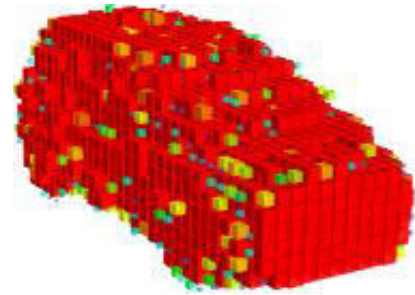
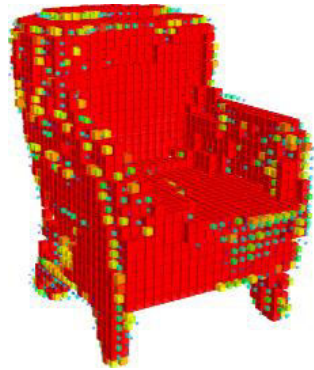


Weakly supervised 3D Reconstruction with Adversarial Constraint



Stanford
University

JunYoung Gwak, Christopher Choy,
Manmohan Chandraker, Animesh Garg, Silvio Savarese

3D reconstruction

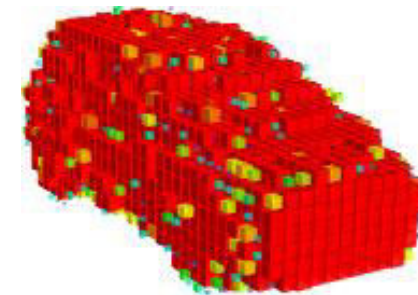
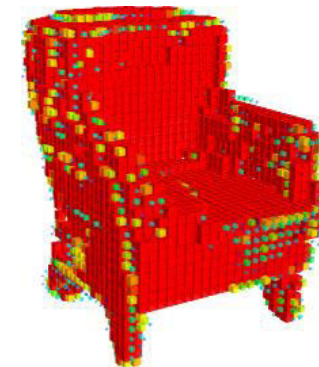
2D mask weak supervision



Adversarial constraint



Realistic 3D reconstruction
of the image

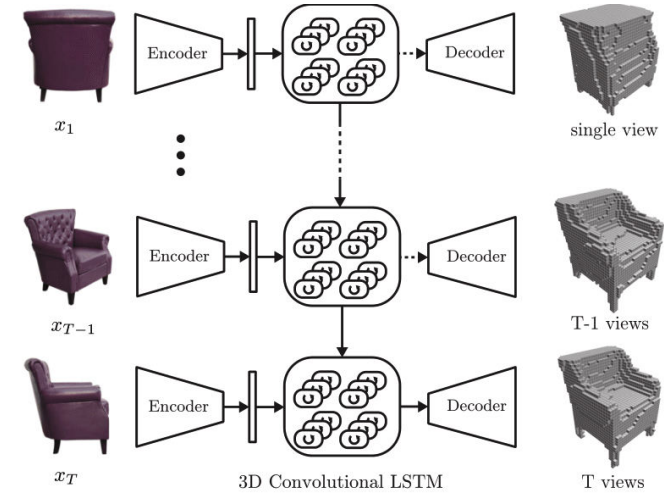


3D reconstruction

Full 3D supervision

[Choy et al, Wu et al, Girdhar et al]

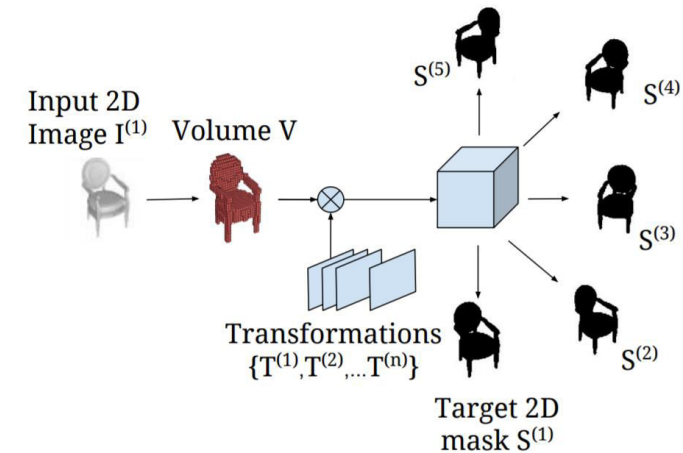
3D models are **expensive annotation**



2D mask supervision

[Yan et al.]

Capped by limitations of **visual hull**



Weakly supervised 3D Reconstruction

2D mask weak supervision



Adversarial constraint



Realistic 3D reconstruction of the image

minimize $\text{ReprojectionError}(x)$

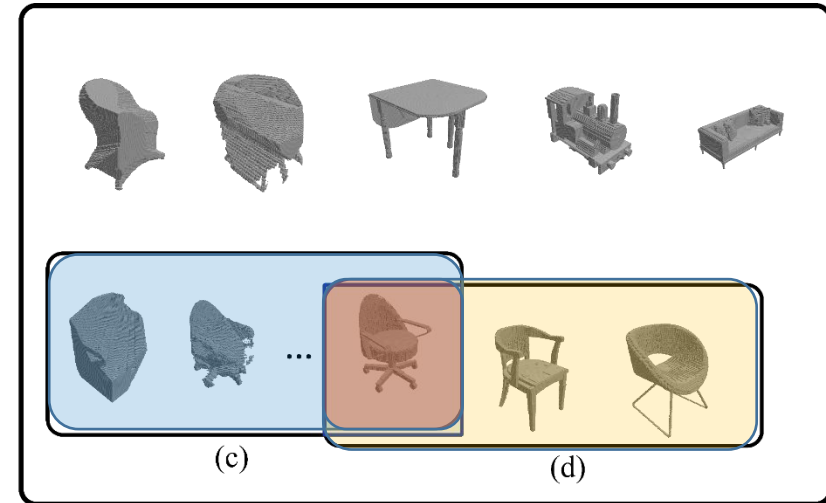
subject to Reconstruction x to be a valid chair



(a) Image



(b) Silhouette



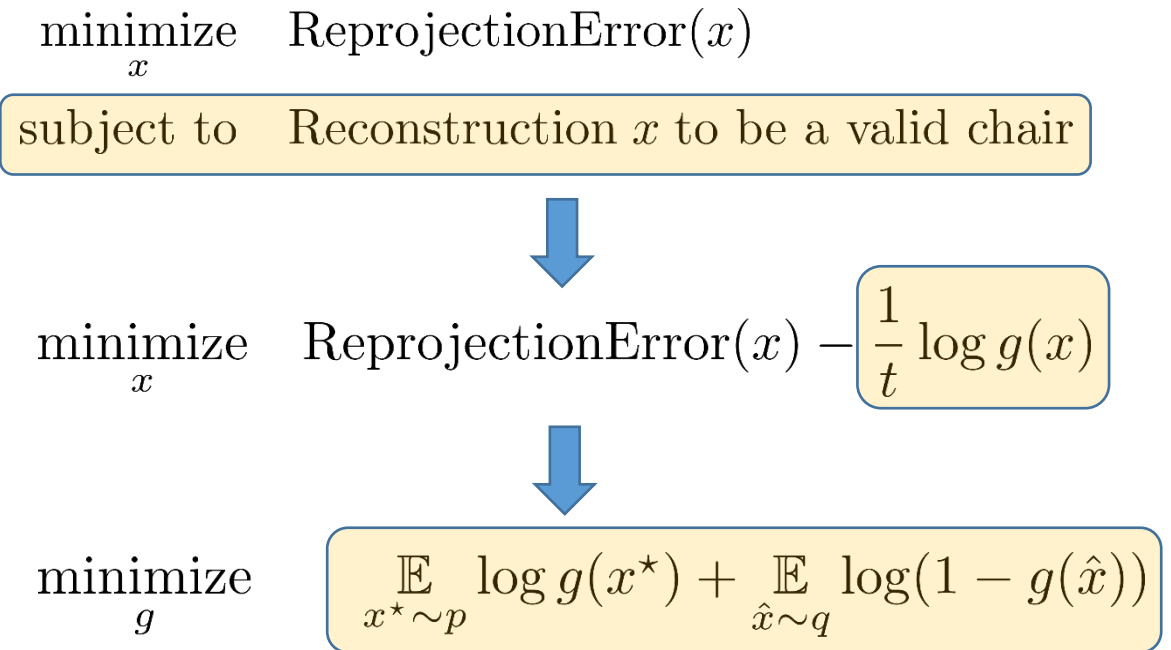
Space of Shapes

(c) Space of shapes that match the silhouette

(d) Space of chairs

Adversarial Constraint

- Rewrite constrained optimization using **log barrier method**
- Train constraint function $g(x)$ as **GAN discriminator**



2D mask weak supervision

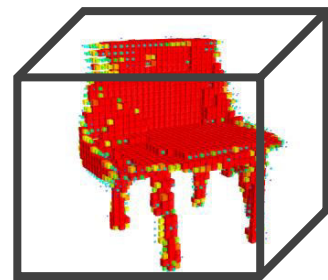
- **Raytrace Pooling:**
Renders reconstruction
to mask

$$\underset{x}{\text{minimize}} \quad \text{ReprojectionError}(x)$$

subject to Reconstruction x to be a valid chair



$$\underset{x}{\text{minimize}} \quad \text{ReprojectionError}(x) - \frac{1}{t} \log g(x)$$



3D Reconstuction

Raytrace Pooling



Rendered 2D mask

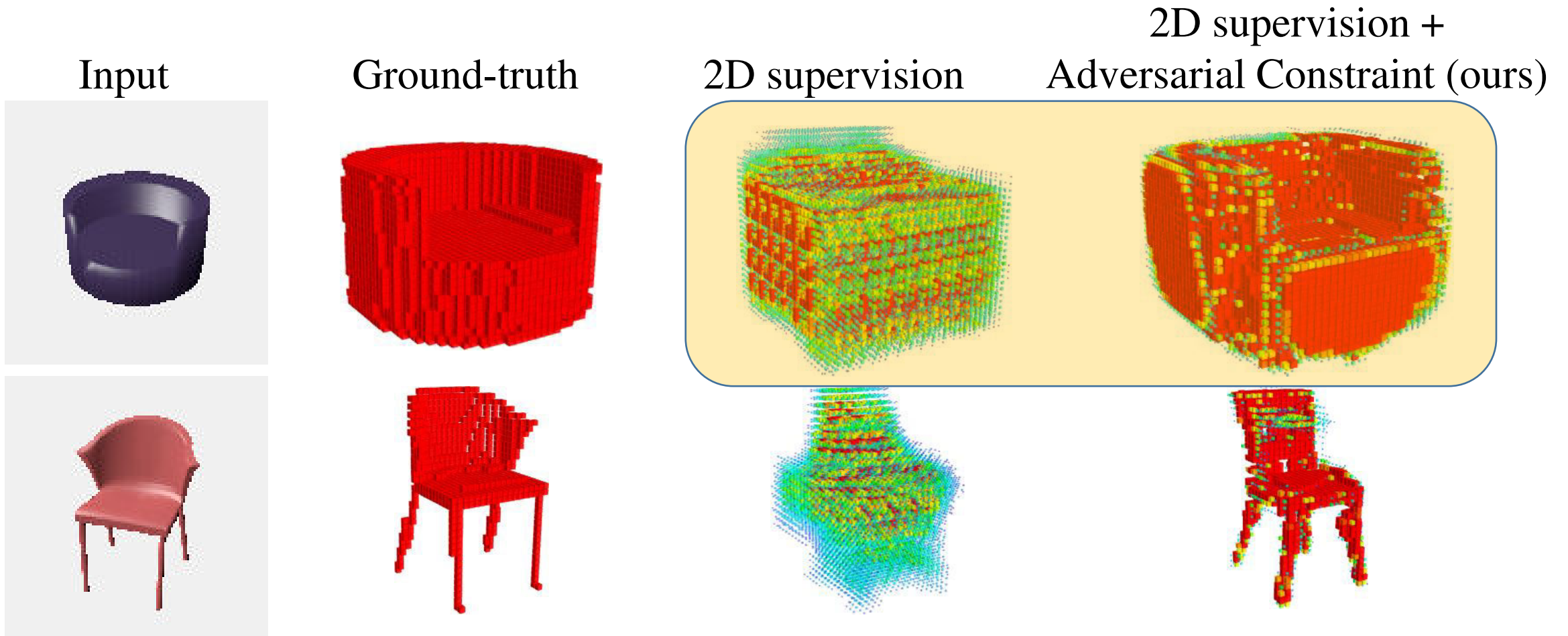
2D mask supervision



Ground-truth mask

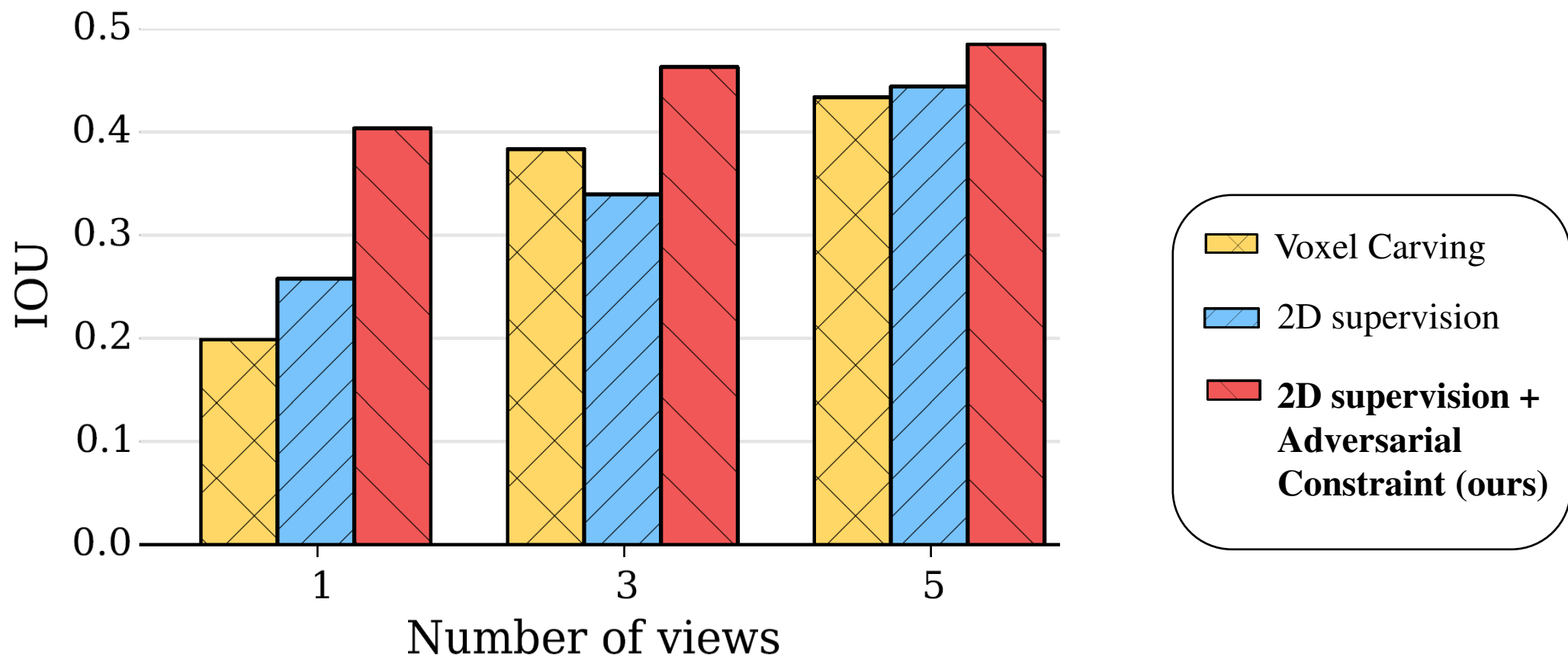
Result 1: Synthetic image reconstruction

Qualitative results



Result 1: Synthetic image reconstruction

Quantitative results

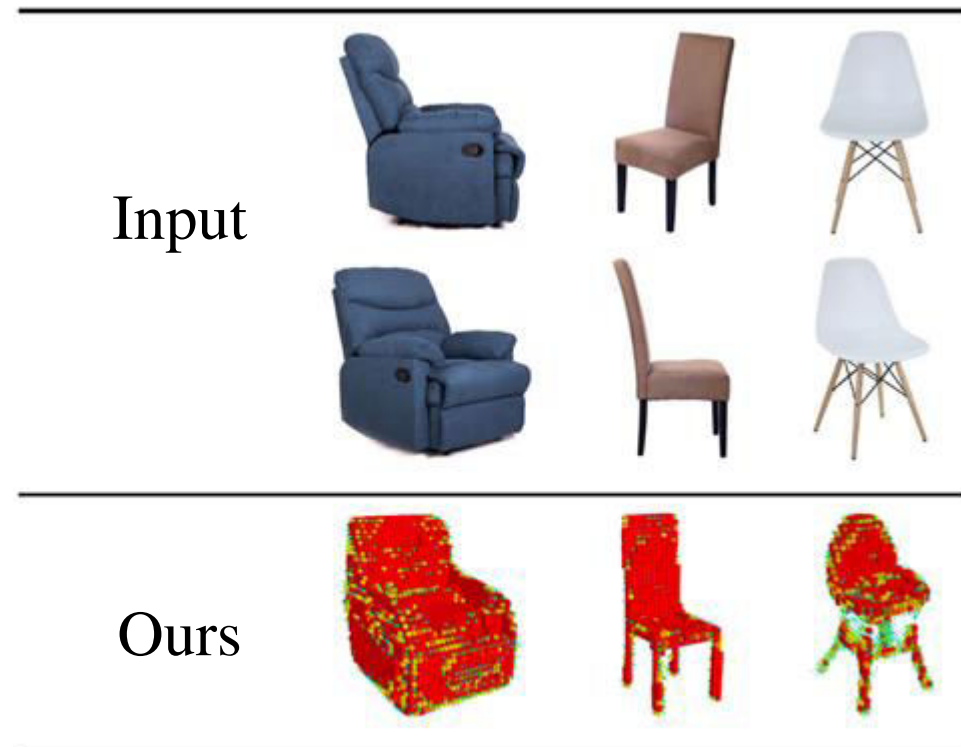


Result 2: Real image reconstruction

Single-view real image reconstruction
on ObjectNet3D



Multi-view real-image reconstruction
on Stanford Online Product

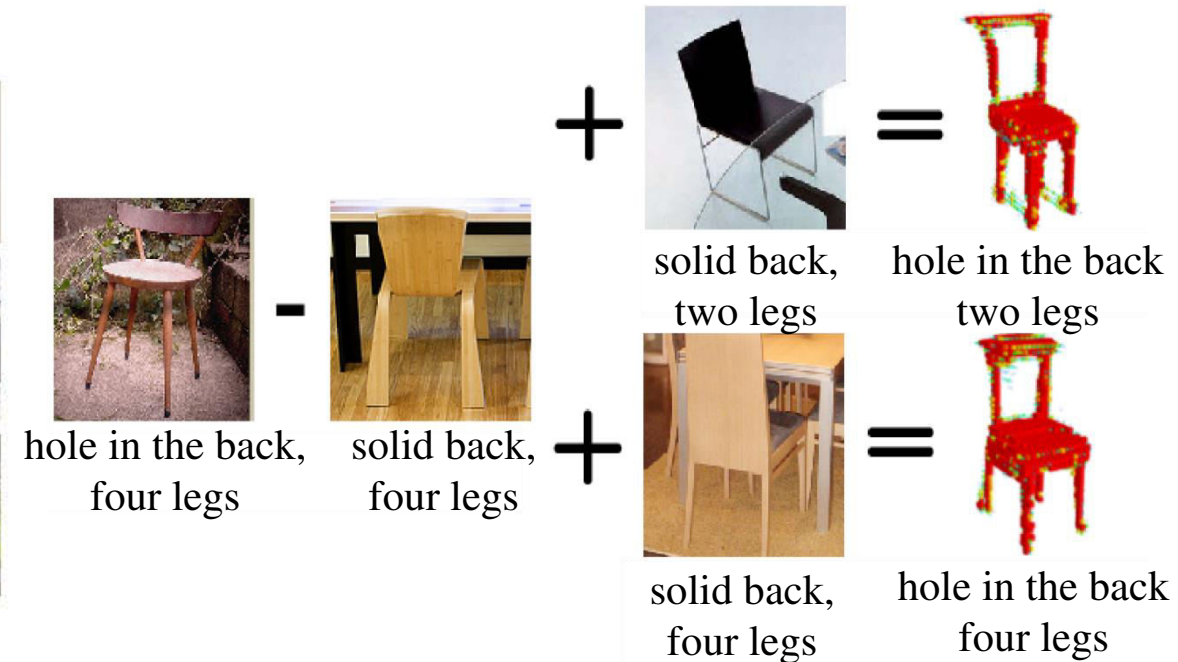


Result 3: Hidden representation analysis

Linear interpolation of hidden variables of two images

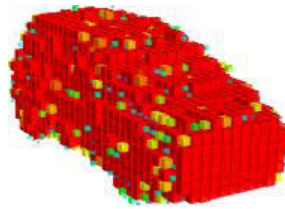
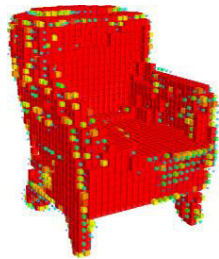


Semantic feature arithmetic of hidden variables



Conclusion

- 2D mask weak supervision
 - Affordable and practical
 - Made possible by **Raytrace Pooling**
- Adversarial constraint
 - **GAN** as **log barrier** constraint
 - Overcomes limitation of **visual hull**



2D mask weak supervision



Adversarial constraint



Realistic 3D reconstruction
of the image