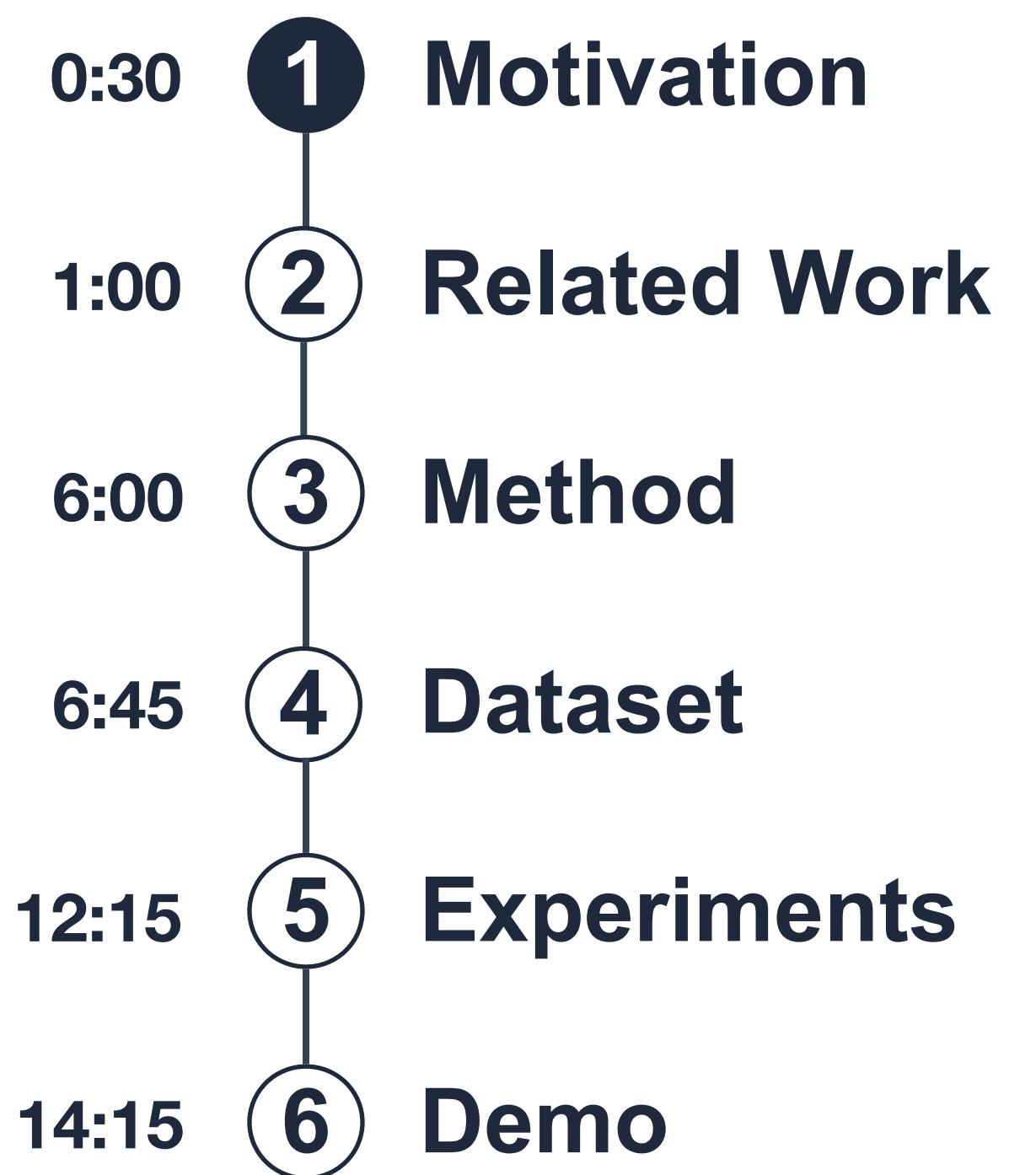


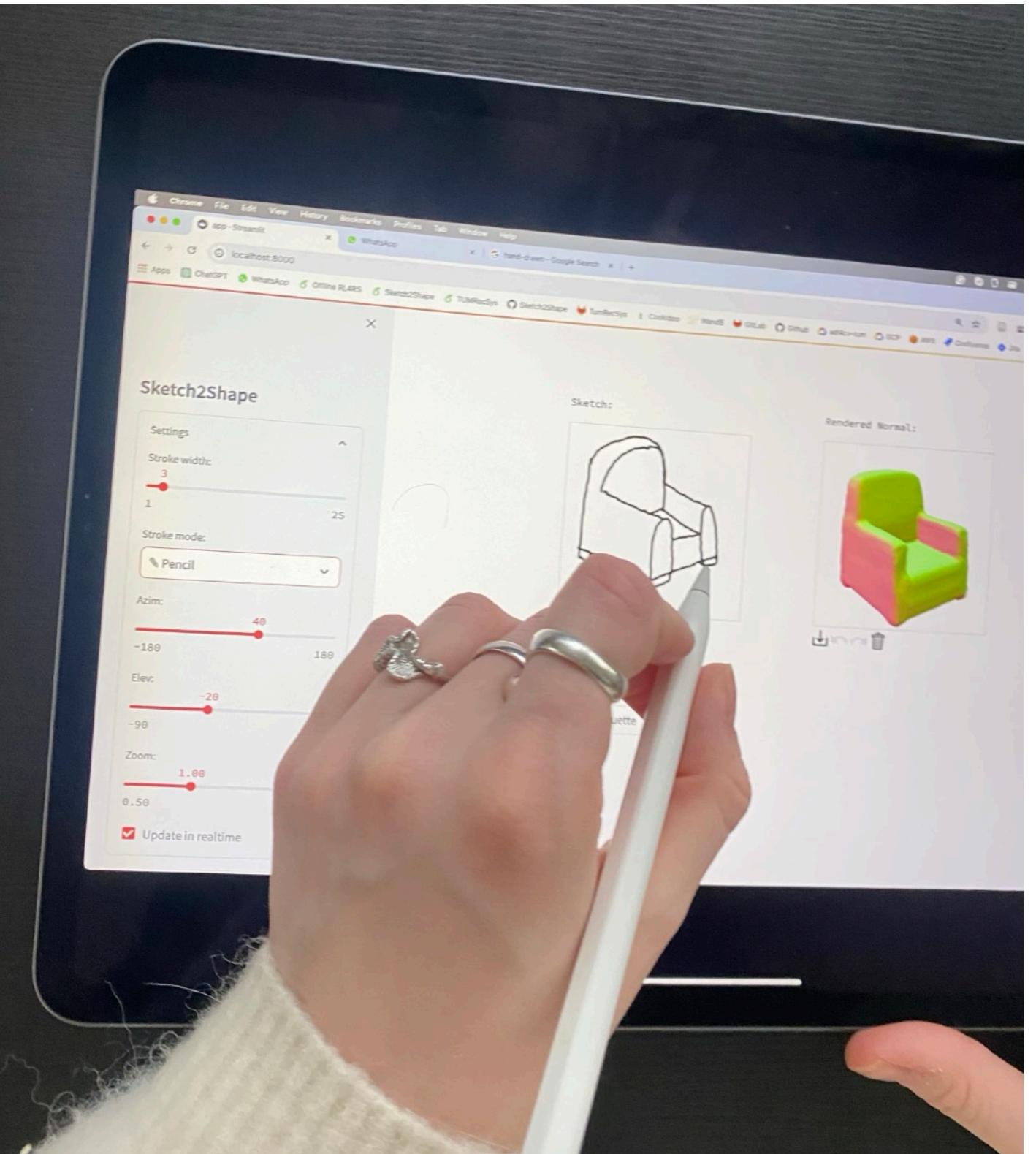
Sketch2Shape

Single-View Sketch-based 3D Reconstruction via Multi-View Differentiable Rendering

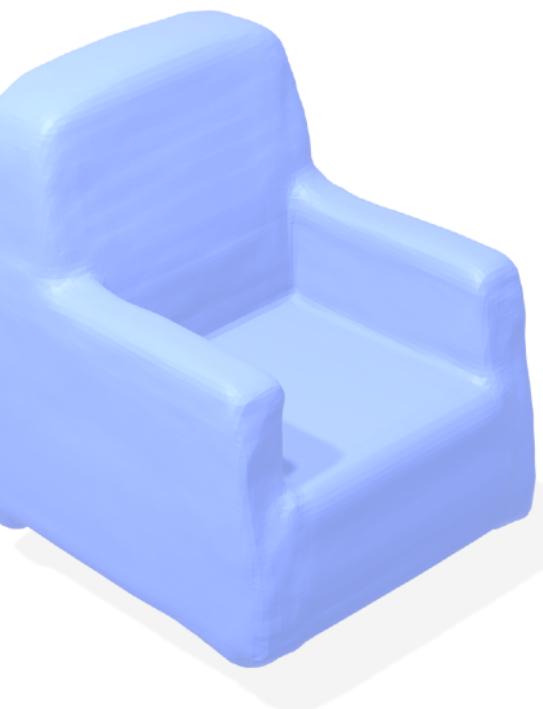
Outline



Motivation: Real-Time 3D Content Creation

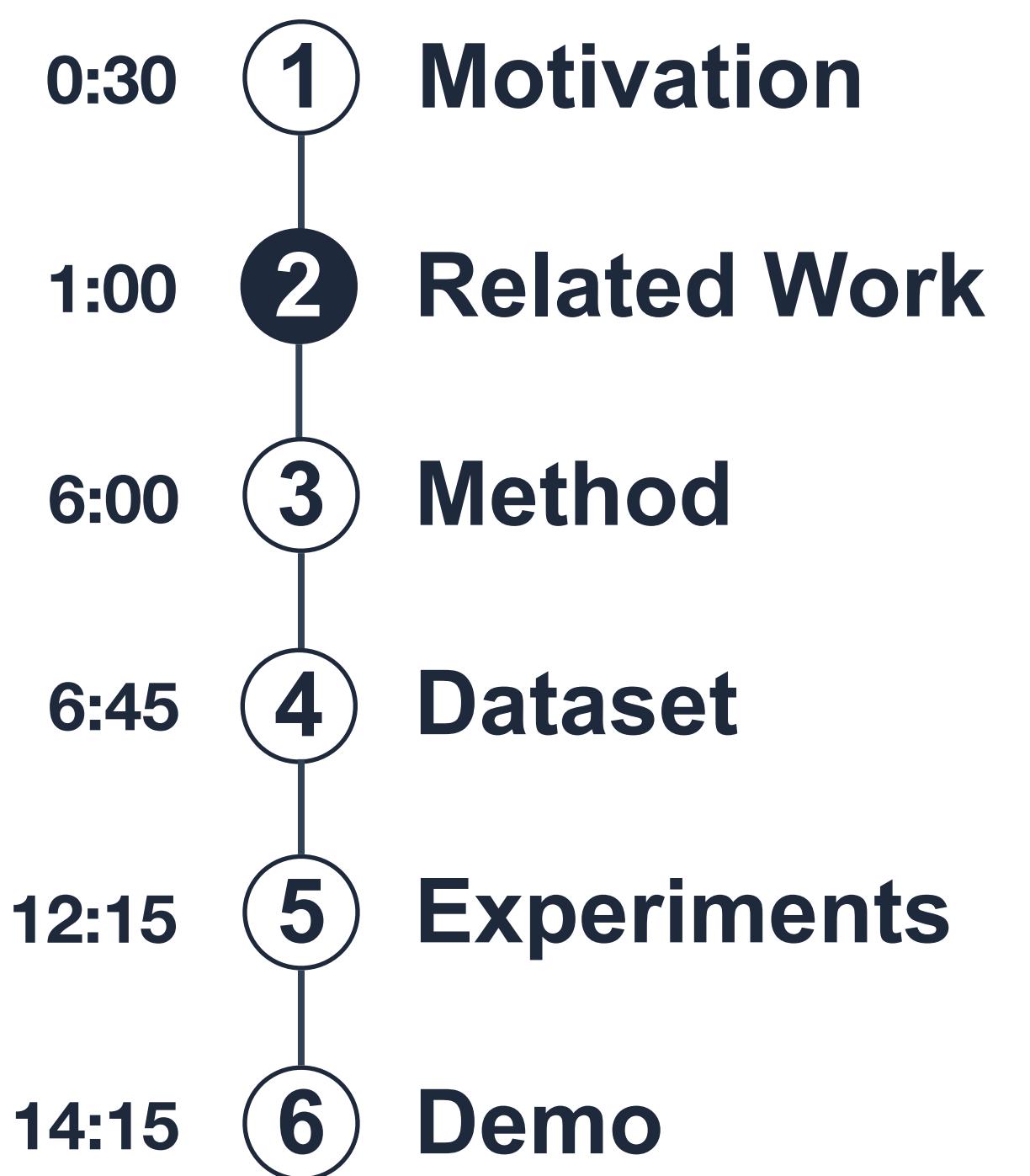


2D Sketch Input



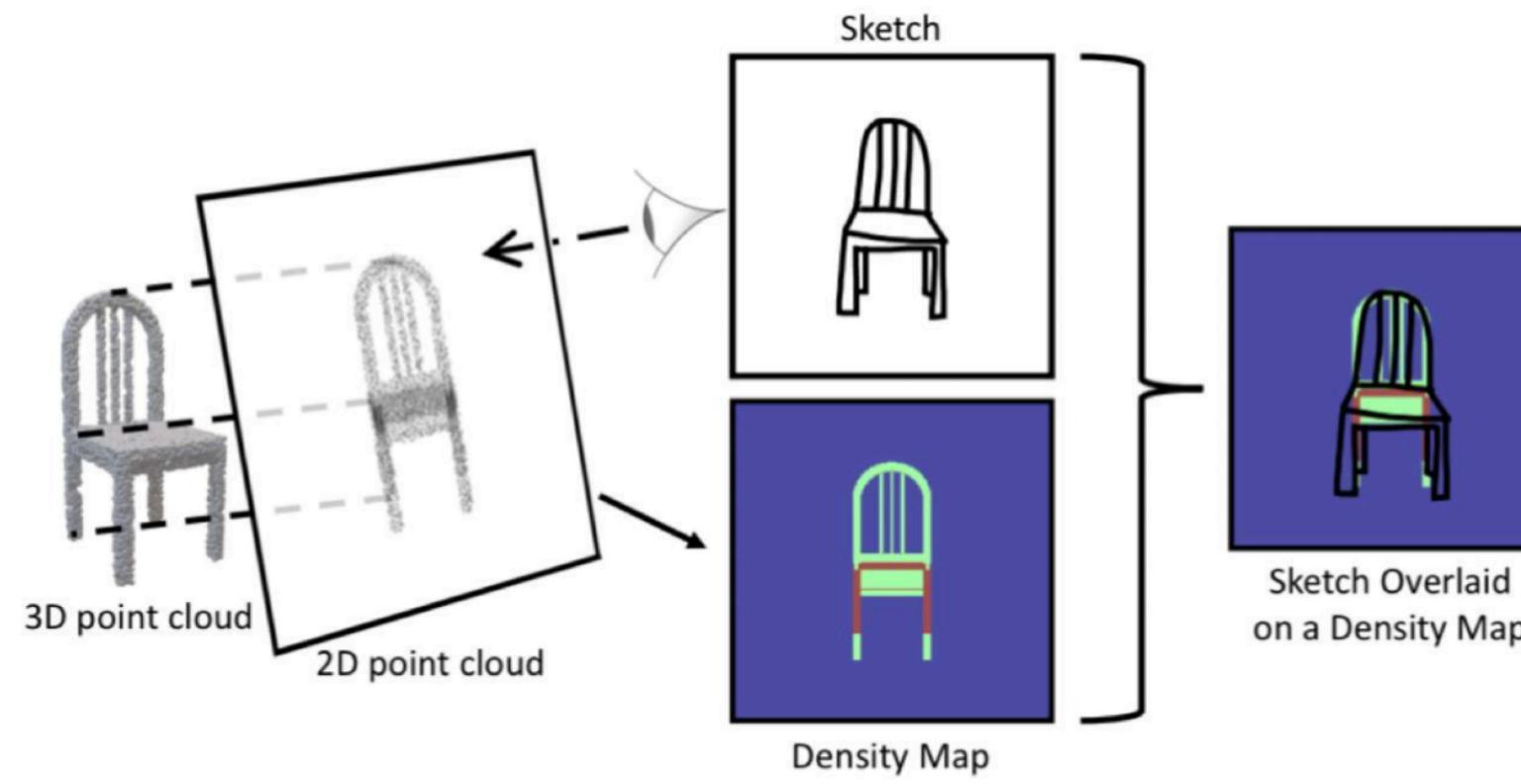
3D Mesh Output

Outline

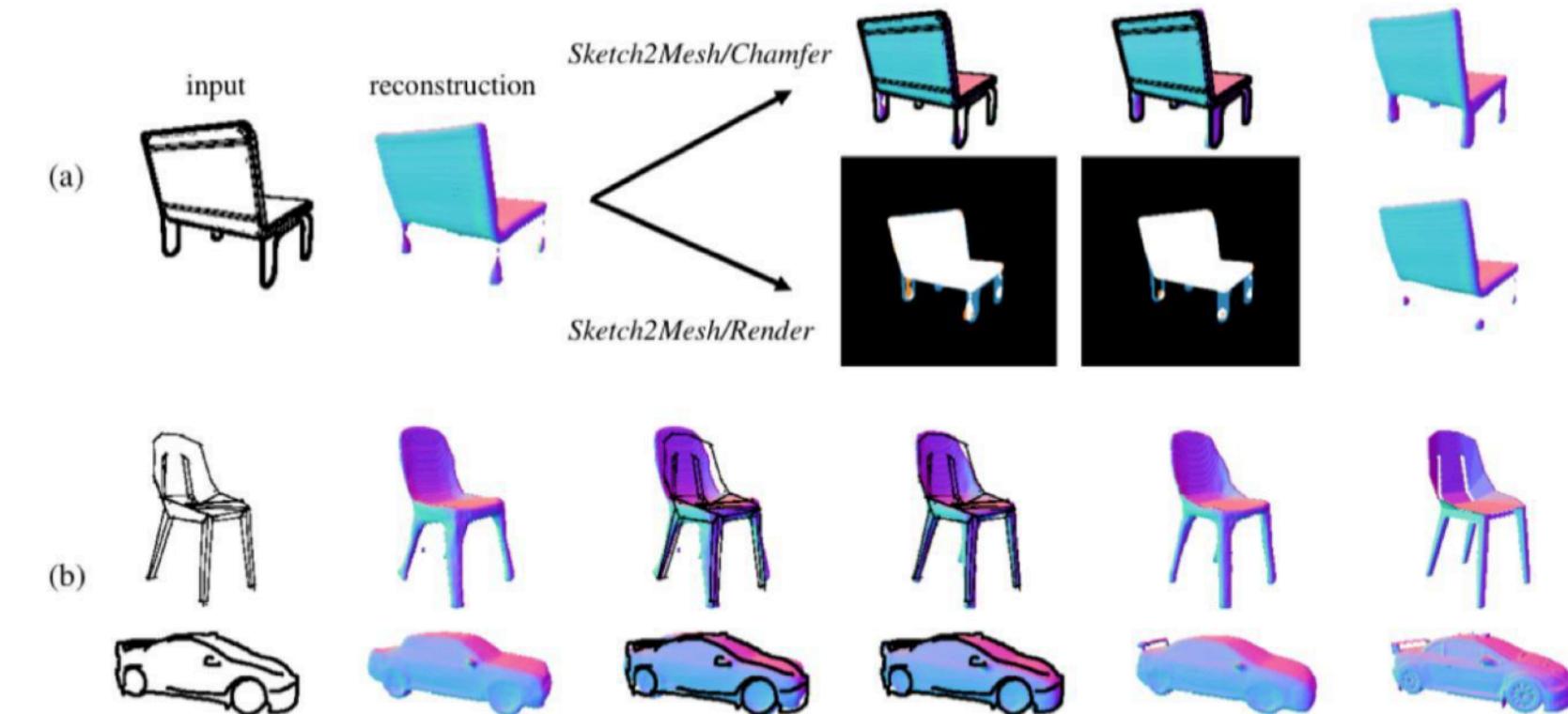


Related Work

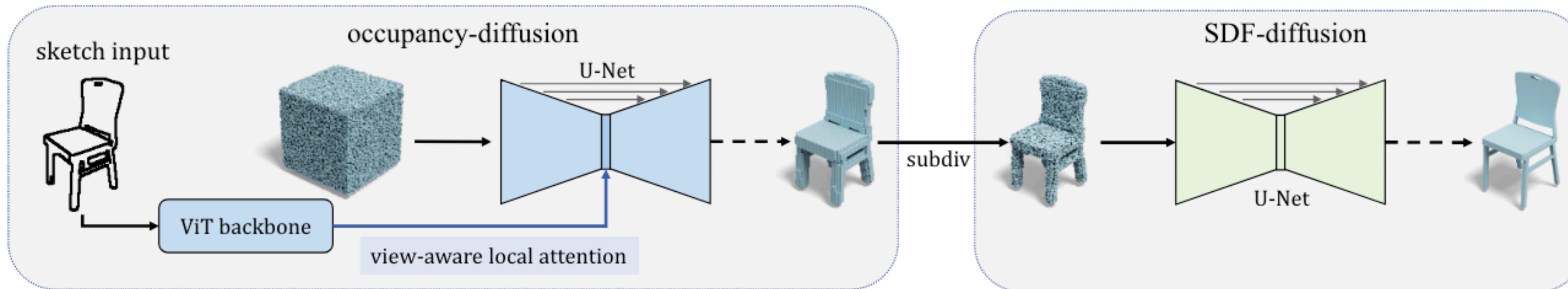
SketchSampler



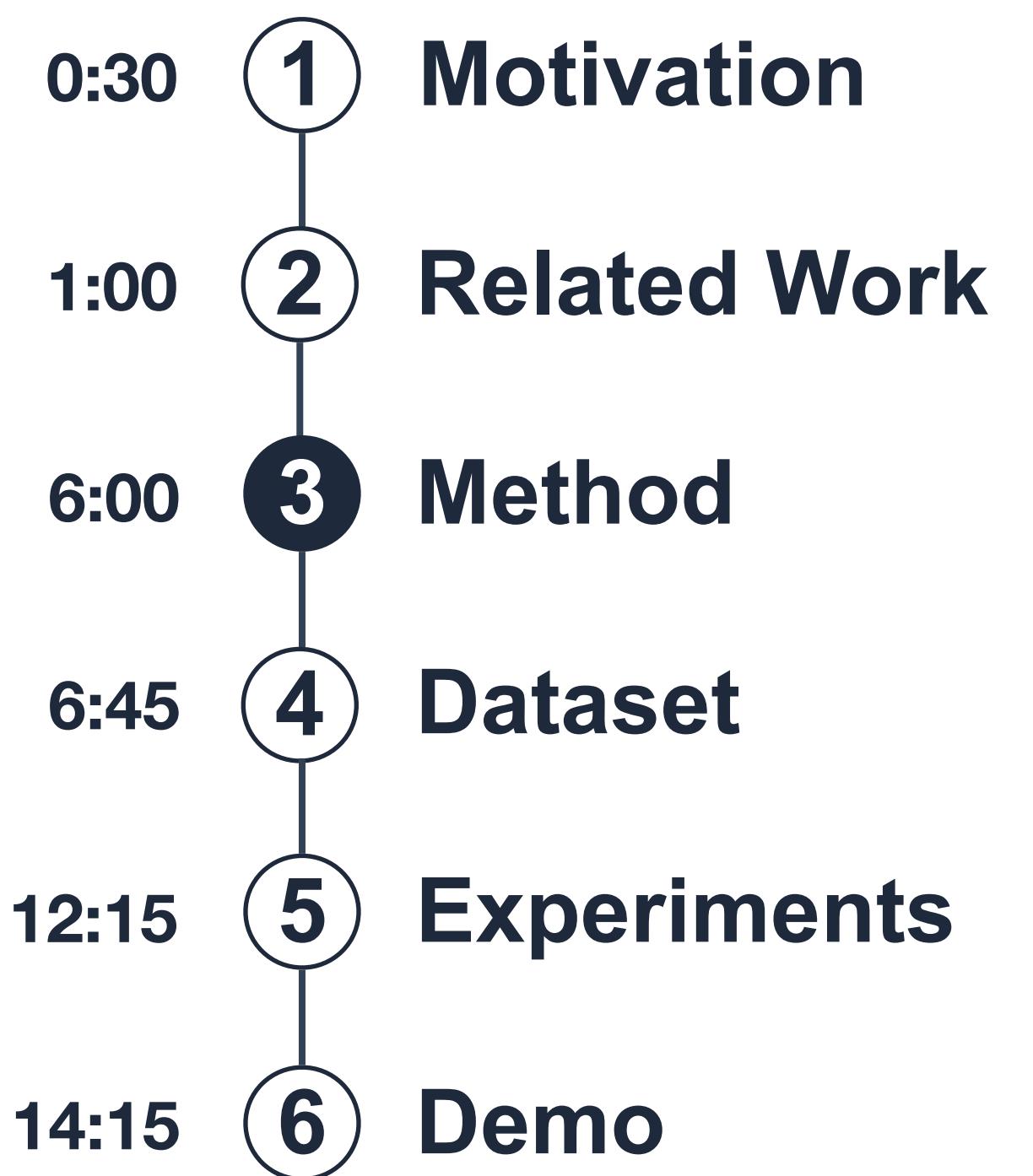
Sketch2Mesh



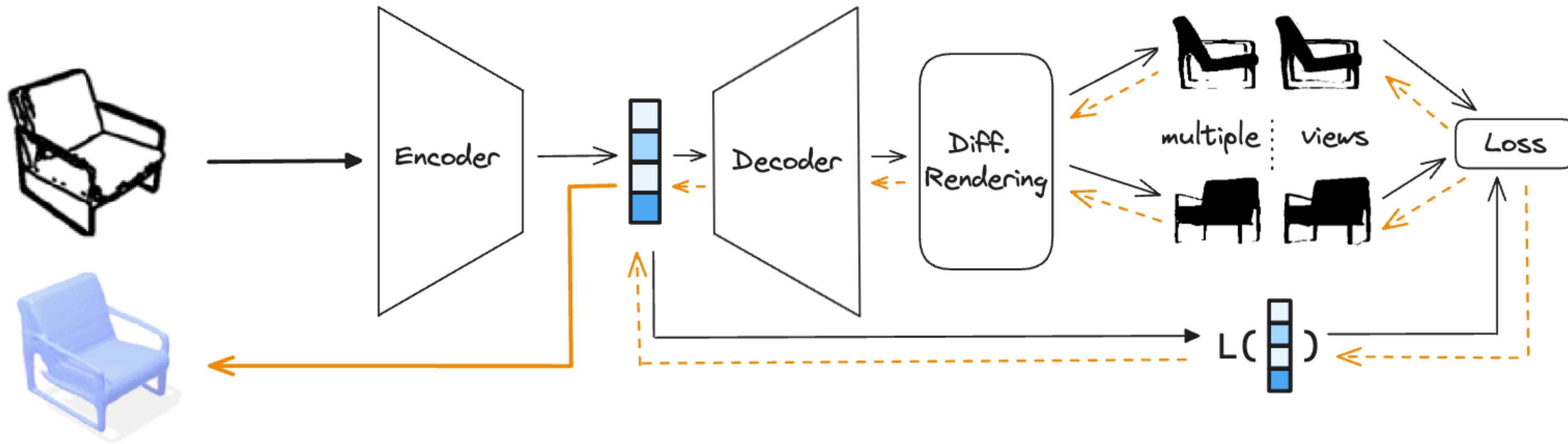
LAS-Diffusion



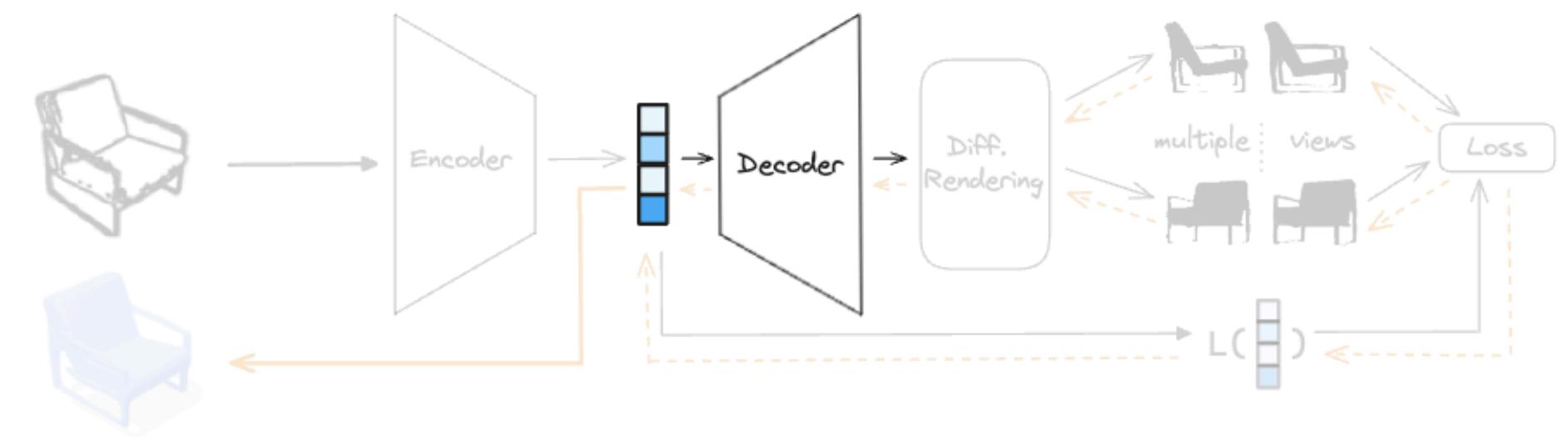
Outline



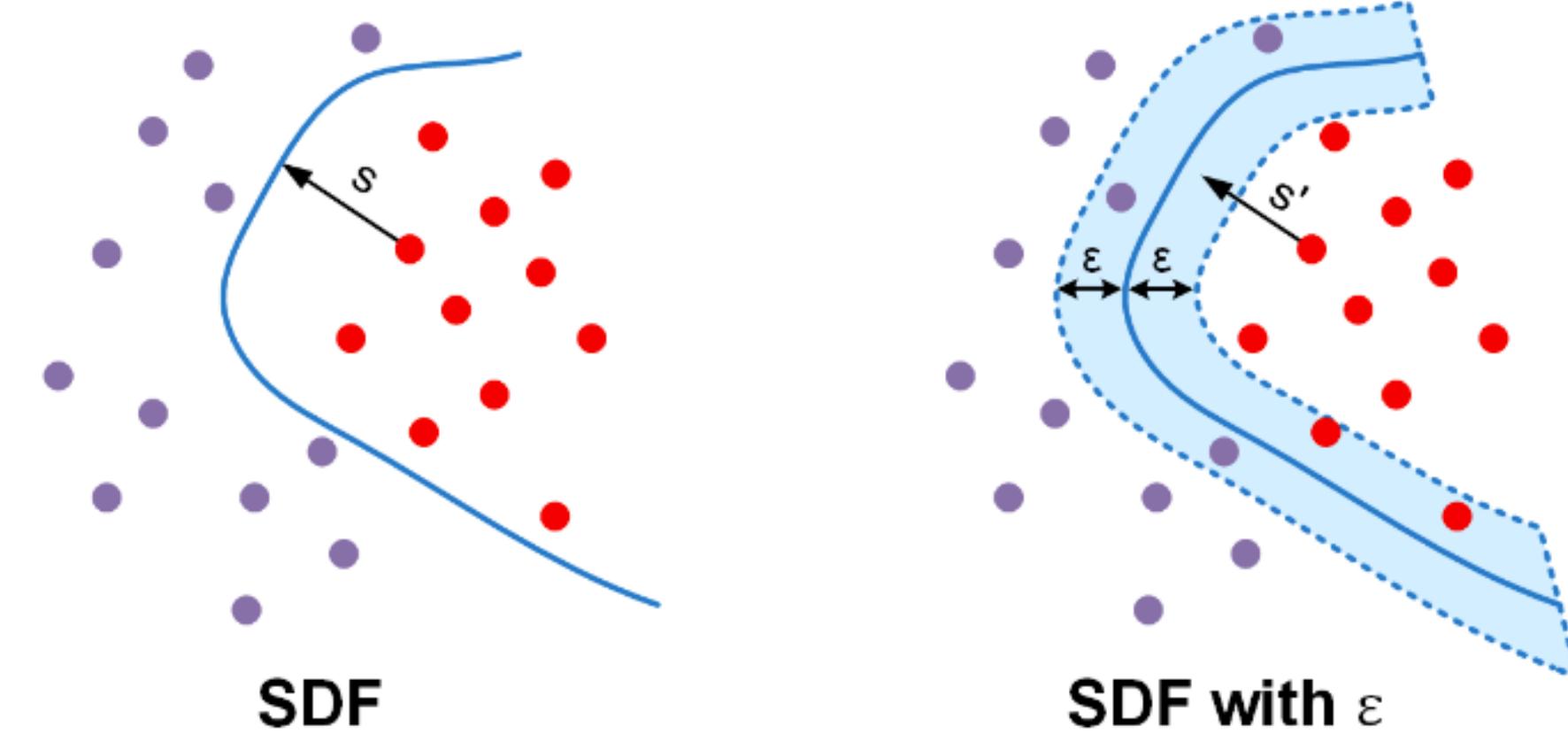
Architecture Overview



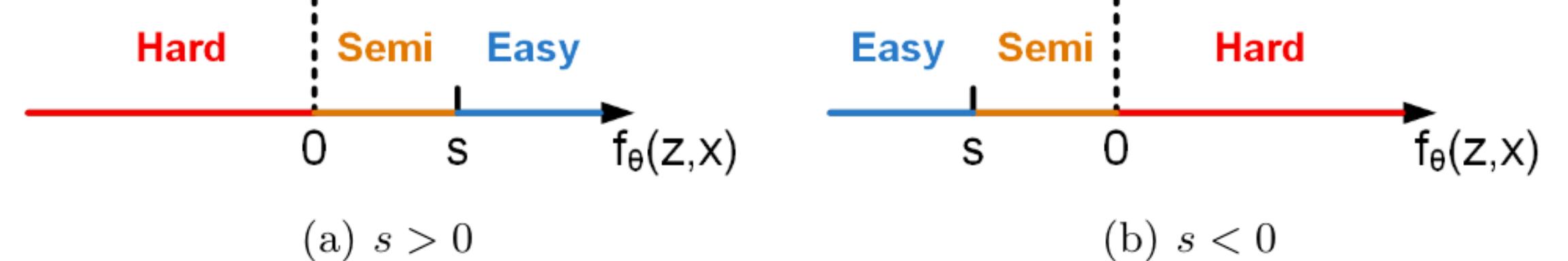
Curriculum DeepSDF



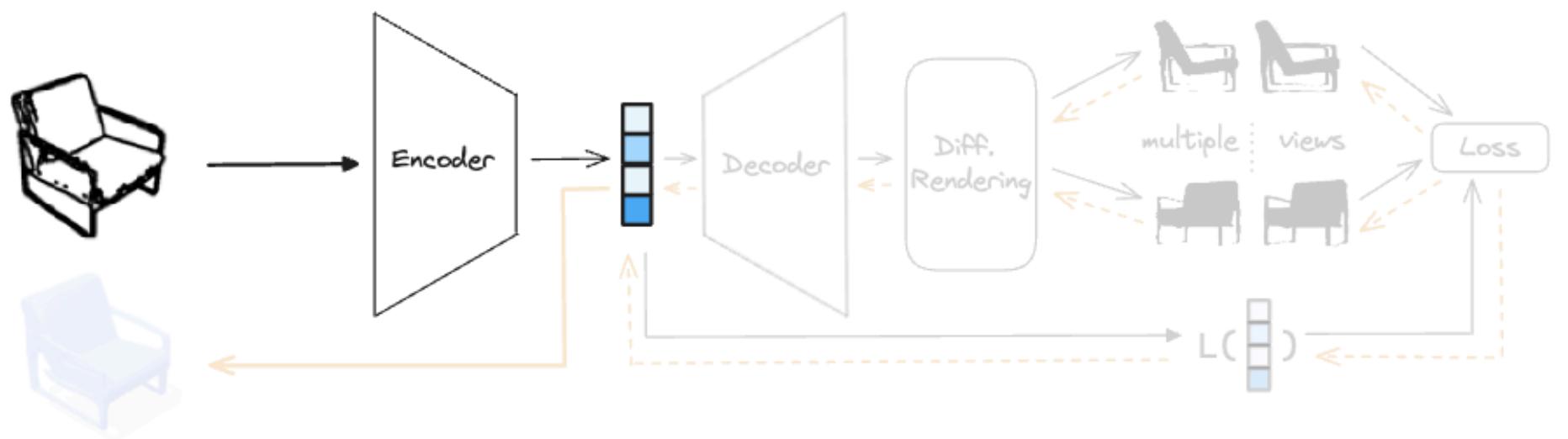
1. Surface Accuracy



2. Sample Difficulty



View-Agnostic Encoder



$$\mathcal{L}_{\text{enc}} = \sum_{i=0}^N \sum_{v \in \mathcal{V}} \|\mathcal{E}_\phi(x_i^v) - z_i\|_1$$

Multi-View Silhouette Motivation

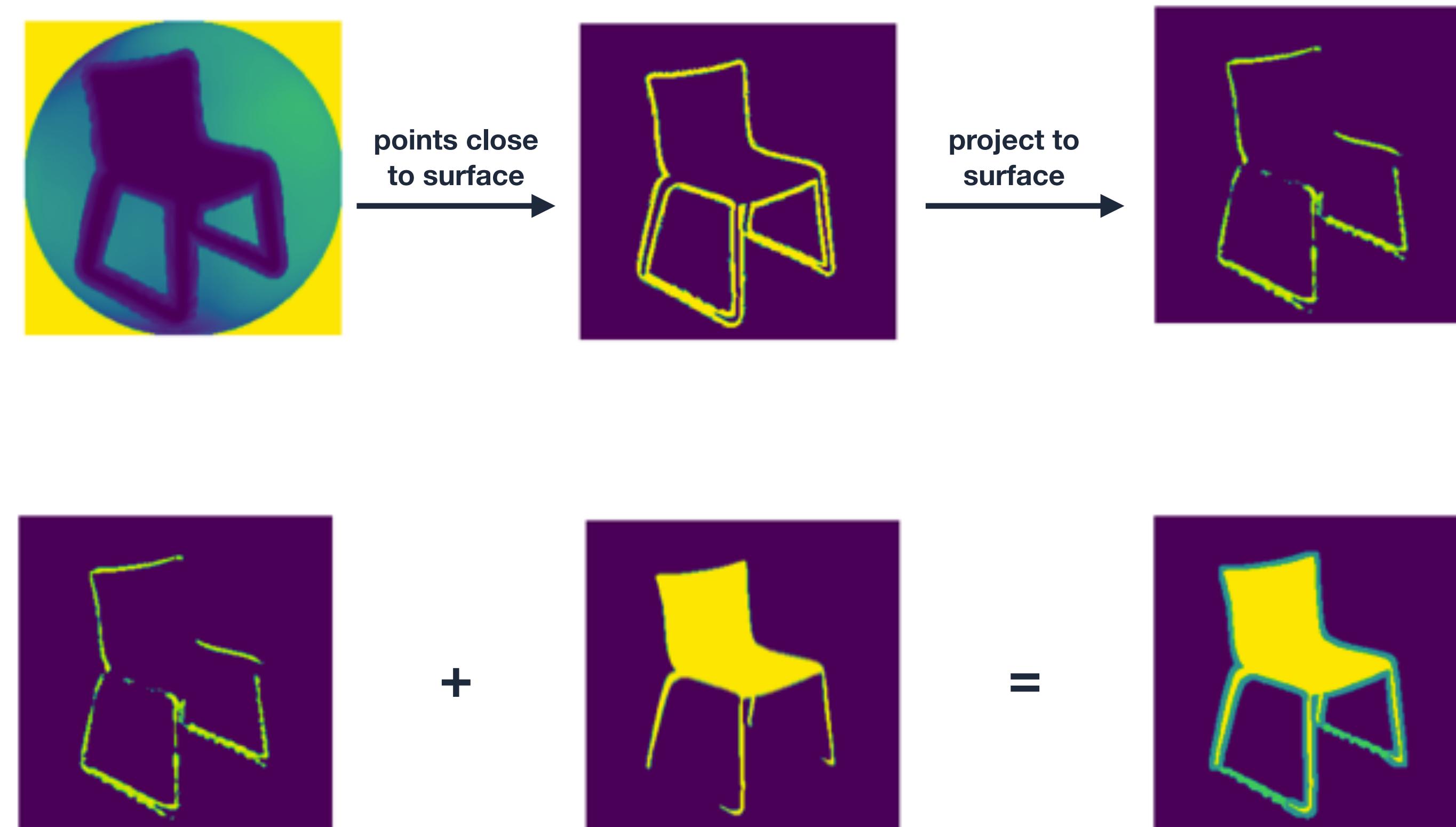


Encoder Output

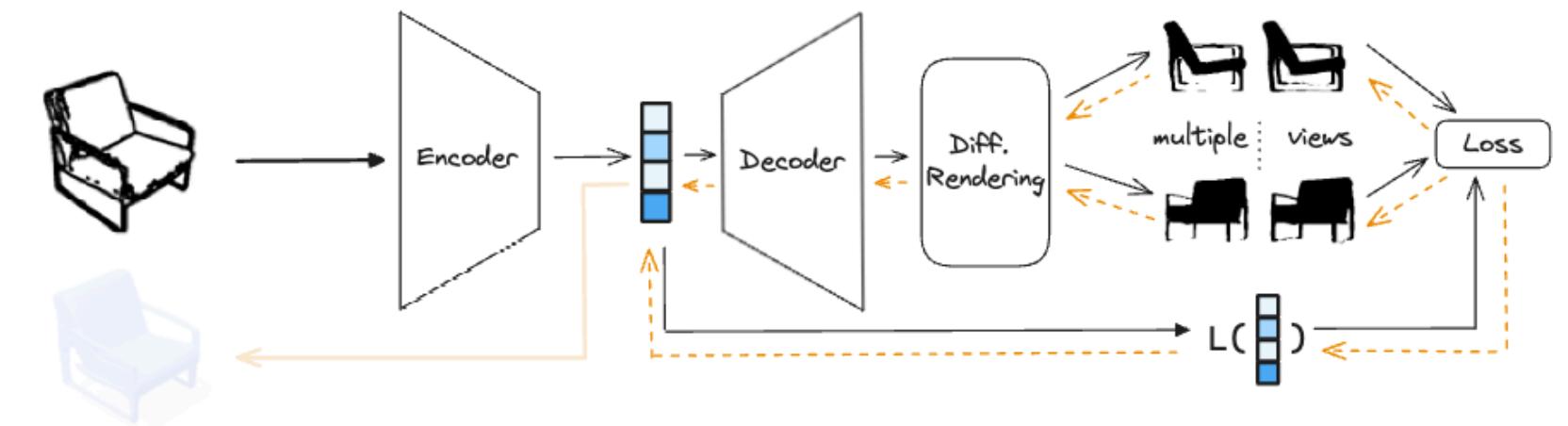


Signed Distance Field

Multi-View Silhouette Computation



Differentiable Rendering



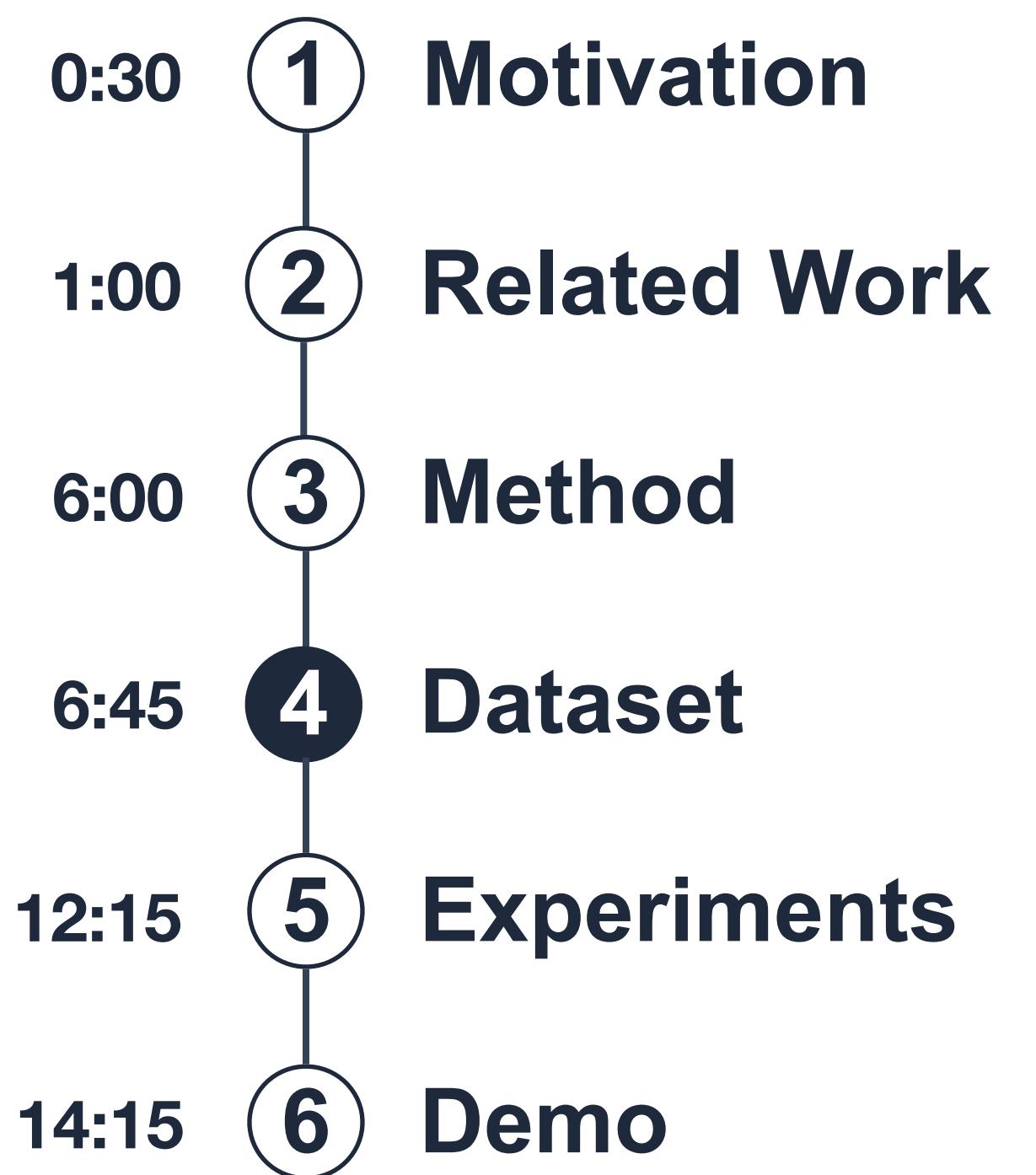
Silhouette Loss

$$\mathcal{L}_{\text{sil}} = S \max(0, \mathcal{S}_r - \epsilon) + (1 - S) \max(0, -(\mathcal{S}_r - \epsilon))$$

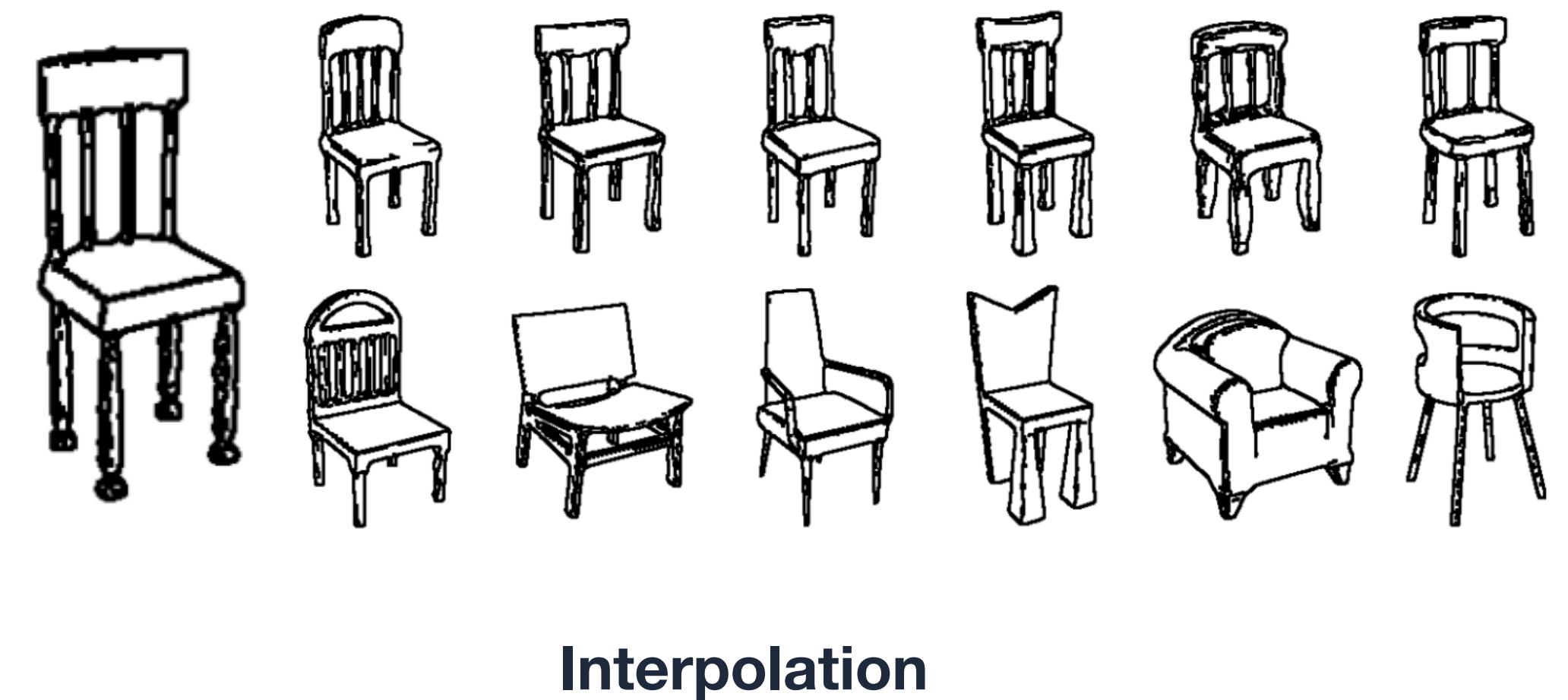
Regularization

$$\mathcal{L}_{\text{reg}} = ||z^0 - z^n||_1$$

Outline



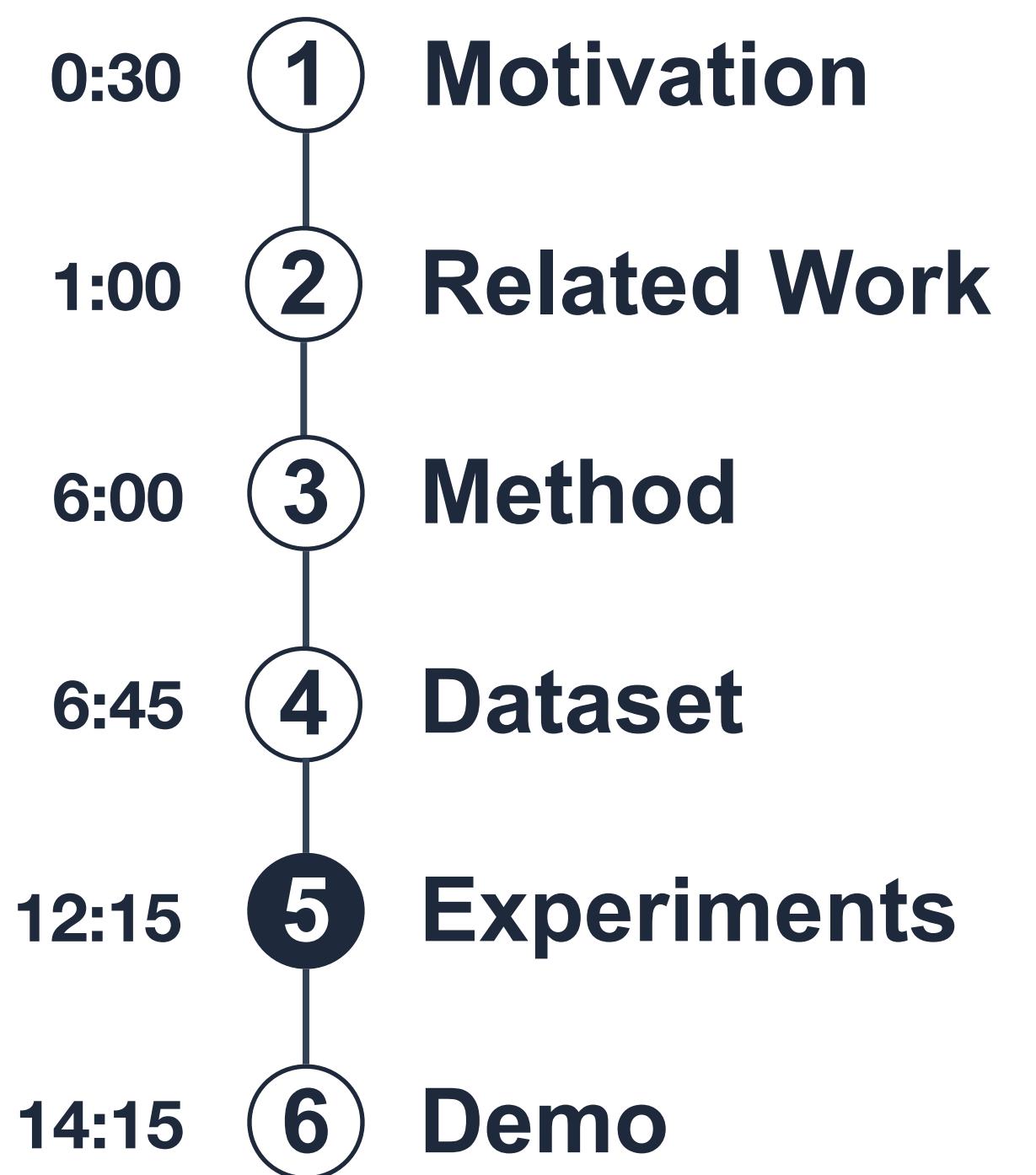
Train Dataset: Multi-View Edge Maps



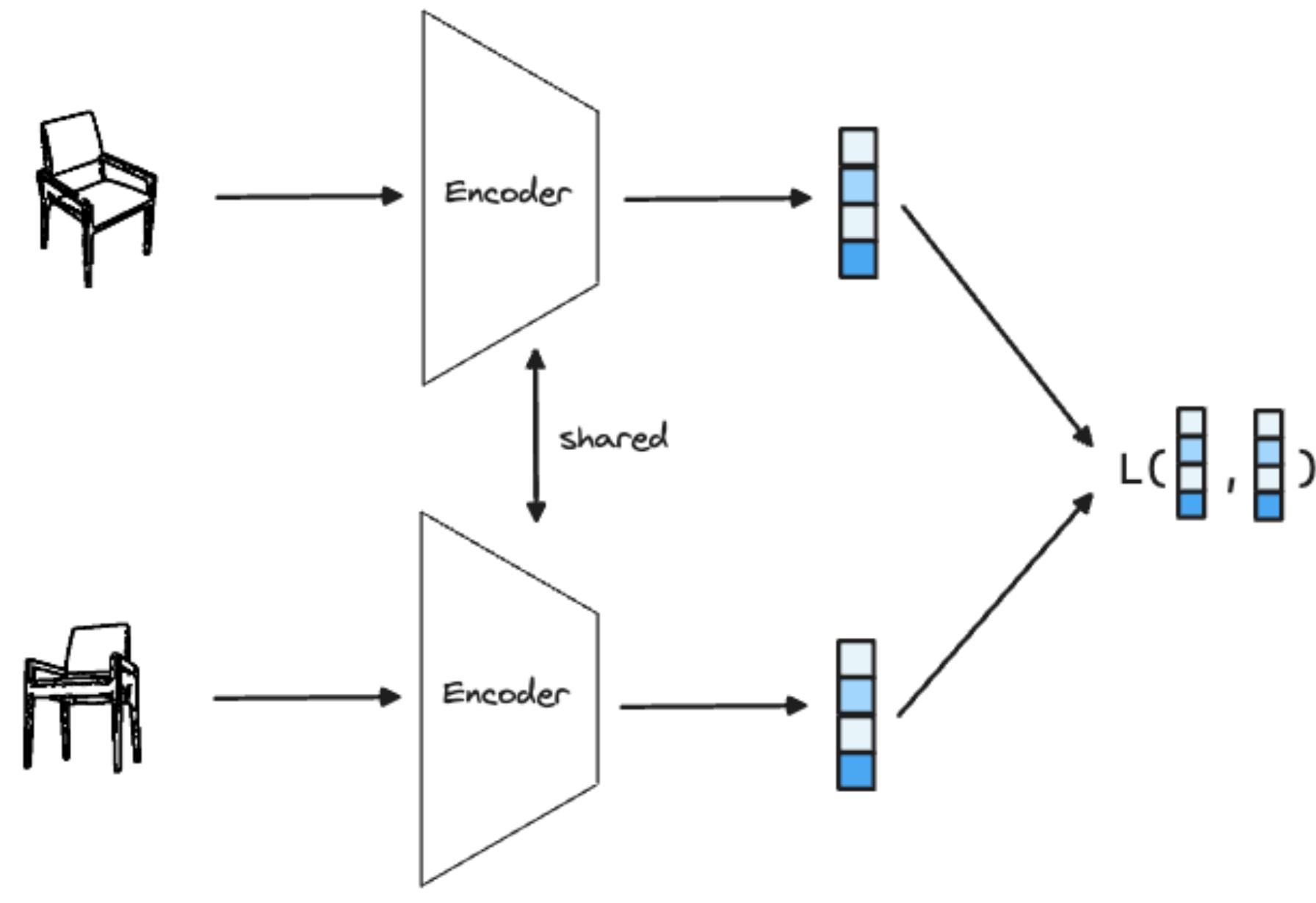
Eval Dataset: Hand-Drawn Sketches



Outline



Retrieval Baseline



Siamese Network

Triplet Loss:

$$\mathcal{L}(A, P, N) = \max(0, d_{ap} - d_{an} + m)$$

Evaluation Metrics

Chamfer Distance (CD)

$$d_{CD}(S_1, S_2) = \sum_{x \in S_1} \min_{y \in S_2} ||x - y||_2^2 + \sum_{x \in S_2} \min_{y \in S_1} ||x - y||_2^2$$

Earth Mover's Distance (EMD)

$$d_{EMD}(S_1, S_2) = \min_{\Phi: S_1 \rightarrow S_2} \sum_{x \in S_1} ||x - \Phi(x)||_2$$

Frechet Inception Distance (FID)

$$FID = \frac{1}{20} \left[\sum_{i=1}^{20} ||\mu_g^i - \mu_r^i||^2 + Tr(\Sigma_g^i + \Sigma_r^i - 2(\Sigma_g^i \Sigma_r^i)^{1/2}) \right]$$

CLIPScore

$$CLIPScore(I, G) = \frac{1}{n} \sum_i \langle E_S, E_{V^{(i)}} \rangle$$

Quantitative: Synthetic Sketch & Hand-Drawn

Method	CD	EMD	FID	CLIPScore
Retrieval	10.43	11.23	33.82	93.96
Encoder	4.40	8.17	46.53	93.99

synthetic sketch

Method	CD	EMD	FID	CLIPScore
Retrieval	14.29	13.41	37.14	92.82
Encoder	8.99	11.42	50.04	92.86

hand-drawn

Quantitative: Synthetic Sketch & Hand-Drawn

Method	CD	EMD	FID	CLIPScore
Retrieval	10.43	11.23	33.82	93.96
Encoder	4.40	8.17	46.53	93.99
+ Silhouette	4.17	8.30	46.78	94.10

synthetic sketch

Method	CD	EMD	FID	CLIPScore
Retrieval	14.29	13.41	37.14	92.82
Encoder	8.99	11.42	50.04	92.86
+ Silhouette	8.59	11.21	49.60	93.14

hand-drawn

Quantitative: Synthetic Sketch & Hand-Drawn

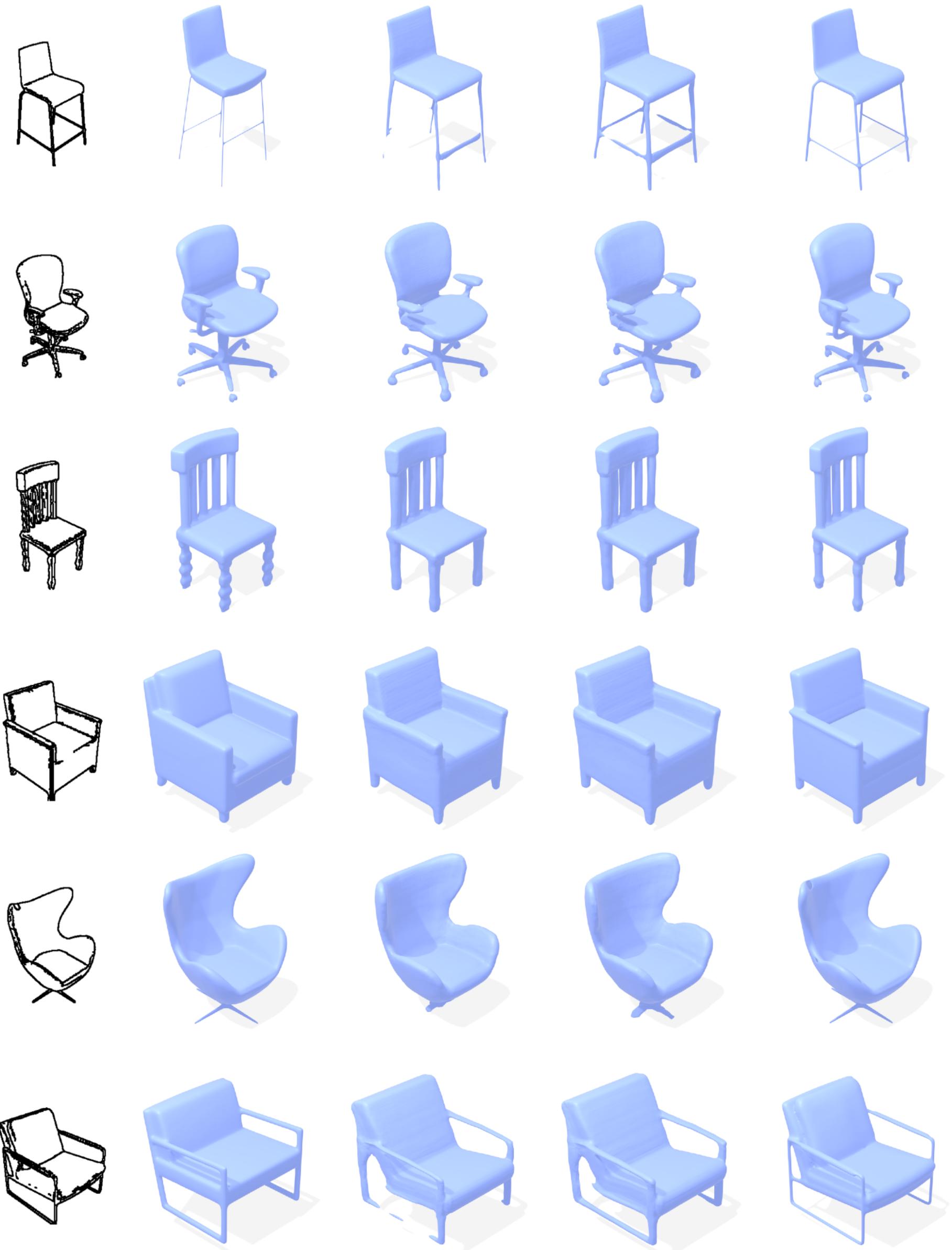
Method	CD	EMD	FID	CLIPScore
Retrieval	10.43	11.23	33.82	93.96
Encoder	4.40	8.17	46.53	93.99
+ Silhouette	4.17	8.30	46.78	94.10
+ Global	4.17	8.31	46.68	94.08

synthetic sketch

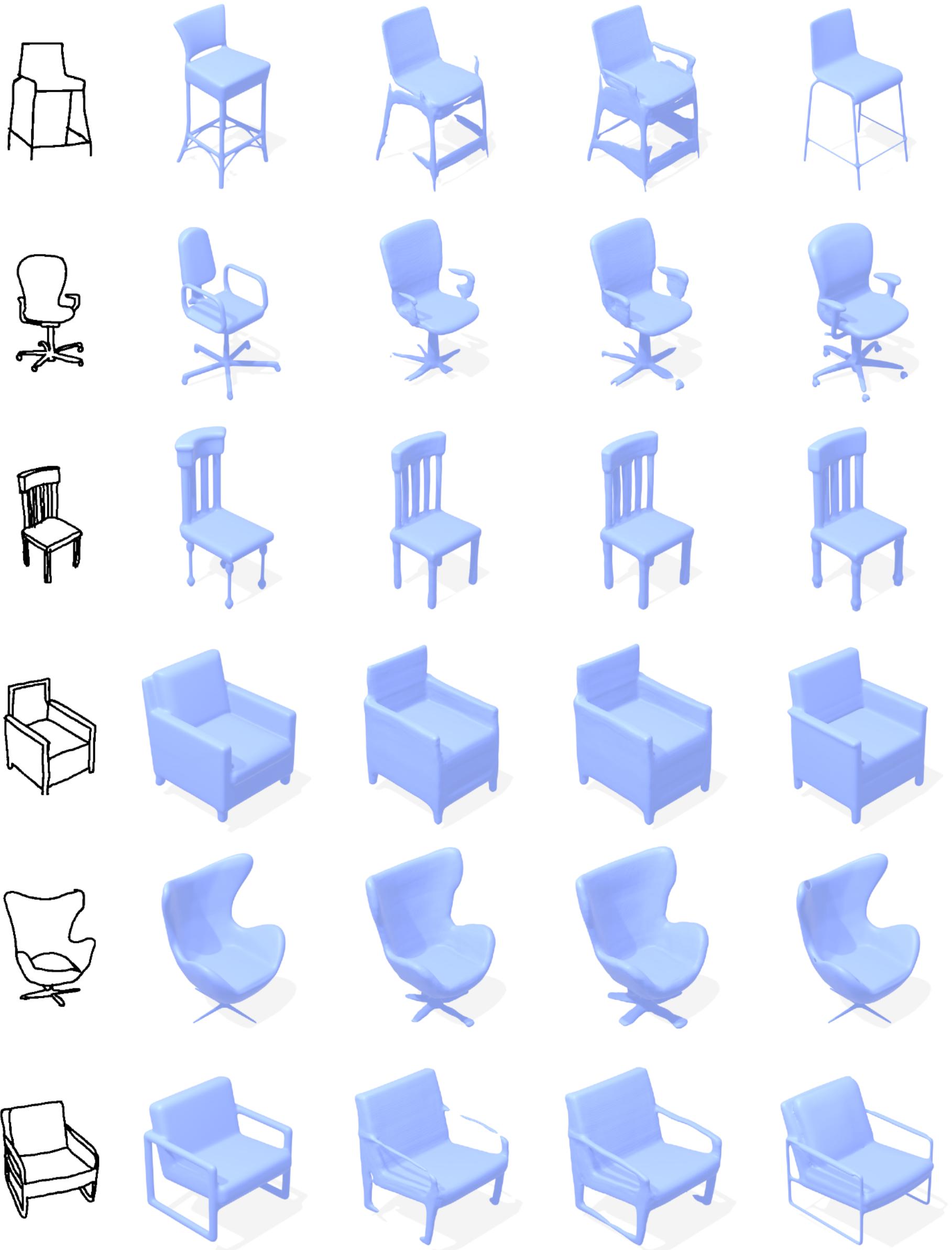
Method	CD	EMD	FID	CLIPScore
Retrieval	14.29	13.41	37.14	92.82
Encoder	8.99	11.42	50.04	92.86
+ Silhouette	8.59	11.21	49.60	93.14
+ Global	8.60	11.23	49.64	93.12

hand-drawn

synthetic sketch



hand-drawn



sketch

retrieval

encoder

+ diff. rend.

GT

sketch

retrieval

encoder

+ diff. rend.

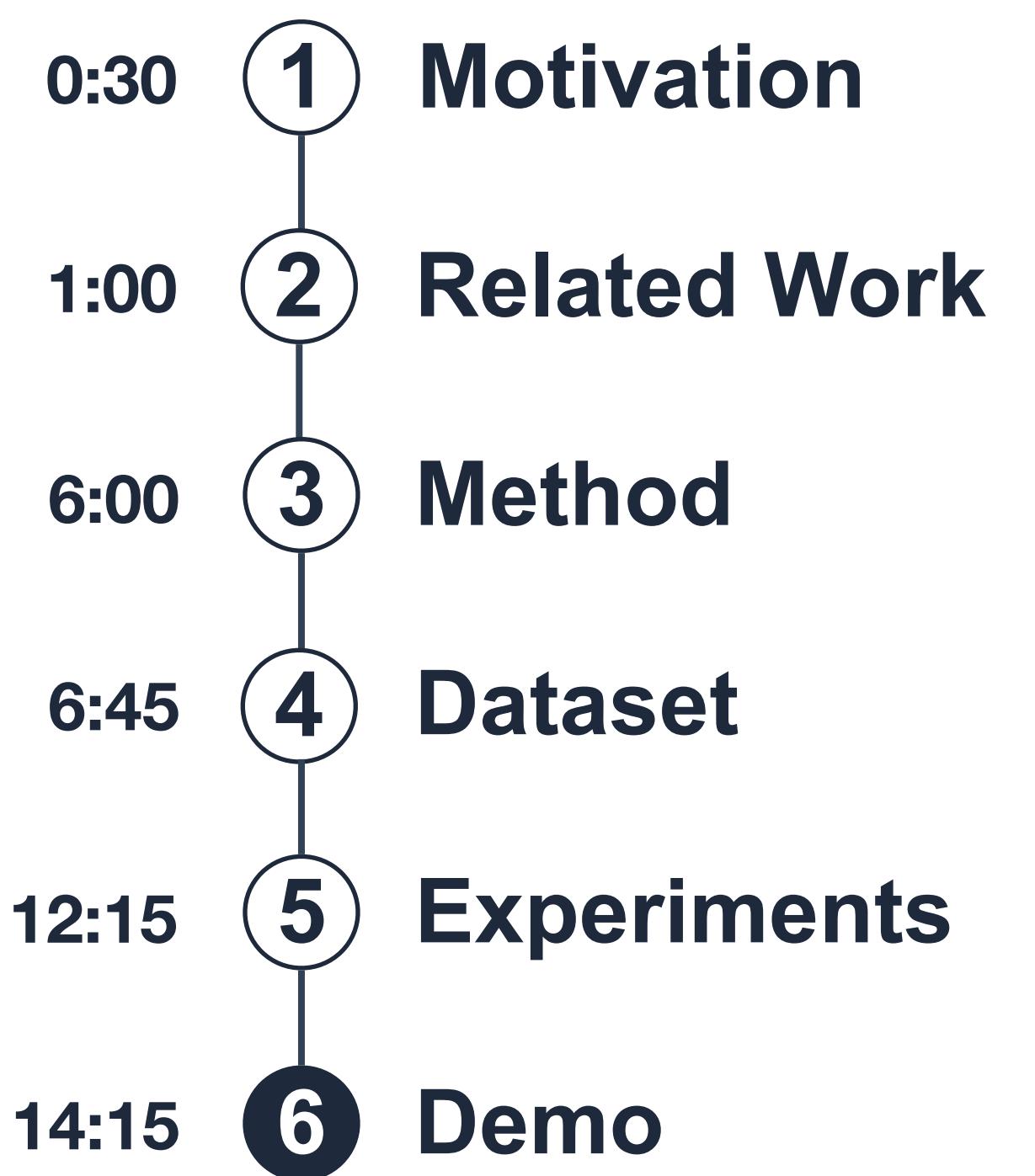
GT

Multi-View Robustness



Synthetic Sketch from Multiple Views

Outline



X

Sketch2Shape

Settings ^

Stroke width:

3

1 25

Stroke mode:

 Pencil ▼

Azim:

40

-180 180

Elev:

-20

-90 90

Zoom:

1.00

0.50 2.00

Update in realtime

Input/Output ▼

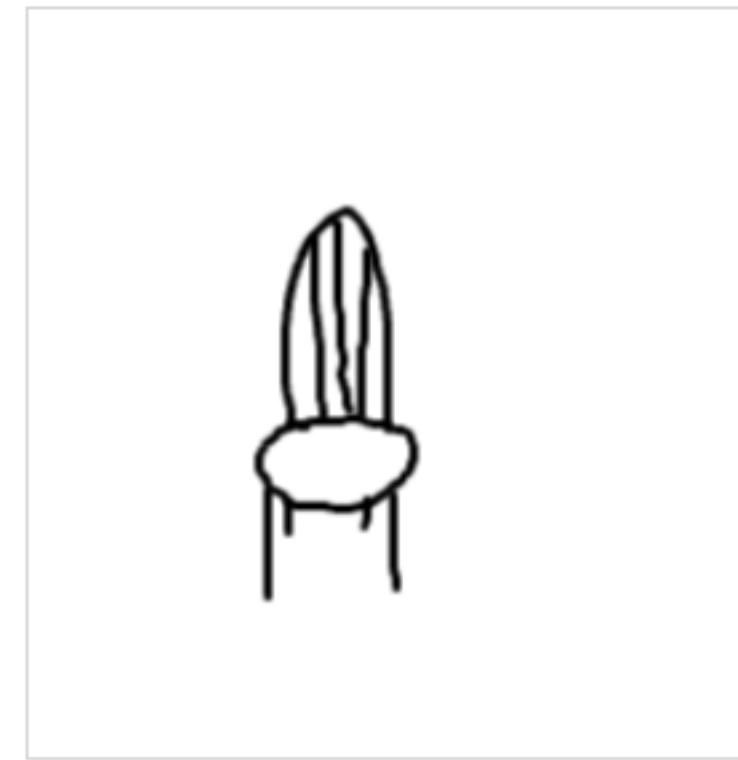
Debug ▼

Sketch:



Hand-Drawn Editing

Sketch: Nicolas



Sketch: Ananth



Sketch: Simon



Sketch: Matthias



Rendered Normal:



Rendered Normal:



Rendered Normal:



Rendered Normal:



Sketch2Shape

Settings ^

Stroke width:

A horizontal slider with a red track and a black dot at the center, labeled with the value "5".

Stroke mode:

Pencil

Azim:

A horizontal slider with a red track and a black dot at the right end, labeled with the value "60".

Elev:

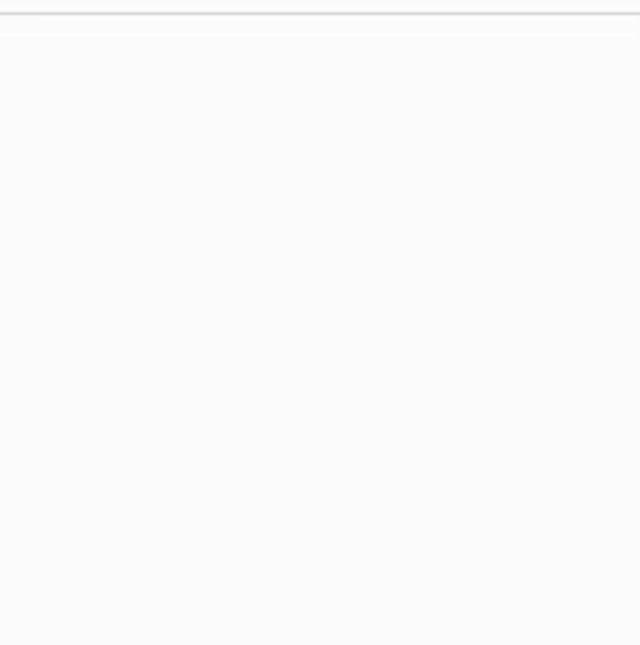
A horizontal slider with a red track and a black dot near the left end, labeled with the value "-20".

Zoom:

A horizontal slider with a red track and a black dot at the left end, labeled with the value "1.00".

Update in realtime

Sketch:



Input/Output ^

Debug ^

Hand-Drawn Editing



Thanks