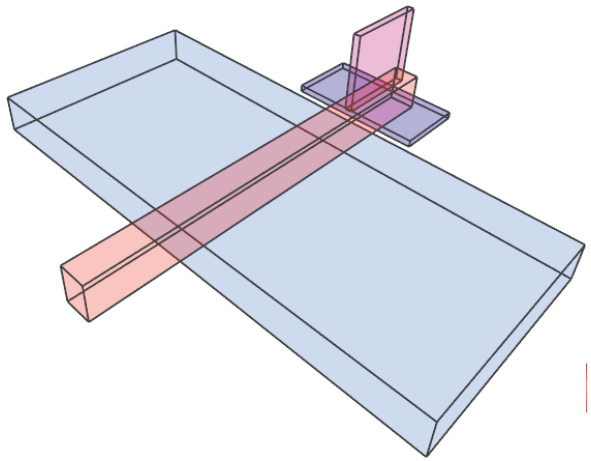
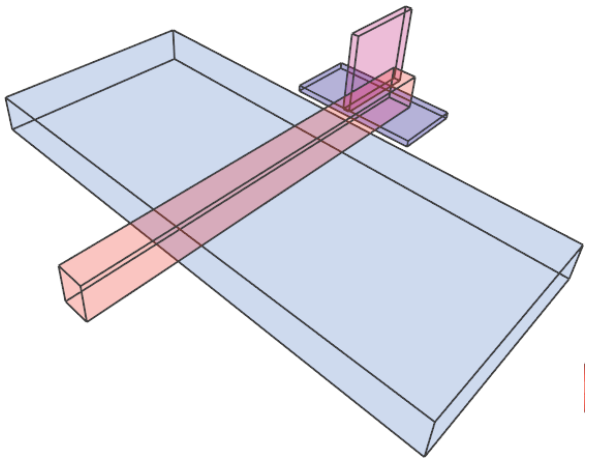
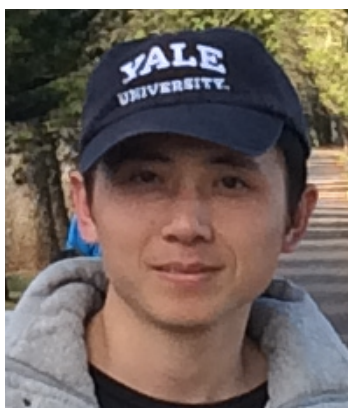


Recurring Part Arrangements in Shape Collections

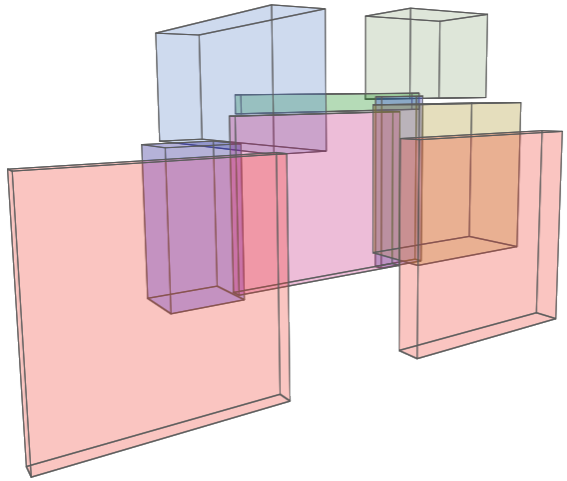
Youyi Zheng Daniel Cohen-Or Melinos Averkiou Niloy J. Mitra

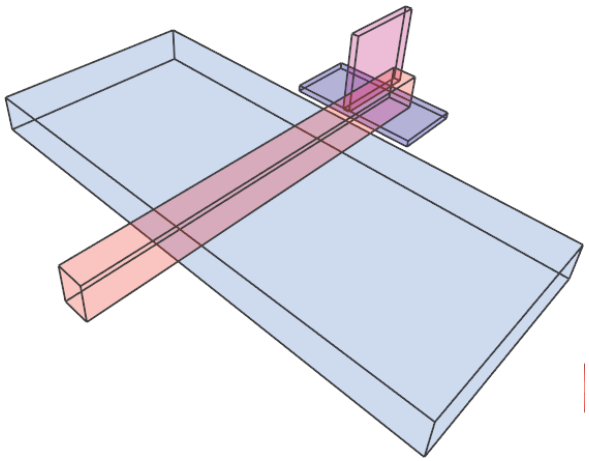


Recurring Part Arrangements in Shape Collections

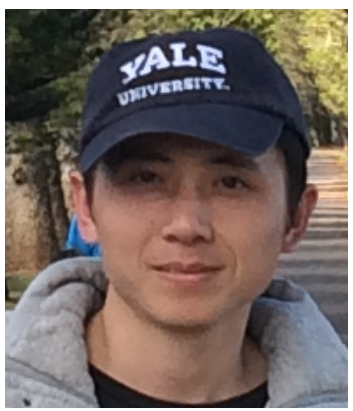


Youyi Zheng Daniel Cohen-Or Melinos Averkiou Niloy J. Mitra





Recurring Part Arrangements in Shape Collections



Youyi Zheng Daniel Cohen-Or Melinos Averkiou Niloy J. Mitra

Data → Knowledge?

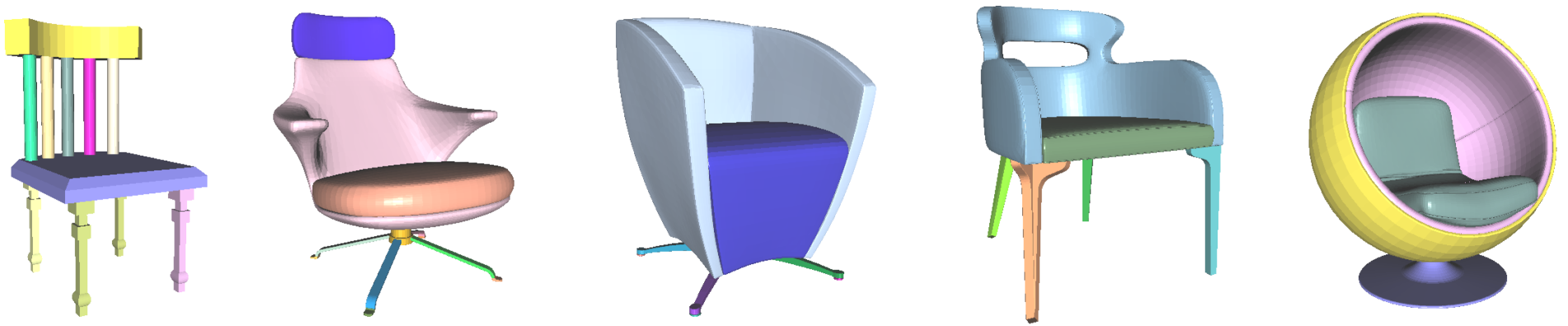



Data → Knowledge?

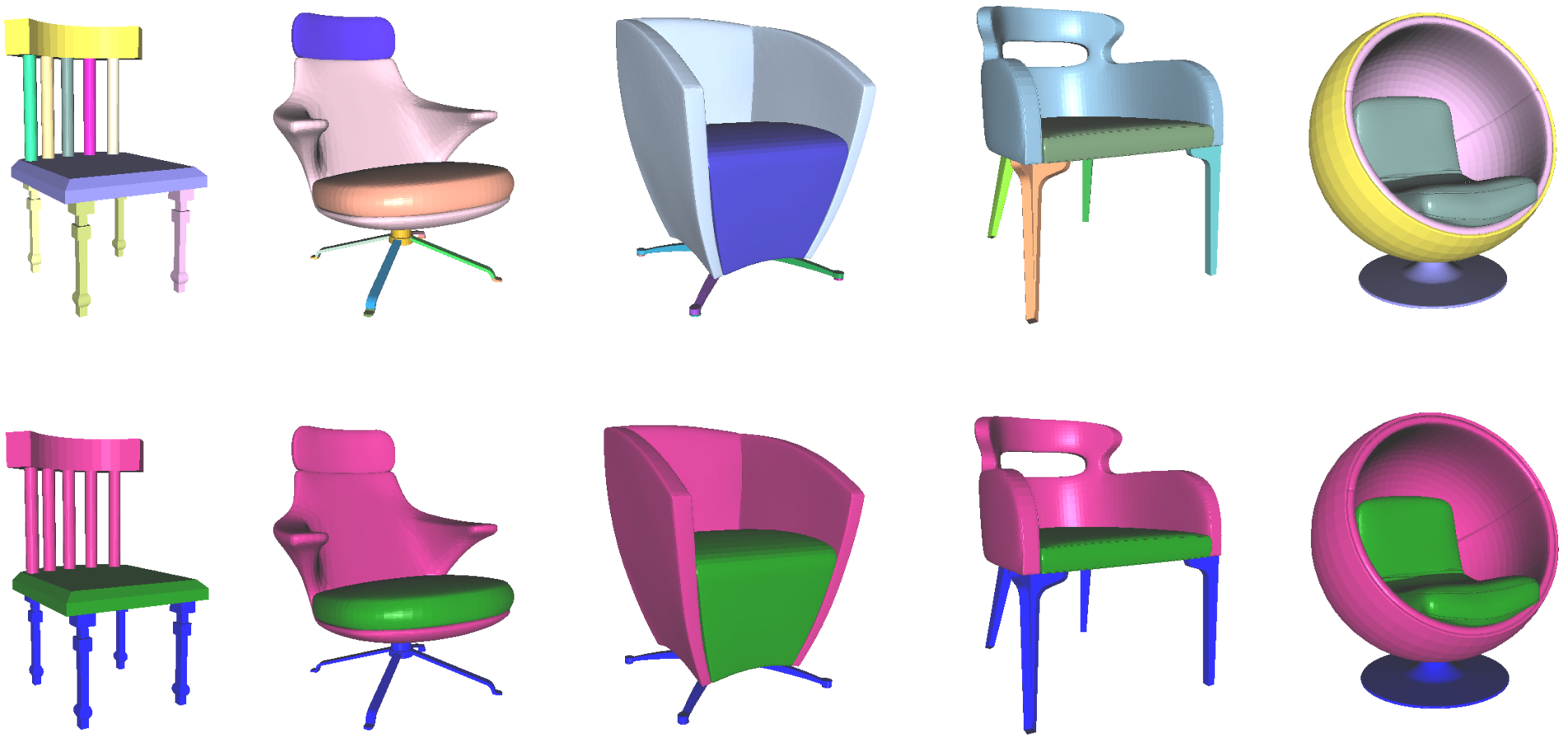



geometric *differences can hide* ***functional*** *correlation*

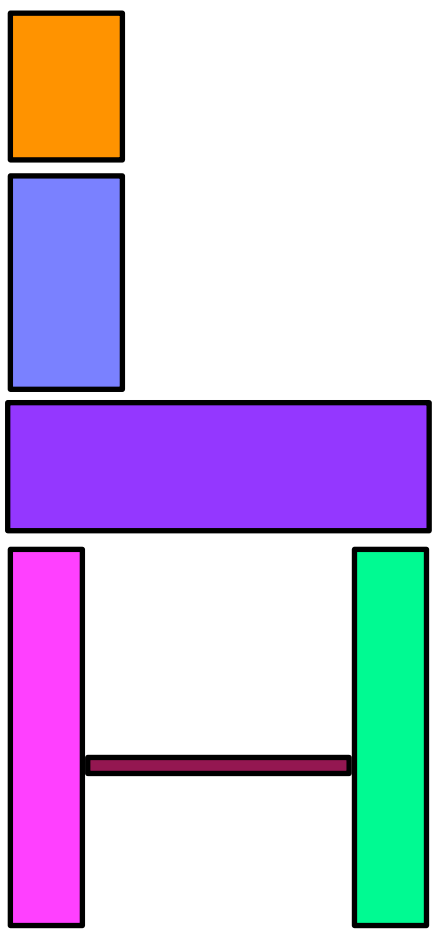
Goal

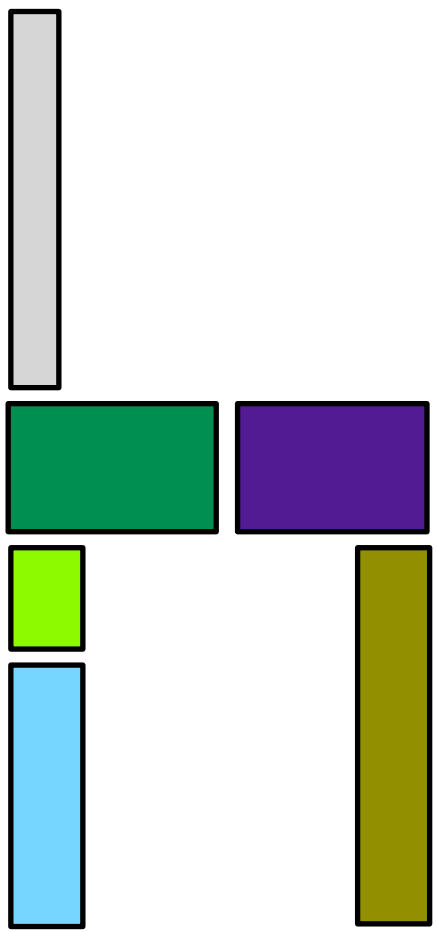


Goal



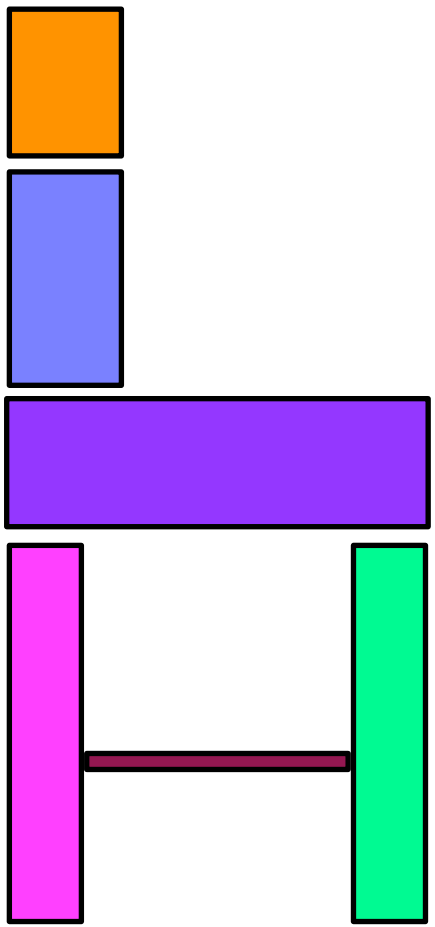
Where is the Challenge?

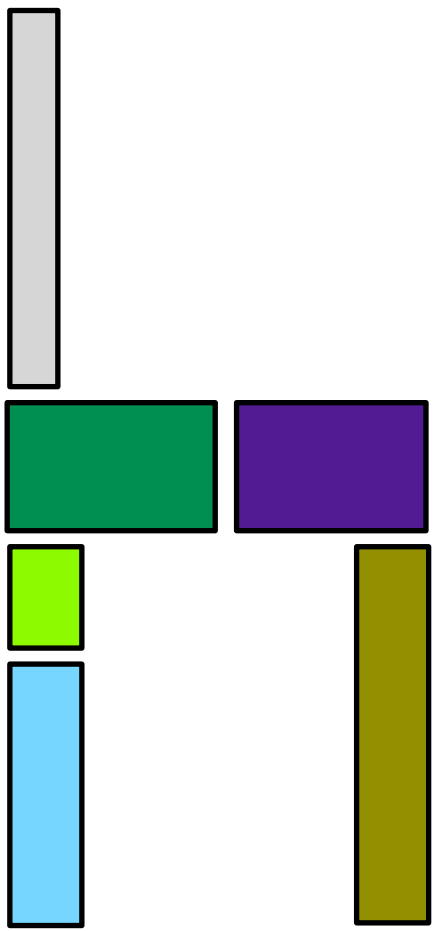




Where is the Challenge?

how to compare parts?

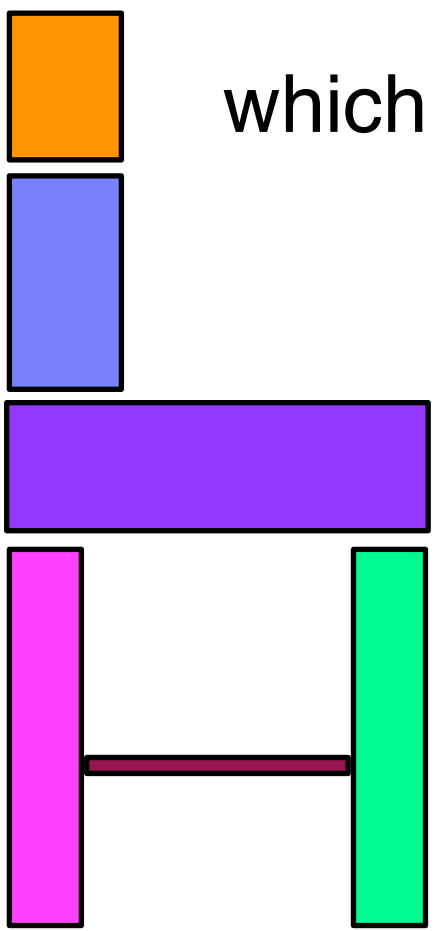


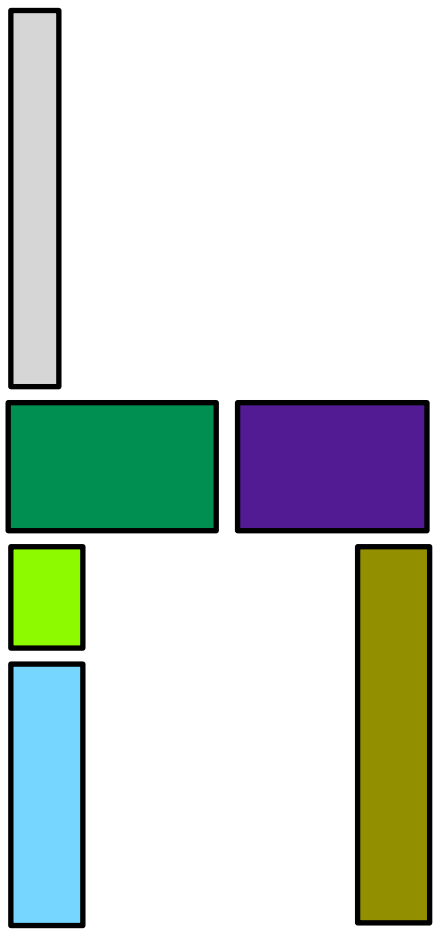


Where is the Challenge?

how to compare parts?

which parts are in correspondence?



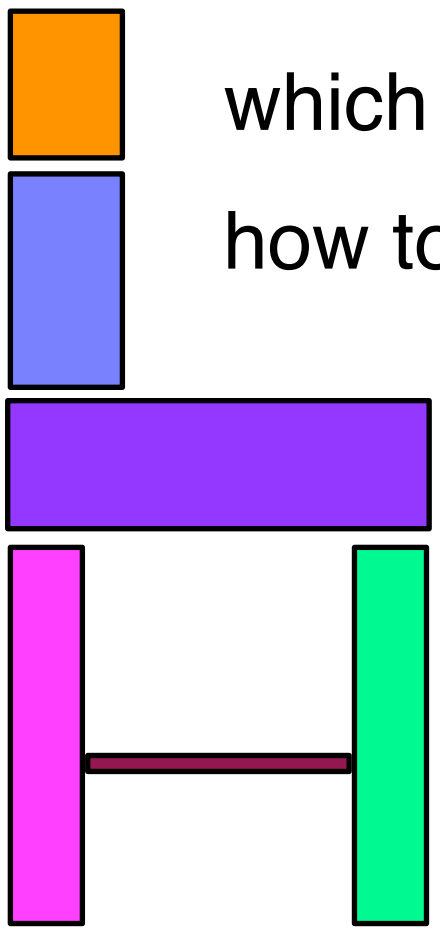


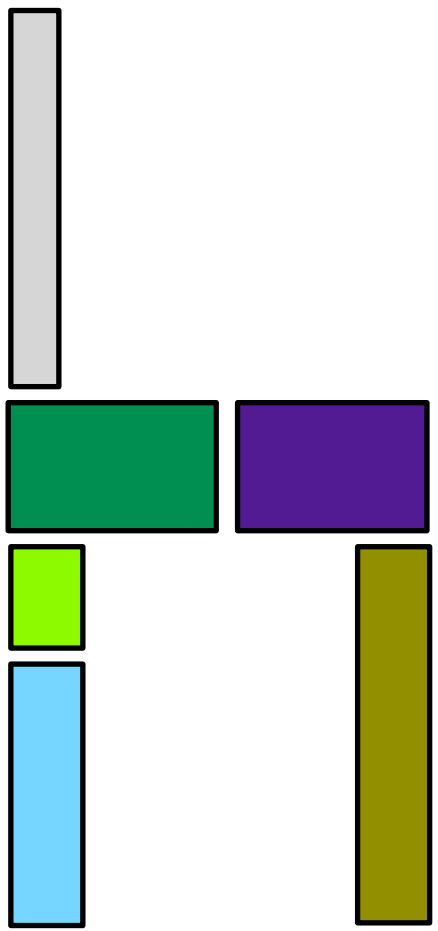
Where is the Challenge?

how to compare parts?

which parts are in correspondence?

how to merge the parts?





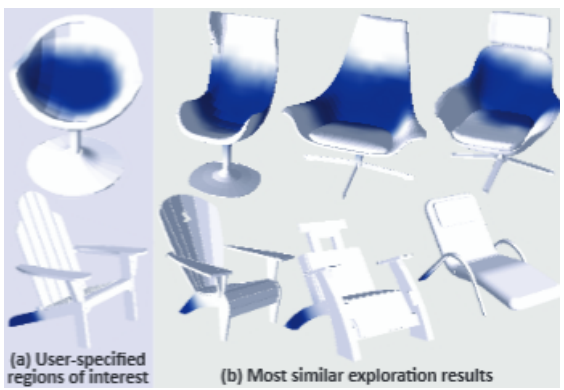
Overview

- Introduction
- Related Works
- Main Idea
- Algorithm
- Results
- Limitations and Future work

Relation to Co-segmentation

supervised and/or use geometric descriptors

Wang et al. 2012



Kim et al. 2012, 2013

Huang et al. 2012

Relation to Co-segmentation

supervised and/or use geometric descriptors

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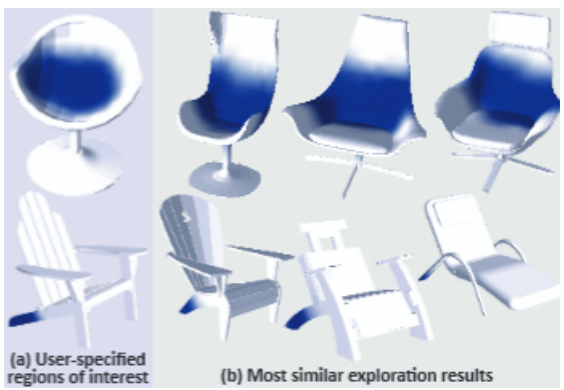
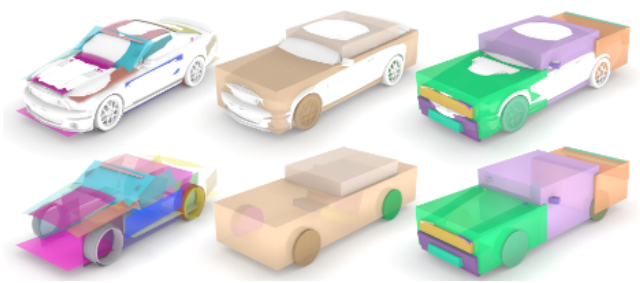


Kim et al. 2012, 2013

Huang et al. 2012

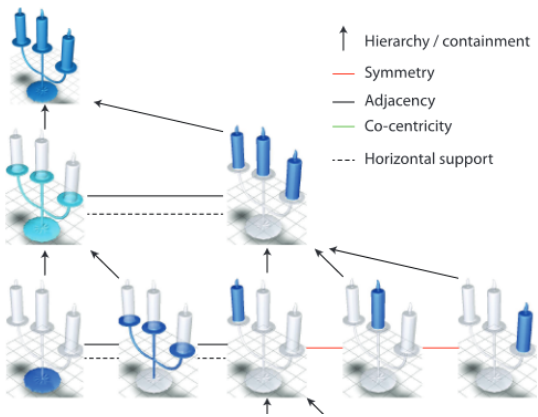
Relation to Co-analysis

applications in synthesis, semantics



Yumer et al. 2012

Kalogerakis et al. 2012



Laga et al. 2013

Overview

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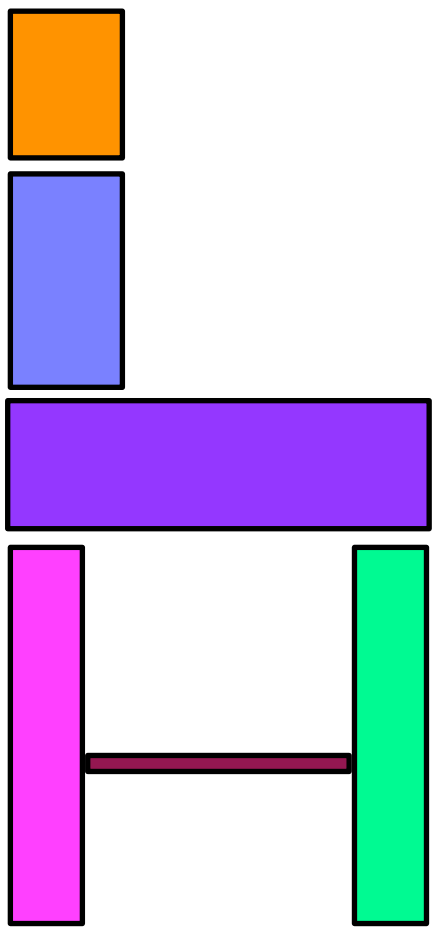
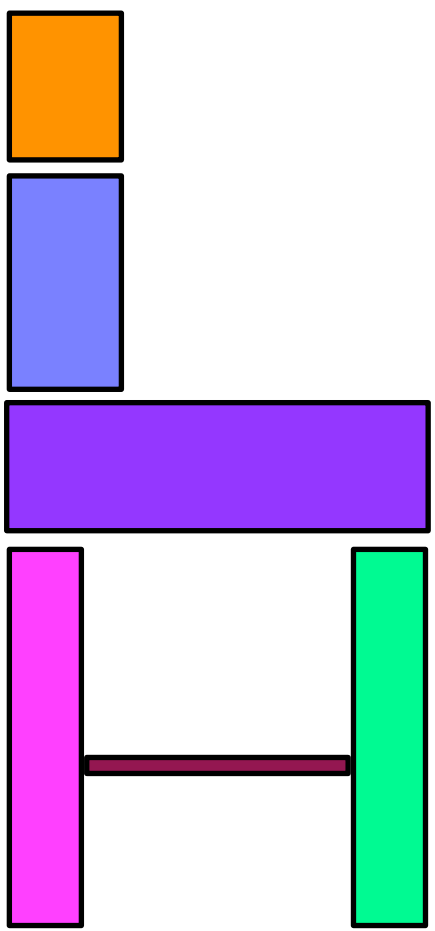
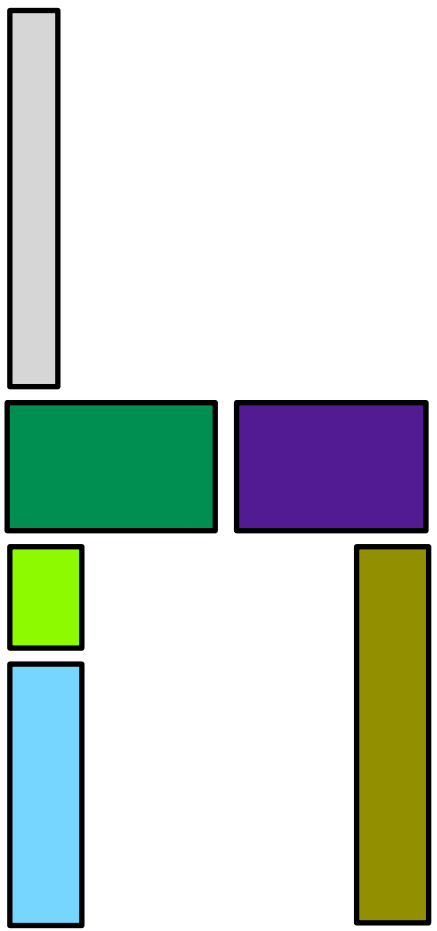
Graph Abstraction

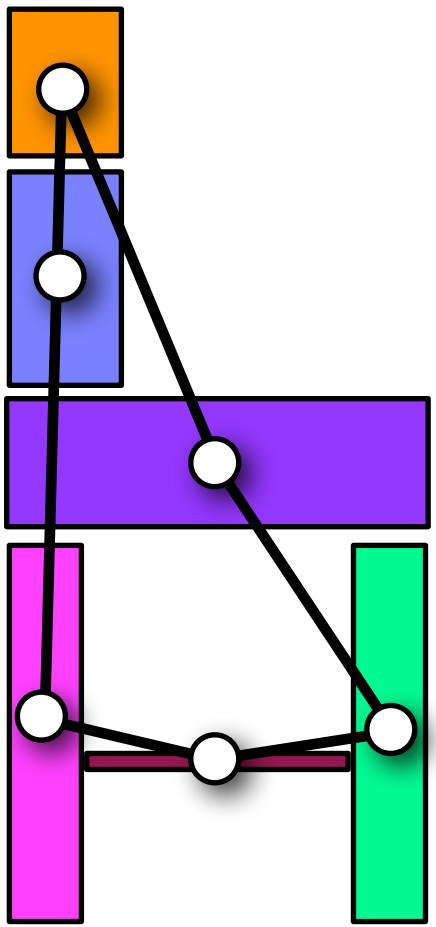


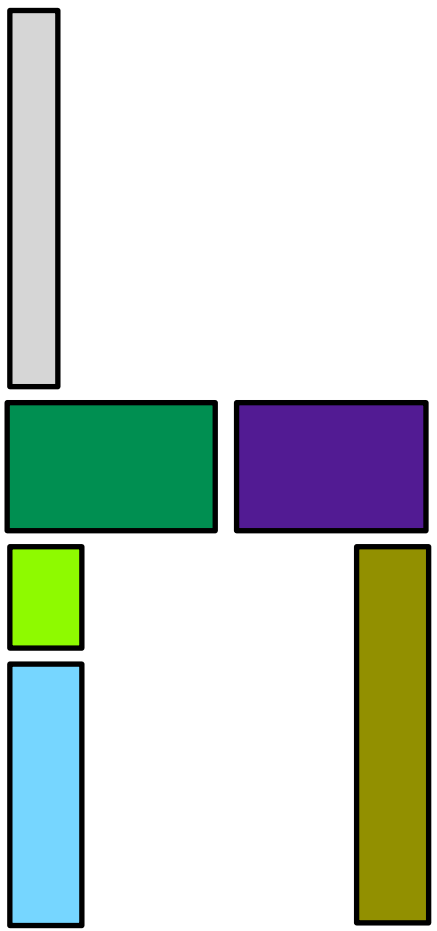
Graph Abstraction



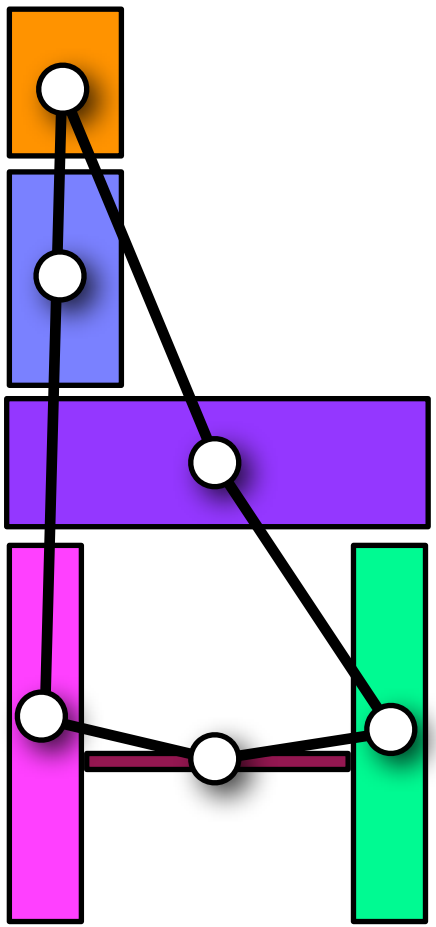


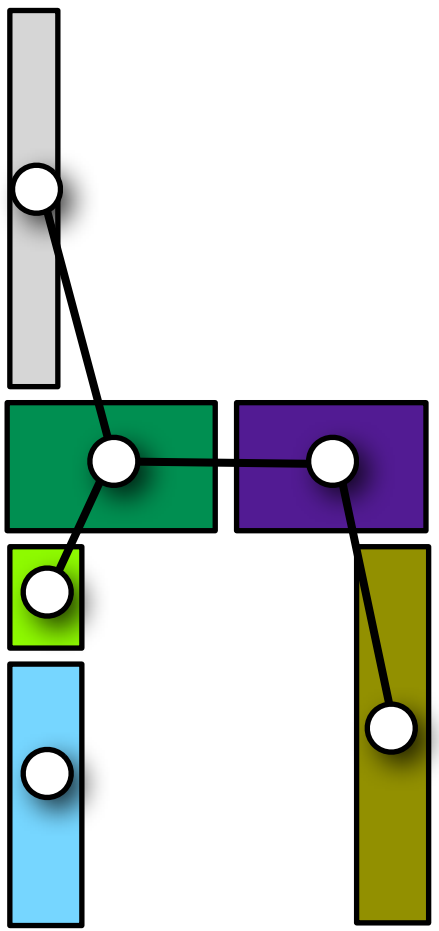
Graph Abstraction



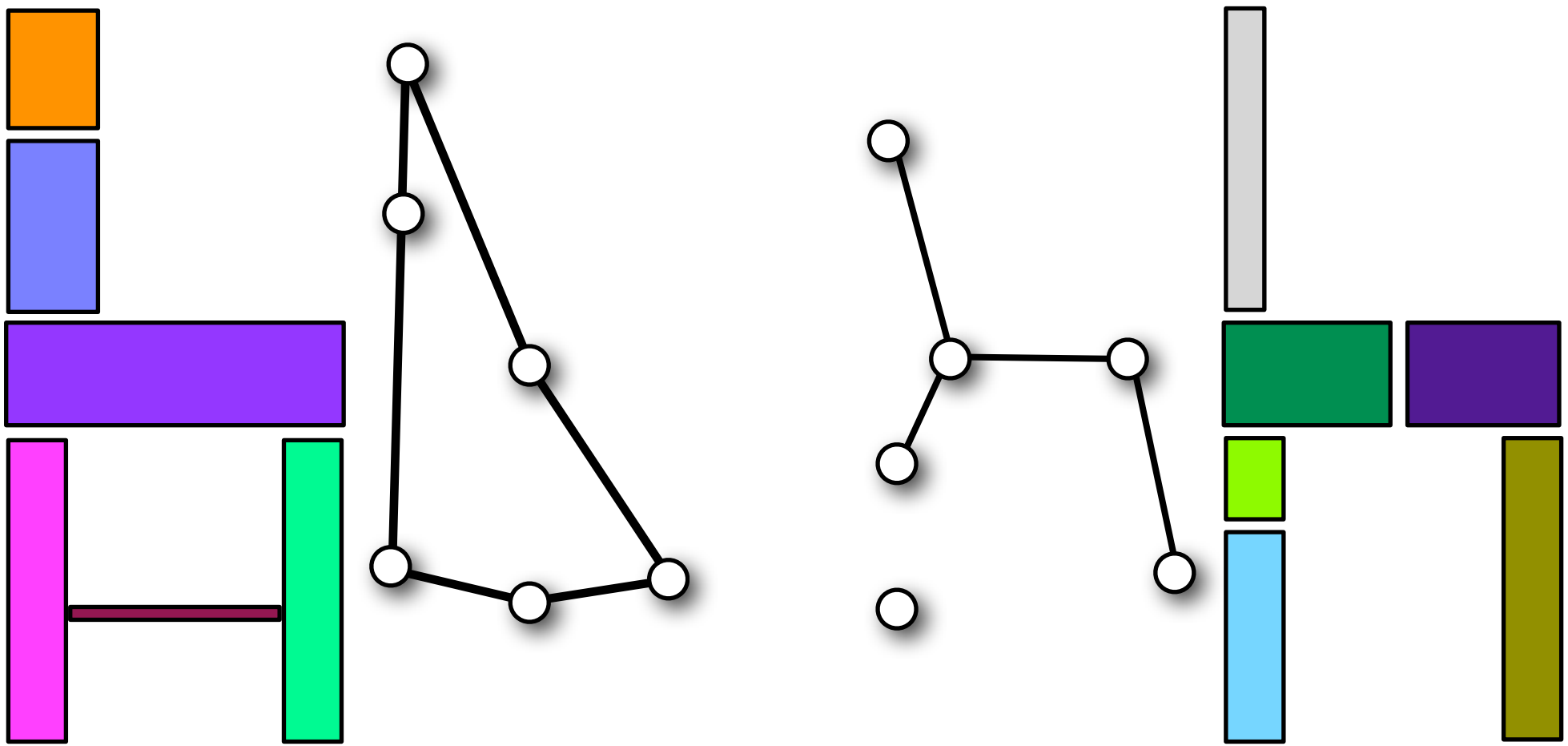


Graph Abstraction

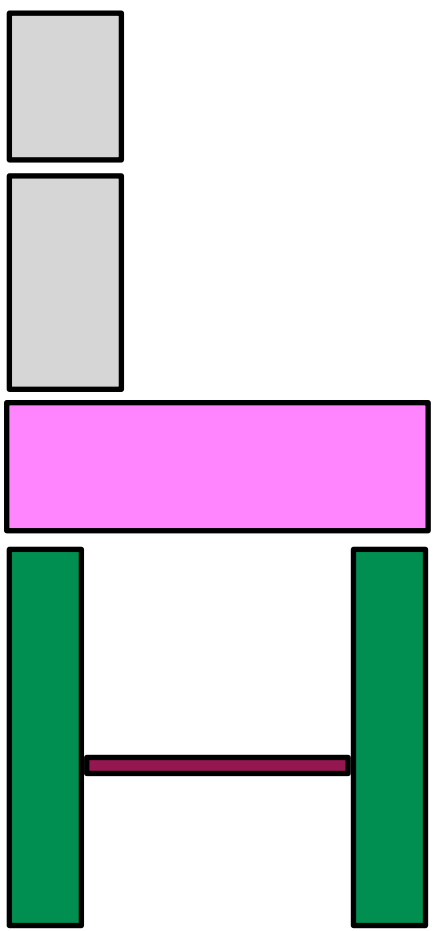


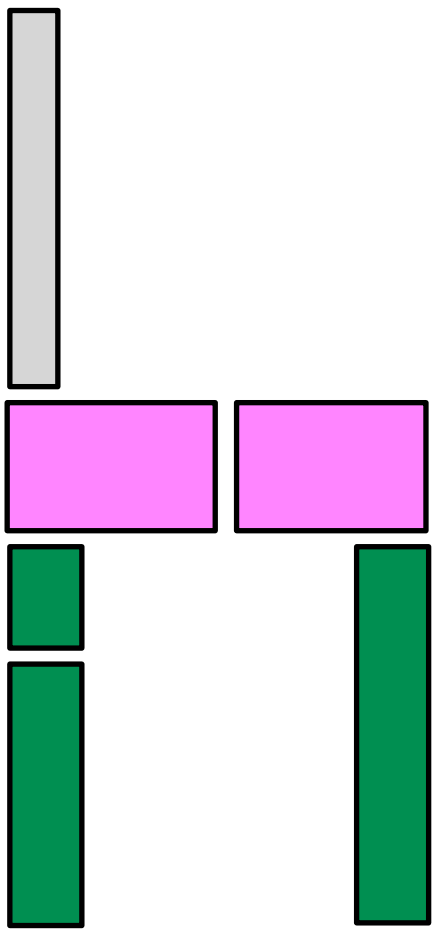


Graph Abstraction



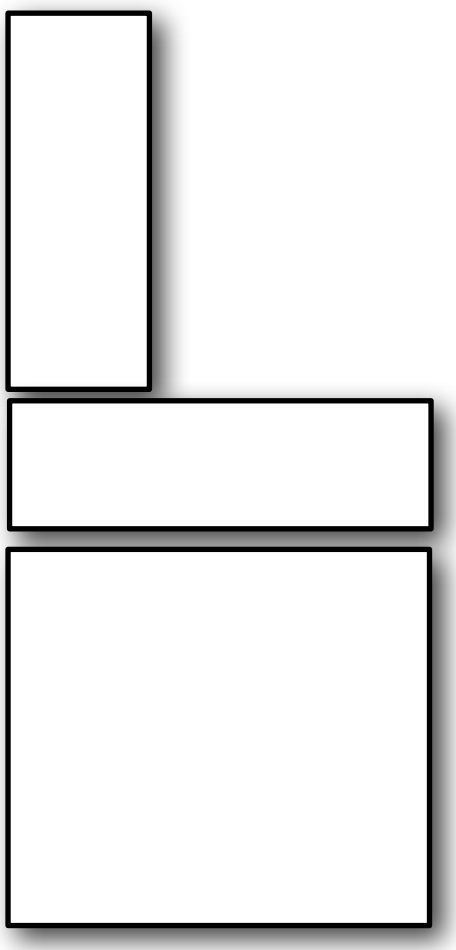
For the Correct Grouping

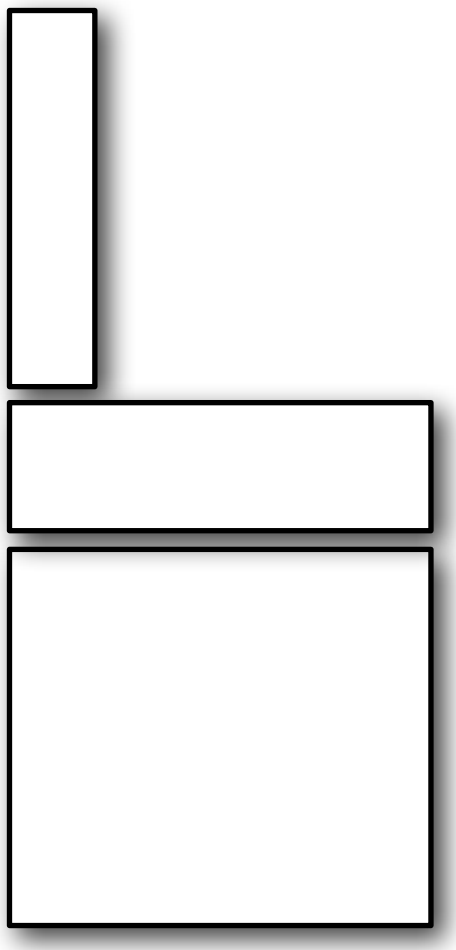




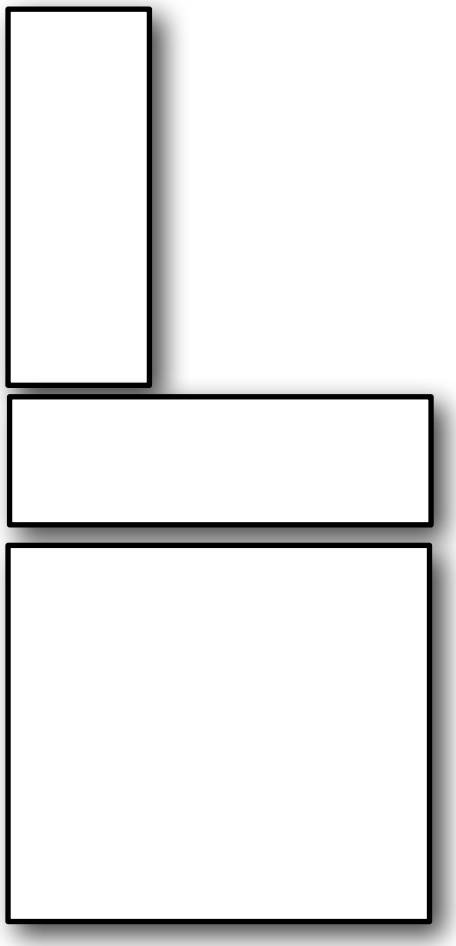
Focus on Arrangements

regroup parts



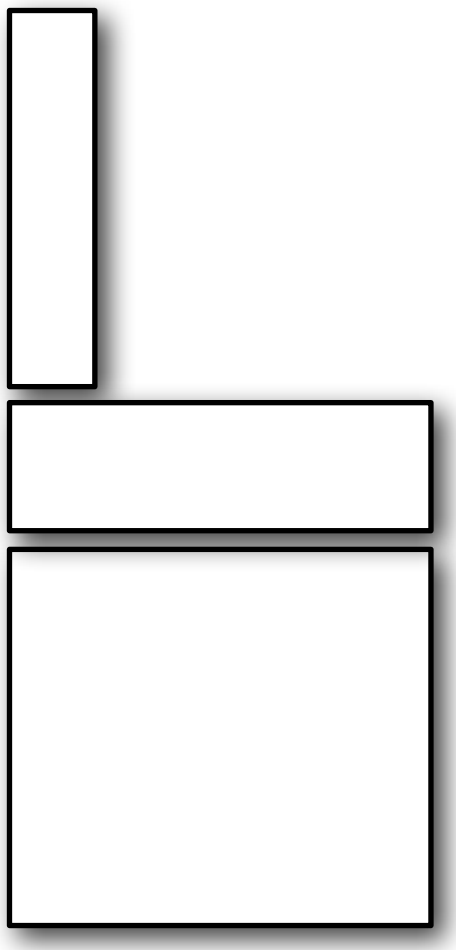


Focus on Arrangements

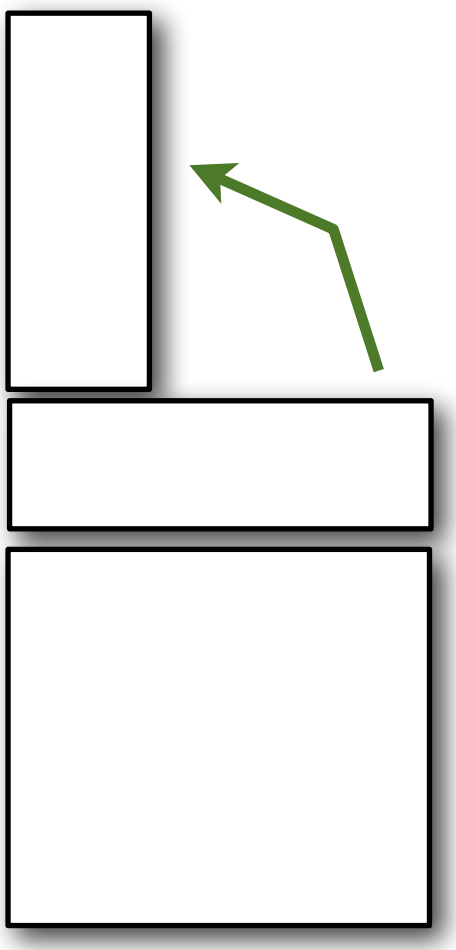


regroup parts

compare ***without***
using correspondence



Focus on Arrangements



regroup parts

compare ***without***
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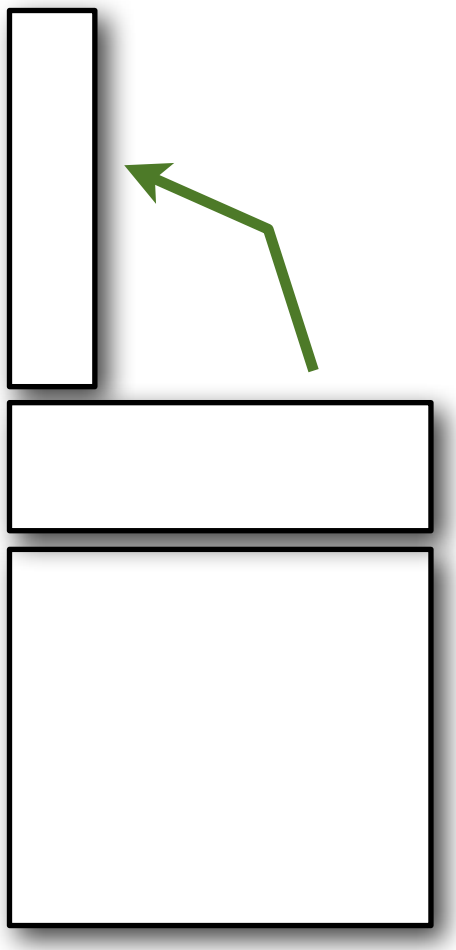
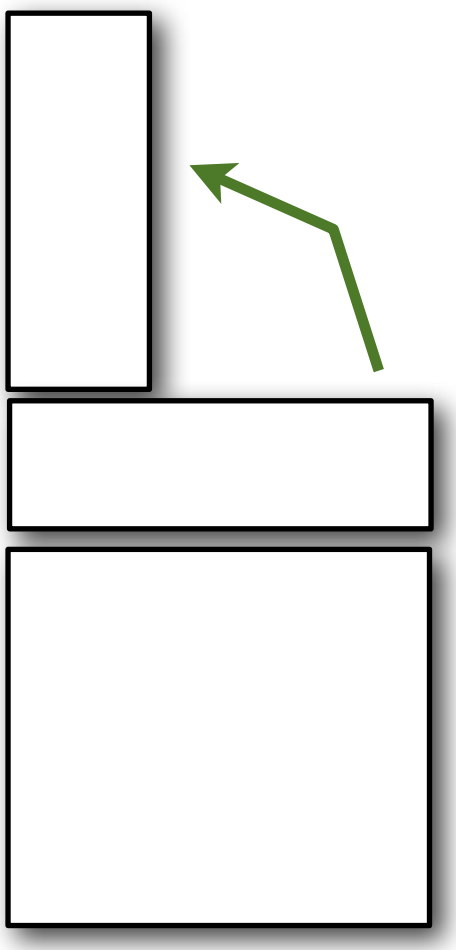


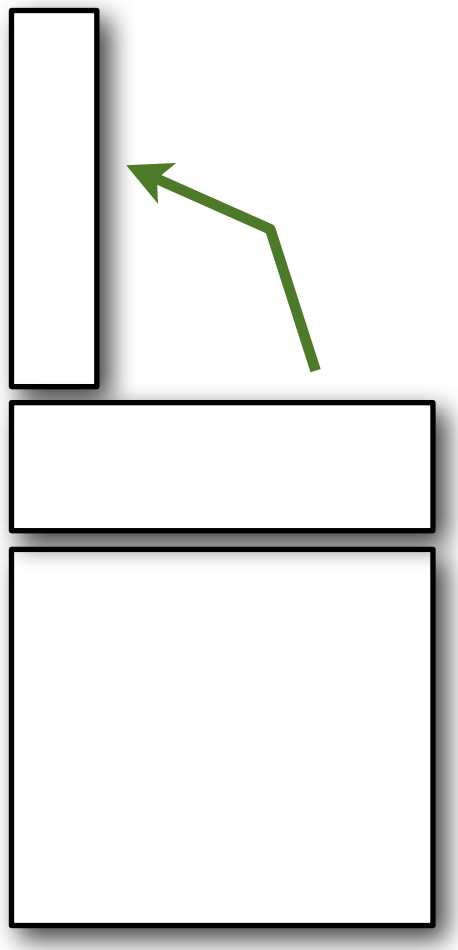
Focus on Arrangements



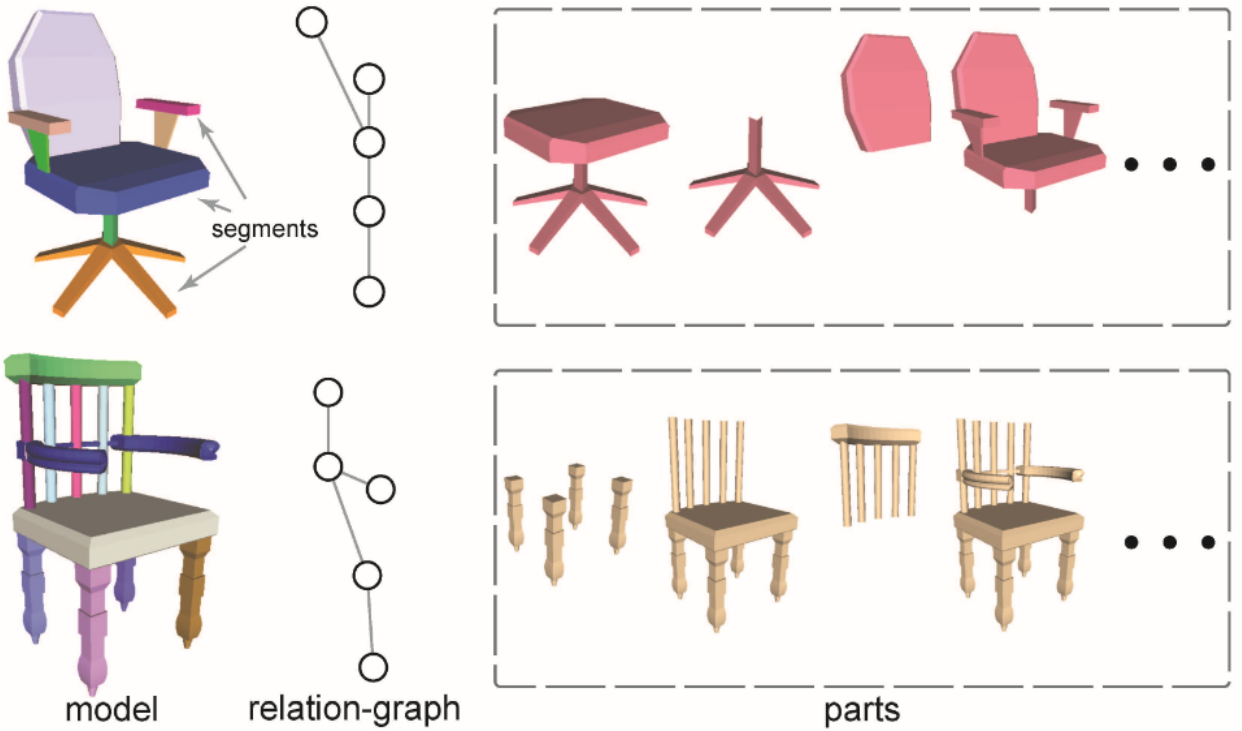
regroup parts

compare ***without*** using correspondence

relative arrangement

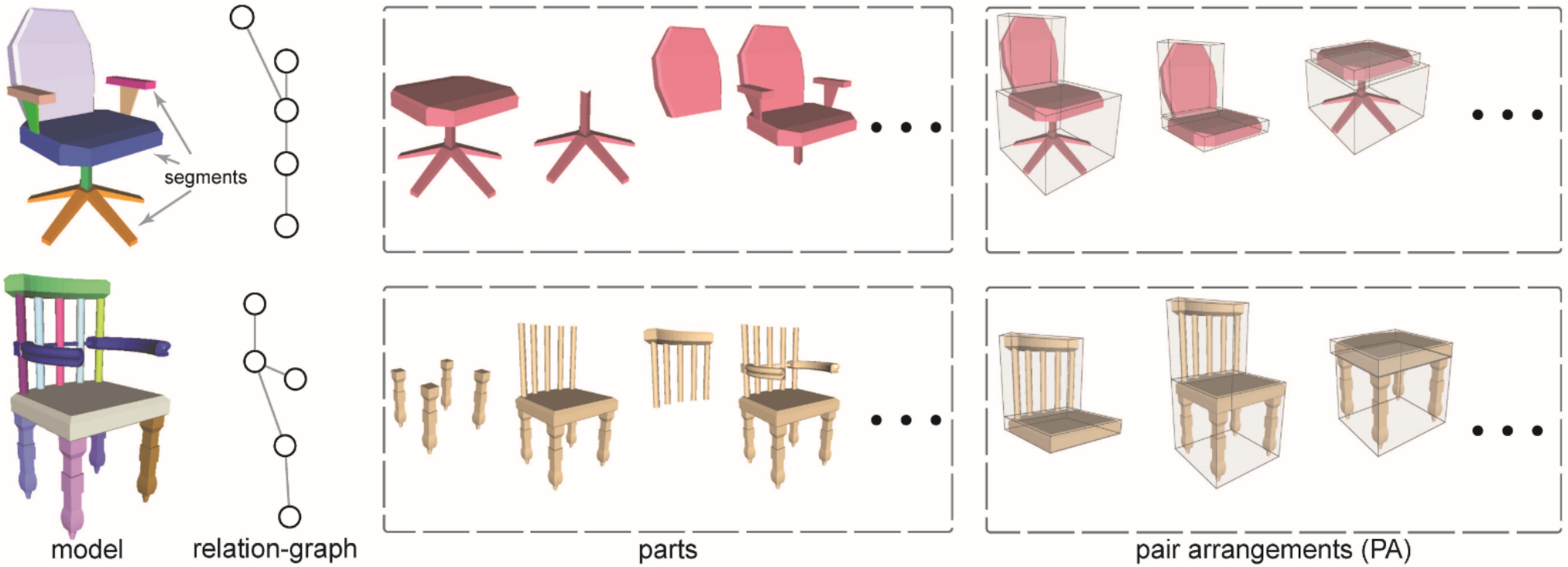


Part Arrangements



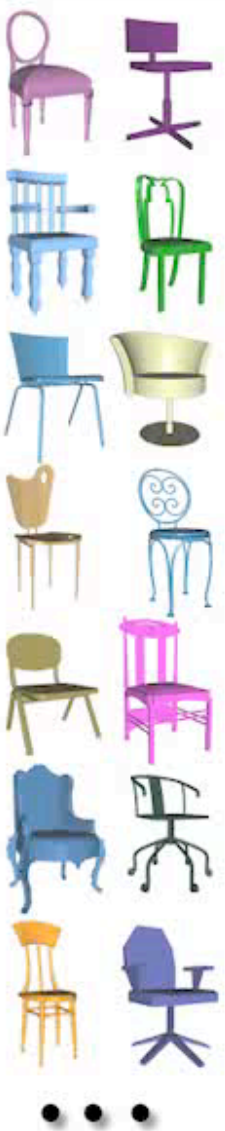
- Components form parts
- Parts from arrangements

Pair Arrangements

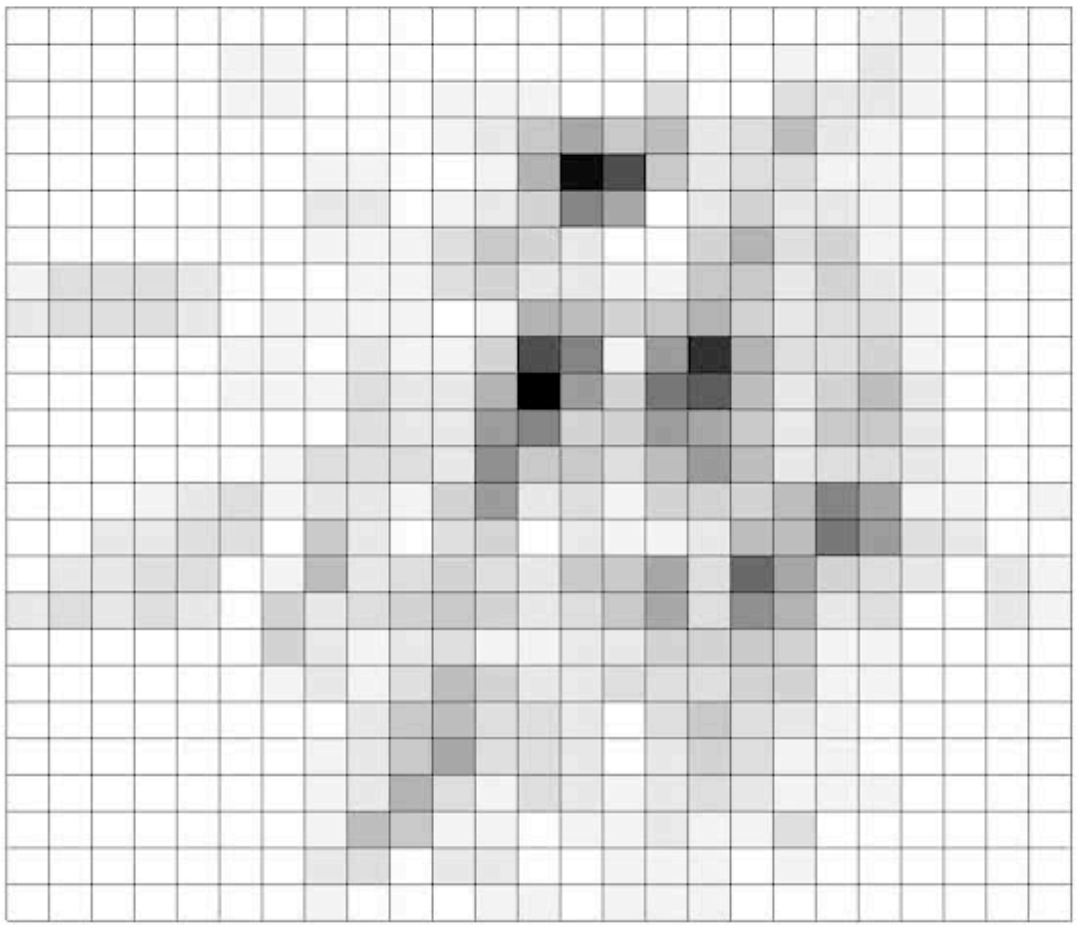


- Components form parts
- Parts from arrangements
- Pair of parts form **pair arrangement** *(PA)*

Arrangements Recur!



# of models = 40



Arrangements Recur!

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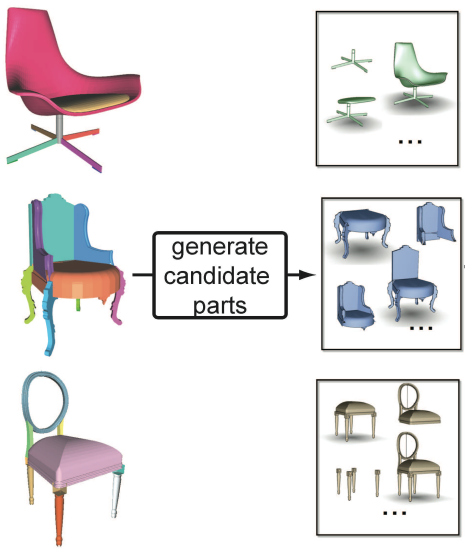
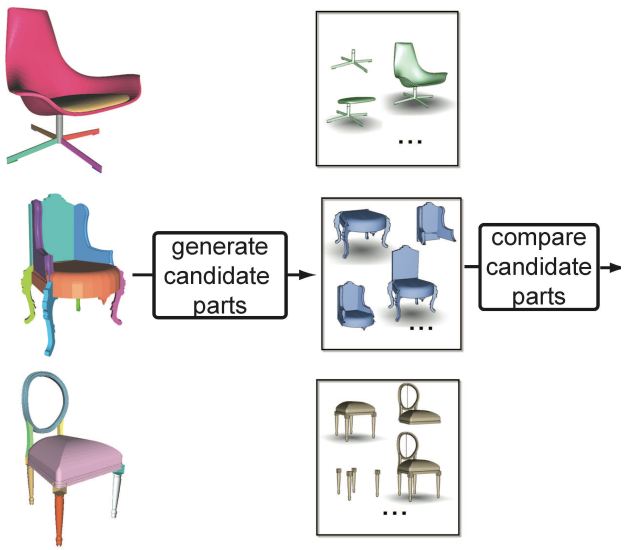
Algorithm



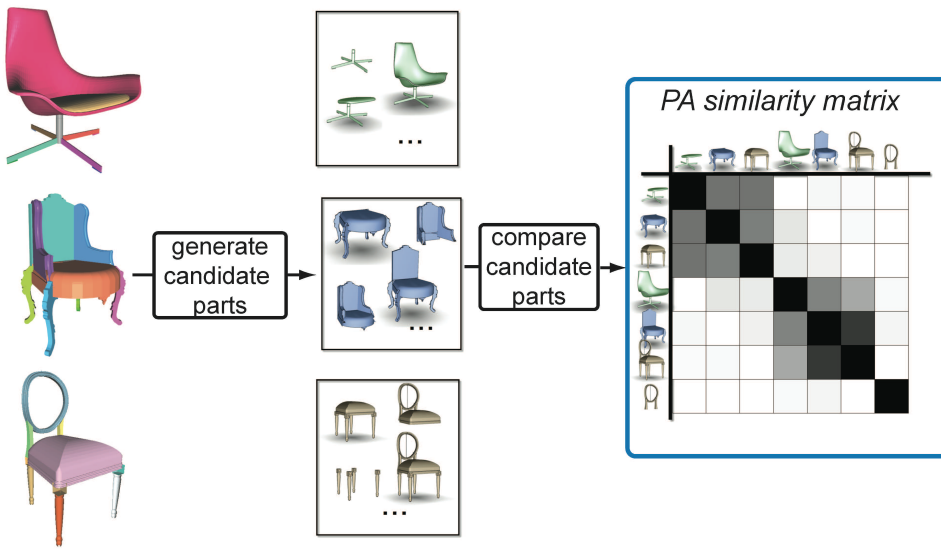
– Candidate *PA*-s generation

Algorithm



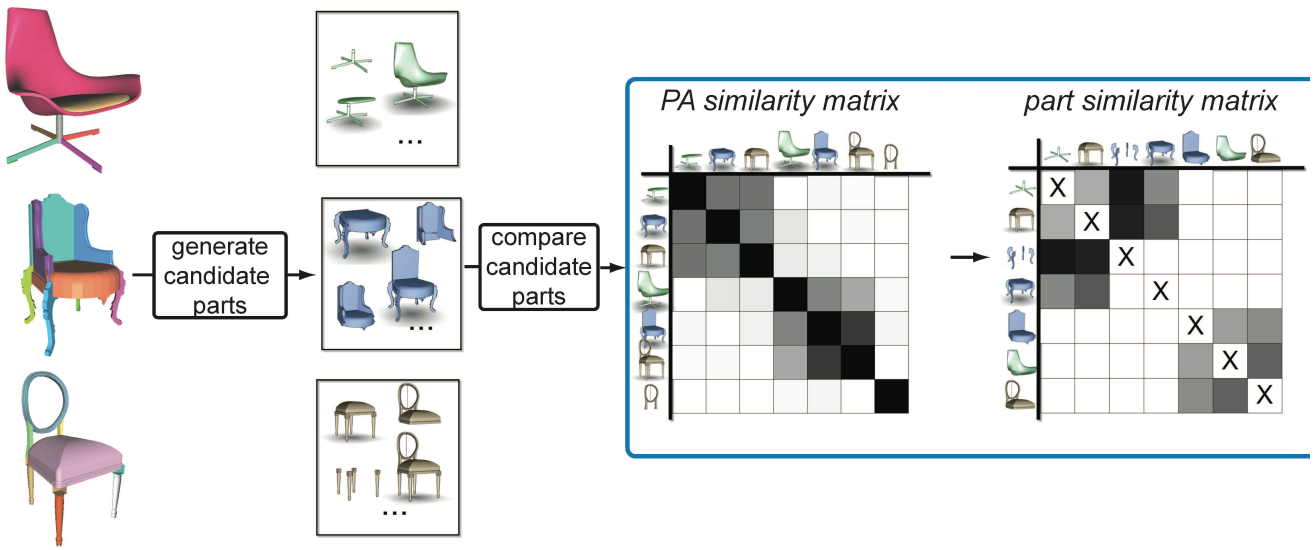
- Candidate *PA*-s generation
- Comparing *PA*-s

Algorithm



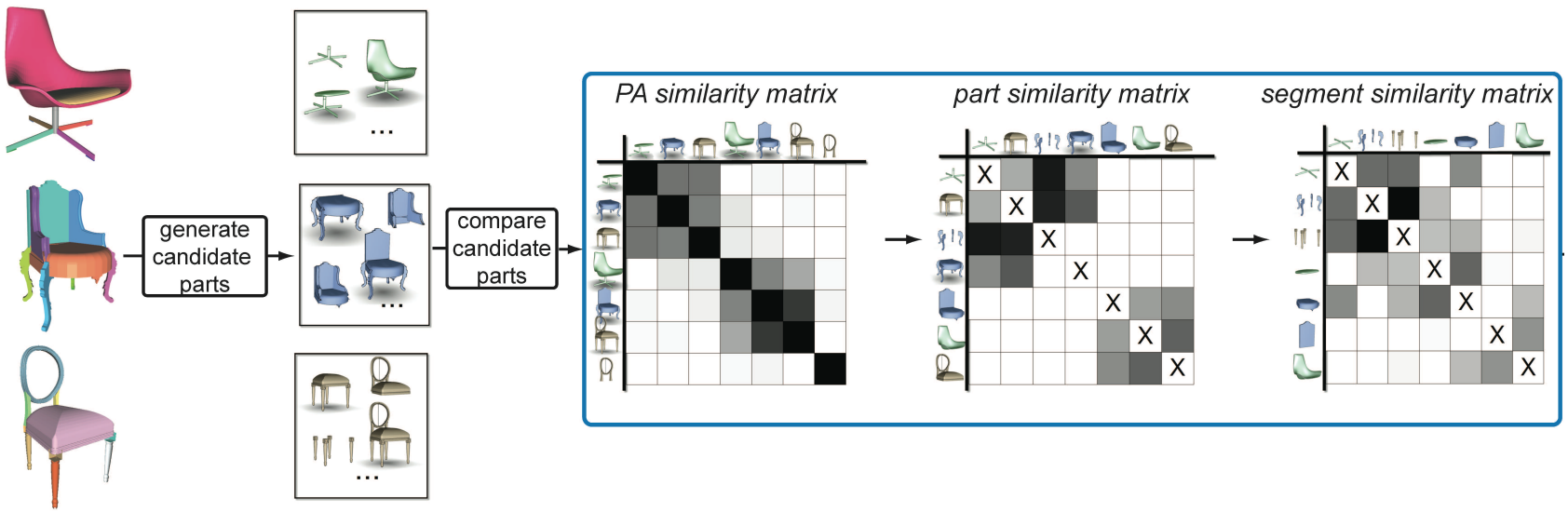
- Candidate *PA*-s generation
- Comparing *PA*-s
  - *PA* similarity matrix (M1)

Algorithm



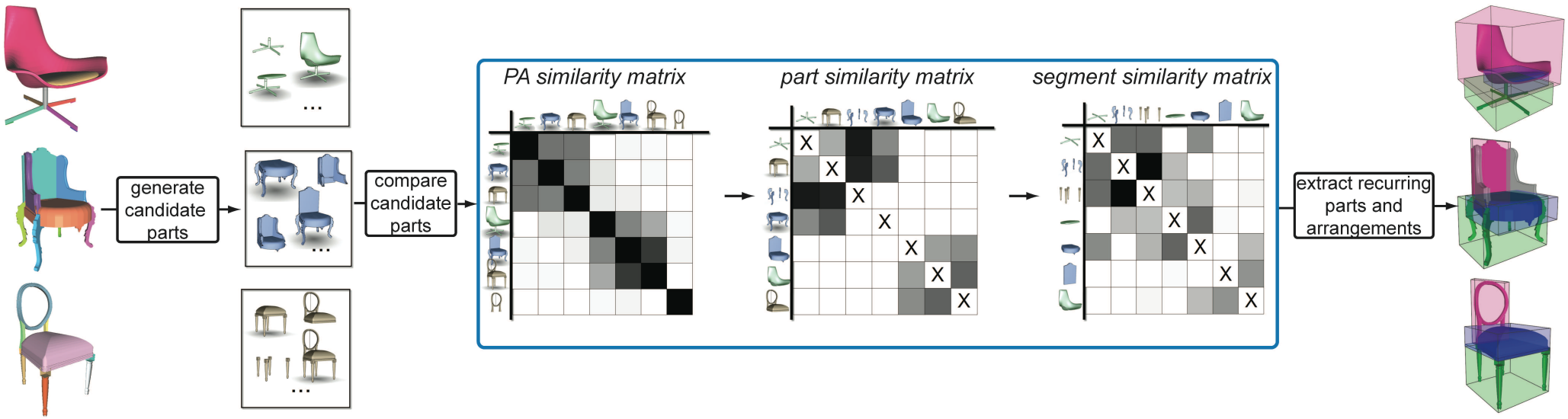
- Candidate *PA*-s generation
- Comparing *PA*-s
  - *PA* similarity matrix (M1)
  - Part similarity matrix (M2)

Algorithm



- Candidate *PA*-s generation
- Comparing *PA*-s
  - *PA* similarity matrix (M1)
  - Part similarity matrix (M2)
  - Component similarity matrix (M3)

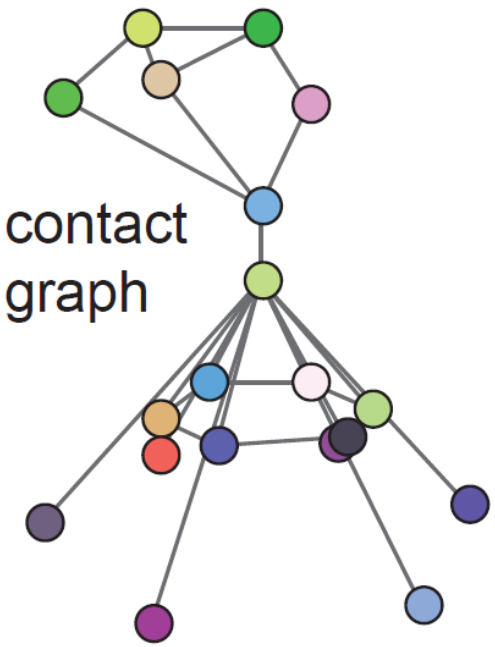
Algorithm



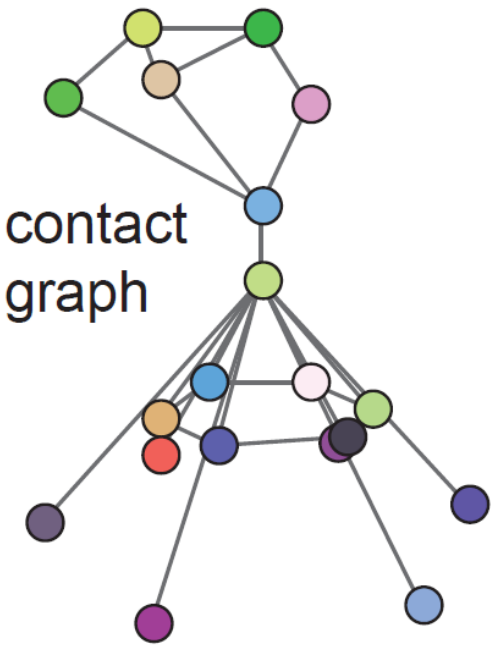
- Candidate *PA*-s generation
- Comparing *PA*-s
  - *PA* similarity matrix (M1)
  - Part similarity matrix (M2)
  - Component similarity matrix (M3)
- Recurring Arrangements Extraction

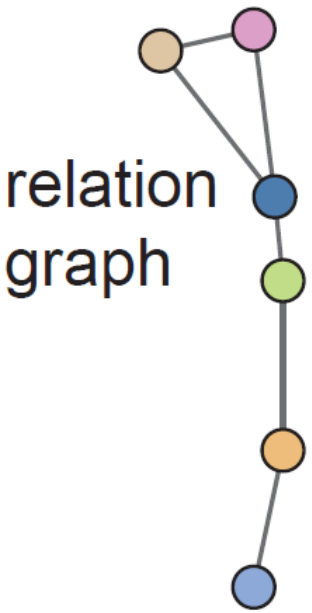
Relation Graph

Relation Graph

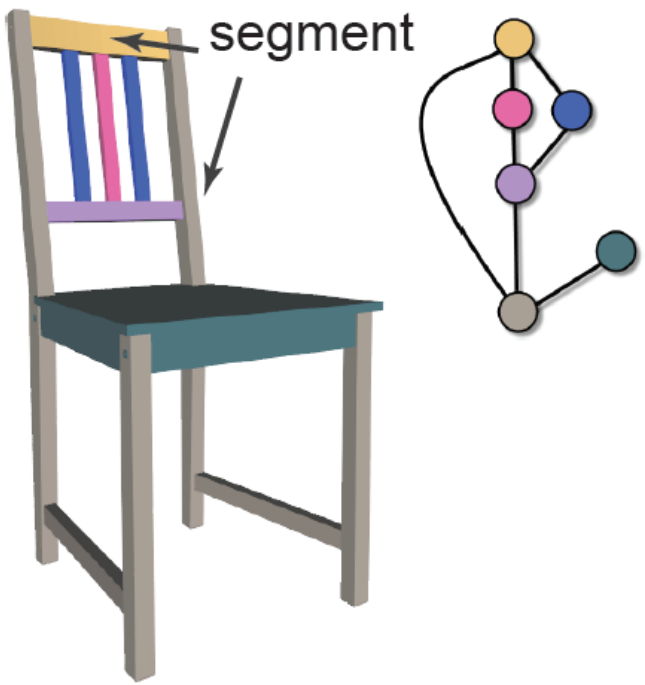


Relation Graph

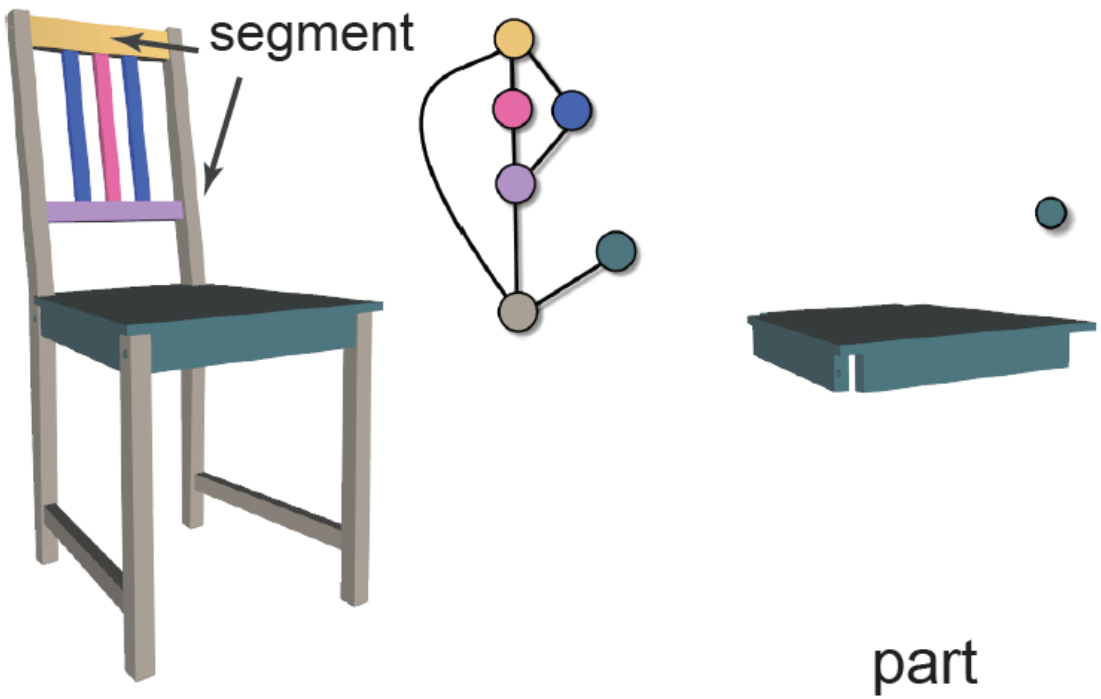




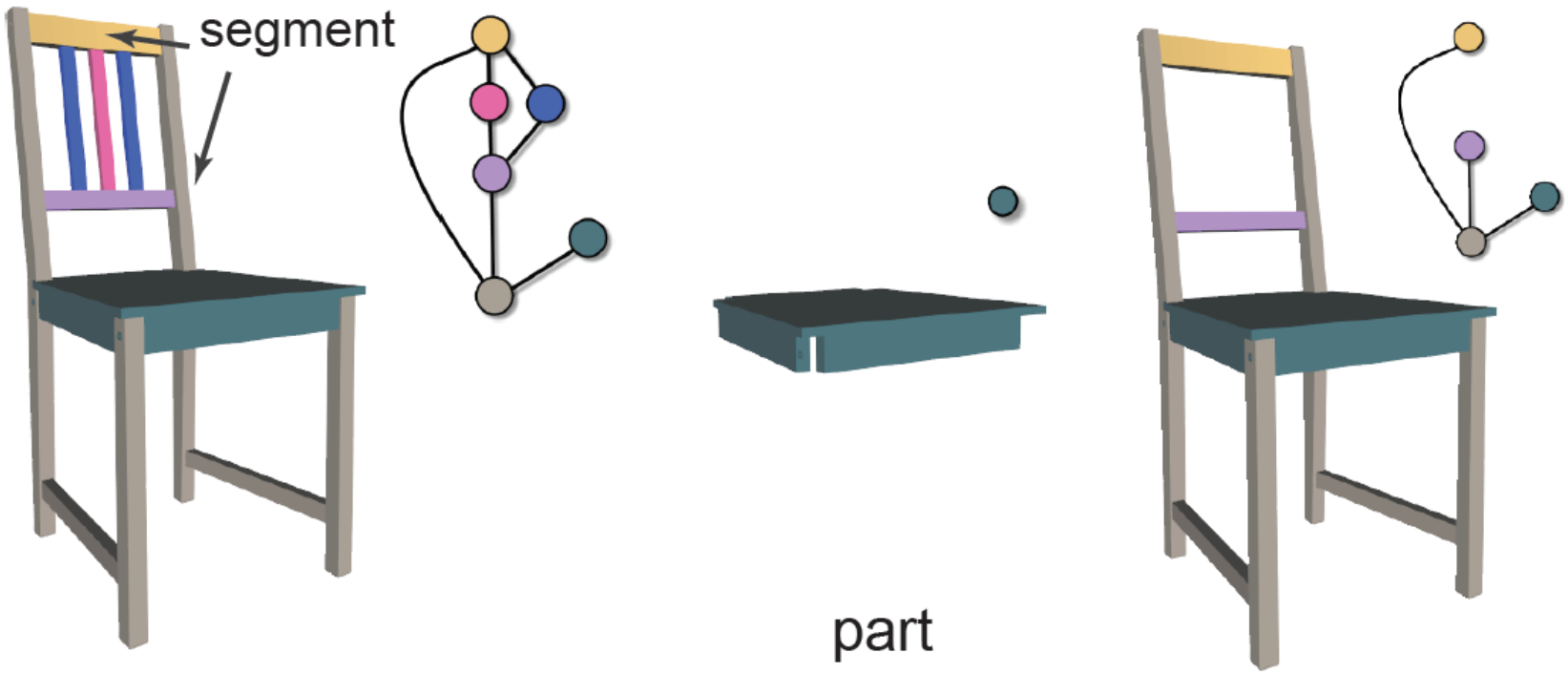
What are Valid Parts?



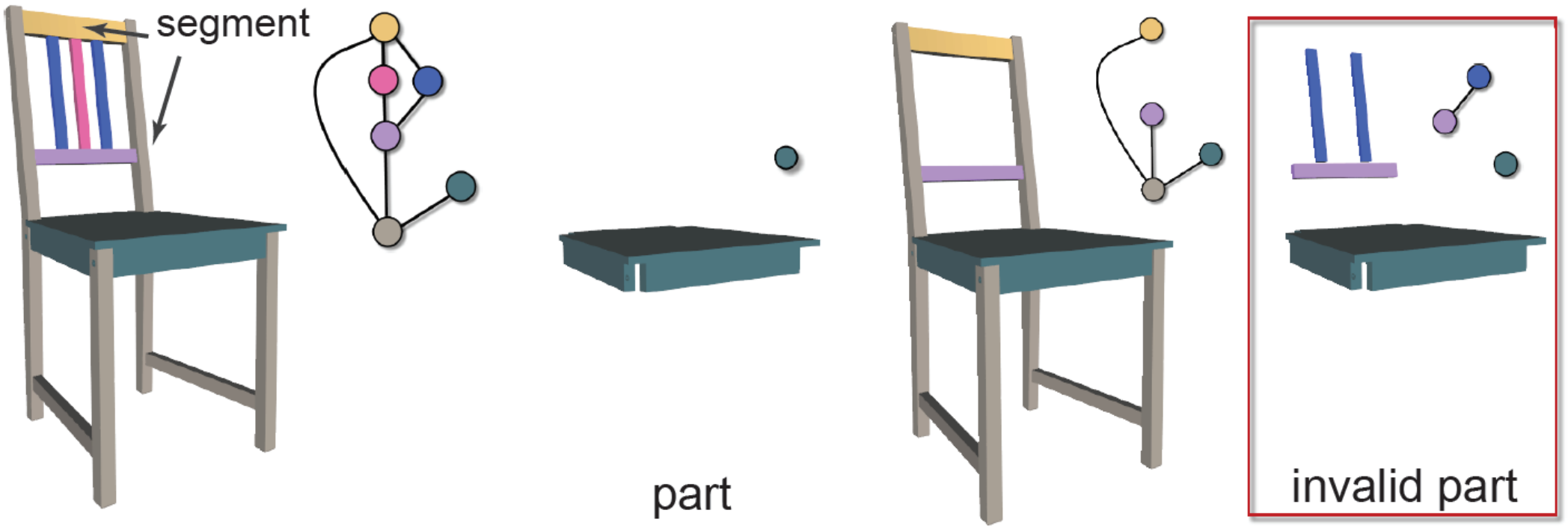
What are Valid Parts?



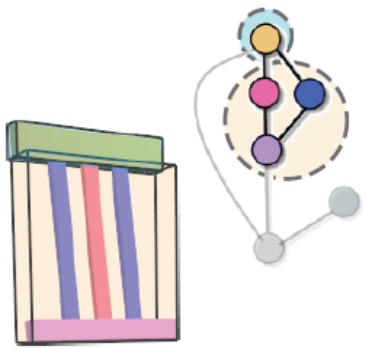
What are Valid Parts?

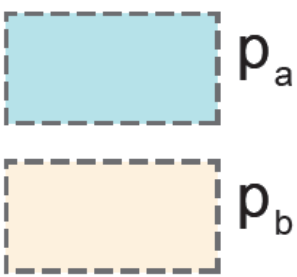


What are Valid Parts?



What are Valid Part Pairs?





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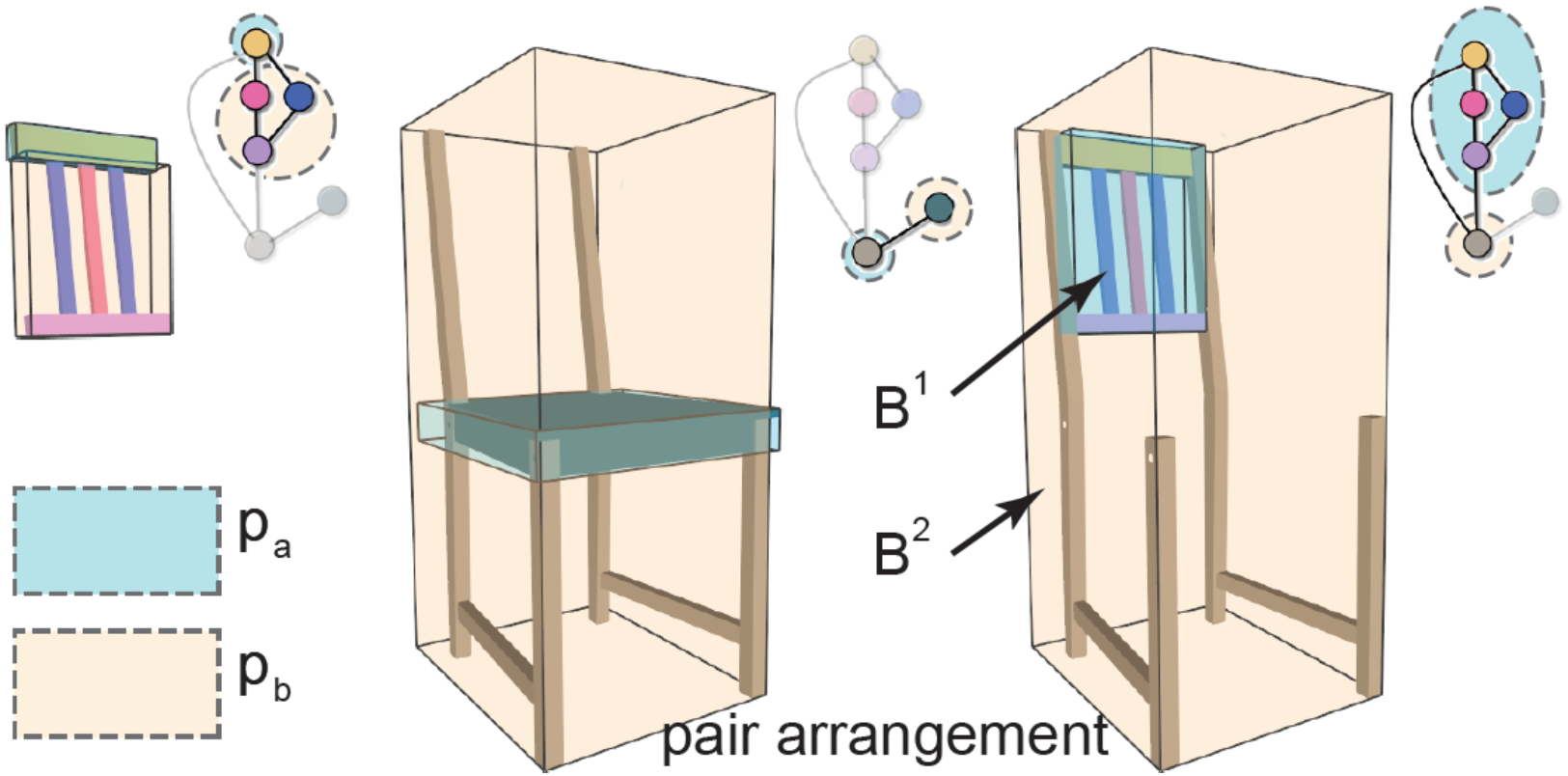

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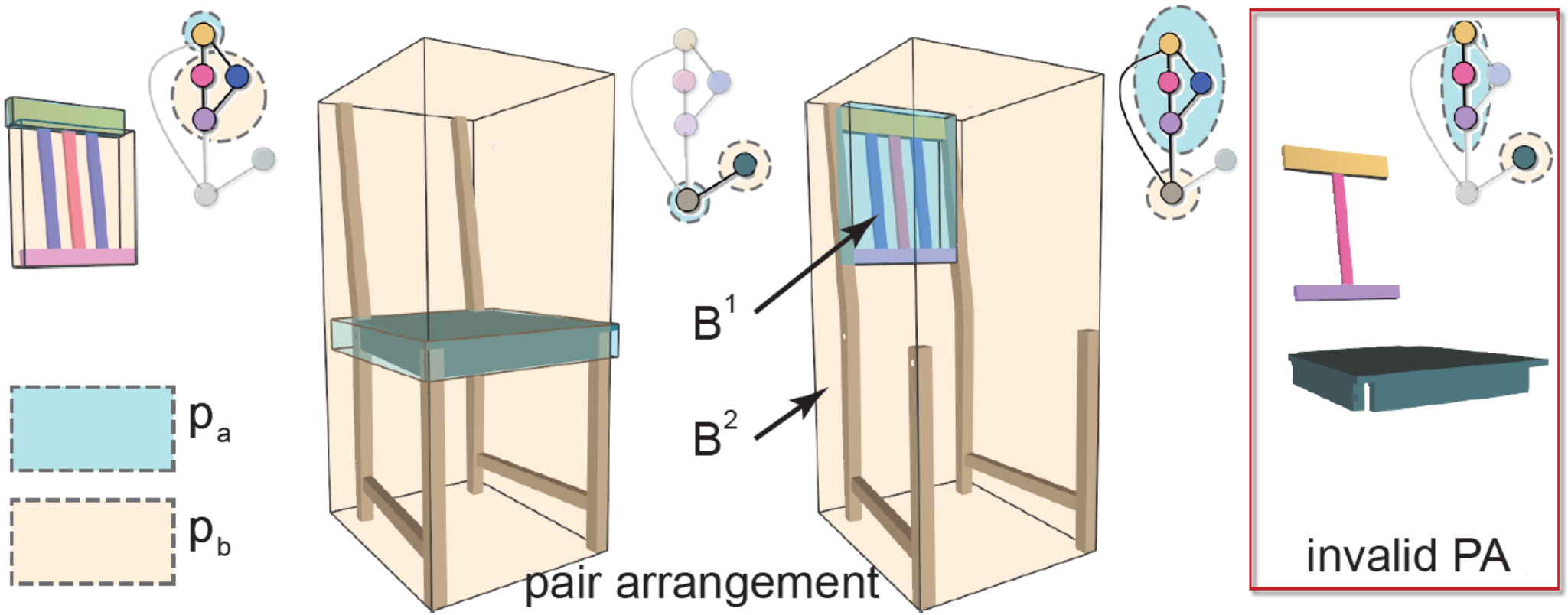
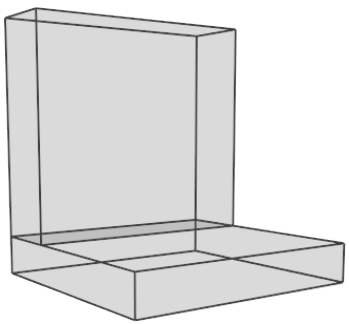
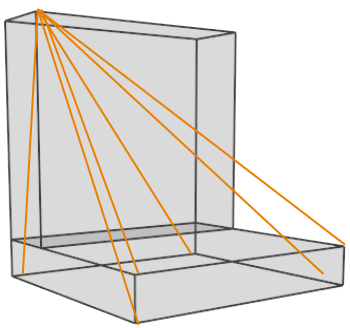


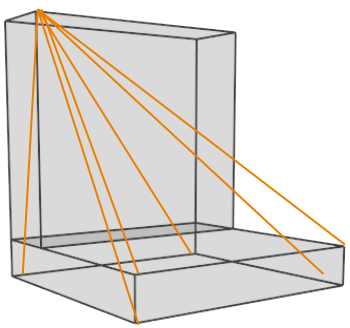
Comparing PA-s



Comparing PA-s

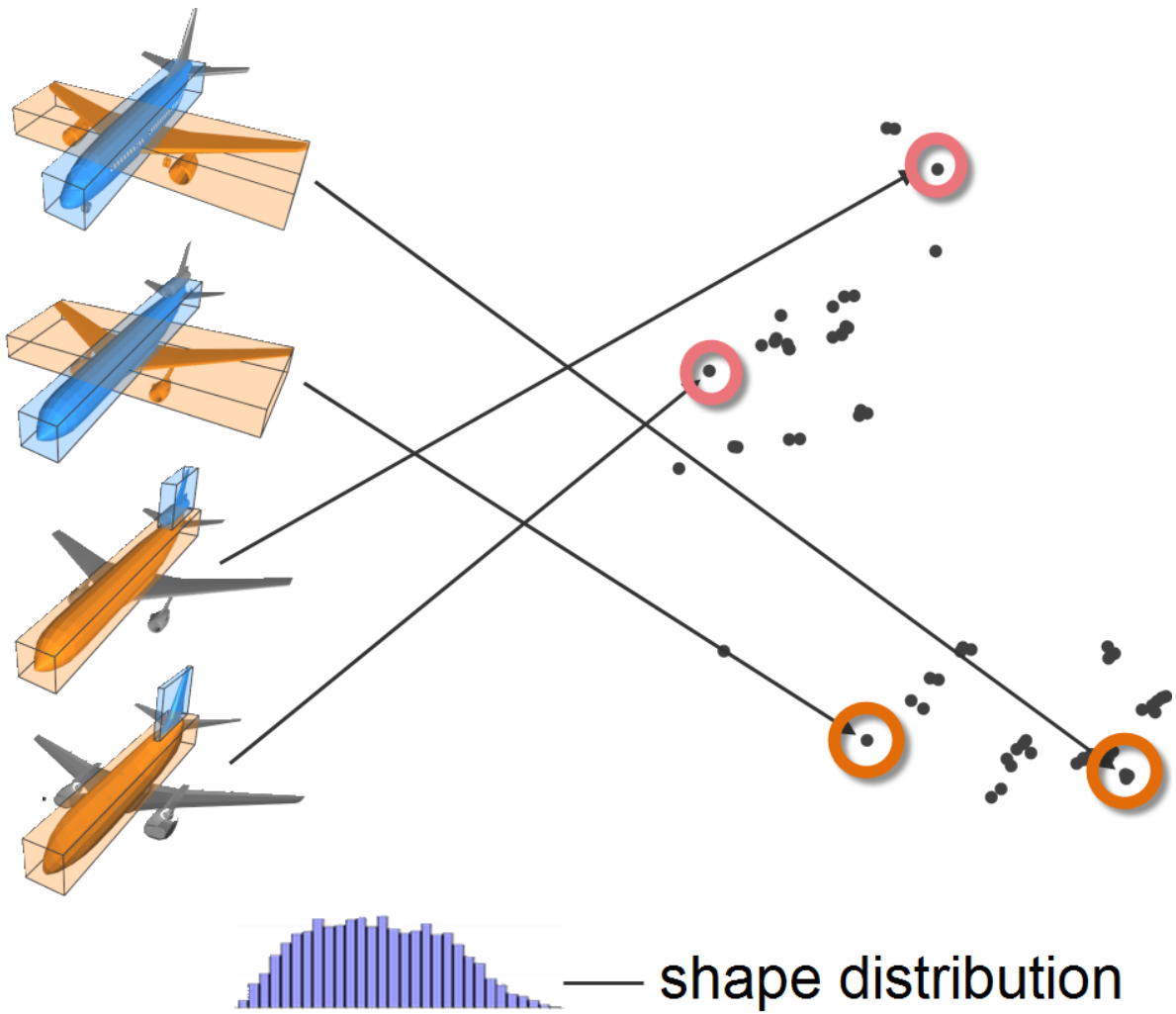


Comparing PA-s

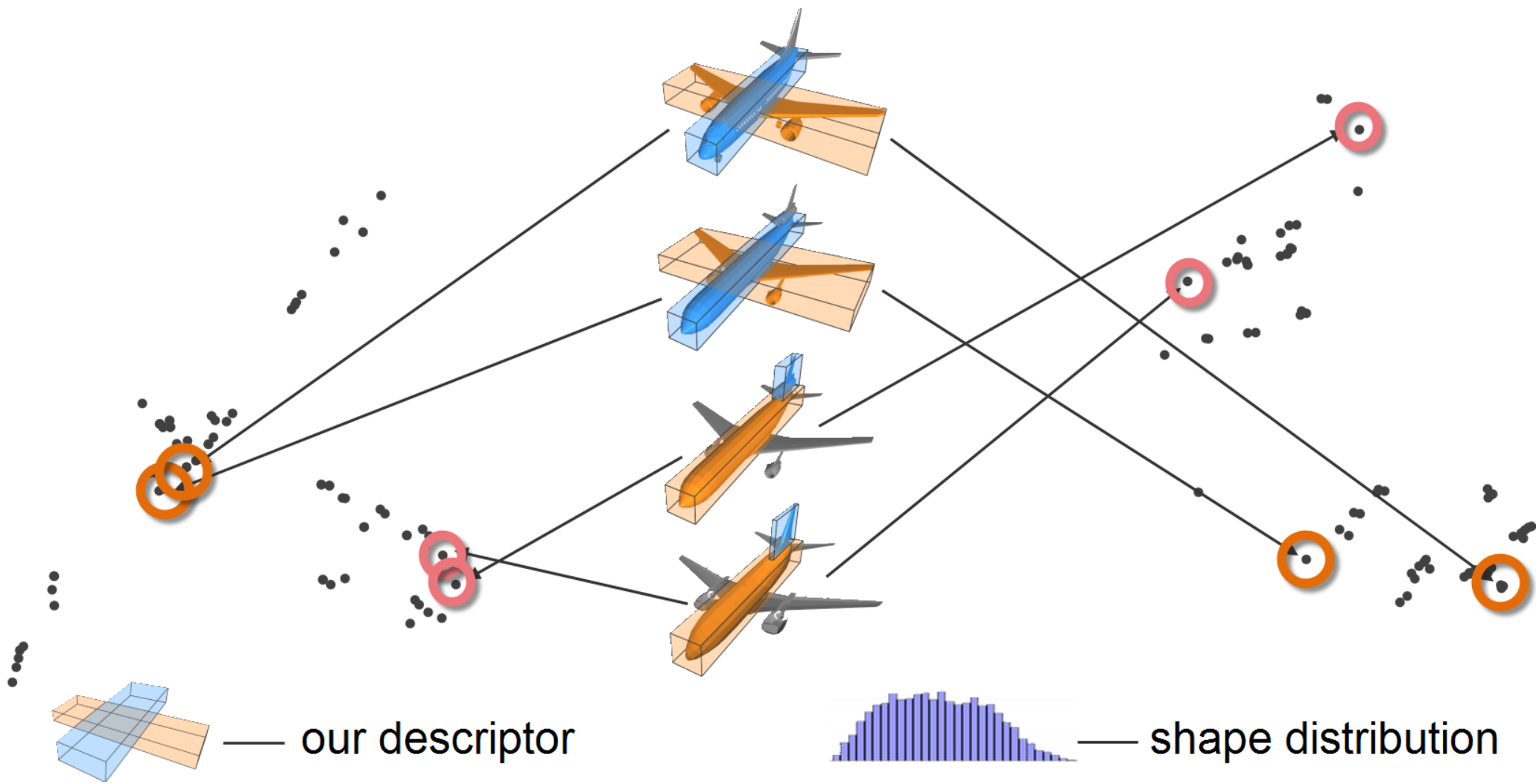


$$\mathcal{S}(s_{ab}) := \{\|\mathbf{v}_i(B^1) - \mathbf{v}_j(B^2)\|\}$$

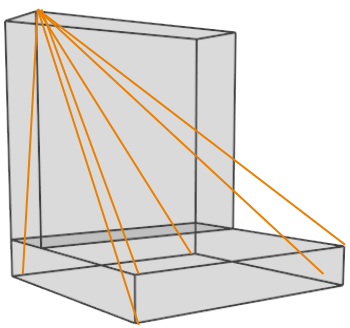
Comparing Arrangements



Comparing Arrangements



PA Similarity Matrix



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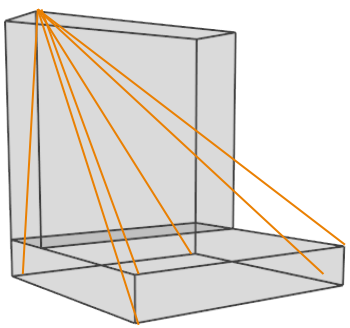

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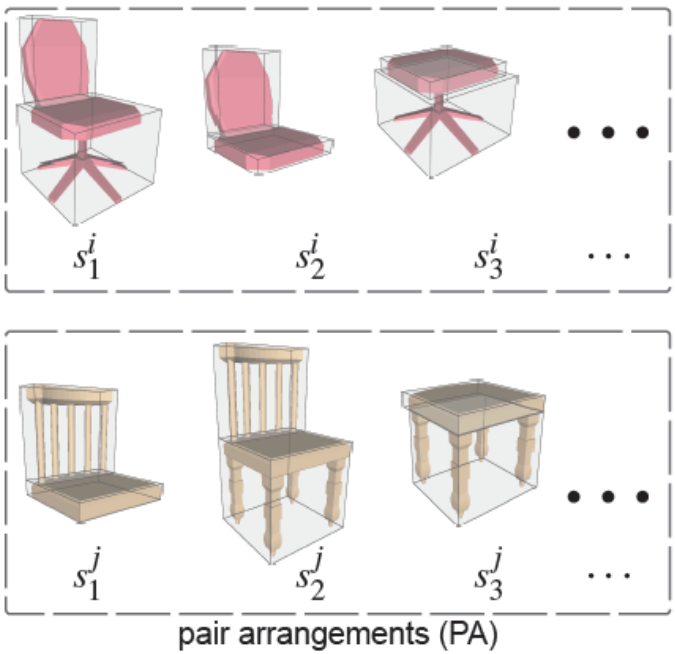
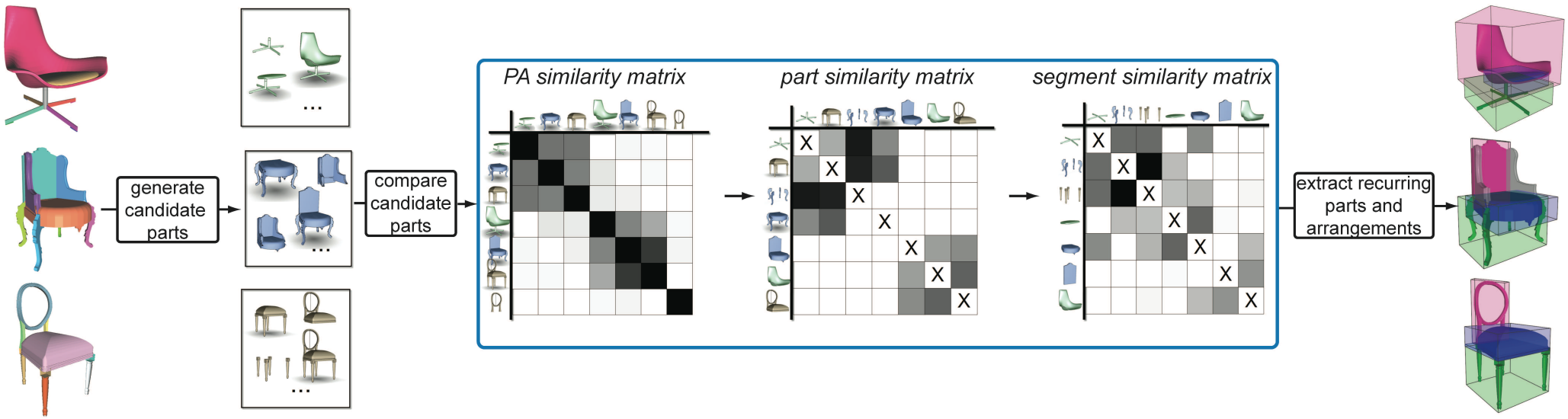


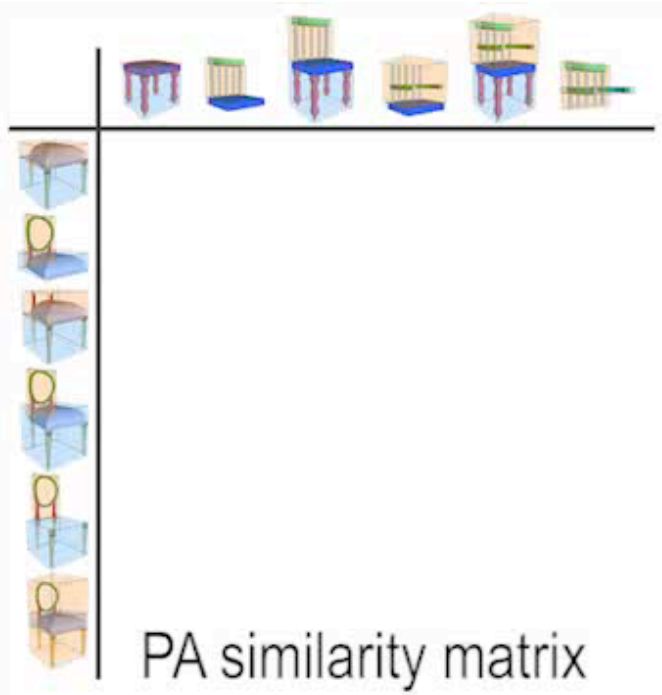
	s_1^i	s_2^i	s_3^i
s_1^j	0.064	0.829	0.002
s_3^j	0.006	0.004	0.802
s_2^j	0.812	0.184	0.013

Algorithm



- Candidate *PA*-s generation
- Comparing *PA*-s
  - *PA* similarity matrix (M1)
  - Part similarity matrix (M2)
  - Component similarity matrix (M3)
- Recurring Arrangements Extraction

PA ⇨ Part Similarity



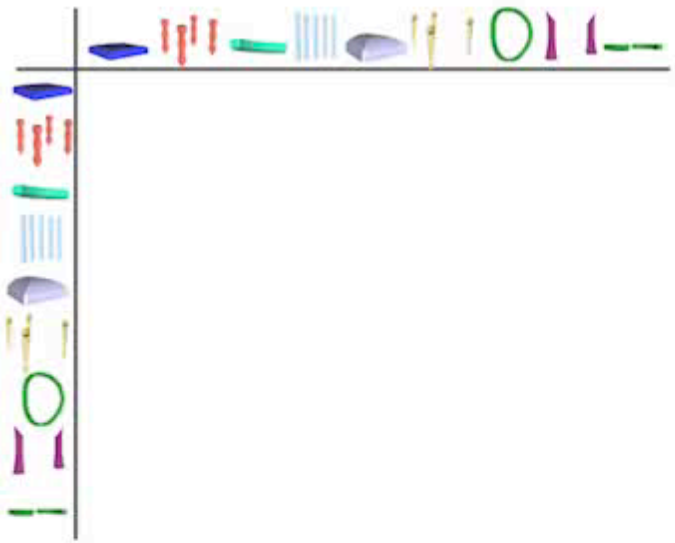
PA ⇨ Part Similarity

Part ⇨ Segment Similarity

Part ⇨ Segment Similarity

Extracting Recurring PAs

Extracting Recurring PAs



Final Step: Part Selection

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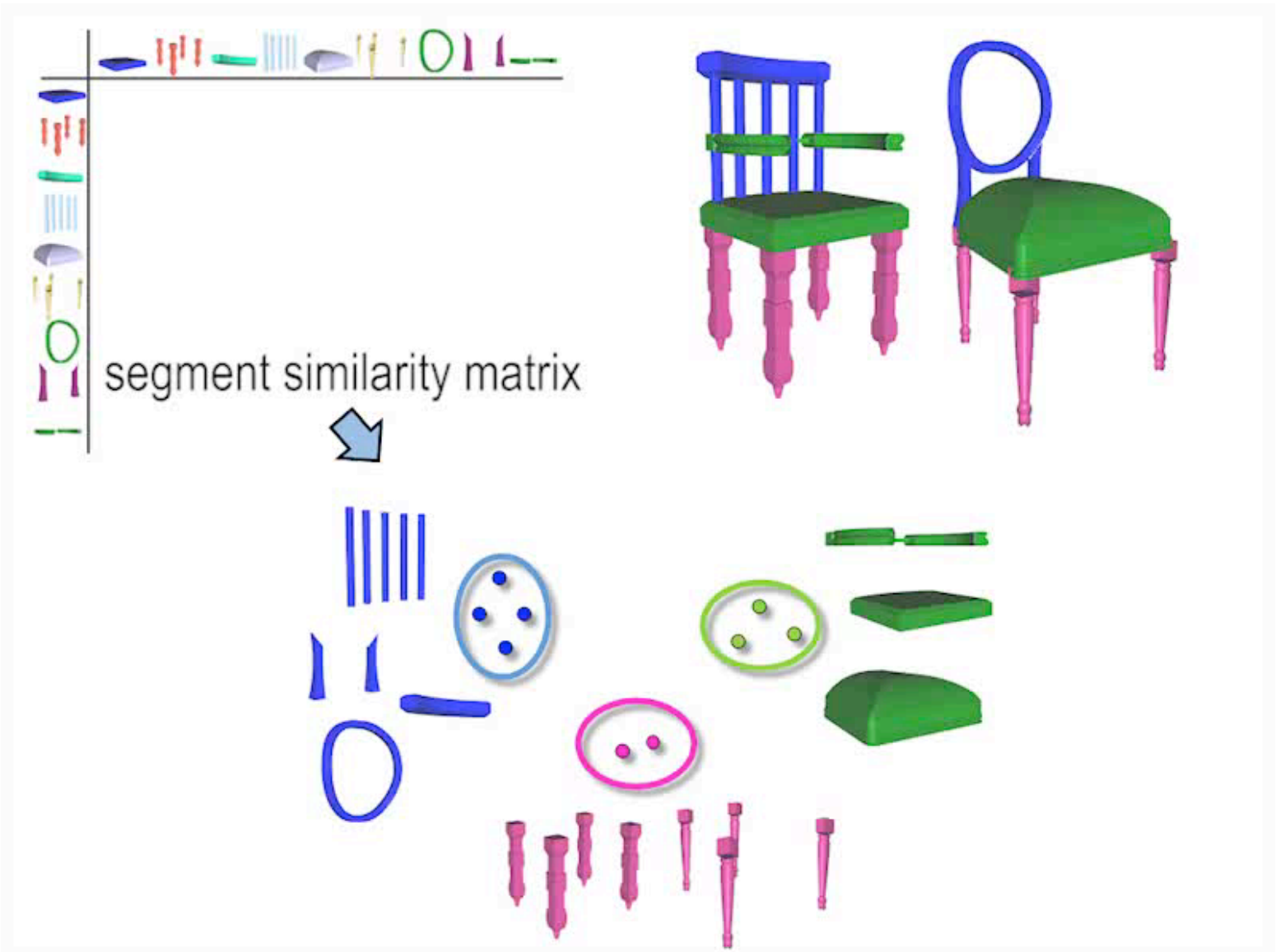
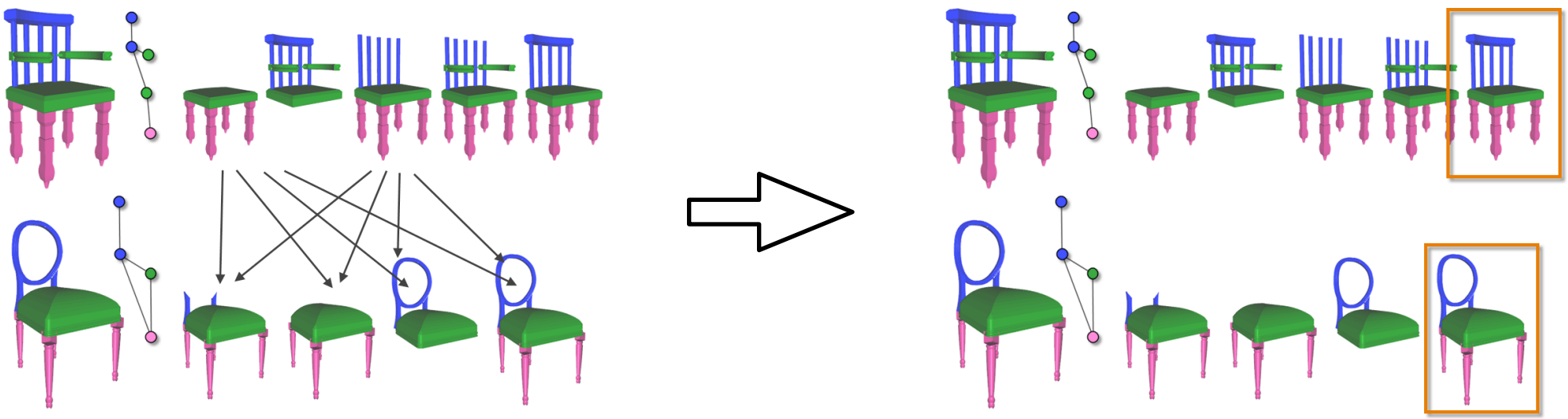


MRF-based Labelling Problem



$$\{l_i\}^\star := \arg\min_{\{l_i\}} \sum E(M_i \to l_j^k) + \sum_{i,j} E(M_i \to l_i^k, M_j \to l_j^l)$$

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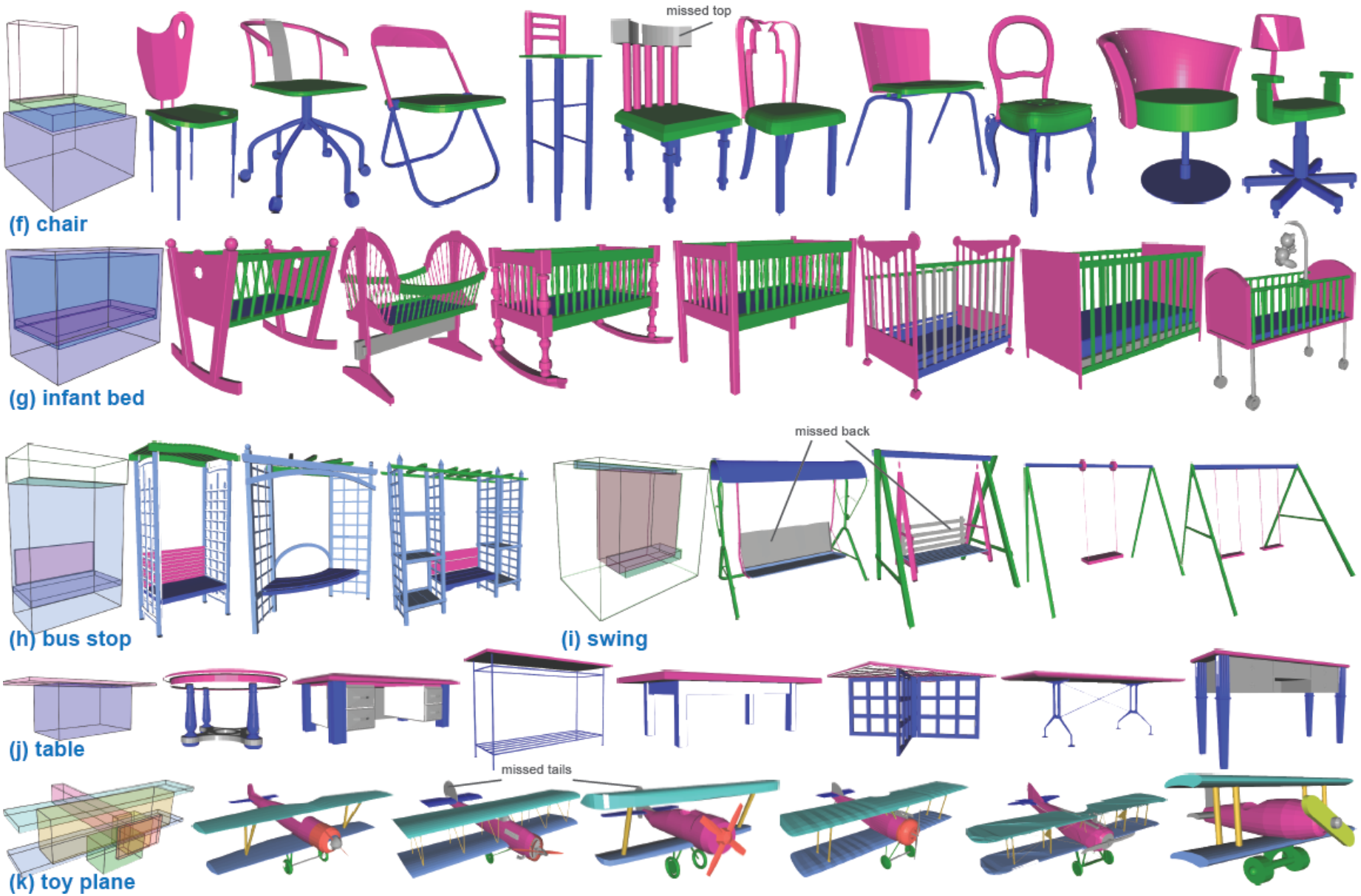
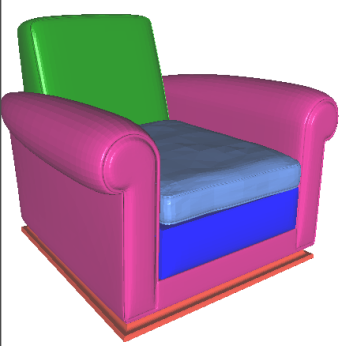
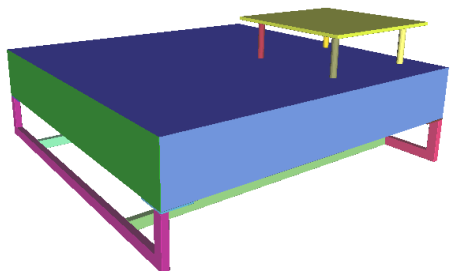
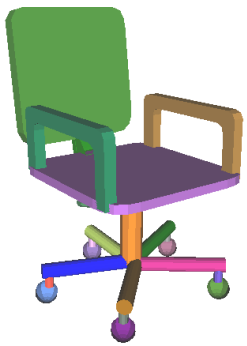
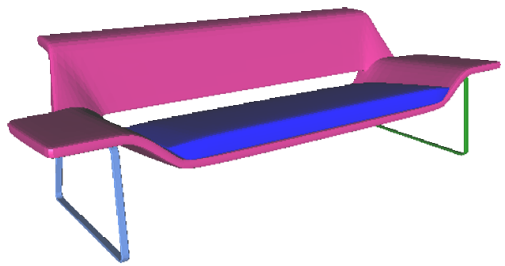
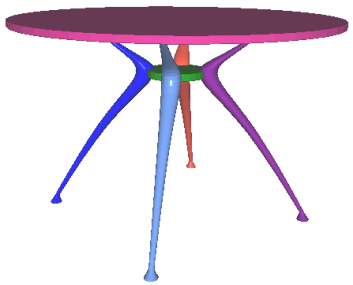
- Limitations and Future work

Results

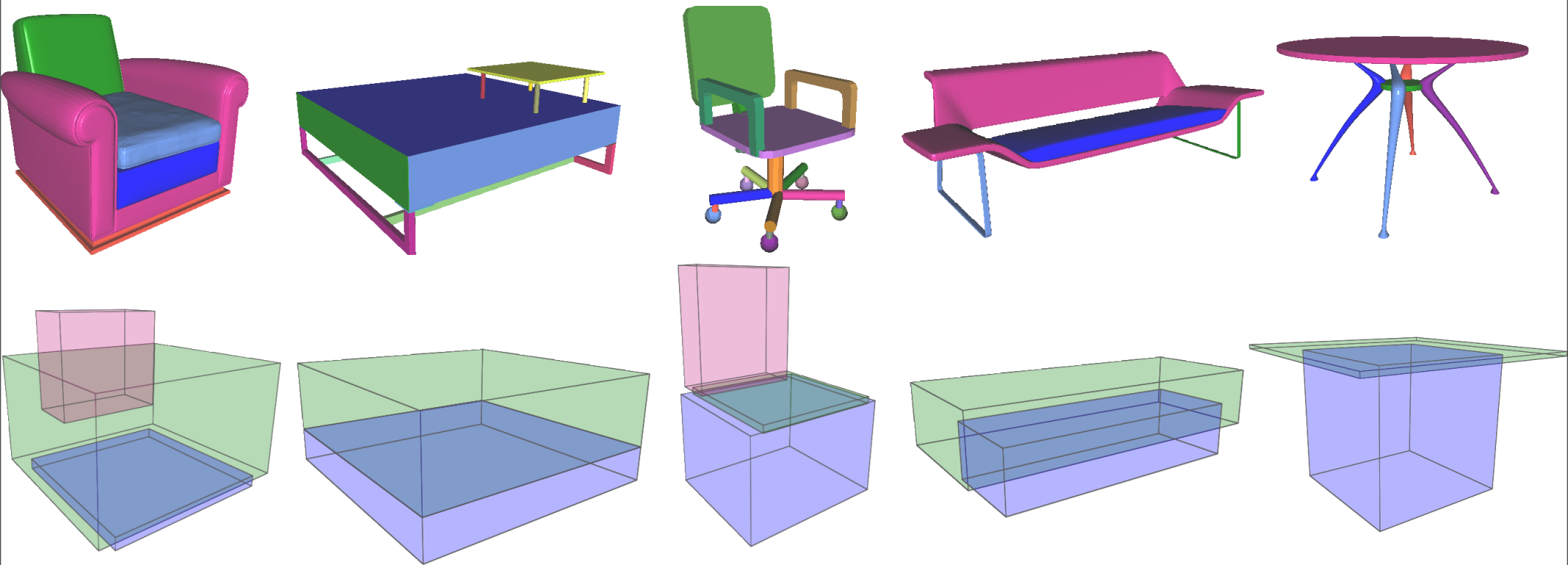
Further Results



Mixed Models

Mixed Models



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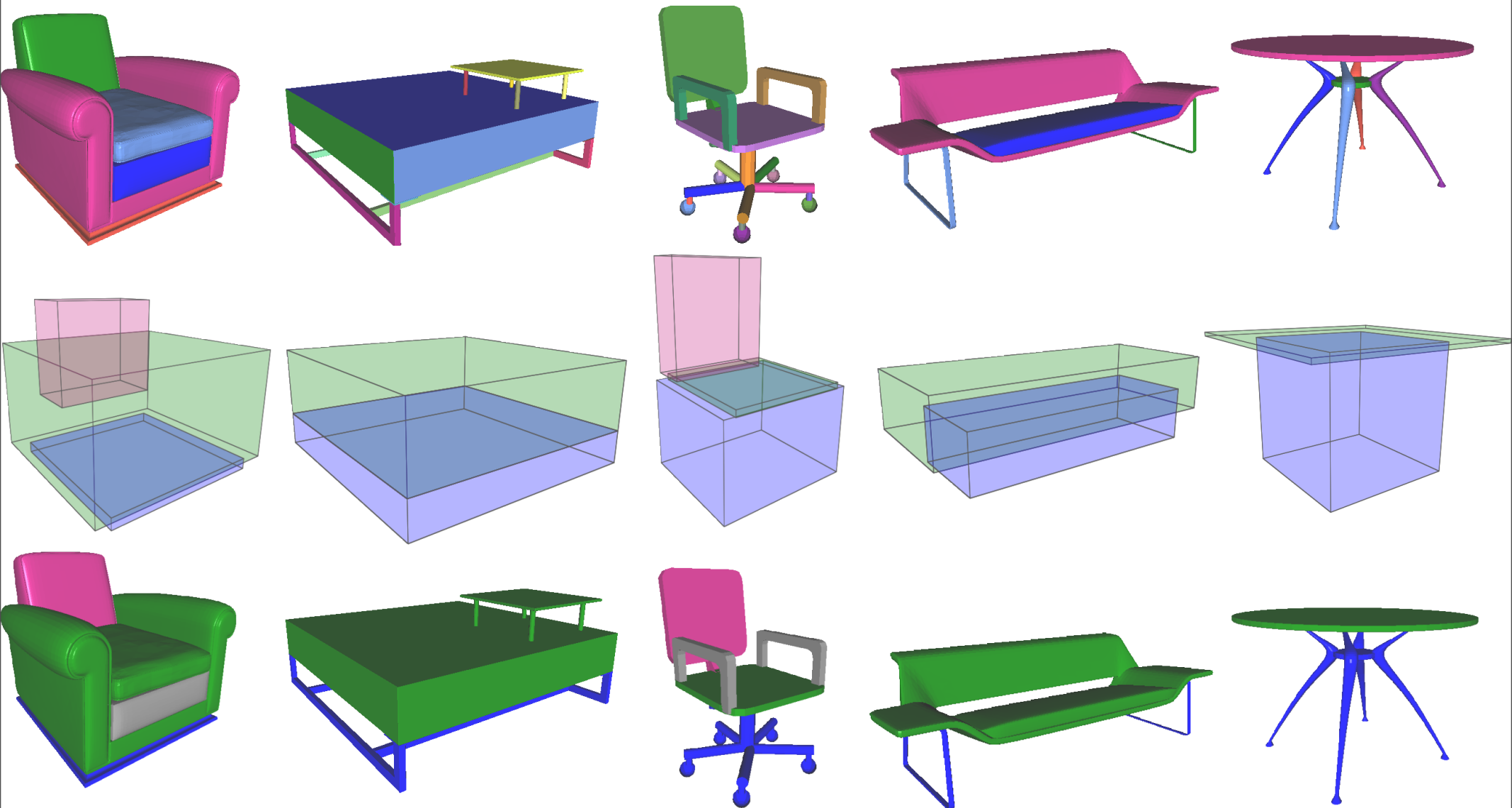
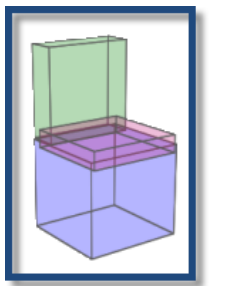


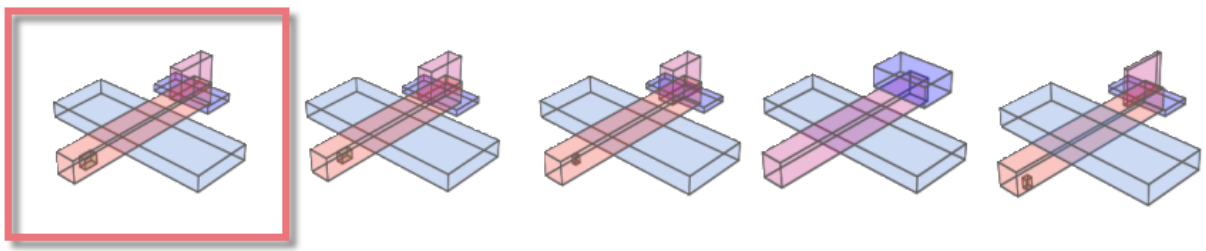
Comparison

Class	Kim'13	Wang'12	Hu'12	Huang'12	ours
chair	0.59	0.69	0.30	0.83	0.96
bed	0.25	0.27	×	0.65	0.91
inf. bed	0.53	0.36	0.61	0.37	0.71
airplane	0.52	0.36	×	0.58	0.94

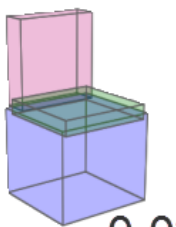
Stability of Abstractions



0.00



0.00 0.01 0.02 0.05 0.003



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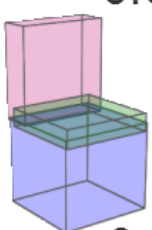

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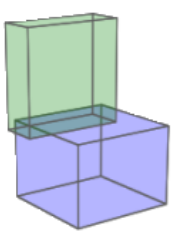

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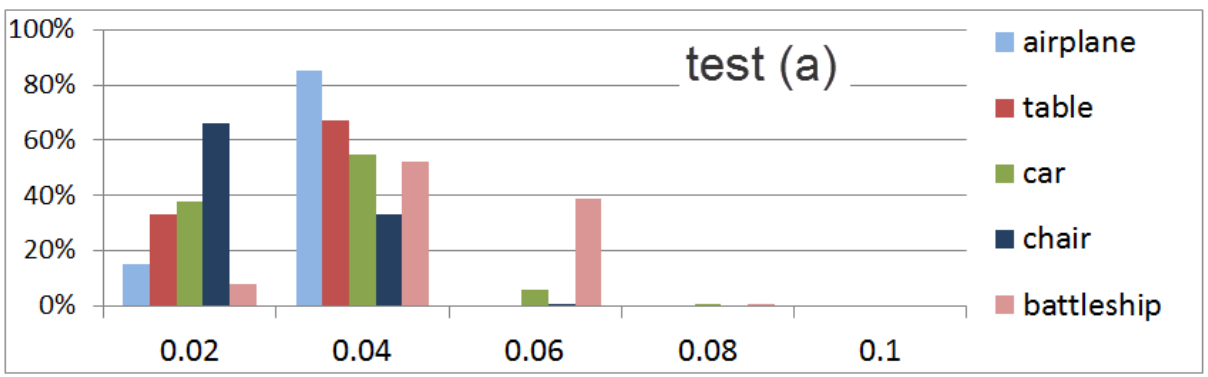

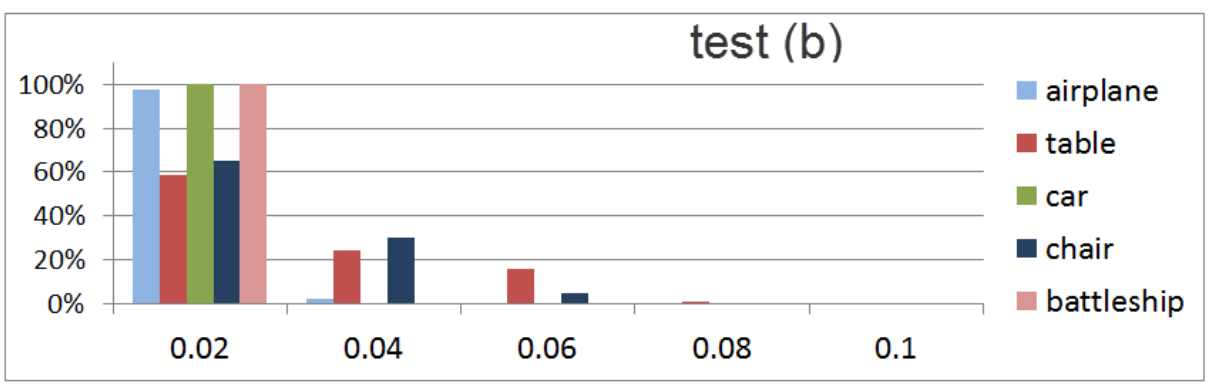

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Summary and Future Work

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- **Arrangements** relates to shape design and functionalities
  - How parts are *arranged*?
  - How parts *interact*?

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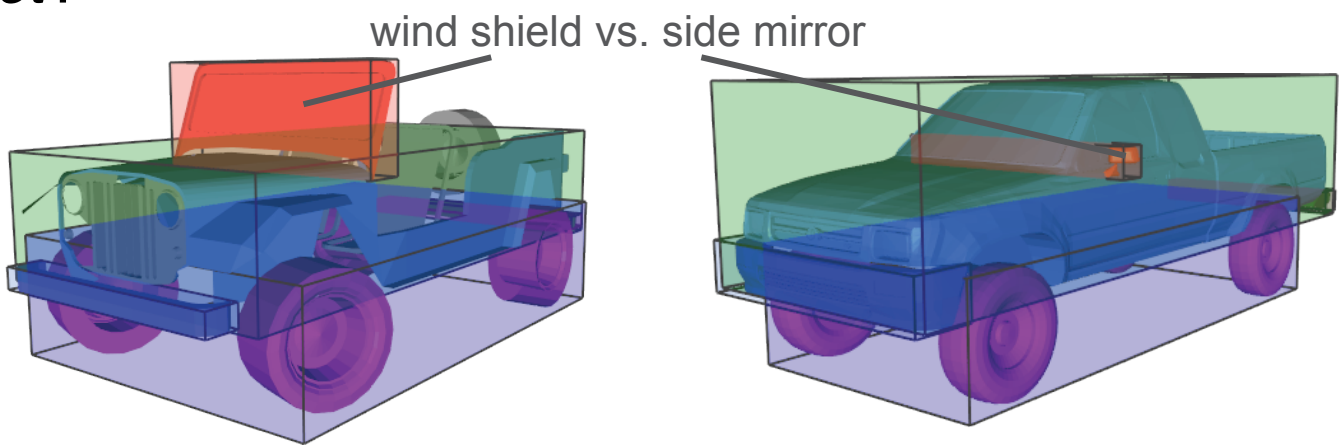

Summary and Future Work

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  - How parts are *arranged*?
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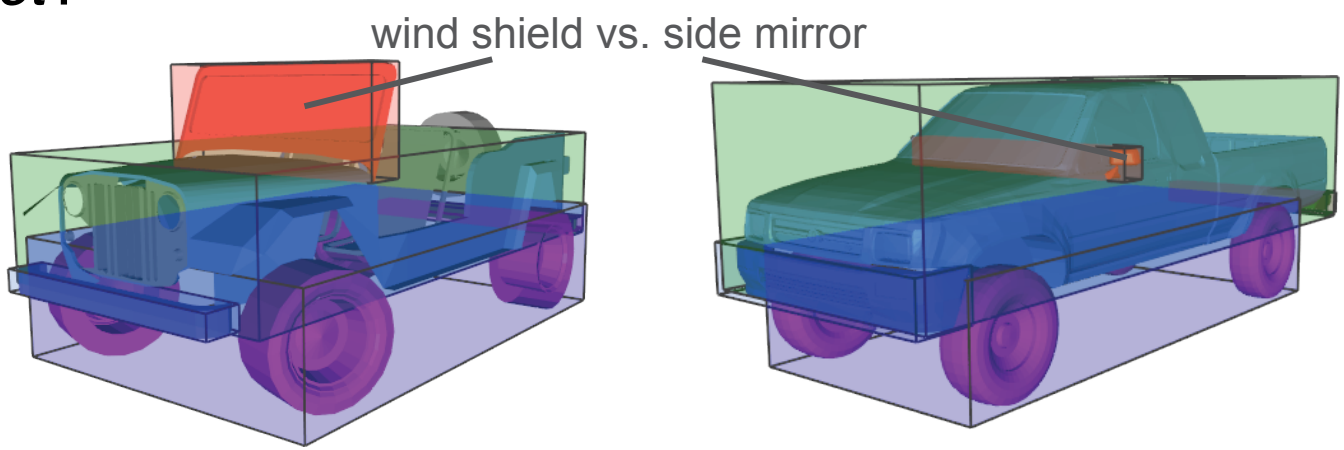


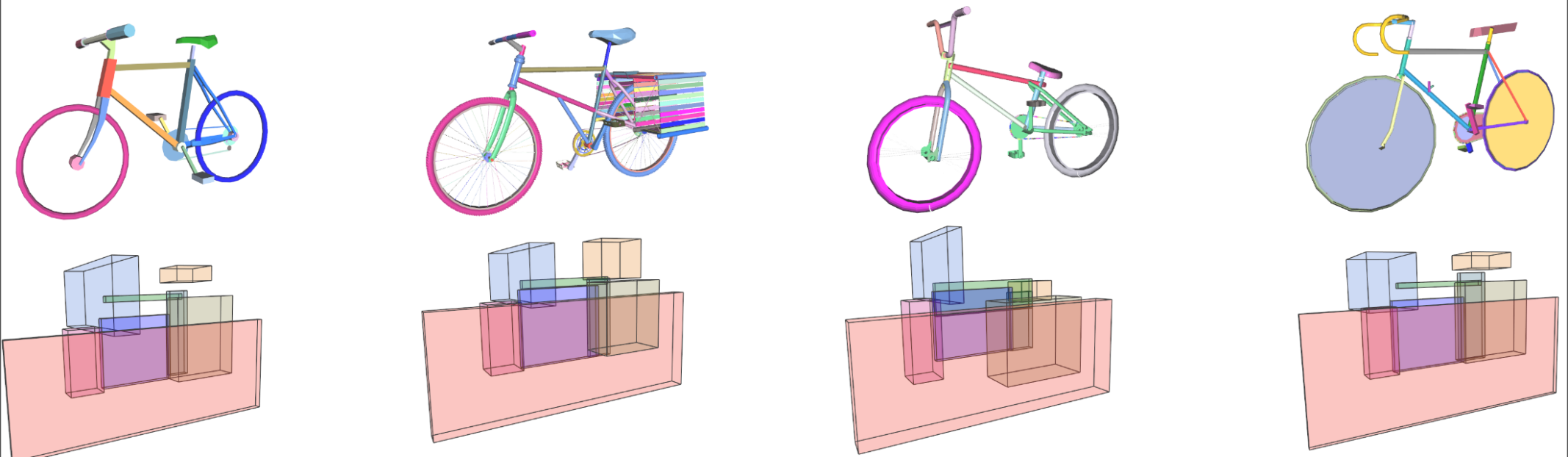
– Beyond **pairwise arrangements**?
  - Structural invariant
  - Pattern relations across shape families

Acknowledgements

- Maks Ovsjanikov
- Qixing Huang
- Vladimir Kim
- Ligang Liu
- Bongjin Koo
- Charlotte Rakhit (video voiceover)

- Marie Curie CIG

Thank You!!



http://geometry.cs.ucl.ac.uk/

(code + data available)