UCSG-NET - Unsupervised Discovering of Constructive Solid Geometry Tree

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Contributions
- The first method that learns CSG operations in unsupervised manner.
- Predicted CSG trees are fully interpretable and controllable. They can aid design of 3D objects.
- In terms of reconstruction quality, our model is on par with existing methods that aim for interpretable 3D object reconstruction.

Motivation
CSG is a common tool that can be in 3D graphics software for modeling objects with complex topology. We aim to automate the process by predicting CSG trees that create these objects.

Existing approaches
- Time consuming inference
- Require supervision of CSG operations

Learnable CSG Layer

UCSG-NET

Encoding

Representing a single shape and CSG operations

Ground truth
Reconstruction
Primitives
CSG Tree
Intersection
Union
Difference

UCSG-NET

First stage

Training UCSG-NET

Results - 2D CAD Dataset

<table>
<thead>
<tr>
<th>Method</th>
<th>Mode</th>
<th>k</th>
<th>t</th>
<th>t = ∞</th>
<th>CD - Chamfer Distance ×10³</th>
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<tbody>
<tr>
<td>Our</td>
<td>Unsupervised</td>
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<td>0.446</td>
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<td>3.98</td>
<td>2.25</td>
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<td>1.02</td>
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Results - 3D ShapeNet

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<th>Method</th>
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<th>k</th>
<th>t</th>
<th>α ≤ 0.05</th>
<th>CD - Chamfer Distance ×10³</th>
<th>High interpretability</th>
<th>Low interpretability</th>
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Training UCSG-NET

First stage

Second stage - when α ≤ 0.05