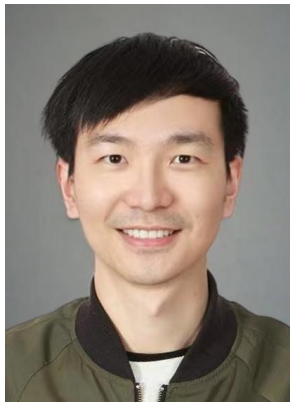
D²CSG: Unsupervised Learning of Compact CSG Trees with Dual Complements and Dropouts

Fenggen Yu[1] Qimin Chen[1] Maham Tanveer[1] Ali Mahdavi Amiri[1] Hao Zhang[1]

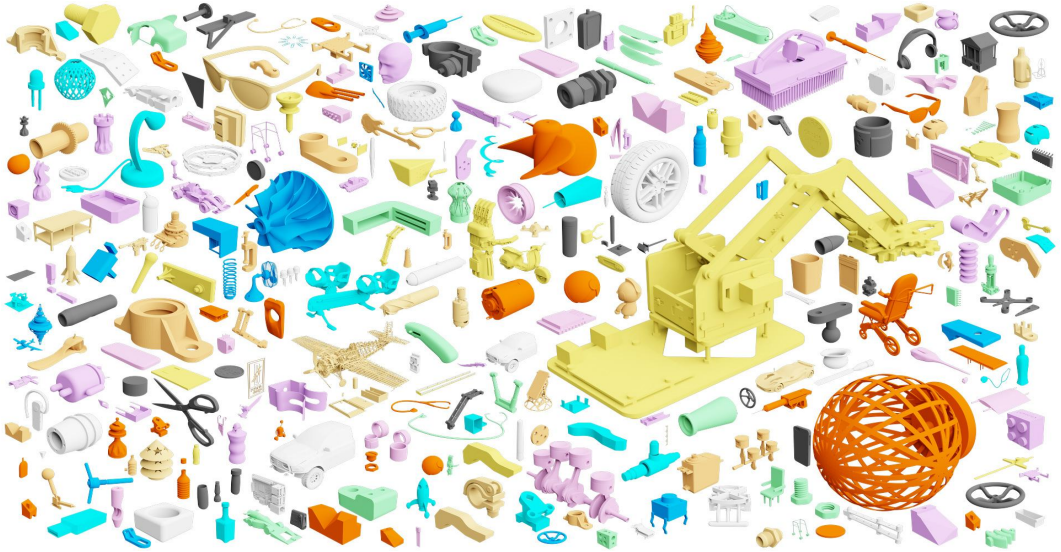
[1]Simon Fraser University





3D CAD Models

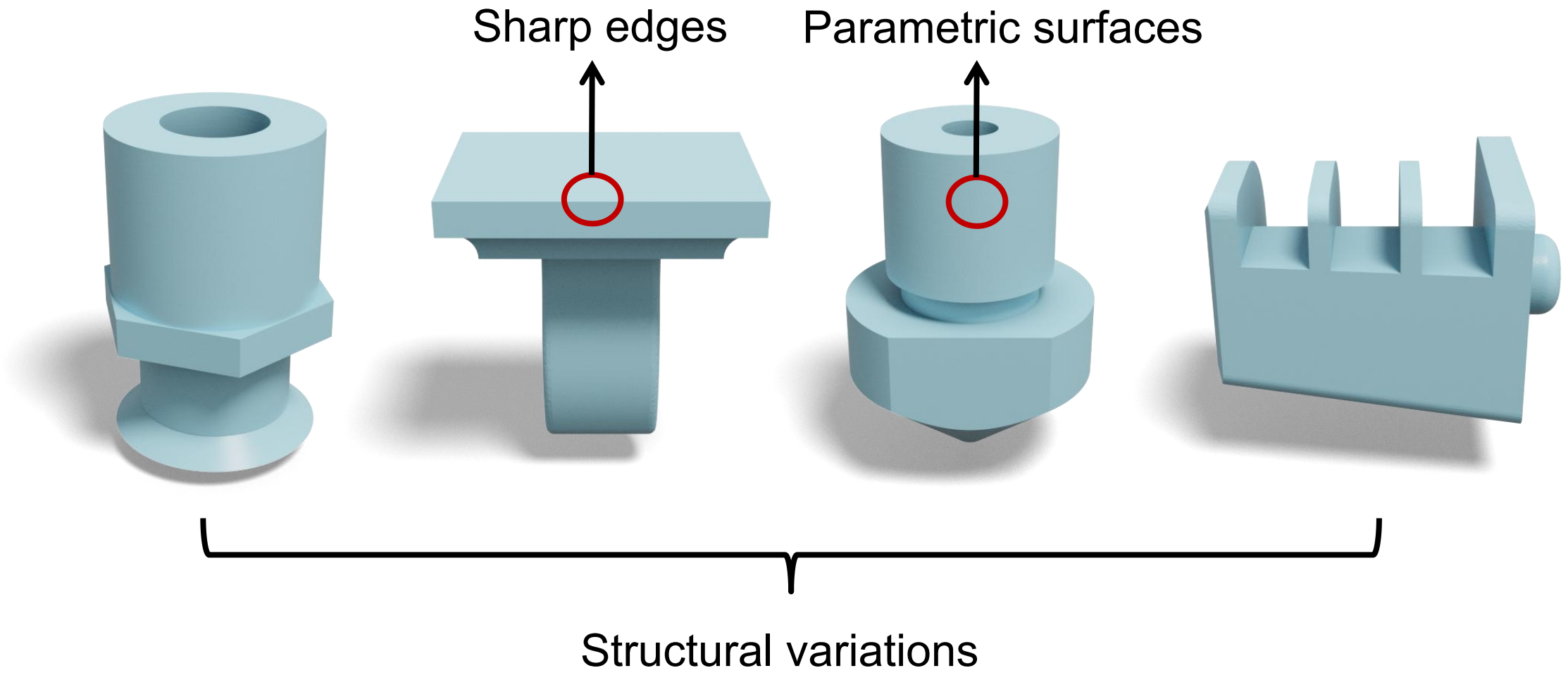
ABC Dataset, Koch et al CVPR 2019



Fusion 360 Gallery, Karl et al TOG 2021

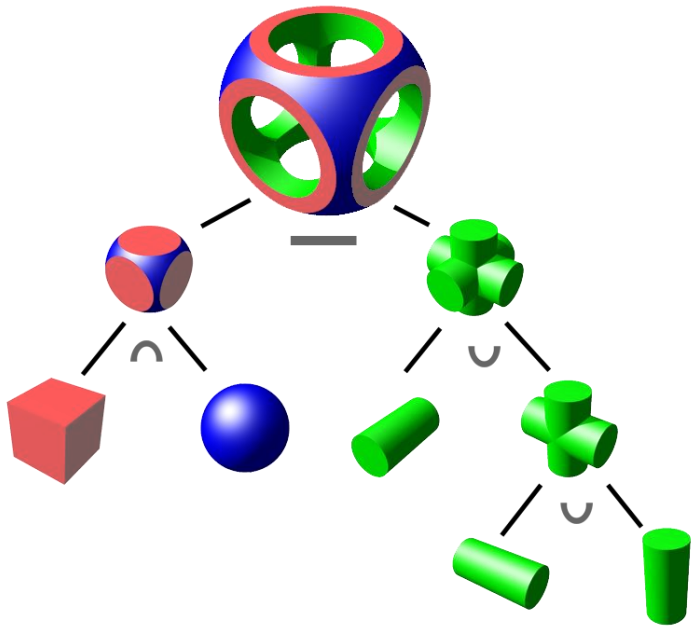
Computer-Aided-Design (CAD) models are widely used in industry design

Learning CAD Model Recontruction

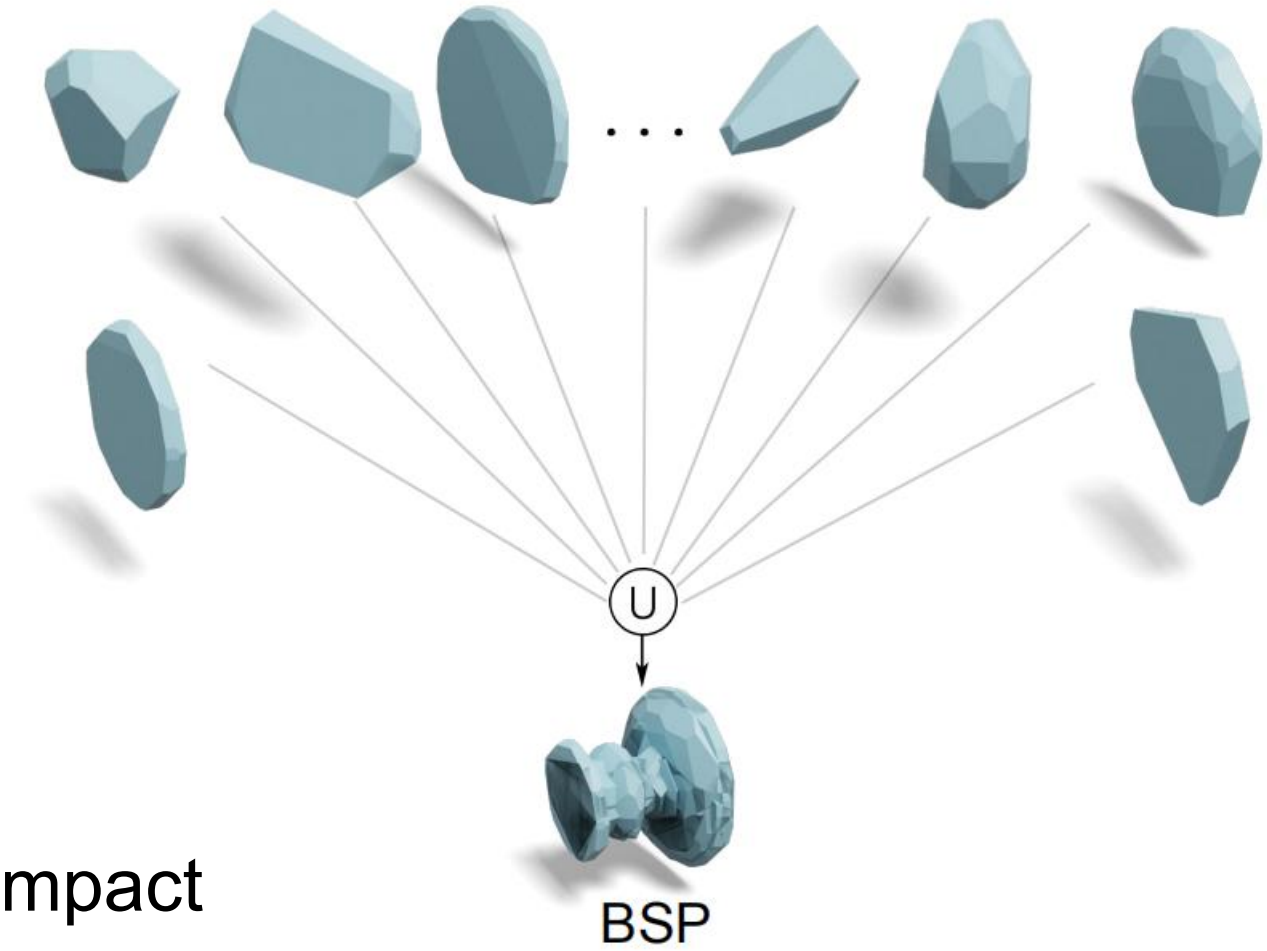


CSG-based CAD Modeling

- Constructive Solid Geometry(CSG) operations are popular in CAD modeling
- **Goal**: Unsupervised learning the CSG sequence for a given 3D shape

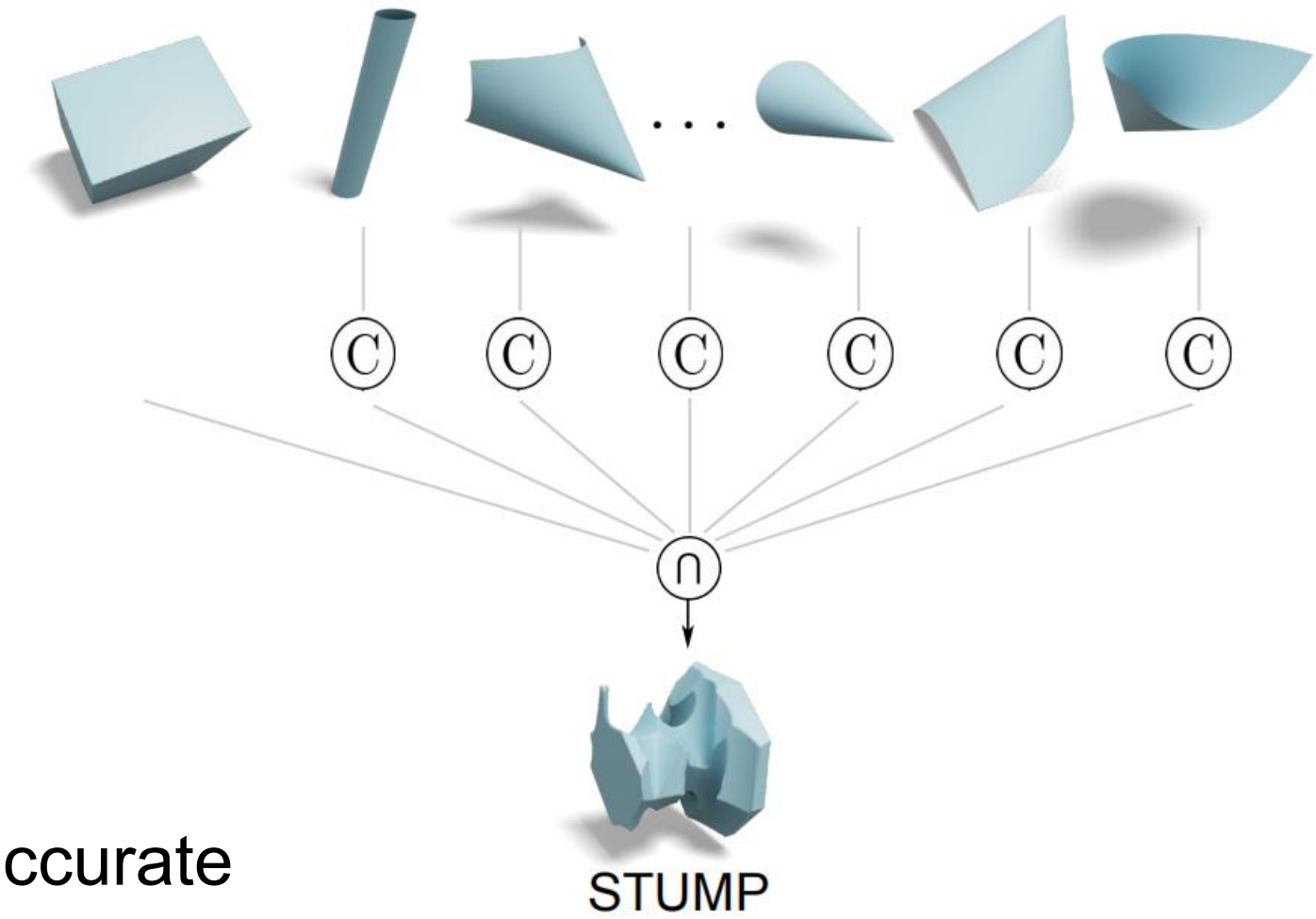


Learning CSG



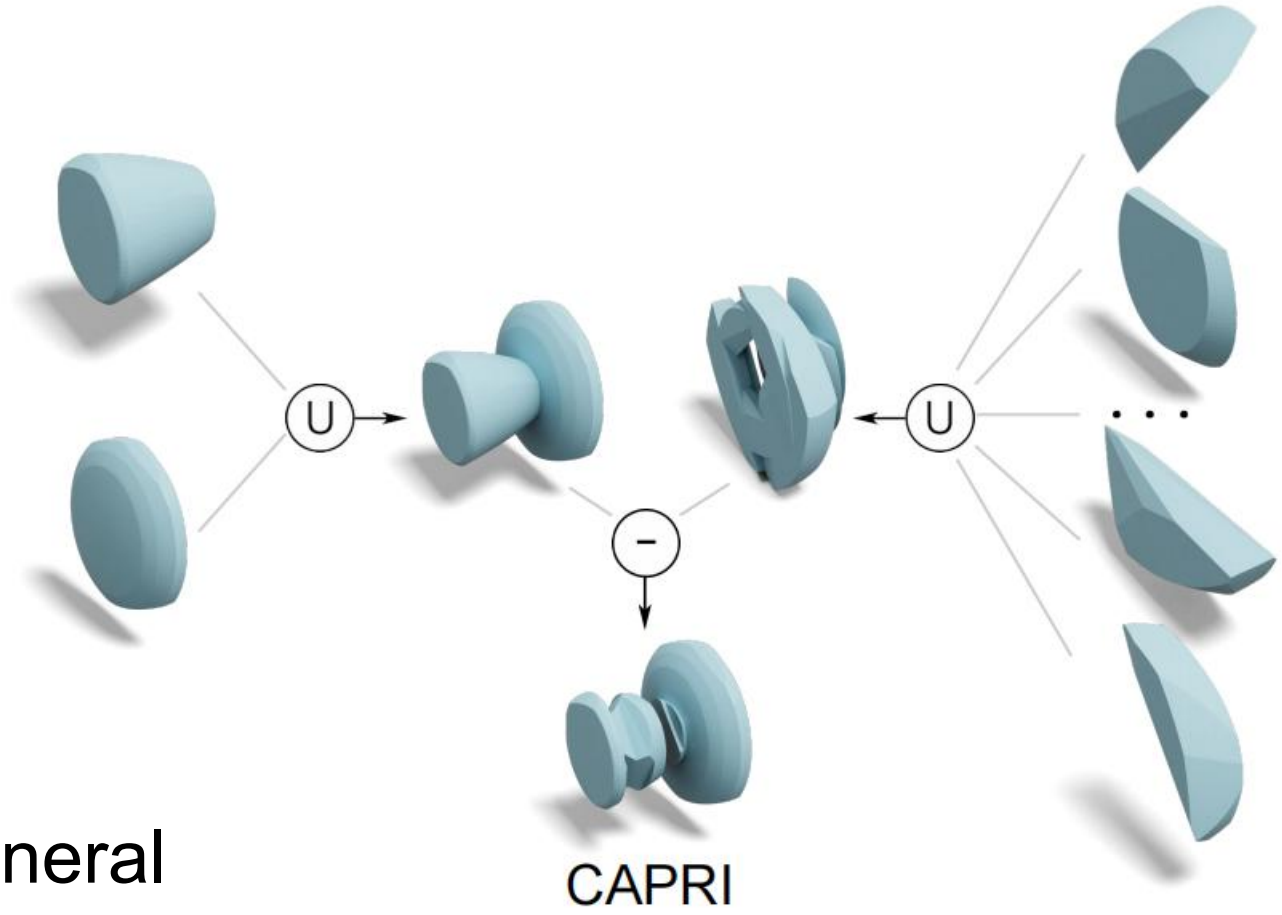
☹ Not compact

Learning CSG



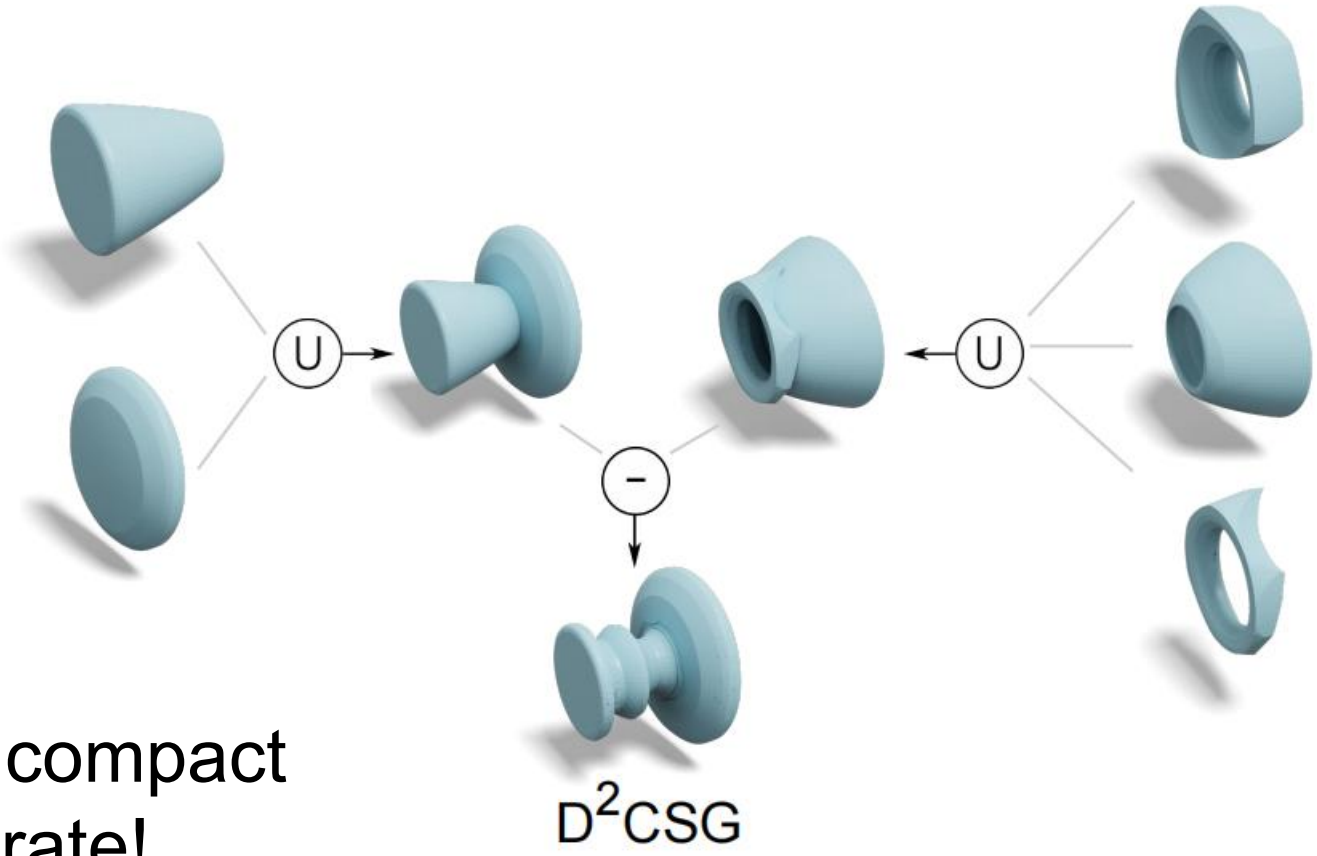
☹ Not accurate

Learning CSG



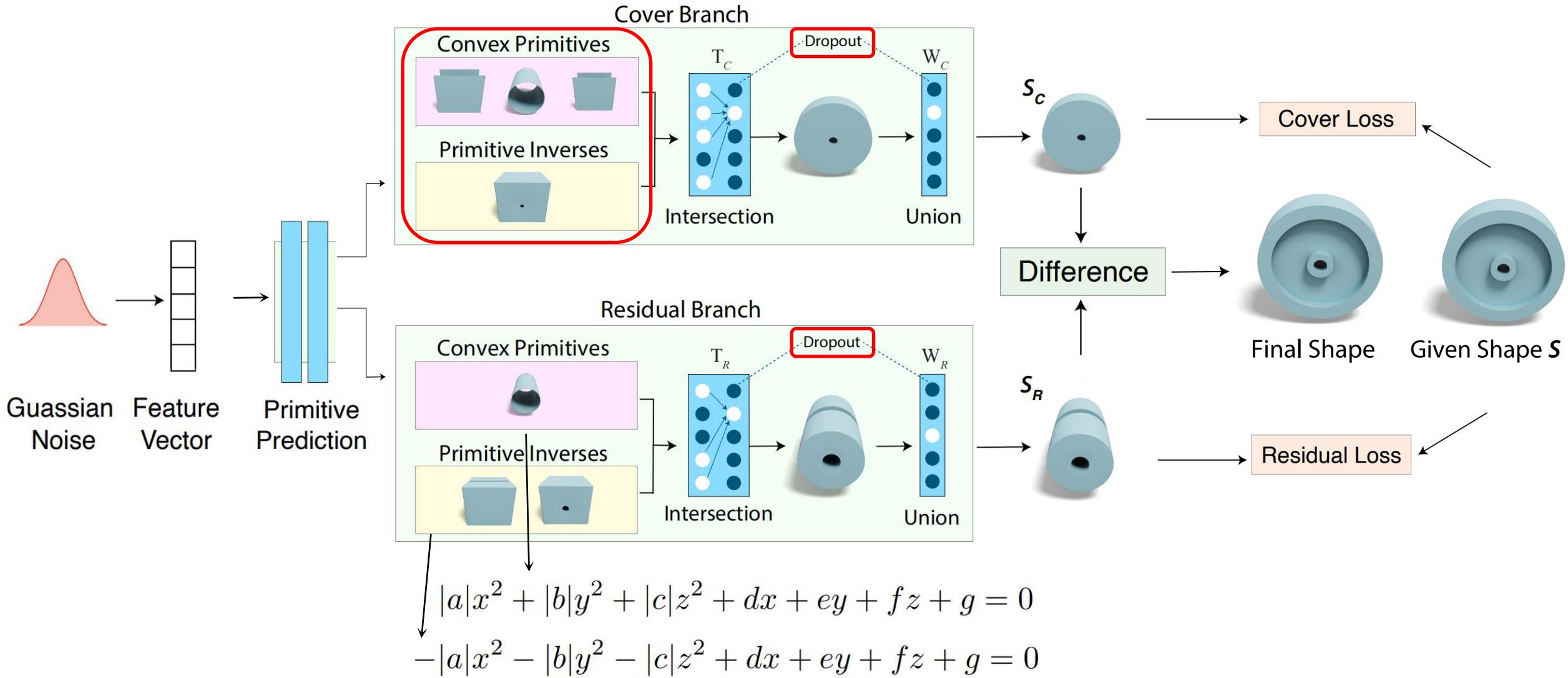
☹ Not general

Learning CSG

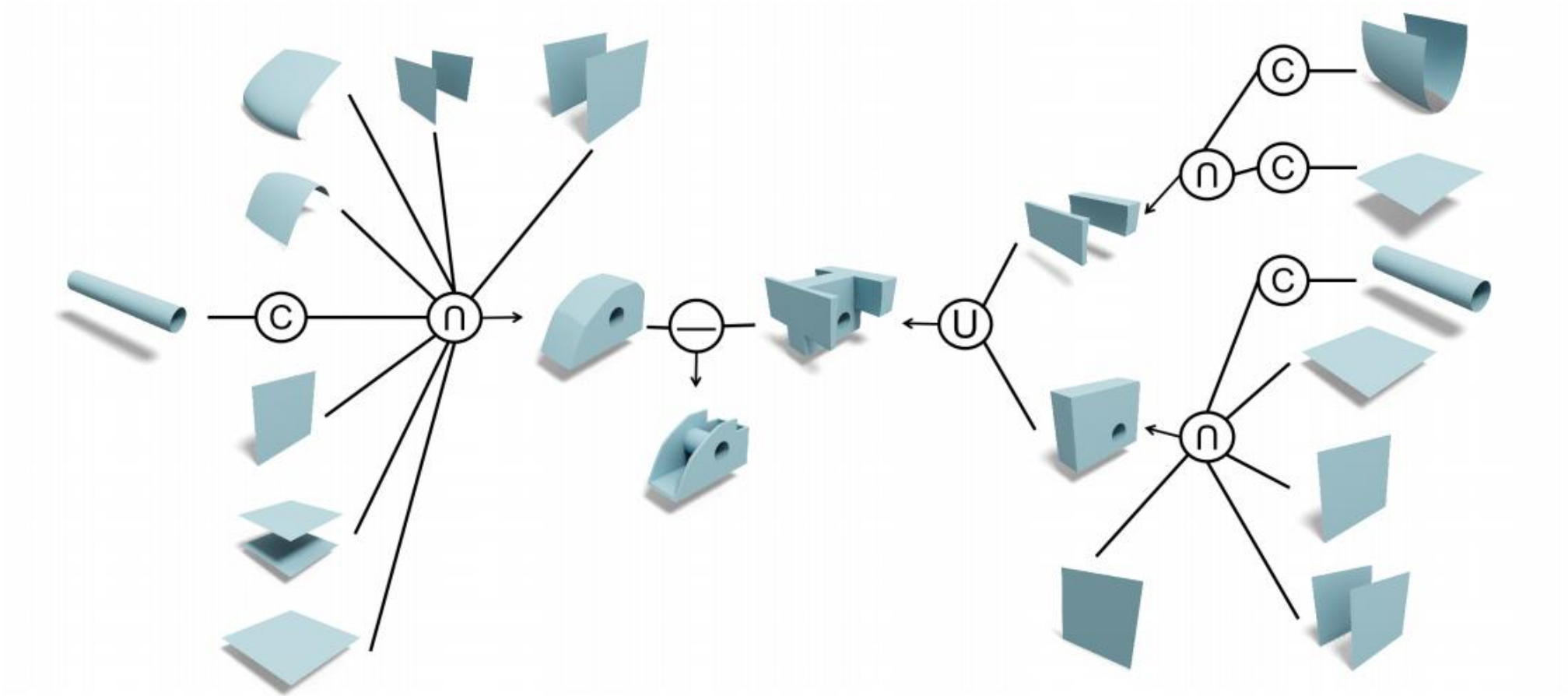


☺ General, compact and accurate!

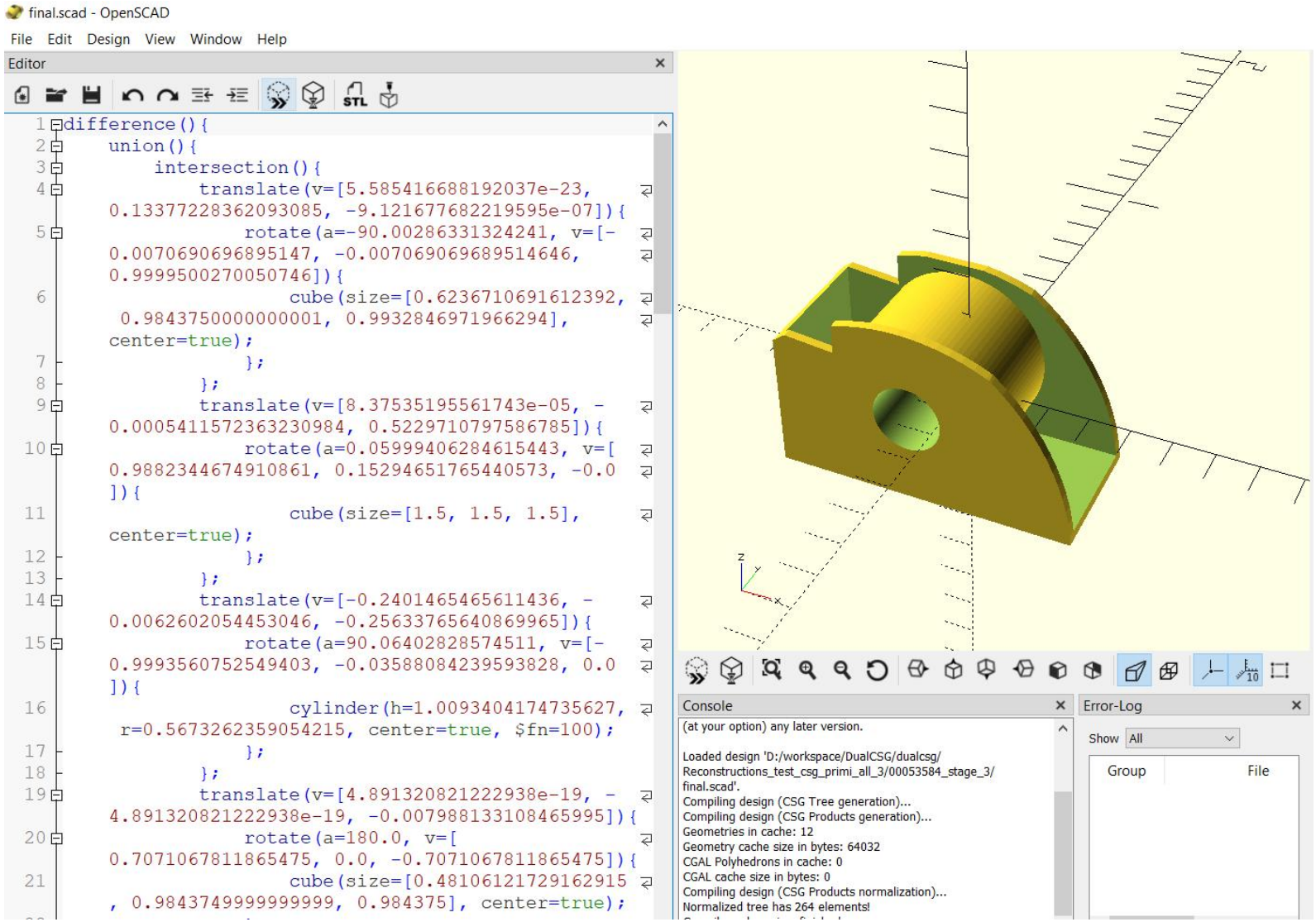
Network Overview



Learned CSG Tree

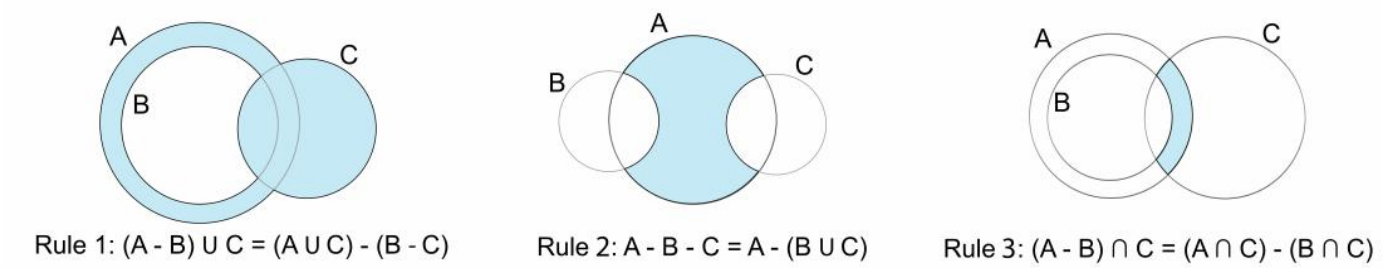


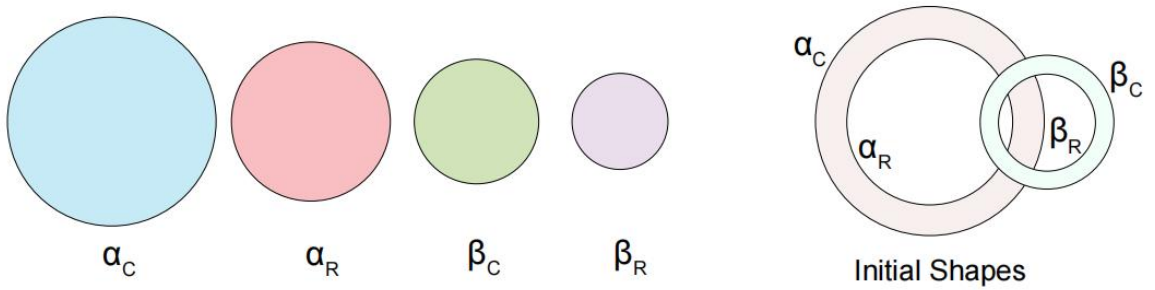
Editable CSG Program



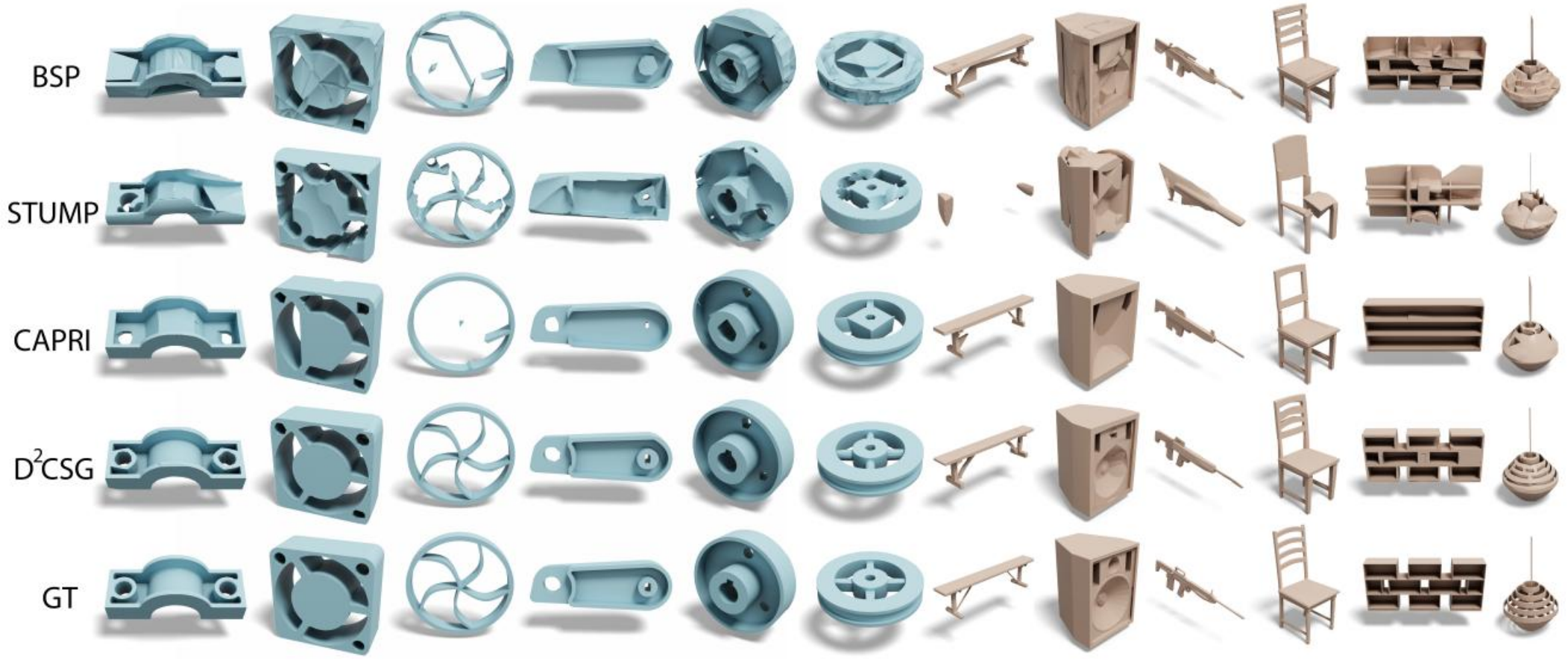
Generalization Proof

- The operation sequence in D^2CSG is able to support any CSG sequence





Experiments: Mesh-to-CSG



ABC DataSet

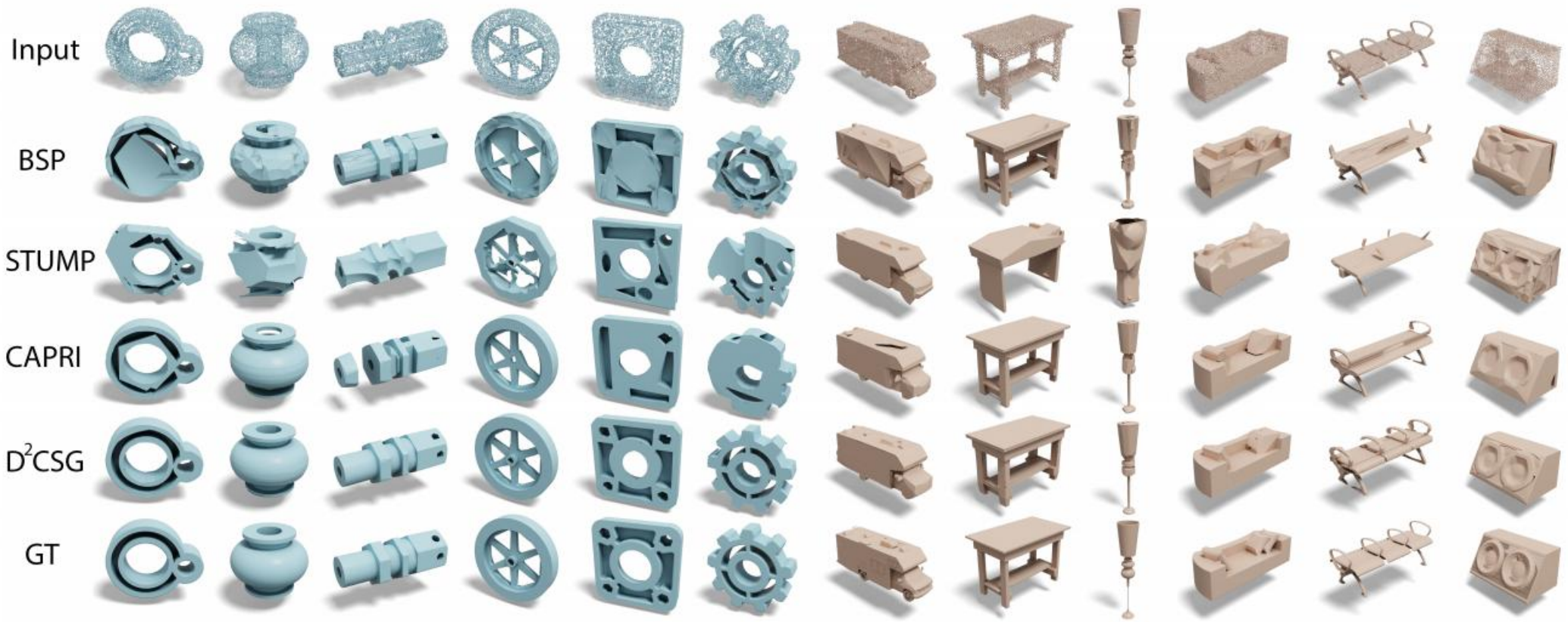
ShapeNet

Experiments: Ablation Studies

w.o CP | w.o DB | w.o DO | Ours | GT

Row ID	CP	DB	DO	CD ↓	NC ↑	ECD ↓	#P ↓	#IS ↓	#Seg ↓
1	-	-	-	0.183	0.907	3.92	77	9.2	93
2	✓	-	-	0.073	0.935	3.12	38	5.8	55
3	✓	-	✓	0.088	0.926	3.48	**27**	**5.3**	**40**
4	✓	✓	-	**0.069**	**0.936**	**2.98**	53	6.8	57
5	✓	✓	✓	**0.069**	0.928	3.09	29	5.7	42

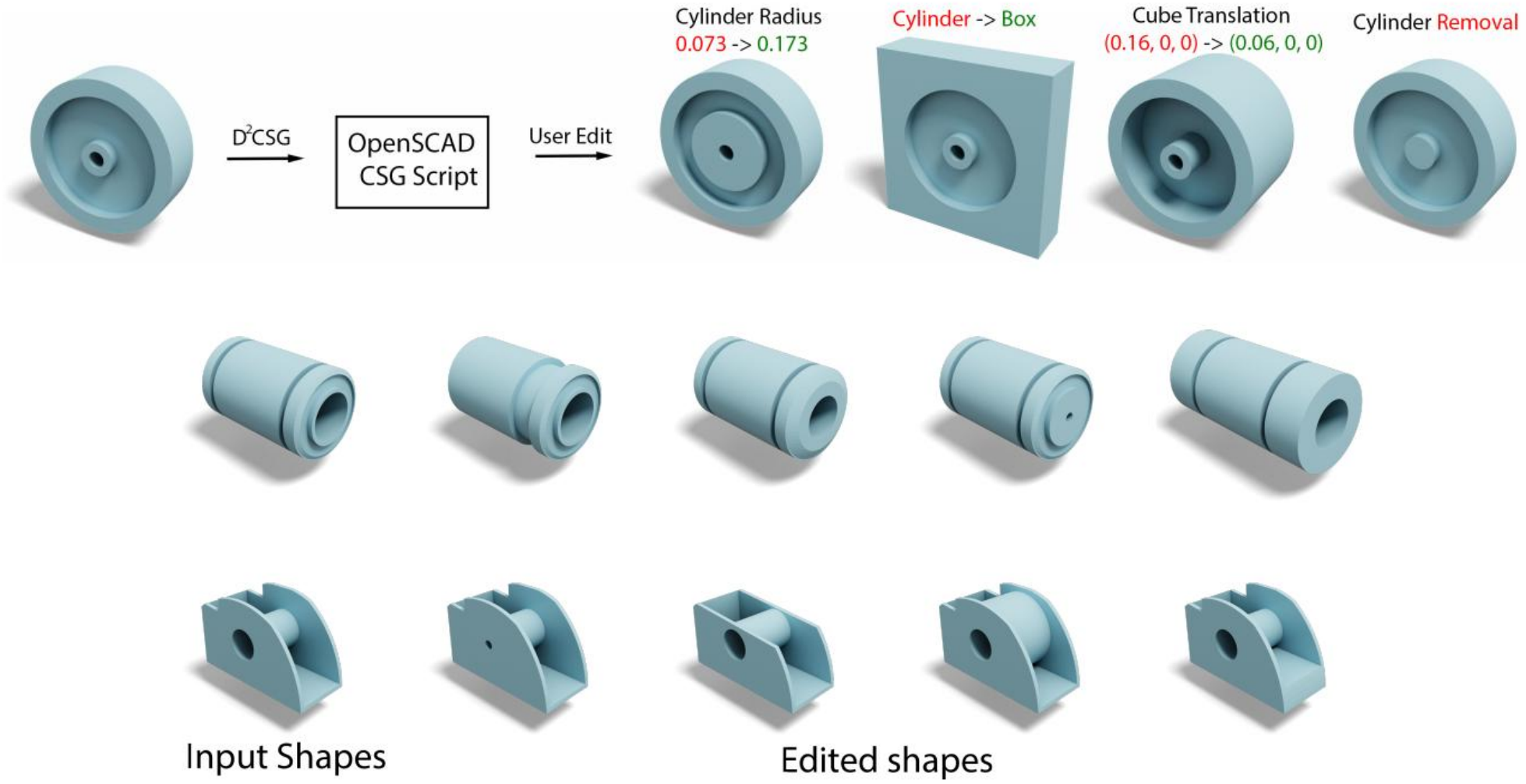
Application: PointCloud-to-CSG



ABC DataSet

ShapeNet

Application: Shape Editing



Thank you!