

Manipulating Structures

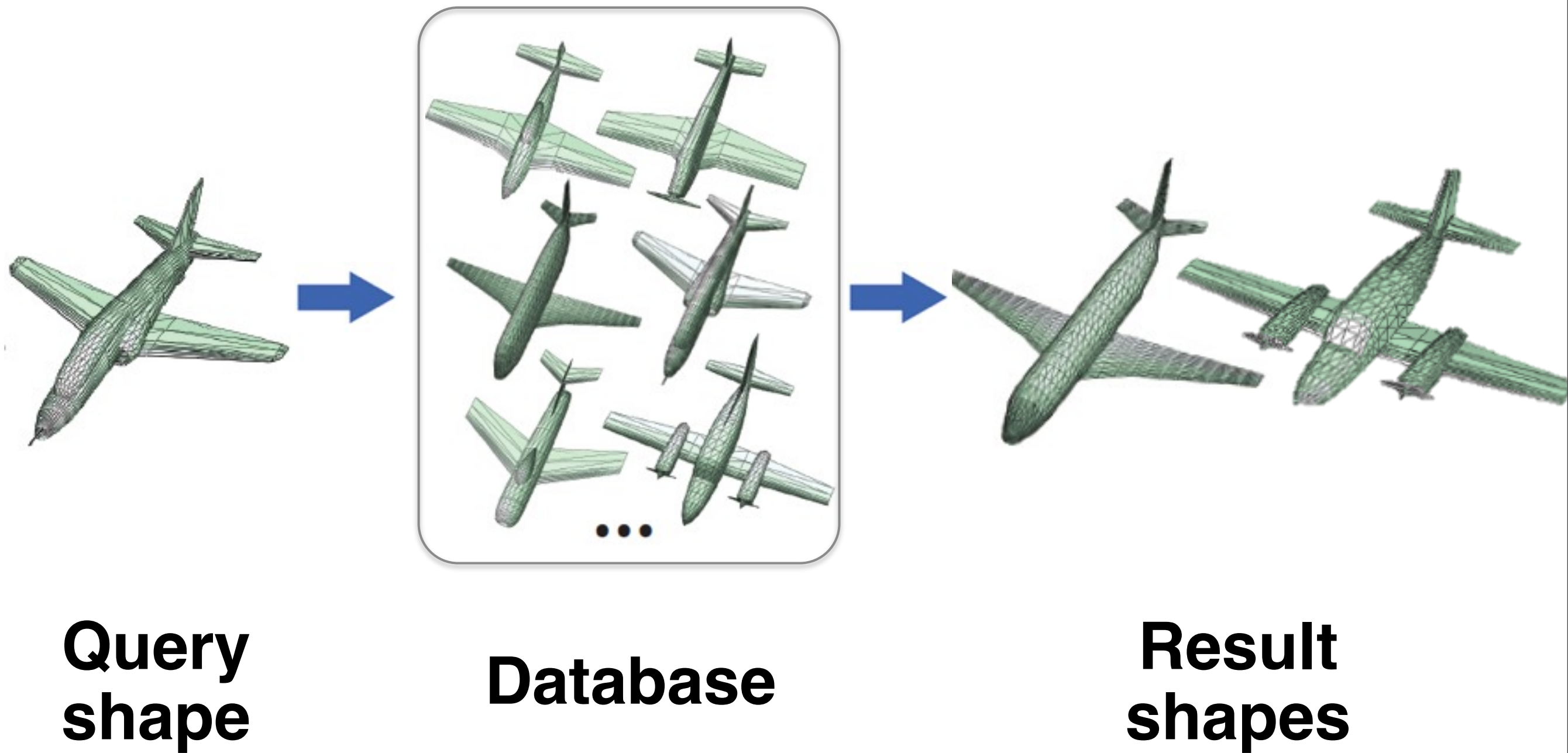
Organization and Exploration of Shape Collections

How to Organize Data

How to Organize Data

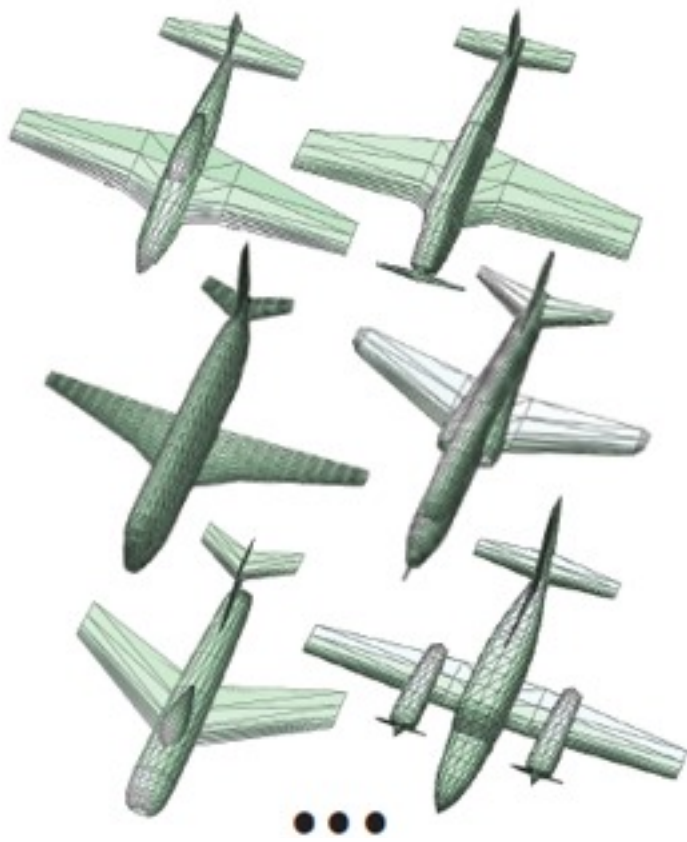


Retrieval-Based Exploration

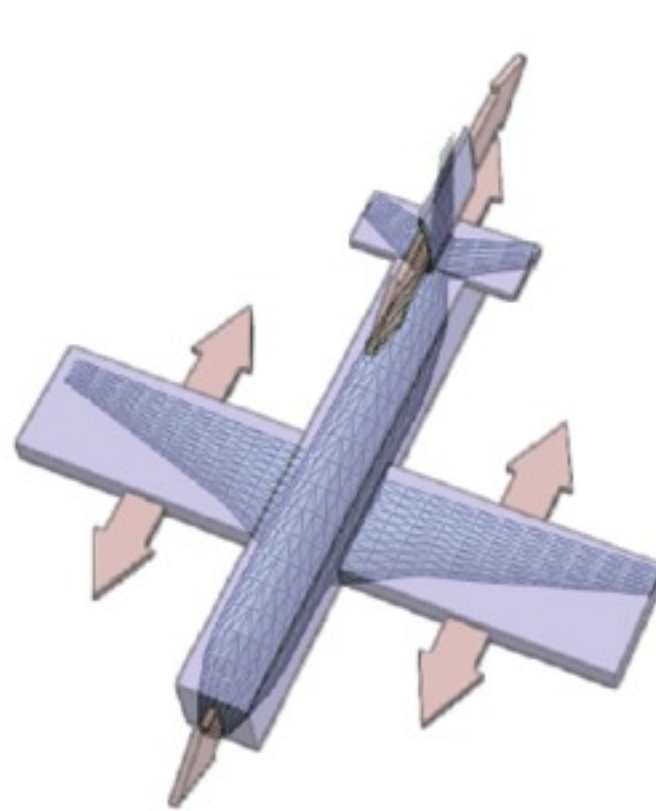


[Ovsjanikov et al. Siggraph 2011]

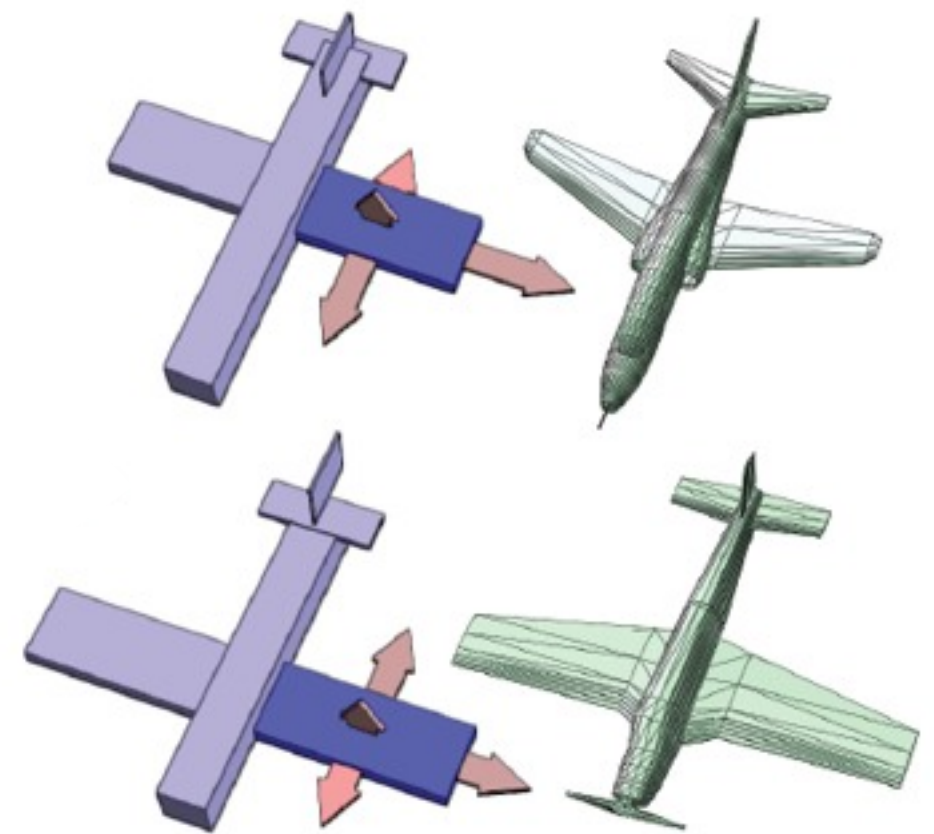
Our Approach



Input collection

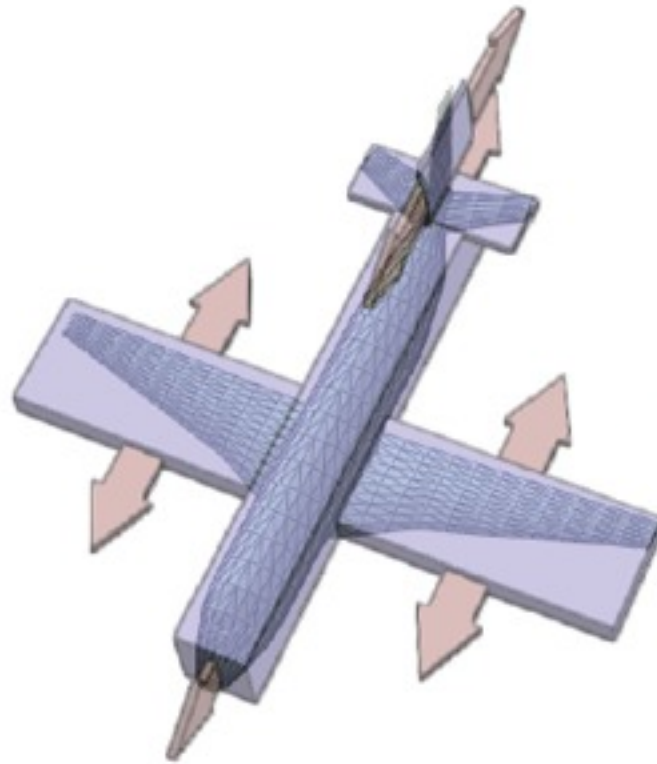


Analysis



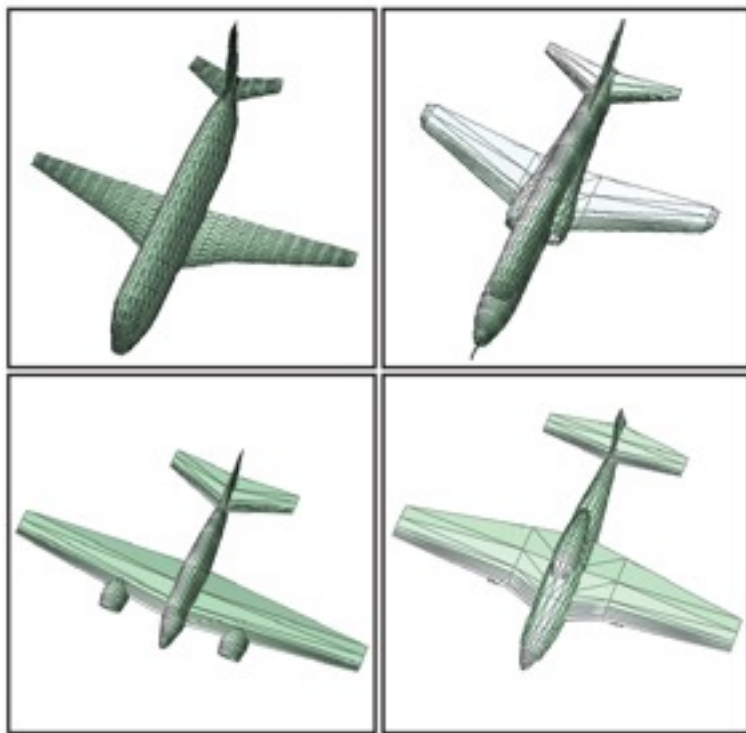
Exploration

Our Approach



Analysis

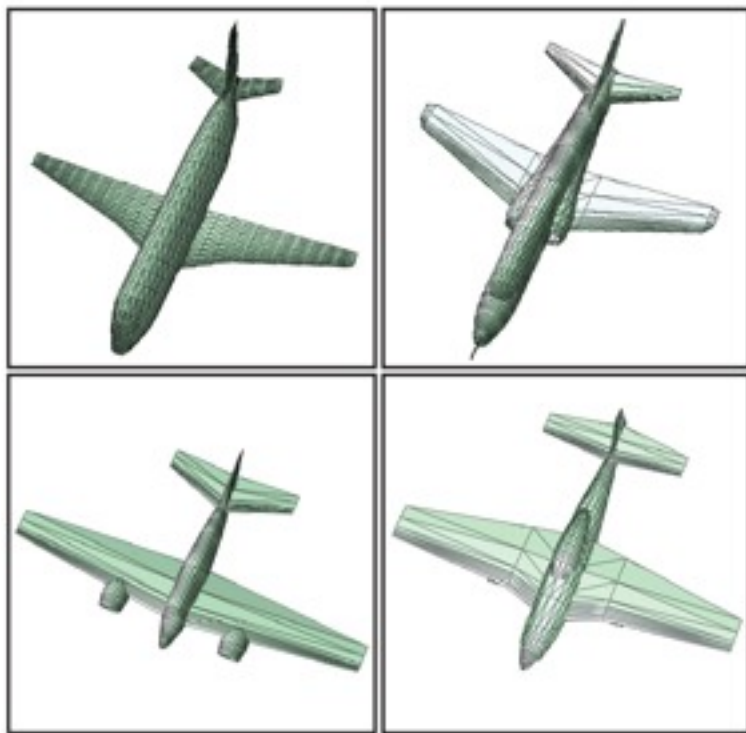
Analysis



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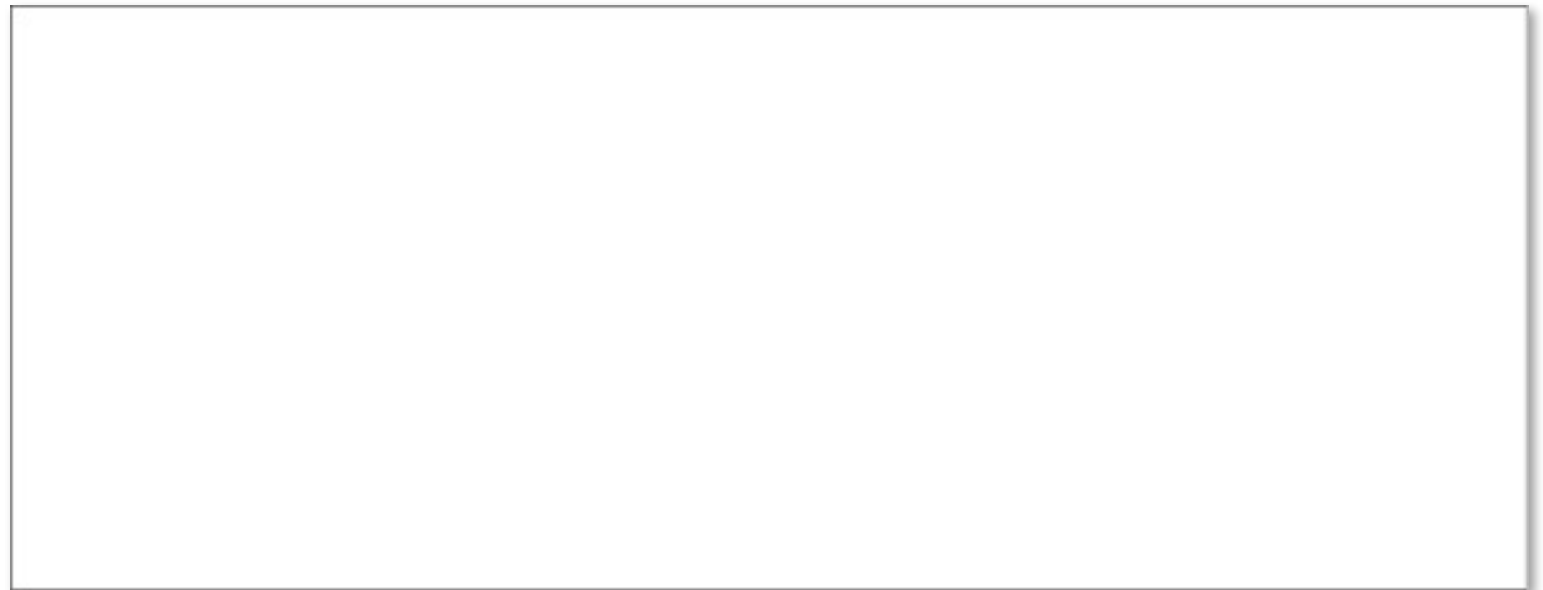
Input collection

Analysis



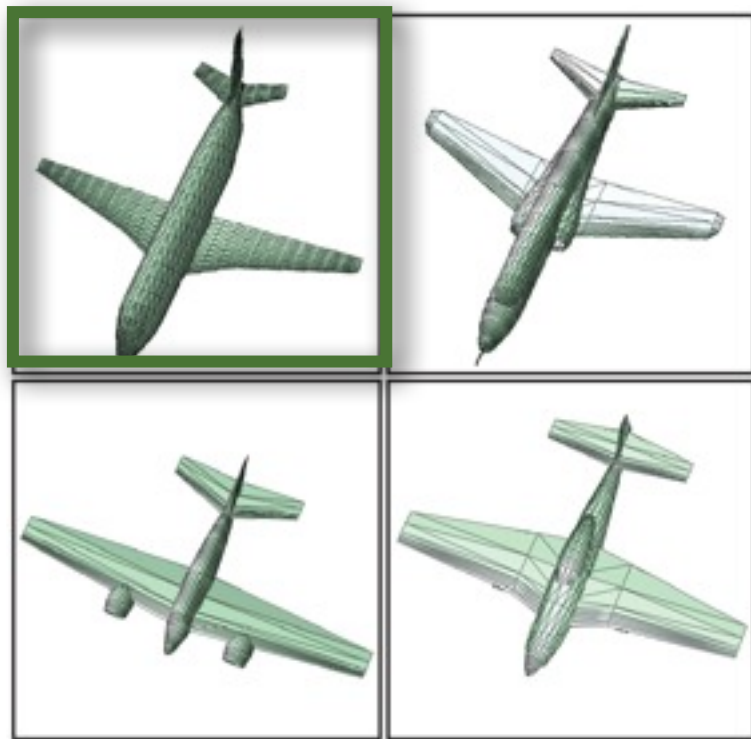
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Input collection

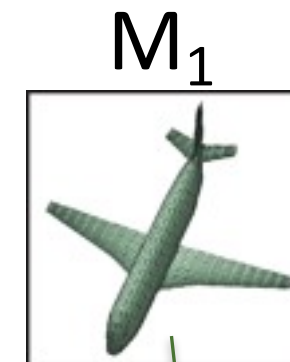


Descriptor space

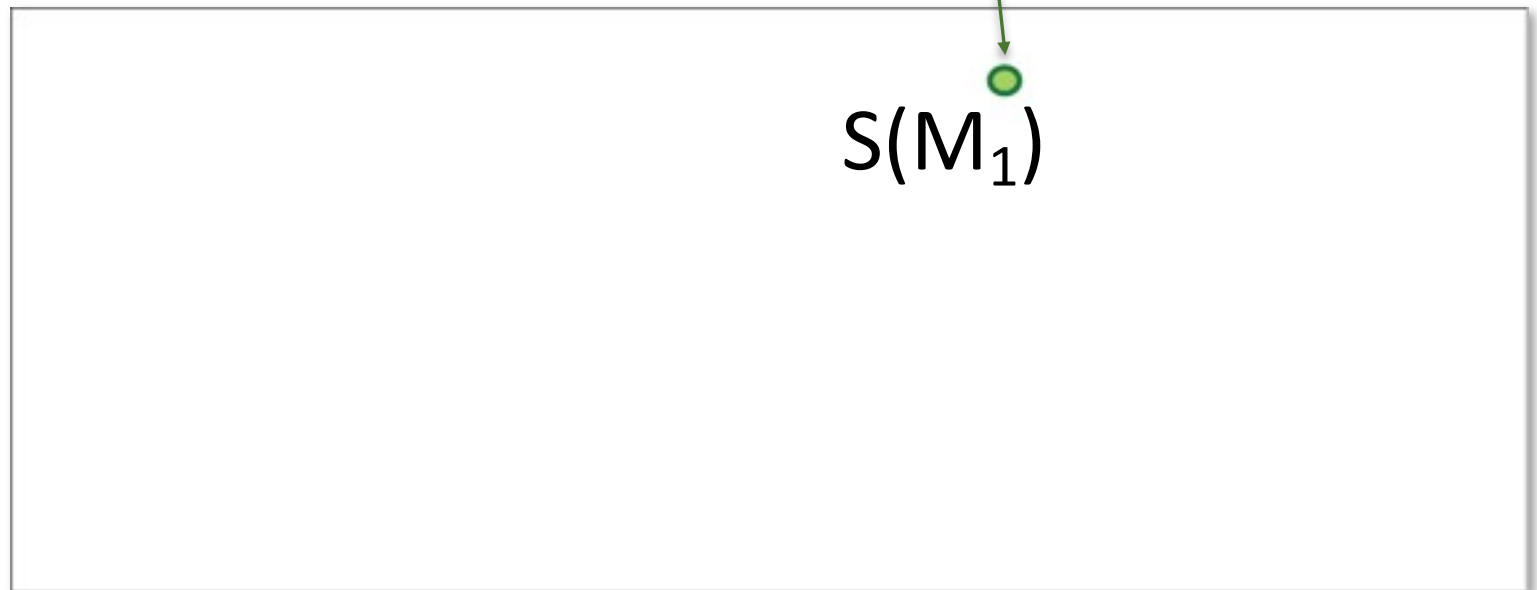
Analysis



Input collection

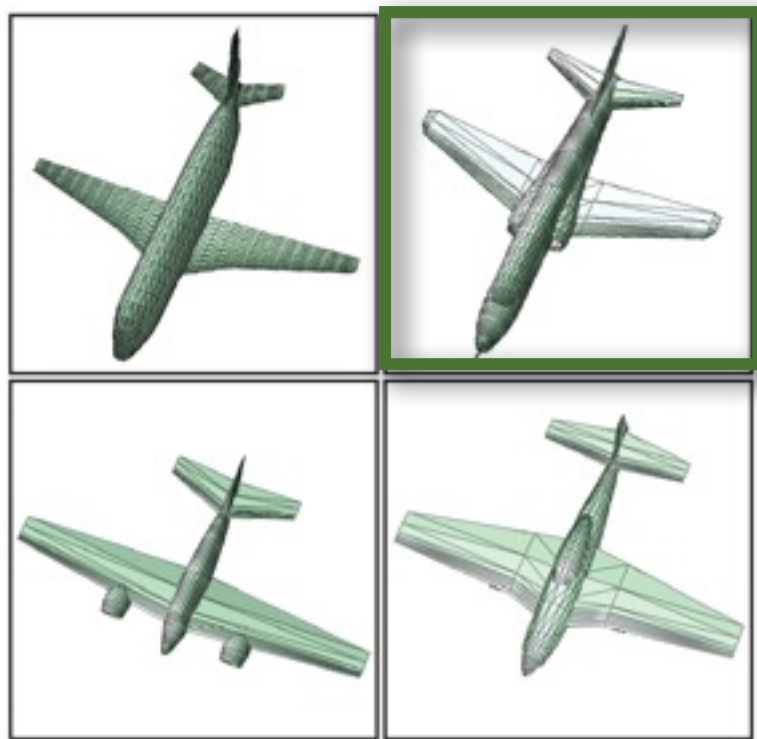


$S(M_1)$



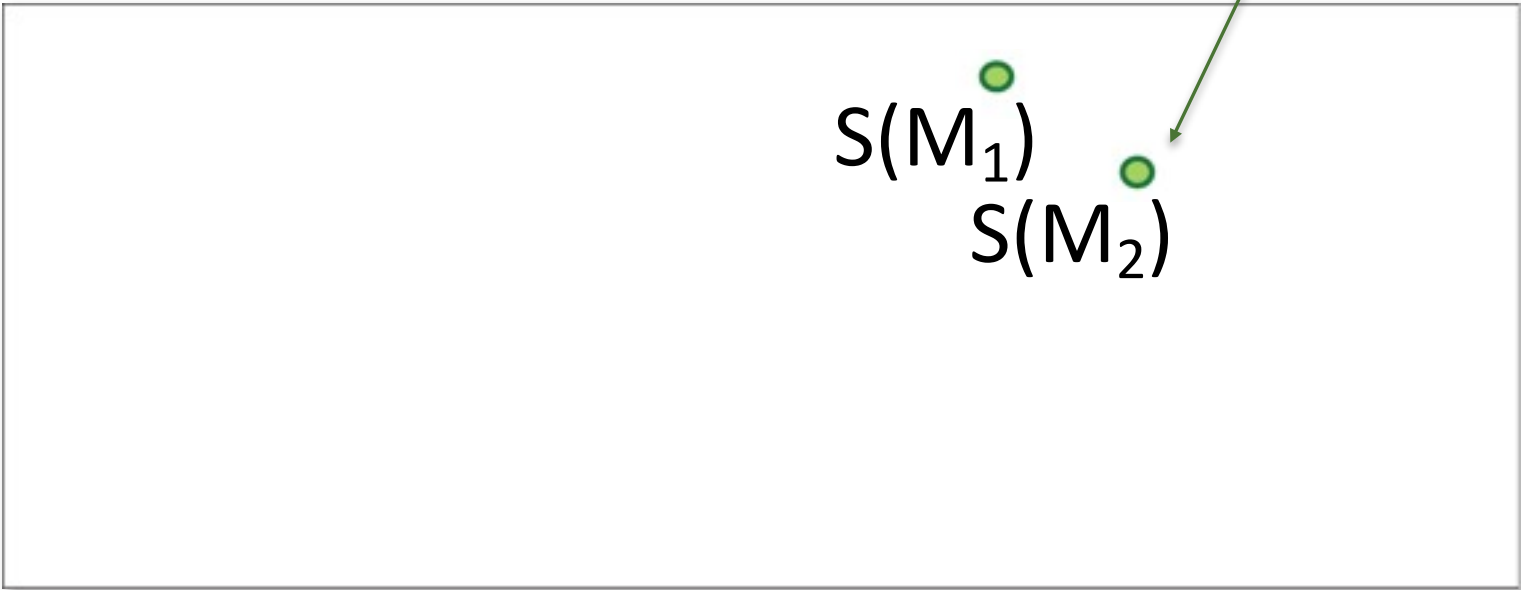
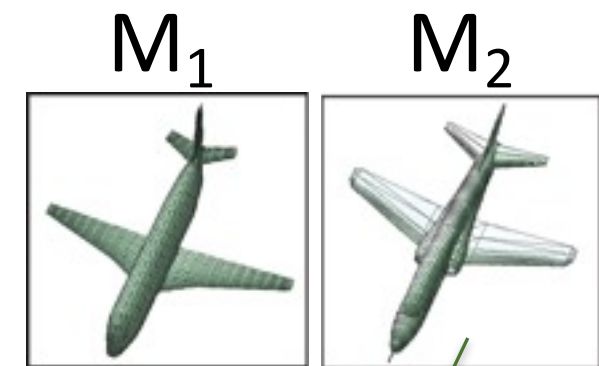
Descriptor space

Analysis



• • •

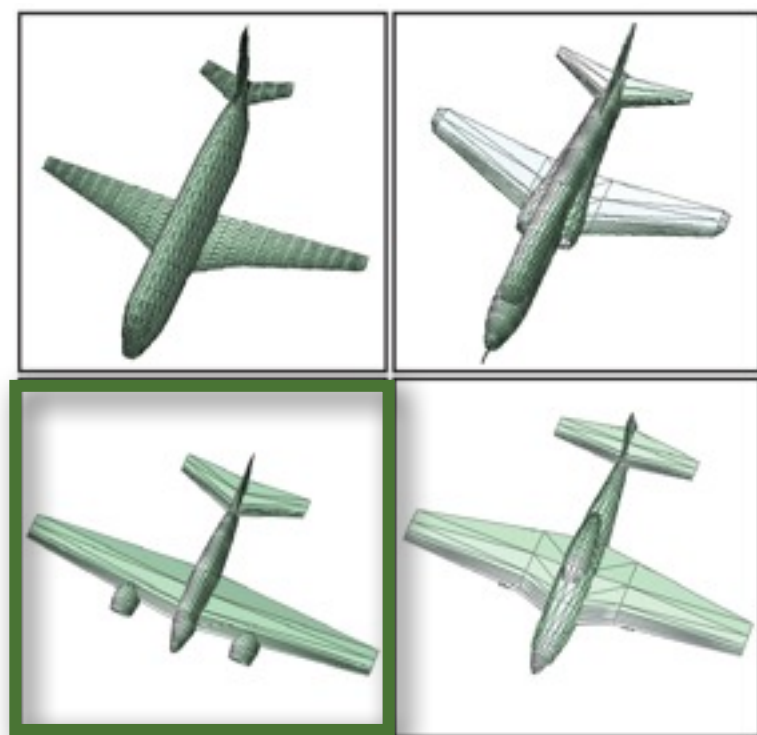
Input collection



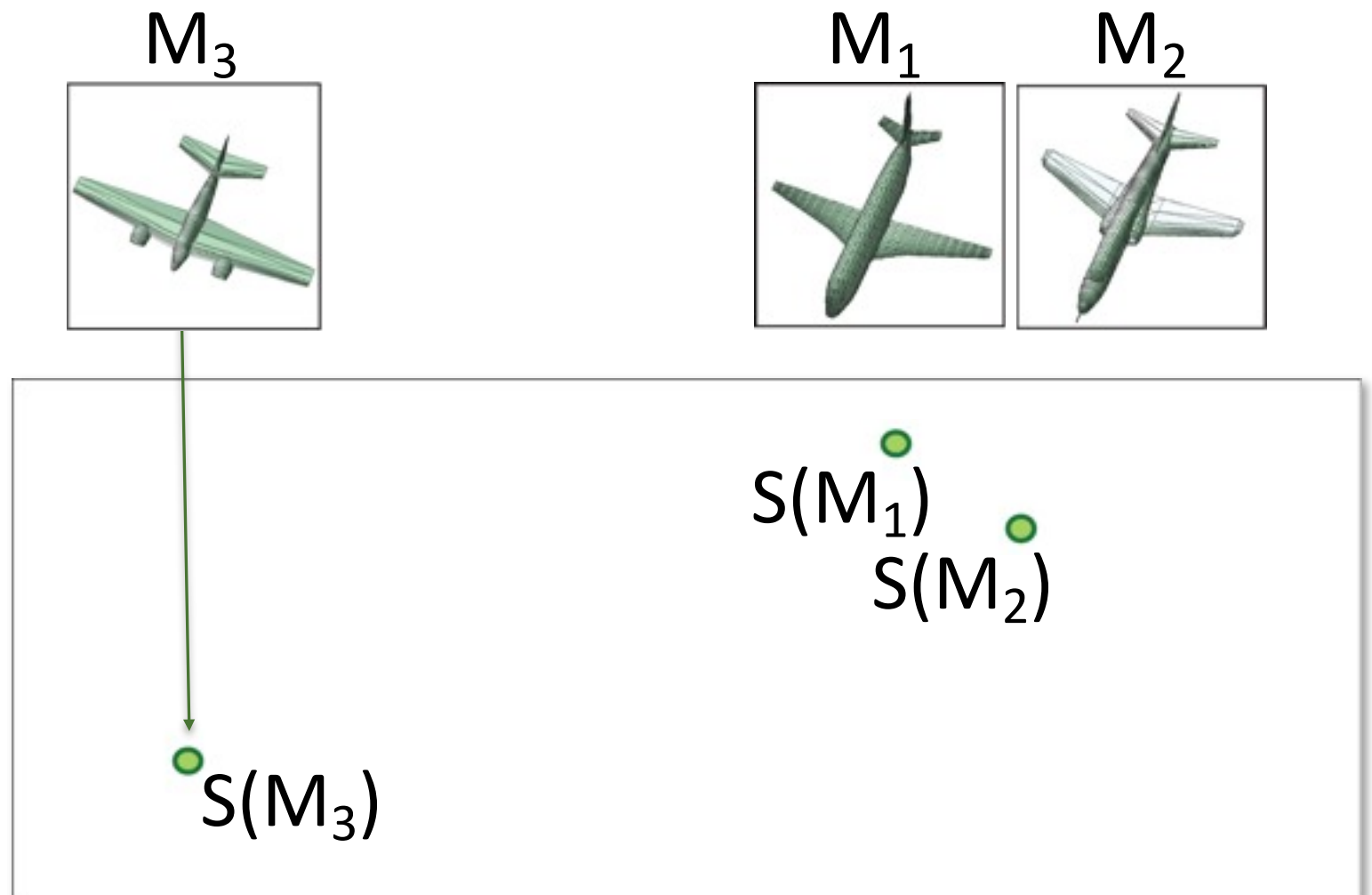
$S(M_1)$
 $S(M_2)$

Descriptor space

Analysis

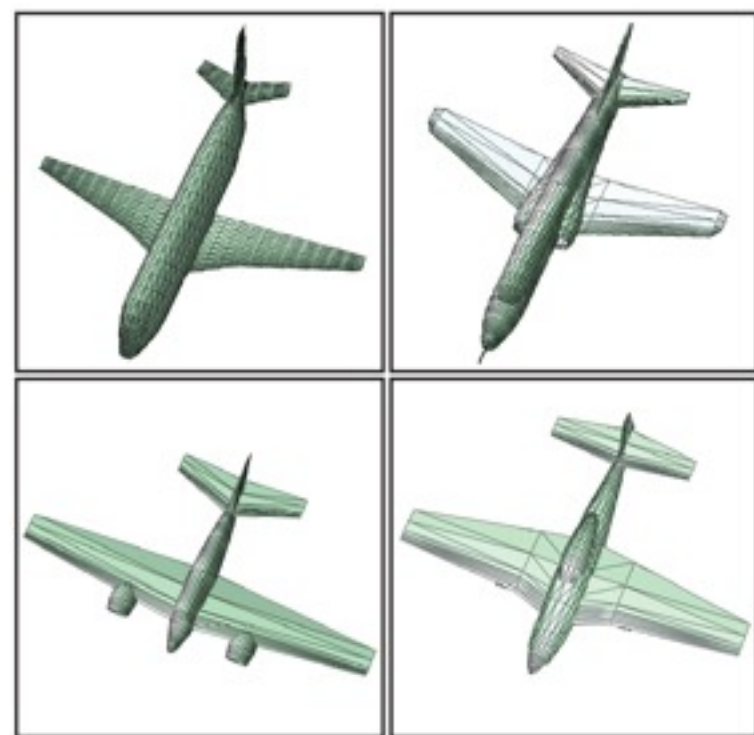


• • •
Input collection

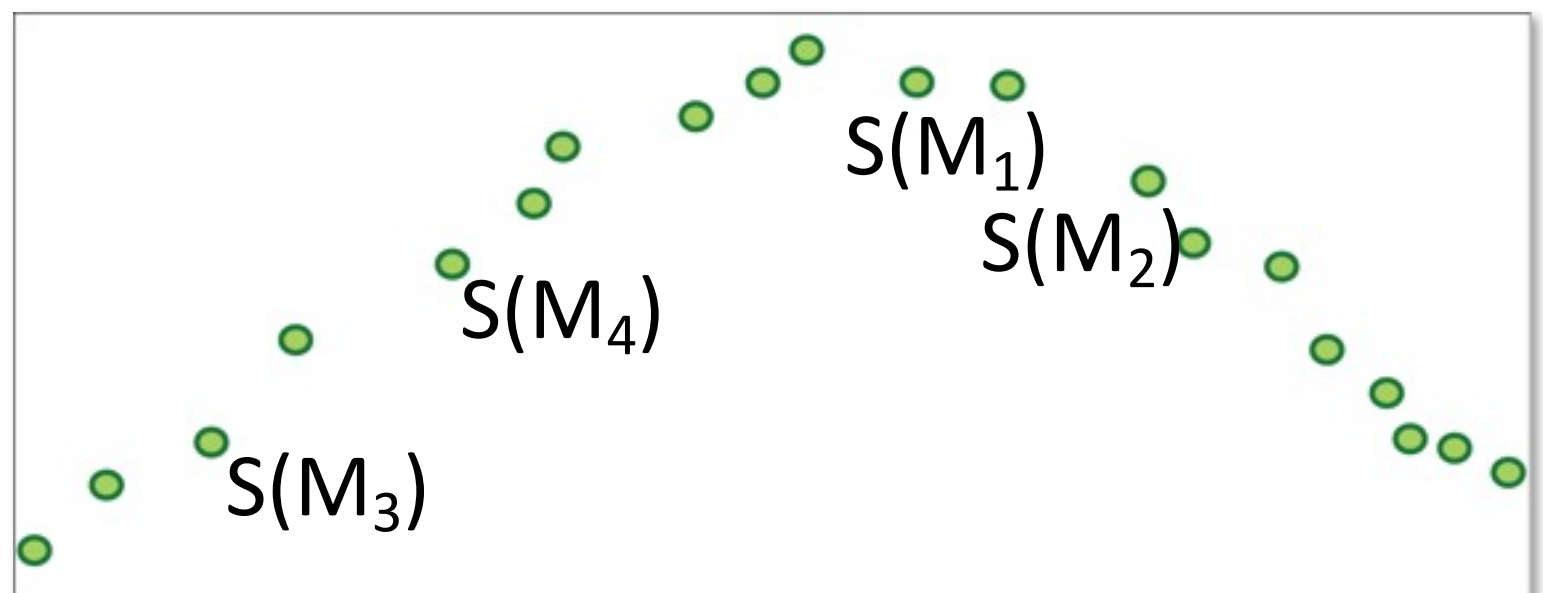
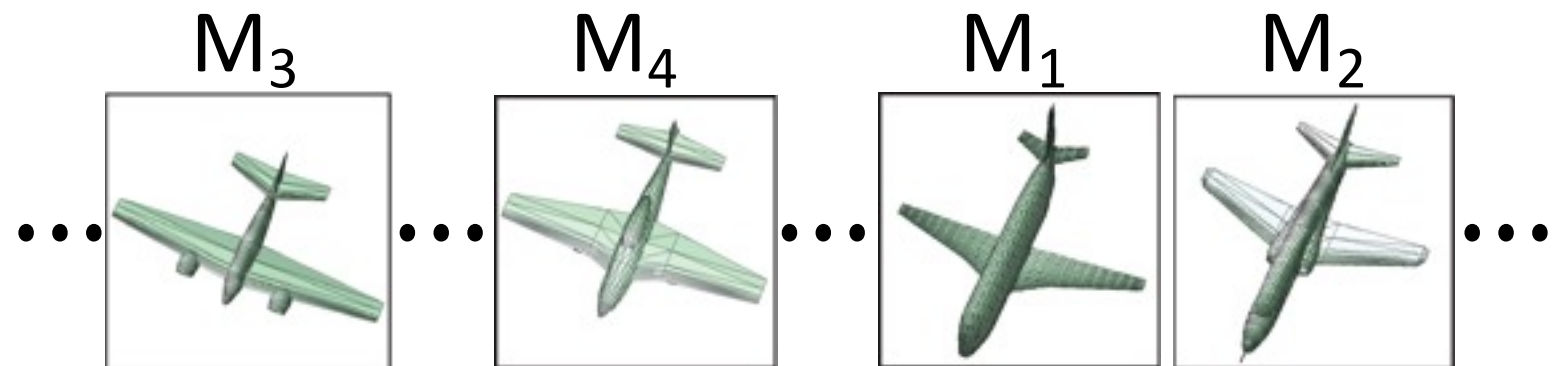


Descriptor space

Analysis

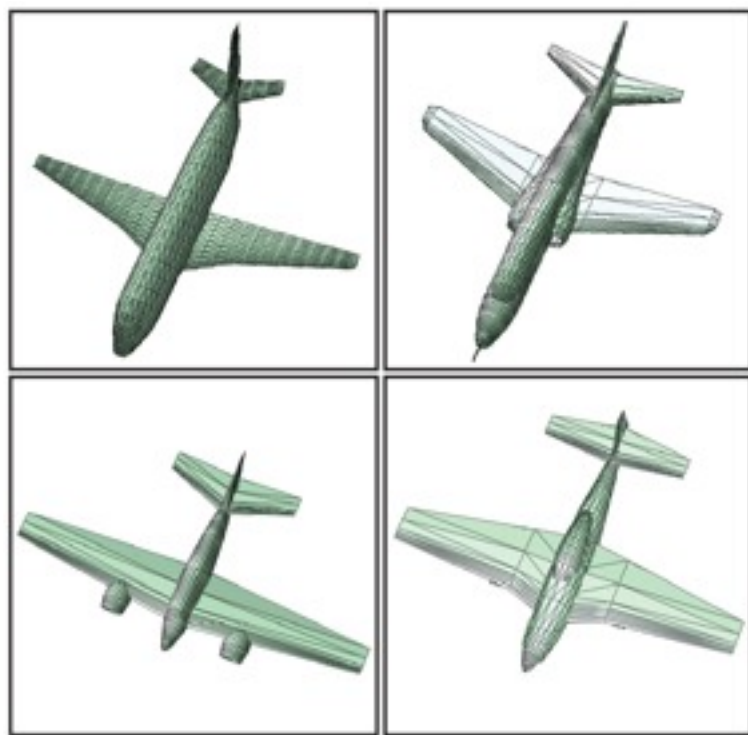


• • •
Input collection

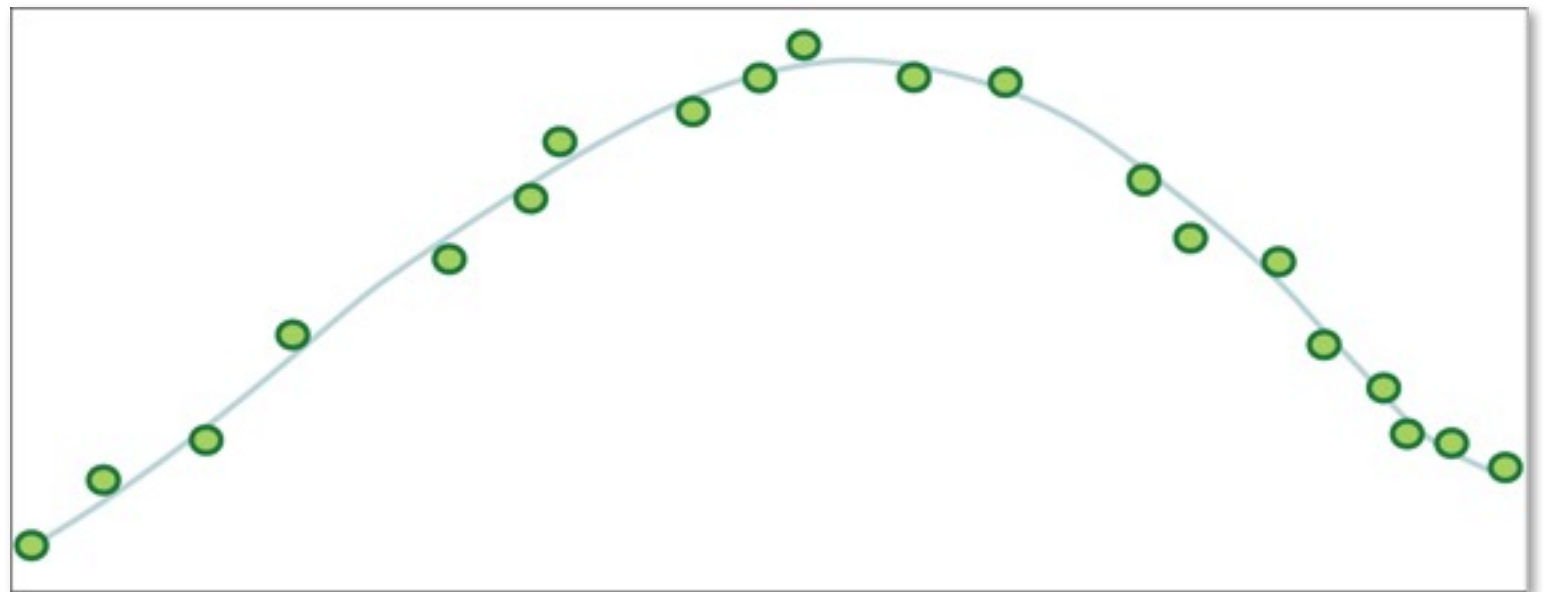
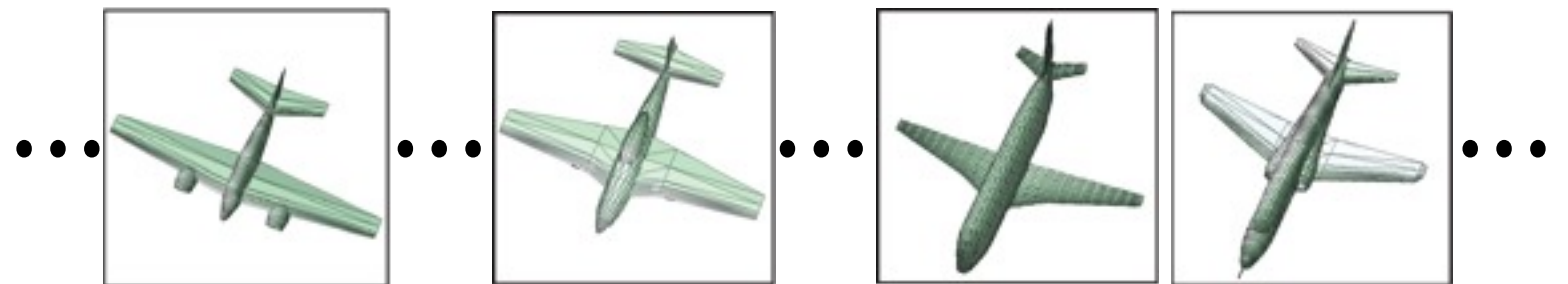


Descriptor space

Analysis

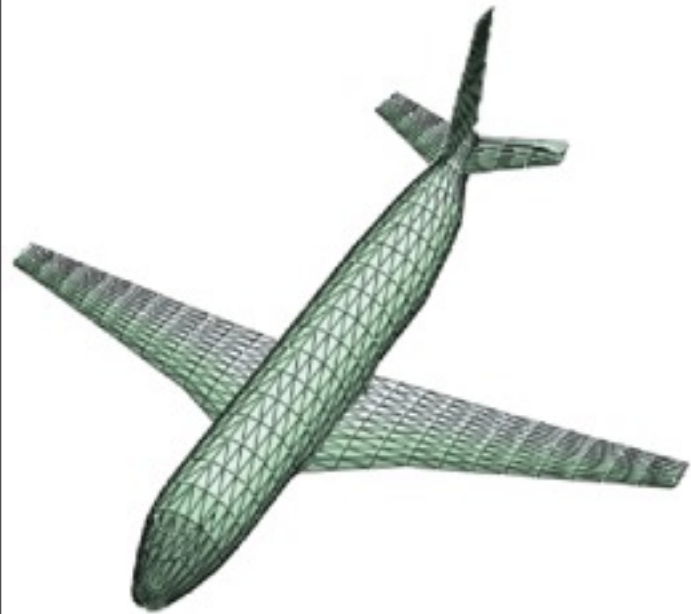


...
Input collection

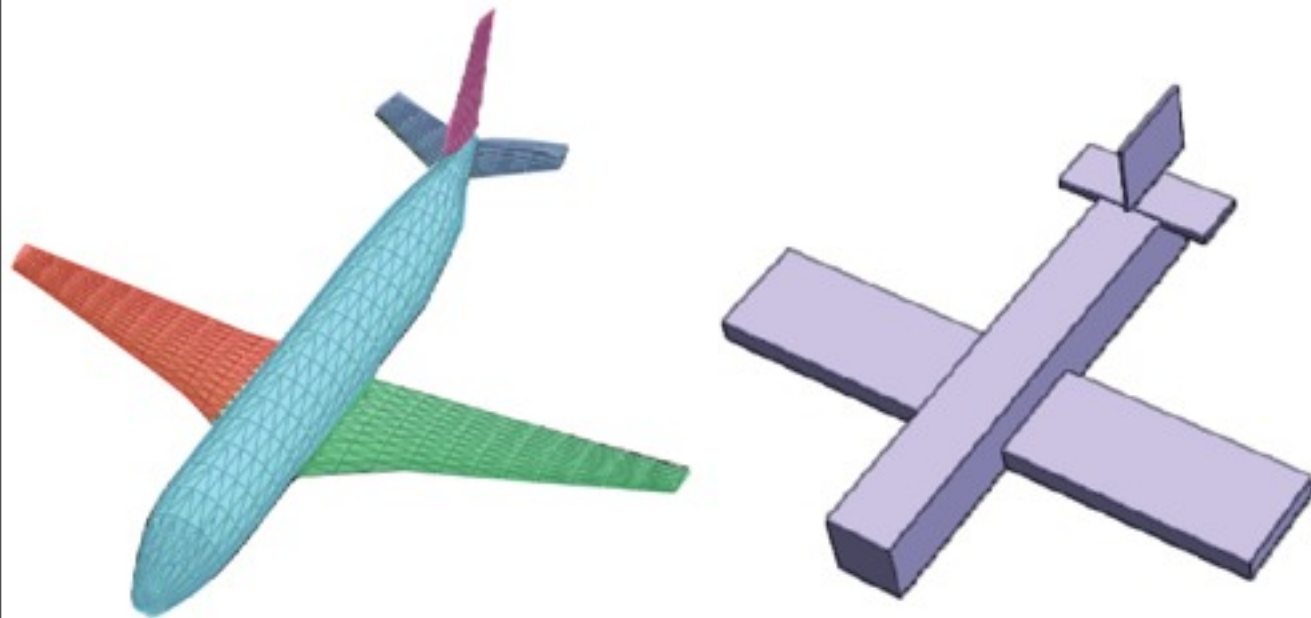


Descriptor space

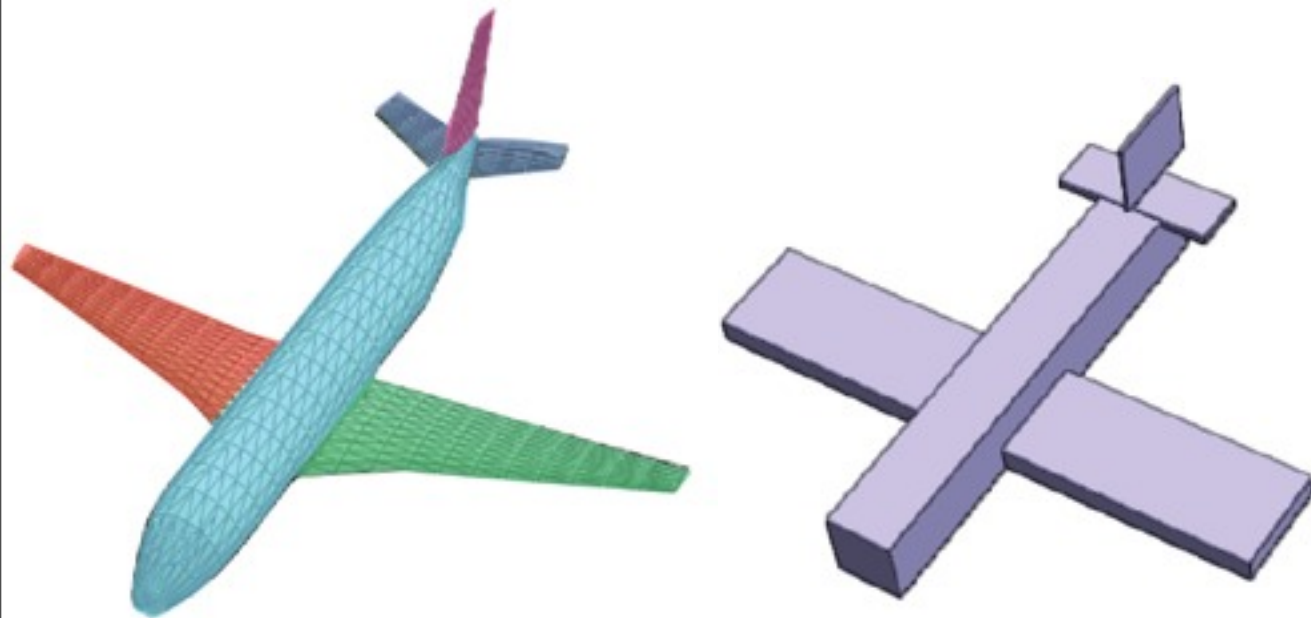
Template Deformation Model



Template Deformation Model



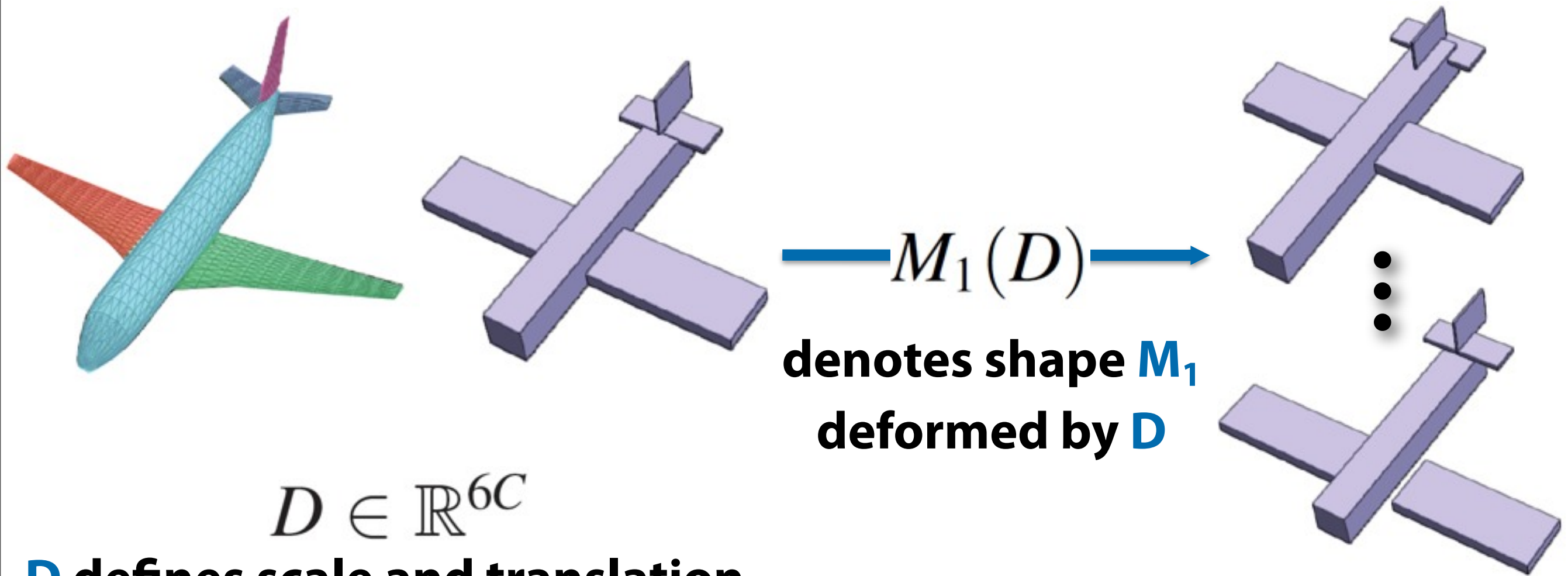
Template Deformation Model



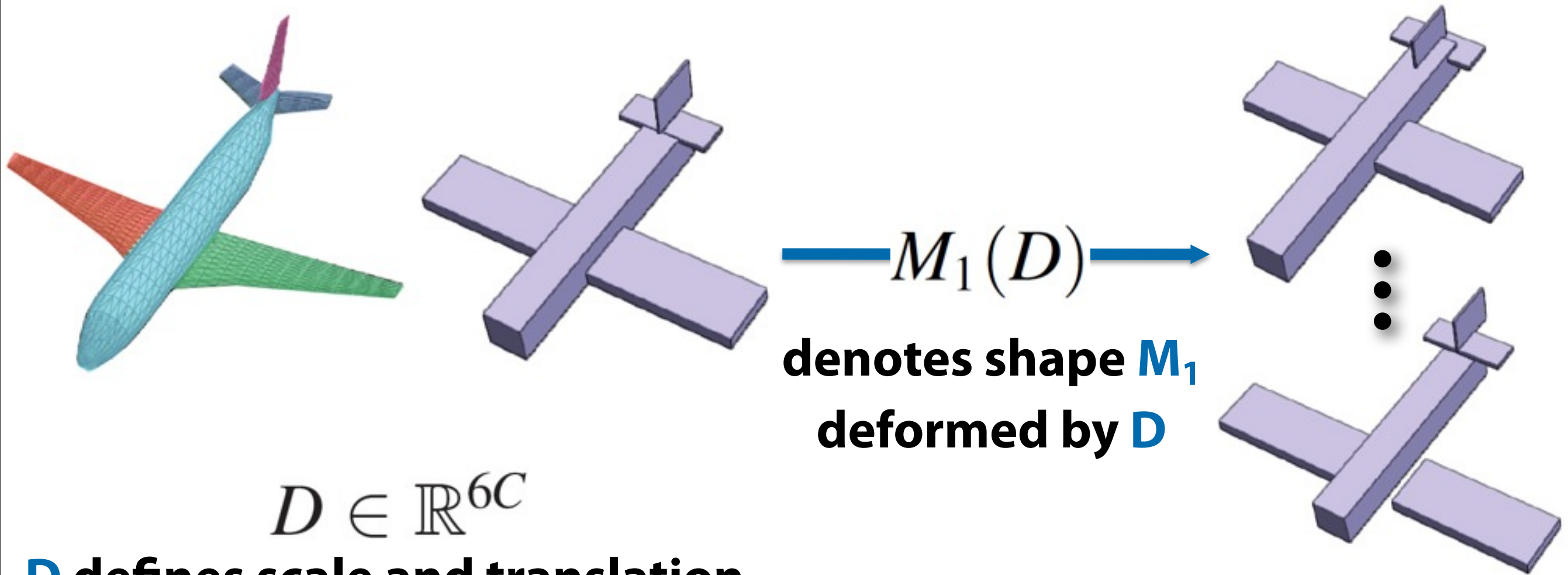
$$D \in \mathbb{R}^{6C}$$

D defines scale and translation
for each of the **C** template
components

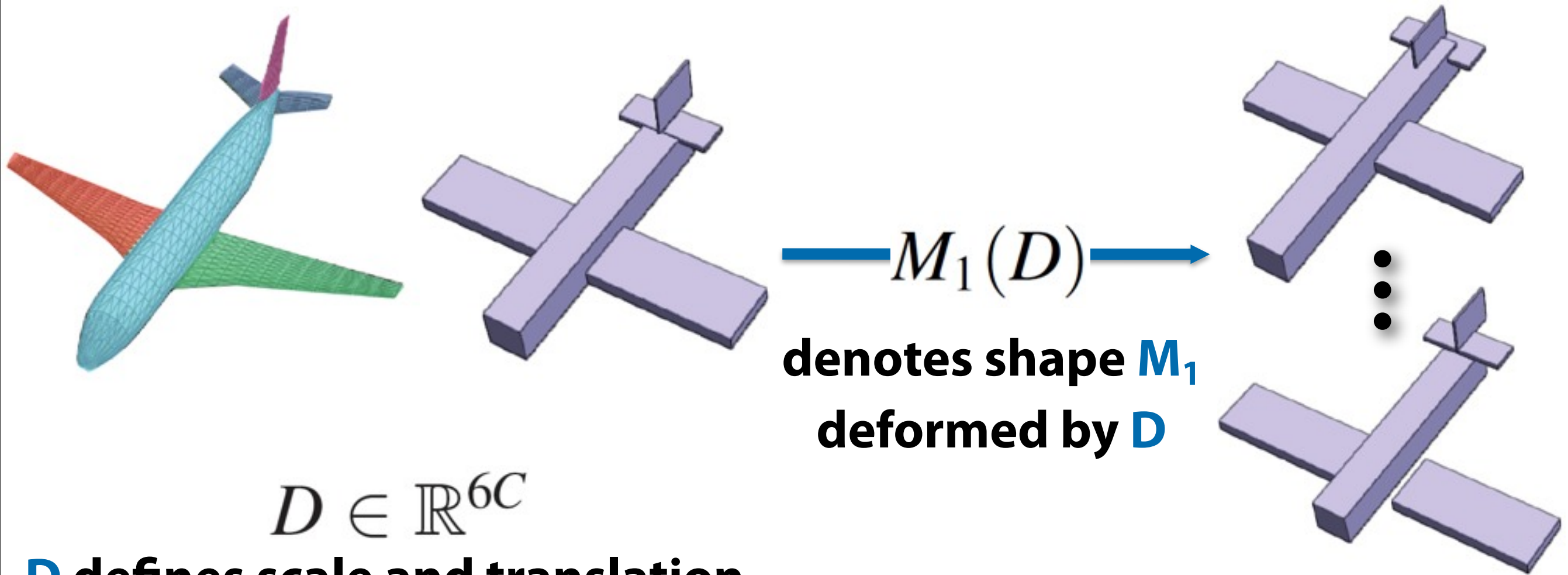
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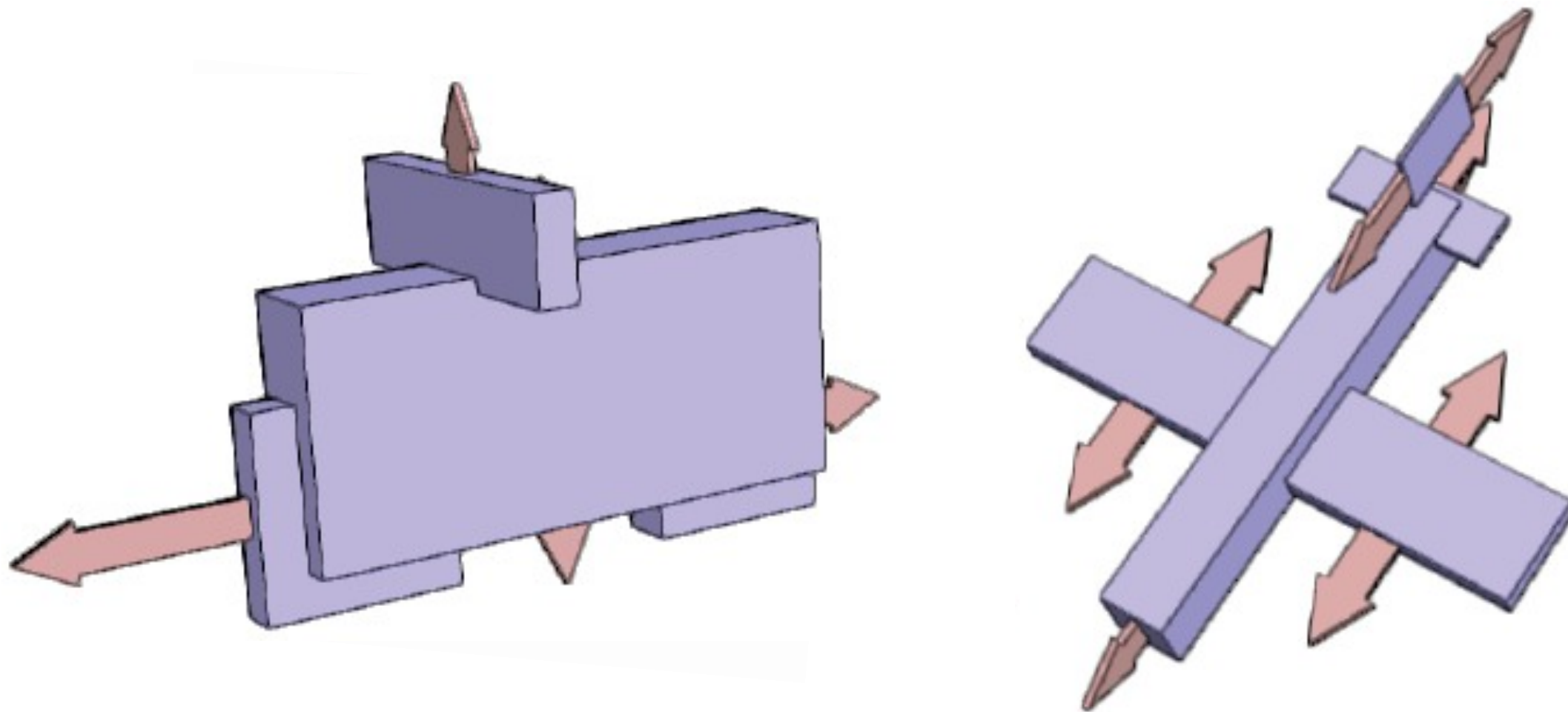
$$D \in \mathbb{R}^{6C}$$

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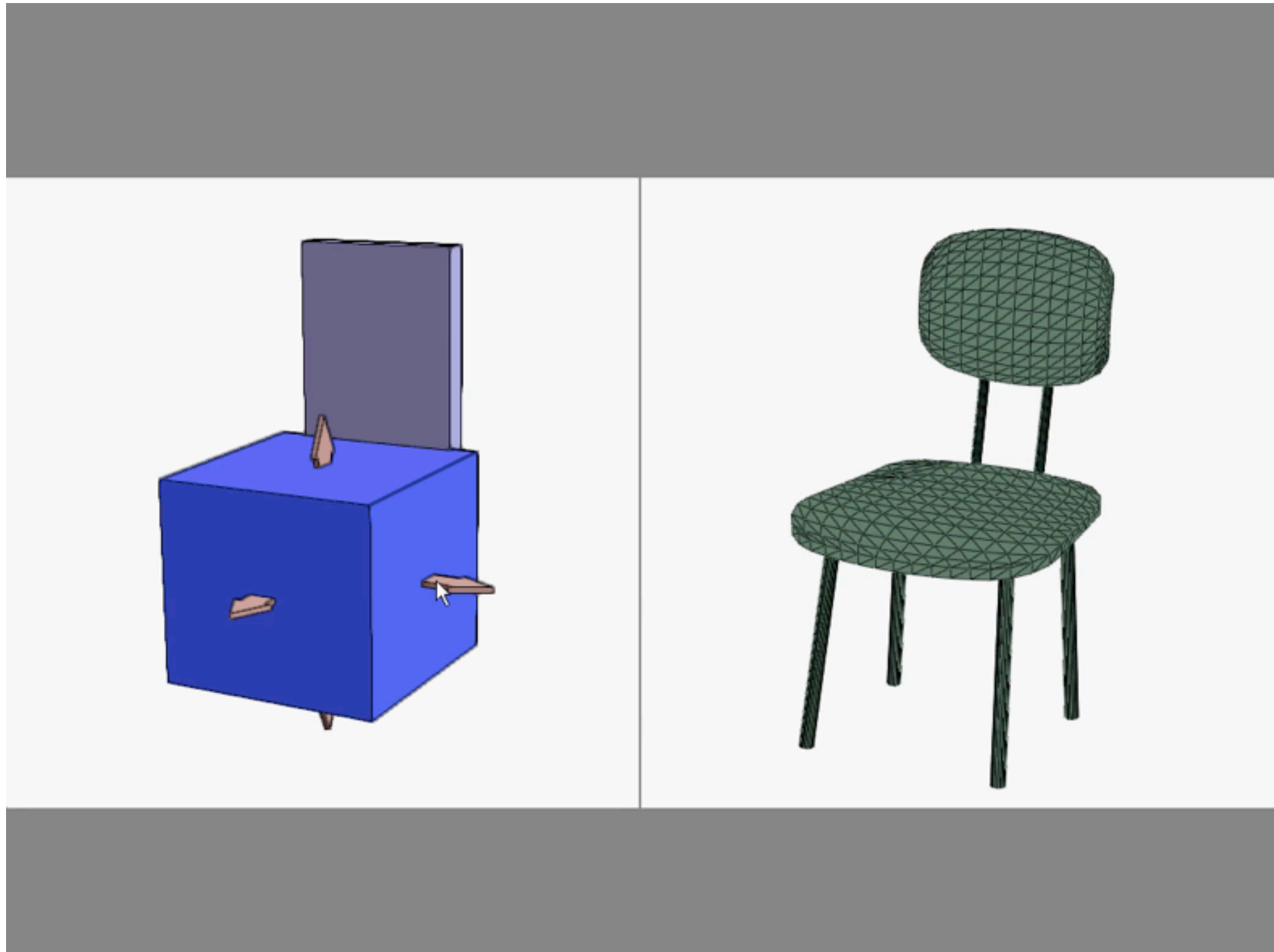
$$E(D) = \|S(M_1(D)) - S(M_2)\|^2$$
$$\nabla E(D) = 2(S(M_1(D)) - S(M_2))J$$
$$J(i, j) = \partial S(M_1(D))_i / \partial D_j$$

Morphable Model

Morphable Model



Exploring Data Collections



Structure among Relations

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$$aRb \quad \text{and} \quad bRc \Rightarrow aRc$$

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$$T_{ab} \cdot T_{bc} \cdot T_{ca} = I$$

Structure among Relations

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$$T_{ab} \cdot T_{bc} \cdot T_{ca} = I$$

$$\begin{bmatrix} a_{00} & a_{10} & a_{20} & a_{30} & a_{40} \\ a_{01} & a_{11} & a_{21} & a_{31} & a_{41} \\ a_{02} & a_{12} & a_{22} & a_{32} & a_{42} \\ a_{03} & a_{13} & a_{23} & a_{33} & a_{43} \\ a_{04} & a_{14} & a_{24} & a_{34} & a_{44} \end{bmatrix}$$

Structure among Relations

$$aRb \quad \text{and} \quad bRc \Rightarrow aRc$$

$$T_{ab} \cdot T_{bc} \cdot T_{ca} = I$$

$$\begin{bmatrix} a_{00} & a_{10} & a_{20} & a_{30} & a_{40} \\ \cdot & a_{11} & a_{21} & a_{31} & a_{41} \\ \cdot & \cdot & a_{22} & a_{32} & a_{42} \\ \cdot & \cdot & \cdot & a_{33} & a_{43} \\ \cdot & \cdot & \cdot & \cdot & a_{44} \end{bmatrix}$$

Structure among Relations

$$aRb \quad \text{and} \quad bRc \Rightarrow aRc$$

$$T_{ab} \cdot T_{bc} \cdot T_{ca} = I$$

$$\begin{bmatrix} a_{00} & a_{10} & ? & a_{30} & ? \\ \cdot & a_{11} & a_{21} & ? & a_{41} \\ \cdot & \cdot & a_{22} & a_{32} & a_{42} \\ \cdot & \cdot & \cdot & a_{33} & a_{43} \\ \cdot & \cdot & \cdot & \cdot & a_{44} \end{bmatrix}$$

Structure among Relations

$$aRb \quad \text{and} \quad bRc \Rightarrow aRc$$

$$T_{ab} \cdot T_{bc} \cdot T_{ca} = I$$

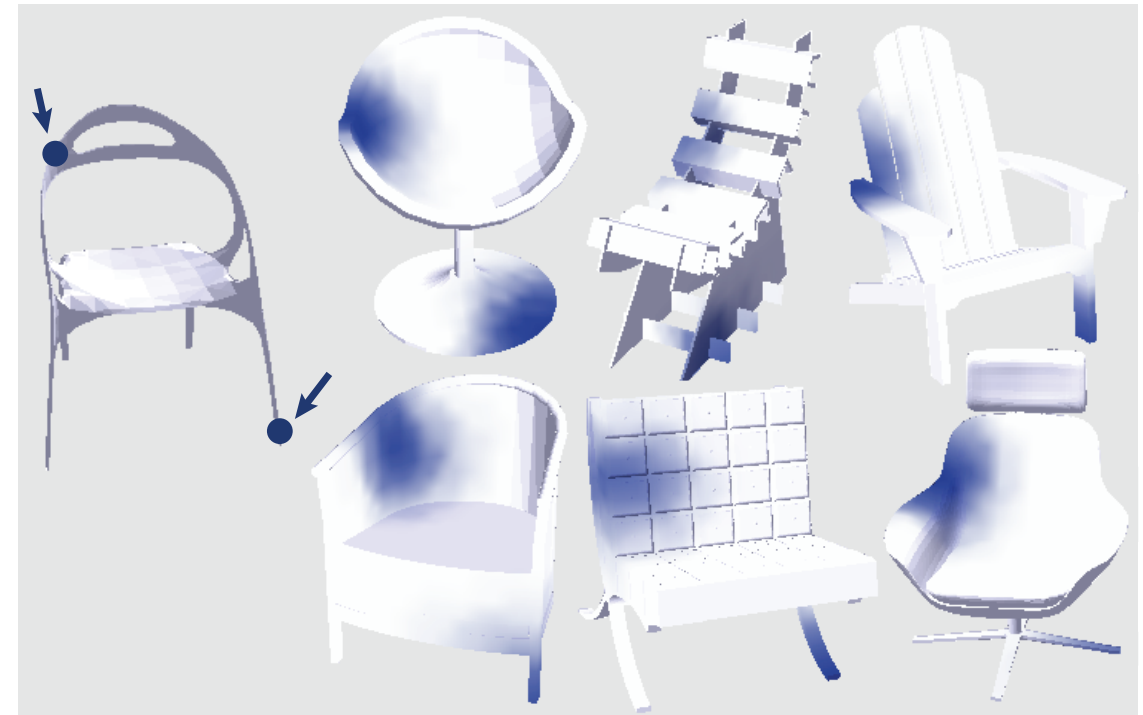
exploit 'structure'
for

compactness (redundancy)
robustness (constraints)

$$\begin{bmatrix} a_{00} & a_{10} & ? & a_{30} & ? \\ \cdot & a_{11} & a_{21} & ? & a_{41} \\ \cdot & \cdot & a_{22} & a_{32} & a_{42} \\ \cdot & \cdot & \cdot & a_{33} & a_{43} \\ \cdot & \cdot & \cdot & \cdot & a_{44} \end{bmatrix}$$

Fuzzy Correspondence

$$\mathbf{S} := \{S_1, S_2, \dots, S_N\}$$

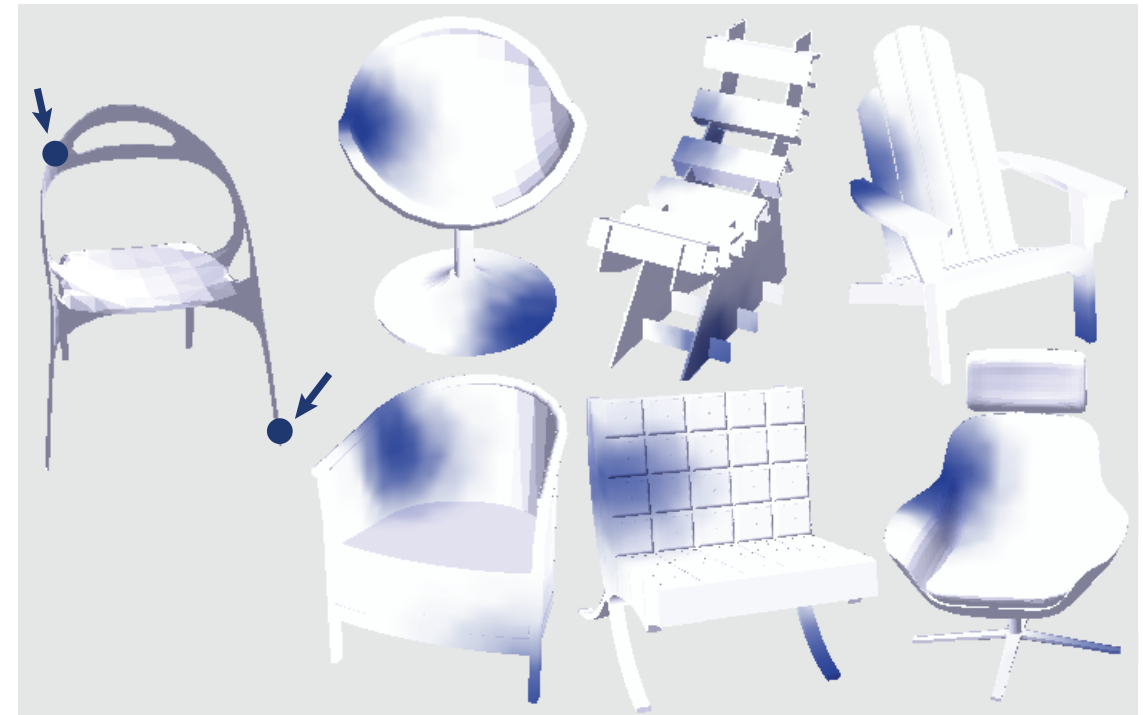


[Kim et al., Siggraph 2012]

Fuzzy Correspondence

$$\mathbf{S} := \{S_1, S_2, \dots, S_N\}$$

$$f(p_i, p_j) : \mathbf{S} \times \mathbf{S} \rightarrow \mathbb{R}$$

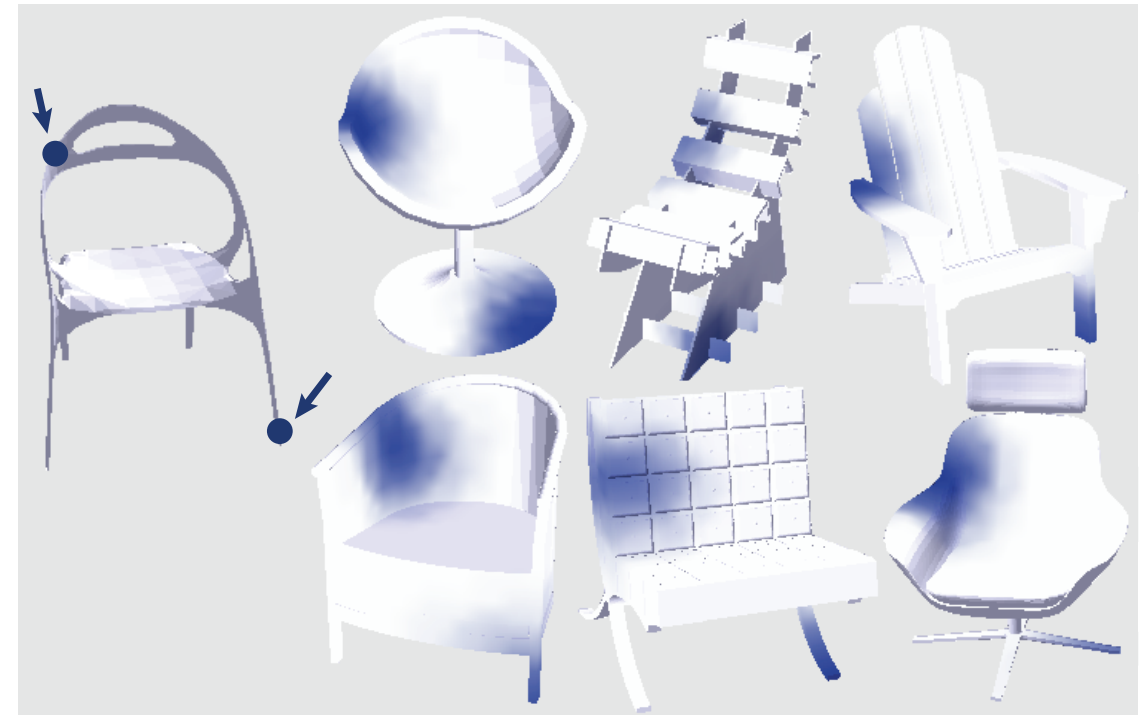


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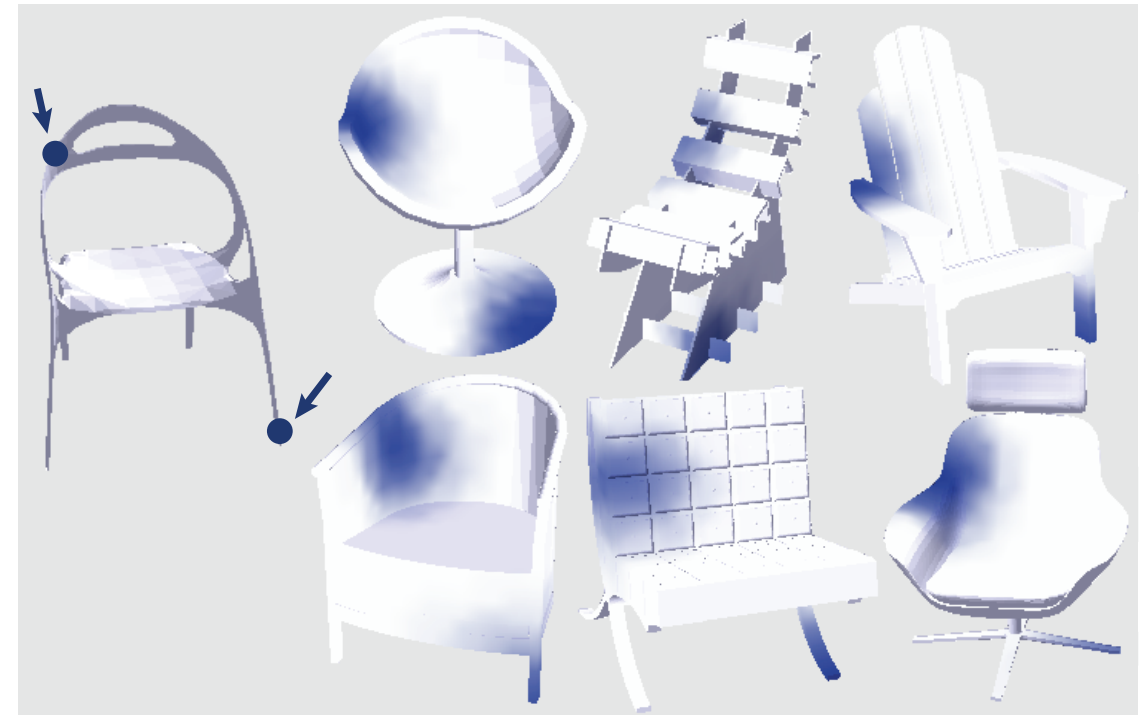
1. Sample
Input Shapes

[Kim et al., Siggraph 2012]

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Input Shapes

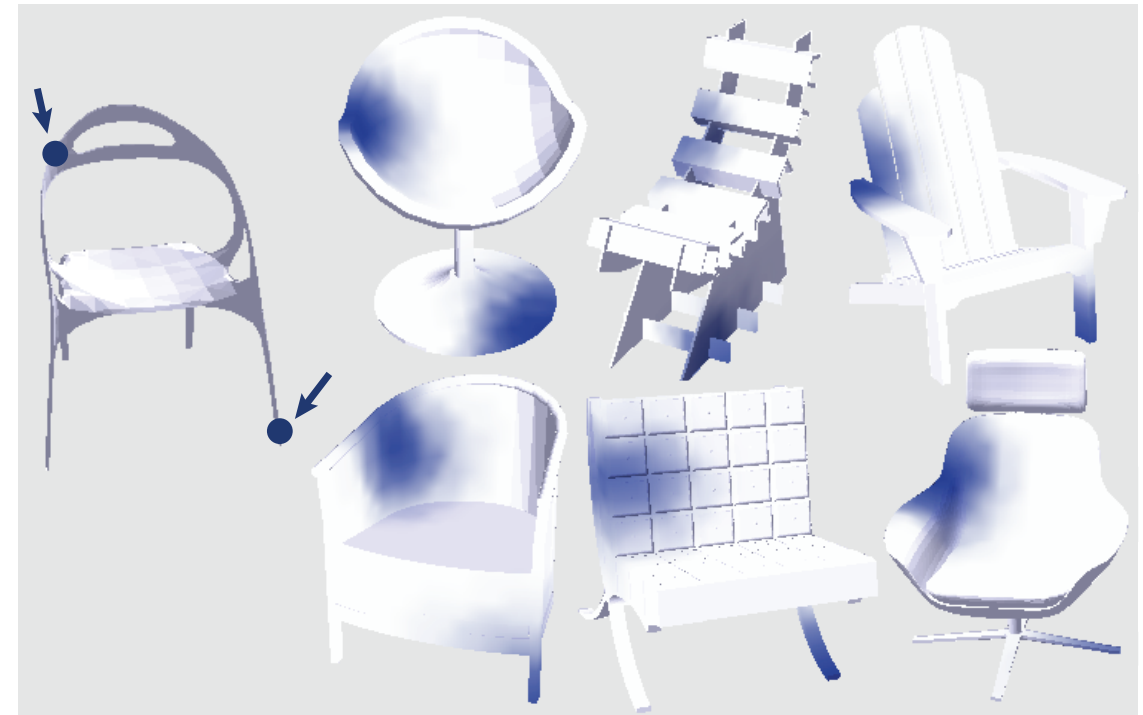
2. Construct
Initial Graph: \mathbf{G}_0

[Kim et al., Siggraph 2012]

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1. Sample
Input Shapes

2. Construct
Initial Graph: \mathbf{G}_0

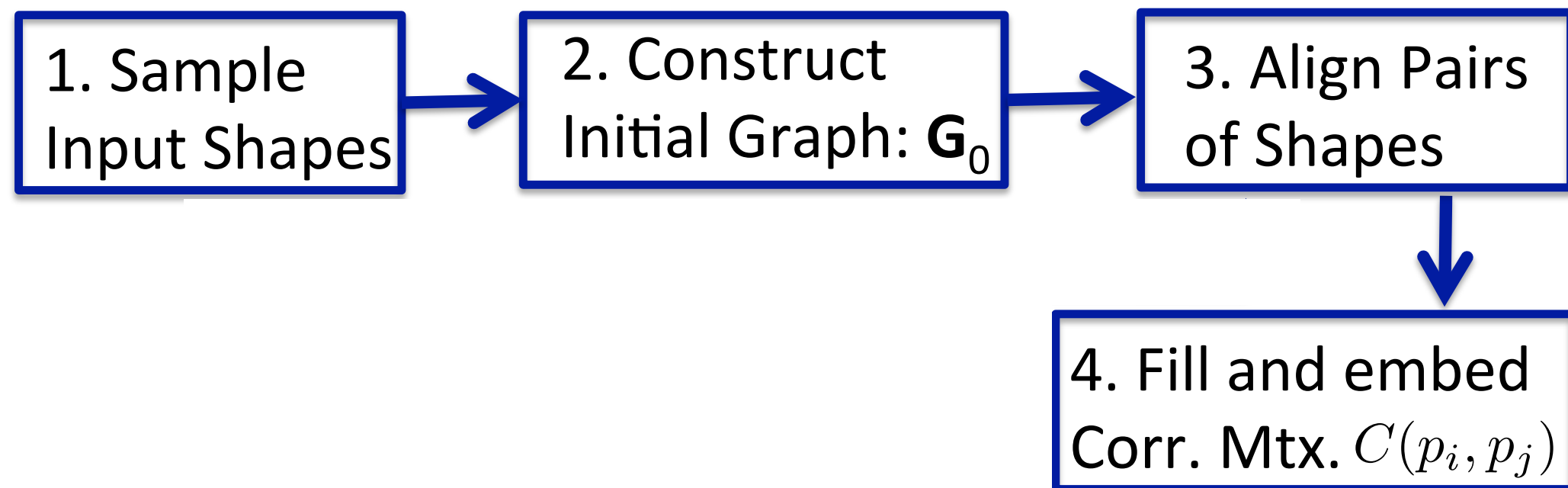
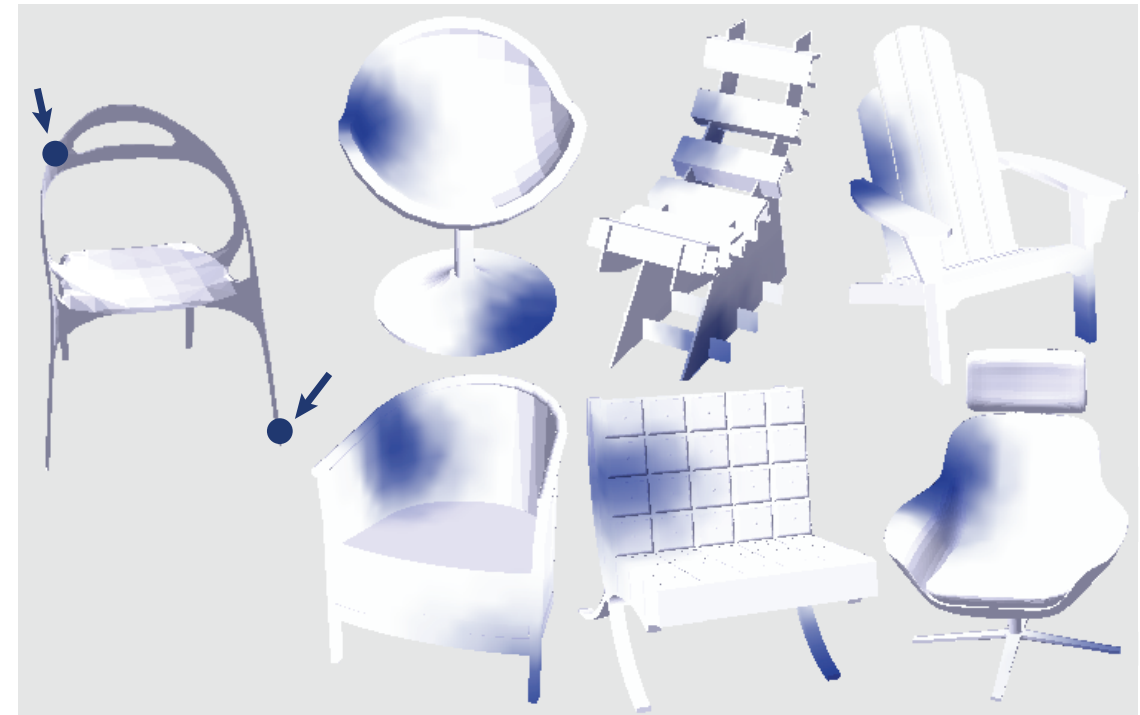
3. Align Pairs
of Shapes

[Kim et al., Siggraph 2012]

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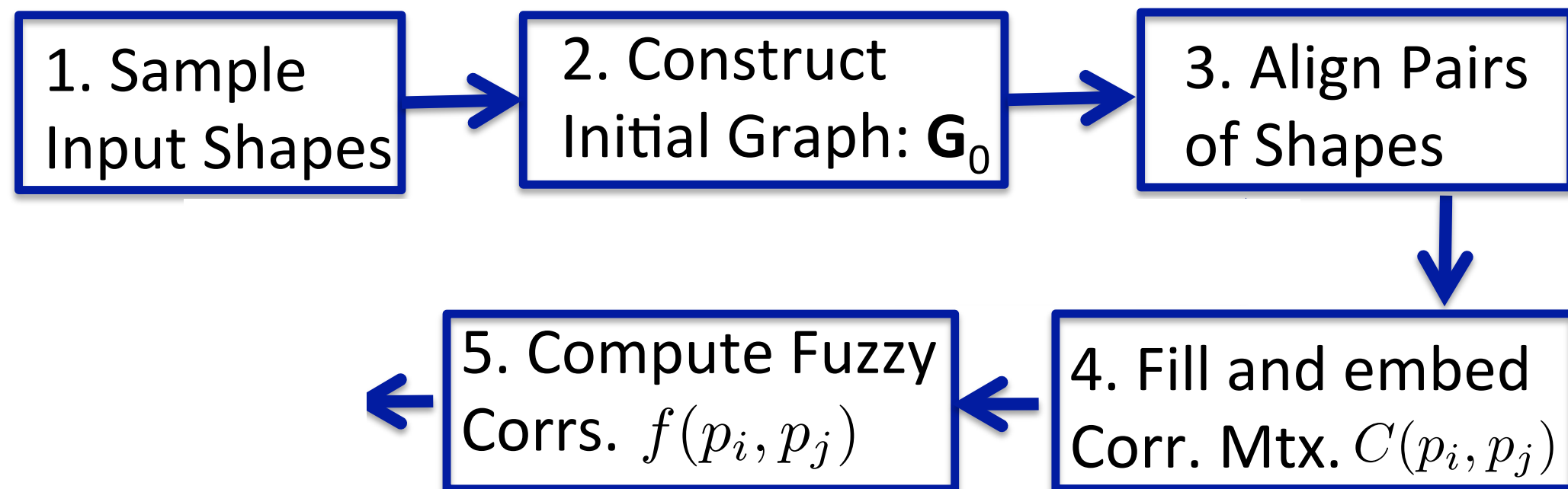
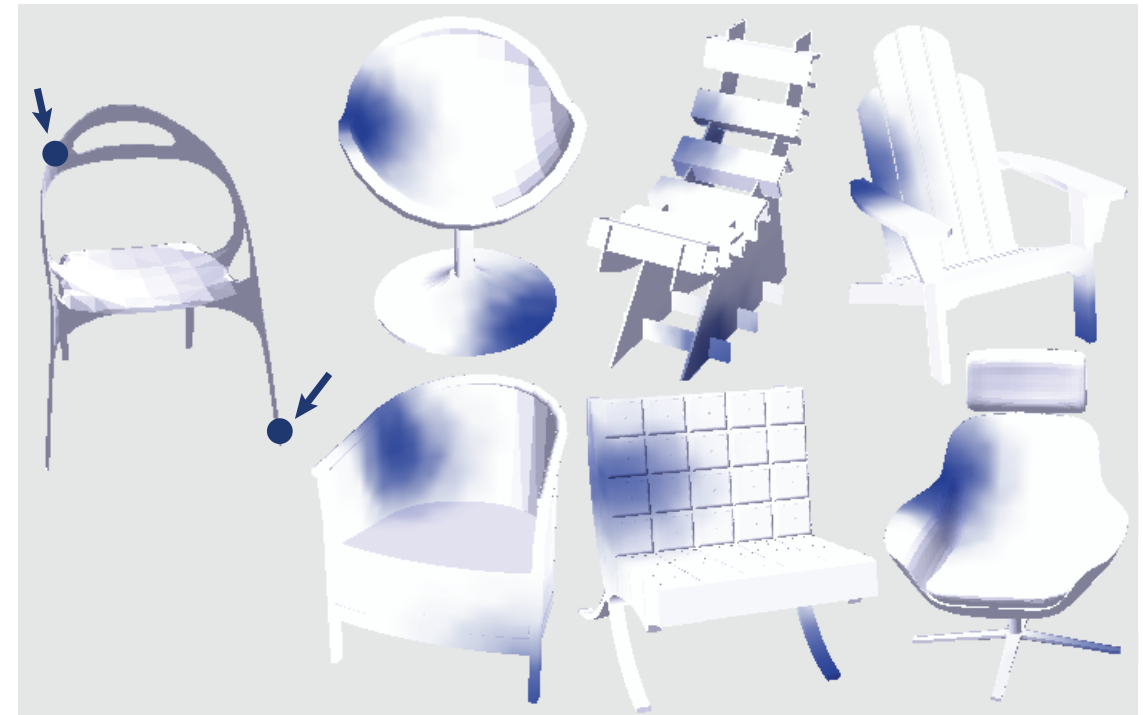


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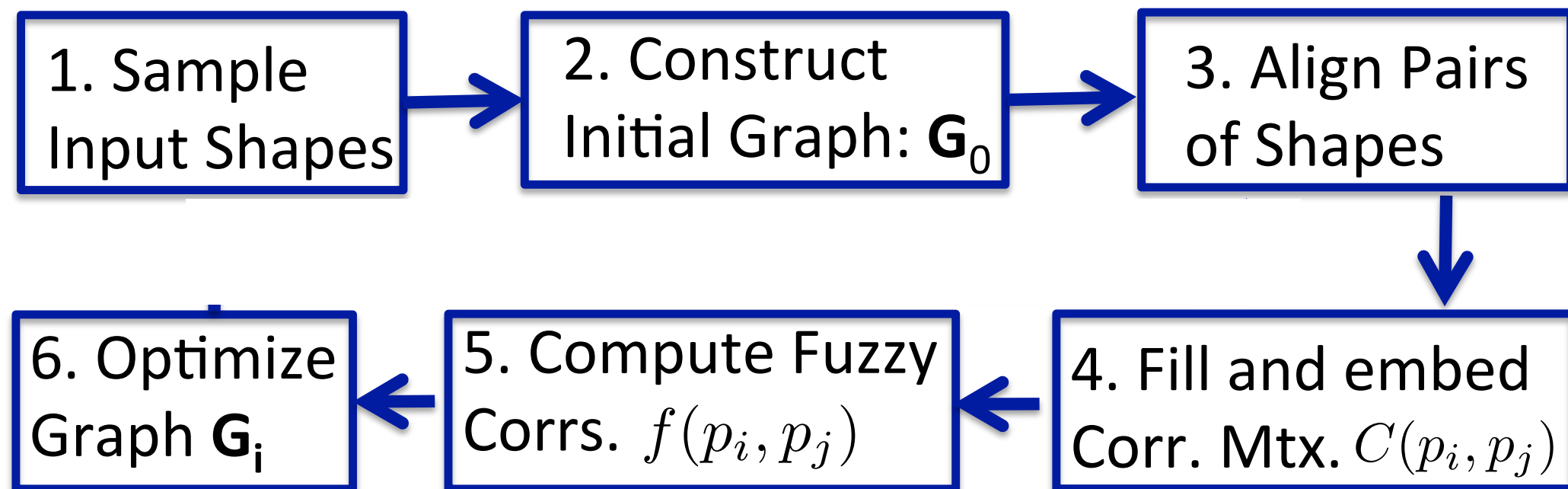
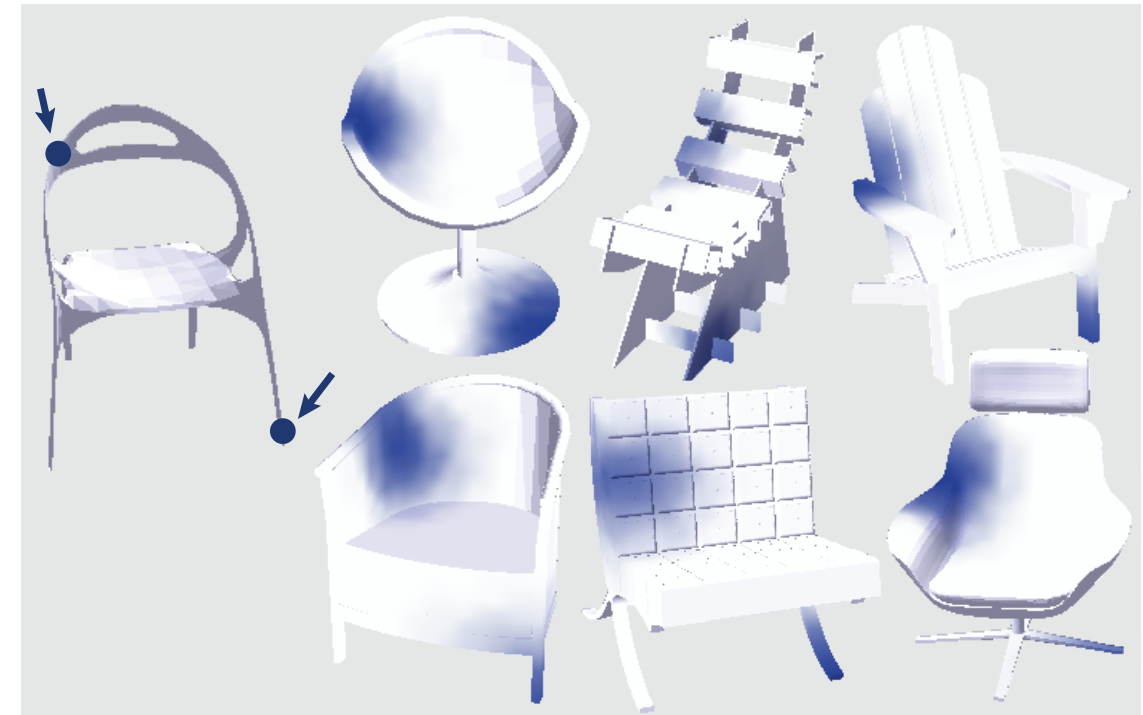


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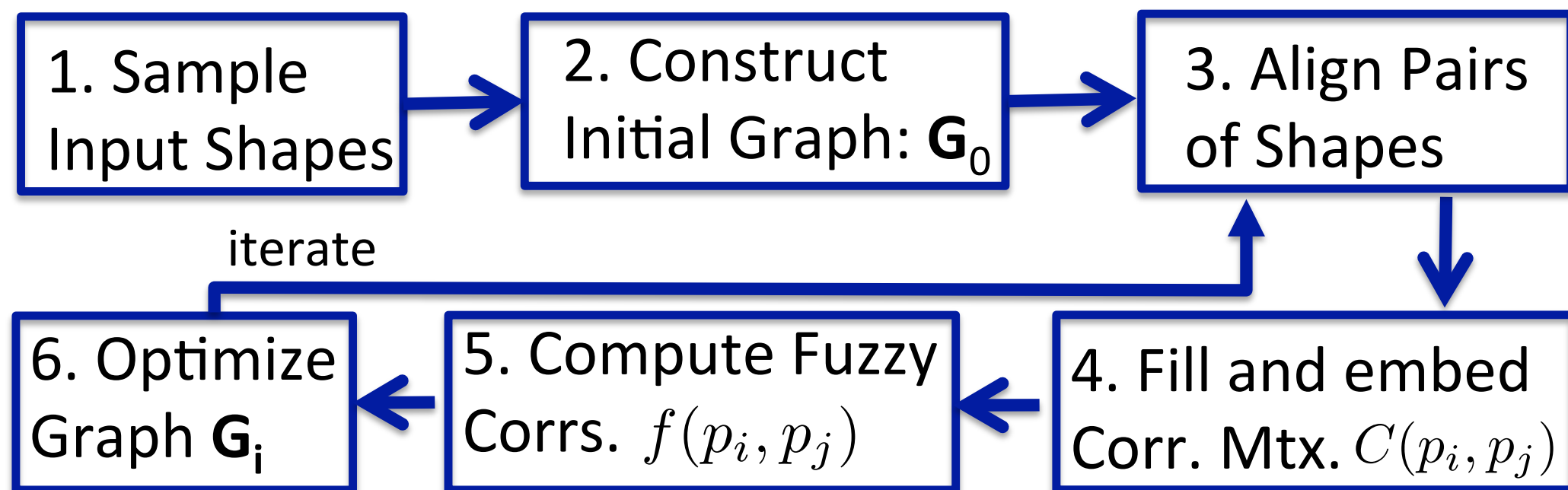
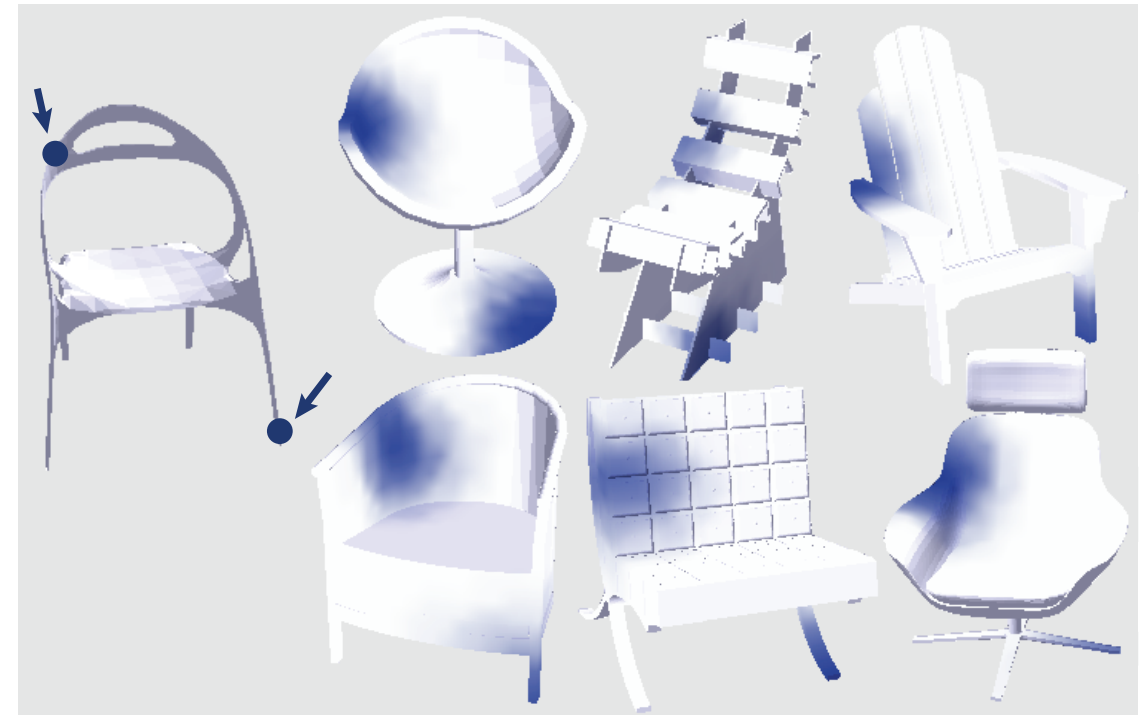


[Kim et al., Siggraph 2012]

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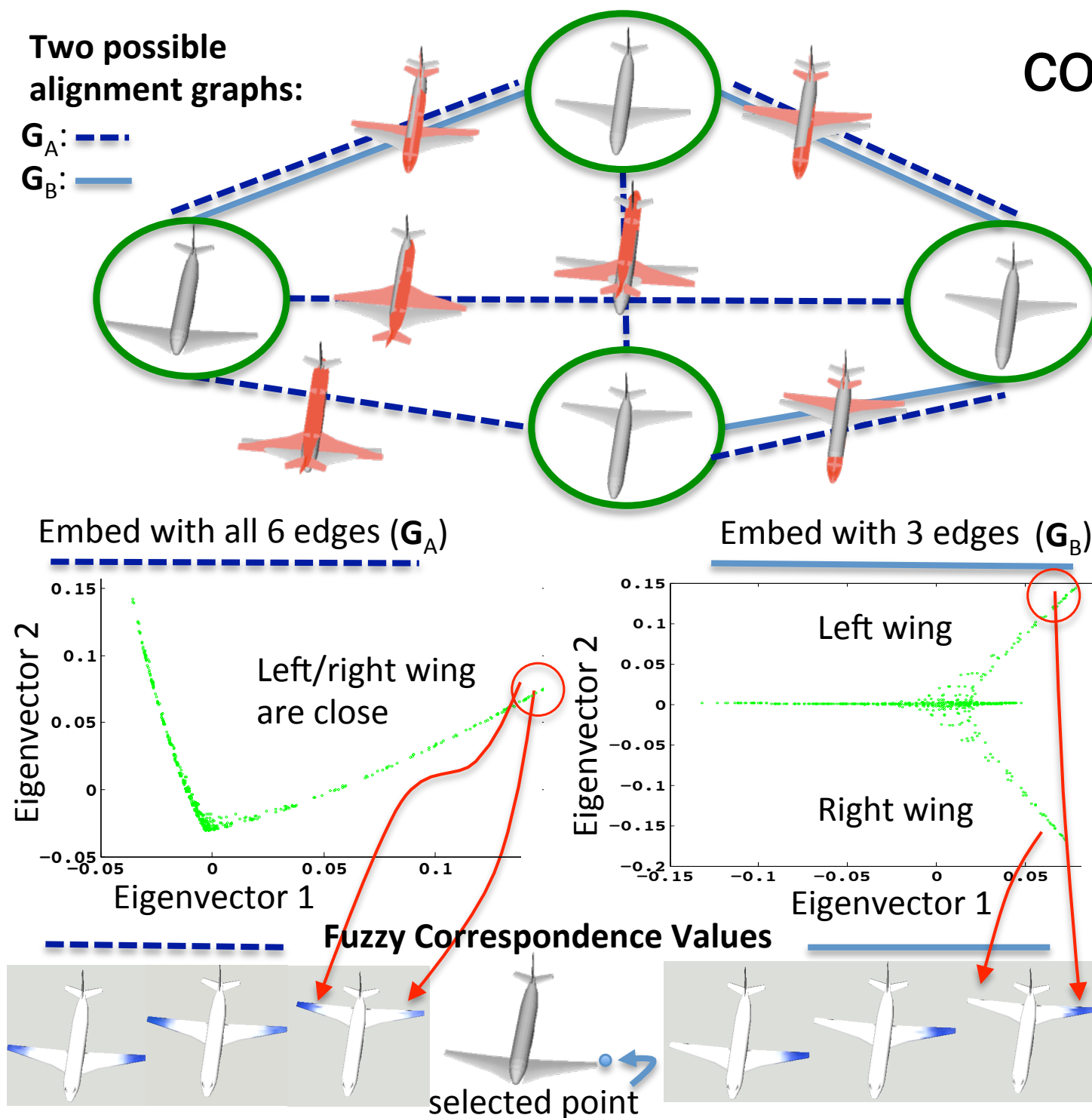
$$f(p_i, p_j) : \mathbf{S} \times \mathbf{S} \rightarrow \mathbb{R}$$



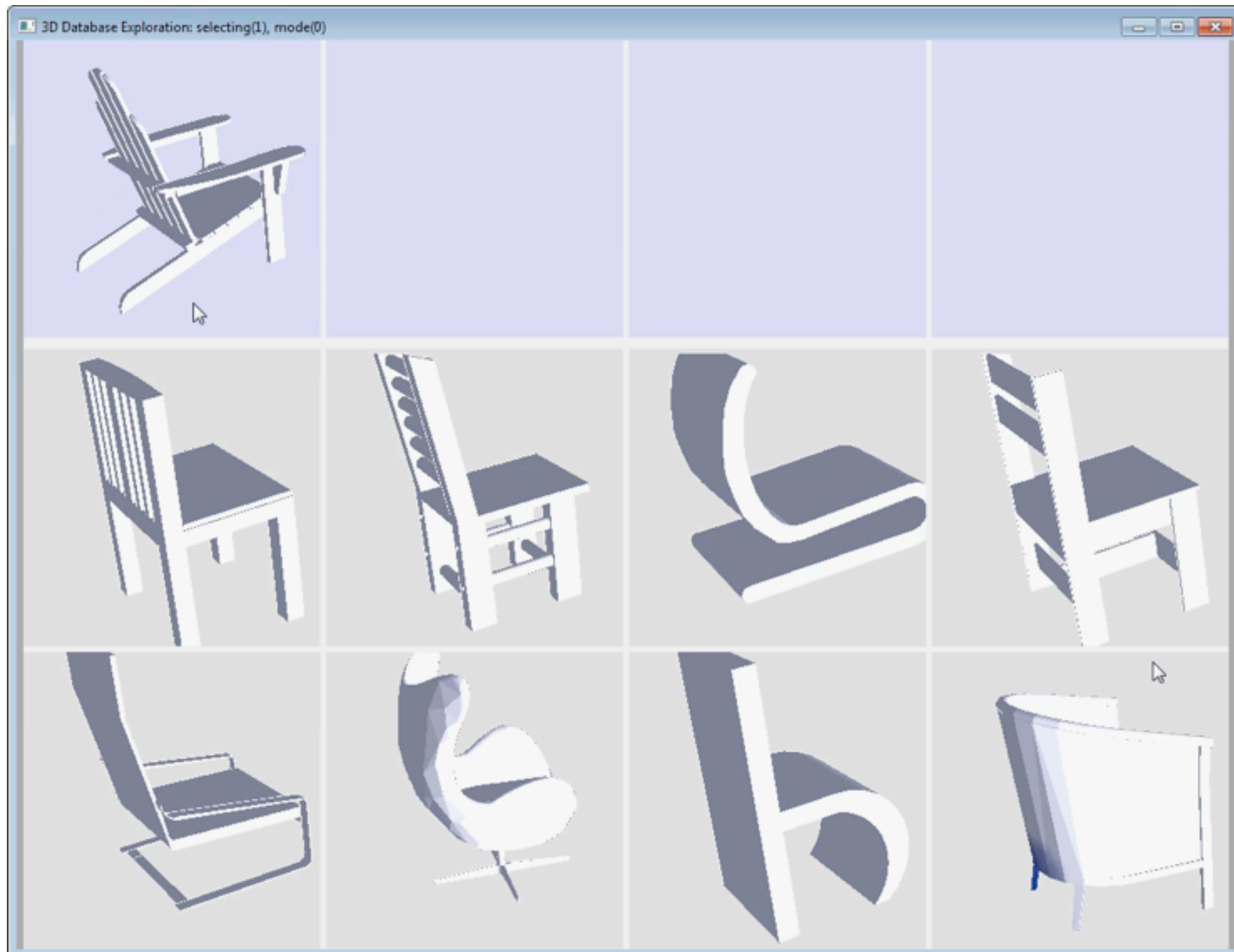
[Kim et al., Siggraph 2012]

Fuzzy Correspondence

correspondence information
can be diffused across
shape collections

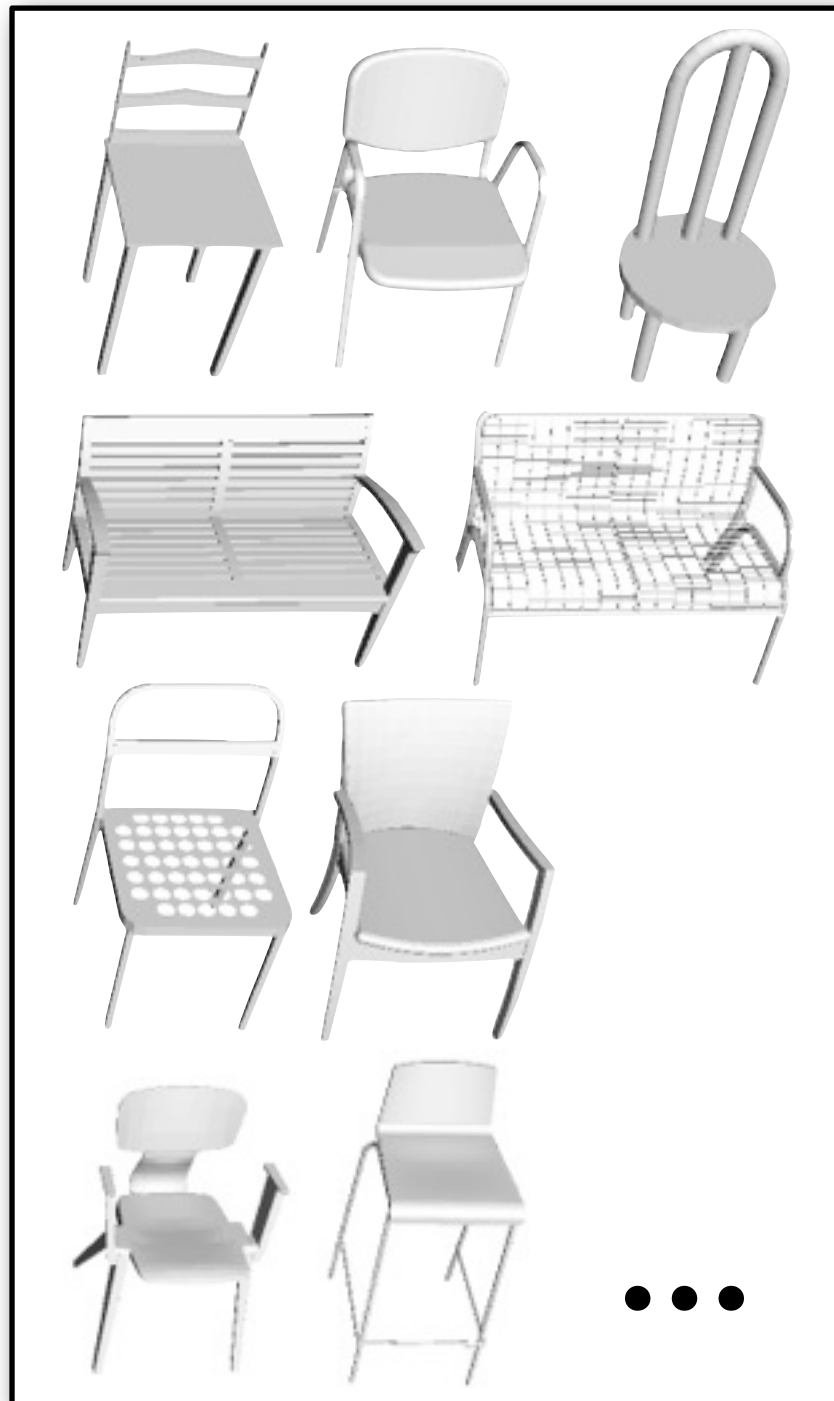


Exploration using FC



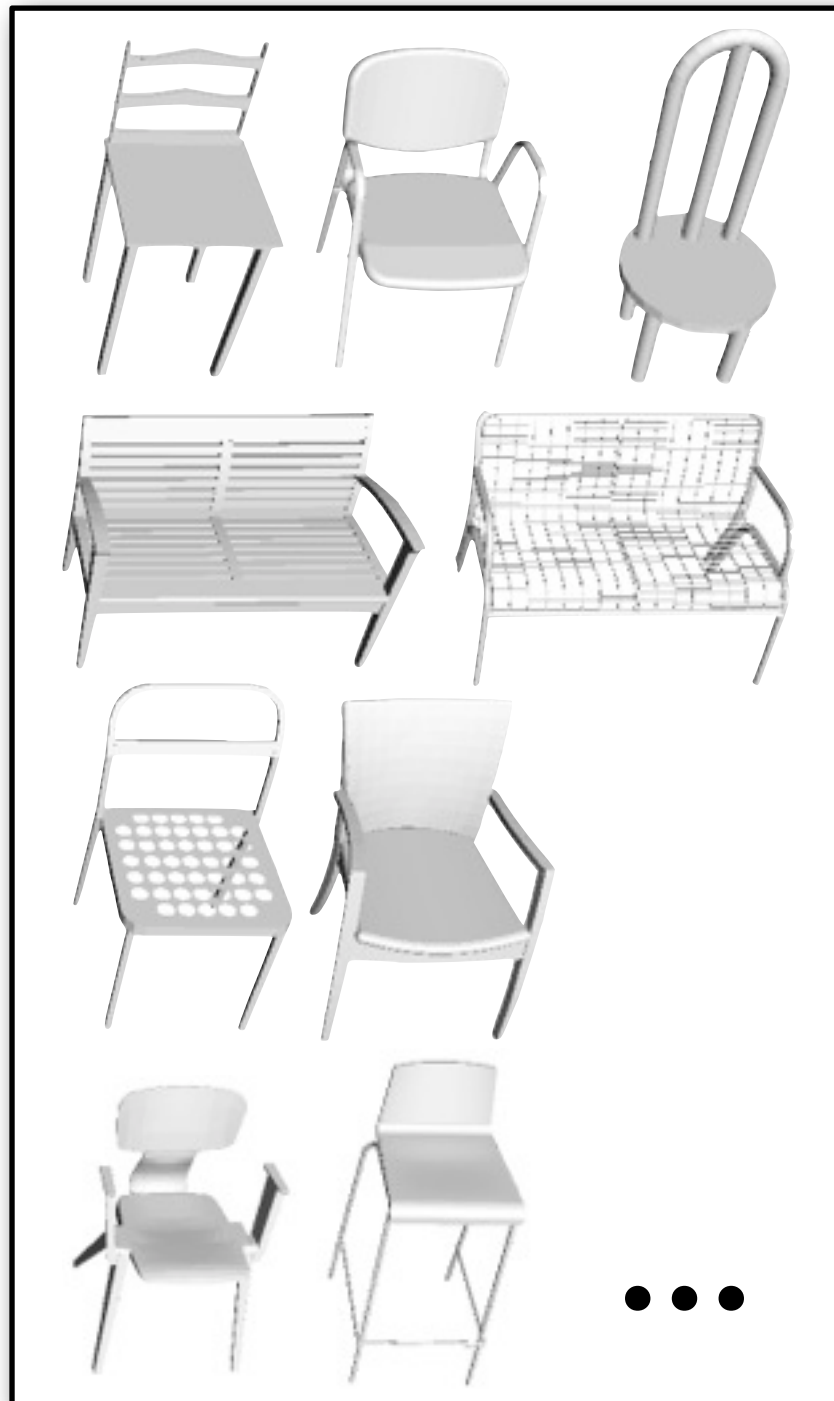
Evolving Templates

[Kim et al., Siggraph 2013]



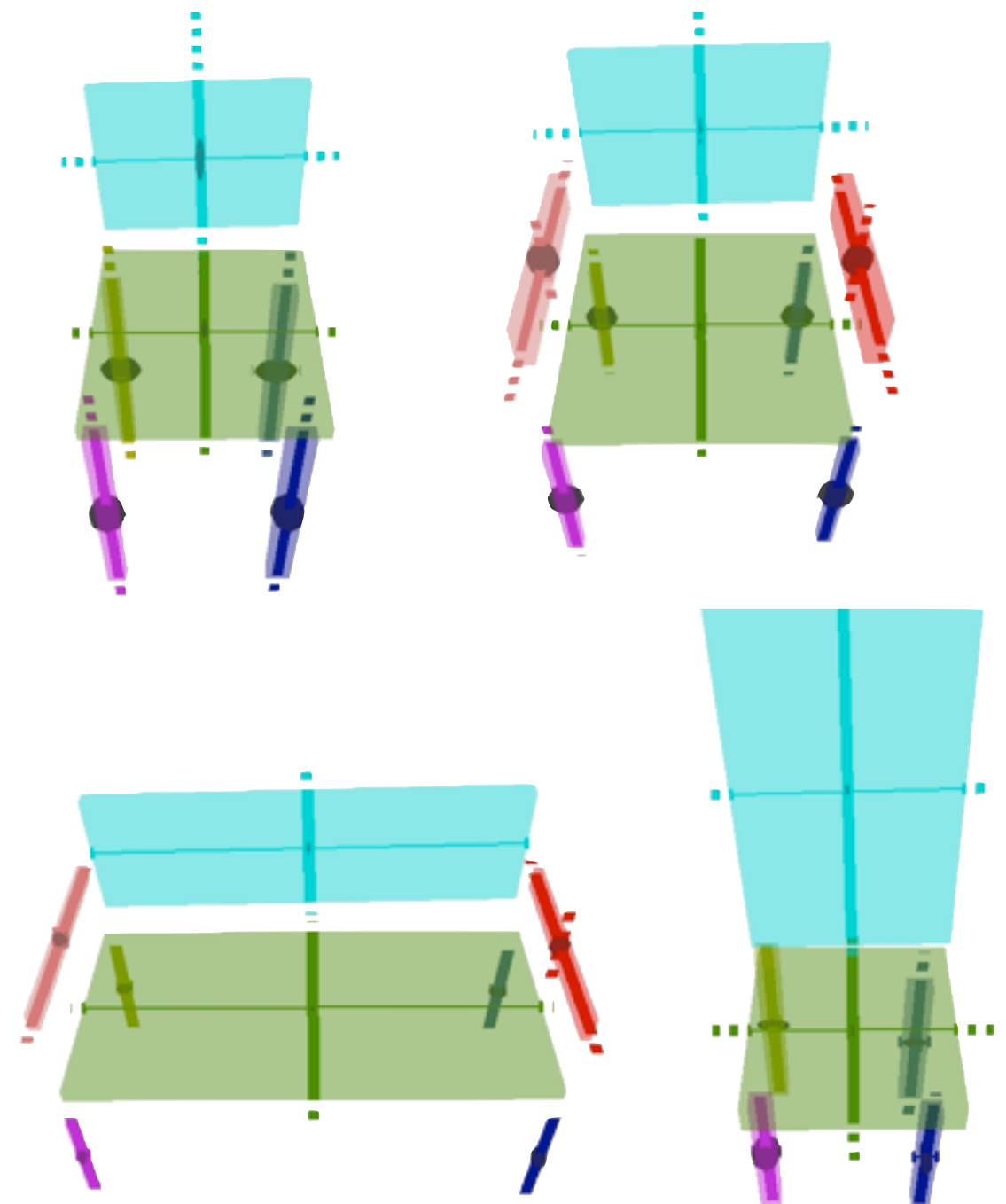
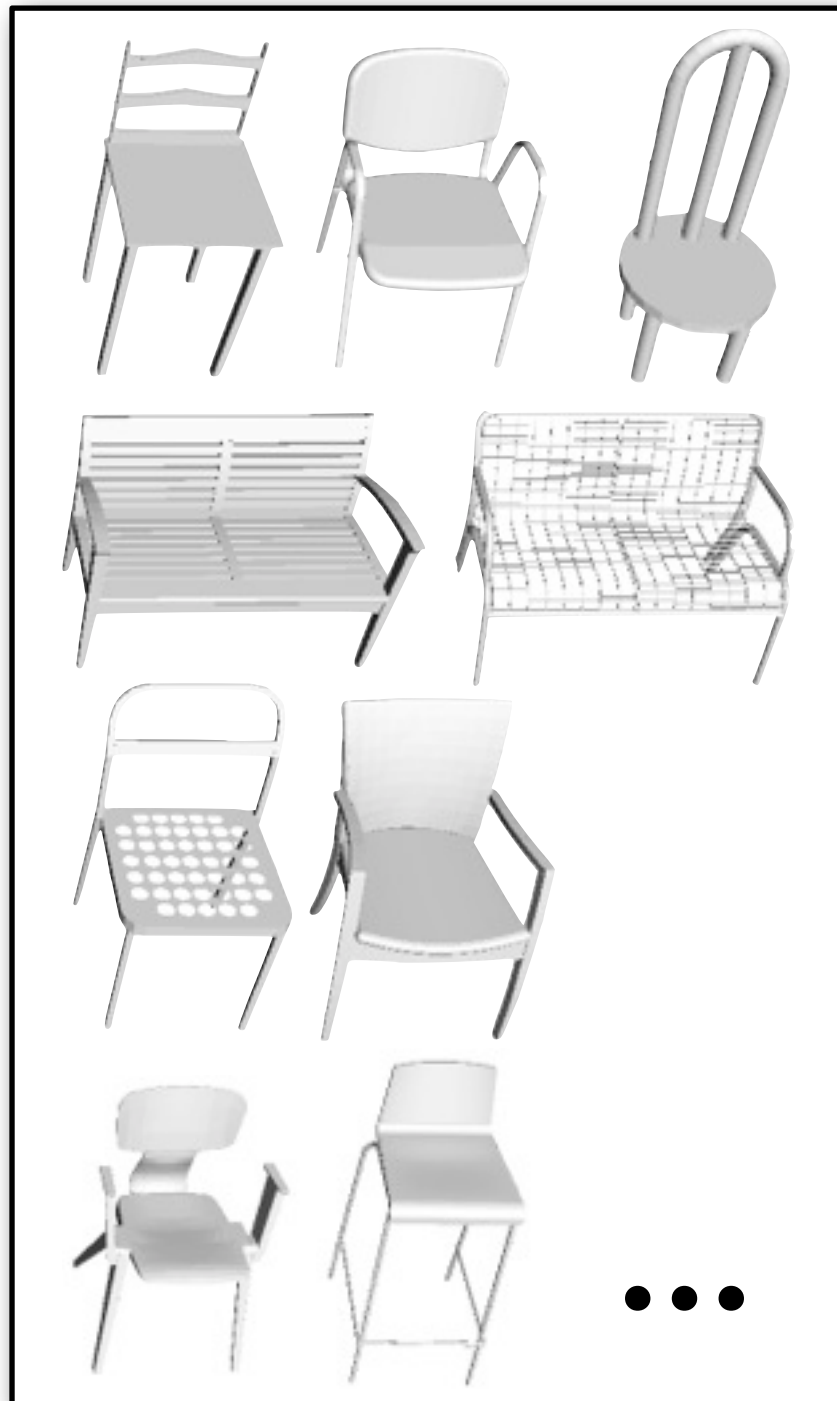
Evolving Templates

[Kim et al., Siggraph 2013]

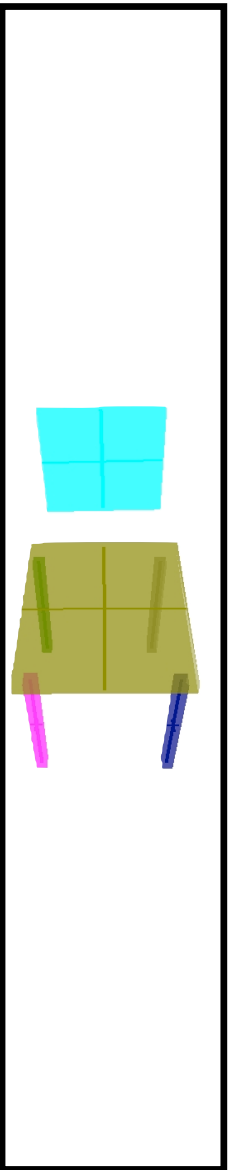


Evolving Templates

[Kim et al., Siggraph 2013]

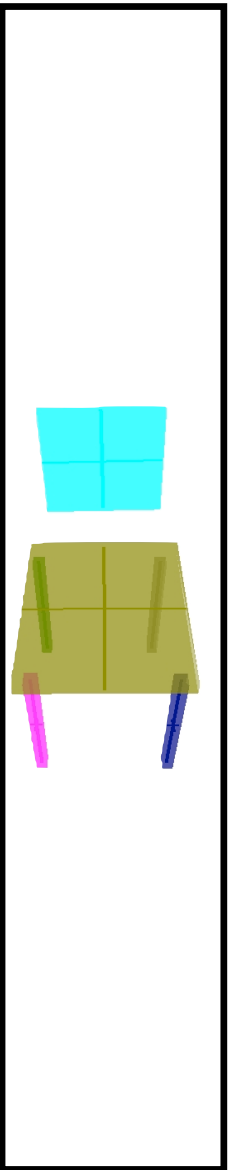


Evolving Templates

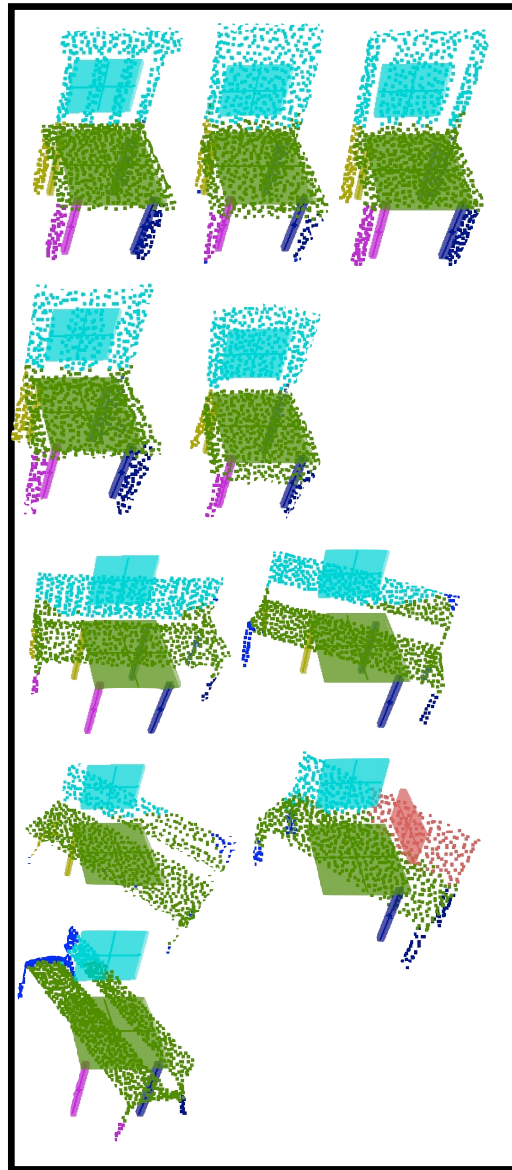


a. Initial Template

Evolving Templates

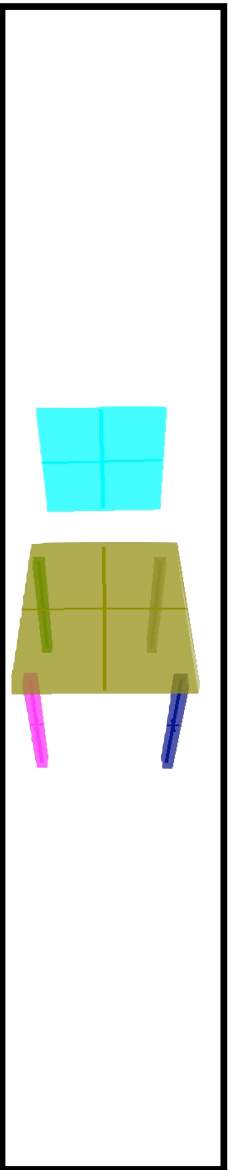


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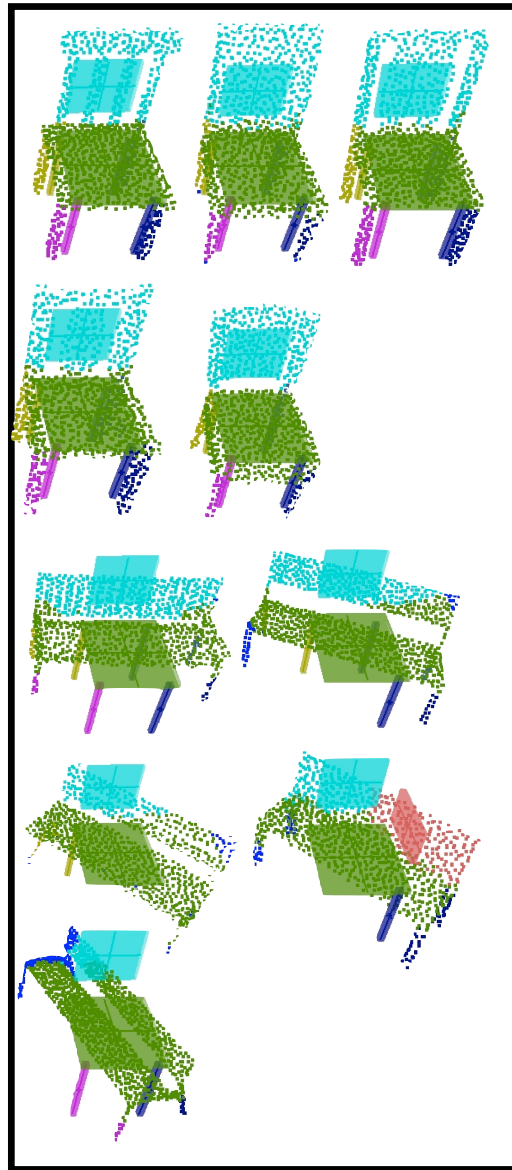


b. Fitting Set

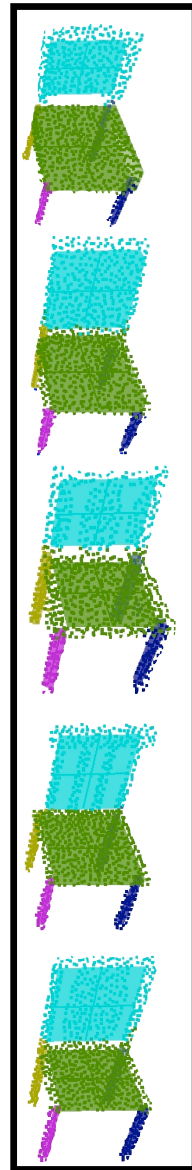
Evolving Templates



a. Initial Template

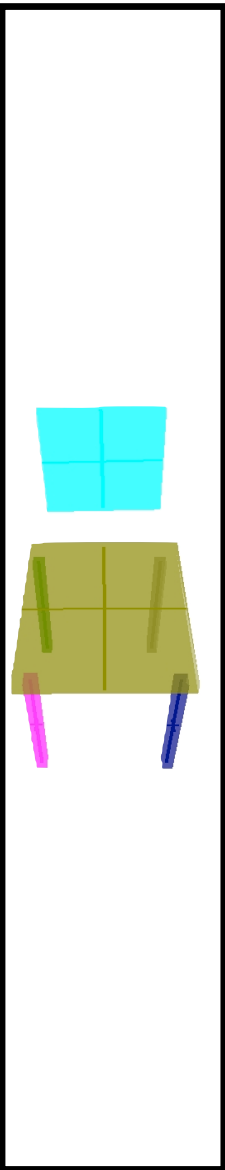


b. Fitting Set

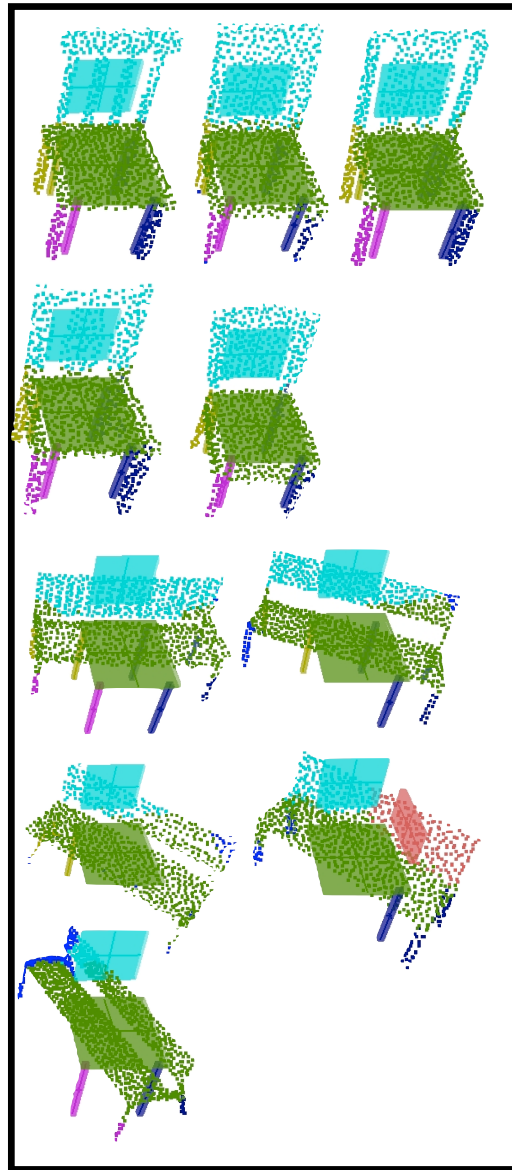


c. Learning Set

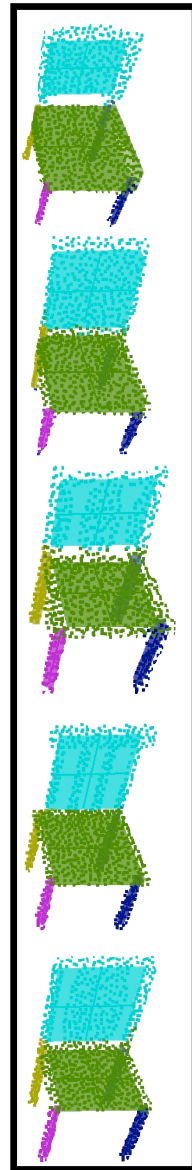
Evolving Templates



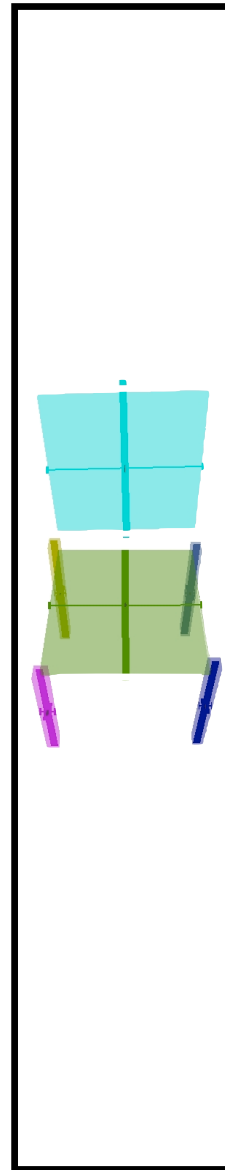
a. Initial Template



b. Fitting Set

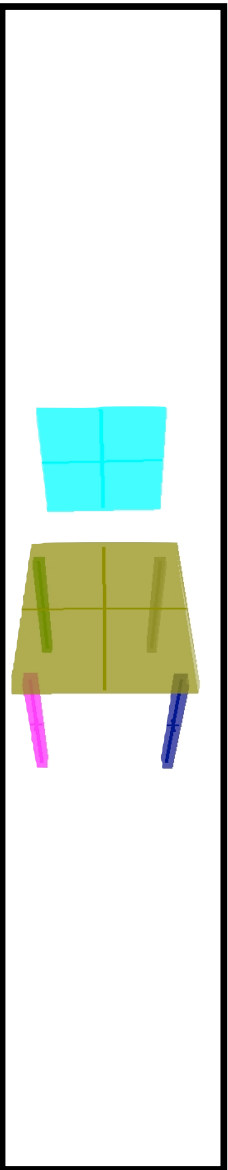


c. Learning Set

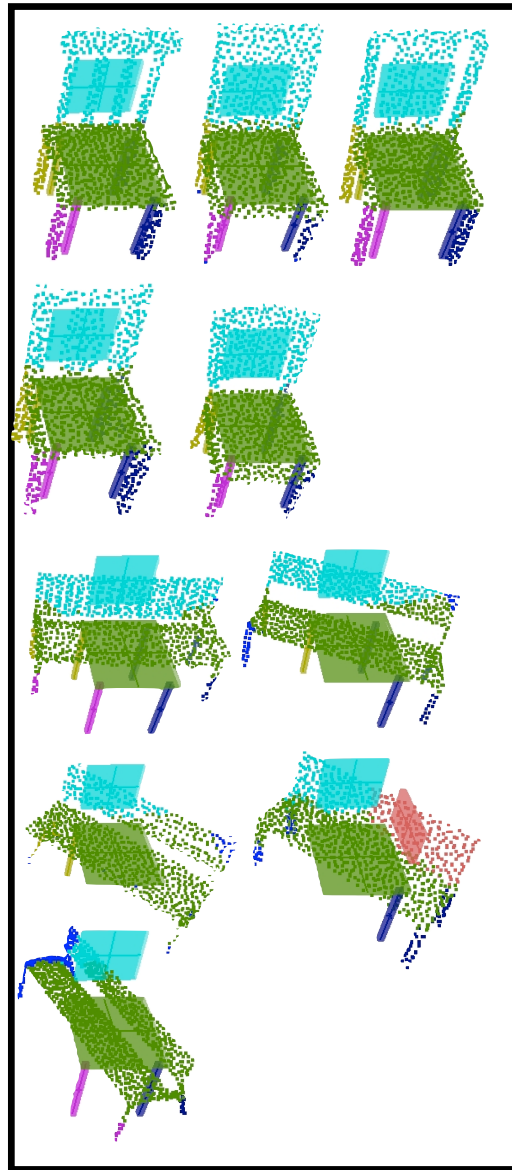


d. Updated Templates

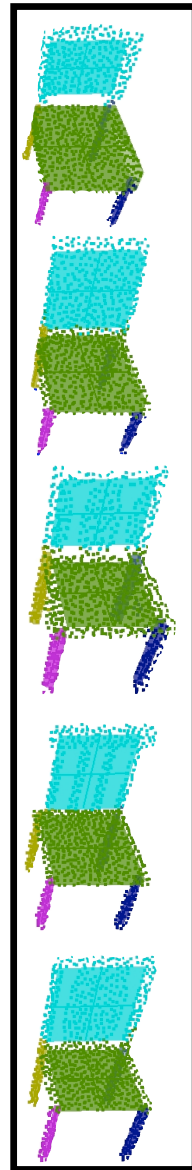
Evolving Templates



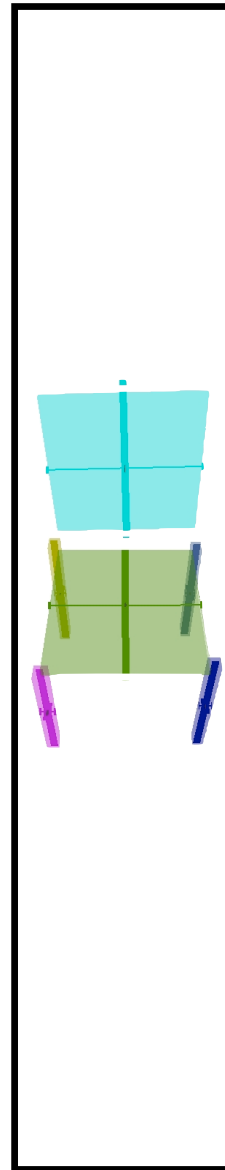
a. Initial Template



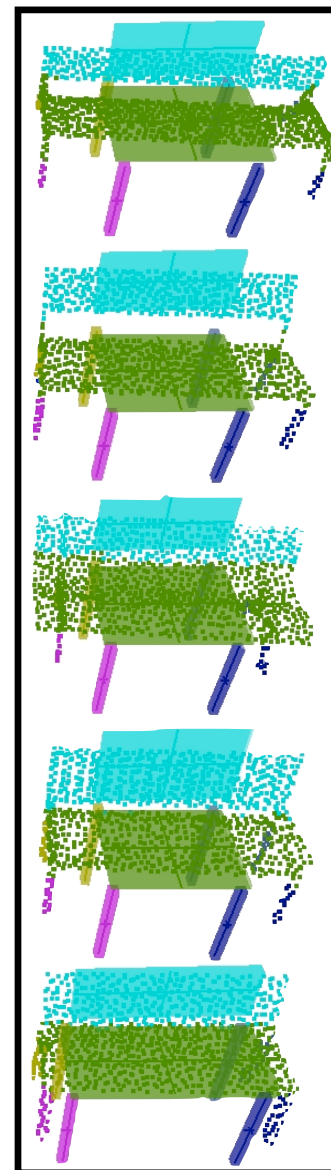
b. Fitting Set



c. Learning Set

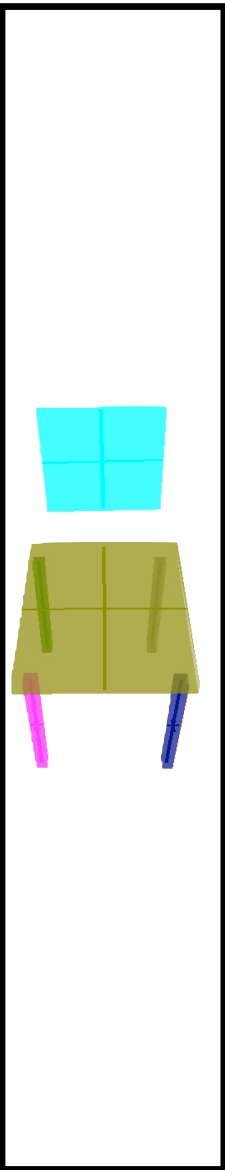


d. Updated Templates

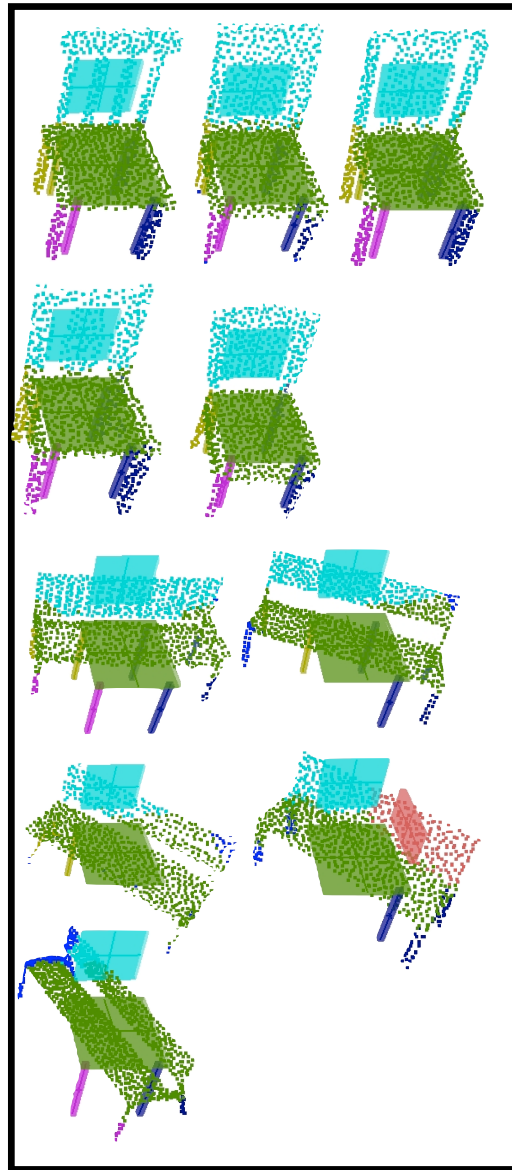


e. Fitting Set

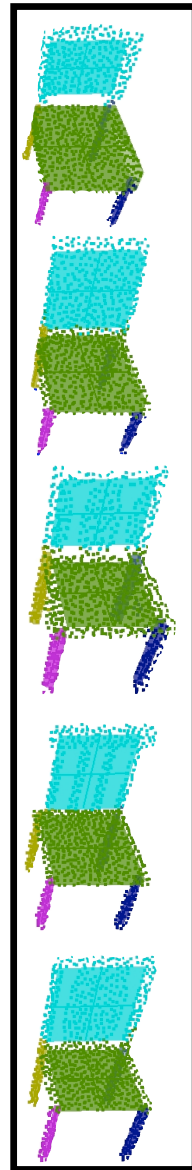
Evolving Templates



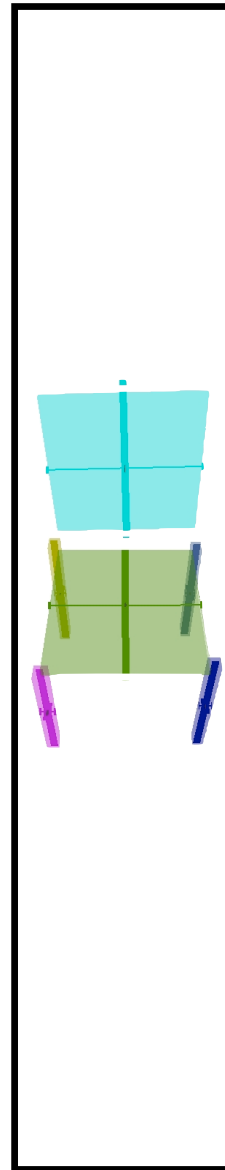
a. Initial Template



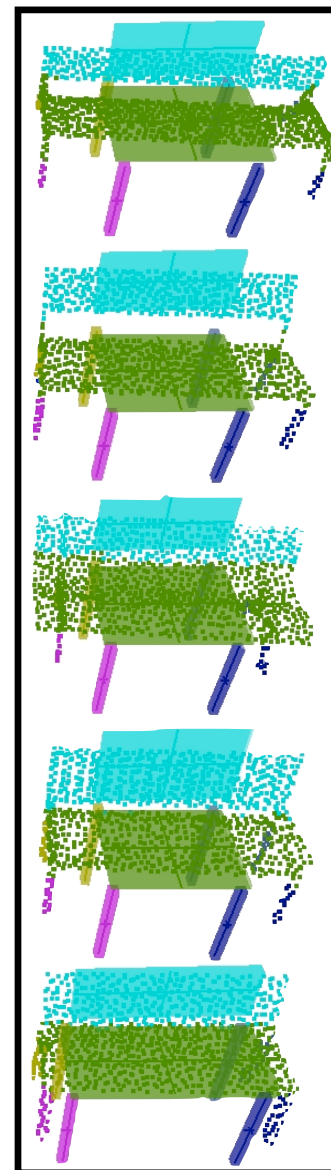
b. Fitting Set



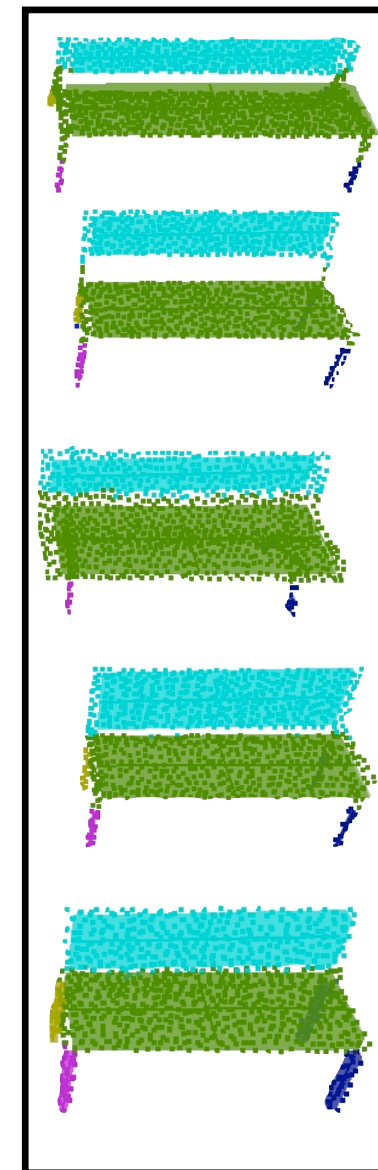
c. Learning Set



d. Updated Templates

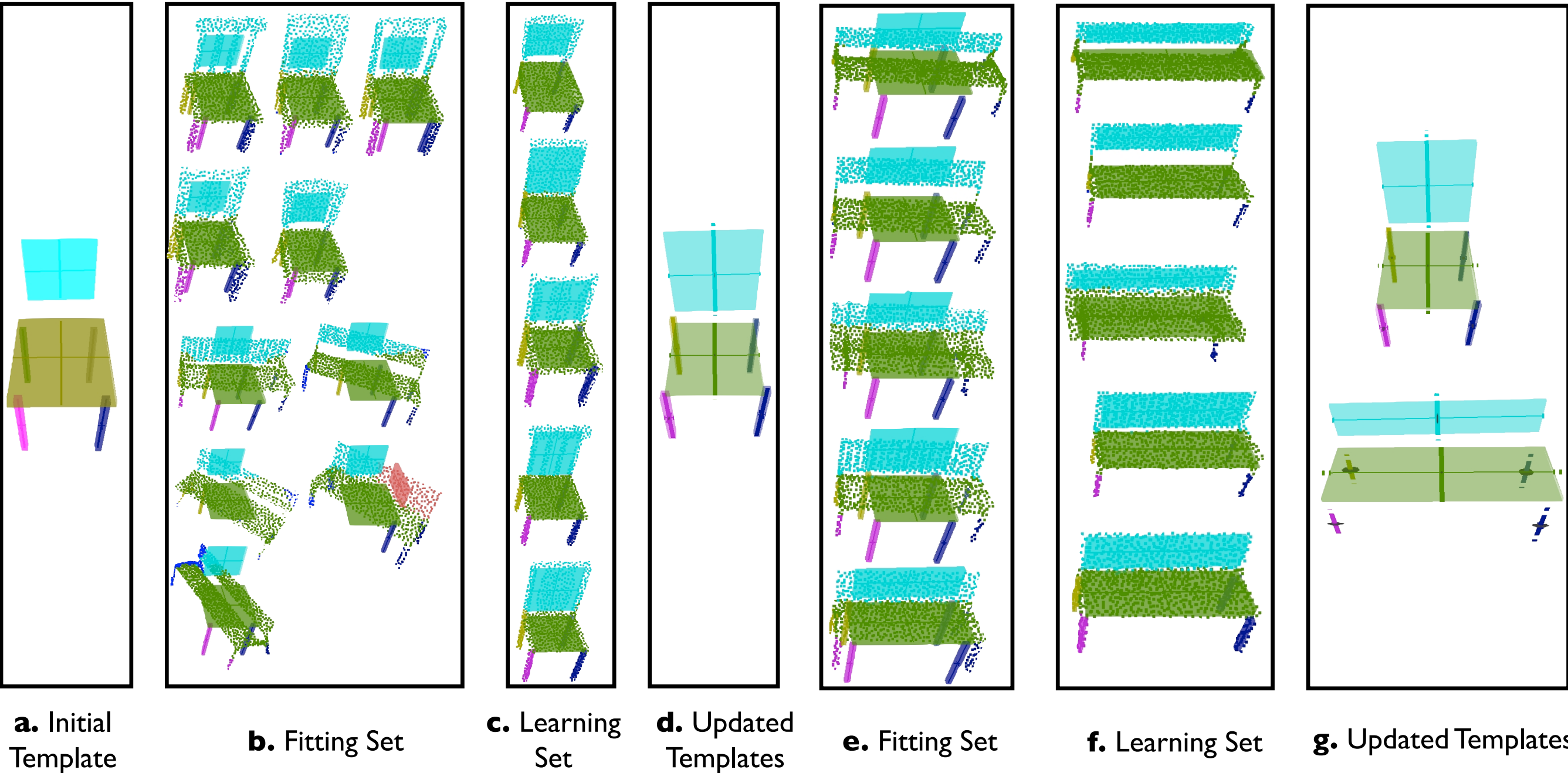


e. Fitting Set

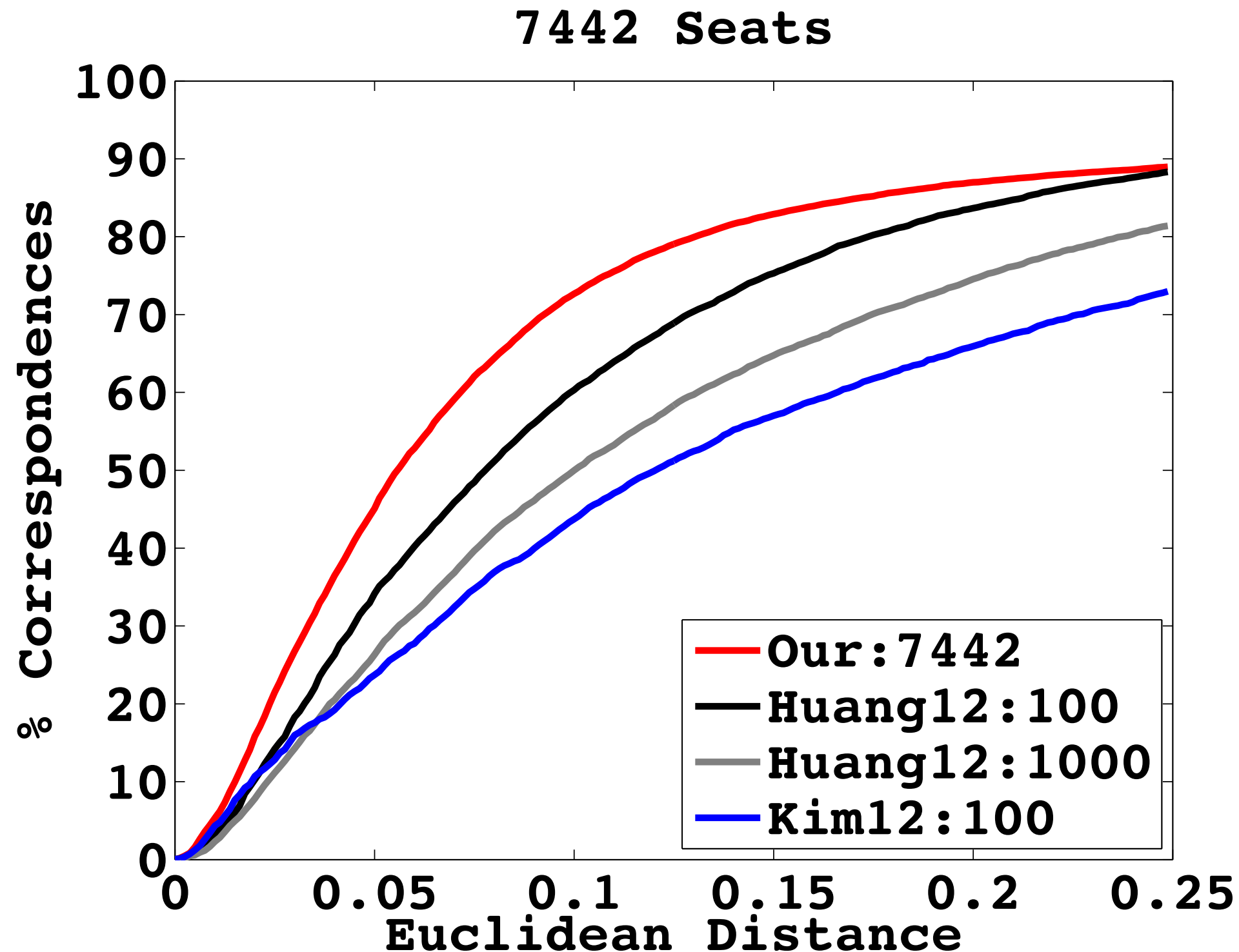


f. Learning Set

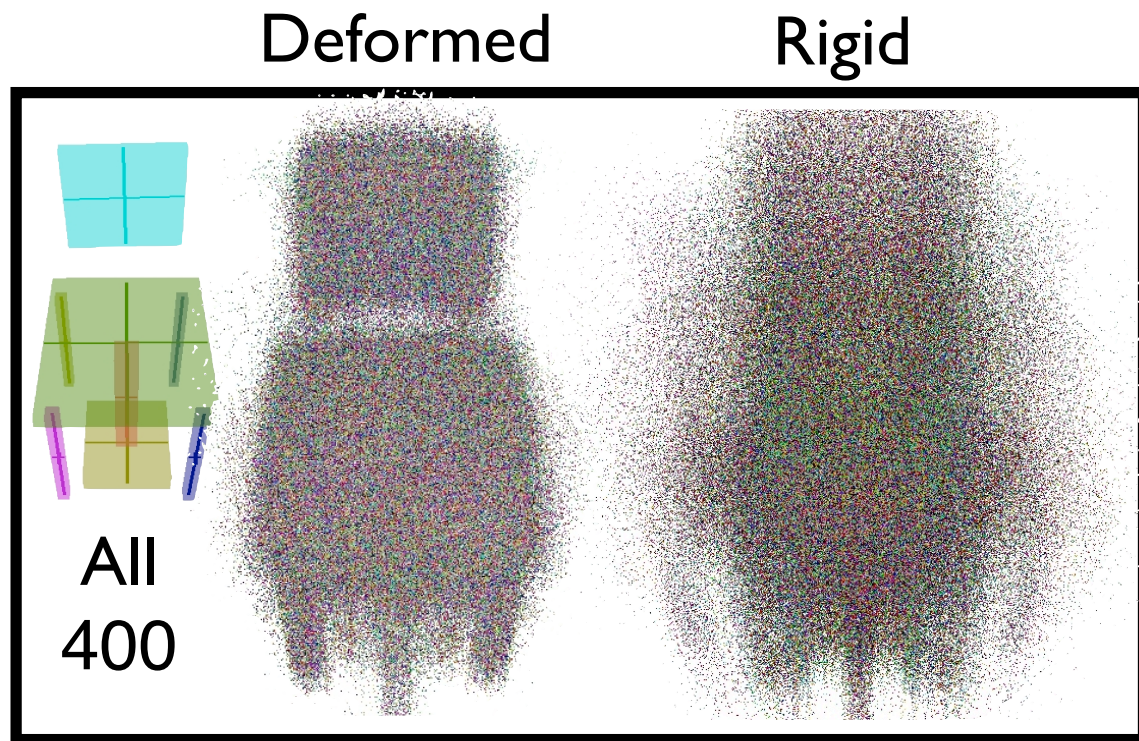
Evolving Templates



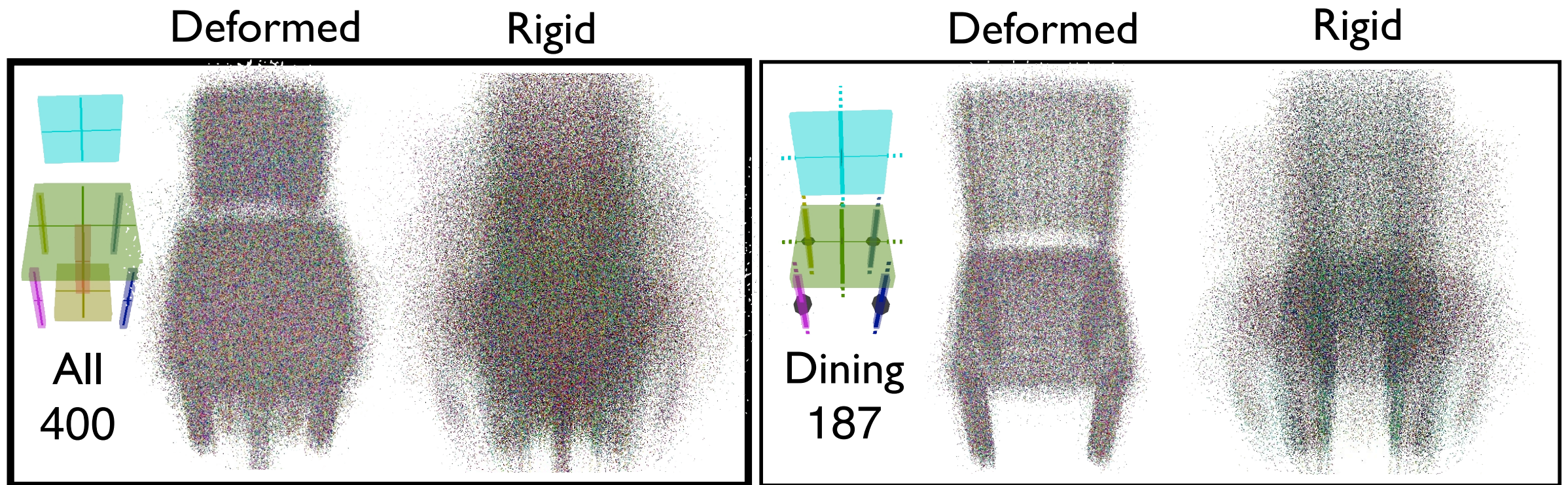
Correspondence Benchmark



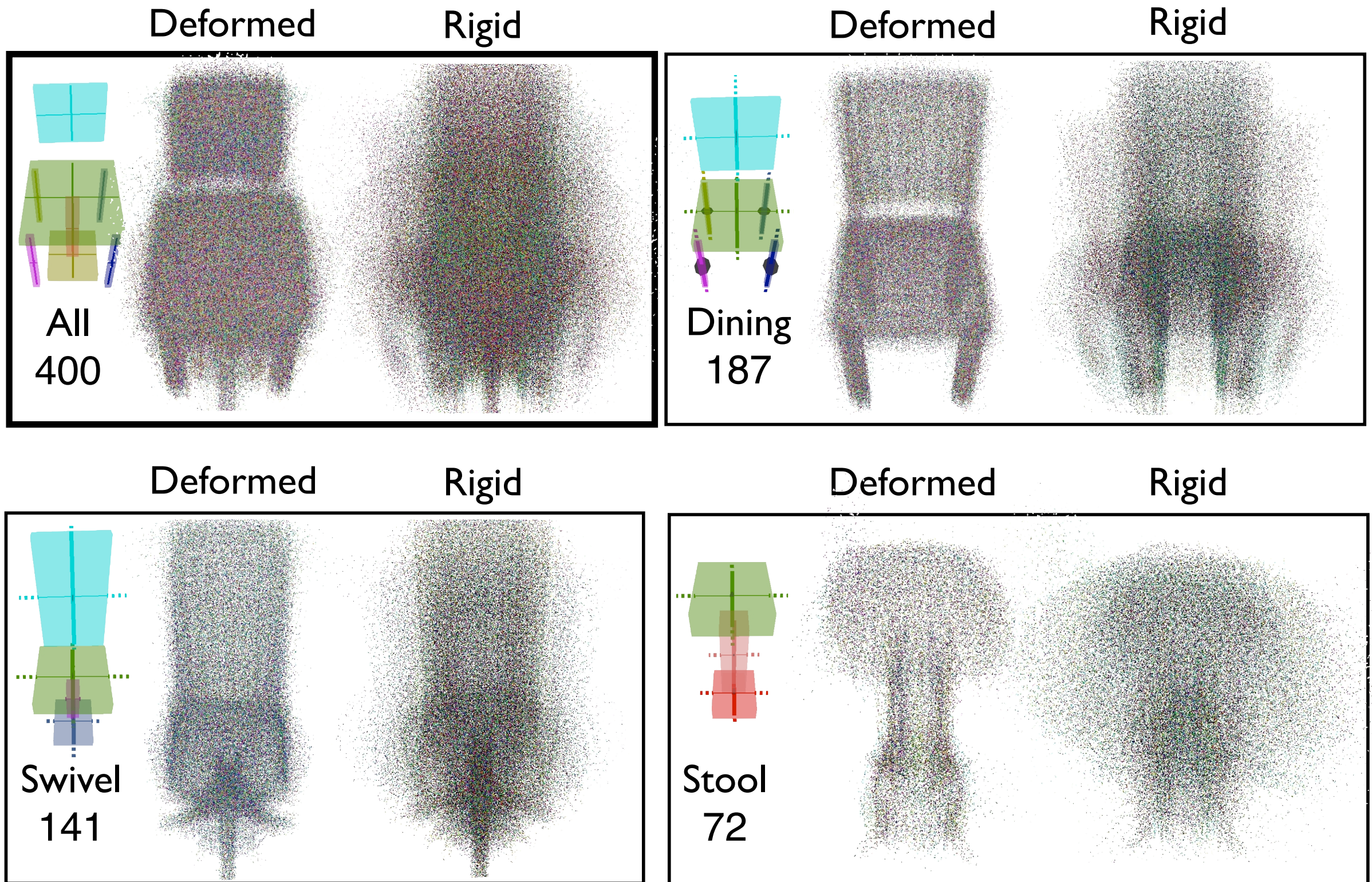
Variations in deformation of parts



Variations in deformation of parts



Variations in deformation of parts

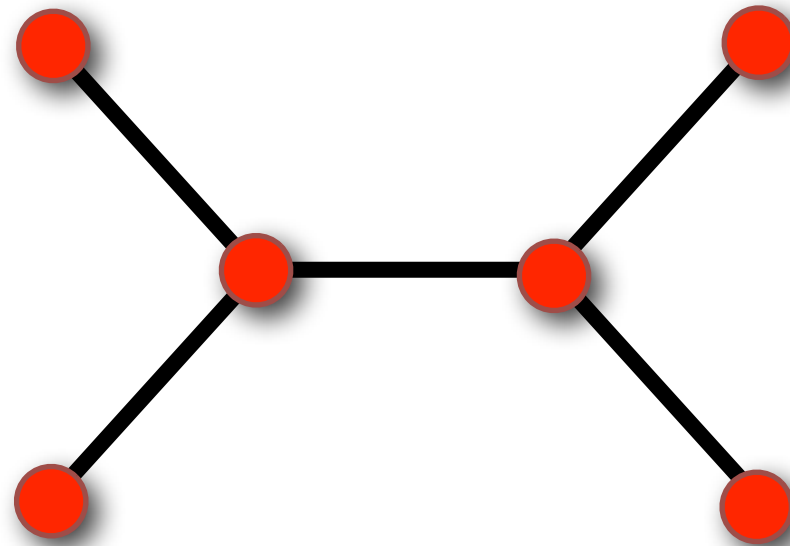


Relative Comparison Among a Quartet of Shapes



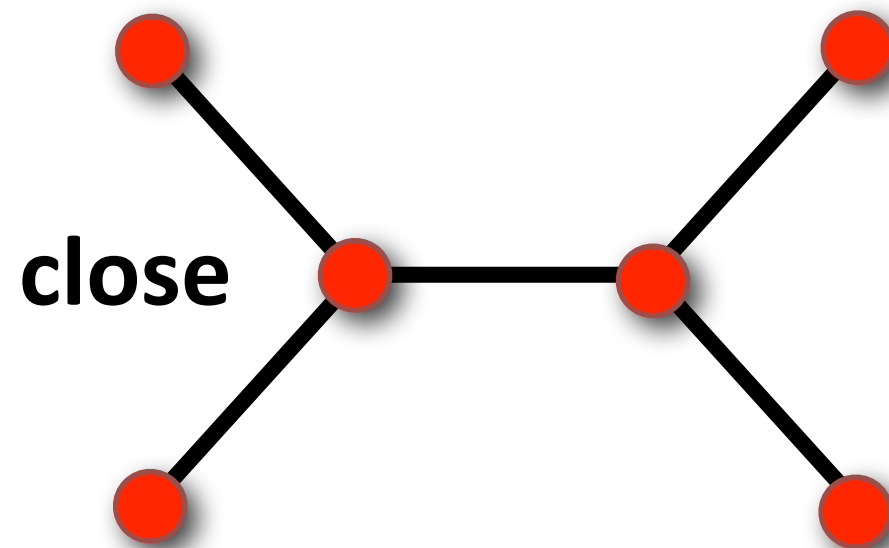
[Huang et al., Siggraph 2013]

Relative Comparison Among a Quartet of Shapes



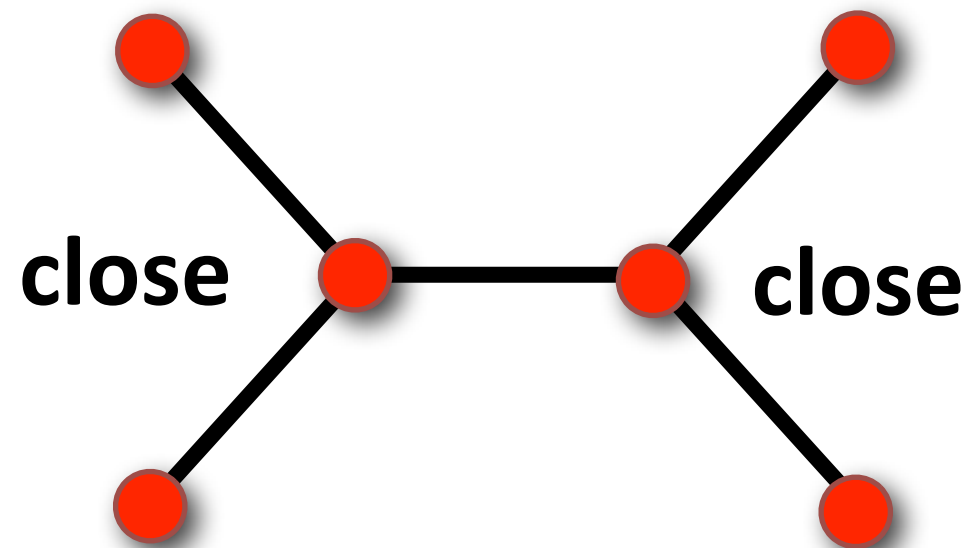
[Huang et al., Siggraph 2013]

Relative Comparison Among a Quartet of Shapes



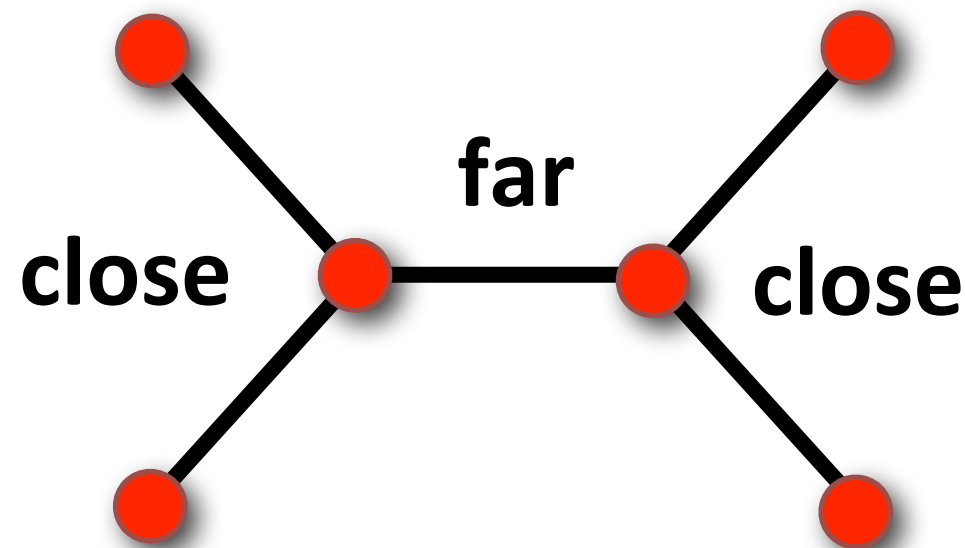
[Huang et al., Siggraph 2013]

Relative Comparison Among a Quartet of Shapes



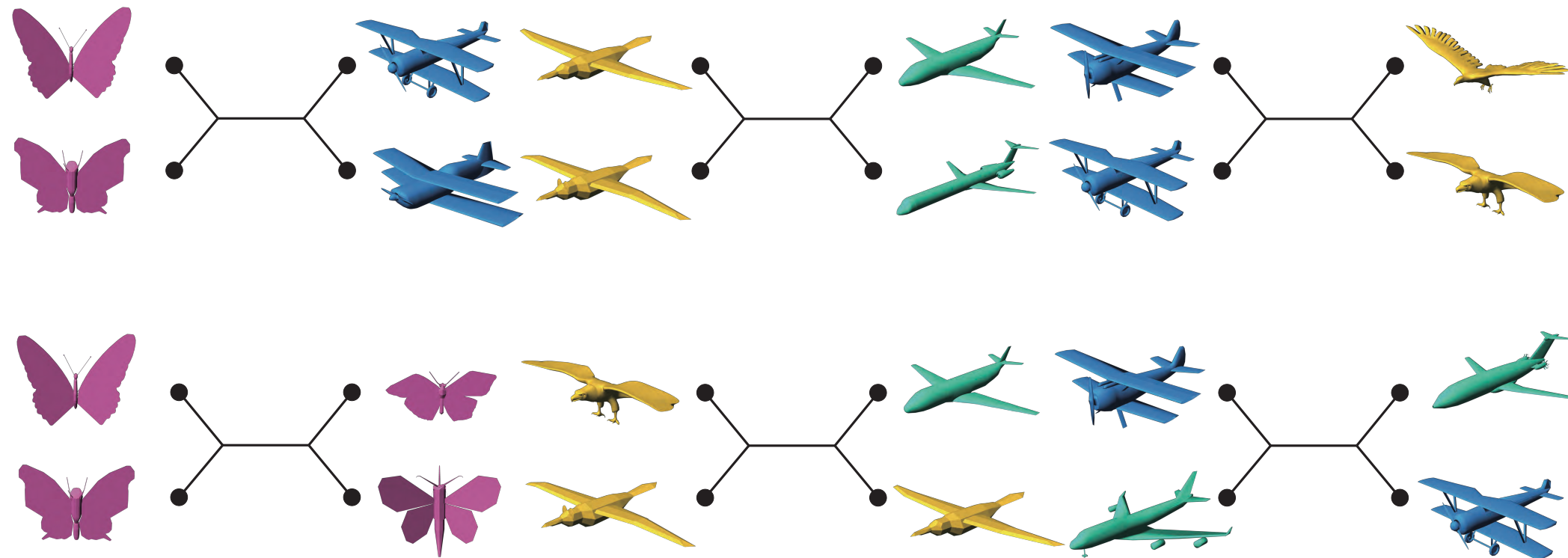
[Huang et al., Siggraph 2013]

Relative Comparison Among a Quartet of Shapes

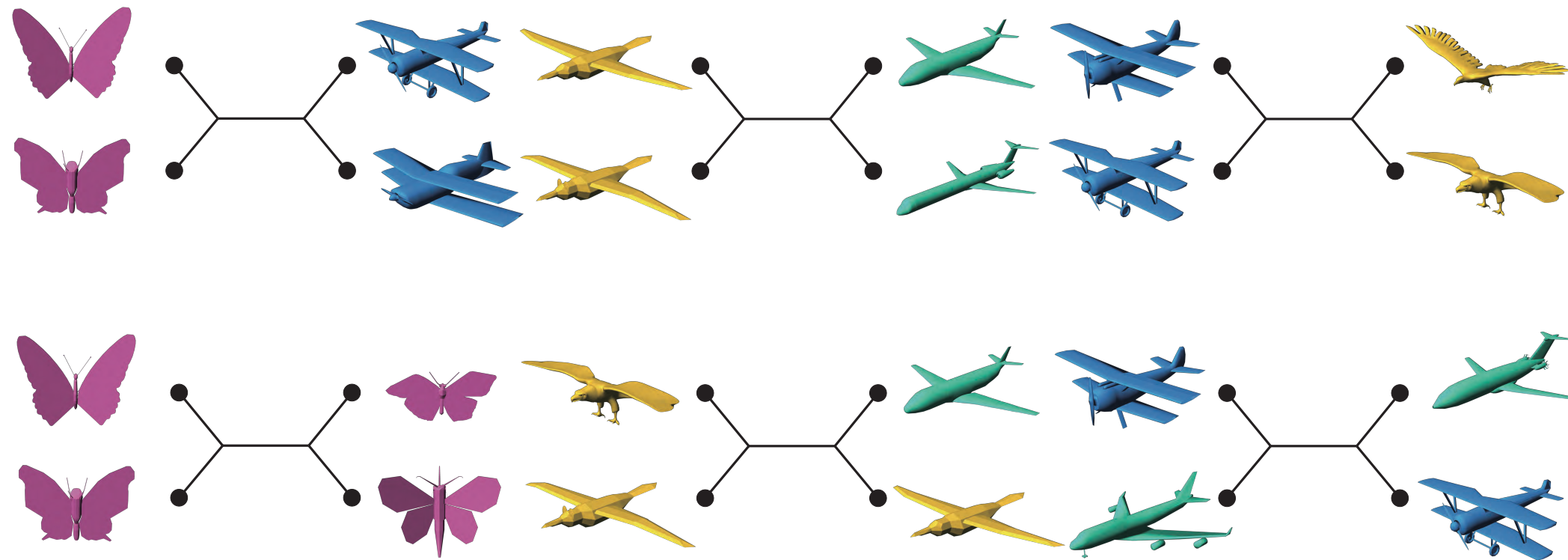


[Huang et al., Siggraph 2013]

Quartet Analysis

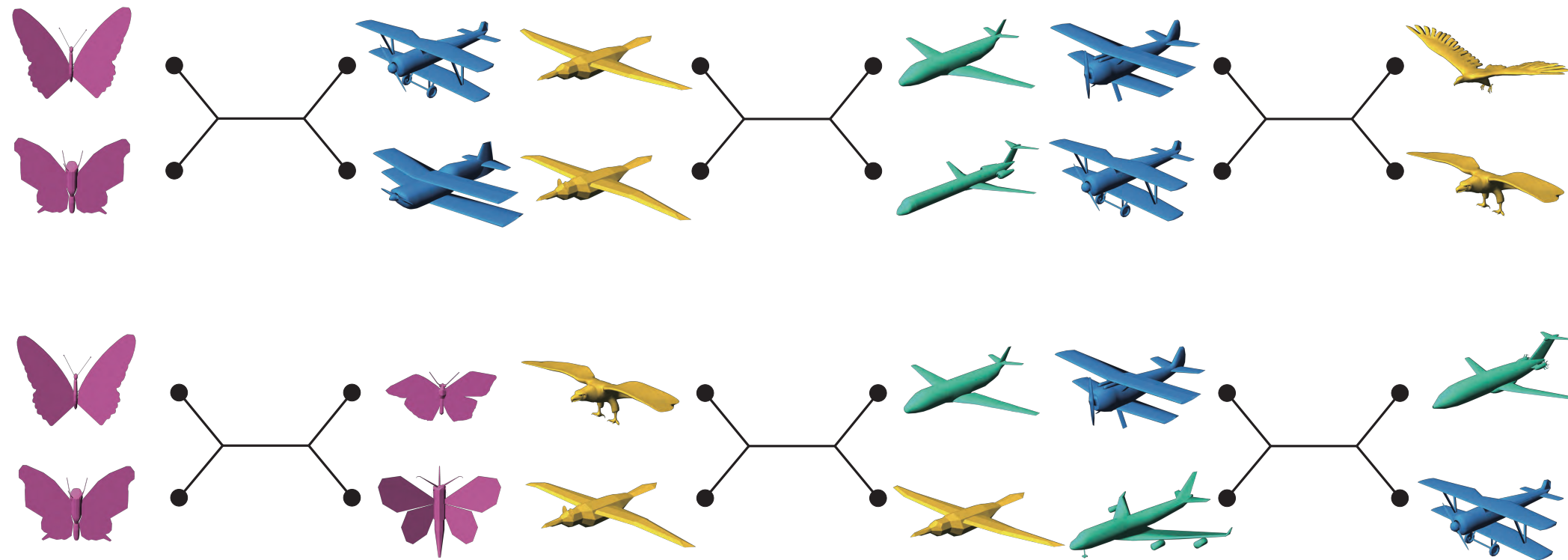


Quartet Analysis



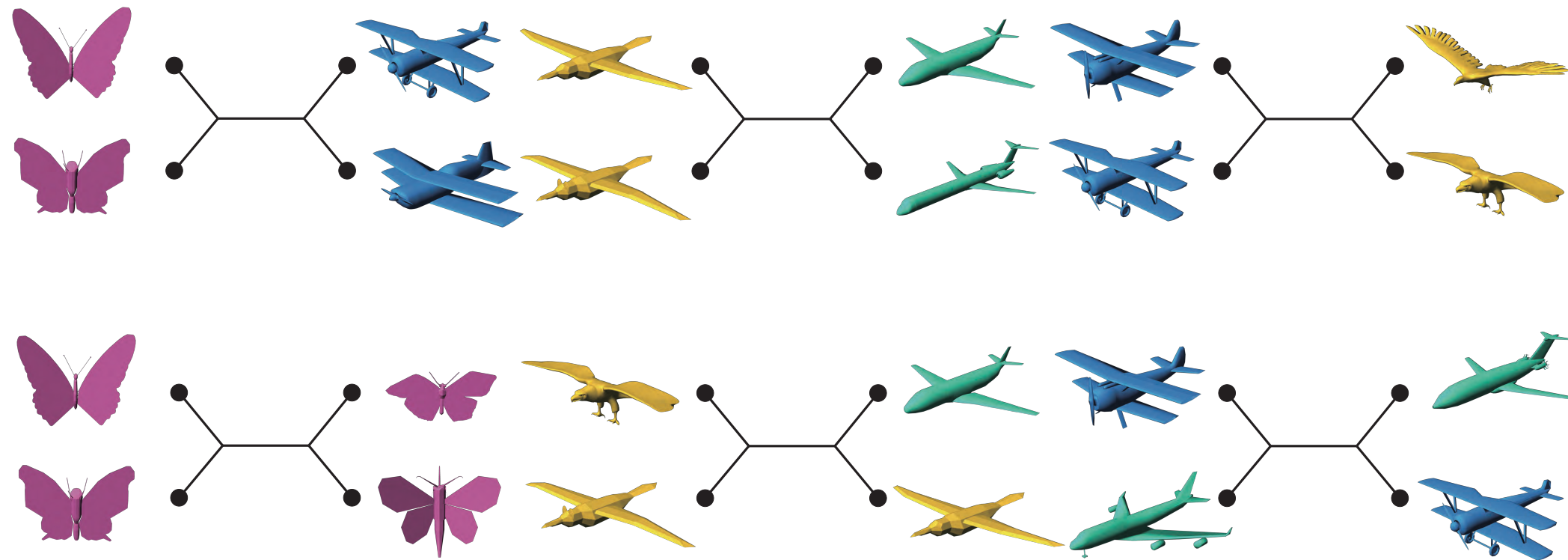
- **reconstruct** Phylogenetic trees [Snir and Rao 2010]

Quartet Analysis



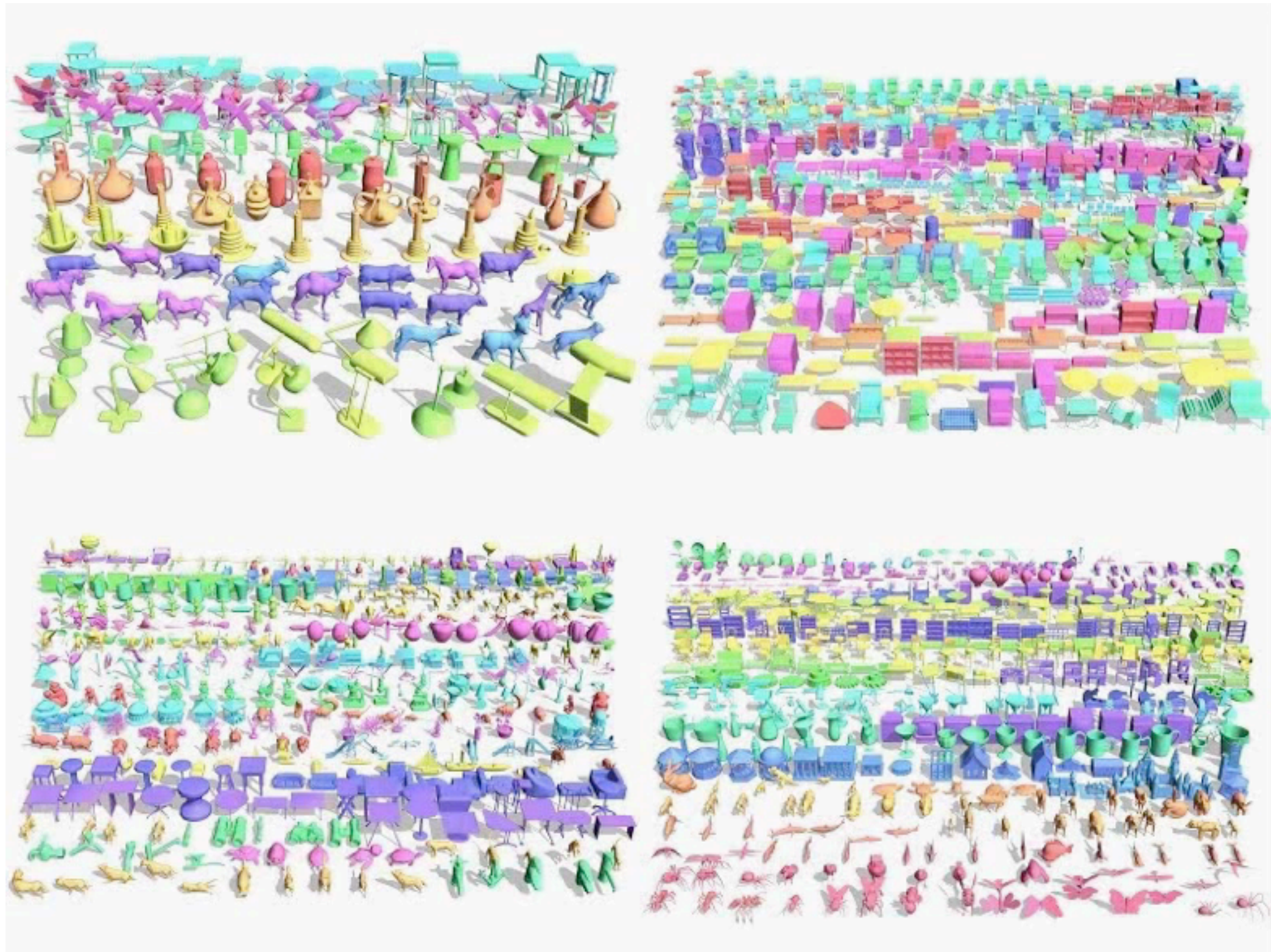
- **reconstruct** Phylogenetic trees [Snir and Rao 2010]
- **embed** points (meshes) using quartet information

Quartet Analysis



- **reconstruct** Phylogenetic trees [Snir and Rao 2010]
- **embed** points (meshes) using quartet information
- use the embedding to **recursively partition** the points to form a hierarchy (agglomerative clustering)

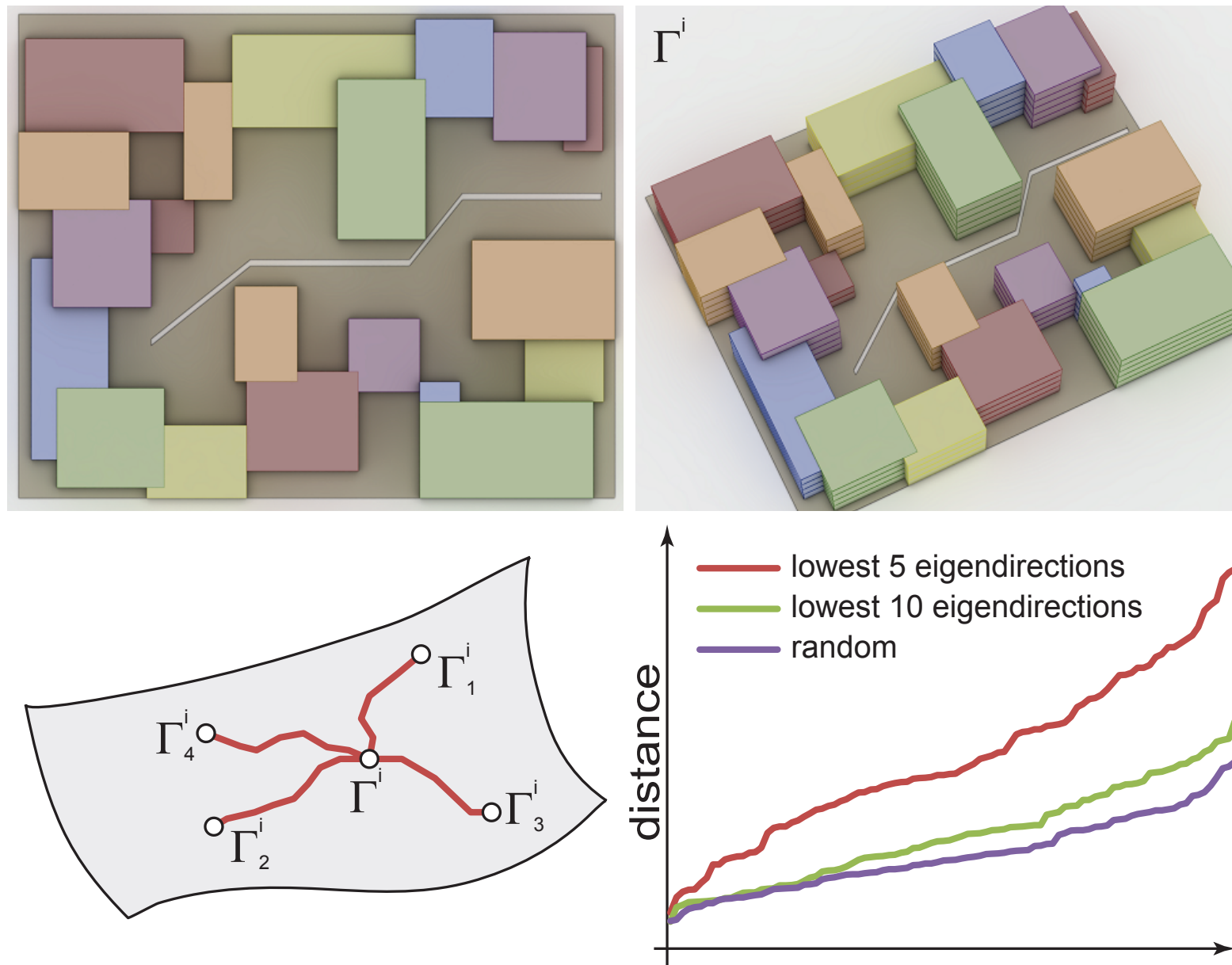
Exploration using Dos Chart



Recall ...

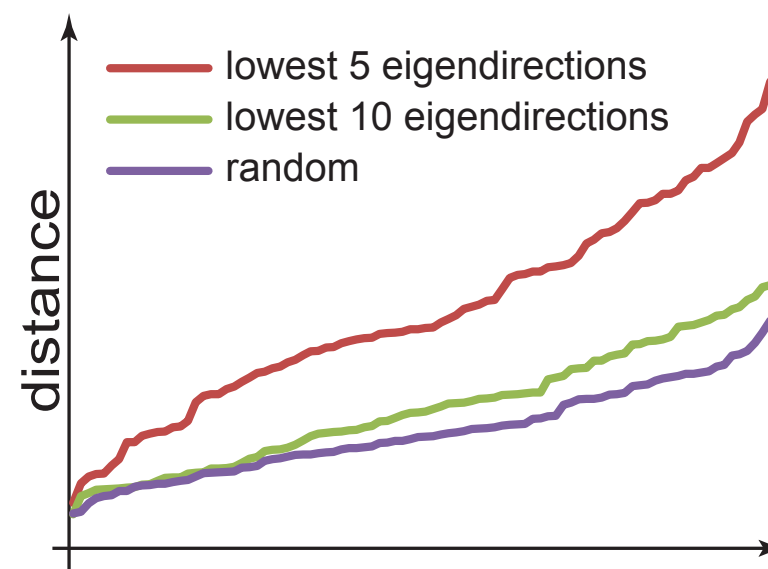
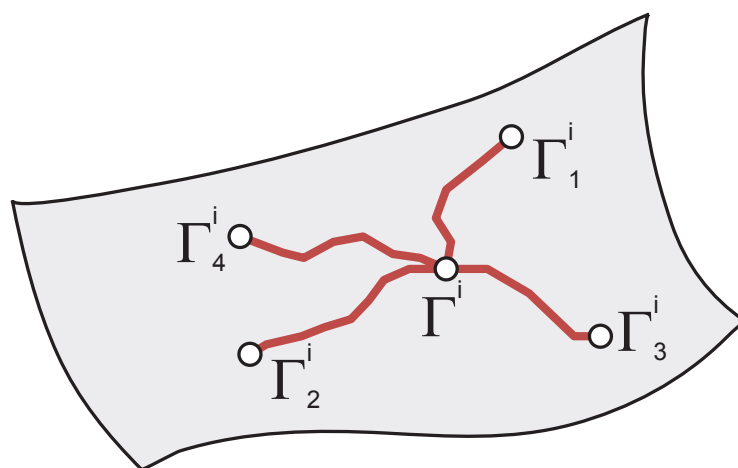
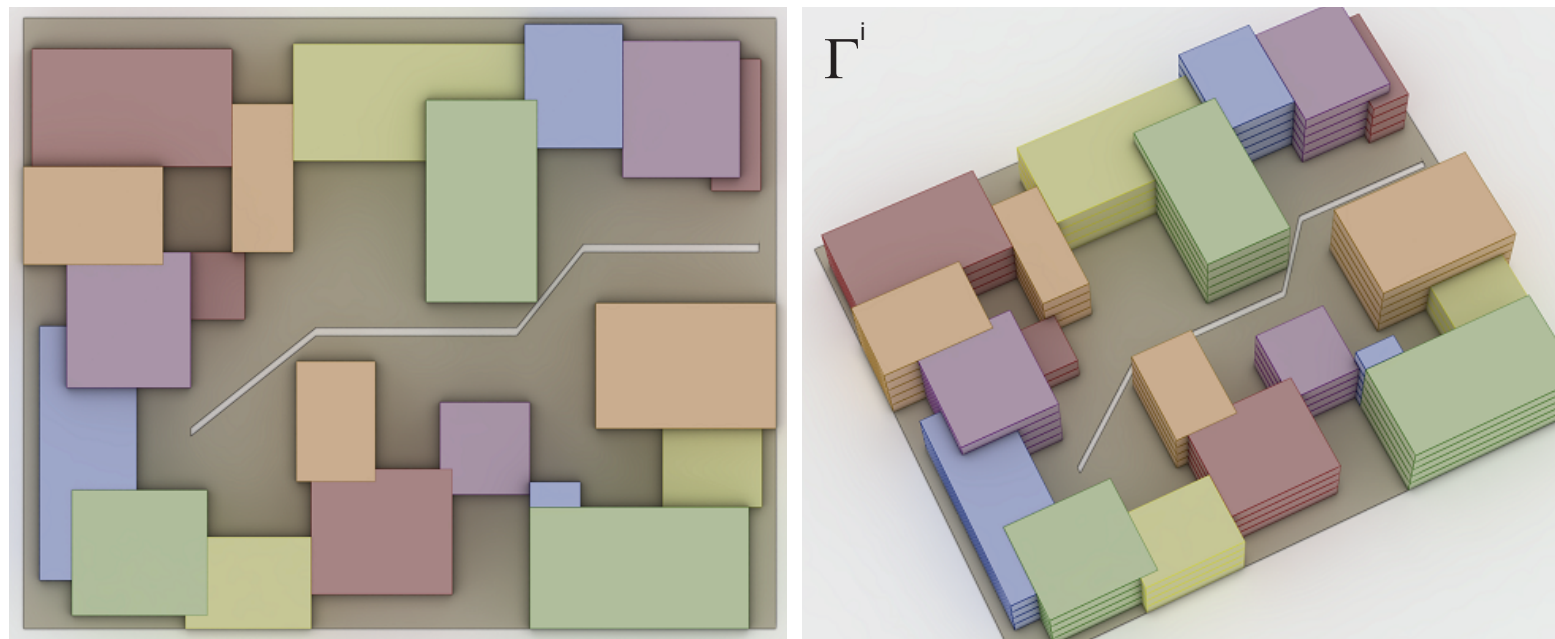
Constrained Mesh

Geometry from Constraints



[Bao et al., Siggraph 2013]

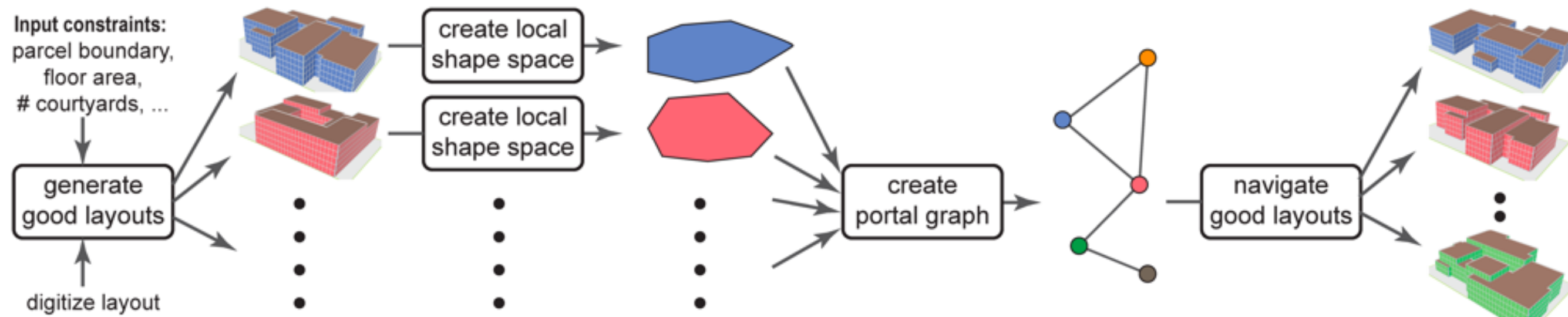
Geometry from Constraints



$$E(\Gamma_v) \sim E(\Gamma^i) + \sum_j \gamma_j^2 \lambda_j / 2$$

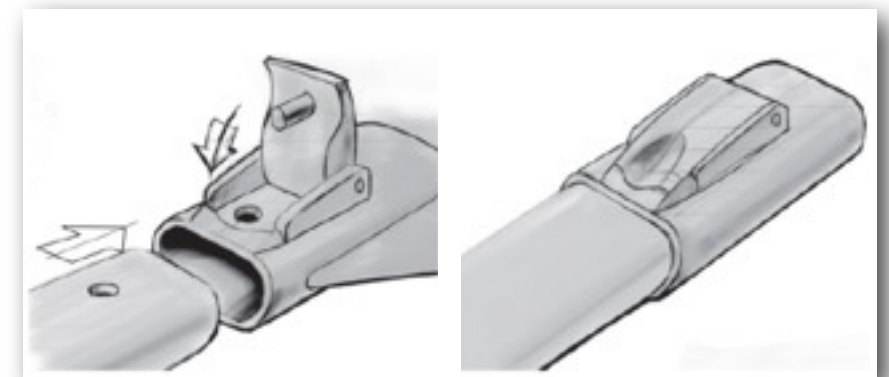
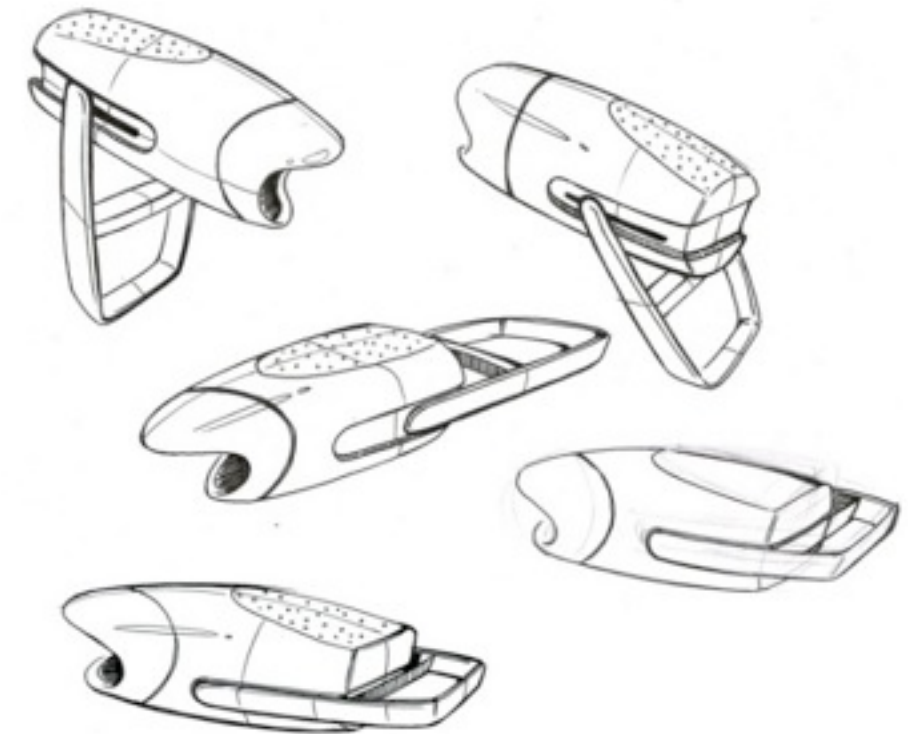
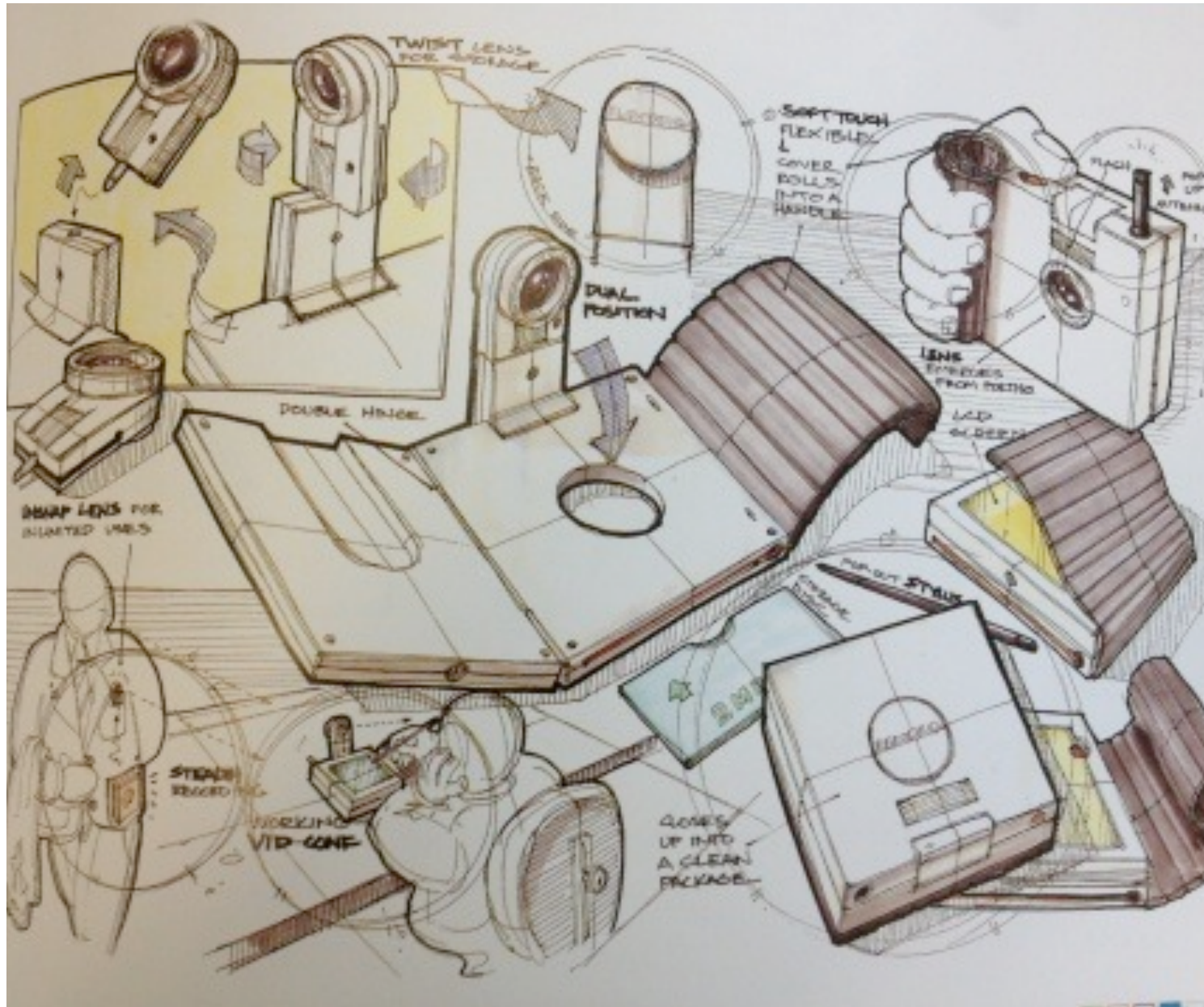
[Bao et al., Siggraph 2013]

Algorithm Steps



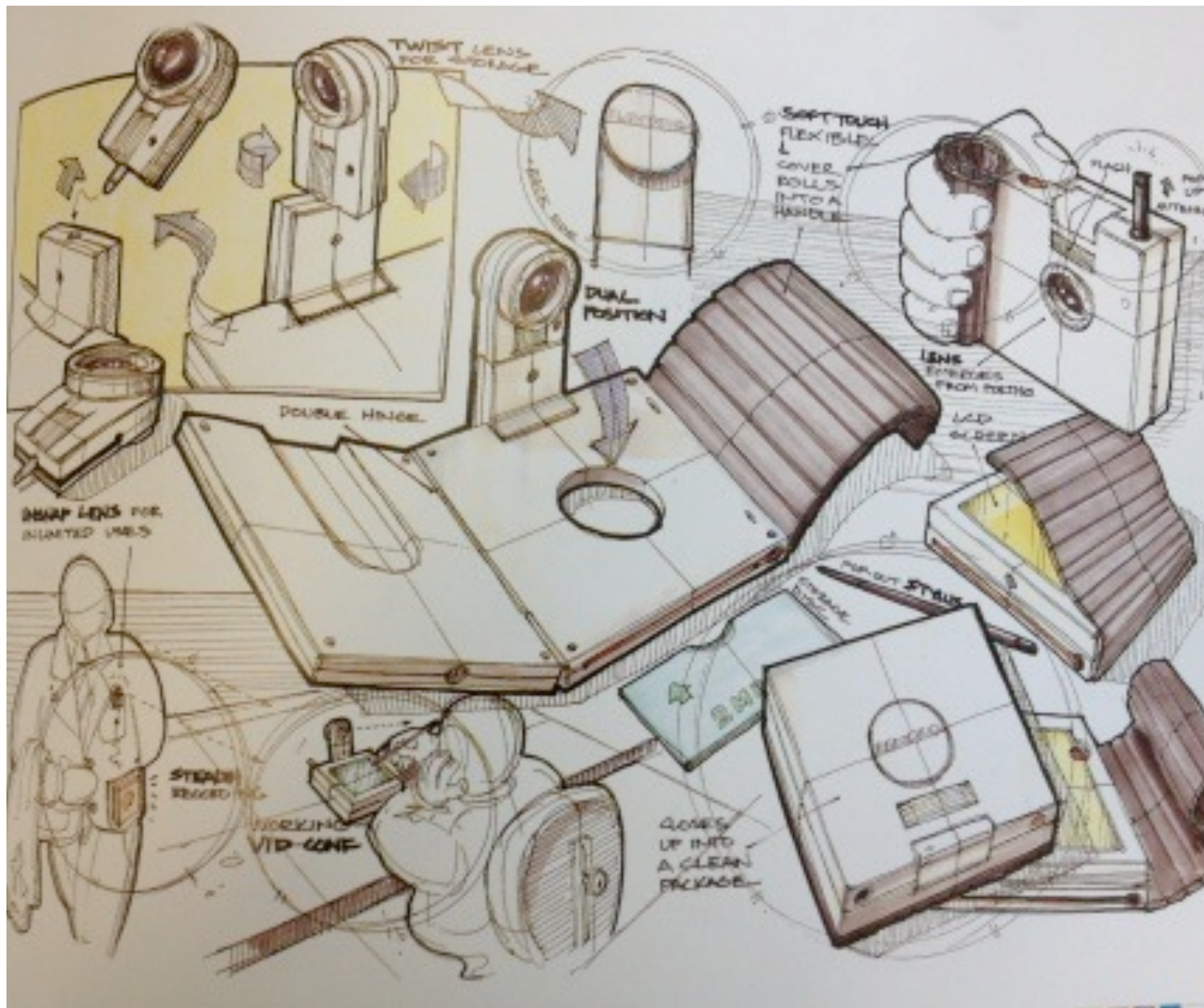
User Interface

Concept Sketches



[Shao et al., Siggraph 2013]

Concept Sketches

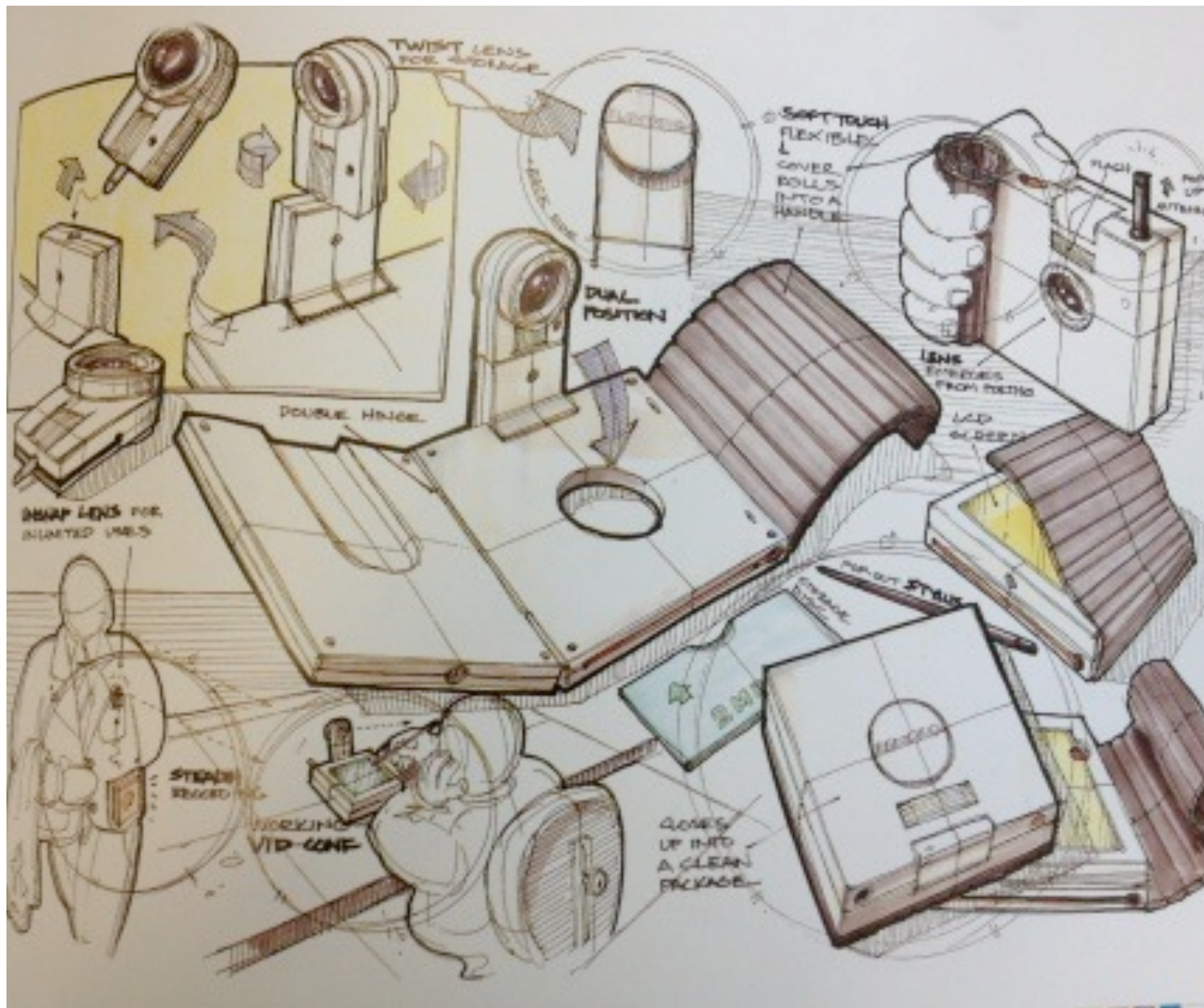


Help designers:

1. Explore design space

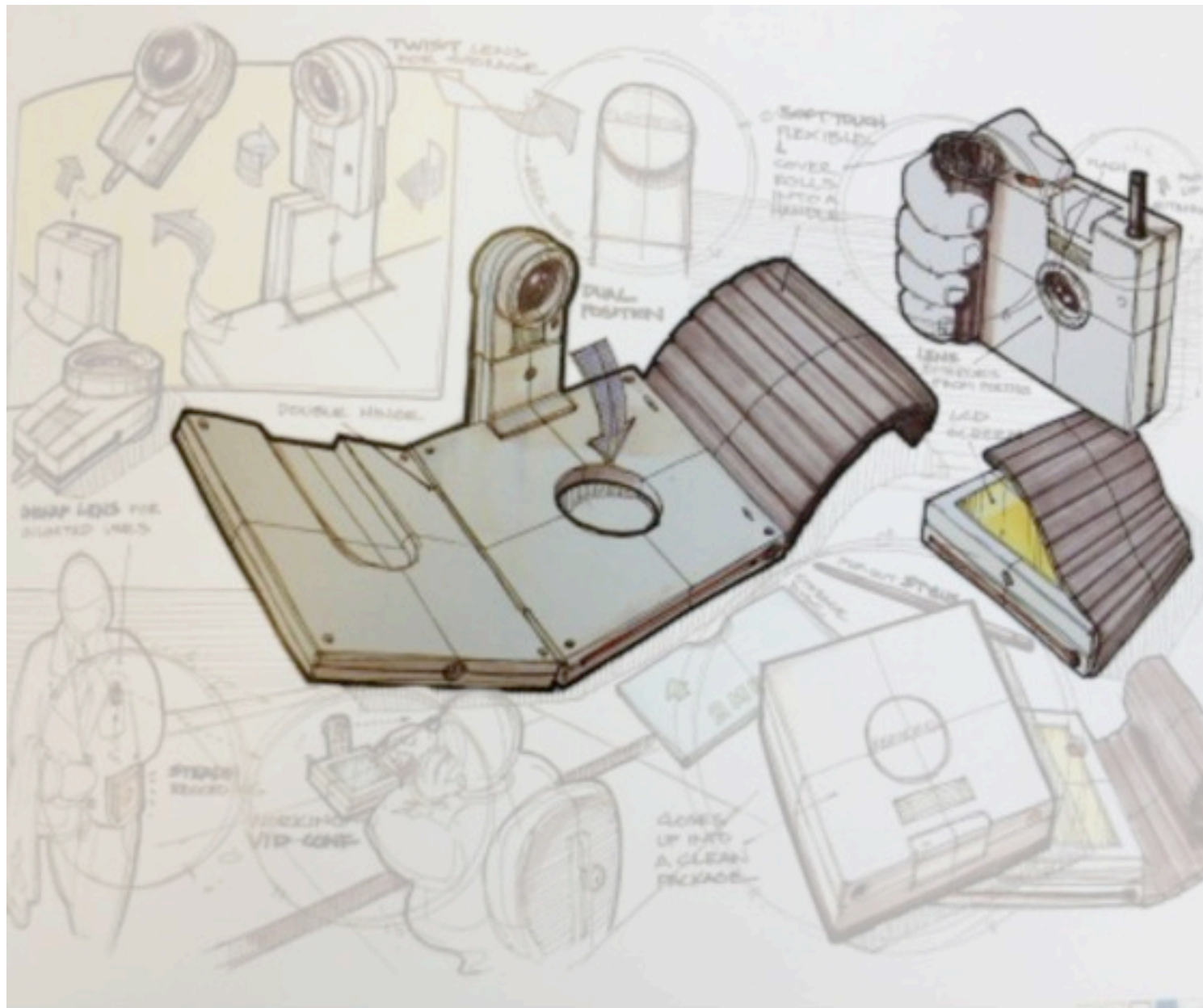
2. Communicate designs to others

Communicating Designs



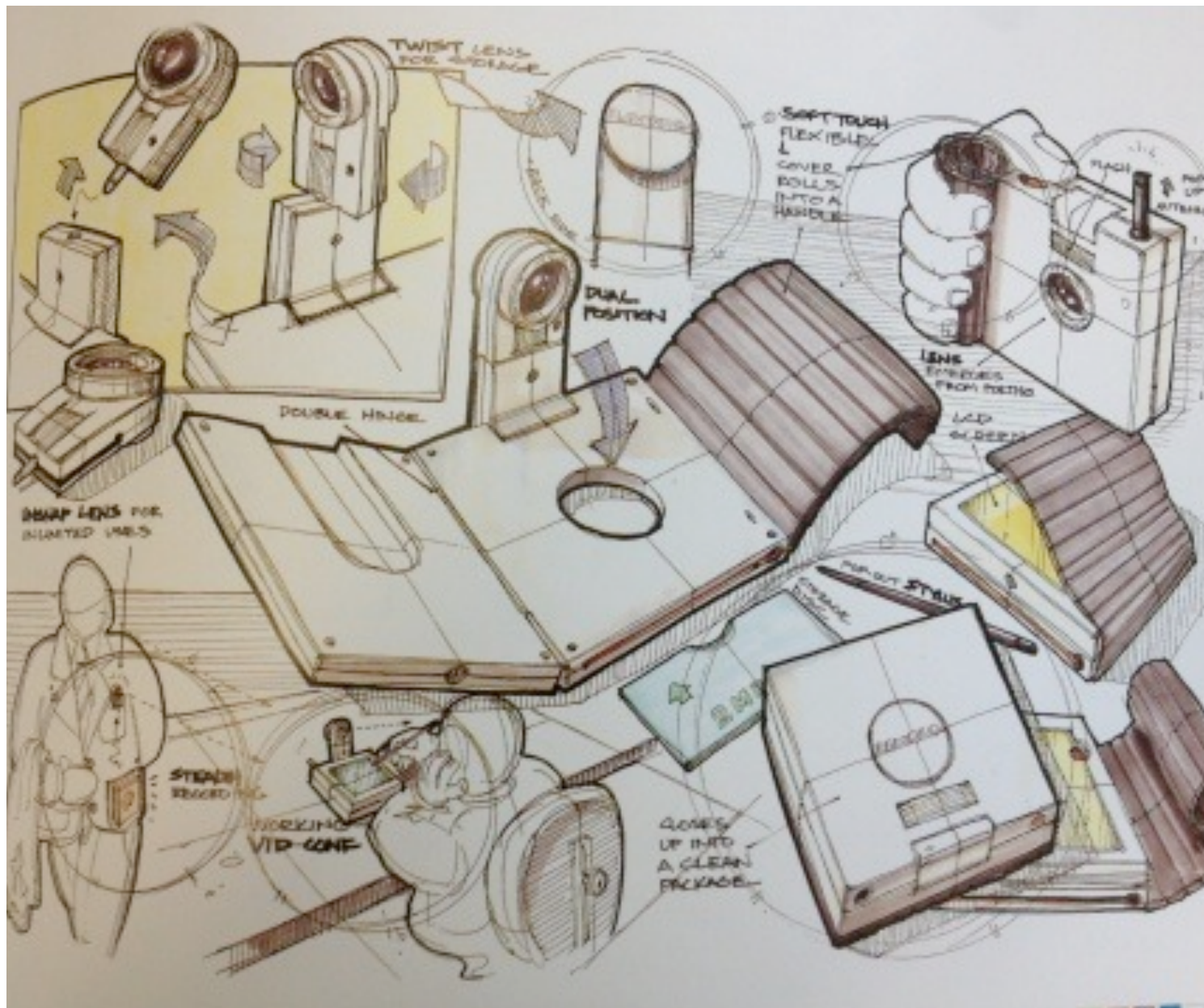
Changes in **viewpoint** and **configuration** make it hard to understand transitions between drawings

Communicating Designs

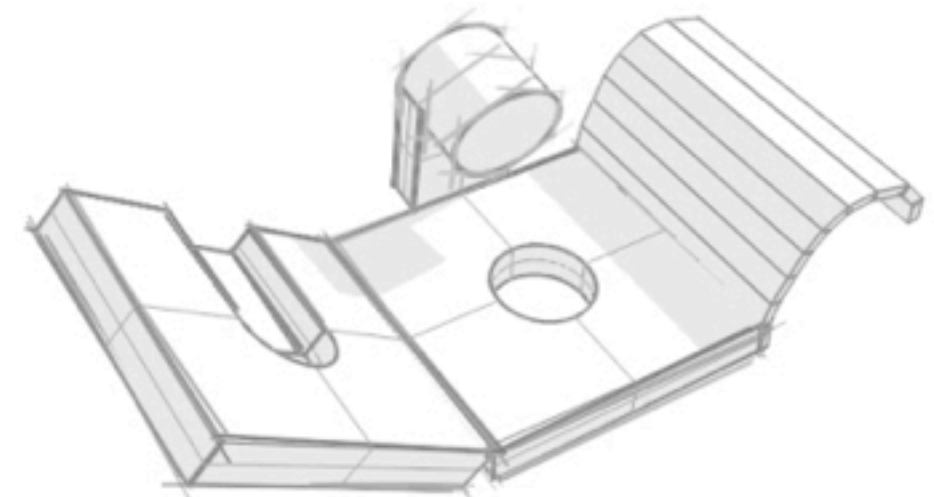
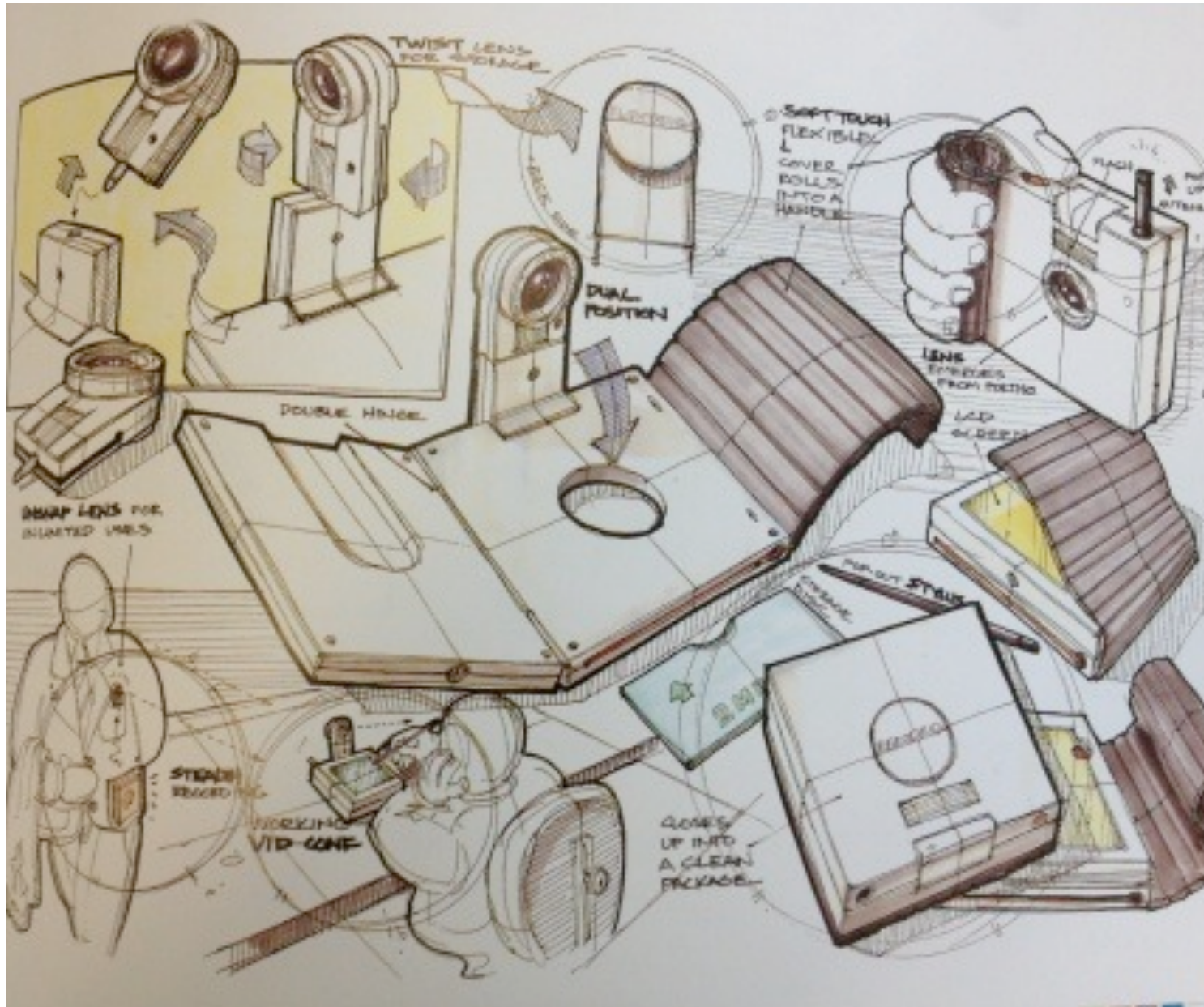


Changes in **viewpoint** and **configuration** make it hard to understand **transitions between drawings**

Our Approach



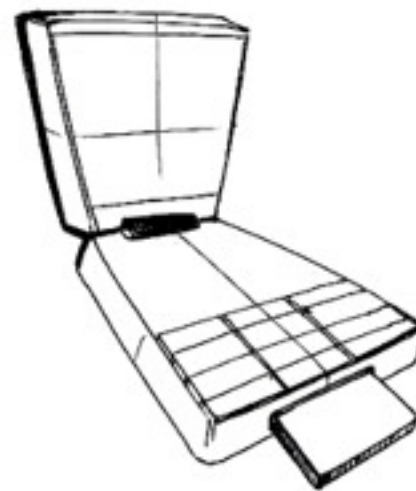
Our Approach



Challenges



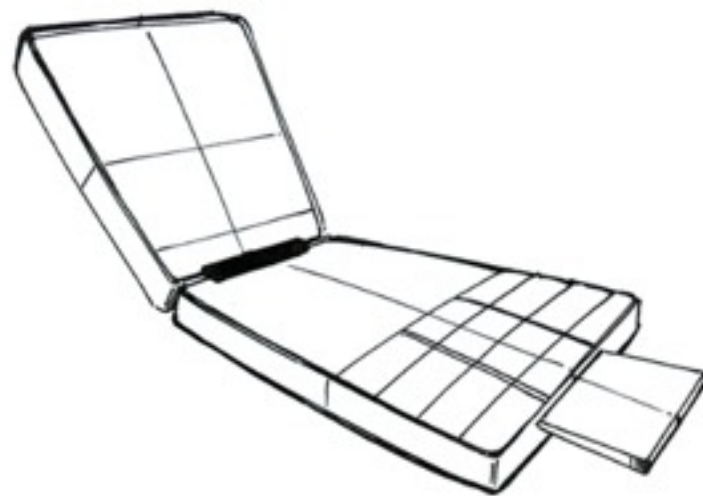
Drawing A



Drawing B

Challenges

Inconsistent geometry



Drawing A



Drawing B

Challenges

Inconsistent geometry

- Proxy proportions don't match across drawings



Drawing A



Drawing B

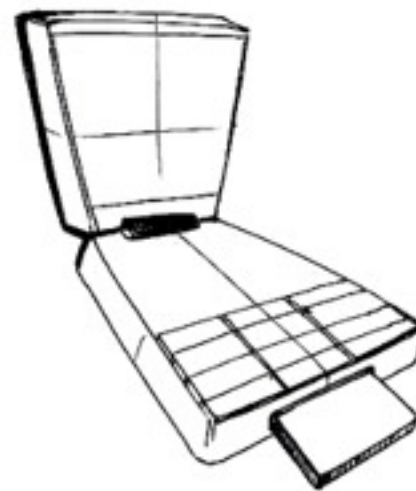
Challenges

Inconsistent geometry

- Proxy proportions don't match across drawings
- Proportions within a drawing are often inconsistent



Drawing A

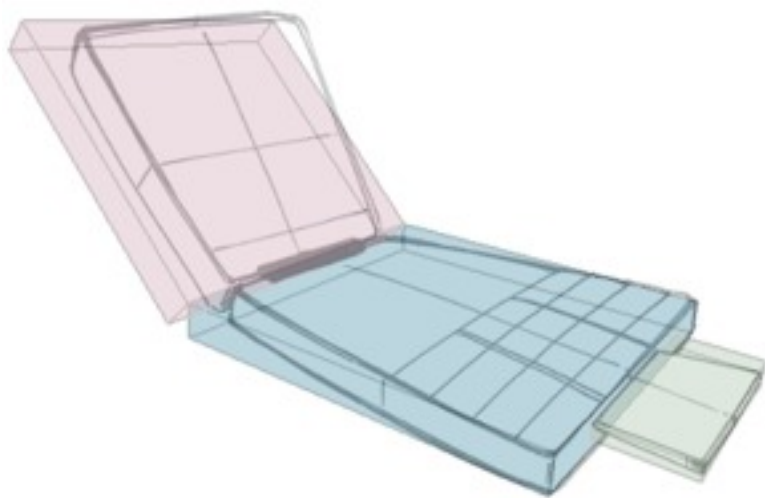


Drawing B

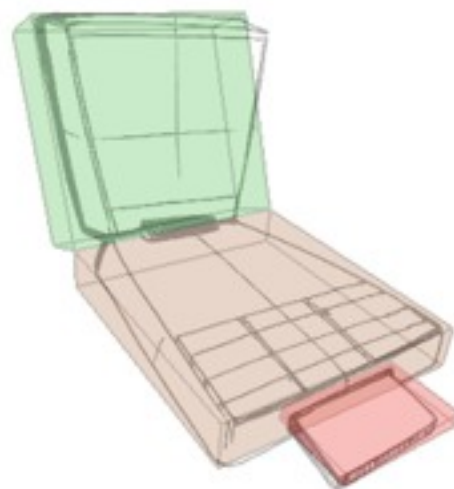
Challenges

Inconsistent geometry

- Proxy proportions don't match across drawings
- Proportions within a drawing are often inconsistent



Drawing A

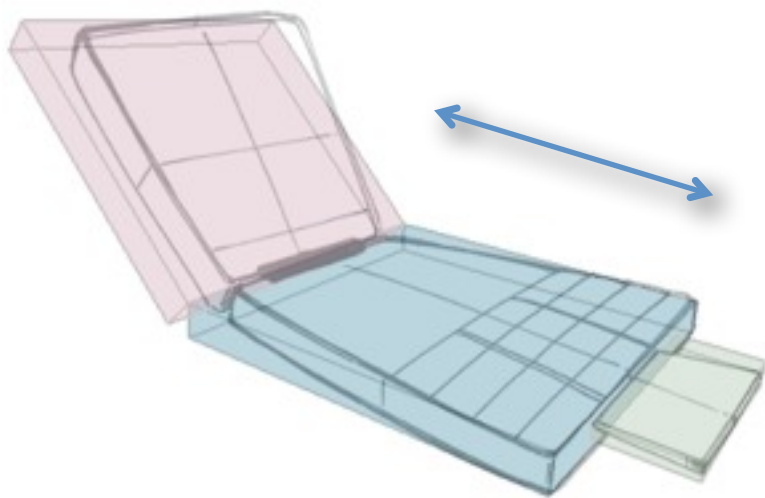


Drawing B

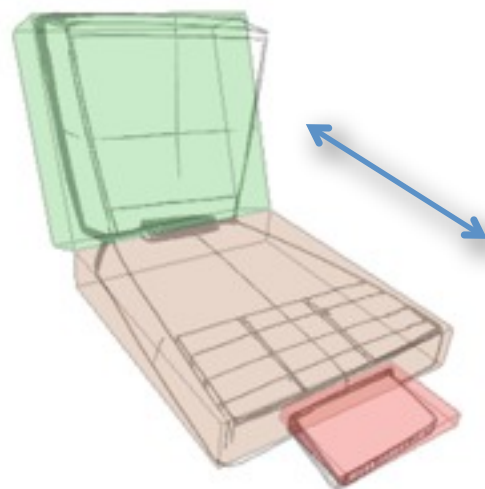
Challenges

Inconsistent geometry

- Proxy proportions don't match across drawings
- Proportions within a drawing are often inconsistent



Drawing A

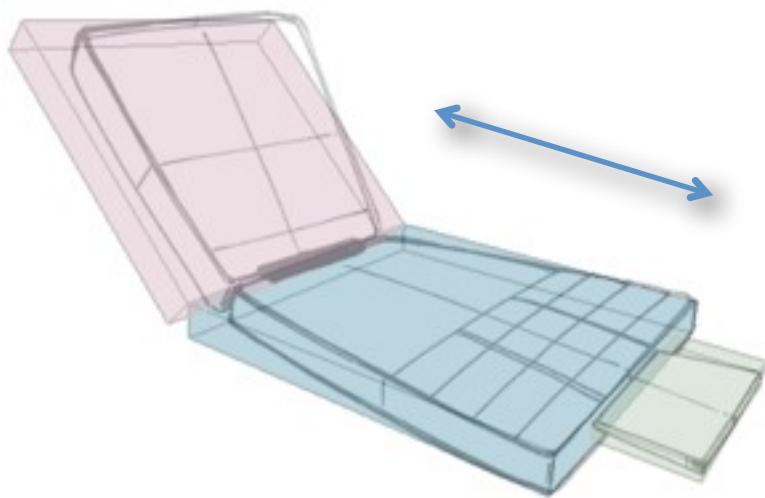


Drawing B

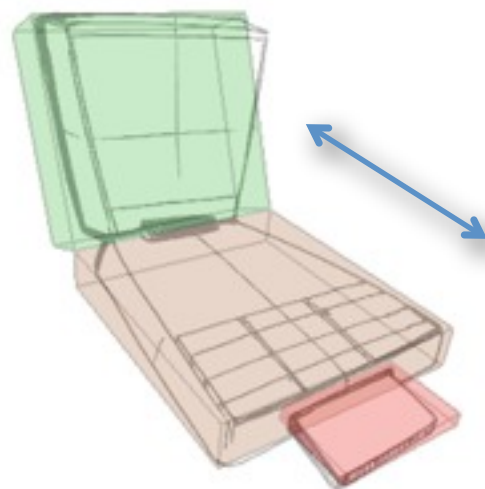
Challenges

Inconsistent geometry

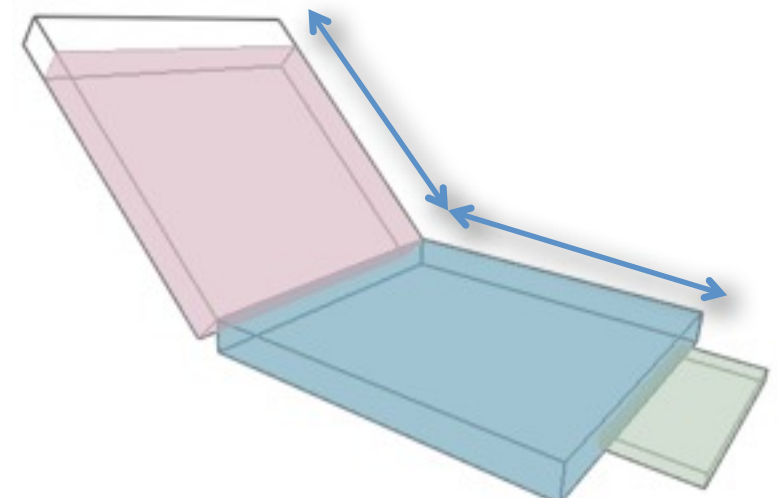
- Proxy proportions don't match across drawings
- Proportions within a drawing are often inconsistent



Drawing A



Drawing B

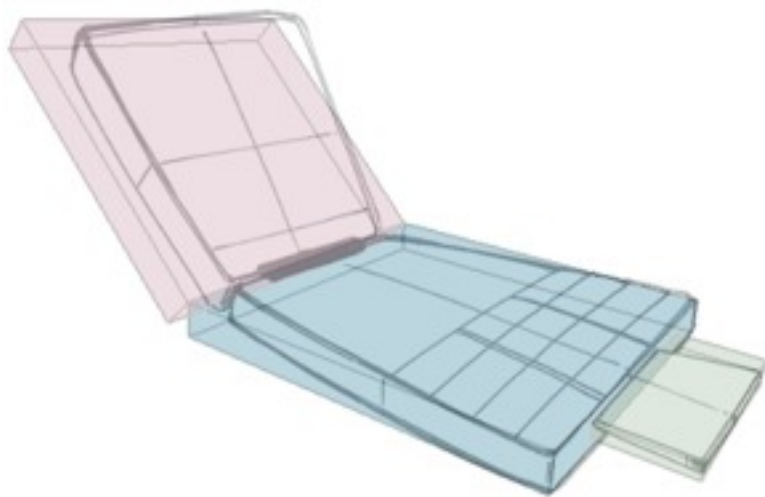


Drawing A

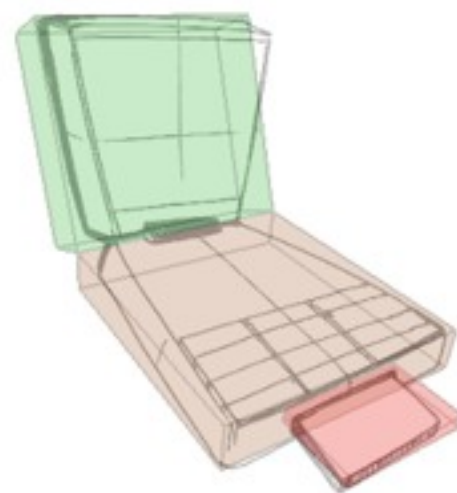
Key Idea

Part geometries are *inconsistent*

Part alignments are *consistent*



Drawing A

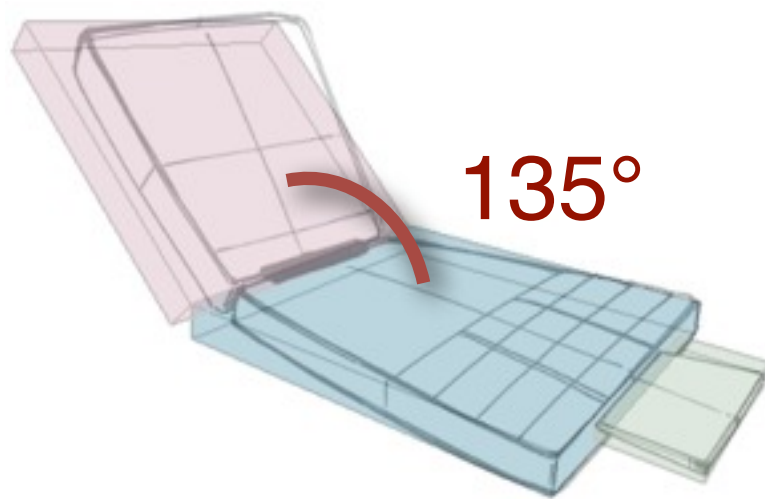


Drawing B

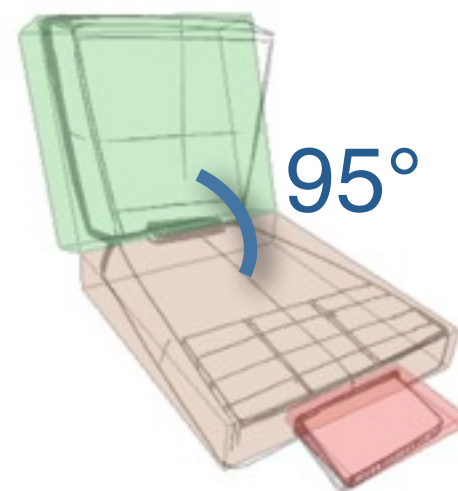
Key Idea

Part geometries are *inconsistent*

Part alignments are *consistent*



Drawing A



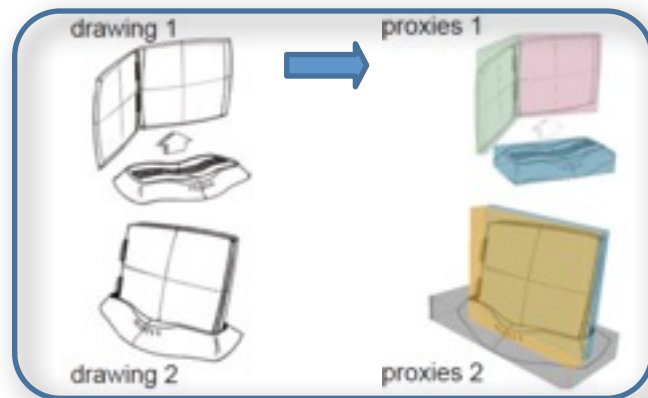
Drawing B

Algorithm Overview



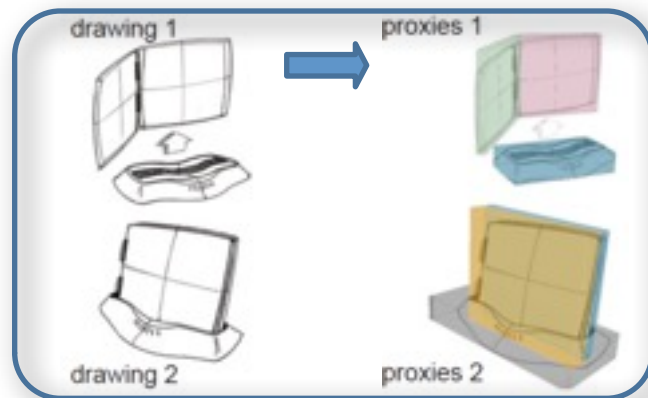
Algorithm Overview

Input

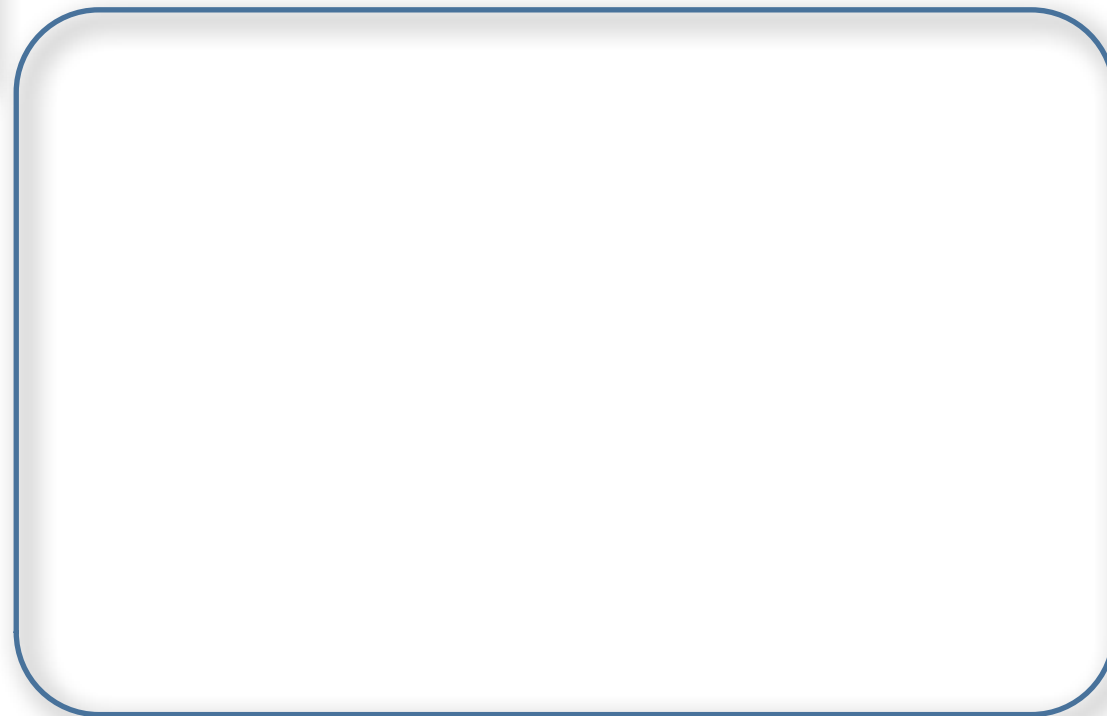


Algorithm Overview

Input

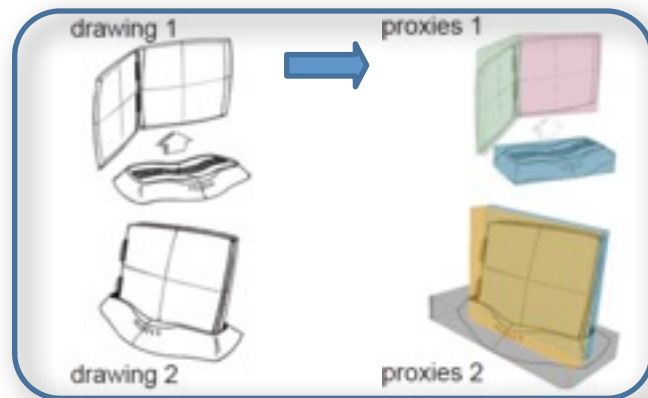


Analysis

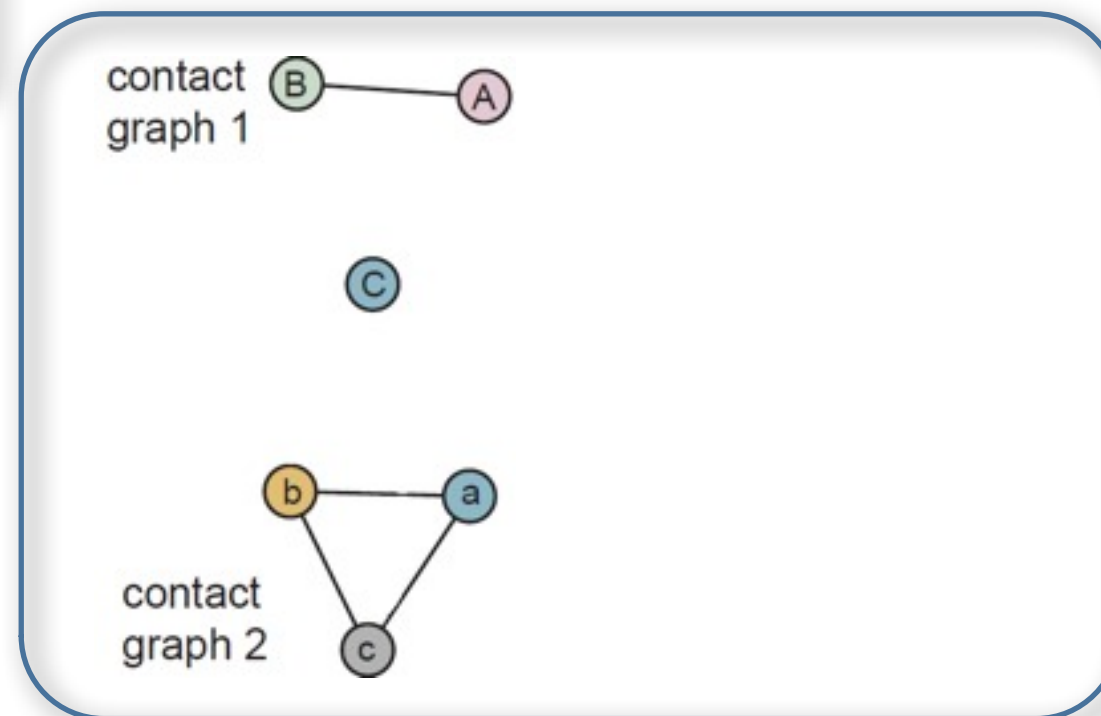


Algorithm Overview

Input

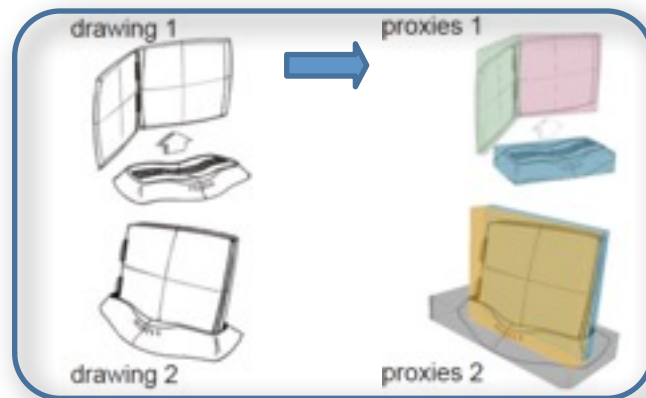


Analysis

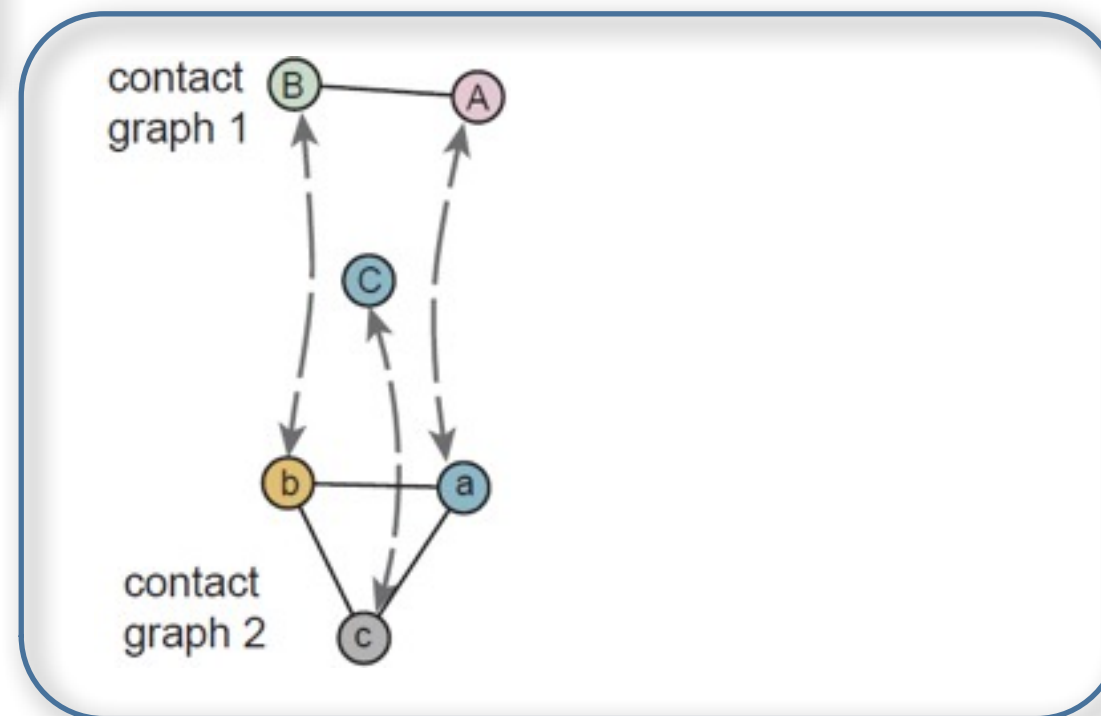


Algorithm Overview

Input

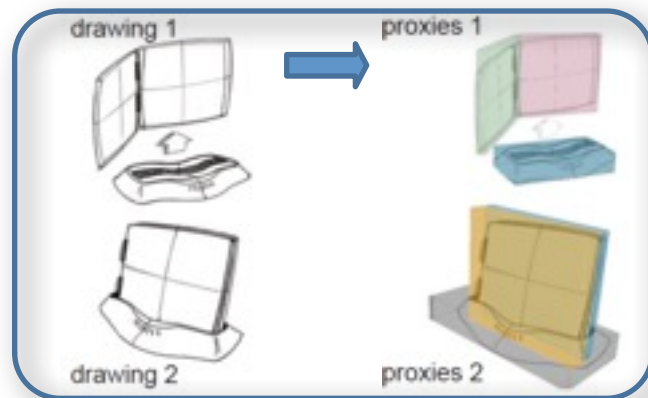


Analysis

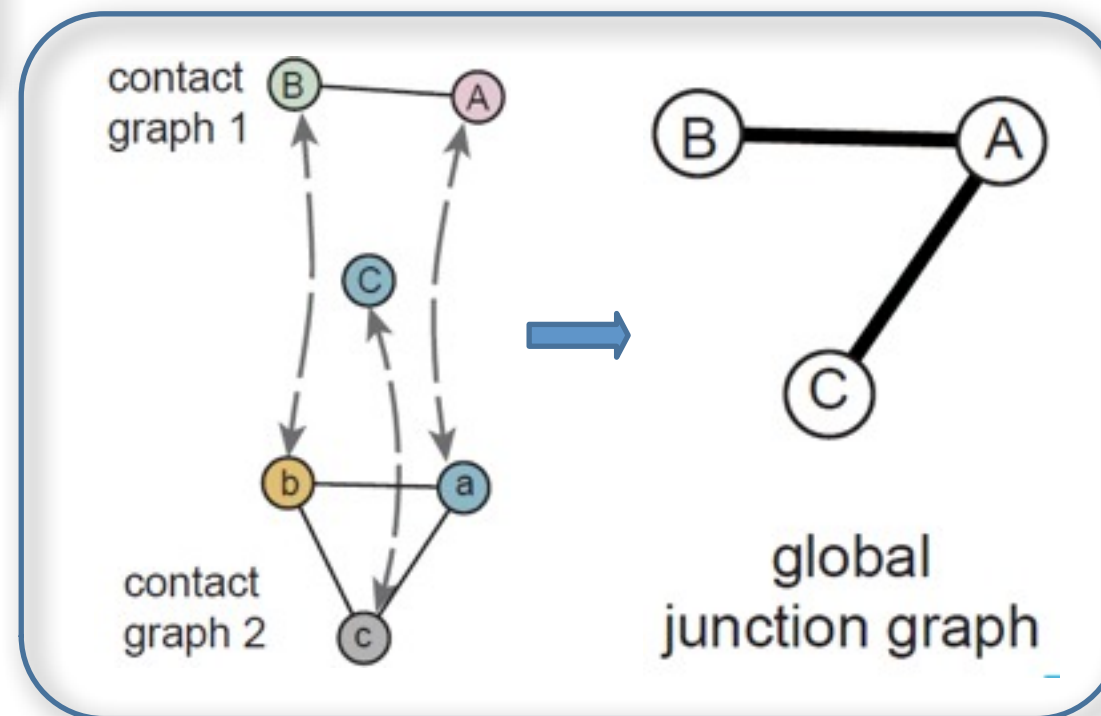


Algorithm Overview

Input

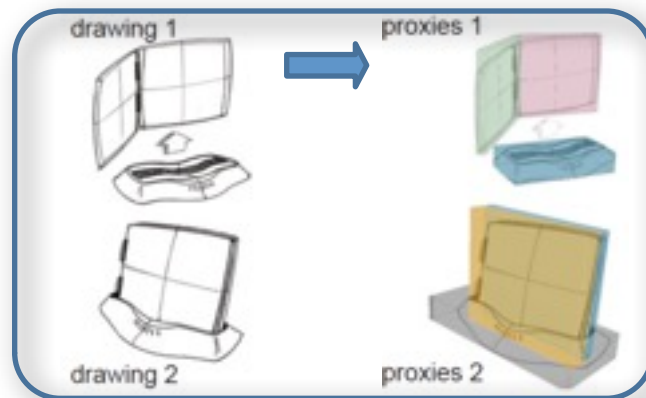


Analysis

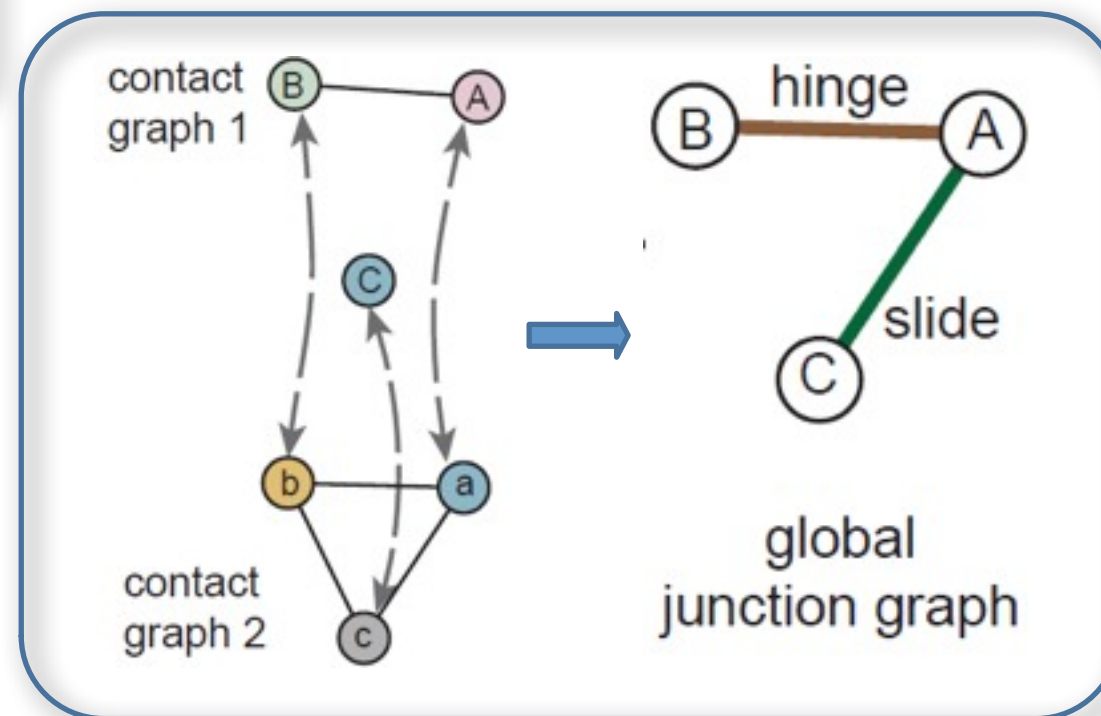


Algorithm Overview

Input

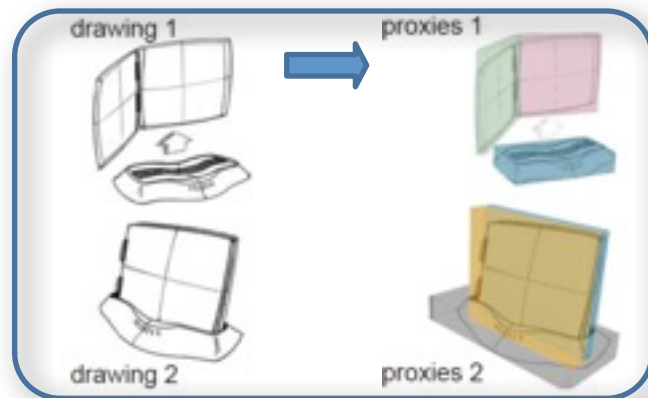


Analysis

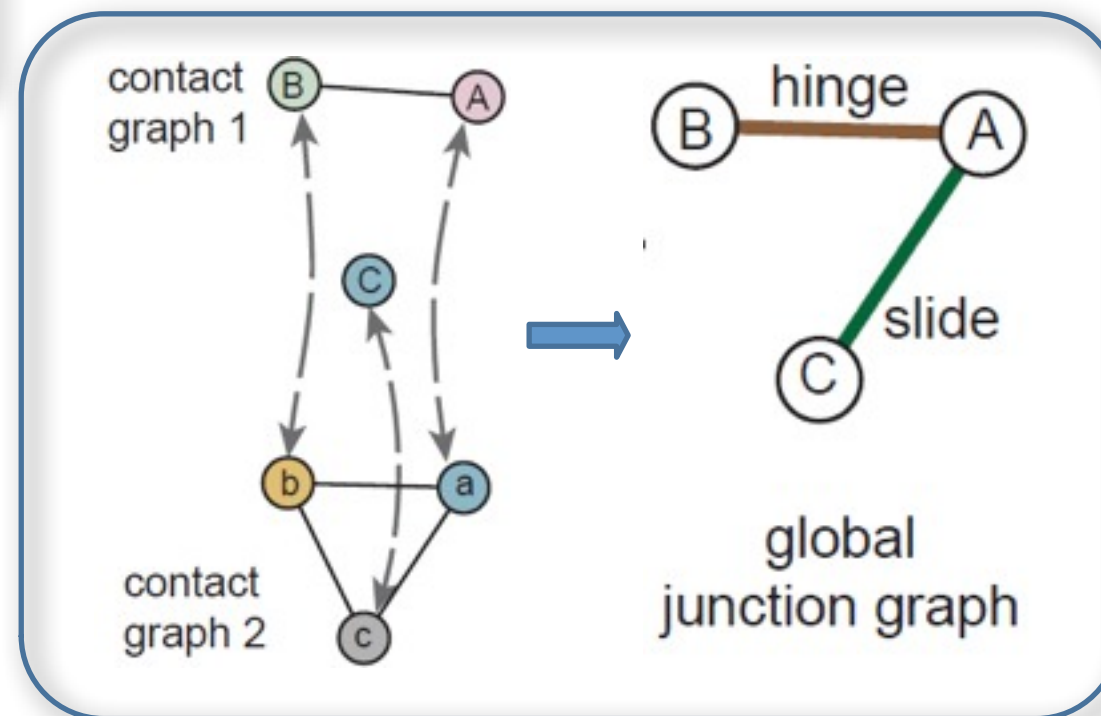


Algorithm Overview

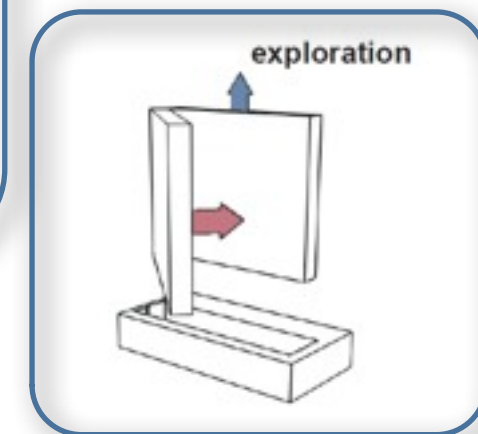
Input



Analysis



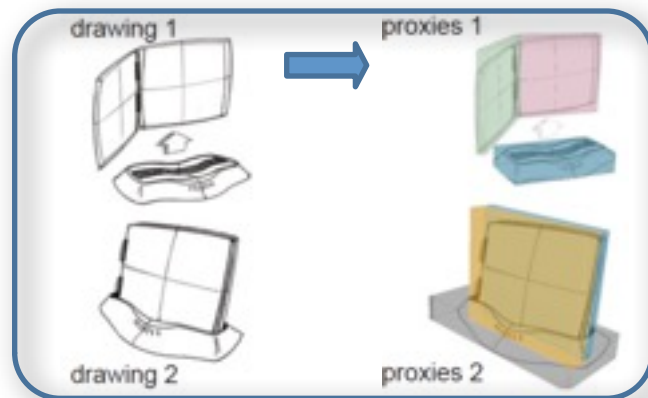
Compute motion paths



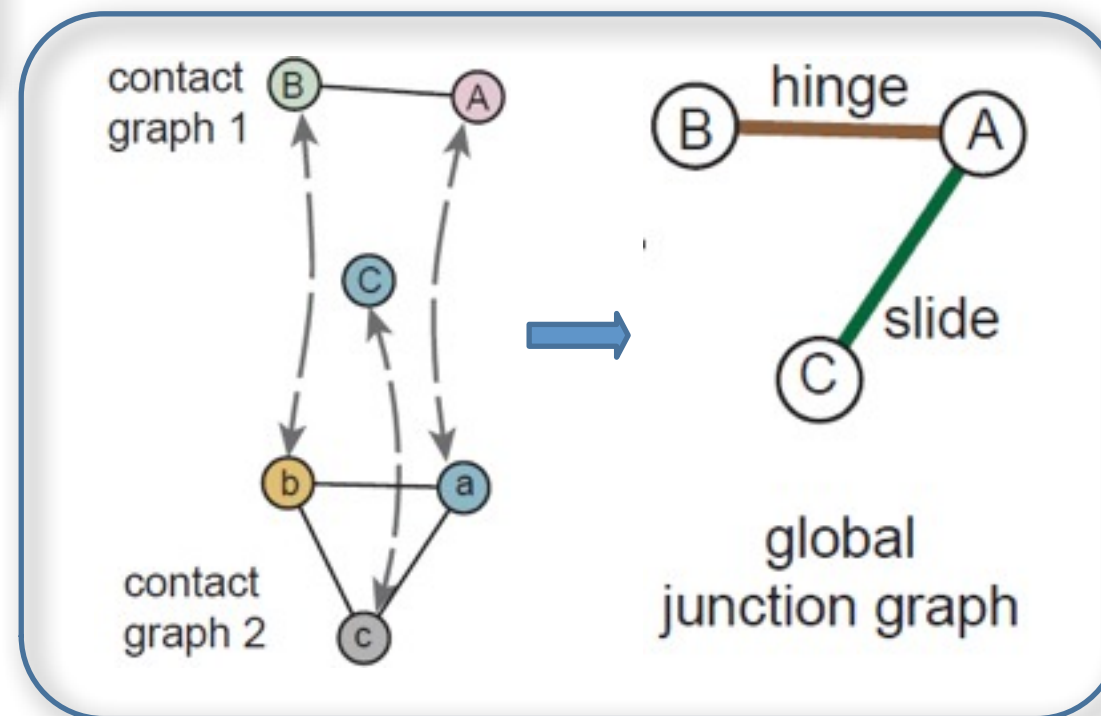
Output

Algorithm Overview

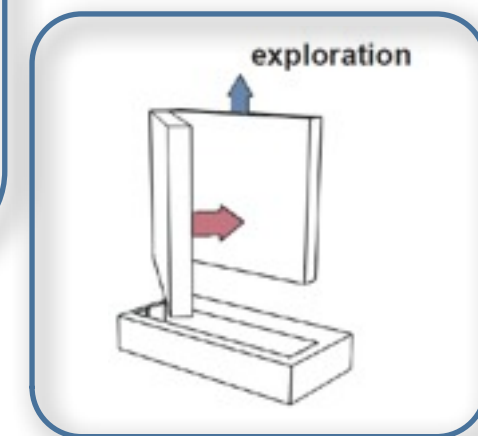
Input



Analysis



Compute motion paths



Establish part
correspondence

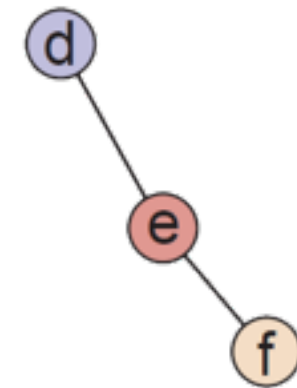
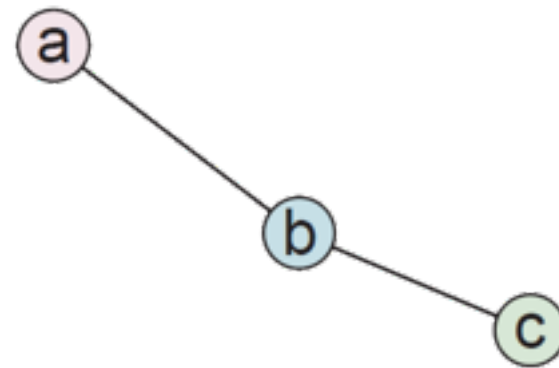
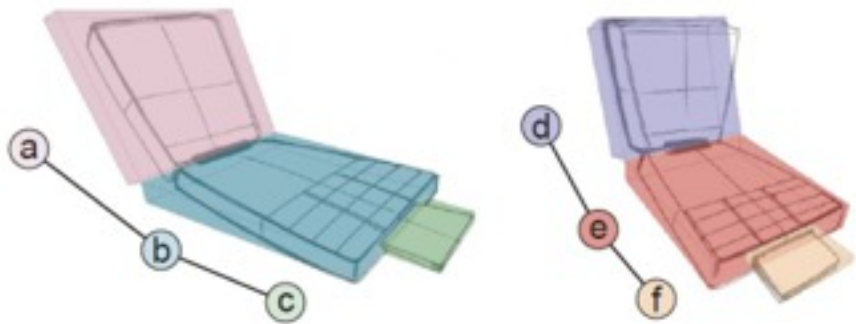
Output

Establish Part Correspondence



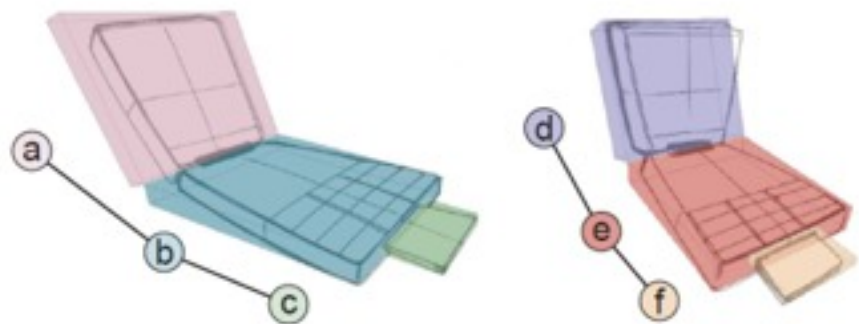
Establish Part Correspondence

- Bipartite match with affinity matrix

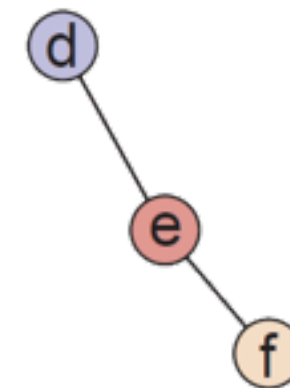
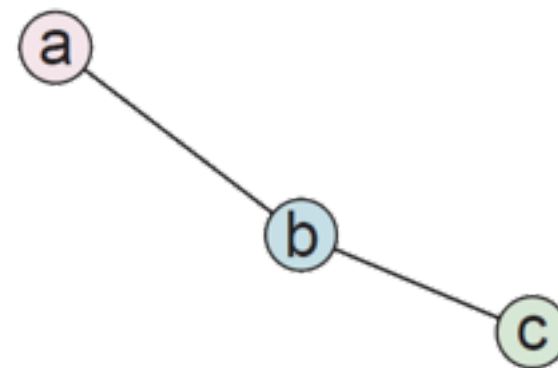


Establish Part Correspondence

- Bipartite match with affinity matrix

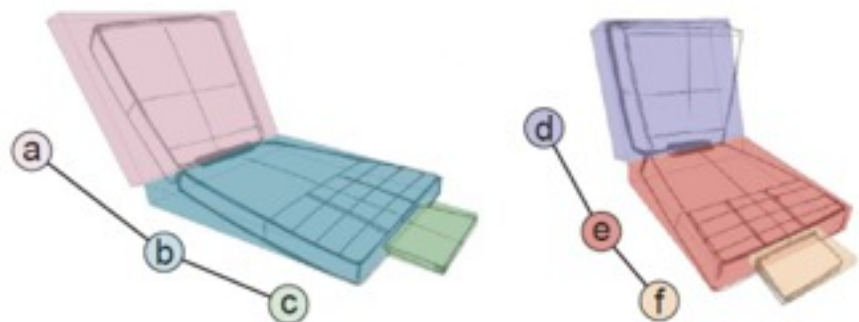


	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08								
(a,e)									
(a,f)									
(b,d)									
(b,e)									
(b,f)									
(c,d)									
(c,e)									
(c,f)									

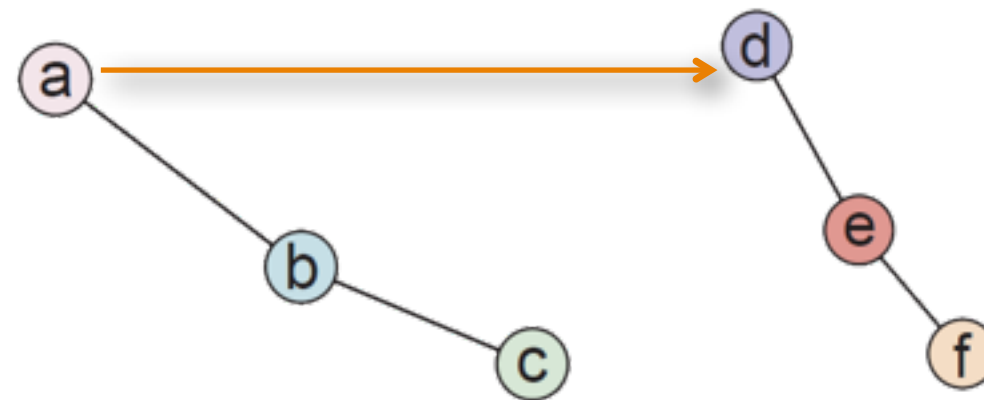


Establish Part Correspondence

- Bipartite match with affinity matrix

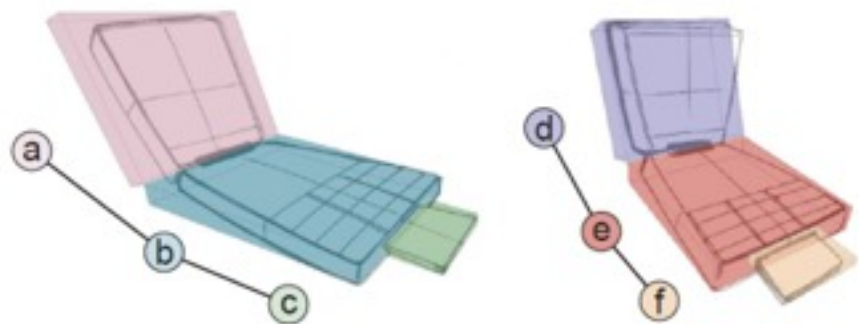


	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08								
(a,e)									
(a,f)									
(b,d)									
(b,e)									
(b,f)									
(c,d)									
(c,e)									
(c,f)									

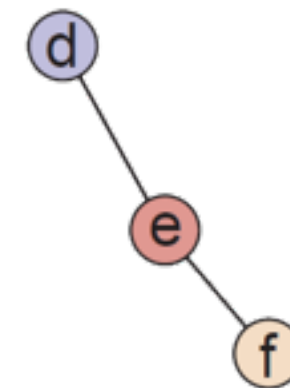
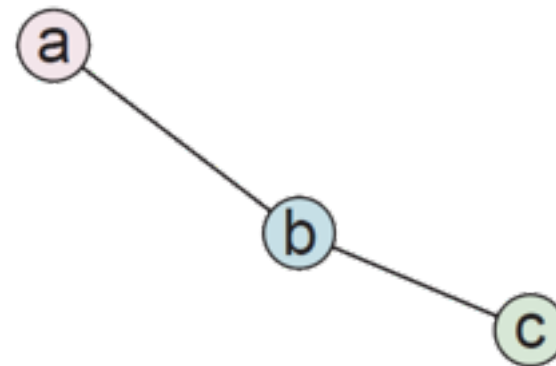


Establish Part Correspondence

- Bipartite match with affinity matrix

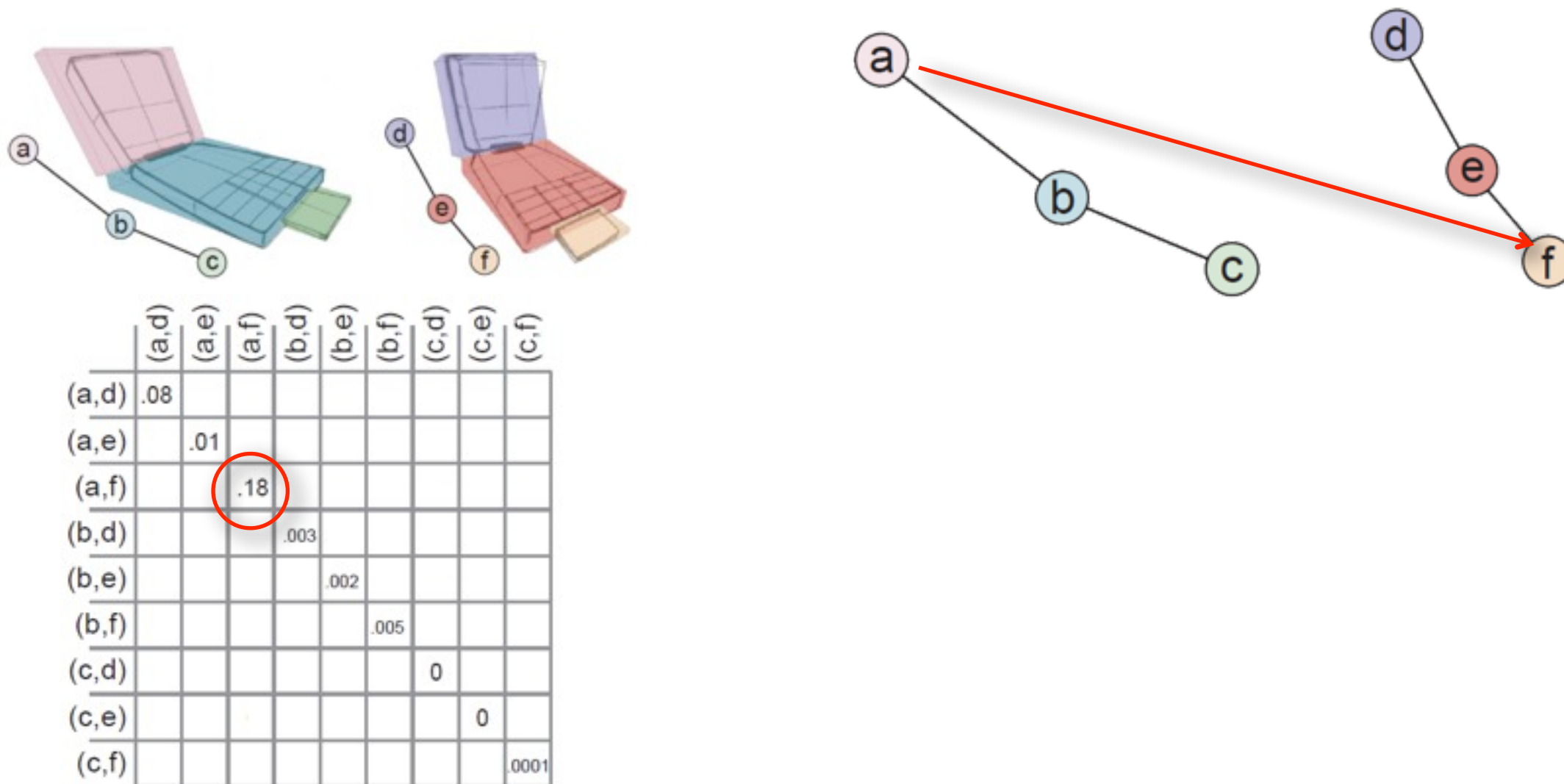


	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08								
(a,e)		.01							
(a,f)			.18						
(b,d)				.003					
(b,e)					.002				
(b,f)						.005			
(c,d)							0		
(c,e)								0	
(c,f)									.0001



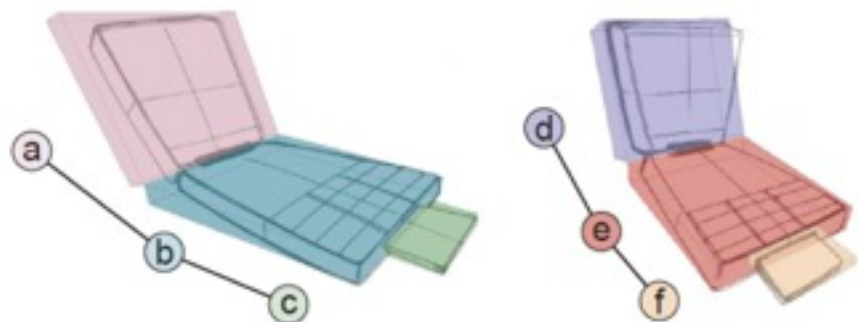
Establish Part Correspondence

- Bipartite match with affinity matrix

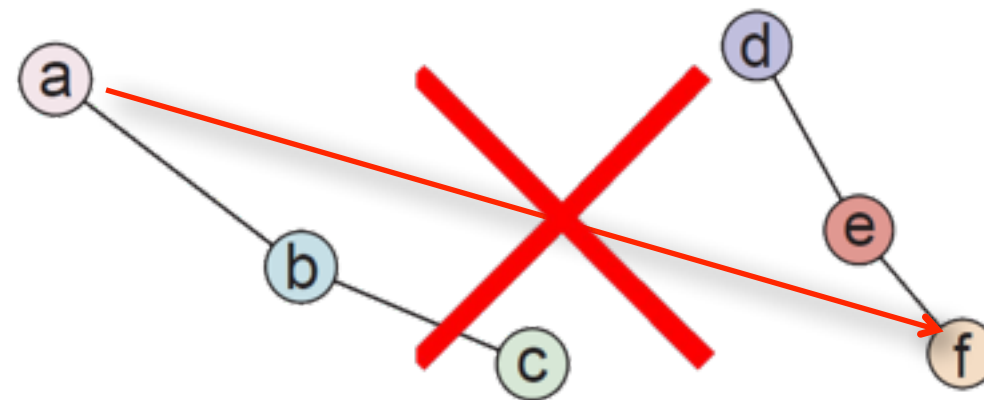


Establish Part Correspondence

- Bipartite match with affinity matrix

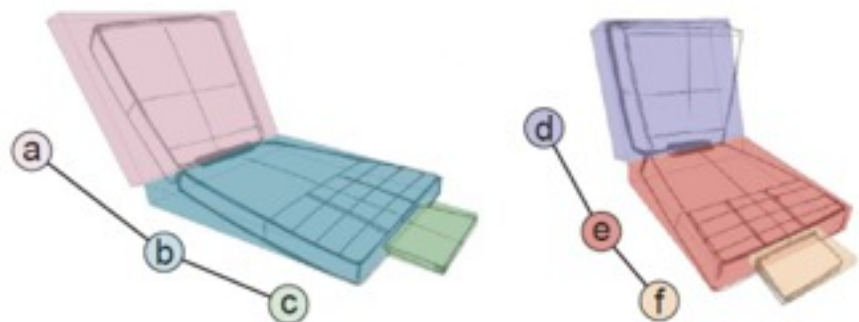


	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08								
(a,e)		.01							
(a,f)			.18						
(b,d)				.003					
(b,e)					.002				
(b,f)						.005			
(c,d)							0		
(c,e)								0	
(c,f)									.0001

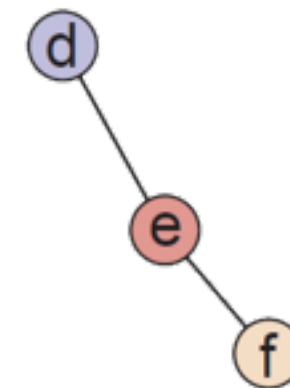
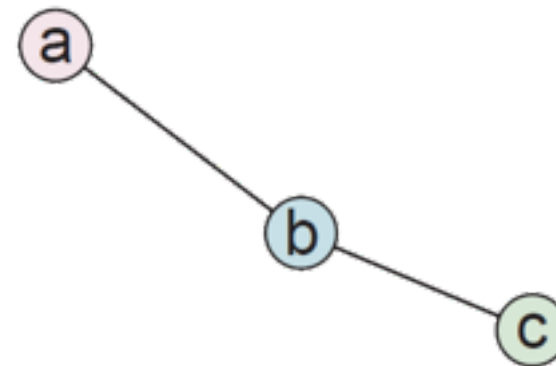


Establish Part Correspondence

- Bipartite match with affinity matrix

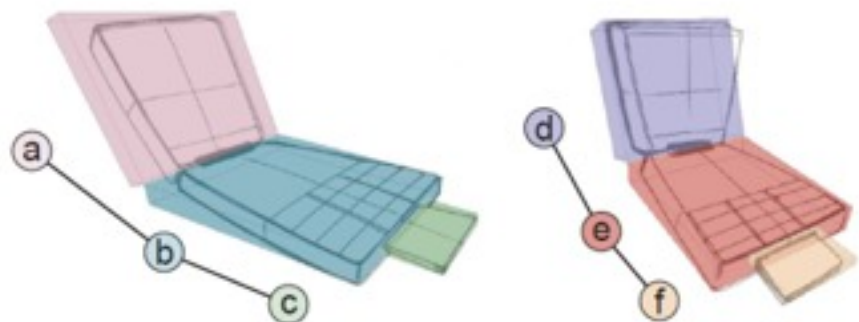


	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08	0	0	0	.61	0	0	0	.61
(a,e)	0	.01	0	.63	0	.33	0	0	0
(a,f)	0	0	.18	0	0	0	0	0	0
(b,d)	0	.63	0	.003	0	0	0	.20	0
(b,e)	.61	0	0	0	.002	0	.52	0	1
(b,f)	0	.33	0	0	0	.005	0	0	0
(c,d)	0	0	0	0	.52	0	0	0	0
(c,e)	0	0	0	.20	0	0	0	0	0
(c,f)	.61	0	0	0	1	0	0	0	.0001

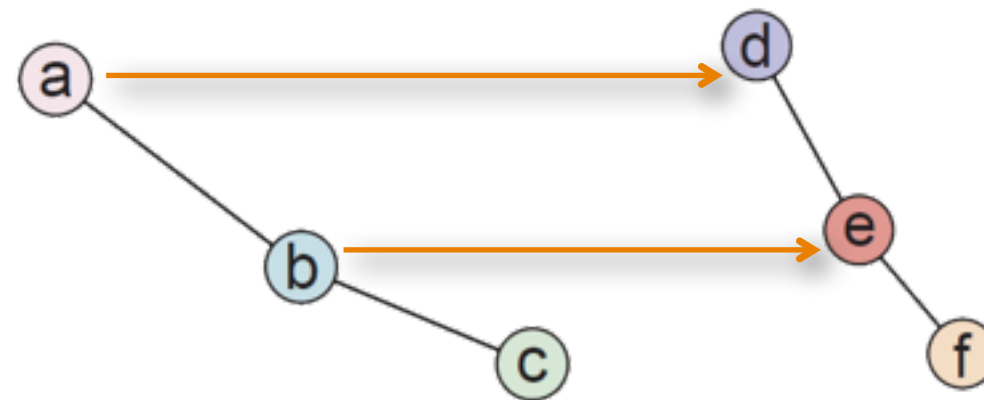


Establish Part Correspondence

- Bipartite match with affinity matrix



	(a,d)	(a,e)	(a,f)	(b,d)	(b,e)	(b,f)	(c,d)	(c,e)	(c,f)
(a,d)	.08	0	0	0	.61	0	0	0	.61
(a,e)	0	.01	0	.63	0	.33	0	0	0
(a,f)	0	0	.18	0	0	0	0	0	0
(b,d)	0	.63	0	.003	0	0	0	.20	0
(b,e)	.61	0	0	0	.002	0	.52	0	1
(b,f)	0	.33	0	0	0	.005	0	0	0
(c,d)	0	0	0	0	.52	0	0	0	0
(c,e)	0	0	0	.20	0	0	0	0	0
(c,f)	.61	0	0	0	1	0	0	0	.0001



Establish Part Correspondence

- Optimization formulation

$$\arg \max_{\mathbf{x}} \mathbf{x}^T M \mathbf{x} \quad x_i \in \{0, 1\}$$

- Side constraint (for normalization) $\|\mathbf{x}\| = 1$

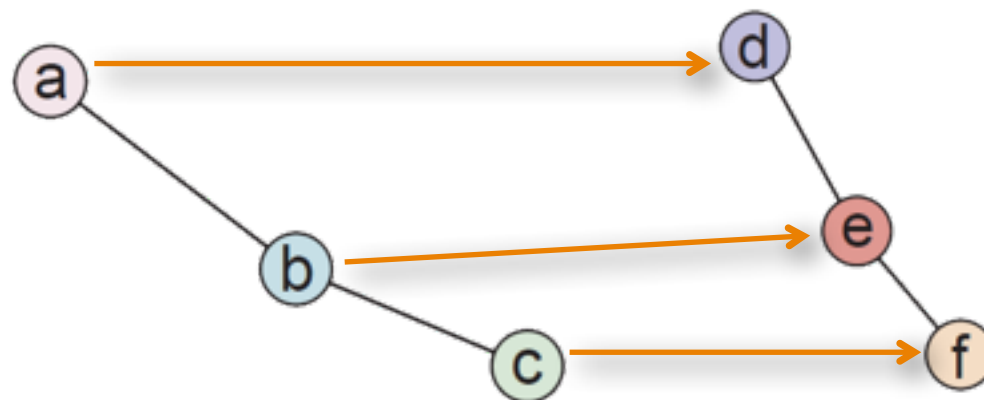
Establish Part Correspondence

- Optimization formulation

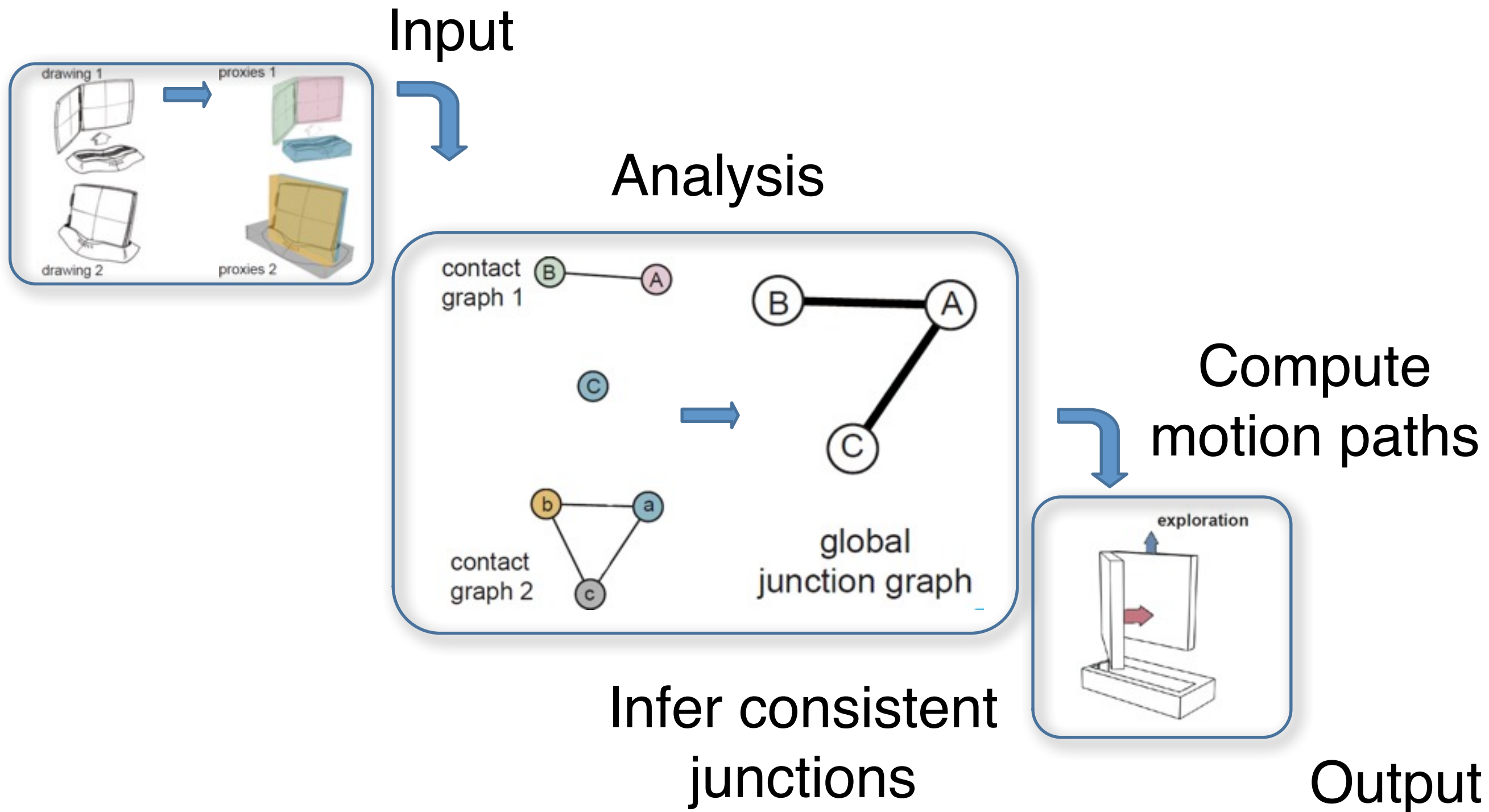
$$\arg \max_{\mathbf{x}} \mathbf{x}^T M \mathbf{x} \quad x_i \in \{0, 1\}$$

- Side constraint (for normalization)

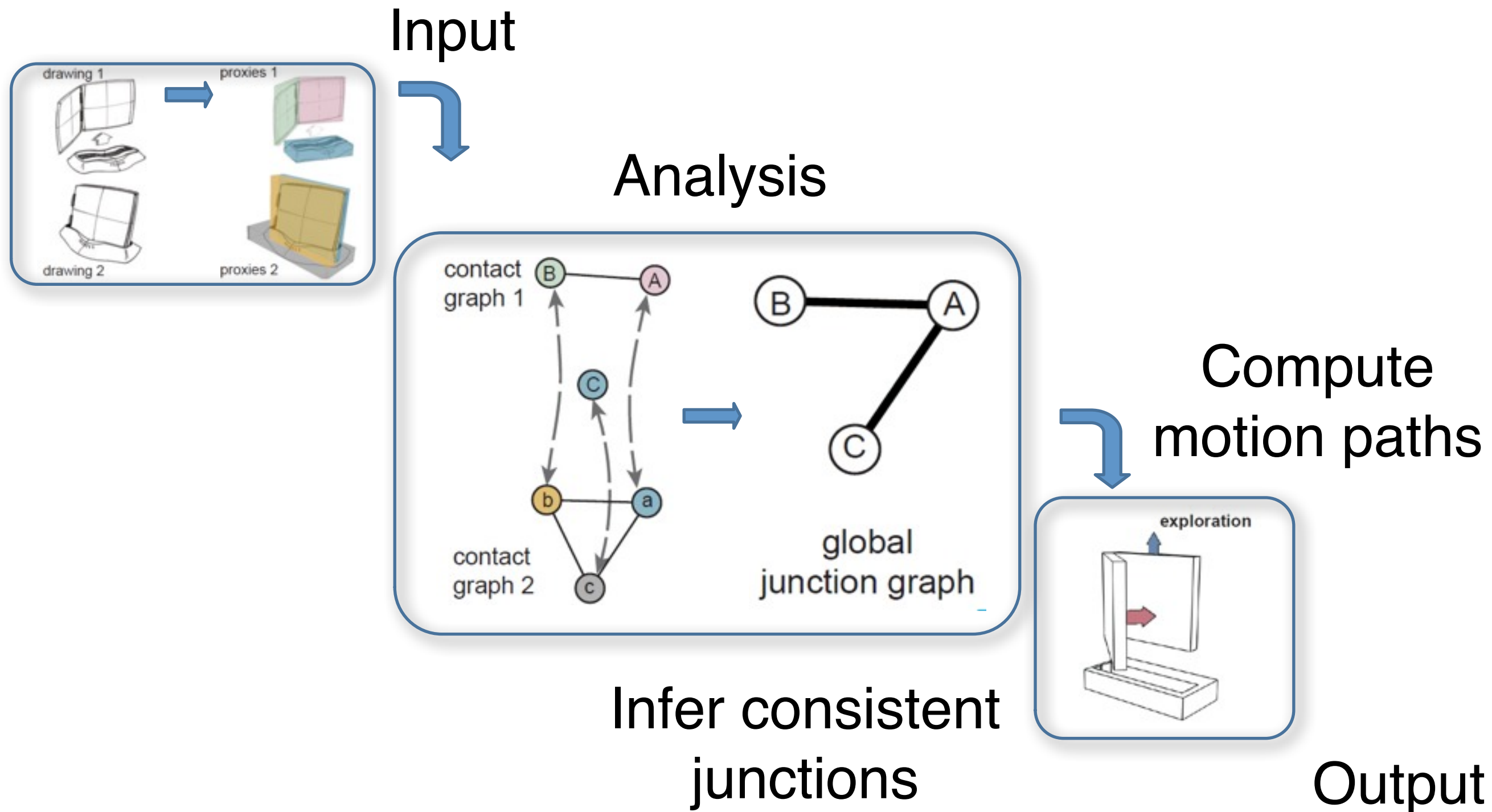
$$\|\mathbf{x}\| = 1$$



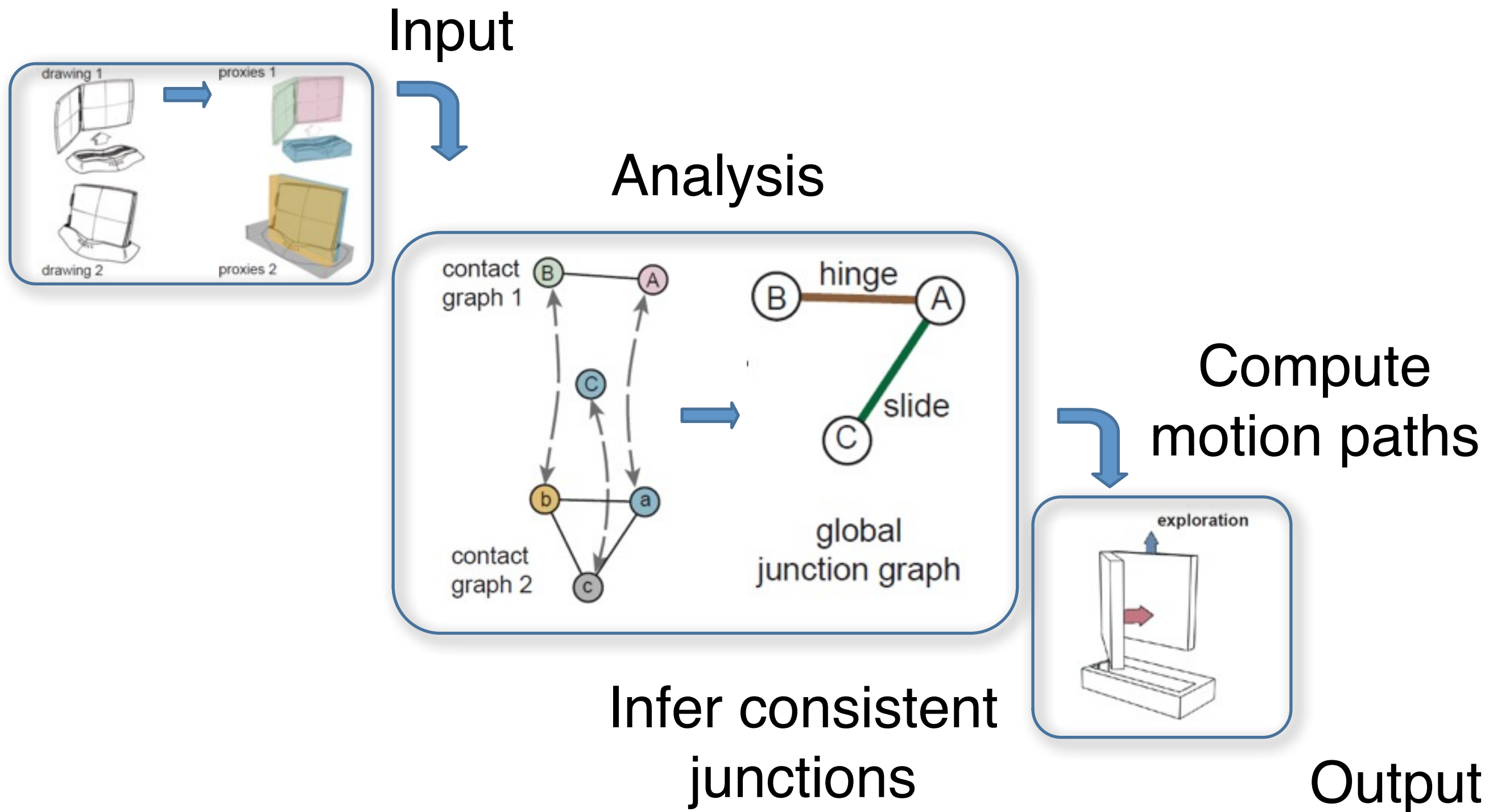
Algorithm Overview



Algorithm Overview



Algorithm Overview



Infer Consistent Junctions

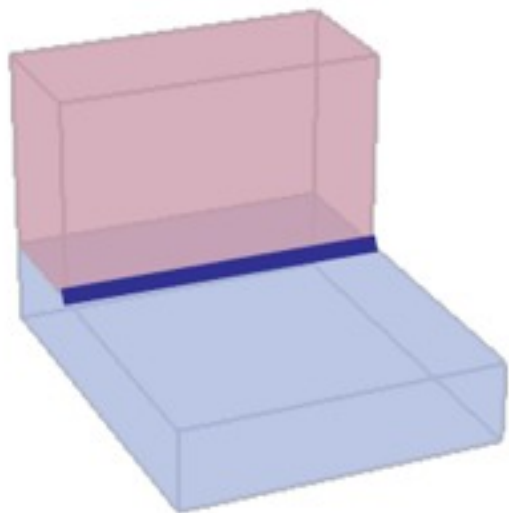


Junction types



Infer Consistent Junctions

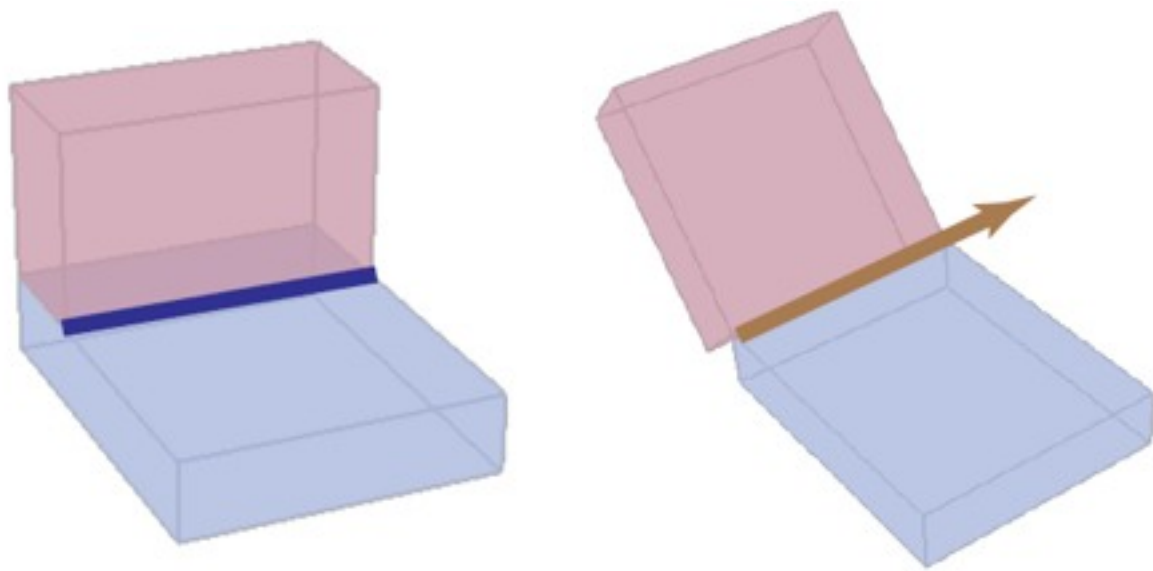
Junction types



Fixed

Infer Consistent Junctions

Junction types

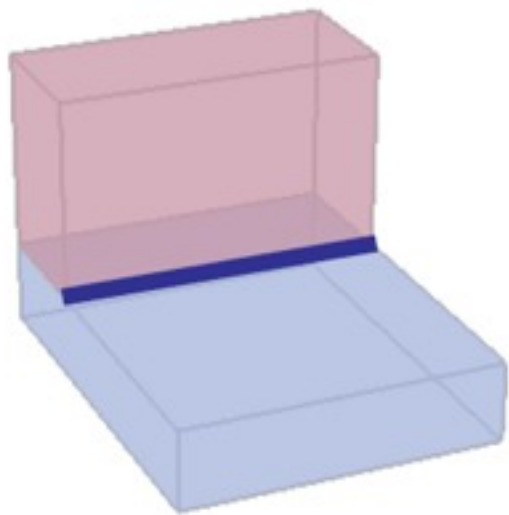


Fixed

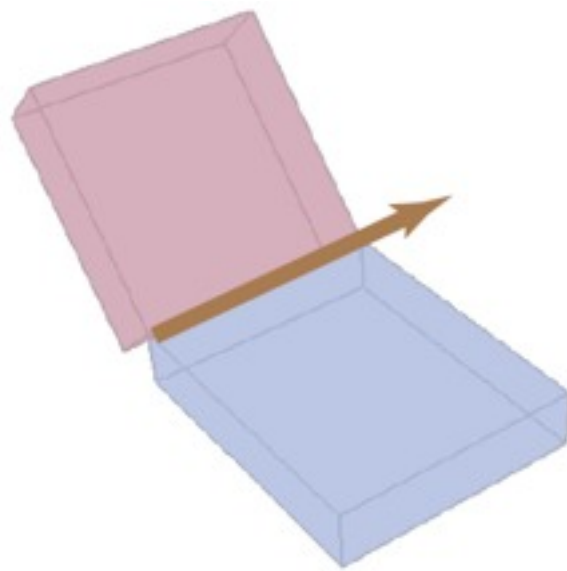
Hinge

Infer Consistent Junctions

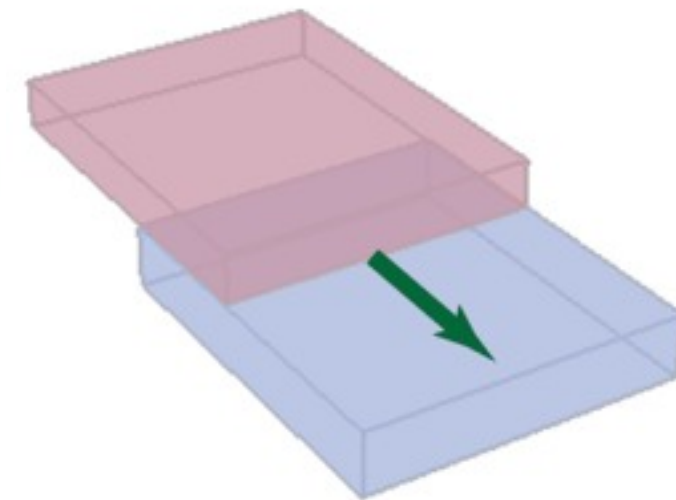
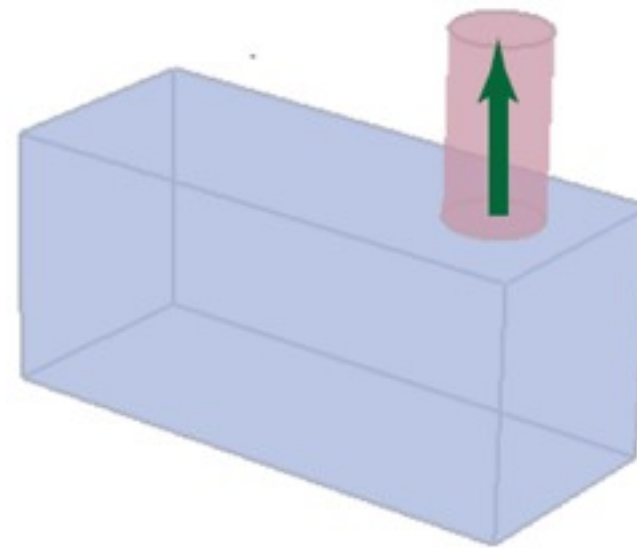
Junction types



Fixed

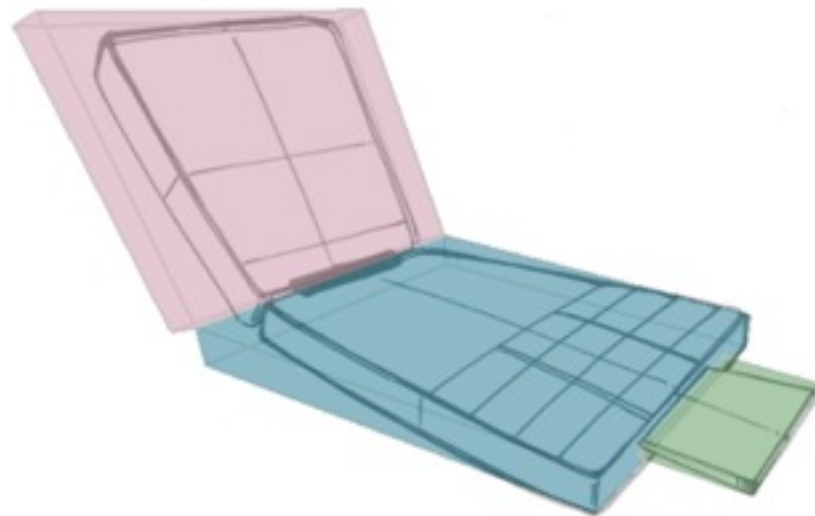


Hinge

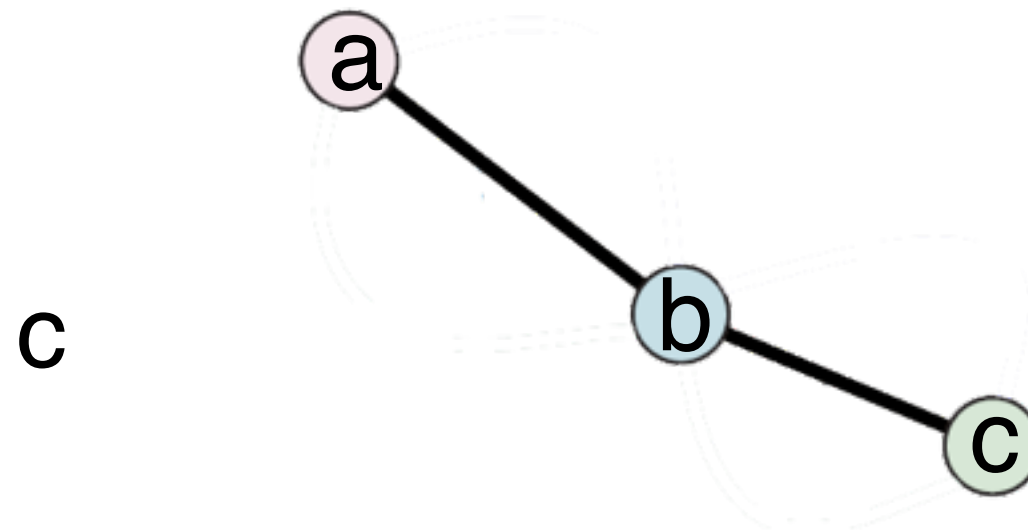
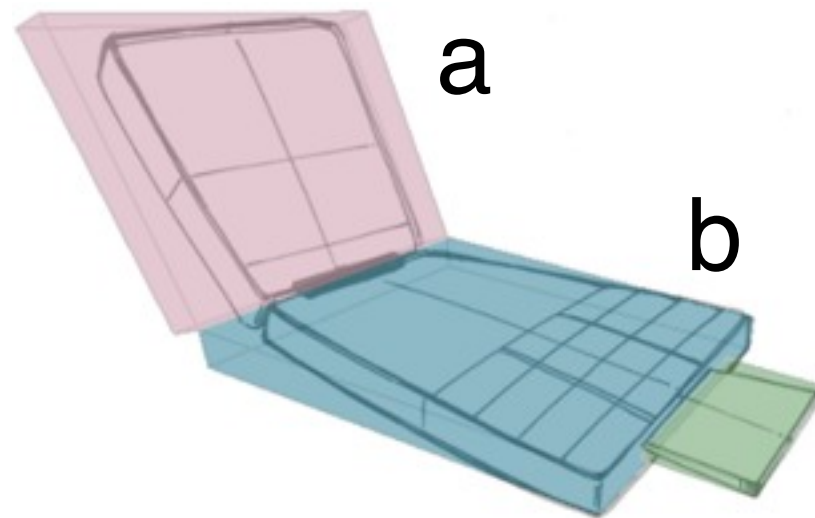


Slide

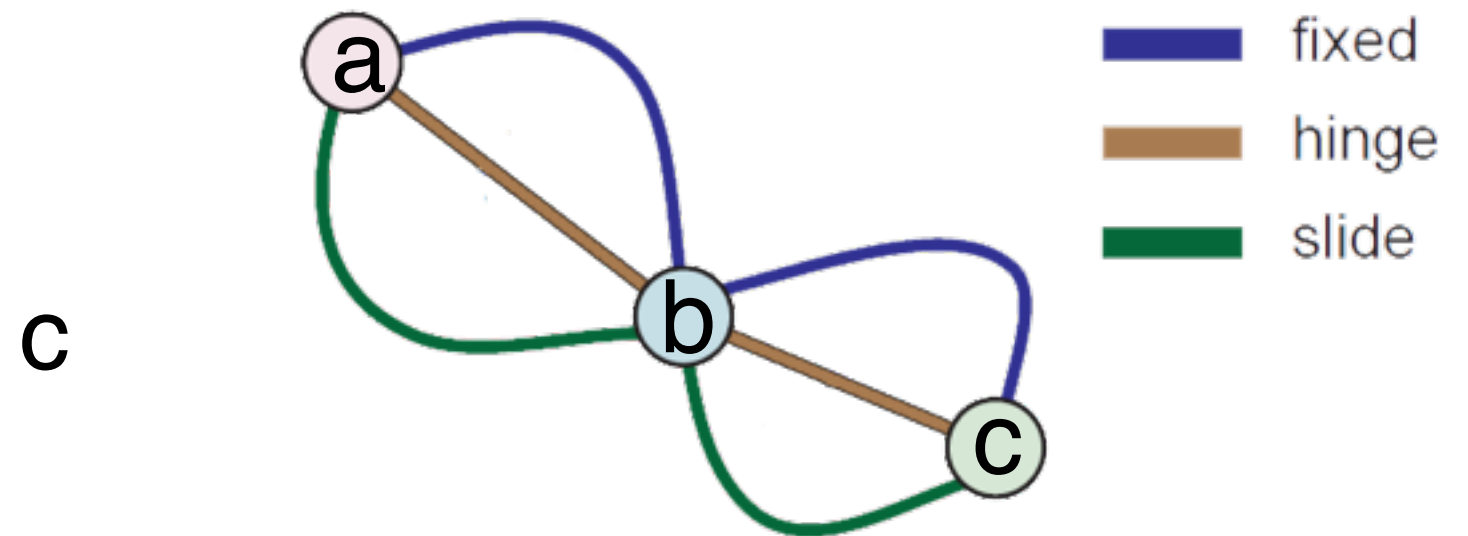
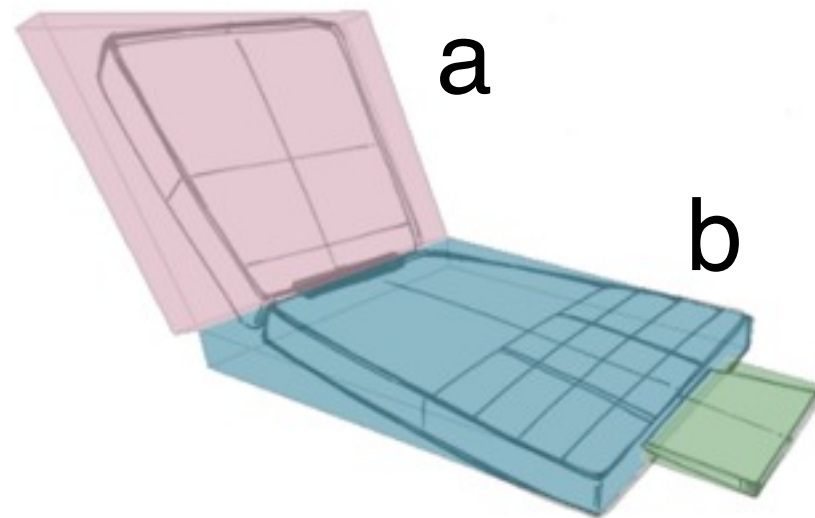
Infer Consistent Junctions



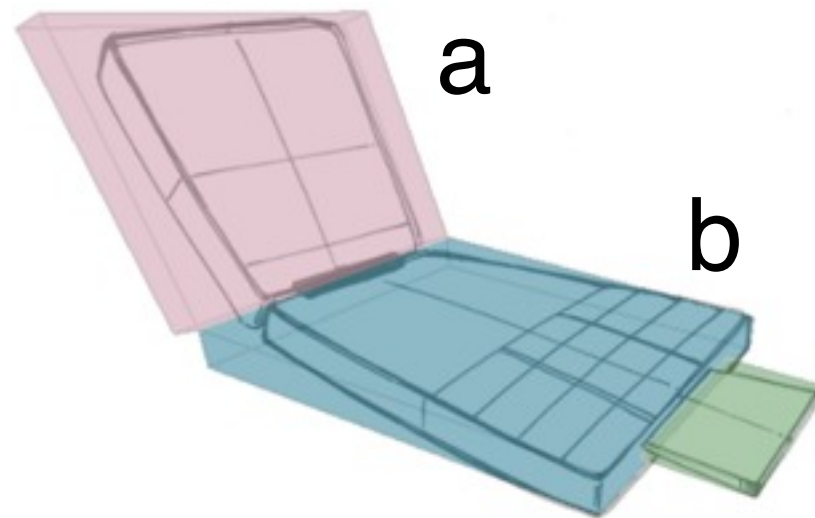
Infer Consistent Junctions



Infer Consistent Junctions

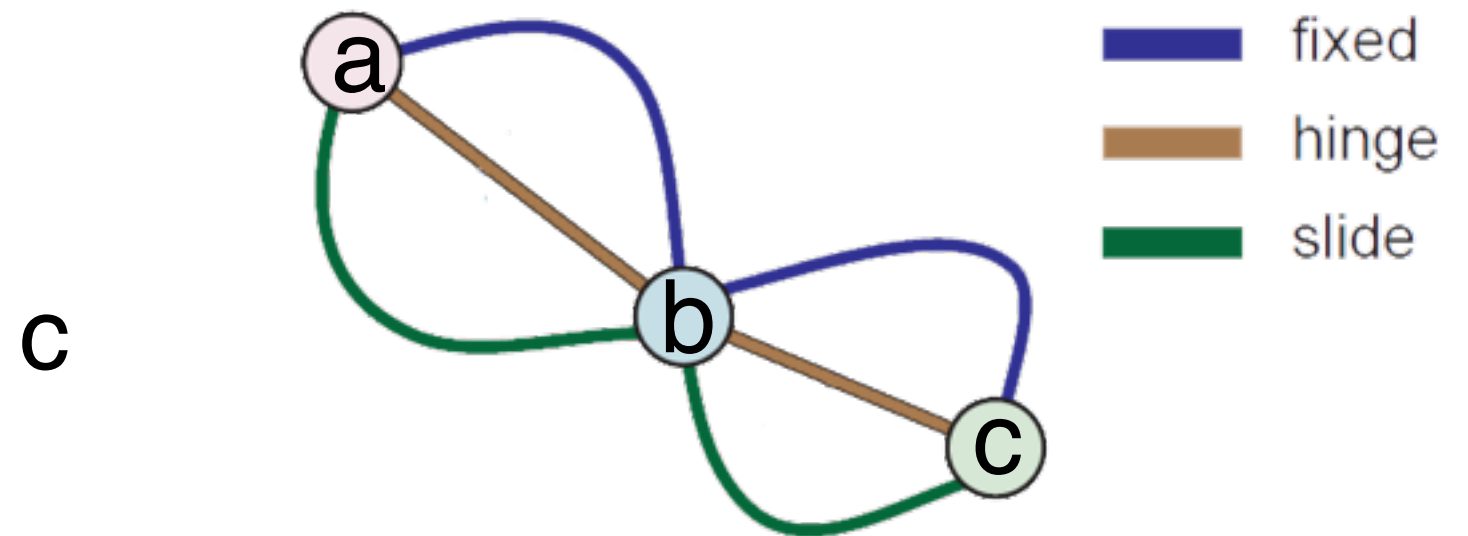


Infer Consistent Junctions

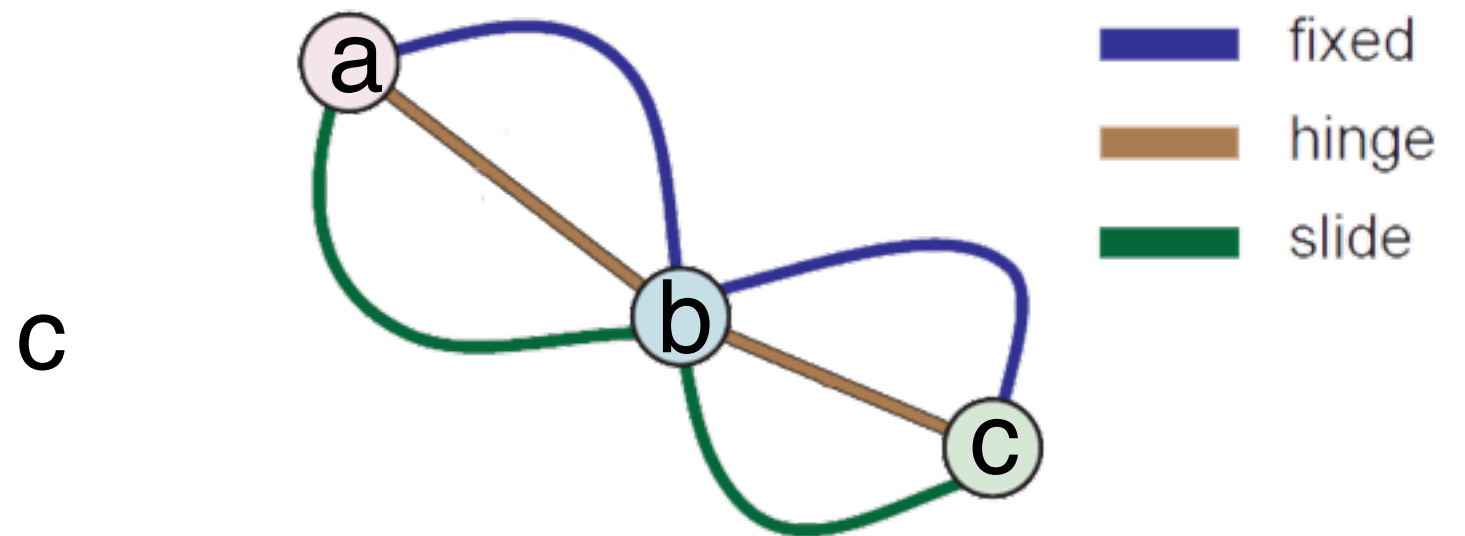
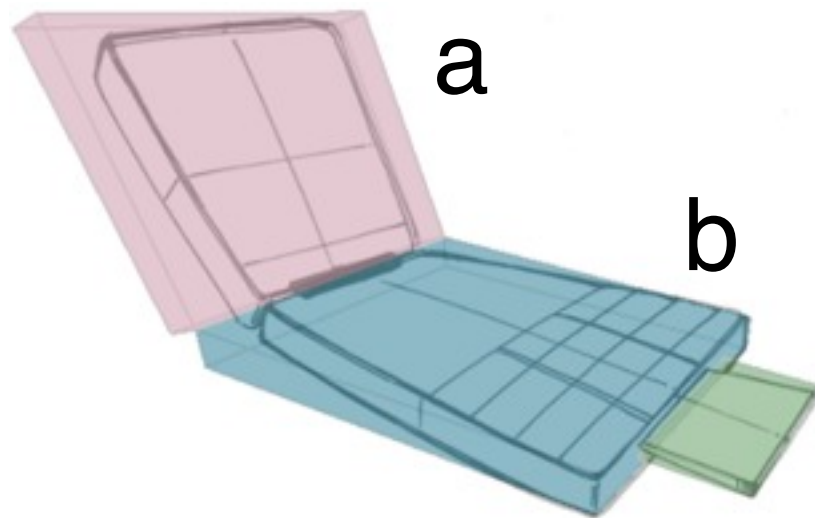


variables

$$x_{ij}^k = 0 \text{ or } 1$$



Infer Consistent Junctions



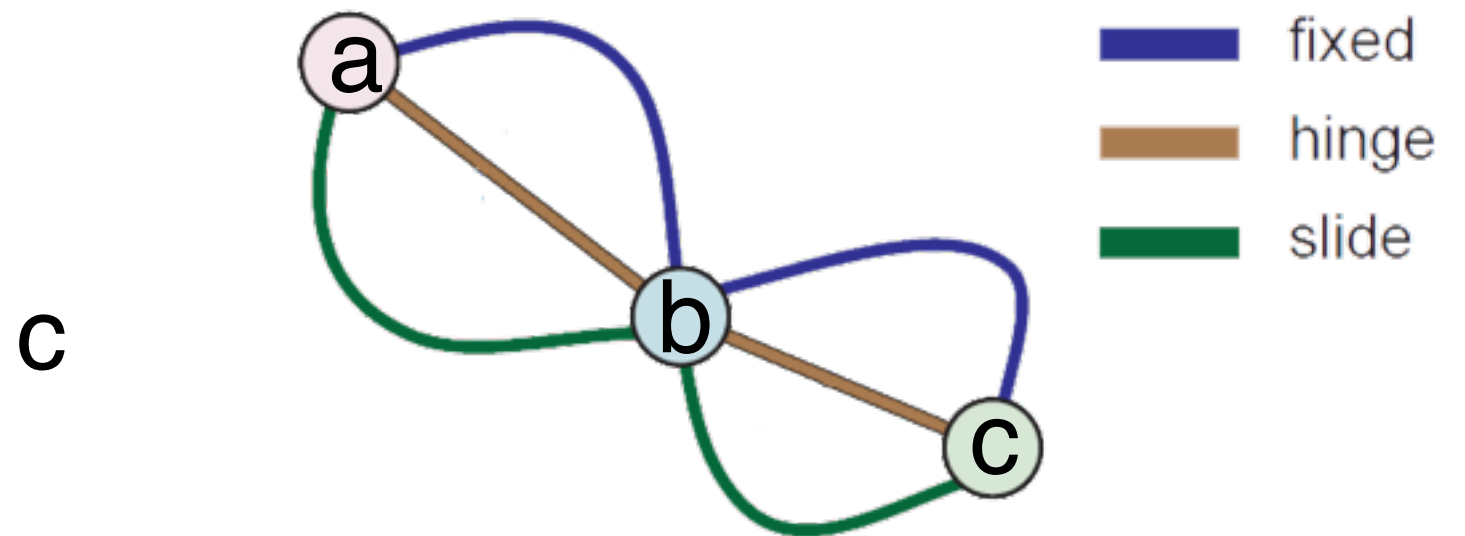
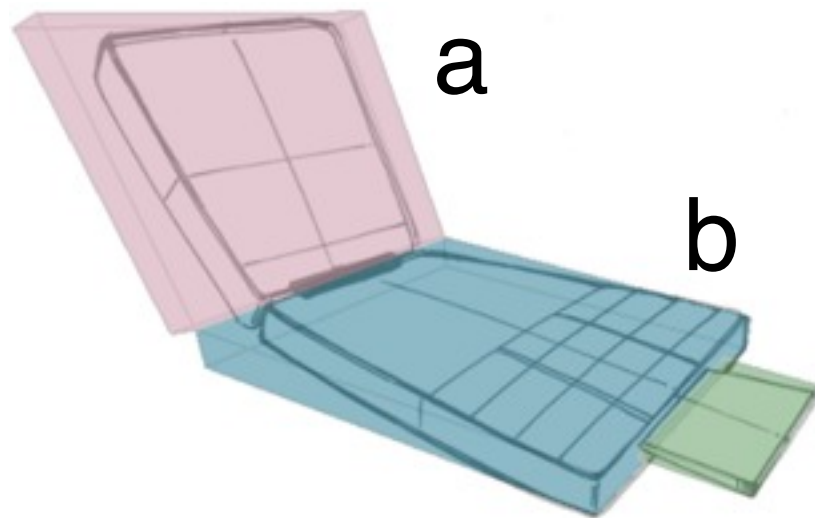
variables

$$x_{ij}^k = 0 \text{ or } 1$$

optimization

$$\arg \min_{\{x_{ij}^k\}} \sum_{k, e_{ij} \in G^*} E(x_{ij}^k) + \sum_{k, l; e_{ij}, e_{jq} \in G^*} E(x_{ij}^k, x_{jq}^l)$$

Infer Consistent Junctions



variables

$$x_{ij}^k = 0 \text{ or } 1$$

optimization

$$\arg \min_{\{x_{ij}^k\}} \sum_{k, e_{ij} \in G^*} E(x_{ij}^k) + \sum_{k, l; e_{ij}, e_{jq} \in G^*} E(x_{ij}^k, x_{jq}^l)$$

constraints

$$\sum_k x_{ij}^k = 1$$

Infer Consistent Junctions



- Single edge penalty term
 - two proxies sharing a direct contact
 - align relative position/orientation across all the views

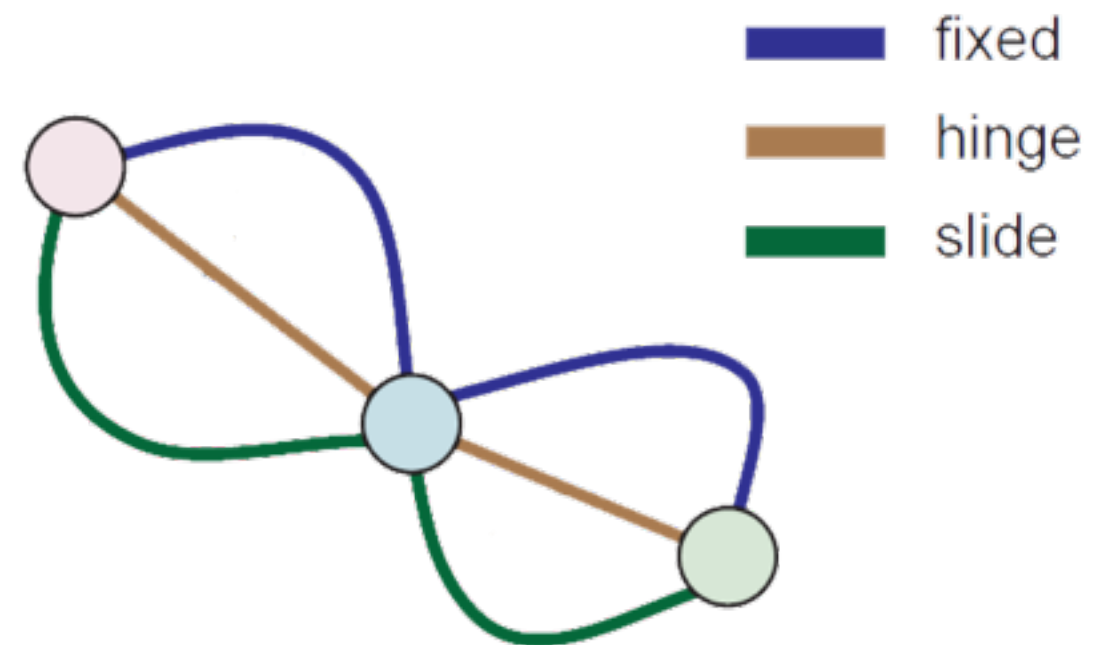


- Single edge penalty term
 - two proxies sharing a direct contact
 - align relative position/orientation across all the views

$$E(x_{ij}^k) := \min_{\mu} \sum_l (\underbrace{\|\mathbf{R}^l(\mu) - \mathbf{R}^0\|_2}_{\text{orientation difference}} + \underbrace{\|\mathbf{t}^l(\mu) - \mathbf{t}^0\|_2}_{\text{position difference}})$$

Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

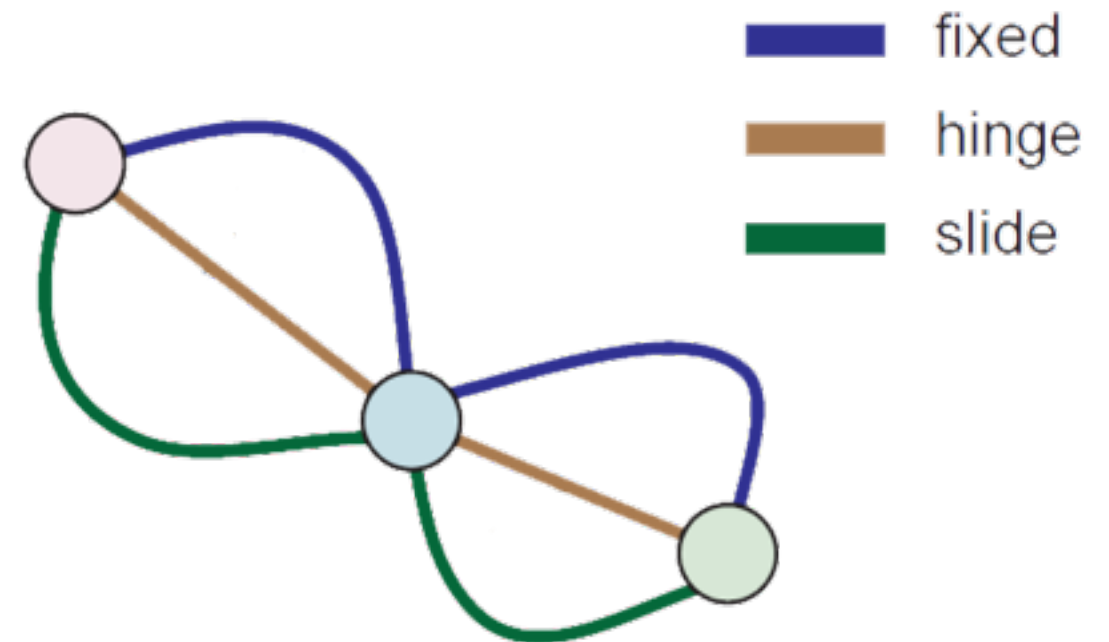


Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

ROUND 1

H	x_{ab}^1	x_{ab}^2	x_{ab}^3	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{ab}^1	20.8	0	0	20.9	20.9	20.9
x_{ab}^2	0	1.27	0	1.28	1.28	1.28
x_{ab}^3	0	0	20.8	20.9	20.9	20.9
x_{bc}^1	20.9	1.28	20.9	.01	0	0
x_{bc}^2	20.9	1.28	20.9	0	.01	0
x_{bc}^3	20.9	1.28	20.9	0	0	.01



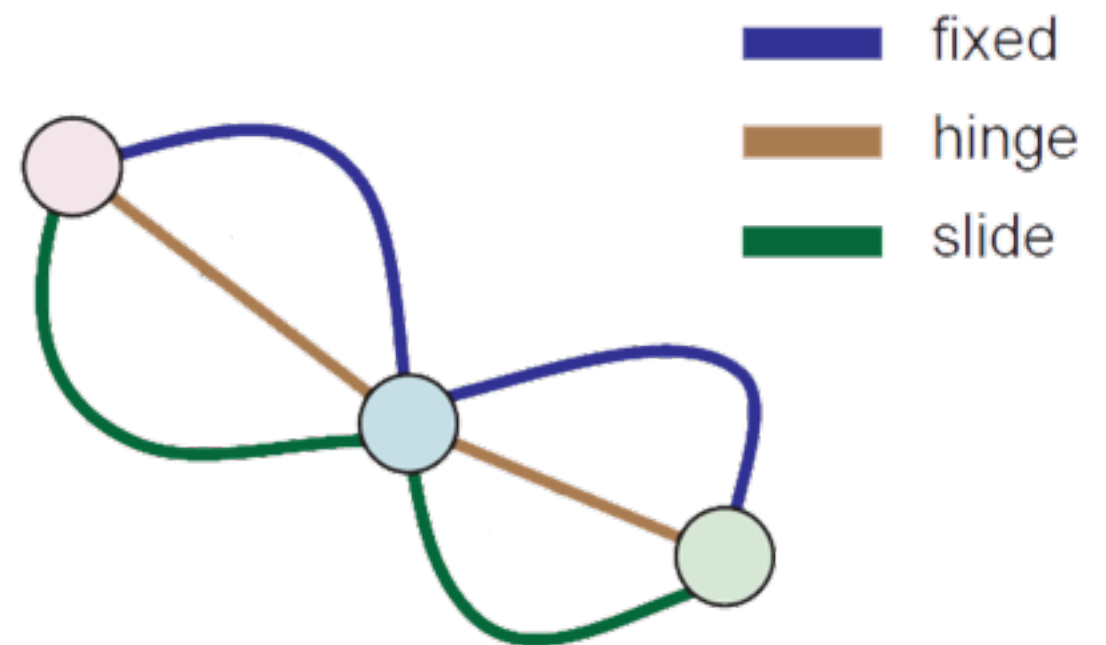
Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

$$\mathbf{y}^* = [0, 1, 0, 0.33, 0.33, 0.35]$$

ROUND 1

H	x_{ab}^1	x_{ab}^2	x_{ab}^3	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{ab}^1	20.8	0	0	20.9	20.9	20.9
x_{ab}^2	0	1.27	0	1.28	1.28	1.28
x_{ab}^3	0	0	20.8	20.9	20.9	20.9
x_{bc}^1	20.9	1.28	20.9	.01	0	0
x_{bc}^2	20.9	1.28	20.9	0	.01	0
x_{bc}^3	20.9	1.28	20.9	0	0	.01



Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

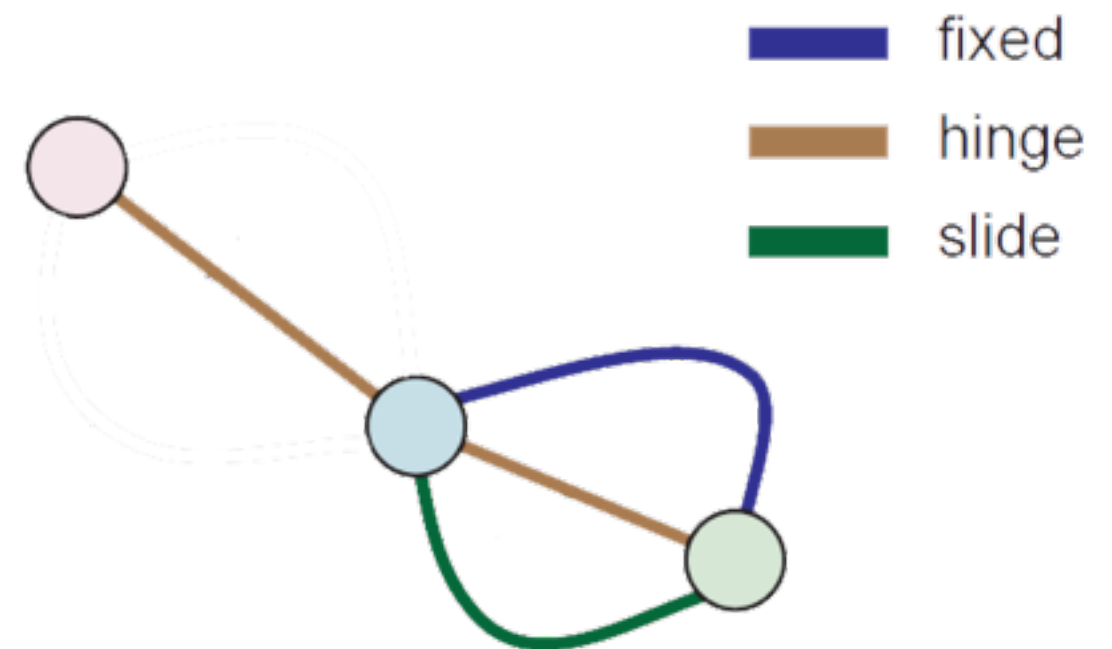
$$\mathbf{y}^* = [0, 1, 0, 0.33, 0.33, 0.35]$$

ROUND 1

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x_{ab}^3	0	0	20.8	20.9	20.9	20.9
x_{bc}^1	20.9	1.28	20.9	.01	0	0
x_{bc}^2	20.9	1.28	20.9	0	.01	0
x_{bc}^3	20.9	1.28	20.9	0	0	.01

ROUND 2

H	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{bc}^1	.005	0	0
x_{bc}^2	0	.005	0
x_{bc}^3	0	0	.004

$$\mathbf{f} = \begin{bmatrix} 0 \\ 7.65 \\ 0 \end{bmatrix}$$


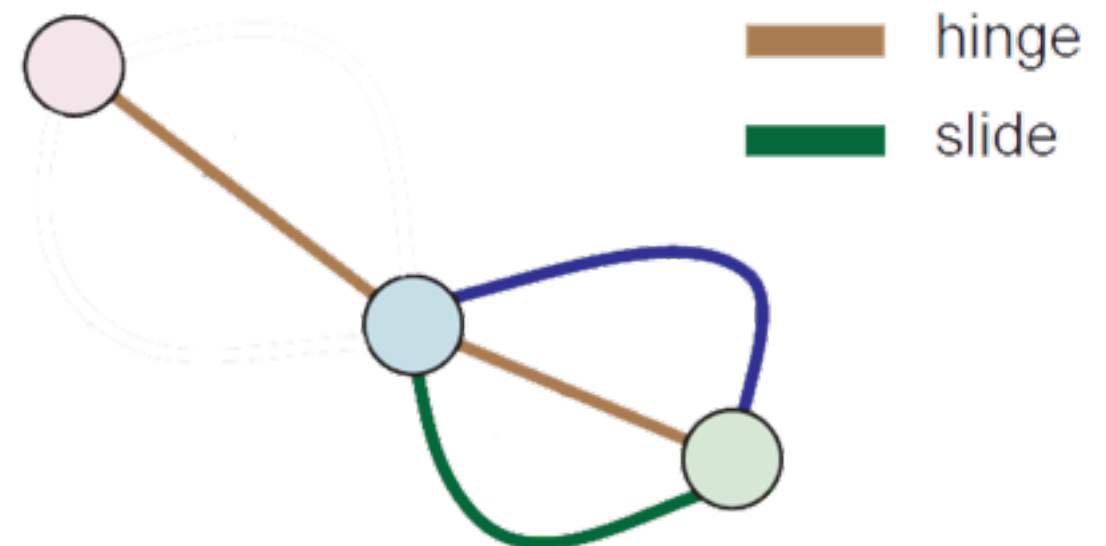
Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

$$\mathbf{y}^* = [0, 1, 0, 0.33, 0.33, 0.35]$$

ROUND 1

H	x_{ab}^1	x_{ab}^2	x_{ab}^3	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{ab}^1	20.8	0	0	20.9	20.9	20.9
x_{ab}^2	0	1.27	0	1.28	1.28	1.28
x_{ab}^3	0	0	20.8	20.9	20.9	20.9
x_{bc}^1	20.9	1.28	20.9	.01	0	0
x_{bc}^2	20.9	1.28	20.9	0	.01	0
x_{bc}^3	20.9	1.28	20.9	0	0	.01



$$\mathbf{y}^* = [0.45, 0, 0.5]$$

ROUND 2

H	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{bc}^1	.005	0	0
x_{bc}^2	0	.005	0
x_{bc}^3	0	0	.004

$\mathbf{f} = \begin{bmatrix} 0 \\ 7.65 \\ 0 \end{bmatrix}$

Infer Consistent Junctions

$$\mathbf{y}^* := \arg \min_{\mathbf{y}} \mathbf{y}^T H \mathbf{y} + \mathbf{f}^T \mathbf{y}$$

$$\mathbf{y}^* = [0, 1, 0, 0.33, 0.33, 0.35]$$

ROUND 1

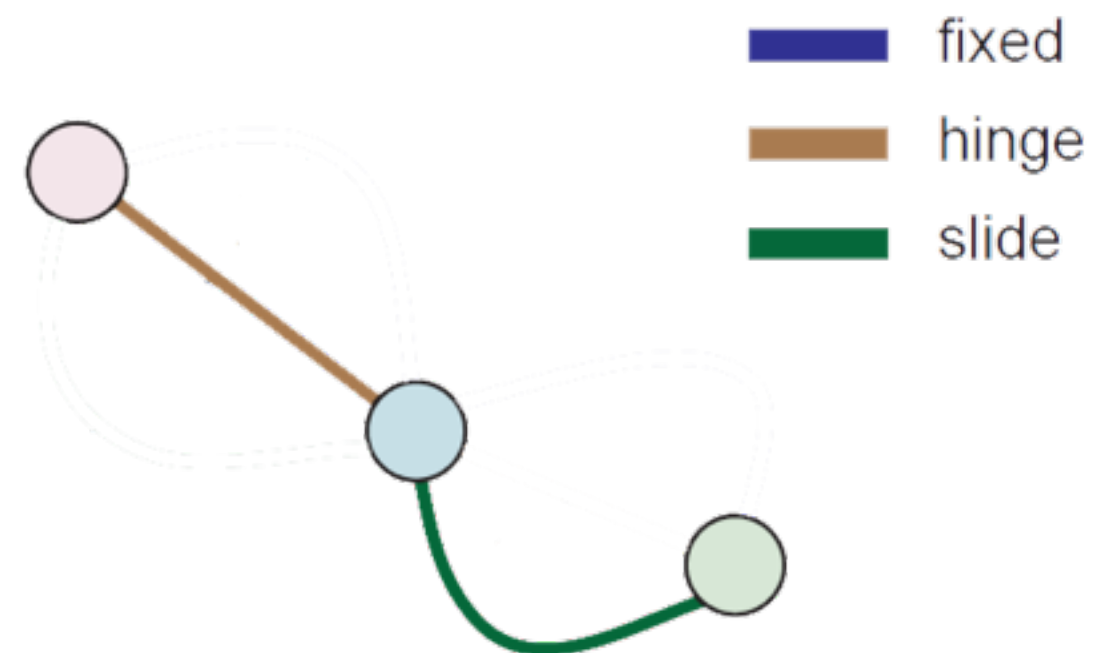
H	x_{ab}^1	x_{ab}^2	x_{ab}^3	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{ab}^1	20.8	0	0	20.9	20.9	20.9
x_{ab}^2	0	1.27	0	1.28	1.28	1.28
x_{ab}^3	0	0	20.8	20.9	20.9	20.9
x_{bc}^1	20.9	1.28	20.9	.01	0	0
x_{bc}^2	20.9	1.28	20.9	0	.01	0
x_{bc}^3	20.9	1.28	20.9	0	0	.01

$$\mathbf{y}^* = [0.45, 0, 0.5]$$

ROUND 2

H	x_{bc}^1	x_{bc}^2	x_{bc}^3
x_{bc}^1	.005	0	0
x_{bc}^2	0	.005	0
x_{bc}^3	0	0	.004

$\mathbf{f} = \begin{bmatrix} 0 \\ 7.65 \\ 0 \end{bmatrix}$



Printer Example



Printer Example



Hair Dryer

Hair Dryer



Future Challenges

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- Beyond part-based models

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- Big data challenge

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- Unified encoding of structure across models

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- Beyond part-based models
- Big data challenge
- Unified encoding of structure across models
- How to deal with inconsistencies among relations?

Future Challenges

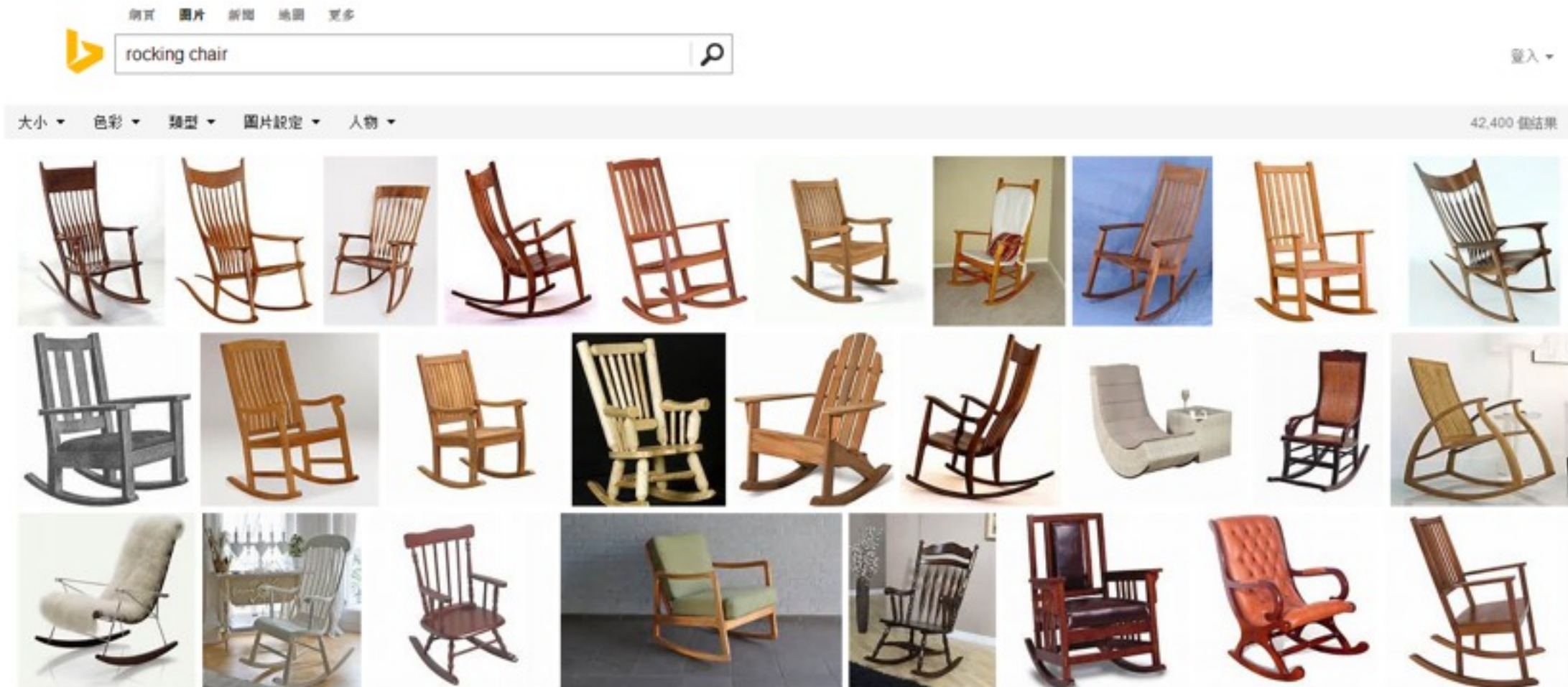
- Beyond part-based models
- Big data challenge
- Unified encoding of structure across models
- How to deal with inconsistencies among relations?
- ‘Semantic’ tagging + infer object function

Future Challenges

- Beyond part-based models
- Big data challenge
- Unified encoding of structure across models
- How to deal with inconsistencies among relations?
- ‘Semantic’ tagging + infer object function

slides, supplementary on project page

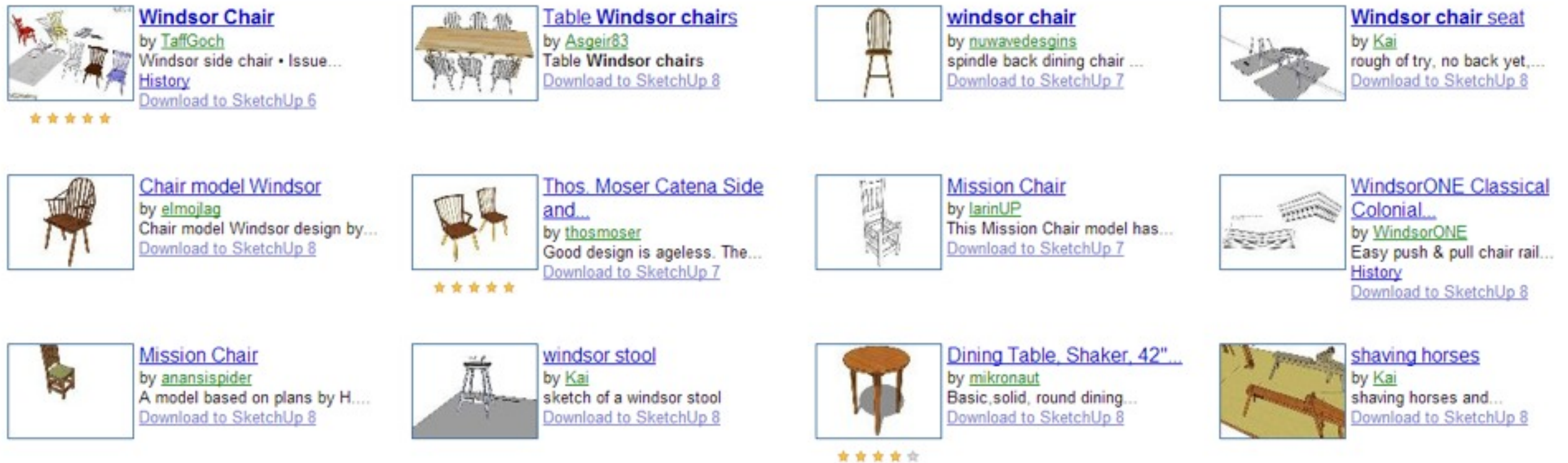
Supervision: Labeled Data



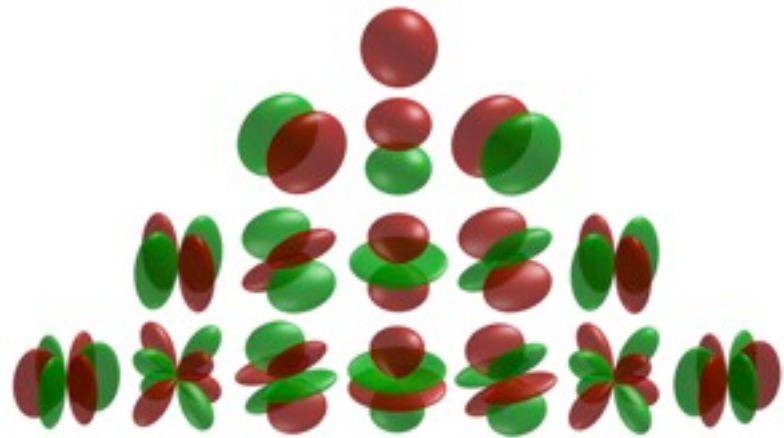
Supervision: Labeled Data



3D Warehouse Results Sorted by relevance Results 1 - 12 of about 16 for windsor ch



Discriminative Feature Descriptors



Shape distributions
Spherical harmonics
Light fields
Heat kernel

...

Research level

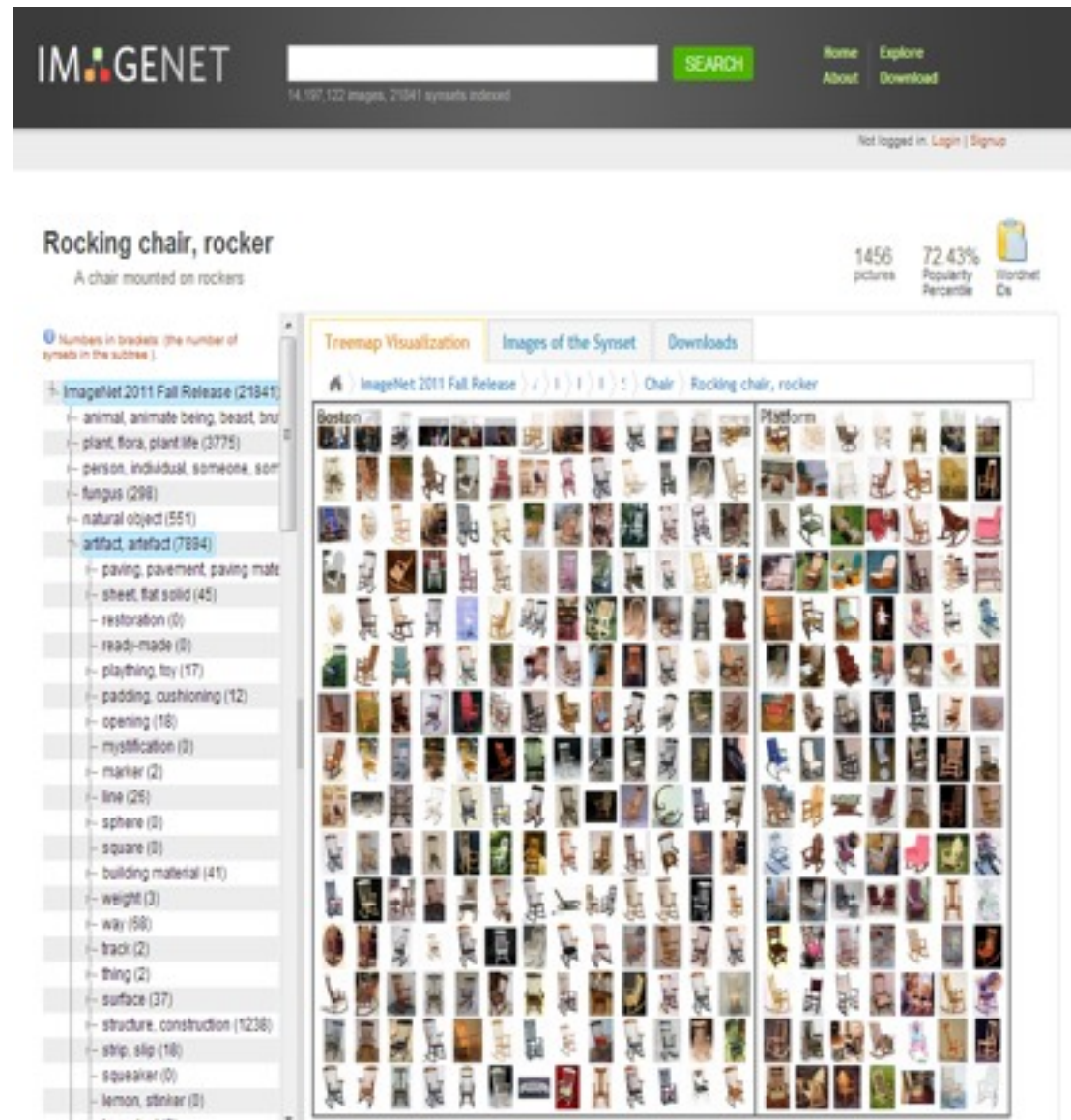


Bag of words
HOG
GIST
SIFT

...

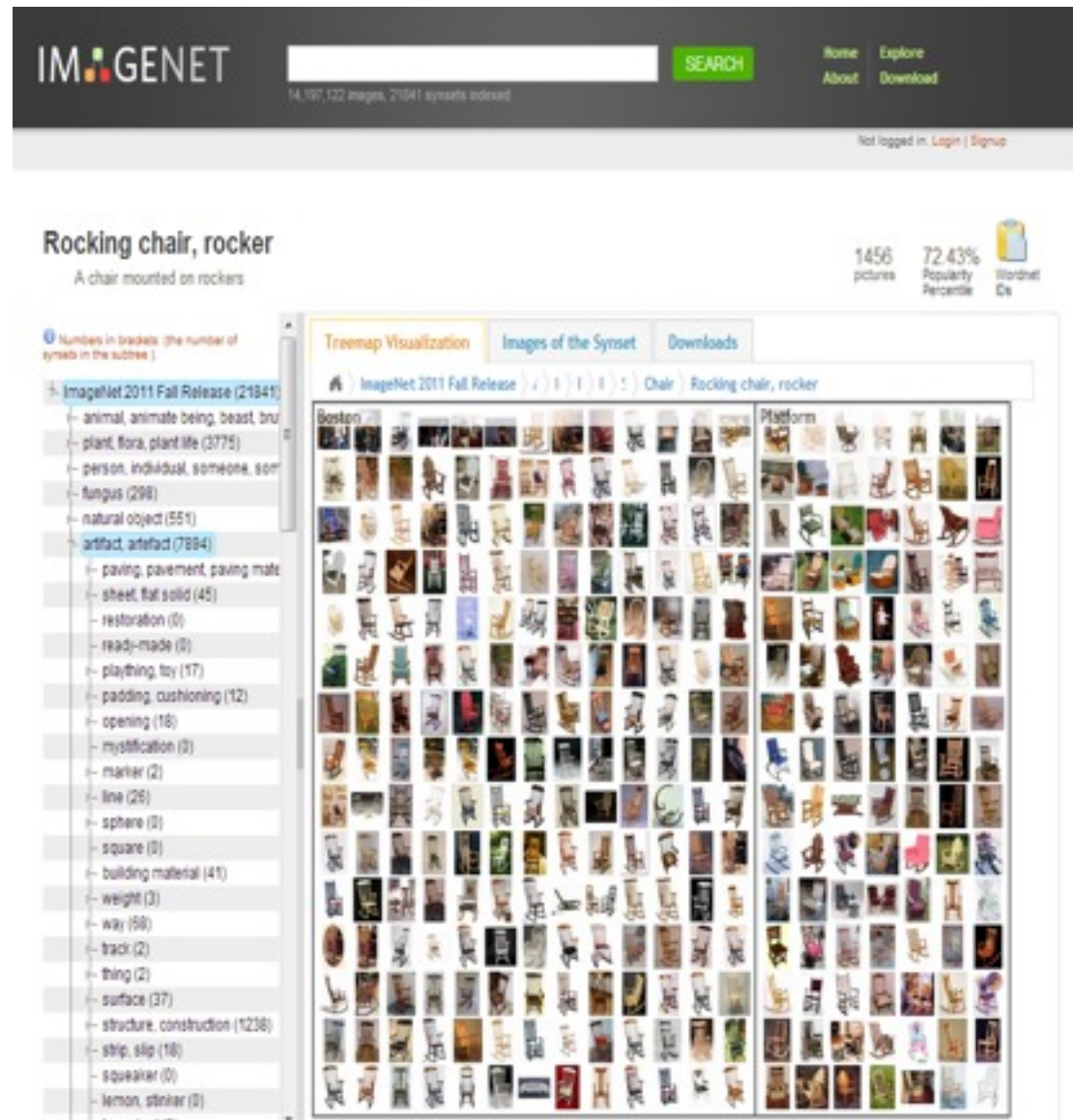
Industry level

Generating Big Data

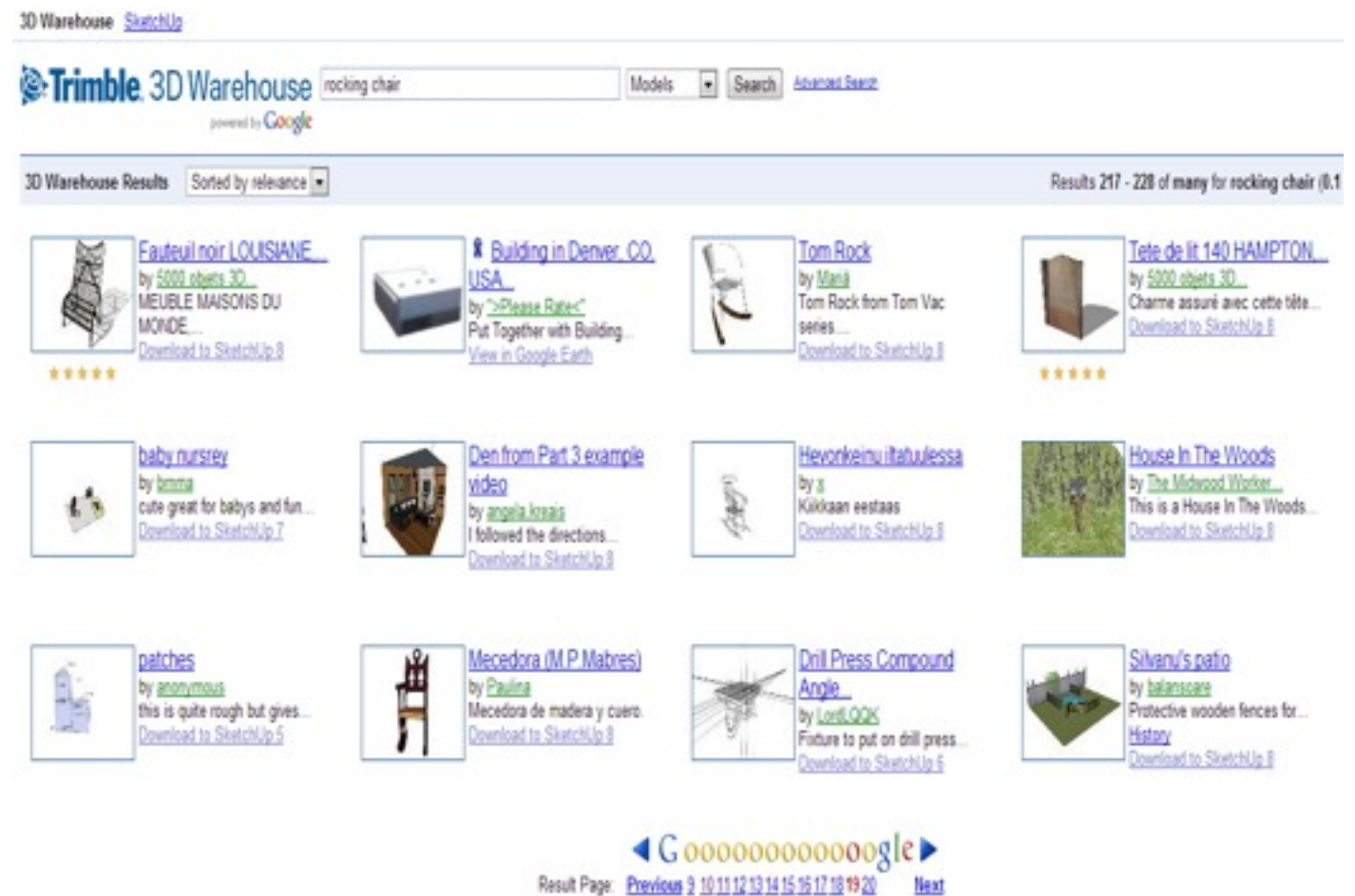


Billions of images

Generating Big Data



Billions of images



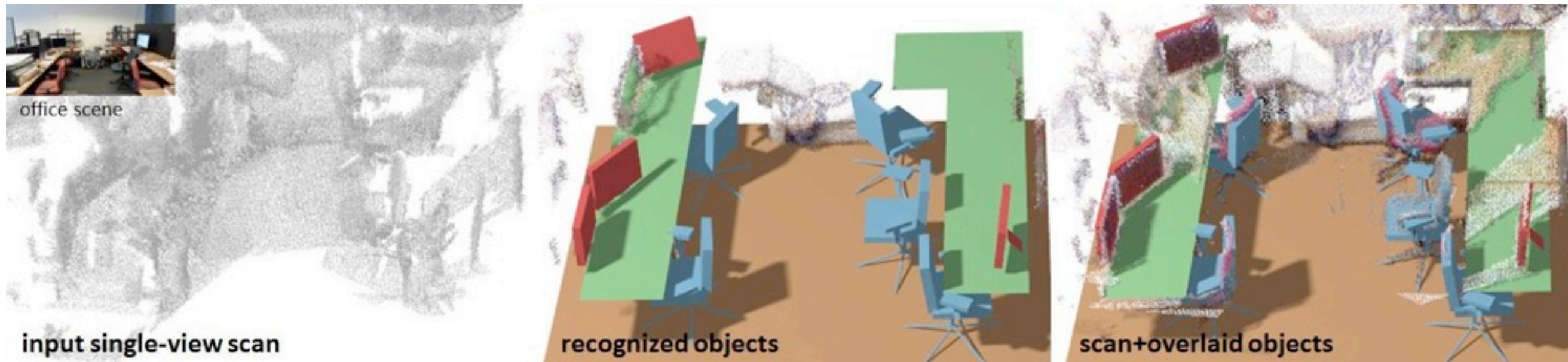
millions of shapes

Architectural Style



gothic

Computational Efficiency



Real-time systems (robotics applications)

Challenges

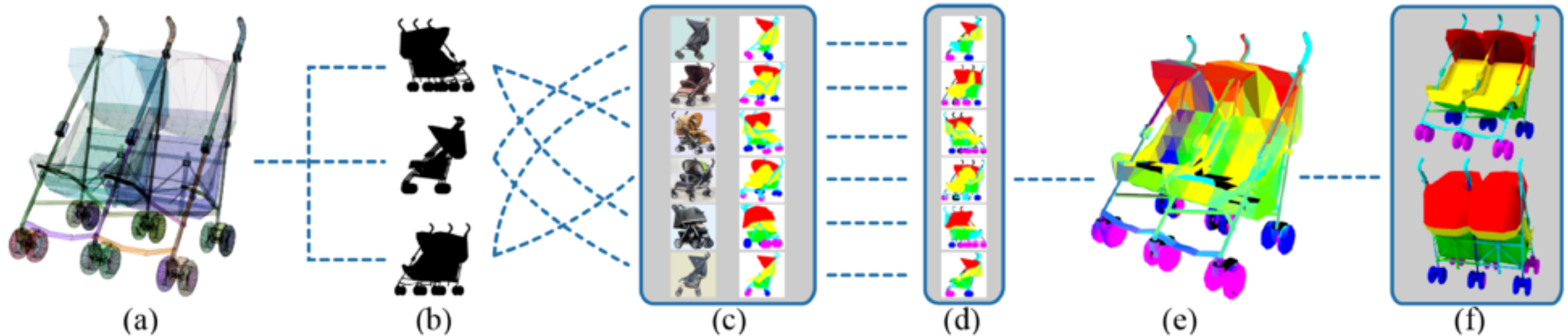
1. **Topology:** continuous structure-aware topology variation



2. **Functionality:** how to describe, compare, classify, and synthesize functionality for 3D objects

Challenges

3. **Big data:** how to best tap into the vast amount of available data (e.g., images) but quickly distil them



Projective shape analysis (PSA): 3D shape analysis by learning from image data (Thursday, 16:00, “Shape and ML” session)

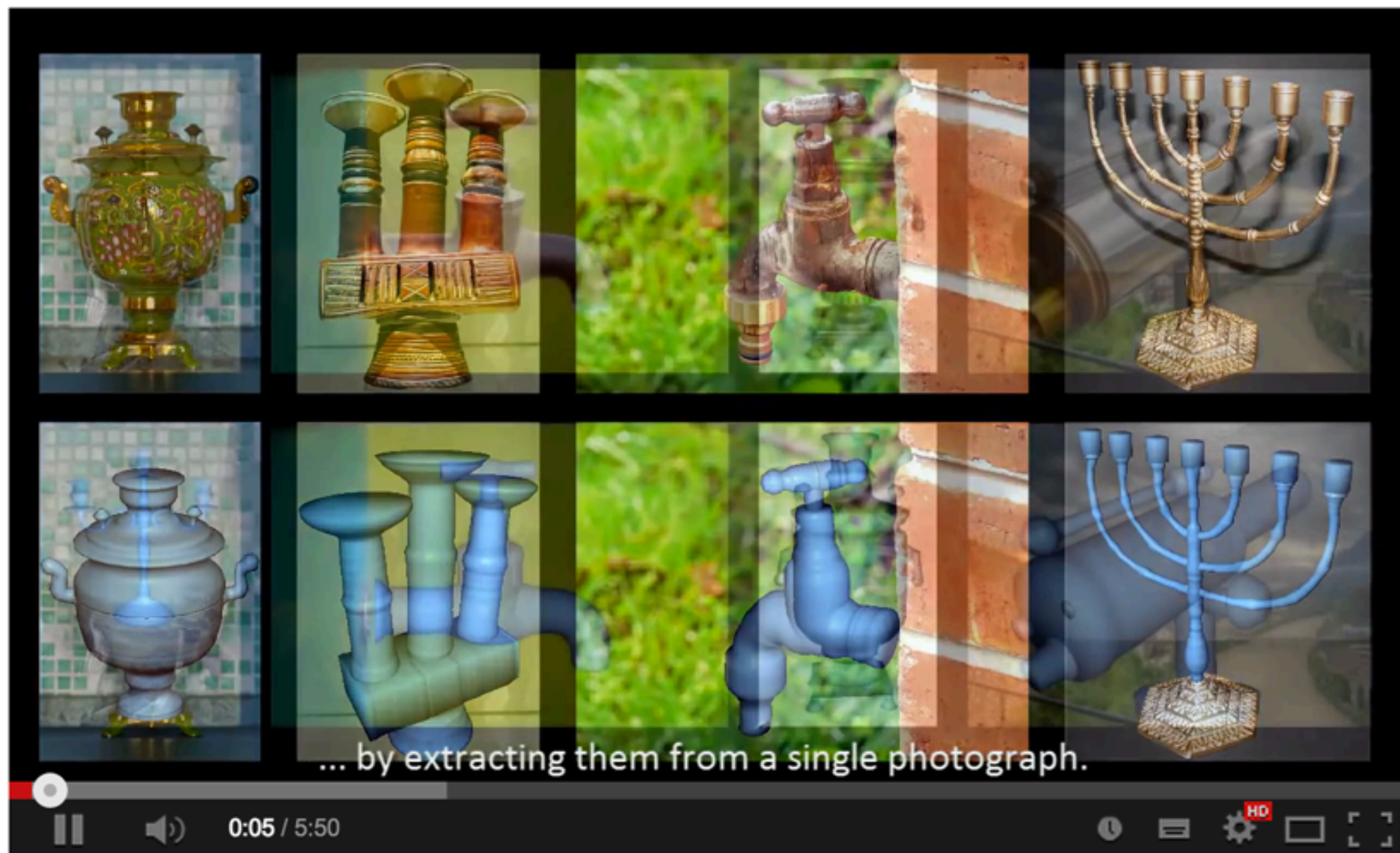
Challenges

4. Too much “preservation”! Let’s **combine** to create truly new structures or even functionalities, e.g., a **functional hybrid**



Challenges

5. **User desires:** Are the modeling paradigms we are developing truly what users want?
- We claim that the tools developed are designed for novice users, was this claim really validated?
 - Could any tool we have developed so far get more than 1.5 million views on Youtube?



3-Sweep: Extracting Editable Objects from a Single Photo, SIGGR...



Daniel CohenOr · 9 videos



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1,202

1,668,871

17,730 127

Feedback Time

[http://tinyurl.com/
m2uqqfb](http://tinyurl.com/m2uqqfb)