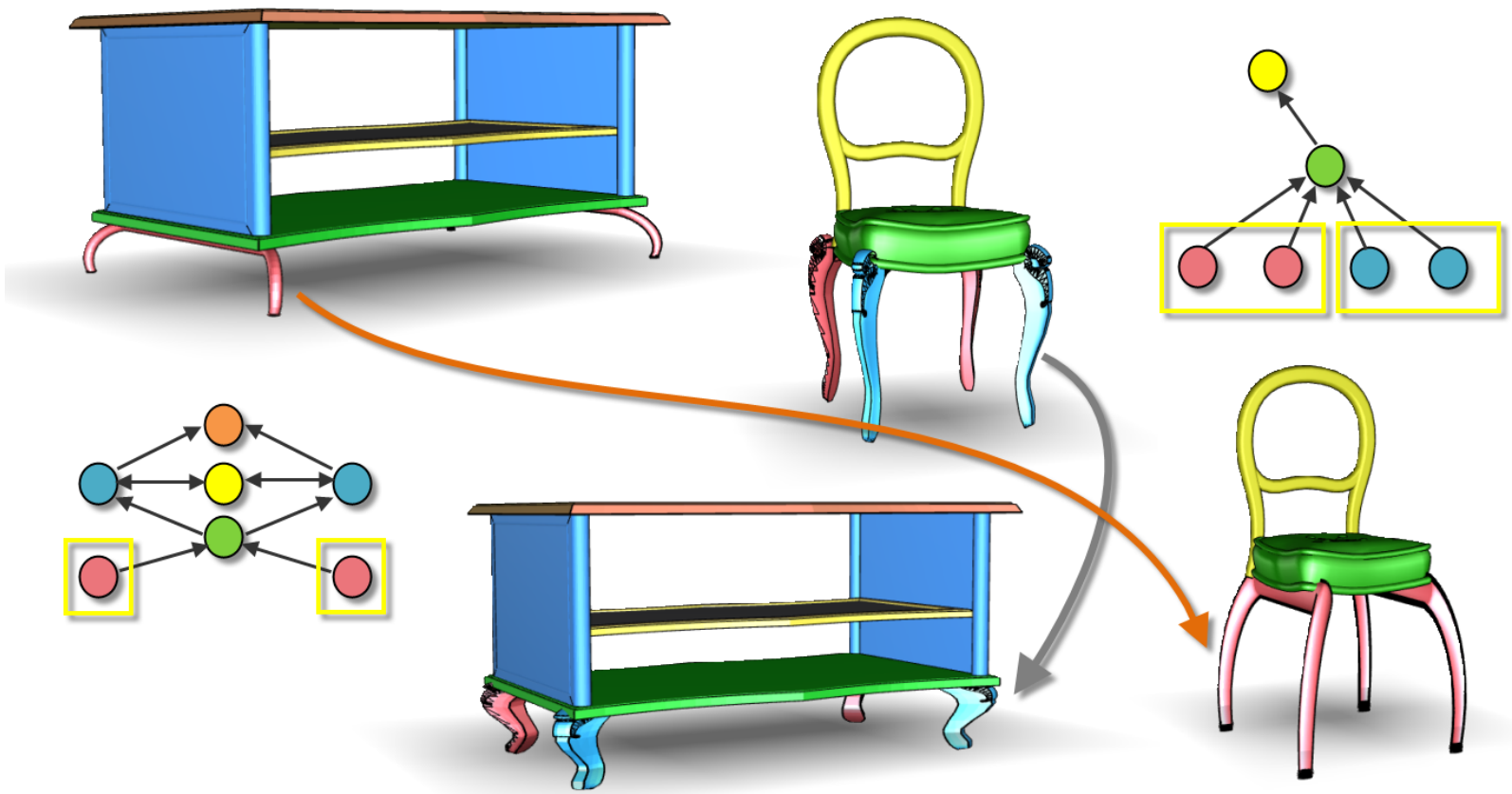
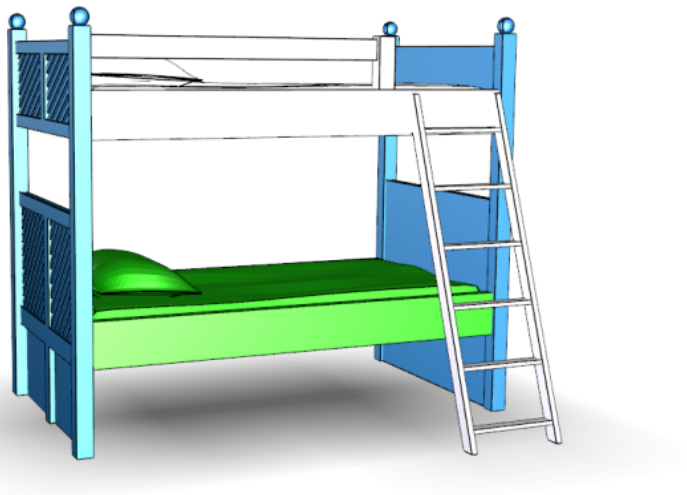


sFarr Reshuffle



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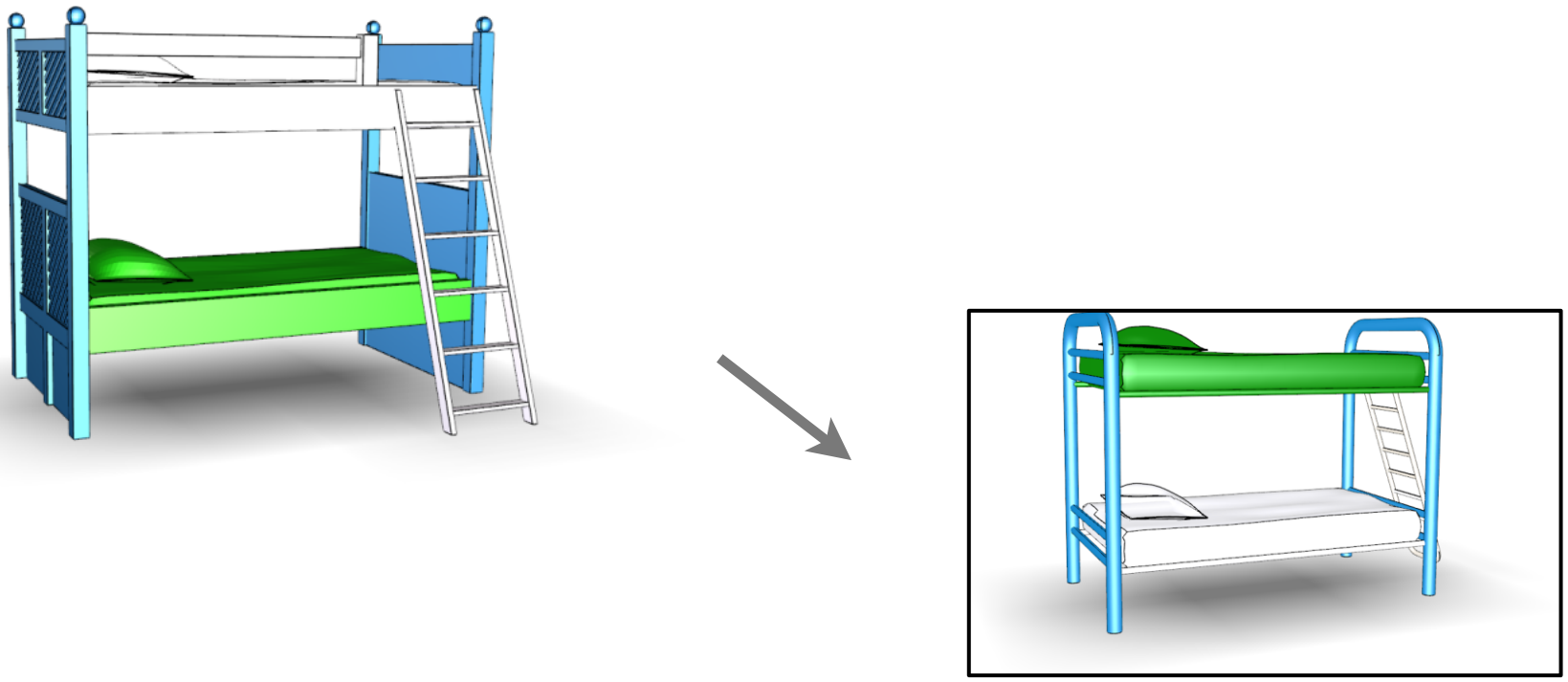

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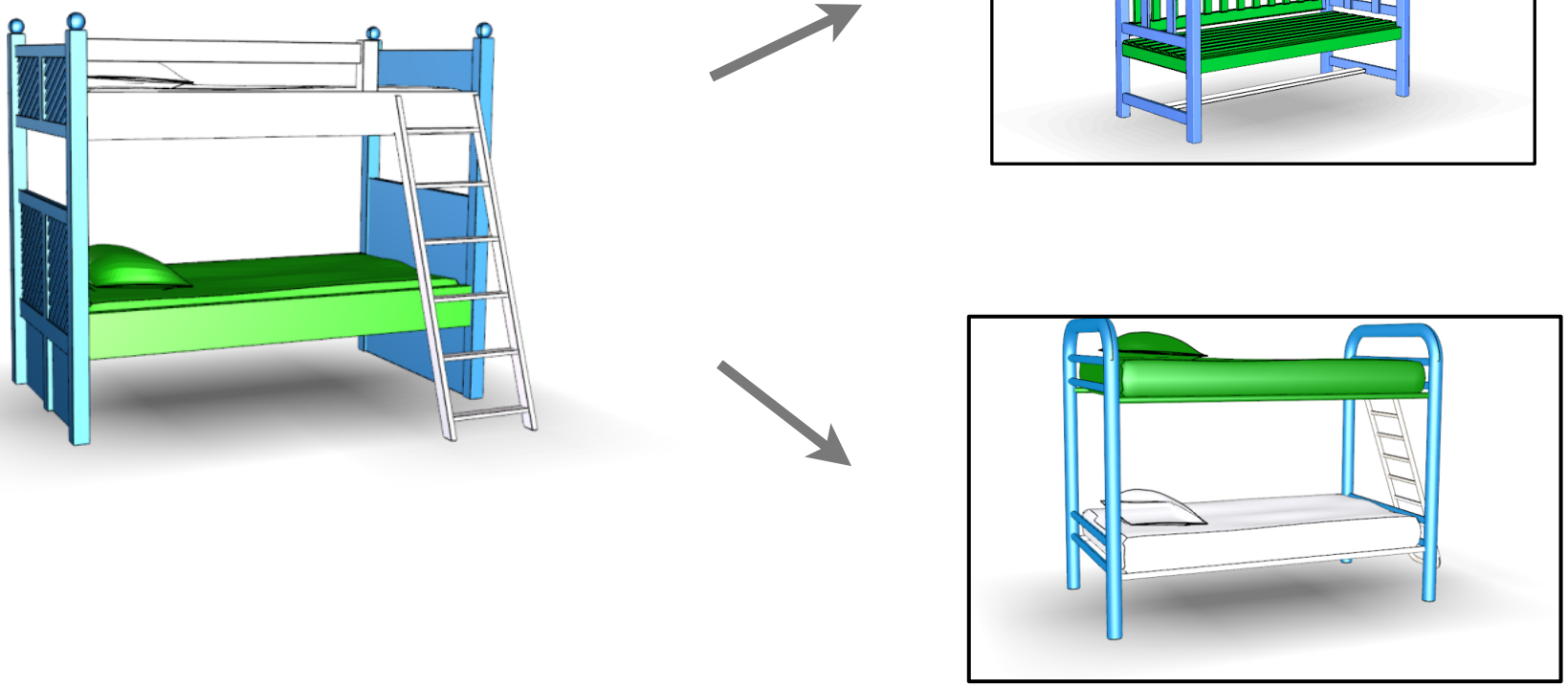
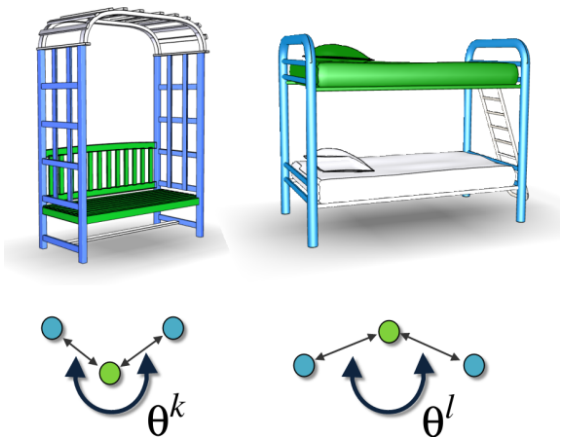


sFarr Compatibility



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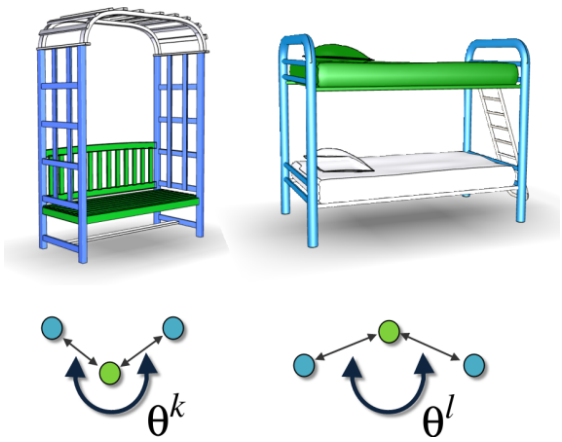

$$\Upsilon(t_k, t_l) = \lambda \cdot \theta \cdot \vartheta$$

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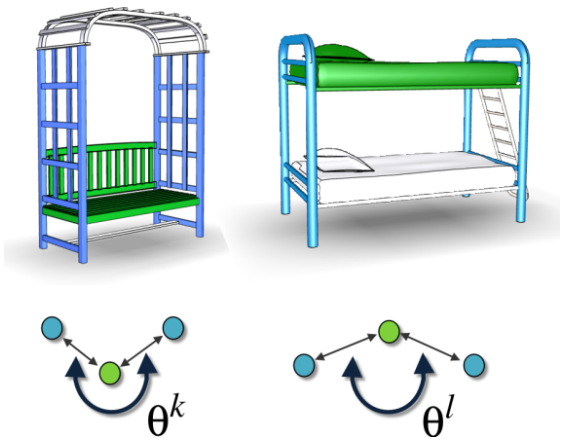

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scale angle distortion

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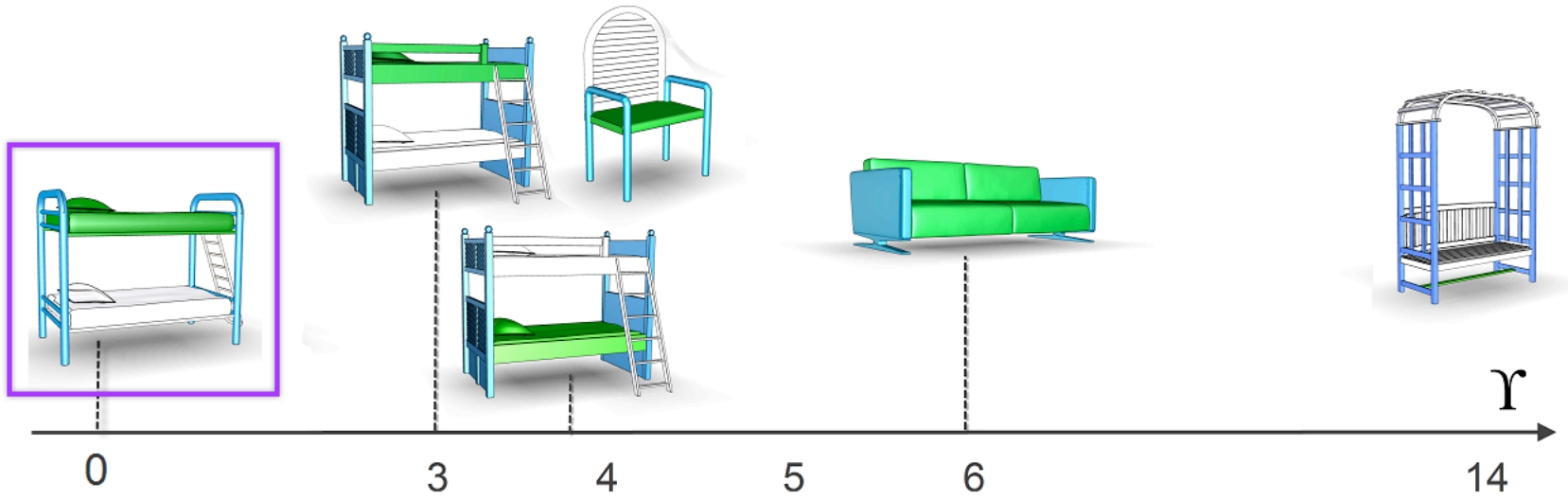

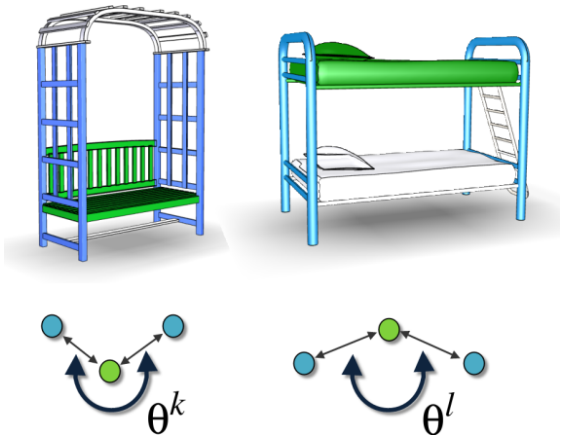

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scale angle distortion

How to Place the Parts?

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- Set of parts, say, $\{P_1, P_2, \ldots\}$

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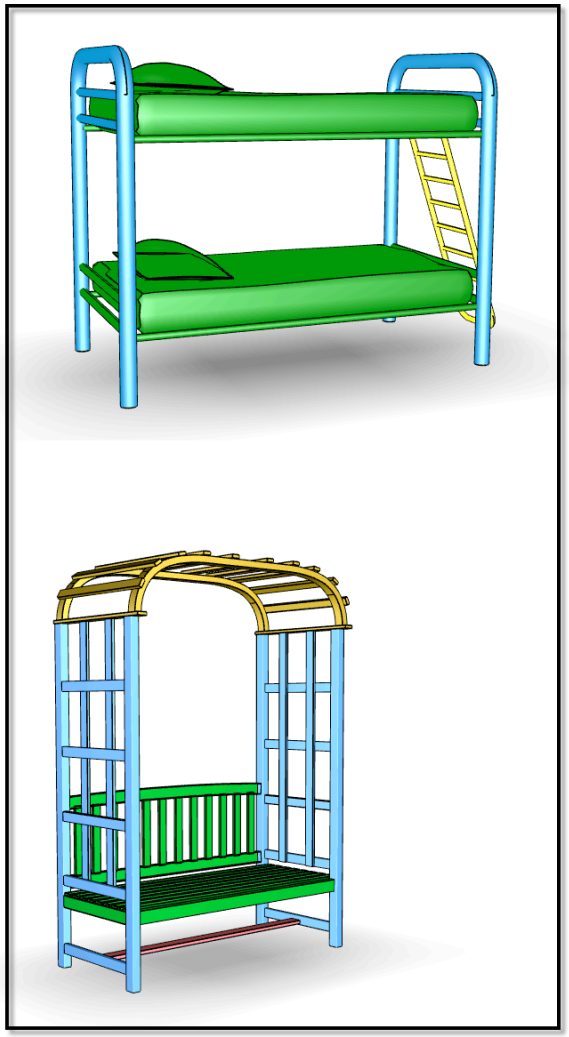
$$\min_{\mathbf{X}} E(\{\mathbf{x}_1, \mathbf{x}_2, \dots\}) \text{ s.t. } g_j(\mathbf{X}) = 0$$

Placement Optimization



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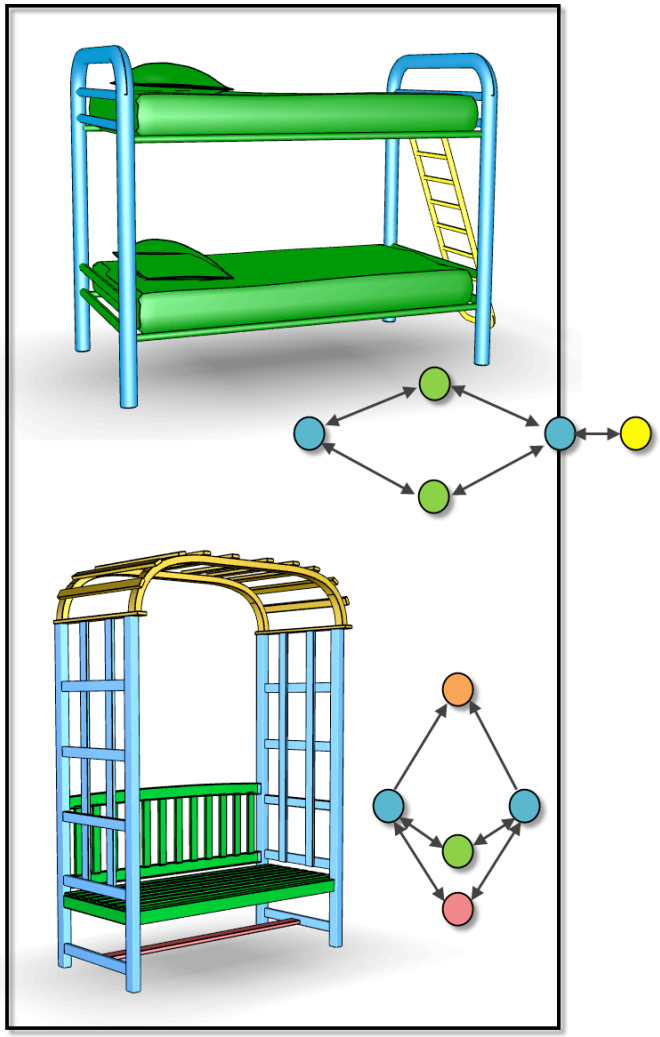

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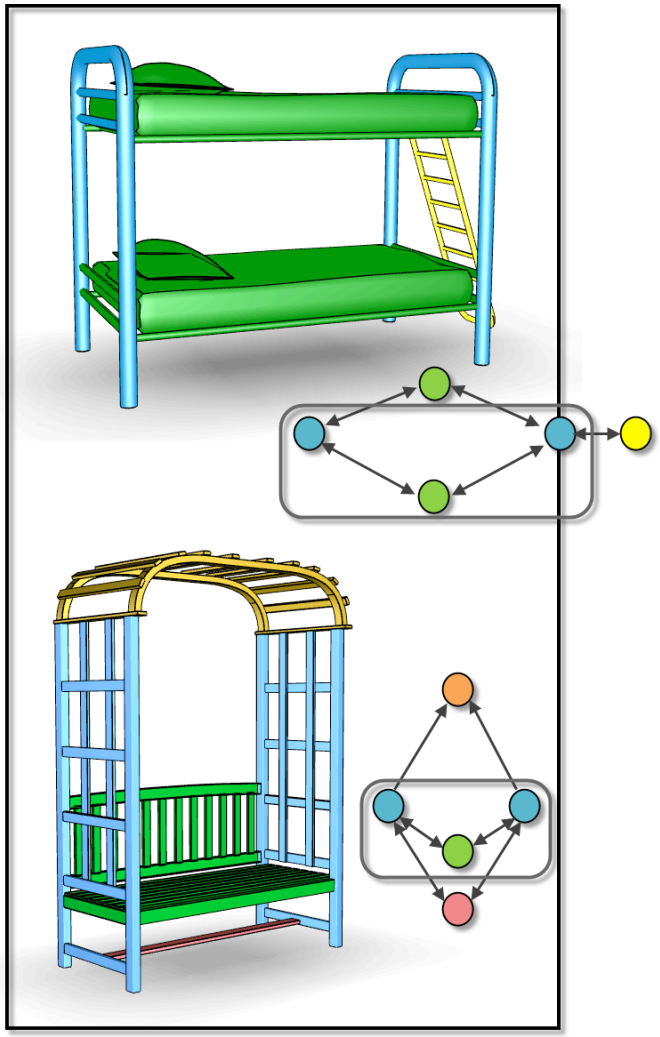

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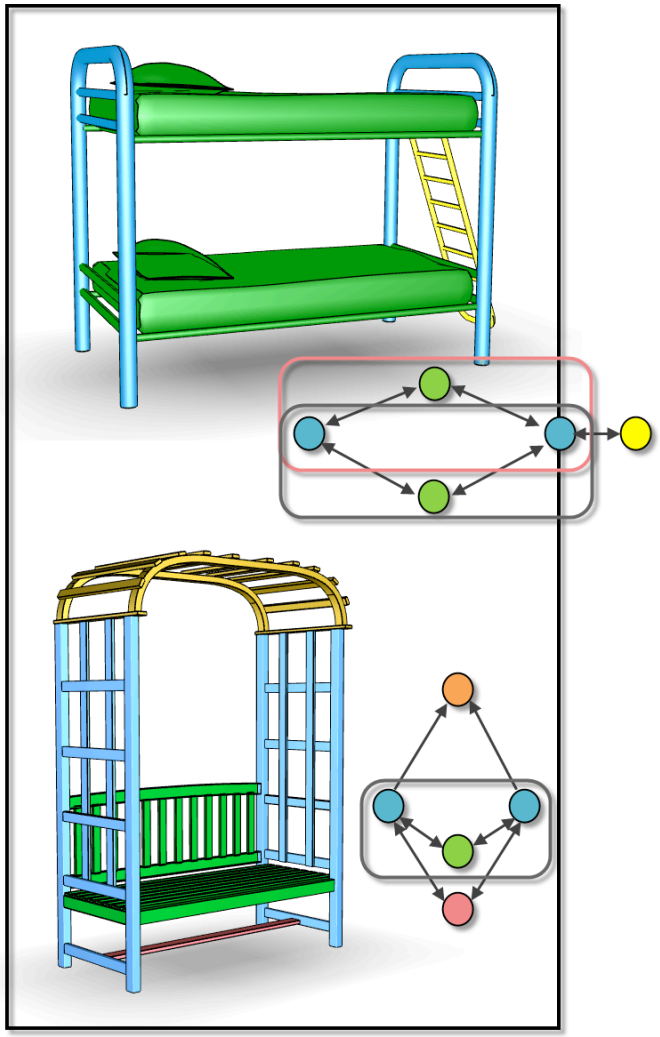
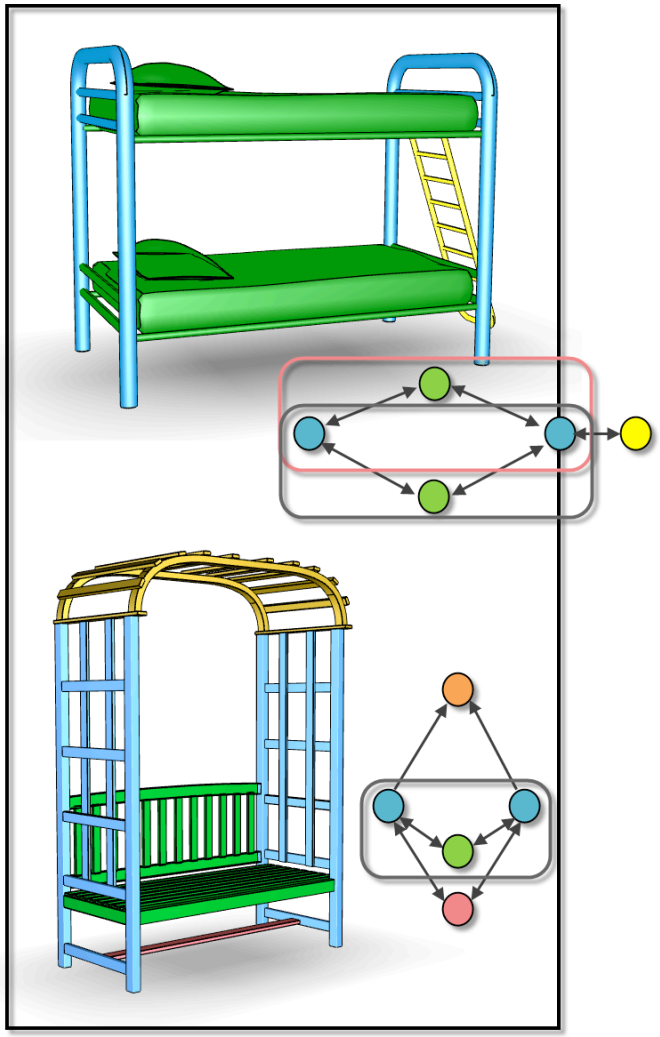
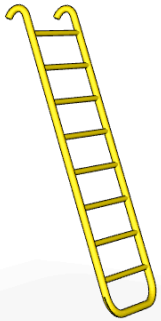


Placement Optimization





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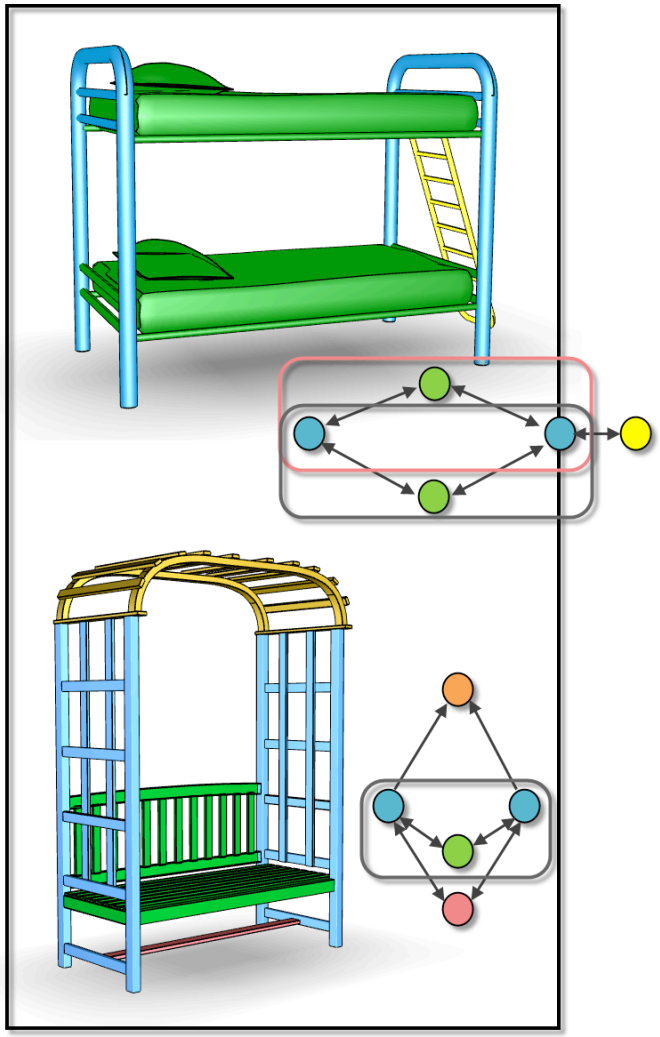

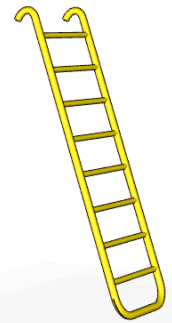

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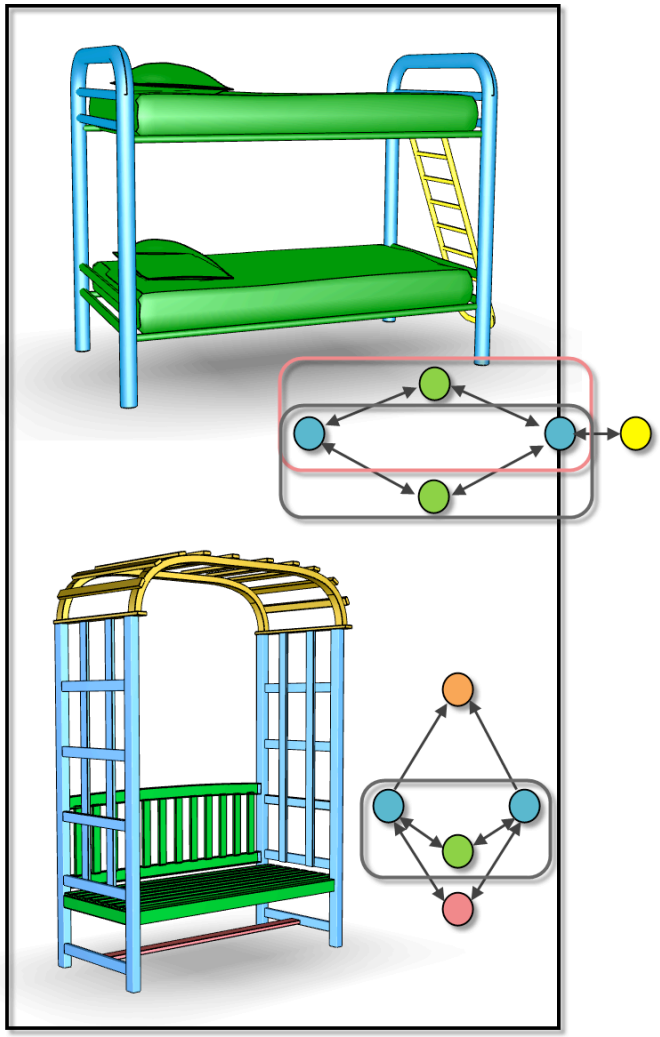

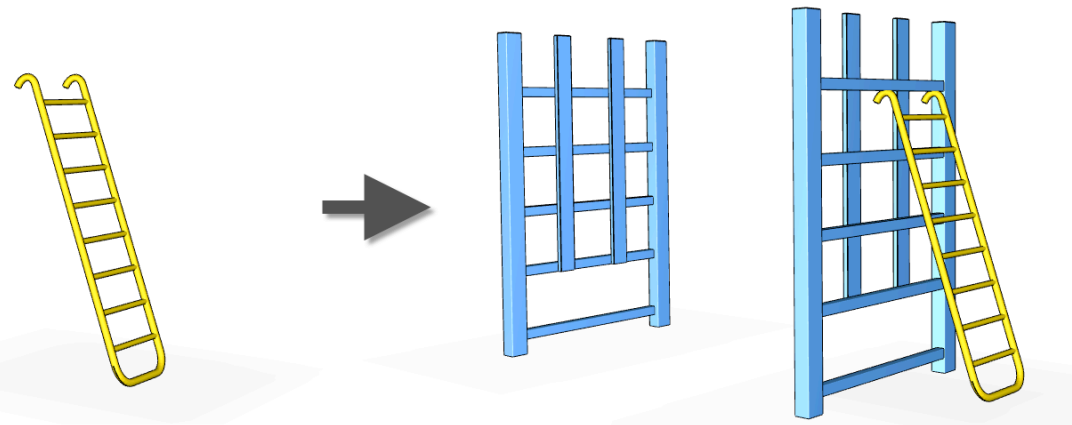

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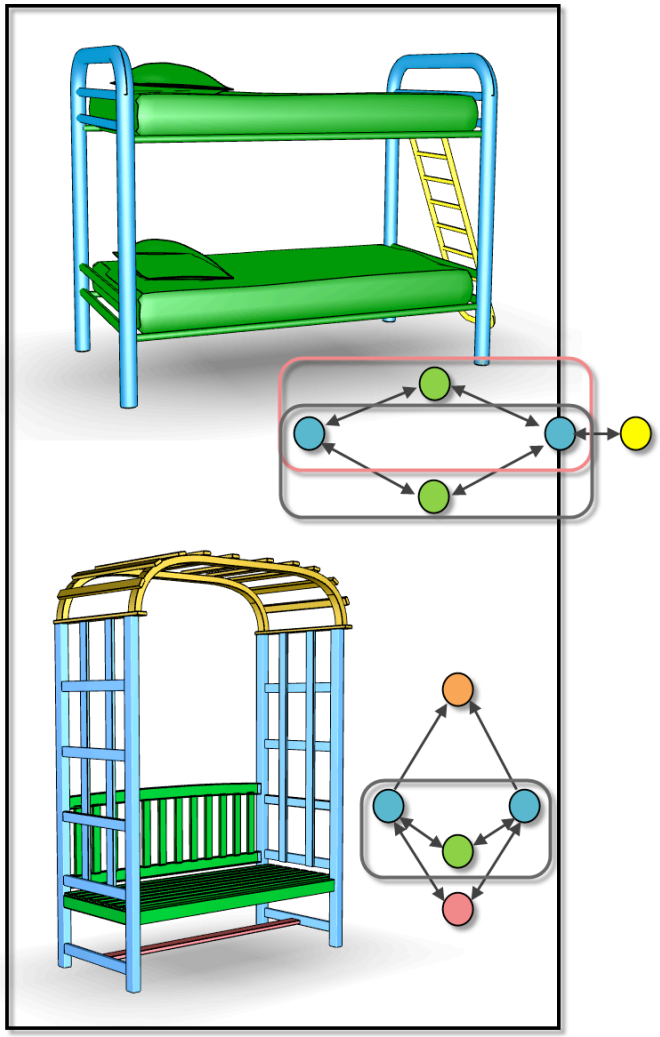

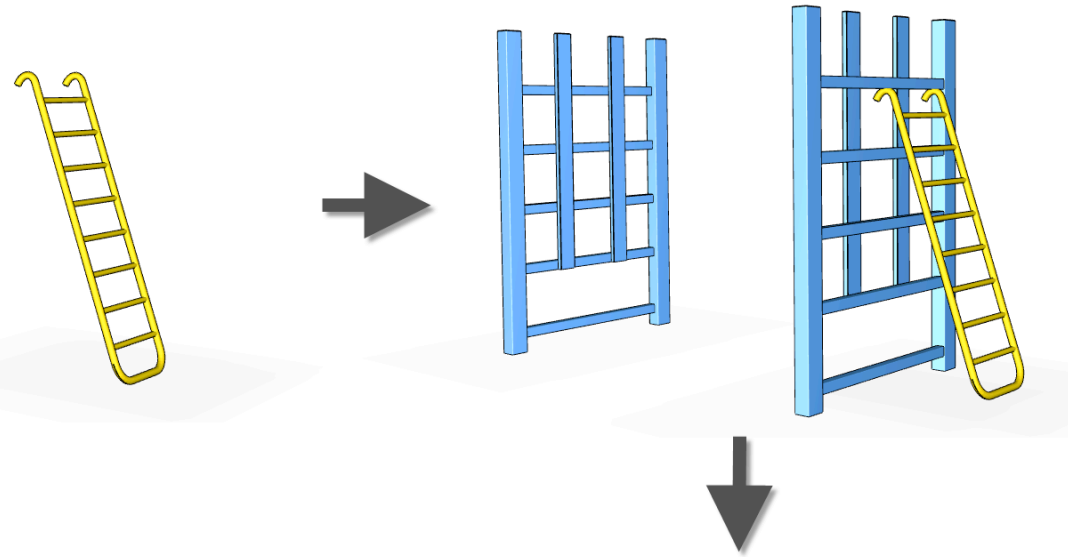

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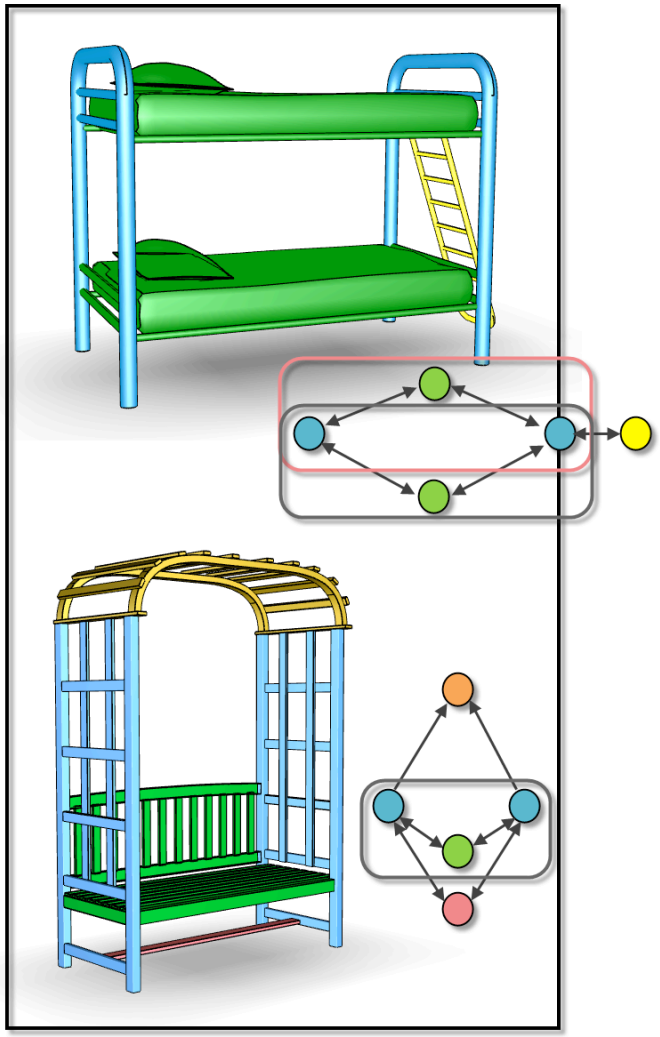

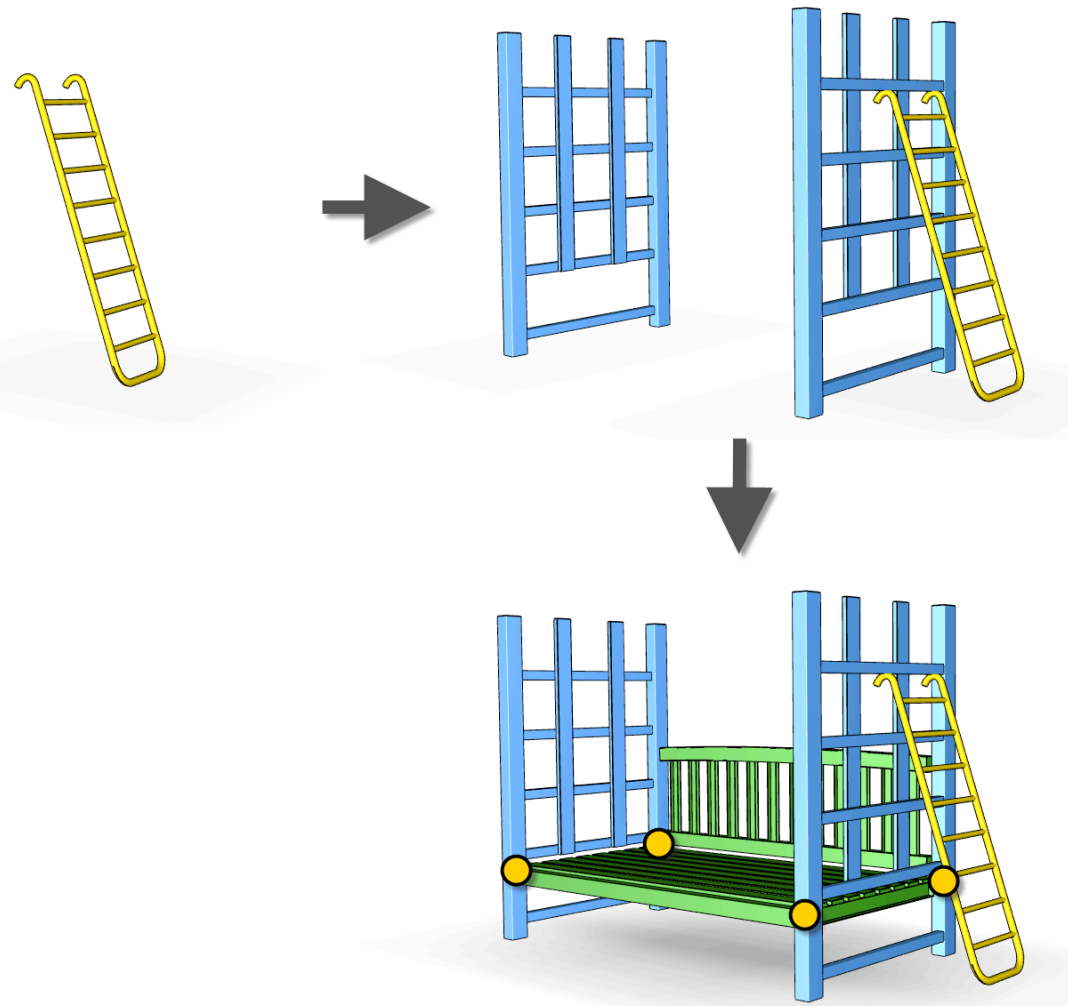

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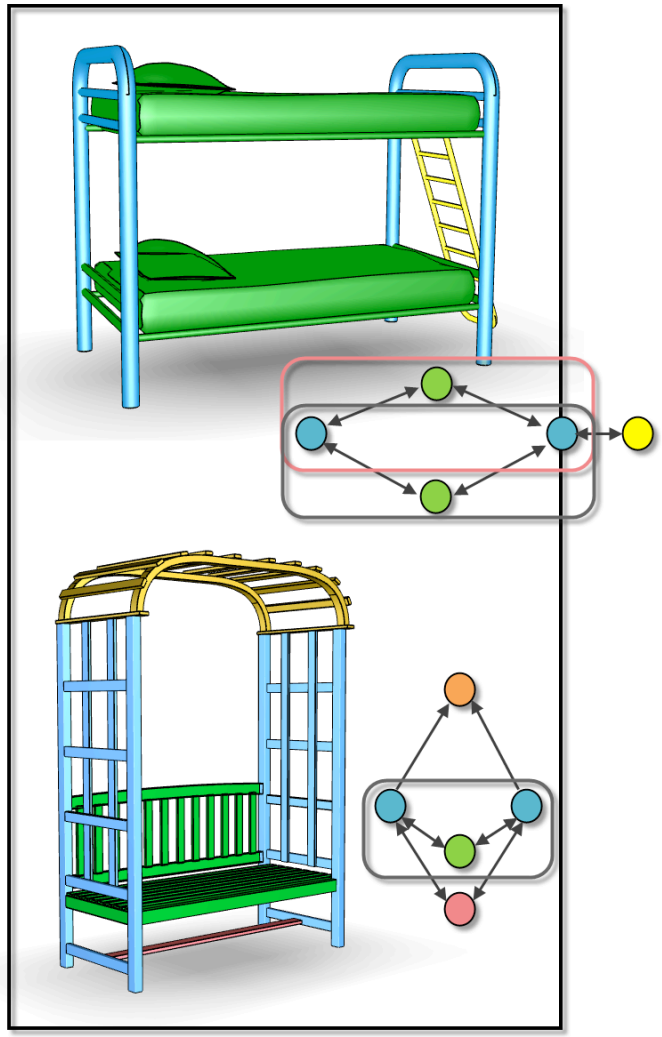

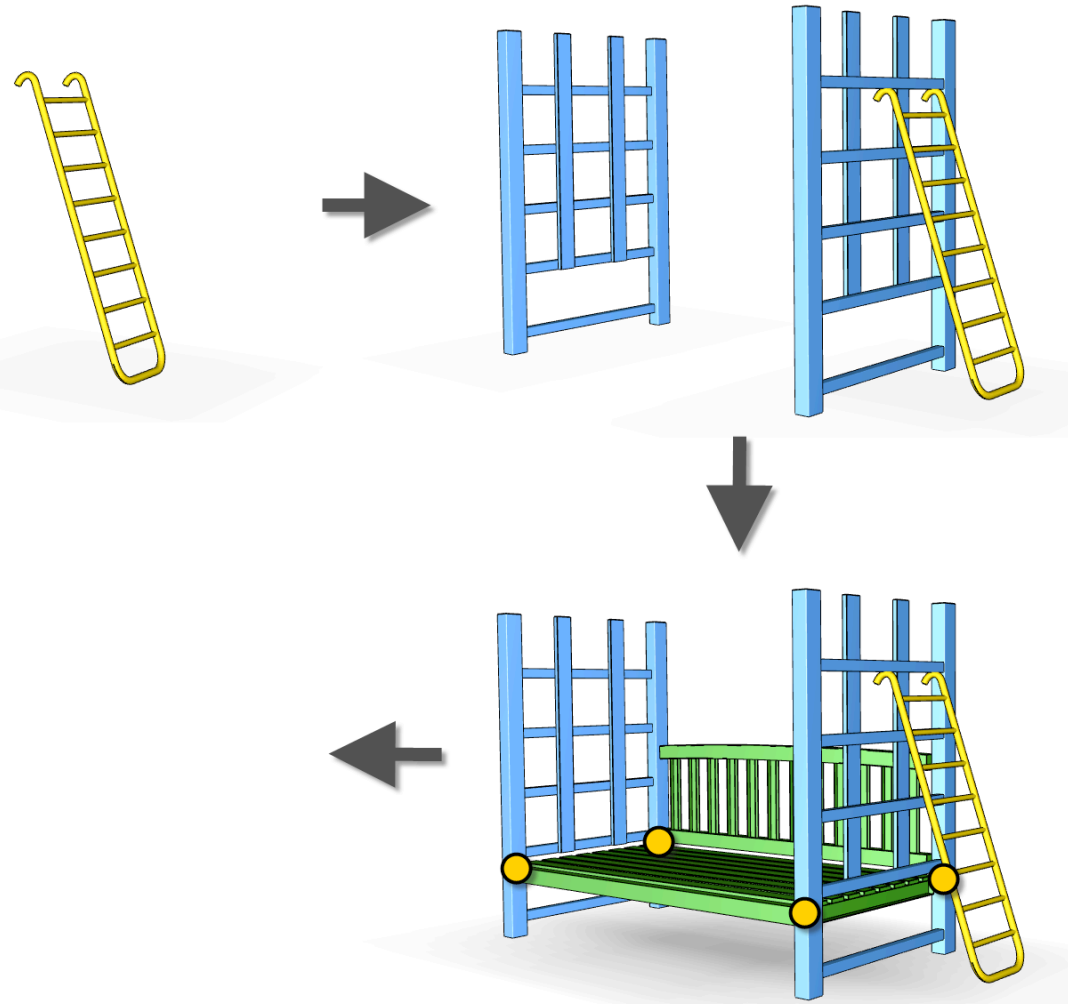

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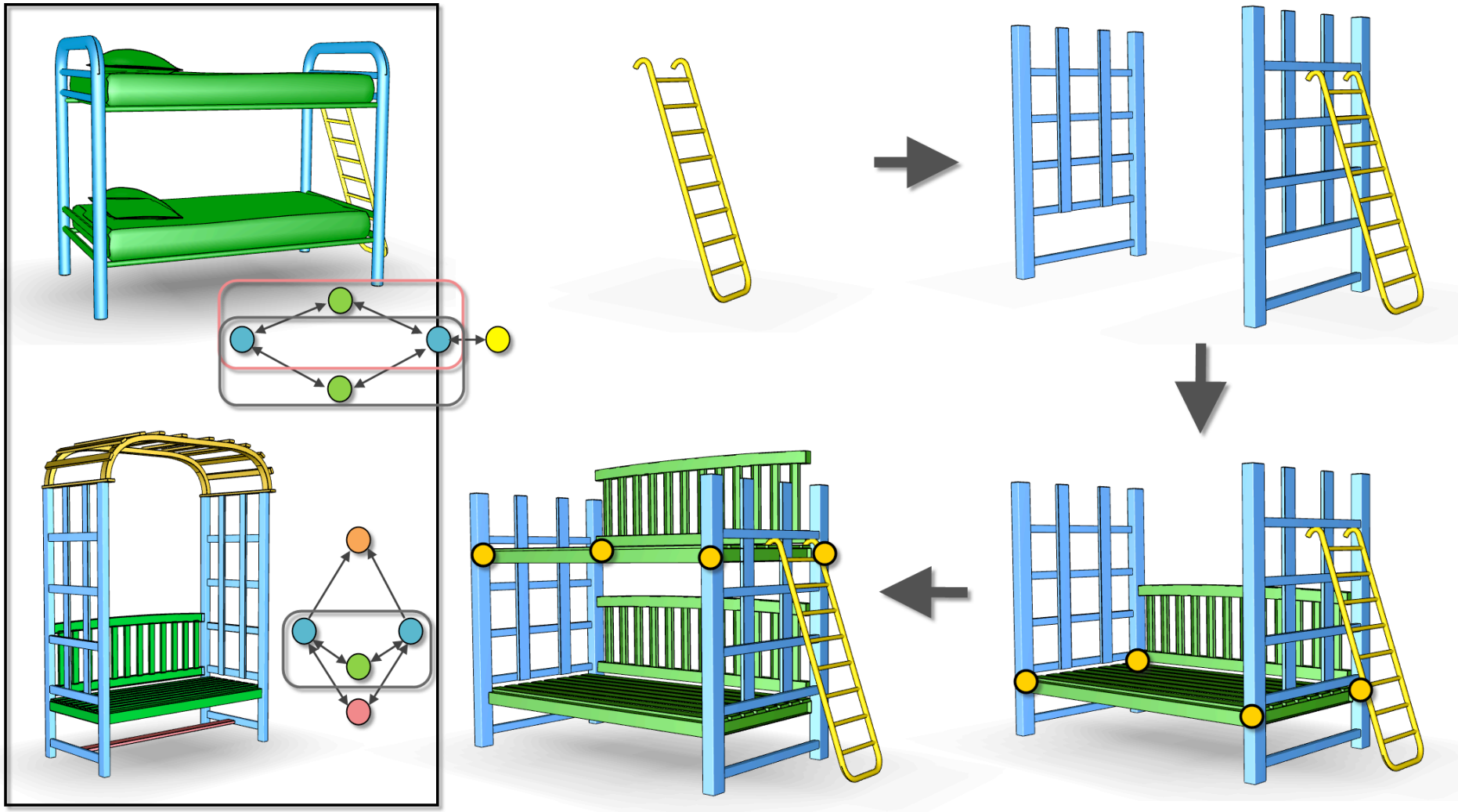

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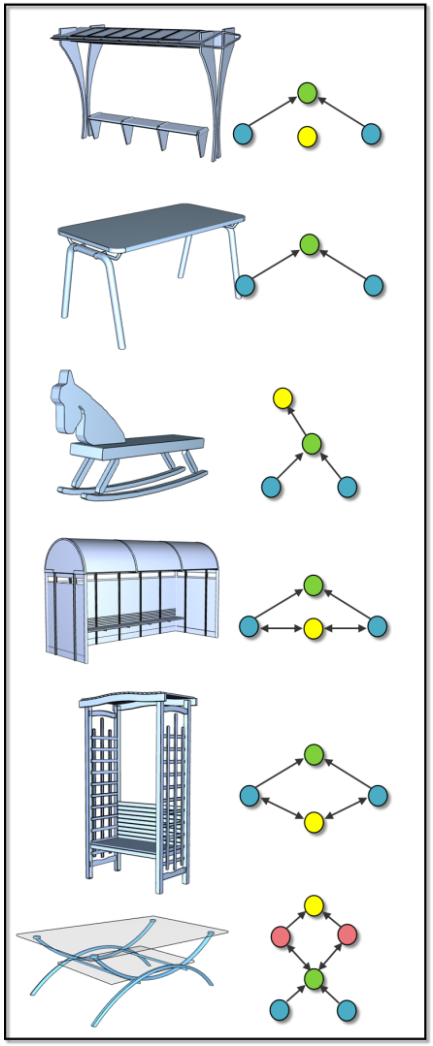

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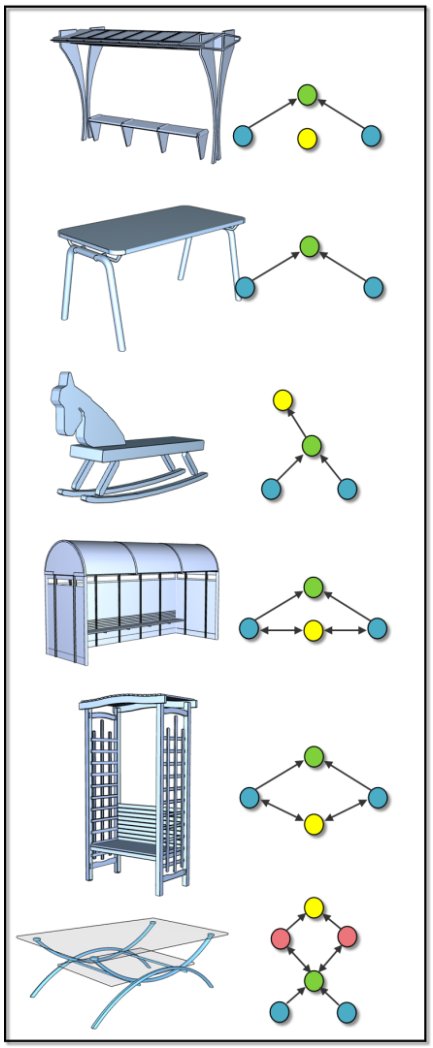

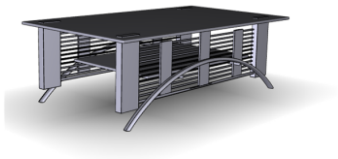

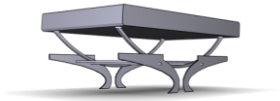

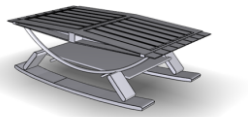

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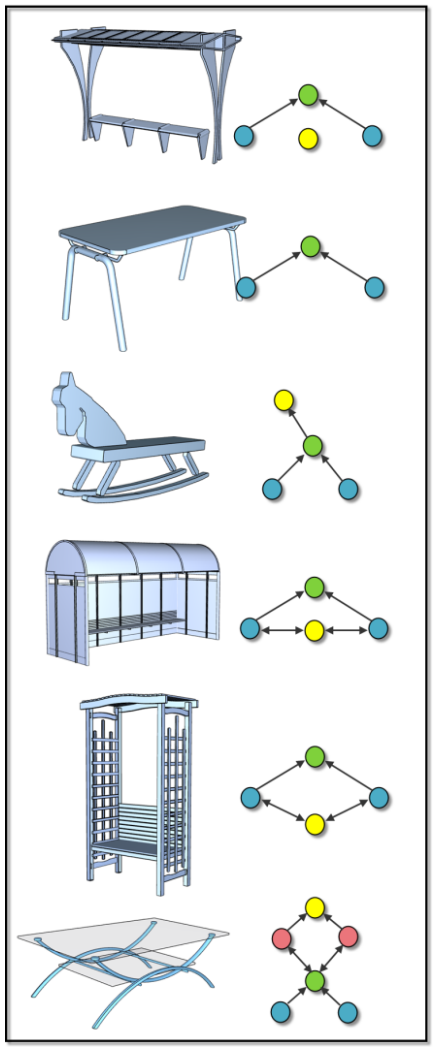

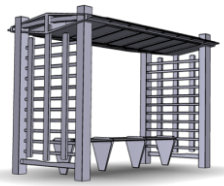

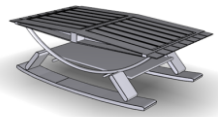

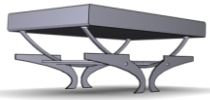

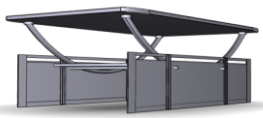

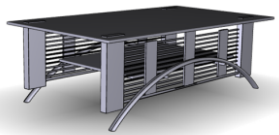

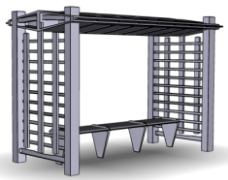

Results

Demo

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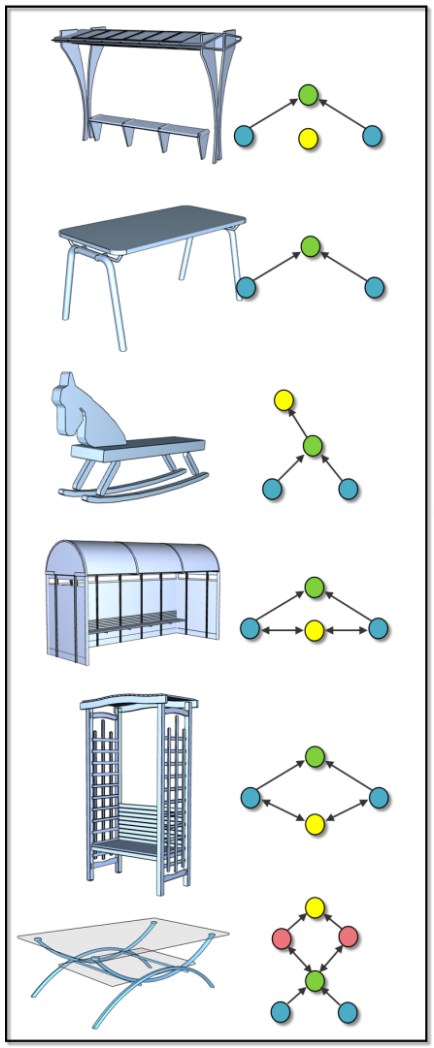

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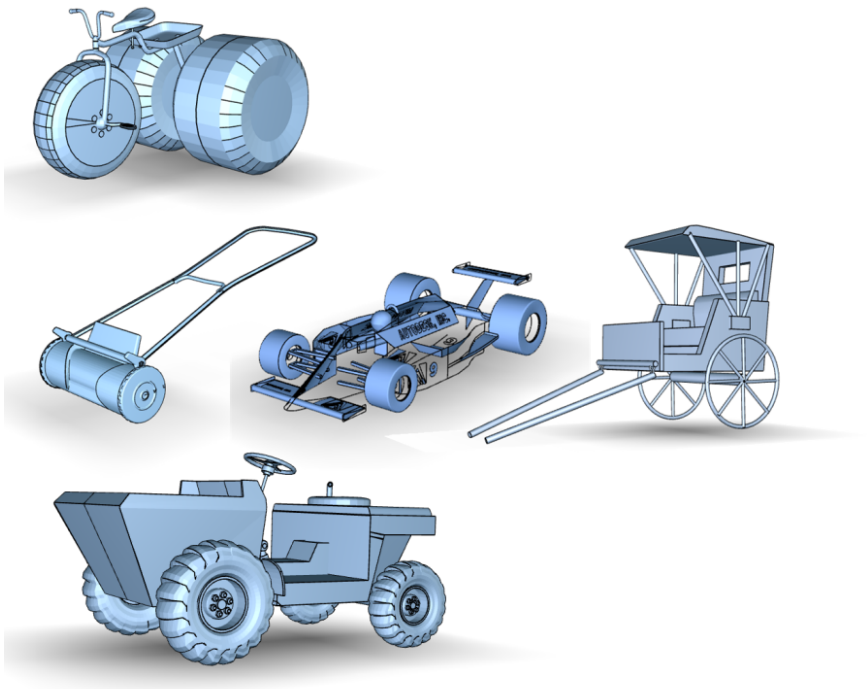

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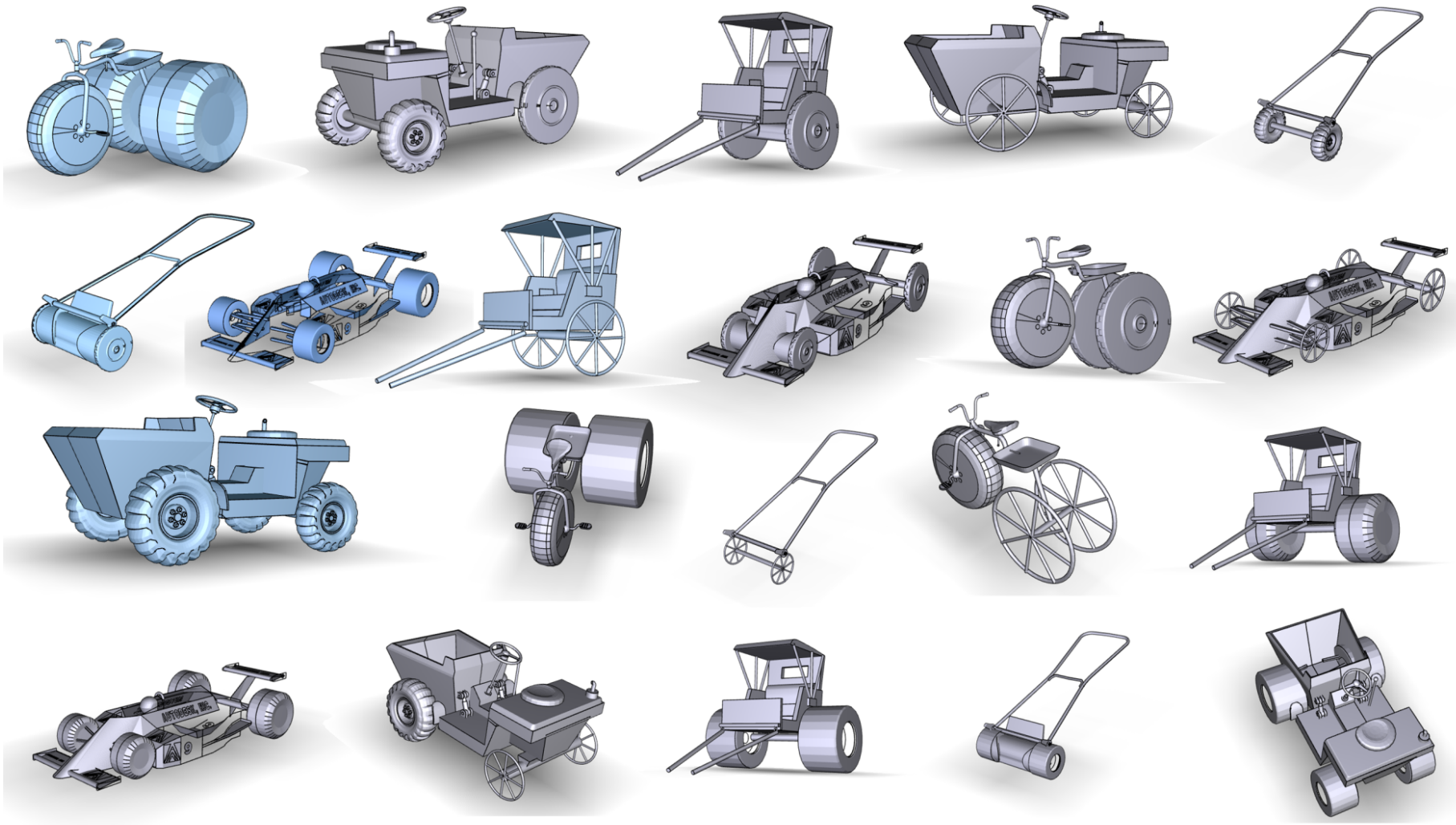

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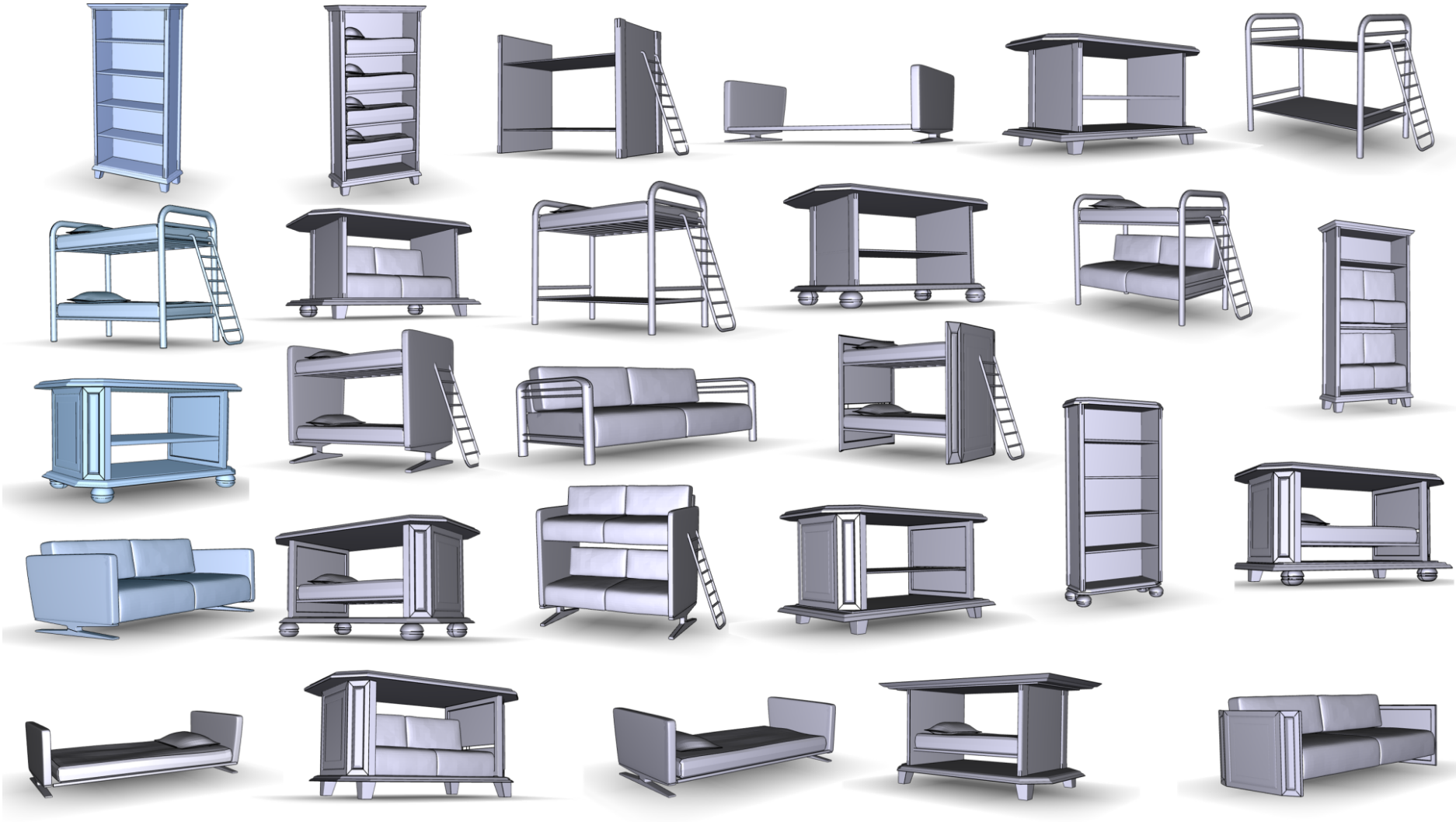

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http://vecg.cs.ucl.ac.uk/Projects/SmartGeometry/sFarr/sFarr_eg13.html