Neural Progressive Meshes

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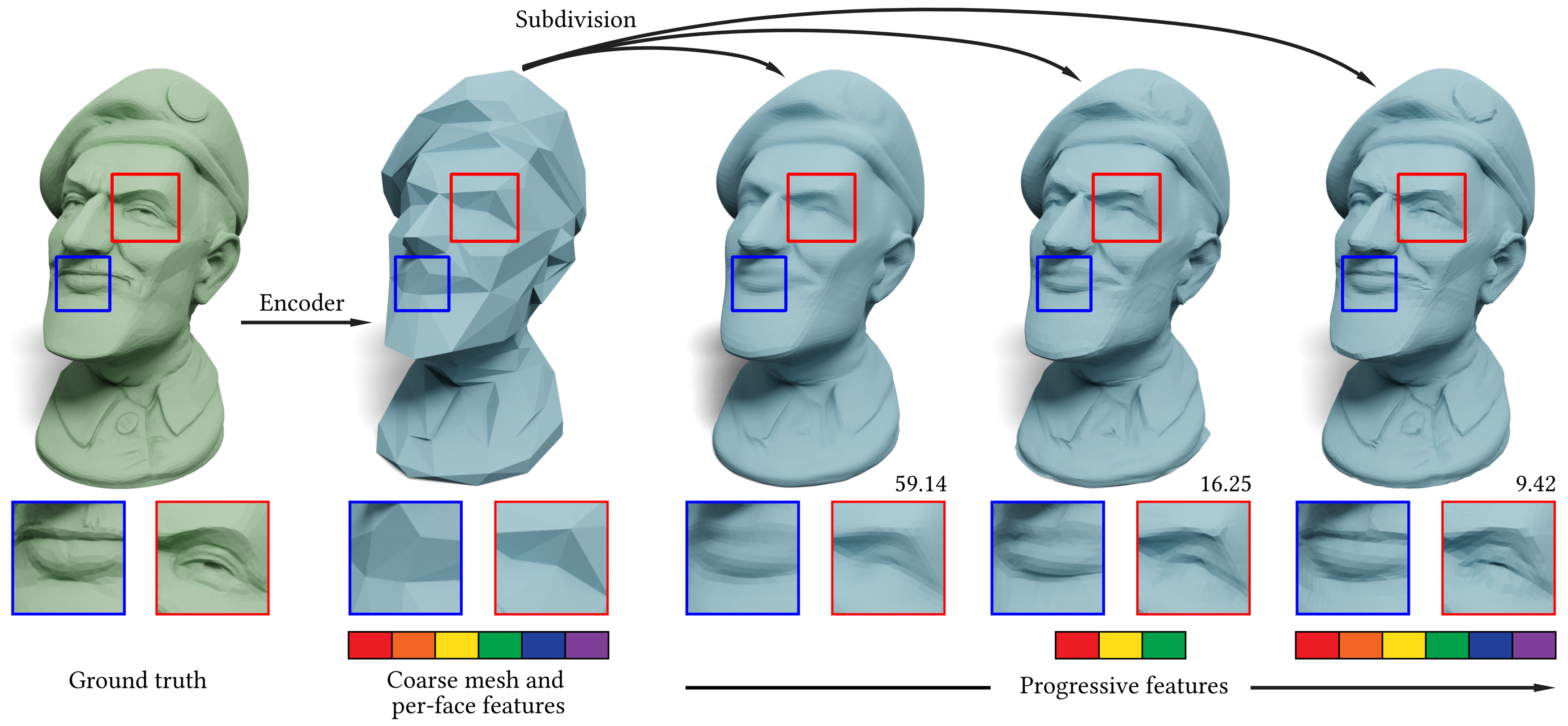
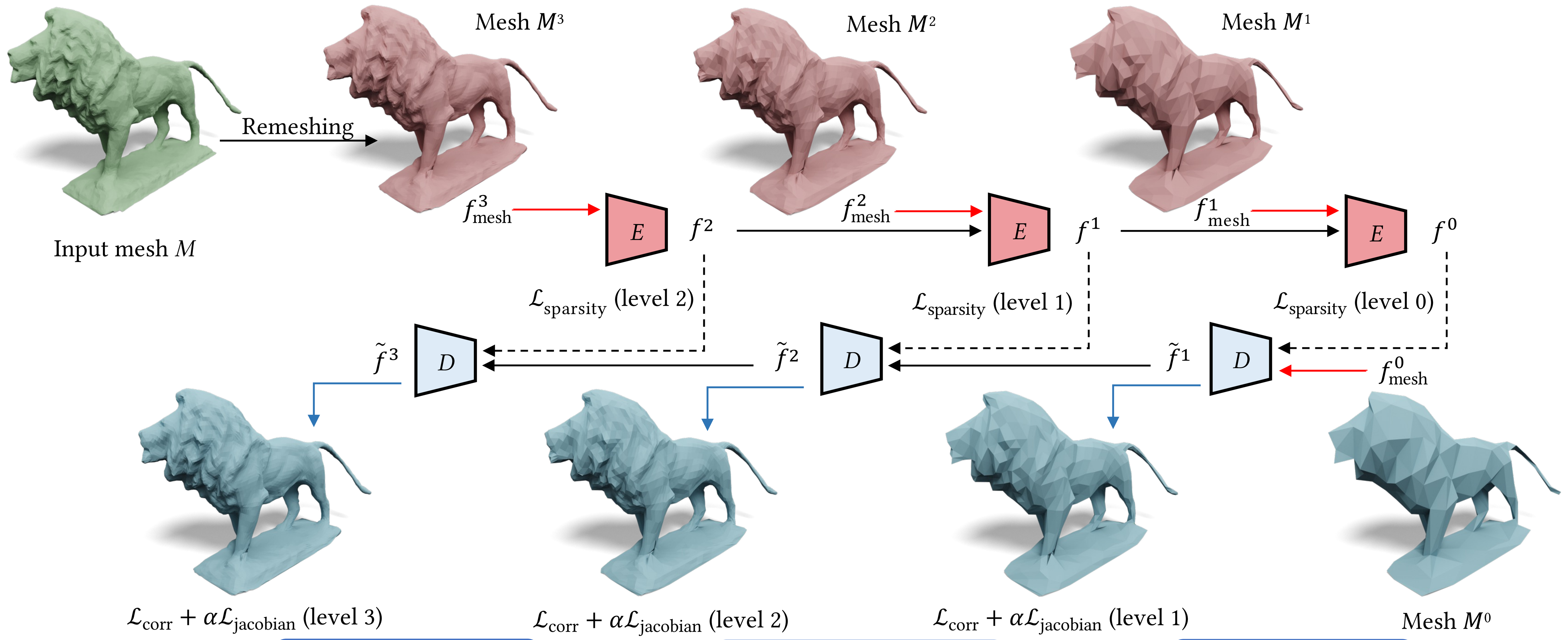
neural-progressive-meshes.github.io

Mesh Compression and Transmission

- Input: A triangle mesh
- Goal: Develop a framework that learns a progressive compressed representation of meshes for transmission purposes



Method: Neural Progressive Meshes



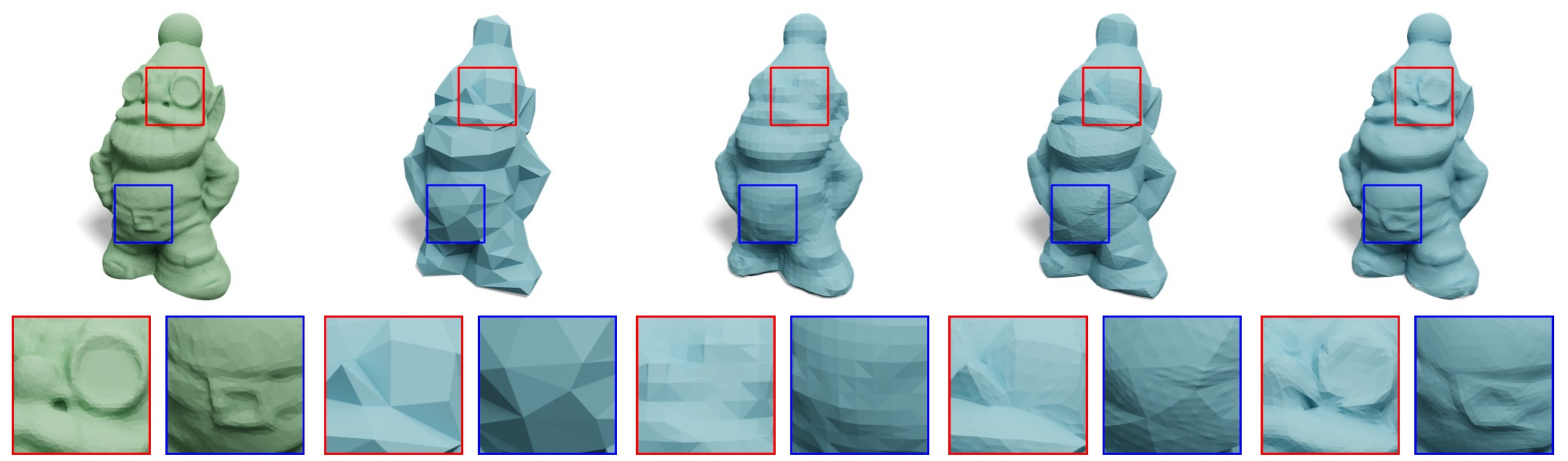
$$\mathcal{L}_{\text{corr}} = \sum_{i=1}^{L} \frac{1}{|V^i|} \|\tilde{V}^i - V^i\|_2$$

$$\mathcal{L}_{\text{jacobian}} = \sum_{i=1}^{L} \frac{1}{|F^i|} \sum_{j=1}^{|F^i|} \|J^i_j - I\|_2$$

$$\mathcal{L}_{\text{sparsity}} = \sum_{i=0}^{L-1} \frac{1}{|F^i|} \|f^i\|_1$$

Experimental Results

Comparison to decimation and subdivision methods

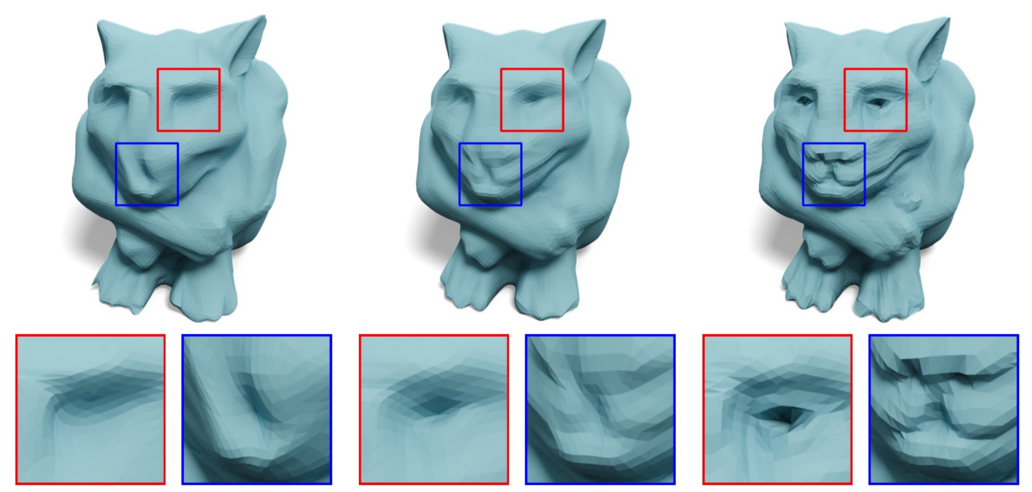


d_{pm} $(\times 10^{-4})$ / d_{normal} Ground truth | 44.94 / 17.42° QSlim | 28.56 / 15.78° SubdivFit | 17.09 / 13.69° Neural Subdivision | 5.32 / 8.62° Ours

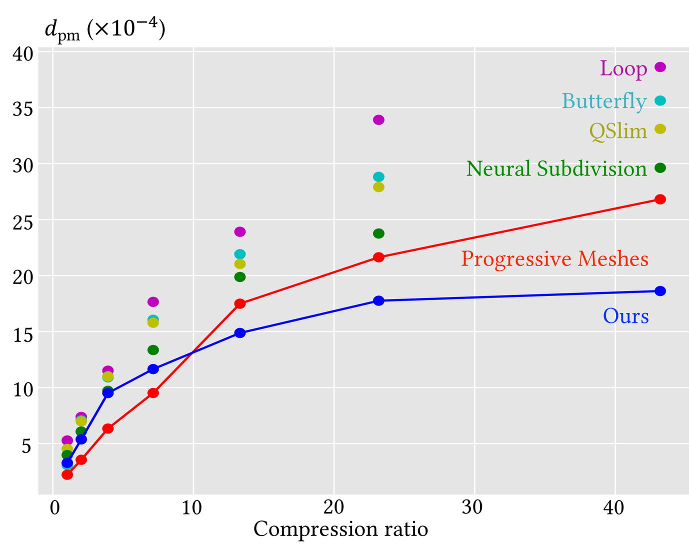
Comparison to neural overfitting methods

CR / d_{pm} $(\times 10^{-4})$ / d_{normal} Ground truth | 1.15 / 2.80 / 10.15° ACORN | 1.15 / 2.91 / 8.79° NGLOD | 1.15 / 2.52 / 4.73° NCS | 39.32 / 2.74 / 8.81° Ours

Progressive features



64.73 / 14.87 / 10.33° Ours w/o features | 17.78 / 11.48 / 6.94° Ours + 40 features | 10.31 / 5.37 / 5.31° Ours + 400 features

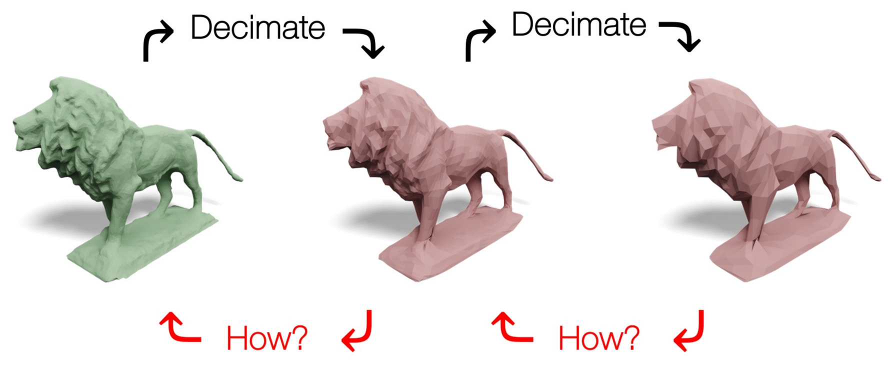


$$CR = \frac{3|V|}{3|V^0| + \sum_{f \in \mathcal{T}} \dim(f)}$$

Decimation and Level-of-Detail Methods

Mesh decimation methods

- E.g., QSlim [Garland et al. 1997]
- Provide a way to compress meshes
- Lose original geometric details
- Do not provide a way to progressively improve the quality of meshes



Level-of-detail methods

- E.g., Progressive Meshes [Hoppe 1996]
- Provide a way to transmit incremental data for mesh quality improvement
- Lose details as polygon count reduces

Encoder and Decoder

Encoder

- Loop maintains a 4-to-1 face mapping

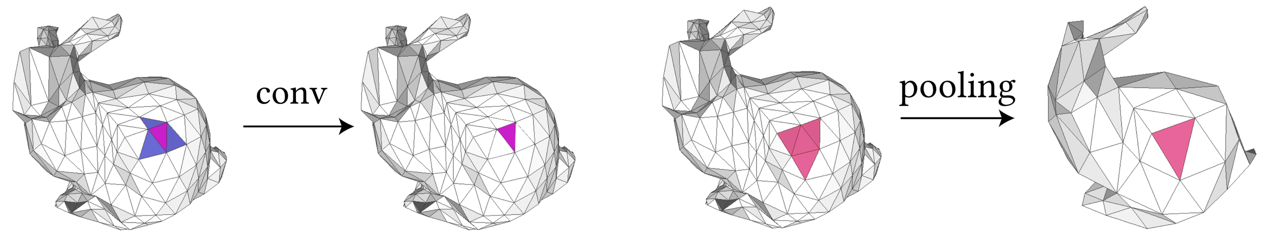
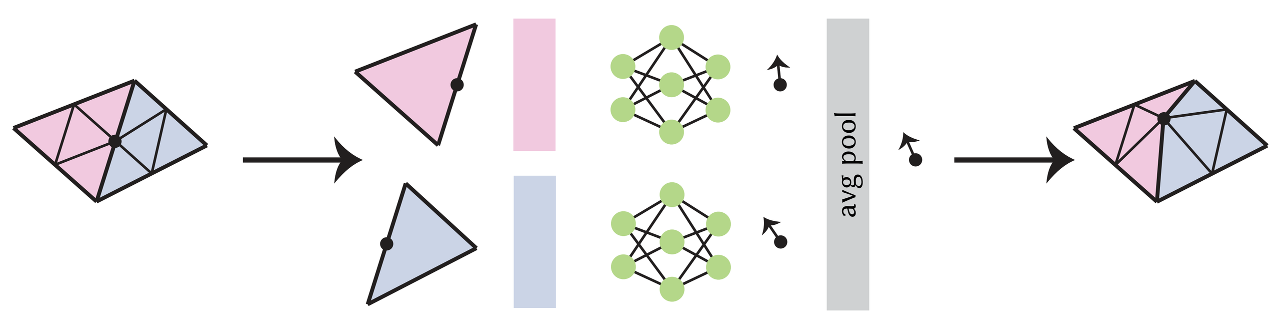


Image courtesy of [Hu et al. 2022]

Decoder

- Adjacent face features for vertex displacement prediction



Data Generation

- Successive self-parameterization in [Liu et al. 2020]
- Maintain a bijective map for each edge collapse
- Stochastic QSlim for data augmentation

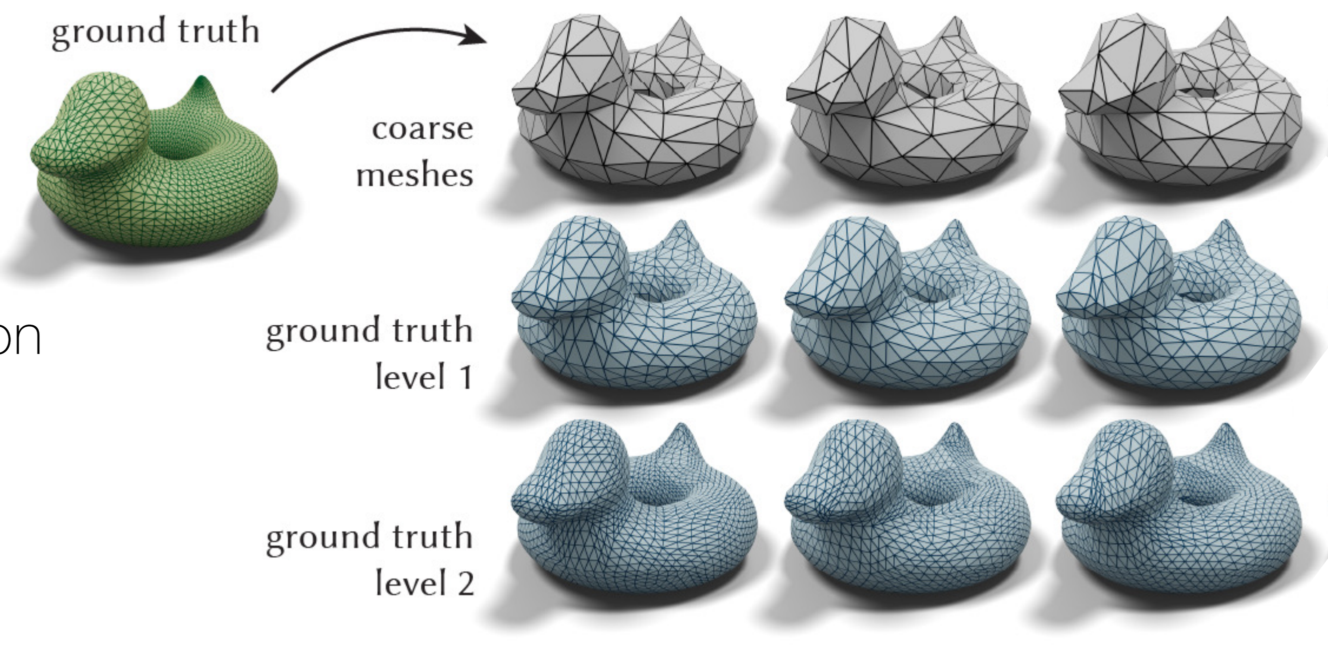


Image courtesy of [Liu et al. 2020]

References

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