CS688: Web-Scale Image Retrieval

Completing 3D Object Shape from One Depth Image (CVPR 2015)

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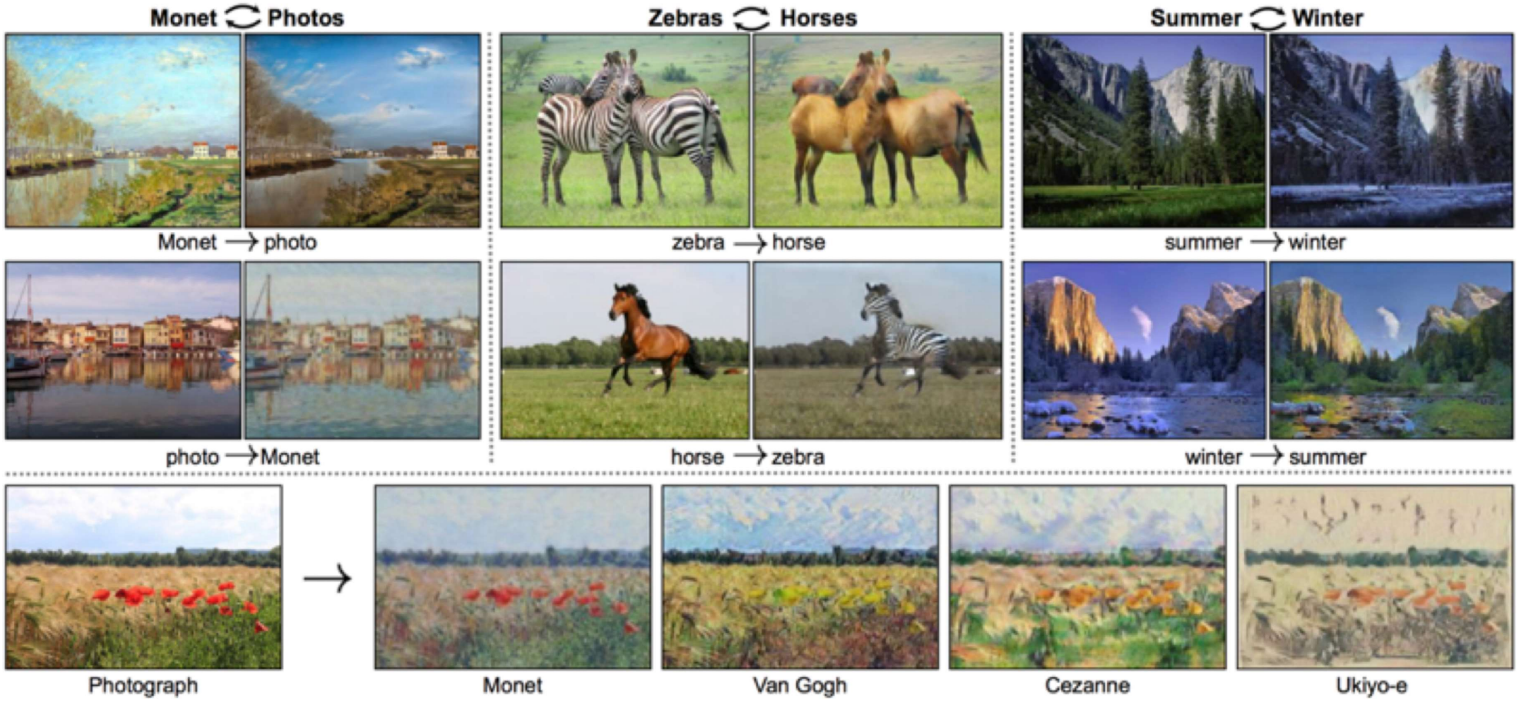
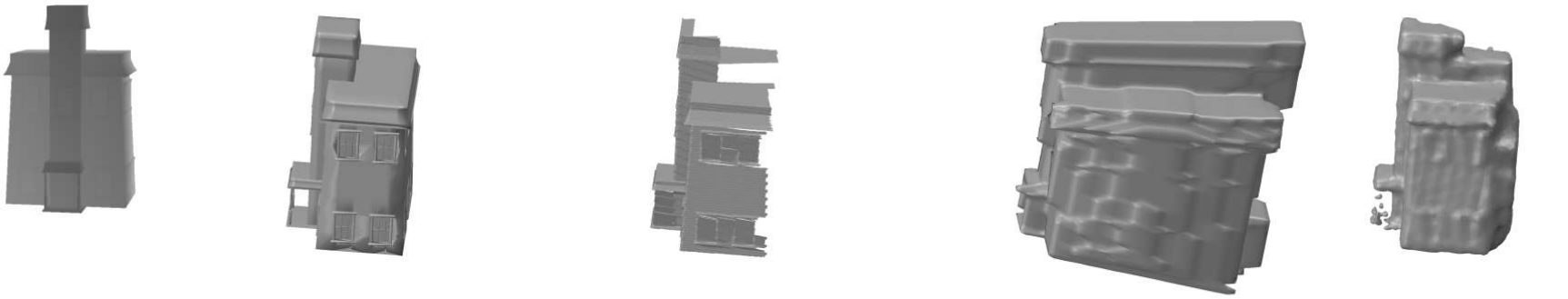
Review: CycleGAN

- **Generate paired image without its pair**



Purpose

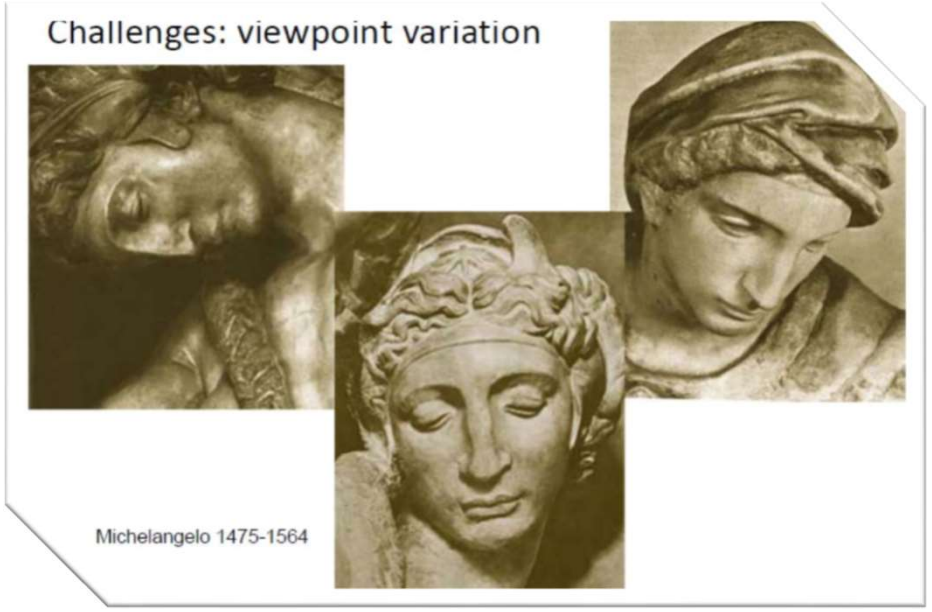
- **Reconstruct 3D object from observed depthmap**



(a) Query Depthmap (b) Query Mesh (Ground Truth) (c) Pointcloud Mesh (d) Reconstruct Baseline (e) Ours

Relation with Image Retrieval

- **RGB-D object classification**
- **3D structure aware object identification**
- **Depthmap retrieval in its pipeline**



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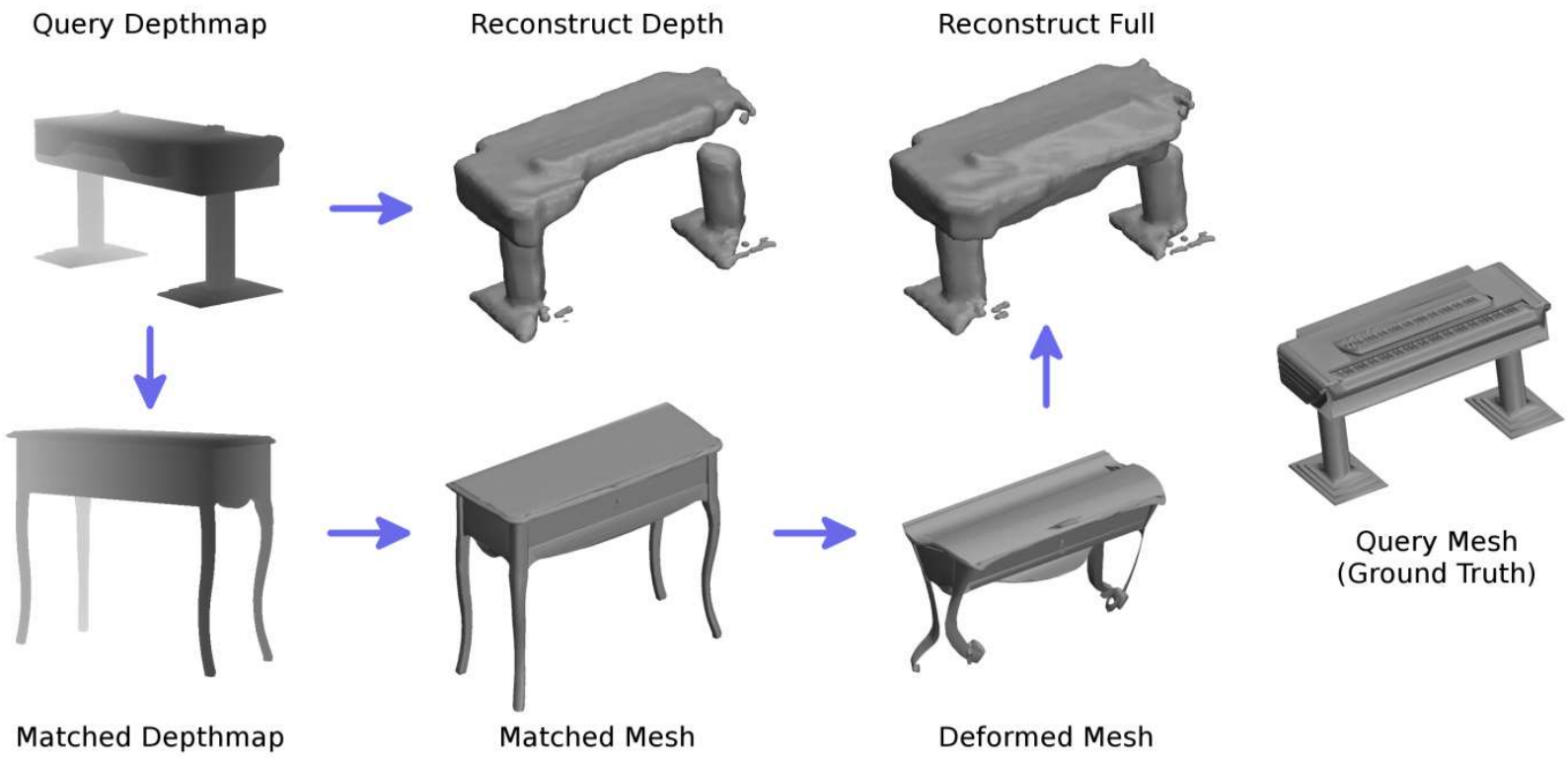
Pipeline Overview

- **Matching –**
  - **retrieve similar 3D model in database**
- **Deformation –**
  - **deform 3D model to make it similar to query**
- **Completion –**
  - **predict unobserved voxels**

Pipeline Overview



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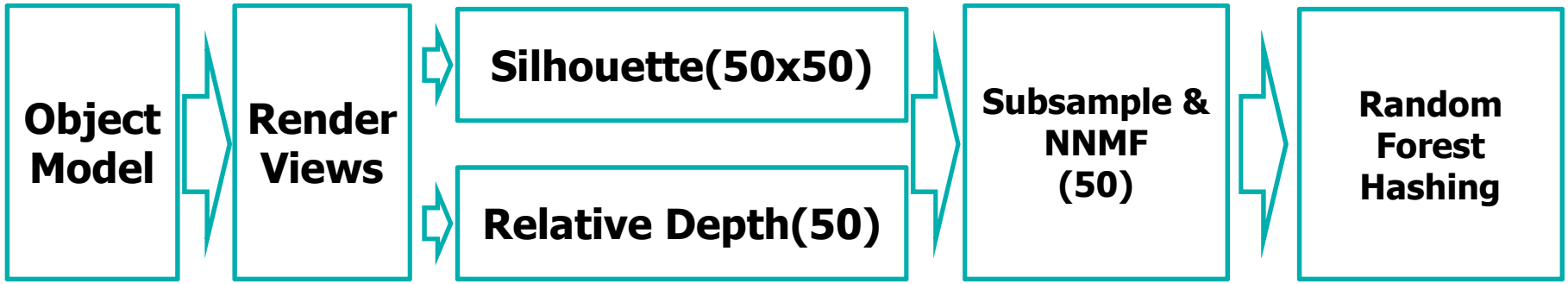
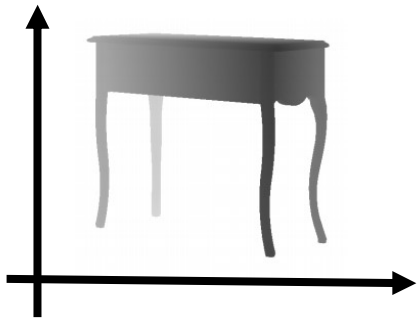
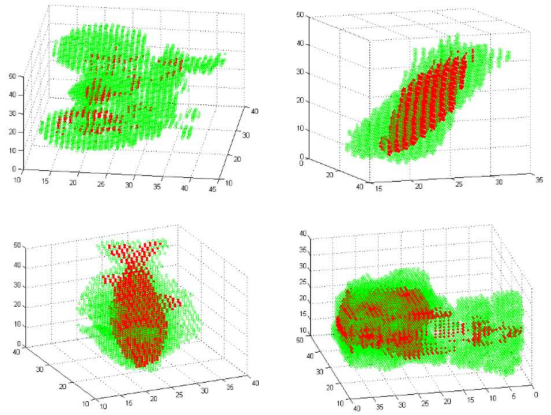
Matching: Training







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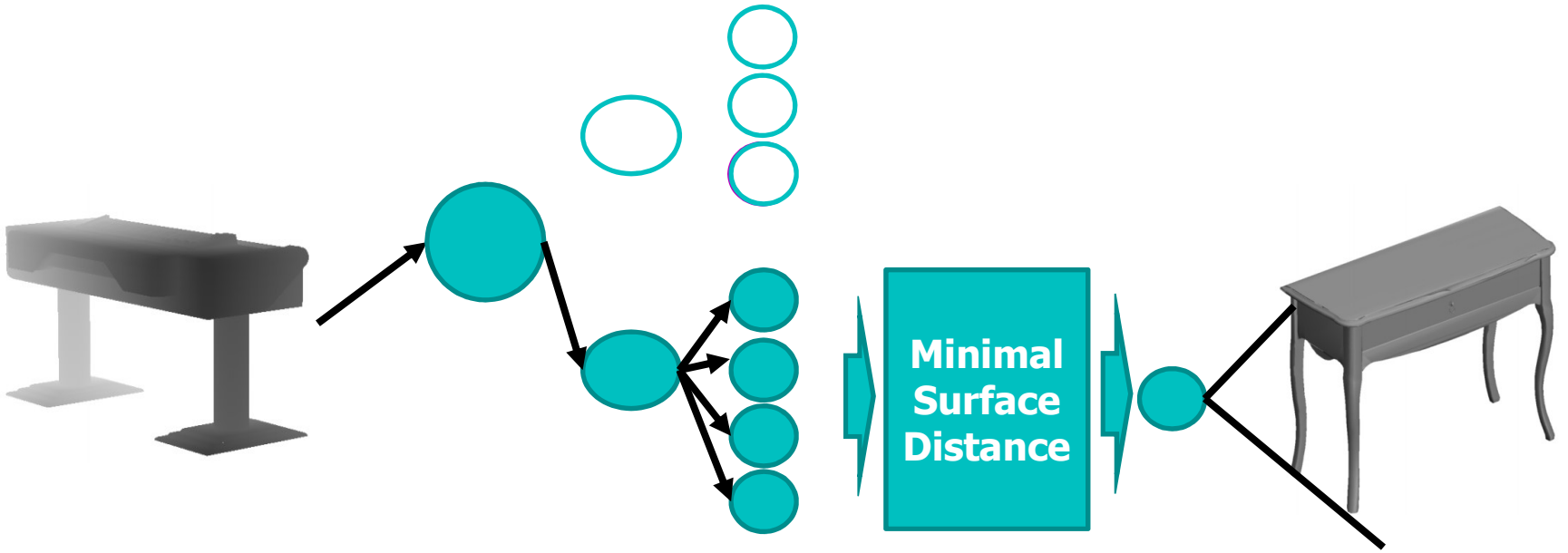
Matching: Retrieval



Query Depthmap

Match Group

Match Depthmap

Match Object

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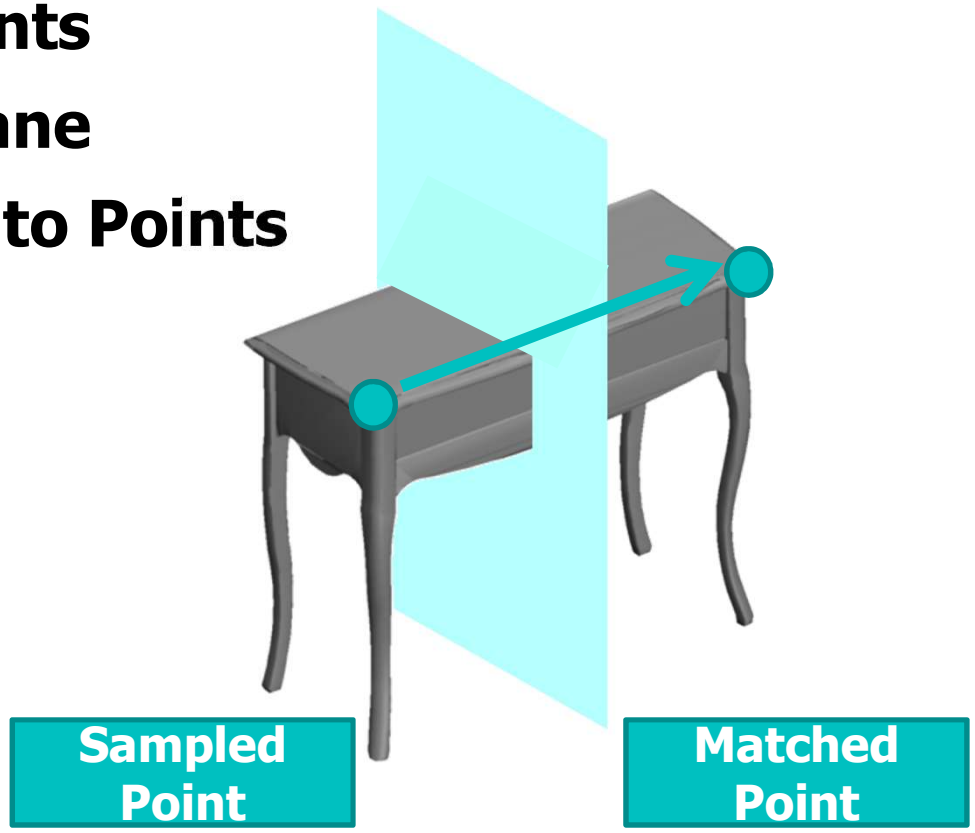
Deformation: Symmetry Detection

1. Find Major Symmetry Planes
2. Model Surface -> Points
3. Match Points over Plane
4. Distribute Symmetry to Points



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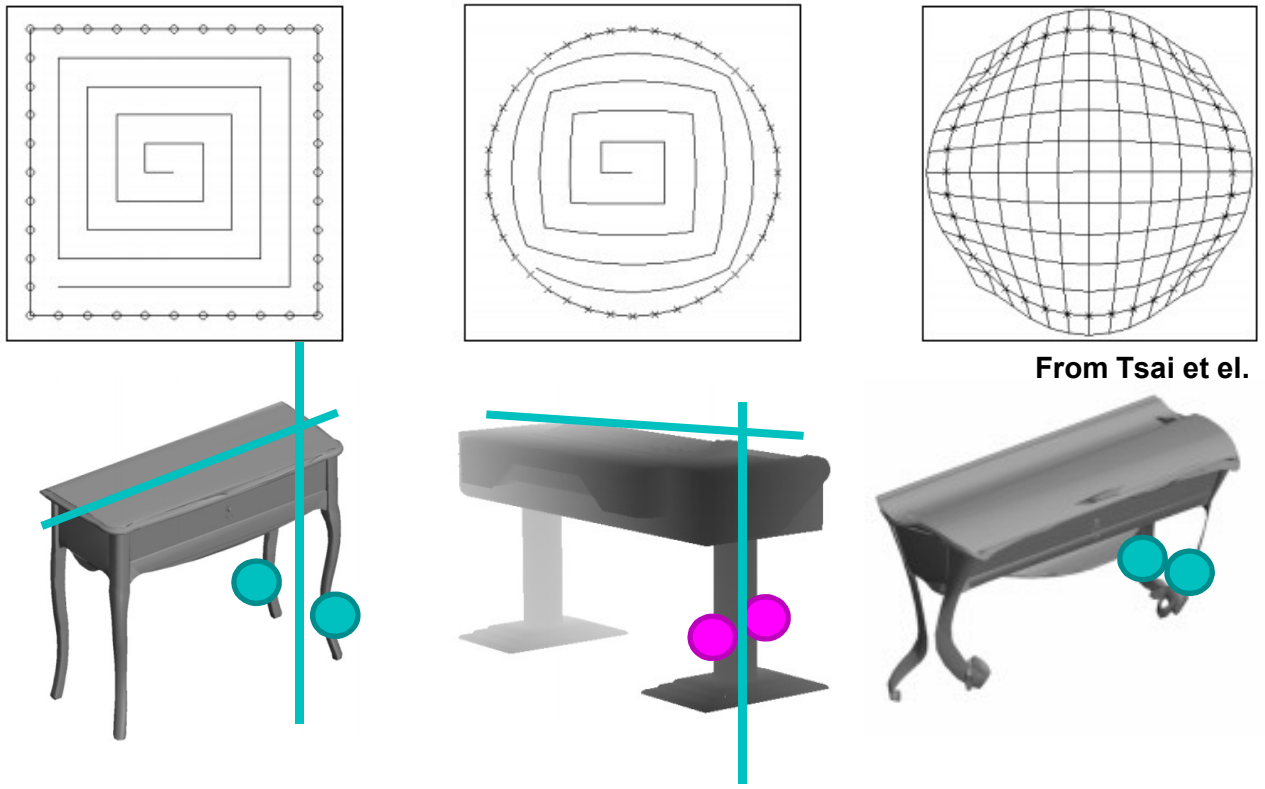
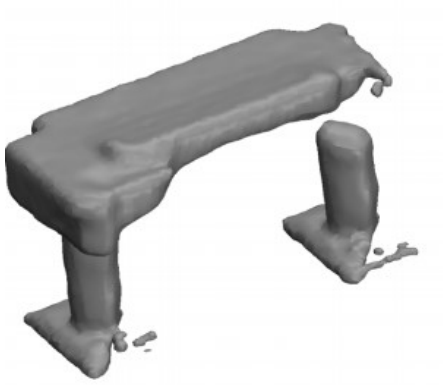
Deformation: Thin Plate Spline



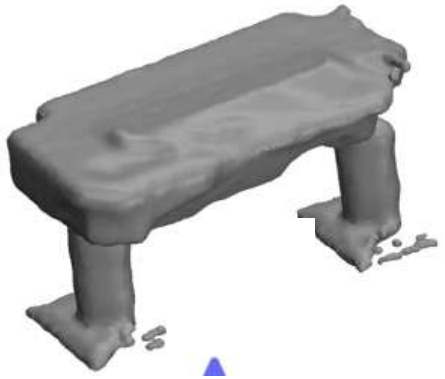
From Tsai et el.

Completion: Cues for Voxels

- **Voxels near observed depth points**
- **Voxels requiring large rotaion**



- **Symmetry reflection from matched mesh**
- **Voxels from matched mesh**
- **Depth distance**
- **Point distance**



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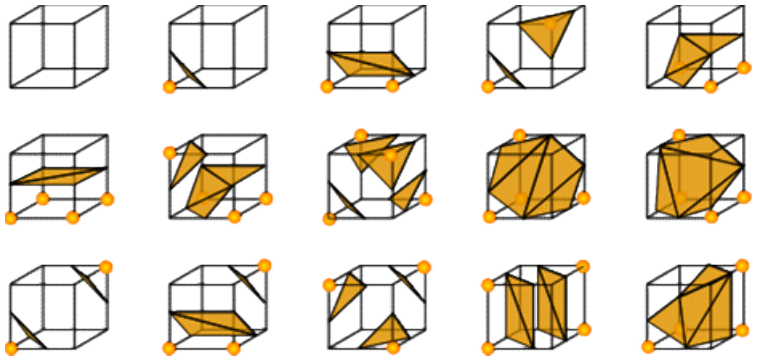
Completion: Voxel Prediction

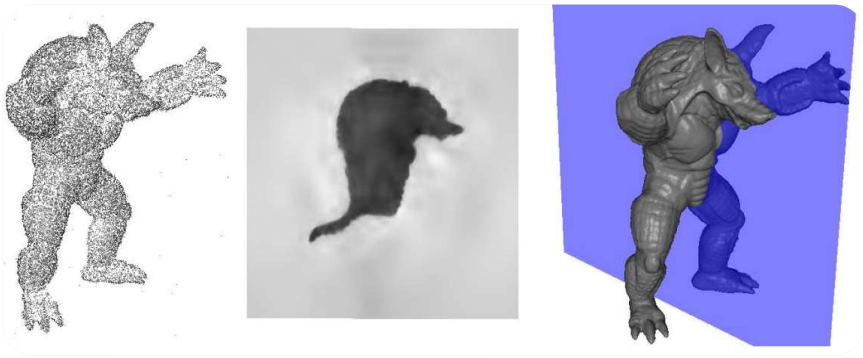
1. Boosted decision tree -> Confidence of each voxel
2. Fit to observations
3. Smoothing

Completion: Voxels to Surface



from wiki.

Marching Cubes



From Kazhdan et el.

Poisson Reconstruction

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Evaluation

- **SHREC12 mesh classification dataset**
- **3 Kinds of Problems :**
  1. **Novel View**
  2. **Novel Model**
  3. **Novel Category**

- **Performance Metric:**
  1. **Intersection over union(large->better)**
  2. **Surface distance(small->better)**

Evaluation Result

Voxel I/U		Baseline	Reconstruct Depth	Matched Mesh	Aligned	Deformed	Reconstruct Full
Novel Class	Mean	0.164	0.425	0.224	0.243	0.265	**0.439**
	Median	0.138	0.429	0.177	0.207	0.236	**0.459**
Novel Model	Mean	0.124	0.424	0.302	0.349	0.368	**0.490**
	Median	0.107	0.408	0.249	0.289	0.322	**0.489**
Novel View	Mean	0.185	0.453	0.453	0.525	0.537	**0.565**
	Median	0.174	0.439	0.430	0.523	0.544	**0.582**
Surface Distance		Baseline	Reconstruct Depth	Matched Mesh	Aligned	Deformed	Reconstruct Full
Novel Class	Mean	0.292	**0.030**	0.057	0.065	0.057	**0.030**
	Median	0.286	**0.025**	0.053	0.058	0.048	**0.025**
Novel Model	Mean	0.264	0.028	0.039	0.042	0.037	**0.022**
	Median	0.267	0.022	0.033	0.035	0.029	**0.018**
Novel View	Mean	0.241	0.032	0.030	0.029	0.025	**0.023**
	Median	0.241	0.026	0.025	**0.019**	0.025	**0.019**

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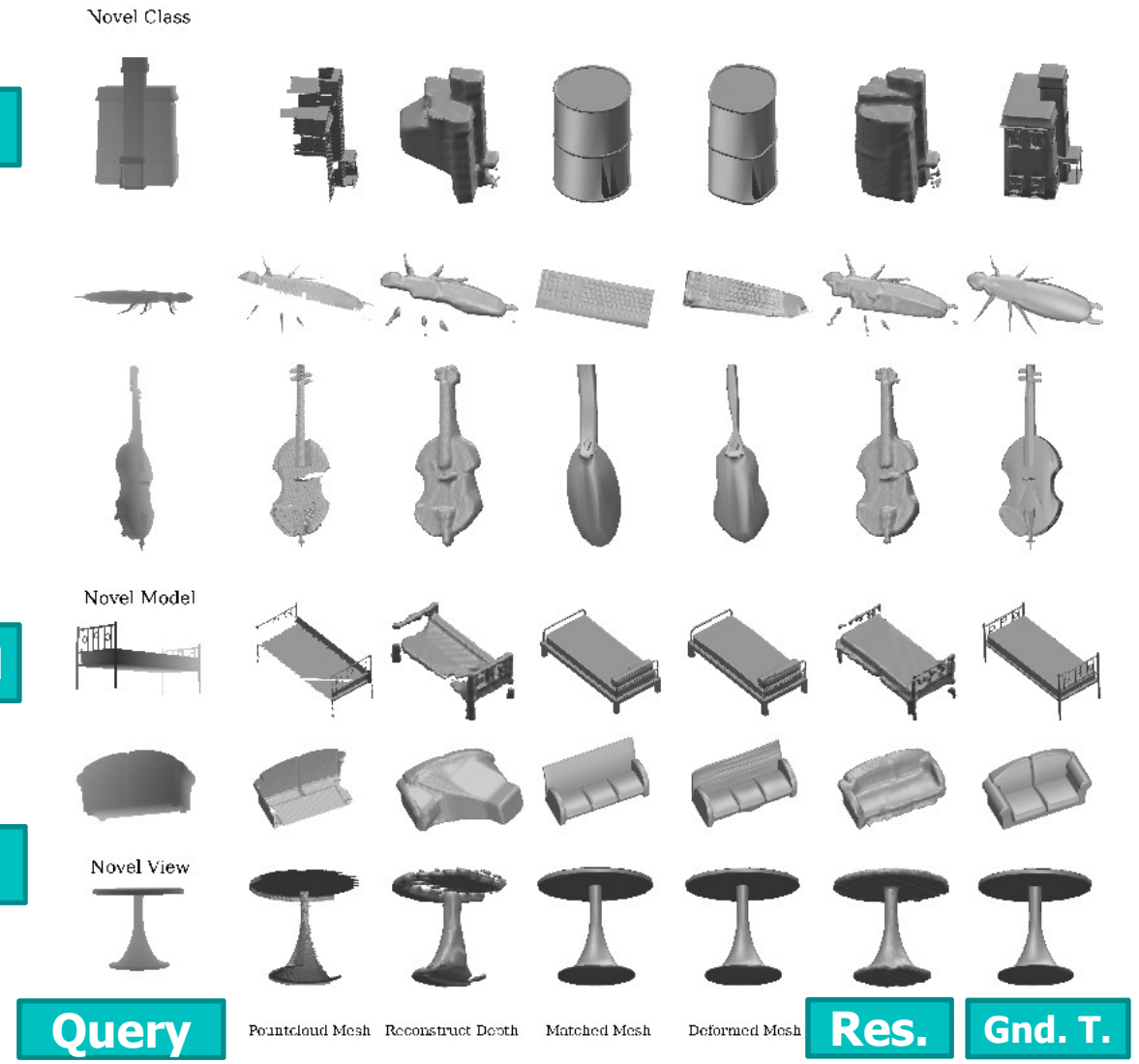
Examples


Novel Class
Novel Class
Novel Model
Novel Model
Novel View
Novel View
Query
Pointcloud Mesh
Reconstruct Depth
Matched Mesh
Deformed Mesh
Res.
Gnd. T.

More Examples