Learning Unsupervised Hierarchical Part Decomposition of 3D Objects from a Single RGB Image

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http://superquadrics.com/hierarchical_primitives
Motivation

Existing shape representations focus only on reconstructing the geometry of a 3D object without considering its part-based decomposition or relations between parts.
Our Structure-aware Representation

Jointly recovers the geometry and the latent hierarchical layout of an object as an unbalanced binary tree of primitives.
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where simple parts are represented with fewer primitives and complex parts with more components.
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The hierarchical part decomposition is learned without any supervision neither on the object parts nor their structure.
Our Structure-aware Representation

Given an input and a target mesh represented as a set of occupancy pairs \( \mathcal{X} = \{(x_i, o_i)\}_{i=1}^N \), our network predicts a binary tree of primitives. For each primitive the network regresses:

- A set of 11 parameters \( \lambda^d_k \) that define the shape, size and position in 3D space of its primitive at each depth level \( d \).
- A reconstruction quality \( q^d_k \).
Expressive Shape Abstractions

We evaluate our model on the single view 3D reconstruction task on ShapeNet and D-FAUST.
Expressive Shape Abstractions

We show that considering the part decomposition improves the reconstruction quality.
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Semantic Interpretation of Learned Hierarchies

We show that our model recovers semantic hierarchies as the same node is consistently used for representing the same object part.
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Thank you for your attention!

Project Page: http://superquadrics.com/hierarchical_primitives