

# DeepCAD: A Deep Generative Network for Computer-Aided Design Models

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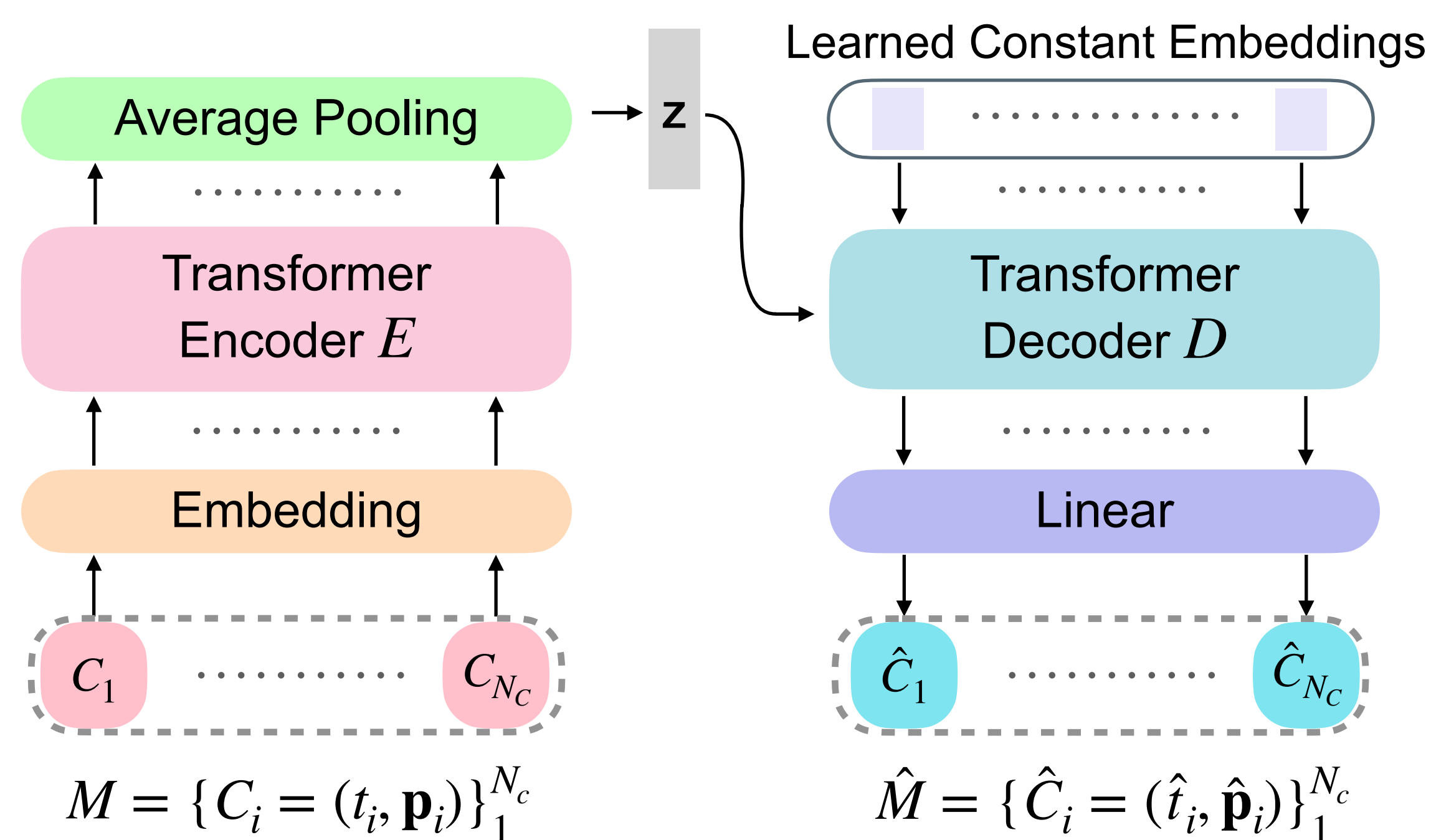
[Project page](#) | [Paper](#) | [Code](#)



## Abstract

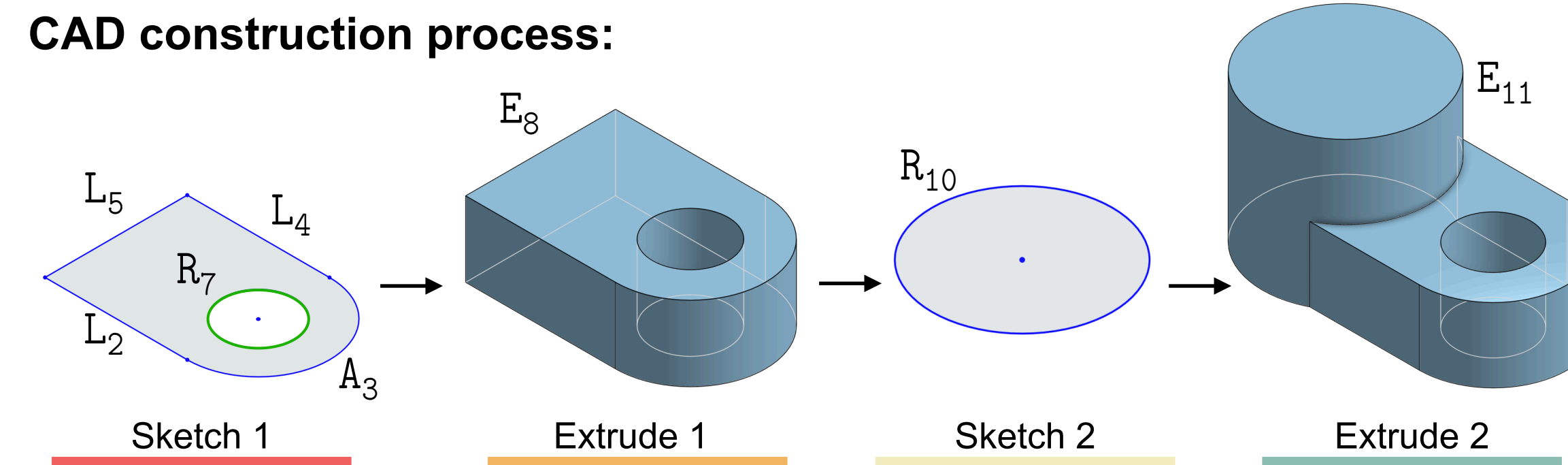
Deep generative models of 3D shapes have received a great deal of research interest. Yet, almost all of them generate discrete shape representations, such as voxels, point clouds, and polygon meshes. We present the first 3D generative model for a drastically different shape representation — describing a shape as a sequence of computer-aided design (CAD) operations. Unlike meshes and point clouds, CAD models encode the user creation process of 3D shapes, widely used in numerous industrial and engineering design tasks. However, the sequential and irregular structure of CAD operations poses significant challenges for existing 3D generative models. Drawing an analogy between CAD operations and natural language, we propose a CAD generative network based on the Transformer. We demonstrate the performance of our model for both shape autoencoding and random shape generation. To train our network, we create a new CAD dataset consisting of 178,238 models and their CAD construction sequences. We have made this dataset publicly available to promote future research on this topic.

## Autoencoder for CAD Models



## A tokenized CAD Representation for Neural Networks

CAD construction process:



Parametrized command sequence:

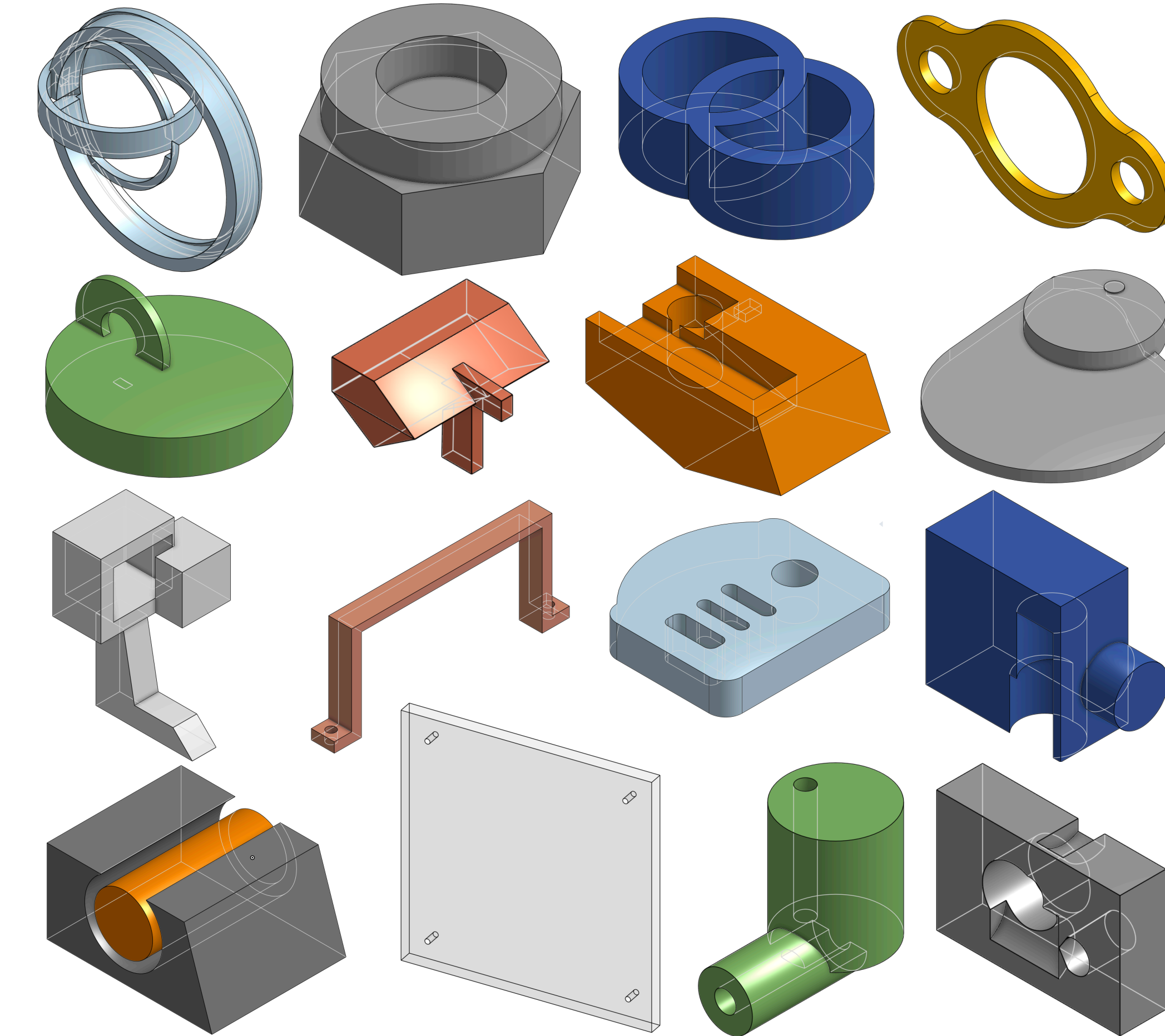
$\langle \text{SOL} \rangle_1 : \emptyset$   
 $L_2 : (2, 0)$   
 $A_3 : (2, 2, \pi, 1)$   
 $L_4 : (0, 2)$   
 $L_5 : (0, 0)$   
 $\langle \text{SOL} \rangle_6 : \emptyset$   
 $R_7 : (2, 1, 0.5)$

$E_8 : (0, 0, 0, -2, -1, 0, 3, 1, 0, \text{New body, One-sided})$   
 $\langle \text{SOL} \rangle_9 : \emptyset$   
 $R_{10} : (0, 0, 1.125)$   
 $E_{11} : (0, 0, 0, -2, 0, 0, 2.25, 2, 0, \text{Join, One-sided})$   
 $\langle \text{EOS} \rangle_{12} : \emptyset$

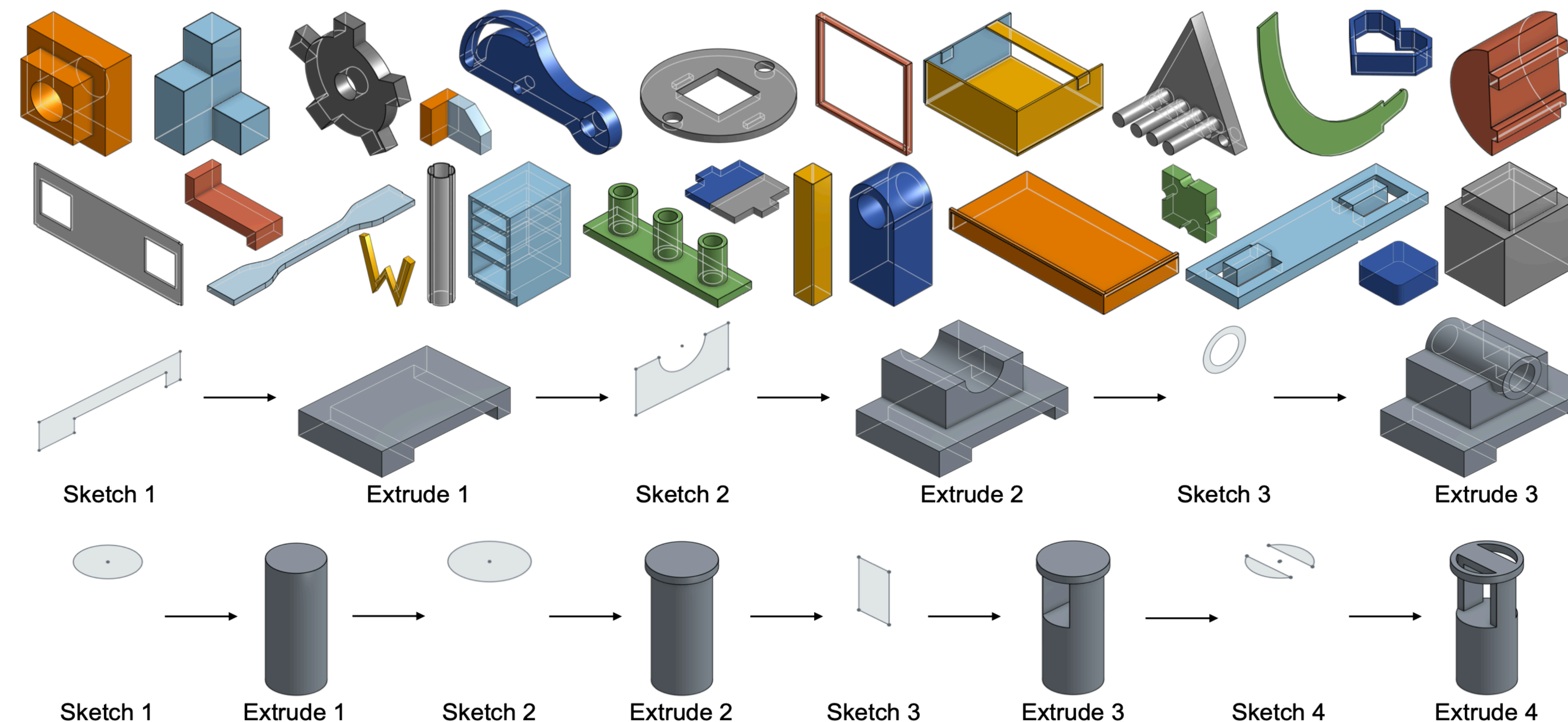
Commands	Parameters
$\langle \text{SOL} \rangle$	$\emptyset$
L (Line)	$x, y$ : line end-point
A (Arc)	$x, y$ : arc end-point $\alpha$ : sweep angle $f$ : counter-clockwise flag
R (Circle)	$x, y$ : center $r$ : radius $\theta, \phi, \gamma$ : sketch plane orientation
E (Extrude)	$p_x, p_y, p_z$ : sketch plane origin $s$ : scale of associated sketch profile $e_1, e_2$ : extrude distances toward both sides $b$ : boolean type, $u$ : extrude type
$\langle \text{EOS} \rangle$	$\emptyset$

Table 1. CAD commands and their parameters.  $\langle \text{SOL} \rangle$  indicates the start of a loop;  $\langle \text{EOS} \rangle$  indicates the end of the whole sequence.

## Auto Generated CAD models



## A large CAD Dataset collected from Onshape



## Reconstruction from Point Clouds

