



Learning to Infer and Execute 3D Shape Programs

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<http://shape2prog.csail.mit.edu/>



Overview

Goal: build a representation that captures higher-level shape structure of object parts, such as repetition and symmetry

Method: represent shapes as programs

Challenge: no annotation

Contribution:

- Infer programs for a shape by explaining it (self-supervised)
- Learn a differentiable program executor
- Reconstruct 3D shapes from 2D images

Domain Specific Language

Program	→	Statement; Program
Statement	→	Draw(Semantics, Shape, Position_Params, Geometry_Params)
Statement	→	For(For_Params); Program; EndFor
Semantics	→	semantics 1 semantics 2 semantics 3 ...
Shape	→	Cuboid Cylinder Rectangle Circle Line ...
Position_Params	→	(x, y, z)
Geometry_Params	→	($g_1, g_2, g_3, g_4, \dots$)
For_Params	→	Translation_Params Rotation_Params
Translation_Params	→	(times i , orientation u)
Rotation_Params	→	(times i , angle θ , axis a)

Quantitative Evaluation

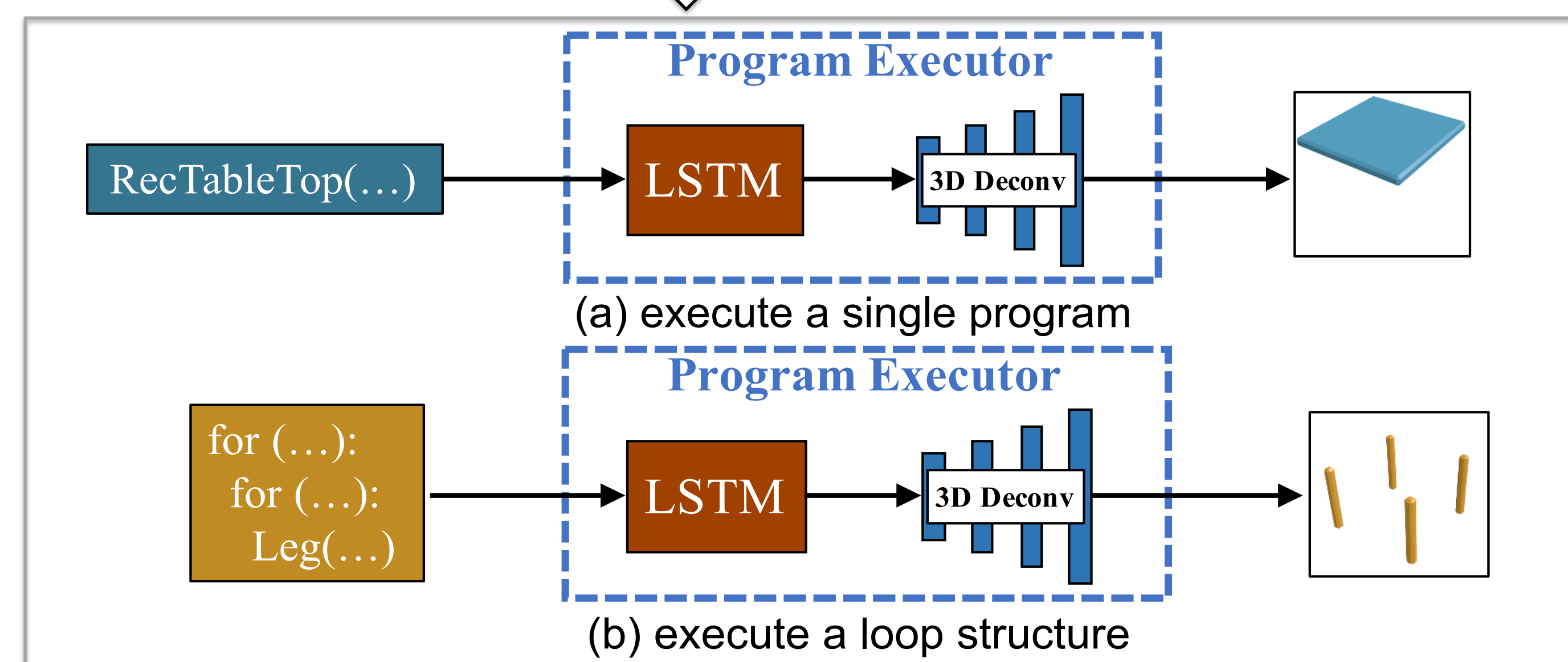
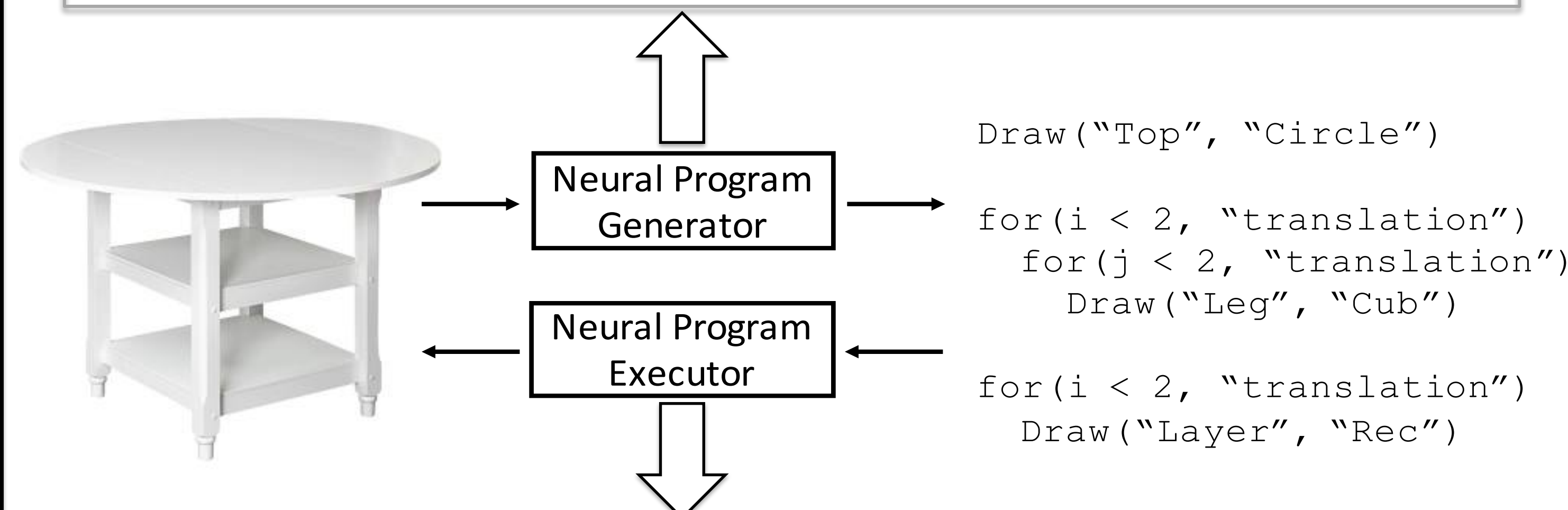
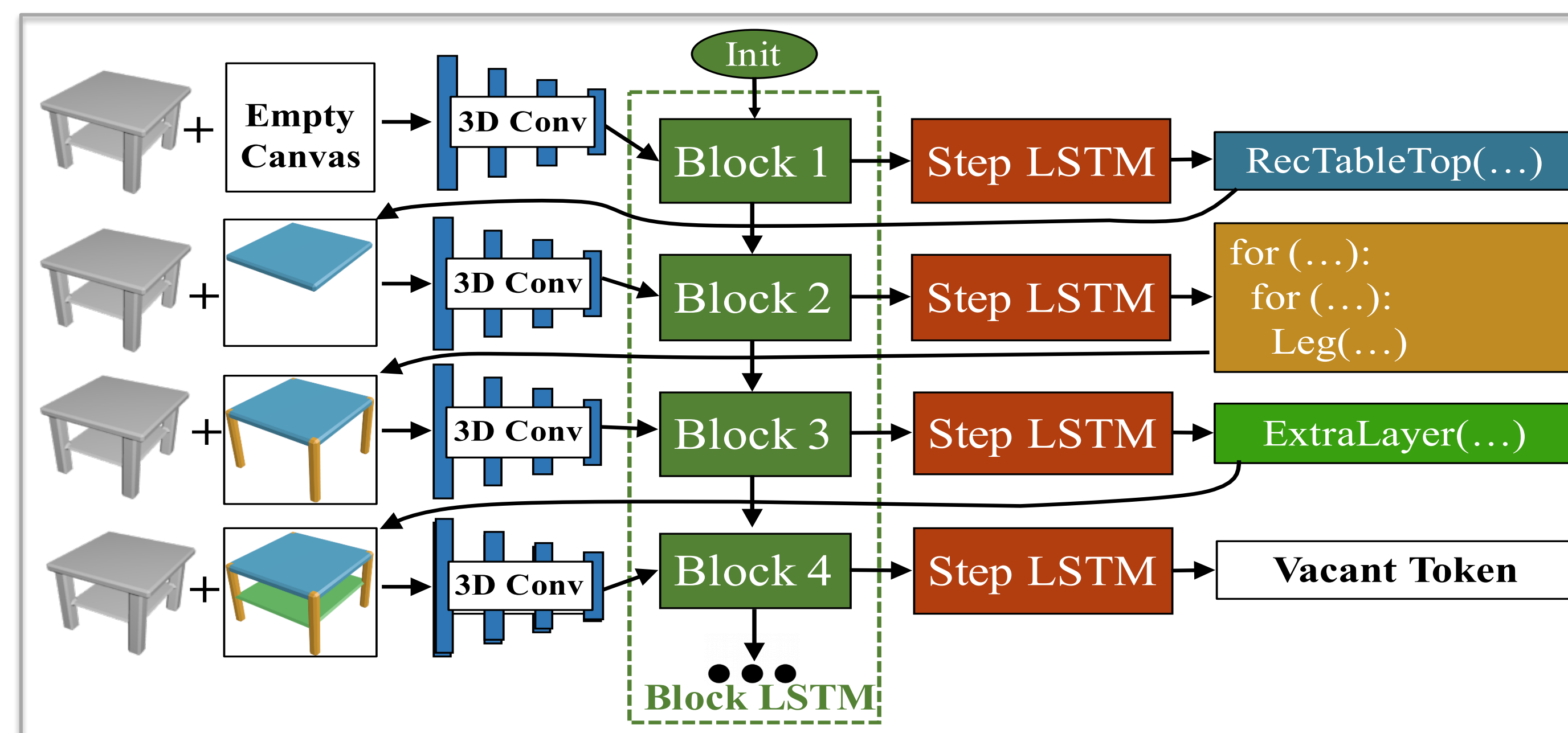
Train and test on **same** classes

	IoU		CD		EMD	
	table	chair	table	chair	table	chair
Tulsiani[CVPR'17]	.357	.406	.083	.079	.073	.072
Csgnet[CVPR'18]	.406	.365	.072	.077	.069	.076
Our w/o adaption	.487	.422	.067	.072	.063	.072
Our w/ adaption	.591	.516	.058	.063	.056	.060

Test on **novel** classes

	IoU				CD			
	bed	sofa	cabinet	bench	bed	sofa	cabinet	bench
w/o adaption	.234	.296	.251	.176	.126	.103	.104	.098
w/ adaption	.367	.597	.478	.418	.096	.067	.092	.059

Model



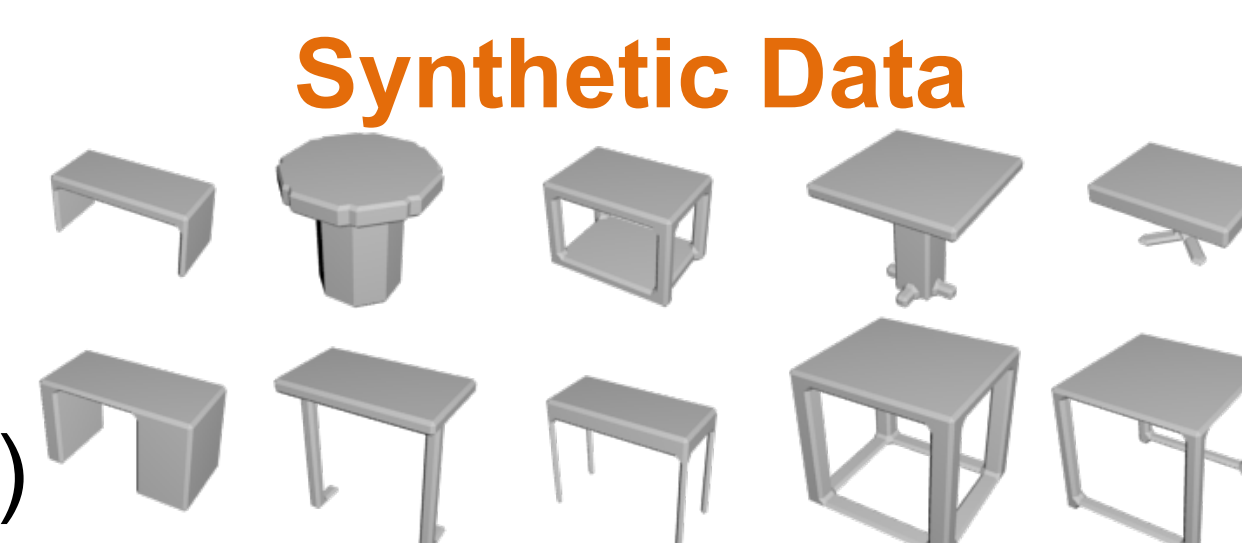
Training

Step 1: with synthetic data:

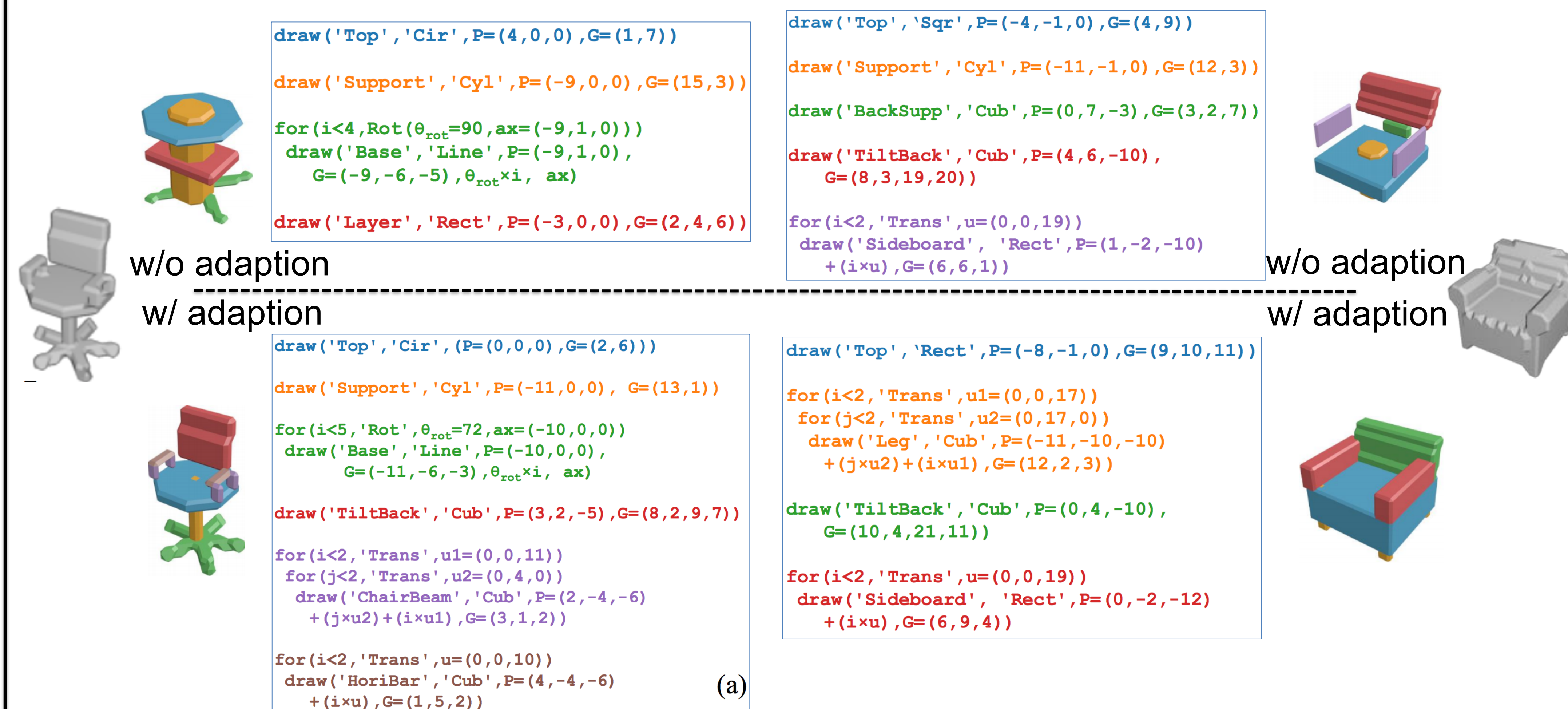
(1) train generator (2) train executor

Step 2: with real data:

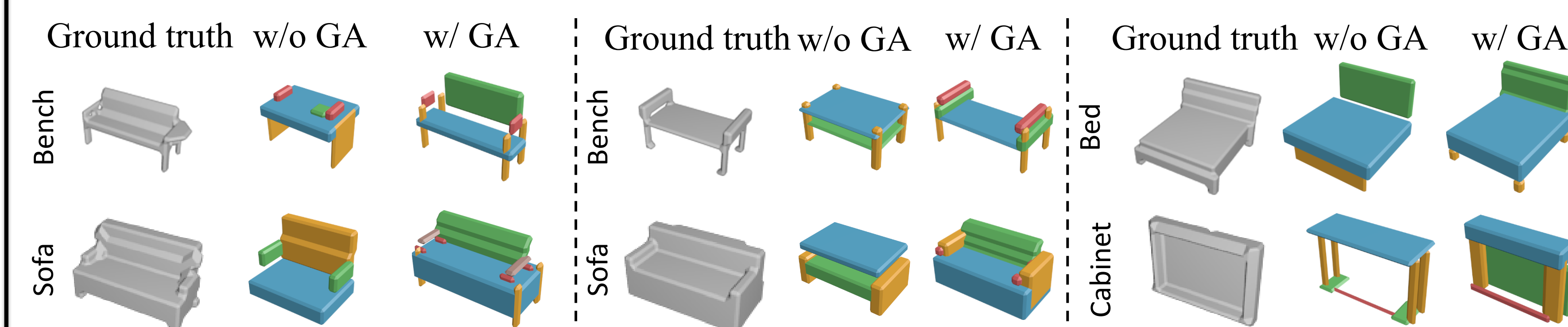
self-supervised guided adaptation (GA)



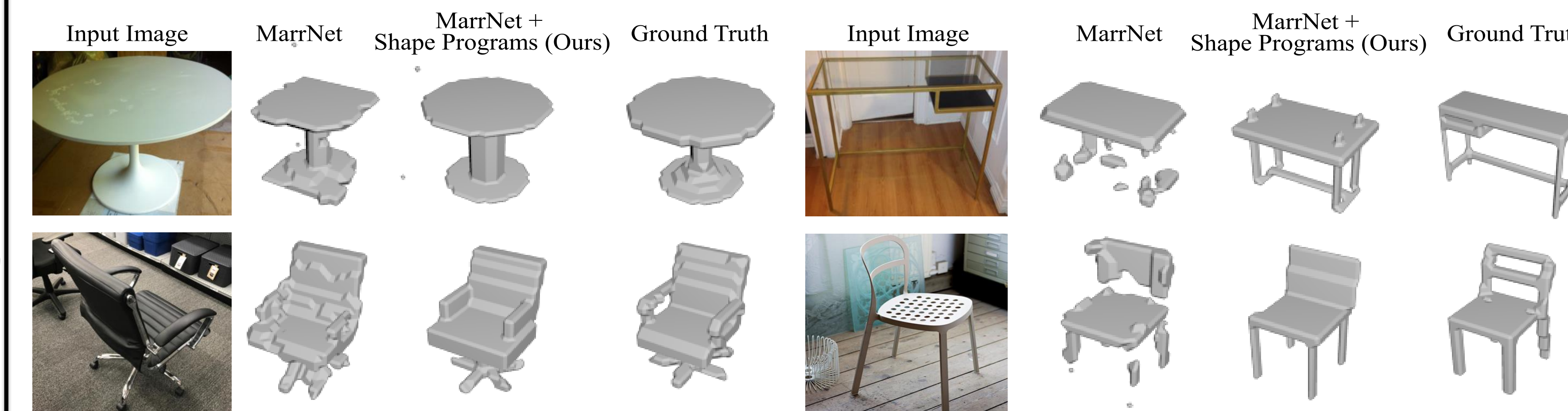
Visualize Program and Shapes



Generalize to Novel Classes



3D Reconstruction from Image



Project



Code

